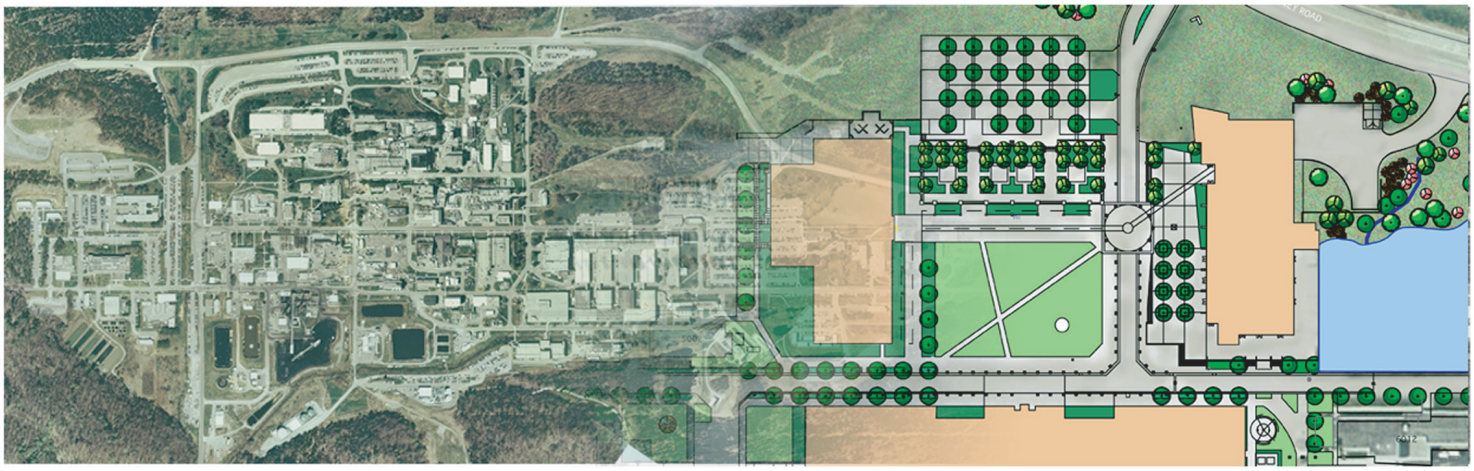
ORNL/TM-2003/266

OAK RIDGE NATIONAL LABORATORY CONCEPTUAL LANDSCAPE PLAN & DESIGN GUIDELINES



MARCH 2003

Hawkins Partners, Inc.
landscape architects

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Prepared By

Hawkins Partners, Inc.
landscape architects

131 Second Avenue North
Nashville, Tennessee 37201
615-255-5218
www.hawkinspartners.com

for
OAK RIDGE NATIONAL LABORATORY
P.O. Box 2008
Oak Ridge, Tennessee 37831-6336
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INTRODUCTION

The Oak Ridge Reservation (ORR) is located in the Valley and Ridge physiography of East Tennessee almost exclusively within the corporate limits of the City of Oak Ridge, Tennessee. Over 1,100 species of vascular plants can be found within the boundaries of the reservation, which rivals the Great Smokey Mountains National Park in species diversity. Of these many species, some, like the Tall Larkspur, (*Delphinium exaltatum*) are rare and endangered. The reservation has provided an unprecedented opportunity to conserve this unique area, educate others about it and provide a springboard for large-scale environmental research.

Within this environmental menagerie lies the Oak Ridge National Laboratory, the largest and most diverse energy research and development institution within the U.S. Department of Energy (DOE). Its research, both basic and applied focuses on advancing the nation's energy resources, environmental quality, and scientific knowledge.

The campus is currently under a major transformation as it focuses itself for the challenges of the twenty-first century. New facilities such as the Research Office Building, Engineering Technology Facility and Computational Sciences Building, are currently under construction. Many more facilities are soon to be constructed or have been planned for the near future.

As this transformation continues, there is an increasing focus on the quality of the outdoor environment. The landscape is one important component of the success of the laboratory due to its ability to tie elements of the campus together and establish a cohesive identity. This in effect has the ability to visually meld old and new facilities. The landscape can also aid in the mitigation of improvements that might have impact on the environment by cleansing stormwater run-off, reducing urban heat islands, reducing water consumption, providing wildlife habitat for using native plant species, and promoting environmental diversity.

Furthermore, the physical quality of the campus has been a minor focus for most of its history. In order to meet its obligation to the natural environment and its employees, ORNL has committed itself to construct a campus that meets today's needs and tomorrow's aspirations. This will not only insure that the Lab will meet its environmental responsibilities, but also attract the best and brightest minds which will continue the Lab's traditions and meet its mission with distinction. As seen with the recent design of new facilities, there is a concerted effort to raise the level of design beyond the utilitarian. The tenet that the campus should inspire and educate while performing its function has contributed to the design caliber of many of the recent projects. The landscape is seen as an integral element to this end.

The landscape conceptual master plan and guidelines presented here in have been prepared to assist ORNL in establishing and maintaining a landscape that reinforces the institution's principles and goals. The landscape design guidelines portion of this plan focus on the following in order to meet the goals of the plan:

- Appropriate Use of Plant Species
- Planting and Seeding Techniques
- Planting and Seeding Schedules
- Landscape Management Principles
- Landscape Lighting Principles

In cooperation with ORNL's Design Steering Committee (DSC), the following goals and objectives were developed to guide this plan:

GOAL1: The landscape should create a cohesive campus that supports the identity of ORNL and the region while recognizing unique areas of the campus.

OBJECTIVES:

- Allow for flexibility when instituting the plant list for specific areas of the campus
- Institute an identifiable environmentally-friendly plant list
- Use street trees to link the campus together through the development of strong axes along major streets, which connect campus centers.

- Provide strong pedestrian connections between uses
- Utilize local materials and traditions creatively

GOAL 2: The landscape should facilitate navigation of the campus.

OBJECTIVES:

- Establish clear identifiable entries for specific users (i.e. employees, visitors)
- Use gateways/thresholds to signal that the users have entered definable area of the campus
- Utilize strategically located signage

GOAL 3: The landscape should inspire and reflect the mission and aspirations of ORNL.

OBJECTIVES:

- Conceive dynamic and thought provoking landscapes that are inspired by the work at ORNL
- Incorporate sustainable technologies in a way that make their presence and function visible to the users
- Provide exterior gathering spaces for formal and/or impromptu meetings where the exchange of information and ideas can take place
- Strategically locate gathering spaces that are easily accessible and are used by all employees
- Incorporate research opportunities into the landscape and make these visible to the ORNL community
- Create spaces that allow for individual and collective discovery through inquiry participation
- Utilize interpretative signage in selective locations
- Consolidate activities within the landscape to increase interaction and activity by ORNL and its public
- Integrate art and science into the landscape seamlessly and imaginatively
- Use color and texture to heighten the senses and a sense of place
- Use plant material that provides interest and engagement during all seasons

GOAL 4: The Landscape Should Require Low Energy Use and Minimal Intervention

OBJECTIVES:

- Utilize plants that require infrequent pruning
- Utilize plants that require little or no fertilization
- Utilize plants that are disease tolerant and are adapted to local conditions
- Use a centrally controlled irrigation system
- Utilize easily cleaned and repaired materials in the built environment
- Lighting sources should be long lasting, utilize minimal maintenance and be adaptable over time

GOAL 5: The landscape should stand the test of time and continue to enhance the campus in the future. The landscape should meet the needs of the campus while not comprising the ability for the campus to meet its future needs.

OBJECTIVES:

- Use durable materials
- Use cost-effective materials and site furnishings that have low life cycle cost (Low Maintenance)
- Utilize energy efficient lighting
- Utilize plant material with long life cycles

- The design of the landscape should aspire to being timeless by considering future changes, its longevity and appropriateness.

- The landscape should serve to bridge the contributions of the scientists from one generation to the next, understanding that the source of scientific investigation rests in nature itself and its mysteries and revelations which transcend all who participate in the scientific enterprise.

GOAL 6: The landscape should reinforce the environmental goals of ORNL

OBJECTIVES:

- Always strive to meet LEED criteria
- Incorporate recycled materials
- Utilize graywater and/or water harvesting for irrigation
- Judiciously use potable water where necessary through the use of efficient irrigation system
- Use only “Night-Sky Friendly” lighting
- Incorporate new energy sources
- Utilize porous pavements
- Improve water quality through passive filtering and protection of riparian zones
- Establish a diverse and complementary plant palette that is comprised of predominantly native plant species (non-native, non-invasive species can be used where native species can not meet the desired outcomes)

GOAL 7: The landscape should provide cost effective solutions for the needs of the campus.

OBJECTIVES:

- Set clear goals, objectives and cost constraints for each project before design
- Evaluate cost benefit of design options based on construction cost, long term maintenance cost, and fulfillment of ORNL's goals. All decisions made regarding the landscape should be reviewed as 50-year decisions as a minimum.

GOAL 8: The landscape should be a working laboratory.

OBJECTIVES:

- Evaluate existing and future research programs to determine those that may be able to utilize the campus and its larger environment for their research
- Identify locations on campus where these research projects and demonstrations could potentially be exhibited

EXPRESSING ORNL'S IDENTITY

What is ORNL's identity? This is an important question to answer before developing design guidelines for the landscape. The role of the landscape is to reinforce and express this identity.

The core of ORNL's identity is that of a leading research and development facility. This identity is based on the laboratory's legacy of scientific discoveries and the creative application of science to meet the nation's needs and aspirations. It is a place that will continue to be a leader in our nation's scientific endeavors. Therefore the landscape should express this leadership through demonstration.

At the same time, the East Tennessee Ridge and Valley Environment is a significant contributor to the physical manifestation of the laboratory's identity. The existing landscape has served ORNL well. The folded geology's valleys have provided protective sites for ORNL's facilities. The landscape's 1,100 vascular native plant species compose numerous complex habitats found on the reservation, making it unique among the Department of Energy's laboratories.

Complementing this is ORNL's dedication to conserving its surrounding environment and improving an understanding of it. Research in successional patterns in disturbed landscapes, invasive plant control, exotic plant research, and natural acceleration bioremediation investigation research are just some examples of research being carried out by ORNL.. All these programs should become a part of the landscape's contribution to ORNL's mission. It is the intention of this landscape management plan that these activities become integral to the daily activities of the built and natural environment of ORNL.

In recognition of ORNL's identity, the uniqueness of its physiographic setting and its dedication conserving the authenticity of that setting all future landscape improvements should equally acknowledge the integrity of the surrounding natural environment through the use of vernacular native plants and building materials. The landscape should further seek to mitigate environmental impacts of the laboratory by utilizing sustainable building practices and providing a living laboratory for the research at ORNL.

CONCEPTUAL LANDSCAPE PLAN

CONCEPTUAL LANDSCAPE PLAN

The conceptual landscape plan establishes a unified vision for all future landscape improvements and provides a framework for fulfilling the goals of this plan. The plan and guidelines were developed through the cooperation of a design review committee comprised of representatives of ORNL.

The conceptual plan unifies the laboratory through landscape enhancements that link the Laboratory together with plantings that accentuate the major entries and axes. In addition, the predominantly native plant palette prepared for this plan(Appendix A) emphasizes the local identity of the campus and strengthens its relationship with the surrounding landscape.

To provide clear direction to users of the Laboratory, the plan recommends signage and landscape at all major entrances along Bethel Valley Road. For the first time in the Lab's history, formal outdoor spaces have been identified and defined of which the east and west quadrangle are the most important.

The landscape guidelines serve to compliment the conceptual plan by providing guidance for implementing and maintain the plan.

An illustration of the overall plan and each selected enlargement areas can be found in Appendix E. The following are descriptions of the various components of the plan.

Bethel Valley Road Corridor. The main objective of the Bethel Valley Road was to enhance its rural and naturalistic character by reducing the amount of turf grass used along the roadside and replacing it with the specified native grasses mix outlined in this plan. Further landscape enhancements included strengthening the tree line with specimen plantings at specified locations, landscape buffers between adjacent parking areas and Bethel Valley Road, removal of parking in some cases, and recognizing stream crossing through specific landscape improvements.

Intersection of Bethel Valley Road and Highway 95. The intersection of Bethel Valley Road and Highway 95 is the western main entrance to the laboratory. The forested areas adjacent to the entry were primarily made up by White Pine and have been devastated by the recent pest infestation that targeted the White Pine. The plan recommends restoring the forest edge condition. As was done along Bethel Valley Road at strategic locations, these tree lines would be strengthened by natives that transition from shade trees at the edge, then to understory trees, then to grasses and perennials. The edge of the road would maintain a minimal mowed shoulder.

West Portal. The West Portal signals the official western entry into the laboratory. The plan recommends shaping the space by accentuating the site's natural features with the tree line. In order to help break up the large open area to the north and create a more defined space it is recommended that groupings of shade trees, flowering trees, shrubs, and evergreen trees be utilized. The existing tree lines have been strengthened through the introduction of native specimen trees. As was recommended at the intersection of Bethel Valley Road and Hwy 95, edges transition using shade trees, understory trees, and native grass and perennials. The road's edge would maintain a narrow mowed shoulder.

East Portal. The East Portal signals the official eastern entry into the laboratory. Similar to the West Portal, the plan recommends shaping the space by accentuating the natural features on the site through the shaping of the tree line. The existing tree lines are augmented with native specimen trees. Existing tree lines will be planted with flowering understory trees, and native grass and perennials. The road shoulder would be mowed at a minimal width.

Intersection of Bethel Valley Road and First Street. The intersection of First Street and Bethel Valley Road is the primary entry to the West Campus Area. The landscape concept plan recommends identifying the entry with signage. The signage would match the design of the current signs that have recently been constructed at Melton Valley Road and Fifth

Street. A backdrop of native shade and flowering trees is recommended as means of improving the existing natural vegetative backdrop and further enhancing the signage.

The existing parking area along the southeast detracts from the Bethel Valley Corridor Experience. The plan recommends a landscape buffer composed of native shade trees, flowering trees, evergreen trees and shrubs be established to screen the view of the parking and enhance the intersection.

Bethel Valley Road crosses First Creek within this area. Accentuation of each significant water crossing on Bethel Valley road is recommended. A simulation of a rustic bridge of stone and concrete pavers combined with landscape plantings will acknowledge that a threshold has been crossed. The plantings within this area would be native and selected from the riparian category listed in Appendix A.

Intersection of Bethel Valley Road and Fifth Street. The intersection of Fifth Street and Bethel Valley Road is the primary employee entry to the laboratory and has recently been realigned. A new sign identifies the entry. A natural landscape backdrop will highlight the signage. The backdrop includes a variety of specimen quality native trees along the existing tree line punctuated by native flowering trees. Native grasses and perennials will provide a dramatic foreground and ground the signage within the landscape.

The parking areas along Bethel Valley Road dominate the Fifth Street Intersection. The landscape concept plan recommends that the parking to the west of Fifth Street, directly adjacent to Bethel Valley Road, be flipped in order to provide enough room for a landscape buffer. The landscape buffer should continue along the parking area on the east side of Fifth Street.

Fifth Street. Upon entering the Laboratory at the Fifth Street Entry, the plan recommends planting a series of ornamental understory trees along the West side of the street. This will create a consistent rhythm that will strengthen the entry experience while staying clear of the overhead power lines. The east side is bound by a steep slope directly adjacent to the pavement edge which prohibits the planting of additional trees. Near the intersection of Fifth Street and Central Avenue trees can be planted on either side of Fifth Street. The plan identifies an opportunity to capture a formal outdoor space by defining the vehicular circulation routes and establishing a focal point on the axis of Fifth Street within this space.

Central Avenue. Central Avenue is the major axis on which the majority of the campus is organized around. In recognition of this, the plan recommends a series of trees along the axis where permitted as means of further strengthening the axis. Because of the array of utilities that are found within the existing planting areas paralleling the road, additional planting space must be provided by narrowing Central Avenue to 22 feet wide. The axis has been extended to the 7000 areas through the use of a rigid line of trees.

West Campus. The West Campus is the western terminus of the axis formed by Central Avenue. Due this prominent location, the area has been targeted for future development. The first of these facilities is the Laboratory for Comparative and Function Genomics and is now under construction. Three additional facilities are planned. They include the Center for Systems Biology, Joint Institute for Biological Studies (JIBS) and Proteomic and Protein Complex Analysis Lab. The plan recommends that these buildings be arranged to form a central West Quadrangle. The Quadrangle would provide a significant western terminus to the campus. The plan envisions the JIBS building terminating the axis while the other Buildings at the entry of the Quadrangle become a gateway. The plan directly continues this axis by extending Central Avenue across First Creek. This extension would provide a stronger pedestrian and psychological connection to the rest of the campus. Street trees along Central Avenue are recommended to further strengthen this axis.

The plan has widened the riparian corridor by removing much of the parking that has encroached upon the creek. The plan recommends that this area be managed to allow views to the creek and highlighted with a variety of native woody plant specimens, grasses and perennials. These planting will enhance the

riparian habitat, the creek's water quality, and the experience along First Street.

The plan proposes to remove the access drive between the West Campus Quadrangle and the Upper Parking Lot to the north. This would facilitate access from the parking area and offer a wider landscape buffer to screen the parking. Access to the Service area of the Laboratory for Comparative and Functional Genomics would be provided along the drive connecting the existing and proposed parking areas.

Within the Quadrangle itself, the plan recommends two large event spaces bisected by a series of rolling mounds that would be reflect the prototypical model used to visualize the DNA double helix. The mounds would provide a visual spectacle and function as potential seating areas. A grid of trees is recommended to buffer the Laboratory for Comparative and Functional Genomics and could function as a research plot.

East Campus. The recently completed Master Plan has designated the East Campus as the major center of the campus. Three major buildings form the East Campus Quadrangle. They include The Third Party Development, Research Support Center (RSC), and the Joint Institute for Computational Studies (JICS). The ORNL visitor center will be relocated within the RSC making the Quadrangle the Lab's most visible showcase to the public. The main focus of the East Campus is the large lawn area, which will become the major event space.

The other major landscape components of the Quadrangle include the grid of large shade trees in the upper parking area, the landscaped arrival terrace and the bosk of trees in front of the RSC. Each of these areas will be passively irrigated by capturing rain water off the parking area and the RSC rooftop. The Arrival Terrace will provide a unique opportunity to showcase the diverse landscape of the ORNL Reservation. Each of the four gathering areas will utilize a variety of native plants arranged to represent habitats found on the Reservation.

The Plan creates a dramatic overlook to the Swan Pond by bring the edge of the Pond up to the RSC East terrace. The Hillside along the pond is proposed to be planted with Native Shade and Evergreen Trees among a planting of grasses and perennials. A re-creation of Eastern Tennessee Stream will generate a significant focal point for users of the RSC Terrace.

The symbolic axis of Central Avenue continues eastward along the Swan Pond, though only pedestrian in nature. An architectural edge "urbanizes" the southern border of the pond and creates a pedestrian promenade where users can sit and enjoy the view of the pond and the water feature.

4500 Parking Area. The 4500 Parking Area serves the 4500 Building Complex which is the epicenter of ORNL's administration. The plan proposes to enhance the aesthetic appeal of the parking area by planting a variety of native shade trees, planting to enhance the woodland edges, and reduce mowing with groundcovers. The exposed river stones will be enter-planted with vines and strategically placed perennials to add color.

The plan recommends reducing the extreme width of Central Avenue to 22 feet, as was done within the East Campus Area, to avoid conflict with underground utilities. Shifting the northern curb to the south would allow enough room to successfully establish the trees along the street without the costly expense of relocating the myriad of underground utilities.

6026 Parking Area. The 6026 Parking Area overlooks the East Campus. Its prominent location offers the opportunity to create a dramatic landscape. The plan recommends planting the hillside between the two parking areas with native grasses and perennials interspersed with groves of native trees and shrubs. Shade Trees with groundcover planted underneath are proposed within the parking islands in an effort to help shade and scale the parking lot. A successional area is recommended to bring the forest edge to the edge of the parking area in a naturalistic way, which also reduces maintenance.

A series of walkways are proposed to facilitate pedestrian access from the upper parking to the

lower parking lot and to the neighboring campus buildings. A walkway is proposed along White Oak Creek with a spur that connects the Third Party Building to White Oak Creek. A seating node is recommended where this spur intersects the main walkway. The node would provide an interpretative overlook to the creek.

The plan recommends that this area of White Oak Creek be managed to allow views to the creek, highlighted with a variety of native woody plant specimens, grasses and perennials.

Southside Avenue. Southside Avenue is parallels White Oak Creek and offers opportunities to provide visual access to White Oak Creek. The plan recommends reconfiguring the 90 degree parking along the south side of the street to parallel parking. This will allow for the inclusion of pedestrian access along White Oak Creek where various gathering nodes could be strategically located.

