Reinventing Wingfield Pines: Creating a Regional Showcase for Floodplain Rehabilitation in a Post-mined Landscape

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Abstract

This project is a comprehensive design masterplan and ecological rehabilitation plan for an 80 acre strip-mined floodplain on Chartiers Creek, in Allegheny County, Pennsylvania. The client, the Allegheny Land Trust (property owner), seeks to recreate this site – called Wingfield Pines – as a regional showcase for ecological rehabilitation and environmental education. This includes passive treatment wetlands to cleanse iron oxide from abandoned mine drainage (AMD), accelerated succession of forest regeneration and habitat enhancements, site access enhancements, as well as educational signage and program development.

We visited the site on five separate occasions between January 2006 and April 2007, during which we mapped topography, measured slopes and site layout, evaluated existing vegetation, conducted a site features inventory, studied aesthetics and viewsheds, and took numerous photographs. We conducted a public survey of visitors' impressions and use patterns following a preliminary design presentation and public meeting. We maintained regular contact with ALT and many other experts and stakeholders as we developed multiple design scenarios for the site and its long-term rehabilitation and management.

This report documents both our process and our final recommendations for the site. We review the cultural and regional context including history, site analysis, and site feature inventory. We have also included planting plans, detail renderings, as well as ecological rehabilitation and management goals and processes. Additionally, we suggest a framework for an effective educational program and catalog important public access improvements. All of this information is integrated into a "50-year vision of Wingfield Pines," along with a discussion on how this vision can be attained.

Project Background and Acknowledgements

Our client, Allegheny Land Trust (ALT) is an independent non-profit incorporated in 1993 to conserve green space in Allegheny County. ALT's mission is "to serve as the lead land trust conserving and stewarding lands that support the scenic, recreational and environmental well-being of communities in Allegheny County and its environs." To date, ALT has conserved over 1,300 acres in Allegheny County and Washington County immediately to the south.

Shortly after ALT acquired the Wingfield Pines property in 2002, Joel Perkovich, one of the primary authors, began a 6-month internship for the organization. This employment matured into an on-going association with ALT and its mission of land conservation in the greater Pittsburgh area. Mr. Perkovich brought the Wingfield Pines property to the attention of the University of Michigan's School of Natural Resources and Environment (SNRE) Masters Project Planning Course in the fall of 2005, where he was working towards a masters degree in landscape architecture. The Masters Project Planning Course links graduate students in SNRE with a capstone project that fulfills the masters thesis/project requirement of the curriculum. Fellow landscape architecture students Brian Chilcott and Mary Walton joined the Wingfield Pines project to create a master plan that will guide ALT's planning and management decisions for the site. The three authors have worked on the project since January 2006 through April 2007.

In 2002, the Wingfield Pines property was the subject of design charettes and an analytical thesis produced by Manasi Atre and Vanessa Rutter, then undergraduate students at Pennsylvania State University's Hamer Center for Community Design Assistance and Department of Landscape Architecture. The preliminary information gathered by these students was invaluable and helped to catalyze our own work.

The authors acknowledge the following individuals for their generous input into this work, without whom the Wingfield Pines master plan would have been incomplete:

Roy Kraynyk, executive director, ALT; Bob Hedin, PhD, president Hedin Environmental; Charles Prine, private donor; Bob Grese, primary faculty advisor, Associate Professor of Landscape Architecture, SNRE, University of Michigan; Larissa Larsen, co-faculty advisor, Assistant Professor of Landscape Architecture, SNRE, and Assistant Professor of Urban Planning, Alfred Taubman College of Architecture and Urban Planning, University of Michigan; Jeff Wagner, director of the Natural Heritage Program, Western Pennsylvania Conservancy; Ed Schroth, Adjunct Professor, Biology, Education, and Environmental

Sciences departments at Duquesne University; Rob McLaughlan, PhD, Upper St. Clair Citizens for Land Stewardship; Sue Gold, Operations Manager, ALT; Donald Gray, PhD, Professor Emeritus, Department of Civil and Environmental Engineering, University of Michigan; Bonnie Wagner, Lower Chartiers Creek Watershed Council and ALT; Angelo Ciotti, Environmental Reclamation Artist, Fellow at the Carnegie Mellon University Studio for Creative Inquiry; Bernadette Kazmarski, Lower Chartiers Watershed Council; Jessica Stombaugh, Program Manager, Regional Environmental Education Center; MaryCarol Hunter, PhD, Assistant Professor Landscape Architecture, SNRE, University of Michigan; Rachel Kaplan, PhD, Professor SNRE, and Department of Psychology, University of Michigan; the community members who attended our preliminary design presentation and workshop at the Regional Environmental Education Center in November 2006.

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1.0 Local and Regional Context

In 2002 the Allegheny Land Trust (ALT), a non-profit land conservation organization based in Pittsburgh, Pennsylvania, acquired an 80-acre parcel of floodplain and wetlands along the banks of Lower Chartiers Creek. The site was named Wingfield Pines after the golf course and swim club that had operated there from 1968-1983; henceforth, it will be referred to as Wingfield Pines Conservation Area (WPCA). Previous site uses also include agriculture, strip mining for coal, and a swim and tennis club. WPCA is located 15 miles from Pittsburgh's city center in Allegheny County and lies in a deep valley, surrounded by bluff ridges and steep slopes, which rise 70-100 feet in elevation. The site lies within both Upper St. Clair Township and South Fayette Township, which together have a population of 32,324 across thirty square miles (US Census Bureau, 2000).

Suburban neighborhoods occupy the eastern ridges overlooking WPCA. Boyce-Mayview Park, a 438-acre property managed by Upper St. Clair Township, is adjacent on the south and east of WPCA. In 1999 the Township approved a master plan for the park that includes a Regional Environmental Education Center (REEC), several soccer and baseball fields, a community pool and recreational facility. As this plan continues to be realized it will increase the use and public awareness of WPCA. Boyce-Mayview Park's entry drive is directly across from WPCA's entry drive on Mayview Road (Figure 1.1). The 280-acre Mayview Valley Biological Diversity Area (BDA), as designated by a 1994 Natural Heritage Inventory of Allegheny County, is included in the park (Western Pennsylvania Conservancy, 1994). WPCA is located just upstream from the Mayview Valley BDA, which possesses high-quality upland-forest plant communities. ALT is actively pursuing a 7-acre parcel of land at WPCA's southern boundary that would provide a continuous conservation corridor from WPCA to Boyce-Mayview Park (Kraynyk, pers. comm.).

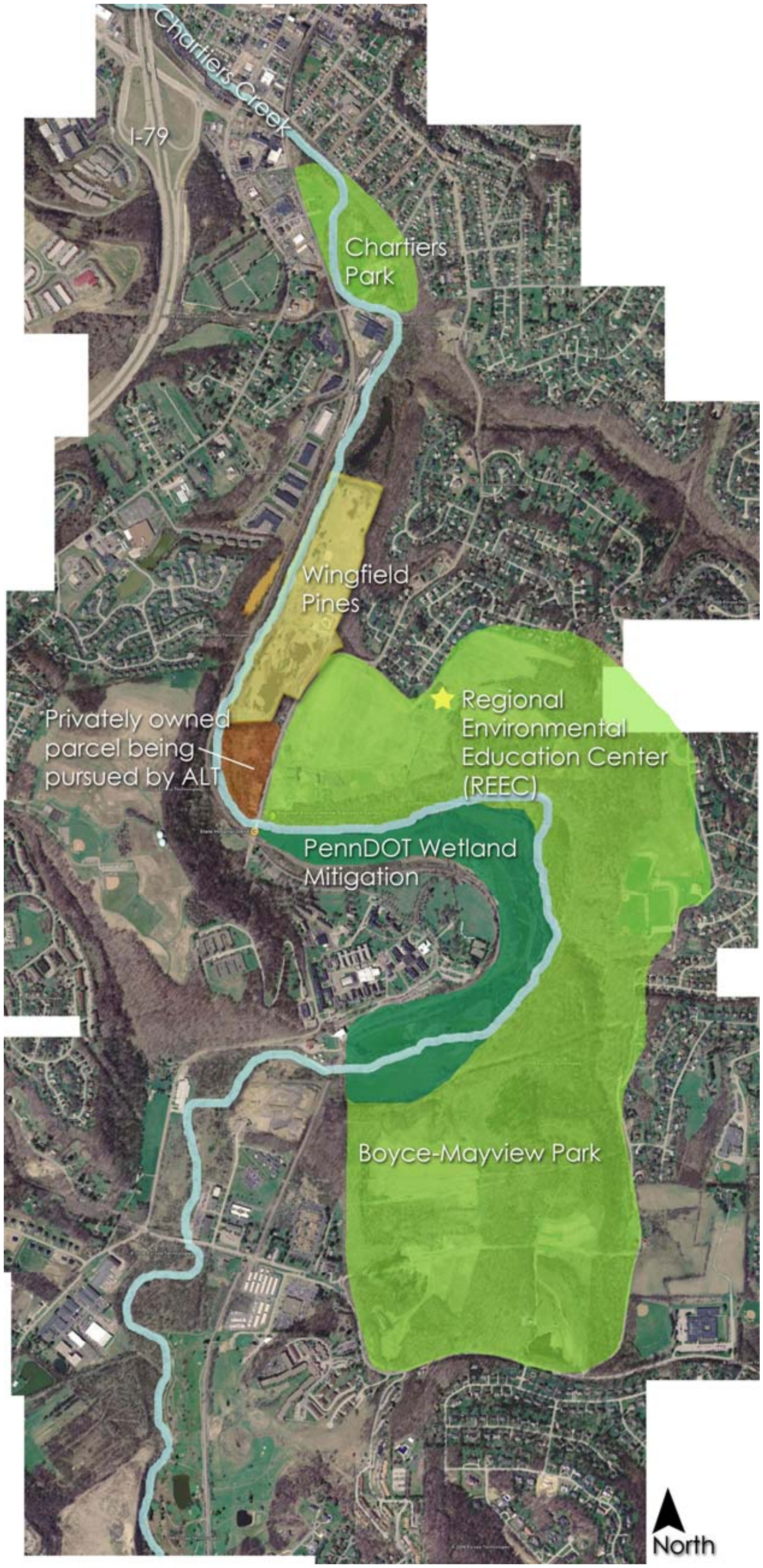

Figure 1.1 Regional context of WPCA.

Lower Chartiers Creek extends over 3,000 feet along WPCA's western edge and is classified as a sub-basin of the Upper Ohio River Basin. Lower Chartiers Creek runs through 16 other townships after it passes WPCA and joins the Ohio River three miles south of the river's source at Pittsburgh's iconic Point State Park – the confluence of the Allegheny and Monongahela Rivers. The entire Chartiers Creek watershed has a drainage area of 277 square miles and is the fifth largest watershed in southwestern Pennsylvania behind the four major rivers – the Youghiogheny, Allegheny, Monongahela, and Ohio. The majority of Upper Chartiers Creek is located in rural Washington County and flows north towards Pittsburgh. Where the tributary of Little Chartiers Creek meets Upper Chartiers Creek it becomes designated as Lower Chartiers Creek. The population of the entire watershed (both upper and lower divisions of the creek) is approximately 160,000 (1998 figure, Lower Chartiers Creek Watershed Council).

The Lower Chartiers Creek Rivers Conservation Plan (LCCRCP), completed in 2002 with a grant from the Pennsylvania Department of Environmental Protection (PADEP), revealed that 93% percent of the streams in the Lower Chartiers Creek watershed do not meet the standards of Pennsylvania's Clean Streams Act (LCCRCP, 2000). Lower Chartiers Creek has a drainage area of 139 square miles and is recognized as one of Pennsylvania's most polluted watersheds due to AMD, urban/suburban/agricultural runoff, and combined sewage overflows (PADEP, 2003). Of Chartiers Creek's 52 mile course (Upper and Lower), 30.7 miles have fish consumption advisory warnings (WRAS, 2004). WPCA's existing site conditions reflect the region's legacy of natural resource exploitation and poor land-use planning responsible for the watershed's impaired condition; it is indeed a microcosm of the environmental challenges throughout – not only within the watershed, but across southwestern Pennsylvania. These primary issues are:

- stormwater mismanagement
- abandoned mine drainage
- loss of native biodiversity

1.1. Stormwater Mismanagement

Southwestern Pennsylvania is notorious for its regional water quality problems. A 2006 study conducted from July 2003-December 2004, revealed that Allegheny County was in the top eight U.S. counties with facilities exceeding their Clean Water Act (CWA) permits. A statewide analysis for the same time period revealed that Pennsylvania ranked third amongst U.S. states in allowing the most exceedences of CWA permits and is one of only seven states that allowed 100 exceedences over 500% of CWA parameters (Leavitt, 2006). Pennsylvania has the greatest number of permitted combined sewage overflows (CSOs) in the country, almost *half* of which are located in southwestern Pennsylvania – 755 of 1,671 (Blaustein, 2006). During the recreational boating season (May-September) the Allegheny County Health Department (ACHD) frequently issues warnings to avoid intimate contact with river water because of dangerous bacteria levels that result from CSOs discharging untreated sewage into surface waters. As little as one-tenth of an inch of rain can trigger CSOs; the region's average storm event produces one-quarter of an inch. In the 2002 recreation season ACHD issued those warnings 50% of the time, and 80% of the days in 2004 (3RWWDP, Blaustein 2006).

The water management challenges in southwestern Pennsylvania are a product of abundant rainfall, averaging 38 inches annually (NOAA, 2004), an antiquated and undersized combined storm and sanitary sewer system, a loss of ecological services from development in wetlands and floodplains, and an increase in impervious surface from sprawling development and poor land-use planning. A 2002 Brookings Institute report indicates that rates of sprawl in southwestern Pennsylvania far exceed national averages. From 1982-1997 the region developed 8.5 acres of land for every new household; the national average was just 1.3 acres of developed land per new household. This slapdash pattern of sprawl built upon 201,800 acres of land, including nearly 21,000 acres of prime farmland during that time (Brookings Institute, 2002). The population of the entire Ohio River sub-basin is projected to increase substantially from its 1990 figure of 360,000 people to 540,000 by 2040 (PADEP, 2003). Seeking cooperative measures to effectively manage stormwater is arguably the greatest public health challenge facing the region, particularly given the patterns of sprawl and the provincial nature of southwestern Pennsylvania's local governments. There are over 800 individual entities responsible for water management in southwestern Pennsylvania (Burns and Muller, 2006). Regional water cooperation strategies that consider downstream impacts, such as the restoration and preservation of riparian zones and wetlands, are critical to improve the environmental health of the watershed (LCCRCP, 2001).

An increase in extreme flood events along Chartiers Creek has renewed local interest in the ecological services of floodplains and wetlands to mitigate floodwaters. Record-breaking floods occurred in 2004 from Hurricane Ivan storm systems, depositing an average of 6.25 inches of rainfall on the watershed over a twenty-four hour period (Lower Chartiers Watershed Council). Communities along Chartiers Creek downstream of WPCA experienced some of the worst property damage in the Greater Pittsburgh area. It is estimated that WPCA stored 50 million cubic feet of water during this storm event and prevented water levels from rising higher in downstream neighborhoods (Figure 1.2; Hedin, pers. comm.). Preserving the region's remaining ecological services through land conservation is paramount for a comprehensive flood control strategy (Chartiers Creek Conservancy).

Figure 1.2 A photograph of WPCA taken on September 17, 2004 following hurricane Ivan. Notice that even the upland golf mounds are entirely submerged. Photograph by Bob Hedin.

1.2. Abandoned Mine Drainage

WPCA was strip mined for coal in 1948 (McLaughlan, pers. comm.). Strip mining removes all the surface soil and rock atop the desired mineral source (coal). Deep Mining requires extensive sub-surface tunneling to extract coal from deep underground seams. All mining that occurred at WPCA was conducted prior to the Federal Surface Mining Control and Reclamation Act (SMCRA). The SMCRA requires mine contractors to restore land to its approximate original contour and amend altered hydrological flows which could result in abandoned mine drainage, which is groundwater that fills and emerges from such mines. As defined by SMCRA, WPCA is an abandoned mine land (AML), which refers to mined lands left in inadequate reclamation status and abandoned prior to August 3, 1977, the date it was signed into law by President Carter (PADEP 1998).

Figure 1.3 AMD outflow at WPCA.

At WPCA's northern edge AMD discharges from a deep mine vent shaft at a 1,500 gallons per minute (gpm) flow (Figure 1.3). This is generally considered a very high flow. The source of AMD at WPCA is from the extensive network of deep mines that comprise the Montour 4 and Montour 10 mine complexes that tunnel to depths of nearly 800 feet and underlie 21,000 acres beneath the Pittsburgh region (Donovan, 2003). A deep mine tunnel to this mine complex was located just beyond WPCA's northern boundary, and the highwall where strip mining ceased at WPCA is evident at the base of the site's eastern slopes (Figure 1.4).

Figure 1.4 WPCA highwall (post-strip mine) and constructed swale (post-golf course)

The metal rich groundwater gushes from the vertical pipe into a small pond and meanders into Chartiers Creek, depositing some 43 tons of iron oxide solids into the water annually. The WPCA AMD discharge has the largest untreated volume of 45 other identified major AMD inputs into the Chartiers Creek Watershed, and is the most upstream discharge into Lower Chartiers Creek (Hedin 2004, LCCRCP 2001).

The water quality impacts of AMD are severe. As dissolved iron precipitates out of AMD it oxidizes to a rust-orange sludge that coats, or "armors" stream bottoms, decimating benthic habitats and disrupting food webs. Often, AMD is highly acidic and can lower stream pH to levels intolerable to most aquatic life. The AMD at WPCA is neutral, between 6.7 and 6.8, and contains only trace amounts of aluminum and manganese (Hedin, 2004). Depending on the composition of rock with which groundwater is in contact before daylighting, AMD can also contain dissolved concentrations of aluminum, arsenic, barium, cadmium, cobalt, copper, manganese, and silver, threatening not only aquatic habitat, but drinking water supplies as well (Volz, 2006). In 2005, the Natural Resource Council declared drainage from abandoned coal mines as "the most pervasive and widespread water pollution in southwestern Pennsylvania's industrial history" (NRC, 2005). A PADEP assessment of the Chartiers Creek watershed in 1998 listed AMD as the greatest source of water quality impairment (Table 1.1). Figure 1.5 illustrates AMD's impact on water quality statewide.

Table 1.1 Sources of non-attainment of PA Clean Streams Act, water quality standards in Lower Chartiers Creek (Adapted from PADEP, 1998).

Pollution Source	Primary Source	Secondary and Tertiary Sources	Total
Abandoned Mine Drainage	35.4	108.7	**144.1**
Urban Impacted (or Habitat Modification)	16.0	29.4	**45.4**
Agriculture	8.4	13.7	**22.1**
Construction	2.5	18.1	**20.6**
Urban Runoff/Storm Sewers	1.4	16.9	**18.3**
Source Unknown	10.1	8.1	**18.2**
On-Site Wastewater	1.9	4.1	**6.0**
Surface Mining		5.6	**5.6**
Natural Sources	0.4	2.3	**2.7**
Hydromodification	0.7	1.8	**2.5**
Combined Sewer Overflow	1.9		**1.9**
Subsurface Mining		0.5	**0.5**
Golf Courses	0.4		**0.4**
Land Development		0.4	**0.4**
In Attainment	6.3		
Total	85.4 mi	209.6 mi	**288.7 mi**

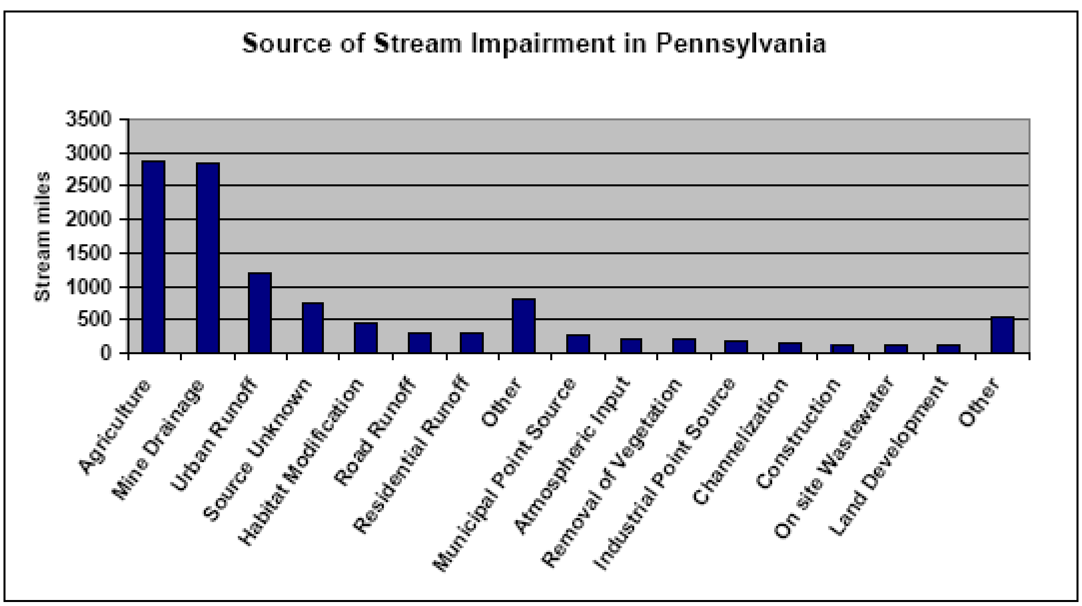

Figure 1.5 Source of stream degradation in DEP stream sampling (Adapted from PGC, 2005).

1.3. Loss of Native Biodiversity

Prior to European arrival, southwestern Pennsylvania's abundant waters, forests, and wild game had supported native peoples at least for the past 12,000 years. This region was largely occupied by the Monongahela, Shawnee, Seneca, Delaware, and Susquehannock cultures (Alberts, 1980). However, as European settlement intensified, particularly with the discovery of abundant coal seams in the mid 18th century, the region's land use patterns began to rapidly change (LCCRCP, 2002). Southwestern Pennsylvania was literally and figuratively at the headwaters of an industrial revolution and no existing legislation would ensure a responsible process of development; consequently, the composition of southwestern Pennsylvania's indigenous people, plants, and wildlife was irrevocably altered. Reports by the Western Pennsylvania Conservancy (WPC) in 1994, and the Pennsylvania Game Commission (PGC) in 2005, urge that preservation and restoration of native biodiversity is critical to the repair of ecosystems throughout the state and region (WPC, 2004, PGC, 2005). Given the elevated visibility of both WPCA and ALT which will occur as implementation of the Boyce-Mayview Park master plan proceeds, a concerted ecological rehabilitation program at WPCA would raise public awareness of, and appreciation for, the endangerment and value of regional native biodiversity.

1.4. WPCA History and Site Conditions

Figure 1.6 is a graphic site analysis, which reveals the spatial organization of many elements across WPCA. The contextual relationships of these elements are important to grasp as they are discussed in greater detail in the next three chapters.

Prior to strip mining, WPCA had been used primarily as pasture and cropland. Ordered agricultural rows are evident in a 1939 aerial photograph (Figure 1.7) only the steep slopes retain some of the forest community. Post-mining, WPCA lie abandoned as upturned earth and mine spoils until 1968 when it was acquired for the construction of an eighteen-hole golf course. Shortly thereafter, the Wingfield Pines golf club opened to the public and operated until 1983 (McLaughlan, pers. comm.). Numerous earthworks were undertaken by the golf course management to improve site drainage and make it suitable for sport. Swales were constructed along the length of the eastern hillsides and highwall (where strip mining stopped leaving an exposed vertical rock face), and three small ponds, fed by the stormwater swales and groundwater, were created on the site's southern half.

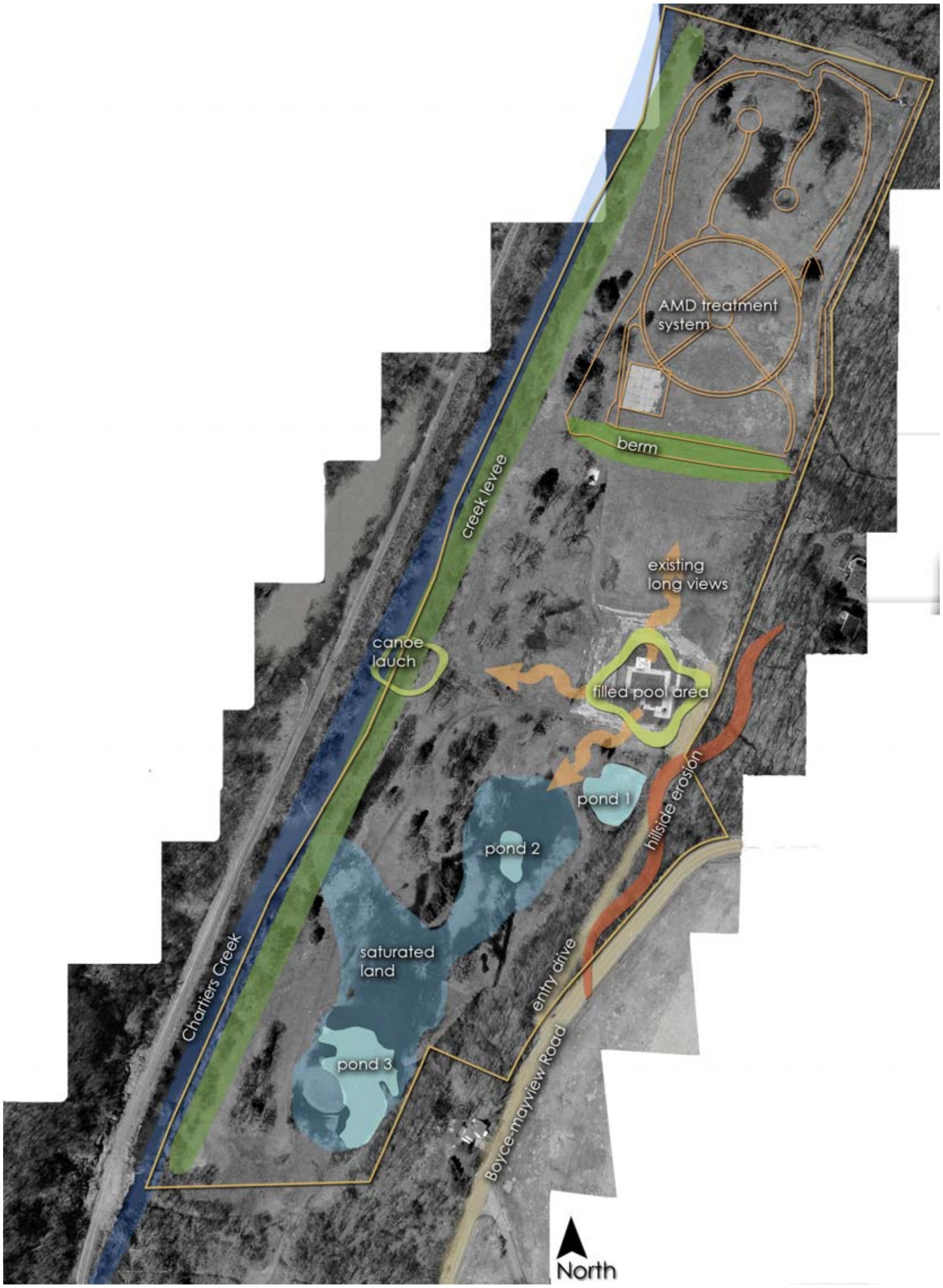

Figure 1.6 WPCA Site Analysis. This graphic site analysis illustrates the spatial organization of elements that will be referenced throughout this document.

Figure 1.7 WPCA 1939 aerial photograph. WPCA (edged in blue) with historical creek channel and evidence of agriculture in the floodplain. (www.pennpilot.psu.edu/)

Along the length of Chartiers Creek an earthen levee was shaped from mine spoils to keep creek water from overrunning its banks and flooding the golf course during high water events. The levee still exists on-site, fundamentally altering the natural floodplain hydrology (to be addressed in Chapter 2). The golf course design featured pine-planted mounds throughout the eighty-acre site, which abruptly emerge from the otherwise flat floodplain, and still exist today. Topsoil was spread over the mine spoils, sown with a turf grass seed mix (Saad, 1993), and managed as such during the golf course's 15 years of operation.

Despite the golf course operators' efforts to craft a well-drained floodplain, it remained regularly saturated from high water tables and excessive road and residential runoff dumping down the eastern slopes. Though sheet flow of rainwater down these slopes contributes significantly to WPCA's saturated soils, years of concentrated runoff from culverts just beneath the slope's plateau have eroded deep channels down to slate bedrock, destabilizing the soil, forming sediment deltas at the slope's base and carrying sediments into the constructed ponds. The area around WPCA's constructed ponds has not yet been delineated, but it is believed to be classified as wetland, based on soil saturation and species composition. The authors visited the site five times from January 2006 - February 2007, and studied these wetland areas with Dr. Bob Hedin and Jeff Wagner. Dr. Hedin is head of Hedin Environmental, and specializes in the construction and design of passive-treatment systems for AMD. Jeff Wagner is director of the Western Pennsylvania Conservancy's Natural Heritage Program and lives one mile from WPCA. The golf course and swim club ceased operations in 1983, as the site's saturated soils (Figure 1.8) proved insurmountable and unprofitable to the ownership.

Figure 1.8 Wet conditions at WPCA. Extensive inundation across WPCA is typical during the wet season.

After Wingfield Pines Golf Club closed, WPCA was again abandoned until 1991 when new investors constructed a pool, tennis courts, and bathhouse on-site and opened the Upper St. Clair Swim Club. Concurrently, a 6 to 8 foot high berm was built across the northern third of the site (Figure 1.6). Excess cut from the 30-acre Pennsylvania Department of Transportation (PENNDOT) Mayview wetland mitigation project a mile south (upstream) of WPCA was spread east-west across WPCA, perpendicular to Chartiers Creek, from the levee to the eastern slopes. The intent of this berm is uncertain. Its purpose may have been to corral AMD sludge-filled floodwaters and prevent them from spreading across the entire property on occasions when Chartiers Creek breached the levee and inundated the floodplain (Wagner, pers. comm.). However, there is also speculation it was built to serve as a driving range, though it never officially served this purpose (McLaughlan, pers. comm.).

The swim club also proved unprofitable and closed in 1997. WPCA went to public auction in 1999; however, there were no bidders. The site continued to be annually mown by Upper St. Clair Township, which prevented any significant woody regeneration. Since, local residents have regularly used WPCA as an unofficial park, typically for passive recreation and dog walking. Footpaths throughout the site follow the more well-drained upland areas created by the original golf course designers. WPCA continues to serve the community in this capacity.

1.5. Purchase by the Allegheny Land Trust

In 2002 ALT purchased the WPCA property for $450,000 with a grant from the Pennsylvania Department of Conservation and Natural Resources (PADCNR), support from the

Upper St. Clair Citizens for Land Stewardship (USCCLS), and other private donations. Since then, all mowing on site has ceased and some woody recruitment has been observed. In 2004, ALT received a $650,000 grant from the state's Growing Greener fund to construct a passive-treatment system for the AMD, consisting of settlement ponds and emergent wetlands. The AMD treatment system design, awarded to environmental engineering firm Hedin Environmental, will comprise twenty acres and is to be sited north of the berm running perpendicular to Chartiers Creek. The system is expected to prevent 250 pounds of iron from entering Lower Chartiers Creek each day, or 99% of the annual iron currently deposited from the WPCA AMD discharge. The treatment system (Figure 1.9) features earthen pathways that provide access to the interior wetlands, enhancing bird and plant observations and promoting educational opportunities (Hedin, 2004).

