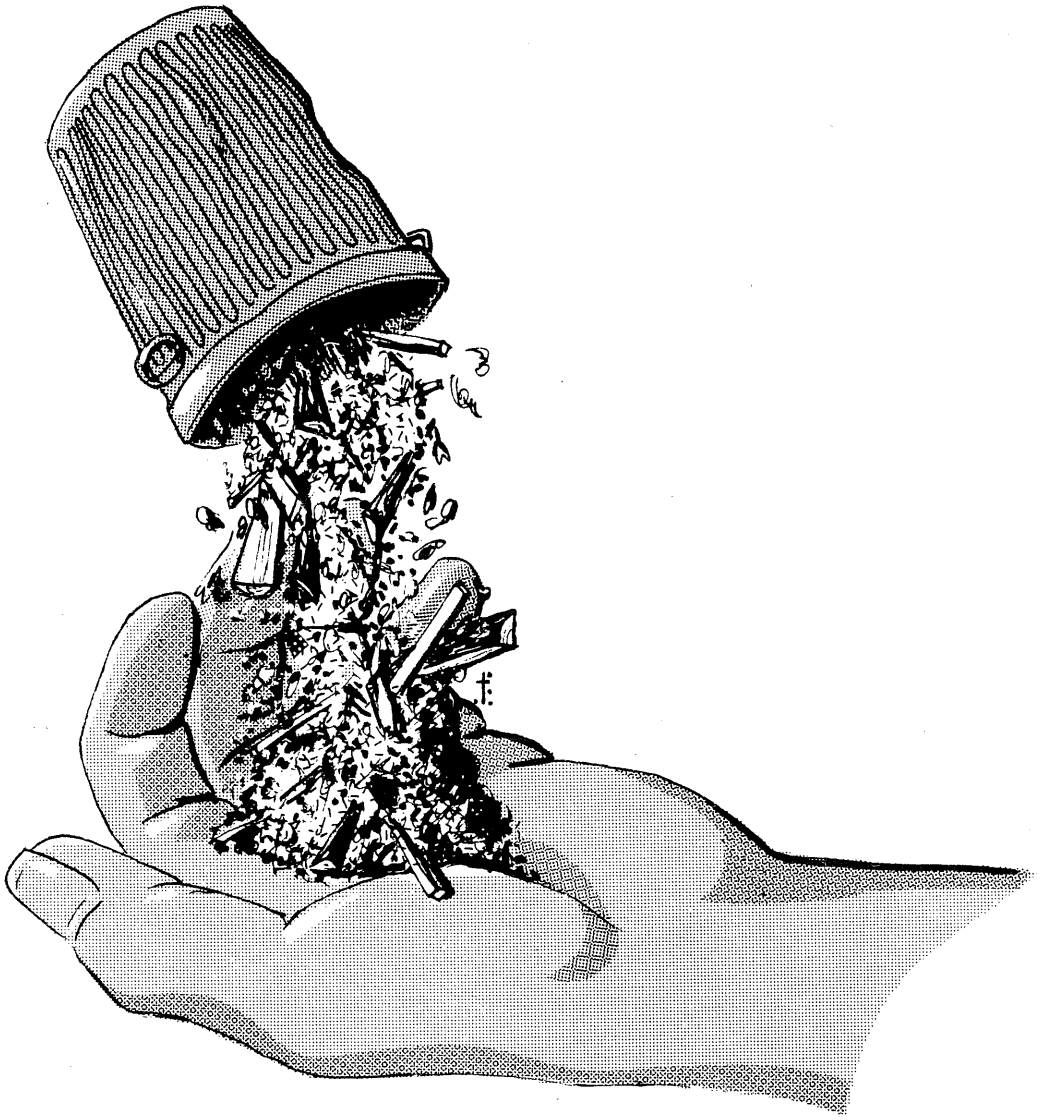
Minnesota Wood Waste Studies

One Man's Trash is Another Man's Treasure



1994

DEPARTMENT OF NATURAL RESOURCES

FORWARD

This project was conducted by the Minnesota Department of Natural Resources, Division of Forestry in cooperation with the University of Minnesota, Department of Forest Products.

The primary processors survey was conducted by the Minnesota DNR. These data were collected by the following DNR Regional Forest Product Utilization Specialists:

Carl Prosek, Grand Rapids
Jeff Edmonds, Bemidji
Paul Peterson, Brainerd
Phil Vieth, St. Paul

The secondary processors survey was conducted by Thomas Milton, University of Minnesota, Department of Forest Products.

The data for the balance of the report was gathered from databases and reports within the Division of Forestry and the Minnesota Pollution Control Agency. Overall coordination of the project, calculation of projected volumes, and preparation of this report was done by the following members of the Forest Management staff of the Division of Forestry in St. Paul:

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EXECUTIVE SUMMARY

The Minnesota Department of Natural Resources (DNR), Division of Forestry, in cooperation with the University of Minnesota, Department of Forest Products, conducted a study of wood waste generated each year in Minnesota. This report identifies the volumes wood wastes generated in a number of categories, and quantifies how those wastes are currently disposed of or utilized.

The data reported here is intended to provide useful information to those interested in identifying wood waste disposal problems, and in utilizing wood wastes for a variety of uses. Examples include energy, fiberboard and paper products, composites that incorporate wood fiber with other materials, landscape mulch, and animal bedding. The major sources of wood residue are listed as follows:

Forest Biomass

More than 4,000,000 cords of wood are harvested from Minnesota's forests each year. Substantial volumes of residues are left standing or lying on the forest floor following harvest operations. A portion of these residues could be recovered for energy production or the manufacture of products. Economic and environmental considerations will limit the volume it is practical and desirable to recover.

Between 1,066,900 to 1,275,400 cord equivalents, or 2,446,400 to 2,924,500 green tons of forest residues could have been recovered during 1993 harvest operations. More than 327,000 cords, or 748,900 green tons of forest residues are recovered for fuelwood each year. This leaves a total of 739,900 to 948,400 cord equivalents, or 1,697,500 to 2,175,600 green tons of forest residue actually available for other uses.

Primary Processor Residue

Primary wood processors are those industries that use roundwood (logs) or chips from roundwood to manufacture a variety of products. There are more than 600 primary mills in Minnesota, and in 1993 they processed 3.6 million cords (excluding fuelwood) of wood. This is an increase of nearly 30% since 1988. These mills generated more than 1.8 million green tons of waste wood. Nearly two-thirds (62%) of these wood wastes are used for fuel. Only 6.5%, 117,100 green tons, are currently not utilized. Over 94% of the unutilized volume, 110,300 green tons, is found at small sawmills scattered around the state.

Secondary Processor Residue

Secondary wood processing industries are those that utilize lumber or other wood products produced by primary processors to manufacture finished products such as cabinets, windows, toys, or moldings. There are approximately 1100 secondary manufacturers in Minnesota. These companies generated nearly 470,000 dry tons of waste wood in 1994. Nearly three quarters (74.2%) of the waste wood was used for fuel or animal bedding. Only 18.4%, less than 86,000 dry tons, is currently not utilized. Nearly two thirds (64.2%) of the unutilized volume, 55,000 dry tons, is generated by small companies, with fewer than 50 employees, widely scattered around the state.

* **Caution:** 61,770 dry tons of wood wastes generated by secondary processors is deposited in municipal solid waste (MSW) or demolition landfills. This volume is double counted.

Urban Wood Wastes

Wood wastes in urban areas present significant disposal problems. Tree and yard waste can no longer be deposited in landfills, and demolition, construction, packaging, and manufacturing wood wastes take up limited land fill space. Little information was available about these volumes until the recent studies by the Minnesota Pollution Control Agency, and the Department of Natural Resources.

Twin City Metropolitan Area Tree Residue

The removal and disposal of urban trees due to mortality or land clearing, as well tree trimmings is a significant problem in the Twin Cities metropolitan area. The Minnesota Department of Natural Resources, Division of Forestry commissioned a study of the issue, and released a report, titled Urban Tree Residue in March 1992.

Approximately 326,000 green tons of urban tree residue are produced annually in the Twin City metro area. However, the volume can fluctuate greatly from year to year. Insect and disease outbreaks, changing levels of construction activity, and the occurrence of damaging storms all influence tree trimming and removal.

The volume and disposition of tree residue generated by urban and rural residents in Greater Minnesota is not known, but the volume per capita is likely similar to the metro area (0.139 tons/year/person). This could represent an additional 293,400 green tons of urban tree waste. However, only the volumes in larger urban centers like Duluth or St. Cloud are likely to be significant.

Construction/Demolition Landfills

Construction and demolition wood waste is wood that is left over after construction or demolition of buildings. This debris is commonly hauled to demolition landfills. Large volumes of wood from crating, old pallets, and manufacturing operations are also hauled to these sites. There are 86 permitted demolition landfills in Minnesota, and approximately 22 additional demolition landfills operated in conjunction with municipal solid waste landfills. Approximately 313,400 dry tons of wood wastes are delivered to these permitted facilities annually. Additional volumes disposed of elsewhere are unknown. It appears feasible that a significant portion of the wood waste entering these facilities can be segregated and diverted to some productive use.

Municipal Solid Waste Landfills

Municipal solid waste (MSW) landfills, public incineration facilities, and composting operations receive municipal solid waste from households and businesses. The Minnesota Pollution Control Agency (MPCA) recently completed studies of the composition of MSW in both the Twin City metropolitan area and Greater Minnesota. Approximately 245,600 dry tons of the MSW waste stream is wood waste. Because much of this volume occurs as small quantities mixed with many other forms of waste, it may not be practical to divert a substantial portion of this volume presently.

Railroad Ties

More than 40,000 tons are discarded each year, based on a 1988 Minnesota Department of Public Service estimate. Most of this volume is being chipped and burned for industrial fuel and to generate electricity.

Total Wood Waste Available for Energy and Other Uses in 1993

	Total	Utilized	Net Available
Forest Biomass - Based on Mechanical Harvest Systems - Green Tons			
Growing Stock Tops	1,029,800		
Cull Tree Boles	1,304,800		
Cull Tree Tops	190,300		
Dead Tree Boles	344,600		
Dead Tree Tops	55,000		
Total Forest Biomass	2,924,500	748,900	2,175,600
Primary Wood Processing Industries - Green Tons			
Sawmills & Related Industries			
Bark	137,450	117,400	20,050
Slabs & Edgings With Bark	177,800	143,600	34,200
Slabs & Edgings Without Bark	305,550	301,950	3,600
Sawdust & Shavings	244,000	197,850	46,150
Pulpwood Based Industries			
Bark	733,400	726,600	6,800
Fines	242,600	242,600	-0-
Total Primary Waste Wood	1,840,800	1,730,000	110,800
Secondary Wood Processing Industries - Dry Tons			
Sawdust	29,730	25,680	4,050
Shavings	5,950	4,400	1,550
Sawdust & Shavings	136,550	121,620	14,930
Chips	36,970	36,970	-0-
Lumber Scraps	34,260	21,980	12,280
Panel Scraps	1,980	380	1,600
Lumber & Panel Scraps	20,500	12,620	7,880
Lumber, Sawdust, & Shavings	19,790	12,010	7,780
Treated Wood	5,590	5,180	410
Mixed Waste Wood	175,550	140,070	35,480
Total Secondary Waste Wood	466,870	380,910	85,960
Urban Waste Wood			
Twin City Metro Area Tree Waste - Green Tons	326,000	185,900	140,100
Wood in Municipal Solid Waste - Dry Tons	245,600	-0-	245,600
Demolition Wood - Dry Tons	313,400	-0-	313,400
Railroad Ties - Dry Tons	40,000	40,000	-0-
Total Urban Waste Wood	925,000	225,900	699,100
Total Waste Wood	6,157,170	3,085,710	3,071,460

FOREST BIOMASS

Abstract

More than 4,000,000 cords of wood are harvested from Minnesota's forests each year. Substantial volumes of residues are left standing or lying on the forest floor following harvest operations. A portion of these residues could be recovered for energy production or the manufacture of products. Economic and environmental considerations will limit the volume it is practical and desirable to recover.

Between 1,066,900 to 1,275,400 cord equivalents, or 2,446,400 to 2,924,500 green tons of forest residues could have been recovered during 1993 harvest operations. More than 327,000 cords, or 748,900 green tons of forest residues are recovered for fuelwood each year. This leaves a total of 739,900 to 948,400 cord equivalents, or 1,697,500 to 2,175,600 green tons of forest residue actually available for other uses.

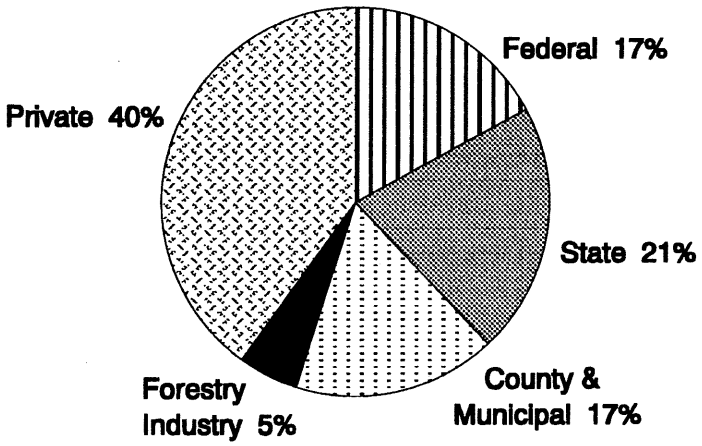
Range of Recoverable Forest Residues
(Green Tons)

	Total Available Residues	Residues Currently Utilized	Net Available Residues
High	2,924,500	748,900	2,175,600
Low	2,446,400	748,900	1,697,500

MINNESOTA'S FOREST LAND BASE

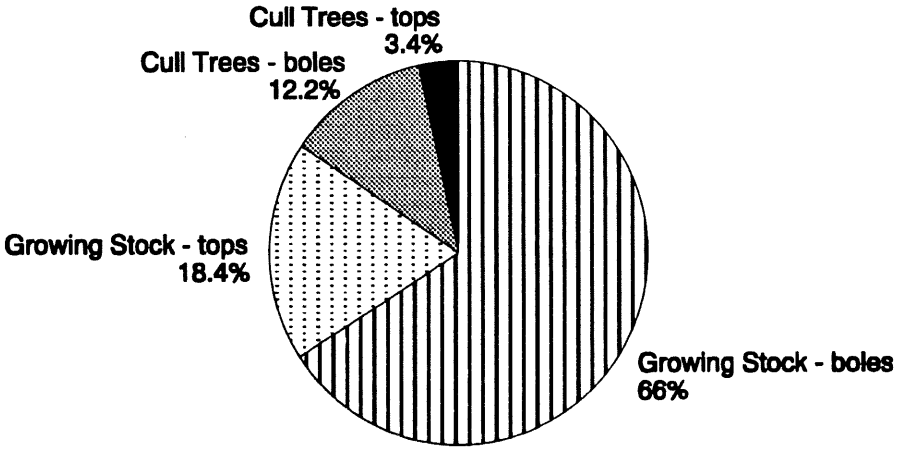
According to Minnesota Forest Statistics, 1990 approximately 33% of the state (16.7 million acres) is forested. Most of these acres are available for harvest (14.8 million acres).

Minnesota Timberland by Ownership
- 14.8 Million Acres -



The acres available for harvest support a total biomass of live trees over 5 inches DBH, excluding leaves, stump, and roots, equivalent to 303,733,000 cords (702,038,000 green tons or 27,640,000,000 cubic feet).

Forest Biomass Composition*



*From Minnesota Forest Statistics, 1990, Table 75, pg. 125

Growing stock bole volume is the biomass of the main stems or trunks of all trees larger than 5 inches in diameter at breast height (DBH), from a one-foot stump to a 4-inch diameter top.

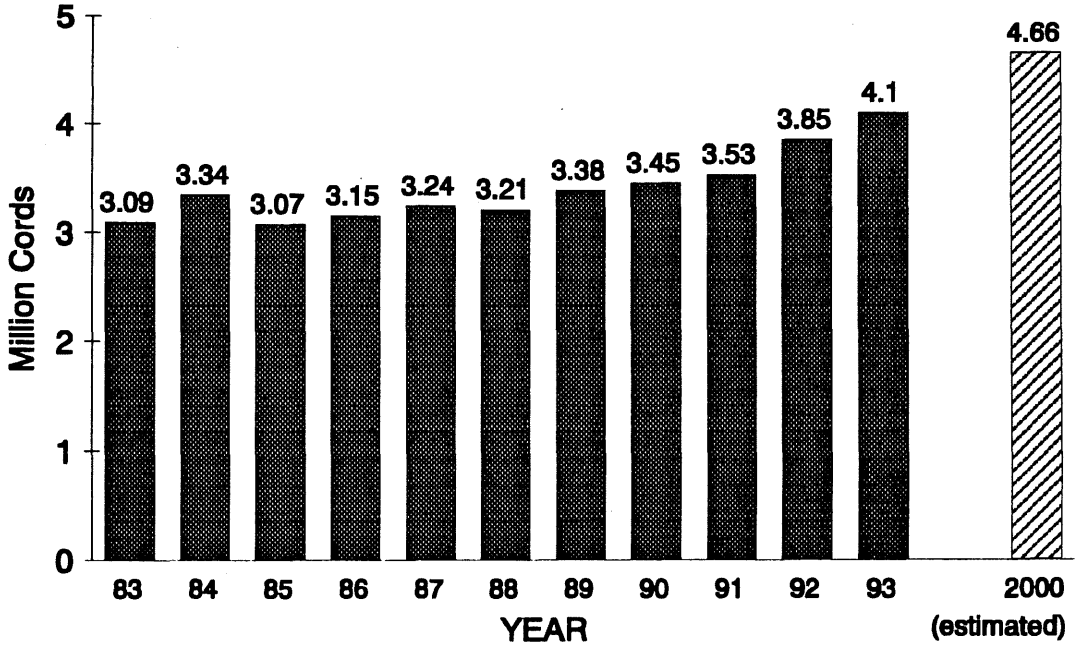
Growing stock top volume is the biomass of all limbs and twigs and the portions of the main stem above a 4-inch diameter top.

