Wetland Assessment of the Proposed Mill Brook Greenway, Village and Town of New Paltz, Ulster County, New York

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Report to the Village of New Paltz and the Town of New Paltz

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Introduction

At the request of the Town and Village of New Paltz, Hudsonia Ltd. conducted a wetland assessment of the "Mill Brook Greenway" area. This area constitutes several parcels, totaling 337 acres, proposed for development. The Greenway area is one of the last remaining major open space areas in the Village of New Paltz, and contains substantial areas of wetlands. Most of the wetlands are associated with the Wallkill River Tributary 13 stream system (Mill Brook and its subtributaries). Wet meadows, marshes, wooded swamps, beaver ponds, woodland pools, and floodplains in the Mill Brook Greenway area have high values for wildlife habitat, biological diversity, and amenity in an area that is rapidly changing from rural to suburban.

The Mill Brook Greenway project represents an unusual collaboration involving two municipalities and five private real estate developers. In the course of land use planning, Village and Town agencies desire to preserve a large greenway focusing on the Mill Brook stream system and its associated wetlands and buffer zones. The role of Hudsonia is to assess the quality of the wetland complex and provide technical assistance to the Village and Town agencies in planning the Greenway. The emphasis of this report is on the Greenway overall rather than individual properties, although some recommendations are also made concerning individual sites.

Hudsonia Ltd. is a nonprofit scientific research institute. Hudsonia does not take advocacy positions concerning land development. Rather we conduct studies based on original field observations and existing information, and recommend how environmental impacts may be reduced. Our particular emphasis is on the biology of a site and the conservation of biological resources.

Study Area

The proposed Mill Brook Greenway is within the quadrilateral bounded by Shivertown Road on the north, North Putt Corners Road on the east, Henry DuBois Road on the south, and Route 32 on the west. The Greenway focuses on the stream and wetland complex associated with Tributary 13 (Mill Brook) of the Wallkill River. This site is in the Village of New Paltz and Town of New Paltz, Ulster County, New York, on the U.S. Geological Survey Rosendale (1964) and Clintondale (1957) 7.5 minute topographic map sheets.

The Greenway area is underlain by the Normanskill formation, in general constituting shale, argillite, and siltstone (Fisher et al. 1970). Mapped soils are shown in Table 1 and are derived from glacial till or lake deposits. Seven of the 13 soils, covering large portions of the study area, are described as Somewhat Poorly Drained, Poorly Drained, or Very Poorly Drained (Tornes 1979). Poorly Drained and Very Poorly Drained soils are wetland soils, and Somewhat Poorly Drained soils are potentially wetland soils. All the soils (Table 1) are calcareous, somewhat calcareous, or (in the case of variable soil complexes) potentially calcareous. “Calcareous” means the soils have moderate to high amounts of calcium compounds (usually calcium carbonate) (Tornes 1979 as summarized in Kiviat and Stevens 2001). Calcareous soils are near-neutral to alkaline in pH and support certain plants and animals not found on non-calcareous soils including many species that are rare in the Hudson Valley.

Table 1. Mapped soils of the Mill Brook Greenway area (modified from Tornes 1979, Kiviat and Stevens 2001). Abbrev. = abbreviation on soil map in Tornes 1979; Reaction: C = calcareous, SC = somewhat calcareous, NC = not calcareous (Kiviat and Stevens 2001); Depth: Deep if > 1 meter to bedrock; Parent material: Lacustr. = lacustrine; Drainage: SX = somewhat excessively drained; W = well drained; MW = moderately well drained; SP = somewhat poorly drained; P = poorly drained; VP = very poorly drained.

Abbrev.	**Soil name**	**Texture**	**Reaction**	**Depth**	**Parent material**	**Drainage**
BnC	Bath-Nassau complex, 8-25% slopes	variable; silty, stony or rocky	SC or NC	variable	Till	W to SX
BOD	Bath-Nassau-Rock outcrop complex, hilly	as for BnC	SC or NC	variable	Till	W to SX
Cd	Canandaigua	silt loam	C	deep	Lacustr.	P-VP
C.F.	Cut-and-fill land	variable	variable	variable	variable	variable
CvA	Churchville, 0-3% slopes	silt loam	C	deep	Lacustr.	SP
CvB	Churchville, 3-8% slopes	silt loam	C	deep	Lacustr.	SP
LY	Lyons-Atherton complex	very stony	C	deep	Till, Outwash	P-VP
Ma	Madalin	silty clay loam	C	deep	Lacustr.	P-VP
MdB	Mardin, 3-8% slopes	gravelly silt loam	SC	deep	Till	MW
MgB	Mardin-Nassau complex, 3-8% slopes	variable	SC or NC	variable	Till	MW to SX
NBF	Nassau-Bath-Rock outcrop complex, very steep	as for BnC	SC or NC	variable	Till	W to SX
VoA	Volusia, 0-3% slopes	gravelly silt loam	SC	deep	Till	SP
VSB	Volusia, gently sloping	very stony	SC	deep	Till	SP

I infer from extant vegetation that land use in the first half of the 1900s, and more recently in local areas, was predominantly agricultural. Most of the Greenway area would have been in pasture, hay, or other crops. There are remains of livestock fences on the study area, and the remains of what may have been a small sheep holding pen south of Wetland ZC East Lobe. Some areas are oldfield or wet meadow and probably were agricultural 20-40 years ago, whereas other areas have been out of agriculture longer and in a few cases support small areas of mature forest. The ruins of an old cider mill are on the north side of Erman Road, in the eastern portion of the Greenway area. An intact (artificial) dam impounds the large pond just off the southwestern corner of the Greenway area, and remnants of old dams, channelization, and other hydrological alterations to streams and wetlands are conspicuous along the stream on both sides of Old Mill Road, on Tributary 13 west of Wetland ZD, on the small stream at the upper end of Wetland ZE, at the pond in ZB, and on the small stream east of the upper end of Wetland ZD. There are several "abandoned" beaver (*Castor canadensis*) dams in various stages of disrepair, some still rather intact, up and down the subtributary of Tributary 13 that runs north to south through the center of the study area, approximately equivalent to Wetland ZC. I call this chain of beaver ponds the "Castornoster Lakes" after "*Castor,"* the scientific name of the beaver, and "paternoster" ("our father") lakes, a geological term for lakes strung along a glacial valley.

