# AUDUBON INTERNATIONAL'S ECOLOGICAL DESIGN for VALHALLA BRANDYWINE

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**Chester County, Pennsylvania**

# DRAFT

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Science is Second Nature

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# EXECUTIVE SUMMARY

1. Valhalla Brandywine and its developer Albert M. Greenfield & Co., Inc. has enrolled in Audubon International's Gold Signature Program. This represents a partnership for sustainability.

2. As a first step in this partnership, this document describes the conceptual design of the natural areas to be preserved or created on the property. These include:
   a. East Brandywine Preserve,
   b. Tributary Preserve, which is the core wildlife habitat for the property, and
   c. Wetland Preserve, which includes corridors to ecologically connect East Brandywine Preserve to onsite and offsite native Piedmont habitat.

3. A major function of the preserve design at Valhalla Brandywine is to preserve, restore, maintain, and buffer the tributary watershed from the impacts of historic and future land use.

4. This document describes the design of the project to restore and maintain water quality, aquatic habitat, and upland habitat. These include:
   a. Utilizing an integrated stormwater management approach to prevent natural resource degradation.
   b. Installing and enhancing vegetative buffers around each water body, including planting a diverse, native understory on stream slopes.
   c. Utilizing Special Management Zones, Natural Systems Engineering, and Best Management Practices (BMPs) Trains to provide maximum protection for resources and manage stormwater.
   d. Establishing a water quality monitoring program.

# 1.0 INTRODUCTION

Valhalla Brandywine will transform a 600-acre parcel in Wallace Township, Chester County, Pennsylvania from mixed hardwood and pine forest, agriculture, stream and wetlands to a mixture of housing, recreation, golf, spa, commercial and restored stream and forest preserve. In keeping with its desire to develop this site in an ecologically sustainable manner, Albert M. Greenfield & Co. has formed a partnership with Audubon International (AI) by enrolling Valhalla Brandywine in AI's Gold Signature Program. Audubon International defines "sustainable" as using resources in a manner that meets our present needs without compromising the ability of future generations to meet their own needs. Valhalla Brandywine will be a thriving human community rooted in ecological integrity, economic strength, and cultural integration.

This report provides a preliminary evaluation of the property in context with the requirements of the AI Gold Signature Program.

## 1.1 BASIC CONCEPTS

Valhalla Brandywine is following these five basic concepts that provide the foundation for the Audubon International Gold Signature Program:

1. **Design in Context with the Landscape.** Designing in context with the landscape minimizes overall site disturbance. Designing without respect to the natural landscape negatively affects biodiversity, stability, and overall ecological health of the site.

2. **Design in an Eco-Centric Manner.** By designing in an eco-centric (ecology focused) manner, the basic ecology of the site and surrounding landscape is central to the overall design, and ensures that ecological attributes will be given due consideration in the decision making process.

3. **Use Design to Increase Ecological Sensitivity and Biodiversity.** Design of the site that considers wildlife inhabiting the property, as well as potential wildlife habitat, will increase biodiversity versus a design that does not consider wildlife needs. Not unlike humans, the most basic elements wildlife need are space, food, shelter, and water. Combining those elements when designing will not only help wildlife

management efforts, but will also ensure harmony between new land uses and the surrounding landscape. In addition, integrating wildlife elements throughout the property and allowing the site ecology to dictate the design of the property will ultimately maximize the environment and economic value of the site after development.

4. **Design in a Proactive Manner.** A proactive approach to protection and enhancement of natural resources is taken at Valhalla Brandywine. Proactive rather than reactive environmental approaches are more likely to be successful and the management failures can be significantly reduced (Smart et al. 1993; Peacock and Smart 1995; Peacock et al. 1996).

5. **Design Buildings in a Sustainable Manner.** Sustainability in the built environment is a goal for Valhalla Brandywine. A wide range of sustainable design strategies including energy, waste, building materials, water, and indoor air quality will be identified. Strategies are optimized for environmental and economic benefit.

## 1.2 THE STRUCTURE OF THE GOLD SIGNATURE PROGRAM

The Gold Signature Program consists of five main phases that correspond with various stages in the development of Valhalla Brandywine.

### 1.2.1 Site Evaluation and Classification

This phase occurs at the earliest planning stages of the project, before the project design is finalized. Audubon International has developed a site classification process based on a previously published system (O'Connell and Noss 1992). The system is based on an analysis of the size of the site, the species and communities found on it, and the surrounding landscape in which the local site is embedded. These characteristics for Valhalla Brandywine are discussed further in **Section 1.3** below. Based on this analysis, a series of objectives is developed for each site. These objectives describe what any plan for developing the site must accomplish in order for Audubon International to consider the project to be sustainable. These objectives are then used to evaluate the suitability of specific site plans (see **Section 1.2.3** below). They also help to determine the specific requirements that the project must meet in order to be eligible for certification in the Gold Signature Program.

### 1.2.2 Establishment of Specific Program Requirements

Audubon International has certain standard requirements that every project must meet in order to be certified in the Gold Signature Program. Every project, regardless of its site classification, must hire a Natural Resource Manager, must develop an education and outreach program, and must meet a variety of other standardized criteria (see **Appendix I**). These requirements are the same for all Gold Signature Projects.

However, in other regards each site is unique and different. It would hardly be reasonable, for example, to have the same requirements for wildlife habitat for a wooded project adjacent to a national park and for an inner-city infill development (Woolbright 2004), or the same water quality requirements for a site surrounded by farm fields and one next to an important salmon stream. Thus the specific program requirements for each project will be a combination of standard and special requirements driven by the site classification process.

Specific program requirements will be developed for Valhalla Brandywine in each of three program areas:

- Wildlife Habitat (**Section 3**)
- Water Quality (**Section 4**)
- Planning, Design and Management (**Appendix I**)

In general, the requirements for wildlife habitat tend to depend on the site classification, and those for water quality tend to be a mixture of site-specific and standard requirements. One of the key functions of this document is to summarize the results of the site classification process and discuss those requirements that depend on it. Requirements for planning, design and management are standardized and are included in Appendix I.

### 1.2.3 Approval of Land Plan

Once the site classification process is concluded and the specific requirements determined by the site classification have been established, then Audubon International is able to evaluate specific land plans to estimate whether or not they will meet the objectives and requirements of the Gold Signature Program. Frequently we advise some level of revision to proposed land plans in response to specific program concerns. When we determine that a proposed land plan appears to meet the objectives and requirements of the Gold Signature Program, then we issue a letter

formally approving the land plan. This ordinarily happens some time around the permitting phase of the project.

Land plan approval means that the project design appears to meet the minimum requirements of the Gold Signature Program. It does not guarantee ultimate certification or promise any particular result on our Diamond Rating Scale (see **Section 1.2.6** below). These can only occur after construction.

### 1.2.4 The Natural Resource Management Plan

After the land plan is approved and the Ecological Design document is completed, the general project design is fixed and we turn our attention to management. The Natural Resource Management Plan is a comprehensive document that summarizes management recommendations for the project. We like to think of it as an ecological "owner's manual" for the site.

The Natural Resource Management Plan (NRMP) is a "living" document that goes through many revisions. It grows with the project, adding new sections as new aspects of the project come on line. The final version is usually completed about the same time construction is concluded, at which time the NRMP is reviewed and updated annually as needed.

### 1.2.5 The Community Education and Outreach Program

The final document of importance to the operation of the project is AI's Community Education and Information Guidelines (CEIG). This document will develop program strategies for involving residents, guests, and neighbors in the environmental focus of the project. The Community Education and Outreach Program is developed by the Natural Resource Manager in conjunction with AI staff members and the CEIG.

### 1.2.6 Certification and Diamond Designation

Only after construction can we evaluate the project to determine whether the result matches the approved land plan and whether all of the program requirements were met. At that point we officially certify the project as a Gold Signature Sanctuary. We also attach a rating of One, Two, or Three Diamonds to the final project. A rating of One Diamond signifies a project that met all minimum program requirements; a rating of Two Diamonds signifies that the project exceeded

minimum requirements; a rating of Three Diamonds indicates a superlative project that far exceeded all program requirements.

We assign the Diamond designation through a process that evaluates separately the requirements in the three areas listed above (Planning, Design and Management; Wildlife Habitat; Water Quality). The overall project receives the minimum rating from among the three individual ratings. For example, a project that is rated 1 Diamond in Planning, 2 Diamonds in Wildlife, and 2 Diamonds in Water will be certified as a One Diamond Gold Signature Project.

To ensure that a completed project continues to operate according to the standards established in the Ecological Design, the Natural Resource Management Plan, and the CEIG, Audubon International conducts an annual recertification visit. A project's rating can be raised or lowered as a result of this annual recertification. In extreme cases, we also reserve the right to revoke certification completely if the project no longer meets our standards.

## 1.3 BIOLOGICAL SITE REVIEW

Biological site review is necessary to determine the nature of the site and its surroundings as part of the site evaluation and classification process. Biological site review is accomplished in part through reports by local experts in archaeology, flora, fauna, and other issues of concern to the project as agreed by AE and the Valhalla Brandywine team. In addition, AE staff conduct site visits as appropriate to synthesize data and complete our process requirements. Site visits to Valhalla Brandywine began in August 2007 and have been conducted by R. Dodson and R. Bodie. In addition, we review available national and regional environmental databases that cover the site. This combination of approaches provides a reasonably thorough picture of the biological elements present on the site.

### 1.3.1 Species of Concern

A primary function of conservation design is to protect the habitat of species whose continued existence is in question, whether they are in imminent danger of extinction, or simply showing trends that could lead to problems in the future. In addition to protecting species identified by federal and state authorities, Audubon International includes a variety of species without formal status in our conservation plans. We believe that good environmental stewardship includes taking special care of populations of species that are:

- Endangered, threatened, or rare;
- Endemic;
- Important to key ecosystem processes;
- Sensitive to human disturbance; or
- Important to community education efforts.

When such species are present, it is our obligation and challenge to afford them special protection. When they are not present, then we should concentrate on maintaining or restoring sufficient combinations of native habitat to prevent any further erosion of biodiversity on the site.

The US Fish and Wildlife Service identified Valhalla Brandywine as having the potential of impacting the federally endangered Indiana bat and federally threatened bog turtle. Hence detailed surveys were conducted on site to detect the presence of these species (Skelly and Loy 2007a, 2007b). No federal or state listed or proposed plant or animal species was confirmed on this site. In the process of surveying, several other species of reptile, amphibian, and bat were noted in the reports (Skelly and Loy 2007a, 2007b).

### 1.3.2 Streams and Wetlands

Streams and wetlands are diminished globally, and stream flora and fauna in particular are imperiled by development in the US. These aquatic habitats harbor critical resources for biological communities: drinking water, feeding habitat, breeding sites, and migration stopovers, to name a few. Streams and wetlands are important in maintaining the structure of wildlife food webs, as well as providing recreation and relaxation opportunities for humans.

The East Branch of Brandywine Creek (EBBC) flows along the southwestern boundary of the Valhalla Brandywine project. An un-named tributary to the EBBC flows northeast to southwest across the property to the EBBC, with the confluence just south of the property. The East Branch of Brandywine Creek and the West Branch of Brandywine Creek merge to form Brandywine Creek near Wawaset, Pennsylvania. Brandywine Creek flows approximately 30 miles to the Delaware Bay.

Water quality of the EBBC just upstream of the project site near Glenmoore is assessed regularly as USGS monitoring station # 01480653. The data reflect moderate levels of nitrogen but with no apparent adverse effects on stream health (USGS 2002; Reif 2002). According to an

assessment of data from 1981-1997 (USGS 2002), this upstream monitoring station had benthic macroinvertebrate communities with large numbers of 'pollution sensitive' species, low numbers of 'pollution tolerant' species, and stable habitat. It is noteworthy that this station had the highest number of species and tied for the highest number of sensitive (EPT taxa) species in the Brandywine Creek basin (USGS 2002).

The upland slopes adjacent to the un-named tributary and associated wetlands are densely vegetated with invasive shrub composed of privet and other species. The conservation value of Valhalla Brandywine lies in part in the great potential to preserve and restore the watershed and encourage a mature, naturally diverse forest on the surrounding slopes and ridges that will support the community. We recommend establishing ecological preserves centered around the site's streams and wetlands and encompassing as much adjacent upland as is practical. Within these preserves, riparian buffers will be useful for protection of water quality (see **Section 1.4.3**). In addition, using a BMP storm water treatment train strategy upstream of EBBC and the un-named tributary will treat storm water and maintain biological integrity downstream.

### 1.3.3 Other Rare or Significant Communities

Audubon International believes that the best way to preserve biodiversity is to concentrate on the preservation of entire communities. Therefore we look for habitats that support natural communities that are vulnerable, rare, species rich, or endemic. The Piedmont Uplands of southeastern Pennsylvania on the eastern edge of the Appalachian Highlands region is home to a variety of significant communities that support rare and diverse species. Valhalla Brandywine's stream and wetlands including adjacent uplands provide the greatest potential for supporting significant wildlife communities.

### 1.3.4 Historical Land Use

Discuss history of Heim and Greenfield farms. Need info - Albert? Archaeological survey?

### 1.3.5 Historical Integrity of the Natural Community

Land use and disturbance history leave signatures that can determine not only what is currently on a site, but also what can grow there in the future. Thus it is important to understand as much about the history of a site as possible. One of Audubon International's conservation priorities is natural communities that represent good examples of their type. We believe in preserving the

best remaining native habitats, whether rare or not. The majority of the site is currently comprised of mixed hardwood and pine forest and pasture following many decades of site-altering events including chestnut blight and agriculture.

On the Piedmont Plateau on the eastern edge of the Appalachian Highlands region, the forest types that likely existed before alteration were Appalachian Oak and Mesophytic Forest (from Küchler 1978). The mesophytic valleys were a diverse composition of maple, beech, ash, and tulip-poplar. The low ridges were dominated by chestnut, oak, hickory, dogwood, persimmon, and blackgum (see plant species list in **Appendix II** in addition to Skelly and Loy 2007a, 2007b). Preservation and restoration of all layers of vegetation on the site are high priorities.

## 1.4 THE ROLE OF ECOLOGICAL RESTORATION AT VALHALLA BRANDYWINE

Restoration can be viewed as a continuum ranging from reclamation (planting exotics and/or monocultures to prevent further loss of ecosystem services) to rehabilitation (planting a subset of native species as a first step in restoring function) to true restoration (a term reserved for re-establishing the structure and diversity originally present on the site) (Lamb and Gilmour 2003). Restoration at Valhalla Brandywine should focus on removal of the invasive exotic plants growing along the former roads and adjacent to the wetlands, and landscaping the development areas and buffers with 100% native flora. This will entail planting a subset of the species that historically grew on the property. The resulting communities will approximate intact, complete, natural assemblages, thus increasing the biodiversity of the site, improving ecosystem functions of the property, and providing opportunities for education and sustainable lifestyles. The following sections outline some basic approaches to these efforts.

### 1.4.1 Native Plants

Audubon International believes that sustainable resource management requires the use of native plants whenever possible. This practice accomplishes a variety of positive goals, including:

- Providing animals with the same food and cover plants they evolved with;
- Minimizing the need to supply extra water, fertilizer, cultivation, and other care; and
- Reducing the need for pesticides because plants are co-evolved with local pests.