Cull tree bole volume is the live main stem or trunk biomass of deformed or otherwise undesirable trees 5 inches DBH, from a one-foot stump to a 4-inch diameter top.

Cull tree top volume is the biomass of all limbs and twigs and the portions of the main stem above a 4-inch top diameter.

It is assumed that the recovery of forest biomass is economical only in conjunction with normal commercial harvest operations. Recoverable forest residues were calculated based on current and anticipated harvest levels.

Actual & Projected Timber Harvest in Minnesota*
- from MN Timberland, all Ownerships, all Species



*Harvest Data Compiled by NCFES and DNR.

Current markets exist, or will very shortly develop for all major tree species. Therefore, it is assumed that harvest levels are approaching maximum desirable levels, and that all growing stock bole volume will be recovered for use during normal harvest operations. It is also assumed that utilization levels have increased such that 15% of the cull tree bole volume is now recovered during normal harvest operations.

Breakdown of Total Harvest in Cords

	1988	1993	2000
Growing Stock	3,151,100	4,027,500	4,578,700
Cull Trees	58,700	75,100	85,300
Total	**3,209,800**	**4,102,600**	**4,664,000**

AVAILABLE FOREST RESIDUES

The remaining 85% of the cull tree boles, and the tops and limbs of all the growing stock and cull trees are potentially available for energy production and other uses.

In addition to live trees, the forest contains many dead trees which are potentially recoverable for human use. Tree mortality averages approximately 1.5% per year. (Minnesota Forest Statistics, 1990, pg. 5). It is assumed dead trees normally remain sound enough to be utilized for about 3 years. Mortality biomass is distributed approximately the same as growing stock and cull trees, 78% boles and 22% tops.

Available Forest Residues - Cords

	1988	1993	2000
Growing Stock Tops	878,500	1,122,800	1,277,500
Cull Tree Boles	523,800	669,400	761,100
Cull Tree Tops	162,300	207,500	235,900
Dead Tree Boles	168,000	214,700	244,100
Dead Tree Tops	46,800	59,900	68,100
Total	**1,779,400**	**2,274,300**	**2,586,700**

RECOVERABLE FOREST RESIDUES

While the boles of unutilized trees are 100% recoverable using current harvesting methods, wildlife management guidelines call for the retention of from 1 to 6 hard (live or sound) snags, and as many soft snags as possible per acre. Furthermore, the tops of the trees are only partially recoverable. Breakage, small size, and other handling difficulties, as well as producer willingness to modify operations, limit recovery.

Full tree skidding and chipping provide the most viable option for recovery and transportation tops and limbs at the present time. A number of such operations already exist. They fill a variety of markets, including boiler fuel, landscape chips, animal bedding, and the production of hardboard and asphalt shingles.

Tree length, shortwood skidding, and cut-to-length systems are more numerous, and can effectively recover the bole volume of cull and dead trees, but the recovery of top volumes would be very difficult. However, these systems offer operational and site protection advantages over full tree harvesting on many sites.

Nutrient depletion and other environmental and site productivity concerns also limit the appropriateness of removing more biomass than is currently recovered in normal commercial harvest from many sites. With these constraints in mind, it is estimated that 85% of the remaining cull tree bole volume (70% overall), 70% of the dead tree bole volume, and between 25% and 40% of the tops and limbs could be recovered for energy or commercial products.

Recoverable Harvest Residues - Cords

	% Recovery	1988	1993	2000
Growing Stock Tops	40%	351,400	449,100	511,000
	25%	219,600	280,700	319,400
Cull Tree Boles	85%	445,200	569,000	646,900
Cull Tree Tops	40%	64,900	83,000	94,400
	25%	40,600	51,900	59,000
Dead Tree Boles	70%	117,600	150,300	170,900
Dead Tree Tops	40%	18,700	24,000	27,200
	25%	11,700	15,000	17,000
Total	**High**	**997,800**	**1,275,400**	**1,450,400**
	Low	**834,700**	**1,066,900**	**1,213,200**

Recoverable Harvest Residues - Green Tons

	% Recovery	1988	1993	2000
Growing Stock Tops	40%	805,800	1,029,800	1,171,700
	25%	503,500	643,600	732,400
Cull Tree Boles	85%	1,021,000	1,304,800	1,483,600
Cull Tree Tops	40%	148,800	190,300	216,500
	25%	93,100	119,000	135,300
Dead Tree Boles	70%	269,600	344,600	391,900
Dead Tree Tops	40%	42,900	55,000	62,400
	25%	26,800	34,400	39,000
Total	**High**	**2,288,100**	**2,924,500**	**3,326,100**
	Low	**1,914,000**	**2,446,400**	**2,782,200**

The Minnesota Residential Fuelwood Survey, 1988 (Table 14, Appendix G) indicates the nearly 327,000 cords, or 748,900 green tons of these recoverable residues are already being utilized for residential fuelwood. This level of use has likely been fairly constant given the relatively stable, low cost of the primary heating fuels over the last several years. However, a sharp increase in fuel costs could result in a drastic and immediate increase. More than one-third of Minnesota homes have wood burning units of some kind. Sixty-four percent of these are primary or supplemental heating units that could immediately increase demand if the prices of other fuels rise.

PRIMARY PROCESSOR WASTE WOOD

Abstract

Primary wood processors are those industries that use roundwood (logs) or chips from roundwood to manufacture a variety of products. There are more than 600 primary mills in Minnesota, and in 1993 they processed 3.6 million cords (excluding fuelwood) of wood. This is an increase of nearly 30% since 1988. These mills generated more than 1.8 million green tons of waste wood. Nearly two-thirds (62%) of these wood wastes are used for fuel. Only 6.5%, 117,100 green tons, are currently not utilized. Over 94% of the unutilized volume, 110,300 green tons, is found at sawmills scattered around the state.

Available Primary Processor Waste Wood
(Green Tons)

	Total Waste Wood Produced	Volume Used	Net Available for Other Uses
Sawmills & Related Industries			
Bark	137,450	117,400	20,050
Slabs & Edgings With Bark	177,800	143,600	34,200
Slabs & Edgings Without Bark	305,550	301,950	3,600
Sawdust & Shavings	244,000	197,850	46,150
Total Sawmill Waste Wood	**864,800**	**760,800**	**104,000**
Pulpwood Based Industries			
Bark	733,400	726,600	6,800
Fines	242,600	242,600	-0-
Total Pulpwood Waste Wood	**976,000**	**969,200**	**6,800**
Total Primary Waste Wood	**1,840,800**	**1,730,000**	**110,800**

PRIMARY PROCESSOR WASTE WOOD

The primary wood processing industries are divided into two major categories, sawmills and pulpwood. The two categories differ greatly in the types and uses of their wood wastes. These mills are periodically surveyed jointly by the Minnesota Department of Natural Resources, Division of Forestry (MnDNR) and the USDA Forest Service, North Central Forest Experiment Station (NCFES). MnDNR surveys the sawmills, and NCFES surveys the pulpwood industries. The data reported here was drawn from the 1993 survey.

The sawmill category has the largest number and variety of mills, but the 16 pulpwood mills consume nearly 70% of the wood.

Primary Mill Wood Consumption by Mill Type

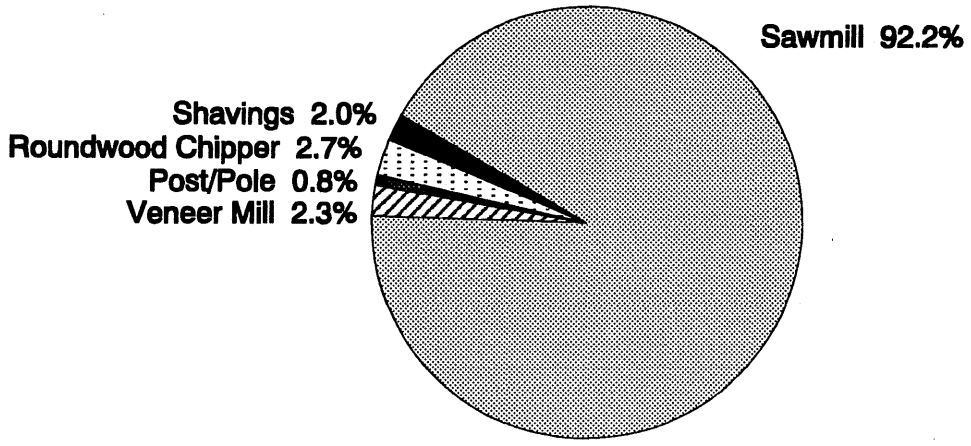
	Number of Mills	Wood Consumed (Cords)
Sawmill Category	**638**	**714,100**
Sawmill	593	627,700
Veneer Mill	3	20,400
Post & Pole Treaters	5	18,200
Shavings Mills	8	27,900
Roundwood Chippers	29	19,900
Pulpwood Mills	**16**	**2,860,000**
Total	**654**	**3,574,100**

The more than 600 primary mills in Minnesota processed 3.6 million cords (excluding fuelwood) of wood in 1993. This is an increase of nearly 30% since 1988. Consumption is expected to increase to 4.1 million cords by 2000. Aspen accounted for almost 60% of wood consumed for all uses, distantly followed by jack pine, red pine, spruce, balsam fir, and oak (Appendix II-A).

SAWMILL INDUSTRIES

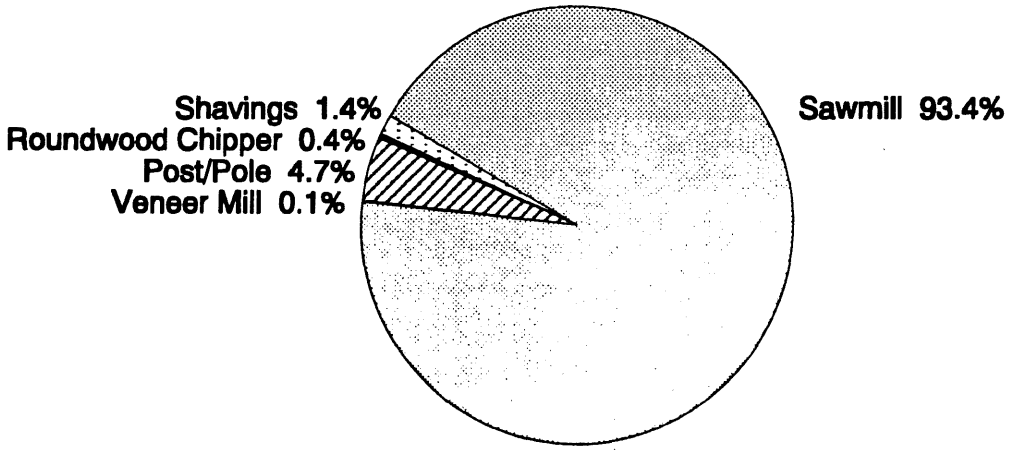
There are over 600 mills in this category. They vary tremendously in size, products produced, and waste generated. Sawmills consume 86.7% of the wood volume, generate 92.2% of the wood waste, and account for 93.4% of the unutilized wood waste.

Total Waste Wood Volume Generated by Sawmill Industries (Green Tons)



864,800 Green Tons

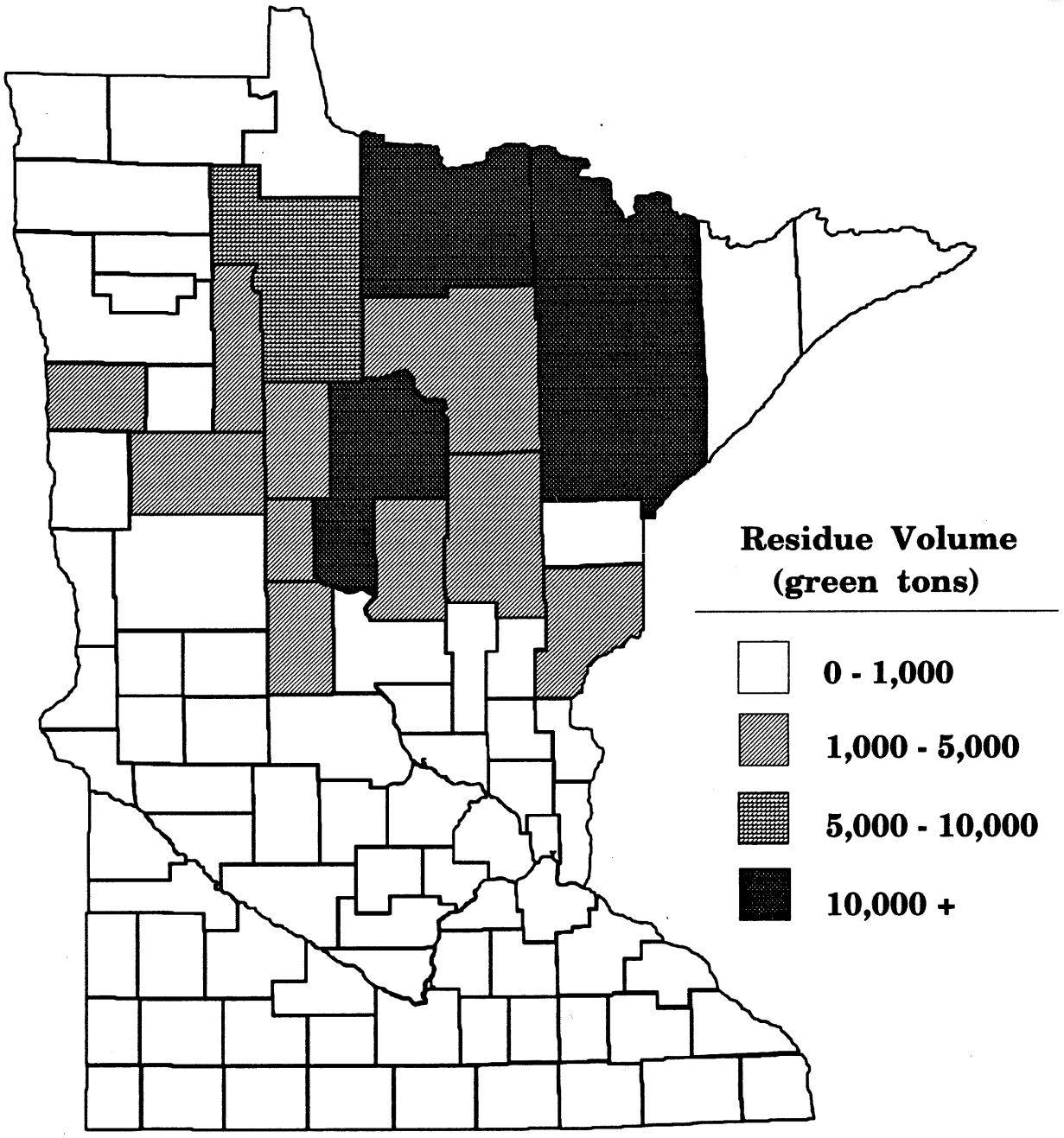
Unutilized Sawmill Industry Waste Wood (Green Tons)



104,050 Green Tons

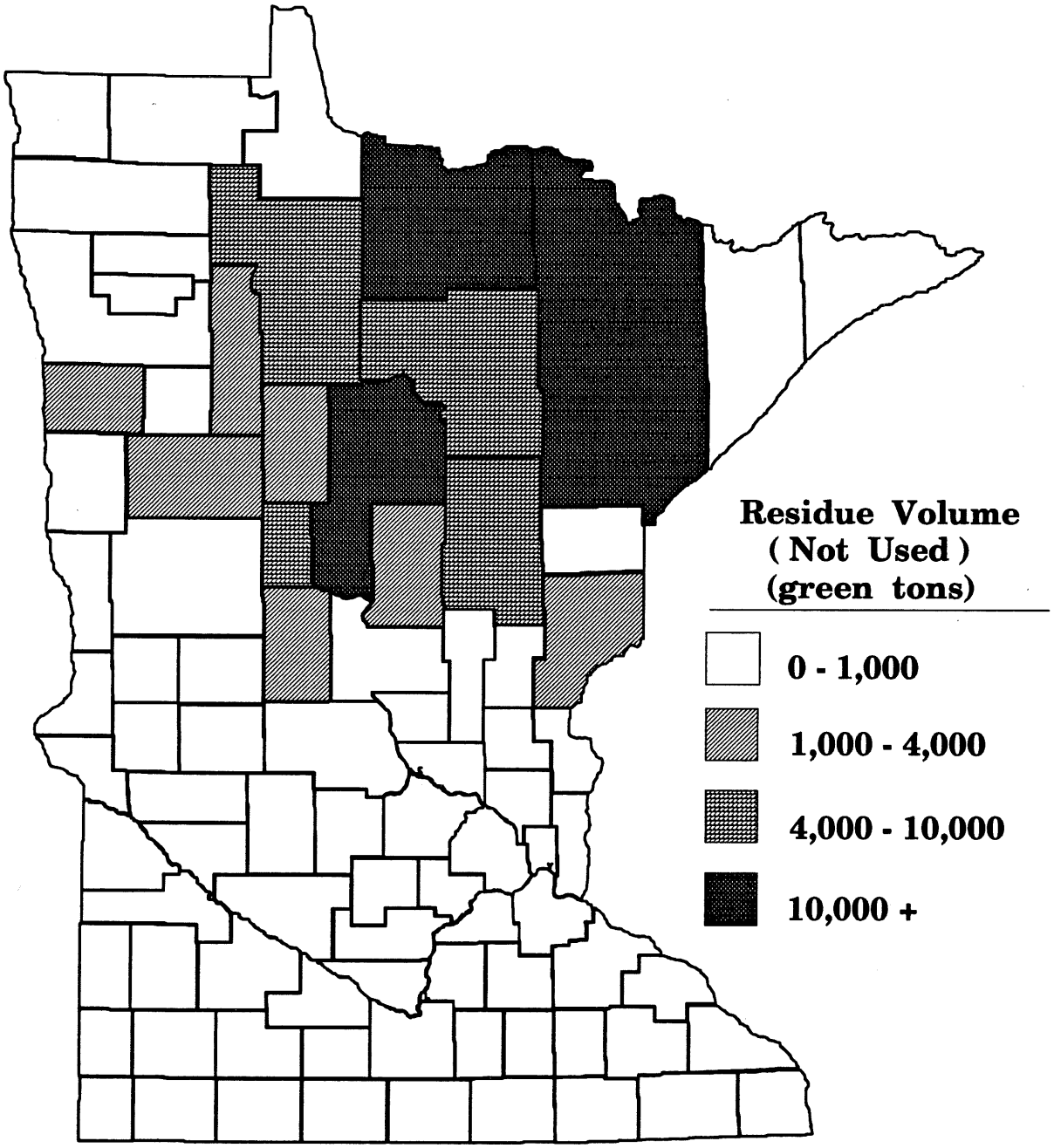
Total Sawmill Industry Waste Wood by County

