






Enhancing Delaware Highways Roadside Vegetation Concept and Planning Manual







Delaware Department of Transportation

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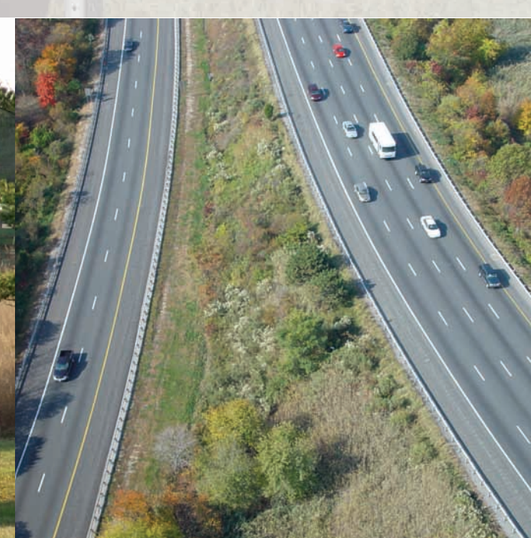

Delaware Department of Transportation

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Enhancing Delaware Highways

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The *Enhancing Delaware Highways* project is a joint venture between the Delaware Department of Transportation (DelDOT), the Delaware Center for Horticulture (DCH) and the University of Delaware (UD). Project leaders are Susan Barton, University of Delaware, Gary Schwetz, Delaware Center for Horticulture and Rick Darke, Rick Darke LLC. Valann Budischak, University of Delaware, serves as project administrator.

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Preface

Enhancing Delaware Highways

More than any other modern society, Americans do the majority of their traveling by automobile. Time spent on the road is an essential part of the American experience. Although safety and efficiency of the road system is paramount, the quality and character of highway vegetation contributes greatly to the pleasure of the overall experience. In addition to making automobile travel more enjoyable, well-managed highway vegetation contributes to regional pride of place and plays a strong supporting role in tourism and local economic development. When sound horticultural and ecological principles are brought to bear on vegetation management, roadside rights-of-way also serve as regional nature preserves, maximizing biodiversity while minimizing routine maintenance requirements.

Planning for roadside landscapes must be an integral part of all road design projects and must begin with the initial phases of design. Early consideration of roadside landscape design maximizes opportunities for cost efficient, attractive and sustainable solutions that are sympathetic to roadway engineering and maintenance. This concept and planning manual is the result of a collaborative research process between the Delaware Department of Transportation (DelDOT), the Delaware Center for Horticulture (DCH) and the University of Delaware (UD). It is intended for all those involved in planning and designing Delaware's highways including DelDOT staff, consultants and community members.

The manual defines and describes an orderly process for planning and design of diverse roadside landscapes utilizing a number of unique elements based directly on research results. Site-specific photography is used to illustrate broad concepts and explicit details.

Three elements essential to the site assessment process are the Roadway Limitations Checklist; the Climate and Growth Conditions Checklist; and the Cultural and Historical Characteristics Checklist.

Recognizing the need for designs matched to the varying priorities of visual appeal, regional conservation and economics, this manual defines three distinct approaches and provides a matrix to be used as a tool for selecting the most appropriate approach for any given location. Illustrated exercises are provided to demonstrate the process of applying the matrix to actual projects.

Other tools included in this manual are charts to guide appropriate plant selection, a table of estimated installation and maintenance costs and a glossary of terms.

Although primarily designed as a tool for DelDOT designers and consultants, the research-based rationales presented in the manual will also prove useful in communicating the challenges and opportunities of roadside landscape design to local communities.

Evolution of the *Enhancing Delaware Highways* Project

Enhancing Delaware Highways originated with an adhoc Horticultural Advisory Committee assembled in 1996 by DelDOT to advise on methods to enhance roadside rights-of-way within the State. Members of this committee applied for a two-year grant from the National Urban & Community Forestry Advisory Council (NUCFAC) that was awarded in 1998 to the University of Delaware and the Delaware Center for Horticulture.

The purpose of the grant was to develop roadside vegetation schemes that would result in reduced maintenance effort and cost while enhancing visual appeal for the driving public DelDOT provided supplemental funding to develop initial research plots in 1998 and 1999. Based on promising results from this research, DelDOT assumed full funding responsibility at the expiration of the NUCFAC grant. Beginning in 2000, the expanded project, called *Enhancing Delaware Highways*, became a cooperative effort involving DelDOT, the University of Delaware, Rick Darke LLC. and the Delaware Center for Horticulture. The project continues to develop new techniques and strategies, many of which have already been applied to Delaware roadsides. The Concept and Planning Manual is an essential product of the project.

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Introduction

This forested edge along Route 1, while largely outside the right-of-way, provides a beautiful background for travelers while serving as an important reserve of regional biological diversity.

Benefits and rationale for roadside landscape design and management

The changing forms, colors and patterns of roadside vegetation are the most common and significant visual stimuli for Delaware travelers. Properly designed and maintained roadside landscapes add to the pleasure of automobile travel while contributing to drivers' awareness and safe operation of vehicles. The First State's regional native vegetation includes a diverse and attractive array of trees, shrubs, grasses and wildflowers offering interest throughout the region's distinct seasons. Roadside landscape design based upon these local natural resources provides visual pleasure while contributing to awareness of Delaware's biological heritage and regional pride of place. Delaware is well known for its parks, gardens, and nature preserves; and roadsides managed for beauty and conservation contribute to the positive impression of the First State, indirectly supporting tourism and economic development.

Though Delaware is a small state, the thousands of acres held in roadside rights-of-way constitute major preserves of public open space, which is otherwise diminishing rapidly due to commercial and residential development. Traditional roadside vegetation management based upon regular mowing minimizes visual and biological diversity and ignores the potential for positioning these lands as preserves of regional biodiversity. Management that blends horticultural techniques for attractive and efficient design with ecological principles of population dynamics results in roadside landscapes that are visually appealing habitats preserving considerable parts of Delaware's native flora and fauna. Additional benefits are a reduction in maintenance costs, primarily through decreased mowing and minimized use of herbicides in vegetation control. This type of management protects Delaware's natural resources, and is in keeping with increasing Federal mandates that public lands be maintained to protect and preserve regional biological diversity.

Roadside landscapes managed for economic efficiency and environmental responsibility will in some situations present a distinct appearance from traditional designs dependent upon high-maintenance exotic plants and routine use of toxic herbicides. A multifaceted program for educating the driving public about the benefits of new designs is an essential part of the management strategy. An effective program building upon Delawareans' pride of place will result in acceptance of roadside management strategies and will also cast the Department of Transportation in the admirable role of a major steward of the First State's legacy of natural resources.

Most state departments of transportation have close ties to the public and political community of their state and have rightly catered to the wishes of the public whenever appropriate. Of all the highway programs, the roadside beautification program receives the most accolades and support from the public, whereas safety and utility programs are often taken for granted (Baker and Barret, 1996; Johnson and Lees, 1988).

Public education is a critical component of any highway vegetation program. Observers note the exceptional beauty of annual plantings during the first year, but don't understand the costs associated with maintaining such plantings. Annuals in wildflower mixes impress the public but create an expectation for massive color that makes it difficult to take the next step to sustainable native perennials and grasses (Oldham, 1998). Native plantings may take two or more years to realize their full potential and may require additional maintenance during establishment. Some plantings look like a failure during the first year while plants are allocating energy to root systems. Educating the public or users of the natural area is often necessary to gain acceptance (Englert, 1998).

If the general public believes a roadside planting is "unsightly" the responsible department of transportation maintenance unit will feel the attitude threatens their reputation and they will mow. Those involved in changing roadside vegetation from mowed grass to a more sustainable and diverse plant community must use the media, interpretive signage and public speaking to educate people about the opportunities for interesting plant communities along the roadway. Harper-Lore suggests the use of interpretive signs in plantings at rest stops and signs along the highway to educate the public about roadside vegetation (Harper-Lore, 1998).

Plantings that are manicured, ornamental or refined indicate that someone takes pride in their surroundings. People need to see some evidence of maintenance in order to appreciate highway vegetation. But tourists interested in recreational sightseeing come to see the natural character of a place. Roadsides should be managed with a focus on the environmental conditions of the site and regional sense of place (Edgecomb, 1998).

Objectives of the manual

This manual presents approaches to the planning, design, installation and maintenance of roadside landscaping. It offers ideas, concepts and schemes to guide designers and administrators in their everyday decisions.

The principal objectives are to:

- document DelDOT policies with respect to roadside plantings and vegetation modifications,
- define criteria necessary to guide judgments and decisions in the roadside design process,
- set forth the most current and effective roadside landscape design techniques and procedures, and
- assure that safety, economic, aesthetic and environmental quality factors are adequately considered in the design process.

The contents of this manual are intended to fully integrate functionality and beauty of Delaware's transportation corridors through planning, design, development, maintenance and administration of quality roadside design concepts.

This manual is not intended to provide all information necessary to prepare bidding documents. Design guidelines including clear zone requirements, traffic control, erosion control, drainage and seeding mixes are not included. Other resources such as the DelDOT Standard Specifications and Details must be referenced for preparation of plan documents. The roadway designer must ensure compliance with the DelDot Road Design Manual and the AASHTO Roadside Design Guide in all projects.

Audiences for the manual

Produced for the Delaware Department of Transportation (DelDOT), this manual is directed principally to Design Section personnel and to design consultants retained by the Department. It will be useful to personnel in other DelDOT organizational units since it documents basic Department policies and responsibilities for various roadside landscape design-related processes. The manual is also intended as a resource to members of communities including civic leaders, legislators and citizens who have a vested interest in the quality, functionality, safety and beauty of transportation corridors in the state.

DelDOT project leaders, consulting engineers, landscape design consultants and DNREC managers review preliminary plans on site for a large project linking transportation, history and natural areas.

Review by interested citizens and transportation professionals provides perspective on roadside landscape planning and design processes.

History and Tradition of Roadside Vegetation

Legislation relevant to roadside vegetation

Numerous state and federal laws, rules and policies support using the principles of landscape architecture in transportation facility development.

- The 1965 Beautification Act enacted by Lyndon Johnson placed emphasis on natural beauty and ecological values in federally funded projects.
- United States Code, Title 23, Section 109(h) reads as follows: " . . . the Secretary . . . shall . . . promulgate guidelines designed to assure that possible adverse economic, social and environmental effects relating to any proposed project on any Federal-aid system have been fully considered . . . taking into consideration . . . the costs of eliminating or minimizing such adverse effects and the following: . . . 2) destruction or disruption of . . . aesthetic values . . ."
- United States Code, Title 23, Section 319 calls for the ". . . acquisition of interests in and improvement of strips of land necessary for the restoration, preservation and enhancement of scenic beauty adjacent to such highways."
- The 1987 Surface Transportation & Uniform Relocation Assistance Act (STURAA) requires that at least .25% of funds expended on federally funded landscaping projects be used to plant native wildflowers.
- United States Code, Title 23, Section 752.2(a) states that "highway aesthetics is a most important consideration in the Federal-aid highway program. Highways must not only blend with our natural, social and cultural environment, but also provide pleasure and satisfaction in their use."

These two historic images of Route 273 (left) and Route 7 (right) demonstrate the dramatic change in Delaware roadsides since the 1920s.

- The National Pollutant Discharge Elimination System (NPDES) component of the Clean Water Act regulates the point discharge of pollutants into surface waters. Roadside vegetation can play a key role in filtering pollutants and the restoration of water quality.
- The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and the National Highway System Designation (NHS) Act of 1995 both make strong commitment to preserving and protecting the environmental and cultural values affected by transportation facilities.
- The National Environmental Policy Act (NEPA) states that it is the government's responsibility "to use all practicable means to assure for all Americans safe, healthful, productive and aesthetically pleasing surroundings." NEPA requires that an Environmental Impact Statement (EIS) be filed for projects that will have a significant effect on the surrounding natural or cultural environment. At the minimum, an Environmental Assessment (EA) must be prepared to determine if the project has the potential to create significant adverse impacts.
- The 1994 Executive Memorandum on Landscaping Guidance promotes the use of regionally native plant species on federally funded projects.
- The 1999 Executive Order 13112 mandates prevention of the introduction of invasive species; provision for their control; and minimization of the economic, ecological and human health impacts that invasive species cause. Public agencies are instructed not to authorize, fund or carry out actions likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere, unless that agency has determined (and made public its determination) that the benefits of such actions clearly outweigh the potential harm caused by invasive species, in which case it must minimize risk and harm.

Once-magnificent larch trees along the Route 52 corridor are nearly enveloped by invasive exotic vines. Roadside vegetation management plans must address such contemporary challenges if Delaware's regional character and diversity are to be preserved.

Context sensitive roadside design recognizes and celebrates historic elements in local landscapes, such as this millstone and millrace along the Brandywine River.

- Delaware General Assembly concurrent Resolution No. 63 directs DelDOT to improve public outreach and involvement and implement context sensitive design standards for the project development process, with preliminary reporting due January 25, 2001.
- Senate Bill #324, passed by the Delaware General Assembly and signed into law by the Governor July 2, 2002, places a high priority on landscaping and reforestation requirements for all transportation construction and improvement projects in the state. Under this Act, minimum standards are provided for the volume of landscaping or reforestation that must take place, and the Department of Transportation is further directed to provide specific standards through its own regulations developed in conjunction with the Department of Agriculture; Department of Natural Resources and Environmental Control; and other public or private agencies. It requires that all activities be spelled out on a formal landscaping or reforestation plan. As a result of this legislation, transportation construction plans will be required not only to reflect the physical structure of the transportation improvement to be installed but also outline the landscaping and reforestation activities to be performed.

DelDOT is committed to identifying and implementing roadside enhancements to meet these legislative mandates including aesthetic improvement, erosion control, invasive species control, reforestation and other uses of native vegetation.

DelDOT policy now dictates that context sensitive design principles be applied to all road design projects. Context sensitive design takes into account the aesthetic, scenic, historic and cultural resources; and the physical characteristics of an area that reinforce community identity, sense of place and local pride. Soliciting and responding to community input is an important step in securing public acceptance of road projects.

To uphold the above laws and policies, DelDOT must incorporate landscape design throughout the transportation facilities development process from inception to construction. Deferring landscape design issues until later in the process leads to expensive add-on solutions as well as missed opportunities to enhance the safety and pleasure of Delaware residents and the traveling public.

History of roadside landscape design

The traditional approach to roadway design has been based primarily on functionality. The standard has been to improve traffic flow using least-cost solutions; however, this is no longer acceptable in light of a growing awareness of roadway projects as community improvements rather than solely transportation improvements.

The notion that roadways might serve communities in broader ways is not new. Through the early twentieth century, as highways evolved into significant thoroughfares and corridors across the nation, people began to realize the importance of the view of the landscape from the car. In the 1930's, it became the trend to maintain roadsides as the nation's front yards. In the 1950's, the development of agricultural herbicides provided new tools for those maintenance needs. In the 1960's, Mrs. Lyndon Baines (Ladybird) Johnson first proposed the concept of landscape conservation rather than simply highway beautification. In the spirit of environmental conservation, Lloyd Benson, senator from Texas, sponsored the bill that became law, requiring 1/4 of 1% of all highway landscape funds spent on "native wildflowers." Many states have ignored the "native" designation and focused on beautification using maintenance-intensive ornamental garden flowers (Harper-Lore, 1998). Among highway vegetation professionals there is a current trend towards roadsides that reflect the natural beauty and biodiversity of a region. This new aesthetic is built on an understanding of the ecology, our natural heritage and good planning. (Harper-Lore, 1998)

Typically the roadside right-of-way is a highly disturbed environment. It serves as a recovery zone, utility corridor, snowdrift buffer, fire barrier and location for sign posting. The result is frequent disturbance that disrupts the balance of existing plant communities and provides opportunities for the unwanted establishment of invasive exotic plants. In an age characterized by widespread introduction of invasive exotic species, we can no longer count on natural succession to create plant communities comprised of regional native species. At one time native seed was prevalent in the soil, but now seeds of

Sidewalk and median plantings along Route 52 provide an attractive, comfortable experience for pedestrians on their way to local shops.

invasive exotic species often dominate. In fact, landscapes let go after disturbance are likely to be populated by undesirable invasive plants that substantially increase the cost of roadside vegetation management.

Roadsides are challenging, harsh environments for vegetation. They are comprised of shallow, often high-salt soils with low fertility, poor moisture retention and pH extremes. Steep slopes and excess sun and wind often result in inhospitable sites. (Airhart, 1998, Harper-Lore, 1998) Norm Poppe from Applewood Seeds in Arvada, CO suggests that when you grade over agricultural land, build artificial slopes, backfill with mixed subsoils, cover with concrete or asphalt so that cars emitting various pollutants can speed through a totally fabricated ecosystem, you no longer have an environment appropriate for native plants (Goff, 1998). Others believe that parts of the roadside are excellent candidates for the creation of special plant community preserves. However, this requires management and long-term commitment. Native grasses are able to withstand long periods of severe conditions in an undisturbed community. But if they are mowed constantly under a normal roadside maintenance regime they will decrease in vigor and eventually succumb to invasion by other less desirable species. (Schutt, 1999)

Pollutants in the runoff at this outflow from I-95 are an example of the extreme conditions faced when trying to revegetate the roadside environment.

Many approaches have been proposed for the management of the highway right-of-way. Some suggest that we should design highways for people not cars. This approach would improve decision-making and preserve the character of the nation's communities. We could enhance the "aesthetic, scenic, historic and cultural resources, and the physical characteristics of an area giving a community its identity and sense of place and source of local pride." This concept has been called "context sensitive design" (Cates, 1998) and is embraced by DelDOT. Studies have demonstrated that positive impressions made by local roadside environments are directly linked to a community's ability to attract and hold desirable industry.

Texas Transportation Institute landscape architect, Jim Schutt states that a context sensitive design approach seeks to enhance the positive values of both the local community and the natural environment. It implies a process that includes 1) identifying the environmental impacts of the highway on the site, 2) identifying the appropriate natural systems processes most suitable to solving highway problems, and 3) gaining input and support from the community in developing design alternatives. (Schutt, 1999)

Texas was the first state to focus on natural roadsides as a beautification tool. In 1934, directives were issued to delay all mowing on the state's roadsides unless essential for safety until spring and early summer wildflower bloom was complete. Recently, states including Washington, California, Nebraska, Oregon, Iowa, Minnesota and Idaho are embracing what Wisconsin calls the "Natural Roadsides Philosophy." This philosophy recognizes advantages that native and naturalized species provide over non-native plants, as well as benefits provided by maintaining the topographical and geological

Grasses and goldenrods are as much a part of Delaware seashore's coastal plain heritage as are the sands and salt air.

Any proposed context sensitive design solution for this Centreville business district must accommodate the diverse and sometimes conflicting needs of motorists, cyclists and pedestrians.

character of the landscape. Vegetation management plans are developed for new planting projects as part of the project design and any important existing plantings or plant communities must be incorporated into these plans. This philosophy has proven to be economically feasible through minimized maintenance while enhancing the aesthetic and ecological integrity of each state's heritage.

Elements of landscape design as they apply to roadsides

The goal of "context sensitive" design is integration of transportation facilities into their surroundings while preserving visual quality and protecting the environment and the community. In the traditional approach, roadway improvements were based solely on functionality, with the goal of safely improving traffic flow at least cost. This is no longer the accepted standard. Roadway projects are now designed as community improvements, not just roadway improvements. Aesthetic design principles are applied to land within and affected by transportation corridors and facilities.

Designers should consider both the view from and the view of the facility, respecting the contrast between highway scale and human scale. A quality design is appropriate to the site, its functions and environs, and contributes to motorist and pedestrian safety, comfort and enjoyment. The desired end result is protection and enhancement of the overall character of the transportation corridor.

To meet these goals, the principles of landscape architecture must be considered at the beginning of the development process. The basic principles of landscape design apply including color, texture, form and line. Several additional elements are particularly relevant to roadside landscape design.

Scale refers to the size of objects in the environment relative to each other, or to the size of humans relative to their environment. The scale of highway planting should be effective at the design speed of the highway.

The leisurely pace of the road bordering Brandywine Park allows passing motorists to appreciate a small grouping of wildflowers at the woodland edge. To be noticed at highway speed, considerably larger masses are necessary.

Though simple in composition, this grouping of red cedars in warm-season grasses at the Milford interchange breaks up the monotony of mowed turf along Route 1.

Movement incorporates highway distance and speed with scale. Spaces and distances are perceived differently depending on the speed of travel. A driver traveling at 10 mph will not experience distance and scale in the same way as a driver traveling at 60 mph.

Rhythm is created by elements that repeat at regular intervals. Evenly spaced street trees or fence posts in a field create different rhythms. Vertical lines heighten the sense of speed, so drivers may believe they are traveling faster than they actually are. This concept is sometimes used to slow traffic in critical areas.

Contrast is a comparative measure of differences in color, texture or form. Contrast also compares differences between elements and their environment.

Proportion concerns the sizes or numbers of objects as related to each other. If elements are too far out of proportion with each other the visual effect is likely to be unbalanced.

The classic beauty of this Plane tree-lined urban street also serves the practical function of calming traffic.

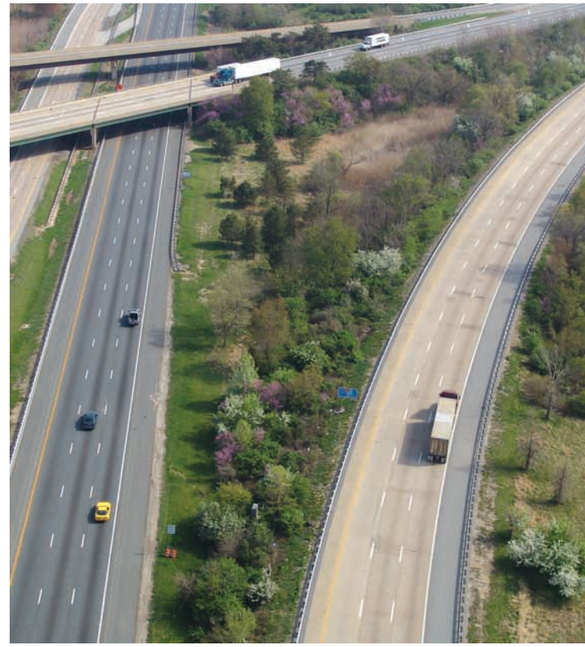
Two bridges spanning the Brandywine River in Wilmington serve the purposes of beauty and safety at dramatically different scales. Built primarily for speed and safety, the I-95 span is undergoing reconstruction (in this 2003 photo) that will enhance its appearance from below. Recently rebuilt Van Buren bridge balustrade helps frame the view and preserve historic design while meeting modern safety standards.

The rural tradition of this one-lane iron bridge, rebuilt to meet modern structural standards blends beautifully into the country character of White Clay Creek State Park. Exceptions to modern safety standards were authorized in order to preserve the country character of this setting.

Balance is related to objects or space in the landscape. It can be attained through the use of numbers of objects, proportions of objects, texture and perceived or physical weights of objects.

Variety in the landscape can increase driver alertness. Using diverse vegetation and varying road and planting alignment can achieve variety. However, too much variety can be confusing or distracting for drivers, so moderation is necessary to maintain balance in the landscape. Planting design should achieve a balanced mix of planted areas and open space vistas.

Additional considerations to be made in visual aspects of highway design include alignment, terrain fit, right-of-way, erosion control and utilities. In addition to complying with geometric design considerations outlined in Chapter 5 of DelDOT Road Design Manual, placement of transportation corridors must be designed to: follow existing topography; preserve scenic views; avoid environmentally sensitive areas; heighten driver awareness by providing visual and directional variety; and blend into the local context of adjacent land uses and users.



Redbuds and red cedars are repeated elements in plantings that offer visual diversity without appearing chaotic.

Transportation facilities should be integrated with topographic features in natural and built settings. Any required structures such as bridges should be appropriate to the environmental context whether urban or rural. Designers must evaluate the potential for erosion and runoff problems in proposed project locations and develop solutions for those problems.

Designers should consider adjacent land use early in the design process. Right-of-way aesthetic design issues include protection or enhancement of existing views, screening of unpleasant views and existing vegetation preservation. Right-of-way plantings can be used to frame a scenic view or screen an unpleasant view. Retaining desirable existing vegetation preserves the integrity of the setting and saves the cost of re-vegetating later. Utilities can detract from the visual quality of transportation corridors. Designers should mitigate adverse visual impacts caused by existing utilities and plan for the long-term impact of new utilities. Burying the utility, bundling multiple lines into one, or screening or siting in a location that is not so visible to residents and to the traveling public may accomplish this.

Public Opinion

A series of focus groups, conducted by the EDH project team reviewing nine distinct roadside images concluded that people prefer roadside plantings with color, order and a background. Mowed turf was rated poorly for attractiveness, appropriateness for roadside planting and effectiveness at reducing highway monotony. Mowed turf is often used along the highway because it provides a well-maintained appearance. This focus group study showed that the public, as represented by respondents, is less concerned with a well-maintained look than with color and order. In this study, natural landscapes were no more or less desirable than contrived landscapes. Respondents valued other factors more than a natural look, but did not downgrade natural looking landscapes.

Delaware Speaks Out, a statewide Cooperative Extension survey conducted in 1999 revealed that Delawareans notice the impact of roadside plantings. Respondents believe that plantings along the roadside have a moderate, significant or major impact (58%) on short trips, but more impact (78% responded with moderate, significant or major impact) for long trips (one hour or more). Colorful flowers (57%), shrub thickets (38%), wooded areas (36%) and open meadows (35%) were rated as having high appeal more frequently than other types of roadside scenes. Delaware's scenery was rated as average (52%) or good (28%) and approximately 60 percent of respondents felt Delaware's roadside vegetation was the same as surrounding states. Approximately 50 percent of respondents expressed some support for spending state tax dollars to beautify Delaware roadways and 12 percent expressed strong support.

Roadside images viewed by focus groups

Cosmos; contrived, with order, with color

Partly wooded slope; natural, without order, without color

Sunny old-field; natural, without order, with color

Spring woodland; natural, without order, with color

Small plot of mowed turf; contrived, with order, without color

Traffic island; contrived, with order, with color

Unmowed turf; natural, without order, without color

Highway infield; natural, without order, with color

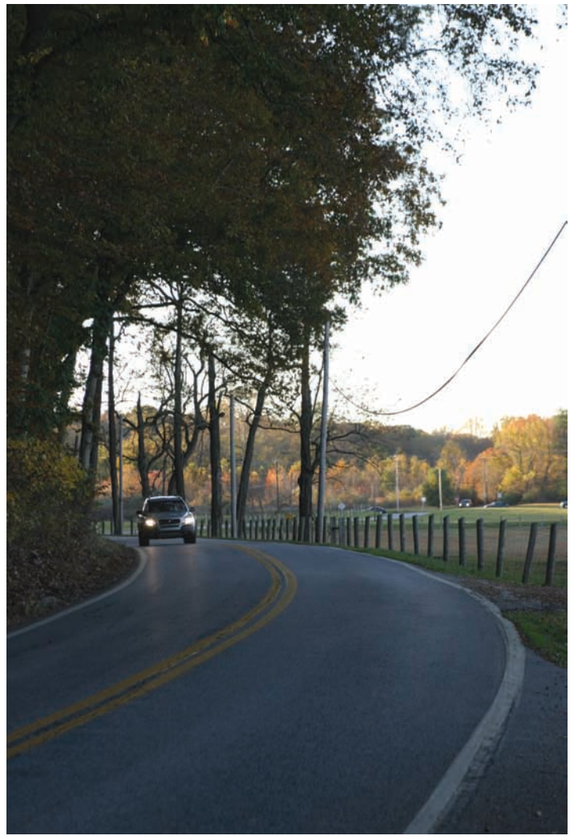
Expanse of mowed turf; contrived, with order, without color

A body of research supports the public's desire for naturalistic scenery along the roadside (Kaplan and Kaplan, 1989). Preferences can be based on content and spatial organization. The most preferred content categories are the ones where nature is dominant in the scenes. The most preferred spatial categories are open, yet defined, where the ground texture is smooth and trees help define the depth of the scene. Least preferred scenes were ones with large expanses of open sky that lacked distinctive foreground features and scenes with blocked views and dense vegetation (Kaplan and Kaplan, 1989).

