May 4, 2000

Dr. Lenore Tedesco
Director, Center for Earth and Environmental Sciences
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723 West Michigan St.
Indianapolis, IN 46202

Dear Dr. Tedesco:

On behalf of the School of Public and Environmental Affairs at IUPUI, we, Emily Kempf, Linda Jacobs, and Heide Liessmann are presenting our final plan of recommendations for the White River Riparian Restoration Project. This document contains final revisions of our past drafts. We would like to take this time to thank you for our experiences and allowing us to contribute to the project. We had learned a great deal in Dr. Greg Lindsey's learning workshop class. We believe that workshops are an excellent way for students to participate in city and University projects. It gave us an actual "hands on" approach to urban planning.

In addition to our last draft, we have added two sections, Proposed Alternative and Implementation. In the Proposed Alternative section we combined our ideas and opinions of the Advisory Committee to develop a hybrid approach. This new approach stresses the importance of education throughout.

The Implementation section contains future research and decisions we think should be taken into consideration before the planting begins. These steps could be critical to the future of the site. These decisions will require more time and effort, but we think they are necessary in order to accomplish the goals of the project and the University.

Again, thank you for this opportunity to be involved in this project.

Sincerely,

Linda Jacobs Emily Kempf Heide Liessmann

White River Riparian Restoration Project Plan

April 2000

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1.0 – Introduction

The White River Riparian Restoration Project (WRRRP) is a project that is currently under development by the Center for Earth and Environmental Sciences (CEES), along with city, state, and private agencies. This project involves reforestation along the eastern bank of the White River on the western boundary of the campus of Indiana University Purdue University Indianapolis (IUPUI). A complete site description can be found in Section 2.0 Background and Methods.

As described in a January 2000 proposal by Dr. Lenore Tedesco and Dr. Greg Lindsey, the project had two primary goals. These goals are currently under revision by the Advisory Committee. It is expected that the emphases on education, along with restoration of ecological function, will remain intact. The current goals of the project are:

1. Strengthen experiential environmental education, including service learning, in the Schools of Science (SOS), Public and Environmental Affairs (SPEA), Education (SOE), and Liberal Arts (SLA) at IUPUI.
2. Support restoration of a riparian forest along the White River in central Indianapolis while evaluating currently utilized restoration projects.

This document is a plan for the WRRRP. This plan consists of 4 major alternatives and 5 sub-alternatives. These alternatives, which are described in Section 3.0, and were presented in April 2000 to the WRRRP Advisory Committee, led by Dr. Tedesco. Section 4.0 outlines the choices of species for each alternative. Issues involving the spacing of the seedlings are addressed in Section 5.0. Planting design alternatives are addressed in Section 6.0.

After reviewing preliminary drafts of this plan, the Advisory Committee has begun making decisions. The Advisory Committee has decided on a hybrid approach that is described in detail in Section 7.0. These decisions were made at meetings of the Advisory Committee and the minutes from these meetings are available in Appendix E. Issues of how to implement these decisions and further research that needs to be completed are addressed in Section 8.0.

2.0 – Background and Methods

This plan is a product of the work completed by the Spring 2000 semester SPEA E400, Workshop on Greenway Management class led by Dr. Greg Lindsey. We began with a concept plan developed by Robert C. Barr and a project proposal developed by Dr. Lenore Tedesco and Dr. Greg Lindsey. We conducted a literature review to gain background information about similar projects. Discussions with members of the CEES advisory board also contributed to the development of this plan.

2.1 – Site Description
The site of the project has been described by Robert Barr in a draft of his document, "Development of a Concept and Project Background". A map of the project area is included as Map 1. Barr's description of the site reads:

> *The project area is a 14-acre section of floodplain that lies along the east bank of the West Fork of the White River; 8.5 acres of the site are being considered for reforestation. The rest of the project area is a riparian marsh. The project site is bounded by the 10th Street Bridge to the north and the New York Bridge to the south. The size of the floodplain in this area is greatly reduced by an earthen levee to the east.*

Barr also writes of the geology, history, and hydrology of the site. He writes, "The soil type on the floodplain is listed as urban land – Genesee complex. This complex includes about 40 percent urban land and 40 percent well drained Genesee soil." Regarding the hydrology of the site, Barr writes, "Principal hydrologic inputs to the project area are from surface water and ground water. The Indianapolis Water Company (IWC), which removes approximately half the discharge of the White River at the IWC Broad Ripple plant, largely controls the surface water supply. The IWC also removes approximately half of Fall Creek's discharge just south of the fairgrounds. The result of these combined withdrawals is apparent during dry months when there is practically no flow in the main channel." Barr also addresses the issue of water quality, stating, "Combined sewer outfalls both above and below the restoration site severely compromise water quality."

2.2 – Development of Plan
The first and most important task we undertook was to develop a master list of riparian and floodplain tree species using six different scientific studies. In general, we used these studies to develop alternative ecological reference conditions. Descriptions of these studies, along with our use of them are described below. The master species list, including lists excluded for reasons indicated below, is in Appendix D. We used these reference lists to develop alternatives considered by the WRRRP Advisory Committee.

2.3 - Reference Lists Used:

- **Lindsey, A. A. et al. (1961)** – Lindsey et al. conducted a detailed study of the vegetation along the Wabash and Tippecanoe Rivers in Indiana. This study is one of the most respected and reliable studies of riparian vegetation conducted in Indiana. In his study, Lindsey distinguished species not only by which river they were found at, but also if they were found on 1st or 2nd bottoms. In our use of this study we have disregarded the 2nd bottom lists, since our site does not have an area similar to Lindsey's 2nd bottom. This is also a relatively old study that provides information about potentially undisturbed riparian forests. We have used Lindsey's study to develop the Purist approach, along with the Consensus Synthesis and Inclusive approaches, which are defined later.

- **Lee (1945)** - Lee's study examined floodplain forests along the White River. He documented the vegetation at 20 sites along the river. Of these 20 sites, 5 were located in close proximity to our site here in Indianapolis (Lee's sites C, D, E, F, and G). Although this is also a relatively old study, these study sites had possibly been subject to human disturbance. We have used this study as the basis for our Geographic approach, along with the Consensus Synthesis and Inclusive approaches.

- **Brothers, T. S. and Hearne, N (1997)** - Brothers and Hearne conducted their study at Crooked Creek and Lake Sullivan in northwestern Marion County. Our use of this study included only species found along Crooked Creek, however, because the environment of Lake Sullivan was determined to be dissimilar to our site. This is, however, a reliable source and we have used it, along with the others, to develop our Consensus Synthesis and Inclusive approaches.

- **General Land Office Survey (GLOS) (1820-1822) -** This reference is the oldest known reference about trees in Marion County. The benefit of this reference is that it provides us with an idea of what vegetation was present before human disturbance. There are, however, drawbacks to this reference. It was not a scientific study and the trees that were documented were subject to the discretion of the surveyor. Surveyors commonly looked for big trees that were common and easy to mark. It would not be unlikely that certain surveyors often marked the same type of tree, which means that many different species could have existed that were never documented. The date of this study does, however, make this a useful reference, as long as the limitations of it are not forgotten. This reference was used in the development of the Consensus Synthesis and Inclusive approaches.

- **Brothers (1994)** - Brothers identified floodplain species in Marion County for inclusion in the Encyclopedia of Indianapolis. This study includes only dominant floodplain species and was not used in the development of the approaches.

- **DNP/IDNR (1980)** - This study was conducted by the Division of Nature Preserves and the Indiana Department of Natural Resources. The study site was the White River at 96th Street in Indianapolis. They identified dominant floodplain species along the White River. This study is fairly recent and the forest they studied has been subject to human modification. It is, however, a study of an area very close to our site and we used it in the development of the Consensus Synthesis and Inclusive approaches.

After developing a list of species alternatives, we addressed the issue of where to plant the chosen species. We developed planting design alternatives (described in Section 6.0), and zonation of the floodplain to attempt to provide the greatest chance of survival of the seedlings.

3.0 – Proposed Alternatives

In this plan, 4 major alternatives for the site were developed and presented to the WRRRP Advisory Committee. These four alternatives were No Action, Tree Planting, Reforestation, and Ecological Restoration. Details of all approaches and alternatives are summarized in Table 1. Table 1 includes information about the objective, rationale for species selection, number of species selected, spacing, maintenance, monitoring, and level of effort of each alternative. Our definitions of these alternatives are listed below. Also addressed are maintenance, monitoring, and level of effort issues.

3.1 – No Action:

3.1.1 **– *Description* -** The no action alternative would constitute, as one could assume, leaving the site as it is at present. There is now mostly grass and a few trees on site. The Department of Public Works currently mows the area and removes debris semi-annually.

3.1.2 **– *Maintenance* –** In this alternative only the current maintenance practices of mowing and debris removal will be continued.

3.1.3 **– *Monitoring* –** Monitoring is not applicable to this approach.

3.1.4 **– *Level of Effort* –** This approach requires no effort from CEES.

3.2 - Tree planting:

3.2.1 **– *Description* -** We have defined tree planting as an exercise to simply 'put trees in the ground'. The primary objective of this alternative is to establish greenery and to be aesthetically pleasing. Tree planting does not involve careful consideration of species selection, spacing, monitoring, and maintenance. The level of effort required is based only on the time it would take to actually plant the trees.

3.2.2 **– *Maintenance* –** Continued mowing and debris removal will be continued with implementation of this approach.

3.2.3 **– *Monitoring* –** Tree planting would require no monitoring, however, it would be beneficial for educational purposes to keep track of which trees grew in what areas.

3.2.4 **– *Level of Effort* –** The level of effort needed for this approach is based on the man-hours it takes to plant 4000 trees. Monitoring will also require effort. Students are available for this task.

