Niagara Biomass Supply Analysis

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PHASE I STUDY

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1.0 Executive Summary

New North contracted with Resource Analytics to conduct a biomass supply analysis within a fifty mile radius of Niagara, WI for the purposes of evaluating this site as a location for a cellulosic biomass ethanol plant. Primary focus was on logging residues as a source of biomass. The study was divided into two parts. This report constitutes the results of the first part which details the availability of biomass supply within the region. The second part of the study will focus on aspects of acquisition, procurement and price of raw material supply to be detailed in a later report.

An overview of area forest resources is included consisting of:

- The condition class of all lands in the project area;
- Ownership characteristics and timberland characteristics by ownership;
- Forest type, stand size class and growing stock volumes;
- Removals from timberland for 2007; and
- Estimates for total logging residue generation and available logging residue generation.

Government policies for each ownership group and forest type, regarding the chipping of logging residue for biomass, were examined and found to be favorable for development of a market for this material - i.e. there are few policy constraints that would preclude the utilization of logging residue for cellulosic ethanol with the exception of policies related to National Forest ownerships.

Other sources of cellulosic biomass from roundwood and agricultural forage crops were also explored. In the case of roundwood, the fact that a previous user of this material recently exited the market (the New Page mill at Niagara), has resulted in a glut of supply in the procurement area which currently has no market outlet. The analysis of agricultural forage crop production suggests that this could be a valuable source of supplemental feedstock for a cellulosic ethanol plant. The ability of a cellulosic ethanol plant to utilize both of these sources of material, in addition to chipped logging residue, will improve the flexibility of procurement options and strategies.

Potential suppliers of biomass from logging residues and in the form of roundwood were identified and seasonal variations related to supply identified. The impact of distance on delivered wood prices was also investigated.

Using conservative estimates, it was concluded that there is sufficient biomass within the proposed procurement area to support a 500,000 green tons/year biomass ethanol plant, especially if a variety of feedstocks are utilized. Within this report, green tons are defined as biomass at approximately 50% moisture content. Chipped logging residue could supply approximately ½ of the volume of biomass within a 50 mile procurement radius which could be supplemented by roundwood and agricultural forage crops.

Increasing the procurement radius increases the total amount of potential biomass available by a considerable factor. Included in section 6.6. are additional estimates of logging residue available

within a 60 mile and 65 mile radius. Data indicate that a 65 mile procurement radius could supply a 500,000 green tons/year biomass ethanol plant with a minimal amount of supplemental fiber. It should be noted, however, that this is based on conservative estimates of available supply as discussed in section 6.0.

Additionally, analysis of logging residue availability and the dynamics of current roundwood markets are reviewed in the context of the Niagara and Kimberly mill closures. In brief, the fiber which used to be procured by these mills is available in the form of roundwood to any new entrant since existing mills in the area are not increasing production to absorb this supply.

The costs of various feedstocks, suppliers of those feedstocks and the optimum mix between the different types of feedstocks will be the focus of the project in phase two.

2.0 Introduction

NewPage bought the pulp and paper mill in Niagara WI from Stora Enso Corp. in 2007. This mill was one of ten mills NewPage purchased from Stora Enso – two in Minnesota and eight in Wisconsin. Later, they purchased one in Michigan. The Niagara mill produced lightweight coated groundwood papers used in magazines and catalogs. The mill was relatively small producing approximately 195,000 short tons annually. This compared to larger NewPage mills producing the same or similar products in Michigan & Wisconsin (Table 1).

Table 1 – NewPage mills in Michigan & Wisconsin producing Coated Groundwood & Coated Free Sheet, 2008.

Location	Capacity/Coated Free Sheet (in short tons annually)	Capacity/Coated Groundwood (in short tons annually)
Escanaba, MI	592,000	155,000
Wisconsin Rapids, WI -Biron Mill	550,000	405,000
Stevens Point, WI -Whiting Mill		230,000
Wisconsin Rapids, WI – Wisconsin Rapids Mill	430,000	
Kimberly, WI	295,000	160,000
Niagara, WI		195,000

An additional eight mills in Michigan, Wisconsin and Minnesota also produce these types of papers. There have been numerous mill closures in these states in recent years with mills producing uncoated and coated free sheet & groundwood being the hardest hit.

With coated paper markets softening, NewPage announced a permanent closure of the Niagara mill effective July 12, 2008. Over 300 employee lost their jobs. Continued soft coated paper markets resulted in an earlier closure in June. As soon as the closing was announced local, state and federal officials and the company itself sought a buyer for the mill. Two potential purchasers emerged in September, 2008 and made offers to purchase the paper machine part of the mill consisting of two machines. At this time, NewPage shut down the Kimberly mill laying off 600 workers.

This history is important within the current context. The Niagara and Kimberly mill closures were the result of market softness and overcapacity in the coated free sheet and groundwood markets NOT a lack of fiber supply. Both mills were successfully competing for fiber within their prospective procurement areas. Their closures left a huge market void for the roundwood they would have otherwise utilized.

This fiber is available to a new entrant within this market due to the fact that other users in the area are not increasing their wood usage in response to these two mill closures. As a result, this fiber is available ABOVE AND BEYOND the volume of logging residue analyzed later in this report if a new entrant configured their operations to utilize it.

As a result of these and other mills in the area, there already exists the necessary logging infrastructure and routines for procurement and delivery of product. This gives a new plant located on the previously existing mill site huge competitive advantages. This is especially true when compared to a location without this infrastructure in place or where a new plant would compete directly with existing users for the same fiber supply. In the case of the Niagara site, a new plant would represent a substitute user for the fiber the closed mill used to procure.

Faced with the loss of over 300 jobs, local officials and New North, an economic development organization for counties in Northeast Wisconsin, contracted with Resource Analytics to complete a biomass supply analysis that would document woody biomass availability to support a cellulosic ethanol plant at the Niagara site.

3.0 Methods

The proposed cellulosic ethanol plant at Niagara WI exists within the procurement radii (i.e. woodshed) of the Verso Paper Holdings pulp & paper mill in Quinnesec MI, the NewPage pulp & paper mill in Escanaba MI and the LP oriented strandboard mill in Sagola MI. Despite the fact that the pulp, paper and board industries are currently in a depressed state, in the long-run these three mills will be strong competitors to any new entrant within this woodshed for pulpwood. Any new entrant would have to meet or beat their price for pulpwood to secure wood supply. However, as discussed in section 2.0., this market dynamic would be tempered with a recognition that any new entrant utilizing roundwood would be a substitute for previously existing mills and the wood supply they utilized.

None of the currently operating mills are competitors for chipped logging slash. Their existence within this woodshed may actually be of benefit to a cellulosic ethanol plant if the primary focus is on logging residue as a source of supply. The three primary mills in this woodshed can not use logging residue as a feedstock and, from preliminary information, generally can meet their energy needs from the bark of the supply they do procure. Consequently, they create a strong market for pulp. This pulp demand creates regional logging activity which, in turn, results in large volumes of logging residue left behind and underutilized. As a result, the primary focus of this project is on quantities and types of logging residue and potential supply chain logistics.

The primary data source utilized to assess logging residue resources is Forest Inventory and Analysis (FIA). This database is recognized as the most accurate forest inventory information

collected nationwide for all ownership classes. The database has a wealth of information that can be extracted and analyzed by county or with circular plot retrieval. The data generated is consistent across state lines. The database is accessible on-line through FIDO (Forest Inventory Data Online).

Historically, FIA data was collected only once every 15 years in the Lake States. In recent years, the Forest Service has developed a system of an "annualized" survey by sampling $1/5^{th}$ of the plots within any one state annually on a five year cycle. This produces more up-to-date information on a timely basis. In the case of Michigan and Wisconsin, these states have supplemented FIA budgets allocated by the Forest Service to "intensify" the inventory. This involves utilizing state monies to increase the number of sample plots thereby generating greater accuracy at smaller geographic scale.

A circular plot centered on Niagara WI with a diameter of 50 miles was used to generate the information in sections 4.0. and parts of 5.0. Sixty and 65 miles circular plots were added in section 6.6. Previous research has shown that a 30 to 50 mile procurement radius is most applicable for wood energy projects and a somewhat larger procurement radius for cellulosic ethanol production. Another FIA data tool (EVALIDator Version 4.0.) was used to generate the biomass information included in section 5.0. The same FIA database is used to generate the information but this is the only retrieval method for biomass data.

The information in section 6.0. was generated via the internet and discussions with various federal, state and county foresters. The information in section 7.0. was generated by consulting the 2007 Agricultural Census. The information in section 8.0. was generated by contacting the Wisconsin DNR, Michigan DNR, Florence County, Forest County and Marinette County. Each source was asked to provide their "active" logger list. This information was further refined by removing marginal producers. The information in section 9.0. was generated from discussions with several local resource professionals. Finally, information contained in the appendix was generated from information from professional journals and reliable internet sources.

