FUEL AVAILABILITY STUDY FOR A WOOD WASTE FIRED GENERATION FACILITY SITED WITHIN SOUTHERN CALIFORNIA EDISON FOREST LAND

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Unloading Facility, Burney Forest Power/Shasta Green Sawmill, Burney, CA

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EXECUTIVE SUMMARY

Currently within the State of California there is a favorable political window for renewable power, including wood waste fired generation. Earlier work conducted by Southern California Edison determined the consistency of fuel supply as a notable constraint against facility siting.

This fuel availability study addresses whether there is a sufficient and sustainable fuel supply available from land owned by Southern California Edison (SCE) to support an electric generation facility. It includes assessment of several types of biomass feedstock including forest fuels reduction/restoration residuals, timber harvest residuals, sawmill residuals, and wildland urban interface treatment residuals. While SCE lands have been managed intensively over the past 30 years, implementation of progressive forest management practices on the Shaver Lake and Dinkey Creek Tracts would generate enough biomass fuel to support a woody biomass fired power generation facility capable of producing approximately 7 MW of electrical power. If stewardship contracts can be secured with the Sierra National Forest, then additional long-term woody biomass resources can be secured, and a facility scaled at 10 MW could be sustained long term. Throughout the report, a conservative estimate was made with each of the variables considered. Thus, these estimates on potential facility scaling could be low.

Community support is key in the development of a biomass power generation facility. The communities adjacent to the Shaver Lake and Dinkey Creek tracts are very aware of the need to proactively treat and remove hazardous forest fuels in order to create defensible space to better protect their residences from catastrophic wildfire. The SCE Forestry Department has been coordinating with these communities in support of defensible space, and it is likely that these same communities will support development of a biomass fired generation facility located in the greater Shaver Lake area. Community support is also required to pursue stewardship contracts with the Sierra National Forest.

The additional values of forest restoration benefiting wildlife habitat, watershed health, and wildfire protection increase the total ecosystem services value significantly. Stocking control realized as a result of thinning and small log harvesting concentrates growth on the healthier, faster growing trees, thus facilitating increased carbon uptake (increased carbon sequestration) and helping California meet the goals of State Assembly Bill 32 (AB32).

The numerous benefits outlined in this fuel availability study fully support the project concept as described. Its deployment will result in a unique demonstration project that will be a leader of combining renewable energy production and progressive land management practices benefiting both local and state residents. Currently, there are 27 operating biomass power plants in California and none are fired solely on feedstocks sourced 100% from forest-based operations.

TABLE OF CONTENTS

ACKNOWLEDGMENTS i
EXECUTIVE SUMMARY ii
ABBREVIATIONS/ACRONYMS v
STUDY OBJECTIVES 1
INTRODUCTION 1
FIRE HAZARD REDUCTION 2
FOREST FUELS TREATMENT 3
BIOMASS FUEL TYPES CONSIDERED 5
TARGET STUDY AREA 6
Environmental Features 7
Vegetation Cover Types 7
Practically Available Fuel 7
Acres Practically Available for Treatment 9
FOREST-SOURCED BIOMASS FUEL 11
SCE Forest Lands 11
Forest Fuels Reduction Residuals 12
Timber Harvest Residuals 14
SCE Forest Lands 16
Biomass Fuel from a Small-Log Sawmill 17
Wildland Urban Interface Residuals 18
Biomass Fuel Availability - SCE 20
Biomass Fuel Availability - SNF 21
RESULTS 23
POTENTIAL SITING OPPORTUNITIES 25
OBSERVATIONS 25
Year-Round Operations 25
Community Support 25
Enhanced Watershed Health – SCE and SNF Lands 26
Carbon Sequestration Benefit 26
Improved Air Quality Co-Benefits 26
Ash as Soil Amendment 28
Environmentally Sensitive Practices 28
Costs Associated With Biomass Fuel Delivery 28
Other Siting Opportunities 28
Additional Fuel Availability 29
FINDINGS 29
RECOMMENDATIONS 30
APPENDIX A 33

APPENDIX B 35
APPENDIX C 36
APPENDIX D-1 37
APPENDIX D-2 38
APPENDIX E 39
APPENDIX F 40

LIST OF TABLES

Table 1 - Practically Available Acres for Fuels Treatment/Forest Restoration 9
Table 2 - Forecasted Forest Fuels Treatment/Restoration Residuals 12
Table 3 - Historic Timber Harvest Levels – Fresno County 2002 through 2006 15
Table 4 - Forecasted Timber Harvest Residuals – Fresno County 15
Table 5 - Forecasted Forest Fuels Availability from SCE Forest Lands 16
Table 6 - Advantages of a Small-Log Sawmill Sited at Shaver Lake 17
Table 7 - Forecasted Sawmill Residuals 18
Table 8 - Forecasted Wildland Urban Interface Fuel Treatment Residuals 19
Table 9 - Biomass Fuel Practically Available Years 1 to 5 – SCE Controlled 20
Table 10 - Biomass Fuel Practically Available Years 6 to 20 – SCE Controlled 21
Table 11 - Biomass Fuel Practically Available Years 1 to 5 – SNF 23
Table 12 - Biomass Fuel Practically Available Years 6 to 20 – SNF 23
Table 13 - Forecasted Biomass Fuel Availability 24
Table 14 - Forecasted Six Year Biomass Fuel Availability 29
Table 15 - Forecasted Six Year Biomass Fuel Availability – Assumptions 30

LIST OF FIGURES

Figure 1 - Fire Return Interval Departure Map 3
Figure 2 - Tree Growth Response to Forest Thinning 4
Figure 3 – Shaver Lake Target Study Area 6
Figure 4 - Land Ownership and Vegetation Cover Map 8
Figure 5 - Vicinity and Land Ownership Map 10
Figure 6 - Biomass Fuel Projection By Type and Ownership Years 1 to 20 24
Figure 7 - Carbon Sequestration Opportunity on SCE and SNF Lands 27

ABBREVIATIONS/ACRONYMS

A range of abbreviations and acronyms were utilized in this report.

<u>Organizations</u>

SCE	Southern California Edison
SNF	Sierra National Forest
TSS	TSS Consultants
USFS	USDA Forest Service

<u>Other Terms</u>

BDT	Bone Dry Ton(s)
DBH	Diameter at Breast Height
FRID	Fire Return Interval Departure
FSC	Fire Safe Council
GIS	Geographic Information System
GT	Green Ton(s)
HFRA	Healthy Forest Restoration Act
LMP	Land Management Plan
MW	Megawatt (electric)
MBF	Thousand Board Feet (log scale)
NEPA	National Environmental Policy Act
REC	Renewable Energy Credit or Certificate
RPS	Renewable Portfolio Standard
TSA	Target Study Area
WUI	Wildland Urban Interface

STUDY OBJECTIVES

This fuel availability study assesses potential fuel sources critical to the development of a wood waste fired power generation facility sited within a forest setting. Primary rationale for studying the feasibility of siting a commercial-scale biomass power generation facility in or near a forested ecosystem are:

1. Produce base-load renewable energy (per California's Renewable Portfolio Standard).
2. Promote forest ecosystem health and mitigation of catastrophic wildfire potential by removing overstocked vegetation, and by decreasing the volume of wood waste that is otherwise left behind following timber sales and addressed as waste through controlled management burns.
3. Increase ability of the forest to sequester carbon (supporting global reduction of greenhouse gases) by promoting the increased growth of wood fiber on healthy fast-growing trees.
4. Increase revenue from timber harvest sales which may provide offset funding for operation of a power generation facility.

This study is geared to provide early assessment for siting such a project as specifically relates to fuel supply. It aims to evaluate estimates for currently available fuel supply as re-directed from annual management burns of timber harvest slash (residuals) and from forest fuels treatment activities. It projects and computes prospective increases in potential fuel supply due to co-location of a small log sawmill, predicts possible changes in forest management practices, and identifies what impact stewardship contracts with the USDA Forest Service might have long term.

INTRODUCTION

A primary concern among resource management professionals, the general public and elected officials in California is the potential for catastrophic wildfire. Bark beetle infestations brought on by overstocked and unhealthy forest conditions in Southern California were the primary causative agent behind the large numbers of acres exhibiting significant tree mortality that served to fuel wildfires in recent years (2003, 2007). California is now facing the most catastrophic wildfire season on record. With the 2008 fire season less than 90 days old, approximately 1.1 million acres have been consumed in over 2,000 separate wildfire events.[1] These recent and ongoing wildfire events have helped raise public awareness of how catastrophic wildfires can impact both life and property. These wildfire events also demonstrate the need for proactive and strategic placement of forest fuels treatment activities so as to mitigate wildfire behavior.

Instead of serving as fuel for wildfires, biomass sourced as a byproduct of forest fuels reduction, forest restoration, and timber harvest activities can be utilized as a long-term sustainable biomass fuel to support the generation of renewable electric power. Thus, a primary aim with this fuel availability study is to ascertain if a consistent fuel supply is

[1]As reported by CAL FIRE on July 26, 2008. http://www.fire.ca.gov/

possible from company-owned forests. Such a concept aligns to the Governor's Executive Order S-06-06 (see Appendix A), which calls for increasing use of abundant state biomass resources to create electricity (aiming for 20% of the state's 20% RPS goal) while contributing solutions to mitigate the risk of catastrophic wildfires.

FIRE HAZARD REDUCTION

Existing forest management practices as outlined in the SCE Land Management Plans are structured to address a number of objectives that are well served through the reduction of forest fuels, thus mitigating wildfire hazard. These multiple objectives include:

- Water Retention and Use
- Wildlife Habitat Enhancement and Protection
- Recreation Availability
- Historical Preservation
- Timber Access

