FOREST BIOMASS TRANSPORT AND VALUE-ADDED MARKET OPTIMIZATION ASSESSMENT FOR THE UPPER FEATHER RIVER WATERSHED

March 28, 2012 Final Report

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This project is a result of the USDA Forest Service Plumas National Forest entering into a Cooperative Agreement with the Sierra Institute for Community and Environment to expand economic uses of biomass through reduction of hazardous fuels on national forest system lands in the Upper Feather River Watershed and adjacent areas. This agreement is funded through the American Recovery and Reinvestment Act of 2009, which seeks to create new jobs and save existing ones, spur economic activity and invest in long-term growth, and foster unprecedented levels of accountability and transparency in government spending.

ACKNOWLEDGMENTS

TSS Consultants conducts feasibility studies and assessments utilizing in-house personnel and resources. This is a business model that our firm has utilized since it was founded in 1986. The Upper Feather River Watershed Feasibility Study was unique in that we added local talent to our team to assure that we delivered optimal work product using local knowledge. A full array of knowledgeable individuals and networks were utilized that proved invaluable during the data gathering and analysis phase of this study.

The authors wish to thank several individuals and organizations for their significant efforts in support of this project. These include, but are not limited to:

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The research team as assembled by TSS Consultants included:

- Tad Mason, Forester and CEO, TSS (Principal Investigator)
- Bill Wickman, Forester (Co-Principal Investigator)
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- Dennis Woods, Forest Roads Engineering Technician
- Lynsey Kelly, Geographic Information Analyst
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ABBREVIATIONS/ACRONYMS

The abbreviations and acronyms used in this report.

Organizations

BOE	California Board of Equalization
BLM	Bureau of Land Management
EPHC	Eastern Plumas Health Care
FSC	Fire Safe Council
HFQLG	Herger Feinstein Quincy Library Group
IOU	Investor Owned Utility
IVCSD	Indian Valley Community Service District
NCRC	Northern California Resource Center
POPI	Pacific Oroville Power Inc.
SDTDC	San Dimas Technology and Development Center
SI	Sierra Institute for Community and Environment
TSS	TSS Consultants
USFS	United States USFS

Other Terms

BDT	Bone Dry Ton(s)
Btu	British Thermal Unit
CEQA	California Environmental Quality Act
CHP	Combined Heat and Power
CPUC	California Public Utilities Commission
CUP	Conditional Use Permit
DBH	Diameter at Breast Height
EIS	Environmental Impact Statement
FSC	Fire Safe Council
GIS	Geographic Information System
GT	Green Ton
HFRA	Healthy Forest Restoration Act
IOU	Investor Owned Utility
ITC	Investment Tax Credit
LOP	Limited Operating Period
LRMP	Land and Resource Management Plan
MBF	Thousand Board Feet
MMBtu	Million British Thermal Units
MW	Megawatt (electric)
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
PIER	Public Interest Energy Research
TASA	Transport Assessment Study Areas
THP	Timber Harvest Plan
TSA	Target Study Area
WUI	Wildland Urban Interface

INTRODUCTION

The Sierra Institute for Community and Environment retained TSS Consultants to investigate opportunities/technologies that improve upon existing forest biomass transportation techniques and assess a range of alternative value-added uses for biomass within the Upper Feather River Watershed.

Historically, the Upper Feather River Watershed region had a robust natural resources based economy focused on agriculture and forest products manufacturing. In the past several decades and for a variety of reasons, the forest products industry has reduced local production capacity. Additionally, local stakeholder collaboration efforts (e.g., Quincy Library Group, Plumas County Fire Safe Council) focused on community stability, treating excess forest fuels, and creating local family wage jobs are very active in the region. These stakeholders are seeking innovative solutions to their multi-pronged questions.

Throughout the Pacific Northwest, road systems within forested areas were designed to accommodate conventional log trucks. Forest landowners and managers are actively seeking ways to cost effectively improve existing roads or utilize innovative transport technologies to facilitate cost effective removal of low-value forest biomass materials generated as a byproduct of fuels reduction, timber harvest and forest restoration activities. This transport assessment quantified these challenges through the use of field analysis, supported by geospatial analysis that is calibrated by field work and transportation system trials.

Specific services expected with this assessment include:

- Confirm and quantify existing local and regional markets (commercial and niche) for low-value logs and woody biomass.
- Investigate and evaluate alternative markets for value-added uses that show promise.
- Characterize the types and sustainable volumes of locally available biomass material (including low-value logs).
- Conduct a geospatial transportation network assessment of select road systems to confirm the potential availability of currently accessible forest biomass material within the Upper Feather River Watershed.
- Conduct field trials using innovative, cost-effective transport technologies that expand access for the recovery of low-value logs and woody biomass material.

STUDY OBJECTIVES

This assessment represents a comprehensive problem-solving analysis that addresses two of the more perplexing challenges that stakeholders are faced with when conducting forest fuels treatment and forest restoration activities.

1. What are the value-added options for the byproducts (low-value logs and woody biomass material) generated during forest-based operations?

2. How can these byproducts be cost effectively transported to market?

Current markets for this material within the Upper Feather River Watershed include firewood, biomass fuel for power/heat, occasionally as feedstock for composite products (e.g., fiberboard, composite decking), and pulp/paper products. This analysis included a review of opportunities to diversify value-added options if additional material can be sourced through enhanced recovery facilitated by an improved transportation model.

SCOPE OF WORK

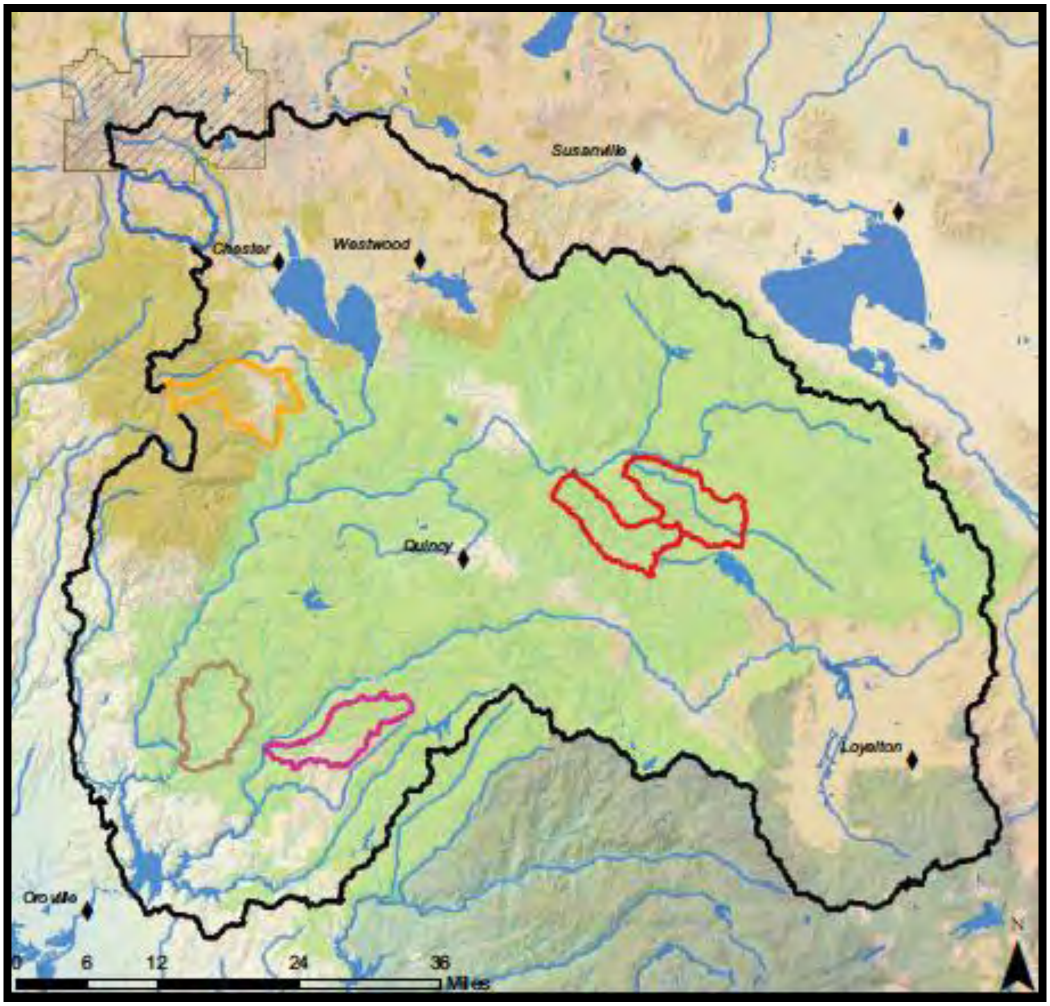
Detailed below are tasks that TSS has implemented in support of this assessment. TSS utilized relevant data and information from existing assessments and studies conducted in the region as well as new data generated as a result of this study. In addition, TSS accessed local knowledge and experience provided by numerous stakeholders and enterprises located within the Upper Feather River Watershed.

This Scope of Work provided general guidance and intent for this assessment.

Task 1. Pre-Work Conference

Convene a meeting with Sierra Institute staff to review approach, implementation schedule/work plan and list of work product deliverables for the feasibility assessment. Confirm primary Institute contacts and project management team members. Review availability of existing studies, technical documents and geospatial data that provide relevant information focused on the Target Study Area. Figure 1 highlights the Target Study Area (TSA) and surrounding region.

Figure 1. Target Study Area[1]



Task 2. Preliminary Market Review – Current and Potential Value-Added Markets

A. Complete a market review to confirm current markets for low-value logs and woody biomass material generated within the TSA. Confirm raw material feedstock specifications for each of the value-added product markets. Interviews with local experts will be key, including discussions with:

- USFS staff
- Sawmill managers – both large and small-scale operations
- Procurement staff – sawmills, biomass power generation facilities and composite products
- Logging, chipping and firewood contractors
- Other candidates (including recommendations from Institute staff)

[1]Map courtesy of the Sierra Institute. Target study area is bordered in black.

B. Conduct a search for potential value-added products and niche markets for low-value logs (e.g., submerchantable logs) and woody biomass material. It is important that a wide range of alternative uses be considered, including:

- Pulp/paper
- Post/poles
- Small thermal or electrical facilities (distributed generation)
- Densified fuels – pellets or firelogs
- Animal bedding
- Other potential markets (including recommendations from Institute staff)

C. Synthesize methods, contacts, and results into an executive summary format report document. Deliver draft document to Institute staff for review and comments.

Task 3. Resource Availability Review

A. Conduct an analysis to determine current availability of low-value logs and woody biomass material generated as a byproduct of fuels treatment, timber harvest, and forest restoration activities within the TSA. Emphasis will be placed on utilization of existing inventory data, geospatial data, and recent studies wherever possible (including the Sierra Institute's existing resource availability analysis). Geospatial analysis will be a primary tool utilized to complete this analysis. A range of potential feedstocks and waste streams will be considered, including:

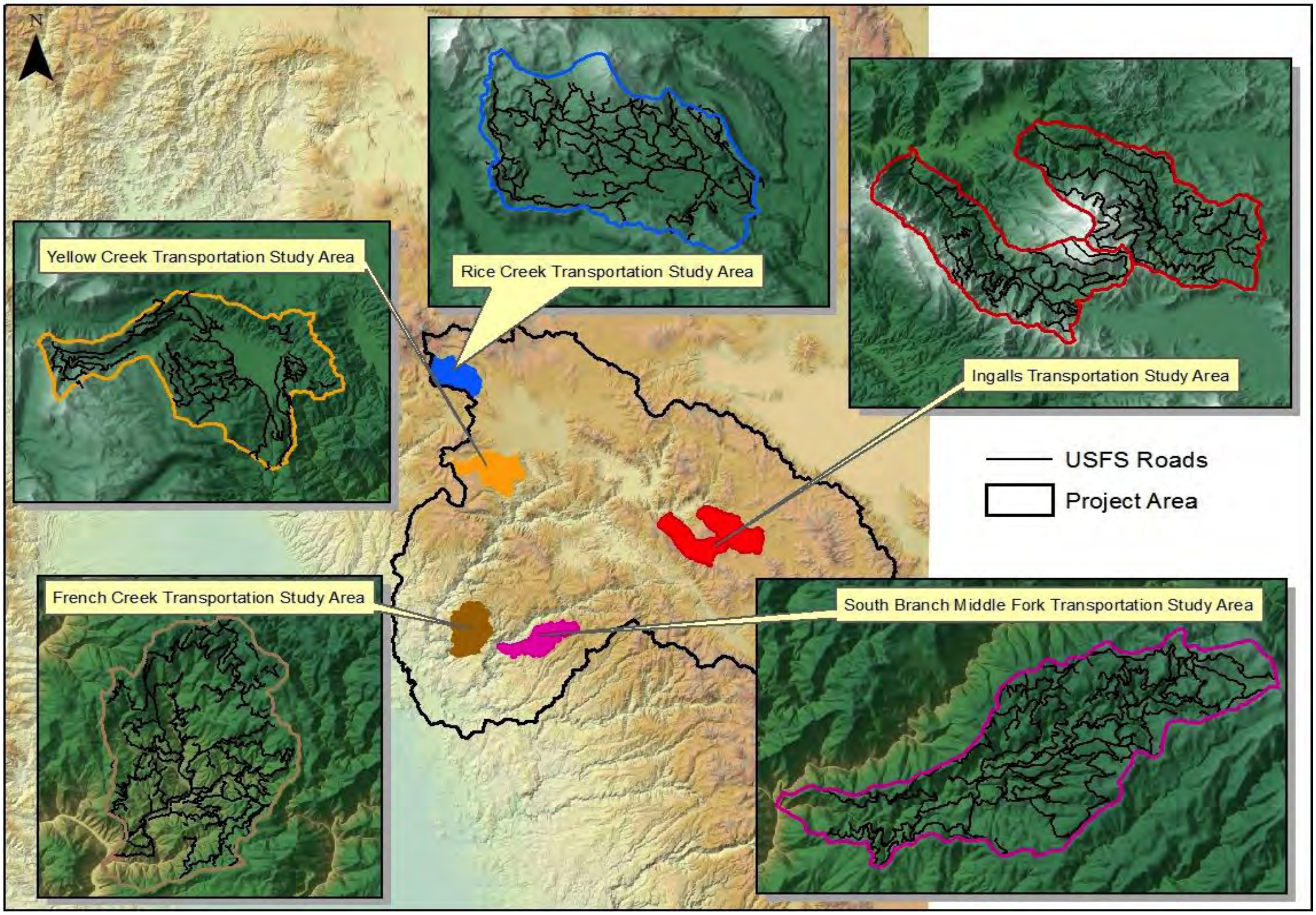
- Woody biomass residuals from forest operations
    - Timber harvest operations
    - Fuels treatment/forest restoration projects (including fire salvage)
    - Timber stand improvement projects

B. Synthesize methods, contacts and results into an executive summary format report document. Deliver draft document to Institute staff for review and comments.

Task 4. Preliminary Transportation Network Assessment

A. Perform a preliminary transportation network assessment of two study areas from the five Transport Assessment Study Areas (TASA) highlighted in Figure 2. The team will consult with Institute staff to select two TASA for detailed analysis.

Figure 2. Transport Assessment Study Areas[2]



B. The transportation network analysis will be anchored in field work and expert knowledge of the existing systems. Local sawlog and biomass transportation experts will be consulted to assure that local knowledge and perspective drives this assessment. On-the-ground field work will comprise a significant component of this analysis.

- Compare/contrast data and methodologies used for this preliminary assessment.
- Review existing USFS road transportation data sets against known field conditions.
- Identify road systems that will accommodate current transportation system technologies (e.g., 40' chip vans) regularly utilized in the TASA using experts and geospatial analysis.

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[2]Map courtesy of the Sierra Institute.

- Identify road systems that will accommodate innovative transport technologies considered (see Task 5).
- Confirm cost effective road modifications (e.g., turn radius adjustment, rolling dip removal) required to improve road access for:
    - Conventional transport technologies
    - Innovative transport technologies
- Conduct basic cost benefit analysis to assess the expense of road system upgrades relative to improved removal of low-value logs and woody biomass material.
- Highlight locations of road improvements, landings, and truck turnarounds using field data results and expert knowledge.
- Confirm cost to improve these features to accommodate removal of low-value logs and woody biomass material.
- Provide observations and recommendations to improve road classification of National Forest System roads.
- Provide observations and recommendations regarding use of geospatial analysis tools (e.g., Network Analyst) that can be applied to existing road system databases.

C. Synthesize methods, contacts and results into an executive summary format report document. Deliver draft document and geospatial data to Institute staff for review and comments.

Task 5. Transportation System Field Trials

A. Design, coordinate, and implement forest transportation system field trials. Working closely with the Institute and USFS staff, select strategic road systems in the TASA to conduct transportation system trials with existing and innovative technologies. Trials will address common transport system challenges from findings generated in Task 4.

Equipment trials will be scheduled and conducted to maximize participation by key target audiences including but not limited to:

- Procurement foresters
- Logging and chipping contractors
- Public and private land managers
- Interested members of the general public

A minimum of four innovative technologies will be utilized in the trials with the following technologies targeted:

- Short chip vans
- Dump trucks moving unprocessed material to a staging site (for additional processing)
- Stinger-steer chip vans

- Chip vans with adjustable rear axles
- Other equipment as available and consistent with project objectives and budget (e.g., small skyline system to remove low-value logs and biomass from steep terrain)

Field trials will be designed to compare and contrast existing transport technologies with innovative transport systems. Analysis will include detailed observations regarding efficiencies and costs associated with each system.

Trials will likely be located on USFS-managed lands in conjunction with an existing timber sale or service contract. Close coordination with USFS staff and timber sale purchaser or service contract holder will be critical. All negotiations and arrangements considered to facilitate these trials will be closely coordinated with Institute staff. Any revenue generated as a result of these field trials will be applied to costs associated with implementation of the trials (e.g., equipment mobilization costs). Due to the challenging terrain, some innovative options may be preferred in specific locations compared to others. All efforts will be made to select field trial locations that could be considered a typical situation in contrast to the rare exception. The team will coordinate these efforts with the Institute and USFS.

B. Synthesize methods, results and recommendations for road system improvements and additional biomass recovery field trials (e.g., innovative processing or biomass recovery equipment) into an executive summary format report document. Deliver draft document to Institute staff for review and comments.

Task 6. Preliminary Feasibility Utilization Analysis

A. Utilizing findings from Tasks 2 through 5, conduct a preliminary feasibility analysis to site value-added utilization enterprises within the TSA, with special emphasis on Indian Valley siting opportunities. Generate a matrix of value-added utilization technology options along with key characteristics to consider (e.g., initial capital expenses, siting requirements, permitting requirements, site availability, community acceptance, local competition for feedstock, minimum-scale and feedstock requirements). Rank the value-added utilization alternatives based on potential outcomes for success. In consultation with the Institute and the USFS, two of the preferred utilization options will be selected for further review and analysis.

Incorporated into the analysis will be observations and analysis addressing economies of transport associated with backhaul opportunities to move feedstocks or other bulk commodities from the Central Valley or San Francisco Bay Area. Additionally, the opportunity to collocate several value-added enterprises on one shared site will be addressed. There may be key and compelling synergies associated with collocation. Potential employment figures for each of the two selected utilization options will be provided.

B. Recommendations regarding next steps will be incorporated with the preliminary feasibility analysis. Clearly defined next steps and potential funding options will be listed. Interim results will be presented at two workshops to be coordinated by the Institute, UC Cooperative Extension, and other local partners, such as the Plumas County Fire Safe Council.

Task 7. Draft Feasibility Study Report

Based upon information, findings, and Institute staff input assimilated in Tasks 2 through 6, generate a draft report document. The draft report will be written so that it is easily comprehended by the target audience (Sierra Institute, USFS staff, logging and chipping contractors, procurement staff and other interested stakeholders). It is assumed that the target audience is knowledgeable but not technically conversant with transport and utilization technologies.

The feasibility study report will include (but not necessarily be limited to) the following sections.

- Title Page (with the following statement: *This project was administered by the Sierra Institute for Community and the Environment under a Cooperative Agreement with the USDA USFS, Plumas National Forest -10-CA-11059702-108)*
- Acknowledgments
- Table of Contents
- List of Tables/Figures
- Introduction
- Study Objectives
- Key Findings
- Preliminary Market Review for Current and Potential Value-Added Markets
- Forest Resource Availability Review
- Preliminary Transportation Network Assessment
- Transportation System Field Trials
- Preliminary Feasibility Utilization Analysis
- Next Steps
- Potential Grant Funding Sources
- Appendices

Draft report will be delivered in both digital and hardcopy format. Appropriate geospatial data, power point presentations (from workshops) and six hardcopies will be delivered.

Task 8. Final Feasibility Study Report and Workshop Presentation

Once Institute staff submits comments, a final report will be generated. The final report will be delivered within two weeks of receiving input. As with the draft report, the final report will be delivered in both digital and hardcopy format with one unbound copy, six bound copies, and two compact disks.

Once the final report is accepted by the Institute, arrangements will be made for presentation of findings at a public workshop. Workshop will be coordinated with Institute staff to confirm optimized timing and location.

Task 9. Project Management

During the course of this assessment, it will be very important that the team and Institute staff communicate regularly. TSS has been conducting due diligence grade studies for over 25 years, and a key lesson learned is that client/contractor communication and coordination is paramount to ensure successful analysis and delivery of work product. TSS will provide project management services including:

- Monthly progress reports that highlight activities undertaken, results achieved, challenges experienced and how those challenges were addressed. Plans for the next 30 days will be summarized.

- Regular communication and coordination via meetings (including conference calls) with the Institute staff.

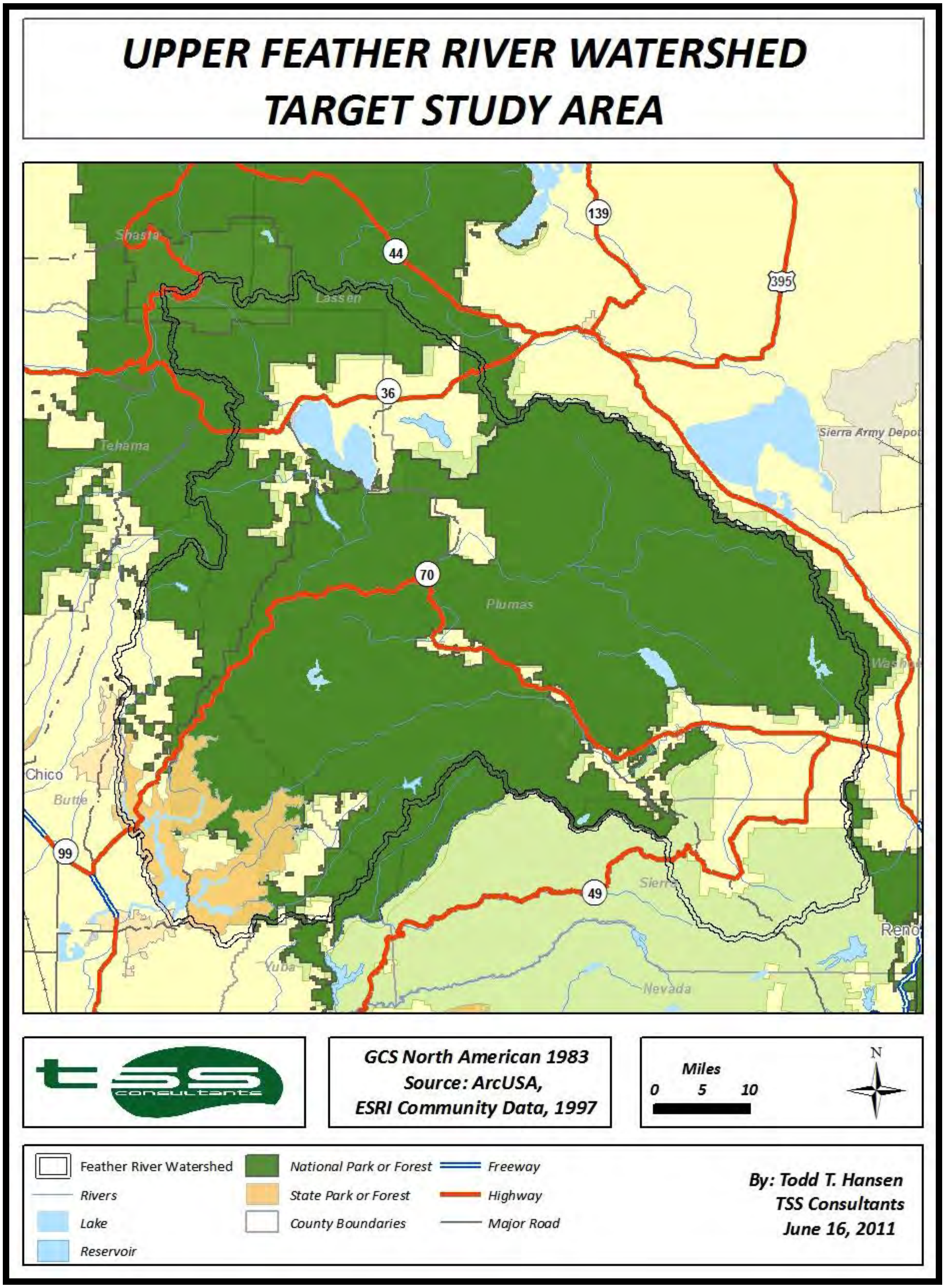
- Quarterly reporting regarding employment and other information required consistent with ARRA reporting.

TARGET STUDY AREA

The target study area (TSA) for this assessment is defined as the upper Feather River watershed.

Figure 1 highlights the region included in the TSA.

Figure 1. Upper Feather River Watershed Target Study Area



KEY FINDINGS

Summarized below are findings generated as a result of this assessment.

Preliminary Market Review for Current and Potential Value-Added Markets

Interviews with land managers, enterprise owners, logging contractors, foresters, agency personnel, raw material procurement staff and others confirmed that a variety of value-added utilization processes are currently deployed within and tributary to the Upper Feather River Watershed including:

- Commercial-scale sawmills;
- Small-scale sawmills;
- Firewood processing operations;
- Biomass power plants;
- Landscape and soil amendment operation;
- Log home manufacturing;
- Rustic furniture and gifts.

Unfortunately, a number of these facilities are facing challenging financial circumstances due to a variety of factors including:

- Reduced demand for products produced (primarily due to downturn in economy);
- Wholesale power rates are not keeping up with cost of collection, processing and transport of forest biomass material;
- Maintaining a skilled workforce;
- Regulatory challenges associated with access to raw materials;
- Regulatory challenges due to additional environmental compliance;
- Seasonal availability of forest biomass material;
- Access to forest biomass due to challenging road network.

Potential value-added opportunities that interviewees suggested include:

- Small-scale biomass power and heating facility;
- Thermal energy facility collocated with community buildings;
- Animal bedding;
- Post and poles;
- Composite panels;
- Firewood;
- Densified fuels (e.g., pellets, firelogs).

Forest Resource Availability Review

The Upper Feather River Watershed Target Study Area (TSA) includes heavily forested landscapes that are comprised of nearly 2/3 public lands. Public policy and federal funding levels to support land management activities have a significant impact on the availability of forest biomass material.

Forest biomass materials are generated as byproduct of forest management operations, fuels treatment activities, restoration and timber stand improvement activities. Table 1 provides an overview of potentially available forest biomass volumes by source.

Table 1. Forest Biomass Material Potentially Available from Forest Operations on Public and Private Lands Conducted Within the TSA

BIOMASS MATERIAL SOURCE	BDT PER YEAR	
	LOW RANGE	HIGH RANGE
Timber Harvest Residuals	81,120	109,750
Fuels Treatment/Restoration/Timber Stand Improvement Activities	51,250	96,250
Fuels Treatment Activities – Fire Safe Councils	550	1,150
TOTALS	**132,920**	**207,150**

Preliminary Transportation Network Assessment

The two Transportation Assessment Study Areas evaluated in this assessment provided the research team with an opportunity to review transportation challenges (and opportunities) that resource managers face regularly when attempting to remove woody biomass material. The primary challenge with regard to transporting woody biomass material over forest transportation road systems is that most forest roads were designed to accommodate log trucks with the ability to navigate tight radius curves and steep grades. Unlike log trucks, standard chip transport trailers used to move forest biomass do not articulate and are not able to navigate tight radius curves and steep grades.

The costs associated with road improvement and building or improving landings are an impediment and need to be calculated relative to the volume of woody biomass that can be recovered (if these improvements are implemented). The research team developed a transportation system calculator tool that provides resource managers and forest road system engineers with an analytical tool to assess biomass recovery options. Using field-based calculations and simulations that incorporate the cost of road improvements and the overall costs to remove woody biomass material, the calculator tool allows resource professionals to compare the cost of road improvements versus the incremental removal of woody biomass material. In addition, the calculator tool can calculate the volume of sawlog material that may be needed to offset the additional costs associated with biomass material removal.

Transportation System Field Trials

Findings from the transportation system field trials are summarized below.

- The stinger steer and short trailer technologies performed well in extreme field conditions (e.g., tight radius curves, steep road grades).

- Innovative transport systems should be deployed with tractors that are well equipped for extreme field conditions. Locking differentials for the drive wheels, enough power to pull grades (e.g., 400 plus horsepower rating) and active braking systems (e.g., compression release engine brake) are important specifications for optimal operating conditions and safe operations.

- Innovative transport technologies available to transport processed forest biomass material are largely dependent on market conditions (market value of biomass) and/or monetary support from the landowner (e.g., service contract) that typically support higher cost innovative transport options.

- There is a high level of interest among natural resource professionals to remove biomass to value-added markets instead of treating slash using historic business-as-usual techniques, i.e., lop and scatter, pile and burn or shred and scatter (masticate).

- Current innovative transportation technologies are not commonly deployed. To increase the use and availability of innovative transportation technology requires substantial capital outlay for a product (processed forest biomass) that currently costs more to move than its value in the marketplace.

Preliminary Feasibility Utilization Analysis

A review of potential value-added utilization sites within the Target Study Area (TSA) was conducted. The top two sites considered include:

- Former Louisiana Pacific sawmill site at Greenville; location of a 3 MW community scale biomass combined heat and power facility should be considered.

- Eastern Plumas Health Care campus at Portola; location of a 3.6 MMBtu/hour thermal energy facility utilizing woody biomass as feedstock could reduce current heating costs by 25%.

PRELIMINARY MARKET REVIEW FOR CURRENT AND POTENTIAL VALUE-ADDED MARKETS

The primary focus of this review was to confirm current markets for low-value sub-merchantable logs and woody biomass generated within the target study area and to review potential markets for other value-added uses.

Current Market Review

In order to better understand current value-added markets for unmerchantable logs and forest biomass material, interviews were conducted with key local experts from the following sectors:

- USFS staff;
- Sawmill managers – both large and small-scale operations;
- Procurement staff – sawmills, biomass power generation facilities and composite products;
- Logging, chipping and firewood contractors;
- Other candidates (including recommendations from Sierra Institute staff).

Appendix A provides a list of local experts interviewed.

Below are examples of questions included in the interviews conducted.

- Does your company utilize or deliver firewood or other value-added products from forest operations?
- What is the type and volume of biomass material utilized from forest operations per year for the last 5 years?
- Describe your business model and current wholesale/retail markets.
- Provide location of processing or collection yards.
- What land ownership or agency lands are you sourcing raw material for value-added uses?
- Do you anticipate any changes to biomass, firewood or other value-added products recovery on forestlands for the next 5 years?
- Would you be willing to assist us in characterizing your raw material sourcing area for this study?
- Estimated market locations for value-added products?
- What periods of the year are forest operations restricted or shut down?
- What are the reasons for the restrictions or shut down?
- What are the primary limitations to sourcing small logs or forest biomass by ownership or agency? What are the operational and economic restrictions?
- Other markets for value-added uses?
- Transport issues moving small logs or biomass from the woods?
- What are the obstacles that, if addressed, would allow your firm to expand?

From these interviews it was confirmed that several value-added markets are currently active in the region.

Table 2 provides an overview of the current markets.

Table 2. Current Value-Added Markets Sourcing Small Logs and Forest Biomass from the Target Study Area

ENTERPRISE	FACILITY LOCATION	VALUE – ADDED USE	FEEDSTOCK	FEEDSTOCK SPECIFICATION	ANNUAL VOLUME SOURCED FROM TSA	COMMENTS
Mt. Lassen Power	Westwood	Power Generation	Forest Biomass	3" minus, <50% Moisture Content (MC)	Variable	Operating intermittently. Currently down.
Collins Pine Company	Chester	Power and Steam Generation	Forest Biomass	3" minus, <50% MC	39,200 BDT 17,600 BDT Collins 17,000 BDT other private 4,600 BDT USFS	Forest-sourced biomass removals are targeting 2-3" DBH and up to sawlog material, tops, and limbs.
Sierra Pacific Industries (SPI) Quincy	Quincy	Power and Steam Generation	Forest Biomass	3" minus, <50% MC	High- 50,000 BDT Low- 174 BDT	Volume depends on number of shifts working in both small and large log mill.
SPI – Loyalton	Loyalton	Power Generation	Forest Biomass	3" minus, <50% MC		Currently closed but may re-start soon.
Pacific Oroville Power	Oroville	Power Generation	Forest Biomass	3" minus, <50% MC		Operating intermittently. Currently operating.
Honey Lake Power	Wendel	Power Generation	Forest Biomass	3" minus, <50% MC	About 50,000 BDT	Feedstock constrained. Only operating at 60% capacity.
Iberdrola Renewables	Lakeview	Power Generation	Forest Biomass	4" minus, <42% MC	Very little	Current project development plans are on hold.
SPI – Quincy	Quincy	Lumber	Sawlogs	6" top and 10"dbh		Plumas NF sales for last 5 years has averaged 44.8 MMBF. About 65% sawlogs and 35% biomass.
Collins Pine Company	Chester	Lumber	Sawlogs	6" top and 10"dbh		Plumas NF sales for last 5 years has averaged 44.8 MMBF. About 65% sawlogs and 35% biomass.

ENTERPRISE	FACILITY LOCATION	VALUE – ADDED USE	FEEDSTOCK	FEEDSTOCK SPECIFICATION	ANNUAL VOLUME SOURCED FROM TSA	COMMENTS
Trinity River Lumber	Weaverville	Lumber	Sawlogs	6" top and 10"dbh	Variable based on log values and supply	Operate satellite log yard at Oroville. Occasionally procure logs from TSA.
Rusty Warren	Quincy	Firewood	Logs – mostly from National Forest land	Cull logs from 8" top and larger	350-500 cords or approximately 175-250 MBF	Sells product locally in Quincy, Portola and Greenville area. $170/cord pick up, $190 delivered and if out of Quincy, delivery fee. Started doing some milling of cull material for fencing and out buildings.
Pew Forest Products	Crescent Mills	Firewood	Logs – mostly from National Forest land	Cull logs	High of 5,000 MBF but average about 1,250 MBF	Sells log truckloads of firewood logs ranging from $500-900 per log truckload. Each load averages about 10 cords.
Cal Hot Woods	Oroville	Firewood	USFS and private land	Cull logs	Variable	Paying $36-38/green ton for delivered logs.
Morning Star Products	Chester	Rustic furniture	Forest products from poles to logs	4" top 16' length to large diameter logs	1-5 MBF/yr	Buys finished white fir clear stock from Shasta Green for edging, FS permits for post/poles and chunks, Roseburg Forest Products, Collins Pine for finished lumber and individual logging contractors for individual logs.
Pacific Crest Furniture Co.	Quincy	Rustic furniture	Forest products	Larger logs for milling	1-5 MMBF depending on sales and markets	Buys or mills local logs and slabs and has bought eastern white pine when local source is not available.

ENTERPRISE	FACILITY LOCATION	VALUE – ADDED USE	FEEDSTOCK	FEEDSTOCK SPECIFICATION	ANNUAL VOLUME SOURCED FROM TSA	COMMENTS
Plumas Crafts	Clio	Rustic furniture and gifts	Logs and unique manzanita	Small-diameter cedar and lodgepole and manzanita	500 lbs per yr	Acquires material from wood cutters, self-collecting or from Graeagle Land and Water.
John Williamson	Portola	Hardwood trays, salt and pepper shakers, etc.	Forest products	Small-diameter logs		Buys many hardwoods commercially and uses oak, madrone, aspen and cottonwood.
Indian Valley Lumber Co	Taylorsville	Lumber and firewood	Sawlogs	All species of logs, but prefer cedar		Operates small portable mill and planer.
Lassen Forest Products	Red Bluff	Landscape cover and soil amendment products	Mill waste from log decks	Bark and fines from log decks	Variable, depending on raw material needs	Receive bark from SPI and Collins log yards.
Sierra Log Homes	Chico	Log homes	Softwood logs	Pole size logs, prefer cedar, lodgepole pine and Douglas fir	Variable depending on availability from various public and private sources	With housing market decline, have tapered back operations.

Interview Results

Summarized below are key interview results. Note that due to the proprietary nature of some interview results, the value-added enterprise data is merged or blended with other enterprise data.

Variety of Value-Added Uses

There are currently a variety of value-added utilization enterprises sourcing biomass material from the TSA. Listed below are the types of enterprises.

- Forest products;
- Biomass power and steam generation (lumber drying kilns);
- Landscaping products;
- Furniture (e.g., book cases, chairs, outdoor swing sets, salt/pepper shakers);
- Firewood;
- Log homes;
- Pulp and paper (this market is extremely dynamic due to swings in domestic paper product demand versus offshore demand).

Scale of Value-Added Enterprises

Value-added enterprises sourcing feedstocks from the TSA range in scale from an annual demand of 500 pounds of small diameter cedar, lodgepole and manzanita (small one person enterprise) to millions of board feet of softwood sawlogs for commercial-scale lumber production (large-scale sawmill complex employing 250 people). Most enterprises utilize local contractors to collect, process and deliver raw material feedstocks ranging from small diameter logs, to chips (for power/thermal energy), to large diameter sawlogs.

Business Models

Current business enterprise models range from a one-person operation to the largest private landowner in the State of California. The majority are privately owned and managed, although some are publicly-owned enterprises (e.g., Covanta Energy - Mt Lassen Power).

On the small side, individuals participate in local arts and crafts shows as well as market products through custom websites. Primary targeted markets for finished products are regional in scope and focused on California and northern Nevada markets. The larger sawmilling enterprises are targeting markets throughout the United States.

Challenges

Forest Products

The forest products sector is currently very depressed due to the status of housing markets in North America. Additionally, imports from Canada and the Pacific Rim have impacted market share (e.g., radiata pine boards from New Zealand are used in place of ponderosa pine boards manufactured in California). Sawlog availability challenges are primarily due to:

- Various restrictions on public lands in relation to endangered or sensitive species (e.g., limited operating periods).
- Inclement weather conditions that restrict forest operations due to soil moisture levels.
- Curtailments due to high fire danger (primarily on public lands).

All of these issues have led to the curtailment and closure of several commercial-scale sawmills over the past decade. As sawmills scale back operations, the demand for logs and logging contractors has diminished and the average haul distance to transport sawlogs to the mill has increased. This has caused numerous logging contractors to reduce operations or close their doors, decreasing the logging infrastructure in the region.

