Brown Farm
Wetland Restoration Site
Orange & Durham Counties,
North Carolina

Cape Fear River Basin
CU 03030002

Mitigation Plan / As-Built Report

Submitted to:

North Carolina
Department of Environment and
Natural Resources
Ecosystem Enhancement Program

Submitted by:

KCI Associates of North Carolina, P.A.
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April 2007

ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.

EXECUTIVE SUMMARY

The Brown Farm Wetland Restoration Site is adjacent to New Hope Creek in Durham, North Carolina along the Orange-Durham County Line. The New Hope Creek is in the Cape Fear Basin within the United States Geologic Survey (USGS) 8-digit Hydrologic Unit Code (HUC) 03030002. The site drains into New Hope Creek to the east, which then flows approximately 11 miles before entering Jordan Lake. The project has a contributing drainage area of 33.3 square miles (21,331 acres) at the downstream limits of the site. Currently, the project watershed is primarily forested, but the surrounding area continues to experience rapid growth. Downstream and outside of the project watershed, there is residential and commercial development expanding along the North Carolina State Highway 15-501 corridor to the east. The project watershed is located within the Piedmont physiographic province and is part of the Triassic Basins Level IV Ecoregion.

The 46.1 acre project site is located on an expansive, active floodplain of New Hope Creek. Moving west from the stream, the site slopes downward at approximately 1% from the levee position of the creek to a lower floodplain position in the center of the site. This central portion is flat extending to the north, south and west to the valley walls on the site. There are no streams that flow directly through the project site. Upper New Hope Creek forms the eastern boundary of the project and the entire site eventually drains to this stream. There were a series of major and minor drainage ditches that ran along and throughout the site. Smaller minor ditches were distributed throughout the site approximately 50 feet apart.

Site hydrology was evaluated during field investigations. Wetland hydrology at the site is driven primarily by surface water inputs: precipitation, overland flow from upstream slopes and overbank events from New Hope Creek. Prior to construction, the conditions were unsaturated within the upper 12 inches of soil throughout the site, except for the 3.3 acres of existing wetland. Ditches and berms prevented the site from experiencing the maximum amount of hydrologic inputs it could receive. The Brown Farm wetland restoration project will restore and enhance a riverine Piedmont Bottomland Hardwood wetland community along the New Hope Creek.

This project proposes to improve water quality and protect aquatic habitat by restoring 24.6 acres of riverine wetland and enhancing 3.3 acres of riverine wetland. Construction of the Brown Farm wetland restoration site was completed in fall of 2006. The wetland restoration area at the project site includes portions of an agricultural field along New Hope Creek. These sections have the necessary hydric soils, but did not contain adequate vegetation and hydrology for jurisdictional wetland status. Hydrologic restoration consisted of filling in ditches, building level spreaders, and creating microtopography to lengthen the path and slow the flow of water through the wetlands. The restored sites have been replanted with hardwood species typical of a Piedmont Bottomland Hardwood Community.

Portions of the project site have jurisdictional wetland status, but will benefit from enhancement. Ditches in these areas will be filled to increase the hydroperiod in these wetlands, ensuring that they retain wetland hydrology. The enhancement areas will also have supplemental planting of Piedmont Bottomland Hardwood trees to increase vegetation diversity.

Mitigation Summary Table

	Restoration	**Enhancement**	**Preservation**	**TOTAL**
Riverine Wetland Acreage	24.6	3.3	0	27.9
Upland Inclusion Acreage	0	0	18.2	18.2
TOTAL	**24.6**	**3.3**	**18.2**	**46.1**

A monitoring program will be implemented to observe the progress toward achieving mitigation goals and objectives within the restored wetland areas. Monitoring data will be collected annually for a period of five years or until vegetative and hydrologic success criteria are achieved. Wetland hydrology will be monitored by automatic recording wells located within the project area and reference wetland. Automatic recording wells will be established within restoration areas at a density of one automatic well per four acres. Wetland hydrology will be considered established if well data from the site indicates that the water table is within 12 inches of the soil surface for 5% (11 consecutive days) of the growing season (222 days) during normal weather conditions. Permanent vegetation monitoring plots (10 x 10 meters) will be established in the wetland restoration areas at a density that will ensure 2% coverage of the total restoration acreage. Data will be collected at each plot for: total number of stems, species, percent survival, height, and evidence of insects, disease or browsing. Survival of planted species must be 320 stems/acre at the end of five years of monitoring. Non-target species must not constitute more than 20 percent of the woody vegetation based on permanent monitoring plots.

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1.0 INTRODUCTION

The Brown Farm Wetland Restoration Project restored 24.6 acres of wetland and enhanced 3.3 acres of wetland in the Cape Fear River Basin. The project was initiated in winter of 2005 and construction was completed in the fall of 2006. The goals of the project are to restore ecosystem processes, structure, and composition to mitigate for wetland functions and values that have been lost as a result of anthropogenic disturbances in this region of the Cape Fear River Basin. Functions that will be restored include:

- Aquatic/Terrestrial Wildlife Habitat
- Water Quality
- Groundwater Recharge
- Nutrient Cycling
- Bottomland Hardwood Communities