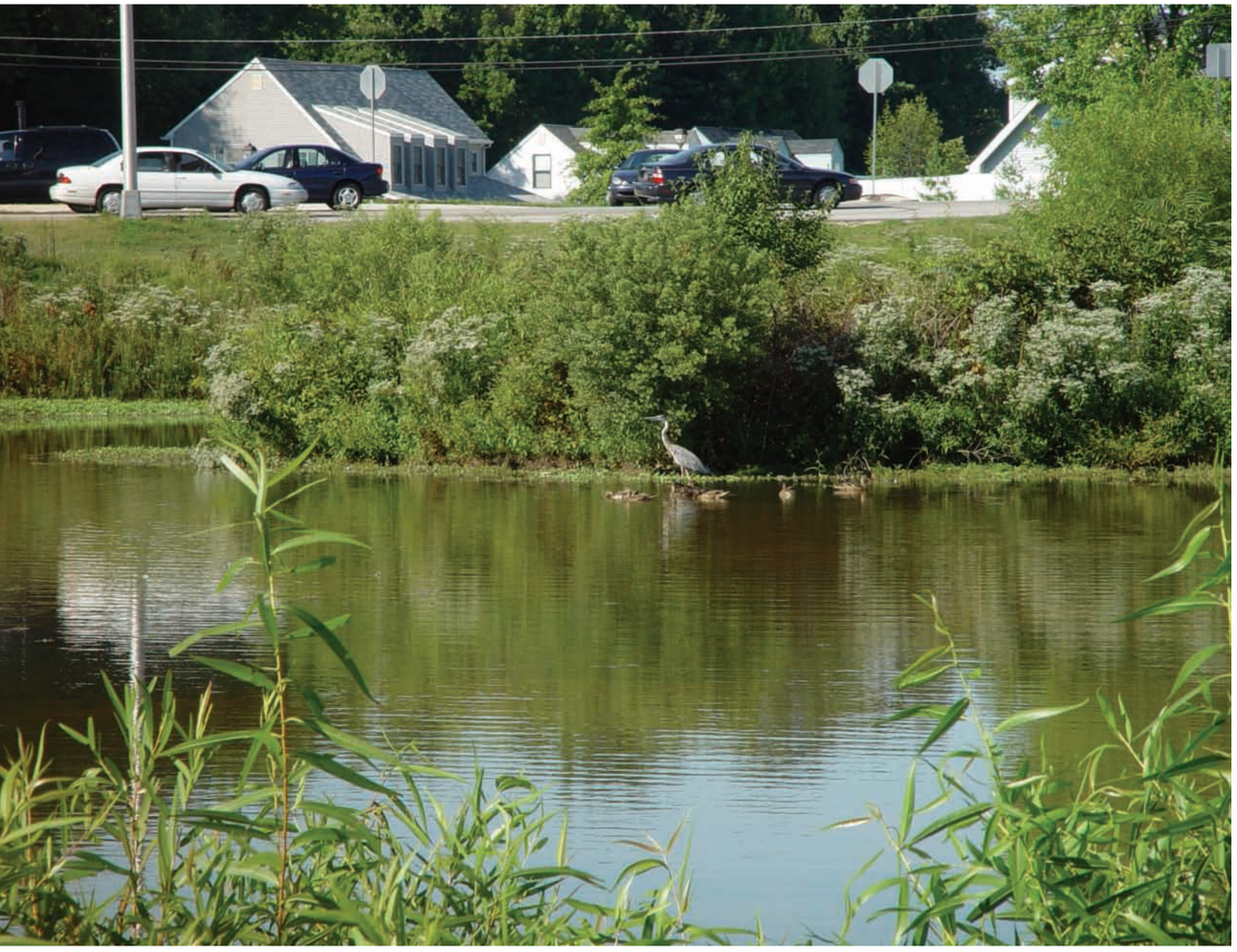
Humans have a need to both understand and explore their environment. These needs influence scene preference. A complex scene warrants exploration, but if it is too complex it will be difficult to understand. Coherence is an important predictor of scene preference. Coherent scenes provide a sense of order and direct attention. Through repeated elements and uniformity of texture, the viewer is able to delineate a region or area. Legible scenes are easy to understand and remember. They include well-structured space with distinctive elements. Mystery is also a strong preference predictor.
Scenes that hold the promise of more provide a pleasant challenge to the imagination. A deflected or curving sightline conveys a sense that new landscape information lies just beyond the observer's visual bounds (Ulrich, 1986). The most preferred scenes have mystery or depth and high legibility. Skyline Drive in the Blue Ridge Mountains, with its curving roadway and frequent panoramic views is full of such character. Disliked scenes have little coherence or little complexity (Kaplan and Kaplan, 1989).

Preferred scenes are comparatively ordered, 'civilized assemblages' of natural elements; most are not wild in terms of conveying a sense that human influences are absent (Ulrich, 1986). Chenoweth and Gobster found that across landscape types, naturalness and spatial structure of scenes were important dimensions related to aesthetic preference for all landscape types (Gobster, and Chenoweth, 1989). People receive the greatest benefit from visual contact with nature when they are in a state of high anxiety (Ulrich, 1981). Exposure to natural environments permits people to recover from mental fatigue (Kaplan and Kaplan, 1989). Facets of settings that facilitate a restorative experience include fascination (resulting in effortless attention) and coherence (orderly patterns) (Kaplan, 1984).

Background trees help define this naturalistic open landscape.



New scenes are continuously revealed as motorists travel this curving stretch of Route 100.

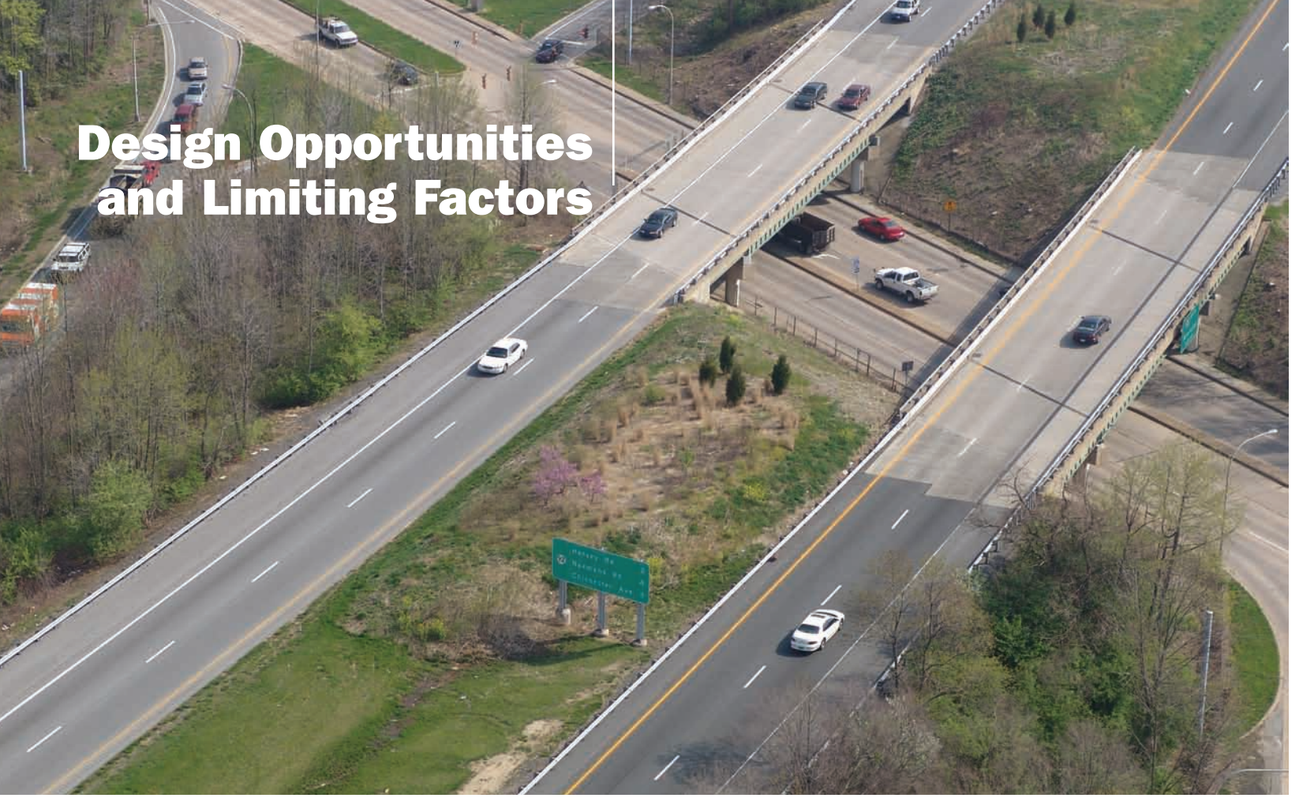


Roadside habitat brings a glimpse of natural diversity to the morning commuter, as herons and ducks enjoy the substance and relative serenity of a stormwater management retention basin with rich regional vegetation.

Higher speeds dictate larger scale plantings. This grand sweep along Route 1 is appropriate for 65mph. The greater detail of this Mermaid Boulevard planting is effective at 35mph and under.

The fact that people spend money to experience beautiful landscapes through outdoor activity, ranging from day-trips to vacations indicates real preferences for scenic beauty (Krutilla, 1967). Krutilla divides this value into 1) option value – having the option to enjoy beautiful places in the future; 2) existence value – knowing that beautiful places exist; and 3) bequest value – knowing that beautiful places will be available for future generations.

To produce the beneficial effects of natural scenes, designed roadside landscapes should be structured and ordered. Designers should avoid featureless landscapes with low complexity; disordered, highly complex landscapes with no focal point; plantings with sharply restricted depth (as often occurs with forested edge on tertiary roadways); and flat, featureless landscapes (such as mowed infields). If vegetation is to have a major aesthetic impact in auto-dependent areas, it must be large-sized in order to be clearly visible to drivers and passengers at middle distances. Smaller vegetation may be effective when concentrated at particular points where motorists must stop for several seconds such as traffic islands adjacent to traffic lights (Ulrich, 1986).

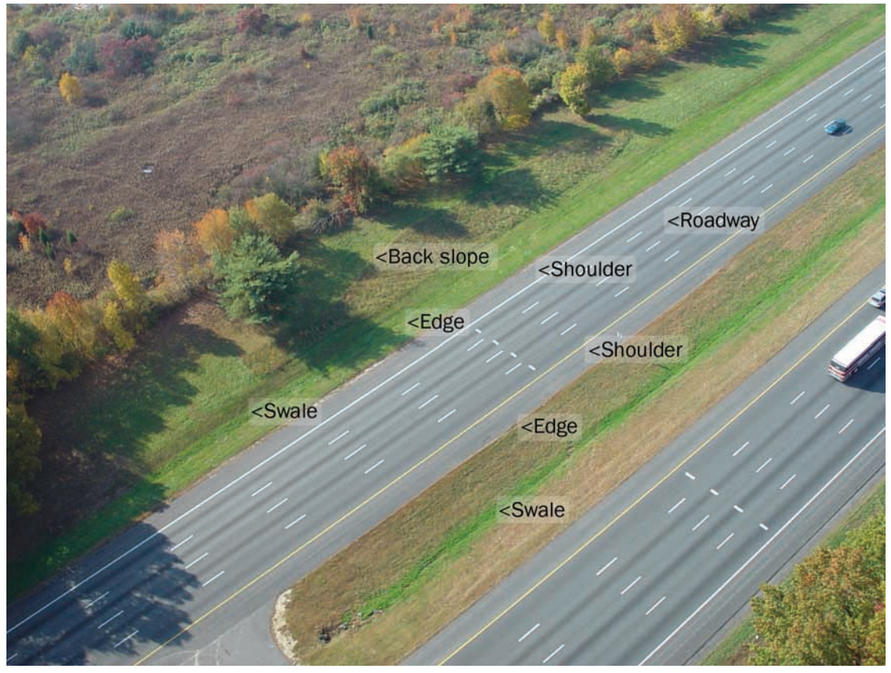


Design Opportunities and Limiting Factors

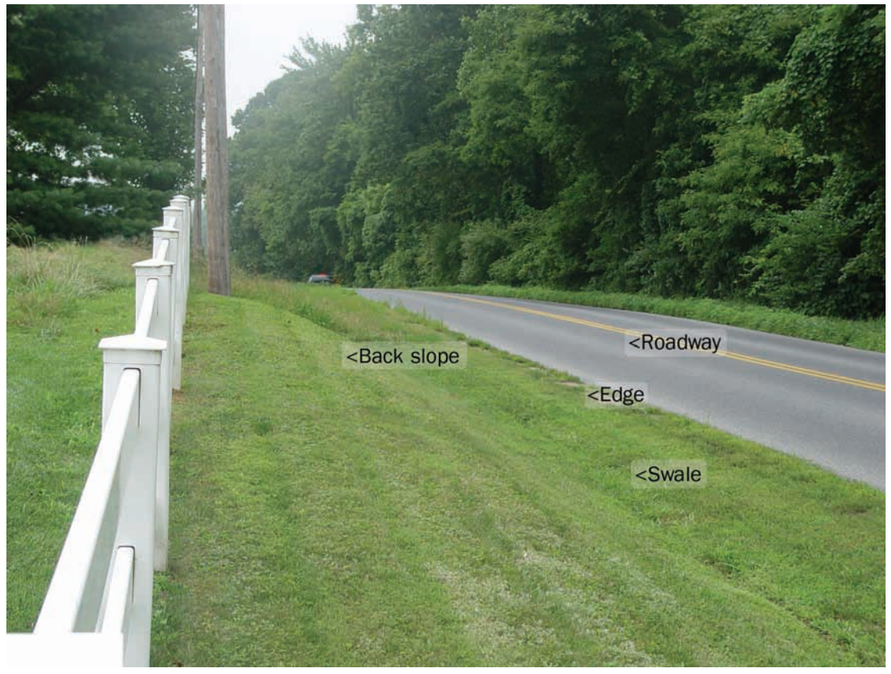
DelDOT's mission is to provide a safe and efficient transportation system. Roadside landscapes shall be designed with safety as the top priority, with roadside aesthetics playing an important role within safety parameters. Plant selection and location design will be such to maintain sight distances and clear zone recovery areas. Plantings will not interfere with the function of shoulders, barriers, guardrail or traffic signs. Every opportunity should be taken to integrate planting into safety strategies such as traffic calming and the reduction of driver fatigue from roadside monotony.

Defining roadside zones

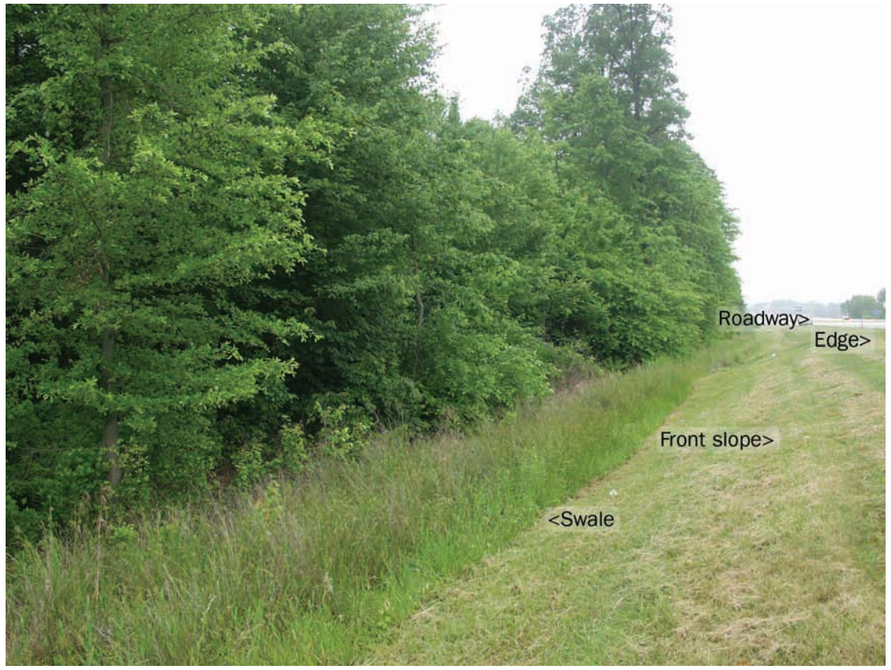
A typical roadside includes five zones that might occur on either side of the pavement (Back slope or cut slope, Swale or ditch zone, Edge or border zone, Edge or border zone, Approach or shoulder zone, Front or fill slope). These areas vary significantly in their geomorphic characteristics from high, dry and well-drained to low, moist wetlands. Slopes vary from steep (2:1) to relatively flat (2% or less) and soils vary from relatively undisturbed to highly compacted or reconsolidated. An optimal environmentally-based design and management approach would be tailored to account for these differences so as to maximize the habitat diversity as well as the species diversity within each zone.



Typical zones on a dual highway.



Typical zones on a rural 2-lane road.



Detail of zones along State Route 1.

Clear zone distances

Clear zones provide areas for drivers of errant vehicles to regain control after running off the road. The clear zone determination defines the clearance between the edge of the outermost travel lane and roadside obstructions such as large trees. A single tree with a trunk diameter greater than 4 inches is considered a fixed obstruction. A minimum allowable clear zone distance is measured laterally to the trunk of the tree. Special considerations will be given to provide additional clearance in potential vehicle accident recovery areas.

Clear zone widths are based on design speed and traffic volume; and the combination of front slopes (outward and downward from the shoulder) and back slopes (upward and outward from the ditch). Knowledge of the front slopes and back slopes is critical for correct application of the clear zone concept (see DelDOT Road Design Manual, 3.3.5.) The front slope has to be recoverable (4:1 or flatter) to be considered part of the clear zone. Traversable berms or back slopes 3:1 or flatter permit the extension of the clear zone. Thirty feet is generally considered a minimum clear zone distance for high volume, high speed highways. Larger trees may be planted outside the existing minimum unobstructed lateral clearance as described in detail in Chapter Four of the DelDOT Road Design Manual.

Clear zone distances greater than 30 feet will be provided at other locations such as the outside of horizontal curves, near ramp intersections, at points of congestion or where evasive maneuvers may be required. Large trees will not be planted in unprotected areas of freeway or expressway medians except for separated roadways with medians of sufficient width to meet the setback requirements for tree plantings.

Large trees may be planted within the 30-foot limit where they will not constitute a fixed object; for example, on cut slopes above a retaining wall, behind existing barrier curbs (2 feet behind) or in areas behind existing guardrails (4 feet behind). Barrier curbing is any curb eight inches or higher. Trees may be planted behind barrier curbs if the road speed is sufficiently low as to prevent cars from mounting the curbing.

Design exceptions may be granted if a reduction of the clear zone obstruction guideline is desired. For exceptions, follow the design exception procedure as outlined in the DelDOT Road Design Manual (Chapter 3).

Exceptions may include:

- exceptional or unique trees because of size, species or historic value;
- locations where the cumulative loss of trees would result in a significant adverse change in character of the roadside landscape;
- landscape, park, recreation, horticultural, residential or similar areas where trees and other forms of vegetation provide significant functional and/or aesthetic value;
- on designated scenic or low speed roads as well as low speed urban roads; and
- where absence or removal of trees would adversely effect rare/endangered/threatened species (plant or animal), wetlands, water quality or result in serious erosion/sedimentation effects.

Trees in this New Castle district are one example of exceptions permitted for the purpose of maintaining historic patterns.

Other considerations such as the potential maintenance problems of roadway shading, leaf or other tree debris litter and tree damage potential from winter maintenance chemicals shall be considered when planting trees closer along roadways.

In areas of the right of way that are not impacted by limitations of the clear zone, naturalistic plant growth shall be encouraged within the guidelines of the prescribed landscaping approaches (fully ornamental, regional-ornamental, and regional–see Design approaches, page 57).

Drainage issues

Vegetation in this parking lot swale slows runoff and increases infiltration.

Landscape plantings and design will enhance the roadside environment without compromising the integrity of the structure of the travel surface. Care must be taken not to interfere with adequate drainage according to road-base design standards (see AASHTO Policy on Geometric Design of Highways and Streets, Chapter 4, Cross Section Elements). Vegetation in drainage ditches must be sufficient to prevent erosion and maintain ditch stability. Ditches must be designed with the capacity to remove water at a sufficient rate. Take advantage of opportunities for riparian plantings on roadsides and in ditches that can exist in a desirable hydrology with respect to the engineering of the road surface. Plantings should not prevent proper drainage of water from beneath the road surface. Drainage issues are addressed in Chapter 6 of the DelDOT Road Design Manual.

Low Impact Design are those practices that reverse the traditional approach to site drainage, using roadside structures to mimic the natural drainage functions; and its use should be encouraged in new design applications and retrofits. Instead of rapidly and efficiently draining the site, low impact drainage design relies on various planning tools and control practices to preserve the natural hydrologic functions of the site. It is a shift from the philosophy of rapid removal and collection of water to the slowing and infiltration of runoff to slower rates of flow and greater infiltration. When the right-of-way is sufficiently wide, drainage ditches should be designed to accomodate vegetation that aids infiltration. (see Low Impact Development Design Strategies, An Integrated Approach, Prince George's County, MD, June 1999.)

Utility locations

Plantings should be planned to avoid direct conflict with maintenance or access of utility installations. For example, tall-growing trees should not be placed in positions that would require pruning to keep them out of high voltage electric wires (see The Plant Palette: charts by Plant Type, page 107). Access to control boxes should be maintained and not obstructed by plantings. Before digging holes to plant trees or shrubs, locate all potentially active utility lines that may be buried in the area. In general, follow utility company guidelines for planting clearances on overhead and underground utilities.

Shrubs or lower-growing trees would be better choices under these high voltage lines. The form and health of this sugar maple are seriously compromised by the need for constant pruning to keep lines clear.

Lines of sight

Plants must not interfere with the effective sight distance limits for stopping, passing or making maneuvers at intersections (DelDOT Road Design Manual, Chapters 5 and 7). Low-growing plants of 18 inches or less may be placed in the sight line area for passing and stopping or in the minimum sight triangle area at intersections as long as other requirements for sight distance are met. Taller growing plants are to be placed beyond these calculated sight line setbacks. In cases where an existing facility does not already provide adequate sight distance because of geometric restrictions, no further reduction will be allowed. Locations such as the inside of curves, inside interchange loops and median shoulders must be kept clear and designed sight distance retained.

For highway interchanges, all plantings must provide ramp and collector-distributor road sight clearances equal to or greater than required by the geometric standards based on design speed criteria (DelDOT Road Design Manual, Chapters 3 and 4). As a general rule-of-thumb, a 50-foot setback (from the edge of traveled way) within an interchange loop is considered the appropriate sight distance setback for trees and shrubs that will grow above an 18-inch height.

Different types of intersections have differing lines of sight requirements. With a simple four-corner intersection (Figure 1), the clear zone is increased at each stop sign to provide a "daylight corner" where there is no vegetation taller than 18". When channelization islands are short (Figure 2), the vegetation should not be taller than 18" in the entire island. But longer channelization islands (Figure 2) may provide the opportunity for taller plantings a specified distance from critical intersections. In some cases, traffic islands are larger and treated as a "ramp infield" (Figure 3). When the intersection is designed to prevent particular turns, there may be opportunities for taller plantings that do not obstruct critical lines of sight.

Figure 1. Four corner intersection

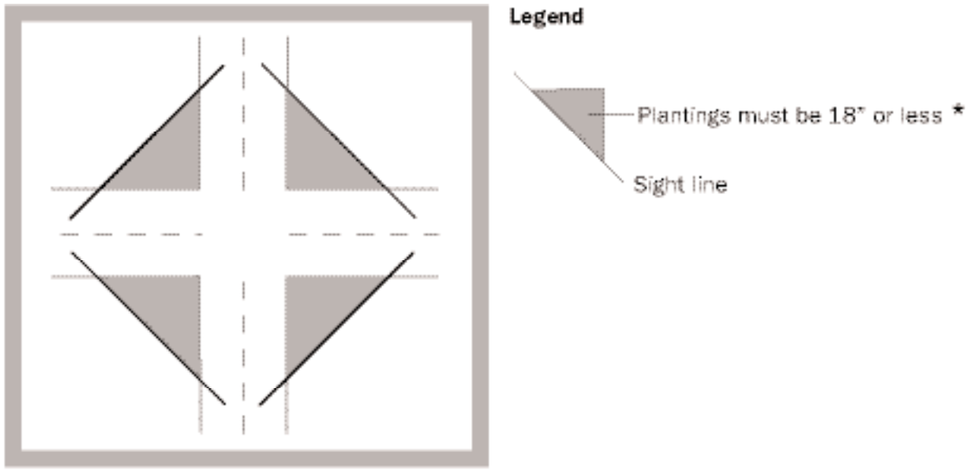


Figure 2. Intersection with channelization Islands

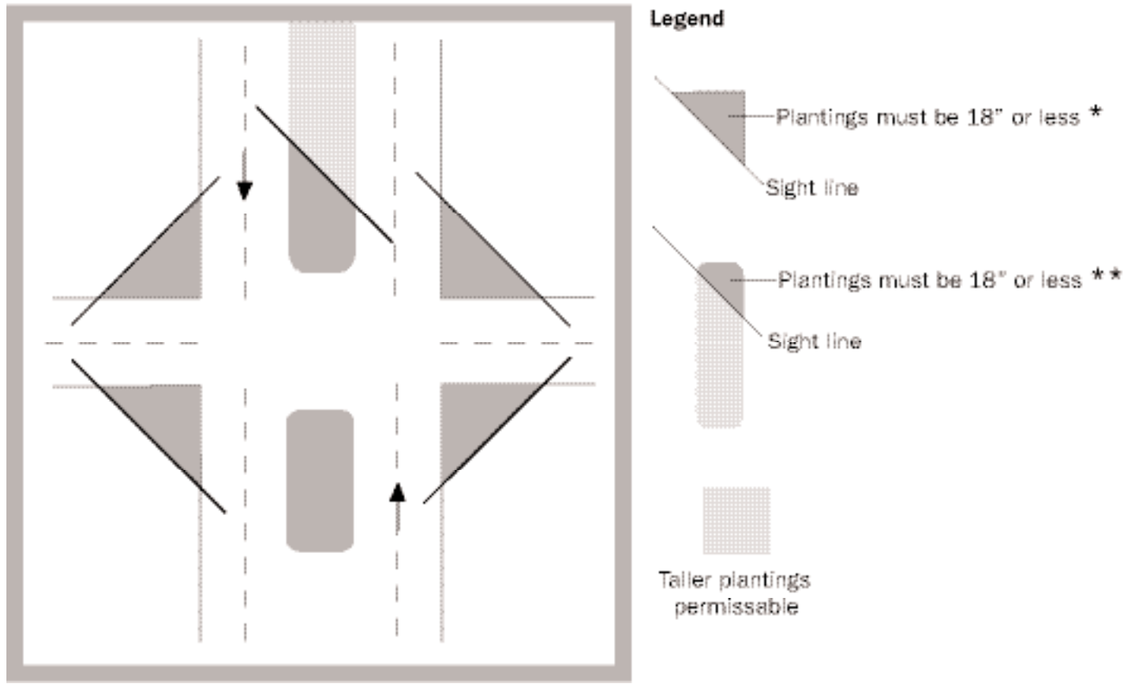
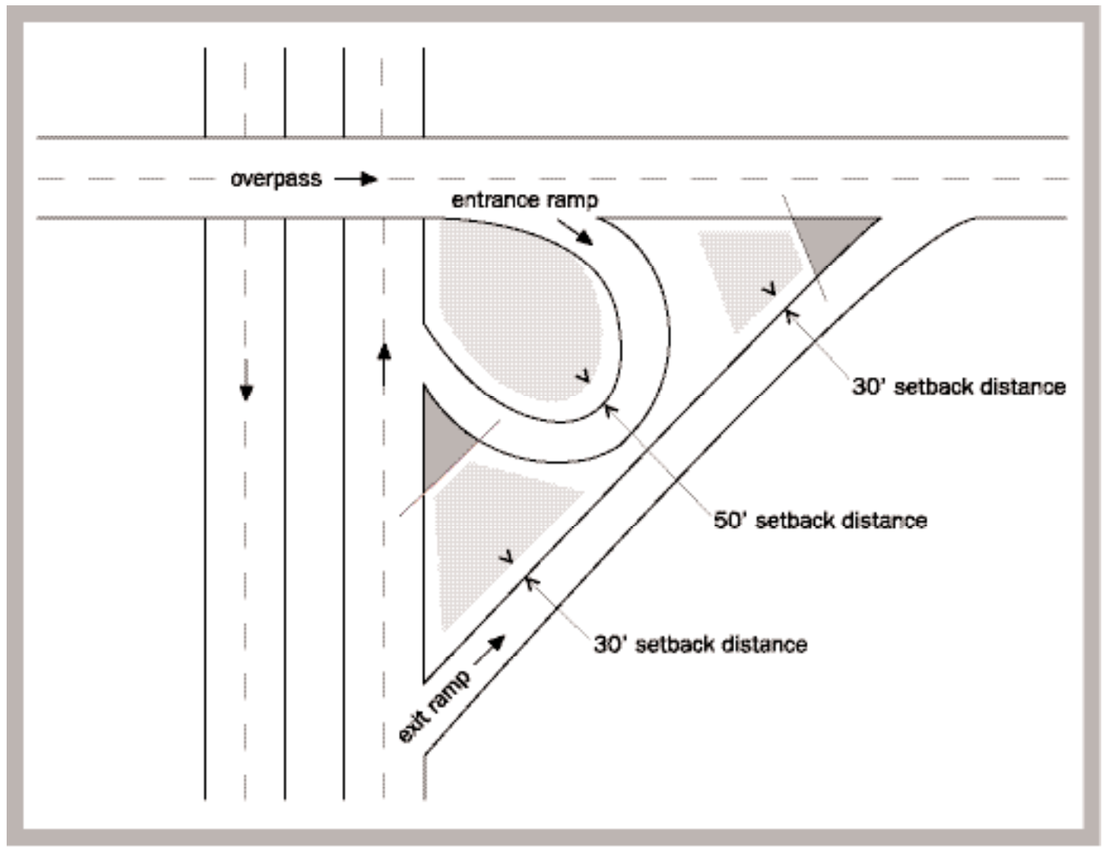


Figure 3. Ramp infield



* Designer should consider vertical roadway geometry at intersection to determine maximum acceptable height.

** Designer should consult with maintenance staff to determine logistics and safety of plant installation in median locations

Erosion control

Vegetation is the most cost effective and aesthetically desirable means of erosion control. Appropriate vegetation must be chosen to stabilize the soil surface both temporarily and permanently to prevent stormwater erosion and sedimentation activity. Existing vegetation on the construction site should be preserved where practical. If this is not possible, vegetation should be re-established using grasses, forbs and woody plants. The Department's landscape policy requires the use of native species as much as possible. (See Chapter 6 of the Road Design Manual, as well as DelDOT ES_2M Design Guide and DNREC Erosion and Sediment Control Handbook for further guidance regarding vegetation as erosion control.)

Functions of roadside vegetation

Vegetation within the right-of-way of transportation corridors can serve various functions in addition to creating an attractive groundcover. The following list outlines some of those additional functions:

- *Screen headlight glare*. Vegetation can shield headlight glare of oncoming traffic. Screening may be accomplished with plants alone or in combination with fences and earth berms, depending on the desired effect.

- *Buffer noise.* Vegetation can be used in combination with berms and barriers to block road noise from the surrounding environment. Plantings that are very dense, wide and high will offer some noise reduction, but will not approach the sound-blocking capacity of a built wall. Obscuring the source of the noise from view will often reduce awareness of the problem, providing some psychological benefit even though actual noise levels may not be affected. Space permitting, plants may be used in conjunction with built barriers. The plants will help absorb sound waves and soften the visual impact of the structure.

- *Indicate change in direction.* Modern roads are designed to make it easy for drivers to anticipate changes in the direction of the roadway. On older roads, particularly rural roads following historic low-speed cartways, vertical and horizontal alignments often combine to make it difficult for the driver to discern the continuing direction. In daylight hours, plants acting as delineators or traffic guidance, can warn a driver of a change in direction of the roadway long before a turn in the pavement is evident, especially when they are located on the outside of curves.