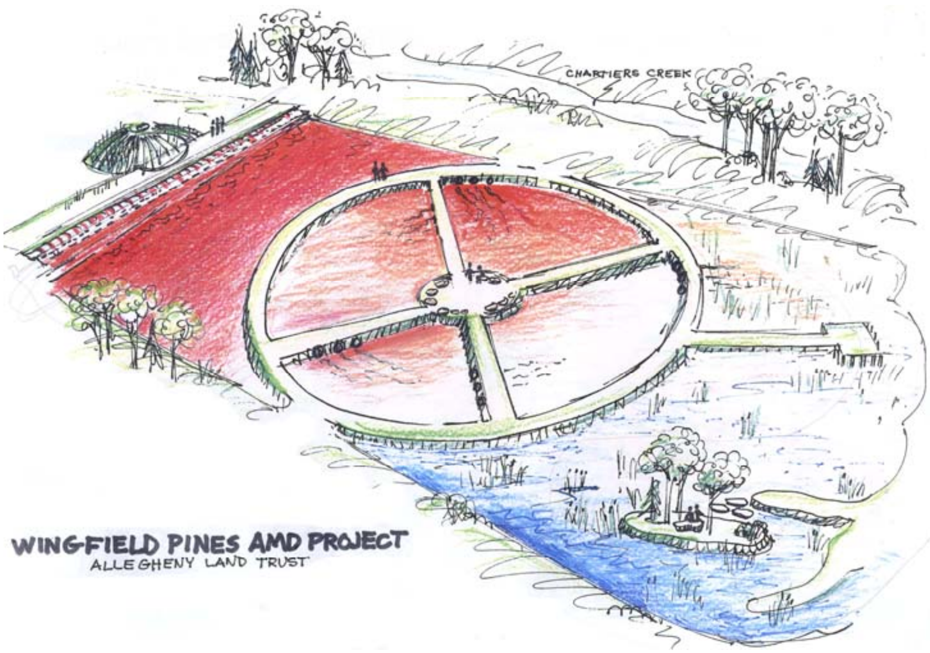

Figure 1.9 Artist's early rendition of the AMD system. Provided by ALT (by Angelo Ciotti, Carnegie-Mellon University Studio for Creative Inquiry)

Final approval for construction of the AMD is currently in negotiation with the Army Corps of Engineers (ACE). The Pennsylvania Department of Environmental Protection (PA DEP), however, has already approved the treatment system's construction. As the construction of the AMD system will displace 1.25 acres of (low quality) existing herbaceous wetland, ACE and ALT are negotiating mitigation options, which are typically required at a 1:1 ratio. Hedin Environmental has adjusted its system design slightly to allow the creation of 0.25 acres of new wetland just east of its original design at the base of the highwall. ALT is proposing the enhancement of the WPCA southern wetlands at a 2:1 ratio to compensate for the remaining one acre of displaced wetland. Enhancement would be achieved by densely planting 2 acres of the site's southern wetlands with mid and late-successional, woody floodplain species indicative of high-quality forested wetlands. We assisted ALT and Hedin Environmental by researching this alternative during the summer of 2006 and have since designed 2 acres of enhanced forested wetland into the WPCA master plan. Figure 1.10 is a graphic timeline, which clearly illustrates the site's colorful history.

1.6. A Context for Collaboration:

The Regional Environmental Education Center (REEC) is now underway, with parking lots that feature porous paving and outdoor gathering spaces. The construction of the proposed facility (see Figure 1.11) remains unrealized, but educational programs are already underway in temporary trailers. REEC appears eager to use Wingfield Pines as a primary site for its environmental education programs. For instance, REEC educators currently travel two miles to suitable wetlands for wetland education programs (Stombaugh, pers. comm.), while WPCA is one quarter mile west. ALT and REEC have an amicable relationship and shared goals for improving environmental stewardship and education in the region. In November 2006, the authors presented preliminary design concepts for the WPCA master plan to community members at the REEC facilities. As REEC continues to mature as an organization, it is important that it and ALT continue to work together and maximize WPCA's role in achieving their shared goals. The two organizations are currently collaborating to host the annual "Celebrate Chartiers Creek Day" at WPCA in June 2007 (Gold, pers. comm.).

Presently, Boyce-Mayview Park is underway with the first major phase of its master plan, the soccer and baseball fields. The next phase of construction includes swimming pools, as well as a recreation and community center. These new facilities will also be accommodated by large areas of surface parking. As part of the park's agreement with ALT, excess stormwater not contained in their retention ponds is being conducted into culverts and discharged atop the eastern slopes at WPCA's southern end. This additional stormwater has increased the volumes of the two southern-most ponds and contributes to the saturated soil conditions (see Appendix A). The increased water volumes provide an opportunity to establish more favorable hydrology for the proposed enhancement to high-quality forested wetlands (Wagner, 2006). However, the increased runoff volumes will exacerbate erosion on these steep slopes and increase sedimentation in the two southern-most ponds. Turbidity in these ponds has already increased as a result, as observed by ourselves and ALT director Roy Kraynyk after separate storm events.

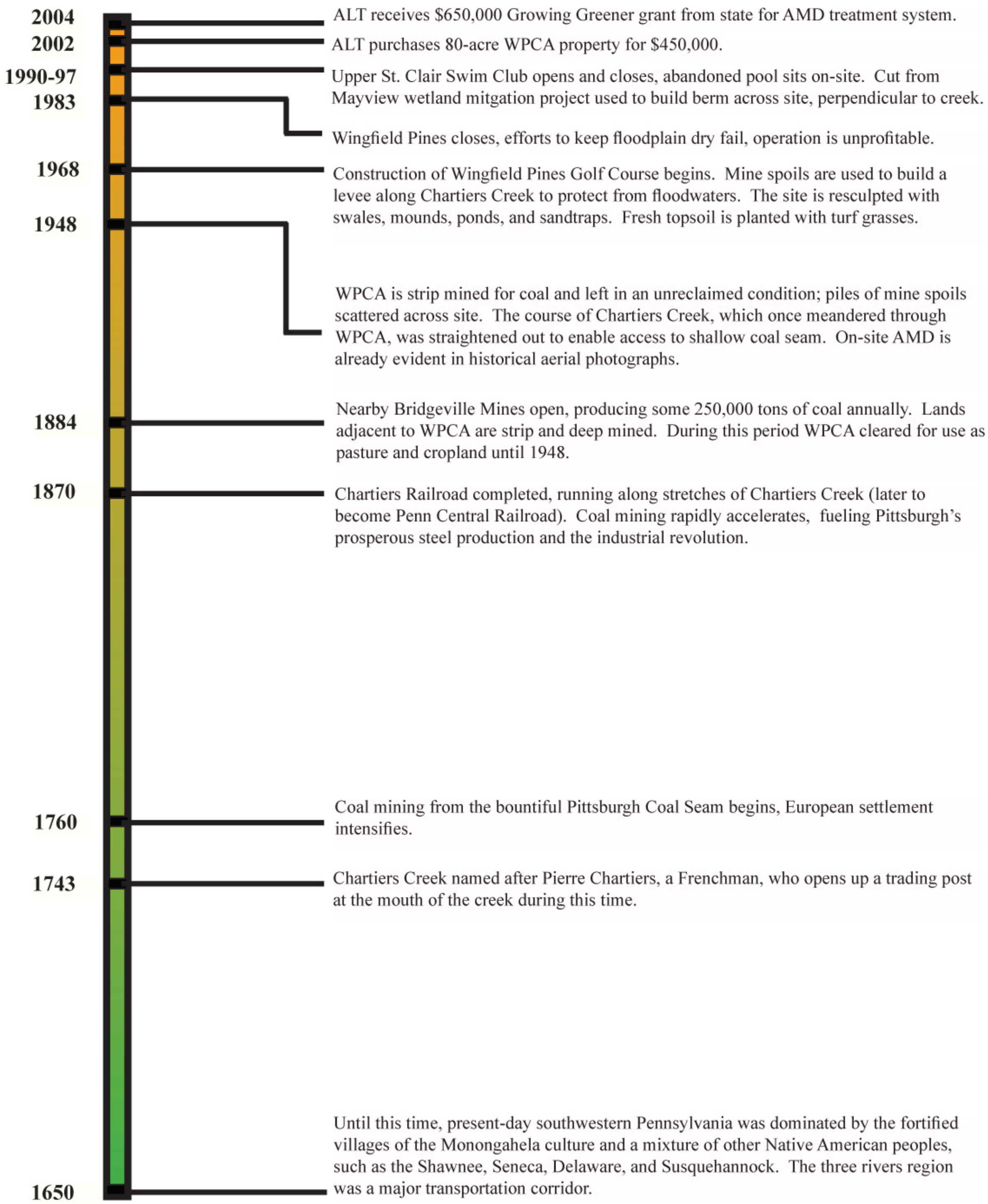

Figure 1.10 Historical timeline of events at WPCA and within the region.

Figure 1.11 Conceptual rendering of Boyce-Mayview Park's planned Regional Environmental Education Center (REEC). (image from USCCLS, 2006, prepared by Wallace Roberts & Todd, LLC)

1.7. Socio-cultural Context

WPCA's landscape legacy is characteristic of the exploitation southwestern Pennsylvania's natural resources have endured through the region's industrial zenith. Collectively, Pittsburgh's people have also endured the externalities of coal mining and steel production. Even though those industries have declined, the after-effects of coal mining in particular still threaten public health on a daily basis. WPCA's AMD treatment system will be a prominent example of progressive AMD problem-solving. The AMD treatment system also provides a stage to illuminate the sacrifices made by the region's people and natural resources.

The waterways that carve the lushly forested hill country of southwestern Pennsylvania are a celebrated source of the region's natural beauty. However, beneath these picturesque slopes and surface waters lay the earthly ingredients that fueled America's great industrial growth. Pittsburgh, Pennsylvania, as the epicenter of river transport and production, played a pivotal role in the American industrial revolution. The generous coal reserves and navigable, westward leading waters made greater Pittsburgh the largest singular producer of steel in American history. Pittsburgh accounted for 8.7 % of the nation's steel production in 1875, 21.6% in 1883, 30.2% in 1890, and 40% by 1900 (Ingham, 1991). Up until 1977, one-third of all the coal ever mined in the United States came from within Pennsylvania's borders (PADEP, 1998).

Coal fueled the fires of steel and iron production, which shaped the skeletons of city skyscrapers, bridges, plows, railroads, nails, submarines, and soup cans. Years upon millions of years of fallen ancient forests, vast swamps, and unknown ecosystems caused the earth to slowly subside under its own weight, ultimately pressing these accumulated layers together under geologic pressures so immense that seams of coal were produced. Each seam was produced by an epoch of accumulated plant and animal tissue, condensed into a hard, energy-loaded “black diamond.” Indeed, coal has been regarded as the mainspring of civilization (Roy, 1905).

In southwestern Pennsylvania, industry’s impact has been as culturally indelible as it has been ecologically devastating. Since 1870 a documented 51,483 workers have died in Pennsylvanian coal mines (PA DEP, 1998). Akin to the immeasurable patience and power with which the earth formed the famous bituminous coal fields of southwestern Pennsylvania, the immigrant laborer arrived to extract it. For example, in 1890 there were 340,000 inhabitants in Greater Pittsburgh, 100,000 of them immigrants, and another 40 percent of the population the children of immigrants. Two-thirds of the city was of recent immigrant origin, and flocked to Pittsburgh for economic salvation in its mushrooming steel, iron, and coal industries (Ingham, 1991). In 1907, 76% percent of Andrew Carnegie’s U.S. Steel plants’ employees were foreign-born, and 56% percent of Slavic birth (Fitch, 1911).

If Pittsburgh’s new residents were not laboring in the region’s coal-fired factories, they were likely toiling beneath its surface, removing millions of years of geologic time with muscles, mechanized cutting machines, picks, and dynamite. And as the integrity of air, water, and soil were compromised in the name of industrial production, so too were the lives of the region’s labor force when the steel industry collapsed in the 1970s and ‘80s. Government statistics indicate that Pittsburgh lost over 125,000 manufacturing jobs by the middle of the 1980s, more than 60,000 in steel alone (Stankowski, 2004). A legacy of depressed economy, polluted waters, upturned earth and livelihoods has depressed the region for decades. Only recently has this begun to change.

1.8. An Opportunity for Recovery

Mitchell (1997) enumerates the benefits of cultural landscapes. They draw attention to historical and cultural elements, explain existing conditions as products of the past, help reveal the complexity of landscape dynamics, and ultimately facilitate a comprehensive approach to landscape preservation and rehabilitation. Public awareness of its own regional history is an essential prerequisite for the support and implementation of (often costly) solutions. In this sense, WPCA is an invaluable cultural landscape because its present form is overtly symptomatic and therefore reflective of its historical narrative.

WPCA is an accessible case study of historical and currently-emerging cultural attitudes towards natural resources; it effectively narrates its past and now demonstrates the process by which a dedicated people can catalyze the process of recovery. Such opportunities for environmental education and to build public support should be seized, and WPCA is ideally suited to this purpose. The 80-acre floodplain has a storied history of abuse characteristic of the region and is now poised to become a regional showcase of environmental problem solving in southwestern Pennsylvania.

Given the context of WPCA's location – within one of Pennsylvania's most impaired watersheds, within an accessible proximity to Pittsburgh's metro population, along the inchoate Chartiers Creek Greenway, and adjacent the ambitious expansion of neighboring Boyce-Mayview Park – its potential cannot be overstated. We hereby propose that ALT pursue public access enhancements that encourage human use of the site and undertake a concerted ecological rehabilitation, which will serve as a model of recovery for southwestern Pennsylvania's post-industrial landscapes. We propose a strategy to achieve this vision based on well-founded principles of ecological landscape design and employing the full leverage of an organized educational program. Finally, we use this vision to reach out to the many engaged and culpable stakeholders: the US Environmental Protection Agency, the Pennsylvania Department of Environmental Protection, Allegheny County, Upper St. Clair and South Fayette Townships, REEC, Lower Chartiers Creek Watershed Council, Upper St. Clair Citizens for Land Stewardship, Chartiers Creek Conservancy, and Western Pennsylvania Conservancy.

2.0. Ecological Rehabilitation and Conservation Management at WPCA

2.1. A Philosophical Preface

With its unique and colorful history, WPCA has emerged into a new chapter of its own disturbed evolution. It has endured a veritable gauntlet of human-induced changes – systemic alterations of its geology, hydrology, biota, and the very landscape mosaic within which it occurs. And although the future of this site has been suddenly re-envisioned, its past is not so pliable. Indeed, the rich, alluvial soils that nourished the forest are gone; they cannot be conjured back on site. And the seed bank of native floodplain flora is similarly lost – a reservoir of biodiversity scoured away in search of coal. The historical site hydrology is so vastly altered by new landforms that it too might be irretrievable. And from the honeycomb of retired deep mines that riddle Allegheny County emerges a groundwater so full of iron oxide it rivals the color of a prairie sunset.

From this context must emerge a vision of ecological rebirth that both remembers the cultural legacy to which it is bound and yet effectively reverses the trend of environmental degradation consequent of that legacy. It must operate within the framework of an irrevocably damaged landscape while attempting to reclaim the myriad benefits of the habitats that were lost and to maintain the benefits of those habitats that remain. That vision – the designers' vision – is one of ecological rebirth, of reinvention, perhaps of rehabilitation, but would not conform to any conventional definition of *restoration*.

Higgs (2003) provides an engaging dialog on restoration ecology and like most writers and practitioners in the field, he emphasizes the importance of historical fidelity in shaping restoration goals. That is, the term itself implies some historical model to which a system could be returned. Ecosystems, however, like organisms are the evolved artifacts of the processes that govern their survival (Barnes *et al*, 1998). It therefore follows that any act of restoration must take into account those processes in order to be successful (Choi, 2004). In other words, the re-establishment of pre-existing species assemblages is not a restored ecosystem – however much it might resemble one – if the underlying processes have changed.

Baldwin (1994) affirms that "… the destruction of landscape created by stripping coal creates such a major disturbance of premining ecosystems that it is economically and probably technically impossible to restore these sites to premining conditions." As mentioned, this is precisely the case at WPCA, and the challenge is then to identify which (if any) of the site's ecosystem components could be restored with historical fidelity, what are the current cultural and ecological functions that such an attempt might compromise, and therefore, what is the composite vision – based upon past and present conditions – that will define the aforementioned ecological rebirth? And what degree of human management should that vision assume sufficient and appropriate?

The other three components of Higgs' (2003) definition are (2) *Ecological Integrity*, (3) *Focal Practices*, and (4) *Wild Design* (the first component, again, being *Historical Fidelity*). While *Focal Practices* refer more to the cultural, political, and spiritual power of restoration as a participatory event (to be addressed in Chapter 3), both *Ecological Integrity* and *Wild Design* are restoration components that help articulate the overarching goals that must guide the rehabilitation process at WPCA. *Ecological Integrity*, at WPCA, is the degree to which native species assemblages and processes are re-established, self-propagating, and stabilized across time. *Wild Design* refers to the role of design aesthetics ("intentionality") coupled with succession and natural selection in influencing the process of ecosystem evolution. This is synonymous with Whisenant's (1999) term *self-design*, and is addressed later in this Chapter.

2.2. Eco-regional Context

Omernik (1987) developed a hierarchical ecoregional classification system, which can help formulate the ecological, geological, geographical, and cultural context of WPCA. According to that hierarchy, the site is located at the northern edge of the Monongahela Transition Zone (Level IV #70b) of the Western Allegheny Plateau (Level III #70). This region is characterized by Mixed Mesophytic forest types and rough, hilly, unglaciated terrain with clayey erosion-prone soils, which are underlain with Pennsylvanian clay shale, siltstone, and sandstone. The mixed deciduous - evergreen forests dominate on slopes, while pasture and agricultural uses are common on suitable terrain.

The World Wildlife Fund (WWF, 1999) aggregated Omernik's (1987) classification scheme based solely on biodiversity and conservation characteristics. Under this characterization, WPCA falls into the Appalachian Mixed Mesophytic Forests, which are among the most biologically diverse temperate regions of the world. Additionally, WWF (1999) estimates that at least ninety-five percent of this ecoregion has been lost or degraded since industrialization; the portion that remains is highly fragmented. This regional context suggests a strong sense of urgency for the preservation and restoration of lands such as WPCA. For example, in a region of high biodiversity and endemism, highly disturbed sites might act as population sources from which invasive species can become established and disperse into adjacent high-quality areas.

Rhoads and Klein (1993) provide a more detailed map of Pennsylvania forest type distribution (Figure 2.1). WPCA is shown in red, within an extensive matrix of Appalachian Oak forest type, with multiple other forest types adjacent. Interestingly, WPCA is located almost equidistant from the southern edge of the northern hardwood and beech-maple forests and the northern edge of the mixed mesophytic forest. Consequently, pockets of these diverse forest types occur on appropriate sites in Allegheny County. The relative diversity of these forest types in southwestern Pennsylvania is worth noting because it provided the framework for our formulation of a diverse species list related to respective habitat zones. Rhoads and Klein (1993) also presents compiled herbarium records of Pennsylvania flora specific at the county level. Using these records, Appendix B is a table of native Allegheny County flora and it includes all native species which are represented in Allegheny County by greater than three records (non-native species are not included). These data became the primary reference by which we compiled habitat-specific woody plant lists (Appendices A - F) and by which herbaceous enhancement recommendations are strictly guided.

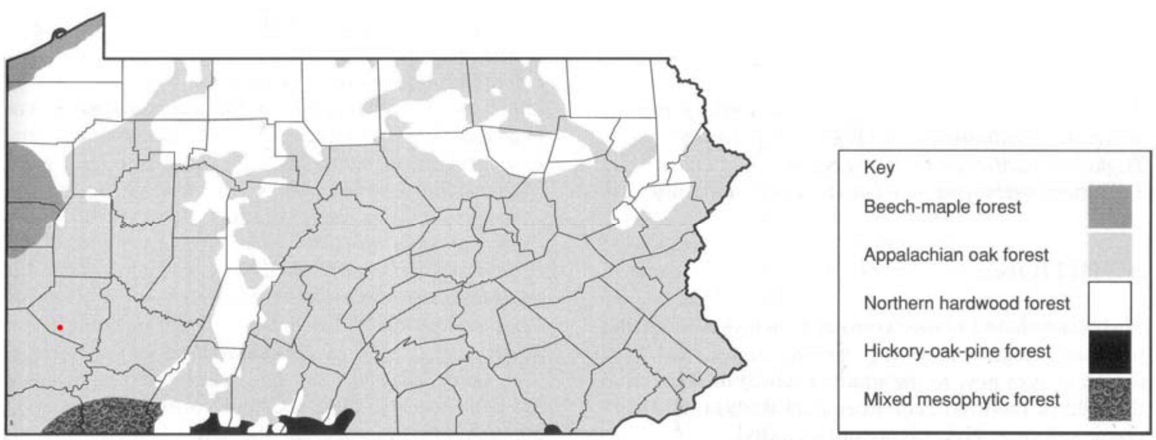

Figure 2.1 Forest types of Pennsylvania. WPCA is shown in red (adapted from Rhoads & Klein, 1993)

2.3. Local Landscape and Ecosystem Context

Figure 2.2 presents the relative position of WPCA within the Upper Ohio sub-basin of the Ohio River watershed. Within this sub-basin, Chartiers Creek is the major water body. It is important to note that this site is far upstream within the basin and sub-basin. Upstream point sources are generally of highest management priority because they impact all of the downstream water quality within the watershed; therefore, downstream water quality cannot be effectively improved without addressing upstream point sources. The site's position upstream is equally relevant regarding its floodwater storage capacity and stormwater management functions. The detention of flood waters nearest the source is ideal, because this can greatly reduce downstream damage. Figure 2.3 is a comparative pair of aerial photographs from 2004 and 1939, respectively. These photographs illustrate the changes in landscape patterns that have occurred in the watershed. Most significantly, they illustrate the conversion of an agricultural forested landscape into a suburban forested landscape. The increase in impervious surfaces is apparent.

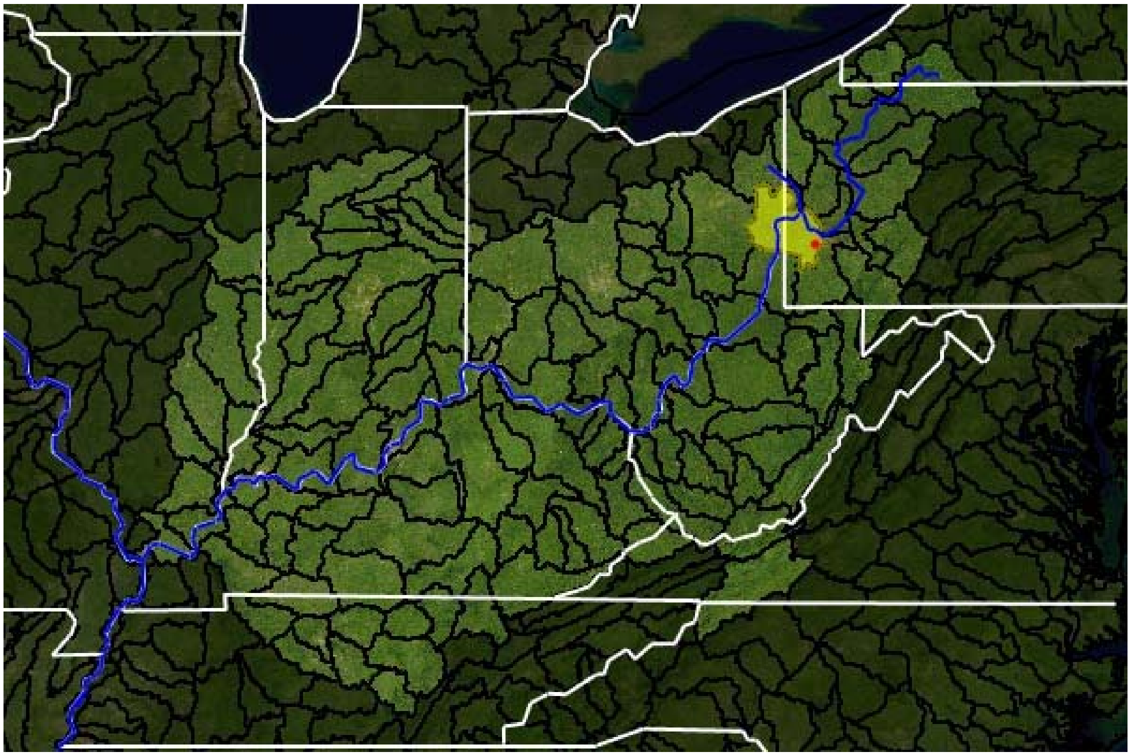

Figure 2.2 The Ohio River Watershed. With sub-basins, state lines, major rivers, and WPCA in red and Upper Ohio Sub-basin in yellow (compiled and adapted from EPA, 2006)

Figure 2.3 Aerial photographs of WPCA from 2004 and 1939. (left, by GoogleEarth, right, by (www.pennpilot.psu.edu/) . WPCA is in green.

Figure 2.4 (from Barnes *et al*, 1998 and Daniels & Zipper, 1995) illustrates the change in landform from typical floodplain forest topography to strip-mined high-wall. WPCA was probably similar in landform to this alluvial floodplain cross-section, so an understanding of the functional and structural ecology of alluvial floodplains is therefore essential to the development of rehabilitation goals at WPCA.

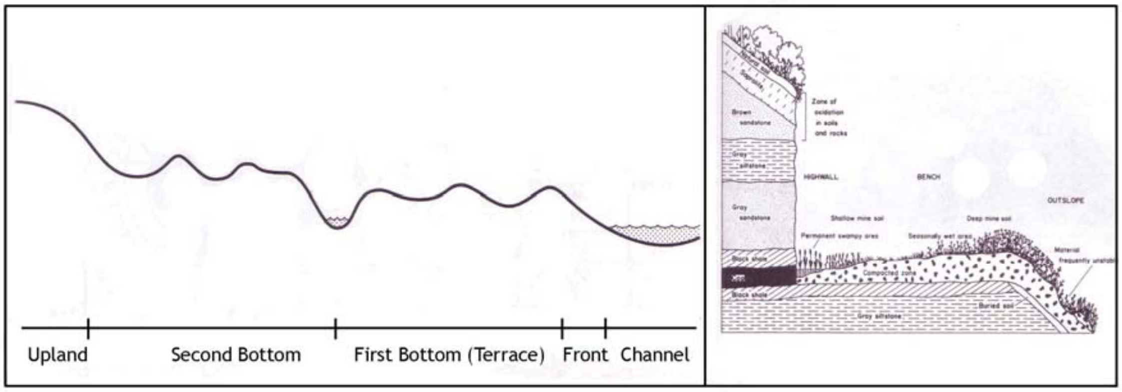

Figure 2.4 Typical floodplain contour in cross-section and typical high-wall structure in a post strip-mined landscape (left, adapted from Barnes et al, 1998; right, adapted from Daniels & Zipper, 1995).

Alluvial sedimentation creates dynamic landforms with diverse micro-habitats, rich fertile soils, and varying degrees of soil saturation, all of which increase the potential for niche specificity and consequently, high levels of biotic diversity within the floodplain ecosystem (Barnes *et al*, 1998; Brinson and Verhoeven, 1999; Ward *et al*, 1989). At the landscape scale, alluvial floodplains are also extremely important for their multiple functional interactions with adjacent aquatic and upland habitats. They serve as linear wildlife corridors, maintain thermal balance of the aquatic system, accept sediment and nutrients to improve water quality, act as buffers between disturbed lands and aquatic systems, and provide essential habitat for multiple aquatic, terrestrial, and amphibious groups (Brinson and Verhoeven, 1999). For example, many fish species have been negatively impacted by the loss of alluvial wetlands and floodplains, which are often necessary as spawning habitat (Copp, 1989; Pearson, 1994).

Fluvial dynamics of hydro-period and flood pulsing are all essential processes that create and maintain alluvial floodplain ecosystems (Brinson and Verhoeven, 1999; Pearson, 1994; Smith and Mettler, 2002). In other words, the meanderings of a stream in its constantly-evolving channel facilitate natural flooding along river bends, where waters are slowed. The fluvial processes – especially channel evolution – are also the primary drivers of between-stand heterogeneity of riparian and floodplain forests (Brinson and Verhoeven, 1999). The engineered channelization of rivers, however, increases flow velocity, which impedes natural flood patterns.

Bank erosion is increased, but the process by which sediments are redeposited is destroyed; therefore water quality is diminished and the riparian zone is impacted by a net loss of soil and by destabilization of riparian edge flora, commonly known as *undercutting*.

The construction of artificial levees to prevent flooding is among the most destructive human interventions on a floodplain ecosystem because it eliminates all of the ecosystem functions that rely on periodic flooding (Sparks, 1995). It is difficult, however, to quantify the ecological impact of these interventions, when they are compounded on one ecosystem (Gergel, 2002). For example, Channelization and levee construction are two interventions that are often combined and have compounding ecosystem effects. If channelization increases undercutting of banks and levees increase the height of the bank, undercutting would likely be more profound and the volume of destabilized sediment collapsing into the aquatic system is markedly increased.

In the context of such a complex and diverse ecological system, the destructive capacity of strip-mining becomes clear. The removal of alluvial soils via strip mining typically eliminates the diversity of habitat, soil depth and natural drainage (Daniels & Zipper, 1995). The slope of the floodplain is leveled when soil and bedrock is removed to expose the carboniferous seams and consequently, a heterogeneous gradient of soil saturation is reduced to a uniformly low and predominantly saturated state. If then coupled with levee construction and channelization, the process of soil regeneration is further diminished (Brinson & Verhoeven, 1999).

2.4. Existing Site Conditions

Arguably the most important existing characteristic of the WPCA floodplain is the constructed levee that separates the site from Chartiers Creek. This hydrologic barrier changed a historically lotic (riverine) system into a primarily lentic (lacustrine) system (see Mitsch and Gosselink, 2000). In extreme events, WPCA will still flood from upstream Chartiers Creek such that water enters from beyond the southern edge of the constructed levee rather than rising over it adjacent to the site (Maclaughlin, pers. comm.). In such floods, waters are trapped on site by the six-foot high berm running across the site perpendicular to the creek and levee. Under typical conditions, the water on site originates as both groundwater and stormwater. The drainage on site (see Figure 2.5) does not flow toward the creek; rather, it pools from high ground into central wetlands primarily located around the existing ponds.

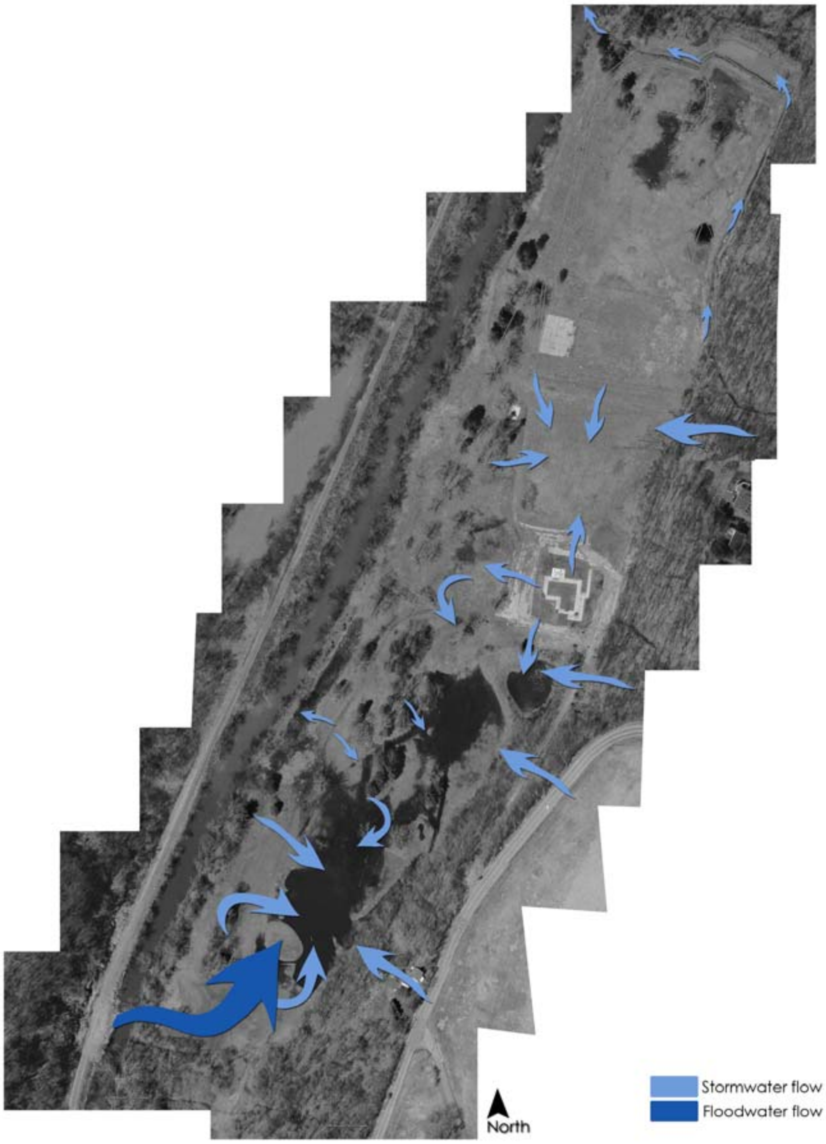

Figure 2.5 Schematic water flow at WPCA. Clearly not 'natural' hydrology.