3.3 - Reforestation:

3.3.1 **– *Description* -** The objective of this reforestation alternative is to replicate a forest that one would expect to find on a Marion County floodplain. Regardless of the approach, the reforestation alternative would involve a significant effort by CEES and the university. Growth and survival rates would be monitored and a database of this information would be developed for use by future researchers. Competitive weeds would possibly need to be removed for a period of time to allow the seedlings to establish. After that period, the site should be allowed to develop naturally, and monitoring of colonizing species would occur. This information would also be added to the database. Within this alternative, five different approaches were developed. They include the USFWS Planting List approach, the Purist approach, the Geographic approach, the Consensus Synthesis approach, and the Inclusive approach. The USFWS approach was developed at the conception of this plan because these were the species that were originally selected to be donated by the USFWS. The

choice of species in each of the other approaches is based on different ecological reference lists developed from the scientific studies.

3.3.2 ***– Maintenance –*** Including all of the alternatives, removal of competitive weeds along with mowing and debris removal will be practiced.

3.3.3 ***– Monitoring –*** Monitoring growth and survival rates of the trees is necessary for all approaches within Reforestation. The results will be valuable to future researchers.

3.3.4 ***– Level of Effort –***

3.3.4.1 – USFWS Approach –

The level of effort is based on the time it takes to plant, maintain, and monitor.

3.3.4.2 -- Purist, Geographic, Consensus, and Inclusive Approaches –

The level of effort is based on the time it takes to acquire additional species, time required to plant the trees, and time required to maintain and monitor. The level of effort increases with the number of different species.

3.3 - Ecological Restoration:

3.3.1 ***– Description -*** We defined Ecological Restoration as an activity to completely replicate a natural forest. At the suggestion of members of the Advisory Committee, we have modified this to be the definition adopted by the Society for Ecological Restoration. It is found in detail in Table 1. This would involve extremely careful species selection, including obtaining and planting all species one would expect to find on Marion County floodplains, including all flora and fauna. Consideration of soil properties and microbial organisms is also important. The level of effort required by CEES and the Advisory Committee would be extremely high, including not only time to acquire and plant trees and shrubs, but also detailed monitoring, maintenance, and examination of the site.

3.3.2 ***– Maintenance –*** The definition of Ecological Restoration is to replicate a natural forest. This would require no maintenance, however, it would be wise to maintain the site for the first couple of years to ensure that the seedlings have established. Debris removal and mowing the competitive weeds would be beneficial as well.

3.3.3 ***– Monitoring –*** Monitoring growth and survival rates of all vegetation (planted and naturally occurring), soil composition before and after planting, microorganisms, birds, and mammals.

3.3.4 ***– Level of Effort –*** The level of effort for this alternative would by very high. Careful consideration and research of all aspects of the site would need to be undertaken. It will take much effort to analyze the site, the soil content, and the naturally occurring vegetation and animal life. Additional time would be required to acquire all species, including all flora, fauna, and microorganisms that should be present at the site. Very careful maintenance and monitoring all of these aspects would be necessary and time consuming.

4.0 – Species Selection

Each alternative and approach consists of a different selection of species, with the exception of the Tree Planting alternative and the USFWS approach in the Reforestation Alternative (these two both consist of using only the trees donated by USFWS). Details of the species selected and the rationale for their selection are detailed below. Tables 2-6 provide choices for species to be planted, such as plant all species on the list, plant only species that will not recruit, plant only dominant species, or plant only dominant species that will not recruit.

The decision about which species were considered dominant was made using Lee's study, since his study was the only one with consistent dominance measures. A limitation of this, however, is that Lee's list does not encompass every species in each alternative, therefore there are species that we lack dominance measures for. We constructed a graph (Appendix B) to provide a 'breaking point' for dominance. Using this graph we determined that any species with a frequency index greater than 15 to be dominant. Dominance measures from the other reference lists, where available, are listed in alternative-specific tables in Appendix C. Judgment about recruitment of species was made by personal communication with Richard Barker, Urban Forester, City of Indianapolis.

4.1 – No Action

This alternative requires that no species be planted; therefore no species have been selected.

4.2 – Tree Planting

Since the objective of this approach is to provide a 'green landscape', with no regard for native or non-native species, the species selected are based on availability. The donated species from USFWS would be planted. The donated species are listed in Table 2.

4.3 – Reforestation

As stated earlier, the reforestation alternative is comprised of five different approaches with different rationale. The species to be planted vary species and number of species within each approach, with the USFWS approach being the simplest and the Inclusive approach being the most detailed.

4.3.1 – USFWS Planting List Approach

These are species that are readily available at the state nursery. They were selected because they are believed to be non-recruiting species and also believed to be native to the area. The 10 species that the USFWS has agreed to donate are listed in Table 2. Table 2 also includes dominance measures (where available) from Lee's 1945 study of the White River. This list does include some of the species that occur on many of the reference lists, such as *hackberry* and *American/white elm*.

4.3.2 – Purist Approach (Lindsey)

In the Purist approach, species present on either one of Lindsey's 1st bottom reference lists were selected. There are a total of 15 species, including one shrub. These species are listed in Table 3.

4.3.3 – Geographic Approach (Lee)

In the geographic approach, species that were present on Lee's reference list were selected. There are a total of 24 species, excluding shrubs[1]. The selected species are listed in Table 4.

4.3.4 – Consensus Synthesis Approach

In developing this approach we selected any species that occurred on at least half (3) of the six reference lists. The six reference lists used were Lindsey's Wabash 1st bottom, Lindsey's Tippecanoe 1st bottom, Brothers Crooked Creek, GLOS, Lee, DNP/IDNR. Lindsey's 2nd bottoms, along with Lake Sullivan were excluded because of the dissimilarity between those sites and our site. Brothers (1994) was excluded because it included only dominant species, and was not a complete study. This approach provides an idea of a well-rounded list of species that are generally found on floodplains within Indiana. There are 14 species that occur on at least three of the reference lists and they are provided in Table 5.

4.3.5 – Inclusive Approach

This approach provides a list of all species that occur on at least one of the above included reference lists. This would include any species that could possibly be found on any floodplain in Indiana. This approach would also mimic a 'total forest'. It would also provide a greater mix of species that could provide greater educational advantages. However, more effort would be required to acquire additional species. There are 43 species and they are listed in Table 6.

4.4 – Ecological Restoration – To accomplish ecological restoration in its purist form much effort would be required from all parties involved. Ecological restoration would involve the acquisition of every species that was at the site prior to human disturbance. This is nearly impossible considering that no one is exactly sure what was there. In addition to trees, all types of flora, fauna and microorganisms that are not already present at the site would need to be introduced. The number of species that would need to be acquired could be countless and take a great deal of time.

4.5 – Species to be Rejected – After the development of these alternatives, it became clear that several of the species to be donated by the USFWS were not on the reference lists developed for the alternatives. The species that would be rejected from this list using each of the reforestation approaches are listed in Table 7. In each of the approaches, excluding the Inclusive Approach, over half of the species would be rejected.

[1] Information concerning shrubs has been given little consideration due to the lack of reliable information.

5.0- Spacing

Spacing of the seedlings is an important consideration when attempting to maximize survival. Table 8 describes a layout of the space needed for planting. The USFWS recommends a spacing of 10x10 feet (Purdue University, Forestry and Natural Resources publication 36). If one were to choose to plant in 10-foot centers, it would take 3488 trees to fill 8 acres. The allotted land for the project is approximately 8.5 acres. Planting 8.5 acres in 10 foot centers would acquire approximately 3706 trees, and by planting the trees in 9-foot centers, all 4000 trees can be accommodated.

5.1 - No Action
This alternative, tree spacing is not applicable.

5.2 - Tree planting
In this approach, the objective is simply to put trees in the ground, not paying much attention to how it is done. However, by planting the trees in 9-foot centers, all 4000 trees can be accommodated.

5.3 - Reforestation
Reforestation in general includes all of the alternatives presented.

5.4 - Ecological Restoration
In Ecological Restoration, how to space the trees becomes a more detailed task. In order to replicate a natural forest, the placement of trees should be in predetermined locations based on survivability and species that are expected to be found together.

6.0 – Planting Designs

Three planting design methods have been developed for this site. Most of these design methods have been divided further into categories. These methods are summarized in Table 9. Table 9 summarizes the objective, species placement, species spacing, maintenance and monitoring, along with advantages and disadvantages of each design method. These methods are also described in detail below.

6.1 – Arbitrary Method

This method is executed with little consideration for ecological factors that may affect the survival rates or other factors. The trees are quickly put in the ground in no systematic way. They are planted for the sole purpose of providing greenery. The placement has no system or method, the spacing is arbitrary, and there is little to no maintenance or monitoring involved. An advantage to this method is that it can be quickly and easily implemented. The disadvantages are that it is a method with little educational value, it is not ecologically sound, there is no scientific basis, there is no consideration of the survivability of the seedlings, and the monitoring would be difficult due to the lack of systematic placement of the trees.

6.2 – Grid Method

We have divided the grid method into two categories: arbitrary and random.

6.2.1 – Arbitrary on grids

An arbitrary grid method is based on the USFWS procedure in that planting the trees in a grid pattern is what the USFWS recommends. The placement of the seedlings is arbitrary and species would probably be planted in the order in which they came off the truck. The first seedling off would be planted in the first hole, the second one in the second hole, and so on. However the spacing of the holes would still be set up in 10, 9, or 8 (or what ever number chosen) foot centers in parallel rows. Keeping a detailed database during the planting period would facilitate easy maintenance and monitoring over an extended period of time. This method has the advantage of easy monitoring and encourages some educational opportunities due to the opportunity to observe what species are surviving and comparing it to where they were planted. However, this system of planting in parallel rows does not replicate a natural forest, it is not aesthetically pleasing, and there is no consideration of the survival of the seedlings.

6.2.2 – Random on grids

Random planting is also based on the USFWS in that the seedlings are planted on 10, 9, 8…foot grids. Random planting on grids involves using a method, such as a random number table, to determine where each species will be planted. This method provides advantages and disadvantages similar to the *Arbitrary on Grids* method described above, however, planting the seedlings randomly could provide a more 'mixed' placement of trees, and reduces the likelihood that all seedlings of the same species would be planted together.