2.0 SUMMARY

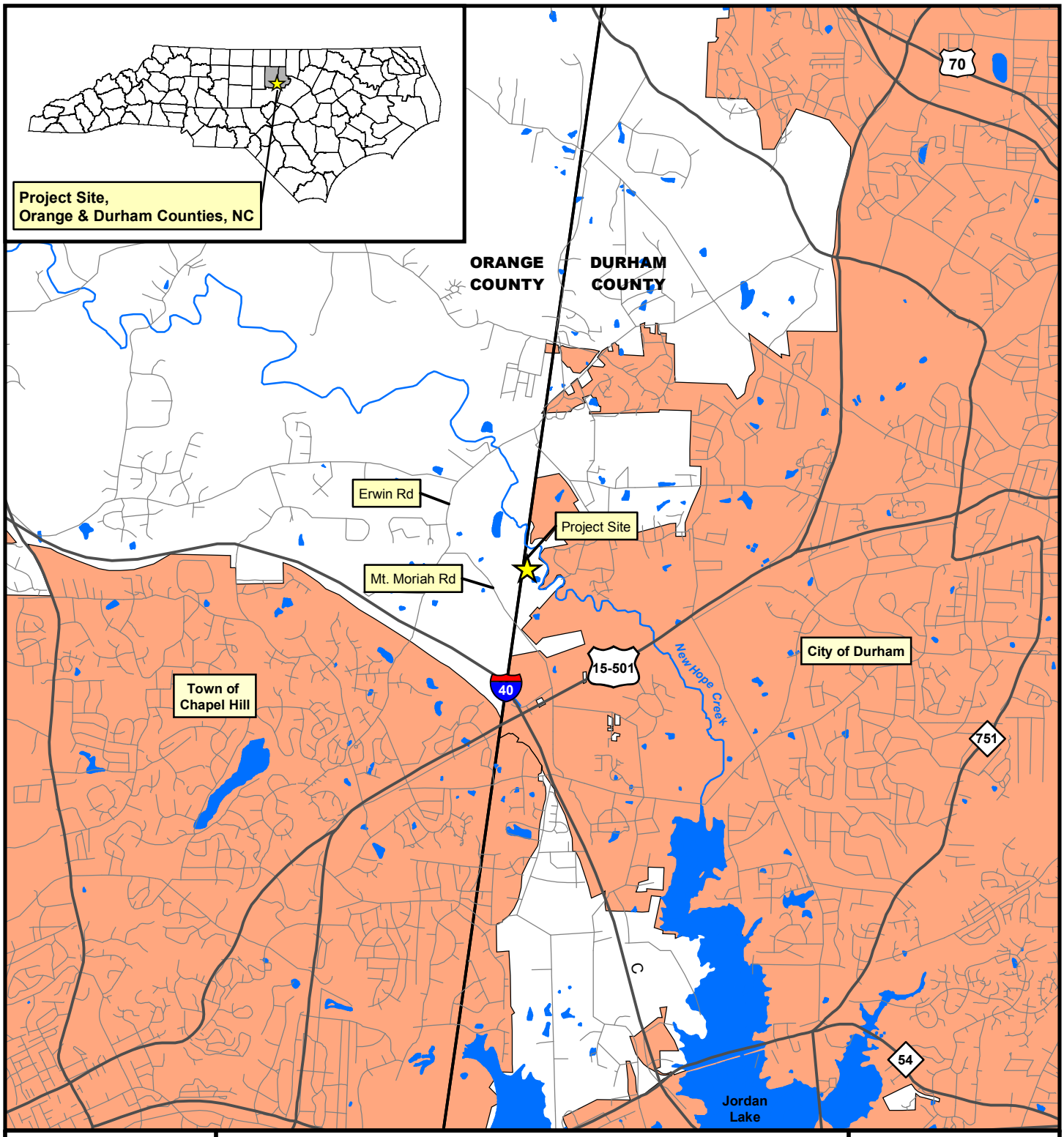
The Brown Farm Wetland Restoration Site is located within the 03030002 (Upper Cape Fear 02) Watershed Cataloging Unit (8-digit HUC) and North Carolina Division of Water Quality (NCDWQ) sub-basin 03-06-05 (Figure 1). The project has a contributing drainage area of 33.3 square miles (21,331 acres) at the downstream limits of the site and contains the headwaters of New Hope Creek, which then flows approximately 11 miles before entering Jordan Lake. The project watershed is located within the Piedmont physiographic province and is part of the Triassic Basins Level IV Ecoregion.

The Orange and Durham County Soil Surveys classify all the soils underlying the site as Chewacla. However, this classification was inconsistent with the observed soil conditions at the site. A detailed soils investigation by a KCI soil scientist identified Wehadkee soils as occupying the central portion of the site where restoration will take place. This detailed soils investigation was conducted by augering numerous soil borings across the site in areas identified by landscape position, vegetation, and slope followed by the preparation of a soil map that identified the extent of each soil mapping unit. The resulting distribution of soils on-site is estimated to be 75% Wehadkee and 25% Chewacla. The Wehadkee and Chewacla soils are defined as hydric soils. The soils in the north-central portion of the project site do not have hydric features until a depth of approximately 18-24 inches. This is likely caused from overwash sediment from flooding events that have accumulated on top of the Wehadkee soil below.

Historic aerial photographs dating from 1955 show the site under cultivation or in pasture in the last fifty years. Drainage ditches throughout the site are evident in each of the photographs. The landowner reports that several ditches along the property were constructed in the 19th century. A large floodplain pool feature in the southeast corner of the project site is visible in all of the historic images.

Site hydrology was evaluated during field investigations. Wetland hydrology at the site is driven primarily by surface water inputs: precipitation, overland flow from upstream slopes and overbank events from New Hope Creek. Pre-restoration site hydrology was modeled by developing an annual water budget that calculates water inputs and outputs in order to compare the change in storage on a monthly time step. A water budget was developed for the agricultural land on the project site. The wetland budget shows that the main losses are due to groundwater seepage and surface water drainage that eventually flow into New Hope Creek. Prior to construction, the conditions were unsaturated within the upper 12 inches of soil throughout the site, except for the 3.3 acres of existing wetland. Ditches and berms prevented the site from experiencing the maximum amount of hydrologic inputs it could receive.

