

17.0 Afforestation

Definition: Practices that mimic the natural regeneration process of restoring forests to the landscape from herbaceous conditions by selectively planting woody species into existing or planted herbaceous cover to enhance the process.



These areas can be positioned on the landscape for retention of sediment and nutrients as well as improving the microclimate, such as providing shade, and habitat complexity. This practice is intended to be carried out on relatively natural soil and not on filled lands. These soils should have a seasonal high water table of greater than 12 inches from the soil surface; that is, the area could be documented as uplands. To provide for adequate rooting of woody species the minimum soil depth should be 4 feet. These areas should receive little management with a goal of establishing a good, brushy land cover in a few growing seasons. As illustrated in Figure 17.1, full establishment of a mature forest can take decades. However, even a young forest provides hydrologic benefits which can be realized in a relatively short time.

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Design variants for Afforestation include:

■ 17-A. Afforestation

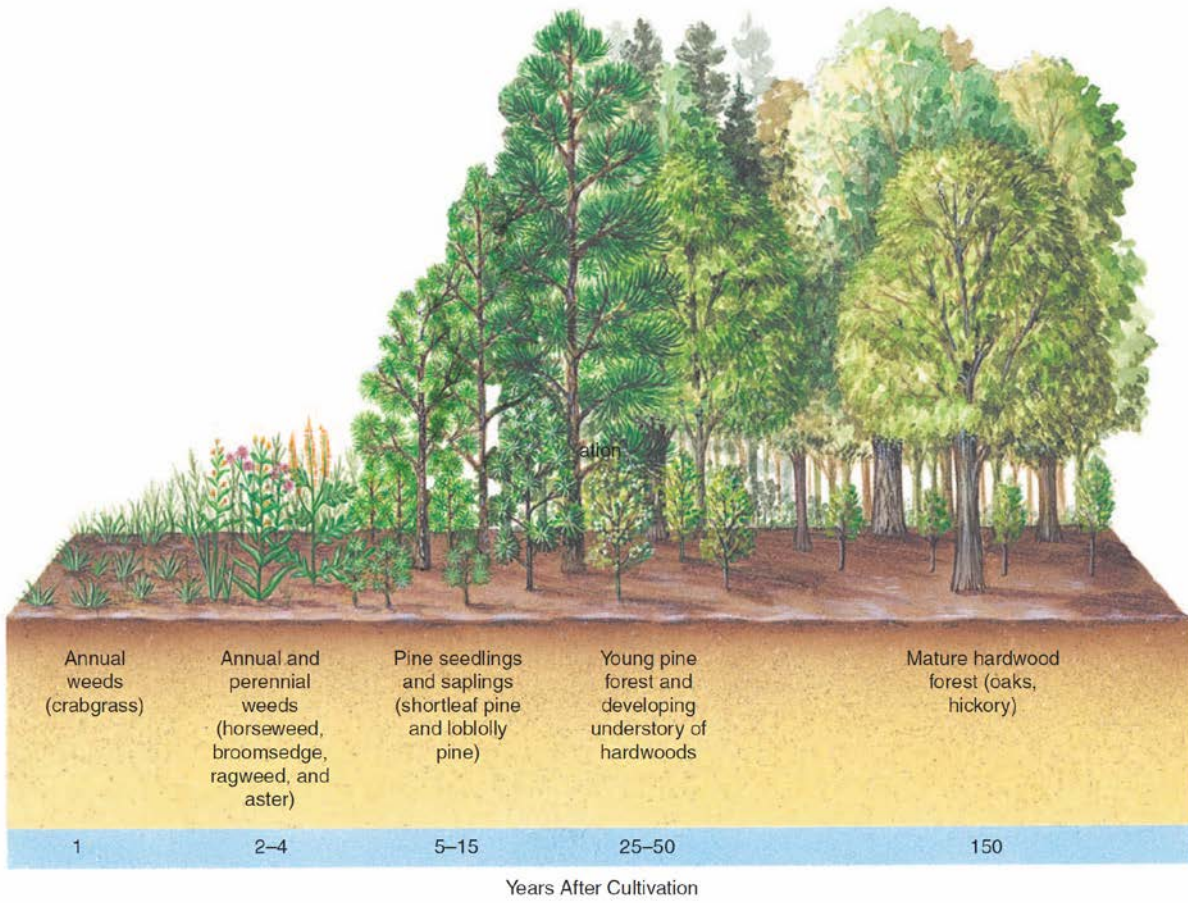


Figure 17.1 Secondary Succession Time Scale

17.1 Afforestation Credit Calculations

Afforestation can be used as both a runoff reduction practice by converting non-forested areas to forested areas as well as a mitigation practice for offsetting the clearing of forested areas during the development process. Table 17.1 summarizes the runoff reduction allowances for the R_{Pv}, C_v and F_v when afforestation is used as a runoff reduction practice. Credit as a mitigation practice shall be consistent with the offset requirements of the Delaware Sediment & Stormwater Regulations.

Table 17.1 Afforestation Performance Credits

<u>Runoff Reduction</u>	
<u>Retention Allowance</u>	<u>0%</u>
<u>R_{Pv}</u>	<u>TBD on Case-by-Case Basis*</u>
<u>C_v</u>	<u>TBD on Case-by-Case Basis*</u>
<u>F_v</u>	<u>TBD on Case-by-Case Basis*</u>
<u>Pollutant Reduction</u>	
<u>TN Reduction</u>	<u>TBD on Case-by-Case Basis**</u>
<u>TP Reduction</u>	<u>TBD on Case-by-Case Basis**</u>
<u>TSS Reduction</u>	<u>TBD on Case-by-Case Basis**</u>

*Credit based on runoff reduction from open space (good) condition to wooded (good) condition.

**Pollutant reduction credit based on load reduction from R_{Pv}.

17.2 Afforestation Design Summary

Table 17.2 summarizes design criteria for afforestation areas. For more detail, consult Sections 17.3 through 17.7. Sections 17.8 and 17.9 describe afforestation implementation and maintenance criteria.