6.3 – Cluster Method

We have also sub-divided the cluster method into two categories: Arbitrary and Random. Planting the trees in clusters more accurately represents a natural forest. Clusters are defined as smaller areas, or groupings of trees, that are placed on the site. A number of cluster areas could be designated on the site.

6.3.1 – Arbitrary within clusters

Planting the trees arbitrarily involves no consideration of which species are found together. Planting the seedlings in clusters still allows for educational opportunities, such as, the ability and opportunity for students to observe what species will live in the environment and making comparisons about the decisions made and the survivability of the seedlings. The outcomes could give guidance for future decision makers. It does not, however, provide for the greatest chance of survival of the seedlings.

6.3.2 – Random within clusters

Planting the seedlings in a systematic manner provides the opportunity for trees that are usually found together on floodplains to be planted together. It also provides greater educational opportunities, as well as allowing for easier maintenance and monitoring. However, this method does not provide the greatest chance of survival of the seedlings.

6.4 – Zonation Method

The goal of the zonation method is to plant the seedlings in zones of saturation according to the seedlings' specific tolerance for soil wetness and/or inundation. This will optimize the chances of survibal of the seedlings. The method has been divided into three categories: arbitrary in zones, random in zones, and clustered grids in zones. The categories are detailed below. The site will be divided into predetermined zones. Final determination of zones will be made by researchers in the Department of Geology who are developing a system of monitoring wells to determine depth of the water table.

6.4.1 – Arbitrary in zones

In this method, each species will be designated a zones based on its possible survival and placement relative to the river. Within each zone, species would arbitrarily be planted. This could be done on a grid or not. This method provides educational benefits along with a greater chance of survival.

6.4.2 – Random in zones

This method is similar to the Arbitrary in zones method described above. It does, however, place each species in a predetermined location within each zone. This is based on the use of a tool such as a random numbers table. The same advantages and disadvantages described above also apply here.

6.4.3 – Clustered Grids in zones

This method involves placing each species on a grid, within a cluster, within the predetermined zones. It provides the greatest chance for survival and the greatest educational opportunities. It most accurately replicates a natural forest. This method would, however, be more labor intensive and require much work to be completed at the beginning to ensure an accurate database and the most educational opportunities.

7.0 – Proposed Alternative

The WRRRP Advisory Committee has reviewed alternatives and discussed advantages and disadvantages of them on April 17, 2000. The Advisory Committee members agreed it was important to maximize diversity for both ecological and educational reasons and that an objective of the project should be to restore ecological function. As a result, the Advisory Committee recommended a hybrid alternative as the preferred approach to reforestation. We called this new approach, which combines elements of inclusive reforestation and ecological restoration, "Ecological Reforestation'. The Advisory Committee also made several other recommendations concerning species lists and species to be planted.

The species list for the hybrid approach is derived from the Inclusive Reforestation Approach. As described in section 4.3.5, the species on this list were species found on any one of the six reference lists used. These species, along with their dominance measures, wetland indicators, and proposed zones are listed in Table 11. They are separated by recruitment, and then are in order by the zones that they would be planted in. The Advisory Committee has chosen to plant only the non-recruiting species from the list and to monitor which of the recruiting species establish themselves. There are 25 species that are non-recruiting and 11 species that are believed to recruit.

In this application, reforestation involves more than originally contemplated, including elements of restoration. The Advisory Committee is particularly interested in ecological function, such as, whether or not the species produce food, the hydrologic effects, and pollution effects. Keeping in mind these decision criteria, some of the 25 non-recruiting species may not make it to the site. For example, the Advisory Committee may decide to not plant certain trees because of the pollution the species emits. The Advisory Committee may want to plant a species with a broad leaf span and rough bark to manipulate the hydrologic effects, or they may want to plant species that produce nuts and berries as to hopefully, eventually bring in different animal species.

The value of choosing Ecological Reforestation is for educational reasons. This approach allows students to monitor recruitment and the survival rates of a higher number of species being planted.

Tree planting and ecological restoration were rejected alternatives. Tree planting was disregarded simply because there is little scientific basis for this approach and because a primary objective is to make the projects as scientific as possible. Complete restoration was rejected because it is not feasible to introduce the all native plant and animal species into the area.

Future considerations for the application of this alternative involve more research. The final choice of species, (e.g. selecting trees that have a broad leaf span or that produce nuts and berries) could have a major impact on the future of the site and help to restore a number of ecological functions. Future decisions should keep in mind the goals of the project.

The Advisory Committee favors a planting design that involves Zonation, more precisely, planting the seedling in clusters, on a grid, and in appropriate zones. Planting in zones would give the seedlings a better chance of survival. Some species have difficulty surviving in

certain levels of saturation. For example, if the Advisory Committee chooses to acquire the Ohio buckeye, its ideal planting zone would be Facultative (FAC), according to Table 11. Planting the trees in clusters would be aesthetically pleasing and more closely replicate a natural forest. The advantage of placing the trees on a grid is for easier reference in the monitoring aspect. Knowing the exact location of each species will allow for a more complete analysis. Planting the trees arbitrarily has little educational value and no scientific basis.

Using the species selected by the Advisory Committee, we developed Table 12, which illustrates the possible number of trees that could be planted in each zone. Researchers in the Department of Geology mapped zones of the site. The zones are rough estimates based on elevation. These zones will be adjusted in the future to account for the bridge easements, which are not taken into account in the estimation of the areas of these zones. The project area was divided into 6 areas, 4 of which (zones 1-4) will be planted. The preliminary area of these zones are listed in Table 13 and a map of these zones is included as Map 2. These areas are expected to change as more geologic information is acquired. The six proposed zones and the approximate areas of each are, and the species tentivaley to be planted in each are:

- Zone 1: (1 acre) The Riparian Fringe (adjacent to the river); Obligate Wetland species
- Zone 2: (2.5 acres) Area adjacent to and just east of the riparian fringe (zone 1); Facultative
  Wetland species, Facultative Wetland- species, and Facultative species (+ and-)
- Zone 3: (5 acres) Area adjacent to and just east of Zone 2 Facultative Wetland species, Facultative Wetland- species, and Facultative species (+ and-)
- Zone 4: (1 acre) Areas of highest elevation located closest to the levee on the east side of the project area; Facultative Upland species
- Zone 5: (3.5 acres) The existing wetland area, or insular bar on the north end of the project area; no planting
- Zone 6: (1 acre) The backwater pocket located in between Zone 5 and Zone 1; no planting

For the purpose of our calculations and since there is little difference between the two, we have combined Zones 2 and 3 into one zone. As shown in Table 12, there are 12 species, 2 of which are dominant on Lee's list, that should be planted in zones 2 and 3 and 13 species to be planted in zone 4. There are no species that should be planted in zone 1. This zone will likely be quickly established with species that will recruit on their own.

If the 12 species to be planted in zones 2 and 3 are planted on 10 foot centers, approximately 3052 trees could be planted (See Table 12). As stated above, 2 of these are dominant. When performing our calculations to determine how many of each species could be planted, we arbitrarily assumed that 25% of the trees planted would be the two dominant species. If a different percentage is chosen, or if an equal number of each species is planted, these numbers will change. However, if it is assumed that 25% of the trees are the two dominant species and 75% of the trees are the remaining 10 species, 382 of each of the two dominant species would be planted and 229 of each of the remaining 10 species would be planted. If a

10% survival rate were assumed, approximately 38 of the dominant species and 23 of the non-dominant species would survive. Still assuming planting on 10-foot centers, 436 trees could be planted in Zone 4. This means that 34 of each of the 13 ‘zone 4’ species could be planted, of which, approximately 3 of each could be expected to survive. It is also important to note that species where no zone
information was available were placed into zone 4. Also included in Table 12 is the same above information, assuming 7-foot centers instead of 10-foot centers.

8.0 – Implementation

There are still many things that need to be considered before a successful project can be undertaken. Issues such as species functionality, the possibility of experimentation, policies and procedures for monitoring, and others should be addressed before planting is undertaken. These issues are addressed below.

We are proposing that a name be given to the proposed alternative and that the goals of the project are finalized as soon as possible. A name that can be consistently used by all involved would be beneficial and eliminate confusion during discussions. In Section 7.0, we proposed "Ecological Reforestation" as a suitable name for the chosen alternative. This is a tentative name and can be revised by the Advisory Committee as it thinks necessary.

During meetings of the Advisory Committee issues of functionality of the species selected have been raised. The issues that were discussed included production of food such as nuts and berries, hydrologic benefits or impacts, and pollution. Decisions need to be made about what functions the Advisory Committee would like the trees to serve before the species can be selected. We believe that clarifying and finalizing the goals of the project would aid in these decisions.

It is also important to make a decision about whether the Advisory Committee would like to leave an area of the site unplanted to monitor what 'naturally' happens. Leaving an area unplanted would allow for experimentation and a sort of 'control' environment to monitor the success of the project. This would be beneficial and would contribute to the educational goals of the project. This is problematic, however, due to the relatively small size of the site.

Policies and procedures for monitoring the site need to be developed. It is important to determine who will be in charge of maintaining the site. Maintenance and monitoring of the site is possible using students from IUPUI, however, the University and professors involved would need to be prepared to commit to these activities for an extended period of time. If the University is not prepared to make this commitment an alternative needs to be developed.

Other decisions that need to be finalized include confirmation of the zones, the general layout of the site, species availability, and the posting of educational signage. These are important decisions that should be addresses as soon as possible. Future classes may also be able to contribute to the research of alternatives for these decisions.

