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# 2.0 Inventory and Analysis

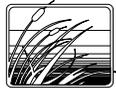
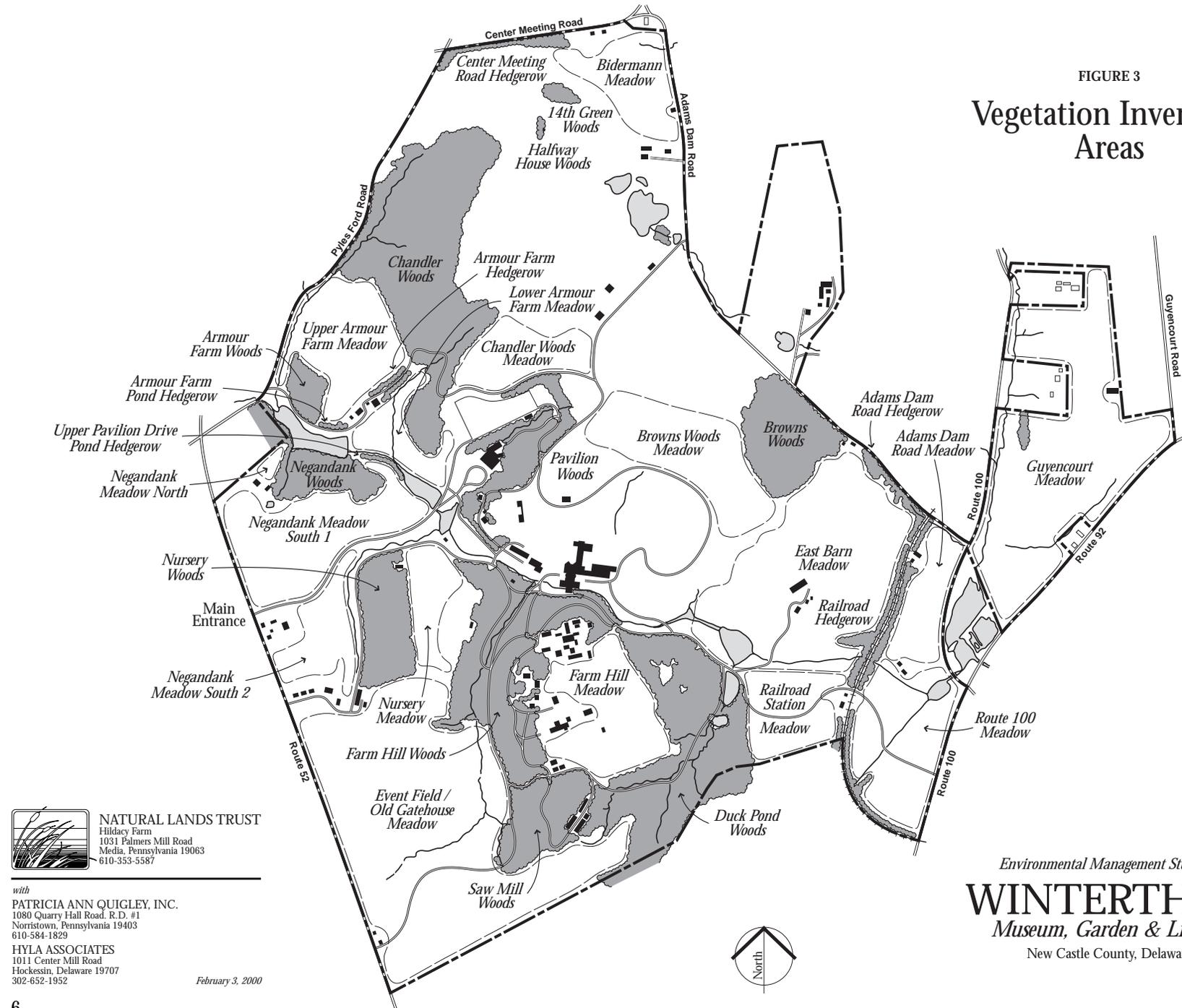
## 2.1 BIOLOGICAL RESOURCES

### 2.1.1 Terrestrial Resources

#### FLORA

Site visits to Winterthur were made by Natural Lands Trust staff between October 1997 and October 1998 to inventory the vegetation. See Figure 3 for the vegetation inventory areas. The vegetation was categorized into three general types: woodlands, hedgerows, and meadows (including wet/riparian areas) and the detailed inventories are included as Appendix A.

FIGURE 3  
Vegetation Inventory  
Areas



NATURAL LANDS TRUST  
Hildacy Farm  
1031 Palmers Mill Road  
Media, Pennsylvania 19063  
610-353-5587

with  
PATRICIA ANN QUIGLEY, INC.  
1080 Quarry Hall Road, R.D. #1  
Norristown, Pennsylvania 19403  
610-584-1829

HYLA ASSOCIATES  
1011 Center Mill Road  
Hockessin, Delaware 19707  
302-652-1952

February 3, 2000

Environmental Management Study for  
**WINTERTHUR**  
Museum, Garden & Library  
New Castle County, Delaware

## Woodland Flora

The woodland areas at Winterthur are dominated by hardwood forests, many of which can be classified as old growth (>150 years old). Like most of the mature forests in this area the woodlands occupy those sites that were inappropriate (too steep or wet) for agriculture. Unlike most of the region's forests, the woodlands at Winterthur did not suffer major disturbance (clearcutting, hurricane) over the last one and a half centuries. The result was the creation of a magnificent canopy of large oak, tuliptree, and beech.

The canopy of the woodlands is dominated by native species: oak (*Quercus* spp.), American beech (*Fagus grandifolia*), and tuliptree (*Liriodendron tulipifera*). Native species, primarily American beech and some black gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), and hickory (*Carya* spp.), also dominate the understory. Norway maple (*Acer platanoides*), an introduced invasive species, is becoming established in the understory of most forested areas and is now the dominant understory species in Browns Woods. The shrub layer is generally sparse and dominated by viburnums (*Viburnum* spp.), both native and introduced. Jetbead (*Rhodotypos scandens*), another introduced invasive species, is becoming established in the shrub layer. The herbaceous layer throughout most of the woodlands is sparse.

These woodlands show signs of the degradation which plagues this region's forests. Invasive vegetation, including species from the formal gardens, are well established in the understory. Regeneration of native tree, shrub and herbaceous species are spotty at best, a result of both competition from exotic vegetation and consumption by white-tailed deer. This raises serious concern for the perpetuation of the existing woodlands.

## 14th Green and Halfway House Woods

± 1.0 acres and ± 0.3 acres

### *Dominant Vegetation*

CANOPY: Oak  
 UNDERSTORY: Dogwood  
 SHRUB: No shrub layer

### *Woodland Health*

INVASIVE VEGETATION IMPACT: Low  
 REGENERATION: None

## Chandler Woods

± 48.5 acres

### *Dominant Vegetation*

CANOPY: Oak, beech, tuliptree  
 UNDERSTORY: Black gum, beech, Norway maple, red maple, hickory  
 SHRUB: Viburnums and spicebush

### *Woodland Health*

INVASIVE VEGETATION IMPACT: Moderate  
 REGENERATION: Occurring in woodland gaps

## Armour Farm Woods

± 4.0 acres

### *Dominant Vegetation*

CANOPY: Oak, beech  
 UNDERSTORY: Beech  
 SHRUB: Sparse

### *Woodland Health*

INVASIVE VEGETATION IMPACT: Moderate on edges, low in interior  
 REGENERATION: Sparse, except for beech

## INVENTORY AND ANALYSIS

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### **Negandank Woods**

± 8.0 acres

#### *Dominant Vegetation*

- CANOPY: Eastern half tuliptree, ash, oak; western half tuliptree, beech, oak  
UNDERSTORY: Eastern half hornbeam and cherry; western half open, beech  
SHRUB: Eastern half euonymus and viburnum; western half no shrub layer

#### *Woodland Health*

- INVASIVE VEGETATION IMPACT: Eastern half - moderate to heavy on edges, moderate in interior; western half - moderate on edges, moderate to low in interior  
REGENERATION: Sparse

### **Pavilion Woods**

± 10.0 acres

#### *Dominant Vegetation*

- CANOPY: Oak, tuliptree, beech  
UNDERSTORY: Tuliptree, beech, red maple  
SHRUB: Sparse, primarily planted rhododendrons; northern portion - dense cover of southern arrow-wood and maple-leaved viburnums

#### *Woodland Health*

- INVASIVE VEGETATION IMPACT: Low to moderate  
REGENERATION: Sparse

### **Browns Woods**

± 14.5 acres

#### *Dominant Vegetation*

- CANOPY: Oak and tuliptree. Young tuliptree (±15 years) in northern corner.  
UNDERSTORY: Norway maple with sparse pignut and mockernut hickory, some beech  
SHRUB: Viburnum, jetbead, euonymus

#### *Woodland Health*

- INVASIVE VEGETATION IMPACT: Moderate to heavy  
REGENERATION: Sparse

### **Nursery Woods**

± 12.5 acres

#### *Dominant Vegetation*

- CANOPY: Oak, tuliptree  
UNDERSTORY: Sparse understory of beech  
SHRUB: Maple-leaved viburnum, brambles

#### *Woodland Health*

- INVASIVE VEGETATION IMPACT: Low to moderate  
REGENERATION: Sparse

### **Farm Hill/Saw Mill/Duck Pond Woods**

± 81.5 acres

#### *Dominant Vegetation*

- CANOPY: Tuliptree, beech, and oak with some hickory (minor component)  
UNDERSTORY: Beech with some hickory, red maple  
SHRUB: More spicebush than in other woodlands

## INVENTORY AND ANALYSIS

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### *Woodland Health*

INVASIVE VEGETATION IMPACT: Farm Hill and Saw Mill Woods - moderate to heavy for groundcovers and shrubs, low for canopy and vines; Duck Pond Woods - low to moderate for vines, moderate for shrubs, groundcover, and canopy  
 REGENERATION: Sparse

<i>Orobanche uniflora</i>	broom-rape	S2, G5
<i>Osmorhiza claytoni</i>	sweet-cicely	S2, G5
<i>Mertensia virginica</i>	Virginia bluebells	S3, G5
<i>Viola affinis</i>	LeConte's violet	SU, G5

\* observed by Janet Ebert, 1990  
 \*\* observed by Janet Ebert, 1991

### *Woodland Species of Special Concern*

The woodlands at Winterthur contain a number of plant species identified as rare and uncommon by the Delaware Natural Heritage Program. The species are ranked for both their rarity within Delaware and throughout the world. These ranks are used to prioritize conservation and protection efforts. See Appendix B for an explanation of the global and state ranks.

Species of concern identified within the woodlands are:

<i>Acer saccharum</i>	sugar maple	S3, G5	
<i>Quercus marilandica</i>	blackjack oak	S3, G5	
<i>Castanea dentata</i>	American chestnut	SU, G4	
<i>Cercis canadensis</i>	redbud	SH, G5	
<i>Actaea pachypoda</i>	white baneberry	S1, G5	
<i>Agrimonia striata</i>	roadside agrimony	S1, G5	
<i>Caltha palustris</i>	cowslip	S1, G5	**
<i>Galium asprellum</i>	rough bedstraw	S1, G5	
<i>Geum vernum</i>	spring avens	S1, G5	**
<i>Geum virginianum</i>	cream-colored avens	S1, G5	
<i>Sanicula marilandica</i>	black snake-root	S1.1, G5	
<i>Thalictrum dioicum</i>	early meadow-rue	S1, G5	**
<i>Allium tricoccum</i>	ramps	S2, G5	
<i>Aralia racemosa</i>	spikenard	S2, G5	*
<i>Galium lanceolatum</i>	wild licorice	S2, G5	

### Hedgerow Flora

Hedgerows function as corridors for wildlife to move between woodland patches. Unfortunately, with the introduction of invasive plants, they have become ideal edge habitat for the proliferation of these species. Invasive vines such as Japanese honeysuckle, Oriental bittersweet, and grape thrive along hedgerows and woodland edges where they receive direct sunlight and physical support from the trees. Invasive shrubs such as the shrub honeysuckles and multiflora rose often join these vines.

The hedgerows at Winterthur are chiefly along roads and the railroad and the impact from invasive vegetation is moderate to heavy throughout. While the canopy trees are mostly native, they are experiencing the same lack of native tree, shrub and herbaceous species regeneration as the woodlands.

The following hedgerows were inventoried: Center Meeting Road Hedgerow, Armour Farm Hedgerow, Armour Farm Pond Hedgerow, Upper Pavilion Drive Pond Hedgerow, Adams Dam Road Hedgerow, and Railroad Hedgerow.

