Biomass Harvesting Guidelines for Forestlands, Brushlands and Open Lands

December 2007

The Minnesota Forest Resources Council (MFRC) has completed development of its biomass harvesting guidelines for forestlands, brushlands and open lands.

These new guidelines are designed to be included in the MFRC's 2005 forest management guidebook titled *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers.* The new biomass guidelines are presented as two additional chapters for the 2005 guidebook:

- Biomass Harvesting on Forest Management Sites
- Woody Biomass Harvesting for Managing Brushlands and Open Lands

Please insert the two enclosed chapters, with tabs, at the back of your 2005 loose-leaf guidebook (directly after the Appendices section). Insert this cover sheet directly before the Table of Contents (to become the fourth sheet in the guidebook).

For the sake of efficiency, and to avoid having to reprint multiple sections of the existing 2005 guidebook, the two new chapters are **not** integrated into the rest of the guidebook. Instead of updating the existing *Rationale, Resource Directory*, *Glossary* and *Appendices* with biomass harvest information, the two biomass harvest chapters include their own *Rationale, Additional Resources, Glossary* and *Appendices* sections.

In addition, the full guidebook Table of Contents, located at the beginning of the guidebook, has not been revised to reflect the two new chapters. Full integration of the new biomass harvest guidelines with the General Guidelines and activity-specific guidelines is expected to occur at the time of the next revision of the entire 2005 guidebook.

(continued on back)

While these new biomass chapters have not been integrated into the rest of the 2005 guidebook, the existing guidelines **have** been fully integrated into the two new chapters. The biomass harvest chapters include extensive references to both the *General Guidelines* and the *Timber Harvesting* guidelines.

As is the case with the rest of the activity-specific forest management guidelines in the guidebook (such as *Timber Harvesting* and *Forest Road Construction and Maintenance*), **it is essential that the biomass harvest guidelines be considered and implemented in close conjunction with the General Guidelines** (the green tabbed section of the guidebook) and, in some instances, the *Timber Harvesting* guidelines (the light blue tabbed section).

For additional hard copies of these two biomass harvest chapters, as well as copies of the entire 2005 *Guidelines*, call or email the Minnesota Forest Resources Council (651-603-6761 or mcine017@umn.edu), or visit the MFRC website (www.frc.state.mn.us) to download copies.

Biomass Harvesting on Forest Management Sites

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Biomass Harvesting on Forest Management Sites

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REMEMBER:

Guidelines help with how to manage, not whether to manage.

These guidelines focus on **how** to protect the functions and values of forest resources during woody biomass harvesting management activities. They generally **do not** provide advice on **whether** to manage or **which** management activities are needed. These guidelines do, however, recommend avoiding or modifying biomass harvest of some sites of statewide ecological significance or ecological sensitivity.

Guidelines provide a menu, not a mandate.

Site-level resource management decisions are based on many different factors, including resource needs, landowner objectives, site capabilities, existing regulations, economics and the best information available at any given time. **No one will apply all of the guidelines** related to a particular activity. Instead, the landowner, resource manager or logger will consider many different factors in determining which combination of guidelines provides the best "fit" for a particular site at a particular time. The intent of these guidelines is to provide a menu of site-level management practices that provide for the harvesting of woody biomass while ensuring the sustainability of forest resources in Minnesota.

General guidelines and activity-specific guidelines are closely related.

Frequent references from activity-specific guidelines back to the General Guidelines will make it easy for landowners, resource managers, loggers, biomass harvesters and others to consider all of the related guidelines—both general and specific—that apply to a particular management activity.

Guidelines are supplemented from time to time by "Additional Considerations."

The guidelines are supplemented from time to time by "Additional Considerations," which provide additional guidance to further promote sustainable forest resources.

INTRODUCTION

Interest in biomass energy in Minnesota has increased recently, driven by higher energy prices and state-supported incentives to produce renewable energy. While wood-fired energy facilities have been in operation in the state for quite some time, recent expansion of the energy industry has raised concerns about the impact of increased removal of biomass from the state's forests.

Examples of new capacity in the renewable fuels industry include such projects as the Laurentian Energy Authority municipal energy project on the Iron Range and the installation of a wood gasifier at the Central Minnesota Ethanol Cooperative in Little Falls. While the benefits of biomass energy are numerous, such as providing jobs locally and reducing use of fossil fuels, increasing removal of biomass from forested sites has the potential to impact long-term site productivity, biodiversity and wildlife populations.

In response to these concerns, the Minnesota State Legislature, as part of its legislation on energy production from woody biomass, directed the Minnesota Forest Resources Council (MFRC) and the Minnesota Department of Natural Resources (DNR) to develop guidelines or best management practices for *sustainably managed woody biomass,* as per Minnesota Statutes Chapter 216B, Section 2424 (M.S. § 216B.2424).

The legislation specifically states the following: "Guidelines …must be adopted...for logging slash, using the most recent available scientific information regarding the removal of woody biomass from forest lands, to sustain the management of forest resources as defined by Minnesota Statutes Section 89.001, Subd. 8 and 9, with particular attention to soil productivity, biological diversity as defined by Section 89A.01, Subd. 3, and wildlife habitat."

Biological diversity is defined in Section 89A.01, Subd. 3, as "the variety and abundance of species, their genetic composition, and the communities and landscapes in which they occur, including the ecological structures, functions, and processes occurring at all of these levels."

For the purposes of these guidelines, **biomass harvesting includes the process of collecting and removing woody biomass from forested sites.** In addition to the utilization of tops and limbs from trees harvested in a roundwood operation, biomass harvest **might** include the utilization of small-diameter trees or stems (which have historically been "non-merchantable"), dead trees (snags), down logs (coarse woody debris), brush and stumps. These guidelines generally recommend retaining coarse woody debris, snags and stumps, as well as some fine woody debris (tops and limbs) and some brush. See Figure BHF-1, page 7.

Biomass harvest removes more woody material from a site than would be removed under typical roundwood harvest. Often biomass harvesting is conducted in addition to roundwood harvesting on the same site, either in conjunction with the roundwood harvest or soon after. In addition, though, biomass harvest is also conducted on sites where a roundwood harvest is not occurring.

The Benefits of Guidelines

Benefits to cultural resources: Woody biomass harvesting guidelines, in conjunction with General Guidelines, can minimize the potential negative effects of harvesting activities, such as mixing of surface soils, rutting, compaction and erosion, which can damage certain kinds of cultural resources. Guidelines for construction of haul roads and landings, felling, skidding and slash management can help to protect cultural resources.

Benefits to soils: Woody biomass harvesting guidelines, in conjunction with General Guidelines, are designed to help protect the physical, chemical and biological properties of soils by minimizing the effects of soil compaction and rutting, erosion and nutrient removal that can result from woody biomass harvesting activities.

