NEZ PERCE TRIBE WASTE TO ENERGY FEASIBILITY STUDY

July 23, 2012 Final Report

Prepared for:

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- Jeff Cronce, Nez Perce Tribe, GIS Analyst and System Administrator
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ABBREVIATIONS/ACRONYMS

The abbreviations and acronyms utilized in this report are indicated below.

Organizations

AESI	Alternative Energy Solutions International
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CFLR	Collaborative Forest Landscape Restoration
CPC	Clearwater Power Company
FEMP	Federal Energy Management Program
IDFG	Idaho Department of Fish and Game
IDL	Idaho Department of Lands
NPT	Nez Perce Tribe
NPTEC	Nez Perce Tribe Energy Committee
TSS	TSS Consultants
UI	University of Idaho
USDA	United States Department of Agriculture
USDOE	United States Department of Energy
USDI	United States Department of Interior
USFS	United States Forest Service
WA DNR	Washington Department of Natural Resources

Other Terms

BDT	Bone Dry Ton(s)
Btu	British thermal unit
CHP	Combined Heat and Power
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortization
GIS	Geographic Information System
GPM	Gallons Per Minute
GT	Green Ton(s)
HHV	Higher Heating Value
HVAC	Heating Ventilation and Air Conditioning
IGCC	Integrated Gasification Combined Cycle
kWh	Kilowatt Hour (Electric)
IFL	Industrial Forest Landowners
ITC	Business Energy Investment Tax Credit
MBF	Thousand Board Feet
MMBF	Million Board Feet
MMBtu	Million British Thermal Units
MSW	Municipal Solid Waste
MW	Megawatt (Electric)
NIPF	Non-Industrial Private Forest Owner
NMTC	New Market Tax Credit
PTC	Production Tax Credit

REC	Renewable Energy Credit
ROE	Return On Equity
RPS	Renewable Portfolio Standard
TSA	Target Study Area
USDOE	U.S. Department of Energy
WUI	Wildland Urban Interface
WWTP	Wastewater Treatment Plant

INTRODUCTION

The Nez Perce Tribe Energy Committee (NPTEC) is evaluating the potential for small-scale waste to energy facilities to be located upon the Nez Perce Reservation. The Nez Perce Tribe (NPT) contracted with TSS Consultants (TSS) to prepare a feasibility study for such facilities. These facilities will utilize sustainable and economically available waste sourced from the region located within and tributary to the Nez Perce Reservation. In addition, these prospective facilities will be scaled appropriately to meet electrical and thermal energy needs of selected community buildings (e.g., NPT administration building), residences or other identified needs. Currently targeted locations for the waste to energy facilities include the communities of Lapwai, Orofino, Kamiah, Kooskia and the Clearwater River Casino. The study evaluated prospective biomass resource availability, conducted a review of prospective facility sites, reviewed potentially suitable technology, and provided a financial analysis of the selected technology.

Historically, the economy of the NPT and surrounding region has been tied directly to forest products manufacturing, timber harvesting and agriculture. While forest biomass is included in the biomass resource assessment, there are other potential feedstocks to consider including agricultural byproducts, tree trimmings, and municipal solid waste.

Specific goals for this feasibility study include:

- Provide cost effective electrical and thermal energy for NPT communities;
- Assess waste utilization, as an alternative energy and/or transportation fuel opportunity;
- Promote NPT job creation and retention;
- Provide revenue to offset the cost of forest health restoration and fuels reduction.

SCOPE OF WORK

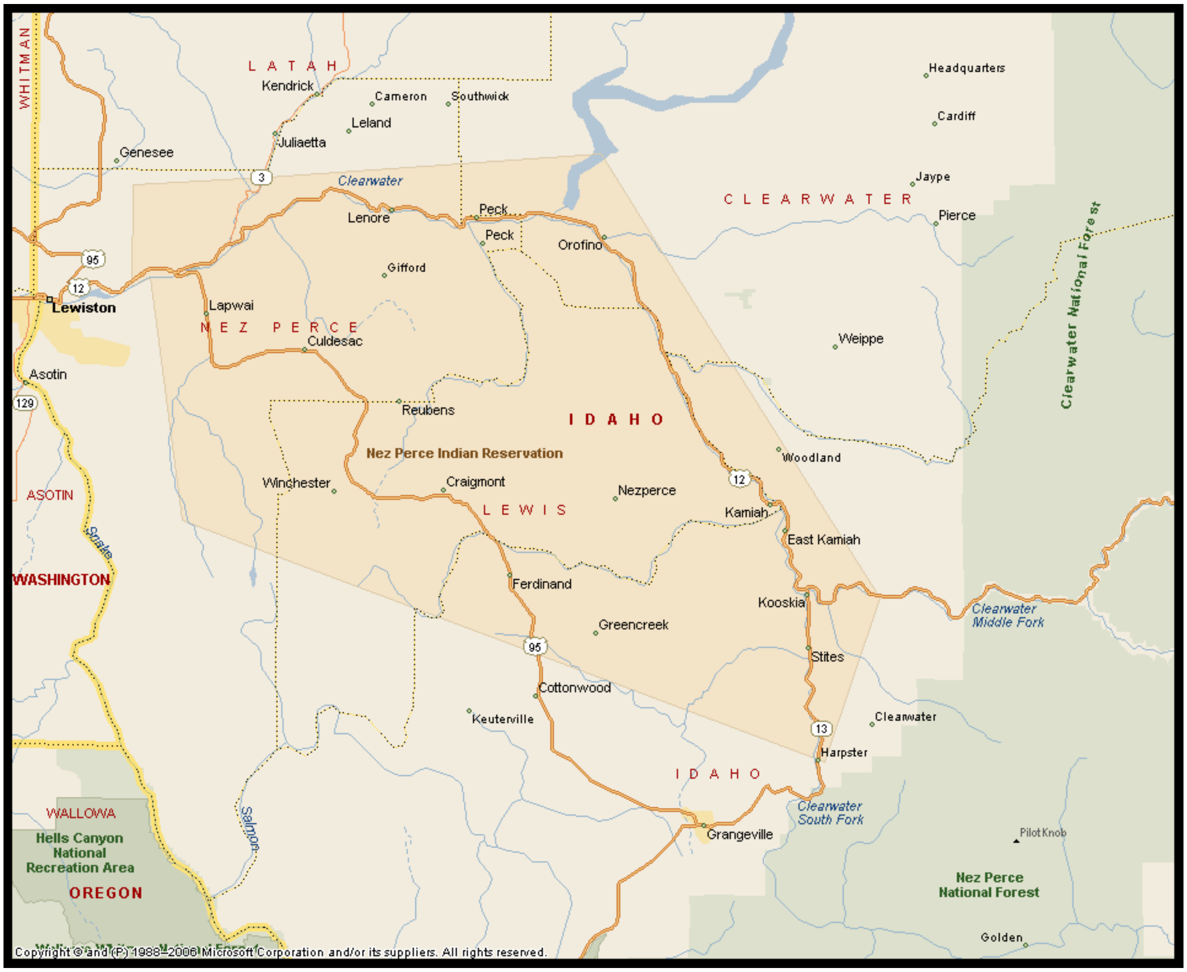
Detailed below are tasks that TSS conducted in support of this feasibility study. TSS made every effort to utilize relevant data and information from existing assessments and studies conducted in the region. For example, the NPT sponsored a study to site a commercial-scale biodiesel production facility on the Reservation. Furthermore, TSS recognized and accommodated the need for flexibility in regard to the current scope of work, as circumstances can change altering project direction.

Task 1. Pre-Work Conference

TSS convened a pre-work meeting with NPTEC. The approach and implementation schedule/work plan for the feasibility study were reviewed. Primary NPT contacts and project management team members were identified and confirmed. TSS reviewed availability of existing studies and data. The target study area for sourcing of potential resources and waste stream materials that could serve as feedstocks was identified.

Figure 1 highlights the Nez Perce Reservation and surrounding region, which could serve as the target study area. An initial review of potential siting opportunities including existing infrastructure and assets on the Reservation was conducted.

Figure 1. Draft Target Study Area



Task 2. Resource Assessment

TSS conducted an analysis of waste resources that are sustainably available from NPT, public lands and other private lands within a specified Target Study Area (TSA). A range of potential resource feedstocks and waste streams considered included:

- Woody biomass residuals from forest operations;
  - Timber harvest operations;
  - Fuels treatment/forest restoration projects;
  - Timber stand improvement projects;
- Woody biomass from urban wood waste (construction/demolition wood, pallets, tree trimmings);
- Municipal solid waste;

- Agricultural byproducts (e.g., wheat straw, row crop residuals);
- Dedicated crops (e.g., switchgrass, sorghum, rapeseed).

Long-term sustainability of the resources considered is a key metric of availability. It is critical that the resource assessment account for environmental and ecological functions on the landscape. For example, some crop residues will likely need to be retained following crop harvest for soil nutrient cycling. Forest biomass availability analysis must account for retention of down woody material for wildlife habitat and nutrient cycling. All forest biomass potentially available from the Reservation must meet NPT guidelines as defined in the NPT Forest Management Plan. Forest biomass potentially available from public lands must be sourced consistent with state and federal guidelines.

An evaluation of current consumers and alternative uses of prospective waste material (competitive analysis) was conducted. The results provide an estimate of the net available suitable waste material volumes and estimated market prices for alternative uses. This methodology assists in development of cost structure necessary to compete in the existing market(s) for suitable waste material.

The costs associated with collection, processing and transport of these potential resource feedstocks were analyzed. Findings from this analysis were used to provide a forecast of waste material meeting feedstock specifications, available annually from the TSA for use in electrical, thermal or liquid fuel production. An evaluation of prospective future supply sources as well as an assessment of risks that may impact future waste material supply availability was conducted. An ESRI ArcMap based Geographic Information System (GIS) was employed to provide graphic demonstration of:

- General TSA and surrounding region;
- Land cover in the defined TSA (forest, agriculture, etc.);
- Land ownership within the TSA of suitable waste material location and ownership;
- Transport/haul analysis;
- Selected sites under siting consideration.

Results of the resource assessment, GIS analysis, and the methodologies used as described above to generate waste material cost/price forecast were delivered in a draft document to NPT staff for review and revision.

Task 3. Site Review

A key objective of the feasibility study is an analysis of siting community scale electrical and thermal energy (combined heat and power) facilities on the Reservation. The NPT conducted an energy load assessment to characterize end-use energy consumption patterns on the Reservation. This load assessment assisted in the selection of optimized siting locations for community scale energy facilities on the Reservation. Utilizing results of the load assessment, TSS worked with NPT staff to select the candidate sites for locating potential energy generation facilities on the Reservation. Site attributes for each of the four sites considered included:

- Land Use Zoning;
- Transportation, Routes, and Corridors;
- Public Health and Safety;
- Waste Water and Reclaimed Water;
- Water Supply Resources;
- Geology/Soils;
- Cultural Resources;
- Power Transmission/Distribution Assets.

TSS interfaced with NPT staff regarding pre-construction requirements (i.e., building permits and land use entitlements) and studies that may be required for the construction of a community scale energy generation facility. Regulatory guidance was obtained from the U.S. Environmental Protection Agency (Region 10), the Nez Perce Department of Natural Resources, and other agencies (where considered appropriate and applicable by the NPT). TSS delivered draft results of the site review findings for NPT staff review and revision.

Task 4. Technology Selection and Financial Analysis

Utilizing findings from Tasks 1 through 3, TSS conducted a biomass electrical, thermal energy, and related biofuels technology review to match feedstock availability/characteristics, local environmental permitting requirements, site attributes and electrical/thermal load forecast with existing, commercially-proven technologies. Selection of a technology that optimizes utilization of sustainably available resources and waste streams while generating electrical and thermal energy (and/or transportation fuels) that meets environmental regulations and stewardship is key to project success. TSS utilized relevant studies completed for the NPT or other agencies in the region. In addition, TSS also used its extensive experience and technology database which has been developed for similar projects in the Western United States.

A candidate technology matrix was generated with the top two technologies presented to NPT staff with recommendations. Key considerations when ranking the top two technologies include:

- Technology maturity;
- Energy efficiency;
- Operating requirements;
- Experience with locally available feedstocks and waste streams;
- Capital and operating costs;
- Costs of production ($/kWh and/or $/MMBtu);
- Environmental considerations (emissions, waste water) and mitigations.

Subsequent to selection of the preferred technology by the NPT staff, the selected technology vendor was contacted and specific cost estimates/details were obtained for the following:

- Equipment capital costs;
- Equipment installation costs;
- Annual operations and maintenance costs;
- Training required for operations personnel;

- Site requirements;
- Infrastructure requirements;
- Estimated raw material supply (product and volume) needs;
- Limiting factors.

TSS provided data and information relative to the prospective economic impact of a community scale energy generation facility including employment opportunities related to fuel supply and facility operation. This review included a brief description of preferred experience/attributes/training necessary for such employment opportunities. Data provided by the technology vendor was utilized to conduct a financial analysis to provide the cost of electrical and thermal energy. Financial analysis results (e.g., $/MM Btu, payback period, operations and maintenance costs) were delivered in draft format to NPT staff for review and revision.

Task 5. Draft Feasibility Study Report

Based upon information, findings and NPT staff input assimilated in Tasks 1 through 4, TSS generated a draft report document. The draft report was written so that the target audience (NPTEC, Project Working Committee, Executive Committee, NPT General Council members and staff, informed members of the public and private sector, financial institution staff, power utilities staff, and associated agency staff) would have no issues comprehending the report.

The feasibility study report included (but is not necessarily limited to) the following sections:

- Title Page
- Table of Contents
- List of Tables/Figures
- Executive Summary
- Key Findings
  - Resource/Waste Stream Availability/Pricing
  - Site Review and Selection Results
  - Energy Technology Matrix
  - Selected Technologies
  - Financial Analysis Results for Energy Installations
- Summary and Relevance of Previous Studies
- Research Team Organization and Structure
- Resource and Waste Steam Availability Analysis
- Site Review and Selection
- Technology Review and Selection
- Financial Analysis for Siting/Installation/Operation of Selected Technologies
- Financing Requirements and Potential Funding Sources
- Recommendations and Next Steps to Consider
- Appendices

Data sources including previous studies were referenced. Analytical methodologies and results were addressed.

Task 6. Final Feasibility Study Report

Subsequent to submission of comments and recommendations by the Energy Committee and NPT staff, a final report was generated (completed within two weeks of receiving input from the committees and staff).

Task 7. Project Management

During the course of this feasibility study, it was important that TSS and NPT 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 assure successful analysis and delivery of work product. TSS provided project management services including:

- Monthly progress reports that highlighted activities undertaken, results achieved, and challenges experienced.

EXECUTIVE SUMMARY WITH KEY FINDINGS

Summarized below are findings generated as a result of this feasibility study.

Biomass Resource Availability and Pricing

The biomass resource assessment portion of the feasibility study focused upon target study areas of a 20-mile circular radius for four locations of NPT owned properties. These locations included Lapwai, Orofino, Kamiah and Kooskia. Kamiah and Kooskia were analyzed as a single location due to their close proximity. Table 1 provides an overview of net available biomass volumes from forest operations, urban wood waste and wheat straw. Net available figures reflect operational and economic filtering of gross biomass volumes as well as consideration of current consumption by alternative uses and competition. The standard unit of measure for woody biomass is bone dry ton (BDT).[1]

[1] One bone dry ton is the nominal equivalent of 2,000 pounds of dry wood fiber (0% moisture content).

Table 1. Net Available Biomass Volumes by Target Location TSA and Feedstock Source

TARGET LOCATIONS	BIOMASS FROM FOREST OPERATIONS (BDT/YR)	BIOMASS FROM URBAN WOOD WASTE (BDT/YR)	BIOMASS FROM WHEAT STRAW (BDT/YR)	TOTAL BIOMASS (BDT/YR)
Lapwai 20-Mile TSA	4,400	800	161,500	**166,700**
Orofino 20-Mile TSA	12,100	1,500	54,800	**68,400**
Kamiah-Kooskia 20-Mile TSA	34,000	2,400	94,300	**130,700**
TOTALS	**50,500**	**4,700**	**310,600**	**365,800**

Table 2 summarizes the estimated costs of collection, processing and transport to deliver biomass material to the specified sites within each respective target study area.

Table 2. Biomass Material Collection, Processing and Transport Costs

FEEDSTOCK SOURCE	PROCESSING COSTS $/BDT		TRANSPORT COST $/BDT		DELIVERED COST $/BDT	
	LOW RANGE	HIGH RANGE	LOW RANGE	HIGH RANGE	LOW RANGE	HIGH RANGE
Forest Operations	$17.50	$35.00	$10.20	$23.80	$27.70	$58.80
Urban Wood	$12.00	$16.00	$8.90	$17.00	$20.90	$33.00
Wheat Straw	$32.50	$37.50	$12.00	$24.00	$44.50	$61.50

Site Review and Selection Results

After reviewing the initial findings, the Nez Perce Tribe Energy Committee (NPTEC) decided to include the Clearwater Casino as a potential site in addition to those sites included in the biomass assessment. (Because the biomass assessment was complete before NPTEC's decision, the committee elected not to amend the biomass resource assessment portion of the feasibility study.) The site review focused upon attributes considered integral to installation and operation of a biomass waste fueled utilization facility. Such attributes include:

- Land Use Zoning;
- Transportation, Routes, and Corridors;
- Public Health and Safety;
- Waste Water and Reclaimed Water;
- Water Supply Resources;
- Geology/Soils;
- Cultural Resources;

- Power Transmission/Distribution Assets.

The final evaluation resulted in selection of the Lapwai WWTP as the most advantageous site for an electrical generation facility location. The location adjacent to the WWTP could allow for labor sharing between the two enterprises to reduce costs, as well as necessary land availability and infrastructure. Orofino would be a preferred site for a larger scale CHP facility, due to the availability of a site suitable for a 3 MW biomass power plant.

Energy Technology Matrix

A technology matrix was developed to provide side-by-side comparison of prospective technologies. The matrix reviews nine prospective vendors using five key attributes: 1) proven technology; 2) biomass utilization experience; 3) air emissions; 4) water impacts; and 5) capital costs. These five attributes serve to differentiate the vendors based on key environmental and economic factors. A three-tiered ranking was employed for each of the five attributes.

Selected Technologies

The vendors with the highest ranking included Alternative Energy Solutions Intl., Phoenix Energy, and Reliable Renewables. Through direct conversations with the three vendors (to assess initial interest), Alternative Energy Solutions Intl. (AESI) and Reliable Renewables were selected as the top two candidates for presentation to NPT staff for the selection of a final candidate. AESI utilizes direct combustion technology while Reliable Renewables uses gasification technology. Discussions with NPT staff indicated a preference for gasification technology; thus Reliable Renewables was selected for more detailed financial analysis.

Financial Analysis Results for Energy Installations

The financial analysis indicates that a biomass combined heat and power (CHP) project at the Lapwai wastewater treatment plant site is not financially viable without 85% capital cost grant funding. Even with the lowest cost feedstock (as projected in the biomass feedstock assessment), a grant covering 85% of the capital cost would be required to meet financial thresholds. This is not to say that a biomass CHP facility should be ruled out across the NPT Reservation. Facility scale, utilization of process heat and steam, a Renewable Portfolio Standard for Idaho, and Renewable Energy Credit market stability would all impact future financial viability. A biomass project does not require all of these variables to align perfectly for success. However, currently none of these variables are available for such a project.

As some of these variables fall into place, the project could become financially viable with support from grant funding. With grant funding available to bring down capital equipment costs, the project's financial feasibility improves and tax equity partners could be attracted to participate in the development and ownership of the project. The tax equity partners could take advantage of available tax credits (e.g., production tax credits or investment tax credits) and further improve the financial viability of the project.

A representative[2] of Energy Northwest recently expressed provisional interest in the proposed power generation facility for NPT. Energy Northwest is a Joint Operating Agency (JOA) in the State of Washington. Energy Northwest owns and operates generation facilities and provides operations and maintenance for their own and other facilities. Their interest in the NPT project is potential acquisition of electricity at rates that could improve the overall financial viability of the opportunity, potential joint venture or equity partnership with NPT.

SUMMARY AND RELEVANCE OF PREVIOUS STUDIES

There are a number of studies regarding waste and energy (woody biomass, solid waste, dedicated crops) conducted within the region over the past few years. The study conducted by RIDOLFI, Inc., "*WASTE STREAM ANALYSIS REVISION 1 FOR THE COUNTIES OF CLEARWATER, IDAHO, LEWIS, LATAH, AND NEZ PERCE,"* issued in August 2007 was particularly useful for evaluation of urban wood waste as well as municipal solid waste. Interviews with Latah County Solid Waste personnel, Public Health officials, and local waste haulers indicate that though the RIDOLFI study occurred in 2007, the basic conclusions and waste stream data are still statistically valid.

The *"Nez Perce Tribe 'Beyond 2010' Solid Waste Plan"* was reviewed and utilized for information regarding existing solid waste enterprises, including composting facilities, non-municipal solid waste landfills, recycling facilities, municipal solid waste landfills as well as transfer stations and container locations.

A study conducted for Clearwater County, *"Clearwater County Biomass Energy Report,"* by Tetra Tech was reviewed for any information or data that could impact the results of this feasibility study. The study recommended siting a small-scale CHP facility at the Idaho Correctional Institute at Orofino, utilizing between 4,000 BDT to 8,000 BDT per year depending upon project scale of between 1 to 2 MW. TSS' experience of feedstock consumption for 1 MW of power typically is from 6,000 to 9,000 BDT/year indicating total fuel consumption for a CHP scaled at 1 to 2 MW at between 6,000 and 18,000 BDT per year. The impact of this project was assessed as potential competition for feedstock within specified location target study areas.

The Hudson Company completed a feasibility study in 2003 for locating a commercial-scale biodiesel facility on the NPT Reservation. Dedicated establishment and cultivation of soft oilseed crops such as rapeseed, canola and mustard at 125,000 acres would produce enough feedstock to produce 7.3 million gallons of biodiesel per year. The Hudson Company recommended that the NPT secure federal grants for 75% of the $19 million capital equipment costs.

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[2]Mr. John Steigers, Project Developer, Energy Northwest.

RESEARCH TEAM ORGANIZATION AND STRUCTURE

The Nez Perce Tribe Energy Committee was composed of personnel primarily responsible for review and suggested edits of work product generated as each task of the feasibility study was completed. Jon Paisano, as Project Manager, was lead for the NPTEC and the primary liaison between NPTEC and TSS. Members of the NPTEC are listed in the ACKNOWLEDGMENTS section of this report and include the following personnel:

- Jon Paisano, Nez Perce Tribe, Energy Technician and Project Manager
- John Wheaton, Nez Perce Tribe, Environmental and Utilities Planner
- Patrick Baird, Nez Perce Tribe, Cultural Resources
- John De Groot, Nez Perce Tribe, Director, Forest Management Division
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- Chris St. Germaine, Nez Perce Tribe, Information Systems
- Valdasue Steele, University of Idaho Agricultural Extension, Nez Perce Reservation

BIOMASS RESOURCE ASSESSMENT

Target Study Area

The target study area (TSA) for this resource feedstock assessment analysis is defined by a 20-mile circular radius from the communities of Lapwai, Orofino, Kamiah, Kooskia, as well as the existing boundaries of the Nez Perce Reservation. Figure 1 shows the TSA, which consists of an estimated 2,121,630 acres.

Figure 1. Nez Perce Tribe Biomass Fuel Target Study Area

The TSA consists of portions of five counties within Idaho and three within Washington. The counties within the TSA and the percentage of each are shown in Table 3. Garfield County in Washington is excluded from the assessment, as less than 1% of the total area of the county was within the TSA.

Table 3. Counties and Percent of Area within the TSA

COUNTY	STATE	TOTAL ACRES	TSA ACRES	PERCENT IN TSA
Clearwater	ID	1,592,070	461,290	29%
Idaho	ID	5,442,330	617,443	11%
Latah	ID	689,100	169,403	25%
Lewis	ID	307,000	255,780	83%
Nez Perce	ID	548,055	447,924	82%
Asotin	WA	409,784	107,056	26%
Whitman	WA	1,393,480	62,400	4%
TOTALS		**10,381,819**	**2,121,298**	

The difference in total acres for the TSA and the totals in Table 3 is due to the exclusion of Garfield County (332 acres).

Land Ownership

Figure 2 shows the distribution of land ownership and jurisdictions within the TSA.

Figure 2. Land Ownership and Jurisdiction within the TSA

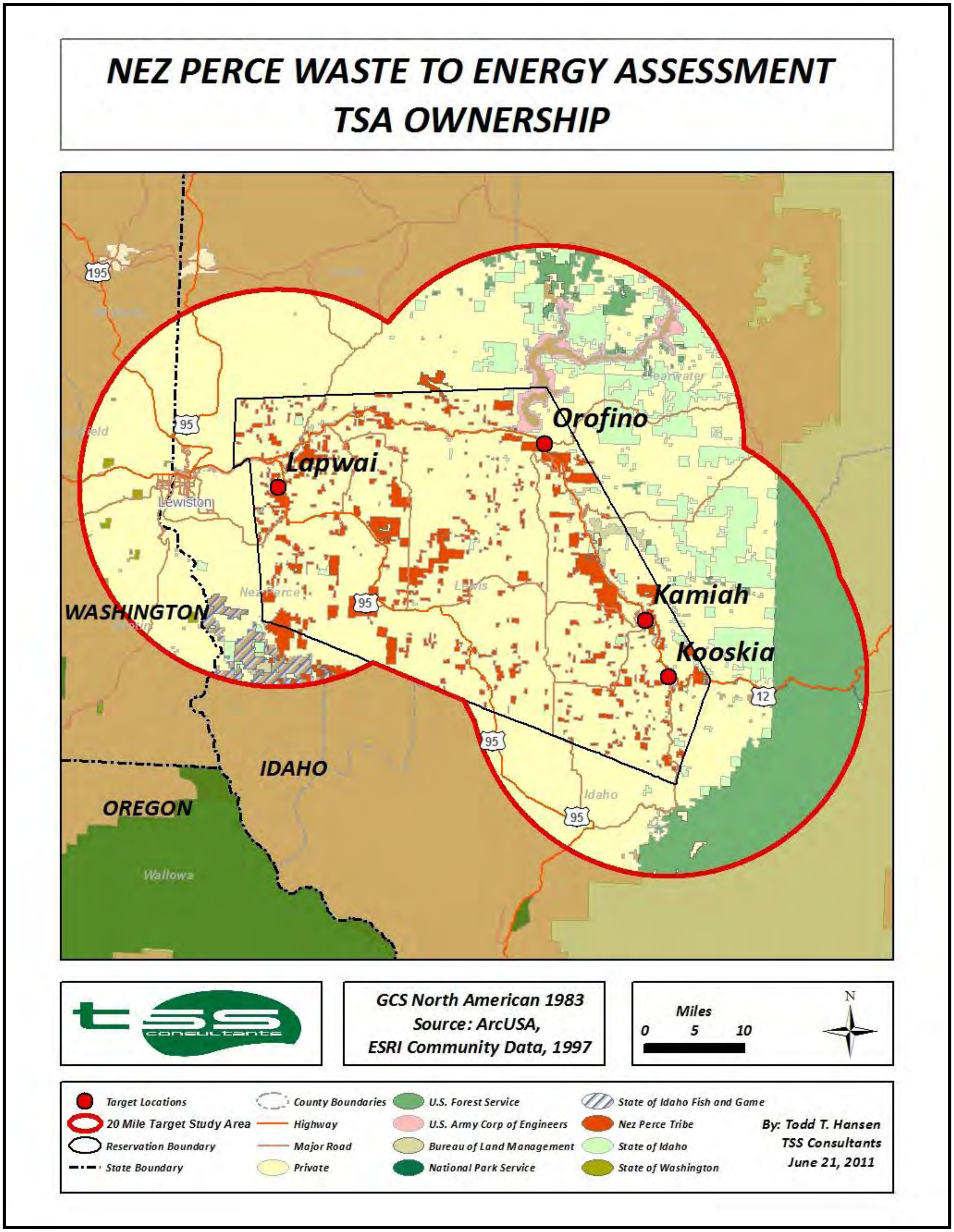


Table 4 shows the number of acres by significant landowner/agency within the TSA in both Idaho and Washington.