Figure 2.6a illustrates the structural diversity of a typical lentic wetland system. This diagram is highly representative of WPCA topography (Figure 2.6b), considering the vertical scale exaggerated and the seepage zone replaced by the strip-mined highwall (Figure 2.4). The floristic diversity suggested by this diagram is, however, mostly absent at WPCA. As will be detailed later in this Chapter, this habitat diversity is an excellent model for WPCA and should help to guide rehabilitation plantings.

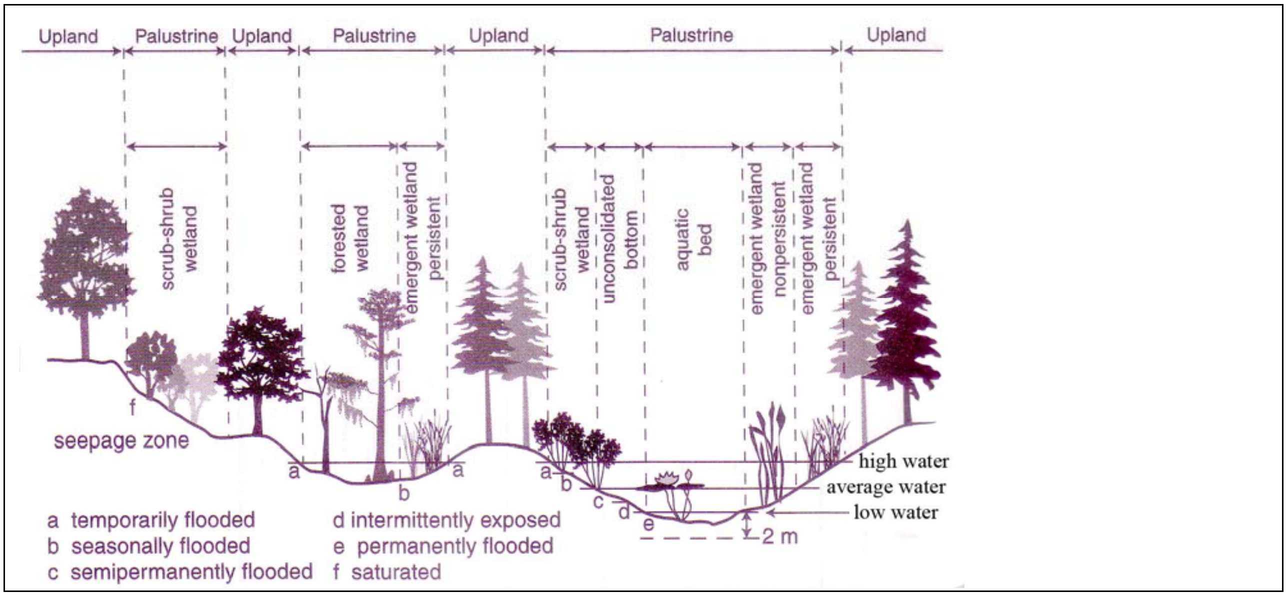

Figure 2.6a The structure of a lentic system. Notice water is typically not moving or moving very slowly (adapted from Mitsch and Gosselink, 2000).

Figure 2.6b Cross-section illustrating golf-course topography at WPCA. Notice the similarities between this section and Figure 2.6a. The seepage zone, as shown in 2.6a, would be cut off at the highwall. (Overlook deck is not an existing feature, but represents a more 'constructed' concept of a wetland educational node).

WPCA has been reclaimed to a dense, primarily non-native herbaceous flora at least since its development and management as a golf club. The managers of that establishment used a typical mix of primarily non-native turf grasses characteristic of golf courses (Saad, 1993). In addition to this turf mix, the site has been colonized by several common invasive species (herbaceous and woody); however, informal site analyses (Wager, pers. comm. 2006; authors' observations) indicate colonization by some native herbaceous species. For example, native members of the genera *Agrostis, Andropogon*, *Carex*, and *Solidago* are common at WPCA. Reed canary grass (*Phalaris arundinacea*) is perhaps the most common plant on site and it is a dominant member of some native emergent wetland communities in Allegheny County. The European genotype of this plant is often highly aggressive and invasive but is otherwise indistinguishable from the native genotype. Due to its regional native dominance, we do not consider it an invasive species at WPCA.

Although regionally native, most of these species are generally considered weedy in habit, and are commonly found on roadsides and disturbed meadows (Rhoads & Klein, 1993). It is unlikely that any significant portion of this herbaceous flora occurred on site in pre-disturbance conditions, and as forest succession proceeds, the persistence of this heliophilic community is highly unlikely, excepting in areas that remain free of canopy.

As mentioned in Chapter 1, mowing at WPCA was ceased upon acquisition of the property by ALT in 2002. Subsequent regeneration of woody species appears to be moderately high beneath and adjacent to existing trees. Areas of regular inundation and saturation are succeeding primarily to sycamore (*Platanus occidentalis*), boxelder (*Acer negundo*), ash *(Fraxinus sp*.), elm (*Ulmus sp*.), and cottonwood (*Populus deltoides*). This group comprises the existing early-successional floodplain forest at WPCA. Well-drained areas, particularly on mounds beneath existing trees, are succeeding almost exclusively to oak (*Quercus sp.*) and some black cherry (*Prunus serotina*). These areas are also colonized with multiple invasive woody species including Amur Honeysuckle (*Lonicera maacki),* Japanese honeysuckle *(Lonicera japonica)*, and Multiflora Rose (*Rosa multiflora)*, all of which could probably crowd out oak seedlings and impede desirable forest succession if left unmanaged (Barnes *et al*, 1998). Areas of weedy herbaceous wetland, however, still dominate large portions of the site, where very little forest regeneration is occurring. Large upland areas along and adjacent to the creekside levee and around the parking area also remain open with very little woody growth.

Herbaceous wetland, wet meadow, and prairie-type communities are historically uncommon in southwestern Pennsylvania (PGC, 2005), and the diversity of species that specialize in these communities must have also been historically uncommon. These habitats have been, as mentioned, reduced by at least fifty percent and consequently, many of the wildlife species that depend on them are endangered or threatened at the state level or higher (Meyers *et al*, 2000; PGC, 2005). The state has developed an integrated method to identify species that are not only rare in Pennsylvania, but for which the Pennsylvania state population is regionally or nationally significant. Table 2.1 provides a list of the species from that list that fall under “Immediate Concern” or “High Level Concern” and could realistically occur at WPCA. This is not a comprehensive list of important Allegheny County wildlife, but includes those species of highest priority. For a more thorough wildlife conservation assessment, see Pennsylvania Game Commission (2005).

Table 2.1 Wildlife species of high conservation concern. These occur in or very near Allegheny County, and for which WPCA existing conditions provides suitable habitat (adapted from Pennsylvania Game Commission, 2005).

PA Management Priority	Species	Habitat
Immediate Concern	Bog Turtle *Clemmys muhlenbergii*	Mosaics of small marshes, wet meadows, small ponds, and slow moving streams
Immediate Concern	Massasauga rattlesnake *Sistrurus catenatus catenatus*	Wetlands with surrounding old field and prairie habitats that contain sunny basking sites (extirpated from Allegheny County)
Immediate Concern	Kirtland's Snake *Clonophis kirtlandii*	Damp vacant lots with debris for cover; open, damp woods/grassy areas in urban/suburban areas; prairie wetlands, wet meadows, the grassy edges of creeks, streams, and ponds and relatively open, wet woods (often in urban/suburban settings) with crayfish burrows
Immediate Concern	Sedge Wren *Cistothorus platensis*	Densely-vegetated wet meadows, hayfields, retired croplands, and upland pond and lake margins, and in coastal, brackish marshes with limited standing water.
Immediate Concern	Spotted Turtle *Clemmys guttata*	Soft-bottomed aquatic habitats, including small streams, marshes, swamps, and vernal pools w/ upland forests or open habitats
Immediate Concern	Wood Turtle *Glyptemys insculpta*	Large streams and associated riparian and forested habitats (edge habitats) with thick cover, sunlight, and food availability. Nesting habitat is open-canopy riparian thickets, well-drained soils with sparse vegetation
High Level Concern	Eastern Ribbon Snake *Thamnophis sauritus sauritus*	Riparian edges of emergent marshes, bogs, streams, rivers, ponds and lakes with dense sedges, grasses, rushes, emergent shrubs, and abundant frogs
High Level Concern	Northern Harrier *Circus cyaneus*	Large open grasslands (reclaimed stripmines); marshy meadows, wet lightly-grazed pastures, open bogs, freshwater and brackish marshes, and riparian woodland
High Level Concern	Shorthead Garter Snake *Thamnophis brachystoma*	Riparian old fields and meadows with grasses, sedges, low herbaceous growth, and early successional perennials
High Level Concern	Virginia Rail *Rallus limicola*	Emergent wetlands
PA Endangered	Regal Fritillary Butterfly *Speyeria idalia*	Adults feed in open meadows with abundant nectar, especially milkweeds (*Aesclepias sp.*) and thistles (*Cirsium sp.*). Larva feed only on violets (*Viola sp.*).

It is interesting to note that none of the Allegheny County species of "Immediate Concern" or "High Level Concern" rely heavily on early-successional forest or thicket habitat (Pennsylvania Game Commission, 2005). Such data suggest the validity of land rehabilitation choices which might, to some degree, include *ecosystem replacement* (Bradshaw, 1995), where a new ecosystem is appropriate to an altered site and offers additional high-priority habitat value not offered by the historical ecosystem. This philosophy is in agreement with Choi's (2004) idea of "futuristic restoration," and it raises a highly relevant question: Should WPCA site management be driven by ecosystem goals, individual species goals, or by some combination of the two? More explicitly, if the entire site would succeed to some type of forest, to what degree should management intervene and ensure that desirable open areas remain open?

As Table 2.1 shows, many reptiles rely on habitats in and around open herbaceous wetlands in Allegheny County, Pennsylvania. Turtles and snakes, in particular, are of high conservation concern in the region, and while each species has unique requirements, this is often due to the multiple habitat types required to complete the life cycle. Foraging, thermoregulation, hibernation, and nesting often require distinctly different habitats in close proximity (Pough *et al*, 2003). This is important to recognize because WPCA currently possesses this necessary habitat diversity and with proper management (to be addressed shortly) the qualities of these adjacent habitats could be improved. Furthermore, WPCA is locally unique because of its history as a golf course, for which sand traps were constructed. Patches of sunny, sandy earth are rare in unglaciated southwestern Pennsylvania; they occur at WPCA and they could provide excellent nesting habitat for multiple species of reptiles. Even if these habitats are not currently being utilized on site, they are extremely valuable because female reptiles of many species travel widely in search of suitable nesting sites. It is therefore realistic that in time, WPCA could be colonized by some of these species (Pough *et al*, 2003).

Specific rehabilitation and management plan goals and processes will be addressed later in this Chapter; however, it is important to reiterate that the planned ecological enhancement and management of open herbaceous wetlands at WPCA is ecologically (and aesthetically) justified. Pennsylvania Game Commission (2005) provides a detailed description of particular herbaceous wetland community types and their dominant species in Pennsylvania. Figure 2.7 illustrates a naturally-occurring floodplain forest opening at Raccoon Creek State Park, Beaver County, Pennsylvania (approximately 50 northwest of WPCA).

Figure 2.7 An herbaceous wet meadow opening within a floodplain forest. From Racoon Creek State Park, Beaver County, Pennsylvania(~50 northwest of WPCA).

The planned management of forest succession is an extremely valuable tool in resource management, land rehabilitation, and ecological restoration (Bradshaw, 1989; Luken, 1990). Active management of this process can be justified from multiple perspectives; for example, succession might be managed to simply speed the process of forest regeneration, to increase the diversity of regenerating species, or to aim for particular aesthetic or functional goals (Baldwin, 1994; Bradshaw, 1993). Active acceleration of succession can also be a useful strategy to compete with some invasive species (Bradshaw, 1989). The invasive multiflora rose (*Rosa multiflora*) around eastern deciduous forests of North America, for example, will tolerate light shade, but cannot survive in dense shade; therefore speeding the development of a denser canopy might help reduce or eliminate the invasive (Szafone, 1991) and help secure higher overall native biodiversity.

After major disturbances, sites are often heavily colonized with relatively few pioneer species, which are essential for unaided succession because they grow rapidly, help prepare the site for early-successional species (by casting adequate shade), and typically have short life spans, thereby providing an abundance of organic material for soil development and habitat. Accelerated succession, however, allows land managers to more quickly and decisively incorporate native early, mid, and even late-successional species to increase floristic quality, attract desirable wildlife, and increase the likelihood that planted species will become a component of the mature and stable ecosystem. Natural selection and community evolution must drive future species assemblages across time, but it is important that rehabilitation incorporate as many appropriate native species as possible, because such an approach helps ensure that this community will develop with robust diversity. Particularly, it will reduce the probability of failure because across time, if one species declines other species will be on site to respond accordingly. This concept is described as 'bet-hedging' by Whisenant (1999).

The application of theoretical dispersal ecology to reforestation schemes has led to the development of a *clump and gap* technique, whereby groups of particular species are strategically placed to increase the likelihood of natural seed dispersal and subsequent regeneration (Bell, 1995; Bullock *et al*, 2002; Harmer and Kerr, 1995; Rodwell and Patterson, 1995; Whisenant, 1999). This particular terminology has been used by Andropogon, a well-respected group of landscape architects from Philidelphia, Pennsylvania, who have been integrating the strategy into their forest restoration projects (Grese, pers. comm.; Roos, pers. comm.). This technique is a compelling means of reforestation when financial, manpower, or time constraints limit the degree to which land can be replanted with desirable forest species. In this way, small areas can be planted and when those trees reach fruiting age, they become the parents from which seeds are dispersed into suitable surrounding habitats.

At WPCA, the *clump and gap* approach is desirable for multiple reasons. It is well-known that planted trees are usually less vigorous than those that grow naturally from seed on site; therefore, simply providing the seed source for desirable species allows that in a broader sense, the long-term health of the forest will likely be improved. One apparent reason for this difference is due to the fact that plants will typically only regenerate unaided if the environmental conditions are suitable. Planted trees, however, might or might not be planted in suitable conditions. By providing mixed clumps of species in the most (apparently) suitable locations, a seed source is provided but the long-term plant community structure is left to evolve based on the natural micro-site-specific preferences of individual species. The result should be not only a more vigorous and well-suited forest community, but a more "natural" aesthetic, as well. Where micro and macro-site conditions are diverse (such as WPCA), plant communities will evolve to be similarly diverse and complex (Barnes *et al*, 1998). This further justifies the clump and gap approach (Rodwell and Patterson, 1995) because greater system complexity would seem to decrease our ability to construct or recreate it with ecological fidelity. Whisenant (1999) supports this notion, suggesting that ecosystem managers should cultivate the capacity of natural systems to organize themselves, rather than attempting to control them.

Greater density of parent trees has the added benefit of more effectively attracting the wildlife species that disperse their seeds (Wiens, 2001). This is fundamental to principles of animal behavior because a larger localized food source will invariably attract a greater number of individuals to feed on that source (Krebs & Davies, 1997). A single seed tree, however, might be insufficient to attract wildlife, especially species that are hesitant to cross large openings to reach isolated habitat patches. Additionally, densely clumped plantings will more rapidly form patches of closed canopy and will probably be more rapidly colonized by woodland bird communities (Harmer and Kerr, 1995; Krebs and Davies, 1997).

The thoughtful placement of woodland clumps will also vivify the mosaic of site conditions consequent of WPCA's quirky golf course topography. For example, juxtaposed upland oak and floodplain forest clumps create a deliberate aesthetic contrast that reflects differences in drainage and soil quality. This aesthetic choice to vivify the different forest communities is also valuable as an educational tool, because it can help less experienced visitors identify and understand the diversity of forest types in western Pennsylvania (see the following chapter).

The species composition of clumps as well as their intra and inter-clump structure is an important consideration in planning this form of reforestation. In general, increased species diversity and spatial heterogeneity of planted clumps is ideal; however, it is also more challenging to successfully install (Rodwell and Patterson, 1995). For example, it is easier to reliably identify a suitable site for one species than to identify a single site suitable for ten species. Figure 2.8 graphically demonstrates differing degrees of clump heterogeneity, and suggests how initial clump structure might influence long-term diversity of canopy. No formula exists for an ideal clump structure or tree spacing, but high density – as high as 10 - 15 feet between individual stems – and heterogeneous structure is preferred.

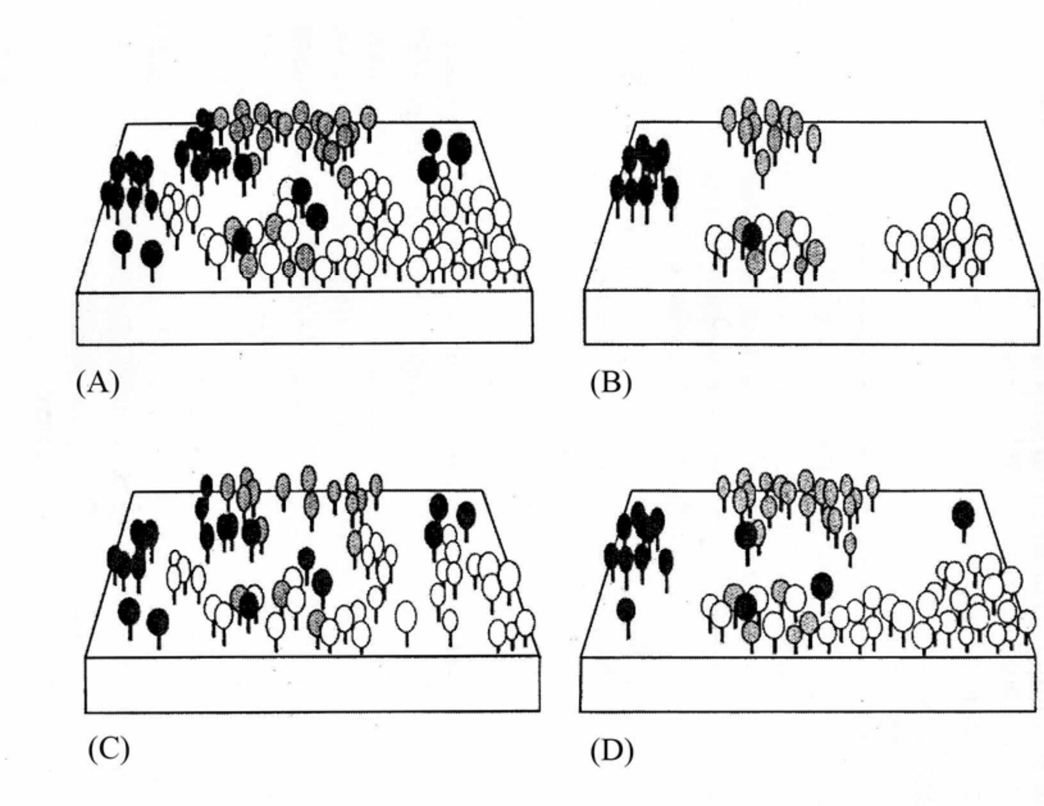

Figure 2.8 Varying degrees of spatial heterogeneity in clump installations. (adapted from Rodwell and Patterson, 1995). (A) Varied spacing between clumps, (B) Nearly pure clumps, (C) Varied spacing within clumps, and (D) Varied clump size.

At WPCA, perhaps the most significant justification for the clump and gap approach is practical and financial in nature. Because ALT is a small local land trust with limited funds and extremely limited staff, planned reforestation of the entire WPCA site is probably not feasible and the challenge of seeking funding for such a large project would probably deter the staff from pursuing that option. On the contrary, the installation of individual clumps, as time and funds permit, is a much less daunting prospect. ALT can more easily seek individual donations for single trees or single clumps. Donors might be willing to 'adopt a clump,' or 'adopt a grove.'

This compiled body of research serves as the foundation of a comprehensive design master plan and management plan for the ecological rehabilitation of WPCA. Although this ecological rehabilitation is certainly the highest objective of the designers, the client (ALT), and the greater Pittsburgh region, it must also sensitively respond to the site's cultural history, its current social functions, and its future as a natural area in a suburban context. While we will encourage wild design within plant communities, strong justifications have been given for active management. The following management processes and goals are therefore multi-faceted and, it is hoped, the most appropriate means to the highest and best use of WPCA.

2.5. WPCA Rehabilitation and Management

At this point, it is useful to refer back to Higgs' (2003) four components of good ecological restoration: (1) Historical Fidelity, (2) Ecological fidelity, (3) Focal Practices, and (4) Wild Design. Focal Practices remains the subject of the following Chapter, but the other three components guide this rehabilitation plan and ultimately, those three components seem to distill down to floristic quality. This is not to suggest that high-quality flora is the single goal; it is more an indicator of success, which will rely on a management plan that maximizes the functionality of ecological processes. Historical fidelity will be achieved (to the extent possible) by matching floristic enhancements with historical Allegheny County herbarium records and by exploring the possibility of further manipulating the creek-side levee to better repair the site's hydrological regime (which must influence floristic quality). Ecological fidelity will be achieved by identifying habitat zones (Figure 2.9) and matching them as closely as possible with historical Allegheny County community types. It will also be achieved by planning for the maintenance of this habitat diversity and by the assertive management of invasive species. Finally, Ecological Fidelity will also be improved by analyzing the effects of strategic levee removal. And Wild Design will be achieved through well-planned clumps, which will represent all forest habitat zones and will be placed to maximize a naturally-dispersed community evolution within the framework of a thoughtful aesthetic. A similar approach will be suggested for herbaceous floral enhancements, which will be specified in areas to encourage Wild Design.

2.6. Management of Invasive Species

The removal of invasive species at WPCA will certainly be one of the most important precursors to long-term ecosystem rehabilitation. The management of invasives must be individually tailored both by species and by the type of plant community they impact. Table 2.2 lists the most common and most troublesome invasives at WPCA.

Table 2.2 Common invasive plants at WPCA that warrant management concern (habitat data from Rhoads and Klein, 1993).

Species	Common Name	Family	Growth Form	Habitat
Conium maculatum	Poison hemlock	Apiaceae	Herbaceous biennial	Roadside ditches, floodplains and moist woods
Cirsium arvense*	Canada thistle	Asteraceae	Herbaceous perennial	Fields, roadsides, waste ground, and shores
Alliaria petiolata	Garlic mustard	Brassicaceae	Herbaceous biennial	Disturbed woods, floodplains, and waste ground

Species	Common Name	Family	Growth Form	Habitat
Lonicera maackii	Amur honeysuckle	Caprifoliaceae	Woody shrub	Cultivated and frequently naturalized in disturbed woods, thickets, old fields, and roadsides
Lonicera japonica	Japanese honeysuckle	Caprifoliaceae	Woody vine	Disturbed woods, fields, thickets, banks, and roadsides
Dipsacus sp.	Teasel	Dipsacaceae	Herbaceous biennial / monocarpic perennial	Roadsides, fields, waste ground
Rosa multiflora*	Multiflora rose	Rosaceae	Woody shrub	Disturbed woods, pastures, old fields, roadsides and thickets

* Designated noxious weed by the state of Pennsylvania

Poison hemlock (*Conium maculatum*) can be identified in its first year by its large basal rosette of fern-like foliage, and in its second year by the emergence of a large white-flowered umbel. According to The Nature Conservancy (1989), poison hemlock is a low management priority primarily because it is easily controlled if hand pulled prior to flowering. Due to its toxicity to grazing animals, it is mostly a high concern in pastures. This plant occurs at WPCA in scattered locations and removal should be focused on second year plants, when the fruiting stalk becomes conspicuous but before it is mature. We do not recommend using herbicide on this plant, because hand pulling is cheaper and more appropriate in the wet meadows where it is most common.

Canada thistle (*Circium arvense*) is a noxious weed across most of the United States, including Pennsylvania. It is prolific and persistent, reproduces both vegetatively and sexually, and is extremely difficult to kill. This species occurs at WPCA around the upland pool area, where it appears to be only recently established. It is a very high management priority, because controlling these plants before they begin to produce seed is critical to management success. The seeds are wind-dispersed; therefore this plant could easily and rapidly spread across the wetlands on site, after which it would be virtually impossible to eradicate. We recommend the application of herbicides as detailed in Beck (2006). Additionally, the isolated area of lawn within the filled pool, because it is densely colonized, might benefit by mid-summer sterilization with a heavy grade black plastic tarp following soil saturation during a hot spell.

Garlic mustard (*Alliaria petiolata*) is a high management priority because it is difficult to remove and has the potential to become more pervasive, especially beneath the upland wooded areas. In areas of sufficient fuel, it can be reduced by prescribed burns; however, the current infestation is mostly within a matrix of non-native grasses, which remain somewhat green through the winter and probably will not effectively burn. Extensive hand-pulling by large volunteer groups is likely the best method of control for WPCA, but the use of herbicide should be considered if such a program does not prove effective. This would best be done when the basal rosettes are still green, and other native species have gone dormant. They will then be highly visible. Finally, planting native plants in areas of infestation should also help slow its spread. Long-term management often needs to be repeated up to ten years until the seed bank is exhausted. See Rowe and Swearingen (2006) for more detailed information on this species.

Amur honeysuckle (*Lonicera maackii*) is an extremely high management priority at WPCA. It has the potential to halt desirable forest succession by excessively shading native tree seedlings, and generally crowds the forest understory. Because the seeds are bird dispersed, WPCA could act as a source from which the species can spread to other high-quality uninfested natural areas. The plant is somewhat abundant at WPCA and should be treated by cutting the plants near the base and treating the fresh-cut stems with herbicide. For more information see Nyboer (1992).

Japanese honeysuckle (*Lonicera japonica*) is another high management priority at WPCA. It is present in upland areas of both sun and shade, where it aggressively over-runs large areas of ground (especially along the top and east side of the levee). Where sufficient fuel is present, regular prescribed burning will effectively control this species, but fall herbicide treatment at the base of cut stems is also recommended. See USDA (2006) for more information on this species.

Teasel (*Dipsacus sp.*) is a relatively low management priority at WPCA, although infestations are currently quite pervasive. Where sufficient fuel is available, prescribed burning can help reduce the population, but in the short term might encourage the germination of seeds that are not killed in the fire. Because the plant is biennial, it can be somewhat easily controlled in small natural areas by cutting the second year stems immediately prior to flowering. The plants will not reflower, but will die. The plants are highly prolific, so this will probably be necessary across years until the seed bank is exhausted. If the plants are cut after flowering, it is important to remove the cut material because immature seeds have proven viable. For more information, see Wisconsin Department of Natural Resources (2004).

Multiflora rose (*Rosa multiflora*) is a noxious weed across many states, including Pennsylvania. For this reason it is a high management priority. Stems should be cut and herbicide treated during the dormant season and where sufficient fuel is available, can be further controlled by prescribed burns. For more information on this species, see Szafone (1991).

Notably, the 30-acres of Mayview mitigated wetlands approximately one mile upstream from WPCA are now colonized with significant populations of purple loosestrife (*Lythrum salicaria*), giant reed (*Phragmites austalis*) and yellow iris (*Iris pseudacorus*). Other locally invasive exotic species (DCNR, 2004), such as Japanese knotweed (*Polygonum cuspidatum*) are established throughout the watershed and "are poised to establish where disturbance creates opportunities" (Wagner, 2006). WPCA should be closely monitored for these species, in order to best maintain an adaptive management strategy. Additionally, the threat of colonization by these species provides strong justification for a minimal-impact approach to site enhancement activities. For example, widespread soil disturbance in wet areas should be avoided; therefore, the most sensitive approach to herbaceous enhancements in and around the WPCA wetlands is to use plugs, rather than widespread reseeding.

2.7. Enhancement of Native Flora

In order to effectively provide management goals that maximize ecosystem function, we mapped out habitat zones at WPCA, which are based on topography, drainage, and soil saturation. These zones are based on repeated site visits across seasons and from aerial photographs; however, this process is complicated by an incipient increase in storm water from Boyce-Mayview Park, as mentioned in Chapter 1. For example, it is expected that many areas that are now wet meadows will likely become emergent wetlands, especially in the low areas around the ponds (Figure 1.8, Figure 2.9). The approximate nature of the habitat zone map is further exacerbated by the absence of a 1' or 2' contour map of the site, which has remained beyond the financial reach of ALT. Nevertheless, we are confident that this habitat zone map is quite sufficient to effectively plan habitat-specific reforestation species lists. This map is illustrated in Figure 2.9.

Figure 2.9 Habitat zones at WPCA.

2.7.1. Appalachian Oak Zone

The most extensive habitat type on site is comprised of the upland areas, which will be reforested with Appalachian Oak species. This zone is relatively well-drained, and it is composed primarily of the central golf mounds, the linear area along and atop the levee, and the southern edge of the site. The upland golf mounds are easily identified by the *Pinus* species that were planted upon them, and the rest of this zone is mostly still open lawn. As mentioned, abundant oak seedlings can be found in this zone, especially beneath existing trees. This zone is infested with Japanese honeysuckle, amur honeysuckle, garlic mustard, and multiflora rose.

Oak ecosystems are fire-dependent, which is primarily due to the moderately light shade the canopy produces. This increased light penetration raises temperatures at the forest floor and helps it to remain drier, thereby slowing decomposition and increasing the accumulation of leaf litter, which (combined with dry vegetation) is the primary fuel for the fire (Barnes *et al*, 1998).

Long-term management of the Appalachian Oak zone should therefore include periodic prescribed burning in the spring or fall, when fuel is sufficiently abundant and dry. Because the oaks are currently all seedlings, burn maintenance should not be instigated until this recruitment class is large enough to develop a protective cork of outer bark. In the meantime, it is absolutely essential that rigorous cutting and treating of invasive shrubs be undertaken at least once per year. This will keep the understory light and will encourage the oaks to grow quickly. Boxelder (*Acer negundo*) is a native pioneer species that should also be cut and treated in this habitat zone, because it too will slow the process of oak regeneration. It is quite abundant along the edges of this zone and should be treated similar to the invasives.

Two common herbaceous plants would be ideal for initial herbaceous enhancements in this zone. Common blue violet (*Viola sororia*), in particular, should be noted as highly desirable because this group is the exclusive host for the larva of the regal fritillary butterfly (*Speyeria idalia*), probably the most imperiled known invertebrate for which WPCA could serve as habitat. Providing both larval hosts (the violets) as well as an abundance of adult food sources (native thistles and milkweeds) would be an excellent provision for the conservation of this species. Pennsylvania sedge (*Carex pennsylvanica*) is also desirable as a common native woodland sedge, which will likely help carry prescribed fire at the ground level. Installation of this species as plugs would probably be most effective.

2.7.2. Floodplain Forest Zone

Another very extensive habitat zone is the floodplain forest. This zone is currently in varying stages of regeneration, with many adult sycamore, cottonwood, and boxelder. This zone relies on periodic flooding to suppress upland species; however, if flooding is too frequent and severe, conditions would become more characteristic of a swamp or even an emergent herbaceous wetland. Although seedlings of pioneer species are abundant across most of this area, this zone is a high priority for the enhancement of diversity with longer-lived mid-successional species. This is especially important because there does not appear to be a nearby seed source for the natural invasion of this zone from adjacent lands.

As mentioned, floodplain forest ecosystems rely on periodic flood events to maintain a diversity of native species. We therefore recommend that ALT consult with a hydrologic engineer to examine the possibilities of removing a strategic section(s) of the creek-side levee, which would enhance the hydrologic connection between this floodplain ecosystem and adjacent Chartiers Creek. Another possibility (although less desirable) might be the installation of culverts within the levee, which would serve a similar function, allowing aquatic vertebrates and invertebrates to more readily access flooded areas for necessary life cycle processes.