4.0 Overview of Area Forest Resources

Table 2 contains information on all land within fifty miles of Niagara WI in Michigan counties, Wisconsin counties and all counties in both states combined by condition status. Condition status includes all land and water in the column categories indicated. Table 3 has the same information by county and ownership. Within each of these tables (and tables which follow) the color of each estimated value represents its percent sampling error (pse). If the estimate is black, pse is less than or equal to 25%. If the estimate is green, pse is greater than 25% and less than or equal to 50%. If the estimate is red, pse is greater than 50%.

Forest inventory plans are designed to meet sampling error standards for area, volume, growth and removals. These standards, along with other guidelines, are aimed at obtaining comprehensive and comparable information on timber resources for all parts of the country. FIA inventories are commonly designed to meet the specified sampling errors at the State level at the 67% confidence limit (one standard error). Sampling error for area cannot exceed 3% per million acres of timberland. Sampling error for growing stock volume on timberland cannot exceed 5%

in the Eastern U.S. per billion cubic feet. This 5% sampling error is also a target for removals and growth.

FIA inventories are extensive inventories that provide reliable estimates for large sampling areas. As data are subdivided into smaller and smaller areas, such as a geographic unit or a county, the sampling errors increase and the reliability of the estimates goes down. This explains, in the tables which follow, why for many cells in a table, the estimates may be over 25 or 50% but in aggregate (the totals) the pse's can be under 25%. For example, in table 2, the area of noncensus water for each county has pse's of over 25% or over 50% because so little exists in each county compared to that counties area. In aggregate, however, over the area comprised of all the counties together the pse is less than 25%. This is a reflection of the larger sample size included within multiple counties.

4.1 All Land Condition Class

Table 2 - Area of land by county and condition class, 2003-2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in acres.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Michigan

County	Condition status					Total
	Accessible forest	Nonforest	Noncensus water	Census water	Denied access	
Baraga	15,248	843	--	--	--	16,091
Delta	182,656	59,404	3,223	3,714	8,459	257,456
Dickinson	405,777	49,108	3,377	12,430	16,351	487,043
Iron	497,249	50,325	11,119	25,211	15,733	599,637
Marquette	412,184	40,540	--	11,677	10,876	475,278
Menominee	505,480	118,861	2,949	--	32,089	659,379
Totals:	2,018,592	319,081	20,669	53,032	83,509	2,494,883

Wisconsin

County	Condition status					Total
	Accessible forest	Nonforest	Noncensus water	Census water	Denied access	
Door	2,068	--	--	--	--	2,068
Florence	276,456	27,645	1,095	3,272	5,079	313,548
Forest	578,166	64,339	4,504	22,051	4,346	673,407
Langlade	63,975	6,205	--	--	--	70,181
Marinette	641,602	185,512	4,646	19,677	28,839	880,275
Oconto	185,443	54,048	482	6,903	--	246,876
Oneida	2,475	--	--	--	--	2,475
Vilas	12,272	--	--	--	--	12,272
Totals:	1,762,457	337,750	10,727	51,903	38,264	2,201,101

Two State Totals

MI & WI	Condition status					Total
	Accessible forest	Nonforest	Noncensus water	Census water	Denied access	
Totals:	3,781,050	656,831	31,395	104,935	121,773	4,695,984

Tables 2 and 3 indicate there are a total of approximately 4.7 million acres of land within 50 miles of Niagara Wisconsin, with approximately half residing in each state. The vast majority of this land (80.5%) is accessible forest. Accessible forest is defined as forest that is accessible for the purposes of forest inventory, is at least 10% stocked at the time of the survey (or in the past) and is not subjected to non-forest uses that prevent normal tree regeneration or stocking. Nearly 81% of the land in Michigan is accessible forest compared to just over 80% in Wisconsin.

4.2 All Land Ownership

As shown in Table 3, ownership is more varied in Wisconsin compared to Michigan with a greater percentage of land in National Forest and County ownership in Wisconsin. In both states, however, private ownership predominates.

Table 3 - Area of land by county and ownership, 2003-2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in acres.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Michigan

	Ownership					
County	Unknown	National Forest	State	Local (county, municipal, etc.)	Undifferentiated private	Total
Baraga	843	--	--	--	15,248	16,091
Delta	74,800	--	27,351	--	155,305	257,456
Dickinson	81,266	--	184,651	10,566	210,560	487,043
Iron	102,388	47,220	83,628	4,804	361,596	599,637
Marquette	63,094	--	166,965	5,055	240,164	475,278
Menominee	153,899	--	84,912	--	420,568	659,379
Totals:	**476,290**	**47,220**	**547,507**	**20,425**	**1,403,441**	**2,494,883**

Wisconsin

	Ownership					
County	Unknown	National Forest	State	Local (county, municipal, etc.)	Undifferentiated private	Total
Door	--	--	--	--	2,068	2,068
Florence	37,091	79,748	5,304	34,174	157,230	313,548
Forest	95,241	336,674	14,260	8,479	218,753	673,407
Langlade	6,205	28,469	2,576	--	32,930	70,181
Marinette	238,674	593	24,138	215,082	401,789	880,275
Oconto	61,433	112,945	--	25,239	47,259	246,876
Oneida	--	2,475	--	--	--	2,475
Vilas	--	12,272	--	--	--	12,272
Totals:	**438,644**	**573,176**	**46,278**	**282,975**	**860,029**	**2,201,101**

Two State Totals

	Ownership					
MI & WI	Unknown	National Forest	State	Local (county, municipal, etc.)	Undifferentiated private	Total
Totals:	**914,934**	**620,395**	**593,785**	**303,400**	**2,263,470**	**4,695,984**

These differences in ownership concentration between the two states are significant since the different ownership categories have differing harvesting rates. The National Forests are the least likely to harvest, followed by State acreages, Privates acreage and, finally, County acreages are managed most intensively and harvest the most as a percentage of their acreage. There are several reasons for these differences in management and harvesting intensity.

National Forests are subject to complex rules and time-consuming procedures regarding planning, management activities and timber harvests. Any decision in these areas can be appealed and legally challenged. The National Forests in Midwest states have been able to maintain fairly strong timber sales programs but such programs are always under threat. As an illustration, in the early part of this decade, the Chequamegon-Nicolet National Forest (which is a forest within this procurement radius) became the top timber producing forest nationwide. This was not because their timber sale offerings increased, but because all other National Forests timber sale offerings decreased.

Wisconsin State forests have maintained strong management & timber sales programs partly as a result of a strong forest industry presence and the funding of the state program through a dedicated property mil tax. While diversions from this mil tax occur, it has offered steady funding not easily "raided" for other projects compared to support from the general fund. The environmental community also appears more accepting of timber management in this state compared to Minnesota and Michigan which is also, probably, a contributing factor.

Michigan used to have a very strong forestry program which has deteriorated over time. In the 1980's forest products was identified as a growth sector in the state. Consequently, the forest management division responded by being strongly oriented toward improving the growth and productivity of state forests to support an expanding industry. Those familiar with current management of the Michigan state forest system suggest that this focus has been lost, despite the states desperate need for a stronger and more solid economic base.

Counties are strongly oriented toward active forest management which includes frequent harvesting. Support of local mills and the jobs they create is strong (especially in the study area). The fact that timber sales receipts are used to support other parts of county budgets is a strong incentive to maintain the focus of county forestry departments.

Research suggests that the vast majority of acreage in private ownership will be harvested at some point in time. There are also programs in both states which encourage active forest management via a substantial reduction in annual property taxes. In Wisconsin, enrolled private owners substitute a portion of severance taxes levied at the time of harvest for a large percentage reduction in annual property taxes. Programs are similar in Michigan, but no severance taxes are paid as a substitute for property tax reductions. Management of these forest lands (with harvesting as a component) is a required condition of this enrollment in Wisconsin, but not in Michigan. Enrollments in these programs in Wisconsin have exploded in recent years as property taxes have gone up. These programs in Michigan have grown, but to a lesser degree than in Wisconsin. This maintains privately owned forests as working forests and as a source of wood fiber.

4.3 Timberland Ownership, Forest Type Group, Stand Size Class and Growing Stock Volume

The following tables focus on increasingly smaller FIA defined acreages that better identify the resource base available for timber production and from which harvests are likely to result. Within the category of "accessible forest" (as shown in Table 2) are acreages which include

timberland, non-productive forestland and reserved forestland. Timberland is defined by the productivity of the forestland. Within the FIA database, timberland is defined as:

"Forestland that is producing, or is capable of producing, more than 20 cubic feet per acre per year of industrial wood crops under natural conditions, that is not withdrawn from timber utilization [reserved], and that is not associated with urban or rural development. Currently inaccessible and inoperable areas are included."