Trees visible beyond the crest of the hill help drivers anticipate an upcoming turn to the left.

From a distance, the trees will be viewed as a solid mass helping the driver to anticipate a turn in the road. At "T" intersections or cul-de-sacs, particularly if a previous through-street has been cut off, plants used as delineators should be large enough to perform their function immediately. They must have enough mass to indicate visually that the roadway direction changes just out of the driver's sight. Even at closer range, landscaping with trees, shrubs and herbaceous plants may serve as guiding elements for vehicular and pedestrian traffic at an intersection. During night time hours or times of limited visibility, designers will continue to rely on reflective devices to delineate hazardous conditions and alignment changes.

- *Increase the effectiveness of traffic signs.* Appropriate plantings can provide a backdrop and draw attention to informational signs. This technique may also help screen out other distracting backgrounds and block glare from low sun at certain hours of the day. Plantings can also aesthetically integrate signs into the highway landscape.

- *Attenuate impact.* Masses of shrubs and small-caliper trees may provide supplemental impact attenuation in conjunction with other systems, safely reducing the speed of an out-of-control vehicle. The plant mass may prevent the vehicle from crossing the highway median and colliding with oncoming traffic. Individual stems of mature plants used for this purpose must not be capable of exceeding four inches in diameter.

Though no one was injured in this mishap, the long-term safety solution is to adjust design and management strategies to reduce mowing on slopes and drainage swales.

- *Reduce mowing time.* Routine mowing can be reduced by allowing existing vegetation to grow or by deliberate planting of low maintenance trees, shrubs and groundcovers. A 20-foot mowed strip is generally sufficient to provide a well-maintained appearance, and periodic spot spraying can be used to control undesirable species.

- *Increase maintenance safety.* Vegetation that does not require mowing can eliminate the need to operate vehicles on difficult-to-mow sites.

- *Control drifting snow.* Mass plantings of trees and/or shrubs are very effective for controlling drifting snow. They are relatively long-lived and require little maintenance once the plants have become established.

- *Block undesirable views.* Plantings can be used to block undesirable views both to and from the highway.

- *Emphasize desirable views.* Highway plantings can be used to frame and emphasize desirable existing views adjacent to the highway. This might include panoramas, pastoral scenes or historic architecture along the right-of-way.

- *Combat highway hypnosis*. Plantings can reduce monotony and provide a varied experience, which encourages the driver to vary focal depth and remain more alert and aware.

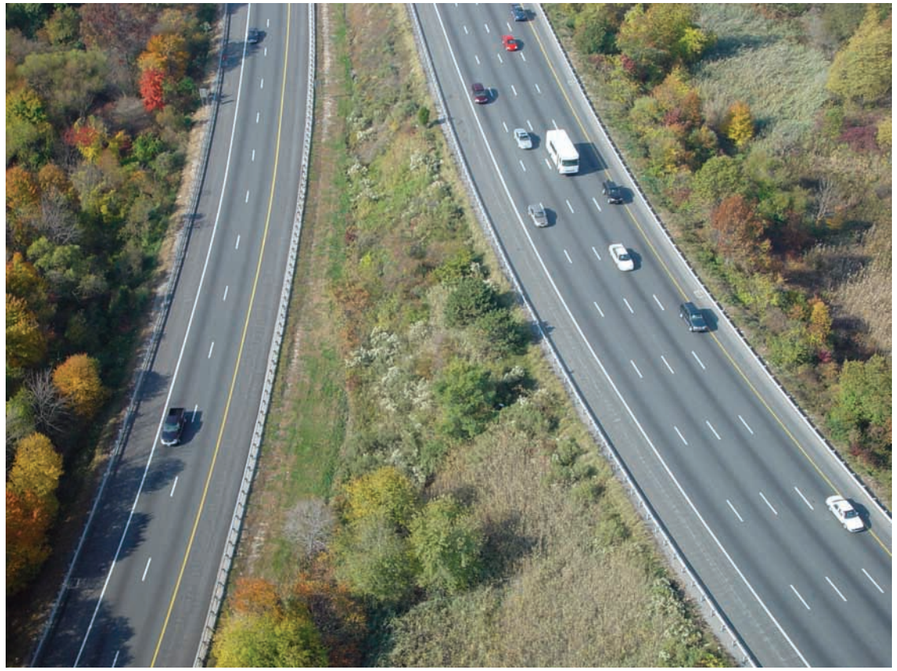
- *Discourage graffiti on structures.* Plantings can screen potential surfaces such as noise walls, windowless buildings and bridge abutments.

- *Provide a buffer between pedestrian and non-motorized traffic (e.g., bicycles and skateboards) and vehicular traffic*. Plantings can be used to improve the pedestrian environment by providing separation from vehicles both physically and visually.

- *Integrate the roadside landscape into the surroundings.* Plantings can conserve and enhance the contextual landscape or existing regional vegetation and mediate the impression of disturbance.

- *Contribute to the health and diversity of the regional environment.* Plantings can enrich the value of roadsides to wildlife and allow rights-of-way to become part of the chain of regional habitats. This can also provide on opportunity for positive publicity regarding the role of the Department of Transportation as an environmental steward.

- *Introduce travelers to Delaware's regional vegetation.* Plantings featuring regional vegetation can welcome and introduce people to Delaware's unique beauty. This is especially appropriate at rest areas, welcome centers and other public facilities located along roadsides.



Continuity of roadside and median vegetation immerses the traveler in the patterns and colors or the regional landscape.

Landscape Planning Process

The planning process begins with a thorough inventory and assessment of the site. Checklists are used to record roadway limitations and the site's climate and growth conditions. A matrix is used to record and organize cultural and historical characteristics. The process continues with the selection of an appropriate design approach based upon the completed cultural and historical matrix. Next is the determination of appropriate installation and maintenance strategies. Choosing the plant palette is the final step.

Visual appeal is always a goal of landscape design, however its relative priority varies as the need to control installation and maintenance costs, express regional identity and preserve regional biodiversity are balanced in the overall planning process. In practice, these varying priorities form a continuum, resulting in an infinite number of possible design solutions. For practical purposes, this manual defines three distinct approaches.

These roadside landscapes provide examples of the three potential design approaches.

The Regional approach places expression of regional character and low installation and maintenance costs at top priority.
Typical of the regional approach, vegetation on this vast right-of-way is the result of minimal planting of locally native shrubs within released existing herbaceous vegetation. The low costs of planting and maintenance are appropriate for this acreage adjacent to Interstate 95.

The Regional-Ornamental approach balances ornamental appeal with the desire to express regional character, all at moderate cost.
Typical of the regional-ornamental approach, this large median planting employs sweeping masses of regionally native plants to add interest to a commercial strip at modest cost.

The Fully Ornamental approach places ornamental appeal at top priority, with cost efficiency and regional uniqueness of much less importance.
Typical of the fully ornamental approach, this island planting employs a complex mix of ornamental high maintenance plants justified by its highly visible location.

A thorough inventory of this woodland edge along Wyoming Road reveals and records assets such as elderberry and red maple as well as undesirables including Japanese honeysuckle.

Site Inventory

The goal for roadside vegetation on a broad scale is to create sustainable landscapes; those requiring minimal maintenance on a continuing basis. One aspect of sustainability is the careful match of cultural requirements of plantings to specific site conditions. Due to varying natural histories and disturbance before and after construction, roadside conditions can vary enormously. A thorough site assessment is a necessary first step in accomplishing the goal of sustainability and low maintenance.

A thorough site inventory includes an assessment of roadway limitations and opportunities; climatic and growth conditions; existing vegetation; and aesthetic and visual considerations (i.e. lines of sight, views to emphasize, areas to screen, indications of change in direction, screening for headlight glare, noise buffer, accentuation of traffic information, pedestrian patterns and issues, etc.).

Three forms are provided for recording information collected during the site inventory and subsequent investigation. The forms are explained in this chapter. Appendix A includes blank forms that may be copied for use in field collection of data (see pages 122-124). The first form is a checklist of roadway limitations of the site. The second is a checklist of climate and growth conditions, and the third is a matrix of cultural and historical characteristics. Record as much information as possible during a thorough site visit.

Roadway limitations

Plantings are limited by characteristics of the site such as overhead wires, underground structures, paving, slope, utility poles and road signage. Observe and record how these structures or components will impact roadside vegetation using the following Roadway Limitations Checklist (Figure 4). (Note: Specific limitations that occur in the roadside environment are described in the Design Opportunities and Limiting Factors chapter of this manual.)

While reviewing Court Street and the Route 13 corridor, this site evaluation team considers sight lines, sign locations and overhead wires, among other limiting factors.

Figure 4. Roadway Limitations Checklist

Check the roadside zone(s) included in the location to be landscaped:
❑ Back slope or cut slope ❑ Swale or ditch zone
❑ Approach or shoulder zone ❑ Edge or border zone ❑ Front or fill slope

Check the appropriate clear zone requirement:
❑ Standard 30 feet ❑ Other (_____feet)

Presence of guard rail and/or barrier curb:
Guard rail ❑ Yes ❑ No ❑ Partial (_____feet)
Barrier curb ❑ Yes ❑ No ❑ Partial (_____feet)

Potential design exceptions to clear zone requirements (For new projects only):
❑ Exceptional trees (note size, species or historic value on seperate sheet)
❑ Adverse character change
❑ Significant functional and/or aesthetic value
❑ Scenic or low speed road
❑ Rare/endangered/threatened species (plant or animal)
❑ Wetland
❑ Reduction of water quality or serious erosion/sedimentation effects

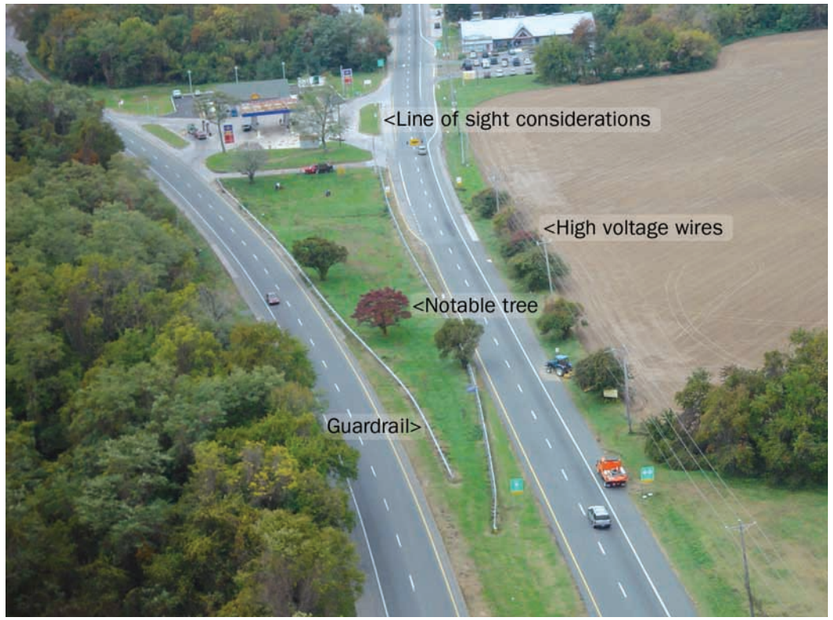
Is the drainage ditch designed with sufficient width to accommodate plantings?
❑ Yes ❑ No

Note the presence of all utilities:
❑ Above ground high voltage electric wires ❑ Buried utilities
❑ Control boxes requiring access

Note required line of sight setback: _____feet required

Note locations requiring erosion control:
_____square feet at_____% slope
_____square feet at_____% slope

Note functions plants are required to perform at this site:
❑ Indicate change in direction
❑ Increase effectiveness of traffic signs
❑ Attenuate impact
❑ Screen headlight glare
❑ Block undesirable views
❑ Emphasize desirable views
❑ Combat highway hypnosis
❑ Buffer noise
❑ Reduce mowing time
❑ Increase maintenance safety
❑ Integrate the roadside landscape into the surroundings
❑ Contribute to the health and diversity of the regional environment
❑ Introduce travelers to Delaware's regional vegetation
❑ Control drifting snow
❑ Discourage grafitti
❑ Provide a buffer for pedestrians



Vegetation planning for this site must document roadway limitations and existing elements such as high voltage wires, line of sight considerations, guardrails and existing trees; using the Roadway Limitations Checklist.

Climate and growth conditions

In nature, climatic factors limit the range and distribution of plants. Similarly, in roadside sites, climatic factors are highly important in governing plant selection. A Climate and Growth Conditions Checklist is provided to record this information (Figure 5). Environmental factors are discussed individually below, however it is important to remember that plants respond to an interaction of climatic factors.

In an overall sense, a region, such as Delaware has characteristic conditions such as temperature extremes, soil type, rainfall and patterns of seasonal variation that dictate the vegetation. This can be thought of as the macroclimate. In addition, localized conditions can significantly impact the vegetation that is sustainable in a specific site. This can be thought of as the microclimate and is ultimately most significant to successful planting design. The roadside microclimate has unique characteristics (i.e. vehicle exhausts, salt spray, salt runoff, modified soil structure and severe topography) that are challenging to plant growth. The inventory of site conditions should include an initial assessment of microclimate; however, predicting the eventual microclimate will require factoring in changes that are likely to occur during subsequent roadway construction or modification. For example, a minor change in slope combined with soil compaction would probably increase runoff and reduce infiltration that provides moisture to the root zone.

Figure 5. Climate and Growth Conditions Checklist

Check the appropriate cold hardiness zone:

❏ Zone 6 or ❏ Zone 7

Project is located in the following county:

❏ New Castle ❏ Kent ❏ Sussex

Project is located in the following physiographic region:

❏ Piedmont ❏ Coastal Plain

Conduct a soil test to determine the following soil characteristics:

Soil texture: ❏ Sand ❏ Sandy loam ❏ Loam ❏ Clay loam ❏ Clay

Organic matter content:_____% **pH:**_____

Soil moisture content: ❏ Dry ❏ Moist ❏ Very wet (drainage < 1"/hr)

Check the light exposure:

❏ Full sunlight ❏ Partial sunlight ❏ Shade

List existing thriving plant species:

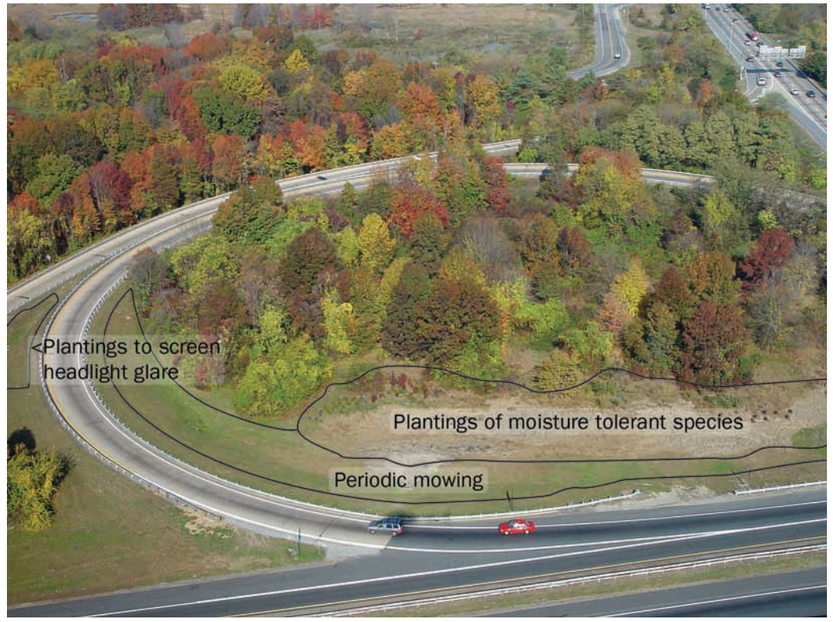
Desirable	**Undesirable**

Indicators of stress on existing species:

❏ Interveinal chlorosis ❏ Chlorosis ❏ Leaf wilting

❏ Marginal leaf scorch ❏ Premature fall coloration

List species affected by stress:



Though desirable native woodland vegetation covers much of this site, there are multiple opportunities to enhance regional diversity, reduce maintenance, and increase functionality. The open space between the woods and the roadway is periodically inundated. Additional plantings of moisture-tolerant species can extend the woodland edge while eliminating routine mowing in soggy soils. The drier slope behind the guardrail can be scheduled for periodic mowing. Strategically placed additional plantings can reduce headlight glare.

Cold hardiness- The USDA has divided the United States into numbered cold hardiness zones, based on cold temperature extremes. Plants are assigned to cold hardiness zones based on the lowest tolerated temperature for a particular species. Delaware includes cold hardiness zones 6 and 7.

Heat hardiness- Warm temperatures also affect plants. Many plants will not grow well in a zone too far south of their listed hardiness zone. The southern range of plant adaptation is much more difficult to quantify since plants don't die after exposure to one high temperature episode. The effect is more chronic. Plants that are grown beyond the southern range of their hardiness usually experience stress and undergo a slow decline. Death may result from a disease or an insect that attacks the weakened plant.

Soil conditions- Soil supplies plants with nutrients, provides habitat for essential microorganisms, anchors plants and provides a balance of air and water. Soil conditions along roadsides are variable and present both limitations and opportunities for plant selection. Factors to be considered are soil texture, soil structure, compaction, drainage, pH and salt contamination. Soil is comprised of mineral components, organic matter and pore spaces. Pore spaces can be filled with water or air. Pore spaces are affected by soil texture—the relative size of soil particles. Clay soils have very small particles and small

Although some amount of compaction is inevitable during road construction and renovation, efforts must be made to minimize compaction areas intended for planting and especially in root zones of existing trees. Placement of fencing and labeling "Do Not Disturb" on the plans would help prevent this.

pore spaces. They hold more water and have less pore space available for air. Thus, clay soils are sometimes waterlogged. But, clay particles are capable of holding more nutrients. Sandy soils have larger particles. They are well drained and have poor nutrient holding capacity. Loam soils have moderately-sized soil particles with characteristics in between clayey and sandy soils. Loam soils usually have a good balance between water and air in their pore spaces.

Soil structure is the percentage of various sized particles in a soil and the aggregation of soil particles. Compaction, a common problem in the roadside environment, is a degradation of desirable soil structure. It is impossible to change the texture of a soil, but soil structure can be improved by adding organic matter, tilling or a combination of the two. Organic matter fills in the pore spaces in a sandy soil and helps to hold water and nutrients. It has the opposite effect in a clayey soil by helping to bind individual clay particles into aggregates, creating larger pore spaces for better drainage. For existing roadways, improvement of soil characteristics is practical only for the most highly ornamental, highest priority planting projects. For new roadways, the desired soil characteristics may be included in the project specifications. In some cases, the poor, infertile soil found on roadsides may help limit the rank growth of invasive plants. By planting tough native plants well-adapted to poor soil conditions on those sites, roadside vegetation managers can reduce required maintenance.

In addition to soil texture and structure, drainage is a function of topography, ground surfaces and drainage system. Sandy soils and slopes have good drainage. On sloped or sandy sites, select plants that tolerate drought. Clay soils and drainage ditches result in moist soils. Sometimes wet sites have less invasive exotic plant pressure and afford greater opportunities for desirable plant communities. Very poorly drained sites with standing water are extremely limiting and only a few plant species will survive. One inch per hour is the minimal drainage required for most plants. If the drainage is slower and the site is highly ornamental, consider installing drainage pipes, raising the soil level or breaking though a layer of existing hardpan if one exists.

Soil pH is the relative acidity or alkalinity of a soil. Most plants native to the east coast grow best in a slightly acid soil (pH 6.0 – 6.5). In that range, plant nutrients are available, but not present in toxic quantities and microorganisms thrive. Soils in Delaware tend to be slightly acid, but construction and disturbance has changed natural soil patterns. Building materials (e.g., stucco, brick and concrete) particularly in urban environments can result in high pH or alkaline soils. In high pH soils, some nutrients, such as iron are bound to the soil and unavailable to the plants. Amend alkaline soils with sulfur to reduce pH and amend acid soils with lime to increase pH. In most highway situations, it is best to measure pH and select plants that tolerate the existing conditions; however fill along roadsides may be so highly acidic that it completely prevents plant growth. In those cases, modify soils to raise pH.

Salt is used on the roadside during the winter to melt ice. It is dissolved in water, but as the water evaporates, salts are left behind in the soil. A buildup of salts can be harmful to plant growth. Under good drainage conditions, most salts are leached from the soil by normal spring rainfall. But in poorly drained sites, salt accumulation may be a problem.

Take one or more soil samples to thoroughly evaluate soil characteristics before planting a site. Agronomic soil analysis labs (e.g., University of Delaware Soils Lab) can identify soil texture, nutrient content and soil pH. A percolation test can be performed to identify poorly drained sites. If percolation is poor, soil modification or wet tolerant plants should be specified.

Residual effects of this wintertime application of salt may limit plant choices, especially if drainage is poor.

Sunlight- Plants require light for photosynthesis. But some plants use light more efficiently than others and can grow at much lower light intensities. These plants are usually classified as "shade tolerant." Some "shade tolerant" plants actually grow best in full sunlight but will grow acceptably in partial to full shade. Other plants require shade for best performance. Plants are usually categorized as desiring full sun, partial shade or full shade. Select plants for roadside planting that best fit the light conditions of the site.

These two roadside environments–one heavily shaded and the other in full sunlight—call for entirely different planting choices.

The full-sun exposure of this Milford site is necessary for the healthy growth of red cedars, groundselbush, frost asters and native warm-season grasses.

Asters and ferns are appropriate for this rocky slope under Brandywine Park woodlands.

The location of plants growing along this drainage swale bordering Route 1 result from individual preference for varied moisture levels. White-flowered frost asters claim the highest, driest ground. Crimson-leaved bushy seed box and woolgrass occupy the wettest habitat at the bottom of the swale. On the slightly drier, better drained backslope, sweet gum trees are prevalent.

Existing plant community indicators- Existing vegetation can indicate certain site characteristics. Healthy, desirable species already growing on the site can serve as cues for a recommended plant palette. For example, thriving sugar maple, red oak and hickory, indicate well-drained soils; sycamore, black gum and sweet gum indicate moist soils; and willow and swamp white oak indicate poorly-drained soils.

In some cases modifications to the site, perhaps due to roadside construction, may significantly change conditions so they are no longer conducive to growth of existing plants. For example, on a regraded slope, the resulting conditions may require a completely different selection of plants.

This steep rocky slope, the result of regrading, is populated by drought tolerant species including warm-season grasses, red cedars, and red maples.

Poor conditions for plant growth may be revealed by indications of plant stress. For example, yellow coloration between leaf veins on plants (interveinal chlorosis) indicates high pH. Brown edges on leaves (marginal necrosis) may indicate excess salt. Premature fall color may signal a droughty location.

The presence of existing invasive exotic species on a site may indicate a history of frequent disturbance, a prevalence of invasive exotic species seeds in soil, and/or weed pressure from nearby populations of invasive exotic species that are serving as germplasm repositories. These factors must be considered when developing strategies for replanting and subsequent maintenance. For example, bittersweet must be thoroughly eradicated from a site before replanting can be undertaken. Unless the adjacent source of bittersweet is removed or reduced the long-term maintenance program must include regular monitoring and removal of new incursions.

Cultural and Historical Characteristics

A site's public exposure, community interest, natural and historic aspects, and available budget are determining factors in selecting one of the design approaches (described on page 57). The "Cultural and Historical Characteristics Matrix" is used to record this information both in the field and through additional site research. The completed matrix score is then used in selecting the design approach (See Selection page 64).

For decades, this right-of-way along a wooded 2-lane rural road through White Clay State Park was kept clear by periodic mowing. When mowing ceased, the highly disturbed sunny edge provided ideal conditions for a mix of bittersweet, multiflora rose and autumn olive. Without intervention, these invasive exotic species will continue to degrade the edge of an otherwise healthy woodland.

Figure 6. Cultural and Historical Characteristics (CHC) Matrix

Use the following chart to determine cultural and historical characteristic values.

Characteristic	Assigned Value				
	High	Medium	Low	Yes	No
Traffic exposure	2	1	0		
Gateway component				4	0
Tourism value	2	1	0		
Intersection component				3	0
Visibility				1	0
Community involvement	2	1	0		
Size	0	2	4		
Existing DE nat. veg. adjacent to site	0	1	2		
Existing DE native vegetation on site	0	1	2		
Historic value				2	0
Available budget	4	2	0		

Fill in appropriate numbers for each site using the blank matrix below. Carry the number assigned for each row to the value column and total the values to arrive at a matrix score for the site.

Characteristic	Assigned Value					Value
	High	Medium	Low	Yes	No	
Traffic exposure						
Gateway component						
Tourism value						
Intersection component						
Visibility						
Community involvement						
Size						
Existing DE nat. veg. adjacent to site						
Existing DE native vegetation on site						
Historic value						
Available budget						
					Total	
				CHC Matrix Score		

The high visibility of this gateway situated at the I95 and 495 split where southbound traffic first enters the state of Delaware justifies deliberate, ornamental plantings. This site has both high visibility and high traffic exposure.

To fill out the matrix, values must be assigned based upon multiple criteria as defined :

Traffic exposure is a measure of the relative number of cars that pass a site (as evaluated by the landscape designer) and is assigned a value of 2 if high, 1 if medium and 0 if low.

Gateway component is a measure of the site's relative importance as a gateway or prominent entrance to a community, town or city. Gateway sites are assigned a value of 4 and non-gateway sites are assigned a value of 0.

Tourism value is a measure of the prominence of the site with regard to tourist traffic. Sites with a high likelihood of making a strong impression on travelers on their way to tourist destinations in Delaware are assigned a value of 2. Sites with a moderate likelihood are assigned a value of 1 and sites with low likelihood are assigned a value of 0.

Intersection component is a measure of the site's positioning at a regulated intersection, since drivers who stop are more likely to notice conditions at such sites. Sites at intersections are assigned a value of 3. Those not at intersections are assigned a value of 0.

Visibility is a measure of how easily a location is seen by travelers. Sites easily seen from the road, especially from longer distances are assigned a value of 1. Sites that are obscured from view by features such as signs, poles or topography are assigned a value of 0.

4-way stop intersections, such as this junction between Route 100 and Route 92, provide more opportunity for travelers to appreciate details including roadside vegetation and quality of materials used in bridges and retaining walls. This site has high visibility but less traffic exposure than the gateway site on I95.

This attractive planting on Mermaid Boulevard in Pike Creek Valley is more complex and requires more maintenance than standard roadside plantings. It can be a practical alternative when a local civic league takes an active role in its upkeep.

Community involvement is a measure of a neighboring community's interest in landscape enhancement and its willingness to accept some ongoing responsible for its planting and maintenance. If both are present, community involvement is assigned a value of 2. If the community is interested but not willing to accept some responsibility, a value of 1 is assigned. If the community is not involved or there is no associated community the value is 0.

Size is assigned a value of 4 for small sites (< 10,000 sq. ft.); 2 for medium sites (10,000 – 100,000 sq. ft); and 0 for large sites (>100,000 sq. ft).

Existing Delaware native vegetation on site is a measure of the relative presence of desirable native species occurring naturally on the site. This might consist of native trees, shrubs, grasses or forbs with ornamental value. If these are present in significant quantity and quality a value of 0 is assigned. If the quantity and quality is medium, a value of 1 is assigned. If it is low, a value of 2 is assigned.

Existing Delaware native vegetation adjacent to site is a measure of the relative presence of desirable native species occurring naturally adjacent to the site. This might consist of native trees, shrubs, grasses or forbs with ornamental value. If these are present in significant quantity and quality a value of 0 is assigned. If the quantity and quality is medium, a value of 1 is assigned. If it is low, a value of 2 is assigned.

Historic value is a measure of a site's significance to Delaware history. If significance is high, a value of 2 (yes) is assigned. If insignificant, a value of 0 (no) is assigned.

Available budget is a measure of the relative financial resources available for planting and maintenance of the site. If financial resources are high, a value of 4 is assigned. If medium, a value of 2 is assigned. If low, a value of 0 is assigned.

Different approaches may be appropriate for sections within large sites. This site adjacent to Route 202 is being redeveloped to include a new road traversing the large open space (see inset). The rich regional diversity of bordering Alapocas Woods results in a matrix value of 0 for "Existing Delaware native vegetation adjacent to site." This contributes to the selection of a regional approach for this portion of the property. The Blue Ball Barn dominates the corner of the site. Its historic significance results in tabulation of a matrix value of 2 for "Historic value" contributing to the selection of a fully ornamental approach, which could accommodate the restoration of non-native traditional plantings typical of the period.

Design approach description and selection

In actuality, there is a continuum between ecologically-based regional design and ornamental, primarily decorative design, however for practical purposes three general approaches have been identified: the regional approach, the regional-ornamental approach and the fully ornamental approach. This section defines and describes each approach, suggests where each may be appropriate and outlines the implementation processes.

Typical of the natural beauty of many Delaware landscapes, this site's rich mix of joe-pye weeds, goldenrods and thoroughworts is the result of adopting the regional approach with minimal intervention.

Regional approach

Description – Plant selection is restricted to Delaware native species. The design intent is to develop attractive, naturalistic landscapes based directly on the regional ecology: the dynamics, patterns, colors and cycles of Delaware's native plant communities. There is a minimal level of intervention, just sufficient to create and maintain an aesthetic order that can be appreciated on a large scale. Though not intended to fully replicate native plant communities, regional plant associations and dynamics are conserved and enhanced, and the low level of intervention allows for considerable natural growth and propagation of native plant species on site. This approach is appropriate for large-scale sites where cultural conditions are suitable (or suitable with minor modification) for Delaware native species, and where the installation and maintenance budget is minimal. It is particularly appropriate in areas where the Delaware native flora remains a significant part of the local context. Low to moderate visibility sites including extended highway margins, broad median strips, and larger highway infields are examples where the regional approach might be selected.