KCI also conducted a hydrologic analysis to determine which wetlands are within the 5-year New Hope Creek floodplain. Based on this analysis, the entire site, with the exception of a few ditch spoils, would be inundated within the 5-year floodplain of New Hope Creek. The drained hydric soils had been used for agriculture and did not qualify as jurisdictional wetlands. A further analysis was completed to determine how often a flood event



KCI TECHNOLOGIES

Figure 1. Vicinity Map

- Project Location
- Major Streams and Rivers
- Lakes and Reservoirs
- Municipalities
- Counties
- Major Roads
- Other Roads

1:63,360
1 inch equals 1 miles

1 0.5 0 1 Miles

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would reach the site. This analysis concluded that a 1.1 year flood event would reach the site, with a 1.2 year flood event showing significant flooding on the site. The 24.6 acre restoration area contained hydric soils, however the hydrology had been altered by drainage ditches for the use of agriculture, and no longer contained jurisdictional hydrology. The filling of the drainage ditches restored historic hydrology and the area has been planted with Piedmont Bottomland Hardwoods vegetation. The US Army Corps of Engineers (USACOE) approved the boundaries of the existing 3.3 acres of wetlands on the site, which are made up of Piedmont Bottomland Hardwood vegetation.

Restoration of the site focused on the removal of hydrologic alterations and reforestation of the site with species common to Piedmont Bottomland Hardwood wetlands. The restoration activities resulted in substantial enhancement of the existing water quality and habitat functions on-site. The elimination of channelized flow from agricultural ditches that drain to New Hope Creek reduced nutrient and sediment runoff from the site. Plugging and filling ditches, installing level spreaders, and creating microtopography resulted in increased short-term surface and subsurface water storage and a subsequent increase in the duration and elevation of the seasonally high water table.

Specific actions conducted to achieve the goals and objectives of the project included:

- Plugging and filling drainage ditches throughout the site
- Removing ditch spoil from wooded areas to restore natural drainage patterns
- Placing water diversion features, where appropriate, to redistribute the surface hydrology
- Recreating microtopography across the site to enhance surface water retention and storage
- Re-vegetating the site with Piedmont Bottomland Hardwood Forest species

Designed/Monitoring by: KCI Technologies, Inc. / KCI Associates of North Carolina, PA

Construction by: KCI Environmental Technologies and Construction Inc.

3.0 SUCCESS CRITERIA

3.1 Hydrology

Wetland hydrology will be considered established if well data from the site indicate that the water table is within 12 inches of the soil surface for a continuous 5% of the growing season during normal weather conditions. The growing season was taken from USDA Natural Resources Conservation Service (NRCS) climatic data for Durham County, which has the closest meteorological station to the project site (Station NC312515). According to the NRCS, the growing season is considered to be the period with a 50% probability that the daily minimum temperature is higher than 28° F. The growing season for Durham County extends from March 24 to November 1 for a total of 222 days. Based on this growing season, success will be achieved at the project site if the water table is within 12 inches of the soil surface for 11 consecutive days or more during the growing season.

The hydrologic data from the restoration site will also be compared to groundwater data at the reference wetland site, which is a mature Piedmont Bottomland Hardwood community approximately 0.8 miles from the restoration site. The reference wetland will serve as a comparison for the restoration site to see if periods of drought or excessive precipitation are reflected at both sites. It is anticipated that the restoration site may experience more saturation than the required 5% of the growing season.

3.2 Vegetation

The success criteria for the planted species in the restoration areas will be based on survival and growth. Survival of planted species must be 320 stems/acre at the end of five years of monitoring. Non-target species must not constitute more than 20% of the woody vegetation based on permanent monitoring plots.

3.3 Soils

A soils investigation was conducted by a certified soil scientist from KCI to determine the extent and distribution of the hydric soils on the site and to classify the predominate soils to the soil series level. The project site has been in agricultural production for approximately 100 years, but no Prior Converted (PC)

wetland determination has been made on the site by the NRCS. The resulting distribution of soils on-site is estimated to be 75% Wehadkee and 25% Chewacla. The Wehadkee and Chewacla soils are defined as hydric soils due to saturation for a significant period during the growing season. There are no success criteria for the project soils due to their previous classification as hydric.

4.0 MONITORING SCHEDULE

The site will be monitored for a period of five years beginning in 2007 through 2011 or until the success criteria are achieved. Reports will be submitted to EEP each year. Monitoring will include collection of vegetative and hydrologic data, photo documentation and an annual site walk (see "As-Built Plans" for monitoring locations).

4.1 Hydrology

Groundwater elevations will be monitored to demonstrate the attainment of jurisdictional hydrology. Verification of wetland hydrology will be determined by automatic recording well data collected within the project area. Seven wells have been established within the restoration area and one well has been set up at the reference wetland, which is in close proximity to the site. Data will be collected from the automatic wells over the 5-year monitoring period following implementation.

4.2 Vegetation

Twenty permanent monitoring plots (10 x 10 meters) have been established in the wetland restoration areas at a density that will ensure 2% coverage of the total restoration acreage. Plots have been systematically located to ensure even placement. Data will be collected at each plot for: total number of stems, species, percent survival, height, estimated percent cover of all species, and evidence of insects, disease or browsing.

5.0 MITIGATION

Mitigation for wetland impacts will be achieved through restoration of agricultural land and the enhancement of existing wetlands. The site is 46.1 acres of land, 24.6 of which are hydric soils drained for hay production and grazing, 3.3 of which have been classified as jurisdictional wetland in need of enhancement and 18.2 of which is an upland inclusion area. The restoration of the site removed artificial drainages and re-vegetated 24.6 acres of Piedmont Bottomland Hardwood Forest that historically occupied this landscape position. The restoration of these wetlands will result in 25.7 wetland mitigation units to offset un-avoidable wetland impacts in the Cape Fear River Basin.

KCI TECHNOLOGIES

Figure 2. Mitigation Type and Extent

Wetland Enhancement (3.3 acres)

Wetland Restoration (24.6 acres)

Project Site Boundary

New Hope Creek

Image Source: USGS Urban Area High Resolution Orthoimagery, March 2002

N

W E

S

1:3,000

1 inch equals 250 feet

250 125 0 250

Feet

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ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.

6.0 MAINTENANCE AND CONTINGENCY PLANS

Activities will be conducted throughout the year and may include invasive species control, debris or trash removal, etc. If the monitoring of the site identifies a failure to attain specific success criteria, a remedial action plan will be developed that investigates the cause of the failure and proposes actions to rectify the problem.