Table 4. TSA Acres by Ownership and Land Manager

LANDOWNER/AGENCY	TSA ACRES	PERCENT OF TOTAL
Bureau of Land Management	12,044	0.6%
Idaho Department of Lands	159,743	7.5%
Idaho Fish and Game	20,926	1.0%
National Park Service	152	0.0%
Nez Perce Tribe	131,193	6.2%
Private	1,522,466	71.8%
U.S. Army Corps of Engineers	17,525	0.8%
U.S. Department of Defense	161	0.0%
U.S. Forest Service	231,658	10.9%
Washington Department of Natural Resources	6,388	0.3%
Washington Department of Fish and Wildlife	3,981	0.2%
All Other Categories	15,393	0.7%
TOTALS	**2,121,630**	**100%**

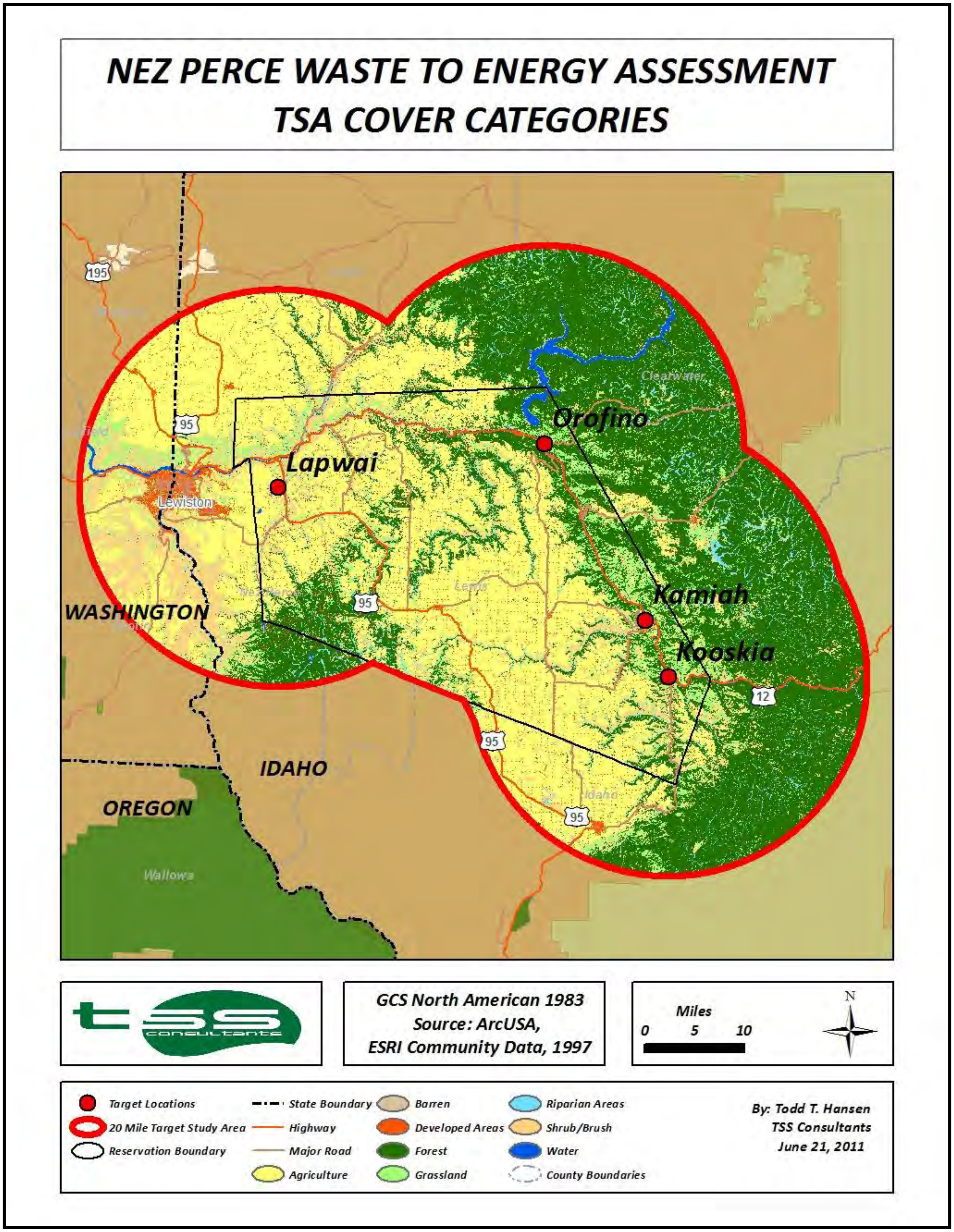
The major ownership class within the TSA is private holdings, comprising over 72% of the entire TSA. The U.S. Forest Service (USFS) manages 11%, the Idaho Department of Lands (IDL) manages nearly 8%, and the NPT owns 6.2% of land within the TSA. The landowners and managing agencies in Table 4 represent 99.4% of the entire TSA.

Vegetation Cover Categories

Feedstock material available on a sustained basis, over time, and for a given area is directly dependent upon vegetation cover type. To appropriately confirm feedstock material availability, it is necessary to evaluate vegetation cover types within the TSA. The primary vegetative data source used in mapping and analysis for this assessment was LANDFIRE. LANDFIRE is a shared project between the USFS and U.S. Department of the Interior (USDI). LANDFIRE data allows ready evaluation of land and vegetative cover composition and structure.[3] Figure 3 highlights the various vegetation and other cover categories within the TSA.

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

Figure 3. Cover Categories Within the TSA



As Figure 3 clearly demonstrates, the TSA is dominated by agriculture and forest cover. Table 5 shows the estimated acres and percent of total for various cover categories within the TSA.

Table 5. Cover Types and Acres Within the TSA

COVER CATEGORY	ACRES	PERCENT OF TOTAL
Agriculture	726,037	34.2%
Barren	1,657	0.1%
Developed Areas	61,670	2.9%
Forest	829,386	39.1%
Grassland	162,490	7.7%
Riparian Areas	77,411	3.6%
Shrub/Brush	243,527	11.5%
Water	19,453	0.9%
TOTALS	**2,121,630**	**100.0%**

Table 5 demonstrates the substantive agriculture and forest resources within the TSA. Over 39% of the TSA consists of forest cover and 34% consists of agricultural crops. Both of these cover categories may offer opportunities for recovery of suitable biomass feedstock material.

Biomass Availability

This section of the report provides a review of prospective feedstock availability from a variety of sources, including woody biomass from conventional forest operations (e.g., timber harvest, fuels reduction, stand management), recovered urban wood (e.g., construction and demolition material, pallets, tree trimmings), municipal solid waste (MSW), agricultural byproducts (e.g., wheat straw) and dedicated energy crops.

Biomass from Forest Operations

Forest Management Activities

The byproducts of timber harvest, stand improvement, forest health and ecosystem restoration projects 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 grinders, this material is an excellent biomass feedstock source.

Woody biomass fuel review studies traditionally rely on data regarding historic timber harvest or other forest operation activities and associated volumes. This information can provide insight in determining historic trends and benchmarks to show actual forest harvest or other operations over time, activities that generate volumes of byproducts (as noted above) potentially available as biomass feedstocks.

The term "timber harvest volume" is used to reflect measurable volume recovered from all forest operations. The majority of forest operations conducted within the TSA are timber harvests, primarily on lands managed by IDL and private ownerships. The USFS conducts a variety of operations, including timber sales, where the primary product is sawlogs. Other operations conducted by the USFS might include hazardous fuel reduction or ecosystem restoration that may involve some sawlog removal.

Sawlogs manufactured during forest operations are typically measured for sale to local sawmills in thousand board feet (MBF)[4] volume. However, some sawlogs and pulp logs are sold by weight (tons). The data for harvest of sawlogs sold by weight was converted to MBF by using a factor of 5.7 tons of sawlogs per MBF.

There are a number of sources of prospective feedstocks from forest operations within the TSA, including forestland owned by the NPT, non-industrial private forest landowners (NIPF), industrial forest landowners (IFL), the IDL, Idaho Department of Fish and Game (IDFG), the USFS, the Bureau of Land Management (BLM) and, to a very limited extent, the Washington Department of Natural Resources (WA DNR). Less than 1% of the WA DNR ownership within the TSA consists of forest cover; the majority of this ownership is comprised of agriculture or shrub/brush.

Non-Industrial Private Forest Landowners

Forest cover owned by both industrial and non-industrial private landowners comprises nearly 391,000 acres or 48% of total forested cover within the TSA. GIS data for forest cover necessary to separate industrial from non-industrial owners within the TSA was not available; therefore, both ownership classes are included within the private forest cover category.

Timber harvest data from private lands within the state of Idaho was sourced from the IDL.[5] The data is separated by industrial and non-industrial private landowners. Industrial landowners are defined as vertically integrated forest products companies owning in excess of 2,000 acres of commercial forestland. Utilizing GIS analysis to determine the percent of private forest cover by county and applying the percentage to overall timber harvest by county yields an estimate of timber harvest levels for the TSA. Table 6 provides a historic perspective of timber harvest levels during the period 2006 through 2010 for NIPF ownership class.

[4]MBF represents 1,000 board foot measure. One board foot is a solid wood board measured 12 inches square by 1 inch thick.
[5]Data provided by Debbie Godfrey, Idaho Department of Lands, Coeur d'Alene Staff Office.

Table 6. Non-Industrial Private Forest Landowners Timber Harvest 2006-2010

TIMBER HARVEST VOLUME (MBF) BY YEAR					
LANDOWNER CLASS	**2006**	**2007**	**2008**	**2009**	**2010**
Non-Industrial Private Forest Landowners	26,281	20,733	11,144	6,189	6,611

NIPF owner timber harvest levels are directly correlated to sawlog market conditions. As is evidenced by timber harvest volume data in Table 6, the 2007/2008 economic downturn impacted construction and wood product manufacturing; sawlog prices began to decline and with them, harvest levels. Typically, NIPF owners' holdings are not tied directly to income production, and this ownership class is afforded the luxury of foregoing harvest activity during substantive market downturns. Harvest levels for 2009 and 2010 represent a nearly 20,000 MBF decline in annual volume compared to 2006. The five-year timber harvest average for the period 2006 through 2010 is 14,200 MBF/year.

Industrial Landowners

As noted above, the timber harvest data for industrial owners is derived from the IDL. Though the definition of industrial owners is enterprises engaged in wood product manufacturing in addition to owning and managing timberland as a portion of the business assets, discussions with IDL staff indicate that changes in company holdings may not be up to date. Though it may be assumed no redundancy in data between the two categories occurs, some industrial owners may have transitioned to the non-industrial private owner category due to changes in manufacturing (e.g., sale of manufacturing assets including sawmills).

Table 7 shows the timber harvest levels for industrial owners during the period 2006 through 2010.

Table 7. Industrial Forest Landowners Timber Harvest 2006-2010

TIMBER HARVEST VOLUME (MBF) BY YEAR					
LANDOWNER CLASS	**2006**	**2007**	**2008**	**2009**	**2010**
Industrial Owners	76,262	78,202	75,962	63,667	75,843

Since industrial owners operate tree farms as their primary business and/or provide raw material supply to integrated manufacturing, they typically continue to harvest timber during economic downturns, though at reduced rates. The high point for harvest activity for industrial owners occurred in 2007, declining nearly 15,000 MBF by 2009. Harvest levels rebounded to previous levels in 2010, as the west coast log export market began to impact sawlog and pulpwood demand in the interior Pacific Northwest and Inland Empire. The five-year timber harvest average for the period 2006 through 2010 is 74,000 MBF/year.

Washington Department of Natural Resources

The WA DNR manages an estimated 6,388 acres within the TSA. The majority of forest cover owned by the WA DNR within the TSA is located in Asotin County. During the period 2006 through 2010, harvest activity has occurred very sporadically, with total harvest volume of 614 MBF. This represents an average of 122 MBF/year during the five-year period. In addition, less than 1% of the WA DNR managed lands within the TSA consists of forest cover. Due to inconsistent harvest levels and the relatively little WA DNR acreage located within the TSA, forest biomass from WA DNR lands was not considered a readily available feedstock.

Idaho Department of Lands

The TSA encompasses all, or portions of, four IDL Supervisory Areas (SA), comprising a total of 159,743 acres. Table 8 shows the total acres and forested acres managed by each Supervisory Area within the TSA.

Table 8. IDL TSA and TSA Forest Cover Acres

IDL SUPERVISORY AREA	TSA ACRES	TSA FOREST COVER ACRES
Clearwater	62,005	56,756
Craig Mountain	1,623	816
Maggie Creek	63,344	53,957
Ponderosa	32,771	28,877
TOTALS	**159,743**	**140,406**

Eighty-eight percent (88%) of the total area managed by IDL within the TSA consists of forest cover.

Discussions with staff[6] of the IDL Craig Mountain Supervisory Area revealed that no harvest activity has occurred on lands within the TSA since the 1990s, and no harvest or other forest operations are planned. For these reasons, it is assumed that forest management activities on the Craig Mountain SA will not generate forest biomass material for the foreseeable future.

According to harvest records from IDL, the three Supervisory Areas have generated an estimated 429,000 MBF total during the period 2006 through 2010. A GIS analysis using LANDFIRE forest cover data was conducted to determine an estimate of forested areas within each SA as a percent of the total SA. This percentage was subsequently applied to develop harvest volume estimates from within each SA. Table 9 shows the estimated timber harvest volumes for years 2006 through 2010 from IDL lands within the TSA.

[6]JeAnn Wilson, Forestry Resource Specialist, Idaho Department of Lands, Craig Mountain SA.

Table 9. IDL Timber Harvest Volume (MBF) 2006-2010

TIMBER HARVEST VOLUME (MBF) BY YEAR					
SUPERVISORY AREA	**2006**	**2007**	**2008**	**2009**	**2010**
Clearwater	19,048	14,731	12,329	12,629	25,179
Maggie Creek	14,363	39,289	27,763	21,195	28,319
Ponderosa	12,991	16,211	8,608	7,109	19,479
TOTALS	**46,401**	**70,231**	**48,700**	**40,932**	**72,977**

The five-year annual average for IDL timber harvest operations within the TSA is 55,849 MBF/year. The harvest data from Table 9 indicates increasing harvest levels through 2007, subsequently declining in 2008 and 2009, and rebounding significantly in 2010, even exceeding 2007 harvest levels.

This trend corresponds to harvest and forest operations activity from other ownership classes in response to the economic downturn. The increase in activity for 2010 reflects increasing demand for local sawlogs, as even wood products manufacturers in the Inland Empire are experiencing the impact of a robust Pacific Rim log export market. In addition, some companies are increasing purchases of lower cost sales, reflecting the market price decline, to offset previous higher cost timber sales.

U.S.D.I. Bureau of Land Management

The BLM manages 12,000 acres within the TSA. Nearly 65% of the total is classified as forest cover (according to the LANDFIRE data). Discussions with BLM staff[7] in the Cottonwood Field Office indicate harvest levels on BLM managed land within the TSA during the period 2006 through 2010 averaged 200 MBF per year. Harvest levels for the next five years are estimated to be near 800 MBF, comprised primarily of two large projects scheduled for lands within the TSA.

Much of the BLM managed land within the TSA lies within and adjacent to the Lolo Creek drainage upstream of its confluence with the Clearwater River, as well as along the Clearwater River. These lands are conducive to multiple resource management objectives but not well suited to intensive timber production. BLM staff indicated that management objectives for these areas are focused on multiple resources (e.g., range, wildlife habitat, forest health) with sawlog production considered ancillary to treatments accomplishing other resource objectives.

U.S. Forest Service

There is an estimated 231,658 acres of primarily forested land managed by the USFS within the TSA. The LANDFIRE GIS analysis used for Figure 3 and Table 5 indicate that 90% of this

[7]Robbin Boyce, Assistant Field Manager, BLM Cottonwood Field Office.

acreage is classified as forest cover. Portions of both the Clearwater and Nez Perce National Forests are located within the TSA.
Forest operations typically conducted by the USFS include prescribed burning, hazardous fuel reduction both within and outside of Wildland Urban Interface (WUI), ecosystem restoration, pre-commercial thinning, and timber harvest. Some of these operations are combined, employing a single entry to meet multiple management objectives. The cut and sold harvest data for the period 2006 through 2010 for these national forests is shown in Table 10.

Table 10. USFS Timber Harvest Volume (MBF) 2006-2010

HARVEST VOLUME (MBF) BY YEAR BY FOREST					
NATIONAL FOREST	**2006**	**2007**	**2008**	**2009**	**2010**
Clearwater	19,282	11,314	7,305	19,099	14,960
Nez Perce	4,795	56,549	28,910	16,859	8,189
TOTALS	**24,077**	**67,863**	**36,215**	**35,958**	**23,149**

Data from USFS timber harvest activity shows a decline in volume after 2007, which is consistent with other forest ownerships. The harvest volume in 2010 represents a 64% decline from the harvest volume of 2007. The five-year average for harvest volume from USFS forest operations is 39,460 MBF/year. Data in Table 10 represents forest operations from throughout the entire forests, not just that portion within the TSA. The intent of Table 10 is to demonstrate that the economic downturn has also impacted harvest volume from USFS timber sales.

Operations for the Clearwater and Nez Perce National Forest are currently being combined, and the combined national forests are being delineated into three zones: North, Central and South Zones. Portions of each zone are within the TSA, although only a very small area from the North Zone lies within the TSA. Data provided by the USFS from both the Clearwater and Nez Perce National Forest indicates that forest operations have generated an estimated 20,500 MBF/year over the past five years from those portions of all three zones located within the TSA. The harvest level for the next five years was estimated to be 23,500 MBF/year. Though the USFS is predicting an increase in overall harvest volume, this assessment assumes an average harvest level of 20,500 MBF per year.

There is currently a Collaborative Forest Landscape Restoration project on the Clearwater and Nez Perce National Forest. In June 2001, the office of the U.S.D.A. Agriculture Secretary announced that the Selway-Middle Fork Clearwater project, collaboration between the Clearwater Basin Collaborative and the two national forests, would be receiving $3.5 million in 2012 for fuels treatment as well as land and water ecosystem restoration. The CFLR program was created in 2009 by Congress under Title IV of the Omnibus Public Land Management Act of 2009 to provide additional funding for approved projects demonstrating the need for collaborative-based ecosystem restoration on landscapes of a minimum 50,000 acres over a 10-year period.

The southeast section of the TSA includes a portion of the Selway-Middle Fork Clearwater project. As long as Congressional funding for these approved projects continues, increasing levels of forest operations such as fuel reduction, commercial thinning, watershed and wildlife habitat improvement, and other ecosystem projects will occur in this portion of the TSA as well as other areas of the national forests tributary to the TSA. The increase in harvest volume estimated by the USFS for the next five years is attributable to the impact of the CFLR.

Nez Perce Tribe

There are several NPT land ownership designations within the TSA. Ownership categories include Tribal Fee Simple, Tribal Fee Wildlife, Tribal Trust, Tribal Trust Allotment, and Individual Indian Trust Allotment. The breakdown by acres for these categories, as well as the distinction between commercial and non-commercial forest, is shown in Table 11.[8]

Table 11. NPT TSA Acres by Ownership Category

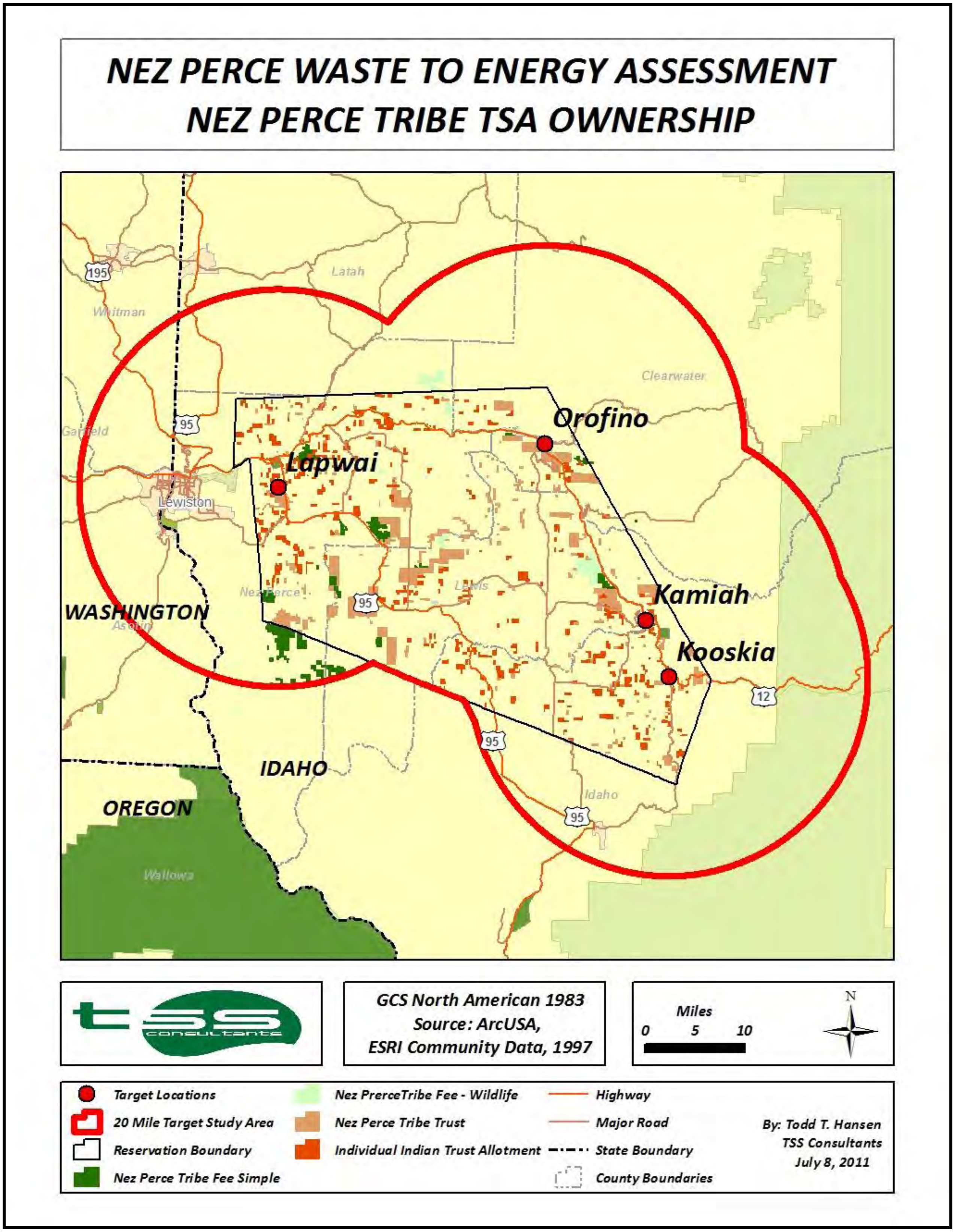
NEZ PERCE TRIBE LANDOWNER CATEGORY	TOTAL ACRES	COMMERCIAL FOREST	NON-COMMERCIAL FOREST	TOTAL FORESTED ACRES
Tribal Fee Simple	23,736	19,822	936	20,758
Tribal Fee Wildlife	7,158	0	2,790	2,790
Tribal Trust	54,762	30,735	5,050	35,785
Individual Indian Trust Allotment	45,536	4,861	1,222	6,083
TOTALS	**131,193**	**55,418**	**9,998**	**65,416**

Non-commercial forest land is typically defined as forested land that is available for management but has limited potential for long-term, sustainable production. The productivity of non-commercial forest land is substantially lower than other lands. Productivity for commercial forestland is defined as a minimum growth of 20 cubic feet per acre per year. If the productivity is less than this, the land is classified as non-commercial.

Figure 4 shows the distribution of NPT ownership throughout the TSA by the categories shown in Table 11.

[8]Data provided by Jeff Cronce, GIS Analyst/System Administrator for the Nez Perce Tribe.

Figure 4. Nez Perce Tribe Ownership and Distribution by Category



The Tribal Fee Simple and Tribal Trust lands are owned by the NPT and managed by the NPT Forestry and Fire Management Division of the Department of Natural Resources. The timber resources on the commercial forest portion of these lands are used in the determination of the annual allowable timber harvest volume. The Forestry and Fire Management Division also manages the Tribal Fee Wildlife and the Individual Indian Trust Allotment lands. However, these resources are not included in the annual allowable timber harvest volumes calculation. Title to the Tribal Trust and Individual Indian Trust Allotment lands is held by the federal government.

As Figures 2 and 4 clearly show, the current ownership pattern for NPT fee ownership and Trust lands consists of areas with concentrations of ownership distributed throughout the TSA. However, the typical pattern is not one of contiguous blocks or parcels. NPT fee ownership consists of many scattered parcels dispersed throughout the Reservation. The Tribal Trust lands consist of larger blocks.

Table 12 shows the annual timber harvest from lands managed by the NPT Forestry and Fire Management Division during the period 2006 through 2010.

Table 12. Nez Perce Tribe Timber Harvest 2006-2010

TIMBER HARVEST VOLUME (MBF) BY YEAR				
2006	**2007**	**2008**	**2009**	**2010**
3,973	1,532	2,009	731	0

Table 12 shows a substantive decline in harvest volume from 2006 to no harvest activity in 2010. Discussions with representatives of the Forestry Division[9] indicate that the decline in sawlog prices from local wood products manufacturing has impacted harvest levels. The business model for harvest activity employed by the NPT is to reduce harvest levels during down markets for sawlogs and increase levels during favorable market conditions. The economic downturn and its impact on the construction sector has seriously reduced wood product manufacturing production and associated timber values.

The annual allowable timber harvest volume[10] for the period 2006 through 2010 is 4,800 MBF. The data provided by the Forestry and Fire Management Division indicate this harvest level is sustainable through the next five-year planning period (through 2015) as well. However, harvest levels will remain well below the allowable volume until market conditions improve. The average annual harvest volume for the period 2006 through 2010 is 1,650 MBF, nearly 66% below annual allowable harvest volume.

Table 13 summarizes timber harvest volumes by landowner or land managing agency during the period 2006 through 2010.

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[9] John DeGroot, Forest Program Director for Forestry and Fire Management Division.
[10] Ibid.

Table 13. TSA Timber Harvest Summary 2006-2010

TIMBER HARVEST VOLUME (MBF) BY YEAR					
OWNER/MANAGER	**2006**	**2007**	**2008**	**2009**	**2010**
BLM	200	200	200	200	200
Idaho Department of Lands	46,401	70,231	48,700	40,932	72,977
Industrial	76,262	78,202	75,962	63,667	75,843
Nez Perce Tribe	3,973	1,532	2,009	731	0
Private Non-Industrial	26,281	20,733	11,144	6,189	6,611
USFS	20,500	20,500	20,500	20,500	20,500
TOTALS	**173,617**	**191,398**	**158,516**	**132,219**	**176,131**

The annual average harvest volume from forest operations within the TSA for the period 2006 through 2010 is estimated to be 166,400 MBF. Figure 5 graphically illustrates the changes in overall harvest volumes during 2006 through 2010.