Implementation processes for the regional approach are:

- Selective removal of existing vegetation may be employed to introduce aesthetic order or remove undesirable species. The existing vegetation is rarely completely removed.
- Only minimal modifications of environmental conditions are employed. Topography may be modified to provide conditions conducive to the growth of regional vegetation.
- The plant palette is selected to compliment the surrounding vegetation in terms of patterns, color and cycles. Plants are selected based in their likelihood to thrive in the existing conditions, employing an understanding and awareness of site ecology and opportunities provided by cultural niches.
- Plants are restricted to tough species that tolerate drought, full sun, wind, salt or other cultural extremes.
- Any method of establishment may be employed.
- Plant competition from desirable species is the primary method of weed control, but spot control of aggressive species that threaten the long-term survival of the site is also practiced.
- Supplemental watering is provided during establishment only.
- Mulch may be used around planted specimens, but the long-term ground layer will develop from seeded, planted or existing vegetation.

Selective removal of tulip trees helps define an existing cluster of sweet gums on this slope bordering an I95 exit ramp. This "editing" process creates visual order from the apparently random natural occurrence of native trees.

Frequently occurring on low, poorly drained ground along this section of I95, sweet pepperbush is an appropriate, well-adapted addition to this summer-blooming roadside.

This combination of river birch and sweet pepperbush planted at the low point of a wet highway median, directly emulates the common occurrence of these two native species in moist-to-wet Delaware habitats.

Although blue and gold is a color combination that may be observed in native Delaware plant communities, the aster and goldenrod species used in this gateway site do not occur together naturally. Both regional natives, they were selected for their proven performance in massed plantings under highway median conditions.

Regional-ornamental approach

Description – Plant selection is restricted to Delaware native species plus other North American native species that reflect the general character of Delaware's native flora. The design intent is to develop ornamental landscapes inspired by the regional colors, patterns and cycles of the native Delaware landscape, but is not necessarily based upon plant community dynamics. There is a moderate level of intervention, sufficient to create and maintain an aesthetic order that is noticeable and attractive on a medium to large scale. The designs rely on well-defined groupings and masses to create ornamental impact, using regional plant associations when practical to suit this purpose. This approach is appropriate for medium-to large-scale sites where cultural conditions are suitable (or suitable with moderate modifications) for a mix of Delaware and North American native species, and when the installation and maintenance budget is moderate. It is appropriate in areas where the Delaware native flora is a modest to minimal part of the local context. Moderate to high visibility sites, including larger traffic islands, highway infields, and city and community gateways are examples where the regional-ornamental approach might be selected.

A dramatic combination of boldly upright Eastern red cedars and sweeping red-berried masses of winterberry holly does not directly emulate any native plant association, but it does draw from the beauty of Delaware's regional flora. The drama is in part due to the precise artificial arrangement of the planting and this requires additional resources to maintain.

Implementation Processes-

- The existing vegetation may be selectively or completely removed. In some cases the existing vegetation can be left as the ground layer.
- Environmental conditions are corrected and maintained to facilitate plant growth. There may be a need to modify soil (e.g. change pH).
- The plant palette is selected for multiple seasons of interest that match regional cycles, organized on a medium to large scale.
- Plants are restricted to tough species that tolerate drought, full sun, wind, salt or other cultural extremes.
- Any method of establishment may be employed.
- Spot control of aggressive weeds on a regular basis may be employed to supplement plant competition as the primary method of weed control.
- Supplemental watering is provided during establishment and only in extreme drought conditions.
- Mulch may be used around planted specimens, but the long-term ground layer will develop from seeded, planted or existing vegetation.

Unmowed cool season turf provides a consistent ground layer for this planting of groundsel bush.

Masses of brilliant red sumac and fleecy white groundsel bush typify autumn in Delaware.

These two sites along Martin Luther King Boulevard and at Vandever and Market Streets are examples of the fully ornamental approach. The primary purpose of these traffic island plantings is ornamental impact and functionality. Delaware native flora is almost entirely absent from the surrounding landscapes and therefore a primarily exotic plant palette is appropriate here. Annuals provide long-lasting color that is independent of Delaware's seasonal color cycles. These high-maintenance plantings are only possible because of community sponsorship.

Fully ornamental approach

Description – Plant selection is unrestricted. Design intent is to create highly ornamental garden-like landscapes based primarily on visual impact and functionality, not necessarily related to the colors, patterns and cycles of the native Delaware landscape. If site conditions are suitable and aesthetic requirements are met, regional flora should be given preference. There is a high level of intervention and maintenance, sufficient to create and maintain a highly ordered aesthetic that is attractive on a small to medium scale, and evident even when viewed at close range. The designs rely on well-defined groupings and masses to create ornamental impact based upon qualities of color, texture and form. This approach is appropriate for small- to medium-scale sites where the desire for a neat, highly ornamental appearance exceeds the capacity of the native and regional flora, and/or where the cultural conditions on the site are so heavily impacted that they severely limit the choice of native or regional species. It is appropriate in areas where the Delaware native flora is a minimal or nonexistent part of the local context. Well-defined, small scale, high visibility sites including traffic islands and parking lots are examples where the fully ornamental approach might be selected. Due to the relatively high installation and maintenance cost of this approach, community sponsorship or assistance may be an important component in the cost-effective management of these sites. Mowed turf falls in this category since cool-season turf is not native and the maintenance cost is high.

Implementation Processes–

- In most cases, the existing vegetation is removed completely. Desirable specimens may be retained.
- Environmental conditions are corrected and maintained to facilitate plant growth. Such changes may include soil tillage, amendment, soil replacement or modification of topography and drainage.
- The plant palette is selected for multiple seasons of interest, resulting in plantings that are neat and attractive on a small scale.
- Plants are selected based on their ability to survive drought, full sun, wind, salt or other cultural extremes as much as possible within the design parameters.
- A greater investment in plant material is used to create immediate impact. Sites are planted rather than seeded. The level of plant maturity at planting depends on the site size. In large sites, plugs may be used to keep planting costs reasonable.
- Routine weed control is employed to remove most non-planted species.
- Supplemental watering is provided whenever conditions would negatively impact the visual effectiveness of the planting.
- Mulch is the typical ground layer.

Although mulch requires annual replenishment, it does contribute to a neat, uniform, relatively weed-free ground layer.

Selection

The "Cultural and Historical Characteristics Matrix" tool provides a basis for the selection of one of the three design approaches. This tool factors in a broad range of characteristics to result in a design that is context sensitive. After assigning values based upon site evaluation and subsequent research, the completed matrix is totaled to arrive at a CHC matrix score.

Filling in the matrix- Various site characteristics have been assigned weighted values reflecting their importance in approach selection. The chart below illustrates the possible values that can be assigned to each characteristic in the matrix (Figure 7).

Figure 7. Cultural and Historical Characteristics CHC Matrix: Possible values

Characteristic	Assigned Value				
	High	Medium	Low	Yes	No
Traffic exposure	2	1	0		
Gateway component				4	0
Tourism value	2	1	0		
Intersection component				3	0
Visibility				1	0
Community involvement	2	1	0		
Size	0	2	4		
Existing DE nat. veg. adjacent to site	0	1	2		
Existing DE native vegetation on site	0	1	2		
Historic value				2	0
Available budget	4	2	0		

Tabulating the result from the matrix- Carry the assigned value for each characteristic to the value column. Add the individual values to get the index value.

Figure 8. Cultural and Historical Characteristics (CHC) Matrix: Hypothetical Site

Characteristic	Assigned Value					
	High	Medium	Low	Yes	No	Value
Traffic exposure	2					2
Gateway component				4		4
Tourism value	2					2
Intersection component					0	0
Visibility				1		1
Community involvement			0			0
Size		2				2
Existing DE nat. veg. adjacent to site		1				1
Existing DE native vegetation on site	0					0
Historic value					0	0
Available budget		2				2
						Total
					CHC Matrix Score	14

If the matrix score is:

- greater than or equal to 20, choose the fully ornamental approach.
- between 17.5 and 12.5, choose the regional-ornamental approach
- less than or equal to 10, choose the regional approach.

There will be some subjectivity involved in cases where values fall in between the category ranges, requiring the designer to use judgement in selecting an approach. By example, if the matrix score is between 17.5 and 20, either fully ornamental or regional-ornamental may be appropriate. If the matrix score is between 12.5 and 10, either regional-ornamental or regional may be appropriate. In this hypothetical example, an matrix score of 14 would indicate the choice of a regional-ornamental approach. To illustrate this process, three examples are outlined.

Example A before site development

Example A after site development

Example A– exit ramp infield off southbound I95 onto 896 North. Since a large volume of drivers exiting I95 view the site, the traffic exposure is rated high (2). This is the most direct southbound exit for the City of Newark and serves as a gateway in this regard so the gateway is rated yes (4). This is the most-used exit in Delaware taken by people visiting the University of Delaware and therefore the tourism rating is high (2). This is an exit ramp rather than a regulated intersection, so the intersection rating is no (0). There are no obstructions to the view of this site, so the visibility rating is yes (1). There is no local community associated with this site so the community involvement rating is low (0). The size is between 10,000 and 100,000 sq. ft. so the size rating is medium (2). This site is comprised of mowed cool-season turf so the quality of existing native vegetation on site is low (2). Also, the quality of existing native vegetation adjacent to the site is low (2). There is no significant historical character to this site so the historic rating is no (0). This site has been mowed at a relatively high rate of 8-10 times per year so the available budget is medium (2). The CHC Matrix Score of 17 clearly assigns the site to the regional-ornamental design approach.

Example B– borders the 896 exit ramp from Northbound I95. Since a large volume of drivers exiting I95 view the site, the traffic exposure is rated high (2). This exit is the first exit in Delaware and the one taken by most northbound traffic heading into Newark or the University of Delaware and therefore the gateway rating is yes (4). Since a good percentage of the traffic passing by this site is comprised of tourists visiting Delaware, the tourism rating is medium (1). This is an exit ramp rather than a regulated intersection, so the intersection rating is no (0). There are no obstructions to the view of this site, so the visibility rating is yes (1). There is no local community associated with this site so the community involvement rating is low (0). The site is greater than 100,000 sq. ft. so the size rating is high (0). This site, part of the Iron Hill complex, is a Delaware Natural Heritage site, so the quality of existing native vegetation on site is high (0). For the same reason, the quality of existing native vegetation adjacent to the site is high (0). There is no significant historical character to this site so the historic rating is no (0). The available budget for this site is low (0). The CHC Matrix Score of 8 clearly assigns the site to the regional design approach.

Figure 9. Design Approach Selection - Example A:

Characteristic	Assigned Value					Value
	High	Medium	Low	Yes	No	
Traffic exposure	2					2
Gateway component				4		4
Tourism value	2					2
Intersection component					0	0
Visibility				1		1
Community involvement			0			0
Size		2				2
Existing DE nat. veg. adjacent to site			2			2
Existing DE native vegetation on site			2			2
Historic value					0	0
Available budget		2				2
						Total
					CHC Matrix Score	17

Figure 10. Design Approach Selection - Example B:

Characteristic	Assigned Value					Value
	High	Medium	Low	Yes	No	
Traffic exposure	2					2
Gateway component				4		4
Tourism value		1				1
Intersection component					0	0
Visibility				1		1
Community involvement			0			0
Size	0					0
Existing DE nat. veg. adjacent to site	0					0
Existing DE native vegetation on site	0					0
Historic value					0	0
Available budget						0
						Total
					CHC Matrix Score	8

Example C– a traffic island located at the intersection of two major roads in a suburban community (Lancaster Avenue, Rt. 41 and Valley Road in Hockessin). Since a large volume of drivers from both roads view the site, the traffic exposure is rated high (2). This intersection is in the center of the community so it does not function as a gateway, therefore the gateway rating is no (0). This community is not a tourist destination so the tourism rating is low (0). It is clearly an intersection so the intersection rating is yes (3). There are no obstructions to the view of this site, so the visibility rating is yes (1). A local volunteer group working in conjunction with a local merchant has offered to take responsibility for site maintenance so community involvement is rated high (2). Since the square footage of this site is less than 10,000, the size rating is small (4). The traffic island is currently vegetated with cool-season turf and derelict shrub plantings, so the quality of existing Delaware native vegetation is low (2). This is a highly urbanized site surrounded by business establishments with ornamental plantings, so the quality of existing Delaware native vegetation adjacent to the site is low (2). There is no significant historical character to this site so the historic rating is no (0). The local merchant is interested in contributing financially to the site design and installation; therefore the available budget rating is high (4). The CHC Matrix Score is 20, clearly assigning the site to the fully ornamental approach. In this example, site conditions are suitable and aesthetic requirements can be met while retaining a preference for regional flora in the planting palette. While there are a few exotic species and cultivars, most of the plants used on this site are Delaware or eastern regional natives.

Figure 11. Design Approach Selection - Example C:

Characteristic	Assigned Value					Value
	High	Medium	Low	Yes	No	
Traffic exposure	2					2
Gateway component					0	0
Tourism value			0			0
Intersection component				3		3
Visibility				1		1
Community involvement		2				2
Size			4			4
Existing DE nat. veg. adjacent to site			2			2
Existing DE native vegetation on site			2			2
Historic value					0	0
Available budget	4					4
						Total
						CHC Matrix Score 20

Example C after site development

All three layers are present in this I95 gateway planting. While fringe trees and American hollies are shrub-sized when first planted they will mature to provide a distinct tree layer. Viburnums are part of the permanent shrub layer and the ground layer is comprised of an herbaceous mix including butterfly milkweed, aster and goldenrod.

Landscape layers and elements

In general, the landscape may be divided into three layers—a ground layer, a shrub layer and a tree layer. In any individual landscape, one or more of these layers may be present. Each layer is typically comprised of one or more elements represented by different types of plants (For individual plant descriptions see The Plant Palette: Charts by Plant Type, page 107).

Ground layer

The ground layer is the lowest layer usually ranging from a few inches to perhaps six feet. Literally covering the ground, it is typically comprised of various types of herbaceous plants. In addition to its aesthetic function, a well-developed ground layer minimizes erosion and reduces the likelihood of invasion by unwanted species.

Cool-season grasses are most frequently encountered in the form of mowed turf and most turfgrasses are non-native species. Mowed turf has the advantage of providing a relatively uniform, neat, durable ground cover at the expense of high maintenance.

Warm-season grasses include the majority of our native prairie and meadow species as well as some familiar exotics such as miscanthus and fountain grass. They generally do not tolerate low mowing, but especially in the case of warm-season native grasses, can provide a dense medium-height (2-6') cover over large expanses. Although less uniform in appearance than mowed cool-season grasses, warm-season grasses offer much greater interest in flowers, texture, form and seasonal color. Native warm-season grasses sometimes occur naturally in near-monocultures and may be deliberately established in this manner on designed sites, introducing additional uniformity.

Whether viewed up close or from a distance, the silvery flowers of splitbeard bluestem, a native warm-season grass, make a striking impression.

Although the warm-season grasses in the center of this highway infield are slightly less uniform than the mowed cool-season grasses at the edge, they provide a consistently attractive cover over large expanses.

Durable herbaceous plants such as this bluestar can serve as effective ground layer plantings even over large expanses.

Perennial forbs are broad-leaved herbaceous flowering plants (as opposed to the narrow-leaved grasses, sedges and rushes). Included in this group are some that form distinct clumps and others that spread aggressively by runners. In addition to their ground-covering function, perennial forbs are often a major source of flowering interest in the landscape, especially in summer and autumn when the flowering of trees and shrubs is at a low ebb.

Herbaceous annuals, biennials and tender perennials are all plants that generally require annual replacement. They can provide highly ornamental flowers, fruit or foliage, but at the cost of high maintenance.

Although these elements may be neatly segregated in the ground layer of designed landscapes, they are sometimes of greatest utility in combination. One of the most durable examples is a mix of warm-season grasses and perennial forbs.

There's a price to "Saying it with Flowers." Included in the seeding mix of a newly renovated site, annual black-eyed Susans make an initial splash that may continue indefinitely or may need renewal after three or more years.

Dominated by perennial forbs these two sites in New Castle County and Kent County, are colorful in mid-August when most Delaware native trees and shrubs are simply green.

Shrub layer

The shrub layer is the middle layer, typically ranging from two to fifteen feet in height. As woody, semi-permanent components of the landscape, shrubs offer diverse multi-season interest from flowers, foliage, fruit, bark and architecture. Evergreen shrubs provide a steady green and a screening presence throughout the year. When planted densely in masses, shrubs take over the ground-covering function normally carried out by the herbaceous layer.

Clump-forming shrubs are suitable for relatively precise designs due to their predictable spread.

Colonizing shrubs create masses by sprouting from spreading roots and this capacity can be of great utility for filling in relatively large areas. Unless contained by fixed barriers, this spread can be unwieldy in precisely designed areas. These plants are best relegated to more naturalistic designs. The colonizing nature can be especially useful when selecting plants to stabilize slopes. Additionally, the density of colonizing root systems is often sufficient to discourage potential invaders.

In October, a shrub layer dominated by sweet pepperbush forms a virtual gold band at the bottom of this woodland edge facing Route 1.

An established colony of sumac holds the slope and creates sufficient shade within its spread to discourage weed competition.

Although not as weed-free as some of the most durable herbaceous perennials, this mass planting of red chokeberry makes a serviceable groundcover with multi-season interest.

Tree layer

The tree layer is the uppermost layer continuing from the upper reaches of the shrub layer to the sky. The tree layer often has two components—an understory layer of smaller trees, ranging in height from 20 feet to 40 feet; and a canopy layer of large trees, which reach heights of 100 feet or more. In addition to offering diverse multi-season interest from flowers, foliage, fruit, bark and architecture; trees play the greatest role in defining and organizing space. In Delaware, deciduous trees make up the vast majority of the native woodlands, with native evergreens generally occurring in the understory or at sunny edges and openings. Other regional native evergreens, such as white pine, are capable of reaching canopy heights.

Understory trees are generally smaller and more often have highly ornamental flowers and fruit. They tend to be more shade tolerant and are capable of growing on a sustained basis below the canopy layer, although floral displays are typically best when provided some direct sunlight. Understory trees are one of the best means of providing flowering interest in springtime. This function is largely taken over by the herbaceous layer in summer and autumn. Some understory trees, such as sassafras and persimmon, are colonial in nature and are often most effective in designed landscapes when grown in groves.

Among the native palette, understory trees offer the most dramatic spring flower displays. Serviceberry along Route 52 in Winterthur, DE and redbud in downtown Wilmington brighten the April roadside.

This healthy forest remnant brings the grand scale of the deciduous woodlands to the experience of the daily commute.

Canopy trees are the largest and most durable living elements in the landscape. Though less commonly offering floral displays, canopy trees are valued primarily for their structure, shade and in the case of deciduous species, for their brilliant autumn foliage displays.

Installation and Maintenance Strategies

Deliberate planting is the most common strategy in developing traditional landscapes. The vast scale of roadside landscape sometimes requires less expensive methods. The desired aesthetic is sometimes best accomplished by adopting strategies involving varying levels of intervention and maintenance, some of which involve little or no deliberate planting. The following are definitions for these strategies.

Editing – Evaluate existing vegetation and identify opportunities to introduce aesthetic order by highlighting individual specimens or plant groups through the process of removing other vegetation.

After editing, consider supplementing the existing landscape with desirable species to enhance the appearance and utility of the resulting landscape. Plants added after editing may be material representing local provenance (if available) or other plants compatible with the design approach employed.

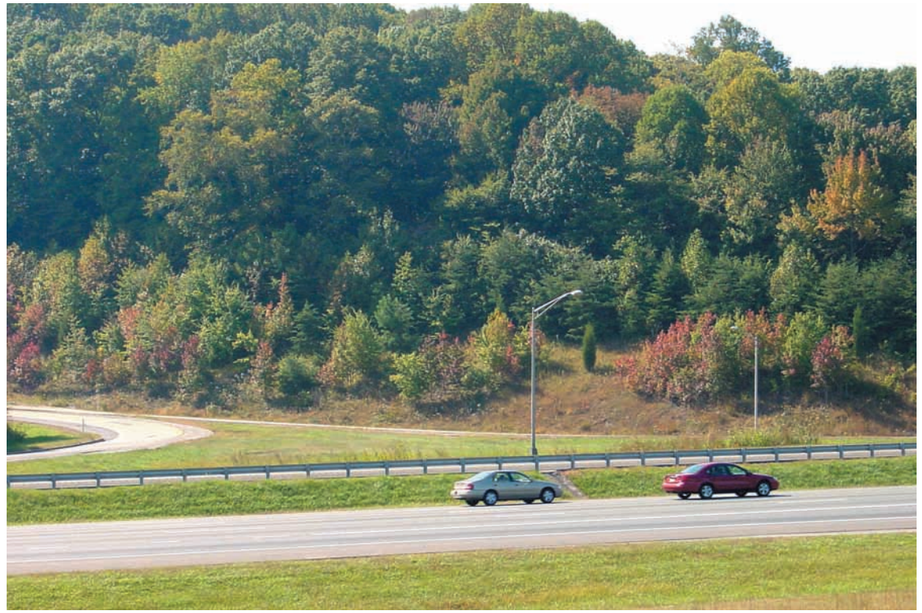
This pleasing landscape is the result of editing. The process is illustrated on the following pages.

Natural regrowth on this exit ramp slope appears random and disorganized to most passing motorists.

The order of the resulting landscape is readily apparent even from a distance.

These four images record steps in the editing process as the random order of regrowth is given definition.

Selective removal results in clearly defined groupings of trees separated by open spaces.



The benefits of this process are that planting cost is eliminated and local species and ecotypes are conserved and celebrated in the managed roadside landscape.

Cutting back – Periodic cutting of woody vegetation maintains dense and healthy growth within desired height and spread parameters.

Trees can be treated as cutbacks too. Stabilizing a slope along Route 896, this mass of sassafras and sumac results from periodic cutting back, brightening the autumn roadside with complementary colors.

A rich diversity of coastal plain trees and shrubs including groundsel bush, winged sumac, bayberry, and sweet-bay magnolia is conserved in an attractive hedge bordering Route 1 through Delaware Seashore State Park. Requiring no planting, this composition is the result of periodic cutting back.

Summer 2000

Spring 2001

Fall 2003

Although groundsel bush comprised a large portion of the vegetation on this slope, most plants were overgrown and unkempt in appearance. This shrub is capable of indefinite rejuvenation if periodically cut to the ground. Attractive regrowth results within three years after cutting back with an articulated arm brush hog.

Periodic mowing can produce very pleasing landscapes. Mowed annually, this large infield between I95 and the Christiana Mall is appealing even in mid-September's dryness, as sunlight plays over the tops of silvery grass seed heads and goldenrods bloom in drifts.

To win popular approval, the aesthetic resulting from periodic mowing critically depends upon a neat, routinely mowed edge.

Periodic mowing – Mow the site annually or as necessary to discourage establishment of woody species and maintain an herbaceous composition.

Set off dramatically by a routinely mowed edge, the warm season grasses covering the majority of this infield reduce maintenance, increase biological diversity, improve ground water recharge and add interest to the regional roadside even in late autumn.

Routine mowing is expensive. However, on a limited basis, especially on relatively even surfaces, it is an effective maintenance strategy resulting in an attractive appearance with a high degree of utility. Along Wyoming Road in downtown Newark, mowed cool-season turf is a neat and practical groundcover for the relatively small area between curb and sidewalk, and between sidewalk and woods edge.

Although an endless sweep of lush green lawn has long been a favorite aesthetic, this is often not the reality of expanses of cool-season mowed turf in the roadside environment. As evident in this mid-August view of an I95 infield, Delaware's frequent summer droughts typically reduce cool-season turf to a parched wasteland.

Routine mowing – Mow the site frequently to maintain a specified height of vegetation.

Routine mowing is least suited to steeply sloping roadsides, where it introduces significant risk of operator injury.

A single mower pass on each side brings the requisite order to this Dewey median. Annual mowing of the center allows the rich diversity of Dewey's coastal plain flora to flourish.

Reduced mowing directly results in increased habitat. Freed from routine mowing's constraint, the existing seedbank in this Dewey median finds its expression in a rich mix of seaside goldenrods, switchgrasses, and thoroughworts that speak of southern Delaware's natural coastal beauty.

Discontinued mowing – Stop routine mowing, releasing the desirable regional vegetation to develop through natural growth or seeding. Undesirable plants will be controlled by spot treatment. A released site may require occasional intervention such as periodic mowing, editing or cutting back.

Over time, cessation of mowing results in an evolution toward woody vegetation, however, interim stages are often dominated by transitional species such as this wild senna.

The transition from routinely mowed turf to an unmowed landscape does require some intervention, however with proper management, such landscapes can be attractive throughout the stages of this evolution. After a year without mowing, this steep slope is pleasantly covered in cool season grasses flowering at a height of two feet. In following stages, the incursion of invasive exotic plants such as autumn olive and multiflora rose must be controlled with periodic spot spraying. Ultimately, such selective intervention will result in a primarily woody mix of regional native species. The composition of this mix will vary depending upon seed sources in the soil and surrounding landscapes. In this example, red maples, sweet gums and eastern red cedars have established themselves.

mid-February

mid-August

There is no good reason to mow the multiple acres on the far side of this drainage swale paralleling the Route 273 entrance ramp to I95. Although previously mowed routinely, mowing was stopped in 1998. Unmowed at the time of this photo for five years, the area has become populated by great sweeps of locally native grasses and flowering forbs that make an attractive impression in multiple seasons.

Deliberate planting – Plants may be deliberately introduced in one of two general ways—by sowing seed or by the installation of plants.

Seeding – This planting method can be economical for establishing herbaceous plants (grasses and forbs). Since seeding results in random or informal distribution, it is most appropriate for larger areas where the precise location of individual plants is not of primary importance.

The success of seed establishment is highly dependent on weather conditions, seed quality and conditions on the site. Because of these variables, the successful establishment of any given species in the mix is lower than when nursery-grown plants are installed. Seedlings rarely provide the immediate impact of nursery-grown plants and often require two or more years before becoming evident or effective. This is especially true in the case of warm-season plant types.

There are other factors to be considered before selecting seeding as the establishment technique. Seed availability is an important issue. Necessary quantities of quality seed may be difficult to obtain within required project schedules and the seed price of certain species can sometimes be prohibitive. When the design calls for plants that represent the regional gene pool, it is best to use seed collected locally. Such seed of local provenance may be difficult to obtain from standard commercial sources. Seed is not an appropriate method of establishing clonal cultivars, which depend upon asexual propagation for their uniformity. In these situations, nursery-grown, clonally propagated plants are required. For example, *Solidago rugosa* 'Fireworks' is a clonal cultivar of goldenrod selected for its outstanding flower form.

One of the ways to obtain plants of local provenance is to arrange for propagation of material collected on site. In this case, the expanded mass of indiangrass results from the addition of plants grown from seed collected on site.

The following are different types of seeding methods:

- hydroseeding – distributing seed with a paper mulch through a stream of high pressure water.
- broadcast seeding – the simple dry distribution of seed often mixed with a carrier such as sawdust to improve dispersal.
- drill seeding – the placement of seed in a shallow trench created by a disc.

Plant installation – This is the necessary method of establishing woody materials such as trees and shrubs and can be appropriate for herbaceous materials. It is most appropriate for designed areas where plants' precise locations are important. Plants may be installed as individual specimens or in clearly defined groups, sweeps or dense aggregations to create desired patterns and masses. Plant installation may be used within a larger seeded or released area to introduce more defined sections in the midst of the random naturalism that results from seeding or release. Individual plants may be acquired as one of the following:

- balled and burlapped (B & B) plants – field grown plants harvested with a root mass and surrounding soil, contained by burlap. This is a common production method for woody shrubs and trees and is less commonly used for large herbaceous plants.
- bare root plants – field grown woody plants harvested with a root mass that is devoid of soil, typically used only for plants in a dormant state.
- container-grown plants – are grown in artificial media within a container. This production method is increasingly used for woody plants and herbaceous perennials.
- plugs – very small herbaceous plants grown in small containers.

This densely dramatic, but irregular pattern of butterfly milkweed is the result of drill seeding. Growing from the existing soil seed bank, the white-flowered daisy fleabane is a beneficial, but fleeting result of disturbance during the drilling process.

Loosely informal, the scattered arrangement of penstemon is not dramatic but is a noticeable feature throughout this large-scale right-of-way.

Planting of Indiangrass on July 8th with a Truax® drill seeder results in a solid stand of grass on August 11th.

These views on August 12th and October 4th illustrate the ordered presence of little bluestem and hyssop-leaved thoroughwort, which were planted as plugs in the midst of a seeded infield.

The uniform pattern of this sweep of Northwind switchgrass is the result of planting small plugs in precise locations.

Eastern red cedars are planted in a naturalistic arrangement along the dry, rocky I95 cut through Wilmington. Requiring less supplemental water than bare root or container material during establishment, balled and burlapped trees offer the best chance of survival in this challenging environment.

Smooth witherod viburnum and sweet pepperbush are planted in a well-defined mass around this large oak.

Illustrated examples

After a context sensitive design approach has been selected (using the Cultural and Historical Characteristics CHC Matrix tool, see Fig.6, page 54) the next step is to choose planting elements, plant selections, and installation and maintenance strategies appropriate to the specific environmental conditions at the site.

Although strategy selection must meet certain criteria for aesthetics, economic efficiency and sustainability, it is a subjective process permitting the designer considerable latitude. It is not easily defined by a series of regimented steps, but is best illustrated by the following set of examples.

Examples of the regional design approach

Regional Example A (see Figure 12): This large site slopes steeply down to the adjacent roadside. It consists of both open sunny areas and increasing shade towards the edge of an existing woodland backdrop. The existing vegetation is the result of natural regeneration following the road cut more than a decade ago and consists of mixed deciduous trees interspersed in large populations of native warm-season grasses. It is evident from plants existing on the site that the soil is sufficiently fertile to support a wide range of vegetation. The presence of acid-loving shrubs, such as blueberry, indicates an acid soil.

