Buffer Zone Management for Golf Courses

BUFFER STRIP BASICS

Golf course design concepts have changed dramatically over the years. Modern design practices encourage designers and architects to incorporate the natural features of the landscape into the overall design of a golf course. This helps to create a more natural appearance and also to protect the surrounding environment from degradation. The use of buffer zones and landscaping with native vegetation is often standard practice on new course designs and is being incorporated into existing courses.

Michigan golf course landscapes commonly feature water as an integral part of the design and challenge of the course. Water features range from the majestic Great Lakes to inland lakes, ponds, streams and wetlands. Golf course superintendents recognize their role as stewards of the environment and strive to incorporate best management practices in their day-to-day operations. Integrating buffer zones on existing courses can be challenging because space adjacent to waterways may be limited due to the layout of the golf holes.

This series of fact sheets will focus upon techniques to incorporate buffer zones on existing golf courses. These techniques may also be applied to newly constructed golf courses if they were not included in the original design. Many good references exist for those planning new golf courses. The "Landscape Restoration Handbook," published by Lewis Publishers and copyrighted by the United States Golf Association, is a particularly helpful reference for those in the planning stages of a new golf course. When interviewing potential design firms, it is important to determine if they have staff trained in evaluating natural resources and methods to reduce impacts to high quality resources on the site or the surrounding area.

Definition of Buffers

The Michigan Department of Environmental Quality defines a *buffer* as a vegetated area adjacent to a waterbody (i.e. river, stream, wetland, lake) that may consist of natural undeveloped land where the existing vegetation is left intact or it may be land planted with vegetation designed to maximize protection. Buffers are often designed to intercept surface runoff and subsurface flow from upland sources in order to filter pollutants before they enter surface waters and groundwater recharge areas.

For use on golf courses, we will define buffers as any vegetated areas, natural or planted, that are designed to minimize the effects of human activities on the environment and maximize the protection of natural resources. These areas may be directly adjacent to waterbodies or positioned anywhere within the golf course property where they are deemed to be beneficial for protecting human, plant, animal, air or soil resources. Areas directly adjacent to waterbodies will be referred to as *riparian buffers* in these fact sheets.

Benefits of Buffers
Buffer strips can perform many valuable functions including the following:

- Trap and filter sediment
- Trap and filter nutrients, pesticides and animal waste
- Stabilize eroding banks
- Provide shade to cool the water
- Provide wildlife habitat
- Enhance aquatic habitat
- Can be designed to deter nuisance species like geese
- Reduce or eliminate time-consuming string trimming or walk mowing
- Provide large woody debris for aquatic habitat
- Food source for aquatic habitat

Riparian forests and grass communities have been shown to substantially reduce the amount of nitrogen reaching surface waters. Microbes in organic forest soils and wetlands convert nitrate into nitrogen gas through denitrification. Tree and plant roots help stabilize streambanks and provide protection from erosion.

Shade from riparian forest buffers keep water temperatures cooler and reduce temperature fluctuations. This can be especially important in cold-water trout streams. Streamside forests are also important in the food chain of aquatic systems. Organic compounds such as leaves, fruit, limbs, and insects fall into the stream and decay. These compounds are fed upon by stream bacteria, fungi and invertebrates and provide the foundation of the aquatic food chain. Fallen trees and branches also create favorable habitat areas for fish.

Buffers are also important areas for wildlife and can be designed to attract a variety of wildlife including songbirds, butterflies, and small mammals. Properly designed, they can add interesting and aesthetic viewing opportunities for golf course patrons. The linear nature of many riparian buffers not only provides food and cover for animals, but they also serve as travel corridors between habitat areas. This connection is important in maintaining biological diversity and prevents the fragmentation of habitat. Alternately, buffers can be designed to discourage unwanted species such as geese. When buffers are located directly adjacent to waterbodies, geese are often reluctant to venture through tall vegetation when exiting the water for fear of predators on the other side.

Golf Course Inputs
The primary pollutants of concern on golf courses are nutrients (nitrogen and phosphorus), pesticides, and sediment that could potentially migrate into nearby water. Research conducted to investigate the movement of nutrients and pesticides from golf courses reveals that wise management practices can minimize the potential for these products to contaminate water supplies. Some studies suggest turfgrass areas generally rank second only to undisturbed forests in their ability to prevent pesticides and nutrients

from reaching groundwater and surface water. The utilization of buffer strips is an added practice to help safeguard waterbodies from nutrients or pesticides that are not utilized by turfgrass.

Buffer Zone Concepts

Much of the information available on the design of buffer zones is based upon a "Three-zone Buffer Concept" recommended by agencies such as the Natural Resources Conservation Service (NRCS) and the USDA Forest Service. This concept divides the areas directly adjacent to a stream into zones, beginning at the water's edge and moving outward. These agencies recommend that Zone 1 (next to the water's edge) should remain an area of undisturbed mature trees. Zone 2 consists of an area of managed forest where plant material may be periodically harvested. Zone 3 is an area of dense grasses and/or forbs (such as wildflowers or broad- leaved herbaceous plants). This zone is periodically mowed or harvested in order to remove nutrients stored in plant materials. Phosphorus becomes physically bound up in plant materials. If it is not removed, the vegetation can reach a saturation point where it is no longer effective in removing nutrients.

Many government agencies use fixed buffer widths in their standards while others recommend a range of widths in order to perform a specific function. For example, the NRCS specifies the following buffer zone widths for various conditions:

A. Establishment of riparian forest buffers to reduce pollution by sediment, nutrients, pesticides, or other pollutants and restore overall water quality. The total combined width of all three zones will be not less than 55 feet.
B. Establishment of riparian forest buffers to provide wildlife habitat, maintain or restore water temperature, and provide large woody debris. The total combined width of the first two zones will not be less than 100 feet.
C. Establishment of riparian forest buffers in areas with existing woody plants that need enhancement and are less than 100 feet wide. The total combined width of the first two zones will not be less than 100 feet.
D. Establishment of riparian forest buffers in areas with existing woody plants that exceed 100 feet in width. The total combined width of the first two zones will not be less than 100 feet .

Please refer to the NRCS web site for more information on these specifications: http://w ww.mi.nrcs.usda.gov/Technical_References_and_Data/Michigan_Tech_Guide/RiparianForestBuffer391.pdf

The width of buffer zones can vary depending upon space. Studies have shown that a range of buffer widths from 3m to 200m have been effective, depending upon site specific conditions. In most cases, a buffer of at least 100 feet is necessary to fully protect aquatic resources. Studies have shown that negative impacts to aquatic invertebrates occur on streams with buffer zones less than 100 feet. If 100 feet is not

available, smaller buffers still afford some level of protection to the water body and are preferable to no buffer at all.

Using Buffers On Golf Courses

In developing criteria for buffer zones on golf courses, it is necessary to distinguish between in-play and out-of-play areas. For existing golf courses, the use of standard fixed width buffer zones is not practical. Space limitations require more flexibility. Based upon a review of current buffer design concepts, scientific literature and collaboration with governmental agencies in Michigan, a flexible zone system for both in-play and out-of-play areas has been developed for use on golf courses. The specific dimensions of the buffer are adjusted based on the site conditions and available space. The in-play buffer zone system incorporates a series of gradually increasing mowing heights adjacent to the water. Research has shown that even buffer zones of 3-inch tall grass will provide some level of protection for streams, lakes, and ponds from pesticides and nutrient pollution when grown between shorter, high maintenance turf and water bodies. The soils, slope, play of the golf hole and available space will determine the size of each buffer zone. Buffer widths should be maximized to the extent possible to provide the most protection of aquatic resources.