### *Hedgerow Species of Special Concern*

The hedgerows at Winterthur contain the following plant species identified as rare and uncommon:

<i>Taxodium distichum</i>	bald cypress	S2, G5
<i>Juglans cinerea</i>	butternut	S3, G3G4
<i>Arabis lyrata</i>	lyre-leaved rock-cress	S1, G5
<i>Tradescantia virginiana</i>	spiderwort	S2, G5

### Meadow Flora

Meadows (including wet/riparian areas) are the dominant vegetation type at Winterthur. The dominant species in the meadows is the native grass broom-sedge (*Andropogon virginicus*). Most of the meadows contain a high degree of native herbaceous vegetation, due primarily to the regular mowing schedule. The upland meadows are presently in hay production, with either one or two cuttings each year, and the wet meadows are not hayed but are rotary mowed annually. Some areas, especially those now being allowed to succeed to woodlands, are moderately to severely impacted with invasive species.

#### **Bidermann Meadow**

± 14.5 acres

INVASIVE VEGETATION IMPACT: Low to moderate

#### **Armour Farm Meadow**

± 23.0 acres

INVASIVE VEGETATION IMPACT: Low on the top of the ridge and the south facing slope, heavy on the lower north facing steep slope

#### **Lower Armour Farm Meadow**

± 9.5 acres

INVASIVE VEGETATION IMPACT: Moderate to heavy

#### **Chandler Woods Meadow**

± 12.5 acres

INVASIVE VEGETATION IMPACT: Low

#### **Negandank Meadow North**

± 1.0 acres

INVASIVE VEGETATION IMPACT: Moderate to heavy

#### **Negandank Meadow South 1**

± 29.5 acres

INVASIVE VEGETATION IMPACT: Low, except for small, heavily impacted areas along Route 52, along edges, and patches throughout

#### **Negandank Meadow South 2**

± 11.0 acres

INVASIVE VEGETATION IMPACT: Low

#### **Nursery Meadow**

± 9.0 acres

INVASIVE VEGETATION IMPACT: Moderate, primarily along edges

#### **Event Field/Old Gatehouse Meadow**

± 100.0 acres

INVASIVE VEGETATION IMPACT: Low

## INVENTORY AND ANALYSIS

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### **Farm Hill Meadow**

± 22.0 acres

INVASIVE VEGETATION IMPACT: Low to moderate

### **Browns Woods Meadow**

± 25.0 acres

INVASIVE VEGETATION IMPACT: Low

### **East Barn Meadow**

± 58.0 acres

INVASIVE VEGETATION IMPACT: Low in general, riparian area moderate

### **Railroad Station Meadow**

± 14.0 acres

INVASIVE VEGETATION IMPACT: Low

### **Route 100 Meadow**

± 26.0 acres

INVASIVE VEGETATION IMPACT: Low, except on steep slopes

### **Adams Dam Road Meadow**

± 11.5 acres

INVASIVE VEGETATION IMPACT: Low

### **Guyencourt Meadow**

± 101.5 acres

INVASIVE VEGETATION IMPACT: Low in general, riparian area moderate

### *Meadow Species of Special Concern*

The meadows at Winterthur also contain a number of plant species identified as rare and uncommon:

<i>Rubus odoratus</i>	purple-flowering raspberry	S1, G5
<i>Apocynum androsaemifolium</i>	pink dogbane	S1, G5
<i>Arabis lyrata</i>	lyre-leaved rock-cress	S1, G5
<i>Calamagrostis canadensis</i>	Canada bluejoint	S1, G5
<i>Campanula aparinoides</i>	marsh bellflower	S2, G5
<i>Lobelia spicata</i>	spiked lobelia	S2, G5 *
<i>Rhynchospora glomerata</i>	beak-rush	S2, G5
<i>Spiranthes lacera</i> var. <i>gracilis</i>	southern slender ladies'-tresses	S2, G5T4T5
<i>Tradescantia virginiana</i>	spiderwort	S2, G5
<i>Carex caroliniana</i>	sedge	S3, G5 **
<i>Polygonum scandens</i> var. <i>scandens</i>	climbing false-buckwheat	SU, G5T5
<i>Asclepias incarnata</i> ssp. <i>incarnata</i>	swamp milkweed	SH, G5T5
<i>Pycnanthemum clinopodioides</i>	mountain-mint	SH, G2

\* observed by Janet Ebert, 1992

\*\* observed by Janet Ebert, 1993

## FAUNA

Field surveys of amphibians, reptiles, birds, mammals, butterflies, dragonflies, and damselflies were conducted by Jim White of Hyla Associates between September 14, 1997 and October 4, 1998. The surveys were conducted on foot, aided by the use of binoculars and spotting scope. Species were identified by visual observation, sound (e.g., frog and bird calls), and signs (e.g., tracks). In addition, live traps (have-a heart and Sherman) were used to capture small mammals and hand nets were used to capture dragonflies.

Tables 2–6 in Appendix C present lists of species that were observed and may occur at Winterthur by habitat type. Tables 8–10 are “short lists” of the species of special concern for amphibians and reptiles, birds, and mammals designated by the Delaware Natural Heritage Program as “S1”, “S2” or “S3” species, which indicates that they are of 1<sup>st</sup>, 2<sup>nd</sup>, or 3<sup>rd</sup> priority ranking for protection, respectively, out of 5 ranking categories.

Included in both tables are species that are believed by Hyla Associates to be “probable” or “possible” on the property, based on past field experience in similar habitats, although they were not observed during this field survey. “Probable” species are those that should occur within the identified habitats on the site and were missed during the survey. “Possible” species are those that generally do not utilize the identified habitats, but may occur under special circumstances or may occur for very brief periods of time. Management practices within identified habitats should include consideration of the biological needs of “probable” species, but in general, need not consider those of “possible” species.

For purposes of summarizing the survey findings, the various areas at Winterthur have been classified into nine general “habitat”

types: woodland, field, edge, pond, stream, spring, vernal pool, gardens area, and golf course.

## Woodland Fauna

The diversity of fauna in the woodlands appears relatively high. Amphibian species observed include American Toad, Wood Frog, Red-backed Salamander, and Northern Spring Peeper. Several other amphibian species probably utilize the woodlands for foraging, including Northern Dusky Salamander, Northern Two-lined Salamander, Long-tail Salamander, Red-spotted Newt, and Northern Red Salamander. While the Eastern Box Turtle was the only reptile species observed, it is very probable that Northern Black Racer, Black Rat Snake, Ring-necked Snake, Eastern Milk Snake and Eastern Garter Snake also occur in these woodlands.

Woodland nesting birds are well represented within Chandler Woods, Browns Woods, and the Farm Hill/Saw Mill/Duck Pond Woods. Species confirmed to have nested in these woodlands include Wood Thrush, Ovenbird, Veery, Scarlet Tanager, Hairy Woodpecker, Eastern Screech Owl, Great Horned Owl, and Red-tailed Hawk.

While no rare mammal species were found, most of the mammal species expected to occur in the woodlands were observed, including Opossum, Northern Short-tailed Shrew, Little Brown Myotis, Big Brown Bat, Red Bat, Eastern Gray Squirrel, Eastern Chipmunk, Red Squirrel, Woodchuck, Raccoon, Red Fox and White-tailed Deer. Mammals that probably occur but were not observed in these woodlands include Eastern Pipistrelle, Southern Flying Squirrel, Meadow Vole, Long-tailed Weasel, and Striped Skunk.

Lepidoptera observed in the woodlands included Question Mark, Eastern Comma, Mourning Cloak, Red-spotted Purple, and Appalachian Brown, and several other species are likely to occur there, as listed in Table 6. No Odonata species were observed in the woodlands.

### *Woodland Species of Special Concern*

The woodlands at Winterthur provide habitat for numerous species of special concern. Although no amphibians or reptiles of special concern were observed in the woodlands during this survey, it is probable that the Longtail Salamander, Northern Red Salamander, and Eastern Milk Snake occur there, and others may be possible (see Table 8). Bird species of special concern that were observed in the woodlands include Black Vulture, Bald Eagle, Cooper's Hawk, Broad-winged Hawk, Hairy Woodpecker, Pileated Woodpecker, White-breasted Nuthatch, Brown Creeper, Veery, Warbling Vireo, American Redstart, Northern Parula, Chestnut-sided Warbler, Black-and-white Warbler, Kentucky Warbler, and Hooded Warbler. Other bird species of special concern that were not observed but are considered likely to utilize the woodlands, such as the Black-billed Cuckoo, are listed in Table 9. Mammal species of special concern observed in the woodlands include Red Bat and Red Squirrel (see Table 10).

### Upland Field and Wet Meadow Fauna

Bird species that depend on upland field habitats that were observed during the surveys include Canada Goose, Black Vulture, Turkey Vulture, Northern Harrier, Red-tailed Hawk, American Kestrel, Mourning Dove, Northern Bobwhite, Ruby-throated Hummingbird, Northern Flicker, Olive-sided Flycatcher, Eastern

Kingbird, Tree Swallow, Northern Rough-winged Swallow, Indigo Bunting, Field Sparrow, American Gold Finch, Eastern Meadowlark, Eastern Bluebird, and Killdeer. Mammal species observed include Opossum, Eastern Mole, Northern Short-tailed Shrew, Little Brown Myotis, Big Brown Bat, Eastern Cottontail, Woodchuck, Meadow Vole, Raccoon, Red Fox, and White-tailed Deer. No amphibian or reptile species were observed in the upland fields.

The upland fields are utilized by numerous species of Lepidoptera, many of which were observed during the field surveys, as listed in Table 6. Many Odonata species were also observed in the fields, as indicated in Table 5.

The wet meadows support a higher diversity of plant species, and therefore a higher diversity of animal species, than do the upland fields. In addition to supporting the vast majority of vertebrate species found in the upland fields, the wet meadows also are likely to support Eastern American Toad, Pickerel Frog, Eastern Box Turtle, Black Rat Snake, Eastern Garter Snake, and Meadow Jumping Mouse. Because of the abundance of flowering plants, Lepidoptera are especially abundant in the wet meadows. Odonata species are also attracted to the wet meadows because of the abundance of prey insect species.

### *Upland Field and Wet Meadow Species of Special Concern*

No amphibian, reptile, or mammal species of special concern were observed in the fields, nor are they considered likely to utilize the field habitat, with the exception of the Bog Turtle which can sometimes be found in very wet meadows. Although the wet meadows surveyed provide only marginal habitat for the Bog

Turtle, it is possible that Bog Turtle may use the wet meadows in transition between more suitable habitat, or that a change in hydrology could make the current wet meadows more suitable.

Bird species of special concern that were observed utilizing the fields include Black Vulture, Northern Harrier, Cooper's Hawk, Broad-winged Hawk, American Kestrel, Common Nighthawk, Chipping Sparrow, and Eastern Meadowlark. Great Blue Heron, Great Egret, and Herring Gull were also observed in the fields, but are not considered to be dependent on them. Additional bird species, such as Bobolink, may occur in the fields, although they were not observed (see Table 9).

### Edge Habitat Fauna

The transitional areas between woodlands and fields are important to many of our common animals. Edge habitat is generally not very supportive of amphibian species, and the only species found during the survey was Northern Spring Peeper. Although no reptiles were found in the edge areas during the field surveys, several species, including Black Rat Snake, probably utilize these areas. Many bird species that are typical of edge habitat were observed in the edge areas including Northern Cardinal, Mockingbird, Carolina Wren, Gray Catbird, Carolina Chickadee, Tufted Titmouse, Cedar Waxwings and several hawk species. Many mammal species were also observed, including Eastern Cottontail, which is particularly adapted to this habitat.

### *Edge Species of Special Concern*

No amphibian or reptile species of special concern were observed in Winterthur's edge areas, although it is considered likely that the

Eastern Milk Snake occurs there. Bird species of special concern that were observed utilizing edge habitat included Cooper's Hawk, American Kestrel, White-breasted Nuthatch, Warbling Vireo, Northern Parula, Chestnut-sided Warbler, Black-and-white Warbler, American Redstart, Yellow-breasted Chat, and Chipping Sparrow. The only mammal species of special concern observed in the edge areas was Red Squirrel. For additional species of special concern that may utilize the edge areas, see Tables 8, 9, and 10.

### Pond Fauna

Amphibians found around the ponds include Bullfrog, Green Frog, and Pickerel Frog and reptiles include Common Snapping Turtle, Eastern Painted Turtle, Redbelly Turtle, Common Musk Turtle, and Northern Water Snake. Many species of birds were found to utilize the ponds including Great Blue Heron, Great Egret, Green Heron, Canada Goose, Wood Duck, American Black Duck, Mallard, Ruddy Duck, Osprey, Solitary Sandpiper, Belted Kingfisher, and Tree, Rough-winged and Barn Swallows. The only mammals found using the ponds were Little Brown Myotis, Big Brown Bat (feeding on insects over pond), Raccoon, Opossum, and Muskrat. Several species of Odonata were also observed using the ponds.