Contingency and maintenance plans were developed to help ensure the proper maintenance of the restored wetlands in order to promote the long-term success of the restoration project. Corrective actions, as detailed in Table 1, will be taken to rectify identified site problems as well as to address monitoring findings that indicate a failure to meet established success criteria.

Table 1 - Contingency Plans.

Identified Problem	*Corrective Action*	*Timeframe*
1. Ditch plugs or other hydrologic feature not functioning as designed.	Evaluate the cause for failure and design a remedial action to ensure hydrologic integrity on the site.	Immediate
2. Woody vegetation not meeting success criteria	Determine reason for failure, determine quantity of plantings required to replant, develop list of species to be utilized, and install in accordance with original design specifications.	Seasonal (during dormancy)
3. Barren areas void of herbaceous vegetation.	Determine reason for failure, prepare area applying topsoil and amendments as necessary, and reseed with appropriate mix.	Immediate
4. Invasive species edging out desirable species.	Hand removal of or herbicide application to invasive plants.	Immediate

Guidance related to the approved seed mixture to be used in the event any reseeding activities are necessary is provided in Table 2.

Table 2 - Re-seeding Specifications.

Summer Mix (April 15 – October 15)

Species		Application Rate (in Mix) % of Mix	lbs./acre
Redtop	*Agrostis alba*	5	1.5
Purple Lovegrass	*Eragrostis spectabilis*	5	1.5
Gama grass	*Tripsacum dactyloides*	35	10.5
Switchgrass	*Panicum virgatum*	30	9.0
Brown Top Millet	*Pennisetum glaucoma*	25	7.5
	TOTALS	100	30.0

Winter Mix (October 15 – April 15)

Same as above except substitute Rye Grain (*Secale cereale*) for Brown Top Millet.

7.0 AS-BUILT CONDITIONS

The site was built in accordance with the restoration plan. See the as-built plans within this document as a reference.

7.1 Vegetation

In the 24.6 acres of wetland restoration were twenty vegetation plots were established to cover 2% of the restored wetland acreage. The as-built condition assessment revealed an average density of 558 trees per acre based on the vegetation monitoring plots, which is well above the minimum requirement of 320 trees per acre (Appendix B). A total of eight trees per vegetation monitoring plot are needed to meet the 320 trees per acre minimum requirement. The as-built conditions assessment was conducted in February 2007. Due to the lack of identifying features on the seedlings, not all of the seedlings were identified to species. Some of the trees species have been labeled unknown in Table 3.

Table 3 - As-Built Vegetation Monitoring Results

Plot Number	Willow Oak	Swamp Chestnut Oak	Laurel Oak	Overcup Oak	Green Ash	Water Tupelo	Cherrybark Oak	Unknown	Total (Year 0)	Density-Year 0 (Trees/Acres)
1	1				4			11	16	640
2		1		1	5			12	19	760
3	1	1						15	17	680
4								13	13	520
5	1	1		1	5			8	16	640
6		2			3			5	10	400
7	1				1			15	17	680
8			1					13	14	560
9			1		3			7	11	440
10	3				2			7	12	480
11				1	1			14	16	640
12					2			11	13	520
13				1	2			13	16	640
14				2			1	15	18	720
15			1					7	8	320
16	3							9	12	480
17					9			6	15	600
18								8	8	320
19	3				3	1		5	12	480
20					6			10	16	640
								Total Average Density		558

Appendix A

As-Built Plans

STATE	STATE CONSTRUCTION PROJECT NO.	SHEET NO.	TOTAL SHEETS
N.C.		1	4

SYM.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

CONTRACT #: D0501I-2

KCI JOB #: 120542S2

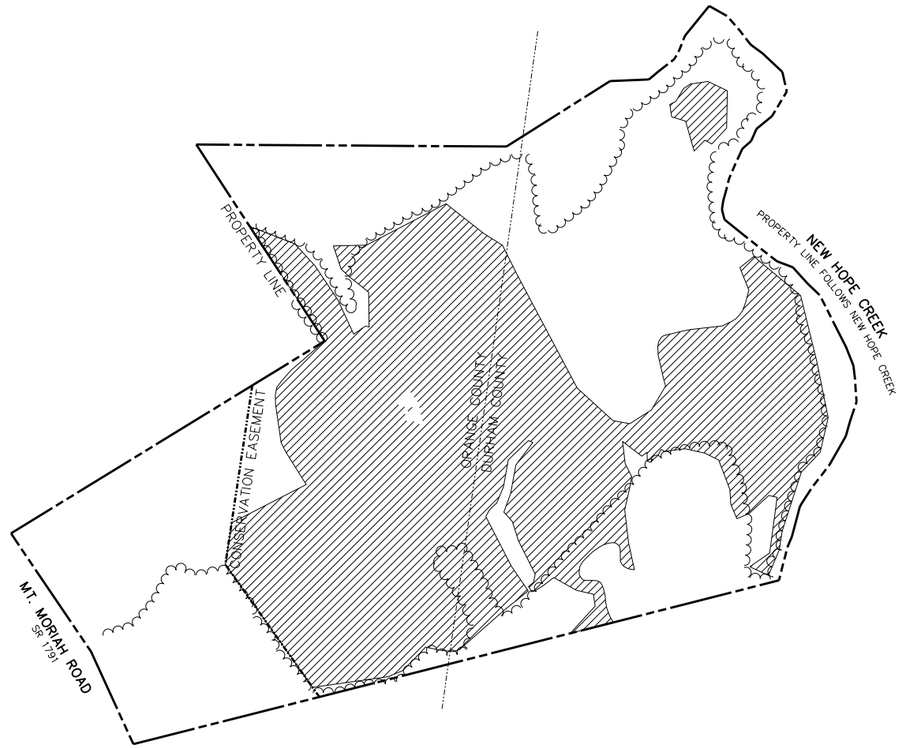
VICINITY MAP
NOT TO SCALE

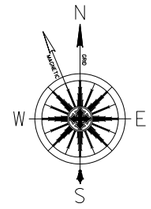
STATE OF NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