Figure 5. Harvest Volume by Owner/Manager in MMBF 2006-2010

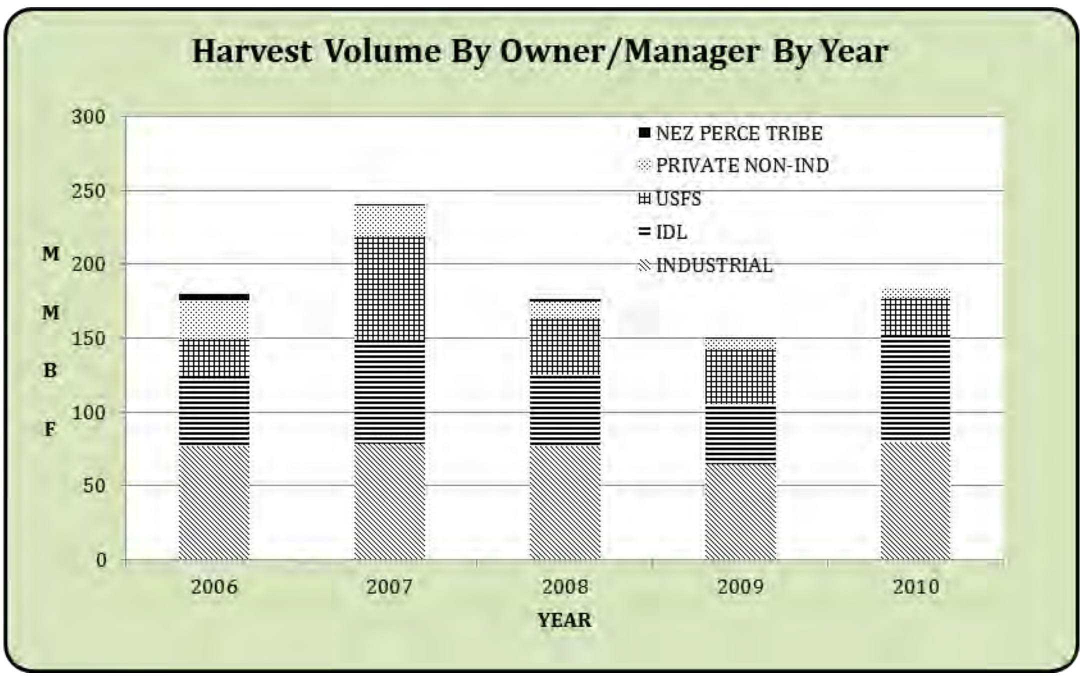

Figure 5 shows the overall harvest volume decline subsequent to 2007, with a rebound in 2010 to near 2006 harvest levels. The increase in 2010 is directly attributable to an increase in IDL harvest volume from 2009 of 78%. The harvest data for the BLM is not shown in the graph because such small volume would be indistinguishable at this scale.

Biomass Recovery From Forest Operations

This portion of the resource assessment analysis is focused on forecasting recovery of suitable biomass material primarily from forest operations that typically include some recoverable sawlog volume. Though biomass material may be generated through other forest operations, such as pre-commercial thinning, this biomass is typically not economically recoverable. Forest operations providing favorable conditions for effective recovery may include timber harvesting, hazardous fuels reduction, and ecosystem restoration, typically with some volume of sawlog material included in the operation.

Timber harvest operations generally provide large volumes of recoverable material in the form of limbs, tops and unmerchantable material (logs too small or diseased for use as sawtimber). In ground-based yarded units, this material is usually located within 100 feet of roads. In pre-commercial thinning operations, the intent is to reduce the number of trees on each acre to mitigate inter-tree competition and increase growth on those trees selected to remain. Not all trees are removed, as in a typical regeneration cut harvest unit. Furthermore, the trees are typically cut by hand, with the intent to leave material on-site to decompose, or are piled for burning. The low volume per acre of available material due to small tree size coupled with the difficulties of removing the material mechanically without damaging the remaining trees renders biomass recovery from pre-commercial thinning operations too expensive to justify recovery for use as biomass feedstock.

Fuels reduction treatments are implemented in a variety of operations, including mastication of standing trees, prescribed fire, understory thinning or a combination of understory and overstory thinning. Most of these treatments do not provide economically recoverable biomass material, although if the understory thinning requires material removal, on occasion this treatment can provide economically recoverable woody biomass material. However, these treatments are costly and generate no revenue to assist in offsetting treatment cost, whereas a treatment employing tree removal from both the understory and overstory may generate sufficient marketable sawlog material to offset some of the cost. Such treatments provide the best opportunity for economically sustainable biomass recovery, as the value of the sawlogs helps to offset the cost of removing small (unmerchantable) trees, thus minimizing the cost per acre.

Based upon estimates of timber harvest volumes by landowner and agency and adjusted to reflect past performance, Table 14 shows the estimated annual timber harvest for the past five-year period.

Table 14. Past Five-Year Annual Average Harvest Volume by Owner/Manager

OWNER/MANAGER	2006-2010 TIMBER HARVEST ANNUAL AVERAGE VOLUME (MBF)
BLM	200
Idaho Department Of Lands	55,849
Industrial	73,987
Nez Perce Tribe	1,649
Private Non-Industrial	14,191
USFS	20,500
TOTALS	**166,376**

Although the BLM and USFS are projecting increases in harvest levels, employing the historic volumes these agencies have achieved in the past provides a realistic, albeit conservative view of prospective forest operations.

Based upon interviews with logging and woody biomass processing contractors as well as with private and public land managers operating in the TSA, the recovery factor estimate for biomass feedstock (fuel) processed from timber harvest residuals is approximately 0.81[11] bone dry ton (BDT) of woody biomass (tops and limbs) that could be generated from each MBF of timber harvested. The BDT per MBF recovery factor is an average for the species mix within the region, reflecting data where recovered biomass volume (BDT) from specific harvest units with recovered volume (MBF) data was available.

Table 15 summarizes potential biomass fuel available from forest operations residuals using the 0.81 BDT/MBF biomass fuel recovery factor. The data used to develop estimates of woody biomass employs the previous five-year harvest average. TSS elects to use the previous five-year average as opposed to future predictions. The five-year average represents what has historically been achievable by all owner classes.

[11]Recovery factors are based upon interviews with logging and wood waste processing contractors as well as with private and public land managers experienced with recovery of biomass material processing and delivery in eastern Washington and north central Idaho.

Table 15. Estimated Annual Timber Harvest (MBF) and Potential Biomass (BDT)

OWNER/MANAGER	HARVEST VOLUME (MBF)	POTENTIAL BIOMASS (BDT)
BLM	200	162
Idaho Department of Lands	55,849	45,238
Industrial	73,987	59,929
Nez Perce Tribe	1,649	1,336
Private Non-Industrial	14,191	11,495
USFS	20,500	16,605
TOTALS	**166,376**	**134,765**

Table 15 indicates that an estimated 134,800 BDT per year of woody biomass are potentially available on an annual basis from forest operations within the TSA.

Harvest operations that do not include the yarding or recovery of whole trees or the tops of trees into central landing locations or adjacent to roads are generally not suitable for effective biomass recovery. Post-harvest slash piles consisting of nothing but limbs, twigs and needles typically do not contain sufficient wood fiber to produce suitable woody biomass material for use as feedstock. Such material may "flash" in the biomass combustion process as opposed to sustained burning to create heat.

Interviews were conducted with landowners or land managers to develop estimates of the harvest configuration utilized by timber harvest contractors. The results, weighted by annual harvest volumes, are shown in Table 16.

Table 16. Harvest Configuration Percent by Owner/Manager

OWNER/MANAGER	GROUND SKID, WHOLE TREE OR TOPS YARDED	GROUND SKID, WHOLE TREE OR TOPS NOT YARDED	CABLE YARDED, WHOLE TREE OR TOPS YARDED	CABLE YARDED, WHOLE TREE OR TOPS NOT YARDED	TOTAL
BLM	10%	10%	40%	40%	100%
Idaho Department of Lands	64%	6%	15%	15%	100%
Industrial	55%	0%	45%	0%	100%
Nez Perce Tribe	75%	5%	10%	10%	100%
Private Non-Industrial	65%	5%	20%	10%	100%
USFS	34%	9%	11%	46%	100%

Not all forest operations are suitable for effective recovery of woody biomass. Steep slopes, remote locations, and road systems that will not accommodate transport of biomass limit fuel volume recovery from timber harvest activities. The estimated percentage of each ownership suitable for effective biomass recovery was determined through discussions with landowners, land managers, and biomass processing company representatives. Table 17 shows the results of the recovery estimate inquiry.

Table 17. Biomass Material Recovery Operability by Ownership

OWNER/MANAGER	ESTIMATED PERCENTAGE OWNERSHIP SUITABLE FOR BIOMASS RECOVERY
BLM	35%
Idaho Department of Lands	55%
Industrial	65%
Nez Perce Tribe	80%
Private Non-Industrial	80%
USFS	60%

The net result of applying the harvest configuration and operability percentage to annual potential biomass volumes, from forest operations in Table 15, to determine an estimate of practically available biomass volumes is shown in Table 18.

Table 18. Potentially and Practically Available Biomass (BDT/Year) from Forest Operations within the TSA

OWNER/MANAGER	POTENTIALLY AVAILABLE BIOMASS (BDT)	PRACTICALLY AVAILABLE BIOMASS (BDT)
BLM	162	28
Idaho Department of Lands	45,238	19,656
Industrial	59,929	38,954
Nez Perce Tribe	1,336	908
Private Non-Industrial	11,495	7,817
USFS	16,605	4,515
TOTALS	**134,765**	**71,879**

The analysis of forest operations and associated byproduct within the TSA as a source of feedstock material indicates that an estimated 71,900 BDT per year are practically available. The majority of this feedstock source is industrial and IDL lands and operations, and these properties are located primarily in the western portion of the TSA.

Biomass from Forest Product Manufacturing

Forest products manufacturing residuals generated within the TSA can provide potential woody biomass feedstock in the form of sawdust, shavings, and bark. There are several commercial-scale forest products manufacturing facilities located within the TSA, including the sawmill associated with Clearwater Paper in Lewiston, TRI-PRO Forest Products in Orofino, Empire Lumber Company in Weippe, Blue North Forest Products, LLC in Kamiah, and Idaho Forest Group in Grangeville.

Most of these facilities utilize the majority of their residuals internally to fuel wood-fired boilers for the dry kiln operations. Currently any excess is sold to Clearwater Paper, except product from Blue North Forest Products, LLC. All byproduct from their manufacturing is used internally. As production increases with improvement in the forest product markets, Blue North could have the ability to generate some minor surplus volumes, estimated at about 32 green tons (GT) per day.

The range of byproduct from manufacturing from sawmills in the region, except the Clearwater sawmill at Lewiston, is estimated to be between 30,000 and 45,000 BDT per year. This volume is considered excess to internal consumption requirements in the current market conditions. The lower limit represents estimated production at current levels during the market downturn, with the upper limits representing production increases during improved market conditions.

The fact that most of these companies have firm commitments with Clearwater Paper, coupled with the fact that many use byproduct internally to fuel boilers co-located on site, would indicate that substantive volumes are not available from these sources. For small-scale projects requiring small volumes, it may be possible to develop an arrangement satisfactory to all parties to secure minor volumes. However, it is unlikely that Clearwater Paper would accommodate a project requiring large volumes and attempting to secure it from their existing suppliers.

Biomass from Agriculture Operations

Portions of the TSA are very suitable for agricultural production. An estimated 726,037 acres or over 34% of the area within the TSA is currently dedicated to commercial agriculture production (as noted in Table 5). An evaluation of the agriculture business sector for the counties within the TSA[12] indicates that the predominant crop is wheat, more specifically winter wheat. Table 19 shows the estimated allocation of harvested acres by percent for year 2010 by crop within each county.

[12]USDA National Agricultural Statistics Service – Quick Stats U.S. & All States County Data–Crops 2010, http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/

Table 19. 2010 Harvest Acres by Crop as Percent of Total

COUNTY	WINTER WHEAT	SPRING WHEAT	ALFALFA	OATS	BARLEY	BEANS
Clearwater	80.0%	0.0%	20.0%	0.0%	0.0%	0.0%
Idaho	49.1%	25.2%	18.1%	1.9%	5.7%	0.0%
Latah	52.4%	24.3%	4.2%	0.0%	4.2%	14.9%
Lewis	62.7%	19.3%	5.5%	1.1%	6.3%	5.1%
Nez Perce	60.6%	12.0%	4.7%	0.3%	5.5%	16.9%
Asotin	72.8%	10.7%	16.5%	0.0%	0.0%	0.0%
Whitman	54.1%	29.5%	2.2%	0.0%	6.5%	7.7%
TOTALS	**55.8%**	**24.5%**	**5.3%**	**0.3%**	**5.8%**	**8.4%**

The data from Table 19 clearly shows the dominance of winter and spring wheat production within the region, at an estimated 80% of total agriculture production.

Discussions with a local and regional agriculture business owner[13] yielded a percent allocation of crop: 55% to 60% winter wheat, 20% spring wheat and 20% to 30% legume crop. The figures for winter and spring wheat are very similar between the two sources. There has been a concerted effort in the region to minimize tilling to prevent additional soil erosion. The local grower employs a harrow designed to shred the wheat straw to increase decomposition rate but expressed interest in removing wheat straw. The current crop rotation cycle employed by this operation includes winter wheat, followed by spring wheat, followed by a legume crop, and then repeating the cycle of crop rotation. There are more legumes included in the rotation for crops grown in the Palouse region north of the Clearwater River than in the Camas Prairie region south of the Clearwater River. The growers on the Camas Prairie seem to favor a rotation of winter and then spring wheat.

The wheat straw yields for winter wheat are estimated by the local grower at 1 ton of wheat straw for every ton of crop harvested. Since yields are measured by bushel, 100 bushels weigh 3 tons and generate 3 tons of wheat straw. Yields for wheat straw from spring wheat are near 50% of the yields from winter wheat and at these yields, only wheat straw from winter wheat is considered economically recoverable.

The GIS analysis of LANDFIRE vegetation cover categories indicated an estimated 726,037 acres of agriculture within the TSA (as noted above). Assuming 55% of the agricultural area within the TSA is planted to winter wheat at any given time would suggest 399,320 acres in production. An analysis of the U.S.D.A. data used in Table 19 for the relationship between planted acres and harvested acres indicated that 98% of acres planted are harvested. Applying this percentage to estimated winter wheat planted acres yields 391,334 harvested acres per year.

[13] Buck Boyer, Boyer Land and Cattle.

Based upon the data from U.S.D.A. for year 2010, the winter wheat yields from harvested acres within the TSA is 73.5 average bushels per acre. The estimated annual total yield from the TSA is 28,757,331 bushels. Applying the conversion of 33 1/3 bushels weighs 1 ton and yields 1 ton of wheat straw indicated the TSA could annually generate an estimated 862,720 tons. The moisture content delivered is estimated at 10%,[14] which would yield 776,450 BDT of wheat straw per year.

Winter wheat is typically planted in September (depending upon the elevation) and harvested in July and/or August. This means that in order to maintain a supply lasting throughout the year, baled material must be stored in inventory, preferably under shelter to maintain low moisture content. In addition, some agricultural operators prefer to leave the straw residual onsite for nutrient augmentation and provide cover to reduce soil erosion. TSS estimates that 40% of the wheat straw from winter wheat production within the TSA would be practically and economically available, yielding an estimated 310,580 BDT per year.

Wheat straw is considered a suitable feedstock for some technologies utilizing biomass for energy. Most of these technologies were developed in Europe. There are a number of research and development projects analyzing different methods to utilize wheat straw for bioenergy or advanced biofuels (e.g., cellulosic ethanol), including current research through the U.S. Department of Energy (USDOE), Energy Efficiency and Renewable Energy Biomass Program with the Idaho National Engineering and Environmental Laboratory and the University of Idaho. TSS is unaware of any large-scale CHP facilities utilizing significant amounts of wheat straw in the United States. Technical challenges with boiler slagging and fouling are significant.

Rapeseed has been considered a promising biomass crop with regard to production of oil (for use in the production of biodiesel). Consultation with the local agricultural business owner[15] indicates that very little rapeseed is produced in the Palouse region. It is planted in more significant acreage on the Camas Prairie. Apparently many agricultural operations view the production of rapeseed for canola oil as a riskier business decision as opposed to other suitable alternatives. The current market prices are fairly low. If air temperatures are high when rapeseed is flowering, yields can be substantively reduced. There are no local oil extraction facilities utilizing the more efficient chemical extraction process and thus providing higher prices than closer facilities employing mechanical extraction. The rapeseed resource was not included as a reasonable feedstock alternative due to the current low production volumes and the poor efficiencies of regional extraction facilities.

Discussions with personnel at the University of Idaho (UI), the UI extension service, the local Farm Service Agency and a local agricultural operation all indicated that no crops identified as dedicated energy crops are currently in production within the region or within the TSA.

Biomass from Urban Wood Waste

Wood waste generated as a result of tree trimming, land clearing, construction, demolition and from commercial (non-forest products manufacturing) operations in the form of pallets and

[14] Ibid.
[15] Ibid.

miscellaneous wood scraps, represents a significant potential biomass fuel resource. Collectively known as urban wood waste, this material is typically low in moisture content (around 20%), has a relatively high heating value (8,000+ Btu[16] per dry pound) and is potentially available as a relatively low-cost feedstock. Communities are considering the recovery of this wood waste for a variety of reasons including:

- The functional life of landfills can be extended through diversion of wood waste material to alternative uses. Tip fees at the landfills are on the rise to provide an incentive for increased recycling/alternative utilization efforts.

- Residential and commercial development within the TSA many times requires land clearing. This creates wood waste in the form of vegetative material (brush, small trees).

- In many places in the western U.S., air quality concerns have placed increased restrictions on open burning of wood waste or vegetative material. Diverting wood waste that is typically open burned, to a controlled combustion or gasification system, reduces air emissions significantly.

- Reduction of greenhouse gas emissions associated with biomass disposal by shifting the form of the emissions from methane (if woody biomass is deposited in landfills or left to decompose) to carbon dioxide (methane is almost 25 times more potent as a greenhouse gas than CO2 on an instantaneous basis).[17]

Urban wood waste generated by a community or region is directly proportional to population. The higher the population within a given area, the more urban wood waste is produced.

In 2007, the NPT commissioned RIDOLFI, Inc. to conduct a waste stream analysis of the MSW from the counties of Clearwater, Idaho, Latah, Lewis and Nez Perce.[18] That portion of the waste stream suitable for use as feedstock for biomass energy projects considered under this section of the Resource Assessment included those components identified in the RIDOLFI report as "yard waste" and "wood."

Table 20 shows the estimated volume of urban wood waste from the RIDOLFI study by county. The total volumes for each county were adjusted by the percentage of each county within the TSA for Table 20. Though the report did not state green or bone dry tons, a discussion with NPT solid waste staff[19] indicated that material used in the weight analysis was weighed "as delivered" and is therefore considered as green tons.

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[16]BTU (British Thermal Unit) is a measure of relative heat value. One BTU represents the quantity of heat required to raise the temperature of one pound of water from 60° F to 61° F at a constant pressure of one atmosphere.
[17]Western Governors Association, Biomass Task Force Report, January 2006.
[18] *"WASTE STREAM ANALYSIS REVISION 1 FOR THE COUNTIES OF CLEARWATER, IDAHO, LEWIS, LATAH, AND NEZ PERCE,"* RIDOLFI, Inc., August 2007.
[19]John Wheaton, Environmental and Utilities Planner, Nez Perce Tribe.

Table 20. Estimated Annual Urban Wood Waste by County within the TSA (Idaho)

COUNTY	GREEN TONS PER YEAR WITHIN TSA	
	YARD WASTE	WOOD
Clearwater	284	299
Idaho	250	255
Latah	1,051	1,100
Lewis	434	450
Nez Perce	5,766	6,036
TOTALS	**7,785**	**8,141**

Interviews with Latah County Solid Waste personnel, Public Health officials, and local waste haulers indicate that even though the RIDOLFI study occurred in 2007, the basic conclusions and waste stream data are still statistically valid. Some minor fluctuations in annual waste tonnage may have occurred but not enough to invalidate the original (2007) findings.

Discussion with waste hauling contractors and inert landfill operations[20] revealed that only very minor volumes of urban wood waste are currently being recovered in the region. The tip fees (fees charged by landfills for the right to dispose or "tip" material) are fairly low, and much of the material with any value associated with demolition projects is currently being recovered by the contractors prior to deposition at local inert landfills or in on-site containers. Interviews with local waste haulers confirmed that little to no demand and the relatively low value of recovered urban wood waste are disincentives to the recovery of wood waste. Operators maintained that if there was sufficient demand and value, some volume of wood waste recovery was a possibility, but not under current market conditions.

The landfill most tributary to the TSA is located near Clarkston in Asotin County, Washington. Discussions with the landfill staff[21] indicate that the current recovery of wood waste suitable for feedstock is confined to tree trimmings, certain yard waste (shrub/brush) and clean pallet material. The landfill generates approximately 25 to 30 green tons per month and is processed and delivered to Clearwater Paper for use as boiler fuel. The landfill does not recover construction and demolition material, and most material from such projects arrives commingled with other material unsuited for feedstock use.

Even if significant efforts were expended to ramp up recovery and processing of construction and demolition material from the Asotin County landfill for use as suitable feedstock material, the nearby location and feedstock consumption (demand) requirements of Clearwater Paper would not allow diversion of such product to alternative markets. Clearwater Paper has a significant competitive advantage due to its location relative to the Clarkston landfill and its ability to pay competitive rates for biomass fuel.

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[20]Robert Simmons of Simmons Sanitation and Vern Snyder of Walco.
[21]Steve Becker, Asotin County Landfill Operations Manager.

There are some companies utilizing small volumes of green yard waste to generate soil amendment material for local markets, especially near Lewiston and Clarkston. Latah County also operates a program of combining recovered wood waste with suitable biosolids for compost. It is not reasonable to expect urban wood waste from Latah County to be available as feedstock given their current uses.

There are currently few efforts to recover wood waste from the MSW generated within the other four counties in north central Idaho outside of these operations. Though the volumes would be minor, the opportunity exists to work with local waste haulers and inert landfill operators to recover urban wood waste for prospective facilities at the four target locations within the Reservation.

The RIDOLFI study states that there are currently four inert landfills in the region, located in Weippe, Kamiah, Grangeville and Lewiston, but no MSW landfill. According to the study, the majority of the MSW is shipped to other landfills, some at extensive distances from the region. For some time there has been an effort coordinated by the Solid Waste Advisory Board contracting with Idaho Waste Systems to develop a MSW landfill in north central Idaho. The determination of an approved location has proven challenging, and siting issues may be the primary reason for a recent lack of forward progress.

TSS estimates that initially only 20% of the urban wood waste from the four counties would be available, as efforts to encourage recovery take time to implement. As recovery projects become established, available volume would increase as well to an estimated 65% after five years of program development. Assuming a mid-range volume would yield an estimated 5,850 green tons per year, and adjusting for 20% moisture content, 4,680 BDT would be yielded annually. In order to capture volume and value, the most appropriate business model is to work with existing waste haul contractors and inert landfill operators to incentivize separation and processing of suitable material.

Biomass from Municipal Solid Waste

As mentioned above, the NPT commissioned RIDOLFI, Inc. to conduct a waste stream analysis of the MSW from the counties of Clearwater, Idaho, Latah, Lewis and Nez Perce.[22] Un-recycled MSW within the five county north central Idaho region is currently transported to landfills located throughout the Pacific Northwest and Inland Empire. Table 21 shows the results of the RIDOLFI study for estimated volume of MSW by county for the five counties in north central Idaho within the TSA. The counties within the TSA in Washington were not included in the RIDOLFI study, and it is assumed any MSW would be disposed of in the Whitman or Asotin County landfills, or other regional landfills.

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[22] *"WASTE STREAM ANALYSIS REVISION 1 FOR THE COUNTIES OF CLEARWATER, IDAHO, LEWIS, LATAH, AND NEZ PERCE,"* RIDOLFI, Inc., August 2007.

Table 21. MSW Tons by Waste Category by County

MSW TYPE		MSW TONS BY COUNTY					
		CLEARWATER	IDAHO	LATAH	LEWIS	NEZ PERCE	TOTALS
PAPER	Cardboard/Kraft	760	1,680	3,330	400	5,490	11,660
	Newspaper/Magazine	490	1,070	2,128	260	3,510	7,458
	High Grade	150	320	640	80	1,060	2,250
	Low Grade	270	600	1,194	140	1,970	4,174
	Non-recyclable	220	480	956	120	1,580	3,356
PLASTIC	Plastic Containers	80	180	362	40	600	1,262
	Film Plastic	160	350	704	90	1,160	2,464
	Other Plastic	210	450	897	110	1,480	3,147
ORGANICS	Food/Grease	840	1,800	3,652	440	6,020	12,752
	Yard Waste	980	2,200	4,273	520	7,050	15,023
	Wood	1,030	2,250	4,473	540	7,380	15,673
	Carpet	90	200	393	50	650	1,383
	Textiles	80	180	360	40	590	1,250
	Vehicle Tires	90	190	372	50	610	1,312
GLASS	Container Glass	220	490	975	120	1,610	3,415
	Other Glass	40	100	191	20	300	651
METAL	Electronics	60	140	273	30	450	953
	Scrap Metal	710	1,550	3,076	370	5,070	10,776
INORGANICS	Asphalt Roofing	200	440	869	110	1,430	3,049
	Gypsum	230	500	992	120	1,640	3,482
	Other Inorganics	1,150	2,530	5,022	610	8,280	17,592
TOTALS		**8,060**	**17,700**	**35,132**	**4,260**	**57,930**	**123,082**

Wood waste and yard waste are included in Table 21 because if waste incineration is employed, it is unlikely this material would be recovered and diverted to a wood biomass combustion facility. The majority of the volumes of MSW are in Latah and Nez Perce counties at nearly 76% of the total. In Nez Perce County, the data from the RIDOLFI study indicates that 47,423 tons or nearly 39% of total MSW is generated in Lewiston alone.

Table 22 shows the MSW gross volumes from Table 21 adjusted to reflect the percentage of the prospective county population within the TSA, as population is the primary driver of MSW generation.

Table 22. MSW Tons by Waste Category by County Within the TSA

MSW TYPE		MSW TONS BY COUNTY					
		CLEARWATER	IDAHO	LATAH	LEWIS	NEZ PERCE	TOTALS
PAPER	Cardboard/Kraft	576	1,375	223	400	5,490	**8,064**
	Newspaper/Magazine	371	875	143	260	3,510	**5,159**
	High Grade	114	262	43	80	1,060	**1,558**
	Low Grade	205	491	80	140	1,970	**2,886**
	Non-recyclable	167	393	64	120	1,580	**2,323**
PLASTIC	Plastic Containers	61	147	24	40	600	**872**
	Film Plastic	121	286	47	90	1,160	**1,705**
	Other Plastic	159	368	60	110	1,480	**2,177**
ORGANICS	Food/Grease	637	1,473	245	440	6,020	**8,814**
	Yard Waste	743	1,800	286	520	7,050	**10,399**
	Wood	781	1,841	300	540	7,380	**10,841**
	Carpet	68	164	26	50	650	**958**
	Textiles	61	147	24	40	590	**862**
	Vehicle Tires	68	155	25	50	610	**909**
GLASS	Container Glass	167	401	65	120	1,610	**2,363**
	Other Glass	30	82	13	20	300	**445**
METAL	Electronics	45	115	18	30	450	**658**
	Scrap Metal	538	1,268	206	370	5,070	**7,452**
INORGANICS	Asphalt Roofing	152	360	58	110	1,430	**2,110**
	Gypsum	174	409	66	120	1,640	**2,410**
	Other Inorganics	872	2,070	336	610	8,280	**12,168**
TOTALS		**6,109**	**14,482**	**2,354**	**4,258**	**57,930**	**85,133**

It is important to note that the estimated volumes in Table 22 reflect total MSW production within the TSA. Without sufficient incentive, some portion of this MSW may not be diverted to alternative locations (such as an MSW to energy facility). Discussions with solid waste representatives from public agencies and private enterprise indicate a range of tip fees for deposition of MSW from $19 to $75 per ton within the region. MSW transport costs range from $9.50 to $17 per ton, depending upon travel time, road condition, etc.

