Woody Biomass Availability Report: Laurentian RC&D Area, Northeast Minnesota

Prepared for:

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WOODY BIOMASS AVAILABILITY ANALYSIS

BACKGROUND

Rising energy costs in recent years and growing interest in renewable alternatives to fossil fuels have focused increasing attention on woody biomass as an energy source in the USA. Woody biomass as energy-producing feedstock systems are an increasing popular renewable fuel solution and provide multiple benefits to communities and forests, including reduced green gas emissions, increased energy independence, reduced wood waste in landfills, support for local wood fuel economies and strengthened local economies. In addition, the use of woody biomass as an energy source will provide new markets for forest landowners; and in so doing can contribute to forest health by removal of hazardous wildfire fuels, speeding recovery from natural disasters, alleviate vegetative-competition that contributes to pest and pathogens infestations, and deterring conversion of forestland to other uses.

This analysis looks at woody biomass fuel availability from all public and private lands in counties within the Laurentian RC&D area. These counties include: Cook, Itasca, Koochiching, Lake, and St. Louis (Figure 1).

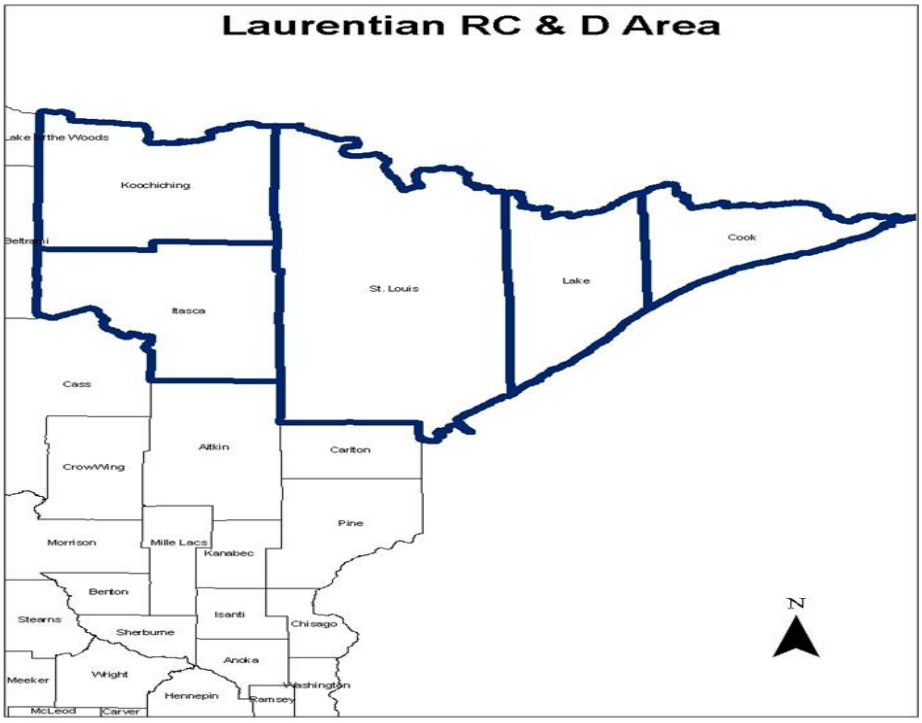

Figure 1. Geographic location of Laurentian RC&D area in Minnesota.

It is important to note that, while there are excellent potential benefits, there are still major challenges to overcome in using wood residue for energy. Some of these include:

1**. Competition for woody biomass**. Many competing industries, such as paper, lumber and oriented strand board, produce higher value products than energy and therefore can afford to pay more for their raw materials.

2. **Woody biomass availability**. Much of the residue resource is small in size and volume and scattered among a large number of landowners and businesses. While significant quantities of biomass may be available, economic viability of some sources is likely to be a significant limiting factor. Actual availability will be impacted not only by operability and economic viability of collection of these various resources but also by the management policies and goals of the various ownership groups.