Invasive species are not yet very abundant in the Floodplain Forest zone. Teasel is perhaps the most abundant, but it is sun-loving and as canopy develops, it will not persist. It is important, however, that as conditions change and canopy develops, ALT observe this habitat zone and ensure that emerging invasives are dealt with before they become pervasive.

2.7.3. Mesic Forest

Some areas of the site are intermediate in degree of soil saturation, between the Appalachian Oak zone and the Floodplain Forest zone. These areas will be treated as the Mesic Forest zone, which will be represented mostly by species characteristic of both northern hardwood forests and mixed mesophytic forests. For this reason, this zone should offer the greatest potential for woody species diversity. Because it will not be suitable for prescribed burning or frequent natural flooding, invasive species management in this zone will probably require more cutting, treating, and hand pulling. This zone will develop a somewhat different long-term aesthetic as well, as its diversity should include an abundance of native shrubs and small trees and thereby have a much less open understory.

2.7.4. Emergent Herbaceous Wetland

Between and around the ponds exists a largely saturated low area, which is inundated with water following storm events. As mentioned, stormwater introduced from the Boyce-Mayview Park development is expected to expand the perimeter and duration of complete inundation during the wet season (see Appendix A); therefore it will probably remain open with minimal deliberate management. Some seedlings of sycamore, cottonwood, and boxelder can be found in this zone, but if deeply and persistently inundated, they will likely die.

The conservation value of this ecosystem type has already been described; therefore, we recommend that this area is deliberately managed to remain open if trees begin to significantly encroach into it. This does not preclude some scattered woody vegetation, especially native hydrophilic shrubs (Such as *Sambucus sp*., *Ilex verticillata*, *Viburnum sp*., and *Vaccinium sp*., among others), but direct sunlight across the ground plane of this zone is an appropriate management goal. The most obvious way to manage this system would be to girdle undesirable trees if they grow large enough to shade the wetland. If a well-timed drought occurs and the ground is dry, a prescribed burn might also be desirable.

Table 2.3 provides a list of dominant emergent herbaceous wetland plants that are native in Allegheny County. These plants, if they can be acquired, should be installed as plugs along conspicuous trail edges of the wetland and especially along the shores of the ponds. The prioritized trail-side and pond-edge areas for herbaceous enhancements are illustrated in Figure 2.18. This does not preclude additional native species, especially additional wetland wildflowers, but this particular list has been specifically selected for local species dominance and therefore, likely habitat value. Tussock sedge, for example, is known to be a species preferred by many reptiles, which can crawl onto the tussock for thermoregulation (PGC, 2005). As mentioned, milkweed and (native) thistle are favored as a nectar source for the regal fritillary butterfly (*Speyeria idalia)* and should therefore be high priority. Because site conditions at WPCA are so altered and varied, dominant plant species from several types of herbaceous wetlands have been incorporated into the aforementioned table. Note the aquatic native water lilies, which provide excellent habitat for an abundance of different taxa.

Long-term management of this habitat zone for increased floristic biodiversity is highly desirable, and should be a focus during volunteer planting events. Each year, for example, different native focal species can be planted. Planting entire flats of a single species should help ensure that some individuals survive to reproduce and hopefully, spread across the wetland. Appendix G is a comprehensive list of native herbaceous plants in Allegheny County represented by greater than three herbarium records.

Table 2.3. A short list of dominant native plants from persistent emergent wetlands to be installed as plugs at WPCA. These are all (excepting the two aquatic Nymphaeaceae) historically common in Allegheny County and cross-checked for suitability between Rhoads and Klein (1993) herbarium records and the Pennsylvania Game Commission (2005).

Species	Common Name	Family	Habitat
Sagittaria latifolia	Arrowhead	Alismataceae	Swamps, wet shores, and shallow waters of ponds and streams
Asclepias incarnata	Swamp milkweed	Asteraceae	Swamps, floodplains, and wet meadows

Species	Common Name	Family	Habitat
Cirsium muticum	Swamp thistle	Asteraceae	Swamps, bogs, stream banks, and wet meadows
Eupatorium sp.	Joe-pye weed	Asteraceae	Floodplains, wet meadows, thickets, roadsides, swamps, bogs, stream banks, open woods
Senecio aureus	Golden ragwort	Asteraceae	Moist fields, woods, floodplains, and roadsides
Impatiens capensis	Touch-me-not	Balsaminaceae	Moist meadows, swamps, and stream banks
Carex lurida	Sedge	Cyperaceae	Swamps, bogs, and wet meadows
Carex stipata	Sedge	Cyperaceae	Wet meadows and swampy woods
Carex stricta	Tussock sedge	Cyperaceae	Swamps, stream banks, and wet meadows
Schoenoplectus tabernaemontani	Soft-stemmed bulrush	Cyperaceae	Swamps, lake and pond margins, wet ditches and mudflats
Scirpus cyperinus	Wool grass	Cyperaceae	Marshes, moist meadows, swamps, shores, and ditches
Juncus acuminatus	Sharp-fruited rush	Juncaceae	Wet meadows, swamps, marshes, and stream banks
Juncus effusus	Soft rush	Juncaceae	Swamps, wet meadows, moist woods, shores, and thickets
Nuphar lutea	Spatterdock	Nymphaeaceae	Ponds, lake margins, slow-moving streams, swamps and tidal marshes
Nyphaeae odorata	Fragrant water-lily	Nymphaeaceae	Quiet water of lakes and ponds
Glyceria striata	Mannagrass	Poaceae	Persistent Emergent Wetlands
Leersia oryzoides	Rice cutgrass	Poaceae	Persistent Emergent Wetlands
Thalictrum pubescens	Tall meadow-rue	Ranunculaceae	Wet meadows, low open woods and swamps
Sparganium americanum	Bur-reed	Sparganiaceae	Muddy shores and shallow waters of rivers, streams, swamps, or ponds

2.7.5. Wet Meadow

This zone is characterized by thick herbaceous flora in perennially saturated soil where inundation is uncommon. This zone will dry out more readily during dry spells and therefore should be well-suited to periodic burn management. The large area of wet meadow on site is between the pool-side native display garden and the berm that contains the AMD treatment system. This area is currently overrun with teasel, which should be managed as previously described. Much of this area will be highly disturbed during the AMD construction activities and should be seeded and blanketed with the wet meadow mix available from Ernst Conservation Seed Company (ECSC), since this is a reliable provider with whom ALT has an existing relationship. Additionally, this zone should be enhanced with native wildflower plugs, particularly along the trails, as funds and volunteers permit. Mown trails can also be further defined with well-placed specimen shrubs at junctures.

Additional small patches of wet meadow occur across the site in too scattered a pattern to display in Figure 2.9. Extensive areas of planned Floodplain Forest are currently wet meadow, and as the forest canopy develops, the existing non-native meadow flora will begin to decline from lack of sun. The herbaceous layer in these reforestation areas should not be of concern until shade develops, at which time herbaceous enhancements can be undertaken with appropriate floodplain species, such as wild ginger (*Asarum canadense*), turtlehead (*Chelone glabra*), and others.

This zone has been designed to remain herbaceous primarily because it serves as the gateway to the amphitheater and subsequently, the AMD treatment site. The view north has been identified by ALT and by the public as a beloved characteristic of WPCA. Furthermore, this additional open herbaceous zone is desirable for wildlife habitat diversity, as previously described. As mentioned, the openness of this zone should be maintained by occasional prescribed burns. If this is not possible, young trees can be girdled when they reach a size to interfere with at least part sun conditions.

2.7.6. Upland Meadow

This habitat zone provides the closest semblance to upland prairie conditions, and encircles the pool-side native display garden. The open character of this zone is highly desirable from an aesthetic perspective, because it allows visitors striking views toward the ponds, wetlands, and different forest types. Scattered trees occur in this zone, but the existing floristic quality is poor, as previously described. This area is an excellent candidate for prescribed burn management; however, this may be difficult as long as non-native grasses and forbs remain green through the winter. This area should therefore be generously spread with native upland prairie seed mix as available from ECSC (per the provider's instructions). If native grasses were to become more abundant in this zone, periodic burning would be quite feasible. This area is becoming infested with Canada thistle (*Cirsium arvense*), which should be aggressively managed, as stated. The installation of native tallgrass plugs such as big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), and indiangrass (*Sorgastrum nutans*), would be an excellent addition to this zone as well, providing an annual seed crop for ongoing revegetation and vivifying the upland aesthetic.

A large area of this zone is currently degraded asphalt (defunct parking), immediately west of the filled pool. This asphalt will be further pulverized and removed when machinery is on-site for AMD wetland construction. Fill from the AMD wetland excavation will then be used atop this bare ground, and will be blanket seeded, as mentioned, with ECSC upland meadow seed mix. Figure 2.10 illustrates the grading plan we produced in order to ensure that the area could sufficiently utilize necessary fill volumes on-site. Using the fill material in this way will help level the grade from the pool towards the floodplain and achieve a more subtle, 'natural' topography.

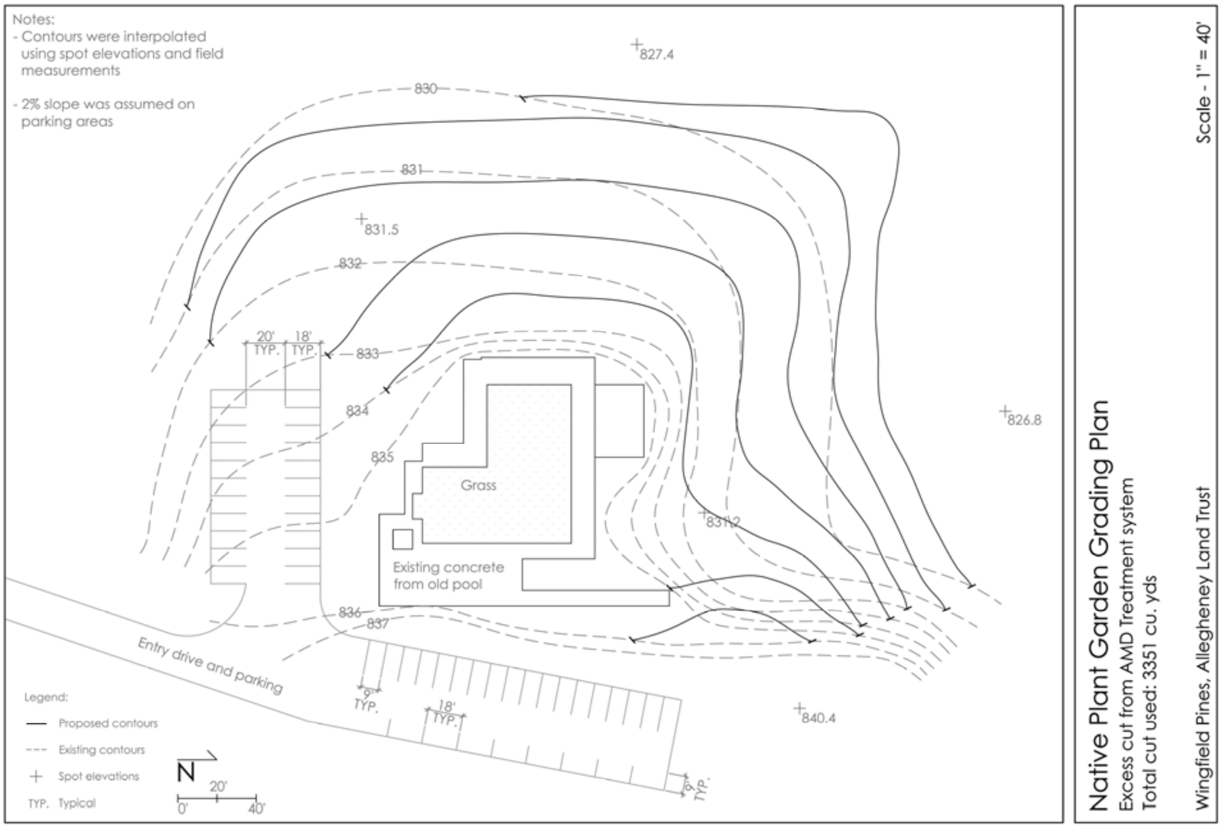

Figure 2.10 Upland meadow grading plan. Regrading allows for an upland meadow to be placed over a defunct parking area and retains fill on-site (not to scale).

2.7.7. Alternative Lawn (WPCA Amphitheater)

ALT expressed a strong desire to have a space that would be suitable for acoustic concerts and other gatherings in an amphitheater style. Figure 2.11 provides one rendition of the view into this area, looking north. The AMD treatment system, as described in Chapter 1, will provide the fill earth with which this area will be sculpted (See Figure 2.12 for amphitheater grading plan). This zone will therefore be generously seeded and blanketed with path rush (*Juncus tenuis*), which is an adaptable native grass-like monocot. This plant thrives in wet or dry conditions, particularly when compressed and trampled as on well-used trails. Seed from this native should also be spread along existing trails, when possible, or even sporadically plugged along the trails. If necessary, the path rush can be substituted with a 'low-mow' native fescue mix.

Figure 2.11 Amphitheater 'before and after.' The view north with a rendition of reforestation framing the amphitheater. The design has since been modified to retain more wet meadow.

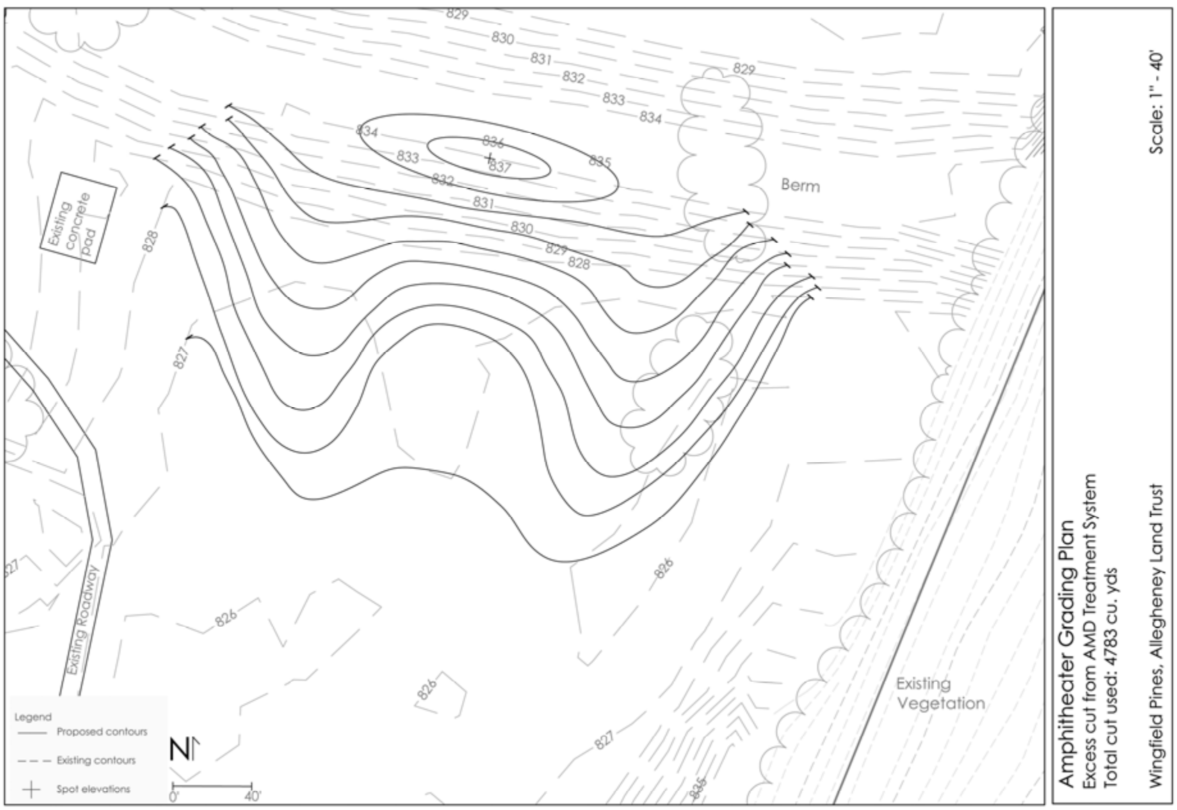

Figure 2.12 Amphitheater Grading Plan. The grading plan that forms the 'arms' of the new amphitheater, easing the slope down the south side of the berm and forming the inner 'bowl' of the performance space (not to scale).

The habitat zone map (Figure 2.9) shows the outline of the amphitheater and how the outer slopes are planted in upland Appalachian Oak forest. The inner slopes and the inner bowl will be framed by seven shagbark hickory (*Carya ovata*). In the (eventually) shadier areas of the amphitheater, we recommend additional plugging with Pennsylvania sedge (*Carex pennsylvanica*). Management of the amphitheater should require mowing only prior to planned events and even then, mowing is probably not necessary. The soft, natural appearance of this native alternative lawn should provide a charming setting for concerts and gatherings. Infrequent mowing should be adequate to prevent the establishment of woody plants, but if undesirable or invasive plants threaten this zone, prescribed burns should be considered.

2.7.8. Pool-side Native Plant Entry Garden

Figure 2.14 is a plan view illustration of how the native plant garden could be organized, including a new rustic information kiosk. This area is designed to be a showcase of native herbaceous plants with occasional woody specimens. Its purpose is to engage visitors in the nuances of native plants, to help them see the beauty of native plants and hopefully, to inspire visitors towards an environmental ethic (to be addressed in Chapter 3). As a facet of our education program, this entry garden is invaluable. These plants will serve as seed sources for ongoing floristic enhancements, so high diversity is essential. Showiness is also a high priority for this zone; therefore the plantings should be constructed accordingly. Figures 2.15 and 2.16 are conceptual illustrations meant to convey the character of this garden and the green informational kiosk associated with it. The kiosk is specified with a green roof, which illustrates progressive stormwater management and adheres to the rustic character of the site.

Figure 2.13 Plan view of amphitheater and poolside native display garden

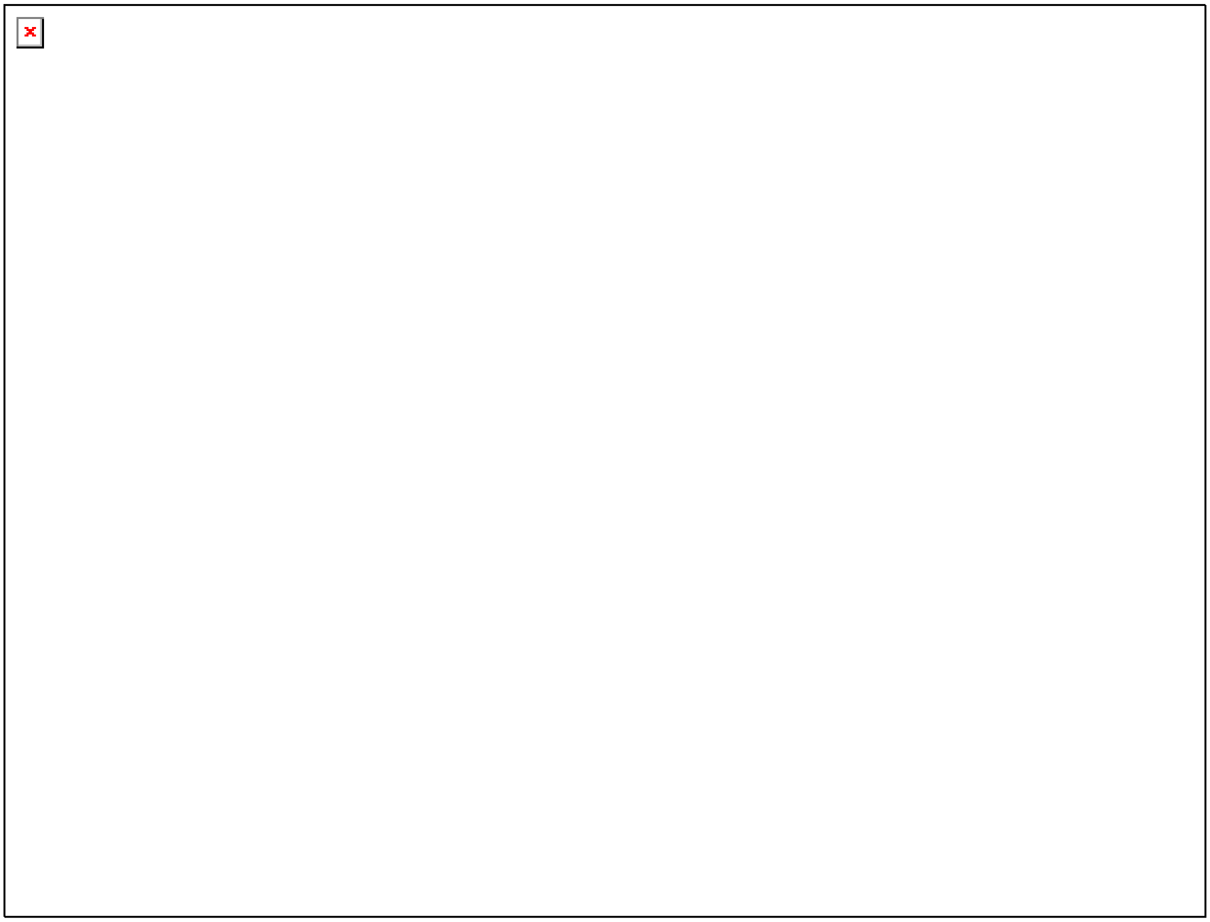

Figure 2.14 Plan view of the pool-side native display garden.

Figure 2.15a The filled pool area as viewed from east parking. View is panoramic and therefore not true to life.

Figure 2.15b Perspective sketch of the pool-side native display garden.

Figure 2.16 Conceptual illustration of an informational kiosk. Kiosk could be located on or adjacent to the existing concrete pad (which once supported a pool house). This early rendering shows the structure as an octagon, but for simplicity might be square or rectilinear.

2.8. WPCA Clump and Gap Design

As mentioned, the clump and gap approach will be employed to facilitate planned forest regeneration. Figures 2.17 and 2.18 illustrate existing woody canopy and a 10 year vision with new clumps, respectively. It is important to note that the ten-year vision is intended as a planting plan; natural reforestation is not shown on this plan although existing vegetation is shown. Based on compiled research and on WPCA aesthetic choices, we have designed these clumps with a heterogenous structure, and an average density of approximately 10 – 15 feet between stems (maximum density is 5 feet between stems). These density estimates are post-mortality, so if seedlings are planted, density should be at least doubled. Each respective clump was designed with an approximate 9 : 1 dominant : specimen ration. In this way, approximately 90% of each clump is comprised of common, reliable species, while the remainder is comprised of specimen trees, which are naturally less common and more specific in habit. Again, this is intended to balance the need for success with the desire for diversity.

Finally, Figure 2.19 illustrates the process of reforestation in a 50-year vision of natural recruitment and canopy development. The character of the site is vastly altered from existing conditions, and dense forest clumps radiate out from the installed clumps. They also are developed surrounding the existing trees, and in other areas of known current regeneration. Note that the emergent wetlands, wet meadows, upland meadows, and amphitheater zones serve as a cerntral open corridor tightly framed by diverse forests. The viewshed of this central corridor is preserved, its habitat values are dramatically increased across the years, and hopefully, it is actively used by an assortment of wildlife, including those of greatest conservation concern. The pond perimeters are shown at their current extent, although these might be enlarged in a 50-year scenario. Due to the flat terrain surrounding these ponds, however, such an expansion would probably serve (as mentioned) as emergent herbaceous wetland.

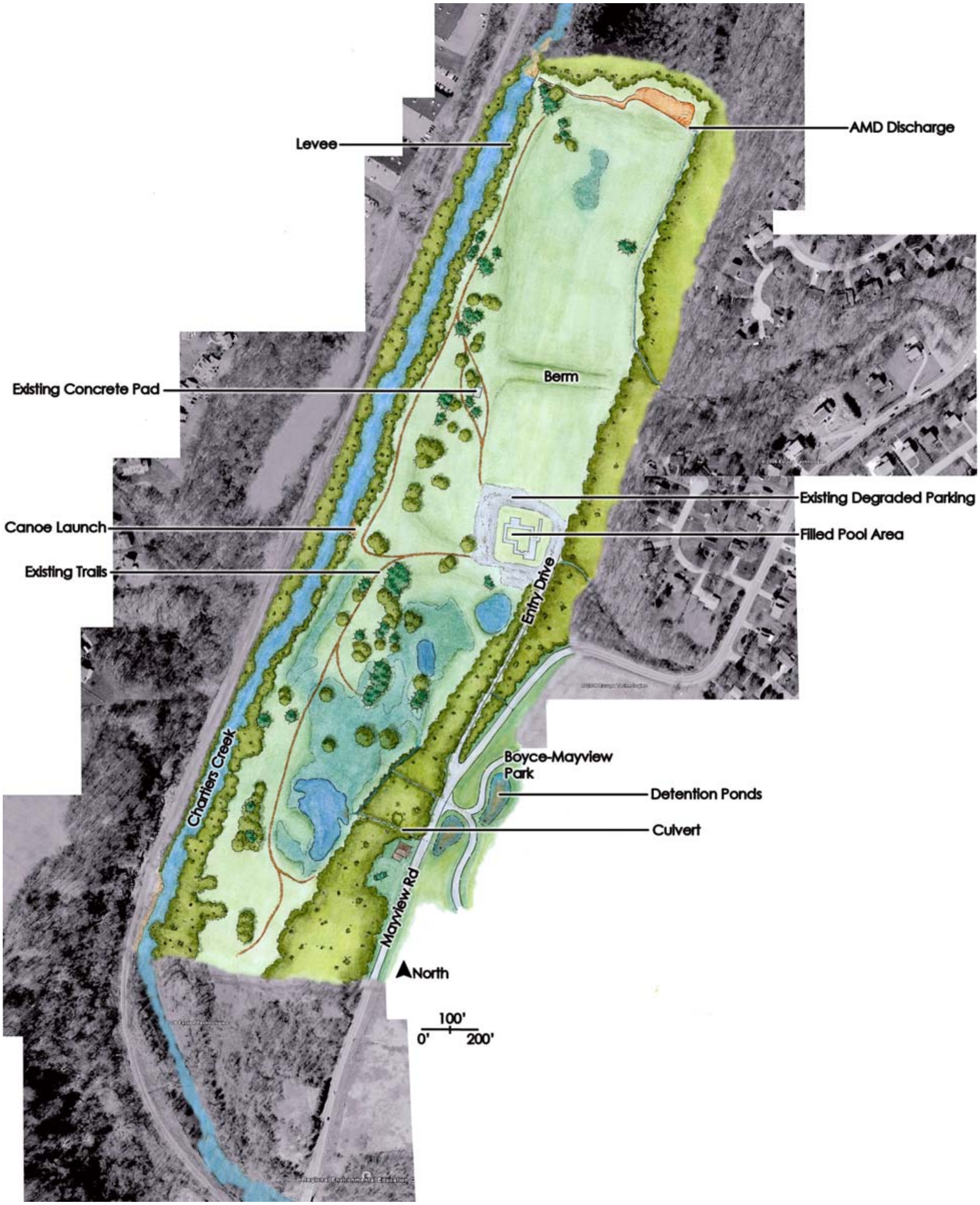

Figure 2.17 WPCA existing conditions

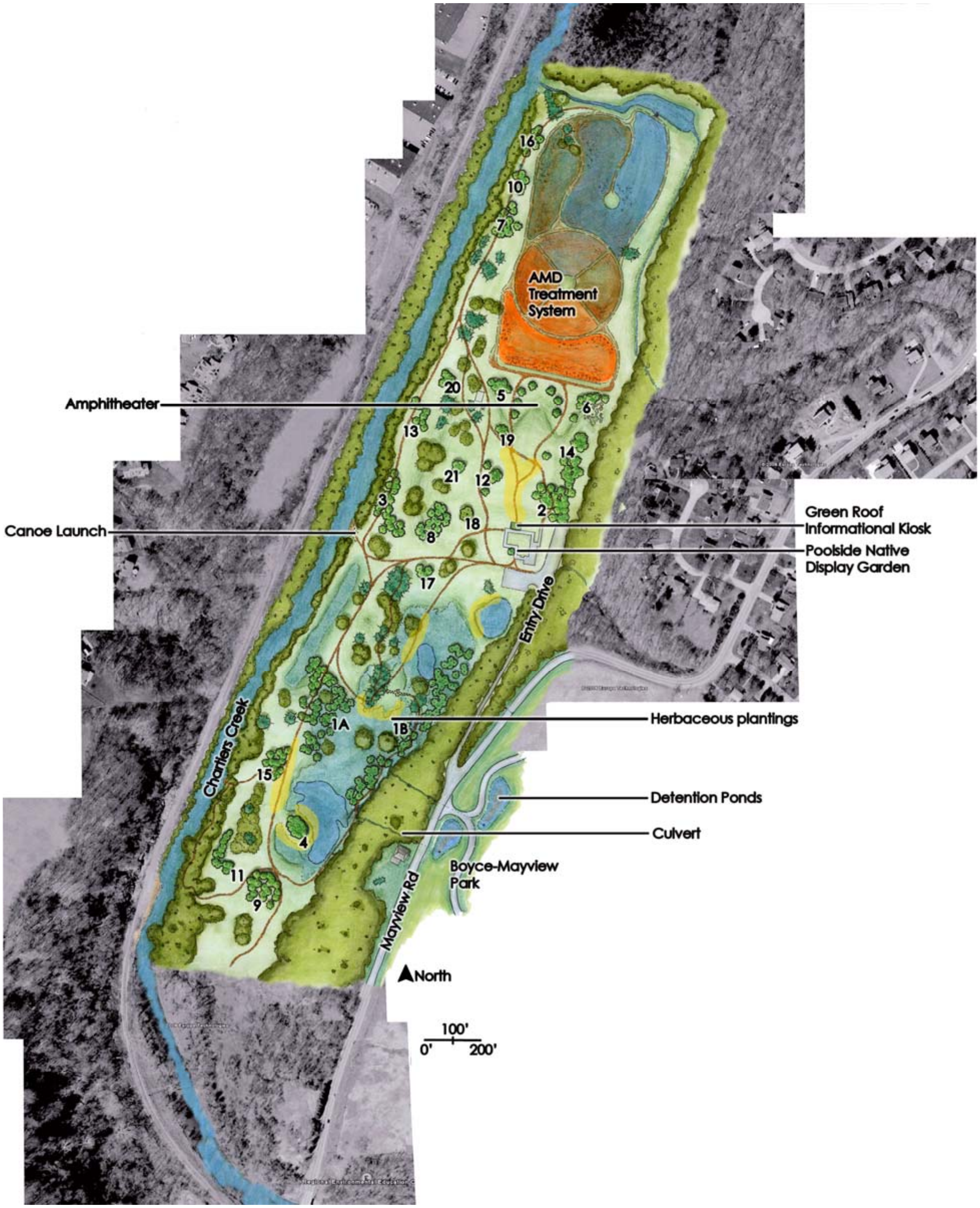

Figure 2.18 WPCA Pines 10-year vision with new clumps and proposed herbaceous plantings

Figure 2.19 WPCA 50-year vision showing clump growth and regneration

Individual clumps are numbered in Figure 2.18 based on our interpretation of overall level of priority. Clumps 1a and 1b are the highest priority because they comprise the 2.0 acres of 2:1 wetland mitigation option, wherein displaced wetlands at the AMD treatment site are compensated by existing-wetland reforestation enhancement. Clump compositions are based primarily on three partially-overlapping species lists: (1) Upland (Appalachian Oak); (2) Floodplain; (3) Mesic. These lists are provided in Appendices C-E, additionally, a fourth 'edge / meadow' list is provided (Appedix F). This list is comprised primarily of sun-loving edge species and shrubs that would be appropriate for enhancements in open areas. Finally, we emphasize that even within habitat zones, adjacent clumps are designed with distinctly different dominant species mixes, which is intended to create striking aesthetic contrasts across clumps, especially regarding characteristic fall colors. Clump compositions are as follows:

Table 2.4 Clump Species Compositions

CLUMP 1A (FLOODPLAIN)		
Species	**Common name**	**#**
Acer rubrum	Red maple	15
Acer saccharinum	Silver maple	5
Quercus bicolor	Swamp white oak	5
Quercus macrocarpa	Bur oak	5
Quercus palustris	Pin oak	5
Nyssa sylvatica	Black gum	5
Carya cordiformis	Bitternut hickory	1
Carpinus caroliniana	American hornbeam	5
Asimina triloba	Paw paw	1
Aesculus flava	Yellow buckeye	1
Morus rubra	Red mulberry	1
Amelanchier intermedia	Serviceberry	1
TOTAL		50

CLUMP 1B (FLOODPLAIN)		
Species	**Common name**	**#**
Quercus bicolor	Swamp white oak	10
Quercus macrocarpa	Bur oak	10
Quercus palustris	Pin oak	10
Acer rubrum	Red maple	5
Acer saccharinum	Silver maple	5
Nyssa sylvatica	Black gum	10
Betula lenta	Black birch	2
Carpinus caroliniana	American hornbeam	1
Aesculus glabra	Ohio buckeye	1
Carya cordiformis	Bitternut hickory	1
Populus grandidentata	Big-tooth aspen	3

TOTAL		58

CLUMP 2 (MESIC)		
Species	**Common name**	**#**
Fagus grandifolia	American beech	10
Tilia americana	American linden	2
Acer saccharum	Sugar Maple	3
Cercis canadensis	Redbud	3
Cornus florida	Flowering dogwood	2
TOTAL		20

CLUMP 3 (UPLAND)		
Species	**Common name**	**#**
Carya glabra	Pignut hickory	5
Carya ovata	Shagbark hickory	5
Quercus coccinea	Scarlet oak	3
Juglans nigra	Black walnut	1
Ostrya virginiana	Hop-hornbeam	1
Populus tremuloides	Trembling aspen	1
Juniperus virginiana	Eastern red cedar	1
Hamamelis virginiana	Witch-hazel	1
TOTAL		18

CLUMP 4 (FLOODPLAIN)		
Species	**Common name**	**#**
Nyssa sylvatica	Black gum	8
Acer rubrum	Red maple	4
TOTAL		12

CLUMP 5 (UPLAND)		
Species	**Common name**	**#**
Large trees		
Sassafras albidum	Sassafras	3
Gleditsia triacanthos	Honey locust	2
Small trees		
Amelanchier arborea	Serviceberry	4
Rhus typhina	Staghorn sumac	4
Quercus prinoides	Dwarf chinkapin oak	4
Shrubs		
Corylus americana	American hazelnut	12
Zanthoxylum americanum	Pricklly-ash	3
Cornus amomum	Silky dogwood	3
TOTAL		35

CLUMP 6 (UPLAND)		
Species	**Common name**	**#**

Trees		
Sassafras albidum	Sassafras	5
Populus tremuloides	Trembling aspen	4
Small trees		
Crataegus sp.	Hawthorn	3
Quercus ilicifolia	Bear oak	3
Rhus copallina	Shining sumac	6
Ostrya virginiana	Hop-hornbeam	3
Shrubs		
Corylus americana	American hazelnut	12
Zanthoxylum americanum	Pricklly-ash	3
Cornus amomum	Silkyy dogwood	5
Prunus virginiana	Choke cherry	5
TOTAL		49

CLUMP 7 (UPLAND)

Species	**Common name**	**#**
Quercus alba	White oak	5
Quercus prinus	Chestnut oak	1
Quercus muhlenbergii	Chinkapin oak	2
Ostrya virginiana	Hop-hornbeam	2
TOTAL		10

CLUMP 8 (MESIC)

Species	**Common name**	**#**
Aralia spinosa	Devil's-walking-stick	2
Liriodendron tulipifera	Tuliptree	5
Morus rubra	Red mulberry	1
Tsuga canadensis	Eastern hemlock	3
Fagus grandifolia	American beech	3
Tilia americana	American linden	1
TOTAL		15

CLUMP 9 (UPLAND)

Species	**Common name**	**#**
Quercus alba	White oak	5
Carya glabra	Pignut hickory	5
Carya ovata	Shagbark hickory	3
Quercus macrocarpa	Bur oak	3
Carya tomentosa	Mockernut hickory	1
Juniperus virginiana	Eastern red cedar	1
Cercis canadensis	Redbud	1
TOTAL		19

CLUMP 10 (UPLAND)

Species	**Common name**	**#**

Carya tomentosa	Mockernut hickory	1
Carya ovata	Shagbark hickory	4
Carya glabra	Pignut hickory	1
TOTAL		6

CLUMP 11 (MESIC)		
Species	**Common name**	**#**
Acer saccharum	Sugar maple	3
Fagus grandifolia	America beech	3
Asimina triloba	Paw paw	1
Acer pensylvanicum	Striped maple	1
Celctis occidentalis	Hackberry	1
Magnolia acuminata	Cucumber tree	1
Tsuga canadensis	Hemlock	3
Cornus florida	Flowering dogwood	1
TOTAL		14

CLUMP 12 (UPLAND/WET MEADOW)		
Species	**Common name**	**#**
Liriodendron tulipifera	Tuliptree	6
TOTAL		6

CLUMP 13 (UPLAND)		
Species	**Common name**	**#**
Quercus macrocarpa	Bur oak	2
Quercus alba	White oak	2
Carya glabra	Pignut hickory	2
Carya ovata	Shagbark hickory	2
TOTAL		8

CLUMP 14 (FLOODPLAIN)		
Species	**Common name**	**#**
Betula lenta	Black birch	3
Diospyros virginiana	Persimmon	3
Aesculus glabra	Ohio buckeye	3
Populus grandidentata	Big-tooth aspen	1
Carya cordiformis	Bitternut hickory	1
Quercus macrocarpa	Bur oak	3
Liriodendron tulipifera	Tuliptree	1
TOTAL		15

CLUMP 15 (FLOODPLAIN)		
Species	**Common name**	**#**
Celtis occidentalis	Hackberry	3
Carya cordiformis	Bitternut hickory	3
Aesculus flava	Yellow buckeye	1

Quercus bicolor	Swamp white oak	2
Tilia americana	American linden	3
TOTAL		12

CLUMP 16 (UPLAND)		
Species	**Common name**	**#**
Quercus macrocarpa	Bur oak	3
Juniperus virginiana	Eastern red cedar	4
TOTAL		7

CLUMP 17 (WET MEADOW)		
Species	**Common name**	**#**
Liriodendron tulipifera	Tuliptree	4
TOTAL		4

CLUMP 18		
Species	**Common name**	**#**
Aesculus glabra	Ohio buckeye	4
TOTAL		4

CLUMP 19 (FLOODPLAIN)		
Species	**Common name**	**#**
Carya glabra	Pignut hickory	3
TOTAL		3

CLUMP 20 (UPLAND)		
Species	**Common name**	**#**
Juglans nigra	Black walnut	3
Quercus muhlenbergii	Chinkapin oak	2
TOTAL		5

CLUMP 21 (FLOODPLAIN)		
Species	**Common name**	**#**
Nyssa sylvatica	Black gum	4
TOTAL		4

3.0. Focal Practices: Education, Access, and Interaction as an Essential Component of WPCA Site Rehabilitation

Ecosystem conservation, restoration and land rehabilitation rarely occur as a purely scientific endeavor. Those who become committed to these practices usually do so on the basis of a deeper emotional drive, which is often the result of a sort of moral epiphany. It is therefore the role of environmental education to facilitate the intellectual and cultural evolution towards a conservation ethic – to orchestrate the epiphany and guide our society towards Jordan's (1994) "new environmental paradigm." WPCA, with its enchanted, solitary setting and its central suburban location is an ideal place for the awakening to occur. The incorporation of Higg's (2003) *focal practices* into our WPCA management plan has therefore become an integral component of a multi-faceted management plan. These focal practices will "create a stronger relationship between people and natural process, a bond reinforced by communal experience."

Focal practices emphasize the work (the process) and community involvement in the rehabilitation process. The result is an activity that brings people together and helps reunite culture and nature. A place is given personal significance and its visitors and volunteers can better understand the site's history, making clear what cultural practices contributed to current ecological conditions. Past practices shape how future practices need to change and how we might achieve landscape coevolution – where human practices become an equal, not dominant, part of landscape change (Higgs, 2003; Kane, 1994). Because WPCA has been so profoundly affected by human practices, it could become an invaluable natural area with its ability to provide a deep educational experience. Its story is so much more informative than the beauty of a pristine, untouched piece of land. Perhaps most important is its ability to prove that rehabilitation can occur by recognizing human influences and compensating for them (Jordan, 1999).

By employing the site's specific environmental needs and values as educational opportunities, ALT will ensure the success of the master plan and indirectly contribute to the aforementioned awakening, the environmental epiphany. The provision of outdoor learning experiences allows people to interact with nature and develop a relationship with the beauty and value it provides (Smith and Williams, 1999). WPCA neighbors are already devoted to this quiet place and their relationships, if properly cultivated, should ripple through their lives and perhaps even begin to guide their daily choices. For example, a first-hand look at the destructive effects of storm water might convince these neighbors not to waste water.

Education is also important for informing the public about the rehabilitation process. As these efforts begin, the current state of WPCA will change and neighbors and frequent visitors might become concerned if they are not adequately informed about the reasons for these changes. A successful prairie restoration program in Chicago, for example, was halted after 19 years of work because the public began to feel left out of the process, as though restorationists were purposefully hiding their efforts. In reality, information had been provided throughout the entire process, which included tours, slide shows, wildflower identification classes, newspaper articles about the restoration programs, signs postings, and flyer distribution (Ross, 1997). Fortunately for the Chicago restoration efforts, the proper public informational steps had been followed. The important lesson learned from this would-be controversy, however, is to simply involve the public from the outset not only by providing information, but by including them in decision making and especially, providing opportunities to participate in restoration activities.

It is also important that stakeholders see the innate value of rehabilitation efforts. The Society for Ecological Restoration recommends fostering the public's support by helping them realize how restoration efforts can benefit them personally. Such benefits could include, for example, a destination for ecotourism that will support local business or environmental educational opportunities for local schools. If the value is clear, the community will be more likely to support these efforts (Society for Ecological Restoration, 2005). The benefits of rehabilitating WPCA are many and can be effectively revealed in a new educational program.

3.1. Components of WPCA Educational Program

With these things in mind, an educational program for WPCA should have three primary objectives, which are as follows.

1. To facilitate visitor awareness of regional environmental problems and make WPCA a destination for environmental education.
2. To help visitors understand site history, present, and future (cultural and ecological).
3. To maximize public awareness of ALT's mission and opportunities for involvement.

The three essential ways in which these objectives can be achieved include the site design, interpretative elements, and a more formal, collaborative educational program. First, through the use of ecological design WPCA can provide a type of education that is more informal, private, and experiential. As the site teems more and more with biodiversity, personal discoveries abound and ultimately, a stronger relationship between man and nature is formed. Second, subtle interpretative elements placed in the landscape can enhance visitors' depth of understanding and awareness. Informational signs that draw attention to unique or special aspects of the site can effectively help the visitor to directly learn about the environment. Third, an organized educational program can make opportunities available that more explicitly inform visitors of the environmental issues and history of the site. This portion of the educational program would further reinforce the connection between the site and the community as focal rehabilitation becomes a primary objective.

3.2. Education by Design

Ecological design is a profoundly effective tool, improving both functional ecosystem results as well as the visibility of those results. This dual benefit depends on the conscious attention of the designers, who must go beyond ecological processes in the development of an ecological *aesthetic*. The use of design to reveal environmental nuances then becomes a more interpretative process, commonly termed *eco-revelatory design*. By making ecological relationships and processes more apparent, people are able to better understand their environment and become more aware of its intricacy. This awareness thereby ushers in the awakening as people deliberately embrace sustainability as a lifestyle choice (Brown *et al*, 1998).

Using this premise as a basis, the WPCA master plan incorporates dense new plantings, trails that traverse different habitat zones as well as gathering spaces that maximize nuanced biodiversity and views of ecosystem patterns. Imbedded within this orchestrated experience are the educational components, envisioned to be rustic and subtle, nestled into and framed by trail-side plantings.

3.2.1. Revealing existing site conditions as a product of the past

As detailed in chapter 2, proposed habitat zones recommend the installation of specific plant communities, which are properly adapted to their respective site conditions. Consequently, the varying plant palettes across the site act as visual cues to visitors, vivifying both hydrology and topography. An additional dimension is added to this experience due to the complexity of the site's previous land uses, the physical and historical narrative present in its scars. Our vision of rehabilitation is therefore a layering of newly-introduced elements, which deliberately reveals that narrative in an exciting and telling juxtaposition. The site's history is celebrated, as the impacts of the past are permanent and obvious artifacts on the landscape – from concrete to sand trap, golf turf, high-wall, levee, and berm. "Matter is the deposit of life, the static residues of actions done, choices made in the past. Living memory is the past felt in the actualities of realities, of change," (Corner, 1997).

The intermingling of these two realities, one of human impact and one of ecological stability, may seem like an odd paradox, but it consciously denies a singularity or hierarchy between man and nature and creates a venue for an understanding between the two (Corner, 1997). As Carol Franklin states, "[changes in our attitude toward the environment] require that we actually see the present deterioration of the landscape, that we recognize the impacts of our interventions, and that we understand each site and each piece of a site as parts of larger systems," (Franklin, 1997). By drawing attention to the past environmental impacts sustained at WPCA and yet overcoming them in the rehabilitation process, ALT will foster an understanding within the community on how to better integrate nature and culture.

3.2.2. Change in the landscape: the educational benefit of clumps and gaps

The benefits of the clump and gap approach have already been described in chapter 2; however, it is worthwhile to reiterate the educational potential of distinct forest clumps in the landscape. The installed clumps will be quite conspicuous as they mature and when they reach fruiting age, the recruitment of seedlings around them will probably be very obvious as well. In this way, the process of forest regeneration will be revealed and repeat visitors will surely understand that ALT's ecological design intervention enabled this process to occur as a spectacle. The long term dichotomy in size will always be apparent between the planted clumps and their offspring; therefore even as the forest matures, the mark of the design approach will always be present to remind visitors and neighbors how the forest was reborn.

As James Corner (1997) states, "A truly ecological landscape architecture might be less about the construction of finished and complete works, and more about the design of "processes," "strategies," "agencies," and "scaffoldings" – catalytic frameworks that might enable a diversity of relationships to create, emerge, network, interconnect, and differentiate." By planting part of the site, people can take an active hand in the rehabilitation process. Individuals who help plant the clumps will probably never forget; they will return to the site to see how the landscape has evolved. Those who make financial donations or 'adopt a clump,' will have the satisfaction of knowing they essentially 'fathered a forest.' In this way, the process and those who are involved in the process become fully integrated and the collaboration between man and nature forms like a marriage bond.

3.2.3. Gathering spaces and planting design

Gathering spaces also play an integral role in the site design by creating places where educational opportunities are revealed and visitors are encouraged to stop, observe, and contemplate their surroundings. Specifically, the pool-side native display garden serves as entry to the site, immediately orienting and welcoming visitors as they come down the drive. The informational kiosk provides a central location for ALT to disseminate information about WPCA, its AMD treatment system, its mission, as well as changing news and events.

The native plant garden can also expose visitors to the native flora of the region and encourage an appreciation of the distinctions between various species of plants. This same opportunity is carried through the site's entire planting design as many rehabilitation plantings are focused around gathering spaces. This is a deliberate attempt to make the early biodiversity conspicuous as well as accessible. For example many of the trails are on dry ground near wet areas. Planting these wet edges will be easier (especially if carried out by volunteers) and will help frame the trails. Ideally, the accessibility of trail-side plantings would enhance the educational experience, as visitors will be introduced to many wildflowers in the pool-side garden and would then discover them along the trails. This facilitates the personal experience and might encourage visitors to employ native landscaping around their own homes. As time passes, these floristic enhancements would hopefully spread throughout the natural area.

3.3. Education through interpretation

The trail network at WPCA builds upon existing trails and includes additional connections to key locations on the site. This network purposefully provides access to areas that help illustrate important environmental concepts, taking advantage of the site's unique environmental character. Each of these areas act as educational nodes and set the framework for a signage program that educates visitors by explicitly describing the various processes and actions that have helped develop a sustainable site design. Including site interpretation can help visitors find the meaning and history behind WPCA, and such meaning is facilitated through the interpretive trails that connect visitors with the land (Gross *et al*, 2006). The location of five educational nodes are therefore shown in Figure 3.1 and the topics addressed are listed in Table 3.1.

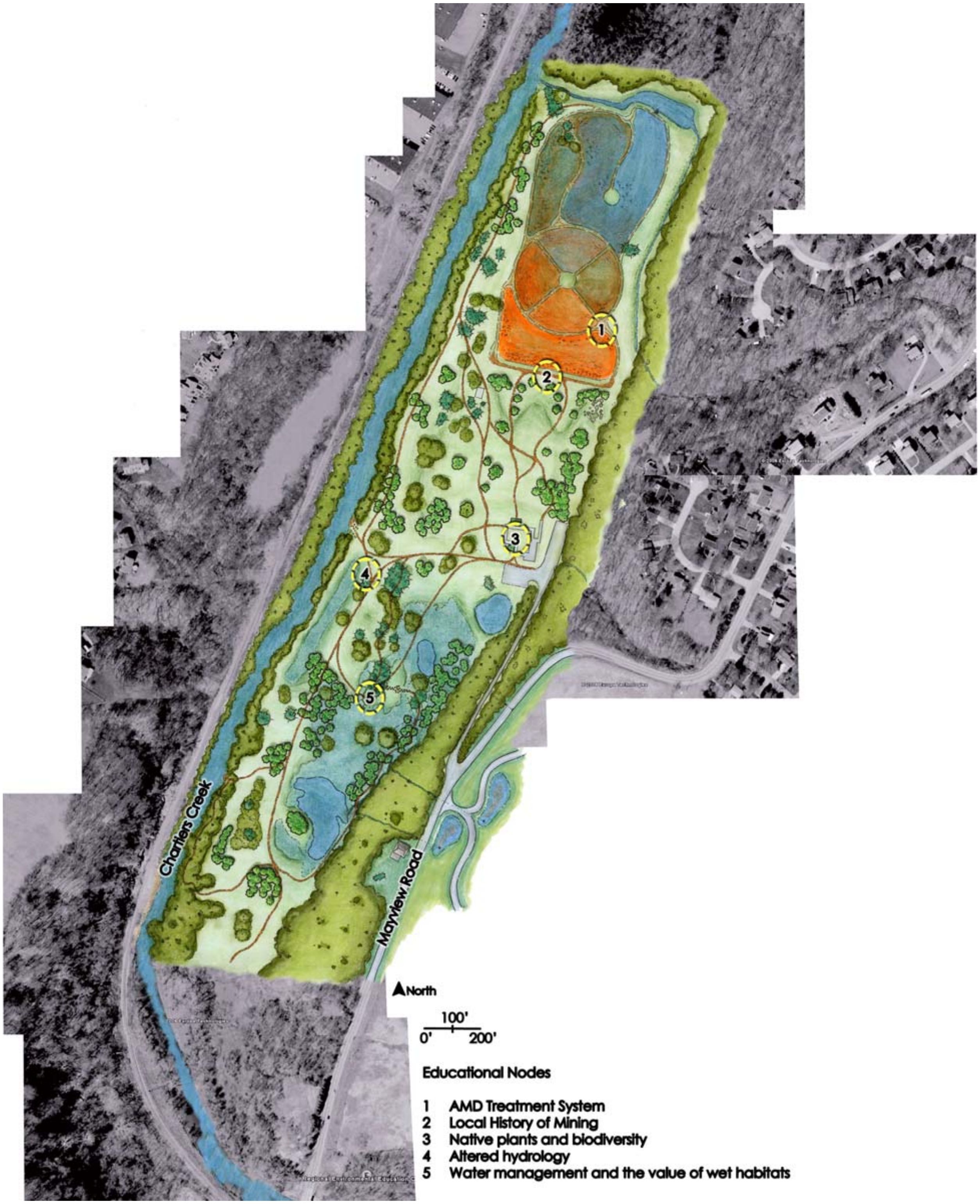

Figure 3.1 Location of the five educational nodes

Table 3.1. Topic descriptions of the five educational nodes

Educational Node	***Topic Description***
Native plants and biodiversity	As detailed, the pool-side native display garden will be a key educational node. It should identify plant species and their naturally-occurring ecosystems. It should incorporate adaptable plants from each habitat zone and encourage visitors to watch for them in their respective habitats at WPCA.
Water Management and the value of wet habitats	This educational node should address the many different issues related to sustainable water management. Specifically, this node can help illustrate the following: • benefits of stormwater detention for the purpose of infiltration, and the negative effects of directing stormwater into conveyance systems. • the multiple watershed-level functions of floodplains, as described in chapter 2. • the incredible ecology of wetlands. This story will connect the site to the larger watershed of Chartiers Creek by addressing historical events, such as the impacts of Hurricane Ivan, and the impacts of increasing impervious surfaces within the watershed. Illustrating such connections will help educational concepts become real, especially if directly connected to the person and their daily life (Krapfel, 1999).
Altered Hydrology of the Site	This node will identify the historical creek bed, where it overlaps with an existing trail. It should also call out the creek-side levee and the perpendicular berm.
Local history of mining practices	This node will describe the regional history of the site, focusing on the cultural and environmental role of strip and deep mining.
AMD Treatment System	This node can describe the function of the AMD treatment system, how it helps cleanse the iron laden water before it enters Chartiers Creek. This node can help place the site within the larger context of the watershed, explaining how the creek is still impacted by other AMD locations.

3.3.1. Effective sign design

Signs are most effective when their design is harmonious with the site character and information is concise (Gross *et al.* 2006). In addition, sign design should be attractive, as such a quality can increase the ability to gain a viewer's attention, as well as hold their interest longer and help them retain the main message of the sign better (Jensen, 2006). It is important, however, that signs used at WPCA provide an educational experience without detracting from the overall natural character of the site. Figure 3.2a included below provides an example taken from Forest Park, Ann Arbor, Michigan. Figure 3.2b provides another example describing native plants. Each sign is simple in format, but effective in message. The signs in Figure 3.3a and figure 3.3b are placed inconspicuously, successfully providing information while not detracting from the views afforded by the trail. This type of straightforward presentation would compliment the understated, natural quality of WPCA.

(A) **(B)**

Figure 3.2 Simple, effective layout of signs. (A) Forest Park, Ann Arbor, Michigan. (B) Creative illustration of native plants (http://www.renewthevalley.org/)

(A) **(B)**

Figure 3.3 Effective sign placement. (http://www.interpretivesigns.qut.edu.au/visitor_attention.html)

Sign construction can play an important role in providing an effective educational tool while still blending into the landscape. There are several material choices available for the sign panels and the sign supports. Appendix H includes a table describing the advantages and disadvantages of different panel materials. For WPCA, panel durability, balanced against sign cost, is crucial as the signs will be exposed to the elements, and periodic flooding, but need to be affordable. Sign panels made of high pressure laminate are an excellent choice for WPCA as they are very durable, lasting 10-20 years, are resistant to vandalism, and are lower in cost than most sign panel materials (Gross *et al.*, 2006). They also can include color if desired, increasing the ability to make an attractive sign. For signs at WPCA, color should be complimentary to the colors of plantings and vegetation.

Sign supports should also be simple and blend into the site's surroundings, while being sturdy and durable. Figure 3.4 shows precedents with wood supports that would fit well within the character of WPCA. Since natural wood would have to be treated in order to remain viable in the elements plastic lumber or cedar provide excellent alternatives that still maintain a rustic quality suitable to WPCA.

Figure 3.4 Sturdy sign construction with a natural color. (http://www.shelleysigns.co.uk/)

The National Association for Interpretation provides vendors for various sign panel material, including high-pressure laminate, which are provided in Table 3.2. Many of these vendors can also design the sign layout and develop the interpretative message. The signs could also be a good source for donations, identified as such through the use of donation plates on the posts, or included directly into the sign panel.

Table 3.2. Interpretative Sign Vendors

Sign Company	Services offered	Location	Website
Envirosigns, Ltd.	Strong on custom design and fabrication	North Canton, OH	www.envirosigns.com

Sign Company	Services offered	Location	Website
Folia Industries Inc.	Indoor/outdoor digital graphic panels: 10-year warranty against UV fading/delaminating.	Quebec, Canada	www.folia.ca
Fossil Industries, Inc.	Fossil manufactures the most durable and highest image quality high-pressure laminate panels available.	Deer Park, NY	www.FOSSILinc.com
Interpretive Graphics	Complete in-house interpretive services: • Planning, concept development, research, writing, fabrication • Wayside signage and support systems • Graphic design and illustrations • Large-format digital prints and screen imaging • Digital audio production, voice talent, script-writing • Digital Message Repeaters (DMRs) for an array of uses, including solar-powered audio posts	Salt Lake City, UT	www.InterpretiveGraphics.com

From: http://www.interpnet.com/resources_interp/greenpages/signage.shtml#laminates

3.3.2. Sign maintenance

While signs provide a valuable educational tool, they are only effective if properly maintained. For high pressure laminate, to maintain sign readability and quality, the sign panels should be washed or waxed bi-annually (Gross *et al.*, 2006). This maintenance requirement can easily be incorporated into the workdays and performed by volunteers. Vegetation around the signs should also be trimmed periodically to maintain access to the sign panels, while preserving the plantings around the sign supports, which can help frame the signs and screen them from some angles, helping them blend in. This type of maintenance can be incorporated into site workdays ensuring the interpretative signs at WPCA retain a high-quality look.

3.4. Education through Action

The second part of the WPCA educational program focuses more specifically on community involvement and the organization of hands-on activitie. By approaching rehabilitation in this way WPCA will offer an alternative to the preservationist stance, which usually focuses on creating "minimal impact" on the land and results in limited interaction between people and nature for fear of in some way destroying it. This creates a separation between humans and nature, as humans are only allowed as observers rather than actual, direct participants in the landscape. While programming access is important for many reasons, such as protecting new plantings, participating in the rehabilitation process offers an alternative approach that allows for increased contact with nature (Jordan, 1999; Turner, 1994). Furthermore, community involvement is crucial for a successful rehabilitation project as those who are accountable for their landscape will be more apt to sustain its value over time (Sauer *et al,* 1998).

Community involvement in the rehabilitation of WPCA can occur through the use of public meetings, newsletters, and public announcements. Information dissemination through the ALT website could also have a broad reach. A brochure is another excellent way of making information available about WPCA, telling the story of the site with attractive layout, smart graphics, and quality printing. Once initial contact is made, the public can be invited to participate in the actual steps of the rehabilitation process. These may include specific tasks such as invasive plant removal, planting days, or monitoring activities.

Monitoring activities, for example, helps assure that rehabilitation efforts are successful and can help determine whether management strategies may need to be adjusted. By having volunteers conduct the monitoring themselves, they can learn directly by doing, which is extremely effective method to convey information to a community (Sauer, 1998). Conducting monitoring activities via volunteer support can ensure this important part of the rehabilitation process does not get overlooked, as well as further the connection between community, the site itself, and the greater regional environment (Sauer, 1998). It is important that volunteers are trained in each of these tasks not only to ensure the accuracy of completing the tasks, but also to provide volunteers with the opportunity to learn something new and thus increase the feeling of satisfaction they will gain from being involved. An individual could be directed, for example, to identify and count a certain species as visible from the trail. In this way, the trail becomes a 'transect' and the project can be repeated across time to help managers understand which species are successful.

The community can also become involved in native plant and seed propagation for the site. To help gather native seed for restoration projects the Chicago Botanic Gardens implemented the Native Garden Project, which involved the community in growing native plants in their yards. The seed produced from the plants was then used in restoration plantings (Grese, pers. comm., 2007). Similar methods could be followed for Wingfield Pines, involving the local community while decreasing the need for buying seed and ultimately managing the cost of rehabilitation efforts. Such a program would further educate the community on the importance of native plants while effectively transforming yards to small patches of native habitat and decreasing possible invasive plants. This is especially appropriate at WPCA because of the suburban context and the many regular locals who use the site.

An organized educational program will best be developed by partnership with local institutions. Specifically, the Regional Environmental Education Center (REEC) located at the adjacent Boyce-Mayview Park offers an excellent opportunity for collaboration. Educational activities may then be expanded beyond just rehabilitation processes, and may include more in-depth research and analysis of various environmental processes. The educational nodes act as an initial basis for an educational program, informing specific topics that may be addressed in a more formal educational program. Linking the interpretative elements to a more formal educational curriculum will help in their overall effectiveness (Ballantyne and Uzzell, 1996).

Other interested local institutions, such as Duquesne University or local public schools, can use the site as an outdoor classroom, while providing useful environmental data for the rehabilitation process. For example, Duquesne University has conducted several electroshocking surveys of aquatic life in the site's three ponds, as well as in the AMD settlement pond. The organization of similar activities will strengthen the connection with local schools and help ALT's limited staff acquire necessary management data.

3.5. Maintaining Involvement

It is essential for ALT to understand why people may want to become involved and what helps them stay involved. In conducting a review of various restoration volunteer newsletters, Schroeder (2000) discovered three main reasons people typically become involved in a restoration project: 1) they experience a sense of urgency and immediacy about the fragility of nature and the impending loss of native sites and species; 2) they believe they can make an important and real difference in the future; and 3) they enjoy the ability to see tangible progress from their efforts in a fairly short time span. Similar reasons for becoming involved have been discovered in other studies (Grese *et al*., 2000; Miles *et al*., 2000). Based on these findings, Grese *et al* (2000) suggest certain methods for maintaining involvement, which include showing volunteers the value of their work and effort, helping them understand the larger goals and desired results of a restoration program, and incorporating learning opportunities into workdays.

At WPCA, prolonged public involvement can be achieved through information dissemination via newsletters and postings at the information kiosk. It is recommended that ALT include an overall explanation of the rehabilitation project, as well as updates on the progress of rehabilitation efforts. Also, visually showing the progress of volunteer efforts will further enhance their understanding of the value of their support. Using before and after pictures of specific areas that are treated for invasive plants, or planted with natives can effectively illustrate the vegetative changes being made. As mentioned above, such monitoring activities can even be performed by the volunteers themselves. Workdays may also include tours to previously restored areas, which not only serve to educate by showing ecologically sustainable plant compositions, but also help volunteers see the real impacts they are making (Grese *et al.*, 2000). Volunteers can be educated on the specific plants they are planting, as the native plant garden will support such learning opportunities, or volunteers may be able to learn more about the procedures and efforts required to develop a restoration plan.

Finally, volunteers have been found to value the personal and social benefits of participating in restoration activities with others from the community. The social aspect of restoration is truly vital to building a successful volunteer base (Higgs, 2003). The incorporation of social or cultural events (such as annual cookouts and concerts) also furthers the bond between involved citizens. One such example in Lake Forest, Illinois is the "Bagpipes and Bonfire" festival, which was at first centered around the annual burning of exotics and nonnatives. The festival has since evolved to include "family entertainment, period actors, hot-air balloons, food and drink…[and]… at dusk, a 100 piece Scottish piping band [that] emerges from the prairie, solemnly circles the brush pile, and plays traditional airs," (as quoted in Higgs, 2003). This bonfire ritual creates a stronger bond among those in the community, as well as between people of the community and natural process and cultural patterns (Higgs, 2003).

The incorporation of such cultural practices into rehabilitation at WPCA will turn the entire process into a celebrated event. Workdays will become anticipated occasions that allow people to enjoy each other's company while renewing their relationship with nature. People can meet other members of the community who share their motivations and interests. The amphitheater area included in the master plan for WPCA provides a beautiful setting for musical concerts and other community events. For example, ALT holds an annual "Bluegrass for Green Space" festival that features local musical artists. This type of event will enliven WPCA and can easily incorporate activities that highlight rehabilitation.

4.0. Access Enhancements

As another component of the WPCA master plan, we propose several public access enhancements. These include:

(1) protect existing hardscape elements from further deterioration consequent of poorly-managed stormwater.

(2) improve visitor experience by corduroy-style trail enhancements and / or stepping stones through wet areas.

(3) provide an enhanced stone canoe launch to protect the eroding creek bank.

(4) potential boardwalk and overlook areas that could decrease trampling of vegetation, augment educational nodes, and provide quiet contemplative spaces (a long-term consideration).