Discussion with representatives of Idaho Waste Systems[23] indicate that the company still has interest in developing a landfill in the region. The current location under consideration is on Camas Prairie. Idaho Waste Systems indicated they will have a final decision on pursuing further development by mid-2012. One private waste collection enterprise was contacted to discuss diversion of their material to the proposed landfill but indicated that at the offered tip fees (between $20 to $25 per ton), they would not change current disposal locations.

MSW is disposed of through high temperature incineration to generate energy in a few facilities located throughout the U.S., with most located along the east coast (where landfill disposal costs are very high). The City of Spokane owns an MSW to energy facility operated by Wheelabrator, a subsidiary of Waste Management. This facility services an estimated 430,000 ratepayers, consuming approximately 720 tons per day, operating 365 days per year.[24] The plant capacity is 800 tons per day. The estimated tip fees in 2010 at the facility in Spokane ranged from $110 to $120 per ton.[25] In addition, Covanta Energy owns and operates a similar facility located in Marion County, Oregon. This facility consumes an estimated 550 tons per day. Tip fees for this solid waste incineration facility are currently approximately $60 per ton. The MSW volume and tip fees necessary to achieve "break-even" financial status for such facilities, as estimated by engineers working on such projects, are 900 tons per day charging $82 per ton.[26] The appropriate operating balance is increasing tip fees as volume declines.

Both facilities can utilize the vast majority of MSW; however, they each screen out some material, such as gypsum, tires, and large appliances if the technician overseeing conveyance can retrieve such material effectively. Small-scale MSW may require some material sorting. Such an operation may require mechanical sorting capability, employing shakers, magnets and an elevated belt system allowing MSW to move through hand-sorting personnel stations.

Although solid waste incineration to generate energy is employed in some facilities in the U.S. (including the facilities mentioned above), this technology is fairly expensive. In addition, efficiencies are generated with economies of scale unsuited to the small volumes of MSW typically developed in portions of the rural western U.S. (like the TSA). As noted above, the data from the RIDOLFI study indicated all MSW from the entire five county area was an estimated 123,082 or 337 green tons per day. TSS is unaware of any community scale waste incineration to energy facilities currently operating in the U.S.

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[23]Discussion with Randy Avery, owner, Idaho Waste Systems.
[24]Spokane Waste to Energy website: http://spokanewastetoenergy.com/WastetoEnergy.htm
[25]Interview with former facility manager.
[26]Discussions with plant operations managers.

Target Location Analysis

In order to assess potentially and practically available woody biomass volume from the various feedstock alternatives within a 20-mile supply area of Lapwai, Orofino, Kamiah and Kooskia, it is necessary to forecast prospective resources into these supply areas. For this assessment, Kamiah and Kooskia were combined to form a single supply area since they are located only eight miles apart, and their individual supply areas would overlap significantly.

Thus, there are three distinct supply areas, with some overlap occurring between the Lapwai and Orofino supply areas as well as between Orofino and the Kamiah-Kooskia supply areas. A GIS analysis was employed to determine the estimates of agricultural cover within each supply area and the overlap area and to determine the estimates of forest cover by ownership within each. This analysis assumes forest and agricultural operations are evenly spread throughout the ownerships or areas, applying feedstock recovery volumes based upon the percentage area within each supply area.

Subsequently, the feedstock resources located within the overlap were analyzed as above, applying 50% of the feedstock resources within the overlap to each supply area. Table 23 shows the allocation of the various feedstock volumes by the three target location supply areas.

Table 23. Practically Available Biomass Volumes by Target Location TSA and Feedstock Source

TARGET LOCATIONS	BIOMASS FROM FOREST OPERATIONS (BDT/YEAR)	BIOMASS FROM URBAN WOOD WASTE (BDT/YEAR)	BIOMASS FROM WHEAT STRAW (BDT/YEAR)
Lapwai 20-Mile TSA	7,468	800	161,524
Orofino 20-Mile TSA	30,421	1,500	54,803
Kamiah-Kooskia 20-Mile TSA	33,989	2,400	94,253
TOTALS	**71,878**	**4,700**	**310,580**

The volumes for urban wood waste were distributed based upon population estimated within each target location TSA. The town of Lewiston and towns within Latah County were not included in the urban wood analysis. These towns have existing infrastructure and demand in place to recover and utilize such material. For this assessment, it was determined that these locations would not be viable sources of supply.

Estimated Costs: Collection, Processing and Transport

TSS has assessed the full expense of collection, processing and transport of biomass feedstocks from within the TSA to better understand the cost of biomass delivered to a prospective biomass utilization facility located at Lapwai, Orofino or Kamiah/Kooskia. The estimated costs were generated as a result of interviews with biomass fuel processing contractors, landowners or land managers, and timber harvesting contractors operating in north central Idaho. The most significant variables impacting cost of processing and delivering biomass material include:

- Haul distance to market;
- Timber harvest residual pile distribution;
- Biomass material volume per acre;
- Access/road condition;
- Cost of diesel;
- Cost of labor;
- Road improvement and maintenance costs;
- Time of year delivery;
- Competing uses for the biomass material (e.g., pulp wood).

Outlined in Table 24 is the range of collection, processing and transportation costs for each feedstock type. These costs are associated with feedstock delivery from within each target location 20-mile TSA and assume a maximum transport distance of 40 miles and a minimum transport distance of 10 miles.

Table 24. Collection, Processing and Transport Costs by Feedstock Type

FEEDSTOCK SOURCE	PROCESSING COSTS $/BDT		TRANSPORT COST $/BDT		DELIVERED COST $/BDT	
	LOW RANGE	HIGH RANGE	LOW RANGE	HIGH RANGE	LOW RANGE	HIGH RANGE
Forest Operations	$17.50	$35.00	$10.20	$23.80	$27.70	$58.80
Urban Wood	$12.00	$16.00	$8.90	$17.00	$20.90	$33.00
Wheat Straw	$32.50	$37.50	$12.00	$24.00	$44.50	$61.50

Current and Prospective Feedstock Competition

Clearwater Paper is currently the most significant purchaser of biomass feedstocks in the region. There are occasions when Clearwater Paper utilizes woody biomass material from forest operations, especially those operations located near Orofino. Thus far, Clearwater Paper has not sourced woody biomass from forest operations from within the southeast portion of the TSA. Feedstock from forest operations in the Lapwai 20-mile TSA and in the north portion of the Orofino 20-mile TSA are at risk to competition from Clearwater Paper.

In addition, Clearwater County is currently considering development of a CHP biomass plant in Orofino. A July 2011 study completed for the county[27] recommended siting a small-scale CHP facility at the Idaho Correctional Institute at Orofino. The report offered recommendations for two alternatives: a CHP utilizing an estimated 20 green tons of woody biomass per day

[27] *"Clearwater County Biomass Energy Report,"* Tetra Tech.

producing 1 megawatt (MW)[28] of electricity; a CHP utilizing an estimated 40 green tons of woody biomass per day producing 2 MW of electricity. Assuming annual operating capacity of 85% (7,446 hours) would require feedstock volumes of from 4,000 BDT at 1 MW to 8,000 BDT at 2 MW (assuming biomass feedstock with 40% moisture content). In TSS' experience, the estimates for feedstock usage for 1 MW of power are typically between 6,000 and 9,000 BDT/year (the Tetra Tech fuel usage estimate appears to be low), indicating total fuel consumption for a CHP scaled at 1 to 2 MW at between 6,000 and 18,000 BDT per year.

The Federal Energy Management Program (FEMP) recently completed a study[29] for developing a biomass fueled thermal energy heating system for the Idaho Correctional Facility in Orofino. The study estimated the woody biomass fuel volume requirements at 769 BDT/year, sourced from wood product manufacturing byproduct or from forest operations.

The impact of Clearwater Paper's current feedstock requirements coupled with the prospect of development of a CHP facility in Orofino with feedstock volume requirements of as much as 18,000 BDT per year substantively impact woody biomass availability from within the Lapwai and Orofino 20-mile TSAs. A review of the data in Table 23 indicates that the Lapwai 20-mile supply area currently has nearly 7,500 BDT/year of biomass feedstock available, and the Orofino 20-mile supply area has nearly 29,700 BDT of available woody biomass from forest operations. Assuming the NPT elects to recover and retain biomass volume from NPT forestry operations would still place 7,100 BDT and 29,400 BDT from Lapwai and Orofino 20-mile supply areas, respectively, at risk to competition.

The worst case scenario assumes the Orofino CHP plant is fully developed at 2 MW, requiring 18,000 BDT per year, primarily from within the Orofino 20-mile supply area, and Clearwater Paper continues to procure fuel from forest operations in the same area. This could effectively render net practical volume to a range from 0 to 3,000 BDT/year from forest operations. An alternative scenario assumes the thermal energy plant is fully developed, requiring 796 BDT per year, hardly impacting current supplies from forest operations.

The impact assumed for this assessment is that Clearwater Paper continues to procure woody biomass fuel from forest operations within both the Lapwai and Orofino 20-mile supply areas estimated to be 33% of the practically available volume from Table 23. In addition, a 1 MW CHP is fully developed utilizing an estimated 8,000 BDT per year, also from forest operations. The impact of the competition under this scenario is shown in Table 25.

[28] One megawatt (MW) is a measure of electrical output and equals 1,000 kilowatts. This is enough generation to support approximately 1,000 households.
[29] *"Preliminary Feasibility Assessment Proposed Biomass Facility,"* National Energy Technology Laboratory, March 2011.

Table 25. Net Available Biomass Feedstock Volumes

TARGET LOCATIONS	BIOMASS FROM FOREST OPERATIONS (BDT/YR)	BIOMASS FROM URBAN WOOD WASTE (BDT/YR)	BIOMASS FROM WHEAT STRAW (BDT/YR)	TOTAL BIOMASS (BDT/YR)
Lapwai 20-Mile TSA	4,400	800	161,500	**166,700**
Orofino 20-Mile TSA	12,100	1,500	54,800	**68,400**
Kamiah-Kooskia 20-Mile TSA	34,000	2,400	94,300	**130,700**
TOTALS	**50,500**	**4,700**	**310,600**	**365,800**

Obviously wheat straw is not impacted by competition, but only through its retention needs for some agricultural operators for nutrient augmentation and soil erosion prevention. Wheat straw clearly represents an opportunity feedstock with little to no active competition in the marketplace. The downside is the relatively high delivered cost of wheat straw ($44.50 to $61.50/BDT) and the need to stockpile large quantities using covered storage. In addition, there are few commercially-proven technologies that can utilize wheat straw in a CHP application.

It is important to note that the other feedstock volumes, including forest product manufacturing byproduct, have been substantively impacted by the recent economic downturn. As the overall economy improves and the construction sector rebounds, woody biomass volumes from forest operations, urban wood waste, and wood product manufacturing can be expected to increase.

SITE REVIEW

The Site Review section provides an analysis of potential sites on the Nez Perce Reservation where a biomass waste fueled utilization facility, such as a community scale CHP facility, could be installed and operated.

Site Review Attributes

A site review of potential locations for establishment of a community scale CHP using biomass waste resources on NPT land within the Nez Perce Reservation was conducted for this task. Community scale is considered to be a biomass waste energy facility in the 1 to 3 MW power output range which could service the local community in which it is located with either electricity or heat, or both. A community scale facility allows for use of local and regional indigenous biomass waste resources, such as forest harvest residuals or agricultural crop residues, at a scale that is both suitable for the community and economically available.

The following site attributes were considered:

- Land Use Zoning;
- Transportation, Routes, and Corridors;
- Public Health and Safety;
- Water Supply Resources and Wastewater Discharge;
- Geology/Soils;
- Cultural Resources;
- Power Transmission/Distribution Assets.

Target Sites

In consultation with NPT staff, four locations were initially considered in this site review. These were:

- **Lapwai** - The community of Lapwai serves as the government center of the Nez Perce Tribe and has several tribal buildings, school facilities, and health clinics in close proximity of each other. The potential site is located just west of the tribal government center.

- **Orofino** - The Orofino site is located on the Clearwater River one mile south of the town of Orofino on U.S. Highway 12. It previously served as an active sawmill site.

- **Kamiah** - The potential site is located in the middle of the community of Kamiah, on U.S. Highway 12.

- **Kooskia** - The potential site is located along the Clearwater River, on the southwest quarter of the intersection of U.S. Highway 12 and Idaho State Highway 13.

Two additional sites were also examined as holding potential for siting a biomass waste CHP facility as well. These sites included was the Nez Perce Tribe-owned Clearwater River Casino and Hotel, located on U.S. Highways 12 and 95 on the western edge of the Nez Perce Reservation (approximately 5 miles east of Lewiston), and at the Lapwai Wastewater Treatment Plant (WWTP), located approximately 2 miles north of the town of Lapwai on U.S. Highway 95.

TSS visited five of the six sites with Nez Perce staff.[30] The potential sites for the biomass waste energy facility were viewed, as well as the surrounding environment. Attention was paid to the potential for use of waste heat from an electrical generating facility, which could enhance the economic viability of the overall biomass waste energy facility (to be further examined in the Technology Selection and Financial Analysis section). The sixth site (Lapwai WWTP) was reviewed via aerial and site photos, and through discussions with Nez Perce staff.

It should be noted that the siting of the biomass waste facility itself, as required by the funding agent for this feasibility study (U.S. Department of Interior), must be on NPT-owned land (Tribal

[30]Jon Paisano, Energy Technician, Nez Perce Tribe.

Trust land) within the Nez Perce Reservation. All of the biomass waste facility sites examined conform to this requirement.

Figure 6 shows the locations of the potential sites and the Clearwater River Casino.

Figure 6. Location of Nez Perce Sites Reviewed

Project Attributes

The site review is predicated on siting of a community scale biomass waste power plant of 1 to 3 MW in size. The biomass waste fuel may consist of woody biomass waste, sourced from the forest or urban sources, and wheat straw from local and regional sources. Given the fact that the biomass waste resources may not be available year round (due to inclement winter weather conditions), there will be a need for onsite storage of biomass fuel. Based on resource assessment findings, if only woody biomass waste is utilized, three months of storage will be required and six months of storage if wheat straw is utilized.

Three months of woody biomass waste storage, with compacted storage piles not exceeding 20 feet in height, would require approximately 1.1 acres for a 3 MW facility. Adding space for access to the fuel may increase this to 1.5 acres. For six months of wheat straw, at least 2.3 acres would be necessary for fuel storage but could easily be more, as the wheat straw may need to be baled and wrapped in plastic so as not to degrade. This could potentially result in a wheat straw fuel yard of 4+ acres.

There will also need to be adequate space for the biomass waste power plant itself. Depending on the technology ultimately selected, a 3 MW power plant with support equipment--such as grinders (for wheat straw) and driers (for high moisture content forest sourced woody biomass waste)--could take up to 1 acre.

Using the above metrics, a 3 MW biomass waste energy facility could require up to 5 acres (an area approximately 490 feet by 490 feet square). Conversely, a 1 MW facility, using only woody biomass waste fuel, could be as small as 1.5 acres (an area approximately 250 feet by 250 feet square).

Some CHP technologies require water. Direct-fired combustion, with its steam cycle turbine, requires about 10 gallons per minute (gpm) of supply and can discharge 5 to 7 gpm. Thus, ample supply and discharge capacity must be available; otherwise, it needs to be developed on site. This generally means a water supply well with ample yield (30 gpm+) and a wastewater disposal pond of at least 2 acres for a 3 MW facility. Gasification systems, on the other hand, require or discharge little, if any, water.

Site Review

Lapwai Site

Lapwai is the seat of government for the NPT and has a population of 1,137 (2010 Census) with approximately 360 residences. As the seat of government, there are numerous Nez Perce government and community buildings within Lapwai, located principally in the southern half of the community. Building complexes, including a high school, elementary school, health clinics, community center, NPT offices, and NPT police headquarters, are all situated in the southern half of Lapwai.

The potential Lapwai energy site is located directly adjacent to the southwestern edge of the community as shown in Figure 7. This site allows relatively close access to the various Nez Perce government and community buildings, which may lead to a CHP potential (see Figure 7). An energy facility would be located outside the inhabited portion of Lapwai on a bluff overlooking the community (see Figure 8). Road access to the potential site will need to be developed.

Land Use Zoning

The NPT currently does not have any zoning or land use ordinances for NPT owned land. Potential use of NPT land is under jurisdiction of the Nez Perce Land Commission and the Tribal Council. No specific restrictions currently exist at the potential Lapwai site for a biomass waste energy facility.

The current specific land use appears to be grazing land. There is a large water tank at the site, which is used for municipal water supply to Lapwai. To the south of the site, approximately 700 to 800 feet, is a single-family residential development (Sundown Heights Subdivision). To the east, beginning at about 300 feet, is the community of Lapwai, with mixed residential and institutional buildings. To the north and west are open fields, used primarily for agricultural purposes.

The potential site appears to have enough developable area for the 3 MW size facility. However, over 2 MW of this capacity may have to come from wheat straw as the primary biomass waste fuel, based on results of the resource assessment study conducted by TSS.

Transportation, Routes, and Corridors

The community of Lapwai is accessed primarily via U.S. Highway 95, an all-weather highway, which is the major north/south route of western Idaho. Lapwai is approximately 15 miles from the more major metropolitan center of Lewiston (ID)/Clarkston (WA). Biomass waste fuel can be easily transported on this highway from all areas within, and outside, the Nez Perce Reservation.

Access to the potential biomass waste energy facility from Highway 95 could be from two different points. Access from the southeast could be from Agency Drive. Access from the northeast could be from Agency Street (connection to Highway 95) to Bever Canyon Road. From either of these roads, direct access to the biomass waste facility would need to be constructed to provide access to biomass waste fuel delivery trucks.

Figure 7. Lapwai Site

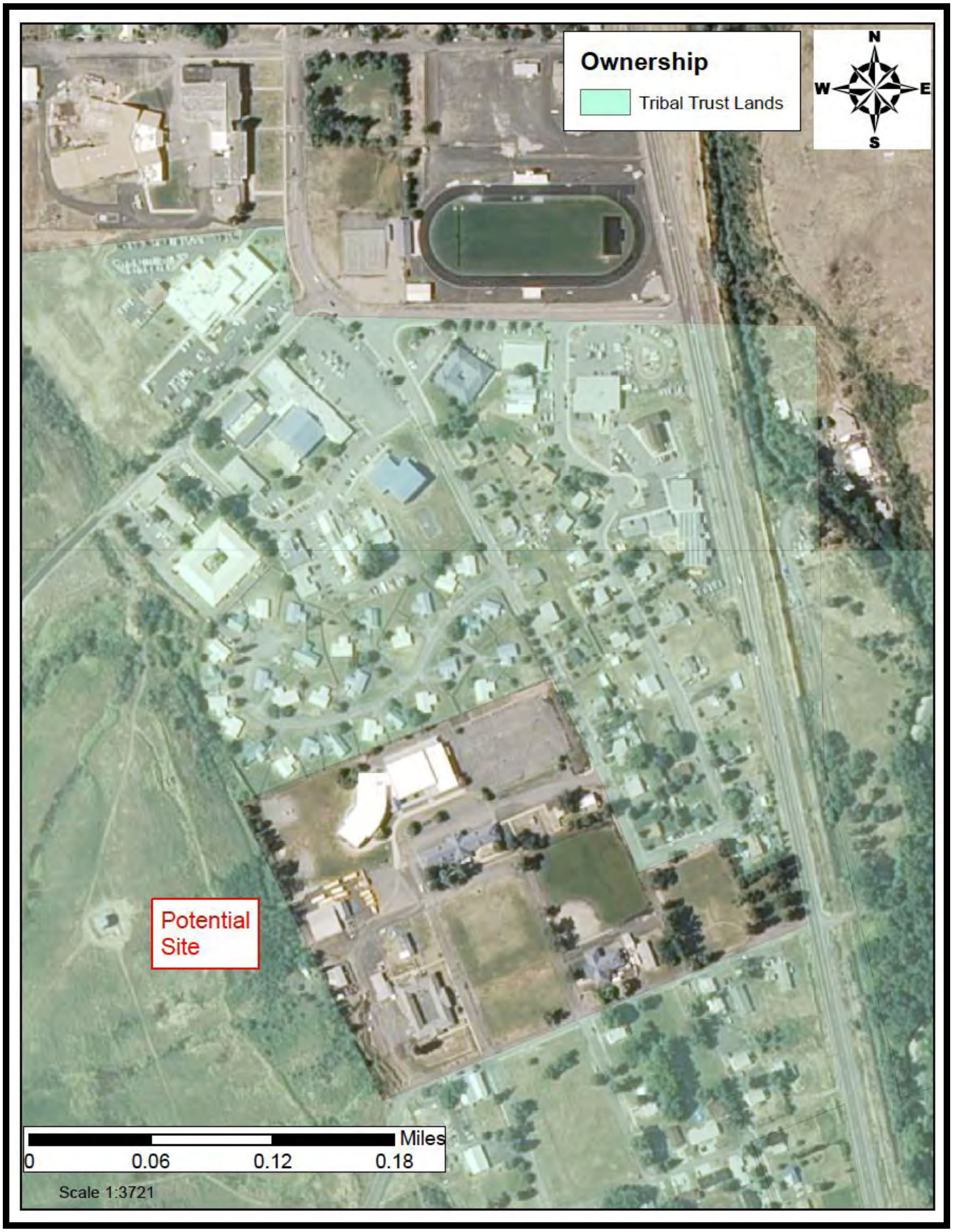


Figure 8. Potential Biomass Waste Facility Location Overlooking the Nez Perce Tribal Offices Area

A community scale biomass waste energy facility at the Lapwai site of 1 to 3 MW could utilize up to 27,000 bone dry tons of biomass waste fuel materials per year.[31] Assuming a biomass waste delivery truck can carry about 14 BDT per load, this calculates to about 1,928 trucks per year accessing the potential plant site. If deliveries occurred six days a week, this would equate to an average of six delivery trucks per day. However, deliveries may not be spaced out evenly over the course of a year and there could be extended periods when no deliveries take place. Thus, truck deliveries would be higher during the spring, summer, and fall months, and storage of biomass waste fuel will be necessary at the potential biomass waste energy facility site.

Public Health and Safety

Public health and safety issues at the potential Lapwai site center around delivery truck traffic and the potential for air quality degradation (due to air emissions from the facility). Fuel deliveries to the potential site will require access by driving through the southern half of the Lapwai community. Two access roads have been identified above the community linking the Lapwai site with Highway 95 (Highway 95 does have a center turning-only lane at both access

[31]This assumes, based on TSS' experience, that a biomass waste energy facility uses between 6,000 to 9,000 BDT of biomass waste fuel per MW per year, depending upon the conversion technology chosen.

roads). The southern access will direct delivery trucks through an area with an elementary school, day care center, and the entryway into the Sundown Heights Subdivision. The northern access will pass by several NPT offices and the Nimiipuu Health Clinic.

Given the potential sensitivity of these access routes to commercial truck traffic, a traffic safety plan must be developed to address public safety concerns before project development commences.

Regarding any potential air quality degradation, such as particulate matter, it is expected that the CHP facility will be equipped with robust particulate matter emissions control systems. Such systems, including a baghouse or electrostatic precipitator for direct-fired combustion systems, can control particulate matter emissions up to 99.9%.

Water Supply Resources and Wastewater Discharge

There is a municipal water supply available in Lapwai, as well as wastewater discharge. Pretreatment of direct-fired combustion wastewater will be necessary prior to discharge to the municipal water system.

Geology/Soils

According to the federal Natural Resources Conservation Service soil survey, the potential site soils are Uhlig silt loam, on topography with 8 to 20 percent slopes. The parent material is mixed alluvium.

The Miocene basalts of the Columbia River basalts underlie the Lapwai site, like nearly all of Nez Perce County. There is an unnamed earthquake fault just north of Lapwai, with additional east-west trending earthquake faults to the north (the Viste Fault - approximately 5 miles) and to the south (the Lime Kiln fault - approximately 7 miles). Design and construction of the biomass CHP facility and any accompanying structures and equipment should take into account the potential for seismic activity conditions.

Cultural Resources

The Lapwai site, like all of the sites reviewed, has the potential for the presence of cultural resources. Thus this site, as well as the others, are subject to the Nez Perce cultural/archaeological resources process. In summary, this process involves:[32]

- Detailed investigation of the proposed site to determine type and extent of the cultural/archaeological resources;
- Determination of the boundaries of the resources at the proposed site;
- Determination of resources adjacent to, or near, the proposed site that could potentially be impacted by the proposed project;

[32]Per personal communication between Patrick Baird, Nez Perce Cultural Resources, and Frederick Tornatore, TSS Consultants, December 13, 2011.

- Development of measures and/or re-siting of the proposed project to avoid impact to the resources;
- Visual impact of the proposed project to the surrounding view shed.

The Nez Perce Cultural Resources office indicated that the Lapwai site may have potential cultural resources. As the site is on the bluff overlooking Lapwai, it will be very visible to the community of Lapwai and those traveling along Highway 95.

Power Transmission/Distribution Assets

The Lapwai site is within the Avista Corporation electrical transmission and distribution territory. In discussions with an Avista representative,[33] it was determined that the electrical distribution system in the Lapwai area does have capacity to accommodate power generation from a 1 to 3 MW facility. However, a tie line would have to be constructed for at least several hundred feet in order to connect to existing electrical distribution lines.

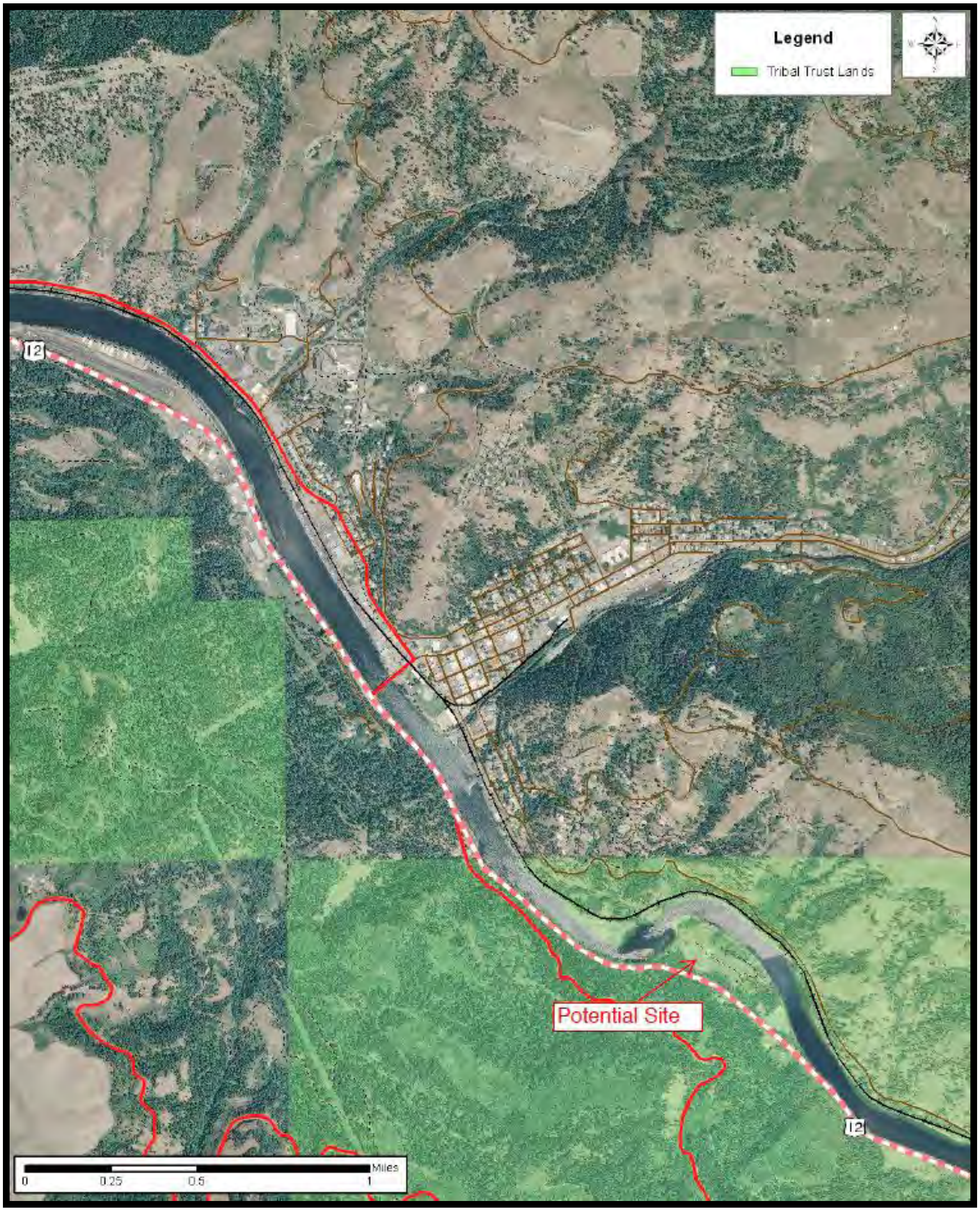
The 1 to 3 MW size of the proposed CHP facility would also require the owner of the facility to participate in Avista's interconnection process. The interconnection process requires, a renewable energy facility between 300 KW (0.3 MW) and 20 MW, must agree to Avista conducting a Feasibility Study, System Impact Study, and a Facilities Study prior to the formal adoption of an Interconnection Agreement.