(Based on Minnesota 1992 Survey)



Surplus Sawmill Industry Waste Wood by County

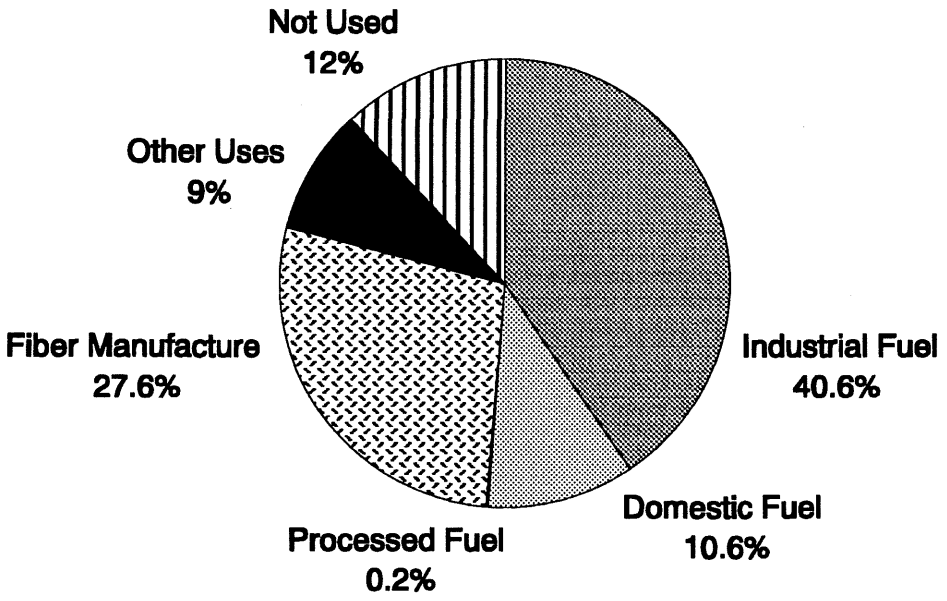
(Based on Minnesota 1992 Survey)



Use of Sawmill Industry Waste Wood by Type

Statewide only 12%, or 104,000 green tons of the waste wood generated by primary wood processing industries are not utilized. Most wood wastes are still utilized for fuel, 51.4%, but this is down from 67% in 1988. Higher value uses have increased significantly, fiber manufacture from 13% to 27.6%, and other uses (primarily landscape mulch and animal bedding) from 6% to 9%. And the unused volume has decreased by 2% since 1988.

Sawmill Industry Waste Wood Use
(Green Tons)



364,800 Green Tons

The 18 largest sawmills (those producing more than 3 million board feet/year) utilize a substantially greater proportion of their waste woods than the smaller sawmills. The large mills generate 59.2% of the wood waste of all the sawmill industries, but only 23.4% is unused. See Appendix II-B, C & D.

The sawmill industries produce 4 types of wood waste;

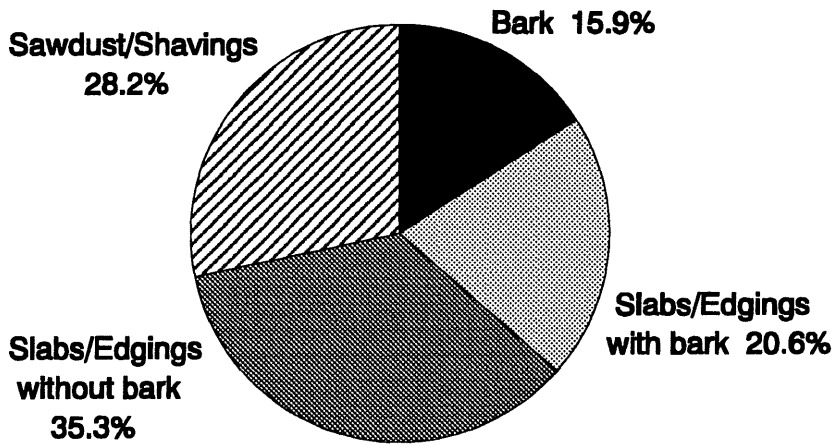
Bark which has been mechanically removed from the logs prior to further processing.

Slabs and edgings without bark are large pieces of scrap produced by mills that remove the bark from the logs prior to sawing lumber. These residues are the irregular pieces of wood that are produced as the log is squared up to produce lumber, and the edge and end trimmings from cutting the lumber to specific widths and lengths. The pieces resulting from cutting posts, poles, and veneer bolts to the proper lengths, veneer bolt cores, and broken or reject pieces at post and pole treating plants, veneer mills, shavings mills, and chipping operations are also included.

Slabs and edgings with bark are large pieces of scrap produced by mills that do not remove the bark from the logs prior to sawing lumber. Large pieces of residues from post and pole treating plants, veneer mills, shavings mills, and chipping operations that have no bark are also included.

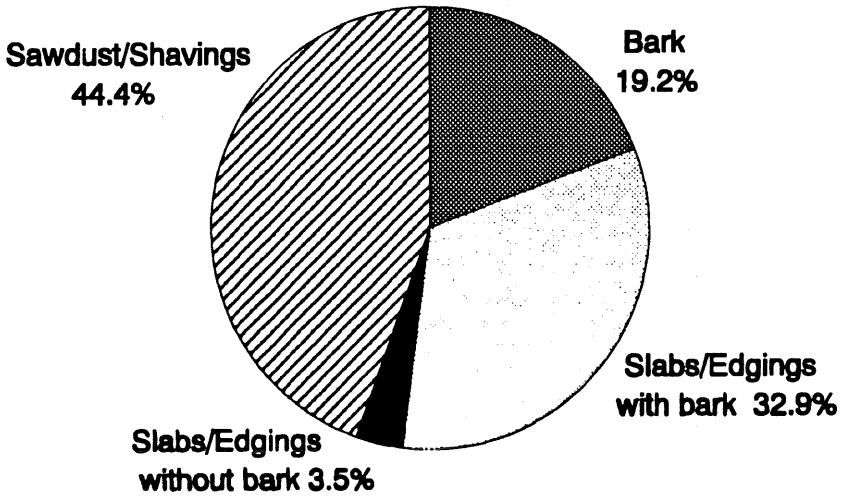
Sawdust and shavings are the fine residues produced from sawing, planing, and sanding lumber, as well similar size residues generated by other mill types included in this category.

Total Sawmill Industry Waste Wood Volume by Type (Green Tons)



864,800 Green Tons

Unutilized Sawmill Industry Waste Wood by Type (Green Tons)



104,050 Green Tons

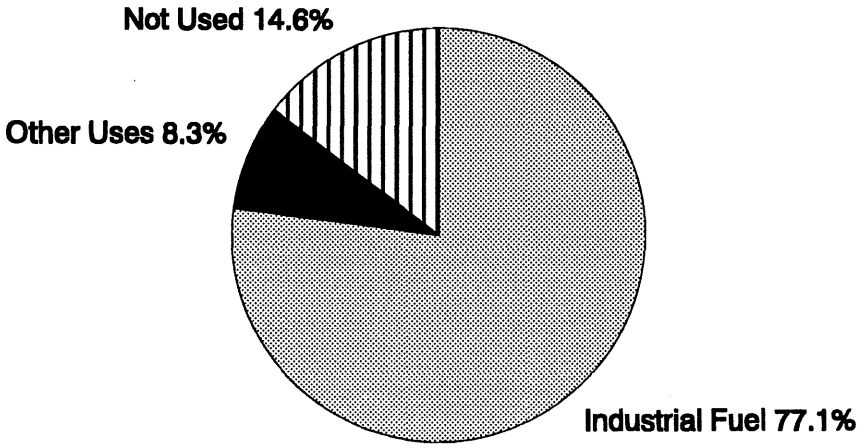
Sawdust and shavings represent the largest volume of unused waste wood, followed closely by slabs and edgings with bark. Note the very small volume of slabs and edgings without bark that are not utilized.

Sawmill industries operate in 69 of Minnesota's 87 counties. Seven counties, Beltrami, Cass, Cook, Hubbard, Itasca, Koochiching, and St. Louis, account for over 60% of the total residue generated. Four of those seven, Beltrami, Cass, Koochiching, and St. Louis, account for nearly 68% of the unused wood wastes in the sawmill industries.

Bark

Bark represents 16.3% of the sawmill wood waste. Only 14.6%, 20,050 green tons was not utilized.

Use of Bark Generated by Sawmill Industries (Green Tons)



137,450 Green Tons

More than three-quarters of the bark is used for industrial fuel. Most of this will be used on site by the mill that generates the bark.

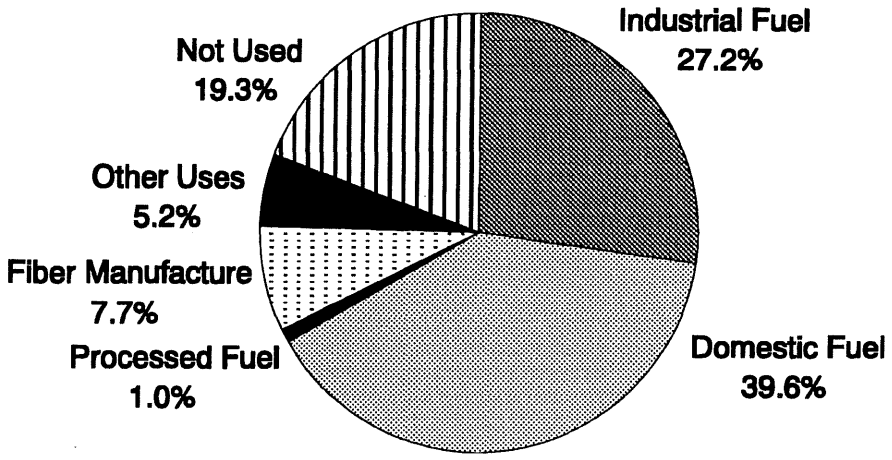
The fuel value for bark is between 7,400 and 10,800 BTUs per pound (oven dry) (Haygreen and Bowyer, 1989, pp. 428-429).

Bark is frequently used for landscape mulch and livestock bedding. Demand for these bark uses in areas such as southeastern Minnesota has resulted in some bark being imported into the area by barge, and has caused problems for an electric utility that co-fires with wood and coal.

Bark usage is greatest where the mill is in close proximity to intensive agriculture, or has dry kilns or other on site high demand energy needs.

Slabs & Edgings With Bark

Use of Slabs & Edgings With Bark Generated by Sawmill Industries (Green Tons)



177,800 Green Tons

Many mills do not have the equipment necessary to remove the bark prior to processing the logs. Many of these mills are small, and cannot afford to invest in the extra equipment. The species processed and mill location may also limit the economic incentive to purchase debarking equipment.

Domestic fuel is the largest use (39.6%) of these wood wastes. Use as industrial fuel (27.2%) may be limited by factors related to those that limit debarking. There may be some opportunities for increased production of processed fuels, but the only charcoal producer in Minnesota recently ceased production.

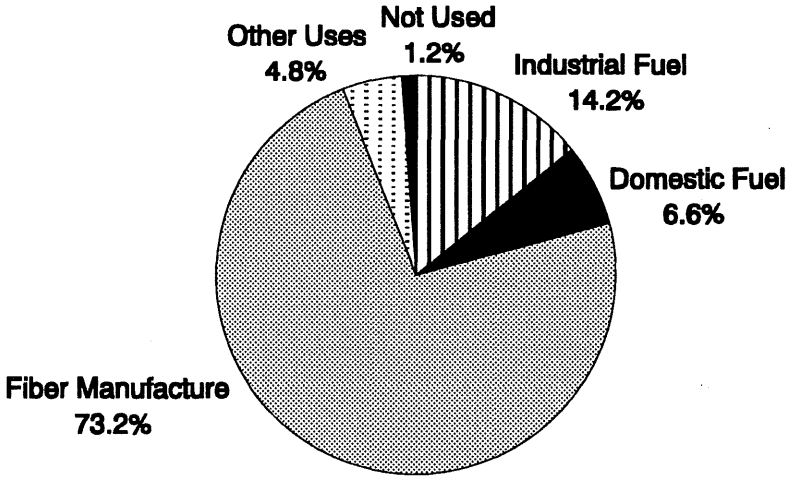
Fiber manufacturing accounts for 7.7% of the total use of slabs and edgings with bark. There are only a limited number of products manufactured in Minnesota for which bark is not a significant problem.

Other uses include chipping or hogging the residue for animal bedding and landscape mulch.

The 34,200 tons (19.3%) of slabs with bark not used, at 6,500 BTUs/pound, has a heating value of over 444 billion BTUs, enough to heat 5,600 homes for one year.

Slabs & Edgings Without Bark

Use of Slabs & Edgings Without Bark Generated by Sawmill Industries (Green Tons)

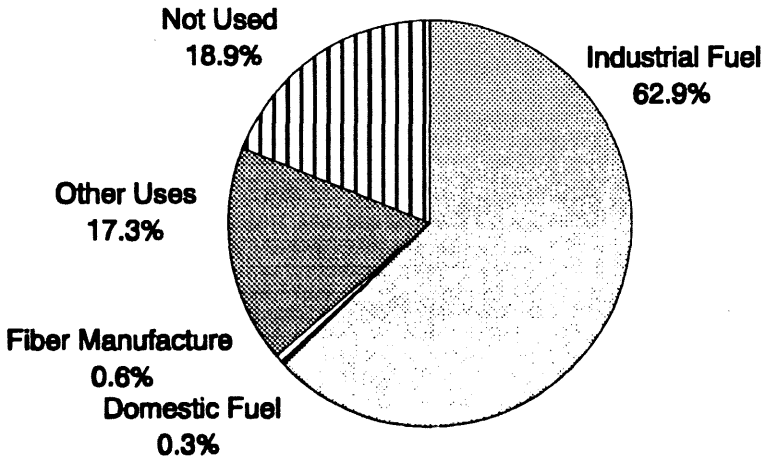


305,550 Green Tons

Fiber manufacture is by far the largest use (73.3%) of these bark-free wood wastes. Slabs and edgings residues free from bark are an excellent source of fiber for paper production. These residues are clean and of an acceptable size, when chipped, for pulping. Sawmills close to pulp and paper mills, that process species such as aspen and pine, have a strong economic incentive to debark their logs.

Sawdust & Shavings

Use of Slabs & Edgings Without Bark Generated by Sawmill Industries (Green Tons)



244,000 Green Tons

Industrial fuel remains the largest use of this form of wood waste. This use has grown dramatically since 1988, increasing from 42.5% to 62.9%. This has coincided with a significant growth in the number of dry kilns.

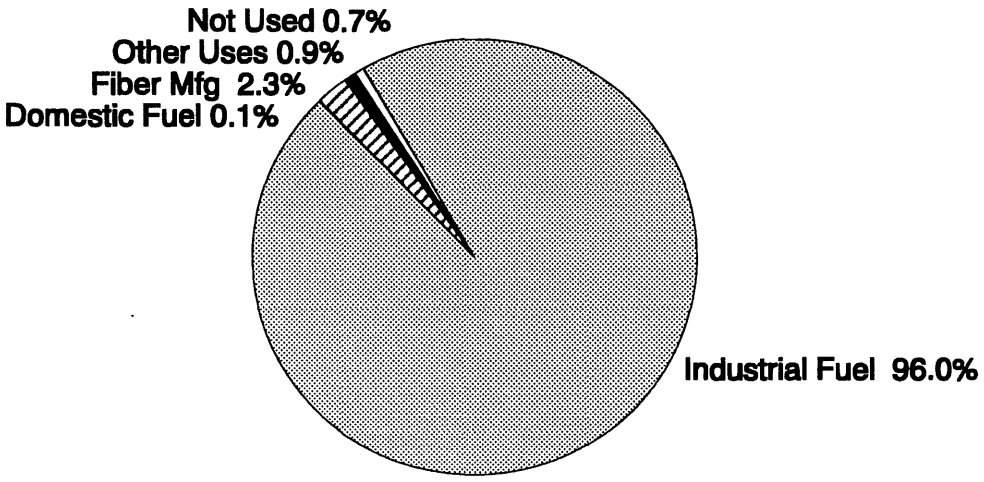
Sawdust is the major component of this wood waste category, probably exceeding 90%. Shavings, while a minor component, do have very strong markets, particularly for poultry bedding. A number of mills produce shavings from roundwood (logs) as their primary product.