Regional Example A

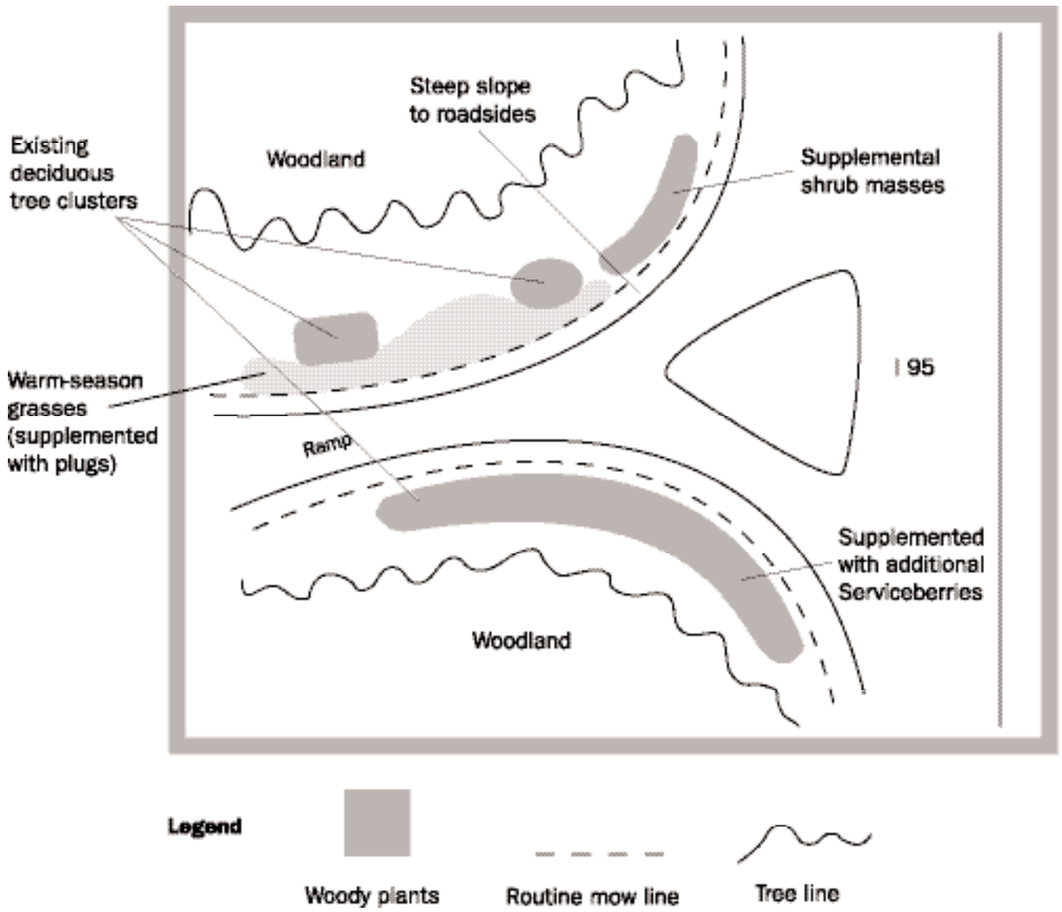
Although the existing vegetation is attractive, it is unordered and would likely be perceived as unmanaged to the casual observer. The site is too steep to safely mow and therefore the cover of warm-season grasses is an asset to be maintained. The composition of deciduous trees presents the opportunity to introduce order through selective removal. The editing process can be employed to create neatly effective groupings of like species that appear as deliberate islands within the sweep of grasses. There are also invasive exotic shrubs on the site, requiring removal. Continuing the sweeps of grasses is the best way of re-establishing the ground layer on areas left bare from removal. Since this area is sloped and of relatively modest size, plugging may be the most cost effective method of continuing the grass cover.

In addition to editing, the site can be enhanced through new plantings. Application of the CHC matrix tool shows that the regional design approach is appropriate for this site and dictates that new plantings consist of regionally native species. A few serviceberries in the existing understory provide the only significant spring bloom. These are a natural choice to enhance spring interest while building upon existing vegetation. Planting them just beyond the edge of the woodland provides sufficient sun for good flowering and positions the trees ornamentally against the woodland backdrop.

The existing shrub layer on the site is minimal. To enhance this element, plants with multi-season interest and tolerance of acid conditions are logical choices. Species such as red chokeberry and blueberry meet these criteria. Due to the relatively large scale of the site, these shrubs must be planted in large masses to make sufficient impact.

To maintain the order introduced through editing, early attention to removal and stump treatment of unwanted tree seedlings and resprouts will be necessary. Although the new plantings and enhanced ground layer will reduce the incidence of invasive exotic species, semi-annual scouting and removal will be required.

Figure 12 Regional Example A
Strategy + Plant Selection
Example of regional design approach



Red chokeberry (*Aronia arbutifolia*) adds seasonal interest to shrub layer.

Even after three years, with minimal intervention, The definition and pattern at this site is still evident.

If uncontrolled, regrowth around this Eastern red cedar (*Juniperus virginiana*) will eventually obscure the order introduced through editing.

The editing approach offers the best likelihood of preserving existing species (such as Large purple false-foxglove, *Agalinus purpurea* (photo on left) *and* Marsh pink, *Sabatia angularis* (photo on right), which might be present on a dry slope). Although not highly visible at highway speeds, such species are important complements of the existing biodiversity.

Regional Example B

Regional Example B (see Figure 13): This full-sun site consists of large expanses of mowed grass, and is bisected at its lowest point by a drainage ditch. The naturally occurring vegetation in the ditch includes a rich diversity of native trees, shrubs and perennials; however, soils on the grassy portion are relatively thin and infertile and the existing cool-season grasses are patchy. The available moisture on the site ranges from extremely dry on the upper portion to moist nearest the ditch.

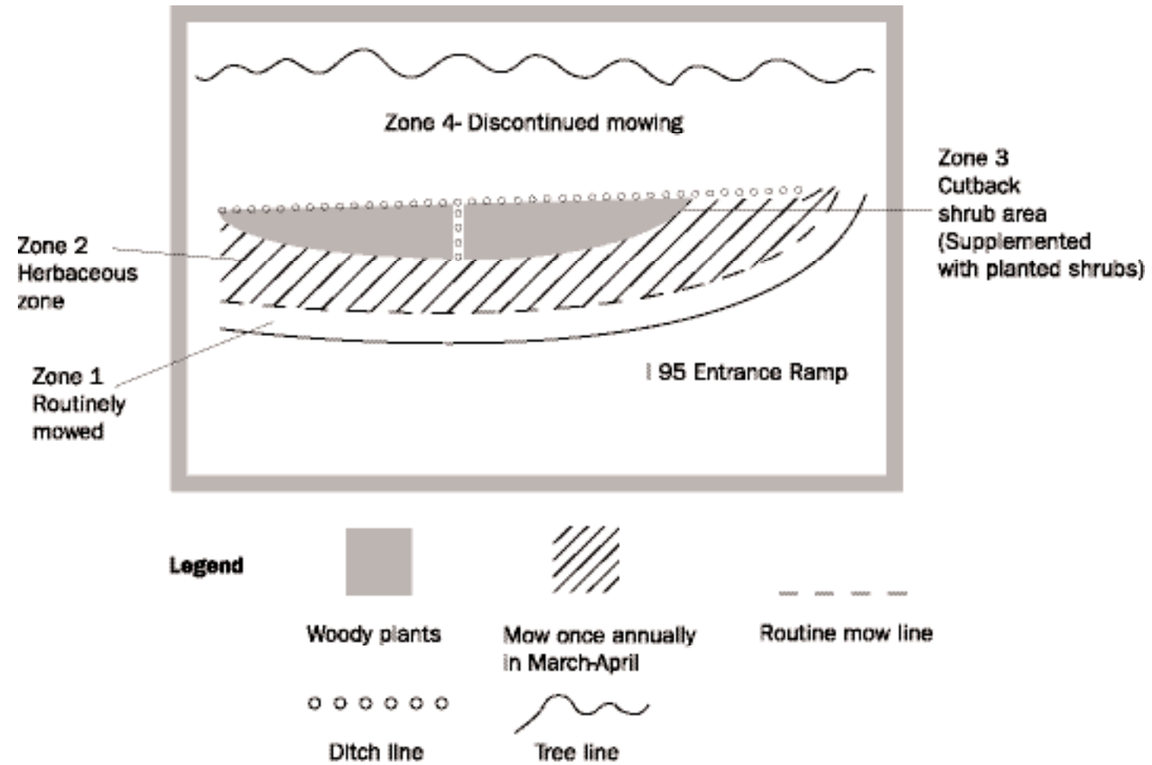
In keeping with traditional maintenance of drainage ditches, the ditch on this site has been periodically cleared of woody vegetation. A new assessment of the site reveals that the ditch is so far below road grade that the growth of woody plants in the ditch will not compromise the drainage and integrity of the road surface. Allowing such growth will add to the ornamental appeal of this site.

There is an opportunity to reduce mowing and allow the natural regeneration of warm-season grasses and native forbs on the far side of the ditch. Due to the relatively thin, infertile soils, the occurrence of grasses such as little bluestem and broomsedge is highly likely and the incursion of invasive exotics should be minimal.

The ditch vegetation can be allowed to grow indefinitely without mowing, gaining size and maturity and providing multi-season interest from flowers to fall foliage.

The area between the ditch and the road, currently in mowed turf, can be organized into three zones. The first zone (Zone 1) nearest the road can be maintained as a narrow band of mowed turf to provide a clean edge at the front of the site. The next zone (Zone 2) can be maintained as an herbaceous zone, consisting of warm-season grasses and perennial forbs. A third zone (Zone 3) can be maintained as a cutback shrub area, consisting of shrubs that spread from the ditch as well as shrubs that are deliberately planted. Application of the CHC matrix tool shows that the regional design approach is appropriate for this site and dictates that new plantings consist of regionally native species.

Figure 13 Regional Example B
Strategy + Plant Selection
Example of regional design approach



Mowing will be discontinued on the far side of the ditch (Zone 4). Occasional intervention such as mowing or spot spraying as necessary to control invasive exotic species may be required. Zone 3 on the near side of the ditch can be cut back every five years to maintain a shrub layer at moderate height distinct from the taller vegetation in the drainage ditch. The herbaceous zone (Zone 2) should be mowed annually to prevent the incursion of woody species. The narrow strip of turf (Zone 1) must be mowed routinely to provide a well-maintained appearance.

Zone 1

Zone 2

Zone 3

Hyssop-leaved thoroughwort
(*Eupatorium hyssopifolium)*

Joe-pye weed
(*Eupatorium dubium)*

Arrowwood viburnum
(*Viburnum dentatum)*

Sweet pepperbush
(*Clethra alnifolia)*

Round-leaved thoroughwort
(Eupatorium rotundifolium)

New York ironweed
(*Vernonia noveboracensis)*

Examples of the regional-ornamental design approach

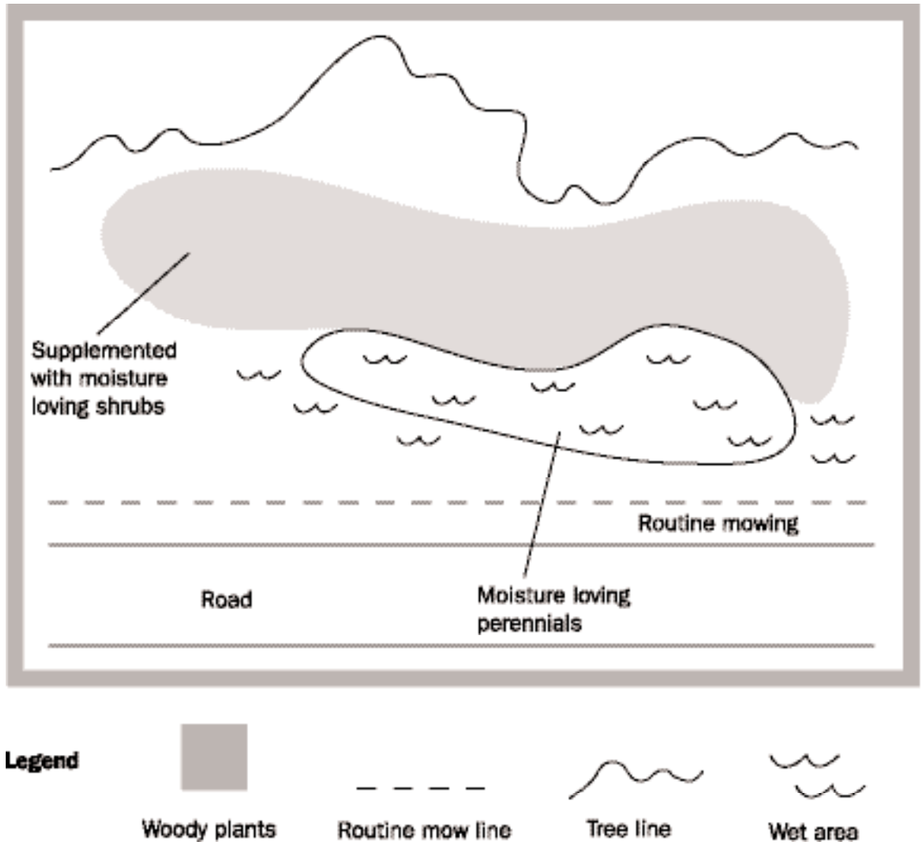
Regional-ornamental Example A (see Figure 14): This relatively small, high visibility site is low and moist and periodically inundated with water. The rear of the site is slightly elevated and contains moisture tolerant trees, which provide a good backdrop with peak ornamental interest in autumn color. There is little other vegetation on the site that is of significant ornamental interest. The front of the site is lower and moister and has been maintained in low grassy growth only with great difficulty. Mowing equipment has been frequently mired in the soggy ground.

Application of the CHC matrix tool shows that the regional-ornamental design approach is appropriate for this site. This approach specifies the use of regional Delaware native species plus other North American natives that reflect the general character of Delaware's flora. Although often viewed as an impediment to planting, the wet conditions toward the front of this site represent desirable habitat. A creative habitat-based approach reconizes this as an opportunity to introduce moisture-loving species such as winterberry holly, sweet pepperbush, button bush, marsh mallow, blue vervain, cardinal flower and redtop panicum. Deliberate planting of these in organized bands will add summer flower interest and brilliant winter berry display.

The wet conditions on this site act as a natural limiter on the number of invasive exotics that become established so no regular mowing or cutting back is required. However, the drier area near the back of the site must be monitored for invasive species, which will require periodic control by herbicides. A narrow strip of turf adjacent to the road must be mowed routinely to provide a well-maintained appearance.

Regional-ornamental Example A

Figure 14 Regional-ornamental Example A
Strategy + Plant Selection
Example of regional-ornamental design approach



Ruts in wet ground indicate the difficulty of maintaining mowed turf on Regional-ornamental Example A. Maximizing the site's potential, a moist habitat increases visual appeal and biological diversity while reducing maintenance. Marsh mallows visually evident at highway speeds, become part of an attractive complex of plants that often occur together naturally in wet Delaware habitats.

All these plants might be found growing in association with one another in moist Delaware habitats like Regional-ornamental Example A.

Red top panicum (*Panicum rigidulum)*

Cardinal flower (*Lobelia cardinalis)*

Marsh mallow (*Hibiscus moscheutos)*

Blue vervain (*Verbena hastata)*

Winterberry holly (*Ilex verticillata)*
and Late-flowering thoroughwort (*Eupatorium serotinum)*

Button bush (*Cephalanthus occidentalis)*

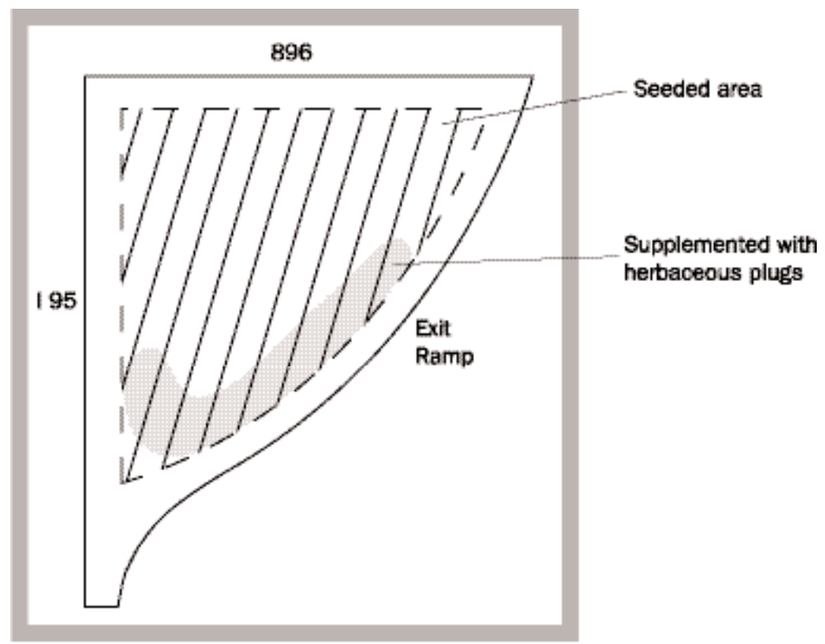
Regional-ornamental Example B (see Figure 15): Located at a gateway to Newark, DE, this relatively large interchange infield is highly visible. The entire five acres is currently maintained as mowed turf. Situated entirely in full sun, this well-drained site has moderately fertile soils. There is an opportunity to enhance the ornamental character of the site while realizing the cost savings of removing five acres from regular mowing.

Application of the CHC matrix tool shows that the regional-ornamental design approach is appropriate for this site. It would be appropriate to introduce both color and order to this gateway site. Due to its size, deliberate planting of the entire site with plugs would not be economically feasible, so seeding with a mix of warm-season grasses and flowering perennials is the best option. Within this seeded area, additional order can be established by planting plugs of highly ornamental perennials. These can be used to make distinct patterns within the more naturalistic mosaic that results from seeding. Since the regional-ornamental approach allows the use of Delaware natives and North American natives, the plants selected might include Delaware natives such as indian-grass, little bluestem and hyssop-leaved thoroughwort as well as North American natives such as black-eyed-susan, false blue indigo and thread-leaved bluestar. A narrow band of mowed turf can be maintained to provide a clean edge around the site.

Maintenance will consist of yearly mowing to keep the site entirely herbaceous. Additional spot treatment of invasive exotics will be required. The narrow strip of turf must be mowed routinely to provide a well-maintained appearance.

Patches of crown vetch will not be controlled by yearly mowing and will require spot treatment with herbicides.

Figure 15 Regional-ornamental Example B
Strategy + Plant Selection
Example of regional-ornamental design approach



Regional-ornamental Example B

Regional-ornamental Example B

Regional-ornamental Example C (see Figure 16): Traffic moves quickly past this visible site, which consists primarily of mowed turf with a dense deciduous forest remnant as a backdrop. The site itself is sunny and relatively flat. Consistently moist conditions have made the current regime of regular mowing difficult.

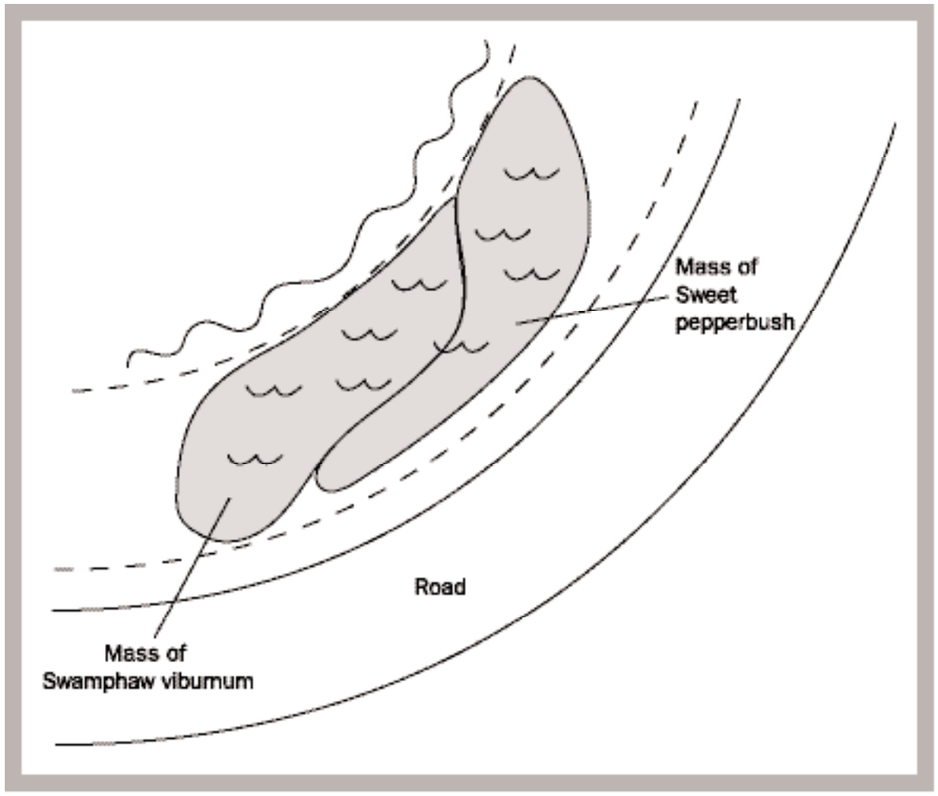
Application of the CHC matrix tool shows that the regional-ornamental design approach is appropriate for this site. The moderate scale of this site and the relatively high traffic speed suggest the use of simple bold massed plantings to make an ornamental impact. A simple arrangement of two moisture-loving shrubs can accomplish this goal while keeping installation and maintenance requirements modest.

Taking cues from the forest backdrop, which is at its peak in autumn, the shrubs might be chosen primarily for fall foliage interest. A combination with contrasting fall colors such as winterthur viburnum (burgundy) and sweet pepperbush (gold) is one option.

If the shrubs are planted so that the masses abut one another, maintenance of the site will consist primarily of mowing around the perimeter. This includes a strip between the back edge and existing woodlands. Periodic removal of invasive exotics, including vines, from within the shrubs may be necessary.

Regional-ornamental Example C

Figure 16 Regional-ornamental Example C
Strategy + Plant Selection
Example of regional-ornamental design approach



Fully ornamental Example A

Examples of the fully ornamental design approach

Fully ornamental Example A (see Figure 17): This site is a highly visible traffic island in the center of a busy commercial corridor. The existing vegetation consists only of mowed turf and there are few, if any, remnants of the Delaware native flora on adjacent plots of ground. Existing site constraints include overhead wires and necessary lines of sight for traffic. The site is flat and the soil is compacted and conditions are relatively droughty.

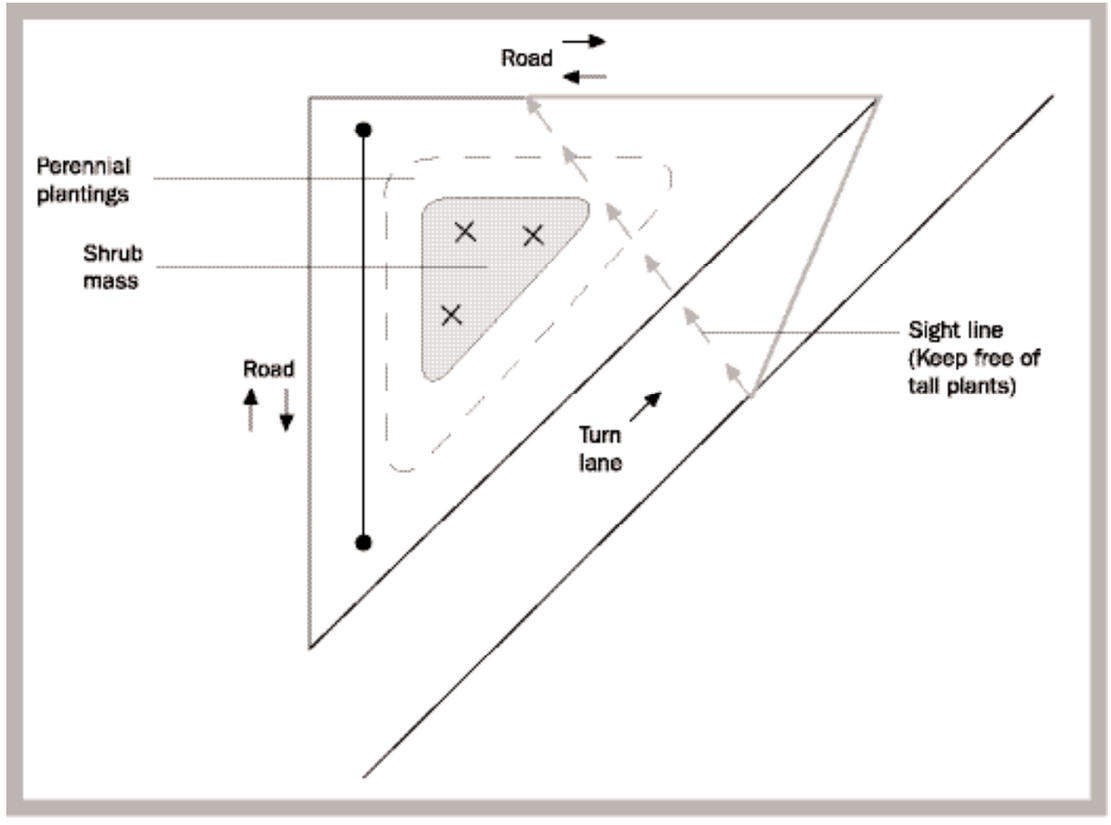
Application of the CHC matrix tool shows that the fully ornamental design approach is appropriate for this site, which specifies that plant selection is unrestricted, though the Delaware regional flora should be utilized if site conditions are suitable and design requirements can be met. Due to the relatively harsh conditions on this site, a mix of native and nonnative species will be needed to meet the aesthetic goals.

Since ornamental impact is a prime goal on this site, a mix of trees, shrubs and perennials should be employed to provide a maximum of year-round interest. Continuous flowering and foliage color is maintained throughout the entire season irrespective of the natural cycles of the regional Delaware flora. Shrub roses are an example of a highly ornamental plant that does not follow regional cycles but offers continuous color.

Trees can be included in the design to introduce structure however, overhead wires and sight lines limit their size and location. Shrub and perennial plantings must also respect necessary sight lines. A band of mowed turf can be maintained around the entire perimeter to provide a sight-line setback and a clean edge.

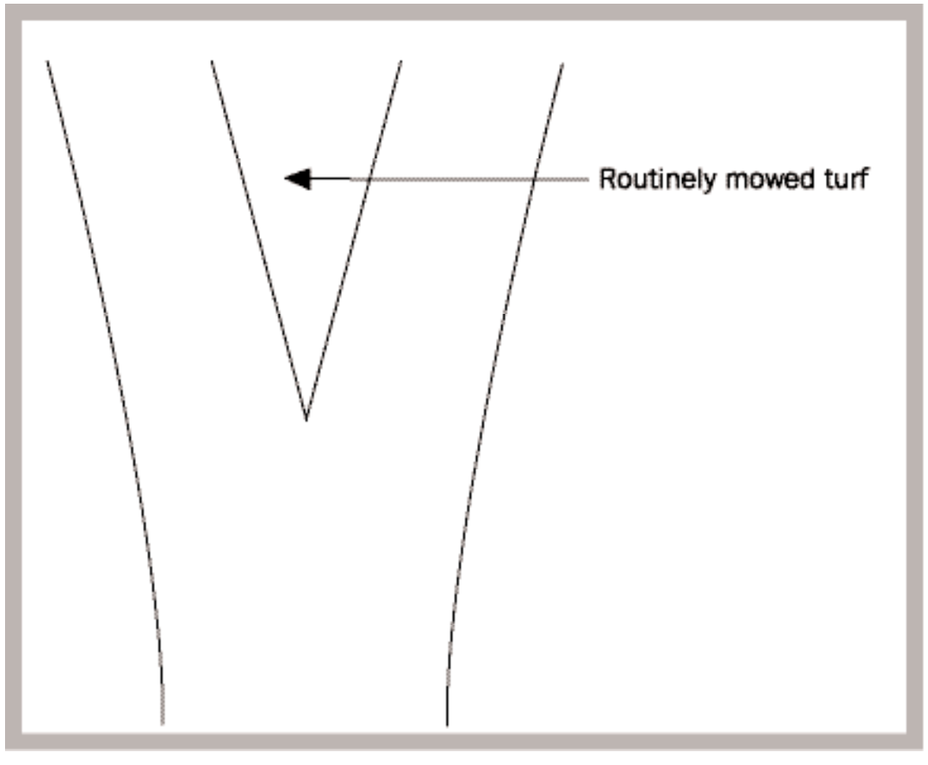
Maintenance of this site is partly predicated on the thoroughness of site preparation. Soil conditions must be improved before planting by rototilling and possibly by amendment with organic materials and or fertilizer. Regular weeding, pruning and cutting back will be required to maintain a neat aesthetic. Mulch can be used to reduce the watering demands of this highly ornamental site. The strip of turf must be mowed routinely to provide a well-maintained margin.

Figure 17 Fully ornamental Example A
Strategy + Plant Selection
Example of fully ornamental design approach



Fully ornamental Example B (see Figure 17): This site is a small triangle separating two merging roadways. Currently in mowed turf, the site is not wide enough to support a clean mowed edge plus a middle planting of perennials or woody plants. In addition, the need to maintain clear sight lines virtually precludes the use anything taller than turf. In this situation, mowed turf is the most economical and aesthetically pleasing planting option. The turf must be mowed routinely to provide a suitably well-maintained appearance.

Figure 17 Fully ornamental Example B
Strategy + Plant Selection
Example of fully ornamental design approach



The Plant Palette: Charts by Plant Type

These charts include plants that have been tested on Enhancing Delaware Highways pilot sites and others whose performance in Delaware conditions is long established. The charts are not all-inclusive. Additional plants may be selected if they meet the following criteria:

- Limited insect and disease problems
- Tolerant to hardiness zone 6
- Not likely to naturalize or invade surrounding natural areas
- Capable of existing without supplemental watering after initial period of establishment
- Tolerant of air pollution
- Plants within splash zone for snow removal should exhibit the necessary salt tolerance.