The major current owners of the Greenway area are shown in Table 2. Surrounding the complex are residential developments and single homes, the Duzine School on the northwest, a self-

storage business and a firehouse on the southeast, a municipal park (Moriello Park) on the southwest, and additional areas of wetlands, forest, and other undeveloped lands. The New York Thruway runs north-south ca. 50-200 meters east of the Greenway area. Tributary 13 flows approximately east to west through the Greenway area and leaves the southwestern corner of the area, crosses Route 32 westward, and drains into a broad complex of developed and undeveloped floodplain habitats between Route 32 and the Wallkill River. The two largest subtributaries of Tributary 13 are: 1. The north-south stream flowing through the Castornoster Lakes, partly on Shawangunk Reserve and partly on Sunset Ridge, with its eastern branches; and 2. A small north-south stream flowing through wetland ZE down to the pond on Tributary 13 off the southwestern corner of the study area.

Table 2. Property owners (developers) in Mill Brook Greenway study area. (Information from Colin Apse, Town of New Paltz Environmental Conservation Commission.) Total acreage is 337.4.

Site	**Owner**	**Acreage**	**Municipality**
Shawangunk Reserve (main parcels) *(proposed site of Woodland Pond development, in part)*	P. Bienstock	145.9	Village
Shawangunk Reserve (western parcel)	P. Bienstock	11.6	Village
Sunset Ridge *(proposed site of Stoneleigh Woods development)*	Michalski-Raphael-Orcutt-Shulkin	63.2	Village
Erman *(proposed site of Woodland Pond development, in part)*	Estate of J. Erman	20.9	Village
Kniffen Properties	A. Enlund	29.8	Town
Lent	D. Lent	66.0	Town

Methods

The emphasis of this study was wetland quality assessment and habitat-based biodiversity assessment. This was not primarily a species survey nor a review of wetland boundary delineations. I walked all but small parts of the wetlands and streams one or more times. Table 3 shows time spent onsite and conditions during field work. Due to high rainfall in the months preceding my survey, water levels in streams, ponds, and wetlands were high during field work.

"Quality" of wetlands is a somewhat problematic concept. I interpret quality to mean apparent biological integrity (i.e., typical species of animals and plants are likely to be present in typical abundances), and apparently typical levels of ecological functions (e.g., nutrient cycling, organic matter storage and decomposition, water storage, etc.). In order to have good quality, wetlands must have relatively intact hydrology and soils. Quality can be degraded by a variety of human-caused impacts including alteration in quantity, timing, and quality of water; increase in siltation or scouring; excessive addition of nutrients (especially nitrogen, phosphorus); contamination by petroleum, pesticides, or other toxic substances; removal of carbon in the form of plant material and consequent changes in structure. I do not expect wetlands in a suburbanizing area to be as high in quality as those in a rural or wild area, thus I assessed the wetlands of the Greenway area against the general reference of formerly agricultural, suburbanizing areas. I assessed wetlands visually by means of the following indicators: evidence of hydrological alteration (e.g., dams,

channelization, ditches); evidence of siltation or scouring; abundance of invasive plants (e.g., common reed [*Phragmites australis*], purple loosestrife [*Lythrum salicaria*], reed canary grass [*Phalaris arundinacea*], multiflora rose [*Rosa multiflora*]). I do not consider these invasive plants indicators of degradation when they are present in small numbers, but I do consider an abundance of invasive plants to indicate degradation or damage to wetlands. (Whether the invasive plants themselves degrade habitat further is a complex issue depending on the site, the plant, its size and abundance, the mixing of invasive and native non-invasive plants, the native animals and plants for which habitat is being assessed or conserved, and the goals of management.)

I collected a few specimens of vascular plants for laboratory identification by Hudsonia Botanist Gretchen Stevens. Some of these specimens have not yet been identified; if they prove to be unusual they will be noted in a memo to append to this report.

Table 3. Field trips to the Mill Brook Greenway area, 2003, showing dates, approximate number of hours spent, weather conditions, and major elements of itinerary.

Date	**Hours**	**Weather**	**Itinerary**
14 October	7.5	Partly sunny, near-calm, mild	ZB, ZC
16 October	5.5	Partly sunny, near-calm to breezy, cool, very brief light rain	Lent site (except east)
21 October	2.8	Partly sunny, light breeze, mild; thunderstorm	Kniffen; C; ZB, ZC
28 October	7.4	Sunny, light breeze, cool	Lent (east); A, AA, AAA
31 October	5	Mostly sunny, light breeze, warm	Shawangunk Reserve northeast corner; ZA, B, FE, ZD, ZE; Southwest Pond

Results

Brief descriptions of the wetlands are in Table 4. I have divided some of the wetlands into segments with different plant communities, but it was not practical to do this for all the wetlands (e.g., the Wetland ZC "Southern Beaver Ponds") due to the brief nature of my field work.

It is intriguing that, in several of the wetlands, the southern portion is more disturbed-looking and apparently of lower quality than the northern portion. This may be due to historic or current influences from land use south of the Greenway area, or in the southern portions of the area.

The stream segment between Lent Northeast Wetland and Lent Northwest Wetland is flagged although it apparently does not constitute federal wetland. The stream segment on the west side of Old Mill Road below Lent Middle Wetland is flagged although most of this stream does not appear to be federal wetland. The same is true of the two streams connecting Lent Middle Wetland to Lent East Wetland. Apparent errors in other wetland boundary delineations are noted in the footnotes to Table 4 (I did not systematically check wetland delineations nor did I examine soils at wetland boundaries; my mentions of apparent errors are based on miscellaneous observations.)

Table 4. Descriptions of the wetlands of the Mill Brook Greenway area, fall 2003. Wetland flag numbers are from the subdivision plat maps listed at the end of this report and are approximate location references for the wetland units described here.

Map code	Site	Wetland type	Prominent plants
A	Shaw. Reserve	Shrubby wet meadow	Goldenrod (*Solidago*), reed canary grass, other grasses (Poaceae), purple loosestrife, silky dogwood (*Cornus amomum*), Bell's honeysuckle (*Lonicera* X *bella*), elm (*Ulmus*), ash (*Fraxinus*), others
AA (includes AB at north end)	Shaw. Reserve	Tree swamp	Ash, swamp white oak (*Quercus bicolor*), red maple (*Acer rubrum*), elm, winterberry (*Ilex verticillata*), silky dogwood, Bell's honeysuckle, tussock sedge (*Carex stricta*), others
AAA	Shaw. Reserve	Woodland pool and shrubby seep(?) (north) and excavated pond (south)	Silky dogwood, gray dogwood (*Cornus racemosa*), pin oak (*Quercus palustris*), multiflora rose, Bell's honeysuckle in seep; buttonbush (*Cephalanthus occidentalis*), pin oak, silky dogwood, purple loosestrife, common duckweed (*Lemna minor*) in woodland pool; watermeal (*Wolffia*), little other vascular vegetation visible in open excavated pond
B	Shaw. Reserve	Tree swamp	Swamp white oak, ash, red maple, Bell's honeysuckle, arrowwood (*Viburnum dentatum*), silky dogwood
FE (2)	Shaw Reserve	Shrubs, trees; shallow	Not recorded
ZA (3)	Shaw Reserve (flags ZA1-ZA38)	Wet meadow	Purple loosestrife, reed canary grass, goldenrod, ash (sapling-size), several other species scattered
ZA Connector	Shaw. Reserve (flags ZA20 to C20)	Woodland seep	Small hardwood trees, abundant nannyberry (*Viburnum lentago*)
ZB Pond	Shaw. Reserve	Constructed pond	Watershield (*Brasenia schreberi*), water-purslane (*Ludwigia palustris*), rushes (*Juncus* spp.),