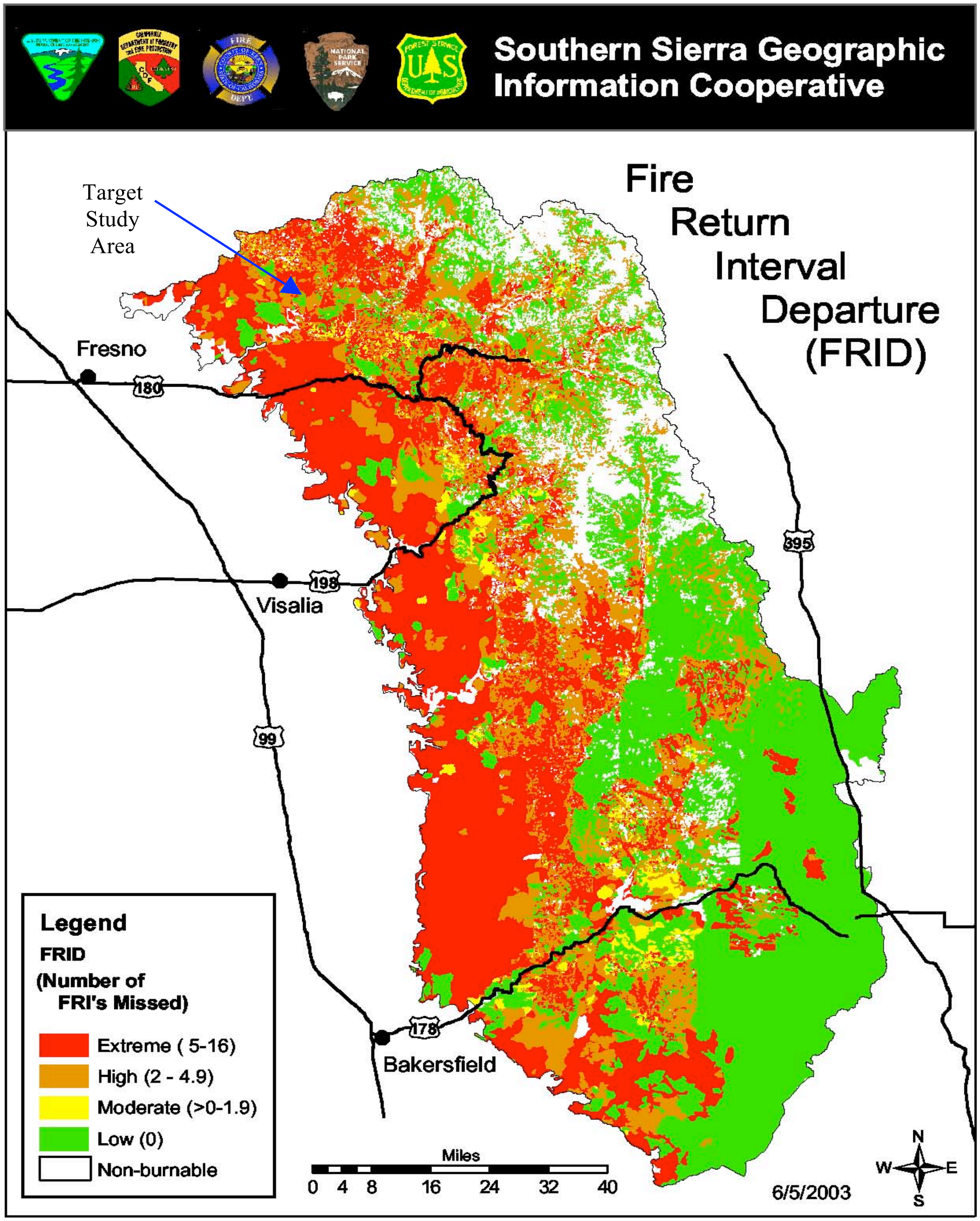
SCE-managed forests are well maintained in alignment with these objectives. In recognition of SCE's commitment to progressive forest management, the SCE Forestry program was awarded the Governor's 2001 Environmental and Economic Leadership Award in the category of Watershed and Ecosystem Management.

Not addressed in the SCE Land Management Plans is management of federal lands adjacent to the Shaver Lake and Dinkey Creek tracts. SCE lands are surrounded by federally-managed lands that include a significant portion of the Sierra National Forest (SNF). If a wildfire were to start on the SNF, it could severely impact the company-owned forest. In order to meet and maintain the land management objectives listed above, it is in SCE's best interests to address, where possible, forest health and wildfire hazards on the forested landscape surrounding company forests – primarily the SNF.

Due to the successful suppression of wildfire over the past century, forest fuels have accumulated to create unnaturally high concentrations of fuels. Foresters and fire scientists use a variety of tools to rank forest regions based on severity of wildfire risk. One index or metric that is utilized to rate hazard levels is the Fire Return Interval Departure (FRID) index. FRID is based on the "natural" fire return interval for the vegetation type of interest (the historical interval between fires, in years), and the years that have elapsed since the last fire. From maps of where and when fires have occurred in the past, average fire return intervals for each vegetation type class can be determined, and along with the time that has elapsed since the last fire, a derived index can be calculated to quantify the departure of an area from its average fire return interval.

The map in Figure 1 summarizes the results of a FRID analysis conducted in 2003 for the southern Sierra Nevada region. Note that the higher the number of fire return intervals that have been missed, the more extreme the fire hazard. As shown, based on the results of the 2003 FRID analysis, most of the forested landscape surrounding the Shaver Lake area is considered at extreme risk for a wildfire event.

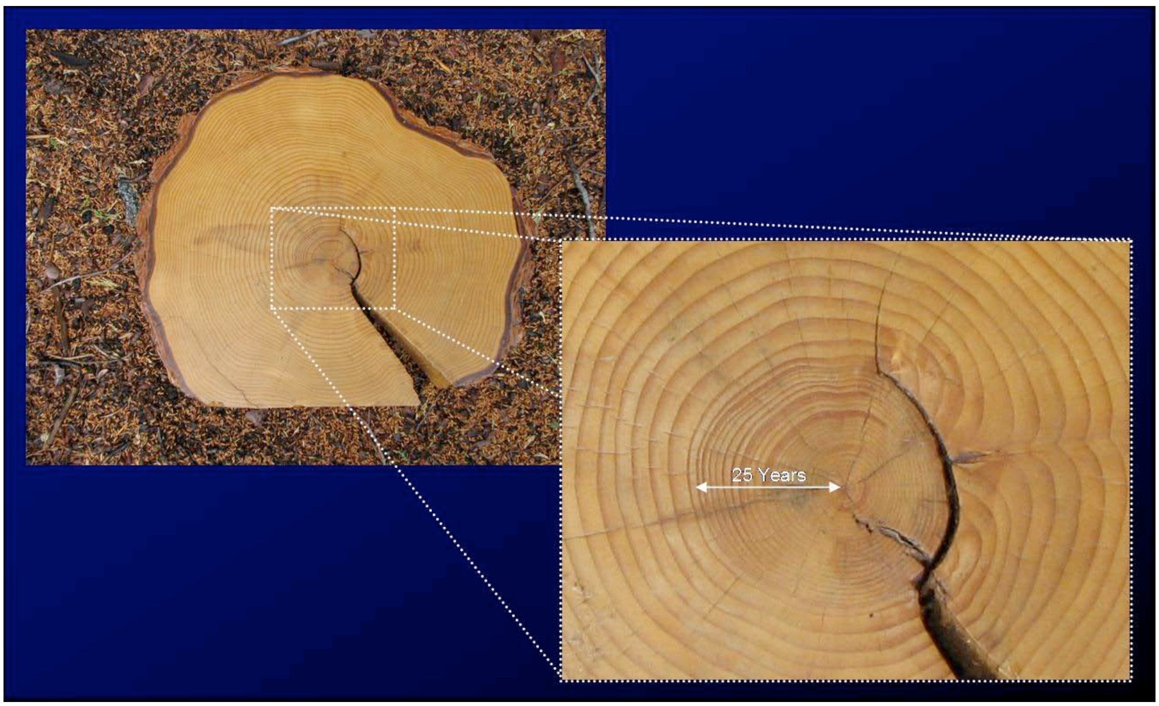
Figure 1 - Fire Return Interval Departure Map



FOREST FUELS TREATMENT

Healthy and productive forest stands have significantly improved growth capacity when compared to stands that are left in an unmanaged condition. Figure 2 displays a cross section of a 60-year old tree. For the first 25 years of its life, this tree grew in an overcrowded stand, competing for sunlight, water, and soil nutrient resources. The annual growth rings for those years are closely spaced, representing very suppressed growth. This approximates conditions on much of the SNF land surrounding SCE forest lands. At approximately age 25, the surrounding stand was thinned, which reduced competition for the above-mentioned resources. As a result, the annual growth (ring width) for the following 35 years was dramatically increased. This phenomenon is not unique to tree species or elevation or weather conditions. It occurs to varying degrees in all stands that receive thinning treatments, and results after thinning such as these can be deemed representative. This increased tree growth associated with thinning accelerates CO_2 uptake, thus carbon sequestration is also significantly enhanced.

Figure 2 - Tree Growth Response to Forest Thinning



The Healthy Forest Restoration Act of 2003 (HFRA), authorizes federal land managers to utilize stewardship contracting as a tool to assist in meeting objectives as defined in each national forest's land management plan. Stewardship contracts allow enterprises to enter into service contracts/timber sales with national forests for landscape level[2] treatments for up to 10 years in duration. A byproduct of these activities afforded by stewardship contracts is woody biomass material made available to enterprises that perform forest restoration services. This woody biomass material could be utilized as a sustainable long-term fuel source for a renewable power generation facility. Thus, included in this fuel availability study is opportunity to utilize stewardship contract agreements to restore forest health and reduce hazardous fuels adjacent to SCE forest lands.

[2]Region-wide application across hundreds of acres.

The land management objectives (as stated earlier) for SCE forest lands are best met by maintaining a vegetative community consistent with forest conditions that were present prior to European settlement (aka pre-settlement conditions). Rejuvenation of vegetative components is also key to the success of the attendant wildlife populations. The SCE forestry program is actually a forest restoration plan that grows a young forest into one that functions as a natural Sierran ecosystem, which is simply described as an "open grown, pine dominated forest" consistent with pre-settlement conditions. This restoration will improve water quality and wildlife habitat, increase water yield, forest growth and carbon sequestration, and restore the natural role of fire to the ecosystem. Thinning of forested ecosystems to more natural stocking levels and removing the excess woody biomass generated can greatly accelerate natural restoration processes, providing more ecosystem benefits sooner. Thus, removing that unnaturally high accumulation of biomass material to a locally-sited electric generation facility could provide a tangible benefit to the forested landscape.

BIOMASS FUEL TYPES CONSIDERED

For the purposes of this study, biomass is defined as any solid, nonhazardous, cellulosic material derived from forest-related resources, solid wood wastes, agricultural wastes, and plants grown exclusively as a fuel.[3]

Currently, 27 power generation facilities operate in California utilizing a blend of biomass fuel types. Almost all of these plants were constructed after 1980 in response to increased demand for baseload renewable power. Because the biopower market sector is considered to be in its infancy, very little peer-reviewed research exists; however, it is clear that none of the California projects are fired 100% on forest-sourced residuals as proposed by this project.

Biomass fuel that is harvested, collected, processed, and transported to these facilities is typically sourced from locations considered tributary to each of these facilities. The relatively high cost associated with transport of biomass fuel precludes hauling this fuel resource long distances. Thus, a biomass power generation facility located at Shaver Lake will likely utilize biomass fuel sourced from activities located within a 30 mile radius of the power plant (see Target Study Area in Figure 3).

Biomass fuel types considered in this study include:

- Timber harvest residuals
- Sawmill residuals
- Forest fuels treatment/forest restoration residuals
- Wildland Urban Interface (WUI) fuels treatment residuals

For this study, it is assumed the primary use of woody biomass material is as fuel for a renewable power generation facility. There are other possible uses for tree stems and

[3]This definition is consistent with the Federal Energy Policy Act of 2005.

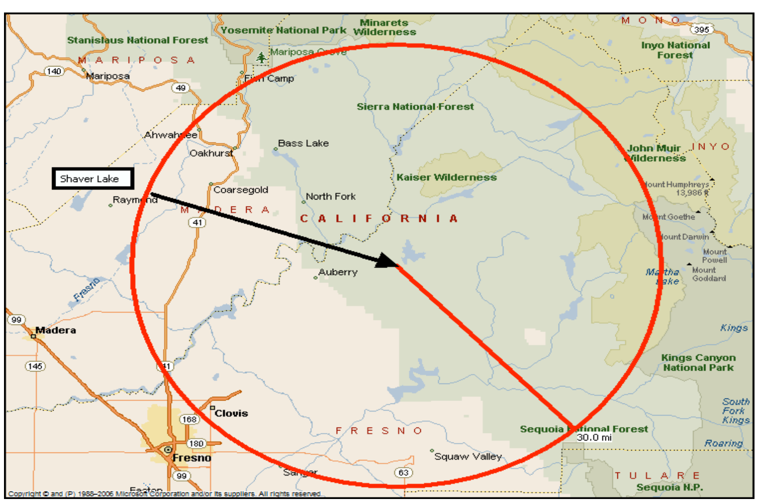
wood fiber sourced from forests near Shaver Lake. Historically, trees have been converted to sawlogs and utilized as raw material in a sawmill to produce lumber. Saw timber has traditionally been sold to the highest bidder in an auction-like process known as a timber harvest sale. Typically, the larger the sawlog, the better the lumber grade (knot free, straight grain). As a result, larger diameter logs (18 inches plus) tend to fetch a higher value and by default, smaller trees, considered to be lower value, are not bid upon and are not harvested. Other uses for the byproducts (small stems, limbs, tops, diseased stems) of timber harvesting and forest fuel treatment/restoration include landscape cover, soil amendment, and (at some distant future date) feedstock for a cellulosic ethanol plant.