In addition, our community principles urge the introduction of as many native species as possible into a restoration area. This maximizes plant and, subsequently, animal biodiversity. A partial

list of native plant species for rehabilitation efforts is provided in **Appendix II**. Please note that these lists were developed based on natural regions that are much larger than one specific site. Thus some of the species listed may not grow in your exact location. Plant lists can be fine-tuned by suggestions from local experts. A good reference for local sources of native plant information can be found at http://www.dcnr.state.pa.us/forestry/wildplant/nativesources.aspx. We recommend that as many native species be used as possible in all landscaped areas of the project. For those that are not available commercially, investigate the possibility that local seed collectors might be able to provide small amounts of seed for some species in most years.

We also recommend establishing a transplant garden on the site. This will provide a place into which can be placed native plants from the parts of the property that are being cleared. This prevents wasting useful material and reduces landscaping costs later on.

### 1.4.2 Vegetative Structure

Natural ecosystems are composed of layers of vegetation, typically including big trees, small trees, shrubs, and herbaceous plants. Wildlife are largely dependent on structural habitat, so species diversity of almost all groups can be increased by adding vertical layers of vegetation to the plant community. Restoration areas and wildlife corridors should include shrub and herb layers as well as trees.

### 1.4.3 Aquatic Buffer Zones

Buffer zones of undisturbed natural vegetation should be established adjacent to water bodies on the property, including newly created ponds and wetlands. For those water bodies adjacent to preserve areas, native vegetation should be continuous between the water body and the preserve. The freshwater features on site are essential to the health of the ecosystem, providing drinking water for all wildlife, habitat for aquatic and semi-aquatic species, and breeding sites for many amphibians. In order to fulfill these functions, they must be clean (i.e., free of chemical residues) and safe for animals to use (i.e., surrounded by natural vegetation). Both of these functions can be accomplished by naturalized buffer zones. Research indicates that the wider the buffers can be, the better they can perform their critical functions (Woolbright 2003). We recommend that these buffers be 100 feet wide along either side of streams. We recommend created ponds and wetlands have a minimum 50-feet-wide buffer. Within these buffer zones are two Special Management Zones as described in **Section 4.1**. Buffers may extend into home lot boundaries if they are protected from disturbance in the community Covenants, Conditions, and

Restrictions. Buffer areas may also be appropriate locations for storm water treatment facilities that are part of a comprehensive “treatment train”.

### 1.4.4 Edges

Provide “soft edges” anywhere forest meets clearing. Research indicates that ecotones (the boundaries between different habitat types) can support more wildlife if there is a transition zone rather than an abrupt change. Planting a shrub layer, as discussed above, is the first step in providing a soft edge. The second is to establish naturalized no-mow/no-spray zones between managed turf and natural areas. The width of these transition zones can be variable to accommodate adjacent functions, but should be 25 feet when feasible. They can be planted in native grasses and wildflowers and mowed once a year in the late fall (after the wildflowers have set seed) or early spring.

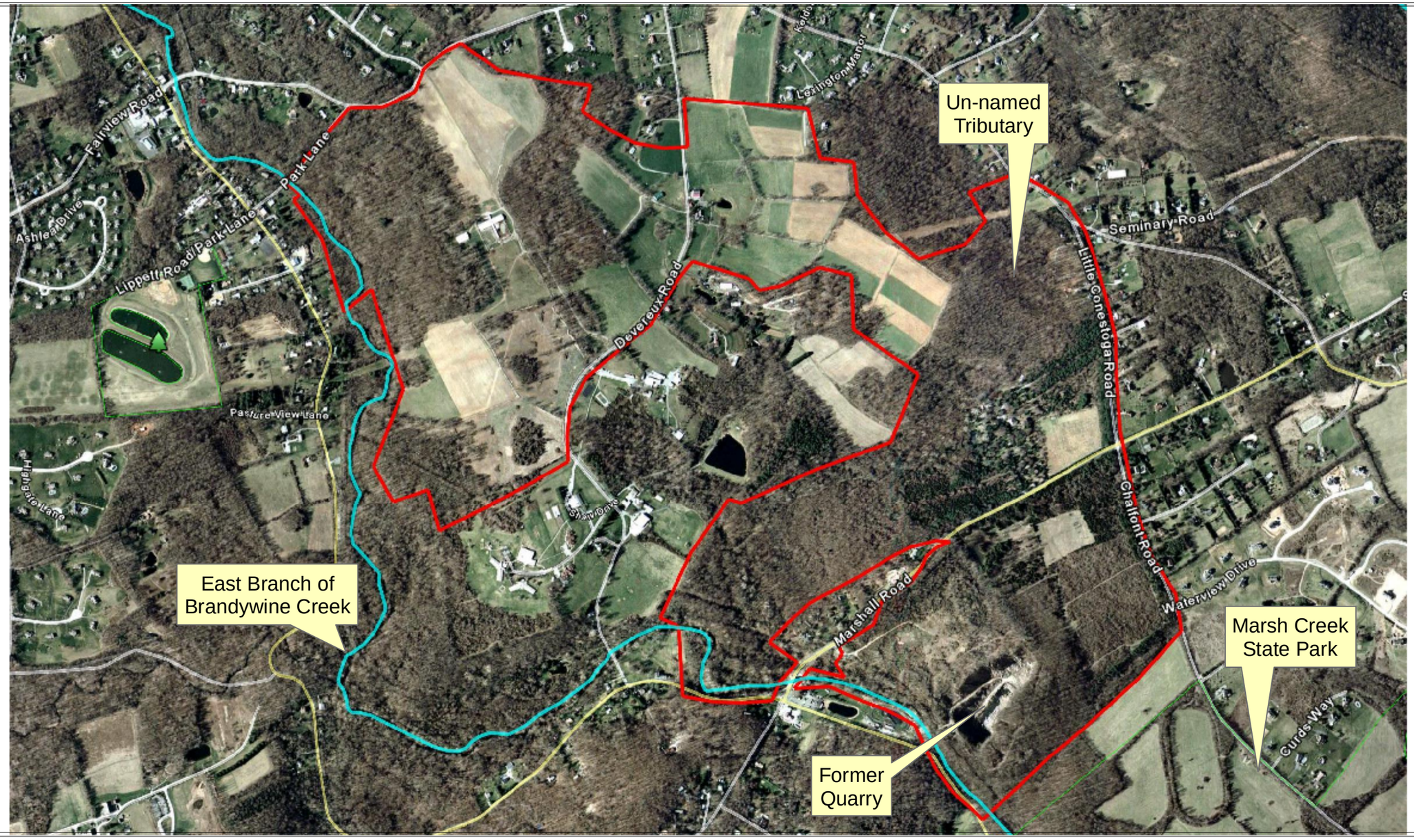
# 2.0 AI'S SITE EVALUATION AND CLASSIFICATION

The first step in the ecological evaluation of a site is to determine what biological communities exist on that site. It is only within the context of the natural ecoregion that a site's biological communities and populations may be evaluated. What is common in one ecoregion may be a critically rare resource in another.

The property comprises approximately 600 acres located within forested, farmed, and sparsely developed land 25 miles northwest of Philadelphia, Pennsylvania. The East Branch of Brandywine Creek (EBBC) runs along the southwestern property boundaries and the 1,705-acre Marsh Creek State Park containing the 535-acre Marsh Creek Lake abuts the southern boundary. The existing site conditions are shown in **Figure 2-1**. Because of the site's location and topography, historically it would have included species typical of uplands and lowlands of the Appalachian Highlands region as described above.

It may not be possible to establish a self-sufficient wildlife preserve on the property. However, the project encompasses nearly the entire watershed of the un-named tributary to its confluence with the EBBC. In addition, this property must be viewed in the context of the larger region, where it can function as a part of the overall Piedmont Upland ecosystem. Thus we should emphasize offsite connections for Valhalla Brandywine's preserve areas, providing regional continuity to the greatest possible extent. For example, the Marsh Creek State Park preserve along the southern boundary, and EBBC along the southwestern boundaries, provide valuable opportunities for habitat connectivity.

The first step in Audubon International's evaluation of a Gold Signature member is the site classification. In its current condition, Valhalla Brandywine was assigned a 4D rating. Site class 4 reflects a moderate acreage site that supports natural communities, no known federal or state listed species, and has relatively minor degradation. While the property historically supported silviculture, agriculture and other human activities, much of the property has since naturalized. Landscape category D recognizes that the property is surrounded by a mix of residential development, agriculture, and forest.

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Base information was provided by
Stuart G. Rosenberg, Architects, PC.

**Figure 2-1. Existing Site Conditions for Valhalla Brandywine**

North

## 2.1 ELEMENTS OF PARTICULAR INTEREST

The Piedmont Uplands on the eastern edge of the Appalachian Highlands are characterized by metamorphic bedrock that underlies this area. Most hills are broad and rolling with shallow valleys, with some containing streams and wetlands. As described above, an un-named tributary flows across the project site to its confluence with the East Branch of Brandywine Creek just southwest of Valhalla Brandywine. The East Branch of Brandywine Creek and the West Branch of Brandywine Creek merge to form Brandywine Creek 12 miles southeast of the site near Wawaset, Pennsylvania. Brandywine Creek flows another 15 miles to the Delaware River in Wilmington, Delaware.

There is a former rock quarry on the southern corner of the property that now contains the 7-acre Canyon Lake with >100-feet cliffs. There is likely a direct groundwater connection to the East Branch of Brandywine Creek.

The property also contains sites of historical significance that include chapels, farmhouses, barns, trees and other cultural assets. We are aware of the interest in the historical value of the property and the goal of the owners to involve its guests with the environment. Both history and recreation must be included in the design of the project.

The entire area west of Philadelphia is experiencing development pressure, threatening to drastically reduce regional wildlife habitat, diminish water quality, and threaten cultural and historical assets. Therefore all native communities, water bodies, and historical sites on the Valhalla Brandywine property are considered significant. The management plan for the property must include provisions to ensure their protection.

We believe the best approach to maximizing biodiversity on the project is to focus on the community level and ensure that critical habitat units are as large, healthy, and connected as possible. Our management recommendations will contrast with a narrow view focused on individual species.

## 2.2 PLACING THE PROPERTY INTO A REGIONAL PERSPECTIVE

The East Branch of Brandywine Creek drains a 25-$m^2$ watershed to primary streams. The 1998 population was 6,200 and expected to increase 38% by 2020. The primary land uses in 1998 were 85% agriculture and other open space with 15% developed. The expected percentage of development by 2020 is 20%. The Philadelphia region is rapidly developing, moving beyond the urban area to the forests and fields to the west, especially along the Pennsylvania Turnpike, which is <1 mile from the project site.

According to the Brandywine Creek Watershed Action Plan (http://dsf.chesco.org/water/lib/water/waps/Brandywine/Brandywine.pdf), the foundations for management are:

- The land use of the watershed is approximately equally represented by wooded, developed, and agricultural lands.

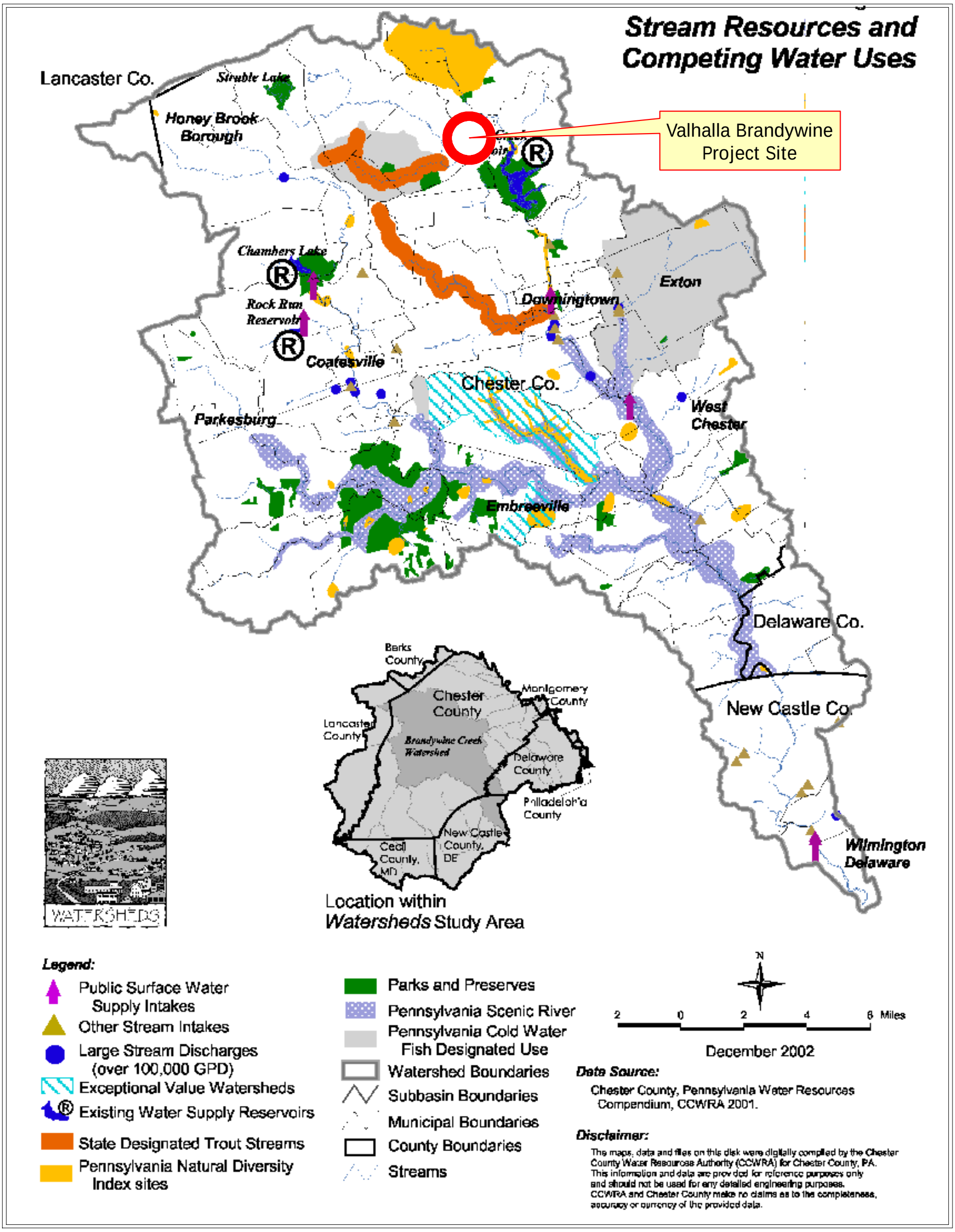
- The watershed is a source of public drinking water supplies for much of Chester County, Pennsylvania and New Castle County, Delaware.

- In several areas, surface and ground water quality suffers from current and historic pollutant runoff from developed and agricultural lands, resulting in 140 miles (or 25% of total stream miles) listed by Pennsylvania and Delaware as “impaired” waters.

- Extensive growth (27% population increase) is projected within the watershed over the next 20 years.

- The watershed includes an extensive assembly of natural, historic, cultural and recreational features, making the watershed and all of its resources collectively a significant and important regional resource.

- Valhalla Brandywine is sandwiched between the large Marsh Creek Lake and preserve to the southeast and a state designated trout stream to the southwest (**Figure 2-2**). Thus preservation and restoration of resources on the Valhalla Brandywine property is critical to bridging this wildlife and water quality corridor.