Compounding the challenges for logging contractors is the very short operating window of five to six months of the year. High insurance rates (e.g., workman's compensation rates) and challenges related to retention of skilled workers (e.g., seasonal work) add to the issues faced by logging contractors.

Biomass Power

The critical issue confronting recovery of forest-sourced biomass is the cost of collection, processing and transport and the current value of wholesale electricity rates. Several biomass plants have reduced production or closed due to low wholesale power rates that have limited their ability to procure forest biomass fuel at prices that compensate contractors for the full costs of collection, processing and transport.

The same issues listed above (sawlog availability challenges) apply to restricted access to forest biomass. Currently, the most cost effective operations integrate logging of sawlogs with removal of sub-merchantable biomass. Value of the sawlogs helps to carry the cost to remove forest biomass. Limited access to sawlogs typically limits access to forest biomass. In addition, the decreasing federal budget and subsequently decreased support to federal agencies for subsidized stewardship contracts with appropriated dollars is reducing the ability of the USFS and BLM to treat and remove biomass from low timber value acres.

Many biomass power plants located in other regions of California utilize a high percentage of low-cost urban and agricultural waste fuels. Some sawmills in the TSA transport waste bark from log decking areas, deliver them into processing sites in the Sacramento Valley, and backhaul agriculture waste for use as biomass fuel. Proposed U.S. EPA standards (e.g., Maximum Achievable Control Technology) may also have a drastic economic impact on existing as well as planned biomass power plants.

Landscaping Products

The current market for landscaping products has greatly diminished due to the overall downturn in the economy. This market should improve as new home and commercial construction ramps up (and the associated landscaping needs for these new homes and businesses).

Furniture

Value-added processors manufacturing rustic furniture are experiencing some raw material sourcing issues. Most large forest landowners do not want to spend the time to accommodate the needs of this niche market. In addition, the USFS permit system still requires an environmental review by resource specialists. As federal agency budgets shrink, staff availability to address these issues for the small forest products enterprises is also constrained.

Firewood

Air quality standards (including spare-the-air days) have decreased the amount of firewood or firewood bundles being used in the larger urban markets. Within the TSA, much of the firewood log resource is sourced from fire salvage operations. Most of the logs available for firewood are softwood, which is not as valuable as hardwood firewood. This limits the ability of local firewood processors to compete with large commercial firewood processors that are marketing hardwood firewood. Firewood is marketed locally with most of the product delivered within a 50-mile radius.

Log Homes

The economic downturn has affected this market similar to the normal housing construction sector. Local log sources are limited because the favored species (lodgepole) form (tree taper) is not as consistent in California as it is in the Rockies. Lodgepole pine logs sourced from the Rockies have better form class (less taper).

Locations

Most of the value-added utilization enterprises are located within the TSA. Some enterprises listed in Table 2 are located outside the TSA but are able to access biomass material due to creative transport arrangements, such as backhauls.

Seasonal Feedstock Sourcing

Forest biomass availability is usually limited to a forest operating season that typically runs from May through mid November. In addition, the USFS requires limited operating periods (LOP) on projects where there are concerns regarding sensitive wildlife habitat. Listed below are examples of LOP that are included in the Sierra Nevada Forest Plan Amendment - Final Supplemental Environmental Impact Statement (SNFPA-FSEIS) Record of Decision, 2004.

- California Spotted Owl – March 1 through August 15
- Goshawk – February 15 through September 15
- Bald Eagle – November 1 through August 31
- Yellow Legged Frog – October 1, or first rain, until April 15
- Red Legged Frog – October 1, or first rain, until April 15
- Marten Den – May 1 through July 31
- Fisher Den – March 1 through June 30
- Red Fox – January 1 through June 30
- Great Grey Owl – March 1 through August 15

Other species of concern that may require LOP (depending on wildlife biologist's professional judgment):

- Palid Bat and Townsend's Big-eared bat – April 1 through October 31
- Western Red Bat – May 20 through August 21

Transport Issues

The primary economic drivers that impact transportation of various materials from the forests can be condensed into two primary considerations: road systems and diesel fuel cost. The most common road system issues are curve turn radius or width, stream crossings (with inadequate crossing radius or width), surface erosion prevention barriers such as rolling dips or water bars and grade (steep grades limit access). Diesel fuel prices and the relation of distance to market can also impact the overall flow of material at any given time. Markets have become more distant as facilities (e.g., sawmills) have closed, which increases average haul distance to market.

Addressing Obstacles that Could Lead to Increases in Forest Biomass Supply

Interviews with foresters and local loggers included a discussion regarding the various operational and economic issues that currently impact the flow of forest biomass material. Most respondents discussed one or more of these obstacles as the barriers to treating more acres, increasing overall supply, and the ability to meet the demands of the current markets in an economical fashion. Most cannot envision new markets developing unless many of the current issues are addressed.

Table 3 summarizes obstacles faced sourcing biomass material from public and private forest lands.

Table 3. Operational and Economic Challenges to Biomass Recovery

CHALLENGE	PUBLIC FOREST LANDS
Operating Season Restrictions	Limited operating periods (LOP) for sensitive species.
Operating Season Restrictions Due to Soil Moisture	Normal winter shutdown from late November to early May. Even during normal operating periods, operations may be shut down if soil moisture and soil properties meet contractual limits.
Litigation Delays Projects	Project litigation that either stops or delays the project. Example: Creeks Project on the Lassen NF original NEPA, sales, litigation and subsequent re-writing of a supplemental EIS has taken six years and still no record of decision.
Small-Scale Projects are Costly to Plan	Time allotted to small projects and permits is often secondary to accomplishing the larger projects. This is due to budget constraints as well as the time it takes to complete Categorical Decisions after the Court required normal review and comment periods to follow the same timeframe as Environmental Analysis (EA). The time changed from a 7-day public notice and completing a document of file information to 30 days' notice and filing an EA.
Fire Equipment Requirements and Fire Weather Curtailments	Region 5 contractual fire requirements have changed and that change has increased fire equipment requirements for contractors and more frequent work curtailments (fire shutdowns) on days worked during the heat of the summer.
Maintaining Skilled Workforce	LOP, fire requirements, and wet conditions have impacted the length of the operating season which impacts contractor's ability to retain skilled workers.
Forest Biomass and Recovery is Costly	Cost of extracting biomass from the woods to the processing facility is not economically viable.
Public Perception	Public and political perception that biomass is not an environmentally sound process. Education of public and political representatives is essential to addressing this barrier.
Appropriated Funding for Fuels Treatment is Inconsistent	Current federal budget reductions and continual debate over the importance of implementing treatments to improve forest and watershed health and the interrelationship of reducing the threat of wildfire.
Outdated Restrictions Regarding Steep Slope Operations	Ground-based treatments on slopes less than 30-35% have been included in standards and guidelines for land management plans on some NF's. The USFS must start addressing slopes over 35%. There is a need to analyze the equipment/technology improvements and biomass recovery and consider treating slopes from 36-45% using cost effective ground-based equipment. Currently the economics of removing biomass from steep slopes with skyline equipment are not financially viable due to market prices for biomass.

CHALLENGE	PRIVATE INDUSTRIAL FOREST LANDS
Operating Season Restrictions	Normal winter shutdown from December to April.
Inconsistent Demand for Biomass Fuel	If a mill is working full production, mill waste will supply co-gen power facility and additional forest biomass is not needed.
Forest Biomass is Costly Compared to Alternative Wood Fuel Sources	Cost of urban and agricultural wood waste is currently less expensive than forest biomass and makes up a substantial amount of the fuel resource procured by the biomass power plants.
Timber Harvest Plan Preparation is Costly	The flow of biomass and logs as feedstock for value-added markets is being inhibited by increased costs for preparation and review of California Timber Harvest Plans (THP). During the last 10-15 years, CALFIRE has witnessed a drastic reduction in THP submittals. Administrative oversight and State and Federal agency review costs have drastically increased. Average annual harvest volume has reduced by 28% over the same time period and acres treated has reduced 49%.
Economics of Biomass Transport	Maximum economic haul distance for forest biomass is approximately 40 miles (three to four round trips per day).
US EPA Proposed Standards	New US EPA standards for commercial boilers (Maximum Achievable Control Technology) have been placed on hold for three years, with several appeals being considered by the federal courts. If implemented, MACT will cost existing facilities millions of dollars to meet and will impact the construction of new facilities.

Table 4 summarizes recommendations regarding pathways to address operational and economic challenges to biomass recovery.

Table 4. Recommendations to Address Operational and Economic Challenges to Biomass Recovery

CHALLENGE	PUBLIC FOREST LANDS
Operating Season Restrictions	Work with USFS and Department of Fish and Wildlife staff to update the LOP if it has been found that operations do not disturb a given species.
Operating Season Restrictions Due to Soil Moisture	Work with USFS staff to review the current soil standards and impacts and update with information from recent peer-reviewed studies.
Litigation Delays Projects	Continue to work with local USFS staff and environmental groups to emphasize the importance of treating over-crowded stands to improve overall ecosystem health and mitigate high hazard fuel accumulation.
Small Scale Projects are Costly to Plan	Review the existing NEPA requirements and possibly establish a new Categorical Exclusion as well as address the timeframe for review.
Fire Equipment Requirements and Fire Weather Curtailments	Continue working with USFS staff and Industrial organization to address issues.
Maintaining Skilled Workforce	If USFS can increase restoration treatment targets and implementation, workforce can increase. If operating season restrictions are addressed, it will be easier to retain skilled workers. Consider winter projects.
Public Perception	Continue to work on environmental education to address the benefits with treating unhealthy ecosystems that result in unnatural buildup of hazardous forest fuels.
Appropriated Funding for Fuels Treatment is Inconsistent	Work with legislative representatives to discuss the benefits of ecosystem health, treating over-crowded forests, watershed improvements and economic benefits by creating more forestry jobs and product value.
Outdated Restrictions Regarding Steep Slope Operations	Continue to work with USFS, industry and technology to implement treatments on selected sites.

CHALLENGE	PRIVATE INDUSTRIAL FOREST LANDS
Operating Season Restrictions	Cannot control.
Inconsistent Demand for Biomass Fuel	During low production periods, continue to provide opportunities for delivery of in-woods biomass to alternative utilization markets.
Forest Biomass is Costly Compared to Alternative Wood Fuel Sources	Work through CPUC or legislatively to gain recognition that wholesale power rates must be increased to reflect value to the electric ratepayers and taxpayers.
Timber Harvest Plan Preparation is Costly	Work with the state legislature and the governor's office to bring awareness to this growing issue and impact.
Economics of Biomass Transport	The costs associated with forest biomass transport are significant and are best addressed through higher wholesale power rates that reflect the true value of forest fuels treatment to the electric ratepayers and taxpayers. With higher power rates the biomass power plants can afford to compensate fuel suppliers and hauling contractors for the costs associated with collection, processing and transport.
US EPA Proposed Standards	Continue to work with legislative representatives, biomass industry, and EPA to address this issue.

Potential Market Review

Interviews conducted yielded a range of alternative value-added uses that may be helpful to improve utilization of small logs and forest biomass sourced from the TSA. As Table 5 indicates, there are existing value-added markets within and tributary to the TSA. Due to inconsistent demand (e.g., biomass power generation curtailments), some contractors are seeking alternative value-added markets for biomass material produced from forest-based operations.

Table 5 lists potential value-added uses as provided by interviewees.

Table 5. Potential Value-Added Markets Within or Tributary to the TSA

VALUE-ADDED USE	FEEDSTOCK	FEEDSTOCK SPECIFICATION	MINIMUM ANNUAL VOLUME REQUIRED	COMMENTS
Small-Scale Power Generation	Forest Biomass	3" minus, <50% MC	10,000 BDT	Have the distinct advantage of sourcing fuel from a smaller region, thus reducing transport costs. Recent technological improvements.
Small Thermal Energy Production	Forest Biomass	3" minus, <50% MC	200 BDT	Best applied when fossil fuel prices (fuel oil, propane or natural gas) are high.
Pulp and Paper	Forest Biomass	3" minus, bark free		No operating pulp/paper facilities in California.
Post/Poles	Small Logs	Ponderosa pine Doug fir		No commercial-scale post or pole operations active in California. Six treating facilities in California. Closest is California Cascade Industries (Woodland, CA).
Composite Panels or Boards	Forest Biomass	3" minus, bark free		Trex Company (Fernley, NV) has expressed interest in forest biomass as furnish.
Densified Fuels (pellets, bricks or firelogs)	Forest Biomass	3" minus, bark free, <40% MC		Prefer dry, bark-free chips. Current market for residential fuel pellets is depressed due to low natural gas prices.
Animal Bedding	Small Logs	Softwood logs, except incense cedar	10,000-20,000 green tons	Closest producer currently is American Wood Fibers at Jamestown, which markets product to SF Bay area and LA. AWF also has a bagging facility in Marysville that utilizes mill residuals (dry shavings) as feedstock.
Firewood	Small Logs	6"+ log diameter		Mostly lower-value softwood logs available.
Log and Processed Lumber Furniture	Small to Large Logs	Pine, cedar, Douglas fir and lodgepole		Current value-added markets prefer hardwood species; most are not available within the TSA.

Previous Work Focused on Potential Value-Added Markets

Contact was initiated with local economic development agencies including Plumas Corporation, Lassen County Economic Development Department, and University of California Cooperative Extension regarding previous work completed within the TSA.

Reports addressing value-added utilization were dated (1997 or older) and include:

- Ethanol Manufacturing Feasibility Study - 1997; Biomass feedstock assessment to determine availability of forest biomass material tributary to six sites including Chester, Westwood, Greenville, Loyalton, Martel, and Anderson.
- Northern Sierra Nevada Biomass Study - 1996; Forest biomass inventory review of the Plumas, Tahoe and El Dorado National Forests.
- Wood Pellets Feasibility Study - 1990; Preliminary study of the potential to site a densified fuel pellet operation in Plumas County.
- Furniture Manufacturing Plan - 1990; Preliminary study of the potential to site a furniture manufacturing operation in Plumas County.

While previous reports provide some context regarding past efforts to consider value-added utilization in the region, they are of limited use due to outdated information and outdated assessment tools and methodologies.

Value-Added Opportunities Considered

TSS is working with University of California Cooperative Extension[3] to coordinate a value-added analysis for use within the Sierra Nevada range. The result of this analysis is a value-added matrix. Table 6 represents the current iteration of this matrix.

[3]Gareth Mayhead, Academic Coordinator, Forest Products.

A range of value-added utilization options were considered in the development of the forest biomass value-added utilization matrix presented in Table 6.[4]

Table 6. Value-Added Utilization Matrix

PROCESS OR PRODUCT	DEVELOPMENT STATUS	FEEDSTOCK SPECIFICATIONS	JOBS (FTE) LOW	HIGH	MAIN EQUIPMENT	MARKET POTENTIAL	COMMENTS
Wood fuel pellets	Commercially deployed	Clean, dry (<10% mc) chip, needs to be <1% ash.	15	85	Pellet mill, dryer, cooler, hammermill, packaging.	Domestic users now, animal bedding now, potential for boilers (including co-fire with coal), niche barbeque pellets? Large scale gives access to international markets for co-firing.	Use of biomass from forest possible (e.g., small logs or chips low in bark) - key issue and expense is drying system. Larger scale facility will face challenges in gaining market share for domestic stoves. Very large-scale export facility will have feedstock sourcing challenges, exposure to currency exchange rate risk and need ready access to international port facilities.
Fuel bricks	Commercially deployed	Chip, dry (<15% mc), needles, bark okay.	3	6	Brick machine, dryer, cooler, hammermill, packaging.	Substitute for firewood is the primary market.	Potential to use field dried material as feedstock?
Fire logs	Commercially deployed	Clean, dry (<10% mc) chip, needs to be <1% ash.	3	9	Log machine, dryer, cooler, hammermill, packaging.	Substitute for firewood is the primary market.	Use of biomass from forest possible (e.g., small logs or chips low in bark) - key issue and expense is drying system. Competition can be a significant challenge.

[4]Gareth Mayhead, Academic Coordinator, Forest Products provided assistance in the development of the value-added matrix.

PROCESS OR PRODUCT	DEVELOPMENT STATUS	FEEDSTOCK SPECIFICATIONS	JOBS (FTE) LOW	HIGH	MAIN EQUIPMENT	MARKET POTENTIAL	COMMENTS
Wood plastic composites (WPC)	Commercially deployed	Clean, dry (2-12% mc) wood flour. Wood is ~55% of feedstock along with plastic and additives. Recycled wood use common.	0	0	Blender (compounder extruder), extrusion line, cooler, cut-off saw.	Landscape (bender board), decking, park furniture (picnic tables and seats).	Requires cost effective thermoplastic feedstock (HDPE, LDPE, PP, PVC). Utilize recycled plastics (milk jugs, plastic bags). Commercial facilities typically use pine, oak and maple. Blending (compounding) of wood and plastic may be two processes or single process depending upon equipment. Commercial molding processes typically continuous extrusion or batch injection molding. Other processes such as resin transfer molding (RTM) and others not commercially deployed. Could just make compounded wood-plastic pellets for WPC manufacturers.
Compound pellets for WPC production	Commercially deployed	Clean, dry (2-8% mc) wood flour. Wood is ~55% of feedstock along with plastic and additives. Recycled wood use common.	0	0	Compounder extruder.	Existing WPC mills (none in CA).	Cheaper way to get into WPC market place than making finished products.
Decorative bark	Commercially deployed	Small roundwood that is easily de-barked. Raw bark from sawmills is common feedstock source.	2	6	Debarker (flail, ring or rosser head), screen (trommel or flat).	High value up in urban areas (FOB $<100/ton).	As sawmill residuals become scarce, value of bark for landscape cover increases. Alternative use is hog fuel.

PROCESS OR PRODUCT	DEVELOPMENT STATUS	FEEDSTOCK SPECIFICATIONS	JOBS (FTE) LOW	HIGH	MAIN EQUIPMENT	MARKET POTENTIAL	COMMENTS
Decorative chip	Commercially deployed	Bark free and sized (no fines) wood chip.	2	6	Debarker (flail, ring or rosser head), screen (trommel or flat).	Colorized landscape cover sold in bulk and/or bagged.	Colored landscape cover requires additional equipment (colorizer). Feedstock (bark free chip) has alternative markets such as pulp/paper and furnish for composite products (particleboard/hardboard/decking).
Heating (buildings)	Commercially deployed	Woody biomass chipped to 3"minus, 50% mc, 3% ash.	1	2	Boiler system and hot water or steam delivery system.	Especially cost effective if replacing existing heating oil or propane heat. Can use for cooling also (using absorption chillers).	Fuel sizing has been an issue with recently installed thermal energy facilities. Design and engineering team needs to address fuel sizing inconsistencies by including screens and hammer mills to assure correct fuel sizing. Typical installations include schools, hospitals, and community buildings.
Firewood	Commercially deployed	Roundwood (hardwood is preferred) logs that can be processed using automated firewood processor.	2	8	Log splitter or firewood processor.	Could be marketed to urban centers in boxes or bundles. Hardwood worth more. Higher prices for firewood near to affluent urban areas.	Numerous firewood contractors already in place. Large contractors and businesses have significant market share.

PROCESS OR PRODUCT	DEVELOPMENT STATUS	FEEDSTOCK SPECIFICATIONS	JOBS (FTE) LOW	HIGH	MAIN EQUIPMENT	MARKET POTENTIAL	COMMENTS
Post and pole	Commercially deployed	Straight, low taper softwood (lodgepole, ponderosa, white fir) is preferred.	5	15	Rosser head peeler and/or doweller. Sorting line. Bucking saw.	Sold to treating facilities or wholesalers. Market includes landscape timbers vineyards fences, furniture.	Need to treat - nearest facility is in Silver Springs, NV. More efficient post/pole mills have merchandizing system to perform multiple sorts to reduce diameter variance in batch runs.
Small-scale sawmill	Commercially deployed	Medium to large size roundwood.	2	10	Debarker, head rig, resaw, edger.	May need to target specialty markets to secure optimal value for products.	Tough to compete with large-scale sawmills for logs and lumber sales. Niche markets for lumber are important. Most lumber is low-value commodity product.
Lumber kiln	Commercially deployed	Lumber products or firewood.	1	2	Kiln (steam or dehumidifier).	Kiln dried lumber has added value in the market place. Transport of dried lumber products is more cost effective (due to lower weight).	Could also dry firewood or heat treat lumber and packaging to meet ISPM15. Could use waste wood as a fuel source.

PROCESS OR PRODUCT	DEVELOPMENT STATUS	FEEDSTOCK SPECIFICATIONS	JOBS (FTE) LOW	HIGH	MAIN EQUIPMENT	MARKET POTENTIAL	COMMENTS
Gasification	Demonstration projects	Woody biomass chipped to 3"minus, 30% mc, 3% ash. Drier fuel preferred.	2	5	Gasifier, gas clean-up, IC engine or turbine-generator.	Technology is evolving quickly and is becoming more cost effective.	More appropriate where electrical and thermal energy wholesale rates are high or in remote installations where power is not currently available.
Slow pyrolysis	Commercially deployed	Wood pieces (flexible spec).	1	2	Charcoal kiln.	Charcoal for cooking, artist's charcoal, filtration, soil amendment (biochar).	Very few slow pyrolysis units currently deployed. Only West Coast facility is Kingsford Charcoal at Springfield, OR.
Mild pyrolysis (torrefaction)	Pilot projects/R&D	Wood pieces (spec is vendor specific).	0	0	Reaction unit.	Co-firing in coal power plants (no modifications required to coal handling systems) or as fuel supplement for biomass power plants.	Torrefied fuel could be highly marketable due to BTU/pound and impervious to water. Coal is a key solid fuel in the marketplace and tends to set the price point.
Fast pyrolysis	Pilot projects/R&D	Small (1/4" minus), dry, clean wood particles.	0	0	Reaction unit.	Char for filtration, cooking, soil improvement. No ready market for bio oil, except at oil refineries (upgrader).	Some significant investments made in R&D, including demonstration facilities (portable and fixed). Promising technology that may be commercially viable soon.

PROCESS OR PRODUCT	DEVELOPMENT STATUS	FEEDSTOCK SPECIFICATIONS	JOBS (FTE) LOW	HIGH	MAIN EQUIPMENT	MARKET POTENTIAL	COMMENTS
Solid fuel steam cycle (biopower)	Commercially deployed	Woody biomass chipped to 3"minus, 50% mc, 3% ash. Drier fuel preferred.	2	30	Fuel handling, boiler, turbine-generator, emissions control, water cooling and recovery.	Technology is evolving quickly and is becoming more cost effective.	More appropriate where electrical and thermal energy wholesale rates are high. Typically found in states with attractive Renewable Portfolio Standards.
Air filtration media	Commercially deployed	Virgin material that will grind to large heterogeneous particles.	0	0	Grinder and screen.	Wastewater treatment facilities, etc.	Need other market for grinder material (e.g., hog fuel or landscaping) that does not meet specifications for filtration media.
Compost	Commercially deployed	Greenwaste (tree trimmings/grass clippings) is optimal.	2	6	Grinder, screen and windrow turner.	Soil amendment market is seasonal. Compost and mulch operations work best on same site. Typically sold in bulk or bagged.	There may be opportunities to install compost operation near existing landfills to divert greenwaste away from landfills.
Mulch	Commercially deployed	Greenwaste (tree trimmings/grass clippings) is optimal.	2	6	Grinder and screen.	Soil amendment market is seasonal. Compost and mulch operations work best on same site.	Very similar to compost operation. In fact, compost/mulch operations typically share the same site.

PROCESS OR PRODUCT	DEVELOPMENT STATUS	FEEDSTOCK SPECIFICATIONS	JOBS (FTE) LOW	HIGH	MAIN EQUIPMENT	MARKET POTENTIAL	COMMENTS
Chip for pulp/paper or composite panel furnish	Commercially deployed	Woody biomass chipped to 3"minus, 50% mc, bark free with few fines.	3	6	Debarking equipment (e.g., chain flail) chipper and screen.	No pulp/paper operations operating in CA. Two composite panel facilities in CA (Martel and Rocklin).	Very limited markets (no pulp mills and two composite panel operations) in CA. Chip export market may ramp up and demand in the Pacific Rim trends higher.
Anaerobic digestion	Commercially deployed	Wide range of feedstocks: greenwaste, manure, and food waste.	1	2	Digester.	Compost market. Methane can be used for heat or electricity generation.	Could complement agricultural or food waste streams. Typically co-located with agricultural operations (dairy).
Veneer	Commercially deployed	Straight logs with limited taper. 8"+ diameter.	40	80+	Steaming vats, veneer lathes, trimming, rolling stock.	Plywood and LVL mills are in Oregon, peeler cores (2"-4") sold into post and pole market.	Typically a large commercial-scale facility (process 420 blocks per hour).
Animal bedding (shavings)	Commercially deployed	Small roundwood (ponderosa pine preferred).	2	6	Whole log shaver, screens, drying, packaging.	Can be sold in bulk and/or in bags.	Closest commercial operation at Jamestown in Tuolumne County.

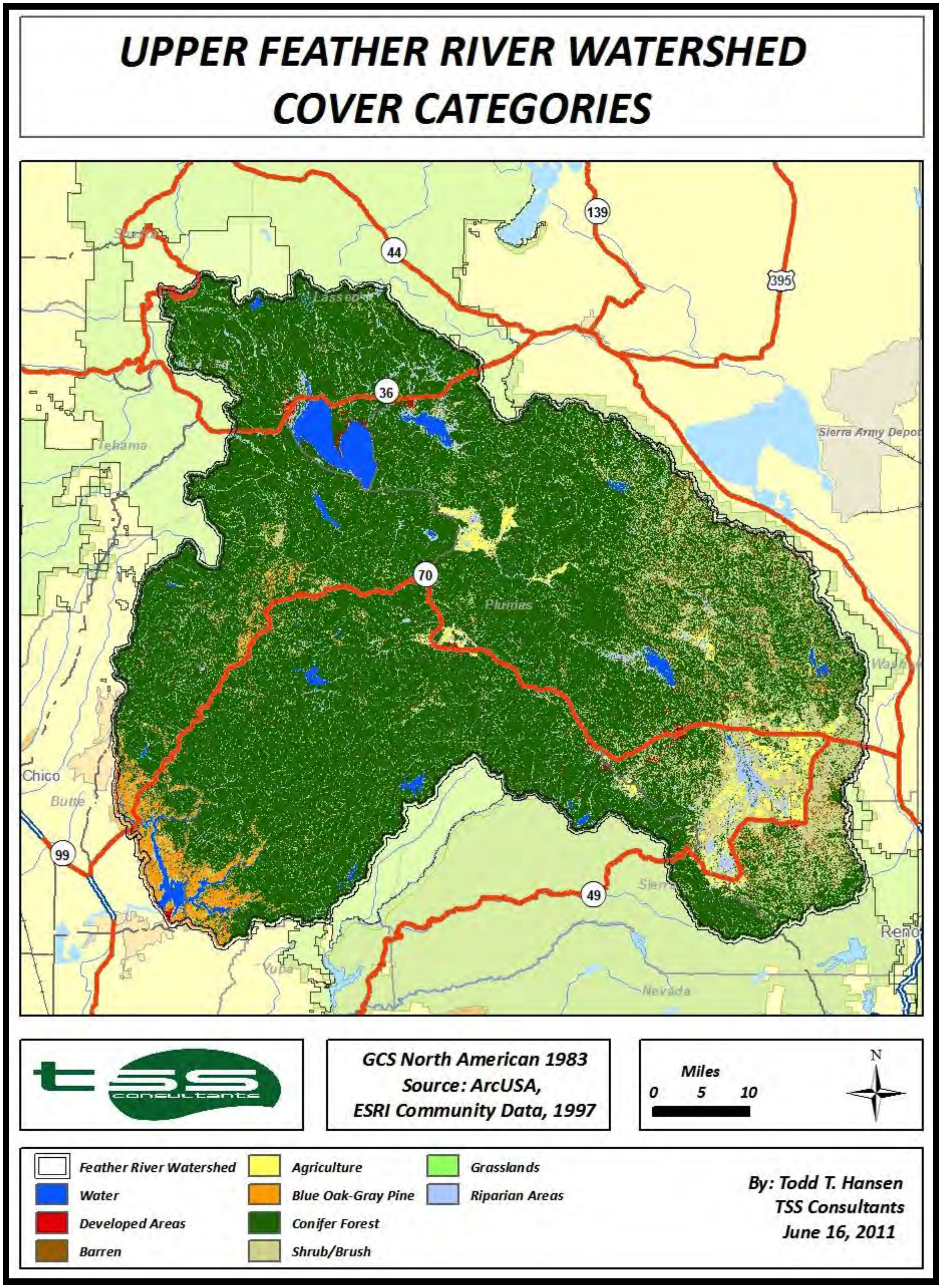
FOREST RESOURCE AVAILABILITY REVIEW

The primary focus of this review was to determine current availability of sub-merchantable logs and forest biomass material generated as a byproduct of timber harvest operations, fuels treatment and timber stand improvement projects conducted with the Upper Feather River Watershed TSA (see Figure 1 for map of TSA).

Vegetation Cover and Land Ownership/Jurisdiction

Forest biomass availability for any given region is heavily dependent on vegetation cover, land management objectives and ownership. Vegetation cover within the TSA is predominantly coniferous forest (74%). Figure 2 shows vegetation cover types within the TSA.

Figure 2. Vegetation Cover Within the Target Study Area



Vegetation cover types significantly influence forest biomass availability. Depending on management objectives, certain cover types could generate significant volumes of woody biomass material for use as feedstock for value-added utilization. Table 7 summarizes vegetation cover by category within the TSA.

Table 7. Vegetation Cover Within the TSA

COVER CATEGORIES	ACRES	PERCENT OF TOTAL
Agriculture	46,494	2.1%
Barren	48,165	2.1%
Developed Areas	17,845	0.8%
Blue Oak-Gray Pine	55,675	2.5%
Conifer Forest	1,672,804	74.2%
Grassland	345	0.0%
Riparian Areas	146,705	6.5%
Shrub/Brush	265,112	11.8%
TOTALS	**2,253,145**	**100.0%**

Land ownership drives vegetation management objectives. Within the TSA, the USFS is the most significant land manager with responsibility for approximately 65% of the forested landscape (see Table 8). Private land makes up about 34% and other public jurisdictions (e.g., state lands, Bureau of Land Management, BLM) make up relatively little acreage at 1%. Land ownership and management is illustrated in Figure 3.

Federal jurisdiction and management objectives have a significant influence regarding forest biomass material availability within the TSA. For example, each national forest has land management standards and guidelines that provide guidance for land managers that design and implement vegetation management activities. Each national forest has a Land and Resource Management Plan (LRMP) that includes standards and guidelines that are consistent with federal policy such as the National Forest Management Act (NFMA) and the National Environmental Policy Act (NEPA). LRMPs are up for review and are programmed to be updated every 10 or 15 years to meet NFMA direction.

Standards and guidelines play a significant role influencing the volume of biomass recovered from forest landscapes. For example, the volume of biomass retained on site for nutrient cycling (down woody material) and wildlife habitat (standing snags and down logs) is set in the standards and guides. Additionally, the slope gradient guide normally followed by federal land managers for ground-based mechanical equipment is commonly set at <35%, which can limit efficient ground-based operations. Private land managers regularly utilize ground-based equipment on slopes up to 45% gradient but will operate on topography reaching to 55% gradient.

Figure 3 highlights the locations of the various ownerships and jurisdictions.

Figure 3. Land Ownership/Jurisdiction Within the TSA

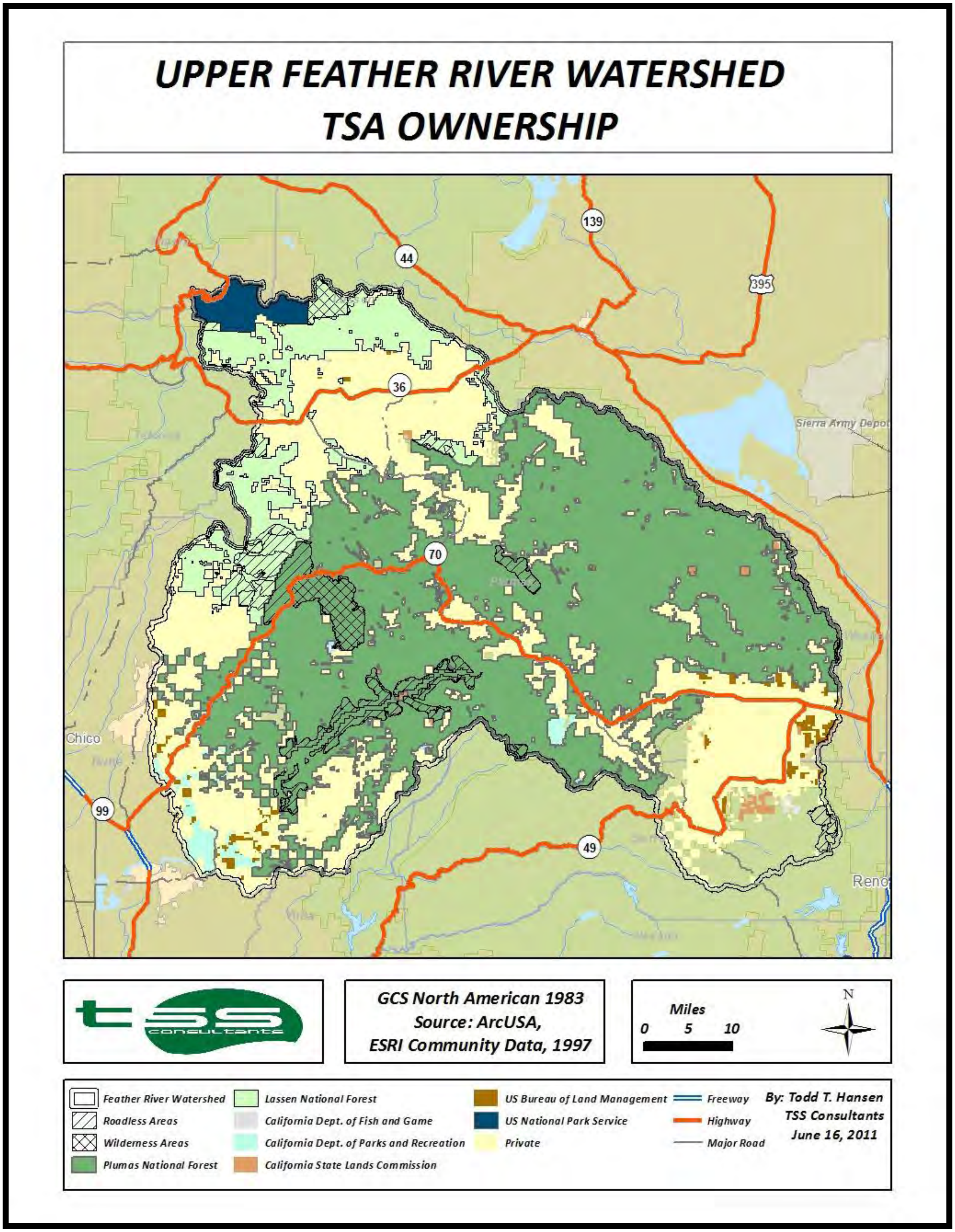


Table 8 summarizes land ownership and jurisdiction within the TSA.

Table 8. Land Ownership/Jurisdiction Forest Vegetation Cover Within the TSA

LAND OWNER/MANAGER	FORESTED ACRES	PERCENT OF TOTAL
Bureau of Land Management	2,486	0.2%
California Department of Fish & Game	415	0.0%
California Department of Parks & Recreation	10,850	0.7%
California State Lands Commission	4,123	0.3%
Private	537,914	33.9%
USFS (Net)[5]	1,029,714	64.9%
TOTALS	**1,585,502**	**100.0%**

There are several land management classifications within the USFS jurisdiction. Some classifications do not allow for biomass material removal. For example, areas designated as wilderness and roadless areas are not subject to active vegetation management activities. The 1,029,714 acres of USFS managed lands listed in Table 8 have been adjusted to address the fact that wilderness and roadless areas are considered off-base for active vegetation management activities.

Topography Within the Target Study Area

Forest biomass recovery activities are generally restricted to topography that will allow ready access for equipment and crew. As discussed above, topography over 35% slope gradient is commonly considered to be the break-off point for ground-based logging and/or biomass recovery equipment on federally (USFS and BLM) managed lands. Private land managers typically utilize ground-based equipment on slopes up to 50 to 55%, but the cost of operating on sustained slopes above 35% is higher due to less production. Alternative technologies such as skyline systems or helicopter removal are very costly and in many cases are not an economic alternative.

Figure 4 highlights topography that is over 35% slope within the TSA.

[5]Adjusted for wilderness and roadless areas which total approximately 128,350 acres wthin the TSA.

Figure 4. Slope Analysis of the TSA

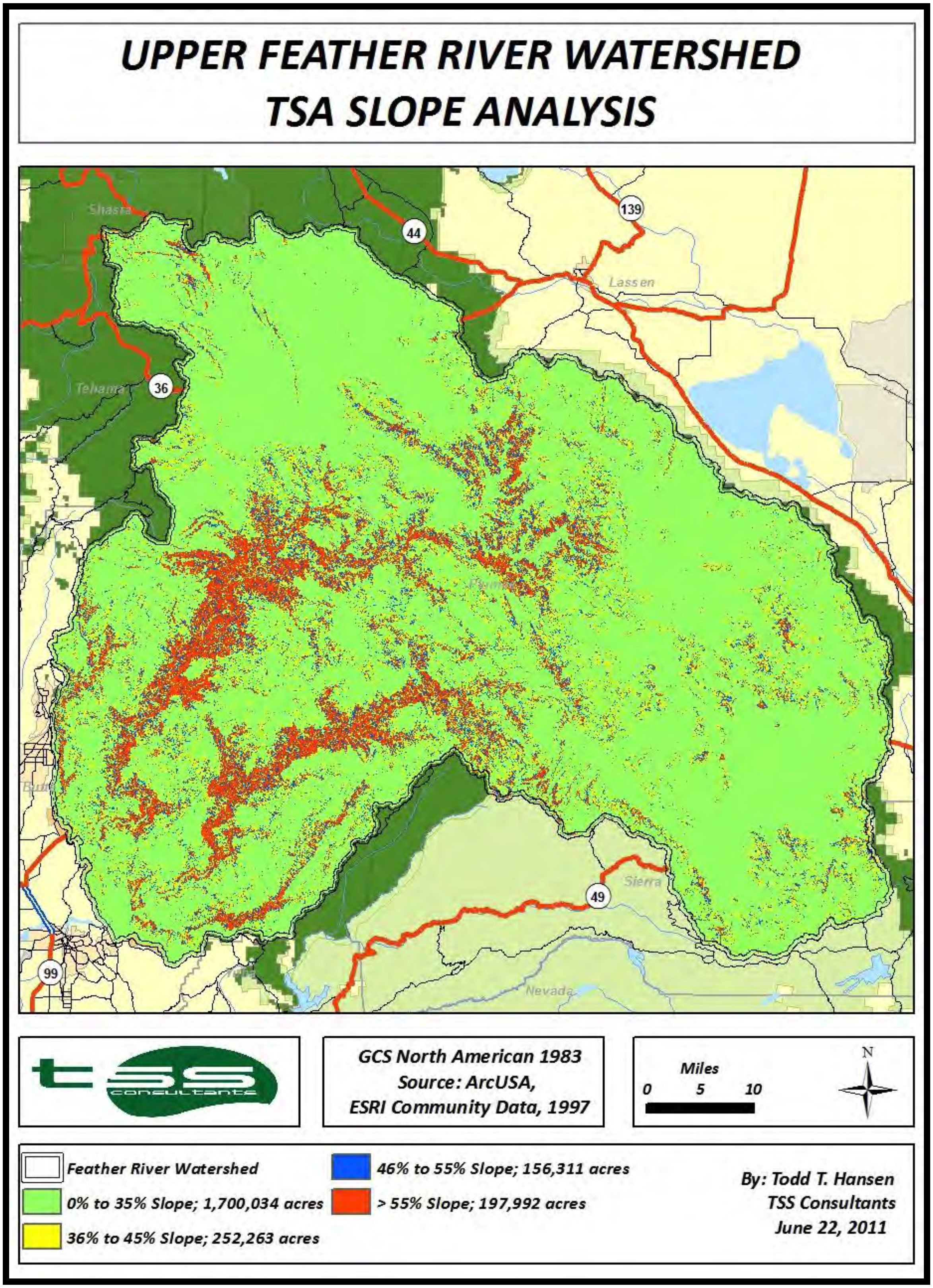


Table 9 summarizes results of the topography review for the TSA.