			spikerush (*Eleocharis*), purple loosestrife
ZB Meadows	Shaw. Reserve (flags ZB68-ZB73, etc.)	Wet meadows adjoining pond	Purple loosestrife, sedges (*Carex* spp.), mountain-mint (*Pycnanthemum*), peat moss (*Sphagnum*)
ZB North End	Shaw. Reserve (flags ZB42-ZB54)	Swamp	Purple loosestrife, multiflora rose, silky dogwood, trees
ZC North End	Shaw. Reserve (flags ZC2-11, 74-78)	Shrub swamp	Elm, red maple, silky dogwood, multiflora rose, purple loosestrife, Bell's honeysuckle, others
ZC Streamside Meadow	Sunset Ridge (flag A15 etc.)	Wet meadow	Sensitive fern (*Onoclea sensibilis*), wintercress (*Barbarea vulgaris*), tussock sedge, grasses, skunk-cabbage (*Symplocarpus foetidus*)
ZC East Lobe	Sunset Ridge & Shaw. Reserve (ZC32-ZC49)	Marsh - wet meadow	Reed canary grass, purple loosestrife, cattail (*Typha*)
ZC Big Beaver Pond	Sunset Ridge	Inactive beaver pond	Purple loosestrife, reed canary grass, silky dogwood on dam; burreed (*Sparganium*) in pond edges; common duckweed, watermeal; wooded swamp along west edge
ZC Wet Meadow (4)	Sunset Ridge (flags DA1-DA12, D32-D48)	Wet meadow adjoining Big Beaver Pond on west	Goldenrod, arrowwood, red cedar (*Juniperus virginiana*), ash, purple loosestrife, others
ZC Knoll Meadow	Sunset Ridge (flags C1-C7)	Shrubby wet meadow on east side of hemlock knoll east of Big Beaver Pond	Silky dogwood, Bell's honeysuckle, meadowsweet (*Spiraea latifolia*), elm, red maple, others
ZC Southern Beaver Ponds	Sunset Ridge & Shaw. Reserve (flags E1-E13, F1-F18, and other flags on west side of ponds)	Inactive beaver ponds (some areas silted)	Purple loosestrife, tussock sedge, reed canary grass, cattail, burreed, meadowsweet, winterberry, silky dogwood, elm, dead trees, open water
ZD	Shaw. Reserve	Floodplain swamp	American hornbeam (*Carpinus caroliniana*), swamp white oak, pin oak, multiflora rose, silky dogwood, common nettle (*Urtica dioica*), sedge (*Carex*), crested woodfern (*Dryopteris cristata*), others

ZE North (5)	Shaw. Reserve (flags ZG4-ZG15, etc.)	Wet meadow with red cedar-covered island	Silky dogwood, gray dogwood, multiflora rose, purple loosestrife, wintercress, arrowleaf tearthumb (*Polygonum sagittatum*), goldenrod, rice cutgrass (*Leersia oryzoides*), sedges (*Carex* spp.), others
ZE South	Shaw. Reserve (flags ZE2-ZE10 approx.)	Swamp along small stream	Bell's honeysuckle, winged euonymus, others
Lent Northeast (6)	Lent	Shallow hardwood swamp	Red maple, elm, winterberry, violet (*Viola*)
Lent Northwest	Lent	Swamp	Japanese barberry (*Berberis thunbergii*) , winterberry, other shrubs and trees
Lent Middle (7)	Lent	Swamp	Elm, ash, purple loosestrife, many others (spaced trees and shrubs with dense herb layer in north; various disturbed shrub, tree, reed canary grass, and purple loosestrife communities in south)
Lent Southwest	Lent	Swamp, wet meadow	Small areas north of stream with trees, shrubs, herbs, common reed
Lent East (8)	Lent	Tree swamp	Ash, elm, pin oak, silky dogwood, Bell's honeysuckle, arrowwood, winterberry, multiflora rose, others
Kniffen	Kniffen	Shrub swamp, etc.	Silky dogwood, gray dogwood, Bell's honeysuckle, multiflora rose, grasses, arrow-leaved tearthumb
Southwest Pond	(Outside Greenway)	Open pond with sparsely vegetated bars	Grasses, etc., on bars in upper (east) part of pond; probably other vegetation not visible in October

(1) Wetland AA includes the area at north end shown on the Woodland Pond development map as "Wetland AB." As far as I could see, AA and AB are separated only by an old road on fill.

(2) Wetland FE is the northward extension of the Lent Northeast Wetland. South of Wetland A, probably in FE, I found wetland boundary flags that are not on the Chazen Companies map of the Shawangunk Reserve "Woodland Pond" site, including flags B55, A67, A68. Some of these flags were altered from "E" to "A." Just southeast of these flags was unflagged wetland (shrub thicket and hardwood trees) on a more-or-less west-facing slope.

(3) An apparently undelineated portion of Wetland ZA is on the north side of Erman Lane. Also flag ZA24 appears to be inside the wetland boundary.

(4) Wetland boundary of wet meadow appears to be greatly underdelineated.

(5) Wetland ZE apparently underdelineated on east side in vicinity of flag ZG7.

(6) Wetland boundary may be overdelineated and underdelineated in small areas.

(7) Wetland boundary may be underdelineated in places on the east side. Also, this wetland may extend farther north, possibly as far as Waring Lane. Development map shows Lent Middle Wetland connected by wetland corridors along the two streams to Lent East Wetland; it is not clear if there is actually wetland all the way along the streams.

(8) Wetland continues south (outside Greenway area) to DuBois Road and beyond.