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Base information was provided by Chester County Water Resources Authority.

**Figure 2-2. Stream Resources and Competing Water Uses**
(from Chester County Water Resources Authority; Brandywine Creek Watershed Action Plan)

North

An additional important feature of this project is Struble Trail, which is a multi-use path that will eventually reach 16 miles in length and be placed on the rail bed of the former Waynesburg Railroad. The trail is planned to border nearly a mile of the southwestern project boundaries and follow East Branch of Brandywine Creek.

## 2.3 OBJECTIVES FOR SUSTAINABILITY

As a result of our site evaluation and classification process, we have identified the following key objectives by which the sustainability of this project will be evaluated in the Audubon International Gold Signature program:

1. Preserve, restore, maintain, and buffer East Branch of Brandywine Creek and its tributaries on the site.

2. Minimize stream crossings, and if absolutely necessary, design a minimum clearance of 48" high with both stream and uplands provided under the crossing.

3. Preserve, restore, maintain, and buffer wetlands on site and connect with effective wildlife corridors to adjacent preserves.

4. Install littoral vegetation and upland vegetative buffers in and along created ponds to provide habitat.

5. Preserve, restore, and maintain Piedmont vegetation where practical.

6. Use a BMP treatment train complex upstream of East Branch of Brandywine Creek and its tributaries and wetlands to intercept and treat stormwater on site and avoid downstream water quality conflicts.

7. Connect on-site habitat preserves with adjacent preserves along East Branch of Brandywine Creek and Marsh Creek State Park.

8. Preserve, restore and maintain historical and cultural resources throughout the project site.

# 3.0 SPECIFIC REQUIREMENTS FOR HABITAT PRESERVE DESIGN

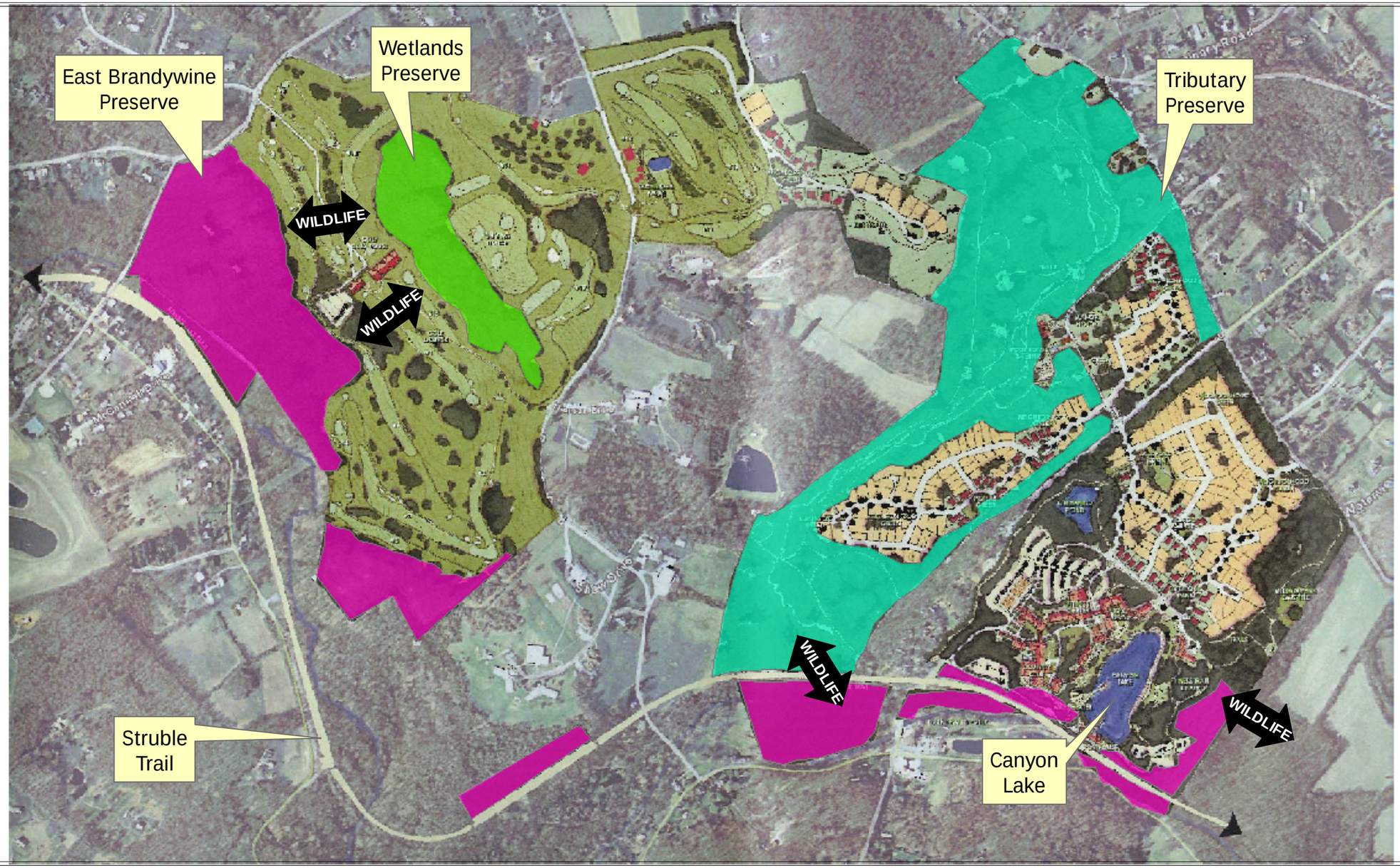
The conceptual preserve design for Valhalla Brandywine is shown in **Figure 3-1**. In general, preserves encompass the existing water bodies and their associated uplands, as well as the aquatic buffer zones as described in **Section 1.4.3** and the Special Management Zones as described in **Section 4.1**. Research indicates that the larger the preserves can be, the better they can perform their critical functions (Woolbright 2003). Portions of preserves may also be appropriate locations for storm water treatment facilities that are part of a comprehensive "treatment train".

The following sections describe the primary preserve areas as well as other aspects of the design.

## 3.1 EAST BRANDYWINE PRESERVE

The East Branch of Brandywine is an important stream, including the channel and riparian uplands, that borders the property and is a significant regional natural feature. A preserve that encompasses the uplands adjacent to the creek is best located generally within 100 feet of the stream channel. There are opportunities to connect this core habitat, for example, along the central tributary as well as with a forested corridor to the large 'isolated' wetland preserve in the northwestern corner of the project.

Initial attention should be focused on restoring a native and attractive plant community along the creek. A critical step in this process is collecting water and soil samples now to determine the appropriate native plant pallette suited to the varied microclimates that exist along this stream corridor (see **Appendix II**). No roads should be planned to cross this feature beyond the existing roads.

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Base information was provided by
Stuart G. Rosenberg, Architects, PC.

**Figure 3-1. Conceptual Preserve Design for Valhalla Brandywine**

North

This East Brandywine preserve is ideal for a recreational and educational trail. The stream is located to easily convey pedestrians throughout the development. As mentioned above, the Struble Trail is planned to run for nearly a mile along the edges of this preserve. Large preserved areas that extend offsite along East Branch of Brandywine Creek as well as southeast in Marsh Creek State Park will supplement this preserve with opportunities for natural and cultural preservation and interpretive information.

## 3.2 TRIBUTARY PRESERVE

The tributary and associated wetlands and uplands that drain to the East Branch of Brandywine Creek are almost entirely encompassed by the project and may be large enough to function as a core preserve. This stream and upland complex is the core wildlife habitat preserve and will be a conduit of project stormwater to the East Branch of Brandywine Creek. A preserve that encompasses the stream channel and associated uplands of the tributary is best located generally within 100 feet of the stream channels. There are numerous opportunities to connect this core preserve, for example, with adjacent parks and with the East Branch of Brandywine Creek.

As with the East Brandywine Preserve, initial attention should be focused on restoring a native and attractive riparian plant community. A critical step in this process is collecting water and soil samples now to determine the appropriate native plant pallette suited to the varied microclimates that exist along this stream corridor (see **Appendix II**).

Another critical focus of attention should be to minimize road crossings, and if necessary, design structures under the main road that are at least 48" tall and encompass both stream channel and uplands to encourage wildlife to cross under versus across the road.

Oriented vertically above the tributary is the forest community as described above in **Section 1.3.5**. The native Piedmont vegetation on the slopes adjacent to the stream is the target of restoration and management. Restoration should proceed as discussed in **Section 1.4** above.

The areas encompassed within the riparian buffers should be preserved, restored, and protected from future disturbance. In the process of rehabilitating this area, it is important that disturbance be minimized and that native vegetation be preserved to the greatest extent possible in order to maximize the buffering function of the preserves.

This preserve may also contain potential nonstructural BMP stormwater treatment facilities. The function of this is to use Natural Systems Engineering to physically and biologically filter stormwater from the development.

## 3.3 WETLAND PRESERVE

Near the center of the Heim parcel in the northwestern corner of the project is a wetland area >10 acres. This preserve will potentially function as key wildlife habitat and refuge with surrounding areas planned for golf or residential development.

The successful conservation of wildlife on a developed parcel depends in large part on whether or not the parcel can provide sufficient natural area to supply the resources needed to support a large enough population of animals to be genetically viable. The wildlife value of a suitable patch of vegetation depends on the size of the patch and the degree to which the patch is connected to other good habitat (Woolbright 2003). Habitat corridors between patches allow animals to move back and forth from their shelters to water and feeding areas on a regular or seasonal basis, without leaving the cover of natural vegetation. They also provide routes for dispersal of young and annual movements of migratory species.

Corridors appropriate to this landscape do not need to be particularly wide or wild. Anything that increases the level of comfort a small animal would have in getting from place to place will help. Rows of native trees with understory plantings (like hedgerows in an agricultural setting) will work well. Even formal landscape elements like native shrub and perennial borders can be used to increase connectivity. The challenge here is to figure out how to connect the maximum number of potential habitat areas with the strongest connections possible in each location.

In this case, the most effective corridor location is to the East Brandywine Preserve along the west side of the wetland. According to Hilty et al. (2006), more than one corridor linkage is preferable, one designed with continuous and one designed with ‘stepping stone’ native vegetation. Although recommendations for dimensions of wildlife corridors vary dramatically

depending on the target species and habitat matrix, preserves of this size (10 acres) generally have corridors 50-100 feet wide.

As with the East Brandywine and Tributary Preserves, initial attention should be focused on restoring native and attractive plant communities along the streams. A critical step in this process is collecting water and soil samples now to determine the appropriate native plant pallette suited to the varied microclimates that exist along the potential wetland-to-stream corridor (see **Appendix II**).

## 3.4 PONDS AS HABITAT

Another feature of Valhalla Brandywine is the degree to which created ponds can provide habitat for fish, amphibians, birds, and other aquatic and semiaquatic wildlife. The typical development lake is designed primarily to hold water, but lacks vegetation that contributes to the habitat integrity of natural water bodies. They also typically lack marginal wetlands and upland vegetation of natural lakes. Yet it is precisely these vegetative areas, both shallow wetlands and adjacent uplands, that determine the habitat value of the lake.

An important part of the Valhalla Brandywine project is the rehabilitation of existing riparian and upland vegetation and the creation of a few small ponds. Although these will be artificial basins, they can be made to more closely resemble natural features. The goal should be to maximize the amount of lake margin that features shallow littoral shelves planted with emergent vegetation and native vegetative buffer extending upland from the water's edge.

# 4.0 STORMWATER MANAGEMENT

Effective Stormwater Management at Valhalla Brandywine utilizes an integrated approach to prevent natural resource degradation. It is a landscape level management program which acts to protect environmentally sensitive areas such as streams and lakes. Through the use of Special Management Zones, Natural Systems Engineering, and Best Management Practices (BMPs) Trains developmental impacts to the environment can be minimized. In **Section 4.2**, we discuss the integration of Natural Systems Engineering and Best Management Practices to manage stormwater.

In this document stormwater management is discussed relative to the overall planning and design for the property. In the Natural Resource Management Plan, these ideas are fully explored and long term management details are specified.

The process of managing the property in an environmentally sensitive manner involves the following:

1. **Establishing Special Management Zones throughout the community.** Special Management Zones are defined as areas that have distinct management practices that coincide with their position in the watershed. For Valhalla Brandywine, these are based on the analysis of resources and habitat protection requirements (See **Section 4.1** for details).

2. **Use Natural Systems Engineering throughout the community.** Natural Systems Engineering is an approach to stormwater management that maximizes the use of natural systems to treat water. This type of stormwater management is very effective because it increases the lag time of stormwater runoff and therefore reduces the quantity of water in channels at any given time

3. **Establish Best Management Practices 'Trains' for maximum environmental protection.** The most effective way to protect surface water and groundwater is by using a comprehensive systems approach that includes integration of preventative practices and structural controls (Smart & Peacock 2002). Preventative measures include nonstructural practices that minimize or prevent the generation of runoff and the contamination of runoff by pollutants; for example, using organic fertilizers on

the pasture lands. Structural controls are capital improvements designed to remove, filter, detain, or reroute potential contaminants carried in surface water. Because water is the primary movement mechanism for contaminants, protection of water resources also provides the basis of protection for sensitive areas and species. See **Appendix III** for examples of effective BMPs.

This comprehensive systems approach will be used throughout Valhalla Brandywine, and it stresses optimum site planning and the use of natural drainage systems, and is considered a "Best Management Practices (BMPs) Train" in which the individual BMPs are considered the cars. The more BMPs incorporated into the system the better the performance of the treatment train. The first "cars" include preventative BMPs to minimize generation of runoff and the final cars generally include structural controls (See **Section 4.2.2** for details).

The effectiveness of pollutant removal is a function of three interrelated factors: 1) the removal mechanisms used by the BMP, which include physical, chemical, and biological processes; 2) the fraction of runoff treated by the BMP; and 3) the nature of the pollutant being removed. An effective "BMP train" is one that treats 100% of runoff by physical, chemical, and biological processes. By including as many removal mechanisms as possible in each "BMP treatment train", the probability of success for removal of a particular pollutant is increased.

## 4.1 SPECIAL MANAGEMENT ZONES AT VALHALLA BRANDYWINE

The process of managing Valhalla Brandywine in an environmentally sensitive and responsible manner involves establishing special management zones throughout the community. Special management zones are defined as areas in the community that have distinct management practices that coincide with their position in the watershed, and are based on the analysis of resources and habitat protection requirements. Special management zones work hand-in-hand with Natural Systems Engineering and establishment of Best Management Practices and Integrated Pest Management. Special Management Zones and buffers occupy the same space. Special management zones are shown generally in **Figure 4-1**.

### 4.1.1 Special Management Zone A: No Spray Zones

No spray zones are established around each water body (stream, pond) 25 feet landward from normal water elevation. No pesticides will be used in these areas, and only slow release nitrogen fertilizers will be used. No phosphorus fertilizer will be used unless the soil test indicates a low level.