Each forest stand treatment and recovery option comes with an associated cost. A comparative analysis that shows the respective cost between company-owned and USDA Forest Service (USFS) lands could be illustrative but is outside the scope of this study. Such will be addressed in a subsequent Fuel Procurement Plan. That plan will also address potential costs of harvest, collection, processing and transport of biomass material as identified in this report, including timber harvest residuals, forest fuels reduction residuals, sawmill residuals, local WUI material, biomass fuel from stewardship contracts, and other nearby wood resources, as appropriate. The Fuel Procurement Plan will also confirm, through detailed analysis, the economical haul distances from which biomass fuel can be effectively sourced. In the course of conducting this fuel availability analysis, the authors were not able to reveal the intended location, facility scale, project developer or business model being considered.

TARGET STUDY AREA

Target Study Area (TSA) is a term used to identify the bounds of the fuel availability study. As a starting assumption, center-point of the TSA was identified as the community of Shaver Lake. For this study, a 30-mile radius of Shaver Lake addresses critical forest lands located close to SCE forest lands (see Figure 3). This radius also represents the geographic region most likely to provide economical woody biomass fuel to a proposed facility.

Figure 3 – Shaver Lake Target Study Area



Environmental Features

To characterize the potential and practical availability of woody biomass sourced from within the Shaver Lake TSA, it is helpful to understand the environmental features that may limit the recovery of woody biomass material from the landscape. For instance, topography that is too steep or landscape that supports sensitive habitat should be excluded from those lands that are considered as part of the practically available land base and part of the long-term sustainable biomass fuel recovery plans.

A set of guidelines was utilized by the authors to define where fuels treatment activities may or may not be feasible or appropriate. These guidelines (detailed in Appendix B) were developed consistent with the SCE Land Management Plan, utilizing knowledge of current fuels treatment equipment technology and of existing road systems that would accommodate biomass transport. These guidelines helped to identify slope-constrained topography (>50% slope) and riparian areas on the Shaver Lake and Dinkey Creek tracts (detailed in Appendix D maps). Descriptions on company-owned forests are understandably more comprehensive. Assumptions using similar guidelines on national forest lands are noted where applicable. As a rough estimate, steep topography, sensitive habitat, and riparian areas excludes approximately 153,000 acres from the practically available land base designation for SNF lands (see Appendix E).

Vegetation Cover Types

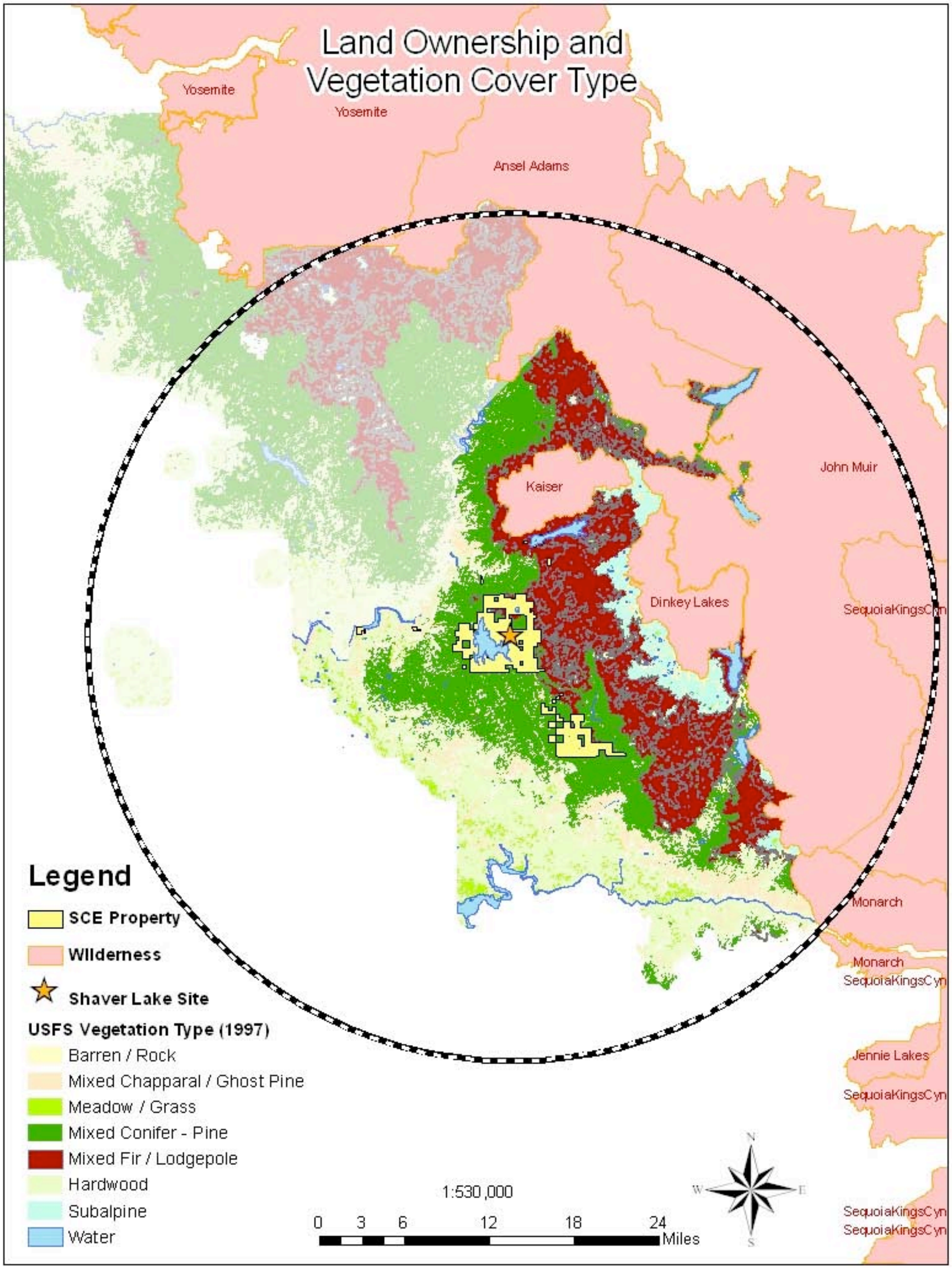
A clear understanding of vegetation cover types within the TSA was another important feature considered as part of this analysis. Understanding the types and location of vegetation cover helps to identify what portions of SNF land near the SCE forest lands might be most appropriate to treat utilizing hazardous fuels reduction and forest restoration activities. Vegetation cover data sets were made available by USFS staff as part of a carbon footprint study currently underway on the SNF (as different vegetation types will sequester different amounts of carbon). SNF vegetation cover data differentiates how much of which vegetative cover type is contained within the forest. It shows acres of different categories of vegetation, including mixed conifer pine, fir/lodgepole (which are potential feedstocks), mixed chaparral, hardwood, sub-alpine conifer (which are not appropriate to include as feedstock), as well as meadow/grass, barren/rock, and water. For complete data set in tabular form, see Appendix E. Data provided by the USFS and from SCE data sources was compiled and synthesized into a map (Figure 4).

Practically Available Fuel

A stated aim in conducting this fuel availability study is to determine if there is sufficient and sustainable fuel supply available from within the forested landscape adjacent to the target site, Shaver Lake. Thus, a starting premise for this study is that woody biomass fuel potentially available for a commercial-scale biomass power project located at Shaver Lake will be sourced directly from forest-based operations.

Figure 4 shows that forested landscape makes up slightly more than one-half of the TSA, thus reducing the 30-mile radius TSA to a half-circle.

Figure 4 - Land Ownership and Vegetation Cover Map



Also, due to topography, it was assumed (the Fuel Procurement Plan will provide additional analysis) that biomass recovery on the north and west side of the San Joaquin River drainage would be more easily recovered from a potential facility sited in that region and therefore is not considered practically available for a project at Shaver Lake. Thus, that region is excluded from the TSA (reduced by a third) and is not currently considered as part of the practically available land base.

To assess biomass fuel supply availability, a clear understanding of land ownership and jurisdiction is important. Identification of land ownership within the TSA was made possible by compilation of data sourced from the USFS and Fresno County. Data collected facilitated development of a vicinity and landownership map showing the location of wilderness areas, Sierra National Forest, company-owned forest, and roads as highlighted in Figure 5. Wilderness area designation accounts for a small portion within the 30-mile TSA. Currently, the land management plan for the Sierra National Forest does not accommodate active forest management within a wilderness area, so these lands were also removed from the practically available land base.

Acres Practically Available for Treatment

Overlay of environmental features and vegetation cover data sets provides interesting results. Table 1 summarizes results of Geographic Information System (GIS) analysis regarding acres of SCE forested land and USFS managed lands that are considered practically available for fuels treatment or forest restoration activities. Summary results are key, as they demonstrate there is significant acreage that is in need of treatment and is considered practically available for treatment on both SCE and USFS managed lands within the TSA (totaling over 182,000 acres).

