



US Army Corps of Engineers

Understanding and Evaluating Ecosystem and Engineering Risks and Benefits Associated with Native Vegetation on Riverside Levees: Mild Temperate Climate of Southeast U.S.

Princeville Levee, 6105006001

Princeville and Tarboro, North Carolina

EWN Project 22-17



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1 BACKGROUND

Levee design and management has traditionally considered the levee as single purpose infrastructure. Levees manage flood risk and are traditionally maintained with a riverward levee slope that is either rock or mowed grasses. However, much information exists on the benefits of vegetation for soils, slope stability, and human, aquatic, and terrestrial ecosystems. However, there is little information available on how to optimally integrate vegetation into levees to achieve a win-win for both flood risk management and ecosystem health.

USACE guidance is necessarily national in scope, making implementation difficult for those managing levees and flood risk reduction locally. The need for more locally applicable guidelines and best practices inspired the project *'Understanding and Evaluating Ecosystem and Engineering Risks and Benefits Associated with Native Vegetation on Riverside Levees'*, funded through the USACE Engineering With Nature (EWN) initiative. This project is working to provide locally relevant information for planting and managing vegetation on riverside levees in different climate sub-regions of the U.S. Each case study report identifies the vegetation that can be maintained on levees and will contribute not only to flood risk reduction but also a healthy and functional river ecosystem for that climate region. Planting alternatives specific to the visited levee system are presented as examples of implementation and maintenance. While the case study is necessarily specific to a single system, the plant tables and planting alternatives may be applied through the climate area with limited case-by-case adjustments.

This report is part of the EWN project and is a site case study of a levee system in North Carolina, within the mild temperate climate of the Southeastern U.S. near the shift from piedmont to coastal plain. Here we present information on how the local levee sponsor could incorporate woody vegetation and other plantings on the levee, in accordance with the National Levee Safety Guidelines in development by USACE and FEMA (please refer to <http://www.leveesafety.org> for information on the draft guidelines).

1.1 Location

The Princeville levee is in Edgecombe County, NC and the USACE Wilmington District. It reduces flood risk from the Tar River to the City of Princeville (City) (Figure 1). The levee was federally constructed in 1938 and rehabilitated in 1967. The City operates and maintains the levee.

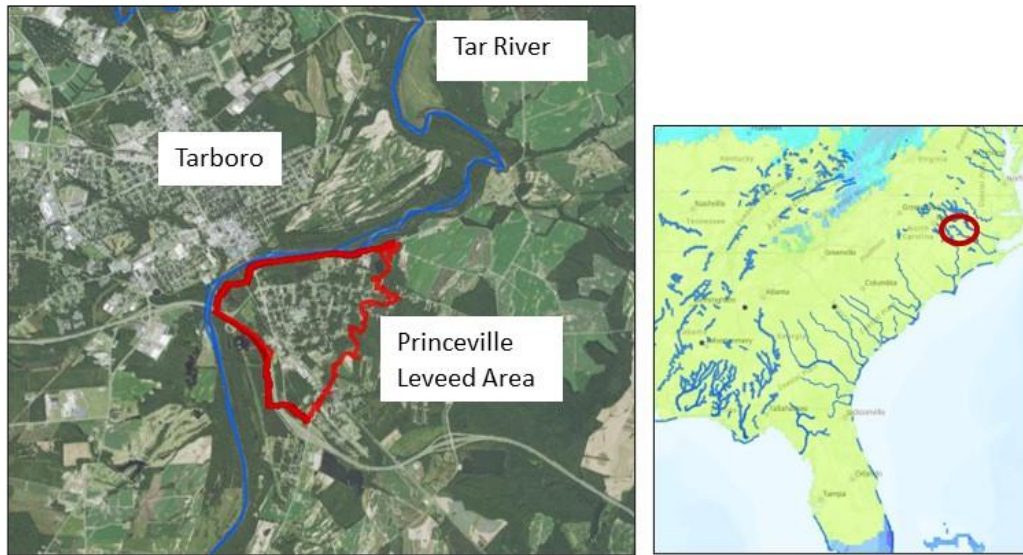


Figure 1. Location of Princeville Levee in North Carolina.

1.2 Tar River

The Tar River flows from the Piedmont region through coastal range to Pimlico Sound. The Princeville levee is entire within the coastal plain reach and downstream of where the river transitions from a gravel and sand channel to a sand bed system. The river planform transitions to become less sinuous through the coastal plain as the geologic formations it flows over change. While most of the coastal plain land in the area is a fossiliferous clay with sand, known as the Yorktown Formation, the Tar River has a sandier bed because it follows the path of the Cape Fear Formation, a sandstone and sand mudstone that cuts through the coastal plain. Outside the city, land use is a mix of crops and pasture. Prior to agriculture, the land was dominated by longleaf pine with smaller areas of oak-hickory-pine forest.

1.3 Climate and Flooding

Area climate is defined as mild temperate or humid subtropical with no distinct dry season and hot summers (Cfa). Rainfall peaks in the summer with thunderstorms that build up due to the intense surface heating and strong subtropical sun angle. Daily intense (but brief) convective thundershowers are common. The native bottomland hardwood forest and river floodplain area reduces the risk and severity of flooding by providing areas to store floodwater. Although infrequent, hurricanes are a significant driver of flooding and levee over-topping. The levee has an AEP of 0.005, which was exceeded by Hurricane Floyd in 1999. When there is levee overtopping, the water flows into the low-lying City of Princeville. When this occurs, the water remains within Princeville for days at a time. The levee flap gates rarely work as intended and as a result the water fills in the Princeville side. There is not a pump station to remove the floodwaters due to the expense and the need for additional O&M. The area is resource constrained due to a small and decreasing population and low property values.

1.4 Flood Risk Management System

The Princeville levee system has a total length of approximately 3.33 miles and a leveed area of 1.28 square miles. It is an earthen embankment constructed from fine sand with some clay (SC) soils over a foundation of fine sand (SP) and sandy clay (CL). The underlying soils are Tarboro Loamy Sand and Wehadkee silt loam. The levee embankment has an approximate crest height of 14 ft and a width of 10 ft. The waterside slope was designed with an inclination ratio of 1:3 (vertical to horizontal). The landside slope has a ratio of approximately 1:2.5. The levee has a riverside berm that extends 30 feet riverward from the toe (Figure 2).

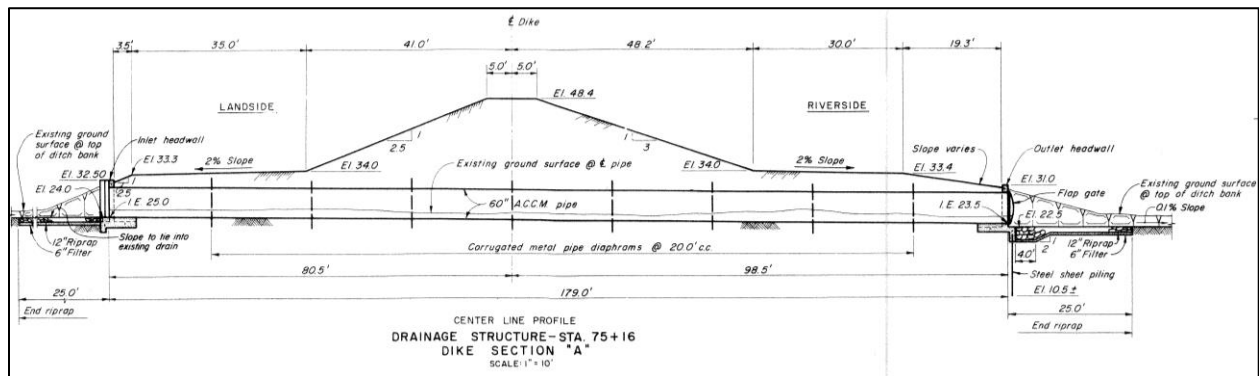


Figure 2. Typical section of the Princeville levee with a drainage structure.

A state law requires there be a minimum 30-foot wide corridor of undisturbed forest vegetation, as measured from the riverside edge of rooted herbaceous vegetation. A minimum 20-foot wide corridor of managed vegetation is required beyond this to create a total buffer 50-foot wide. Adherence to the 50-foot buffer law is evident in the placement of the Princeville Levee (Figure 3).

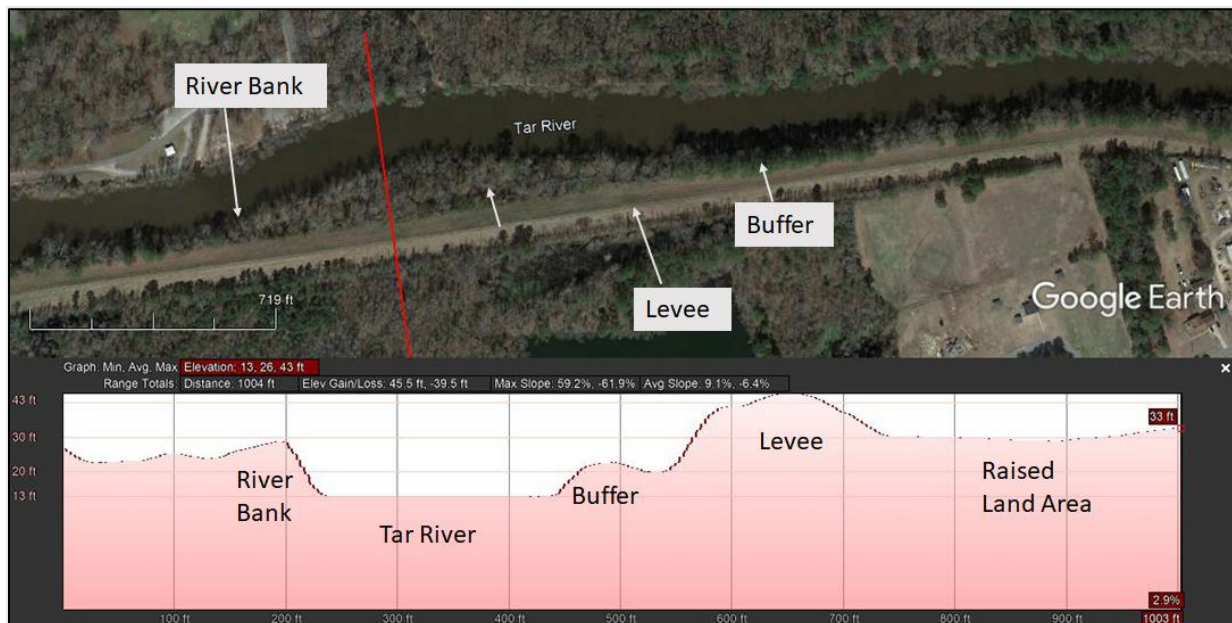


Figure 3. Plan view and cross-section illustrating the riparian buffer between the Levee and the Tar River.

1.5 Vegetation and Ecology

The required riparian buffer sets the levee back from the river. The ecosystem and fluvial functions within the buffer area are intact and minimally impacted. Thus, the Tar River is set in a wide, low floodplain with low terraces that is frequently inundated (Figure 4).



Figure 4. Photos of the Tar River within the bottomland hardwood forest.

Because terraces create a variable floodplain topography, the low overflows create multiple channels and backwater ponds within the larger floodplain. The Tar River has a typical southeastern, brownwater floodplain due to the mineral rich sediment transported from the Appalachians. Dominant plant species are those characteristic of a bottomland hardwood forest, colloquially referred to as a river swamp. Sweetgum and Black Birch Trees up to 30 feet tall with diameters of 12 inches and 18 inches, respectively, are common along with Loblolly Pines 40 feet tall with diameter 24 inches. Other notable species present in the Tar River include Water and Willow Oaks and Bald Cypress, which all evolved to flourish in areas that are either seasonally flooded or covered with water much of the year. The grass growing on the floodplain terraces are Carolina Sedge, which is a wetland species. The River through Princeville has approximately 60% canopy coverage, providing a significant amount of shade to the undergrowth and river.

1.6 Water Quality Concerns

A major issue in the system is water quality impairment due to non-point source pollution and nutrient loading from upstream agriculture, notably hog farms, and area septic systems. The impaired water quality has negative implications for the Tar River Spiny mussel and the

threatened Carolina Madtom fish as well as the other mussels listed. To counter the pollution, the Tar-Pimlico Agricultural Nutrient Control Strategy Rule and Law became effective in 2001. The law set goals and strategies for farmers to reduce total Nitrogen by 30% and have no further increases total Phosphorus, but these have not been met. Bottomland swamps and floodplains natural to the Tar River system in this area are known to improve water quality by filtering and flushing nutrients, processing organic wastes, and reducing sediment before it reaches open water.

2 SITE VISIT

The Princeville levee was visited by the EWN – Vegetation on Levees team on 27APR2023. The team walked the crest of several portions of the 3.34 mile levee system, with frequent excursions down the riverside levee slope to the channel. We talked with the levee sponsor and district personnel about the condition of the levee, levee history, and community concerns.

The levee is maintained as much as possible without any woody vegetation and herbaceous vegetation no taller than 6 inches. Plant growth has been prevented by prescribed burns or mowing. The last prescribed burn was 4 years ago. Although favored by the sponsor, the conditions have not been appropriate for a burn since that time. The levee is mowed twice a year, but the sponsor would like to mow more frequently. The resources required for mowing are 6 people with bush hog, tractor, and side mower at an estimated annual cost of \$50K-\$60K. Each year the sponsor uses a drone to fly the levee and look for any potential issues, including any hazard trees. If a tree has fallen, it is typically within the riparian area. Only one instance in recent history was noted where a tree fell onto the levee from the riparian area and was subsequently removed. The need for removal was questioned at the time by USACE but desired by the sponsor.

We have separated our site observations into 3 levee sections (Figure 5).

1. The first is the federally constructed levee upstream of the railroad tracks. This segment is the main focus of current, on-going maintenance.
2. The second segment is the federal levee southwest, or downstream, of the railroad tracks where plant growth has been unimpeded for 4 years.
3. The third segment is the non-federal portion that was superseded by construction of Highway 64.

The highway replaced the risk management provided by a portion of the levee due to its higher elevation, and the levee slopes have been left to re-grow without intervention. Observations of three sections of the levee system that were inspected by the team are presented below.



Figure 5. Princeville levee with three sections identified.