Connectivity of Wetlands

Wetlands of the Greenway area are interconnected to a high degree. ZC is all one wetland. Only a spillway a few meters wide separates ZB from ZC, and there is probably a perennial flow of surface water between the two wetlands. Wetland ZA apparently has wetland connections to ZC and B. The Kniffen wetland is directly connected to ZD by Tributary 13 with only a stone wall between, and ZD is contiguous with ZC. The Lent Northeast and Northwest wetlands are connected to Tributary 13 by a stream but there does not appear to be a wetland connection *per se,* and the Lent Middle Wetland is similarly connected to Tributary 13 by a non-wetland stream. Lent East Wetland is connected to Lent Middle Wetland by streams but probably not a direct wetland connection. Wetlands A, AA, and AAA are not connected to the "Z" wetlands. Wetland AB is a continuation of the north end of Wetland AA.

Table 5. Quality assessment of wetlands in the Mill Brook Greenway area.

Wetland	**Quality assessment**
A	Poor; dominated by invasive plants (purple loosestrife, reed canary grass), low plant diversity, small extent, relatively dry soil, buffer constitutes shrubby oldfield
AA	Good; deep-flooding, low abundance of invasive plants, good extent, moderate tree size, mostly well buffered by forest (a few houses near east side)
AAA	Seep of fair quality; woodland pool of good quality (dominated by buttonbush in deep water, low abundance of invasive plants, well buffered by forest); excavated pond of poor quality as a wetland, but it may have value as a pond, extensive ruins and refuse on south
B	Good; low abundance of invasive plants, medium flooding, moderate hummock development, good extent, well buffered by forest
FE	Fair; not distinctive, relatively dry, small extent, well buffered by forest
ZA	Fair; good extent, purple loosestrife and reed canary grass are abundant but there is enough admixture of other plants to provide some diversity for animals, buffered by forest and shrubby oldfield

ZA Connector	Good; small extent but supports unusually large stand of nannyberry, well buffered by forest
ZB	Good despite historic disturbance; calcareous, relatively unusual flora, good habitat for pond and wet meadow wildlife, good potential for rare plants (NOTE: pond spillway may be eroding and should be evaluated by an engineer), buffered by young forest and oldfield
ZC	Good; large extent, varied complex of beaver ponds in various stages of silting and with varied plant communities, good habitat for wildlife of secluded ponds, well buffered by forest
ZD	Fair to good, inproves northward (more invasive plants southward), well buffered by forest
ZE North	Fair to good; moderate extent, invasive plants abundant but well mixed with native plants, good plant diversity, well buffered by forest
ZE South	Poor, invasive plants, small extent, well buffered by forest
Lent Northeast	Good; moderate extent, abundant water from seepage, moderate hummock development, trees not large, well buffered by forest
Lent Northwest	Poor to fair; small extent, invasive plants (Japanese barberry) common, well buffered by forest
Lent Middle	Good quality north of stream; more alteration and invasive plants south of stream; good extent, diverse savannah community in north with rare plant (small-flowered agrimony [*Agrimonia parviflora*]), good plant diversity for wildlife, historic alteration in middle and south, well buffered by forest, development on southwest and north end
Lent East	Overall of good quality, better northward
Kniffen	Quality improves downstream (northward), more natural appearance; apparently substantial siltation upstream; invasive plants possibly less abundant downstream

Wetlands ZD and and the Castornoster Lakes of ZC appear to cover more than 8 acres (ca. 100 feet wide x > 3300 feet long north-south). Wetland ZB alone is stated on the subdivision map to cover more than 3 acres. Once the Kniffen Wetland and the branches of ZC and ZD are added, the total probably exceeds 12.4 acres of contiguous wetland (including units with non-wetland surface water connections < 165 feet long, such as ZB and ZC), and thus would seem to qualify for regulation under the New York State Freshwater Wetlands Act.

The Greenway wetlands are also connected to wetlands outside the study area. Tributary 13 provides a connection to wetlands on the Wallkill River floodplain west of Route 32. Lent East Wetland continues southward off the Greenway where there is additional wetland both north and south of DuBois Road. Wetland ZE North connects northward to wetland on the east side of the Duzine School. I do not know if there are direct connections via surface water, but east of the Thruway are very extensive wetlands (known locally as "Plutarch Swamp") associated with the Swarte Kill. Waterfowl and other flying animals (birds, bats, insects) are presumably able to travel between the Greenway wetlands and Plutarch Swamp. The Thruway and North Putt Corners Road may be a barrier to the movement of small terrestrial animals, however. Connectivity to off-Greenway wetlands may enhance the suitability of the Greenway wetlands as habitat for certain species by facilitating their movement on and off site. This could be true for certain rare or vulnerable species such as river otter, great blue heron, American black duck, wood duck, American woodcock, wood turtle, and northern cricket frog, all of which are known to require mosaics of wetland habitats among which they move at various time scales.

Indicators of Calcareous Habitats

Calcareous (limy) habitats support many rare species and are important for biological diversity in the Hudson Valley where calcareous bedrock is of restricted distribution. Many of the wetland soils of the Greenway area are calcareous or somewhat calcareous (Table 1). Certain plants in the Greenway area attest to the calcareous soils, including basswood *(Tilia americana*), American prickly-ash (*Zanthoxylum americanum*), watershield, small-flowered agrimony, beardtongue (*Penstemon digitalis*), golden-saxifrage *(Chrysosplenium aureum),* wild yam (*Dioscorea villosa*), and knotted rush (*Juncus nodosus*). Generally, however, the low abundances of calcicolous plants suggest mildly, rather than highly, calcareous soils. Wetland ZB had the most calcicolous-looking plant communities; perhaps at that location calcium carbonate from the subsoil was mobilized by historic mining and pond construction.

Invasive plants

Table 6 lists selected invasive plant species observed in the study area. Multiflora rose, purple loosestrife, Bell's honeysuckle, and reed canary grass were locally abundant enough to indicate disturbance to wetlands (probably from siltation, ATV activity, historic agriculture, and other human activities). At present, I do not believe any invasive plant is causing unacceptable degradation of habitat functions or ecological services. I make this judgment because I did not see extensive, dense stands of invasive species, rather small patches or sparse stands well-mixed with native, non-invasive species. The potential exists for certain invasive species to spread and consolidate to the point where they are a real nuisance to people and a negative factor in habitat quality. The site preparation, construction, and occupation of the proposed development projects are likely to disturb and alter soils and vegetation in ways that strongly facilitates the spread and consolidation of most or all of the invasive species listed in Table 6.

I did not see Japanese knotweed (*Fallopia japonica*) on the Greenway area (this species has become a serious pest in portions of the Catskill Mountains; see Talmage and Kiviat 2003). My field work was too late in the year to see any water-chestnut (*Trapa natans*) that might have been present (see Kiviat 1993). These are two invasive plants that should be watched for, and any initial small stands should be removed promptly to prevent potentially rapid formation of extensive, dense stands.