By utilizing filters in generating tables which only include accessible timberland, the true base of land available for timber production can be determined. In Table 4 below, the unknown ownership category of forestland in Table 3 is also removed in an attempt to produce the most conservative estimate of the productive timberland base. **From this point forward, all the statistics provided will be for unreserved timberland only.**

Table 4 - Area of timberland by county and ownership, 2003-2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in acres.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Michigan

	Ownership				
County	**National Forest**	**State**	**Local (county, municipal, etc.)**	**Undifferentiated private**	**Total**
Baraga	--	--	--	14,765	14,765
Delta	--	27,552	--	161,753	189,305
Dickinson	--	186,787	11,421	224,327	422,536
Iron	47,220	84,621	4,965	371,569	508,374
Marquette	--	166,128	5,222	242,393	413,743
Menominee	--	84,978	--	446,864	531,842
Totals:	**47,220**	**550,067**	**21,608**	**1,461,671**	**2,080,565**

Wisconsin

	Ownership				
County	**National Forest**	**State**	**Local (county, municipal, etc.)**	**Undifferentiated private**	**Total**
Door	--	--	--	2,098	2,098
Florence	77,571	5,565	32,461	161,537	277,133
Forest	324,878	10,224	8,479	221,443	565,025
Langlade	28,469	2,681	--	35,191	66,340
Marinette	593	25,301	213,488	423,041	662,423
Oconto	112,952	--	25,247	47,803	186,002
Oneida	2,475	--	--	--	2,475
Vilas	11,679	--	--	--	11,679
Totals:	**558,617**	**43,771**	**279,675**	**891,113**	**1,773,175**

Two State Totals

	Ownership				
MI & WI	**National Forest**	**State**	**Local (county, municipal, etc.)**	**Undifferentiated private**	**Total**
Totals:	**605,836**	**593,838**	**301,283**	**2,352,783**	**3,853,740**

In comparing the total acreage for timberland in Table 4 and all land in Tables 2 and 3, approximately 842,244 acres have been eliminated from the productive forest base. Most of this is a result of excluding water and other non-forest lands and lands of unknown ownership. The relative importance of each ownership class in each state remains relatively the same with private and state owners the most important in Michigan (on a per acre basis) and private, national forest and county owners the most important in Wisconsin.

Another important consideration regarding the harvesting of logging slash for biomass is which harvesting method is utilized in the pulpwood or sawtimber extraction process. Clearcuts utilized in even-aged management systems leave the fewest residual obstacles in the way of collection of remaining logging slash. Some forest types, managed utilizing uneven-aged harvesting regimes where select cuts or sheltercuts are the norm, make access for collecting logging slash more difficult but could be the source of biomass from un-merchantable products produced in pre-commercial thinning operations in younger stands. Given these differing dynamics, the Forest types within the target supply area are important as is their size class. Table 5 identifies the Forest type groups in the 50 mile target supply area for Michigan & Wisconsin counties by stand-size class.

Table 5 - Area of timberland by Forest type group and stand size, 2003-2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in acres.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Forest-type group	Stand-size class				Total
	Large Diameter	Medium Diameter	Small Diameter	Nonstocked	
White / red / jack pine	185,015	70,176	26,806		281,997
Spruce / fir	185,267	449,682	236,647	--	871,596
Fir / spruce	--	--	1,643	--	1,643
Exotic softwoods	--	3,216	5,508	--	8,724
Oak / pine	28,097	27,258	26,100	--	81,455
Oak / hickory	49,558	75,591	29,119	--	154,268
Elm / ash / cottonwood	41,557	90,569	48,686	--	180,812
Maple / beech / birch	651,609	589,930	73,907	--	1,315,446
Aspen / birch	132,192	381,870	427,389	--	941,450
Nonstocked	--	--	--	16,348	16,348
Totals:	**1,273,295**	**1,688,292**	**875,805**	**16,348**	**3,853,740**

Large diameter stands are stands with 50% of all live stocking in medium and large trees (defined as at least 11" diameter and 5" diameter for softwoods and hardwoods, respectively) with the stocking of large diameter trees equal to or greater than that of medium diameter trees. Medium diameter stands are stands with more than 50% of all live stocking in medium and large diameter trees with the stocking of large diameter trees less than that of medium diameter trees. Small diameter trees have stocking of at least 50% of trees below 5" in diameter.

The Maple/beech/birch forest type group is the most common in the target supply area as well as the most mature. The maturity of this forest type is not surprising given the fact that this forest type is most often managed utilizing uneven aged management systems where partial cuts are the

norm, and intended to create large diameter stands to produce saw and veneer logs. Medium diameter stands still provide opportunities for products from pre-commercial thinnings which don't meet pulpwood standards but that could be used as biomass.

The Aspen/birch forest type is most often managed utilizing an even-aged management regime with clearcutting occurring anywhere from 40 years of age on the most productive sites to 60 or 70 on less productive sites. As stated previously, clearcutting is the most economical cutting regime from which to harvest biomass since no residual trees remain to hinder operations. However, the age class distribution of this forest type is strongly skewed toward younger stands at present in the target supply area. This may limit younger stands potential to generate usable biomass.

The other major harvesting opportunity occurs in the White/red/jack pine forest type, which is dominated by large diameter stands (most likely red & white pine). Jack pine stands are much like aspen stands, in that they are managed on relatively short rotations and utilizing clearcuts as the primary harvest method. The use of logging slash from these stands, however, is often precluded due to the serotonus nature of the regeneration of this species. Jack pine cones must be opened by heat (historically by ground fires) to release seed for regeneration purposes. It is common practice in the Lake States to prohibit harvesting of logging slash from jack pine slash so it remains on-site to provide a seed source for naturally regenerating new stands. Red and white pine stands are typically managed as uneven aged stands, with periodic thinnings, but unlike Maple/beech/birch forest types, logging slash is more easily retrievable due to the spacing of residual trees and the fact that red pine, in particular, frequently exist in plantations with even row spacing which is ideal for mechanical operations.

The last major forest type in the area is Spruce/fir. Both species tend to grow on moister sites in lowland areas on highly organic soils. Given the sites where this type typically occurs, winter only logging is the norm to reduce soil disturbance and rutting. Clearcuts are a common harvesting technique in this type. Over half of this forest type is in medium density stands which is typically when harvesting occurs. Since this forest type usually grows on poorer & wet soils, only the best of sites produce a large proportion of large diameter stands.

Table 6 identifies the net volume of growing stock on timberland by forest type group and stand size. Net volume of growing stock is defined as the volume of wood in the central stem of a sample tree 5 inches in diameter or larger, from a 1-foot stump to a minimum 4-inch top diameter. Not included are rotten trees and form cull (trees that meet the minimum diameter but due to poor form or defect would not be utilized for pulp).

Table 6 - Net volume of growing stock on timberland by Forest type group and stand size, 2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in cubic ft.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Forest-type group	Stand-size class				Total
	Large Diameter	Medium Diameter	Small Diameter	Nonstocked	
White / red / jack pine	467,518,428	82,863,538	3,806,421	--	554,188,387
Spruce / fir	376,247,250	675,357,145	71,529,031	--	1,123,133,426
Fir / spruce	--	--	339,400	--	339,400
Exotic softwoods	--	3,469,922	--	--	3,469,922
Oak / pine	50,784,624	35,911,233	5,971,377	--	92,667,233
Oak / hickory	80,051,881	84,195,563	4,820,225	--	169,067,669
Elm / ash / cottonwood	85,540,120	119,435,020	16,562,513	--	221,537,654
Maple / beech / birch	1,320,129,287	912,442,087	16,375,909	--	2,248,947,282
Aspen / birch	275,495,931	478,952,209	114,721,403	--	869,169,543
Nonstocked	--	--	--	1,247,941	1,247,941
Totals:	**2,655,767,521**	**2,392,626,716**	**234,126,279**	**1,247,941**	**5,283,768,457**

5.0 Removals from Timberland and Estimates of Total Logging Residue/Biomass Generation.

There are ample forest resources in the area to support a large forest industry presence. Their existence, however, does not ensure supply as anyone familiar with the catastrophic impact a lack of harvesting has had on forest products industries in the west. This section reviews current and past removal rates, estimates how much logging residue results from those harvests and how much actual harvest might be possible without policy restrictions.