2.1 Section 1: Between Heritage Park and S Main St. (Upstream Section)

Section 1 extends over the upstream 6,537 feet of levee. All vegetation on the crown, slopes, and within 15 ft of either toe consists of non-native lawn species grasses, mowed to less than three inches (Figure 6). Several small forbs could be recognized growing within the grasses, however, they were not identifiable based on mowing disturbance. Primary herbaceous species, able to be identified, consisted of centipede grass (*Eremochloa ophiuroides*), sweet vernal grass (*Anthoxanthum odoratum*), field clover (*Trifolium campestre*), little vetch (*Vicia hirsuta*), and hare's foot clover (*Trifolium arvense*). All of these species are introduced, cosmopolitan species, that are generally associated with lawns, fallowed or abandoned fields, and vacant lots. The plants on the levee would reach a maximum height of 2-3 feet if not

mowed. The grasses may grow to near this height between mowing, particularly on the levee slopes where there is no vehicular traffic.



Figure 6. Views of the levee in Section 1. Left is looking down the levee crest. Right is looking downslope at the levee toe and riparian buffer.

The field clover and hair's foot clover may provide some value to generalist pollinator species such as the European honeybee and various species of butterfly but are unlikely to be used by native bees or hummingbirds who require more specialized flowers. The margins of the maintained area consisted largely of ornamental species such as glossy privet (*Ligustrum lucidum*), Japanese honeysuckle (*Lonicera japonica*), and various geraniums.

The levee maintains and fulfills the flood risk management function. Riverward and landward of the levee, bottomland hardwood species are present. Wildlife activity in the area was focused around the river and riparian buffer with the exception of fire ants. A number of birds were observed, including blue birds and red tail hawk. A fox trail led down the riverside levee slope to a burrow at the edge of the forest buffer. The sponsor indicated there have not been significant issues related to animal burrows.

2.2 Section 2: Between Railroad Tracks and Highway 64 (downstream Section)

The transition to Section 2 occurs with a stoplog closure where the CSX railroad tracks pass through the levee. Section 2 extends 2,472 feet to Highway 64. The only large-scale repair needed to the closure was due to seepage following Hurricane Matthew in 2016. At that time a sheet pile wall was installed to supplement the stoplog closure system. However, the railroad tracks create a maintenance issue for the sponsor. CSX does not allow heavy equipment to cross the tracks, including mowers. As a consequence, the part of the levee that is on the southwest side of the tracks has been left to grow at will for the past 4 years.

Prior to the cessation of mowing and burning, section 2 would have been the same as section 1. Because of the absence of maintenance, the levee crest and slopes have developed an uneven surface.

The vegetation on the levee has become a mix of introduced and native species. The levee had originally been seeded with the same species mix as in section 1. The reduced mowing provides the opportunity for some of the native plants to establish and for other, introduced plants to appear. It is suspected that initial seed mix contained seeds of the native species but that they had been prevented from growing in section 1 by the introduced species having a greater tolerance for repeat mowing. Without the mowing, the native plants have begun to establish and out-compete some introduced species.



Figure 7. Looking across the railroad tracks toward Section 2.

Young liquidambar trees (*Liquidambar styraciflua*) are growing all along both sides of the slopes and on the crown. In general, the trees appear to be less than 5 years old and are on average about 10 feet tall with a DBH of 4 inches (Figure 7). Most trees appeared vigorous, with the exception of a few that appeared to have an insect infestation. Sweetgum Trees had grown as tall as 10 feet on the crown tall and up to 12 feet on the slopes. These trees have a potential to live for up to 400 years. The roots are shallow and would not impact the underlying levee structure to a significant depth. These are fruiting trees that attract squirrels and chipmunks, both of which have a tendency to burrow. None were sighted during our visit.

The understory on the crown of the levee consisted of similar lawn type species such as sweet vernal grass and field clover (Figure 8). The waterside slopes hosted a number of native

pollinator-supporting species including Virginia creeper (*Parthenocissus quinquefolia*), swamp rose (*Rosa palustris*), dewberry (*Rubus flagellaris*), and trumpetvine (*Campsis radicans*). Non-native and invasive species were limited to sweet grass, hair's foot clover, field clover, little vetch, hare's foot clover and Japanese honeysuckle. Non-native potentially pollinator supporting species little vetch and hare's foot clover were found on the waterside.

At the waterside levee toe, adjacent to the riparian buffer zone, Sweetgum and Black Birch Trees reached up to 30 feet. Loblolly Pines and Water Oaks were also growing tall along the waterside toe, indicating a possible expansion of the native riparian species where water inundation remained frequent. Both species produce acorns that may attract squirrels. The location in the riparian area where flooding is frequent would reduce the risk of burrowing.



Figure 8. Waterside slope and levee toe in Section 2.

Section 2 is indicative of what a reduction in the level of effort exerted on vegetation maintenance would mean for vegetation growth left unto itself over the span of 4 years. The sponsor cannot bring any equipment over the railroad due to potential fines. The team did not see any animal burrows and the sponsor indicated that there have been no significant issues in the past related to burrowing animals.

2.3 Section 3: West of Highway 64 (Superseded Levee Portion)

The I-64 highway was built taller than the levee, providing a greater level of protection to the town than the levee, superseding this part of the levee. The levee remains in place and now serves as means for accessing the highway for maintenance and the recreational ponds on the land side. Because it is no longer a levee inspected for, and expected to provide, flood risk management, we refer to it as a berm for clarity. The ponds are the former borrow pits left from highway construction and are now stocked with game fish and managed for waterfowl.

The only maintenance of the berm is to mow the crown. The same non-native grass species present at the other sections of the levee are also dominant on the berm crest. These and other non-native species are probably re-populated periodically when the crest is mowed as the seeds may be brought into the area inadvertently on the mowing equipment. Continued crown area mowing has maintained these plants by unintentionally transporting seeds to the area while also reducing the probability of a native species taking hold and replacing one of the grasses. Mowers often transport seeds between areas and that is likely what has occurred here. The invasive Japanese honeysuckle and mimosa tree (*Albizia julibrissin*) growing at the site may have been brought in unintentionally by the mower. One mature mimosa tree appears to have given rise to many seedling and sapling class mimosa trees as all seedlings and saplings radiated out from this single individual. No other mature specimens were observed.

The berm slopes have not been mowed for approximately 35 years. As a result, the growth here represents a long-term succession of the vegetation on the slopes without any intervention (Figure 9). Greater vertical species diversity is immediately evident. In addition to dewberry and Virginia creeper, which are present in the expanding riparian area at the second site, the berm slopes host shining sumac (*Rhus copallinum*), which roots to approximately 10 inches and grows in full sun. This is a pioneer species, growing where there are open areas free of shading vegetation. All the species on the berm slopes attract butterflies and other pollinators. Vines provide ground cover. While native, these species may not be appropriate for every zone of an operational levee. Trumpet vine can be difficult to control and has a deep rooting depth. Common greenbrier (*Smilax rotundifolia*) vines can sprout quickly with extensive root spread. Eastern poison ivy is also growing at the site.

Trees growing in the area average 18-24 inches in DBH and are located primarily on the lower half of the slope and toes of the slope. In addition to liquidambar, Loblolly pine (*Pinus taeda*), American Beech (*Fagus grandifolia*), and Sassafras (*Sassafras albidium*) were present. These tree species are fast growing with roots in the upper two feet of soil. Most are considered pioneer species that would be replaced by slower growing and longer-lived American Beech trees in time. Figure 9 illustrates the tree growth and the influence of mowing on tree location. The trees are primarily in lines with one on the slope and one along the toe. The area between the lines is frequented by community members accessing the fishing ponds and the driving has precluded tree growth.



Figure 9. Section 3 where only the crest has been mowed for 35 years.

This site indicates what vegetation would grow and how a levee may perform if a large amount of the maintenance was removed for 35 years. As in the other two sections, there are few authorized encroachments that consist of poles with power lines. There was no evidence of sloughs, slides, erosion, or cracks in any of the sections. There was minor rutting on the berm crest that are likely from inspection vehicles and mowers. Culverts through the berm section provide drainage and they appeared to be in good condition. No animal burrows were observed by the team in this area.

3 PLANT SPECIES SUMMARY

The most prevalent plant species identified during the site visit were noted and have been documented with respect to species characteristic growth patterns, potential origin, abundance, and ecosystem benefits. The most common species are Liquid-amber (*Liquidambar styraciflua*), Black Birch (*Betula nigra*), Water Oak (*Quercus nigra*), Loblolly pine (*Pinus taeda*), Virginia Creeper (*Parthenocissus quinquefolia*), and Common greenbrier (*Smilax rotundifolia*). Because of their dominance, the characteristic growth patterns, ecological traits, rooting patterns, and both benefits and drawbacks to their growth on levees are detailed in Appendix A for each of these six species. More than these six species were identified while in the field and the field sheets from the site visit are provided in Appendix C for reference.

Liquid-amber is a pioneer species and grows quickly in full sun. It is often fast to colonize a bare slope, as evidenced by the abundance of Liquid-amber in Section 2. The fast growth rate of the tree is useful for creating shade quickly, which may allow the longer-lived but slower growing species to develop. It was likely brought to the site through birds and wind drift from surrounding areas. Liquid-amber is one of the dominant canopy species along the landside toe, along with Loblolly pine, another fast growing, native species. The dominant species on the waterside toe of the levee are the Black Birch (*Betula nigra*) and the Water Oak (*Quercus nigra*), reflecting the bottomland hardwood setting. Both are acclimated to frequent water inundation and have shallow, dense root systems. Predominant shrubs and ground cover are from Virginia Creeper (*Parthenocissus quinquefolia*), and Common greenbrier (*Smilax rotundifolia*). These were found at every location with the exception of the levee crown. Virginia Creeper is a hardy plant that can grow under all conditions in the area. It provides ground cover and is maintained by mowing. In contrast, the common greenbrier is a pioneer species, growing quickly to cover bare ground. Once taller plants establish, greenbrier growth is suppressed by the shade.

4 LEVEL PLANTING AND MAINTENANCE OPTIONS

Following the site visit, the team met and, using the input gathered from the site visit and conversations with the local district and sponsor, defined options and the associated O&M actions possible for the Princeville Levee. A common misconception when discussing vegetation on levees is that proponents are advocating for a “no maintenance” scenario in which the levee owner discontinues vegetation maintenance and vegetation is left to establish and mature. Under such a scenario, there would be no planned planting, vegetation growth management, mowing, or debris removal.

Without vegetation management, the Princeville levee would be immediately populated with liquid-amber and loblolly pines along with other pioneer species, both native and non-native. Potential colonizer species include those with population sources adjacent to the levee and those distributed by birds. The levee would quickly become difficult to inspect using conventional methods. Vines and shrubs may fill in the understory as the trees grow and establish a canopy. The ground surface would become uneven. Over time, the unmaintained levee would resemble a forested berm.

While discontinuing vegetation maintenance would have the greatest short term cost savings, the risk of levee breaches, loss of flood protection, and the need for costly rehabilitation repairs would increase. Any defects formed in the levee over time would be less likely to be identified during inspection. The increased chance for undiscovered defects impacts the current level of flood risk management and therefore is not considered further and is not a recommended option. There is a need for maintenance to continue regardless of vegetated state of the levee, particularly with respect to invasive species whose seeds may be transported into the site by birds, animals, and people.

The team identified four options for the Princeville Levee (**Error! Reference source not found.**). Each option has actions to meet an objective that is in addition to flood risk management. Maintenance actions and planting plans were divided into location on the levee. Each option is detailed below.

Table 4-1. Maintenance options for the Princeville Levee.

OPTION	DESCRIPTION
A	current maintenance
B	optimize ecosystems with current plants
C	optimize ecosystems
D	minimize resource costs

Appendix B includes tables identifying those plants suitable for the region and option. The tables separate plants by preferred planting location on landside toe, landside slope, crown,

waterside upper and lower slopes, and waterside toe. Larger plants become preferable with distance down the waterside slope towards the toe. This is due to both the difference in rooting patterns, species soil preference, and plant height. Larger shrubs and tree are identified for the lower slope and toe while forbs and low shrubs are more common higher up on the slope.

4.1 Option A: current maintenance

Option A presents no change in current O&M. Current maintenance include debris removal and mowing of levee crown and sides four times per year. There is also no change to the selection of grasses using the locally available 'native' grass mix when re-seeding the levee crown. This Option does not affect the flood risk management provided by the levee. The plants detailed in Appendix A and identified on the field sheets in Appendix C would continue to grow on the levee.

4.2 Option B: optimize ecosystems with current plants

This option focuses on changes in O&M practices to increase ecosystem benefits as much as possible with minimal planting of additional species and no change to the level of flood risk management.

Current maintenance practices are adjusted to favor growth of those species that are already present and can be managed to increase ecosystem benefits. These plants have shown their ability to grow in the area and most currently grow outside of the mowed reach. Table B-1 in Appendix B lists the plant species present that are native to the area, non-poisonous, and acceptable for levees due to rooting depth and spread, growth characteristics, and ecosystem benefit. Table B-1 may be used to help adjust maintenance practices to focus on which plants need to be actively removed, which may be left in place, and where to intervene. An example intervention may be to remove liquid-amber trees from upper slopes while allowing the taller plants that create shade to expand closer to the waterside toe. An example intervention on the crown is to change the current seed mix to one of native plants tolerant to mowing.

Landside Slope and Toe: The landside plants are primarily grasses, forbs, and low growth shrubs. Lower growing species can be preferable where inspections during high water events focus on watching for boils landward of the levee. Plants favoring drier soils are preferable on the landward side as well as those species that grow quickly, provide erosion protection to the slope, and help preclude colonization by liquid-amber. Tall fescue is already present on the levee and can be difficult to remove. While it is not recommended for supplemental continued seeding, it can be left in place. Flattened Oatgrass is suggested as a replacement in the table.

Example Plants: Lyreleaf Sage, and Dwarf Sumac

Crown: Plants on the levee crown should grow easily and be able to withstand mowing. Native plants recommended for the crown are those with natural growth height of less than a foot.

Example Plant: Little Barley

Waterside Slope: The waterside slope species transition from lower growing shrubs on the upper slope to larger shrubs and trees on the lower slope and toe. There is greater emphasis on maintaining plants of different heights and types on the waterside slope where the potential ecosystem benefits are greater. While the species identified all have limited depth roots, root growth would generally direct toward the water and not into the levee prism. Trees are recommended further down slope where they can aid in creating a larger canopy.