### *Pond Species of Special Concern*

Vertebrate species of special concern that were observed at Winterthur ponds included Great Blue Heron, Great Egret, and Osprey. For a listing of other vertebrate species of special concern that may utilize the ponds but were not observed (such as Bald Eagle and Red Bat) see Tables 7, 8, 9, and 10.

## Stream Fauna

Clenny/Wilson Run and, to a greater extent, its tributaries provide important salamander habitat. Species found include Northern Dusky Salamander, Northern Two-lined Salamander, Northern Red Salamander. Although not found during the survey, the Longtail Salamander probably exists in or near the Duck Pond Woods stream. Reptiles that were found in the streams included Northern Watersnake and Eastern Garter Snake. Although not found during the survey, the Queen Snake occurs on Wilson's Run, just downstream of Winterthur and may occur along Clenny/Wilson Run west of East Barn Pond. Marginal Bog Turtle habitat also exists along the upper portions on Event Field/Old Gatehouse Meadow stream.

Many birds utilize the streams on the property but only a few species rely on them for much of their food, including the following species observed during the survey: Belted Kingfisher, Great Blue Heron, Great Egret, Green Heron, Wood Duck, and Northern Rough-winged Swallow. Other bird species, such as the Louisiana Waterthrush, Northern Waterthrush, and Spotted Sandpiper, although not found during the surveys, are also dependent on the streams and probably occur there.

Many mammal species were observed utilizing the streams on the property, including the Raccoon and Muskrat which are particularly dependent on the streams for their existence.

The streams on the property are also important to several species of Odonata; however, few species were observed during the survey.

## *Stream Species of Special Concern*

Vertebrate species of special concern that were observed in Winterthur streams included Northern Red Salamander, Queen Snake, Great Blue Heron, and Great Egret. Several other species of special concern that were not observed but are considered likely to utilize the streams include Swallowtail Shiner, Longtail Salamander, Spotted Sandpiper, and Louisiana Waterthrush (see Tables 7, 8, 9, and 10).

## Spring Habitat Fauna

The spring located on the west bank of Upper Duck Pond is the best example of a wooded spring and it creates a cool wet boggy area that is particularly good salamander habitat. Amphibian species found include Northern Two-lined Salamander, Northern Dusky Salamander, and Pickerel Frog. Although not found during the survey, Longtail Salamander, Northern Red Salamander, and Four-toed Salamander may also occur in wooded springs of this type. Other vertebrate species may utilize springs but only the Opossum, Raccoon, and Louisiana Waterthrush are likely to be regular visitors to these areas.

The non-wooded springs that are found in more open, disturbed areas may be interesting botanically but provide only marginal faunal habitat.

## *Spring Habitat Species of Special Concern*

Longtail Salamander and Northern Red Salamander are the only two vertebrate species of special concern that are considered likely to utilize the springs/spring seeps at Winterthur.

## Vernal Pool Fauna

Vernal pools are small to medium sized, closed system wetlands that have standing water at least part of the year but only occasionally year round. Because of their perennial dry periods, these pools are usually fishless, and therefore, provide very valuable wildlife habitat and breeding sites for aquatic invertebrates and amphibians. Water levels are generally influenced by rainwater runoff and/or groundwater levels and are at their highest in winter and spring. Dry down generally occurs in mid to late summer. Vernal pools are rare on the Winterthur property.

Although only the Northern Spring Peeper and Green Frog were found at a vernal pool at Winterthur during the survey period, other amphibian species including Four-toed Salamander, Spotted Salamander, Eastern American Toad, Wood Frog, and Pickerel Frog are known vernal pool breeders. In addition, reptiles such as Spotted Turtle, Northern Water Snake, and Ribbon Snake may also be found at these pools. Although there are no bird or mammal species that depend on vernal pools, several species may visit these areas in search of food. Various Odonata species also utilize vernal pools, although not observed there during the field surveys.

### *Vernal Pool Species of Special Concern*

No species of special concern were observed at the vernal pool during the survey period; however, several species, including Spotted Salamander, Four-toed Salamander, Northern Red Salamander, Spotted Turtle, Bog Turtle, and Eastern Ribbon Snake, may possibly occur there.

## Garden Area Fauna

A few common amphibian species, including Redback Salamander, American Toad, Northern Spring Peeper, and Green Frog were observed in the Gardens Area. The only reptile that was observed in the Gardens Area was the Ringneck Snake. Other amphibian and reptile species that probably are found there include Pickerel Frog, Black Rat Snake, Eastern Milk Snake, and Eastern Garter Snake.

Birds of many species are found commonly in the Gardens Area. Woodland songbirds such as Tufted Titmouse, Carolina Chickadee, Brown Creeper, Red-breasted and White-breasted Nuthatch, Carolina Wren, Scarlet Tanager, Downy Woodpecker, and Hairy Woodpecker were observed in the gardens. The gardens were also used by spring and fall migrating songbirds. Birds of prey including Sharp-shinned Hawk, Cooper's Hawk, Red-tailed Hawk and American Kestrel were also observed hunting in the gardens. The evergreen trees within the Gardens Area appear to offer very good resting areas for Great Horned Owls, Eastern Screech Owls and possibly the uncommon Northern Saw-whet Owl and Long-eared Owl although no owls were observed there during the survey.

Numerous common mammals were also observed in the Gardens Area, as listed in Table 4.

Insects are abundant in the Gardens Area with the many flowers attracting many species of butterflies including Black Swallowtail, Eastern Tiger Swallowtail, Spicebush Swallowtail, Eastern Tailed Blue, Gray Hairstreak, Spring Azure, Variegated, Meadow and Great Spangled Fritillary, Pearl Crescent, Question Mark, Eastern Comma, Common Buckeye, Painted Lady, Red Admiral, Mourning Cloak, Viceroy, and Monarch. One uncommon species,

the Appalachian Azure, was found to be fairly common in the Azalea Woods portion of the Gardens Area. This species has only been found in one other location in Delaware. Several Appalachian Azure larvae were found on their host plant, Black Cohosh.

### *Garden Area Species of Special Concern*

Although no amphibian, reptile, or mammal species of special concern were observed in the Gardens Area during the survey, it is likely that Eastern Milk Snake, Red Bat, and Red Squirrel utilize the Gardens Area (see Tables 8 and 10). Bird species of special concern observed in the Gardens Area included Cooper's Hawk, American Kestrel, Hairy Woodpecker, White-breasted Nuthatch, Brown Creeper, and Chipping Sparrow and it is likely that Black Vulture and several species of warblers also utilize the Gardens Area, although they were not observed there (see Table 9).

As mentioned above, the Appalachian Azure was also found to be fairly common in the Azalea Woods portion of the Gardens Area. Although not listed by the Delaware Natural Heritage Program as a species of special concern, this butterfly has only been found in one other location in Delaware.

### **Golf Course Fauna**

No amphibians or reptiles were observed in the golf course area except in and around the ponds (as discussed above). Numerous common species of birds were observed in the golf course area, as indicated in Table 3. Mammals observed on the golf course were Little Brown Myotis, Eastern Cottontail, Eastern Gray Squirrel, Woodchuck, Raccoon, Red Fox, and White-tailed Deer. Although

a few butterflies were observed flying over the golf course grounds, in general there is little suitable habitat for them there.

### *Golf Course Species of Special Concern*

As mentioned above, the grounds of the golf course area provide only marginal wildlife habitat. The only species of special concern observed in the golf course area were Black Vulture, Sharp-shinned Hawk, Cooper's Hawk, and American Kestrel.

## 2.1.2 Aquatic Resources

Aquatic resources within the ±966-acre Winterthur property consist of streams, ponds, and wetlands. The property almost fully includes Clenny/Wilson Run, a first to second order tributary of the Brandywine Creek. The segment of the stream that flows through the Winterthur grounds (northwest of Routes 92 and 100) is designated by the State of Delaware Surface Water Quality Standards (February 26, 1993) as "ERES" or waters of exceptional recreational or ecological significance. The watershed is part of the highly valued Brandywine Creek system and is largely undeveloped except for the Winterthur property, several golf courses and low density residential development.

The original hydrology within the property has been altered through dam and stream channel construction, the capping or diversion of natural seeps and springs, the deposition of landscaping waste and rubble into wetlands, and the mowing of stream buffers. The latter has created ideal habitat for Canada geese which further degrade water quality.

Clenny/Wilson Run within the project area was most recently sampled by the Delaware Department of Natural Resources and Environmental Control (DNREC) in the Fall of 1993. Sampled parameters included flow, pH, dissolved oxygen, conductivity, temperature, macroinvertebrates, and habitat. Findings indicate a loading of nutrients and oxygen demand associated with the ponds, resulting in a pollution tolerant benthic macroinvertebrate community in downstream areas.

The sampling of the unvegetated components of the inventory (stream and pond) was guided by the methodologies currently in use by DNREC Division of Water Resources. For this project DNREC required on-site sampling at established sampling stations. Their method of biological assessment of non-tidal streams in the Piedmont Region relies on a modified version of the "EPA Rapid Bioassessment Protocols for Use in Streams and Rivers" (EPA 1989). The Rapid Bioassessment Protocols (RBP) utilize an integrated assessment procedure that compares physical habitat and biological measures at sites of interest with regional "reference sites" that represent the optimum or least disturbed condition. However, the DNREC data base for reference streams in the northern Delaware Piedmont had very little data on only a few streams and these were not at all comparable in land use or geology to Clenny Run and therefore not directly applicable. Therefore, the results of the stream sampling are summarized based on other biological indicators of stream quality, such as aquatic organism diversity, especially of those species known to be pollution sensitive such as those of the taxa Ephemeroptera, Plecoptera, and Trichoptera.

## STREAMS

The evaluation procedures provided by DNREC for this study call for two 1-meter square kicknet samples to be obtained in a riffle zone according to RBP Protocol Level II 1/2 methodology (with the exception that a Course Particulate Matter sample is not required). RBP metrics to be assessed include: total taxa, EPT (Ephemeroptera, Plecoptera, Trichoptera) index, % EPT, % dominant, % Chironomid, and Hilsenhoff diversity index. In addition to the biological data collection, stream habitat is also to be characterized at each station using RBP. Habitat parameters include bottom substrate, available cover, embeddedness, riffle quality and frequency, channel modification, sediment deposition, velocity, water depth, bank condition (shading and stability), and width of riparian zone. Water quality parameters to be sampled include the following: flow, pH, conductivity, and temperature.