Benefits to riparian areas: Woody biomass harvesting guidelines, in conjunction with General Guidelines, minimize the alteration of vegetation within the riparian area. That vegetation is important for providing inputs of coarse and fine woody debris to water bodies; retaining nutrients, sediment and energy; stabilizing banks and shorelines; maintaining moderate water temperatures through shading; and providing wildlife habitat.

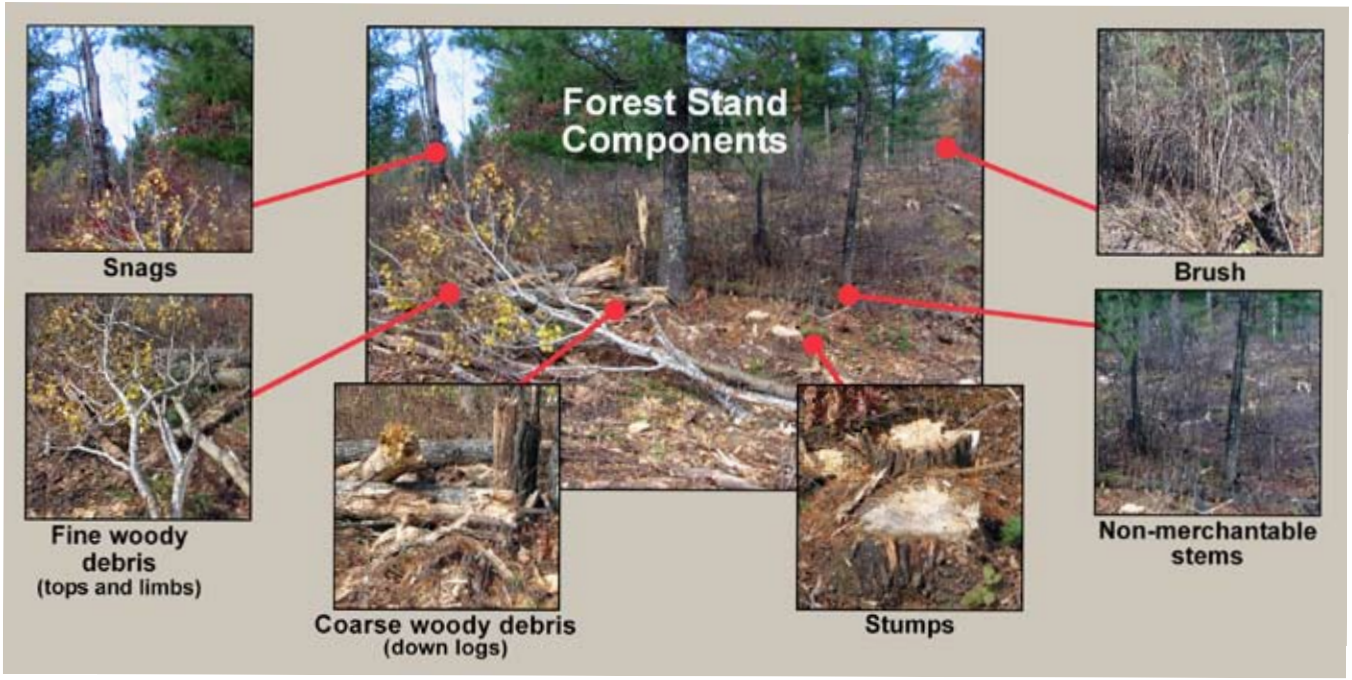


Figure BHF-1

The definition of biomass includes the following components of a forest stand: snags, tops and limbs, coarse woody debris, stumps, undersized or "non-merchantable" stems, and brush. The guidelines in this chapter generally recommend retaining coarse woody debris, snags and stumps, as well as some fine woody debris (tops and limbs) and some brush. *Photos courtesy of Minnesota DNR Forestry*

Benefits to water quality, water quantity and wetlands: Woody biomass harvesting guidelines, in conjunction with General Guidelines, are designed to protect water quality by minimizing potential nonpoint source pollution resulting from soil disturbance, disruption of vegetative cover, and biomass harvesting activities in close proximity to streams, lakes and wetlands.

Benefits to wildlife habitat: Woody biomass harvesting guidelines, in conjunction with General Guidelines, reduce the potential for biomass harvesting activities to disturb sensitive sites, rare species, water features and unique habitats. Guidelines are aimed at maintaining structural components of the site (including live trees, snags, fine and coarse woody debris, shrubs and ground cover) that are needed for forest wildlife both now and as the forest stand regenerates.

RATIONALE

Wildlife and Biodiversity

A general premise of forestry that considers wildlife and biodiversity is that silvicultural practices more closely resemble relevant natural disturbance regimes and natural stand development (Hunter 1999; Kohm and Franklin 1997). Furthermore, a greater opportunity exists for sustaining biodiversity when the disparity between managed stands and their natural analogs is reduced.

Biological legacies (see *Glossary*) are central to the development of silvicultural systems that emulate natural models. Creating and leaving biological legacies maintains critical structural elements of managed stands, thereby sustaining many organisms and ecological processes dependent upon these structures (Kohm and Franklin 1997).

Natural disturbances rarely eliminate all structural elements from the preceding stand, even in the case of extreme or multiple disturbances (Franklin et al. 1995, 2002; Foster et al. 1997). The lack of significant biological legacies is a major difference between traditional even-aged harvesting methods and natural stand replacement disturbances, whether by fire, wind or insects (Lee and Crites 1999).

Most prominent among the legacies lacking from harvested stands is remnant live trees, abundant snags and down trees (with associated pit-and-mound topography) (Franklin et al. 1995). Many roundwood harvesting strategies involve the removal of most large trees from a site, while natural disturbance, even fire, does not. Therefore, recent forest management guidelines, including the *MFRC Voluntary Site-Level Forest Management Guidelines,* include recommendations to maintain minimum amounts of snags and down logs. Biomass harvesting following roundwood harvest increases the disparity between managed stands and their natural analogs by removing additional coarse woody debris (CWD), as well as slash, thus further challenging natural resource managers to manage sustainably.

These biomass harvesting guidelines, in conjunction with existing forest management guidelines, attempt to incorporate natural disturbance patterns and processes into any harvesting scheme. This effort can be accomplished by 1) maintaining biological legacies through leave tree clumps, and 2) maintaining structural complexity throughout the harvest area by retaining a level of snags, down CWD and slash (or fine woody debris).

Role of woody debris in maintaining forest biodiversity

While an abundance of literature demonstrates the importance of standing and down CWD in providing habitat for vertebrate species, small life forms related to fine woody debris (FWD) have not been as well studied—particularly fungi, lichens, bryophytes and arthropods, which are central to the health and productivity of forest ecosystems (Crow 1988, 1990). Woody debris, both CWD and FWD, provides habitat for many of these species (Samuelsson et al. 1994).