Table 17.2 Afforestation Design Summary

<u>Feasibility</u> (Section 17.3)	<u>Relatively undisturbed soil</u> <u>Upland setting, depth to seasonal high water table should be greater than 12 inches</u> <u>Minimum depth to bedrock should be 4 feet</u> <u>During the first 10 to 15 years the vegetation will be thick with limited sight distance and this may be a safety concern.</u>
<u>Conveyance</u> (Section 17.4)	<u>NA</u>
<u>Pretreatment</u> (Section 17.5)	<u>NA</u>
<u>Design</u> (Section 17.6)	<u>0-8% slope, min. 2500 SF, min. width 35 feet</u> <u>+8% slope, min. 10000 SF, min. width 50 feet</u> <u>200 live woody plants per acre after two growing seasons</u>
<u>Landscaping</u> (Section 17.7)	<u>Consider development plan and utilities</u> <u>Designed by a knowledgeable individual</u> <u>Minimal long-term management, but must address invasive species</u> <u>At least 70% ground cover after the second growing season</u>

17.3 Afforestation Feasibility Criteria

Soils. These planting areas should be sited on relatively undisturbed soil in uplands. Depth to seasonal high water table will be greater than 12 inches and the minimum depth to bedrock will be 4 feet.

Community and Environmental Concerns. During the first 10 to 15 years the planting will grow into a thick vegetated condition. There will be limited sight distance and this may be a safety concern.

17.4 Afforestation Conveyance Criteria

Not Applicable.

17.5 Afforestation Pretreatment Criteria

Not Applicable

17.6 Afforestation Design Criteria

Afforestation plans should be designed by a qualified individual. Examples include individuals with a degree in Forestry (or related Science), landscape architects, certified arborists and horticulturists or other disciplines that possess the necessary knowledge, skills and training.

Afforestation areas should be reviewed and adjusted in relation to proposed site development plans. Where the slope of the afforestation area is 0 to 8 percent, the minimum area shall be 2500 square feet (SF) with a minimum width of 35 feet. If the slope of the land is greater than 8 percent the minimum area shall be 10,000 SF with a minimum width of 50 feet. The long dimension of the area should be perpendicular to the slope.

Soils in the proposed afforestation area shall have a seasonal high water table greater than 12 inches from the soil surface; this is meant to be an upland area. To provide adequate rooting depth, minimum depth to bedrock should be 4 feet.