The criteria for in-play areas differs from the traditional three-zone approach in the following manner:

- A management plan for inputs will be implemented for each in-play buffer zone area
- A series of increased mowing heights of turf grass are incorporated into the in-play zones
- The in-play areas require turf grass to be less than 8 inches tall to allow play
- Not all zones must be used in each situation depending upon space limitations

The criteria for the out-of-play areas are similar to the traditional three-zone concept. However, they have been revised to allow more flexibility in areas where either space or other considerations require a different treatment.

Public Education

Public education is an important element in the successful implementation of any buffer zone strategy on golf courses. Some golf course managers have been forced to remove buffer plantings because of member complaints. Many golfers have become accustomed to the manicured look common on older golf courses. They may view the introduction of buffer plantings as unattractive weeds that eat golf balls. Therefore, it is recommended that golf course managers and superintendents educate their clientele before, during and after the implementation of buffer plantings. Newsletters, fact sheets, membership meetings, and interpretive signing along the golf course are all mechanisms for informing the public about the merits of buffers.

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Thanks is also extended to the following organizations who participated in the steering committee involved in developing criteria for implementing buffer strips on Michigan golf course properties:

- Michigan State University – Department of Crop and Soil Sciences; Department of Fisheries and Wildlife
- Michigan Department of Environmental Quality – Surface Water Quality Division; Land and Water Management Division
- Michigan Department of Natural Resources – Wildlife Division; Fisheries Division
- U.S. Natural Resources Conservation Service
- U.S. Fish and Wildlife Service
- Michigan Turfgrass Foundation
- Golf Course Owners Association
- Golf Course Architects Association

Buffer Zone Management for Golf Courses

BUFFER STRIP TECHNIQUES

Buffer strategies have been divided into two separate categories for implementation on golf courses: 1) out-of-play areas, and 2) in-play areas. This fact sheet will discuss specific techniques to help golf course managers implement buffer strategies in both areas. In order to gain the most benefit from the implementation of buffers, the buffer zone designer should have an understanding of how water flows through the entire golf course property and determine the most important functions for buffers on their property. In golf situations, nutrient / pesticide filtering is often a primary function. Other valuable functions will include stabilizing eroding banks, providing wildlife habitat, enhancing aquatic habitat, creating aesthetic value and reducing difficult to maintain areas.

If nutrient removal is a goal of the buffer zone strategy, it is important to understand the structure of the landscape and the underlying soils. Studies have shown that buffers implemented for nutrient filtering are most effective when water moves across the surface in sheet flow and/or through shallow subsurface flow of groundwater. Longer water residence times and extensive contact with the root systems of vegetation and organic-rich soils within a buffer zone will promote rapid nitrate removal by plant uptake or microbial processes. A buffer zone will have little to no value for nutrient removal if water flows too rapidly through the area in concentrated flows or avoids the area completely (such as stormwater discharged directly to waterbodies through enclosed pipes). In these cases, the site should be evaluated to see if water can be intercepted at another location (perhaps further inland) in an area where the landscape and soil conditions are more favorable. In some cases, the creation of wetlands and/or detention basins can be used to retain water and allow it to be gradually flow through a buffer area before moving into a water body. Other mechanical structures can also be used to divert water in order to create sheet flow as an alternative to the creation of wetlands or detention areas.

In designing buffers for your area, first analyze the movement of water throughout the property and then complete the following steps to determine a strategy for both out-of-play and in-play areas:

1. Determine what functions are needed
   - Nutrient and/or pesticide filtering
   - Bank stabilization
   - Wildlife habitat (do you want to attract songbirds, butterflies, etc?)
   - Aesthetic value (wildflowers, native grasses?)
   - Maintain and enhance aquatic habitat (does a stream run through the property?)
   - Discourage geese in critical play areas
   - Reduce walk mowing and/or string trimming
2. Determine the minimum and maximum buffer width available
3. Identify the best types of vegetation to provide the needed benefits

4. Develop an installation and maintenance plan

Out-of- Play Strategies

The criterion for out-of- play areas incorporates a zone strategy similar to those used by the Natural Resources Conservation Service (NRCS) and the U.S. Forest Service. The potential for creating wildlife habitat and enhancing aquatic habitat is much greater in these areas as opposed to in-play areas. There is often much more flexibility in the height of vegetation that can be planted in out-of- play areas without affecting the play of golf. When space permits, an ideal riparian buffer zone includes three zones:

1. Zone 1 – consisting of mature trees next to a stream, lake, or other waterbody.
2. Zone 2 – consisting of managed trees/shrubs, and
3. Zone 3 – consisting of grasses and/or forbs (such as native grasses and wildflowers)

The width of buffer zones may vary according to specific conditions and the objective of the buffer zone. The following are examples of four NRCS buffer zone specifications for various conditions:

A. Establishment of riparian forest buffers to reduce pollution by sediment, nutrients, pesticides, or other pollutants and restore overall water quality. The total combined width of all three zones will be not less than 55 feet.
B. Establishment of riparian forest buffers to provide wildlife habitat, maintain or restore water temperature, and provide large woody debris. The total combined width of the first two zones will not be less than 100 feet.
C. Establishment of riparian forest buffers in areas with existing woody plants that need enhancement and are less than 100 feet wide. The total combined width of the first two zones will not be less than 100 feet
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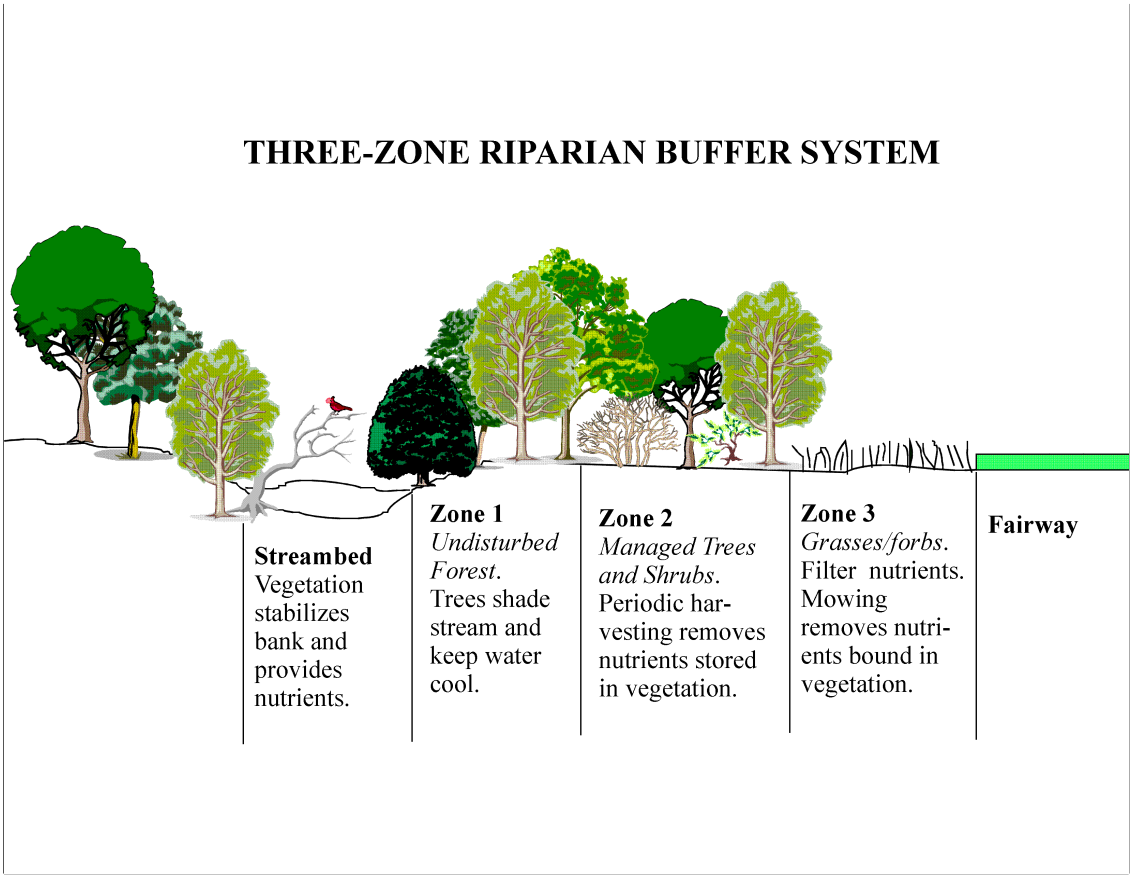
Please refer to the NRCS web site for more information on these specifications : http://ww w.mi.nrcs.usda.gov/Technical_References_and_Data/Michigan_Tech_Guide/RiparianForestBuffer391.pdf)