ORANGE & DURHAM COUNTIES

LOCATION: BROWN SITE
MT. MORIAH ROAD
DURHAM, NC 27707

TYPE OF WORK: WETLAND RESTORATION SITE





AS-BUILT PLAN

INDEX OF SHEETS

1 *TITLE SHEET*
2 *AS-BUILT SITE PLAN*
3 *MONITORING LOCATIONS*
4 *PLANTING PLAN*

GRAPHIC SCALES

Prepared in the Office of:

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SOIL SCIENTIST

PROJECT ENGINEER:
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SIGNATURE:

PROFESSIONAL WETLAND SCIENTIST:
P.W.S.
SIGNATURE:

SOIL SCIENTIST:
L.S.S.
SIGNATURE:

SITE PLAN LEGEND

- EXISTING EASEMENT LINE
- EXISTING 1.0' CONTOUR LINES
- EXISTING 0.5' CONTOUR LINES
- TREE LINE
- LEVEL SPREADER
- ROCK STABILIZED OUTLET
- ENHANCED WETLAND
- RESTORED WETLAND

PROPERTY LINE

NEW HOPE CREEK
PROPERTY LINE FOLLOWS NEW HOPE CREEK

CONSERVATION EASEMENT

CONSERVATION EASEMENT

MT. MORIAH ROAD
SR 1791

NC GRID
NAD '83

–100 –50 0 100 200
GRAPHIC SCALE

REVISIONS

NO.	DESCRIPTION	DATE	APPROVED
1			

Ecosystem Enhancement Program

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4601 SIX FORKS RD., RALEIGH, NC

BROWN FARM - NEW HOPE CREEK WETLAND RESTORATION PROJECT

ORANGE / DURHAM COUNTY, NORTH CAROLINA

DATE: FEB 2007
SCALE: 1"=100'

AS-BUILT SITE PLAN

SHEET 2 OF 4

SITE PLAN LEGEND

- EXISTING EASEMENT LINE
- EXISTING 1.0' CONTOUR LINES
- EXISTING 0.5' CONTOUR LINES
- DRAINAGE DITCH
- TREE LINE
- LEVEL SPREADER
- ROCK STABILIZED OUTLET
- GROUNDWATER WELL
- RAIN GAUGE / BARROLOGGER
- PHOTO POINT
- VEGETATION PLOT

PROPERTY LINE

NEW HOPE CREEK
PROPERTY LINE FOLLOWS NEW HOPE CREEK

MT. MORIAH ROAD
SR 1791

CONSERVATION EASEMENT

CONSERVATION EASEMENT

RAIN GAUGE AND BAROLOGGER

PP #1 PP #2 PP #3 PP #4 PP #5 PP #6 PP #7

PLOT #1 PLOT #2 PLOT #3 PLOT #4 PLOT #5 PLOT #6 PLOT #7 PLOT #8 PLOT #9 PLOT #10 PLOT #11 PLOT #12 PLOT #13 PLOT #14 PLOT #15 PLOT #16 PLOT #17 PLOT #18 PLOT #19 PLOT #20

WELL #1 WELL #2 WELL #3 WELL #4 WELL #5 WELL #6 WELL #7

NC GRID
NAD '83

–100 –50 0 100 200
GRAPHIC SCALE

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

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BROWN FARM - NEW HOPE CREEK WETLAND RESTORATION PROJECT

ORANGE / DURHAM COUNTY, NORTH CAROLINA

DATE: FEB 2007
SCALE: 1"=100'

MONITORING LOCATIONS

SHEET 3 OF 4

PLANTING PLAN LEGEND

- PLANTING ZONE A
- PLANTING ZONE B
- ENHANCEMENT PLANTING ZONE

ZONE A :

GREEN ASH	(FRAXINUS PENNSYLVANICA)
WATER TUPELO	(NYSSA AQUATICA)
OVERCUP OAK	(QUERCUS LYRATA)
SWAMP CHESTNUT OAK	(QUERCUS MICHAUXII)
WILLOW OAK	(QUERCUS PHELLOS)

ZONE B :

GREEN ASH	(FRAXINUS PENNSYLVANICA)
TULIP POPLAR	(LIRIODENDRON TULIPFERA)
LAUREL OAK	(QUERCUS LAURIFOLIA)
CHERRYBARK OAK	(QUERCUS PAGODA)

ENHANCEMENT ZONE

LAUREL OAK	(QUERCUS LAURIFOLIA)
OVERCUP OAK	(QUERCUS LYRATA)
WATER TUPELO	(NYSSA AQUATICA)

PROPERTY LINE

NEW HOPE CREEK
PROPERTY LINE FOLLOWS NEW HOPE CREEK

CONSERVATION EASEMENT

CONSERVATION EASEMENT

MT. MORIAH ROAD
SR 1791

NC GRID
NAD '83

-100 -50 0 100 200
GRAPHIC SCALE

REVISIONS			
SYM.	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement Program

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BROWN FARM - NEW HOPE CREEK WETLAND RESTORATION PROJECT

ORANGE / DURHAM COUNTY, NORTH CAROLINA

DATE: FEB 2007
SCALE: 1"=100'