A long-term goal for these areas would be to support at least 100 trees or woody species per acre; at least 50 percent of those individuals have the potential, in seven years, of growing to a diameter at breast height (DBH) of 2 inches. Planting of woody species is meant to supplement the likely volunteer individuals if the afforestation area is within 150 feet of mature, native seed trees. Where volunteers are less likely, a planting density shall be at a minimum 400 seedlings per acre. At the end of the second growing season there must be at least 200 live, planted and/or volunteer, woody individuals. This level of planting addresses both mortality and the potential for volunteers toward the long term goal of 100 woody plants per acre, given that the onsite monitoring will be limited. Invasive and/or exotic species need to be controlled especially if planting is to occur in an area already stabilized by a vegetative cover. Reference **Appendix 2 – Landscaping Guidelines** for additional afforestation planting and maintenance specifications.

17.7 Afforestation Landscaping Criteria

These areas can be positioned on the landscape for retention of sediment as well as improving the microclimate, such as providing shade, and habitat complexity. Afforestation areas should be reviewed and adjusted in relation to proposed site development plans including contact with Miss Utility. Afforestation adjacent to existing wooded areas or water bodies, including wetlands, can increase habitat quality. These plantings can also serve as visual screens and buffers to absorb air borne pollutants. The following is a list of recommended tree species for different physiographic regions in Delaware:

Outer (Southern) Coastal Plain

1. White oak: *Quercus alba*
2. Scarlet oak: *Quercus coccinea*
3. Hackberry: *Celtis occidentalis*
4. Tulip poplar: *Liriodendron tulipifera*
5. Loblolly pine: *Pinus taeda*
6. Flowering dogwood: *Cornus florida*
- 7 Persimmon: *Diospyros virginiana*
8. Eastern red cedar: *Juniperus virginiana*
9. Pawpaw: *Asimina triloba*
10. Staghorn sumac: *Rhus typhina*

Inner (Northern) Coastal Plain

1. White oak: *Quercus alba*
2. Black oak: *Quercus velutina*
3. Hackberry: *Celtis occidentalis*
4. Tulip poplar: *Liriodendron tulipifera*
5. American holly: *Ilex opaca*
6. Flowering dogwood: *Cornus florida*
- 7 Redbud: *Cercis canadensis*
8. Eastern red cedar: *Juniperus virginiana*
9. Southern bayberry: *Morella cerifera*
10. American hazelnut: *Corylus americana*

Piedmont

1. Chestnut oak: *Quercus prinus*
2. Red oak: *Quercus rubra*
3. Hackberry: *Celtis occidentalis*
4. American linden: *Tilia americana*
5. White pine: *Pinus strobus*
6. Flowering dogwood: *Cornus florida*
- 7 Redbud: *Cercis canadensis*
8. Eastern red cedar: *Juniperus virginiana*
9. American witch-hazel: *Hamamelis virginiana*
10. Northern bayberry: *Morella pensylvanica*

The afforestation plan should include a minimum of five (5) different species selected from the appropriate list above. Suitable substitutions are permitted depending upon availability at the time of planting. Planted species should supplement potential volunteer species from nearby seed trees. Refer to **Appendix 2 – Landscaping Guidelines** for additional plant selection guidance. These are not intended to be highly managed areas. As result, multiple inspections are needed for

the first two years with annual inspections thereafter to identify necessary maintenance activities.

Minimize soil disturbance in planting areas whenever possible to increase the chance of success and minimize the need for soil amendments. A combination of nursery material and natural regeneration can be used to provide a greater diversity of species. Plants need to be selected based on site drainage conditions. Seedling planting is quicker and may be less expensive than larger stock. However, the planting density must account for mortality, which over time can result in more random arrangement of the trees. Plantings that include larger tree stock can result in quicker habitat diversity. A ground cover of herbaceous species should be included to minimize sediment generation by rapidly establishing vegetative cover. At the end of the second growing season there must be at least 70 percent ground coverage.

17.8 Afforestation Construction Sequence

Step #1

Conduct a soil test for the proposed afforestation area. Soil amendments are not typically required with this practice unless the soil test indicates low fertility. If the soil test indicates low organic matter content, the designer may consider the addition of compost materials (see **Specification 14. Soil Amendments**). Incorporation of organic material prior to planting will improve the moisture and nutrient holding capacity of the soil and the success of the planting.