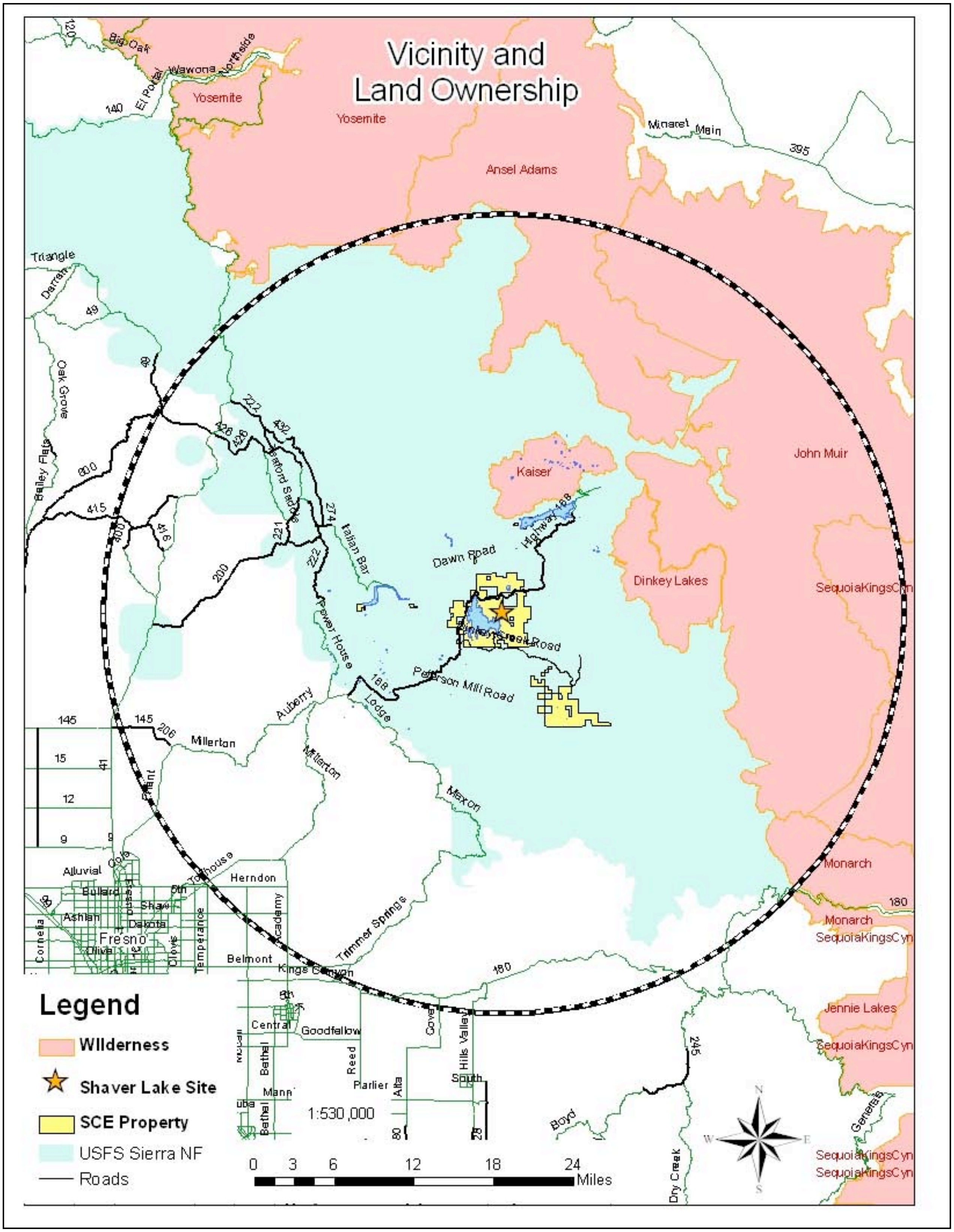
Biomass feedstock generated as a byproduct of fuels treatment and forest restoration activities could provide a long-term sustainable and stable source of biomass fuel for a biomass power facility sited at Shaver Lake. Such results imply that renewable biomass fuel recovery could be sustained over time (to be further addressed in a subsequent Fuel Procurement Plan). Table 1 summarizes the practically available acreage figures by ownership.

Table 1 - Practically Available Acres[4] for Fuels Treatment/Forest Restoration

Forest Ownership	Available Acres in Mixed Conifer and Lodgepole Pine/ Red Fir Forest Types
Private - SCE	12,017
Public – SNF	170,999
Total	**182,390**

[4]Excludes unavailable and inaccessible acreage within a 30-Mile Radius of Shaver Lake, including sensitive areas such as riparian areas and lands designated as wilderness.

Figure 5 - Vicinity and Land Ownership Map



A starting assumption for this fuel availability study was that biomass harvest treatments from 1,000 acres would support 1 MW of biomass power generation. Thus, with 15,000 acres of company-owned forest, there is potential to site a 15 MW facility. As shown in this study, the actual sustainable volume of biomass material, and thus potential facility size, is determined by type and density of vegetative cover growing on adjacent acres, topography, sensitive environmental features, land ownership, and management objectives. These are all factors which define the amount of acres that constitute the practically available land base. The SCE forest lands and the surrounding national forest are different on all counts so potential yield would vary. Study results as posted here provide an estimate of how these factors impact acres that are practically available for recovery of biomass material. As it is recognized that these are estimates, assumptions regarding variables are provided in case there is cause at some future date to assign certain variables with less weight than represented in this assessment.

FOREST-SOURCED BIOMASS FUEL

SCE Forest Lands

Potential yield from SCE forest lands is determined by implementation of established forest management practices, such as forest fuel treatment/restoration activities and timber harvest operations. The selection of specific trees to be harvested and the application of site specific harvesting methods expand and maximize vegetative diversity, wildlife habitat, wildfire prevention, water yield, and overall forest vigor. For more information, see SCE's Shaver Lake and Dinkey Creek Land Management Plan[5] (LMP).

It is clearly evident that SCE lands have been well managed. Past treatments have enhanced growth of new vegetation and promoted growth on existing residual trees. Natural reproduction is significantly increased due to reintroduction of fire following forest thinning activities. Active planting of tree seedlings has continued since first implemented in 1987 and those plantations are now ready and available for thinning treatments. Good forest management includes active thinning and restoration of overcrowded stands (see Figure 2), which improves the health of the individual tree, sequesters additional carbon, and helps prevent catastrophic wildfires.

Active wildlife monitoring programs at Shaver Lake indicate that thinning activities have had a positive impact on native wildlife populations and sensitive habitat. Bio-diversity has been enhanced by having a variety of tree sizes and age classes on site. Additionally, wildlife habitat is more fire resilient if forest stands are thinned to pre-settlement conditions stocking levels.

As mentioned earlier in this report, thinned forests will support improved water yields. This is accomplished by removing excess trees, thus reducing the number of trees per acre that are taking up water through evapo-transpiration. Fewer stems per acre allow additional water flows which support SCE's hydropower assets and fisheries habitat downstream. Timing of water flow is also enhanced due to the shading of snowpack

[5]SCE Land Management Plan is available from the SCE Forestry Department.

afforded by a thinned forest stand. Lastly, protecting watershed resources from catastrophic wildfire by thinning the forest landscape will minimize ladder fuels, thus mitigating catastrophic wildfire behavior. A healthy, productive watershed that is thinned properly will be protected from the potential impacts of wildfire, including excessive erosion events (turbidity/sediment flow into waterways) following wildfire.

Due to proactive and ongoing forest management on SCE lands, there likely will be less biomass material available per acre than other forests considered for treatments such as the SNF. Nonetheless, fuel treatments on company-owned forests can occur at a level that would provide a consistent feedstock to support a biomass power generation facility (consistent with the LMP). This could likely increase the biomass volume or frequency of harvest from selected stands on SNF, SCE and other private lands consistent with the intent of improved forest health.

Forest Fuels Reduction Residuals

Forest fuels treatment and forest restoration material sourced from within the TSA will likely access biomass material from a variety of forest ownerships including SCE, other private lands, and SNF lands. A century of successful forest fire suppression activities have impacted the fire return interval (see Figure 1) and thus unnatural accumulations of forest fuels have built up over time. Forest fuels treatment supports forest restoration due to the fact that during treatment activities, unnatural accumulations of forest fuels are removed, thus restoring the forest ecosystem to a more natural state.

Table 2 summarizes the findings with regard to fuels treatment and restoration on forest landscapes located within the TSA in years 1 to 5.

Table 2 - Forecasted Forest Fuels Treatment/Restoration Residuals

Forest Fuels Treatment/Restoration Residuals					
Forest Ownership	**Treated Acre/Yr**	**Potentially Available GT/Year[6]**	**Potentially Available BDT/Year[7]**	**Practically Available BDT/Year**	**Comments**
Private (SCE)	2,200	77,000	42,350	42,350	Years 1-5, then taper-off as SCE lands are treated.
Private (other)	200	7,000	3,850	3,850	Years 1-5, then ramp-up starting year 6+ to 9,600+ BDT/Year.[8]
Public (SNF)	1,500	37,500	20,625	13,400[9]	Years 1-5, then ramp-up starting year 6+ to 44,000+ BDT/Year.[10]
Totals		**96,500**	**66,825**	**59,600**	

The primary assumption here is that landowners (private and public) will take advantage of a ready market for otherwise wasted biomass material, if a biomass fuel market were

[6]Recovery of 35 GT/acre (SCE forest lands and other private lands) and 25 GT/acre (SNF lands).
[7]Average of 45% moisture content.
[8]Fuels treatment activities on private lands step up to 500 acres of treatments per year commencing in year 6.
[9]Conservative 65% of potentially available fuel is practically available (see text for basis).
[10]See Table 12, Biomass Fuel Practically Available Years 6 to 20 – SNF.

established with the development of a power generation facility at Shaver Lake. Past experience in other regions of California has shown that creation of a biomass fuel market will provide an economic incentive for land managers to increase the treatment of overstocked and unhealthy forest stands located tributary to the facility. In addition to improved forest health and fire resiliency, treated forest stands support a wide variety of native wildlife and are visually attractive to recreating public, which could serve to raise the value of the land. Figures arrived at as part of this study may represent a conservative estimate of future availability of biomass provided by landowners other than SCE.

This estimate of available fuel supply is based on available biomass on a green ton (GT) basis will be delivered to a power plant at Shaver Lake with 45% moisture content, (which is usual for this forest), thus a 55% conversion factor from green tons (GT) to bone dry tons (BDT) is utilized in this study. Based on their knowledge and hands-on experience, SCE foresters expect average biomass recovery of 35 GT/acre on company-owned lands.

Recovery of biomass from SNF lands is expected to average 25 GT/acre. As the SNF staff is directed to manage for multiple objectives (see directives listed below), more woody biomass is retained on site. Due to concerns regarding confidentiality in this conceptual review stage, the authors were not able to ask detailed questions of SNF staff, and the 25 GT/acre recovery figure may be a low estimate. A number of land management directives define the standards and guidelines that SNF staff must address as forest fuels treatment and restoration activities are planned:

- Sierra National Forest – Forest and Land Management Plan – 1991
- Sierra Nevada Forest Management Plan Amendment – 2001
- Healthy Forest Restoration Act of 2003
- Sierra Nevada Forest Management Plan Record of Decision – 2004

This difference in anticipated yield is weighted toward SCE lands, even though the SCE forested lands are well-managed to a high level (see Introduction section of this report). This is due to the intention of increased recovery for the earlier years (years 1 to 5) from company-owned forests, while increasing recovery (increasing acres treated) from SNF lands in later years (years 6 to 20). SCE forestry staff confirmed that stepping-up fuels treatment on SCE lands to a level averaging 2,200 acres per year of treatment was clearly attainable in the short-term. Existing infrastructure, including available fuels treatment contractors and trucks, are readily available to achieve this level of annual treatment. This rate of treatment is sustainable on SCE lands for years 1 to 5. It represents an increase from the current level of 500 to 800 acres of treatment per year. An additional benefit of this strategy is it provides for allowing SNF staff to witness the proven workability of SCE fuels treatment and biomass recovery efforts. Such demonstration projects could support their determination of whether to expand use of SCE services to assist in the management of the national forest, where Stewardship Guidelines[11] allow for issuing contracts based on "Best Value," not solely on "Least Cost." Thus, this recovery rate (25 GT/acre on SNF lands) could likely be increased over time.

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[11]Forest Service Handbook, version 12/12/2005 Chapter 60 – Stewardship Contracting.

As noted in multiple directives, federal statutes and regulations provide for and limit fuels treatment and timber harvesting to accommodate multiple management objectives such as recreation, sensitive plant species, and sensitive wildlife habitat. Due to regulatory constraints on federally-managed lands, the authors estimate that 65% (recovery factor) of the potentially available biomass material on the SNF from fuels treatment activities is practically available. This conservative recovery factor will serve as a placeholder until more detailed interviews can be conducted with SNF staff. It is also assumed an increasing amount of available forest treatment residuals from SNF lands will be available over time as additional stewardship contracts are implemented.

USFS executive leadership has been favorably impressed with the results of landscape-level stewardship contracts and has ramped up the use of these contracts as a result of enabling legislation, the Healthy Forests Restoration Act of 2003. The Chief of the USFS issued direction in April, 2005 (see Appendix C) confirming support from the Washington office for implementation of stewardship contracts. Nearby forests (Stanislaus and El Dorado) have awarded stewardship agreements for landscape-scale projects amounting to about 16,000 acres[12] of USFS lands. Based on existing working relationships between SCE and SNF and the trend towards landscape-level projects, the authors feel data supports the assertion that stewardship contracts to treat SNF lands can be secured in the near term. Additionally, the USFS staff have been directed[13] to report annual accomplishments regarding the volumes of woody biomass material that is diverted for use as fuel for renewable energy generation.