PULPWOOD INDUSTRIES

Minnesota's 16 pulpwood based mills consume nearly 70% of the roundwood processed to manufacture products in the state. They also consume large volumes of sawmill residues and significant volumes of pulp fiber produced outside Minnesota. Nearly all are also consuming increasing amounts of recycled paper.

The pulpwood industries are generally quite large, with huge energy demands. This allows them to utilize the wastes they generate on site for their own energy needs. Several must supplement their own wood wastes with waste wood from other sources, such as sawmills, forest biomass, and old railroad ties. Over 96% of their wood wastes are used for industrial fuel. Less than 1% is not utilized.

Use of Pulpwood Industry Waste Wood
(Green Tons)



976,000 Green Tons

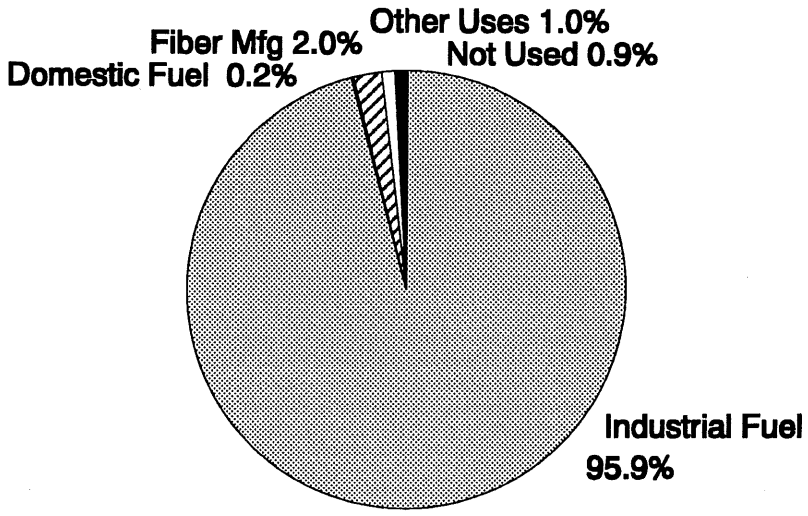
Pulpwood industry wood wastes are divided into two major types, bark and fines.

Bark: The bark is mechanically removed from the logs (pulp sticks) prior to chipping or flaking the wood for further processing.

Fines: Fines are the under-sized chips or flakes and sawdust-size material produced in the manufacture of OSB and waferboard, and the individual wood fibers that pass through the pulp screens (a major component of pulp sludge) in the paper-making process.

There is a very small volume of more course wood waste not reported here, reject logs, that are frequently given away to employees for domestic fuel.

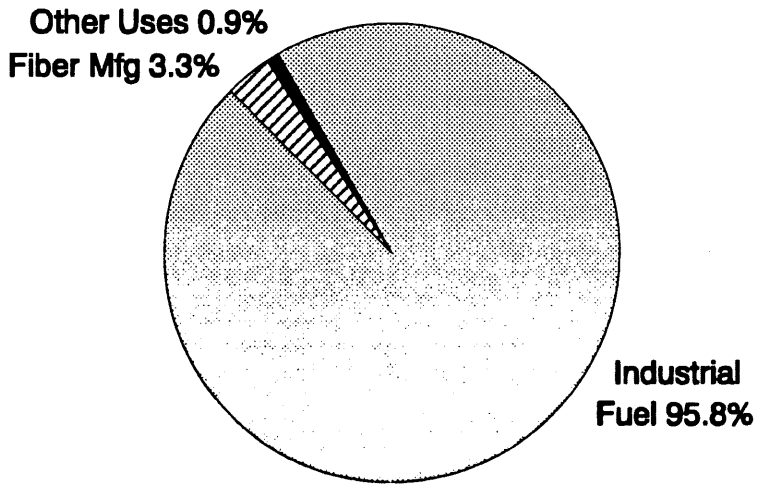
Use of Bark Generated by Pulpwood Industries (Green Tons)



733,400 Green Tons

Data on bark is more complete than for fines, because not all mills provided information on pulp sludge. For the volumes reported, the use of the two major residue types is nearly identical. Some pulp sludge volumes do get landfilled or sent to sewage treatment plants. These volumes are currently unknown.

Use of Fines Generated by Pulpwood Industries (Green Tons)



242,600 Green Tons

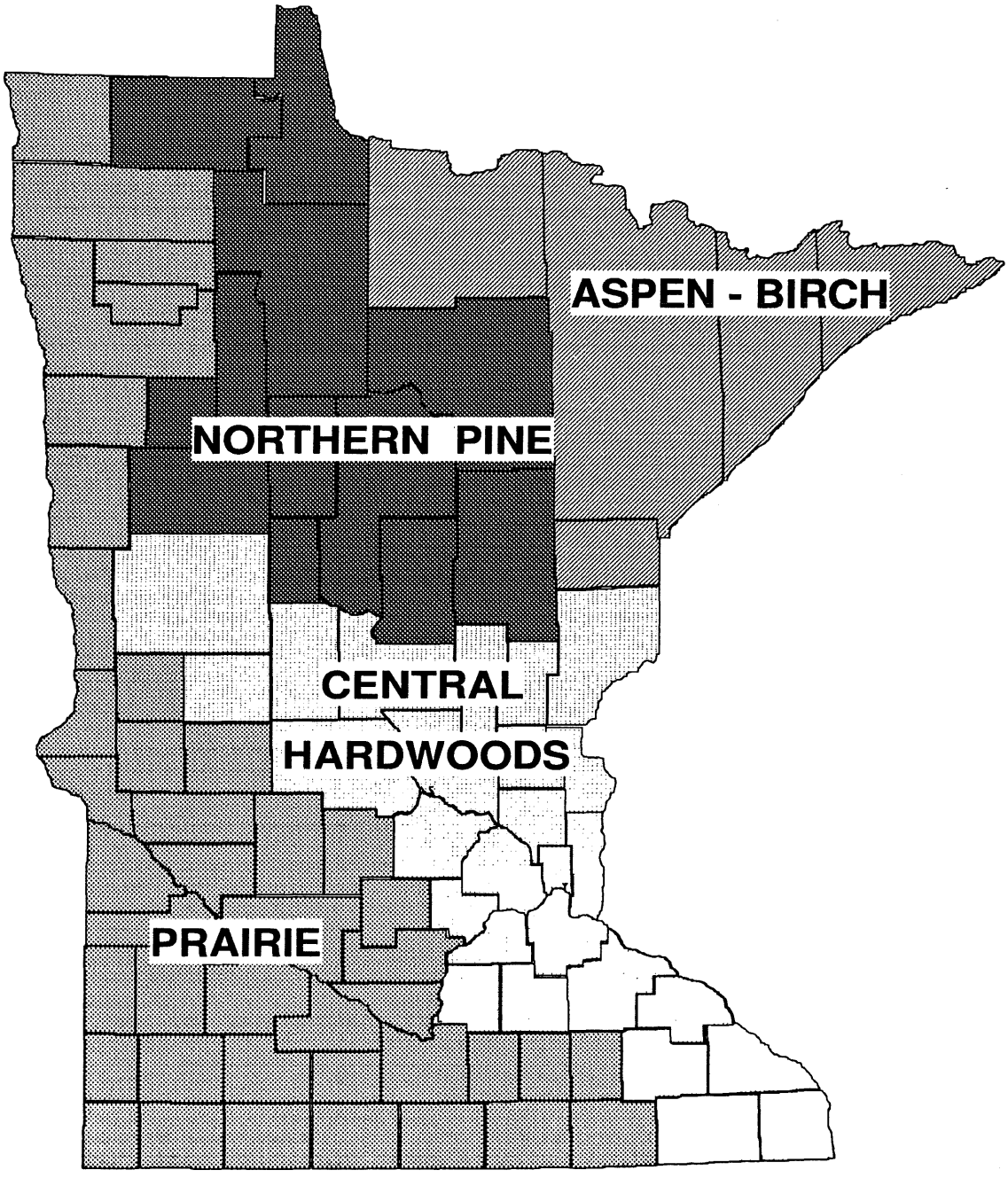
The pulpwood industry wood wastes are reported for the four forest inventory geographic areas, rather than on a county basis, for proprietary reasons.

All pulpwood industry data provided by Ron Hacket, USFS NCFES

Annual Residue Usage by Survey Unit
(1000 Green Tons)

Residue Type	Survey Unit	Fiber Mfg	Industrial Fuel	Domestic Fuel	Other Uses	Not Used	Total
Fines	Aspen-Birch	3.1	94.6	0.0	0.1	0.0	97.8
	Central	2.9	16.5	0.0	1.6	0.0	21.0
	Northern Pine	1.9	121.5	0.0	0.5	0.0	123.8
	Total Fines	**7.9**	**232.5**	**0.0**	**2.2**	**0.0**	**242.6**
Bark	Aspen-Birch	7.6	363.0	1.2	0.3	6.8	378.9
	Central	7.5	34.3	0.0	4.2	0.0	46.1
	Northern Pine	0.0	306.1	0.0	2.4	0.0	308.5
	Total Bark	**15.2**	**703.4**	**1.2**	**7.0**	**6.8**	**733.4**
	MN Total	**23.1**	**935.9**	**1.2**	**9.2**	**6.8**	**976.1**

MINNESOTA FOREST SURVEY UNITS



SECONDARY PROCESSOR WASTE WOOD

Abstract

Secondary wood processing industries are those that utilize lumber or other wood products produced by primary processors to manufacture finished products such as cabinets, windows, toys, or moldings. There are approximately 1100 secondary manufacturers in Minnesota. These companies generated nearly 470,000 dry tons of waste wood in 1994. Nearly three quarters (74.2%) of the waste wood was used for fuel or animal bedding. Only 18.4%, less than 86,000 dry tons, is currently not utilized. Nearly two-thirds (64.2%) of the unutilized volume, 55,000 dry tons, is generated by small companies, with fewer than 50 employees, widely scattered around the state.

Available Secondary Processor Waste Wood
(Dry Tons*)

	Total Waste Wood Produced	Volume Used	Net Available for Other Uses
Lumber Scraps	34,260	21,980	12,280
Chips	36,970	36,970	-0-
Saw & Sander Dust	29,730	25,680	4,050
Shavings	5,950	4,400	1,550
Sawdust & Shavings	136,550	121,620	14,930
Panel Scraps	1,980	380	1,600
Lumber & Panel Scraps	20,500	12,620	7,880
Lumber, Sawdust, & Shavings	19,790	12,010	7,780
Treated Wood	5,590	5,180	410
Other Mixed	175,550	140,070	35,480
Total	**466,870**	**380,910**	**85,960**

*8% moisture content assumed

SECONDARY PROCESSOR WASTE WOOD

The approximately 1,100 secondary wood based manufacturing companies in Minnesota were surveyed by the University of Minnesota, Extension Service in 1994. Information was gathered for several purposes, including to determine the volume and disposition of wood wastes generated by these industries.

Nearly 68% of the companies (743) responded to the survey, and more than 48% (536) provided wood waste information. Nearly 90% of the companies have fewer than 50 employees. Almost 62% have fewer than 10 and produce less than 65 tons of wood waste per year.

The survey data was expanded to the estimated total number of secondary companies, based on the assumption that the non-reporting companies have the same size and geographic distribution, and waste wood usage pattern as the reporting companies.

Waste Wood Volumes of Secondary Wood Processing Industries, by Number of Employees, Based on 1993 Production

Employee Size Class	Number of Companies	Wood Waste Volumes (Dry Tons*)
1-3	429	24,700
4-9	284	20,290
10-19	138	38,580
20-49	176	121,610
50-99	35	59,280
100-199	19	37,350
200-499	13	30,990
500-999	3	25,610
1000+	3	108,460
Total	**1,100**	**466,870**

*8% moisture content assumed

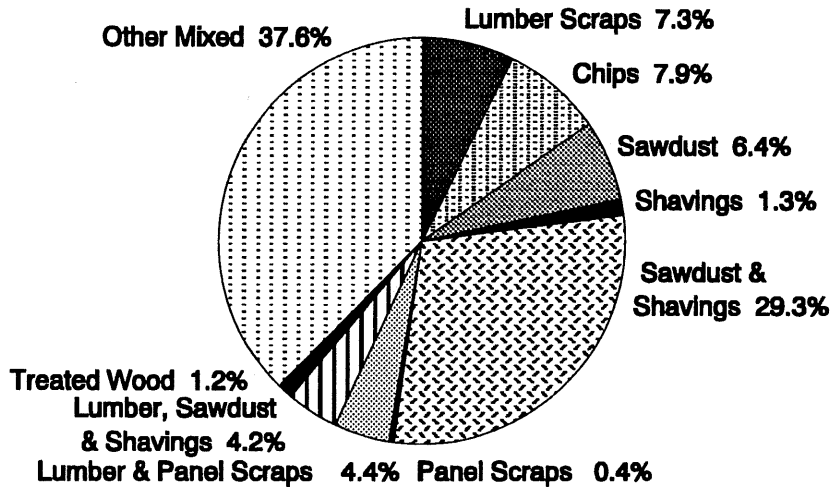
Kiln dried wood has a moisture content of about 8%. Some companies, such as pallet and crating manufacturers, do use green lumber, but it is not possible to identify this volume separately. Therefore, all secondary wood processor volumes are reported as dry tons, with an assumed moisture content of 8%.

TYPES OF WASTE WOOD

Secondary processors generate a wide variety of wood wastes. They use solid lumber, plywood or particleboard, and a wide variety of wood species in their manufacturing operations. And depending on the products manufactured, they may use other types of materials such as plastic or paper overlays, metal, glues, paint, and a variety of finishes. These contaminants restrict the utility of secondary wood wastes.

The largest category of waste wood for secondary wood industries is **mixed wood waste.** These materials are thrown into a common container before disposal, and may include metal, plastic, and other non-wood wastes.

Secondary Manufacturing Waste Wood Volumes by Type



Many companies do keep their wood wastes segregated for a number of reasons. The broad categories are:

Lumber scraps are end and edge trimmings of lumber. Most of this is solid wood, but some engineered lumber, such as laminated veneer or oriented strand lumber may also be included. The latter two contain glues or resins.

Sawdust is dust generated from sawing and sanding.

Shavings are from planing wood components to a desired thickness.

Panel scraps with plastic are pieces of plywood, oriented strand board, particleboard, and other reconstituted wood panels. These all contain glues or resins to hold them together, and have a plastic, paper, or other non-wood overlay.

Panel scraps with no plastic are pieces of reconstituted wood panels that do not have a non-wood overlay.

Treated wood is pieces of lumber or plywood that have been treated with a wood preservative.

Chips/hogged material is lumber scraps, and sometimes panel pieces, that have been run through a chipper, hammer mill, or some other machine to reduce them to a smaller size. This is most often done so the material can be utilized for fuel on site.

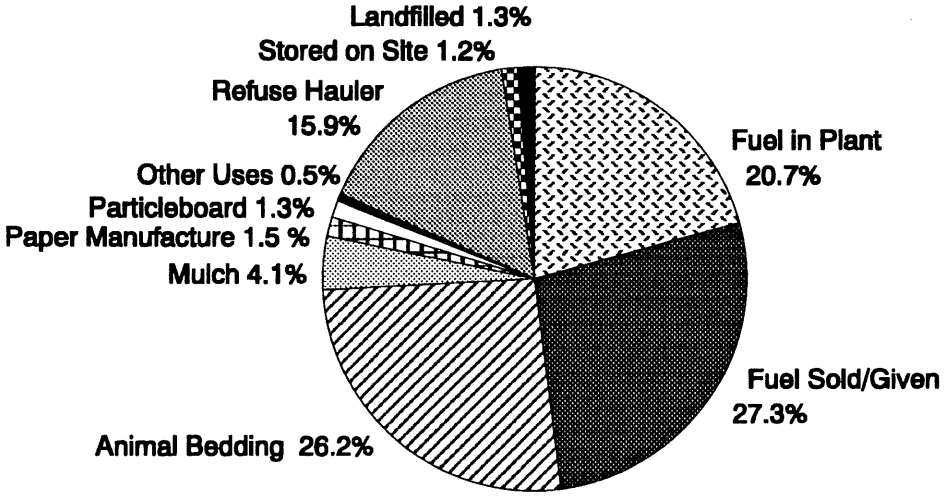
Sawdust and shavings is a mixture of the two types of waste.

Lumber and panel scraps is a mixture of these two types of waste.

USES OF WASTE WOOD

The largest use of secondary processor waste wood is for fuel, nearly 224,000 dry tons. An additional 122,400 dry tons is used for animal bedding. Only 18.4% or 85,960 dry tons of secondary wood wastes are not utilized. More than 86% of this volume, 74,290 dry tons, is handled by refuse haulers.

Uses of Secondary Manufacturing Waste Wood



The volume of waste wood that is not used may actually be less than reported here. This is because some of the volume handled by refuse haulers may actually be utilized rather than landfilled.

By consolidating volumes from several companies, and possibly sorting or processing materials, some refuse haulers are able to access markets that individual manufactures could not attract. One Twin City area refuse hauler estimates that as much as 25% of the waste wood volume handled by refuse haulers is marketed for some use rather than landfilled. The remaining 75%, 55,720 dry tons,* is deposited in municipal solid waste (MSW) or demolition landfills.