Table 6. Prominent invasive plant species of the Mill Brook Greenway area.

Common name	**Scientific name**	**Introduced or native**	**Significance**
Purple loosestrife	*Lythrum salicaria*	Introduced subshrub	Widespread and locally abundant on site but loosestrife patches are small or mixed with native plants
Reed canary grass	*Phalaris arundinacea*	Partly native, partly introduced, tall grass (1)	Dense vigorous patches in a few small areas (mixed with other species)
Common reed	*Phragmites australis*	Partly native, partly introduced, very tall grass (1)	Very local, e.g., Lent Southwest

Multiflora rose	*Rosa multiflora*	Introduced shrub or clambering vine	Widespread and common
Bell's honeysuckle	*Lonicera* X *bella (L. morrowi* X *L. tatarica)*	Introduced shrub	Fairly common in a few areas
Autumn-olive	*Elaeagnus ?umbellata*	Inroduced shrub	Scattered individuals
Japanese barberry	*Berberis thunbergii*	Introduced shrub	Common in and around Lent Northwest Wetland, present in Kniffen Wetland, Wetland ZD, possibly elsewhere
Winged euonymus	*Euonymus alata*	Introduced shrub	Present near Kniffen Wetland, Wetland ZE, probably elsewhere
Norway maple	*Acer platanoides*	Introduced tree	Edge of Kniffen wetland; probably elsewhere

* Study area genotypes have not been identified as native or introduced.

Habitat Assessment

Table 7 shows ecologically significant habitats of the Greenway area and selected rare or vulnerable species of native vertebrates and vascular plants likely to be supported by these habitats. I have not specifically addressed rare invertebrates, but information on certain species is in Kiviat and Stevens (2001). Wood turtle (*Clemmys insculpta*; Special Concern) is the only rare or vulnerable animal species I observed in the Greenway area. There are large areas of suitable habitat for wood turtle, including the entire Kniffen Wetland, the Castornoster Lakes, Wetland ZB, and other sluggish stream segments, ponds, and associated wet meadow and riparian woods. Wood turtle overwinters in sluggish stream reaches with undercut banks, partly submerged logs, deep pools, or muskrat burrows, or in ponds. The species spends summer foraging in wetlands and uplands near the stream. Females lay eggs in bare or sparsely vegetated sunny loose soil, such as in an abandoned gravel pit. Wood turtle is vulnerable to road or machinery mortality where vehicles or machines are operated in areas that wood turtles use or cross.

The high quality woodland pool in Wetland AAA probably supports breeding populations of spring peeper (*Pseudacris crucifer*), wood frog (*Rana sylvatica*), and spotted salamander (*Ambystoma maculatum*); the less common marbled salamander (*Ambystoma opacum*), Jefferson salamander (*Ambystoma jeffersonianum*; both Special Concern), and four-toed salamander (*Hemidactylium scutatum*) are possible breeders. Deep-flooding tree swamp, e.g., in Wetland AA or Lent East Wetland, may support blue-spotted salamander (*Ambystoma laterale*).

Red-shouldered hawk (*Buteo lineatus;* Special Concern) breeds in wetlands near New Paltz, and may breed in the Greenway area. Swamps or upland forests with closed-canopy stands of hardwoods having some large trees are suitable breeding habitat. Extensive complexes of habitat with larger trees are better.

There is a large population of northern cricket frog (*Acris crepitans*; State Endangered) within 4 km of the Greenway area. The pond in Wetland ZB, and portions of the Castornoster Lakes, are suitable habitat for cricket frog. These habitats are probably not ideal because they lack floating

peat masses or floating mats (Dickinson 1993), but cricket frog is a definite possibility in the Greenway.

Miscellaneous Observations of Wildlife

I found an adult female wood turtle next to the stream on the Kniffen site on 21 October (see above). I saw small flocks of yellow-rumped warblers (*Dendroica coronata*) on several occasions (14 through 31 October); on 14 October I watched one eating poison-ivy (*Toxicodendron radicans*) fruits in a tree in wetland ZC. I saw various common bird species including red-bellied woodpecker (*Melanerpes carolinus*), downy woodpecker (*Picoides pubescens*), blue jay (*Cyanocitta cristata*), American robin (*Turdus migratorius*), and song sparrow (*Melospiza melodia*). I saw a ruffed grouse (*Bonasa umbellus*) on the Lent site; this species is apparently undergoing a pronounced decline, perhaps due to land use change and natural vegetation change in forests (Berger 2004). I saw few ducks, perhaps because of mild weather delaying southward migration of the later-migrating species. Green frog (*Rana clamitans*; seen) and spring peeper (heard) were common. I found several redback salamanders (*Plethodon cinereus*), a two-lined salmander (*Eurycea bislineata*), a garter snake (*Thamnophis sirtalis*), and painted turtles (*Chrysemys picta*): all common species in the Hudson Valley. Sign of white-tailed deer (*Odocoileus virginianus*) was everywhere, and I saw gray squirrels (*Sciurus carolinensis*), eastern chipmunks (*Tamias striatus*), a white-footed mouse (*Peromyscus*), and muskrat (*Ondatra zibethicus*) sign.

Rare and Uncommon Plants

I did not see puttyroot (*Aplectrum hyemale*) or prairie wedge grass (*Sphenopholis obtusata* var. *obtusata*), two species on the New York Natural Heritage Program Active Inventory List that have been reported in the general area. These are both upland species and I was not specifically searching for them. The only Heritage-listed species I noticed was small-flowered agrimony (*Agrimonia parviflora*), on the Watch List. I found about 10 plants in the northeastern corner of the wetland on the east side of Old Mill Road on the Lent site. Two of the plants were fruiting. There may have been other small-flowered agrimony plants in the northern portion of this wetland which I did not survey thoroughly. In the Hudson Valley, small-flowered agrimony is rare northward and east of the Hudson River, but in Orange County it becomes somewhat more common.

Several plants observed are scarce or regionally-rare in the Hudson Valley. These included marsh speedwell (*Veronica scutellata*; wetland ZB), and watershield (abundant in the pond in wetland ZB). Two shrubs that are usually uncommon have noteworthy occurrences in the Greenway area. Nannyberry was common among small trees in one area of west-sloping wetland between approximately wetland boundary flags ZA20 and C20 on the Shawangunk Reserve site. Winterberry was generally uncommon to locally common in the wetlands of the Greenway area. There was a particularly large winterberry individual in the middle of an area of wooded swamp in wetland B near flag C57. This winterberry clump had more than 100 stems up to 5 cm or larger dbh (diameter-at-breast-height), and the crown was at least 8 meters in diameter. Crested woodfern, usually scarce in our region, is locally fairly common in wooded and shrubby swamps

of the Greenway. Pin oak is common in or at the edges of many of the wetlands. Pin oak tends to be uncommon to rare in Hudson Valley wetlands.