Table 9. Topography Classification Within the TSA

TOPOGRAPHY	ACRES	PERCENT OF TOTAL
35% slope and less	1,700,034	73.7%
36% to 45% slope	252,263	10.9%
46% to 55% slope	156,311	6.8%
Over 55% slope	197,992	8.6%
TOTALS	**2,306,600**	**100.0%**

Approximately 74% of the topography within the TSA is 35% slope or less and is considered potentially available for biomass recovery activities. TSS further analyzed the TSA topography to account for acres by forest ownership that are potentially available for vegetation management. Table 10 summarizes the results by incremental slope classification gradients by forest ownership.

Table 10. Forest Cover Topography Classification by Ownership Within the TSA

OWNERSHIP	BLM	USFS	OTHER PUBLIC	PRIVATE
35% slope and less	1,389	695,305	9,791	418,901
36% to 45% slope	405	141,543	1,963	56,730
46% to 55% slope	295	88,308	1,390	31,186
Over 55% slope	397	104,558	2,243	31,097
TOTALS	**2,486**	**1,029,714**	**15,388**	**537,914**

Ground-based forest biomass harvest, collection, and processing equipment has evolved in recent years so that treatment of steeper topography is possible. Light on the land, low impact tracked equipment utilizing self-leveling technologies allow foresters to treat land up to 55% slope on private lands using environmentally sensitive, cost effective and efficient ground-based equipment.

The evolution of ground-based harvesting equipment has been dictated by changes in silvicultural practices that in recent decades have transitioned away from even-aged management to uneven-aged management. Prevalent today are thinning prescriptions aimed at fuel reduction, forest and watershed health restoration with the dominant cutting method being mechanical cutting with feller/bunchers and bundles of whole trees being transported roadside by grapple skidders. Feller bunchers have been designed for lower ground pressure (wide tracks) and self-leveling cabs to keep the center of gravity over the middle of the pads to increase safety on steeper slopes and reduce soil disturbance. Field trials to exhibit and monitor steep slope ground-based equipment should be considered.

If demonstrated to have minimal impact, standards and guides should be modified to reflect findings.

Biomass Fuel Availability

Woody biomass material sources considered in this study included a range of forest-sourced biomass:

- Timber harvest operations;
- Fuels treatment/restoration projects/timber stand improvement projects.

Timber Harvest Operations

Timber harvest residuals can provide significant volumes of woody biomass material. Typically available as limbs, tops and unmerchantable logs, these residuals are byproducts of commercial timber harvesting operations. As such, these residuals can be a relatively economic raw material fuel supply. Once collected and processed using portable chippers or grinders, this material is an excellent biomass fuel source or feedstock for compost/mulch.

Small, non-merchantable logs that do not meet sawlog specifications can also be recovered from timber harvest operations. Sawlog specifications (e.g., 6" and larger diameter measured small end inside bark) are set so that most of the tree stem is made available for solid wood products (e.g., lumber and veneer). The tops (<6" stem) are typically left on the landing following de-limbing and could be made available for value-added uses such as firewood, post/poles or animal bedding logs.

Timber harvest activity within California is monitored by the Board of Equalization (BOE). The BOE levies timber harvest taxes based on annual timber harvest levels. A review of the 2006 through 2010 timber harvest data (courtesy of the BOE) was conducted to confirm historic timber harvest activities by county within the TSA. Note that four counties (Butte, Lassen, Plumas and Sierra) make up over 98.5% of the forested landscape within the TSA. Yuba and Shasta counties each make up less than 1% of the forested acres in the TSA and so were not included in forest harvest calculations. Table 11 provides the results.

Table 11. 2006 Through 2010 Timber Harvest Volume Produced Within the TSA (Expressed in MBF[6]/Year)

COUNTY	2006	2007	2008	2009	2010	5 YEAR AVERAGE HARVEST	PERCENT OF COUNTY IN TSA	WTD AVERAGE ANNUAL HARVEST
Butte	62,797	65,964	92,484	70,688	31,739	64,734	49.9%	32,287
Lassen	60,307	29,139	35,450	31,015	47,418	40,666	9.2%	3,726
Plumas	118,936	136,521	146,094	63,742	88,996	110,858	91.4%	101,333
Sierra	22,041	50,105	9,790	8,632	20,755	22,265	18.1%	4,039
Totals	**264,081**	**281,729**	**283,818**	**174,077**	**188,908**	**238,523**		**141,386**

Results of historic timber harvest figures confirm that harvest levels over time have been variable. A primary driver is the demand for sawlogs, which was significantly diminished in 2009 and 2010 due to curtailment of the Sierra Pacific Industries small log sawmill at Quincy. The Quincy mill is now operating at full capacity with both the small log mill and large log mill operating on a two-shift basis.

The 2006 through 2010 historic record of timber harvest across all four counties results in an average annual harvest of 238,523 MBF. The TSA is made up of portions of these counties and using GIS analysis, TSS was able to determine the portion of each county that lies within the TSA (see Table 11). Using this data, a weighted average timber harvest figure was calculated for each county. From this methodology, TSS was able to conclude that the average annual timber harvest for the TSA amounts to 141,386 MBF per year.

TSS' experience with forest biomass recovery within the TSA confirms that a recovery factor of 0.9 bone dry ton (BDT)[7] per MBF would apply to forest stands located in the TSA. This amounts to a gross potential of 127,247 BDT per year of timber harvest residuals.

Not all topography or road systems will accommodate biomass recovery operations. Based on slope analysis (see Table 10) and for the purposes of this forecast, it is assumed that 75% of the timber harvest operations within the TSA are located on topography (<35% on federal lands and <55% on private lands) and road systems that will support biomass recovery. Using this assumption, approximately 95,435 BDT per year (75% of 127,247 BDT) are projected to be available as timber harvest residuals from forested acres within the TSA.

Economic recovery of forest biomass from forested landscapes is highly dependent upon the technologies deployed to transport forest biomass. Most forest road systems were designed to accommodate sawlog removal which is accomplished using log trucks. Log trucks are designed to articulate and are able to navigate relatively tight radius curves and

[6]MBF = thousand board foot measure. One board foot is nominally 12" long by 12" wide and 1" thick.
[7]One bone dry ton equals 2,000 dry pounds of wood fiber.

steep grades. Most biomass recovery operations are conducted using conventional 40 or 48 foot chip vans that require forest roads with wider radius curves and slopes under 15%.

In recent years, there have been innovative technologies developed to deploy biomass chip transport systems that can navigate challenging forest road systems and facilitate higher rates of biomass recovery. TSS conducted a transportation network system assessment of two Transport Assessment Study Areas located within the TSA.[8] This assessment provides additional information regarding ready access and recovery of forest biomass within the TSA. In addition, TSS implemented forest transportation system field trials to evaluate innovative transport system technologies that can improve recovery of forest biomass.[9] Both the transport network system analysis and the forest transport system field trials results are addressed in later sections of this report.

Another element of the transportation system involves roadside landings that are used to sort, process and load sawlogs and biomass material for transportation. As additional forest biomass material is considered for recovery, sorting, processing, transport and utilization, there is a need to expand landing size to accommodate additional machinery and allow truck access (truck turn-around areas).

Fuels Treatment/Forest Restoration/Timber Stand Improvement

The Upper Feather River Watershed is home to numerous communities with residential neighborhoods situated within or adjacent to the wildland urban interface (WUI). Due to high fire danger conditions within the WUI, there are concerted efforts across all forest ownerships to proactively reduce hazardous forest fuels in support of defensible communities.

The TSA is home to several grass roots based Fire Safe Councils that facilitate implementation of fuels treatment activities strategically located near communities, including:

- Lassen County Fire Safe Council
- Plumas County Fire Safe Council
- Sierra County Fire Safe Council

Each of these councils is responsible for facilitating fuel treatment on private lands amounting to hundreds of acres per year. Funding support for these councils comes from a variety of state and federal sources. Unfortunately, in recent years, funding levels have dropped precipitously as have the number of acres treated. Whenever possible, the Fire Safe Councils market woody biomass material and sawlogs to value-added markets to offset some of the costs associated with treatment and removal of excess fuels.[10]

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[8]Per Task 4 of the Scope of Work.
[9]Per Task 5 of the Scope of Work.
[10]Per discussions with Tom Esgate, Lassen County FSC; Jerry Hurley, Plumas County FSC; and Cindy Noble, Sierra County FSC.

Interviews with private foresters[11] managing commercial forest operations within the TSA on large and small forest ownerships confirmed that most fuels treatment activities on private lands are conducted in concert with commercial harvests. These integrated operations employ single forest entry for removing sawtimber and hazardous fuels. Once treated, many of these forest stands will not require additional treatments or entries for 15 to 20 years.

Discussions with public land managers[12] confirmed a similar approach with integrated, single entry forest management operations facilitating multiple objectives consistent with standards and guides set in each forest's LRMP.

Forest restoration activities are typically associated with wildfire events or insect/disease. These occur as unpredictable events and are considered episodic and at times, random. Because these events are not predictable, they are not included in this biomass availability review. However, recovery and utilization of forest biomass following catastrophic wildfire events have historically (e.g., Cottonwood Fire, Moonlight Fire) allowed forest managers to accelerate reforestation and restoration activities. In addition, the revenue generated from value-added uses of fire-damaged biomass resources (sawlogs and biomass fuel for power generation) has offset many of the costs incurred to restore fire-damaged landscapes.

In recent years, wildlife habitat restoration activities utilizing sawlog harvesting and biomass recovery techniques have been implemented to restore aspen stands. Over the last century, conifer forest encroachment has severely reduced once prevalent aspen stands.

On federal lands, there are concerted efforts to treat targeted forest stands (e.g., forest plantations and managed stands) for stocking control. Most forest plantations are established with reforestation techniques using 10' by 10' tree planting densities. This results in about 400 trees per acre planted. At a certain age (10 to 15 years), these plantations require thinning of the less dominant trees so that residual trees (dominant trees) are free to grow and not compete for soil moisture/nutrients and sunlight. Known as timber stand improvement projects, these activities typically generate volumes of forest biomass that can be recovered. Timber stand improvement projects are more prevalent on federal lands and are dependent upon federal appropriations set annually by Congress. On private lands, the timber stand improvement activities are integrated with fuels treatment and sawlog removal.

Discussions with public land managers, Fire Safe Councils and private land management foresters confirmed near-term plans to conduct fuels treatment, habitat restoration and timber stand improvement activities. Estimates of acres targeted for treatment that will allow recovery of forest biomass were provided.

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[11] Danielle Banchio and Jay Francis.
[12] Ryan Tompkins, Plumas NF, John Zarlengo, Almanor RD, Walter Levings, Tahoe NF.

External factors play a significant role in providing funding and revenue that directly impact fuels treatment, habitat restoration and timber stand improvement activities and include:

- Market prices for sawtimber;
- State/federal appropriations for fuels treatment and defensible communities;
- Federal appropriations for USFS timber management, habitat restoration and timber stand improvement activities;
- Market prices for biomass fuel;
- Extension of the HFQLG[13] Act.

Summarized in Table 12 are the results of these interviews. Note that results are presented as a low and high range to reflect the externalities listed above and the fact that acres treated per year will vary over time. Also note that Table 12 assumes that the HFQLG Act is extended for another five-year pilot period.

Table 12. Forest Fuels Treatment/Habitat Restoration/Timber Stand Improvement Activities Planned Within the TSA

ORGANIZATION	ACRES PER YEAR	
	LOW RANGE	HIGH RANGE
USFS – Almanor RD, Plumas NF & Sierraville RD	2,125	5,225
Lassen County Fire Safe Council	200	400
Plumas County Fire Safe Council	300	500
Sierra County Fire Safe Council	50	150
Private forest lands	3,000	4,500
TOTALS	**5,675**	**10,775**

Interviews with forest managers and fiber procurement foresters confirmed that between 8 and 15 BDT per acre of forest biomass is typically recoverable from forest harvest/restoration/timber stand improvement activities within the TSA. Public land managers typically retain at least 10 BDT[14] of down woody material per acre, and this is not considered recoverable. Assuming an average recovery factor of 10 BDT per acre and the annual acres treated shown in Table 12, between 56,750 and 107,750 BDT will be generated per year from fuels treatment/restoration and timber stand improvement operations in the TSA.

Quincy Library Group

The USFS-managed portions of the TSA are currently subject to land management policies set by the Herger Feinstein Quincy Library Group Forest Restoration Act of

[13]Herger Feinstein Quincy Library Group Forest Restoration Act.
[14]Per standards and guides consistent with the 2004 Sierra Framework.

1998. Initially set by Congress to be implemented over a five-year pilot period, the HFQLG has been extended once (initial pilot period commenced in fiscal year 2000) and is currently set to sunset September 30, 2012.

Congress originally supported the HFQLG Act by appropriating about $30 million dollars annually to support innovative approaches and landscape level strategies focused on fuels treatment and forest restoration. Most of the efforts have been concentrated on installation of defensible fuels profile zones strategically located near communities and at-risk forest landscapes.

Federal funding will likely drop considerably should Congress decide not to extend the HFQLG as proposed in HR 3685 for a second five-year period. With this drop in appropriated funding, there will be fewer acres treated (hazardous fuels reduction/forest restoration) and less forest biomass available for recovery and utilization. Total acres receiving fuels treatment, restoration or timber stand improvement treatments within the TSA on the Almanor RD, Plumas NF and Sierraville RD are forecast to range from 840 acres to 2,180 acres per year if the HFQLG is not extended.

Biomass Fuel Results

Summarized in Table 13 are the results of forest biomass material availability review from forest management activities within the TSA.

Table 13. Forest Biomass Material Potentially Available from Forest Operations Conducted Within the TSA

BIOMASS MATERIAL SOURCE	BDT PER YEAR	
	LOW RANGE	HIGH RANGE
Timber Harvest Residuals	81,120	109,750
Fuels Treatment/Restoration/Timber Stand Improvement Activities	51,250	96,250
Fuels Treatment Activities – Fire Safe Councils	550	1,150
TOTAL	**132,920**	**207,150**

Time of Year Availability

Discussions with local foresters indicate that the typical field season for forest operations is May 1 through November 15 on private lands. On USFS-managed lands, the normal operating season is typically June 1 through October 31. A variety of factors impact the operating season, including snow depth and wet soil conditions (e.g., soil compaction). In 2011, the field season did not begin until mid June for many parts of the TSA, as snow depth prevented road access and unseasonal snow/rain kept soil conditions wet.

PRELIMINARY TRANSPORTATION NETWORK ASSESSMENT

This transportation network assessment is a problem-solving analysis to address key forest biomass transport challenges associated with forest fuels treatments and forest restoration activities. This assessment seeks to quantify these challenges through the use of field analysis, supported by geospatial analysis that is calibrated by field work and transportation system trials. Current markets for biomass material within the TSA include firewood, biomass fuel for power and heat, and occasionally as feedstock for composite products. There may be opportunities to diversify value-added options if an improved transportation model can enhance the economic recovery of additional material.

Previous tasks in this study have identified current and potential value-added markets that support low-value woody biomass materials and determined the current availability of such materials generated within the TSA. The availability review portion of this assessment, in particular, will help answer four key questions necessary to conducting a geospatial transportation network assessment of select road systems to confirm the nature of current accessible forest biomass material. These key questions are:

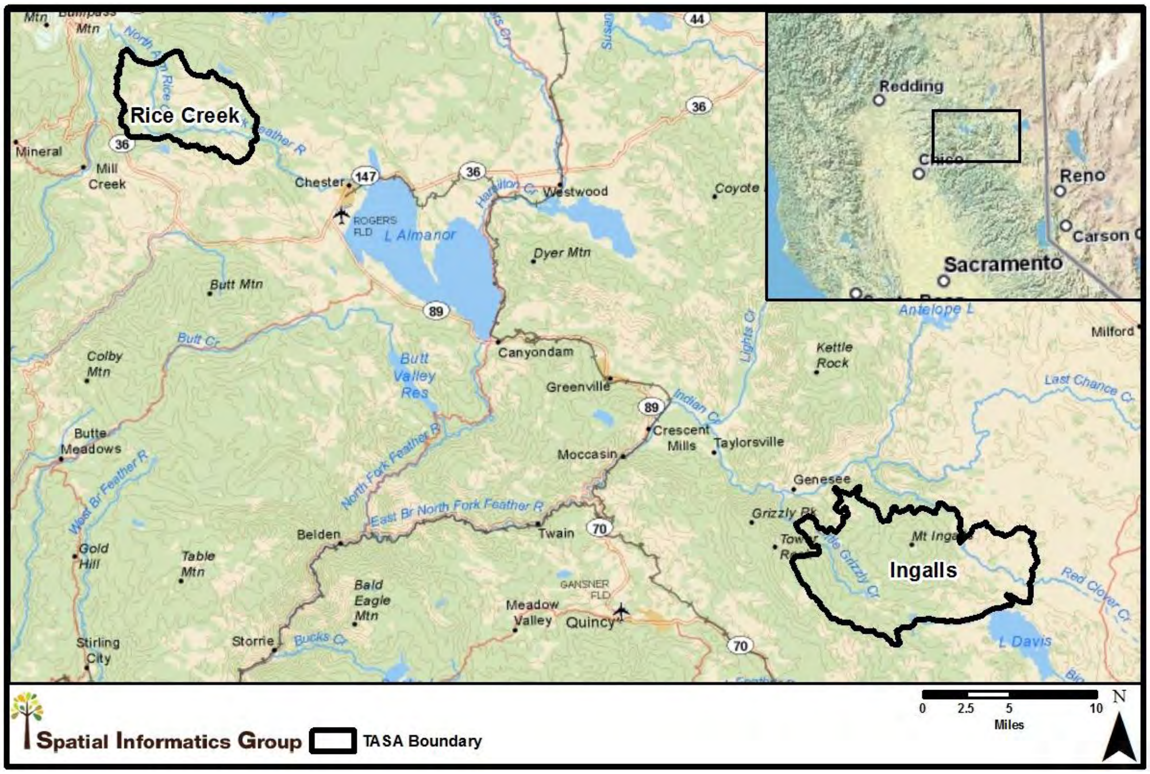
- How much biomass is available on the existing transportation system?
- How much does it cost to move the material to a facility?
- How much will it cost to fix existing problems in the system?
- If road improvements are completed, what additional volumes of forest biomass are available?

Transportation Assessment Study Area

The transportation network assessment was focused on two study areas from the five Transport Assessment Study Areas identified by the Sierra Institute. The two TASA chosen for assessment are Rice Creek (21,475 acres) and Ingalls (49,400 acres) (see Figure 5). Selecting the two TASA involved consideration for comparison of various analysis benefits. TSS selected one TASA within the Northern Sierra Nevada Geologic Province (Ingalls) and one within the Southern Cascade Geologic Province (Rice). The desired result of such a selection would illustrate geologic, topographic and possibly vegetation variation on biomass supply, accessibility and transportation.

The Ingalls TASA was reconfigured once the research team reviewed the original boundaries. The team determined that the potential biomass supply and related transportation issues would provide a more realistic perspective for analysis if the boundaries were reconfigured. Areas that could only be treated through helicopter systems as well as those that were dominated by rocky outcrops were deleted. Added were adjacent areas that had an existing transportation system and higher density (better supply) of potential biomass.

Figure 5. Transportation Assessment Study Areas



Biomass Transportation Analytical Framework

This analysis was divided into four phases. The first phase of the analysis consisted of collecting and developing the most accurate geospatial data for the TASA. The second phase quantified biomass availability at a project scale to get a detailed estimate of biomass availability. The third phase consisted of quantifying how the existing transportation network can be modified and how such modifications could impact biomass availability and its recovery costs. The final phase created an analytical framework that quantifies the economic tradeoffs between different transportation systems and biomass recovery assumptions on the total biomass availability and costs. A summary of each phase is provided below.

Phase 1. Data Development

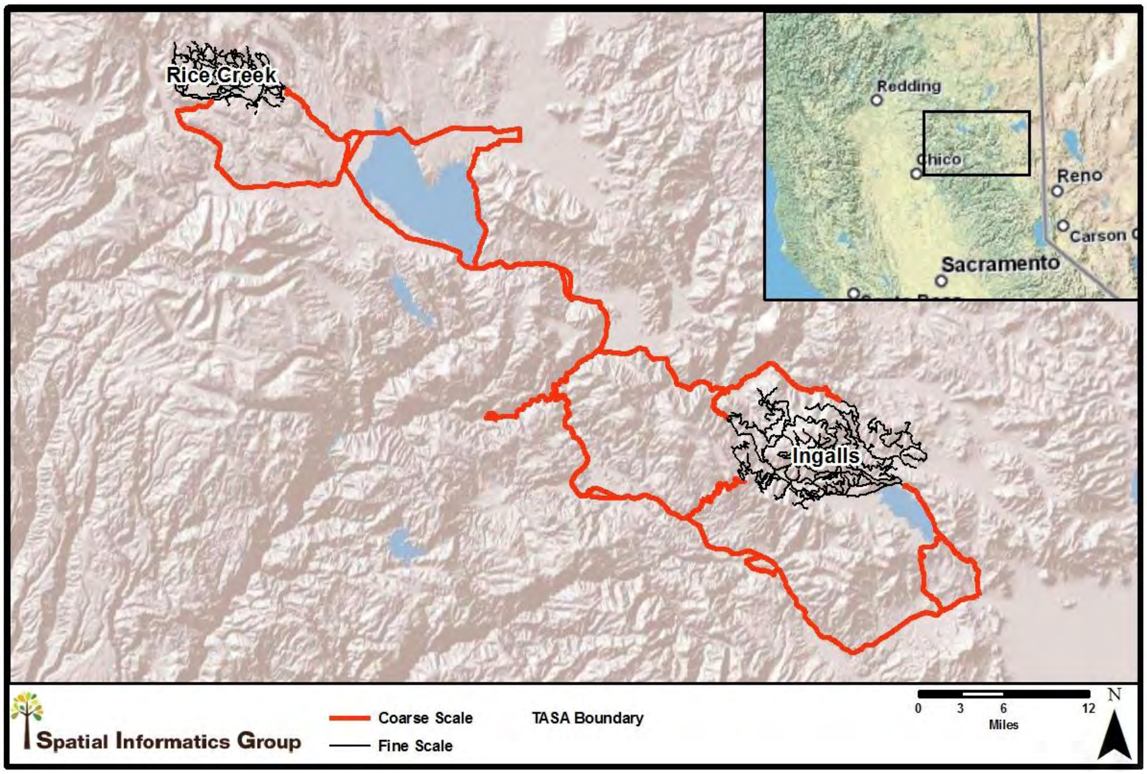
The transportation network analysis was anchored in field work and expert, local knowledge of existing systems. On-the-ground field work comprised a significant component of this analysis. This field work was used for validation and to update existing USFS GIS datasets as well as to create accurate field data sets (e.g., landings and choke point locations). Field work was also used to identify road systems that accommodate current transportation system technologies (e.g., 40' chip vans) regularly utilized in the TASA through consultation with experts (including truck drivers) and geospatial analysis. GPS units were used to verify existing transportation networks, register choke points, and identify the capacity of existing landings for allowing standard vans to turn around. This data collection assisted in the identification of areas needing improvement in order to accommodate transportation technologies, both current and innovative.

Spatial data for this analysis was obtained by the team from various sources including field work, governmental agencies, NGOs, and universities. Data sources were assessed for overall reliability and screened for appropriateness and general accuracy. Where necessary, all spatial data were re-projected from their native projection into Universal Transverse Mercator, Zone 10 N (North American Datum 1983). All data was obtained for an area greater than this study's analysis area and clipped to the data domain. Subsequent analysis of spatial data was performed primarily in the GIS software ArcGIS Desktop 10 SP2. All raster-based data obtained was in 30m resolution and was snapped (co-registered) to the same base layer and resampled where necessary. Data used in this analysis are described below.

Transportation Networks

The transportation network dataset served as one of the most important layers in the analysis. It was developed for two separate but linked purposes: create a project level understanding of biomass transportation improvement costs; and quantify total biomass transportation costs from the forest to the utilization facilities (e.g., biomass power plant). Additionally, a coarse scale and fine scale dataset were developed that included the following attribution: Surface Type, Ownership, and Networking Priority (see Figure 6).

Figure 6. Transportation Network



Fine Scale Road Network

Data were obtained from USFS staff based on the Plumas National Forest and Lassen National Forest. Both datasets were needed to support analysis efforts in the two TASA of Rice Creek (Lassen) and Ingalls (Plumas). The network was validated from field verification as well as from aerial photography in areas where the networks were not accessible in the field. Surface type and maintenance levels were verified or updated from field collection.

Coarse Scale Road Network

Data were obtained from either existing USFS data, from major roads datasets, or from digitizing aerial photos. This road network connects the potential available biomass available in each TASA to the utilization facilities. Each surface type was verified from field review for this analysis.

Table 14 summarizes the road miles by attribute type.

Table 14. Transport Network Miles by Surface Type, Ownership, TASA, and Source

COARSE SCALE	INGALLS	RICE	MILL NETWORK	TOTAL
Fed AGG	5.0	0.0	0.0	5.0
Fed DIRT	1.5	0.1	0.6	2.2
Non-Fed DIRT	16.9	0.0	3.0	19.9
Non-Fed BIT	0.0	0.0	0.0	0.0
Non-Fed PAVE	128.7	0.0	50.4	179.1
FINE SCALE	**INGALLS**	**RICE**	**MILL NETWORK**	**TOTAL**
Fed AGG	17.8	34.0	0.0	51.8
Fed DIRT	175.2	63.8	0.1	239.1
Non-Fed DIRT	27.7	0.0	0.0	27.7
Non-Fed BIT	0.0	5.2	0.0	5.2
Non-Fed PAVE	0.0	1.0	0.3	1.3
TOTALS	**INGALLS**	**RICE**	**MILL NETWORK**	**TOTAL**
TOTAL FED AGG	**22.8**	**34.0**	**0.0**	**56.8**
TOTAL FED DIRT	**176.7**	**63.9**	**0.7**	**241.3**
TOTAL NON-FED DIRT	**44.6**	**0.0**	**3.0**	**47.6**
TOTAL NON-FED BIT	**0.0**	**5.2**	**0.0**	**5.2**
TOTAL NON-FED PAVE	**128.7**	**1.0**	**50.7**	**180.4**

Fed = Federal land, Non-Fed = Non-Federal Land, AGG = Crushed Aggregate Surface Type, DIRT = Dirt Surface Type, PAVE = Paved Surface Type, BIT = Bituminous, Mill Network = road miles outside of the TASA that link TASA to utilization facilities.

Biomass Harvest Opportunities/Constraints

We utilized a 'Go/No-Go' analysis to determine areas suitable for biomass harvest. A 'Go' attribute would be a characteristic that favors harvest and a 'No-Go' attribute would be a characteristic that would prohibit harvest. These attributes included slope, ownership, and regulatory restrictions. Several datasets were needed for this analysis including a Digital Elevation Model, Hydrology and Sensitive Areas layers.

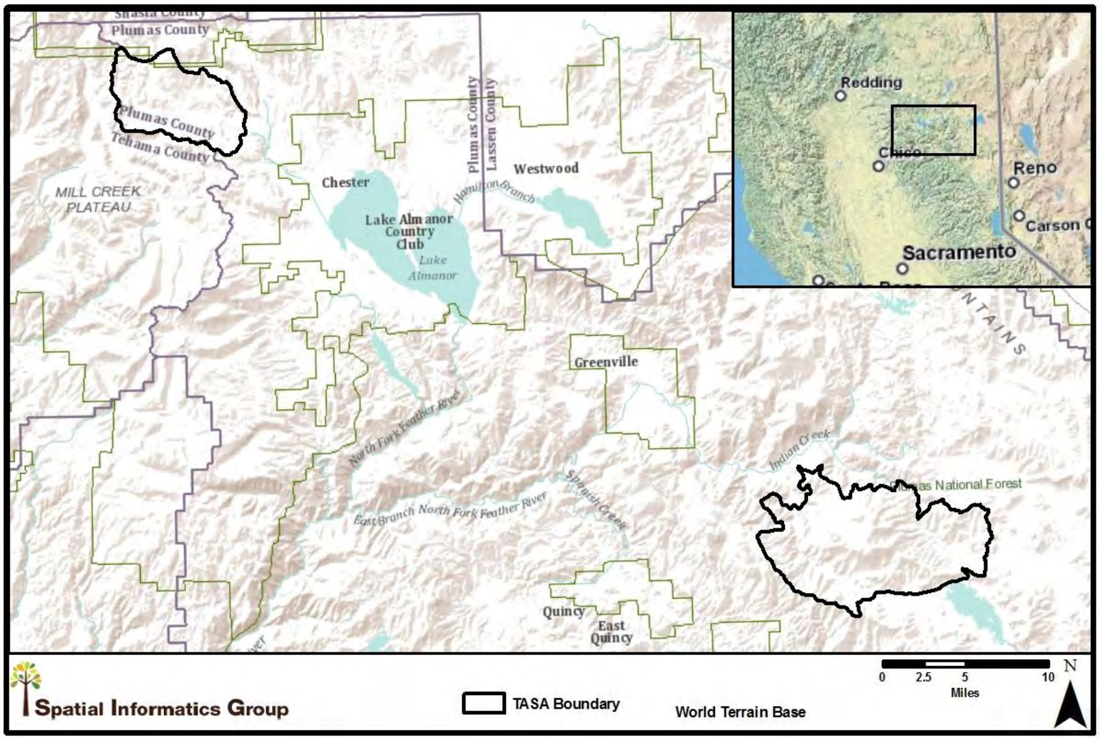
Digital Elevation Model (DEM)

A DEM was used in both the Go/No-Go analysis and the landing assessment (see Figure 7). The slope gradient normally followed by federal land managers for ground-based mechanical equipment is commonly set at <35%, which can limit efficient ground-based operations. Private land managers regularly utilize ground-based equipment on slopes up to 45% gradient but will operate on topography reaching to 50% gradient. The DEM was also utilized in the analysis for locating areas that could support landings. These sites typically are within a 0-15% slope range.

The Go/No-Go analysis used a comparison of ground-based mechanical equipment on slopes of 0-35% as the normal operating range. Because of changes in both forest practice prescriptions and forest harvesting technology, the analysis also compared the difference of accessing slopes of 0-45% for ground-based operations. Currently, most National Forests use standards and guides that were developed and approved in the 1980s. At that time, most forest projects were still using prescriptions for overstory removal and clear-cutting that involved treatment of sawlogs only and dominated by intermediate to old growth age trees. The common harvesting methods were hand falling and skidding to landings with the use of chokers behind larger rubber tired skidders and D6 to D7 conventional cats.

Since the mid 1990s to the present, the majority of National Forest projects within Region 5 use prescriptions calling for thinning of biomass to small diameter sawlogs with random removal of intermediate and old growth trees. The current technology to address this change is dominantly mechanical and includes cutters (aka feller-bunchers) that bunch the material that is then transported to the landing with the use of rubber tired or tracked grapple skidders. The low ground pressure self-leveling cabs on the mechanical cutters have allowed the USFS to consider such changes (allowing operations on slopes up to 45%) when reviewing individual projects. This change in technology can allow thinning prescriptions and ground-based harvest methods on certain soil types to occur on slopes from 0-45% instead of the normal 0-35%. This comparative analysis was run to provide potential expansion of ground-based harvesting and supply of biomass considering these changes.

Figure 7. TASA Terrain



Hydrology

Hydrologic data was obtained from both the Plumas and Lassen National Forests personnel (see Figure 8). Data sources originated from the National Hydrography Dataset (NHD). The NHD is a comprehensive set of digital spatial data that represents the surface waters of the United States using common features such as lakes, ponds, streams, rivers, canals, stream gauges, and dams. Streams were utilized in this analysis for exclusion of areas from which biomass would not be recovered (due to riparian conservation area buffers). Since the NHD does not classify the stream network, USGS blue line streams were used to differentiate between perennial and non-perennial networks. A 300-foot buffer was placed on the blue line designated streams in accordance with the riparian conservation area buffer guidelines in the Sierra Nevada Framework Plan Amendment Supplemental EIR. For the rest of the streams in the NHD network that are not designated as a blue line stream, a 50-foot buffer was used. The 50-foot buffer was determined by using USDA Scientific Assessment Team Guidelines (see Tables 15 and 16) for buffer widths and equipment exclusion zones in intermittent and ephemeral streams.

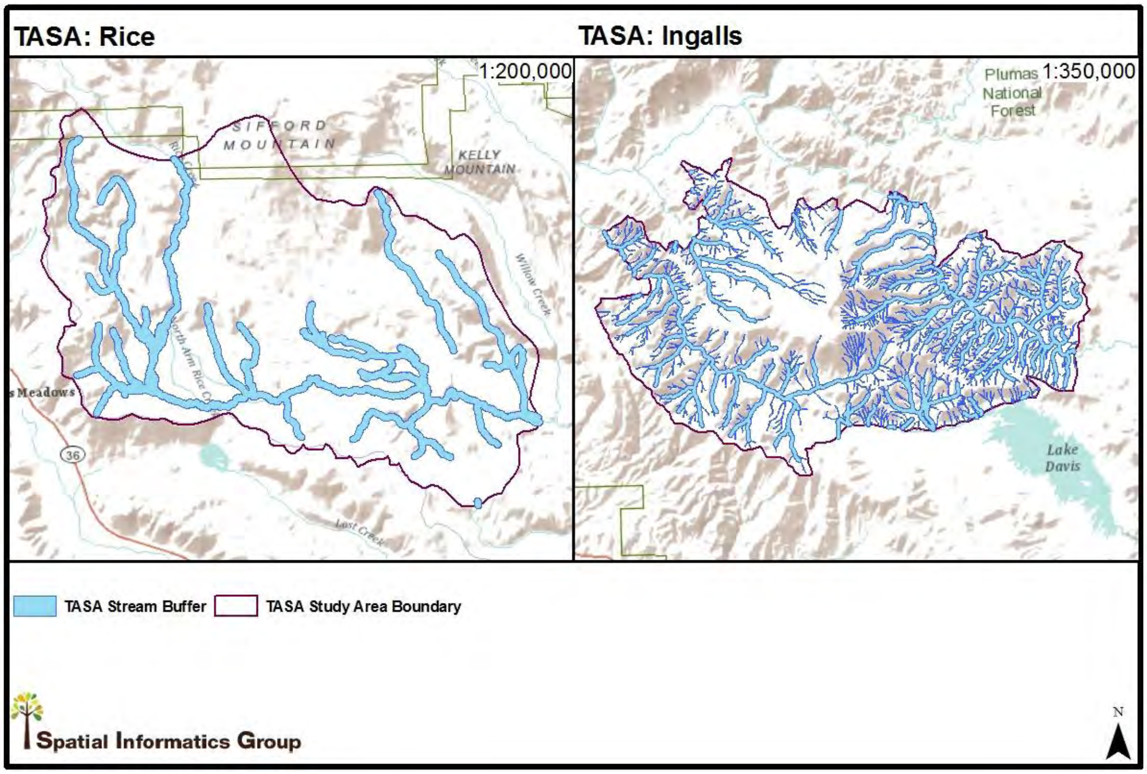
Table 15. Scientific Assessment Team (SAT) Guidelines for Stream Buffers

STREAM TYPE	PRESCRIBED STREAM BUFFER WIDTH (FEET)
Perennial, fish bearing	300
Perennial, non-fish bearing	150
Intermittent	100
Ephemeral	100

Table 16. Equipment Exclusion Zones in Stream Zones by Slope Class (Expressed in Feet)

STREAM TYPE	SLOPE CLASS		
	0 - 15%	15% - 25%	>25%
Perennial, fish bearing	100	150	No mechanical equipment allowed
Perennial, non-fish bearing	50	100	No mechanical equipment allowed
Intermittent	25	50	No mechanical equipment allowed
Ephemeral	25	25	No mechanical equipment allowed
Reservoirs/wetlands >1 acre	50	75	No mechanical equipment allowed

Figure 8. TASA Hydrology

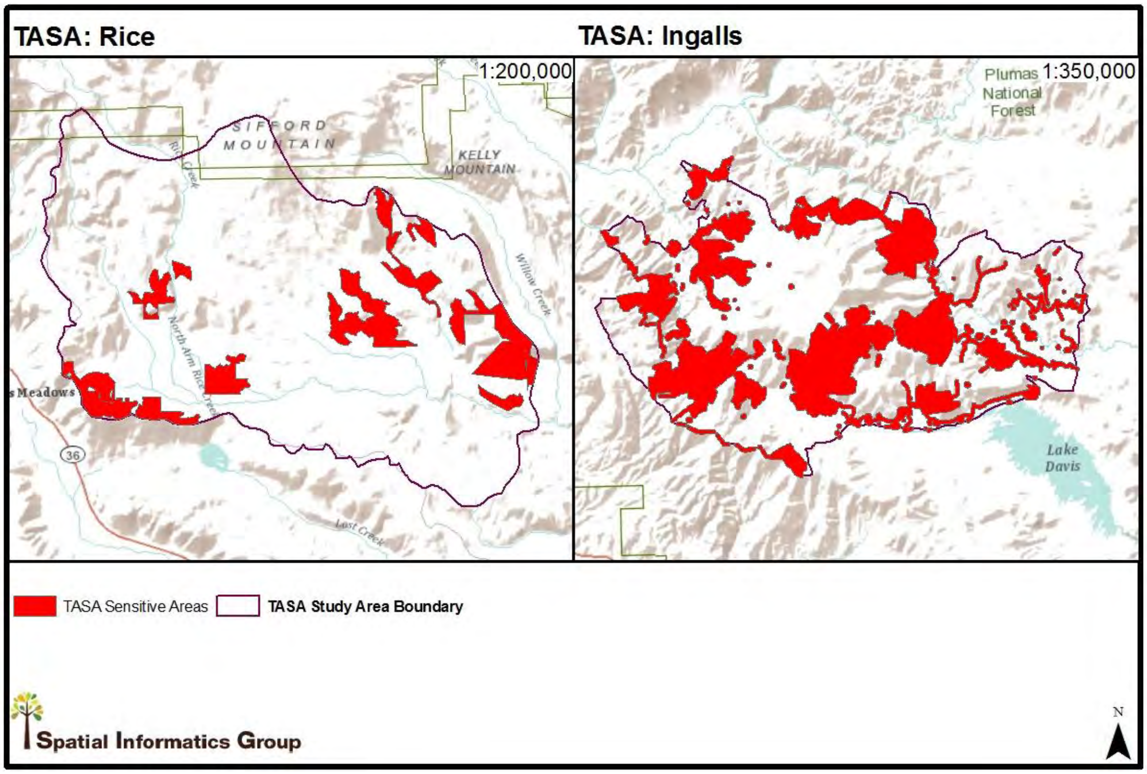


Sensitive Areas

The sensitive area data was generated for the study by Plumas and Lassen National Forest personnel. The areas were defined as "sensitive" if they had any vegetation, wildlife, or archeological special status. These areas were determined to not be available for recovery of biomass material (see Figure 9). The sensitive polygon data received from the Plumas NF arbitrarily buffered any sensitive species or archaeological sites to reflect pre-designated constraints in the harvesting of biomass. The Lassen NF data produced sensitive areas of biological and archaeological sites. The biological data includes territorial areas along with most suitable habitat to support the territories. Archaeological areas are survey based.