Improved site access at WPCA would likely increase the volume of visitors on site, which could have several positive effects. This increase would ensure that environmental education on site reaches a larger number of residents. As described in Chapter 3, this is an essential component of the socio-cultural function at WPCA and it justifies serious consideration of these access issues. It would also increase the profile of ALT, help them increase their membership, help develop a regular volunteer base and importantly, help garner financial support for ongoing projects. Improved access also reduces unwanted foot traffic off of the existing trails and thereby helps preserve new plantings from trampling. The prevention of stormwater impacts on the access drive and the parking areas is a particularly high priority. It will ensure vehicular access for multiple purposes and will delay costly, repetitious repairs of cracked and broken asphalt.

It is, however, a delicate balance between the built presence and the quiet, natural character that residents seem to prefer. Public opinion polls (conducted in November 2006) indicate that many residents are very attached to the perceived ‘natural’ character, and did not want it to develop excessive park-like qualities. Rather, they appreciated feeling as though they were far removed from suburbia. We therefore recommend a very cautious and thoughtful approach to any built elements such as creek overlooks, boardwalk trail connectors, the information kiosk, and all signage. While concepts for these elements were positively received by the community, concern was expressed about their physical characters.

One of ALT’s primary goals identified in its 2006 “New Strategy for Land Conservation,” is to become the region's "'Go To' land trust through a marketing plan" (Vistas, 2006). Additionally, in a January 2007 survey conducted by ALT of 400 community members via on-line surveys and personal interviews, respondents indicated that "wetlands and floodplains" were the most important types of land to conserve in southwestern Pennsylvania. It could be argued that ALT has already accomplished its mission of land conservation by preserving WPCA's floodplains and wetlands. As detailed across this document, however, the AMD treatment wetlands should catalyze the profile of ALT and WPCA will therefore probably become its flagship property.

The following site enhancements will be sufficient and appropriate for a flagship property with moderate to high traffic and a collaborative educational program, while remaining sensitive to primary ecological and aesthetic management goals.

4.1. Trail Conditions

The existing footpaths throughout WPCA generally follow the more well-drained upland areas, which are consistently drier than the rest of the site. These trails probably do not require any mowing; however, as trailside plantings become more abundant, it might be desireable to periodically mow messy sections of trail to encourage visitors to follow these trails. New sections of trail, designed to protect new seeded meadow areas, should be mown in order to prevent trampling of these plantings. This is especially pertinent for the trail network between the pool-side native display garden and the amphitheater (see Figure 2.13). Figure 4.2 illustrates the entire system of trail enhancements, which are shown in yellow.

Certain trail segments do, however, traverse wet, low-lying areas, which hinder access to important nodes. One of the site's most beloved nooks, a large pine-planted mound that overlooks the southern-most pond, is not reliably accessible due to a frequently saturated segment of trail. These low-areas encourage users to "trail-blaze" in search of drier ground, which disturbs more naturalized areas of the site via trampling of vegetation and soil compaction (Sauer, 1998).

Figure 4.1 Wet trail conditions. The primary access point to the picnic bench under these pines is frequently inundated. This is perhaps the most frustrating section of trail on site.

An improved trail surface at this location (or even a series of stepping stones) will improve the visitor experience and protect the surrounding vegetation and soil conditions from human disturbance. An effective way to augment soggy trail surfaces is the "corduroy technique." This method raises the elevation of the trail surface but still allows migrating surface water to pass beneath it via alternating rows of wood and gravel in the base layer. Implementation of this technique is achieved with volunteer labor and could provide an appropriate solution to wet trail segments across WPCA. Basic construction details for the implementation of corduroy trail improvements in the location at Figure 4.1 are provided in Appendix I, but are applicable to all saturated trail segments site-wide. A simpler solution could also be achieved by the use of stepping stones through short inundated trail sections.

Figure 4.2 Proposed additional trails and enhancements

4.2. Creek Access

Safe and inviting access to Chartiers Creek is critical to improve communities' physical and psychological connections to the creek, to foster a sense of ownership, and to build support for conservation and access to these resources. Recreational boaters, for example, will more intimately experience the rapid decline in water quality as they pass AMD outflows. Increasing access therefore increases awareness, which could be pivotal to the long-term water quality of Chartiers Creek. Improved recreational access to Chartiers Creek is also identified as a primary element in both the LCCRCP and CCG plans. Creek access at WPCA is proposed via a canoe launch and overlook deck that will serve both active and passive recreationalists.

A canoe launch site already exists at WPCA, but in a muddied and unstable condition. It was seeded with turf grasses in the spring of 2005 (Kraynyk, pers. comm.), but has failed to establish a vigorous cover to stabilize the 27% slope (see Figure 4.3). Presently, a silt fence at the base of the slope is collecting sediment, but this is not an effective solution because the land-water interface is clearly unstable and prone to significant erosion during storm events.

A quiet and concealed creek overlook is planned for a southern site along Chartiers Creek (Figure 4.2). This is a particularly inviting site where visitors must walk a trail over the levee onto the only significant level riparian edge between the levee and the creek. This site is hidden, charming, and would be ideally suited to an overlook. This element could take multiple forms, but should be sensitive to its environment and should probably be constructed of recycled plastic due to the frequency with which it will be inundated. A precendent photograph of a built creek overlook is illustrated in Figure 4.4.

Figure 4.3 Existing eroded conditions at the WPCA canoe launch.

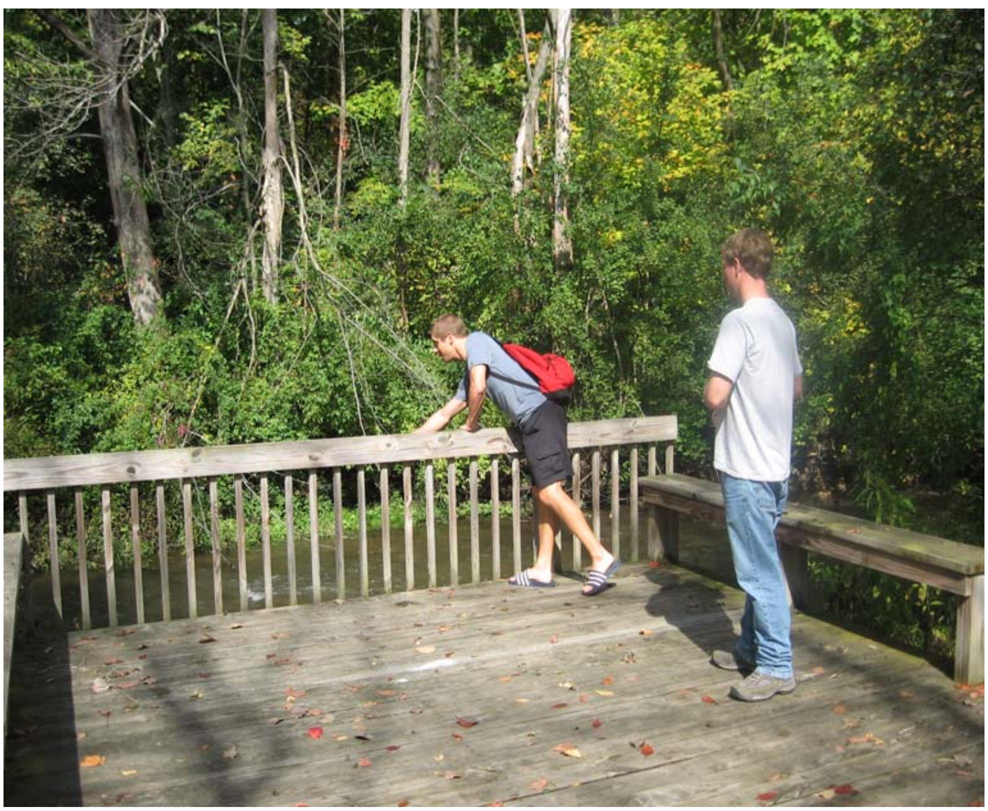

Figure 4.4. Creek Overlook from Forest Park, Ann Arbor, MI

We propose stabilizing the canoe launch slope with native rushes and sedges well-suited to the fluctuating wet and dry soil conditions, and stepping stones that will improve access to the water's edge. Plants should be densely plugged, especially around the stones (6"-8" approximate spacing) and the entire slope should be seeded and blanketed against erosion. At the slope's base we have designed a stone launch area extending approximately 6 feet into the water and constructed entirely of recycled materials on-site, which include concrete parking curbs and large flat stones. The large stones appear to have been part of the pool-side landscaping. To further stabilize the eroding bank's northern edge, a vegetated stone retaining wall is proposed, which consists of large natural stone and live willow stakes (*Salix sp*.) and adjacent dogwood (*Cornus amomum*) shrubs. Dense native shrub plantings will frame both edges of the canoe launch, provide wildlife habitat, and further stabilize the vulnerable soil conditions. See Appendix J.

4.3. Entry Drive Erosion

The entry drive into WPCA is being significantly degraded due to unmanaged stormwater from Mayview Road. Soil, rock, and water regularly wash across the road, which has caused fractures in the pavement surface and subsequent colonization with vegetation (See Figures 4.5).

Figure 4.5 Degraded entry drive. Stormwater from culverts at the top of the hill continue to erode the entry hardscape.

Responsible, non-erosive stormwater management will be very difficult to achieve on the slope above and below the entry drive. The concentrated flow midway down the drive should be conducted through a pipe beneath the entry drive and into a simple forebay at the bottom of the hill. Sheet flow of water down the slope above the road is an equally difficult challenge.

The best solution is probably to construct a swale along the uphill side of the entry drive, which would capture sediment and water before it can wash over the road. This could be approximately three feet wide (wider, if possible, would be preferable), should include periodic stone riffles to capture sediment, should incorporate as much soft-bottom planted area as possible, and must follow down the uphill edge of the pavement until it reaches the culvert at the bottom of the hill (Gray, pers. comm.). Two shrubs could be effectively used along this shady swale to help stabilize the surface, slow water, and capture sediment. These are chokecherry (*Prunus virginiana*) and ninebark (*Physocarpus opulifolius*), and they can be installed as available.

Construction of this magnitude would logically occur when resurfacing the entire entry drive. This will be a complex, costly, but necessary undertaking. A schematic detail provided in Appendix K illustrates one vision of how this swale could operate. Access for iron oxide recovery equiptment is one important justification for the improvements to the entry drive. As part of Hedin Environmental's treatment process, the settled iron oxide precipitate will be harvested from the bottoms of the settlement ponds when accumulation reaches 1-2 feet (Hedin, 2004).

The steep slopes at the southern end of the site are also severely eroded. As mentioned in Chapter 1, culverts release Mayview road runoff into deep eroded channels and when that runoff reaches the bottom of the hill, it contributes to the existing ponds and wetlands. Sediment loading from the road and the Boyce-Mayview Park to the ponds is a consequence of this circumstance; however, when the bare slopes and retention ponds of the park are stabilized, sediment in this water should greatly diminish.

Heavy black flexible pipes, such as those shown in Figure 4.6, can be fixed to the culverts at the top of the hill and carry the water safely down to the wetland without further exacerbating erosion along the length of this hill. Simple forebays should be constructed at the outflow of these pipes. This will reduce the impact of stormwater on habitat quality within the WPCA wetlands. Many consider such pipes rather unsightly; therefore, the use of shrubs for screening should be maximized.

Figure 4.6 Erosion prevention soluntion for southeastern slope. The black pipes allow for the concentrated discharge to be directed towards the bottom of the slope, preventing erosion. (photographs from School Girl's Glen, Ann Arbor, MI).

4.4. Seating at WPCA

The installation of rustic seating site-wide is a highly desireable site improvement. Primitive benches could be constructed out of logs on-site, out of raised flat stones, and other materials. The site currently boasts only one picnic bench, and additional seating would allow visitors places to relax. The most logical place for these enhancements is at the educational nodes; however, secluded seating in other places might be even more desirable. If local residents seek refuge from suburbia, quiet secluded seating would probably be well-used. Figure 4.7 and Figure 4.8 provide character examples of a recently-installed stone bench and a primitive wooden bench, respectively. Locations for seating at WPCA are shown in Figure 4.2.

Figure 4.7 Character example of a stone bench.

Figure 4.8 Character examples of wooden benches and tables.

4.5. Art at WPCA

It has been established that WPCA's history resonates with southwestern Pennsylvania's cultural and ecological narrative. The layers of history on-site can be communicated textually in signage or remedied with restoration plantings. However, the levity, complexity, and emotion of this story is not easily captured in words or newly sown seeds. It is suggested that art is incorporated into WPCA as a medium to encourage reflection and conversation about culture, ecology, and recovery on-site and throughout southwestern Pennsylvania. Artistic additions should compliment WPCA's natural setting and not detract from it. Character examples of sculpture are provided in Figure 4.9. The open lawn gathering area in the old pool area could provide a stage for rotating sculpture, or displays during on-site events like the annual "Bluegrass for Greenspace" fundraiser, or "Celebrate Chartiers Creek Day." The concrete pillars in the southernmost pond invite a sculptural reinvention (see Figure 4.10).

Figure 4.9 Character examples of Sculpture.

Figure 4.10 Concrete pillars in southernmost pond

5.0. Conclusion

We have herein supplied a vision for WPCA that oversteps the bounds of definition. Rehabilitation is a word frequently cited within these pages and it conveys a sense of healing. It also suggests a process of correction and guidance. WPCA is not, of course, guilty of error; it is a landscape wronged by its keepers. It is a landscape that has been stripped not only of its surface, but of its highest and best use – its biological diversity and its ecological services. Clearly, this is a subjective realm, and an industrialist or a golf enthusiast might disagree with that claim. We must, however, approach our goals and visions from the perspective of our acknowledged client, with whom we are lucky to share a common ethos. We are also lucky that ALT aims to serve the greater public good in its preservation of special lands. We can therefore confidently state that our vision of WPCA truly aims for its highest and best use, and rehabilitates on multiple levels.

The ecological services provided by WPCA are impossible to quantify, but if native species have intrinsic value – and we believe they do – our enhancements of native biodiversity vastly increase the value of the site. In this way, the deliberate and designed re-introduction of native communities facilitates healing. The management of invasive species – for the same long-term objective – is the correction and guidance that will keep the healing process moving forward. And the encouragement of natural ecosystem processes is the physical medicine, the buffer against contrary forces. The floodplain is in constant changing relations with Chartiers Creek; it accepts the excess of the creek, keeping it stable and protecting the web of life that depends on it. But the favor is returned; Chartiers Creek gives to the floodplain its fertility and hence, its biodiversity. If these relationships continue to heal WPCA and Chartiers Creek, rehabilitation should succeed.

But if WPCA is not to blame for its afflictions, mustn't we also rehabilitate its offenders? WPCA is a social landscape, beloved but also neglected, and correcting the behavior of the keepers might even be more important than the aforementioned ecological healing. We believe that our vision creates a new and profound relationship between the site and those who use it. On a broader scale, WPCA will become a force in a movement towards an environmentally conscientious society. It will teach its users to understand how their lives depend on local as well as global ecosystems, how their lifestyles and their choices can impact the services provided by those systems. The effects of this revelation will ripple outward, unseen and yet profound. We hope the site's natural wonders will also bring its users joy as they discover wilderness returning to their neighborhood.

So we rehabilitate this site and we rehabilitate those who use it. The past is our palette – from historical forests and from recent landforms, we inherited a landscape and from our client received an invitation to dream. And so we move beyond rehabilitation through the creative process and have chosen to call what we've done a *reinvention*. We have used color and texture and the exaggerated juxtaposition of living communities with constructed forms; we have employed its physical stories to shape a narrative landscape, revealing folly and beauty alike in a new composition, guided by reason, by our convictions, and ultimately by the faith that our invention is healthy, sustainable, and will be clearly understood by all as the highest and best use. Wingfield Pines is reborn as Wingfield Pines Conservation Area and we will return ourselves, as stewards, to dig small holes and plant them, to dirty our fingers for tomorrow.

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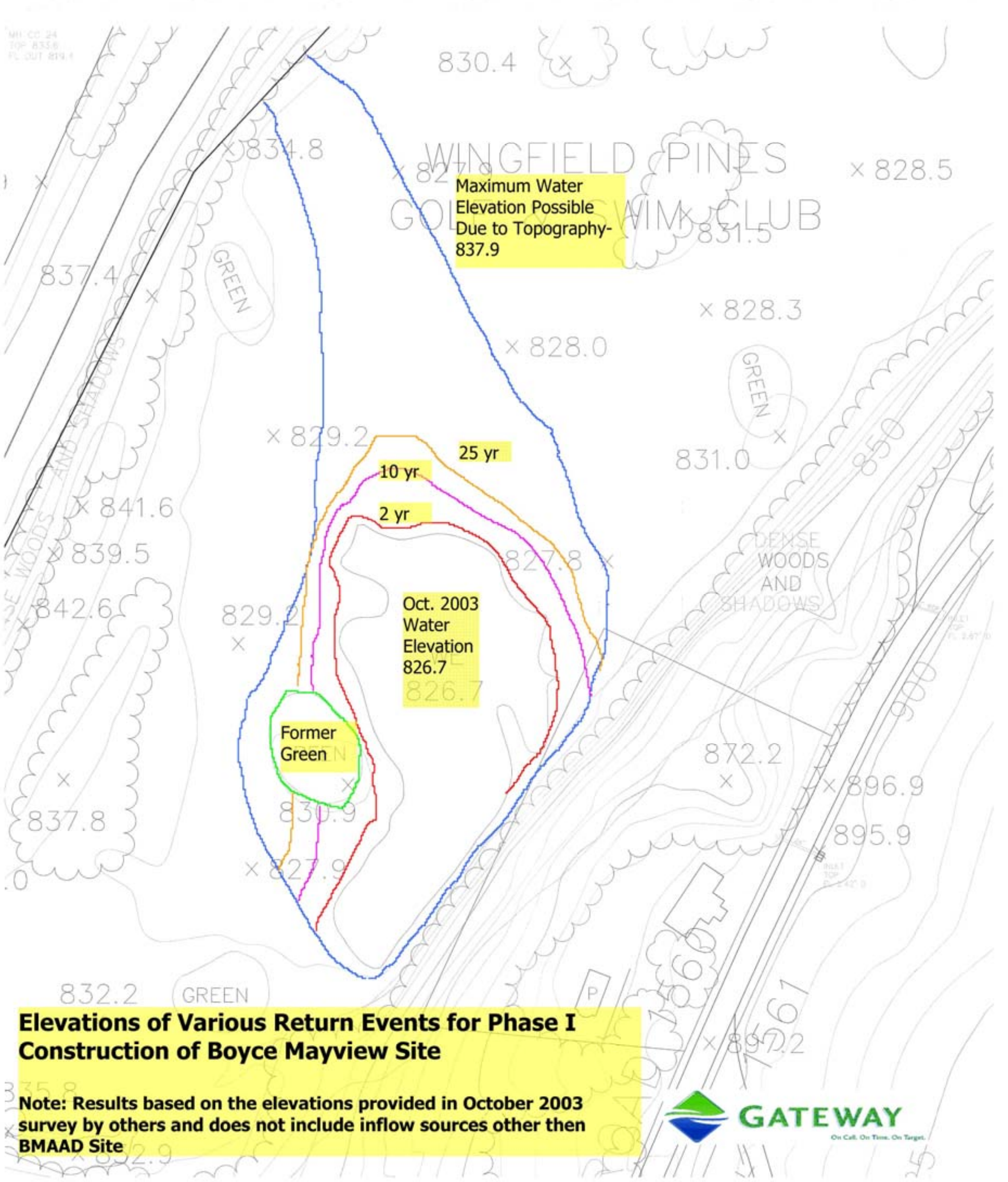
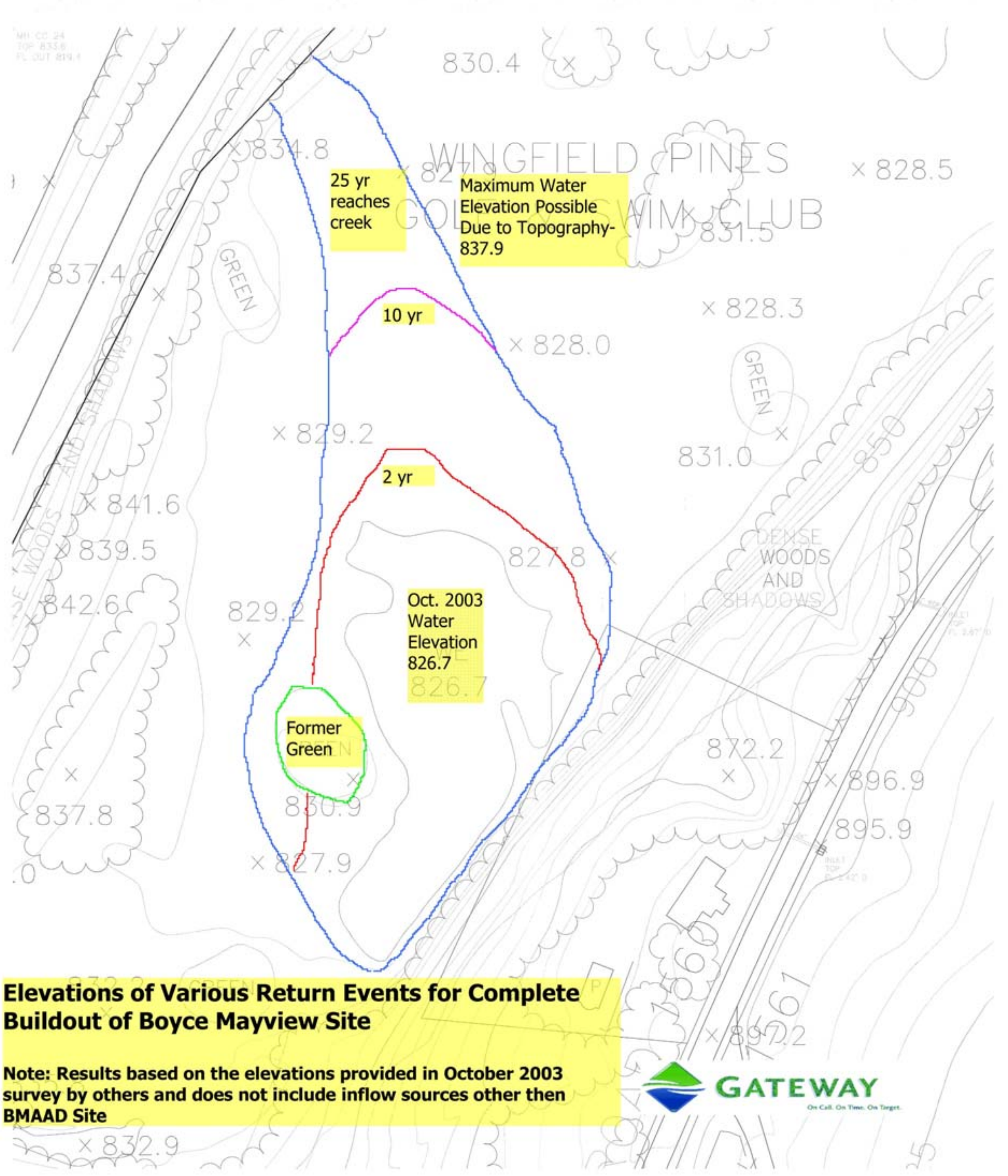
Appendix A. Projected expansion of WPCA's southernmost pond after completion of Phase I and Complete Buildout of Boyce-Mayview Park. Both diagrams show pond expansion following storm events of 2, 10, and 25 year average.




830.4
WINGFIELD PINES
GOLF & SWIM CLUB
× 828.5
× 834.8
25 yr
reaches
creek
Maximum Water
Elevation Possible
Due to Topography-
837.9
837.4
10 yr
× 828.3
× 828.0
× 829.2
2 yr
831.0
× 841.6
× 839.5
842.6
827.8
DENSE
WOODS
AND
SHADOWS
829.2
Oct. 2003
Water
Elevation
826.7
Former
Green
872.2
× 896.9
837.8
830.9
895.9
× 827.9
× 897.2
× 832.9
Elevations of Various Return Events for Complete
Buildout of Boyce Mayview Site
Note: Results based on the elevations provided in October 2003
survey by others and does not include inflow sources other then
BMAAD Site
GATEWAY

Appendix B. Comprehensive list of native woody plants of Allegheny County, Pennsylvania. Species listed are represented by greater than three herbarium records as compiled by Rhoads and Klein (1993).

Species	Common name	Family	Growth Form*	Habitat	Habitat Zone**
Acer rubrum	Red maple	Aceraceae	D.t.	Dry or moist woods, swamps, bogs	1
Acer saccharum	Sugar maple	Aceraceae	D.t.	Rich moist woods, alluvial areas	1
Acer nigrum	Black maple	Aceraceae	D.t.	Rich woods, ravines, river banks	3
Acer pensylvanicum	Striped maple	Aceraceae	D.t.	Moist rocky woods	3
Acer saccharinum	Silver Maple	Aceraceae	D.t.	Moist woods, stream banks, alluvium	3
Acer spicatum	Mountain maple	Aceraceae	D.s.	Moist rocky woods	3
Acer negundo	Box-elder	Aceraceae	D.t.	Low moist areas	1,2,3,4
Toxicodendron vernix	Poison sumac	Anacardiaceae	D.t.	Swamps, fens, marshes	1
Rhus copallina	Shining sumac	Anacardiaceae	D.s.	Woods, thickets, old fields	2,4
Rhus glabra	Smooth sumac	Anacardiaceae	D.s.	Fields, barrens, open slopes	2,4
Rhus typhina	Staghorn sumac	Anacardiaceae	D.s.	Dry open soil, fields, roadsides	2,4
Toxicodendron radicans	Poison Ivy	Anacardiaceae	W.v.	Open woods, roadside thickets	2,4
Asimina triloba	Pawpaw	Annonaceae	D.t.	Moist rich woodlands	1,3
Ilex verticillata	winterberry	Aquifoliaceae	D.s.	Swamps, bogs, moist woods	1
Aralia spinosa	Devil's-walking-stick	Araliaceae	D.t.	Moist woods, river banks, roadsides	1,3,4
Alnus serrulata	Smooth alder	Betulaceae	D.s.	Low wet woods, swamps	1
Ostrya virginiana	Hop-hornbeam	Betulaceae	D.t.	Dry wooded slopes	2
Corylus americana	Hazelnut	Betulaceae	D.s.	Rich woods, edges	1,2,3,4
Carpinus caroliniana	American hornbeam	Betulaceae	D.t.	Rich moist woods, stream edges	1,3,4
Betula lenta	Black birch	Betulaceae	D.t.	Woods and streambanks	1,4
Gleditsia triacanthos	Honey-locust	Caesalpiniaceae	D.t.	Wooded slopes, floodplains, river banks	2,4
Cercis canadensis	Redbud	Caesalpiniaceae (Fabaceae?)	D.t.	Woods, dry or moist	2,3
Sambucus racemosa	Red-berried elder	Caprifoliaceae	D.s.	Ravines, moist cliffs, rocky woods	3
Sambucus canadensis	American elder	Caprifoliaceae	D.s.	Woods, fields, stream banks, moist roadsides	1,4
Viburnum lentago	nannyberry	Caprifoliaceae	D.s.	Woods, swamps, roadsides	1,4

Species	Common name	Family	Growth Form*	Habitat	Habitat Zone**
Viburnum acerifolium	Maple-leafed viburnum	Caprifoliaceae	D.s.	Woods, thickets	2,3
Viburnum prunifolium	Black-haw	Caprifoliaceae	D.s.	Woods, old fields, thickets	2,3,4
Celastrus scandens	American bittersweet	Celastraceae	W.v.	Dry fields, woods, thickets	4
Euonymous atropurpureus	Burning-bush	Celastraceae	D.s.	Wooded slopes, floodplain thickets	3,4
Hypericum prolificum	Shrubby St.-John's-wort	Clusiaceae	D.s.	Low fields, swamps, thickets	1,4
Cornus florida	Flowering dogwood	Cornaceae	D.t.	Rich moist woods, wood edges	3
Cornus alternifolia	Alternate-leafed dogwood	Cornaceae	D.s.	Low moist woods	1,3,4
Cornus amomum	Silky dogwood	Cornaceae	D.s.	Moist woods, meadows, old fields, swamps	1,4
Cornus racemosa	Swamp dogwood	Cornaceae	D.s.	Swampy meadows, wet woods	1,4
Juniperus virginiana	E. red cedar	Cupressaceae	E.t.	Moist-dry sterile soils	2
Diospyros virginiana	Persimmon	Ebenaceae	D.t.	Woods edges, floodplains, old fields	1,2,3,4
Vaccinium angustifolium	Low sweet blueberry	Ericaceae	D.s.	Dry open woods, barrens	2
Vaccinium pallidum	Lowbush blueberry	Ericaceae	D.s.	Dry acidic woods	2
Vaccinium stamineum	Deerberry	Ericaceae	D.s.	Dry open woods slopes	2
Rhododendron maximum	Rosebay	Ericaceae	E.s.	Moist woods, swamps, ravines	3
Rhododendron periclymenoides	Pinxter-flower	Ericaceae	E.s.	Dry, moist woods, acidic	3
Vaccinium corymbosum	Highbush blueberry	Ericaceae	D.s.	Moist woods, bogs, swamps	1,4
Epigeae repens	Trailing Arbutus	Ericaceae	E.s.s.	Dry, moist woods, edges	2,3
Gaultheria procumbens	Wintergreen	Ericaceae	E.s.s.	Dry, moist acidic woods	2,3
Gaylussacia baccata	Black huckleberry	Ericaceae	D.s.	Dry, moist acidic woods, bogs	2,3
Kalmia latifolia	Mountain laurel	Ericaceae	E.s.	Dry, moist acidic woods, slopes	2,3
Amorpha fruticosa	False-indigo	Fabaceae	D.s.	Alluvial soils along streams, other low wet areas	1,3,4
Quercus bicolor	Swamp white oak	Fagaceae	D.t.	Low swampy woods	1
Quercus coccinea	Scarlet oak	Fagaceae	D.t.	Dry uplands, poor soils	2
Quercus ilicifolia	Bear oak	Fagaceae	D.s.	Dry sandy barrens	2
Quercus prinoides	Dwarf Chinkapin Oak	Fagaceae	D.s.	Dry slopes, ridge tops	2
Quercus velutina	Black oak	Fagaceae	D.t.	Moist or dry	2

Species	Common name	Family	Growth Form*	Habitat	Habitat Zone**
Quercus prinus	Chestnut oak	Fagaceae	D.t.	Dry slopes	2
Fagus grandifolia	American beech	Fagaceae	D.t.	Moist rich soils, dominant	3
Quercus imbricaria	Shingle oak	Fagaceae	D.t.	Moist rich bottomlands	3
Quercus palustris	Pin oak	Fagaceae	D.t.	Low wet woods, swamps	1,2
Quercus marcrocarpa	Bur oak	Fagaceae	D.t.	Dry, moist forests	1,2,3
Quercus alba	White oak	Fagaceae	D.t.	Dry, moist woods	2,3
Quercus muhlenbergii	Chinkapin Oak	Fagaceae	D.t.	Wooded slopes	2,3
Quercus rubra	N. red oak	Fagaceae	D.t.	Moist or dry, dominant	2,3
Ribes americanum	Wild black currant	Grossulariaceae	D.s.	Moist woods, swamps, thickets	1,4
Ribes cynosbati	Prickly gooseberry	Grossulariaceae	D.s.	Thin, moist woods	1,4
Hamamelis virginiana	Witch-hazel	Hamamelidaceae	D.s.	Rich, rocky woods	3,2
Aesculus flava	Yellow buckeye	Hippocastanaceae	D.t.	Low woods along streams	1
Aesculus glabra	Ohio buckeye	Hippocastanaceae	D.t.	Moist woods, bottomlands	1,3
Hydrangea arborescens	Wild hydrangea	Hydrangeaceae	D.s.	Rich woods, slopes, streambanks	3
Carya glabra	Pignut hickory	Juglandaceae	D.t.	Upland woods	2
Carya tomentosa	Mockernut hickory	Juglandaceae	D.t.	Moist open woods, slopes	2
Juglans cinerea	Butternut	Juglandaceae	D.t.	Lowland woods, rich hillsides	3
Carya ovata	Shagbark Hickory	Juglandaceae	D.t.	Low moist woods and slopes	1,2
Carya cordiformis	Bitternut hickory	Juglandaceae	D.t.	Moist woods and streambanks	1,2,3
Juglans nigra	Black walnut	Juglandaceae	D.t.	Open woods, meadows in moist alluvial soils	2,3
Lindera benzoin	spicebush	Lauraceae	D.s.	Common in moist rich woods	3
Sassafras albidum	sassafras	Lauraceae	D.t.	Wood edges, old fields	4
Liriodendron tulipifera	tuliptree	Magnoliaceae	D.t.	Common in rich woods	3
Magnolia acuminata	Cucumber tree	Magnoliaceae	D.t.	Rich upland woods and slopes	3
Morus rubra	Red mulberry	Moraceae	D.t.	Rich moist floodplains and slopes	1,3
Nyssa sylvatica	Black-gum	Nyssaceae	D.t.	Dry or moist woods, slopes, ridge tops	1,3
Fraxinus americana	White ash	Oleaceae	D.t.	Rich wooded slopes, fields, river banks	1,3
Fraxinus nigra	Black ash	Oleaceae	D.t.	Swamps, wet woods, bottomlands	1,3
Fraxinus pennsylvanica	Red ash	Oleaceae	D.t.	Alluvial woods, stream banks, moist fields	1,3