* **Caution:** The volumes landfilled by refuse haulers, as well as the 6,048 dry tons landfilled by the generating companies are also counted in the sections on landfills in the chapter on Urban Waste.

Small companies that do not handle large volumes of material often have more difficulty finding alternatives to landfilling their wood wastes. Companies with fewer than 100 employees must dump or landfill 24% of their wood wastes, while larger companies have progressively smaller disposal problems.

Unused Secondary Manufacturing Waste Wood by Company Size
(Dry Tons*)

Employee Size Class	Number of Companies	Total Wood Waste Volumes	Unutilized Wood Waste Volumes	Percent Unutilized Wood Waste
1-3	429	24,700	3,850	15.6%
4-9	284	20,290	7,070	34.8%
10-19	138	38,580	9,010	23.4%
20-49	176	121,610	35,300	29.0%
50-99	35	59,280	13,880	23.4%
100-199	19	37,350	6,410	17.2%
200-499	13	30,990	3,080	9.9%
500-999	3	25,610	2,020	7.9%
1000+	3	108,460	5,350	4.9%
Total	**1,100**	**466,870**	**85,970**	**18.4%**

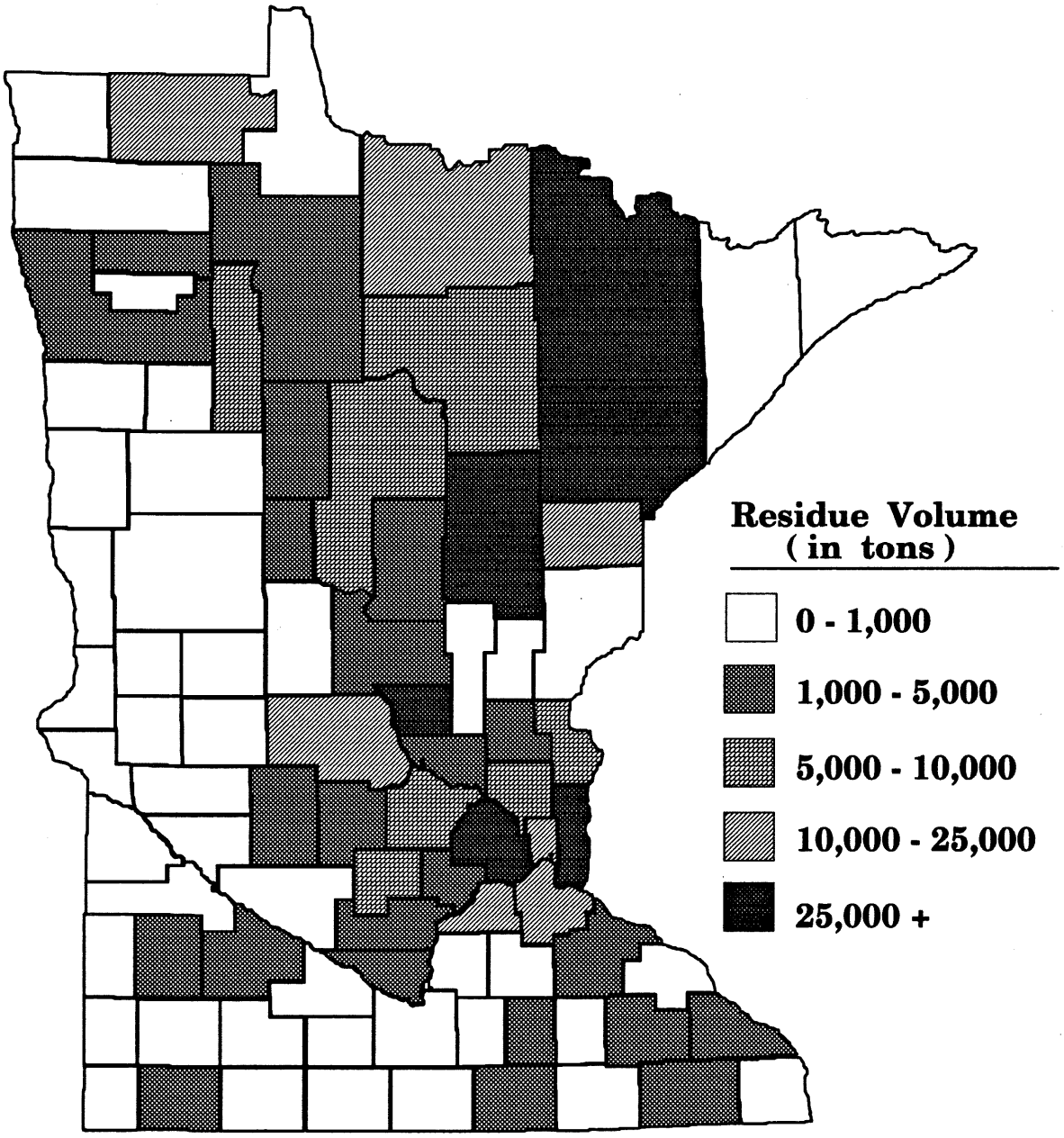
*8% moisture content assumed

Contaminants such as plastic or paper overlays, metal, glues, paint, and a variety of finishes restrict the utility of wood wastes. Air quality concerns may limit the use of some wood wastes for fuel. Animal bedding cannot have contaminants and must have a consistent particle size. Wood species may also be a limiting factor for animals such as turkeys and horses.

Manufacturing uses such as particleboard and medium density fiberboard also require consistent, clean material. These markets may soon expand substantially. Manufacturing uses will likely have higher value than fuel or animal bedding. This would provide an incentive to consider separating, or further processing waste wood, and may promote the consolidation of wood wastes from multiple producers. This would greatly benefit small companies.

Total Secondary Manfacturing Wood Waste by County

Minnesota Secondary Wood Manufacturers , 1993 Survey

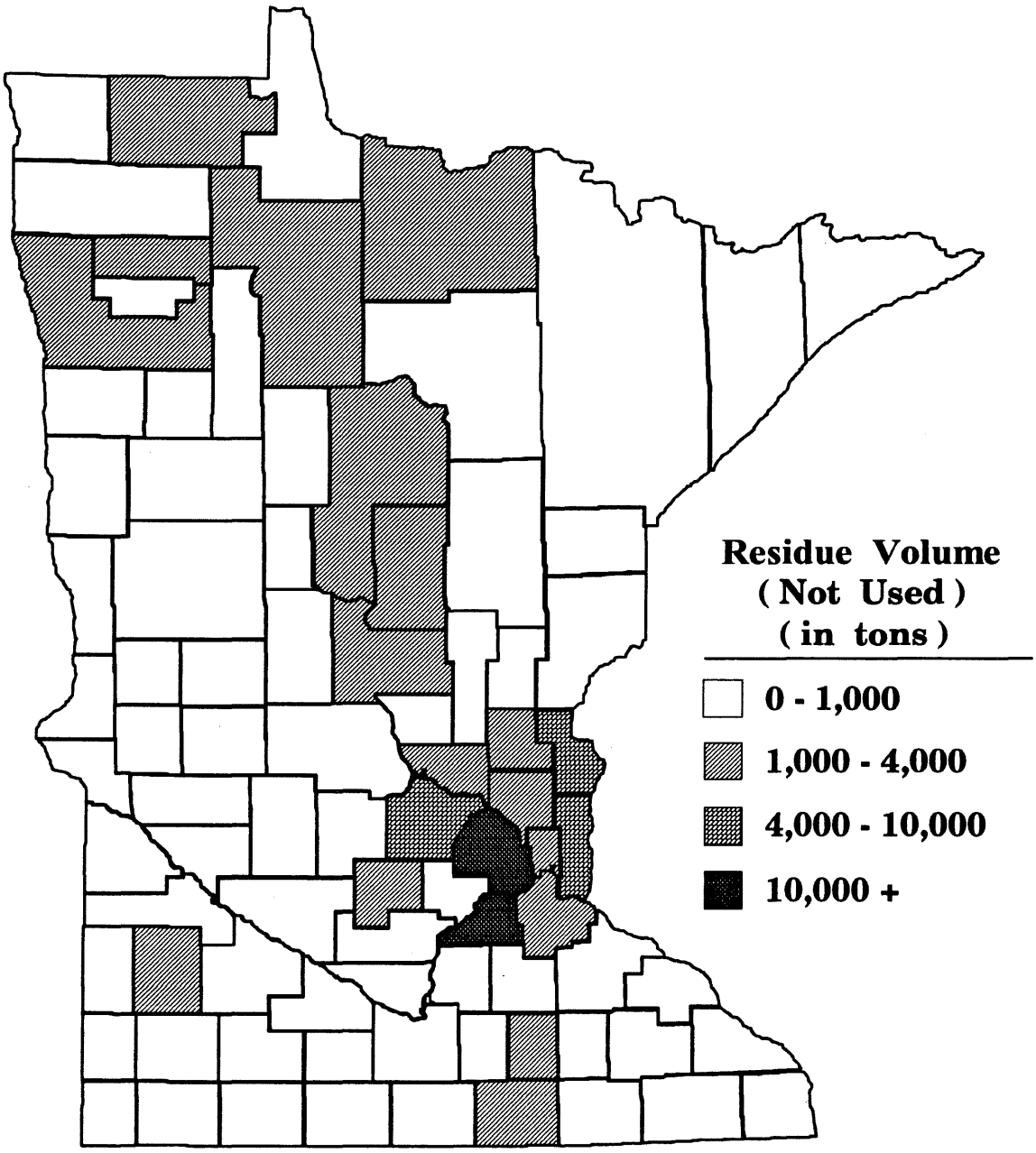


Companies located in the seven county twin city metropolitan area* generate 42% (196,400 dry tons) of the secondary processor wood waste in Minnesota. Hennepin and Washington counties alone generate more than 148,300 dry tons per year. Aitkin, Benton, and St. Louis counties generate the largest volumes outstate, 25,600, 30,100, and 41,300 dry tons respectively.

* Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties

Surplus Secondary Manufacturing Wood Wastes by County

Minnesota Secondary Wood Manufacturers , 1993 Survey



Hennepin and Scott counties have the largest surplus volumes of wood waste, 12,400 and 13,800 dry tons respectively. Washington County has a surplus of more than 8,000 dry tons, and Chisago, Dakota, Morrison, Ramsey, and Wright counties all have surplus wood waste volumes in excess of 3,000 dry tons. These surpluses include the volumes handled by refuse haulers, of which as much as 25% is actually utilized as discussed previously.

URBAN WOOD WASTES FROM OTHER SOURCES

Abstract

Wood wastes in urban areas present significant disposal problems. Tree and yard waste can no longer be deposited in landfills, and demolition, construction, packaging, and manufacturing wood wastes take up limited landfill space. Little information was available about these volumes until the release of recent studies by the Minnesota Pollution Control Agency, and the Department of Natural Resources.

Urban Wood Residues

	Units*	Used or Given Away	Not Used	Total
Metro Area Tree Residues	Green Tons	185,900	140,100	326,000
MSW Landfills	Dry Tons	-0-	245,600	245,600
Demolition Landfills	Dry Tons	-0-	313,400	313,400
Railroad Ties	Dry Tons	40,000	-0-	40,000
Total	**Tons**	**225,900**	**699,100**	**925,000**

*Green Tons assume a moisture content of approximately 50%. Dry Tons assume a moisture content of 8%.

The volume and disposition of tree residue generated by urban and rural residents in Greater Minnesota is not known, but volume per capita is likely similar to that of the metro area (0.139 tons/year/person). This could represent an additional 293,400 green tons of urban tree waste. However, only the volumes in larger urban centers like Duluth or St. Cloud are likely to be significant.

Wood residues in Municipal Solid Waste (MSW) and demolition landfills and related facilities is often mixed with many other materials. Separating the wood from these waste streams is a significant barrier to utilizing the wood residues.

A portion of the wood entering MSW and demolition landfills is from secondary wood processing companies. The above figures represent double counting of that volume. Refer back to the chapter on secondary wood manufactures for clarification.

It is worth noting that paper is a very large portion of MSW (40%). MPCA estimates of paper in MSW for 1992 totaled 1,076,300 tons.

TWIN CITIES METROPOLITAN AREA TREE RESIDUE

The removal and disposal of urban trees due to mortality or land clearing, as well tree trimmings is a significant problem in the Twin Cities metropolitan area. The Minnesota Department of Natural Resources, Division of Forestry commissioned a study of the issue, and released a report, titled Urban Tree Residue in March 1992.

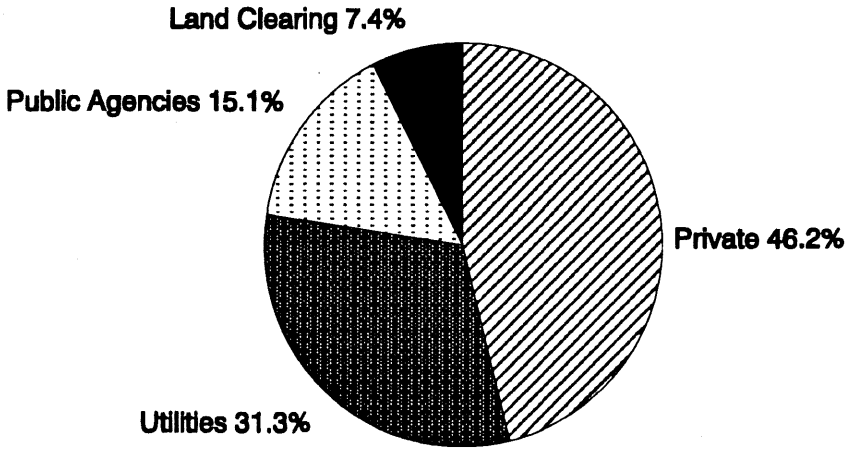
Approximately 326,000 green tons of urban tree residue are produced annually in the Twin Cities metro area. However, the volume can fluctuate greatly from year to year. Insect and disease outbreaks, changing levels of construction activity, and the occurrence of damaging storms all influence tree trimming and removal.

Private tree service companies and electric utilities generate the largest volumes of urban tree waste, (150,700 and 101,900 green tons respectively). Most urban tree residue is chipped (55.8%) to reduce bulk for ease of handling and transportation. And most is either given away (42.8%) or stored (35.1%) at an intermediate site for future use or disposal. The high cost of transporting and processing tree waste, the potential presence of metal and other foreign materials, and the relatively low cost of other energy and wood fiber sources are all significant barriers to higher levels of use.

The volume and disposition of tree residue generated by urban and rural residents in Greater Minnesota is not known, but the volume per capita is likely similar to the metro area (0.139 tons/year/person). This could represent an additional 293,400 green tons of urban tree waste. However, only the volumes in larger urban centers like Duluth or St. Cloud are likely to be significant.

Private tree trimming and removal companies and utilities generate the largest volumes of material, 46.2% and 31.3% respectively.

Sources of Metro Area Tree Residue*



326,000 Green Tons

*Urban Tree Residue, pg.11

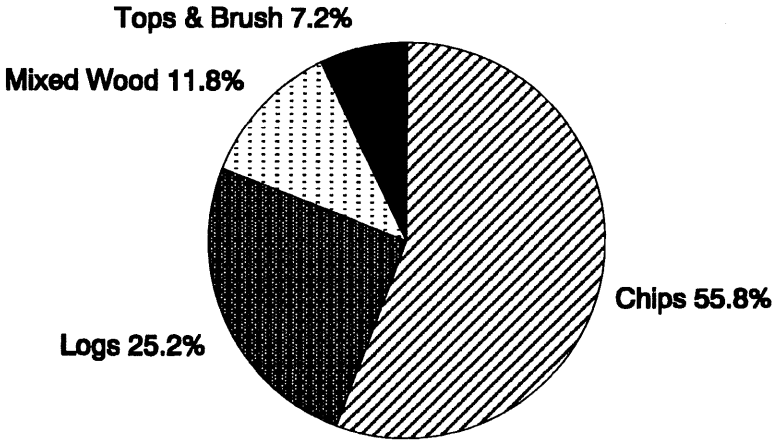
Private: Private tree service companies - trimming and removal of yard trees.

Utility: Company or contractor right-of-way maintenance of powerlines and telephone lines.

Public Agencies: Municipalities or their contractors.

Land Clearing: Construction site land clearing.

Composition of Metro Area Tree Residue*



326,000 Green Tons

*Urban Tree Residue, pg.11

Chips: Wood from brush and limbs and logs from trees chipped either on the site generated or at a processing or disposal site.

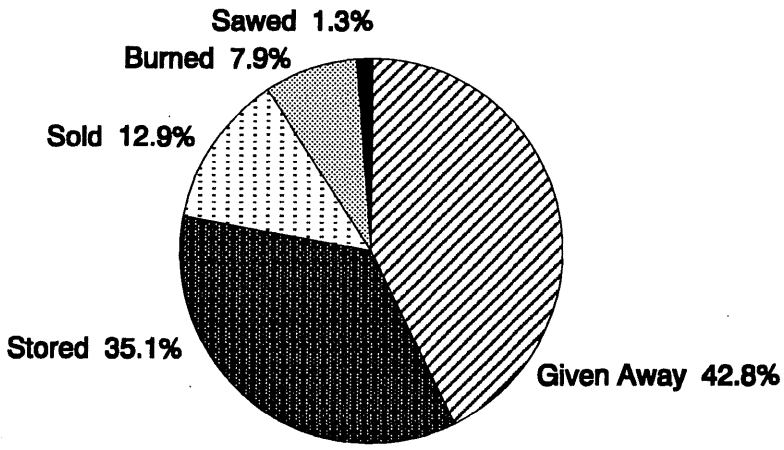
Logs: Roundwood material greater than 12 inches in diameter.

