HONOR ★ REMEMBER ★ EXPLORE

Arlington National Cemetery Millennium Project Final Environmental Assessment

Lead Agency:
Arlington National Cemetery
Cooperating Agency:
U.S. National Park Service

June 2013

US Army Corps of Engineers ®
Norfolk District

Appendix G
Natural Resource Inventories

Arlington House Woods Geologic Inventory

Fleming Vegetation Survey

Garrow Forestry Study

NPS 1999 Bird Survey

WSSI Vegetation Survey Report

WSSI Wildlife Survey Report

WSSI Stream Characteristics Survey Report

Property: **Arlington House Woods**
Quad: **Washington West**
Geologic Map: **Washington West**
Waypoint Designation: **AH**

Geologic Setting: Arlington House sits atop a prominent late Tertiary river terrace (Tt2), thought to be between 2 and 4 million years old (m.a.), or late Pliocene. It is one of about ten Tertiary and Quaternary terraces that represent the eroded remains of higher channels occupied by the Potomac River prior to and during the present regime of downcutting triggered by Pleistocene glaciation and sea-level changes. Each terrace occupies a specific elevation interval, resulting in a landscape that descends in step-like fashion from the highest terrace at Tyson's Corner to the modern river channel. Arlington House occupies approximately the third step down from the top. The terrace acts as a ground-water recharge area, and numerous springs that emerge along and just below its edges are the headwaters of the several ravines on the property. At many places, the edge of the terrace is an actively eroding scarp shedding abundant colluvial fans of gravel and cobbles onto the slopes and ravines below. The colluvium is the dominant soil parent material in some slope positions, and has a major impact on community ecology.

The terrace overlies a relatively thick section of the Potomac Group, which consists of bar, overbank, and slackwater (swamp) sediments deposited by an even more ancient version of the Potomac during the lower Cretaceous (~120-130 m.a.). At many places in northern Virginia, the Potomac Group can be divided into a lower, sandier lithofacies, and an upper fine-grained unit composed chiefly of variegated silty clays with occasional sandy and gravelly interbeds. This division appears to be applicable in a general way to Arlington House Woods, where the lower part of the formation appears to be dominated by medium to coarse sand and gravel, while the upper part consists chiefly of silty clay and fine sand. The Potomac Group underlies all but the very highest parts of the slopes at this site, and appears to be ~75 feet thick. It is covered by colluvium at many places. Typically, the upper slopes consist of narrow to broad benches separated by small scarps and moderate slopes, whereas the lowest slopes are steep and straight, reflecting the different mechanical properties of the upper fine-grained unit versus the lower sandy one. Although the benches are ultimately held up by the silty clays, they are commonly capped by extensive colluvial fans. Deeply weathered bedrock of the Sykesville Formation crops out at two places in the lower part of the main ravine. The bedrock is weathered into saprolite, which preserves the structure and texture of the original rock clearly, but is soft enough to be hand excavated. The interface between the top of the weathered bedrock and the Potomac Group is commonly marked by abundant ground-water discharge, typically as diffuse seepage along the banks of the ravine.

Features Observed:
AH-1: Steep bank on the east side of the main road below Arlington House, probably an old road cut. A large quartz boulder can be seen coming out of the bank a few feet above the road. Boulders this size are commonly concentrated near the base of the terrace gravels. The soil surface above the boulder is gravelly, typical of a terrace landscape.

Muddy sand with a few small pebbles is exposed in a bare spot on a small sapped face below the boulder; this kind of sediment is more typical of the Potomac Group.
AH-2: Tree throw along the N side of an old grade on a gently sloping, colluvial surface. Cobbles and gravel in a matrix of orange clay loam, with scattered pieces of variegated green and brown silty clay. Interpretation: colluvium over Potomac Group clay. Similar sediment is exposed in a degraded old tree throw at AH-2A.
AH-3: Fresher tree throw lower and further NE on the same colluvial surface. Coarse gravel in a sandy loam matrix, mixed with scattered sandstone boulders and cobbles. Semi-stratified, appears to grade downward into a heavy argillic horizon (subsoil) composed of reddish-orange gravelly sandy clay loam. Interpretation: colluvium over Potomac Group gravel with a well-developed upland soil profile. The colluvial surface is a fan emanating from the small scarp directly uphill of this slope, at the north edge of Arlington House, which defines the actively retreating edge of the high terrace.
AH-4: 4' boulder of Weverton Quartzite (from Blue Ridge) laying in the woods next to the graded area. Presumably the boulder came from the gravel terrace with the rest of the colluvium, and turned up during the grading.
AH-5: Old, degraded tree throw just below the NW corner of the graded area. Appears to be sand and gravel with a heavy clay subsoil.
AH-6: Large tree throw in lower part of hollow. Sand, gravel, and cobbles in light brown loam, moderate soil development. Slightly micaceous. Interpretation: colluvium mixed with Potomac Group sand.
AH-7: Gully in the small ravine below graded area. Mix of fill and disturbed soil pushed over the bank from the bulldozed area. Orange clayey gravel exposed in very bottom of gully: truncated soil in Potomac Group sand and gravel? Poor exposure.
AH-8: Small seepage bog in a small depressional area on an alluvial terrace between the base of the slope and edge of main ravine. Rusty and oily black staining indicates the water discharging here is high in iron and manganese, respectively. The seepage is likely emanating from coarse beds in the lower Potomac Group, near the top of the weathered bedrock surface.
AH-9: Small cut bank along the south bank of the ravine. The lower 1-3' of the exposure is deeply weathered bedrock of the Sykesville Formation. The saprolite is soft enough to excavate with your fingers, but still retains the textures and structures of the original rock. The rock contains scattered but conspicuous quartz pebbles, that lie within a moderately strong schistosity inclined to the east at ~35^{o}. Immediately overlying the saprolite is a 1-2" layer of gravel composed mainly of angular quartz fragments—essentially a gravel lag derived from the weathered bedrock surface and present when the Potomac Group started being deposited some 130 million years ago. Above that are at least three different units of laminated fine-grained material composed of various proportions of tan and greenish, very cohesive muddy fine sand, silt, and silty clay. These sediments thicken across the face, from less than a foot on the east, to more than 2 feet on the west. Their upper surface is an almost perfectly level erosion surface truncated by gravel and sand. Golden, micaceous fine to medium sand—so characteristic of the lower Potomac Group— is well exposed on the hillside and in the roots of the beech tree immediately adjacent to the E end of this exposure. The fine-grained sediments are interpreted to be swamp and overbank deposits, whereas the overlying pebbly sand is a bar deposited in a high-energy river channel.

AH-10: Sizable spring about 80 feet SW of AH9. The spring issues from sand and gravel near the head of a small swale in the floodplain, below the mouth of the tributary ravine that starts near the superintendent's house. The flow coming out of the tributary ravine disappears into colluvium above the floodplain; the spring at this waypoint may simply represent the resurgence of that flow at a lower elevation. The discharge appears to contain little iron, which would tend to favor a short ground-water flow path.
AH-11: Small seepage area in a rutted track along the floodplain. Fine-grained modern alluvial soil underlies this part of the floodplain.
AH-12: This section of the main ravine is somewhat to strongly gullied, producing large, nearly continuous exposures of the lower Potomac Group for several hundred feet, especially along the south bank of the stream. The anomalously steep north bank is mostly fill; only the 1-3 feet closest to water level is in-situ. A persistent zone of silty clay occurs at the bottom along the downstream half of the exposure, presumably slackwater deposits similar to AH-9, just above the bedrock surface. One small outcrop of weathered bedrock was observed at the waypoint, along with an angular, 3-foot-long quartz boulder that must have been derived from a nearby stream outcrop. This section of the Potomac Group is a complex assortment of gravel, sand, and variegated silty clay units characterized by much lensing and channeling among the different units. The section becomes increasingly sandy and gravelly upstream, most of it deeply weathered to a reddish color. These sediments record the migration of various stream channels, floodplains, and backswamps across a low-relief landscape.
AH-13: The sandy lower unit of the Potomac Group is exposed in the stream banks below the superintendent's house, around the confluence of the main ravine with a smaller tributary from the NW. The sediment is dominantly a stiff, medium, micaceous, clayey sand, with a few thin seams of interbedded green silty clay. The sand is overlain by 1 to 3 feet of gravelly colluvium which displays crude, slope-parallel layering.
AH-14: Green and brown variegated clay and silt are exposed for 40-50 feet around the uppermost confluence of ravines and up the western of the two forks, which is strongly gullied. The bottom of the south branch appears to flow on a bed of colluvial cobbles. Water was flowing in both branches, with the south branch having 2-3 times the flow of the west branch.
AH-15: The headwaters spring is high up the south branch, emerging below a small, oversteepened bank of fill near the crest of the hill. The orifice cannot be seen directly, but the spring discharge is very likely coming out of the base of the terrace gravel.
AH-16: The mid slopes of this landscape are characterized by a series of gently-sloping benches, separating the steeper slopes above and below. This is a common shape of long slopes on this formation: the benches develop on the more cohesive silty clays that dominate the upper parts of the unit, whereas the steeper toe slopes form on the underlying sandy and pebbly strata. The benches lie below the steep eroding scarp at the edge of the terrace gravel, and are a prime location for the accumulation of colluvial fans. This is illustrated at the waypoint, where a tree throw exposes at least 2-3 feet of cobbles and boulders embedded in a brown loamy matrix. Northward on this bench, several 2-4' boulders of Weverton quartzite can be seen on the surface. All of this material has worked its way downslope from the scarp north of Arlington House.
AH-17: Reddish, micaceous, fine and medium pebbly sand is exposed for about ten feet vertically, in an extremely steep bank above the ravine. Classic Potomac Group sand.

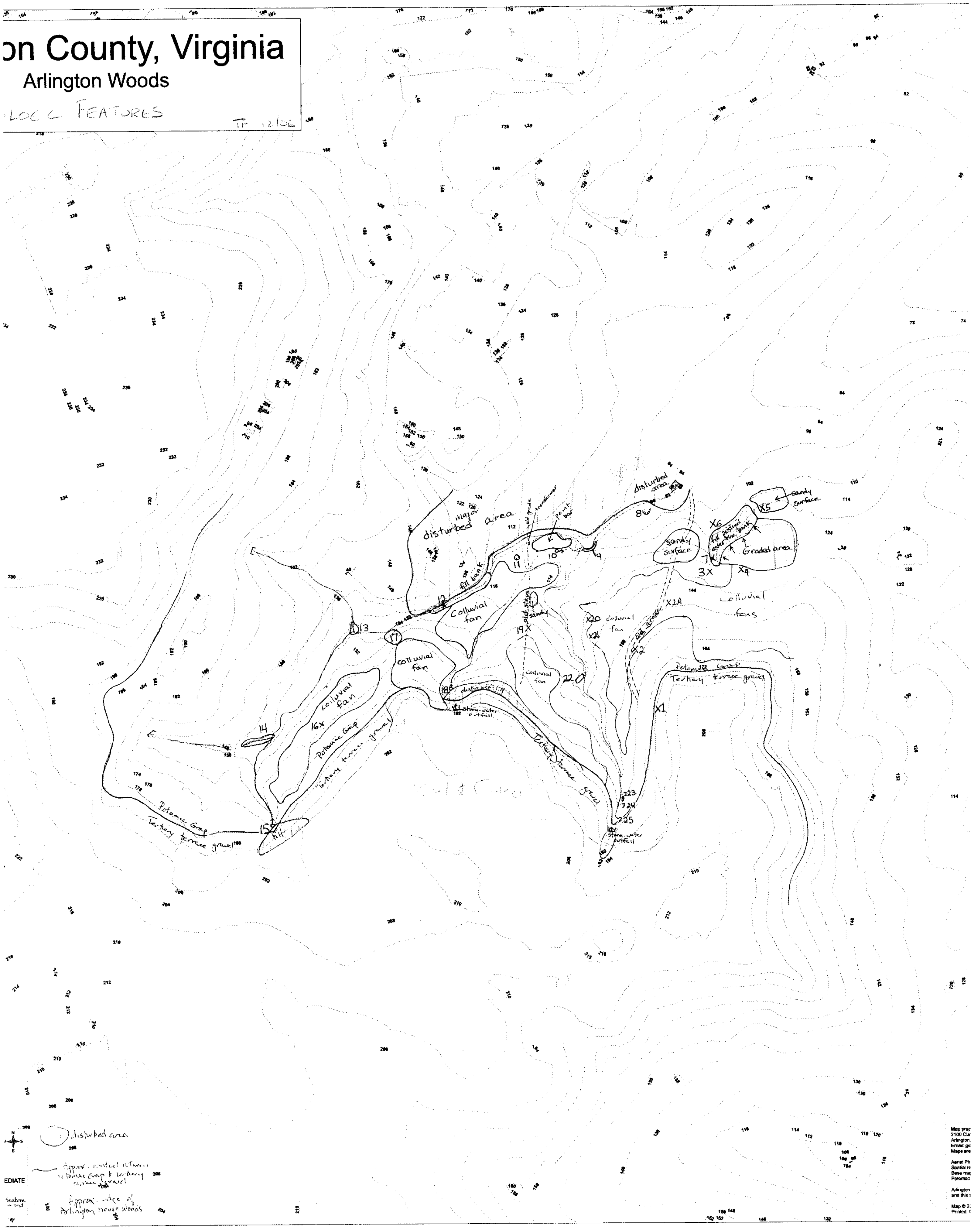
AH-18: Disturbed spring in the tributary ravine directly below the superintendent's house. The oversteepened bank above the ravine has clearly had gravel and fill pushed over it, which has affected the morphology of the upper part of the ravine. The original spring orifice is probably buried by the fill, and it seems likely that the spring now discharges down-ravine from its natural position, after migrating through the boulders pushed into the ravine. The strong rusty color indicates a high iron level in the ground water; the iron most likely originates from leaching of the soil profile in the terrace gravel, and is fairly common in springs derived from these terraces. A sizable storm-water outfall discharges near the top of the filled ravine, and the stormwater has caused significant gullying of the ravine bottom at places. This has exposed green and brown variegated silty clay (upper Potomac Group) at the first sharp bend below the spring.
AH-19: Old, double tree throw on the outer part of a high bench, a short distance above the top of the old concrete steps in the woods. Although degraded, the original material appears to have been red, weathered silty clay.
AH-20: Fresh, large tree throw on lower part of bench, near slope break. Mostly red silty clay with a few pebbles. A hint of lamination in the larger pieces. Probably a thin layer of colluvial pebbles over silty clay.
AH-21: Old, partially degraded tree throw located ~60 feet south of AH-20 and several feet higher in elevation. Lots of cobbles in the roots and laying nearby—colluvium. Significant volume of standing water in the hole left by the throw: roughly 4' x 6', up to 1' deep. Apparently standing on poorly permeable silty clays.
AH-22: Dense, green and brown silty clay exposed at the confluence of a small ravine. Widely spaced, long, straight, oxidized fractures were observed cutting through the unit. Colluvial cobbles are abundant on the slopes and benches near this waypoint.
AH-23: The lowest source of water in the headwaters of this ravine: small volume is discharging from outfall structure on E bank of ravine, minor iron. A much larger volume is discharging directly from a seepage face immediately above stream level and immediately up-ravine from the outfall. The seepage face is on the order of 10-12' long.
AH-24: Another presumed spring discharges from a pipe 4' high on the east bank, 50 feet up-ravine of AH-23. Discharges < 1 gpm, with minor iron staining.
AH-25: The highest water source, also on the east bank, is a small outfall structure about 5 feet above the bottom of the ravine, 50 feet up-ravine of AH-24, and 15-20 feet from the storm-water outfall at the head of the ravine. Discharge is very small, probably < ¼ gpm, with minor iron staining.

This property is significant in being one of only two public natural areas in the county (Barcroft Park is the other) to completely span a Coastal Plain slope from the bedrock, through the Potomac Group, to the terrace gravel. The relationship of both natural communities and spring hydrology to geologic setting is illustrated exceptionally clearly here. Conversion of some of the woods to interment sites is a bad idea: disturbance of the Potomac Group clays on slopes this steep very commonly results in slope failures and severe erosion. This is especially possible when the silty clays are interbedded with more permeable sand and gravel, as they are here: ground water preferentially flows through the more permeable sand and gravel beds, resulting in high pore pressures that destabilize the overlying clays.

Agreement With Existing Geologic Map(s): Generally quite good, *except* that the geologic quadrangle (GQ) shows the Potomac Group at this site as consisting entirely of the lower sandy lithofacies, whereas field observations clearly indicate the presence of a robust, upper silty-clay unit that is probably somewhat thicker than the lower sandy unit. Colluvium is not mapped on the GQ, mainly due to scale.

All of the major ravines at this site have perennial streams, as shown on my map. None of these streams appear on the hydrology layer of the county GIS, however.

Degree and Distribution of Soil Disturbance: Most of the slopes south of the main ravine are little disturbed, except: 1) the graded area noted in the vicinity of waypoints AH-4-5-6-7; 2) the very top of the slope has had fill (mostly terrace gravel) pushed over it at places, especially near the filled heads of ravines; and 3) minor localized disturbances associated with various old walkways, road grades, and similar. All of the ravines are being impacted by excessive storm-water runoff, which is causing moderate to deep gullies to form, and accelerating the undermining of ravine banks. Most of the area north and west of the main ravine appears to have had significant disturbance of one sort or another.


on County, Virginia
Arlington Woods
Features
disturbed area
major disturbed area
fill bank
point bar
Colluvial fan
colluvial fan
Colluvial fans
sandy surface
Sandy surface
fill pushed over the bank
Graded area
old stone
sandy
old grade
Potomac Group
Tertiary terrace gravel
disturbed fill
storm-water outfall
fill
disturbed area

October 28, 1996
Cris Fleming

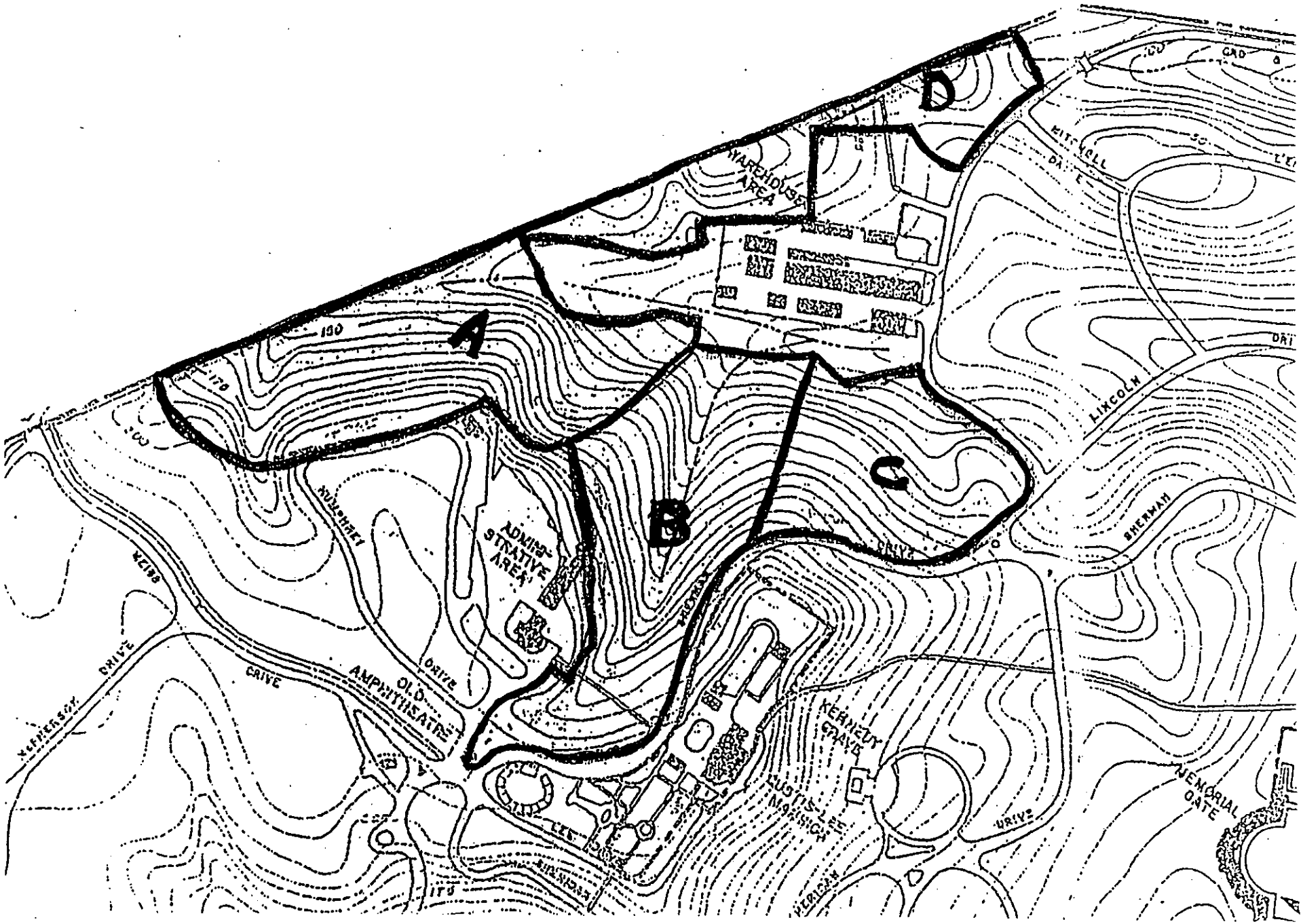
ARLINGTON HOUSE PLANT INVENTORY

Key to Locations:
- A - western section (main ravine to stone wall)
- B - central section (main ravine and lawn south of it)
- C - eastern section (ravine to Sherman Drive)
- D - north section (north of warehouse area)
- T - throughout

Key to Habitat:
- O - open lawn or field
- W - woods

Key to Notes:
- 1 - rare in Virginia
- 2 - uncommon in Piedmont region
- 3 - scarce at this site
- 4 - exceptionally large specimens
- 5 - planted and escaped (naturalized)
- 6 - only found planted here
- 7 - dominant at this site

Acalypha rhomboidea - three-seeded mercury	EUPHO	C	O	
Acer negundo - box-elder	ACERA	B	W	
Acer rubrum - red maple	ACERA	T	W	
Acer saccharum - sugar maple	ACERA	A	W	2,3
Ailanthus altissima - ailanthus	SIMAR	AC	W	7
Alliaria petiolata - garlic mustard	BRASS	T	W	
Allium vineale- onion grass	LILIA	T	O	
Ambrosia artemisiifolia - common ragweed	ASTER	T	O	
Ambrosia trifida - giant ragweed	ASTER	T	O	
Amelanchier arborea - shadbush	ROSAC	CD	W	3
Ampelopsis brevipedunculata - porcelain berry	VITAC	BC	O	
Amphicarpea bracteata - hog-peanut	FABAC	B	W	
Anagallis arvensis - scarlet pimpernel	PRIMU	C	O	
Anthemis cotula - mayweed	ASTER	A	O	
Apocynum androsaemifolium - spreading dogbane	APOCY	A	O	
Aralia nudicaulis - wild sarsaparilla	ARALI	C	W	2
Aralia racemosa - American spikenard	ARALI	B	W	2
Artemsia vulgaris - mugwort	ASTER	AC	O	
Asclepias syriaca - common millkweed	ASCLE	C	O	
Aster divaricatus - white wood aster	ASTER	AC	W	
Aster dumosus - bushy aster	ASTER	ABC	O	
Aster lateriflorus - calico aster	ASTER	BD	O	
Aster simplex - panicled aster	ASTER	AC	O	
Aster vimeneus - small white aster	ASTER	A	O	
Berberis vulgaris - Japanese barberry	BERBE	B	W	5
Bidens polylepis - tickseed sunflower	ASTER	C	O	
Buxus sp. - boxwood	BUXAC	B	O	6
Catalpa speciosa - hardy catalpa	BIGNO	B	W	
Cardamine hirsuta - hairy bittercress	BRASS	BC	O	
Carya glabra - pignut hickory	JUGLA	T	W	
Carya tomentosa - mockernut hickory	JUGLA	T	OW	


A
B
C
D
WAREHOUSE AREA
ADMINISTRATIVE AREA
OLD AMPHITHEATRE
KEARNEY GRAVE
MEMORIAL GATE
LINCOLN
SHERMAN
DRIVE
100
110
120
130

