Wood Fuel Availability Assessment for a Commercial-Scale Biomass Power Generation Facility at the Laskin Energy Center, Hoyt Lakes, Minnesota

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Acknowledgments

TSS Consultants typically implements fuel availability assessment analysis utilizing in-house personnel and resources. This is a business model that our firm has utilized since it was founded in 1986. The Laskin Fuel Study project was very unique in that the client made available an array of knowledgeable staff, research institutions, transportation consultants and networks that proved invaluable during the data gathering and analysis phase of this project. Minnesota Power executive management can be confident that the very best and most current information was made available to TSS Consultants in support of this assessment.

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- Keith Jacobson, Utilization and Marketing Program Leader, Minnesota DNR

The assessment team as assembled by TSS Consultants included:

- Tad Mason, Forester and Managing Partner, TSS
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ABBREVIATIONS/ACRONYMS

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

Organizations

BIA	Bureau of Indian Affairs
DNR	Minnesota Department of Natural Resources
FSC	Forest Stewardship Council
IATP	Institute for Agriculture and Trade Policy
IWL	Izaak Walton League
MCEA	Minnesota Center for Environmental Advocacy
MEP	Minnesota Environmental Partnership
MFI	Minnesota Forest Industries
MFRC	Minnesota Forest Resources Council
MLEP	Minnesota Loggers Education Program
MP	Minnesota Power
TSS	TSS Consultants
USFS	United States Forest Service

Other Terms

BDT	Bone Dry Ton
CN	Canadian dollar equivalent or Canadian National Railway
CWPP	Community Wildfire Protection Plan
DBH	Diameter at Breast Height
EAW	Environmental Assessment Worksheet
EIS	Environmental Impact Statement
ERC	Emission Reduction Credit
FIA	Forest Inventory Analysis
GAP	Gap Analysis Program
GIS	Geographic Information System
GT	Green Ton
HFRA	Healthy Forest Restoration Act
LSA	Laskin Study Area
MSW	Municipal Solid Waste
MW	Megawatt (electric)
NEPA	National Environmental Policy Act
NFP	National Fire Plan
OCC	Old Corrugated Cardboard
OSB	Oriented Strand Board
PPA	Power Purchase Agreement
PTC	Production Tax Credit
REC	Renewable Energy Credit or Certificate
RES	Renewable Energy Standard
SRWC	Short Rotation Woody Crop

1.0 Executive Summary

Minnesota Power (MP) is committed to developing cost effective renewable energy generation in the region and complying with Minnesota's Renewable Energy Standards. As part of that effort, MP has completed an initial assessment of a number of biomass generation initiatives at customer sites and company locations throughout northern Minnesota. Based upon this assessment, potential biomass generation development options have been identified including a 25 MW facility located at the Laskin Energy Center (Laskin) in Hoyt Lakes.

MP has retained TSS Consultants (TSS) to lead a team in the development of a fuel availability assessment and fuel procurement plan for the Laskin facility. As the project leader, TSS conducted an extensive review of the biomass fuel markets in northern Minnesota. Additionally, TSS reviewed potential fuel availability in the provinces of Ontario and Manitoba, Canada. Based on the results of this assessment, TSS has ascertained that the wood fiber markets of northern Minnesota, Ontario and Manitoba are undergoing one of the most significant economic downturns in decades. In fact, the situation in Ontario has been described as an outright crisis.

Under this backdrop of tumbling forest products industry production and drastically reduced roundwood harvest levels, TSS has attempted to determine the potential of producing an additional 275,000 green tons (GT) per year of wood fuel for the Laskin project beginning in late 2010. Although it is the opinion of TSS that the worst part of this declining forest products industry market may be over, the recovery period is anticipated to stretch into 2010. For purposes of this assessment, TSS has assumed that beginning in 2010 and continuing into 2011, the industry will recover to pre-2006 levels of production. In other words, TSS is anticipating that harvest levels in Minnesota forests will return to 3.5 to 3.7 million cords per year. This is a key assumption for the development of the biomass fuel availability volumes used in this assessment.

Based on this assessment, TSS has determined that the timberlands within the LSA have the potential of generating over 2.2 million GT of biomass fuel per year. However, when taking into account the regulatory, environmental, economic and operational constraints associated with forest biomass recovery, this volume drops substantially. Considering the biomass retention guidelines as outlined in the Minnesota Forest Resources Council Guidelines (Minnesota Forest Resources Council, 2007) and the logistics associated with biomass harvesting, TSS has assumed that only 67% of this total potential biomass will be practically available to the Laskin project. This results in approximately 1.575 million GT of forest-derived biomass available annually within the LSA. Taking into account all other forms of biomass fuel available within the LSA results in a total volume of practically available biomass fuel of 1,670,564 GT per year.

Given the current and future wood fiber and fuel usage of forest-derived fuels generated within the LSA, TSS estimated that approximately 1,247,000 GT will be consumed per year by 2010. (Refer to Tables 15 and 16 for a breakdown of the estimated fuel usage by project.) Based on these figures, TSS estimates that over 423,000 GT of total biomass fuel will be practically available per year for the Laskin project. This fuel consists of forest-derived fuels, urban wood waste and Canadian-sourced fuel. As a result of this assessment, TSS believes the 25 MW Laskin biomass project will have adequate wood fuel supply.

1.1 Study Objectives

The primary objectives of this study include quantifying the biomass resources by type and ownership.

Type

- **Forest residues**: timber harvest residues, forest thinnings, non-merchantable round-wood, brushlands, and forest fuels reduction residues.
- **Energy crops**: short rotation, intensively-managed wood crops, including hybrid poplar and willow.
- **Agricultural residues**: including, but not limited to northwest Minnesota and northwest Wisconsin agricultural residues.
- **Other**: railroad ties, clean construction/demolition debris, etc.

Ownership

- Work with major resource and land managers to identify forest management plans and projections, unique resource options, partnership potential, and harvest development timelines and challenges.
- Public agencies include, but are not limited to: MN DNR, USFS, USDA, selected county land departments and Tribal trust lands.
- Private landowners and managers include, but are not limited to: Forest Capital, Plum Creek, Potlatch, Blandin and Abitibi.
- Explore key strategic partnerships with major regional parties (government agencies, major land owners, customers, etc.) to supply significant portions of the Laskin supply.

1.2 Findings

Fuel Availability

- Within the LSA it is estimated that almost two-thirds of the timberland is concentrated in state/county and private ownership. This fact is critically important since these timberlands contributed over 93% of the harvested roundwood volume in Minnesota in 2005 (Department of Natural Resources, 2006) while federally-managed timberlands, including BIA, contributed less than 7%.
- Total potentially available biomass fuel within the LSA is estimated at 2.3 to 2.4 million GT per year.
- After consideration for regulatory, economic and operational limitations, TSS has estimated that approximately 1,670,564 GT of biomass fuel is practically available annually within the LSA.
- Forest-derived biomass fuels represent the largest potential fuel source for the Laskin project. TSS estimates that on an annual basis there are approximately 1,575,925 GT of practically available forest-derived biomass fuel within a 100-mile supply radius of the Laskin project site. This represents approximately 94% of the practically available fuel. Canadian supplies consisting of mill residues and some experimental densified agricultural residues make up approximately 4%. Local urban wood waste and tree service residues make up approximately 2% of the remaining practically available fuel supply.
- Within the LSA, it is estimated that there is a 925,000 GT per year demand for forest-sourced biomass fuel; an additional 322,000 GT per year usage has the potential of being added over the short term (by 2010).
- The volume of biomass practically available for the Laskin project is estimated at 423,564 GT per year.

2.0 Fuel Availability Assessment

2.1 Introduction

The forest products industry is well known for its cyclical nature. The past two years have witnessed one of the most dramatic downturns in decades. The timber harvest data used to develop this assessment is based on 2005 harvested acres (Department of Natural Resources, MN Logged Area Residue Analysis, 2007). As such, the volume estimates used for potential biomass availability are undoubtedly overstating biomass fuel currently available in 2007. However, based on lumber market reviews, TSS believes that by 2010-2011, the forest products markets will again return to their historical harvest levels.

2.2 Laskin Study Area

For the purposes of this investigation, the Hoyt Lakes area and the surrounding region is considered to be that geographic landscape included as the Laskin Study Area (LSA). In order to assess environmentally and economically available biomass fuel volumes and costs, it is assumed that a biomass power project could be located at Hoyt Lakes, Minnesota. The target study area is defined as that region located within a 100-mile radius of Hoyt Lakes. Note that while the LSA represents the geographic region most likely to provide economical woody biomass fuel to the Laskin facility, additional woody biomass fuel located tributary to the LSA was also included in this wood fuel supply assessment. Exhibit 1 below provides an overview of the Laskin target study area.

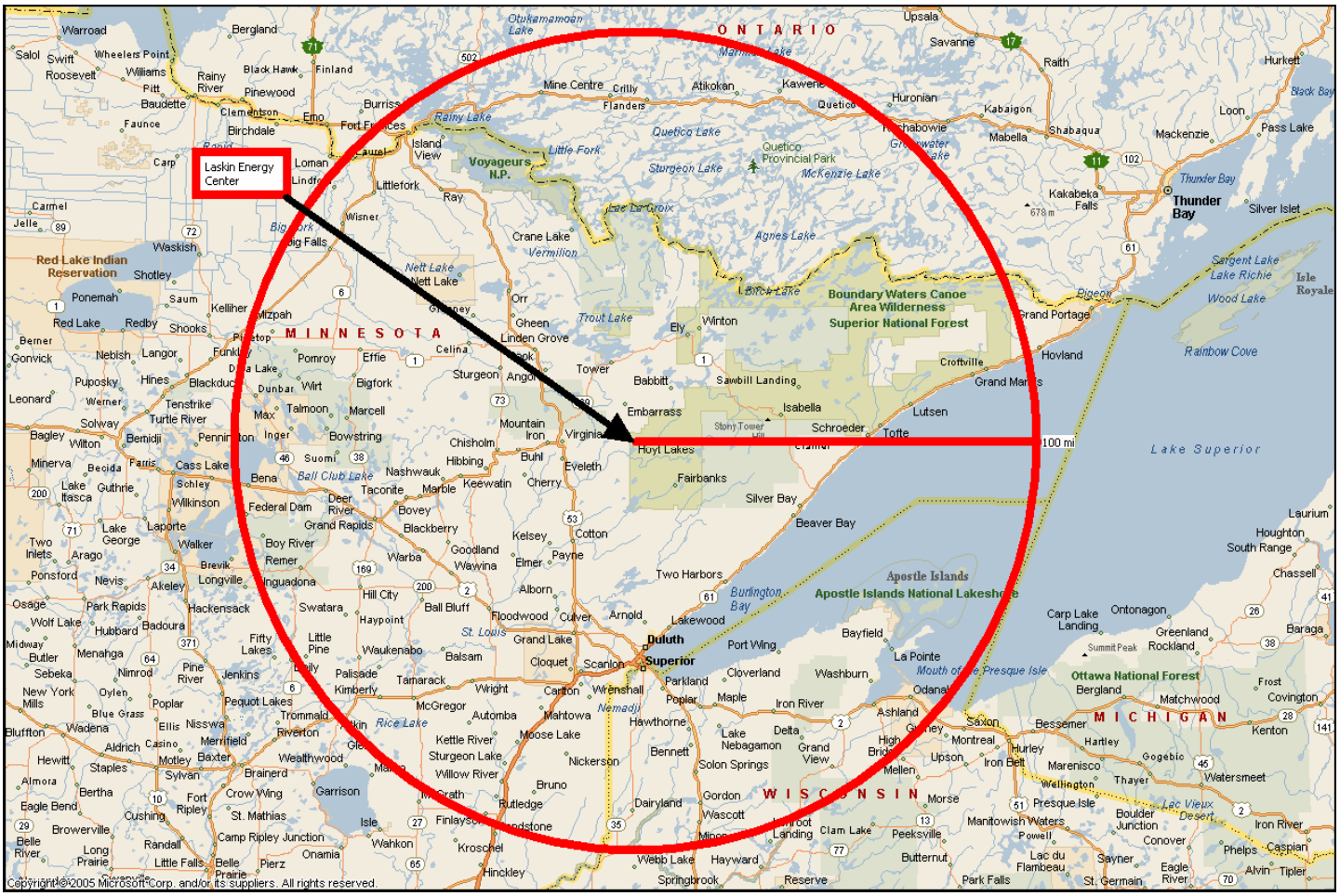


Exhibit 1. Laskin Energy Center Target Study Area

2.3 Findings

- Within the LSA, it is estimated that almost two-thirds of the timberland is concentrated in state/county and private ownership. This fact is critically important since these timberlands contributed over 93% of the harvested roundwood volume in Minnesota in 2005 (Department of Natural Resources, 2006) while federally-managed timberlands, including BIA, contributed less than 7%.
- Total potentially available biomass fuel within the LSA is estimated at 2.3 to 2.4 million GT per year.
- After consideration of regulatory, economic and operational limitations, TSS has estimated that approximately 1,670,564 GT of biomass fuel is practically available on an annual basis within the LSA. See Table 13 for summary.

- Forest-derived biomass fuels represent the largest potential fuel source for the Laskin project. TSS estimates that there are approximately 1,575,925 GT per year of practically available forest-derived biomass fuel within a 100-mile supply radius of the Laskin project site. This represents approximately 94% of the practically available fuel. Canadian supplies consisting of mill residues and some experimental densified agricultural residues make up approximately 4%. Local urban wood waste and tree service residues make up approximately 2% of the remaining practically available fuel supply. See Table 10 for summary.

2.4 Forest Vegetation Cover

To better assess woody biomass material available for the Laskin project, it is helpful to understand the vegetation and ownership types within the study area. Woody biomass material available on a sustained basis for a given area is directly dependent upon vegetation type, ownership patterns, and distance to the project site.

Working closely with the Natural Resource Research Institute (NRRI), TSS analyzed vegetation and ownership data to identify potential fuel availability by distance to the Laskin site at Hoyt Lakes, MN. Consistent with the Forest Biomass Guidelines (Minnesota Forest Resources Council, 2007) and the Minnesota Forest Practice Rules, elevation, stream data, sensitive soils, and biologically significant sites were used to identify areas where treatment activities may or may not be feasible or appropriate. While the State of Wisconsin does not currently have Forest Biomass Guidelines (or equivalent),[1] TSS asked NRRI to apply the Minnesota Biomass Guidelines/Forest Practice Rules to the Wisconsin landscape as future policies may dictate changes to current Wisconsin forest practices. In order to facilitate this treatment analysis, a series of data layers were compiled, synthesized and evaluated by the Center for Water and the Environment at the NRRI. Combining these data sets and removing inoperable areas like Lake Superior and the Boundary Waters Canoe Area Wilderness, the NRRI identified locations within the LSA where treatment activities may be conducted in the near and long term. The data sources[2] utilized for this analysis are listed below by State.

Minnesota

1. MN GAP[3] Land Cover
2. MN Digital Elevation Model
3. MN Scientific and Natural Area Boundaries
4. MN County Boundaries
5. MN Department of Natural Resources 24K Streams
6. MN MCBS Native Plant Communities
7. MN MCBS Sites of Biodiversity Significance

[1]Per discussions with Scott Henker, Senior Resources Manager, and Paul Hanson, Senior Resources Forester, Plum Creek.
[2]Metadata for each GIS data layer is available upon request.
[3]Gap Analysis Project.

8. MN Scientific and Natural Area Boundaries
9. MN Trout Streams
10. MN Wildlife Management Area Boundaries
11. MN GAP Stewardship - All Ownership Types
12. The Nature Conservancy of Minnesota's Preserve Boundaries and Managed Areas

Wisconsin

1. WI Department of Natural Resources (DNR) County Forests
2. WI DNR Forestry Areas
3. WI DNR Managed Lands
4. WI Digital Elevation Model
5. WI DNR Open Water
6. WI DNR Rivers & Shorelines
7. WI GAP Land Cover Classes[4]
8. WI GAP Stewardship - All Ownership Types
9. WI GAP Land Cover Grid
10. WI GAP USGS Stewardship
11. WI Land Cover Level 2

Ownership and vegetation cover data sets were not available for that portion of the LSA that falls within Canada. In addition, due to the predominant public management (Crown Lands) of Canadian forests and the robust nature of the Canadian forest products industry (most all of the forest resource is currently utilized and not available), the assessment team did not include Canada in the vegetation and ownership analysis.