The following diagram depicts a riparian three-zone system:



In general, it is recommended that this 3-zone configuration be used in riparian buffer areas when feasible. Ideally, out-of-play riparian buffer zones should be maintained at a width of 100 feet or more. If space is limited, then the buffer zone should be maximized to the extent possible. In some cases, the inclusion of all three zones is not necessary depending upon the desired functions. Inland buffers, (those not adjacent to waterbodies) may only include one or more of the above zones, depending upon the desired functions. The incorporation of natural areas on golf courses can not only provide added aesthetic value, but also reduce long-term mowing and maintenance costs.

The width of the buffer can vary depending upon space. Studies have shown that a range of buffer widths from 3m to 200m have been effective, depending upon site specific conditions. In most cases, a buffer of at least 100 feet is necessary to fully protect aquatic resources. Studies have shown that negative impacts to aquatic invertebrates occur on streams with buffer zones less than 100 feet. If 100 feet is not available, smaller buffers still afford some level of protection to the water body and are preferable to no buffer at all. Generally, buffer widths toward the lower end of the range may provide for the

maintenance of the natural physical and chemical characteristics (such as nutrient filtering) of aquatic resources. Buffer widths toward the upper end of the range are necessary for maintaining the biological components (such as wildlife habitat) of many wetlands and streams.

Obviously, space requirements on existing golf courses may preclude large buffer zones in some areas. Therefore, it is recommended to use the above information as a guide and maximize riparian buffer areas to the extent possible. As noted earlier, the relocation of fairways and use areas away from sensitive water resources (ponds, streams, wetlands) should be evaluated first before implementing buffer strategies. When relocation is not possible, the installation of any sized buffer zone (even if it is below optimal widths) is preferable to no buffer at all.

In-Play Strategies

A flexible, zone system has also been developed for in-play areas on golf courses. This allows golf course managers to implement buffer strategies based upon site-specific conditions. The following items were considered essential elements in the development of in-play buffer zone criteria:

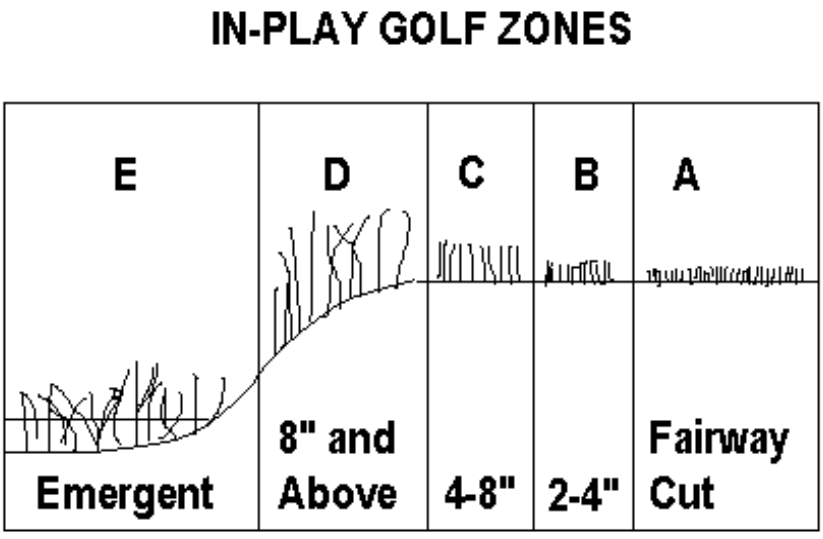
- Relocation of fairways and use areas away from sensitive water resources (ponds, streams, wetlands) should be considered as an option to enhance protection
- Buffer zones can address one or more environmental issues, a few such areas of concern include nutrient/pesticide filtering and bank stabilization on waterways
- Buffer zones may not be able to address all possible resource protection issues
- Buffer zones can be established using various widths, heights and plants
- Buffer zones should not impede the play of golf

Research has shown that even buffer zones of 3-inch tall grass provide some level of protection for streams, lakes, and ponds from pesticide and nutrient pollution when grown between turf and water bodies. Therefore, the In-Play buffer zone system incorporates a series of gradually increasing mowing heights within the fairway. The diagram below depicts Zones A thru E. In general, turf heights up to 4 inches are still considered playable. Therefore, Zones A and B could be used within playable areas. Zones C and D could be installed between the fairway and the water body when space permits. Zone E includes shallow water areas adjacent to lakes or wetlands. Planting of emergent vegetation in Zone E can provide important benefits such as taking up nutrients contained in surface runoff and helping to buffer shorelines from erosion. In areas where there are very small buffer zones and inadequate space to provide buffers in Zones A thru D, Zone E may provide the only feasible location to provide some level of buffering.

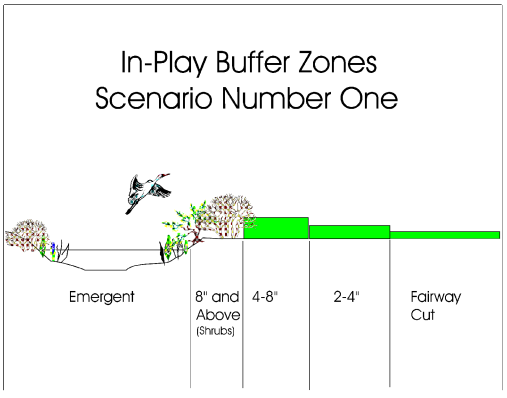
An important element of the buffer zone strategy for In-Play areas includes the implementation of a management plan for inputs. This consists of reducing and/or eliminating fertilizer and pesticide inputs within the In-Play buffer area, particularly in

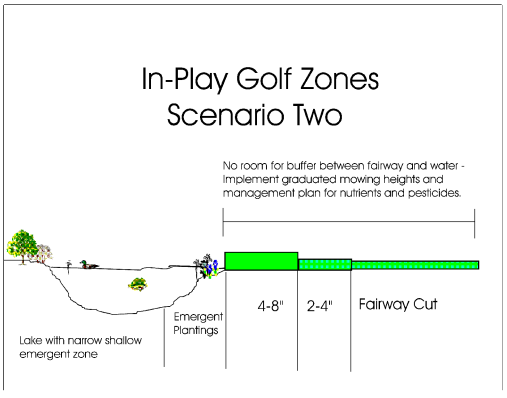
Zones A and B. Grass/vegetation clippings should be removed from the buffer zone periodically in order to remove accumulated nutrients.