Species	Common name	Family	Growth Form*	Habitat	Habitat Zone**
Tsuga canadensis	Canada hemlock	Pinaceae	E.t.	Moist cool woods	3
Platanus occidentalis	sycamore	Platanaceae	D.t.	Floodplains, streambanks	1
Ceanothus americanus	New Jersey Tea	Rhamnacee	D.s.	Wooded bluffs, roadside banks, slopes	4
Malus coronaria	American crabapple	Rosaceae	D.t.	Woods, old fields	4
Aronia melanocarpa	Black chokeberry	Rosaceae	D.s.	Swamps, bogs, wet or dry woods	1,2,3,4
Physocarpus opulifolius	Ninebark	Rosaceae	D.s.	Moist, wet woods, cliffs, shores	1,3,4
Amelanchier intermedia	Serviceberry	Rosaceae	D.s.	Wet woods, swamps, bogs, river banks	1,4
Aronia arbutifolia	Red chokeberry	Rosaceae	D.s.	Swamps, bogs, moist woods	1,4
Rosa palustris	Swamp rose	Rosaceae	D.s.	Swamps, marshes	1,4
Spiraea alba	Meadow-sweet	Rosaceae	D.s.	Bogs, moist peaty meadows	1,4
Spiraea tomentosa	Hardhack	Rosaceae	D.s.	Wet meadows, old fields, swamps, bogs	1,4
Amelanchier arborea	Serviceberry	Rosaceae	D.t.	Rocky bluffs, upper slopes	2,3
Prunus serotina	Black cherry	Rosaceae	D.t.	Woods	2,3
Prunus virginiana	chokecherry	Rosaceae	D.s.	Upland woods	2,3,4
Crataegus sp.	Hawthorn	Rosaceae	D.t.	Open fields	2,4
Prunus americana	Wild plum	Rosaceae	D.s.	Wooded slopes, riverbanks, thickets	2,4
Rosa carolina	Pasture rose	Rosaceae	D.s.	Fields, dry open ground	2,4
Rubus allegheniensis	Common blackberry	Rosaceae	D.s.	Old fields, open woods	2,4
Waldsteinia fragarioides	Barren-strawberry	Rosaceae	H.p.	Moist rich woods, pastures	3,4
Cephalanthus occidentalis	Buttonbush	Rubiaceae	D.s.	Low wet ground, swamps, bogs, lake edges	1
Zanthoxylum americanum	N. prickly-ash	Rutaceae	D.s.	Stream banks, river bluffs, roadside thickets	1,4
Populus deltoides	Cottonwood	Salicaceae	D.t.	River banks, rich alluvial soils	1
Salix eriocephala	Heart-leaved willow	Salicaceae	D.s.	Shores, bottomlands	1
Salix nigra	Black willow	Salicaceae	D.t.	Swamps, wet meadows	1
Salix humilis	Upland willow	Salicaceae	D.s.	Dry, moist thickets, barrens	2
Populus grandidentata	Big-toothed aspen	Salicaceae	D.t.	Woods, floodplains	1,3
Salix bebbiana	Long-beaked willow	Salicaceae	D.s.	Moist or dry thickets, edges	1,4
Salix caroliniana	Carolina willow	Salicaceae	D.t.	River banks, shores	1,4
Salix discolor	Pussy willow	Salicaceae	D.s.	Swamps, wet woods	1,4
Salix exigua	Sandbar willow	Salicaceae	D.s.	Alluvial bars and shores	1,4

Species	Common name	Family	Growth Form*	Habitat	Habitat Zone**
Salix sericea	Silky willow	Salicaceae	D.s.	Swamps, bogs, stream banks, wet woods	1,4
Populus tremuloides	Trembling aspen	Salicaceae	D.t.	Old fields, open woods, sand	2,4
Staphylea trifolia	Bladdernut	Staphyleaceae	D.s.	Moist rocky woods, stream banks	1,4
Tilia americana	American linden	Tiliaceae	D.t.	Rich woods	1,3
Ulmus americana	American elm	Ulmaceae	D.t.	Streambanks, floodplains	1
Ulmus rubra	Red elm	Ulmaceae	D.t.	Streambanks, floodplains	1
Celtis occidentalis	Hackberry	Ulmaceae	D.t.	Dry or moist woods	3
Vitis aestivalis	Summer grape	Vitaceae	W.v.	Upland woods, wooded slopes	2
Vitis labrusca	Fox grape	Vitaceae	W.v.	Rocky woods, moist thickets, stream banks	1,4
Vitis riparia	Frost grape	Vitaceae	W.v.	River banks, alluvial thickets	1,4
Vitis vulpina	Frost grape	Vitaceae	W.v.	Woods, thickets, roadsides, sand dunes	1,4
Parthenocissus quinquifolia	Virginia creeper	Vitaceae	W.v.	Woods, fields, edges	2,3,4

* Growth forms: D.t. = Deciduous tree; D.s. = Deciduous shrub; E.t. = Evergreen tree; E.s. = Evergreen shrub; E.s.s. = Evergreen sub-shrub; W.v. = Woody vine

** Habitat zones are: 1 = Floodplain forest; 2 = Upland oak / hickory forest; 3 = Mesic forest; 4 = Woodland edge, thicket, or scattered meadow

Appendix C. Species list for Upland (Appalachain Oak) habitat zone. As selected from the comprehensive list of native woody plants of Allegheny County, Pennsylvania represented by greater than three herbarium records as compiled by Rhoads and Klein (1993).

Species	Common Name	Family	Growth Form	Habit	Habit Zone
Acer negundo	Box-elder	Aceraceae	D.t.	Low moist areas	1,2,3,4
Rhus copallina	Shining sumac	Anacardiaceae	D.s.	Woods, thickets, old fields	2,4
Rhus glabra	Smooth sumac	Anacardiaceae	D.s.	Fields, barrens, open slopes	2,4
Rhus typhina	Staghorn sumac	Anacardiaceae	D.s.	Dry open soil, fields, roadsides	2,4
Toxicodendron radicans	Poison Ivy	Anacardiaceae	W.v.	Open woods, roadside thickets	2,4
Ostrya virginiana	Hop-hornbeam	Betulaceae	D.t.	Dry wooded slopes	2
Corylus americana	Hazelnut	Betulaceae	D.s.	Rich woods, edges	1,2,3,4
Gleditsia triacanthos	Honey-locust	Caesalpiniaceae	D.t.	Wooded slopes, floodplains, river banks	2,4
Viburnum acerifolium	Maple-leafed viburnum	Caprifoliaceae	D.s.	Woods, thickets	2,3
Viburnum prunifolium	Black-haw	Caprifoliaceae	D.s.	Woods, old fields, thickets	2,3,4
Juniperus virginiana	E. red cedar	Cupressaceae	E.t.	Moist-dry sterile soils	2
Diospyros virginiana	Persimmon	Ebenaceae	D.t.	Woods edges, floodplains, old fields	1,2,3,4
Vaccinium angustifolium	Low sweet blueberry	Ericaceae	D.s.	Dry open woods, barrens	2
Vaccinium pallidum	Lowbush blueberry	Ericaceae	D.s.	Dry acidic woods	2
Vaccinium stamineum	Deerberry	Ericaceae	D.s.	Dry open woods slopes	2
Epigeae repens	Trailing Arbutus	Ericaceae	E.s.s.	Dry, moist woods, edges	2,3
Gaultheria procumbens	Wintergreen	Ericaceae	E.s.s.	Dry, moist acidic woods	2,3
Gaylussacia baccata	Black huckleberry	Ericaceae	D.s.	Dry, moist acidic woods, bogs	2,3
Kalmia latifolia	Mountain laurel	Ericaceae	E.s.	Dry, moist acidic woods, slopes	2,3

Species	Common Name	Family	Growth Form	Habit	Habit Zone
Cercis canadensis	Redbud	Fabaceae	D.t.	Woods, dry or moist	2,3
Quercus coccinea	Scarlet oak	Fagaceae	D.t.	Dry uplands, poor soils	2
Quercus ilicifolia	Bear oak	Fagaceae	D.s.	Dry sandy barrens	2
Quercus prinoides	Dwarf Chinkapin Oak	Fagaceae	D.s.	Dry slopes, ridge tops	2
Quercus velutina	Black oak	Fagaceae	D.t.	Moist or dry	2
Quercus prinus	Chestnut oak	Fagaceae	D.t.	Dry slopes	2
Quercus palustris	Pin oak	Fagaceae	D.t.	Low wet woods, swamps	1,2
Quercus marcrocarpa	Bur oak	Fagaceae	D.t.	Dry, moist forests	1,2,3
Quercus alba	White oak	Fagaceae	D.t.	Dry, moist woods	2,3
Quercus muhlenbergii	Chinkapin Oak	Fagaceae	D.t.	Wooded slopes	2,3
Quercus rubra	N. red oak	Fagaceae	D.t.	Moist or dry, dominant	2,3
Hamamelis virginiana	Witch-hazel	Hamamelidaceae	D.s.	Rich, rocky woods	3,2
Carya glabra	Pignut hickory	Juglandaceae	D.t.	Upland woods	2
Carya tomentosa	Mockernut hickory	Juglandaceae	D.t.	Moist open woods, slopes	2
Carya ovata	Shagbark Hickory	Juglandaceae	D.t.	Low moist woods and slopes	1,2
Carya cordiformis	Bitternut hickory	Juglandaceae	D.t.	Moist woods and streambanks	1,2,3
Juglans nigra	Black walnut	Juglandaceae	D.t.	Open woods, meadows in moist alluvial soils	2,3
Aronia melanocarpa	Black chokeberry	Rosaceae	D.s.	Swamps, bogs, wet or dry woods	1,2,3,4
Amelanchier arborea	Serviceberry	Rosaceae	D.t.	Rocky bluffs, upper slopes	2,3
Prunus serotina	Black cherry	Rosaceae	D.t.	Woods	2,3
Prunus virginiana	chokecherry	Rosaceae	D.s.	Upland woods	2,3,4
Crataegus sp.	Hawthorn	Rosaceae	D.t.	Open fields	2,4
Prunus americana	Wild plum	Rosaceae	D.s.	Wooded slopes, riverbanks, thickets	2,4
Rosa carolina	Pasture rose	Rosaceae	D.s.	Fields, dry open ground	2,4
Rubus allegheniensis	Common blackberry	Rosaceae	D.s.	Old fields, open woods	2,4

Species	Common Name	Family	Growth Form	Habit	Habit Zone
Salix humilis	Upland willow	Salicaceae	D.s.	Dry, moist thickets, barrens	2
Populus tremuloides	Trembling aspen	Salicaceae	D.t.	Old fields, open woods, sand	2,4
Vitis aestivalis	Summer grape	Vitaceae	W.v.	Upland woods, wooded slopes	2
Parthenocissus quinquifolia	Virginia creeper	Vitaceae	W.v.	Woods, fields, edges	2,3,4

* Growth forms: D.t. = Deciduous tree; D.s. = Deciduous shrub; E.t. = Evergreen tree; E.s. = Evergreen shrub; E.s.s. = Evergreen sub-shrub; W.v. = Woody vine

Appendix D. Species list for Floodplain Forest habitat zone. As selected from the comprehensive list of native woody plants of Allegheny County, Pennsylvania represented by greater than three herbarium records as compiled by Rhoads and Klein (1993).

Species	**Common Name**	**Family**	**Growth Form**	**Habit**	**Habit Zone**
Acer rubrum	Red maple	Aceraceae	D.t.	Dry or moist woods, swamps, bogs	1
Acer pensylvanicum	Striped maple	Aceraceae	D.t.	Moist rocky woods	3
Acer negundo	Box-elder	Aceraceae	D.t.	Low moist areas	1,2,3,4
Toxicodendron vernix	Poison sumac	Anacardiaceae	D.t.	Swamps, fens, marshes	1
Asimina triloba	Pawpaw	Annonaceae	D.t.	Moist rich woodlands	1,3
Ilex verticillata	winterberry	Aquifoliaceae	D.s.	Swamps, bogs, moist woods	1
Aralia spinosa	Devil's-walking-stick	Araliaceae	D.t.	Moist woods, river banks, roadsides	1,3,4
Alnus serrulata	Smooth alder	Betulaceae	D.s.	Low wet woods, swamps	1
Corylus americana	Hazelnut	Betulaceae	D.s.	Rich woods, edges	1,2,3,4
Carpinus caroliniana	American hornbeam	Betulaceae	D.t.	Rich moist woods, stream edges	1,3,4
Betula lenta	Black birch	Betulaceae	D.t.	Woods and streambanks	1,4
Sambucus canadensis	American elder	Caprifoliaceae	D.s.	Woods, fields, stream banks, moist roadsides	1,4
Viburnum lentago	nannyberry	Caprifoliaceae	D.s.	Woods, swamps, roadsides	1,4
Hypericum prolificum	Shrubby St.-John's-wort	Clusiaceae	D.s.	Low fields, swamps, thickets	1,4
Cornus alternifolia	Alternate-leafed dogwood	Cornaceae	D.s.	Low moist woods	1,3,4
Cornus amomum	Silky dogwood	Cornaceae	D.s.	Moist woods, meadows, old fields, swamps	1,4
Cornus racemosa	Swamp dogwood	Cornaceae	D.s.	Swampy meadows, wet woods	1,4
Diospyros virginiana	Persimmon	Ebenaceae	D.t.	Woods edges, floodplains, old fields	1,2,3,4
Vaccinium corymbosum	Highbush blueberry	Ericaceae	D.s.	Moist woods, bogs, swamps	1,4

Species	Common Name	Family	Growth Form	Habit	Habit Zone
Amorpha fruticosa	False-indigo	Fabaceae	D.s.	Alluvial soils along streams, other low wet areas	1,3,4
Quercus bicolor	Swamp white oak	Fagaceae	D.t.	Low swampy woods	1
Quercus palustris	Pin oak	Fagaceae	D.t.	Low wet woods, swamps	1,2
Quercus marcrocarpa	Bur oak	Fagaceae	D.t.	Dry, moist forests	1,2,3
Ribes americanum	Wild black currant	Grossulariaceae	D.s.	Moist woods, swamps, thickets	1,4
Ribes cynosbati	Prickly gooseberry	Grossulariaceae	D.s.	Thin, moist woods	1,4
Aesculus flava	Yellow buckeye	Hippocastanaceae	D.t.	Low woods along streams	1
Aesculus glabra	Ohio buckeye	Hippocastanaceae	D.t.	Moist woods, bottomlands	1,3
Carya ovata	Shagbark Hickory	Juglandaceae	D.t.	Low moist woods and slopes	1,2
Carya cordiformis	Bitternut hickory	Juglandaceae	D.t.	Moist woods and streambanks	1,2,3
Morus rubra	Red mulberry	Moraceae	D.t.	Rich moist floodplains and slopes	1,3
Nyssa sylvatica	Black-gum	Nyssaceae	D.t.	Dry or moist woods, slopes, ridge tops	1,3
Fraxinus americana	White ash	Oleaceae	D.t.	Rich wooded slopes, fields, river banks	1,3
Fraxinus nigra	Black ash	Oleaceae	D.t.	Swamps, wet woods, bottomlands	1,3
Fraxinus pennsylvanica	Red ash	Oleaceae	D.t.	Alluvial woods, stream banks, moist fields	1,3
Platanus occidentalis	sycamore	Platanaceae	D.t.	Floodplains, streambanks	1
Aronia melanocarpa	Black chokeberry	Rosaceae	D.s.	Swamps, bogs, wet or dry woods	1,2,3,4
Physocarpus opulifolius	Ninebark	Rosaceae	D.s.	Moist, wet woods, cliffs, shores	1,3,4
Amelanchier intermedia	Serviceberry	Rosaceae	D.s.	Wet woods, swamps, bogs, river banks	1,4
Aronia arbutifolia	Red chokeberry	Rosaceae	D.s.	Swamps, bogs, moist woods	1,4
Rosa palustris	Swamp rose	Rosaceae	D.s.	Swamps, marshes	1,4

Species	Common Name	Family	Growth Form	Habit	Habit Zone
Spiraea alba	Meadow-sweet	Rosaceae	D.s.	Bogs, moist peaty meadows	1,4
Spiraea tomentosa	Hardhack	Rosaceae	D.s.	Wet meadows, old fields, swamps, bogs	1,4
Cephalanthus occidentalis	Buttonbush	Rubiaceae	D.s.	Low wet ground, swamps, bogs, lake edges	1
Zanthoxylum americanum	N. prickly-ash	Rutaceae	D.s.	Stream banks, river bluffs, roadside thickets	1,4
Populus deltoides	Cottonwood	Salicaceae	D.t.	River banks, rich alluvial soils	1
Salix eriocephala	Heart-leaved willow	Salicaceae	D.s.	Shores, bottomlands	1
Salix nigra	Black willow	Salicaceae	D.t.	Swamps, wet meadows	1
Populus grandidentata	Big-toothed aspen	Salicaceae	D.t.	Woods, floodplains	1,3
Salix bebbiana	Long-beaked willow	Salicaceae	D.s.	Moist or dry thickets, edges	1,4
Salix caroliniana	Carolina willow	Salicaceae	D.t.	River banks, shores	1,4
Salix discolor	Pussy willow	Salicaceae	D.s.	Swamps, wet woods	1,4
Salix exigua	Sandbar willow	Salicaceae	D.s.	Alluvial bars and shores	1,4
Salix sericea	Silky willow	Salicaceae	D.s.	Swamps, bogs, stream banks, wet woods	1,4
Staphylea trifolia	Bladdernut	Staphyleaceae	D.s.	Moist rocky woods, stream banks	1,4
Tilia americana	American linden	Tiliaceae	D.t.	Rich woods	1,3
Ulmus americana	American elm	Ulmaceae	D.t.	Streambanks, floodplains	1
Ulmus rubra	Red elm	Ulmaceae	D.t.	Streambanks, floodplains	1
Vitis labrusca	Fox grape	Vitaceae	W.v.	Rocky woods, moist thickets, stream banks	1,4
Vitis riparia	Frost grape	Vitaceae	W.v.	River banks, alluvial thickets	1,4
Vitis vulpina	Frost grape	Vitaceae	W.v.	Woods, thickets, roadsides, sand dunes	1,4

* Growth forms: D.t. = Deciduous tree; D.s. = Deciduous shrub; E.t. = Evergreen tree; E.s. = Evergreen shrub; E.s.s. = Evergreen sub-shrub; W.v. = Woody vine

Appendix E. Species list for Mesic habitat zone. As selected from the comprehensive list of native woody plants of Allegheny County, Pennsylvania represented by greater than three herbarium records as compiled by Rhoads and Klein (1993).

Species	Common Name	Family	Growth Form	Habit	Habit Zone
Acer nigrum	Black maple	Aceraceae	D.t.	Rich woods, ravines, river banks	3
Acer saccharum	Sugar maple	Aceraceae	D.t.	Rich moist woods, alluvial areas	1
Acer saccharinum	Silver Maple	Aceraceae	D.t.	Moist woods, stream banks, alluvium	3
Acer spicatum	Mountain maple	Aceraceae	D.s.	Moist rocky woods	3
Acer negundo	Box-elder	Aceraceae	D.t.	Low moist areas	1,2,3,4
Asimina triloba	Pawpaw	Annonaceae	D.t.	Moist rich woodlands	1,3
Aralia spinosa	Devil's-walking-stick	Araliaceae	D.t.	Moist woods, river banks, roadsides	1,3,4
Corylus americana	Hazelnut	Betulaceae	D.s.	Rich woods, edges	1,2,3,4
Carpinus caroliniana	American hornbeam	Betulaceae	D.t.	Rich moist woods, stream edges	1,3,4
Sambucus racemosa	Red-berried elder	Caprifoliaceae	D.s.	Ravines, moist cliffs, rocky woods	3
Viburnum acerifolium	Maple-leafed viburnum	Caprifoliaceae	D.s.	Woods, thickets	2,3
Viburnum prunifolium	Black-haw	Caprifoliaceae	D.s.	Woods, old fields, thickets	2,3,4
Euonymous atropurpureus	Burning-bush	Celastraceae	D.s.	Wooded slopes, floodplain thickets	3,4
Cornus florida	Flowering dogwood	Cornaceae	D.t.	Rich moist woods, wood edges	3
Cornus alternifolia	Alternate-leafed dogwood	Cornaceae	D.s.	Low moist woods	1,3,4
Diospyros virginiana	Persimmon	Ebenaceae	D.t.	Woods edges, floodplains, old fields	1,2,3,4
Rhododendron maximum	Rosebay	Ericaceae	E.s.	Moist woods, swamps, ravines	3
Rhododendron periclymenoides	Pinxter-flower	Ericaceae	E.s.	Dry, moist woods, acidic	3
Epigeae repens	Trailing Arbutus	Ericaceae	E.s.s.	Dry, moist woods, edges	2,3
Gaultheria procumbens	Wintergreen	Ericaceae	E.s.s.	Dry, moist acidic woods	2,3

Species	Common Name	Family	Growth Form	Habit	Habit Zone
Gaylussacia baccata	Black huckleberry	Ericaceae	D.s.	Dry, moist acidic woods, bogs	2,3
Kalmia latifolia	Mountain laurel	Ericaceae	E.s.	Dry, moist acidic woods, slopes	2,3
Cercis canadensis	Redbud	Fabaceae	D.t.	Woods, dry or moist	2,3
Amorpha fruticosa	False-indigo	Fabaceae	D.s.	Alluvial soils along streams, other low wet areas	1,3,4
Fagus grandifolia	American beech	Fagaceae	D.t.	Moist rich soils, dominant	3
Quercus imbricaria	Shingle oak	Fagaceae	D.t.	Moist rich bottomlands	3
Quercus marcrocarpa	Bur oak	Fagaceae	D.t.	Dry, moist forests	1,2,3
Quercus alba	White oak	Fagaceae	D.t.	Dry, moist woods	2,3
Quercus muhlenbergii	Chinkapin Oak	Fagaceae	D.t.	Wooded slopes	2,3
Quercus rubra	N. red oak	Fagaceae	D.t.	Moist or dry, dominant	2,3
Hamamelis virginiana	Witch-hazel	Hamamelidaceae	D.s.	Rich, rocky woods	3,2
Aesculus glabra	Ohio buckeye	Hippocastanaceae	D.t.	Moist woods, bottomlands	1,3
Hydrangea arborescens	Wild hydrangea	Hydrangeaceae	D.s.	Rich woods, slopes, streambanks	3
Juglans cinerea	Butternut	Juglandaceae	D.t.	Lowland woods, rich hillsides	3
Carya cordiformis	Bitternut hickory	Juglandaceae	D.t.	Moist woods and streambanks	1,2,3
Juglans nigra	Black walnut	Juglandaceae	D.t.	Open woods, meadows in moist alluvial soils	2,3
Lindera benzoin	spicebush	Lauraceae	D.s.	Common in moist rich woods	3
Liriodendron tulipifera	tuliptree	Magnoliaceae	D.t.	Common in rich woods	3
Magnolia acuminata	Cucumber tree	Magnoliaceae	D.t.	Rich upland woods and slopes	3
Morus rubra	Red mulberry	Moraceae	D.t.	Rich moist floodplains and slopes	1,3

Species	Common Name	Family	Growth Form	Habit	Habit Zone
Nyssa sylvatica	Black-gum	Nyssaceae	D.t.	Dry or moist woods, slopes, ridge tops	1,3
Fraxinus americana	White ash	Oleaceae	D.t.	Rich wooded slopes, fields, river banks	1,3
Fraxinus nigra	Black ash	Oleaceae	D.t.	Swamps, wet woods, bottomlands	1,3
Fraxinus pennsylvanica	Red ash	Oleaceae	D.t.	Alluvial woods, stream banks, moist fields	1,3
Tsuga canadensis	Canada hemlock	Pinaceae	E.t.	Moist cool woods	3
Aronia melanocarpa	Black chokeberry	Rosaceae	D.s.	Swamps, bogs, wet or dry woods	1,2,3,4
Physocarpus opulifolius	Ninebark	Rosaceae	D.s.	Moist, wet woods, cliffs, shores	1,3,4
Amelanchier arborea	Serviceberry	Rosaceae	D.t.	Rocky bluffs, upper slopes	2,3
Prunus serotina	Black cherry	Rosaceae	D.t.	Woods	2,3
Prunus virginiana	chokecherry	Rosaceae	D.s.	Upland woods	2,3,4
Waldsteinia fragarioides	Barren-strawberry	Rosaceae	H.p.	Moist rich woods, pastures	3,4
Populus grandidentata	Big-toothed aspen	Salicaceae	D.t.	Woods, floodplains	1,3
Tilia americana	American linden	Tiliaceae	D.t.	Rich woods	1,3
Celtis occidentalis	Hackberry	Ulmaceae	D.t.	Dry or moist woods	3
Parthenocissus quinquifolia	Virginia creeper	Vitaceae	W.v.	Woods, fields, edges	2,3,4

* Growth forms: D.t. = Deciduous tree; D.s. = Deciduous shrub; E.t. = Evergreen tree; E.s. = Evergreen shrub; E.s.s. = Evergreen sub-shrub; H.p. = Herbaceous perennial; W.v. = Woody vine

Appendix F. Species list for Edge/Meadow habitat zones. As selected from the comprehensive list of native woody plants of Allegheny County, Pennsylvania represented by greater than three herbarium records as compiled by Rhoads and Klein (1993).

Species	Common Name	Family	Growth Form	Habit
Acer negundo	Box-elder	Aceraceae	D.t.	Low moist areas
Rhus copallina	Shining sumac	Anacardiaceae	D.s.	Woods, thickets, old fields
Rhus glabra	Smooth sumac	Anacardiaceae	D.s.	Fields, barrens, open slopes
Rhus typhina	Staghorn sumac	Anacardiaceae	D.s.	Dry open soil, fields, roadsides
Toxicodendron radicans	Poison Ivy	Anacardiaceae	W.v.	Open woods, roadside thickets
Aralia spinosa	Devil's-walking-stick	Araliaceae	D.t.	Moist woods, river banks, roadsides
Betula lenta	Black birch	Betulaceae	D.t.	Woods and streambanks
Carpinus caroliniana	American hornbeam	Betulaceae	D.t.	Rich moist woods, stream edges
Corylus americana	Hazelnut	Betulaceae	D.s.	Rich woods, edges
Sambucus canadensis	American elder	Caprifoliaceae	D.s.	Woods, fields, stream banks, moist roadsides
Viburnum lentago	nannyberry	Caprifoliaceae	D.s.	Woods, swamps, roadsides
Viburnum prunifolium	Black-haw	Caprifoliaceae	D.s.	Woods, old fields, thickets
Celastrus scandens	American bittersweet	Celastraceae	W.v.	Dry fields, woods, thickets
Euonymous atropurpureus	Burning-bush	Celastraceae	D.s.	Wooded slopes, floodplain thickets
Hypericum prolificum	Shrubby St.-John's-wort	Clusiaceae	D.s.	Low fields, swamps, thickets
Cornus alternifolia	Alternate-leafed dogwood	Cornaceae	D.s.	Low moist woods
Cornus amomum	Silky dogwood	Cornaceae	D.s.	Moist woods, meadows, old fields, swamps
Cornus racemosa	Swamp dogwood	Cornaceae	D.s.	Swampy meadows, wet woods

Species	Common Name	Family	Growth Form	Habit
Diospyros virginiana	Persimmon	Ebenaceae	D.t.	Woods edges, floodplains, old fields
Vaccinium corymbosum	Highbush blueberry	Ericaceae	D.s.	Moist woods, bogs, swamps
Amorpha fruticosa	False-indigo	Fabaceae	D.s.	Alluvial soils along streams, other low wet areas
Gleditsia triacanthos	Honey-locust	Fabaceae	D.t.	Wooded slopes, floodplains, river banks
Ribes americanum	Wild black currant	Grossulariaceae	D.s.	Moist woods, swamps, thickets
Ribes cynosbati	Prickly gooseberry	Grossulariaceae	D.s.	Thin, moist woods
Sassafras albidum	sassafras	Lauraceae	D.t.	Wood edges, old fields
Ceanothus americanus	New Jersey Tea	Rhamnacee	D.s.	Wooded bluffs, roadside banks, slopes
Amelanchier intermedia	Serviceberry	Rosaceae	D.s.	Wet woods, swamps, bogs, river banks
Aronia arbutifolia	Red chokeberry	Rosaceae	D.s.	Swamps, bogs, moist woods
Aronia melanocarpa	Black chokeberry	Rosaceae	D.s.	Swamps, bogs, wet or dry woods
Crataegus sp.	Hawthorn	Rosaceae	D.t.	Open fields
Malus coronaria	American crabapple	Rosaceae	D.t.	Woods, old fields
Physocarpus opulifolius	Ninebark	Rosaceae	D.s.	Moist, wet woods, cliffs, shores
Prunus americana	Wild plum	Rosaceae	D.s.	Wooded slopes, riverbanks, thickets
Prunus virginiana	chokecherry	Rosaceae	D.s.	Upland woods
Rosa carolina	Pasture rose	Rosaceae	D.s.	Fields, dry open ground
Rosa palustris	Swamp rose	Rosaceae	D.s.	Swamps, marshes
Rubus allegheniensis	Common blackberry	Rosaceae	D.s.	Old fields, open woods
Spiraea alba	Meadow-sweet	Rosaceae	D.s.	Bogs, moist peaty meadows
Spiraea tomentosa	Hardhack	Rosaceae	D.s.	Wet meadows, old fields, swamps, bogs

Species	Common Name	Family	Growth Form	Habit
Waldsteinia fragarioides	Barren-strawberry	Rosaceae	H.p.	Moist rich woods, pastures
Zanthoxylum americanum	N. prickly-ash	Rutaceae	D.s.	Stream banks, river bluffs, roadside thickets
Populus tremuloides	Trembling aspen	Salicaceae	D.t.	Old fields, open woods, sand
Salix bebbiana	Long-beaked willow	Salicaceae	D.s.	Moist or dry thickets, edges
Salix caroliniana	Carolina willow	Salicaceae	D.t.	River banks, shores
Salix discolor	Pussy willow	Salicaceae	D.s.	Swamps, wet woods
Salix exigua	Sandbar willow	Salicaceae	D.s.	Alluvial bars and shores
Salix sericea	Silky willow	Salicaceae	D.s.	Swamps, bogs, stream banks, wet woods
Staphylea trifolia	Bladdernut	Staphyleaceae	D.s.	Moist rocky woods, stream banks
Parthenocissus quinquifolia	Virginia creeper	Vitaceae	W.v.	Woods, fields, edges
Vitis labrusca	Fox grape	Vitaceae	W.v.	Rocky woods, moist thickets, stream banks
Vitis riparia	Frost grape	Vitaceae	W.v.	River banks, alluvial thickets
Vitis vulpina	Frost grape	Vitaceae	W.v.	Woods, thickets, roadsides, sand dunes

* Growth forms: D.t. = Deciduous tree; D.s. = Deciduous shrub; E.t. = Evergreen tree; E.s. = Evergreen shrub; E.s.s. = Evergreen sub-shrub; W.v. = Woody vine

Appendix G. Comprehensive list of native herbaceous plants of Allegheny County, Pennsylvania. As represented by greater than three herbarium records as compiled by Rhoads and Klein (1993).