5.1 Removals from Timberland.

Table 7 - Removals from growing stock on timberland by Forest type group and stand-size class, 2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in cubic ft.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Forest-type group	Stand-size class				Total
	Large Diameter	Medium Diameter	Small Diameter	Nonstocked	
White / red / jack pine	3,929,514	432,393	0	--	4,361,907
Spruce / fir	375,775	322,981	6,776,534	--	7,475,290
Oak / pine	94,223	0	0	--	94,223
Oak / hickory	1,722,912	431,436	1,157,362	--	3,311,709
Elm / ash / cottonwood	51,727	466,265	0	--	517,991
Maple / beech / birch	12,449,063	7,762,298	696,008	--	20,907,369
Aspen / birch	1,721,082	2,137,958	17,793,180	--	21,652,221
Nonstocked	--	--	--	346,185	346,185
Totals:	**20,344,295**	**11,553,330**	**26,423,084**	**346,185**	**58,666,895**

Table 7 displays the limits of the data set when used for small areas and for limited information. While information on growing stock volume is available for every plot each year, harvest only occurs on some plots in any given year. Consequently, the data in Table 7 is generated from a sub-set of all plots sampled resulting in higher error estimates for any given area.

Harvests are highest in the Aspen/birch, Maple/beech/birch, Spruce/fir and White/red/jack pine forest types. Harvests in the Maple/beech/birch and White/red/jack pine forest types, as expected, are highest in large diameter stands followed by medium diameter stands. Harvests in the Aspen/birch and Spruce/fir forest types are highest in small diameter stands. This can be explained by examining the age class distribution of these two forest types as shown in Table 8.

Table 8 - Area of timberland by Forest type group and stand age, 2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in acres.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

	Stand age classifications									
Forest-type group	**0-19 years**	**20-39 years**	**40-59 years**	**60-79 years**	**80-99 years**	**100-119 years**	**120-139 years**	**140-159 years**	**160+ years**	**Total**
White / red / jack pine	43,798	48,448	87,547	61,688	6,462	22,485	6,489	3,781	657	281,355
Spruce / fir	44,041	60,321	196,648	329,518	177,772	47,386	7,430	3,035	5,446	871,596
Fir / spruce	1,643	--	--	--	--	--	--	--	--	1,643
Exotic softwoods	5,508	3,216	--	--	--	--	--	--	--	8,724
Oak / pine	16,109	21,205	25,650	13,731	4,760	--	--	--	--	81,455
Oak / hickory	9,478	26,228	30,023	79,206	24,384	1,574	--	--	--	170,893
Elm / ash / cottonwood	10,618	18,440	52,149	59,000	32,214	3,694	1,982	2,714	--	180,812
Maple / beech / birch	28,702	55,990	259,835	737,889	179,102	32,177	2,643	2,482	--	1,298,821
Aspen / birch	217,357	312,580	228,838	155,404	23,760	3,511	--	--	--	941,450
Nonstocked	16,348	--	--	--	--	--	--	--	--	16,348
Totals:	**393,602**	**546,427**	**880,691**	**1,436,437**	**448,454**	**110,827**	**18,544**	**12,012**	**6,039**	**3,853,097**

Spruce and fir are tolerant species which means they can reproduce in shady stands. The predominant amount of acreage in Spruce/fir stands is over 60 years old, which is most often characterized by some larger trees with a sapling or poletimber understory. These older stands are ripe for harvesting but may be classified as small diameter simply because the proportion of small diameter trees in the understory out-number large or medium diameter trees in the overstory. The vast majority of these types of stands are in Michigan.

The Aspen/birch forest type also has a large number of acres 60 years and older. Unlike spruce and fir, aspen is an intolerant species and needs full sunlight to regenerate. A sixty year old stand is old for the Aspen/birch forest type and the emergence of smaller and younger trees often results from mortality of the older trees in a stand where an opening is created. Consequently, an old aspen stand may be included in the small diameter size class simply because the larger trees are dying which results in more small diameter trees than large, precisely because of the stands advanced age.

A common policy among forest managing entities is to give high priority to harvesting stands of advanced age in the Aspen/birch type. This is especially true if regeneration to the same type is

the management objective. It is also a means of extracting some value from the stand before the large trees succumb to mortality. This explains the large harvest volumes in small diameter stands of the Aspen/birch forest type. The vast majority of this over-aged aspen is in Wisconsin.

Removals data by forest type and age class clearly illustrate this for the Aspen/birch forest type. The same removals data is less clear for the Spruce/fir type, which shows the vast majority of removal volume occurring in the 20-59 age classes.

Over time, removal rates from various forest types have been highly variable as shown in Table 9. Removals from Spruce/fir and Aspen/birch have been relatively stable or increasing, while those from the other forest types have been quite variable, most likely due to market conditions and age class distributions.

Table 9 – Removals from growing stock on timberlands by Forest type group and year - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in cubic ft.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

	Year		
Forest-type group	**2003**	**2005**	**2007**
White / red / jack pine	11,586,107	251,032	4,361,907
Spruce / fir	7,476,933	9,534,450	7,475,290
Oak / pine	3,851,138	0	94,223
Oak / hickory	1,661,467	544,060	3,311,709
Elm / ash / cottonwood	1,401,599	826,939	517,991
Maple / beech / birch	32,990,703	15,226,203	20,907,369
Aspen / birch	14,240,865	11,820,369	21,652,221
Nonstocked	479,570	-	346,185
Totals:	**73,688,382**	**38,203,053**	**58,666,895**

As discussed in section 6.0, removals from growing stock on various ownerships offer differing opportunities for biomass harvest from logging slash due to different policy environments on each ownership. Table 10 shows removals on timberland from various ownerships and forest type groups. Removals from National Forests and from local ownerships (overwhelmingly from county ownership) are entirely from Wisconsin. Despite the fact that error estimates for most ownerships are over 50% in Table 10, this distribution is important as discussed in section 6.0.

Table 10 - Removals from growing stock on timberland by Forest type group and ownership, 2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in cubic ft.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Forest-type group	Ownership				Total
	National Forest	State	Local (county, municipal, etc.)	Undifferentiated private	
White / red / jack pine	81,949	288,139	334,054	3,657,765	4,361,907
Spruce / fir	0	156,025	0	5,367,676	5,523,700
Oak / pine	0	0	263,093	83,710	346,802
Oak / hickory	0	0	711,969	2,599,740	3,311,709
Elm / ash / cottonwood	0	0	11,244	522,261	533,505
Maple / beech / birch	1,896,114	586,211	3,492,538	16,226,291	22,201,154
Aspen / birch	2,417,000	294,538	3,560,650	15,380,033	21,652,221
Nonstocked	--	0	--	346,185	346,185
Totals:	**4,395,063**	**1,324,913**	**8,373,547**	**44,183,661**	**58,277,184**

5.2 Logging residue/biomass generation from existing harvests.

The quantity of logging residue generated from harvesting activities is dependant on stand condition and species type. Species in the White/red/jack pine forest type typically generate the least logging residue, while species in the Maple/beech/birch forest type generate the most. These differences result from differing percentages of merchantable volume as a proportion of total biomass.

For example, prior studies have shown that for the forest type of Sugar maple, yellow birch & beech in New Hampshire (comparable to Maple/beech/birch in Wisconsin & Michigan) only 20% of the total biomass was in the merchantable portion of the tree. In contrast, 67% of total biomass was in the merchantable portion of red spruce & balsam fir stands in Maine and 71% of total biomass was in the merchantable portion of aspen stands in a study conducted in Minnesota.

Consequently, harvests in different forest types are important in the calculation of logging residue available for use. The source of the information which follows in this section is the EVALIDator Version 4.0, another analysis program utilizing FIA data from the Forest Service, Forest Inventory & Analysis unit. Biomass information is currently unavailable from FIDO.

Table 11 contains information on total above ground biomass and merchantable biomass on timberland for stands within the project area. The proportion of potential logging residue by forest type can be determined by subtracting one from the other. Applying the percentages of logging residue in relation to total biomass to harvest quantities, generates the estimates for total logging residue generation from current harvests as shown in Table 12.

Table 11 – Biomass on timberland by forest type group, 2007 - 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in oven dry short tons.				
(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)				
Forest-type group	**All live biomass**	**All merchantable biomass**	**Total potential logging residue**	**Percentage of logging residue in all live biomass**
White / red / jack pine	10,174,196	7,741,163	2,433,033	24%
Spruce / fir	24,444,002	15,574,170	8,874,369	36%
Exotic softwoods	59,973	39,954	20,019	33%
Oak / pine	2,203,314	1,492,459	710,855	32%
Oak / hickory	5,637,435	3,872,145	1,765,290	31%
Elm / ash / cottonwood	6,139,181	3,733,991	2,405,190	39%
Maple / beech / birch	61,824,727	42,548,083	19,276,644	31%
Aspen / birch	24,107,260	13,428,957	10,678,303	44%
Nonstocked	27,605	20,557	7,048	25%
Totals:	134,617,695	88,451,480	46,166,215	34%

Applying the percentages in the last column of Table 11 to existing harvests in the supply area yields potentially available logging residues as indicated in Table 12. The estimates in Table 12 should be considered conservative estimates given the fact that the percentages applied are the proportion of total biomass which consists of logging residue. Existing harvests are for merchantable volumes only (not total biomass).