Mixed Wood: A mixture of limbs, logs, and brush.

Tops & Brush: Tree limbs & brush smaller than 12 inches in diameter.

Chips and logs are the largest categories of urban tree residue. Nearly half of the chips in this group come from chipping twigs and smaller limbs. These chips are referred to as "brush chips", and are less desirable for landscape mulch. They have a high percentage of fines and readily biodegrade giving off unpleasant odors. The sawlogs from urban areas are less desirable because of the many short pieces and the frequent occurrence of nails, wire or other foreign material.

Annual Use of Metro Area Tree Residue*



326,000 Green Tons

*Urban Tree Residue, pg. 11

Given Away: Given at no charge to anyone, often available at various storage site to be picked up by the user. Exact disposition is not known, but most likely uses for include chips for landscape mulch, and logs and limbs for firewood.

Stored: Materials permanently stored in their original condition, or chipped for permanent storage at the disposal site.

Sold: Materials sold to a user. Exact disposition is not known, but most likely uses include chips for boiler fuel and landscape mulch, logs and limbs for firewood, and logs for sawing lumber.

Burned: Materials burned as a form of disposal.

Sawed: Logs sold or given away to be sawn for lumber.

The volume of urban tree residue in Greater Minnesota is not known, but volume per capita for each urban center is likely similar to that of the metro area. The 1993 population of the Twin Cities metro area was 2,352,000*. This population generates 326,000 green tons of tree waste generated annually, or approximately 0.139 tons per person per year. The population of Greater Minnesota is 2,117,000*. This could represent an additional 293,400 green tons of urban tree waste. However, only the volumes in larger urban centers like Duluth or St. Cloud are likely to be significant enough to attract commercial interest.

*Report on 1993 Score Programs, Table 13, pg.56

Barriers to Utilization of Urban Tree Residues

Recent legislative action prohibits disposal of tree residues in landfills. This has greatly increased the concerns about disposal. Separation of species and types of residue, and additional processing may increase use. Additional storage and processing sites would be necessary to facilitate this.

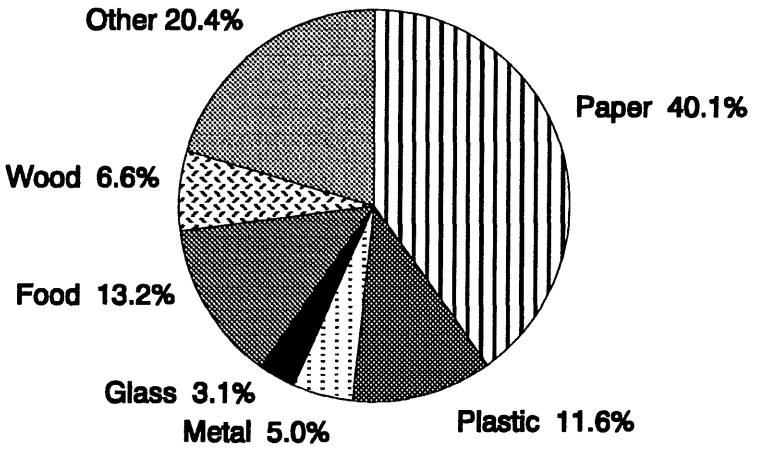
Currently there are only a few reprocessing sites in the metro area. This means higher disposal costs caused by large volumes of material to be processed and the limited number of facilities. This results in longer hauls, and encourages haulers to take the residue to sites outside of the metro area, or to dump or burn the material illegally.

The current low value of tree residues also limits disposal options. Increase value due to higher energy prices or increased industrial resource demands will be necessary to stimulate development. The latter holds the most immediate promise. Solving consumer concerns over metal and other foreign materials in tree residues, is one key to improving marketability.

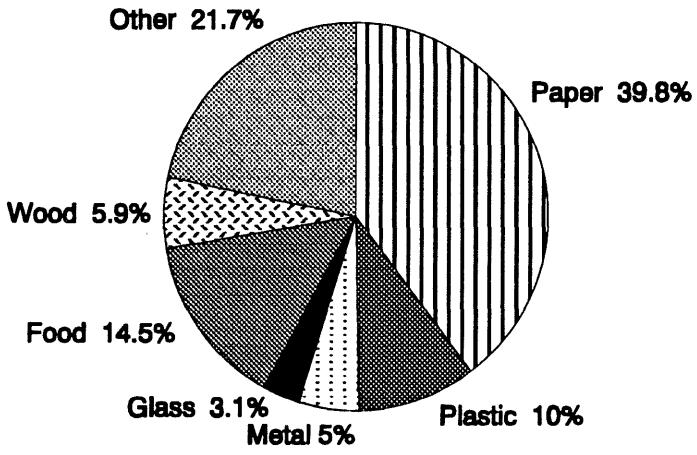
WOOD WASTE CONTENT OF MUNICIPAL SOLID WASTE

Municipal solid waste (MSW) landfills, public incineration facilities, and composting operations receive municipal solid waste from households and businesses. The Minnesota Pollution Control Agency (MPCA) recently completed studies of the composition of MSW in both the Twin Cities metropolitan area and Greater Minnesota.

Composition of MSW in the Twin Cities Metro Area



Composition of MSW in Greater Minnesota



Pie charts of composition of MSW for metro & outstate based on Table VII-1, pg 76, MN Solid Waste Composition Study, Part II.

The wood content in Metro area MSW averaged 6.6%, while in Greater Minnesota wood content averaged 5.9%.

Total Volume of Municipal Solid Waste Delivered to Minnesota Disposal Facilities in 1993* (Cubic Yards)

	Metro	Greater MN	Total
Municipal Solid Waste Landfill	1,592,000	3,307,000	4,899,000
Composting operations	-0-	1,054,100	1,054,100
Incineration Facilities	2,344,600	5,386,900	7,731,500
Total	**3,936,500**	**9,748,000**	**13,684,500**

*From internal MPCA records

Cubic yards of MSW was converted to tons using the secondary manufacturing conversion factor for lumber scraps (3.4 cubic yards/ton at 8% moisture).

Wood Content of Municipal Solid Waste Delivered to Minnesota Disposal Facilities in 1993 (Dry Tons)

	Metro	Greater MN	Total
Municipal Solid Waste Landfill	30,900	57,400	88,300
Composting operations	-0-	18,300	18,300
Incineration Facilities	45,500	93,500	139,000
Total	**76,400**	**169,200**	**245,600**

The wood volumes processed in composting and incineration facilities will be very difficult to access for other uses. Wood plays an important role in the efficient operation of these facilities. A portion of the wood entering MSW disposal sites is from secondary wood processing companies. The above figures represent double counting of that volume. Refer back to the chapter on secondary wood manufactures for clarification.

It is worth noting that paper is a much larger portion of MSW (40% statewide) than wood (6.5%). MPCA estimates of paper in MSW for 1992 totaled 1,076,300 tons.

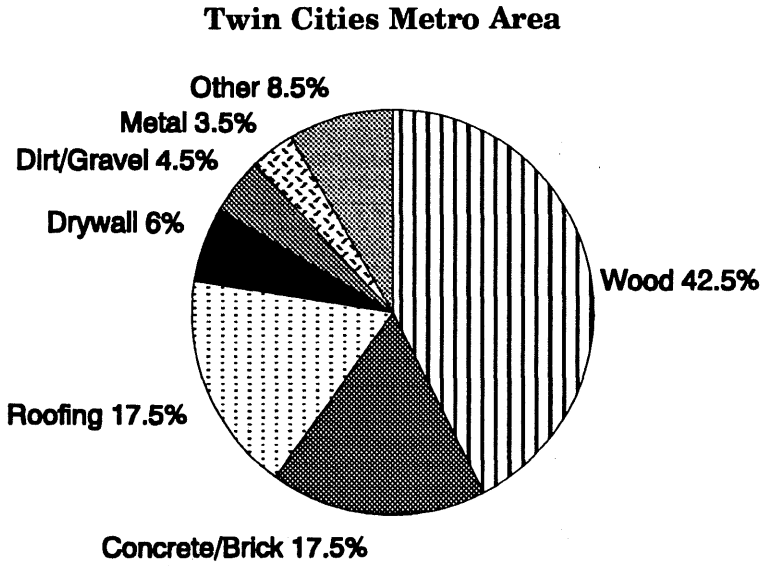
CONSTRUCTION AND DEMOLITION WOOD WASTE

Construction and demolition wood waste is wood that is left over after construction or demolition of buildings. This debris is commonly hauled to demolition landfills. Large volumes of wood from crating, old pallets, and manufacturing operations are also hauled to these sites. There are 86 permitted demolition landfills in Minnesota, and approximately 22 additional demolition landfills operated in conjunction with municipal solid waste landfills. Only the volumes delivered to these permitted facilities are reported here. Additional volumes disposed of elsewhere are unknown.

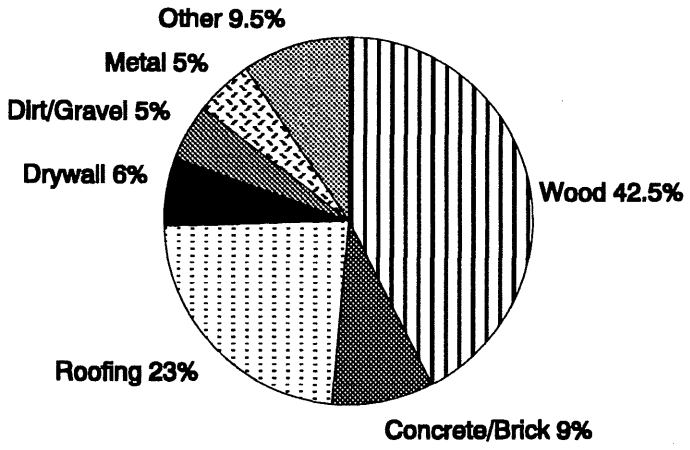
The cost of recovering construction and demolition wood wastes for use is unclear. Most of this residue is contaminated with metals, paint, plaster, and other materials. Incentives are slowly developing to encourage segregation of wood wastes from other materials, at the site where the wastes are generated, so that they can be economically processed.

Two studies of demolition/construction landfills and internal Minnesota Pollution Control records were reviewed to develop the information reported here. A 1989 study funded by the Metropolitan Council (Barnes-Driscoll, 1990) estimated that 56% of the material at demolition landfills was wood. A later study by the MPCA (Latham, 1993) estimated the volume of wood in metro and Greater Minnesota demolition landfills was 40-45%. The study was done over a six-month period in 1992 and 1993.

Composition of Materials Delivered to Demolition Landfills



Greater Minnesota



Pie Charts created using tables on pages 28 and 29 of Measure Twice Cut Once, Latham, 1993.

The composition of demolition waste was slightly different in Greater Minnesota than in the seven county Twin Cities metro area, but the percentage of wood was constant. No figures are available about usage of construction/demolition wood residue. A small amount of this material is being used, but the quantities are unknown.

Total Volume of all Construction/Demolition Materials Delivered to Minnesota Landfills in 1993 (Cubic Yards)

	Metro	Greater MN	Total
Demolition Landfills	1,310,900	753,000	2,063,900
Municipal Solid Waste Landfills*	54,700	389,100	443,800
Total	**1,365,600**	**1,142,100**	**2,507,700**

*These are demolition landfills operated in conjunction with MSW landfills. The volumes reported here are for the demolition landfill part of those operations.

The majority of the demolition wood was kiln dried before use, or has been drying inside a structure for many years, so the secondary manufacturing weight conversion factor for lumber scraps of 3.4 cubic yards/ton (at 8% moisture content) was used to convert cubic yards to tons.

Demolition and Construction Wood Delivered to Minnesota Landfills in 1993 (Tons)

	Metro	Greater MN	Total
Demolition Landfills	163,900	94,100	258,000
Municipal Solid Waste Landfills	6,800	48,600	55,400
Total	**170,700**	**142,700**	**313,400**

A portion of the wood entering demolition landfills is from secondary wood processing companies. Secondary wood processing wood wastes are reported in a previous chapter. The above figures represent double counting of a portion of their volume. Refer back to the chapter on secondary wood manufactures for clarification.

RAILROAD TIES

Old railroad ties are a type of industrial wood waste which is not accounted for in the demolition landfill reports. The Minnesota Department of Public Service estimates (1988) that 300,000 to 400,000 railroad ties are discarded annually in Minnesota. At 10 ties per ton, this represents 40,000 tons-per-year. The majority of these are shredded and burned to produce electricity.

APPENDIX

APPENDIX I - FOREST BIOMASS

I-A Total Tree Biomass

	Units	Boles	Tops & Limbs	Total
Growing Stock	M CU.FT.	18,249,410	5,093,799	23,343,209
	Green Tons	460,963,683	129,680,496	590,644,179
	Cords	200,542,967	55,975,813	256,518,780
Cull Trees	M CU.FT.	3,368,507	927,951	4,296,458
	Green Tons	87,262,750	24,131,271	111,394,021
	Cords	37,016,560	10,197,564	47,214,124
Mortality	M CU.FT.	219,228	117,070	326,298
	Green Tons	5,482,264	2,916,964	8,399,228
	Cords	2,409,099	1,286,491	3,695,590
Total	**M CU.FT.**	**21,837,145**	**6,138,820**	**27,975,965**
	Green Tons	**553,708,697**	**156,728,731**	**710,437,428**
	Cords	**239,968,626**	**67,459,868**	**307,428,494**

M CU.FT. = 25.2 Green Tons & 91 CU.FT. = 1 Cord
M CU.FT. = Thousand Cubic Feet

Growing Stock & Cull Tree M CU.FT. volumes from Table 75, pg.125, Minnesota Forest Statistics, 1990.

Mortality Bole M CU.FT. volumes from Table 25, pg.61, Minnesota Forest Statistics, 1990.

Mortality Tops & Limbs M CU.FT. volume calculated using the same ratio of bole to tops as shown in the Live Biomass Composition Table below.

I-B Live Biomass Composition

	Boles	Tops & Limbs	Total
Growing Stock	66.0%	18.4%	84.4%
Cull Trees	12.2%	3.4%	15.6%
Total	**78.2%**	**21.8%**	**100.0%**

Composition based on the M CU.FT. volumes listed above.

Harvest Residue Calculations

Available Live Biomass

It is estimated that 15% of the cull trees are currently harvested and utilized during normal commercial harvest. Cull tree boles represent 12.2% of the live biomass. 12.2% x 15% = 1.83% of the total harvest is from cull trees.

I-C Breakdown of Total Harvest in Cords

	1988	1993	2000
Growing Stock	3,151,100	4,027,500	4,578,700
Cull Trees	58,700	75,100	85,300
Total	**3,209,800**	**4,102,600**	**4,664,000**

Growing Stock Tops
1988 3,151,100 x (18.4%/66.0%) = 878,488 cords
1993 4,027,500 x (18.4%/66.0%) = 1,122,818 cords
2000 4,578,700 x (18.4%/66.0%) = 1,277,457 cords

Unutilized Cull Tree Boles
1988 [3,151,100 x (12.2%/66.0%)] - 58,700 = 523,776 cords
1993 [4,027,500 x (12.2%/66.0%)] - 75,100 = 669,377 cords
2000 [4,578,700 x (12.2%/66.0%)] - 85,300 = 761,066 cords

Cull Tree Tops
1988 (523,776 + 58,700) x (3.4%/12.2%) = 162,329 cords
1993 (669,377 + 75,100) x (3.4%/12.2%) = 207,477 cords
2000 (761,066 + 85,300) x (3.4%/12.2%) = 235,872 cords

Available Mortality

Mortality averages 1.5% of the live biomass per year (Minnesota Forest Statistics, 1990, pg.5). It is estimated that dead trees remain salvageable for about 3 years. This means that the salvageable mortality biomass available is approximately equal to 4.5% of the live biomass found on a harvest site.

Dead Tree Boles
1988 (3,151,100 + 58,700 + 523,776) x 4.5% = 168,010 cords
1993 (4,027,500 + 75,100 + 669,377) x 4.5% = 214,739 cords
2000 (4,578,700 + 85,300 + 761,066) x 4.5% = 244,128 cords

Dead Tree Tops
1988 (878,488 + 162,329) x 4.5% = 46,837 cords
1993 (1,122,818 + 207,477) x 4.5% = 59,863 cords
2000 (1,277,457 + 235,872) x 4.5% = 68,100 cords

I-D Available Forest Residues - Cords

	1988	1993	2000
Growing Stock Tops	878,500	1,122,800	1,277,500
Cull Tree Boles	523,800	669,400	761,100
Cull Tree Tops	162,300	207,500	235,900
Dead Tree Boles	168,000	214,700	244,100
Dead Tree Tops	46,800	59,900	68,100
Total	**1,779,400**	**2,274,300**	**2,586,700**

Recoverable Top Volumes

While the boles of unutilized trees are 100% recoverable using current harvesting methods, the tops of the trees are only partially recoverable. Breakage, small size, and other handling difficulties, as well as producer willingness to modify operations, limit recovery.

Full tree skidding and chipping provide the most viable option for recovery and transportation tops and limbs at the present time. A number of such operations already exist. They fill a variety of markets, including boiler fuel, landscape chips, animal bedding, and the production of hardboard and asphalt shingles.

Tree length, shortwood skidding, and cut-to-length systems are more numerous, and can effectively recover the bole volume of cull and dead trees, but the recovery of top volumes would be very difficult. However, these systems offer operational and site protection advantages over full tree harvesting on many sites.

Nutrient depletion and other environmental and site productivity concerns also limit the appropriateness of removing more biomass than is currently recovered in normal commercial harvest from many sites. A very rough estimate is that between 25% and 40% of the tops and limbs could be recovered with these constraints in mind.