Golden-saxifrage is a regionally-rare plant restricted to locations of calcareous groundwater discharge. There are small areas of golden-saxifrage in Lent Northeast Wetland and Lent Northwest Wetland.

Table 7. Ecologically significant habitats and known or potential rare biota of the Mill Brook Greenway area. (Assessment focused on wetlands; significant habitats distant from wetlands may have been overlooked.) More information on significant habitats and their rare species is in Kiviat and Stevens (2001).

Habitat type	**Potential rare or vulnerable species**	**Occurrence in Greenway area**
Beaver pond (active, inactive)	Bats, river otter (*Lutra canadensis*), pied-billed grebe (*Podilymbus podiceps*), great blue heron (*Ardea herodias*), American black duck (*Anas rubripes*), wood duck (*Aix sponsa*), ribbon snake (*Thamnophis sauritus*), wood turtle, spotted turtle (*Clemmys guttata*), northern cricket frog; barbed-bristle bulrush (*Scirpus ancistrochaetus*)	Several ponds on north-south subtributary (Castornoster Lakes)
Red cedar grove (especially larger trees)	Roost for nonbreeding birds of prey; breeding saw-whet owl (*Aegolius acadicus*)	East side of ZC Southern Beaver Ponds; other locations
Hemlock grove	Owls, other birds of coniferous forest (hemlock itself is threatened by parasitic insects)	Knoll on east side of ZC Big Beaver Pond; other locations
Intermittent woodland pool ("vernal pool")	American black duck, wood duck, breeding spotted salamander, Jefferson salamander, marbled salamander, four-toed salamander, wood frog, spring peeper	Large pool in Wetland AAA; small pool in central-western edge of Lent East Wetland
Calcareous wet clay meadow (see Kiviat et al. 1993) and other wet meadow or wet savannah	American woodcock (*Philohela minor*), sedge wren (*Cistothorus platensis*), spotted turtle; various rare plants including small-flowered agrimony	Best areas are in Wetland ZB; also ZA, A, small patches at other locations
Wet thicket (shallow shrub swamp)	American woodcock, wood turtle	Many locations
Tree swamp	Red-shouldered hawk, American woodcock, barred owl (*Strix varia*), blue-spotted salamander, four-toed salamander	Wetland A, Lent East Wetland, Lent Northeast Wetland, ZC North End,
Mature forest (hardwoods or hemlock-hardwoods)	Bat (roost sites), Wood duck (nest sites), red-shouldered hawk, barred owl; possibly cerulean warbler (*Dendroica cerulea*) where near water, or Acadian flycatcher (*Empidonax virescens*) where there	Lent, along stream west of Old Mill Road (trees up to 50-100 cm dbh)

	are steep slopes	
Stream segment with associated floodplain habitat	Bats, wood duck, American woodcock (floodplain), wood turtle, red salamander (*Pseudotriton ruber*) in sluggish segments; green dragon (*Arisaema dracontium*), winged monkeyflower (*Mimulus alatus*), goldenseal (*Hydrastis canadensis*)	All but the smallest streams in Greenway
Constructed pond (especially if marshy)	River otter, pied-billed grebe, American black duck, wood duck, wood turtle, spotted turtle, northern cricket frog	Wetland ZB Pond (good quality); Wetland AAA Pond (poor quality)

Dodders are small, non-photosynthesizing vines that parasitize other vascular plants. I collected a dodder (*Cuscuta*), still in flower, from purple loosestrife in Wetland ZC East Lobe; this specimen is being identified. There was also abundant dodder in a small area at the north end of the pond in wetland ZB that was no longer in flower. We are unable to identify dodders to species when they are not flowering. There is one common species (swamp dodder, *Cuscuta gronovii*) and several rare species in our region, and we have found two or three of the rare species as well as the common one using purple loosestrife as a host.

Localized areas of the Hudson Valley have clayey soils, often calcareous, that formed in lake beds. Where the clays are flat, they often underlie wetlands that accumulate precipitation and runoff waters. Clayey wet meadows abandoned from agriculture may support sedge-dominated communities, and rare plants are often present (Kiviat et al. 1993). The wet clay meadows at Wetland ZB are likely to support rare plants. This habitat may also be important for Cecropia moth (*Hyalophora cecropia*) and Polyphemus moth (*Anteraea polyphemus*) (Barbour and Kiviat 1997), two species of giant silk moths that are declining in the northeastern states (Jeff Boettner, personal communication). Certain rare birds (e.g., sedge wren) might occur in wet clay meadows. Generally wet meadows and dry meadows (old fields) of the Greenway area are not large enough to attract other grassland bird species.

Floodplains of small streams in the Hudson Valley may support rare plants, especially where soils are calcareous. Among the rare plants of these habitats are the Natural Heritage Program-listed goldenseal, winged monkeyflower, and small-flowered agrimony, and the regionally-rare green dragon (Kiviat and Stevens 2001). Areas of stream floodplain in the Greenway have potential to support these and other rare species.

The Wetland ZB Pond in some respects resembles a circumneutral bog lake (see Kiviat and Stevens 2001) although floating peat mats appear to be absent from ZB. This pond seems suitable or even high quality habitat for breeding and nonbreeding ducks (e.g., American black duck, wood duck), breeding pied-billed grebe, spotted turtle, and northern cricket frog, among other rare species. A regionally-rare bulrush, *Scirpus subterminalis*, and other rare plants could be present.

Stressors and Threats

Some of the most obvious and widespread environmental damage to the Greenway has been caused by all-terrain vehicles (ATVs). There are many old and active ATV trails, and many of these cross, or follow the edges of, wetlands and streams. Ruts in wet soils up to ca. 25 cm deep are common. Some of these ruts were water-filled at the time of my field work, and constitute potential breeding habitats for mosquitoes. Because wheelruts create small isolated pools that tend to lack many predators, these habitats may be worse mosquito producers than many natural wetlands and ponds. ATV trails are channelizing water flow on slopes, thus reducing infiltration, and promoting erosion and siltation. In wetlands, some ATV trails are interfering with movement of surface waters. The trails are also damaging vegetation and degrading potential habitats for rare plants (e.g., in wetland ZB). The largest property owner has recently closed his land to ATVs (Wasserman 2003).