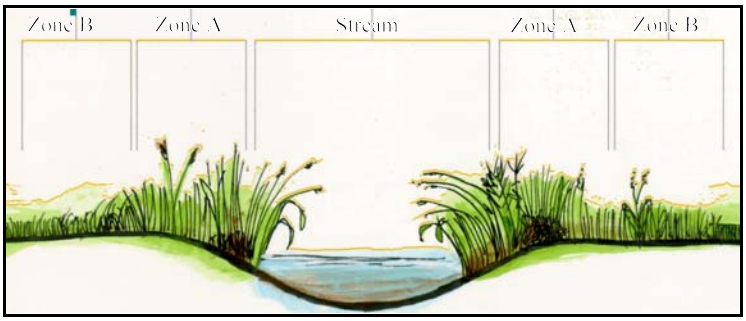



*Figure 4-1. Cross section of a typical Special Management Zone*

### 4.1.2 Special Management Zone B: Limited Spray Zones

Limited spray zones are established around each water body (stream, pond), beginning 25 feet landward from normal water elevation and extending to 50 feet landward from normal water elevation. A limited set of pesticides (identified in the Natural Resource Management Plan and based on the Tier 1 Risk Assessment) may be used in this zone, and fertilization will be as described for Special Management Zone A.

By following a system of using wetland buffers, chemical reduction, and chemical application procedures, the golf portion of the project should have minimal impact on water quality. **Figure 4-2, Recommended Management Zones & Practices for Audubon International Signature Courses**, illustrates the location of Special Management Zones for golf courses.

## 4.2 BEST MANAGEMENT PRACTICES AND NATURAL SYSTEMS ENGINEERING

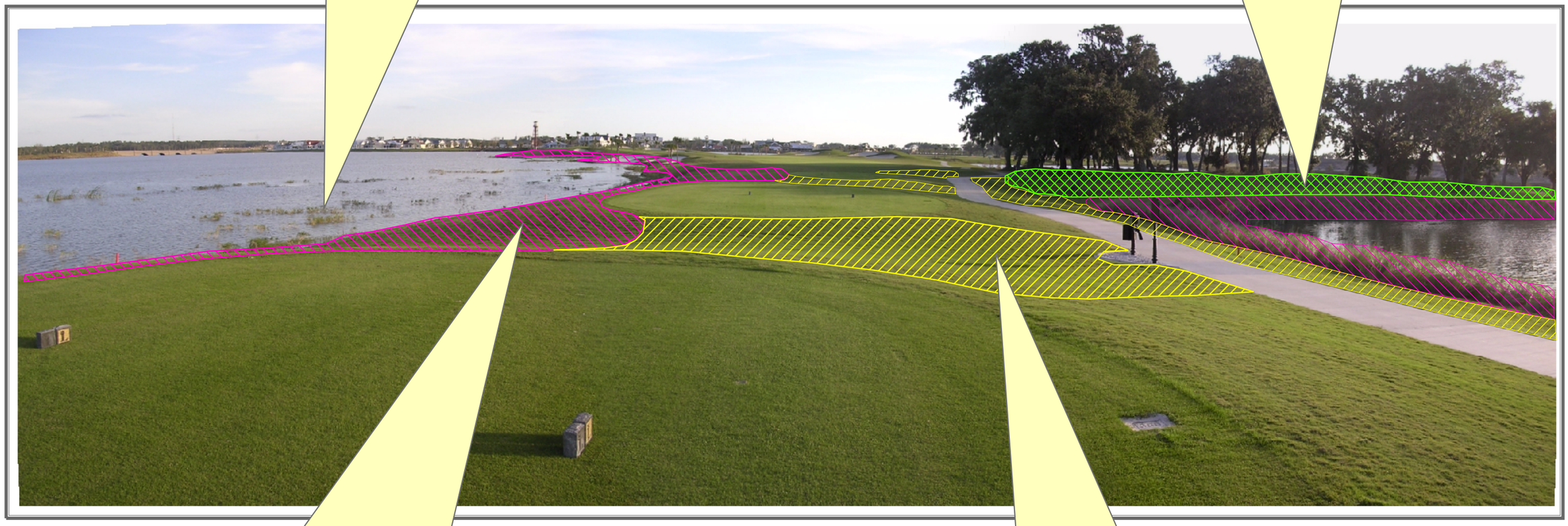
### 4.2.1 Establish a Natural Systems Engineering Approach Coupled with Best Management Practices 'Trains' for Maximum Environmental Protection

Stormwater drainage from all areas on the property will be treated with a combination of Natural Systems Engineering and BMP Trains. Natural Systems Engineering results in the least amount of stormwater that needs to be treated, and BMP Trains provide a series of treatments to ensure water is the best possible water quality (**Figure 4-3**). In the planning and design phase of development, preventative practices are identified, and specific land use practices will be identified later in the development process.

# Recommended Management Zones & Practices for Audubon International Signature Courses

LAKE PROTECTION: Monitor, identify and manage potential nuisance aquatics

NATIVE FOREST UNDERSTORY: Transplant or plant native shrub and groundcover species in forest patch



MANAGEMENT ZONE A - NO SPRAY ZONE: 25 feet from lake, plant native grasses and eliminate irrigation or increase turf mowing height and decrease mowing frequency

MANAGEMENT ZONE B - LIMITED SPRAY ZONE: 25-50 feet from lake, increase turf mowing height and decrease mowing frequency

### 4.2.2 Natural Systems Engineering and Preventative Practices BMPs

Preventative measures are considered the 'first line of defense' in an integrated storm water management system. The preventative measures used at Valhalla Brandywine include land use controls and source prevention practices. Natural Systems Engineering is part of the prevention practice BMPs; and recommended implementation includes both design/construction and management protocols.

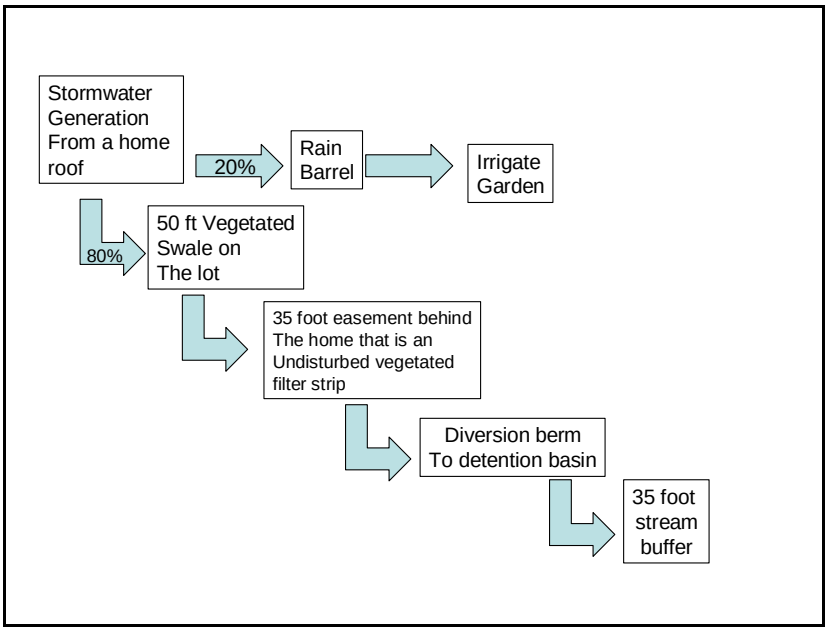



*Figure 4-3. An Example of a BMP Train, showing the multiple steps used to effectively treat stormwater.*

1. **Minimize site disturbance**. In keeping with the primary goal for environmentally responsible development, the amount of site disturbance should be minimized. Preserving the existing landscape by limiting the amount of disturbance reduces:
    - the need for soil stabilizing and erosion control measures,
    - the re-vegetation and restoration costs associated with development, and
    - the disruption to the ecosystem.

    To minimize site disturbance:
    - Disturb only those areas where development will occur.
    - Use an ecosystem approach to environmental planning.
    - Develop in areas that are already disturbed.
    - Provide habitat linkages between open spaces.
    - Place land uses with potential impacts to ecological resources away from the resource.
    - Keep to a minimum the increase in the amount of impervious surface that will result from the development.
    - Design around significant natural resource features such as wetlands, streams, and high-quality habitat.

- Incorporate natural resources into the design as amenities.
- Restore and enhance ecological functions damaged by prior site activities such as the mining operation.
- Use natural systems engineering to manage stormwater on the property.

2. **Utilize a Natural Systems Engineering approach to provide protection of water resources and increase wildlife habitat**. Key points in the Natural Systems Engineering approach at Valhalla Brandywine include:
   - Drainage is integrated into the community and the drainage systems provides a benefit to the property, for example, as a source water for irrigation.
   - Roadways are constructed with no curb and gutter where practical and vegetated swales are used to direct flow away from the roads.
   - Stormwater is treated in the smallest increments possible, allowing effective treatment without the necessity of large basins. Home lots are the ideal place to begin treating stormwater (**Figure 4-4**). Developed pods of relatively large home lots should not have curb and gutter and the stormwater generated on each home lot is treated within each lot, or at least treatment begins with each home lot.


*Figure 4-4. On Lot Treatment for Effective Stormwater Management (from Low Impact Development-Technical Guidance Document for Puget Sound, January 2005).*

- Store stormwater to recharge groundwater, use in irrigation, or be an amenity.
- Conduits are of natural materials, with riparian corridors providing good water management and habitat value.
- While areas of high development density may not accommodate all of the above, a combination of for example, on-site controls, discharge to natural drainage ways, natural treatment devices at point of discharge, and buffers along receiving waterways may be employed to treat stormwater.

To utilize a Natural Systems Engineering approach at Valhalla Brandywine:

- Runoff from areas within Valhalla Brandywine will not be directly discharged into an environmentally sensitive area; e.g., wetland, stream, or forest preserve without proper treatment.

- Water quality will be protected with the BMP train approach.

- Native or naturalized plant material will be used at home sites or other areas that are landscaped.

- Consider constructing underground rainwater storage basins for irrigation at individual properties.

- Minimize the width of roadways and sidewalks

- Identify a proper irrigation system and location of heads (one that gets the right amount of water in the right place at the right time).

- Identify building envelopes and road locations. Landscaping outside the building envelope is not recommended. Within the building envelope, landscaping and features are allowed.

- Identify proper timing and placement of fertilizers and the use of soil testing to establish fertilizer application rates. Use slow release fertilizers.

- Physical or cultural control of pests or encouraging natural biological control

- Establish buffers around sensitive areas.

- Use a risk-based process to select pesticides which are less toxic, persistent, soluble and volatile whenever feasible. Only materials which have a reasonable margin of safety will be included in the recommended list.

- Identify and train landscape vendors, or limit the number of vendors, so that we are assured that they will follow the Natural Resource Management Plan when maintaining landscapes at Valhalla Brandywine.

### 4.2.3 Land Use Control BMPs

Land use control BMPs that will be used at Valhalla Brandywine include many different vegetative practices that will be identified later in the development process. At this point in the assessment and analysis of the property, it is important to note that BMPs will be incorporated into 'treatment trains' and that little hardscape, if any, will be used to treat stormwater.

# 5.0 OUTLOOK FOR FINAL DIAMOND RATING

Valhalla Brandywine will not be certified or given a diamond rating until an example of each broad type of land use is substantially complete. However, we attempt as early as possible to try to anticipate the likely outcome and provide suggestions on how to maximize the ultimate diamond rating. None of this section should be construed as a promise or a guarantee. The final rating and certification are at the complete discretion of the Audubon International staff who evaluate the completed project, and will be based on project conditions as they exist at that time.

Based on the analysis presented in this document, we do not see any reason why Valhalla Brandywine should fail to achieve certification as a Gold Signature Sanctuary. We believe the objectives and specific requirements outlined in this document are consistent with the planning process to date and the wishes of the project team as expressed to us during our initial site visit. Therefore we are confident that if planning and construction meet the guidelines presented here Valhalla Brandywine will be certified at least at the two-diamond level.

The challenge before the development team is to try to guide the project in such a way as to receive a two-diamond designation. The main opportunities to achieve two diamonds are to maximize upland preserve and connectivity among preserves.

Key strategies towards the goal of a two-diamond designation would be:

1. Increasing the functionality of the core Tributary Preserve by maximizing the upland preserve in addition to the stream and wetlands (discussed above in **Section 3.2**);

2. Maintaining sizeable (50-100 feet) buffers on created ponds and using a BMP train on the slopes above the created ponds and streams to intercept and biologically filter the stormwater generated from development (discussed above in **Section 4.0**); and

3. Increasing the amount and quality of connectivity between small habitat patches and the larger core habitats by preserving or restoring sizeable (50-100 feet) wildlife corridors (discussed above in **Section 3.3**).

All three of these strategies are consistent with the current conceptual design for Valhalla Brandywine, and all three could be implemented in varying degrees ranging from poor to outstanding.

Because this document is being written at the same time the site plans for the project are being finalized, it is impossible at this time to provide specific estimates of the impact of these efforts. However, as soon as the site plan is finalized and approved, we can develop much more accurate projections and begin to give more specific advice. We will be happy to continue to revise our projections as the planning and construction of the project move forward. It is our goal to have this project be as environmentally sound and highly rated as possible.

# 6.0 DEVELOPMENT OF ONGOING MONITORING AND MANAGEMENT PLAN

Environmental planning is an imprecise science. Ecological understanding of complex ecosystems is not well developed. What worked in one type of ecosystem might not work in another. The current astonishing rate of species extinctions and changes in climate make even what we do know uncertain in the future. Therefore, the impact of any management plan must be evaluated after it is in place, and we must be ready to revise and adjust it. This kind of adaptive management is a key to successful conservation planning (Peck 1998).

## 6.1 POPULATIONS OF SPECIAL CONCERN OR INTEREST

A primary task of the Natural Resource Manager for the project will be to identify and track existing populations of all of species identified as worthy of special consideration on this site. The location of conservation areas and "off-limits" areas is expected to shift as a result of adaptive management based on these surveys.

In addition, we suggest that animal surveys be a key part of the community education program at Valhalla Brandywine. An ongoing list of mammals, birds, reptiles, and amphibians should be kept for the community, and residents should be encouraged to notice the wildlife around them and add to the list. Please include this list with the annual reports that are sent to Audubon International.

We also recommend that Valhalla Brandywine participate in Audubon International's annual nestbox survey. Nestboxes suitable for small cavity-dwelling birds should be placed on the property, and on home lots as residents wish, and the nesting success of breeding birds tracked each year. In addition to these, large boxes for waterfowl can be placed around created lakes. Audubon International distributes a data reporting sheet to member properties once a year, and we compile data nationally for statistical analysis.

For the status and distribution of threatened and endangered species in Pennsylvania, see the Pennsylvania Department of Conservation and Natural Resources report found at http://www.dcnr.state.pa.us/wrcf/contents.aspx.

## 6.2 NATURAL COMMUNITIES THAT REQUIRE CONTINUED ATTENTION

In order to evaluate the success of the major preserve areas, plant biodiversity should be tracked annually in them. Plants should be monitored along permanent vegetation transects, perhaps associated with walking trails, and the plant community should be photographed from standardized camera points once each year for a visual record. It will be important to know whether the plant communities are maintaining their integrity or whether they are being threatened by exotic species. In the latter case, corrective management would be required. For a field guide on identification and control of invasive exotics typical of Pennsylvania, see this list http://www.dcnr.state.pa.us/Forestry/invasivetutorial/List.htm developed by the Department of Conservation and Natural Resources and the Mid-Atlantic Exotic Pest Plant Council.