9.0 - Acknowledgements

We would like to thank the members of the WRRRP Advisory Committee for all of their help and support during the development of this plan. They have been very helpful and supportive of our work and have provided us with many valuable comments and suggestions. They members of the Advisory Committee are:

Lenore Tedesco, Department of Geology, IUPUI
Richard Barker, City of Indianapolis, Environmental Resources Management Division
Tom Bruns, Indianapolis Water Company
Forest Clark, U.S. Fish and Wildlife Service
Bob Holm, City of Indianapolis, Environmental Resources Management Division
Jeff Kiefer, U.S. Fish and Wildlife Service
Evan Kimble, City of Indianapolis, Department of Public Works
Greg Lindsey, School of Public and Environmental Affairs, IUPUI
Susan J McLoud, Indiana Department of Environmental Management
Don Miller, Land Stewardship, Indy Parks
Catherine Souch, Department of Geography, IUPUI

Technical advisors to the Advisory Committee:
Robert Barr, Center for Earth and Environmental Science, IUPUI
Dawn Bauman, Greenhouse, Department of Biology, IUPUI
Bob E. Hall, Center for Earth and Environmental Science, IUPUI

Appendix A – Draft Goals Statement

R.C. Barr and L.P. Tedesco

Mission Statement:

- The White River Riparian Restoration Project (WRRRP) is an effort by the Center for Earth and Environmental Science (CEES) at IUPUI to support restoration of an urban riparian forest.

Goals:

- The primary goal for this work is to increase experiential learning in a natural laboratory for both formal and informal education groups.

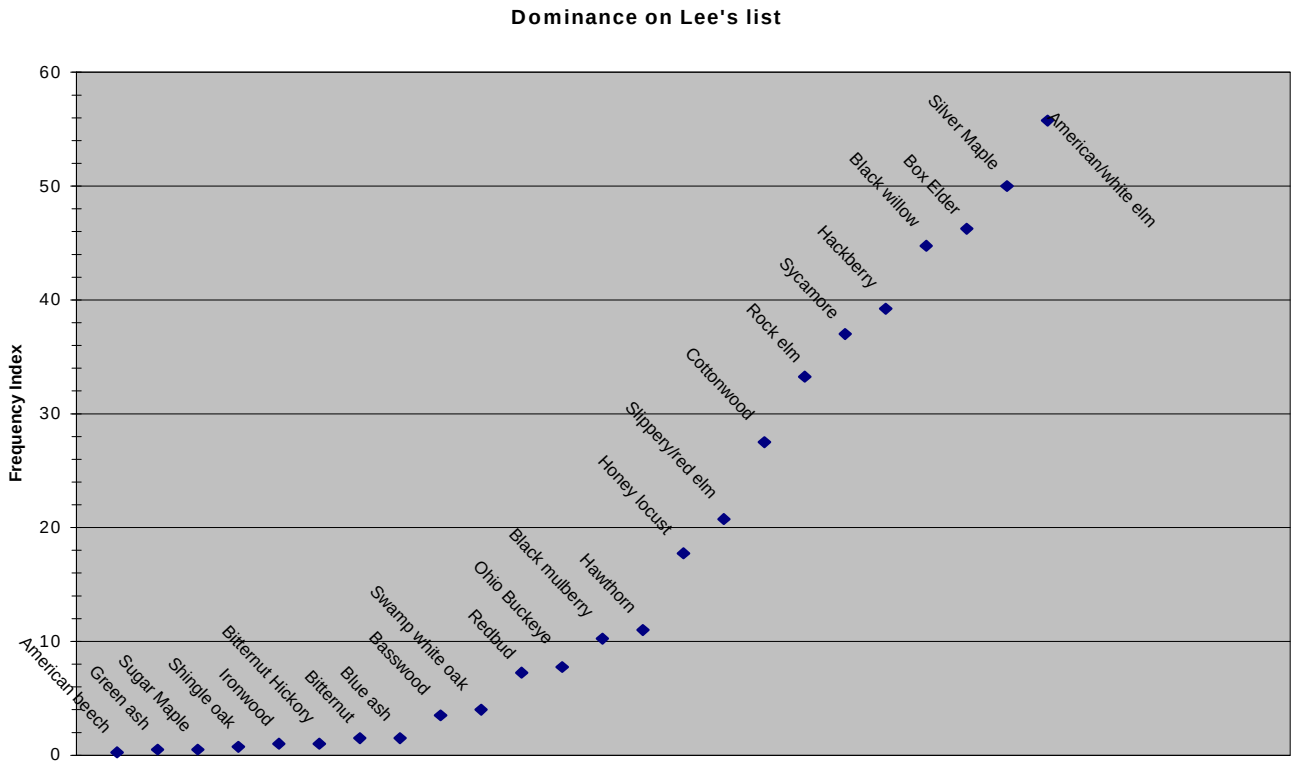
- The principal secondary goal of this project is to restore stream corridor structure and functions, and to bring the project area as close to a state of dynamic equilibrium, or proper functioning, as possible.

- In order to evaluate existing restoration procedures and to facilitate environmental education, this project will utilize the principle of self-design for the establishment of a naturalistic vegetation community.

Proposed Ecological Reference Condition:

- The ecological reference condition used as a standard for this project will be the 96th Street Woods. This reference area was selected because of its evaluation by the Division of Nature Preserves, Indiana Department of Natural Resources, as the highest quality floodplain forest community found for over 150 miles along the White River.

Appendix B


Dominance on Lee's list
Frequency Index
60
50
40
30
20
10
0
American beech
Green ash
Sugar Maple
Shingle oak
Ironwood
Bitternut Hickory
Bitternut
Blue ash
Basswood
Swamp white oak
Redbud
Ohio Buckeye
Black mulberry
Hawthorn
Honey locust
Slippery/red elm
Cottonwood
Rock elm
Sycamore
Hackberry
Black willow
Box Elder
Silver Maple
American/white elm

Appendix C – Alternative Specific Dominance Measures

USFWS Approach

Species	Recruitment	Dominance – Lindsey	Dominance – Lee (over 15)	Dominance – Brothers (1997) (# of stems)	Dominance – Brothers (1994)
Swamp White Oak		N	N (3.50)	N	N
Sycamore		Y	Y (37.00)	Y (20)	Y
Shellbark Hickory		N	N	N	N
Pin Oak		N	N	N	N
Green Ash		N	N (0.50)	Y*	N
Black Gum		N	N	N	N
Bur Oak		N	N	N	N
White Oak		N	N	N	N
Tulip Poplar		N	N	N	N
Button Bush (shrub)		N	N	N	N

Purist Approach

Species	Recruitment	Dominance – Lindsey	Dominance – Lee (over 15)	Dominance – Brothers (1997) (# of stems)	Dominance – Brothers (1994)
Box Elder		Y	Y (46.25)	Y (96)	Y
Silver Maple		Y	Y (50.00)	N	Y
Sugar Maple		N	N (0.50)	N	N
Catalpa		N	N	N	N
Hackberry		N	Y (39.24)	Y (40)	N
White Ash		N	Y (34.75)	Y*	N
Green Ash		N	N (0.50)	Y*	N
Black Walnut		N	N (12.50)	Y	Y
Sycamore		Y	Y (37.00)	Y (20)	Y
Cottonwood		Y	Y (27.50)	N	N
Salix Cordata		N	N	N	N
Black Willow		Y	Y (44.75)	Y (10)	Y
American/white Elm		Y	Y (55.75)	Y (53)	N
Slippery/red Elm		N	Y (20.75)	N	N
Poir (shrub)		?	Y (137)		N

Geographical Approach

Species	Recruitment	Dominant – Lindsey	Dominant – Lee	Dominant – Brothers (1997) (# of stems)	Dominant – Brothers (1994)
Box Elder		Y	Y (46.25)	Y (96)	Y
Silver Maple		Y	Y (50.00)	N	Y
Sugar Maple		N	N (0.50)	N	N
Ohio Buckeye		N	N (7.75)	N	N
Bitternut Hickory		N	N (1.00)	N	N
Hackberry		N	Y (39.24)	Y (40)	N
Redbud		N	N (7.25)	N	N
Hawthorn		N	N (11.00)	N	N
American beech		N	N (0.25)	N	N
Green ash		N	N (0.50)	Y*	N
Blue ash		N	N (1.5)	N	N
Honey locust		N	Y (17.75)	N	N
Bitternut		N	N (1.5)	N	N
Black mulberry		N	N (10.25)	N	N
Ironwood		N	N (1.00)	N	N
Sycamore		Y	Y (37.00)	Y (20)	Y
Cottonwood		Y	Y (27.50)	N	Y
Swamp white oak		N	N (3.50)	N	N
Shingle oak		N	N (0.75)	N	N
Black willow		Y	Y (44.75)	Y (10)	Y
Basswood		N	N (4.00)	Y (25)	N
American/white elm		Y	Y (55.75)	Y (53)	N
Slippery/red elm		N	Y (20.75)	N	N
Rock elm		N	Y (33.25)	N	N
Shrubs					
Indigo bush			N		
Pawpaw			N (51)		
Wahoo			Y (156)		
Poir			Y (137)		
Black huckleberry			N		
Gooseberry			N		
Spice bush			Y (182)		
Common chokeberry			N (13)		
Hop tree			Y (149)		
Rose			N		
Rasberry/ blackberry			N		
Elderberry			Y (1553)		
Bluddernut			N (3)		
Nannyberry			N		

Consensus Synthesis

Species	Recruitment	Dominance – Lindsey	Dominance – Lee	Dominance – Brothers (1997) (# of stems)	Dominance – Brothers (1994)
Box Elder		Y	Y (46.25)	Y (96)	Y

Silver Maple		Y	Y (50.00)	N	Y
Sugar Maple		N	N (0.50)	N	N
Ohio Buckeye		N	N (7.75)	N	N
Hackberry		N	Y (39.24)	Y (40)	N
Hawthorne		N	N (11.00)	N	N
White Ash		N	N	Y*	N
Green Ash		N	N (0.50)	Y*	N
Sycamore		Y	Y (37.00)	Y (20)	Y
Cottonwood		Y	Y (27.50)	N	Y
Black Willow		N	Y (44.75)	Y (10)	Y
American/white elm		Y	Y (55.75)	Y (53)	N
Slippery/red elm		N	Y (20.75)	N	N
Rock Elm		N	Y (33.25)	N	N