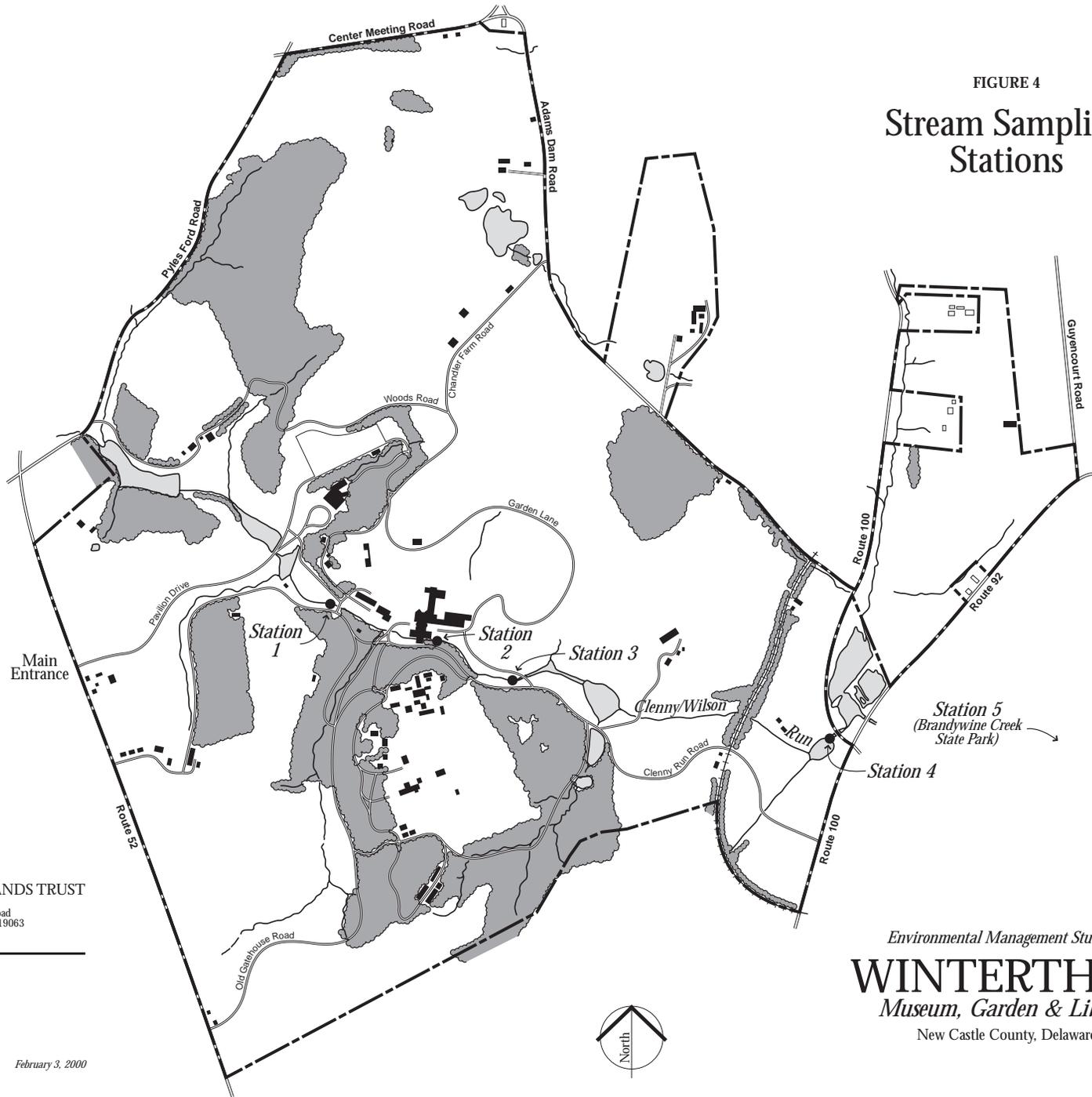
On October 23, 1997, kick net samples of macroinvertebrates were obtained by Patricia Ann Quigley, Inc. at five locations along Clenny/Wilson Run (see Figure 4 and Table 1). Four samples were obtained within Winterthur and one sample was obtained within the Brandywine Creek State Park. Stations 1, 2, and 5 correspond with the established DNREC water quality sampling stations.

## Sampling Station Descriptions

Station 1 (DNREC Site #NC185) is upstream of the Clenny Run Road stream crossing near the Winterthur Museum building. This represents man-made stream habitat modified for bridge construction, with a stone and mortar creek bed and banks to the north, and a more natural but manicured bank to the south. Substrate consists primarily of mortar and cobble with gravel and

FIGURE 4

# Stream Sampling Stations



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with

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February 3, 2000

Environmental Management Study for  
**WINTERTHUR**  
Museum, Garden & Library  
New Castle County, Delaware

INVENTORY AND ANALYSIS

**Table 1: Stream Sample Results**

CLASS/ORDER	FAMILY	STATION 1	STATION 2	STATION 3	STATION 4	STATION 5
Oligochaeta		3	5?	1		
Crustacea	Gammaridae				6	6
	Asellus			2	3	3
Insecta/Coleoptera	Elmidae			Stenelmis larva - 5 Stenelmis adult - 5		Stenelmis adult - 1
Diptera	Tipulidae	1		7		14
	Chironomidae				2+	89
Ephemeroptera	Heptageniidae					
	Ephemerellidae	1				6
	Leptophlebiidae	1			1	
Odonata	Corydalidae			3		6
	Lestidae	10		7		
	Gomphidae	1		1		2
	Coenagrionidae	1				
Plecoptera	Perlidae					1
Tricoptera	Hydropsychidae	3		41	200+	35+
Gastropoda	Physidae	1		2		1
<b>Total Taxa</b>		9	1	9	5	9
<b>Total Individuals</b>		22	5	74	212	173
<b>EPT Index</b>		3	0	1	2	4
<b>% EPT</b>		0.23	0	0.55	0.95	0.76
<b>% Dominant</b>		0.45	100.0	0.55	0.94	0.51
<b>% Chironomid</b>		0	0	0	0.01	0
<b>Hilsenhoff Diversity Index</b>		7.50 Very Poor	10.0 Very Poor	5.42 Fair	5.08 Fair	1.01 Excellent

## INVENTORY AND ANALYSIS

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sand. The stream averages 4' wide with a 3" to 5" deep perennial flow. Filamentous green algae covers most of the rocks and lush beds of true-forget-me-not (*Myosotis scorpioides*) grow along the edges. Large specimen trees provide partial shade and the water temperature was 45° F. The general macroinvertebrate habitat is poor because the substrate is primarily flat, slime covered, and armored with very few loose rocks.

Station 2 (DNREC Site #NC186) is located next to the Winterthur Museum building. It represents poorer man-made habitat than Station 1. For this reason DNREC did not sample this station during their last campaign. The stream is completely lined with large flat rocks that are closely pieced together. Substrate consists of slime covered sections of stone approximately 4' square. The stream averages 20' wide with a 1" deep perennial flow which meanders over the stone. A few large specimen trees provide partial shade and the water temperature was 36° F.

Station 3 is located approximately 100' upstream of the Museum Road crossing and about 30' downstream of the Museum's sewage treatment plant effluent outfalls. It is the most natural habitat sampled on the property. The natural substrate is composed primarily of cobble and gravel with some sand deposits. The stream averages 6' wide with a 4" deep fairly turbulent flow which oxygenates the water below. Although vegetation grows along the stream edges, it is regularly mowed and there is very little overhead shading of the stream. The water temperature was 42° F.

Station 4 is located toward the southeastern corner of the property, below the Routes 100/92 Pond. It represents man-made habitat at the spillway of the small dam. The stream averages 6' wide with a 6" deep flow over the dam. The rough texture of the dam base provides good macroinvertebrate habitat and the waterfall serves to oxygenate the downstream waters. Shrubs provide a small amount

of overhead shading of the stream. The water temperature was 45° F.

Station 5 (DNREC Site #NC191) is located downstream of the Brandywine Creek State Park entrance on Adams Dam Road. It represents good macroinvertebrate habitat and this portion of Clenny/Wilson Run is stocked with trout by DNREC. Substrate consists of boulder, cobble, gravel, and sand. The stream averages 4' to 7' wide and between 8" and 14" deep. Small amounts of filamentous green algae cover some rocks. Large trees provide partial shade and the water temperature was 49° F.

**Total Taxa (Taxa Richness)** roughly approximates diversity through a measurement of the variety of taxa (families). This is expected to increase with improving water quality. **Total Individuals** is a reflection of biomass and productivity. The **EPT Index** also increases with improving water quality. It is the total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera. These are typically pollution sensitive organisms and are usually absent from degraded waters. The % **EPT** would also increase with improving water quality. The % **Chironomid** values increase with decreasing water quality because Chironomid typically thrive in low quality, poorly oxygenated waters. The **Hilsenhoff Diversity Index (HDI)** assigns tolerance values from 0 to 10, increasing as water quality decreases.

Station 1 displayed fair species diversity with low numbers of individuals per sample. Total taxa values were fairly high and the HDI indicated very poor water quality. Two blacknose dace (*Rhinichthys atratulus*) were collected at Station 1. These minnow provide a good forage base for largemouth bass (*Micropterus salmoides*) and bluegills (*Lepomis macrochirus*) that were seen in deeper portions of the creek and likely reside in all the ponds at Winterthur.

Station 2 yielded a sample of only five Oligochaete worms. Two tadpoles were also obtained in this sample. Poor habitat and water quality likely minimizes macroinvertebrate colonization. The HDI indicated very poor water quality.

Conditions improved at Station 3 even though this zone received effluent from the Museum's sewage treatment plant. Diversity and number of individuals were good as was habitat. The HDI indicated fair water quality.

Station 4 provided somewhat limited diversity, however very high numbers of caddisflies were collected. This yielded a high % EPT and % dominant values. The HDI indicated fair water quality.

Station 5 probably indicated the most favorable water quality of all samples because both diversity and numbers of individuals were high and the HDI calculations indicated excellent water quality.

### Literature Cited

Hilsenhoff, W. L., 1988. "Rapid Field Assessment of Organic Pollution with a Family-Level Biotic Index" *J. N. Am. Benthol. Soc.*, 7(1): 65-68.

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Lind, O. T. "Handbook of Common Methods in Limnology" Kendall/Hunt Publishing Company. 199 pp.

## PONDS

The methodologies used for evaluation of the ponds at Winterthur correspond to those used by the DNREC Division of Water Resources. Water chemistry parameters obtained include: dissolved oxygen and temperature profiles, secchi transparency, total phosphorus, total suspended solids, chlorophyll a, and pH. Algae

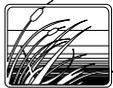
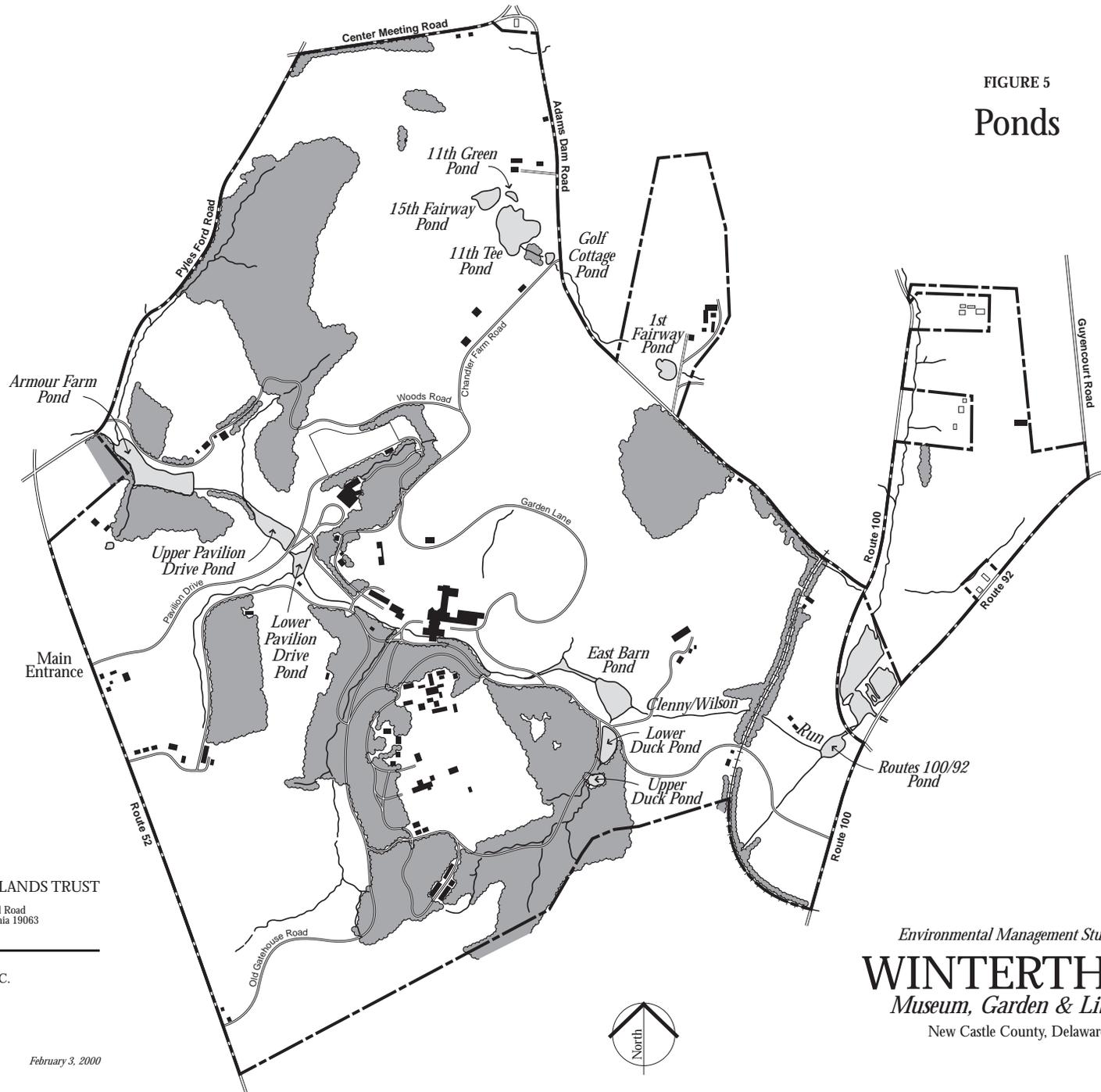
and rooted macrophytes were sampled, identified and estimated for % cover. This information is used, along with dissolved oxygen profiles, to infer overall habitat and pond water quality. Pond morphometry, including shoreline features and bathymetry is desired in an effort to gauge lake volume in the event that chemical treatment or aeration is recommended. A general investigation of land use within the watershed is included and obvious problems identified during background or field investigations are noted.