Example Plants: Lyreleaf Sage, Creeping Bush-Clover, and Northern Dewberry on the upper slope. Smooth Azalea, Winter Oak, and Sassafras on the lower slope.

Plants that provide ground cover should remain between the slower growing shrubs and trees. These include Roundleaf Greenbrier, Trumpet Vine, and Dwarf Sumac.

Waterside Toe: The trees and shrubs recommended for the waterside toe are those adapted to frequent inundation and provide benefits of pollutant reduction through flow bioretention. The Tar River is impaired for excessive nutrients coming from upstream hog farm runoff. These plant species provide an additional benefit through their ability to uptake excess nutrients from the river.

Example Plants: Swamp Rose, Carolina Sedge, Willow Oak, Water Oak, and Black Birch

Costs: New plants do not need to be procured or planted. Where seed mixes are changed, there may be an exchange of costs. For example, the costs of purchasing specific seed species for the crown or slopes would replace the current seed mix purchase. Because the plants are being changed slowly, the maintenance costs would remain the same during the transition phase and decrease over time

Benefits: Maintenance related costs would stay relatively constant in the initial years as savings from the reduced need for mowing are replaced by the cost to maintain open sightlines and inspection path. As the native species develop and the desired plant distribution becomes dominant, slope and pathway maintenance would be needed less frequently than the current practice of four times per year. Although there will be reduced likelihood that invasive species will establish at the site, there will continue to be maintenance to remove invasive species. Because the transition would be gradual, a conservative estimate is that benefits would not be realized until after 7-10 years. Ecosystem benefits are less readily apparent but accrue as the native plants take hold. The pollinators benefit first, with the birds following as the habitat from shrubs and tree canopy increases. The local community may enjoy increased opportunities for birding or hunting. Indirect benefits include improved air quality from the increase in trees.

4.3 Option C: optimize ecosystems

In this option, planting and maintenance focus on creating a levee with the maximum aquatic and terrestrial ecosystem benefits while maintaining the existing level of flood risk management. In contrast to Option B, rather than optimizing existing species assemblages, Option C includes native plant species that provide the greatest possible benefits for incorporation at each location on the levee.

* Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 in Appendix B includes all plants suitable to the area that may be used when planning a planting and maintenance plan to enhance terrestrial and aquatic ecosystems. * Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 identifies the preferred planting locations for each species while taking levee inspection and habitat benefits into consideration. Terrestrial ecosystems are enhanced by selecting plants from Table B-2 that have pollinating features and grow to variable heights so that a range of bird nesting habitats are created. While aquatic ecosystem benefits are already present along the levee due to the buffer setback, benefits could be enhanced by selecting plants from Table B-2 that are flood tolerant species along the levee toe. When interacting with high flows from the Tar River, these plants would add hydraulic complexity, encourage fine sediment deposition, and provide water quality benefits for the channel.

Included in * Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 are plants that provide benefits to butterflies, insects, bees, birds, and pollinators in general; plants species that out-compete and help prevent invasive species growth; and those tolerant of mowing. * Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 is much longer than Table B-1 because it is inclusive of all possible choices for maximum flexibility. However, when planning planting for a levee, a limited number of species should be chosen from the list for each part of the levee to create a mix of species and associated benefits.

Crown: Plants identified for the crown are those that naturally grow to less than 12 inches tall, have pollinator benefits, and are tolerant of foot traffic and mowing. Many of the species spread easily, prefer full sun, and would expand to cover bare areas. All provide ecosystem benefits beyond ground cover. With a maximum natural growth height of under 12 inches, mowing frequency could be reduced.

Example Plants: Plantain Pussytoes, Pennsylvania Sedge, Carolina Clover

Levee Slopes: The land and water side slopes are combined to maximize design options. Planting plans for the slopes should select a limited number of species that include a range in growth heights. Ground plants are important to include in the slope planting plan. These will provide cover between shrubs and while slower growing plants establish, precluding colonization by liquid-amber and other undesirable species, and provide erosion resistance on inspection sightlines and paths that are maintained without larger plants. Ground cover plants include the vines and those herbs that remain under six inches tall but are not as well suited to the crown due to a preference for shade.

Shrubs and herbs identified for the slope are organized by upper or lower slope based on natural growth heights and tolerances for drought or flood. The upper slope plants include those that prefer drier soils and grow to a height of less than three feet. Lower slope plants include taller shrubs and species tolerant of flooding.

Example Plants: Lyreleaf Sage, Lloyd's St. John's-wort, Carolina Rose on the upper slope. Dwarf Wax Myrtle and Silverling, on the lower slope.

Plants that provide ground cover between the slower growing shrubs and trees include Common Butterfly-weed, Green-and-gold, Purple Lovegrass, and Cross-vine

Levee Toes: Trees and tall shrubs are recommended for the levee toes as these are the areas where they are furthest from the levee core and won't impede visibility. The trees in * Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 are not known for deep taproots, and those with water seeking roots are identified as specific to the waterside toe. The toe plant mixture will provide the highest canopies and transition the levee habitats to the adjacent buffer zone or landscape. On the waterside toe the trees can provide additional shade and leaf litter to the channel to benefit the Neuse River Waterdog while the roots can help trap fine sediments, increasing habitat for the Carolina Madtom.

Example Plants: White Wood Aster, Lyreleaf Sage, Wreath Goldenrod, Southern Sugar Maple, and Wax Myrtle on the landward toe. Fringed Loosestrife, Foamflower, Carolina Willow, Black Birch, and Black Willow on the waterside toe.

Costs: Initial costs for this option are high because some amount of the existing levee vegetation (those plants not part of the new vegetation plan) would have to be removed mechanically or through burning. New plants and plant seed would need to be procured and planted. It takes, on average, three to five years for new plants to establish. There could be a need for irrigation and active management during this period, including replacing failed plantings and removing any invasives.

Benefits: Cost savings are achieved as the new plants take hold and the need for irrigation ceases. The initial plantings will favor those species that provide immediate ground cover, such as willows. These species provide the stability and cover necessary for slower growing plants to establish. Over time, as more plants establish and grow, the initial ground cover plants should be brushed back or removed. The mowing and irrigation areas becomes smaller over time, and the frequency of mowing would reduce as plants with limited growth heights would populate the pathways and sightlines. Although there will be reduced likelihood that invasive species will establish at the site, there will continue to be maintenance to remove invasive species. After about five years, only minimal maintenance is expected with a focus on maintaining inspection sightlines and paths and invasive species removal.

Ecosystem benefits will increase as the native plants take hold. Pollinating species, and any nearby farms reliant on pollination, are immediate beneficiaries as the grasses and flowering plants grow quickly. The population and diversity of pollinators will increase as more native plants establish and flower. The addition of canopy trees can benefit a large number of special status birds, including Bald Eagle, Chimney Swifts, Prairie Warbler, Prothonotary Warbler, and Red-Headed Woodpecker. Additional special status species that would benefit from the canopy include Tricolored Bats and Monarch Butterflies. Aquatic habitat benefits will accrue primarily to the Neuse River Waterdog due to input of leaf litter for habitat and the Carolina Madtom through hydraulics that increase and maintain areas of riverbed with fine sediment, both special status species.

The local community may enjoy increased opportunities for birding or hunting. Indirect benefits include improved air quality from the increase in trees.

4.4 Option D: minimize resource costs

Option D seeks to minimize long-term maintenance costs by prioritizing plantings that are the lowest resources cost to procure, establish, and maintain without lowering the existing level of flood risk management. The plants are predominantly low growing shrubs and herbs. These are selected from * Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 to ensure that while prioritizing low cost, the potential ecosystem benefits are not completely lost.

Example Crown Plants: Plantain Pussytoes

Example Slope and Toe Plants: Lobed Tickseed, Placella, and Common Stargrass on the upper slopes. Northern Sundrops, Lyreleaf Sage, New Jersey Tea, Dwarf Live Oak, and Lloyd's St. John's wort on the lower slope and toe areas.

Example Cover Plants: Green-and-gold and Creeping Phlox

Costs: Similar to Option C, initial costs for this option are high because some amount of the existing levee vegetation (those plants not part of the new vegetation plan) would have to be removed mechanically or through burning. New plants and plant seed would need to be procured and planted. These plants would likely require two to three years to establish, less time than Option C. There could be a need for irrigation and active management during this period, including replacing failed plantings and removing any invasives.

Benefits: Cost savings are achieved as the new plants take hold and the need for irrigation ceases. The initial plantings will favor those species that provide immediate ground cover. These species provide the stability and cover necessary for slower growing plants to establish. Over time, as more plants establish and grow, the initial ground cover plants should be mowed to reduce their cover area while encouraging the mowing tolerant native species. The mowing and irrigation areas becomes smaller over time, and the frequency of mowing would reduce as plants with limited growth heights populate the levee. Although there will be reduced likelihood that invasive species will establish at the site, there will continue to be maintenance to remove invasive species. After about five years, only minimal maintenance is expected with a focus on maintaining inspection sightlines and paths and removing invasives.

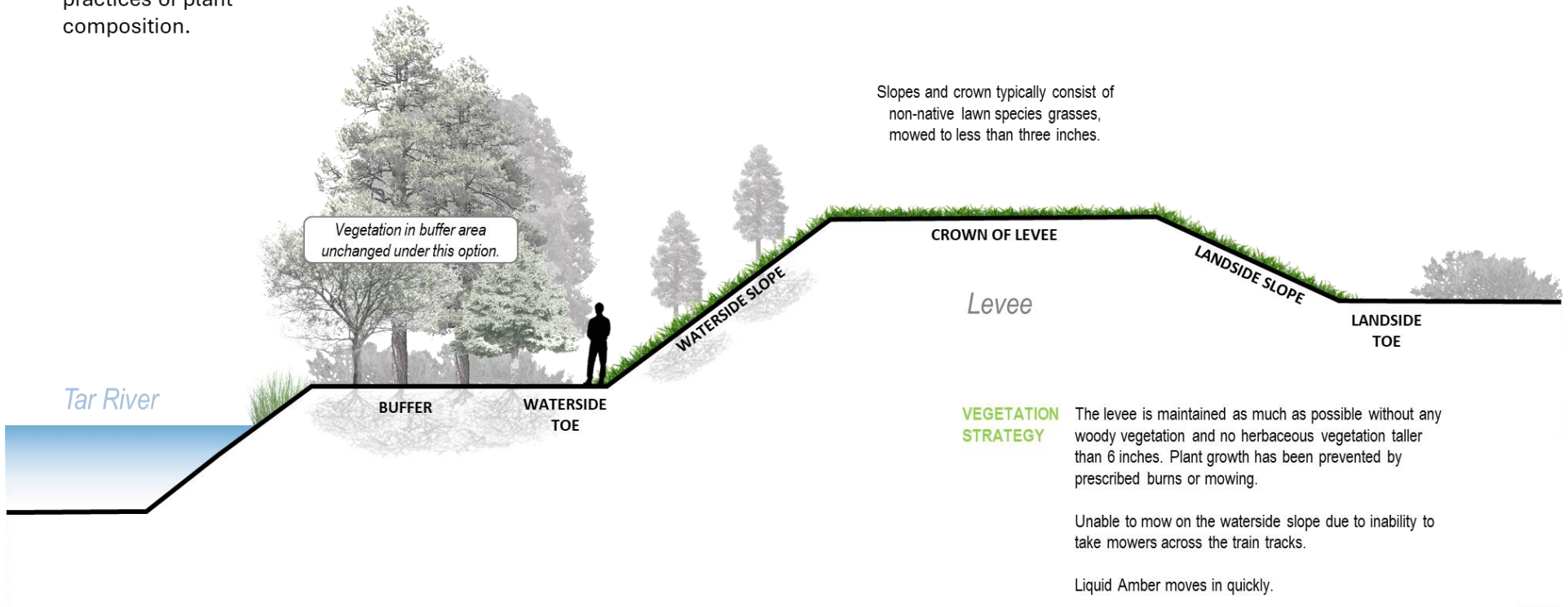
4.5 Costs and Benefits of Each Option

The relative costs and benefits of each option are qualitatively compared to the estimated current costs and benefits. Current O&M was estimated by the sponsor as \$60K per year or \$15K per maintenance event in April, 2023. Current benefits to ecosystem and community are estimated from the field visit observations. Because Option A represents no change to current O&M, it also represents the current state of the levee.

OPTION A

Current maintenance practices

No change in maintenance practices or plant composition.



VEGETATION STRATEGY

The levee is maintained as much as possible without any woody vegetation and no herbaceous vegetation taller than 6 inches. Plant growth has been prevented by prescribed burns or mowing.

Unable to mow on the waterside slope due to inability to take mowers across the train tracks.

Liquid Amber moves in quickly.