Vegetation Cover

The vast majority of the target study area is in the State of Minnesota and is covered by forested lands. Of the 8,101,842 forested acres in the Minnesota portion of the LSA, more than half of those acres are comprised of the aspen/birch forest type (4,231,391 acres). The next largest vegetation cover classes within the forested types are lowland black spruce followed by lowland northern white cedar and tamarack. Of the 3,481,517 non-forested acres in the Minnesota portion of the Laskin study area, the majority of the vegetation is comprised of lowland deciduous shrub (1,140,455 acres) followed by upland shrub (538,430 acres).

Of the 1,317,303 forested acres in the Wisconsin portion of the LSA, the dominant vegetation cover types are aspen/birch and upland deciduous with 384,517 and 370,781 acres respectively. The next largest vegetation cover class within the forested types is lowland conifer-deciduous mix. Within the 545,499 non-forested acres in the Wisconsin portion of the Laskin study area, the majority of the vegetation is comprised of grasslands (205,105 acres) followed by lowland deciduous shrub (155,612 acres).

As previously mentioned, to better assess woody biomass material available for the Laskin project, it is helpful to understand the vegetation types, forested and non-forested,

[4]WI GAP Land Cover classes are cross-walked to MN Gap Land Cover as per the table in Appendix 3.

within the study area. While the emphasis of this fuel availability study has been on those traditional timberland acres that will likely provide woody biomass material on a long-term basis, some experts have indicated that croplands may serve as non-traditional biomass fuel sources through cultivation of native grasses (blue stem and reed-canary).[5] This vegetation cover analysis found that cropland makes up a relatively small component at two percent of the landscape included in the LSA. Exhibit 2 provides a map highlighting the diversity of vegetation cover types in the study area.

[5]Interviews with Al Doering, Associate Scientist, Co-Products, Agricultural Utilization Research Institute.

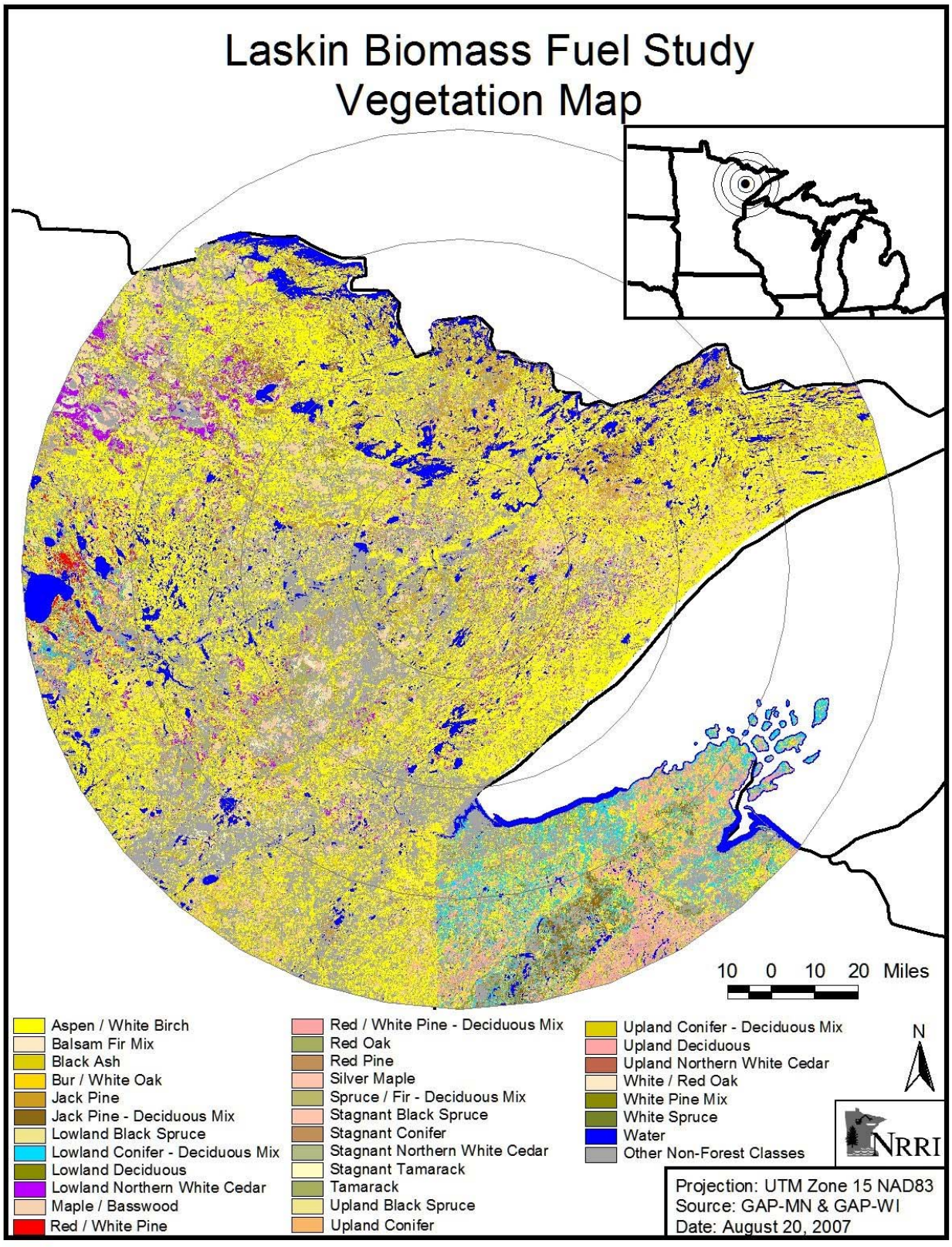


Exhibit 2. Laskin Fuel Study Vegetation Cover Map

In order to simplify the vegetation cover analysis and apply average residue recovery factors, these 30 forested cover types (Exhibit 2 above) are aggregated into four major groupings. Exhibit 3 highlights by pie chart the distribution of these vegetation groupings over the entire study area. For detailed information regarding how these 30 forest classes are grouped and the acreage by specific vegetation type, refer to Appendix 3.

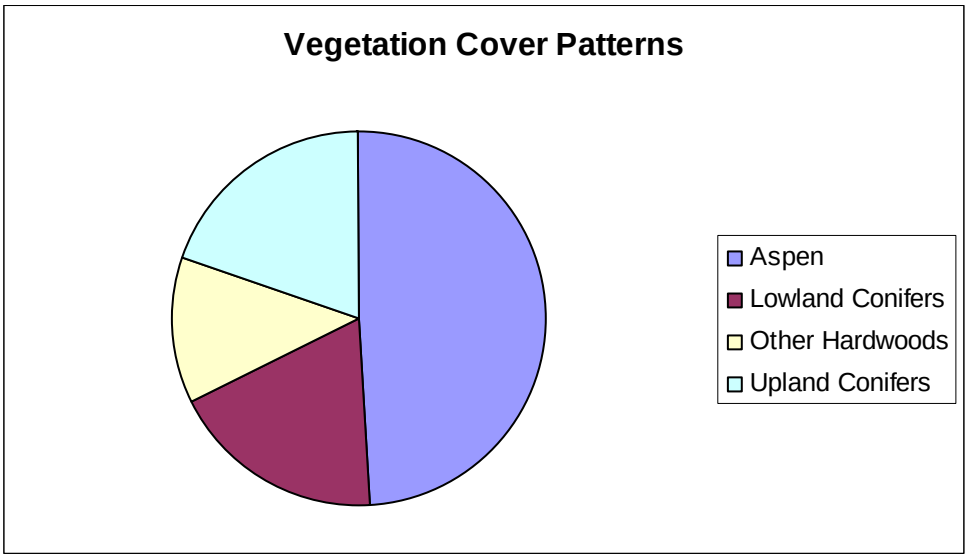


Exhibit 3. Laskin Fuel Study Vegetation Groupings

These four vegetation groupings are important to the overall fuel analysis because average residue recovery factors were applied to each grouping using data from DNR's Minnesota Logged Area Residual Analysis (2007). The volume of biomass fuel generated as a result of forest management activities can vary significantly depending on the existing forest conditions, harvest systems and silvicultural objectives. Interviews with fuel procurement managers, chipping contractors, private forest managers and national forest staff indicate that biomass fuel recovered during forest management activities can vary significantly. These interviews indicated that the DNR logging area research is the best available science to address forest residue volumes potentially available from forest management activities. Based upon this work, residue recovery factors were applied to the four vegetation groupings as designated in the DNR analysis. As previously mentioned, the aspen grouping[6] makes up half of the acres within the 100-mile radius.

[6]The aspen grouping within DNR's Fuel Recovery Class includes only the Aspen/Birch GAP Land Cover class.

2.5 Forest Ownership

Using a Geographic Information System (GIS), TSS and NRRI were able to evaluate the available woody biomass by vegetation and ownership types within the LSA. Ownership classifications from the Gap Analysis Program (GAP) Stewardship layer are stratified by the following types of ownerships for both Minnesota and Wisconsin portions of the study area:

1. Federal
2. Tribal
3. State, including tax-forfeited lands under county stewardship in Minnesota
4. Private lands which include Private Industrial and Non-Industrial Private or Trust[7]
5. County (Wisconsin)

In analyzing the acres where treatment activities may be performed in the LSA, over 46% would include those lands owned and managed by the state and counties. The federal ownership contributes 25% while private lands contribute 26% of operable acres. The analysis included a ring-by-ring view of 25, 50, 75 and 100-mile radius areas around the Laskin project site (Exhibit 4 below) so that biomass estimates may account for the haul distance and potential competitors for the same forest residue resources. For this report, only the 100-mile radius LSA data is summarized.

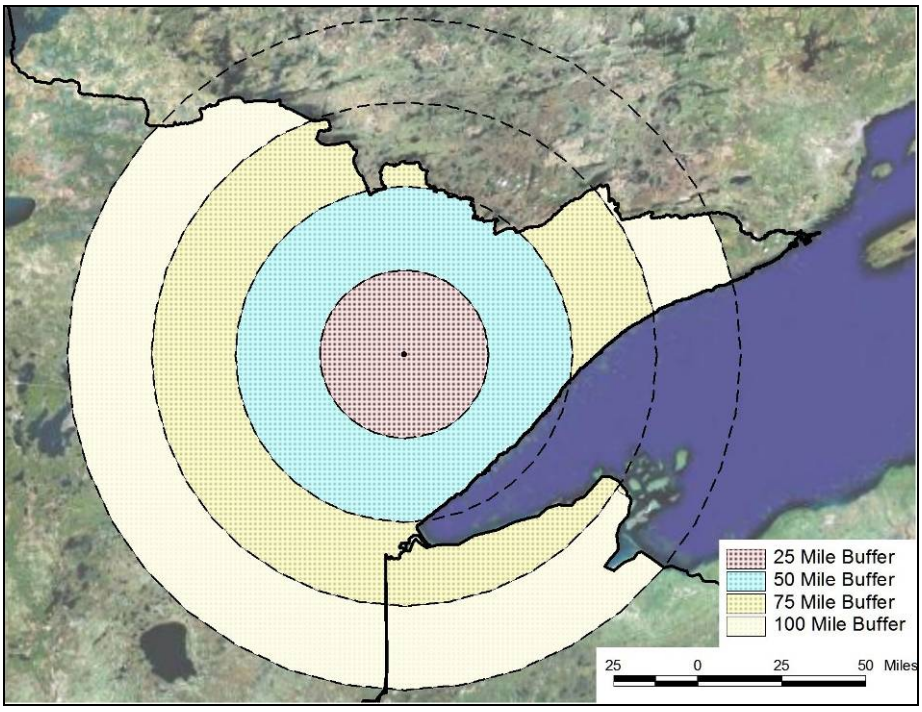


Exhibit 4. Laskin Fuel Study Radial Ring Analysis Map

[7]More than 1000 acres owned within the affected county.

Exhibit 5 provides graphic representation of the land ownership patterns in the LSA.

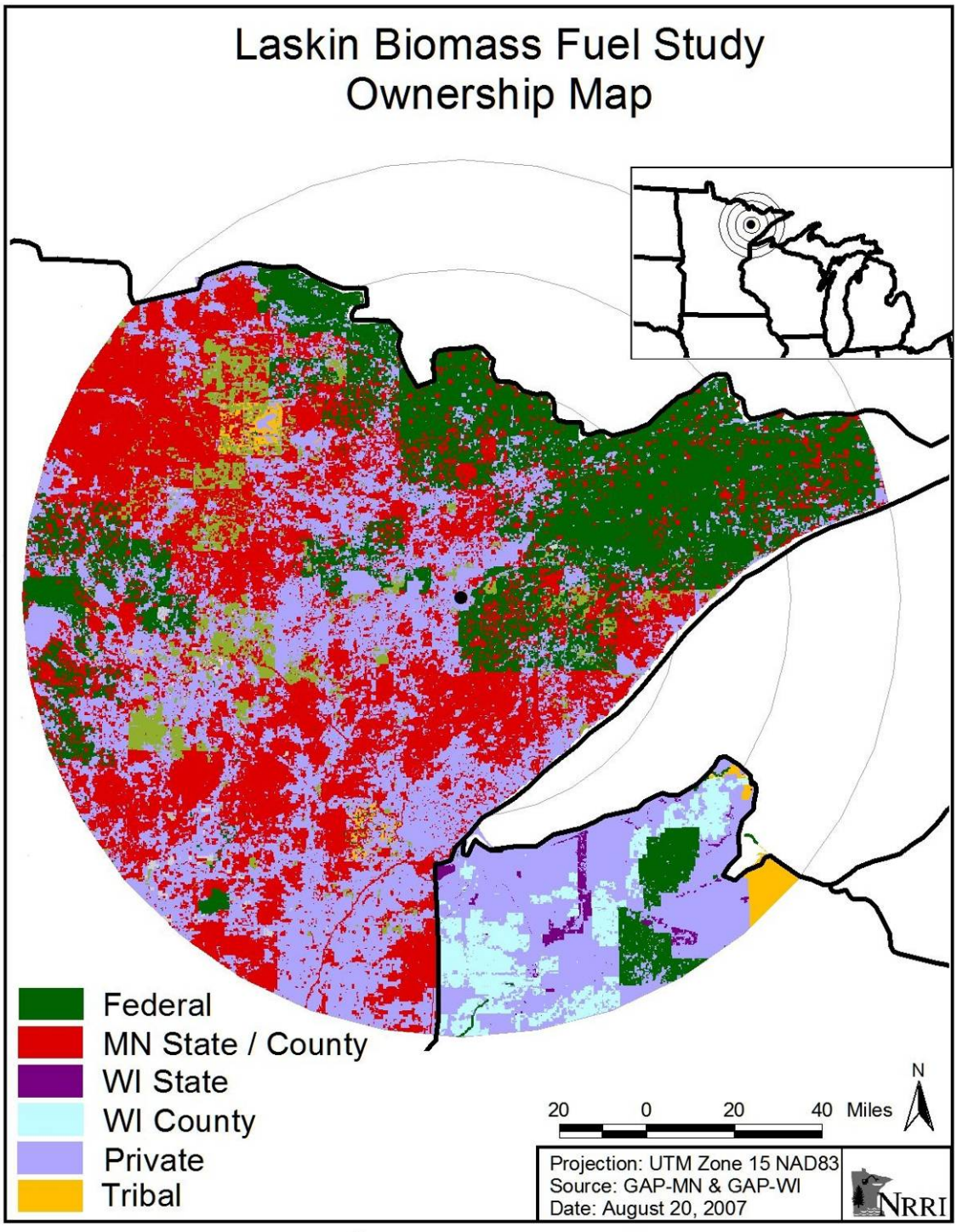


Exhibit 5. Laskin Fuel Study Ownership Cover Map

Operable Area Analysis

Within each radial ring, land ownership was used to identify treatment potential within each vegetation type through what is called an operable area analysis or Go/No Go Analysis. Utilizing the December, 2007 Forest Biomass Guidelines, the Minnesota Forest Practice Rules and relevant data layers (such as Sites of Biodiversity Significance, elevation, stream data), NRRI identified areas where treatment activities may or may not be feasible or appropriate. Combining these data sets identified locations within the LSA where treatment activities may be conducted in the near and long term (also termed "Go" acres). The Go/No Go analysis was performed on all vegetation types and ownerships within 100 miles of the Laskin project site. Appendix 3 has the detailed request that TSS provided to NRRI to define and exclude lands that are not expected to sustain forest residue recovery operations over time.