## Sampling Station Descriptions

On October 21, 1997, grab samples of pond water were obtained by Patricia Ann Quigley, Inc. at the outflow structures at a total of six ponds along Clenny/Wilson Run within Winterthur (see Figure 5 and Table 2). The ponds are in series along the creeks and represent approximately 7,000 linear feet of stream length. The uppermost pond, Armour Farm Pond, is situated near the northwestern property boundary at Pyles Ford Road. The last pond, the Routes 100/92 Pond, is located near the eastern property boundary near the intersection of Routes 100 and 92. Samples were collected from 10:30 to 14:00 hr., maintained on ice and relinquished to the laboratory at 15:20 hr.

**Total Suspended Solids (TSS)** were below the 10 mg/l detection limit in all ponds except East Barn Pond which displayed 12.0 mg/l TSS. TSS relates directly to turbidity, and to some extent, silt loading. The State of Delaware, Surface Water Quality Standards, as amended February 26, 1993, recommends a turbidity level of 10 or less for Clenny/Wilson Run's watershed. Excessive TSS can reduce the amount of light entering the water, reducing plant and algae growth. The gills of juvenile fish, invertebrates, and mussels and clams can become clogged by excessive TSS. Benthic

FIGURE 5  
Ponds



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INVENTORY AND ANALYSIS

**Table 2: Pond Sample Results**

	ARMOUR FARM POND	11TH TEE POND	UPPER PAVILION DRIVE POND	LOWER DUCK POND	EAST BARN POND	ROUTES 100/92 POND
Total Suspended Solids (mg/l)	N.D.	N.D.	N.D.	N.D.	<b>12.0</b>	N.D.
Dissolved Oxygen (mg/l)	<b>4.7</b>	11.0	9.3	9.0	8.5	15.0
pH	6.73	<b>8.81</b>	7.2	7.32	7.3	<b>9.24</b>
Total Phosphorus (mg/l)	<b>0.099</b>	N.D.	N.D.	N.D.	<b>1.3</b>	N.D.
Total Coliform (CFU/100 ml)	<b>&gt;1,600</b>	9	8	<b>140</b>	<b>170</b>	<b>90</b>
Chlorophyll a (mg/l)	2.4	<b>16.0</b>	7.5	4.2	1.9	1.9

*\* Bold-italicized values indicate levels outside of mandated or recommended parameters*

macroinvertebrate habitat is degraded and sometimes eliminated by siltation (Hynes, 1979). Much of the TSS within Clenny/Wilson Run is removed by the ponds, which allow suspended items to settle out. Armour Farm Pond is currently being dredged. This will reduce the amount of sediment and nutrient loading to downstream reaches.

**Dissolved Oxygen (DO)** is a measure of the amount of oxygen dissolved in the water. DO levels were generally favorable except for Armour Farm Pond. DO values ranged from 4.7 to 15.0 mg/l. DO is necessary for aquatic life, which absorb oxygen through gills. DO levels below 4.0 are typically stressful to most forms of aquatic life. The Surface Water Quality Standards mandates a

minimum dissolved oxygen level of 4.0 mg/l and an average for the June–September period of no less than 5.5 mg/l for Clenny/Wilson Run’s watershed. The ponds did not exceed these criteria for any of the water samples.

**pH** is a measure of aqueous acidity and basicity, ranging from zero (most acidic) to fourteen (most basic) with seven being neutral. pH levels were generally favorable except for the 11th Tee Pond and Routes 100/92 Pond which had elevated pH values. pH values ranged from 6.73 to 9.24 standard units. The Surface Water Quality Standards mandates a pH range of 6.5–8.5 for Clenny/Wilson Run’s watershed. These criteria were exceeded in the 11th Tee Pond, which had a pH of 8.81, and the Routes 100/92 Pond,

which had a pH of 9.24. Most lakes have a pH of 6 to 9, and a pH of 10 may indicate eutrophic soda lakes or marl (Goldman and Horne, 1983).

**Total Phosphorus (TP)** is an important nutrient for plant growth and excessive phosphorus can cause increased algal or macrophyte growth leading to pond eutrophication. TP concentrations of nonpolluted waters are usually less than 0.1 mg/l (Lind, 1985). However, because phosphorus is often a limiting nutrient, a small phosphorus increase can lead to a marked rise in plant growth because nitrogen and carbon are usually present in excess. TP levels were favorable except for East Barn Pond which slightly exceeded the recommended value at 1.3 mg/l. The Surface Water Quality Standards do not provide guidance for phosphorus. Phosphorus is primarily found within pond sediments and by dredging Armour Farm Pond inputs of phosphorus should decrease downstream.

**Total Coliform (TC)** is a measure of certain bacteria which are associated with sewage. The bacteria are derived from the digestive tracts of mammals, and measuring total coliform does not distinguish between human or animal origin. Certain levels of these bacteria are always present in healthy aquatic systems. TC values ranged from 8 to >1,600 colonies/100 ml. The highest TC values occurred within Armour Farm Pond, Lower Duck Pond, East Barn Pond, and the Routes 100/92 Pond. Coliform inputs to the ponds do occur naturally and wide variation in TC values is common. However, excessive loadings are occurring through the droppings of resident Canada Geese and probably from off-site septic systems.

**Chlorophyll a** is a plant pigment which converts light energy to chemical energy during photosynthesis. This indirectly measures growth, primary productivity, and algal abundance or standing

crop. Surface Water Quality Standards does not provide guidance for this parameter, however a healthy non-eutrophic lake or pond should have chlorophyll a levels below 10 mg/l (Hynes, 1979). Only the 11th Tee Pond exceeded this value at 16.0 mg/l.

### Literature Cited

- Golden, C. R., and A. J. Horne. 1983. "Limnology" McGraw-Hill, Inc. 464 pp.  
Hynes, H. B. 1979. "The Ecology of Running Waters" Liverpool Press. 555 pp.  
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## WETLANDS

Due to the large study area, a full-scale point-to-point survey of all regulatory wetlands on the Winterthur grounds was not recommended. To meet the goals of an overall land stewardship plan, it is essential though to have preliminary boundary identification, based on field observations, with detailed observations recorded of the wetland type, dominant species, rare or endangered species, and degree of disturbance. Full-scale surveying of wetland boundaries should be reserved for key areas where potential future facilities development or expansion is considered which may encroach on regulated wetlands.

A diversity of wetland types — swamps, marshes, and ponds — are found at Winterthur and were examined by Patricia Ann Quigley, Inc. on various field visits between September 1997 and October 1998 (see Hydrology map). These wetlands occur in association with seeps, streams, and impoundments located in the watershed of Clenny/Wilson Run which drains eastward to Brandywine Creek. Forested wetlands occur where a canopy has

remained and wet meadows occur in areas that are periodically mowed. Extensive manipulation of the ground and surface water resources at Winterthur have effected the wetlands. Piping has depleted water from some areas causing wetlands to diminish in area over time while elsewhere, wetter circumstances have been created. Winterthur as a whole has an abundance of water which supports an array of relatively natural wetlands as well as the many lovely, yet unnatural, ponds.

Wetlands and some adjacent non-wetland areas are described below in the order that they occur moving downstream from headwater areas and from north to south and west to east across the property. Also refer to Appendix D for a master species list of plants occurring in sampled wetlands.

## Wet area in Bidermann Meadow

An area of wet meadow grading into scrub/shrub wetland occurs in Bidermann Meadow. Springs and seeps support the wetland. Young red maples (*Acer rubrum*) dominate the scrub/shrub zone on the northern side of the wetland. The southern portion supports a diversity of herbaceous species including soft rush (*Juncus effusus*), sensitive fern (*Onoclea sensibilis*), fowl manna grass (*Glyceria striata*), grass-leaved goldenrod (*Euthamia graminifolia*), deer-tongue grass (*Panicum clandestinum*), purple-stemmed aster (*Aster puniceus*), swamp milkweed (*Asclepias incarnata*), and New York ironweed (*Vernonia noveboracensis*). A raspberry species (*Rubus* sp.) and multiflora rose (*Rosa multiflora*) are interspersed among the herbaceous plants. A dogbane species (*Apocynum* sp.) and Japanese honeysuckle (*Lonicera japonica*) grow in drier areas at the edge of the wetland. Little bluestem (*Andropogon scoparius*) dominates the surrounding non-wetland meadow. An intermittent

stream that drains the wet meadow flows eastward under Adams Dam Road.

## Forested wetlands in Chandler Woods

Downgradient along a generally dry swale southeast of a golf green along Pyles Ford Road, the swale gathers more water and becomes a headwater stream of Clenny/Wilson Run that parallels and runs east of the road. In an open area of wetland where there is a break in the surrounding upland forest canopy, one observes 40' sour gum (*Nyssa sylvatica*), a shrub layer dominated by spicebush (*Lindera benzoin*) with some wineberry (*Rubus phoenicolasius*), and an herbaceous layer dominated by clearweed (*Pilea pumila*) with smartweed (*Polygonum* sp.), stiltgrass (*Microstegium vimineum*), bulrush (*Scirpus* sp.), garlic mustard (*Alliaria petiolata*), skunk cabbage (*Symplocarpus foetidus*), curly dock (*Rumex crispus*), and Indian strawberry (*Duchesnea indica*). Grape (*Vitis* sp.) is the dominant vine. The soil has a silty clay loam texture and from the surface to 8" has a 5Y 3/1 matrix with 10YR 3/6 and 10YR 4/6 mottles indicating hydric conditions.

Further downstream a finger of forested wetland fed by seeps joins the Clenny/Wilson Run tributary from the east. The forested wetland has an 80' canopy of tulip tree (*Liriodendron tulipifera*) on slightly higher ground, a 20' subcanopy of black ash (*Fraxinus nigra*), beech (*Fagus grandifolia*), and sour gum (*Nyssa sylvatica*), a shrub layer dominated by spicebush (*Lindera benzoin*) with some elderberry (*Sambucus canadensis*) and arrowwood (*Viburnum dentatum*), and a diverse herbaceous layer dominated by skunk cabbage (*Symplocarpus foetidus*) and golden saxifrage (*Chrysosplenium americanum*) with turtlehead (*Chelone glabra*), spotted touch-me-not (*Impatiens capensis*), primrose (*Primula* sp.),

sedge (*Carex* sp.), cinnamon fern (*Osmunda cinnamomea*), false nettle (*Boehmeria cylindrica*), clearweed (*Pilea pumila*), jack-in-the-pulpit (*Arisaema triphyllum*), and violet (*Viola* sp.). The herbaceous cover is sparse in the shade and lush in open areas near a dirt road that passes nearby. Between the surface and 8" the saturated soil has a color of 5Y 2.5/1 indicating that it is hydric. Frogs and toads were observed in the area on 10/10/97.

## Wet area in Armour Farm Meadow

Continuing downstream along the Clenny/Wilson Run tributary that parallels Pyles Ford Road, the forest cover opens into wet meadow. Soft rush (*Juncus effusus*) and arrow-leaved tearthumb (*Polygonum sagittatum*) dominate the wet meadow with numerous other species present in lesser amounts including purple-stemmed aster (*Aster puniceus*), lurid sedge (*Carex lurida*), dogbane (*Apocynum* sp.), multiflora rose (*Rosa multiflora*), deer-tongue grass (*Panicum clandestinum*), goldenrod (*Solidago* sp.), sensitive fern (*Onoclea sensibilis*), rough-leaved goldenrod (*Solidago patula*), spotted touch-me-not (*Impatiens capensis*), smartweed (*Polygonum* sp.), bedstraw (*Galium* sp.), New York ironweed (*Vernonia noveboracensis*), umbrella sedge (*Cyperus* sp.), mountain mint (*Pycnanthemum* sp.), and purple-leaved willow herb (*Epilobium coloratum*). Between the surface and 8" the soil matrix is 10YR 3/2 with 7.5YR 3/4 mottles indicating hydric conditions. The wet meadow extends along the eastern side of the stream down to where an access road from Pyles Ford Road crosses the drainage. From the access road downstream to where the tributary flows into Armour Farm Pond, disturbance in the form of filling, regrading, planting, and mowing has obscured natural wetland boundaries. Soft rush (*Juncus effusus*) grows here in the closely-cropped lawn.

## Armour Farm Pond

At the upstream end of Armour Farm Pond where the previously described Clenny/Wilson Run tributary enters the pond and a second Clenny/Wilson Run tributary which enters the Winterthur property from the west also flows into the pond, spikerush (*Eleocharis* sp.) and mud plantain (*Heteranthera reniformis*) grow. Due to inputs of sediment from upstream, the pond is less than 1 foot deep in this area.