Cedrus deodor - deodor cedar	PINAC	B	O	6
Cerastium vulgaris - mouse-ear chickweed	BRASS	BC	O	
Chaemacyparis sp. - white-cedar	CUPRE	B	O	6
Chenopodium album - lamb's-quarter	CHENO	ABC	O	
Chamaecrista(Cassia) fasciculata - partridge-pea	FABAC	B	O	
Chimaphila maculata - striped wintergreen	ERICA	B	O	3
Chionanthus virginicus - fringetree	OLEAC	D	W	3
Cichorium intybus - chicory	ASTER	BC	O	
Cimicifuga racemosa - black cohosh	RANUN	B	W	
Circaea lutetiana - enchanter's nightshade	ONOGR	BC	W	
Cirsium arvense - Canada thistle	ASTER	B	O	
Cirsium vulgare - bull thistle	ASTER	B	O	
Collinsonia canadensis - horsemint	LAMIA	C	W	
Commelina communis - Asiatic dayflower	COMME	B	O	
Convolvulus sepium - hedge bindweed	CONVO	B	O	
Cornus florida - flowering dogwood	CORNA	T	W	
Cornus kousa -kousa dogwood	CORNA	B	O	6
Cryptotaenia canadensis - honewort	APIAC	C	W	
Cuscuta gronovii - common dodder	CONVO	B	O	
Cyperus strigosus - nutsedge	CYPER	B	O	
Dactylis glomerata - orchard grass	POACE	C	O	
Digitaria sanguinalis - crabgrass	POACE	B	O	
Dentaria laciniata - cut-leaved toothwort	BRASSA	B	W	
Dioscorea villosa - wild yam	DIOSCO	B	W	
Dryopteris marginalis - marginal wood-fern	POLYPO	B	W	
Duchesnea indica - Indian strawberry	ROSAC	C	O	
Echinocloa crusgali - barnyard grass	POACE	B	O	
Eleagnus commutata - silverberry	ELEAG	C	O	5
Elephantopus carolinianus - elephant's foot	ASTER	B	O	
Epifagus virginiana - beechdrops	OROBA	C	W	
Erigeron annus - daisy fleabane	ASTER	B	O	
Erigeron philadelphicus - common fleabane	ASTER	C	O	
Euonymus sp. - creeping euonymus	CELAS	C	W	5
Eupatorium purpureum - sweet Joe-Pye-weed	ASTER	B	W	
Eupatorium rugosum - white snakeroot	ASTER	C	W	
Euphorbia supina - milk purslane	EUPHO	B	O	
Fagus grandifolia - American beech	FAGAC	T	W	
Fraxinus americanus - white ash	OLEAC	T	W	
Galium aparine - cleavers bedstraw	RUBIA	C	O	
Galium cirzacens - wild licorice	RUBIA	B	W	
Geum canadense - white avens	ROSAC	C	O	
Geranium carolinianum - Carolina cranesbill	GERAN	B	O	
Ginkgo biloba - ginkgo	GINKG	B	W	6
Glechoma hederacea - gill-over-the-ground	LAMIA	T	W	
Hamamelis virginiana - witch-hazel	HAMAM	B	OW	
Hedera helix - English ivy	ARALI	T	W	5,7
Hemerocallis fulva - daylily	LILIA	B	W	5
Houstonia purpurea - large-leaved houstonia	RUBIA	A	W	3
Hydrangea arborea - wild hydrangea	SAXIF	B	OW	
Ilex sp. - English holly	AQUIL	B	O	6
Ilex opaca - American holly	AQUIL	AB	W	
Impatiens capensis - orange jewelweed	BALSA	B	W	
Juglans nigra - black walnut	JUGLA	B	W	
Juncus tenuis - path rush	JUNCU	C	O	

Kalmia latifolia - mountain laurel	ERICA	AC	W	
Lactuca serriola - prickly lettuce	ASTER	B	O	
Laportea canadensis - wood nettle	URTIC	B	W	
Lepidium virginicum - wild peppergrass	BRASS	B	O	
Lespedeza cuneata - Chinese bushclover	FABAC	C	O	5
Lespedeza striata - Japanese bushclover	FABAC	B	O	6
Lindera benzoin - spicebush	LAURA	T	W	
Liriodendron tulipifera - tuliptree	MAGNO	T	W	
Lobelia inflata - Indian tobacco	CAMPA	A	O	
Lonicera japonica - Japanese honeysuckle	CAPRI	T	W	
Lonicera morrowii - bush honeysuckle	CAPRI	C	W	
Lonicera sempervirens -trumpet honeysuckle	CAPRI	B	W	
Lysimachia ciliata - fringed loosestrife	PRIMU	B	W	
Magnolia grandiflora - southern magnolia	MAGNO	B	O	6
Medeola virginica - Indian cucumber-root	LILIA	B	W	
Medicago lupulina - black medic	FABAC	B	O	
Mitchella repens - partridge berry	RUBIA	C	W	
Morus alba - white mulberry	MORAC	AB	W	
Morus rubra - red mulberry	MORAC	B	O	
Narcissus sp. - daffodil	LILIA	B	W	5
Nyssa sylvatica - tupelo, black gum	NYSSA	ABC	W	
Osmorhiza claytoni - sweet cicely	APIAC	B	W	
Oxalis stricta - yellow woodsorrel	OXALI	B	O	
Pachysandra terminalis - pachysandra	BUXAC	B	W	5
Parthenocissus quinquefolia - Virginia creeper	VITAC	T	W	
Perilla frutescens - beefsteak plant	LAMIA	A	O	
Phyllostachys aurea - bamboo	POACE	A	O	5
Phytolacca americana - pokeweed	PHYTO	B	O	
Pilea pumila - clearweed	URTIC	B	W	
Pinus strobus - white pine	PINAC	B	O	6
Plantago lanceolata - English plantain	PLANT	B	O	
Plantago major - Common plantain	PLANT	B	O	
Poa pratense - Kentucky bluegrass	POACE	B	O	
Podophyllum peltatum - mayapple	BERBE	AB	W	
Polygonatum biflorum - smooth Solomon's-seal	LILIA	BCD	W	
Polygonum cespitosum - long-bristled smartweed	POLYG	B	O	
Polygonum pennsylvanica - pinkweed	POLYG	B	O	
Polygonum (Tovara) virginica - jumpseed	POLYG	B	W	
Prunus avium - sweet cherry	ROSAC	C	W	5
Prunus pennsylvanica - pin cherry	ROSAC	B	O	
Prunus serotina - black cherry	ROSAC	T	W	
Prunus persica - peach	ROSAC	B	O	6
Prunus sp. - flowering cherry	ROSAC	B	O	6
Pyrus angustifolia - wild crabapple	ROSAC	C	O	
Quercus alba - white oak	FAGAC	T	OW	4,
Quercus phellos - willow oak	FAGAC	B	O	6
Quercus prinus - chestnut oak	FAGAC	T	W	4
Quercus rubra - red oak	FAGAC	T	W	4,
Ranunculus abortivus - aborted buttercup	RANUN	C	O	
Ranunculus bulbosa - bulbous buttercup	RANUN	C	O	
Rhododendron periclymenoides - pinxter-flower	ERICA	ACD	W	
Rhus glabra - smooth sumac	ANACA	C	O	
Rhus radicans - poison ivy	ANACA	T	W	
Robinia psuedoacacia - black locust	FABAC	AB	W	

Rubus arguta - tall blackberry	ROSAC	AC	OW	
Rubus occidentalis - wild black raspberry	ROSAC	C	O	
Rubus phoenicolasius - wineberry	ROSAC	BC	O	
Rumex crispus - curly dock	POLYG	BC	O	
Agropyron(Elytrigia) repens - quackgrass	POACE	C	O	
Sambucus canadensis - elderberry	CAPRI	B	W	
Sanicula gregaria - clustered snakeroot	APIAC	B	W	
Sassafras albidum - sassafras	LAURA	T	W	
Schizachyrium scoparium - little bluegrass	POACE	C	O	
Scleranthus annus - knawel	CAPRI	B	O	
Setaria faberi - foxtail grass	POACE	BC	O	
Setaria flava - yellow foxtail	POACE	AB	O	
Smilacina racemosa - false Solomon's-seal	LILIA	AB		
Smilax glauca - glaucous greenbrier	LILIA	A	W	
Smilax rotundifolia - common greenbrier	LILIA	T	W	
Solanum carolinense - horsenettle	SOLAN	B	O	
Solidago caesia - blue-stemmed goldenrod	ASTER	ABC	W	
Solidago juncea - early goldenrod	ASTER	D	O	
Stellaria media - common chickweed	CARYO	B	OW	
Taraxacum officinalis - dandelion	ASTER	B	O	
Taxus baccata - English yew	TAXUS	B	O	6
Thalictrum coriaceum - leatherleaf meadowrue	RANUN	B	W	2
Thalictrum dioicum - early meadowrue	RANUN	B	W	
Thelypteris noveboracensis - New York fern	POLYP	B	W	
Thuja occidentalis - northern white-cedar	CUPRE	B	O	6
Trifolium campestre - low hop-clover	FABAC	B	O	
Trifolium pratense - red clover	FABAC	B	O	
Trifolium repens - white clover	FABAC	B	O	
Tsuga canadensis - eastern hemlock	PINAC	A	W	6
Ulmus americana - American elm	ULMAC	B	W	2
Ulmus rubra - slippery elm	ULMAC	AB	W	
Vaccinium stamineum - deerberry	ERICA	C	W	
Vaccinium vaccillans - lowbush blueberry	ERICA	CD	W	
Veronica persica - birds-eye speedwell	SCROP	B	O	
Veronica serphyllifolia - thyme-leaved speedwell	SCROP	C	O	
Viburnum acerifolium - maple-leaved viburnum	CAPRI	AC	W	
Vinca minor - periwinkle	APOCY	C	W	5
Viola papilionacea - common blue violet	VIOLA	B	W	
Vitus labrusca - fox grape	VITAC	T	W	
Wisteria chinensis - Chinese wisteria	FABAC	AB	W	5
Yucca filamentosa - yucca	LILIA	A	O	5

October 28, 1996
Cris Fleming

REPORT ON VASCULAR PLANT INVENTORY OF WOODED RAVINE AT ARLINGTON HOUSE

General Information

The 24.4 acre site known as the wooded ravine behind Arlington House is located next to the Arlington Memorial Cemetery and is owned and managed by the National Park Service (NPS). Options are being studied concerning transfer of portions of the site to the Department of the Army for cemetery purposes. Therefore, the Park Service requested more information on the plant species and communities of this site.

The botanist began inventory work on March 1, 1996 and visited the site five other times through the growing season: 4/16, 5/23, 6/25, 7/21 and 9/28. Her complete report consists of this written report plus a list of all vascular plants found on the site, including the scientific name, common name, plant family, location, habitat, and notations on certain species.

The site consists of a wooded north-facing ravine leading down to a small stream. Both sides of the ravine are wooded hillsides. The small area behind the warehouses is also wooded. Some open areas exist, mainly the large mowed area at the entrance to the NPS Administrative Area, and edges along the road and the parking lot.

Four sections of the site

For ease of noting locations, the site was broken into four sections. Section A is the western section which runs from the stone wall along the boundary with Fort Meyer to the parking lot near the NPS office; Section B is the middle section, including the main ravine approached from the NPS office and the mowed lawn south of the ravine; Section C, the eastern section, runs from the main ravine to Sherman Drive and includes the road edges and a small meadow along the road; Section D is the area north of the warehouse area. Location in these different sections was noted for each species. Several species occur throughout the site.

Section A, the western part of the site, is very weedy, consisting mostly of escaped wisteria vines and ailanthus trees, plus lots of poison ivy. In some areas, the wisteria is so thick, a machete is needed to go through it. Only the far western part of this section has native woodland species such as Mayapple (Podophyllum peltatum) and False Solomon's-seal (Smilacina racemosa).

Section B, the wooded ravine itself, is in better shape. Large oaks, beech, and tuliptree indicate that this forest is more mature and less disturbed that the forest in Section A. Although the ground layer is thick with English ivy, several native herbaceous species do occur, including spring wildflowers such as cut-leaved toothwort (Dentaria laciniata), early meadowrue (Thalictrum dioicum), and smooth Solomon's-seal (Polygonatum biflorum). Attractive fall wildflowers occuring

here are white wood aster (Aster divaricatus) and blue-stemmed goldenrod (Solidago caesia). Unusual species in these woods include American spikenard (Aralia racemosa), a plant usually found in the mountains in Virginia, trumpet honeysuckle (Lonicera sempervirens), a native species but probably escaped from a garden at this site, and a ginkgo tree that must have been planted here. With large trees and a cool north-facing aspect, this ravine would be a pleasant place if there were no invasive species such as English ivy and poison ivy.

The upper part of Section C is covered with grapevines, but below the open field at the corner of Sherman Drive and Lincoln Drive is a small area with no invasive species. Here is an attractive woodland of about one acre with shrubs such as shadbush (Amelachier arborea), pinxterflower (Rhododendron periclymenoides), maple-leaved viburnum (Virburnum acerifolium), and deerberry (Vaccinium stamineum). In this area is a large stand of wild sarsaparilla (Aralia nudicaulis), another species found more often in the mountains than in the Piedmont or Coastal Plain of Virginia.

The woods behind the warehouses in Section D are younger and the soil is drier than in the other sections. Because of this, these woods are more open and are not covered with invasive vines. Chestnut oak (Quercus prinus) dominates here and there are many oak seedlings. Several young hickories occur here; shrubs include lowbush blueberry (Vaccinium vacillans), pinxterflower, southern arrowwood (Viburnum dentatum), and fringetree (Chionanthus virginicus).

Results

Over 180 species of vascular plants were found during this inventory. No species rare or uncommon in Virginia were found. Two species were noted that are common in the mountains but unusual in the Piedmont: American spikenard and wild sarsaparilla. Probably the north-facing hillside provides the cool habitat needed by these species.

The main ravine has many large trees and well-developed shrub and herbaceous layers. Despite the prevalence of English ivy and other invasive species, a diversity of native species occurs.

Only two areas were free of invasive species: the little woodland along the road at the north end of Section C and the woods behind the warehouses. Most of the other areas are more or less covered with invasive species, the most extreme being the wisteria and ailanthus dominating Section A.

APPENDIX D

Forestry Study

from

Draft Report - Cultural Investigations at Section 29, Arlington National Cemetery, Arlington County Virginia by Garrow & Associates Inc., Chapel Hill, North Carolina, submitted to U.S. Army Corps of Engineers, Baltimore, District Planning Division

FORESTRY STUDY

There are five relatively distinct forest types in the project area: Mixed Hardwood Forest, Northern Red Oak Forest, Chestnut Oak Forest, White Oak Forest, and Disturbed Hardwood Forest (Figure 100). In the Preservation Zone there is primarily one type, a Mixed Hardwood Forest (on mesic slopes), with a very small amount of Chestnut Oak Forest and two small areas of Disturbed Hardwood Forest. In the Interment Zone all five forest types are represented. Most forested areas have been invaded by exotic horticultural plant species in understory, shrub, and ground layers.

The Mixed Hardwood Forest type contains a mixture of white oak (*Quercus alba*), northern red oak (*Quercus rubra*), chestnut oak (*Quercus prinus*), and tulip poplar (*Liriodendron tulipifera*), with scattered beech (*Fagus grandifolia*) in the upper canopy above 30 feet high (Figure 101). The understory (15–30 feet high) contains hickory (*Carya tomentosa* and *C. glabra*), several oak species (*Quercus* spp.), tulip poplar, and other hardwood species, with occasional hemlock (*Tsuga* sp.) and other conifers escaped from adjacent garden areas. The shrub zone and ground layers contain sugar maple (*Acer saccharum*), maple-leafed viburnum (*Viburnum acerifolium*), spicebush (*Lindera benzoin*) (near stream), Christmas fern (*Polystichum acrostichoides*), false Solomon's seal

(*Smilacina racemosa*), bedstraw (*Gallium* sp.), Virginia creeper (*Parthenocissus quinquefolia*), and mayapple (*Podophyllum peltatum*), where not dominated by poison ivy (*Toxicodendron radicans*), wisteria (*Wisteria chinensis*), English ivy (*Hedera helix*), periwinkle (*Vinca minor*), and other exotic horticultural species. The Mixed Hardwood Forest type occurs in the ravine just behind Arlington House, The Robert E. Lee Memorial, and is mostly in the Preservation Zone, but is also present east of the channel in the very lower portion of the ravine in the Interment Zone.

The Northern Red Oak Forest, Chestnut Oak Forest, and White Oak Forest are largely in the Interment Zone and are dominated by the title species in the upper canopy. The Northern Red Oak Forest is predominant in the ravine in the southwestern segment of Section 29. Northern red oak dominates the canopy; very minor amounts of hickory, white oak, tulip poplar, and chestnut oak are scattered in the canopy, with northern red oak, hickory, beech, and red maple (*Acer rubrum*) in the understory (Figure 102). The shrub and ground layers are dominated by wisteria and English ivy (often codominant with poison ivy) in many places. More "natural" portions of the shrub and ground layers contain maple-leafed viburnum, spikenard (*Aralia racemosa*), azalea (*Rhododendron* sp.), mayapple, false Solomon's seal, and poison ivy.

The Chestnut Oak Forest occurs on a ridge in the northwestern segment of the project area, along the southern boundary of the Interment Zone, and in a very small portion of the Preservation Zone along Sherman Drive. The canopy is dominated by chestnut oak with scattered northern red oak and beech (Figure 103). This forest type contains young chestnut oak, hickory, maple-leafed viburnum, sugar maple, poison ivy, and blueberry (*Vaccinium vacillans*) in the understory, shrub, and ground layers.

The White Oak Forest occurs on an isolated slope and ridge in the northwestern corner of Section 29. Dominated by white oak, the canopy also contains scattered hickory, chestnut oak, and tulip poplar. Hickory, flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), maple-leafed viburnum, red maple, mayapple, and poison ivy are present in the understory, shrub, and ground layers (Figure 104).

The Disturbed Hardwood Forest stands are present in the northern portion of the Interment Zone and in two small inclusions in the Mixed Hardwood Forest of the Preservation Zone. This forest canopy contains scattered oaks and other typical hardwoods that were prevalent before disturbance (Figure 105). Primarily, however, the canopy contains black locust (*Robinia pseudoacacia*), sweetgum (*Liquidambar styraciflua*), tree of heaven (*Ailanthus altissima*), and other disturbance-response species and escaped horticultural trees from surrounding gardens. The understory contains hardwood saplings with blackberry (*Rubus* spp.), Japanese honeysuckle (*Lonicera japonica*), and poison ivy. The Disturbed Hardwood Forests have been thoroughly disturbed in the past 50–75 years and no longer resemble the original stand of hardwoods that were present in the Civil War era. These forests were likely impacted by development within nearby Fort Myer and within ANC at the adjacent maintenance facility.

The White Oak Forest and Chestnut Oak Forests in the northwestern segment of Section 29 are probably typical of the mature forests that would have occupied these topographical positions naturally. These are mature stands; however, they appear to be slightly younger (ca. 90 years old) than the Northern Red Oak Forest (ca. 130 years old) and the Mixed Hardwood Forest (ca. 220 years old) in the remainder of the Interment Zone and Preservation Zone. These forests are isolated by the presence of the ANC maintenance facility and the Fort Myer motor pool, and their integrity has been compromised by these developments.

The Northern Red Oak Forest and Chestnut Oak Forest (and a portion of the Mixed Hardwood Forest) in the southwestern ravine are in the area mapped as harvested during the Civil War by contemporary maps (see Figures 2 and 5). Stumps in the area (Northern Red Oak Forest) date older trees in the stand to approximately the time of the Civil War (Figure 106). A few larger red

oaks may have been saplings that were not cut during the Civil War period. These are very mature forests and, given the dominance of northern red oak and chestnut oak in the stands today, northern red oak and chestnut oak were undoubtedly very strong components of the previous stands. These forests likely look very similar to the forests in this ravine at the time of the Civil War, except for the invasion of horticultural species (with poison ivy) in the understory, shrub, and ground layers. The Mixed Hardwood Forest in the boundary between the two zones is probably closer in age to the Northern Red Oak Forest in the southern portion of the Interment Zone than to the Mixed Hardwood Forest in the ravine behind Arlington House, The Robert E. Lee Memorial, as a result of clearing during the Civil War.

The Mixed Hardwood Forest in the ravine behind Arlington House, The Robert E. Lee Memorial, is arguably the oldest stand on Section 29. A fresh cut was made across the base of a hickory tree that had recently fallen; tree rings indicate that it dates to approximately 1775 (Figures 107 and 108). Other very large trees, including white oaks, chestnut oaks, and beech (Figure 109), are probably similar in age to this hickory tree. While many of the larger trees present in this stand today were probably only occupying space in the lower canopy at the time of the Civil War, they were well established as the "next generation" of canopy dominants.

Numerous large, decayed hardwood stems on the ground and advanced hardwood regeneration are present in the understory of the older Chestnut Oak Forest (Figure 110), the Northern Red Oak Forest, and the Mixed Hardwood Forest (Preservation Zone and southern portion of Interment Zone). This indicates that these forests are in very late seral stages of development. These may or may not be "climax" forests per se; however, hardwood forests can maintain this seral stage for many years. The appearance of these forest canopies today is probably very similar to their appearance during the Custis-Lee occupation. However, the understories of the older Chestnut Oak Forest, Northern Red Oak Forest, and Mixed Hardwood Forest stands have changed in many areas due to adjacent disturbances and the subsequent invasion of English ivy, wisteria, periwinkle, and other horticultural species.

Birds of the Wooded Ravine (Section 29) Behind Arlington House, the Robert E. Lee Memorial

Karen Anderson, Mike Carpenter, Melissa Kangas

July 28, 1997

Objective: To determine what birds inhabit the 25-acre wooded ravine or use it for migratory stopovers by conducting periodic censuses/surveys throughout the Spring, Summer, and Fall.

Protocol: The survey was conducted using a modified version of the point count protocol followed by the Audubon Naturalist Society for the D.C.-Birdscape project. Three listening points were established in the wooded ravine. Two sites were near the edges of the property, and one was in the forest interior. (Please refer to attached map.) Each point was sampled for exactly five minutes, and all species identified by call, song, or visually were tallied. All birds seen or heard, regardless of the distance from the point, were tallied.

Timeframe: The survey was conducted biweekly from mid-May through the end of September, 1996. Additional data was collected in April and May of 1997. Exact dates for the survey are as follows:

1996:	Survey number listed on table:
May 18	1
June 1	2
June 16	3
June 29	4
July 11	5
July 28	6
August 17	7
September 1	8
September 28	9

1997:	
April 5	0
April 19	1
May 5	2

Preliminary results: A total of sixty-two species were found in this survey. The attached table represents the species that were tallied in at least one of the points for each day the survey was conducted.

Of the sixty-two species present, four are confirmed breeders and twenty-six are possible breeders. The designation possible breeder means that the species was seen or heard in breeding habitat during the height of the breeding season, from June 1 through June 29. Confirmed breeders were seen either nest-building or entering/leaving the nest. Due to limited time and resources, the breeding status of each species was not evaluated by means of criteria established for the Virginia Breeding Bird Atlas any further than to note presence/absence during the peak of the breeding season.

Confirmed breeders:

American robin
Carolina chickadee
Red-bellied woodpecker
Tufted titmouse

Possible breeders:

Acadian flycatcher
American crow
American goldfinch
American robin
Barn swallow
Blue jay
Brown-headed cowbird
Carolina chickadee
Carolina wren
Chimney swift
Common grackle
Downy woodpecker
Eastern wood-pewee
European starling
Gray catbird
Great crested flycatcher
House finch
House sparrow
House wren
Mourning dove
Northern cardinal
Northern flicker
Northern mockingbird
Red-eyed vireo
Red-shouldered hawk
Tufted titmouse
White-breasted nuthatch
White-eyed vireo
Wood thrush

Eighteen neotropical migrant species were counted during the Spring and/or Fall migrations (May and September):

American redstart
Bay-breasted warbler
Black-throated blue warbler
Black-throated green warbler
Black-and-white warbler
Blackpoll warbler
Blue-grey gnatcatcher
Hermit thrush
Hooded warbler
Indigo bunting
Magnolia warbler
Northern parula
Ovenbird
Scarlet tananger
Swainson's thrush
Veery
Warbling vireo

Protected species: Of the neotropical migrants listed above, three are listed on the Rare Animals list compiled by the Division of Natural Heritage, Virginia Department of Conservation and Recreation. These species and their protective statuses (global rank, state rank, state status) are as follows:

Hermit thrush	G5	S1	SC
Swainson's thrush		G5	S1
Magnolia warbler		G5	S1S2 SC

In addition to these three species, the following protected species were detected during the April 4, 1997 survey:

Brown creeper	G5	S2S3	SC
Winter wren	G5	S2	SC

Twenty resident species were present throughout the sampling period (April through September):

American crow
American goldfinch
American robin
Blue jay
Carolina chickadee
Carolina wren
Common grackle
Downy woodpecker
Eastern screech-owl
European starling
Fish crow
House finch
Mourning dove
Northern cardinal
Northern mockingbird
Red-bellied woodpecker
Rufous-sided towhee
Song sparrow
Tufted titmouse
White-breasted nuthatch

Additional surveys: Two additional owl surveys were conducted using recorded owl call tapes on March 23 and April 13, 1996, from 3:30 am to 6:00 am. On March 23 one Eastern screech-owl and one American woodcock (*Scolopax minor*) were detected. On April 13 no owls were detected. Due to scheduling delays which resulted from the Blizzard of '96 and the federal government shutdown, these surveys were conducted too late in the breeding season to expect the optimal level of response to the recorded owl tapes. Accordingly, these results may not fully represent the owl population in the wooded ravine.