<u>Orofino Site</u>

The Orofino site is located approximately 1 mile south of the downtown district of Orofino in Clearwater County (see Figure 9). Orofino has a total population of 3,142 residents (per the 2010 census). The potential site is located at the former site of a sawmill (which has subsequently been removed in its entirety) between U.S. Highway 12 and the Clearwater River and is across the river from the downtown district. This is the closest Tribal Trust land to Orofino that could be developed into a CHP facility.

[33]Personal communication between Jon Paisano, Nez Perce Tribe, and Kelly Magee, Avista Corporation, on November 30, 2011.

Figure 9. Orofino Site



Land Use Zoning

The NPT currently does not have any zoning or land use ordinances for NPT owned land. Potential use of NPT land is under jurisdiction of the Nez Perce Land Commission and the Tribal Council. No specific restrictions currently exist at the potential Orofino site for a CHP facility.

The site is currently not being used, except that during the site visit, a mobile fireworks stand was operating on the property (Figure 10). To the south of the potential facility are some NPT offices, with a few single-family residences across Highway 12. To the west, across Highway 12, is a steeply rising forested hillside. The east and north side of the site is bounded by the Clearwater River.

The potential site appears to have enough developable area for the 3 MW size facility.

Figure 10. Orofino Site - Former Sawmill Location

Transportation, Routes, and Corridors

The site is accessed primarily via U.S. Highway 12, an east-west route connecting Lewiston to Missoula, MT. The site is approximately 45 miles from the metropolitan center of Lewiston/Clarkston. Biomass waste fuel can be easily transported to the Orofino site from all areas within, and outside, the Nez Perce Reservation.

Access to the potential facility from Highway 12 is very direct, via an existing driveway in the northern portion of the site.

A community-scale CHP facility at the Orofino site in the range of 1 to 3 MW could use up to 27,000 bone dry tons of biomass waste fuel material per year. Assuming a biomass waste delivery truck can carry about 14 BDT per load, this calculates to about 1,928 trucks per year accessing the potential plant site. If deliveries occurred six days a week, this would equate to an average of six delivery trucks per day. However, deliveries may not be spaced out evenly over the course of a year and there could be extended periods when no deliveries take place. Thus, truck deliveries would be higher during the spring, summer, and fall months and storage of biomass waste fuel will be necessary at the potential biomass waste energy facility site.

Public Health and Safety

Public health and safety issues at the potential Orofino site center around delivery truck traffic and the potential for air quality degradation (due to air emissions from the facility).

In order to access the potential facility site, biomass fuel delivery trucks will have to enter the site by turning off of Highway 12 into the site. There are no deceleration lanes or turning lanes on the portion of Highway 12 that runs past the Orofino site.

Regarding any potential air quality degradation, such as particulate matter, it is expected that the CHP plant will be equipped with robust particulate matter emissions control systems. Such systems, including a baghouse or electrostatic precipitator for direct-fired combustion systems, can control particulate matter emissions up to 99.9%.

Water Supply Resources and Wastewater Discharge

The Orofino site is not connected to the municipal water system in Orofino; thus, water supply here will require a supply well. Given the nearby location of the Clearwater River, a water supply well at the site should be adequate. A wastewater discharge pond will be necessary. There should be room for a discharge pond to support up to a 3 MW system.

Geology/Soils

According to the federal Natural Resources Conservation Service soil survey, the potential site soils are Oxyaquic Xerofluvents-Itzee complex on topography with zero to five percent slopes. The parent material is mixed alluvium.

The Miocene basalts of the Columbia River basalts underlie the Orofino site. There is an unnamed earthquake fault, which appears to trend northwest/southeast under or nearly under the site. Design and construction of the CHP plant and any accompanying structures and equipment should take into account the potential for seismic activity conditions.

Cultural Resources

The Orofino site area has previously been investigated by the Nez Perce Cultural Resources office. The site where the sawmill was located has a hardened surface (packed gravel and soil), which may protect any subsurface cultural resources. However, much of the area of the proposed project is fuel yard, and construction of the fuel yard would not have to breach this hardened surface. This site may have some of the least potential impacts on cultural resources of the five candidate sites.

Power Transmission/Distribution Assets

The Orofino site is within the Avista Corporation electrical transmission and distribution territory. In discussions with the Avista representative, it was determined that an electrical distribution system adjacent to the potential Orofino site area does have capacity to accommodate power generation from a 1 MW facility. An increase to 2 or 3 MW would be questionable and would require additional detailed analysis. Electrical distribution lines are immediately adjacent to the Orofino site. The 1 to 3 MW size of the potential Orofino facility would require the more extensive Avista interconnection review process.

Kamiah Site

The Kamiah site is located approximately 21 miles south of the Orofino site on Highway 12 in the downtown area of Kamiah. Kamiah has a total population of 1,295 residents (per the 2010 census). Tribal trust property is limited to a four square block of land, which contains three NPT community facilities: the Kamiah Nimiipuu Health Clinic, Early Childhood Development (ECDP), and the Wa-A-‘Yas Community Center. There is also a fourth building of the NPT enterprise, It’se-Ye-Ye Bingo and Casino, located in the northwest portion of the four-block area.

The southeastern quadrant of the tribal trust land in Kamiah is currently an open grass field approximately 300 feet square or about two acres (see Figure 11). This area is occasionally used for NPT activities, most notably the Annual Chief Lookingglass Powwow, held the third weekend of August.

Figure 11. Kamiah Site

Figure 12. Potential Kamiah Site, Looking Northwest Towards the Nimiipuu Health Clinic

Land Use Zoning

The NPT currently does not have any zoning or land use ordinances for NPT owned land. Potential use of NPT land is under jurisdiction of the Nez Perce Land Commission and the Tribal Council. No specific restrictions currently exist at the potential Kamiah site for a CHP facility. However, the potential site is in a populated area with non-tribal single-family residential dwellings directly across the street on the southern boundary of the site.

The potential site currently does not have any structures on it. To the north and west are the NPT community structures previously mentioned. To the east is an open field and residence, with an operating sawmill (Empire Lumber) approximately 1,500 feet distant. To the south are the aforementioned residential units, across 5th Street.

The open grass area of the site is approximately two acres in size. Using the metrics discussed above for the CHP facility and accompanying fuel yard, the site is sized to support a 1 MW facility.

Transportation, Routes, and Corridors

The Kamiah site is just off U.S. Highway 12, an east-west route connecting Lewiston to Missoula. The site is approximately 65 miles from the metropolitan center of Lewiston/Clarkston. Biomass waste fuel can be transported on this highway from all areas within, and outside, the Nez Perce Reservation.

Access to the potential CHP facility from Highway 12 would have to be via the commercial/residential streets of Idaho Street (southbound from Highway 12) to 5th Street (eastbound from Idaho Street).

A community scale CHP facility at the Kamiah site in the range of 1 MW could use up to 9,000 BDT of biomass waste fuel materials per year. Assuming a biomass waste delivery truck can carry about 14 BDT per load, this calculates to about 643 trucks per year accessing the potential plant site. If deliveries occurred six days a week, this would equate to an average of three delivery trucks per day. However, deliveries may not be spaced out evenly over the course of a year and there could be extended periods when no deliveries take place. Thus, truck deliveries would be higher during the spring, summer, and fall months and storage of biomass waste fuel will be necessary at the potential CHP facility site.

Public Health and Safety

Public health and safety issues at the potential Kamiah site center around delivery truck traffic and the potential for air quality degradation (due to air emissions from the facility).

As mentioned above, in order to deliver biomass fuel to the potential Kamiah CHP facility site, biomass waste fuel delivery trucks will have to access the site by turning south off Highway 12 and onto Idaho and 5th Streets, both commercial/residential streets. The delivery trucks would have to drive by the Wa-A-'Yas Community Center as they turn east onto 5th Street. Single-family residential homes are concentrated along the south side of 5th Street. It may be possible to construct an access road from Highway 12 directly to the site along the eastern edge of the NPT property where the Kamiah Nimiipuu Health Clinic building is located.

Given the potential sensitivity of these access routes to large truck traffic, a traffic plan must be developed to mitigate public safety concerns before project development commences.

Regarding any potential air quality degradation, such as particulate matter, it is expected that the CHP plant will be equipped with robust particulate matter emissions control systems. Such systems, including a baghouse or electrostatic precipitator for direct-fired combustion systems, can control particulate matter emissions up to 99.9%.

Water Supply Resources and Wastewater Discharge

The Kamiah site, being relatively small and only having about two useable acres, will need a water supply well and a wastewater pond if a direct-fired combustion unit is contemplated, as municipal services are not available for such a facility. With a potential wastewater discharge pond, the site may become even more unsuitable for a 1 MW biomass waste power plant and accompanying fuel yard due to its relatively smaller size.

Geology/Soils

According to the federal Natural Resources Conservation Service soil survey, the potential site soils are Uhlig silt loam on topography with two to eight percent slopes. The parent material is mixed alluvium.

The Miocene basalts of the Columbia River basalts underlie the Kamiah site. There is an unnamed earthquake fault about four miles east northeast of the Kamiah site.

Design and construction of the CHP plant and any accompanying structures and equipment should take into account the potential for seismic activity conditions.

Cultural Resources

The Kamiah site is considered to be culturally significant.[34] It is the site of the Annual Chief Lookingglass Powwow, a very significant Nez Perce cultural event. The proposed project, even at the 1 MW size (see above discussion) with the fuel storage yard, would likely take up the entire site. In addition, the CHP plant and fuel piles would have a large visual impact to Kamiah.

Power Transmission/Distribution Assets

The Kamiah site is within the Avista Corporation electrical transmission and distribution territory. In discussions with the Avista representative, it was determined that the electrical distribution system in the potential Kamiah site area has the capacity for a 3 MW facility. Electrical distribution lines are located very nearby the potential site.

Kooskia Site

The Kooskia site is located approximately seven miles south of the Kamiah site at the southwest corner of the intersection of U.S. Highway 12 and Idaho State Highway 13 (see Figure 13). Across the Clearwater River immediately to the southeast is the community of Kooskia with a population of 675 residents (per the 2000 census).

The tribal trust land at the Kooskia site is about eight acres in size and is currently an open grassy field. There is currently no use on the land other than a mobile fireworks stand. Part of the site is not in NPT ownership (an area next to Highway 13 just north of the bridge over the Clearwater River - see Figure 13).

[34] Per personal communication between Patrick Baird, Nez Perce Cultural Resources and Frederick Tornatore, TSS Consultants, December 13, 2011.

Land Use Zoning

The NPT currently does not have any zoning or land use ordinances for NPT owned land. Potential use of NPT land is under jurisdiction of the Nez Perce Land Commission and the Tribal Council. No specific restrictions currently exist at the potential Kooskia site for a CHP facility.

The potential site currently does not have any structures on it. Adjoining to part of the north edge of the property is an Idaho State Highway Rest Area. Across Highway 12 to the north is a steeply rising slope. To the east of the property, across Idaho State Highway 13, is what appears to be a vacant residence with adjacent grazing land. The southern and southwestern boundary of the site is the Clearwater River. Between the river and site are a sandbar and a flood channel. As mentioned previously, the community of Kooskia is located to the southeast across the river.

This eight-acre site has ample size for up to a 3 MW CHP plant and accompanying fuel yard.

Transportation, Routes, and Corridors

As mentioned earlier, the Kooskia site is at the intersection of U.S. Highway 12 and Idaho State Highway 13. The site is approximately 73 miles on Highway 12 from the metropolitan center of Lewiston/Clarkston. Biomass waste fuel can be transported on this highway and Highway 13 from all areas within, and outside, the Nez Perce Reservation.

Access to the potential CHP facility from Highway 12 would likely be a southbound turn onto Highway 13, and access via the eastern access to the Idaho State Highway Rest Area. A potential alternate could direct access off Highway 12 at the northern edge of the property west of the western access to the rest area.

Figure 13. Kooskia Site

Figure 14. Looking West onto the Potential Kooskia Site

A CHP facility at the Kooskia site of 1 to 3 MW could utilize up to 27,000 BDT of biomass waste fuel material per year. Assuming a biomass waste delivery truck can carry about 14 BDT per load, this calculates to about 1,928 trucks per year accessing the potential plant site. If deliveries occurred six days a week, this would equate to an average of six delivery trucks per day. However, deliveries may not be spaced out evenly over the course of a year and there could be extended periods when no deliveries take place. Thus, truck deliveries would be higher during the spring, summer, and fall months and storage of biomass waste fuel will be necessary at the potential biomass waste energy facility site.

Public Health and Safety

Public health and safety issues at the potential Kooskia site center around delivery truck traffic and the potential for air quality degradation (due to air emissions from the facility).

Fuel truck deliveries to the Kooskia site could access the site via Highway 13 or Highway 12. If from Highway 13, trucks would have to cross over the roadway exiting from the rest area and if coming south on Highway 13, this turn would require trucks to conduct a very tight left turn to access the site (while still crossing over the roadway exiting from the rest area). If the access were moved to the western portion of the site, ingress and egress would not be affected by the rest area exit. There are, however, no center turning lanes on Highway 12 at the west end of the potential site.

Regarding any potential air quality degradation, such as particulate matter, it is expected that the CHP plant will be equipped with robust particulate matter emissions control systems. Such systems, including a baghouse or electrostatic precipitator for direct-fired combustion systems, can control particulate matter emissions up to 99.9%.

Water Supply Resources and Wastewater Discharge

The Kooskia site does not have access to municipal services, so a water supply well and wastewater discharge pond would need to be constructed if a direct-fired combustion system is considered. Given the close proximity of the Clearwater River, an adequate water supply well could be constructed and operated. There appears to be sufficient area to construct a wastewater discharge pond as well.

Geology/Soils

According to the federal Natural Resources Conservation Service soil survey, the potential site soils are Nicodemus loam on topography with zero to seven percent slopes. The parent material is loess over mixed alluvium.

The Miocene basalts of the Columbia River basalts underlie the Kooskia site. There is an unnamed earthquake fault about five miles east northeast of the Kooskia site. Design and construction of the CHP plant and any accompanying structures and equipment should take into account the potential for seismic activity conditions.

Cultural Resources

The Kooskia site, given its relatively undisturbed location directly along the Clearwater River, is believed by the Nez Perce Cultural Resources office to be a potentially significant cultural resources site. The proposed project at the 3 MW scale would take up much of the site.

Power Transmission/Distribution Assets

The Kooskia site is within the Avista Corporation electrical transmission and distribution territory. In discussions with the Avista representative, it was determined that the electrical distribution system in the potential Kooskia site area could possibly accommodate a CHP facility generating 1 MW. A facility scaled at 2 or 3 MW may prove difficult due to the one-mile distance to adequate electrical distribution lines and facilities. The 1 to 3 MW size of the potential Kooskia facility would require the more extensive Avista interconnection review process.

Clearwater River Casino Site

The Clearwater Casino site is located approximately 6 miles east of downtown Lewiston on U.S. Highway 12. The potential CHP site is situated north of the casino in a previously disturbed area (see Figures 15 and 16).[35] Given the rather steep topography of the site (20 to 45 percent slope), it may require extensive grading and earthmoving work to accommodate a CHP facility with fuel yard. The area inside the dirt access road (see Figure 15), which makes a loop within the potential site, is approximately five acres in size.

Land Use Zoning

The NPT currently does not have any zoning or land use ordinances for NPT owned land. Potential use of NPT land is under jurisdiction of the Nez Perce Land Commission and the Tribal Council. No specific restrictions currently exist at the potential Clearwater Casino site for a CHP facility.

The potential site currently does not have any structures on it. It is an area of extensive land disturbance, as earthmoving work was conducted in the past for developing housing on the site, which did not occur. It is located upslope north of the casino and accompanying hotel complex. Acreage to the north, east, and west of the site is open, sloping land. Agricultural activities, such as livestock grazing and wheat cultivation, are occurring on some of that land.

As previously mentioned, the potential is about five acres in size. It is unclear per this preliminary review if the whole site could be adequately developed for a 3 MW CHP facility. Thus, only a 1 or 2 MW facility should be considered at this time.

Transportation, Routes, and Corridors

The Clearwater Casino site is located on Nez Perce Road just off of U.S. Highway 95. Direct access to the site requires exiting Highway 95 at either the west or east end of Nez Perce Road. Access to the site is via the upper casino parking lot. New access may be necessary if the biomass waste energy facility is sited above the upper casino parking lot.

[35] Although not indicated on the aerial map in Figure 10, the potential is tribal trust land.

Figure 15. Potential Site at Clearwater Casino Area[36]

[36]It has been reported that the potential site area in the figure is now Tribal Trust land.

Figure 16. Casino Area Potential Site Overlooking Upper Casino Parking Lot

A community scale CHP facility at the casino site scaled at 1 to 2 MW could use up to 18,000 BDT of biomass waste fuel per year. Assuming a biomass waste delivery truck can carry about 14 BDT per load, this calculates to about 1,286 trucks per year accessing the potential plant site. If deliveries occurred six days a week, this would equate to an average of four delivery trucks per day. However, deliveries may not be distributed evenly over the course of a year and there could be extended periods when no deliveries take place. Thus, truck deliveries would be higher during the spring, summer, and fall months, and storage of biomass waste fuel will be necessary at the potential biomass waste energy facility site.

Public Health and Safety

Fuel truck deliveries to the Clearwater Casino site would have relatively easy access to Nez Perce Road from U.S. Highway 95. However, the trucks would then have to traverse the upper parking lot to access the potential CHP plant and fuel yard site. However, it may possible to construct an alternative access route from near the east end of Nez Perce Road, which currently has an existing access road to a large water tank.

Regarding any potential air quality degradation, such as particulate matter, it is expected that the biomass waste power plant will be equipped with robust particulate matter emissions control systems. Such systems, including a baghouse or electrostatic precipitator for direct-fired combustion systems, can control particulate matter emissions up to 99.9%.

Water Supply Resources and Wastewater Discharge

The Clearwater Casino site has access to the City of Lewiston water supply system, as well as wastewater conveyance. Pretreatment of any direct-fired combustion steam cycle wastewater will need to be accomplished prior to discharge to the Lewiston municipal wastewater system.

Geology/Soils

According to the federal Natural Resources Conservation Service soil survey, the potential site soils are Chard-Tammany complex on topography with 20 to 45 percent slopes. The parent material is loamy alluvium.

The Miocene basalts of the Columbia River basalts underlie the Clearwater Casino site, like nearly all of Nez Perce County. There is an east-west trending earthquake fault, the Viste Fault, that runs nearly under the potential site. Design and construction of the CHP plant and any accompanying structures and equipment should account for potential seismic activity.

Cultural Resources

Although the potential Clearwater Casino site is relatively disturbed from previous (and now abandoned) earthwork, the area immediately adjacent to the site has cultural resource significance per the opinion of the Nez Perce Cultural Resources Office.[37]

Power Transmission/Distribution Assets

The Clearwater Casino site is within District 1 of the Clearwater Power Company electrical transmission and distribution territory. In discussions with a Clearwater representative,[38] it was determined that the electrical distribution system in the potential Clearwater Casino site area could accommodate generation from a CHP facility scaled at 1 to 3 MW. However, the CHP facility would need to install a feeder electrical line from the potential site to the Clearwater Power substation located about one mile to the west. Clearwater Power would also require a complete integration study for the interconnection of a CHP facility to the Clearwater Power electric grid.

Lapwai Wastewater Treatment Plant Site

The Lapwai Wastewater Treatment Plant (WWTP) site is located approximately 2 miles north of Lapwai on U.S. Highway 95. The land surrounding the WWTP on the north, east, and particularly south side could be suitable for a biomass power plant and biomass fuel storage yard, as it has relatively flat topography. Accommodations would have to be made for the WWTP

[37]Per personal communication between Patrick Baird, Nez Perce Cultural Resources and Frederick Tornatore, TSS Consultants, December 13, 2011.
[38]Personal communication between Jon Paisano, Nez Perce Tribe, and Bob Pierce, Clearwater Power, on November 21, 2011.

treated effluent discharge line, which empties into the field directly east of the WWTP. The currently vacant, and treeless, land portion of the site is approximately 5 acres in size. The property is shown in aerial view in Figure 17. Figure 18 is a photo of the site.[39]

Figure 17. WWPT Potential Site

[39] This photo is taken from Google Earth Street View

Figure 18. Southern Half of the WWTP Site

Land Use Zoning

The Nez Perce tribe currently does not have any zoning or land use ordinances for tribal owned land. Potential use of tribal land is under jurisdiction of the Nez Perce Land Commission and the Tribal Council. No specific restrictions currently exist at the WWTP site for a CHP facility.

The potential site currently has the WWTP structure and associated equipment on it. Immediately adjacent to the north is the tribal fish hatchery. It is an area of extensive surface land disturbance as it has been agriculturally cultivated in the past. The treeless portion of the property is relatively flat.

As previously mentioned the potential is about five acres in size. It is unclear per this preliminary review if the whole site could be adequately developed for a 3 MW CHP facility. It does appear to be suitable for at a 1 to 2 MW facility with accompanying biomass fuel storage

Transportation, Routes, and Corridors

The Lapwai WWTP site is located adjacent to U.S. Highway 95, which is approximately 2 miles north of the town of Lapwai. Direct access to the site from Highway 95 would be a turn to the west southwest onto Thunder Hill Road (through the small community of Spalding).

A community-scale CHP facility at the Lapwai WWTP site scaled at 1 to 2 MW could use up to 18,000 BDT of biomass waste fuel per year. Assuming a biomass waste delivery truck can carry about 14 BDT per load, this calculates to about 1,286 trucks per year accessing the potential plant site. If deliveries occurred 6 days a week, this would equate to an average of 4 delivery trucks per day. However, deliveries may not be spaced out evenly over the course of a year and there could be extended periods where no deliveries take place. Thus, truck deliveries would be higher during the spring, summer, and fall months and storage of biomass waste fuel will be necessary at the potential biomass waste energy facility site.

Public Health and Safety

Biomass fuel truck deliveries to the Lapwai WWTP site would have relatively easy access from U.S. Highway 95, via Thunder Hill Road. However, this road passes through the small community of Spalding (which consists of a few houses). Thus, extreme caution would have to be exercised. Fuel delivery drivers will need to be made aware of this traffic/residential conflict.

Regarding any potential air quality degradation, such as particulate matter, it is expected that the biomass waste power plant will be equipped with robust particulate matter emissions control systems. Such systems, including a baghouse or electrostatic precipitator for direct-fired combustion systems, can control particulate matter emissions up to 99.9%.

Water Supply Resources and Wastewater Discharge

Water supply needs at the Lapwai WWTP site could potentially be supplied by the treated water discharge from the WWTP (it would require some additional treatment by the power plant facility before use). Pretreatment of any direct-fired combustion steam cycle wastewater will need to be accomplished prior to discharge to the Lapwai WWTP.

Geology/Soils

According to the federal Natural Resources Conservation Service soil survey, the potential site soils are Uhlig silt loam, on topography with two to eight percent slopes. The parent material is mixed alluvium.

The Lapwai WWTP site is underlain by alluvial deposits of Lapwai Creek as it begins its entry into the Clearwater River. There is an east-west trending earthquake fault about halfway between the site and town of Lapwai to the south. Design and construction of the facility and any accompanying structures and equipment should account for potential seismic activity.

Cultural Resources

Although the potential Lapwai WWTP site is a relatively disturbed from previous agricultural production activities, it is a documented archaeological site. The Nez Perce Cultural Resource Program conducted considerable mitigation work at the WWTP site and at the adjacent (to the north) tribal fish hatchery, the Cultural Resource Program has not systematically investigated the area south of the WWTP. Additional work would be needed to identify resources in this area, and possibly expensive data recovery mitigation work.[40]

Power Transmission/Distribution Assets

The Lapwai WWTP site is within the Avista Corporation electrical transmission and distribution territory. In discussions with an Avista representative[41] it was determined that the electrical distribution system in the Lapwai area should have capacity to accommodate power generation from a 1 to 2MW facility. However, any potential upgrades necessary would be determined in the required interconnect study.

The 1 to 2 MW size of the proposed biomass facility would also require the owner of the facility to participate in Avista's interconnection process. This process requires, a renewable energy facility with electrical output between 300 KW (0.3 MW) and 20 MW, must agree to Avista conducting a Feasibility Study, System Impact Study, and a Facilities Study prior to the formal adoption of an Interconnection Agreement.

Siting Review Summary

Using findings from this site review analysis, a site review observations summary table has been generated (see Table 26). Potential site locations are presented in ranked order with the Lapwai WWTP site as the prime candidate site, due to site attributes that are appropriate for possible development of a community scale CHP facility.

[40] Per personal communication between Patrick Baird, Nez Perce Cultural Resources and Frederick Tornatore, TSS Consultants, January 30, 2012
[41] Personal communication between Jon Pisano, Nez Perce Tribe, and Kelly Magee, Avista, on November 30, 2011.

Table 26. Site Review Analysis Findings - Site Ranking and Observations

POTENTIAL SITE LOCATION	OBSERVATIONS
Lapwai WWTP	Although the size of the Lapwai WWTP site biomass facility would be constrained by the lower availability of woody biomass, it being collocated with the WWTP offers the potential for some limited CHP, and the ability to use WWTP personnel for operating the biomass facility
Orofino	The Orofino site, although somewhat isolated with no CHP potential, is a large site where a 3 MW biomass waste power plant could be sited with ample room.
Lapwai	Lapwai is the center of the Nez Perce Tribe government, with numerous NPT government and community buildings, which could allow for collocated potential CHP facility. However, all of the buildings are currently electrically heated with low utility rates
Clearwater Casino	Although the casino and hotel may have potential on site demand for both heat and power, the site has development constraints (size and topography) limiting the size of a CHP facility at the site.
Kooskia	There are several constraints to development at this site, particularly due to cultural resources (Pow Wow site), and electrical transmission to the grid.
Kamiah	The Kamiah site is very small, even limiting a 1 MW size facility. It is located very close to residential dwellings, day care center, and health clinic. The site also has high cultural resources significance.