Southside Parking Area. Due to the subsurface conditions of the parking lot, shade plantings within these areas could be replaced by constructing arbors upon which an overhead solar array could be built. This would provide opportunities for solar power research, shading for the parking lot, and power for security lighting. The plan recommends providing a stronger pedestrian connection to neighboring laboratory facilities by providing a centrally located walkway and a pedestrian bridge crossing White Oak Creek to the future AMCL facility, to the existing walkways.

PLANT SELECTION

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Two components that have great influence on the physical identity of the ORNL campus they are buildings and the surrounding landscape. Of the two, landscape plantings are in many ways a more dominant feature and play a more significant role in the aesthetic quality of the campus. The benefits of landscaping include the following:

- Enhance aesthetic qualities and improve human scale
- Provision of pleasant experiences for staff and visitors
- Reduce cooling cost for buildings in the summer
- Reduce heating cost for buildings in the winter
- Reduce "heat island" effect in parking lots and other large paved areas
- Cleanse atmospheric pollutants
- Cleanse stormwater run off
- Provide habitat for wildlife

The development of a strategy for selection of appropriate plant material to be used in the ORNL landscape is one of the most important defining strategies for the laboratory. This plant palette will not only influence the campus appearance, it will also impact ORNL's operations costs. Plants that require constant pruning or watering require considerably more man-hours and financial resources to maintain the aesthetic expectations of the laboratory.

Utilizing of native plant species is the clear choice to meet campus needs. Plants that are indigenous to the Oak Ridge Reservation and/or are native to the region are better adapted to local conditions and require much less maintenance than their exotic counterparts. Often natives are hardier and can better withstand extreme weather conditions such as cold winters or dry summers. Native plants are also typically more resistant to common disease problems.

By planting native species, an aesthetic will be established that grounds the laboratory to its surrounding environment and embraces the unique vernacular of East Tennessee. This fusion between the constructed campus and its environs will underscore ORNL's commitment to the environment and promote a legacy of biodiversity and stewardship.

Nature and The Built Environment. The natural environment is an incredibly complex system. The developed landscape, though in many ways equally complex, does not directly mimic conditions found within the natural landscape.

For instance, Natural soils contain a complex community of organisms that benefit the plants by aiding in nutrient collection. Soils in a constructed landscape are often more compacted and sterile in a constructed landscape. In effect reducing the oxygen, organic matter, moisture and nutrient availability. Compounding this is the fact that soils within a built environment are mixed and do not simulate the complex soil horizons found in the natural environment.

The built environment can impose additional stress to plants. The combination of solar reflection and heat absorption from buildings and pavement produces extreme temperatures. These built features can also restrict the natural rooting zones of plants and prevent moisture and air from accessing the root zone.

Because of such differences between the built environment and natural conditions, not all native plants are appropriate choices for a landscape installed in the built environment. In order to develop a viable list of appropriate species for use on the ORNL campus, this distinction must be realized. This distinction was the first step used in deciding if a particular plant should be considered for use within the campus landscape. Plants that could not survive demands of the built landscape were eliminated from consideration.

When choosing native plants for the landscape, their commercial availability is nearly as important as to their ability to withstand stress of the built environment. Many native plants are available commercially, but a significant number of others are not. This could be the result of limited demand, state or federal protection, or difficulty in propagation. When plants are available, it is also important to know that they can be secured in a sufficient size to meet the expectations of the landscape. For example, a tree seedling will not make an ideal street tree

for at least 5 to 10 years nor will a shrub from seed make a very good screen for a number of years into the future.

Commercial availability in sufficient sizes was a second factor used to filter the developing list of landscape materials. All plants are expected to be available commercially.

LOCAL, REGIONAL, & NON-NATIVE PLANTS

The Master Plant List first categorizes the plant species as locally native, regionally native, or non-native. Primarily, the list consists of locally native plants.

Plants categorized as “local” have been chosen from the vascular plant database developed by the Environmental Science Division at ORNL. The list is a compilation of over 1,000 species of plants that can be found on the Oak Ridge Reservation.

Those plants categorized as “regional” are documented as native to the Southeastern United States. This list has been compiled from numerous resources. A select group of non-native plants have also been included. They were required to be non-invasive and offer compelling aesthetic benefits. Non-native species may be chosen only if local plants do not fulfill a necessary role, or, in situations where a non-native specimen might add extraordinary aesthetic value.

In cases where native plants can not sufficiently meet the design needs of the campus, non-natives that are non-invasive were added to the plant list.

APPROPRIATE LOCATIONS

Obviously, not all identified plants are suitable for all locations. Each plant species has specific needs and preferences. Some prefer full-sun while others will only thrive in full shade. The Master Plant List recognizes this and includes plants suitable for a variety of conditions throughout the campus in order to assure that the list will meet all future needs of the campus. The Master Plant List identifies the ranges of conditions that a specific plant can tolerate and still perform its role in the landscape. The conditions listed include sun exposure, moisture levels, and specific soil requirements.

Light conditions are classified as full sun, partial shade, or full shade.

Moisture levels include hydric, mesic, sub-xeric, and xeric. Hydric plants need water nearly constantly and some are inundated by water. Mesic plants prefer adequate moisture year round. Sub-xeric plants prefer seasonally moist conditions, but can withstand periods of dry weather. Xeric plants have low water needs and are often very drought resistant.

Soil conditions include many elements such as texture, pH, and drainage characteristics that can affect plant development.

Texture of the soil is defined by particle sizes and determines many of the soils behavioral properties (i.e. drainage). Soils range from coarse to fine and are composed on a combination of sand, clay, loam and gravel. The finer the particles of soil the more difficult it is for water, air and nutrients to enter the soil. Many of the naturally occurring soils on campus have poor internal drainage.

The soil pH is the quantitative representation of its acidic or alkaline qualities. A value of 7 represents soils that are neutral. Some plants prefer alkaline soils, those soils over a pH of 7; and some plants prefer more acidic soils, pH below 7. Plants that will perform only under specific pH conditions are identified as such within the Master Plant List. Many plants however can adapt to various pH ranges.

RESPONDING TO PHYSIOGRAPHY

Certain communities of plants are found in specific habitats where growing conditions are favorable. Along the Bethel Valley, plants can be observed in relationship to the landform. In an effort to respect this, a basic physiological analysis was conducted for use in the Design Guidelines. This analysis was primarily limited to the topography and hydrology of the campus. Areas of the campus were categorized into three

broad habitats (Figure 1.1). They include the following:

- Ridge
- Riparian
- Valley

Generalizations based on the Roane County Soil Survey can be made for each category. Areas identified as **Ridge** are characterized by steep sideslopes and hilltops. These areas are typically drier and have shallower, rockier and less fertile soils that are typically more acidic. Plant communities within these areas help to serve the function of securing the soils.

Riparian areas are found along the edges of major streams. Soils within these areas are typically well drained, have a moderate content of organic matter and low water-holding capacity. Soil pH is typically acidic to slightly acidic. Plants within these areas contribute significantly to the health of the stream by providing filtration for stormwater run-off, protecting the stream bank from erosion, regulating the temperature of the stream through shade, and providing habitats for wildlife.

Valley areas make up the remainder of the campus, characterized by gentle slopes characterize these areas. Soils can be shallow and lean toward acidic. Drainage is good though subsoil drainage can be rather poor.

The Master Plant List identifies generally where each plant may be found. Many plants can be associated with a variety of habitats while others are typically found in a single habitat. These broad categories were used as a way of recognizing specific plant associations that respond to physiography of the campus.

The broad habitat categories are to be used with the understanding that much of the campus's natural landscape has been altered, from the original habitat, though some of the characteristics such as steep slopes still are relevant. These habitat groupings are being used as a philosophical design gesture that responds to the environment and offers conceptual guidance for plant selection. They will also serve as a means of further refining/filtering the plant list for specific areas. Finally, this organizational structure provides a degree of variation and interest within the restrictive plant palette used throughout the campus.

RESPONDING TO THE DEVELOPED LANDSCAPE

As previously discussed, the built or constructed environment does not mimic the conditions found within nature. It can impose additional stresses on the plants. Plants selected for ORNL's landscape must successfully cope with the demands in a built environment. The recommended Master Plant List acknowledges

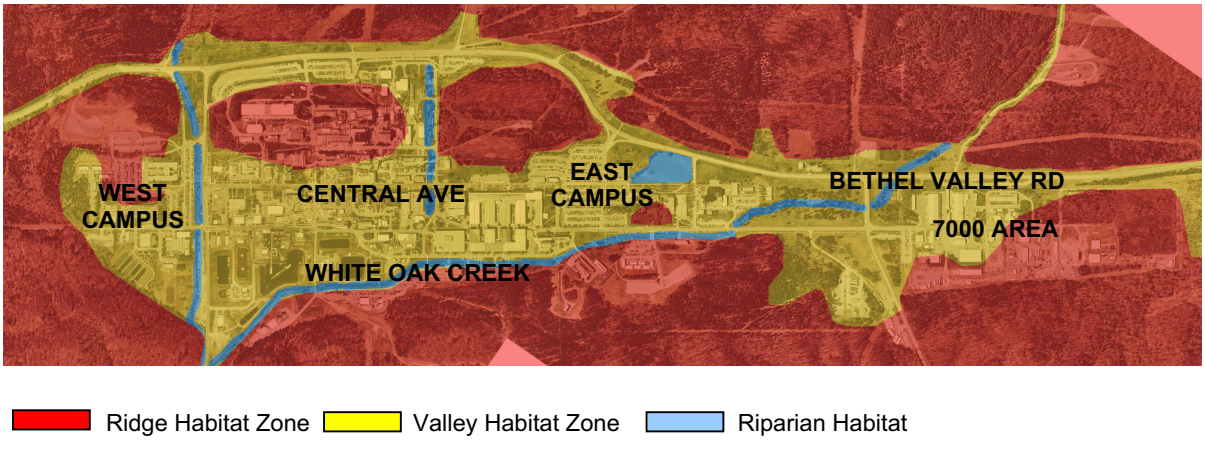


Figure 1.1 General Habitat Zones

that not all conditions within the built environment are equal and provides a further filter for selecting the appropriate plant for a particular location. The plan distinguishes the microclimatic differences in the following landscape conditions:

- Streetscape
- Parking Lots
- Highly Constructed
- Open Space

Streetscapes require that plants be tolerant of urban conditions. These include air pollution, reduced humidity, compacted soils, restricted root zones and higher temperatures. Plants that are most successful within these areas require full sun to partial shade, moderate to limited amounts of water, and air pollution tolerance. It is recommended that plants used within a streetscape be limited to large shade trees with single central leaders in combination with understory groundcovers (less than 12 inches in height). Shrubs and tall evergreens would unnecessarily narrow the corridor and obscure views to and from the street. Appendix A provides a list of plants that are appropriate for use these conditions.

Parking Lots exhibit very similar conditions to streetscapes, and plants within them must have similar tolerances; however parking lots have different design needs. Screening parking, erosion control and/or using plants for cleaning stormwater runoff are some of the added roles the plants must fill within parking lots. The Master Plant List recognizes the need for a more diverse plant palette and identifies a mix of shade trees, evergreen trees, shrubs, groundcovers, and vines. Appendix A provides a list of plants that are appropriate for use within these conditions.

The **Highly Constructed** category of landscapes are related to building sites and other formally designed outdoor spaces. These landscapes tend to be more detailed and can require more maintenance than other landscapes. Their conditions can vary significantly. Plants that are intolerant of developed site conditions should not be used. Many planting zones within these landscapes are small. Appendix A provides a list of plants that are appropriate for use within these conditions.

The **Open Space** category consists of large areas that are undeveloped or have not been significantly impacted by development. Their root zones are unrestricted. Moisture levels are adequate for a variety of plants. Re-radiated heat is usually not a factor in selecting plants for this category. Appendix A provides a list of plants that are appropriate for use within the Open Space conditions.

SPECIFIC LANDSCAPE COMPONENTS

The Master Plant List provides an easy to follow process for determining which plants are appropriate for certain conditions. However, it is not intended to prescribe how the designer is to compose them in the landscape. The Master Plant List acknowledges that the ORNL campus is comprised of various landscape "typologies" which contribute to its identity. It is important that all aspects of landscape improvements are coordinated in a way that reinforces this campus identity. Each "typology" has unique characteristics and functions requiring separate design approaches. The following design guidelines define the characteristics of the varying typologies and how design of the landscape should appropriately address them.

Primary Entries and Secondary Entries

The street network is the primary means of accessing the laboratory. As users navigate the network, there are particular elements of the landscape that offer clues about their environs and guidance to their destination. This can be as pronounced as the placement of a directional sign or as subtle as the change in landscaping or pavement.

Primary vehicular entries announce to everyone that they are entering ORNL. These entry stations are found on Bethel Valley Road, one to the west of First Street and a second to the east of the 7000 Area. Besides indicating to users that they are entering ORNL, these entries also serve as security "gates". In light of recent events and the increased national security, this function is critical. The landscape must be functional here and set a standard for the remainder of the campus. For that reason the

following guidelines are recommended for the landscape planting of these two primary entries:

- Utilize native plants that reinforce the surrounding natural landscape
- Plants should be low when in close proximity of the gate area, and not disrupt the line of sight for the user and security personnel
- Plants should express the natural qualities of east Tennessee's seasonal changes and provide visual interest through the use of color, form, and/or texture
- Plants should be low maintenance and drought tolerant

Secondary entries can be found at the intersections of the laboratory's main streets and Bethel Valley Road. As a user enters the campus area, they should perceive where they are allowed to go and how to get to their intended destination. Users must be able to ascertain easily and quickly which of the 6 entries to choose when seeking particular campus destinations. The following guidelines are recommended for secondary entry landscapes:

- Utilize native plants that reflect the micro environment of the entry (i.e. mesic/ bottomlands, xeric/high points)
- Compose plant material to emphasize sense of entry and topographic relief
- Plants should compliment and not obscure the entry signage, therefore larger plant material should be used as a backdrop while lower plantings should be used to emphasize the sign
- Entry landscapes should be visually distinctive from the neighboring landscape through the use of color, form and/or texture and provide seasonal interest throughout the year

Stream Crossings

Stream crossings are a unique opportunity to connect the users to the physiography of the site. Too often streams are seen as liabilities that must be crossed instead of natural features that can enrich the user experience of the site. Many of the streams on the campus are visually inconspicuous. In an effort to recognize and respond to the local environment and bring it to the users attention, it is recommended that these crossing areas be enhanced. The following guidelines are recommended for landscapes at stream crossings:

- Utilize native plants that reflect riparian habitat along the creek, particularly related to tree species
- Planting arrangement should be simple, uncluttered and naturalistic
- Planting should be planned and managed so as not to obscure views of the stream

Streetscapes

The streetscape classification can be divided into two categories; “rural” and “urban”.

The **rural** streetscapes are primarily along roads that lead to the major developed areas of the campus. They are oriented toward vehicular circulation and are often experienced at speeds over 35 miles per hour. They have few pedestrian related facilities. The streetscape corridor is often defined by the tree line of nearby forested areas.

The following landscape guidelines are recommended for rural streetscapes:

- Utilize native plantings that are similar in species to the neighboring habitat
- Native grasses and trees should be the primary plantings
- Parking should be buffered with more naturalistic plantings and berms
- Planting arrangement should be used to complement the existing landscape and accentuate the topography and road alignment
- Planting should be simple and designed to be appreciated from a moving vehicle

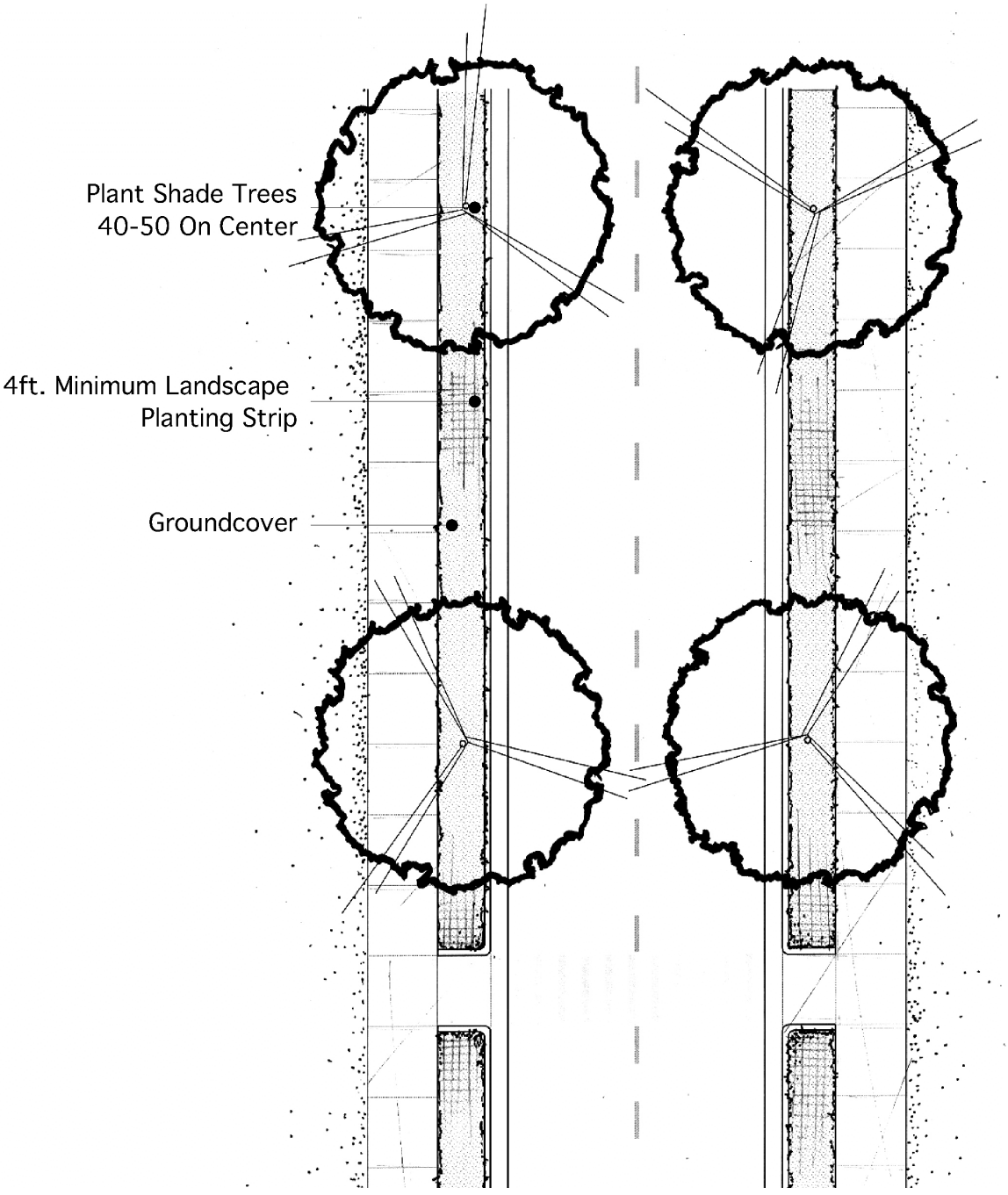


Figure 1.2 Prototypical Urban Streetscape

- Planting should not obscure views of entries
- Planting should require no artificial irrigation whenever possible

Urban streetscapes are located within the developed portion of the campus and are oriented toward shared access between vehicles and pedestrians. They typically have sidewalks on a least one side of the road. Buildings primarily define the streetscape corridor. (Refer to Figure 1.2)

The following landscape guidelines are recommended for urban streetscapes:

- Utilize native tree species that are identified as appropriate for use as street trees
- Provide a six foot wide (4 ft. Minimum) landscape planting strip between the curb and the sidewalk where possible
- Plant landscape buffer strip with a low maintenance evergreen groundcover, particularly in “higher profile” areas of campus
- Provide clear lines of site for both pedestrians and vehicles

Planting should require minimal to no irrigation beyond establishment

Pedestrian Corridors

Pedestrian corridors are defined as circulation ways/sidewalks, not associated with the streetscape, that connect laboratory destinations. Their primary purpose is to provide safe pedestrian access throughout the laboratory. The following landscape guidelines are recommended for plantings associated with pedestrian corridors:

- Planting should be primarily comprised of native shade trees
- Native understory trees should be used as accents in the landscape
- Hybrid Fescue lawn should be used as the dominant groundcover
- Plantings should be positioned to provide shade for pedestrians on the sidewalk
- Provide clear lines of site for pedestrian users
- Plantings should require minimal to no irrigation beyond establishment

Building Sites

Building sites can be greatly enhanced by the addition of landscape. Plants provide a context for the building and firmly ground it to the site. Plants can further improve a building's energy efficiency by shading it in the summer and allowing the sun to penetrate to the building in the winter. The following landscape guidelines are recommended for buildings:

- Planting should be primarily comprised of natives
- Planting should be positioned to frame or improve views to and from windows
- Plants should emphasize the entries of the building, and not impede travel to and from the entry
- Large shade trees should be planted, when possible, on the south and west sides of the building in order to cast shade on the building walls
- Loading areas and utility cabinets should be screened from entries and gathering areas with the use of evergreens, opaque walls or fences

Centers

Centers are large formal gathering areas. These areas provide seating for both large and small groups. The following landscape guidelines are recommended for centers:

- Plantings within these areas should be more visually complex and worthy of close scrutiny
- Plants used within these areas should provide a level of detail that can be

appreciated by nearby users (i.e. fragrance, flowers, texture)

- Plants should reinforce the overall design concept of the space
- There should be a balance of shaded and sunny seating areas created by plantings

Hybrid Fescue lawn should be used in areas

Nodes

Nodes are smaller seating areas than centers that are strategically located throughout the

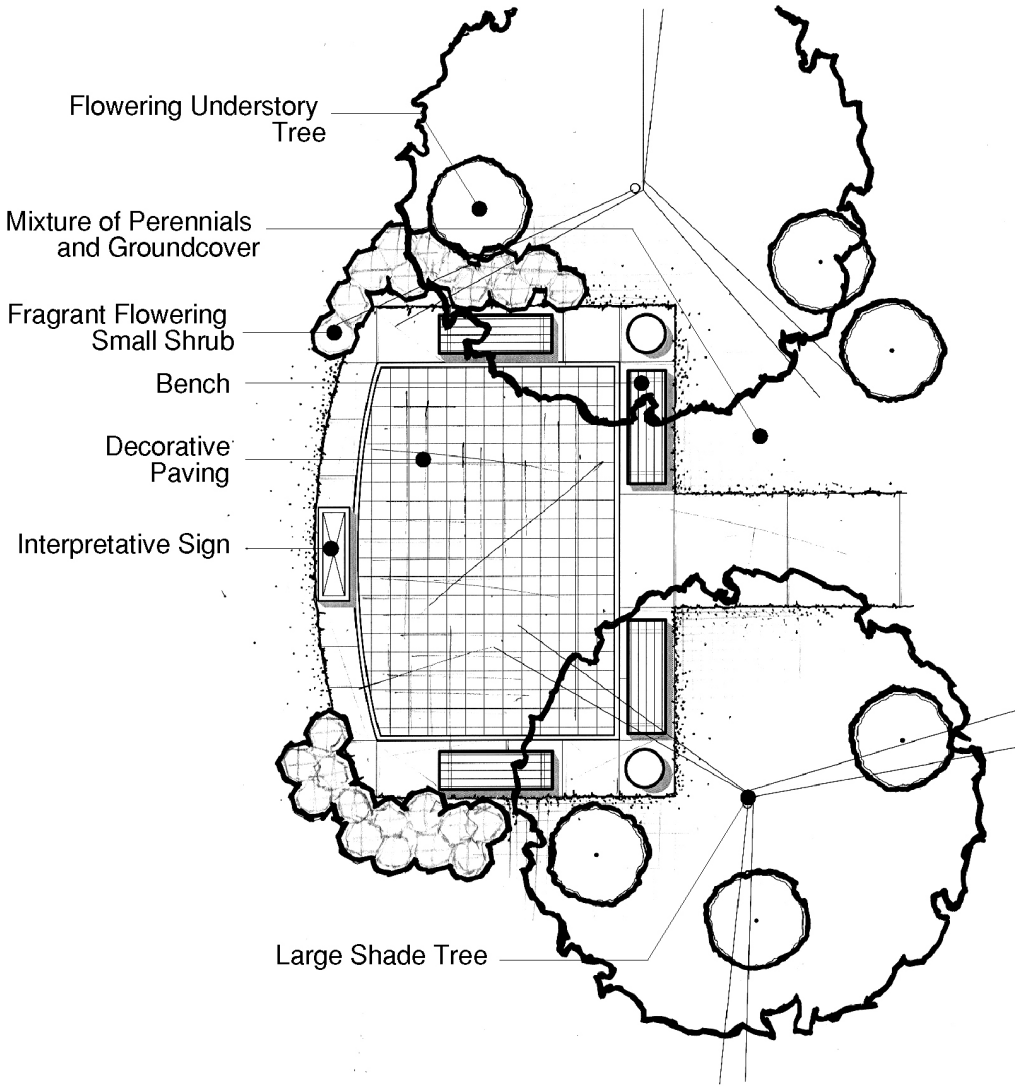


Figure 1.3 Prototypical Node

campus. They are primarily designed for use by individuals and small groups. These outdoor areas are intended to provide space for a brief pause or a short conversation near the workplace. The following landscape guidelines are recommended for nodes:

- Plants used within these areas should provide detail that can be appreciated by users (i.e. fragrance, flowers, texture)
- Large or small deciduous trees should be used to provide shade and human scale
- The landscape should not obscure views to and from the node
- for non-paved gathering areas

Riparian Corridors

Riparian corridors are important to the health of the streams and the region. As noted previously, they serve numerous roles in protecting regional water quality and the environment as a whole. A stream corridor plan has been developed for the ORNL campus that acknowledges the importance of these areas. The goal of the plan is to protect and restore the health of the riparian zones at ORNL. It is to guide ORNL 's future operations and development. The plan is an outgrowth of the on-going water improvement initiatives at ORNL as necessitated by federal and state requirements and the best management practices under the National Pollutant Discharge Elimination System Permit Program.

The primary means of restoring the riparian habitat has been passive restoration. This involves removing all human disturbances and letting it function naturally. This practice has been implemented in many of the ORNL riparian corridors. Within the developed areas of the campus, the preliminary results have not always been aligned with aesthetic expectations. This is usually because most passive restoration areas have resulted in obscured views of the streams and are populated with overgrown plants. In an effort to create a riparian habitat that meets the aesthetic expectations of the developed areas of the campus while maintaining the riparian habitat's function, it recommended that the riparian restoration efforts be divided into two categories Figure 1.4. The first category would be **unmanaged**. These areas would continue under current management guidelines. The second category would be **managed** riparian corridors. The following landscape guidelines are recommended within managed riparian corridors:

- Use plants that are under 3 feet in height along the immediate banks of the creek.
- Plant large trees and shrubs along mid to upper banks
- Use trees and shrubs to highlight the creek particularly where users may see it.
- Establish a pruning regimen for trees and shrubs that maximizes aesthetic appeal by

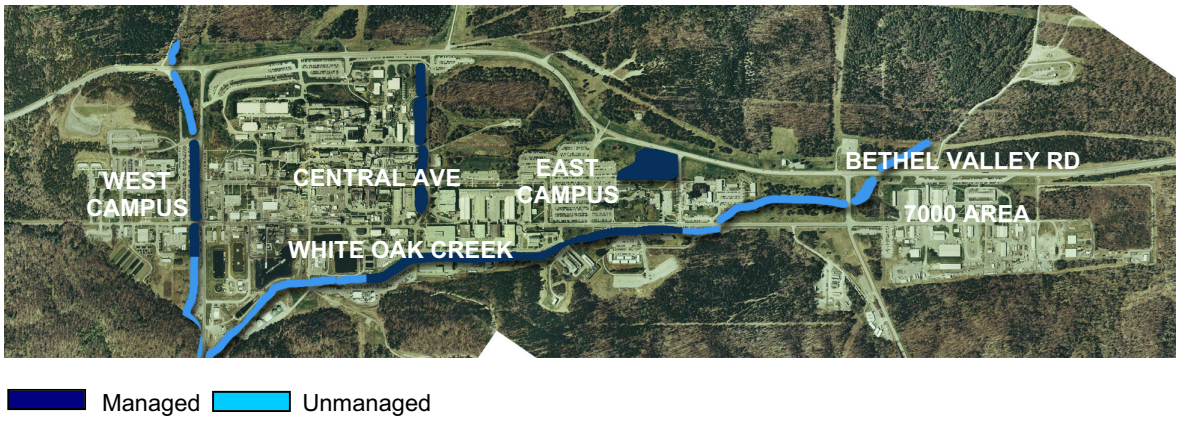


Figure 1.4 Managed and Unmanaged Riparian Habitat Zones

preventing overgrown plants and obscured views while maintaining protective riparian vegetation

- Intermittently provide views to stream and provide pedestrian gathering nodes within these areas
- Remove any invasive exotic plants by cutting them down and applying spot post emergent herbicides (i.e. Roundup) to wounds per manufacture recommendations in order to minimize soil disturbance
- Existing native plant specimens (i.e. dogwood, button bush, passion flowers, Cardinal Flowers) should be identified, protected and incorporated in future planting

Parking Lots

Parking lots, particularly large ones, are often unsightly places. With proper landscaping some of the negative impact of parking lots can be mitigated. The following landscape guidelines are recommended for parking lots:

- Planting islands should be interjected throughout the lot so that shade trees can be used to shade a target amount of at least 30 percent of the lot
- Low maintenance groundcover should be used within parking islands under the shade trees
- Shade trees used in parking lots should not introduce excessive litter or sap that may damage or deface parked vehicles, nor should species attract roosting birds
- Parking islands should be the size of at least one parking space per tree

Refer to figure 1.5 and 1.6 for example planting compositions within parking lots.

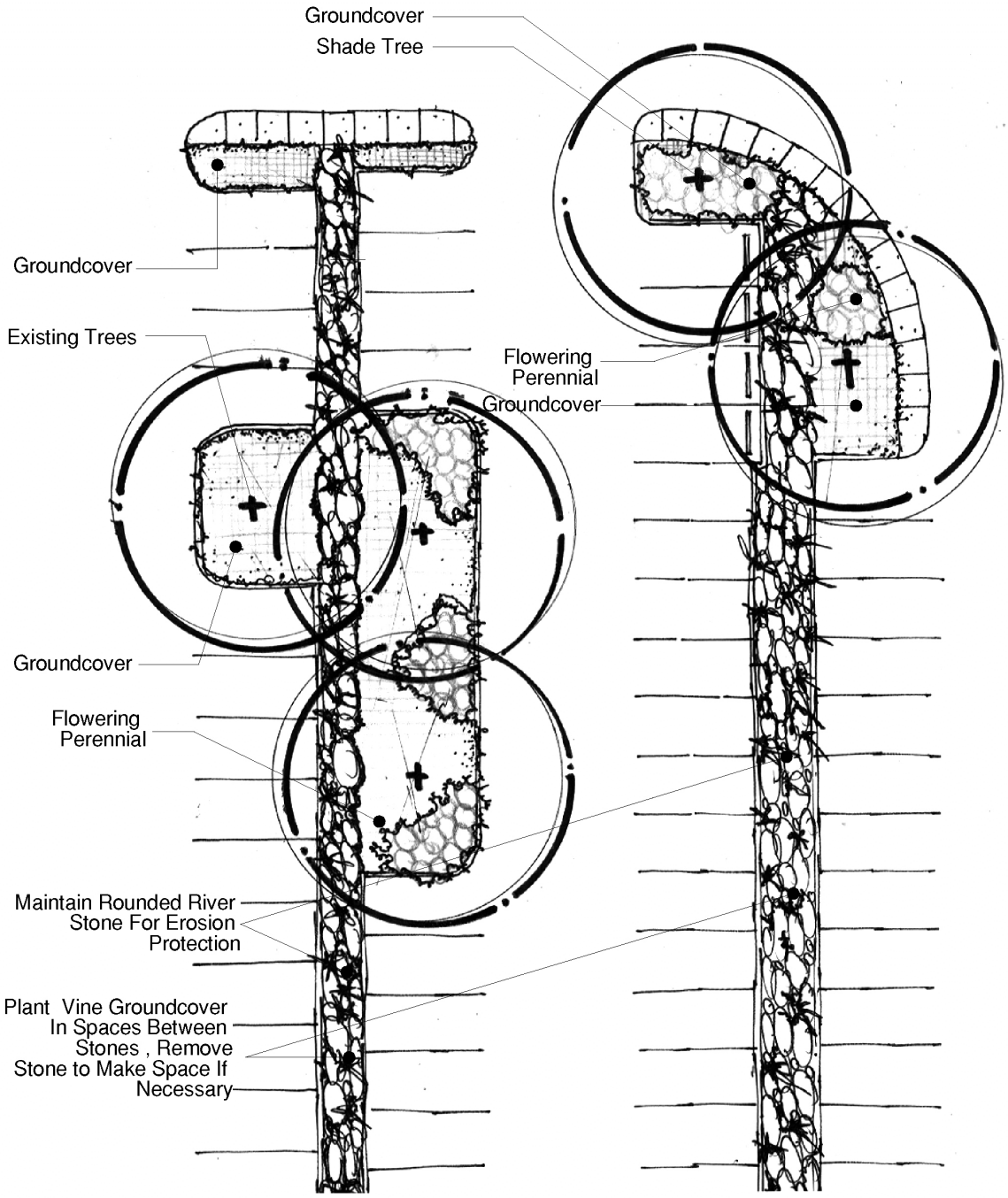


Figure 1.5 Parking Lot: 4500 Parking

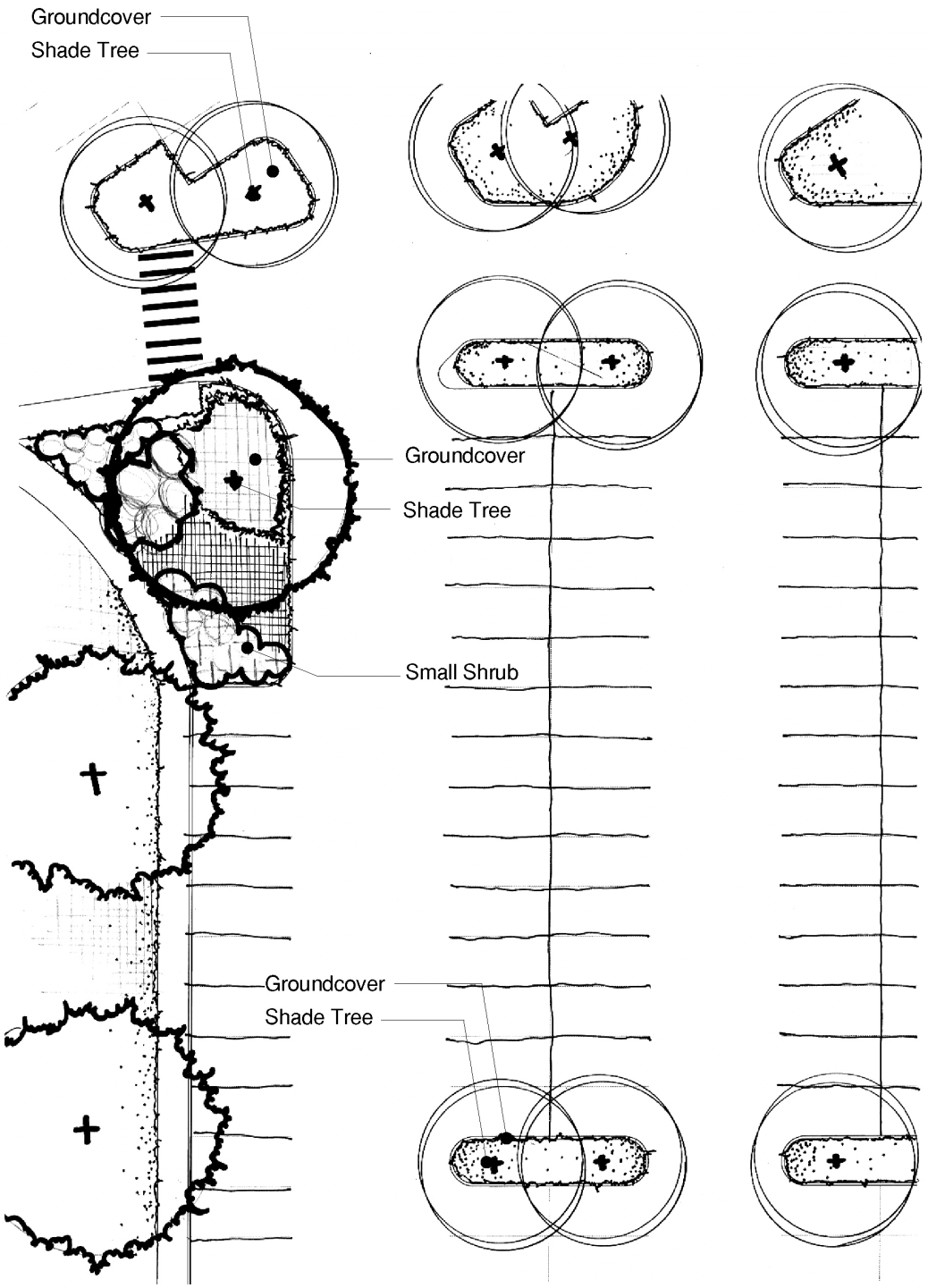


Figure 1.6 Parking Lot: 6200 Parking

PLANTING TECHNIQUES & SCHEDULE

Tree, Shrub and Groundcover Planting For Success

Using the proper planting techniques will significantly improve the success of the plant and insure the greatest benefit from the laboratory's investment. The following is a step by step guide for planting woody ornamentals and perennials in the landscape. Details for a variety of plant types is provided in Appendix C.

Step 1: Bed Preparation. If plants have been grouped into a single area then it is best to prepare the entire bed at one time prior to planting each individual plant. When planting only a single plant proceed to Step 2. To prepare the bed, take the following actions:

- Test the soil for pH, texture, and available nutrients
- Scarify the soil to a depth of between 8" to10" with a tiller or other mechanical means
- After tilling, add amendments as required (i.e. organic matter, topsoil, lime) to meet the minimum requirements. Add amendments to the surface of the soil and till again
- Use a rake to level out the soil to provide positive drainage and to eliminate low spots within the planting bed

Step 2: Preparing the Planting Pit. Once the bed is prepared, then proceed with digging the hole for each individual plant.

- The hole should be twice as wide as the root ball or container but 2” to 4" shallower than the root mass
- The sides of the hole should be sloped in order to maximize area for feeder roots and be scarified in order to prevent barriers to future roots
- Before plant installation the holes should be filled with water to ensure that there is adequate drainage. Drainage is considered to be adequate if it drains within 24 hrs.
- If the hole does not drain adequately, then supplemental drainage should be provided per the detail found in Appendix C

Step 3: Planting. The hole should now be ready for the plant.

- The plant should be planted at 2” to 4" higher than the surrounding grade in order to insure adequate positive drainage away from roots.
- If it is balled and burlapped, cut twine, wire, or string from top of ball after plant has been set. Cut, turn down and bury burlap from the to ;1/3rd of the ball
- If it is a container plant, remove plant from container and gently scarify the roots
- Backfill to 2/3 full with specified topsoil mix
- Water thoroughly to eliminate air pockets and settling before filling to grade
- Form shallow saucer at edge of plant pit to hold water
- Water again thoroughly
- If the plant stem or trunk is damaged, paint all cuts over 1/2" in diameter with tree wound dressing
- Hand grade and rake planting area so that the grade conforms to surrounding areas and surface water drains freely

Step 4: Staking or Guying. should a tree that is being planted meet the following conditions, stake it as detailed in Appendix C.

- For deciduous trees over 2 1/2" caliper inches
- For Fall planted evergreen trees
- High wind conditions

Step 5: Mulching. Once the plant has been staked proceed with mulching.

- Spread mulch solid in planting beds
- Mulch all plants pits and beds with 3" depth (minimum) of specified mulch, uniform throughout, except at base of plant
- Make sure that mulch does not come in contact with the trunk or stems at the base of the plant

Planting Schedule

Generally, late fall and early winter offer the best opportunity to plant almost any plant. The reason for this is that a plant's metabolism is less active or dormant during these times. The food produced by the plant has been moved to the root system in order to promote further development. Soil temperatures can remain warm during winter giving the plant a chance to establish its root system prior to next growing season, which begins as days lengthen in the spring. If the soil becomes frozen to a depth of 12", planting should be suspended until it thaws. Typically, nursery-grown trees are not dug for shipment until late November and early December depending on how much precipitation has fallen during the Fall. So many times freshly dug tree plant material will not even be available until this time.

Early Spring is the second best time to plant. This later date may even be necessary due to the limited availability of some perennials or shrubs. None-the-less, it is typically undesirable to plant after May 1st because the transplanted plants must then immediately deal with the stresses inherent with the hot summer months ahead.