PLANTING PLAN

SHEET 4 OF 4

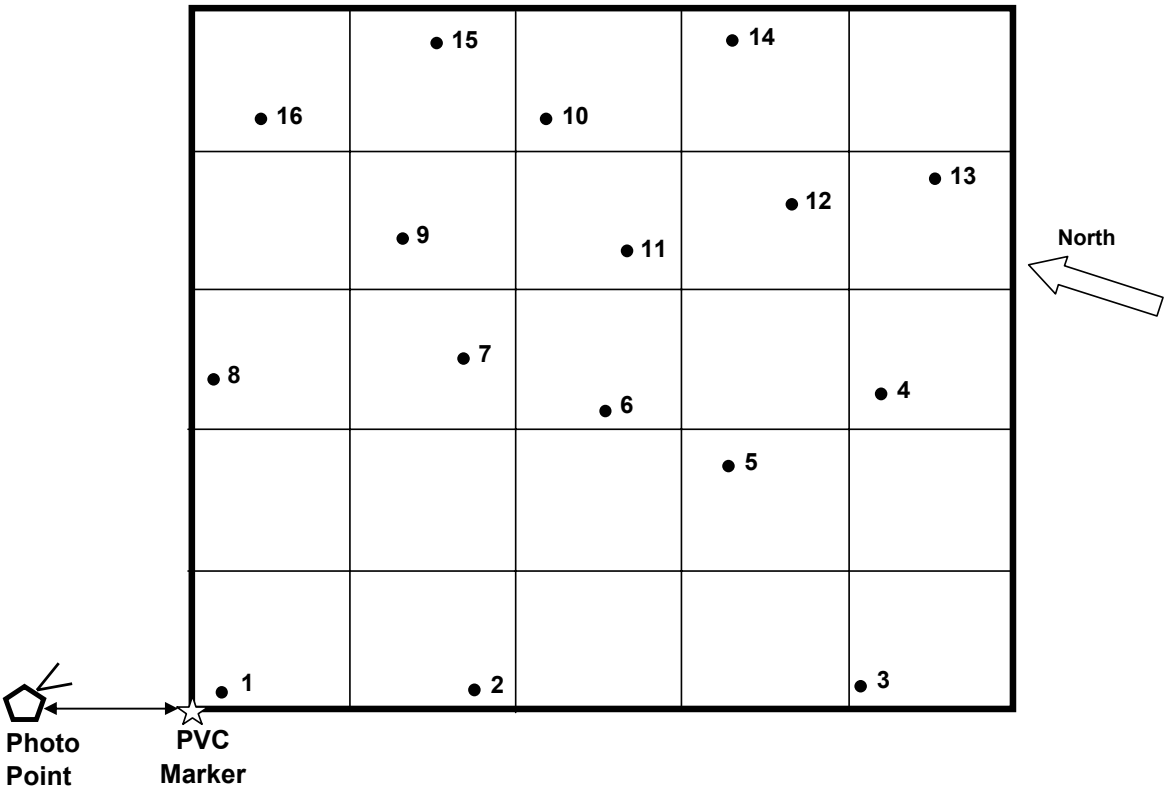
Appendix B

As-Built Vegetation Monitoring Plot Data Sheets

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 1 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Green Ash (*Fraxinus pennsylvanica*)	0.70	4	
2	Unknown	0.68	3	
3	Green Ash (*Fraxinus pennsylvanica*)	0.44	4	
4	Green Ash (*Fraxinus pennsylvanica*)	0.62	3	
5	Unknown	0.68	4	
6	Unknown	0.62	3	
7	Unknown	0.63	3	
8	Green Ash (*Fraxinus pennsylvanica*)	0.65	4	
9	Unknown	0.57	3	
10	Unknown	0.58	3	
11	Willow Oak (*Quercus phellos*)	0.41	3	
12	Unknown	0.75	4	
13	Unknown	0.59	4	
14	Unknown	0.55	3	
15	Unknown	0.46	4	
16	Unknown	0.54	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	25.0%
Willow Oak (*Quercus phellos*)	6.3%
Unknown	68.8%

Density:

Total Number of Trees **16** / **0.025 acres** = **640** **trees / acre**

Survivability:

Total Number of Trees **16** / **16 trees** x **100** = **100** **% survivability**

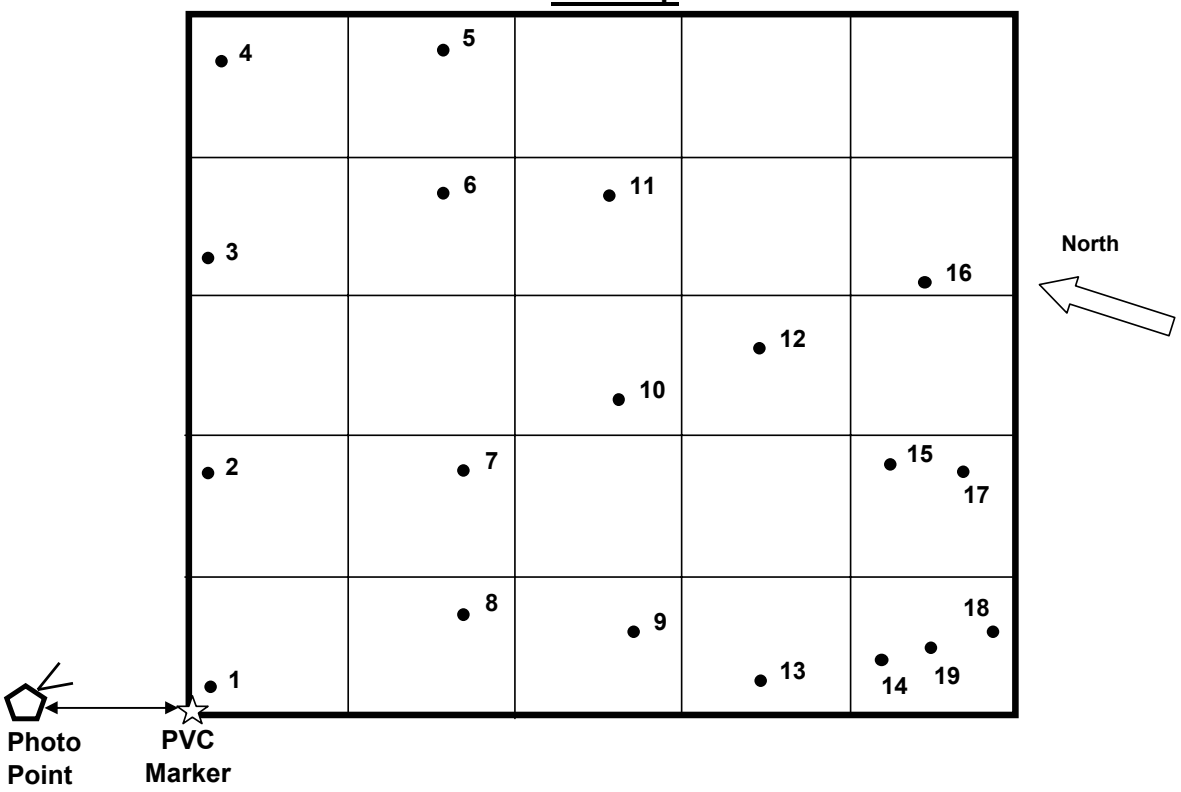
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 2 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Green Ash (*Fraxinus pennsylvanica*)	0.50	4	
2	Unknown	0.45	4	
3	Unknown	0.82	4	
4	Unknown	0.79	4	
5	Overcup Oak (*Quercus lyrata*)	0.48	4	
6	Unknown	0.49	3	
7	Unknown	0.60	3	
8	Green Ash (*Fraxinus pennsylvanica*)	0.39	4	
9	Swamp Chestnut Oak (*Quercus michauxii*)	1.10	4	
10	Unknown	0.58	3	
11	Green Ash (*Fraxinus pennsylvanica*)	0.61	3	
12	Green Ash (*Fraxinus pennsylvanica*)	0.52	4	
13	Unknown	0.42	3	
14	Unknown	0.65	3	
15	Green Ash (*Fraxinus pennsylvanica*)	0.52	4	
16	Unknown	0.37	3	
17	Unknown	0.29	4	
18	Unknown	0.32	3	
19	Unknown	0.27	2	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