Those relatively few studies of the importance of woody debris for invertebrates often reveal an immense diversity of species that require woody debris. For example, one three-year study in the Canadian boreal forest reported that 257 taxa (mostly species) of saproxylic beetles utilized decaying aspen logs (Hammond et al. 2004). Few studies, however, have quantified amounts of woody debris needed to maintain specific populations, much less whole communities.

Harvest of slash and other woody debris for biomass, as part of or following timber harvest, decreases the amount of decaying wood on forest landscapes and changes the chemical and physical environment in clearcuts (Astrom et al. 2005). Astrom also reported that slash harvests in Sweden significantly reduced the species richness of liverworts (with one-third of the species disappearing) but didn't affect the species richness of vascular plants (Astrom et al. 2005). In Finland, where biomass removals have occurred for a longer time, recommendations are to retain 30% of harvest residue in stands to help maintain biodiversity.

In clearcuts, benefits of slash or FWD include the following:

❒ It provides shelter, reducing wind velocity and fluctuations in ground surface temperature (Mahendrappa and Kingston 1994; Proe et al. 1994).

❒ It provides habitat for small mammals (Ecke et al. 2002) and ground-active beetles (Gunnarsson et al. 2004).

❒ It may shelter plants sensitive to desiccation immediately following clearcuts (cf. McInnis and Roberts 1994; Brakenhielm and Liu 1998).

With the development of a market for woody biomass, much of the CWD and slash (or FWD) that would have remained on site following timber harvest for roundwood is likely to be removed. Although a certain amount of woody debris retention is essential for sustaining biodiversity and wildlife populations, science does not tell us how much woody debris can be sustainably removed from forest harvest sites. (See photos on page 11.)

The science is clear, however, in confirming that natural disturbances create and retain considerably more woody debris than commercial timber harvests do, and that this difference is increased by woody biomass harvest. These guidelines provide a best scientific judgment, tempered by the consensus process among a broad group of forest management interests, related to practices that will sustain a high level of biodiversity.

These two photos demonstrate differing levels of biomass utilization after a timber harvest. The top photo depicts a roundwood harvest area in which all of the slash and CWD has been retained on the site. In contrast, the lower photo depicts a high level of biomass utilization, with most of the slash, CWD, snags and brush removed from the site. *Photos courtesy of Minnesota DNR Forestry*

Water Quality

The 2005 *MFRC Voluntary Site-Level Forest Management Guidelines* (2005 *Guidelines)* focus on retaining water quality by avoiding sediment and nutrient movement into wetlands and water bodies through the use of filter strips and water diversion practices. The 2005 *Guidelines* also focus on minimizing impacts to wetland form and function by avoiding direct damage to wetlands due to trafficking, drainage or filling.

Re-entry into timber havest sites increases the potential for sediment movement into wetlands through disturbance of erosion control features and rehabilitated infrastructure. The 2005 *Guidelines* do not address re-entry into sites for the purpose of recovering biomass. They also do not address the removal of stand components, such as small-diameter trees, CWD and brush within filter strips. Because increased biomass harvest activity in filter strips increases the potential for filter strip disturbance, consideration must be given to how much non-merchantable material and residual CWD should be harvested or retained in filter strips.

Riparian Management Zones

Riparian management zone (RMZ) guidelines included in the 2005 *Guidelines* deal with most issues related to harvest of biomass in or near RMZs. They do not, however, specifically address removal or disturbance of brush, small trees or CWD in RMZs.

Issues related to biodiversity mentioned in previous sections of this chapter have particular relevance to management within riparian zones. The 2005 *Guidelines* allow for harvesting of some trees in RMZs, and it seems reasonable to utilize the tops and limbs of these harvested trees. Removal of additional biomass, however, must be balanced with the protection of biodiversity in these special management zones.

Soil Productivity

These guidelines are designed to maintain the productive capacity of forest soils in Minnesota during biomass harvesting activities. Identifying and reducing negative impacts to soil resources should be an essential part of any strategy to achieve sustainable forest management.

In **most** cases, evidence suggests that, if the current site-level guidelines are followed, biomass harvesting will not create additional or increased physical impacts to soil productivity, as compared to conventional forest harvesting. Where biomass harvesting **may** create an increased impact, compared to conventional forest harvesting, is with respect to nutrient removals. Removing more biomass from a site inevitably removes more nutrients.

Nevertheless, even in the case of biomass harvesting, where more nutrients are removed than in conventional forest harvesting, new research, resulting in updated nutrient budgets, and the results of long-term studies indicate that, for most mineral soils in Minnesota, the nutrient capital is sufficient to tolerate a large number of such harvest rotations without harmful effects (Grigal 2004).

On deep organic soils (ombrotrophic sites), however, potassium and phosphorus depletion may occur if aggressive biomass removal is practiced over multiple rotations. Very shallow to bedrock mineral soils are also susceptible to nutrient loss. Based on current available information and technology, the guidelines outlined in this chapter will protect the nutrient capital of the average forested site in Minnesota.

The 2005 *Guidelines,* with respect to nutrient depletion, were developed using information in *Minnesota's Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota* (GEIS). The portion of the GEIS dealing with soils was completed in 1992, and nutrient budgets in the report were based on state-of-the-science information available at that time (Grigal and Bates 1992).

Since the GEIS was published, however, an update of the nutrient portion of the GEIS has been completed (Grigal 2004), based on research published since 1992. The 2004 update revisited assumptions used in the original GEIS and modified them based on current knowledge. Major changes included the following:

❒ Slightly modifying the magnitude of atmospheric inputs.

❒ Reducing the magnitude of nutrient inputs by weathering (by 2 to 3 times).

❒ Adding inputs via ground-water flow to organic soils (peatlands).

❒ Eliminating leaching of nutrients to ground water during the normal silvicultural rotation.

❒ Increasing the estimated removal of nutrients associated with merchantable bole harvesting and reducing the removal associated with whole-tree harvesting.

❒ Increasing nutrient capital for mineral soils by assuming uniform nutrient availability to 40 inches depth and by calculating release of nutrients from soil organic matter over 10 years rather than over one year.

❒ Altering nutrient capital for organic soils and forest floor by calculating release of nutrients from organic matter over 10 years.