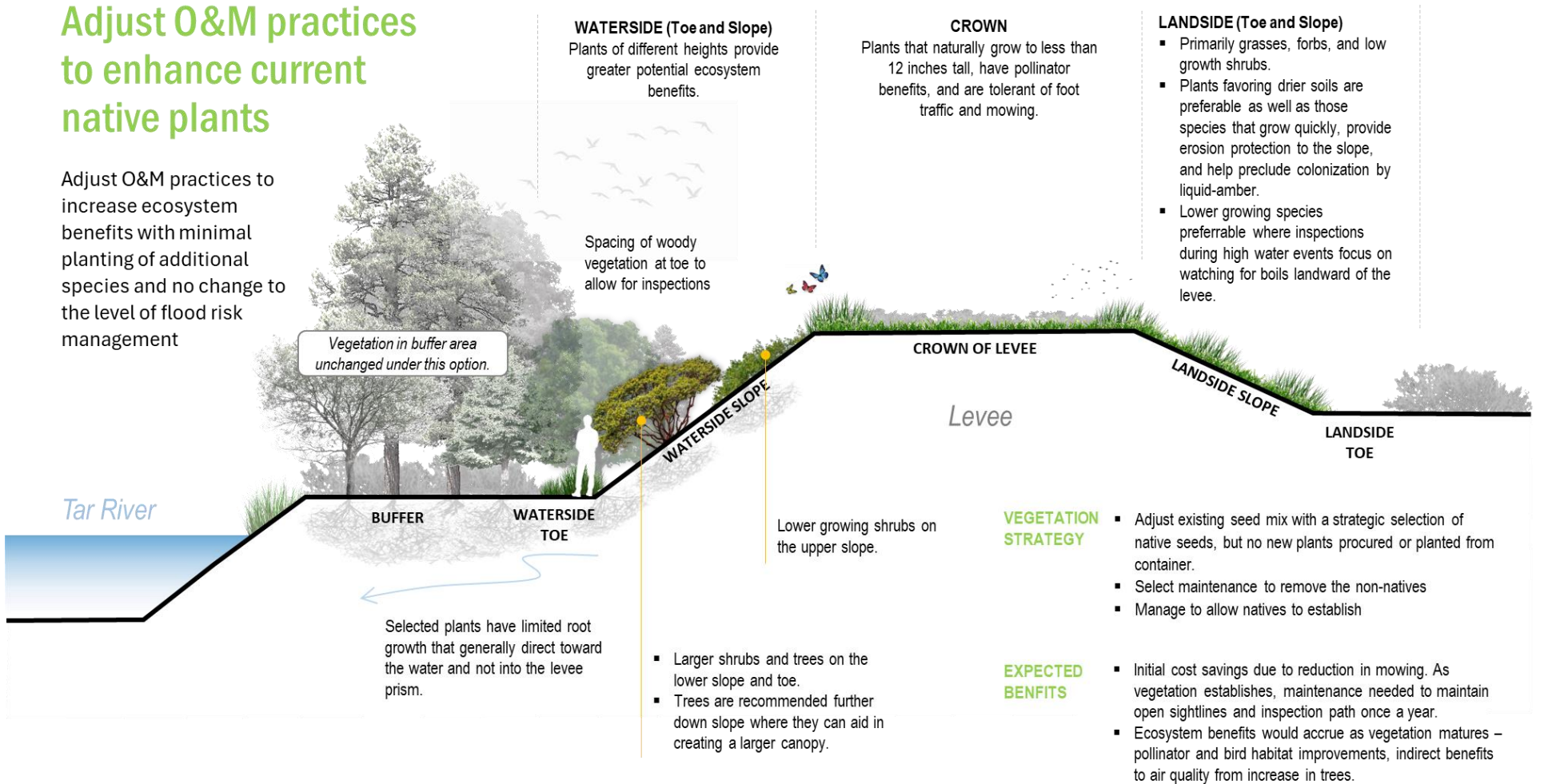
EXPECTED BENEFITS

Existing conditions – no change.

OPTION B

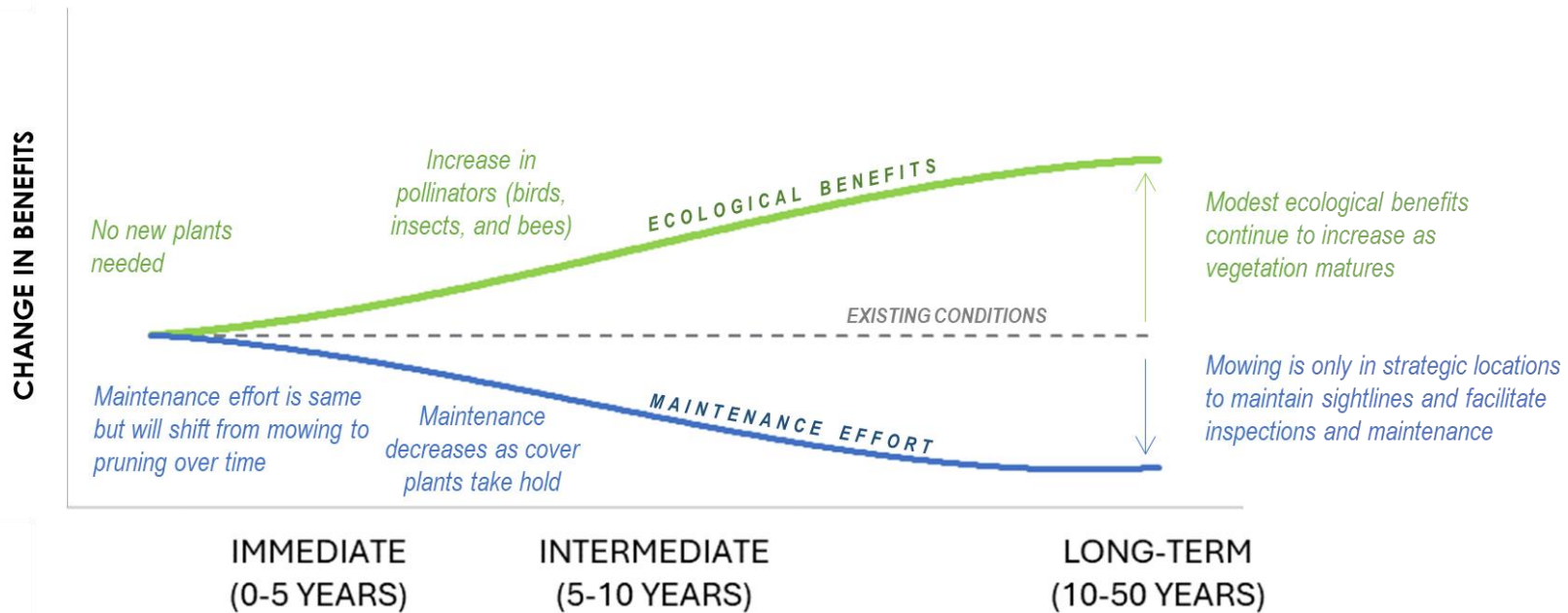
Adjust O&M practices to enhance current native plants

Adjust O&M practices to increase ecosystem benefits with minimal planting of additional species and no change to the level of flood risk management



OPTION B

Adjust O&M practices to enhance current native plants

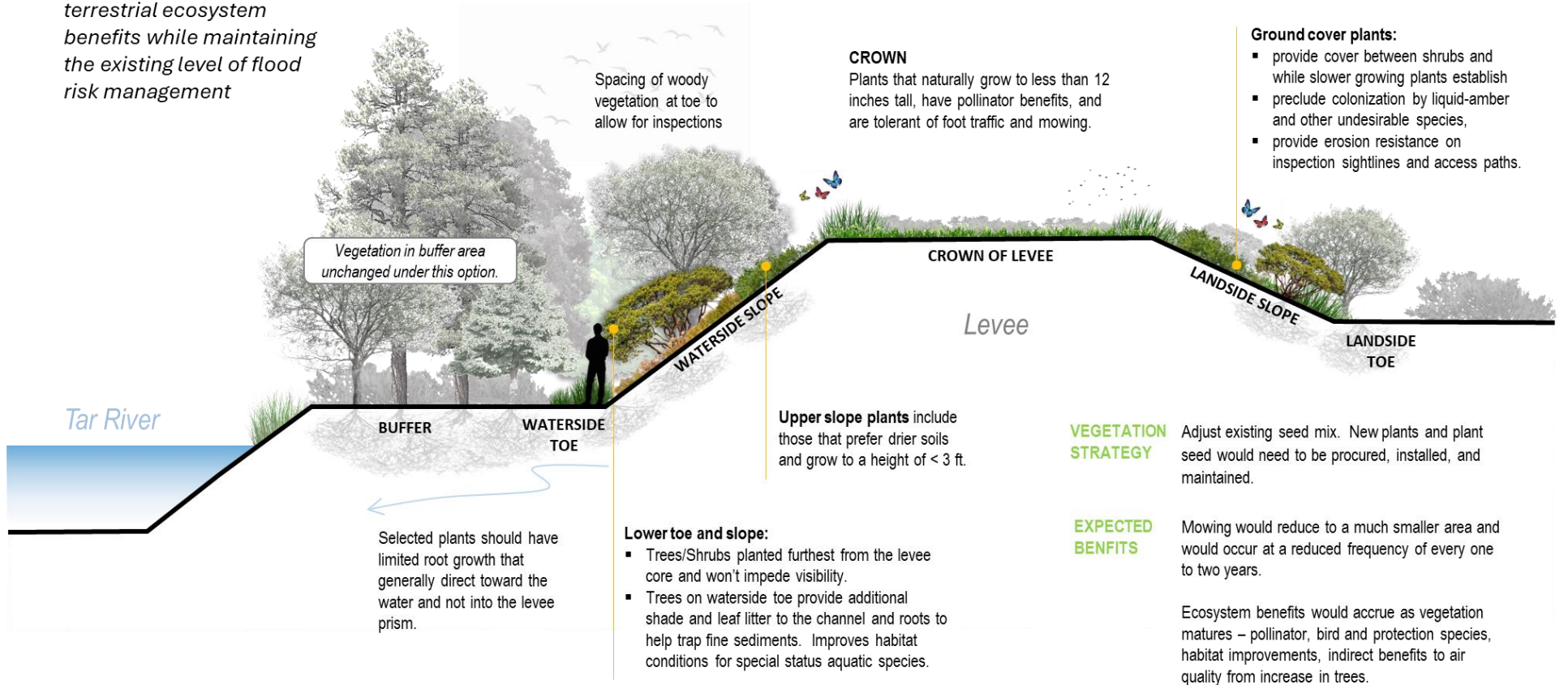


MAINTENANCE	<ul style="list-style-type: none"> • 4 maintenance events per year • Less mowing and more pruning 	<ul style="list-style-type: none"> • Slope mowing frequency and area reduced • Mow crown once per year • Expect planting adjustments and pruning 	<ul style="list-style-type: none"> • Mowing and pruning to maintain sightlines and inspection paths • Maintenance of levee slope plants as needed
ECOSYSTEM	<ul style="list-style-type: none"> • No new plants needed • Increase in pollinators 	<ul style="list-style-type: none"> • Continue increase in pollinators • Potential increase in bioretention during floods • Maintenance costs begin to reduce 	<ul style="list-style-type: none"> • Increase ecosystem benefits to many plants, wildlife, and people • Reduced mowing

OPTION C

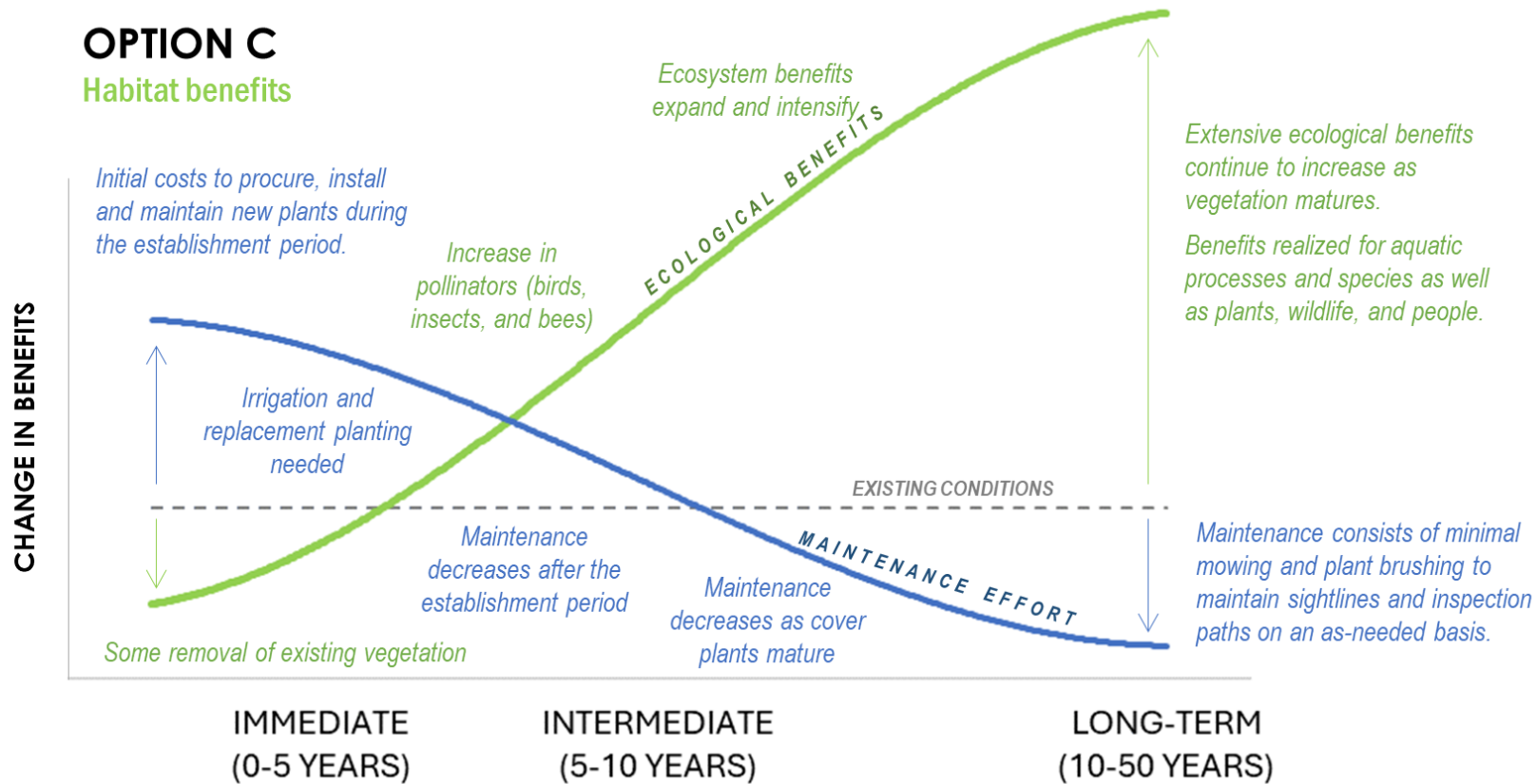
Habitat benefits

Maximum aquatic and terrestrial ecosystem benefits while maintaining the existing level of flood risk management