Topsoil

Quality topsoil is critical to the success of any planting and is often least considered at construction sites. Topsoil stockpiled on a building site should be used in all planting areas. When necessary additional topsoil should be transported to the site. Table 3.1 shows the proper minimum depths for specified topsoil within planting beds. when planting and mulching can not commence immediately, protect stockpiled topsoil from erosion by wind, water, or other forces

The topsoil should be tested in order to insure that meets the required specifications. At least two samples should be taken and tested by an approved soil-testing lab. Based on the results of the test, the topsoil should be amended to meet the following specifications:

- Fertile, friable naturally occurring topsoil, free of stones,subsoil, clay lumps, hardpan, roots, stumps, branches sticks and other debris larger than two inches in any dimension; free of noxious weeds, grasses, seeds, plants, extraneous matter and any substance harmful to plant growth.
- pH should be between 5.0 and 7.0
- It should contain at least 5 to 10% of organic matter, 30-50% of sand, less than 30% of silt and 15 to 30% clay
- All extraneous matter measuring 1-1/2" or larger in any dimension from 4" of placed topsoil should be removed

Table 3.1
MINIMUM DEPTH OF
TOPSOIL FOR PLANTING

Plant Type	Depth of Topsoil
Shade Trees	4 feet
Evergreen Trees	4 feet
Small Trees	3 Feet
Large Shrubs	3.5 feet
Small Shrubs	2 feet
Perennials	1.5 feet
Groundcovers	1 foot
Vines	1 foot
Hybrid Tall Fescue	6 inches
Native Grasses	6 inches

Mulch

Mulching serves four important functions in the landscape. First and foremost, it serves as a barrier that helps retain moisture for the plants. Second, it reduces weed seed germination within planting areas. Third, mulch provides an aesthetic continuity to the planting areas and helps tie the planting design together. Fourth, as it degrades it adds organic matter to the soil and nitrogen for the plants to utilize as nutrition.

Types of mulch are numerous. It is recommended that shredded hardwood mulch and pine straw mulch be the predominant choices on the campus. Pine straw should always be used in areas where slopes exceed 10 percent. Mulch should meet the following specifications:

• 100% of Specified Mulch Type that is free from foreign material, leaves, twigs, grasses, weeds, plants and seeds, and any other substance harmful to plant growth

Because the mulch material is biodegradable, the planting areas should be re-mulched once in the Spring and a second time in the Fall in order to maintain a 3” minimum depth.

Staking and Guying

For situations that require staking or guying, it is important to provide additionally stability for trees while they adjust to new settling soils and their root systems begin to expand into the soil. **It is important that all staking and guying be removed within one year in order to prevent damage to the trunk of the tree.** Planting details in Appendix C illustrate both proper staking and guying techniques. The materials should meet the following specifications:

- Tree straps used for wire guying should be made of polypropolene web with two brass eyelets, be an minimum of 1 1/2" in width and an olive color.
- Turnbuckles for guying should be galvanized and 1/4" diameter
- Wire for guying should be #12 or #10 gauge and double twisted
- Vertical staking material should be made of pressure treated Southern Yellow Pine, or other approved wood, 2"x4" length required.
- Stakes for anchoring wire guying should be of the same material as vertical stakes and be at least 4 feet in length
- Tree Straps for staking should be made of flexible vinyl and be black or green in color

SEEDING TECHNIQUES & SCHEDULES

The Use of Native Grasses, Wildflowers & Hybrid Tall Fescues

Native grasses, wildflowers and hybrid tall fescue each have their place on the ORNL campus. Each serves a different role on the campus. When deciding which to use it is important to understand the benefits and liabilities of each.

Native grasses and wildflowers have numerous benefits. They are well adapted to the environment; in fact they can thrive on marginal soils and withstand drought conditions. Their deep root system is excellent for erosion control. Native grasses and wildflowers increase soil fertility while also providing excellent food and habitat for wildlife. They provide more interest than traditional grasses as they change throughout the year, but require considerably less maintenance than traditional lawn grasses.

The height of native grasses and wildflowers range between 3 to 8 feet making them unsuitable in developed areas where pedestrians gather, sit, play sports and other activities. However, they can effectively be used in shaping spaces and within landscape beds. There is often a cultural barrier regarding native grasses and wildflowers within a campus environment because they are viewed as unkempt and attractive to pest (i.e. mice, insects, snakes). This barrier is not as prevalent at ORNL as with other environments because many of the staff understands the environmental benefits of these grasses. With proper models to illustrate how grasses can be used and managed effectively within a built environment, this barrier can be overcome.

Hybrid Fescues are beneficial because they can be maintained at a height of 2” to 3" and can withstand pedestrian foot traffic. This makes them very suitable for all the pedestrian activities mentioned above. However, compared to native grasses and wildflowers they require significantly more maintenance and resources.

In general, it is recommended that Hybrid Fescue lawns be limited to the core of the campus, activity areas and areas where sight distances and safety are a concern (i.e. intersections, road shoulders). Native grasses and wildflowers are then appropriately incorporated along the Bethel Valley Road corridor, north of the Swan Pond, along White Oak Lane from the 7000 area westward, and other areas where their scale is appropriate. Additionally, some native grasses and wildflowers should be considered for use in some landscape beds.

Planting Native Grasses & Wildflowers

The native grass and wildflower mix recommended for the ORNL campus excludes native tall grasses such as Big Blue Stem and switchgrass that grow to heights of 6 to 8 feet. The mix favors Little Bluestem that grow 3-4 feet in height and is mixed with a variety of wildflowers. The following is a species list included in the mix per acre.

Wildflowers

Butterflyweed	1.0 lbs
Smooth Aster	0.5 lbs
Purple Coneflower	1.0 lbs
Dense Blazing Star	0.75 lbs
Black Eyed Susan	0.25 lbs

Native Grasses

Little Bluestem	6 lbs
Annual Ryegrass	8 lbs

This mix was chosen for its height and seasonal interest. Larger grasses that could obscure signage and other important features in the landscape have been excluded.

The following is a step by step guide for planting native grasses and wildflowers in the landscape.

Step1: Site Preparation. Planting sites usually have existing vegetation and require for planting. Following steps should be taken for preparing the site:

- Identify the area to be planted

- Tall vegetation should be removed, mowed and sprayed with a glyphosate (Roundup), a broad spectrum postemergent herbicide, in early Fall
- After two weeks, the soil should be lightly cultivated
- Avoid deep tilling because it can bring viable weed seeds to the surface and stimulate germination
- A second application of glyphosate maybe necessary to eliminate additional weeds

Step 2: Sowing and Mulching. Once the area for planting has been prepared, planting can begin.

- Secure seed species for ORNL planting mix
- For large areas, mix seed with dry sand and spread with a drop spreader or rotary spreader at a rate of 10 pounds per acre. No-till is an alternative to the drop spreader. This method creates furrows in the soil and places seeds below soil surface. ESD/TWRA have a drill available on the campus that can be used for this purpose. No-till is often a more successful practice because it reduces the exposure of the soil, which reduces the potential for weeds. This method can potentially reduce the quantity of seed by as much as 50% depending on the equipment used.
- For smaller areas, seeds can be sown by hand at a rate of four to five ounces per 1,000 square feet.
- Apply a light mulch (i.e. straw, or pine needles) 1/4-1/2" thick over seeded area
- Avoid weed infested hay mulches
- Seeds can be sown from September through November or from February through May. These times are often the most ideal time to plant, however anytime the soil temperature is below 55F and not frozen, seeds can be planted successfully.
- Provide erosion control measures (i.e. nets, mats) when seeding areas over 3:1 slope

Step 3: Irrigation. Plants need sufficient moisture for germination and development.

- If possible, set up temporary supplemental irrigation watering system for 6-8 weeks
- If irrigation is not possible, sow seeds in anticipation of seasonal rains, usually late fall or early winter
- On steep slopes care must be taken to avoid washing away seeds and mulch

Step 4: Weed Control. Weeds are inevitable in native grass plantings. Special care should be taken to manage them. Weeds are characterized as plants that are undesirable. Undesirable plants would include exotics, invasive exotics, or other invasive plants that reduce biodiversity and out compete the native grasses and wildflowers.

- Manually remove weeds if possible
- Treat tall weeds with a wick application of glyphosate herbicide
- Grassy weeds can be sprayed with herbicides specific to grass control
- Mowing weeds is effect prior to the emergence of the native grasses and wildflowers

Step 5: Care and Maintenance. Once native grasses and wildflowers are established, little or no maintenance is required. Wildflowers typically need no fertilization. General maintenance includes the following:

- Mow the planting area in mid-February to distribute the dried seed heads. This will make seeds available to wildlife during the winter months. Do not set mowing height less than 8 inches.
- To establish additional planting areas, collect no more than 1/3 of the seeds from seed heads

- Remove any non-native plants from the planting area
- Remove unwanted trees and shrub seedlings
- Reseeding of annuals and perennials, where desirable, should be sown after fall maintenance operations are complete

Seeding Hybrid Turf Fescue

Utilization of a blend of Hybrid Turf Fescue (i.e. Rebel III) is recommended for turf areas because of the following characteristics:

- Excellent, darker green color retention
- Fine textured, dense growth
- Lower Maintenance as compared to other fescues and other non-native grasses
- More Heat and Drought Tolerant than other fescues and other non-native grasses
- For lawns and turf in sun or shade

The following is a step by step guide for establishing Hybrid Turf Fescue:

Step1: Site Preparation. Properly preparing the site is critical to the success of a lawn area. The following steps should be taken when preparing a site:

- Identify the extent of the area to be planted
- Test soil 6 to 8 weeks before sowing to determine levels of phosphorous, potassium and pH
- Remove undesirable vegetation from seeding area (i.e. brush, weeds)
- Use glyphosate (Roundup), if there are visible weeds
- Mechanically remove all debris (i.e. wood, construction waste, rocks) that would disrupt plant growth
- Establish rough grades that account for additional topsoil
- Mix 4" to 6" of topsoil in the underlying soil
- Apply commercial grade 10-10-10 fertilizer at a rate of not less than 20 lb/1000 square foot and agricultural limestone at a rate of not less than 75 lb/1000 ft2
- Till the soil to a depth of 6" or more, thoroughly mixing fertilizer
- Fine grade to assure final dressing is within reasonably close conformity to lines, grades, and cross-sections
- Lightly water to aid dissipation of fertilizer

Step 2: Sowing and Mulching. Once the site has been prepared for planting, the following steps should be taken:

- Apply seed at a rate of 3 lb/1000 square feet evenly in two intersecting directions. Rake in lightly. Do not seed area in excess of that which can be mulched on same day.
- Do not use same equipment to spread seed as used for spreading fertilizer
- Do not sow immediately following rain, when ground is too dry, or during windy periods
- Roll seeded area with appropriate roller to insure seed to seedbed contact
- Immediately following seeding and rolling with an application of weed free straw at a rate of 100 lb/1000 square feet. Maintain clear of shrubs and trees.
- Cover seeded slopes where grade is 3 : 1 or greater with an appropriate erosion control matting. Mulch is not required for areas using erosion control matting
- Apply water with a fine spray immediately after each area has been mulched. Saturate with water to a depth of 2 inches. Moist conditions should be maintained. Once the

grass has reached 2 inches in height, discontinue daily misting and apply water less often (i.e. 1" per week) until grass is fully established (6-8 weeks).

- Mow lawn for the first time when it reaches a height of 4"
- Avoid use of lawn until after first mowing

***Alternate #1* Step 2 Hydroseeding.** Hydroseeding is the process of mixing seed, fertilizer and mulch into a liquid mixture and spraying it on the surface of the soil. It offers a convenient way to apply the planting components at a cost less than sod. This method can also be used when seeding native grasses and wildflowers as well. The following steps should be taken when hydroseeding:

- Prepare mixture of seed, mulch, and fertilizer per manufacture recommendations and construction specifications
- Allow planting area to dry out one day prior to applying hydroseed (the first 1/4 of soil should have some residual moisture)
- Apply the hydroseed slurry with an appropriate hydraulic sprayer
- When hydroseed is sprayed the mulch shall form a blotter-like material
- Direct the spray so it will drill and mix the slurry mix into the soil
- The slurry mix should penetrate the soil surface and ensure maximum impregnation and coverage
- Do not leave hydroseeding slurry in machine for more than two hours because it can damage seeds. If this happens add 50% more of the original specified seed (for slurry sitting for two hours) and 75% (for slurry sitting for up to 8 hours). Beyond 8 hours the material should be disposed of off site.
- Spray area with uniform visible coat, using the dark green mulch as a guide. The slurry shall be applied in a downward drilling motion via a fan stream nozzle
- Confirm that all slurry components are mixing with the soil
- Take special care to prevent overspraying
- Water thoroughly by use of sprinkler or spray, without erosive force prior to germination.
- After germination water similarly to seeding (light mist to maintain moisture for at least 14 days)
- Mow for the first time when the lawn reaches a height of 4 inches
- Physically remove weeds by hand for the first 60 days
- After 60 days an approved pre-emergent herbicide can be used to treat weeds
- Avoid use of lawn until after first mowing

***Alternate #2* Step 2: Placing Sod.** Sod offers the convenience of creating an almost instant truf area. The following steps should be taken when laying sod.

- Lay sod when sod bed is not excessively wet or frozen, but when soil is damp for a depth of 2".
- Immediately upon approval of bed preparation, lay sod smoothly, edge-to-edge, with staggered joints.
- Press firmly into contact with soil bed by tamping or rolling by approved means to eliminate all air pockets, providing a true and even surface, and assuring knitting.
- Fill cracks between sod blocks with strips of living sod, sand, topsoil, or humus.
- Water thoroughly by use of sprinkler or spray, without erosive force until roots have been established in new soil which typically takes about two weeks
- For the first three weeks avoid heavy use of the lawn area

Planting Schedules

Native grasses and wildflowers should be planted during the months of September to November or February through May. These periods are ideally suited for establishing native grasses and wildflowers because they are cool and supply adequate rainfall for seed germination. Once they are established they can withstand the stresses of summer and winter. Seeds sown after November will remain dormant until spring.

Hybrid turf fescues are ideally planted in late summer, early fall or early spring. This timing prevents seedling emergence into drought and/or heat stress periods. Planting within these windows will offer the best chance of success. Often times, due to construction schedules, it is required to establish lawns outside of these optimal periods. When this occurs, the young plantings will require considerably more water to survive the stressfully extremes of summers and winters.

LANDSCAPE MANAGEMENT

Landscape Management

Landscapes are unique to the constructed environment because unlike buildings and parking lots they are living things that are in a constant state of flux. They are forever growing and changing with the seasons; unique because they can respond to even the most subtle changes in the environment. It could be argued that they are incredibly more sophisticated than the most brilliantly engineered building. An understanding of this complexity and sensitivity is important to the proper management of the landscape. One should also remember that the landscape is never finished and frequently does not fulfill its intended role until far into the future.

Plants in the wild can often survive without the help of man. Unfortunately, the built environment does not mimic nature. As discussed earlier, there are numerous stresses with which to cope with in the built environment. Furthermore, we demand that plants conform to our ideal aesthetic. Our image of what we consider the perfect tree or flowering shrub. We often expect continuity in plants that are not exhibited in nature. This is reflected in our use of plant cultivars, which are essentially clones of the ideal plant found in nature. We appreciate the predictability of a cultivar. This plan can help to change the "ideal aesthetic" through the creation of landscapes that demonstrate how the less controlled landscape can provide equal beauty and an experience where the user notices small changes and variations.

The ORNL landscape should be maintained in a way that respects the natural tendencies of the landscape, protects and maximizes ORNL's investment, and insures that the landscape successfully fulfills its intended role.

The following provides a clear set of management principles, that if applied, will ensure that the landscape meets or exceeds its expectations.

Watering

Water is critical to the survival of all plants and must always be considered in the landscape. When determining supplemental watering options it is important to remember that while supplemental applications of water on newly installed landscapes may be critical to the success of healthy root establishment, the landscape should be designed to economize water usage. Water must be allocated wisely. The following should be considered when designing any landscape:

Landform/Grading. The manipulation of landform can help divert water to the plants and concentrate it where it is needed. Special care should be taken, however, to avoid delivering water in excessive quantities so as to drown plants. Positive drainage should always be maintained. Helpful infiltration of storm water into the soil can be encouraged by vegetated swales sloped at no more than 4 percent.

Soils. Understanding the soils of a site can help a designer predict the water needs of a particular area. Soils that are excessively well drained will require more water to keep plants from dessicating, even drought tolerant plants, while those soils with better water holding capacity can support a greater range of plants with limited supplemental watering.

Curbing Paved Areas. Curbs often prevent water from draining into planting beds and divert natural rainfall into convenient stormwater systems. Curbing should be limited for use where necessary for design or safety concerns. If curbs are deemed important then consideration should be given to providing periodic openings within them to allow some water to infiltrate into nearby landscape soils. This technique can be effective particularly in parking lots where pervious areas are so limited.

Water Harvesting. There are many water harvesting opportunities that should be considered within the built environment. Much of the rain water that falls on impervious services is diverted to the stormwater system. Roofs are an excellent example of this. Much of this water could be

captured and diverted to planting areas or stored for later redistribution to planting areas.

Use of Lawn. Lawn can be one of the largest consumers of water. When examining areas of existing or proposed lawn on campus, consideration should be given to the life cycle costs of the choosing lawn grasses over native grasses, or other landscape plantings. The initial low cost of lawn installation is a small expenditure when comparing the cost of management, including mowing, edging, fertilization and supplemental watering. Areas of lawn should be carefully examined and be limited over the campus acreage to areas where it serves an important function.

Use of Water Absorbing Polymers. Water absorbing polymers can be added to the landscape soils as means of increasing a soil's water holding capacity. These granular materials are designed to be incorporated into the top 18 inches of topsoil or planting mix for new landscapes. They increase in volume many times as they absorb available water. The water is then released over time to root systems in the amended soil.

Establish Supplemental Water-Use Zones. Dividing the landscape into water-use zones can help determine supplemental watering priorities. All areas do not have to be treated the same.

Supplemental Water Use-Zones. It is recommended that three supplemental water use zones be established when designing future landscapes for the ORNL Campus. They include high, moderate and low.

High water use zones should be minimally used. These areas should only occur in high profile areas of the campus.

Moderate use zones are areas that only require irrigation after they have been established only when signs of drought are present.

Low water use zones should be planted with exclusively drought tolerant plants and rely only on natural rainfall once the plants are established.

Irrigation. An automatic irrigation system can be used to supply water supplementally to meet water shortfalls during periods of drought and to help establish newly installed plants. The primary purpose of the irrigation system is to insure the UT-Battelle landscape investment and to maintain the aesthetic quality expected at ORNL. This level of expectation is an important factor in determining the water needs for the landscape. In order to significantly reduce supplemental water use, one must accept that the appearance of plant material may be less than optimal during periods of drought stress.

For the laboratory's irrigation needs, it is recommended that drip irrigation be used for planting areas in high and moderate water-use zones. Drip irrigation is a very efficient system because it focuses the water directly where the water is needed verses using rotor heads and spray heads that broadcast the water. Drip irrigation reduces the amount of water needed because it is efficiently targeted and its method of delivery limits the amount of water lost to evaporation.

For establishing newly installed materials within these areas it is important to provide the equivalent of 1 inch of water per week. It is recommended that drip irrigation be used to supplement 100% of any rainfall deficit during the first year and 50% during the second year. Beyond two years the irrigation should only be used when there are prolonged signs of drought.

Drip irrigation can not effectively irrigate lawns and large open spaces. It is recommended that these areas be designated as low water use zones. When deemed necessary to irrigate selected lawn areas, an efficient layout of rotor-type heads can be used.

For areas designated as low water use zones, hand watering is recommended for establishing planting material for a period of 10 weeks. This involves supplying a hose bib with a quick couple device to facilitate attaching a hose. In more isolated areas, where water supply lines can not be economically tapped, a large trailer-mounted watering tank can be hauled by a truck

or tractor. When watering manually use the following guidelines:

- A one minute duration with a garden hose should suffice for shrubs under 4 feet
- Add an additional 15 seconds for each foot over the height of 4 feet
- Apply 6 to 7 gallons of water on large trees for every 10 square feet of the canopy area

When establishing plants in all water use zones, the time of planting can make all of the difference. Do not plant plants in late Spring through early Fall, especially in low water use zones.

Lawns require significant amounts of water to establish. During the establishment period, portable irrigation sprinklers should be used for newly planted seed or sod. Soding requires 1/3rd inch of water three times a week. Seeding requires that the area be continually moist for seed germination and rooting. Sod or hydroseeding should be considered for lawn establishment on slopes greater than 8 percent.

Choosing a Water Source. When considering a water source for the irrigation system, there are basically two options; potable water and harvested water. Water harvesting from rainwater or other gray water sources should be first considered for supplying water to an irrigation system. As mentioned earlier in this section, there are numerous impervious areas in the built environment where water can be collected and then stored for later use. Harvested water should be stored in an underground reservoir in order to minimize evaporative losses and stop algae growth. A suitable pump is required to extract and pressurize the water for irrigation distribution.

Potable water supplies can be used for supplemental watering, but should be considered secondary to other sources. When used, it should be incorporated into an efficient drip irrigation system.