Step #2

If the area does not have established vegetation, immediately prior to planting, the afforestation area should be seeded with annual ryegrass at the rate of 10 lbs. per acre and switchgrass (*Panicum virgatum*) at the rate of 15 lbs. per acre, in order to establish suitable groundcover. For existing cover, in the fall prior to spring planting, the afforestation area should receive an herbicide treatment for invasive plant control followed by subsequent mowing to minimize herbaceous vegetation competition.

Step #3

Afforestation planting should occur during the first spring planting window after the approval of the sediment and stormwater plan. The sizes and types of plantings shall be in accordance with the planting schedule developed for the site. Installation should be at random throughout the planting areas. Shrubs may be planted in clusters. Each transplant should receive a surface application of mulch at the time of planting. Spring planting will often eliminate the need for watering at the time of planting.

Construction Reviews: These are necessary to the success of any phase of a project and planting is not exempt: Pre-construction meeting; Planting Phase (with designer and labor); and Final Review (check list of corrections for acceptance).

17.9 Afforestation Maintenance Criteria

Following planting, a period of maintenance and monitoring will begin. The afforestation planting will be considered successful if the survival of seedlings at the end of the second growing season is at least 200 live, planted and/or volunteer, woody individuals per acre. Further, at the end of the second growing season there must be at least 70 percent ground coverage.

An Operation and Maintenance Plan for the project shall be approved by the Department or the Delegated Agency prior to project closeout. The Operation and Maintenance Plan shall specify the property owner's primary maintenance responsibilities and authorize the Department or Delegated Agency staff to access the property for maintenance review or corrective action in the event that proper maintenance is not performed. Afforestation areas must be located in common areas, community open space, community-owned property, jointly owned property, or within a recorded easement dedicated to public use. Maintenance of afforestation areas is driven by annual maintenance reviews that evaluate the condition of the vegetation. Operation and Maintenance Plans should clearly outline how vegetation in the afforestation area should be managed or harvested in the future. Mature trees increase timber resources and could be harvested to provide income and improve stand and habitat quality. Inclusion of invasive plant control actions early in the establishment of the afforestation area is critical. Based on maintenance review results, specific maintenance tasks may be required. Additional reviews are required during the first two years of establishment.

First Two Years:

The proposed forestry type planting should be done during the early spring to avoid immediate needs for watering after initial watering at the time of planting. Weed and invasive plant control should be done prior to planting so as to control competing vegetation. In addition, to retain soil moisture a mulch collar should be provided at the time of planting. Following initial planting an environmental or forestry consultant working on behalf of the owner should make an assessment of the need for seasonal mowing necessary to reduce the height of or to control competing vegetation to be undertaken on or about June 1 of the first growing season and June 1 and October 15 of the second growing season. The need for watering should be assessed on a monthly basis during the growing season by the environmental or forestry consultant. In addition, between the period of September 1 and September 30, the environmental or forestry consultant should assess the survival rate of transplants and determine the necessity for reinforcement planting the following spring. Reinforcement planting should be conducted in the event that losses during the first growing season exceed 35 percent mortality based on the planting density.

Utilizing the strategy of adaptive management in the event of excessive mortality, the owner and his environmental consultant should evaluate mortality with respect to species and losses from disease, pests or predators. If required to meet afforestation success goals, additional techniques such as the use of other species or the use of tree shelters may be instituted in consultation with

and approved by the Department or the Delegated Agency. The inspection should consider the success, progress or failure of the afforestation planting including all necessary remediation measures undertaken.

Annual, On-going Maintenance:

Managing vegetation is an important ongoing maintenance task. Thinning or harvesting operations should be scheduled to occur approximately 5 and 10 years after the initial planting to improve stand and habitat quality. Reference the Landscape Plan for additional requirements. Occasional mowing, as described above, may be needed early on to minimize competition and aid in the establishment of the woody species. Invasive plant control will be an on-going activity.

17.10 References

Delaware Code, Title 3, Ch. 10, Subchapter V, Delaware Seed Tree Law.

Delaware Department of Agriculture, Forest Service, Forestry Best Management Practices to Protect Delaware's Water Quality, October 2006.

Maryland Department of Natural Resources, State Forest Conservation Technical Manual, 3rd Edition, 1997

Thomson, Fiona J., et al. (2011) Seed dispersal distance is more strongly correlated with plant height than with seed mass. *Journal of Ecology*, **99**, 1299-1307.