Other field observations: A pair of Red-tailed hawks (*Buteo jamaicensis*) has been observed on several occasions in the ravine but was not detected during these surveys.

Discussion: According to data presented by Robbins (1989), the probability of detecting forest interior neotropical migrants like red-eyed vireo, wood thrush, scarlet tananger, and ovenbird increases as the area of forest increases. Conversely, a reduction in the size of the wooded ravine would decrease the probability of occurrence for these area-sensitive species.

References:

Audubon Naturalist Society. 1995. D.C. - Birdscape Count Instructions.

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Roble, S. M. 1996. Natural Heritage Resources of Virginia: Rare Animal Species. Natural Heritage Technical Report 96-11. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. 23 pp. plus appendices.

Virginia Society of Ornithology. 1989. Virginia's Breeding Birds: An Atlas Workbook. William Bird Press, Richmond, Virginia. 228 pp.

Birds of the wooded ravine (Section 29) behind Arlington House, the Robert E. Lee Memorial

	M	June			July		A	Sep		April		M
Species	1	2	3	4	5	6	7	8	9	0	1	2
Acadian flycatcher (*Empidonax virescens*)	x		x									
American crow (*Corvus brachyrhynchos*)	x	x	x	x	x	x	x	x	x	x	x	x
American goldfinch (*Carduelis tristis*)		x				x		x	x	x		
American redstart (*Setophaga ruticilla*)	x											
American robin (*Turdus migratorius*)	x			x	x	x	x	x	x	x	x	x
Barn swallow (*Hirundo rustica*)	x		x		x							
Bay-breasted warbler (*Dendroica castanea*)	x											
Black-and-white warbler (*Mniotilta varia*)												x
Black-throated blue warbler (*Dendroica caerulescens*)	x								x			x
Black-throated green warbler (*Dendroica virens*)									x			x
Blackpoll warbler (*Dendroica striata*)	x	x										
Blue jay (*Cyanocitta cristata*)	x	x	x	x	x	x	x	x	x	x	x	x
Blue-gray gnatcatcher (*Polioptila caerulea*)	x											
Brown creeper (*Certhia americana*)										x		
Brown thrasher (*Toxostoma rufum*)							x					
Brown-headed cowbird (*Molothrus ater*)	x	x	x							x	x	x
Carolina chickadee (*Parus carolinensis*)		x	x	x	x	x	x		x	x	x	x
Carolina wren (*Thyothorus ludovicianus*)	x	x	x	x	x	x	x	x	x			
Cedar waxwing (*Bombycilla cedrorum*)	x											
Chimney swift (*Chaetura pelagica*)	x	x	x	x	x	x	x	x	x			
Chipping sparrow (*Spizella passerina*)												x
Common grackle (*Quiscalus quiscula*)	x			x		x		x		x	x	
Common yellow throat (*Geothlyps trichas*)	x											
Downy woodpecker (*Picoides pubescens*)			x	x	x	x			x	x		
Eastern phoebe (*Sayornis phoebe*)										x	x	
Eastern screech-owl (*Otus asio*)	x											
Eastern wood-peewee (*Contopus virens*)	x	x	x	x	x	x	x	x	x			
European starling (*Sturnus vulgaris*)	x	x	x	x	x	x	x	x	x	x	x	x
Fish crow (*Corvus ossifragus*)						x				x	x	x
Gray catbird (*Dumetella carolinensis*)	x	x		x	x	x	x	x	x			x
Great crested flycatcher (*Mylarchus crinitus*)	x	x	x									x
Hermit thrush (*Catharus guttatus*)										x	x	x
Hooded warbler (*Wilsonia citrina*)												x
House finch (*Carpodacus mexicanus*)		x	x		x		x				x	x
House sparrow (*Passer domesticus*)	x	x	x	x	x	x						
House wren (*Troglodytes aedon*)	x	x				x						x
Indigo bunting (*Passerina cyanea*)	x											x
Junco, dark-eyed (*Junco hyemalis*)										x		
Magnolia warbler (*Dendroica magnolia*)	x								x			
Mourning dove (*Zenaida aurita*)	x	x	x		x	x		x	x			x
Northern cardinal (*Cardinalis cardinalis*)	x	x	x	x	x	x	x	x	x	x	x	x
Northern flicker (*Colaptes auratus*)		x	x	x	x	x	x	x	x	x	x	x
Northern mockingbird (*Mimus polyglottos*)		x	x		x		x		x		x	
Northern parula (*Parula americana*)	x								x			x
Ovenbird (*Seiurus aurocapillus*)	x						x					x
Pine warbler (*Dendroica pinus*)												x
Red-bellied woodpecker (*Melanerpes carolinus*)	x	x	x	x	x	x	x	x	x		x	x
Red-eyed vireo (*Vireo olivaceus*)	x		x									x
Red-shouldered hawk (*Buteo lineatus*)		x										
Rufous-sided towhee (*Pipilo erythrophthalmus*)										x	x	x
Scarlet tananger (*Piranga olivacea*)	x											x
Song sparrow (*Melospiza melodia*)										x		
Swainson's thrush (*Catharus ustulatus*)	x											
Tufted titmouse (*Parus bicolor*)	x	x	x	x	x	x	x	x	x	x	x	x
Veery (*Catharus fuscescens*)											x	x
Warbling vireo (*Vireo gilvus*)	x											
White-breasted nuthatch (*Sitta carolinensis*)	x	x	x			x	x	x	x			
White-eyed vireo (*Vireo griseus*)		x							x			x
White-throated sparrow (*Zonotrichia albicollis*)											x	x
Winter wren (*Troglodytes troglodytes*)										x		
Wood thrush (*Hylocichla mustelina*)	x			x	x	x						x
Yellow-rumped warbler (*Dendroica coronata*)												x

Arlington National Cemetery Millennium Project

Arlington County, Virginia

WSSI #22191.01

Vegetation Survey

February 19, 2013

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Vegetation Survey

Arlington National Cemetery Millennium Project
Arlington County, Virginia
WSSI #22191.01

Executive Summary

Wetland Studies and Solutions, Inc. (WSSI) has conducted a vegetation survey on the Arlington National Cemetery Millennium Project site in Arlington County, Virginia. This report has been prepared in order to characterize the vegetative communities present within the study area, in response to comments received during the public comment period for the Environmental Assessment prepared for the site.

Four general vegetative communities are present on the site, as described in this report, including mature hardwood forest, medium-aged disturbed forest, disturbed field/old field, and maintained parkland. A high prevalence of invasive species is present throughout the site, attesting to the level of disturbance, adjacent development, and other anthropogenic pressures that influence these communities as a result of the sites generally urban location.

Site Description

The Arlington National Cemetery Millennium Project site is located on the west side of Ord and Weitzel Drive and east of McNair Road, within Arlington National Cemetery in Arlington County, Virginia. Exhibit 1 is a vicinity map that depicts the approximate location of the site. The topography of the study area is depicted on the USGS Topographic Map in Exhibit 2. General vegetative cover can be seen in the aerial photographs in Exhibit 3 (a 2011 natural color photograph from ESRI).

Previous Studies

The Arlington National Cemetery Millennium Project site, or portions of the site, has been characterized in the past by others, including the Virginia Native Plant Society and by the National Park Service (NPS), as described in an Environmental Assessment prepared by the NPS in 1999. The Virginia Native Plant Society has listed the Arlington House Woods (which is the NPS administered property adjacent to the Millennium project) as a Virginia Native Plant Society Registry Site which, although this is not a legal designation, recognizes a site for one or more reasons, including: "…an exemplary occurrence of a habitat, a plant community, or a plant species. Sites may include an unusual, persisting variation of a plant species, or an assemblage of species. Or the site may exhibit some quality with the unique potential to inspire community awareness."[1]

The Virginia Native Plant Society Registry characterizes the Arlington House Woods as "…one of northern Virginia's surviving examples of Old-age Terrace Gravel Forest. The ravine forest canopy consists mainly of oaks, hickories, tulip tree and beech with an

[1] http://vnps.org/wp/conservation/know-your-vnps-registry-sites/, accessed February 12, 2013.

understory of fringetree, witch-hazel, pinxter azalea, black haw and maple-leaved viburnum, and a carpet of spring wildflowers."

The 1999 Environmental Assessment prepared by the NPS includes an "Appendix E, Plant Inventory" which includes the Arlington House Woods and the majority of the Arlington National Cemetery Millennium Project site, and was conducted in 1996. This Appendix is included as Exhibit 4 in this report. As noted in the results of the 1996 report, over 180 different species were found during the inventory, and none of the species were determined to be rare or uncommon in Virginia.

In February 2013, WSSI received email correspondence from the U.S. Army Corps of Engineers, which had sent several foresters to the site to determine the approximate age of the trees on the Arlington National Cemetery Millennium Project site. The foresters determined that, based on ring counts of large trees that had fallen down and core samples, the older trees in the forest community were between 130-150 years old. They went on to describe the forest community as a mixed oak/hardwood stand of approximately 150 years old, and would not categorize the stand as old growth, but that the forest was likely cleared during the civil war and has since regenerated.[2]

Vegetation Survey Methodology

The vegetation survey was conducted on February 7 and 12, 2013 by Benjamin N. Rosner, PWS, PWD, CT, CE[3] and Alison Robinson, WPIT, CT[4]. Utilizing topographic mapping and aerial photography, as well as previous knowledge of the site, general vegetative communities were determined and plot locations were randomly selected within each community to reduce sampling bias. Plots were defined using a 30-foot radius around a fixed point (plot center). Vegetation information was collected by stratum and included a tree stratum, sapling/shrub stratum, and herbaceous/vine stratum. Relative percent cover by each species in each stratum was then determined and recorded. The scientific name, common name, and relative percent cover by each species at each plot is included as Exhibit 5. While this survey is not a complete inventory of species, species that were noted outside of a plot or between plots were recorded for information purposes. Photographs of each plot are included as Exhibit 6. The approximate boundaries of the vegetation communities, plot locations, and photographs are depicted on Exhibit 7.

Vegetation Survey Results

Utilizing the visual observations and results of the plot data, the Arlington National Cemetery Millennium Project site consists of four main vegetative community types. These types are: mature hardwood forest (Plots 1, 2, and 3), medium-aged disturbed forest (Plots 4 and 5), disturbed field/old field (Plot 6), and maintained parkland (Plot 7). A description of the composition of each of these vegetative community types is provided below.

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2 From email correspondence forwarded by Susan Conner of the USACOE on February 8, 2013.

3 Professional Wetland Scientist #1766, Society of Wetland Scientists Certification Program, Inc. VA Certified Professional Wetland Delineator #3402-000080; North American Benthological Society (NABS) Certified Level 1 Taxonomist: All Phyla; Certified Ecologist, Ecological Society of America.

4 Wetland Professional In-Training, Society of Wetland Scientists Certification Program, Inc.; North American Benthological Society (NABS) Certified Level 1 Taxonomist: All Phyla; ISA Certified Arborist MA-5179A.

Mature Hardwood Forest

The mature hardwood forest is present primarily in the southern and eastern portion of the site and is dominated by tulip tree (*Liriodendron tulipifera*), chestnut oak (*Quercus prinus*), white oak (*Q. alba*), American beech (*Fagus grandifolia*), and various cherries (*Prunus* spp.) in the tree layer, American holly (*Ilex opaca*), bush honeysuckle (*Lonicera maackii*), Chinese wisteria (*Wisteria sinensis*), and spicebush (*Lindera benzoin*) in the sapling/shrub layer, and English ivy (*Hedera helix*), poison ivy (*Toxiocodendron radicans*), Japanese honeysuckle (*Lonicera japonica*), and serrate-leaf blackberry (*Rubus argutus*) in the herb/vine layer. In addition, WSSI noted a number of standing dead snags and trees with partially dead crowns. It appears that the forest community has undergone a significant shift since the 1996 inventory was conducted, with the majority of the understory now dominated by invasive and noxious species, leaving little space for native species. However, given the time of year that this survey was conducted, other plants would be expected to be visible in the spring and summer months.

Medium-Aged, Disturbed Forest

The medium-aged, disturbed forest is present primarily in the northeastern portion of the site and is dominated by white oak, black cherry (*P. serotina*), black locust (*Robinia pseudoacacia*), and various hickories (*Carya* spp.) in the tree layer, bush honeysuckle, American holly, black-haw (*Viburnum prunifolium*), and white mulberry (*Morus alba*) in the shrub layer, and English ivy, Japanese honeysuckle and poison ivy in the herb/vine layer. These disturbed areas are exhibiting a community type shift (i.e., an apparent increase in the amount/density of invasive species) most likely as a result of disturbance from ongoing activities at the adjacent maintenance yard. The disturbance has also allowed for the introduction of the *Hypoxylon* canker in oaks, affecting the overall health of this forest community.

Disturbed Field/Old Field Area

The disturbed field/old field area is present in the central portion of the site and is dominated by black locust, wineberry (*Rubus phoenicolasius*), Bradford pear (*Pyrus calleryana*), and bush honeysuckle in the sapling/shrub layer, and garlic mustard (*Alliaria petiolata*), mugwort (*Artemisia vulgaris*), grape vines (*Vitis* sp.), English ivy, chickweed (*Stellaria media*), and goldenrod (*Solidago* sp.) in the herb/vine layer. No tree layer is present. This area is typical of a disturbed area undergoing regeneration, with a moderate amount of invasive species in the herbaceous layer.

Maintained Parkland Area

The maintained parkland area is located primarily in the western portion of the site, north of a stone wall dividing the cemetery property from the previous Fort McNair property. A picnic area is present in the southern portion of this area. The area is dominated by white oak, chestnut oak, and northern red oak (*Q. rubra*) in the tree layer and crabgrass (*Digitaria* sp.) and an unknown bluegrass (*Poa* sp.) dominating the lawn area. This area is best characterized as a man-altered and maintained area.

Limitations

This study is based on examination of the habitat conditions on the study site at the time of our review and does not address conditions at a given time in the future. Such habitat conditions change over time. Therefore, our conclusions may vary from future observations.

Our vegetation survey and report have been prepared in accordance with generally accepted guidelines for the conduct of such surveys. We make no other warranties, either expressed or implied, and our report is not a recommendation to buy, sell, or develop the property.

WETLAND STUDIES AND SOLUTIONS, INC.

Benjamin N. Rosner, PWS, PWD, CE, CT
Senior Associate Environmental Scientist

Frank Graziano, PE
Vice President - Engineering

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Exhibit 1

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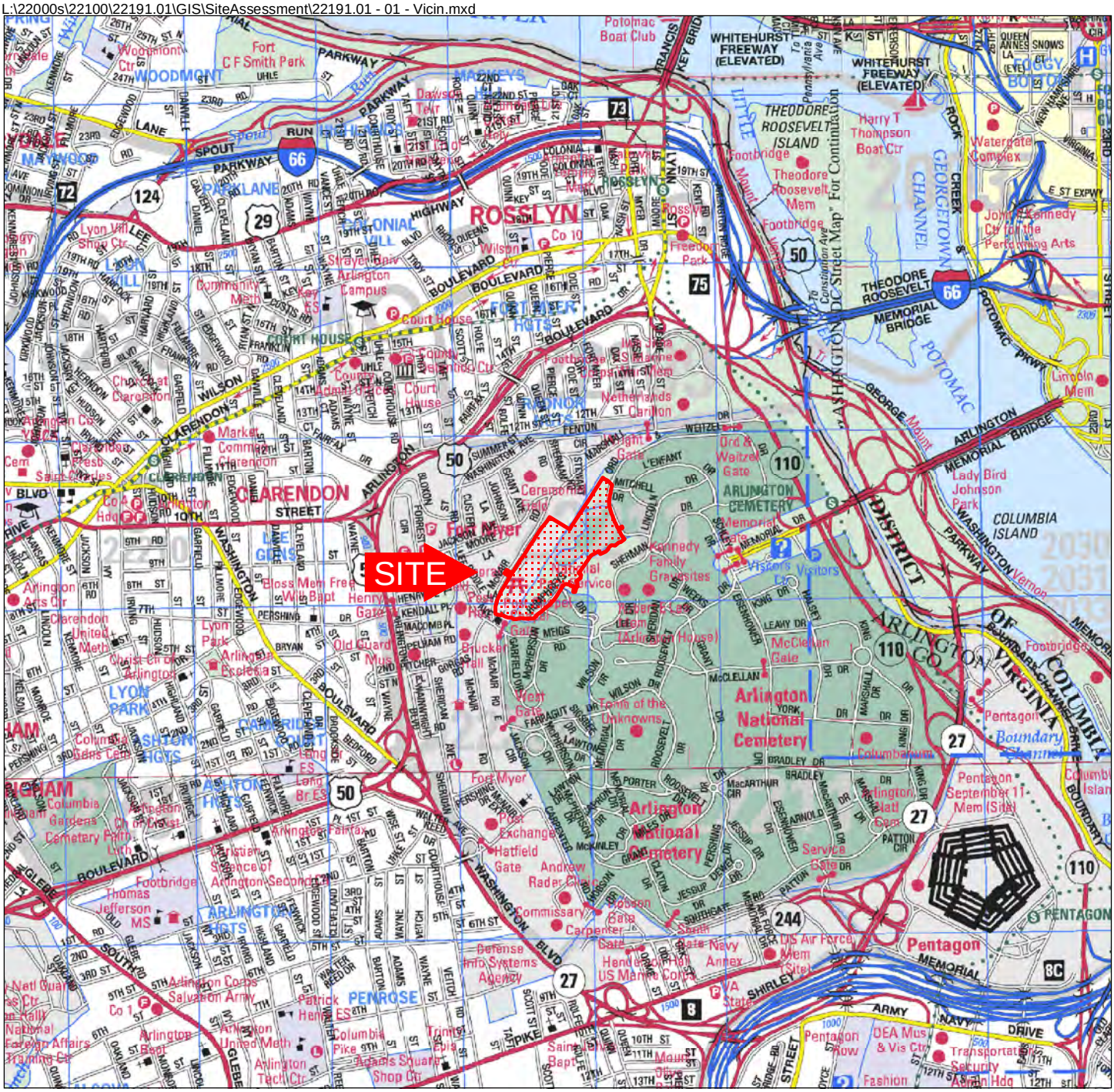

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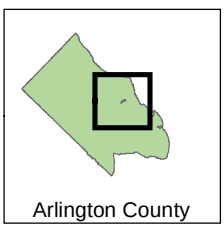
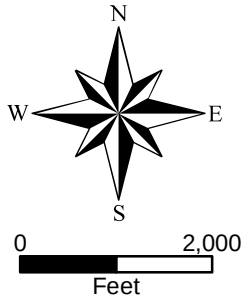
Vicinity Map
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 2000'





Wetland Studies and Solutions, Inc.

Exhibit 1

Exhibit 2

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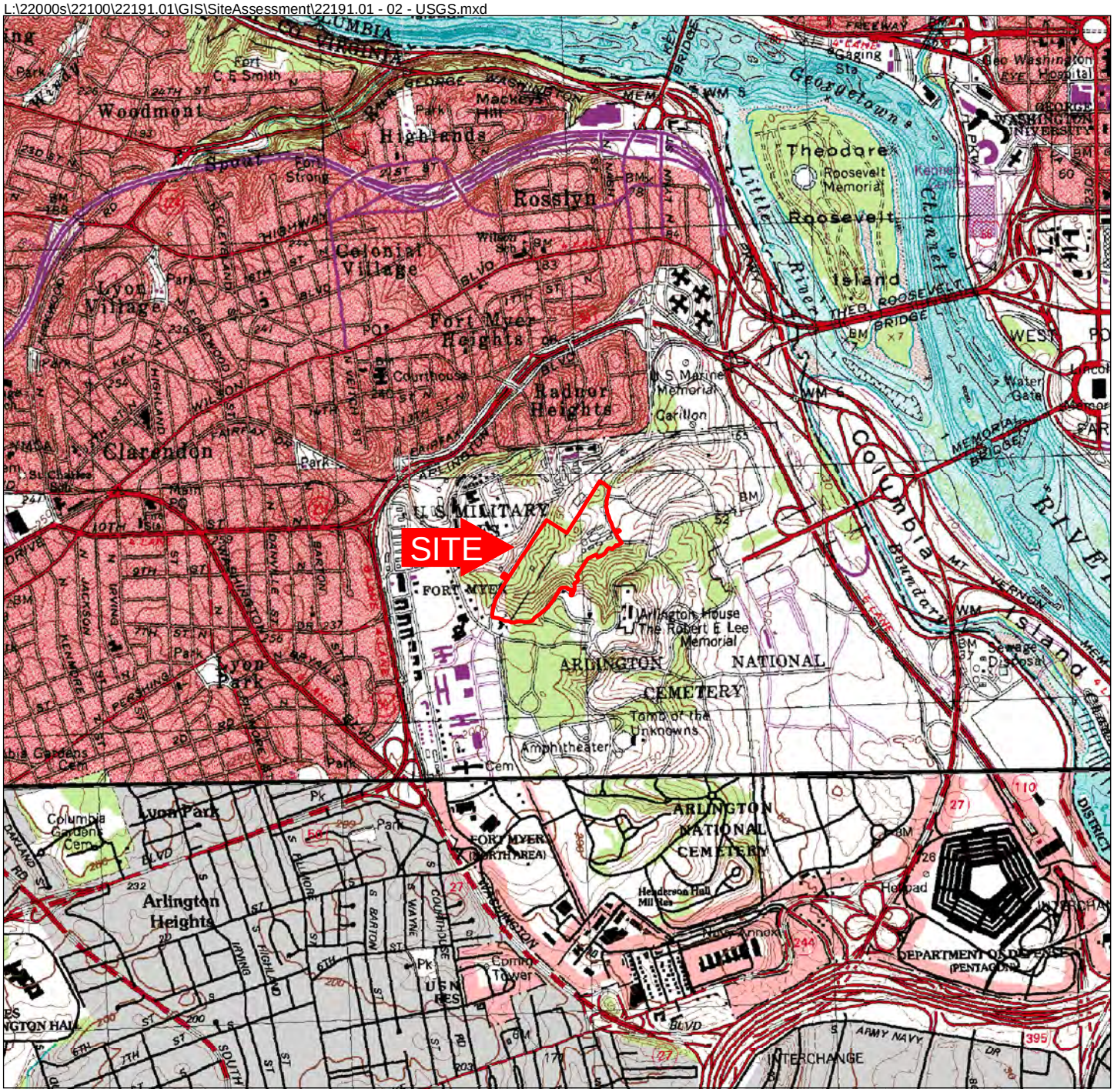

USGS Quad Maps
Alexandria, VA-DC-MD 1994 & Washington West, DC-MD-VA 1983
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 2000'

N
W E
S

0 2,000
Feet

Latitude: 38°52'40" N
Longitude: 77°04'08" W
Hydrologic Unit Code (HUC): 020700100103
Stream Class: III
Name of Watershed: Potomac River
COE Region: Atlantic and Gulf Coastal Plain

Exhibit 3

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Site

April 2011 Natural Color Imagery
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 300'

N
W E
S

0 300
Feet

Image Source: Esri

Wetland Studies and Solutions, Inc.