Pruning

All plants may require some form of pruning. Pruning is an important management practice that promotes healthy growth and desirable form. To minimize the extent of pruning it is important that new plantings be selected appropriately. It is also important to understand the natural characteristics of the plant. Plants should be pruned only for the following reasons:

- There is obvious dead, damaged, or diseased plant tissue
- Branches are deformed, crowded, rubbing together, or drooping onto other branches for support
- Branches have crotch angles of less than 30 degrees or greater than 70 degrees
- To stimulate new growth
- To promote flowering or fruiting
- To enhance the natural form of plant

Improper pruning can permanently damage the plant. Only two types of pruning should be used, heading and thinning. Heading reduces the length of the stem or branch while thinning completely removes it.

The following are general principles that should be followed when pruning **shade trees**:

- **A shade tree should never be "topped"**. Topping is the indiscriminate removal of branches in order to reduce the height of the tree. Topping creates an inferior plant that can never reach its full potential because it removes the central leader, promotes weak limb joints and creates numerous slow-healing stubs where disease can thrive.
- The blades of equipment should be clean and sharp
- Cuts should be made at nodes or back to the next limb
- Never remove more than one-third of a living branch. If the removal of the entire branch is desired, the cut should be made adjacent to the branch collar

- Remove limbs that have crotch angles of less than 30 degrees or greater than 75 degrees. 45-60 degrees are ideal

- Trees in pedestrian areas may be limbed up to 1/3 the height of the tree.

- Trees under 4 caliper inches should have scaffold branches spaced about 6-12 inches apart. Mature trees should have at least 8" but preferably 20-24" between scaffold branches

- There should be and even distribution of 5-7 scaffold branches to ensure a well-rounded tree.

When pruning mature trees, the branches over 1 1/2 inches should be cut with the three-cut method. This method involves cutting partway through the branch from beneath at a point one or two feet from the trunk. Then making a second cut on the top branch several inches out from the first cut. This should allow for the branch to drop from its own weight. After it has fallen the remaining portion of the limb is removed.

- Pruning should be done in late winter to early spring, unless a particular species requires an alternative schedule

The following are general principles that should be followed when pruning **evergreen trees:**

- Avoid pruning back to old wood because few if any latent buds are on these older branches

- To give the tree a more full form, remove no more than half of the candle (new growth) using sharp pruning shears

- Pruning should typically be done in early December

The following are general principles that should be followed when pruning **shrubs**:

- Shrubs with desirable fruit should be pruned after the fruit has lost its beauty. Fruit may have a wildlife benefit, in which case no removal should be necessary

- Shrubs that flower prior to July 1st should be pruned after flowers have faded

- Shrubs that flower after July 1st should be pruned in late winter

- It is desirable to maintain a natural form of the plant so no shrub should be sheared

- Selective thinning will increase the density of the shrub

- In order to stimulate new growth, pruning the tips of new growth will activate adjacent stem buds which would otherwise remain dormant

- Pruning should be done in late winter to early spring to promote strong, healthier shoots, though fruiting or flowering shrub pruning should be scheduled as recommended above

The following are general principles that should be followed when pruning **perennials, ferns and ornamental grasses:**

- Typically, dead plant material above the ground is desirable because of its aesthetic qualities (i.e. grasses, blackeyed susan). This dead material should not be removed until February to early March, just prior to spring flush of new growth

- Ferns should not be pruned

Fertilizing Trees and Shrubs

Fertilizing can help aid the development of the plants in the landscape. In the built environment, soils can become depleted of the necessary nutrients required by the plant, particularly if fallen leaves are removed from the area. Since this natural cycle can be disrupted, organic and inorganic fertilizers are used to make up the difference. Plants should be evaluated for fertilization needs under the following conditions:

- The presence of abnormally small leaves and a shortened new growth

- Yellow leaves are noticeable

When these symptoms are present, further diagnoses should be conducted in order to determine if the problem is related to fertilization deficiencies or pests.

Soil tests should be used to get as much information as possible prior to selecting types and quantities of fertilizer.

Plants require a combination of 16 elements for proper growth. They include nitrogen, phosphorous, potassium, calcium, magnesium, sulfur, carbon, hydrogen, oxygen, iron, manganese, zinc, boron, molybdenum, copper, and chlorine. They first nine are required in relatively large amounts. Of these Nitrogen, Phosphorous and Potassium are the most common found in fertilizers.

The following are general principles that should be used when applying fertilizers.

- Fertilizers should be applied at time of planting and be included within the soil amendments. Some forms of inorganic fertilizers can be too strong and can burn new root growth
- Slow release granular fertilizer should be used for all other times, unless there is an immediate need for nutrients. It maximizes the fertilizer's effectiveness and is easy to apply.
- Fertilizer should be applied in dry conditions and rely on rainwater or supplemental watering to transport nutrients to roots.
- In order to maximize vegetation growth, nitrogen may be applied to trees and shrubs in the first few years after planting.
- Once a plant has matured, levels of nitrogen can be reduced because it is not as important to maintaining growth
- The rate and application of fertilizer should be determined by testing the soil.
- Trees and shrubs should only be fertilized between late Fall and early Spring. Optimal time to fertilize is late Winter just prior to new root growth in the Spring.

Excessive applications of nitrogen fertilization should be avoided. Runoff containing nitrogen can have a negative impact on water quality due to increased growth of algae, which in effect reduces oxygen levels and temperatures of streams and other bodies of water.

Pest Management

Pests can negatively effect the health of the plants in the landscape. Often severe pest infestations can kill a plant and/or significantly reduce their effectiveness and attractiveness.

The following principles should be followed when dealing with pests that affect plants:

- Select plants that are appropriately suited to their locations as a means of minimizing stress on plants that may cause them to be susceptible to pest
- Select species that do not have common pest-related problems (i.e. Eastern white pine, dutch-elm susceptible Elms)
- When first signs of pest are discovered, immediate action should be taken to minimize spread and reduce the pest's impact on the affected species
- Identify the specific pest causing the problems
- Consider using biological pest control options (i.e. predatory insects) first, if available
- Use insecticide judiciously and as a second choice

Another pest in the landscape can be an undesirable plant, sometimes referred to as a "weed". Removal of weed species can be a tediously and labor intensive activity. However, it is an important task for ensuring the aesthetic beauty of the landscape. Weeds, if allowed to go unchecked, can also compete with plants for nutrients and space. The following principles should be followed when dealing with weeds:

- When preparing a new planting bed, apply post-emergent herbicide to planting area prior to installation
- Maintain a minimum depth of 3 inches of specified mulch in all plant beds; mulch should be replenished twice a year
- After installation of landscape, the soil surface should be disturbed as little as possible in order to prevent further exposure of weed seeds to sun and air
- If after planting only a few weeds appear, remove them manually. Cover disturbed soil with 3 inch layer of mulch
- Should the extent of weedy pest become wider spread, utilize chemical herbicides
- Prepare and use herbicides per manufacturer recommendations
- Apply sparingly (per manufacturer's recommendations) a broad-spectrum herbicide like Glyphosate (Roundup) for spot spraying of weeds
- Do not apply herbicides under windy conditions
- Post emergent herbicides should not be applied prior to rain or irrigation
- Calibrate herbicide application equipment to ensure proper amount of herbicide is being applied
- Special care should be taken not to spray native vegetation, damage animal habitats or contaminate soil or run-off

Invasive-exotic plants are an increasing problem in the landscape. In 1999, the White House issued an Executive Order (13112) preventing the authorization of actions that it believes are likely to cause or promote the introduction of invasive species. It further directed, to the extent practicable, federal agencies to use relevant programs and authorities to prevent the introduction of invasive species, detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner. These guidelines are in accordance with principles set forth within the Executive Order. A list of invasive-exotics identified on the Oak Ridge Reservation are listed in Appendix D. They threaten the biodiversity of the region by crowding out native plant species or even killing them. The loss of native plant habitats diminishes our natural heritage and habitat for wildlife that need them. The following principles should be followed when dealing with invasive exotic plants:

- Information of characteristics should be provided to all maintenance crews in effort to enable staff to correctly identify invasive-exotic species
- Report all invasive-exotic species to the ORNL Environmental Sciences Division
- Upon detection of any invasive-exotic species action plans should be developed immediately to remove them
- When it is possible, manually removing weeds should be considered over herbicide application. Cover disturbed soil with 3 inch layer of mulch
- Herbicides should be used judiciously per manufacturer's recommendations and under same principles as general weed control
- Vehicles and machinery that have come in contact with areas affected by invasive-exotics should be thoroughly cleaned to remove plant parts and seeds that might propagate the species
- Vehicles and machinery should be not be allowed in areas where the invasive exotics are found
- No known invasive-exotics species should be introduced into the landscape

Lawn Care

The lawn can be one of the most labor intensive management tasks within the landscape. Proper lawn care involves mowing, fertilizing, irrigation, dethatching, aeration, and pest and disease control. With proper planning and reasonable

expectations this burden can be minimized. Because of the magnitude of the ORNL campus lawn care can monopolize ORNL's maintenance staff's time. Because of this it is important to prioritize the campus' lawn areas into high profile and low profile areas.

High profile areas would include all centers and other key locations. Low profile areas would include other designated areas not considered as High Profile.

This section addresses the care of Hybrid Fescue lawn grasses and not native grasses or wildflower plantings.

The following principles should be followed for mowing:

- Mower mechanisms used should have regularly sharpen blades; dull blades can damage grass tissue
- Lawns should be mowed only when dry
- Cut Hybrid Fescue lawn to a height of 3 inches
- During a single cutting you should never remove more than 1/3 of the leaf tissue. If grass is over 9 inches in height between mowings (3 times the optimal height) then the height should be gradually reduced over a period of 2 to 3 mowings.
- Mulching mowers should be used in order to return organic matter back to soil
- Mow only during growing season when grass exceeds 4 inches

The following principles should be followed for fertilization:

- Fertilization regiment should be based on soil testing in order to minimize unnecessary fertilization and potential negatively impact to water quality
- Slow release fertilizers should be used when fertilization is necessary.
- September 1st through November 15th is considered the ideal time to apply a single application of fertilizer to Cool-Season lawns, such as Hybrid Fescue. Only soil testing can allow for the optimization of the application amounts and nutrients required

The following principles should be followed for lawn irrigation:

- Lawn irrigation in High profile areas should attempt to utilize alternative water sources to potable water where available
- When irrigating, a combination of rainwater and supplemental irrigation should supply a total of 1" of water per week to the lawn. A soil moisture sensor should be incorporated into the irrigation control mechanism to prohibit irrigation operation when soil moisture is adequate
- Do not irrigate Low profile areas, except at establishment time
- Use rotor-type irrigation heads to maximize coverage with a minimum number of heads, but avoid overthrow onto unintended site areas
- Remember that the natural tendency of lawns is to go dormant and turn brown during periods of drought. This should be an accepted aesthetic so as to reduce irrigation needs. (Once the rainfall returns so will the green grass).

Dethatching is the removal of old grass tissue that has not decomposed and has collected at the base of the grass. This should be removed because it provides an environment for pest and disease to thrive, it can restrict water and nutrients and make new grass plants that root in this layer more susceptible to drought. The following principles should be followed for thatching:

- Mechanically remove thatch when it reaches a depth of 1/2"
- Dethatching can be performed in late summer, early fall or spring

Where lawns are frequently traveled by pedestrian traffic, the soils can become compacted and prevent air, water and nutrients from getting to the roots. Aeration is an important maintenance practice to improve

these conditions. The following principles should be followed for aeration:

- Use coring equipment to remove cores of soil to allow air, water and nutrients back into the soil
- Only aerate lawn in high traffic areas (i.e. event area) once a year

Pests and diseases can also cause turf to look unsightly. The following principles should be followed when dealing with pest and disease:

- Use a proven blend of pest and disease resistant hybrid fescue grass (i.e. including Rebel III and other varieties)
- Institute recommended management (i.e. mowing, irrigation, dethatching)
- Properly use pesticides or herbicides when necessary

APPENDIX A: MASTER PLAN LIST

ORNL MASTER PLANT LIST

			Light			Moisture				Soil			Natural			Developed			
Scientific Name	**Common Name**	**Native**	**F**	**P**	**S**	**H**	**M**	**S**	**X**	**B**	**A**	**R**	**Ridge**	**Valley**	**Riparian**	**Streetscape**	**Open**	**Parking**	**Highly Developed**
Large Deciduous Tree (>25ft.)																			
Acer rubrum	Red Maple	Local																	
Acer saccharum	Sugar Maple	Local																	
Aesculus flava	Yellow Buckeye	Local																	
Betula nigra	River Birch	Local																	
Fagus grandifloria	American Beech	Local																	
Fraxinus pennsylvanica	Green Ash	Local																	
Liquidambar styraciflua	Sweetgum	Local																	
Liriodendron tulipifera	Tulip Poplar	Local																	
Magnolia macrophylia	Bigleaf Magnolia	Regional																	
Nyssa sylvatica	Black Gum	Local																	
Platanus occidentalis	Sycamore	Local																	
Quercus alba	White Oak	Local																	
Quercus bicolor	Swamp White Oak	Local																	
Quercus nuttalli	Nuttal Oak	Regional																	
Quercus rubra	Northern Red Oak	Local																	
Quercus shumardi	Southern Red Oak	Local																	
Quercus velutina	Black Oak	Local																	
Sassafras albidum	Sassafras	Local																	
Taxodium distichum	Baldcypress	Local																	
Tilia americana	Basswood	Local																	
Ulmus americana 'Princeton'or'Valley Forge'	American Elm	Local																	
Small Deciduous Tree (<25ft.)																			
Amelanchier arborea	Serviceberry	Local																	
Amelanchier laevis	Serviceberry	Local																	
Carpinus carolina	American Hornbeam	Local																	
Cercis canadensis	Redbud	Local																	
Chionanthus virginicus	Fringe Tree	Local																	
Cornus florida	Flowering Dogwood	Local																	
Hamamelis virginiana	Witchhazel	Local																	
Magnolia virginiana	Sweet Bay Magnolia	Regional																	
Ostrya virginiana	Hop- Hornbeam	Local																	
Oxdendrum arboreum	Sourwood	Local																	
Ptelea trifoliata	Hoptree	Local																	
Rhus glabra	Smooth Sumac	Local																	
Salix nigra	Black Willow	Local																	
Evergreen Tree (>20ft.)																			
Ilex opaca	American Holly	Local																	
Juniperus virginiana	Eastern Red Cedar	Local																	
Magnolia grandiflora	Southern Magnolia	Regional																	
Pinus taeda	Loblolly Pine	Local																	
Pinus virginiana	Virginia Pine	Local																	
Thuja occidentalis	American Arborvitae	Local																	
Tsuga canadensis	Hemlock	Local																	
Large Deciduous Shrub (>4ft.)																			
Aronia arbutifolia	Red Chokeberry	Local																	
Calycanthus floridus	Sweetshrub	Local																	
Clethra alnifolia	Sweet Pepper bush	Regional																	
Cornus amomum	Silky Dogwood	Local																	
Fothergilla major	Large Fothergilla	Local																	
Hydrangea quercifolia	Oakleaf Hydrangea	Regional																	
Ilex verticillata	Deciduous Holly	Local																	
Itea virginica	Itea	Local																	
Lindera benzoin	Spicebush	Local																	
Rhamnus caroliniana	Carolina Buckthorn	Local																	
Rhododendron canescens	Native Azalea	Local																	

ORNL MASTER PLANT LIST

			Light			Moisture				Soil			Natural			Developed			
Scientific Name	**Common Name**	**Native**	**F**	**P**	**S**	**H**	**M**	**S**	**X**	**B**	**A**	**R**	**Ridge**	**Valley**	**Riparian**	**Streetscape**	**Open**	**Parking**	**Highly Developed**
Vaccinium arboreum	Farkleberry	Regional																	
Vaccinium corymbosum	Highbush Blueberry	Regional																	
Viburnum acerifolium	Mapleleaf Viburnum	Local																	
Viburnum dentatum	Arrowwood Viburnum	Regional																	
Viburnum prunifolium	Blackhawk Viburnum	Local																	
Viburnum rufidulum	Rusty Blackhawk Viburnum	Local																	
Small Deciduous Shrub (<4ft.)																			
Aronia melanocarpa	Black Chokeberry	Regional																	
Ceanothus americanus	New Jersey Tea	Local																	
Cephalanthus occidentalis	Buttonbush	Local																	
Clethra alnifolia 'Hummingbird'	Dwarf Clethra	Regional																	
Euonymus americanus	Strawberrybush	Regional																	
Fothergilla gardina	Dwarf Fothergilla	Local																	
Hypericum frondosum 'Sunburst'	Shrubby St. Johnswort	Regional																	
Hypericum prolificum	Shrubby St. Johnswort	Local																	
Itea virginica 'Henry's Garnet'	Dwarf Itea	Local																	
Large Evergreen Shrub (>4ft.)																			
Ilex glabra	Inkberry Holly	Regional																	
Kalmia latifolia	Mountain Laurel	Regional																	
Rhododendron catawbiense	Catawba Rhodedendron	Regional																	
Small Evergreen Shrub (<4ft.)																			
Ilex glabra 'compacta'	Dwarf Inkberry Holly	Regional																	
Kalmia latifolia 'Elf'	Dwarf Mountain Laurel	Local																	
Groundcover (<1.5ft.)																			
Asarum canadense	Wild Ginger	Local																	
Chasmanthium latifolium	River Oats	Regional																	
Gaultheria procumbens	Wintergreen	Local																	
Gelsemium sempervirens	Carolina Jassamine	Regional																	
Ophiopogon japonicus 'Kioto'	Dwarf Mondo Grass																		
Opuntia humifusa	Prickly Pear Cactus	Local																	
Pachysandra procumens	Alleghany Pachysandra	Local																	
Phlox pilosa	Downy Phlox	Regional																	
Rhus aromatica	Frangrant Sumac	Local																	
Sedum ternatum	Wild Stonecrop	Local																	
Water/Bog Plant																			
Equisetum hymale	Horsetail Rush	Local																	
Perennial																			
Aquilega canadensis	Columbine	Local																	
Aruncus diocus	Goat's Beard	Local																	
Arisaema triphyllum	Jack-in-the-Pulpit	Local																	
Asclepias tuberosa	Butterfly Weed	Local																	
Astilbe bitnernata	Astilbe	Regional																	
Baptisia australis	Blue Wild Indigo	Regional																	
Coreopsis lanceolata	Lanceleaf Coreopsis	Local																	
Echinacea purpurea	Purple Coneflower	Local																	
Iris cristata	Dwarf Crested Iris	Local																	
Lobelia cardinalis	Cardinal Flower	Local																	
Monarda didyma 'Jacob Kline'	Beebalm	Local																	
Penstemon digitalis	Penstemon	Local																	
Polygonatum biflorum	Solomon's Seal	Local																	
Rudbeckia fulgida	Blackeyed Susan	Local																	
Silene virginica	Firepink	Local																	
Sisyrinchium angustifolium	Blue-eyed Grass	Local																	
Fern																			
Adiantum pedatum	Maidenhair Fern	Local																	

ORNL MASTER PLANT LIST

			Light			Moisture				Soil			Natural			Developed			
Scientific Name	**Common Name**	**Native**	**F**	**P**	**S**	**H**	**M**	**S**	**X**	**B**	**A**	**R**	**Ridge**	**Valley**	**Riparian**	**Streetscape**	**Open**	**Parking**	**Highly Developed**
Athyrium filix-femina	Lady Fern	Local																	
Osmunda regalis	Royal Fern	Local																	
Polystichum acrostichoides	Christmas Fern	Local																	
Pteridium aquilinum	Bracken Fern	Local																	
Osmunda cinnamomea	Cinnamon Fern	Local																	
Tall Grass (>4ft.)																			
Arundinaria gigantea	River Cane	Local																	
Andropogon gerardii	Big Bluestem	Local																	
Sorghastrum nutans	Indian Grass	Local																	
Panicum virgatum	Switchgrass	Local																	
Short Grasses/Sedges (<4ft.)																			
Andropogon ternarius	Split Beard Bluestem	Local																	
Carex flaccosperma	Blue Wood Sedge	Regioal																	
Carex stricta	Tussock Sedge	Regional																	
Juncus effusus	Soft Rush	Local																	
Hystrix patula	Bottlebrush Grass	Local																	
Schizachyrium scoparium	Little Bluestem	Local																	
Sporobolus heterolepis	Prairie Dropseed	Regional																	
Vines																			
Parthenocissus quincefolia	Virginia Creeper	Local																	
Campsis radicans	Trumpet Creeper	Local																	
Gelsemium sempervirens	Carolina Jassamine	Local																	
Decumaria barbara	Leatherflower	Regional																	

F=Full Sun P= Partial Shade S=Full Shade H=Hydric M=Mesic S=Sub-Xeric X=Xeric B=Alkaline A=Acidic R= Restricted to Indicated Soil Type