OPTION C

Habitat benefits

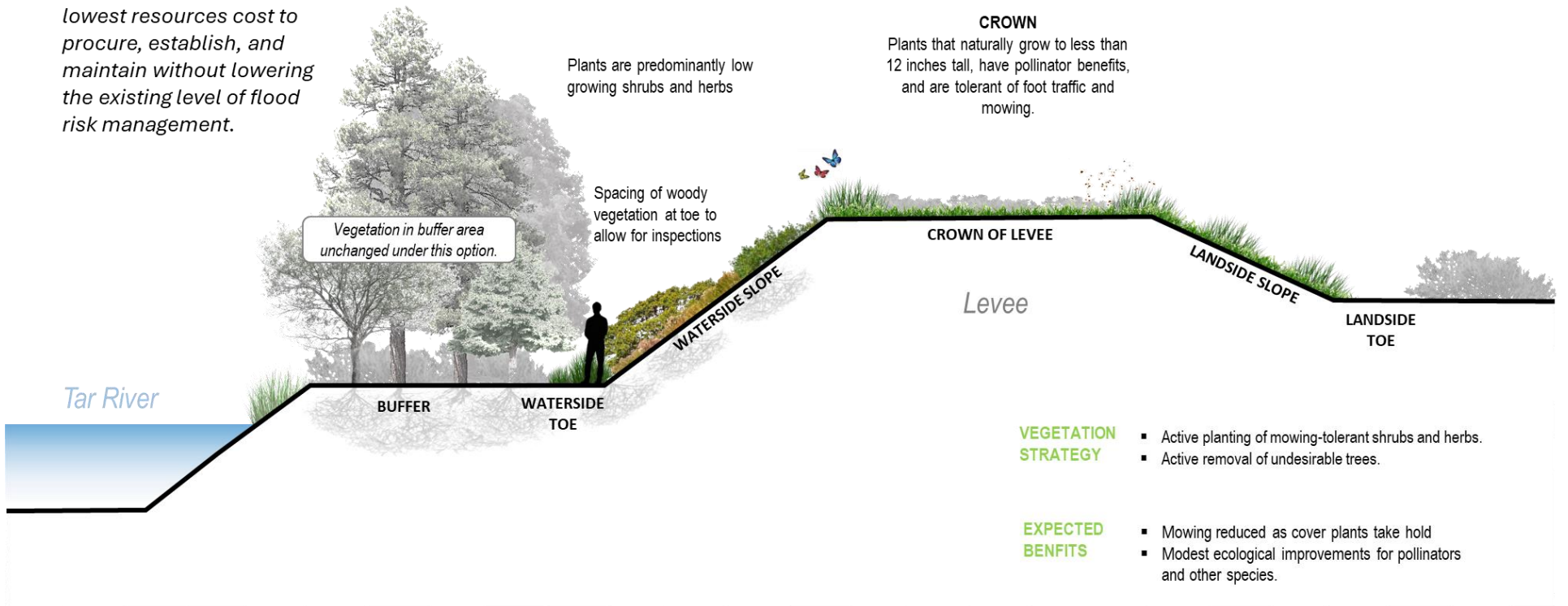


MAINTENANCE	<ul style="list-style-type: none"> Remove existing vegetation Procure new plants Establish new plantings with irrigation, maintenance, and replacements as needed 	<ul style="list-style-type: none"> Slope and crown mowing frequency and area reduced Expect pruning and cutting to maintain sightlines and inspection paths Reduce and then end irrigation 	<ul style="list-style-type: none"> Mowing and pruning to maintain sightlines and inspection paths as needed
ECOSYSTEM	<ul style="list-style-type: none"> Increase in pollinators- birds, insects, and bees Ecosystems improve over time 	<ul style="list-style-type: none"> Continue increase in pollinators Potential increase in bioretention during floods Maintenance costs begin to reduce as plants establish and invasive species are out-competed. 	<ul style="list-style-type: none"> Max ecosystem benefits aquatic processes and species as well as plants, wildlife, and people. Minimal mowing and plant brushing.

OPTION D

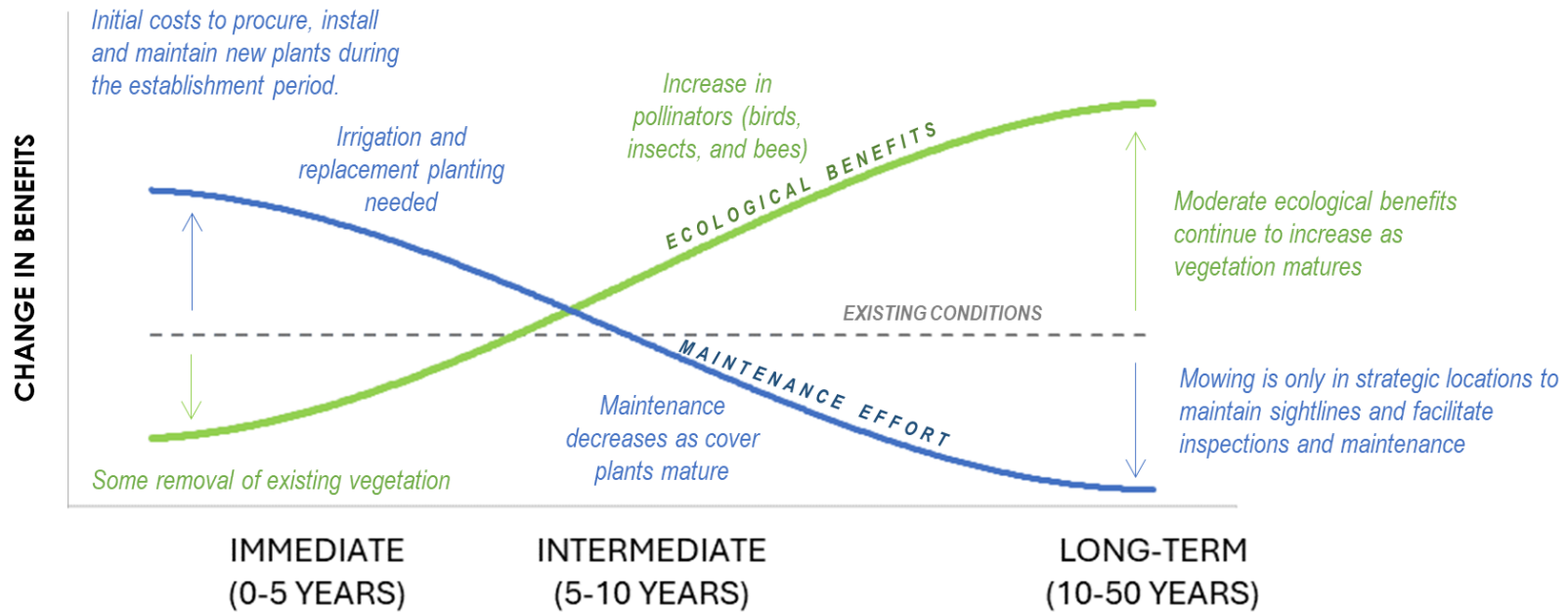
Minimize resource costs

Planting and maintenance measures that are the lowest resources cost to procure, establish, and maintain without lowering the existing level of flood risk management.



OPTION D

Minimize resource costs



MAINTENANCE	<ul style="list-style-type: none"> Remove existing vegetation Procure new plants Establish new plantings with irrigation, maintenance, and replacements as needed Establishing time and irrigation needs are less than in Option C 	<ul style="list-style-type: none"> Mowing reduced as cover plants take hold Reduce and then end irrigation 	<ul style="list-style-type: none"> Minimal and only as needed
ECOSYSTEM	<ul style="list-style-type: none"> Increase in pollinators- birds, insects, and bees 	<ul style="list-style-type: none"> Continue increase in pollinators Maintenance decreases as ground cover plants spread 	<ul style="list-style-type: none"> Pollinator related ecosystem benefits No mowing and minimal plant brushing.

5 SUMMARY

The Princeville levee reduces the risk of flooding from the Tar River to the community of Princeville, NC and immediate surrounding area. The levee has traditionally been maintained in accordance with IAW Corps policy. All vegetation on the crown, slopes, and within 15 ft of either toe consists of mowed herbaceous vegetation. The exception is a reach where there are extenuating circumstances concerning mowing due to restrictions on crossing the railroad tracks. USACE policy regarding vegetation on levees has been modified in recent decades due to congressional requirements set forth in the Water Resources Reform and Development Act of 2014 and further changes may be considered. These changes are focused on allowing for planned and managed woody and non-woody vegetation on levees so that levees can provide flood risk management and ecosystem benefits. EWN project 22-17, Understanding and Evaluating Ecosystem and Engineering Risks and Benefits Associated with Native Vegetation on Riverside Levees, is focused on developing the information needed for levee sponsors and USACE districts to design, implement, maintain, and inspect a levee with the appropriate ecosystem enhancing vegetation. An essential part of this project is identifying vegetation species and planting locations that are easily managed and do not reduce the flood risk management function of the levee.

The USACE team working on this EWN project visited the Princeville levee as an example of levees in the Southeastern US temperate climate near the transition from Piedmont to Coastal Plain. We walked the majority of the levee length with district personnel and were joined by the levee sponsor for some of the site visit. During this full day field visit we learned about the operation and maintenance practices and costs, how the levee has performed in high flow events, levee repair history, and existing biological conditions. The different sections of the levee have different maintenance practices due to access restrictions to the area past the railroad crossing and the construction of the highway which made part of the old levee redundant. Thus, we were able to see how and what vegetation would opportunistically populate the levee slopes and crown without maintenance. From these observations, conversations, and additional background research the team developed four options for future levee operation and management.

Each option is defined through the O&M actions that would be needed to meet an objective that is in addition to flood risk management. Option A posits no change to the current levee O&M practices. This provides the cost and ecosystem benefits basis on which the remaining options could be evaluated. Option B focuses on changes in O&M practices to increase ecosystem benefits as much as possible while minimizing the planting of additional species and maintaining the current level of flood risk management. In this option, the plants are not changed, and the focus is on shifting the maintenance to encourage growth of some existing plants over others. Option C envisions a full-scale change in plantings on the levee in order to maximize aquatic and terrestrial ecosystem benefits while maintaining the existing level of

flood risk management. In contrast to Option B, rather than optimizing existing species assemblages, native plant species that provide the greatest possible benefits are planted. Option D selects for the lowest cost over the long term. The levee is replanted with species that will require minimal maintenance once established.

The relative costs and benefits of Options B-D are compared to Option A, maintaining the existing condition. The initial costs of Options C and D are high due to the need to remove existing vegetation, procure new plants, and establish the new plantings. Option C may have higher initial costs than Option D, depending on the plants and irrigation needs. There is potential to schedule plantings, and associated costs, over time to create staggered blooming times and plan for plant succession. Options C and D have the lowest long-term O&M costs as the maintenance will be reduced to brushing and sightline clearing as needed for inspection. Option B is a mid-range choice. Option B has the least changes in planting, and therefore no or minimal increase in costs, and instead focuses on how maintenance may be adjusted to encourage growth of those natives that are present and beneficial while continuing to mow and remove non-native and undesirable species. The long-term maintenance is reduced the most when the vegetation is changed for this purpose, as in Options C and D. The difference between them is extent of ecosystem benefits that may be realized. Option C produces the greatest ecosystem benefits by creating vertical habitat diversity and generating greater community and water quality benefits.

This report is meant to inform the options and planting choices, while the choice of O&M option is made locally. Two tables of plant species are included. Table B-1 lists the plant species currently growing on or near the levee, that are native to the area, do not pose a hazard to workers or inspectors, and are appropriate for planting due to rooting depth and spread, growth characteristics, native status, and ecosystem benefits such as pollination or bioremediation. * Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 includes all plants that would be suitable to be planted on the levee, would enhance the terrestrial and aquatic ecosystems along with plant characteristics and the ecosystem benefits provided. In both tables, the appropriate planting location on the levee is identified. The tables are meant to be inclusive, providing many plant options. In practice, a limited number of plants should be chosen to keep the O&M reasonable. For each levee zone, there should be three to five species selected and mixed together well in terms of cover, height, and benefit.

APPENDIX A: DOMINANT SPECIES PROFILES FROM THE SITE VISIT

Species: Liquidamber (*Liquidambar styraciflua*)



© Texas Tech University

Maximum size for the species*: 48 inches DBH, 50-150 feet tall

Location on levee profile found: Located on all zones of the profile but with a majority on the slopes and crown

**Record tree size excluded*

CONSIDERATIONS FOR LEVEE SAFETY:

Deciduous

ECOLOGICAL TRAITS:

- Early successional species, adaptable and versatile, but poor competitor
- Food source for beavers and other rodents

MANAGEMENT CONSIDERATIONS:

- Not shade tolerant, easily shaded out by other species at all phases of life
- Native to eastern US
- Re-sprouts from root suckers after being top-killed
- Not tolerant of fire, particularly in the growing season
- Rots rapidly

TREE FAILURE MECHANICS:

Soft weak wood with high water content

ROOTING PATTERN:

- Root geometry varies with environmental conditions. Deep and gravelly soils result in deep taproots, trees grown in areas with poor drainage develop a shallow spreading root system.
- Maximum rooting depth: 3-5 feet

**Note that figures are representative of geometry and not to scale.*

Species: Black Birch (*Betula nigra*)



Maximum size for the species*: 24-36 inches DBH, 50-80 feet tall

Location on levee profile found: Only found at the waterside toe and beyond

*Record tree size excluded

Considerations for Levee Safety:

Deciduous

Ecological traits:

- Occurs solely in bottomland habitats, serves as an indicator for these habitat types
- Seeds are an important food source for wild birds including song birds and ground birds
- Provides nesting and cover habitat for waterfowl
- Native to eastern US

Management Considerations:

- Disease, heat, and flood tolerant to 240 days
- Re-sprouts from root crown after being top-killed
- Fire and shade intolerant
- Does not spread vegetatively
- Almost always composed of numerous small trunks

Tree Failure Mechanics:

Wood is hard, strong, and close grained.

Rooting pattern:

- Black birch roots are very shallow and spreading, forming a dense mat.
- Maximum rooting depth: Less than 3 feet

*Note that figures are representative of geometry and not to scale.

Species: Water Oak (*Quercus nigra*)



Maximum size for the species*: 24-36 inches DBH, 60-80 feet tall

Location on levee profile found: Only found at the waterside toe and beyond

*Record tree size excluded

Considerations for Levee Safety:

Winter deciduous

Ecological traits:

- Of great importance to wildlife. Provides cover, food, and habitat to numerous species.
- Provides cavities for nesting for woodpeckers
- Provides habitat for flying squirrels
- Acorns are a vital fall/winter food source for birds and mammals. Acorns have a long “shelf life”
- Native to eastern US

Management Considerations:

- May grow 24 inches per year
- Highly susceptible to insects and disease, although this damages the tree, it is unlikely to kill it
- Re-sprouts from root crown after being top-killed
- Tolerant of flooding in non-consecutive years
- Intolerant of fire
- Does not spread vegetatively

Tree Failure Mechanics:

- Wood varies based on growing conditions. When grown under moist conditions, wood is weak.
- Prone to drop branches and trunk is often hollow at maturity.

Rooting pattern:

- Shallow spreading root habit
Maximum rooting depth: Less than 3 feet

**Note that figures are representative of geometry and not to scale.*

Species: Loblolly pine (*Pinus taeda*)



Maximum size for the species*: 24-30 inches DBH, 90-110 feet tall

Location on levee profile found: Found on the lower half of the waterside of the levee and on the landside toe.