Exhibit 3

Exhibit 4

APPENDIX E

Plant Inventory

Report on Vascular Plants of Wooded Ravine at Arlington House

by

Chris Fleming

October 28, 1996
Cris Fleming

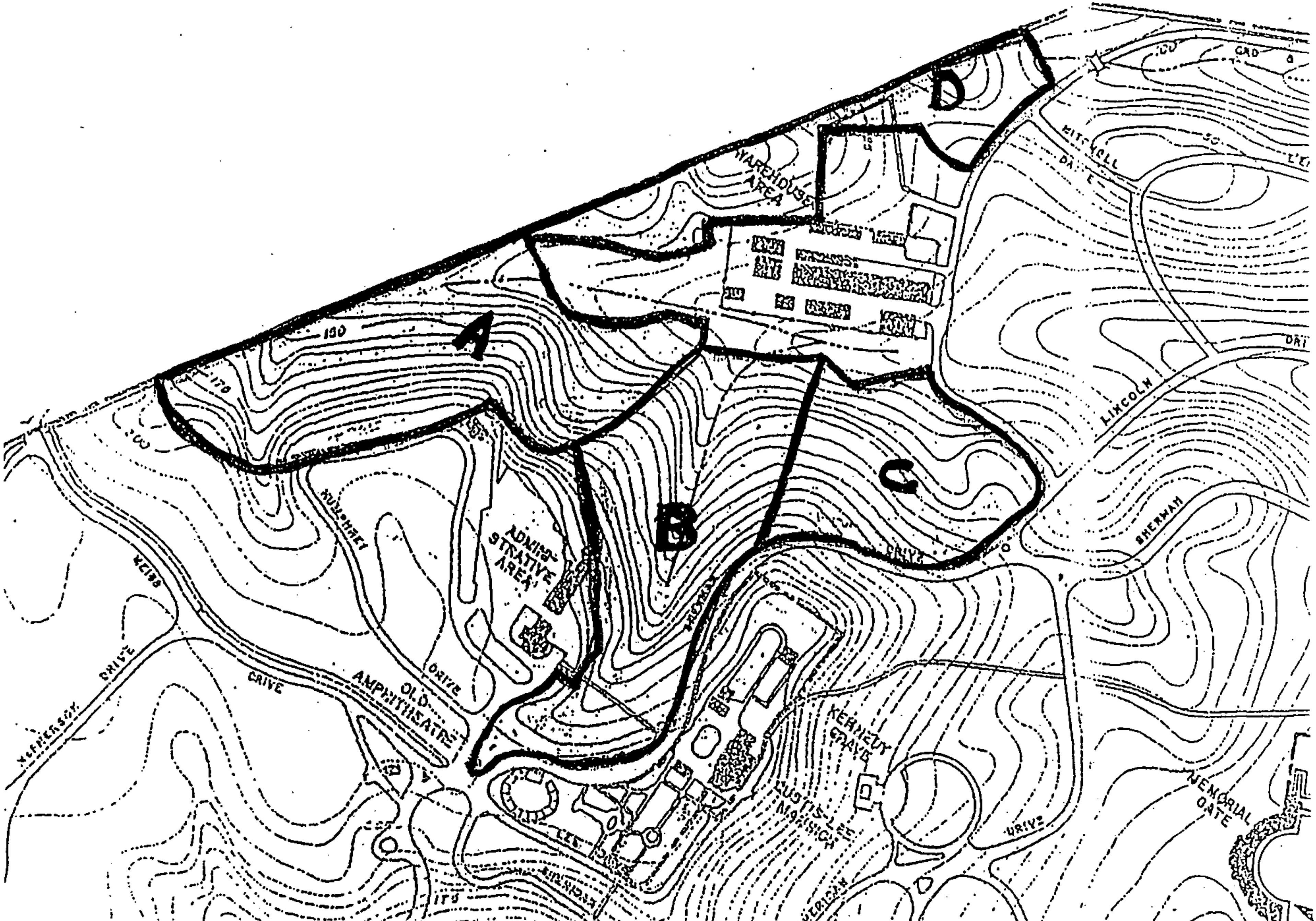
ARLINGTON HOUSE PLANT INVENTORY

Key to Locations:
- A - western section (main ravine to stone wall)
- B - central section (main ravine and lawn south of it)
- C - eastern section (ravine to Sherman Drive)
- D - north section (north of warehouse area)
- T - throughout

Key to Habitat:
- O - open lawn or field
- W - woods

Key to Notes:
- 1 - rare in Virginia
- 2 - uncommon in Piedmont region
- 3 - scarce at this site
- 4 - exceptionally large specimens
- 5 - planted and escaped (naturalized)
- 6 - only found planted here
- 7 - dominant at this site

Acalypha rhomboidea - three-seeded mercury	EUPHO	C	O	
Acer negundo - box-elder	ACERA	B	W	
Acer rubrum - red maple	ACERA	T	W	
Acer saccharum - sugar maple	ACERA	A	W	2,3
Ailanthus altissima - ailanthus	SIMAR	AC	W	7
Alliaria petiolata - garlic mustard	BRASS	T	W	
Allium vineale- onion grass	LILIA	T	O	
Ambrosia artemisiifolia - common ragweed	ASTER	T	O	
Ambrosia trifida - giant ragweed	ASTER	T	O	
Amelanchier arborea - shadbush	ROSAC	CD	W	3
Ampelopsis brevipedunculata - porcelain berry	VITAC	BC	O	
Amphicarpea bracteata - hog-peanut	FABAC	B	W	
Anagallis arvensis - scarlet pimpernel	PRIMU	C	O	
Anthemis cotula - mayweed	ASTER	A	O	
Apocynum androsaemifolium - spreading dogbane	APOCY	A	O	
Aralia nudicaulis - wild sarsaparilla	ARALI	C	W	2
Aralia racemosa - American spikenard	ARALI	B	W	2
Artemsia vulgaris - mugwort	ASTER	AC	O	
Asclepias syriaca - common millkweed	ASCLE	C	O	
Aster divaricatus - white wood aster	ASTER	AC	W	
Aster dumosus - bushy aster	ASTER	ABC	O	
Aster lateriflorus - calico aster	ASTER	BD	O	
Aster simplex - panicled aster	ASTER	AC	O	
Aster vimeneus - small white aster	ASTER	A	O	
Berberis vulgaris - Japanese barberry	BERBE	B	W	5
Bidens polylepis - tickseed sunflower	ASTER	C	O	
Buxus sp. - boxwood	BUXAC	B	O	6
Catalpa speciosa - hardy catalpa	BIGNO	B	W	
Cardamine hirsuta - hairy bittercress	BRASS	BC	O	
Carya glabra - pignut hickory	JUGLA	T	W	
Carya tomentosa - mockernut hickory	JUGLA	T	OW	


A
B
C
D
WAREHOUSE AREA
ADMINISTRATIVE AREA
OLD AMPHITHEATRE
KENNEDY GRAVE
CUSTIS-LEE MANSION
MEMORIAL GATE
LINCOLN
SHERMAN
MITCHELL
HUMPHREYS
DRIVE

Cedrus deodor - deodor cedar	PINAC	B	O	6
Cerastium vulgaris - mouse-ear chickweed	BRASS	BC	O	
Chaemacyparis sp. - white-cedar	CUPRE	B	O	6
Chenopodium album - lamb's-quarter	CHENO	ABC	O	
Chamaecrista(Cassia) fasciculata - partridge-pea	FABAC	B	O	
Chimaphila maculata - striped wintergreen	ERICA	B	O	3
Chionanthus virginicus - fringetree	OLEAC	D	W	3
Cichorium intybus - chicory	ASTER	BC	O	
Cimicifuga racemosa - black cohosh	RANUN	B	W	
Circaea lutetiana - enchanter's nightshade	ONOGR	BC	W	
Cirsium arvense - Canada thistle	ASTER	B	O	
Cirsium vulgare - bull thistle	ASTER	B	O	
Collinsonia canadensis - horsemint	LAMIA	C	W	
Commelina communis - Asiatic dayflower	COMME	B	O	
Convolvulus sepium - hedge bindweed	CONVO	B	O	
Cornus florida - flowering dogwood	CORNA	T	W	
Cornus kousa -kousa dogwood	CORNA	B	O	6
Cryptotaenia canadensis - honewort	APIAC	C	W	
Cuscuta gronovii - common dodder	CONVO	B	O	
Cyperus strigosus - nutsedge	CYPER	B	O	
Dactylis glomerata - orchard grass	POACE	C	O	
Digitaria sanguinalis - crabgrass	POACE	B	O	
Dentaria laciniata - cut-leaved toothwort	BRASSA	B	W	
Dioscorea villosa - wild yam	DIOSCO	B	W	
Dryopteris marginalis - marginal wood-fern	POLYPO	B	W	
Duchesnea indica - Indian strawberry	ROSAC	C	O	
Echinocloa crusgali - barnyard grass	POACE	B	O	
Eleagnus commutata - silverberry	ELEAG	C	O	5
Elephantopus carolinianus - elephant's foot	ASTER	B	O	
Epifagus virginiana - beechdrops	OROBA	C	W	
Erigeron annus - daisy fleabane	ASTER	B	O	
Erigeron philadelphicus - common fleabane	ASTER	C	O	
Euonymus sp. - creeping euonymus	CELAS	C	W	5
Eupatorium purpureum - sweet Joe-Pye-weed	ASTER	B	W	
Eupatorium rugosum - white snakeroot	ASTER	C	W	
Euphorbia supina - milk purslane	EUPHO	B	O	
Fagus grandifolia - American beech	FAGAC	T	W	
Fraxinus americanus - white ash	OLEAC	T	W	
Galium aparine - cleavers bedstraw	RUBIA	C	O	
Galium cirzacens - wild licorice	RUBIA	B	W	
Geum canadense - white avens	ROSAC	C	O	
Geranium carolinianum - Carolina cranesbill	GERAN	B	O	
Ginkgo biloba - ginkgo	GINKG	B	W	6
Glechoma hederacea - gill-over-the-ground	LAMIA	T	W	
Hamamelis virginiana - witch-hazel	HAMAM	B	OW	
Hedera helix - English ivy	ARALI	T	W	5,7
Hemerocallis fulva - daylily	LILIA	B	W	5
Houstonia purpurea - large-leaved houstonia	RUBIA	A	W	3
Hydrangea arborea - wild hydrangea	SAXIF	B	OW	
Ilex sp. - English holly	AQUIL	B	O	6
Ilex opaca - American holly	AQUIL	AB	W	
Impatiens capensis - orange jewelweed	BALSA	B	W	
Juglans nigra - black walnut	JUGLA	B	W	
Juncus tenuis - path rush	JUNCU	C	O	

Kalmia latifolia - mountain laurel	ERICA	AC	W	
Lactuca serriola - prickly lettuce	ASTER	B	O	
Laportea canadensis - wood nettle	URTIC	B	W	
Lepidium virginicum - wild peppergrass	BRASS	B	O	
Lespedeza cuneata - Chinese bushclover	FABAC	C	O	5
Lespedeza striata - Japanese bushclover	FABAC	B	O	6
Lindera benzoin - spicebush	LAURA	T	W	
Liriodendron tulipifera - tuliptree	MAGNO	T	W	
Lobelia inflata - Indian tobacco	CAMPA	A	O	
Lonicera japonica - Japanese honeysuckle	CAPRI	T	W	
Lonicera morrowii - bush honeysuckle	CAPRI	C	W	
Lonicera sempervirens -trumpet honeysuckle	CAPRI	B	W	
Lysimachia ciliata - fringed loosestrife	PRIMU	B	W	
Magnolia grandiflora - southern magnolia	MAGNO	B	O	6
Medeola virginica - Indian cucumber-root	LILIA	B	W	
Medicago lupulina - black medic	FABAC	B	O	
Mitchella repens - partridge berry	RUBIA	C	W	
Morus alba - white mulberry	MORAC	AB	W	
Morus rubra - red mulberry	MORAC	B	O	
Narcissus sp. - daffodil	LILIA	B	W	5
Nyssa sylvatica - tupelo, black gum	NYSSA	ABC	W	
Osmorhiza claytoni - sweet cicely	APIAC	B	W	
Oxalis stricta - yellow woodsorrel	OXALI	B	O	
Pachysandra terminalis - pachysandra	BUXAC	B	W	5
Parthenocissus quinquefolia - Virginia creeper	VITAC	T	W	
Perilla frutescens - beefsteak plant	LAMIA	A	O	
Phyllostachys aurea - bamboo	POACE	A	O	5
Phytolacca americana - pokeweed	PHYTO	B	O	
Pilea pumila - clearweed	URTIC	B	W	
Pinus strobus - white pine	PINAC	B	O	6
Plantago lanceolata - English plantain	PLANT	B	O	
Plantago major - Common plantain	PLANT	B	O	
Poa pratense - Kentucky bluegrass	POACE	B	O	
Podophyllum peltatum - mayapple	BERBE	AB	W	
Polygonatum biflorum - smooth Solomon's-seal	LILIA	BCD	W	
Polygonum cespitosum - long-bristled smartweed	POLYG	B	O	
Polygonum pennsylvanica - pinkweed	POLYG	B	O	
Polygonum (Tovara) virginica - jumpseed	POLYG	B	W	
Prunus avium - sweet cherry	ROSAC	C	W	5
Prunus pennsylvanica - pin cherry	ROSAC	B	O	
Prunus serotina - black cherry	ROSAC	T	W	
Prunus persica - peach	ROSAC	B	O	6
Prunus sp. - flowering cherry	ROSAC	B	O	6
Pyrus angustifolia - wild crabapple	ROSAC	C	O	
Quercus alba - white oak	FAGAC	T	OW	4,
Quercus phellos - willow oak	FAGAC	B	O	6
Quercus prinus - chestnut oak	FAGAC	T	W	4
Quercus rubra - red oak	FAGAC	T	W	4,
Ranunculus abortivus - aborted buttercup	RANUN	C	O	
Ranunculus bulbosa - bulbous buttercup	RANUN	C	O	
Rhododendron periclymenoides - pinxter-flower	ERICA	ACD	W	
Rhus glabra - smooth sumac	ANACA	C	O	
Rhus radicans - poison ivy	ANACA	T	W	
Robinia psuedoacacia - black locust	FABAC	AB	W	

Rubus arguta - tall blackberry	ROSAC	AC	OW	
Rubus occidentalis - wild black raspberry	ROSAC	C	O	
Rubus phoenicolasius - wineberry	ROSAC	BC	O	
Rumex crispus - curly dock	POLYG	BC	O	
Agropyron(Elytrigia) repens - quackgrass	POACE	C	O	
Sambucus canadensis - elderberry	CAPRI	B	W	
Sanicula gregaria - clustered snakeroot	APIAC	B	W	
Sassafras albidum - sassafras	LAURA	T	W	
Schizachyrium scoparium - little bluegrass	POACE	C	O	
Scleranthus annus - knawel	CAPRI	B	O	
Setaria faberi - foxtail grass	POACE	BC	O	
Setaria flava - yellow foxtail	POACE	AB	O	
Smilacina racemosa - false Solomon's-seal	LILIA	AB		
Smilax glauca - glaucous greenbrier	LILIA	A	W	
Smilax rotundifolia - common greenbrier	LILIA	T	W	
Solanum carolinense - horsenettle	SOLAN	B	O	
Solidago caesia - blue-stemmed goldenrod	ASTER	ABC	W	
Solidago juncea - early goldenrod	ASTER	D	O	
Stellaria media - common chickweed	CARYO	B	OW	
Taraxacum officinalis - dandelion	ASTER	B	O	
Taxus baccata - English yew	TAXUS	B	O	6
Thalictrum coriaceum - leatherleaf meadowrue	RANUN	B	W	2
Thalictrum dioicum - early meadowrue	RANUN	B	W	
Thelypteris noveboracensis - New York fern	POLYP	B	W	
Thuja occidentalis - northern white-cedar	CUPRE	B	O	6
Trifolium campestre - low hop-clover	FABAC	B	O	
Trifolium pratense - red clover	FABAC	B	O	
Trifolium repens - white clover	FABAC	B	O	
Tsuga canadensis - eastern hemlock	PINAC	A	W	6
Ulmus americana - American elm	ULMAC	B	W	2
Ulmus rubra - slippery elm	ULMAC	AB	W	
Vaccinium stamineum - deerberry	ERICA	C	W	
Vaccinium vaccillans - lowbush blueberry	ERICA	CD	W	
Veronica persica - birds-eye speedwell	SCROP	B	O	
Veronica serphyllifolia - thyme-leaved speedwell	SCROP	C	O	
Viburnum acerifolium - maple-leaved viburnum	CAPRI	AC	W	
Vinca minor - periwinkle	APOCY	C	W	5
Viola papilionacea - common blue violet	VIOLA	B	W	
Vitus labrusca - fox grape	VITAC	T	W	
Wisteria chinensis - Chinese wisteria	FABAC	AB	W	5
Yucca filamentosa - yucca	LILIA	A	O	5

October 28, 1996
Cris Fleming

REPORT ON VASCULAR PLANT INVENTORY OF WOODED RAVINE AT ARLINGTON HOUSE

General Information

The 24.4 acre site known as the wooded ravine behind Arlington House is located next to the Arlington Memorial Cemetery and is owned and managed by the National Park Service (NPS). Options are being studied concerning transfer of portions of the site to the Department of the Army for cemetery purposes. Therefore, the Park Service requested more information on the plant species and communities of this site.

The botanist began inventory work on March 1, 1996 and visited the site five other times through the growing season: 4/16, 5/23, 6/25, 7/21 and 9/28. Her complete report consists of this written report plus a list of all vascular plants found on the site, including the scientific name, common name, plant family, location, habitat, and notations on certain species.

The site consists of a wooded north-facing ravine leading down to a small stream. Both sides of the ravine are wooded hillsides. The small area behind the warehouses is also wooded. Some open areas exist, mainly the large mowed area at the entrance to the NPS Administrative Area, and edges along the road and the parking lot.

Four sections of the site

For ease of noting locations, the site was broken into four sections. Section A is the western section which runs from the stone wall along the boundary with Fort Meyer to the parking lot near the NPS office; Section B is the middle section, including the main ravine approached from the NPS office and the mowed lawn south of the ravine; Section C, the eastern section, runs from the main ravine to Sherman Drive and includes the road edges and a small meadow along the road; Section D is the area north of the warehouse area. Location in these different sections was noted for each species. Several species occur throughout the site.

Section A, the western part of the site, is very weedy, consisting mostly of escaped wisteria vines and ailanthus trees, plus lots of poison ivy. In some areas, the wisteria is so thick, a machete is needed to go through it. Only the far western part of this section has native woodland species such as Mayapple (Podophyllum peltatum) and False Solomon's-seal (Smilacina racemosa).

Section B, the wooded ravine itself, is in better shape. Large oaks, beech, and tuliptree indicate that this forest is more mature and less disturbed that the forest in Section A. Although the ground layer is thick with English ivy, several native herbaceous species do occur, including spring wildflowers such as cut-leaved toothwort (Dentaria laciniata), early meadowrue (Thalictrum dioicum), and smooth Solomon's-seal (Polygonatum biflorum). Attractive fall wildflowers occuring

here are white wood aster (Aster divaricatus) and blue-stemmed goldenrod (Solidago caesia). Unusual species in these woods include American spikenard (Aralia racemosa), a plant usually found in the mountains in Virginia, trumpet honeysuckle (Lonicera sempervirens), a native species but probably escaped from a garden at this site, and a ginkgo tree that must have been planted here. With large trees and a cool north-facing aspect, this ravine would be a pleasant place if there were no invasive species such as English ivy and poison ivy.

The upper part of Section C is covered with grapevines, but below the open field at the corner of Sherman Drive and Lincoln Drive is a small area with no invasive species. Here is an attractive woodland of about one acre with shrubs such as shadbush (Amelachier arborea), pinxterflower (Rhododendron periclymenoides), maple-leaved viburnum (Virburnum acerifolium), and deerberry (Vaccinium stamineum). In this area is a large stand of wild sarsaparilla (Aralia nudicaulis), another species found more often in the mountains than in the Piedmont or Coastal Plain of Virginia.

The woods behind the warehouses in Section D are younger and the soil is drier than in the other sections. Because of this, these woods are more open and are not covered with invasive vines. Chestnut oak (Quercus prinus) dominates here and there are many oak seedlings. Several young hickories occur here; shrubs include lowbush blueberry (Vaccinium vacillans), pinxterflower, southern arrowwood (Viburnum dentatum), and fringetree (Chionanthus virginicus).

Results

Over 180 species of vascular plants were found during this inventory. No species rare or uncommon in Virginia were found. Two species were noted that are common in the mountains but unusual in the Piedmont: American spikenard and wild sarsaparilla. Probably the north-facing hillside provides the cool habitat needed by these species.

The main ravine has many large trees and well-developed shrub and herbaceous layers. Despite the prevalence of English ivy and other invasive species, a diversity of native species occurs.

Only two areas were free of invasive species: the little woodland along the road at the north end of Section C and the woods behind the warehouses. Most of the other areas are more or less covered with invasive species, the most extreme being the wisteria and ailanthus dominating Section A.

Exhibit 5

PLOT 1

Stratum	Scientific Name	Common Name	Relative % Cover
Tree	*Ailanthus altissima*	Tree-of-Heaven	15
	Liriodendron tulipifera	Tulip Tree	35
	Prunus avium	Bird Cherry	25
	Prunus serotina	Black Cherry	15
	Quercus alba	White Oak	5
	Quercus prinus	Chestnut Oak	35
	Quercus rubra	Northern Red Oak	10
Sapling/Shrub	*Carya tomentosa*	Mockernut Hickory	10
	Ilex opaca	American Holly	5
	Lindera benzoin	Spicebush	10
	Quercus prinus	Chestnut Oak	30
Herb/Vine	*Hedera helix*	English Ivy	90
	Lonicera japonica	Japanese Honeysuckle	40
	Rubus argutus	Serrate-leaf Blackberry	5
	Toxicodendron radicans	Poison Ivy	50

PLOT 2

Stratum	Scientific Name	Common Name	Relative % Cover
Tree	*Acer rubrum*	Red Maple	15
	Fagus grandifolia	American Beech	30
	Prunus serotina	Black Cherry	20
	Quercus alba	White Oak	35
	Quercus prinus	Chestnut Oak	25
Sapling/Shrub	*Ilex opaca*	American Holly	20
	Prunus serotina	Black Cherry	2
	Quercus prinus	Chestnut Oak	10
	Rubus phoenicolasius	Wineberry	10
	Viburnum acerifolium	Maple-leaf Viburnum	5
	Wisteria sinensis	Chinese Wisteria	40
Herb/Vine	*Hedera helix*	English Ivy	70
	Lonicera japonica	Japanese Honeysuckle	5
	Rubus argutus	Serrate-leaf Blackberry	15

Additional Plants Seen:

Tree	*Celtis occidentalis*	Hackberry
	Tsuga canadensis	Eastern Hemlock
Herb/Vine	*Celastrus orbiculatus*	Oriental Bittersweet
	Smilax rotundifolia	Greenbriar

PLOT 3

Stratum	Scientific Name	Common Name	Relative % Cover
Tree	*Acer platanoides*	Norway Maple	50
	Carya tomentosa	Mockernut Hickory	15
	Celtis occidentalis	Hackberry	5
	Fagus grandifolia	American Beech	10
	Fraxinus pennsylvanica	Green Ash	20
	Liriodendron tuliperfera	Tulip Tree	30
Sapling/Shrub	*Lindera benzoin*	Spicebush	10
	Lonicera maackii	Bush Honeysuckle	5
Herb/Vine	*Allium vineale*	Wild Onion	2
	Celastrus orbiculatus	Oriental Bittersweet	10
	Hedera helix	English Ivy	90
	Lonicera japonica	Japanese Honeysuckle	10
	Anemonella thalictroides	Rue anemone	2
	Sanicula marilandica	Maryland Black Snakeroot	2
	Toxicodendron radicans	Poison Ivy	45
	Vitis labrusca	Fox Grape	5

Additional Plants Seen:

Sapling/Shrub	*Elaeagnus umbellata*	Autumn Olive
Herb/Vine	*Epifagus virginiana*	Beech drops
	Euonymus fotunei	Winter creeper

PLOT 4

Stratum	Scientific Name	Common Name	Relative % Cover
Tree	*Carya tomentosa*	Mockernut Hickory	10
	Prunus avium	Bird Cherry	15
	Prunus serotina	Black Cherry	25
	Quercus alba	White Oak	40
	Robinia pseudoacacia	Black Locust	20
	Ulmus rubra	Slippery Elm	10
Sapling/Shrub	*Lonicera maackii*	Bush Honeysuckle	40
	Morus alba	White mulberry	20
	Viburnum prunifolium	Black-haw	30
Herb/Vine	*Hedera helix*	English Ivy	85
	Lonicera japonica	Japanese Honeysuckle	40
	Toxicodendron radicans	Poison Ivy	50

Additional Plants Seen:

Tree	*Acer negundo*	Box Elder
Sapling/Shrub	*Elaeagnus umbellata*	Autumn Olive
	Rosa multiflora	Multiflora Rose
	Phyllostachys sp.	Unknown Bamboo

PLOT 5

Stratum	Scientific Name	Common Name	Relative % Cover
Tree	*Carya glabra*	Pignut Hickory	15
	Nyssa sylvatica	Black Gum	15
	Prunus serotina	Black Cherry	25
	Quercus prinus	Chestnut Oak	60
Sapling/Shrub	*Carya tomentosa*	Mockernut Hickory	5
	Fagus grandifolia	American Beech	5
	Ilex opaca	American Holly	15
	Quercus alba	White Oak	5
	Quercus prinus	Chestnut Oak	25
Herb/Vine	*Hedera helix*	English Ivy	10
	Lonicera japonica	Japanese Honeysuckle	5
	Vaccinium sp.	Unknown Blueberry	2

PLOT 6

Stratum	Scientific Name	Common Name	Relative % Cover
Sapling/Shrub	*Lonicera maackii*	Bush Honeysuckle	10
	Pyrus calleryana	Bradford Pear	10
	Robinia pseudoacacia	Black Locust	50
	Rubus phoenicolasius	Wineberry	20
Herb/Vine	*Alliaria petiolata*	Garlic Mustard	60
	Allium vineale	Wild Onion	10
	Artemisia vulgaris	Mugwort	40
	Festuca arundinacea	Tall Fescue	10
	Hedera helix	English Ivy	30
	Lonicera japonica	Japanese Honeysuckle	30
	Solidago sp.	Unknown Goldenrod	30
	Stellaria media	Chickweed	30
	Vitis sp.	Unknown Grape	40

PLOT 7

Stratum	Scientific Name	Common Name	Relative % Cover
Tree	*Quercus alba*	White Oak	50
	Quercus prinus	Chestnut Oak	10
	Quercus rubra	Northern Red Oak	10
Herb/Vine	*Digitaria sp.*	Unknown Crabgrass	60
	Hedera helix	English Ivy	5
	Poa sp.	Unknown Grass	10
	Taraxacum officinale	Dandelion	5

Additional Plants Seen:

Tree	*Ailanthus altissima*	Tree-of-Heaven
	Carya tomentosa	Mockernut Hickory
	Pinus resinosa	Red Pine
	Quercus alba	White Oak
	Quercus rubra	Red Oak
Sapling/Shrub	*Juniperus virginiana*	Eastern Red Cedar
Herb/Vine	*Andropogon virginicus*	Broomsedge
	Festuca arundinacea	Tall Fescue
	Setaria glauca	Yellow Foxtail
	Trifolium pratense	Red Clover

Exhibit 6

EXHIBIT 6
SITE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETERY MILLENNIUM PROJECT
WSSI #22191.01

1. **Looking east at Plot 1 in the mature hardwood forest community. The green plant visible in the herbaceous layer is English ivy (*Hedera helix*), an invasive plant.**

2. **Looking northeast at Plot 2 in the mature hardwood forest community. American beech (*Fagus grandifolia*) and American holly (*Ilex opaca*) are visible on the left side of the photograph. Chinese wisteria (*Wisteria sinensis*), an invasive plant, is a dominant in the shrub layer.**

EXHIBIT 6
SITE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETERY MILLENNIUM PROJECT
WSSI #22191.01

3. Looking southeast at Plot 3 in the mature hardwood forest community. The green plant visible in the herbaceous layer is English ivy, an invasive plant.