3. **Transportation cost**. Transportation cost of biomass as feedstock often restricts the effective operating radius for collection and distribution. While this condition affects nearly all fuel types, woody biomass or woody fuels are particularly sensitive to this variable given their lower energy density per unit of weight compared to other major fuel types. In other words, on an energy equivalent basis, it is often more expensive to transport wood fuel products. As a result, to compete more effectively, in many cases, geographic distribution of procurement activities becomes smaller.

4. **Changing technologies.** Technology and infrastructure investment has historically and will continue to play a vital role in the evolution of the energy industry. Advances have the effect of lowering costs, overcoming production barriers, driving efficiencies and increasing market growth rates.

Technology adoption, and hence biomass energy consumption, will depend on technology cost and efficiencies and on prices of fossil fuels. The availability or perceived availability of biomass may also alter facilities' decisions on fuel sources. In the short run, because fossil fuels are often used to supplement self-generated biomass and/or generate electricity, companies evaluate costs of alternative energy sources when choosing a fuel mix. Over the long run, technologies can be changed or improved to increase biomass energy utilization. A period of time and significant investment may be necessary to get timber producers equipped and knowledgeable on biomass collection. As well, prices paid for biomass material would need to be high enough to motivate producers to collect and deliver the material.

5. **Forest management and ecological considerations**. A minimum of approximately 33 percent of logging residue needs to be left on all harvested sites according to the best management practices guidelines. There are additional requirements to retain additional live and dead snags for wildlife. Because of this, some sites will need to retain more residuals than others.

WOODY BIOMASS FUEL ESTIMATES

Using the Minnesota Forest Inventory and Analysis (FIA) system, an analysis of all counties within the Laurentian RC&D area was conducted. The FIA system permits an understanding of the standing forest inventory, land ownerships patterns, timber growth and harvest volumes and timber mortality volume.

General Description of Procurement Area:

The proposed procurement within the Laurentian RC&D area is the most heavily wooded portion of Minnesota. There is a mixture of a modest amount of agricultural land and urban land compared to the rest of Minnesota, and a significant woodland resource. Predominant tree species include aspen, birch, jack pine, black spruce, balsam fir and other hardwoods.

Present Demand for Wood: Currently demand for pulpwood for most hardwood species in the proposed procurement area is modest to weak due to the global economic downturn. There is moderate demand for saw log material of virtually all species in the entire area.

Within the Laurentian RC&D area, there are approximately 7,124,000 acres of timberland, representing about 73 percent of land area in the region. Of this timberland, 31 percent is privately owned, 31 percent state owned with the remainder under municipal or federal ownership (Table 1). St. Louis County has the largest share (38 percent) of timberlands in the Laurentian area, with the remaining distributed among the four counties (Figure 2).

Table 1. Land classification within the seven-county Laurentian RC&D Area.

	Area (Acres)	**percent Timberlands**	**percent All lands**
Total All Lands	9,805,186		
Private	2,241,713	31	23
Municipal and County	1,041,787	15	11
State	2,204,713	31	22
Federal	1,635,724	23	17
Total Timberland	**7,124,000**		**73**