The following diagram depicts the In-Play buffer zones described above:



As noted above, the amount of room available for buffer zones in In-Play areas may vary greatly. The diagrams on the following page depict two possible scenarios for In-Play buffer zones:





In Scenario One, the diagram depicts shrubs adjacent to the water. However, shorter plants could be planted if there is a concern over losing golf balls. For example, some golf courses have found a mix of little bluestem and fine fescues to be aesthetically pleasing while still allowing members to retrieve golf balls. In the second scenario, there is no room for a buffer zone between the water and the fairway, but a series of graduated mowing heights and a management plan for nutrients and pesticides has been implemented. Emergent plantings were added in the shallow

areas along the shoreline for added protection. Taller emergent vegetation may deter geese from using the shoreline.

Fact Sheet #3 provides more information on plant selection for buffer zone areas on golf courses.

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- U.S. Fish and Wildlife Service
- Michigan Turfgrass Foundation
- Golf Course Owners Association
- Golf Course Architects Association
- Regional Golf Course Superintendent Associations – representing 4 regional associations within Michigan: Forest Lake Country Club, Kalamazoo Country Club, Grayling Country Club, and Grossbeck Golf Course

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Buffer Zone Management for Golf Courses

BUFFER ZONE VEGETATION

The first step in implementing a successful buffer plan is to identify the waterways throughout a golf course along with potential contaminants that could affect these waterways. Fact Sheet I (Buffer Zone Concepts) describes the merits of using buffer zones. Fact Sheet II (Buffer Zone Techniques) explains the criteria used to identify and implement a comprehensive buffer strategy. This fact sheet (Fact Sheet III) will address the selection of vegetation for buffer zones. Examples of plant communities for each zone (trees, shrubs, herbaceous, emergent) have been included as well as several seed mixes that have been used in Michigan. A list of references is also included to help identify additional plant materials and resources that can be used for creating buffer zones on golf courses. The vegetation selected for these areas will depend on whether they are located in "in-play" or "out-of-play" areas, the desired functions, and specific environmental conditions.

In-Play Areas

The ability to play and retrieve a golf ball is of primary concern for in-play areas. Therefore, the height of the turf, rough, and surrounding vegetation is important. Once you have determined the amount of space you have to work with and the desired functions of the buffer (nutrient uptake, wildlife habitat, aesthetics), you are ready to begin selecting vegetation that will fulfill the required functions without interfering with the play of golf. Managing turf height might be the only practical option for buffer zones closer to the fairway and areas of highest play. However, in many cases, it may be possible to vary plantings even within in-play areas. Where sight distance and ball retrieval is not as critical to the play of golf (such as in shoot over areas), vegetation that provides color, water quality and wildlife benefits (such as native grasses, wildflowers, shrubs, and emergent vegetation) may be good choices and should be considered. Figures 1 through 3 depict several scenarios for in-play buffer zones.

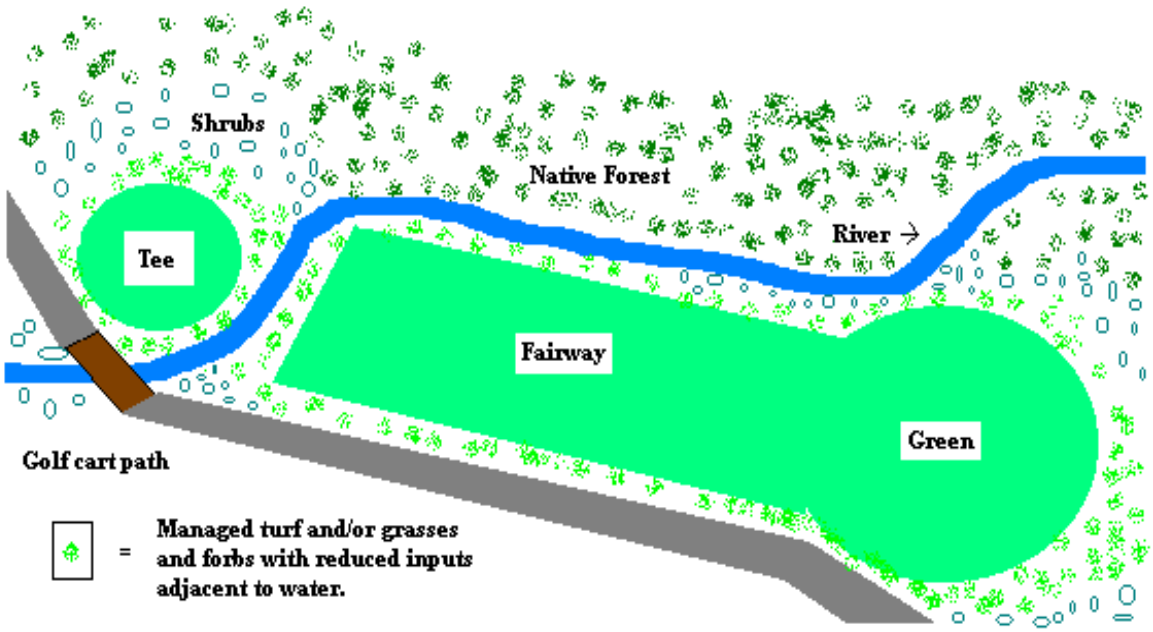

Figure 1: *This diagram depicts a natural river running through a golf course. Areas directly adjacent to the tee, fairway and green contain managed turf and/or grasses and forbs where plant height is of concern. These areas blend into stands of native shrubs and trees in the out-of- play areas.*