TECHNOLOGY SELECTION AND FINANCIAL ANALYSIS

The technology selection and financial analysis utilizes findings from the Biomass Resource Assessment and Site Review Tasks to conduct a technology review to match feedstock availability/characteristics, local environmental permitting requirements, site attributes and electrical/thermal load forecast with existing, commercially-proven technologies. Biomass utilization technologies were examined which optimized use of sustainably available biomass resources and waste streams, as outlined in the resource assessment, to generate electrical and thermal energy. TSS presented biomass utilization technology options for consideration by the NPT staff. Once a preferred technology was selected, TSS conducted a detailed financial analysis for the potential deployment at the Lapwai Wastewater Treatment Plant (WWTP) site and possibly, the Orofino site.

Technology Review of Direct-Fired Combustion and Gasification Systems

Biomass, such as woody wastes from forest residues, can be supplied to energy conversion systems and converted to useful steam, heat, or combustible gases. These energy conversion systems vary widely but fall under two basic types for electricity generation: gasification[42] and direct combustion.[43] These two types of power generation represent the leading commercially available technologies for community scale projects.

Direct-fired combustion utilizes a steam cycle to produce electricity at an efficiency of approximately 15% to 25%. Gasification utilizes internal combustion engines to produce electricity at an efficiency of approximately 20 to 35%. Other technology systems for biomass conversion to electricity, such as fuel cells, are neither currently economically available nor projected to be economically or technically available within the proposed timeframe of this project (operations in 2013).

Unlike larger-scale biomass-to-electricity systems (greater than 10 MW), of which there are scores in the United States and internationally, there are few small-scale (1 to 5 MW) biomass-to-electricity facilities operating in the United States or Europe. However, with the rising price of electricity, continued technological advancement, and governmental policy encouraging the development of biomass energy, community scale (less than 5 MW) facilities are fast becoming more popular in regions with abundant biomass resources.

Direct-Fired Combustion

The most basic direct-fired combustion system for heat is a wood fire. Direct-fired combustion combined with steam cycles have been used for mechanic work since the 1600's and for electrical generation since the 1800's. Technological advances have greatly increased the efficiencies by maximizing heat transfer. Direct-fired combustion is responsible for the vast majority of large-scale power generation facilities. For small-scale applications, direct-fired combustion has traditionally been the preferred technology for power generation. Unfortunately, there are significant economic challenges associated with small-scale, direct-fired combustion power generation systems, including relatively high capital cost per unit of output ($/MW), lower efficiency, and relatively high labor costs.

In direct-fired combustion systems, the biomass fuel is burned (combusted) in some type of furnace or combustion unit that then supplies heat to a boiler. Nearly all commercial biomass power applications today use boilers in conjunction with a steam turbine to generate electricity. Common boilers used for biomass direct-fired combustion systems include traditional stoker boilers[44] and fluidized bed boilers.[45] Each combustion technology operates best on biomass fuel that meets certain specifications (size, moisture content, heat value). It is critical that careful analysis be conducted to match combustion technology to the locally available biomass fuel resource. Characteristics of locally available biomass feedstocks will determine the appropriate configuration of a direct combustion system. When using woody biomass as a fuel, the most common feedstock systems are round wood, chunk wood, wood chips, and pellets (listed by size from largest to smallest). The size of the feedstock is important, as it affects the optimal

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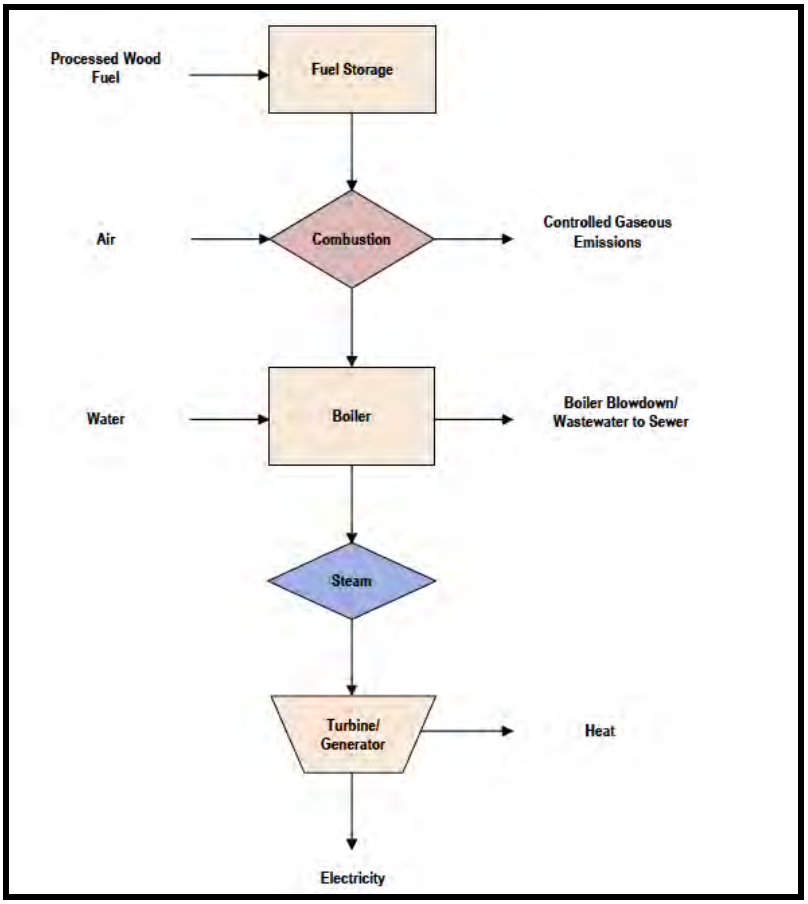
[42]Gasification systems generate electricity through combustion of syngas in an internal combustion engine or turbine generator. Electricity generation efficiency can range from 15% to 35%.
[43]Direct combustion systems generate electricity through the production of steam in a boiler, and utilization of the steam in a steam turbine.
[44]In stoker boilers, wood chips burn on a grate, with combustion air supplied both from under the grate and above the burning bed.
[45]In fluidized bed boilers, wood chips burn in a suspension with inert materials, forced through upward air jets.

temperature and oxidation rates in the furnace to achieve complete combustion. A schematic of a typical direct-fired combustion system is show in Figure 17.

Figure 19. Schematic of a Typical Direct-Fired Combustion System



In addition to the direct-fired combustion system depicted in Figure 1, hybrid systems exist where the fuel is gasified and the producer gas rises from the gasification vessel to a combustion chamber where it is combusted to heat the boiler. Some vendors call this configuration a gasification system. TSS classifies these technologies as combustion systems because the producer gas cannot be collected and conditioned into synthetic gas.

<u>Gasification</u>

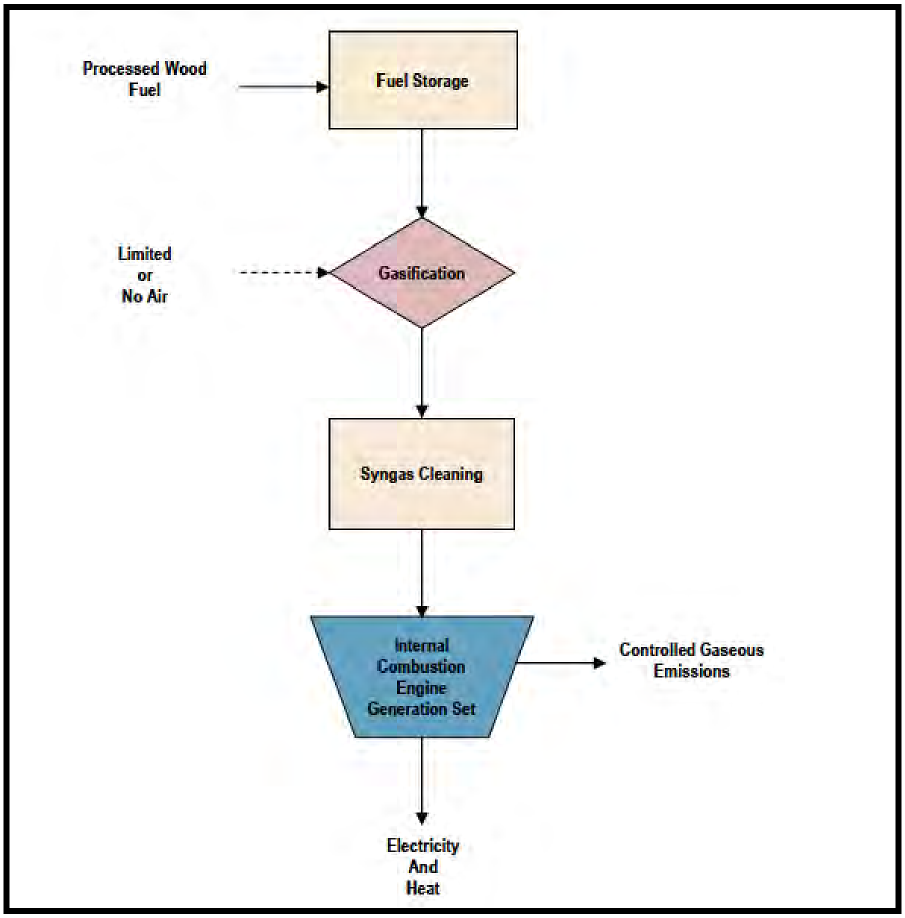
The earliest uses of gasification date back to the production of city (or town) gas from coal in the late 1800's. Gasification has been in commercial use for more than 50 years with the production of synthetic gas (syngas) as a substitute for natural gas. The growth of gasification for power production has traditionally focused on large integrated gasification combined cycle (IGCC) plants with coal as the fuel source. Gasification of biomass resources is currently on the upswing in Europe, and interest is growing in the United States. Several community-scale units are currently being deployed in the United States. Advanced gasification technologies are beginning to produce biomass-based syngas at rates that are competitive with retail natural gas market prices and traditional direct-fired combustion biomass energy production.

There are several variations on biomass gasification systems but in general, these systems can be classified as either updraft or downdraft gasifiers. Updraft gasifiers consist of a fixed bed of biomass fuel through which the "gasification agent" (steam, oxygen and/or air) flows in counter-current configuration (flowing from the bottom to the top of the gasifier). Thermal efficiency is high since the producer gas exit temperatures are relatively low. However, the low temperatures result in significant tar and methane being generated, so the producer gas must be conditioned (impurities removed) before use. The tar can be separated from the producer gas through a variety of controls and is traditionally collected and recycled in the gasification reactor. Once the producer gas is cleaned up so it can be used in applications normally reserved for natural gas or liquid petroleum gas (propane gas), it is known as synthetic gas or syngas.

Downdraft gasifiers are configured the same way as an updraft gasifier, but the gasification agent flows in a co-current configuration (flowing from the top to the bottom of the gasifier). The producer gas leaves the gasifier at a high temperature, and most of this heat is transferred to the gasification agent added in the top of the bed, resulting in energy efficiency on level with the counter-current type. Since all tars must pass through a hot bed of bio-char in this configuration, tar levels are much lower than the counter-current type and thus the producer gas requires less conditioning to meet syngas specifications.

In either configuration, syngas is delivered to an internal combustion engine power generation process that allows for greater efficiency over direct-fired combustion energy production for small-scale systems. Figure 18 shows a schematic for a typical gasification system.

Figure 20. Schematic of a Typical Gasification System



Technology Selection

A candidate technology matrix was developed using several technology vendors that have biomass utilization systems potentially available to meet the NPT's objectives. From this matrix, the top two candidate technologies were further reviewed to allow the NPT staff to select the preferred technology candidate. NPT staff selected Reliable Renewables as the technology vendor of choice. Additional details regarding Reliable Renewables are addressed in the Technology Cost and Financial Analysis section.

Technology Matrix

The technology matrix is presented in Table 27. The matrix reviews nine suitable vendors using five key attributes: proven technology; biomass utilization experience; air emissions; water impacts; and capital costs. These five attributes serve to differentiate the vendors based on key environmental and economic factors. The definitions for each attribute category can be found in the legend at the end of the matrix.

Table 27. Technology Matrix

VENDOR & LEAD CONTACT	TECHNOLOGY TYPE*	PROVEN TECHNOLOGY	BIOMASS UTILIZATION EXPERIENCE	AIR EMISSIONS	WATER IMPACTS	CAPITAL COSTS	TOTAL SCORE	COMMENTS
Adaptive Arc San Francisco, CA (858) 704-0508 Rita Damore www.adaptivearc.com	Plasma Arc	1	2	3	1	2	9	Potentially high maintenance costs.
Advanced Recycling Equipment, Inc. St. Marys, PA (814) 834-4470 Don Kunkel www.advancedrecyclingequip.com	Combustion	3	3	3	1	3	13	Little experience with integrating thermal unit and electric turbine.
Alternative Energy Solutions Intl. Wichita, KS (314) 201-4143 Joe Lotts www.aesintl.net	Combustion	2	3	3	1	2	11	Requires a high-pressure steam boiler operator.
Emery Energy Salt Lake City, UT (801) 363-0818 Ben Phillips www.emeryenergy.com	Gasification	2	2	3	3	2	12	Has a pilot facility in Wyoming but no fully operational commercial facilities.

VENDOR & LEAD CONTACT	TECHNOLOGY TYPE*	PROVEN TECHNOLOGY	BIOMASS UTILIZATION EXPERIENCE	AIR EMISSIONS	WATER IMPACTS	CAPITAL COSTS	TOTAL SCORE	COMMENTS
Eqtec Iberia Barcelona, ES +34 – 93 870 24 62 Luis Sanchez www.eqtec.es	Gasification	2	2	3	2	2	11	No water consumption but potential complications with water discharge.
PHG Energy Nashville, TN (615) 251-8619 Mark Jacobs www.phgenergy.com	Gasification	2	2	2	2	1	9	Core competency is with gasifiers, working on a partnership with an ORC manufacturer.
Phoenix Energy San Francisco, CA (415) 367-2531 Greg Stangl www.phoenixenergy.net	Gasification	3	2	3	2	3	13	Small amounts of wastewater that must be treated.
Reliable Renewables Houston, TX (832) 865-0593 Zach Scott www.rrbtu.com	Gasification	2	2	3	3	3	13	No operational domestics units (one under construction in Massachusetts), many operational units overseas.
West Biofuels Woodland, CA (530) 383-8260 Matt Summers www.westbiofuels.com	Gasification	2	2	3	2	2	11	Pilot facility only. Main focus is on larger-scale facility.

Table 28. Technology Matrix Legend

TECHNOLOGY MATRIX LEGEND	
Proven Technology: Are there operating units in commercial applications?	
3	Many similar scale units operating over 5 years with same design and fuels, and the company has active commercial applications of similar scale.
2	Some similar scale units operating over 2 years with similar design and fuels, but the company does not have any active commercial applications of similar scale, or few similar scale units operating over 2 years with similar design and fuels, but the company has several active commercial applications of similar scale.
1	No similar scale units operating in the field.
Biomass Utilization Experience: Do they have experience in biomass feedstock utilization?	
3	Experience in combusting or converting woody biomass forest residuals and wheat straw.
2	Experience in combusting or converting biomass but not necessarily forest residuals and wheat straw.
1	No experience in combusting or converting biomass.
Air Emissions (projected): Is there demonstrated ability to control air emissions to comply with Best Available Control Technology (BACT) standards?	
3	Demonstrated ability to control air emissions beyond current air district standards.
2	Demonstrated ability to control air emissions that could meet air district standards.
1	No demonstrated ability to control air emissions.
Water Impacts: What are the water requirements and is there a demonstrated ability to control wastewater effluent?	
3	Requires little water for process, and effluence meets or exceeds regional water quality control board and/or local sanitation district standards.
2	Requires considerable water for process, and effluence meets regional water quality control board and/or local sanitation district standards, or requires little water for process, and effluence does not meet regional water quality control board and/or local sanitation district standards.
1	Requires considerable water, and effluence may not meet regional water quality control board and/or local sanitation district standards.
Capital Costs: What are the projected costs and vendor experience in installing units pursuant to total capital cost budget?	
3	Low capital costs and demonstrated ability to complete a project in accordance with a capital budget.
2	High capital cost and demonstrated ability to complete a project in accordance with a capital budget, or low capital costs and little demonstrated ability to complete a project in accordance with a capital budget.
1	No installation experience to date, or high capital cost and little demonstrated ability to complete a project in accordance with a capital budget.

To determine the top two potential candidates for the project, a point system was implemented where a number score was awarded for each category, from a high score of three to a low score of one. The highest scoring candidates were Alternative Energy Solutions Intl., Phoenix Energy, and Reliable Renewables. Through direct conversations with the three vendors to assess initial interest, Alternative Energy Solutions Intl. and Reliable Renewables were selected as the top two candidates for presentation to NPT staff for the selection of a final candidate. The top two technologies are discussed below. For additional information about any of the technology companies shown in Table 27, their websites are included under each company's Vendor and Lead Contact column.

Technology Finalists

<u>Alternative Energy Solutions Intl.</u>

Alternative Energy Solutions Intl. (AESI) is a direct-fired combustion technology. The direct combustion system recommended for the Nez Perce project is in the GLOBAL series, a combustion unit designed specifically to accommodate a wide range of fuels. The biomass fuel is burned and the heat is transferred to a boiler to create steam. The steam is used to operate a steam turbine to generate electricity. AESI is a combustion unit manufacturer and sources their boilers and turbine units from a select group of established manufacturers. An example of the GLOBAL series combustion unit is shown in Figure 19.

Figure 21. AESI GLOBAL Series Combustion Unit

Reliable Renewables, LLC

Reliable Renewables, LLC (Reliable) is a small scale biomass gasification technology vendor. As previously discussed, in a gasification system, fuel is broken down through high heat and pressure with carefully controlled oxygen levels to minimize complete combustion. The gasification unit generates a producer gas, which is cleaned into a synthetic gas (syngas) and burned in an internal combustion engine. Reliable uses a Biogen gasifier that is compatible with a variety of internal combustion engine manufacturers including Cummins, General Electric, and Caterpillar. A Reliable 500 kWe (one-half megawatt) is shown in Figure 20. This unit is installed outside of the Biogen manufacturing facility in the Dominican Republic.

Figure 22. Reliable Renewables 500 kWe Gasification Unit

Direct Combustion vs. Gasification Units

As noted earlier, there are two major technologies with the potential for economic feasibility: direct combustion and gasification. Table 29 compares the two technology types. Note that Table 29 reflects the generalized technology and not the specific vendors mentioned above.

Table 29. Comparison Table: Direct Combustion and Gasification

DIRECT COMBUSTION	GASIFICATION
Can burn 0-45% moisture content fuels without a fuel dryer.	Can burn 10-20% moisture content fuels without a fuel/feedstock dryer.
Requires a high-pressure boiler operator when in commercial operation. This equates to higher labor costs.	Can be operated without advanced specialty training. Labor costs are relatively low.
All emissions cleanup is at the stack. This can increase costs in strict air districts.	Emissions control begins with syngas cleaning so less cleanup required at the stack. This is advantageous for strict air districts.
Generate electricity through steam turbines which typically require cooling towers. This increases water consumption and requires management of waste water.	Can operate with little or no water consumption and generates little to no waste water effluent.
Not as sensitive to fuel sizing.	Sensitive to fuel sizing and may require additional fuel handling, drying and processing.
Older commercial technology.	Relatively new technology at this scale.
Direct combustion is not as modular in design as gasification units, making expansion difficult and more costly.	Gasification systems are typically modular, so overall system can be easily expanded.

Selected Technology Costs and Financial Analysis

Discussions with NPT staff indicated that the gasification technology is the preferred biomass utilization technology and Reliable has the technology of choice for further analysis. Reliable was contacted and specific cost estimates/details were obtained for the following:

- Equipment capital costs
- Equipment installation costs
- Annual operations and maintenance costs
- Training required for operations personnel
- Site requirements
- Infrastructure requirements
- Estimated raw material supply (product and volume) needs
- Limiting factors

In the following Financial Analysis section, data provided to Reliable was utilized to conduct a financial analysis that provides the cost of electrical and thermal energy along with other financial analysis results (e.g., \$/MMBtu, payback period, operations and maintenance costs).

Project Cost

To perform a financial analysis for the project, Reliable was contacted to provide specific capital cost, operations, and maintenance data for a 1 MW (0.9 MW net) facility and a 3 MW (2.7 MW net) facility. The values provided are indicative cost estimates based on similar projects and are not considered formal, quotable prices for the project.

Capital Costs

Unlike large, utility scale power generation projects, community scale gasification units (due to their relatively small scale) have no economies of scale with respect to the capital cost of equipment. Small economies of scale are realized with the engine, fuel dryer, and building envelope. Gasification units are typically modular units scaled between approximately 0.5 MW and 1.0 MW. The efficiency of a gasifier depends greatly on the shape and geometry of the gasification reaction vessel. This limitation constrains the size of an individual gasification unit, and larger systems are typically comprised of several redundant smaller gasification units operating in parallel. The capital cost of the equipment is detailed in Table 30.

Table 30. Estimated Capital Costs

EQUIPMENT TYPE	ESTIMATED COST	
	0.9 MW (NET)	2.7 MW (NET)
Engine (Guascor, Cummins, GE, Caterpillar or equivalent)	$900,000	$2,500,000
Air Emissions Equipment (Catalytic Converters)	$200,000	$600,000
Gasifier Equipment	$1,200,000	$3,600,000
Fuel Dryer	$600,000	$1,500,000
Conveyors and Hoppers	$200,000	$600,000
Roof Structure with Day Storage	$150,000	$350,000
Step-Up Transformers	$150,000	$450,000
TOTAL	**$3,400,000**	**$9,600,000**

Upfront Costs

In addition to the capital cost of the equipment, there are one-time, upfront costs associated with the installation of any CHP system. Table 31 details the major upfront costs that are not capital investments. One important distinction between the capital costs listed in Table 30 and these additional costs is that the costs in Table 31 are not always eligible for tax incentives and have no future resale value.

Table 31. Upfront Costs

SERVICE PROVIDED	ESTIMATED COST	
	0.9 MW (NET)	2.7 MW (NET)
Interconnection Study	$25,000	$25,000
Cultural Resources Investigation/Mitigation	$150,000	$150,000
System Design and Engineering	$50,000	$75,000
Site Design and Engineering	$150,000	$200,000
Permitting	$25,000	$25,000
Construction and Installation	$350,000	$750,000
Fees, Insurance, and Interest	$100,000	$150,000
TOTAL	**$850,000**	**$1,375,000**

Annual Operations and Maintenance Costs

Operations and maintenance costs are a key economic driver that impact the annual cash flow of the unit. They represent the expenses incurred when operating and properly caring for a facility over its lifetime (typical service life is 30 years). Operations costs include system inputs like fuel, water, pollution control requirements, and labor. Maintenance costs represent the cost of replacing system parts and paying specially-trained technicians to perform the labor associated with major repairs. The maintenance cost does not include revenue loss from downtime. The equipment vendors often provide maintenance services. Table 32 displays expected operations and maintenance costs associated with the Reliable system and include amortized major maintenance. It is important to understand the operations and maintenance costs are directly related to how many hours the equipment is in use. All values in Table 32 assume an 86% capacity factor (i.e., the gasification system runs 86% of the time on a yearly basis, or 7,534 hours total).

Table 32. Operations and Maintenance Costs

SERVICE PROVIDED	ESTIMATED COST ($/YEAR)	
	0.9 MW (NET)	2.7 MW (NET)
Feedstock Use[46]	$240,000	$720,000
Labor	$32,120	$48,180
Maintenance	$140,000	$420,000
Insurance and Administrative	$33,000	$73,000
Utilities (Water, Electricity, Emissions Controls)	$20,000	$60,000
TOTAL	**$465,120**	**$1,321,180**

[46]Average fuel pricing, see Table 33 for detailed breakdown of fuel pricing scenarios.

Fuel Consumption

Fuel use is the most significant operations and maintenance cost and represents approximately half of the total annual expenditures. The Reliable system consumes approximately 0.87 bone dry tons of fuel per hour (estimate based on a high heating value of 8,700 Btu/dry lb) and between 7,500 to 8,000 BDT annually per MW (gross). Thus, a 0.9 MW (net) Reliable system could consume up to 8,000 BDT annually. Due to the quantity of feedstock needed, the feedstock price is paramount to a project's success. Utilizing the findings from the Resource Assessment, Table 33 depicts the component of the total operating cost that stems directly from the price of feedstock.

Table 33. Costs Associated with Feedstock Pricing

FEEDSTOCK TYPE	DELIVERED PRICE ($/BDT)		FEEDSTOCK PRICE ($/kWh)	
	LOW RANGE	HIGH RANGE	LOW RANGE	HIGH RANGE
Forest Operations	$27.70	$58.80	$0.0292	$0.0621
Urban Wood	$20.90	$33.00	$0.0221	$0.0348
Wheat Straw	$44.50	$61.50	$0.0470	$0.0649

As indicated in Table 32 and Table 33, the price of feedstock represents a large component of the cost of electricity. The high price for feedstock alone may negate all revenue from the sale of power produced. A detailed discussion of the available power rates is presented in the Sales Potential section below.

Labor Cost

The Reliable system, similar to many community scale biomass power systems, is designed to operate without around-the-clock staff. A control system monitors the operations and will automatically shut down when necessary and alert the operator (via smartphone or pager if no one is on site) of any malfunction. Often the source of the error is in the feedstock conveyance system because of the wide variety of sizing associated with processed biomass feedstock. It is helpful if an operator is on-site for proper performance. Optimally, a biomass facility will be located near a commercial operation (e.g., waste water treatment plant) with maintenance staff that has appropriate mechanical experience (detailed information regarding staffing requirements can be found in the Staff and Training Requirement section below). The instrument and control panel can be located with the controls in the co-located facility, and there is no need for dedicated full-time staff to operate the gasification unit. By locating the facility next to the Lapwai WWTP, savings from decreased on-site personnel can be realized. The labor figures in Table 32 are based on a workload average of four hours per day. Typically, daily requirements are approximately two hours for regular checks, startup and shutdown. The four-hour value accounts for regular maintenance with a total salary of $22 per hour.

Maintenance Cost

Maintenance for the system is the second largest annual cost associated with owning and operating a biomass gasification facility. Maintenance contracts are typically negotiated with component providers and are based on runtime or kWh produced. Annual maintenance costs are estimated assuming the 86% capacity factor and Reliable's experience negotiating with system component suppliers.

Insurance and Administrative Cost

Annual cost estimates for insurance and administrative expenses are based on TSS interviews with vendors that own and operate small-scale biomass units. The estimates cover equipment and worker insurance and the time involved in managing supply acquisition and delivery, maintenance, legal filings, and electricity and heat sales.

Utilities Cost

The estimate for utilities encompasses all supplies used to successfully operate the system. During start up, electricity is required to move the conveyors, to ignite the gasifier, and to start the engine. Additional resources such as water, sand, and urea may be used during the gas conditioning process and for the air emissions controls. The costs of these resources vary by vendor and the Reliable system does not require sand or water. The estimate is based on information supplied by Reliable.

Infrastructure Requirements

A community scale gasification unit requires several basic infrastructure systems.

- Land: Sufficient land is necessary for both the equipment and feedstock storage. Feedstock storage is an important part of the facility as it creates a buffer for delays in feedstock delivery. A 0.9 MW (net) unit requires as little as 1.5 acres of total area for the equipment and biomass fuel storage. The equipment requires approximately ½ to 1 acre of space and the fuel storage encompasses the rest. The land requirements are approximately 5 acres for a 2.7 MW (net) unit including fuel storage.
- Power: A gasification unit requires approximately 60 kW of power during startup and must have enough power line distribution capacity to export 0.9 MW or 2.7 MW to the grid. An interconnection study is necessary to determine local power line/grid capacity.
- Water: Water is necessary for both the operation of the unit and for fire safety and prevention.
- Road Access: Chip vans, weighing up to 40 tons and up to 50 feet long, must be able to access the feedstock storage facility from the road. The access road must be capable of carrying the weight of the trucks and to facilitate turning and unloading.