Inclusive Approach

Species	Recruitment	Dominance – Lindsey	Dominance – Lee	Dominance – Brothers (1997) (# of stems)	Dominance – Brothers (1994)
Box elder		Y	Y (46.25)	Y (96)	Y
Silver maple		Y	Y (50.00)	N	Y
Sugar maple		N	N (0.50)	N	N
Ohio buckeye		N	N (7.75)	N	N
River/yellow birch		N	N	N	N
Catalpa		N	N	N	N
Bitternut hickory		N	N (1.00)	N	N
Shagbark hickory		N	N	N	N
Hackberry		N	Y (39.24)	Y (40)	N
Redbud		N	N (7.25)	N	N
Hawthorne		N	N (11.00)	N	N
American beech		N	N (0.25)	N	N
White ash		N	N	Y*	N
Green ash		N	N (0.50)	Y*	N
Blue ash		N	N (1.5)	N	N
Honey locust		N	Y (17.75)	N	N
Butternut		N	N (1.5)	N	N
Black walnut		N	N	Y	N
Tulip poplar		N	N	N	N
White mulberry		N	N	Y (35)	N
Black mulberry		N	N (10.25)	N	N
Ironwood		N	N (1.00)	N	N
Blue spruce		N	N	N	N
Sycamore		Y	Y (37.00)	Y (20)	Y
Cottonwood		Y	Y(27.50)	N	Y
Black cherry		N	N	N	N
White oak		N	N	N	N
Swamp white oak		N	N (3.50)	N	N
Shingle oak		N	N (0.75)	N	N
Bur oak		N	N	N	N
Chinquapin oak		N	N	N	N
Pin oak		N	N	N	N
Oak		N	N	N	N
Black locust		N	N	N	N
Weeping willow		N	N	N	N
Salix cordata		N	N	N	N
Black willow		Y	Y (44.75)	Y (10)	Y
Willow		N	N	N	N
Scholar tree		N	N	N	N
Basswood		N	N (4.00)	Y (25)	N
American/ White elm		Y	Y (55.75)	Y (53)	N
Slippery/red elm		N	Y (20.75)	N	N
Rock elm		N	Y (33.25)	N	N
Shrubs					
Indigo Bush			N		

Pawpaw			N (51)		
Flowering dogwood			N		
Wahoo			Y (156)		
Poir			Y (137)		
Black huckleberry			N		
Gooseberry			N		
Spicebush			Y (182)		
Common chokeberry			N (13)		
Hop tree			Y (149)		
Staghorn sumac			N		
Rose			N		
Rasberry/ *Blackberry*			N		
Elderberry			Y (1553)		
Bluddernut			N (3)		
Maple-leaf viburnum			N		
Nannyberry			N		
Black haw			N		

Appendix D – Master Species List

Species		Lindsey, A. A, et al.(1961)				Brothers, T. and Hearne, N. (1997)		GLOS 1820-1822	Lee, M. B. 1945	Brothers 1994	DNP/IDNR 1980		
		Wabash (Vincennes – Logansport)		Tippecanoe						Dominant Fldpln Species	Dominant Fldpln Species		
Scientific Name	Common Name	1st Bottom	2nd Bottom	1st Bottom	2nd Bottom	Crooked Creek	Lake Sullivan	Marion County	White River Marion County		96th street	Present at WRRRP site	Planting list
Acer negundo	box elder	x	x	x	x	x	x	x**	x (46.25)	X			
Acer nigrum	black maple		x					x					
Acer rubrum	red maple											X	
Acer saccharinum	silver maple		x	x	x	x	x	x**	x (50.00)	X	X	X	
Acer saccharum	sugar maple	x	x			x	x	x	x (0.50)		X		
Aesculus glabra	Ohio buckeye		x		x	x		x**	x (7.75)		X		
*Ailanthus altissima**	tree of heaven						x						
*Alnus glutinosa**	European black alder						x						
Betula nigra	river/yellow birch					x		x**					
*Catalpa bignoides**	catalpa			x		x							
Carpinus caroliniana	water beech							x					
Carya cordiformis	bitternut hickory		x		x				x (1.00)				
Carya glabra	pignut hickory		x										
Carya laciniosa	shellbark hickory												x
Carya ovata	shagbark hickory					x							
Carya sp	hickory							x					
Celtis occidentalis	hackberry	x	x		x	x	x	x**	x (39.24)		X		
Cercis canadensis	redbud		x		x	x	x		x (7.25)				
Crataegus sp.	hawthornwhite thorn		x			x		x**	x (11.00)				
Cupressus sp. ?*	cypress						x						
Fagus grandifolia	American beech		x			x		x	x (0.25)				
Fraxinus americana	white ash	x	x	x	x	x	x						
Pennsylvanica	green ash	x	x	x	x			x**	x (0.50)		X		x
Species		**Lindsey, A. A, et al.(1961)**				**Brothers, T. and Hearne, N. (1997)**		**GLOS 1820-1822**	**Lee, M. B. 1945**	**Brothers 1994**	**DNP/IDNR 1980**		
		Wabash (Vincennes – Logansport)		Tippecanoe						Dominant Fldpln Species	Dominant Fldpln Species		

Scientific Name	Common Name	1st Bottom	2nd Bottom	1st Bottom	2nd Bottom	Crooked Creek	Lake Sullivan	Marion County	White River Marion County		96th street	Present at WRRRP site	Planting list
Fraxinus quadrangulata	blue ash							x	x (1.50)				
Gleditsia tricanthos	honey locust						x	x	x (17.75)				
Gymnocladus dioicus	Kentucky coffeetree				x								
Jug;lans cinera	butternut							x	x (1.50)				
Juglans nigra	black walnut		x	x		x	x	x					
Liriodendron tulipifera	tulip poplar					x		x			X		x
*Morus alba**	white mulberry		x		x	x	x						
Morus rubra	black mulberry								x (10.25)				
Nyssa sylvatica	black gum												x
Ostrya virginiana	Ironwood							x	x (1.00)				
*Pica abies**	Norway spruce						x						
*Picea pungens**	blue spruce					x							
*Pinus resinosa ?**	red pine						x						
Pinus strobus	white pine					x							
Platanus occidentalis	sycamore	x			x	x	x	x**	x (37.00)	X	X	X	x
Populus deltiodes	cottonwood	x		x		x	x	x**	x (27.50)	X		X	
Populus grandidentata	bigtooth aspen							x					
Prunus serotina	black cherry		x			x							
Ptelea trifoliata	hop tree						x						
*Pyrus sp. ?**	apple						x						
Quercus alba	white oak					x	x	x					x
Quercus bicolor	swamp white oak								x (3.50)				x
Quercus imbricaria	shingle oak								x (0.75)				
Quercus macrocarpa	bur oak				x	x							x
Species		**Lindsey, A. A, et al.(1961)**				**Brothers, T. and Hearne, N. (1997)**		**GLOS 1820-1822**	**Lee, M. B. 1945**	**Brothers 1994**	**DNP/IDNR 1980**		
		Wabash (Vincennes – Logansport)		Tippecanoe						Dominant Fldpln Species	Dominant Fldpln Species		
Scientific Name	Common Name	1st Bottom	2nd Bottom	1st Bottom	2nd Bottom	Crooked Creek	Lake Sullivan	Marion County	White River Marion County		96th street	Present at WRRRP site	Planting list
Quercus muhlenbergii	chinquapin oak					x							
Quercus palustris	pin oak										X		x

Quercus rubra	red oak						x	x					
Quercus velutina	black oak							x					
Quercus sp.	oak					x		x					
*Robinia pseudo-acacia**	black locust					x	x						
*Salix babylonica**	weeping willow					x							
Salix cordata				x									
Salix discolor	pussy willow												
Salix nigra	black willow	x		x		x	x	x	x (44.75)	X		X	
*Salix sp.**	willow					x	x	x**				Xpeachleaf?	
*Sophora japonica**	scholar tree					x							
Taxodium distichum	bald cypress						x						
Tilia americana/glabra	basswood					x	x	x**	x (4.00)				
Ulmus americana	American/white elm	x	x	x	x	x			x (55.75)				
*Ulmus pumila**	Siberian elm						x						
Ulmus rubra/fulva	slilppery/red elm	x	x	x	x	x	x		x (20.75)		X		
Ulmus thomasi	rock elm								x (33.25)				
Ulmus sp.								X					

		Lindsey, A. A, et al.(1961)				**Brothers, T. and Hearne, N. (1997)**		**GLOS 1820-1822**	**Lee, M. B. 1945**	**Brothers 1994**	**DNP/IDNR 1980**		
		Wabash (Vincennes – Logansport)		Tippecanoe						Dominant Fldpln Species	Dominant Fldpln Species		
		1st Bottom	2nd Bottom	1st Bottom	2nd Bottom	Crooked Creek	Lake Sullivan	Marion County	White River Marion County		96th street	Present at WRRRP site	Planting list
Total		9	17	10	14	32	27	30	25				
Total Native Species		9	16	9	13	26	18	30	25				
Species on ref list & planting list		2	1	1	3	5	2	2	3				
Species on Ref list only (w/o exotics)		7	15	8	10	21	15	28	22				
Species on ref list only (w/exotics)		7	16	9	11	27	24		22				
Species on planting list only		8	9	9	7	5	7	8	7				
Shrubs													
Amorpha fruticosa	Indigo bush								X				
Asimina triloba	pawpaw		X		X				X				
Cephalantus occidentalis buttonbush		x(sloughs in second bottoms)											x
Cornus alternifolia	altern.leaf dogwood				X								
Cornus florida	flowering dogwood				x			X					
Cornus stolonifera	red-osier dogwood					X							
Evonymus atropurpurea	wahoo								X				
Evonymus obovatus			X		X								
Forestiera acuminata	poir	X							X				
Gaylussacia baccata	black hucklebery								X				
Grossularia cynosbti	gooseberry								X				