4. Looking northeast at Plot 4 in the medium-aged disturbed forest. Again, English ivy is a dominant in the herbaceous layer. White mulberry (*Morus alba*) and bush honeysuckle (*Lonicera maackii*) are also prevalent in this plot.

EXHIBIT 6
SITE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETERY MILLENNIUM PROJECT
WSSI #22191.01

5. Looking northeast at Plot 5 in the medium-aged disturbed forest.

6. Looking southwest at Plot 6 in the disturbed field/old field community. This area appears to have been used in the past as a dumping ground for yard waste such as mulch, soil, and tree branches.

EXHIBIT 6
SITE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETERY MILLENNIUM PROJECT
WSSI #22191.01

7. Looking northeast at the mature forest between Plots 1 and 2. This photo depicts the extent to which English ivy has dominated the understory.

8. Looking east at Plot 7 in the maintained parkland community. White oak (*Quercus alba*) is the dominant tree in this area, and visible in this photograph.

EXHIBIT 6
SITE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETERY MILLENNIUM PROJECT
WSSI #22191.01

9. Looking south at the maintained parkland community in the western portion of the site. This area is regularly mowed and used for recreation by staff at Ft. Myer.

Exhibit 7

L:\22000s\22100\22191.01\GIS\SiteAssessment\22191.01 - 07 - PhotoLocation.mxd

Site

Vegetation Type Boundary

1 Approximate Plot Location

Photo Location Map
2011 Natural Color Imagery
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 200'

N
W E
S

0 200
Feet

Image Source: Esri

Wetland Studies and Solutions, Inc.

Exhibit 7

Arlington National Cemetery Millennium Project

Arlington County, Virginia

WSSI #22191.01

Wildlife Habitat Survey

February 19, 2013

Prepared for:
Jacobs
1100 North Glebe Road, Suite 500
Arlington, Virginia 22201

Prepared by:

5300 Wellington Branch Drive, Suite 100
Gainesville, Virginia 20155
Tel: 703-679-5600 Email: contactus@wetlandstudies.com
www.wetlandstudies.com

Wildlife Habitat Survey

Arlington National Cemetery Millennium Project
Arlington County, Virginia
WSSI #22191.01

Executive Summary

Wetland Studies and Solutions, Inc. (WSSI) has conducted a Wildlife Habitat Survey of the Arlington National Cemetery Millennium Project site in Arlington County, Virginia. This report has been prepared in order to determine the location of active, inactive, potential wildlife denning and nesting features within the study area, in response to comments received during the public comment period for the Environmental Assessment prepared for the site.

In summary, a number of wildlife habitat features were found, including stick nests, squirrel nests, tree cavities, ground dens, and snags within the study area. Wildlife species observed during the survey were those that would be commonly found in an urban park like setting.

It is specifically noted that the wildlife observed while conducing this survey is only a small snap shot of the wildlife that may currently or potentially be found within the study area. Depending on time of day, time of year, weather condition and season the wildlife are utilizing the study area could vary greatly.

Site Description

The Arlington National Cemetery Millennium Project site is located on the west side of Ord and Weitzel Drive and east of McNair Road, within Arlington National Cemetery in Arlington County, Virginia. Exhibit 1 is a vicinity map that depicts the approximate location of the site. The topography of the study area is depicted on the USGS Topographic Map in Exhibit 2. General vegetative cover can be seen in the aerial photographs in Exhibit 3 (a 2011 natural color photograph from ESRI).

The study area consists of mature hardwood forest, medium-aged disturbed forest, disturbed field/old field, maintained parkland and an active maintenance facility, as depicted in the 2011 Natural Color Imagery from ESRI in Exhibit 3. Holmes Run flows in a north-northeasterly direction through the central portion of the study area. The study area is gently to moderately sloping. The topography can be seen in the excerpt from the Washington West, DC-MD-VA 1983 USGS topographical quadrangle map included as Exhibit 2.

Methodology

On February 6 & 7, 2013, Wildlife Biologist Roy Van Houten, PWS, CE, AWB[1] and Environmental Compliance Manager Michael Wills CPESC[2], examined the entire study area for potential wildlife habitat. The study time frame on February 6, 2013 was from 10 am to 3:30 pm, skies were clear and the temperature ranged from 34 to 49 degrees Fahrenheit with gusty winds. The study time frame on February 7, 2013 was from 8:00 am to 3:00 pm, skies were overcast and the temperature ranged from 31 to 43 degrees Fahrenheit with light winds. The study area was

[1] *WSSI* – Professional Wetland Scientist, Society of Wetland Scientists Certification Program, Inc., Certified Ecologist, Ecological Society of America and Associate Wildlife Biologist, The Wildlife Society

[2] *WSSI* – Certified Professional in Erosion and Sediment Control

transected to identify and map specific wildlife habitat features to classify them according to type. Only representative wildlife habitat features were photographed, as depicted in the representative photos in Exhibit 4. Any wildlife species directly observed (seen or heard) or animal signs such as tracks and scat were noted during the fieldwork. For the purpose of this report, WSSI has defined the wildlife habitat features as follows:

A. Nest – A nest is defined as a place of refuge to hold an animal's eggs and/or provide a place to raise their offspring. Nests are usually made of sticks and leaves. Nests were subsequently categorized in Table 1 as:

1) Stick Nest
2) Squirrel Nest

B. Cavity – A cavity is defined as a hollowed out feature in a standing tree which can provide an animal with refuge and a place to raise their offspring. Cavities were subsequently categorized in Table 1 as:

1) Snag
2) Live Tree

C. Den – A den is defined as a hollowed out feature, either in a deadfall, tree hollow, or ground hollow. Dens were subsequently categorized in Table 1 as:

1) Ground Burrow
2) Tree Hollow

D. Snags - A snag refers to a standing, partly or completely dead tree and often missing a top or most of the smaller branches. These features were identified regardless of evidence of known wildlife usage.

E. Representative Wildlife and Wildlife Sign – Either visual or auditory confirmation that a wildlife species was present within the study area at the time of the survey. Also included within this section is representative sign that wildlife species have previously been in the area as indicated by the tracks, scat, burrows, etc. that they have left behind.

Results and Conclusions

A number of wildlife habitat features were noted in the study area during this inventory, including stick and squirrel nests, cavities, snags, and dens. The location of these features is depicted on the Wildlife Habitat Survey Location Map (Exhibit 5) and is summarized in Table 1 below.

A list of wildlife species directly observed (seen or heard) or animal signs such as tracks and scat noted during the fieldwork can be found in Table 2. In an effort to reduce redundancy, only representative photos are included in the photo document (Exhibit 4) and on the site map (Exhibit 5). The bird and wildlife species observed during this survey are consistent to those observed in the Environmental Assessment, dated June 1999, prepared by the Denver Service Center, National Park Service, Department of the Interior. * *Although not included in the tables below, it is noted that brush piles, fallen trees and tree tops scattered throughout the study area also provide habitat for small mammals and song birds.*

Table 1. Wildlife Habitat Features Observed

Feature	Location	Description
A1	Tree 1110	Stick Nest
A1	Tree T396	Stick Nest
A1	Tree 1023	Stick Nest
A2	Tree T483	Squirrel Nest
A2	Tree T564	Squirrel Nest
A2	Tree T503	Squirrel Nest (Photo #2)
A2	South of Tree 2072	Squirrel Nest
A2	Tree T248	Squirrel Nest
A2	Tree T335 & T341	Squirrel Nest
A2	Tree T353	Squirrel Nest
A2	Adjacent to Tree 1399	Squirrel Nest
A2	Tree T409	Squirrel Nest
A2	Adjacent to Tree 1560	Squirrel Nest
A2	Adjacent to Tree 1456	Squirrel Nest
B1	North of Tree1925	Active Cavity – Dead Tree
B1	Adjacent to Tree 1729	Cavity – Dead Tree
B1	North of Tree 1308	Cavity – Dead Tree
B1	Adjacent to Tree 1411	Cavity – Dead Tree
B1	Tree T451	Cavity – Dead Tree
B1	Tree T85	Cavity – Dead Tree
B1	Tree 1169	Cavity – Live Tree
B2	Tree T504	Cavity – Live Tree
B2	West of Tree T583	Active Cavity – Live Tree
B2	Tree T21	Cavity – Live Tree
B2	North of Tree 1846	Active Cavity – Live Tree
B2	Tree 2020	Active Cavity – Live Tree
B2	Southeast of Tree 1941	Cavity – Live Tree
B2	Tree 1971	Active Cavity – Live Tree
B2	Adjacent to Tree 1907	Active Cavity – Live Tree
B2	Tree 1803	Cavity – Live Tree
B2	Tree 1738	Cavity – Live Tree
B2	Tree 1146	Active Cavity – Live Tree
B2	Tree 1082	Active Cavity – Live Tree
B2	Tree 1075	Cavity – Live Tree
B2	Tree T255	Active Cavity – Live Tree
B2	Tree 1026	Active Cavity – Live Tree
B2	Tree 1024	Active Cavity – Live Tree
B2	Tree 1087	Cavity – Live Tree
B2	Tree 1140	Active Cavity – Live Tree
B2	East of Tree 1167	Active Cavity – Live Tree
B2	Tree T389	Cavity – Live Tree
B2	Tree 349	Cavity – Live Tree
B2	South of Tree 1381	Active Cavity – Live Tree

Table 1. Wildlife Habitat Features Observed, continued

Feature	Location	Description
B2	Tree T430	Active Cavity – Live Tree
B2	Tree T457	Active Cavity – Live Tree
B2	Tree T640	Cavity – Live Tree
C1	Slope South of T124	Active Den - Fox
C1	Slope South of T114	Active Den – Fox
C1	Slope South of T112	Active Den
C1	Stone wall Adjacent to T201	Active - Rodent
C1	Southeast of Tree 1943	Inactive Den
C2	Adjacent to T20	Tree Hollow
C2	Adjacent to Tree 1489	Tree Hollow
C1	Tributary – Southwest of T207	Active Rodent Burrow
D	Tree T494	Snag
D	Tree T496	Snag
D	Tree T515	Snag
D	Tree T589	Snag
D	Adjacent to Ord & Wetzel Drive	Snag
D	Tree 2022	Snag
D	Tree 1950	Snag
D	Tree 1952	Snag
D	Adjacent to Tree 1840	Snag
D	Adjacent to Tree 1728	Snag
D	Adjacent to Tree 1729	Snag
D	Tree T253	Snag
D	Tree T248	Snag
D	Tree T261	Snag
D	Tree T306	Snag
D	Adjacent to Tree 1670	Snag
D	Tree 1669	Snag
D	Tree T131	Snag
D	Tree T121	Snag
D	Tree T150	Snag
D	Tree 148	Snag
D	Tree 177	Snag
D	Trees T310, 311 & T363	Snag
D	Trees T321, T297 & 1264	Snag
D	Trees T281 & T276	Snag
D	Adjacent to Tree 1194 & Tree 1269	Snag
D	Tree T373	Snag
D	North of Tree 1308	Snag
D	Trees 1402, 1411, 1413 & 1414	Snag
D	Tree 1396	Snag
D	Tree 1332	Snag
D	Adjacent to 1440 & Tree 1438	Snag
D	Adjacent to Tree 1447	Snag

Table 1. Wildlife Habitat Features Observed , continued

Feature	Location	Description
D	Adjacent to Tree 1466 & Trees 1466, 1523, 1524 & 1530	Snag
D	Tree T638	Snag
D	Tree T661	Snag
D	Tree T84	Snag
E	Adjacent to T488	White-tailed Deer Scrape
E	Adjacent to Tree 1575	White-tailed Deer Buck Rub
E	Adjacent to T512	Red Fox Track
E	Adjacent to T513	Raccoon Track
E	Southeast of Tree 2022	Trail & White-tailed Deer Buck Rub
E	North of Tree 1700	Inactive – Canine Sent Post
E	Adjacent to T193	White-tailed Deer Beds

Table 2. Wildlife and Wildlife Sign

Common Name	Latin Name	Observation
Blue Jay	*Cyanocitta cristata*	Visual/Sound
Carolina Chickadee	*Poecile carolinensis*	Visual/Sound
Tufted Titmouse	*Baeolophus bicolor*	Visual/Sound
White Breasted Nuthatch	*Sitta caolinensis*	Visual/Sound
House Wren	*Troglodytes aedon*	Visual
American Robin	*Turdus migratorius*	Visual/Sound
Northern Mockingbird	*Mimus polyglottos*	Visual
Wood Thrush	*Hylocichla mustelina*	Visual/Sound
Northern Cardinal	*Cardinalis cardinalis*	Visual/Sound
Savannah Sparrow	*Passerculus sandwichensis*	Visual
Mourning Dove	*Zenaida macroura*	Visual
American Crow	*Corvus brachyrhynchos*	Visual/Sound
European Starling	*Sturnus vulgaris*	Visual/Sound
Red-tailed Hawk	*Buteo jamaicensis*	Visual
Common Grackle	*Quiscalus quiscula*	Visual/Sound
Carolina Wren	*Thryothorus ludovicianus*	Visual/Sound
Downy Woodpecker	*Picoides pubescens*	Visual
Hairy Woodpecker	*Picoides villosus*	Visual
Dark-eyed Junco	*Junco hyemalis*	Visual
Pileated Woodpecker	*Dryocopus pileatus*	Visual
Red-bellied Woodpecker	*Melanerpes carolinus*	Visual
Chipping Sparrow	*Spizella passerina*	Visual/Sound
White-tailed Deer	*Odocoileus virginianus*	Visual/Tracks/Scrapes/Rubs/Scat
Red Fox	*Vulpes fulva*	Tracks/Scat/Den
Raccoon	*Procyon lotor*	Tracks/Scat
Eastern Cottontail	*Sylvilagus floridanus*	Visual/Tracks/Scat
Eastern Gray Squirrel	*Sciurus carolinensis*	Visual/Feeding sign/Nests

Limitations

This study is based on examination of the conditions on the study site at the time of our review and does not address conditions in the future. Such conditions change over time. Therefore, our conclusions may vary from future observations. Our wildlife habitat survey report has been prepared in accordance with generally accepted guidelines for the conduct of such evaluations. We make no other warranties, either expressed or implied that other wildlife species will not be observed in the project site during future wildlife surveys. As previously stated, the wildlife observed while conducting this survey is only a small snap shot of the wildlife that may currently or potentially be found within the study area. Depending on time of day, time of year, weather condition and season the wildlife utilizing the study area could vary greatly.

If you have any questions regarding this report, please contact me at (703) 679-5631 or rvanhouten@wetlandstudies.com.

WETLAND STUDIES AND SOLUTIONS, INC.

Roy Van Houten, PWS, CE, AWB
Wildlife Biologist

Frank R. Graziano, PE
Vice President – Engineering

Exhibit 1

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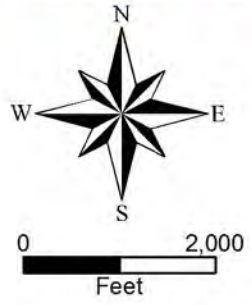
Copyright ADC The Map People
Permitted Use Number 20711184

Vicinity Map
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 2000'



Wetland Studies and Solutions, Inc.

Exhibit 1

Exhibit 2

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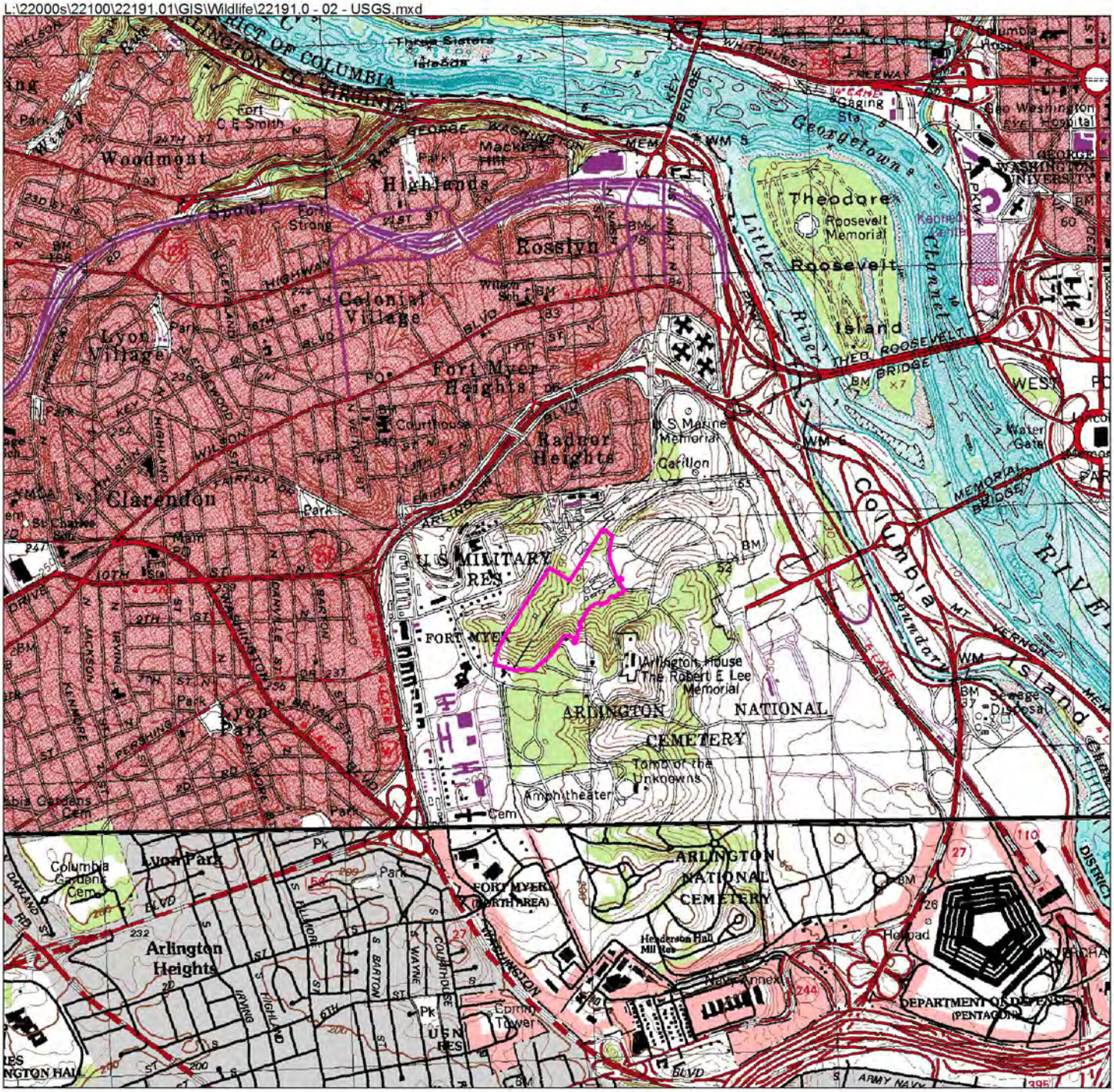

Site

USGS Quad Maps
Washington West, DC-MD-VA 1983
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 2000'

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Feet

Latitude: 38°52'40" N
Longitude: 77°04'08" W
Hydrologic Unit Code (HUC): 020700100103
Stream Class: III
Name of Watershed: Potomac River
COE Region: Atlantic and Gulf Coastal Plain

Exhibit 3

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Site

April 2011 Natural Color Imagery
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 300'

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Image Source: Esri

Wetland Studies and Solutions, Inc.