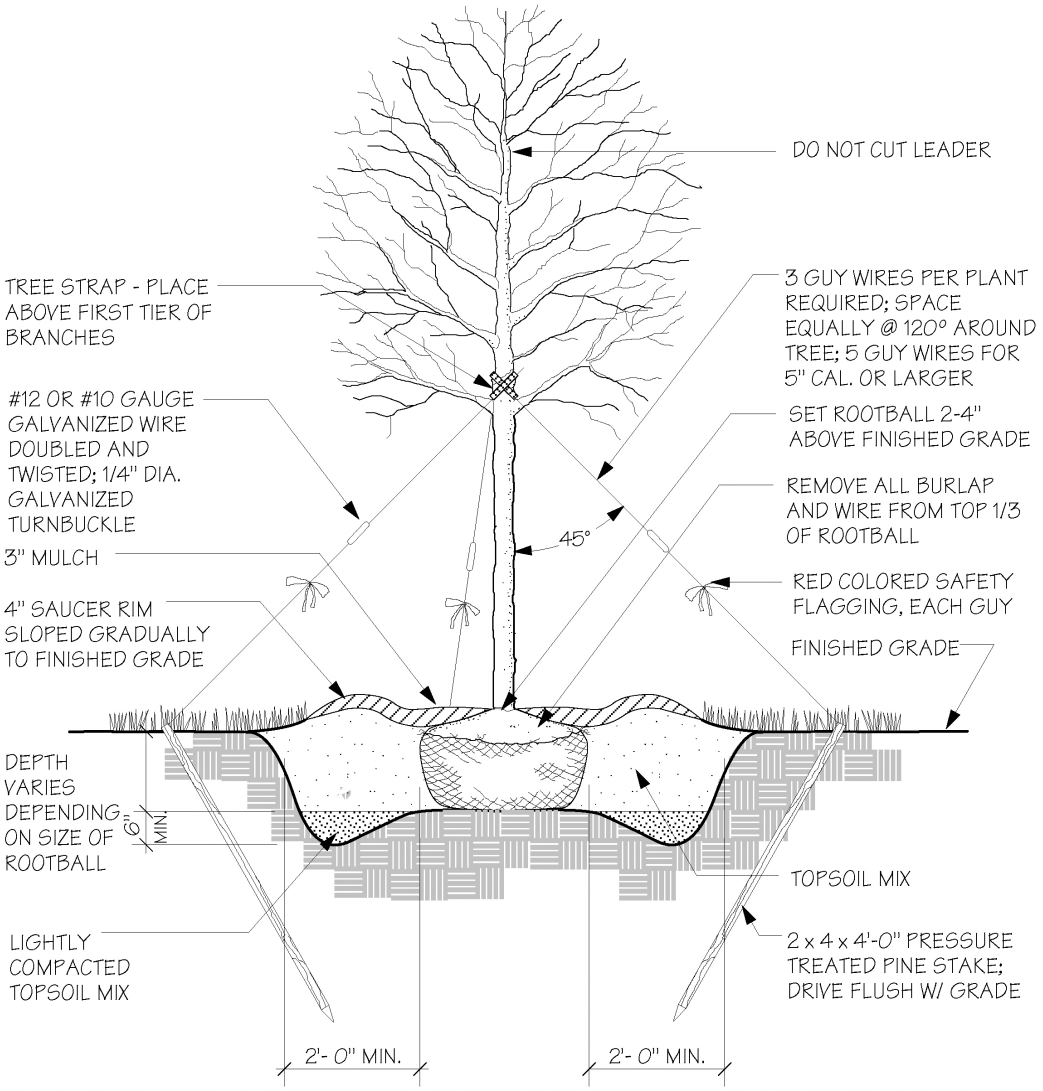
*The plants on this list were chosen for their adaptibility and low maintenance needs within the built environment. Due to the significant plant diversity of the region, this list should not exclude other native plants that would be appropriate within the built environment.

APPENDIX B: LANDSCAPE CALENDAR

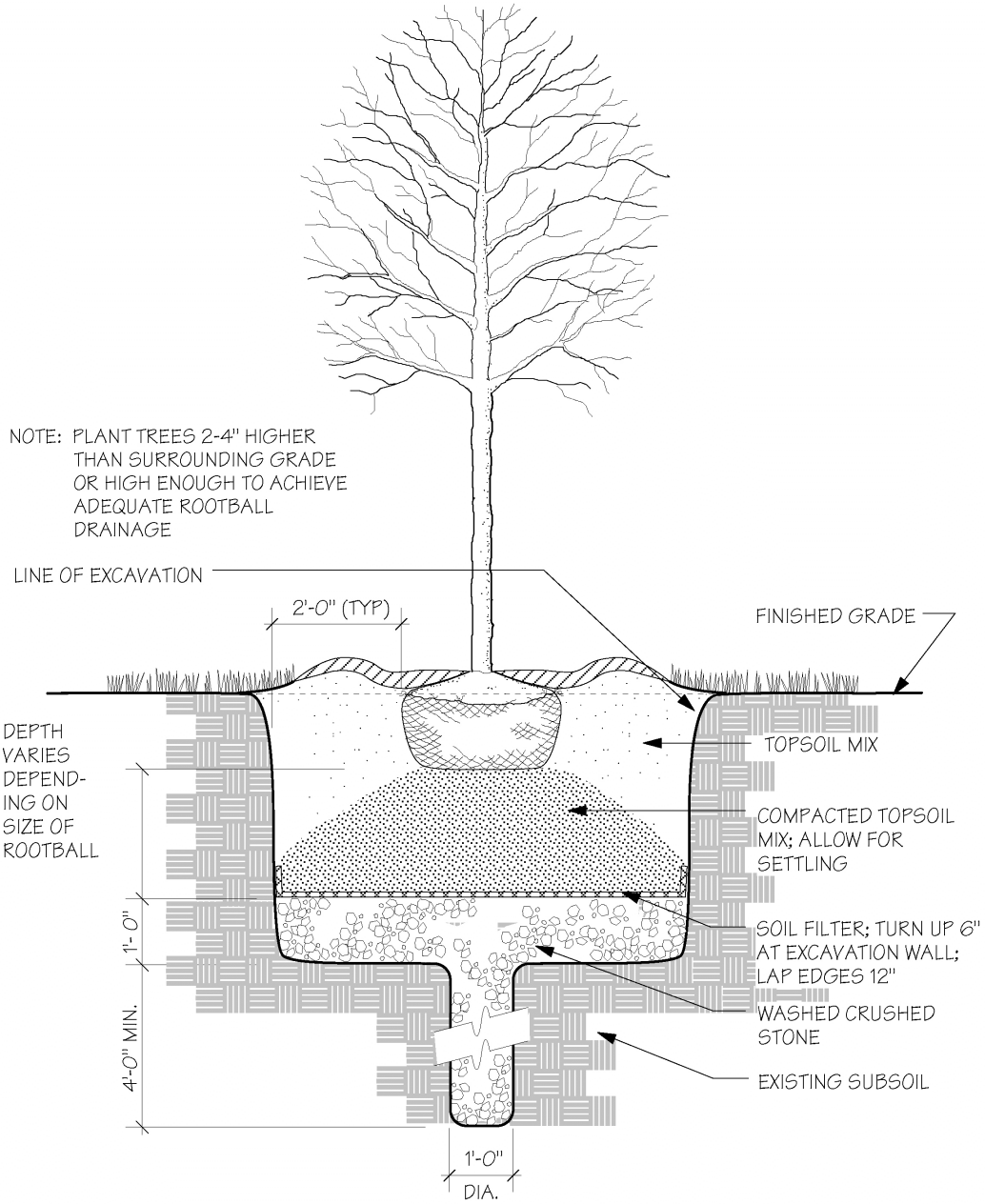
LANDSCAPE
MANAGEMENT CALENDAR

	January			February			March			April			May			June			July			August			September			October			November			December		
INSTALLATION																																				
Planting Trees & Shrubs	■	■	■	■	■	■	■	■	■	■	■																				■	■	■	■	■	■
Perennials, Groundcovers and Vines	■	■	■	■	■	■	■	■	■	■	■																				■	■	■	■	■	■
Sowing Native Grassess & Wildflowers				■	■	■	■	■	■	■	■	■	■	■	■										■	■	■	■	■	■	■	■	■			
Sowing Hybrid Tall Fescue								■	■	■	■													■	■	■	■	■	■						
Sodding Hybrid Tall Fescue								■	■	■	■													■	■	■	■	■	■						
Hydroseeding Hybrid Tall Fescue								■	■	■	■													■	■	■	■	■	■						
PRUNING																																				
Pruning Trees				■	■	■	■	■																												
Pruning Shrubs that Flower Before July 1st																						■	■	■	■	■	■	■								
Pruning Shrubs that Flower After July 1st				■	■	■	■	■																												
Pruning Evergreen Trees																																■	■	■		
Pruning Perennials, Groundcovers, and Vines				■	■	■																														
MOWING																																				
Mowing Native Native Grasses & Wildflower																															■	■	■			
Mowing Hybrid Tall Fescue								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
FERTILIZATION																																				
Fertilizing Trees and Shrubs	■	■	■	■	■	■																										■	■	■	■	■
Fertilizing Evergreen Trees	■	■	■	■	■	■																										■	■	■	■	■
Fertilizing Perennials, Groundcovers, and Vines	■	■	■	■	■	■																										■	■	■	■	■
Fertilizing Native Grasses and Wildflowers																																				
Fertilizing Hybrid Tall Fescue																									■	■	■	■	■	■	■	■	■			

APPENDIX C: PLANTING DETAILS

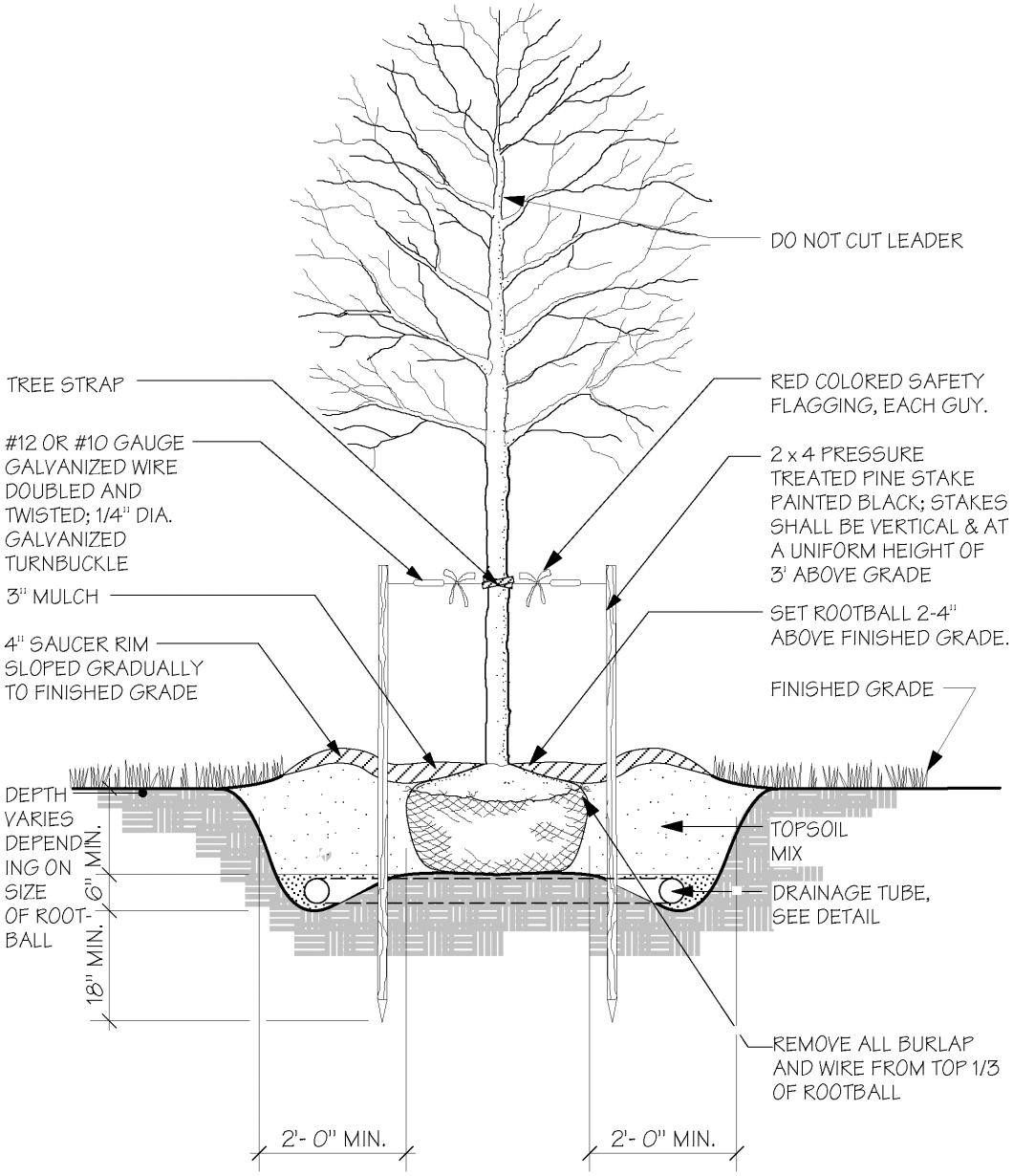


SECTION: TREE W/ GUY WIRES
N.T.S.



SECTION: TREE W/ DRAINAGE PIT

N.T.S.



SECTION: TREE W/ VERTICAL STAKING

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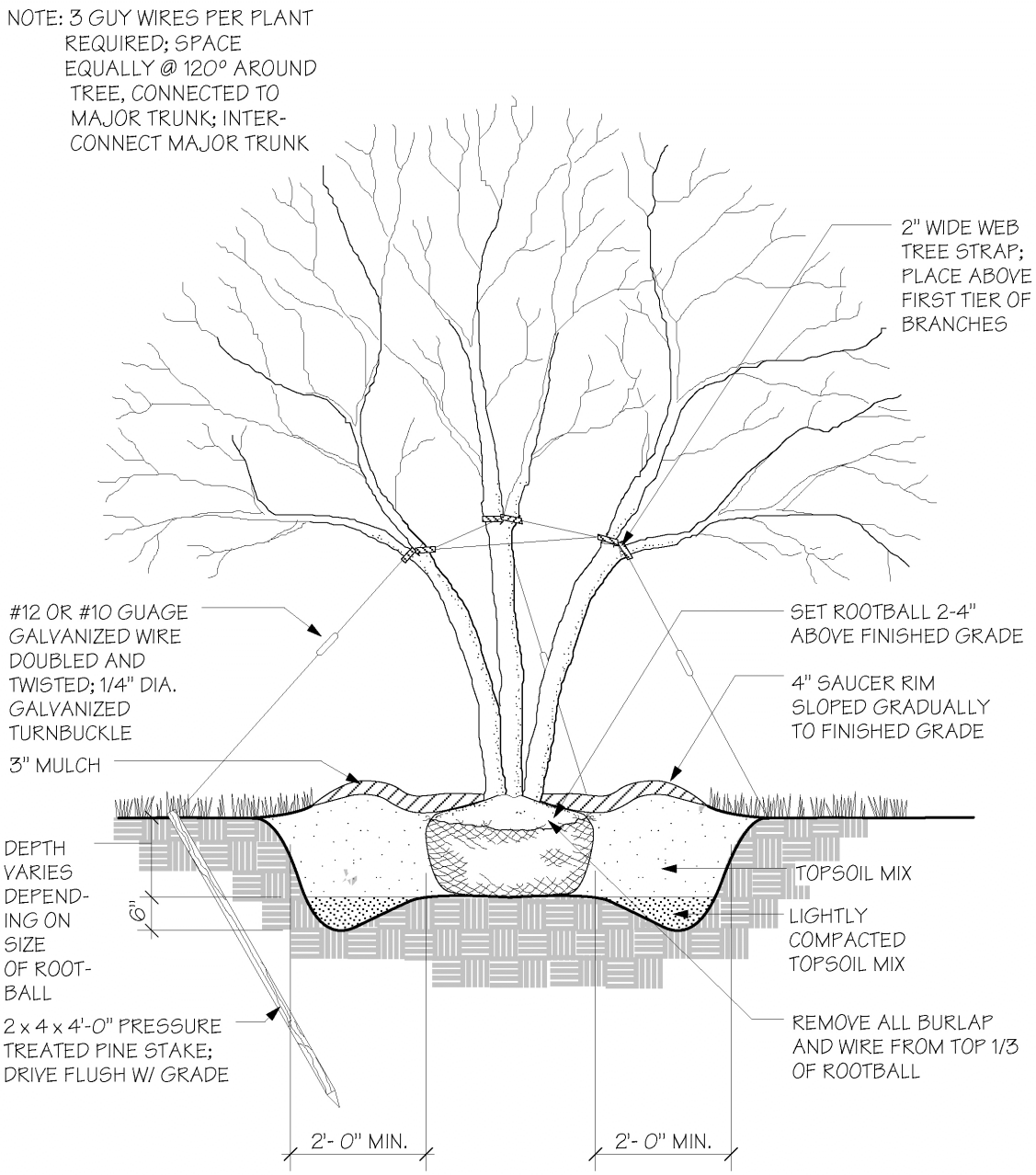
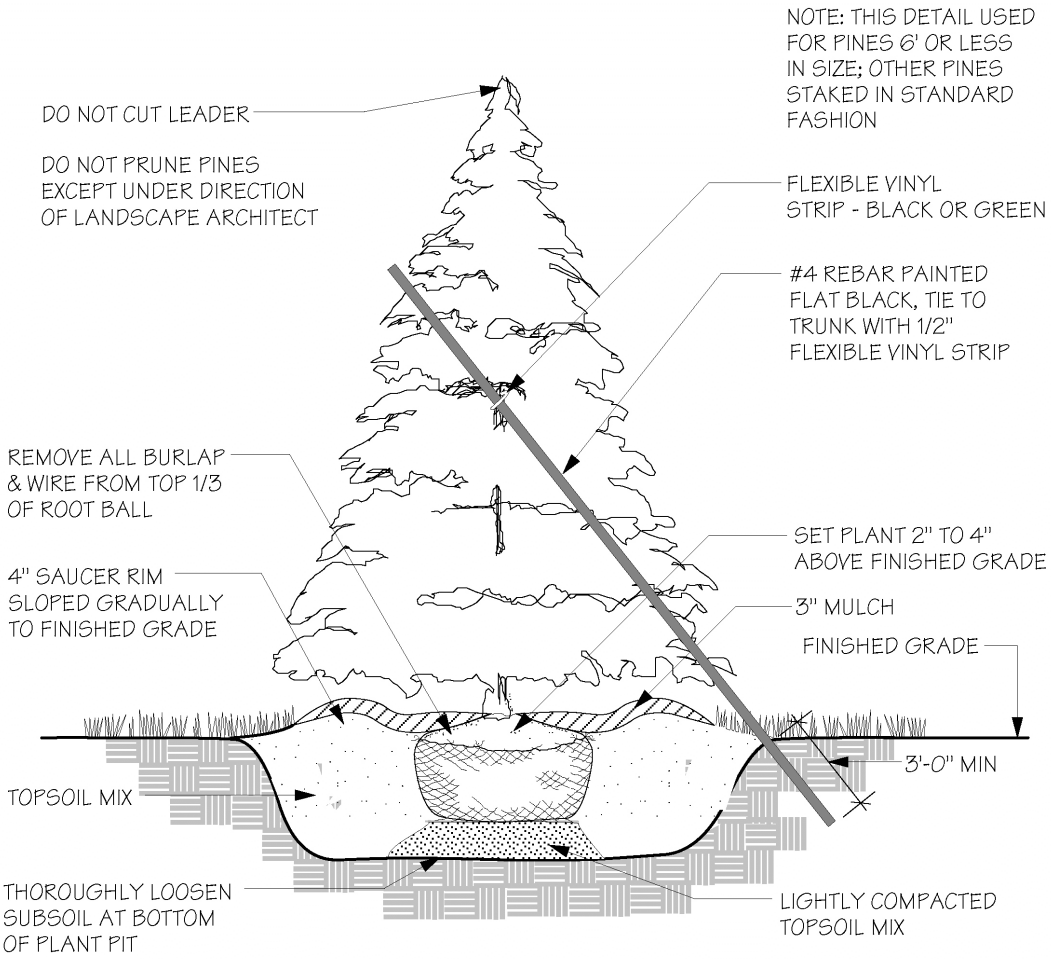


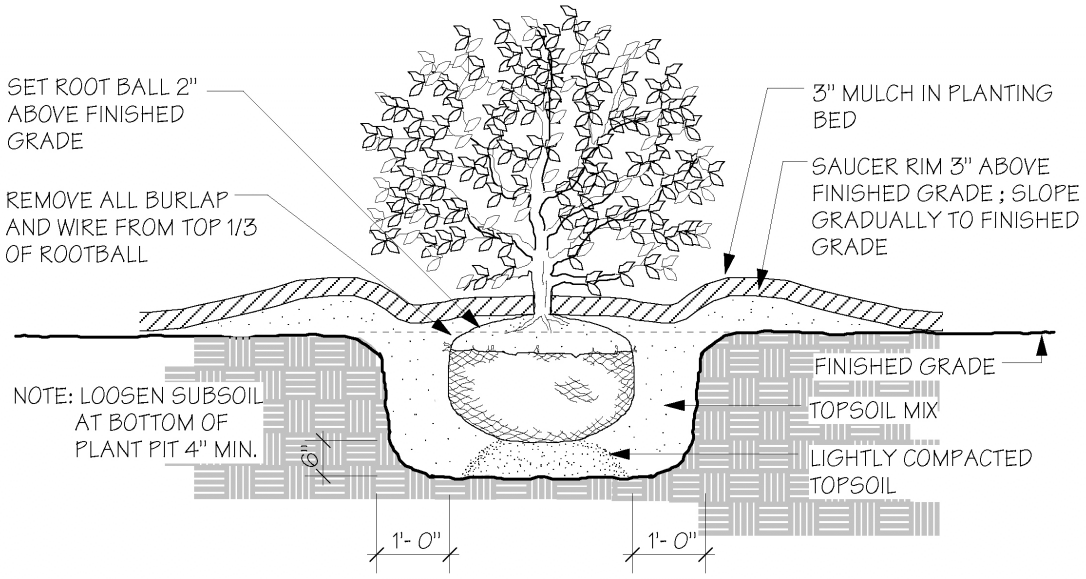
SECTION: MULTI-TRUNK TREE

N.T.S.