Project Revenue

For any electricity generation facility that is connected to the grid or connected to a co-located facility, which is also connected to the grid, the facility must have a working relationship and contract with the utility provider to which it is connected. When working with private utility companies, it is important to understand that all transactions are negotiable. Many utilities have both company policies and federal and state policies that they must abide by; however, this typically places a limit on the utility's ability to negotiate downward. The financial analysis will focus on the opportunities available at the selected site (the Lapwai WWTP). However, given that the Orofino site can accommodate a 3 MW facility using woody biomass only, it is also analyzed and briefly discussed.

Net Metering

Net metering means measuring the difference between the electricity supplied by an electric utility and the electricity generated by a customer-generator that is fed back to the electric utility over the applicable billing period. Net metering is often the most lucrative economic opportunity for a distributed generation facility. Net metering typically allows the facility to sell at higher rates because the power is displacing electricity that is paid for by a customer. In most cases, these rates incorporate the mark up (e.g., profit margin) by the utility. However, the opportunity for net metering is limited by both the consumption of the net metering entity and the policies of the utility, or regulations of the state in which the electric generation facility is located.

The Lapwai WWTP is supplied electricity by Clearwater Power Company (CPC). CPC is a non-profit rural electric cooperative utility that serves approximately 8,000 customers in 11 counties in Idaho, Washington, and Oregon. CPC is a member of a non-profit cooperative that includes 14 utilities that pool together to provide the power needs to all of the cooperative members. CPC is not required to adhere to the Public Utilities Regulatory Policies Act (PURPA) and is not bound by any state-level Renewable Portfolio Standards (RPS). There is no RPS in Idaho. Any potential net metering opportunities would be through a partnership with the Lapwai WWTP and the CPC.

The current regulations, Policy Bulletin No. 67B, published by CPC, state that net metering is only permissible for generating facilities of nameplate generating capacity of not more than 50 kilowatts. This provision eliminates the ability for a biomass facility at the scale that has been discussed in this feasibility study (0.9 MW and 2.7 MW) from net metering. Granted, negotiating with CPC is an option. However, during discussions with CPC representatives, there was no indication that the CPC would be interested in making an exception to this policy.

Power Purchase Agreement with Clearwater Power Company

Another alternative is to develop a power purchase agreement (PPA) with the CPC (as the local utility). CPC does not have any published data regarding their PPA policy; however, larger utilities base their figures on avoided cost rates as dictated by PURPA. Avoided cost rates are calculated by the average cost of generating 1 kWh given a utility's power supply mix. The CPC avoided cost is currently estimated at $0.035 per kWh.[47]

CPC has a green power choice for its members. The alternative energy that is currently available to CPC is from the Coffin Butte Resource project, landfill gas recovery facility, located just outside Corvallis, Oregon. Another renewable energy site is the Reedsport Ocean Power Technology Wave Park located near Reedsport, Oregon. Wave power is a new and typically expensive technology. If CPC's Cooperative is considering purchasing power from this technology, it suggests that the cooperative may be willing to pay a premium for renewable energy generated within its service territory.

CPC also has green power options for members. Members may purchase blocks of alternative energy (green power) for $2 per 100 kWh (equivalent to a $0.02 energy price adder per kWh) or opt for their entire consumption to be from alternative energy sources for an additional $0.01 per kWh.

CPC is also promoting small-scale solar and wind renewable energy projects. Solar and wind projects represent relatively cost effective renewable energy opportunities for renewable power production. However, one downside to solar and wind energy is that the electricity production is intermittent and difficult to predict. Biomass power is consistent and very predictable (24/7 baseload) which is preferred by utilities because it reduces their costs from ancillary services required (e.g., small, natural gas-fired power plants that can be quickly dispatched to provide power when wind is not blowing or sun is not shining) for quick response to changes in electricity demand.

A biomass facility is a renewable energy source, and the electricity from the biomass facility would benefit from green power pricing premiums. The current investment of the CPC cooperative in renewable energy suggests that there is room for negotiation. Since the avoided cost rates primarily reflect the cost of natural gas, coal, and hydro power, the renewable energy rates are typically lower than rates that larger utilities are usually willing to offer for renewable energy.

Power Purchase Agreement with Avista Power

A third alternative is to wheel the power across CPC's lines to sell to another utility. The nearest utility to the Lapwai WWTP is Avista Power (Avista). Avista is a large investor owned utility that provides electrical power and natural gas to approximately 481,000 customers in Idaho and Washington. Avista is subject to the State of Washington's RPS and is mandated to abide by PURPA.

The advantage to selling power to a different utility (other than CPC) is the possibility of realizing higher rates for electricity. Since Avista is bound by the Washington RPS and PURPA,

[47]Personal communication with Robert Pierce, Clearwater Power Company, February 13, 2012

Avista does offer slightly more favorable rates. Table 34 below displays the avoided cost rates for Avista.[48]

Table 34. Avista Power Avoided Cost Schedule

AVOIDED COST RATES FOR NON-FUELED PROJECTS AS OF AUGUST 30, 2011 ($/kWh)								
LEVELIZED							NON LEVELIZED	
CONTRACT LENGTH (YEARS)	ON-LINE YEAR						CONTRACT YEAR	NON LEVELIZED RATES
	2011	2012	2013	2014	2015	2016		
1	0.05159	0.05347	0.05518	0.05686	0.05867	0.06061	2011	0.05159
2	0.05249	0.05429	0.05599	0.05773	0.0596	0.0616	2012	0.05347
3	0.05332	0.05508	0.05681	0.05861	0.06054	0.06264	2013	0.05518
4	0.0541	0.05587	0.05765	0.05951	0.06152	0.06365	2014	0.05686
5	0.05487	0.05667	0.0585	0.06043	0.06249	0.06466	2015	0.05867
6	0.05564	0.05748	0.05937	0.06135	0.06344	0.06566	2016	0.06061
7	0.05642	0.0583	0.06024	0.06226	0.0644	0.06666	2017	0.06268
8	0.05721	0.05913	0.0611	0.06317	0.06535	0.06765	2018	0.06498
9	0.05799	0.05995	0.06196	0.06407	0.0663	0.06864	2019	0.06726
10	0.05955	0.06077	0.06282	0.06497	0.06724	0.06962	2020	0.0696
11	0.06033	0.06158	0.06367	0.06586	0.06817	0.07059	2021	0.07211
12	0.06109	0.06239	0.06452	0.06675	0.06909	0.07155	2022	0.07477
13	0.06185	0.06319	0.06536	0.06762	0.07001	0.07251	2023	0.07743
14	0.06261	0.06399	0.06619	0.06849	0.07091	0.07345	2024	0.08025
15	0.06335	0.06477	0.06701	0.06935	0.0718	0.07438	2025	0.08325
16	0.06409	0.06555	0.06782	0.07019	0.07269	0.0753	2026	0.08624
17	0.06481	0.06632	0.06862	0.07103	0.07356	0.07621	2027	0.08942
18	0.06481	0.06708	0.06941	0.07186	0.07448	0.07711	2028	0.0928
19	0.06553	0.06782	0.07019	0.07267	0.07527	0.078	2029	0.09627
20	0.06624	0.06856	0.07096	0.07347	0.07677	0.07888	2030	0.09985
No Levelized Rates Calculated Past 20 Years							2031	0.10367
							2032	0.10763
							2033	0.11175
							2034	0.11606
							2035	0.12056
							2036	0.12525

[48]Avista's avoided cost rates are published in their Schedule 62 in dollars per mega-watt hour ($/MWh). This was converted to $/kWh, the unit of electricity pricing used in the Nez Perce electric utility bills.

Avista offers two options for energy contracts: levelized and non-levelized. A levelized contract means that for the duration of the contract length, there will be a set price for electricity. The set price is higher than non-levelized rates for the first years of operation and lower than non-levelized rates for the last years of operations. The levelized price contracts allow the operator to front-load the income stream; however, it is important to analyze whether or not the project can maintain profitability in the long run since inflation will affect costs and not revenue. Levelized contracts are preferable when the rate is sufficiently high for profitable operations throughout the contract duration. The security deposit required by Avista for levelized rate contracts depends on the length of the contract. The levelized price, as shown in Table 34, is found by using the column headers to identify the date of commissioning and the row header to determine the length of the contract.

Non-levelized contracts use the price indicated in the ninth (last) column of Table 34. These prices generally increase annually according to the published rates, which are determined by the Idaho State Public Utilities Commission to reflect expected avoided costs. There is no security deposit required with this type of rate schedule.

To sell power to Avista, the electricity must be wheeled across CPC's transmission lines. From the Lapwai WWTP site, the power would be wheeled approximately 4 miles to the nearest Avista substation. The costs for wheeling power must be negotiated with CPC and from conversations with CPC representatives, appears likely to be in the range of $0.001–$0.005/kWh.

Unlike CPC, Avista is bound to the Washington RPS which requires utilities serving over 25,000 customers to maintain 15% of their total energy supply from renewable sources by 2020. In this case, as described previously, a premium for renewable power may be negotiable.

<u>Secondary Revenue Streams</u>

Heat Sales

In addition to generating electricity, biomass gasification systems create heat, which is typically released to the air. There are three primary heat sources in the Reliable system. The most basic source is 800°F hot air that is expelled in the engine exhaust. The other two heat sources are the engine radiator and the synthetic gas cooling radiator. These are lower temperature heat sources, and the system operations can be tuned to offer a range of temperatures.

Heat from engine exhaust is captured in the form of air, which limits the transportation distance. Exhaust air is typically used to provide heat to the feedstock dryer. The air is conveyed from the engine to the dryer via a duct. The moisture of the incoming feedstock determines how much heat is required for the dryer. The Reliable system operates most efficiently with feedstocks that are dried to 15% to 20% moisture content.

Heat from the engine or gas-cooling radiators is captured by a working fluid (the Reliable system would use water as the working fluid) in a series of small metal coils (heat exchanger) around the radiator. The heat is transferred to the working fluid and is typically expelled to another medium or used via a secondary heat exchanger. This closed loop system is typically 60% to 80%

efficient and requires significantly more equipment and installation costs to install when compared to the duct work required to transport hot air.

After using the necessary heat required to dry the incoming feedstock, the Reliable system has approximately 1.1 MMBtu/hr of available heat. Potential heat loads are common with industrial processes. Typical sources of heat load include WWTPs, greenhouses, lumber and firewood drying, and heating for large building complexes.

Heat sales are typically reported in units of million British thermal units (MMBtu) or decatherms[49] delivered. Pricing is traditionally lower than the available alternative heat source. Customers served by Avista receive natural gas at $13.618/MMBtu. Companies served by CPC receive propane for, on average, $35/MMBtu.

From discussions with Lapwai WWTP staff,[50] the WWTP has two potential heat loads. The most consistent load is the steam boiler which is part of the pasteurization process for biosolids. This boiler is being powered by electricity. The electricity prices for the Lapwai WWTP are approximately $0.086/kWh, and electric boilers are traditionally between 92% and 98% efficient. With the low cost of energy to run the boilers, it is unlikely that the required infrastructure upgrades to utilize hot air or hot water from the biomass unit will be cost effective.

An alternative heat source is to employ an absorption chiller to air condition the mechanic room at the WWTP. The mechanic room houses several pieces of equipment that should not be exposed to high ambient temperatures. Process heat from the Reliable system can be used to support an absorption chiller. However, since high temperatures are uncommon in Lapwai, the heat load would be highly intermittent, requiring the biomass facility to operate without revenue from heat sales for most of the year (when air conditioning is not needed). The Lapwai WWTP is not an ideal site for co-generation because it lacks a consistent heat demand and the infrastructure for hot air or hot water heating.

Renewable Energy Credits

Renewable Energy Credits (REC), also commonly known as Renewable Energy Certificates or Green Tags, are a tradable energy commodity that are earned by producing 1 MWh of renewable electricity. The REC represent ownership of the energy that was produced, and the owner of the REC can claim that 1 MWh of renewable energy generation as their own (and the environmental benefits that come with renewable power). REC can be sold separately from the electricity and typically represent the price premium received for renewable energy by a utility. There is no regulated market for REC and this mechanism, created mostly by the demand from state RPS, allows for negotiation with utilities as previously discussed. A voluntary program through the Center for Resource Solutions manages REC to ensure credibility. There is an audit and tracking process and fees associated with registering REC and while this process is not necessary for REC sales, non-audited and non-tracked REC have a much smaller market.

[49] 1 million Btu = 1 decatherm. One British thermal unit (BTU) is approximately the amount of energy needed to heat 1 pound of water, from 39°F to 40°F.
[50] Jason Vangen, Operator, Lapwai WWTP.

From discussions with representatives from the Washington Public Utilities District Association, predicted prices for REC in the Pacific Northwest are to be between $7 and $8 per MWh by 2014. This would represent a revenue adder of $0.007-$0.008 per kWh to the electricity sales price. As an unstable market, there could be vast fluctuations in the prices of REC.

Biochar

Biochar is a byproduct of the gasification process. It has a high carbon content and is similar to traditional charcoal. The market for biochar is growing, as it is being used for soil amendment and has potential as a raw material for activated carbon. From discussions with biochar vendors, spot prices range from $20-$100 per dry ton on the wholesale market and up to $1 per pound on the retail market. Depending on how demand develops over time, biochar could be a very profitable component of the biomass gasification process or the market could disappear. Biochar, after it has been cooled, can be disposed of in a landfill or spread on agricultural fields, so there is little or no cost associated with biochar removal when there is no market. TSS is not aware of any long-term contracts for biochar, but it is certainly a market sector to monitor, especially in agricultural areas.

Financial Analysis

There are many ways to analyze the financial output of a project. A cash flow forecast and a return on equity (ROE) driven analysis is presented below. Earnings cash flow forecast will present earnings before interest, taxes, depreciation, and amortization (a.k.a. EBITDA). Depending on the financing structure of the business, all of the excluded variables can change; therefore, an EBITDA analysis shows the business model before financing. EBITDA analyses are useful in determining the best fit for project financing.

A return on equity (ROE) driven analysis sets a required or target rate of return on equity. This analysis will show the required amount of grant funding needed to achieve a given ROE. A financing scenario is included in this analysis and is detailed in the Return on Equity analysis section.

Financial analyses were performed based on two criteria. The first analysis represents the "baseline" Lapwai WWTP site as selected in the Site Review analysis. The second analysis will show the "best case" project finances based on an ideal, yet realistic, project site.

The Lapwai site will have a heat load to sufficiently utilize the available heat from the CHP facility (even after fuel drying) and replace propane for $25/MMBtu; will use the Avista avoided cost rates; have no wheeling charges from CPC; assume REC sales of $8/MWh, biochar sales of $75/ton; be co-located to share staff; and incur low fuel cost as defined by Table 24 in the Resource Assessment section. To achieve all of these conditions, significant time will need to be spent securing long-term contracts (e.g., power sales, heat sales, biochar sales, fuel procurement) to present to financiers.

Earnings Cash Flow

Two scenarios will be addressed for this analysis: levelized price schedule and non-levelized price power sales schedule. The analysis is performed based on a 0.9 MW plant with average fuel costs and uses the WWTP site information. Table 35 summarizes cash flow forecasts comparing levelized versus non-levelized power sales rates (see Table 34 for power sales rates).

Table 35. Baseline Cash Flow Levelized vs. Non-Levelized Rates ($)

YEAR[51]	1	3	5	7	9	11	13	15	17	19
1) Operating Cash Flow - Levelized	33,796	19,903	5,547	-9,290	-24,625	-40,475	-56,860	-73,798	-91,311	-109,418
2) Operating Cash Flow - Non-Levelized	-69,409	-57,876	-42,603	-26,115	-6,396	14,910	39,139	66,678	96,967	131,609

The difference in operating cash flow is clearly indicated in Table 35. The levelized price schedule allows the operator to realize profits earlier but as expenses increase with time, inflation reduces profitability. The non-levelized price schedule, as indicated in the second cash flow in Table 35, contains power sales rate inflation that exceeds operating expense inflation. Therefore, although the price of electricity is initially too low for profitable operations, the losses are sustained in the early years of operation. The assumptions made in this analysis are listed in Table 36.

[51]Results are shown for every other year only to conserve space.

Table 36. Baseline Assumptions

ASSUMPTION	VALUE
Capacity Factor	86%
Economic Life	20 years
Electricity Sales	Schedule 62
Heat Sales	$0/MMBtu
Biochar Sales	$0/ton
REC	$0/MWh
Salvage Value	10%
Net Electrical Generation	0.9 MW
Nominal Heat Capacity	1.1 MMBtu/hr
System Factors	RR[52]
Feedstock Cost	$40.75/BDT
Feedstock HHV	8,700 Btu/dry lb
Capital Cost	$3,400,000[53]
Variable Cost	$465,120/year[54]

As input prices fluctuate, the cash flow forecast will shift up and down relative to the results in Table 34; however, the trends will remain constant. Table 37 displays the cash flow from the best case scenario with both the levelized and non-levelized pricing.

Table 37. Best Case Cash Flow Levelized vs. Non-Levelized Rates ($)

YEAR[55]	1	3	5	7	9	11	13	15	17	19
1) Operating Cash Flow - Levelized	413,413	403,377	393,000	382,269	371,171	359,693	347,820	335,538	322,833	309,687
2) Operating Cash Flow - Non-Levelized	300,793	315,082	333,167	352,523	375,169	399,459	426,733	457,379	490,836	528,711

The difference in the values in Table 35 (baseline calculations) and Table 37 (best case calculations) are from the increased revenue generated from heat sales and the decreased price of fuel. The difference in positive cash flow between the base case (Table 35) and best case (Table 37) highlights the importance of a CHP biomass facility. The REC and the biochar sales do

[52]Reliable Renewables supplied confidential data to TSS.
[53]From Table 30, Estimated Capital Costs.
[54]From Table 32, Operations and Maintenance Costs.
[55]Results are shown only for every other year to conserve space.

contribute to the profitability but represent only about 25% of the difference in cash flow projections. The assumptions used for the best case scenario are displayed in Table 38.

Table 38. Best Case Assumptions

ASSUMPTION	VALUE
Capacity Factor	86%
Economic Life	20 years
Electricity Sales	Schedule 62
Heat Sales	$25/MMBtu
Biochar Sales	$75/ton
REC	$8/MWh
Salvage Value	10%
Net Electrical Generation	0.9 MW
Nominal Heat Capacity	1.1 MMBtu/hr
System Factors	RR[56]
Feedstock Cost	$26.65/BDT
Feedstock HHV	8,700 Btu/dry lb
Capital Cost	$3,400,000[57]
Variable Cost	$465,120/year[58]

Return on Equity

The ROE analysis assumes project financing and takes into account the time value of money.[59] The financing assumptions for the analysis are listed in Table 39 and are used in addition to the baseline and best case scenarios.

[56]Reliable Renewables supplied confidential data to TSS.
[57]From Table 30, Estimated Capital Costs.
[58]From Table 32, Operations and Maintenance Costs.
[59]The time value of money is the value of money figuring in a given amount of interest earned over a given amount of time. For example, $100 of today's money invested for one year and earning 5% interest will be worth $105 after one year.

Table 39. Financing Assumptions

ASSUMPTION	VALUE
Taxes	None
Debt Ratio	75%
Equity Ratio	25%
Grant Ratio	0%
Interest Rate on Debt	5%
Debt Term	15 years
Return on Equity Required	15%
Fuel Cost Escalation	1%
Electricity Escalation	Schedule 62
Other Escalation	2%

For the first ROE analysis, grant pricing was evaluated based on fluctuations of feedstock pricing in the baseline scenario with a non-levelized price schedule. A levelized price schedule never yielded a positive cash flow when debt payments were included in the calculations. The percent of the capital cost that needs to be covered by grant funding yields a 15% ROE and is shown in Table 40. Note that the debt and equity ratios remain constant as they are calculated relative to the capital cost less the grant funding.

Table 40. Grant Funding Sensitivity to Feedstock Pricing – Baseline

FEEDSTOCK PRICE ($/BDT)	GRANT FUNDING REQUIRED
$26.65	85%
$40.75	>100%
$54.83	>100%

The 0.9 MW baseline scenario is financially challenging due to the lack of additional revenue streams. Table 41 displays the same sensitivity analysis performed on the best case scenario.

Table 41. Grant Funding Sensitivity to Feedstock Pricing – Scaled at 0.9 MW - Best Case

	FEEDSTOCK PRICE ($/BDT)	GRANT FUNDING REQUIRED
LEVELIZED PRICING	$26.65	14.90%
	$40.75	34.00%
	$54.83	53.20%
	FEEDSTOCK PRICE ($/BDT)	**GRANT FUNDING REQUIRED**
NON-LEVELIZED PRICING	$26.65	21.70%
	$40.75	40.87%
	$54.83	60.00%

As shown in Table 41, the best case scenario still requires some grant funding to be considered financially viable. The levelized pricing schedule yields a better result in this model because the profits are achieved earlier, which help balance the debt payments and have more value due to the time value of money.

While the Lapwai WWTP site cannot support a 2.7 MW facility due to the limited feedstock resources, the Orofino site considered in the site review has the potential for the larger facility. To demonstrate the relationship between the economies of scale realized with a larger facility and the increased cost of fuel due to the distribution of fuel sourcing, Table 42 displays the best-case scenario scaled up to a 2.7 MW facility. All input values will change as discussed in Table 31 and Table 32.

Table 42. Grant Funding Sensitivity to Feedstock Pricing – Scaled at 2.7 MW - Best Case

	FEEDSTOCK PRICE ($/BDT)	GRANT FUNDING REQUIRED
LEVELIZED PRICING	$26.95	0%
	$41.45	17.60%
	$55.95	40.50%
	FEEDSTOCK PRICE ($/BDT)	**GRANT FUNDING REQUIRED**
NON-LEVELIZED PRICING	$26.95	2.60%
	$41.45	25.50%
	$55.95	48.60%

While the feedstock prices increase by a small fraction, the economies of scale of the larger system outweigh the feedstock price increase.

Financing Options

The ROE financial analyses above are based on one particular financing strategy. There are numerous ways to structure the debt required to fund the project, and the EBITDA analysis is appropriate to help determine financing. The financial analysis in this report is intended to provide an understanding of the relative financial position of this project.

One consideration not evaluated is that of involving a tax equity partner. Again, there are numerous ways to structure a tax equity partnership, but there are several tax incentives available to small-scale biomass projects that should be considered, including capital depreciation incentives, production tax credits (PTC), investment tax credit (ITC), and New Market Tax Credits (NMTC). Tax incentives are only available to entities that pay federal or state taxes; therefore, NPT would have to investigate the availability of a tax equity partner (as NPT has no tax liabilities). These four tax incentives should be reviewed if tax equity partners are being considered.

Capital Depreciation

A biomass facility is eligible for the 7-year modified accelerated cost recovery system (MACRS 7). This depreciation schedule is faster than traditional capital equipment depreciation and entitles the owners to significant tax credits during the early years of the project.

Production Tax Credit

The Production Tax Credit (PTC) reduces the federal income taxes of qualified tax-paying owners of renewable energy projects based on the electrical output (measured in kWh) of grid-connected renewable energy facilities. Biomass facilities are eligible for a $0.011/kWh PTC for the first 10 years of operation. Entities are only eligible for the PTC if they do not use the ITC (see below for ITC explanation). Entities that do not pay taxes, such as publicly-owned electric utilities, rural electric cooperatives, government agencies, and tribes, may not take advantage of the PTC. The biomass facility must be in commercial service by December 31, 2013 to qualify for the PTC.

Investment Tax Credit

The Business Energy Investment Tax Credit (ITC) reduces federal income taxes for qualified tax-paying owners based on capital investment in renewable energy projects (measured in dollars). The ITC is earned when the equipment is placed into service. Up to 30% of the biomass energy project expenditures can be applied to the ITC. Tax paying entities are only eligible for the ITC if they do not elect to use the PTC. Like the PTC, the ITC is applicable to projects that are placed into service on or before December 31, 2016.

New Market Tax Credits

As part of the Community Renewal Tax Relief Act of 2000, New Market Tax Credits (NMTC) are offered to investments in eligible low income and impoverished communities. The NMTC provides tax credits amounting to 39% of the total capital cost paid out over seven years, 5% for each of the first three years and 6% for each of the following four years. None of the sites reviewed are in areas that qualify for use of the NMTC.

Currently, a tax equity partner would be able to realize the capital depreciation for the ITC or the PTC but not the NMTC. Table 43 lists the assumptions for tax equity partner involvement.

Table 43. Tax Assumptions for Tax Equity Partner Participation

ASSUMPTION	VALUE
Federal Tax Rate	34%
State Tax Rate	7.60%
Investment Tax Credit[60]	30%
Capital Cost Depreciation	MACRS 7
Upfront Cost Depreciation	None
Production Tax Credit	$0.011/kWh

The ITC will be used for the tax equity partner analysis as the best case scenario. The advantage of the ITC is that it provides a large lump sum tax incentive for the first year of operation. The advantage of the PTC is that the tax incentives are typically higher but spread over 10 years, which may be beneficial to entities that do not have the tax appetite to utilize the full ITC credit (with MACRS 7) depreciation schedule in year one.

Table 44 and Table 45 show the results of bringing a tax equity partner into the existing financial model compared to the tribe only scenarios discussed above.

Table 44. Grant Sensitivity to Feedstock Pricing with Tax Equity Partner Scaled at 0.9 MW – Baseline[61]

FEEDSTOCK PRICE ($/BDT)	GRANT FUNDING REQUIRED (%) – NO TAX EQUITY PARTNER	GRANT FUNDING REQUIRED (%) – WITH TAX EQUITY PARTNER
$26.65	85%	18.20%
$40.75	>100%	31.30%
$54.83	>100%	50.20%

[60] Only the ITC or the PTC can be used, but not both.
[61] Baseline is a 0.9 MW (net) facility located at the Lapwai WWTP site.

Table 45. Grant Sensitivity to Feedstock Pricing with Tax Equity Partner Scaled to 2.7 MW – Best Case[62]

	FEEDSTOCK PRICE ($/BDT)	GRANT FUNDING REQUIRED
LEVELIZED PRICING	$26.95	0%
	$41.45	0.00%
	$55.95	7.40%
	FEEDSTOCK PRICE ($/BDT)	**GRANT FUNDING REQUIRED**
NON-LEVELIZED PRICING	$26.95	0.00%
	$41.45	0.00%
	$55.95	12.70%

It is important to recognize that this financial analysis is driven by the expected present value of cash flow. The tax incentives (ITC or PTC) greatly increase the value of the cash flows for the first few years. In this analysis, in some of the fuel price scenarios shown in Table 45 that do not require grant funding, there are several years where the cash flows are negative towards the end of the debt service term. Before determining a financing structure, a detailed investigation into all of the financing options should be performed.

Financial Analysis Conclusions

For the current scenario at the Lapwai WWTP site, a biomass CHP project is not feasible unless a long-term feedstock contract guarantees low-cost fuel. Even with the lowest cost feedstock (as projected in the feedstock analysis), a grant covering 85% of the capital cost would be required.

This is not to say that a biomass CHP facility should be ruled out across the NPT reservation. As the analysis indicates, there are several important factors that would allow for savings in the form of economies of scale and increased revenues. As the economic development plan for the area matures and state regulations change, it will be important to monitor the area for a more ideal site. Major factors to consider are the availability of a constant heat load that displaces propane (anywhere served by CPC), a large enough site to accommodate a 2.7 MW plant, state regulation changes including an Idaho Renewable Portfolio Standard, farm practice changes relating to crop residue removal, Renewable Energy Credit market stabilization, and more cost effective biomass fuel. A successful biomass project does not require all of these variables to align perfectly; however, at this time, none of these variables are available for a community scale distributed biomass generation facility.

The financial analysis also examined what potential electricity prices the biomass project might need from the utility if grant funding was not available. Using the baseline case and without a

[62]Best case assumptions are described in Table 38 (Best Case Assumptions).

tax equity partner, the levelized power purchase rate would have to be $0.141/kWh for a 20-year contract. With a tax equity partner, the target rate needed could be as low as $0.108/kWh. While these rates are expensive compared to current wholesale electricity prices in Idaho, these are not unreasonable rates when compared to the price of purchased renewable power from solar or wind systems in the region.