Exhibit 3

Exhibit 4

Wildlife Habitat Survey Photos

Arlington National Cemetery Millennium Project
(±27 acres)
WSSI #22191.01

Date Taken:	February 6 & 7, 2013
Time:	AM & PM
Photos By:	Michael Wills and Roy Van Houten
Description:	Provided with Individual Photos

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EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

1. **Representative Photo of a Stick nest: Located in Tree 1110.**

2. **Representative Photo of a squirrel nest: Located in live beech tree T503.**

EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

3. **Representative Photo of a squirrel nest: Located in Tree T564.**

4. **Representative Photo of a cavity in dead tree: Located north of Tree 1925.**

EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

5. Representative Photo of a cavity in a live tree: Located in Tree 1075.

6. Representative Photo of a cavity in live tree: Located in Tree 1146.

EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

7. Representative Photo of an active fox den: Slope south of T124.

8. Representative Photo of an inactive burrow: Located southeast of Tree 1943.

EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

9. Representative Photo of an active burrow: Located southwest of T207.

10. Representative Photo of a tree hollow: Located adjacent to T20.

EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

11. Representative Photo of a snag: Tree T85.

12. Representative Photo of a snag: Tree T177.

EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

13. Representative White-tailed Deer buck scrape: Located adjacent to T488.

14. Representative Photo of a White-tailed Deer buck rub: Adjacent to Tree 1575.

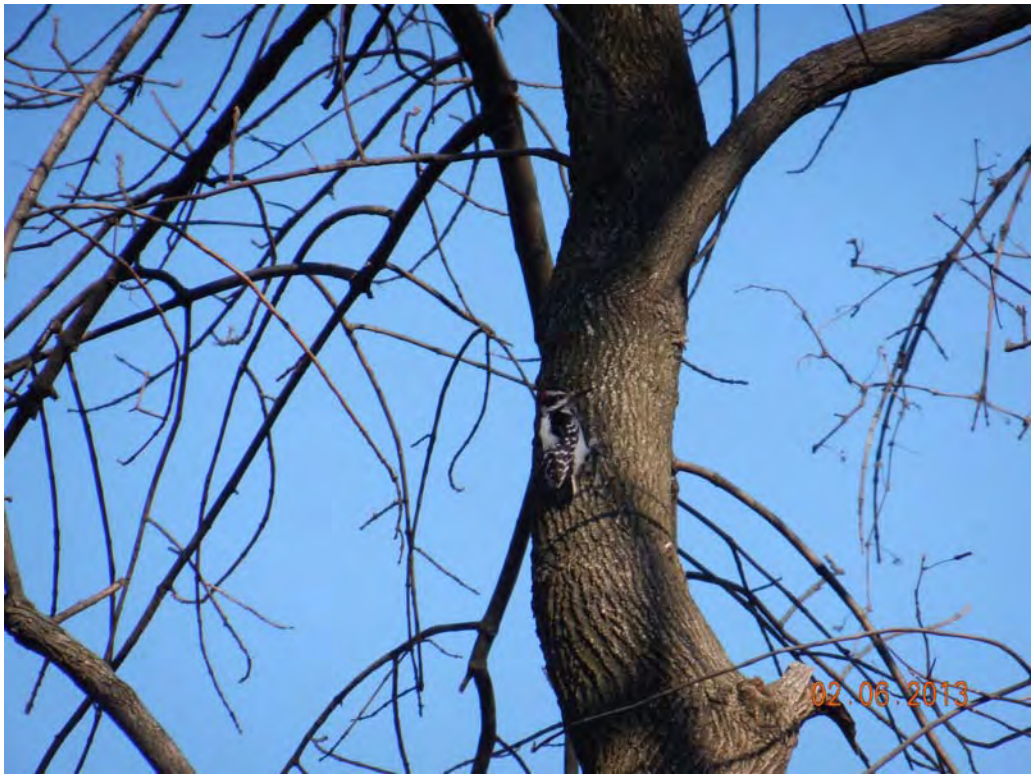
EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

15. Representative Photo of a White-tailed Deer bedding area: Adjacent to Tree T193.

16. Representative Photo of a Red Fox track: Located adjacent to Tree T152.

EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

17. Representative Photo of a Raccoon Track: Located adjacent to Tree T1.



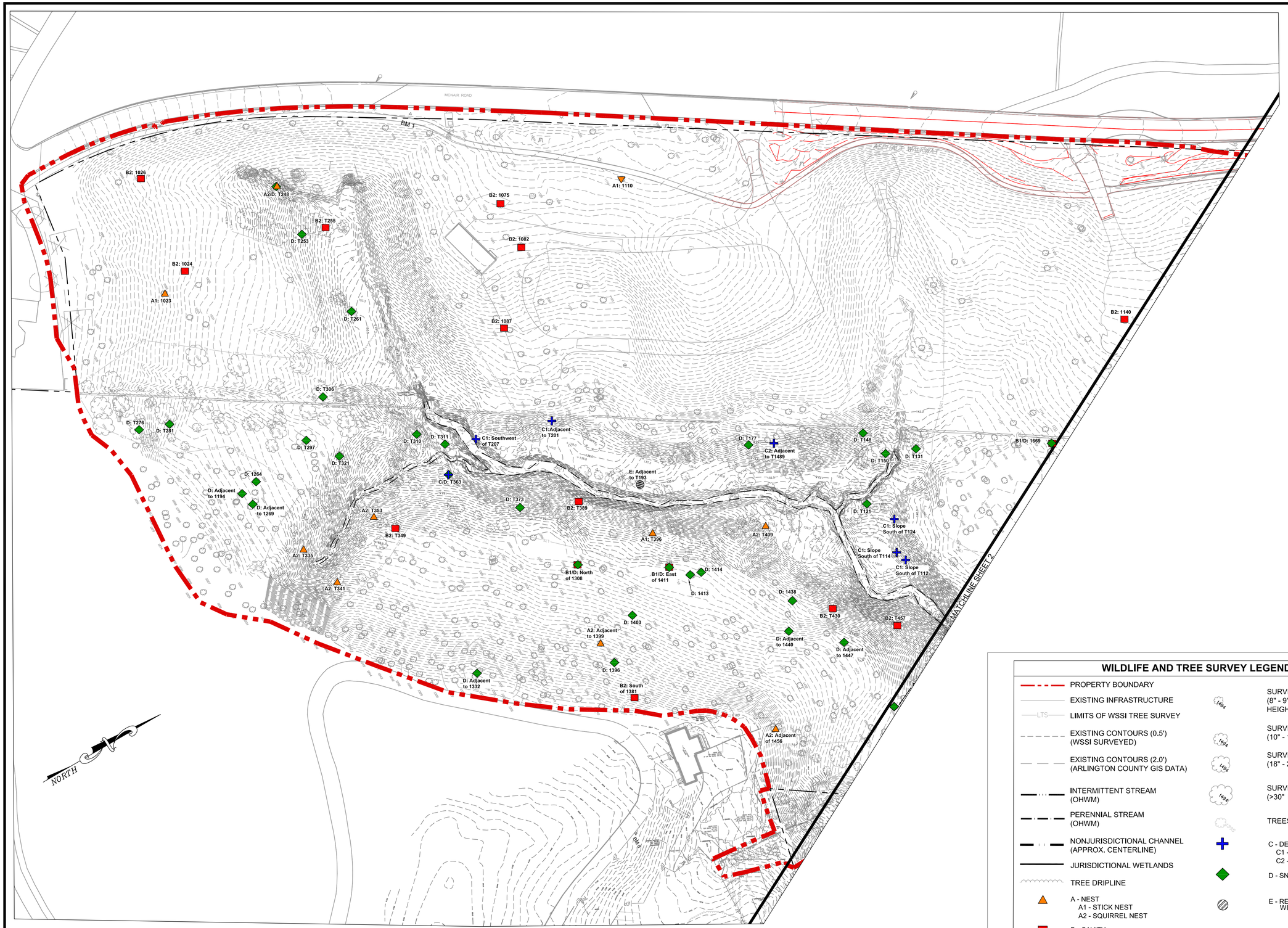
18. Representative Photo of a Hairy Woodpecker.

EXHIBIT 4
REPRESENATIVE PHOTOGRAPHS
ARLINGTON NATIONAL CEMETARY MILLENNIUM PROJECT
WSSI #22191.01

19. Representative Photo of a Hermit Thrush.

20. Representative Photo of White-tailed Deer.

Exhibit 5



WILDLIFE AND TREE SURVEY LEGEND

- PROPERTY BOUNDARY
- EXISTING INFRASTRUCTURE
- LTS — LIMITS OF WSSI TREE SURVEY
- EXISTING CONTOURS (0.5') (WSSI SURVEYED)
- EXISTING CONTOURS (2.0') (ARLINGTON COUNTY GIS DATA)
- INTERMITTENT STREAM (OHWM)
- PERENNIAL STREAM (OHWM)
- NONJURISDICTIONAL CHANNEL (APPROX. CENTERLINE)
- JURISDICTIONAL WETLANDS
- TREE DRIPLINE
- A - NEST
  - A1 - STICK NEST
  - A2 - SQUIRREL NEST
- B - CAVITY
  - B1 - SNAG
  - B2 - LIVE TREE

- SURVEYED TREES (8" - 9" DIAMETER AT BREAST HEIGHT - DBH)
- SURVEYED TREES (10" - 17" DBH)
- SURVEYED TREES (18" - 29" DBH)
- SURVEYED TREES (>30" DBH)
- TREES SURVEYED BY RICE
- C - DEN
  - C1 - GROUND BURROW
  - C2 - TREE HOLLOW
- D - SNAG
- E - REPRESENTATIVE WILDLIFE & WILDLIFE SIGN

Wetland Studies and Solutions, Inc.
5300 Wellington Branch Drive, Suite 100 • Gainesville, VA 20155
Phone 703 679 5600 • Fax 703 679 5601
wetlandstudies.com

Wildlife Habitat Survey Location Map

Prepared For: Jacobs

Arlington National Cemetery Millennium Project

Arlington County, Virginia

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REVISIONS

No.	Date	Description	Rev. By	App. By

SCALE: 1" = 50'

DATE: February 2013

Horizontal Datum:

Vertical Datum:

Boundary and Topo Source: WSSI, Rice and Associates, Arlington County and Hurt and Proffitt, Inc

Design	Draft	Approved
MJW	MJW	RVH

Sheet # 1 of 2

Computer File Name:

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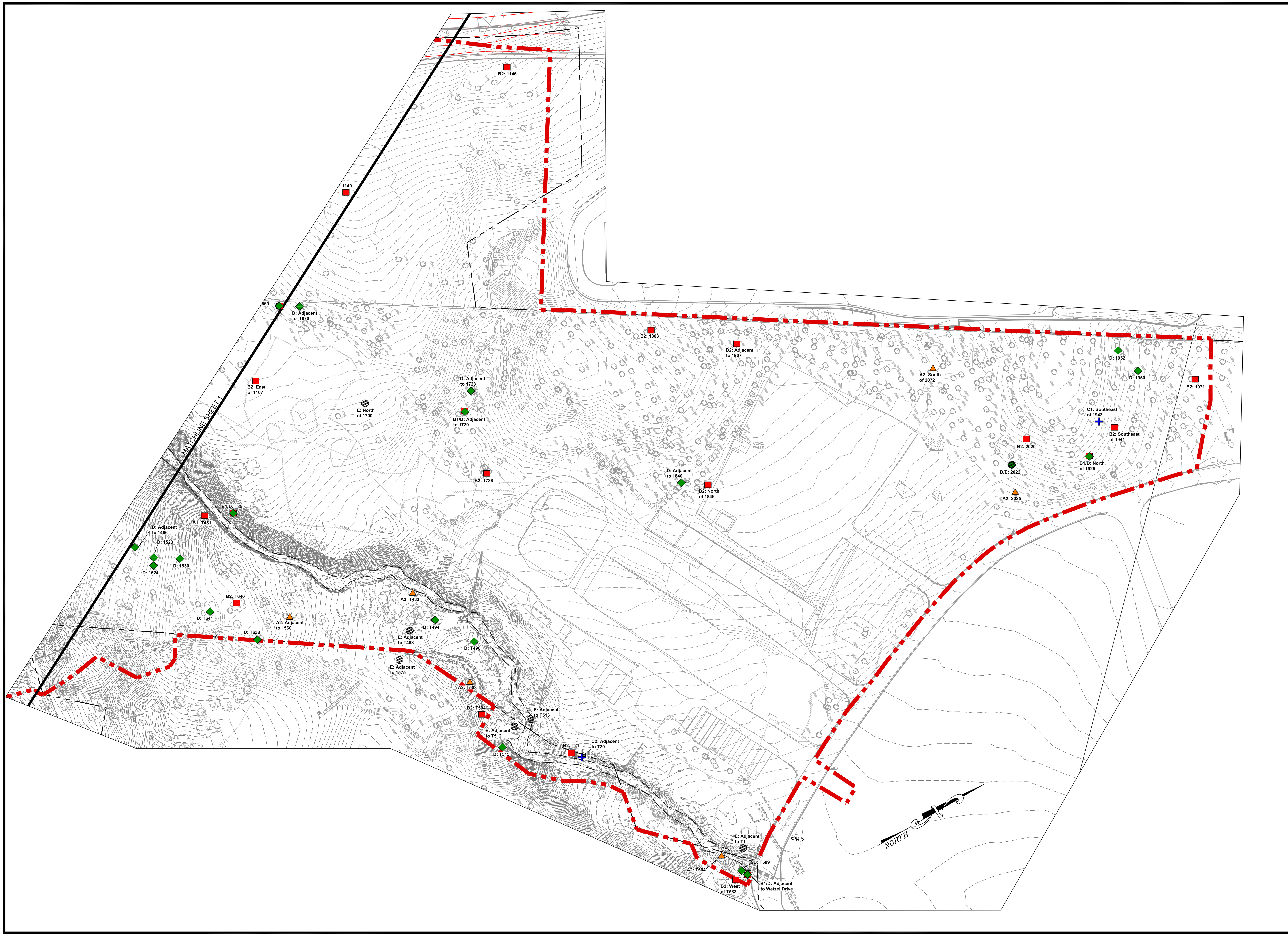

Wildlife Habitat Survey Location Map

Prepared For: Jacobs

Arlington National Cemetary Millennium Project

Arlington County, Virginia

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REVISIONS

No.	Date	Description	Rev. By	App. By

SCALE: 1" = 50'

DATE: February 2013

Horizontal Datum: VCS NAD 83

Vertical Datum:

Boundary and Topo Source: WSSI, Rice and Associates, Arlington County, and Hurt and Proffitt, Inc.

Design	Draft	Approved
MJW	MJW	RVH

Sheet #
2 of 2

Computer File Name:

Arlington National Cemetery Millennium Project

Arlington County, Virginia

WSSI #22191.01

Stream Assessment

March 4, 2013

Prepared for:
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Stream Assessment

Arlington National Cemetery Millennium Project
Arlington County, Virginia
WSSI #22191.01

Executive Summary

Wetland Studies and Solutions, Inc. (WSSI) has conducted a stream assessment on the Arlington National Cemetery Millennium Project site in Arlington County, Virginia. This report has been prepared in order to characterize the existing condition of the main stream on the site (i.e., the stream subject to proposed restoration work), in response to comments received during the public comment period for the Environmental Assessment prepared for the site.

The physical assessment included cross-section surveys, bank erosion hazard index (BEHI), Pfankuch evaluation, sediment load analysis (pebble counts), benthic macroinvertebrate assessments, and a chemical analysis of the water and sediments. The cross section analysis shows that the stream is deeply incised and disconnected from the floodplain, with the exception of a 200-foot reach at the downstream end of the site. The BEHI analysis concluded that the stream banks are unstable and actively eroding, with the exception of the 200-foot reach at the downstream end. The Pfankuch evaluations indicate that the streams are in Fair to Good condition. Given the findings of the cross section survey and the BEHI analysis, restoration of the stream system is warrented. The pebble counts indicate that, given the proposed conditions, the in-situ streambed material would not remain stable, thus a reinforced bed material will be incorporated into the stream restoration design.

The benthic macroinvertebrate habitat is categorized as "fair", and the benthic macroinvertebrate community is in "severe stress" and is dominated by pollution tolerant organisms. This stress is a direct consequence of the stream bed and bank instability and the resulting loss of habitat. The chemical analysis indicates that the pH, dissolved oxygen content, and temperature levels are within normal and accepted parameters for such streams, however the soil sediment samples found elevated levels of arsenic and chromium (total) at several sampling locations when compared to VDEQ VRP Tier II Sediment Screening Concentration and EPA. However, the concentrations of these metals were within expected background performed by others[1]. Speciation of chromium, performed by others, determined that the type of chromium present in soil was likely chromium III. The concentrations of chromium detected in the samples were below EPA-RSL-ISs for chromium III which is 1,500,000 mg/kg. The reinforced stream bed in the proposed stream restoration work will prevent further erosion of the existing streambed into the Potomac.

Stream restoration is necessary to correct the active erosion, reconnect the stream to its floodplain, and to prevent contaminated soils from washing downstream. Restoration

[1] A-Zone Environmental Services, LLC. *Preliminary Findings of Expanded Environmental Investigation Arlington National Cemetery Millennium Project Arlington, Virginia*. Prepared for Norfolk District, U.S. Army Corps of Engineers.

activities are also expected to improve riparian and benthic macroinvertebrate habitat, though recovery of the benthic macroinvertebrate community should not be expected in the near-term.

Site Description

The Arlington National Cemetery Millennium Project site is located on the west side of Ord and Weitzel Drive and east of McNair Road, within Arlington National Cemetery in Arlington County, Virginia. Exhibit 1 is a vicinity map that depicts the approximate location of the site. The topography of the study area is depicted on the USGS Topographic Map in Exhibit 2. General vegetative cover can be seen in the aerial photograph in Exhibit 3 (a 2011 natural color photograph from ESRI).

Stream Assessment Methodology

The stream assessment was conducted on February 7, 12, and 26, 2013 by Scott Petrey, EIT[2], Jamey Smith, EIT, Benjamin N. Rosner, PWS, PWD, CT, CE[3], Alison Robinson, WPIT, CT[4], and Lauren Shaffer, WPIT. The assessment included walking the entirety of the stream, subdividing the stream into five (5) representative reaches based on the relative observed physical conditions (see Exhibit 4), and photo documenting the existing conditions (see Exhibit 5). Reaches 1 and 3 are deeply incised with raw eroded banks. Reaches 2 and 4 are less incised but show significant bank erosion. Reach 5 is stable with the exception of a developing headcut where the stream flows into the culvert under Ord & Weitzel Drive. Within each reach the following information was collected: cross-section analysis, Bank Erosion Hazard Index (BEHI), channel stability evaluation (Pfankuch Evaluation), sediment load analysis (i.e., pebble counts, pavement/sub-pavement sample, and bar sample), benthic macroinvertebrate assessment, and water and sediment sampling for chemical analysis. A map depicting the location of each stream reach, the benthic sampling areas, and the approximate location of each sampling point is included in Exhibit 4.

The lower 70 foot portion of Stream Reach 5, just upstream of where the stream flows into the culvert under Ord and Weitzel Drive, is not included within this analysis because it is the subject of temporary restoration activity for the marker removal project. This area will be permanently restored as part of the Arlington National Cemetery Millennium Project.

Stream Assessment Results

Cross Section Survey

Within each identified stream reach, a representative cross section was measured to determine the relative hydraulic condition of the reach. The riffle cross section locations were selected during the field visit and then measured in AutoCAD Civil 3D using field run 0.5' contour interval topography[5]. The cross sections and the cross section sample locations are depicted in Exhibit 4; Table 1 provides a summary of the measured dimensions.

---

2 Engineer In Training.

3 Professional Wetland Scientist #1766, Society of Wetland Scientists Certification Program, Inc. VA Certified Professional Wetland Delineator #3402-000080; North American Benthological Society (NABS) Certified Level 1 Taxonomist: All Phyla; Certified Ecologist, Ecological Society of America.

4 Wetland Professional In-Training, Society of Wetland Scientists Certification Program, Inc.; North American Benthological Society (NABS) Certified Level 1 Taxonomist: All Phyla; ISA Certified Arborist MA-5179A.

5 0.5' contour interval topography was surveyed by WSSI in August 2012.

Table 1. Summary of Cross Section Dimensions

Existing Reach	Maximum Bankfull Depth[1] D_{rmax}	Low Bank Height LBH	Bank Height Ratio BHR = LBH/D_{Rmax}	Stability Rating (based on BHR)[2]	Bankfull Width W_{bkf}	Floodprone Width W_{fp}	Entrenchment Ratio[3] ER = W_{fp}/W_{bkf}	Entrenchment Classification
	(ft)	(ft)	(ft/ft)		(ft)	(ft)	(ft/ft)	
Reach 1	0.7	6.3	9.0	Deeply Incised	12.0	13.4	1.1	Entrenched
Reach 2	1.0	5.4	5.4	Deeply Incised	6.2	9.8	1.6	Mod. Entrenched
Reach 3	1.2	7.4	6.2	Deeply Incised	8.6	10.9	1.3	Entrenched
Reach 4	1.2	4.0	3.3	Deeply Incised	11.9	15.9	1.3	Entrenched
Reach 5	1.3	1.8	1.4	Stable	14.9	69.1	4.6	Slightly Entrenched

[1] No strong bankfull indicators were observed in the field so maximum bankfull depth is based on the design bankfull depth.

[2] Rosgen, David L. River Restoration and Natural Channel Design Field Manual. Page A64. Fort Collins, CO: Wildland Hydrology. 2004. (BHR = 1.0 to 1.1, Stable; BHR = 1.2 to 1.44, Slightly Incised; BHR = 1.45 to 1.62, Moderately Incised; BHR ≥ 1.63, Deeply Incised).

[3] The ideal ER ≥ 2.2. (ER < 1.4, Entrenched; ER = 1.4 to 2.2, Moderately Entrenched; ER > 2.2, Slightly Entrenched)

With the exception of Reach 5, these findings indicate that the existing stream is incised and disconnected from its floodplain.

Bank Erosion Hazard Index (BEHI)

A BEHI assessment was performed in each of the existing reaches at a location representative of the stream banks within the reach. BEHI sample locations are shown in Exhibit 4. Values for the measured parameters were entered into the stream analysis program RiverMorph™, and a qualitative bank condition was determined based on the scores. Table 2 provides a summary of the results.

Table 2. Summary of Bank Height Erosion Index Survey

BEHI Sample	Bank Height	Bankfull Depth	Root Depth	Root Density	Bank Angle	Surface Protection	BEHI Rating
	(ft)	(ft)	(ft)	(%)	(degrees)	(%)	
1	6.3	0.7	3	30	80	75.0	High
2	2.4	1.0	1.4	20	80	75.0	Moderate
3	7.9	1.2	3.3	20	70	5	High
4	3.6	1.2	2.5	30	45	20	High
5 (Left Bank)	4.7	1.3	4.7	70	45	70	Low
5 (Right Bank)	1.5	1.3	1.5	70	60	70	Low

With the exception of Reach 5, these findings indicate that the banks of the existing stream are not stable and are susceptible to continued erosion.

Pfankuch Evaluation

A Pfankuch evaluation was performed in each of the existing reaches at the same locations as the BEHI assessment. The purpose of the Pfankuch evaluation is to provide information regarding the stability of a stream channel and its capacity to adjust and recover from potential changes in flow volume and increases in sediment load production. Table 3 provides a summary of the results, and data sheets for each evaluated reach are provided in Exhibit 6.

Table 3. Summary of Pfankuch Evaluation

Existing Reach	Total Pfankuch Score	Stream Type	Rating
Reach 1	108	G4	Fair
Reach 2	99	G4	Good
Reach 3	113	G4	Fair
Reach 4	100	G4	Good
Reach 5	83	C4	Good

Sediment Load Analysis

Five (5) riffle pebble counts, a pavement/subpavement sample, and a bar sample were performed. The riffle pebble counts were performed at representative locations along the existing stream (see Exhibit 4). Each pebble count consists of a random sampling of 100 substrate particles measured along their respective intermediate axis[6]. The measurements were then compiled and the mean particle size (D_{50}) was determined for each sample. The bar sample was collected at locations representative of Reaches 4 and 5. The bar sample was collected along the downstream-third of the bar at one-half bankfull depth, separated into size classes using a wet sieve, and weighed. No bars were present in Reaches 1, 2, or 3 so a pavement/subpavement sample was collected in a representative location in Reach 2. The pavement/subpavement sample was collected in a riffle and measured similar to the bar sample. Table 4 provides a summary of the results and data sheets for each sample are provided in Exhibit 7.

Table 4. Summary of Sediment Analysis

Existing Reach	Sampling Method	Existing Substrate D_{50}	
		(mm)	(in)
Reach 1	Pebble Count	8.18	0.32
Reach 2	Pebble Count	12.48	0.49
Reach 2	Pavement/Subpavement	31.09	1.22
Reach 3	Pebble Count	16.00	0.63
Reach 4	Pebble Count	29.49	1.16
Reach 4	Bar Sample	57.8	2.28
Reach 5	Pebble Count	28.56	1.12

[6] The intermediate axis is the maximum dimension that would fit through the screen on a sieve.

To determine if the in-situ sediment would be suitable streambed material under the proposed conditions, a sheer stress analysis was performed using the following formula:

$$t_0 = \gamma_f * R * S$$

where:

t_0 = mean boundary sheer stress
γ_f = specific weight of water
R = hydraulic radius
S = maximum riffle slope

The mean boundary sheer stress is then used to determine the stable mean particle size for the proposed channels using the following formula:

$$D_{50} = 3.07 * t_0^{1.042}$$

where:

D_{50} = stable mean diameter of the substrate
t_0 = mean boundary sheer stress

As presented on Sheet CH-203 of the Arlington National Cemetery Millennium Project Site Cemetery Expansion 65% design plans, the in-situ substrate is not of sufficient size to withstand erosion in the proposed channel. As depicted in the plans, the required D_{50} of the large rock fraction of the reinforced bed mix under the most severe proposed conditions is approximately 20 in. (i.e., boulders). This is significantly larger than the in-situ sediment size. In addition, any sediment that may currently be entering the system as a result of bank erosion will be stopped by the restoration. Thus, sediment in the proposed condition must be sized such that it is not mobilized.

Benthic Macroinvertebrate Assessment

Within each reach, WSSI conducted a quantitative survey of the benthic macroinvertebrate community (the locations of the two benthic sampling areas are depicted on Exhibit 4). Note that only two sampling areas were conducted due to reach size constraints and length of time to process the samples. The survey consisted of a habitat evaluation for each sample area and a survey for species using the single habitat approach methodology. All benthic macroinvertebrates were preserved in the field and then returned to the WSSI lab for sub-sorting and identification to the family level[7]. Work was conducted under a Scientific Collection Permit from the Virginia Department of Game and Inland Fisheries (Permit #044625). The resulting data was used to calculate the Stream Condition Index for Virginia Non-Coastal Streams (VA-SCI). Table 5 summarizes the habitat evaluation findings, and Table 6 summarizes the results of the VA-SCI.

Habitat conditions were assessed by qualitatively rating ten habitat parameters, including Epifaunal Substrate/Available Cover, Pool Substrate Characterization, Pool Variability, Sediment Deposition, Channel Flow Status, Channel Alteration, Channel Sinuosity, Bank Stability, Vegetative Protection, and Riparian Vegetative Zone. The overall habitat quality of each sample area was determined by calculating the percentage of the best possible score, where the best possible score for each sample area equals 200. The following formula was used to determine the percentage of best possible score for each sample area:

[7] Due to time constraints, collection work took place three days prior to the start of the spring index period for benthic samples (March 1- May 31), however it did not affect the ability of WSSI's certified taxonomists to identify the organisms to family level.