In Minnesota, the GAP USGS Stewardship layer does not distinguish between state and county lands. The state/county ownership category data thus includes both state and county lands. As demonstrated by Exhibit 3 above, the majority of these acres are covered by the aspen cover type.

The forested acres in Wisconsin demonstrate dynamically different ownership and vegetation patterns. Within the LSA, state and county lands make up over 83% of the Wisconsin acres.

Total accessible acres within the entire LSA amounts to 90% of the landscape (see Table 1 below). Of the Federal ownership, 88.5% is considered Go acres. All private lands, including non-industrial and industrial private ownerships, have 87.5% of their lands identified as "Go." County and state lands are 92.5% accessible under this Go/No Go analysis. Table 1 and Exhibit 6 highlight this Go/No Go analysis by ownership within the LSA. Exhibit 7 displays the No Go acres (in red) by each analysis ring within the LSA.

Table 1. Total Go/No Go Acres by State and Ownership Class within the LSA

STATE	Go/No Go	County/State	Federal	Private	Tribal	Grand Total
MN	Go	4,246,414	2,558,921	3,722,815	59,809	10,587,959
	No Go	317,906	339,871	530,549	2,148	1,190,473
MN Total		4,564,320	2,898,792	4,253,363	61,957	11,778,432
WI	Go	1,427,502	203,027	2,218	62,037	1,694,784
	No Go	141,438	17,931	454	8,395	168,218
WI Total		1,568,939	220,958	2,672	70,432	1,863,001
Total Go Acres		5,673,915	2,761,948	3,725,033	121,847	12,282,743
Percentage Go Acres		92.5%	88.5%	87.5%	92.0%	90.0%
Total		6,133,259	3,119,750	4,256,035	132,390	13,641,434

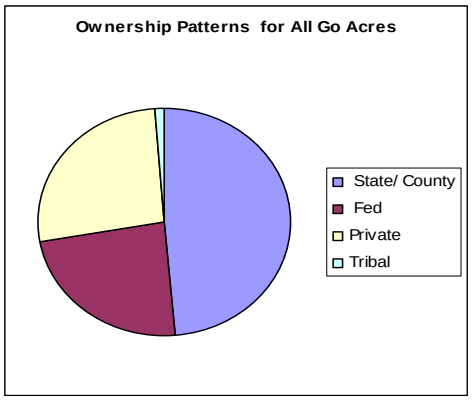


Exhibit 6. Total Go Acres by Ownership Class

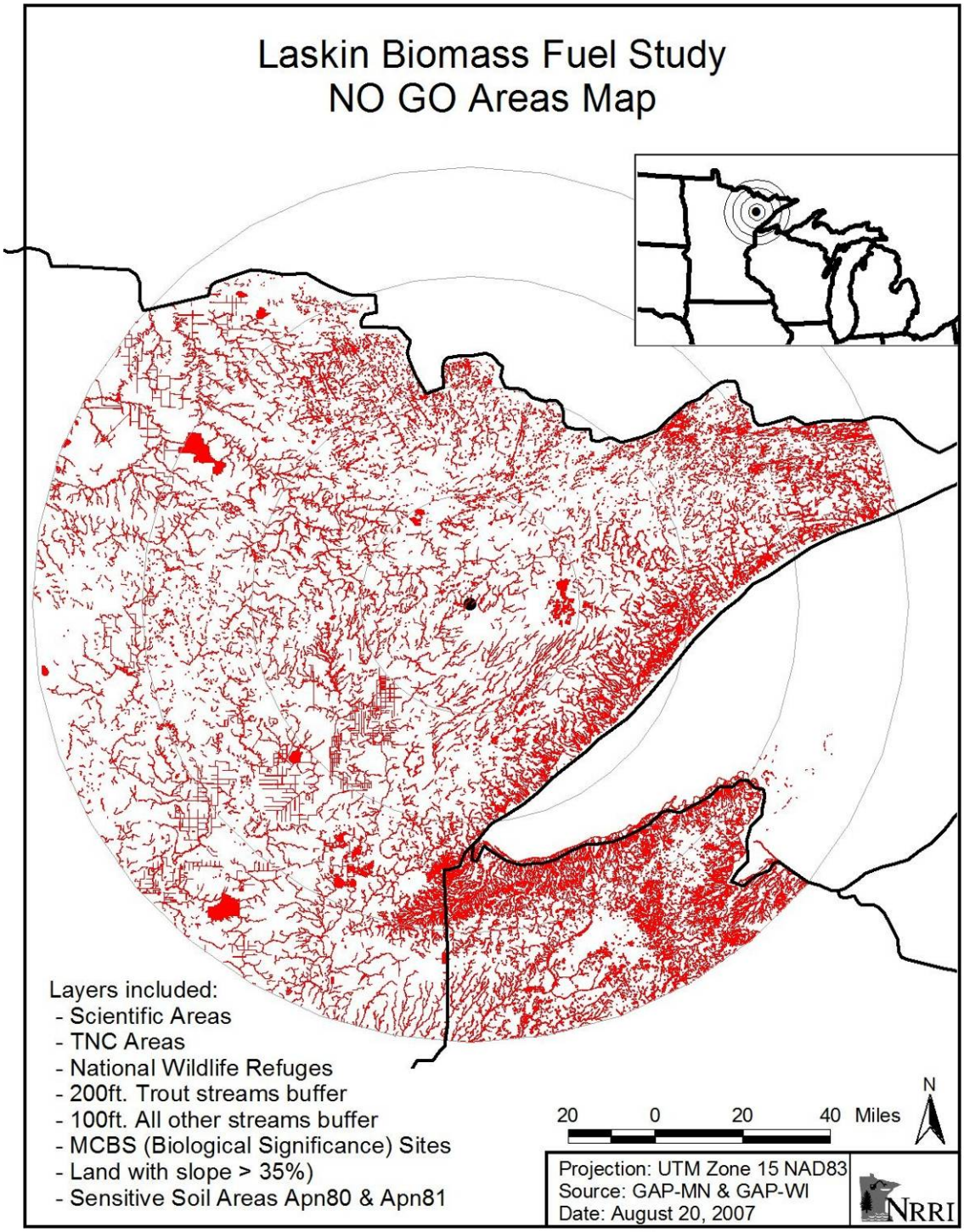


Exhibit 7. Laskin Fuel Study Go/No Go Coverage Map

Typical equipment limitations pose challenges to traditional forested treatments and removal operations confined to operate on slopes that range from 0% (flat) to just under 35% (moderately steep). Based upon the Go/No Go analysis, slope does not seem to be a limiting factor for operations in northern Minnesota. Exhibit 8 displays sloped classes within the Laskin Study Area.

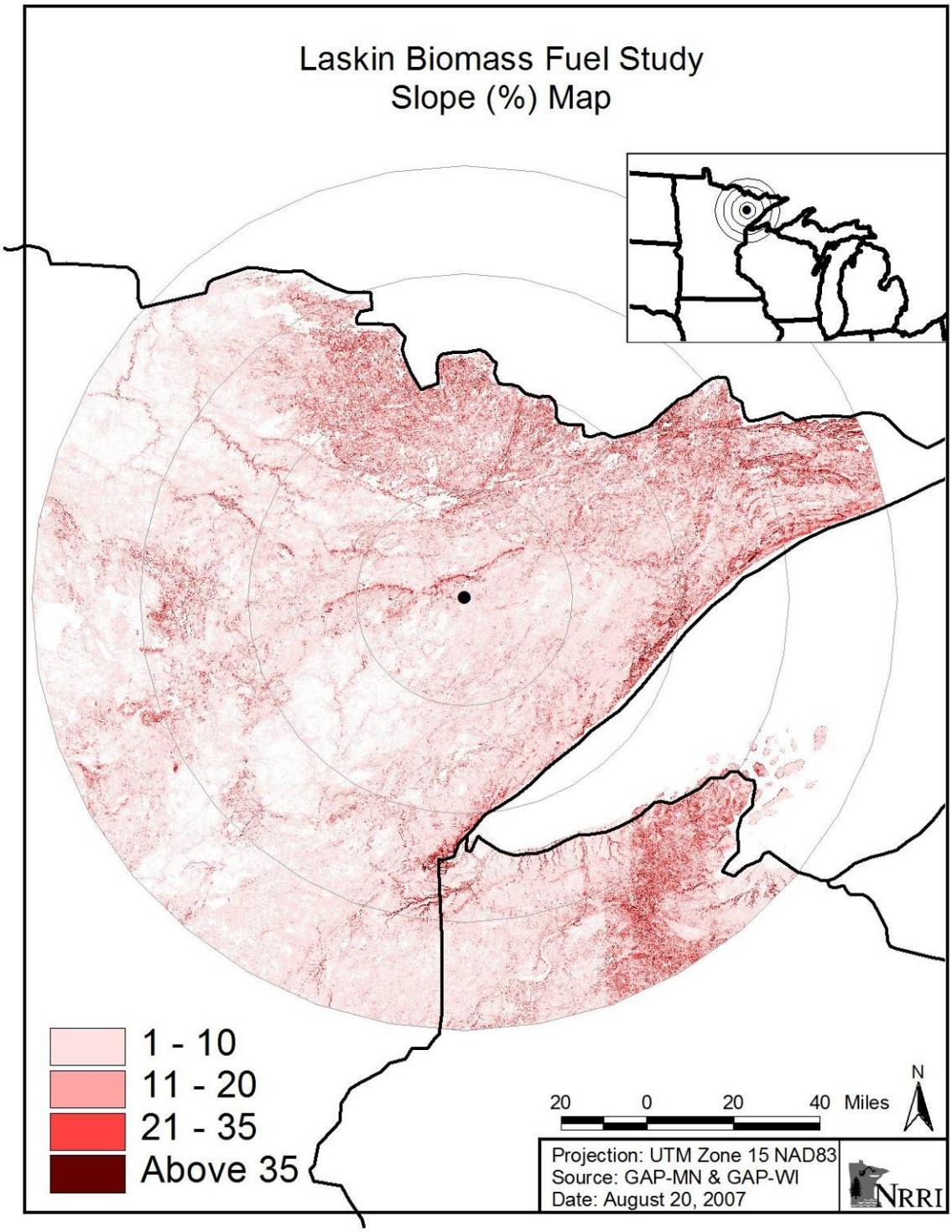


Exhibit 8. Laskin Fuel Study Slope Map

Table 2 shows the amount of Go acres by vegetation and ownership types within the LSA.

Table 2. Total Go Acres by Vegetation and Ownership within the LSA

STATE	CLASS NAME	% of State Total	Fed	State/County	Private	Tribal	Grand Total
MN	Aspen/White Birch	38.4%	1,116,081	1,382,745	1,552,799	13,563	4,065,188
	Balsam Fir mix	2.2%	82,573	75,358	78,072	1,720	237,723
	Barren	0.6%	4,699	19,128	34,171	597	58,595
	Black Ash	2.4%	18,272	131,621	104,229	1,025	255,147
	Broadleaf Sedge/Cattail	0.4%	13,498	20,785	10,240	194	44,717
	Bur/White Oak	0.1%	70	2,617	2,964	5	5,657
	Cropland	1.9%	4,843	25,839	168,485	430	199,597
	Floating Aquatic	0.2%	3,024	12,293	9,892	59	25,269
	Grassland	4.4%	12,683	106,203	342,157	831	461,874
	Jack Pine	4.5%	281,225	109,469	82,001	2,364	475,059
	Jack Pine-Deciduous mix	0.0%	170	139	422	6	738
	Lowland Black Spruce	7.2%	169,172	441,780	141,506	8,658	761,116
	Lowland Conifer-Deciduous mix	0.2%	6,940	14,685	2,351	102	24,078
	Lowland Deciduous	0.4%	11,605	13,375	12,408	245	37,633
	Lowland Deciduous Shrub	9.4%	140,775	548,841	306,009	4,602	1,000,227
	Lowland Evergreen Shrub	0.7%	2,304	60,074	13,402	382	76,161
	Lowland Northern White-Cedar	3.1%	45,180	215,947	60,544	4,939	326,609
	Maple/Basswood	2.2%	33,005	100,795	95,689	1,816	231,305
	Red Oak	0.6%	2,934	25,924	32,602	343	61,804
	Red Pine	2.0%	69,015	70,277	66,127	3,611	209,029
	Red/White Pine	0.3%	21,123	4,164	8,291	188	33,767
	Red/White Pine-Deciduous mix	0.7%	52,930	14,062	10,024	38	77,054
	Sedge Meadow	1.8%	25,295	95,320	64,767	1,216	186,598
	Silver Maple	0.0%	0	235	336	1	572
	Spruce/Fir-Deciduous mix	0.5%	35,894	8,051	6,037	15	49,997
	Stagnant Black Spruce	2.3%	56,257	152,561	37,016	401	246,236
	Stagnant Conifer	0.0%	310	892	609		1,810
	Stagnant Northern White-Cedar	0.2%	1,478	12,984	2,040	198	16,701
	Stagnant Tamarack	0.6%	993	54,006	9,953	241	65,193
	Tamarack	2.9%	30,560	214,083	63,919	2,102	310,664
	Upland Black Spruce	0.1%	7,613	1,593	1,522	1	10,729
	Upland Conifer	0.0%	971	762	1,544	15	3,292
	Upland Conifer-Deciduous mix	0.1%	1,540	5,470	5,667	69	12,746
	Upland Deciduous	0.9%	24,378	28,334	41,983	192	94,888
	Upland Northern White-Cedar	0.3%	6,161	12,595	10,473	1,458	30,686
	Upland Shrub	4.9%	128,899	173,648	214,302	2,166	519,014
	Urban	0.9%	1,451	11,940	79,501	425	93,317
	Water	1.6%	120,040	34,725	6,147	3,416	164,328
	White Pine mix	0.8%	20,870	30,909	25,749	1,985	79,514
	White Spruce	0.2%	3,871	9,610	12,017	189	25,687
	White/Red Oak	0.1%	220	2,573	4,847	0	7,639
MN Total			2,558,921	4,246,414	3,722,815	59,809	10,587,959
WI	Aspen/White Birch	20.8%	40,701	292,175	300	19,992	353,168
	Barren	0.5%	157	8,454	4	31	8,645
	Broadleaf Sedge/Cattail	0.7%	600	10,671	18	971	12,260
	Cropland	0.6%	334	9,375	2	2	9,713
	Grassland	11.2%	2,764	185,190	41	1,293	189,288
	Jack Pine-Deciduous mix	4.7%	13,914	64,895	110	54	78,973
	Lowland Black Spruce	2.6%	2,398	39,811	503	1,248	43,960
	Lowland Conifer-Deciduous mix	12.6%	18,858	185,962	242	9,253	214,315
	Lowland Deciduous	2.4%	1,916	34,077	149	3,954	40,096
	Lowland Deciduous Shrub	8.2%	3,107	125,373	197	10,104	138,782
	Lowland Evergreen Shrub	0.4%	667	6,826	32	2	7,527
	Red Oak	1.0%	1,912	15,315	40	6	17,273
	Red Pine	3.1%	14,098	37,712	42	596	52,448
	Silver Maple	2.0%	10,126	24,339	42	118	34,624
	Spruce/Fir-Deciduous mix	1.7%	7,314	21,170	42	664	29,190
	Upland Deciduous	20.1%	68,708	261,302	335	10,263	340,608
	Upland Shrub	4.5%	13,608	58,981	116	2,759	75,463
	Urban	0.5%		7,817	-	140	7,957
	Water	2.1%	959	34,355	2	510	35,827
	White/Red Oak	0.3%	885	3,701	1	78	4,665
WI Total			203,027	1,427,502	2,218	62,037	1,694,784
Grand Total			2,761,948	5,673,915	3,725,033	121,847	12,282,743

2.6 Forest-Derived Fuel

For purposes of this study, TSS has focused analysis efforts on forest-derived biomass fuels composed of timber harvest residues, sub-merchantable material (<5" DBH[8]), forest fuels treatment and forest restoration and thinning material.