A home heating fuel spill occurred last winter south of DuBois Road upstream of the Kniffen site (F. Kniffen, personal communication). Absorbent oil booms were left in the stream on the Kniffen site, and should be removed and disposed of safely.

The ruins of a cider mill, with associated equipment and dumps, are present on the Erman site on the north side of Erman Road (private road). There is the remains of a structure, an old abandoned truck, and dumps (including a tire dump) on the west side of the wetland in the northeast corner of the Shawangunk Reserve site (Wetland AA-AB). I also noticed dumps at the north end of wetland ZC near the northern property line (old farm dump mixed with rocks), and the west side of the woodland pool in Wetland AAA. Tires and other containers in dumps are likely to produce mosquitoes, as well as polluting water and acting as mechanical hazards to wildlife.

The U.S. Geological Survey topographic maps show extensive orchards in and around the study area, although I noticed very little evidence of fruit trees. Residues of orchard pesticides may persist in soils. The most likely chemicals, commonly used as insecticides in Hudson Valley orchards, are lead arsenate (before about 1950) and DDT (after about 1950). Soils or sediments should be analyzed for lead, arsenic, and DDT metabolites before any significant disturbance that could remobilize these chemicals.

Siltation and nutrient loading from roads, construction, and intensive land uses are stresses that are likely to increase the spread and consolidation of invasive wetland and aquatic plants including common reed, purple loosestrife, and reed canary grass. Remains of old dams, channelization, and drainage structures may also promote weed invasions, although existing dams and their impoundments (e.g., Wetland ZB Pond) may also be beneficial to biological diversity (see preceding section).

Recommendations

The Greenway contains wetland, stream, and upland habitat resources important in a suburbanizing area. Points of vulnerability to human impacts include existing and potential road crossings. Roads or trails approaching or following wetland or stream edges create impacts on wetlands and streams. Trails should be designed to approach or cross wetlands or streams at

points of lower vulnerability. Views can be created with observation platforms or overlooks rather than by means of trails or boardwalks directly bordering streams or wetlands.

Reducing the potential for silt, nutrients, petroleum hydrocarbons, pesticides, and other pollutants to reach streams and wetlands will help maintain environmental quality. This may require special control of erosion and siltation (e.g., by using settling ponds in addition to silt barriers), and covenants or other limitations on, e.g., use of fertilizers and pesticides.

Open Space Boundaries

In addition to the "existing and proposed areas of open space" shown on the "Mill Brook Greenway Preserve Concept" map, I recommend that additional open space be preserved around the Lent Northeastern Wetland, Lent East Wetland, the northern portion of the Lent Middle Wetland, and the AAA Woodland Pool. Also the western branch (apparently partly undelineated) of Wetland ZC is very close to proposed features of the Stoneleigh Woods development and needs a review of the boundary delineation and a larger buffer zone. The mature forest on the north side of the stream west of Old Mill Road on the Lent site should also be considered for protection. Finally the Preserve Concept map does not show wetland or open space around the Wetland ZE North meadow and this should be considered.

Buffer Zones

Buffer zones for wildlife and hydrological protection should be at least 100 feet unless there is a specific reason for smaller buffers. Larger buffers are needed for pool-breeding amphibians (see below) and wood turtle. For wood turtle, at least the 100-year floodplain should be protected and there may be reason to protect uplands adjoining the floodplain in some cases. Many animals move back and forth between wetlands and uplands, and larger buffer zones help conserve the habitat combinations for these species.

Connectivity

The Village and Town should request that the DEC make a formal determination whether the central wetland complex (Castornoster Lakes and connected wetlands) are subject to state Freshwater Wetlands jurisdiction. It is not unusual to find New York State-regulated wetlands that have not been mapped on the State Freshwater Wetlands Maps. State regulation incorporates an automatic 100 foot upland buffer zone and also prohibits actions not necessarily prohibited under federal regulation, e.g., wetland drainage, clearcutting in wetland or buffer zone, and soil disturbance in the buffer zone.

It may also be appropriate for the Village or Town to retain an independent, experienced wetland delineator to check the wetland boundary delineations in the areas I have noted as apparently underdelineated (Table 4 footnotes). This may be helpful in conducting detailed site plan reviews and protecting wetlands from encroachment. Accurate wetland delineations also protect the developers, as encroachment on one-tenth of an acre of federal jurisdictional wetland could result in violation of federal wetland law and resulting enforcement action.

Stormwater Management

Stormwater from the proposed developments will carry silt, nutrients, petroleum hydrocarbons, and other pollutants into the wetlands. These pollutants are likely to degrade habitats for many of the rare or vulnerable species discussed here. It is important that features intended to contain stormwater pollutants be designed, built, maintained, and decommissioned properly. In addition to "traditional" siltation barriers and detention ponds, it may be appropriate to install "rain gardens" in which constructed areas of upland soil and vegetation are specifically designed to remove pollutants and improve infiltration of stormwater, or "sponges" that can absorb, e.g., petroleum hydrocarbons, and be removed for cleaning.

The farther away from wetlands and streams stormwater treatment can take place, the better. Although it was outside the scope of my study to specifically analyze stormwater management, I am aware of at least two locations where stormwater management features are likely to have negative impacts on wetlands. First, the "dumpster location" in Stoneleigh Woods near wetland flags DA9-DA10, and the "Comm. Ctr." just to the southeast, are very close to, if not actually inside, the wetland (see my comment, above, that the wetland boundary appears to be underdelineated in this vicinity). It may be necessary to move these features of the proposed development uphill to avoid the wetland and leave a reasonable width of upland buffer zone. Second, the retention ponds in the wetland buffer zone on the east side of Lent Middle Wetland are likely to cause degradation in the wetland during construction and operation. It may be appropriate to move the retention ponds farther from the wetland to leave a wider upland buffer zone. Wetland-upland edges in general are zones of intense ecological activity (e.g., biogeochemical transformations) and high biodiversity, and these zones when disturbed are also particularly vulnerable to invasions of weedy plants such as purple loosestrife and multiflora rose.

ATVs

The Greenway area should be closed to ATVs. Existing ATV trails and ruts should be filled and revegetated to prevent erosion and mosquito breeding. Where ATV trails cross surface water flows in wetlands, it may be necessary to fill the ruts with permeable material such as gravel or sand. I do not know if wetland permits would be required for restoration activities.