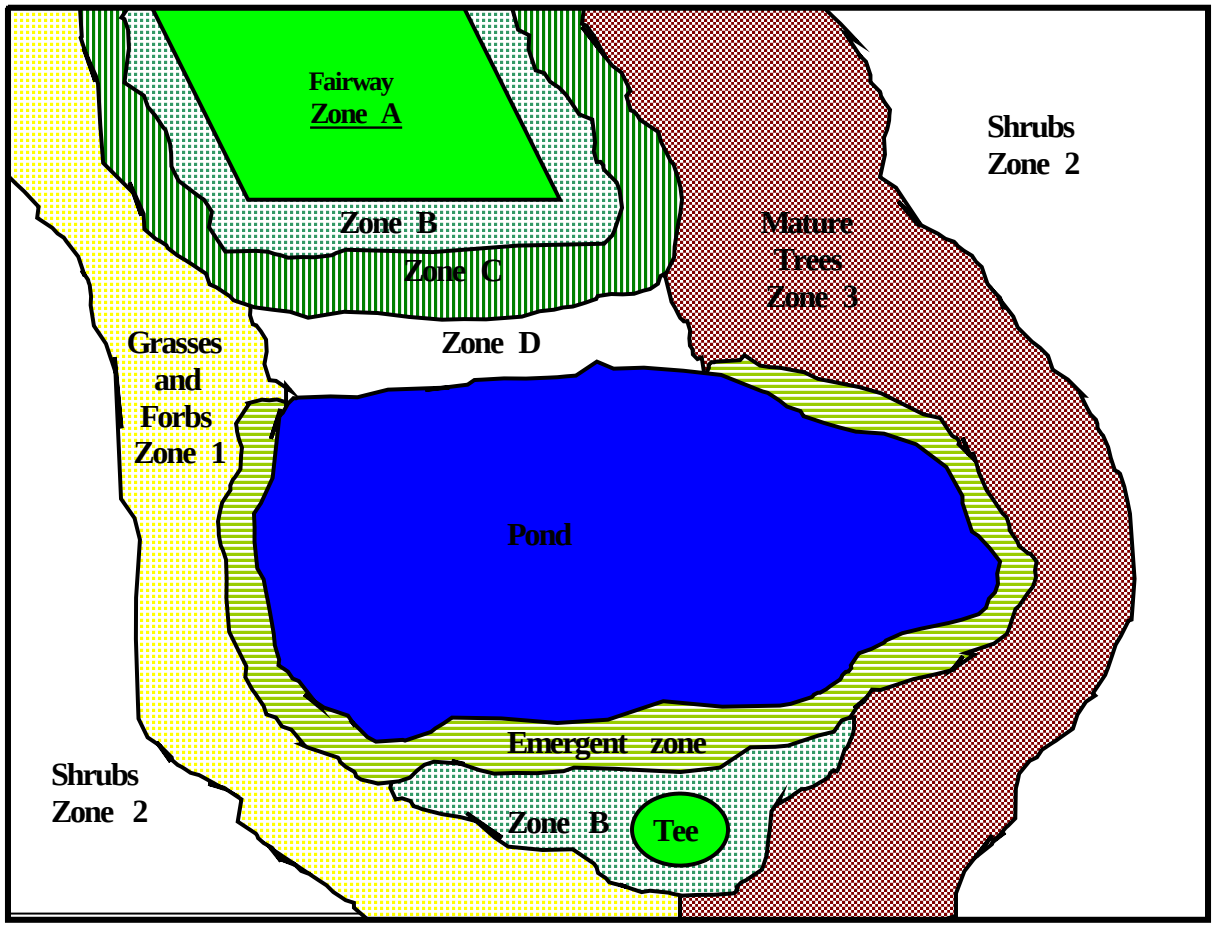

Figure 2: *The above diagram depicts several scenarios for combining buffer zones for both in-play and out-of- play areas. The selection of both the number and width of zones will depend upon site specific conditions.*

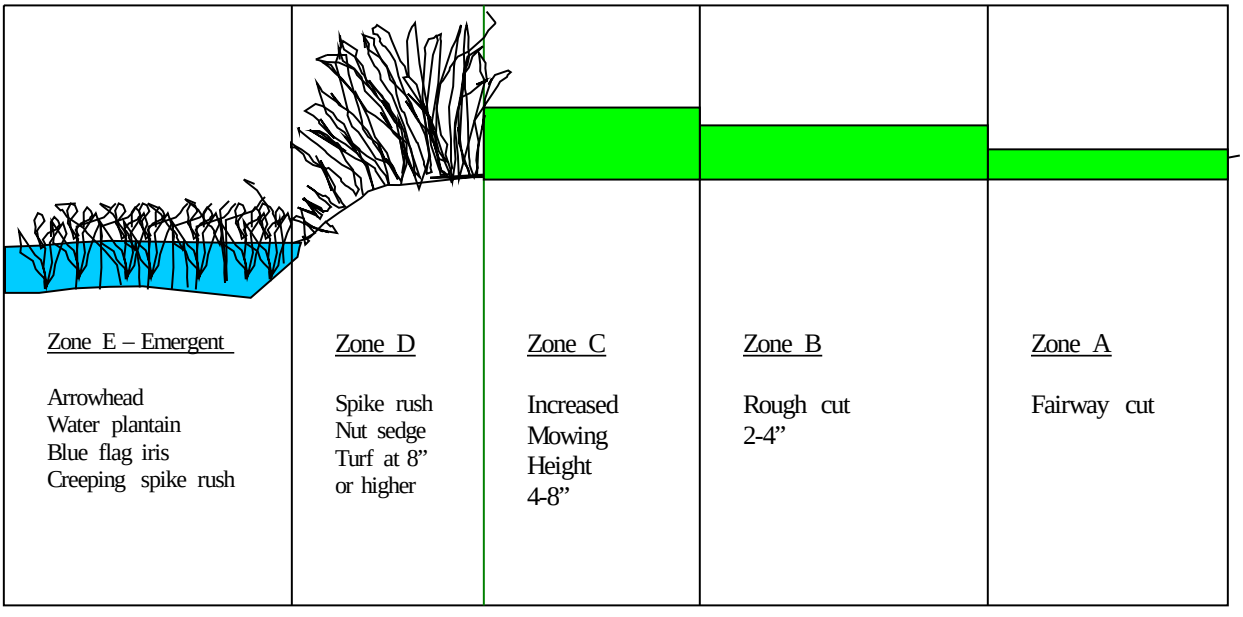

Figure 3: *The above diagram depicts an example cross section of an in-play buffer zone. The selection of vegetation will depend upon desired plant height, soils, light and moisture content.*

Out-of- Play Areas

In general, vegetation options increase dramatically for out-of- play golf areas. Plant height and ball retrieval are usually not as important in these areas. Figures 1 and 2 describe several options for combining out- of-play and in-play buffer zones on a golf course. In choosing plants for these areas, you must first decide whether you plan to use non-native ornamental plantings or native vegetation. It is recommended that native species be used in buffer zone plantings whenever feasible given the invasive nature of many non-native species and their ability to spread into areas where they are not desired. However, there may be cases where non-native plants will be more effective in achieving the desired function of the buffer (such as nutrient filtering or erosion control). This should be determined on a site-specific basis. Care should be taken not to plant aggressive or invasive species adjacent to natural areas where they have the potential to spread and displace native vegetation. The following guidelines may be helpful in determining whether to use native or non-native plants:

1) Is the area in-play or out-of- play? This may affect vegetation choices in terms of height. Are there native plants available that will grow in your specific in-play areas that can be maintained less than 12" and not affect the play of golf? *If not, then you may wish to consider maintaining turfs such as fine fescues at higher mowing heights.*
2) What is the surrounding vegetation? Is it native or non-native? *If your planting area is adjacent to existing natural areas or has the potential to spread to adjacent natural areas – use native plants.*
3) What is the resource value of the area?
    a. Does your golf course contain any woodlots, streams, ponds, rivers or other natural areas? *If yes, then native vegetation should be considered.*
    b. Is your golf course in an urban setting with non-native ornamental landscaping? *If your planting area is in a completely contained urban setting and your current landscaping consists of non-native ornamental plants - non-native plants may make sense in this situation .*
    c. Do any of the water bodies on your course have a connection to the surrounding watershed? In other words, do ponds, lakes or streams discharge off the property? *If yes, you should consider planting native vegetation adjacent to these water bodies. Installing and maintaining buffer zones on your property can also help to improve water quality downstream.*
    d. Do any of the natural areas on your golf course connect to natural areas beyond your property boundaries? *If yes, consider planting native vegetation.*
4) What is the slope of the land area you wish to plant? Does the slope create an erosion problem that limits vegetation choices? *Native plants should be considered first. But there may be some cases where non-native plants are more practical for stabilizing the soil. Severe erosion problems might require additional engineering solutions to stabilize the area prior to planting. You may wish to contact a consultant who specializes in erosion control measures .*

Many non-native undesirable plants are now growing throughout Michigan. Some of these plants were brought to the United States by settlers and have escaped into the wild, aggressively displacing our native species. After habitat destruction, invasion of non-native species (also called exotic or alien species) is the greatest threat to rare native species and to the integrity of ecosystems. Some native species can also be highly aggressive and, therefore, are not recommended for golf course settings where they can invade turf

areas. Species such as crown vetch, birdsfoot trefoil, reed canary grass and orchardgrass have often been used for erosion control in the past. These species are aggressive and can quickly spread to take over other areas. Therefore, we are not recommending them for inclusion in golf course settings.