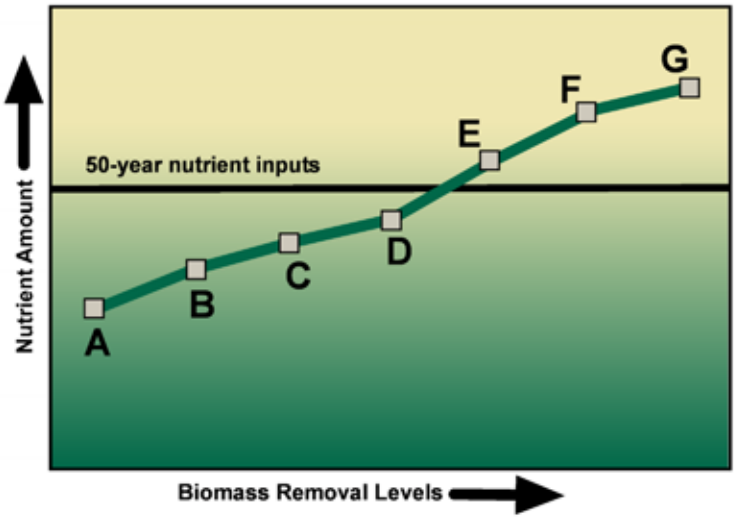
Specifically with respect to biomass harvesting, the update assumed that 100% of the logging residue would not be removed following conventional harvest. The material that remains would primarily be high-nutrient small branches and leaves. On average, about 25% of above-ground nutrients in the pre-harvest stand would be retained following residue removal, compared to about 40% retained following conventional harvest.

Future technology, however, may make it possible to remove much more of the woody material from sites, along with nutrients associated with that material. For example, Figure BHF-2 (see page 15) qualitatively compares the increasing removal of biomass and nutrients with the natural nutrient inputs estimated to occur over a rotation. Data are for harvest from the aspen-birch cover type, 50-year rotation, 20 cords-per-acre yield on an average Minnesota forest soil. As biomass removal increases, natural inputs are no longer sufficient to replace nutrients that have been removed, and depletion of the nutrient capital of the site will occur.

Figure BHF-2

Comparison of Biomass and Nutrient Removal Levels with Natural Nutrient Inputs
(typical aspen-birch cover, 50-year rotation, 20 cords/acre yield)

Note: The nutrient capital of an average Minnesota forest soil is about 20 times greater than that removed under Scenario "G."



This figure correlates relative amounts of nutrients removed with increasing biomass removal compared to natural nutrient inputs. Scenarios are for harvest from the aspen-birch cover type, 50-year rotation, 20 cords-per-acre yield, on an average Minnesota forest soil.

Scenario A: Conventional merchantable bole harvest
Scenario B: Whole-tree harvest (not including breakage and loss of tops and limbs that stay on the site)
Scenario C: Whole-tree harvest with an additional 50% of the remaining tops and limbs removed
Scenario D: Whole-tree harvest with removal of all tops and limbs
Scenario E: "D" harvest plus removal of all dead logs on forest floor
Scenario F: "E" harvest plus removal of all standing snags
Scenario G: "F" harvest plus removal of all brush

NOTE: Biomass harvesting guidelines in this chapter recommend that approximately one-third of FWD be retained on site, which represents a point close to nutrient removal in Scenario B.

Figure based on information from Grigal 2004

The nutrient capital of an average Minnesota forest soil is about 20 times that removed under Scenario G in Figure BHF-2; therefore, even that extreme scenario (G) would be unlikely to affect site productivity over multiple rotations. If the frequency of biomass harvest increases (decreased rotation age), accumulation of natural inputs between harvests will be less. For example, natural inputs over a 25-year period will be roughly half of natural inputs over a 50-year period. Depending on the amount of woody material being removed, the likelihood of negative impacts to site productivity over multiple rotations will increase with decreased rotation ages.

Nutrient storage in coarse-textured (sandy) soils is lower than in an "average" mineral soil. For example, the calcium capital for an average mineral soil in Minnesota is about 15,000 lb/ac, while that for coarse-textured soils is about half that amount, or 7,000 lb/ac. Even on these soils, however, only a small percentage of the system potassium and calcium would be removed in each 50-year rotation, including residue removal.

Some Minnesota soils, however, such as those that are very shallow over bedrock or are deep ombrotrophic peats, have much lower nutrient capital than the average soil. In the case of these soils, high levels of biomass removals are likely to negatively affect their productivity.

Soils provide an environment suitable for a vast array of plant and animal populations, ranging from microscopic bacteria to small mammals. Careful guideline implementation that sustains the physical and chemical characteristics of the soil will, in large part, maintain the biological characteristics of the soil.

Most biological activity in the soil, however, takes place in the surface soil or litter layers. Although surface soil and litter layers are a potential source of biomass, they are also extremely important to maintaining a wide variety of ecosystem functions, such as nutrient supply, erosion control, water retention and rooting medium. Therefore, surface soil and litter layers should not be removed without strong overriding silvicultural reasons. This is true for all sites, not just nutrient-sensitive sites.

Additional trafficking by biomass harvesting or collection equipment may increase physical impacts to the soil. Existing

guidelines—such as keeping equipment on trails and infrastructure, avoidance of rutting, and operating on frozen ground—should be adequate for biomass harvest, as well. Re-entry into the general harvest area of a site, however, to collect forest residue (slash) may be problematic and is therefore discouraged. Re-entry while operating equipment on existing infrastructure (roads and landings) is best. Any re-entry onto a site may impact regeneration and disturb rehabilitated infrastructure. Restoring erosion control features and rehabilitating infrastructure is necessary.

PLANNING, DESIGN AND OPERATIONAL ACTIVITIES

➤ **Have you considered the suitability of the site for biomass harvest, based on levels of habitat and species sensitivity?**

➤ **Have you identified your objectives?**
See *Identifying Goals and Objectives* in *General Guidelines* (pages 7-9).

➤ **Have you conducted a site inventory?**
See *Conducting a Site Inventory* in *General Guidelines* (pages 10-17).

➤ **IMPORTANT! For all activities, review and implement General Guidelines.**

In addition:

☛ **For all biomass harvest on forest sites,** review and implement guidelines in *Timber Harvesting,* except where identified or modified in this chapter.

☛ **If an access road will be constructed or used** on a biomass harvest site, review and implement guidelines in *Forest Road Construction and Maintenance.*

☛ **For timber stand improvement activities,** follow applicable guidelines in this chapter, as well as guidelines found in *Timber Stand Improvement.*

These guidelines combine planning and design activities with operational activities. This combined approach recognizes a commitment to resource sustainability related to both planning/design and operational considerations:

❒ **Planning guidelines** recognize that many considerations related to resource protection and sustainability are common to most management activities, and that the commitment to sustainability begins in the early planning stages—long before the actual management activity begins.

❒ **Operational guidelines** recognize that on-site activities carry out the commitment to sustainability that was begun during the planning phase.