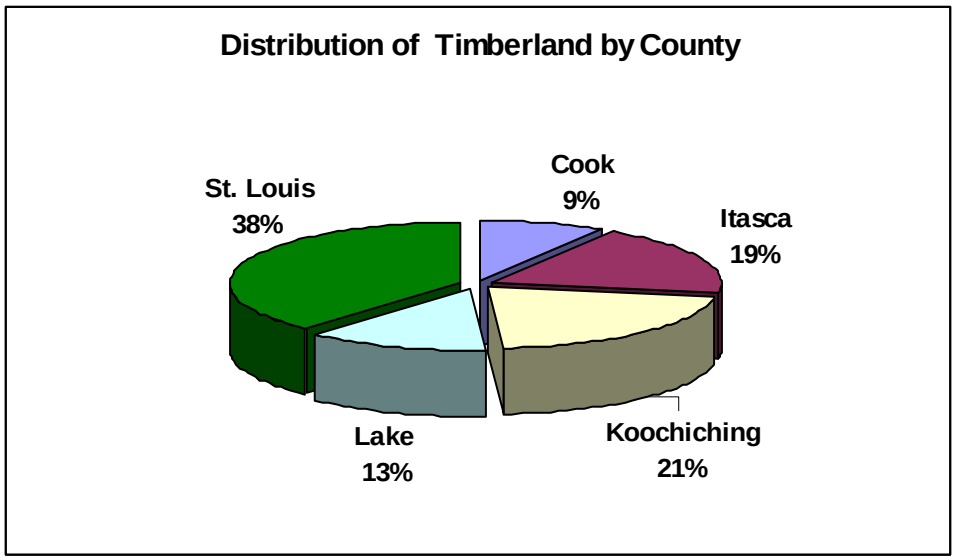

Figure 2. Distribution of timberland by county within Laurentian RC&D Area.

AVAILABLE WOODY BIOMASS RESOURCES:

A number of potential sources of woody biomass exist in the area, from residue existing in logging sites, to chips from sawmill operations, to wood derived from land clearing. Each type of biomass fuel has a unique characteristic including moisture content and BTU content (British thermal unit, a measure of heat content).

As a rule of thumb, it takes approximately 1.7 green tons of wood (45 percent moisture content) to make 1 megawatt hour (MWH) of electricity using most existing technologies currently available.

Logging Residue

Logging residue is currently the most economically available, largely untapped woody biomass source. When timber stands are harvested, pulpwood and saw logs are the usual products produced. Tree tops are traditionally left in the forests except for small amounts of firewood for residential use that is sometimes hauled out to a landing. Some unmerchantable (cull) and dead trees are also left on site after harvest for wildlife habitat.

The average annual harvest for the five-county area prior to the recent downturn was **75,000** acres with approximately **1,128,000** green tons of biomass available for collection (Table 2).

It is a common forestry practice to leave some coarse woody debris (residue) and some den and snag trees for wildlife habitat in the forests after logging. On sites with nutrient deficient soils, it

is important to leave an even greater percentage of residues on-site after harvest. This is detailed in the "Biomass Harvesting Guidelines" recently completed and available on the Forest Resource Council's website, http://www.frc.state.mn.us/ . Given these and other constraints and operability considerations, a rough estimate of the volume of tops, mortality and cull trees that is potentially recoverable for energy production is approximately one half of the total available for collection, thus **564,000** green tons per year in the Laurentian RC&D area with St. Louis county being the major contributor (268,000 green tons) of potentially available and recoverable biomass (Figure 3).

The available biomass figures are estimates and can vary widely. Most figures in this report contain gross residue volumes and will only be partially recoverable. Breakage, small size and other handling difficulties will limit how much residue can be recovered from a site. In addition, nutrient maintenance and habitat concerns limit the amount of residue that should be recovered from a site. Rough estimates of the percentage of total residue volume that may actually be recoverable obtained from literature, range from 25- 40 percent (Dahlman 1994) to a high of 75 percent (Berguson et al. 2005). "*Minnesota Logged Area Analysis*" updated April 2007. In our recoverable estimate, we used a 50 percent figure as a "best guess".

Table 2. Logging residue generated by harvesting activity in the Laurentian RC&D area. *Source: MN DNR Logged Area Residue Analysis.*

County	Estimated Annual Harvest Area (Acres)	[1]Estimated Annual Logging Residue (Green tons)
Cook	2,629	39,250
Itasca	13,281	200,000
Koochiching	16,496	250,240
Lake	6,901	102,610
St. Louis	35,792	535,900
Total	**75,000**	**1,128,000**
[1]Estimated recoverable		**564,000**

[1]Green tons/cord conversion by cover type was done using Minnesota Logged Area Residue Analysis, Sorensen et al. 2007: Aspen=2.25; Other hardwood=2.55; Low land conifers=2.20; Upland conifers=2.32; Unknown=2.25. Values for totals are rounded-up and may not add up accurately.

It is worth pointing out that, there will be costs associated with getting any biomass material out of the forests to a facility and therefore needs to be carefully analyzed. New technologies for collecting, processing and bundling woody biomass have been demonstrated but the economic viability of much of these equipments is questionable in current market conditions.