Timber Harvest Residuals

Timber harvest residuals can provide a significant volume of woody biomass material (see Biomass Fuel Types Considered). Available as limbs, tops, and un-merchantable logs, these residuals are generated as byproducts of timber harvesting activities and as such can be a relatively economical raw material. Once collected and processed using portable grinders, this material is an excellent biomass fuel source.

Woody biomass fuel assessments traditionally rely on information regarding historic timber harvest levels as a basis to determine the volume of timber harvest residuals that may be available over time. Such information can provide insight to determine trends and historical benchmarks based on actual timber harvest activities. Table 3 provides an historic perspective on forest harvest activities from 2002 through 2006 within Fresno County. Annual timber harvests[14] during this five-year period ranged from a high of 12,745 thousand board feet[15] (MBF[16]) in 2002 to a low of 8,212 MBF in 2004.

It is worth noting that the average annual timber harvest as represented by the 2002 through 2006 study period is 10,657 MBF and that 70% of this harvest occurred on

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[12]Figures provided by Don Golnick, Timber Group Leader, Region 5, USFS.
[13]Per discussions with Steve Brink, Vice President, California Forestry Association.
[14]This data is presented courtesy of the California State Board of Equalization (BOE).
[15]One board foot is a solid wood board measured 12 inches square by 1 inch thick.
[16]MBF represents 1,000 board foot measure.

private lands. For all practical purposes, the timber harvests on private lands in Fresno County are concentrated on SCE forest lands.

Table 3 - Historic Timber Harvest Levels – Fresno County 2002 through 2006

Calendar Year	Harvest in Target Study Area (By Year) Public and Private Lands (MBF)			Harvest Ownership Percent of Total Timber Harvest	
Year	**Private**	**Public**	**Total**	**Private**	**Public**
2002	9,941	2,804	12,745	78%	22%
2003	7,844	2,614	10,458	75%	25%
2004	5,913	2,299	8,212	72%	28%
2005	9,105	2,420	11,525	79%	21%
2006	4,966	5,379	10,345	48%	52%
Totals	**37,769**	**15,516**	**53,285**		
Average	7,554	3,103	10,657	70%	30%

Based upon the authors' working experience with logging and chipping operations in the central Sierra Nevada region, the recovery factor for biomass fuel processed from timber harvest residuals is roughly 0.9 BDT of woody biomass (tops and limbs) that could be generated from each MBF of timber harvested. If a small log mill were to be installed at Shaver Lake, more of the sawlog stem would be utilized in the production of lumber (and less volume available for recovery as biomass fuel). Thus, the recovery factor used for this analysis was conservatively estimated at 0.7 BDT/MBF. Table 4 summarizes potential biomass available from timber harvest residuals using the 0.7 BDT/MBF biomass fuel recovery factor. The recovery factor will likely be adjusted as projects are implemented on the ground and recovery efficiencies of a small-log sawmill are confirmed, or if operations are focused solely on producing biomass fuel.

Table 4 - Forecasted Timber Harvest Residuals – Fresno County[17]

Annual Timber Harvest[18] (MBF/year)	Timber Harvest Residuals		Harvest Ownership Percent of Total Timber Harvest	
	Potentially Available (BDT/year)	**Practically Available (BDT/year)**	**Percent Private**	**Percent Public**
10,657	**7,460**	**4,850**	**70%**	**30%**

Not all timber harvest operations lend themselves to ready recovery of harvest residuals. Steep slopes, remote locations, and road systems that will not accommodate chip trucks (for transport of biomass fuel) will limit the volume of biomass fuel recovered from timber harvest activities. The region considered for fuels treatment and restoration activities (TSA) has existing road systems that allow ready access; however, some of the curve radii may have to be adjusted to support chip truck traffic to facilitate movement of

[17]0.7 BDT/MBF recovery factor. Currently 65% of sawlog harvest area roads will accommodate processing equipment and chip trucks/trailers (see text for basis).
[18]Based on average historic timber harvest (2002-2006).

biomass fuel. For this reason, biomass fuel recovery numbers in Table 4 were calculated on the basis that approximately 65% of harvest operations are conducted on landscapes that will accommodate recovery of biomass fuel. As road systems are improved to accommodate truck/trailer traffic, this factor will likely increase and could reach 90%.

Using the five year (2002-2006) average harvest level as a benchmark, approximately 4,850 BDT per year of biomass fuel is potentially available from timber harvest activities within Fresno County. With improved road systems, that number could feasibly be 6,700 BDT per year of biomass fuel. The smaller number is used in this assessment, since the larger is only prospective. Work conducted as part of the Fuel Procurement Plan will likely provide more detailed information and estimates.

Further assessment of these data, with appropriate assumptions, has allowed the authors to forecast the volume of fuel available from different fuel sources and ownerships.

Table 5 - Forecasted Forest Fuels Availability from SCE Forest Lands
Table 7 - Forecasted Sawmill Residuals
Table 8 - Forecasted Wildland Urban Interface Fuel Treatment Residuals
Table 9 - Biomass Fuel Practically Available Years 1 to 5 – SCE Controlled
Table 10 - Biomass Fuel Practically Available Years 6 to 20 – SCE Controlled
Table 11 - Biomass Fuel Practically Available Years 1 to 5 – SNF
Table 12 - Biomass Fuel Practically Available Years 6 to 20 – SNF

SCE Forest Lands

Utilizing the findings from Table 2 and Table 4, the authors determined the volume of biomass fuel that could be recovered annually from SCE forest lands over time.

Table 5 - Forecasted Forest Fuels Availability from SCE Forest Lands

Fuel Type	Practically Available BDT/Year	Comments
Forest Fuels Reduction Residuals	42,350	Years 1-5, then taper off as landscape level treatments are completed.
Timber Harvest Residuals	3,400	Based on 2002 through 2006 historic timber harvests.
Total	**45,750**	

Table 4 shows 4,850 BDT per year practically available from Fresno County. As historic data demonstrates, approximately 70% of timber harvest is on private lands and substantially all is on SCE lands (see Timber Harvest Residuals), with 3,400 BDT (70% of 4,850 BDT) per year practically available from SCE lands over time. Adding the volume practically available from forest fuels treatment/restoration activities (see Table 2) brings the total forecasted biomass fuel practically available from current forestry practices on SCE forest lands to 45,750 BDT for years 1 to 5 (Table 5).

Biomass Fuel from a Small-Log Sawmill

A small-log sawmill designed to handle logs less than 18" in diameter at breast height (DBH) will provide a significant volume of residual fuel to a power generation facility and provide multiple benefits to the current land management program. The increased feasibility (economic efficiency) of harvesting small trees will improve the health and vigor of the remaining forest stand (see Figure 2), increase the effectiveness of SCE's prescribe burn program, as well as provide beneficial habitat to wildlife species.

Advantages of a small-log sawmill sited at Shaver Lake are numerous and are outlined in Table 6.

Table 6 - Advantages of a Small-Log Sawmill Sited at Shaver Lake

Enhanced wildlife interaction and use (treatment of over-crowded stands).
Enhanced recreational opportunities (visual aesthetics more appealing).
Improved growth on remaining trees (increased growth and yield).
Sustained forest health improvement (not a one-time quick-fix).
Sustained watershed health protection/improvement/restoration. - enhanced water yield and availability - improved timing of delivery - sustained water quality - reduced potential for erosion/sedimentation
Enhanced wildfire protection (removal of unnatural accumulations of hazardous fuels). - residential homes - local communities - private forests - national forests
Reduced truck traffic on public roads.
Reduced truck emissions (shorter distance from woods to mill).
Eliminated truck emissions (removal of travel leg from mill to market).
Enhanced economic stability of local communities (more local family wage jobs).
Consistent provider of sawtimber to the local markets.
Increased stumpage price for timber harvest sales.
Better-supplied timber (appropriately sized) to meet market demand.
Provide consistent fuel feedstock (meeting state RPS requirements) to cogeneration facility.
Improved use of residuals utilized in renewable energy facility.
Opportunity to utilize waste heat (lumber drying) generated from renewable energy facility.

A byproduct of the sawlog-to-lumber conversion process is residuals in the form of bark, sawdust, shavings and chips. Overall sawmill residuals available as biomass fuel are estimated to be even more than from timber harvest residuals. From previous fuel availability assessments, the authors find as a general rule (proprietary sawmill studies) approximately 1 BDT/MBF of sawlogs converted is recoverable as residuals from a small-log sawmill. A small-log sawmill could be scaled to most any size to support a biopower generation facility. Any sawlogs not used to meet the local timber market could potentially be utilized as biomass fuel. A likely production level for a small-log sawmill at Shaver Lake would be 5,000 MBF per year, given historical timber harvests. Scaled to this level, 5,000 BDT per year of biomass fuel is forecasted to be practically available. This represents roughly 10% of biomass fuel from forest recovery on SCE lands. If the sawlogs were utilized as biomass fuel (not merely residuals), it would represent a higher percent. Table 7 summarizes these findings.

Table 7 - Forecasted Sawmill Residuals

Sawmill Log Usage MBF/Year[19]	Sawmill Residuals Potentially Available BDT/Year	Sawmill Residuals Practically Available BDT/Year
5,000	5,000	5,000

Transportation costs for small trees, less than 18" DBH has always reduced the average stumpage price for timber sales on SCE lands. Additionally, as noted earlier, small sawlogs are less valued in the marketplace. If small sawlogs are sorted and utilized in a small log sawmill at Shaver Lake, then bid prices for the SCE timber sales will increase due to an increase in the average size of sawlogs hauled to distant sawmills. The sawlogs sized at <18" DBH under this scenario will be utilized at a small-log sawmill co-located with a generation facility in or near Shaver Lake. Addition of a small-log sawmill reduces transportation costs with the added benefit of a significant reduction in air emissions associated with truck transport of sawlogs (addressed in subsequent Regulatory Rule Analysis portion of the feasibility study/see Recommendations).

A small-log sawmill has an operational footprint of <5 acres. Further analysis regarding development of a small-log sawmill will be conducted during the Engineering phase of this feasibility study (see Recommendations).

Wildland Urban Interface Residuals

Most private land holdings in eastern Fresno County (excluding SCE land) are relatively small residential parcels. While not productive commercial timber land, these parcels are capable of producing a significant volume of woody biomass in the form of tree trimmings, small tree removals, brush, and other biomass material removed as a result of hazardous fuels reduction activities. As noted earlier, wildfire risk in the Shaver Lake area is significant (see Fire Hazard Reduction).

In direct response to the wildfire threat in California, numerous (over 100 statewide) volunteer-based organizations known as Fire Safe Councils (FSC) have been formed to coordinate removal of high hazard fuels around homes and along roadways. Membership in the FSC typically includes representatives from state and federal firefighting agencies, concerned citizens, and land managers. The Highway 168 FSC coordinates fuels treatment activities on private parcels and roadways local to the Shaver Lake area.

[19] 1 BDT of residuals (bark, sawdust, shavings, chips) per MBF of sawlog volume processed.

California residents are mandated per Public Resource Code (PRC) 4291 to treat hazardous fuels within 100 feet of residences or outbuildings. Annual clearance activities associated with PRC compliance generate significant volumes of woody biomass material that could be processed into biomass fuel.