In addition to biomass fuel removal and recovery opportunities mentioned above, there will be some opportunities to recover biomass material as a result of salvage operations associated with episodic events such as:

- Wildfire
- Insect infestations (e.g., emerald ash borer and the gypsy moth)
- Tree pathogens/diseases
- Weather (e.g., blowdown)

For example, the emerald ash borer has killed an estimated 20 million ash trees, mostly in southeastern Michigan (University of Minnesota Extension News, 2007). The mandated method of disposal for these dead trees is to chip and burn in biomass power plants. This has resulted in an estimated 500,000 GT of biomass fuel to the biomass power plants of Michigan (TSS Report, 2006). A similar outbreak in Minnesota could be significant as Minnesota has an estimated 870 million ash trees, one of the largest concentrations of ash in any state. It appears inevitable that the ash borer will eventually invade Minnesota; the question is, to what extent. Due to the unpredictable and episodic nature of these events, this fuel assessment does not consider these potential biomass fuel sources as part of the wood fuel mix.

2.6.1 Timber Harvest Residues

Timber harvest residues, commonly referred to as logging slash, consist of tops and limbs derived from harvested timber and typically left on site after removing the merchantable portion of the tree. There are several methods used to calculate the potential volume of timber harvest residues. However, after conducting an extensive literature review and discussing the validity of various methodologies with numerous industry and academic experts, TSS settled on a methodology utilizing a combination of residue factors to estimate this component of forest-derived fuels. In order to increase the accuracy of this estimate, TSS utilized Forest Inventory Analysis[9] (FIA) data specific to forest stands within the LSA. The FIA data was segregated by timberland cover types into the following four major vegetation groupings: Aspen/Birch, Other Hardwoods, Upland Conifer and Lowland Conifer.

[8]Diameter at Breast Height. This is a common forestry term used to describe the measurement of tree diameter at 4.5 feet above ground level.
[9]Forest Inventory Analysis data base as maintained by the USDA Forest Service, North Central Research Station.

For each of these major vegetation groupings, TSS used data developed by the Minnesota Department of Natural Resources and scaling specialist, George Deegan (Department of Natural Resources, Marketplace Bulletin, Summer, 2007), estimating the volume of residue generated as a percentage of the harvested volume. This data was combined with data developed by Bill Berguson of NRRI (Berguson, 2007) calculating the merchantable volume of roundwood harvested per acre for each of these vegetation groupings. Using this combination of data, residue factors were estimated for these major vegetative groupings. Combining the data from these studies, TSS developed residue factors by major vegetation grouping. Table 3 shows a breakdown of these estimated residue volumes.

Table 3. Estimated Volume of Residue by Vegetation Grouping

Vegetation Grouping	% Residue	Roundwood (Cords/Acre)	Conversion (GT/Cord)[10]	Residue (GT/Acre)
Aspen/Birch	28%	22.2	2.25	14
Other Hardwoods	40%	16.6	2.5	16.6
Upland Conifers	25%	17.2	2.3	9.9
Lowland Conifers	27%	17.4	1.8	8.5

Using these estimated residue volumes per acre multiplied by the acres harvested in the LSA provides an estimate of the approximate volume of forest residue generated annually within the LSA. Harvested acres per county were estimated using data developed by Minnesota DNR in the Minnesota Logging Area Residue Analysis report. TSS estimated the harvested acreage by using the approximate percentage of each county that was located within the 100-mile radius of the Laskin project site.

The Wisconsin counties of Douglas and Bayfield lie within the 100-mile radius LSA. However, due to a lack of harvested acres data for Wisconsin, TSS developed an estimated residue volume based on harvest residue data compiled by the USDA Forest Service (USFS) North Central Research Station. This data is shown as a separate line item in Table 4. Following is the potential residue volume for the estimated harvested area within100 miles of the Laskin project site.

Table 4. LSA 100-Mile Radius Timber Harvest Residue

Vegetation Grouping	Residue (GT/Acre)	Acres Harvested	Volume of Residue (GT/Year)
Aspen/Birch	14	55,229	773,212
Other Hardwoods	16.6	4,668	77,491
Upland Conifers	9.9	12,544	124,186
Lowland Conifers	8.5	6,973	59,271
Wisconsin Residue Estimated from USFS Data			159,300
Total			**1,193,000**

[10]Department of Natural Resources. Timber Sale and Scaling Manual, 2007.

Based on this analysis, TSS estimates that there are over 1 million GT of timber harvest residues generated annually within the LSA. It is important to note that this volume is the estimated total potential available timber harvest residue and because of MP's commitment to adhere to the current Minnesota Forest Resource Council's Forest Biomass Guidelines, as well as other regulatory, operational and competitive constraints, not all of this volume would be practically available to the project.

2.6.2 Sub-Merchantable Forest Material

Another component of forest-derived fuels is the sub-merchantable or sapling-sized material. This material typically consists of smaller diameter trees, which are 1 to 5 inches DBH and makes up a major component of the understory vegetation within a timber harvest area. Although these stems are not large in size, the high number of stems per acre can generate a significant volume of biomass fuel. It is anticipated that sub-merchantable forest material would be harvested in conjunction with commercial timber harvest activities, particularly in stands utilizing an even-aged silvicultural prescription.

In order to evaluate this component of potential fuel, TSS utilized the FIA Mapmaker[11] to approximate GT estimates of biomass for the 1 to 5 inch DBH class throughout the LSA. This data was broken down into the four major vegetation groupings listed in Table 4. Table 5 provides a breakdown of the GT per acre of sub-merchantable forest material by vegetation grouping.

Table 5. Sub-Merchantable Material (<5" DBH) Volume - by Major Vegetation Grouping

Vegetation Grouping	Sub-Merchantable Volume (GT)	Acres of Timberland by Grouping	Sub-Merchantable Volume per Acre (GT/Acre)
Aspen/Birch	31,725,060	3,437,364	9.2
Other Hardwoods	10,859,423	1,580,374	6.9
Upland Conifers	10,246,286	1,390,455	7.4
Lowland Conifers	16,882,882	1,423,580	11.9

Using these estimated sub-merchantable volumes per acre multiplied by the annual harvested acres for each of these vegetation groupings in the LSA provides an estimate of the potential sub-merchantable volume available per year. As with the timber harvest residue estimate, the harvested acreage data was developed using the Minnesota Logged Area Residue Analysis report. TSS estimated the harvested acreage by using the approximate percentage of each county that was located within the LSA.

The Wisconsin counties of Douglas and Bayfield lie within the 100-mile radius LSA. However, due to a lack of harvested acres data for Wisconsin, TSS developed an estimated sub-merchantable volume based on forest residue data compiled by the USFS

[11] Analytical data base maintained by the USDA Forest Service.

North Central Research Station. This data is shown as a separate line item in Table 6 below. Following is the potential sub-merchantable forest material volume for the estimated harvested acres within 100 miles of the Laskin project site.

Table 6. LSA 100 Mile Radius Sub-Merchantable Forest Material

Vegetation Grouping	Sub-Merchantable Volume (GT/Acre)	Acres Harvested	Volume of Sub-Merchantable (GT/Year)
Aspen/Birch	9.2	55,229	508,107
Other Hardwoods	6.9	4,668	32,209
Upland Conifers	7.4	12,544	92,826
Lowland Conifers	11.9	6,973	82,979
Wisconsin Sub-Merchantable Volume Estimated from USFS Data			106,200
Total			**822,000**

Based on this analysis, TSS estimates that there are 822,000 GT of sub-merchantable forest material potentially available annually within the LSA. As previously stated, it is important to note that this volume is the estimated total potential available sub-merchantable forest material and because of regulatory, operational and competitive constraints, not all of this volume would be practically available to the project.

2.6.3 Forest Fuels Treatments

Biomass generated from forest fuels reduction activities to create defensible space around homes and communities at risk of wildfire may be used as fuel for the generation of renewable power. An integral part of the Laskin fuel study was a fuel availability assessment of the forest fuels reduction activities within northern Minnesota. The primary purpose of a forest fuels treatment is to change the behavior of a fire entering a fuel-altered zone, thus lessening the impact of that fire to an area of concern. This change in fire behavior is often quantified as a reduction in flame length, intensity, or rate-of-spread and is manifested as a change in severity or growth of the fire. This is best achieved by fragmenting the wildland fuel complex and repeatedly disrupting or locally blocking fire growth, thus increasing the likelihood that suppression efforts will be effective or weather conditions will change (Finney, 2000).

This assessment will provide MP and other interested parties with an understanding of the fire threat and the potential to coordinate fuel procurement with biomass generated from forest fuels reduction activities planned for northern Minnesota. Through the utilization of these traditionally underutilized fuel sources, biomass power generation provides an alternative to piling and burning of forest residues, which impacts air quality, adds to fuel loads in areas at risk of wildfire, and makes forest management activities such as site preparation, regeneration, and timber stand improvement difficult to implement. The development of a new commercial-scale biomass power generation facility at the Laskin Energy Center will provide a biomass market for forest fuels

reduction activities, reduce the threat of catastrophic fire, and contribute to the State of Minnesota's Renewable Energy Standard.

Describing the Threat

Recent fire history indicates the potential for large wildland fire events in northern Minnesota (Table 7). Most large wildland fires occurring are drought based and wind driven. Slower spreading, small surface fires with the occasional tree consumed by fire are the norm, especially when winds are blowing less than 15 miles per hour (Cook County Community Wildfire Protection Plan, 2005). Mini-droughts, typically of limited duration, can quickly dry out surface fuels, increasing the potential for extreme fire behavior. During the normal fire season, most fires remain fairly small and are caught during initial attack.

Table 7. Recent Wildfires and Acres Burned in Northern Minnesota

Year of Fire	Name of Fire	Acres Burned
1995	Sag Corridor	12,600
1996	Swede	1,010
1996	South Temperance	4,450
2002	Three Mile Island	2,000
2003	South Seagull	4,000
2004	Hummitch Lake Fire	500
2005	Alpine Lake	1,335
2006	Cavity Lake	31,830
2006	Winchell	1,792
2006	Red Eye	1,792
2006	Famine Lake Fire	4,044
2007	Ham Lake Fire	16,266

Crown fires can and have developed on landscapes where tree tops are in close proximity of one another and wind speeds are adequate to carry the fire. Under these conditions, ladder fuels[12] can assist a fire from moving from the shorter fuels to the taller fuels, specifically between lower limbs of aerial fuels and the nearest surface fuels and grass/weeds. With the right weather conditions, northern Minnesota has experienced fire spread of up to 7 miles in a single day. Large runs like this occurred on the Sag Corridor Fire in Cook County.[13] The presence of numerous lakes can make effective firebreaks under low to moderate fire conditions. During extreme fire conditions, ¼ to ½-mile spotting distances make all but the largest lakes ineffective at stopping fire spread (Superior National Forest Fire Management Plan, 2004).

[12]Defined by Minnesota's FireWise Community Mitigation Grant Program as vertical fuel, typically material 2 to 10 feet tall, contributing to intermittent crown fires or free running, continuous crown fires.
[13]As noted in the Cook County Community Wildfire Protection Plan, 2005.

Forest Fuels Reduction Activities

Providing a suitable market for forest fuels reduction activities may facilitate the creation of defensible space around homes and protect communities at risk of wildfire. The forest fuels reduction activities will not guarantee that wildfire does not threaten, damage or destroy natural resources, homes or endanger lives. A common misconception among land managers and the public is that wildland fuels treatments stop fires. Alternatively, the treatments are designed to fragment the wildland fuel complex, disrupt or temporarily block fire growth, and increase the likelihood that suppression efforts will be effective or weather conditions will change. Based upon recent experience working with fuels treatments on federal and private ownerships, TSS's biomass fuel availability projections differentiate between private and public lands due to differences in management objectives for fuels treatment activities.

Public Lands

The National Fire Plan (NFP), as implemented by the USFS and the Bureau of Land Management, seeks to treat millions of acres of overstocked forests as outlined in the Healthy Forests Restoration Act of 2003 (HFRA). The NFP is the foundation for a long-term program to reduce fire risks and restore healthy, fire-adapted ecosystems, primarily on public lands.

Timber and fire staff managing public lands typically accomplish fuels treatment using a variety of treatment options/tools including:

- Treat and leave on site (mastication).
- Treat and remove.
- Prescribed fire to combust unwanted vegetation on site (pile and burn or broadcast burn).

In recent years, public lands managers have begun to reassess the use of prescribed fire as the primary fuels management tool of choice. Public stakeholders have voiced concerns regarding the predominant use of prescribed fire due to the following issues and opportunities.

- Air quality impacts (haze, human health issues associated with air quality).
- Air emissions contribution to greenhouse gas production.
- Potential for escape (concerns for a repeat of the 2007 Mississippi Meadow fire).
- Visual impacts of burned and blackened forests.
- Biomass utilization for value-added products and rural employment.

Interviews with land managers[14] on the Chippewa and Superior National Forests indicate that approximately 3,000 to 4,000 acres of fuels treatment are planned annually on federally-managed lands within the study area (including pile and burning, prescribed burning, mastication and removal).

The volume of biomass fuel generated as a result of fuels treatment activities can vary significantly depending on the existing forest conditions and the management objectives of each national forest. Interviews with fuel procurement managers and national forest staff[15] indicated that very little biomass material is currently removed and utilized as fuel as a result of fuels treatment or timber harvest activities on public land forests. Experience as a result of fuels treatment projects implemented in Oregon and California by TSS staff demonstrates that biomass fuel recovered can range from 6 to 30 GT per acre.

Using an average removal/recovery factor of 20 GT/acre and the assumption that approximately 2,000 acres per year of USFS managed lands receive fuels treatments on lands conducive to the removal of small sub-merchantable stems, about 40,000 GT/year of biomass fuel is potentially available as a result of fuels treatment activities on public lands within the study area.

Private Lands

Communities with a Community Wildfire Protection Plan (CWPP) may receive significant benefit in the future should funding be appropriated through HFRA for fuels reduction and fire prevention. Central to the concept behind the CWPP is use of multiple stakeholders in the process of community-based planning initiatives. Complementary to this effort, there exists a significant opportunity for utilization of the woody biomass generated by hazardous fuels reduction activities to be used as fuel for the generation of renewable power. In order to understand what volume of material may be available over time for use as biomass fuel, it is necessary to evaluate the CWPPs currently in place and their forecasted forest fuels reduction activities.

As the counties within the geographical scope of the LSA continue to develop CWPPs, it may be feasible to predict the timing of biomass volumes coming from forest fuels reduction activities. Funding support from both the state (administered through the Minnesota FireWise Hazard Mitigation Grant program) and the USFS (National Fire Plan) has facilitated the development of at least three county-wide CWPPs. Table 8 highlights the CWPPs currently in place, the proposed funding levels requested under Minnesota FireWise–Hazard Mitigation Grants,[16] and the number of acres projected for treatment due to high-risk conditions and which need immediate attention. While this information has provided some insight to determine trends and forecast forest fuels

[14]Ellen Bogardus-Szymaniak, Fuels Specialist, Chippewa National Forest.
[15]Denise Dexter, Resource Specialist, Superior National Forest.
[16]Under the FireWise Grant system, at least 40% of each grant must be spent on implementation of forest fuels reduction activities.

reduction activities, the CWPPs in place in northern Minnesota currently do not have a level of detail to show actual forest harvest and mechanical fuel treatments over time.