		40% Recovery	25% Recovery
Growing Stock Tops	1988	351,400 cords	219,600 cords
	1993	449,100 cords	280,700 cords
	2000	511,000 cords	319,400 cords
Cull Tree Tops	1988	64,900 cords	40,600 cords
	1993	83,000 cords	51,900 cords
	2000	94,400 cords	59,000 cords
Dead Tree Tops	1988	18,700 cords	11,700 cords
	1993	24,000 cords	15,000 cords
	2000	27,200 cords	17,000 cords
Total	1988	435,000 cords	271,900 cords
	1993	556,100 cords	347,600 cords
	2000	632,600 cords	395,400 cords

I-E Total Recoverable Harvest Residues - Cords

	% Recovery	1988	1993	2000
Growing Stock Tops	40%	351,400	449,100	511,000
	25%	219,600	280,700	319,400
Cull Tree Boles	85%	523,800	669,400	761,100
Cull Tree Tops	40%	64,900	83,000	94,400
	25%	40,600	51,900	59,000
Dead Tree Boles	100%	168,000	214,700	244,100
Dead Tree Tops	40%	18,700	24,000	27,200
	25%	11,700	15,000	17,000
Total	**40%**	**1,126,800**	**1,440,200**	**1,637,800**
	25%	**963,700**	**1,231,700**	**1,400,600**

I-F Total Recoverable Harvest Residues - Green Tons

	% Recovery	1988	1993	2000
Growing Stock Tops	40%	805,800	1,029,800	1,171,700
	25%	503,500	643,600	732,400
Cull Tree Boles	85%	1,201,200	1,535,000	1,745,400
Cull Tree Tops	40%	148,800	190,300	216,500
	25%	93,100	119,000	135,300
Dead Tree Boles	100%	385,200	492,300	559,800
Dead Tree Tops	40%	42,900	55,000	62,400
	25%	26,800	34,400	39,000
Total	**40%**	**2,583,900**	**3,302,400**	**3,755,800**
	25%	**2,209,800**	**2,824,300**	**3,211,900**

2.293 Green Tons = 1 Cord

APPENDIX II - PRIMARY MILL WOOD WASTES

Wood waste volumes for the sawmill category of primary mills were calculated by applying ratio factors for each residue type appropriate for a specific mill to the mills wood consumption. These factors were developed by the US Forest Service, North Central Forest Experiment Station in St. Paul, Minnesota. The ratios reflect the volume of residue, in green tons, generated for each one thousand board feet (MBF) of wood processed.

Bark:		0.57 tons/MBF
Slabs & Edgings Without Bark:		1.34 tons/MBF
Slabs & Edgings With Bark:	0.57 + 1.34 =	1.91 tons/MBF*
Sawdust & Shavings:		0.78 tons/MBF

* The bark volume for mills that do not debark their logs was assigned fully to the slabs and edgings category. Clearly a portion should also be assigned to sawdust and shavings. This was done for simple convenience, and had a very minimal impact on the results. The total "not used" volume would be almost exactly the same. The adjusted volumes can be calculated on request for those needing a more precise breakdown.

The adjusted factors should be:

Slabs & Edgings With Bark -	1.70 tons/MBF
Sawdust & Shavings With Bark -	0.99 tons/MBF

The impact on the total "not used" category would have been a reduction of 122 tons statewide.

II-A PRODUCTION of MINNESOTA MILLS by SPECIES and MILL

- 1992 Production Survey -

(includes all harvested locations)

SPECIES NAME	STATIONARY	PORTABLE	VENEER BUYER	VENEER MILL	POST/POLE	CHIPPERS	SHAVING	TOTAL MBF
BLACK ASH	6582.4	51.0	734.7	0.0	0.0	0.0	50.0	7,418
GREEN ASH	230.1	13.8	29.4	0.0	0.0	0.0	0.0	273
ASPEN	82476.2	136.1	0.0	1852.0	0.0	9663.3	8111.0	102,239
WHITE BIRCH	14092.9	41.1	14.7	8323.0	0.0	0.0	0.0	22,472
BALM/GILEAD	816.5	0.0	0.0	0.0	0.0	0.0	0.0	817
ELM	1891.2	165.5	402.7	0.0	0.0	0.0	0.0	2,459
COTTONWOOD	3573.9	120.4	141.6	0.0	0.0	0.0	100.0	3,936
SOFT MAPLE	1390.3	16.6	47.7	10.0	0.0	0.0	0.0	1,465
HARD MAPLE	1534.3	50.0	109.0	0.0	0.0	0.0	0.0	1,693
BASSWOOD	10984.6	108.0	1591.9	25.0	0.0	0.0	50.0	12,759
YELLOW BIRCH	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1
WALNUT	178.5	35.0	251.6	0.0	0.0	0.0	0.0	465
BUTTERNUT	0.0	5.0	0.0	0.0	0.0	0.0	0.0	5
CHERRY	4.6	8.0	0.0	0.0	0.0	0.0	0.0	13
RED OAK	29681.5	438.7	293.9	0.0	0.0	0.0	84.0	30,498
WHITE OAK	6501.5	213.6	829.6	0.0	0.0	0.0	20.0	7,565
HICKORY	223.4	0.0	0.0	0.0	0.0	0.0	0.0	223
WHITE PINE	14617.3	55.0	100.3	0.0	0.0	0.0	0.0	14,773
RED PINE	50163.2	50.5	54.7	0.0	6121.8	122.3	1312.5	57,825
JACK PINE	67617.2	25.0	0.0	0.0	1796.7	127.5	4197.5	73,764
WHITE SPRUCE	7979.4	4.0	0.0	0.0	0.0	12.2	0.0	7,996
BALSAM FIR	3815.5	0.0	0.0	0.0	0.0	9.8	0.0	3,825
BLACK SPRUCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
TAMARACK	121.0	2.5	0.0	0.0	0.0	0.0	0.0	123
RED CEDAR	10.0	0.0	0.0	0.0	0.0	0.0	0.0	10
WHITE CEDAR	1797.5	10.4	0.0	0.0	1174.5	0.0	0.0	2,982
MIXED SOFTWDS	843.8	205.0	0.0	0.0	0.0	0.0	0.0	1,049
MIXED HDWDS	1314.5	248.1	0.0	0.0	0.0	0.0	0.0	1,563
MIXED SPECIES	2863.1	557.5	0.0	0.0	0.0	0.0	0.0	3,421
TOTAL :	311305.2	2560.5	4602.0	10210.0	9092.9	9935.0	13925.0	361,631
	86.1%	0.7%	1.3%	2.8%	2.5%	2.7%	3.9%	100.0%

II-B TOTAL NUMBER OF MILLS by PRODUCTION CLASS by MILL TYPE

- 1992 Sawmill Production Survey -

(includes counties in Minnesota only)

TYPE OF MILL	1-100 MBF	101-500 MBF	501-1000 MBF	1001-3000 MBF	3001 + MBF	TOTAL NO. MILLS
Sawmill	429	88	27	31	18	593
Veneer Mill	2	0	0	0	1	3
Post/Pole	0	3	1	0	1	5
Stationary Rd Wd Chipper	1	1	0	0	5	7
Whole Tree Chipper	20	0	0	1	1	22
Shaving	1	3	2	1	1	8
TOTAL:	453	95	30	33	27	638

II-C VOLUME of RESIDUE by PRODUCTION CLASS by MILL TYPE

- 1992 Sawmill Production Survey -

(includes counties in Minnesota only)

TYPE OF MILL	1-100 MBF	101-500 MBF	501-1000 MBF	1001-3000 MBF	3001 + MBF	TOTAL GREEN TONS
Sawmill	24603	58216	55015	147650	511992	797,475
Veneer Mill	161	0	0	0	19387	19,548
Post/Pole	0	1305	1412	0	4033	6,750
Stationary Rd Wd Chipper	192	171	0	0	23424	23,787
Whole Tree Chipper	0	0	0	0	0	0
Shaving	0	1488	2829	8070	4875	17,262
TOTAL:	24956	61179	59256	155720	563710	864,821

II-D VOLUME of RESIDUE NOT USED by PRODUCTION CLASS by MILL TYPE

- 1992 Sawmill Production Survey -

(includes counties in Minnesota only)

TYPE OF MILL	1-100 MBF	101-500 MBF	501-1000 MBF	1001-3000 MBF	3001 + MBF	TOTAL GREEN TONS
Sawmill	7163	16728	15497	33466	24327	97,182
Veneer Mill	94	0	0	0	0	94
Post/Pole	0	868	0	0	4033	4,901
Stationary Rd Wd Chipper	0	0	0	0	435	435
Whole Tree Chipper	0	0	0	0	0	0
Shaving	0	1420	0	0	0	1,420
TOTAL:	7256	19016	15497	33466	28795	104,031 (available)

II-E RESIDUE VOLUME by MILL TYPE by RESIDUE CATEGORY MN STATEWIDE

(Based on MN 1992 Sawmill Production Survey)

(in green tons)

TYPE OF MILL	BARK	BARK MIXED with SLABS/EDGINGS	SLABS/EDGINGS and CHIPS	SAWDUST/ SHAVINGS	TOTAL GREEN TONS
Sawmill	103481	167720	291961	2324313	797,475
Veneer Mill	5786	115	13601	47	19,548
Post/Pole	4175	1939	0	636	6,750
Stationary Rd Wd Chipper	23370	191	0	226	23,787
Whole Tree Chipper	0	0	0	0	0
Shaving	656	7831	0	8775	17,262
TOTAL:	137467	177795	305562	243997	864,821

II-F VOLUME by FUEL USE CLASS by RESIDUE CATEGORY MN STATEWIDE

(Based on MN 1992 Sawmill Production Survey)

(in green tons)

FUEL USE CLASS	BARK	BARK MIXED with SLABS/EDGINGS	SLABS/EDGINGS and CHIPS	SAWDUST/ SHAVINGS	TOTAL GREEN TONS
Industrial Fuel	105965	48376	43492	153426	351,259
Domestic Fuel	0	70485	20038	734	91,257
Processed Fuel	0	1714	0	0	1,714
Fiber Manufacture	0	13771	223685	1418	238,874
Other Uses	11470	9224	14729	42263	77,685
Not Used	20033	34225	3617	46156	104,031
TOTAL:	137467	177795	305562	243997	864,821

II-G VOLUME of WOOD WASTE NOT USED by RESIDUE CATEGORY by COUNTY

(Based on MN 1992 Mill Production Survey)

COUNTY NAME	BARK	BARK MIXED with SLABS/EDGINGS	SLABS/EDGINGS and CHIPS	SAWDUST/SHAVINGS	TOTAL GREEN TONS
AITKIN	143	1146	0	3260	4,549
ANOKA	0	0	0	14	14
BECKER	0	1050	0	566	1,615
BELTRAMI	3006	2920	62	3019	9,007
BENTON	0	11	0	0	11
CARLTON	0	118	0	97	215
CARVER	0	72	0	1	72
CASS	0	13262	0	8818	22,080
CHISAGO	0	277	0	16	293
CLEARWATER	0	315	0	2845	3,161
COOK	0	17	0	142	159
CROW WING	0	344	0	1936	2,279
DOUGLAS	0	0	0	12	12
FILLMORE	0	346	0	119	465
FREEBORN	0	229	0	33	262
GOODHUE	0	0	0	8	8
GRANT	0	0	0	1	1
HOUSTON	0	0	0	23	23
HUBBARD	0	758	0	1319	2,077
ISANTI	0	0	0	1	1
ITASCA	0	2574	0	1528	4,102
KANDIYOHI	0	0	0	22	22
KITTSON	0	95	0	39	133
KOOCHICHING	11604	976	2567	10715	25,862
LAKE	0	33	0	57	90
LAKE OF WOODS	499	0	0	261	760
MAHNOMEN	0	0	0	21	21
MILLE LACS	0	111	0	49	160
MORRISON	0	77	0	0	77
MURRAY	0	48	0	29	77
NICOLLET	0	115	0	0	115
NORMAN	0	1146	0	780	1,926
OLMSTED	0	2	225	139	366
OTTER TAIL	0	158	0	402	560
PINE	1710	19	0	764	2,494
POLK	0	143	0	59	202
POPE	0	0	0	62	62
RED LAKE	0	0	0	47	47
RICE	0	0	0	8	8
ROSEAU	0	0	0	156	156
ST. LOUIS	2930	3559	764	6197	13,449
SCOTT	0	0	0	70	70
SHERBURNE	0	308	0	95	404
SIBLEY	0	19	0	8	27
STEARNS	0	57	0	57	114
STEELE	0	275	0	113	388
TODD	0	501	0	555	1,056
WABASHA	0	8	0	32	40
WADENA	143	2980	0	1560	4,682
WASHINGTON	0	96	0	78	174
WILKIN	0	2	0	0	2
WINONA	0	57	0	23	81
TOTAL:	20033	34225	3617	46156	104,031

APPENDIX III - SECONDARY WOOD PROCESSORS

III-A Secondary Wood Waste Conversion Factors

	Bone Dry Weight (lbs/CU.YD.)	8% Moisture Content (lbs/CU.YD.)	8% Moisture Content (CU.YD./Ton)
Chips	162	175	11.4
Sawdust	297	321	6.2
Shavings	162	175	11.4
Sawdust & Shavings	-	248	8.1
Lumber & Panel Scraps	540	583	3.4
Bark	378	408	4.9
Hogged Fuel	356	385	5.2
Mixed Residues	-	455	4.4

From: 1990 Wood Residue Survey and Directory of Secondary Wood Processing Facilities in Washington State, Washington State Energy Office, Olympia, Washington, September, 1990, and Assessment of Situation and Potential for Co-firing Coal and Biomass in Energy Facilities, The Irland Group with Dames & Moore, Consulting Engineers. Additional cross reference with Handbook for Conversion to Wood Energy Systems, Progressive Architects/Engineers/Planners, Inc., and local wood residue haulers.

Lumber and panel scraps of all kinds are assumed to have the same weight. Insufficient data was available to identify appropriate weights for each category.

Mixtures of sawdust and shavings were assumed to be a 50%/50% mix. The adjusted weight per CU.YD. was 248 lbs., or 8.1 CU.YD./ton.

Mixed residues were assumed to contain 33% sawdust, 33% shavings, and 34% scraps. The adjusted weight per CU.YD. was 455 lbs., or 4.4 CU.YD./ton.

III-B Total Number of Companies Surveyed (Minnesota 1993 2nd Wood Users)

COUNTY NAME	No. of Employees 1-49	50 +	TOTAL
AITKIN	7	1	8
ANOKA	34	3	37
BECKER	6	1	7
BELTRAMI	7	0	7
BENTON	9	4	13
BLUE EARTH	5	0	5
BROWN	4	0	4
CARLTON	6	1	7
CARVER	12	2	14
CASS	8	0	8
CHIPPEWA	1	0	1
CHISAGO	10	2	12
CLAY	5	0	5
CLEARWATER	3	0	3
COOK	1	0	1
COTTONWOOD	4	0	4
CROW WING	17	0	17
DAKOTA	28	4	32
DODGE	2	1	3
DOUGLAS	8	0	8
FARIBAULT	4	0	4
FILLMORE	2	1	3
FREEBORN	2	2	4
GOODHUE	2	4	6
GRANT	1	0	1
HENNEPIN	152	19	171
HOUSTON	1	0	1
HUBBARD	13	1	14
ISANTI	4	0	4
ITASCA	0	1	11
JACKSON	1	0	1
KANABEC	2	0	2
KANDIYOHI	8	0	8
KOOCHICHING	3	0	3
LAC Q. PARLE	4	0	4
LAKE	1	0	1
LAKE OF WOODS	1	0	1
LE SUEUR	3	0	3
LYON	2	1	3
MC LEOD	6	4	10
MARSHALL	1	0	1
MARTIN	6	0	6
MEEKER	5	0	5
MILLE LACS	4	1	5
MORRISON	5	3	8
MOWER	4	0	4
MURRAY	1	0	1
NICOLLET	6	0	6
NOBLES	4	0	4
OLMSTED	11	0	11
OTTERTAIL	21	0	21
PENNINGTON	2	0	2
PINE	7	0	7
POLK	6	0	6
POPE	2	0	2
RAMSEY	34	3	37
RED LAKE	1	1	2
REDWOOD	7	1	8
RENVILLE	1	0	1
RICE	5	0	5
ROCK	1	0	1
ROSEAU	1	2	3
ST. LOUIS	28	2	30
SCOTT	15	0	15
SHERBURNE	7	0	7
SIBLEY	1	1	2
STEARNS	23	1	24
STEELE	5	0	5
STEVENS	3	0	3
SWIFT	1	0	1
TODD	3	0	3
WABASHA	4	1	5
WADENA	4	0	4
WASECA	4	0	4
WASHINGTON	20	2	22
WINONA	1	1	2
WRIGHT	14	2	16
YELL. MEDICINE	2	1	3
Total Counties Surveyed	**669**	**74**	**743**

III-C Total Number of Secondary Wood Users Sampled (Minnesota 1993 Survey)

	No. of Companies		
Employee Class	No Resid	W. Resid	Total
1-3	87 30.4%	199 69.9%	286 100%
4-9	43 24.6%	132 75.4%	175
10-19	35 35.4%	64 64.6%	99
20-49	22 21.0%	83 79.0%	105
50-99	7 20.0%	28 80.0%	35
100-199	2 10.5%	17 89.5%	19
200-499	3 23.1%	10 76.9%	13
500-999	0	3 100.0%	3
1000+	2 50.0%	2 50.0%	4
Unknown	2 50.0%	2 50.0%	4
TOTAL	**203**	**540**	**743**

No Resid - Did not report wood waste volumes
W. Resid - Did report wood waste volumes

III-D Total Expanded Volume of Residue by Residue Use & Residue Type

(Based on Mn Statewide 2nd Wood Users Survey, 1993)

Use Class	Lbr Scraps	Chips	Sawdust	Shavings	Sawdust & Shavings	Panel	|---Lbr Scraps w.---| Panel	Sawdu/Shav	Treated Woods	Other Mixed	Total Tons
Refuse hauler	8656	0	2750	1509	11880	1337	7510	7534	53	33061	74,288
Stored at comp.	1104	0	1138	37	226	266	368	220	359	1910	5,629
Landfill	2521	0	162	0	2829	0	0	22	0	513	6,048
Fuel in plant	6090	9249	259	117	20958	33	4298	4320	5180	45951	96,454
Sold/given fuel	14921	19077	49	153	32820	321	7326	2746	0	50083	127,495
Animal bedding	302	795	19189	4063	67586	0	344	3791	0	26346	122,415
Mulch	0	640	96	64	90	0	15	792	0	17447	19,144
Paper mfgr	0	7210	0	0	0	0	0	0	0	0	7,210
Particle/fiberbd	0	0	6047	0	59	0	0	0	0	0	6,106
Other uses #	667	0	39	2	106	27	639	363	0	237	2,079
Total	34260	36971	29730	5944	136552	1984	20500	19788	5592	175547	466,868

Other uses include:

w.p. mfgr for compo., children toys, pieces for woodworkers, smoking food, camp fire, burned outdoors, oil absorbent, glass cleaner, packing, recycling/reused and insulations.