The Plumas data seemed to cover more area due to the general buffers placed around sensitive areas whereas the Lassen data was more habitat specific or survey specific. The same species were accounted for in both datasets, which included Goshawks and Owl Protected Activity Centers (PACs) and Archaeological sites.

Figure 9. Sensitive Areas



Landings

The landing dataset was developed by the research team for use in all phases of the analysis and was critical for cross linkage between the information flows. For this analysis, biomass was considered accessible from a landing based on the previous steps. Several key attributes were then applied to the landing as a placeholder, including the cost to create it, the minimum biomass that was required to open it, and its location in context to the road network. The preparation costs can be changed in the tool discussed in Phase 4. This data was collected using both field and remote sensing approaches. Table 17 provides a summary of the total number of landings by TASA and source data used in this analysis.

Existing landing locations were pinpointed using GPS equipment during field survey and analyzed for size and ability to turn a standard chip van. Each landing was also assessed to determine how to improve each location to accommodate turning radius. The majority of the landing locations for the Ingalls TASA and the Rice TASA were located using field work and placement from the GIS ortho-photo layer. The criteria used for both the remote sensing, field and placement from the GIS ortho-photo layer all followed the same selection criteria.

The following describes criteria used for determining landing locations optimal to biomass collection, processing and transport operations.

- **Location:** Location of landings must take into account resource issues that exist on any given piece of land.

    - "Best" location is on topographic points where roads curve. "Favorable" locations have slope from 0-15% so that the amount of soil disturbance is minimized.
    - Placement on such points allow for disturbance to be away from drainages and also allow biomass/small sawlog material to feed to the point from down ridge lines as well as from both sides of the ridge slope break.
    - If landings are off of curve/topographic points, then locate along roads where slope is gentle (0-15%) so that road cuts are at a minimum.
    - If road cuts and slope are over approximately 3 feet high and slopes are increasing in the range of 20% plus, consider alternative sites that may be above or below the road that are more gentle in slope and would/could accommodate a short temporary road spur.
    - Locations as described above should also use areas that are open (not wet/meadow) or fairly devoid of trees. The more vegetation (especially trees), the more disturbance it takes to construct, the more room needed for stump disposal, and there are additional costs in equipment (e.g., dozer) time to construct.
    - General practice is to allow landings about every 1,300 to 1,600 feet along road systems assuming that maximum external yarding distance for each skid trail is from 660 to 800 feet. This would allow skidding of material between landings to go both ways. Longer or shorter skids and thus landing spacing will occur depending on topography and amount of biomass material targeted for removal. This is an approximate figure for economic consideration and skid time into each landing.

- **Size:**

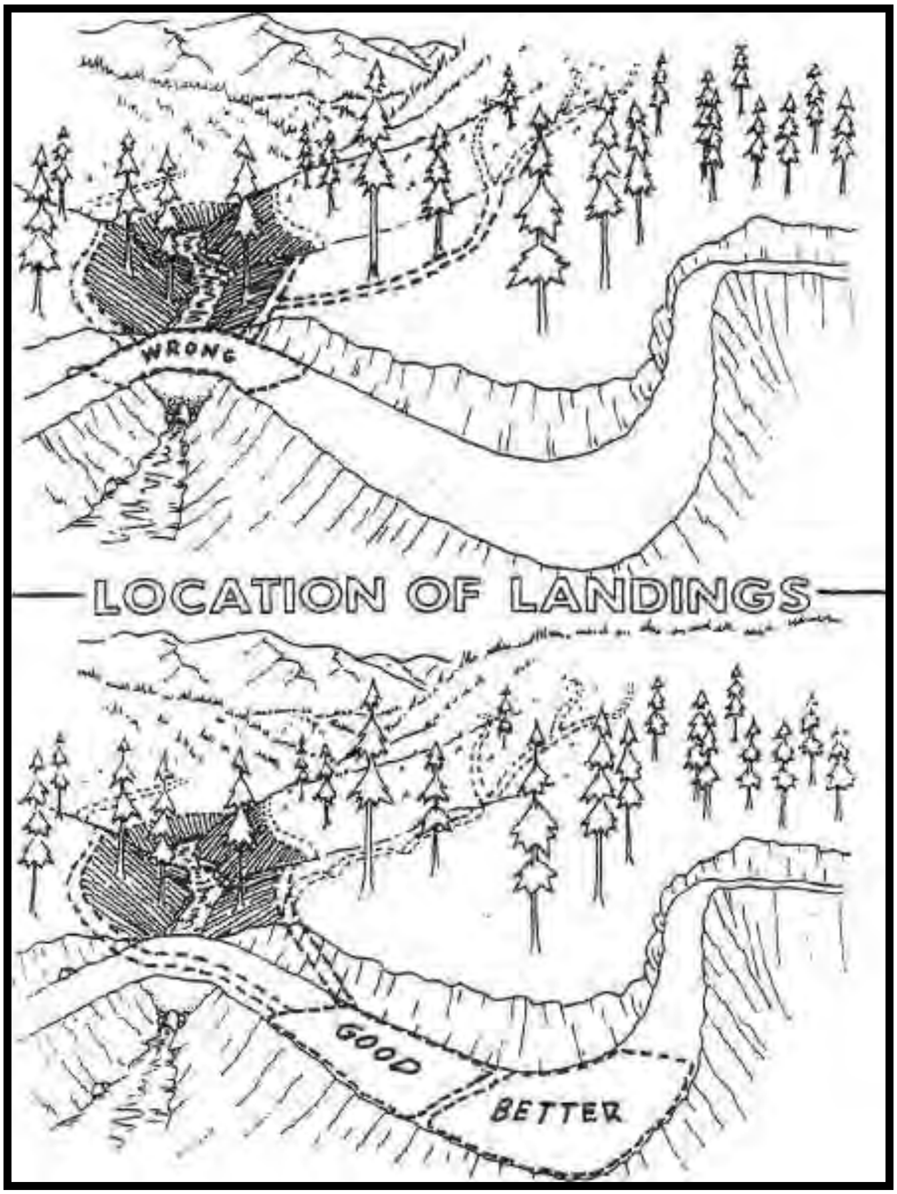
    - Landing locations should accommodate construction of approximately .3 to .5 acres to allow for processor, chipper, biomass pile (small trees and tops from small sawlogs), room for entry in and out for skidding equipment, and room to allow chip vans to turn on the landing.

- **Areas to Avoid:**

    - Do not locate landings near drainages. This is a more important factor as streams transition from perennial to ephemeral drainages.
    - Do not locate landings in areas that show signs of water flow or drainage (springs or meadow/seep locations).
    - Avoid known archeology sites, endangered or sensitive plants as well as owl PACs, other known nesting locations for goshawk, eagle and other sensitive species. Noxious weed locations are also to be avoided.

The following diagram (Figure 10) illustrates the locations discussed above as far as placement on the landscape.

Figure 10. Optimized Landing Location Diagram[15]



GPS Landings

Landings were located by the research team using GPS tools. Each landing was reviewed for the potential to turn a standard chip van within the existing limits or the potential for expanding the existing landing if it was too small.

[15]This diagram was developed by USFS Soil Scientist Jack Fisher of the Shasta-Trinity National Forest in the early 1970s and is still used in Sale Administration training.

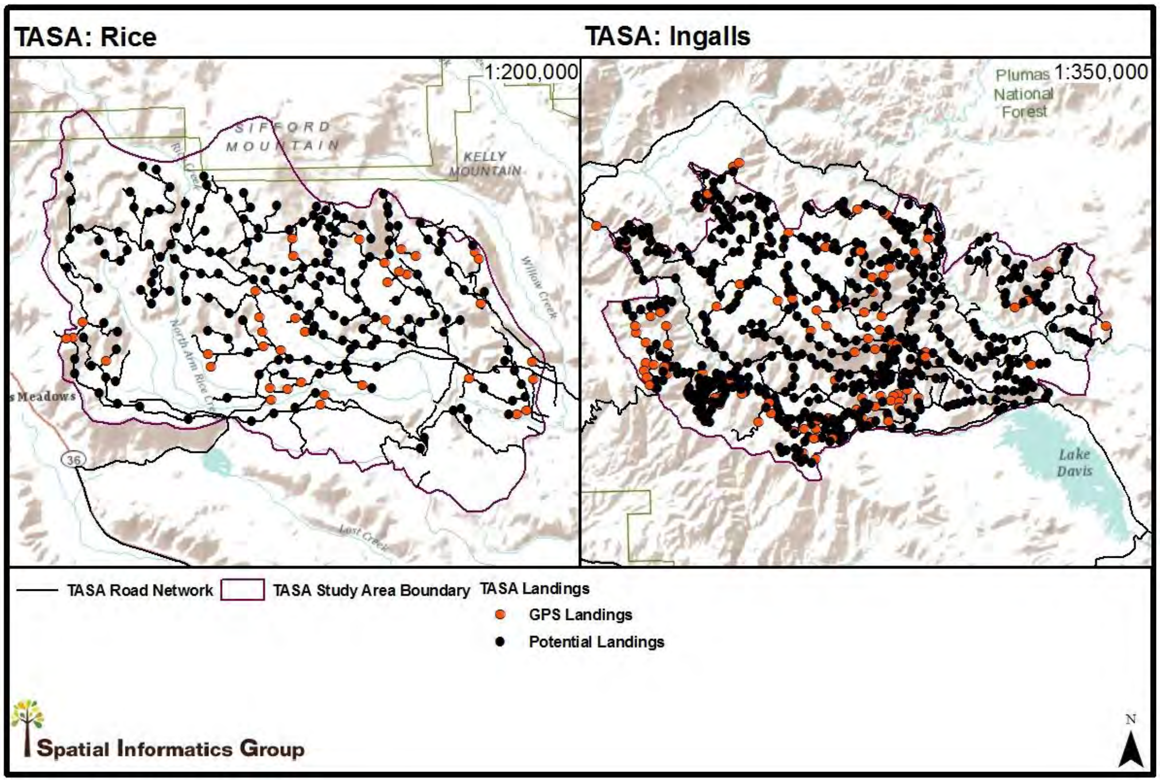
Potential Landings

Potential landings were first analyzed using geospatial information and local knowledge of best site locations. Landing criteria for analysis included slope zones less than 15% that were in existing sites of open to partially open non-forested vegetation areas, generally spaced one-quarter mile distance apart to realize a normal external yarding (skidding) distance of 800 feet from each side of the landing within 800 feet of known road networks and outside of any biologically, archaeologically or riparian sensitive areas. The research team used aerial photos with slope layers to identify potential locations and validate the geospatial analysis. First, aerial photography was examined for vegetation type and recovery around the potential landings, slope, streams and existing road networks. Then both datasets were compared for accuracy. Only a handful of landings that were digitized overlapped with locations selected geospatially. Therefore, the error in using the geospatial source versus heads-up digitizing locations illustrates the difficulty associated with exact vegetation supply location, relationship to open vegetation sites and more exact spacing associated with these factors. In addition, the landing criteria that was developed and used for the GIS ortho-photo location and field location cannot be used for geospatial analysis and location. Figure 11 highlights existing and potential landings for both the Ingalls and Rice TASA. Table 17 summarizes the number of landings by data source and TASA.

Table 17. Total Landings by TASA and Source

DATA SOURCE	INGALLS	RICE	TOTAL
GPS	92	38	130
Heads Up Interpretation	536	178	714
TOTAL	**628**	**216**	**844**

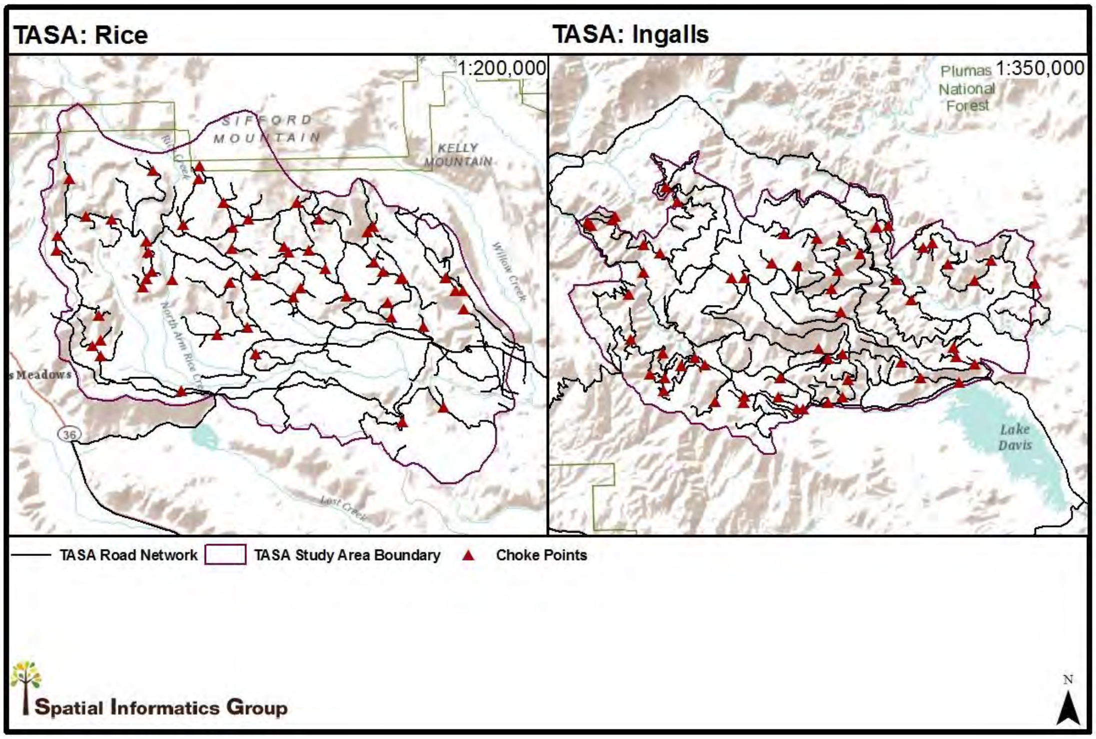
Figure 11. TASA Landings



Choke Points

Choke points are found along the transportation network in areas with steep grade, tight turn/curve radius, heavy brush or vegetation cover, road closures, or rolling dips that are not passable by conventional 40' or 48' chip vans in their current state. These points were used in analyzing the feasibility and cost of completing road improvement or maintenance and comparison with potential biomass accessible beyond these points. The choke points were collected using GPS techniques during fieldwork validating existing transportation networks. There were a total of 53 choke points found in the Rice TASA and 59 in the Ingalls TASA (see Figure 12). In general, there was a higher density of choke points in Rice when accounting for area or transportation miles compared to Ingalls. However, all of the Rice choke points were related to road closure or vegetation, which are a normal maintenance consideration versus possible road re-construction or relocation issues. Each choke point was assessed in terms of the ability to correct and the cost associated with it. These costs can be changed in the calculator tool discussed in Phase 4.

Figure 12. TASA Choke Points



The vast majority of the choke points in both TASA areas would be restrictive to any chip van configuration or type. Field verification confirmed that only two choke points were restrictive to the use of the standard chip van versus such alternative vans as a short van or stinger-steer van. These two choke points were caused by excessive grade and curve radius that restricted the use of standard chip vans. All other choke points related to rolling dips, road closures, vegetation and grade that would be restrictive to all van types and configurations.

Choke points were reviewed and recorded in the field by driving all accessible roads and reviewing closed or heavily vegetated roads. Exact choke points related to grade, curve radius and rolling dips were located using GPS tools. Road closure and vegetation points were recorded by GPS at the beginning of such points and the exact choke issue was recorded for cost determination. For the data collection, the following procedures were utilized:

- Use of San Dimas Technology Center Curve Calculator (see Appendix B).
- Review of random choke points with an experienced chip van driver.
- Field review of roads by road engineering experts to verify specific choke points and issues.
- Discussion with other resource managers conducting similar biomass transportation studies on the Klamath National Forest.[16]
- Discussion with local USFS resource specialist.[17]

[16]Larry Alexander, Executive Director, Northern California Resource Center.

The general consensus was that the San Dimas Curve Calculator was an appropriate starting point when reviewing specific curves. However, it did not allow for on-the-ground factors in relation to road width and possible easy fixes (such as cleaning bank slough or use of ditch and re-establishing the ditch after use).

One of the most informative choke point verification procedures was reviewing roads and potential choke points with experienced drivers that are currently hauling biomass material in the area. This was also verified by Larry Alexander, Executive Director of the Northern California Resource Center (NCRC) in Etna, California. NCRC is assisting the Klamath NF in support of a biomass transportation study. Their study has also used expert drivers to verify potential choke points. The most apparent difference is with the common USFS determination of grade issues. The normal grade issue determination as set by the USFS is a grade of 10% or more. Expert drivers provided feedback on grade issues within our study area as well as on the Klamath NF. In both instances, drivers expressed that as long as the roads were maintained and the surface was compact, they could navigate grades from 12-15%. This also meant that they had a rolling distance and grade from the landing of 5-8% for a few hundred feet to gain speed to pull the steeper grades.

Utilization Facility Locations

Utilization facility locations were applied to the road network to define the end point (destination for value-added utilization) of the network analysis (see Figure 13). Utilization facilities were categorized into existing and alternative sites to investigate the potential opportunities associated with opening up new facilities at logical sites compared to using the existing facilities. The results from the analysis are reported as if the entire volume is sent to one of the utilization facilities.

The Upper Feather River Watershed has a long history of forest management and forest products manufacturing. Numerous commercial-scale sawmill facilities operated in the region for decades. Two currently remain (Collins Pine Company and Sierra Pacific Industries) and provide primary markets for sawlogs and forest biomass material (utilized as fuel for cogeneration facilities collocated with the sawmills).

Sites selected for development of commercial sawmills typically require flat ground, significant acreage (generally 10 acres plus), location to transport networks (highways and/or rail) and access to utilities (power and water). These same site attributes work well for value-added utilization yards. Alternative value-added sites selected in this study were once active sawmill sites.

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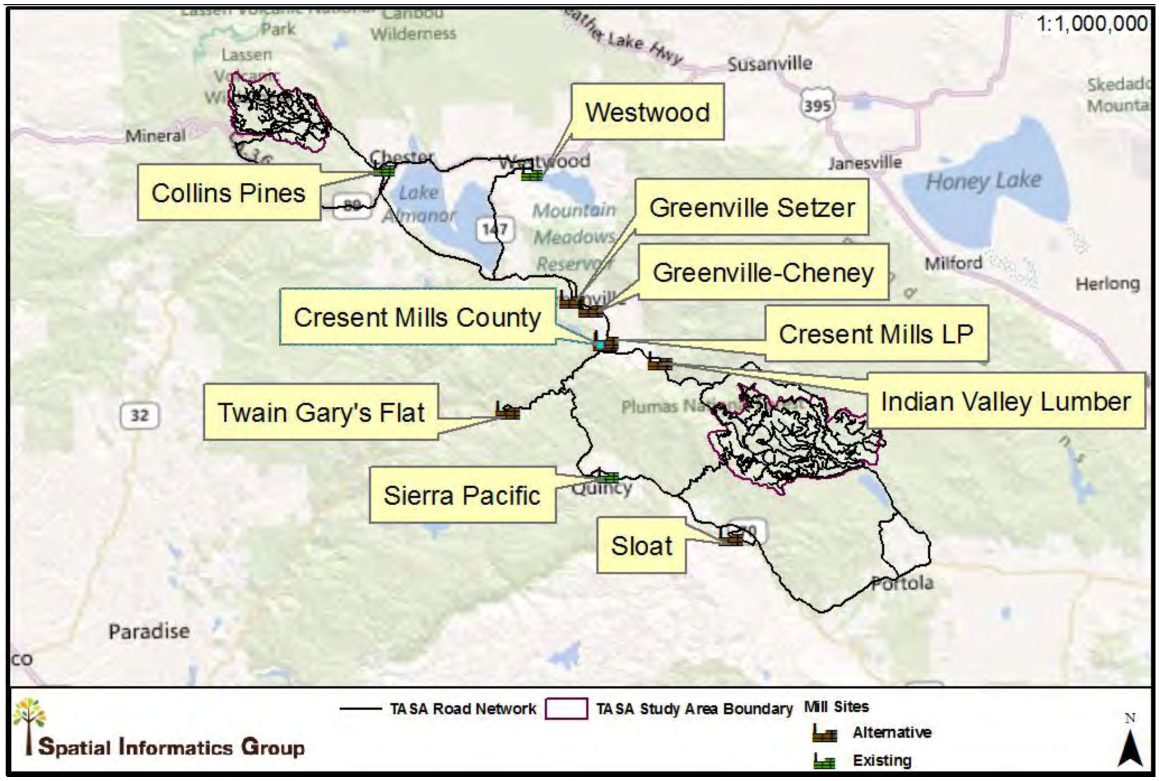
[17]Elaine Vercruysse, Logging Engineer, Mt. Hough Ranger District.

Figure 13. Value-Added Utilization Facility Locations Tributary to TASA



Existing

Three existing sites within the TSA were considered, including Sierra Pacific Industries in Quincy, Collins Pine Company in Chester, and Covanta Energy Mount Lassen Power in Westwood (stand-alone biomass power facility recently closed).

Alternative

Locations to analyze the cost effectiveness of alternative sites enhanced as value-added utilization yards were also selected. These locations were generally situated at pre-existing mill sites that have been closed for varying lengths of time. The alternative sites were identified and addressed in the preliminary market review section of this report. If alternatives for markets and products did develop within the study area, these sites and others would need to be further studied as alternative collection yards for redistribution or development for value-added utilization.

Vegetation

The vegetation data used to develop Figure 14, as well as for the entire TSA, was derived from employing a GIS analysis of LANDFIRE[18] existing vegetation cover type.

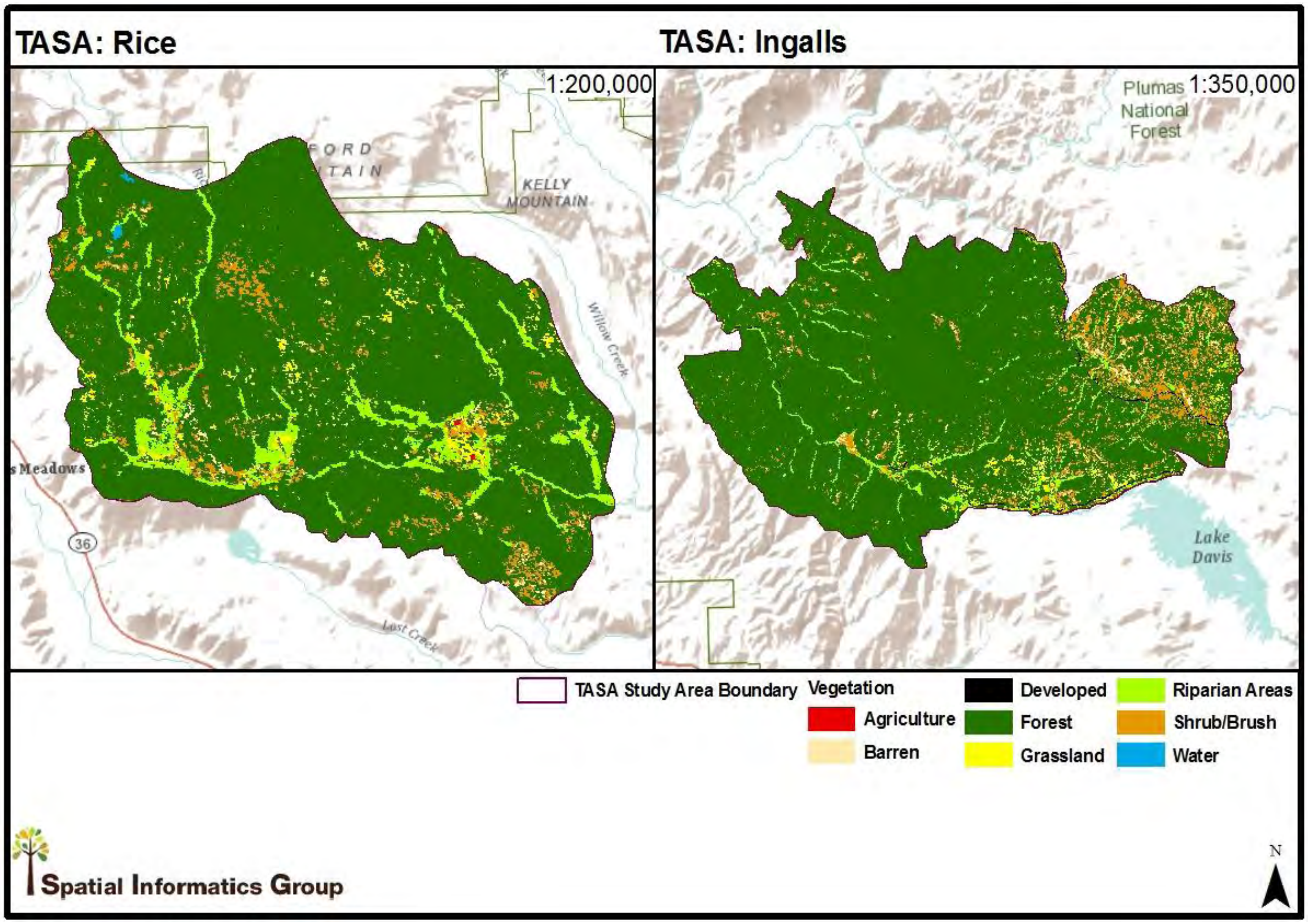
[18] LANDFIRE. [Homepage of the LANDFIRE Project, U.S. Department of Agriculture, USFS; U.S. Department of Interior]: http://www.landfire.gov/index.php [2010, October 28]

LANDFIRE was originally developed as a tool to assist fire and fuels management and planning. The data and analysis tools were developed by the U.S. Department of Agriculture and the U.S. Department of the Interior.

The existing vegetation type (EVT) data selected represents terrestrial ecological systems classification from NatureServe.[19] The data for the entire TSA consisted of 46 distinct types, though not all are strictly related to forest vegetation. There are cover classifications for agriculture, areas of development, water, snow or ice, and barren areas in addition to typical vegetative cover. The raw data consisted of 13 different forest ecosystem classifications and 18 shrub or brush ecosystem classifications. The raw data was subsequently aggregated into 8 distinct cover categories, including agriculture, barren areas, developed areas, forest, grassland, riparian areas, shrub or brush, and water. These are the cover categories used for Figure 14.

[19] http://www.natureserve.org/publications/usEcologicalsystems.jsp

Figure 14. TASA Vegetation



Phase 2. Project Scale Biomass Availability Assessment

The second phase quantified the landscape at a project scale to produce a detailed estimate of biomass availability. This was accomplished using multiple steps including:

- Defining the Go/No-Go regions in the TASA.
- Identifying the potential biomass available on the landscape.
- Determining the operationally available biomass volume and cost estimates to each landing. Below is a description of each step.

Step 1: Go No-Go Analysis

The goal of this task was to identify the harvestable (Go) and non-harvestable (No-Go) regions within the study area that include but are not limited by topography (slope), regulations (e.g., distance from watercourses), and sensitive regions (locations of threatened and endangered species, archeology sites). The Go and No-Go regions were used to analyze potential feedstock volume in the study area (see Figure 15). To create this data, an overlay analysis was conducted on the following layers: slope, hydrology, and sensitive regions. The resulting dataset had the following Go/No-Go rules applied to them.

Slope:

- 0-35% = Go
- 36%-45% = Goq (go questionable)
    - Questionable, as private land managers regularly utilize ground-based equipment on slopes up to 45% gradient. Such consideration is on a site-by-site basis and takes into account soil type and use of self-leveling cutting machines in a thinning prescription.
- >45% = No-Go

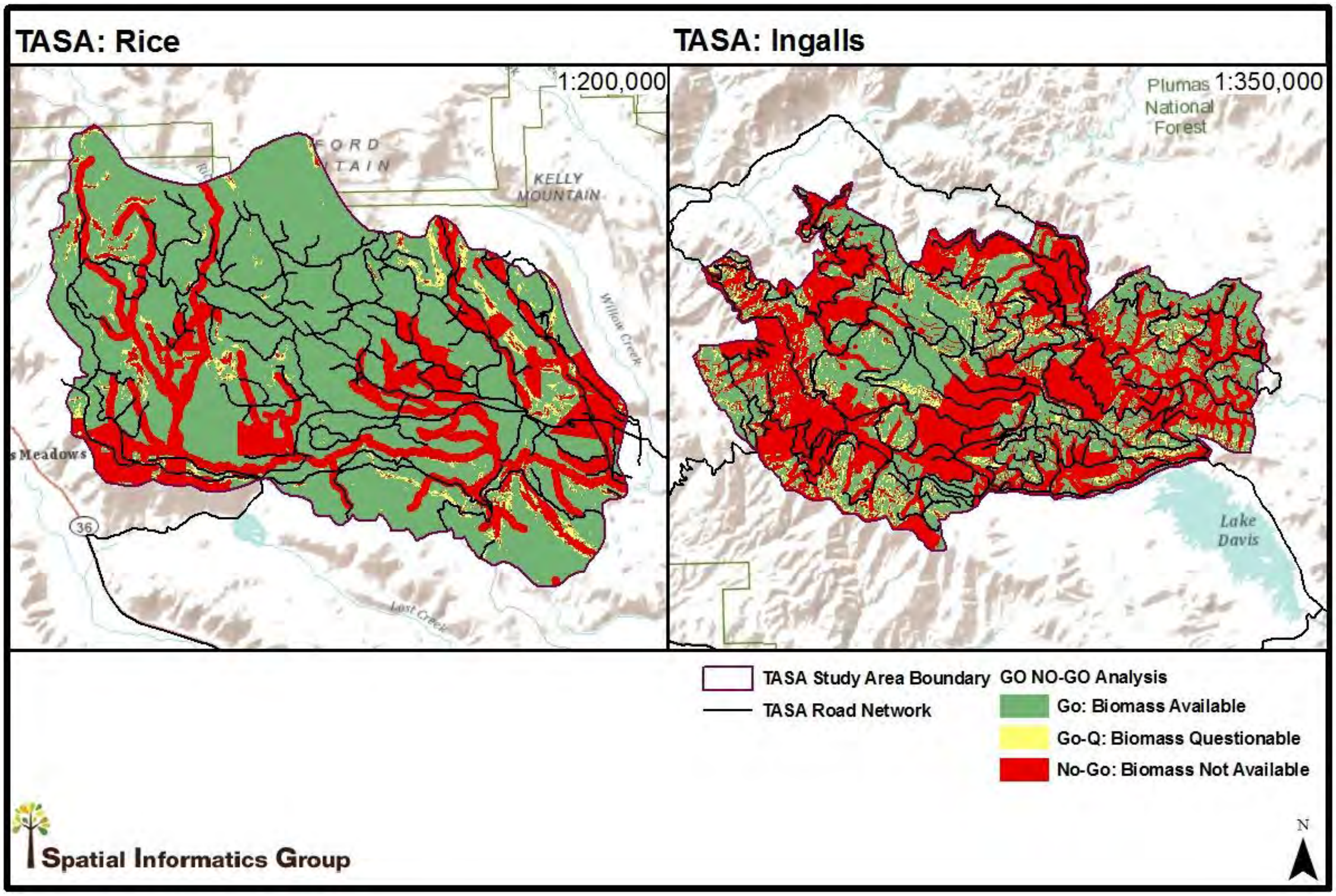
Hydrology:

- Outside the Stream Buffer = Go
- Within a Stream Buffer = No-Go
    - NHD - Use class I requirements of 300 feet within Perennial streams (blue line streams in this analysis) and 50 feet within the remainder of NHD streams. The 50-foot standard is common practice for buffer width to protect around intermittent and ephemeral streams when conducting USFS project work.

Sensitive Areas:

- Outside the Sensitive Area = Go
- Within a Sensitive Area = No-Go

Figure 15. TASA Go No-Go Analysis



<u>Step 2: Potential Biomass Availability in the TASA</u>

Biomass availability was estimated across the TASA by multiplying a biomass recovery factor by its corresponding vegetation type excluding regions that were considered not accessible from the Go/No-Go analysis. This was accomplished by first intersecting the Go/No-Go analysis with the vegetation layer described above. Biomass recovery factors specific to each vegetation type were then used to generate estimates. Table 18 summarizes the recovery factors used in this analysis. These values can be changed in the calculator tool (addressed in Phase 4).

Biomass recovery factors utilized in this analysis are based on local contractor and forester experience utilizing mechanical equipment (feller bunchers, grapple skidders and chippers) to facilitate recovery. Biomass recovery depends heavily on a variety of factors, including:

- Landowner or land manager objectives
- Pre-operations stand conditions
- Leave tree and biomass retention goals

Recovery factors used for this analysis assumed a high of 14 BDT/acre for upland evergreen forest to a low of 6 BDT/acre for recently disturbed upland evergreen or mixed forest.

Table 18. Biomass Recovery Factors

Veg_Name	Veg_Group	Recovery Factor (BDT/ac)
Artemisia tridentata ssp. vaseyana Shrubland Alliance	Shrub/Brush	0
Barren	Barren	0
California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna	Shrub/Brush	0
California Montane Jeffrey Pine(-Ponderosa Pine) Woodland	Forest	12
California Montane Riparian Systems	Riparian Areas	0
California Montane Woodland and Chaparral	Shrub/Brush	0
Developed-Roads	Developed	0
Developed-Upland Deciduous Forest	Forest	10
Developed-Upland Evergreen Forest	Forest	14
Developed-Upland Herbaceous	Grassland	0
Developed-Upland Mixed Forest	Forest	14
Developed-Upland Shrubland	Shrub/Brush	0
Great Basin Pinyon-Juniper Woodland	Shrub/Brush	0
Great Basin Semi-Desert Chaparral	Shrub/Brush	0
Herbaceous Wetlands	Grassland	0
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Forest	8
Inter-Mountain Basins Big Sagebrush Shrubland	Shrub/Brush	0
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	Shrub/Brush	0
Inter-Mountain Basins Greasewood Flat	Shrub/Brush	0
Inter-Mountain Basins Montane Riparian Systems	Riparian Areas	0
Inter-Mountain Basins Montane Sagebrush Steppe	Shrub/Brush	0
Inter-Mountain Basins Semi-Desert Grassland	Grassland	0
Inter-Mountain Basins Sparsely Vegetated Systems	Barren	0
Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland	Forest	12
Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland	Forest	11
Mediterranean California Mesic Mixed Conifer Forest and Woodland	Forest	10
Mediterranean California Mesic Serpentine Woodland and Chaparral	Shrub/Brush	0
Mediterranean California Mixed Evergreen Forest	Forest	14
Mediterranean California Mixed Oak Woodland	Forest	8
Mediterranean California Red Fir Forest	Forest	14
Mediterranean California Sparsely Vegetated Systems	Barren	0
Mediterranean California Subalpine Woodland	Forest	7
North Pacific Montane Grassland	Grassland	0
Northern and Central California Dry-Mesic Chaparral	Shrub/Brush	0
Open Water	Water	0
Recently Disturbed Developed Upland Deciduous Forest	Forest	6
Recently Disturbed Developed Upland Evergreen Forest	Forest	6
Recently Disturbed Developed Upland Mixed Forest	Forest	6
Recently Disturbed Developed Upland Shrubland	Shrub/Brush	0
Rocky Mountain Aspen Forest and Woodland	Forest	8
Sierra Nevada Alpine Dwarf-Shrubland	Shrub/Brush	0
Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland	Forest	12

Table 19 provides the Go/No-Go analysis results by vegetation type for each TASA.

Table 19. Vegetation Type TASA and Go/No-Go Analysis Results (Expressed in BDT)

	Go	GO-Q	NOGO	Grand Total
Ingalls	**15,362**	**2,563**	**19,876**	**37,800**
California Montane Jeffrey Pine(-Ponderosa Pine) Woodland	7,332	1,128	9,479	17,940
Developed-Upland Deciduous Forest	7	0	34	41
Developed-Upland Evergreen Forest	13	2	105	120
Developed-Upland Mixed Forest	1	0	19	21
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	18	6	77	101
Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland	39	18	120	178
Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland			0	0
Mediterranean California Mesic Mixed Conifer Forest and Woodland	2,989	766	6,388	10,144
Mediterranean California Mixed Evergreen Forest		0	2	2
Mediterranean California Mixed Oak Woodland	25	5	41	70
Mediterranean California Red Fir Forest	4,852	615	3,420	8,886
Mediterranean California Subalpine Woodland	1	0	0	1
Recently Disturbed Developed Upland Deciduous Forest	13	2	31	46
Recently Disturbed Developed Upland Evergreen Forest	15	3	55	73
Recently Disturbed Developed Upland Mixed Forest	3	3	22	28
Rocky Mountain Aspen Forest and Woodland	50	15	79	144
Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland	4	0	2	6
Rice	**15,638**	**1,343**	**6,418**	**23,399**
California Montane Jeffrey Pine(-Ponderosa Pine) Woodland	1,101	49	331	1,481
Developed-Upland Deciduous Forest			1	1
Developed-Upland Evergreen Forest			6	6
Developed-Upland Mixed Forest			2	2
Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland	38	1	19	58
Mediterranean California Mesic Mixed Conifer Forest and Woodland	9,859	722	5,110	15,691
Mediterranean California Mixed Oak Woodland	2	0	1	4
Mediterranean California Red Fir Forest	4,638	571	947	6,155
Mediterranean California Subalpine Woodland	0	0	0	0
Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland	0			0
Grand Total	**31,000**	**3,906**	**26,294**	**61,200**

Step 3: Potential Biomass Availability at the Landing

Several factors determine if a landing is going to be opened to biomass utilization including skid distance, landing preparation costs, and total available biomass. This step quantifies each of these elements within the TASA carrying forward information from the previous step.