Table 8. Current CWPP Proposed Projects, Number of Acres to be Treated, Types of Treatments and Requested Funding Levels[17]

CWPP County	High Priority Sites	Acres to be Treated	Types of Treatment	Funding Levels
Lake County	Two Harbors Railroad Corridor	123	uneven-aged regeneration harvests	no data
Lake County	Fernberg Corridor/ Kawishiwi Triangle	1310	clearcut, shelterwood thinning, seed tree thinning	no data
Lake County	Birch/Slate Lake Area	227	clearcut, commercial thinning, seed tree thinning	no data
Lake County	Isabella Area	372	clearcut, commercial thinning	no data
Lake County	Thomas/Marble/ Kane Lake Area	514	uneven-aged regeneration harvests, clearcut, commercial thinning	no data
Cook County	Upper Gunflint Trail Area	no data	defensible space, hazardous fuel removals	$ 45,000
Cook County	Two Island Area	no data	harvesting, thinning, burning	no data
Cook County	Tom Lake Area	no data	uneven-aged regeneration harvests	no data
Cook County	Paradise Beach/ Colvill Area	no data	hazardous fuels removal	$ 25,000
Cook County	Midtrail Gunflint	no data	hazardous fuels removal, mechanical, fuel ladder removal	$ 45,000
Cook County	Ludsen Township Area	no data	hardwood harvest, fuel ladder & hazardous fuels removal	no data
Cook County	Hovland Area	no data	mechanical treatments	$28,000
Cook County	End of Gunflint Trail	no data	defensible space, hazardous fuels removal	$ 45,000
Itasca County	20 WUI Communities	no data	defensible space, mechanical, fuel ladder & hazardous fuels removal	no data

At this juncture, erratic funding levels, statutorily-defined contracting procedures that impede efforts to reduce wildland fuels, and the federal focus (and funding) on the western United States' hazardous fuel predicaments, make it extremely difficult to predict the amount of forest fuels reduction activities that will be conducted on private lands. Regardless, it is feasible to make some assumptions and generate a prediction for private forest fuels reduction activities within northern Minnesota.

Utilizing the proposed funding levels and the existing planned fuels treatments, about 10,000 GT/year of biomass fuel is potentially available for fuels treatment activities from private lands within the study area. This assumes an average removal/recovery factor of

[17]Table only includes those areas prioritized as HIGH risk/ Priority Level 5 through the CWPP process.

20 GT/acre and approximately 500 acres per year of private lands receiving fuels treatments.
Table 9 summarizes total wood fuel volume expected annually from private and public fuels reduction activities within the LSA.

Table 9. Wood Fuel Generated as a Result of Forest Fuels Treatment Activities within the LSA

Land Ownership	Acres Treated/Year	Wood Fuel Generated (GT/Year)
USDA Forest Service	2,000	40,000
Private lands	500	10,000
Total	**2,500**	**50,000**

2.6.4 Forest Restoration/Thinning

A final category of forest-derived fuels considered in this assessment are the potential volumes of material generated through species restoration activities and timber stand improvement work. During the course of this investigation, TSS was informed that past efforts to encourage the establishment of aspen have led to substantial acreages of native forests being converted to higher-value aspen vegetation type. Forest managers have found over time that many of these are stands that are better suited to support other tree species such as conifers. In the case of Lake County, it was estimated that as much as 8,500 acres could be considered for restoration from aspen to conifer. Blandin Paper Company forestry staff[18] also indicated that they had lands targeted for restoration activities. The challenge for some land managers has been how to restore these off-site aspen stands when the aspen is too small for commercial harvest. A viable biomass fuel market will provide some economic value to offset a portion of the costs associated with forest restoration activities.

While difficult to quantify over the entire LSA, TSS believes there are sufficient acreages within Lake County and St. Louis County to generate 8,500 to 10,000 GT per year of biomass fuel from these types of restoration activities. This assumes that between 400 and 500 acres of restoration is conducted annually that generate an average of 20 GT per acre.

In addition to off-site aspen stands, there are also several species that appear to lack strong market demand, particularly from pulp, paper and board manufacturers. Such species as tamarack and basswood may offer some interesting opportunities to harvest and chip the entire stem for biomass fuel. These species should provide fuel production opportunities without directly competing with higher-valued markets. Based on discussions with various forest managers in the LSA, TSS estimates that potentially

[18]Robert Behr, Forest Operations Coordinator, Blandin Forestry.

45,000 cords of these less popular species could be generated annually in the LSA. Assuming 1.45 tons per cord, this equates to 65,250 GT per year.

The biomass fuel market also provides an interesting market for timber stand improvement work, particularly pre-commercial thinning of conifer stands. Within the state, it is estimated that there are over 125,000 acres of Red Pine (Berguson, 2007) plantations less than 30 years old and ready for thinning. According to Potlatch personnel,[19] the company has 1,800 acres to thin and has estimated that 20 tons per acre or 36,000 GT of biomass could be generated from this thinning. Assuming 10 to 20 GT per acre and 125,000 acres, this could represent 1.25 to 2.5 million GT over a 10-year period, or approximately 125,000 to 250,000 GT per year.

Following is a summary of the potential volume of forest restoration and thinning fuels that could be generated annually.

Off-site aspen restoration	8,500 to 10,000 GT
Tamarack and basswood	65,250 GT
Thinnings	125,000 to 250,000 GT
Total Potential:	200,000 to 325,250 GT

2.6.5 Forest-Derived Biomass Fuels Summary

This section provides a summary of both the potentially and practically available fuel for all forest-derived biomass.

Table 10. Summary of Total Potentially and Practically Available Forest - Derived Biomass Fuels within the LSA Per Year

Forest-Derived Fuel Type	Potential Volume in the LSA (GT/Year)	Practical Volume in the LSA (GT/Year)
Timber Harvest Residues	1,193,000	799,310
Sub-Merchantable Forest Material (<5" DBH)	822,000	550,740
Forest Fuels Treatment	50,000	50,000
Forest Restoration/Thinning	200,000 to 325,000	175,875
Total Potential Volume	**2,265,000 to 2,380,000**	**1,575,925**

Based on this assessment, TSS estimates that there are 2.3 to 2.4 million GT of forest-derived biomass fuel generated annually within the LSA. An important consideration in this type of macro fuel assessment is the estimated practically available biomass fuel. Of critical importance to the fuel supply are the recently enacted biomass guidelines and the woody debris retention standards (Minnesota Forest Resources Council, 2007). Based on a review of these guidelines, TSS concluded that 20% of this potentially available biomass will need to be retained on site. In addition, based on TSS's experience with

[19]Discussions with Mark Grossman, Forester, Potlatch Corporation.

biomass fuel processing operations, it is estimated that an additional 10% to 15% of the potential volume is not readily available due to operational and economic constraints such as the size of the timber, the sale area, the site conditions and the volumes per acre. When considering all these parameters, TSS estimates that 67% of the total potential biomass will be practically available to the biomass markets.

Thus, TSS concludes that approximately 67% of the total potential 2.3 million to 2.4 million (see table 10 above) results in 1.5 to 1.6 million GT per year of forest-derived biomass that will be practically available on an annual basis within the LSA.

2.7 Other Fuels (Canadian)

As part of this assessment, TSS also conducted an extensive review of potentially available biomass fuels sourced from the provinces of Ontario and Manitoba. In general, the Canadian forest products industry offers only limited availability of excess biomass fuels. The current economic crisis in the Canadian forest products industry coupled with increased local demand for wood fuel have decreased the opportunities to obtain low-cost biomass fuel. In addition, due to the predominant public management (Crown Lands) of Canadian forests and the robust nature of the Canadian forest products industry (most all of the forest resource is currently utilized and not available), the assessment team did not include Canada in the vegetation and ownership analysis.

There are some current opportunities to access Canadian biomass fuel supplies. However, there is much uncertainty regarding future supplies, particularly those located near the AbitibiBowater, Fort Frances, Ontario operation. The company has started construction on a 700,000 GT per year biomass fueled power plant that is scheduled to become operational in October, 2008. This facility will have a major presence in the biomass fuel markets in southwestern Ontario and southeastern Manitoba. Based on the results of recent discussions with a large forest products company in Ontario, it appears there may be approximately 30,000 to 35,000 GT of mill residues available annually.

TSS also investigated the availability of densified agricultural residues as a potential fuel source. Although highly experimental at this time, a Canadian company has been working on a potential fuel product consisting of cubed agricultural residues such as flax shives, wheat straw, and old corrugated cardboard (OCC). The company is also investigating the potential of canola plant residue in cubed form. Although herbaceous crop residues traditionally have high potential for low ash fusion temperatures, the flax shives and canola plant residue merit further investigation. At this time, the producer has indicated the potential of producing 30,000 GT per year of cubed agricultural residues.

2.8 Urban Wood Waste

Another resource that represents a significant biomass fuel recovery opportunity is wood waste generated by communities as part of the municipal waste stream. This waste, in combination with industrial wood residues (wood blocks, pallets, plywood, etc.) and vegetation available as a residue of land clearing or vegetation management activities (trees, brush, stumps, etc.), makes up a potential biomass fuel resource known as urban wood. Across North America, solid waste departments and private sector waste haulers are seeking alternative disposal methods for recovery and utilization of wood waste. Discussions with the St. Louis Solid Waste Department staff[20] indicated a strong interest to recover and utilize urban wood waste as wood fuel rather than pile and burn or bury this waste in landfills (current fates).

County solid waste department staff and private sector waste haulers are quite interested in recovery and utilization of urban wood for a variety of reasons, including:

- Communities are attempting to extend the life of landfills by diverting material to alternative uses. Tip fees at the landfills are on the rise to provide an incentive for increased recycling/alternative utilization efforts.
- New residential and commercial development generates land-clearing material, construction and demolition wood. This creates waste in the form of brush, small trees, and other woody material.
- Air quality concerns have placed increased restrictions upon the open burning of wood waste.
- Minnesota Waste Management Act has set a 35% recycle target.

St. Louis County Solid Waste Department manages several landfills and demolition wood collection sites, including two located near the Laskin project site at Hibbing and Ely. County staff indicated a willingness to stockpile raw wood waste for processing into wood fuel at these two sites. In response to this interest, TSS and MP generated a list of raw wood waste that is considered acceptable and unacceptable as raw material for wood fuel. The following wastes qualify as acceptable materials for processing into wood fuel for MP facilities:

- Tree limbs/tops.
- Logs and stumps (substantially free of rocks and soil).
- Clean wood pallets.
- Clean, untreated construction wood waste (paint free).
- Clean, untreated demolition wood waste (paint free, sheetrock, metal); some nails are acceptable.

[20]Ted Troolin, Director, and Dave Fink, Planner, St. Louis County Solid Waste Department.

The following wastes are considered unacceptable for processing into wood fuel:

- Grass, leaves and other non-woody yard waste.
- Non-combustible material (concrete, metal, glass, sand, soil, rocks, etc.).
- Plastics.
- Painted wood.
- Pressure-treated wood, including railroad ties.
- Tar paper, composition roofing material.

St. Louis County is currently stockpiling wood waste at the Ely collection site utilizing this acceptable/unacceptable list. It is anticipated that this stockpiled material will be processed into wood fuel for use at the Rapids or Hibbard Energy Centers in order to test the firing characteristics and better understand the economics of urban wood recovery and processing.

MP also generated a letter request to all county solid waste departments operating within the LSA, asking for data regarding wood waste generated by landfill, collection yard and transfer station. Three counties out of the twelve located within the LSA responded to this request. Due to the low response rate, this assessment utilized default assumptions from previous TSS urban wood assessments to generate estimates of urban wood waste availability.

Based upon TSS's experience with wood waste generation, processing and procurement, it is estimated that approximately 11.5 pounds of solid waste is generated per capita, per day. Of this, about 10.5% of the solid waste stream is wood. For that portion of each county within a 100-mile radius of the facility, TSS estimated the total solid waste generated and the total wood waste generated. Approximately 65% of the total wood generated is estimated to be recoverable; however, due to the rural nature of the LSA and the disposal alternatives (pile and burn, home heating) that such a population has, TSS estimates that only 25% of the total wood generated would be available as biomass fuel. Table 11 shows a breakdown for the estimated recoverable urban wood for the LSA.

Table 11. Urban Wood Waste Availability within the LSA

County	% in Study Area	2006 Population	2006 Population Within Study Area	Urban Wood Waste (GT/Year)
Cook	100%	5,329	5,329	294
Lake	100%	10,966	10,966	604
St. Louis	100%	196,067	196,067	10,802
Carlton	100%	34,116	34,116	1,880
Douglas	100%	44,061	44,061	2,427
Bayfield	90%	15,147	13,632	751
Itasca	90%	44,729	40,256	2,218
Aitkin	75%	16,149	12,112	667
Koochiching	55%	13,658	7,512	414
Pine	50%	28,419	14,210	783
Cass	30%	29,036	8,711	480
Crow Wing	10%	61,009	6,101	336
Totals		**498,686**	**393,072**	**21,655**

Based on this assessment, TSS estimates that there are approximately 21,655 GT per year of urban wood waste potentially recoverable as biomass fuel within the LSA.

Tree Trimmings

In addition to the urban/industrial wood waste, a portion of the tree trimmings generated by tree service companies, maintenance agencies for public streets and trees, and power utilities can be processed and utilized as biomass fuel. Approximately 250 pounds of tree trimmings suitable for fuel is generated on an annual per capita basis. Tree trimmings typically have about 40% moisture content. Approximately 65% of this waste is suitable for biomass fuel. The remainder is wood waste that is contaminated or so commingled with other waste that it is not economical to separate and process. Again, due to the rural nature of the LSA, TSS estimates that approximately 25% of the total tree trimmings generated is available as biomass fuel. Table 12 shows a breakdown for the estimated recoverable tree trimmings.

Table 12. Tree Trimming Waste Availability within the LSA

County	% in Study Area	2006 Population	2006 Population Within Study Area	Tree Trimmings (GT/Year)
Cook	100%	5,329	5,329	108
Lake	100%	10,966	10,966	223
St. Louis	100%	196,067	196,067	3,983
Carlton	100%	34,116	34,116	693
Douglas	100%	44,061	44,061	895
Bayfield	90%	15,147	13,632	277
Itasca	90%	44,729	40,256	818
Aitkin	75%	16,149	12,112	246
Koochiching	55%	13,658	7,512	153
Pine	50%	28,419	14,210	289
Cass	30%	29,036	8,711	177
Crow Wing	10%	61,009	6,101	124
Totals		**498,686**	**393,072**	**7,984**

Based on this analysis, it is estimated that there is approximately 29,640 GT of urban waste (including tree trimmings) potentially available annually within the LSA.

2.9 Other Fuel Sources

In addition to forest-derived fuels, Canadian wood and urban wood, TSS assessed the opportunity to utilize forest products manufacturing residues, short rotation woody crops, agricultural byproducts and brushland-derived fuels.

2.9.1 Forest Products Manufacturing Residues

Based upon the results of this review, TSS concluded that the existing wood fiber markets have already absorbed the vast majority of primary and secondary forest products manufacturing residues. According to a detailed study conducted by NRRI (Berguson, 2002), the total potential forest products manufacturing residues available within northern Minnesota amount to approximately 185,000 GT/year. Since the time of that study, most of these readily available residues have found established and stable markets. An important consideration for these residues will be specific transportation distances to the Laskin project site, and there will no doubt be opportunities to shift some of this existing residue fuel to Laskin simply due to transportation advantages. Regardless, the potential volume of forest products manufacturing residues is inconsequential compared to the forest-derived biomass fuels.

2.9.2 Short Rotation Woody Crops

The development of fast-growing woody crops has been driven in recent years by significant improvements in the clonal propagation of fast-growing crop trees such as cottonwood, poplar and eucalyptus. Known as short rotation woody crops (SRWC), these tree species are prized for value-added uses such as pulp/paper, engineered wood products and even solid lumber products. In Minnesota, several commercial-scale hybrid poplar plantations have been established, including a 22,000 acre plantation located near Sartell.

The second largest poplar plantation in the state, a 3,000 acre site near Oklee, is managed by MP. Initially propagated to serve as a trial demonstration for plantation-grown biomass fuel, MP staff[21] currently responsible for management of the poplar plantations noted that plans are to begin harvesting the plantation around 2010. Current growth and yield rate estimates indicate that the plantation may only yield 2.5 to 3 BDT/acre of biomass annually. MP staff confirmed that these relatively poor growth and yield rates, when coupled with the cost of real estate, make this hybrid poplar uneconomical as a potential wood fuel source for a commercial-scale biomass power plant. As a result of these findings, TSS concluded that short rotation woody crops are currently not a viable, economic long-term fuel source.