For example, total biomass in the White/red/jack pine forest type includes both merchantable and un-merchantable biomass. The un-merchantable portion is 24% of this total. In Table 12, this percentage is applied only to the merchantable portion – a subset of total biomass. This constraint is justified by recognizing that every sale where slash might be harvested, might not be primarily as a result of lack of capability of the logging contractor (assuming markets for this material are strong enough to make removal economical). As chipping capacity increases, this dynamic will change.

Column 3 in Table 12 applies the percentages calculated in the last column of Table 11 to 2007 volume removals. Column 4 in Table 12 is the volume of logging slash that is potentially available in the absence of any policy constraints. Although slash harvesting is still not common in the Lake States, field trials have been conducted by equipment manufacturers testing new machines for this purpose. Additionally, there has been some research and practical experience by loggers engaged in slash harvesting to determine how much of the generated slash can be removed. In most cases, 60% to 70% of the slash on any given site can be harvested while minimizing inclusion of dirt. This is well within state best management practice guidelines for slash harvest, which suggests up to 1/3 of the generated slash be retained on site. Taking a conservative approach, 60% is used to generate the potentially harvestable volumes in Table 12.

Table 12 – Potentially harvestable biomass from 2007 timber sales within a 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in cubic ft.			
(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)			
Forest-type group	**2007 Removals**	**Total logging slash generated**	**Potentially harvestable volume (60% of total generated)**
White / red / jack pine	4,361,907	1,046,858	628,115
Spruce / fir	5,523,700	1,988,532	1,193,119
Oak / pine	346,802	110,977	66,586
Oak / hickory	3,311,709	1,026,630	615,978
Elm / ash / cottonwood	533,505	208,067	124,840
Maple / beech / birch	22,201,154	6,882,358	4,129,415
Aspen / birch	21,652,221	9,526,977	5,716,186
Nonstocked	346,185	86,546	51,928
Totals:	**58,277,184**	**19,814,242**	**11,888,545**

The fourth column of Table 12 indicates the estimate of how much total biomass is available from logging slash that could potentially be harvested in the target supply area in the absence of any policy restrictions. To put this volume in perspective, a semi-truck load of green chips weighs approximately 30 tons. Aspen and red pine weigh approximately 42 lbs./cubic foot. Oak weighs approximately 63 lb./cubic foot. Using an average between these two species of 52.5 lbs./ cubic foot, the total weight of potentially harvestable logging slash equals 11,888,545 X 52.5 = 624,148,612 lbs. or 624,148,612 lbs./2,000 lbs. per ton = 312,074 green tons annually. 312,074 tons/30 tons per load = 10,402 truckloads per year or 10,402/365 days per year = 28 truckloads a day. Policy constraints, as outlined in the next section, will reduce the availability of this biomass.

6.0 Government Policies Regarding Treatment of Logging Slash

Each government jurisdiction has differing policies regarding the treatment of logging slash on their own ownerships and on private lands enrolled in various programs which offer property tax relief in exchange for keeping forestland in-tact and managed. All ownerships have responded to the growing interest in use of logging slash for energy, and as a feedstock for ethanol or chemical production. One policy which is common on all ownerships is that foresters generally do not allow double entries. This means that the harvest has to occur over one continuous time period when all the cutting and hauling is completed. In other words, a contractor can not cut the merchantable material and wait for a year to come back and remove the slash. The ownership with the most restrictions currently is the USDA Forest Service. On all other ownerships, there are few policy constraints on the use of logging residue for biomass.

6.1 Chequamegon-Nicolet National Forest policies regarding harvest of logging slash

A majority of the Nicolet portion of this National Forest is within the procurement area. Traditional timber sales from the National Forest are sold via written competitive bidding where bidding is by species, type of product (sawlogs & pulpwood) and price bid per unit of measure. The volumes of each product are determined by a cruise of the sale by Forest Service personnel. Contracts are awarded to the highest total bid submitted for any one sale. These are pre-

measurement sales, meaning the winning bidder pays the amount listed on the sales contract for each product and absorbs any underrun or overrun. This is in contrast to sales from Wisconsin state & county lands which are scaled sales. In the case of a scaled sale, a cruise is made to estimate the volumes of various products but as the timber is cut, it is scaled and the contractor pays for the scaled volumes, not the cruise estimates.

Given the complexity of the policies the Forest Service must follow, they currently do not have guidelines on harvesting of logging residue on traditional timber sales. Their last forest plan was completed in 1994 and did not include such guidelines. If it is not in the plan, it can't be done. They are in the process of developing such guidelines for the next planning cycle. The only instance currently where they allow or encourage slash removal is in areas in the urban/rural interface (houses in predominately forested areas) where there is high wildfire risk. In this instance, the removal of slash is used as a tool to reduce this risk. Currently approximately 85% of sales on the Chequamegon-Nicolet are thinnings and 15% are clearcuts. Generally residue removals from clearcuts are more economical than from thinnings.

The Forest Service also uses Stewardship sales (also called hazardous fuel reduction grants) primarily to reduce the density of stands through thinning. This type of cutting is not economical because the majority of timber removed is small diameter and below merchantable size. These types of contracts are used most often in the Western US to reduce fire danger. In this case, the logger is paid by the Forest Service to remove this wood. These types of contracts are used on the Chequamegon-Nicolet but not on a frequent basis.

Several years ago straight line winds destroyed some Forest Service owned northern hardwood stands in the Lakewood-Laona Ranger District. A research project was approved in November of 2008 to investigate the impact of removing slash for bio-energy purposes on nutrient availability and above and below ground community assemblages on rich soils under regenerating stands. The study is being undertaken by the Forest Service, US Geological Survey and the University of Wisconsin-Madison. On an 800 acre tract, logging slash will be left on 1/3 of the area, 65% will be removed on another 1/3 and 85% removed on the remaining third.

This research and the fact that the Forest Service is developing biomass harvesting guidelines clearly shows that in the field and at the forest level, they are responding to increased interest in use of logging residue for biomass. Whether this will result in increased availability in the future, however, is dependant on future planning cycles and national policies. At present, circumstances do not look favorable.

The Forest Service is unlikely to be a reliable source of biomass from logging residue. While the Allowable Sale Quantity on the Chequamegon-Nicolet is projected to rise over the next five decades, it is greatly reduced from historic levels. With every round of planning there is pressure for further reductions from environmental groups. This pressure will only increase in the future given the fact that powerful national environmental groups that were successful in reducing timber sale by 90% in the Western US have recently turned their attention to Midwest and Eastern forests. It is these same groups that have blocked use of wood for biomass from federal lands (except to reduce fire hazards or restore ecosystem health) in the Waxman-Markey climate bill under the proposed national renewable energy standard. This policy environment is unlikely

to change despite the fact that current energy policy is strongly oriented toward use of renewables.

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6.2 State of Wisconsin forest lands & tax law programs

A modest amount of state owned land occurs within the project area. Harvesting policies as related to the use of logging slash essentially mirror those of county lands. The bidding procedures, contracts and payment policies are all similar. State land managers have demonstrated flexibility in contract terms on the issue of use of logging residue for biomass. It is reported that sales from the Northern Highland State Forest frequently include sale of chips as a separate product on the bid form because there is demand for them in this area. On one sale the bid on logging residue from this forest was $2.50/ton.

Where the state of Wisconsin really has impact on the supply of logging residue for biomass is on private forest lands enrolled on one of two tax law programs. These are the Managed Forest Tax Law and the Forest Crop Law programs. Both programs substitute a severance tax for a large proportion of annual property taxes as an incentive to keep forest land from being developed and ensure that it remains "working forest". A management plan is required within each program and harvesting is also required as outlined in the plan. Wisconsin DNR foresters oversee these landowners to ensure compliance.

Both programs allow lands to be withdrawn, but the withdrawal penalties are very high. For example, the withdrawal tax on Managed Forest Tax Law land is the *higher* of 5% of the value of the merchantable timber on the land (less any amounts paid of acreage share or yield tax) or a calculation based on the previous year's assessed value, multiplied by the previous year's net property tax rate, multiplied by the number of years the land has been in the program. This is essentially a recapture of more of the property tax an owner would have paid if land values are rising from the time they entered the program. Lands in the MFL have to be a minimum of 10 contiguous acres and at least 80% forested. The landowner has a choice of a 25 or 50 year enrollment period. Up to 160 acres per ownership per municipality may be closed to public access. On acreages above this amount, public access is allowed for non-motorized recreational activities.