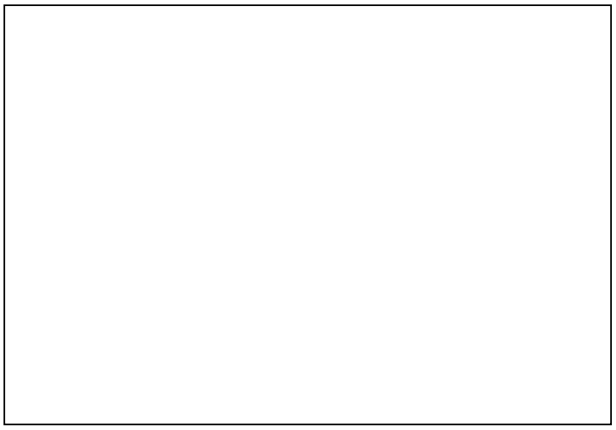
Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	26.3%
Overcup Oak (*Quercus lyrata*)	5.3%
Swamp Chestnut Oak (*Quercus michauxii*)	5.3%
Unknown	63.2%

Density:

Total Number of Trees **19** / **0.025 acres** = **760** **trees / acre**

Survivability:

Total Number of Trees **19** / **19 trees** x **100** = **100** **% survivability**



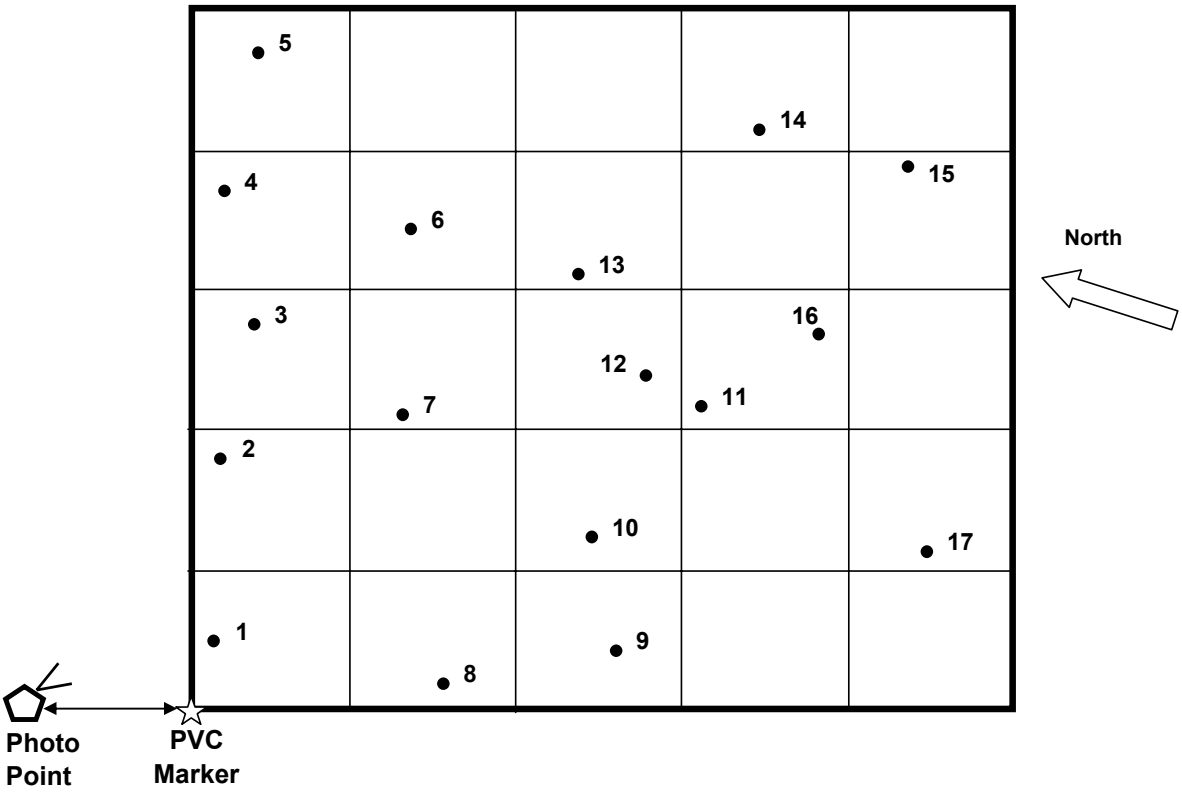
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 3 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.62	4	
2	Unknown	0.59	3	
3	Unknown	0.67	3	
4	Unknown	0.52	3	
5	Willow Oak (*Quercus phellos*)	0.53	3	
6	Unknown	0.58	3	
7	Unknown	0.51	4	
8	Unknown	0.56	3	
9	Unknown	0.44	3	
10	Unknown	0.63	3	
11	Unknown	0.60	3	
12	Unknown	0.64	3	
13	Swamp Chestnut Oak (*Quercus michauxii*)	0.54	3	
14	Unknown	0.64	4	
15	Unknown	0.53	3	
16	Unknown	0.59	3	
17	Unknown	0.63	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Willow Oak (*Quercus phellos*)	5.9%
Swamp Chestnut Oak (*Quercus michauxii*)	5.9%
Unknown	88.2%