2.9.3 Agricultural Residues

Another potential source of economic biomass fuel is agricultural residues generated as a byproduct of commercial agricultural operations. In some regions of North America, orchard prunings, walnut shells, olive pits, peach pits and almond shells are readily available, cost effective fuel sources combusted for power generation. Key to economic availability of these byproducts is proximity of commercial agriculture operations to the power plants.

The vegetation cover analysis (see vegetation cover and ownership analysis section of this report) conducted in support of this fuel availability assessment found that approximately 2% of the landscape located within a 100-mile radius of the Laskin site is dedicated to commercial crops. Discussions with the Agricultural Utilization Research Institute (AURI), Waseca, MN staff[22] confirmed that currently there are very limited opportunities in northern Minnesota to utilize agricultural byproducts as fuel. Research is underway to better understand the potential opportunities to grow native grasses such as reed-canary or big blue stem as row crops for biomass fuel markets.

[21]Tom Houghtaling, Manager, Land and Real Estate, Minnesota Power.
[22]Al Doering, Associate Scientist, Co-Products, Agricultural Utilization Research Institute.

As a result of the vegetation cover analysis and information provided by AURI (Doering, 2007), TSS concluded that agricultural byproducts are currently not a viable fuel source for the Laskin project.

2.9.4 Brushland

From past experience and as confirmed by interviews with land managers in northern Minnesota, brushland management activities in conjunction with wildlife habitat improvement efforts or fuels treatment activities may produce some biomass material suitable as wood fuel. A research effort lead by NRRI[23] will be investigating the potential to economically recover biomass material as a result of brushland management activities with study results expected in 2008. As harvest equipment technology and market demand develop in the future, sourcing woody biomass residues from brushland could represent an interesting opportunity fuel for the Laskin project.

2.10 Fuel Availability Summary

Table 13 provides a summary of the practically available volume of all fuel types assessed for the Laskin Energy Center project.

Table 13. Practically Available Fuel Summary within the LSA

Fuel Type	GT/Year
Timber Harvest Residues	799,310
Sub-Merchantable Forest Material	550,740
Forest Fuels Treatment	50,000
Forest Restoration/Thinning	175,875
Other Fuels (Canadian)	
Mill Residues	35,000
Densified Agricultural Residues	30,000
Urban Wood Waste	21,655
Tree Service Residue	7,984
Total	**1,670,564**

The total estimated practically available biomass fuel volume in the Laskin Energy Center Study Area is 1,670,564 GT per year.

[23]Per discussions with Bill Berguson, NRRI.

Exhibit 9 shows the breakdown of the practically available fuel mix by percentage.

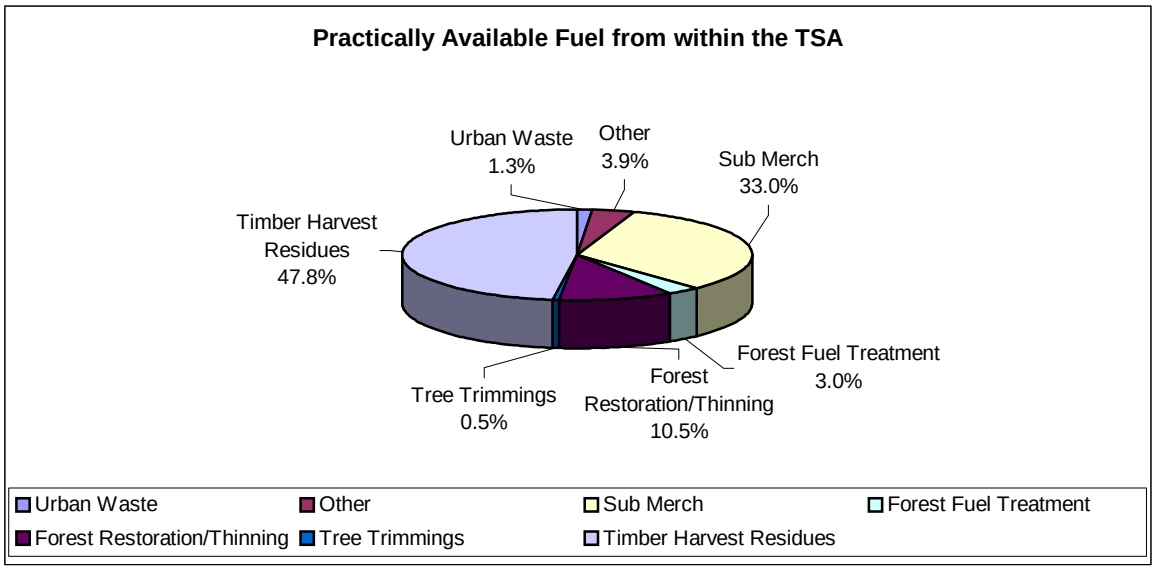


Exhibit 9. Practically Available Fuel from within the LSA

3.0 Wood Fiber and Fuel Demand and Supply Summary

3.1 Introduction

The market demand for wood fiber and fuel in the LSA has been steadily increasing over the past two years. This demand for fiber and fuel will continue to provide forestland owners and managers with valuable markets for their forest products. In addition, these markets will allow forestland managers to utilize a broader array of land management tools to improve the health of their forests. The biomass fuel market tends to provide a long-term stable market for lower-valued wood residues.

3.2 Laskin Biomass Project Fuel Requirements

The Laskin biomass project is a proposed 25 MW wood-fired power plant and is expected to consume approximately 275,000 GT per year of wood fuel. Based on the results of this fuel assessment, TSS estimates that there are over 1.67 million GT per year of wood fuel available in the LSA. Currently there are an estimated 925,000 GT of yearly demand with an additional 322,000 GT per year of possible usage coming online by 2010. Considering all potential supplies and current and planned usage within the next two years, TSS estimates that there are approximately 423,564 GT of wood fuel practically available per year for the Laskin project.

Table 14 provides an estimated breakdown of the volume and type of wood fuel anticipated to be used by the Laskin biomass project. This fuel blend projection represents TSS's recommended forecast based on optimized availability and anticipated costs.

Table 14. Anticipated Annual Fuel Blend for the Laskin Biomass Project

Fuel Type	Amount (GT/Year)	% Blend
Timber Harvest Residues	123,750	45%
Sub-Merchantable Forest Material	82,500	30%
Forest Fuels Treatment	19,250	7%
Forest Restoration/Thinning	16,500	6%
Other Fuels[24] (Canada)	5,500	2%
Urban Wood/Tree Trimmings	27,500	10%
Total	**275,000**	**100%**

[24]Other fuels include only forest products manufacturing residues.

As this data shows, the estimated fuel consumption of the Laskin Biomass Project represents about 65% of the practically available wood biomass fuel within the LSA.

3.3 Competition for Wood Fuel

Within the LSA there is a large and well-established set of commercial-scale facilities actively utilizing wood fiber and fuel. In addition, there are several new and expanded wood fuel utilization projects planned. Exhibit 10 shows the location of the current major wood fiber users and Table 15 provides a breakdown of the estimated volume of forest-sourced wood fiber from within the LSA.

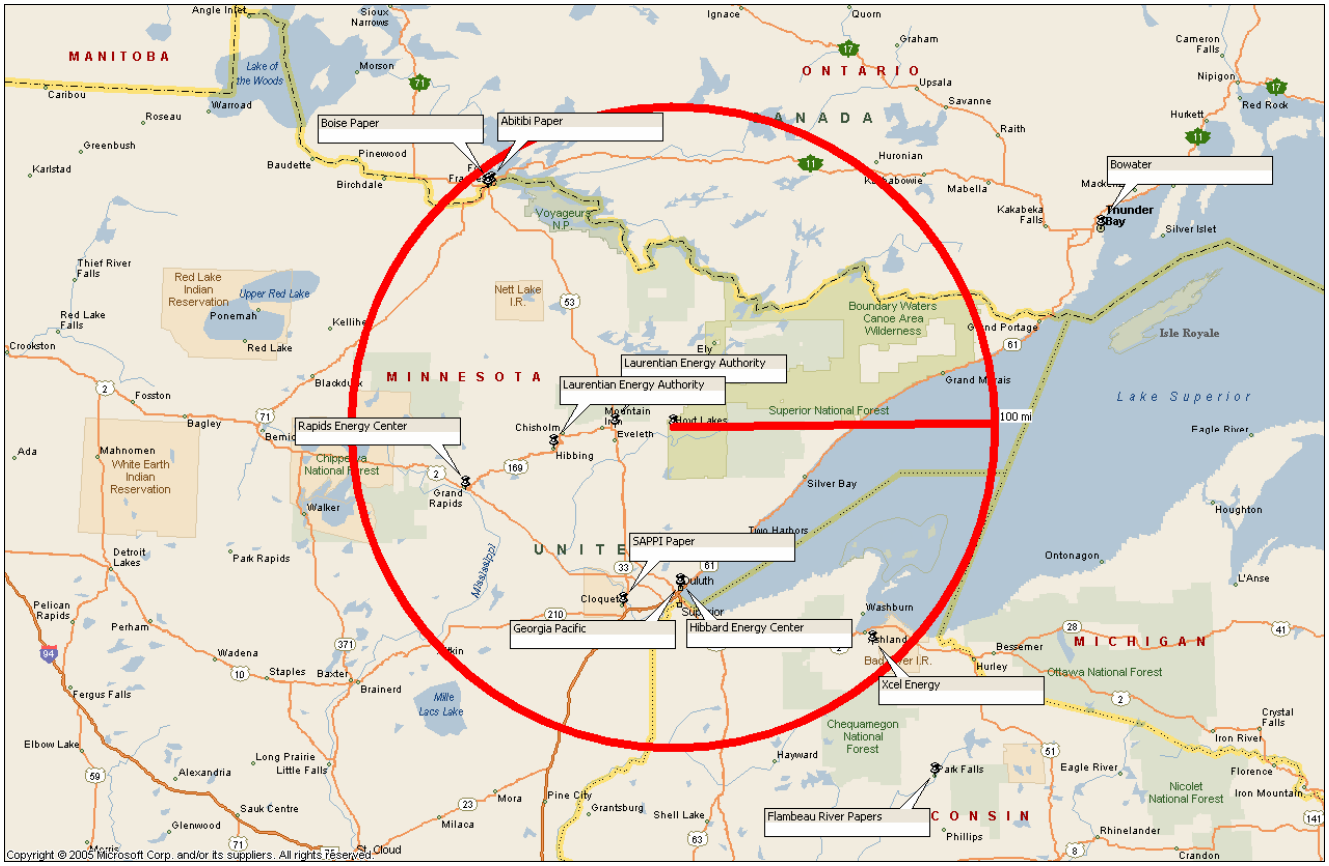


Exhibit 10. Current Wood Fiber Users in the LSA

Table 15. Existing Forest-Sourced Wood Fiber Usage in the LSA

Existing Commercial-Scale Facilities Utilizing Fuel and Fiber	Location	Fuel/Fiber Usage (GT/Year)	Open Market Purchases – Forest-Sourced Material From Study Area (GT/Year)	Fuel/Fiber Procurement Radius - Miles
Hibbard Energy Center	Duluth, MN			100
Rapids Energy Center	Grand Rapids, MN			100
SAPPI Paper	Cloquet, MN			80
Boise Paper	International Falls, MN			100
AbitibiBowater	Fort Frances, ON			70
Potlatch	Bemidji, MN			80
Laurentian Energy Authority	Virginia, MN			50
Laurentian Energy Authority	Hibbing, MN			50
District Energy	St. Paul, MN			50
AbitibiBowater	Thunder Bay, ON			75
Minn Tac	Mountain Iron, MN			
Great River Energy	Elk River, MN			
Xcel Energy	Ashland, WI			80
Flambeau River Papers	Park Falls, WI			75
Georgia Pacific - Hardboard Plant	Duluth, MN			80
Totals		**3,500,000**	**925,000**	

Table 16 provides a breakdown of the planned wood fiber users within the LSA.

Table 16. Planned Forest-Sourced Wood Fiber Usage in the LSA

Potential Biomass Utilization Facilities (New and Expanded)	Location	Fuel/Fiber Usage (GT/Year)	Open Market Purchases Forest-Sourced Material From Study Area (GT/Year)	Fuel/Fiber Procurement Radius - Miles
Flambeau River Papers	Park Falls, WI			75
Company A	MN			80
Company B	MN			80
Forest BioProducts Inc	Atikokan, ON			
Bio-Pellets	Deer River, MN			50
Valley Forest Wood Products LLC (Birchem)	Marcell, MN			60
Mountain Timber Wood Products LLC (Birchem)	Mountain Iron, MN			70
Totals		**778,000**	**322,000**	

Based on this competition analysis, it is estimated that there are approximately 925,000 GT of forest-sourced material purchased annually in the LSA. In addition, there are another 322,000 GT per year of potential demand expected to be coming online in the near future. Total current and projected demand for wood fuel and fiber sourced from forest management activities in the LSA is estimated at 1,247,000 GT per year. In addition to these planned projects, TSS is aware of two additional wood pellet projects being considered for possible development within the LSA. Renewafuels, a Michigan-based start-up company, is considering the construction of a new biomass pellet plant in the study area, and the Kedco Group, headquartered in County Cork, Ireland, has made some preliminary investigations into a similar wood pellet plant in the Duluth area. TSS believes not all of these planned or proposed pellet projects will be able to demonstrate adequate feedstock availability. Projects most likely to succeed will be those which are in "first position" as regards to project and fuel supply development.

Combining this data with TSS's projected biomass fuel availability, 1,670,564 GT within the LSA results in an estimated volume of 423,564 GT per year of fuel practically available for the Laskin project. Assuming the Laskin project will consume 275,000 GT of fuel annually, the resulting fuel coverage ratio (tons of fuel available/tons of fuel consumed) is 1.54.

3.4 Conclusions

In conclusion, TSS has estimated that there are approximately 1.67 million GT per year of woody biomass practically available in the LSA. Of this volume, there are approximately 1.25 million GT per year of existing and anticipated future demand. Therefore, it is estimated there are over 423,564 GT per year of unutilized woody biomass available for use by the Laskin Biomass Project. It is estimated that the Laskin Biomass Project will consume 275,000 GT of woody biomass fuel per year, leaving an estimated 148,564 GT per year of woody biomass remaining (after all other uses are accounted for).

4.0 Stakeholder Support/Concerns

4.1 Introduction

An initial assessment of support for the proposed Laskin biomass project was gauged through meetings with various stakeholders representing the wood products industry, public and private forest landowners, conservation organizations, research organizations, and local and county government entities. Public documents and newspaper reports were also reviewed to further identify key issues. Meetings were held June through August 2007 to better understand stakeholder perspectives regarding utilization of woody biomass material for energy production and to isolate key concerns and recommendations.

This is a preliminary assessment and may not represent the full range of perspectives of the different organizations. A more complete assessment afforded by the implementation of a Communications Plan (see Appendix 4) will be necessary to ensure effective and timely identification of key issues and communication with prominent partners and stakeholders. A primary goal of a Communications Plan would be to ensure that partners, cooperators, and key audiences understand the purpose and outcome of the fuels study, to solicit feedback from stakeholders, and to garner support from those audiences for this project and future proactive efforts that seek to accomplish state-mandated generation of renewable energy sources. Initial meetings have been effective at broadening the support base for MP's continued role in promoting biomass energy and identifying key issues. These issues are organized relative to a) procurement and supply of forest residues, and b) permitting and operation of the Laskin project.

4.2 Procurement and Supply of Forest Residues

- *Sustainability of forest residues.* One key issue identified was the concern for the proposed volume of biomass to be removed from forests in northern Minnesota. Stakeholders expressed concern that a preferred size (range) for a biomass power generation facility has been established before first determining how much forest biomass is sustainably available given existing and other potential uses. Conservation organizations encouraged procurement of biomass from sources certified by the Forest Stewardship Council (FSC) as a means to ensure high-quality management of forests and reduced harvesting on sensitive sites, referred to as High Conservation Value Forests in the FSC standards.