III-E Total Expanded Residue Volume by Employee Size & Residue Type

(Based on Mn Statewide 2nd Wood Users Survey, 1993)

Employee Size	Lbr Scraps	Chips	Sawdust	Shavings	Sawdust & Shavings	Panel	|---Lbr Scraps w.---| Panel	Sawdu/Shav	Treated Woods	Other Mixed	Total Tons
1-3	8587	640	3284	524	3128	162	1289	965	0	6123	24,703
4-9	2253	0	680	517	5144	139	2671	3773	30	5083	20,291
10-19	2269	299	8509	140	9609	33	840	1546	0	15334	38,577
20-49	14509	19933	15674	4599	12533	1297	4044	9794	382	38849	121,613
50-99	1403	9100	478	164	2747	353	4650	3617	0	36764	59,276
100-199	1479	0	384	0	4702	0	0	93	0	30694	37,351
200-499	795	0	720	0	1680	0	5569	0	0	22228	30,993
500-999	0	7000	0	0	17101	0	1438	0	0	73	25,611
1000+	2966	0	0	0	79908	0	0	0	5180	20400	108,453
Total	34260	36971	29730	5944	136552	1984	20500	19788	5592	175547	466,868

III-F Total Expanded Residue Volume by Employee Size & Residue Use Class

(Based on Mn Statewide 2nd Wood Users Survey, 1993)

Employee Size	Refuse hauler	Stored at company	Landfill	Fuel in plant	Sold/Given fuel	Animal bedding	Mulch	Paper mfgr	Particle /fiberbd	Other uses	Total Tons
1-3	2278	1523	47	5221	10180	4219	768	0	41	427	24,703
4-9	6404	449	215	5202	3448	3909	197	0	0	467	20,291
10-19	8942	9	58	1329	6535	20669	858	0	0	176	38,577
20-49	31650	3648	0	18957	24985	25683	3046	7210	6065	371	121,613
50-99	13755	0	126	11132	25893	8371	0	0	0	0	59,276
100-199	6185	0	228	10785	3221	10283	6454	0	0	193	37,351
200-499	3080	0	4	1687	16955	1445	7822	0	0	0	30,993
500-999	1993	0	22	0	15273	8324	0	0	0	0	25,611
1000+	0	0	5348	42141	21005	39513	0	0	0	445	108,453
Total	74288	5629	6048	96454	127495	122415	19144	7210	6106	2079	466,868

Other uses include:

w.p. mfgr for compo., children toys, pieces for woodworkers, smoking food, camp fire, burned outdoors, oil absorbent, glass cleaner, packing, recycling/reused and insulations.

III-G Total Expanded Residue Volume by MN County & Residue Type

(Based on Mn Statewide 2nd Wood Users Survey, 1993)

County Name	Lbr Scraps	Chips	Sawdust	Shavings	Sawdust & Shavings	Panel	Lbr Scraps w. Panel	Lbr Scraps w. Sawdu/Shav	Treated Woods	Other Mixed	Total Tons
AITKIN	494	1590	0	0	1527	0	0	0	0	22019	25,629
ANOKA	131	0	248	12	310	65	842	0	0	4561	6,169
BECKER	0	0	0	0	1	0	46	480	0	439	965
BELTRAMI	21	0	0	1504	0	0	0	0	0	1701	3,226
BENTON	759	7000	264	164	19769	0	987	604	0	564	30,112
BLUE EARTH	12	0	0	0	50	12	0	0	0	11	85
BROWN	1	0	0	0	15	0	0	0	0	26	42
CARLTON	30	0	0	0	102	0	5615	0	0	17322	23,069
CARVER	437	0	21	0	172	0	0	3	0	390	1,024
CASS	3318	0	1694	47	69	0	79	11	0	431	5,649
CHIPPEWA	0	0	0	0	2	0	0	0	0	6	9
CHISAGO	13	0	8	0	18	0	30	144	8	5320	5,541
CLAY	11	0	6	25	0	0	0	0	0	323	366
CLEARWATER	0	0	0	0	0	0	1	9	0	7846	7,856
COOK	0	0	0	0	0	0	0	0	0	12	12
COTTONWOOD	0	0	40	0	0	0	38	3	0	67	149
CROW WING	152	0	1	0	966	0	33	1306	0	532	2,990
DAKOTA	218	0	7235	18	938	0	109	0	0	6193	14,711
DODGE	0	0	0	0	0	0	0	90	0	0	90
DOUGLAS	21	0	1	3	0	0	0	160	0	104	289
FARIBAULT	23	0	0	0	10	0	0	0	0	2	35
FILLMORE	7	0	4	0	0	0	0	0	0	2772	2,782
FREEBORN	0	0	130	0	1109	0	1445	400	0	200	3,284
GOODHUE	86	0	39	0	17	0	1912	0	0	2923	4,976
HENNEPIN	3958	9542	8443	311	3382	979	2878	2819	23	19409	51,745
HOUSTON	259	0	27	0	0	0	0	0	0	0	286
HUBBARD	1004	0	23	406	2041	0	265	42	0	2	3,785
ISANTI	1035	0	4	0	13	0	65	327	0	0	1,445
ITASCA	4	0	7	88	2	2	24	88	0	5283	5,498
JACKSON	0	0	0	0	0	0	0	0	0	9	9
KANABEC	3	0	0	0	1	0	0	0	0	0	4
KANDIYOHI	663	0	470	0	5	0	58	44	0	85	1,325
KOOCH	187	7210	6150	1704	0	0	98	0	0	1672	17,021
LAC Q. PARLE	52	0	5	9	114	33	0	0	0	8	222
LE SUEUR	65	0	0	0	89	0	263	0	0	0	418
LYON	0	0	187	0	0	0	0	630	0	1837	2,655
MC LEOD	0	0	18	0	2174	0	20	63	0	3215	5,489
MARSHALL	0	0	0	0	0	0	0	4	0	0	4
MARTIN	2	0	4	4	17	0	75	0	0	134	236
MEEKER	717	0	6	0	0	0	0	4	0	600	1,328
MILLE LACS	0	0	0	0	25	0	46	3	0	73	147
MORRISON	650	0	844	0	28	0	8	152	0	1887	3,567

Total Expanded Residue Volume by MN County & Residue Type

(Based on Mn Statewide 2nd Wood Users Survey, 1993) cont.

County Name	Lbr Scraps	Chips	Sawdust	Shavings	Sawdust & Shavings	Panel	Lbr Scraps w.- Panel	Lbr Scraps w.- Sawdu/Shav	Treated Woods	Other Mixed	Total Tons
MOWER	2	0	0	0	0	0	0	0	0	318	321
NICOLLET	19	0	269	0	29	0	0	554	0	758	1,629
NOBLES	0	0	0	0	0	0	0	0	0	1137	1,137
OLMSTED	2238	640	546	0	86	0	15	0	0	821	4,347
OTTER TAIL	144	0	33	3	67	232	0	0	0	425	905
PENNINGTON	486	0	0	0	8	0	1297	0	0	0	1,792
PINE	0	0	172	0	32	0	150	0	0	21	376
POLK	66	0	40	2	8	0	0	1098	359	43	1,616
POPE	0	0	0	0	0	0	0	0	0	21	21
RAMSEY	4272	0	471	1104	1760	35	1546	383	0	1804	11,374
RED LAKE	66	0	0	0	0	0	0	160	0	228	453
REDWOOD	494	0	0	0	1034	3	13	15	0	1194	2,752
RENVILLE	0	0	17	0	0	0	0	0	0	0	17
RICE	6	0	36	0	0	0	0	0	0	206	248
ROCK	0	0	12	0	0	0	0	0	0	29	42
ROSEAU	0	0	0	0	0	0	0	2145	0	20400	22,545
ST. LOUIS	458	9100	79	247	109	19	37	47	0	31266	41,363
SCOTT	5175	0	16	0	9087	0	4	317	0	172	14,771
SHERBURNE	66	0	123	0	278	49	218	788	0	194	1,715
SIBLEY	0	0	0	0	636	0	0	0	0	938	1,573
STEARNS	1464	299	695	166	9359	13	750	7	0	537	13,289
STEELE	0	0	297	0	0	0	163	16	22	2119	2,618
STEVENS	26	0	0	0	0	0	0	0	0	74	101
SWIFT	0	0	0	0	53	0	342	0	0	0	395
TODD	0	0	47	0	0	0	0	24	0	40	110
WABASHA	8	0	33	126	28	0	0	0	0	270	464
WADENA	132	0	0	0	76	0	0	895	0	0	1,103
WASECA	0	0	0	0	39	0	5	0	0	10	54
WASHINGTON	3055	1590	95	0	80090	0	329	5567	5180	722	96,628
WINONA	392	0	12	0	611	0	0	0	0	0	1,015
WRIGHT	1303	0	854	0	143	540	696	386	0	3809	7,729
YELL. MEDICINE	61	0	0	0	53	0	0	0	0	12	125
Total	34260	36971	29730	5944	136552	1984	20500	19788	5592	175547	466,868

III-H Total Expanded Residue Volume by MN County & Residue Use Class

(Based on Mn Statewide 2nd Wood Users Survey, 1993)

County Name	Refuse hauler	Stored at company	Landfill	Fuel in plant	Sold/Given fuel	Animal bedding	Mulch	Paper mfgr	Particle /fiberbd	Other uses	Total Tons
AITKIN	0	21	0	8116	3996	7041	6454	0	0	0	25,629
ANOKA	2077	81	0	823	1583	1584	13	0	0	8	6,169
BECKER	218	0	0	23	244	480	0	0	0	0	965
BELTRAMI	1504	32	43	1622	23	0	0	0	0	2	3,226
BENTON	879	0	0	1238	18728	9264	0	0	0	1	30,112
BLUE EARTH	12	19	0	14	12	28	0	0	0	0	85
BROWN	0	0	0	26	1	15	0	0	0	0	42
CARLTON	0	101	0	1621	13485	44	7817	0	0	0	23,069
CARVER	228	0	0	202	320	207	1	0	0	65	1,024
CASS	500	826	0	1507	1741	874	48	0	0	152	5,649
CHIPPEWA	0	0	0	0	7	1	0	0	0	0	9
CHISAGO	5294	4	0	130	33	76	4	0	0	0	5,541
CLAY	54	0	215	11	54	0	32	0	0	0	366
CLEARWATER	0	5	0	7851	0	0	0	0	0	0	7,856
COOK	0	0	0	0	12	0	0	0	0	0	12
COTTONWOOD	74	0	0	2	53	10	0	0	0	11	149
CROW WING	1113	29	0	1661	188	0	0	0	0	0	2,990
DAKOTA	3141	0	0	73	1130	10174	0	0	0	193	14,711
DODGE	0	0	0	0	0	90	0	0	0	0	90
DOUGLAS	238	0	0	22	0	27	2	0	0	0	289
FARIBAULT	4	0	0	23	1	6	0	0	0	0	35
FILLMORE	0	0	0	2772	7	2	2	0	0	0	2,782
FREEBORN	1993	200	126	108	100	754	4	0	0	0	3,284
GOODHUE	375	0	0	2079	380	2125	17	0	0	0	4,976
HENNEPIN	11909	525	0	1995	19515	14308	3459	0	0	35	51,745
HOUSTON	0	0	0	130	130	13	13	0	0	0	286
HUBBARD	0	9	1	1582	928	1000	0	0	0	265	3,785
ISANTI	392	998	0	0	37	17	0	0	0	0	1,445
ITASCA	0	44	2	79	3502	1870	0	0	0	1	5,498
JACKSON	4	0	0	4	0	0	0	0	0	0	9
KANABEC	0	1	0	3	0	0	0	0	0	0	4
KANDIYOHI	52	0	58	22	779	411	0	0	0	3	1,325
KOOCHICHING	0	1775	0	98	187	1704	0	7210	6047	0	17,021
LAC Q. PARLE	13	0	0	167	27	14	0	0	0	0	222
LE SUEUR	47	0	0	164	164	42	0	0	0	0	418
LYON	1683	0	0	24	854	94	0	0	0	0	2,655
MC LEOD	2680	0	0	63	1886	860	0	0	0	0	5,489
MARSHALL	0	0	0	1	1	1	0	0	0	0	4
MARTIN	45	2	0	76	48	64	0	0	0	1	236
MEEKER	609	0	0	218	283	218	0	0	0	0	1,328
MILLE LACS	9	0	22	3	15	74	23	0	0	0	147
MORRISON	3009	0	0	313	75	145	25	0	0	0	3,567

Total Expanded Residue Volume by MN County & Residue Use Class

(Based on Mn Statewide 2nd Wood Users Survey, 1993) cont.

County Name	Refuse hauler	Stored at company	Landfill	Fuel in plant	Sold/Given fuel	Animal bedding	Mulch	Paper mfgr	Particle /fiberbd	Other uses	Total Tons
MOWER	318	0	0	2	0	1	0	0	0	0	321
NICOLLET	589	134	0	0	742	164	0	0	0	0	1,629
NOBLES	954	0	0	0	184	0	0	0	0	0	1,137
OLMSTED	527	0	0	45	2417	713	645	0	0	0	4,347
OTTER TAIL	473	71	0	111	151	98	0	0	0	0	905
PENNINGTON	1297	0	0	0	486	8	0	0	0	0	1,792
PINE	184	0	0	153	1	33	5	0	0	0	376
POLK	35	359	0	502	352	23	0	0	0	344	1,616
POPE	0	0	0	11	0	11	0	0	0	0	21
RAMSEY	3130	0	0	2348	2392	3435	3	0	41	25	11,374
RED LAKE	160	0	228	66	0	0	0	0	0	0	453
REDWOOD	736	3	0	1030	7	975	0	0	0	0	2,752
RENVILLE	0	0	0	0	8	0	8	0	0	0	17
RICE	120	0	0	43	49	36	0	0	0	0	248
ROCK	0	0	0	29	0	12	0	0	0	0	42
ROSEAU	2145	0	0	20400	0	0	0	0	0	0	22,545
ST. LOUIS	593	119	4	10487	23530	6517	63	0	18	32	41,363
SCOTT	13793	0	0	345	184	446	2	0	0	0	14,771
SHERBURNE	1113	0	0	26	198	294	0	0	0	84	1,715
SIBLEY	0	0	0	0	0	1573	0	0	0	0	1,573
STEARNS	510	0	0	960	1807	9987	0	0	0	25	13,289
STEELE	2256	0	0	49	5	303	5	0	0	0	2,618
STEVENS	73	0	0	28	0	0	0	0	0	0	101
SWIFT	0	189	0	171	0	18	18	0	0	0	395
TODD	0	0	0	110	0	0	0	0	0	0	110
WABASHA	154	1	0	7	116	185	0	0	0	0	464
WADENA	0	0	0	287	127	689	0	0	0	0	1,103
WASECA	0	0	0	0	9	39	0	0	0	5	54
WASHINGTON	2731	78	5348	24005	22466	41081	474	0	0	445	96,628
WINONA	12	0	0	0	392	611	0	0	0	0	1,015
WRIGHT	4227	1	0	371	1271	1494	6	0	0	359	7,729
YELL. MEDICINE	0	0	0	0	72	30	0	0	0	23	125
Total	74288	5629	6048	96454	127495	122415	19144	7210	6106	2079	466,868

Other uses include:

w.p. mfgr for compo., children toys, pieces for woodworkers, smoking food, camp fire, burned outdoors, oil absorbent, glass cleaner, packing, recycling/reused and insulations.

III-I Estimation on Number of Secondary Wood Industries with Fewer than 50 Employees

Employee Size Class	Companies Reporting Wood Waste Data	Percent of Reporting Companies	Estimated Total Number of Companies
1-3	199	41.8%	429
4-9	132	27.6%	284
10-19	64	13.4%	138
20-49	82	17.2%	176
Total	**477**	**100%**	**1027**

Expanded to total number of companies statewide by:

1) assuming a total of 1100 companies
2) assuming all companies with more than 50 employees responded to surveys (63)
3) assumed remaining companies were distributed by size and location in the same ratio as those that responded to the survey.

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