Species to Avoid (non-native* or highly aggressive)

Autumn olive	*Elaeagnus umbellata*
Barberry	*Berberris spp.*
Common buckthorn	*Rhamnus cathartica*
Glossy buckthorn	*Rhamnus frangula*
Crown vetch	*Coronilla varia*
European alder	*Alnus glutinosa*
Honeysuckle	*Lonicera tatarica, L. japonica, L. maackii, L. morrowi, L. x-bella & their cultivars*
Multiflora rose	*Rosa multiflora*
Norway maple	*Acer platanoides*
Oriental bittersweet	*Celastrus orbiculatus*
Periwinkle (myrtle)	*Vinca minor*
Privet	*Ligustrum vulgare*
Purple loosestrife	*Lythrum salicaria*
Siberian elm	*Ulmus pumila*
Common mullein	*Verbascum thapsus*
Spotted Knapweed	*Centaurea maculosa*
Bull thistle	*Cirsium vulgare*
Canada thistle	*Cirsium arvense*
Queen Anne's lace	*Daucus carota*
Brome grass	*Bromus spp.*
Orchard grass	*Dactylis glomerata*
Timothy	*Phleum pratense*
Poison ivy	*Toxicodendron radicans*
Ragweed	*Ambrosia artemisiifolia*
Yarrow	*Achillea millefolium*
Hoary Alyssum	*Berteroa incana*
Common St. John's Wort	*Hypericum perforatum*
Common Motherwort	*Leonurus cardiaca*
Bladder campion	*Silene vulgaris*
Nightshade	*Solanum dulcamara*
Red Clover	*Trifolium pratense*
White Clover	*Trifolium repens*
Reed Canary Grass	*Phalaris arundinacea*
Birdsfoot Trefoil	*Lotus corniculatus*

* For information on non-native species, refer to the website of the Michigan Invasive Plant Council: http://www.msue.msu.edu/mipc/ . For more information on whether a plant is considered native to Michigan, refer to the Floristic Quality Assessment for Michigan available from the Michigan Department of Natural Resources, Wildlife Division, Natural Heritage Program, P.O. Box 30444, Lansing, MI 48909-7944.

Because there are so many planting combinations for golf course buffer plantings, this fact sheet cannot address all possible scenarios. Instead, we have included some basic information on native Michigan plants (trees, shrubs, grasses, and wildflowers) along with several example buffer zone plant mixes for the grass/forb zone. At the end of the fact sheet, we have included a list of helpful reference materials that can be used by those interested in devising their own planting schemes, including an interactive native plants CD-ROM available from Springfield Township, Michigan that can be used to identify plants appropriate for

specific conditions. Information on how to order this CD-ROM is included in the reference section under native vegetation. In addition, many nurseries now specialize in native plants and have staff capable of assisting you in the development of plant mixtures to meet specific on-site requirements. The lists of plants contained within this fact sheet are not a complete listing of all native Michigan plants. Please refer to the attached reference section if you would like additional information.

Trees

In selecting trees for riparian buffers, several factors should be considered. Trees closest to the waterway are most likely to be flooded during a portion of the year. If this is the case, you should select trees with a greater tolerance for high water tables. If the area has been recently disturbed, trees with a fast growth rate will quickly establish root systems to hold the soil. Fast-growing trees are not necessarily long-lived, therefore you may want to interplant some species with longer life spans. Trees with shallow rooting systems hold surface soils well, but do not provide as much stability to high banks and steep slopes as trees with deeper root systems. Deeper root systems anchor trees better where there are repeated flooding/drying cycles.

Example Native Trees

Wet to Moist Conditions	
Ash, Green	*Fraxinus pennsylvanica*
Aspen, Trembling	*Populus tremuloides*
Birch, River	*Betula nigra*
Birch, Yellow	*Betula alleghaniensis*
Blackgum	*Nyssa sylvatica*
Cedar, Northern white	*Thuja occidentalis*
Hemlock, Eastern	*Tsuga canadensis*
Hickory, bitternut	*Carya cordiformis*
Maple, Red	*Acer rubrum*
Maple, Silver	*Acer sacharinum*
Musclewood	*Carpinus caroliniana*
Oak, bur	*Quercus macrocarpa*
Oak, Pin	*Quercus palustris*
Oak, Swamp white	*Quercus bicolor*
Sycamore	*Platanus occidentalis*
Willow, Black	*Salix nigra*

Moist to Drier Conditions	
Ash, blue	*Fraxinus quadrangulata*
Ash, white	*Fraxinus americana*
Basswood	*Tilia americana*
Beech, American	*Fagus grandifolia*
Birch, Paper	*Betula papyrfiera*
Cedar, eastern red	*Juniperus virginiana*
Cherry, black	*Prunus serotina*
Crab apple, wild	*Malus coronaria*
Dogwood, flowering	*Cornus florida*
Hackberry	*Celtis occidentalis*
Hickory, pignut	*Carya glabra*
Hickory, shagbark	*Carya ovata*
Ironwood	*Ostrya virginiana*
Maple, sugar	*Acer saccharum*
Oak, black	*Quercus velutina*
Oak, chinquapin	*Quercus muehlenbergii*
Oak, red	*Quercus rubra*
Oak, White	*Quercus alba*
Pawpaw	*Asimina triloba*
Redbud	*Cercis canadensis*
Sassafras	*Sassafras albidum*
Tuliptree	*Liriodendron tilipifera*
Walnut, black	*Juglans nigra*

Note: Some of the species listed above are not native to the entire state. Species native to southern Michigan may not be considered native in northern Michigan or the Upper Peninsula.

Shrubs

Shrubs may also be incorporated into buffer areas, either alone or in the understory of larger trees. Shrubs often do well at the edge of forested areas, serving as a transition between forested and grassed areas.

Planting shrubs increases the diversity of wildlife habitat by providing more layers of vegetation. Many songbirds use shrub species for nesting habitat.

Example Native Shrubs

Wet to Moist Conditions		Moist to Drier Conditions	
Alder, speckled	*Alnus rugosa*	Arrow- wood, downy	*Viburnum rafinesquianum*
Bladdernut, American	*Staphylea trifolia*	Vibernum, mapleleaf	*Viburnum acerifolium*
Buttonbush	*Cephalanthus occidentalis*	Chokecherry	*Prunus virginiana*
Cranberry, highbush	*Viburnum trilobum*	Dogwood, gray	*Cornus foemina*
Dogwood, red- osier*	*Cornus stolinifera*	Hazelnut, American	*Corylus americana*
Dogwood, silky	*Cornus amomum*	New Jersey Tea **	*Ceanothus americanus*
Elderberry, American	*Sambucus canadensis*	Rose, wild	*Rosa blanda*
Meadowsweet	*Spirea alba*	Serviceberry, shadblow	*Amelanchier arborea*
Nannyberry	*Viburnum lentago*	Serviceberry, Allegheny	*Amelanchier laevis*
Ninebark*	*Physocarpus opulifolius*	Sumac, Staghorn	*Rhus typhina*
Rose, swamp	*Rosa palustris*		
Spicebush	*Lindera benzoin*		

* can be aggressive ** prefers dry, open environments

Grasses and Wildflowers

Grassed buffer areas may typically consist of warm or cool season grasses. Warm season grasses include species such as big bluestem, little bluestem, Indiangrass, and switchgrass. Fine fescues are a good cool season choice for golf course buffer areas. When appropriate, wildflowers may also be interspersed into grassed buffer areas for added aesthetic value and attracting butterflies.