In past years, the Highway 168 FSC sponsored a yard and annual clean-up collection known as the Pine Needle Program. As burning restrictions[20] are prohibiting the piling and burning of woody debris from residential clearance activities, alternatives such as collection yards are being considered. These yards allow residents and FSC to accumulate woody material for grinding and utilization as compost or biomass fuel. Interviews with the Highway 168 FSC president[21] and FSC records from recent Pine Needle Program clean-up activities indicate that approximately 9,000 cubic yards of woody biomass material is generated annually from FSC sponsored activities.

From previous experience with tree trimming and small-stem removal from residential areas, the authors estimate that approximately 5 cubic yards make up 1 GT of woody biomass material. Using this conversion factor, 9,000 cubic yards is the equivalent of 1,800 GT of biomass material. Assuming 50% moisture content (per the authors' experience with like materials), the annual volume generated from residential collection activities is approximately 900 BDT. Table 8 summarizes these findings.

Table 8 - Forecasted Wildland Urban Interface Fuel Treatment Residuals

Cubic Yards/Year	GT/Year	BDT/Year
9,000	1,800	900

The Highway 168 FSC also sponsors roadside clearing of hazardous fuels. Primary objective of the roadside clearing projects is to create a defensible zone for firefighters to actively suppress a wildfire. Additionally, by treating along roadways, a "safe zone" is created to allow residents to flee an oncoming fire and allow emergency vehicles to readily access the area. Roadside clearing projects can generate significant volumes of woody biomass (potentially up to an additional 900 BDT/year). However, funding of roadside clearing projects is completely dependent upon grant funding, so it is not consistent or predictable. For this reason, the authors did not include roadside fuel hazard removal as a ready and repeating source of biomass fuel.

The Highway 168 FSC has expressed a very strong interest in participating with SCE in stewardship contracting opportunities with the SNF. This level of concurrence is based on reduction of fuel that could otherwise threaten lives and property, not necessarily on ultimate use of the biomass as fuel for a generating station. This was discussed as a general concept, not a specific SCE project. This type of collaboration with local stakeholders will likely be very helpful when communicating with the USFS (SNF) the immediate need for landscape-level stewardship contracts. The enabling legislation for

[20]San Joaquin Valley Air Pollution Control District is limiting the number of burn days that pile and burn activities can be conducted. Burn permits are issued by local agencies (CAL FIRE and USFS).
[21]Per discussions with Richard Bagley, President, Highway 168 Fire Safe Council.

stewardship contracting (HFRA) stipulates that collaboration with local residents must be part of the stewardship contracting process.

Biomass Fuel Availability - SCE

In conducting this fuel availability study, it is important to acknowledge and summarize separately the fuel availability findings from the two primary fuel supply sources, because one (SCE) is determinant while the other (SNF) is currently prospective.

Total biomass fuel practically available from SCE land management activities along with the development of a small-log sawmill and use of Highway 168 FSC/SCE sponsored collection yards yield a significant volume of material. This material represents a fuel source that is directly controlled by SCE and therefore is considered a core part of the annual fuel supply. Table 9 summarizes biomass fuel available from SCE land management activities.

Table 9 - Biomass Fuel Practically Available Years 1 to 5 – SCE Controlled

Fuel Type	Practically Available BDT/Year	Comments
Forest Fuels Reduction Residuals Private - SCE lands	42,350	SCE lands - Years 1-5, then taper off.
Forest Fuels Reduction Residuals Private - Other	3,850	Other private lands – SCE manages operations at 200 acres treated per year.
Timber Harvest Residuals	3,400	Per 2002-2006 historic timber harvests.
Small Log Sawmill Residuals	5,000	5,000 MBF converts to 5,000 BDT.
Wildland Urban Interface Residuals	900	Highway 168 FSC/SCE sponsored collection yards.
Total	**55,500**	

As noted earlier, the forest fuel reduction is stepped up in the initial five-year period to represent progressive land management practices. If SCE were to treat 12,000 acres over a span of 30 years, it would treat approximately 400 acres per year. At 35 GT/acre and 45% moisture content, forest fuel treatments would average 7,700 BDT/year. With the above-noted timber harvest residuals, sawmill residuals, and private land fuel reductions, it would yield a total of 21,950 BDT controlled by SCE (or the equivalent of about 2.75 MW). However, ramping up fuels treatment activities in years 1 to 5 increases the base amount to 55,500 BDT/year for the first five-year period.

As a general rule of thumb, a commercial-scale biomass-fired power generation facility consumes approximately 8,000 BDT of fuel per year per MW of generation. Utilizing this rule of thumb, 55,500 BDT of biomass fuel per year from SCE-managed lands alone with progressive fuel reduction will support a biopower facility scaled at approximately 7 MW of generation. Additional biomass fuel sourced from SNF lands will provide fuel that will allow scaling up of the generation facility above this 7 MW level of generation. (See the following sections on Biomass Fuel Availability – SNF.)

Heating value of the fuel (Btu/dry lb) is often used to size a power generation facility. Such heating value could be approximated utilizing existing peer-reviewed databases, since heating value will vary by the feedstock mix. Heating values of the various fuel types will be assessed as part of the Fuel Procurement Plan. Determining the appropriate facility size will be addressed in subsequent engineering work (see Recommendations).

Out year forecasts for years 6 to 20 must take into account the fact that most of the SCE lands will have received the benefit of fuels treatment and restoration activities during years 1 to 5. Nonetheless, SCE Forestry staff indicate that some level (approximately 500 acres per year equivalent) of fuels treatment maintenance activities will likely continue in years 6 to 20. Timber harvest levels on SCE lands are likely to remain consistent (at 2002 to 2006 historic levels). As WUI fuels treatment activities ramp up with the use of FSC/SCE sponsored collection yards, biomass fuel from WUI activities in years 6 to 20 are projected to more than double. Table 10 summarizes fuel availability projected for years 6 to 20 from SCE land and management activities.

Table 10 - Biomass Fuel Practically Available Years 6 to 20 – SCE Controlled

Fuel Type	Practically Available BDT/Year	Comments
Forest Fuels Reduction Residuals Private – SCE lands	9,600	Assumes 500 SCE acres per year treated.
Forest Fuels Reduction Residuals Private - Other	9,600	Other private lands – SCE manages operations at 500 acres per year treated.
Timber Harvest Residuals	3,400	Per 2002-2006 historic timber harvests.
Small Log Sawmill Residuals	6,000	5,000 MBF converts to 5,000 BDT.
Wildland Urban Interface Residuals	2,000	Highway 168 FSC/SCE sponsored collection yards.
Total	**30,600**	

Biomass Fuel Availability - SNF

Even though the available fuel supply from SCE activities alone would support a demonstration-level power generation facility (as noted above), it is appropriate to consider other forested landscapes included in the TSA, namely the SNF lands near Shaver Lake.

Historic forest practices as well as fire suppression on the SNF have led to the unnatural accumulation of significant volumes of small stems <18” DBH on national forest lands within the TSA. Unlike management practices on SCE forest lands, the SNF has not been able to proactively treat significant numbers of acres. Discussions with SNF staff[22] indicate that the continued reduction in USFS funding available for fuels treatment activities, forest staffing reductions, and reduced timber harvests due to ongoing litigation have severely limited the SNF in accomplishing forest fuels reduction work.

[22]Mark Smith, Ecosystem Staff, Sierra National Forest.

Inability of the SNF to effectively address the growing accumulations of brush and small stems poses a significant threat to SCE lands, national forest lands, and local communities due to the high probability of catastrophic wildfires. Stepped up fuels treatment activities on the SNF are required to reduce this threat, create open grown forest settings, enhance wildlife habitat, and meet management goals as set by various legislative initiatives and directives[23] for these public lands. This fact should facilitate favorable interest by the SNF in working with SCE and the Highway 168 FSC to accomplish management goals through the following:

- A ready market for biomass fuel will improve the economics of fuels treatment activities, thus addressing the reduction in annual federal appropriations.
- Stewardship contracting as enabled through the HFRA should allow the SNF to treat acreage with fewer staff, thus addressing the USFS' lack of staff available to support landscape-level fuels treatments and timber sales.
- A small-log sawmill at Shaver Lake will provide a local market for the relatively high volume of small sawlogs that need to be removed for the SNF to meet land management objectives.
- If a ready market for woody biomass and small sawlogs exists in the Shaver Lake area, litigation from stakeholders concerned about the harvesting of large trees will likely subside.
- Active thinning and fuels treatment will allow the SNF to increase carbon uptake in the residual forest stands.
- By thinning and manicuring unnaturally dense forest stands, the SNF will increase and enhance the habitat of all native species of wildlife as well as countless numbers of insect species and microscopic organisms.

This study found and recommends that a large component of the future fuel supply in the TSA should be sourced directly from SNF lands as a byproduct of forest fuels treatment and restoration activities. Broad scale landscape-level treatments on the SNF will generate a sustainable flow of biomass fuel in addition to the SCE sourced biomass fuel.

Utilizing the findings from Table 2 and Table 4, the authors forecast the volume of biomass fuel that could be recovered annually from SNF lands for years 1 through 5. Findings from Table 4 show 4,850 BDT per year practically available as timber harvest residuals generated in Fresno County. As historic data demonstrates, approximately 30% of the timber harvest is on public lands. As noted earlier, all timber harvest on public lands in Fresno County is for all practical purposes on SNF-managed lands. Thus, 1,400 BDT (30% of 4,850 BDT) from timber harvest activities is practically available from SNF lands over time. Adding the volume practically available from fuels reduction and forest restoration activities (see Table 2) brings the total forecasted biomass fuel practically available from SNF forest lands to 14,850 BDT for years 1 to 5. Table 11 summarizes these findings.

[23] Healthy Forests Restoration Act of 2003 and the Sierra Nevada Forest Management Plan Record of Decisions – 2004. For latest information on the 2004 Record of Decision, see http://www.fs.fed.us/r5/snfpa/

Table 11 - Biomass Fuel Practically Available Years 1 to 5 – SNF

Fuel Type	Practically Available BDT/Year	Comments
Forest Fuels Reduction Residuals	13,400	Years 1-5, then ramp up starting year 6.
Timber Harvest Residuals	1,450	Per 2002-2006 historic timber harvests.
Total	**14,850**	

The work needed to be done on the SNF can support a step up of stewardship contracts over time such that by years 6 to 20, approximately 5,000 acres per year of fuels treatments will be accomplished. This minimum scale of treatment will be required if the SNF is to treat the backlog of hazardous fuels now accumulated on lands under its jurisdiction. Litigation has caused fuels treatment and timber harvest activities to come to a virtual standstill in the past ten years, causing a significant backlog of forest fuel reduction projects to accumulate. Along with this level of treatments, the sawlog harvest will likely double from 2002 to 2006 historic levels, thus doubling the timber harvest residuals generated as a byproduct and available as biomass fuel on the SNF. Table 12 provides findings for biomass fuel sourced from the SNF in years 6 to 20.

Table 12 - Biomass Fuel Practically Available Years 6 to 20 – SNF

Fuel Type	Practically Available BDT/Year	Comments
Forest Fuels Reduction Residuals	44,700	Fuels treatment activities on approximately 5,000 acres per year.[24]
Timber Harvest Residuals	2,900	As stewardship contracts are implemented, small log harvest levels will also increase (double) from 2002-2006 historic harvest levels.
Total	**47,600**	

RESULTS

Values (both economic and land based) derived from the utilization of forest-sourced biomass fuel in the generation of renewable electricity clearly justify the construction of a generation facility and small log sawmill at Shaver Lake.