It was assumed that the longest operational skid distance from a landing would not exceed 800 feet. This distance was selected to provide an economic buffer in relation to distance from landing and the round trip time for skidding equipment and biomass material recovery. If alternative skidding equipment was utilized (such as a forwarder), then the operational skid distance would need to be adjusted (e.g., not to exceed 1,500 feet). It was also assumed that biomass would be delivered to the closest landing location. Using these assumptions, a multi-ring buffer was created in 200-foot increments from 0 to 800 feet. A thespian polygon was created from the landing location to identify nearest relationships and the two layers were intersected. The resulting data identified the nearest area for each landing in 200-foot increments. This layer was then intersected with information from the previous step to define the total available biomass at each landing location (see Figure 16). Data was collected on the operational costs (harvest, skid, and process) associated with biomass recovery (see Table 20). It was assumed that only stems 4" to 10" DBH are harvested, no adverse skidding (uphill skidding), landing size will accommodate chipping operations, landing locations are strategic, and the chipper produces 10 loads per day. This information was then combined with the landing preparation costs to compute a total cost estimate ($/BDT) for processed biomass material delivered to a utilization facility.

Figure 16. Potential Biomass Availability at the Landing in the TASA

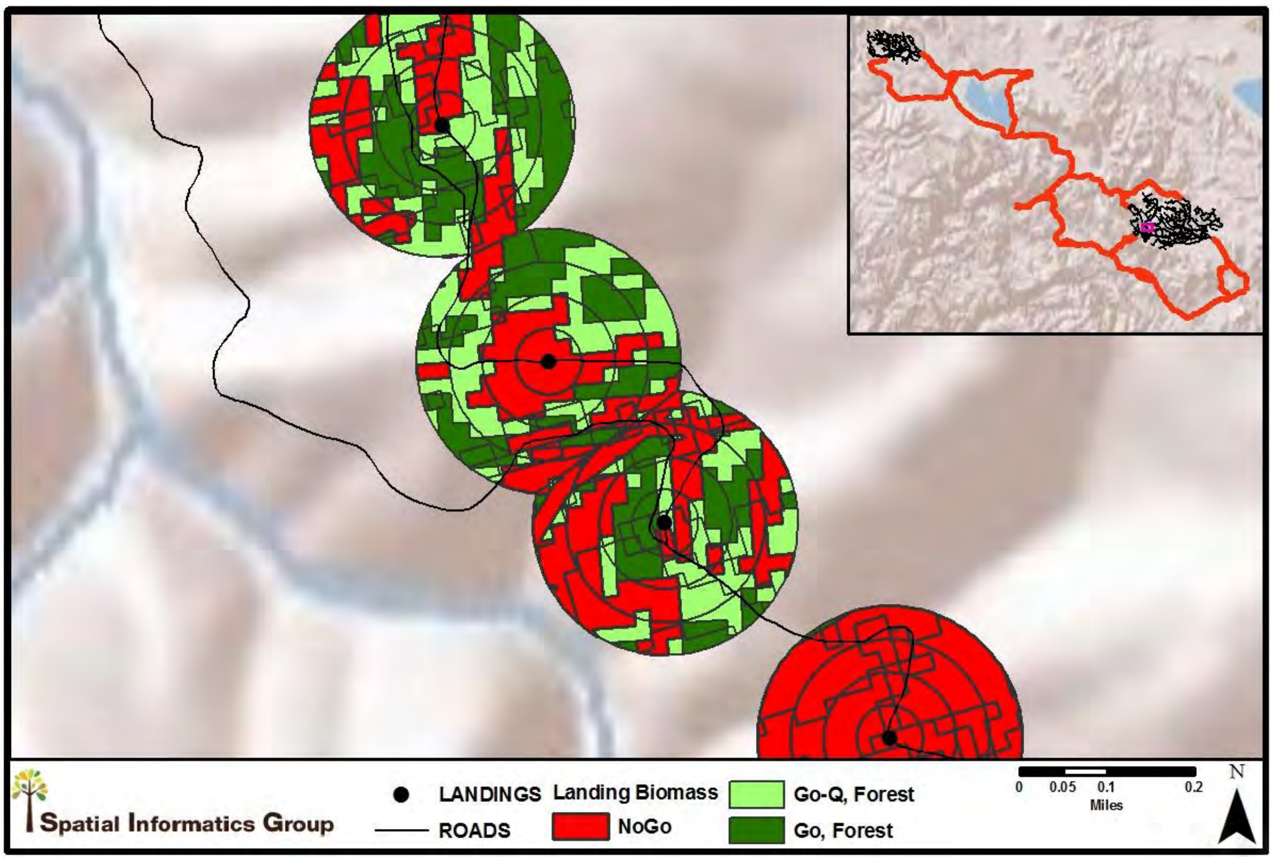


Table 20. Biomass Recovery Costs - Landing Extraction Factors

SLOPE FACTOR	SKID DISTANCE (FT)	FALL ($/BDT)	SKID ($/BDT)	CHIP ($/BDT)	TOTAL ($/BDT)
Go	200	$14.00	$10.00	$13.00	**$37.00**
Go	400	$14.00	$12.00	$13.00	**$39.00**
Go	600	$14.00	$14.00	$13.00	**$41.00**
Go	800	$14.00	$16.00	$13.00	**$43.00**
Go-Q	200	$18.00	$12.00	$13.00	**$43.00**
Go-Q	400	$18.00	$14.00	$13.00	**$45.00**
Go-Q	600	$18.00	$16.00	$13.00	**$47.00**
Go-Q	800	$18.00	$18.00	$13.00	**$49.00**

Fall, skid and chip costs as presented in Table 20, are based on contractor and forester experience conducting forest thinning operations within the northern Sierra Nevada and southern Cascade region. These costs are based on current conditions. As diesel fuel costs, labor, and equipment costs change, so too will fall, skid and chip costs. Stand conditions can also impact these costs. Forest stands with scattered concentrations of small stems that are targeted for removal tend to have higher fall and skid costs. Equipment mobilization costs are included in the fall, skid, and chip cost estimates.

Phase 3. Transportation Network Assessment

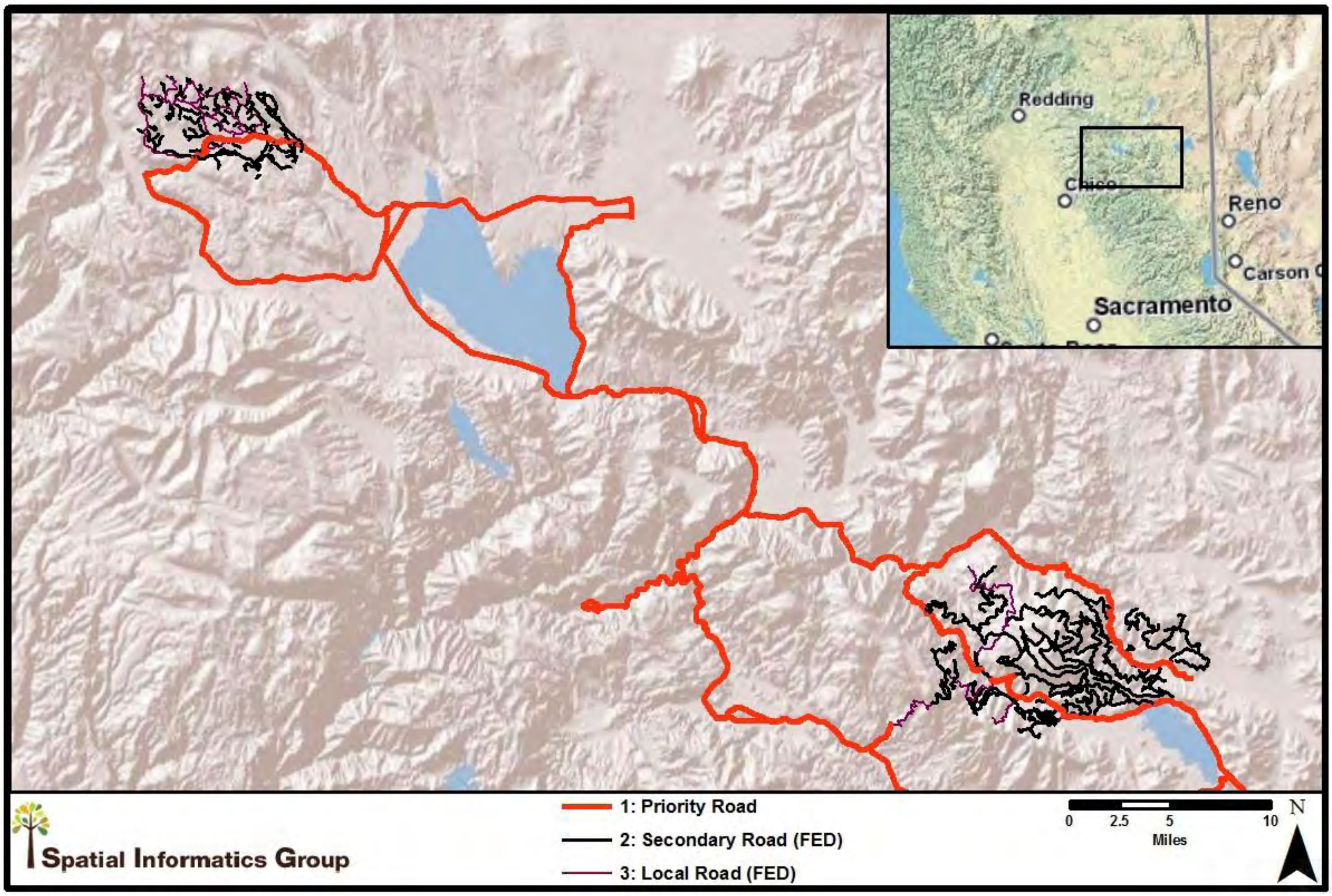
The third phase consisted of quantifying how the existing transportation network can be modified and how those modifications could impact biomass availability and the costs associated with recovery operations. This was accomplished by creating a detailed network analysis that integrated landing location, surface type, surface priority, choke points, utilization facility location, and detailed scenarios. The road network was first created with a priority scheme that minimizes surface replacement costs and distance to paved roads. Once the transportation network model was operational, multiple scenarios were applied that were based on transportation mode and choke point locations. Below is a summary of the two steps.

Step 1: Developing the Transportation Network

The first step was to create a detailed network between each landing location and the utilization facility location. It was clear from conversations with USFS staff that the closest distance between a landing and the utilization facility location was not how this system functioned on the ground. Operators typically estimated the cheapest route from a landing to a mill site taking into consideration surface replacement and road maintenance (e.g., dust abatement, road grading) costs. Thus, a hierarchical network was built that prioritized roads without a surface maintenance fee to replicate this behavior.

Hierarchical network analysis works by favoring primary roads (non-fee roads) over secondary roads (cost effective fee roads) and secondary roads over local roads (expensive fee roads). The route solver begins by simultaneously traveling forward from the landing and backward from the utilization facility. Local roads are searched until the best transitions to secondary roads are found, from which point only secondary and primary roads are searched. The solver continues on secondary roads until the best transitions to primary roads are found. The solver then only searches primary roads, ignoring roads in the lower hierarchical classes, until the path from the origin meets the path going backward from the destination, thereby connecting the landing and utilization facility and finding a route with the cheapest cost and distance. Figure 17 highlights the network developed for this study.

Figure 17. Hierarchical Biomass Transportation Network for TASA



Step 2: Choke Point Scenario Analysis

Choke points from Phase 1 were integrated with step 1 above as barriers to the network. Barriers are blockages to road segments that prohibit vehicles from traveling on those roads, forcing the solution to find another route based on the hierarchy built within the network. Since each combination of choke points will create a unique network solution, a variety of scenarios were defined and modeled to assess the total road miles traveled by ownership type, surface type, and connection between landing and utilization facility location. Results from this step were reported by scenario for each utilization facility-landing combination by ownership and surface type (see Table 21). The scenarios include:

- Scenario 1 - Fix everything: all choke points addressed (all repaired).
- Scenario 2 - Fix everything possible: include only the choke points that were identified as not fixable on network (most repaired).
- Scenario 3 - Best case: include choke points that the typical manager would not fix (best repaired).
- Scenario 4 - Do nothing: include all the choke points (no repairs).

Table 21. Transportation Data Used in Analysis

Index TASA	Index Scenario	Index LANDING ID	Index MILL_ID	Index Destination Rank	Miles Grand Total Miles	Miles Total Non-Fed PAVE	Miles TOTAL Non-Fed BIT	Miles TOTAL Non-Fed DIRT	Miles TOTAL Fed AGG	Miles TOTAL Fed DIRT	Miles TOTAL Non-Fed AGG
Ingalls	S1	0	1	1	23.08	6.39	-	10.72	0.47	5.51	-
Ingalls	S1	0	9	2	27.91	6.38	-	3.80	9.48	8.25	-
Ingalls	S1	0	2	3	29.42	12.73	-	10.72	0.47	5.51	-
Ingalls	S1	0	3	4	29.64	12.94	-	10.72	0.47	5.51	-
Ingalls	S1	0	7	5	29.65	8.12	-	3.80	9.48	8.25	-
Ingalls	S1	0	4	6	33.28	16.58	-	10.72	0.47	5.51	-
Ingalls	S1	0	5	7	35.24	18.55	-	10.72	0.47	5.51	-
Ingalls	S1	0	6	8	41.36	24.16	-	11.23	0.47	5.51	-
Ingalls	S1	0	10	9	56.04	39.34	-	10.72	0.47	5.51	-
Ingalls	S1	0	8	10	57.93	41.24	-	10.72	0.47	5.51	-
Ingalls	S1	1	1	1	23.07	6.39	-	9.71	0.76	6.21	-
Ingalls	S1	1	9	2	27.90	6.38	-	2.79	9.77	8.95	-
Ingalls	S1	1	2	3	29.40	12.73	-	9.71	0.76	6.21	-
Ingalls	S1	1	3	4	29.62	12.94	-	9.71	0.76	6.21	-
Ingalls	S1	1	7	5	29.64	8.12	-	2.79	9.77	8.95	-
Ingalls	S1	1	4	6	33.26	16.58	-	9.71	0.76	6.21	-
Ingalls	S1	1	5	7	35.22	18.55	-	9.71	0.76	6.21	-
Ingalls	S1	1	6	8	41.34	24.16	-	10.22	0.76	6.21	-
Ingalls	S1	1	10	9	56.02	39.34	-	9.71	0.76	6.21	-
Ingalls	S1	1	8	10	57.91	41.24	-	9.71	0.76	6.21	-
Ingalls	S1	2	1	1	23.15	6.39	-	9.71	0.76	6.29	-
Ingalls	S1	2	9	2	27.98	6.38	-	2.79	9.77	9.03	-
Ingalls	S1	2	2	3	29.49	12.73	-	9.71	0.76	6.29	-
Ingalls	S1	2	3	4	29.71	12.94	-	9.71	0.76	6.29	-
Ingalls	S1	2	7	5	29.72	8.12	-	2.79	9.77	9.03	-
Ingalls	S1	2	4	6	33.34	16.58	-	9.71	0.76	6.29	-
Ingalls	S1	2	5	7	35.31	18.55	-	9.71	0.76	6.29	-
Ingalls	S1	2	6	8	41.43	24.16	-	10.22	0.76	6.29	-
Ingalls	S1	2	10	9	56.10	39.34	-	9.71	0.76	6.29	-
Ingalls	S1	2	8	10	58.00	41.24	-	9.71	0.76	6.29	-
Ingalls	S1	3	1	1	23.48	6.39	-	9.71	0.76	6.62	-

Fed = Federal land, Non-Fed = Non-Federal Land, AGG = Crushed Aggregate Surface Type, DIRT = Dirt Surface Type, PAVE = Paved Surface Type, BIT = Bituminous, Mill Network = road miles outside of the TASA that link TASA to utility facilities.

Phase 4. Integration: Cost Benefit Analysis for Improvement

The final phase consisted of creating an analytical framework that allows the user to quantify the tradeoffs between different transportation and biomass recovery assumptions to assess total biomass availability and costs. This phase integrated elements from the previous three phases into an excel spreadsheet tool. Below is a summary of the steps involved.

Step 1: Importing Data

The datasets required for phase 4 are generated in phases 1 (step 3) and 2 (step 2), as landing identification is the common linkage between each. It is from this linkage that individual values can be added at the appropriate scale.

Step 2: Defining Assumptions

Several assumptions based on specific operational characteristics are necessary to complete this analysis. This calculator tool allows the analyst to change the assumptions on a project-by-project basis. Below is a list of assumptions made in the tool along with the values used in our analysis.

- **Vegetation Biomass Available (From Phase 3)**
  - **Slope Class (%):** Allows the user to select the 0-35% or 0-45%. This analysis used the 0-35% option because it is the prevalent range of slope gradient, which is the most economical and environmentally sensitive for ground-based biomass treatments.
  - **Extraction Distance (ft):** Allows the user to select the recovery skid distance from the landing. This analysis used 0-800 feet; this distance was selected to provide an economic buffer in relation to distance from landing and the round trip time for skidding equipment and biomass material recovery.
  - **Minimum Required Volume (BDT):** Allows the user to select the minimum amount of biomass necessary at a landing to open it up for use. 130 BDT was selected based on a 10-truck limit at 13 BDT/truck.
  - **Ownership Type:** Allows the user to include or exclude specific ownership types from the analysis. We did not exclude any ownership type in our analysis.
- **Transportation Assumptions (From Phase 4)**
  - **Surface Replacement Costs ($ / BDT – Mile):** This is the fee associated with specific transportation systems based on ownership and surface type.

The network analysis avoided roads that contained a fee. There were two types that were included in this analysis: dirt (native surface) federal roads at ($0.025 / BDT – mile) and aggregate (rocked surface) federal roads at ($0.05 / BDT – mile).

- **Transportation Type:** These series of values allow the user to identify different modes of transportation. The tool allows for four modes of customizable transportation. Operational elements for each transport type include:

    - Capacity of the Mode: 13 BDT/load is typical
    - Hourly Rental Rate: this can range between $70-$100/hour
    - Average Speed on Paved Roads: we used 40 MPH
    - Average speed on Off Pavement Roads: we used 20 MPH

- **Forest Management:** These assumptions allow the user to estimate the volume of additional stumpage required to balance the costs associated with biomass utilization. They were included as an example of how this analysis can be integrated with other efforts. Assumptions used in this report are summarized in Table 22.

Table 22. Stumpage Calculation

COST CENTERS	$/MBF
Saw Timber Value	$250.00
Recovery Cost	($125.00)
Haul Cost	($9.00)
Road Surface Replacement Cost	($1.00)
Tax 2.9%	($7.25)
Other Costs	($5.00)
NET SAW TIMBER VALUE	**$102.75**

Step 3: Understanding the Calculations

Two types of calculations were generated from this analysis: the amount of biomass available (BDT); and the cost of its recovery ($/BDT). Based on the project design, scale needs to be factored into the analysis when making these calculations. Below is a summary of the flow of information used to calculate available biomass and its associated cost.

- Forest Level

    - *BDT of Biomass at Forest (BDT)* = available vegetation type (acres) * recovery factor (BDT/acre).

    - Items are filtered based on ownership type, skid distance, and accessibility (the Go/No-Go layer).

    - *Cost of Biomass at Forest ($)* = biomass (BDT) * landing extraction factor ($/BDT).

    - Items are filtered based on ownership type, skid distance, and accessibility (the Go/No-Go layer).

    - Both results are summarized by landing identification number.

- Landing Level

    - *BDT of Biomass at Landing (BDT)* = BDT of biomass at forest filtered by minimum biomass volume threshold needed to open landing.

    - *Cost of Biomass at Landing ($)* = cost of biomass at forest + cost needed to prepare landing.

        - Filtered by minimum biomass volume threshold needed to open landing.

- Hierarchical Transportation Network

    - *BDT of Biomass in Scenario (BDT)* = BDT of biomass at landings summarized by scenario.

    - *Surface Replacement Cost ($)* = [[federal dirt roads coefficient ($/BDT – mile) * federal dirt roads distance (miles)] +[federal aggregate roads coefficient ($/BDT – mile) * federal aggregate distance (miles)]] * BDT of biomass at landing (BDT).

        - Filtered by landing, utilization facility location, and scenario.

    - *Travel Costs ($)* = [[paved roads coefficient ($/BDT – mile) * paved roads distance (miles)] +[offroad coefficient ($/BDT – mile) * offroad distance (miles)]] * BDT of biomass at landing (BDT).

        - Filtered by landing, utilization facility location, and scenario.

    - *Total B-T Costs ($)* (Total Cost of recovering Biomass at the landing and Transportation) = Cost of biomass at landing ($) + surface replacement cost ($) + transport costs ($).

        - Results are summarized by scenario.

- Integrating Scenario-Mill Destination Results
    - *Total B-T-CP Costs ($)*(Total Cost of recovering Biomass at the landing, Transportation, and Choke Point) = Total B-T Costs ($) + the cost necessary to fix the choke points identified in the scenario ($).
        - Results are summarized by scenario and utilization facility.
    - *Relative Cost ($ / BDT)* = Total B-T-CP Costs ($) / BDT of biomass in scenario (BDT).
        - Results are summarized by scenario and utilization facility.
    - *Biomass Profit Made At The Gate ($/BDT)* = Relative cost ($ / BDT) – biomass gate price ($ / BDT).
        - Results are summarized by scenario and utilization facility.
    - *Funds Needed to Offset Biomass Recovery Costs ($)* = (biomass profit made at the gate ($/BDT)) * BDT of biomass in scenario (BDT).
        - Results are summarized by scenario and utilization facility.
    - *Saw Logs potentially needed to balance Biomass budget (MBF): at 102.75 ($/MBF)* = Funds needed to offset biomass recovery costs ($) / net saw timber Value ($/MBF).
        - Results are summarized by scenario and utilization facility.
- Cost Benefit Results
    - A cost benefit analysis was conducted by comparing the results from Scenario 3 (Best case: include choke points that the typical manager would not fix) to Scenario 4 (Do nothing: include all the choke points).
    - The results were then summarized by utilization facility location using the same indices described in the integrating scenario-utilization facility destination results.

<u>Step 4: Tool Functionality</u>

The calculation tool was developed to stand alone once the geospatial data and assumption scenarios were integrated, meaning that one could run it using only an Excel 2010 workbook. There are a few steps necessary to operate the tool properly. The first step is to review all the major assumptions found under the yellow tabs in the assessment tool within Excel. The Excel based assessment tool also contains assumptions for vegetation, landing, landing maintenance, choke points, and utilization facilities. Next, use the master assumption tab to review assumptions, including the transportation mode selection. Then, press the update calculations button (see Figure 18) followed by using the results tabs to review findings. Figure 18 illustrates the major assumptions used for the simulations within this report.

Figure 18. Assumption Interface

Vegetation - Biomass Available

Slope Class (%)	0-35%
Extraction Distance (ft)	0-800 ft
Min Requiered at Landing (BDT)	130

Update Calculations

Owner
- NON FOREST SERVICE
- USDA FOREST SERVICE

SIG
SPATIAL INFORMATICS GROUP

Mill Average	S1: Fix all choke points	S2: Fix all possible choke points	S3: Best Case	S4: Fix Nothing
Ingalls				
TOTAL BIOMASS (BDT):	73,414	73,202	72,985	56,216
TOTAL COST ($):	4,344,362	4,332,003	4,309,568	3,500,957
AVERAGE ($/BDT):	$ 59.18	$ 59.18	$ 59.05	$ 62.28
Rice				
TOTAL BIOMASS (BDT):	50,248	49,996	49,996	35,516
TOTAL COST ($):	2,848,535	2,835,054	2,835,054	1,958,454
AVERAGE ($/BDT):	$ 56.69	$ 56.71	$ 56.71	$ 55.14

Transportation

Surface Replacement: Pavement ($ / GT B-A	$ 0.07
Surface Replacement: Dirt ($ / GT B-A Mile)	$ 0.03
Surface Replacement: Ag ($ / GT B-A Mile)	$ 0.05

Type	1	1 CONVENTIONAL TRUCK/TRAILER	2 STINGER STEER/TRAILER	3 Short Van	4 Other
Capacity (BDT)	14	14	14	10	
Cost ($/hr)	85	$ 85.00	$ 95.00	$ 90.00	
Haul Spped-PAVED (MPH)	45	45	45	45	
PAVED COST ($/Mile) A-B	$ 1.89				
PAVED COST ($/Mile) A-B-A	$ 3.78				
PAVED COST ($/BDT-Mile) A-B	$ 0.13				
PAVED COST ($/BDT-Mile) A-B-A	$ 0.27				
Haul Spped-OFFROAD (MPH)	20	20	20	20	
OFFROAD COST ($/Mile) A-B	$ 4.25				
OFFROAD COST ($/Mile) A-B-A	$ 8.50				
OFFROAD COST ($/BDT-Mile) A-B	$ 0.30				
OFFROAD COST ($/BDT-Mile) A-B-A	$ 0.61				

Forest Management

Biomass Gate Price ($/BDT)	$ 45.00
Saw Timber Value (+$/MBF)	$ 250.00
Recovery Cost (-$/MBF)	$ (125.00)
Haul Cost (-$/MBF)	$ (9.00)
Surface Replacement Cost (-$/MBF)	$ (1.00)
Tax 2.9% (-$/MBF)	$ (7.25)
Other Costs (-$/MBF)	$ (5.00)
Net Saw Timber Value ($/MBF)	**$ 102.75**

Unit Conversion

GT/BDT	2	
GT/CCF	2.4	One Hundred Cubic Feet (CCF) = 2.4GT
CCF/BDT	0.83333333	
CCF/MBF	2	One Hundred Cubic Feet (1 CCF) = 0.5 MBF

Step 5: Added Analysis Benefits that are Key to Providing Economical Projects

The first four steps outlined meet the intent of the overall premise of the transport network assessment in relation to biomass transport to a variety of utilization facilities located in the TSA. However, these steps do not address the ability to analyze projects in relation to the potential value of sawlogs. By adding sawlogs to the mix of resources recovered during forest fuels reduction or forest restoration activities, forest managers have the option to offset forest biomass recovery costs (if biomass market prices do not support all of the recovery costs). In order for the geospatial analysis for biomass and its transportation issues to be a complete analytical tool, this step was added to determine the required sawlog volume to address economic constraints. Thus, agencies can determine not only the cost of treating biomass on any given landscape, but also the volume of sawlogs that would be needed to offset any deficit costs associated with this treatment.

This same step can be used to assist inter-disciplinary teams in determining the volume of sawlogs that would facilitate bundling service work in stewardship contracts. Current direction is to put projects under the stewardship authority, which then bundles service work with the product treatment portion of any given landscape.

Results from the Simulation

Three separate analyses were completed as part of this study, in which three different modes of transportation (conventional trailer, stinger steer trailer and short trailer) were applied to two different TASA. The results of these simulations are presented in Appendix C.

TRANSPORTATION SYSTEM FIELD TRIALS

Work conducted in support of the Preliminary Transportation Network Assessment confirmed the transportation system challenges faced by land managers when attempting to transport processed forest biomass material to market using chip vans. These challenges arise because most forest transport system roads were designed to accommodate log trucks that have the ability to articulate and navigate relatively tight corners and steep grades.

In order to address these challenges, stimulate discussions among land managers and demonstrate innovative transport technologies, TSS implemented transportation system field trials in late September 2011. The primary objective of the field trials was to compare and contrast existing forest biomass transport technologies with innovative transport systems.

Field Trials Location

Consistent with the objectives of the transportation system field trials, TSS conducted a search of existing USFS projects currently under contract with local (northern Sierra Nevada region) contractors. The key was finding a willing contractor who was planning to implement a project with the following attributes:

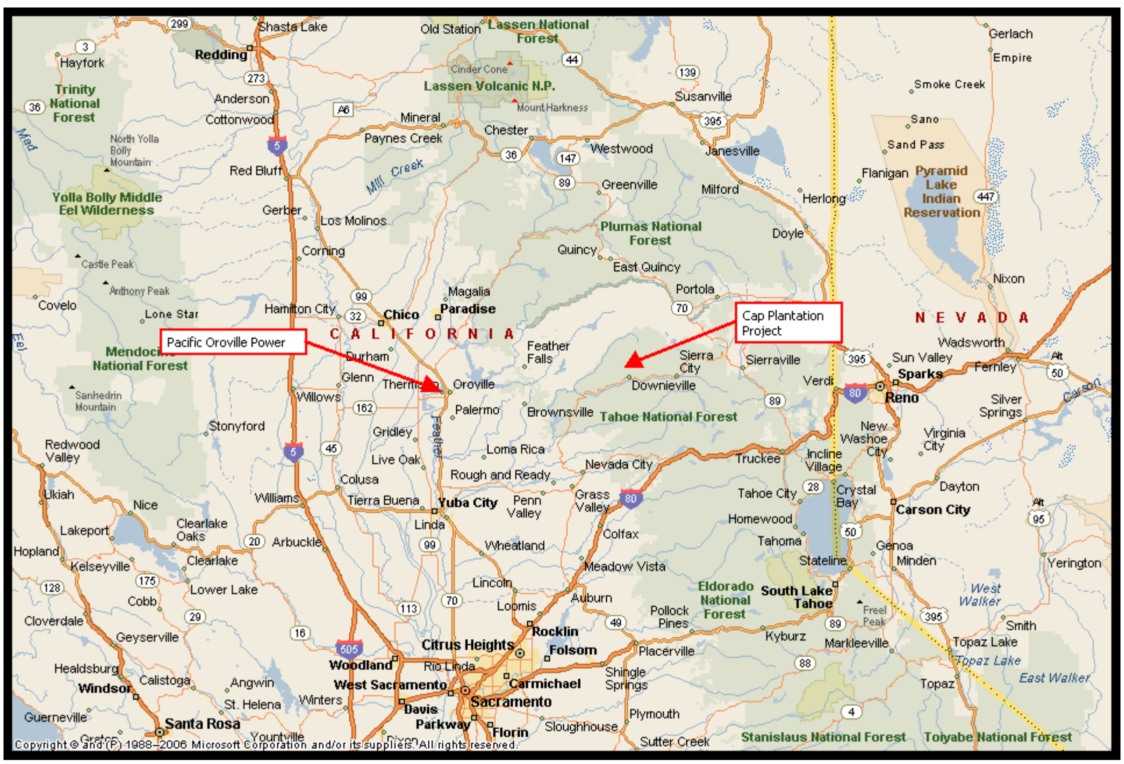
- Includes plans to process and remove forest biomass material.
- Operational in 2011.

- Located on a challenging road system with choke points that conventional chip transport technologies would find challenging.
- Currently under contract with a contractor willing to accommodate innovative equipment and numerous guests.

The contractor and project search resulted in TSS contacting Nathan Bamford, General Manager of Bamford Enterprises. Mr. Bamford suggested that the Cap Plantation Thin Service Contract on the Yuba River Ranger District, Tahoe National Forest, would be a good candidate for field trials, primarily due to the challenging road system required to access the project. A key objective of the trials was selection of a location that allowed innovative transport systems to be tested in field conditions consistent with those that TSS found in the Transportation Assessment Study Areas. The road system accessing the Cap Plantation Thin project (County Road 509) has steep road grades and tight radius curves that closely matched conditions that were observed in the Ingalls TASA.

Figure 19 highlights the location of the field trials.

Figure 19. Transportation System Field Trials Location



TSS and Bamford Enterprises worked closely to assure that the Cap Plantation Thin project road system would offer the opportunity to test various types of transportation technologies. The project, as originally proposed, required biomass material to be removed by dump truck to a central collection point, where the material would be chipped and scattered.

After careful field review of the proposed field trial location and road system, TSS and Nathan Bamford developed a proposal that would test innovative technologies and compared those methods of removal to the proposed contractual treatments as well as limitations regarding standard chip van removal. TSS then searched for various innovative transportation systems appropriate for the study. The three systems identified were the stinger steer, force steer and short van. A fourth system was considered (adjustable axle chip van) but road conditions and concern for safe operations precluded this option.

The reason the force steer trailer was not tested was because it is too costly (capital cost is over $140,000)[20] and the closest available source for the force steer trailer was on the Olympic Peninsula in Washington. A similar biomass transportation study was occurring on the Klamath National Forest and that study was employing the use of a stinger steer trailer. That technology was made available through the Forest Service San Dimas Technology and Development Center (SDTDC). TSS contacted SDTDC staff and arrangements were made to deploy the stinger steer trailer. The short van technology was available within the target study area and arrangements were made[21] for the use of one 32-foot chip van.

Nathan and Joel Bamford graciously allowed the trials to be conducted in conjunction with the Cap Plantation Thin project and cooperated in all phases of the planning and operation of the trials. Bamford Enterprise's cooperation and foresight were key to the successful implementation of the trials. Cooperation of the project administration team from the Yuba River Ranger District (RD) and Siller Brothers Inc. (logging contractor also using County Road 509 to remove sawlogs from the Red Ant Timber Sale) was also important to the success of the trials.

Field Trials Outreach

In order to maximize participation of natural resource managers in the trials, a trials announcement (see Appendix D) was generated and distributed widely, 35 days ahead of the September 22, 2011 participation date. Distribution was targeted for a specific audience, including:

- Fiber procurement foresters;
- Logging and chipping contractors;
- Public and private land managers;
- Interested members of the general public.

A total of 18 professionals attended the trials. Due to safety concerns, participation was limited to 18. The participants included a cross-section of professionals:

- Fiber procurement foresters – 2;
- Trailer vendor representative – 1;

[20]Per John Sambucetti, Sales Representative, Western Trailers.
[21]Short van was provided by Clint Pearson, chipping contractor headquartered in Quincy, California.

- USFS staff (logging engineers, road engineers, sales administration, silviculture, regional office) – 13;
- Sierra Institute representatives – 2;

Feedback from the participants was positive. See Appendix E for a complete list of trial participants.

Field Trials Implementation

Transportation system trials were held over a four-day period from September 19 through September 22. The first three days of the trial were devoted to field testing the stinger steer trailer and on September 21, the short trailer.

Initially, Nathan Bamford planned to utilize a dump truck to transport biomass material from the plantation to a staging area located about a nine miles drive north of the Cap Plantation Thin project area. The biomass material was to be chipped and scattered at the disposal site. However, once it became clear that the stinger steer and short van system could navigate County Road 509 to State Highway 49 and to the Pacific Oroville Power Inc. (POPI) facility, there was no need to use the dump truck to haul and chip at the designated disposal site.

Safety concerns required considerable coordination prior to the launch and during the field trials. An emergency contact list was distributed to the drivers and TSS foresters. Safety discussions were held with the drivers and with the trial participants. Selected images from the trials are included below.

Figure 20. Pre-Trial Overview and Safety Discussion with Trial Participants

Figure 21. Stinger Steer Trailer with Truck

Figure 22. Stinger Steer Truck and Trailer Being Towed by Water Truck

Figure 23. Biomass Processed and Loaded into Stinger Steer Trailer

Figure 24. Stinger Steer Navigating Tight Radius Turn on County Road 509

Figure 25. Stinger Steer Trailer Clearing Obstacles

Figure 26. Short Trailer Maneuvering at the Landing in Preparation for Loading

Detailed field notes were generated by Bill Wickman (see Appendix F).

Field Trials Results

The stinger steer trailer and short trailer transport technologies performed well during the trials. Bamford Enterprises continued using the short trailer after the trials to transport processed biomass material to POPI. The field trials results allowed Bamford Enterprises to rethink how to optimize treatment and removal of forest biomass residuals (limbs, tops and sub-merchantable stems). The short trailer technology allowed Bamford to recover some of the costs incurred during Cap Plantation Thin thinning operations, thereby reducing treatment costs per acre. Net revenue from the sale of biomass chips to POPI (after subtracting short trailer transport costs) provided income, rather than expense, compared to the initial plan involving the use of a dump truck and chip/scatter techniques. The short trailer technology improved the overall economics of the service contract project.

Technologies Utilized

Two technologies were deployed during the trials. Table 23 provides data regarding the physical dimensions of the stinger steer and short trailer technologies. For comparison, Table 23 also includes the dimensions of typical chip trailers (drop bed and straight bed) that are deployed by local contractors.

Table 23. Transport System Physical Dimensions

TRANSPORT SYSTEM TECHNOLOGY	TOTAL LENGTH	VAN LENGTH	WIDTH	HEIGHT	CUBIC CAPACITY CUBIC UNITS[22]	WEIGHT CAPACITY TONS GROSS	NET
Stinger Steer	56.7’	40’	8’	13.4’	21	40	21
Short Trailer	49’	32’	8.5”	13.5’	19	40	26
Conventional Trailer (Drop bed trailer)	64’	45’	8.5’	13.5’	27	40	25
Conventional Trailer (Straight bed trailer)	59’	40’	8.5’	13.5’	21	40	25

Load, Haul and Unload Times

Load, haul and unloading times were monitored using Driver Log Sheets (see Appendix G). A total of five trips (four with stinger steer trailer and one with short trailer) were accomplished during the field trials. The costs to haul bulk commodities (such as biomass) over the road are typically calculated on a cost per hour basis. Monitoring load, haul and unload times is key to determining the total cost of transport.

Table 24 provides the results of load, haul and unload times (as provided by the drivers).

[22]One cubic unit equals 200 cubic feet.

Table 24. Transport System Load, Haul and Unload Times (Expressed in Hours)

TECHNOLOGY	DATE	LOAD TIME	HAUL TIME	UNLOAD TIME	RETURN TIME	TOTAL TIME (ROUNDTRIP)
Stinger steer	Sept 19	.5	3.5	.5	2.0	6.5
Stinger steer	Sept 20	.4	3.4	.6	2.0	6.4
Stinger steer	Sept 21	.5	2.7	.7	1.9	5.8
Stinger steer	Sept 22	.4	2.3	.6	2.0[23]	5.3
Averages for Stinger Steer		**.5**	**3**	**.6**	**2**	**6**
Short Trailer	Sept 21	.3	5.2[24]	.5	2	8

Due to challenges experienced with the short trailer accessing the Cap Plantation Thin project area (rock overhang), an alternative route was utilized to transport the loaded trailer to POPI. Rather than attempt to navigate past the rock outcropping, the loaded short trailer was transported northbound on County Road 509 to the Cal-Ida road and then down to Highway 49. This alternative route added an additional two hours to the haul time (as reflected in Table 24 above).

<u>Deliveries to POPI</u>

A total of 100.15 green tons[25] were transported to the POPI facility during the trials. Table 25 presents haul deliveries by technology and date. Legal gross weight capacity for California is 40 green tons (80,000 pounds). Tare weight represents the weight of the empty truck/trailer and net weight is the weight of the biomass material delivered to POPI. All weights were measured at the POPI facility using weight scales certified by the State of California.

[23]Stinger steer did not return to field trial site as trials had ended. Return haul time is an average of the three previous return haul times.
[24]Short trailer haul route was longer than the stinger steer due to use of alternate route because of obstacles on County Road 509.
[25]Green ton equals 2,000 pounds of biomass material with no adjustment for moisture content.