There are two components to the fees paid under each program. One is an acreage share tax the other is a severance tax. The acreage share tax is paid annually and substitutes for the property tax. Acreage share tax rates for 2008 through 2012 are as follows:

- Tax rates (per acre) for land enrolled before 2005
  Open land - $0.67
  Closed land - $1.57
- Tax rates (per acre) for land enrolled after 2004
  Open land - $1.67
  Closed land - $8.34

Severance taxes are paid when timber is harvested. Severance rates are recalculated annually using a running average over a few years. They also differ by area. The state is divided into 13 zones for this purpose. The project area lies within the Civitz and Rhinelander zones. For the four most common species in the target area, severance taxes are as follows:

- Crivitz – tax rates (per cord)
  Aspen - $1.55
  Birch – $1.70
  Other Hardwood - $1.35
  Red Pine - $2.80
- Rhinelander – tax rates (per cord)
  Aspen - $1.15
  Birch – $1.30
  Other Hardwood - $1.20
  Red Pine - $2.15

Using Aspen from the Crivitz zone as an example, aspen weights approximately 42 pounds/cubic foot. With chips, there is approximately 75 cubic feet of solid wood in a cord. So the number of tons in a cord are 42 X 75 = 3,150 lbs/2,000 lbs per ton = 1.575 tons. Therefore, the severance tax on a ton of aspen chips would be $1.55 X .75 = $1.16 per ton. This money provides reimbursement to local units of government and **does not** include any amount the landowner may demand as reimbursement for use of this material. During 2009, public hearings will be held to discuss the addition of a chip product category to the existing three. The Wisconsin DNR expects the new category to be in use by 2010.

This program is significant due to the fact that applications for enrollment have ballooned in recent years as property tax rates have risen.

The Forest Crop Law program is the older of the two and is now closed to new entrants. The primary users of the forest crop law program were forest industry holdings (now Real Estate Investment Trusts or Timber Investment Management Organizations). Severance tax rates under the Forest Crop Law Program are higher than under MFL. For example in the Crivitz zone per cord rates are as follows:

- Crivitz – tax rates (per cord)
  Aspen - $3.10
  Birch – $3.40
  Other Hardwood - $2.70
  Red Pine - $5.60

Wisconsin just approved Best Management Practices for removal of logging slash that are similar to other previously established BMP guidelines for timber harvesting. These new BMP's should not be a significant barrier to slash harvesting on most sites.

The significance of these private forest landowner programs is that harvest is required on enrolled lands thereby providing some certainty of supply. The addition of chips as a product

category to the severance tax tables will explicitly identify logging residue as a viable and harvestable product and, hopefully, aid in market development .

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6.3 State of Michigan forest lands & tax law programs

There are half-a-million acres of Michigan state-owned forestland within the project area. The state sells only merchantable timber defined as 100" to a 4" top. It is this material that is included in the bid and contract documents. However, most contracts do not prohibit the harvest of tree tops. By default, the contractor is allowed to harvest this material and essentially acquires this material for free since contracts are bid lump sum. It is likely that a contractor's intention to chip the tops will influence the amount bid for a sale, but the state does not explicitly include chips as a product in the bid documents.

Given the large acreage of this ownership within the project area and the liberal contract terms for timber sales from this ownership, this could be a major source of woody biomass for a plant at Niagara. In addition, Michigan is in the process of adopting Best Management Practices for removal of logging slash. These guidelines are currently in draft form, but are very similar to those in Wisconsin, and should not be a deterrence to use of logging residue.

Similar to Wisconsin, Michigan also has two programs for private forest landowners to reduce annual property taxes as an incentive to preserve land in forests. The Commercial Forest program is the older of the two and includes 2.2 million enrolled acres statewide, 2 million of which is located in the Upper Peninsula. There is increasing interest in this program as evidenced by a doubling of the rate of enrollment in the last year (8,500 acres in 2008) compared to the historic average.

Under this program, the enrolled landowner pays $1.20/acre to the county in lieu of property taxes which is matched by the state. A minimum of 40 contiguous forested acres is required for enrollment and a management plan is also required. Harvesting of timber is not required but, if done, must follow the management plan and be approved by the state. No severance taxes apply. Enrolled lands must be open to the public for hunting, trapping and fishing (foot access only) but, as with other programs, this right of use is limited. For example, the public can not use off road vehicles, cut shooting lanes, camp, construct blinds, etc. without the written permission of the landowner.

Similar to private forest landowner programs in Wisconsin, withdrawal penalties are high, totally $4,000 - $6,000 per 40 acres after 7 years. Program managers report that there is little tracking of the results of this program.

In September of 2006, the state created a second program, the Qualified Forest Property program. This program is for smaller acreages (20 acre minimum, 320 acres maximum) and landowners are not required to allow public access. Landowners enrolled in this program are exempt from the tax levied by a local school district for school operating purposes. Similar to the Commercial Forest program a management plan is required. There is no severance tax and the

costs of withdrawal are high. This program has been less popular than the Commercial Forest program and currently includes only 45,000 acres.

While Michigan's private forest landowner programs are less robust than Wisconsin's in ensuring harvest of timber, they still encourage management of forestland and discourage its conversion to other uses.

State of Michigan contacts – Shirley Businski (517) 373-1277 or businsks@michigan.gov
Doug Heym (517) 335-3342 or heymd@michigan.gov

6.4 State of Wisconsin County lands

County owned forest lands within the project area exist only in Wisconsin. Marinette County has the largest acreage within the project area. County forests are the jurisdiction most responsive to changing market conditions and most able to alter sales contracts in response to those conditions. County sales are sold by written competitive bidding where bidding is by species, type of merchantable product (sawlogs & pulpwood) and price bid per unit of measure. Contracts are awarded to the highest total bid submitted for any one sale. Like sales from state lands, the products cut are scaled by species and product type. The price bid per unit of measure is applied to the scaled volume to determine the cost to the logger.

Loggers can also bid "variable top bidding" (added last year in Marinette County) where they can sell the merchantable products and chip the logging residue. Loggers can also bid "whole tree" and chip the entire tree. In both cases, the severance taxes paid are based on cord equivalents utilizing the rates for pulpwood. This will change in 2010 when a chip product category is added to the severance tax rates. While the following is based on a conversation with the Marinette County forester, the same circumstances are likely to apply to other county land acreages in slightly varied form.

Marinette County allows contractors to take logging residue from the sale and currently charges the logger 50 cents/ton. The logging community has shown increasing interest in harvesting logging slash in the last year or two. This interest has picked up in the last year as there is a perception that some markets may be developing soon. Some operability issues are also being addressed (particularly a new type of forwarder that can pick up both tops and roundwood). The county forester has one logger that chips piled jack pine slash to clear the site for planting. This logger pays $5/ton for the slash and ships the chips to the pulp mill in Escanaba for boiler fuel.

In the northern part of the county (closest to Niagara) about 48% of county forest types are Aspen/birch, 20% are Maple/beech/birch, 10-15% are White/red/jack pine with the balance in other types. This is a favorable forest type mix for the harvest of logging slash.

The allowable cut on Marinette county lands is currently 6,000 acres and will be increasing between 2013 and 2018 as aspen stands grow to merchantable size. As seen in Table 8, there is an aspen age class imbalance on timberland in the project area with the largest acreages occurring in the 20-39 and 40-59 age classes. It is these acreages that will allow increased harvest in the future. The Marinette County forester will allow harvest of logging residue in

northern hardwood stands (logged by thinning) if the haul lanes are wide enough and the equipment suitable (forwarders not skidders) to ensure no damage will occur to the residual stand. This is likely to be true on all ownerships within this forest type.

Marinette County Contact – John Scott (715) 732-7525 or jscott@marinettecounty.com

6.5 Slash harvest on private lands enrolled or not enrolled in a tax law program

The only barrier to harvesting slash on any private land holding would be reluctance on the part of the landowner. This will probably not be a barrier because most private forest landowners do not like the look of a site after harvesting and would probably welcome some slash removal to improve aesthetics.

6.6 Summary impacts of policies on availability of logging slash in the project area

Adjustments to the potentially available logging slash in section 5.2 are needed to account for its lack of availability from Forest Service lands and the fact that part of the logging slash will be unavailable from Maple/beech/birch stands on other ownerships as a result of restrictions to prevent damage to the residual stand. Table 10 indicates that Aspen/birch removals from forest Service lands represent 11.2% of the total on all ownership groups for this forest type while Maple/beech/birch removal represents 8.5% of the total on all ownership groups for this forest type. Appling these percentages to the estimate of total logging slash generated in column 3 of Table 12 for each forest type would reduce the available total to 8,459,956 cubic feet in Aspen/birch and 6,297,358 cubic feet in Maple/beech/birch.

It is further assumed that half the harvests in the Maple/beech/birch Forest type on other ownerships would not allow removal of slash, due to concerns about residual damage. This would reduce logging slash availability from this forest type to 3,148,679 cubic feet. The result of applying these two policy constraints is shown in Table 13.