## Forested wetlands in Negandank Woods

A northward-flowing spring-fed stream drains into the southern side of Armour Farm Pond and supports forested wetland with some emergent patches along its length. At the upper end of this system is a pond, supporting burreed (*Sparganium* sp.) and common reed (*Phragmites australis*), that is connected to the creek corridor by underground pipes. In a seepy wet meadow along the creek one finds clearweed (*Pilea pumila*), a tussock-forming sedge (*Carex* sp.), false nettle (*Boehmeria cylindrica*), spotted touch-me-not (*Impatiens capensis*), fowl manna grass (*Glyceria striata*), stiltgrass (*Microstegium vimineum*), common arrowhead (*Sagittaria latifolia*), tussock sedge (*Carex stricta*), violet (*Viola* sp.), jumpseed (*Polygonum virginianum*), long-bristled smartweed (*Polygonum cespitosum*), arrow-leaved smartweed (*Polygonum sagittatum*), and mild water-pepper (*Polygonum hydropiperoides*). Spicebush (*Lindera benzoin*) edges the wet meadow. The combination of mucky substrate, flowing water, and tussocks makes the area potential bog turtle habitat. From the surface to refusal at 5", the inundated and saturated soil has a color of 2.5Y 2.5/1 indicating hydric conditions.

## Wet area in Lower Armour Farm Meadow

Downstream of Armour Farm Pond there is a disturbed wet meadow on the north side of Clenny/Wilson Run. Mowing of the area has set back desirable wetland plant species and damaged wildlife as evidenced by a large mowed snapping turtle shell on 10/10/97. A diverse mix of species includes sweetflag (*Acorus calamus*), soft rush (*Juncus effusus*), purple-stemmed aster (*Aster puniceus*), lurid sedge (*Carex lurida*), black bulrush (*Scirpus atrovirens*), reed canary grass (*Phalaris arundinacea*), dogbane (*Apocynum* sp.), a white-flowering smartweed (*Polygonum* sp.), barnyard grass (*Echinochloa crusgalli*), umbrella sedge (*Cyperus* sp.), a white aster (*Aster* sp.), thistle (*Cirsium* sp.), Canada goldenrod (*Solidago canadensis*), wild mint (*Mentha arvensis*), yellow foxtail grass (*Setaria glauca*), and water purslane (*Ludwigia palustris*).

## Forested wetland in Chandler Woods and wet area in Lower Armour Farm Meadow

Another Clenny/Wilson Run tributary flowing from northeast to southwest joins Clenny/Wilson Run at the upper end of Upper Pavilion Drive Pond. The upper most segment of this tributary above Woods Road was dry on 10/10/97 and lacked hydric soils therefore precluding it from qualifying as wetland. A wetland fringe along the tributary extends from a small waterfall below Woods Road downstream to Upper Pavilion Drive Pond. A seepy emergent wetland dominated by turtlehead (*Chelone glabra*) and elderberry (*Sambucus canadensis*) occurs on the eastern side of the tributary below Woods Road. Capped cisterns indicate past use of the area for spring water collection. Downstream of a second lower crossing of the tributary by Woods Road, wet meadow extends along the tributary. A representative sample point next to a spring

house on the western side of the creek in an area where many cut logs have been placed supports a diverse mix of emergents including arrow-leaved tearthumb (*Polygonum sagittatum*), spotted touch-me-not (*Impatiens capensis*), purple-stemmed aster (*Aster puniceus*), and bulrush (*Scirpus* sp.) as dominants and curly dock (*Rumex crispus*), Canada goldenrod (*Solidago canadensis*), soft rush (*Juncus effusus*), purple-leaved willow herb (*Epilobium coloratum*), rice cutgrass (*Leersia oryzoides*), grass-leaved goldenrod (*Euthamia graminifolia*), sensitive fern (*Onoclea sensibilis*), and umbrella sedge (*Cyperus* sp.) in lesser amounts.

## Upper Pavilion Drive Pond

In walking around Upper Pavilion Drive Pond, one sees “dwarfed” awl aster (*Aster pilosus*) in repeatedly mowed drier areas. Cup plant (*Silphium perfoliatum*), swamp milkweed (*Asclepias incarnata*), purple-stemmed aster (*Aster puniceus*), multiflora rose (*Rosa multiflora*), and alder (*Alnus* sp.) fringe the pond. Mud plantain (*Heteranthera reniformis*) and water purslane (*Ludwigia palustris*) grow in shallow water at the pond’s edge.

## Waters with marshy pockets in Pavilion Woods

Drainageways that feed into Clenny/Wilson Run in the vicinity of the Picnic House and Pavilion have been manipulated. One such drainageway has some broader fringing areas of emergent vegetation and in many places has steep-sided banks that would qualify it as waters. At its upper end, grey hydric soils occur in an area supporting beggarticks (*Bidens* sp.), sensitive fern (*Onoclea sensibilis*), stiltgrass (*Microstegium vimineum*), and spotted touch-me-not (*Impatiens capensis*). Continuing downstream, one finds

drainage pipes along the western side of the drainageway that direct stormwater runoff from the nearby Visitor Parking Lot into the small stream. One also finds a series of breached walls crossing the drainageway that once impounded sections to create small pools. Wetland emergents including skunk cabbage (*Symplocarpus foetidus*), stiltgrass (*Microstegium vimineum*), New York fern (*Thelypteris noveboracensis*), clearweed (*Pilea pumila*), and aster (*Aster* sp.) grow on benches adjacent to the small stream. At its lower end, the drainageway is piped underground.

## Lower Pavilion Drive Pond

Vegetation fringes Lower Pavilion Drive Pond. Upper Pavilion Drive Pond flows into this pond from the northwest, the previously described drainageway flows into the pond from the northeast, and another Clenny/Wilson Run tributary flows into the pond from the southwest. Numerous Canada geese utilize the lawn surrounding the pond and the pond itself. Fringing vegetation includes yellow iris (*Iris pseudacorus*), swamp milkweed (*Asclepias incarnata*), purple-stemmed aster (*Aster puniceus*), smartweed (*Polygonum* sp.), arrow-leaved tearthumb (*Polygonum sagittatum*), true forget-me-not (*Myosotis scorpioides*), false nettle (*Boehmeria cylindrica*), rose-mallow (*Hibiscus moscheutos*), willow (*Salix* sp.), beggarticks (*Bidens* sp.), soft rush (*Juncus effusus*), sedge (*Carex* sp.), curly dock (*Rumex crispus*), umbrella sedge (*Cyperus* sp.), mud plantain (*Heteranthera reniformis*), spotted touch-me-not (*Impatiens capensis*), halberd-leaved tearthumb (*Polygonum arifolium*), sensitive fern (*Onoclea sensibilis*), and primrose (*Primula* sp.).

## Wet area in Negandank Meadow South 2 and forested wetland fringe north of Nursery Woods and Meadow

The Clenny/Wilson Run tributary that drains into Lower Pavilion Drive Pond begins in Negandank Meadow South 2 and has a manhole cover at its uppermost end. Seeps feed the tributary along its length and support a band of wet meadow. At its uppermost end, sensitive fern (*Onoclea sensibilis*), spotted touch-me-not (*Impatiens capensis*), and Canada thistle (*Cirsium arvense*) grow. Continuing downstream one find stiltgrass (*Microstegium vimineum*) and halberd-leaved tearthumb (*Polygonum arifolium*) in soils that were saturated on 8/6/98. Where the wetland band broadens, umbrella sedge (*Cyperus* sp.), common cattail (*Typha latifolia*), curly dock (*Rumex crispus*), true forget-me-not (*Myosotis scorpioides*), common arrowhead (*Sagittaria latifolia*), stiltgrass (*Microstegium vimineum*), aster (*Aster* sp.), and grass grow. On 8/6/98, the wetland band had been mowed across. Continuing downstream, one sees sprinkler heads along the tributary. Cardinal flower (*Lobelia cardinalis*) and primrose (*Primula* sp.) are dominant here. The wetland band along the tributary narrows moving downstream toward Lower Pavilion Drive Pond as the banks steepen. The stream in this stretch is generally shallow with a rocky to gravelly substrate, abundant leaf litter, and an average width of four feet. Common privet (*Ligustrum vulgare*), multiflora rose (*Rosa multiflora*), spotted touch-me-not (*Impatiens capensis*), and poison ivy (*Toxicodendron radicans*) dominate the narrow wetland band that extends along the stream here. White oak (*Quercus alba*), red maple (*Acer rubrum*), and sour gum (*Nyssa sylvatica*) are dominant trees in the adjacent upland forest fringe along the tributary. Flowering dogwood (*Cornus florida*) is present as well as common privet (*Ligustrum vulgare*), multiflora rose (*Rosa*

*multiflora*), and wineberry (*Rubus phoenicolasius*). Upland herbaceous layer and vine species include white ash (*Fraxinus americana*) seedlings, New York fern (*Thelypteris noveboracensis*), Asiatic bittersweet (*Celastrus orbiculatus*), and grape (*Vitis* sp.).

## Marsh along Clenny/Wilson Run from Lower Pavilion Drive Pond to bridge at H.F. du Pont House

A band of marsh vegetation extends along the main channel that flows from Lower Pavilion Drive Pond. A diverse mix includes true forget-me-not (*Myosotis scorpioides*), sensitive fern (*Onoclea sensibilis*), moneywort (*Lysimachia nummularia*), English ivy (*Hedera helix*), poison ivy (*Toxicodendron radicans*), curly dock (*Rumex crispus*), Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), aster (*Aster* sp.), spotted touch-me-not (*Impatiens capensis*), stiltgrass (*Microstegium vimineum*), mud plantain (*Heteranthera reniformis*), false nettle (*Boehmeria cylindrica*), iris (*Iris* sp.), cup plant (*Silphium perfoliatum*), primrose (*Primula* sp.), purple-stemmed aster (*Aster puniceus*), turtlehead (*Chelone glabra*), soft rush (*Juncus effusus*), and arrow-leaved tearthumb (*Polygonum sagittatum*).

On the south side of the main channel there is an abandoned quarry with natural seeps that feed a fern garden.

## Wet area in Event Field/Old Gatehouse Meadow and forested wetland in Farm Hill Woods

A northward-flowing tributary joins the main channel a short distance beyond the quarry. The southwest arm of the tributary is lined with soft rush (*Juncus effusus*) in its uppermost stretch. Below a gravel crossing, a wet meadow band broadens and includes both soft rush (*Juncus effusus*) and sensitive fern (*Onoclea sensibilis*). Moving downstream, the channel meanders with sluggish flow. The stream suffers from Canada geese use and lack of shade. Continuing downstream along this southwest arm, the southern side becomes steeply banked and a shallow rivulet with good flow issues into the stream. Dense sweetflag (*Acorus calamus*), spotted touch-me-not (*Impatiens capensis*), and arrow-leaved tearthumb (*Polygonum sagittatum*) grow here. Numerous red-winged blackbirds were observed in this area. The southeast arm of the tributary has seeps at its uppermost end supporting spotted touch-me-not (*Impatiens capensis*) and garlic mustard (*Alliaria petiolata*). Moving downstream, the tributary qualifies as waters where it flows through a beech (*Fagus grandifolia*) and tulip tree (*Liriodendron tulipifera*) forest. Downstream of the confluence of the southwest and southeast arms of the tributary, it flows through open meadow and is flanked by emergent wetland. A drainage joins the tributary from the west. Below a road crossing the tributary flows through forest and is flanked by forested wetland. Seeps feed into the tributary along its length. Dominant herbaceous plants in the forested wetland include spotted touch-me-not (*Impatiens capensis*), fowl manna grass (*Glyceria striata*), and wood nettle (*Laportea canadensis*). Spicebush (*Lindera benzoin*) is dominant in the creek valley with non-native viburnums (*Viburnum* sp.). Near the confluence of the northward-

flowing tributary and the main channel, one find numerous alien shrub and groundcover species along the tributary.

## Marsh along main channel from bridge at H.F. du Pont House to below Museum Road

Downstream of the confluence of the northward-flowing tributary and the main channel there is a shallow section of the main channel near a stone crossing and just upstream of where it flows under the Museum and Library. Here, one finds a great diversity of herbaceous plants along the channel including true forget-me-not (*Myosotis scorpioides*), mud plantain (*Heteranthera reniformis*), rice cutgrass (*Leersia oryzoides*), lady's thumb (*Polygonum persicaria*), beggarticks (*Bidens* sp.), arrowleaved tearthumb (*Polygonum persicaria*), beggarticks (*Bidens* sp.), arrow-leaved tearthumb (*Polygonum sagittatum*), umbrella sedge (*Cyperus* sp.), spotted touch-me-not (*Impatiens capensis*), yellow iris (*Iris pseudacorus*), watercress (*Nasturtium officinale*), stiltgrass (*Microstegium vimineum*), burreed (*Sparganium* sp.), smartweed (*Polygonum* sp.), and halberd-leaved tearthumb (*Polygonum arifolium*). Beyond where the main channel flows under the building, Japanese knotweed (*Polygonum cuspidatum*) fringes the southern edge of the creek.