Plant community sampling and basic water quality sampling are appropriate tasks for Valhalla Brandywine's Natural Resource Manager. They are important basic quantities that need to be monitored on a regular basis using standardized and verifiable methodologies. Good documentation is essential.

In addition to these basic requirements, we recommend that management be on the lookout for other opportunities to collect information on the ecology of Valhalla Brandywine. Local schools can be approached about adopting monitoring efforts as part of their environmental education programs. A great deal could be accomplished if one or more schools could identify science teachers willing to make a commitment to such a long-term project. Local environmental groups might also be willing to lend their expertise on such things as bird counts. The costs of such a partnership would be minimal, and the potential pay-off in information and public exposure would be great. Standardization and repeatability are less critical with such partnership efforts.

## 6.3 WATER QUALITY MONITORING

The Environmental Monitoring Program for the Valhalla Brandywine community will include monitoring of surface water and groundwater. The monitoring program is based on sound scientific principles and the program has goals that include:

1. Establish a baseline of water quality prior to construction,
2. Establish a method for measuring compliance with environmental regulations, and
3. Ensure that Integrated Pest Management is functioning properly.

Results of the Environmental Monitoring Program provide feedback to the managers and thus provide a useful management tool. **Table 6-1** is a summary of the monitoring program.

**Table 6-1. Summary of the Monitoring Program for the Valhalla Brandywine Community. See text for details.**

| Monitoring Phase | Sample stations | Sample Frequency (see text for conditions that may result in reduced sampling) | Variables to analyze | Collection and analyses notes |
|---|---|---|---|---|
| Phase I (pre-construction) | SW-1,2,3,4 | Four times prior to Phase II | Field and Lab as given in Table 6-2 | Pesticides analyzed one time only |
| | GW-1,2,3,4,5 | Four times prior to Phase II | Field and Lab as given in Table 6-2 | Pesticides analyzed one time only |
| Phase II construction | SW-1,2,3,4 | Quarterly | Field and Lab as given in Table 6-2 | No pesticide analysis |
| | GW-1,2,3,4,5 | Quarterly | Field and Lab as given in Table 6-2 | No pesticide analysis |
| Phase III (operations) | SW-1,2,3,4 | Quarterly | Field and Lab as given in Table 6-2 | analyze only pesticides that are used |
| | GW-1,2,3,4,5 | Quarterly | Field and Lab as given in Table 6-2 | analyze only pesticides that are used |

The Environmental Monitoring Program is established in phases that coincide with development. Phase I is the pre-construction time frame; Phase II is the construction time frame; and Phase III is the post-development, operational phase for the community.

### 6.3.1 Phase I: Surface Water and Groundwater Quality during Pre-Construction

The goal of Phase I is to define background conditions for surface water and ground water quality.

#### 6.3.1.1. *Sample Locations*.

*Surface Water*. Surface water will be sampled at the location described below and shown on **Figure 6-1** (SW means surface water):

- Sample Station SW-1. Pond on the golf course at golf hole number 16.
- Sample Station SW-2. Un-named tributary to the East Branch of Brandywine Creek at the point of inflow onto the property.
- Sample Station SW-3. Un-named tributary to the East Branch of Brandywine Creek at the point of outflow from the property.
- Sample Station SW-4. Within Canyon Lake.

Obtaining water samples from the same location is important so that comparisons can be made. Sample stations will be located and identified on maps, and photographed so that stations are easily located during subsequent sampling efforts.

*Groundwater.* Groundwater will be sampled at the locations that are described below and shown on **Figure 6-1** (GW means groundwater):

- Sample Station GW-1. Shallow groundwater to the north of the tees at golf hole number 11.
- Sample Station GW-2. Shallow groundwater well near the greens for golf holes 12 and 14.
- Sample Station GW-3. Shallow groundwater well between the un-named tributary and the development pod to the south of the tributary.
- Sample Station GW-4. Shallow groundwater well near the SE corner of the property.
- Sample Station GW-5. Shallow groundwater well between golf hole number 3 and East Branch Brandywine Creek.

Groundwater sample stations will be field marked, identified on maps, and photographed.

Groundwater wells are environmental monitoring wells, not water consumption wells, and are installed according to standards.

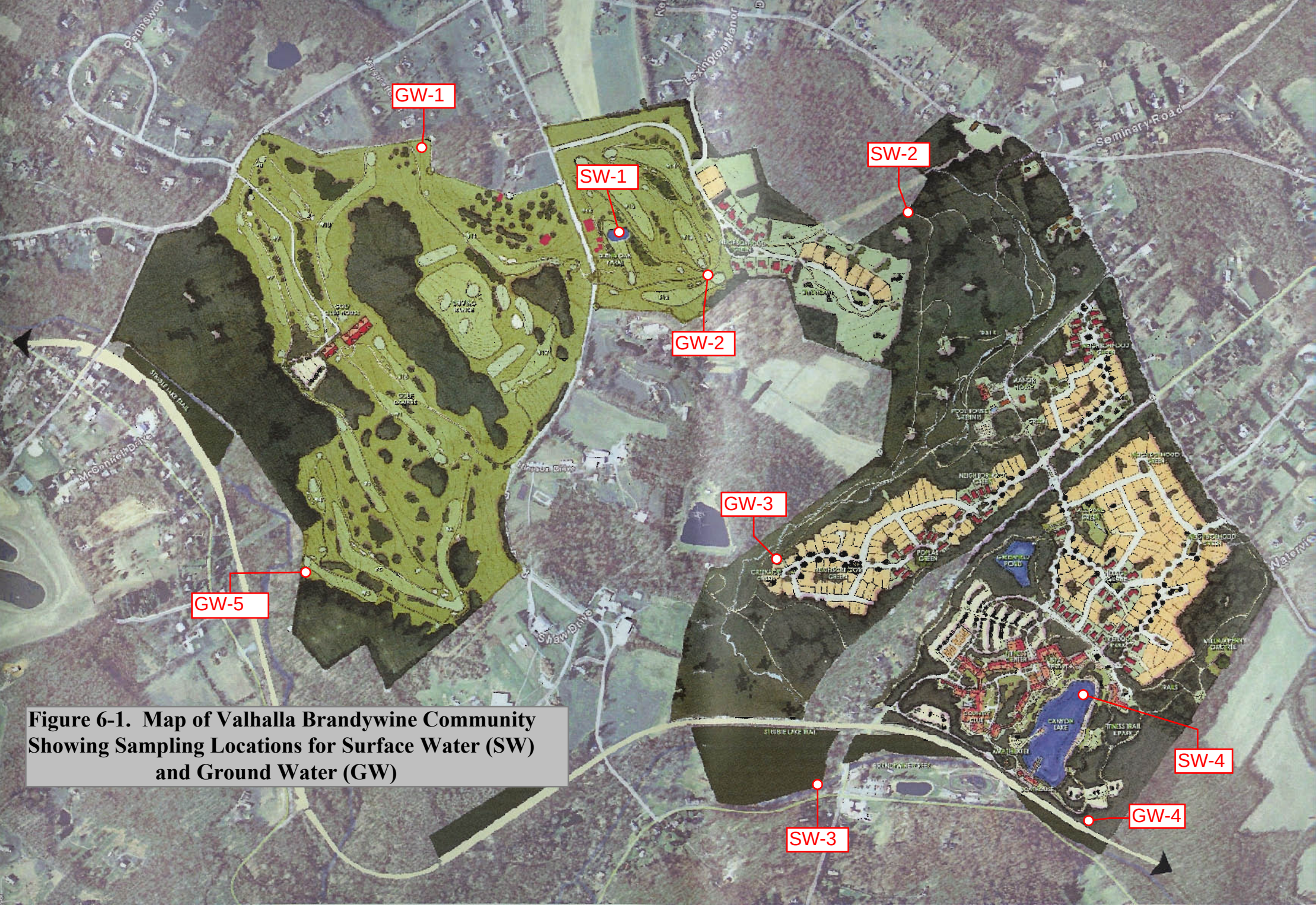



**Figure 6-1. Map of Valhalla Brandywine Community Showing Sampling Locations for Surface Water (SW) and Ground Water (GW)**

**6.3.1.2. *Sample Frequency*.**

*Surface Water*: Surface water samples will be collected a minimum of four times prior to the beginning of Phase II. Ideally, one sample event will be in Spring (March, April, May), one in Summer (June, July, August), one in Autumn (September, October, November), and one in Winter (December, January, February). Samples should be taken during 'dry' conditions which are defined as two days with no precipitation.

*Groundwater*: Groundwater samples will be collected four times prior to the beginning of Phase II. Samples will be collected once in Spring, once in Summer, once in Autumn and once in Winter at the same time that surface water samples are collected.

**6.3.1.3. *Sample Variables*.** Surface water and groundwater will be analyzed for the variables listed in **Table 6-2**. A pesticide scan that includes most of the pesticides that may be used at the golf course and community will be run on the samples to assess Phase I conditions (see the list of pesticides in **Appendix IV**). This scan will be modified based on the ecological risk assessment that will be conducted as part of preparing the Natural Resource Management Plan. Once the ecological risk assessment is completed, pesticides will be included in the monitoring program if their "risk ratio" exceeds 0.1. The "risk ratio" is the quotient of the maximum anticipated concentration of the pesticide divided by its effects criteria (see **Appendix I** in the NRMP for a description of the maximum anticipated concentration and effects criteria).

A risk ratio of a given pesticide which is greater than 1.0 indicates that the maximum anticipated concentration exceeds the effects criteria; meaning that the use of that pesticide at Valhalla Brandywine community represents more than a negligible risk. A risk ratio of less than 1.0 indicates that the use of that pesticide at the golf course represents only negligible risk. By including as analytes all pesticides whose risk ratio is greater than one-tenth the point at which risk is presumed to be more than negligible, the monitoring program design ensures that all potentially risky pesticides are monitored for.

In Phase I of the monitoring program, pesticides will be analyzed one time.

**Table 6-2. Variables to be Analyzed (x) in Surface- and Ground- Water at the Valhalla Brandywine Community [a].**

| Variable | PHASE I Environmental Monitoring Program | | PHASE II Environmental Monitoring Program | | PHASE III Environmental Monitoring Program | |
|---|---|---|---|---|---|---|
| | Surface Water | Ground Water | Surface Water | Ground Water | Surface Water | Ground Water |
| **Field Analyses** | | | | | | |
| pH | X | X | X | X | X | X |
| Water Temperature | X | X | X | X | X | X |
| Specific Conductance | X | X | X | X | X | X |
| Dissolved Oxygen | X | | X | | X | |
| **Laboratory Analyses** | | | | | | |
| Total Nitrogen | X | X | X | X | X | X |
| Nitrate-Nitrite Nitrogen | X | X | X | X | X | X |
| Ammonia-Nitrogen | X | X | X | X | X | X |
| Total Phosphorus | X | X | X | X | X | X |
| Orthophosphate Phosphorus | X | X | X | X | X | X |
| Turbidity | X | X | X | X | X | X |
| ***Pesticides*** A pesticide scan will be run on samples in Phase I. It may be modified in Phase III as given above. The list of pesticides included in the scan are given in **Appendix IV**. | | | | | | |

**6.3.1.4.** ***Field Methods*.** Variables, container type, preservation and holding times for water samples are given in **Table 6-3.**

*Surface Water*. A number of variables will be measured *in-situ*, including pH, water temperature, dissolved oxygen, and specific conductance. pH will be measured with a pH probe that has been calibrated just prior to use. Specific conductance will be measured with a calibrated specific conductance meter. Dissolved oxygen will be measured with a dissolved oxygen probe adjusted for altitude. Water temperature will be measured with a temperature probe attached to the specific conductance meter or to the dissolved oxygen meter.

Stream water will be sampled by obtaining 'discrete' grab samples of water. Discrete grab samples are taken at a selected location, depth and time, and then analyzed for the constituents of interest. Stream water will be obtained from the center of flow at mid-depth and analyzed for the variables listed in **Table 6-2**. Water will be collected in sample bottles that face upstream, and water is transferred to sample containers that include proper preservatives and labels. The sample containers are immediately placed in a cooler with ice and are taken to a laboratory for analysis.

Lake water will be sampled by obtaining 'discrete' grab samples of water. Discrete samples will be taken from approximately 6 inches below the surface. Water is transferred to sample containers that include proper preservatives and labels. The sample containers are immediately placed in a cooler with ice and are taken to a laboratory for analysis.

A chain-of-custody program is followed to assure that proper transportation and storage practices are documented and that the appropriate analyses are being conducted.

A field sampling log of surface water sampling and observations will be maintained. The log book documents site conditions, observations, weather conditions, and field measurements. Calibration information is maintained in the field log book. An example of a page from a field log is given in **Appendix V**.

*Groundwater Wells.* Groundwater elevation is determined for each well on each sampling date. After measuring water elevation, the standing water in the well is removed, and replaced by fresh formation water. The quantity of water removed is determined from the well volume and recharge rate. In general, high-yield wells are purged of three well casing volumes of water and low-yield wells are pumped to dryness. Each well is purged using a portable pump that is cleaned between well samplings. Water is suitable for sampling when three consecutive measures of water have stable pH, temperature and specific conductance readings.

Wells are allowed to recharge after purging to allow the system to equilibrate. Depth to the water table is remeasured, recorded and water samples are extracted. Extraction occurs with a pump, or a dedicated Teflon® bailer. Water temperature, pH, and specific conductance are measured in water that will not be used for laboratory analyses. Water samples are taken and decanted or drained into an appropriate sample container that has

the proper preservatives and is labeled. Samples are transferred from the sample device to the sample container in a manner that will minimize turbulence and the loss of volatile compounds. Samples are immediately placed in a cooler with ice and transported to the analytical laboratory. Whenever non-dedicated equipment is used, standard cleaning procedures will be instituted. Special attention will be given to thoroughly cleaning samplers, tubing, and other equipment. And, to ensure that the sample is not contaminated, blanks will be collected and analyzed.

A chain-of-custody program is followed to assure that proper transportation and storage practices are documented and that the appropriate analyses are being conducted.

A field sampling log on groundwater sampling and observations will be maintained. The log book documents site conditions, including water depth, observations, weather conditions, and field measurements. Calibration information will be maintained. An example of a page from a field log is given in **Appendix V**.