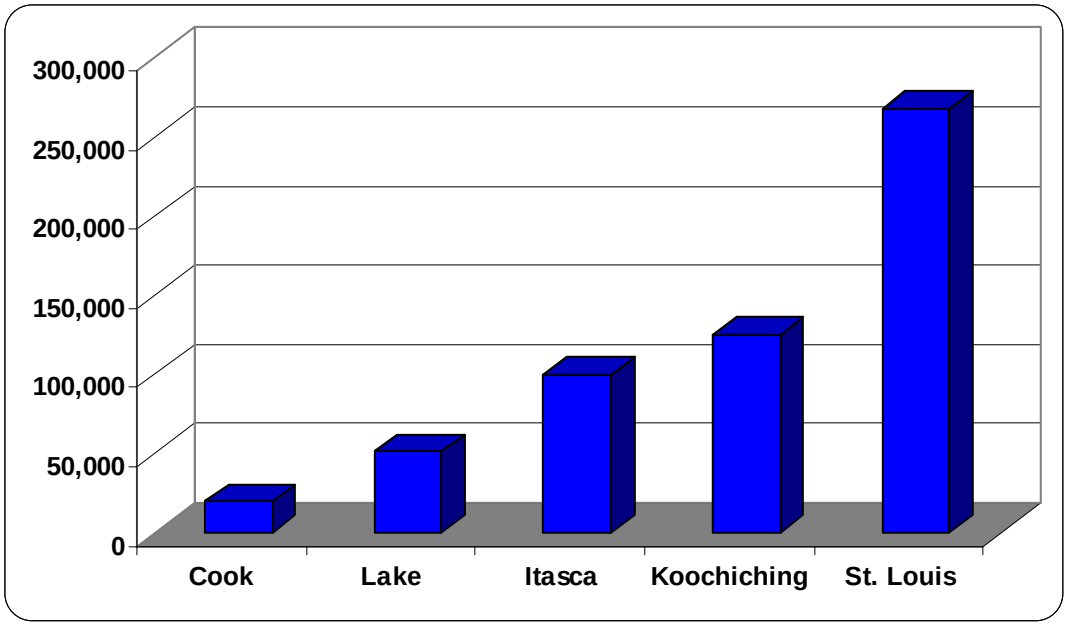

Figure 3. Potential annual logging residue available as biomass in Laurentian RC&D area based on 50 percent recoverable rates.

Pre-Commercial Thinning, Timber Stand Improvement (TSI)

Very young stands and mature commercial sized stands could be thinned for forestry and wildlife habitat improvement. The DNR-Division of Forestry has been directed to study how to bring more of this material to market. Area offices are now working to add more of this type of sale to their annual harvest quotas.

Estimates of potential volume from all ownership types for Pre-Commercial Thinning for the five county Laurentian RC&D area is approximately **802,000** green tons (Table 3). Because of landowner constraints, access issues, economic availability, nutrient concerns and the need to harvest less than growth to address landscape-level forest sustainability concerns, as per Minnesota Biomass Harvesting Guidelines as mentioned above, probably only half of this will be considered actually "available" to the marketplace. Thus, only **401,000** green tons might be recoverable with 34 percent of this coming from private lands (Figure 4). It is important to note that there will be far greater challenges with bringing large volumes of this material to market, than with logging residue. **Readers should be aware that this is not an annual volume figure.**

Table 3. Estimated acres amenable to pre-commercial thinning or timber stand improvement and total biomass yield per cover type and ownership in the Laurentian RC&D area.