Table 25. Transport System Haul Deliveries

TECHNOLOGY	DATE	GROSS WEIGHT (GREEN TONS)	TARE WEIGHT (GREEN TONS)	NET WEIGHT (GREEN TONS)	NET WEIGHT (BDT)
Stinger steer	Sept 19	38.14	19.25	18.90	9.37
Stinger steer	Sept 20	33.03	19.24	13.79	7.51
Stinger steer	Sept 21	35.51	19.26	16.25	6.25
Stinger steer	Sept 22	42.65	19.64	23.01	13.11
Averages for Stinger Steer		37.33	19.35	17.99	9.06
Short Trailer	Sept 21	41.97	13.76	28.21	10.86

Most biomass power plants in California procure biomass fuel on a bone dry ton basis. Each delivery of fuel is sampled for moisture content and payment to suppliers is made on a $/BDT basis. The net weight in BDT delivered is key, as all payment is based on BDT.

As shown in Table 25, the stinger steer trailer deliveries ranged from 6.25 to 13 BDT per load. This represents a very wide range, one that could be reduced if the trailer was equipped with weight scales. On board weigh scales would allow the driver to monitor biomass material weight loaded into the trailer at the landing on a real-time basis. By monitoring weight as the trailer is loaded, the driver and chipper operator can coordinate loading procedures to make sure that the trailer is fully loaded. This also allows the driver to make sure that the trailer is not overloaded (as on September 22). In California, commercial trucks are allowed a gross loaded weight of 80,000 pounds (40 tons).

<u>Transport Costs</u>

The cost to own and operate conventional transport equipment (drop bed trailers or straight bed trailers) averages about $80 per hour. This figure will trend upward if diesel prices increase (e.g., exceed $4/gallon). Diesel fuel costs are the most significant cost variable affecting biomass transport costs.

Interviews with San Dimas Technology and Development Center staff[26] confirmed an approximate ownership/operating/maintenance cost of $90 per hour. Interviews with the owner[27] of the short trailer confirmed ownership/operating/maintenance costs of $90 per hour. TSS believes that the relatively high cost quoted for the short trailer technology was due to the fact that few trailers of this size are currently available in Plumas or Yuba counties. If more short trailers were available, a more competitive pricing schedule could be expected, one approaching the current cost for traditional chip trailers at $80 per hour. For the purposes of this analysis, TSS assumed an $85/hour rate for the short trailer.

[26]Ed Messerlie, Forester, San Dimas Technology and Development Center, US Forest Service.
[27]Clint Pearson, Quincy, California.

Table 26 summarizes transport system haul costs by hour and by weight of delivered biomass fuel.

Table 26. Transport System Haul Costs

TECHNOLOGY	COST PER HOUR	COST PER GT	COST PER BDT	COMMENTS
Stinger Steer	$90	$30.02	$59.60	Assumes six hour round trip.
Short Trailer	$85	$18.08	$46.96	Assumes six hour round trip.

<u>Logs and Biomass Fuel Removed</u>

At the completion of the Cap Plantation Thin project, Bamford Enterprises provided data regarding total volumes and weights of logs and biomass fiber removed.

Table 27 summarizes total volumes removed by type and destination.

Table 27. Sawlogs and Biomass Removed and Transported to Value-Added Markets

MATERIAL REMOVED AND DESTINATION	VOLUME REMOVED	TRUCK LOADS	AVERAGE VOLUME PER LOAD	COMMENTS
Sawlogs to SPI Lincoln	522 MBF	157	3.3 MBF	All ponderosa pine sawlogs. Total volume by weight = 4,386 GT.
Firewood logs to Cal Hotwood	610 GT	25	24.4 GT	Primarily small logs made up of tops and cull logs.
Firewood logs to Bamford yard	342 GT	14		Very small logs (known as baseball bats). No weigh scale at Bamford yard. Used 24.4 GT/load average (from Cal Hotwood deliveries).
Biomass fuel to Pacific Oroville Power	1,313 GT (697 BDT)	52	25.2 GT (13.4 BDT)	Tops, limbs and defective boles that would not make sawlogs or firewood. Averaged 47% moisture content.
TOTALS	**6,651 GT**	**248**		Average biomass fuel volume per acre removed = 16 GT (8.5 BDT).

The Cap Plantation Thin project treated approximately 82 acres[28] and removed 248 truck loads of commercial product (as noted in Table 27). A key finding is the volume of forest biomass fuel removed to Pacific Oroville Power amounted to 1.34 BDT/MBF of sawlog harvested. Known as the forest biomass recovery factor, TSS' experience with

[28] Acreage estimate provided by Bamford Logging.

timber stand improvement projects throughout the Pacific Northwest has confirmed biomass recovery factors ranging from 0.5 BDT to 2.2 BDT/MBF removed. The biomass recovery factor was higher than conventional pine plantation thinning operations due to the recovery of very small logs (sorted for firewood logs) and reduced the volume of sawlogs recovered (MBF removed). Biomass recovery factors for pine plantation thinning operations are typically closer to 0.9 BDT/MBF.[29]

Observations

The stinger steer and short trailer transport technologies were able to navigate very challenging road systems that traditional chip trailers could not. While these innovative systems have slightly higher operating costs than traditional chip trailers, they can be useful when utilized to deliver biomass material for value-added uses that justify the additional transport costs (as was the case with the Cap Plantation Thin project).

The stinger steer trailer is currently equipped with walking floor capabilities and as such is able to deliver and unload biomass fuel (without the need for a truck tipper). This feature does add to the tare weight of the truck, thus reducing its net payload. Loggers and chipping contractors considering use of the stinger steer trailer should investigate the need for the walking floor function. Without the walking floor, the stinger steer trailer should be able to transport 23 to 24 green tons (conventional trailers can carry up to 25 to 26 green tons) payload.

The short trailer is able to transport relatively wet fuel (50% moisture content) and achieve a net legal payload of 26 green tons (see Table 25). However, if transporting drier fuel, the trailer may not achieve the 26 green ton payload due to the smaller cubic capacity of the trailer (18 cubic units) when compared to the stinger steer trailer (21 cubic units).

Regardless of the type, trailers should be equipped with on-board weight scales so that optimized weights can be achieved. On board weight scales allow a driver to monitor biomass material weight loaded into the trailer at the landing on a real-time basis. By monitoring weight as the trailer is loaded, the driver and chipper operator can coordinate loading procedures to make sure that the trailer is fully loaded (and not overloaded).

Field Trials Recommendations

- Use experienced drivers to determine the actual road issues prior to making final engineering and road reconstruction decisions.
- Pay attention to more than the running surface of roads in steep areas. Rock or vegetation overhang combined with road width can cause access problems for square-sided vans.
- In sale prospectus and contracts, discuss the exact road issues, i.e., curve, grade, width, so that purchasers can determine tractor and van requirements.

[29] TSS' experience with pine plantation thinning operations and biomass recovery.

- Provide opportunities for sale planners and road engineers to hold field reviews of perceived road issues with experienced drivers and prospective purchasers early in the planning process.
- Chip trailers should be equipped with on board weight scales to maximize haul volumes (material on board) and monitor gross weight to comply with state regulations regarding maximum weight restrictions (80,000 pound weight restriction in California).

PRELIMINARY FEASIBILITY UTILIZATION ANALYSIS

TSS conducted a comprehensive review of value-added opportunities for under-utilized woody biomass material generated within the TSA, with emphasis on potential siting options within Indian Valley. Results of interviews conducted during the Preliminary Market Review provided local perspectives and recommendations on utilization opportunities and potential siting options. A site attribute matrix was created to facilitate site and value-added opportunity analysis. The matrix summarizes key site attributes ranging from acreage available to existing infrastructure (e.g., power, water).

Table 28 is the target site matrix with specific sites ranked based on site attributes and value-added utilization opportunity.

Table 28. Target Site Attribute Matrix for Potential Forest Biomass Value-Added Enterprises Located in the Upper Feather River Watershed Region

CANDIDATE SITES	OWNERSHIP	ACRES	POWER AT SITE	WATER AT SITE	TRANSPORT SYSTEM	PROX TO HOMES	COMMENTS	RANK
GREENVILLE CHENEY #2	Indian Valley Community Service District	5	Yes	Community	Hwy 89	Residents are located across Hwy 89 from site.	IVCSD willing to take a leadership role in siting a 3 MW CHP facility. Zoned Commercial (C-2).	1
CRESCENT MILLS (FORMER LP SAWMILL)	Greg Lehman ETAL, 1665 S Sutro Terrace, Carson City, NV 89706 (Cinderlite)	15.89 (3 parcels that equal 20+ ac)	Yes	Community	RR siding and Hwy 89	Residence on west of property	Greg Lehman quoted a $450K asking price. Zoned heavy industry.	2
EASTERN PLUMAS HEALTH CENTER	EPHC	25+	Yes	Community	City Road		Discussions for biomass-fired thermal energy option. Urgent need for boiler replacement.	3
CRESENT MILLS	1st Crescent Cap. LLC, Reno	5.48	Yes	Community	RR siding and Hwy 89			4
SLOAT #1	Sierra Pacific Industries							5
SLOAT #2	Jon Valdez, Graeagle	9.97	Yes	Yes	County Rd			6

CANDIDATE SITES	OWNERSHIP	ACRES	POWER AT SITE	WATER AT SITE	TRANSPORT SYSTEM	PROX TO HOMES	COMMENTS	RANK
TWAIN	Delbert and Donna Lehr, Taylorsville	64.81	Yes		Hwy 70 and UP RR		Issue could be bridge across Feather River.	7
GREENVILLE SETZER #1	Mary Lorraine Anson, San Jose	20.5	440 note below	Community	Wolf Creek Rd		Heavy traffic thru residential area.	8
GREENVILLE SETZER #2	Tucker/ Wilson Trustee	11.74	440 on premise	Community	Wolf Creek Rd		Heavy traffic thru residential area.	9
INDIAN VALLEY LUMBER	David Schramel		Yes		Taylorsville/ Genesee Rd			10
CRESCENT MILLS (COUNTY OWNED)	Plumas County Community Development	11.14			RR siding and Hwy 89Hwy H	Residence on west of property	Designated wetlands on site.	11

Value-Added Utilization Opportunity Ranking

Key site attributes critical for successful outcomes were considered when ranking sites and value-added opportunities. Siting attributes considered critical include:

- Proximity to feedstock sources;
- Existing infrastructure (e.g., power, water) ;
- Site zoning;
- Transport systems nearby;
- Current and previous site uses;
- Current site ownership's interest in supporting value-added opportunities.

TSS presented the target site matrix to SI and USFS representatives who concurred with the site ranking methodology and selection of the top two value-added utilization alternatives. Summarized below is a discussion regarding these two siting locations and value-added alternatives as assimilated by TSS.

Greenville Cheney #2 - Indian Valley Community Service District

Formerly the location of a sawmill complex owned and operated by the Cheney Stud Company, this site is currently owned by the Indian Valley Community Service District (IVCSD). Zoned for commercial use (C-2) this site has about five acres of flat usable land that formerly served as the log storage area for the mill. During the February 21, 2012 public workshop (held in Greenville), a representative for the IVCSD Board of Directors[30] indicated a possible interest in siting a small cogeneration facility at the site. The Board has formed a committee to research the potential opportunity. As a result of these discussions, this site became the number one ranked location in the siting matrix (replacing the old Louisiana Pacific mill site in Crescent Mills, which now is ranked third in order of potential biomass facilities development sites).

The Greenville Cheney site is served by a major state highway (State Highway 89). Additionally, with the recent closure of the Mt. Lassen Power biomass power plant located at Westwood, California (about 20 road miles from Greenville), there is a significant need for additional biomass utilization infrastructure in the region. This site appears well suited for location of a small community-scale biomass combined heat and power generation facility but will need further evaluation. See Figure 27 for aerial view of the site.

[30]Jane Braxton Little.

Figure 27. Aerial Image of the Greenville Site

<u>Portola - Eastern Plumas Health Care</u>

Located on the Portola campus of Eastern Plumas Health Care (EPHC), this site is one of several managed by EPHC. EPHC provides health care services to much of Plumas and Sierra counties and maintains clinics at Graeagle, Greenville, Loyalton and Portola. The Portola campus includes a small hospital, outpatient services and a skilled nursing facility for both short-term rehabilitation and long-term care. The Portola campus is currently heated by three diesel-fired boilers, two of which are over 40 years old. These boilers are very costly to operate and maintain and are in need of replacement. In addition, pipes delivering heat using steam and hot water to the hospital and skilled nursing facility are deteriorating and causing down time and elevated repair costs. This site was selected as a candidate for a small biomass-fired thermal energy facility. A new, state-of-the-art biomass-fired thermal energy facility could service the EPHC campus heat load, replacing the need to operate and maintain the relatively high cost diesel-fired boilers. Discussions with EPHC representatives[31] confirmed an interest in the technology. Figure 28 is an aerial image of the EPHC campus.

[31]Tom Hayes, CEO, East Plumas Health Center and Stan Pieler, Operations Staff, East Plumas Health Center.

Figure 28. Aerial Image of the EPHC Campus

Value-Added Opportunities Analysis

As noted above, the top two ranked sites/value-added opportunities were selected for more detailed preliminary analysis.

<u>Small-Scale Combined Heat and Power Facility at Greenville</u>

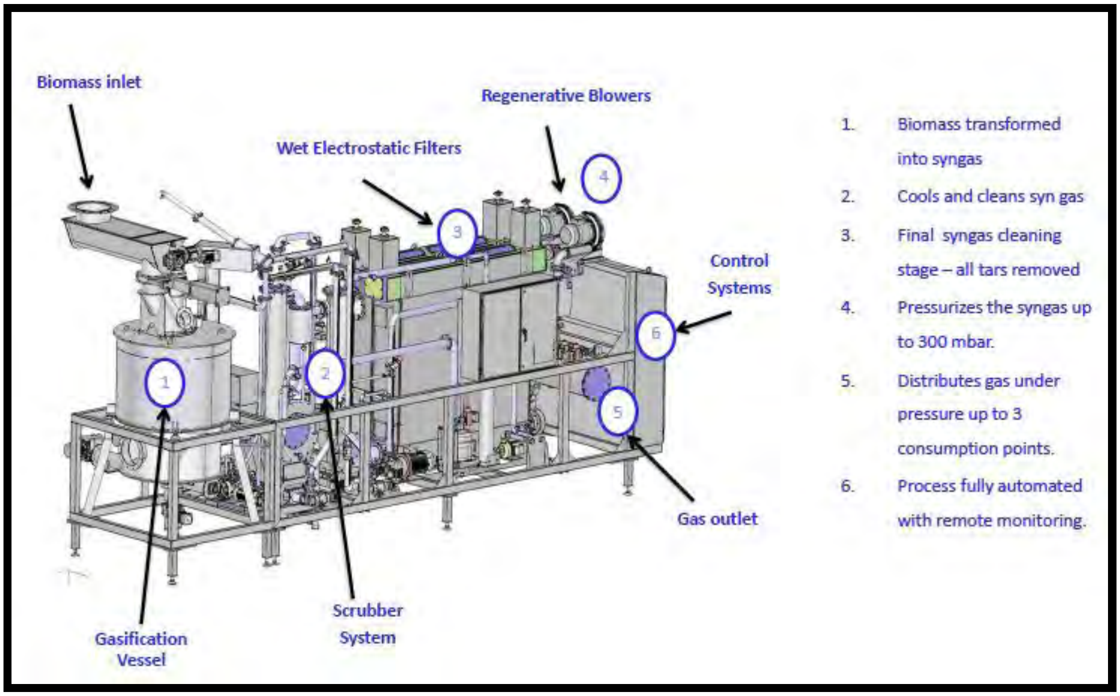
Technologies to convert woody biomass material to thermal and electrical energy have evolved significantly in recent years. Especially impressive has been the improved conversion efficiencies and cost effective operations associated with biomass gasification technologies. As a direct result of these improvements, biomass gasification-to-energy conversion technologies have improved both the operating efficiencies and the economic performance of small-scale facilities.

For this preliminary feasibility analysis, a 3 megawatt (MW)[32] combined heat and power facility was selected for review. A facility scaled at 3 MW (net power output) will require approximately 24,000 BDT per year of biomass fuel to operate at 86% capacity. The feedstock resource availability analysis confirmed over 132,000 BDT per year are potentially available at this time (see Table 1).

[32]One megawatt is the equivalent of 1,000 kilowatts of electrical energy. One MW is enough electrical energy to power about 1,000 homes.

The Biogen gasification system[33] was selected as the preferred technology for this analysis. Other promising technologies exist and could be utilized at Greenville; however, Biogen appears to have a scalable and commercially viable technology that can operate on a wide range of feedstocks. Biogen currently has over 12 gasification units deployed worldwide.[34] Figure 29 provides a schematic representation of the Biogen Advanced Gasification Technology.

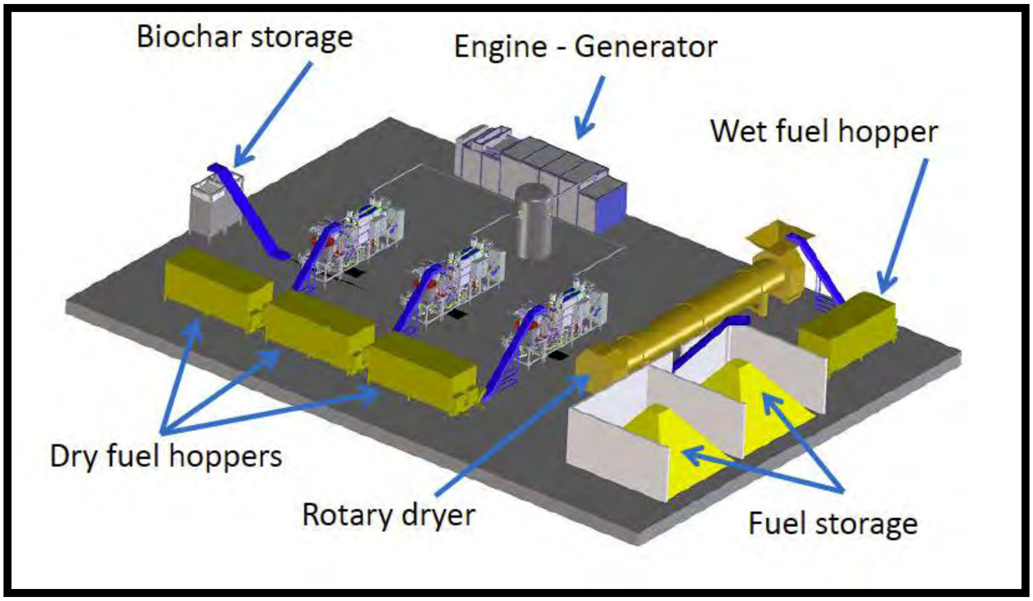
Figure 29. Biogen/AGT Gasification Equipment Schematic



While Biogen is the technology of choice, a project developer is required to design, engineer, build and operate a complete and integrated CHP system. TSS worked with Reliable Renewables, LLC, to provide information and cost estimates for a 3 MW CHP system. Figure 30 is a site layout example (1.3 MWe facility) provided by Reliable Renewables.

[33]http://www.biogendr.com/app/en/frontpage.aspx
[34]Per Biogen provided information.

Figure 30. Reliable Renewables Site Layout Example



Other important data is outlined below.

- Thermal energy can be recovered and utilized to dry biomass fuel (forest biomass can have up to 55% moisture content) or to dry other products (e.g., lumber, firewood). Waste heat can be extracted at three locations in the process:
  - Heat exchanger at the gas-cooling step;
  - Water jacket around the generator engine;
  - Radiator at the generator engine.
- Biomass fuel usage is approximately 1 BDT per megawatt hour (MWh)[35] or about 24,000 BDT per year for a 3 MW facility.
- Capital and construction costs for the Reliable Renewables installation, using the Biogen gasification system, with fuel receiving system and thermal energy extraction (for fuel drying), are approximately $12.7 million. The capital cost includes $1 million for a building to house the facility.
- Footprint of the fuel receiving and power generation equipment is less than two acres. Fuel storage for stockpiling fuel through winter months (when forest operations are not active due to wet soil conditions and inclement weather) may take up an additional two acres.

As noted earlier, the Greenville Cheney #2 site is currently owned and managed by the Indian Valley Community Service District. Figure 27 provides an aerial image of the Greenville site.

[35] MWh is 1,000 kW per hour of electrical generation.

Financial Analysis

Using an excel-based proforma workbook, TSS conducted a financial feasibility analysis to determine what the sale price of power produced would have to be to make the project financially viable.

Summarized below are assumptions used for conducting the financial analysis:

- 17% return on equity (after taxes)
- \$3.80 million/MW_e for equipment and installation
- \$500,000/MW_{th} for heat recovery
- 3 MW_e nominal (net) generation
- 2MMBtu[36]/hr heat sold (1/5 of maximum possible heat recovery)
- \$1 million for the building at \$100/sf
- \$198,000/year labor cost (approximately three employees)
- \$430,000/year maintenance cost (including major maintenance)
- \$20,000/year insurance cost
- \$127,000/year property tax
- \$400/year utilities
- \$35/ton ash disposal
- \$48,000/year land lease cost
- \$13,000/year administration costs
- 86% Operating Capacity Factor
- \$20/MMBtu for heat sales (2/3 the price of residential liquid propane gas)
- 5-year tax depreciation schedule for equipment
- Straight line 20-year tax depreciation schedule for the building
- Production tax credit of 1.1 cents/kWh for 10 years
- 34% federal tax bracket
- 8.84% state tax
- 15-year debt service (amortization period)
- 20-year economic life for the project
- 5% interest rate on debt
- 75% debt/25% equity in year one (for Capital Cost less Grant Funding)
- 8700 Btu/lb HHV for fuel
- 1%/year escalation of fuel prices
- 0%/year escalation of power sales price
- 1%/year escalation of heat price
- 1%/year escalation of biochar sale price
- 1%/year escalation of other component

Other variables, such as the cost of biomass fuel and the availability of grant funding (to underwrite capital expenses), were included and ramped both up and down to confirm the financial impacts.

[36]MMBtu = Million British thermal units.

The results of a sensitivity analysis based on the available grant funding and the fuel price are displayed in Table 29.

Table 29. Sensitivity Analysis for the Proposed CHP Facility

GRANT FUNDING ($)	FUEL PRICE ($/BDT)	REQUIRED ELECTRICITY PRICE ($/kWh)
0	$45	$.1002
0	$50	$.1047
0	$55	$.1093
2,000,000	$45	$.0851
3,175,000	$45	$.0762

Note that the financial analysis results posted in Table 29 assume the enterprise that owns this CHP facility has the ability to utilize tax credits (e.g., federal investment tax credit). Also note that in order for biomass power facilities to qualify for the federal investment tax credit, the facility must be in commercial operation by December 31, 2013.

Should the enterprise not have an appetite for tax credits (e.g., not for profit organization) or not be in commercial service by December 31, 2013, the financial performance will change. Table 30 shows the results of the financial analysis assuming the enterprise that owns the facility has no tax liabilities.

Table 30. Sensitivity Analysis for the Proposed CHP Facility Owned by Entity with No Tax Liabilities

GRANT FUNDING ($)	FUEL PRICE ($/BDT)	REQUIRED ELECTRICITY PRICE ($/kWh)
0	$45	$.1264
0	$50	$.1309
0	$55	$.1354
2,000,000	$45	$.1153
3,175,000	$45	$.1089

State legislation (SB 32) enacted in 2009 requires that investor-owned utilities (IOU such as PG&E) offer a standard feed-in tariff (FIT) rate for renewable energy generation facilities with a capacity of 3 MW or less. CPUC has requested comments on the FIT pricing. Placer County Air Pollution Control District has gained party status and is promoting an initiative to have an energy price adder (known as the Wildfire Hazard Reduction Adder), available for small-scale (< 3 MW) forest biomass power facilities located in high and medium priority landscapes at significant risk to wildfire. If the Wildfire Hazard Reduction Adder is accepted by the CPUC and implemented by the IOU, wholesale energy prices for small-scale biomass power plants located in at-risk landscapes may qualify for an energy price adder of $.055/kWh. See Appendix I for more information on the Placer County initiative.

Small-Scale Thermal Energy Facility at EPHC Portola Campus

The existing fuel oil (diesel) fired system at the EPHC campus is comprised of three boilers, two Burnham steam boilers and a Bryan hot water boiler. The Burnham boilers were installed around 1971[37] with one unit operating almost daily to provide steam heat to the hospital. The second Burnham boiler provides backup steam when needed. The Bryan hot water boiler was installed in 1997 and provides hot water to the long-term care skilled nursing facility.

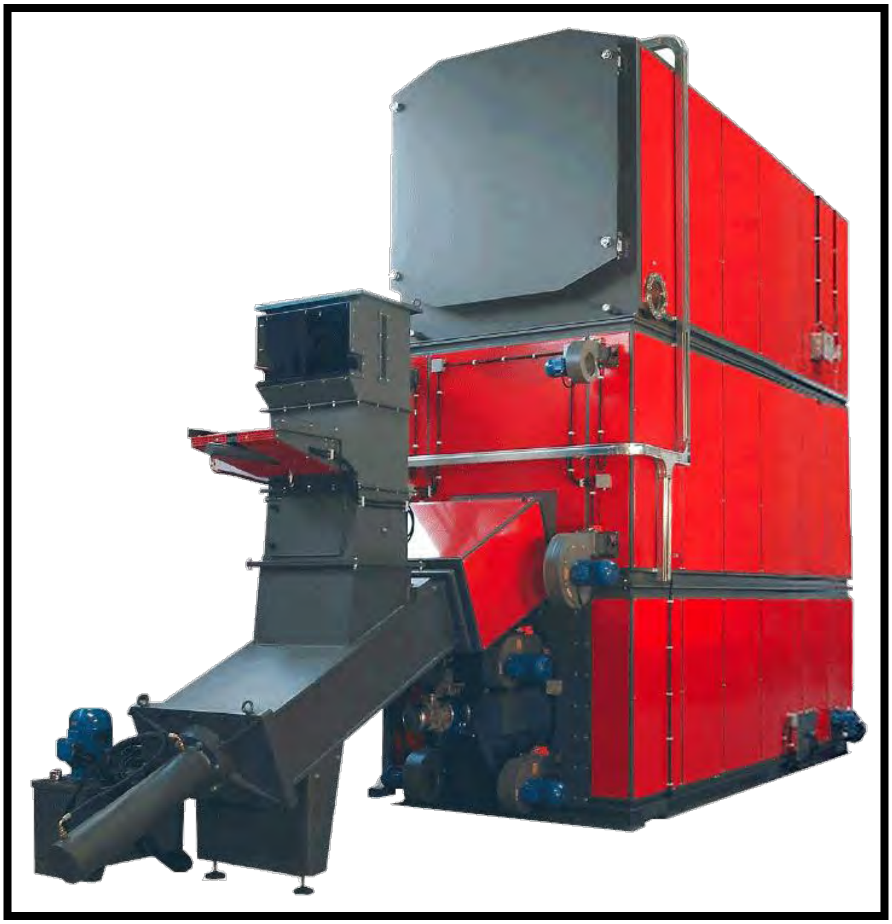
Diesel fuel purchase records provided by EPHC staff confirm that the cost of diesel has been trending upward the last six years. Fuel purchases in 2006 averaged $2.41/gallon and in 2011 (through November 25) averaged $3.70/gallon. TSS calculates that the cost of heating the EPHC campus in 2011 (through November) averaged $26.68/MMBtu.

Thermal energy facilities utilizing woody biomass feedstocks are regularly installed in cold climate regions where fuel oil (e.g., diesel) fired systems are being replaced. The relatively recent ramp-up in fuel oil pricing is providing an incentive for homeowners and commercial-scale enterprises to seek out alternative thermal energy sources. A number of biomass-fired thermal energy technologies have been developed over the last 50 years to serve growing demand in this market sector.

For the purposes of this preliminary feasibility analysis, TSS selected the Alternative Energy Solutions International (AESI) technology. AESI has over 5,000 biomass systems installed and operating worldwide.[38] In addition, this technology is able to utilize a wide range of biomass feedstocks, including forest-sourced biomass. Figure 31 is an image of the AESI Global Series model. The Global Series is capable of providing steam or hot water for thermal energy delivery.

[37]Per Stan Peiler, Operations Staff at EPHC.
[38]Per information provided by AESI.

Figure 31. AESI Global Series Model



Financial Analysis

Using an excel-based proforma workbook, TSS conducted a preliminary financial feasibility analysis to determine what the equivalent cost of thermal energy produced would have to be to make the project financially viable.

Summarized below are assumptions used when conducting the financial analysis:

- 17% return on equity
- $155,000/MMBtu for equipment and installation
- System scaled at 3.6 MMBtu/hour
- $285,000 for building with $114/sf average construction cost
- $32,120/year labor cost (approximately 4 hours/day)
- $3,000/year maintenance cost
- $50,000 for major maintenance every 5 years
- 756 BDT/year fuel usage (about 1 truckload per week)
- $35/ton ash removal

- $0/year land lease cost
- $0/year administration costs
- 26% Operating Capacity Factor
- 15-year debt service (amortization period)
- 30-year economic life for the project
- 5% interest rate on debt
- 75% debt/25% equity in year one
- 1%/year escalation of fuel prices
- 1%/year escalation of heat price
- 1%/year escalation of other components

Other variables, such as the cost of biomass fuel and the availability of grant funding (to underwrite capital expenses), were included and ramped both up and down to confirm the financial impacts.

Table 31. Sensitivity Analysis for the Proposed Thermal Energy Facility

GRANT FUNDING ($)	FUEL PRICE ($/BDT)	COST OF HEAT ($/MMBtu)
0	$45	$20.95
0	$50	$21.41
0	$55	$21.87
100,000	$45	$19.59
210,750	$45	$18.08

As mentioned earlier, the current cost of thermal energy (using existing fuel oil boilers) is $26.68/MMBtu. If the delivered biomass fuel price is $45/BDT, then the thermal energy cost is $20.95/MMBtu, amounting to a net cost savings of about 20%.

NEXT STEPS

Value-Added Utilization

This feasibility study determined that a small-scale biomass combined heat and power generation facility sited at Greenville and a biomass-fired thermal energy facility at the EPHC campus at Portola have the greatest potential for value-added opportunities in the Upper Feather River Watershed region. Outlined below are suggested next steps for the Sierra Institute and/or other entities to consider. Note that this is a draft task list, one that provides a high-level view of next steps to consider.

- Provide a formal presentation, targeting community stakeholders, with the findings of this study analysis and outline plans for next steps (public meeting to roll out draft findings was held February 21, 2012, public meeting is planned for April 2012 to roll out final report).

- Develop and implement a communications plan to educate local stakeholders, elected officials, county, state and federal agency staff, and the general public about the societal benefits provided as a result of siting sustainable, small-scale, value-added enterprises at Greenville and Portola. Seek out local agencies and other potential supporters and potential equity partners.
- Develop and implement a strategic plan to source grants/loan guarantees from targeted private foundations, federal and state agencies (TSS met with Plumas Corporation on March 14, 2012 to start discussions regarding potential grant funding).
- Seek out and engage potential private/public sector partnerships (e.g., memorandum of understanding with technology vendor).
- Confirm strategic private/public partnership arrangement with a term sheet and memorandum of understanding.
- Review options for additional use of thermal energy (e.g., greenhouse for native plants, food drying processes, lumber drying, etc.) for the Greenville site.
- Conduct preliminary discussions with electrical utilities (target PG&E first) regarding potential for a power sales agreement at Greenville.
- Update detailed financial analysis based on discussions with utilities.
- Secure private foundation, state/federal grant support to offset a portion of expenses (primarily capital expenses).
- Prepare an environmental permitting plan for both the Greenville and EPHC projects.
- Prepare a feedstock (e.g., biomass fuel) procurement plan.
- Conduct technology assessment/selection and preliminary design.
- Update detailed financial analysis based on latest data.
- Issue Request for Quotes from select technology vendors.
- Issue Request for Quotes from select engineering and construction firms.
- Update detailed financial analysis based on latest data.
- Select and contract with technology/engineering and construction firm.
- Engineer, construct, and start up.

Steep Slope Field Trials

In the course of conducting this analysis, it became clear that while forest road systems can be a barrier to the collection and removal of forest biomass, there are other significant issues including steep topography. In recent years forest harvest technologies have improved significantly and are more efficient/cost effective while minimizing soil disturbance. Traditionally foresters and land managers have only treated landscapes that were below 35 percent slope on public lands and generally less that 45 percent on private lands. Relatively new ground-based harvest technologies allow operations on 50 percent plus slopes. Unfortunately, most national forest standards and guidelines have set limits for ground-based equipment at 30 to 35 percent. Currently industry and the USFS are working together to analyze steep slope treatments that provide an opportunity to more economically thin forest stands to assist in reducing the threat of wildfire and impacts to watersheds. To facilitate this analysis, more field trials to showcase the latest steep slope treatment equipment are needed. These trials could be organized as a field demonstration that allows forest land managers, foresters, watershed specialist and various stakeholder groups to view this equipment first hand, while facilitating environmental impact monitoring (e.g., soil disturbance).

APPENDIX A - INTERVIEW LIST

REPRESENTATIVE	TITLE	COMPANY
BIOMASS FUEL PROCUREMENT		
Steve Jolley	Fuel Procurement Manager	Iberdrola Renewables
Gordon Bauer	Fuel Procurement Manager	Pacific Oroville Power
Tom Hickman	Fuel Procurement Manager	Burney Forest Power
Dave Allen	Fuel Procurement Manager	Honey Lake Power
Mark Bosseti	Fuel Procurement Manager	Sierra Pacific Industries
Jay Francis	Forester	Collins Pine Company
VALUE-ADDED ENTERPRISES		
David Schramel	Owner	Indian Valley Lumber
David Sims	Owner	Topper's Tree Service
Mike Simmons	Owner	Mountain Star Products
Guy Senter	Owner	Pacific Crest Furniture Co
John Williamson	Owner	
Vicki Albrecht	Owner	Sierra Resource Management, Inc.
John Lullo	Owner	Pacific Crafts
Larry Tremobli		Sierra Log Homes
Krista Stewart	Natural Resource Advisor	Greenville Rancheria
OTHER		
Randy Pew	Owner	Pew Forest Products
Nathan Bamford	Owner	J.W. Bamford, Inc.
Doug Stoy	Owner	D.L. Stoy Logging
Gary Warner	Owner	Warner Enterprises
Clint Pearson	Owner	Pearson Wildland Fuel Reduction
David Sims	Owner	Topper's Tree Service

APPENDIX B - CHIP TRAILER CURVE CALCULATOR

San Dimas Technology and Development Center

This is a curve calculator for calculating the curve widening needed to allow the passage of trucks and trailers. The first step is to determine the central angle of the curve. This is done by measuring the azimuth of the roads coming into the curve. Measure these angles from the point of tangent with the curve.

Click on this link to download a desktop version of this calculator, Curve Widening. This is a zip file that contains three files. Put the files into one folder on your computer. For the sake of simplicity create a shortcut to the .exe file on your Desktop and run it from the shortcut. Otherwise, you can just double click the .exe file to run the program. All three files must be in the same folder for the help to work.

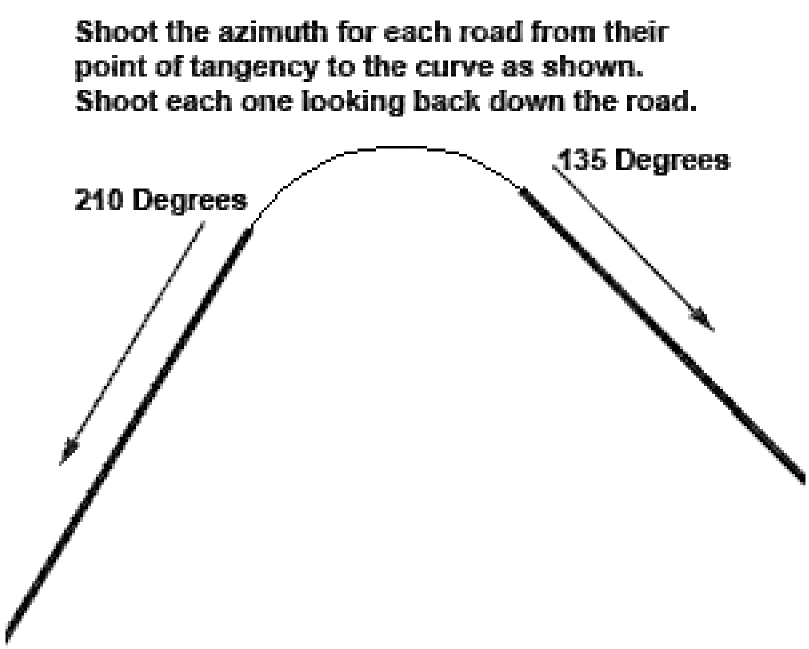
The first azimuth must be the smaller of the two measurements or the calculator will return a wrong central angle.

Enter the first azimuth 0

Enter the second azimuth 0

Hit the calculate button to calculate the central angle

Central Angle, I in degrees



The next step is to calculate the radius of the curve. This is done by measuring the arc length of the curve at the center line. The radius is then calculated from the central angle and the arc length.

Enter the arc length 0

Hit the calculate button to calculate the radius

Radius, in feet 0

The final step is to put this all together to calculate the width of curve required to pass a tractor-trailer. At the right are the fields required for input.

1. Truck type is the type of tractor-trailer combo being analyzed. 1 is a standard lowboy or tractor-trailer. 2 is a stinger type log truck
2. L1 is the wheel base of the tractor, in feet
3. For a standard tractor-trailer, L2 is the distance from the fifth wheel to the middle of the rear duals of the first trailer. For a stinger log truck, L2 is the length of the stinger.
4. For a standard tractor-trailer, L3 is the distance from the fifth wheel to the middle of the rear duals of the second trailer. For a stinger log truck, L3 is the bunk to bunk distance minus the stinger length.

The calculator gives three numbers:

1. The effective length is the effective length of the tractor-trailer combo, in feet.
2. Curve Widening is the extra width needed at the inside of the curve.
3. Minimum land width is the overall lane width required to pass the tractor-trailer. Standard lane width is 12 feet, so this number is just 12 plus the curve widening.