**Table 6-3. Variables, Container Type, Preservation, and Holding Times for Water Samples in Surface- and Ground-Water at Valhalla Brandywine Community.**
**(Analytical methods are from the latest edition of Standard Methods or EPA Methods.)**

| Variable | Container Type | Preservation | Holding Time | Target Detection Limit (mg/L) |
|---|---|---|---|---|
| pH | not applicable | not applicable | not applicable | 0.01 units |
| Water Temperature | not applicable | not applicable | not applicable | 0.1 °C |
| Dissolved Oxygen | not applicable | not applicable | not applicable | 0.01 |
| Specific Conductance | not applicable | not applicable | not applicable | 0.5 units |
| Total-N | P, G | Cool, 4° C, $H_2SO_4$ to pH <2 | 28 d | 0.02 |
| Nitrate-Nitrite-N | P, G | Cool, 4°C | 48 h | 0.01 |
| Ammonia-N | P, G | Cool, 4° C, $H_2SO_4$ to pH <2 | 28 d | 0.01 |
| Total Phosphorus | P. G | Cool, 4° C, $H_2SO_4$ to pH <2 | 28 d | 0.01 |
| Orthophosphate Phosphorus | P, G | Cool, 4° C, $H_2SO_4$ to pH <2 | 28 d | 0.01 |
| Turbidity | P, G | Cool, 4°C | 48 h | 0.1 |
| ***Pesticides*** - As given in Appendix IV. Detection limits are less than 0.5 of the HAL or 0.1 of the $LC_{50}$. | | | | |

| Table 6-3. Variables, Container Type, Preservation, and Holding Times for Water Samples in Surface- and Ground-Water at Valhalla Brandywine Community. (Analytical methods are from the latest edition of Standard Methods or EPA Methods.) | | | | |
|---|---|---|---|---|
| **Variable** | **Container Type** | **Preservation** | **Holding Time** | **Target Detection Limit (mg/L)** |
| note that container types are 'G' for glass and 'P' for plastic. | | | | |

**6.3.1.5.** ***Laboratory Methods*****.** The Laboratory used for sample analysis must retain certification by the Environmental Protection Agency (EPA) or its designated State Agency to conduct chemical analyses on surface water and drinking water.

In cases where standard methods are not available, the Laboratory will execute method development and follow closely related standard practices, and demonstrate accuracy and precision of the method with at least a 5-point standard curve, sample spikes, and duplicate analyses.

### 6.3.2 Phase II: Surface Water and Groundwater during Construction

The goal of Phase II is to monitor surface water and groundwater quality during construction of the Valhalla Brandywine community.

#### 6.3.2.1. *Sample Locations*.

*Surface Water*. Surface water will be sampled at the location described in Phase I monitoring program. Locations on the property are given in **Figure 6-1**.

*Groundwater*. Groundwater will be sampled at the locations that are identified in the Phase I monitoring program. Locations of groundwater wells are shown on **Figure 6-1**.

#### 6.3.2.2. *Sample Frequency*.

*Surface Water*. Sample frequency will be as given in Phase I.

*Groundwater*. Sample frequence will be as given in Phase I.

**6.3.2.3.** ***Sample Variables.*** Surface water and groundwater will be analyzed for the variables listed in **Table 6-2**.

**6.3.2.4.** ***Field Methods.*** Variables, container type, preservation and holding times for water samples are given in **Table 6-3**.

*Surface Water*. Surface water sampling will follow the protocols outlined in Phase I.

*Groundwater*. Groundwater sampling will follow the protocols outlined in Phase I.

**6.3.2.5.** ***Laboratory Methods.*** Laboratories used for sample analysis will follow the protocols outlined in Phase I.

### 6.3.3 Phase III: Surface Water and Groundwater during the Post-Construction/Operational Time Frame

The goal of Phase II is to monitor surface water and groundwater quality during the post construction/operational time period of the Valhalla Brandywine community.

**6.3.3.1.** ***Sample Locations.***

*Surface Water*. Surface water will be sampled at the location described in Phase I monitoring program. Locations on the property are given in Figure 6-1.

*Groundwater*. Groundwater will be sampled at the locations that are identified in the Phase I monitoring program. Locations of groundwater wells are shown on Figure 6-1.

**6.3.3.2.** ***Sample Frequency.***

*Surface Water*. Sample frequency will be as given in Phase I.

*Groundwater*. Sample frequence will be as given in Phase I.

*Sample Frequency in Future Years*. Sampling will be reduced to two sample times in Spring and Autumn during times after three years of operation, provided that no

detections or changes in water quality triggering a management response (see Section 6.3.6) have occurred.

**6.3.3.3. *Sample Variables*.** Surface water and groundwater will be analyzed for the variables listed in Table 6-2.

**6.3.3.4. *Field Methods*.** Variables, container type, preservation and holding times for water samples are given in Table 6-3.

*Surface Water*. Surface water sampling will follow the protocols outlined in Phase I.

*Groundwater*. Groundwater sampling will follow the protocols outlined in Phase I.

**6.3.3.5. *Laboratory Methods*.** Laboratories used for sample analysis will follow the protocols outlined in Phase I.

### 6.3.4 Data Storage

Data generated from this monitoring program for the community will be maintained by the superintendent along with other course records and data on pesticide and fertilizer use, personnel, and training. This information will be provided annually to the Signature Program Office of Audubon International.

Monitoring data from field sampling and from laboratory analyses will be entered into a computer spreadsheet (e.g., EXCEL, QuattroPro). Data analyses will be performed with this data set. The data set will be printed after each update and the printed data will be stored in a notebook. A backup of the computer spreadsheet data will be maintained. Field data sheets will be maintained in a notebook. A summary of the results of the surface and groundwater samples, with a list of any remedial actions that were taken will be kept.

The golf course superintendent will maintain records of cultural activities at the course. Items will include application schedules of all pesticides and fertilizers applied to the golf course as outlined in the pesticide section of this Plan. Information will include the date of application, rate of application, product used, and specific location where the material was applied. Scouting records as part of the IPM program will also be kept.

One time per year, a report will be prepared and submitted to the Signature Program Office, and to appropriate agency personnel. The report will summarize applications of fertilizers and pesticides, water data collected (including changes from background or upgradient sources, trends, and concerns), and any management responses. A discussion of the data relative to the data analysis section below will also be highlighted in the report.

### 6.3.5 Data Analysis

Data generated in the monitoring program will be compared to background concentrations and State surface water and groundwater standards.

Pesticide analysis data will be compared with toxicological triggers as specified in **Table 6-4**. In Phase III, concentrations of water variables will be compared with background concentrations to determine changes from background conditions.

Data will also be compared with State water quality criteria and the USEPA pesticide Health Advisories Limits (HAL's, given in **Appendix I, Table I-1** of the NRMP) that have been reduced by a factor of 0.5. This is a very conservative factor given that HALs have a margin of safety of 100 to 1000 already built into the HAL number.

Protection of aquatic life will be evaluated by comparing measured concentrations against $LC_{50}$ data (**Appendix I, Table I-1** of the NRMP) that have been reduced by a factor of 10. $LC_{50}$ data exist for most of the chemicals, and the lowest $LC_{50}$ obtained for the pesticide was divided by a correction factor of 10 to obtain a screening criteria (Suter et al., 1989; Warren-Hicks et al., 1989, 1995). This is a conservative factor that serves as an estimate for chronic values.

### 6.3.6 Criteria for Management Response

Criteria for management response are summarized in **Table 6-4**.

**6.3.6.1.** ***Non-Pesticide Analytes*****.** If concentrations of non-pesticide variables exceed Applicable Water Quality Criteria, or if measured concentrations of nutrients exceed the standard deviation of background levels by more than two-times, then the media will be resampled and a review of management practices, site conditions and weather conditions will be implemented to determine reasons for increased concentrations. The immediate action will also include a reduction in fertilizer use and/or an increased proportion of slow-release fertilizers. Following the review

cited above, these immediate restrictions may be lifted or modified, as appropriate. Records of all actions taken will be maintained by the superintendent and included in the annual report.

**6.3.6.2.** ***Pesticide Concentration below a Toxicologically Significant Level*.** If a pesticide listed in **Table 6-2** is detected in samples at concentrations below a toxicologically significant level [i.e., one-half the USEPA Health Advisory Limits (HAL x 0.5) or one-tenth the $LC_{50}$ for the most sensitive aquatic organism ($LC_{50}$ x 0.1), whichever is lower] the following responses will be implemented:

1. The sample station from which the detection was obtained will be resampled immediately upon receipt of the data from the laboratory and reanalyzed for the pesticide.
2. If the results of the resampling indicate a detection of the pesticide, a review of the application, weather conditions after its application, and possible alternative control measures will be conducted and adjustments to the application protocol will be made based on the results of this review. Also, management responses 3 and 4 below will be implemented. If the results of the resampling indicate no detection of the pesticide, no further management response will be implemented.
3. The sample station from which the detection was obtained will be resampled and analyzed for all pesticides applied to the golf course and community common areas within one year prior to the sampling event.
4. All samples collected from the sampling station from which the detection was obtained, for a period of one year from the date of the detection, will be analyzed for all pesticides applied to the golf course and community within one year prior to the sampling event.

**6.3.6.3.** ***Pesticide Concentration above a Toxicologically Significant Level*.** If a pesticide listed in **Table 6-2** is detected in samples at concentration above a toxicologically significant level as determined by the USEPA Health Advisories Limits (HAL x 0.5) or by the aquatic toxicity as measured by $LC_{50}$ x 0.1, whichever is lower, the following responses will result:

1. The pesticide immediately will be removed from the list of recommended pesticides and its use at the Valhalla Brandywine community will be terminated.
2. The sample station from which the toxicologically significant detection was obtained will be resampled twice (once immediately upon receipt of the data from the

laboratory and once approximately ten days after receipt of the data) and reanalyzed for the detected pesticide.

3. If the results of the resampling indicate a detection of the pesticide but at a concentration below the toxicologically significant level, a review of the application, weather conditions after its application, and possible alternative control measures will be conducted; use of the pesticide at the golf course and community common areas may be reinstated, with adjustments in the application protocol being made based on the results of this review; and management responses 4 and 5 below will be implemented. If the results of the resampling indicate no detection of the pesticide, use of the pesticide at the golf course and common areas may be reinstated and no further management response will be implemented.
4. The sample station from which the detection was obtained will be resampled and analyzed for all pesticides applied to the golf course and common areas within one year prior to the sampling event.
5. All samples collected from the sampling station from which the detection was obtained, for a period of one year from the date of the detection, will be analyzed for all pesticides applied to the golf course and common areas within one year prior to the sampling event.
6. If the results of the resampling indicate a detection of the pesticide at a concentration above the toxicologically significant level, use of the pesticide at the Valhalla Brandywine community will be terminated permanently.

**Table 6-4. Response Thresholds for Variables at the Valhalla Brandywine Community.**

| Variable | Surface Water | Ground Water |
|---|---|---|
| pH | Outside of 6.5 to 8.5 | Outside of 6.5 to 8.5 |
| Dissolved Oxygen | below 4 mg/L | NA[a] |
| Total Nitrogen | Pennsylvania water standard or two standard deviations above the baseline mean, whichever is lower. | Pennsylvania standard or two standard deviations above the baseline mean, whichever is lower. |
| Nitrate-Nitrogen | Pennsylvania water standard or two standard deviations above the baseline mean, whichever is lower. | Pennsylvania standard or two standard deviations above the baseline mean, whichever is lower. |

| Table 6-4. Response Thresholds for Variables at the Valhalla Brandywine Community. | | |
|---|---|---|
| **Variable** | **Surface Water** | **Ground Water** |
| Ammonia-Nitrogen | Pennsylvania water standard or two standard deviations above the baseline mean, whichever is lower. | Pennsylvania standard or two standard deviations above the baseline mean, whichever is lower. |
| Total Phosphorus | Pennsylvania water standard or two standard deviations above the baseline mean, whichever is lower. | Pennsylvania standard or two standard deviations above the baseline mean, whichever is lower. |
| Orthophosphate Phosphorus | Pennsylvania water standard or two standard deviations above the baseline mean, whichever is lower. | Pennsylvania standard or two standard deviations above the baseline mean, whichever is lower. |
| Turbidity | Pennsylvania water standard or no increase from baseline | NA |
| ***Pesticides*** Levels are either the USEPA Health Advisories Limits (HAL x 0.5) or the aquatic toxicity ($LC_{50}$ x 0.1), whichever is lower. The HAL and $LC_{50}$ concentrations are in Appendix I of the NRMP. | | |
| [a] NA means not applicable because the variables are not analyzed as per the Monitoring Plan. | | |

### 6.3.7 Field Quality Control and General Water Sampling Considerations

The field quality assurance program is a systematic process which, together with the laboratory quality assurance programs, ensures a specified degree of confidence in the data collected for an environmental survey. The field quality assurance program involves a series of steps, procedures and practices which are described below.

#### 6.3.7.1 *General Measures*.

a. All equipment, apparatus and instruments should be kept clean and in good working condition.
b. Records should be kept of all repairs to the instruments and apparatus and of any irregular incidents or experiences which may affect the measures taken.
c. It is essential that standardized and approved methodologies be used by field personnel.

**6.3.7.2.** ***Prevention of Sample Contamination*.** The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, the field personnel must take appropriate measures to protect samples from deterioration and contamination.

a. Field measurements should always be made on a separate sub-sample, which is then discarded once the measurements have been made. They should never be made on the same water sample which is returned to the analytical laboratory for chemical analysis.
b. Sample bottles, new or used, must be cleaned according to recommended procedures.
c. Only the recommended type of sample bottle for each parameter should be used.
d. Water sample bottles should be employed for water samples only.
e. Recommended preservation methods must be used. All preservatives must be of an analytical grade.
f. Solvent-rinsed Teflon liners can be used to prevent contamination from the bottle caps of water samples which are to be analyzed for organic compounds.
g. The inner portion of sample bottles and caps should not be touched with bare hands, gloves, mitts, etc.
h. Sample bottles must be kept in a clean environment, away from dust, dirt, fumes, and grime. Vehicle cleanliness is important.
I. All foreign and especially metal objects must be kept out of contact with acids and water samples. Petroleum products and exhaust fumes should be kept away from samples.
j. Specific conductance should never be measured in sample water that was first used for pH measurements. Potassium chloride diffusing from the pH probe alters the conductivity of the sample.
k. Samples must never be permitted to stand in the sun; they should be stored in an ice chest.
l. Samples must be shipped to the laboratory without delay.
m. The sample collector should keep their hands clean and refrain from smoking while working with water samples.
n. Samplers must wear latex gloves.

**6.3.7.3.** ***Field Quality Control*.** Quality control is an essential element of a field quality assurance program. In addition to standardized field procedures, field quality control requires the submission of samples to check contamination, sample containers, or any equipment that is used in sample collection or handling, and to detect other systematic and random errors

occurring from the time of sampling to the time of analysis. Replicate samples must also be collected to check the reproducibility of the sampling. The timing and the frequency of equipment blanks, duplicate, and replicate samples are listed in **Table 6-5.**

**Table 6-5. Number and Types of Samples Taken for Field Quality Control.**

| | |
|---|---|
| Equipment Blank | one equipment rinsate blank per water medium per day |
| Duplicate | one per 10 samples |
| Replicate | one per sample medium per quarter |

**Equipment Blanks**. An equipment blank is prepared in the field at the end of each day's sampling; and one equipment rinsate blank per water medium per day is prepared. An equipment blank is prepared by filling appropriate sample bottles with rinsate from the final cleaning of non-dedicated, sample equipment, and transporting them to the laboratory in the same manner as the water samples for analysis.

**Duplicates**. Duplicate samples (splits) are obtained by dividing one sample into two sub-samples. One sample in every ten water samples is split. Splits are done periodically to obtain the magnitude of errors owing to contamination, random and systematic errors, and any other variabilities which are introduced from the time of sampling until the samples arrive at the laboratory.

**Replicates**. Two samples are taken simultaneously in a given location. The samples are taken to measure the cross-sectional variations in the concentration of the parameters of interest in the system. One water sample per quarter will be replicated.