**Record tree size excluded*

Considerations for Levee Safety:

Evergreen

Ecological traits:

- Pine seeds are an important food source for songbirds and mammals.
- Trees provide cover and habitat for white-tailed deer, ground birds, and squirrels. Older trees provide cavity nest sites for woodpeckers.
- Native to eastern US

Management Considerations:

- Prone to several diseases and insect infestations including bark beetles and root rots.
- Fire resistant and reliant on fire to control diseases, insects, and competition at the stand level
- Fast growing, produces abundant litter

Tree Failure Mechanics:

- Wood is hard, dense, straight grained and possessing an excellent strength-to-weight ratio.
- Windfirm in deep soils, but prone to windthrow in shallow soils.

Rooting pattern:

- Maximum rooting depth: Up to 5 feet

*Note that figures are representative of geometry and not to scale.

Species: Virginia Creeper (*Parthenocissus quinquefolia*)



Maximum size for the species: Climbing vine 3 to 40 feet tall; stems to 3 inches in diameter

Location on levee profile found: Found on both the land and waterside of the levee from the toe to the crown, but not on the crown.

CONSIDERATIONS FOR LEVEE SAFETY:

Deciduous

ECOLOGICAL TRAITS:

- Fruits provide important food source for song birds
- Leaves provide browse for deer
- Plant provides important shelter habitat for small birds and mammals
- Often used for watershed protection and erosion control

MANAGEMENT CONSIDERATIONS:

- Can survive in full sun or full shade, or anything in between
- Tolerates of any kind of soil
- Not sensitive to pollution, salt, or windy conditions.
- Hardy survivor, difficult to kill
- Native to eastern US
- Re-sprouts from root suckers after being top-killed; can be cut back to the base
- Can grow 20 to 50 feet in a year
- Not tolerant of fire

ROOTING PATTERN:

- Roots occur at any point where stems touch the soil. Also forms adventitious roots that climb up structures.
- Maximum rooting depth: unknown, but likely less than 3 feet

Species: Common greenbrier (*Smilax rotundifolia*)



Maximum size for the species: Less than 6 inches DBH, climbs to 20 feet.

Location on levee profile found: Located on all zones of the profile

Considerations for Levee Safety:

Winter Deciduous

Ecological traits:

- Fruits provide a food source to songbirds
- Food source for white tailed deer
- Provides cover for small birds
- A pioneer species that decreases in percent cover, but remains present in smaller amounts, as the system matures

MANAGEMENT CONSIDERATIONS:

- Has an extreme flammability rating
- Native to eastern US
- Re-sprouts from rhizomes after being top-killed
- Fire persistent
- Resistant to herbicides
- Shading suppresses growth

ROOTING PATTERN:

- Shallow and spreading from rhizomes
- Maximum rooting depth: 3-5 feet

APPENDIX B: PLANTING TABLES

Two planting tables are presented.

Table B-1 corresponds to Option B: optimize ecosystems with current plants. lists the plant species present that are native to the area, non-poisonous, and appropriate for planting due to rooting depth and spread, growth characteristics, native status, and ecosystem benefits such as pollination or bioremediation.

* Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 may be used when planning a planting and maintenance plan for Option C: optimize ecosystems. * Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2 includes all plants suitable to the area that would enhance the terrestrial and aquatic ecosystems and maximize ecosystem benefits to plants, animals, and people.

Table B-1. Preferred planting locations for species identified during site visit. Corresponds to Option B.

Type	Common Name	Scientific Name	Average Height (ft)	Benefits	Landside toe	Landside slope	Crown	Waterside Upper Slope	Waterside Lower Slope	Waterside Toe
Forb, shrub	Virginia Creeper	<i>Parthenocissus Quinquefolia</i>	0.25 – 0.5	Grows easily, can be mowed	x	x	x	x	x	x
Forb	Lyreleaf Sage	<i>Salvia Lyrata</i>	1	Meadow areas, Pollinator. Tolerant of mowing	x	x		x		
Forb	Creeping Bush-clover	<i>Lespedeza Repens</i>	0.75	Vine, drier soils, Pollinator	x	x		x		
Grass (like)	Carolina Sedge	<i>Carex Caroliniana</i>	1	Floodplain forests						x
Grass	Little Barley	<i>Hordeum Pusillum</i>	0.5	good for crown			x			
Grass or Forb	Flattened Oatgrass	<i>Danthonia compressa*</i>	1	good for slopes, drought tolerant, easy to grow and maintain	x	x				
Shrub	Swamp Rose	<i>Rosa Palustris</i>	0.5	Bioretention capable, Pollinator						x
Shrub	Northern Dewberry	<i>Rubus Flagellaris</i>	0.5	Grows as a vine in semi-shade, Pollinator		x		x		
Shrub	Trumpet Vine	<i>Campsis Radicans</i>	0.5	Grows everywhere, Pollinator	x	x		x	x	x
Shrub	Roundleaf Greenbrier	<i>Smilax Rotundifolia</i>	3	Pioneer vine-like species, Pollinator		x		x		
Shrub	Dwarf Sumac	<i>Rhus Copallium</i>	3	NCSU recommended for erosion control, Pollinator		x		x	x	
Shrub	Smooth Azalea	<i>Rhododendron Arborescens</i>	8	Bioretention capable, wet soils, Pollinator						x
Shrub	Winter Grape	<i>Vitis Cinera</i>	5	Pollinator						x
Tree	Willow Oak	<i>Quercus Phellos</i>	6	Bioretention capable, well drained soils				x	x	
Tree	Sassafras	<i>Sassafras Albidium</i>	6	taproots can be reach 20 inches, Pollinator				x	x	
Tree	Water Oak	<i>Quercus Nigra</i>	20	Bioretention capable						x
Tree	Black Birch	<i>Betula Nigra</i>	30	Bioretention capable, dense shallow roots						x
Tree	American Beech	<i>Fagus Grandifolia</i>	35	Grows in well drained soils	x					
Tree	Loblolly Pine	<i>Pinus Taeda</i>	40	better in deeper soils, such as on landside toe	x					

* Flattened oatgrass is not currently present on the levee but is proposed to replace invasive Tall Fescue (*Festuca arundinacea*), for any routine re-seeding.

Table B-2. Preferred planting locations and benefits for all species that would be suitable under Option C. The furthest column to the right indicates those plants that minimize resource costs, Option D.

Type	Common Name	Scientific Name	Characteristics	Benefits	Crown	Ground Cover	Upper Slope	Lower Slope	Waterside Toe	Landside Toe	Lowest Cost
Herb	Plantain Pussytoes	<i>Antennaria plantaginifolia</i>	Less than 1 foot tall at maturity. Perennial wildflower.	Tolerant of mowing.	x		x	x			x
Herb	Canada wild ginger	<i>Asarum canadense</i>	Up to 6 inches tall, thrives in full shade, forms dense colonies from rhizomes	Benefits pollinators. Helps prevent invasive species.		x					
Herb	Common Butterfly-weed	<i>Asclepias tuberosa</i> var. <i>tuberosa</i>	Grows to about 36 inches, seeds readily.	Benefits butterflies at multiple life stages.			x	x			
Herb	Meadow Sedge, Blue Wood Sedge	<i>Carex flaccosperma</i>	Grows to 12 inches. Flood tolerant.	Benefits butterfly larvae. Helps prevent invasive species.					x		
Herb	Pennsylvania Sedge	<i>Carex pennsylvanica</i>	Less than 1 foot tall at maturity. Occurs on grass balds.	Reproduces readily and promotes good ground cover.	x						x
Herb	Green-and-gold	<i>Chrysogonum virginianum</i>	Less than 2 inches tall at maturity. Forms a spreading mat.	Benefits birds, butterflies, and native bees. Reproduces readily, promotes good ground cover, helps prevent invasive species.	x	x					x
Herb	Mistflower, Ageratum	<i>Conoclinium coelestinum</i> (<i>Eupatorium coelestinum</i>)	Grows to about 36 inches. Flood tolerant.	Benefits birds and pollinators. Helps prevent invasive species.					x		
Herb	Lobed Tickseed	<i>Coreopsis auriculata</i>	Less than 1 foot tall at maturity. Perennial wildflower. Naturally occurs on slopes.	Pollinator benefit			x	x			x
Herb	Longstalk Coreopsis	<i>Coreopsis lanceolata</i>	Grows to about 24 inches. Tolerant of a wide range of conditions.	Benefits birds and pollinators.			x				
Herb	Flattened Oatgrass	<i>Danthonia compressa</i>	Less than 1 foot tall at maturity. Occurs on grass balds.	Tolerates a wide range of conditions	x		x	x			x
Herb	Scouring rush	<i>Equisetum hyemale</i>	Forms dense colonies. Aggressive.	Benefits birds. Helps prevent invasive species.			x	x			
Herb	Purple Lovegrass	<i>Eragrostis spectabilis</i>	Up to 18 inches tall. Reproduces easily.	Benefits insects.			x	x			x
Herb	Robin's Plantain	<i>Erigeron pulchellus</i> var. <i>pulchellus</i>	Up to 18 inches tall. Forms colonies.	Benefits pollinators.			x	x			x

Type	Common Name	Scientific Name	Characteristics	Benefits	Crown	Ground Cover	Upper Slope	Lower Slope	Waterside Toe	Landside Toe	Lowest Cost
Herb	White wood aster	<i>Eurybia divaricate</i>	Grows to about 36 inches. Shade tolerant.	Benefits pollinators. Helps prevent invasive species.				x		x	
Herb	Beetleweed	<i>Galax urceolata</i>	Grows up to 6 inches. Thrives in deep shade, forms colonies.	Benefits insects. Helps prevent invasive species.		x					
Herb	Rose Verbena, Rose Vervain	<i>Glandularia canadensis (Verbena canadensis)</i>	Grows to about 12 inches. Drought tolerant, self-seeding and spreading.	Benefits birds, pollinators, and other insects.			x				
Herb	Common Stargrass	<i>Hypoxis hirsuta</i>	Up to 10 inches tall. Spreads easily.	Benefits pollinators.			x	x			x
Herb	Fringed Loosestrife	<i>Lysimachia ciliata</i>	Grows to about 30 inches. Flood tolerant.	Benefits birds, pollinators, and other insects. Helps prevent invasive species.					x		
Herb	Whorled Loosestrife	<i>Lysimachia quadrifolia</i>	Grows to about 36 inches. Tolerant of a wide range of conditions.	Benefits birds, pollinators, and other insects. Helps prevent invasive species.				x			
Herb	Northern Sundrops	<i>Oenothera tetragona</i>	Less than 2 feet tall at maturity. Hardy, tolerates many conditions.	Benefits pollinators.			x	x			x
Herb	Phacelia	<i>Phacelia bipinnatifida</i>	Less than 1 foot tall at maturity. Perennial wildflower.	Pollinator benefit	x						x
Herb	Eastern Blue Phlox	<i>Phlox divaricata</i>	Less than 2 feet tall at maturity.	Benefits pollinators. Helps prevent invasive species.			x				
Herb	Downy Phlox	<i>Phlox pilosa ssp. pilosa</i>	Less than 2 feet tall at maturity.	Benefits pollinators. Helps prevent invasive species.			x				x
Herb	Creeping Phlox	<i>Phlox stolonifera</i>	Up to 10 inches tall. Needs some shade.	Benefits pollinators.		x	x	x			x
Herb	Fragrant Rabbit Tobacco	<i>Pseudognaphalium (Gnaphalium) obtusifolium</i>	Grows to about 40 inches, with dense fibrous roots, forms colonies.	Benefits butterfly larvae.				x		x	
Herb	Lyre-leaf Sage	<i>Salvia lyrata</i>	Less than 2 feet tall at maturity. Tolerates mowing and foot traffic.	Benefits pollinators. Helps prevent invasive species.			x				x
Herb	Little Bluestem	<i>Schizachyrium scoparium var. scoparium (Andropogon scoparius)</i>	Grows to 48 inches, tolerates a wide range of moisture and sun	Benefits butterfly larvae. Helps prevent invasive species.				x			

Type	Common Name	Scientific Name	Characteristics	Benefits	Crown	Ground Cover	Upper Slope	Lower Slope	Waterside Toe	Landside Toe	Lowest Cost
Herb	Heartleaf Skullcap	<i>Scutellaria ovata ssp. ovata</i>	Grows to about 18 inches. Aggressive spreader.	Benefits bumblebees and moths.			x				
Herb	Eastern Blue-eyed Grass	<i>Sisyrinchium atlanticum</i>	Less than 1 foot tall at maturity. Perennial wildflower.	Pollinator benefit	x						x
Herb	Wreath Goldenrod	<i>Solidago caesia var. caesia</i>	Up to 48 inches.	Benefits birds, pollinators, and other insects.				x		x	
Herb	Meadow-parsnip	<i>Thaspium barbinode</i>	Grows to about 36 inches. Spreads easily.	Benefits birds, pollinators, and other insects.				x			
Herb	Foamflower	<i>Tiarella cordifolia</i> (includes <i>Tiarella wherryi</i>)	Survives well in deep shade, tolerant of flooding. Grows to about 12 inches.	Benefits birds, pollinators, and other insects. Helps prevent invasive species.					x		
Herb	Carolina Clover	<i>Trifolium carolinianum</i>	Grows to 12 inches. Thrives in full sun, tolerates foot traffic and mowing.	Benefits birds, pollinators, and other insects.	x						
Herb	Appalachian Ironweed	<i>Vernonia glauca</i>	Grows to about 36 inches. Tolerant of a wide range of soil conditions.	Benefits birds, pollinators, and other insects.				x		x	
Herb	Sand violet	<i>Viola affinis</i>	Grows to about 6 inches. Rhizomatous.	Benefits pollinators. Helps prevent invasive species.		x					
Herb	White violet	<i>Viola blanda</i>	Grows to about 6 inches. Rhizomatous.	Benefits pollinators. Helps prevent invasive species.		x					
Herb	Downy violet	<i>Viola pubescens</i>	Grows to about 12 inches. Self-seeds.	Benefits pollinators. Helps prevent invasive species.			x				
Herb	Stiped white violet	<i>Viola striata</i>	Grows to about 12 inches. Self-seeds.	Benefits pollinators. Helps prevent invasive species.			x				
Herb	Heartleaf Golden-Alexanders	<i>Zizia aptera</i>	Grows to about 36 inches.	Benefits butterfly larvae.				x		x	
Herb	Common Golden-Alexanders	<i>Zizia aurea</i>	Grows to about 24 inches, tolerates a wide variety of soils and light regimes.	Benefits butterfly larvae.			x				
Shrub	Silverling	<i>Baccharis halimifolia</i>	Up to 6 feet tall, tolerant of a wide range of conditions.	Provides a late season nectar source. Benefits pollinators. Helps prevent invasive species.				x		x	