Cover Type	Ownership	Area (Acres)	Biomass (Green tons)
Aspen/Balm	Federal	37,816	140,684
	State	34,704	129,108
	County	29,185	108,576
	Private	61,340	228,198
Birch	Federal	6,031	16,268
	State	2,549	6,874
	County	1,736	4,682
	Private	2,947	7,948
Jack pine	Federal	4,381	4,528
	State	732	758
	County	646	668
	Private	1,061	1,096
White spruce	Federal	2,201	6,044
	State	2,260	6,206
	County	282	774
	Private	1,713	4,704
Balsam fir	Federal	6,927	22,080
	State	4,918	15,676
	County	1,904	6,068
	Private	6,207	19,786
Black Spruce	Federal	4,460	10,368
	State	7,074	16,442
	County	2,824	6,564
	Private	2,417	5,618
Other hardwoods	Federal	2,697	8,570
	State	2,025	6,434
	County	1,723	5,476
	Private	3,669	11,658
Total		**236,000**	**802,000**
Estimated[2] recoverable			**401,000***

[2]Values suggests volume of standing trees open to thinning.

* **Readers should be aware that this is not an annual volume figure.**

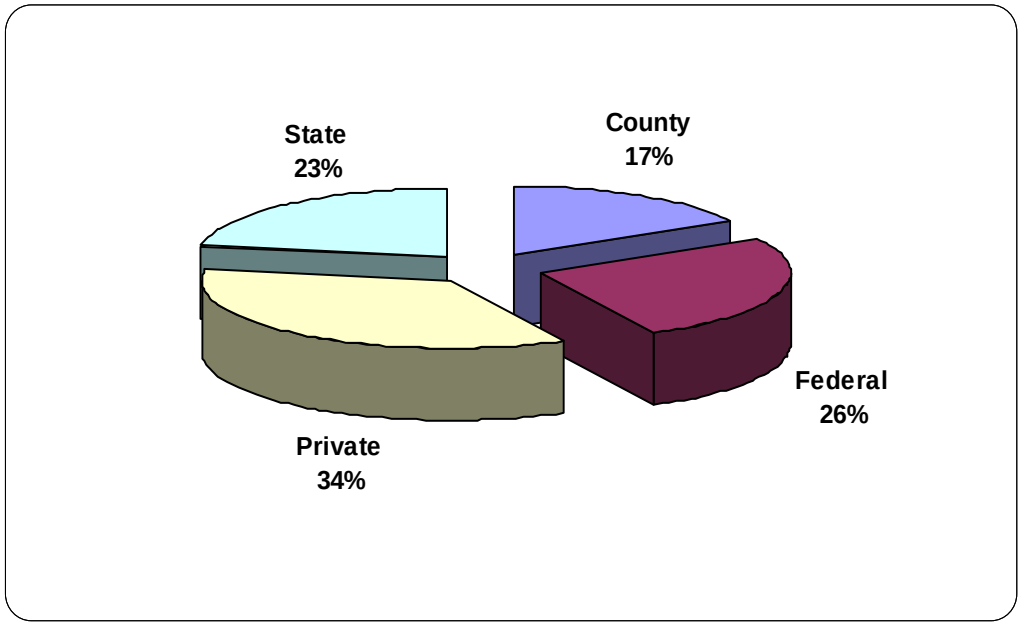

Figure 4. Distribution of potential biomass available from pre-commercial thinning from different land ownerships in Laurentian RC&D area.

Brushland:

Brushland acreages also contain currently unutilized biomass. DNR Wildlife sometimes shears brushlands in the winter to regenerate them, and leaves the biomass on-site. Economically feasible methods for harvesting brush biomass are currently being studied nationwide. Hence it will be difficult to estimate a realistic volume that could be generated from these sources. As a practical matter, it is unlikely that one would be able to access much of this resource for economic reasons in current market conditions. Some demonstration projects are in the works to assess the economics and practicality of utilizing this material. Notwithstanding, our analysis shows that there is an estimated **3.9 million** green tons gross aggregate of brush biomass potentially available at the Laurentian RC&D area (Table 4). **Readers should be aware that this is not an annual volume figure.**

It needs to be clearly stated that while there is a large potential biomass resource from brushlands, as noted above, there is still not a developed system for collection of this material economically at this time. Therefore potential users would need to be committed and engaged in efforts to develop efficient and economical harvest and transport systems. DNR would be pleased to partner with potential collaborators on such efforts in the future. Demonstration projects are proposed and will likely be worked on over the next few years. These projects will allow development of some cost estimates for the recovery and equipment development for brushland harvest.