Species		Lindsey, A. A, et al.(1961)				Brothers, T. and Hearne, N. (1997)		GLOS 1820-1822	Lee, M. B. 1945	Brothers 1994	DNP/IDNR 1980		
		Wabash (Vincennes – Logansport)		Tippecanoe						Dominant Fldpln Species	Dominant Fldpln Species		
Scientific Name	Common Name	1st Bottom	2nd Bottom	1st Bottom	2nd Bottom	Crooked Creek	Lake Sullivan	Marion County	White River Marion County		96th street	Present at WRRRP site	Planting list
Hibiscus militaris												X	
Lindera benzoin	spicebush		X		X	X			X				
Prunus virginiana	common chokeberry								X				
Ptelea trifoliata	hop tree								X				
Rhus typhina	staghorn sumac					X							
Rosa sp.	rose					X			X				
Rubus sp	raspberryblackberry		X			X			X				
Sambucus canadensis	elderberry		X		X	X			x				
Staphylea trifolia	bluddernut				X				X				
Viburnum acerifolium	maple-leaf viburnum					X							
Viburnum lentago	nannyberry								x				
Viburnum prunifolium ?	black haw				X	X							
listed shrubs are from Brothers and Hearne, Lee, and Lindsey lists only													
Ptelea trifoliata is listed under shrubs in Lee's list													
* not native to Indiana; not listed in Deam's 'Trees of Indiana"													
** floodplain being the assumed forest association													

Appendix E – Meeting Minutes

MINUTES—ADVISORY TEAM
WHITE RIVER RIPARIAN RESTORATION PROJECT
3/27/00, Monday

PRESENT: Tedesco (Chair), McLoud, Souch, Bruns, Clark, Barker, Holm, Lindsey, Kempf, Barr, Hall

Meeting was called to order at 9:40 a.m.

Dr. Tedesco opened the meeting by stating that CEES has taken stewardship of WRRRP project oversight and monitoring as part of mission to promote science-based research, education, and service. The CEES Executive Committee approved the overall project, and suggested formation of the Advisory Team to evaluate it and provide oversight and advice regarding restoration strategies.

The WRRRP is primarily an education project, as noted by:

- Service learning groups which utilize the site
- Natural lab use by classes
- School of Education science methods class
- SPEA greenways workshop class
- Data set will result from project

Bob Barr provided background information to the Advisory Team by reporting on the history of the WRRRP project. He noted that it began with the simple idea of planting some trees with aide of service learning students. He and Don Miller (IndyParks) initially began clean-up projects along the river about 31/2 years ago. He and Don had worked on similar project at Northwestway Park. They hoped to reintroduce natural species at the river with aide of student labor. They noted that many natural components still remained on site at north end of what is now the WRRRP project area, and thought that clean-up projects would expand the natural succession on the site. They were able to implement a change in the mowing strategies by the City to avoid the narrow margin on the site, and noted that species such as hibiscus, milkweed, cottonwood and maples immediately began to reappear. Don suggested contacting Fish & Wildlife Service at IUB, noting that they had been involved in this type of project for over 50 years. They also contacted White River State Park, and Susan McLoud (IDEM Water Management District), who were both in favor of a river clean-up.

At this point, Bob realized that many groups showed favorable interest in what might be done to improve the river site, so he took the project idea to Dr. Tedesco to investigate possibility of CEES involvement. Dr. Tedesco and Bob began talking to City agencies to exchange ideas. One of the meetings was with representatives from local radio station WENS to discuss relocating the Sky Concert which is held at the river each year in September. The concert attracts approximately 100,000 people to the flood plain area, which would obviously hinder restoration efforts. WENS is considering other sites, but no final decision has been reached at this time.

Rick Barker (Environmental Resources Mngmt. Division) stated that the Acting Deputy Director of the Department of Public Works has endorsed the WRRRP Project, and is prepared to write support letter and partner on the project as soon as the WENS concert issue is rescheduled to another location.

Dr. Tedesco noted that the original plan was to begin planting at the river site in April, 2000, with aide of 4,000 trees donated by the Fish & Wildlife Service. This idea is being reexamined, however, because we do not have a definitive answer yet from WENS. We do not want to take delivery of trees in April unless we can plant them right away.

Barker also noted that the Army Corp of Engineers is prepared to tear out the concrete levee blocks which currently line the river banks. The Greenways project also includes plans to terrace the river bank after the blocks are removed, and install lights and benches.

Tom Bruns inquired as to whether the Sky Concert attendees spill over off of the lawn area along the river into the "crescent" zone.

Bob Barr replied that people do wade into the water and the trash they leave behind impacts this area heavily.

Bob Holm stated that, if necessary, a temporary fence could be put up this year before the Sky Concert if the concert could not be rescheduled until the following year.

Dr. Tedesco said that the highest impact is on the mowed area, but trash ends up everywhere. She feels confident that WENS will relocate the concert; the question is whether they can move this year versus next year. As a last resort, the location of the concert this year could slide to the area south of New York Street, especially if the City can arrange to put up a temporary fence to protect other areas.

Dr. Tedesco also updated the Committee on other progress toward the WRRRP Project as follows:

- A grant was obtained from the Center of Public Service and Leadership which will provide $1,500 per semester to each of 3 students to work on the project. This includes time for surveying the property, mapping existing trees, and installing water wells. Three shallow wells have been installed to date to provide information on the water table.
- Dr. Eliot Atekwana (Geology Department) has been installing wells and collecting data with students from his Hydrology class.
- John Mundell (Mundell & Associates) indicated that they previously installed 14 deep wells on the floodplain which CEES can utilize for data collection

Bob E. Hall reported that survey work on the floodplain is complete, and the data is now being analyzed.

Dr. Tedesco reported that a seedbank study is in process with students in the Biology Department, and that core samples have also been taken. Data from the seedbank study and vertical sedimentary descriptions of the core sample will be posted on the WRRRP website. She hopes that the website will be up and running very soon.

Dr. Tedesco noted that students from Greg Lindsey's 400-level SPEA greenways workshop course are investigating and analyzing planting strategies for the site. Their findings will be presented in report form to the Advisory Committee, and become part of the formal record for the project. She then introduced Emily Kempf, one of the students in the SPEA course who is working on the report.

Emily stated that she and her fellow students in the class determined three main category options for the White River project: tree planting, reforestation, ecological restoration. She noted that the method which is utilized will be determined by the overall scientific basis of the project, and the level of effort and ongoing maintenance available. Tree planting would obviously take the least amount of time and effort, while the reforestation option would give more consideration to native versus nonnative species being planted. Ecological restoration would require a high level of time and effort.

Tom Bruns inquired as to whether any consideration was being given to the ultimate size of trees, which could ultimately impede water flow and/or flood control.
Rick Barker noted that he views this project as a good test site for future projects. He noted that the levee side of the river project area would continue to be mowed, and if log jams occur they would be handled on an as-needed basis as it is at other river sites around the city.

Bob Holm suggested the term “habitat enhancement” as a strategy by which some species would be planted and other species would be allowed to recruit naturally.

Susan McLoud asked whether a decision had been made regarding a benchmark to establish a point in time for the project, and noted that this is critical data if the Committee is to make a decision about which restoration scenario is appropriate.

Bob Holm indicated that determining the ultimate use of the site will give insight into determining the planting strategy.

Dr. Tedesco stated that she feels the main focus of the sight should be education and research. She feels that full ecological restoration is not a feasible option.

Bob Barr noted that no matter which strategy is chosen, the river itself will ultimately control the environment.

Dr. Tedesco stated that she would receive the final report tomorrow (3/27/00) from the SPEA class, and offered the option of distributing this document to members of the Advisory Committee for review.

Tom Bruns felt that the Committee needs a statement of purpose and input on what public access to the site will be before making a decision.

Bob Holm indicated that a foundation would be laid in this project for other projects. If citizens see a benefit from the project, they will perceive it as a positive thing.

Dr. Tedesco proposed that the planting not be scheduled for April, and suggested that planting could take place in the next dormant run in October.

Bob Holm inquired as to whether there were some wetland species which could be planted on the crescent area in the meantime?

Rick Barker stated that many species will begin to grow if mowing is stopped. Dr. Tedesco felt that the committee should evaluate the mowing schedule in relation to the WENS decision.

Forest Clark voiced concern about the 4,000 trees already ordered if they are not planted in April. Mr. Clark will meet with Dr. Tedesco at conclusion of this meeting to discuss tree options.

Greg Lindsey stated that he could implement “user counts” (i.e., the number of people using the area along the river over the summer) to provide data to the project. He stated that he feels it is important that an effort is made to proceed slowly with the project, and document why each decision is made along the way.

Dr. Tedesco indicated that she will provide hard copies of the planting document written by the SPEA class to all committee members after it is submitted to her on 3/27/00. This will provide the necessary background information for the committee to make a decision regarding a planting strategy. At the next meeting, the Committee will discuss the mission and goals of the White River Restoration project. She hopes by then to have additional feedback from WENS regarding relocating the Sky Concert this year.

The next meeting of the Committee will be held on Monday, April 17, from 9:30-11:00 in SL 236.

Meeting was adjourned at 11:15 a.m.