- *Biomass harvest guidelines.* Stakeholders routinely requested MP to secure biomass from only those suppliers who voluntarily abide by guidelines recently approved for "*Biomass Harvesting on Forest Management Sites in Minnesota*." These guidelines were developed by the Biomass Harvesting Guideline Development Committee in conjunction with the Minnesota Forest Resources Council as an addendum to the State forest management guidelines (*Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines*). Key considerations of the guidelines include retention of snags, down woody debris, and remnant live trees to sustain wildlife diversity; management of water courses to minimize nutrient losses after harvesting; limits on biomass removal in riparian areas; and maintenance of soil productivity, especially leaching of nutrients on sensitive soils.

- *Competition for roundwood*. Wood products industry representatives, particularly those representing Minnesota Forest Industries (MFI), expressed concern for increased competition for roundwood that could materialize as a result of increased demand for forest residues. As the available supply of forest residues declines, demand could increase for roundwood traditionally destined for higher-value uses (oriented strand board, pulp and paper). As a result of additional competition for a finite roundwood resource, there may be upward pressure on delivered roundwood log prices, thus potentially impacting the traditional forest products industry infrastructure. Conservation organizations also expressed concern for using roundwood in energy generation and the net increase in carbon as a result of decreased ability to sequester carbon in longer harvest rotations.

- *Competition for forest residues.* Stakeholders included current wholesale energy customers of MP who procure forest residues for competitive uses (feedstock for engineered panels, pulp/paper, and power generation). These stakeholders have expressed concern that the increased demand for forest residues within the proposed procurement radius of 100 miles from the Laskin Energy Center could increase fuel costs for both MP and its customers. Existing competition for biomass includes the Laurentian Energy Authority projects in Virginia and Hibbing, MN. Projected demand will continue to increase as additional projects (see table 16) are developed and begin commercial operation.

- *Job creation and tax revenue.* Stakeholders expressed optimism that the proposed Laskin project would create additional jobs and tax revenue for local entities. According to a U.S. Department of Energy sponsored study (Morris, 1999), approximately 4.9 jobs are created per megawatt of biomass-generated electricity installed. Those jobs include the personnel necessary to operate and maintain the energy facility, as well as jobs associated with the procurement, harvesting, processing and transport of woody biomass. Based on these estimates, approximately 123 new jobs could be created with the development of a 25 MW Laskin facility. Additional economic benefits would include short-term employment opportunities created through the construction of the facility and long-term increases in tax revenues, which would provide a ripple effect in terms of indirect jobs generated in the area.

4.3 Stakeholder Meetings and Communication Tools

It is recommended that if MP decides to proceed with the Laskin project, this initial assessment be followed by the implementation of a Communications Plan (see Appendix 4) to continue to solicit feedback from stakeholders on these and related issues/concerns and to provide consistent, accurate, and transparent information to project partners and concerned parties.

The list of key issues was generated through a series of meetings held between June and August 2007 to better understand perspectives of the following stakeholders.

- Counties (land department, forestry, land commissioner)
- Private Industrial Landowners
- State
    - Minnesota Department of Natural Resources (forestry staff, ecological services)
    - Minnesota Forest Resources Council
- National Forests
    - Chippewa NF
    - Superior NF
- Conservation Organizations
    - Institute for Agriculture and Trade Policy
    - Minnesota Center for Environmental Advocacy
    - Sierra Club
    - Minnesota Environmental Partnership
    - Izaak Walton League

- Non-Government Organizations
    - Blandin Foundation
    - Agricultural Utilization Research Institute
- Industry Organizations
    - Minnesota Forest Industries
    - Minnesota Logger Education Program

APPENDIX 1. GLOSSARY OF COMMON TERMS

Listed below are some of the more common terms/abbreviations frequently used by resource managers. These definitions are from a variety of sources including the USDA Forest Products Lab and the Society of American Foresters – Forestry Dictionary.

Biomass – Organic matter in trees, agricultural crops and other living plant material. Carbohydrates are the organic compounds that make up biomass. These compounds are formed in growing plant life through photosynthesis, a natural process by which energy from the sun converts carbon dioxide and water into carbohydrates, including sugars, starches and cellulose.

Board Foot – The amount of wood contained in an unfinished board 1 inch thick, 12 inches long, and 12 inches wide. Abbreviated "BF". Common units as related to saw log volume measurement include - 1,000 BF or MBF and 1,000,000 BF or MMBF.

Bone Dry Ton – Traditional unit of measure used by industries (pulp/paper, biomass power) that utilize biomass as a primary raw material. One bone dry ton (BDT) is 2,000 pounds of biomass (usually in chip form) at zero percent moisture. Typically biomass collected and processed in the forest is delivered "green" to the end use facility at 50% moisture. One BDT (assuming 50% moisture content) is two green tons (4,000 pounds at 50% moisture content).

British Thermal Unit – The quantity of heat required to raise the temperature of one pound of water from 60 degrees F (Fahrenheit) to 61 degrees F at a constant pressure of one atmosphere.

Chip – A small piece of wood typically used in the manufacture of pulp/paper, composite panels, fuel for power/heat generation, and landscape cover/soil amendment.

Cogeneration – The combined generation of both heat and power at one facility using the same fuel source. Typically the heat is used to generate steam that is utilized on site (process steam). Power generated is in the form of electricity that is utilized on site or sold to a local utility.

Cord – Common unit of measure for roundwood delivered to a forest products manufacturing facility. One cord is equal to 79 cubic feet or 500 cubic feet.

Cull Log – Logs that do not meet certain minimum specifications for usability or grade. A cull log typically has very little value in the production of lumber products.

Generation – The process of creating electricity. Typically generation is accomplished to supply electricity to an on site facility and/or for sale to an electric utility.

Green Ton - Traditional unit of measure used by industries (pulp/paper, biomass power) that utilize biomass as a primary raw material. One green ton (GT) is 2,000 pounds of biomass (usually in chip form) with no correction for moisture content.

Kilowatt – A standard unit for expressing the rate of electrical output.

Megawatt – One thousand kilowatts. Enough electricity to support approximately 750 to 1,000 households.

Moisture Content – The amount of moisture contained in biomass material. Typically expressed as a percentage of total weight.

Roundwood – Log, bolts or other round sections cut from bole of trees.

Saw log – A log that meets minimum regional standards of diameter, length, and defect, intended for sawing into lumber products.

Urban Wood Waste – Processed wood fuel consisting of tree limbs, prunings, pallets and clean construction waste wood.

Volume (Gross) – Measurement of log content in log-scale board foot (see board foot definition – above) without deduction for defect.

Volume (Net) – Measurement of the actual amount of merchantable wood in log-scale board foot – after deductions for defect.

APPENDIX 2. CONVERSION FACTORS

Summarized below are some woody biomass conversion factors that are commonly used by natural resource managers in North America:

1 green ton (GT) of chips	= 2000 lbs.(not adjusted for moisture)
1 green metric ton of chips	= 2240 lbs. (not adjusted for moisture)
1 bone dry ton (BDT) of chips	= 2000 dry lbs.(assumes no moisture content)
1 dry metric ton of chips	= 2240 dry lbs.(assumes no moisture content)
1 bone dry unit (BDU) of chips	= 2400 dry lbs. (assumes no moisture content)
1 unit of chips	= 200 cubic feet
1 BDT chips	= 2.0 GT (assuming 50% moisture content)
1 unit of chips	= 1.0 BDT chips (uncompacted)
1 ccf (hundred cubic feet) roundwood	= 1.0 BDU chips
1 ccf roundwood (logs)	= 1.2 BDT chips
1 ccf roundwood (logs)	= 1.2 units of chips
1 ccf roundwood (logs)	= 1.2 cords roundwood (@ 85 cu. ft. wood/cord)
1 cord of roundwood	= 500 board feet or 79 cubic feet
1 board foot	= volume of lumber measured 12” x 12” x 1” thick

1 standard chip van typically carries 25 green tons, or approximately 12.5 BDT assuming 50% moisture content.

When woody biomass is utilized in a commercial (10+ MW electrical output) scale power generation facility the following energy output rules of thumb typically apply:

1 BDT fuel will produce approximately 10,000 lbs. of steam
10,000 lbs. of steam will generate 1 megawatt hour (MWH) of electricity
1 MW = 1,000 horsepower
1 MW = power for approximately 750 to 1,000 homes

APPENDIX 3. GIS METHODOLOGY AND DETAIL

VEGETATION COVER AND OWNERSHIP DATA REQUEST FOR LASKIN FUEL STUDY

In order to characterize the potential availability of woody biomass fuel for a commercial scale biomass power facility located in Northern Minnesota, it would be helpful to secure the following information:

GIS data - Base Map:

Showing vegetation types and ownerships within 100 mile radius of the Laskin Energy Center, near Hoyt Lakes, Minnesota.

Exclude from the map (as unsuitable for timber harvesting, fuels treatment or mechanical forest restoration) the following areas:

- Private lands – those areas located within riparian management zones (RMZ) as defined by the MN Dept of Natural Resources (MN DNR).
- National forests – those areas located in riparian areas located within 300 feet of class I, or II, stream.
- National forests – late successional reserves or other areas managed for sensitive species habitat.
- National Park Service
- USFS – wilderness areas
- State, County Parks
- Private/state/county lands where endangered, threatened or species of special concern are known to occur (as identified in the MN DNR natural heritage data base).
- Scientific and Natural Areas
- Private/state/county lands located on the following soil types:[25]
    - Northern Spruce Bog (APn80)
    - Northern Poor Conifer Swamp (APn81)

[25] As defined in the *Field Guide to the Native Plant Communities of Minnesota- The Laurentian Mixed Forest Province,* MN DNR2003.

- Shallow soils (8 inches or less for Aspen or hardwood cover types only)

- Biological Diversity Significance
- Residential areas
- Land that is over 35% slope

Other features that should be included on the Map

- Roads
- Jurisdictional boundaries – County, State, Reservation
- Streams (including trout bearing), rivers and lakes
- Ownership/Managing agency – NPS, USFS, DNR, County, tribal, small private etc.
- If available – specific ownership of industrial forest landowners.
- Agricultural Lands by crop types

As for data produced – in conjunction with the base map, it would be helpful to know number of acres by vegetation type in tabular format by ownership and excluding land that is not going to sustain harvest operations or biomass thinning operations over time (see above).

Table shows the “cross-walk” between GAP WI and GAP MN

Original WI GAP Name	Reclass MN Class Names
Urban / High Intensity	**Urban**
Urban / Low Intensity	**Urban**
Agriculture	**Cropland**
Corn	**Cropland**
Other Row Crops	**Cropland**
Forage Crops	**Cropland**
Grassland	**Grassland**
Jack Pine	**Jack Pine-Deciduous mix**
Red Pine	**Red Pine**
Mixed / Other Conifer	**Spruce/Fir-Deciduous mix**
Aspen	**Aspen/White Birch**
Oak	**White/Red Oak**
Northern Pin Oak	**Red Oak**
Red Oak	**Red Oak**
Maple	**Silver Maple**
Mixed / Other Deciduous	**Upland Deciduous**
Mixed Decid. / Conifer	**Lowland Conifer-Deciduous mix**
Open Water	**Water**
Emergent / Wet Meadow	**Broadleaf Sedge/Cattail**
Lowland Shrub	**Lowland Deciduous Shrub**
Decid. Shrub	**Lowland Deciduous Shrub**
Evergreen Shrub	**Lowland Evergreen Shrub**
Needle Leaved Shrub	**Lowland Evergreen Shrub**
Broad Leaved Forested Wetlan	**Lowland Deciduous**
Coniferous Forested Wetland	**Lowland Black Spruce**
Mixed Forested Shrub	**Lowland Deciduous Shrub**
Barren	**Barren**
Shrubland	**Upland Shrub**

Table shows the DNR Group and the “cross-walk” to GAP Vegetation Cover Types

DNR Grouping	GAP Vegetation Cover Type
Aspen	Aspen/White Birch
Lowland Conifers	Lowland Black Spruce
	Lowland Conifer-Deciduous mix
	Lowland Northern White-Cedar
	Stagnant Black Spruce
	Stagnant Conifer
	Stagnant Northern White-Cedar
Other Hardwoods	Black Ash
	Bur/White Oak
	Lowland Deciduous
	Maple/Basswood
	Red Oak
	Silver Maple
	Upland Deciduous
	White/Red Oak
Upland conifers	Balsam Fir mix
	Jack Pine
	Jack Pine-Deciduous mix
	Red Pine
	Red/White Pine
	Red/White Pine-Deciduous mix
	Spruce/Fir-Deciduous mix
	Stagnant Tamarack
	Tamarack
	Upland Black Spruce
	Upland Conifer
	Upland Conifer-Deciduous mix
	Upland Northern White-Cedar
	White Pine mix
	White Spruce

Table Total Acres by State, Vegetation Types and Classes within Laskin Study Area

STATE	CLASS TYPE	CLASS NAME	Total
MN	Forested	Aspen/White Birch	4,231,391
		Balsam Fir mix	252,932
		Black Ash	268,561
		Bur/White Oak	5,881
		Jack Pine	501,783
		Jack Pine-Deciduous mix	744
		Lowland Black Spruce	801,967
		Lowland Conifer-Deciduous mix	24,279
		Lowland Deciduous	38,928
		Lowland Northern White-Cedar	341,215
		Maple/Basswood	238,443
		Red Oak	62,861
		Red Pine	216,095
		Red/White Pine	34,066
		Red/White Pine-Deciduous mix	79,942
		Silver Maple	621
		Spruce/Fir-Deciduous mix	51,612
		Stagnant Black Spruce	267,098
		Stagnant Conifer	1,854
		Stagnant Northern White-Cedar	18,798
		Stagnant Tamarack	68,104
		Tamarack	318,768
		Upland Black Spruce	12,167
		Upland Conifer	3,362
		Upland Conifer-Deciduous mix	13,418
		Upland Deciduous	95,963
		Upland Northern White-Cedar	31,716
		White Pine mix	83,156
		White Spruce	28,234
		White/Red Oak	7,903
	Forested Total		8,101,862
	Non Forested	Barren	61,192
		Broadleaf Sedge/Cattail	49,647
		Cropland	207,531
		Floating Aquatic	28,744
		Grassland	482,919
		Lowland Deciduous Shrub	1,140,455
		Lowland Evergreen Shrub	82,658
		Sedge Meadow	219,038
		Upland Shrub	538,430
		Urban	99,819
		Water	771,084
	Non Forested Total		3,681,517
WI	Forested	Aspen/White Birch	384,517
		Jack Pine-Deciduous mix	81,802
		Lowland Black Spruce	46,730
		Lowland Conifer-Deciduous mix	240,281
		Lowland Deciduous	45,969
		Red Oak	18,029
		Red Pine	54,889
		Silver Maple	37,055
		Spruce/Fir-Deciduous mix	32,226
		Upland Deciduous	370,781
		White/Red Oak	5,024
	Forested Total		1,317,303
	Non Forested	Barren	9,330
		Broadleaf Sedge/Cattail	17,154
		Cropland	10,417
		Grassland	205,105
		Lowland Deciduous Shrub	155,612
		Lowland Evergreen Shrub	8,305
		Upland Shrub	80,691
		Urban	8,370
		Water	50,715
	Non Forested Total		545,699

APPENDIX 4. COMMUNICATIONS PLAN

Communications Plan for Minnesota Power Bioenergy Fuels Study (Laskin Energy Center)

Background

In February of 2007, the State of Minnesota passed legislation requiring all electric utilities in Minnesota to generate 25% of their energy through the use of renewable fuel by the year 2025. Minnesota Power is a significant provider of electricity in Minnesota providing retail electricity to more than 137,000 customers and wholesale electric service to 16 municipalities in northeastern Minnesota. Minnesota Power is committed to developing cost effective renewable energy sources to meet this growing consumer demand. Electricity produced by combustion of wood wastes and forest residues is a primary component of Minnesota Power's efforts.