Table 4. Potential biomass available from Brushlands in Laurentian RC&D area.

County	Area (ac)	Biomass (Green tons)
Cook	30,525	256,406
Itasca	176,833	1,485,398
Koochiching	195,757	1,644,364
Lake	93,701	787,084
St. Louis	436,114	3,663,358
Total		**7,836,600**
[3]Estimated potentially Available	**933,000**	**3,918,000****

[3]Assumes each acre of brushland yields 4.2 dry tons (8.4 green tons) of biomass Berguson et al. 2005. Values suggests volume of standing biomass.

** **Readers should be aware that this is not an annual volume figure.**

Sawmill and Secondary Wood Manufacturing Residue.

Minnesota's forests support a very large and diverse forests products manufacturing sector. Major product categories include pulp, paper, lumber, wood panels, furniture, floorings, cabinets and a variety of other value-added products. The forest industry is often categorized into primary manufacturing and secondary manufacturing sectors. The primary manufacturing sector includes those industries that utilize logs as raw materials. Examples will include pulp and lumber manufacturing operations. The secondary manufacturing sector would include those segments of the industry that utilize a product output of the primary industry as raw material for value-added product. Example will include flooring, furniture and cabinets. Both of the primary and secondary industry sectors produce wood waste materials as by-products of their manufacturing operation. Nearly all of these wood by-products have potential for use as fuel for energy production.

Sawmill Residue:

When sawmills cut cylindrical logs into rectangular boards, residue is produced including bark, saw dust and mill chips. Actual residue generation varies by species and mill equipment, but a general rule of thumb is that a log in a sawmill produces 60 to 70 percent of useful timber as boards, 20 to 30 percent as woodchips, and 10 percent as sawdust.

Data regarding the volumes of primary mill wood residues in Minnesota is currently available from the Minnesota DNR-Division of Forestry which periodically surveys the manufacturing industry of the state. Based on the available data it is estimated that, there are about **107, 000** green tons of biomass generated in the Laurentian RC&D area (Table 5). **However given that most primary manufacturing residuals are already being utilized, active markets exists for these materials in most areas.**

Table 5. Potentially available biomass from sawmills and specialty mills in the Laurentian RC&D Area in green tons.[3]

Residue Use Class	Total Residue	Bark	Bark Mixed with Slabs/ Edgings	Slabs/Edgings	Sawdust/ Shavings
Industrial Fuel	28,519	14,697	823	6,352	6,648
Domestic Fuel	1,773	128	1,008	302	335
Industrial Fuel, Other Mills	10,059	7,578	0	0	2,480
Manufacture Fiber Product	6,571	0	0	6,311	259
Other Uses	29,212	5,483	0	10,988	12,741
Not Used (Available)	6,617	257	869	4,382	1,110
Animal Bedding	18,858	128	115	0	18,615
Landscape Mulch	5,107	1,000	2,150	1,943	14
Totals	**107,000**	**29,000**	**5,000**	**30,000**	**42, 000**

[3]MN DNR Residue Report for Sawmill and Specialty Mill, 2009. Note that most of this material is already being utilized.

Secondary Wood Manufacturer Residue:

Secondary forest products residue are by-products of manufacturing consumer-ready material from lumber. Manufacturers that buy lumber and create a consumer-ready product such as furniture, pallets, or factory made housing are secondary forest products. The residue created at these facilities; shavings, sawdust, chips, and cut-offs can be an excellent source of biomass fuel. Because the raw material is purchased as lumber, and is generally kiln or air dried, secondary forest products residues are low-moisture content fuel, and have a higher heating value per ton than green wood fuels. Be aware however, that residue from many secondary manufacturers is considered unsuitable for energy facilities that need to burn clean wood, due to resins or finishes on the wood. In addition, the chemical composition of certain types of woody biomass may also present problems to boiler or reactor. For instance, woody biomass feedstock with high nitrogen content can cause elevated levels of NO_x (Nitrogen compounds such as nitrates) which has severe environmental implications.