Table 13 – Realistic estimate of harvestable biomass from 2007 timber sales, including policy constraints, within a 50 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in cubic ft.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Forest-type group	2007 Removals	Total available logging slash generated	Potentially harvestable volume (60% of total available generated)
White / red / jack pine	4,361,907	1,046,858	628,115
Spruce / fir	5,523,700	1,988,532	1,193,119
Oak / pine	346,802	110,977	66,586
Oak / hickory	3,311,709	1,026,630	615,978
Elm / ash / cottonwood	533,505	208,067	124,840
Maple / beech / birch	22,201,154	3,148,679	1,889,207
Aspen / birch	21,652,221	8,459,956	5,075,974
Nonstocked	346,185	86,546	51,928
Totals:	**58,277,184**	**16,076,245**	**9,645,747**

Under this more realistic scenario, total available logging residue within a 50 mile radius would total 9,645,747 X 52.5 = 506,401,717 lbs. or 506,401,717 lbs/2,000 lbs. per ton = **253,209 green tons annually**. This is about half of the projected demand of the proposed cellulosic ethanol plant envisioned for Niagara.

Using similar methodologies to those described above, 60 mile and 65 mile circular plots were run and the same calculations made to determine potentially harvestable material within these procurement areas. Results are shown in Tables 14 and 15.

Table 14 – Realistic estimate of harvestable biomass from 2007 timber sales, including policy constraints, within a 60 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in cubic ft.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Forest-type group	2007 Removals	Total available logging slash generated	Potentially harvestable volume (60% of total available generated)
White / red / jack pine	5,212,009	1,052,649	631,589
Spruce / fir	9,355,086	3,367,831	2,020,698
Oak / pine	346,802	110,977	66,586
Oak / hickory	8,053,679	1,881,615	1,128,969
Elm / ash / cottonwood	533,505	208,067	124,840
Maple / beech / birch	36,306,605	5,333,626	3,200,176
Aspen / birch	32,954,657	13,009,243	7,805,546
Nonstocked	2,051,482	512,870	307,722
Totals:	**94,812,825**	**25,476,878**	**15,286,126**

The 60 mile procurement radius yields 401,261 green tons of potentially harvestable logging slash annually.

Table 15 – Realistic estimate of harvestable biomass from 2007 timber sales, including policy constraints, within a 65 mile circular plot on Niagara WI (Lat. 45.7401 N, Long. -88.0271 W) in cubic ft.

(The color of each estimated value represents its percent sampling error (pse); if estimate is **black**, pse is less than or equal to 25%; if estimate is **green**, pse is greater than 25% and less than or equal to 50%; if estimate is **red**, pse is greater than 50%)

Forest-type group	2007 Removals	Total available logging slash generated	Potentially harvestable volume (60% of total available generated)
White / red / jack pine	6,814,496	1,437,246	862,348
Spruce / fir	9,443,955	3,399,824	2,039,894
Oak / pine	1,914,919	612,774	367,664
Oak / hickory	9,107,638	2,208,342	1,325,005
Elm / ash / cottonwood	1,098,628	428,465	257,079
Maple / beech / birch	41,537,290	6,114,382	3,686,629
Aspen / birch	36,150,558	14,415,440	8,649,264
Nonstocked	2,051,482	512,870	307,722
Totals:	**108,118,966**	**29,129,343**	**17,477,605**

The 65 mile procurement radius yields 458,787 green tons of potentially harvestable logging residue annually. Again, it should be noted, that these estimates are based on conservative assumptions. Flexibility to utilize a variety of feedstocks will have the effect of shrinking the procurement radius needed to obtain fiber supply.

7.0 Sources of Mill Residue and Other Potential Sources of Low Cost Cellulosic Materials

Mill residue would not be a realistic source of cellulosic biomass. The closest major purchasers of so called “dirty chips” for boiler fuel are located in Escanaba & Tomahawk, thereby essentially splitting the proposed procurement area in half. In a 1996 wood residue study, the Northeast Region of Wisconsin generated the most sold coarse residue of any region in Wisconsin and utilized this material inter-regionally the least. While this data is dated, it does show that the common pattern in this region is to ship this material elsewhere. Further study investigating current markets for this material is warranted and was outlined in part two of the study.

Possible agricultural sources of cellulosic biomass were examined next. The 2007 Census of Agriculture was consulted to determine acres devoted to and harvests from agricultural lands in counties within the project area devoted to production of forage. This included land used for all hay and all haylage, grass silage and greenchop. It should be noted that the information in Table 14 is for the entire counties indicated. The agricultural database does not allow for circle plot retrievals. Data is only available for entire counties.

Table 16 – Forage Land used for all hay and all haylage, grass silage and greenchop, 2007.

Michigan			
County	**# of Farms**	**Acres**	**Quantity (Tons, Dry Equivalent)**
Baraga	45	4,787	6,626
Delta	179	20,289	34,021
Dickinson	94	5,916	7,675
Iron	72	5,940	6,813
Marquette	53	6,976	12,504
Menominee	267	28,163	48,249
Totals	**710**	**72,071**	**115,888**
Wisconsin			
County	**# of Farms**	**Acres**	**Quantity (Tons, Dry Equivalent)**
Door	366	26,383	65,209
Florence	79	7,176	9,486
Forest	120	8,438	12,562
Langlade	251	22,411	49,438
Marinette	380	31,151	82,690
Oconto	768	45,755	120,084
Oneida	65	4,705	5,146
Vilas	21	1,040	NA
Totals	**2,050**	**147,059**	**344,615**
Two State Total			
MI & WI	**# of Farms**	**Acres**	**Quantity (Tons, Dry Equivalent)**
Totals	**2,760**	**219,130**	**460,503**

Table 16 shows that **460,503 dry equivalent tons** are produced from these counties. If only 10% of this material could be captured as feedstock for a cellulosic biomass facility, this could supplement the logging residue by 46,000 dry ton equivalents. If it is assumed that dry ton equivalents have a 10% moisture content, this equates to 64,400 green tons at 50% moisture

content. Farmer receptivity and anticipated costs for this material should be explored in phase two of the project.

If used upon delivery, this source of biomass would have very seasonal variability being delivered in mid-summer (after a first cutting) and fall after a second. It is common, however, for farmers to "store" baled hay on-site for use or sale in the winter. Contractual arrangements could be made for delivery of this material in late winter (just before spring break-up) for use in an ethanol facility during spring break-up when wood deliveries decrease.

A third possibility for supplementing logging residue is the purchase of roundwood. Although this would be a higher cost form of biomass, there may be advantages for use of this material as a supply bridge through spring break-up. Chips are a bulky commodity and difficult to store for long periods of time. Roundwood can be stored much more easily for longer periods of time in the winter and take up less yard space than chips per unit of volume.

At approximately 1.5 tons/cord of green aspen pulpwood as calculated in Section 6.2, purchase of 100,000 cords of aspen pulpwood annually would yield 150,000 tons of biomass. This could be yarded up to supplement chips & agricultural residue, as needed, to maintain a steady supply of material to the plant.

8.0 Potential Suppliers of Logging Residue

The list of potential suppliers in Table 17 was compiled by contacting the Wisconsin DNR, Michigan DNR, Florence County, Forest County and Marinette County. Each source was asked to provide their "active" logger list with any additional information regarding listed loggers. These lists were then compared and purged of repeat listings, non-logging firms or poor performers.

The listings on the spreadsheet that are bolded have been identified as currently dealing with residue in some form or are very good contractors. There remain very few logging contractors that currently chip residue or roundwood for the chip or residue market. Olsen Brothers, Earl St. John and Jim Carey were the only producers identified as having chipping capability. An address for Earl St. John in Michigan could not be located. The contractors that are bolded on the list should be considered as the "short list" to be further considered for face-to-face discussions.