Percentage of Best Possible Score = (Total Habitat Score)/(200)*100

Each sample area was then assigned a narrative rating according to the calculated percentage of best possible score, where "Excellent" is >90, "Good" is 75-88, "Fair" is 60-73, and "Poor" is <58. WSSI Habitat Assessment Field Data Sheets (developed from the EPA's RBP Habitat Assessment Field Data Sheets) for each sample area are included as Exhibit 8.

Table 5. Benthic Macroinvertebrate Habitat Score Summary

Existing Reach	Total Habitat Assessment Score	Percent Best Possible Score	Rating
Benthic Sample Area 1	119	60	Fair
Benthic Sample Area 2	129	65	Fair

Benthic macroinvertebrate samples were processed and subsampled by WSSI staff. Specifically, a fixed-count method was used, where one hundred organisms were randomly picked from a gridded (numbered) tray and the organisms were identified to the family level (if possible) using a dissecting microscope. Each individual (containing a head) found in a sample was recorded and enumerated on a WSSI Benthic Macroinvertebrate I.D. and Enumeration Bench Sheet, which are included in Exhibit 9 for each sample area.

Benthic macroinvertebrate data were analyzed by calculating the Stream Condition Index for Virginia Non-coastal Streams (VA-SCI), following guidance established in "A Stream Condition Index for Virginia Non-Coastal Streams" and "Using Probabilistic Monitoring Data to Validate the Non-Coastal Virginia Stream Condition Index". The VA-SCI is a multi-metric Index of Biotic Integrity developed for the DEQ to assess Streams of the Commonwealth. The VA-SCI uses seven biotic metrics and one biotic index including Total Taxa, EPT Taxa, Percent Ephemeroptera, Percent Plecoptera + Trichoptera (Excluding Hydropsychidae), Percent Scrapers, Percent Chironomidae, Percent Top Two Dominant Taxa, and Hilsenhoff Biotic Index.

The VA-SCI was calculated by taking the weighted average of the individual metric (and index) scores, with a VA-SCI range of 0-100. The weighting is as follows:

- Total Taxa: Score = 100 x (X/22), where X = Metric Value
- EPT Taxa: Score = 100 x (X/11), where X = Metric Value
- Percent Ephemeroptera: Score = 100 x (X/61.3), where X = Metric Value
- Percent Plecoptera + Trichoptera less Hydropsychidae: Score = 100 x (X/35.6), where X = Metric Value
- Percent Scrapers: Score = 100 x (X/51.6), where X = Metric Value
- Percent Chironomidae: Score = 100 x [(100-X) (100-0)], where X = Metric Value
- Percent Top 2 Dominant: Score = 100 x [(100-X) (100-30.8)], where X = Metric Value
- Hilsenhoff Biotic Index: Score = 100 x [(100-X) (100-3.2)], where X = Metric Value

Each sample area was then assigned a narrative rating according to the calculated VA-SCI, where "Excellent" is >73, "Good" is 60-72, "Stress" is 43-59, and "Severe Stress" is <42.

Table 6: Biotic Metric and Index Weighting and VA-SCI

WEIGHTED METRIC	BIOLOGICAL MONITORING SAMPLE	
	Sample Area #1	**Sample Area #2**
Total Taxa	31.82	36.36
EPT Taxa	18.18	0.00
Percent Ephemeroptera	0.00	0.00
Percent Plecoptera + Trichoptera (Excluding Hydropsychidae)	12.00	0.00
Percent Scrapers	0.00	0.00
Percent Chironomidae	11.97	45.00
Percent Top Two Dominant	13.59	23.12
HBI	64.23	92.21
VA-SCI Numerical Score	**18.97**	**24.59**
VA-SCI Narrative Score	**Severe Stress**	**Severe Stress**

These findings indicate that the benthic macroinvertebrate community throughout the stream is in severe stress, being primarily comprised of pollution tolerant organisms. Such a pollution tolerant community is indicative of a stream within an urbanized watershed.

Chemical Analysis

WSSI obtained samples of surface water and streambed sediment with each of the bottom, middle, and upper portions of the stream in order to prepare a chemical analysis of the stream. The sediment samples were submitted to an accredited laboratory (Phase Separation Science, (PSS) of Baltimore, Maryland, Virginia Certification #296) for laboratory analyses as outlined below:

- Total Petroleum Hydrocarbons, Diesel Range Organics (TPH-DRO) by EPA Method 8015C;
- Semi-volatile Organic Compounds (SVOCs) by EPA Method 8270;
- Metals by EPA Method 200.8/6020;
- Hexavalent Chromium by SM 7196A/3500D;
- Polychlorinated biphenyls (PCBs) by EPA Method 8082;
- Pesticides by EPA Method 8081;
- Regulated Herbicides by EPA Method 8150;
- Total Phosphorus by EPA Method 365.1

The surface water samples were submitted to PSS for laboratory analyses as outlined below:

- Volatile Organic Compounds (VOCs) by EPA Method 8260;
- Semi-volatile Organic Compounds (SVOCs) by EPA Method 8270;
- Metals by EPA Method 200.8/6020A;
- Hexavalent Chromium by SM 7196A/3500D;
- Polychlorinated biphenyls (PCBs) by EPA Method 8082;

- Pesticides by EPA Method 8081;
- Regulated Herbicides by EPA Method 8150;
- Nitrogen, Total Kjeldahal (TKN) by SM 450-NH3;
- Total Phosphorus by EPA Method 365.1

The full results of the PSS laboratory analyses are included as Exhibit 10. In addition to the surface water and sediment sampling, WSSI recorded the stream temperature, dissolved oxygen (DO) levels, pH, and specific conductivity at each reach using a YSI Professional Plus (ProPlus) instrument. Table 7 summarizes the results of the surface water chemical analysis results, while Table 8 summarizes the results of the testing of other parameters completed in the field. Table 9 summarizes the results of the sediment chemical analysis.

Table 7. Surface Water Chemical Testing Results

Analyte	Sample 1	Sample 2	Sample 3	VDEQ VRP Tier II Surface Water - Fresh*
Total Metals (by EPA Method 200.8) in micrograms per liter (µg/L)				
Antimony	--	--	--	640
Arsenic	8.1	--	--	150
Beryllium	--	--	--	-
Cadmium	--	--	--	1.1
Chromium (total)	1.9	--	--	11
Copper	6.6	1.9	3.3	9
Lead	5.2	--	--	14
Mercury	--	--	--	0.77
Nickel	14	6.1	9.8	20
Selenium	--	--	--	-
Silver	--	--	--	-
Thallium	--	--	--	0.47
Zinc	34	25	31	120
Chromium (VI, by EPA 7196A)	--	--	--	11
Total Nutrients (by EPA Method 351.2 and 365.1) in milligrams per liter (mg/L)				
Total Kjeldahl Nitrogen	--	--	--	10[1]
Total Phosphorus	--	--	--	-

*VDEQ VRP Tier II Surface Water - Fresh values from "Selection of Contaminants of Concern Other Surface Water - Fresh (Table 2.7b)", found at: http://www.deq.virginia.gov/Programs/LandProtectionRevitalization/RemediationProgram/VoluntaryRemediationProgram/VRPRiskAssessmentGuidance/Guidance.aspx

Highlighted concentrations exceed Tier II Standard;

- = Not Tested / Not Applicable

[1]Values for Nitrogen and Phosphorus from Criteria for Surface Water found at 9VAC25-260-140, found at:http://lis.virginia.gov/cgi-bin/legp604.exe?000+reg+9VAC25-260-140

-- = Not Detected at or above the reporting limits.

No detectable levels of VOCs, SVOCs, PCBs, Pesticides or Herbicides were found in any of the surface water samples.

Table 8. Surface Water Other Criteria Testing Results

Parameter	Sample 1	Sample 2	Sample 3	Numerical Criteria per 9VAC25-260-50*
Other Criteria				
Temperature (ºC)	6.0	5.1	5.5	32 (maximum)
Dissolved Oxygen (mg/L)	14.91	14.85	12.65	4.0 (minimum)
pH	7.95	7.93	7.66	6-9
Specific Conductivity	163.0	423.2	430.9	-

*Values from Criteria for Surface Water found at: 9VAC25-260-140, found at:http://lis.virginia.gov/cgi-bin/legp604.exe?000+reg+9VAC25-260-140

Highlighted concentrations exceed Tier II Standard;

- = Not Tested / Not Applicable

Table 9. Sediment Chemical Testing Results

Analyte	Sample 1	Sample 2	Sample 3	VDEQ VRP Tier II Sediment Unrestricted
Total Metals (by EPA Method 6020A) in milligrams per kilogram (mg/kg)				
Arsenic	5.7	2.5	4	3.9
Chromium (total)	17	20	35	2.9*
Copper	16	45	42	3,100
Lead	41	39	43	400
Mercury	--	0.2	0.5	10
Nickel	8.4	22	19	390
Zinc	41	120	95	5,840
Chromium (VI, by EPA 7196A)	--	--	--	2.9
Total Nutrients (via EPA 365.1) in milligrams per kilogram (mg/kg)				
Total Phosphorus	400	440	462	-
Petroleum (Diesel Range Organics via EPA Method 8015C) in milligrams per kilogram (mg/kg)				
TPH-DRO	7.5	34	7	-
Semi-Volatile Organic Compounds (via EPA Method 8270C) in micrograms per kilogram (µg/kg)				
Benzo(a)anthracene	--	--	--	1.5
Benzo(a)pyrene	--	--	--	0.15
Benzo(b)fluoranthene	--	--	--	1.5
Benzo(g,h,i)perylene	--	--	--	1,700
Benzo(k)fluoranthene	--	--	--	15
Chrysene	--	--	--	150

Table 9. Sediment Chemical Testing Results

Analyte	Sample 1	Sample 2	Sample 3	VDEQ VRP Tier II Sediment Unrestricted
Fluoranthene	--	460	--	2,300
Indeno(1,2,3-c,d)Pyrene	--	--	--	1.5
Phenanthrene	--	350	--	1,700
Pyrene	--	340	--	650
Organochlorine Pesticides (via EPA Method 8081B) in micrograms per kilogram (mg/kg)				
4,4-DDE	--	--	0.013	14
4,4-DDD	--	--	0.027	20

*VDEQ VRP Tier II Surface Water - Fresh values from "Selection of Contaminants of Concern Sediment Unrestricted (Table 2.8)", found at:
http://www.deq.virginia.gov/Programs/LandProtectionRevitalization/RemediationProgram/VoluntaryRemediationProgram/VRPRiskAssessmentGuidance/Guidance.aspx

Metals and TPH-DRO concentrations reported in milligrams per kilogram (mg/kg);
SVOC concentrations reported in micrograms per kilogram (µg/kg);
Highlighted concentrations exceed Tier II Standard;
- = Not Tested / Not Applicable

No detectable levels of PCBs or Herbicides were found in any of the sediment samples.

The surface water chemical analysis indicates that known pollutants are at or below regulated levels on the Millennium project site; however, sediment samples indicate that several priority pollutant metals (Arsenic and total Chromium), are present in elevated levels within the sediment in the streambed.

Conclusions

In reviewing the findings for each assessed parameter, the cross section analysis shows that the stream is deeply incised and disconnected from the floodplain, with the exception of a 200-foot reach at the downstream end of the site. The BEHI analysis concluded that the stream banks are unstable and actively eroding, with the exception of the 200-foot reach at the downstream end. The active erosion is most notable in Reach 3, where channel incision is also the deepest. The Pfankuch evaluations indicate that the streams are in Fair to Good condition. However, it should be noted that the volume of stormwater that historically flowed into this stream from Ft. Myer has been reduced by a flow diversion system installed along McNair Road, which has allowed the streambed to recover somewhat, resulting in higher than expected Pfankuch ratings. However, given the findings of the cross section survey and the BEHI analysis, restoration of the stream system is needed due to the continued erosion of the streambanks and disconnection from the floodplain.

The pebble counts indicate that, given the proposed conditions, the in-situ streambed material would not remain stable, thus a reinforced bed material will be incorporated into the stream restoration design.

The benthic macroinvertebrate habitat is categorized as “fair” due primarily to the instability of the stream channel and the relative lack of habitat diversity within the stream. The VA-SCI scores conclude that the benthic macroinvertebrate community is in severe stress

and dominated by pollution tolerant organisms. This stress is a direct consequence of the stream bed and bank instability and the resulting loss of habitat.

The chemical analysis indicates that the pH, dissolved oxygen content, and temperature levels are within normal and accepted parameters for such streams, however the soil sediment samples found elevated levels of arsenic and chromium (total) at several sampling locations when compared to VDEQ VRP Tier II Sediment Screening Concentration and EPA. However, the concentrations of these metals were within expected background performed by others. Speciation of chromium, performed by others, determined that the type of chromium present in soil was likely chromium III. The concentrations of chromium detected in the samples were below EPA-RSL-ISs for chromium III which is 1,500,000 mg/kg. The reinforced stream bed in the proposed stream restoration work will prevent further erosion of the existing streambed into the Potomac.

Stream restoration is necessary to correct the active erosion, reconnect the stream to its floodplain, and to prevent contaminated soils from washing downstream. Restoration activities are also expected to improve riparian and benthic macroinvertebrate habitat, though recovery of the benthic macroinvertebrate community should not be expected in the near-term.

Limitations

This study is based on examination of the stream conditions on the study site at the time of our review and does not address conditions at a given time in the future. Such stream conditions change over time. Therefore, our conclusions may vary from future observations.

Our stream assessment and report have been prepared in accordance with generally accepted guidelines for the conduct of such assessments. We make no other warranties, either expressed or implied, and our report is not a recommendation to buy, sell or develop the property.

WETLAND STUDIES AND SOLUTIONS, INC.

Benjamin N. Rosner, PWS, PWD, CE, CT
Senior Associate Environmental Scientist

Frank Graziano, PE
Vice President - Engineering

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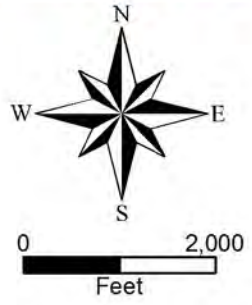
Vicinity Map
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 2000'



Wetland Studies and Solutions, Inc.

Exhibit 1

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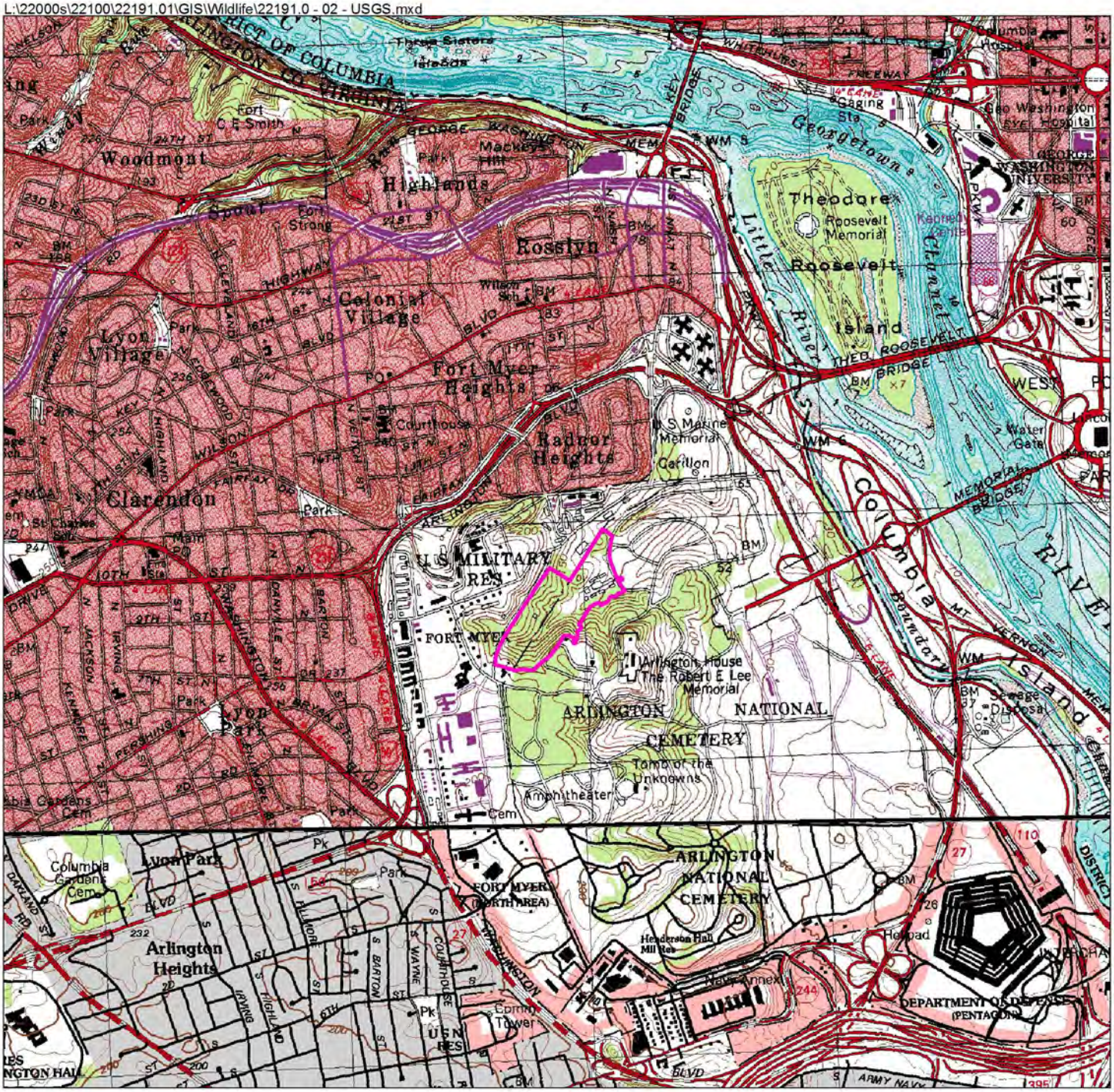


Site

USGS Quad Maps
Washington West, DC-MD-VA 1983
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 2000'

N
W E
S

0 2,000
Feet

Latitude: 38°52'40" N
Longitude: 77°04'08" W
Hydrologic Unit Code (HUC): 020700100103
Stream Class: III
Name of Watershed: Potomac River
COE Region: Atlantic and Gulf Coastal Plain

L:\22000s\22100\22191.01\GIS\Wildlife\22191.01 - 03 - Aerial2011.mxd

Site

April 2011 Natural Color Imagery
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 300'

N
W E
S

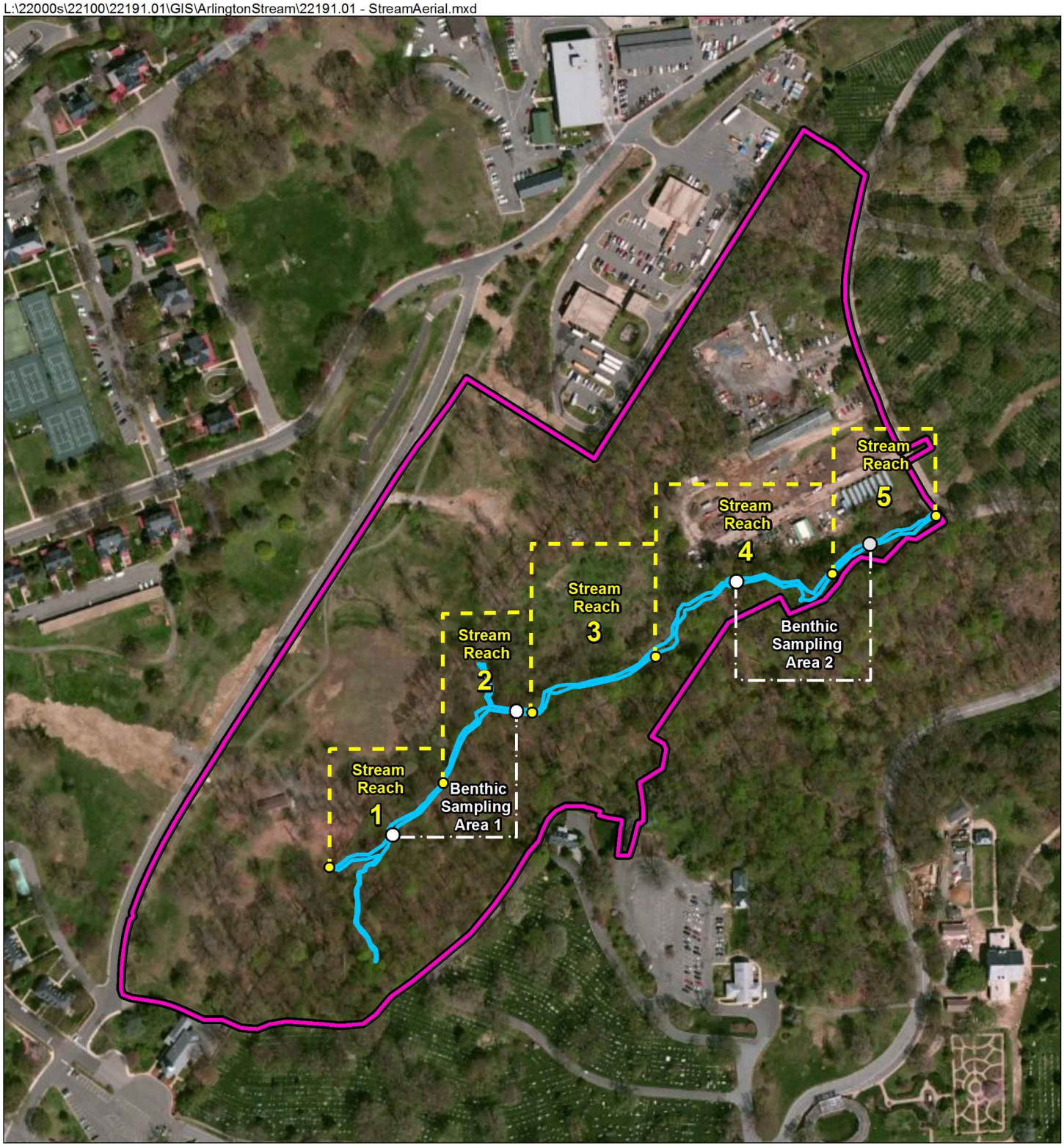
0 300
Feet

Image Source: Esri

Wetland Studies and Solutions, Inc.

Exhibit 3

L:\22000s\22100\22191.01\GIS\ArlingtonStream\22191.01 - StreamAerial.mxd



ANC Study Area Boundary
Stream
Stream Reach
Benthic Sampling Area

Exisiting Stream Conditions Study Area Map
Arlington National Cemetery
WSSI #22191.01
Original Scale: 1" = 300'

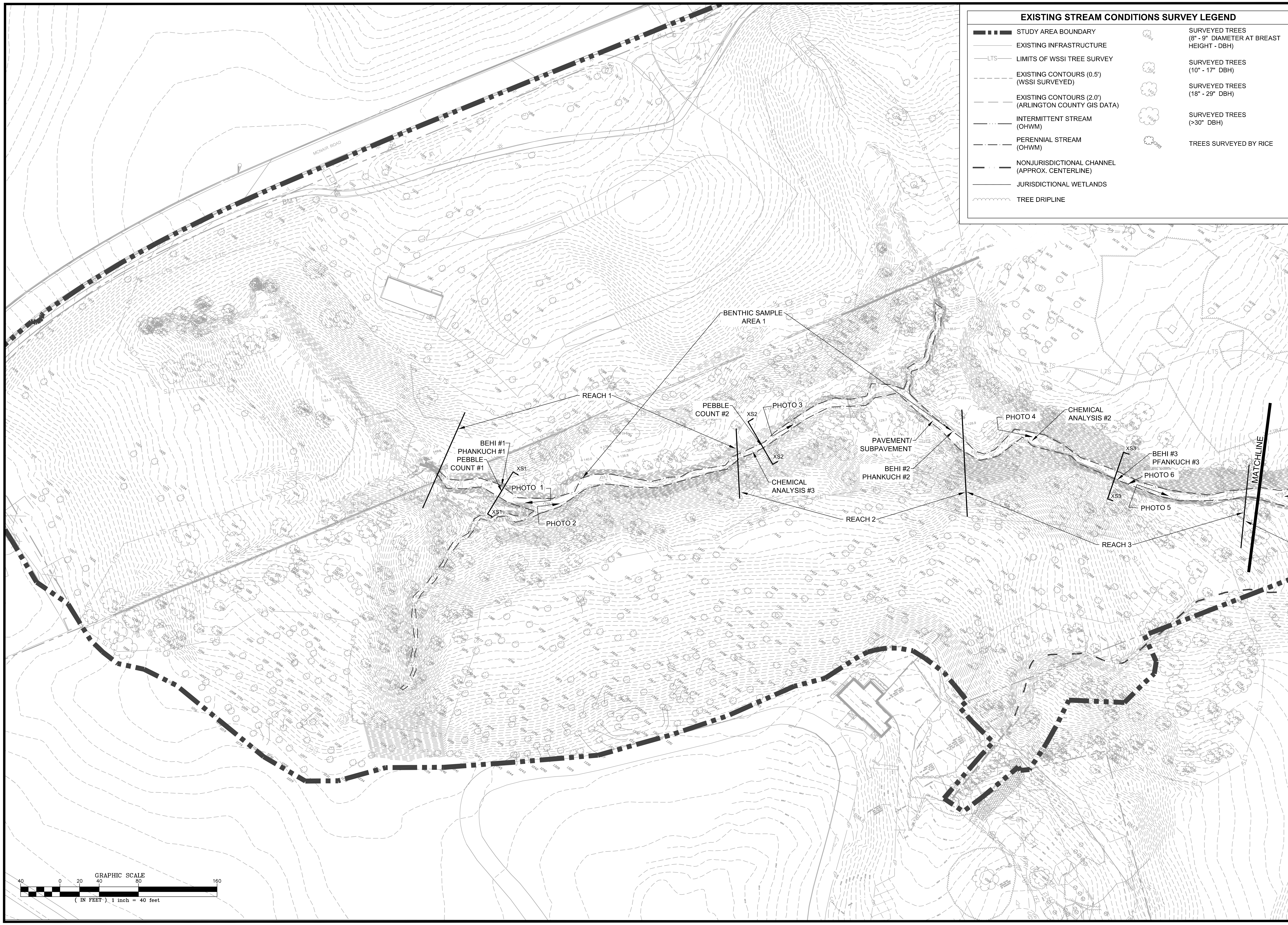
N
W E
S

0 300
Feet

Aerial: April 2011 - ESRI

Wetland Studies and Solutions, Inc.