Biomass Harvest on Sensitive Sites

☛ **Review existing guidelines:** Review *General Guidelines* and *Timber Harvesting* guidelines, especially those relating to checking for the presence of known endangered, threatened and special concern species (ETS), sensitive plant communities or cultural resources, including:

General Guidelines:
- Gathering Information (pages 10-11)
- Rare or Sensitive Species (pages 23-24)
- Protecting Cultural Resources (pages 68-69)

Timber Harvesting:
- Protecting Sensitive Areas (pages 20-21)

☛ **In addition:**

✔ **Avoid biomass harvesting in native plant communities listed in Appendix J.**

• To determine whether any of these native plant communities are known to occur on the site, consult with local DNR Forestry offices and/or the Minnesota County Biological Survey (MCBS) Native Plant Communities GIS (geographic information system) layers, which may be downloaded from the DNR Data Deli at http://deli.dnr.state.mn.us (GIS software and skills are necessary).

• **Biomass harvesting may still be appropriate** under the following conditions:

* If management plans specifically include strategies to maintain habitat for rare species and/or to restore degraded native plant communities.

* If biomass harvesting is used as a tool to restore degraded native plant communities (e.g., overgrown savanna plant communities). Consult appropriate DNR Ecological Resources regional plant ecologist.

* If biomass harvesting is used as a management tool to assist with ecological management of the native plant community (e.g., creating a fire break as part of burning a fire-dependent native plant community). Consult appropriate DNR wildlife manager and DNR regional plant ecologist.

✔ **Avoid biomass harvest within specific sites where plant or animal species listed as endangered or threatened** at the state or federal level are known to exist (e.g., sites identified in the DNR Natural Heritage Information System), or where such species are discovered during operations and where biomass harvesting would harm them (unless harvest has been demonstrated to maintain or improve habitat for these species).

- To determine whether these species are known to occur on the site, consult local DNR offices.

- If a bald eagle nest occurs on or near the site, see *Recommendations for Avoiding and Minimizing Impacts* at http://files.dnr.state.mn.us/natural_resources/animals/ birds/eagles/factsheet.pdf

The presence of an eagle's nest is one example of a sensitive site that should be taken into consideration when planning for and operating on a biomass harvest site. *Photo courtesy of Minnesota DNR Parks and Recreation*

✔ **Reference M.S. § 216B.2424 (Biomass Power Mandate)** and urge affected utilities to follow the statute as reference.

• M.S. § 216B.2424, Subd. 1a and f, directs that, for utilities specified within this statute, no woody biomass may be harvested from any lands identified by the final or preliminary Minnesota County Biological Survey as having statewide significance as native plant communities, large populations or concentrations of rare species, or critical animal habitat. See *Additional Resources* (page 35) to access complete statute online.

Managing Water Quality and Riparian Management Zones

☛ **Review existing guidelines:** Review *General Guidelines* and *Timber Harvesting* guidelines related to water quality and RMZ management, including:

General Guidelines:
- Water Quality and Wetlands (pages 22-23)
- Maintaining Filter Strips (pages 24-28)
- Managing Riparian Areas (pages 29-67)
- Protecting the Normal Flow of Streams and Wetlands (pages 71-72)
- Protecting Non-Open Water Wetlands and Seasonal Ponds (page 73)
- Managing Dry Washes in Southeastern Minnesota (pages 74-75)

Timber Harvesting:
- Water Quality and Wetlands (pages 30-31)

☛ **In addition:**

✔ **Avoid harvest of additional biomass from within RMZs over and above the tops and limbs of trees** normally removed in a roundwood harvest under existing timber harvesting guidelines.

✔ **Avoid additional biomass removal within 25 feet of a dry wash bank except tops and limbs of trees** normally removed in a roundwood harvest under existing timber harvesting guidelines, when managing near a dry wash in southeastern Minnesota.

Managing Soil Productivity

☛ **Review existing guidelines:** Review *General Guidelines* and *Timber Harvesting* guidelines relating to soil productivity, including infrastructure management, nutrient conservation and avoiding impacts to physical properties:

General Guidelines:
- Designing Operations To Fit Site Conditions (page 20)
- Managing and Minimizing Infrastructure (pages 20-21)

Timber Harvesting:
- Design Outcomes To Maintain Soil Productivity (page 10)
- Protecting Sensitive Areas (pages 20-21)
- Minimizing Rutting (page 28)

☛ **In addition:**

✔ **Avoid biomass harvesting (over and above bolewood utilization)** on organic soils deeper than 24 inches that are ombrotrophic.

- Ombrotrophic sites typically have more than 90% of the basal area in black spruce, with no alder or willow in the understory. These sites fit the Northern Spruce Bog (APn80) and Northern Poor Conifer Swamp (APn81) native plant communities, as described in *Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province*, Minnesota DNR, 2003. (See upper photo on page 23.)

✔ **Avoid biomass harvesting (over and above bolewood utilization)** on aspen or hardwood cover types on shallow soils (8 inches or less) over bedrock. (See lower photo on page 23.)

Photo at left: Avoid biomass harvesting (over and above bolewood utilization) on organic soils deeper than 24 inches that are ombrotrophic. This photo depicts an ombrotrophic site (APn80) in northern Minnesota. *Photo courtesy of Minnesota DNR Ecological Resources*

Photo at right: Avoid biomass harvesting (over and above bolewood utilization) on aspen or hardwood cover types on shallow soils (8 inches or less) over bedrock. This photo depicts a birch stand on shallow soil in northern Minnesota. *Photo courtesy of Minnesota DNR Ecological Resources*

✔ **Do not remove the forest floor, litter layer and/or root systems** for utilization as biomass.

- Some silvicultural prescriptions may call for disturbance of the forest floor, but removal of this material or piling should be avoided.

✔ **Plan roads, landings and stockpiles** to occupy no more than 1-3% of the site.

✔ **Avoid additional biomass harvest from erosion-prone sites** (e.g., those sites on steep slopes of 35% or more) over and above the tops and limbs of trees normally removed in a roundwood harvest under existing timber harvesting guidelines.

✔ **Ensure that landings or on-site areas used to store biomass are in a condition that favors regeneration** and growth of native vegetation and trees after use.

✔ **Install temporary erosion control devices,** such as straw bales, mulch or woody debris, to help stabilize soils prior to establishment of vegetative cover (see Figure ROAD-13 in *Forest Road Construction and Maintenance,* page 32). Take care to avoid introduction of invasive species in bales or mulches.

✔ **Encourage native seed mixes and avoid invasive species seed sources** when seeding roads and trails to stabilize exposed soils.

Additional Considerations

☛ **For soils with 8-20 inches of soil over bedrock and droughty sands,** consider that the recommended retention of one-third or more of fine woody debris (FWD) on the site benefits soil productivity as well as biodiversity. FWD should be distributed relatively evenly throughout the site rather than piled. (See also *Managing and Retaining Wildlife Habitat and Structural Diversity,* pages 27-29.)

☛ **Consider that biomass products piled on landings for the majority of one growing season** or longer will usually reduce natural regeneration.