Figure 18. Trees

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Riparian	Soil moisture	Salt tolerant	Use under power lines	Flowering	Fall color	Urban conditions	USDA zones	Habit	Notes
				P=Piedmont C=Coastal plane	U=upland L=lowland	W=wet D=dry	S=salt tolerant	N=no Y=yes	X=flowering	C=good fall color	T=tolerant			
Acer rubrum	Red maple	60	40-60	PC	L	WD		N		C		3 to 9	dense, rounded	great red fall color
Acer saccharum	Sugar maple	60-75	40-50	P		W		N		C		3 to 7	upright-oval to rounded	great orange fall color
Amelanchier arborea	Downy serviceberry	15-25	10-20	PC	U			Y	X	C		4 to 9	upright-narrow	white flowers first in spring, fruit and orange fall color
Amelanchier canadensis	Shadblow	6-20		C	L	W		Y	X	C		3 to 8	shrubs with erect stems spreading by suckers	white flowers first in spring, fruit and orange fall color
Amelanchier x grandiflora	Apple serviceberry	15-25	10-20	PC	U			Y	X	C		4 to 9	single stemmed cultivars available	white flowers first in spring, fruit and orange fall color
Amelanchier laevis	Allegheny serviceberry	15-25	10-20	PC	U			Y	X	C		4 to 9	multi-stemmed	white flowers first in spring, fruit and orange fall color
Asimina triloba	Common pawpaw	15-20	15-29	PC	L	W		y	X	C		5 to 8	suckers into loose colonies	good fall color
Betula nigra	River birch	70	40-60	PC	L	WD		N		C	T	4 to 9	pyramidal	peeling bark
Carpinus caroliniana	Ironwood	20-30	20-30	PC	L	W		Y		C		3 to 9	flat or round-topped irreg. crown	smooth bark with clean neat leaves
Cercis canadensis	Eastern redbud	20-35	20-35	PC	UL	WD		Y	X	C		4 to 9	broad globular	early pinkish purple flowers
Celtis occidentalis	Hackberry	75-100	75-100	PC	UL	WS	S	N		C	T	3 to 7	globular	
Chionanthus virginicus	White fringetree	25	25	PC	UL			Y	X	C	T	4 to 9	spreading	white fleecy flowers in late spring
Cladrastis kentukea	Yellowwood	30-50	40-55		L	W		Y	X	C		4 to 8	globular	white pendulous clusters of flowers
Cornus alternifolia	Pagoda dogwood	15-25	20-35	PC		W		Y	X	C		3 to 7	horizontal low branched tree	good horizontal form
Cornus florida	Eastern flowering dogwood	20-35	20-35	PC	U	D		Y	X	C		5 to 9	broad globular (urban intolerant)	early spring flowers
Crataegus viridis 'Winter King'	Green hawthorn	20-35	20-35	C	L			Y	X	C	T	4 to 7	rounded spreading dense tree	bright red berries throughout winter
Cryptomeria japonica 'Yoshino'	Yoshino cryptomeria	30-40	10-20		L	W		N			T	5 to 8	pyramidal with blue green foliage	good clean evergreen
Diospyros virginiana	Persimmon	35-60	20-35	PC	UL	WD		N	X	C	T	4 to 9	slender, oval rounded crown; forms colonies	nice fall color and fruit
Fagus grandifolia	American beech	50-70	50-70	PC				N	X	C		4 to 9	wide-spreading crown	large majestic tree
Fraxinus americana	White ash	50-80	50-80	PC	UL	W	S	N		C		4 to 9	irregular ovoid	
Fraxinus pennsylvanica	Green ash	60	40-50	PC	UL	WD	S	N		C	T	2 to 9	pyramidal	
Ginkgo biloba	Maidenhair tree	50-80	30-40			WD	S	N		C	T	4 to 9	pyramidal (use male only)	interesting leaf shape and yellow fall color
Gymnocladus dioicus	Kentucky coffeetree	60-76	40-50			D	S	N		C	T	3 to 9	narrow obovate crown (males only)	bold winter habit but can be messy
Halesia diptera var. *magniflora*	Two-winged silverbell	20-30	20			D		Y	X			4 to 8b	usually multistemmed or low-branched	white bell-shaped flowers in late spring
Halesia tetraptera	Carolina silverbell	30-40	20-35		U	D		N	X			4 to 9	low branched tree with ascending branches	white bell-shaped flowers in early spring
Ilex opaca	American holly	15-30	10-20	PC	U			N			T	5 to 9	pyramidal	good evergreen
Juniperus virginiana	Eastern red cedar	50-60	25-35	PC	U	D	S	Y			T	3 to 8	broadly conical to columnar	upright evergreen with irregular form
Juniperus virginiana 'Emerald Sentinnel'	Emerald Sentinnel cedar	15-20	6-8		U	D	S	N			T	3b to 9	pyramidal columnar form	upright evergreen with blue green color and regular form
Liquidambar styraciflua	American sweetgum	60	40	PC	UL			N		C	T	5 to 9	pyramidal	purple, yellow and orange fall color on same tree

Figure 18. Trees

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Riparian	Soil moisture	Salt tolerant	Use under power lines	Flowering	Fall color	Urban conditions	USDA zones	Habit	Notes
				P=Piedmont C=Coastal plane	U=upland L=lowland	W=wet D=dry	S=salt tolerant	N=no Y=yes	X=flowering	C=good fall color	T=tolerant			
Liriodendron tulipifera	Tulip tree	80	30-50	P	U			N	X	C		4 to 9	upright-oval	very straight trunked tree
Magnolia grandiflora	Southern magnolia	40-80	25-40					N	X			7 to 10	dense-pyramidal	evergreen magnolia with summer flowers
Magnolia stellata	Star magnolia	10-20	10-15					Y	X			4 to 9	dense-rounded	early white flowers with straplike petals
Magnolia virginiana	Sweetbay magnolia	20-50	15-30	PC	L	W	S	Y	X	C		5 to 9	pyramidal	semi evergreen with fragrant summer flowers
Magnolia 'Yellow Bird'	Yellow Bird magnolia	40	40					N	X			3 to 8	pyramidal	yellow-flowered
Magnolia 'Galaxy'	Galaxy magnolia							N						large white flowers
Magnolia 'Merrill'	Merrill magnolia	25-30	35					N	X			3b to 8	broad-rounded	free-flowering fragrant form
Magnolia acuminata	Cucumber magnolia	50-80	50-80					N	X			3 to 8	pyramidal when young, rounded with age	large bold leaves
Malus 'Donald Wyman'	Donald Wyman crabapple	20	25					Y	X		T	4 to 7	large spreading form	early flowers (white fading pink) and red fruit
Nyssa sylvatica	Black tupelo	30-50	25-35	PC	L	WD	S	N		C	T	4 to 9	irregular (difficult to transplant)	first red fall color and glossy green summer leaves
Ostrya virginiana	Hophornbeam	35-50	20-35	P	U			Y		C		3 to 8	conical	good clean leaf
Oxydendrum arboreum	Sourwood	25-30	20	P	U	D		Y	X	C		4 to 9	pyramidal	summer flowers, red fall color and winter structure
Pinus strobus	White pine	70	50					N				3 to 7	pyramidal	open evergreen
Pinus taeda	Loblolly pine	60-90	40-60	C	L	W		N				6 to 9	loosely pyramidal	long-needled evergreen
Pinus virginiana	Virginia pine	15-40	10-30	PC	U			N			T	4 to 8	broad open pyramid	heavily coned evergreen
Platanus occidentalis	American sycamore	75-100	60-80	PC	L	WD		N			T	4 to 9	globular (susceptible to anthracnose)	white peeling bark
Platanus x acerifolia	London plane	70-100		PC	L		S	N		C	T	4 to 9	(not susceptible to anthracnose)	white peeling bark
Prunus x yedoensis	Flowering cherry	40-50						N	X	C		5 to 8	rounded, spreading	early white spring flowers
Quercus alba	White oak	75-100	75-100	PC	U	D	S	N		C		4 to 8	wide globular	holds leaves all winter
Quercus bicolor	Swamp white oak	50-80		P	UL	WD	S	N		C	T	4 to 7	rounded	holds leaves all winter
Quercus coccinea	Scarlet oak	50-75	50-75	PC	U	D	S	N		C	T	5 to 7	globular	holds leaves all winter
Quercus imbricaria	Shingle oak	40-60	30-45	P	UL	WD	S	N		C	T	5 to 8	conical	holds leaves all winter
Quercus macrocarpa	Bur oak	70-80	70-80	PC	UL	WD		N			T	3 to 8	broad crown (difficult to transplant)	holds leaves all winter
Quercus michauxii	Swamp chestnut oak	80-100	80-100		L	W		N		C		5 to 8	pyramidal	holds leaves all winter
Quercus phellos	Willow oak	50	40	PC	UL	WD	S	N		C	T	5 to 9	oblong (transplant only in spring)	holds leaves all winter
Quercus prinus	Chesnut oak	60-70	60-70	P		WD		N		C	T	4 to 8	pyramidal	holds leaves all winter
Quercus rubra	Red oak	60-75	40-50	PC	UL	WD	S	N		C	T	4 to 8		holds leaves all winter
Quercus shumardii	Shumard oak	40-60	40-60	PC	U	D		N		C	T	5 to 9	pyramidal to spreading	holds leaves all winter
Sassafras albidum	Common sassafras	30-60	25-40	PC	U			N	X	C	T	4 to 9	flat topped with age, forms thickets	brilliant orange and yellow fall color
Syringa reticulata	Japanese tree lilac	20-30	15-25					Y	X		T	3 to 7	stiff oval to rounded crown	white flowers in summer
Taxodium distichum	Bald cypress	75-100	20-30	PC	L	WD	S	N			T	4 to 11		deciduous conifer
Thuja plicata 'Green Giant'	Giant arborvitae	30-40	30			WD		N			T	4 to 8	broad pyramidal	bold screening evergree
Tilia americana	American linden	60-80	40-60	P	UL			N		C		3 to 8	ovoid	clean neat leaves

Figure 19. Shrubs

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Riparian	Soil moisture	Exposure	Salt tolerant	Flowering	Fall Color	Urban conditions	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	U=upland; L=lowland	W=wet; D=dry	S=sun; PS=part shade; SH=shade	S=salt tolerant	X=flowering	C=good fall color	T=tolerant			
Abelia x grandiflora	Glossy abelia	6	6				S, PS		X	C		6 to 9	open and spreading, banks or hedges	pinkish white flowers with persistent sepals
Amorpha fruticosa	False indigo-bush	6 to 20	5 to 15	PC	L	WD	S	S	X		T	4 to 9	leggy shrub	purplish-blue with orange anthers in upright spikes in June
Alnus serrulata	Smooth alder	6 to 10	6 to 10	PC	L	W	S, PS					5 to 9	multi-stemmed and suckering	yellow catkins
Aronia arbutifolia	Chokeberry	6 to 10	3 to 5	PC	L	WD	S, PS		X	C	T	4 to 9	upright,naturalizing habit; spreads and suckers	white flowers and bright red fruits
Aronia melanocarpa	Black chokeberry	3 to 5	3 to 5	P		WD	S, PS		X	C	T	3 to 9	suckers profusely forming large colonies	white flowers and blackish purple fruits
Baccharis halimifolia	Groundselbush	5 to 12	5 to 12	C	L	WD	S	S	X		T	5 to 9	rounded habit, good filler plant	fall flowering with white silky hairs
Calycanthus floridus	Sweetshrub	6 to 9	6 to 12		U		S, SH		X		T	4 to 9	broadly rounded shrub	maroon flowers with fruity fragrance; cultivars with yellow flowers; yellow fall color
Campsis radicans	Trumpet vine	30 to 40		PC		D	S	S	X		T	4 to 9	rampant clinging vine	trumpet shaped, rich orange to scarlet flowers
Cephalanthus occidentalis	Buttonbush	6	6	PC	L	W	S		X			5 to 11	rounded loose shrub with coarse winter texture	creamy white, globular flowers in summer; will grow in standing water
Clethra alnifolia	Summersweet clethra	3 to 8	4 to 6	C	L	W	S, PS	S	X	C		4 to 9	oval, round-topped shrub; forms broad colonies	fragrant, upright flower clusters in summer
Cornus amomum	Silky dogwood	6 to 10	6 to 10	PC	L	W	S, PS		X			4 to 8	multi-stemmed shrub	yellow-white flattopped cymes
Cornus racemosa	Gray dogwood	10 to 15	10 to 15	P	U	WD	S, SH		X			3b to 8	multi-stemmed, suckering shrub	whitish panicles that terminate every stem
Cornus sericea (C.stolonifera)	Redosier dogwood	7 to 9	10+	PC	L	W	S, SH		X	C		2 to 7a	multi-stemmed and suckering	red stems showy in winter
Forsythia x intermedia	Border forsythia	8 to 10	10 to 12				S		X		T	6 to 8	arching canes; suckers slowly	first yellow flower in spring
Fothergilla gardenii	Dwarf fothergilla	3 to 6	2 to 3				S, PS		X	C		5 to 8	rounded and suckering	white, fragrant terminal spikes; great yellow, orange, scarlet fall color
Fothergilla major	Large fothergilla	6 to 10	6 to 10				S, PS		X	C		4 to 8	rounded mulit-stemmed shrubs with erect stems	white, fragrant terminal spikes; great yellow, orange, scarlet fall color
Hamamelis virginiana	Common witchhazel	20 to 30	15 to 20	PC	U		S, SH		X	C	T	3b to 8	irregular rounded, with spreading branches	yellow strap-shaped, fragrant flowers in fall
Hydrangea quercifolia	Oakleaf hydrangea	4 to 6	4 to 6				S, PS		X	C		5 to 9	upright; forming mounded colonies	white erect panicles with excellent purple fall color
Hypericum prolificum	Shrubby St. johnswort	1 to 4	1 to 4	P	U	WD	S, PS		X		T	4 to 8	dense stout shrub habit	bright yellow axillary and terminal clusters
Ilex glabra	Inkberry	6 to 8	8 to 10	C	L	W	S,SH					5 to 9	upright, naturalizing habit, rounded shape	good dark green leaves
Ilex verticillata	Winterberry	6 to 10	6 to 10	PC	L	W	S, PS					3 to 9	multi-stemmed and suckering	showy red berries all winter
Ilex x meserveae	Blue holly	varied	varied				S, SH					6 to 8	variable habits for different cultivars	blue green evergreen foliage
Itea virginica	Virginia sweetspire	3 to 5	5 to 7	C	L	WD	S, SH		X	C		5 to 9	erect, clustered branches; forms colonies	white, fragrant racemes; persistent yellow, orange, purple, scarlet fall color
Iva frutescens	Marsh elder			C	L	W	S	S	X					

Figure 19. Shrubs

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Riparian	Soil moisture	Exposure	Salt tolerant	Flowering	Fall Color	Urban conditions	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	U=upland; L=lowland	W=wet; D=dry	S=sun; PS=part shade; SH=shade	S=salt tolerant	X=flowering	C=good fall color	T=tolerant			
Juniperus conferta	Shore juniper	1 to 2	6 to 9			D	S	S			T	6 to 9	low ground cover	
Leucothoe axillaris	Mountain fetterbush	2 to 4	3 to 6		U	W	PS, SH		X	C		5 to 8	arching habit	white axillary racemes; can get spots on foliage
Leucothoe racemosa	Sweetbells leucothoe	4 to 6	4 to 6	C	L	W	PS, SH		X	C		5 to 9	multi-stemmed and suckering habit	white axillary racemes
Lindera benzoin	Spicebush	6 to 12	6 to 12	PC	L	W	S, PS, SH		X	C		4 to 9	loose habit in wild, broad rounded in cultivation	yellow; small but effective in mass; golden yellow fall color
Myrica pensylvanica	Northern bayberry	5 to 12	5 to 12	PC		D	S, PS	S				3 to 7	suckering, large colonies	greyish-white fruit can be effective
Parthenocissus quinquefolia	Virginia creeper	30 to 50		PC	U		S, PS, SH	S		C	T	4 to 9	deciduous vine with tendrils	crimson red in fall; first to color
Prunus maritima	Beach plum	6 to 8	6 to 8	C	U	D	S	S	X			3 to 6	rounded habit, dense suckering shrub	white flowers in May
Rhododendron atlanticum	Coast azalea	3 to 6	3 to 6	C		W	S, PS, SH		X			5 to 8	shrub with suckering habit	blue green foliage and white to pink flowers
Rhododendron canescens	Hoary azalea	10 to 15		PC	L	W	PS, SH		X			5 to 9	large shrub forming large colonies	fragrant, white to pink flowers
Rhododendron periclymenoides	Pinxterbloom azalea	4 to 6		PC	U	D	S, PS, SH		X			4 to 8	low, much branched, stonoiferous, deciduous shrub	fragrant, white to pale pink flowers
Rhododendron viscosum	Swamp azalea	1 to 8	3 to 8	C	L	W	S, PS		X			4 to 9	open habit with spreading branches	white with clove scent
Rhus aromatica	Fragrant sumac	2 to 6	6 to 10				S, PS		X	C		3 to 9	low, irregular spreading shrub	fall color orange to reddish purple
Rhus aromatica 'Gro-low'	Gro-low fragrant sumac	2	6 to 8				S, PS		X	C		3 to 9	ground cover use, fast to fill in an area	orange red fall color
Rhus copallina	Winged sumac	20 to 30	20 to 30	PC	U	D	S		X	C		4 to 9	compact and dense then open and irregular in habit	scarlet fall color
Rhus glabra	Smooth sumac	9 to 15	9 to 15	PC	U	D	S		X	C		3 to 9	suckers to form colonies	orange-red-purple fall color with persistent scarlet fruit
Rhus typhina	Staghorn sumac	15 to 20	15 to 20	PC	U	D	S		X	C		4 to 8	loose open forming large colonies	yellow, orange and scarlet fall color with large crimson fruit
Spiraea x bumalda	Bumald spirea	2 to 3	3 to 5			D	S		X			3 to 8	flat-topped twiggy shrub	Magic Carpet', 'Limemound' and 'Goldflame' have interesting foliage colors
Spiraea japonica 'Nana'	Japanese spirea	1 1/2 to 2 1/2	6				S		X			4 to 8	dainty fine-textured low mass	pink flowers against bluegreen leaves
Spiraea nipponica 'Snowmound'	Snowmound spirea	3 to 5	3 to 5				S		X			4 to 7	neat semi-upright in habit	white flowers against blue green leaves
Staphylea trifolia	American bladdernut	10 to 15	10	P	U		PS, SH		X			4 to 8	upright, suckering shrub	bell-shaped flowers in panicles
Syringa meyeri	Meyer lilac	4 to 8	6 to 12				S		X			3 to 7	broad rounded, mounded shrub	fragrant violet purple flowers; mildew resistant
Syringa patula 'Miss Kim'	Manchurian lilac	3 to 5	3 to 4				S		X	C		4 to 7	oval rounded shrub	purple buds open to fragrant icy blue flowers; reddish purple fall color
Vaccinium angustifolium	Lowbush blueberry	1/2 to 2	2 to 3	P	U	D	S		X	C		2 to 6	low, open growing shrub	white flowers, tinged pink and crimson fall foliage

Figure 19. Shrubs

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Riparian	Soil moisture	Exposure	Salt tolerant	Flowering	Fall Color	Urban conditions	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	U=upland; L=lowland	W=wet; D=dry	S=sun; PS=part shade; SH=shade	S=salt tolerant	X=flowering	C=good fall color	T=tolerant			
Vaccinium corymbosum	Highbush blueberry	6 to 12	8 to 12	PC	L	W	S, PS		X	C		3 to 7	upright multi-stemmed	white urn-shaped flowers, blue fruit and red fall color
Viburnum acerifolium	Mapleleaf viburnum	4 to 6	4	PC	U	D	PS, SH		X	C		4 to 8	low branched forming suckering thickets	yellowish white flattopped flowers with pink, rose, purple fall color
Viburnum bracteatum	Bracted viburnum	10	10			D	S, PS		X	C		6 to 8	dense rounded shrub with arching branches	large cream white flowers with yellow-bronze fall color
Viburnum carlesii	Koreanspice viburnum	4 to 5	4 to 8				S, PS		X	C		5 to 7	rounded dense shrub	fragrant pink flowers opening white
Viburnum cassinoides	Witherod viburnum	5 to 6	5 to 6	C	L	W	S, PS		X	C		3 to 8	compact rounded shrub	fruit changes from green to pink to red to blue to black
Viburnum dentatum	Arrowwood viburnum	6 to 8	6 to 8	PC			S, PS		X	C		3 to 8	multi-stemmed, dense	creamy white flowers with good fall color (especially in cultivars)
Viburnum x juddii	Judd viburnum	6 to 8					S, PS		X	C		4 to 8	full and rounded shrub	highly fragrant flowers
Viburnum lentago	Nannyberry viburnum	15 to 18	10			WD	S, SH		X	C		3 to 7	slender finely arching branches	creamy white flowers
Viburnum nudum	Swamphaw viburnum	6	6	PC	L	W	S, PS		X	C		5 to 9	suckering rounded habit	white flowers; fruit is showy
Viburnum nudum 'Winterthur'	Wintethur viburnum	6	6	PC	L	W	S, PS		X	C		5 to 9	suckering rounded habit	white flowers; consistent purple fall color
Viburnum prunifolium	Blackhaw viburnum	12 to 15	8 to 12	PC	U	D	S, SH		X	C		3 to 9	multi-stemmed, round-headed tree-like habit	creamy white flowers and dull red fall color
Viburnum trilobum	Cranberrybush viburnum	8 to 12	8 to 12				S, PS		X	C		2 to 7	round-topped and dense	large white flower clusters

Figure 20. Herbaceous Plants

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Soil moisture	Exposure	Salt tolerance	Flowering characteristics	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	W=wet; D=dry	S=full sun; PS=part shade; SH=full shade	S=salt tolerant				
Amsonia ciliata	Downy blue star	1 to 3	3			S, PS		pale blue starry flowers	7 to 10	upright	hairy foliage, golden fall color
Amsonia hubrichtii	Threadleaf blue star	3	3		D	S, PS		clusters of steely blue flowers in May	5 to 9	graceful; upright bushy habit	fine-textured foliage; golden fall color
Amsonia tabernaemontana	Willow leaf blue star	1 to 3	3			S, PS		blue flowers	3 to 9	upright	broader leaves; yellow fall color
Amsonia 'Blue Ice'	Blue Ice blue star	1 to 1 1/2	3			S, PS		darker blue flowers	5 to 9		broader leaves; yellow fall color
Arunus dioicus	Goat's beard	4 to 6	6		W	PS, SH		creamy white feathery plumes in early summer	3 to 7	forms large clumps	
Asclepias incarnata	Swamp milkweed	2 to 4	2	PC	W	S, PS		rose-pink flowers	3 to 9		willow-like leaves
Asclepias syriaca	Common milkweed	2 to 4		PC		S		deep pink clusters of fragrant flowers in June/July		robust and stoloniferous	pods of silky seeds in October
Asclepias tuberosa	Butterfly milkweed	2 to 3	2	PC	D	S		bright orange	4 to 9	rambling	ornamental seed pods
Asclepias verticillata	Whorled milkweed	1 to 2		PC	D	S		sweet-scented white flowers	4 to 8	clumps increase by runners	yellow to orange fall color and pencil thin seed capsules
Aster concolor	Eastern silvery aster	1 to 3		C	D			blue to pink daisy-like flowers		creeping rhizomes	
Aster cordifolius	Heart-leaf aster	2 to 3		P	D	PS, SH		blue flowers in Sept./Oct.	3 to 8	short and creeping rhizomes	
Aster divaricatus	White wood aster	1 to 2	3	P		PS, SH		clusters of small, star-like white flowers with yellow centers	4 to 8	spreading habit, good ground cover	
Aster ericoides	White heath aster	1 to 3		C		S, PS		single white flowers with gold centers in September	5 to 8	dense, carpeting ground cover	
Aster laevis	Smooth blue aster	3 to 4		PC		S, PS		blue cone-shaped clusters of single violet blue flowers with golden yellow centers in Sept./Oct.	4 to 8	vase-shaped clump	needs no staking
Aster lateriflorus	Goblet aster	3	3	PC		S, PS		white, reddish centers	6 to 8	multi-stemmed habit	
Aster linariifolius	Stiff aster	1 to 1 1/2			D	S, PS		single lavender with gold centers from late August through October	4 to 8	clump-forming	fine-textured foliage; golden fall color
Aster nova-angliae	New England aster	4 to 6	4	PC	W	S, PS		violet to purple; 1 1/2 -2" across in August/Sept.	4 to 8	mounded to upright habit	
Aster novi-belgii	New York aster	2 to 6	3	C	W	S		light blue flowers in August/Sept.	4 to 8	mounded to upright habit	
Aster oblongifolius 'October Skies'		1 1/2 to 3	4		D	S		blue flowers in late Sept./October	5 to 8	low mound of bushy foliage	
Aster oblongifolius 'Raydon's Favorite'		3	4		D	S		medium blue flowers in October	3 to 7	mound of bushy foliage	
Aster patens	Late purple aster	1 to 5		PC	D			blue flowers	3 to 8		
Aster pilosus	Smooth heath aster	4	2	PC	D			small white flowers	5 to 8	very floriferous, narrow foliage	
Aster puniceus	Bristly aster	6		PC	W	S, PS		light blue flowers in Sept./early Oct.	4 to 8	shiny deep green rosettes	
Aster spectabilis	Showy aster	1/2 to 2		C	D	S, PS	S	clusters of 1-inch blue single flowers in Sept./Oct.	5 to 9	stoloniferous	low, deep green foliage
Baptisia australis	False blue indigo	3 to 4	4			S, PS		indigo blue, pea-shaped flowers on 10-12" spikes	3 to 8	spreads by rhizomes; forms substantial bush	grey-green foliage leafs out early
Chrysopsis mariana	Maryland golden aster	2 to 3		PC	D	S		loose clusters of single 1" daisy flowers	4 to 7		silvery foliage
Cimicifuga racemosa	Black bugbane	6 to 8	4	PC	W	PS, SH		2'-tall open racemes in late summer	3 to 8	graceful, yet wiry form	

Figure 20. Herbaceous Plants

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Soil moisture	Exposure	Salt tolerance	Flowering characteristics	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	W=wet; D=dry	S=full sun; PS=part shade; SH=full shade	S=salt tolerant				
Coreopsis lanceolata	Lanceleaf coreopsis	1 to 2	2			S		bright yellow 2 1/2 inch flowers in May to August	3 to 8		deadheading extends flowering season
Echinacea pallida	Pale coneflower	3 to 4	2		D	S		pale purple flower with reflexed petals	4 to 8		
Echinacea purpurea	Purple coneflower	2 to 3	2		D	S, PS		purple flower with large gold centers in July and August	3 to 8		
Eupatorium album	White thoroughwort	2 to 3		C	D						
Eupatorium capillifolium	Small dog-fennel thoroughwort	2 to 4									
Eupatorium coelestinum	Hardy ageratum	2 to 3	3			S, PS, SH		blue flowers in Sept./Oct.	6 to 10	spreads by rhizomes	attractive dark red stems
Eupatorium dubium	Joe-pye thoroughwort	2 to 4		PC	W			purple, rounded heads			
Eupatorium fistulosum	Hollow Joe-pye weed	6 to 10		PC	W	S, PS		pink-lavender, huge rounded heads	4 to 8	tall narrow in habit	
Eupatorium hyssopifolium	Hyssop-leaved thoroughwort	3 to 4		PC	D	S, PS		flat-topped clusters of white fringed flowers in fall	4 to 8		combines well with Schizachyrium
Eupatorium perfoliatum	Common boneset	3 to 4		PC	W	S, PS		white flat-topped flowers	4 to 8		
Eupatorium purpureum	Sweet Joe-pye weed	4 to 7		PC	W	S		large purple flower clusters	4 to 9		
Eupatorium rotundifolium	Roundleaf thoroughwort	2 to 3		PC	D			white flowers			
Eupatorium serotinum	Late-flowering thoroughwort	2 to 5		C				white flowers			
Euthamia graminifolia	Grassleaf goldenrod	1 to 3		PC	W			yellow flowers			
Euthamia tenuifolia	Tiny headed goldenrod	1 to 2		C	W			yellow flowers			
Gnaphalium obtusifolium	Fragrant cudweed	1 to 3		PC							
Helianthus angustifolius	Swamp sunflower	5 to 6	4	C	W	S		bright yellow flowers in late summer to fall that cover plant	6 to 9	tall but requiring no support in sun	
Helianthus decapetalus	Thin-leaved sunflower	4 to 6	3	P		S		single light yellow flowers in late summer	4 to 8		
Helianthus divaricatus	Woodland sunflower	4 to 6		P	D						
Heliopsis helianthoides	Ox-eye	4 to 6	4	PC	WD	S, PS		medium gold with brownish disc for 8 weeks peaking in July	3 to 9		self sowing
Hibiscus moscheutos	Swamp rosemallow	3 to 7	4	C	W	S, PS	S	rose pink or white 3-4" flowers in Aug./Sept.	5 to 9		
Liatris graminifolia	Grassleaf gayfeather	1 to 2		C	D				5 to 8		
Liatris spicata	Blazing star	2 to 3	2	PC	D	S, PS		upright purple spikes in July	3 to 9	upright in habit, dark green foliage	
Lobelia cardinalis	Cardinal flower	2 to 4	2	PC	W	PS, SH		brilliant red spikes in July./Aug.	2 to 9	hummingbirds attracted	
Lobelia siphilitica	Great Blue Lobelia	2 to 3	1 1/2	PC	W	S, PS		blue spikes in Aug./Sept.	4 to 8		