Land-based values of forest restoration benefiting wildlife, water, and wildfire protection increase the total value significantly but are very hard to quantify. Additionally, this project will increase the storage of carbon by maximizing total tree growth on selected fast-growing stems. Appropriate use of long-term forestry management and thinning methods will lead to increased carbon sequestration by increasing the carbon uptake.[25]

[24]Requires upfront work and stewardship contracts.
[25]Hoover, C. and Stout, S. 2007. The Carbon Consequences of Thinning Techniques: Stand Structure Makes a Difference. Journal of Forestry, 105(5), 266-270.

Summation of the numerous benefits outlined in this fuel availability study fully support the biomass-fired generation facility and a co-located small-log sawmill project concept as described.

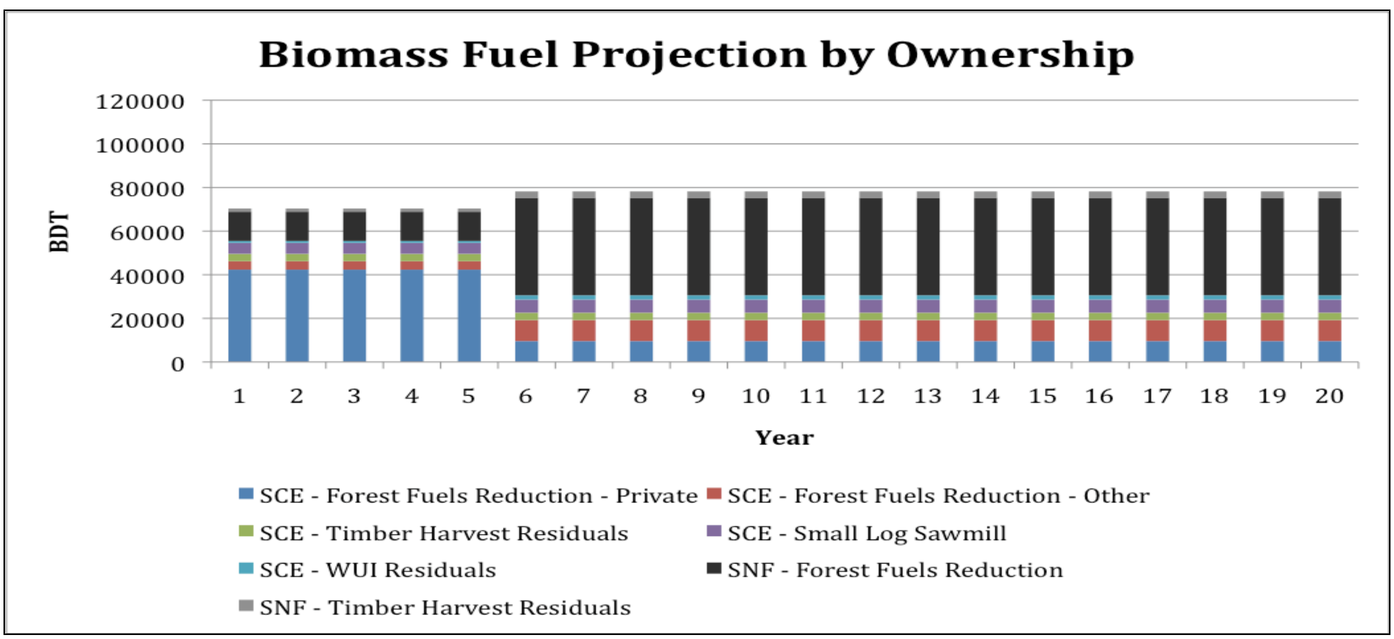
Calculations show that a biomass power generation project at Shaver Lake could be viable based on a sustainable supply of practically available fuel. This study confirms and validates the long-term availability of woody biomass feedstocks. The combined results from the fuel availability analysis are presented in Table 13. It shows forest biomass recovered from management activities on SNF lands adds an additional 13,000 to 44,000 BDT per year (first 5 years and year 6 onward, respectively). SCE forest management activities will produce approximately 55,500 BDT per year during years 1 through 5 and about 30,600 BDT in years 6 onward.

Table 13 - Forecasted Biomass Fuel Availability
(By Fuel Type and Forecast Period)

Fuel Type	Years 1 to 5 Practically Available BDT/Year	Years 6 to 20 Practically Available BDT/Year
Forest Fuels Reduction Residuals	59,600	63,900
Timber Harvest Residuals	4,850	6,300
Small-Log Sawmill Residuals	5,000	6,000
Wildlife Urban Interface Residuals	900	2,000
Totals	**70,350**	**78,200**

Figure 6 provides a graphic representation of fuel supply blend over time by type and ownership.

Figure 6 - Biomass Fuel Projection By Type and Ownership Years 1 to 20



POTENTIAL SITING OPPORTUNITIES

In the course of conducting this fuel availability analysis, the authors became aware of several potential siting opportunities near Shaver Lake. Appendix F provides specific information and the location for each of the three sites found to be likely candidates for a commercial-scale generation facility and small-log sawmill facility. This study does not account for the differences that may be inherent in the three sites considered such as co-location near a substation, or different landownership, or difference in elevation, or accessibility during snow months.

OBSERVATIONS

In the course of conducting this fuel availability analysis, a number of key observations were generated that are clearly relevant to the business model being considered. They include several areas of interest and impacts directly attributable to improved forest management that are anticipated as a result of a biomass generation facility and co-located sawmill operating at Shaver Lake. Outlined below are those observations presented with no specific order or ranking.

Year-Round Operations

There has been no analysis of how a requirement for a year-round supply of fuel would impact the current seasonal business practices of SCE Forestry. Also there is no mention of how to address potential or known impacts of weather conditions, i.e., weeks to months of possible restricted access to the forest, and how such temporary inaccessibility to a fuel supply could affect ability of a powerhouse to operate as baseload (24/7) power generation. Consistent with baseload operation and potential for restricted access, there needs to be an assessment of fuel storage capacity required. Such an assessment will be included in the Fuel Procurement Plan. Strategies to be considered include a larger fuel storage area on site (adjacent to the biopower generation facility) and/or strategic fuels treatment activities operating at lower elevations (drier sites) during winter months.

Community Support

Community support for any commercial-scale project is critical. In particular, with respect to a biomass power generation facility/small-log sawmill at Shaver Lake, it appears that community support is significant, primarily as a direct result of SCE forestry staff maintaining outreach efforts and general education to the community at large. Due to the severity of the potential for catastrophic wildfire, support for fuels treatment activities in the Shaver Lake/Dinkey Creek region appears strong. As is the case with many forest management proposals, not all stakeholders will agree on the particular scale or methodology. Therefore, continued outreach to the community and all stakeholders will be important as next steps are considered.

On May 22, 2008 a Town Hall meeting was held in Shaver Lake. A generic idea of conducting landscape-level fuels treatment activities on surrounding national forest (SNF) lands was discussed. Attendees enthusiastically supported the need to lobby the USFS to conduct stewardship contracts to harvest small trees to reduce fire hazard surrounding their communities with an eye toward the enterprises collecting that fuel and using it for the generation of renewable power.

Enhanced Watershed Health – SCE and SNF Lands

Another important benefit generated as a result of fuels treatment and forest restoration activities includes enhanced watershed health. Included attributes that fall under the watershed health umbrella include:

- Enhanced water flow.
- Improved timing of flow.
- Fire resilient watershed.
- Reduced incidence of wildfire with reduced potential for excessive soil erosion.

SCE forest holdings alone are not significant enough in scale to add water flow and runoff to appreciably affect nearby hydro generation. If stewardship contracts to thin surrounding national forest lands are implemented, there will be an increase in water flow, thereby benefiting hydro generation.

Carbon Sequestration Benefit

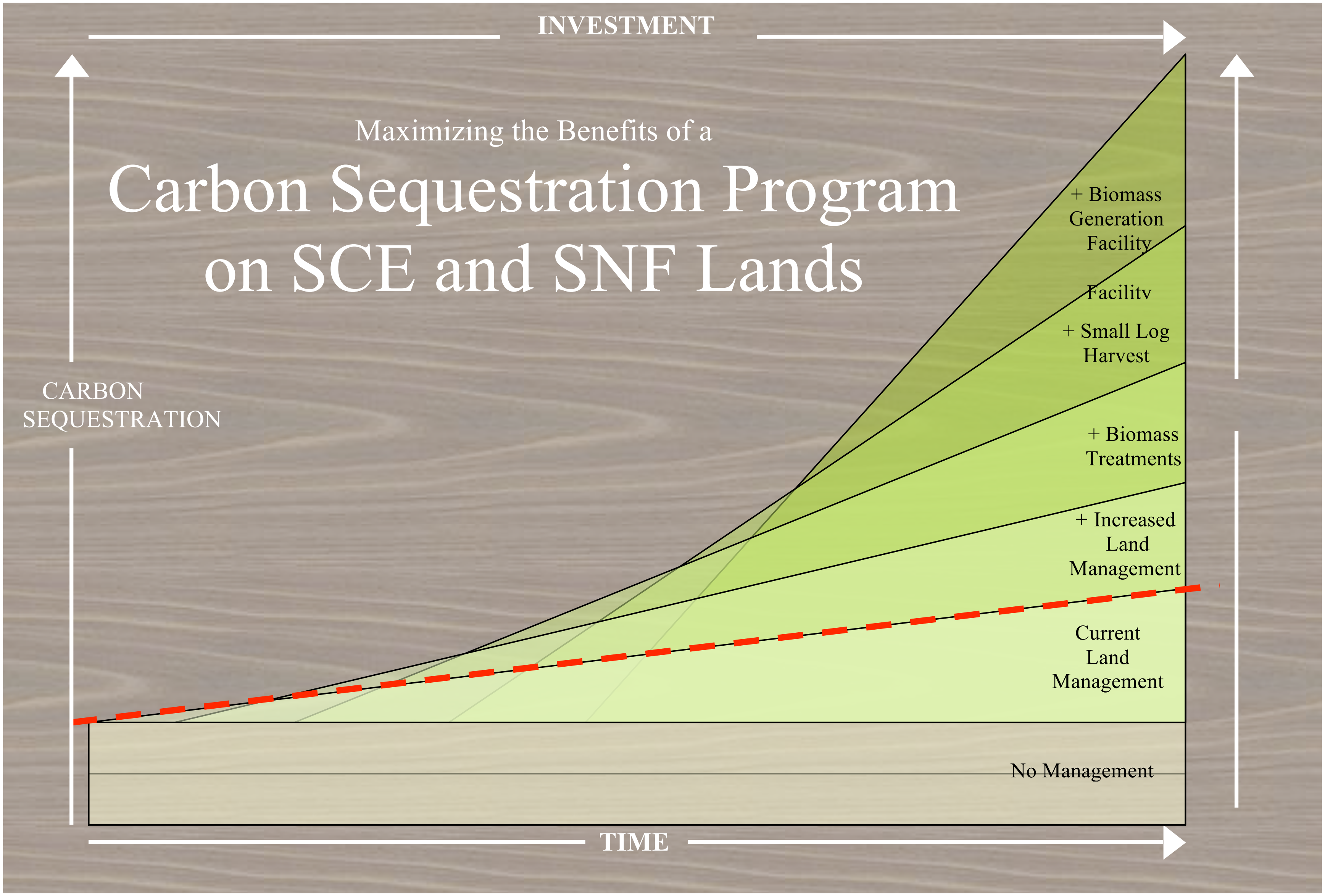
A project implemented consistent with the business model described in this study will significantly improve the carbon sequestration program now being established by the SCE Forestry Department. Removing smaller trees improves the ability to concentrate wood fiber growth on the healthiest, fastest-growing trees and thus appreciably increases growth rates. Thus, carbon will be stored in larger amounts. Figure 7 provides a graphic representation of how fuels treatment, forest restoration, and the development of a biopower/sawmill facility will significantly improve carbon storage. The monetary value of such benefit was not addressed in this study but is currently under review by international, national, and local agencies and remains an unknown at this time. The expectation is that there will be value ascribed to activities that sequester carbon.