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# APPENDIX I

## Minimum Standard Requirements for all Gold Signature Projects

| Table 1. Sustainable Development Requirements | |
|---|---|
| **Sustainable Development Requirements** | |
| **1.** | **Natural Resource Manager is an onsite member of the development/management team.** |
| **2.** | **Degraded habitats such as eroded slopes, compacted soils, and polluted water sources have been restored.** |
| **3.** | **An Integrated Pest Management (IPM) Program is established for the property and must include the following elements.** |
| a. | Maintenance staff understands the basic tenets of integrated pest management (IPM), including: (1) scouting and monitoring; (2) selecting thresholds; (3) making decisions based on treatment options; (4) proper timing and spot treatment; (5) documenting and evaluating results. A component of the IPM program for the property continually seeks effective alternatives to pesticide use and reduction in the amount of pesticides used. |
| b. | A risk assessment has been used to select pesticides appropriate for the property. |
| c. | "No spray zones" and buffer areas have been established, particularly around water features. These areas have been communicated via map and/or site tour to all spray technicians. |
| d. | There are designated and trained scouts to monitor plant health and pest populations as part of the IPM program. |
| e. | A property map has been developed to identify turf/common space "hot spots" and problem areas. |
| f. | Scouting forms are used to record the type, severity, location, and treatment of pest problems. |
| g. | Aesthetic and functional thresholds for *insects, fungal diseases, and weeds* have been established for all managed areas to precisely and efficiently manage pest populations and reduce chemical inputs. |
| h. | Management strategies include a program for scouting waterbodies for potential problems, (e.g., high concentrations of algae that may result in a 'bloom,' or unwanted submersed aquatic weeds; e.g. Eurasian milfoil, *Myriophyllum spicatum*). Invasive species are removed. |
| **4.** | **Design the irrigation system to conserve water and energy.** |
| a. | A proper system must only irrigate where, when, and in the amount needed to maintain landscape beds and turf. |
| b. | The amount of water used is documented on a quarterly and yearly basis. Targets are set for current use, and for further water conservation and are monitored and documented. |
| c. | Water-saving irrigation equipment such as drip irrigation, soaker hoses, and part-circle irrigation heads is installed. |

| Table 1. Sustainable Development Requirements |
|---|
| **Sustainable Development Requirements** |
| **5. Repair and Maintenance Facilities** |
| a. Procedures and policies are in place to deal with accidental releases of maintenance materials and chemicals. |
| b. Gasoline, motor oil, brake and transmission fluid, solvents, and other chemicals are prohibited from directly or indirectly entering water bodies through BMPs. |
| c. Storage facilities for chemicals and fuels are housed with proper containment (on an impervious surface that has spill containment) to prevent spills from spreading, and fuel storage and delivery is managed in accordance with state and local regulations. |
| d. Dry chemicals, including pesticides and fertilizers, are stored on pallets or shelves to keep them off the floor. |
| e. Liquid products are stored *below* dry materials. |
| f. Staff are trained in spill prevention, containment, and emergency procedures. |
| g. Chemicals and wash water from facilities are not discharged directly to a water body or left to soak into the ground. All chemical containers and waste are disposed of in a manner that eliminates the potential for contamination of water bodies, and are managed in accordance with state and local regulations. |
| h. Wash water is allowed to filter through a vegetative area (e.g. turf areas, native plant areas, etc) or is recycled. |
| i. A safe storage facility is provided for anti-freeze, oils, paints and batteries that includes a concrete pad and containment system. |
| j. All hazardous wastes are recycled or disposed of correctly (e.g. participate in collection events sponsored by local municipality or waste authority or other appropriate means). |
| k. Maintenance staff checks on a regular basis for leaks from vehicles and tanks. |
| l. Maintenance areas are kept clean and orderly. No pools of liquid or persistent odors exist at the facility. |
| m. No drums with 55 gallons or more of capacity and filled with chemicals, soaps, oils, fuels, pesticides, herbicides or other chemicals are stored on site. |
| n. A regular maintenance schedule for all equipment and vehicles is adhered to. Equipment is maintained for operational efficiency, including regular calibration, preventative maintenance, and regular cleaning. |
| o. Salt for roads and sidewalks is either not stored on the property, or is stored under cover and setback from slopes, ponds, wetlands or streams. |
| p. A spill containment kit is readily available and spill containment procedures are in place. |

| Table 1. Sustainable Development Requirements |
|---|
| **Sustainable Development Requirements** |
| **6. Adhere to the Audubon International Construction Management Guidelines** |
| **7. Highly managed turf to the edge of a waterbody is prohibited.** |
| **8. A water quality monitoring program is ongoing in the construction and management phases of development.** |

| Table 2. Sustainable Development Criteria – Planning, Design, and Management |
|---|
| **Sustainable Development Criteria** |
| **1. Process Criteria** |
| a. Time AI Involvement began |
| b. Member must provide a Natural Resources Manager at the appropriate time |
| **2. Vegetation/Landscape** |
| a. Establish and maintain native trees, shrubs, and herbaceous plants. Native plants are defined as those indigenous to the ecological region of the property. |
| b. Establish and maintain low maintenance plants in all areas not planted with native plants (i.e., areas not in 2a (above) and in those areas prescribed by AI. A 50% bonus is given for the use of naturalized plants (i.e., low maintenance) in 100% of areas not planted with native plants. |
| c. Flowers in gardens and/or container plants provide nectar for hummingbirds and/or butterflies. |
| d. Purchase landscape plants from locally-grown sources whenever possible to support the genetic integrity of local native plant communities. |
| e. Identify and remove invasive exotic species. |
| f. Plant and/or maintain varying heights and types of plants, from ground cover to shrub and tree layers, in habitat areas such as woods, desert, or prairie (e.g. In woodlands, leave understory, including shrubs, herbaceous (non-woody) plants, debris, and leaf litter, intact). This maximizes structural and plant species diversity. |
| g. Leave dead trees standing when they do not pose a safety hazard. |
| h. Water features include abundant shallow water (<2ft. deep) planted with emergent aquatic vegetation. Have naturalized at least 50% of pond margins with emergent-aquatic and shoreline plants (e.g., rushes, pickerel weed). |
| i. Known bird nests or den sites are avoided until after young have dispersed. These areas are identified when needed (e.g., roping killdeer nests; not mowing out-of-play fields until after bird nesting season- July 30). Shrubs or trees are not moved during bird nesting season if nests are present. |
| j. Buffers, edges, and naturalized areas are mowed no more than once per year and only after bird nesting season- July 30. |
| k. Roads, cart paths, trails, and necessary vegetation removal are confined to the edges of existing habitats to minimize habitat disturbance and fragmentation. |
| l. Create various habitats in deeper waters, as well as in the littoral areas, by placing artificial reefs in the water. Habitat may be created from such diverse items as used Christmas trees, and other material that will add three-dimensional structure to the waterbody. Do not use materials that are hazardous or that will create hazards. |

| Table 2. Sustainable Development Criteria – Planning, Design, and Management |
|---|
| **Sustainable Development Criteria** |
| **3. Water Conservation** |
| a. Regularly monitor and maintain outdoor irrigation equipment and indoor plumbing. |
| b. Install low-flow water saving devices, including: toilets that are low-flush models; sink and shower fixtures that have faucet aerators; etc. |
| c. Reduce irrigated lawns by naturalizing or using alternative landscaping. |
| d. Stormwater is collected and used to irrigate community plantings. |
| e. A gray water system is installed and used to irrigate plantings |
| f. Lawns and gardens are watered in conjunction with weather forecasts and avoid watering if it is likely to rain. Programmed irrigation systems are turned off when it is raining. |
| g. Lawns and gardens are irrigated during the early morning or evening hours to reduce water loss to evaporation. |
| h. Lawns are watered on a deep, infrequent basis to promote plant health. |
| i. Mulches are used in gardens and landscaped areas to reduce water loss. |
| j. Appropriately treated reclaimed water is used for irrigation of all common spaces and golf courses. If not available, then the lowest water quality available is used (Do not use potable water for irrigation) |
| **4. Green Building** |
| a. Meet the guidelines for certification for an existing program (e.g., City of Scottsdale, AZ or Austin, TX; LEEDS) OR meet the principles of green building by providing AI the list of green building materials and practices that have been implemented which include, but are not limited to the following<br>i. Steps taken in the design and construction of those buildings to reduce water usage.<br>ii. Steps taken in the design and construction of those buildings to reduce energy usage.<br>iii. Steps taken to use recycled content or reused materials in the construction of those buildings.<br>iv. Steps taken in the design and construction of those buildings to reduce construction material waste.<br>v. Steps taken in the design and construction of those buildings to ensure healthy indoor air quality. |
| b. Provide for an Audubon International “green” home package options. |
| **5. Information and Outreach** |
| a. Implement environmental education/ recreation features (opportunities identified during planning stages) unique to the project site. |
| b. Use signage and interpretive information to highlight key habitats, plants, and other natural resources on the property. |

| Table 2. Sustainable Development Criteria – Planning, Design, and Management |
|---|
| **Sustainable Development Criteria** |
| c. Programs and outings for those who live, work and recreate at the property |
| d. Present AI information throughout the property |
| e. Provide education of AI program benefits to those who live, work and recreate at the property. |
| f. Promote AI mission through dissemination of information about AI programs (e.g., treasuring home, ACSP, etc) and fundraising. |
| **6. Waste and Recycling** |
| a. The project has a written program to reduce waste and has policies in place to work to reduce solid wastes. |
| b. A recycling program has been established. |
| c. Recycling receptacles in convenient locations to encourage homeowner, employee and guest use. |
| d. Litter is routinely removed from entry roads and common space. |
| e. Outdoor wastes such as grass clippings, leaves, and tree limbs are either composted on site or sent to local composting facilities. |
| **7. Energy** |
| a. Energy audits of building(s) are conducted to identify drafts, poorly insulated areas, and lights and machines left on when not in use. Homeowners are encouraged to do the same through education. |
| b. Energy-efficient lighting such as compact flourescent bulbs, energy efficient flourescent lamps, task lighting or lighting controls are used in at least 50% of lighting fixtures in common spaces and homeowners are encouraged through education to do the same. |
| c. *Energy Star* or other energy efficient appliances such as computers, air conditioners and refrigerators are purchased, and also are recommended for homeowners. |
| d. LED exit signs have been installed. |
| e. Exterior lights have been set or retrofitted to high pressure sodium. |
| f. Other energy efficient practices such as south facing windows, and shade trees to keep buildings cooler or for wind barriers, etc. are used, and also are promoted. Shades and blinds are used as appropriate to allow sunlight to enter in cool weather, and reduce sunlight and the need for increased air conditioning in warm weather. Homeowners are encouraged through education to do the same. |
| g. Heating pipes and ducts are kept in good repair. Ducts are checked and maintained at least yearly to seal duct joints and elbows where accessible, and repair damaged or disconnected ducts. Duct work in unconditioned space such as roofs, attics, crawl spaces, and basements is insulated. Homeowners are encouraged through education to do the same. |

| Table 2. Sustainable Development Criteria – Planning, Design, and Management |
|---|
| **Sustainable Development Criteria** |
| h. Regular maintenance is performed on furnaces/AC units to maximize energy efficiency. If the furnace or A/C unit needs to be replaced, an energy-efficient model has been installed or selected. Homeowners are encouraged through education to do the same. |
| I. Appliances are cleaned annually as appropriate. Homeowners are encouraged through education to do the same. |
| j. Vehicles more fuel efficient than legally required are used. |

# APPENDIX II

## Partial Species List for Use in the Valhalla Brandywine Project
**(Adapted from Harker et al. 1993)**

# Appendix II. Partial Species List for Use in the Valhalla Brandywine Project
**(Adapted from Harker et al. 1993)**

The property at Valhalla Brandywine consists of Oak-Hickory-Pine Forest and Southern Mixed Hardwoods Fores. The major groups are listed below with their characteristic species. Be aware that individual species listed may not be suitable on the project site. Local experts can provide advice about which of the species listed here are most important in the local area.

## Appalachian Oak Forest

Appalachian Oak Forest is widespread throughout this region and has many variants. It occupies lower elevation slopes and ridges that are well drained and range from dry to dry-mesic. Before chestnut blight eliminated the American chestnut, it was one of the most important canopy trees in this community and the region. This community corresponds to Küchler #104 and Eastern Deciduous and Mixed Forests ERT.

### Canopy

***Characteristic Species***

| | |
|---|---|
| *Castanea dentata* | American chestnut |
| *Quercus alba* | northern white oak |
| *Quercus coccinea* | scarlet oak |
| *Quercus prinus* | chestnut oak |
| *Quercus velutina* | black oak |

***Associates***

| | |
|---|---|
| *Acer rubrum* | red maple |
| *Carya glabra* | pignut hickory |
| *Carya alba* | mockernut hickory |
| *Liriodendron tulipifera* | tuliptree |
| *Nyssa sylvatica* | black tupelo |
| *Pinus echinata* | short-leaf pine |
| *Pinus rigida* | pitch pine |
| *Quercus rubra* | northern red oak |
| *Quercus stellata* | post oak |

### Woody Understory

| | |
|---|---|
| *Amelanchier arborea* | downy service-berry |
| *Clethra acuminata* | mountain sweet-pepperbush |
| *Cornus florida* | flowering dogwood |
| *Corylus cornuta* | beaked hazalnut |
| *Epigaea repens* | trailing-arbutus |
| *Gaultheria procumbens* | eastern teaberry |
| *Gaylussacia baccata* | black huckleberry |
| *Hamamelis virginiana* | American witch-hazel |

# Appalachian Oak Forest

## Woody Understory (continued)

| | |
|---|---|
| *Kalmia latifolia* | mountain-laurel |
| *Oxydendrum arboreum* | sourwood |
| *Prunus pensylvanica* | fire cherry |
| *Pyrularia pubera* | buffalo-nut |
| *Quercus ilicifolia* | bear oak |
| *Rhododendrum calendulaceum* | flame azalea |
| *Rhododendrum maximum* | great-laurel |
| *Sassafras albidum* | sassafras |
| *Vaccinium corymbosum* | highbush blueberry |
| *Vaccinium stamineum* | deerberry |
| *Viburnum acerifolium* | maple-leaf arrow-wood |

## Herbaceous Understory

| | |
|---|---|
| *Aureolaria laevigata* | entire-leaf yellow false-foxglove |
| *Chimaphila maculata* | striped prince's-pine |
| *Coreopsis major* | greater tickseed |
| *Galax urceolata* | beetleweed |
| *Goodyeara pubescens* | downy rattlesnake-plantain |
| *Heuchera longiflora* | long-flower alumroot |
| *Hieracium venosum* | rattlesnake-weed |
| *Lysimachia quadrifolia* | whorled yellow-loosestrife |
| *Maianthemum racemosum* | feathery false Solomon's-seal |
| *Medeola virginiana* | Indian cucumber-root |
| *Melanthium parviflorum* | Appalachian bunchflower |
| *Pedicularis canadensis* | Canadian lousewort |
| *Polygonatum biflorum* | King Solomon's-seal |
| *Prenanthes trifoliolata* | gall-of-the-earth |

# Mesophytic Forest

In this region, Mesophytic Forest is well developed. It is the richest and most diverse forest type occurring in the southern Appalachians and Cumberland Mountains. Dominance in these forests is often shared by many species and numerous variants occur. This community corresponds to Küchler #103 and Eastern Deciduous and Mixed Forests ERT.