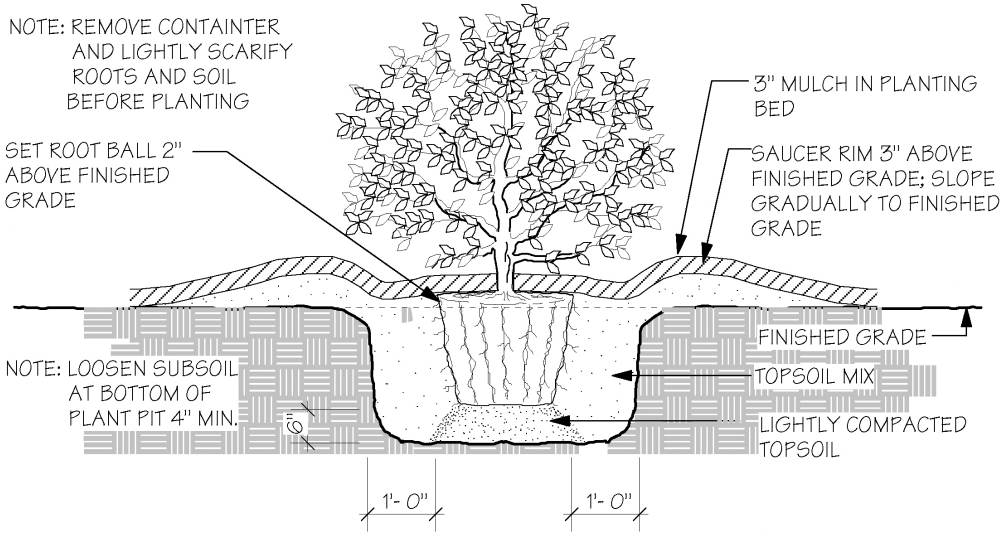
SECTION: EVERGREEN DETAIL

N.T.S.



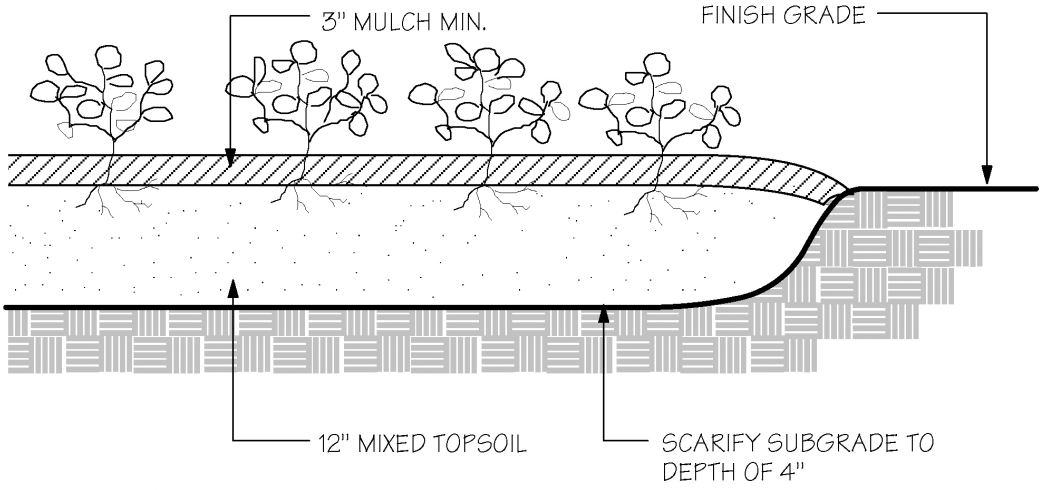
SECTION: B & B SHRUB

N.T.S.



SECTION: CONTAINER SHRUB

N.T.S.



SECTION: GROUNDCOVER / PERENNIAL BED

N.T.S.

APPENDIX D: EXOTIC PEST PLANT LIST

Oak Ridge Reservation Exotic Pest Plants

GENUS	SPECIES	COMMON NAME
Agrostemma	githago	corncockle
Agrostis	stolonifera	creeping bentgrass
Ailanthus	altissima	tree-of-heaven
Albizia	julibrissin	mimosa
Allium	ampeloprasum	garlic
Allium	vineale	field garlic
Amaranthus	hybridus	amaranth
Amaranthus	spinosus*	spiny amaranth
Anagallis	arvensis	pimpernel
Anthoxanthum	odoratum	sweet vernal grass
Arabidopsis	thaliana	mouse-ear cress
Arctinium	minus	burdock
Arenaria	serpyllifolia	thyme-leaf sandwort
Arthraxon	hispidus	
Asparagus	officinalis	asparagus
Barbarea	vulgaris	yellow rocket
Belamcanda	chinensis	blackberry lily
Berberis	thunbergii*	Japanese barberry
Brassica	rapa	rape mustard
Bromus	commutatus	common brome grass
Bromus	hordeaceus	soft chess
Bromus	japonicus	Japanese chess
Bromus	tectorum	brome grass
Buglossoides	arvense	
Buxus	sempervirens*	boxwood
Calamintha	nepeta	basil-thyme
Capsella	bursa-pastoris	sheperd's purse
Cardamine	hirsuta	hairy bittercress
Cardamine	parviflora	
Catalpa	bignonioides	catalpa
Celastrus	orbiculatus	Oriental bittersweet
Centaurea	cyanus	bachelor's button
Centaurea	maculosa	bachelor's button
Cerastium	fontanum	mouse-ear chickweed
Cerastium	glomeratum	mouse-ear chickweed
Chaennorrhinum	minus	lesser toadflax
Chenopodium	album	white goosefoot
Chenopodium	ambrosioides	fragrant goosefoot
Chrysanthemum	leucanthemum	daisy
Cichorium	intybus	chicory
Cirsium	arvense	Canada thistle
Cirsium	vulgare	bull thistle
Commelina	communis	common dayflower
Consolida	ambigua	rocket larkspur
Convallaria	majalis	lily-of-the-valley
Coronilla	varia	crown-vetch
Crepis	pulchra	hawk's beard
Cynodon	dactylon	Bermuda grass
Dactylis	glomerata	orchard grass
Datura	stramonium	jimson weed
Daucus	carota	Queen Anne's lace

Oak Ridge Reservation Exotic Pest Plants

GENUS	SPECIES	COMMON NAME
Dianthus	armeria	deptford pink
Digitaria	ischaemum	smooth crabgrass
Digitaria	sanguinalis	crabgrass
Dioscorea	batatas	Chinese yam
Dipsacus	fullonum	teasel
Draba	verna	whitlow grass
Duchesnea	indica	barren strawberry
Echinochloa	crusgalli	barnyard grass
Elaeagnus	pungens	oleaster
Elaeagnus	umbellata	oleaster
Eleusine	indica	goosegrass
Eragrostis	cilianensis	lovegrass
Eragrostis	curvula	South African lovegrass
Erysimum	cheiranthoides	worm-seed mustard
Festuca	arundinacea	meadow fescue
Festuca	pratensis	fescue
Festuca	rubra	red fescue
Galium	parisiense	
Galium	pedemontanum	narrow bedstraw
Geranium	columbinum	longstalk crane's-bill
Glechoma	hederacea	ground-ivy
Hedera	helix*	English ivy
Hemerocallis	fulva	day-lily
Hibiscus	trionum	flower of an hour
Holcus	lanatus	velvet grass
Holosteum	umbellatum*	jagged chickweed
Hypericum	perforatum	common St.John's-wort
Ipomoea	coccinea	scarlet morning-glory
Ipomoea	hederacea	ivy-leaved morning-glory
Ipomoea	purpurea	purple morning-glory
Iris	germanica*	German iris
Iris	pseudacorus	yellow European iris
Kummerowia	stipulacea	Korean bush-clover
Kummerowia	striata	Japanese clover
Kyllinga	brevifoliodes	
Lactuca	saligna	willow-leaved lettuce
Lactuca	serriola	prickly lettuce
Lamium	amplexicaule	henbit
Lathyrus	latifolia	everlasting pea
Leonurus	cardiaca	motherwort
Lepidium	campestre	cow-cress
Lespedeza	bicolor	shrubby bushclover
Lespedeza	cuneata	cuneate bus-clover
Ligustrum	sinense	privet
Ligustrum	vulgare*	privet
Linaria	vulgaris	butter-and-eggs
Lolium	multiflorum	Italian ryegrass
Lolium	perenne	perennial ryegrass
Lonicera	japonica	Japanese honeysuckle
Lonicera	maackii	
Lotus	corniculatus	birdfoot trefoil

Oak Ridge Reservation Exotic Pest Plants

GENUS	SPECIES	COMMON NAME
Lysimachia	nummularia	moneywort
Lythrum	salicaria	purple loosestrife
Maclura	pomifera	Osage-orange
Mahonia	bealei	Oregon grape
Malus	pumila*	apple
Medicago	lupulina	black medick
Medicago	sativa*	alfalfa
Melilotus	alba	white sweet-clover
Melilotus	officinalis	yellow sweet-clover
Mentha	spicata	spearmint
Mentha	x piperita	peppermint
Microstegium	vimineum	Nepal grass
Mollugo	verticillata	carpet-weed
Mosla	dianthera	
Murdannia	keisak	
Myriophyllum	spicatum	European water-milfoil
Narcissus	pseudonarcissus*	daffodil
Nasturtium	officinale	watercress
Nicandra	physalodes	apple-of-Peru
Ornithogalum	umbellatum	star of Bethlehem
Paspalum	dilatatum	
Paulownia	tomentosa	princess-tree
Perilla	frutescens	beefsteak plant
Phleum	pratense	common timothy
Plantago	lanceolata	plantain
Poa	annua	annual bluegrass
Poa	compressa	bluegrass
Poa	pratensis	Junegrass
Polygonum	cespitosum	smartweed
Polygonum	cuspidatum	Japanese knotweed
Polygonum	hydropiper	water-pepper
Polygonum	persicaria	smartweed
Poncircus	trifoliata	trifoliate orange
Populus	alba	silvery poplar
Populus	x jackii	
Potamogeton	crispus	pondweed
Potentilla	recta	rough-fruited cinquefoil
Prunella	vulgaris	heal-all
Pueraria	lobata	kudzu
Ranunculus	acris	common buttercup
Ranunculus	bulbosus	bulbous buttercup
Ranunculus	repens	creeping buttercup
Ranunculus	sardos	
Rosa	multiflora	multiflora rose
Rubus	phoenicolasius	wineberry
Rumex	conglomeratus	dock
Rumex	crispus	curled dock
Rumex	obtusifolius	bitter dock
Salix	alba	white willow
Salix	babylonica	weeping willow
Saponaria	officinalis	soapwort

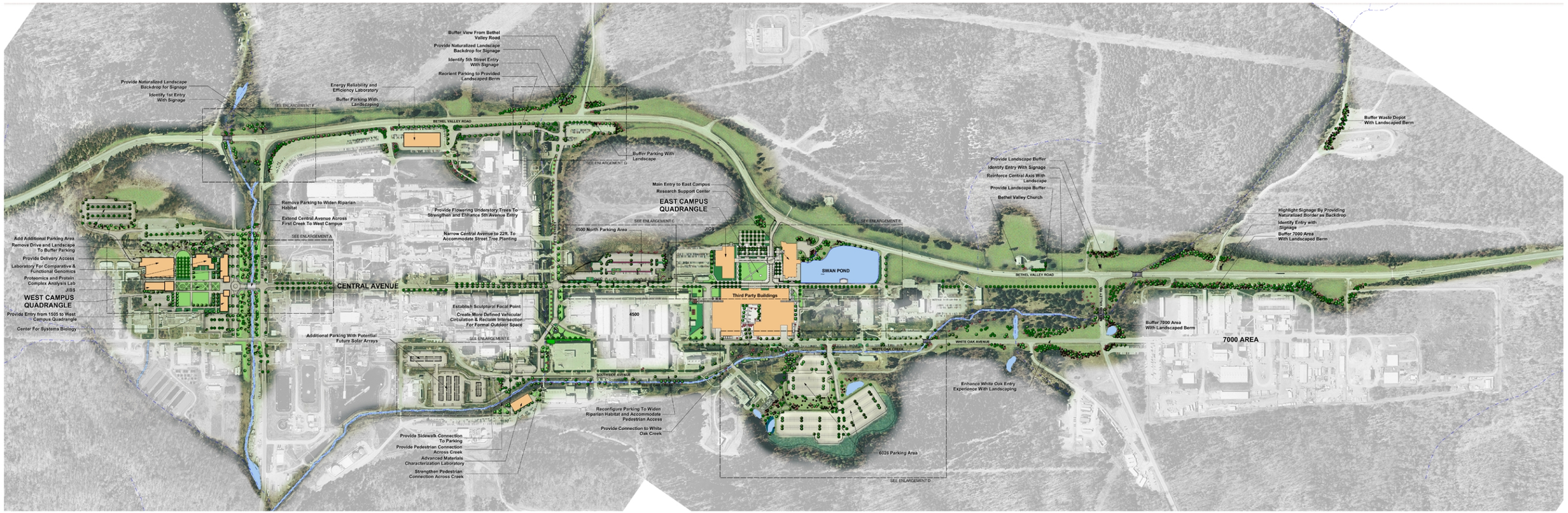
Oak Ridge Reservation Exotic Pest Plants

GENUS	SPECIES	COMMON NAME
Secale	cereale*	rye
Senna	obtusifolia	sickle-pod
Setaria	faberi	foxtail
Setaria	pumila	foxtail
Setaria	viridis	green foxtail
Sida	spinosa	prickly mallow
Sonchus	asper	prickly sow-thistle
Sorghum	bicolor*	milo
Sorghum	halepense	Johnson grass
Spiraea	douglasii*	spiraea
Sporobolus	indicus	smutgrass
Stellaria	media	common chickweed
Taraxacum	officinale	common dandelion
Thlaspi	perfoliatum*	thoroughwort penny-cress
Tragopogon	dubius	
Trifolium	campestre	low hop-clover
Trifolium	hybridum	alsike clover
Trifolium	pratense	red clover
Trifolium	repens	white clover
Triticum	x aestivum*	wheat
Tussilago	farfara	coltsfoot
Urtica	dioica	stinging nettle
Verbascum	blattaria	moth mullein
Verbascum	thapsus	mullein
Veronica	arvensis	corn speedwell
Veronica	officinalis	common speedwell
Veronica	serpyllifolia	thyme-leaved speedwell
Vicia	angustifolia	narrow-leaved vetch
Vicia	villosa	hairy vetch
Vinca	minor	periwinkle
Vitex	agnus-castus*	
Vulpia	myuros	rat-tail fescue

APPENDIX E: CONCEPTUAL LANDSCAPE PLAN ILLUSTRATIONS

Prepared For UT-Battelle, LLC

March, 2003



LEGEND:

- SHADE TREES
- UNDERSTORY TREES
- EVERGREEN TREES
- GROUNDCOVER
- PROPOSED BUILDINGS
- NATIVE GRASSES & WILDFLOWERS
- SUCCESSIONAL AREAS
- LAWN / TURFGRASS
- SHRUBS

200 100 0 200

SCALE 1" = 200'-0"

N

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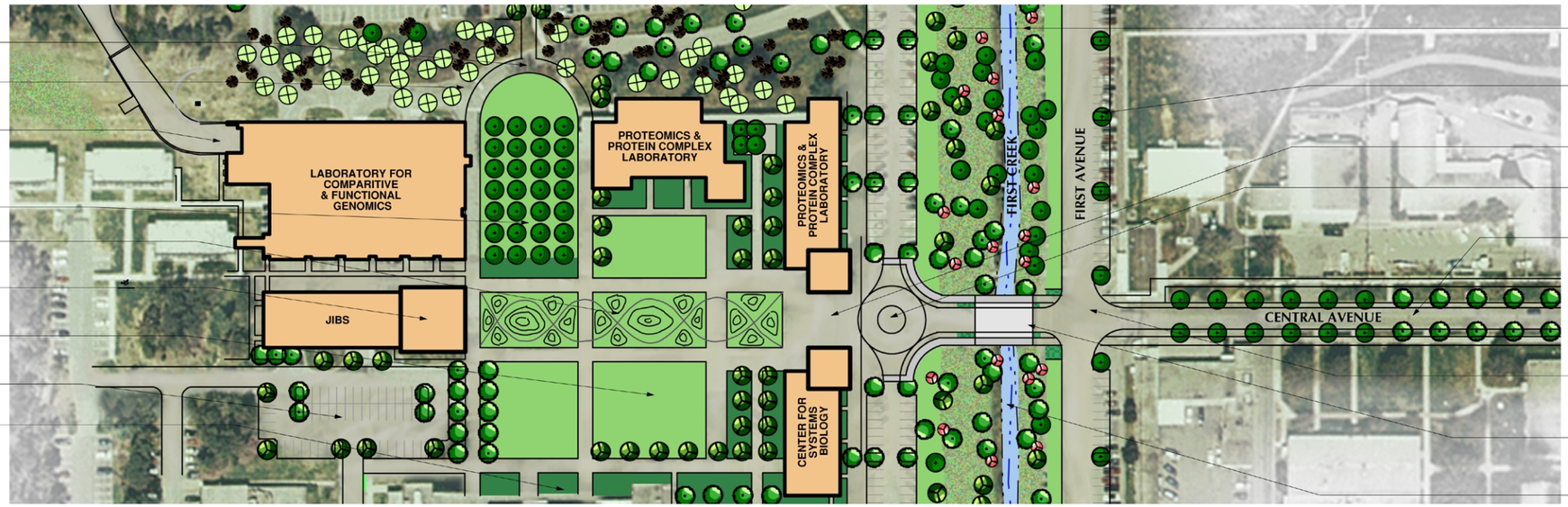

Provide Stronger Connection Between Upper Parking Lot And West Campus Quadrangle

Remove Existing Access Drive And Replace with Walkway

Provide Alternative Service Access to Laboratory

Buffer Laboratory For Comparitive & Functional Genomics Building with Large Shade Trees (Potential Research Plot)

Create "DNA Inspired" Mounds

Use JIBS Architecture As A Focal Point On Central Avenue Axis

Define West Quadrangle With Future Buildings

Add Parking

Create New Entry to 1505 Building On To The West Quadrangle

Relocate Some Parking From Along First Street to Increase Riparian Corridor

Add Shade Trees to Existing Parking

Use Future Buildings to Define Gateway to West Quadrangle

Drop-Off

Shift North Curb To Narrow Central Avenue to 22ft. To Accommodate Street Trees

Reduce Turning Radius At Intersection and Narrow First Street To Two 11ft. Lanes

Extend Central Avenue Across First Creek

Manage Riparian Corridor

60 30 0 60

SCALE 1" =60'-0"

N

LEGEND:

- SHADE TREES
- UNDERSTORY TREES
- EVERGREEN TREES
- GROUNDCOVER
- PROPOSED BUILDINGS
- NATIVE GRASSES & WILDFLOWERS
- SUCCESSIONAL AREAS
- LAWN / TURFGRASS
- SHRUBS