Table 17 – Potential suppliers of logging residue in the project area.				
Albrecht Trucking Inc.	P. O. Box 90B	Laona	WI	54541
Ambrosius Forest Products	Rt. 1, Box 179	Laona	WI	54541
Bill Sebero	P. O. Box 13	Porterfield	WI	54159
Brown's Trucking	7710 Trout Creek Road	Rhinelander	WI	54501
Buechler Logging	N9896 Highway 141	Wausaukee	WI	54177
Central Timber Inc.	P. O. Box 2221	Eagle River	WI	54521
Christian Logging	P. O. Box 129	Sagola	MI	49881
Dale Stepien Logging	Box 82	Pembine	WI	54156
Dan Zahorik	P. O. Box 203	Amberg	WI	54102
DeLaet Enterprises LTD	**168 Van Buren Street**	**Wausaukee**	**WI**	**54177**
Dugree Trucking	W6087 Old Highway 2	Hermansville	MI	49847
Dvorak Logging, Inc.	5127 E. Lakeview Street	Crandon	WI	54520
Forstrom Logging	3755 Wells, Box 387	Quinnesec	MI	49876
Frank's Logging, Inc.	**N2512 County Road Y**	**Peshitigo**	**WI**	**54157**
G & G Forest Products	5042 Loon Lake Road	Florence	WI	54121
Great Lakes Timber, Inc.	P. O. Box 218	Eagle River	WI	54521
Grunville Trucking, Inc.	**P. O. Box 77**	**Niagara**	**WI**	**54151**
Hageny Logging	10258 Cemetery Lane	Crandon	WI	54520
Holli Forest Products	P. O. Box 117	Ishpeming	MI	49849
J K Forest Products	6725 E. Springside Road	Coleman	WI	54112
J. Carey Logging, Inc.	**Sawyer Lake Road**	**Channing**	**MI**	**49815**
James McTrusty	N15195 Rocky Lane	Amberg	WI	54102
Jim Cazzola	520 Mine Street	Norway	MI	49870
Joe Darga	HCR 1, Box 1	Athelstane	WI	54104
Joe's Logging	N1462 Highway 27	Conrath	WI	54731
John Sivula & Sons	N13300 Sivula Lane	Dagget	MI	49821
K. L. & P. Logging	5791 Highway 8	Laona	WI	54541
Kirschner Forest Products	N15107 Township Line Rd	Powers	MI	49874
Kowalkowski & Sons Logging	P. O. Box 2213	Kingsford	MI	49802
Kowalkowski Logging	8698 Wall Road	Armstrong Creek	WI	54103
Ledvina Logging	W7490 Moonshine Hill	Wausaukee	WI	54177
Lee Schuman	N20580 LaFave Drive	Fence	WI	54210
LeFluer Forest Products	P. O. Box 282	Florence	WI	54121
Lonnie Nowak Logging	P. O. Box 104	Long Lake	WI	54542
Lucas Logging	W1564 Highway M69	Hardwood	MI	49807
Mihalko Land & Logging	3915 Highway 55 South	Crandon	WI	54520
Mike Piontek Logging	7591 Dicksamz Road	Argonne	WI	54511
Miller Logging	533 Adams Avenue	Niagara	WI	54151
Minerick Logging, Inc.	P. O. Box 99	Sagola	MI	49881
Nickels Logging, Inc.	**P. O. Box 213**	**Norway**	**MI**	**49870**
NRG Ducaine Logging	**N8150 Smith Creek Road**	**Crivitz**	**WI**	**54114**
Olson Bros. Enterprises, LLC	**W9297 Moonshine Hill**	**Crivitz**	**WI**	**54114**
Paul Cleereman Logging	7901 Highway 139	Cavour	WI	54511
Pomeroy, Ed	Rt 4, Box 258	Crivitz	WI	54114
Ray Gordon	1115 Division Street	Wausaukee	WI	54177
Rich Wickland	P. O. Box 2441	Kingsford	MI	49802
Richard Brown	W7753 Tower Line Road	Pembine	WI	54156
Richard Kirschner	P. O. Box 35	Powers	MI	49874
Robert Cleereman Jr.	Rt 2, Box 1050	Newald	WI	54511
Schwittay Logging	HC 1, Box 324	Athelstane	WI	54104
Scott Barker	W9104 US Highway 8	Dunbar	WI	54119
Shamco, Inc.	P. O. Box 436	Iron River	MI	49935
Shane Mclain	HC 3, Box 156	Florence	WI	54121
Steve Mattison	P. O. Box 163	Amberg	WI	54102
Todd Stepien	W7837 Cemetery Road	Pembine	WI	54156
WI Waste Wood Recycling	**1339 Flobengo Lane**	**Sobieski**	**WI**	**54171**
Wild Rivers Forestry	**W6666 Judy Street**	**Wausaukee**	**WI**	**54177**

9.0 Seasonal Variations Related to Supply & Impact of Distance on Delivered Wood Prices

Factors that may affect seasonal supply were evaluated and discussed with several local resource professionals. Spring break-up refers to the annual period following the traditional winter logging season as rising temperatures and spring rains thaw frozen soils. The thawing process has a significant influence on the load bearing capability of the soil and roads. The break-up period typically is referenced by the period of time that the weight restrictions are posted on a variety of town or county roads. These weight restrictions may vary from 4 tons to 20 tons GVW on various roads, but have the same impact of making trucking uneconomical during this period.

The procurement area near Niagara experiences restrictive weight limits during the spring, typically from the second week in March to the third week in April. This restrictive period historically fluctuates depending upon the seasonal weather conditions, but normally by not more than a week in either direction. Inevitably, there is at least a 5 to 6 week window of restricted hauling which must be dealt with on an annual basis.

Niagara is serviced by Highway 141 which is a class A highway and available for hauling throughout the year. There are several additional class A highways that provide access to Highway 141 and thus open up a rather large area for potential hauling during the spring period. County roads and town roads that access public and private timber away from the main highways are posted to the reduced weights and limit additional hauling access. A common practice within the logging industry is to deck (i.e. store) harvested roundwood timber in locations accessible for hauling during the restrictive spring season. This option may not be available for consideration of this project if only residue type products are considered for use. Stockpile locations would need to be explored for chip or other residue products.

Geologic landform influences the ability to harvest and haul during various periods of the year, including break-up and wet summer months. Niagara is located in a region of highly glaciated landforms, of which a significant proportion are sand or sandy loam in character. These soils support the opportunity for logging throughout the year, at times regardless of the ability to truck the wood. In general, available break-up wood has become more difficult to obtain in the absence of additional public road improvement or upgrading to access further off class A highways.

Marinette County, for example, indicated that possibly 25% of the County forest has sufficient access and soil capability to support the concept of break-up work. This area has sufficient class A highway access as well as soil/forest types conducive to cutting, skidding and hauling during the spring. Florence County however, felt they had little to no break-up sale chance due to the lack of class A highway access, but not due to soil limitations. Florence County indicated that they commonly experience crews which may cut, skid and deck the products during the spring for hauling following removal of weight restrictions.

Transportation costs relative to delivery of supply material to the Niagara site under this project is considered consistent with the industry standard. Consuming plants (regardless of roundwood or chip) offer financial consideration for product delivered from varying distances. One contractor delivering residue material indicated that prior to each job they discussed haul distance, product composition, and character of the job with the plant manager to determine a delivered rate for each job.

Procurement area for the proposed Niagara site should not be limited by a random distance, but rather calculated on the factors affecting quality, quantity and timing of delivered product. Transportation costs, which are correlated to fuel costs, have fluctuated wildly within the last few years. These fluctuations have directly influenced the decisions transporters have made to deliver product to various consuming mills. The consuming mill must be prepared to adapt and cover cost factors in transportation or the supply stream will be reduced or terminated.

10.0 Conclusions

Conservative assumptions of available logging residue indicate that approximately 250,000 green tons of chipped tops could be procured within a 50 mile radius of Niagara, 400,000 green tons within 60 miles and 460,000 within 65 miles. Delivered wood costs of this **material** need to be explored in phase 2 of the project. Expansion of the procurement radius would yield more material but at higher cost due to higher transportation costs.

There is an opportunity to utilize agriculture forage crops in the region to supplement logging residue chips but the cost and actual availability of this source of biomass needs to be explored further. Preliminary guesstimates indicate that if 10% of 2007 production of agricultural forage crops in the counties included in the procurement could be secured, this would generate 64,400 green tons of biomass.

While there are several competitors for roundwood in the proposed procurement area, it makes sense to compete in this market, primarily as a means to store product to get through the spring break-up period. As discussed in the introduction, the closure of the Niagara and Kimberly mills left a void in the market for the roundwood they once consumed. This form of biomass is likely to be more expensive than logging residue and agricultural forage crops but its use as a supplement could avoid supply problems in the spring. It is estimated that purchase of 100,000 cords of roundwood may be required to supply 150,000 green tons of biomass annually to a plant using 500,000 tons of green biomass if the supply projections for logging residue within a 50 mile radius and agricultural forage crops are accurate.

Flexibility in feedstock supply (being able to utilize chipped residue, agricultural products and roundwood) is highly recommended to allow a cellulosic ethanol company to better manage their supply chain and adjust it based on seasonal considerations and changing market dynamics/prices for each potential feedstock. A plant will also have to be able to utilize all species of wood in chipped material since that is the only form in which chipped material from logging slash can potentially be economically produced.

Harvesting in the proposed procurement area is supported by generally good markets (with typical ups and downs based on paper markets) and locally supportive communities. Government policies are not restrictive regarding the harvest of logging slash for biomass – indeed they are very accommodating and flexible in this regard. The lone exception to this rule occurs on Forest Service owned lands.

The logging contractor infrastructure appears to be more than adequate to undertake chipping operations if a market develops and chipping capability can be added to existing operations. Logging contractors will have to be convinced, however, of this market opportunity via the form of contractual arrangements at specified prices before they will invest in equipment to undertake logging residual harvest.

Seasonal variations related to supply exist but are manageable if such variations are recognized in procurement strategies.