Improved Air Quality Co-Benefits

Timber harvest residuals are currently piled and burned onsite adjacent to a harvest area utilizing seasonal burning permits issued by the San Joaquin Valley Air Pollution Control District. Air emissions and human health impacts from the piling and burning of timber harvest residuals are notable. These operations are typically planned for the early fall when temperatures are lower, ambient humidity is higher, and the potential for crown fires is reduced.

By providing a ready market for these residuals, forest land managers will be able to reduce air emissions (carbon dioxide and greenhouse gases, particulate matter, volatile

Figure 7 - Carbon Sequestration Opportunity on SCE and SNF Lands



organic compounds), reduce human health impacts (due to improved air quality) and reduce financial costs associated with burning this material in the open, compared to combustion in the controlled environment of a boiler equipped with best available control technology (see Regulatory Rule Analysis in Recommendations).

Ash as Soil Amendment

A potential co-product of a biomass-fired power generation facility is the ash that remains after the wood is used as fuel. Typically, 2 to 3% of biomass fuel utilized in combustion is converted to ash. This ash has a significant nutrient content and is prized as a soil amendment. In certain parts of northern California, wood ash is applied to forest plantations and working rangelands with very positive results.

Environmentally Sensitive Practices

It was assumed that any biopower/sawmill project going forward from concept to realization would recognize and follow known and established practices and guidelines when working within the forest, including those for protected species. The California Environmental Quality Act (CEQA) and the California Forest Practices Act provide significant statutes and regulations that provide oversight and guidance for land management activities on all private lands within the State. For land management activities on federal lands, there are numerous policy initiatives that provide guidance, including the National Environmental Policy Act (NEPA) and the National Forest Management Act.

Costs Associated With Biomass Fuel Delivery

Economic costs associated with harvest, collection, processing and transport of biomass fuel will be addressed in the Fuel Procurement Plan. Current costs of biomass treatment practices (pile and burn, broadcast burn) will also be assessed in order to compare cost savings associated with biomass fuel recovery and use in a biopower generation facility. Other preliminary calculations showed that hundreds of thousands of natural regeneration seedlings germinate each year, which need to be removed (as saplings) from the forest to maintain its healthy status. Saplings represent ladder fuels that will allow ground-based wildfires to "climb" into the crowns of older trees, thus acting as a catalyst for crown fires that can move quickly, especially in a wind-driven weather event. Eliminating unwanted growth costs hundreds of thousands of dollars each year. The subsequent Fuel Procurement Plan will pose an opportunity to reassess the volume of unwanted vegetation, to verify it is accurate, and to be able to compare treatment options and expenses.

Other Siting Opportunities

With the current forest conditions of the Inland West region (including California) and the need for ramping up forest fuels treatment activities, locating biopower facilities immediately adjacent to forest ecosystems is a business model that could be applied to numerous locations. Recognizing the arena within which the company (SCE) works and its perspective on the public good, it would be helpful to identify how applicable these study results could be for more broad application, whether additions or exceptions need to be specified, and what factors were not considered.

Additional Fuel Availability

This fuel availability analysis was conducted without the benefit of the authors being able to candidly discuss the potential for siting a biopower/sawmill facility in the Shaver Lake area. All interviews conducted did not have the added advantage of transparency. The authors fully expect that if participating land managers (public and private) and local stakeholders (e.g., Resource Conservation Districts and FSC) become cognizant of this potential project, a new level of cooperation and heightened interest will result. It is anticipated that an additional volume of biomass fuel ranging from 15 to 25% of current estimates could be expected. During the Fuel Procurement Plan phase, there will hopefully be opportunity to share SCE's interest in a biopower/sawmill facility at Shaver Lake so that this additional fuel availability can be quantified and included in the siting parameters.

FINDINGS

Implementation of progressive forest management practices employed by SCE foresters, consistent with the 2006 LMP for the Shaver Lake and Dinkey Creek Tracts, would generate enough woody biomass fuel to support a biomass fired power generation facility capable of producing approximately 7 MW of electrical power. If stewardship contracts can be secured with the SNF, then additional woody biomass resources can be sourced and a facility scaled at 10 MW could be sustained long term. The volume of woody biomass material generated currently by SCE with no ramp up in management practices would support a 2 to 3 MW biomass power generation facility.

Utilizing findings from this fuel availability analysis as well as general observations, a six year fuel availability forecast was produced. Presented in Table 14, this forecast shows findings and results from worst case, base case, and best case scenarios. Assumptions used to generate these scenarios are presented in Table 15.

Table 14 - Forecasted Six Year Biomass Fuel Availability

	Fuel Availability Forecast - Years 1 through 6					
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Worst Case	56,100	57,800	87,500	61,200	62,900	64,600
Base Case	66,000	68,000	70,000	72,000	74,000	76,000
Best Case	82,500	85,000	87,500	90,000	92,500	95,000

Table 15 - Forecasted Six Year Biomass Fuel Availability – Assumptions

Base Case – Year 1	Sawmill operates at 5 MMBF production level.
	Local collection yard (pine needle program) generates 900 BDT.
	SCE treats 2,200 acres - fuels treatment/forest thinning.
	Other private lands are treated (200 acres) - fuels treatment/forest thinning.
	USFS lands treated - 1,500 acres - fuels treatment/forest thinning.
	Private timber harvest (SCE + other) - 7.5 MMBF.
	USFS timber harvest - 3 MMBF.
Base Case – Year 6	Sawmill operates at 6 MMBF production level.
	Local collection yard (pine needle program) generates 2,000 BDT.
	SCE treats 500 acres - fuels treatment/forest thinning.
	Other private lands are treated (500 acres) - fuels treatment/forest thinning.
	USFS lands treated - 5,000 acres - fuels treatment/forest thinning.
	Private timber harvest (SCE + other) - 7.5 MMBF.
	USFS timber harvest - 6 MMBF.
Worst Case 15% Adjustment	Sawmill does not operate.
	USFS participation implementation delayed/scaled back.
Best Case 25% Adjustment	More biomass/acre is retrieved from forest fuels treatments.
	Hwy 168 Fire Safe Council ramps up to collect 3,000+ BDT per year.
	USFS stewardship contracts implemented at accelerated pace and scale.
	Sawmill operates at higher production levels (6+ MMBF per year).

RECOMMENDATIONS

Next steps to consider in support of the development of a biomass power generation facility and co-located small-log sawmill sited at or near Shaver Lake are summarized below.

(A) Fuel Supply – Any going concern that results from installing a power plant should include a true-up of anticipated-to-achieved results to be used in future planning.

(B) Fuel Procurement – Complete a comprehensive fuel procurement plan to address:

- Expenses associated with the harvest, collection, processing, and transport of biomass recovered to be used as fuel.
- Cost and availability of supplemental fuel supplies.
- Recommendations regarding optimized fuel blend.
- Observations regarding heating value (Btu/dry lb) of each fuel type.
- Analysis of current costs of fuels treatment using existing methods (pile and burn, broadcast burn, mastication) on public and private lands.
- Potential to secure stewardship contract(s) with the SNF.
- Market survey to determine current biomass fuel pricing and availability trends within a 50-mile radius of Shaver Lake.
- Analysis noting current and potential competitive forces in the marketplace.

- Assess fuel storage needs to assure baseload year round operations.
- Review regional road systems to confirm access for equipment and trucks.
- Assess future supply risks and opportunities.

(C) Regulatory – Current environmental, regulatory, or permitting situation appears favorable to the concept of improving forest management and reducing hazardous fuels while also utilizing the byproducts (woody biomass material) as fuel for power generation. An exhaustive rule analysis will be conducted to determine if such is allowed or encouraged within the existing framework and if so, what is a proposed path to securing permits for the proposed project. The Rule Analysis should identify whether there are differences to the process when sourcing fuel from public or private forests.

(D) Technology – Using wood waste as fuel for power generation is not a new concept. What is new is combining the beneficial elements of forest management, fire hazard reduction, and power generation for a facility sited within the forest. Improvement in overall coordination is the aim, coupled with having a replicable design. Hence, this study proposes using conventional boiler technology that is commercially available. Alternate technologies, and whether fuel is solid, liquid, or gas, could be considered for future proposals, if such technologies evolve and meet the "commercially viable" standard. The focus of these installations is on viability, not demonstrating heretofore unproven commercial-scale technologies.

(E) Site Selection – Three sites in this study were chosen since they are located within or adjacent to SCE lands, have some amount of pre-cleared land, are relatively close to existing electricity distribution system connection or corridor, have potential for water access, and nearby access to roadways for transport of fuel. In order to run calculations, Site #1 (see Appendix F) was identified as the primary target study site. A more thorough criteria identification and selection process should be specified and used in order to capture the variables of operating within the forest.

(F) Powerhouse – There were no assumptions made for a powerhouse configuration. Layout and technology preferences need to be specified for a Request for Proposals.

(G) Engineering – In the course of this analysis, a 25-acre footprint was estimated. Engineering for the various plant components needs to be conducted. If results of that work could arrive at the space requirements in a modular fashion, it might facilitate application of this concept to other sites in other forests, allowing for different space availability with optimized efficiencies.

(H) Communications Plan – Any steps forward should incorporate a communications plan that can be utilized to keep the community, regulatory agencies, and federal land management agencies informed regarding a biomass power generation facility/small-log sawmill being developed at Shaver Lake.

(I) Carbon Sequestration – Considering that the State of California is currently (per Assembly Bill 32) formulating policy and protocols in support of carbon capture and sequestration, a comprehensive study (life cycle analysis) addressing the implications of a biomass power generation facility at Shaver Lake should be implemented. The implications of carbon uptake are very significant when coupled with forest fuels reduction and forest restoration activities.

(J) Air Quality Improvement – A biomass power generation facility co-located with a small-log sawmill will contribute to overall net improvement of air quality in the Shaver Lake area (and central Sierra Nevada region). Listed below are the alternative practices that should be closely monitored so that net air emissions reduction can be quantified:

- Biopower facility will combust biomass fuel in a highly controlled environment using best available control technologies. Rather than piling and burning or broadcast burning small stems, limbs, and brush, this material will be utilized in a controlled environment, thus minimizing air emissions (particulate matter, volatile organic compounds).
- Small sawlogs and biomass fuel will be utilized close in to the forest operations where this material is generated. Normally this material would be transported some distance by truck before conversion into lumber and power.

(K) Stewardship Contracts – Stewardship contracts represent a significant opportunity for SCE to coordinate and implement landscape-level fuels treatment activities adjacent to SCE lands and the community of Shaver Lake. Stewardship contracts with terms up to 10 years are existing contracting tools the USFS is currently equipped to negotiate. Steps should be initiated to begin the process of contacting the SNF to start discussions that could ultimately lead to a stewardship contract. Stakeholder groups such as the Highway 168 FSC will likely be key partners in this process.

(L) Ash – Byproduct of wood waste combustion process is ash. Biomass fuel sourced from forest-based operations will generate ash that contains a blend of nutrients that, when applied to certain soil types, will enhance vegetation growth and productivity. Trial applications should be considered if a biopower project is developed at Shaver Lake.