APPENDIX C - TRANSPORT SYSTEM CALCULATOR TOOL SIMULATION RESULTS

CONVENTIONAL TRUCK/TRAILER	INGALLS				RICE			
Scenario Results	S1: Fix all choke points	S2: Fix all possible choke points	S3: Best Case	S4: Fix Nothing	S1: Fix all choke points	S2: Fix all possible choke points	S3: Best Case	S4: Fix Nothing
1 Indian Valley Lumber:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,081,445	$ 4,070,027	**$ 4,054,051**	$ 3,503,690	$ 2,960,690	$ 2,946,918	**$ 2,946,918**	$ 2,049,393
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 55.00	$ 55.00	**$ 54.95**	$ 61.46	$ 57.82	$ 57.83	**$ 57.83**	$ 56.30
Biomass Profit Made At The Gate ($/BDT)	$ (10.00)	$ (10.00)	**$ (9.95)**	$ (16.46)	$ (12.82)	$ (12.83)	**$ (12.83)**	$ (11.30)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 742,068	$ 740,191	**$ 734,007**	$ 938,254	$ 656,403	$ 653,981	**$ 653,981**	$ 411,321
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	7,222	7,204	**7,144**	9,131	6,388	6,365	**6,365**	4,003
2 Cresent Mills LP:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,208,348	$ 4,196,568	**$ 4,180,220**	$ 3,495,177	$ 2,873,122	$ 2,859,782	**$ 2,859,782**	$ 1,987,143
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 56.71	$ 56.71	**$ 56.66**	$ 61.31	$ 56.11	$ 56.12	**$ 56.12**	$ 54.59
Biomass Profit Made At The Gate ($/BDT)	$ (11.71)	$ (11.71)	**$ (11.66)**	$ (16.31)	$ (11.11)	$ (11.12)	**$ (11.12)**	$ (9.59)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 868,971	$ 866,731	**$ 860,176**	$ 929,741	$ 568,835	$ 566,845	**$ 566,845**	$ 349,071
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	8,457	8,435	**8,372**	9,049	5,536	5,517	**5,517**	3,397
3 Cresent Mills County:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,212,678	$ 4,200,885	**$ 4,184,524**	$ 3,498,503	$ 2,870,134	$ 2,856,809	**$ 2,856,809**	$ 1,985,019
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 56.77	$ 56.77	**$ 56.72**	$ 61.37	$ 56.05	$ 56.07	**$ 56.07**	$ 54.53
Biomass Profit Made At The Gate ($/BDT)	$ (11.77)	$ (11.77)	**$ (11.72)**	$ (16.37)	$ (11.05)	$ (11.07)	**$ (11.07)**	$ (9.53)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 873,301	$ 871,048	**$ 864,480**	$ 933,067	$ 565,848	$ 563,872	**$ 563,872**	$ 346,947
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	8,499	8,477	**8,413**	9,081	5,507	5,488	**5,488**	3,377
4 Greenville Cheney:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,285,540	$ 4,273,538	**$ 4,256,964**	$ 3,554,478	$ 2,819,858	$ 2,806,780	**$ 2,806,780**	$ 1,949,279
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 57.75	$ 57.75	**$ 57.70**	$ 62.35	$ 55.07	$ 55.08	**$ 55.08**	$ 53.55
Biomass Profit Made At The Gate ($/BDT)	$ (12.75)	$ (12.75)	**$ (12.70)**	$ (17.35)	$ (10.07)	$ (10.08)	**$ (10.08)**	$ (8.55)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 946,162	$ 943,702	**$ 936,920**	$ 989,042	$ 515,571	$ 513,843	**$ 513,843**	$ 311,207
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,208	9,184	**9,118**	9,626	5,018	5,001	**5,001**	3,029
5 Greenville Setzer:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,324,837	$ 4,312,724	**$ 4,296,034**	$ 3,584,668	$ 2,792,160	$ 2,779,218	**$ 2,779,218**	$ 1,929,589
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 58.28	$ 58.28	**$ 58.23**	$ 62.88	$ 54.53	$ 54.54	**$ 54.54**	$ 53.01
Biomass Profit Made At The Gate ($/BDT)	$ (13.28)	$ (13.28)	**$ (13.23)**	$ (17.88)	$ (9.53)	$ (9.54)	**$ (9.54)**	$ (8.01)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 985,460	$ 982,887	**$ 975,990**	$ 1,019,232	$ 487,873	$ 486,281	**$ 486,281**	$ 291,517
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,591	9,566	**9,499**	9,920	4,748	4,733	**4,733**	2,837
6 Twain Gray's Flat:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,438,307	$ 4,425,807	**$ 4,408,720**	$ 3,523,141	$ 3,069,454	$ 3,055,147	**$ 3,055,147**	$ 2,126,712
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 59.81	$ 59.81	**$ 59.76**	$ 61.80	$ 59.94	$ 59.96	**$ 59.96**	$ 58.42
Biomass Profit Made At The Gate ($/BDT)	$ (14.81)	$ (14.81)	**$ (14.76)**	$ (16.80)	$ (14.94)	$ (14.96)	**$ (14.96)**	$ (13.42)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,098,930	$ 1,095,971	**$ 1,088,677**	$ 957,705	$ 765,167	$ 762,210	**$ 762,210**	$ 488,640
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,695	10,666	**10,595**	9,321	7,447	7,418	**7,418**	4,756
7 Sloat:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,374,349	$ 4,361,660	**$ 4,318,847**	$ 3,238,962	$ 3,336,970	$ 3,321,346	**$ 3,321,346**	$ 2,316,884
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 58.95	$ 58.94	**$ 58.54**	$ 56.81	$ 65.17	$ 65.18	**$ 65.18**	$ 63.65
Biomass Profit Made At The Gate ($/BDT)	$ (13.95)	$ (13.94)	**$ (13.54)**	$ (11.81)	$ (20.17)	$ (20.18)	**$ (20.18)**	$ (18.65)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,034,972	$ 1,031,823	**$ 998,803**	$ 673,526	$ 1,032,683	$ 1,028,408	**$ 1,028,408**	$ 678,812
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,073	10,042	**9,721**	6,555	10,050	10,009	**10,009**	6,606
8 Collins Pines:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 4,779,211	$ 4,765,799	**$ 4,747,777**	$ 3,933,735	$ 2,479,207	$ 2,467,807	**$ 2,467,807**	$ 1,707,117
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 64.40	$ 64.41	**$ 64.35**	$ 69.00	$ 48.42	$ 48.43	**$ 48.43**	$ 46.90
Biomass Profit Made At The Gate ($/BDT)	$ (19.40)	$ (19.41)	**$ (19.35)**	$ (24.00)	$ (3.42)	$ (3.43)	**$ (3.43)**	$ (1.90)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,439,834	$ 1,435,963	**$ 1,427,733**	$ 1,368,299	$ 174,920	$ 174,870	**$ 174,870**	$ 69,045
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	14,013	13,975	**13,895**	13,317	1,702	1,702	**1,702**	672
9 Sierra Pacific:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 4,439,001	$ 4,426,411	**$ 4,383,235**	$ 3,279,615	$ 3,142,312	$ 3,127,647	**$ 3,127,647**	$ 2,178,505
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 59.82	$ 59.82	**$ 59.41**	$ 57.53	$ 61.37	$ 61.38	**$ 61.38**	$ 59.85
Biomass Profit Made At The Gate ($/BDT)	$ (14.82)	$ (14.82)	**$ (14.41)**	$ (12.53)	$ (16.37)	$ (16.38)	**$ (16.38)**	$ (14.85)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,099,623	$ 1,096,575	**$ 1,063,191**	$ 714,179	$ 838,026	$ 834,709	**$ 834,709**	$ 540,433
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,702	10,672	**10,347**	6,951	8,156	8,124	**8,124**	5,260
10 Westwood:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 4,741,272	$ 4,727,969	**$ 4,710,058**	$ 3,904,589	$ 2,674,458	$ 2,662,097	**$ 2,662,097**	$ 1,845,917
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 63.89	$ 63.89	**$ 63.84**	$ 68.49	$ 52.23	$ 52.24	**$ 52.24**	$ 50.71
Biomass Profit Made At The Gate ($/BDT)	$ (18.89)	$ (18.89)	**$ (18.84)**	$ (23.49)	$ (7.23)	$ (7.24)	**$ (7.24)**	$ (5.71)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,401,895	$ 1,398,132	**$ 1,390,014**	$ 1,339,153	$ 370,172	$ 369,159	**$ 369,159**	$ 207,845
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	13,644	13,607	**13,528**	13,033	3,603	3,593	**3,593**	2,023

Cost Benefit Anlysis	CONVENTIONAL TRUCK/TRAILER INGALLS BEST CASE =	EXISTING Infrastructure +	IMPROVEMENT Impacts	RICE BEST CASE =	EXISTING Infrastructure +	IMPROVEMENT Impacts
1 Indian Valley Lumber:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,054,051	$ 3,503,690	$ 550,360.92	$ 2,946,918	$ 2,049,393	$ 897,525
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 54.95	$ 61.46	$ 32.82	$ 57.83	$ 56.30	$ 61.67
Biomass Profit Made At The Gate ($/BDT)	$ (9.95)	$ (16.46)	$ 12.18	$ (12.83)	$ (11.30)	$ (16.67)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 734,007	$ 938,254	$ (204,247)	$ 653,981	$ 411,321	$ 242,660
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	7,144	9,131	(1,988)	6,365	4,003	2,362
2 Cresent Mills LP:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,180,220	$ 3,495,177	$ 685,042.41	$ 2,859,782	$ 1,987,143	$ 872,639
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 56.66	$ 61.31	$ 40.85	$ 56.12	$ 54.59	$ 59.96
Biomass Profit Made At The Gate ($/BDT)	$ (11.66)	$ (16.31)	$ 4.15	$ (11.12)	$ (9.59)	$ (14.96)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 860,176	$ 929,741	$ (69,566)	$ 566,845	$ 349,071	$ 217,774
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	8,372	9,049	(677)	5,517	3,397	2,119
3 Cresent Mills County:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,184,524	$ 3,498,503	$ 686,020.77	$ 2,856,809	$ 1,985,019	$ 871,790
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 56.72	$ 61.37	$ 40.91	$ 56.07	$ 54.53	$ 59.91
Biomass Profit Made At The Gate ($/BDT)	$ (11.72)	$ (16.37)	$ 4.09	$ (11.07)	$ (9.53)	$ (14.91)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 864,480	$ 933,067	$ (68,587)	$ 563,872	$ 346,947	$ 216,924
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	8,413	9,081	(668)	5,488	3,377	2,111
4 Greenville Cheney:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,256,964	$ 3,554,478	$ 702,485.46	$ 2,806,780	$ 1,949,279	$ 857,501
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 57.70	$ 62.35	$ 41.89	$ 55.08	$ 53.55	$ 58.92
Biomass Profit Made At The Gate ($/BDT)	$ (12.70)	$ (17.35)	$ 3.11	$ (10.08)	$ (8.55)	$ (13.92)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 936,920	$ 989,042	$ (52,122)	$ 513,843	$ 311,207	$ 202,636
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,118	9,626	(507)	5,001	3,029	1,972
5 Greenville Setzer:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,296,034	$ 3,584,668	$ 711,365.71	$ 2,779,218	$ 1,929,589	$ 849,630
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 58.23	$ 62.88	$ 42.42	$ 54.54	$ 53.01	$ 58.38
Biomass Profit Made At The Gate ($/BDT)	$ (13.23)	$ (17.88)	$ 2.58	$ (9.54)	$ (8.01)	$ (13.38)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 975,990	$ 1,019,232	$ (43,242)	$ 486,281	$ 291,517	$ 194,764
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,499	9,920	(421)	4,733	2,837	1,896
6 Twain Gray's Flat:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,408,720	$ 3,523,141	$ 885,579.64	$ 3,055,147	$ 2,126,712	$ 928,435
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 59.76	$ 61.80	$ 52.81	$ 59.96	$ 58.42	$ 63.80
Biomass Profit Made At The Gate ($/BDT)	$ (14.76)	$ (16.80)	$ (7.81)	$ (14.96)	$ (13.42)	$ (18.80)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,088,677	$ 957,705	$ 130,972	$ 762,210	$ 488,640	$ 273,570
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,595	9,321	1,275	7,418	4,756	2,662
7 Sloat:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,318,847	$ 3,238,962	$ 1,079,885.18	$ 3,321,346	$ 2,316,884	$ 1,004,462
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 58.54	$ 56.81	$ 64.40	$ 65.18	$ 63.65	$ 69.02
Biomass Profit Made At The Gate ($/BDT)	$ (13.54)	$ (11.81)	$ (19.40)	$ (20.18)	$ (18.65)	$ (24.02)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 998,803	$ 673,526	$ 325,277	$ 1,028,408	$ 678,812	$ 349,597
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,721	6,555	3,166	10,009	6,606	3,402
8 Collins Pines:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 4,747,777	$ 3,933,735	$ 814,041.69	$ 2,467,807	$ 1,707,117	$ 760,690
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 64.35	$ 69.00	$ 48.54	$ 48.43	$ 46.90	$ 52.27
Biomass Profit Made At The Gate ($/BDT)	$ (19.35)	$ (24.00)	$ (3.54)	$ (3.43)	$ (1.90)	$ (7.27)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,427,733	$ 1,368,299	$ 59,434	$ 174,870	$ 69,045	$ 105,825
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	13,895	13,317	578	1,702	672	1,030
9 Sierra Pacific:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 4,383,235	$ 3,279,615	$ 1,103,619.28	$ 3,127,647	$ 2,178,505	$ 949,141
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 59.41	$ 57.53	$ 65.81	$ 61.38	$ 59.85	$ 65.22
Biomass Profit Made At The Gate ($/BDT)	$ (14.41)	$ (12.53)	$ (20.81)	$ (16.38)	$ (14.85)	$ (20.22)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,063,191	$ 714,179	$ 349,011	$ 834,709	$ 540,433	$ 294,276
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,347	6,951	3,397	8,124	5,260	2,864
10 Westwood:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 4,710,058	$ 3,904,589	$ 805,468.54	$ 2,662,097	$ 1,845,917	$ 816,180
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 63.84	$ 68.49	$ 48.03	$ 52.24	$ 50.71	$ 56.08
Biomass Profit Made At The Gate ($/BDT)	$ (18.84)	$ (23.49)	$ (3.03)	$ (7.24)	$ (5.71)	$ (11.08)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,390,014	$ 1,339,153	$ 50,861	$ 369,159	$ 207,845	$ 161,314
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	13,528	13,033	495	3,593	2,023	1,570

STINGER STEER/TRAILER	INGALLS				RICE			
Scenario Results	S1: Fix all choke points	S2: Fix all possible choke points	S3: Best Case	S4: Fix Nothing	S1: Fix all choke points	S2: Fix all possible choke points	S3: Best Case	S4: Fix Nothing
1 Indian Valley Lumber:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,180,149	$ 4,168,446	**$ 4,156,113**	$ 3,633,801	$ 3,048,350	$ 3,034,220	**$ 3,034,220**	$ 2,111,181
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 56.33	$ 56.33	**$ 56.33**	$ 63.74	$ 59.53	$ 59.55	**$ 59.55**	$ 58.00
Biomass Profit Made At The Gate ($/BDT)	$ (11.33)	$ (11.33)	**$ (11.33)**	$ (18.74)	$ (14.53)	$ (14.55)	**$ (14.55)**	$ (13.00)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 840,772	$ 838,609	**$ 836,069**	$ 1,068,365	$ 744,064	$ 741,283	**$ 741,283**	$ 473,110
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	8,183	8,162	**8,137**	10,398	7,241	7,214	**7,214**	4,604
2 Cresent Mills LP:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,321,982	$ 4,309,874	**$ 4,297,125**	$ 3,622,322	$ 2,950,481	$ 2,936,832	**$ 2,936,832**	$ 2,041,608
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 58.24	$ 58.24	**$ 58.24**	$ 63.54	$ 57.62	$ 57.64	**$ 57.64**	$ 56.09
Biomass Profit Made At The Gate ($/BDT)	$ (13.24)	$ (13.24)	**$ (13.24)**	$ (18.54)	$ (12.62)	$ (12.64)	**$ (12.64)**	$ (11.09)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 982,605	$ 980,037	**$ 977,081**	$ 1,056,886	$ 646,194	$ 643,895	**$ 643,895**	$ 403,536
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,563	9,538	**9,509**	10,286	6,289	6,267	**6,267**	3,927
3 Cresent Mills County:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,326,821	$ 4,314,699	**$ 4,301,936**	$ 3,626,039	$ 2,947,142	$ 2,933,510	**$ 2,933,510**	$ 2,039,234
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 58.31	$ 58.31	**$ 58.31**	$ 63.60	$ 57.55	$ 57.57	**$ 57.57**	$ 56.02
Biomass Profit Made At The Gate ($/BDT)	$ (13.31)	$ (13.31)	**$ (13.31)**	$ (18.60)	$ (12.55)	$ (12.57)	**$ (12.57)**	$ (11.02)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 987,444	$ 984,862	**$ 981,892**	$ 1,060,603	$ 642,855	$ 640,572	**$ 640,572**	$ 401,162
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,610	9,585	**9,556**	10,322	6,256	6,234	**6,234**	3,904
4 Greenville Cheney:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,408,254	$ 4,395,900	**$ 4,382,898**	$ 3,688,599	$ 2,890,950	$ 2,877,594	**$ 2,877,594**	$ 1,999,289
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 59.40	$ 59.41	**$ 59.41**	$ 64.70	$ 56.46	$ 56.47	**$ 56.47**	$ 54.92
Biomass Profit Made At The Gate ($/BDT)	$ (14.40)	$ (14.41)	**$ (14.41)**	$ (19.70)	$ (11.46)	$ (11.47)	**$ (11.47)**	$ (9.92)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,068,877	$ 1,066,063	**$ 1,062,854**	$ 1,123,163	$ 586,663	$ 584,657	**$ 584,657**	$ 361,217
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,403	10,375	**10,344**	10,931	5,710	5,690	**5,690**	3,515
5 Greenville Setzer:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,452,176	$ 4,439,695	**$ 4,426,565**	$ 3,722,341	$ 2,859,993	$ 2,846,790	**$ 2,846,790**	$ 1,977,282
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 60.00	$ 60.00	**$ 60.00**	$ 65.29	$ 55.85	$ 55.87	**$ 55.87**	$ 54.32
Biomass Profit Made At The Gate ($/BDT)	$ (15.00)	$ (15.00)	**$ (15.00)**	$ (20.29)	$ (10.85)	$ (10.87)	**$ (10.87)**	$ (9.32)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,112,798	$ 1,109,859	**$ 1,106,521**	$ 1,156,905	$ 555,706	$ 553,853	**$ 553,853**	$ 339,210
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,830	10,802	**10,769**	11,259	5,408	5,390	**5,390**	3,301
6 Twain Gray's Flat:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,578,942	$ 4,566,030	**$ 4,552,456**	$ 3,651,090	$ 3,169,910	$ 3,155,181	**$ 3,155,181**	$ 2,197,596
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 61.70	$ 61.71	**$ 61.70**	$ 64.04	$ 61.90	$ 61.92	**$ 61.92**	$ 60.37
Biomass Profit Made At The Gate ($/BDT)	$ (16.70)	$ (16.71)	**$ (16.70)**	$ (19.04)	$ (16.90)	$ (16.92)	**$ (16.92)**	$ (15.37)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,239,565	$ 1,236,193	**$ 1,232,412**	$ 1,085,654	$ 865,624	$ 862,244	**$ 862,244**	$ 559,524
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	12,064	12,031	**11,994**	10,566	8,425	8,392	**8,392**	5,445
7 Sloat:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,500,460	$ 4,487,359	**$ 4,444,565**	$ 3,333,020	$ 3,468,899	$ 3,452,697	**$ 3,452,697**	$ 2,410,141
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 60.65	$ 60.64	**$ 60.24**	$ 58.46	$ 67.74	$ 67.76	**$ 67.76**	$ 66.21
Biomass Profit Made At The Gate ($/BDT)	$ (15.65)	$ (15.64)	**$ (15.24)**	$ (13.46)	$ (22.74)	$ (22.76)	**$ (22.76)**	$ (21.21)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,161,083	$ 1,157,522	**$ 1,124,521**	$ 767,584	$ 1,164,612	$ 1,159,760	**$ 1,159,760**	$ 772,069
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	11,300	11,265	**10,944**	7,470	11,334	11,287	**11,287**	7,514
8 Collins Pines:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 4,960,005	$ 4,946,074	**$ 4,931,454**	$ 4,112,475	$ 2,510,223	$ 2,498,743	**$ 2,498,743**	$ 1,728,637
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 66.84	$ 66.84	**$ 66.84**	$ 72.14	$ 49.02	$ 49.04	**$ 49.04**	$ 47.49
Biomass Profit Made At The Gate ($/BDT)	$ (21.84)	$ (21.84)	**$ (21.84)**	$ (27.14)	$ (4.02)	$ (4.04)	**$ (4.04)**	$ (2.49)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,620,627	$ 1,616,237	**$ 1,611,410**	$ 1,547,039	$ 205,936	$ 205,805	**$ 205,805**	$ 90,565
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	15,773	15,730	**15,683**	15,056	2,004	2,003	**2,003**	881
9 Sierra Pacific:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 4,571,095	$ 4,558,104	**$ 4,514,913**	$ 3,377,426	$ 3,251,340	$ 3,236,210	**$ 3,236,210**	$ 2,255,483
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 61.60	$ 61.60	**$ 61.20**	$ 59.24	$ 63.49	$ 63.51	**$ 63.51**	$ 61.96
Biomass Profit Made At The Gate ($/BDT)	$ (16.60)	$ (16.60)	**$ (16.20)**	$ (14.24)	$ (18.49)	$ (18.51)	**$ (18.51)**	$ (16.96)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,231,718	$ 1,228,268	**$ 1,194,869**	$ 811,990	$ 947,054	$ 943,273	**$ 943,273**	$ 617,411
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	11,988	11,954	**11,629**	7,903	9,217	9,180	**9,180**	6,009
10 Westwood:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 4,917,602	$ 4,903,792	**$ 4,889,297**	$ 4,079,900	$ 2,728,445	$ 2,715,890	**$ 2,715,890**	$ 1,883,767
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	**73,779**	57,010	51,206	50,954	**50,954**	36,402
Relative Cost ($ / BDT)	$ 66.27	$ 66.27	**$ 66.27**	$ 71.57	$ 53.28	$ 53.30	**$ 53.30**	$ 51.75
Biomass Profit Made At The Gate ($/BDT)	$ (21.27)	$ (21.27)	**$ (21.27)**	$ (26.57)	$ (8.28)	$ (8.30)	**$ (8.30)**	$ (6.75)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,578,225	$ 1,573,956	**$ 1,569,253**	$ 1,514,464	$ 424,158	$ 422,952	**$ 422,952**	$ 245,695
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	15,360	15,318	**15,273**	14,739	4,128	4,116	**4,116**	2,391

STINGER STEER/TRAILER Cost Benefit Anlysis	INGALLS BEST CASE =	EXISTING Infrastructure +	IMPROVEMENT Impacts	RICE BEST CASE =	EXISTING Infrastructure +	IMPROVEMENT Impacts
1 Indian Valley Lumber:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,156,113	$ 3,633,801	$ 522,312.60	$ 3,034,220	$ 2,111,181	$ 923,038
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 56.33	$ 63.74	$ 31.15	$ 59.55	$ 58.00	$ 63.43
Biomass Profit Made At The Gate ($/BDT)	$ (11.33)	$ (18.74)	$ 13.85	$ (14.55)	$ (13.00)	$ (18.43)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 836,069	$ 1,068,365	$ (232,295)	$ 741,283	$ 473,110	$ 268,173
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	8,137	10,398	(2,261)	7,214	4,604	2,610
2 Cresent Mills LP:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,297,125	$ 3,622,322	$ 674,803.45	$ 2,936,832	$ 2,041,608	$ 895,224
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 58.24	$ 63.54	$ 40.24	$ 57.64	$ 56.09	$ 61.52
Biomass Profit Made At The Gate ($/BDT)	$ (13.24)	$ (18.54)	$ 4.76	$ (12.64)	$ (11.09)	$ (16.52)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 977,081	$ 1,056,886	$ (79,804)	$ 643,895	$ 403,536	$ 240,359
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,509	10,286	(777)	6,267	3,927	2,339
3 Cresent Mills County:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,301,936	$ 3,626,039	$ 675,896.91	$ 2,933,510	$ 2,039,234	$ 894,275
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 58.31	$ 63.60	$ 40.31	$ 57.57	$ 56.02	$ 61.45
Biomass Profit Made At The Gate ($/BDT)	$ (13.31)	$ (18.60)	$ 4.69	$ (12.57)	$ (11.02)	$ (16.45)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 981,892	$ 1,060,603	$ (78,711)	$ 640,572	$ 401,162	$ 239,410
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	9,556	10,322	(766)	6,234	3,904	2,330
4 Greenville Cheney:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,382,898	$ 3,688,599	$ 694,298.62	$ 2,877,594	$ 1,999,289	$ 878,306
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 59.41	$ 64.70	$ 41.40	$ 56.47	$ 54.92	$ 60.35
Biomass Profit Made At The Gate ($/BDT)	$ (14.41)	$ (19.70)	$ 3.60	$ (11.47)	$ (9.92)	$ (15.35)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,062,854	$ 1,123,163	$ (60,309)	$ 584,657	$ 361,217	$ 223,441
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,344	10,931	(587)	5,690	3,515	2,175
5 Greenville Setzer:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,426,565	$ 3,722,341	$ 704,223.61	$ 2,846,790	$ 1,977,282	$ 869,508
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 60.00	$ 65.29	$ 42.00	$ 55.87	$ 54.32	$ 59.75
Biomass Profit Made At The Gate ($/BDT)	$ (15.00)	$ (20.29)	$ 3.00	$ (10.87)	$ (9.32)	$ (14.75)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,106,521	$ 1,156,905	$ (50,384)	$ 553,853	$ 339,210	$ 214,643
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,769	11,259	(490)	5,390	3,301	2,089
6 Twain Gray's Flat:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,552,456	$ 3,651,090	$ 901,365.89	$ 3,155,181	$ 2,197,596	$ 957,585
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 61.70	$ 64.04	$ 53.75	$ 61.92	$ 60.37	$ 65.80
Biomass Profit Made At The Gate ($/BDT)	$ (16.70)	$ (19.04)	$ (8.75)	$ (16.92)	$ (15.37)	$ (20.80)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,232,412	$ 1,085,654	$ 146,758	$ 862,244	$ 559,524	$ 302,720
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	11,994	10,566	1,428	8,392	5,445	2,946
7 Sloat:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,444,565	$ 3,333,020	$ 1,111,544.68	$ 3,452,697	$ 2,410,141	$ 1,042,556
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 60.24	$ 58.46	$ 66.29	$ 67.76	$ 66.21	$ 71.64
Biomass Profit Made At The Gate ($/BDT)	$ (15.24)	$ (13.46)	$ (21.29)	$ (22.76)	$ (21.21)	$ (26.64)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,124,521	$ 767,584	$ 356,937	$ 1,159,760	$ 772,069	$ 387,691
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	10,944	7,470	3,474	11,287	7,514	3,773
8 Collins Pines:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 4,931,454	$ 4,112,475	$ 818,979.12	$ 2,498,743	$ 1,728,637	$ 770,106
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 66.84	$ 72.14	$ 48.84	$ 49.04	$ 47.49	$ 52.92
Biomass Profit Made At The Gate ($/BDT)	$ (21.84)	$ (27.14)	$ (3.84)	$ (4.04)	$ (2.49)	$ (7.92)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,611,410	$ 1,547,039	$ 64,371	$ 205,805	$ 90,565	$ 115,240
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	15,683	15,056	626	2,003	881	1,122
9 Sierra Pacific:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 4,514,913	$ 3,377,426	$ 1,137,486.23	$ 3,236,210	$ 2,255,483	$ 980,727
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 61.20	$ 59.24	$ 67.83	$ 63.51	$ 61.96	$ 67.39
Biomass Profit Made At The Gate ($/BDT)	$ (16.20)	$ (14.24)	$ (22.83)	$ (18.51)	$ (16.96)	$ (22.39)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,194,869	$ 811,990	$ 382,878	$ 943,273	$ 617,411	$ 325,862
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	11,629	7,903	3,726	9,180	6,009	3,171
10 Westwood:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 4,889,297	$ 4,079,900	$ 809,397.37	$ 2,715,890	$ 1,883,767	$ 832,123
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 66.27	$ 71.57	$ 48.27	$ 53.30	$ 51.75	$ 57.18
Biomass Profit Made At The Gate ($/BDT)	$ (21.27)	$ (26.57)	$ (3.27)	$ (8.30)	$ (6.75)	$ (12.18)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,569,253	$ 1,514,464	$ 54,789	$ 422,952	$ 245,695	$ 177,258
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	15,273	14,739	533	4,116	2,391	1,725

Scenario Results	Short Van INGALLS S1: Fix all choke points	Short Van INGALLS S2: Fix all possible choke points	Short Van INGALLS S3: Best Case	Short Van INGALLS S4: Fix Nothing	RICE S1: Fix all choke points	RICE S2: Fix all possible choke points	RICE S3: Best Case	RICE S4: Fix Nothing
1 Indian Valley Lumber:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,486,130	$ 4,473,544	$ 4,472,506	$ 4,037,143	$ 3,320,098	$ 3,304,854	$ 3,304,854	$ 2,302,725
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 60.45	$ 60.46	$ 60.62	$ 70.82	$ 64.84	$ 64.86	$ 64.86	$ 63.26
Biomass Profit Made At The Gate ($/BDT)	$ (15.45)	$ (15.46)	$ (15.62)	$ (25.82)	$ (19.84)	$ (19.86)	$ (19.86)	$ (18.26)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,146,753	$ 1,143,707	$ 1,152,462	$ 1,471,707	$ 1,015,812	$ 1,011,917	$ 1,011,917	$ 664,653
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	11,161	11,131	11,216	14,323	9,886	9,848	9,848	6,469
2 Cresent Mills LP:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,674,246	$ 4,661,122	$ 4,659,532	$ 4,016,469	$ 3,190,292	$ 3,175,688	$ 3,175,688	$ 2,210,448
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 62.99	$ 62.99	$ 63.16	$ 70.45	$ 62.30	$ 62.32	$ 62.32	$ 60.72
Biomass Profit Made At The Gate ($/BDT)	$ (17.99)	$ (17.99)	$ (18.16)	$ (25.45)	$ (17.30)	$ (17.32)	$ (17.32)	$ (15.72)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,334,869	$ 1,331,285	$ 1,339,488	$ 1,451,033	$ 886,006	$ 882,750	$ 882,750	$ 572,376
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	12,991	12,957	13,036	14,122	8,623	8,591	8,591	5,571
3 Cresent Mills County:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,680,664	$ 4,667,521	$ 4,665,913	$ 4,021,400	$ 3,185,863	$ 3,171,281	$ 3,171,281	$ 2,207,300
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 63.07	$ 63.08	$ 63.24	$ 70.54	$ 62.22	$ 62.24	$ 62.24	$ 60.64
Biomass Profit Made At The Gate ($/BDT)	$ (18.07)	$ (18.08)	$ (18.24)	$ (25.54)	$ (17.22)	$ (17.24)	$ (17.24)	$ (15.64)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,341,286	$ 1,337,685	$ 1,345,869	$ 1,455,964	$ 881,577	$ 878,343	$ 878,343	$ 569,228
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	13,054	13,019	13,098	14,170	8,580	8,548	8,548	5,540
4 Greenville Cheney:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,788,670	$ 4,775,219	$ 4,773,294	$ 4,104,374	$ 3,111,335	$ 3,097,120	$ 3,097,120	$ 2,154,319
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 64.53	$ 64.53	$ 64.70	$ 71.99	$ 60.76	$ 60.78	$ 60.78	$ 59.18
Biomass Profit Made At The Gate ($/BDT)	$ (19.53)	$ (19.53)	$ (19.70)	$ (26.99)	$ (15.76)	$ (15.78)	$ (15.78)	$ (14.18)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,449,293	$ 1,445,383	$ 1,453,250	$ 1,538,938	$ 807,049	$ 804,182	$ 804,182	$ 516,247
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	14,105	14,067	14,144	14,978	7,854	7,827	7,827	5,024
5 Greenville Setzer:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,846,923	$ 4,833,306	$ 4,831,210	$ 4,149,127	$ 3,070,277	$ 3,056,264	$ 3,056,264	$ 2,125,132
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 65.32	$ 65.32	$ 65.48	$ 72.78	$ 59.96	$ 59.98	$ 59.98	$ 58.38
Biomass Profit Made At The Gate ($/BDT)	$ (20.32)	$ (20.32)	$ (20.48)	$ (27.78)	$ (14.96)	$ (14.98)	$ (14.98)	$ (13.38)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,507,546	$ 1,503,470	$ 1,511,166	$ 1,583,691	$ 765,991	$ 763,326	$ 763,326	$ 487,060
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	14,672	14,632	14,707	15,413	7,455	7,429	7,429	4,740
6 Twain Gray's Flat:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 5,014,911	$ 5,000,720	$ 4,998,035	$ 4,047,732	$ 3,481,325	$ 3,465,287	$ 3,465,287	$ 2,417,338
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 67.58	$ 67.58	$ 67.74	$ 71.00	$ 67.99	$ 68.01	$ 68.01	$ 66.41
Biomass Profit Made At The Gate ($/BDT)	$ (22.58)	$ (22.58)	$ (22.74)	$ (26.00)	$ (22.99)	$ (23.01)	$ (23.01)	$ (21.41)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,675,534	$ 1,670,884	$ 1,677,992	$ 1,482,296	$ 1,177,039	$ 1,172,350	$ 1,172,350	$ 779,266
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	16,307	16,262	16,331	14,426	11,455	11,410	11,410	7,584
7 Sloat:2:2Alternative								
Sum of TOAL B-T-CP ($)	$ 4,891,406	$ 4,877,024	$ 4,834,291	$ 3,624,602	$ 3,877,879	$ 3,859,888	$ 3,859,888	$ 2,699,240
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 65.91	$ 65.91	$ 65.52	$ 63.58	$ 75.73	$ 75.75	$ 75.75	$ 74.15
Biomass Profit Made At The Gate ($/BDT)	$ (20.91)	$ (20.91)	$ (20.52)	$ (18.58)	$ (30.73)	$ (30.75)	$ (30.75)	$ (29.15)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,552,029	$ 1,547,188	$ 1,514,247	$ 1,059,166	$ 1,573,592	$ 1,566,950	$ 1,566,950	$ 1,061,168
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	15,105	15,058	14,737	10,308	15,315	15,250	15,250	10,328
8 Collins Pines:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 5,520,465	$ 5,504,924	$ 5,500,852	$ 4,666,567	$ 2,606,371	$ 2,594,643	$ 2,594,643	$ 1,795,350
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 74.39	$ 74.39	$ 74.56	$ 81.86	$ 50.90	$ 50.92	$ 50.92	$ 49.32
Biomass Profit Made At The Gate ($/BDT)	$ (29.39)	$ (29.39)	$ (29.56)	$ (36.86)	$ (5.90)	$ (5.92)	$ (5.92)	$ (4.32)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 2,181,088	$ 2,175,087	$ 2,180,808	$ 2,101,131	$ 302,085	$ 301,705	$ 301,705	$ 157,278
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	21,227	21,169	21,224	20,449	2,940	2,936	2,936	1,531
9 Sierra Pacific:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 4,980,588	$ 4,966,354	$ 4,923,114	$ 3,680,640	$ 3,589,327	$ 3,572,757	$ 3,572,757	$ 2,494,115
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 67.12	$ 67.12	$ 66.73	$ 64.56	$ 70.10	$ 70.12	$ 70.12	$ 68.52
Biomass Profit Made At The Gate ($/BDT)	$ (22.12)	$ (22.12)	$ (21.73)	$ (19.56)	$ (25.10)	$ (25.12)	$ (25.12)	$ (23.52)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,641,211	$ 1,636,517	$ 1,603,070	$ 1,115,204	$ 1,285,041	$ 1,279,820	$ 1,279,820	$ 856,043
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	15,973	15,927	15,602	10,854	12,506	12,456	12,456	8,331
10 Westwood:2:2Existing								
Sum of TOAL B-T-CP ($)	$ 5,464,226	$ 5,448,845	$ 5,444,939	$ 4,623,362	$ 2,895,802	$ 2,882,648	$ 2,882,648	$ 2,001,101
Sum of TOTAL BIOMASS (BDT)	74,208	73,996	73,779	57,010	51,206	50,954	50,954	36,402
Relative Cost ($ / BDT)	$ 73.63	$ 73.64	$ 73.80	$ 81.10	$ 56.55	$ 56.57	$ 56.57	$ 54.97
Biomass Profit Made At The Gate ($/BDT)	$ (28.63)	$ (28.64)	$ (28.80)	$ (36.10)	$ (11.55)	$ (11.57)	$ (11.57)	$ (9.97)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 2,124,849	$ 2,119,009	$ 2,124,895	$ 2,057,926	$ 591,516	$ 589,711	$ 589,711	$ 363,029
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	20,680	20,623	20,680	20,028	5,757	5,739	5,739	3,533

Cost Benefit Anlysis	Short Van INGALLS BEST CASE =	EXISTING Infrastructure +	IMPROVEMENT Impacts	RICE BEST CASE =	EXISTING Infrastructure +	IMPROVEMENT Impacts
1 Indian Valley Lumber:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,472,506	$ 4,037,143	$ 435,362.79	$ 3,304,854	$ 2,302,725	$ 1,002,130
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 60.62	$ 70.82	$ 25.96	$ 64.86	$ 63.26	$ 68.86
Biomass Profit Made At The Gate ($/BDT)	$ (15.62)	$ (25.82)	$ 19.04	$ (19.86)	$ (18.26)	$ (23.86)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,152,462	$ 1,471,707	$ (319,245)	$ 1,011,917	$ 664,653	$ 347,264
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	11,216	14,323	(3,107)	9,848	6,469	3,380
2 Cresent Mills LP:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,659,532	$ 4,016,469	$ 643,062.68	$ 3,175,688	$ 2,210,448	$ 965,239
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 63.16	$ 70.45	$ 38.35	$ 62.32	$ 60.72	$ 66.33
Biomass Profit Made At The Gate ($/BDT)	$ (18.16)	$ (25.45)	$ 6.65	$ (17.32)	$ (15.72)	$ (21.33)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,339,488	$ 1,451,033	$ (111,545)	$ 882,750	$ 572,376	$ 310,374
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	13,036	14,122	(1,086)	8,591	5,571	3,021
3 Cresent Mills County:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,665,913	$ 4,021,400	$ 644,512.96	$ 3,171,281	$ 2,207,300	$ 963,981
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 63.24	$ 70.54	$ 38.43	$ 62.24	$ 60.64	$ 66.24
Biomass Profit Made At The Gate ($/BDT)	$ (18.24)	$ (25.54)	$ 6.57	$ (17.24)	$ (15.64)	$ (21.24)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,345,869	$ 1,455,964	$ (110,095)	$ 878,343	$ 569,228	$ 309,115
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	13,098	14,170	(1,071)	8,548	5,540	3,008
4 Greenville Cheney:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,773,294	$ 4,104,374	$ 668,919.44	$ 3,097,120	$ 2,154,319	$ 942,800
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 64.70	$ 71.99	$ 39.89	$ 60.78	$ 59.18	$ 64.79
Biomass Profit Made At The Gate ($/BDT)	$ (19.70)	$ (26.99)	$ 5.11	$ (15.78)	$ (14.18)	$ (19.79)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,453,250	$ 1,538,938	$ (85,689)	$ 804,182	$ 516,247	$ 287,935
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	14,144	14,978	(834)	7,827	5,024	2,802
5 Greenville Setzer:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,831,210	$ 4,149,127	$ 682,083.11	$ 3,056,264	$ 2,125,132	$ 931,132
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 65.48	$ 72.78	$ 40.68	$ 59.98	$ 58.38	$ 63.98
Biomass Profit Made At The Gate ($/BDT)	$ (20.48)	$ (27.78)	$ 4.32	$ (14.98)	$ (13.38)	$ (18.98)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,511,166	$ 1,583,691	$ (72,525)	$ 763,326	$ 487,060	$ 276,266
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	14,707	15,413	(706)	7,429	4,740	2,689
6 Twain Gray's Flat:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,998,035	$ 4,047,732	$ 950,303.24	$ 3,465,287	$ 2,417,338	$ 1,047,949
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 67.74	$ 71.00	$ 56.67	$ 68.01	$ 66.41	$ 72.01
Biomass Profit Made At The Gate ($/BDT)	$ (22.74)	$ (26.00)	$ (11.67)	$ (23.01)	$ (21.41)	$ (27.01)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,677,992	$ 1,482,296	$ 195,695	$ 1,172,350	$ 779,266	$ 393,084
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	16,331	14,426	1,905	11,410	7,584	3,826
7 Sloat:2:2Alternative						
Sum of TOAL B-T-CP ($)	$ 4,834,291	$ 3,624,602	$ 1,209,689.12	$ 3,859,888	$ 2,699,240	$ 1,160,648
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 65.52	$ 63.58	$ 72.14	$ 75.75	$ 74.15	$ 79.76
Biomass Profit Made At The Gate ($/BDT)	$ (20.52)	$ (18.58)	$ (27.14)	$ (30.75)	$ (29.15)	$ (34.76)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,514,247	$ 1,059,166	$ 455,081	$ 1,566,950	$ 1,061,168	$ 505,782
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	14,737	10,308	4,429	15,250	10,328	4,922
8 Collins Pines:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 5,500,852	$ 4,666,567	$ 834,285.14	$ 2,594,643	$ 1,795,350	$ 799,292
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 74.56	$ 81.86	$ 49.75	$ 50.92	$ 49.32	$ 54.92
Biomass Profit Made At The Gate ($/BDT)	$ (29.56)	$ (36.86)	$ (4.75)	$ (5.92)	$ (4.32)	$ (9.92)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 2,180,808	$ 2,101,131	$ 79,677	$ 301,705	$ 157,278	$ 144,427
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	21,224	20,449	775	2,936	1,531	1,406
9 Sierra Pacific:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 4,923,114	$ 3,680,640	$ 1,242,473.76	$ 3,572,757	$ 2,494,115	$ 1,078,643
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 66.73	$ 64.56	$ 74.09	$ 70.12	$ 68.52	$ 74.12
Biomass Profit Made At The Gate ($/BDT)	$ (21.73)	$ (19.56)	$ (29.09)	$ (25.12)	$ (23.52)	$ (29.12)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 1,603,070	$ 1,115,204	$ 487,866	$ 1,279,820	$ 856,043	$ 423,778
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	15,602	10,854	4,748	12,456	8,331	4,124
10 Westwood:2:2Existing						
Sum of TOAL B-T-CP ($)	$ 5,444,939	$ 4,623,362	$ 821,576.72	$ 2,882,648	$ 2,001,101	$ 881,547
Sum of TOTAL BIOMASS (BDT)	73,779	57,010	$ 16,769.07	50,954	36,402	14,553
Relative Cost ($ / BDT)	$ 73.80	$ 81.10	$ 48.99	$ 56.57	$ 54.97	$ 60.58
Biomass Profit Made At The Gate ($/BDT)	$ (28.80)	$ (36.10)	$ (3.99)	$ (11.57)	$ (9.97)	$ (15.58)
Funds Needed to Offset Biomass Recovery Costs ($)	$ 2,124,895	$ 2,057,926	$ 66,969	$ 589,711	$ 363,029	$ 226,682
Saw Logs potentially needed to balance Biomass budget (mbf): at 102.75 ($/mbf)	20,680	20,028	652	5,739	3,533	2,206

APPENDIX D - FIELD TRIALS ANNOUNCMENT

FOREST BIOMASS TRANSPORTATION TRIAL
SEPTEMBER 22, 2011
DOWNIEVILLE, CALIFORNIA

Forest biomass transportation trials will be conducted the week of September 19, 2011 on the Tahoe National Forest. These trials are designed to demonstrate innovative and cost-effective methods to transport chipped forest biomass on road systems which accommodate log truck traffic. Resource managers, road engineers and foresters are invited to view the trial firsthand on September 22.