Appendix F – References

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Table 1. Alternatives for White River Riparian Restoration Project

	No Action	Tree Planting	Reforestation					Ecological Restoration
			USFWS	Purist	Geographical	Consensus	Inclusive	
Definition / Objective	Mowing to control vegetation; debris removal	Plant trees in the ground to provide a "green" atmosphere.	To replicate a forest one would expect to find on Marion county floodplains.					To completely replicate natural flora and fauna, microorganisms.*
Rationale for Species Selection	N/A	Based on availability	Based on availability	Based on most rigorous scientific studies	Based on study done in closest geographic proximity	Based on species more likely to be found on floodplains	Based on species that could possibly be found on floodplains	Based on a natural Marion County floodplain forest
Species	Grass	The trees are based on availability. They could either be natives or exotics. Include all on the proposed planting list: *Button Bush, Swamp White Oak, Sycamore, Shellbark Hickory, Pin Oak, Green Ash, Black Gum, Bur Oak, White Oak, Tulip Poplar.*	Species based on different reference lists					Species that were present at the site before human disturbance - replicate closely as possible with current knowledge of past site conditions.
• Reference list	N/A	N/A	Planting list	Lindsey's (1961) first bottom lists (union)	Lee's White River Study (1945)	Species on at least three of six ref. lists	Species on at least one of six ref. lists	*Revised definition: *Ecological restoration is the process of assisting the recovery and management of ecological integrity. Ecological integrity includes a critical range of variability in biodiversity, ecological processes and structures, regional and historical context, and sustainable cultural practices.*
• Total species[2]	N/A	10	10	15	24	14	43	
• On planting list	N/A	10	10	2	3	2	7	
• Present at site	N/A	1	1	4	4	4	4	
• Dominant species (Lee)	N/A	N/A	1	10	10	9	10	
• Expected to recruit	N/A	N/A	3	10	11	9	15	
• To be acquired (not on planting list or present at site)	N/A	N/A	N/A	10	18	9	33	
• To be acquired (not expected to recruit)	N/A	N/A	N/A	5	12	5	23	
• To be acquired (dominant and not expected to recruit)	N/A	N/A	N/A	2	2	2	4	

[2] Includes only tree species, Lindsey list includes one shrub

	No Action	Tree Planting	Reforestation					Ecological Restoration
			USFWS	Purist Approach	Geographical Approach	Consensus	Inclusive	
Spacing	N/A	By planting the trees in 9 foot centers, all 4000 trees can be accommodated.	By planting the trees in 9 foot centers, all 4000 trees can be accommodated.					Same as reforestation, but can also plant closer together to replicate a 'natural' forest. Placement of trees in pre-determined locations based on survivability and species expected to be found together.
Monitoring and Maintenance	DPW mows semiannually and removal of debris	None	Monitor growth and survival rates, removal of competitive weeds for set period of time.					Monitor growth and survival rates of vegetation, (planted and naturally occurring), soil composition, microorganisms, birds, mammals, etc.
Level of Effort	None from CEES	Man hours of planting 4000 trees. (Based on Table 3)	Time to plant, monitor and maintain	Time to acquire additional species, time required to plant, time required to monitor and maintain. Much of this can be conducted by students. Increases with the number of different species.				Much effort required to acquire species, examine soil, and monitor. Student labor still feasible.

Table 2 – Species Donated by USFWS

Species	Present at site	Dominant – Lee	Expected to recruit
Swamp White Oak		N (3.50)	N
Sycamore	Y	Y (37.00)	Y
Shellbark Hickory		N **	N
Pin Oak		N **	N
Green Ash		N (0.50)	Y
Black Gum		N **	N
Bur Oak		N **	N
White Oak		N **	N
Tulip Poplar		N **	N
Button Bush (shrub)		N **	Y
Totals (10)	**1**	**1**	**3**

** No dominance measure, not present on Lee's list

Table 3 – Purist (Species present on Lindsey's list)

Species	Present on planting list	Present At site	Dominant (Lee)	Expected to recruit*	Acquire all species not on planting list or present at site	Acquire all species not expected to recruit	Acquire dominant species not expected to recruit
Box Elder			Y (46.25)	Y	Y	N	N
Silver Maple		Y	Y (50.00)	Y	N	N	N
Sugar Maple			N (0.50)	N	Y	Y	N
Catalpa			N **	Y	Y	N	N
Hackberry			Y (39.24)	Y	Y	N	N
White Ash			Y (34.75)	N	Y	Y	Y
Green Ash	Y		N (0.50)	Y	N	N	N
Black Walnut			N (12.50)	N	Y	Y	Y
Sycamore	Y	Y	Y (37.00)	Y	N	N	N
Cottonwood		Y	Y (27.50)	Y	N	N	N
Salix Cordata			N **	N	Y	Y	N
Black Willow		Y	Y (44.75)	Y	N	N	N
American/white Elm			Y (55.75)	Y	Y	Y	N
Slippery/red Elm			Y (20.75)	Y	Y	N	N
Poir (shrub)			Y (137)	?	Y	?	
Totals (15)	**2**	**4**	**10**	**10**	**10**	**5**	**2**

* Barker, personal communication

** No dominance measure, not present on Lee's list

Table 4 – Geographic (present on Lee's list)

Species	Present on planting list	Present at site	Dominant (Lee)	Expected to recruit*	Acquire all species not on planting list or present at site	Acquire all species not expected to recruit	Acquire dominant species not expected to recruit
Box Elder			Y (46.25)	Y	Y	N	N
Silver Maple		Y	Y (50.00)	Y	N	N	N
Sugar Maple			N (0.50)	N	Y	Y	N
Ohio Buckeye			N (7.75)	N	Y	Y	N
Bitternut Hickory			N (1.00)	N	Y	Y	N
Hackberry			Y (39.24)	Y	Y	N	N
Redbud			N (7.25)	Y	Y	N	N
Hawthorn			N (11.00)	N	Y	Y	N
American beech			N (0.25)	N	Y	Y	N
Green ash	Y		N (0.50)	Y	N	N	N
Blue ash			N (1.5)	N	Y	Y	N
Honey locust			Y (17.75)	N	Y	Y	Y
Bitternut			N (1.5)	N	Y	Y	N
Black mulberry			N (10.25)	N	Y	Y	N
Ironwood			N (1.00)	N	Y	Y	N
Sycamore	Y	Y	Y (37.00)	Y	N	N	N
Cottonwood		Y	Y (27.50)	Y	N	N	N
Swamp white oak	Y		N (3.50)	N	N	N	N
Shingle oak			N (0.75)	N	Y	Y	N
Black willow		Y	Y (44.75)	Y	N	N	N
Basswood			N (4.00)	Y	Y	N	N
American/white elm			Y (55.75)	Y	Y	N	N
Slippery/red elm			Y (20.75)	Y	Y	N	N
Rock elm			Y (33.25)	N	Y	Y	Y
Totals (24)	**3**	**4**	**10**	**11**	**18**	**12**	**2**

* Barker, personal communication

Table 5 – Consensus Synthesis (present on at least three lists)

Species	Present on planting list	Present at site	Dominant (Lee)	Expected to recruit*	Acquire all species not on planting list or present at site	Acquire all species not expected to recruit	Acquire dominant species not expected to recruit
Box Elder			Y (46.25)	Y	Y	N	N
Silver Maple		Y	Y (50.00)	Y	N	N	N
Sugar Maple			N (0.50)	N	Y	Y	N
Ohio Buckeye			N (7.75)	N	Y	Y	N
Hackberry			Y (39.24)	Y	Y	N	N
Hawthorne			N (11.00)	N	Y	Y	N
White Ash			N **	N	Y	Y	Y
Green Ash	Y		N (0.50)	Y	N	N	N
Sycamore	Y	Y	Y (37.00)	Y	N	N	N
Cottonwood		Y	Y (27.50)	Y	N	N	N
Black Willow		Y	Y (44.75)	Y	N	N	N
American/white elm			Y (55.75)	Y	Y	N	N
Slippery/red elm			Y (20.75)	Y	Y	N	N
Rock Elm			Y (33.25)	N	Y	Y	Y
Totals (14)	**2**	**4**	**9**	**9**	**9**	**5**	**2**

* Barker, personal communication

** No dominance measure, not present on Lee's list

Table 6 – Inclusive (present on at least one list)

Species	Present on planting list	Present at site	Dominant (Lee)	Expected to recruit*	Acquire all species not on planting list or present at site	Acquire all species not expected to recruit	Acquire dominant species not expected to recruit
Box elder			Y (46.25)	Y	Y	N	N
Silver maple		Y	Y (50.00)	Y	N	N	N
Sugar maple			N (0.50)	N	Y	Y	N
Ohio buckeye			N (7.75)	N	Y	Y	N
River/yellow birch			N **	N	Y	Y	N
Catalpa			N **	Y	Y	N	N
Bitternut hickory			N (1.00)	N	Y	Y	N
Shagbark hickory			N **	N	Y	Y	N
Hackberry			Y (39.24)	Y	Y	N	N
Redbud			N (7.25)	Y	Y	N	N
Hawthorne			N (11.00)	N	Y	Y	N
American beech			N (0.25)	N	Y	Y	N
White ash			N **	N	Y	Y	Y
Green ash	Y		N (0.50)	Y	N	N	N
Blue ash			N (1.5)	N	Y	Y	N
Honey locust			Y (17.75)	N	Y	Y	Y
Butternut			N (1.5)	N	Y	Y	N
Black walnut			N **	N	Y	Y	Y
Tulip poplar	Y		N **	N	N	N	N
White mulberry			N **	Y	Y	N	N
Black mulberry			N (10.25)	N	Y	Y	N
Ironwood			N (1.00)	N	Y	Y	N
Blue spruce			N **	N	Y	Y	N
Sycamore	Y	Y	Y (37.00)	Y	N	N	N
Cottonwood		Y	Y(27.50)	Y	N	N	N
Black cherry			N **	N	Y	Y	N
White oak	Y		N **	N	N	N	N
Swamp white oak	Y		N (3.50)	N	N	N	N
Shingle oak			N (0.75)	N	Y	Y	N
Bur oak	Y		N **	N	N	N	N
Chinquapin oak			N **	N	Y	Y	N
Pin oak	Y		N **	N	N	N	N

Table 6 (continued) Species	Present on planting list	Present at site	Dominant (Lee)	Expected to recruit*	Acquire all species not on planting list or present at site	Acquire all species not expected to recruit	Acquire dominant species not expected to recruit
Oak			N **	N	Y	Y	N
Black locust			N **	Y	Y	N	N
Weeping willow			N **	N	Y	Y	N
Salix cordata			N **	N	Y	Y	N
Black willow		Y	Y (44.75)	Y	N	N	N
Willow			N **	Y	Y	N	N
Scholar tree			N **	N	Y	Y	N
Basswood			N (4.00)	Y	Y	N	N
American/White Elm			Y (55.75)	Y	Y	N	N
Slippery/red elm			Y (20.75)	Y	Y	N	N
Rock elm			Y (33.25)	N	Y	Y	Y
Totals (43)	**7**	**4**	**10**	**15**	**33**	**23**	**4**