Below the Museum and Library, a diverse mix of emergents continues to thrive in a fringe along the main channel. These species include curly dock (*Rumex crispus*), true forget-me-not (*Myosotis scorpioides*), clearweed (*Pilea pumila*), stiltgrass (*Microstegium vimineum*), spotted touch-me-not (*Impatiens capensis*), lady's thumb (*Polygonum persicaria*), water pepper (*Polygonum hydropiper*), Japanese knotweed (*Polygonum cuspidatum*), false nettle (*Boehmeria cylindrica*), Canada goldenrod (*Solidago canadensis*), reed canary grass (*Phalaris arundinacea*), cup

plant (*Silphium perfoliatum*), hosta, dodder (*Cuscuta* sp.), mint (*Mentha* sp.), beggarticks (*Bidens* sp.), halberd-leaved tearthumb (*Polygonum arifolium*), and purple-stemmed aster (*Aster puniceus*).

Downstream of Museum Road, the main channel broadens as it flows into a small triangular pond also fed by a tributary draining the rock garden. The channel above this small pond has Japanese knotweed (*Polygonum cuspidatum*), cup plant (*Silphium perfoliatum*), true forget-me-not (*Myosotis scorpioides*), umbrella sedge (*Cyperus* sp.), and willow (*Salix* sp.) along its length. Banded killifish live in this stretch of the channel as well.

## Marsh in Quarry Garden

The Quarry Garden drains into the small triangular pond. At the upper end of the Quarry Garden one discovers that seeps feeding the lovely feature derive, at least in part, from the upslope pump house. In late summer, cardinal flower (*Lobelia cardinalis*) of multiple hues and great blue lobelia (*Lobelia siphilitica*) fill the garden. Below the garden, a flowing stream traces a curving path downslope with periodic low walls impounding small ponds. At the bottom of the slope a seep feeds into the stream from the northwest.

## Triangular Pond

Mud plantain (*Heteranthera reniformis*) and water purslane (*Ludwigia palustris*) grow in mats in shallow areas. At the edge, one finds a fringe of spotted touch-me-not (*Impatiens capensis*), false nettle (*Boehmeria cylindrica*), water pepper (*Polygonum hydropiper*), sensitive fern (*Onoclea sensibilis*), true forget-me-not (*Myosotis scorpioides*), swamp milkweed (*Asclepias incarnata*), bugleweed

(*Lycopus* sp.), sweetflag (*Acorus calamus*), purple-stemmed aster (*Aster puniceus*), common water plantain (*Alisma subcordatum*), St. Johnswort (*Hypericum* sp.), mint (*Mentha* sp.), and curly dock (*Rumex crispus*).

## East Barn Pond

East Barn Pond occurs downstream of the triangular pond. Cup plant (*Silphium perfoliatum*) and creeping water primrose (*Ludwigia peploides*) grow along the southwestern edge. The northern edge has a steep, abrupt, and eroded silty loam bank. Asiatic bittersweet (*Celastrus orbiculatus*), true forget-me-not (*Myosotis scorpioides*), spotted touch-me-not (*Impatiens capensis*), small white aster (*Aster* sp.), English plantain (*Plantago lanceolata*), Queen Anne's lace (*Daucus carota*), swamp milkweed (*Asclepias incarnata*), cup plant (*Silphium perfoliatum*), dogbane (*Apocynum* sp.), dodder (*Cuscuta* sp.), St. Johnswort (*Hypericum* sp.), multiflora rose (*Rosa multiflora*), and speckled alder (*Alnus incana*) grow along the northern edge. Seeps feed into the pond along its northern edge at the break in slope. The pond has submerged aquatic plants that swans feed upon. A great blue heron was observed here, too.

## Forested wetland in Duck Pond Woods

A northward-flowing tributary feeds into the southern side of East Barn Pond. A southwestern arm of the tributary has a channel that was dry on 11/1/98 at its upper end. A seep-fed scrub-shrub area dominated by spicebush (*Lindera benzoin*) and spotted touch-me-not (*Impatiens capensis*) occurs downslope. Above the first road crossing, the small creek was flowing on 11/1/98. A wetland band of arrowwood (*Viburnum dentatum*), spicebush (*Lindera benzoin*),

and garlic mustard (*Alliaria petiolata*) extends along the creek in this area. Below the road crossing, a narrow wetland band extends along the creek as it flows through beech (*Fagus grandifolia*) forest. A southeastern arm of the tributary also had a dry channel as of 11/1/98 at its upper end. Debris is strewn in this channel. Downslope, seeps feed a small wetland dominated by Japanese knotweed (*Polygonum cuspidatum*), multiflora rose (*Rosa multiflora*), and spicebush (*Lindera benzoin*). An old road crosses the lower end of this small wetland. A pipe under the old road discharges water from the wetland into a narrow, steep-sided channel that would qualify as waters. Downstream seeps feed into the channel creating a relatively broad wetland area with spicebush (*Lindera benzoin*) and spotted touch-me-not (*Impatiens capensis*) dominant. Below the first existing road crossing the southwest and southeast arms join. Continuing downstream, a dry (on 11/1/98) steep-sided channel with abundant debris along its sides joins the tributary from the east. A broad band of forested wetland fed by numerous seeps issuing from the slope east of the tributary occurs below the second road crossing. The wetland supports spicebush (*Lindera benzoin*), skunk cabbage (*Symplocarpus foetidus*), clearweed (*Pilea pumila*), jack-in-the-pulpit (*Arisaema triphyllum*). Although some winged euonymus (*Euonymus alatus*) and Asiatic bittersweet (*Celastrus orbiculatus*) are present, the forested wetland is relatively natural. Downstream there are two ponds. At the eastern edge of the southern pond, Upper Duck Pond, one finds stiltgrass (*Microstegium vimineum*), halberd-leaved tearthumb (*Polygonum arifolium*), sedge (*Carex* sp.), spotted touch-me-not (*Impatiens capensis*), skunk cabbage (*Symplocarpus foetidus*), and beggarticks (*Bidens* sp.). Seeps feed into the southern end of the northern pond, Lower Duck Pond, to support wood nettle (*Laportea canadensis*), spotted touch-me-not (*Impatiens capensis*), hosta, and skunk cabbage (*Symplocarpus foetidus*). A steep bank extends along parts of the western and northern edges of the pond.

At the northern end, one finds a narrow wetland band of beggarticks (*Bidens* sp.), water purslane (*Ludwigia palustris*), and yerba-de-tajo (*Eclipta alba*).

## Wet area in East Barn Meadow and Route 100 Meadow

Downstream of East Barn Pond wet meadow grading to scrub/shrub wetland extends along the main channel. Upstream of the railroad embankment, one finds a diversity of herbaceous species including spotted touch-me-not (*Impatiens capensis*), purple-leaved willow herb (*Epilobium coloratum*), sensitive fern (*Onoclea sensibilis*), sweetflag (*Acorus calamus*), Canada goldenrod (*Solidago canadensis*), trumpetweed (*Eupatorium fistulosum*), swamp goldenrod (*Solidago uliginosa*), and soft rush (*Juncus effusus*). Multiflora rose (*Rosa multiflora*) and speckled alder (*Alnus incana*) are present here along with black cherry (*Prunus serotina*) seedlings, Japanese honeysuckle (*Lonicera japonica*), and Asiatic bittersweet (*Celastrus orbiculatus*). Downstream of the railroad embankment, one finds wet meadow extending along the main channel that is dominated by reed canary grass (*Phalaris arundinacea*) and New York ironweed (*Vernonia noveboracensis*) with an admixture of soft rush (*Juncus effusus*), umbrella sedge (*Cyperus* sp.), purple-stemmed aster (*Aster puniceus*), moneywort (*Lysimachia nummularia*), dwarf St. Johnswort (*Hypericum mutilum*), dogbane (*Apocynum* sp.), and poison-hemlock (*Conium maculatum*). The main channel drains into Routes 100/92 Pond which has clumps of rose-mallow (*Hibiscus moscheutos*) around its edge.

Route 100 Meadow has a patchwork of upland areas dominated by broom sedge (*Andropogon virginicus*) with some New York ironweed (*Vernonia noveboracensis*), aster (*Aster* sp.), and Queen

Anne's lace (*Daucus carota*) and wetland areas. A typical wetland patch supports soft rush (*Juncus effusus*), New York ironweed (*Vernonia noveboracensis*), beggarticks (*Bidens* sp.), multiflora rose (*Rosa multiflora*), dwarf St. Johnswort (*Hypericum mutilum*), Queen Anne's lace (*Daucus carota*), goldenrod (*Solidago* sp.), sedge (*Carex* sp.), moneywort (*Lysimachia nummularia*), violet (*Viola* sp.), broom sedge (*Andropogon virginicus*), and a grass (*Paspalum* sp.).

A straight ditch extending northeast across the broad meadow to Routes 100/92 Pond is fringed by wetland dominated by reed canary grass (*Phalaris arundinacea*) and New York ironweed (*Vernonia noveboracensis*). Watercress (*Nasturtium officinale*) grows in standing water in the channel.

## Ponds and forested wetland south of Bidermann Barn

A series of ponds occurs south of Bidermann Barn and west of Adams Dam Road. On 11/15/98, the area surrounding the uppermost pond, 15th Fairway Pond, appeared to have been recently reseeded and was devoid of vegetation.

The largest pond in the series, 11th Tee Pond, has a fringe of vegetation in some areas and has been mowed to the edge in other areas. Much of the southern edge of the pond lacks a vegetative fringe. The northern edge has some large patches of common reed (*Phragmites australis*) which is an aggressive species that should be controlled. Red maple (*Acer rubrum*) trees grow along part of the western pond edge south of a pumphouse. A narrow fringe of willow (*Salix* sp.) and common cattail (*Typha latifolia*) extends along the southwestern edge of the pond.

The stream draining from 11th Tee Pond flows through a concrete-lined channel for a short distance and then through a low broad area supporting forested wetland. White ash (*Fraxinus americana*) and silver maple (*Acer saccharinum*) dominate the canopy while black cherry (*Prunus serotina*) is a dominant sapling. An exotic shrubby honeysuckle (*Lonicera* sp.) and multiflora rose (*Rosa multiflora*) are common shrubs and spotted touch-me-not (*Impatiens capensis*) is a dominant herbaceous species.

Below the forested wetland, the stream is impounded to form a small pond, Golf Cottage Pond, surrounded by a narrow fringe of rose-mallow (*Hibiscus moscheutos*), stiltgrass (*Microstegium vimineum*), a smartweed species (*Polygonum* sp.), and a sedge species (*Carex* sp.). Below this small pond the stream, bordered along much of its length by a fringe of wetland, continues southeast and flows under Adams Dam Road.

## Wet area along Adams Dam Road Hedgerow and Meadow

Wet meadow and forested wetland fed by seeps and a stream occur along the south side of Adams Dam Road west of Route 100. The first segment of wetland to be described occurs upstream of the railroad embankment, along Adams Dam Road Hedgerow. At the upper end of this wetland segment, an upland forest of tulip tree (*Liriodendron tulipifera*) and beech (*Fagus grandifolia*), including one notably large specimen, grows on relatively steeply-sloping ground. Wetland begins at the break in slope. Forested wetland extends along a creek that crosses from the north to the south side of Adams Dam Road in this area. Sycamore (*Platanus occidentalis*) and black willow (*Salix nigra*) dominate the canopy while musclewood (*Carpinus caroliniana*), American elm (*Ulmus americana*), spicebush (*Lindera benzoin*), multiflora rose (*Rosa*

*multiflora*), and Japanese barberry (*Berberis thunbergii*) are present in the understory. Pachysandra and spotted touch-me-not (*Impatiens capensis*) are dominant herbaceous species while Japanese honeysuckle (*Lonicera japonica*) is a common vine. A broad zone of wet meadow fed by seeps lies adjacent to the forested wetland. Reed canary grass (*Phalaris arundinacea*) dominates the herbaceous layer. Additional species include purple-stemmed aster (*Aster puniceus*), lurid sedge (*Carex lurida*), soft rush (*Juncus effusus*), daylily (*Hemerocallis* sp.), and goldenrod (*Solidago* sp.).