Figure 20. Herbaceous Plants

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Soil moisture	Exposure	Salt tolerance	Flowering characteristics	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	W=wet; D=dry	S=full sun; PS=part shade; SH=full shade	S=salt tolerant				
Lupinus perennis	Purple lupine	2 to 3		C	D	S, PS		dense spires of deep lavender flowers in late spring to early summer	4 to 7	self sowing	
Mertensia virginica	Virginia bluebells	1 to 2	1	P	W	PS, SH		clusters of pink and blue tubular flowers in early spring	3 to 9	foliage dies back by midsummer	
Monarda clinopodia	Basil bee-balm	3 to 4									
Monarda didyma	Oswego-tea bee-balm	2 to 4	3	P	W	PS		bright scarlet flowers in whorled clusters	4 to 9	spreads by rhizomes	gets mildew
Monarda fistulosa	Wild bergamot	2 to 5	3	P	D	S, PS		pink to lavender purple in June/July	3 to 8		
Oenothera fruticosa	Shrubby sundrops	1 1/2 to 2	2	PC		S		bright yellow terminal clusters in June	4 to 8		
Oenothera speciosa	Showy evening primrose	1 to 2			D	S		white to pink in summer	5 to 8	stoloniferous	
Oenothera tetragona	Four-angled sundrop	1 to 3	1			S		yellow flowers in late spring	3 to 8		short lived
Penstemon digitalis	Tall white beard-tongue	3 to 4	2	PC	D	S, PS		white tubular flowers on branching stalks in early summer	3 to 8	upright in habit, dark green foliage	
Phlox carolina		2 to 3				S, PS		bright pink flowers	3 to 8		
Phlox divaricata	Blue phlox	1 to 1 1/2	1			PS, SH		fragrant blue panicles in spring	4 to 8	creeping rhizomes	
Phlox paniculata	Garden phlox	3 to 4	2			S, PS		large panicles of pink to purple flowers in summer	4 to 8		select mildew resistant cultivars
Phlox pilosa	Downy phlox	1 to 1 1/2		P							
Phlox stolonifera	Creeping phlox	1/2 to 1			D	PS, SH		loose panicles above low foliage in early spring	5 to 8	forms dense cover	
Porteranthus trifoliatus	Bowman's root	2 to 3		P	WD	S, PS		white flowers with red petioles	4 to 8	compact habit	mahogany stems with seed heads persisting into winter
Pycnanthemum virginianum	Virginia mountain-mint	3		P	W	S, PS		showy silver bracts surround small clusters of pale lavender flowers spotted with purple	4 to 8		
Rudbeckia fulgida	Orange coneflower	2 to 21/2		P	D	S, PS		bright gold with deep brown cone from mid July to October	5 to 7		
Rudbeckia hirta	Black-eyed Susan	2 to 3	2 to 3	PC	D	S		yellow ray, brown disc	5 to 7	re-seeding annual	
Rudbeckia laciniata	Cutleaf coneflower	5 to 8		PC	W	S, PS		bright yellow surround green cones	5 to 8		
Rudbeckia triloba	Brown-eyed Susan	2 to 3			WD	S,PS		hundreds of small deep gold flowers from midsummer to fall	5 to 7	self-seeder	
Saururus cernuus	Lizard's tail	1 1/1 to 4		PC	W	S		white flowers in slender spikes			
Sedum x 'Autumn Joy'		2 to 3			D	S		pink rounded flower heads turning to red	3 to 9		flower heads remain all winter
Sedum x 'Matrona'		2 to 3			D	S		pale pink flower heads	3 to 9	upright habit	strong shiny red stems
Senecio aureus	Golden ragwort	1		PC	W	S, PS, SH		golden daisy flowers in May	4 to 9	shiny green basal leaves	
Senna hebacarpa	Wild senna	2 to 6		PC		S, PS		yellow in July/Aug.		erect perennial	
Senna marilandica	Maryland senna	3 to 6		C	W	S, PS		yellow in July/Aug.		erect perennial	
Solidago caesia	Bluestem goldenrod	2 to 3		PC	D	S, PS, SH		arching wands of gold in Sept.	4 to 8		
Solidago juncea	Early goldenrod	1 to 4		PC	D	S		yellow flowers in June/July			

Figure 20. Herbaceous Plants

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Soil moisture	Exposure	Salt tolerance	Flowering characteristics	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	W=wet; D=dry	S=full sun; PS=part shade; SH=full shade	S=salt tolerant				
Solidago nemoralis	Gray-stem goldenrod	1/2 to 3		PC	D	S		yellow flowers			
Solidago puberula	Downy goldenrod	1 to 3		C	D	S		yellow flowers			
Solidago rugosa	Rough-leaf goldenrod	2 to 5		PC	W	S		yellow flowers	4 to 9		
Solidago rugosa 'Fireworks'		3 to 4				S		radiating yellow flowers in Sept.	4 to 9	clump forming	
Solidago sempervirens	Seaside goldenrod	5 to 7		C			S	yellow flowers in Sept.	4 to 9	semi-evergreen rosettes	
Tephrosia virginiana	Goat's rue	1 to 2		PC	D	S		bicolored flowers (yellow and pink) in June/July			
Tradescantia virginiana	Virginia spiderwort	1 to 2	3	P		S, PS		blue to purple flowers in leaf axils for 8 weeks in summer	4 to 9		linear foliage declines after flowering
Typha angustifolia	Narrowleaf cattail	3 to 9		PC	W	S	S	deep brown spikes			
Typha latifolia	Broadleaf cattail	3 to 9		PC	W	S		deep brown spikes			
Verbena hastata	Blue vervain	4 to 6		PC	W	S		tall thin spikes of violet blue	3 to 9		short-lived but self sows
Vernonia glauca	Broadleaf ironweed	3 to 5		PC	D	S		deep purple loose upright flower clusters in Aug./Sept.	6 to 8		
Vernonia noveboracensis	New York ironweed	4 to 7		PC	W	S		deep purple	5 to 8		
Veronicastrum virginicum	Culver's root	4 to 5		PC	D	S, PS		spikes of white flowers in July/Aug.	5 to 8		

Figure 20. Herbaceous Plants – Ferns

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Soil moisture	Exposure	Salt tolerance	Flowering characteristics	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	W=wet; D=dry	S=full sun; PS=part shade; SH=full shade	S=salt tolerant				
Athyrium filix-femina	Lady fern	2 to 3	1	PC	W	PS, SH			4 to 8		bright green new fronds appearing throughout season
Dennstaedtia punctilobula	Eastern hay-scented fern	1 to 1 1/2		PC	D	PS			4 to 8	occurs in large patches	yellowish green fronds
Dryopteris goldiana	Goldie's wood fern	3 to 4	1	PC	W	PS, SH			3 to 8	stands of broad arching fronds	golden green color
Dryopteris intermedia	Evergreen wood fern	1 to 1 1/2		PC	W						
Dryopteris marginalis	Marginal wood fern	1 to 1 1/2		PC	WD	PS, SH			3 to 8	tidy clump that doesn't spread	leathery evergreen leaves
Osmunda cinnamomea	Cinnamon fern	3 to 5		PC	W	PS, SH		coppery spikes of spore bearing fronds in Spring	3 to 7	clump forming with arching fronds	
Osmunda claytoniana	Interrupted fern	3 to 4		PC	D	PS, SH			3 to 7	arching growth	distinct interruptions in center of leaf
Osmunda regalis	Royal fern	4 to 6		PC	W	PS, SH			4 to 7		widely spaced oblong leaflets; purple stems
Polystichum acrostichoides	Christmas fern	1 to 1 1/2		PC	WD	PS, SH			4 to 8	neat, bouquet-like clusters	lustrous, nearly evergreen leaves
Thelypteris noveboracensis	New York fern	1 1/2		PC	W	S, PS			3 to 8	tufts of several leaves	yellow, green delicate fronds
Thelypteris palustris	Marsh fern	1 1/2		PC	W	S, PS			3 to 8	thin and delicate	leaves produced all summer so uncoiling fronds mixed with fully developed leaves

Figure 20. Herbaceous Plants – Grasses and Sedges

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Soil moisture	Exposure	Salt tolerance	Flowering characteristics	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	W=wet; D=dry	S=full sun; PS=part shade; SH=full shade	S=salt tolerant				
Andropogon gerardii	Big bluestem	5 to 8		PC	D	S		not showy	3 to 8	upright, clump forming	rich orange and copper-red in fall
Andropogon glomeratus	Bushy beardgrass	2 to 4		PC	W	S	S	densely clustered bushy bracts in Sept. at top of stems	3 to 8	sturdy and upright	copper-orange in fall
Andropogon gyrans	Beardgrass	2 to 3		PC	D	S		inflorescences clustered at upper part of stem	5 to 8	clump forming	vivid orange in fall and winter
Andropogon ternarius	Silver bluestem	2		C	D	S		silvery inflorescences on slender stalks	6 to 8		glaucous blue green in summer and purple-bronze to copper red in fall
Andropogon virginicus	Broomsedge	2 to 4		PC	D	S		silver inflorescence	3 to 8	upright, clump forming	dark red-purple in fall to orange in winter
Bromus latiglumus	Riverbank brome			P	W						
Carex flaccosperma	Blue wood sedge	1/2 to 1			D	PS, SH		insignificant flowers	5 to 8	loose tussocks	glaucous blue-green leaves; evergreen
Carex pensylvanica	Pennsylvania sedge	1/2 to 1		PC	D	S, PS, SH		insignificant flowers	4 to 8	mowable groundcover	
Carex stricta	Tussock sedge	2 to 3		PC	W	S, PS			4 to 8	spreads by rhizomes	dense tussocks of straw-colored leaves at base with bright green new growth emerging from top
Chasmanthium latifolium	Wild-oat	3 to 4		PC	W	S, PS		dangling oatlike spikelets on nodding stems	5 to 8	upright in sun, lax in shade	spikelets salmon-buff through winter
Deschampsia flexuosa	Crinkled hairgrass	1 to 2		PC	D	S, PS		billowy inflorescences from bronze to pale greenish yellow	4 to 8	densely tufted	self sows manageably
Elymus canadensis	Canada wild rye	3 to 6			D	S		nodding and attractive into winter	3 to 8	clump forming	nurse grass for other prairie species
Eragrostis spectabilis	Purple love-grass	1 1/2 to 2		PC	D	S		reddish purple clouds just above ground level	5 to 8		self seeding
Festuca ovina	Sheep fescue	1/2 to 1				S			4 to 8		
Festuca rubra	Red fescue	1/2 to 1		PC	W	S, PS			4 to 8	spreads by rhizomes	low growing stabilizing turf
Glyceria obtusa	Blunt mannagrass	2 to 3		C	W	S		erect dense flower panicles turning deep brown by late summer	6 to 8	spreads by rhizomes	bright yellow-green foliage
Hystrix patula (Elymus hystrix)	Bottle-brush grass	3 to 4		PC	D	PS		delicate bottlebrush flowers	4 to 9	upright blades	
Juncus effusus	Smooth rush	3 to 4		PC	W	S, PS			5 to 9	upright and arching in a broad fan	dark forest green stems
Lolium perenne	Perennial ryegrass	1/2 to 2				S, PS			3 to 8	clump forming	mowed lawngrass
Muhlenbergia capillaris	Purple muhly grass	3		P	D	S		masses of delicate pink to pink-red flowers in Sept./Nov.	6 to 9	clump forming	
Panicum amarum	Coastal switchgrass	3 to 6		C	D	S		panicles sparsely flowered	4 to 9	creeping rhizomes	
Panicum amarum 'Dewey Blue'		3 to 6		C	D	S		panicles sparsely flowered	4 to 9	creeping rhizomes	good blue foliage
Panicum virgatum	Switchgrass	3 to 5		C	WD	S, PS		airy panicles	4 to 9	clump forming	blue glaucous leaves
Panicum virgatum 'Cloud Nine'		5 to 7				S, PS		airy panicles	4 to 9	tall and erect	
Panicum virgatum 'Dallas Blues'		5 to 7				S		large purple panicles	4 to 9	fuller plant	wide blue foliage
Panicum virgatum 'Haense Herms'	Red switchgrass	4			D	S		airy panicles	4 to 9	fountain-like	burgundy fall color
Panicum virgatum 'Northwind'		6			D	S		airy panicles	4 to 9	upright	steel blue wide leaf blades

Figure 20. Herbaceous Plant List – Grasses and Sedges

Scientific Name	Common Name	Height (feet)	Width (feet)	Native	Soil moisture	Exposure	Salt tolerance	Flowering characteristics	USDA zone	Habit	Notes
				P=Piedmont; C=Coastal Plain	W=wet; D=dry	S=full sun; PS=part shade; SH=full shade	S=salt tolerant				
Panicum virgatum 'Rehbraun'		3 to 4			D	S		airy panicles	4 to 9	fountain-like	burgundy fall color
Panicum virgatum 'Shenandoah'		2 to 4			D	S		red airy panicles	4 to 9		brightest red foliage
Panicum virgatum 'Squaw'		4			D	S		pink airy panicles	4 to 9		red to pink fall color
Saccharum brevibarbe	Bent-awn plume grass	10		C	W	S		brownish with purple tinge	7 to 9	clump forming and narrow upright	
Saccharum coarctatum	Bunched plume grass			C	D						
Saccharum giganteum	Giant plume grass	10		C	W	S		pink, red; silvery in winter	6 to 9	upright; spreads by rhizomes	dark red to bronze purple fall color
Schizachyrium littorale	Keeled little bluestem			C	D						
Schizachyrium scoparium	Little bluestem	2 to 4		PC	D	S		silvery when dry	3 to 8	clump forming	apricot winter color
Schizachyrium scoparium 'The Blues'		2 to 4			D	S		silvery when dry	3 to 8	clump forming	glaucous blue stems and purple fall color
Scirpus cyperinus	Woolgrass bulrush	5 to 6		PC	W	S		large woolly inflorescence in midsummer	4 to 8	erect stems form dense tussocks	
Sesleria caerulea	Blue moor grass	1/2 to 1				S		spike like panicles in April/May	4 to 8	basal mounds	2-toned blue green foliage
Sorghastrum nutans	Indiangrass	6 to 7		PC	D	S		tan flowers with yellow pollen sacs	4 to 8	more upright	green and blue forms
Sorghastrum nutans 'Sioux Blue'		5 to 6			D	S		tan flowers with yellow pollen sacs	4 to 8	arching habit	metallic blue leaves
Spartina alterniflora	Smooth saltmarsh cordgrass	7		C	W	S	S	stiff open panicles in July/Aug.	4 to 8		
Spartina pectinata	Fresh water cordgrass	7		C	W	S	S	stiff open panicles in July/Aug.	4 to 8	strong upright to arching stems	
Sporobolus heterolepis	Prairie dropseed	1 to 2			D	S, PS		delicate open panicles held high above foliage; fragrant	3 to 8	fine textured mound	pumpkin orange fall color
Tridens flavus	Purple-top	4		PC	WD	S, PS		open metalic red-purple panicles	4 to 8	upright and clump forming	bronze purple tints in fall

Cost Analysis

Costs are based on average conditions calculated from research plot applications. Costs can vary considerably depending on specific site conditions. These examples are intended for comparison purposes and should not be used as bid prices.

Figure 21. Estimated Unit Costs for Installation and Maintenance Procedures (2004)

Material, Installation Procedure or Maintenance Procedure	**Estimated Price**
Drill seeding/sq. ft.	$ 0.06
Hydroseeding/sq. ft.	$ 0.04
Seed cost, low fescue, approximate cost/1000 sq. ft.	$ 2.25
Seed cost, warm-season grass mixture, approximate cost/1000 sq. ft.	$ 4.50–18.00
Seed cost, warm-season grass/perennial forb mix/1000 sq. ft.	$ 11.50-45.00
Plugging with herbaceous plants/plant	$ 0.46
Plant cost (average), herbaceous plugs,	$ 1.00
Planting herbaceous plants in one quart containers/plant	$ 1.00
Plant cost (average), herbaceous quart	$ 2.25
Planting herbaceous plants in one gallon containers/plant	$ 1.75
Plant cost (average), herbaceous gallon	$ 4.00
Planting shrubs in one gallon container/plant	$ 7.00
Plant cost (average), one gallon shrub	$ 7.50
Planting shrubs in B & B form/plant	$ 20.00
Plant cost (average), B & B shrub	$ 20.00
Planting trees in three gallon container/plant	$ 20.00
Plant cost (average), three gallon tree	$ 20.00
Planting trees in 2” caliper B & B form/plant	$ 75.00
Plant cost (average), 2” caliper B & B tree	$ 150.00
Glyphosate treatment of low herbaceous layer/1000 sq. ft.	$ 20.00
Glyphosate treatment of low herbaceous layer/acre	$ 400.00
Glyphosate treatment of brush/1000 sq. ft.	$ 80.00
Glyphosate treatment of brush/acre	$ 700.00
Glyphosate spot treatment/1000 sq. ft.	$ 30.00
Glyphosate spot treatment/acre	$ 160.00
Mowing/1000 sq. ft.	$ 10.00
Cutback/1000 sq. ft.	$ 50.00
Brush removal/1000 sq. ft.	$ 125.00

Note: Estimated costs do not include bark mulch applied as a continuous bed. If that is the desired treatment, an additional mulch materials and application cost would apply. Estimated costs do not include plant or installation warranties.

Figure 21. Estimated Costs for Installation and Maintenance, for comparison (2004)

Installation or Maintenance Procedure	Estimated Price
Drill seeding with low fescue/1000 sq. ft.	$ 62.25
Drill seeding with warm-season grass mixture/1000 sq. ft.	$ 64.50 – 78.00
Drill seeding with warm-season grass/perennial forb mix/1000 sq. ft.	$ 71.50 – 105.00
Hydroseeding with low fescue/1000 sq. ft.	$ 42.25
Hydroseeding with warm-season grass mixture/1000 sq. ft.	$ 44.50 – 58.00
Hydroseeding with warm-season grass/perennial forb mix/1000 sq. ft.	$ 51.50 – 85.00
Plugging with herbaceous plants/1000 sq. ft. on 18” centers	$ 650
Plugging with herbaceous plants/1000 sq. ft. on 30” centers	$ 235
Planting herbaceous plants in one quart containers/1000 sq. ft on 18” centers	$ 1,445
Planting herbaceous plants in one gallon containers/1000 sq. ft. on 18” centers	$ 2,556
Planting herbaceous plants in one quart containers/1000 sq. ft. on 30” centers	$ 520
Planting herbaceous plants in one gallon containers/1000 sq. ft. on 30” centers	$ 920
Planting shrubs in one gallon container/1000 sq. ft. on 5’ centers	$ 580
Planting shrubs in B & B form/plant/1000 sq. ft. on 5’ centers	$ 1,600
Planting trees in three gallon container/1000 sq. ft. on 15’ centers	$ 2,667
Planting trees in 2” caliper B & B form/plant/1000 sq. ft. on 15’ centers	$ 15,000
Glyphosate treatment of low herbaceous layer/1000 sq. ft.	$ 43.00
Glyphosate treatment of low herbaceous layer/acre	$ 400.00
Glyphosate treatment of brush/1000 sq. ft.	$ 80.00
Glyphosate treatment of brush/acre	$ 700.00
Glyphosate spot treatment/1000 sq. ft.	$ 80.00
Glyphosate spot treatment/acre	$ 160.00
Routine mowing (8x/year)/1000 sq. ft.	$ 80.00
Routine mowing (8x/year)/acre	$ 3,480
Periodic mowing (1x/year)/1000 sq. ft.	$ 10.00
Periodic mowing (1x/year)/acre	$ 435.00
Cutback/1000 sq. ft.	$ 50.00
Brush removal/1000 sq. ft.	$ 125.00

Note: Estimated costs do not include bark mulch applied as a continuous bed. If that is the desired treatment, an additional mulch materials and application cost would apply. Estimated costs do not include plant or installation warranties.

Drilling holes prior to planting quart containers.

Appendix A: Checklists–Inventory of Site Conditions

1. Climate and Growth Conditions Checklist

Check the appropriate cold hardiness zone:

❏ Zone 6 or ❏ Zone 7

Project is located in the following county:

❏ New Castle ❏ Kent ❏ Sussex

Project is located in the following physiographic region:

❏ Piedmont ❏ Coastal Plain

Conduct a soil test to determine the following soil characteristics:

Soil texture: ❏ Sand ❏ Sandy loam ❏ Loam ❏ Clay loam ❏ Clay

Organic matter content:_____% **pH:**_____

Soil moisture content: ❏ Dry ❏ Moist ❏ Very wet (drainage < 1"/hr)

Check the light exposure:

❏ Full sunlight ❏ Partial sunlight ❏ Shade

List existing thriving plant species:

Desirable	**Undesirable**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Indicators of stress on existing species:

❏ Interveinal chlorosis ❏ Chlorosis ❏ Leaf wilting

❏ Marginal leaf scorch ❏ Premature fall coloration

List species affected by stress:

_____	_____
_____	_____

2. Roadway Limitations Checklist

Check the roadside zone(s) included in the location to be landscaped:

❏ Back slope or cut slope ❏ Swale or ditch zone

❏ Approach or shoulder zone ❏ Edge or border zone ❏ Front or fill slope

Check the appropriate clear zone requirement:

❏ Standard 30 feet ❏ Other (_____feet)

Presence of guard rail and/or barrier curb:

Guard rail ❏ Yes ❏ No ❏ Partial (_____feet)

Barrier curb ❏ Yes ❏ No ❏ Partial (_____feet)

Potential design exceptions to clear zone requirements (For new projects only):

❏ Exceptional trees (note size, species or historic value on seperate sheet)

❏ Adverse character change

❏ Significant functional and/or aesthetic value

❏ Scenic or low speed road

❏ Rare/endangered/threatened species (plant or animal)

❏ Wetland

❏ Reduction of water quality or serious erosion/sedimentation effects

Is the drainage ditch designed with sufficient width to accommodate plantings?

❏ Yes ❏ No

Note the presence of all utilities:

❏ Above ground high voltage electric wires ❏ Buried utilities

❏ Control boxes requiring access

Note required line of sight setback: _____feet required

Note locations requiring erosion control:

_____square feet at_____% slope

_____square feet at_____% slope

Note functions plants are required to perform at this site:

❏ Indicate change in direction

❏ Increase effectiveness of traffic signs

❏ Attenuate impact

❏ Screen headlight glare

❏ Block undesirable views

❏ Emphasize desirable views

❏ Combat highway hypnosis

❏ Buffer noise

❏ Reduce mowing time

❏ Increase maintenance safety

❏ Integrate the roadside landscape into the surroundings

❏ Contribute to the health and diversity of the regional environment

❏ Introduce travelers to Delaware's regional vegetation

❏ Control drifting snow

❏ Discourage grafitti

❏ Provide a buffer for pedestrians

3. Cultural and Historical Characteristics (CHC) Matrix

Use the following chart to determine cultural and historical characteristic values.

Characteristic	Assigned Value				
	High	Medium	Low	Yes	No
Traffic exposure	2	1	0		
Gateway component				4	0
Tourism value	2	1	0		
Intersection component				3	0
Visibility				1	0
Community involvement	2	1	0		
Size	0	2	4		
Existing DE nat. veg. adjacent to site	0	1	2		
Existing DE native vegetation on site	0	1	2		
Historic value				2	0
Available budget	4	2	0		

Fill in appropriate numbers for each site using the blank matrix below. Carry the number assigned for each row to the value column and total the values to arrive at a matrix score for the site.

Characteristic	Assigned Value					Value
	High	Medium	Low	Yes	No	
Traffic exposure						
Gateway component						
Tourism value						
Intersection component						
Visibility						
Community involvement						
Size						
Existing DE nat. veg. adjacent to site						
Existing DE native vegetation on site						
Historic value						
Available budget						
					Total	
					CHC Matrix Score	

Trees

Common Name	Scientific Name
Allegheny serviceberry	*Amelanchier laevis*
American holly	*Ilex opaca*
American beech	*Fagus grandifolia*
American linden	*Tilia americana*
Sycamore	*Platanus occidentalis*
Apple serviceberry	*Amelanchier x grandiflora*
Bald cypress	*Taxodium distichum*
Black tupelo	*Nyssa sylvatica*
Bur oak	*Quercus macrocarpa*
Carolina silverbell	*Halesia tetraptera*
Chestnut oak	*Quercus prinus*
Common pawpaw	*Asimina triloba*
Common sassafras	*Sassafras albidum*
Cucumber magnolia	*Magnolia acuminata*
Donald Wyman crabapple	*Malus* 'Donald Wyman'
Downy serviceberry	*Amelanchier arborea*
Eastern flowering dogwood	*Cornus florida*
Eastern red cedar	*Juniperus virginiana*
Eastern redbud	*Cercis canadensis*
Emerald sentinnel cedar	*Juniperus virginiana* 'Emerald Sentinnel'
Flowering cherry	*Prunus x yedoensis*
Galaxy magnolia	*Magnolia* 'Galaxy'
Giant arborvitae	*Thuja plicata* 'Green Giant'
Green ash	*Fraxinus pennsylvanica*
Green hawthorn	*Crataegus viridis* 'Winter King'
Hackberry	*Celtis occidentalis*
Hophornbeam	*Ostrya virginiana*
Ironwood	*Carpinus caroliniana*
Japanese tree lilac	*Syringa reticulata*
Kentucky coffeetree	*Gymnocladus dioicus*
Loblolly pine	*Pinus taeda*
London plane	*Platanus x acerifolia*
Maidenhair tree	*Ginkgo biloba*
Merrill magnolia	*Magnolia* 'Merrill'
Pagoda dogwood	*Cornus alternifolia*
Persimmon	*Diospyros virginiana*

Trees

Common Name	Scientific Name
Red maple	*Acer rubrum*
Red oak	*Quercus rubra*
River birch	*Betula nigra*
Scarlet oak	*Quercus coccinea*
Serviceberry	*Amelanchier canadensis*
Shingle oak	*Quercus imbricaria*
Shumard oak	*Quercus shumardii*
Sourwood	*Oxydendrum arboreum*
Southern magnolia	*Magnolia grandiflora*
Star magnolia	*Magnolia stellata*
Sugar maple	*Acer saccharum*
Swamp chestnut oak	*Quercus michauxii*
Swamp white oak	*Quercus bicolor*
Sweetbay magnolia	*Magnolia virginiana*
Sweetgum	*Liquidambar styraciflua*
Tulip tree	*Liriodendron tulipifera*
Two-winged silverbell	*Halesia diptera* var. *magniflora*
Virginia pine	*Pinus virginiana*
White ash	*Fraxinus americana*
White fringetree	*Chionanthus virginicus*
White oak	*Quercus alba*
White pine	*Pinus strobus*
Willow oak	*Quercus phellos*
Yellow bird magnolia	*Magnolia* 'Yellow Bird'
Yellowwood	*Cladrastis kentukea*
Yoshino cryptomeria	*Cryptomeria japonica* 'Yoshino'

Shrubs

Common Name	Scientific Name
American bladdernut	*Staphylea trifolia*
Arrowwood viburnum	*Viburnum dentatum*
Beach plum	*Prunus maritima*
Black chokeberry	*Aronia melanocarpa*
Blackhaw viburnum	*Viburnum prunifolium*
Blue holly	*Ilex x meserveae*
Border forsythia	*Forsythia x intermedia*
Bracted viburnum	*Viburnum bracteatum*
Bumald spirea	*Spiraea x bumalda*
Buttonbush	*Cephalanthus occidentalis*
Chokeberry	*Aronia arbutifolia*
Coast azalea	*Rhododendron atlanticum*
Common witchhazel	*Hamamelis virginiana*
Cranberrybush viburnum	*Viburnum trilobum*
Dwarf fothergilla	*Fothergilla gardenii*
False indigo-bush	*Amorpha fruticosa*
Fragrant sumac	*Rhus aromatica*
Glossy abelia	*Abelia x grandiflora*
Gray dogwood	*Cornus racemosa*
Gro-low fragrant sumac	*Rhus aromatica* 'Gro-low'
Groundselbush	*Baccharis halimifolia*
Highbush blueberry	*Vaccinium corymbosum*
Hoary azalea	*Rhododendron canescens*
Inkberry	*Ilex glabra*
Japanese spirea	*Spiraea japonica* 'Nana'
Judd viburnum	*Viburnum x juddii*
Koreanspice viburnum	*Viburnum carlesii*
Large fothergilla	*Fothergilla major*
Lowbush blueberry	*Vaccinium angustifolium*
Manchurian lilac	*Syringa patula* 'Miss Kim'
Mapleleaf viburnum	*Viburnum acerifolium*
Marsh elder	*Iva frutescens*
Meyer lilac	*Syringa meyeri*
Mountain fetterbush	*Leucothoe axillaris*
Nannyberry viburnum	*Viburnum lentago*
Northern bayberry	*Myrica pensylvanica*

Shrubs

Common Name	Scientific Name
Oakleaf hydrangea	*Hydrangea quercifolia*
Pinxterbloom azalea	*Rhododendron periclymenoides*
Possum-haw viburnum	*Viburnum nudum*
Redosier dogwood	*Cornus sericea (C. stolonifera)*
Shore juniper	*Juniperus conferta*
Shrubby St. Johnswort	*Hypericum prolificum*
Silky dogwood	*Cornus amomum*
Smooth alder	*Alnus serrulata*
Smooth sumac	*Rhus glabra*
Snowmound spirea	*Spiraea nipponica* 'Snowmound'
Spicebush	*Lindera benzoin*
Staghorn sumac	*Rhus typhina*
Swamp azalea	*Rhododendron viscosum*
Swamphaw viburnum	*Viburnum nudum*
Sweet pepperbush	*Clethra alnifolia*
Sweetbells leucothoe	*Leucothoe racemosa*
Sweetshrub	*Calycanthus floridus*
Trumpet vine	*Campsis radicans*
Virginia creeper	*Parthenocissus quinquefolia*
Virginia sweetspire	*Itea virginica*
Winged sumac	*Rhus copallina*
Winterberry	*Ilex verticillata*
Witherod viburnum	*Viburnum cassinoides*

Herbaceous Plants

Common Name	Scientific Name
Aromatic aster	*Aster oblongifolius* 'October Skies'
Aromatic aster	*Aster oblongifolius* 'Raydon's Favorite'
Basil bee-balm	*Monarda clinopodia*
Black bugbane	*Cimicifuga racemosa*
Black-eyed Susan	*Rudbeckia hirta*
Blazing star	*Liatris spicata*
Blue ice blue star	*Amsonia* 'Blue Ice'
Blue phlox	*Phlox divaricata*
Blue vervain	*Verbena hastata*
Bluestem goldenrod	*Solidago caesia*
Bowman's root	*Porteranthus trifoliatus*
Bristly aster	*Aster puniceus*
Broadleaf cattail	*Typha latifolia*
Broadleaf ironweed	*Vernonia glauca*
Brown-eyed Susan	*Rudbeckia triloba*
Butterfly milkweed	*Asclepias tuberosa*
Cardinal flower	*Lobelia cardinalis*
Common boneset	*Eupatorium perfoliatum*
Common milkweed	*Asclepias syriaca*
Creeping phlox	*Phlox stolonifera*
Culver's root	*Veronicastrum virginicum*
Cutleaf coneflower	*Rudbeckia laciniata*
Downy blue star	*Amsonia ciliata*
Downy goldenrod	*Solidago puberula*
Downy phlox	*Phlox pilosus*
Early goldenrod	*Solidago juncea*
Eastern silvery aster	*Aster concolor*
False blue indigo	*Baptisia australis*
Four-angled sundrop	*Oenothera tetragona*
Fragrant cudweed	*Gnaphalium obtusifolium*
Garden phlox	*Phlox paniculata*
Goat's beard	*Aruncus dioicus*
Goat's rue	*Tephrosia virginiana*
Goblet aster	*Aster lateriflorus*
Golden ragwort	*Senecio aureus*
Goldenrod	*Solidago rugosa* 'Fireworks'