In natural areas, native warm season grasses are preferred for wildlife habitat. These grasses provide excellent cover necessary for the mating, nesting, brood- rearing and feeding activities of many small birds and mammals. Most warm season grasses are not shade tolerant and may not do well planted directly adjacent to shady forested areas. A good solution is to plant a shrub transition zone in between the grassed and forested areas.

Example Short Native Grasses and Sedges (up to 4')

Wet to Moist Conditions		Moist to Drier Conditions	
Creeping spike rush	*Eleocharis palustris*	Bluestem, Little	*Schizachyrium scoparium*
Soft rush	*Juncus effusus*	Pennsylvania sedge	*Carex pensylvanica*
Lake sedge	*Carex lacustris*	Purple lovegrass	*Eragrostis spectabilis*
Green bulrush	*Scirpus atrovirens*	June grass	*Koeleria macrantha*

Example Tall Native Grasses and Sedges

Wet to Moist Conditions		Moist to Drier Conditions	
Hardstem bulrush	*Scirpus acutus*	Bluestem, big	*Andropogon gerardii*
Prairie cordgrass	*Spartina pectinata*	Switch grass	*Panicum virgatum*
Wild- rye, Canada	*Elymus canadensis*	Indian grass	*Sorghastrum nutans*
Wild- rye, Virginia	*Elymus virginicus*		
Wool grass	*Scirpus cyperinus*		
Bottlebrush grass	*Hystrix patula*		

Example Short Native Wildflowers (up to 3')

Wet to Moist Conditions		Moist to Drier Conditions	
Anemone, Canada	*Anemone canadensis*	Smooth aster	*Aster laevis*
Beard- tongue, hairy	*Penstemon hirsutus*	Butterflyweed	*Asclepias tuberosa*
Golden alexanders	*Zizia aurea*	Black- eyed Susan	*Rudbeckia hirta*
Lobelia, great blue	*Lobelia siphilitica*	Blazing star, rough	*Liatris aspera*
Marsh marigold	*Caltha palustris*	Blue- eyed grass	*Sisyrinchium angustifolium*
		Columbine, wild	*Aquilegia canadensis*
		Lupine	*Lupinus perennis*
		Onion, nodding wild	*Allium cernuum*
		Spiderwort	*Tradescantia ohioensis*

Example Tall Native Wildflowers (over 3')

Wet to Moist Conditions		Moist to Drier Conditions	
Aster, New England	*Virgulus novae- anglii*	Showy goldenrod	*Solidago speciosa*
Aster, swamp	*Aster puniceus*	Stiff goldenrod	*Solidago rigida*
Dotted mint	*Monarda punctata*	Sky blue aster	*Aster oolantangiensis*
Golden alexanders	*Zizia aurea*	Frost aster	*Aster pilosus*
Red milkweed	*Asclepias incarnata*	Bergamot	*Monard fistuloa*
Tall coreopsis	*Coreopsis tripteris*	Meadow blazingstar	*Liatris ligulistylus*
Ox eye sunflower	*Heliopsis helianthoides*	Sweet black eyed susan	*Rudbeckia subtomentosa*
Prairie blazingstar	*Liatris pycnostachya*		

Wetland Vegetation

The following are examples of vegetation adapted to grow in low, wet areas and along the shoreline of ponds and lakes. Wetland areas are particularly useful in buffering nitrates because microbes in the organic soils convert nitrate into nitrogen gas through denitrification and can substantially reduce the amount of nitrogen reaching surface waters. They can also help to stabilize erosion areas along the shorelines of waterbodies.

Example Wetland Species

Damp to Muddy Soils		**Moist shoreline to 1 foot of water**	
Joe pye weed	*Eupatorium purpureum*	Yellow water iris	*Iris pseudacorus*
Boneset	*Eupatorium perfoliatum*	Blue flag iris	*Iris versicolor*
Cardinal flower	*Lobelia cardinalis*	Soft- stem bulrush	*Scirpus validus*
Blue vervain	*Verbena hastata*	Bur reed	*Sparganium eurycarpum*
Lizard's tail	*Saururus cernuus*	Arrowhead	*Saggitaria latifolia*
Great blue lobelia	*Lobelia siphilitica*	Sweet flag	*Acorus calamus*
Wool grass	*Scirpus cyperinus*	Arrow Arum	*Peltandra virginica*
Sedges	*Carex spp.*	Water plantain	*Alisma plantago- aquatica*
American bulrush	*Scirpus americanus*		
Dark green rush	*Scirpus atrovirens*		

1 to 3 feet of water

Hardstem bulrush	*Scirpus acutus*
White waterlilly	*Nymphaea odorata*
Yellow waterlilly	*Nuphar advena*
Pickeral plant	*Pontederia cordata*

NRCS Plant Mixtures

The following seed mixtures were developed by the Natural Resources Conservation Service (NRCS) for their Conservation Reserve Enhancement Program (CREP). These particular seed mixtures may not be applicable in all golf course situations due to plant height. However, we have included these mixtures for general reference and as an example of some commonly used buffer species for the grass/forb zone. These mixtures can be altered to meet specific requirements. For instance, if plant height is of major concern, then you might want to consider a mix of little bluestem combined with a short wildflower mix.

NRCS recommended native plant mixtures

(smaller quantities may be suitable when combined with a cover crop)

- Mix 1: *Upland Soils*
  - Big bluestem @ 2 lbs/acre (pls*)
  - Indiangrass @ 2 lbs/acre (pls) OR Switchgrass @ 5 lbs/acre (pls)
  - Little bluestem @ 2 lbs/acre (pls)
  - Wildflower mixture @ 0.5 lbs/acre
- Mix 2: *Wet Soils*
  - Big bluestem @ 2 lbs/acre (pls)
  - Switchgrass @ 2 lbs/acre (pls)
  - Little bluestem @ 1 lbs/acre (pls)
  - Lowland wildflower mixture @ 0.5 lb/acre

*(pls = pure live seed)

Turf mixtures

In buffer areas that must be maintained as turf, mixtures containing fine fescue blends may be a good choice. Blends containing species such as Hard, Chewings, Creeping Red, Sheep, and Slender fescues have been used with some success in low maintenance situations. These mixes are available at several professional turf product distributors.

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Example Golf Course Seed Mixes

The following seed mixes were developed specifically for the golf courses mentioned and are not intended to serve as recommended plant mixtures. Rather, they have been included as examples of how seed mixes may be tailored for individual golf courses. In addition, these lists are not intended to serve as an endorsement of any particular nursery or firm. These seed mixes were designed for different geographic regions and tailored to meet the specific needs of each site.

It should be pointed out that the cost of native grass and wildflower mixes may vary dramatically from year to year. This is usually because the availability of specific species is variable due to fluctuations in supply and demand. Therefore, the cost of a seed mix may be dramatically increased by only a few species. You may wish to bid species separately or work with your supplier to adjust the amounts of certain species to lower the cost of the seed mix.

Example #1: The following seed mix was developed by Esther Durnwald of the Michigan Wildflower Farm and Mike DeVries of DeVries Designs, Inc. for the Kingsley Club located in Traverse City, Michigan. Approximately 80 acres was the original estimate, with about 100-110 acres ultimately planted with a cover crop of fine fescues combined with the a seed mix of native grasses (primarily little bluestem) and

wildflowers. The seeding rates were approximately 17 lbs per acre of fescue, 4 lbs per acre of little bluestem and 1 lb per acre of wildflower mix. The cost per acre was approximately $280.00.