Type	Common Name	Scientific Name	Characteristics	Benefits	Crown	Ground Cover	Upper Slope	Lower Slope	Waterside Toe	Landside Toe	Lowest Cost
Shrub	New Jersey Tea	<i>Ceanothus americanus</i>	Less than 3 feet tall at maturity. Hard mast fruit, unlikely to attract rodents.	Benefits pollinators and birds. Winter deciduous.			x				x
Shrub	Sevenbark	<i>Hydrangea arborescens</i>	Generally 2-4 feet tall, occurring along stream banks.	Benefits pollinators.					x		
Shrub	Lloyd's St. John's-wort	<i>Hypericum lloydii</i>	18 inches at maturity. Greatly spreading.	Forms colonies. Adapted to fire and drought. Benefits insects, birds, and caterpillars.			x				x
Shrub	Northern Sheepkill	<i>Kalmia angustifolia</i>	12 inches tall at maturity.	Colonial, providing good groundcover. Benefits pollinators, moths, and birds. Helps prevent invasive species.			x				x
Shrub	Dwarf Wax-myrtle	<i>Morella pumila</i>	Up to 4 feet tall, tolerant of a wide range of conditions.	Benefits butterflies and moths at multiple lifestages. Helps prevent invasive species.				x			
Shrub	Dwarf Live Oak	<i>Quercus minima</i>	Less than 3 feet tall at maturity.	Forms colonies. Adapted to fire and drought. Benefits insects, birds, and caterpillars.			x				x
Shrub	Carolina Rose	<i>Rosa carolina</i>	Generally 2-3 feet tall, occurs in a wide variety of habitats.	Benefits pollinators, other insects, birds, and mammals. Helps prevent invasive species.			x	x		x	
Shrub	Coralberry	<i>Symphoricarpos orbiculatus</i>	Generally 3-4 feet tall, occurs on abandoned land.	Benefits birds and mammals. Helps prevent invasive species.						x	
Tree	Southern Sugar Maple	<i>Acer floridanum</i>	Generally, 20-25 feet tall. Tolerant of wind and a wide variety of soil types.	Pollinator benefit.					x	x	
Tree	Smooth Alder	<i>Alnus serrulata</i>	Generally, 12-20 feet tall, often multi-trunked and producing numerous root suckers. Described as very flood tolerant.	Pollinator benefit					x		
Tree	Black Birch	<i>Betula nigra</i>	30-50 feet tall. Naturally occurs on riverbanks, flood tolerant.	Seeds are an important food source for birds.					x		
Tree	Witch-hazel	<i>Hamamelis virginiana</i>	10-35 feet tall. Naturally occurs on stream banks, tolerant of flooding.	Provides crucial habitat for butterflies and moths at multiple life stages. Provides food source for birds.					x		
Tree	Wax myrtle	<i>Myrica cerifa</i>	Max height of 20 feet. Commonly used for erosion control. Tolerates a wide range of environmental conditions, including drought and flood.	Provides pollinator benefits. Dry waxy fruits are attractive to birds but not rodents. Helps prevent invasive species.					x	x	
Tree	Carolina willow	<i>Salix caroliniana</i>	Grows to 20 feet. Tolerant of saline soils, very flood tolerant	Sole habitat plant of the viceroy butterflies. Benefits numerous other butterfly species. Helps prevent invasive species.					x		

Type	Common Name	Scientific Name	Characteristics	Benefits	Crown	Ground Cover	Upper Slope	Lower Slope	Waterside Toe	Landside Toe	Lowest Cost
Tree	Black willow	<i>Salix nigra</i>	Can grow to 80 feet tall. Readily accepts pruning, tolerant of flooding, has a shallow spreading root system and often used in erosion control.	Provides food and habitat for pollinators at multiple life stages. Helps prevent invasive species.					x		
Tree	Silky willow	<i>Salix sericea</i>	Grows to about 12 feet. Tolerates standing water and siltation.	Provides special value to bees. Helps prevent invasive species.					x		
Vine	Climbing Aster	<i>Ampelaster carolinianus</i>	Climbing, deciduous vine	Benefits birds, butterfly larvae, bees, and browsing mammals.		x					
Vine	Cross-vine	<i>Bignonia capreolata</i>	Climbing, evergreen vine	Benefits hummingbirds and other pollinators. Helps prevent invasive species.		x					
vine	Trumpet-creeper	<i>Campsis radicans</i>	Climbing, deciduous vine	Benefits hummingbirds and other pollinators.		x					
Vine	Marsh Clematis, Southern Leatherflower	<i>Clematis crispa</i>	Climbing, deciduous vine	Benefits hummingbirds and other pollinators.		x					
Vine	Virgin's-bower, Old Man's Beard	<i>Clematis virginiana</i>	Climbing, deciduous vine	Benefits birds and moth larvae.		x					
Vine	Carolina Jessamine	<i>Gelsemium sempervirens</i>	Climbing, evergreen vine	Benefits hummingbirds and other pollinators. Helps prevent invasive species.		x					
Vine	Scarlet Creeper, Red Morning-glory	<i>Ipomoea coccinea</i>	Annual vine	Benefits hummingbirds and other pollinators.		x					
Vine	Passionflower, Maypops	<i>Passiflora incarnata</i>	Climbing, deciduous vine	Benefits hummingbirds and other pollinators.		x					
Vine	Eastern Yellow Passionflower	<i>Passiflora lutea</i>	Climbing, deciduous vine	Benefits hummingbirds and other pollinators.		x					

APPENDIX C: FIELD SHEETS

Data sheets completed by the team during the site visit in April 2023.

Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good,</i>		<i>(Check for yes)</i>
None- Mowed					<input type="checkbox"/>
N/A					<input type="checkbox"/>
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>		<i>(Check for yes)</i>
None- Mowed					<input type="checkbox"/>
N/A					<input type="checkbox"/>
N/A					<input type="checkbox"/>
Dominant Herbaceous Species	Grass or Forb	Average Height	Density		Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
Anthoxanthum odoratum	Grass	3	c	I	<input type="checkbox"/>
Trifolium campestre	Forb	3	c	I	<input checked="" type="checkbox"/>
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
Eremochloa ophiuroides	Grass	3	P	I	<input type="checkbox"/>
Vicia hirsuta	Forb	3	p	I	<input checked="" type="checkbox"/>
Trifolium arvense	Forb	3	s	I	<input checked="" type="checkbox"/>
Substrate Type:	Substrate Condition	Biotic Stressors	Physical Stressors	Human Stressors	<input type="checkbox"/>
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrow <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails <input type="checkbox"/>	
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments <input type="checkbox"/>	
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering <input type="checkbox"/>	
Soil/Loam <input checked="" type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging <input type="checkbox"/>	
Clay/Fines <input checked="" type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism <input type="checkbox"/>	
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other: <input type="checkbox"/>	
Debris <input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>		
<p>This segment is maintained IAW Corps policy. All vegetation on the crown, slopes, and within 15 ft of either toe consists of mowed herbaceous vegetation. The primary species discernable are sweet vernal grass and centepede grass. Identification was made by distinctive odor for vernal grass and root tillers for centepede grass.</p>					

Levee Crown		Princeville Segment B- unmaintained (railroad)					
River:	Bank:	Right	Date:	4/27/2023	GPS:	35.891N / -077.533W	
Tar					Section:	Princeville Segment B- unmaintained (railroad)	
Levee Crown							
Total Canopy Coverage this zone: 5				Total exposed soil/dirt this zone: 0			
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>		<i>(Check for yes)</i>		
Liquidambar styraciflua	10	4	Good	N	<input type="checkbox"/>		
N/A					<input type="checkbox"/>		
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>		<i>(Check for yes)</i>		
N/A					<input type="checkbox"/>		
N/A					<input type="checkbox"/>		
N/A					<input type="checkbox"/>		
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>		<i>(Check for yes)</i>		
N/A					<input type="checkbox"/>		
N/A					<input type="checkbox"/>		
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>		<i>(Check for yes)</i>		
N/A					<input type="checkbox"/>		
N/A					<input type="checkbox"/>		
N/A					<input type="checkbox"/>		
Dominant Herbaceous Species	Grass or Forb	Average Height	Density		Pollinator Supporting		
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>		
Anthoxanthum odoratum	Grass	8	c	I	<input type="checkbox"/>		
Trifolium campestre	Forb	6	c	I	<input checked="" type="checkbox"/>		
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>		
Salvia lyrata	Forb	8	P	N	<input checked="" type="checkbox"/>		
					<input type="checkbox"/>		
					<input type="checkbox"/>		
Substrate Type:	Substrate Condition	Biotic Stressors	Physical Stressors	Human Stressors			
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrow <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails <input type="checkbox"/>			
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments <input type="checkbox"/>			
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering <input type="checkbox"/>			
Soil/Loam <input checked="" type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging <input type="checkbox"/>			
Clay/Fines <input checked="" type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut root <input type="checkbox"/>	Vandalism <input type="checkbox"/>			
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other:			
Debris <input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>				
Other:			Excess <input type="checkbox"/>				

Levee Upper Slope		Princeville Segment B- unmaintained (railroad)					
River:	Bank:	Right	Date:	4/27/2023	GPS:	35.891N / -077.533W	
Tar					Section:	Princeville Segment B- unmaintained (railroad)	
Upper Half							
Total Canopy Coverage this zone:			30		Total exposed soil/dirt this zone:		0
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>			(Check for yes)	
Liquidambar styraciflua	12	<2	Good*	N		<input type="checkbox"/>	
N/A	-	-	-	-		<input type="checkbox"/>	
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>			(Check for yes)	
N/A	-	-	-	-		<input type="checkbox"/>	
N/A	-	-	-	-		<input type="checkbox"/>	
N/A	-	-	-	-		<input type="checkbox"/>	
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>			(Check for yes)	
Parthenocissus	0.5	<1	G	N		<input checked="" type="checkbox"/>	
Lonicera japonica	0.5	<1	G	I		<input checked="" type="checkbox"/>	
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>			(Check for yes)	
Rosa palustris	0.5	<1	G	N		<input checked="" type="checkbox"/>	
-	-	-	-	-		<input type="checkbox"/>	
-	-	-	-	-		<input type="checkbox"/>	
Dominant Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>			(Check for yes)	
Anthoxanthum odoratum	G	24	C	I		<input type="checkbox"/>	
-	-	-	-	-		<input type="checkbox"/>	
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>			(Check for yes)	
-	-	-	-	-		<input type="checkbox"/>	
-	-	-	-	-		<input type="checkbox"/>	
-	-	-	-	-		<input type="checkbox"/>	
Substrate Type:	Substrate	Biotic Stressors	Physical Stressors	Human Stressors			
Riprap	<input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrows <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails	<input type="checkbox"/>	
Gravel	<input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments	<input type="checkbox"/>	
Sand	<input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering	<input type="checkbox"/>	
Soil/Loam	<input type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging	<input type="checkbox"/>	
Clay/Fines	<input checked="" type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism	<input type="checkbox"/>	
Paved	<input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other:		
Debris	<input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>			
Other:				Excess <input type="checkbox"/>			
*Pest infestation noted on some liquid amber trees, numerous caterpillars, some scale and galls present. Infestation and illness limited to a few trees.							

Levee Lower Slope		Princeville Segment B- unmaintained (railroad)			
River:	Bank:	Right	Date:	4/27/2023	GPS: 35.891, -77.534
Tar	Section: Princeville Segment B- unmaintained (railroad)				
Lower Half					
Total Canopy Coverage this zone:			20	Total exposed soil/dirt this zone: 0	
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Liquidambar styraciflua	10	3	G	Native	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Rubus flagellaris	0.5	<1	G	N	<input checked="" type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Campsis radicans	0.5	<1	G	N	<input checked="" type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Dominant Herbaceous Species	Grass or Forb	Average Height	Density		Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
Anthoxanthum odoratum	Grass	8	C	I	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
Vicia hirsuta	Forb	8	P	I	<input checked="" type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Substrate Type:	Substrate Condition	Biotic Stressors	Physical Stressors	Human Stressors	
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrows <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails <input type="checkbox"/>	
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments <input type="checkbox"/>	
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering <input type="checkbox"/>	
Soil/Loam <input checked="" type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging <input type="checkbox"/>	
Clay/Fines <input type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism <input type="checkbox"/>	
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other: <input type="checkbox"/>	
Debris <input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>		
Other: <input type="checkbox"/>			Excess <input type="checkbox"/>		

Levee Waterside Toe		Princeville Segment B- unmaintained (railroad)					
River:	Bank:	Right	Date: 4/27/2023	GPS:	35.891/-77.535		
Tar	Section: Princeville Segment B- unmaintained (railroad)						
Waterside Toe							
Total Canopy Coverage this zone:			60	Total exposed soil/dirt this zone:		0	
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>		
Betula nigra	30	18	G	N	<input type="checkbox"/>		
Liquidambar styraciflua	30	12	G	N	<input type="checkbox"/>		
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>		
Quercus nigra	20	8	G	N	<input type="checkbox"/>		
Pinus taeda	40	24	G	N	<input type="checkbox"/>		
NA	-	-	-	-	<input type="checkbox"/>		
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>		
Quercus phellos	6	2	G	N	<input type="checkbox"/>		
Quercus nigra	6	2	G	N	<input type="checkbox"/>		
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>		
Vitis cinera	5*	<1	G	N	<input checked="" type="checkbox"/>		
Liquidambar styraciflua	6	<1	G	N	<input type="checkbox"/>		
Parthenocissus quinquefolia	0.5	<1	G	N	<input checked="" type="checkbox"/>		
Rubus flagellaris	0.5	<1	G	N	<input checked="" type="checkbox"/>		
Dominant Herbaceous Species	Grass or Forb	Average Height	Density		Pollinator Supporting		
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>		
Anthoxanthum odoratum	Grass	6	C	I	<input type="checkbox"/>		
Carex caroliniana	Grass (like)	12	S	N	<input type="checkbox"/>		
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>		
NA	-	-	-	-	<input type="checkbox"/>		
NA	-	-	-	-	<input type="checkbox"/>		
NA	-	-	-	-	<input type="checkbox"/>		
Substrate Type:	Substrate Condition	Biotic Stressors	Physical Stressors	Human Stressors			
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrows <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails <input type="checkbox"/>			
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments <input type="checkbox"/>			
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering <input type="checkbox"/>			
Soil/Loam <input type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging <input type="checkbox"/>			
Clay/Fines <input checked="" type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism <input type="checkbox"/>			
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other: <input type="checkbox"/>			
Debris <input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>				
1 windthrown tree in the channel well beyond the levee toe. Canopy provided by adjacent riparian buffer.							