Woodland Pool

This pool may be surveyed in late winter - early spring (about March, depending on weather) for wood frog choruses, egg masses of wood frog, spotted salamander, and Jefferson salamander, large larvae of marbled salamander, and adults of four-toed salamander. Calhoun and Klemens (2002) recommended that a 100 foot zone around an amphibian breeding pool be preserved without disturbance, and a 750 foot zone around the pool be maintained or restored such that a minimum of 75% has contiguous forest with undisturbed ground cover. Barriers to amphibian movement (e.g., roads, curbs, storm drains, walls) should be avoided in the 100 foot zone, and (in my opinion) minimized between 100 and 750 feet. If blue-spotted salamander is present in tree swamps, these areas should also be subject to the buffer zone recommendations for woodland pools.

Beaver Management

Beaver activity creates and maintains habitat for a wide range of common, rare, or vulnerable biota. Beaver activity should be allowed as much as possible in the Greenway wetlands, and especially in the Castornoster Lakes. It would be prudent to avoid construction of roads and other infrastructure where beaver flooding is likely. Where water levels raised by beaver threaten roads, valuable trees, or other crucial features, a variety of drainage devices (some known as "beaver deceivers") is available for controlling water levels at beaver dams.

Dead Trees

There are standing dead trees and down logs in the Castornoster Lakes and wooded swamps. These features provide cavities likely to be used by many animals (bats, many birds including nesting eastern bluebird, black rat snake [*Elaphe obsoleta*], gray treefrog [*Hyla versicolor*], many invertebrates). Some animals depend on tree cavities for nesting or roosting. Down logs are important foci for invertebrate production in streams on the forest floor, provide crucial shelter for fish, amphibians, reptiles, and small mammals, provide habitat for fungi, and store carbon. Standing and down deadwood should be left in place unless it constitutes a direct hazard to, e.g., a road, trail, or building. I do not recommend removing snags and beaver dams from Greenway streams to create paddling trails, as this would negatively affect biodiversity and habitat, as well as reducing flood storage.

Invasive Plants

It may be prudent to remove small infestations of autumn-olive, winged euonymus, and Norway maple before they spread extensively. This can be done by grubbing, or cutting with wipe-on application of herbicide to cut stumps. There are readily available recommendations for techniques, seasons, and chemicals that should be followed carefully, and herbicide use should be minimized.

Currently, I do not see the need to manage other invasive species such as purple loosestrife. Invasive plants should be monitored for rapid spread or consolidation. The Greenway should also be monitored for establishment of troublesome species such as Japanese knotweed, water-chestnut, and giant hogweed; these three species should be removed promptly if they arrive. The wet meadows of the Greenway area will tend to grow in with tall herbs, shrubs, and trees, unless disturbed by human activities, beaver, or severe flooding. Because wet meadow communities dominated by sedges are important for biodiversity, it may be appropriate to manage certain areas to prevent development of tall dense woody vegetation. Mowing portions of the ZB wet meadows in rotation (e.g., one-fourth of the meadows in rotation every four years, or one-third every three years) using low-ground-pressure machinery may be necessary to maintain the unusual vegetation and the habitat for rare species. Without management, these meadows are likely to develop dense stands of tall purple loosestrife or thickets of tall shrubs and young trees which would replace the mixed communities now present.

Rare Plants

Surveys for prairie wedge grass and putty root should be conducted at appropriate seasons and habitats by experienced field biologists. Surveys for other rare plants likely to occur in the habitats of the Greenway area (including species not mentioned in this report) should be conducted prior to significant new disturbance or management.

Acknowledgments

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References Cited

Barbour, J.G. & E. Kiviat. 1997. Introduced purple loosestrife as host of native Saturniidae (Lepidoptera). Great Lakes Entomologist 30(3):115-122.

Berger, C. 2004. Snowbird. National Wildlife 42(1):37-41.

Calhoun, A.J.K. and M.W. Klemens. 2002. Best development practices: Conserving pool-breeding amphibians in residential and commercial developments in the northeastern United States. Wildlife Conservation Society, Metropolitan Conservation Alliance Technical Paper 5. Bronx, New York. 57 p.

Dickinson, R.A. 1993. Northern cricket frog (*Acris crepitans*) survey in Ulster County, New York, 1992. M.S. thesis, Bard College, Annandale, NY. 95 p.

Fisher, D.W., Y.W. Isachsen and L.V. Rickard. 1970. Geologic map of New York 1970. New York State Museum and Science Service Map and Chart Series 15, 5 sheets, 1:250,000, 100 foot contour.

Kiviat, E. 1993. Under the spreading water-chestnut. News from Hudsonia 9(1):1-6.

Kiviat, E. and G. Stevens. 2001. Biodiversity assessment manual for the Hudson River estuary corridor. New York State Department of Environmental Conservation, New Paltz, New York. 508 p.

Kiviat, E., G. Stevens & S. Barbour. 1993. Blossoms and clay: Landfill siting, wetlands, and biodiversity. News from Hudsonia 9(2):1-7.

Talmage, E. & E. Kiviat. 2003. Japanese knotweed and water quality on the Batavia Kill in Greene County, New York: Background information and literature review. Report to Greene County Soil and Water Conservation District, and New York City Department of Environmental Protection. Hudsonia Ltd., Annandale, NY. 29 p.

Tornes, L.H. 1979. Soil survey of Ulster County, New York. U.S. Department of Agriculture Soil Conservation Service, Washington, DC. 273 p. + maps.

Wasserman, G. 2003. Developer to limit use of New Paltz property to 'responsible users'. Poughkeepsie Journal (25 November):3B.

Development Maps (Subdivision Plats)

Chazen Engineering & Land Surveying Co., P.C. 23 April 2003. "Stoneleigh Woods at New Paltz Conceptual Plan." 1 inch = 100 feet.

Chazen Engineering & Land Surveying Co., P.C. 13 February 2002. "Kingston Regional Health Care System Woodland Pond at New Paltz Conceptual Site Plan." 1 inch = 100 feet.

Hagopian Engineering. 3 July 2003. "Proposed project For Lent: Town of New Paltz." 1 inch = 100 feet.

John H. Dippel, L.L.S. 24 August 2003. "Lot Line Revision of Lands of Alfred H. Enlund Prepared For Kniffen Properties." 1 inch = 100 feet.

Figure 1. Sketch map of the study area, based on Tornes (1979), development site maps, and field observations. K = Kniffen Wetland, LE = Lent East Wetland, LM = Lent Middle Wetland, LNE = Lent Northeast Wetland, LNW = Lent Northwest Wetland, LSW = Lent Southwest Wetland, S = Southwest Pond; all other wetlands are coded as in Table 4 (A, AA, AAA, B, FE, ZA, ZB, ZC, ZD, ZE).

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