From the downstream side of the railroad embankment to Route 100 is a second segment of wetland along the northern edge of Adams Dam Road Meadow. Reed canary grass (*Phalaris arundinacea*) dominates with sensitive fern (*Onoclea sensibilis*), a smartweed species (*Polygonum* sp.), spotted touch-me-not (*Impatiens capensis*), common cattail (*Typha latifolia*), climbing nightshade (*Solanum dulcamara*), purple-leaved willow herb (*Epilobium coloratum*), soft rush (*Juncus effusus*) also present. On 11/1/98, this segment of wetland had standing water present. At its lower end, the wetland drains under Route 100.

## Wet area in Guyencourt Meadow

Wet meadow extends along the length of an unnamed tributary to Clenny/Wilson Run that flows south along the east side of Route 100 from Guyencourt to the ponds at the intersection of Routes 100 and 92. At the northern end, there is a relatively broad swath of wetland including a loop that extends eastward that is fed by seeps and supports at its upper end purple-leaved willow herb (*Epilobium coloratum*), soft rush (*Juncus effusus*), lurid sedge (*Carex lurida*), monkeyflower (*Mimulus ringens*), and purple-stemmed

aster (*Aster puniceus*). In the area north of a residential driveway crossing, the wetland plant assemblage is fairly typical and includes stiltgrass (*Microstegium vimineum*), purple-stemmed aster (*Aster puniceus*), purple-leaved willow herb (*Epilobium coloratum*), reed canary grass (*Phalaris arundinacea*), soft rush (*Juncus effusus*), blue vervain (*Verbena hastata*), sensitive fern (*Onoclea sensibilis*), swamp milkweed (*Asclepias incarnata*), seedbox (*Ludwigia alternifolia*), skunk cabbage (*Symplocarpus foetidus*), umbrella sedge (*Cyperus* sp.), and bugleweed (*Lycopus* sp.).

A significant spring-fed tributary to the aforementioned unnamed Clenny/Wilson Run tributary extends from east to west from Route 92. Wet meadow fills the swale. At its upper end, the wetland supports swamp milkweed (*Asclepias incarnata*), purple-stemmed aster (*Aster puniceus*), sedge (*Carex* sp.), reed canary grass (*Phalaris arundinacea*), New York ironweed (*Vernonia noveboracensis*), common cattail (*Typha latifolia*), soft rush (*Juncus effusus*), umbrella sedge (*Cyperus* sp.), purple-leaved willow herb (*Epilobium coloratum*), and sensitive fern (*Onoclea sensibilis*). Moving downstream, there is a recent fill pad placed across the swale with a culvert permitting continued flow. A similar species mix occurs downstream of the fill pad.

## FISH

Field surveys were conducted by Jim White of Hyla Associates between September 14, 1997 and October 4, 1998. Seines, hand nets and small traps were used to capture fish. Table 1 in Appendix C presents a list of fish that may occur at Winterthur by habitat type. Table 7 is a “short list” of the species of special concern for fish designated by the Delaware Natural Heritage Program as “S1”, “S2” or “S3” species, which indicates that they are of 1<sup>st</sup>, 2<sup>nd</sup>, or 3<sup>rd</sup> priority ranking for protection, respectively, out of 5

ranking categories. Included in both tables are species that are believed by Hyla Associates to be “probable” or “possible” on the property, based on past field experience in similar habitats, although they were not observed during this field survey.

All of the twelve relatively small ponds at Winterthur maintain populations of fish including American Eel, Common Carp, Brown Bullhead, Pumpkinseed, Bluegill Sunfish, Large Mouth Bass, and White Crappie. Clenny/Wilson Run supports a moderate diversity of piedmont stream fish, including Common Shiner, Black-nosed Dace, Creek Chub, White Sucker, and Tessellated Darter, whereas only Black-nosed Dace and Tessellated Darter were found in the smaller tributaries.

## 2.2 PHYSICAL RESOURCES AND FEATURES

### 2.2.1 Geology

Refer to Geology map.

*Excerpted from Piedmont Basin Preliminary Assessment Report, Delaware Department of Natural Resources and Environmental Control, www.dnrec.state.de.us, October 27, 1998.*

[Winterthur] lies within the Piedmont Province in Delaware. This geologic province, whose name literally means lying at the base or the foot of the mountains, occupies the northernmost, 6% of the state and is commonly referred to as “Delaware’s hard rock country.”

## INVENTORY AND ANALYSIS

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The geology of the Piedmont Province consists predominantly of a thick mass of highly deformed metamorphic and igneous rocks estimated to be more than 500 million years old, likely ranging from Proterozoic to early Paleozoic in age (Woodruff and Plank, 1995). These rocks are highly faulted, folded, jointed, and foliated in some areas. Gneisses and schists form the major rock types. Igneous intrusive rocks, including coarse varieties of granite called pegmatites, are also present in some areas. This crystalline mass is overlain with saprolite (weathered rock material) and in some isolated areas is capped with much younger fluvial sedimentary deposits. Recent work by Woodruff and Plank (1995) categorizes the Piedmont crystalline rock complex into five units. [Table 3] below provides their names, ages, and lithologies.

The Baltimore Gneiss forms the base upon which the younger Piedmont sediments were deposited. In Proterozoic time, the area was under water, and the Baltimore Gneiss formed the ocean floor. The Setters, Cockeysville, and Wissahickon formations were originally deposited as sedimentary cover over the Baltimore Gneiss (Woodruff and Plank, 1995).

The Cockeysville Formation resulted from shallow-water deposition of carbonates on a continental margin, while the Wissahickon Formation formed as a result of deep-water sedimentation and turbidity-current deposits. During Paleozoic time, a mountain-building event — the Taconic Orogeny (480 to 435 million years ago) — caused extreme deformation and metamorphism of the sedimentary deposits. This is when the majority of the Wilmington Complex rocks are believed to have formed (Woodruff and Plank, 1995).

Beginning in the Devonian Period (345 to 405 million years ago), much of the Piedmont Province emerged from the ocean and remained emerged until Cretaceous time. During this period, thousands of feet of crystalline rock were removed from the area by extensive erosion (Woodruff and Thompson, 1975). Delaware's Piedmont Province continues to undergo this weathering and erosion.

Due to the extensive saprolite mantle — in excess of 80 feet thick in some areas — fresh, unaltered exposures of the aforementioned rock units are not common. The saprolite's thickness in Delaware's Piedmont

Province averages approximately 20 to 50 feet (Christopher and Woodruff, 1982).

Of the formations described, the Wilmington Complex and the Wissahickon Formation are by far the most widespread surficial units of the Piedmont Province. In contrast, the Baltimore Gneiss, Setters Formation, and Cockeysville Formation have been mapped only in the northwestern portion of the basin in small, isolated locations.

[Winterthur lies almost completely within the Wissahickon Formation with two small areas on the far eastern boundary, along Routes 92 and 100, within the Wilmington Complex.]

### The Wissahickon Formation

The Wissahickon Formation forms the dominant rock type in the northwestern Piedmont Province and may be greater than 8,000 feet thick (Woodruff and Plank, 1995). This formation is less resistant to chemical and physical weathering than the Wilmington Complex. Thus, deeply incised stream valleys and steep slopes characterize this portion of the basin. Amphibolites and gneisses of the Wissahickon support ridges while mica schists erode to form deep-sided valleys (Christopher and Woodruff, 1982). The formation has considerably more secondary porosity than the Wilmington Complex and therefore has more capacity to store and transmit groundwater. Although high densities of joints and faults exist in some locations and may be able to support initial groundwater yields of 300 to 400 gallons per minute, groundwater typically yields 10 gallons per minute (Woodruff, 1981).

### The Wilmington Complex

The Wilmington Complex represents the dominant rock type in the eastern Piedmont Province. This formation is more resistant to chemical and physical weathering than the Wissahickon Formation; for this reason, the eastern Piedmont Province is characterized by relatively gentle slopes and less deeply incised valleys than found in its western portions (Christopher and Woodruff, 1982).

## INVENTORY AND ANALYSIS

**Table 3: Rocks of the Piedmont Basin**

(Adapted from Woodruff and Plank, 1995)

ROCK UNIT NAME	AGE (millions of years)	GENERAL LITHOLOGICAL DESCRIPTION
Wilmington Complex	340 Early Paleozoic Period	<ul style="list-style-type: none"> <li>• Mafic and felsic gneisses and intrusive igneous rock including gabbroic and dioritic plutons and amphibolites</li> </ul>
Glenarm Series Wissahickon Formation		<ul style="list-style-type: none"> <li>• Gneisses and schists derived from sandstones and mudstones, amphibolites, and serpentinite</li> </ul>
Cockeysville Formation Setters Formation	>570 Proterozoic Period	<ul style="list-style-type: none"> <li>• Calcareous schists and dolomitic marble</li> <li>• Impure quartzite</li> </ul>
Baltimore Gneiss	>570 Proterozoic Period	<ul style="list-style-type: none"> <li>• Gneisses of varying lithologies and amphibolites</li> </ul>

Wilmington Complex rocks are generally massive and do not exhibit significant secondary porosity (faults and joints). These rocks do not readily transmit or store groundwater and do not make good aquifers. An average domestic well in the Wilmington Complex typically yields one gallon per minute or less (Woodruff, 1981). Small quantities of groundwater of questionable quality do exist where the saprolite is of sufficient thickness.

Joints and other fractures in the bedrock, through which groundwater flows, are moderately abundant in metamorphic and igneous rock. Areas above jointed rock, usually evidenced by drainage swales, ephemeral streams, and spring-fed rills and brooks, will generally have greater infiltration rates and recharge capacities, and therefore, can be particularly good locations for stormwater impoundments that can also function as groundwater

recharge basins. Because of these same characteristics, they can just as easily be sources of contamination to the groundwater.

### 2.2.2 Soils

The Soil Survey for New Castle County, Delaware (Natural Resources Conservation Service, formerly the Soil Conservation Service, 1965), divides the county into soil associations. A soil association is “a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.”

Winterthur lies with the Glenelg–Manor–Chester association (see Soils map). The Survey describes the association as follows:

This association is in one large area in the northern and northwestern parts of the county. It consists mainly of gently sloping to moderately sloping soils. On the bottomlands and crests, however, the soils are nearly level, and in some areas above streams they are steep. This association occupies about 15% of the county. Glenelg soils make up about 43% of the association; Manor soils about 28%; Chester soils about 14%; and minor soils the remaining 15%.

The major soils in this association are deep, well drained, and micaceous. The Glenelg soils have a subsoil of silt loam and silty clay loam that generally extends to a depth of not more than 36". The Chester soils have a subsoil of clay loam and silt loam that generally extends to a depth of more than 36". The Glenelg and Chester soils are more micaceous in their underlying material than in the material above it. The Manor soils are highly micaceous. They generally are fairly uniform loam throughout the profile; the subsoil is not finer textured than the surface layer.

The most important minor soils in this association are in the Glenville, Codorus, and Hatboro series. The Glenville soils occur mainly around the head of drainageways and at the base of slopes. They contain a brittle fragipan and are moderately well drained to somewhat poorly drained. The Codorus soils are moderately well drained, and the Hatboro soils are poorly drained. Both kinds of soils occur mainly on floodplains and are susceptible to flooding. Some areas are on foot slopes.

The major soils of this association provide good building sites, though slope is a limitation in places. In most places excavation is not difficult and is not limited by wetness. The soils generally have only slight to moderate limitations to use for sewage disposal by septic tanks. Care should be taken, however, not to place filter fields on steep soils or on wet soils of the floodplains.

### 2.2.3 Topography and Slopes

Winterthur's topography is very typical of the character of the underlying Wissahickon Formation — deeply incised stream valleys with steep slopes (see 2.2.1 Geology). The primary feature is the main Clenny/Wilson Run valley running roughly west to east. The ridges to the north and south of the stream have gentle, 0–8%, slopes on their tops with the side walls typically over 15% with large areas over 25% (see Slopes map). The highest elevation is approximately 432 feet, occurring in the northwestern corner of Bidermann Golf Course near the intersection of Center Meeting and Pyles Ford Roads. The lowest elevation, approximately 218 feet, occurs just below the Routes 100/92 Pond for an overall difference of 214 feet.

## 2.2.4 Existing Land Use

Meadows.....	± 468 ac.	48%	of total area
Woodlands and hedgerows.....	± 192 ac.	20%	
Golf course .....	± 150 ac.	16%	
Gardens, incl. Pinetum .....	± 52 ac.	5%	
Ponds.....	± 11 ac.	1%	
All other areas .....	± 93 ac.	10%	
<hr/>			
<b>Total .....</b>	<b>± 966 ac.</b>		

Streams .....	28,000+ lf / 5.0+ miles
Railroad .....	3,500+ lf / 0.5+ miles
Roads.....	75,500+ lf / 14.0+ miles (± 80% are "improved")