Herbaceous Plants

Common Name	Scientific Name
Grassleaf gayfeather	*Liatris graminifolia*
Grassleaf goldenrod	*Euthamia graminifolia*
Gray-stem goldenrod	*Solidago nemoralis*
Great blue lobelia	*Lobelia siphilitica*
Hardy ageratum	*Eupatorium coelestinum*
Heart-leaf aster	*Aster cordifolius*
Hollow Joe-pye weed	*Eupatorium fistulosum*
Hyssop-leaved thoroughwort	*Eupatorium hyssopifolium*
Joe-pye thoroughwort	*Eupatorium dubium*
Lanceleaf coreopsis	*Coreopsis lanceolata*
Late purple aster	*Aster patens*
Late-flowering thoroughwort	*Eupatorium serotinum*
Lizard's tail	*Saururus cernuus*
Maryland golden aster	*Chrysopsis mariana*
Maryland senna	*Senna marilandica*
Narrow-leaf cattail	*Typha angustifolia*
New England aster	*Aster nova-angliae*
New York aster	*Aster novi-belgii*
New York ironweed	*Vernonia noveboracensis*
Orange coneflower	*Rudbeckia fulgida*
Oswego-tea bee-balm	*Monarda didyma*
Ox-eye	*Heliopsis helianthoides*
Pale coneflower	*Echinacea pallida*
Phlox	*Phlox carolina*
Purple cone flower	*Echinacea purpurea*
Purple lupine	*Lupinus perennis*
Rough-leaf goldenrod	*Solidago rugosa*
Roundleaf thoroughwort	*Eupatorium rotundifolium*
Seaside goldenrod	*Solidago sempervirens*
Showy aster	*Aster spectabilis*
Showy evening primrose	*Oenothera speciosa*
Shrubby sundrops	*Oenothera fruticosa*
Small dog-fennel thoroughwort	*Eupatorium capillifolium*
Smooth blue aster	*Aster laevis*
Smooth heath aster	*Aster pilosus*
Stiff aster	*Aster linariifolius*

Herbaceous Plants

Common Name	Scientific Name
Stonecrop	*Sedum x* 'Autumn Joy'
Stonecrop	*Sedum x* 'Matrona'
Swamp milkweed	*Asclepias incarnata*
Swamp rosemallow	*Hibiscus moscheutos*
Swamp sunflower	*Helianthus angustifolius*
Sweet Joe-pye weed	*Eupatorium purpureum*
Tall white beard-tongue	*Penstemon digitalis*
Thin-leaved sunflower	*Helianthus decapetalus*
Threadleaf blue star	*Amsonia hubrichtii*
Tiny headed goldenrod	*Euthamia tenuifolia*
Virginia bluebells	*Mertensia virginica*
Virginia mountain-mint	*Pycnanthemum virginianum*
Virginia spiderwort	*Tradescantia virginiana*
White heath aster	*Aster ericoides*
White thoroughwort	*Eupatorium album*
White wood aster	*Aster divaricatus*
Whorled milkweed	*Asclepias verticillata*
Wild bergamot	*Monarda fistulosa*
Wild senna	*Senna hebacarpa*
Willow leaf Blue Star	*Amsonia tabernaemontana*
Woodland sunflower	*Helianthus divaricatus*

Herbaceous Plants—Grasses, Sedges, and Rushes

Common Name	Scientific Name
Beardgrass	*Andropogon gyrans*
Bent-awn plume grass	*Saccharum brevibarbe*
Big bluestem	*Andropogon gerardii*
Blue moor grass	*Sesleria caerulea*
Blue wood sedge	*Carex flaccosperma*
Blunt mannagrass	*Glyceria obtusa*
Bottle-brush grass	*Hystrix patula*
Broomsedge	*Andropogon virginicus*
Bunched plume grass	*Saccharum coarctatum*
Bushy beardgrass	*Andropogon glomeratus*
Canada wild rye	*Elymus canadensis*
Woolgrass	*Scirpus cyperinus*
Crinkled hairgrass	*Deschampsia flexuosa*
Fresh water cordgrass	*Spartina pectinata*
Giant plume grass	*Saccharum giganteum*
Wild oat	*Chasmanthium latifolium*
Indiangrass	*Sorghastrum nutans*
Indiangrass	*Sorghastrum nutans* 'Sioux Blue'
Keeled little bluestem	*Schizachyrium littorale*
Little bluestem	*Schizachyrium scoparium*
Little bluestem	*Schizachyrium scoparium* 'The Blues'
Purple muhly grass	*Muhlenbergia capillaris*
Coastal switchgrass	*Panicum amarum*
Pennsylvania sedge	*Carex pensylvanica*
Perennial ryegrass	*Lolium perenne*
Prairie dropseed	*Sporobolus heterolepis*
Purple love-grass	*Eragrostis spectabilis*
Red fescue	*Festuca rubra*
Red switchgrass	*Panicum virgatum* 'Haense Herms'
Riverbank brome	*Bromus latiglumus*
Sheep fescue	*Festuca ovina*
Silver bluestem	*Andropogon ternarius*
Smooth rush	*Juncus effusus*
Smooth saltmarsh cordgrass	*Spartina alterniflora*
Coastal switchgrass	*Panicum amarum* 'Dewey Blue'
Switchgrass	*Panicum virgatum*

Herbaceous Plants—Grasses, Sedges, and Rushes

Common Name	Scientific Name
Switchgrass	*Panicum virgatum* 'Cloud Nine'
Switchgrass	*Panicum virgatum* 'Dallas Blues'
Switchgrass	*Panicum virgatum* 'Northwind'
Switchgrass	*Panicum virgatum* 'Rehbraun'
Switchgrass	*Panicum virgatum* 'Shenandoah'
Switchgrass	*Panicum virgatum* 'Squaw'
Purple-top	*Tridens flavus*
Tussock sedge	*Carex stricta*

Herbaceous Plants—Ferns

Common Name	Scientific Name
Christmas fern	*Polystichum acrostichoides*
Cinnamon fern	*Osmunda cinnamomea*
Eastern hay-scented fern	*Dennstaedtia punctilobula*
Evergreen wood fern	*Dryopteris intermedia*
Goldie's wood fern	*Dyropteris goldiana*
Interrupted fern	*Osmunda claytoniana*
Lady fern	*Athyrium filix-femina*
Marginal Wood fern	*Dryopteris marginalis*
Marsh fern	*Thelypteris palustris*
New York fern	*Thelypteris noveboracensis*
Royal fern	*Osmunda regalis*

Appendix C: Illustrated Plant Palette: Selected Examples

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1 *Acer rubrum* (red maple) flowers

2 *Acer rubrum* (red maple) fall color

3 *Amelanchier x grandiflora* (serviceberry) backed by *Juniperus virginiana* (eastern red cedar)

4 *Amsonia hubrichtii* (threadleaf bluestar) in front of *Amsonia tabernaemontana* (common bluestar) blooming in spring with *Panicum virgatum* (switchgrass) emerging alongside

5 *Amsonia hubrichtii* (threadleaf bluestar), *Amsonia tabernaemontana* (common bluestar), *Cornus sericea* (redosier dogwood), *Panicum virgatum* (switchgrass), and *Cercis canadensis* (Eastern redbud) planted on highway median berm

6 *Amsonia hubrichtii* (threadleaf bluestar) turning yellow and *Amsonia tabernaemontana* (common bluestar) in its tan winter color

7 *Andropogon glomeratus* (bushy beard grass) backed by a woods edge containing *Clethra alnifolia* (sweet pepperbush), *Magnolia virginiana* (sweetbay magnolia), and *Quercus phellos* (willow oak)

8 *Andropogon glomeratus* (bushy beard grass) close up

9 *Andropogon ternarius* (silver bluestem)

10 *Aronia arbutifolia* (red chokeberry) spring flower with *Cercis canadensis* (redbud)

11 *Aronia arbutifolia* (red chokeberry) fall color

12 *Asclepias incarnata* (swamp milkweed) flowers

13 *Asclepias tuberosa* (butterfly milkweed) seeded with naturally occurring *Asclepias syriaca* (common milkweed)

14 *Aster laevis* 'Bluebird' (smooth aster) blooming

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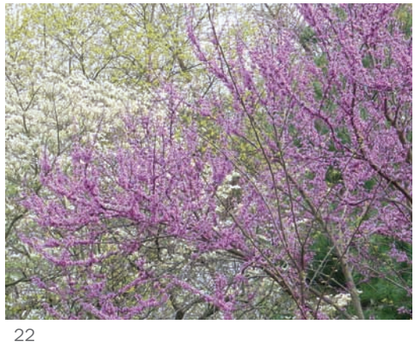

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15 *Aster novae-angliae* (New England aster) and *Solidago rugosa* (rough-stemmed goldenrod) naturally occurring in open field

16 *Aster novae-angliae* (New England aster), *Solidago rugosa* (rough-stemmed goldenrod) and *Eupatorium hyssopifolium* (hyssop-leaved thoroughwort) seeded in a wet swale

17 *Aster novae-angliae* (New England aster) and *Panicum virgatum* (switchgrass)

18 *Aster oblongifolius* 'October Skies' (aromatic aster) with *Amsonia hubrichtii* (threadleaf blue star)

19 *Baccharis halimifolia* (groundsel bush) in a mass of *Panicum virgatum* (switchgrass) backed by *Juniperus virginiana* (eastern red cedar)

20 *Baccharis halimifolia* (groundsel bush) flowers

21 *Cephalanthus occidentalis* (button bush) flower

22 *Cercis canadensis* (redbud) flowering

23 *Chionanthus virginicus* (fringetree) flowering

24 *Clethra alnifolia* (sweet pepperbush) in fall color planted with *Betula nigra* (river birch) in wet swale

25 *Clethra alnifolia* (sweet pepperbush) in flower naturally occurring with *Nyssa sylvatica* (black gum) along a moist wood edge

26 *Clethra alnifolia* (sweet pepperbush) flowers

27 *Cornus sericea baileyi* (red twig dogwood) winter color

28 *Diospyros virginiana* (persimmon) and *Myrica pensylvanicum* (northern bayberry) naturally occurring in a sandy roadside

29 *Diospyros virginiana* (persimmon) fruit

30 *Eupatorium capillifolium* (dog fennel) naturally occurring in a sandy roadside

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31 *Eupatorium dubium* (hollow joe-pye weed) and *Typha latifolia* (broadleaf cattail) naturally occurring on the slope of a roadside ditch.

32 *Eupatorium hyssopifolium* (hyssop-leaved thoroughwort) flowers

33 *Eupatorium hyssopifolium* (hyssop-leaved thoroughwort) and *Schizachyrium scoparium* (little bluestem) planted from plugs in a seeded highway infield

34 *Eupatorium serotinum* (late-flowering thoroughwort) and *Solidago canadensis* (Canada goldenrod) naturally occurring

35 *Euthamia graminifolia* (grass-leaf goldenrod), *Baccharis halimifolia* (groundselbush) naturally occurring in a sandy ditch

36 *Hamamelis virginiana* (witchhazel) flowers

37 *Hibiscus moscheutos* (marsh mallow) flowers

38 *Ilex verticillata* (winterberry holly) and *Juniperus virginiana* (eastern red cedar) planted on dry highway median slope

39 *Juncus effusus* (common rush) at pond edge

40 *Liquidambar styraciflua* (sweet gum) fall color

41 *Lobelia cardinalis* (cardinal flower) with *Hibiscus moscheutos*, (marsh mallow) seeded in a wet roadside

42 *Magnolia* ‘Butterflies’ (butterflies magnolia) flowers

43 *Magnolia virginiana* (sweetbay magnolia), *Rhus copallina* (winged sumac) and *Baccharis halimifolia* (groundselbush) naturally occurring in a sandy roadside

44 *Magnolia virginiana* (sweetbay magnolia) flowers

45 *Malus* ‘Donald Wyman’ (Donald Wyman crabapple) in fruit

46 *Malus* ‘Donald Wyman’ (Donald Wyman crabapple) flower and fruit closeup

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47 *Myrica pensylvanica* (northern bayberry), *Baccharis halimifolia* (groundselbush), and *Rhus copallina* (winged sumac) naturally occurring on a sandy roadside dune

48 *Myrica pensylvanica*, (northern bayberry) and *Euthamia tenuifolia* (tiny-headed goldenrod) naturally occurring in a sandy roadside

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49 *Narcissus sp.* (daffodil) blooming

50 *Nyssa sylvatica* (black gum) fall color

51 *Panicum amarum* (Coastal switchgrass) on sandy dune

52 *Panicum amarum* 'Dewey Blue' with *Aster oblongifolius* 'October Skies' (October Skies aster)

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53 *Panicum virgatum* 'Cloud Nine' (Cloud Nine switchgrass) and *Aster oblongifolius* 'Raydon's Favorite' (Raydon's Favorite aster) flowering

54 *Panicum virgatum* 'Dallas Blues' (Dallas Blues switchgrass) flowering

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55 *Panicum virgatum* 'Northwind' (Northwind switchgrass) in early June edged with *Amsonia* 'Blue Ice' (Blue Ice blue star)

56 *Panicum virgatum* 'Northwind' (Northwind switchgrass) flowering with upright form

57 *Rhexia mariana* (Maryland meadow beauty) flowers

58 *Rhododendron atlanticum* (coast azalea) flowering

59 *Rhododendron atlanticum* (coast azalea) flower close up

60 *Rhododendron periclymenoides* (pinxterbloom azalea) flowering

61 *Rhus copallina* (winged sumac) fall color

62 *Rhus glabra* (smooth sumac) fruit and fall color

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63 *Rhus glabra* (smooth sumac) and *Eupatorium hyssopifolium* (hyssop-leaved thoroughwort) on a dry roadside

64 *Rhus typhina* (staghorn sumac) fall color

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65 *Rhus typhina* (staghorn sumac) fruit

66 *Rudbeckia hirta*, (black-eyed susan) seeded with *Schizachyrium scoparium* (little bluestem) on a dry infield slope

67 *Rudbeckia hirta* (black-eyed susan) and *Silphium laciniatum* (compass plant) in dry infield

68 *Sambucus canadensis* (elderberry) flowering

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69 *Sassafras albidum* (common sassafras)

70 *Schoenoplectus tabernaemontani* (great bulrush) in wet swale

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71 *Schoenoplectus tabernaemontani* (great bulrush) flowers close up

72 *Scirpus cyperinus* (woolgrass) and *Liquidambar styraciflua* (sweetgum) naturally occurring in wet roadside swale.

73 *Scirpus cyperinus* (woolgrass) and *Solidago rugosa* (rough leaf goldenrod) in masses with *Liquidambar styraciflua* (sweetgum) and *Baccharis halimifolia* (groundsel bush)

74 *Schizachyrium scoparium* (little bluestem) winter color

75 *Senna hebecarpa* (northern wild senna) flowering

76 *Solidago* 'Fireworks' (Fireworks goldenrod) with *Aster oblongifolius* 'October Skies' (October Skies aster) and *Panicum virgatum* 'Northwind' (Northwind switchgrass)

77 *Solidago* 'Fireworks' (Fireworks goldenrod) with *Aster laevis* 'Bluebird (Bluebird aster) flowers

78 *Solidago rugosa*, (rough leaf goldenrod) and *Eupatorium hyssopifolium* (hyssop-leaved thoroughwort) naturally occurring on dry roadside

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79 *Solidago sempervirens* (seaside goldenrod) and *Panicum amarum* (panic beachgrass) naturally occurring in sandy median

80 *Solidago sempervirens* (seaside goldenrod) flowers

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81 *Sorghastrum nutans* (indiangrass) and *Rudbeckia hirta* (black-eyed susan) seeded on a dry infield slope

82 *Sorghastrum nutans* (indiangrass) flowering

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83 *Typha latifolia* (broad-leaved cattail) in a wet swale with seeded *Rudbeckia hirta* (black-eyed susan)

84 *Typha angustifolia* (narrow-leaved cattail) in seed

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85 *Verbena hastata* (blue vervain) seeded with *Hibiscus moscheutos* (marsh mallow) planted in a routinely wet roadside

86 *Vernonia noveboracensis* (New York ironweed) flowering

87 *Viburnum dentatum* (arrowwood viburnum) variations in fall color

88 *Viburnum nudum* 'Winterthur' (Winterthur swamphaw viburnum) fall color and fruit

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Appendix D: Recommended References

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Glossary

Annual – a plant that completes its life cycle in one growing season.

Backslope – the slope extending upward and outward from side ditches to intersect the natural ground.

Balled and burlapped (B & B) plants – field grown plants harvested with a root mass and surrounding soil, contained by burlap. This is a common production method for woody shrubs and trees and is less commonly used for large herbaceous plants.

Bare root plants – field grown woody plants harvested with a root mass that is devoid of soil, typically used only for plants in a dormant state.

Berm – mounded and shaped soil.

Biennial – a plant that completes its life cycle in two growing season; usually undergoing vegetative growth only during the first season and reproductive growth during the second season.

Biological diversity (Biodiversity) – the variety of life forms, including genetic types, species and natural communities, present. Species diversity, or the number of species present, is the predominant measure of biodiversity used by most ecologists.

Broadcast seeding – the simple dry distribution of seed often mixed with a carrier such as sawdust to improve dispersal.

Brush removal – cut and remove designated woody plants by manual hand or mechanical means; leave stump height not to exceed 10 inches; remove cut material from site to acceptable disposal area; and treat stump with appropriate chemical herbicide to prevent regrowth.

Canopy trees – trees with heights of 100 feet or more making up the top layer of the forest.

Channelization – the separation or regulation of conflicting traffic movements into definite paths of travel by traffic islands or pavement marking to facilitate the safe and orderly movements of both vehicles and pedestrians.

Clear zone (lateral clearance) – the distance between the outside edge of the traveled way to a roadside obstruction, a clear area allowing drivers the opportunity to recover control if their vehicle accidentally leaves the pavement surface. The desired width of this clear zone varies with operating speeds, volume of traffic, steepness of slopes, degree of curvature and accident history (see chapter 4, DelDOT Road Design Manual.)

Clump-forming shrubs – shrubs that spread in width from a central stem or clusters of stems.

Coherence – sense of order and direction of a viewed scene.

Colonizing shrubs – shrubs that spread by woody rhizomes and have the capacity to fill in relatively large areas.

Community – (a) group of species of plants and/or animals living and interacting at a particular time and place. (b) group of people residing in the same place and under the same government; spatially defined places such as towns or neighborhoods.

Community involvement – a neighboring community's interest in landscape enhancement at a particular roadside location and its willingness to accept some ongoing responsibility for its planting and maintenance.

Complexity – characteristics of scenes that warrant exploration.

Container-grown plants – grown in artificial media within a container. This production method is increasingly used for woody plants and herbaceous perennials.

Context sensitive – aesthetic, scenic, historic and cultural resources and the physical characteristics of an area giving a community its identity and sense of place and source of local pride.

Cool-season grass – grass species that grow best when temperatures are 60˚ – 75˚ F and usually undergo summer dormancy; include most of the mowed turfgrasses.

Cultural and historical characteristics (CHC) matrix – a tool designed to provide an objective basis for the selection of one of the three design approaches.

Cutback (Cutting back) – periodic cutting of woody vegetation to maintain dense and healthy growth within desired height and spread parameters.

Deliberate planting – plants may be deliberately introduced in one of two general ways—by sowing seed or by the installation of plants.

Design exception – a special circumstance where the departure from minimum design standards can be allowed as justified by supporting rationale. The designer must provide thorough documentation for review and approval by the Chief Engineer for each request in format as established in Chapter 3 of the DelDOT Road Design Manual.

Discontinued mowing – cessation of any routine mowing practice releasing the desirable regional vegetation to develop through natural growth or seeding. Undesirable plants will be controlled by spot treatment. A released site may require occasional intervention such as periodic mowing, editing or cutting back.

Drill seeding – the placement of seed in a shallow trench created by a disc.

Ecology – the study of interactions between organisms and the environment.

Ecological landscape design – an approach to landscape design intended to consciously create a meaningful order or balance based on the composition, structure and processes of ecosystems (whole communities that work in the self-sustaining and self-limiting ways of nature.) The design seeks to optimize the positive ecological impacts based on a thorough observation and analysis of the (physical and experiential) qualities of a place; i.e., the site and the surrounding context; balancing cultural or human needs and natural processes.

Ecotype – locally adapted variant of a plant species.

Editing – evaluate existing vegetation and identify opportunities to introduce aesthetic order by highlighting individual specimens or plant groups through the process of removing other vegetation.

Editing and adding – after editing, supplement the existing landscape with desirable species to enhance the groupings.

Erosion (control) – removal of soil particles through the action of water and wind.

Fascination – facet of a setting resulting in effortless attention.

Fauna – the whole of the animal world, as opposed to the flora or plant life; also the animals of a particular area.

Fertility – quantity of nutrients present in soil system.

Flora – the whole of the plant world, as opposed to the fauna or animal life; also the plants of a particular area.

Forbs – broadleaved flowering herbaceous plants.

Frontslope – the slope extending outward and downward from the finished shoulder to the side ditch.

Gateway component – a measure of the site's relative importance as a gateway or prominent entrance to a community, town or city.

Glyphosate – an herbicide used for non-selective herbicide control of vegetation (selection can be achieved with spot application).

Ground layer – the lowest layer usually ranging from a few inches to perhaps six feet.

Habitat – the natural environment of an organism; the place where it is usually found.

Hardiness zones – regions outlined by the USDA to indicate where a plant can live year round with out protection; both cold and warm hardiness zones are outlined.

Herbaceous – a term referring to any non-woody plant; a plant that dies back to the ground seasonally.

Herbicide – chemical used to kill plants either selectively or non-selectively.

Horticultural – referring to cultivation of plants using a higher intensity than agronomic crops.

Human scale – an installation is of a human scale if its size, position and details relate to passers-by in a way that makes them feel comfortable rather than intimidated.

Hydroseeding – distributing seed with fiber mulch through a stream of high-pressure water.

Impact attenuation – a means to prevent vehicles from impacting fixed objects head-on by stopping the vehicle at a rate of deceleration that is tolerable to the vehicle occupants.

Intersection component – a measure of the site's positioning at a regulated intersection, since drivers who stop are more likely to notice conditions at such sites.

Invasive plants (nonnative invasive species) – plants that reproduce rapidly, spread over large areas of the landscape and have few, if any, natural controls, such as herbivores and diseases to keep them in check.

Landscape character – the appearance of land, including its shape, form, colors and elements; the way these (including those of roads) components combine in a way that is distinctive to particular localities; the way they are perceived; and an area's cultural and historical associations.

Legibility – visible characteristics of scenes that result in ease of understanding and ability of the viewer to remember the scene.

Line of sight (sight distance) – minimum safe unobstructed vision distances as measured from the vehicle operator's position in the lane of travel. Sight distances must be sufficiently designed to allow reasonably competent and alert drivers to make safe decisions under ordinary circumstances for vehicle operations such as passing, turning or stopping.

Low-impact design – a shift from the philosophy of rapid removal and collection of water to the slowing and infiltration of water; a reversal of the traditional approach to site drainage design to more closely mimic the natural drainage functions.

Macroclimate – characteristic conditions such as temperature extremes, soil type, rainfall and patterns of seasonal variation that dictate the vegetation.

Median – center space set aside on divided multi-lane highways to provide a separation of opposing traffic lanes.

Microclimate – localized conditions that dictate whether vegetation is sustainable in a specific site.

Mystery – characteristic of scenes that provide a pleasant challenge to the imagination.

Native plant – a plant that records indicate to be naturally occurring prior to European settlement. Unless otherwise specified in this manual, "native plants" are native to Delaware.

Naturalization – the process of allowing existing soil-banks to germinate and/or encroaching adjacent seed sources to take over. Proximity to natural plant communities and a diligence to remove invasive plants are required for success (Harper-Lore, 1998).

Noxious weed – a plant that is regulated by a state; property owners can not allow these plants to go to seed on their properties.

Ornamental – serving to embellish or adorn; decorative.

Passing sight distance – sufficient sight distance to enable drivers to occupy the opposing traffic lane for passing other vehicles on certain two-lane highways without risk of a crash.

Perennial – a plant that lives for two or more growing seasons.

Perennial forb – broadleaved herbaceous flowering plant (as opposed to the narrow-leaved grasses, sedges and rushes).

Periodic mowing – mowing annually or as necessary to discourage establishment of woody species and maintain an herbaceous composition (defined for Costs Section as 1x).

pH – relative alkalinity or acidity of a soil.

Physiographic region – Region characterized by climate, topography and soil type.

Plant community – all the plants inhabiting a common environment and interacting with one another.

Plugs – very small herbaceous plants grown in small containers.

Population dynamics – change in the composition of species within a plant community.

Preservation – preserving and managing existing remnants of ecosystems wherever possible (Harper-Lore, 1998).

Provenance – the geographical area or place of origin of a collection of genetic material (generally in the form of seed, pollen or cuttings) for which the process of natural selection has resulted in some common or shared population characteristics.

Ramp infield – the enclosed area between the travel lanes of divided multi-lane highways and the exit or entrance ramps.

Re-creation – the process of returning an ecosystem type to the vicinity, but not exact site, of that ecosystem type (Harper-Lore, 1998).

Reclamation – the process of revegetating severely disturbed lands where plants and soil no longer resemble the original. The primary objective is to cover the soils and limit erosion, with a goal of increased usable land (Harper-Lore, 1998). In other words, any deliberate attempt to return a damaged ecosystem to some kind of productive use or socially acceptable condition (Jordan et. al., 1998).

Regeneration – the process of allowing existing soil-banks to germinate and/or encroaching adjacent seed sources to take over. Proximity to natural plant communities and a diligence to remove invasive plants are required for success (Harper-Lore, 1998).

Regional – as it pertains to design and management strategies, a regional approach considers the local character and ecology of the place and allows for input of local citizens. To be truly regional, an application must be fitted to the local biological processes and systems, and must conform to the local knowledge of cultural and historical traditions that result from extended residence in a place.

Rehabilitation – the process of improving the ecosystem health of disturbed land. When soils are not disturbed, the site will revegetate without aid, but disturbed soils are subject to weed invasion, compromising the original ecosystem. The primary focus of rehabilitation may be weed control (Harper-Lore, 1998).

Restoration – defined as “the process of establishing the original site characteristics (ecosystem) that existed prior to land disturbance” (Gerling, 1996) or “the recreation of entire communities of organisms, closely modeled on those occurring naturally” (Jordan et. al., 1998).

Revegetation – the process of returning plant cover to exposed soils. Revegetation can be accomplished through planting, allowing existing seed to germinate or allowing seed from surrounding vegetation to encroach (Harper-Lore, 1998).

Rhizomes – an underground stem distinguishable from a root by presence of nodes, buds or scale-like leaves.

Right-of-way – legal limits of use or boundaries of a transportation corridor as defined on property deeds.

Routine mowing – frequent mowing (defined for Costs Section as 8x) of the site to maintain a specified height of vegetation.

Sedimentation – pertaining to drainage ditches and basins, an accumulation of soil particles as carried by surface stormwater runoff.

Seeding – this planting method can be economical for establishing herbaceous plants (grasses and forbs). Since seeding results in random or informal distribution it is most appropriate for larger areas where the precise location of individual plants is not of primary importance.

Sense of place – the meaning, values and feelings that people associate with physical locations because of their experiences there. The aesthetic, nostalgic or spiritual effects of physical locations on humans based on personal, use-oriented or attachment-oriented relationships between individuals and those locations. [National Trust for Historic Preservations: Those things that add up to a feeling that a community is a special place, distinct from anywhere else. J. B. Jackson: It is place, permanent position in both the social and topographical sense, that gives us our identity. Forman: Goals of good designs include: relink people with genius of their places, revivify image and identity with places, and maintain identity of places.]

Shrub layer – middle layer, typically ranging from two to fifteen feet in height; comprised of woody, semi-permanent components of the landscape.

Spatial organization – how space is organized in a viewed scene. Can range from open to densely packed with objects. Ground texture and depth can be defined.

Stopping sight distance – minimum safe unobstructed vision distance such that drivers can control the operation of their vehicles to avoid striking an unexpected object in the traveled way. Distances to be used in the design of roadside and road profiles may be calculated as per criteria described in Chapter 5 of the DelDOT Road Design Manual.

Succession – an ecologically predictable process of changes in structure and composition of plant and animal communities over time.

Sustainability –the ability of a society, ecosystem, or any such ongoing system to continue functioning into the indefinite future. Sustainable development involves meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Tourism value – a measure of the prominence of the site with regard to tourist traffic.

Traffic exposure – a measure of the relative number of cars that pass a site.

Traffic island – a roadway median space separating traffic lanes, typically at intersections or on lower-speed urban arterials, potentially providing opportunities for community-supported landscape enhancement.

Transportation corridor – the long, narrow portion of land dedicated to movement of humans and human commodities usually delineated by rights-of-way boundaries.

Tree layer – the uppermost layer continuing from the upper reaches of the shrub layer to the sky; including an understory layer of smaller trees and a canopy layer of larger trees.

Understory trees – trees ranging in height from 20 feet to 40 feet.

Visibility – a measure of how clear the lines of sight are from the roadway.

Vista – a view, particularly a long narrow view, as opposed to a panorama, which is a wide sweep.

Visual priority – an integrated priority level determined by visibility and contribution to corporate image or tourism potential.

Warm-season grass – grass species that grows best when temperatures are 80˚– 90˚ F; include the majority of our native prairie and meadow species.

Wildflower – a term used to describe a plant wild or native to a place, but often misused as a generically desirable plant for a specific landscape application.

Wetland Mitigation – the use of wetland restoration to “offset” an unavoidable wetland disturbance (Harper-Lore, 1998).

Woody plant – plant that contains secondary xylem (wood); it has a permanent above ground structure whereas herbaceous plants die back to the ground seasonally.

Zone – component of the roadside.

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