Based upon his experience with this project, Mr. DeVries now recommends that a spraying program to control weed growth be implemented prior to planting the wildflower mix. For the mix used on this project, he indicated he would plant the fescue and little bluestem first, implement a spraying program for 2 to 3 years to control weed growth, and then plant the wildflowers either by drilling in the seeds or broadcasting the seeds after a controlled burn.

Forbs – Mixed and spread together, except for the stiff goldenrod (cost at the time - $146.50/lb.)

Columbine	*Aquilegia canadensis*
Butterflyweed	*Asclepias tuberosa*
New England Aster	*Aster novae- angiae*
Frost Aster	*Aster pilosus*
Sand tickseed	*Coreopsis lanceolata*
Wild lupine	*Lupinus perennis*
Bergamot	*Monarda fistulosa*
Early wild rose	*Rosa blanda*
Blackeyed Susan	*Rudbeckia hirta*
Gray goldenrod	*Solidago nemoralis*
Stiff goldenrod	*Solidago rigida*
Hoary vervain	*Verbena stricta*

Native Grasses – Distributed Individually (cost at the time - $24.00/lb.)

Little bluestem	*Schizachyrium scoparius*
Big bluestem / Turkeyfoot	*Andropogon gerardii*
Switchgrass	*Panicum virgatum*
Indian grass	*Sorghastrum nutans*
Junegrass	*Koeleria macrantha*

Example #2 – The following seed mix was developed by Thomas Smith of Grass Roots Inc. for Groesbeck Golf Course in Lansing, Michigan. This project cost approximately $8,250 per acre and included some live plug plantings along with preparation and labor costs. Approximately 2-1/4 acres were planted on the project.

Native Forbs – Upland

Columbine	*Aquilegia Canadensis*	
Butterflyweed	*Asclepias tuberosa*	
Smooth aster	*Aster laevis*	
New England aster	*Aster novae- angliae*	(in selected areas only)
Sand tickseed	*Coreopsis lanceolata*	
Tall coreopsis	*Coreopsis tripteris*	(in selected areas only)
Purple coneflower	*Echinacea purpurea*	
Western sunflower	*Helianthus occidentalis*	(in selected areas only)
Rough blazing star	*Liatrus aspera*	
Lupine	*Lupinus perennis*	
Bergamot	*Monarda fistulosa*	
Horsemint	*Monarda punctata*	
Hairy beardstongue	*Penstemon hirsutus*	
Grayheaded coneflower	*Ratibida pinnata*	
Black- eyed susan	*Rudbeckia hirta*	
Prairie dock	*Silphium terebinthinaceum*	(in selected areas only)

Cupplant	*Silphium perfoliatum*	(in selected areas only)
Stiff goldenrod	*Solidago rigida*	
Hoary vervain	*Verbena stricta*	

Native Forbs – Wetland Edge

Joe pye weed	*Eupatorium purpureum*	
Boneset	*Eupatorium perfoliatum*	
Cardinal flower	*Lobelia cardinalis*	
Blue flag	*Iris versicolor*	
Great blue lobelia	*Lobelia siphilitica*	
Blue vervain	*Verbena hastata*	
Lizard's tail	*Saururus cernuus*	
Spiderwort	*Tradescantia ohiensis*	
Prairie blazingstar	*Liatris pycnostachya*	

Native Grasses/Sedges/Rushes Mix

Big bluestem	*Andropogon gerardii*	(In selected areas only)
Switch grass	*Ramcum virgatum*	(In selected areas only)
Little bluestem	*Schizachyrium scoparium*	
Indiangrass	*Sorghastrum nutans*	(In selected areas only)
Assorted sedges and rushes	*Carex, Juncus, Scirpus, sp.*	(In wetland edge)

Non-native annuals

Pimpernel	*Anagallis arvensis*
Dwarf godetia	*Clarkia amoena*
Clarkia	*Clarkia unguiculata*
Dwarf plains coreopsis	*Coreopsis tinctoria*
Rocket larkspur	*Delphinium ajacis*

Non-native annuals - continued

African daisy	*Dimorphotheca aurantiaca*
California poppy	*Eschschoizia californica*
Bird's eyes	*Gilia tricolor*
Candytuft	*Iberis umbellate*
Spurred snapdragon	*Linaria maroccana*
Sweet alyssum	*Lobularia maritime*
Texas bluebonnet	*Lupinus texensis*
Five-Spot	*Nemophila maculata*
Baby blue-eyes	*Nemophila menziesii*
Corn poppy	*Papaver rhoeas*
Dwarf catchfly	*Silene armeria*

The procedure for buffer expansion is as follows:

- Spray out marked areas with Roundup/Rodeo, being careful not to spray desirable vegetation previously planted.
- Re-treat as above if needed.
- After 7 days, scarify surface to expose soil, leaving approximately 50% cover.
- Install plugs in all areas within budget. Those species marked, "in selected areas only" are designated as such due to size.
- Overseed with forbs mix, grasses/sedges/rushes and non-native annual cover crop.

USEFUL REFERENCE MATERIAL

SPECIFIC TO GOLF

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NATIVE VEGETATION

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Your Landscape and Our Natural Areas
Native Trees
Native Shrubs
Native Wildflowers
Native Vines, Grasses, Sedges, and Ferns

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Organizations

Michigan Native Plant Producers Association
Contact: Bill Schneider
517-244-1140

Michigan Wildflower Association
Contact: Marilyn Case
616-781-8470

USEFUL BUFFER ZONE WEB SITES

www.nrcs.usda.gov
Natural Resources Conservation Service web site. Contains interactive program for choosing appropriate buffer zone widths and downloadable Practice Standards for numerous subjects including filter strips and riparian forest buffers.

www.agnr.umd.edu/ces/
University of Maryland Cooperative Extension Service. Has a series of helpful fact sheets on Buffer Zones.

www.unl.edu/nac
USDA National Agroforestry Center web site. Contains a series of fact sheets on Riparian Buffer Systems.

www.crjc.org
Contains 10 fact sheets in the series, "Riparian Buffers for the Connecticut River Watershed."

www.usga.org/green
United States Golf Association web site. Contains articles reprinted from the USGA Green Section Record, such as "Using Native Plants in the Golf Course Landscape," "Wildflowers on Your Course," and "Aquascaping."

www.ctic.purdue.edu
Core4 Conservation web site. Contains fact sheets on definition and benefits of buffer zones.

www.buffercouncil.org
Web site of National Conservation Buffer Council.

www.nacdnet.org/buffers
Contains "Buffer Notes" newsletter with interesting articles regarding buffer zones.

NATIVE PLANT WEB SITES

www.wildflowersmich.org
Web site for the Michigan Wildflower Association. Their stated mission is to promote, coordinate, and participate in education, enjoyment, science, and stewardship of wildflowers and their habitat --- including promoting public education of proper principles ethics and methods of landscaping with native wildflowers and associated habitats. **Contains links to numerous other web sites related to native plants** .

www.prairiesource.com
Web site with information on native grasses and wildflowers

www.wildflower.org
Web site for The Lady Bird Johnson Wildflower Center

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- Michigan State University – Department of Crop and Soil Sciences; Department of Fisheries and Wildlife
- Michigan Department of Environmental Quality – Surface Water Quality Division; Land and Water Management Division
- Michigan Department of Natural Resources – Wildlife Division; Fisheries Division
- U.S.D.A. Natural Resources Conservation Service
- U.S. Fish and Wildlife Service
- Michigan Turfgrass Foundation
- Golf Course Owners Association
- Golf Course Architects Association
- Regional Golf Course Superintendent Associations – representing 4 regional associations within Michigan: Forest Lake Country Club, Kalamazoo Country Club, Grayling Country Club, and Grossbeck Golf Course