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Enlargement A

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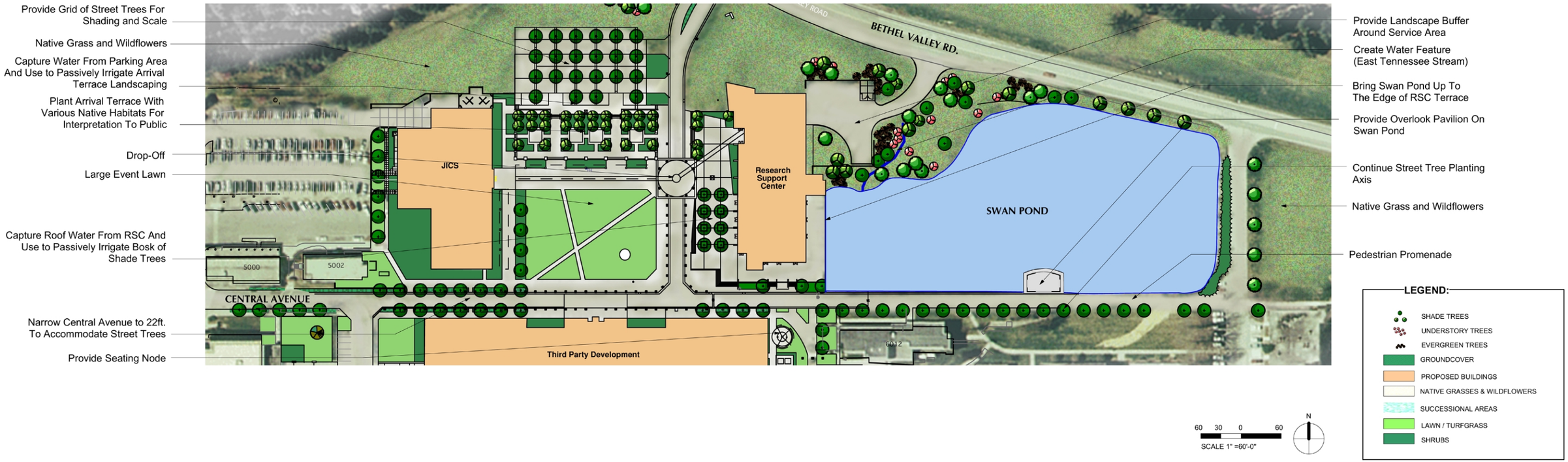

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Enlargement B

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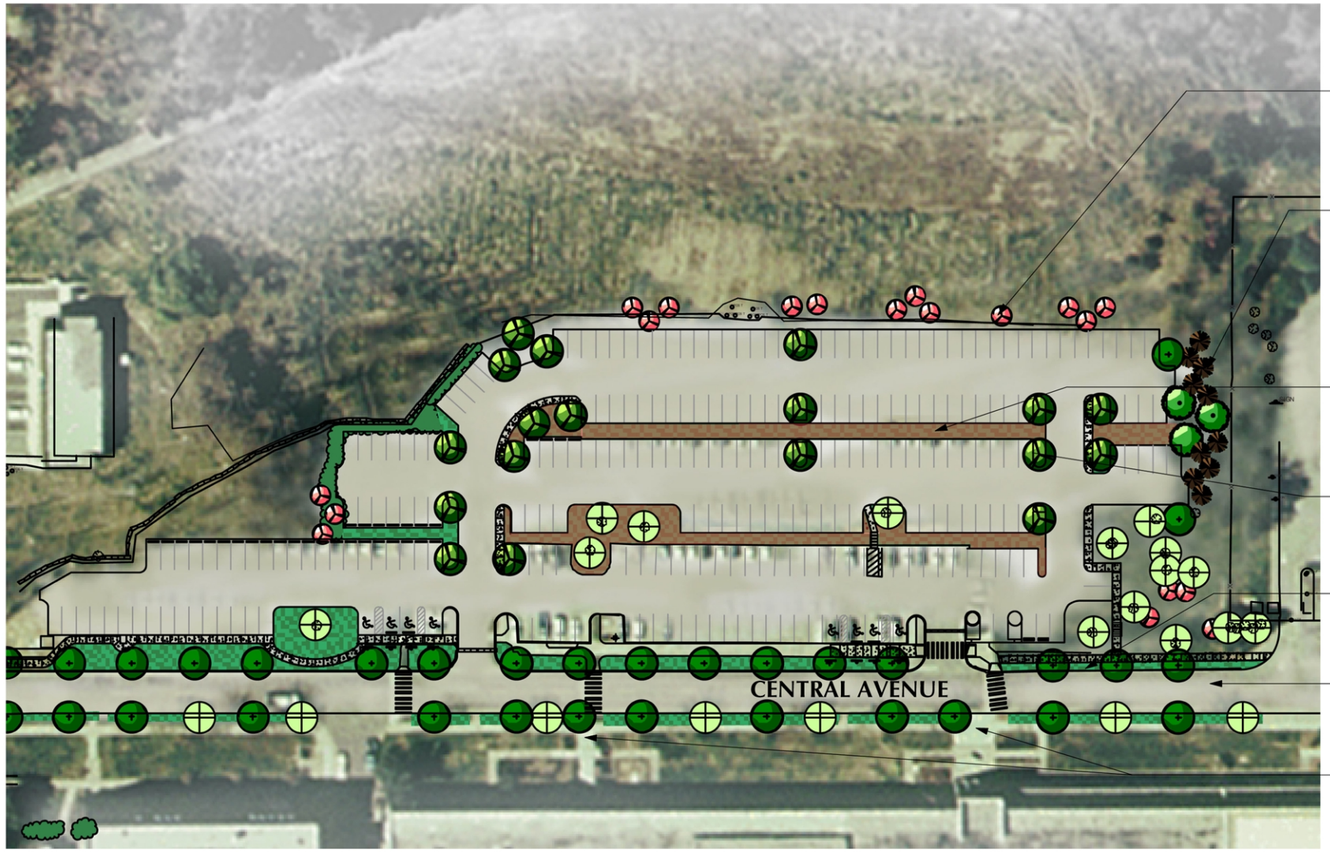

Highlight Existing Edge With Understory Flowering Trees

Provide Buffer Between Parking To Break Up Size of Parking Area

Plant Vines and Perennials Among River Stone Protecting Grade Change

Plant Variety of Tree Species In Parking Lot for Scale and Shading

Establish Groundcover In Landscape Strip Between Walkways and Curb

Narrow Central Avenue To 22ft. To Accommodate New Street Trees

Provide Seating Nodes At 4500 North

LEGEND:

- SHADE TREES
- UNDERSTORY TREES
- EVERGREEN TREES
- GROUNDCOVER
- PROPOSED BUILDINGS
- NATIVE GRASSES & WILDFLOWERS
- SUCCESSIONAL AREAS
- LAWN / TURFGRASS
- SHRUBS

ENLARGEMENT C: 4500 Parking Area

60 30 0 60

SCALE 1" =60'-0"

N

ENLARGEMENT D: 6026 Parking Area

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Enlargement D: 6026 Parking Area

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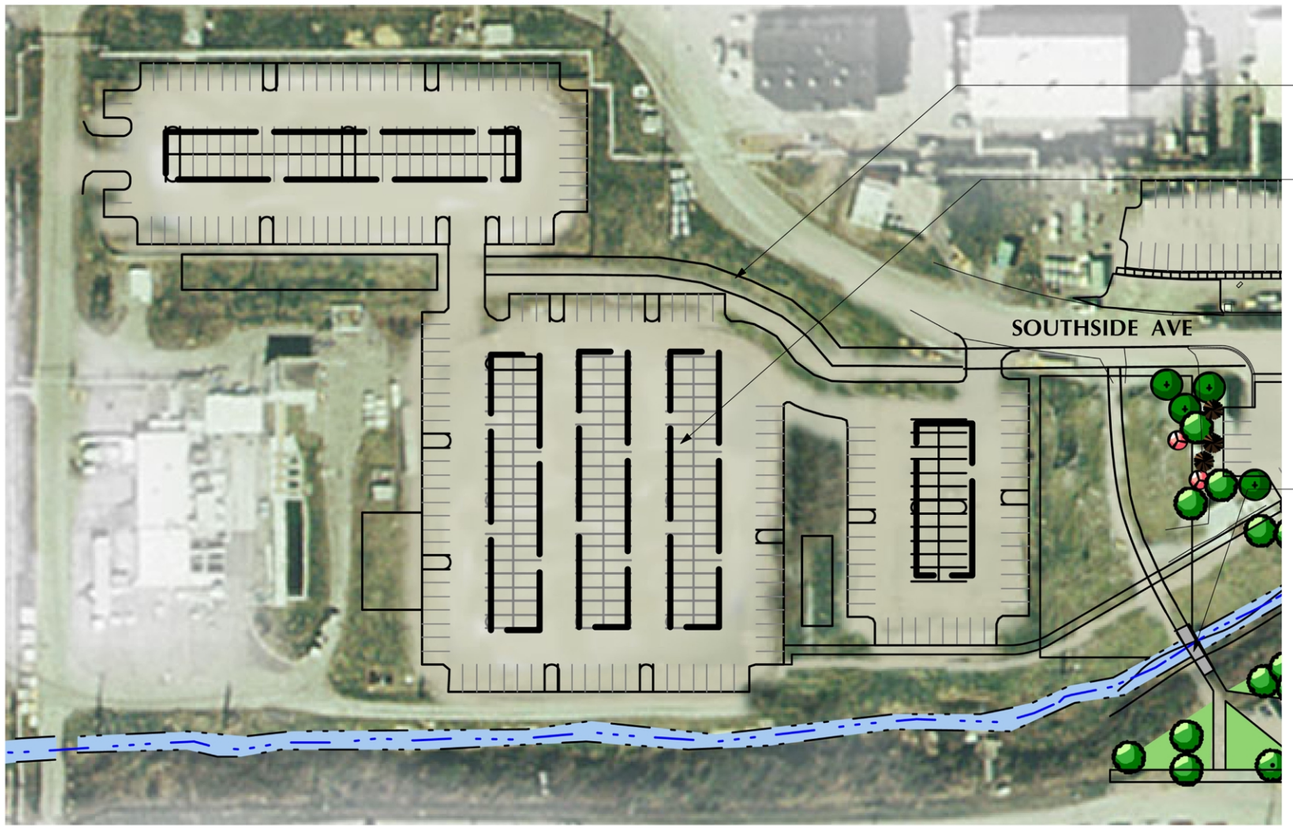

Providing Pedestrian Walkways To Connect With Major Destinations Within The Laboratory

Opportunity to Shade Parking Lot with Potential Future Overhead Solar Arrays Built Into Arbors

Provide Pedestrian Connection to Future AMCL Facility

LEGEND:

- SHADE TREES
- UNDERSTORY TREES
- EVERGREEN TREES
- GROUNDCOVER
- PROPOSED BUILDINGS
- NATIVE GRASSES & WILDFLOWERS
- SUCCESSIONAL AREAS
- LAWN / TURFGRASS
- SHRUBS

ENLARGEMENT E: Southside Parking Area

60 30 0 60

SCALE 1" =60'-0"

N

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Enlargement E: Southside Parking Area

Augment Naturalized Planting For Backdrop to Signage

Provide Signage for First Street Entry

Native Grass & Wildflowers

Accentuate Water Crossing With Riparian Planting At Simulated Bridge Construction

Native Grass & Wildflowers

Provide Landscape Buffer To Screen Parking

ENLARGEMENT F: Intersection of First St. & Bethel Valley Rd.

60 30 0 60

SCALE 1" =60'-0"

N

LEGEND:

- SHADE TREES
- UNDERSTORY TREES
- EVERGREEN TREES
- GROUNDCOVER
- PROPOSED BUILDINGS
- NATIVE GRASSES & WILDFLOWERS
- SUCCESSIONAL AREAS
- LAWN / TURFGRASS
- SHRUBS

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Enlargement F: Intersection of First St. & Bethel Valley Rd.

ENLARGEMENT G:Intersection of Fifth St. & Bethel Valley Rd.

60 30 0 60

SCALE 1" =60'-0"

N

LEGEND:

- SHADE TREES
- UNDERSTORY TREES
- EVERGREEN TREES
- GROUNDCOVER
- PROPOSED BUILDINGS
- NATIVE GRASSES & WILDFLOWERS
- SUCCESSIONAL AREAS
- LAWN / TURFGRASS
- SHRUBS

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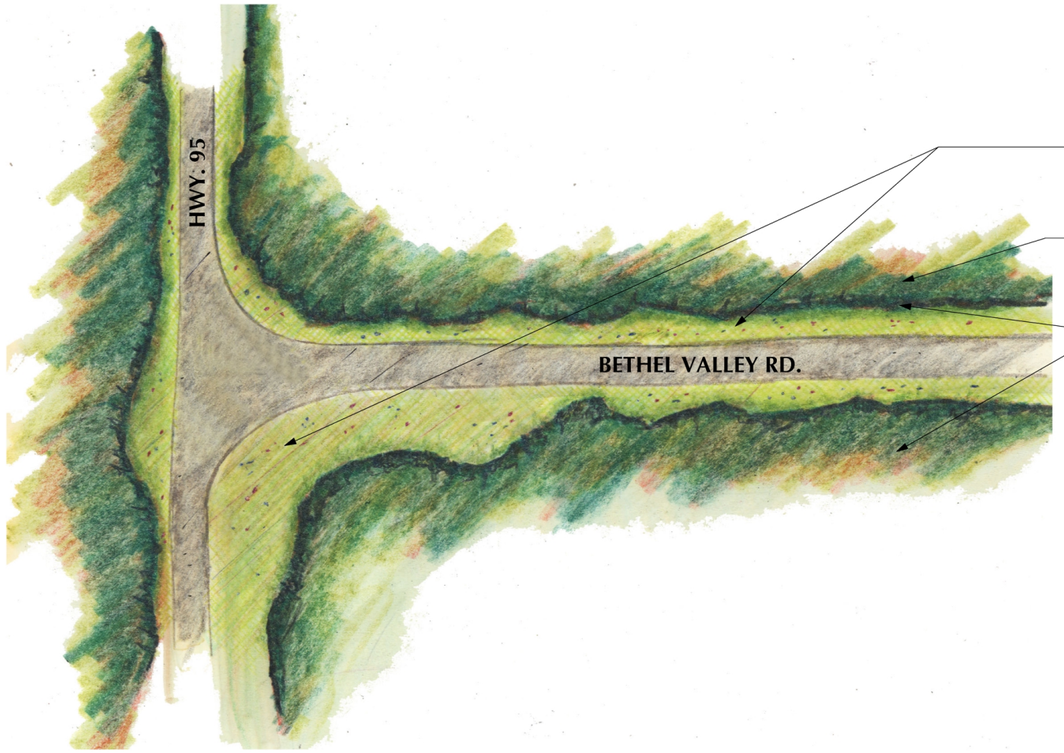
Enlargement G: Intersection of Fifth St. & Bethel Valley Rd.



Establish Native Grass And Wildflowers Along Edge of Road And Open Areas, Maintain Sight Lines

Restore Forest Landscape to Previous Tree Line

Plant Specimen Native Shade an Flowering Trees Along Tree Line

ENLARGEMENT H: Intersection of Hwy 95 & Bethel Valley Rd.

60 30 0 60

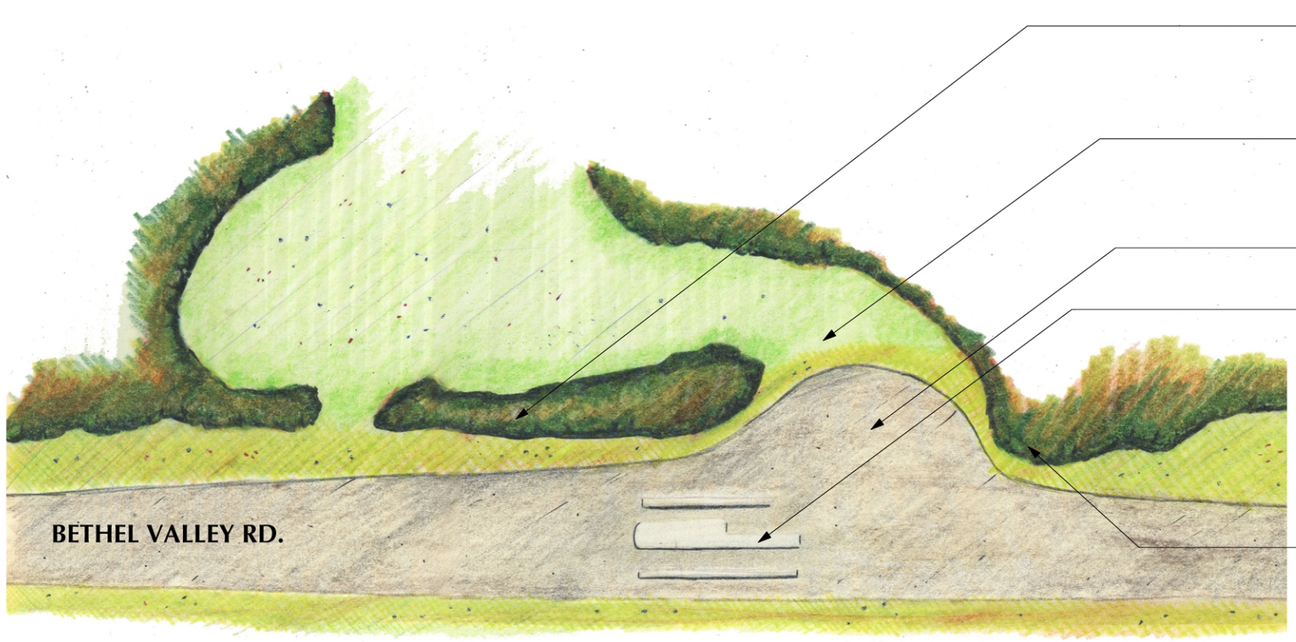
SCALE 1" =60'-0"

N

LEGEND:

NATIVE GRASSES AND PERENNIALS

NATIVE SHADE AND FLOWERING TREES



Supplement Existing Landscape With Native Shade and Flowering Trees To Define Open Space

Establish Native Grass and Wildflowers Along Edge Between Road And Existing Tree Line

Turn Around

Existing West Portal

Plant Specimen Native Shade an Flowering Trees Along Tree Line

ENLARGEMENT I: West Portal

60 30 0 60

SCALE 1" =60'-0"

N

LEGEND:

NATIVE GRASSES AND PERENNIALS

NATIVE SHADE AND FLOWERING TREES

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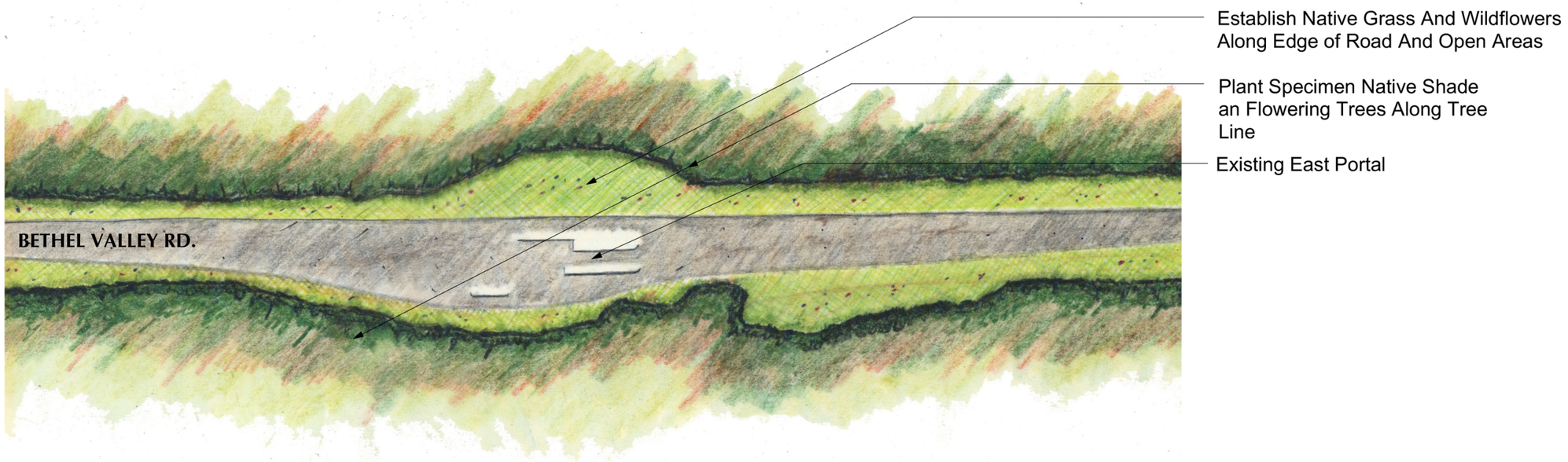
Enlargement I: West Portal



ENLARGEMENT J: East Portal

60 30 0 60

SCALE 1" =60'-0"

N

LEGEND:

NATIVE GRASSES AND PERENNIALS

NATIVE SHADE AND FLOWERING TREES

ORNL Conceptual Landscape Plan

Enlargement J: East Portal

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