Re-entry into Previously Harvested Sites To Retrieve Biomass

Residue from timber harvests and other forest management activities often remains piled on site after harvesting activities are completed. The preference is to remove biomass at the time of harvest. If re-entry is necessary, use caution to avoid reducing future forest regeneration and compromising infrastructure rehabilitation efforts.

This large slash pile is surrounded by aspen regeneration. Once regeneration has begun or planting has been completed, re-entry into the general harvest area should be avoided. *Photo courtesy of Minnesota DNR Forestry*

✔ **Avoid re-entry into the general harvest area** of a site with a second operation for the purpose of harvesting biomass once regeneration has begun or planting has been completed. (See photo above.)

✔ **If re-entry is needed** once regeneration has begun or planting has been completed, restrict traffic to existing infrastructure.

✔ **Re-establish erosion control measures** on roads and landings, including vegetative cover and water diversion devices, after re-entering a site for biomass harvest.

✔ **Avoid re-entry of sites across non-frozen wetlands.**

Additional Consideration

☛ **Retain slash piles that show evidence of use by wildlife.** Piles left on site for an extended period may be inhabited by species such as Canada lynx, black bears and other wildlife known to den in slash piles. In addition, consider retaining slash piles that are difficult to access. (See photo below.)

This black bear den has been established in a large pile left from a debarking operation. *Photo courtesy of Minnesota DNR Forestry*

Managing and Retaining Wildlife Habitat and Structural Diversity

☛ **Review existing guidelines:** Review and incorporate leave tree, snag and CWD guidelines in *General Guidelines* and *Timber Harvesting*:

General Guidelines:
- Retaining Leave Trees (live trees) (pages 75-78)
- Providing Coarse Woody Debris (pages 79-80)

Timber Harvesting:
- Snags (standing dead trees) (page 33)
- Leave Trees (live trees) (pages 33-40)

The intent of these biomass harvesting guidelines is to leave all pre-existing CWD and snags possible. For exceptions, see *General Guidelines* and *Timber Harvesting* guidelines:

General Guidelines:
- Retaining Leave Trees (live trees) (page 78)
- Providing Coarse Woody Debris (page 80)

Timber Harvesting:
- Snags (standing dead trees) (page 33)
- Leave Trees (live trees) (pages 38-39)

☛ **Of particular importance are the following General Guidelines:**

✔ **Leave all snags possible** standing in harvest areas.

- Snags cut for safety reasons should be left where they fall.

✔ **Retain and limit disturbance to all pre-existing CWD** (except in skid trails or landings).

☛ **In addition:**

✔ **Retain stumps** and uprooted stumps.

✔ **In filter strips, avoid removal of pre-existing CWD material** from the forest floor.

✔ **Avoid biomass harvest in leave tree clumps,** except tops and limbs of trees normally removed in a roundwood harvest under existing *Timber Harvesting* guidelines (see *Timber Harvesting*, pages 33-40).

✔ **Avoid biomass harvest from within RMZs,** except tops and limbs of trees normally removed in a roundwood harvest under existing *Timber Harvesting* guidelines.

✔ **Retain and scatter tops and limbs from 20% of trees harvested** in the general harvest area (one "average-sized" tree out of every five trees harvested).

✔ **Avoid removing FWD resulting from incidental breakage** of tops and limbs in the general harvest area.

✔ **If harvesting brush and small trees for biomass associated with a timber harvest,** leave 20% of this material on the site. This material may be run over or cut, but it should remain on the site. (See photo on page 29.)

Retaining Fine Woody Debris: The Overall Goal

The overall goal of FWD retention is to retain about one-third of the FWD on a site. This goal is achieved by intentionally retaining 20% of the FWD (tops and limbs from one "average-sized" tree out of every five trees harvested), with an additional 10-15% achieved by incidental breakage during skidding. (Usually, more breakage occurs in winter than in summer.) When implementing FWD retention guidelines, specific operations may vary depending on the type of equipment used. Two examples:

- **When using a cut-to-length system,** tops and branches from one "average-sized" tree out of every five should be processed and left on the site. Tops and limbs from the remaining four trees could be piled for utilization as biomass.

- **When using a full-tree skidding operation,** the tops and limbs from one "average-sized" tree out of every five processed at the landing should be hauled back and redistributed over the general harvest area.

Brush retained on a harvest site may be run over (as seen in the left half of the photo), or it may be left standing (as seen in the right half of the photo). *Photo courtesy of Minnesota DNR Forestry*

Biomass Harvest for Fuel Reduction

Use these guidelines when harvesting understory vegetation for purposes of wildfire fuel reduction. It may be necessary to modify biomass utilization in some cases, such as on sites with excessive fuel loading or urban interface situations.

✔ **Retain understory vegetation in several reserve patches** that total at least 20% of the harvest area.

- Reserve patches should represent soil moisture conditions within the harvest area. (See Figure BHF-3 on page 31.)

✔ **Retain snags greater than 12 inches DBH and down logs** where at least one end is greater than 12 inches in diameter and 6 feet in length. Place emphasis on retaining only larger snags and pre-existing CWD, because these larger fuels do not contribute as much to the initial speed and flame length of a wildfire.

✔ **Modify management activities to maintain, promote or enhance ETS species** (endangered, threatened or special concern) on the site.

POST-OPERATIONAL ACTIVITIES

➤ **IMPORTANT! Review General Guidelines:**
Post Operational Activities and Followup Visits (pages 80-81)

In addition to the *General Guidelines*:

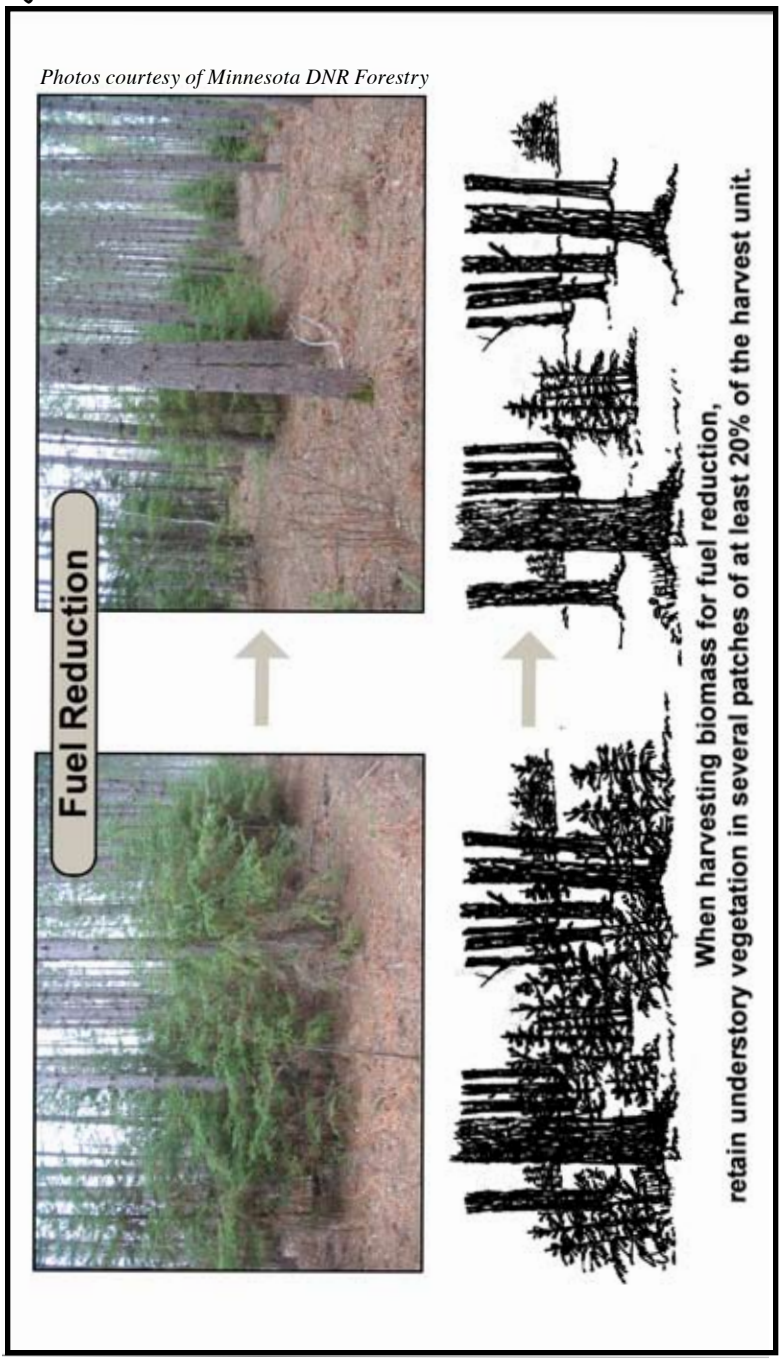
✔ **Evaluate the harvest operation and plan future adaptations** at post-harvest conferences with the logger and landowner.

✔ **Plan for removal of equipment and cut material** from wetland areas at the end of the winter season prior to thawing.

✔ **Avoid removing soil from the general harvest area** to rehabilitate roads, landings and skid trails. Use already disturbed soil, if needed, rather than disturbing additional soil.

✔ **Rehabilitate landings and skid trails,** when necessary, to mitigate soil compaction and reduce erosion.

Figure BHF-3


Photos courtesy of Minnesota DNR Forestry
Fuel Reduction
When harvesting biomass for fuel reduction,
retain understory vegetation in several patches of at least 20% of the harvest unit.

BIOMASS HARVEST AS A TOOL FOR SILVICULTURE MANAGEMENT

Harvesting of biomass may provide an excellent tool to help accomplish various silvicultural management objectives on many sites. On other sites, however, biomass harvesting may not fit within management strategies or facilitate silvicultural objectives. It may be necessary to modify utilization standards and harvesting techniques to fit site conditions and management objectives.

The following examples demonstrate how biomass harvest may or may not help accomplish management objectives (these are generalized examples intended to stimulate critical thinking; **they are not intended to be specific guidelines):**

Swamping: Removal of live woody vegetation may temporarily increase the wetness of some sites due to decreased transpiration, which may increase the chances of poor regeneration. When harvesting lowland hardwood stands, consider retaining understory vegetation and non-merchantable stems. Retention of transpiring vegetation reduces the potential for "swamping" of some sites.

Artificial regeneration: If planning for artificial regeneration of a site, consider biomass harvesting as a means of preparing or improving a site for planting. Removal of biomass from a site can reduce the need for some site preparation practices, such as brush raking or shearing.

Browse deterrent: Consider the use of heavy slash or strategically placed slash as a deterrent to browsing by large ungulates (deer and moose). For example, when working in oak stands with the goal of natural oak regeneration, consider leaving heavy oak tops and branches that form a "cage"-type structure when felled to the ground. This technique has been shown to reduce deer browse within the "cage" and increase survival of oak regeneration from seed. Heavy slash loads (even on clearcut sites) can be used as a deterrent to browsing.

Natural regeneration: If planning natural regeneration of conifers from seed (especially serotinous cones), consider modifying biomass harvest by retaining all or some cone-bearing slash to provide a seed source. Timing of harvest, site conditions and species being managed for will influence strategies. In some cases, prior removal of understory brush (such as hazel or balsam fir) may facilitate natural regeneration by removing competition and scarifying the seedbed.

Bark beetles: Biomass harvesting may promote management strategies for insect and disease control. For example, consider the utilization of slash and non-merchantable stems in red pine thinnings to prevent bark beetle buildups. In red pine harvests, biomass removals could benefit nearby and residual pines by preventing or mitigating bark beetle populations. Take care, however, to avoid damage to residual trees by biomass and harvesting machinery that would negate this benefit.

Removal of fresh slash and non-merchantable stems, along with logs from abandoned piles and log decks on harvested sites, will prevent bark beetle buildup during the following season. Complete all removals by June 1. If necessary, during the late spring or summer, directly control bark beetle populations by harvesting the infestation pockets, removing slash and non-merchantable stems on the site, and removing logs from abandoned piles and log decks.

Complete removals within three weeks of initial cutting. Do not permit biomass retrieval at this critical time of year if the activity is likely to cause wounding of red pine stems or root systems.

Thinning stands: Many plantations may benefit from pre-commercial thinning, before individual stems are large enough to provide traditional roundwood products. Consider biomass harvest as a means of marketing early thinnings in these plantations.

For example, some studies show that thinning white spruce plantations at age 25 yields the best growth response in the residual stand, but typically there is not enough pulp volume

at that age to make a commercial sale. Biomass harvesting may provide a commercial avenue to encourage thinning in these stands. Benefits of early thinning of stands include better growth and form of residual crop trees and improved in-stand structure for some wildlife species. Damage to residual stems and root systems should be avoided.

Utilization of biomass in this pine thinning will help prevent bark beetle buildup, as well as provide potential markets for previously non-merchantable stems. *Photo courtesy of Minnesota DNR Forestry*

ADDITIONAL RESOURCES

Minnesota state statutes, laws and rules

General:

www.leg.state.mn.us/leg/statutes.asp

www.revisor.leg.state.mn.us/

Biomass Power Mandate: Go to www.leg.state.mn.us/leg/statutes.asp and enter *216B.2424* under *Retrieve a section*.

Sustainable Forest Resources Act, Chapter 89A: Go to www.leg.state.mn.us/leg/statutes.asp and search for Chapter 89A in *Table of Chapters*.