Exhibit 4



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ARLINGTON NATIONAL CEMETERY
MILLENNIUM PROJECT
Arlington County, Virginia

Exhibit 4: Existing Stream Conditions Study

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REVISIONS

No.	Date	Description	Rev. By	App. By

DATE: FEBRUARY 2013

SCALE: 1" = 40'

Horizontal Datum: VCS NAD 83

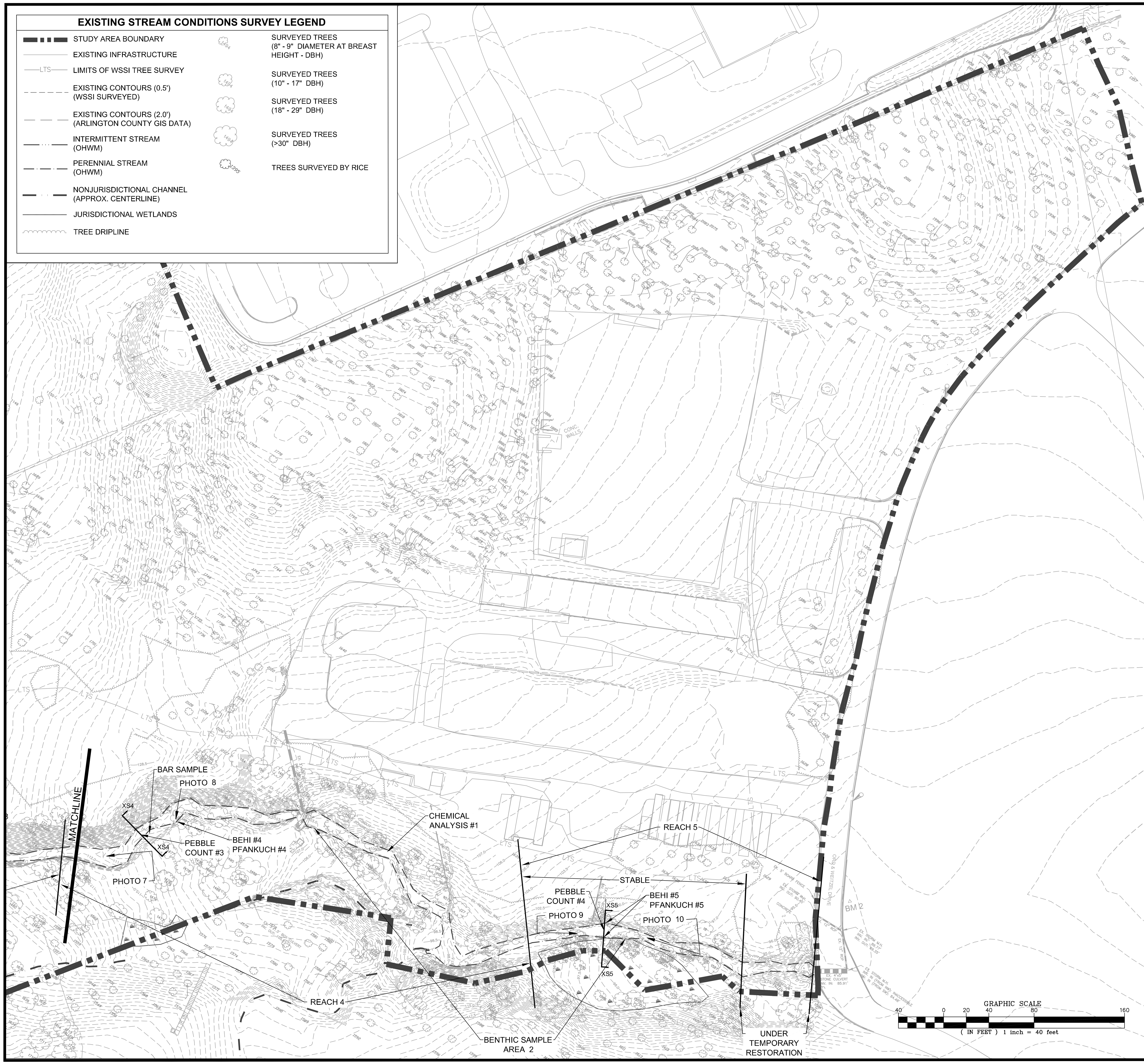
Vertical Datum: NGVD 29

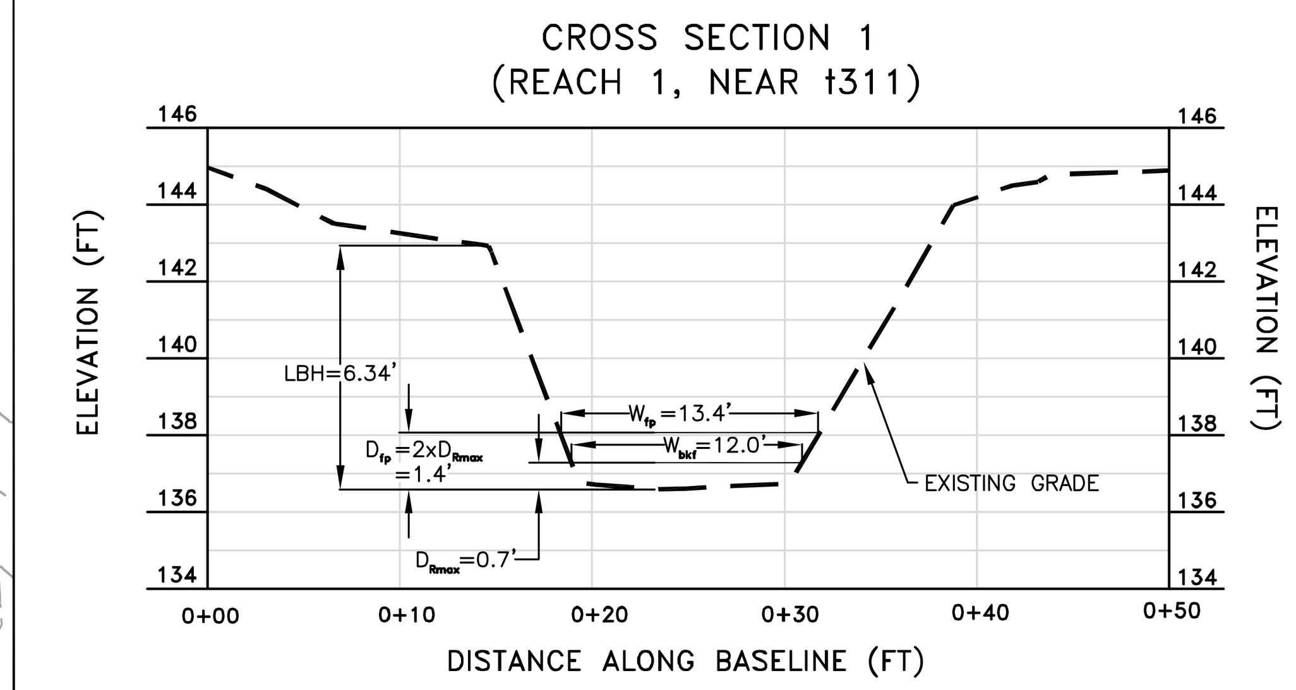
Boundary and Topo Source: JACOBS, RICE ASSOCIATES, & WSSI

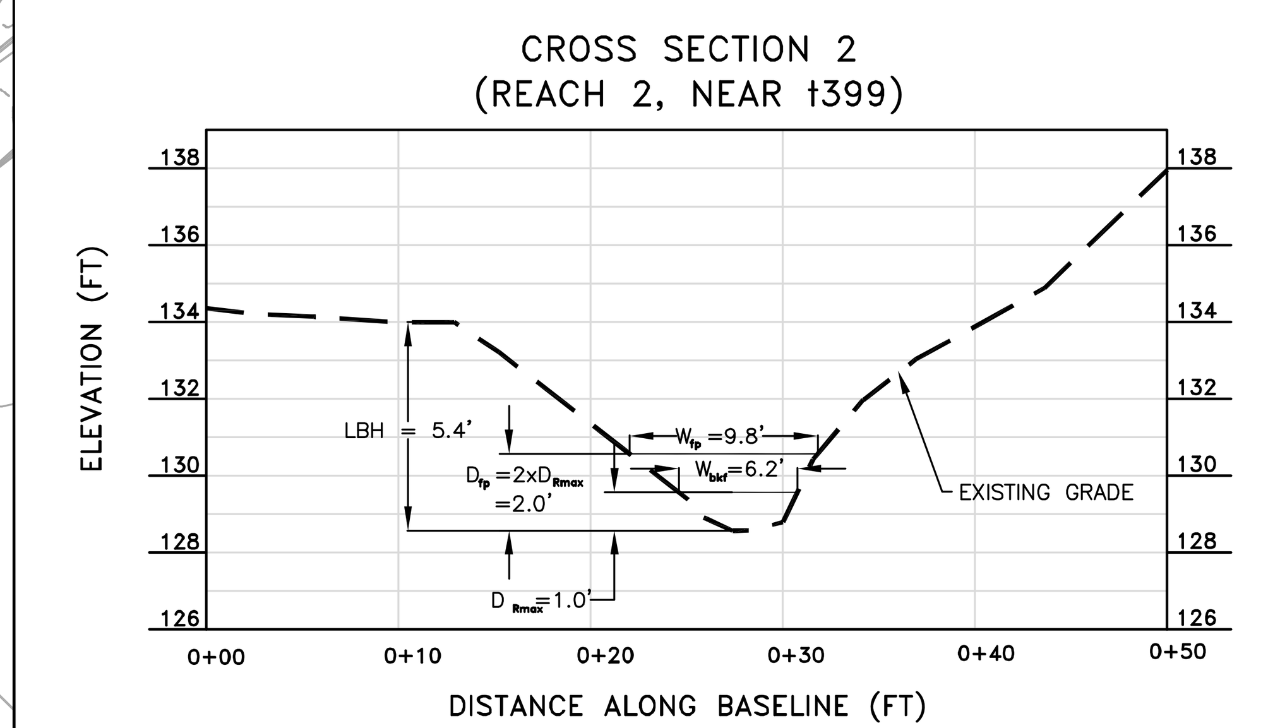
Design	Draft	Approved
JLS	JLS	FRG

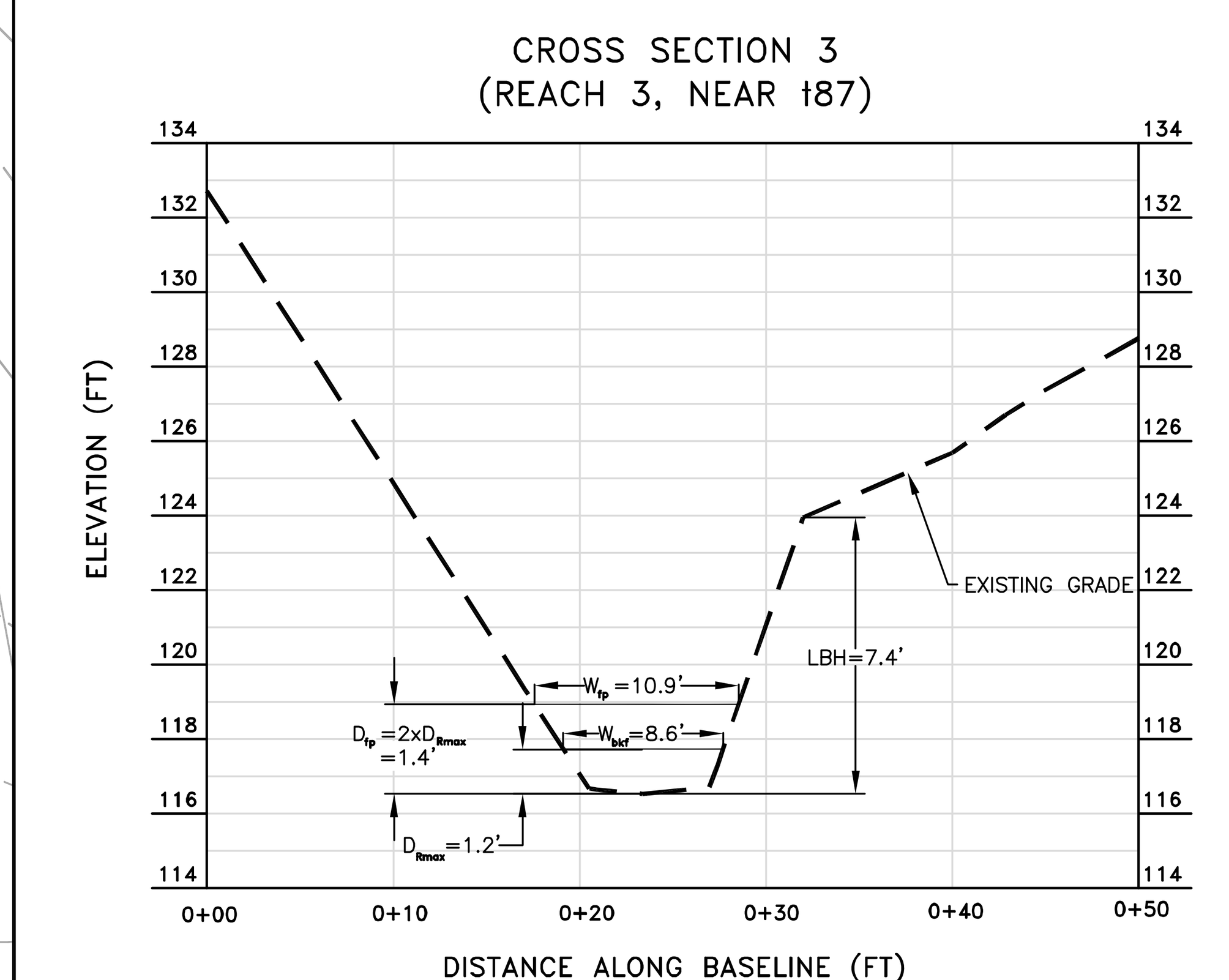
Sheet #
1 of 2

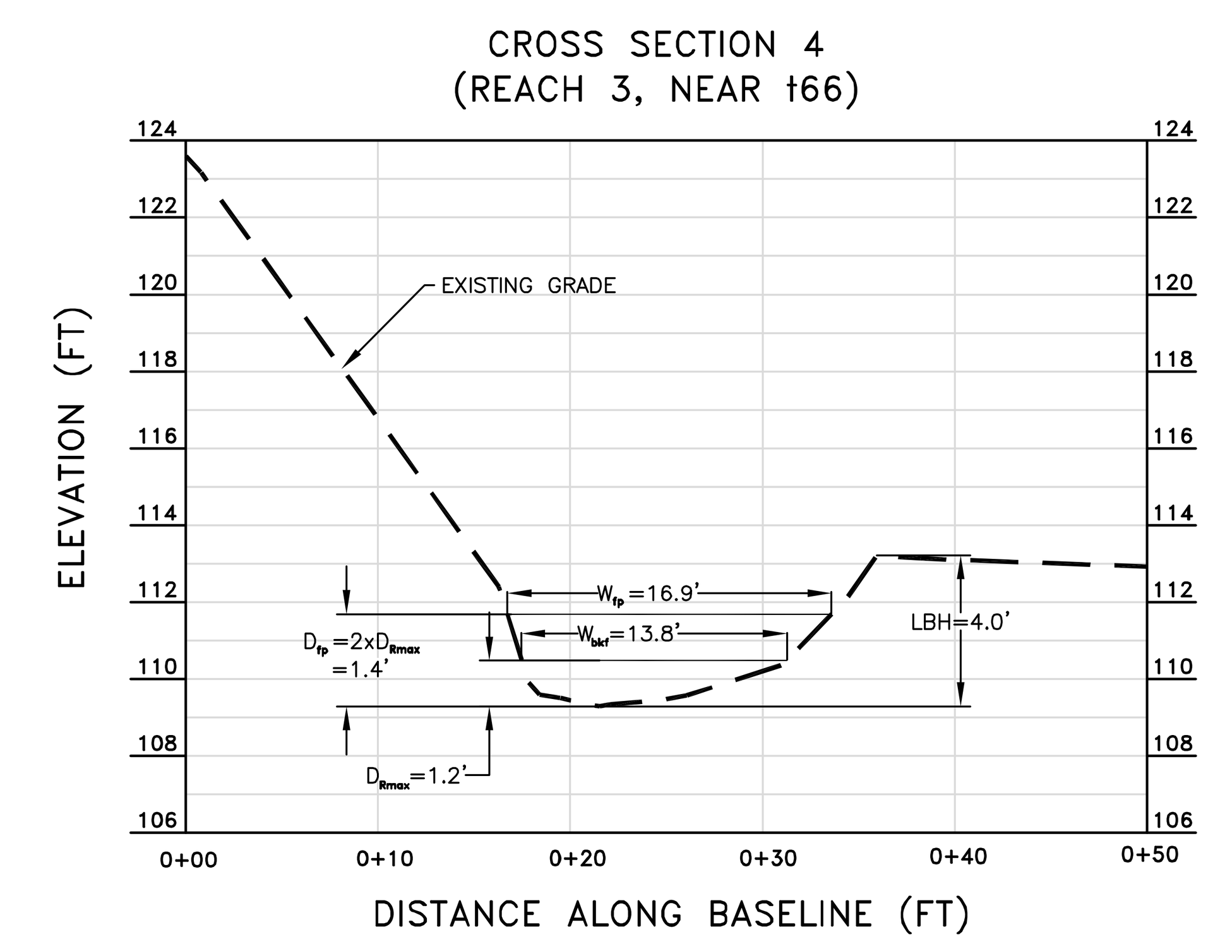
Computer File Name:

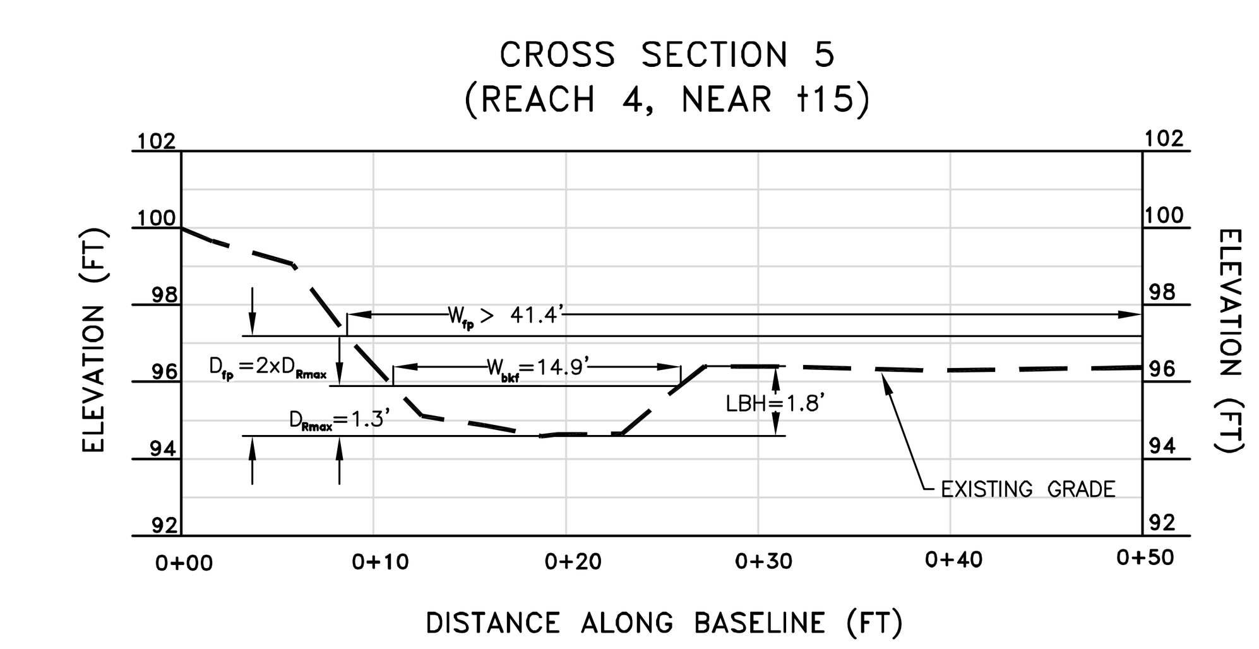












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ARLINGTON NATIONAL CEMETERY MILLENNIUM PROJECT

Arlington County, Virginia

Exhibit 4: Existing Stream Conditions Study

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REVISIONS

No.	Date	Description	Rev. By	App. By

DATE: FEBRUARY 2013

SCALE: 1" = 40'

Horizontal Datum: VCS NAD 83

Vertical Datum: NGVD 29

Boundary and Topo Source: JACOBS, RICE ASSOCIATES, & WSSI

Design	Draft	Approved
JLS	JLS	FRG

Sheet #

2 of 2

Computer File Name:

EXHIBIT 5
ARLINGTON NATIONAL CEMETERY
MILLENNIUM PROJECT – STREAM RESTORATION
(WSSI #22191.01)
EXISTING CONDITIONS – FEBRUARY 2013
PHOTOS TAKEN BY SCOTT PETREY & JAMEY SMITH

1. **Reach 1, looking upstream.**

2. **Reach 1, looking downstream.**

EXHIBIT 5
ARLINGTON NATIONAL CEMETERY
MILLENNIUM PROJECT – STREAM RESTORATION
(WSSI #22191.01)
EXISTING CONDITIONS – FEBRUARY 2013
PHOTOS TAKEN BY SCOTT PETREY & JAMEY SMITH

3. **Reach 2, looking downstream.**

4. **Reach 3, looking downstream.**

EXHIBIT 5
ARLINGTON NATIONAL CEMETERY
MILLENNIUM PROJECT – STREAM RESTORATION
(WSSI #22191.01)
EXISTING CONDITIONS – FEBRUARY 2013
PHOTOS TAKEN BY SCOTT PETREY & JAMEY SMITH

5. **Reach 3, looking downstream.**

6. **Reach 3, typical eroded bank (BEHI location).**

EXHIBIT 5
ARLINGTON NATIONAL CEMETERY
MILLENNIUM PROJECT – STREAM RESTORATION
(WSSI #22191.01)
EXISTING CONDITIONS – FEBRUARY 2013
PHOTOS TAKEN BY SCOTT PETREY & JAMEY SMITH

7. **Reach 4, looking downstream.**

8. **Reach 4, looking at eroded right bank (typical outside meander, BEHI Location).**

EXHIBIT 5
ARLINGTON NATIONAL CEMETERY
MILLENNIUM PROJECT – STREAM RESTORATION
(WSSI #22191.01)
EXISTING CONDITIONS – FEBRUARY 2013
PHOTOS TAKEN BY SCOTT PETREY & JAMEY SMITH

9. **Reach 5, looking downstream (typical bank condition, BEHI location).**

10. **Reach 5, looking upstream.**

For a full version of this report with all appendices and lab results, please contact Susan Conner, USACE Norfolk, at 757-201-7390.