Minnesota Power has completed an initial assessment of biomass generation sites in northern Minnesota. Based upon this assessment, potential options have been identified for development including co-locating a new 25 MW biomass fueled unit at its Laskin Energy Center in Hoyt Lakes. This project, called the Minnesota Power Laskin Biomass Fuel Plan Study, will conduct a fuel study in order to accomplish the following:

- Quantify the biomass resources by type and ownership type.
- Develop a fuel supply availability analysis for the various resources over time and account for expanded and potential new biomass utilization projects.

Purpose

The purpose of this communications plan is to ensure effective and timely communication throughout the implementation of the Minnesota Power Laskin Biomass Fuel Plan Study. A primary goal of this plan is to ensure that partners, cooperators, and key audiences understand the purpose and potential outcomes of the Fuels Study, to solicit feedback from stakeholders, and garner support from those audiences for this project and future proactive efforts that seek to accomplish State mandated generation of renewable energy sources.

A variety of tools and methods will be used to implement the communications goals for this project. Tools and methods will range from simple email correspondence, fact sheets, and news releases to web based information, public meetings, and focused interviews with key constituents. Within this communication plan, the general approach is to use these tools and methods not only to inform audiences of project purpose and garner public support, but also to identify key factors of success related to aspects of the fuel supply delivery chain. In particular, implementation of the communications plan will assist with identifying key issues associated with delivered fuels costs including fuel sources, volume, delivery logistics, and plant operations.

Goals

1) Proactively and strategically engage all stakeholders willing to contribute feedback and incorporate their concerns in the Fuels Study.
    a. Objectives:
        i. Identify key stakeholders and constituents through a variety of sources.
        ii. Solicit input on key concerns related to all aspects of the Laskin facility including fuels procurement, delivery, and plant operation.

2) To ensure timely and effective communications with target audiences.
    a. Objectives:
        i. Ensure that project briefs, FAQs, and news releases are consistent, updated, and distributed in a timely fashion to key stakeholders and constituents.
        ii. Ensure that project staff is conversant in the latest project developments.
        iii. Ensure that project staff has the appropriate communication tools to effectively converse with the stakeholders identified in Goal One.

3) Promote trust and good working relationships with all stakeholders and constituents.
    a. Objectives:
        i. Maintain transparent relationships with landowners, timber industry, environmental/conservation groups, tribes, county land representatives, state agency representatives, federal forest representatives, congressional staff, elected officials and other influential leaders.
        ii. Build a positive relationship between project staff and those stakeholders willing to engage and contribute input relative to the Fuels Study.

4) Increase understanding, acceptance and support of proposed projects.
    a. Objectives:
        i. Solicit feedback from all stakeholders on key concerns and challenges.
        ii. Provide consistent, accurate, and transparent information to key project partners, stakeholders, and concerned parties. Project updates should be made for all communications products in a timely manner.
        iii. Ensure that target audiences clearly understand the purpose and scope by developing talking points that accurately describe the Laskin project and by ensuring that at least one of those points is used in all briefing products.
        iv. Maintain a positive image of the project and the net benefits of renewable energy production.

FAQs – Frequently Asked Questions

Potential questions shall be anticipated and answers developed and expressed in a FAQ document to be supplied to stakeholders, potential collaborators, and media outlets. Questions could include, but not limited to:

- What is the Laskin Bioenergy Project?
- What is the primary objective of the Fuels Study?
- Who is involved in the Fuels Study?
- How is the Fuels Study being financed?
- What types of biomass fuels will be considered for the Laskin site?
- Where will the biomass fuel come from?
- What types of energy will be considered in this study?
- What size or scale of facility will be considered?
- Is this project being used to justify logging?
- Will removal of woody biomass impact soil productivity by reducing available nutrients?
- Will air emissions be a problem?
- What are the byproducts of the plant and how will they be disposed (ash, water)?
- How will these byproducts affect water quality in northern Minnesota?
- What are related potential new developments and value-added products (biofuels, paper modifications, organic compost, etc.)?
- How many jobs will this generate (harvesting, delivery, energy production)?
- What will be the economic impact to the region (direct and indirect benefits)?
- How does this fit with forest management in northern Minnesota?
- What are Biofuels?

Target Audiences, Collaborative Partners, Stakeholders

1) Forest Products Industry
    a. Minnesota Forest Industries, Inc.
    b. Minnesota Forest Resources Council
    c. Minnesota Forest Partners
    d. UPM, Sappi, Stora Enso, etc.
    e. Logging contractors
2) Environmental, Conservation Groups, and Non-Governmental Organizations
    a. Alliance for Sustainability
    b. American Lands Alliance
    c. Dovetail Partners, Inc.
    d. Duluth Audubon Society
    e. Friends of the Boundary Waters Wilderness

f. Institute for Agriculture and Trade Policy
g. Izaak Walton League of America, Minnesota Division
h. Minnesota Center for Environmental Advocacy
i. Minnesota Environmental Partnership[26]
j. Sierra Club
k. The Nature Conservancy

3) Renewable Energy
    a. Biobusiness Alliance
    b. Sustainable Energy for Economic Development (SEED) members
    c. Minnesota Green Power Programs
    d. Clean Energy Minnesota
4) Local and County Government
    a. State Forester – Dave Epperly
    b. County Land Commissioners (Lake, St Louis, Itasca, Koochiching, Aitkin, Cook, Carlton)
    c. Minnesota Association of County Land Commissioners
5) State Agencies
    a. Minnesota Dept. of Natural Resources
    b. Minnesota Pollution Control Agency
    c. Minnesota Division of Fish and Wildlife
    d. Minnesota State Private Lands
    e. Minnesota State Energy Office
    f. Minnesota Association of Watershed Districts
    g. Minnesota Association of SWCDs
    h. Minnesota Association of Townships
    i. Minnesota Association of Counties
    j. Minnesota Rural Partners
    k. Minnesota Farm Bureau Federation
    l. Minnesota Forest Resources Council[27]
    m. Minnesota Board of Soil and Water Resources
    n. Minnesota Association of Planning/Zoning
    o. Minnesota State Forester
6) Federal Agencies
    a. Superior National Forest
    b. Chequamegon National Forest
    c. Chippewa National Forest
    d. Bureau of Indian Affairs
    e. Minnesota Offices of US Fish and Wildlife Service
7) County Government
8) Tribal Nations
9) Other External
    a. Federally elected officials
        i. Senators
        ii. Representatives
    b. State and local elected officials

[26] Consortium that includes many of the stakeholder in this category.
[27] Biomass harvesting BMPs have been developed by this organization.

        i. County Boards of Supervisors
        ii. State Senators/Reps
c. Local and Regional Media
        i. Associated Press
        ii. Duluth News Tribune
        iii. St. Paul Pioneer Press
        iv. Ely Echo
        v. Star Tribune
d. Minnesota Public Utilities Commission

Laskin Energy Center-located at Hoyt Lakes, Minnesota.

Laskin Fuel Plan Study

FACT Sheet

Minnesota Power is assessing the feasibility of a biomass generation facility at the Laskin Energy Center near Hoyt Lakes, Minn. The facility, called the Laskin Bioenergy Project, would produce approximately 25 megawatts of electricity from woody biomass fuels that are underutilized or deposited as waste in the region. The use of these fuels would create jobs, promote economic development, provide an alternative to fossil-based energy, reduce wood waste destined for local landfills, minimize piling/burning of forest residuals and facilitate reduction of hazardous forest fuels.

Key themes of the proposed project

- Development of a new commercial-scale biomass electric generation facility at the Laskin Energy Center will help Minnesota Power meet its commitment to the State of Minnesota's recently enacted Renewable Energy Standard.
- Renewable energy from biomass contributes to broader economic activities in northeastern Minnesota while at the same time assisting private, county, state and federal partners to achieve their forest management objectives.
- Biomass electric generation at the Laskin Energy Center would provide job opportunities for local communities and residents. The production, procurement and handling of woody biomass and the construction and operation of a bioenergy facility would also generates taxes, creating a ripple effect in economic impact in the surrounding area.
- Biomass electric generation also provides a value-added advantage to the timber industry through the increased use of wood wastes and underutilized forest biomass. The Laskin Energy Center procurement strategy would be to adhere to the Biomass Harvesting Guidelines when utilizing low-value forest residues generated during roundwood harvest and/or thinning activities to increase forest productivity and decrease the risk of catastrophic wildfire. Fuel sources being evaluated would not compete with higher value roundwood markets in the region.

This map represents a 100 mile radius within which woody biomass will be located and potentially used to supply the fuel needed for the Laskin Biomass Facility. The center of the circle is Hoyt Lakes, the proposed location for the new facility.

- Minnesota Power's goal is to develop a project that will address key issues raised by interested stakeholders, including the ecological functions of the forest resource, baseload energy demands, guidelines for biomass harvesting and facility operation concerns for water usage, wastes and air quality.

Minnesota Power provides electricity to approximately 140,000 customers and 16 wholesale service municipalities in northeastern Minnesota. MP is committed to developing cost-effective, renewable energy sources to help meet growing consumer demand. Electricity sustainably produced by combustion of wood wastes and forest residues is a primary component of Minnesota Power's efforts to comply with the State of Minnesota's 2007 law requiring electric utilities to generate 25 percent of retail sales through the use of renewables by the year 2025.

Laskin Fuel Plan Study
Frequently asked questions

- **What is the Laskin Bioenergy Project?**

  In February of 2007, the State of Minnesota passed legislation requiring all electric utilities in Minnesota to generate 25 percent of their electric sales to retail customers with eligible renewable energy technologies by the year 2025.

  Minnesota Power is a significant provider of electricity in Minnesota to more than 140,000 customers and 16 wholesale electric service municipalities in northeastern Minnesota. While also promoting energy conservation, Minnesota Power is committed to developing cost effective renewable energy sources to help meet its growing consumer demand. Electricity produced by combustion of wood wastes and forest residues is a primary component of Minnesota Power's commitment to meet the Renewable Energy Standard as legislated.

  Minnesota Power has completed an initial assessment of generation sites in northern Minnesota. Based upon this assessment, potential options have been identified for development including co-locating a new 25 megawatt (MW) biomass fueled unit at its Laskin Energy Center in Hoyt Lakes.

- **What are the primary objectives of the Laskin Fuel Plan Study?**

  Minnesota Power's formal Fuel Plan Study will assess the feasibility of procuring a sustainable source of biomass for electrical energy and heat production in northern Minnesota, using fuel from wood wastes and traditionally underutilized forest residue generated from forest harvesting activities. The Fuel Plan Study will:

  - » Quantify the availability of woody biomass resources by location and type;
  - » Develop a fuel cost model to assess the feasibility of various sources of biomass over time;
  - » Assess procurement sources and delivery options of biomass to the Laskin facility; and
  - » Provide recommendations for fuel procurement strategies, delivery and transportation bottlenecks.

- **What size or scale of biomass energy facility is Minnesota Power considering?**

  While the size and scale have not been finalized, options include a power plant with a design capacity of approximately 25 MW. The size and scale of any biomass energy facility will be dependent upon the volumes and characteristics of environmentally and economically available woody biomass material that is sourced on a sustainable, long-term basis. Most bioenergy facilities are designed to be in service at least 30 years. 25 MW of electrical generation would supply the electrical demand for approximately 25,000 homes.

- **What types of biomass fuels will be considered for the Laskin site?**

  The Laskin Energy Center is located in Minnesota's northern forests. Thousands of acres of managed public and private forests are within close proximity, providing an abundant and renewable source of biomass. Woody biomass is material that is typically made up of small stems and brush not traditionally utilized or suited for commercial wood products manufacturing such as pulp/paper or composite panel. Procurement of a sustainable source of woody biomass generated from timber harvesting activities in the region on state and county forest lands, national forests, private industrial forests and on private non-industrial forests is being assessed. Agricultural waste products and railroad ties will also be considered.

- **Where will the woody biomass fuel come from?**

  The fuels, or biomass feedstocks, to be considered would be sourced from federal (U.S. Forest Service), state (DNR), county and private lands in northern Minnesota. The location of the project study area also presents a unique opportunity to potentially transport biomass using both rail and water-based transport systems. There is a long history of wood fiber transport by train. The efficiencies of railway transport systems allow wood chips and agricultural wastes to be transported long distances more economically. Biomass resources are being evaluated at 25-, 50- and 100-mile radii of the proposed facility.

- **How does bioenergy development fit with forest management in northern Minnesota?**

  The proposal to use woody biomass for electricity generation is not being used to justify increased logging of Minnesota's forests. The byproducts of existing forest harvesting activities, including tree limbs and tops not used for higher valued purposes, will have a ready use as biomass fuel. Biomass generated from forest fuels reduction activities to create defensible space around homes and communities at risk of damage or destruction by wildfire may also be used.

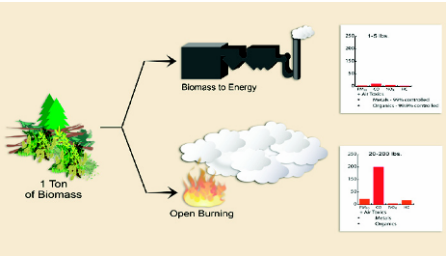
In many cases limbs, tops and small non-merchantable stems are currently being piled and burned at the harvest site. Through the utilization of these traditionally underutilized fuel sources, adhering to the published Biomass Harvesting Guidelines, biomass electric generation provides a value-added advantage to the timber industry through the increased use of wood wastes. It also provides an alternative to piling and burning of forest residuals, which impacts air quality, adds to fuel loads in areas at risk of wildfire and makes site preparation and regeneration difficult.

- **What types of energy production will be considered in this study?**

  The primary focus of the Laskin Fuel Plan Study is on the utilization of biomass for generation of heat and electric power.

- **What is the air emission impact of a biomass facility?**

  Air pollution control experts have determined that on average more than 97 percent of all pollutants can be removed through the use of a combined heat and power process of biomass conversion to energy as compared to open burning of biomass. Specifically there would be a 95 percent reduction of particulate matter, 75 percent reduction of nitrous oxides (NOx), 98 percent reduction of carbon, 97 percent reduction of volatile organic compounds and reductions of 99 percent of toxic metals and 99.9 percent of toxic organics.



More than 97 prcent of pollutants can be removed through combined heat and power process of biomass conversion to energy.

Graphic courtesy of Placer County Air Pollution Control District, Auburn, CA June 2006

- **What are the byproducts of a biomass energy facility and how will they be disposed (ash, water)?**

  Ash is the primary byproduct of the energy conversion process. Ash is commonly used for agriculture and forest soil nutrient. Water used in the boiler during the process is recycled and used for cooling purposes.

- **What would be the economic and environmental benefits to the region?**

  According to a U.S. Department of Energy sponsored study, approximately 4.9 jobs are created per megawatt of biomass-generated electricity installed. Those jobs include the personnel necessary to operate and maintain the energy facility, as well as jobs associated with the procurement, harvesting, processing and transport of woody biomass. Based on these estimates, approximately 123 new jobs could be created by a 25 MW Laskin facility.

  Such a project could also lead to greater investments in renewable energy, as well as the potential for waste heat generated from the facility to be used in local businesses. Utilization of biomass reduces wood wastes destined for local landfills, and may also facilitate reduction of hazardous forest fuels.

- **Who is involved in the Laskin Fuel Plan Study?**

  Minnesota Power is working with TSS Consultants, an interdisciplinary consulting and project development services firm to conduct a feasibility study of the technical, economic, and environmental aspects of biomass energy generation at the Laskin Energy Center. TSS Consultants is working to enhance public understanding of the various aspects of the study, and in turn is working with local biomass experts from the Natural Resources Research Institute in Duluth and the Department of Forest Resources at the University of Minnesota in St. Paul. TSS is also working with LE Peabody & Associates to develop transportation and logistics alternatives for moving large varying quantities of biomass from different locations to the Laskin site.

- **How are the Fuel Plan Study and site analysis being financed?**

  Minnesota Power believes that renewable energy development is a significant part of the future of energy generation in Minnesota. All investments made to identify sustainable supplies of woody biomass are investments in the future of the region's energy supply and help to support Minnesota's goal of 25% renewable energy by 2025. The study is being financed and coordinated by Minnesota Power.

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