## Canopy

***Characteristic Species***

| | |
|---|---|
| *Acer saccharum* | sugar maple |
| *Aesculus flava* | yellow buckeye |
| *Betula lenta* | sweet birch |
| *Fagus grandifolia* | American beech |

# Mesophytic Forest

## Canopy (continued)

| | |
|---|---|
| *Fraxinus americana* | white ash |
| *Liriodendron tulipifera* | tuliptree |
| *Magnolia acuminanta* | cucumber magnolia |
| *Quercus alba* | northern white oak |
| *Tilia americana* | American basswood |
| *Tsuga canadensis* | eastern hemlock |

***Associates***

| | |
|---|---|
| *Acer rubrum* | red maple |
| *Betula alleghaniensis* | yellow birch |
| *Carya cordiformis* | bitter-nut hickory |
| *Carya ovata* | shag-bark hickory |
| *Halesia carolina* | Carolina silverbell |
| *Juglans cinerea* | white walnut |
| *Juglans nigra* | black walnut |
| *Prunus serotina* | black cherry |
| *Quercus rubra* | northern red oak |
| *Ulmus rubra* | slippery elm |

## Woody Understory

| | |
|---|---|
| *Acer pensylvanicum* | striped maple |
| *Acer spicatum* | mountain maple |
| *Asimina triloba* | common pawpaw |
| *Carpinus caroliniana* | American hornbeam |
| *Cornus florida* | flowering dogwood |
| *Hydrangea arborescens* | wild hydrangea |
| *Leucothe axillaris* | coastal doghobble |
| *Magnolia fraseri* | Fraser’s magnolia |
| *Magnolia tripetala* | umbrella magnolia |
| *Ostrya virginiana* | eastern hop-hornbeam |
| *Rhododendrum maximum* | great-laurel |

## Herbaceous Understory

| | |
|---|---|
| *Actaea pachypoda* | white baneberry |
| *Adiantum pedatum* | northern maidenhair |
| *Ageratina altissima* | white snakeroot |
| *Arisaema triphyllum* | jack-in-the-pulpit |
| *Asarum canadense* | Canadian wild ginger |
| *Aster cordifolius* | common blue wood aster |
| *Cardamine concatenata* | cut-leaf toothwort |
| *Caulophyllum thalictroides* | blue cohosh |

# Mesophytic Forest

## Herbaceous Understory (continued)

| | |
|---|---|
| *Cimicifuga racemosa* | black bugbane |
| *Clintonia umbellulata* | white bluebead-lily |
| *Dicentra canadensis* | squirrel-corn |
| *Dicentra cucullaria* | Dutchman's-breeches |
| *Dryopteris intermedia* | evergreen wood fern |
| *Galium triflorum* | fragrant bedstraw |
| *Hepatica nobilis* | liverwort |
| *Hydrophyllum canadense* | blunt-leaf waterleaf |
| *Hydrophyllum virginianum* | Shawnee-salad |
| *Impatiens capensis* | spotted touch-me-not |
| *Impatiens pallida* | pale touch-me-not |
| *Laportea canadensis* | Canadian wood-nettle |
| *Meehania cordata* | Meehan's-mint |
| *Mitchella repens* | partridge-berry |
| *Mitella diphylla* | two-leaf bishop's-cap |
| *Osmorhiza claytonii* | hairy sweet-cicely |
| *Panax quinquefolius* | American ginseng |
| *Podophyllum peltatum* | may-apple |
| *Polystichum acrostichoides* | Christmas fern |
| *Sedum ternatum* | woodland stonecrop |
| *Stellaria pubera* | great chickweed |
| *Thalictrum clavatum* | mountain meadow-rue |
| *Thelypteris noveboracensis* | New York fern |
| *Tiarella cordifolia* | heart-leaf foamflower |
| *Trillium erectum* | stinking-Benjamin |
| *Trillium grandiflorum* | large-flower wakerobin |
| *Viola canadensis* | Canadian white violet |
| *Viola rostrata* | long-spur violet |
| *Viola rotundifolia* | round-leaf yellow violet |

# APPENDIX III

## Audubon International's Recommended Best Management Practices

# Best Management Practices for Community Drainage

Audubon International's goal is to protect water quality through proper treatment of runoff prior to discharge to surface waters or environmentally sensitive areas.

## Inlet Control Practices

There are a number of control practices to reduce the impacts of stormwater on receiving water bodies. Inlet control measures are designed to protect water quality by managing runoff before it is collected in the drainage system.

- Inlets located in natural / unmanaged area
- Inlet management plan
- Curb cuts / no curb and gutter

** Under most circumstances, inlet controls must be selected in combination with one or more practices from the following list of BMPs**

## Vegetative Practices

Vegetation can be used to reduce the velocity of stormwater, which helps promote infiltration into the soil and settling of solids. Plants also protect against erosion and remove pollutants through uptake.

***Dry / Wet Swale***

- Swales are earthen channels covered with a dense growth of a hardy grass. Swales have a limited capacity to convey large volumes of runoff, but are effective outlet devices or components of a BMP treatment train. Swale effectiveness can be enhanced by adding small check dams (4-10 inches high) across the swale bottom, thereby increasing detention time.

***Filter Strip / Outlet to Natural Area***

- Filter strips are typically bands of close-growing vegetation, usually grass, planted between pollutant source areas and a receiving water (e.g., pond, lake, or stream). They can also be used as outlet or pretreatment devices for other stormwater control practices. Filter strips reduce pollutants such as sediment, organic matter, and many trace metals by the filtering action of the vegetation, infiltration of pollutant-carrying water and sediment deposition.

***Vegetated Buffer***

- A vegetated buffer is a natural or landscaped strip of land that protects the edges of waterbodies and provides vegetative treatment of runoff.

## Infiltration Practices

Treatment structures that promote water entering into the soil and recharging or replenishing ground water. Infiltration devices include basins, trenches, and dry wells. If properly designed and maintained, infiltration devices can effectively remove pollutants through adsorption to soil particles.

## Best Management Practices for Community Drainage

***Infiltration Basin / Trench***

- Infiltration trenches are excavations typically filled with stone aggregate used to capture and allow infiltration of stormwater runoff. This runoff volume gradually exfiltrates through the bottom and sides of the trench into the subsoil and eventually reaches the water table. Infiltration systems are limited to areas with highly porous soils and where the water table and/or bedrock are located well below the bottom of the trench. Infiltration trenches are not intended to trap sediment and must always be designed with appropriate pretreatment measures to prevent clogging and failure.

***Bioretention Area***

- Bioretention devices are shallow (6"-9" inches of ponded runoff) stormwater basins or landscaped areas that utilize engineered soils and vegetation to promote infiltration and treatment of stormwater. These areas are typically excavated and filled with a porous soil mixture and then planted. Soils should be suitable to drain the area within two days or less. Bioretention areas are best suited to treat small drainage areas, parking lots, roadways, and individual lots.

***French Drain***

- French drains are systems of perforated pipe set in trenches. The trenches are filled with porous stone which allows runoff to percolate out of the drain pipes and into the surrounding soil. French drains are designed to infiltrate only small volumes of runoff. Pretreatment measures may be necessary to prevent clogging and failure.

**Outlet Control Structures**

Outlet control measures are designed to treat runoff collected and transported to them through the drainage system. These control practices treat runoff at the point of discharge through settling, biological uptake of substances, and infiltration.

***Phytozone***

- A phytozone is a small pocket wetland at the edge of a lake designed to function as a combination forebay/wetland treatment structure. Phytozones are constructed to receive runoff directly from the stormwater drainage system, where the runoff is detained and treated before flowing into the main body of the lake. The wetland system is defined by earthen berm heavily vegetated with appropriate aquatic plants. Phytozones are typically sized to treat runoff from smaller more frequent storm events through a combination of physical settling of solids and uptake of dissolved nutrients by aquatic plants. Phytozones can also be beneficial as habitat and feeding areas for wading birds and other wildlife.

***Water Quality Pond***

- Stormwater ponds can be designed and constructed to look like natural basins. The outlet structures, however, are engineered to retain a portion of runoff for treatment. Runoff from each rain event is detained in the pond and treated primarily through settling and biological uptake.

## Best Management Practices for Community Drainage

***Dry Detention Basin***

- Dry detention basins temporarily detain a portion of stormwater runoff for a specified length of time, releasing the stormwater slowly to reduce flooding and remove a limited amount of pollutants. These basins are designed to dry out between storm events. Pollutants are removed by allowing particulates and solids to settle out and limited uptake from vegetation.

***Constructed Wetland***

- Artificial wetland systems that behave like natural wetlands. These devices remove pollutants through settling and vegetative uptake. Wetlands can provide numerous benefits by reducing stormwater flows, effectively filtering pollutants, providing wildlife habitat, and being attractive centerpieces to a development.

***Vegetated Outlet Structures***

- Vegetated outlet control measures should have a minimum flow path length of 25 feet to effectively reduce pollutants entering a receiving water. These measures include grassed swales, filter strips, and buffer zones. Care must be taken to properly size the treatment area, to minimize slopes and velocities, and to prevent erosive scouring.

***In-Line Filters***

- Filters that are designed to treat water flowing through the runoff collection system. The in-line filters use a specific media (peat, sand, or granular activated carbon) to treat runoff in the drainage system prior to discharge. These devices require active maintenance and inspection.

**** BMP pollutant removal efficiency is improved by creating a "treatment train" of two or more practices. For example, a roadside swale that collects runoff before discharging to a constructed wetland****

# APPENDIX IV

## Information on the EHL-S150 Scan

# Environmental Health Laboratories
# Turfgrass Pesticide Monitoring Program

By utilizing the turfgrass panels listed below, they can provide a cost-effective solution to environmental monitoring requirements.

| Environmental Health Laboratories | |
|---|---|
| **Contact** | Paul Bowers |
| **Direct Line** | 574-237-6336 |
| **Toll Free** | 800-332-4345 |
| **Address** | 111 S. Hill Street<br>South Bend, IN 46617 |
| **Fax** | 574-233-8207 |

| EHL-S150: $375 | | | | | |
|---|---|---|---|---|---|
| **Chemical** | **MRL** | **Units** | **Chemical** | **MRL** | **Units** |
| Alachlor | 0.1 | ug/L | Etridiazole | 0.1 | ug/L |
| Aldrin | 0.1 | ug/L | Fenamiphos | 0.1 | ug/L |
| Ametryn | 0.1 | ug/L | Fenarimol | 0.1 | ug/L |
| Atrazine | 0.1 | ug/L | Fenoxaprop-ethyl | 0.1 | ug/L |
| Benfluralin | 0.1 | ug/L | Fluazifop-butyl | 0.1 | ug/L |
| Butylate | 0.1 | ug/L | Flurprimidol | 0.1 | ug/L |
| Chloroneb | 0.1 | ug/L | Flutolanil | 0.1 | ug/L |
| Chlorothalonil | 0.1 | ug/L | Heptachlor | 0.1 | ug/L |
| Chlorpyrifos | 0.1 | ug/L | Heptachlor epoxide | 0.1 | ug/L |
| Chlorpyrifos methyl | 0.1 | ug/L | Hexazinone | 0.1 | ug/L |
| Cyanazine | 0.1 | ug/L | Iprodione | 0.1 | ug/L |
| Cyfluthrin | 0.5 | ug/L | Isofenphos | 0.1 | ug/L |
| DCPA | 0.1 | ug/L | Metolachlor | 0.1 | ug/L |
| Deltamethrin | 0.1 | ug/L | Metribuzin | 0.1 | ug/L |
| Desethylatrazine | 0.1 | ug/L | Metsulfuron-methyl | 5 | ug/L |
| Desisopropylatrazine | 0.1 | ug/L | Molinate | 0.1 | ug/L |
| Diazinon | 0.1 | ug/L | Myclobutanil | 0.1 | ug/L |
| Dichlobenil | 0.1 | ug/L | Napropamide | 0.1 | ug/L |
| Dicofol | 0.1 | ug/L | Norflurazon | 0.1 | ug/L |
| Dieldrin | 0.1 | ug/L | Oxyfluorfen | 0.1 | ug/L |
| Diphenamid | 0.1 | ug/L | Pebulate | 0.1 | ug/L |
| Dithiopyr | 0.1 | ug/L | Pendimethalin | 0.1 | ug/L |
| EPTC | 0.1 | ug/L | Pentachloronitrobenzene | 0.1 | ug/L |
| Endosulfan I | 0.1 | ug/L | Profluralin | 0.1 | ug/L |
| Endosulfan II | 0.1 | ug/L | Prometon | 0.1 | ug/L |
| Endosulfan sulfate | 0.1 | ug/L | Prometryn | 0.1 | ug/L |
| Endrin | 0.1 | ug/L | Pronamide | 0.1 | ug/L |
| Esfenvalerate | 0.1 | ug/L | Propachlor | 0.1 | ug/L |
| Ethalfluralin | 0.1 | ug/L | Propiconazole isomer a | 0.1 | ug/L |
| Ethofumesate | 0.1 | ug/L | Propiconazole isomer b | 0.1 | ug/L |
| Ethoprop | 0.1 | ug/L | Simazine | 0.1 | ug/L |

| EHL-S150: $375 | | | | | |
|---|---|---|---|---|---|
| **Chemical** | **MRL** | **Units** | **Chemical** | **MRL** | **Units** |
| Terbacil | 0.1 | ug/L | beta-BHC | 0.1 | ug/L |
| Thiobencarb | 0.1 | ug/L | delta-BHC | 0.1 | ug/L |
| Trichlorfon | 5 | ug/L | gamma-BHC (Lindane) | 0.1 | ug/L |
| Trifluralin | 0.1 | ug/L | lambda -Cyhalothrin | 0.1 | ug/L |
| Trinexapac-ethyl | 1 | ug/L | 4,4'-DDD | 0.1 | ug/L |
| Vernolate | 0.1 | ug/L | 4,4'-DDE | 0.1 | ug/L |
| Vinclozolin | 0.1 | ug/L | 4,4'-DDT | 0.1 | ug/L |
| alpha-BHC | 0.1 | ug/L | | | |

# APPENDIX V

## Data Reporting Forms

# Surface Water Sampling Data

## General Information

1. Sample Station ID _____
2. Station Description _____

   _____
3. Date Collected _____
4. Time Collected _____
5. Collector _____
6. Weather _____
7. Rain within past 3 days? (circle one) heavy medium light dry
8. Observations (turbidity, algae, fish, wildlife, odor, etc.)

## Field Analyses

1. Air Temperature (°F) _____
2. Water Temperature (°F) _____
3. DO (mg/l) _____
3. Conductivity (mS/cm) _____
4. pH _____
5. Turbidity (mg/l) _____

# Ground Water Field Sampling Sheet

Well Number: _____ Samplers: _____

Description: _____

Weather: _____

Date of Sampling: Day _____ Month _____ Year _____

Time of Sampling: Hour _____ Minute _____

## Field Measurements

Water Temp (°C) _____ Air Temp (°C) _____

pH _____ Specific Cond (µS) _____

Depth of Water at which sample was taken (m): _____

## Calibration of Instruments

Specific Conductance: Meter _____ Meter Reading in KC1 soln: _____

pH Meter Model: _____ Calibration buffers used: _____

Sample Apparatus: _____

Mode of Transport: _____

Shipping Date: _____

Remarks:

_____

_____