As some of these variables fall into place, the project could become viable with reasonable grant funding. With grant funding available to bring down capital equipment costs, the project's financial feasibility improves, and tax equity partners could be attracted to participate in the development and ownership of the project. The tax equity partners could take advantage of the PTC or ITC and further improve the financial viability of the project.

Staff and Training Requirements

Operations and basic maintenance for the Reliable gasification system can be performed by most workers with basic mechanical and electrical systems knowledge. Staff that operate heavy machinery, HVAC systems, or industrial equipment have the core competency required to operate a gasification unit. Staff must be available for daily routine checks and managing the controller interface.[63]

Training is provided by Reliable upon installation and commissioning. It is strongly recommended that personnel who will be operating and maintaining the unit are available for the installation process. Training includes a comprehensive overview of the full system and detailed instructions for the automated controls. A user manual will be provided for the operators and will have detailed descriptions of the different operating systems, their use, and troubleshooting for common problems.

Major maintenance will be provided by the component suppliers and includes phone support and personnel support when required.

Job Training and Employment

A biomass energy facility located at the Lapwai WWTP site (or the Orofino site) would utilize locally and regionally available biomass resources as a primary feedstock source. In order to utilize this local and regional biomass (generated as a byproduct of timber harvest activities or agricultural harvesting), it must be collected, processed and transported to the biomass energy facility. These three cost centers – collection, processing and transport – all require skilled labor and specialized equipment.

A biomass energy facility at the Lapwai WWTP site will require approximately 7,500 to 8,000 BDT per year, with three times that necessary to fuel a 3 MW facility at the Orofino site. The volume of material brought to the Lapwai WWTP would amount to nearly 50 truckloads per month (an Orofino facility would need nearly 150 truckloads per month). There may be an

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[63]Controller interface is the control panel with interface that manages system operations on a real-time basis.

opportunity to create a NPT enterprise dedicated to the recovery of biomass for value-added uses including feedstock for a CHP facility.

In order to establish a forest biomass recovery enterprise on the reservation, there will need to be some very defined steps to consider, including:

- Capital expense for equipment
- Job training program
- Safety and illness prevention program
- Marketing of processed forest biomass
- Financial analysis to confirm viability of business model

RECOMMENDATIONS AND NEXT STEPS

The feasibility study has provided the framework for a CHP facility scaled for the Lapwai WWTP site. A number of issues constraining successful project development are dynamic, and as such are always subject to changes. As some certainty develops with regard to current obstacles noted above, the project could become more economically viable.

While the current low prices for natural gas have significantly impacted power prices and provided a low cost alternative for power plants with woody biomass utilization capability, the latest technology employed for natural gas extraction is being challenged by the environmental community. Short-term power rates in some regions of the U.S. are insufficient to support woody biomass fueled power generation facilities; however, the current trend is for increasing power rates. Many of the renewable power mandates for states, while providing percentage goals for utility companies, lack regulatory measures for non-compliance. Those states with strong interest in renewable energy are pushing for punitive measures for non-compliance.

For western states subject to significant forest resource managed by public agencies, there is a critical need to address forest conditions conducive to catastrophic wildfires. Working in collaboration with the state energy or utility commission to demonstrate the value of community scale biomass utilization facilities (such as combined heat and power) fueled by material from forest restoration or ecosystem projects on federal lands can generate impetus for power rates ensuring project financial viability.

A representative[64] of Energy Northwest recently expressed provisional interest in the proposed power generation facility for NPT. Energy Northwest is a Joint Operating Agency (JOA) consisting of 28 public utility members from within the State of Washington. Energy Northwest owns and operates four electricity generation facilities and provides operations and maintenance under contract for other facilities. Their interest in the NPT project is potential acquisition of electricity at rates that could improve the overall financial viability of the opportunity. It could

[64]Mr. John Steigers, Project Developer, Energy Northwest.

be of significant benefit to NPT to initiate discussions with Energy Northwest to further investigate alternative power markets, which could in turn impact successful project development. Energy Northwest is unique in that as a JOA, they have the ability to develop, own and operate power generation facilities and may be interested in a joint venture or equity partnership with the NPT.

TSS recommends that NPT:

- Initiate discussions with Energy Northwest;
- Continue seeking grant funding opportunities;
- Monitor power rates available from Clearwater Power Company and the published PURPA rates from Avista;
- Monitor legislation regarding extension of the PTC and ITC;
- Monitor changes in the REC markets;
- Identify prospective tax equity partners with interest in participation in the CHP project or utilization of the tax incentives only;
- Work to solve the financial inequities associated with small-scale renewable power CHP within Idaho.

With grant funding available to bring down capital equipment costs, the project's financial feasibility improves, and tax equity partners could be attracted to participate in the development and ownership of the project. The tax equity partners could take advantage of available tax credits and further improve the financial viability of the project.

APPENDIX A - POTENTIAL GRANT AND LOAN FUNDING RESOURCES

TSS conducted a literature search for grant and loan support targeting small-scale bioenergy projects. Outlined below are the results.

Rural Energy for America Program (REAP)
Administered by the USDA Rural Business-Cooperative Service, this program replaced the Renewable Energy Systems and Energy Efficiency Improvements program in the 2002 farm bill. The 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.

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.

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 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.

Wells Fargo Regional Foundation/Community Development Program
Wells Fargo looks for projects that keep communities strong, diverse, and vibrant. 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.

APPENDIX B - JOURNAL OF AIR AND WASTE MANAGEMENT ASSOCIATION ARTICLE

TECHNICAL PAPER

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Emission Reductions from Woody Biomass Waste for Energy as an Alternative to Open Burning

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ABSTRACT

Woody biomass waste is generated throughout California from forest management, hazardous fuel reduction, and agricultural operations. Open pile burning in the vicinity of generation is frequently the only economic disposal option. A framework is developed to quantify air emissions reductions for projects that alternatively utilize biomass waste as fuel for energy production. A demonstration project was conducted involving the grinding and 97-km one-way transport of 6096 bone-dry metric tons (BDT) of mixed conifer forest slash in the Sierra Nevada foothills for use as fuel in a biomass power cogeneration facility. Compared with the traditional open pile burning method of disposal for the forest harvest slash, utilization of the slash for fuel reduced particulate matter (PM) emissions by 98% (6 kg PM/BDT biomass), nitrogen oxides (NO_x) by 54% (1.6 kg NO_x/BDT), nonmethane volatile organics (NMOCs) by 99% (4.7 kg NMOCs/BDT), carbon monoxide (CO) by 97% (58 kg CO/BDT), and carbon dioxide equivalents (CO_2e) by 17% (0.38 t CO_2e/BDT). Emission contributions from biomass processing and transport operations are negligible. CO_2e benefits are dependent on the emission characteristics of the displaced marginal electricity supply. Monetization of emissions reductions will assist with fuel sourcing activities and the conduct of biomass energy projects.

INTRODUCTION

Woody biomass waste material is generated as a byproduct throughout Placer County portions of the Sacramento Valley, foothills, and Sierra Nevada mountains from forest management projects, defensible space clearing, tree trimming, construction/demolition activities, and agricultural operations.

Forest management projects that produce woody biomass byproducts (tree stems, tops, limbs and branches, and brush) include fuel hazard reduction, forest health and productivity improvement, and traditional commercial harvest. These projects take place on private land and lands managed by various public agencies including the U.S. Forest Service (USFS), Bureau of Land Management, and state/federal parks. Forest fuel hazard reduction activities involving selective, targeted thinning treatments are implemented to lessen wildfire severity and improve forest-fire resiliency through reducing hazardous fuel accumulations resulting from a century of successful wildfire suppression efforts. Commercial timber harvests include thinning to improve health and productivity, and intensive management to optimize the yield of merchantable material for lumber production.

Defensible space clearings and fuel breaks in an expanding wildland urban interface area, including residential and commercial structures, produce woody biomass that typically includes deciduous and coniferous trees and brush.

Agricultural operations such as fruit and nut orchards and grape vineyards are a source of biomass wastes from annual pruning and periodic removal and replacement with more productive varieties or growing stock.

Open burning (in piles or broadcast burning) near the site of generation is the usual method of disposal for a significant quantity of the excess woody waste biomass throughout much of the western United States. A forest slash pile burn in the Lake Tahoe Basin is shown in Figure 1. The cost to collect, process, and transport biomass waste is often higher than its value for fuel or wood products because of the distance of the forest treatment activity location from the end user (e.g., mill, biomass energy facility), lack of infrastructure, and/or economics of biomass energy compared with fossil fuel generation. This limits the feasibility of using biomass waste for energy production although such use has significant environmental benefits.

IMPLICATIONS

Economic considerations frequently dictate the disposal of woody biomass wastes by open burning. The alternative use for energy provides significant reduction in criteria air pollutant and greenhouse emissions. Valuing these reductions will improve the economic viability and increase the use of biomass for energy as well as assist with forest and agricultural management objectives.

Figure 1. Open pile burn of forest fuel treatment woody biomass in Lake Tahoe Basin.

The Placer County Air Pollution Control District (PCAPCD), with responsibility for managing air quality in Placer County, shares regulatory authority over open burning with local fire agencies. Open burning is problematic because of the limited time of year it can be conducted, subsequent monitoring of smoldering piles for days after they are lit, and the production of significant quantities of air pollutant emissions and esthetically unpleasing residuals (blackened logs and woody debris). The PCAPCD expends significant resources reviewing smoke management plans, issuing burn permits, inspecting burn piles, and responding to complaints from smoke.

PCAPCD[1,2] and others[3,4] report that the utilization of woody biomass waste for energy as an alternative to open burning can provide significant air emissions mitigation for criteria pollutants, air toxics, and greenhouse gases, along with energy benefits through production of renewable energy in a well-controlled conversion process. To quantitatively value these benefits, PCAPCD is developing an emission reduction accounting framework and has sponsored several biomass waste-for-energy field operations to evaluate alternatives to minimize open burning.

EMISSION REDUCTION ACCOUNTING FRAMEWORK

The emission reduction framework is intended to provide a basis for financial support for the utilization of biomass wastes for energy in which the biomass waste under "baseline, business as usual" conditions would have been open-burned. This requires an evaluation of the economics of the biomass management alternatives and institutional and regional practices to demonstrate that the biomass waste would be open-burned without the additional financial contributions from a biomass project proponent. Biomass must also be shown to be a byproduct of forest or agricultural harvest projects that meet local, state, and federal environmental regulations, including the National Environmental Policy Act, the California Environmental Quality Act, and/or Best Management Practices. The biomass must also be demonstrated to be excessive to ecosystem needs.

Net emission reductions are considered to be the difference between the biomass energy project and the open burning baseline. As shown in Figure 2, the biomass project boundary includes processing (loading and chipping), transport, and the energy conversion plant. The baseline considers biomass open burning and the marginal generation of energy that was displaced by the biomass project. Table 1 details the project activities and data requirements for emissions reduction determinations that are real, permanent, quantifiable, verifiable, and enforceable.

Emissions from the forest management projects and agricultural operations that generate the excess biomass waste (e.g., chain saws and yarders) are not considered in the accounting framework because biomass removal is required for management purposes and will occur regardless of which biomass disposal option is pursued. Biomass waste that falls under the framework must have economic value that is less than the cost to process and transport (it must be a disposal burden). The biomass removal operations must be required for reasons (e.g., fire hazard reduction, forest management, timber production, or food production) that are unrelated to any potential biomass value. Furthermore, emission contributions from the biomass removal operations are minor compared with processing, transport, or open burning.[3,4]

Emissions from operations to process and transport fossil fuels, which are used in the baseline to provide equivalent energy and in the biomass project to facilitate wood chip transport and biomass processing/loading equipment, are not considered because of the difficulty of accurately defining their energy usage and emission characteristics.

It is anticipated that reductions resulting from biomass utilization projects may be banked or sold for air emissions and/or greenhouse gas mitigation obligations.

DEMONSTRATION PROJECT

PCAPCD and the County of Placer Biomass Program teamed with USFS, Sierra Pacific Industries (SPI), and the Sierra Nevada Conservancy to sponsor an on-the-ground biomass waste-for-energy demonstration project. The project targeted woody biomass waste piles that were originally generated from two USFS fuel reduction stewardship contracts implemented in 2007 on the Tahoe National Forest, American River Ranger District, which is located above Foresthill, CA. The stewardship contracts involved the thinning treatment of over 1215 ha of mixed conifer and ponderosa pine stands with 500-1000 trees/ha (preharvest). The thinning prescription had a target of

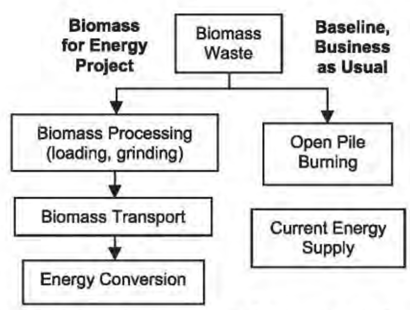

Figure 2. Biomass-for-energy project emission reduction procedure.

Table 1. Project data and monitoring.

Parameter	Method, Frequency
Biomass weight delivered to energy conversion facility	Transport vehicle weight scale, each separate delivery
Biomass moisture	Representative sample, when biomass source changes
Biomass heating value	Representative sample, when biomass source changes
Transport vehicle miles traveled and gas mileage	Vehicle odometer, fuel dispensing
Processing equipment diesel engine operating hours and fuel usage	Engine hour meter, fuel dispensing
Energy production efficiency of energy conversion facility	Fuel input and useful energy output
Emission factors for open pile burning	Literature review
Emission factors for fossil fuel combustion engines	Engine manufacturer, literature
Emission factor for grinding	Literature review
Emission factor for transport over unpaved roads	Literature review
Emission factors for biomass energy conversion facility	Source testing, annual
Emission factors for displaced energy	Marginal energy supply analysis, source testing

180–250 trees/ha at 7.6-m spacing through selected removal of trees 10–51 cm in diameter at breast height (DBH). Removed biomass that was greater than 15 cm DBH and greater than 3.1 m long was transported to a sawmill for processing into lumber products. The stewardship contracts called for unmerchantable slash to be piled at the site for later open burning, the traditional method of disposal.

For the demonstration project, a forest products contractor, Brushbusters, Inc., was retained to process and transport the woody biomass waste piles for use as fuel in a cogeneration facility located at a SPI lumber mill in Lincoln, CA. At each landing slash pile location, excavators were used to transfer the piles into a horizontal grinder. Wood chips from the grinder were conveyed directly into chip vans and transported to the SPI Lincoln mill, a 97-km one-way trip. Equipment and engines used for the chipping and transport operations are described in Table 2.

The SPI Lincoln sawmill facility includes a wood-fired boiler that produces steam for use in lumber drying kilns and a steam turbine that produces up to 18 MW of electricity. The boiler is a McBurney stoker grate design with a firing rate capacity of 88 MW that produces 63,560 kg of steam at 90 bar and 510 °C. It is fueled by biomass wastes including lumber mill wood wastes generated on-site (primarily sawdust), agricultural wastes including nut shells and orchard removals and prunings, wood waste from timber operations, and urban wood waste (tree trimmings and construction debris). The boiler utilizes selective noncatalytic reduction for control of nitrogen oxides (NO_x), multiclones, and a three-field electrostatic precipitator for particulate matter (PM) control. The net boiler heat rate is 16.8 MJ of heat input per kWh electric net, a net efficiency of 22%.

Table 2. Equipment and engines for biomass processing and transport.

Equipment	Vendor, Model, Year	Engine, Model, Horsepower
Horizontal grinder	Bandit Beast, model 3680, 2008	Caterpillar C18, Tier III, 522 kW
Excavator	Linkbelt, model 290, 2003	Isuzu CC-6BG1TC, 132 kW
Excavator	Linkbelt, model 135, 2003	Isuzu BB-4BG1T, 66 kW
Chip van	Kenworth, 1997	Cummins N14, 324 kW
Chip van	Kenworth, 2006	Caterpillar C13, 298 kW

During the period of April 14, 2008 through December 12, 2008, on 86 separate work days, 6096 bone-dry metric tons (BDT) (9537 green tons [GT]) of forest slash were collected, processed, and transported. A total of 444 separate chip vanloads were delivered to the SPI boiler, with each delivery averaging 13.7 BDT (21.5 GT).

The biomass processing machines (a grinder and two excavators) each worked a total of 265 hr and produced biomass fuel at the rate of 36.3 GT per hour of equipment operation. Diesel engine fuel consumption for the grinder and two excavators averaged 2.92 and 0.79 L/GT, respectively. This is comparable with the grinder fuel usage of 2.1 and 3.1 L/GT reported in other studies.[3,4] Chip transport truck/trailer diesel fuel usage averaged 1.9 km/L over the 193-km round trip (4.6 L/GT), also comparable to other studies.[3,4]

Biomass fuel delivered to the boiler had an average heating value of 20.9 MJ/kg, a moisture content of 36.1%, and an ash content of 2% dry weight. The boiler produced 7710 MWh of electricity utilizing biomass fuel from this project.

The biomass project significantly reduced the utilization of fossil fuels. The project required 511 MJ of diesel/BDT, but it displaced the need for 9806 MJ of natural gas/BDT for electricity generated by the biomass-fired cogeneration facility. Energy benefits would be greater if the fossil fuel energy required to collect, refine, and deliver fossil fuel to market (with added fossil fuel energy penalty on the order of 20%) was considered.[3]

Table 3 shows the emission factors used to calculate project and baseline operations, including NO_x, PM, carbon monoxide (CO), nonmethane volatile organics (NMOCs), methane (CH_4), and carbon dioxide (CO_2). Open pile burning factors considering numerous laboratory-, pilot-, and full-scale studies on conifer biomass are compiled in Table 4.[5–23] The burn pile emission factor was used with a burn pile consumption efficiency rate of 95%. Diesel engine combustion, chipping, and unpaved road travel emission factors are from the California Air Resources Board and the U.S. Environmental Protection Agency (EPA).[24–28] Biomass boiler factors are from annual

Table 3. Emission factors for project and baseline operations.

Process/Reference	Units	NO_x	PM	NMOC	CO	CO_2	CH_4
Open pile burning[5–20]	g/dry kg wood	3	6.5	5	63	1833	3
Chip van engine[24]	g/km traveled	10.6	0.25	0.31	25	1381	0.6
Chip van[25]	g/km unpaved road	–	300	–	–	–	–
Grinder engine[26]	g/kWh	3.1	0.18	0.16	4.0	530[b]	0.32
Excavator engine[26]	g/kWh	5.6	0.17	0.25	5.4	350[b]	0.51
Excavator engine[26]	g/kWh	6.4	0.26	0.31	6.7	370[b]	0.62
Grinder[27]	g/green kg wood	–	0.05	–	–	–	–
Biomass boiler[22]	g/GJ	52	7.7	1.7	73	88,000	4
Natural gas combined cycle[23]	Kg/MWh	0.016	0.011	0.002	0.005	384	–
California in-state electricity production[a28]	Kg/MWh	0.08	0.025	0.01	0.13	250	–

Notes: [a]Shown for comparison purposes; [b]Determined from engine diesel fuel usage, operating hours, and rated power output.

manual method stack sampling test programs and continuous emission monitors that are required by PCAPCD to demonstrate compliance with permit limits.[22] Electricity production factors are from the displacement of marginal power from a local utility natural gas combined cycle 120-MW plant that uses selective catalytic reduction and oxidation catalysts for NO_x and CO control.[23] For comparison, overall California state electricity generation emissions factors are also shown.[28]

Table 5 compares biomass project emissions with baseline (open pile burning) emissions. The project reduced PM emissions by 98% (6 kg PM/BDT biomass), NO_x emissions by 54% (1.6 kg NO_x/BDT), NMOC emissions by 99% (4.7 kg NMOCs/BDT), CO emissions by 97% (58 kg CO/BDT), and CO_2 equivalent (CO_2e; determined as $CO_2 + 21 \times CH_4$) emissions by 17% (0.38 t CO_2e/BDT).

The cost to process and transport the piles to the SPI cogeneration facility averaged \$64.40/BDT, including \$33/BDT to process and \$31/BDT to transport the piles. The competitive market value at the time of the project for biomass sourced from timber harvest residual in the central Sierra Nevada region was approximately \$33/BDT. The cost to dispose of the biomass wastes at the site of generation with open pile burning is relatively small. Thus, the demonstration program operated with a cost deficit of \$31.30/BDT biomass processed.

For the demonstration project to be economically viable, the cost to process and deliver the biomass must be reduced, the price paid at the cogeneration facility must be increased, and/or emission reduction credits must be sold. To break even, emission reduction credits would need to be valued for CO_2e at \$83/t CO_2e, NO_x at

Table 4. Emission factors for open pile burning of woody biomass.

Source, Reference, Test Conditions, Material Type	Material Type	Emission Factor (g/kg dry biomass burned)				
		PM	CO	CH_4	NMOC	NO_x
EPA AP-42,[18] conifer logging slash, piled	Flaming	4	28	1.0	–	–
	Smoldering	7	116	8.5	–	–
	Fire	4	37	1.8	–	–
EPA AP-42,[17] pile burn	Unspecified	14	116	4.7	15	–
	Fir, cedar, hemlock	3.4	75	1	3.4	–
	Ponderosa pine	10	164	2.9	9	–
Ward et al.,[10] Hardy,[10] consume model, 90% consumption efficiency	Dozer piled	6	77	6	4	–
	Crane piled	13	93	11	8	–
	Consume 90% consumption efficiency	9	80	3.8	3.1	–
Jenkins et al.,[12] wind tunnel simulator	Almond	5	53	1.3	10	4
	Douglas fir	7	56	1.5	6	2
	Ponderosa pine	6	43	0.9	4.4	3
	Walnut tree	5	71	2.0	7	5
Lutes and Karher,[14] pilot, land clearing piles		7–22	19–29	–	4–16[a]	0.2–2
Andreae and Merlet,[5] literature compilation		5–17	81–100	–	–	–
Janhall et al.,[11] literature compilation, forest residues		8	–	–	–	–
Chen et al.,[7] laboratory	Ponderosa pine wood	4	17	–	0.5[a]	0.8
	Ponderosa pine needles	3.3	32	–	3.5[a]	4.1
Freeborn et al.,[8] laboratory, pine, fir, aspen		7	50	–	–	4
McMeeking et al.,[16] laboratory, pine, fir		–	90	3.7	5	2.2
Yokelson et al.,[20] pilot	Broadcast	8	–	–	2[a]	3
	Slash	4	–	–	2[a]	2
	Crowns	–	–	–	4[a]	3

Notes: [a]Total hydrocarbons.

Table 5. Emissions comparison: open pile burning vs. biomass energy.

Operation	Air Emissions (t)						
	NO_x	PM	NMOC	CO	CO_2	CH_4	CO_2e[a]
Baseline, open pile burning							
Open pile burning	17.37	37.65	28.96	362	10,618	17.37	10,983
Displaced power from grid	0.47	0.28	0.06	1	2,733		2,733
Total	17.84	37.93	29.02	363	13,352	17.37	13,717
Biomass project							
Boiler	6.58	0.98	0.22	9	11,178	0.55	11,189
Process and transport							
Grinding	0.43	0.52	0.02	1	73	0.04	74
Loading	0.31	0.01	0.01	0	19	0.03	19
Chip van transport	0.91	0.02	0.03	2	118	0.05	119
Total	8.23	1.53	0.28	12	11,388	0.70	11,402
Emissions reductions	9.62	36.39	28.74	350	1,965	16.7	2,315
Percent reduction	54%	96%	99%	97%	15%	96%	17%

Notes: [a]CO_2e determined as $CO_2 + 21 \times CH_4$.

\$19,570/t NO_x, or at a lower price if a combination of pollutant credits is sold. Biomass market fuel prices are trending upward partly because of an increased demand for renewable energy (resulting from the California Renewable Portfolio Standard).

Opportunities were identified to significantly reduce future biomass waste processing costs through maximizing equipment productive work time (minimizing equipment downtime and mobilization) by careful formation of piles, creation of larger piles, and efficient scheduling and coordination of truck transport and grinding equipment. In particular, the grinder (the most expensive cost center) was frequently idle while waiting for the arrival of chip truck transport. Cost reductions can be achieved through operating the grinder closer to full time by using additional chip trucks or grinding into piles that are subsequently loaded into chip trucks at a later time with less expensive equipment such as front-end loaders.

The largest source of uncertainty in the emissions determinations is from the biomass open pile burning emissions factor. Open pile burn emission factors vary depending on woody biomass chemical composition (moisture, ash), physical characteristics (pile packing size and arrangement, biomass particle size), and atmospheric conditions (temperature, humidity, wind speed). Variability in the biomass open pile burn emissions factor will impact the magnitude of the emission reductions, but it will not alter the conclusion that emissions from the biomass energy project are lower compared with open pile burning. Variability for emissions from the diesel engines, biomass boiler, and displaced electricity grid operations are not significant to the project results because emissions factors from the processes are well established, process operating rates are accurately measured and monitored, the processes are inherently steady, and contributions from these sources are generally much smaller than those from open pile burning.

The demonstration project results are readily applicable to a very broad range of potential forest sourced biomass projects throughout the West and the entire United States. The biomass energy recovery boiler design, operation, and performance used for the demonstration project are representative of existing plants that are in commercial service throughout the United States. Emission contributions from biomass processing and transport are very small in comparison with traditional open pile burning. Thus variations in grinding efficiency, transportation distance, and engine emission characteristics will have very little impact on emission reductions. Transportation distance has a significant impact on the economic viability of biomass energy projects, adding approximately \$0.13/BDT per additional kilometer traveled, but it has very little impact on emission benefits.

CO_2 benefits are strongly dependent on the CO_2 emissions profile from the displaced marginal electricity source. Reductions will be much greater than achieved in the demonstration project for biomass projects in areas where coal firing is prevalent, whereas benefits will be minimal in areas where production is from lower CO_2-emitting sources such as hydroelectric and/or nuclear sources.

NO_x benefits are somewhat dependent on biomass boiler performance. NO_x reductions will be significantly greater than in the demonstration program for low NO_x-emitting systems including emerging energy conversion technologies such as gasification, pyrolysis, and fuel cells and recently constructed or modified biomass boilers that use selective catalytic reduction.

CONCLUSIONS

A framework is developed to quantify air emission reductions for projects that utilize woody biomass waste as fuel for energy production as an alternative to open burning. A demonstration project was conducted involving the grinding and 97-km transport of forest slash in the Sierra Nevada foothills for use in a biomass-fired cogeneration boiler. Significant air emission benefits were obtained: PM emissions were reduced by 98% (6 kg PM/BDT), NO_x emissions by 54% (1.6 kg NO_x/BDT), NMOC emissions by 99% (4.7 kg NMOC/BDT), CO emissions by 97% (58 kg CO/BDT), and CO_2e emissions by 17% (0.38 t CO_2e/BDT).

PM, NO_x, CO, and volatile organic emission reductions result from the utilization of biomass wastes in an energy conversion process that provides efficient combustion and uses add-on control methods for PM and NO_x emissions compared with the inefficient and uncontrolled disposal of biomass wastes using traditional open burning techniques. CO_2e benefits result from the production of renewable energy that displaces marginal supply and elimination of CH_4 emissions from open burning.

Biomass processing (grinding) and transport operations have a significant cost burden on the biomass energy project but a negligible contribution to air emissions. CO_2e benefits are strongly dependent on the CO_2e emission characteristics of the displaced marginal energy generation; benefits will be much greater for projects in regions where coal firing is predominant. Recognition of the value of emission benefits through sale of emission reduction credits will improve the financial performance of biomass power generation facilities and allow them to access more forest- and agricultural-sourced biomass waste fuel.

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