Assessment of the Minnesota Timber Harvesting GEIS

Minnesota Timber Harvesting GEIS: An Assessment of the First 10 Years, August 2005, is available as Paper #182, along with other University of Minnesota staff papers, at http://fr.cfans.umn.edu/publications/staffpapers/

Remaining woody residue after typical timber harvest

Minnesota Logged Area Residue Analysis: This report summarizes the results of data collected on woody logging residue remaining on timber harvest sites across Minnesota. The report includes tables with estimates of average harvest acreage by county and forest type. The report is available at www.dnr.state.mn.us/forestry/um, under *Information and Reports on Forest Resources and Wood Use.*

Potential markets for woody biomass

Potential markets, including a directory of primary and secondary forest products in Minnesota: www.dnr.state.mn.us/forestry/um under *Wood Industry Directories.*

The MarketPlace Bulletin: www.dnr.state.mn.us/publications under *Division publications.*

Woody biomass resources and opportunities in the emerging energy industry

For additional information, refer to *Minnesota's Woody Biomass Resources and Opportunities in the Emerging Energy Industry,* a paper written by Bill Berguson, University of Minnesota, Natural Resources Research Institute, Duluth, Minnesota.

Go to www.blandinfoundation.org. Click on *Public Policy & Engagement*; then click on *Vital Forests/Vital Communities*; then click on *Conferences & Events*; then click on *Seizing Opportunity: Forestry and the BioEconomy*; and then look for *Informing Report: Minnesota's Woody Biomass Resources and Opportunities in the Emerging Energy Industry.*

Minnesota DNR Ecological Classification System

For additional information, including descriptions of Native Plant Communities (NPCs), visit www.dnr.state.mn.us/ecs

GLOSSARY

Biological legacy: Anything handed down or carried over from a predisturbance forest ecosystem, including green trees, patches of undisturbed vegetation, surviving propagules and organisms (e.g., buried seeds, seeds stored in serotinous cones, surviving roots, basal buds, mycorrhizal fungi and other soil microbes, invertebrates and mammals), dead wood, and certain aspects of soil chemistry and structure. (Source: Kohm, K. A., and J. F. Franklin, *Creating a Forestry for the 21st Century: The Science of Ecosystem Management.* Island Press, Washington, D.C.)

Biomass: The organic materials produced by plants, such as leaves, roots, seeds and stalks. In some cases, microbial and animal metabolic wastes are also considered biomass. The term *biomass* is intended to refer to materials that do not directly go into foods or consumer products but may have alternative industrial uses. Common sources of biomass are (1) agricultural wastes, such as corn stalks, straw, seed hulls, sugarcane leavings, bagasse, nutshells, and manure from cattle, poultry and hogs; (2) wood materials, such as wood or bark, sawdust, timber slash and mill scrap; (3) municipal waste, such as waste paper and yard clippings; and (4) energy crops, such as poplars, willows, switchgrass, alfalfa, prairie bluestem, corn (starch) and soybean (oil). (Source: *McGraw-Hill Encyclopedia of Science and Technology*, 5th edition, The McGraw-Hill Companies, Inc.)

Coarse woody debris (CWD): Stumps and fallen trunks or limbs of more than 6-inch diameter at the large end.

Fine woody debris (FWD): Tops, limbs and woody debris of less than 6-inch diameter at the large end.

Ombrotrophic: A condition where minerals and nutrients are received solely from precipitation and dust fall, not from runoff or ground water; characteristic of bogs. (Source: Minnesota DNR *Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province,* 2005)

Roundwood harvest: Roundwood harvest refers to a timber harvest where only the main stems of trees are removed from the site. For purposes of this definition, *main stem* refers to those parts of the tree that meet the utilization standards for pulpwood, posts, bolts or sawtimber, as described in the Minnesota Department of Natural Resources Division of Forestry *Timber Sales Manual,* 1998, as amended May 1, 2005, and the Minnesota Department of Natural Resources *Timber Scaling Manual*, 1981, as amended May 1, 2005 (see brief description directly below), **except** woody material that is intentionally cultivated, harvested and prepared for use, in whole or in part, as a fuel for the generation of electricity **or** (1) brush, trees and other biomass harvested from within designated utility, railroad and road rights-of-way; (2) upland and lowland brush harvested from lands incorporated into brushland habitat management activities of the Minnesota Department of Natural Resources; and/or (3) upland and lowland brush harvested from lands managed, as per state statute, in accordance with the Minnesota Forest Resources Council's *Woody Biomass Harvesting for Managing Brushlands and Open Lands* in *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers.*

Description of Utilization Standards from the Minnesota DNR Division of Forestry *Timber Sales Manual:*

F.3.1 Top Diameters:

Each species/product must be utilized down to a minimum merchantable top diameter outside bark (dob) as follows:

- 3 inches for cordwood material (all species)
- 6 inches for sawtimber (conifers, aspen, balm of Gilead, birch)
- 10 inches for sawtimber (other hardwoods)

Appraisers may apply more restrictive top-diameter standards based on local markets. For example, in areas with hardwood pallet markets, sales with the appropriate quality of wood could be marketed with the statement: "This permit contains hardwoods suitable for processing at sawmills down to a six (6) inch minimum top diameter outside bark." In this case, the minimum top diameter for hardwood saw logs would be set to 6 inches on the permit appraisal.

Sustainably managed woody biomass: For purposes of biomass guideline development and in accordance with M.S. § 216B.2424 Subd. 1 (d), *sustainably managed woody biomass* is defined as: (1) brush, trees, and other biomass harvested from within designated utility, railroad, and road rights-of-way *[Note: Guidelines will not be developed for this category of biomass];* (2) upland and lowland brush harvested from lands incorporated into brushland habitat management activities of the Minnesota Department of Natural Resources; (3) upland and lowland brush harvested from lands managed in accordance with the Minnesota Forest Resources Council's *Woody Biomass Harvesting for Managing Brushlands and Open Lands;* (4) logging slash or waste wood that is created by harvest, by pre-commercial timber stand improvement to meet silvicultural objectives, or by fire, disease, or insect control treatments, and that is managed in compliance with the Minnesota Forest Resources Council's *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers,* as modified by the requirement of this subdivision; and (5) trees or parts of trees that do not meet the utilization standards for pulpwood, posts, bolts, or sawtimber as described in Minnesota Department of Natural Resources Division of Forestry *Timber Sales Manual*, 1998, as amended as of May 1, 2005, and the Minnesota Department of Natural Resources *Timber Scaling Manual*, 1981, as amended as of May 1, 2005, except as provided by M.S. § 216B.2424–Biomass Power Mandate, Subdivision 1, in paragraph (a), clause (1)—"[biomass that] is intentionally cultivated, harvested, and prepared for use, in whole or in part, as a fuel for the generation of electricity"—and this paragraph, clauses (1) to (3).

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