In order to safely accommodate numerous participants, we ask that interested parties contact us (see contact information below) to confirm plans to attend. Due to safety concerns, we will meet at a location near Downieville and carpool to the trial site. There will be two opportunities to view the equipment, one in the morning and one in the afternoon. Participants will be signed up to participate on a first-come/first-serve basis.

Transportation systems that will be demonstrated include:

- Stinger-steer chip trailer
- Short chip trailer
- Dump truck transport to storage site
- Reload to standard chip van

The Sierra Institute for Community and Environment along with TSS Consultants are coordinating these trials with the objective to review alternative biomass transport technologies that are able to navigate challenging road systems. Please contact Bill Wickman by email if you are interested in participating and indicate a preference for the morning or afternoon time slot.

KEY CONTACTS

TSS Consultants:
Tad Mason, TSS Project Manager, 916.266.0546, tmason@tssconsultants.com
Bill Wickman, Lead Forester and Local Representative, 530.283-0973, billwickman@sbcglobal.net

Sierra Institute:
Jonathan Kusel, SI Project Manager, jkusel@sierrainstitute.us
Emily Creely, Project Coordinator, ecreely@sierrainstitute.us

Funding for this project is made available through the American Recovery and Reinvestment Act and the Plumas National Forest

APPENDIX E - FIELD TRIALS PARTICIPANT LIST

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APPENDIX F - FIELD TRIALS NOTES

Field Trials Summary
(Notes taken by Bill Wickman)

Sunday, September 18- At 1430 got a call from Lauren Pearson informing me of a driver and short van for Monday. This is after a month and a half of discussions, contract negotiations and cancellations of other drivers. At 2030 on Sunday evening, Clint called to inform me that he would not be sending in a driver on Monday, but thought he could have someone in on Tuesday or Wednesday. After all of the run-around and cancellations, I felt that I needed to have firm commitment. I called Jared Pew, of Pew Forest Products, to ask if he had a driver available. PFP could send a driver on Tuesday and use Clints short van.

Monday, September 19- Met Tad and the Stinger Steer truck and driver from San Dimas at 0800 at Downieville. Driver Joe Fleming informed us that his Jake brake was not working properly, his CB antenna was broken and his old Diamond Rio truck is under-powered and does not have locking differentials. Oh Oh. All three of us drove the rode from the bottom into the landing and back down. Joe felt that there could be some grade issues that may make him spin because of non-locking differentials in combination with some tight corners. He still felt he could make the road. We arranged for the water truck driver to be in front of us while we went in. Joe did slip on several grades and at a sharp corner with a short steep pitch of 18-20%, he was stopped. This was just above MP 2.5. We had the water truck attach and pull Joe up to the turn around at MP 3. We met up with Joe Smailes (Mt Hough RD) on site and he joined us to observe the stinger steer trailer in the field. On the FS road into the unit from MP 3, Joe again spun and had to be pulled at the first steep grade approximately .2 mile in. A skidder from the landing came and pulled him up that grade. The approximately .5 mile in, there was a steep grade and corner. The grade was 18%. Again, the skidder had to assist the truck. The stinger steer did track well on the way in and tracking was not an issue with the van. We started in approximately 0930 and finally got to the landing at ??. Once we had the van in place, it took 15 minutes to blow the chips into the van.

Tad and I followed Joe down and he went slower because of the jake brake issue. The only turn or road issue that he had going out was on a overhanging rock and tree roots at approximately MP 1.5. His van side did rub the roots on the top of the rock. The van tracking was almost identical to the logging truck tracking. Prior to leaving for POPI in Oroville, we discussed that Joe would have to come in a different route because we could not have him pulled up the County road and have log truck traffic delayed. Tad and I drove the Cal Ida road into the top of the project. Instead of a 3 mile trip up from Highway 49, it became a 23 mile trip into MP 3. On the trip to Oroville, Joe encountered a bridge load limit issue that did not show on his GPS and had to take a different route. This meant the trip to Oroville went from 74 to 89 miles one way. The Stinger steer van has a walking bed and Joe said it took 7-10 minutes to unload.

Tad and I made the decision that because of the stinger steer access issues, and still not having a short van in yet, we would only do one viewing on the actual field trial day. I sent a message to all participants with this change. Monday afternoon I checked in with PFP to assure the driver was going to be in Downieville at 0800 on Tuesday morning. I found out that they would be but the driver had changed.

Tuesday, September 20- I went to Clints van in E. Quincy to wait for PFP driver. I called Clint to assure that he had talked with PFP about the van and yes, it had been arranged. I left E. Quincy a little after 0700. Jared said the driver would be there soon. Once I got to Downieville, I had cell coverage and there was a message from Jared. The van lift arms were broke and could not be raised. PFP worked on the van approximately 2 hours to try and fix and could not. I proceeded up to meet Joe at MP 3 to go into the landing with him. At the landing, Joel Bamford informed me that they had contacted Clint to get the second van as they now wanted to haul all of the chips out because of the trials working, so far. I informed him about the issue with the short van and that it would not be in today. We just loaded the stinger steer and I left to try and resolve the short van issue since we now only had one day to test before the actual trial date. Once back in Quincy, I called Jared to assure that everything was OK for Wednesday to test the short van before the trials. It was a go and I would meet his truck in Downieville at 0600. I also called Bamford's truck manager to inform him of the van switch and issues with the second van. He informed be that they would still pick the van up and get it fixed so they could use it.

Wednesday, September 21- I met PFP driver Bob Stoy at 0545 at the pull-out on Hwy 49. Bob informed that his normal logging truck was down and that he had an older tractor that they had adapted with a 5th wheel attachment for the van. This truck did not have the dual locking differentials and only the front drivers locked, so, another possible issue. In addition because this was a converted log truck tractor, the wheel base was 240 inches versus the 210 that a normal van tractor had. We both drove the road to let Bob see the issues that were in front of him. He had concern at the rocks that were close to the road before MP 1.5 and we also discussed the grade and turns as we went up. We stopped and looked at the rocks, grade and corner going into the landing from MP 3. Bob still felt he could do it but we would not know until we tried. We waited at the bottom until the last log truck was down from the first string. We started up just after 0730. We had a Bamford work truck and trailer behind us.

First issue was we got the van stuck on the rock around MP 1.5. On this road there are no options to back out, so we had to try and go forward. The Bamford driver and I got Bob backed off of the rock. We both then worked with Bob as spotters to get his front tractor wheels approximately 6-12 inches further over towards the edge of the road. It worked, the van did make it past the rock. We were right on the edge of the steep drop-off. The road at this section had a slight inside slope with a ditch and this tipped the van just enough to cause a problem. Bob felt that he could and would not be able to come down the road loaded because the weight would tip the van box even harder into the rock.
We met Joe at MP3. I started the short van in first with Joe to come in after we loaded. We asked Joe if he felt that the short van could make it out the top on the Cal Ida road.

He stated that even with the stinger steer, there were a couple tight corners that he did rub trees on. Grade was a slight concern towards the top of the county road. We had no choice.

We proceeded into the landing from MP 3. At the beginning of the road in, there was a FS gate with 2 gate standards and a gate tie back. The tie back was below the standard on the inside of the road and just slightly out from the standard. The short van box hung on the tie back because of a slight corner going out of the gate. We had to back the van and again, spot the tires to the extreme outside edge to pass. We made it through.
The next issue was on the first corner at the bottom of the grade. The van did not track the same as the logging trucks and stinger steer and got hung up on the inside dirt berm. We tried backing and going out to the very outside to the existing road edge but could still not make it. There was a skidder waiting up the road so I went and got it. We re-worked the outside of the corner and widened it approximately 3-4 feet and knocked the dirt berm off the inside by about 3 feet. This did allow enough turning width to get the van through. The next issue was the 18% grade and turn that had stopped Joe's old Diamond Rio. The van had to be pulled also. Bob did feel that if he had his normal truck with dual locks, he could have made it.

It took 16 minutes for the short van to be loaded. On the trip back out from the landing, everything was fine until the gate and tie back. We got hung on the tie back. We had to back and spot on the extreme outer edge but did get it through. I led Bob out the top and informed Joe that he was on his own to load and go out the normal haul route. The short van left the landing approx 1030 and we did not get back to hwy 49 at the Cal Ida intersection until 1300. So, one load from hwy 49 and back down took from 0740 to 1300. The net weight of the chips on this one load was 56420 lbs. After I led Bob back down the Cal Ida road, I proceeded back to Quincy. I had concern for the actual trial day which was the next day. I wanted to assure that because we would not have the short van available for the trials that we should precede.
Once back to Quincy I called Larry Swan and discussed the situation with him. Larry reassured me that the intent of the trials did not always mean that all proposed vehicle would actually perform during the trial day. It was important to have tried and observed the issues relative to each proposed vehicle.

Thursday- September 22- Field Trial day. We met in Downieville with the participants for the trials. There were seventeen individuals present for the trials (18 including Joe Smailes on Sept 19). The make up of the group was;

- Two Sierra Institute Representatives
- Two Biomass Procurement Representatives (Greenleaf Power and Iberdrola)
- One Western Trailer Representative (Woodland)
- Twelve Forest Service; Logging engineers, Road engineers, Sale Admin and Silviculturist.

Name	Organization	Email
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We had a short discussion of the safety and timing issues before us. I explained the situation with the regular chip van, short van and dump truck. I outlined the issues we would be seeing as we drove up the road and wanted them to observe on our way in. I briefly described the grade, curve radii and grade and narrow road widths with over hanging rock and vegetation. We met Joe Fleming and the stinger steer at MP3. I then went into the landing to alert the crew that we were coming in and that the skidder should come out to assist the truck in as we had to do on each day. Joe showed the group the stinger steer and answered questions while I was going into and out of the landing.
As we proceeded into the landing we stopped to observe the following;

- Forest Service gate with tie back that had caused a problem for the short van.
- Short radius curve with narrow road width that had to be widened to allow passage of the short van.
- Sharp corner with an 18% grade where the stinger steer had to be assisted (this again was more an issue because of the old, under powered tractor with non-locking differential)

At the landing the participants were able to talk with Nathan Bamford and ask questions about the operation while observing the loading operation. The chipper was a Peterson re-mote control operated belt feed machine. We watched the stinger steer trailer get loaded with chips and then proceeded back to MP3. We led the truck out and stopped at the sharp radius turn just above MP 2.5. Participants stationed themselves on the corner so that they could observe how the stinger steer tracked. The tracking was almost identical to a logging truck. The slight difference was due to the approximate 3-4 foot extended reach of the back trailer duals. This is due to the fact that the box requires the stinger on the trailer be placed all the way at the back of the reach to fit the box adaptation. This variation did not cause enough off-set that would hinder the stinger steer from negotiating the same curve radius as a log truck.

Our second stop was at the rock and root wad overhang at MP 1.5. Again the participants placed themselves so that they could watch the tracking of the from tractor tires on the outside edge of the road and the van box just missing the rock over hang. The lesson discussed at this point was the fact that not all access issues are tied to the running surface of the road. In this case, a narrow road width with the overhanging rock created the potential choke point. This is the same point that the short van had a slightly different tracking that cause the van to rub. Even though the stinger steer could track the same as a logging truck, the issue was the taller, rigid box that had a height that is normally more than a log load. The rigid height and length was enough to cause the van box to rub and not a log load.

The close out was a discussion of the trials by the purchaser/contractor, Nathan Bamford. Nathan went through the background of the project. Proposed as a project to thin a plantation and treat the material on site, Nathan went through the changes in thought and outcome.

- Project offered as an ARRA service contract.
- Material was analyzed to be loaded in dump trucks and hauled 9 miles to a disposal site. At the disposal site, the material was to be chipped and spread.
- BCAP was occurring when the project was first offered so Nathan had considered chipping the material at the landings, load in dump trucks, dump at a van accessible location, reload into the chip vans and then take to Oroville (POPI).
- Once Nathan was approached to participate in the field trials, he started consideration of what could happen with the use of the van configurations proposed by TSS as a part of the trials.
- At that point, product markets and considerations were further pursued. By the time of the trials, three products were being marketed.
    - Small saw logs
    - Tops from sawlogs for firewood
    - Chips
- Knowing that the stinger steer was just on loan for the trials from the Forest Service, the short vans were pursued to continue removing the chips.
- Because the contract was a lump sum, this provided the utilization flexibility to market the products that were the best fit for the operator.

The final results for the trials illustrated the road and transportation difficulties as well as the feasibility of various transportation modes to remove biomass material. It also provided the opportunity to show how such transportation modes and accessibility did allow for a variety of products to be removed from a site that was analyzed to be disposed of on site.

APPENDIX G - FIELD TRIAL DRIVER LOG SHEETS

FOREST BIOMASS TRANSPORTATION TRIAL
SEPTEMBER 19 to 22, 2011
DOWNIEVILLE, CALIFORNIA
DRIVER LOG

In order to monitor haul times and productivity we are asking the drivers to keep a daily log.
Please keep a record of loading, haul and unloading activities using this log:

Driver: ______________________________

Phone #: _____________________________

Truck/Trailer Type: ______________________________

TRIP#	DATE	LOAD-OUT TIME	HAUL TIME	UNLOAD TIME	RETURN HAUL TIME	COMMENTS

APPENDIX H - COST ESTIMATES TO FABRICATE STINGER STEER TRAILER

Briefing Paper
Stinger-Steered Chip Trailer

USFS San Dimas Technology and Development Center
Project leader: Dave Haston
Technician/Designer: Joe Fleming
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Need: Timber sales are increasingly being sold with a fuels reduction component that often includes chipping. Chip vans are typically used to transport material from the sale area. Unfortunately, most forest roads were designed to accommodate traditional west coast-style stinger-steered log trucks, and were not designed with chip trailers in mind. Conventional chip trailers have significant off-tracking problems (increasing with trailer length) as well as decreased ground clearance.

Concept:
- Convert conventional stinger-steered log trucks for chip hauling
- Utilize standard ISO shipping containers
- Separate sub frames (front and rear) to create stinger/reach clearance for rolling dips and curves, as well as allowing the use of various container lengths
- Containers available in different lengths (20/40/45/48/53') / heights (8.5 and 9.5'), closed and open top

Estimated Cost (assume tractor and stinger trailer available):

Basic system (closed top, use dump table)		**Advanced system**	
Container	$2,500	Open-top container	$2,500
Blow-in chip door	$3,000	Side-to-side roll tarp	$2,000
Sub frames	$5,000	Walking floor	$24,000
Landing gear	$2,000	Wet kit (PTO/pump)	$2,500
Misc. *	$1,500	Sub total	$31,000
	$14,000	Total, as-built	~ $45,000

* Used 5th wheel, new cups (saucer), plywood, etc.

Desirable tractor features:
Air ride suspension (for deploying landing gear)
Quick-change system (to interchange log bunk and fifth wheel)
Wet kit (to power live floor)

Potential issues:
Disconnecting trailer on dump tables that do not accommodate tractor.
Structural integrity and long term durability of container (unsupported mid-span)

Operating parameters:
Container Volume: 88 cubic yards
Estimated payload: 21-22 tons @80,000 lb
Height: 13' 3" (50-state legal)

APPENDIX I – PLACER COUNTY AIR POLLUTION CONTROL DISTRICT INITIATIVE

Placer County
AIR POLLUTION CONTROL DISTRICT

CPUC FEED IN TARIFF RULEMAKING AND THE OPPORTUNITY TO SUPPORT COMMUNITY SCALE BIOPOWER FREQUENTLY ASKED QUESTIONS

Introduction

California law is now requiring that investor-owned utilities (IOU's such as PG&E, SCE and SDG&E) offer a standard feed in tariff (FIT) rate for renewable energy generation facilities with a capacity of three megawatts (MW) or less. CPUC has requested comments on the FIT pricing. The October 13, 2011, CPUC staff proposal suggests FIT pricing be based on the results of the Nov. 15, 2011 renewable auction mechanism (RAM) price. If the RAM price is used as the basis for the FIT rate, then the CPUC has considered the use of "rate adders" by which some additional cost would be charged to the ratepayer with the expectation that the additional cost would eventually be recovered, or even a potential financial benefit would be realized, by the ratepayer over time. This benefit to the ratepayer is an essential part of the process.

What is the Difference Between Ratepayer and Taxpayer?

IOU retail ratepayers are made up of individuals that pay IOU's for services delivered (typically to ratepayer's residence) in the form of electrical energy and natural gas (depending on the service territory). Taxpayers are individuals that pay taxes based on local, state and federal tax schedules. In most cases the IOU ratepayers are also taxpayers. Benefits accrued to the ratepayers in many cases benefit the taxpayers. As mentioned above the rate adder needs to directly benefit the ratepayer. The fact that there is a generalized taxpayer benefit does not undermine or negate the fact that ratepayers are the primary beneficiary.

What is the Locational Adder?

The CPUC staff is recommending that a "locational adder" energy payment be considered for those renewable power generators (under three MW in size) that are sited in high-value locations that will generate power during peak demand periods. Delivered value to the ratepayers could include avoided transmission/distribution costs and avoided line loss. The IOU's have identified "hotspots" where they could use additional generation during peak demand periods. By locating small renewable generation facilities in these hotspots, the IOU's do not need to install additional generation facilities or upgrade the transmission/distribution system to deliver added power thus delivering cost savings to the IOU ratepayers.

What is the "Wildfire Hazard Reduction Adder"?

The Placer County Air Pollution Control District is proposing that an adder (as mentioned above) be considered for certain biopower facilities. This public safety adder would be available to small (under three MW) community-scale forest biopower facilities strategically located in high hazard wildfire zones. This adder would monetize the value of wildfire mitigation and improved watersheds afforded by strategic forest/range restoration efforts facilitated through development of small biopower projects within IOU service territories.

The wildfire hazard reduction adder (WHRA) will be financially critical to the successful deployment of small community-scale forest biopower facilities, due to the relatively high costs associated with collection, processing and removal of hazardous fuels (small trees and brush). Removal of high hazard fuels will reduce the incidence of catastrophic wildfire and facilitate defensible communities (public safety), healthy forests, healthy watersheds, wildlife habitat protection, bio-diversity, and preservation of recreational opportunities. As landscapes are treated and acres impacted by wildfire are reduced,[39] the costs associated with wildfire (landscape restoration, fire suppression, IOU's cost settlements)[40] and borne by IOU ratepayers will be reduced. In addition, the high cost of homeowner insurance premiums and recently state mandated fire-suppression fees[41] should drop over time as wildfire hazards are reduced and fire threats mitigated.

The amount charged to the ratepayers for the WHRA would be approximately $.15/month, amounting to approximately $20,476,500 on an annual basis, while the estimated annual cost savings associated with prevention of wildfire is approximately $20,705,000. Comparing these two amounts illustrates how the ratepayer will realize a net gain over the long term. More specifics about these amounts, and the other non-monetary benefits of the WHRA, are discussed in further detail below.

How Many Acres are Impacted, and What are the Annual costs of Wildfire in California?

California has a long history of catastrophic wildfire. In the past five years (2006 through 2010), an average of 913,973 acres[42] per year have been impacted by wildfire. The economic costs to support wildfire suppression and landscape restoration (after wildfire events) are significant. Fire suppression and landscape restoration costs incurred by the three largest fire agencies in the state (CALFIRE, US Forest Service, and the Bureau of Land Management) amounted to an average of $1.201 billion dollars per year for the past five years (2006 through 2010).[43]

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[39]USDA Forest Service, Pacific Southwest Research Station. 2009. ***Biomass to Energy: Forest Management for Wildfire Reduction, Energy Production, and Other Benefits.*** California Energy Commission, Public Interest Energy Research (PIER) Program. CEC-500-2009-080.

[40]IOU cost settlements are typically a result of power line caused wildfires that result in significant fire suppression and damage recovery compensation.

[41]California Board of Forestry November 9, 2011 ruling that levies a fee on private landowners with structures located in the 31 million acres of state responsibility area.

[42]Data provided by CALFIRE and US Forest Service.

[43]Wildfire suppression and landscape restoration figures provided by CALFIRE, US Forest Service and BLM staff.

How can Investment in Hazardous Fuels Treatment Activities Reduce Costs Associated with Wildfire?

Strategic placement of fuels treatment activities are effective in modifying wildfire behavior, resulting in fire size reduction and mitigation of fire suppression costs.[44,45] Deployment of small biopower generation facilities in strategic high wildfire hazard zones will facilitate proactive fuels treatment. Small biopower generation facilities would provide a ready market for biomass material (small trees and brush) generated as a result of fuels reduction activities thus offsetting most of the costs associated with collection, processing and removal. Experience from existing biomass power generation facilities in California indicates that if new, small biopower generation facilities were installed with a combined generation capacity of 50 MW, it would result in the treatment of approximately 30,770 acres per year.[46] Proactive fuels treatment activities reduce accumulations of hazardous fuels thus mitigating wildfire behavior and protecting communities.[47]

How are Avoided Costs to the IOU's Ratepayers Calculated?

While not all of the $1.201 billion per year in fire suppression and landscape restoration costs are paid directly by IOU's ratepayers, these very significant costs are borne by the taxpayers, which include almost all ratepayers. Assuming that 75 percent of California ratepayers are served by the IOU's, then wildfire related costs to the IOU's ratepayers amount to about $900,750,000 ($1.201B * 75%) per year. Using the five-year acres burned average of 913,973 acres per year, the annual wildfire cost to the IOU's ratepayers is $985/acre ($900,750,000/913,973 acres) for each acre burned.

A recent study[48] sponsored by the California Energy Commission and conducted by the US Forest Service (Pacific Southwest Research Station) found a net reduction in burned acres as a direct result of strategic placement of fuels treatment projects across a northern California study area comprised of 2.7 million acres. On a per decade basis, burned acre reduction over the 40 year modeling period ranged from 11% to 36% with an average per decade reduction of 23.5%. Using a median 2.3% per year reduction in burned acres results in a net reduction of 21,021 acres (913,973 * 2.3%) burned per year. A net reduction of 21,021 acres impacted by wildfire results in an annual avoided cost savings to the IOU's ratepayers of $20,705,000 (21,021 acres * $985). This avoided cost value to the IOU's ratepayers amounts to a WHRA of $.055/kWh assuming 50 MW of installed biopower operating at 85% capacity. Table 1 summarizes the calculations used to generate the WHRA cost back to the IOU ratepayers.

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[44]USDA Forest Service, "A Summary of Fuel Treatment Effectiveness in the Herger-Feinstein Quincy Library Group Pilot Project Area," publication #R5-TP-031, December 2010.

[45]USDA Forest Service, Pacific Southwest Research Station. 2009. *Biomass to Energy: Forest Management for Wildfire Reduction, Energy Production, and Other Benefits.* California Energy Commission, Public Interest Energy Research (PIER) Program. CEC-500-2009-080.

[46]Acreage treated figure assumes a total of 400,000 bone dry tons of forest biomass utilized to generate 50 MW and that 13 bone dry tons per acre are recovered from fuels treatment activities.

[47]US Forest Service presentation - How Fuels Treatment Saved Homes from the 2011 Wallow Fire.

[48]USDA Forest Service, Pacific Southwest Research Station. 2009. *Biomass to Energy: Forest Management for Wildfire Reduction, Energy Production, and Other Benefits.* California Energy Commission, Public Interest Energy Research (PIER) Program. CEC-500-2009-080.

How is the Wildfire Hazard Reduction Adder Price Calculated?
The basis for the WHRA is an amount of 5.5 cents per kWh because this amount will help small biomass facilities by providing enough income to support collection, processing and removal of high hazard fuels (small trees and brush). This will allow for jobs to be more stable, and it is an amount that can stimulate more investment, facilitate project financing, and justify entry into contracts with federal agencies and private landowners to support fuels treatment activities. All of these beneficial activities occur within the IOU's service territories, often within watersheds that provide sustainable water resources for existing hydropower assets, domestic and agricultural water supplies and significant recreational opportunities.
Reducing the incidence of catastrophic wildfire will be especially critical within California's at risk watersheds as climate change impacts snow loads and extends the wildfire season. The upstream watersheds provide a plethora of societal benefits that are at significant risk and the best method to restore and protect these watersheds is through strategic removal of unnatural concentration of hazardous fuels (small trees and brush).

Table 1. Incremental Cost to IOU Ratepayer for the WHRA

Total Kilowatt Capacity (50MW = 50,000 kW)	50,000 kW
Operating Hours/Year (85% capacity)	7,446 hours/Year
Total Kilowatt Hours Generated and Sold	372,300,000 kWh
Wildfire Hazard Reduction Adder	$.055/kWh
Total Annual Cost of WHRA	$20,476,500
Number of IOU Retail Ratepayers	11,600,000
Incremental Cost per Ratepayer/Month	**$.15/Month**

What is the Net Cost to the IOU's Ratepayer?
Assuming that the WHRA is set at $.055/kWh and facilities with a combined output of 50 MW of community-scale biopower projects are deployed across all three IOU service territories, the net cost to the IOU ratepayer will amount to approximately $.15/month. See Table 1 (above) for details.

How Can the Ratepayers Realize a Financial Benefit Commensurate with the WHRA Net Cost Over Time?
IOU ratepayers are often burdened with additional fees or costs associated with continued wildfire cost settlements and fire insurance premiums. For example San Diego Gas & Electric (SDG&E) is currently in settlement discussions to address damages incurred by

private property owners due to the 2007 Witch Creek, Guejito and Rice Canyon fires. Started by SDG&E power lines, these fires destroyed over 1,300 homes and caused the death of two residents. Estimated cost to settle claims could be as high as $900 million.[49] In addition, SDG&E representatives have noted that the equipment recovery costs associated with the 2007 wildfires will cause ratepayer's power rates to increase $.35 to $.75 per month.[50]

The WHRA cost to the IOU's ratepayers of $.15/month is clearly the more cost effective investment, one that facilitates the proactive treatment of hazardous fuels. Treatment of high wildfire hazard landscapes will reduce the incidence of catastrophic wildfire, driving down wildfire cost settlements, fire insurance premiums (for both the IOU's and the ratepayers) and equipment recovery costs.
If wildfire incidents are reduced, there will most certainly be a tangible financial benefit to the ratepayers as the costs for wildfire settlements, equipment recovery and fire insurance premiums would not be incurred by the IOU's. There is a high likelihood that while the ratepayer is paying 15 cents per month more for the WHRA public safety adder, the IOU cost savings from the reduction in wildfire will result in net savings (due to wildfire cost reduction) that would more than make up for WHRA cost. Over time, as more landscapes are treated and the incidence of wildfire mitigated, there will be a net savings to the IOU's and to the ratepayers.

How does the Public Utility Regulatory Policy Act (PURPA) Relate to the WHRA?
Pursuant to PURPA, energy purchase rates must be just and reasonable to the ratepayer and not discriminatory to the IOU's. There are a number of FERC decisions that elaborate on this conclusion. The WHRA provides long term cost benefits through wildfire reductions while also providing for jobs, healthy forests and water quality enhancements that occur within the ratepayer's region (IOU service territories). There is no-net financial loss over time, as well as numerous non-monetary benefits to the ratepayers which supports the federal law requirements relating to energy purchase rates.

Are There Any Limitations to the use of the WHRA in the Relevant State Law?
Section 399.20 of the Public Utilities Code was amended by AB 32 to take into account costs, *including but not limited to* various costs associated with environmental compliance costs, including those associated with green house gas emissions. The benefits of reducing wildfire from an air pollution control perspective are clear. The fewer acres burned in catastrophic wildfires, the fewer the green house gas emissions generated (e.g., CO_2, methane). Use of the WHRA is consistent with the intent of AB 32 and the changes made to the public utilities code.

[49]May 7, 2009 news report on 10News.com.
[50]November 2, 2010 KPBS news report by Peggy Pico.

APPENDIX J – POTENTIAL GRANT FUNDING RESOURCES

TSS conducted a literature search for grants and loans to support value-added utilization projects. Outlined below are the results.

Rural Energy for America Program (REAP)
Administered by the USDA Rural Business-Cooperative Service, this program provides grants and loans for a variety of rural energy projects, including efficiency improvements and renewable energy projects. Assistance is limited to small businesses, farmers and ranchers with projects located in a rural community. REAP grants and guarantees can be used individually or in combination. Together the grants and loan guarantees can finance up to 75% of a project's cost. Grants alone can finance up to 25% of the project cost, not to exceed $500,000 for renewables and $250,000 for efficiency.

Rural Business Enterprise Grant Program (RBEG)
Administered by USDA Rural Development, the RBEG program provides grants for rural projects that finance and facilitate development of small and emerging rural businesses, help fund distance learning networks, and help fund employment related adult education programs. To assist with business development, RBEGs may fund a broad array of activities. There is no maximum level of grant funding. However, smaller projects are given higher priority. Generally grants range $10,000 up to $500,000.

Rural Economic Development Loan And Grant (REDLG)
Administered by USDA Rural Development, the REDLG program provides funding to rural projects through local utility organizations. Under the REDLG loan program, USDA provides zero interest loans to local utilities which they, in turn, pass through to local businesses (ultimate recipients) for projects that will create and retain employment in rural areas. Recipients repay the lending utility directly. The utility is responsible for repayment to the Agency. Under the REDLG grant program, USDA provides grant funds to local utility organizations which use the funding to establish revolving loan funds. Loans are made from the revolving loan fund to projects that will create or retain rural jobs. When the revolving loan fund is terminated, the grant is repaid to the Agency.

Rural Business Opportunity Grants (RBOG)
Administered by USDA Rural Development, the RBOG program promotes sustainable economic development in rural communities with exceptional needs through provision of training and technical assistance for business development, entrepreneurs, and economic development officials and to assist with economic development planning. The maximum grant for a project serving a single state is $50,000. The maximum grant for a project serving two or more states is $150,000.

Business and Industry Guaranteed Loans
Administered by USDA, the purpose of the Business and Industry Guaranteed Loan Program is to improve, develop, or finance business, industry, and employment and improve the economic and environmental climate in rural communities. This purpose is

achieved by bolstering the existing private credit structure through the guarantee of quality loans which will provide lasting community benefits. A borrower must be engaged in or proposing to engage in a business that will:

- Provide employment;
- Improve the economic or environmental climate;
- Promote the conservation, development, and use of water for aquaculture; or
- Reduce reliance on nonrenewable energy resources by encouraging the development and construction of solar energy systems and other renewable energy systems.

Department of Commerce/Economic Adjustment Assistance
Provides a wide range of technical, planning, and public works and infrastructure assistance in regions experiencing adverse economic changes that may occur suddenly or over time (e.g., strategy development, infrastructure construction, revolving loan fund capitalization). (CFDA No. 11.307)

Department of Energy (DOE)/Energy Efficiency and Conservation Block Grant (EECBG) Program
The Energy Efficiency and Conservation Block Grant (EECBG) Program represents a priority to deploy the cheapest, cleanest, and most reliable energy technologies we have—energy efficiency and conservation—across the country. The Program, authorized in Title V, Subtitle E of the Energy Independence and Security Act (EISA) and signed into law on December 19, 2007, is modeled after the Community Development Block Grant program administered by the Department of Housing and Urban Development (HUD). It is intended to assist U.S. cities, counties, states, territories, and Indian tribes to develop, promote, implement, and manage energy efficiency and conservation projects and programs designed to:

- Reduce fossil fuel emissions;
- Reduce the total energy use of the eligible entities;
- Improve energy efficiency in the transportation, building, and other appropriate sectors; and
- Create and retain jobs.

Through formula and competitive grants, the Program empowers local communities to make strategic investments to meet the nation's long-term goals for energy independence and leadership on climate change

California Housing and Community Development (HCD)/Community Development Block Grant (CDBG) Program
The primary federal objective of the federal CDBG program is the development of viable communities by providing decent housing and a suitable living environment and by expanding economic opportunities, principally for persons of low and moderate income. "Persons of low and moderate income" or the "targeted income group" (TIG) are defined

as families, households, and individuals whose incomes do not exceed 80 percent of the county median income, with adjustments for family or household size.

California Community Services and Development/Community Services Block Grant (CSBG)
Legislation provided for the CSBG program in the federal Omnibus Budget Reconciliation Act of 1981 to help eliminate the causes and ameliorate the conditions of poverty. Currently each state receives an allocation of funds to distribute to community service providers who provide a variety of services to clients who meet the income guidelines. Services to eligible clients must contribute to the achievement of one or more of the six goals developed by the National CSBG Monitoring and Assessment Task Force.

- Low-income people become more self-sufficient;
- The conditions in which low-income people live are improved;
- Low-income people own a stake in their community;
- Partnerships among supporters and providers of services to low-income people are achieved;
- Agencies increase their capacity to achieve results;
- Low-income people achieve their potential by strengthening family and other supportive systems.

California Economic Development Lending Institute (CEDLI)
CEDLI, the California Economic Development Lending Initiative, is a multibank community development corporation established in 1995 to invest capital in small businesses and nonprofit community organizations throughout California in both urban and rural communities. The institute is committed to increasing access to capital for small businesses and community organizations to allow them to grow, create jobs and to facilitate community economic development.

Wells Fargo Regional Foundation/Community Development Program
Wells Fargo looks for projects that keep communities strong, diverse, and vibrant. In California, Wells Fargo makes grants in community economic development to support the improvement of low- and moderate-income communities through programs that:

- Create and sustain affordable housing
- Promote economic development by financing small businesses or farms
- Provide job training and workforce development
- Revitalize and stabilize communities

Woody Biomass Utilization Grants
Administered by the USFS, the Woody Biomass Utilization Grant program (WBU) is a nationally competitive grant program that supports wood energy projects requiring engineering services. The projects use woody biomass material removed from forest restoration activities, such as wildfire hazardous fuel treatments, insect and disease

mitigation, forest management due to catastrophic weather events, and/or thinning overstocked stands. The woody biomass must be consumed in a bioenergy facility that uses commercially proven technologies to produce thermal, electrical or liquid/gaseous bioenergy. Maximum grant is $250,000.

Biomass Research and Development Initiative
Administered by the US Department of Agriculture and the US Department of Energy. Both agencies produce joint solicitations each year to provide financial assistance in addressing research and development of biomass-based products, bioenergy, biofuels, and related processes. Approximate funding per project is $7,500,000.

Public Interest Energy Research (PIER)
Administered by the California Energy Commission, the PIER program provides funding in support of research, development and deployment of innovative business models and technologies. Primarily focused on research that forward the development of renewable energy in California, including community scale (<10 MW) project deployment. Past funding for PIER was provided by ratepayers through the system benefits charge (also known as the public goods charge). The system benefits charge expired on January 1, 2012. The California Public Utilities Commission (CPUC) is in the process of implementing the Electric Program Investment Charge (EPIC) to replace the system benefits charge. The CPUC has provided a proposed decision[51] that confirms plans for the EPIC to fund renewable energy and research, development and deployment programs.

Healthy Forests Grant Program
Administered by the Sierra Nevada Conservancy, the Healthy Forests Grant Program provides grant funding in support of projects that preserve or improve Sierra Nevada conifer and mixed conifer ecosystems. A primary focus is the reduction of risks and impacts of large catastrophic wildfires and preserving ecosystem functions in forests and meadows. Funding for this program is provided by Proposition 84 allocation and is available through fiscal year 2013. Funding in fiscal year 2012-2013 is focused on ranching and agricultural lands.

[51]November 15, 2011 proposed decision (Agenda ID #10848) by Administrative Law Judge Gamson.