Species	Common Name	Family	Growth Form	Habit
Asarum canadense	Wild ginger	Aristolochiaceae	H.p.	Moist rich woods
Caulophyllum thalictroides	Blue cohosh	Berberidaceae	H.p.	Moist rich woods
Podophyllum peltatum	May-apple	Berberidaceae	H.p.	Moist woods
Cardamine bulbosa	Bitter-cress	Brassicaceae	H.p.	Low wet ground, shallow water
Cardamine diphylla	Pepper-root	Brassicaceae	H.p.	Rich woods, floodplains
Cardamine pensylvanica	Penn. Bitter-cress	Brassicaceae	H.p.	Low wet ground, swamps, springs
Rorippa palustris	Marsh watercress	Brassicaceae	H.a.	Wet shores, low open ground
Chamaecrista fasciculata	Partridge-pea	Caesalpiniaceae	H.a.	River banks, sandy flats
Senna hebecarpa	Wild senna	Caesalpiniaceae	H.p.	River banks, sandy shores
Humulus lupulus	Brewer's hops	Cannabaceae	H.p.	Moist alluvial soil, woods edges
Cerastium nutans	Nodding Chickweed	Caryophyllaceae	H.a.	Rich wooded slopes, alluvium
Silene stellata	Starry campion	Caryophyllaceae	H.p.	Rocky slopes, barrens, roadside banks
Silene virginica	Fire pink	Caryophyllaceae	H.p.	Upland woods, slopes, streambanks
Stellaria longifolia	Long-leaved stitchwort	Caryophyllaceae	H.p.	Marshy open ground, swamps, woods
Stellaria pubera	Great chickweed	Caryophyllaceae	H.p.	Moist, alluvial woods
Hypericum mutilum	Dwarf St.-John's-wort	Clusiaceae	H.p.	River banks, moist fields, swamps
Hypericum punctatum	Spotted St.-John's-wort	Clusiaceae	H.p.	Moist fields, floodplains
Sedum ternatum	Wild stonecrop	Crassulaceae	H.p.	Rocky banks, cliffs, woods

Species	Common Name	Family	Growth Form	Habit
Echinocystis lobata	Prickly cucumber	Cucurbitaceae	H.a. vine	Moist alluvial soil, stream banks, wood edges
Athyrium filix-femina	N. lady fern	Dryopteridaceae	H.p.	Damp woods, swamps
Dryopteris carthusiana	Fancy fern	Dryopteridaceae	H.p.	Moist-wet woods
Onoclea sensibilis *	Sensitive fern	Dryopteridaceae	H.p.	Marsh, swamps, moist open woods
Equisetum arvense	Common horsetail	Equisetaceae	H.p.	stream banks, meadows
Equisetum hyemale	Scouring rush	Equisetaceae	H.p.	Sandy banks, roadsides
Acalypha rhomboidea	Three-seeded mercury	Euphorbiaceae	H.a.	Wooded slopes, fields
Euphorbia corollata	Flowering spurge	Euphorbiaceae	H.p.	Dry open woods, fields
Amphicarpaea bracteata	Hog-peanut	Fabaceae	H.p. vine	Moist woods, alluvium
Apios americana	Ground-nut	Fabaceae	H.p. vine	Low rich moist ground
Baptisia australis	Blue false-indigo	Fabaceae	H.p.	Open woods, river banks, sandy floodplains
Baptisia tinctoria	Wild indigo	Fabaceae	H.p.	Dry open woods in sandy acidic soil
Desmodium canadense	Beggar-ticks	Fabaceae	H.p.	Open woods
Desmodium nudiflorum	Naked-flowered tick-trefoil	Fabaceae	H.p.	Rich woods, edges
Desmodium paniculatum	Beggar-ticks	Fabaceae	H.p.	Clearings and edges of moist or dry woods
Desmodium perplexum	Tick-trefoil	Fabaceae	H.p.	Dry or moist open woods
Lespedeza intermedia	Bush-clover	Fabaceae	H.p.	Dry, open, rocky woods, thickets
Vicia caroliniana	Wood vetch	Fabaceae	H.p. vine	Rich woods, thickets
Adlumia fungosa	Alleghany-vine	Fumariaceae	H.b. vine	Moist slopes and woodlands
Corydalis flavula	Yellow fumewort	Fumariaceae	H.b.	Moist open woods, edges

Species	Common Name	Family	Growth Form	Habit
Dicentra canadensis	Squirrel corn	Fumariaceae	H.p.	Rich moist woods
Dicentra cucullaria	Dutchman's breeches	Fumariaceae	H.p.	Rich woods
Diphasiastrum digitatum	S. ground cedar	Lycopodiaceae	H.p.	Woods and thickets, acid
Cuphea viscosissima	Blue waxweed	Lythraceae	H.a.	Dry open banks, fields
Menispermum candadense	moonseed	Menispermaceae	H.p. vine	Moist ground of streambanks
Circaea lutetium canadensis	Enchanter's-nightshade	Onagraceae	H.p.	Woods, floodplains
Epilobium angustifolium	Fireweed	Onagraceae	H.p.	Wood edges, clearings, open sandy ground
Epilobium coloratum	Purple-leaved willow-herb	Onagraceae	H.p.	Marshes, stream or pond banks, floodplains
Gaura biennis	gaura	Onagraceae	H.a.	Moist meadows, floodplains, streambanks
Ludwigia alternifolia	False loosestrife	Onagraceae	H.p.	Swampy fields, wet woods
Oenethera fruticosa	Sundrops	Onagraceae	H.p.	Meadows, dry fields, barrens
Botrychium dissectum	Cut-leaf grape fern	Ophioglossaceae	H.p.	Moist woods and meadows
Osmunda cinnamomoea	Cinnamon fern	Osmundaceae	H.p.	Swamps, bog margins, streambanks
Sanguinaria canadensis	bloodroot	Papaveraceae	H.p.	Rich woods, roadsides
Linum virginianum	Slender yellow flax	Polygalaceae	H.p.	Dry open woods, old fields, shaly slopes
Polygonum pensylvanicum	Smartweed	Polygonaceae	H.a.	Fields, stream banks
Polygonum sagittatum	Arrow-leaved tearthumb	Polygonaceae	H.a.	Low moist ground
Polygonum scandens	Climbing false-buckwheat	Polygonaceae	H.p. vine	Moist woods, thickets
Polygonum virginianum	Jumpseed	Polygonaceae	H.p.	Moist open woods, floodplains
Claytonia virginica	Spring beauty	Portulacaceae	H.p.	Moist woods, meadows

Species	Common Name	Family	Growth Form	Habit
Lysimachia ciliata	Fringed loosestrife	Primulaceae	H.p.	Low moist ground, stream banks, swamp edges
Lysimachia quadrifolia	Whorled loosestrife	Primulaceae	H.p.	Dry open woods
Pyrola americana	Wild Lily-of-the-valley	Pyrolaceae	H.p.	Woods
Pyrola elliptica	Shinleaf (WLV)	Pyrolaceae	H.p.	Dry to moist woods
Actaea pachypoda	Doll's eyes	Ranunculaceae	H.p.	Rich woods
Anemone virginiana	Tall anemone	Ranunculaceae	H.p.	Dry open woods, slopes, edges
Aquilegia canadensis	Wild columbine	Ranunculaceae	H.p.	Rocky slopes, cliffs
Caltha palustris	Marsh marigold	Ranunculaceae	H.p.	Swamps, wet meadows, wet woods
Clematis virginiana	Virgin's bower	Ranunculaceae	H.p. vine	Thickets, wood edges
Delphinium tricorne	Dwarf larkspur	Ranunculaceae	H.p.	Rich woods on slopes
Hepatica nobilis	Liverleaf	Ranunculaceae	H.p.	Rich woods
Hydrastis Canadensis	goldenseal	Ranunculaceae	H.p.	Moist rich woods, declining PE
Ranunculus abortivus	Kidney-leaf buttercup	Ranunculaceae	H.a.	Low woods, clearings, damp shores
Ranunculus caricetorum	Marsh buttercup	Ranunculaceae	H.p.	Woods meadows, alluvial thickets
Ranunculus hispidus	Hairy buttercup	Ranunculaceae	H.p.	Rich, moist woods
Ranunculus recurvatus	Hooked crowfoot	Ranunculaceae	H.p.	Damp swampy woods, stream edges
Thalictrum pubescens	Tall meadow-rue	Ranunculaceae	H.p.	Wet meadows, low open woods
Thalictrum thalictroides	Rue-anemone	Ranunculaceae	H.p.	Rich woods
Agrimonia gryposepala	Agrimony	Rosaceae	H.p.	Woods, fields, floodplains
Agrimonia parviflora	S. agrimony	Rosaceae	H.p.	Bogs, moist woods
Aruncus dioicus	Goat's-beard	Rosaceae	H.p.	Rich woods
Fragaria virginiana	Wild strawberry	Rosaceae	H.p.	Woods, meadows

Species	Common Name	Family	Growth Form	Habit
Geum canadense	White avens	Rosaceae	H.p.	Woods, streambanks
Geum vernum	Spring avens	Rosaceae	H.p.	Rich woods, ravines
Potentilla canadensis	Cinquefoil	Rosaceae	H.p.	Dry open woods, fields
Potentilla simplex	Old-field cinquefoil	Rosaceae	H.p.	Dry woods, meadows fields
Waldsteinia fragarioides	Barren-strawberry	Rosaceae	H.p.	Moist rich woods, pastures
Saxifraga pensylvanica	Swamp saxifrage	Saxifagaceae	H.p.	Wet woods, bogs, swamps
Heuchera americana	Alum-root	Saxifragaceae	H.p.	Rich woods, rocky slopes
Mitella diphylla	Bishop's-cap	Saxifragaceae	H.p.	Rich moist woods
Penthorum sedoides	Ditch stonecrop	Saxifragaceae	H.p.	Low wet ground, ditches
Saxifraga virginiensis	Early saxifrage	Saxifragaceae	H.p.	Moist rock crevices
Thelypteris palustris	Marsh fern	Thelypteridaceae	H.p.	Marshes, wet meadows
Boehmeria cylindrica	Bog-hemp	Urticaceae	H.p.	Moist shady woods, stream margins
Laportea canadensis	Wood-nettle	Urticaceae	H.p.	Low moist woods, stream banks
Pilea pumila	Clearweed	Urticaceae	H.a.	Cool moist shady areas
Viola conspersa	American dog violet	Violaceae	H.p.	Seamps, meadows, alluvial woods
Viola cucullata	Blue marsh violet	Violaceae	H.p.	Swamps, bogs, wet meadows
Viola eriocarpa	Smooth yellow violet	Violaceae	H.p.	Rich woods
Viola macloskeyi	Sweet white violet	Violaceae	H.p.	Bogs, swamps, wet woods
Viola sororia	Common blue violet	Violaceae	H.p.	Meadows and woods
Viola striata	Striped violet	Violaceae	H.p.	Moist rich woods, floodplains

* Growth forms: H.a. = Herbaceous annual; H.b. = Herbaceous biennial; H.p.= Herbaceous perennial

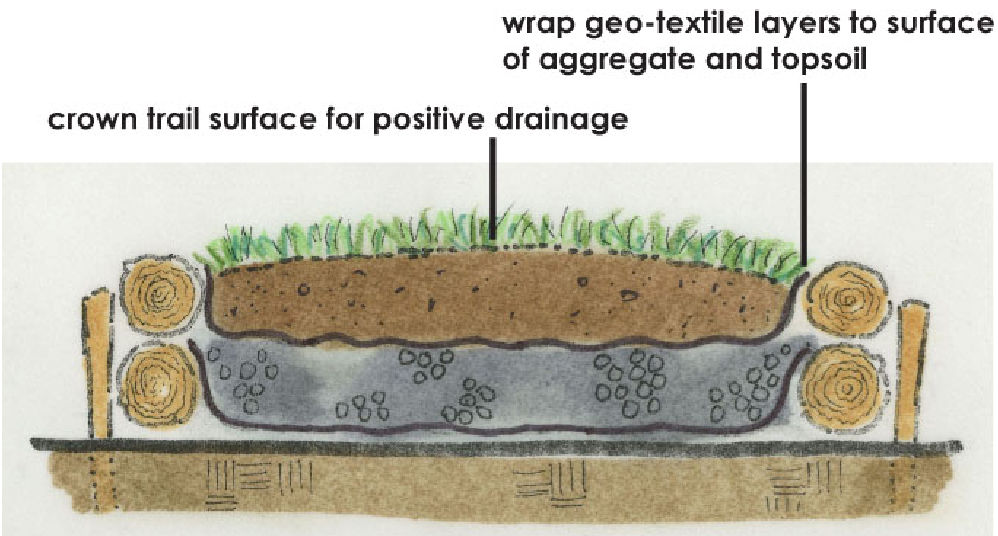
Appendix H. Summary of Sign Panel Materials

	High Pressure Laminate	Fiberglass Embedment: Digital	Fiberglass Embedment: Screened	Porcelain Enamel	Color-Embed Anodized Aluminum	Photo Etched Anodized Aluminum
Graphics and Color						
Graphics Capability/ Resolution	Very good	Very good	Very good	Excellent	Very good	Good, line art, half-tones
Color Capability	4-color digital	4-color digital	4-color screen	4-color screen	4-color screen	Anodized colors
Image/Color Retention Over Time	Good	Good	Good	Excellent	Excellent	Excellent
Photo Reproduction Capability	Very good, full color	Good, full color	Very good, full color	Excellent, full color	Very good, full color	Good, half-tone, black-and-white
Material Durability						
Life Expectancy in Serviceable Condition	Good, 10-20 years	Good, 5-10 years	Good, 8-10 years	Excellent, 40+ years	Excellent, 40+ years	Excellent, 40+ years
Scratch/Abrasion Resistance	Very good	Very good	Very good	Excellent	Very good	Very good
Cracking/ Peeling/Warping Resistance	Good	Good	Good	Excellent	Excellent	Excellent
Maintenance Needed	Bi-annual wash/wax	Bi-annual wash/wax	Bi-annual wash/wax	Annual wash/ wax	Annual wash	Annual wash
Framing Needed	≧ 1/2" No	Yes	Yes	Yes	Yes	No
Impact Resistance (Hard Blows)	Very good	Very good	Very good	Poor	Good	Fair
Graffiti Removal	Very good	Very good	Very good	Excellent	Excellent	Good
Replaceability/ Duplication	Very good, inexpensive	Excellent, duplicates	Excellent, duplicates	Poor	Good	Poor
Typical Applications						
Wayside Exhibits/ Trail Panels	Very good	Very good	Very good	Excellent	Very good	Good
Site and Facility Identification	Good	Good	Good	Good	Very good	Very good
Memorials/Plaques	Poor	Poor	Poor	Poor	Good	Excellent
Identification Labels	Good	Good	Good	Good	Excellent	Very good
Cost Range per sq. ft. (2006 prices)	Low: $50-$70	Low: $40-$60	High: $250-$530	High: $300-$600	Mod: $100-$150	High: $250-$400

	Metal: Cast	Metal: Screened	Wood: Routed/ Carved	Wood: Sand-blasted	Back-Screened Plastic	Wood Composite: Screened	Stone Etching	Laminated Prints
Graphics and Color								
Graphics Capability/ Resolution	Poor	Poor	Carved, routed, painted	Excellent letters and line art	Good	Good	Good	Very good
Color Capability	Painted	4-color screen	Painted, stained	Painted, stained	4-color screen	4-color screen	Lithochrome paints	4-color digital
Image/Color Retention Over Time	Excellent	Good	Fair	Fair	Good	Fair	Excellent	Poor
Photo Reproduction Capability	N/A	Fair, half-tone	N/A	N/A	Good, full color	Fair, half-tone, black-and-white	Fair, half-tone, black-and-white	Very good, full color
Material Durability								
Life Expectancy in Serviceable Condition	Excellent, 40+ years	Good, 10-15 years	Fair, 5-6 years, can refurbish	Fair, 5-6 years, can refurbish	Good, 8-10 years	Fair, 4-6 years	Very good, 15-20 years	Poor, 1-3 years with UV protect
Scratch/Abrasion Resistance	Excellent	Poor	Good	Good	Good	Fair	Excellent	Poor
Cracking/ Peeling/Warping Resistance	Excellent	Very good	Excellent	Excellent	≧ 1/2" Good	Good	Excellent	Fair
Maintenance Needed	None	Bi-annual wash	Stain every 5-6 years	Stain every 5-6 years	Bi-annual wash	Bi-annual wash	None	Bi-annual wash
Framing Needed	No	≧ 1/2" No	No	No	Yes	No	No	Yes
Impact Resistance (Hard Blows)	Fair	Fair	Good	Good	Good	Poor	Poor	Poor
Graffiti Removal	Poor	Good	Fair	Fair	Very good	Good	Poor	Good
Replaceability/ Duplication	Poor	Fair	Poor	Poor	Poor	Fair	Poor	Very good, inexpensive
Typical Applications								
Wayside Exhibits/ Trail Panels	Poor	Poor	Poor	Poor	Good	Good	Good	Good
Site and Facility Identification	Fair	Poor	Excellent	Excellent	Fair	Very good	Good	Poor
Memorials/Plaques	Excellent	Poor	Poor	Fair	Poor	Poor	Very Good	Poor
Identification Labels	Good	Fair	Good	Very Good	Good	Good	Very Good	Fair
Cost Range per sq. ft. (2006 prices)	Very High: $500-$1000	Low-Mod: $50-$125	Mod-High: $125+	Mod-High: $160+	Mod: $150-$200	Low-Mod: $80-$130	High: $200-$350	Very Low: $10-$30

From Signs, Trails, and Wayside Exhibits: Connecting People and Places.

Appendx I. Trail Enhancement Construction Details



Figur I.1 Section of trail crown for positive drainage.

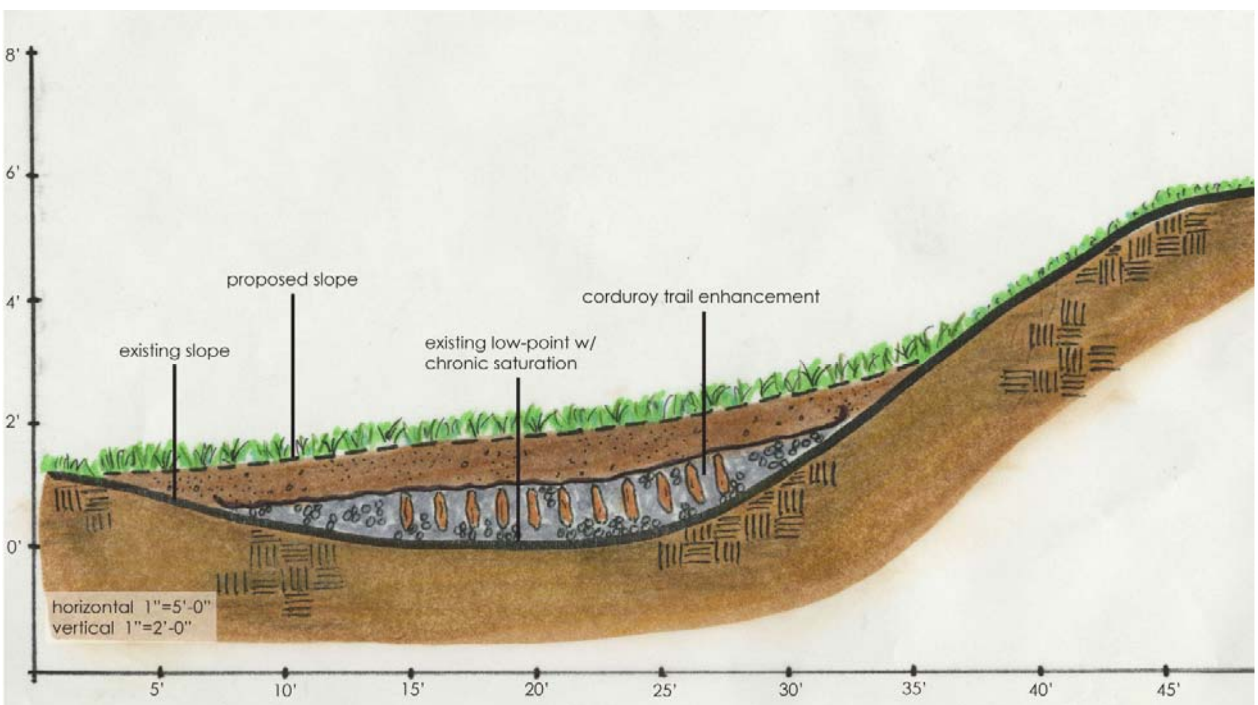


Figure I.2 Section detailing vertical elevation for trail enhancement.

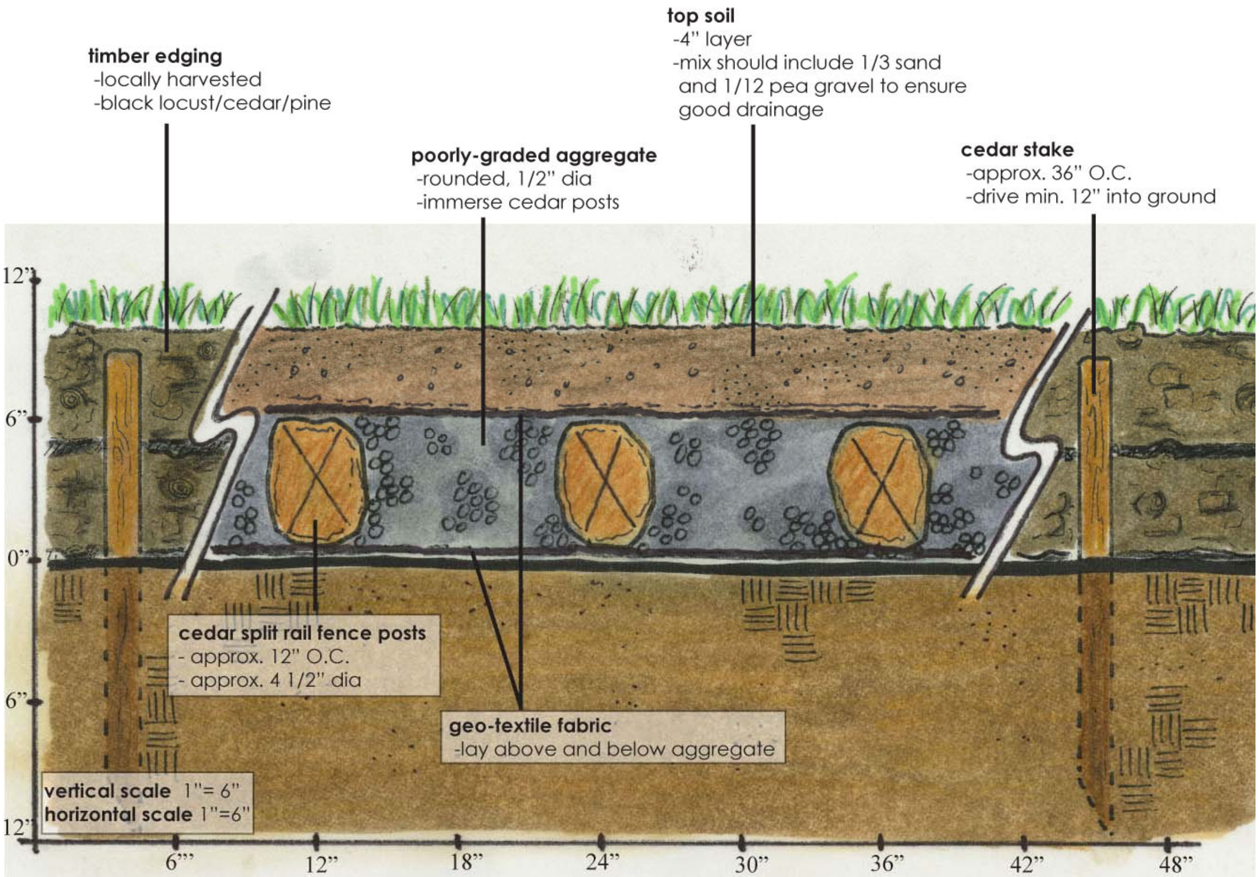


Figure I.3 Section detailing construction layers.

Appendix J. Canoe Launch Enhancement Construction Details

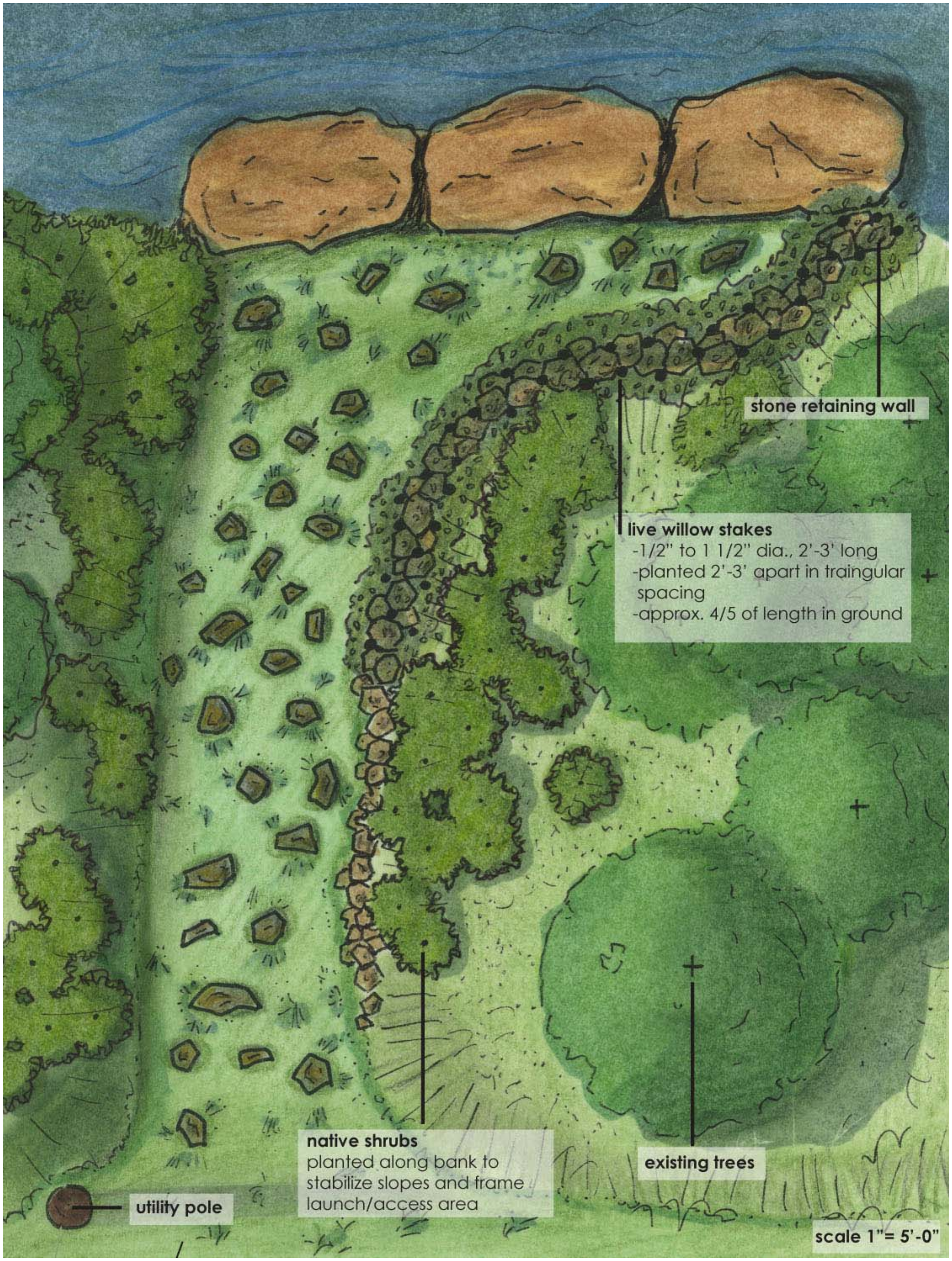


Figure J.1. Plan view of canoe launch enhancement.

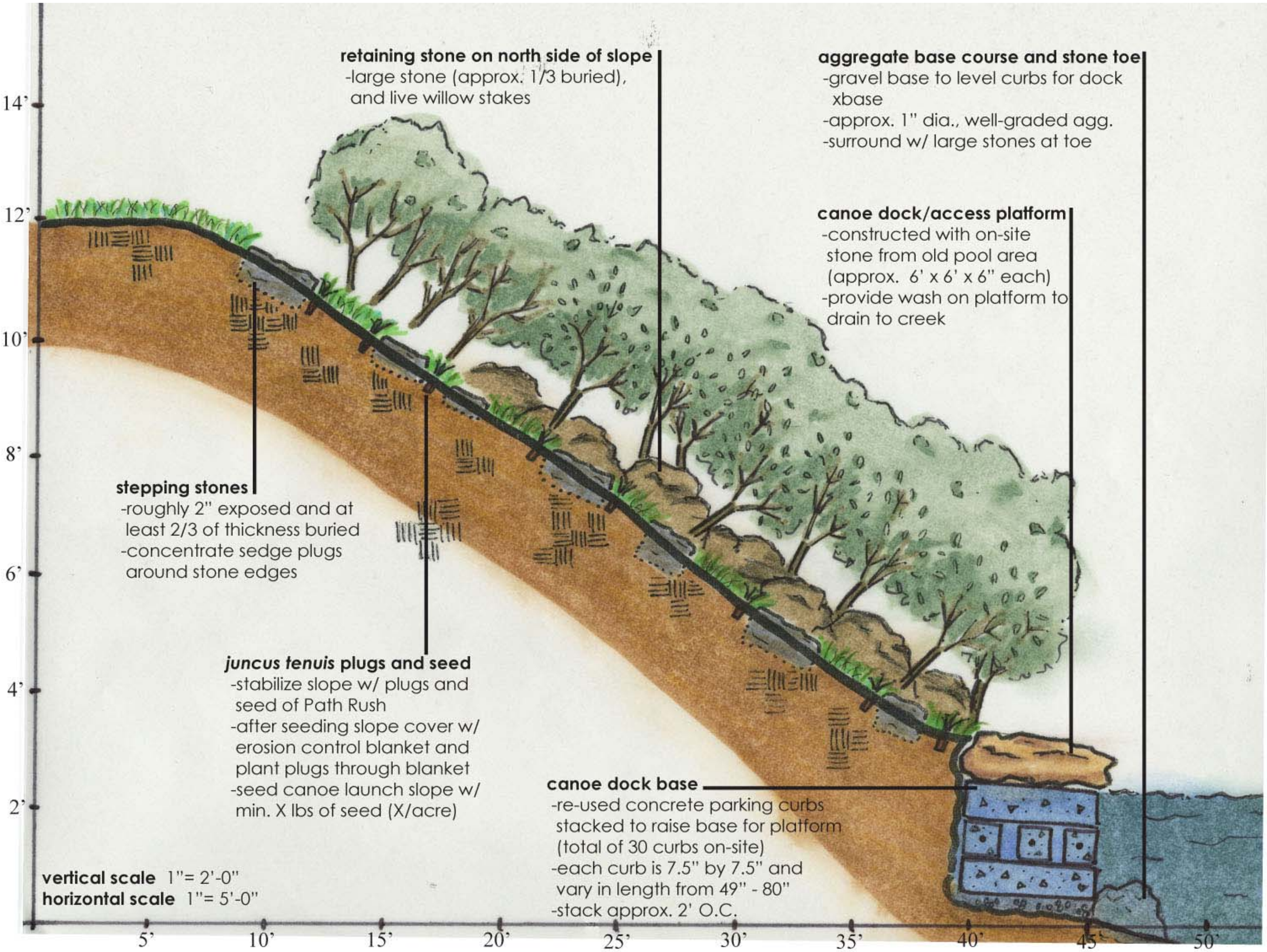


Figure J.2. Cross-section of canoe launch enhancement.

Appendix K. Entry Drive Swale Construction Detail