* Barker, personal communication

** No dominance measure, not present on Lee's list

Table 7 – Species to be rejected from planting list*

Species	Purest (Lindsey)	Geographic (Lee)	Synthesis (3 lists)	Inclusive (one list)
Button Bush	N	N	N	N
Swamp White Oak	Y	N	Y	N
Sycamore	N	N	N	N
Shellbark Hickory	Y	Y	Y	Y
Pin Oak	Y	Y	Y	N
Green Ash	N	N	N	N
Black Gum	Y	Y	Y	Y
Bur Oak	Y	Y	Y	N
White Oak	Y	Y	Y	N
Tulip Poplar	Y	Y	Y	N
Total	7	6	7	2
* Assuming all species in approach will be acquired				

Table 8 – Number of trees that can be planted with different spacing

Spacing (feet)	1 acre	2 acres	3 acres	4 acres	5 acres	6 acres	7 acres	8 acres
5x5	1742	3484	5226	6968	8710	10452	12194	13936
6x6	1210	2420	3630	4840	6050	7260	8470	9680
7x7	889	1778	2667	3556	4445	5334	6223	7112
8x8	681	1362	2043	2724	3405	4086	4767	5448
9x9	538	1076	1614	2152	2690	3228	3776	4304
10x10	436	872	1308	1744	2180	2616	3052	3488

Source: Purdue University, Forestry and Natural Resources publication 36

Table 9 - Planting Designs	Arbitrary	Grid		Clusters		Zones		
		Arbitrary	Random	Arbitrary	Random	Arbitrary	Random	Cluster/Grid
Objective/ Rationale	Quickly plant trees to provide 'greenery'	Based on recommendations from theUSFWS		More accurately replicate a 'natural' forest		More accurately replicate a 'natural' forest, trees are placed based on predicted survivability		
Species Placement (which species are to be planted where)	Arbitrary, planting the trees based on what species is in hand at that point in time	Arbitrary	Species planted in a set 'pattern', or using a random numbers table, not concerned with survival of seedlings	Species planted in clusters, no consideration of which species are found together or will survive	Cluster species that are usually found together on a floodplain, no consideration of which species will survive	Place species within predetermined zones, based on survivability of species, where species are usually found on a floodplain		
Species Spacing	Arbitrary	Plant in grids, 10 (or 9, 8, 7…) foot centers in parallel rows		Determine a 'cluster' area to be planted and place species anywhere within the boundaries of the area		Arbitrary within zones	Clustered within zones (cluster alternative within zones)	Clustered within zones, grids within clusters
Maintenance and Monitoring	Little to none	Careful record keeping (an accurate database) during the planting period would facilitate easy maintenance and monitoring over an extended period of time.						
Advantages	Fast and easy, some educational opportunities	Easy maintenance and monitoring, some educational opportunities		More accurately replicates a 'natural' forest, easier maintenance and monitoring, greater educational opportunities		Greater chance of seedling survival, more accurately replicates a 'natural' floodplain forest, greater educational opportunities		Greater chance of seedling survival, more accurately replicates a 'natural' floodplain forest, easier monitoring due to known locations of seedlings, many educational opportunities
Disadvantages	Not 'ecologically' sound, no scientific basis, monitoring difficult, no consideration of survival of seedlings	Does not replicate a 'natural' forest, not aesthetically pleasing, no consideration of survival of seedlings		No consideration of survival of seedlings		More time and effort required to plant seedlings		

Table 10 – Level of Effort

Time per Tree	Total Time for 4000 Trees	Total Time for 3000 trees
5 minutes	333 hours	250 hours
10 minutes	666 hours	500 hours
15 minutes	1000 hours	750 hours
20 minutes	1333 hours	1000 hours
25 minutes	1666 hours	1250 hours
30 minutes	2000 hours	1500 hours

Table 11 – Ecological Reforestation Alternative - Non-recruiting Species

Species	Scientific Name	Dominant (Lee)	Expected to Recruit*	Species to Acquire**	Present at site	Zone	Wetland Indicator (R3 Indiana)
Swamp white oak	*Quercus Bicolor*	N (3.50)	N	Y	N	2 or 3	FACW+
Ohio buckeye	*Aesculus Glabra*	N (7.75)	N	Y	N	2 or 3	FAC+
River/yellow birch	*Betula Nigra*	N ***	N	Y	N	2 or 3	FACW/FAC
Pin oak	*Quercus Palustris*	N ***	N	Y	N	2 or 3	FACW
Heartleaf Willow	*Salix Cordata*	N ***	N	Y	N	2 or 3	FAC+
Rock elm	*Ulmus Thomasi*	Y (33.25)	N	Y	N	2 or 3	FAC+
Bitternut hickory	*Carya Cordiformis*	N (1.00)	N	Y	N	2 or 3	FAC
Hawthorne	*Crataegus sp.*	N (11.00)	N	Y	N	2 or 3	FAC
Honey locust	*Gleditsia Tricanthos*	Y (17.75)	N	Y	N	2 or 3	FAC
Black mulberry	*Morus Rubra*	N (10.25)	N	Y	N	2 or 3	FAC?
Shingle oak	*Quercus Imbricaria*	N (0.75)	N	Y	N	2 or 3	FAC-
Bur oak	*Quercus Macrocarpa*	N ***	N	Y	N	2 or 3	FAC-
Sugar maple	*Acer Saccharum*	N (0.50)	N	Y	N	4	FACU
Shagbark hickory	*Carya Ovata*	N ***	N	Y	N	4	FACU
White ash	*Fraxinus Americana*	N ***	N	Y	N	4	FACU
Black walnut	*Juglans Nigra*	N ***	N	Y	N	4	FACU
Black cherry	*Prunus Serotina*	N ***	N	Y	N	4	FACU
White oak	*Quercus Alba*	N ***	N	Y	N	4	FACU
Butternut	*Juglans Cinerea*	N (1.5)	N	Y	N	4	FACU+
Tulip poplar	*Liriodendron Tulipifera*	N ***	N	Y	N	4	FACU+
Ironwood	*Ostrya Virginiana*	N (1.00)	N	Y	N	4	FACU-
American beech	*Fagus Grandifolia*	N (0.25)	N	Y	N	4~	?
Blue ash	*Fraxinus Quadrangulata*	N (1.5)	N	Y	N	4~	?
Chinquapin oak	*Quercus Muhlenbergii*	N ***	N	Y	N	4~	NI
Oak	*Quercus Sp.*	N ***	N	Y	N	4~	?
Total Non-recruiting	25	2	0	25	0	-	-

* Barker, personal communication

** Non-recruiting, native species not present at the site

*** No dominance measure, not present on Lee's list

Table 11 (continued) – Ecological Reforestation Alternative - Recruiting Species							
Species	**Scientific Name**	**Dominant (Lee)**	**Expected to Recruit***	**Species to Acquire****	**Present at site**	**Zone**	**Wetland Indicator (R3 Indiana)**
Black willow	*Salix Nigra*	Y (44.75)	Y	N	Y	1	OBL
Box elder	*Acer Negundo*	Y (46.25)	Y	N	Y	2 or 3	FACW-
American/White Elm	*Ulmus Americana*	Y (55.75)	Y	N	N	2 or 3	FACW-
Silver maple	*Acer Saccharinum*	Y (50.00)	Y	N	Y	2 or 3	FACW
Green ash	*Fraxinus Pennsylvanica*	N (0.50)	Y	N	N	2 or 3	FACW
Sycamore	*Platanus Occidentalis*	Y (37.00)	Y	N	Y	2 or 3	FACW
Cottonwood	*Populus Deltiodes*	Y(27.50)	Y	N	Y	2 or 3	FAC+
Slippery/red elm	*Ulmus Rubra/Fulva*	Y (20.75)	Y	N	N	2 or 3	FAC
Hackberry	*Celtis Occidentalis*	Y (39.24)	Y	N	N	2 or 3	FAC-
Redbud	*Cercis Canadensis*	N (7.25)	Y	N	N	4	FACU
Basswood	*Tilia Americana/Glabra*	N (4.00)	Y	Njj	N	4	FACU
Total recruiting	11	8	11	0	5	-	-
Totals	36	10	15	25	5	-	-

* Barker, personal communication

** Non-recruiting, native species not present at the site

Table 12 – Possible number of trees to be planted in each zone

Zone	Acres (approx.)	Total Species to be planted	Dominant Species	Non Dominant Species	Trees 10 X 10 Grid*	Number of each species	Survival of each species (at 10%)	7 X 7 Grid*	Number of each species	Survival of each species (at 10%)
1	1	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a
2 and 3	7	12	2	10	3052	-	-	6223	-	-
Dominant					763	382	38	1556	778	78
Non - dominant					2289	229	23	4667	467	47
4	1	13	0	13	436	34	3	889	68	7
Wetlands (5 and 6)	4	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a

*See Table 8

Non-Dominant Species, plant equal proportion

Dominant Species:

2 dominant species = 25% of total

10 non-dominant species = 75% of total

This results in a ratio of 1.7 to 1.

Note: Dominance criterion (>15) chosen arbitrarily, reduction or increase of dominance criterion would alter results.

Table 13 – Preliminary Estimates of Area of Zones

Zone	Square Feet	Acres	Zone Description
1	51688.20	1.18	Riparian Fringe
2	110657.73	2.54	
3	210640.10	4.83	
4	35454.43	0.81	Highest Area, adjacent to levee
Subtotal	408440.46	9.37	
5	151574.90	3.48	Insular Bar
6	31878.08	0.73	Backwater Pocket
Total	591893.44	13.58	