Currently, the MN DNR Utilization and Marketing program does not survey secondary wood manufacturers for residue amounts, so we don't know what is available from cabinet shops, pallet makers, etc. According to the DNR's 1994 publication, "Minnesota Waste Wood Studies," more than 81 percent of secondary manufacturer residues were already being used. Current usage has almost certainly increased, so a smaller percentage of secondary residues are likely to be available at present. The DNR's directory of secondary manufacturers is available online at www.dnr.state.mn.us/timber_producer/index_secondary.html.

Short Rotation Woody Crops:

Short rotation crops include hybrid poplar and other fast growing woody crops that can be planted on poor or marginal agricultural lands.

It is possible that more of this resource could be planted for energy crops on marginal agricultural lands, but care needs to be taken to consider their impact on other resource amenities such as wildlife habitat. In the right places, short rotation woody crops have potential to provide a portion of biomass energy facilities' raw material needs. Serious study of the feasibility of establishing significant acreages of short rotation woody crops would need to be undertaken prior to their inclusion in any facility's fuel plan.

In the future there may be some policy changes to allow willow and alder to be planted on marginal cropland lands to produce energy crops as a complement to hybrid poplar. While this is yet a concept, there is discussion at various levels on such a possibility. Some of these developments will also depend on the landowner's objectives for their property so not every area may be available for this crop system.

SUMMARY:

- **Logging Residue**: In the entire area of the analysis, residue is available annually for biomass in the form of tops and wood not currently utilized in logged areas.

- **Thinning and Brushland Volume**: Some wood could be available from intensified forest and brushland management. This is a large potential biomass resource and opportunity, but would require investment of significant effort and resources from a project developer to develop economically & environmentally harvest and transport systems.

- **Sawmill and Secondary Wood Manufacturer Residue**: A small residue resource may be available from wood manufacturers. Most of this resource is currently being utilized, but there is a small amount that is potentially available for collection and use. Secondary manufacturer residue is somewhat of an unknown commodity. In addition, due to resins and some preservatives applied on this wood, it has the potential of causing some environmental hazards when collected for use as biomass feedstock. Care should be taken to ensure that

biomass from this source is free of these potentials harmful chemicals before it is used as biomass feedstock.

Table 6. Summary of Potentially Available biomass for Laurentian RC&D.

Source of Biomass	**Acres**	**Potentially Available (green tons)**
Logging residue	75,000	564,000[+]
Pre-commercial thinning.	236,000	401,000
Brushland	933,000	3,918,000
Sawmill residue	-	6,600[+]
Total estimated	1,924,000	**4,889,600**

[+] Denotes volume of biomass recoverable annually.

Conclusion

Whiles there has been growing interest in utilization of woody biomass for energy in recent years, the development of bio-energy systems is still evolving and is dependent on the maintenance and productivity on agricultural and forest operations. With the current increase in fuel prices coupled with national security concern on dependence of foreign fuel, it is highly likely that the demand for renewable energy will increase. In particular, the development of new energy sources whether bio-fuels for transportation or biomass for energy (heat and electricity), will result in jobs and economic growth in forested and agricultural areas having available biomass. New jobs and economic growth will be created in the field of biomass production, collection, conversion and distribution. Biomass sources including roundwood, forest harvest residues, forest thinning and agricultural residue could provide a significant amount of woody biomass to be used as feedstock to produce alternate energy in the Laurentian area in particular and Minnesota in general. Additional opportunity exists in new biomass sources such as brushlands and production of energy crops such as poplar and willow.

Minnesota DNR is interested in collaborating with sister agencies and partners to develop markets to support sustainable use of woody biomass. Nevertheless, there are still lots of uncertainties as the industry continues to grow and we urge caution in interpreting these figures on biomass availability. For any serious consideration of using woody biomass for energy in the Laurentian area, we suggest that a serious consideration should be given in conducting a feasibility studies first to ascertain conditions on the ground as well as the economic viability of such a venture. A complete and sustainable supply of woody biomass should be considered carefully before any money and other resources are invested.

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