Levee Landside Toe		Princeville Segment B- unmaintained (railroad)			
River:	Bank:	Date: 4/27/2023	GP	35.891/77.534	
Tar		Section: Princeville Segment B- unmaintained (railroad)			
Landside Toe					
Total Canopy Coverage this zone:		20		Total exposed soil/dirt this zone: 0	
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Liquidambar styraciflua	15	4	G	N	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Rubus flagellaris	4	<1	G	N	<input checked="" type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Dominant Herbaceous Species	Grass or Forb	Average Height	Density		Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
Anthoxanthum odoratum	Grass	8	C	I	<input type="checkbox"/>
Salvia lyrata	Forb	10	P	N	<input checked="" type="checkbox"/>
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Substrate Type:	Substrate	Biotic Stressors	Physical Stressors	Human Stressors	
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrows <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails <input type="checkbox"/>	
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments <input type="checkbox"/>	
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering <input type="checkbox"/>	
Soil/Loam <input checked="" type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging <input type="checkbox"/>	
Clay/Fines <input type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism <input type="checkbox"/>	
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other: <input type="checkbox"/>	
Debris <input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>		
Other: <input type="checkbox"/>			Excess <input type="checkbox"/>		

Levee Crown		Princeville Segment C- Relict							
River:	Bank:	Right	Date: 4/27/2023	GPS:	35.87799N / -077.52972W				
Tar				Section:	Princeville Segment C- Relict				
Levee Crown									
Total Canopy Coverage this zone: 0				Total exposed soil/dirt this zone: 0					
Dominant Canopy Layer Species	Height	Average DBH	General Health		Native or Introduced	Pollinator Supporting			
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks and photograph)</i>			<i>(Check for yes)</i>			
N/A	-	-	-		-	<input type="checkbox"/>			
N/A	-	-	-		-	<input type="checkbox"/>			
Other Canopy Layer Species	Height	Average DBH	General Health		Native or Introduced	Pollinator Supporting			
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>			<i>(Check for yes)</i>			
N/A	-	-	-		-	<input type="checkbox"/>			
N/A	-	-	-		-	<input type="checkbox"/>			
N/A	-	-	-		-	<input type="checkbox"/>			
Dominant Shrub Layer Species	Height	Average DBH	General Health		Native or Introduced	Pollinator Supporting			
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>			<i>(Check for yes)</i>			
N/A	-	-	-		-	<input type="checkbox"/>			
N/A	-	-	-		-	<input type="checkbox"/>			
Other Shrub Layer Species	Height	Average DBH	General Health		Native or Introduced	Pollinator Supporting			
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>			<i>(Check for yes)</i>			
N/A	-	-	-		-	<input type="checkbox"/>			
N/A	-	-	-		-	<input type="checkbox"/>			
N/A	-	-	-		-	<input type="checkbox"/>			
Dominant Herbaceous Species	Grass or Forb	Average Height	Density			Pollinator Supporting			
<i>(Scientific Name)</i>		(in)	<i>(sparse, patchy, continuous)</i>			<i>(Check for yes)</i>			
Hordeum pusillum	Grass	6	c		N	<input type="checkbox"/>			
Trifolium arvense	Forb	6	p		I	<input checked="" type="checkbox"/>			
Other Herbaceous Species	Grass or Forb	Average Height	Density		Native or Introduced	Pollinator Supporting			
<i>(Scientific Name)</i>		(in)	<i>(sparse, patchy, continuous)</i>			<i>(Check for yes)</i>			
Anthoxanthum odoratum	Grass	6	P		I	<input type="checkbox"/>			
NA	-	-	-		-	<input type="checkbox"/>			
NA	-	-	-		-	<input type="checkbox"/>			
Substrate Type:	Substrate	Biotic Stressors		Physical Stressors		Human Stressors			
Riprap	<input type="checkbox"/>	Eroding	<input checked="" type="checkbox"/>	Animal Burrows	<input type="checkbox"/>	Fire	<input type="checkbox"/>	Social trails	<input type="checkbox"/>
Gravel	<input type="checkbox"/>	Aggrading	<input type="checkbox"/>	Overgrazing	<input type="checkbox"/>	Windthrow	<input type="checkbox"/>	Encampments	<input type="checkbox"/>
Sand	<input type="checkbox"/>	Stable	<input type="checkbox"/>			Full tree	<input type="checkbox"/>	Littering	<input type="checkbox"/>
Soil/Loam	<input checked="" type="checkbox"/>	Slumping	<input type="checkbox"/>			Branches	<input type="checkbox"/>	Digging	<input type="checkbox"/>
Clay/Fines	<input type="checkbox"/>	Rilling	<input type="checkbox"/>			Undercut roots	<input type="checkbox"/>	Vandalism	<input type="checkbox"/>
Paved	<input type="checkbox"/>	Scalloping	<input type="checkbox"/>			Water Stress	<input type="checkbox"/>	Other: Unpaved Road	
Debris	<input type="checkbox"/>	Cracking	<input type="checkbox"/>			Drought	<input type="checkbox"/>		
Other:						Excess	<input type="checkbox"/>		
Vehicular erosion, pot holes, settling on crown									

Levee Upper Slope		Princeville Segment C- Relict			
River:	Bank:	Date: 4/27/2023	GPS:	35.87799N / -077.52972W	
Tar			Section:	Princeville Segment C- Relict	
Upper Half					
Total Canopy Coverage this zone:		25	Total exposed soil/dirt this zone:		0
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Smilax rotundifolia	3	<1	G	N	<input checked="" type="checkbox"/>
Rubus flagellaris	0.5	<1	G	N	<input checked="" type="checkbox"/>
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Rhus copallium	3	<1	G	N	<input checked="" type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Dominant Herbaceous Species	Grass or Forb	Average Height	Density		Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
Viscia hirsuta	F	6	C	I	<input checked="" type="checkbox"/>
Festuca arundinacea	Grass or Forb	12	C	N	<input type="checkbox"/>
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
Parthenocissus	F	4	P	N	<input checked="" type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Substrate Type:	Substrate Condition	Biotic Stressors	Physical Stressors	Human Stressors	
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrows <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails <input type="checkbox"/>	
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments <input checked="" type="checkbox"/>	
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering <input type="checkbox"/>	
Soil/Loam <input checked="" type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging <input type="checkbox"/>	
Clay/Fines <input type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism <input type="checkbox"/>	
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other: <input type="checkbox"/>	
Debris <input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>		
Other: <input type="checkbox"/>			Excess <input type="checkbox"/>		

Levee Lower Slope		Princeville Segment C- Relict					
River: Tar	Bank: Right	Date: 4/27/2023	GPS:	35.87799N / -077.52972W			
			Section:	Princeville Segment C- Relict			
Lower Half							
Total Canopy Coverage this zone:		60		Total exposed soil/dirt this zone:		0	
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>		
Liquidambar styraciflua	35	18	G	N	<input type="checkbox"/>		
Pinus taeda	40	24	G	N	<input type="checkbox"/>		
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>		
Fagus grandifolia	35	18	G	N	<input type="checkbox"/>		
Sassafras albidum	6	2	G	N	<input checked="" type="checkbox"/>		
NA	-	-	-	-	<input type="checkbox"/>		
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>		
Rhododendron arborescens	8	1	G	N	<input checked="" type="checkbox"/>		
Lonicera japonica	8	<1	G	I	<input checked="" type="checkbox"/>		
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>		
Smilax rotundifolia	6	<1	G	N	<input checked="" type="checkbox"/>		
Parthenocissus quinquefolia	0.5	<1	G	N	<input checked="" type="checkbox"/>		
Toxicodendron radicans	0.5	<1	G	N	<input checked="" type="checkbox"/>		
Dominant Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>		
Viscia hirsuta	F	6	P	N	<input checked="" type="checkbox"/>		
Lespedeza repens	F	8	S	N	<input checked="" type="checkbox"/>		
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting		
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>		
NA	-	-	-	-	<input type="checkbox"/>		
NA	-	-	-	-	<input type="checkbox"/>		
NA	-	-	-	-	<input type="checkbox"/>		
Substrate Type:	Substrate Condition	Biotic Stressors	Physical Stressors	Human Stressors			
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrows <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails <input type="checkbox"/>			
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments <input type="checkbox"/>			
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering <input type="checkbox"/>			
Soil/Loam <input checked="" type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging <input type="checkbox"/>			
Clay/Fines <input checked="" type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism <input type="checkbox"/>			
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other: <input type="checkbox"/>			
Debris <input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>				
Other: <input type="checkbox"/>			Excess <input type="checkbox"/>				
No variation between middle and lower thirds, levee considered as upper half and lower half							

Levee Waterside Toe		Princeville Segment C- Relict			
River:	Bank: Right	Date: 4/27/2023	GPS:	35.87799N / -077.52972W	
Tar			Section:	Princeville Segment C- Relict	
Waterside Toe					
Total Canopy Coverage this zone:		0		Total exposed soil/dirt this zone: 0	
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Lonicera japonica	0.5	<1	G	I	<input checked="" type="checkbox"/>
Parthenocissus quinquefolia	0.5	<1	G	N	<input checked="" type="checkbox"/>
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>
Campsis radicans	0.5	<1	G	N	<input checked="" type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Dominant Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
Viscia hirsuta	F	4	C	I	<input checked="" type="checkbox"/>
Anthoxanthum odoratum	G	4	C	I	<input type="checkbox"/>
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
NA	-	-	-	-	<input type="checkbox"/>
Substrate Type:	Substrate Condition	Biotic Stressors	Physical Stressors	Human Stressors	<input type="checkbox"/>
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrows <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails <input type="checkbox"/>	
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments <input type="checkbox"/>	
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering <input type="checkbox"/>	
Soil/Loam <input checked="" type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging <input type="checkbox"/>	
Clay/Fines <input checked="" type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism <input type="checkbox"/>	
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other: <input type="checkbox"/>	
Debris <input type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>		
Other: <input type="checkbox"/>			Excess <input type="checkbox"/>		
Mowed as a road					

Levee Landside Toe		Princeville Segment C- Relict				
River:	Bank: Left	Date: 4/27/2023	GPS:	35.87799N / -077.52972W		
Tar			Section:	Princeville Segment C- Relict		
Landside Toe						
Total Canopy Coverage this zone:		100		Total exposed soil/dirt this zone:		0
Dominant Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting	
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>	
Pinus taeda	30	18	G	N	<input type="checkbox"/>	
Liquidambar styraciflua	30	4	G	N	<input type="checkbox"/>	
Other Canopy Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting	
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>	
Albizia julibrissin	12	2	G	I*	<input checked="" type="checkbox"/>	
NA	-	-	-	-	<input type="checkbox"/>	
NA	-	-	-	-	<input type="checkbox"/>	
Dominant Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting	
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>	
Rhus copallinum	6	<1	G	N	<input checked="" type="checkbox"/>	
Smilax rotundifolia	6	<1	G	N	<input checked="" type="checkbox"/>	
Other Shrub Layer Species	Height	Average DBH	General Health	Native or Introduced	Pollinator Supporting	
<i>(Scientific Name preferred)</i>	(ft)	(in)	<i>(If less than good, describe in remarks)</i>		<i>(Check for yes)</i>	
Prunus serotina	10	2	G	N	<input checked="" type="checkbox"/>	
Elaeagus umbellata	12	2	G	I*	<input checked="" type="checkbox"/>	
Parthenocissus quinquefolia	0.5	<1	G	N	<input checked="" type="checkbox"/>	
Campsis radicans	0.5	<1	G	N	<input checked="" type="checkbox"/>	
Dominant Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting	
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>	
Anthoxanthum odoratum	G	8	C	I	<input type="checkbox"/>	
Viscia hirsuta	F	6	P	I	<input checked="" type="checkbox"/>	
Other Herbaceous Species	Grass or Forb	Average Height	Density	Native or Introduced	Pollinator Supporting	
<i>(Scientific Name preferred)</i>		(in)	<i>(sparse, patchy, continuous)</i>		<i>(Check for yes)</i>	
NA	-	-	-	-	<input type="checkbox"/>	
NA	-	-	-	-	<input type="checkbox"/>	
NA	-	-	-	-	<input type="checkbox"/>	
Substrate Type:	Substrate Condition	Biotic Stressors	Physical Stressors	Human Stressors		
Riprap <input type="checkbox"/>	Eroding <input type="checkbox"/>	Animal Burrows <input type="checkbox"/>	Fire <input type="checkbox"/>	Social trails	<input type="checkbox"/>	
Gravel <input type="checkbox"/>	Aggrading <input type="checkbox"/>	Overgrazing <input type="checkbox"/>	Windthrow <input type="checkbox"/>	Encampments	<input type="checkbox"/>	
Sand <input type="checkbox"/>	Stable <input checked="" type="checkbox"/>		Full tree <input type="checkbox"/>	Littering	<input type="checkbox"/>	
Soil/Loam <input checked="" type="checkbox"/>	Slumping <input type="checkbox"/>		Branches <input type="checkbox"/>	Digging	<input type="checkbox"/>	
Clay/Fines <input checked="" type="checkbox"/>	Rilling <input type="checkbox"/>		Undercut roots <input type="checkbox"/>	Vandalism	<input type="checkbox"/>	
Paved <input type="checkbox"/>	Scalloping <input type="checkbox"/>		Water Stress <input type="checkbox"/>	Other:		
Debris <input checked="" type="checkbox"/>	Cracking <input type="checkbox"/>		Drought <input type="checkbox"/>			
Other:			Excess <input type="checkbox"/>			

Roadside private land. Significantly less herbaceous layer under loblolly pine. Patchy herbs only. Mimosa tree and autumn olive are