Density:

Total Number of Trees							
17	/	0.025 acres	=	**680**	trees / acre		

Survivability:

Total Number of Trees								
17	/	17 trees	x	100	=	**100**	% survivability	

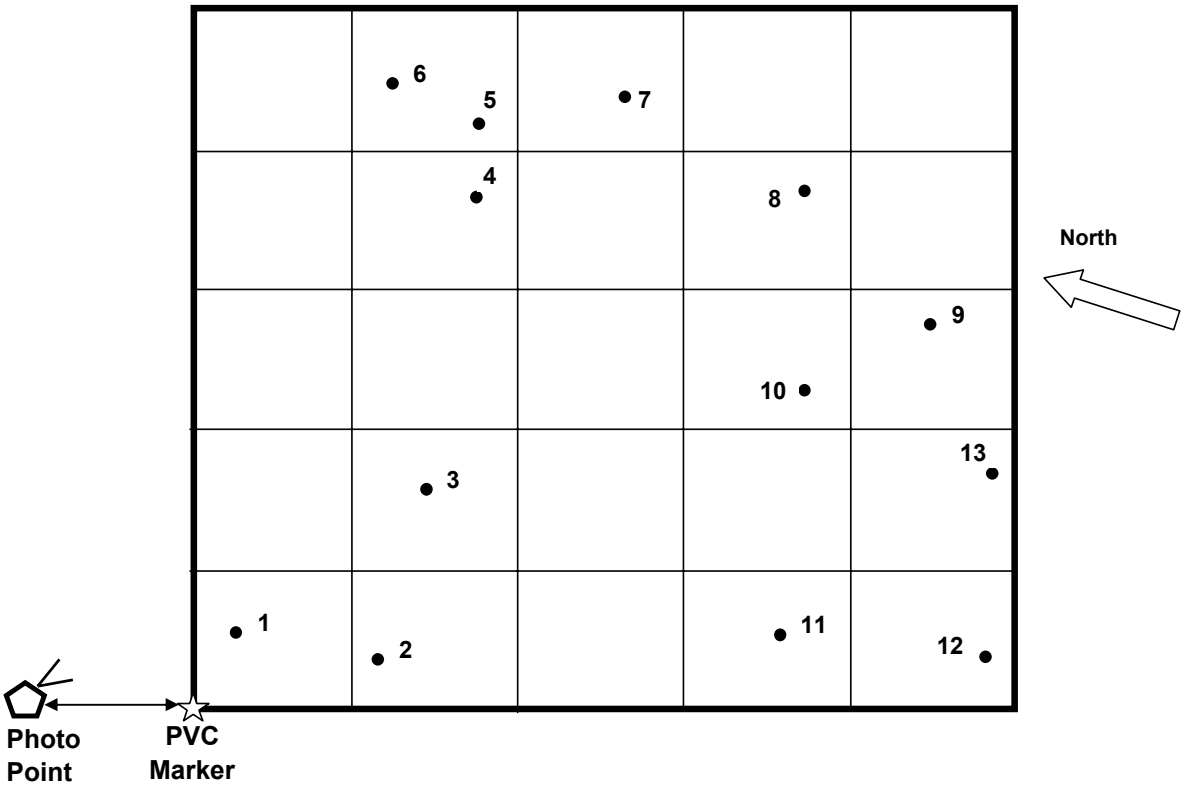
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 4 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.82	3	
2	Unknown	0.62	3	
3	Unknown	0.58	3	
4	Unknown	0.99	2	
5	Unknown	0.66	2	
6	Unknown	0.55	3	
7	Unknown	0.62	3	
8	Unknown	0.65	3	
9	Unknown	0.41	3	
10	Unknown	0.64	3	
11	Unknown	0.48	3	
12	Unknown	0.59	3	
13	Unknown	0.57	2	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Unknown	100.0%

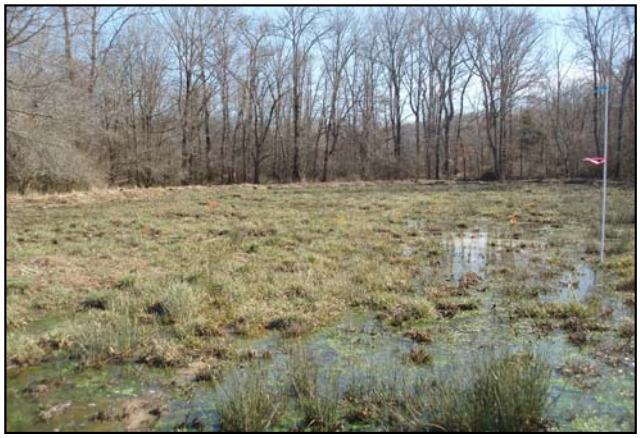
Density:

Total Number of Trees **13** / **0.025 acres** = **520** **trees / acre**

Survivability:

Total Number of Trees **13** / **13 trees** x **100** = **100** **% survivability**

Previous

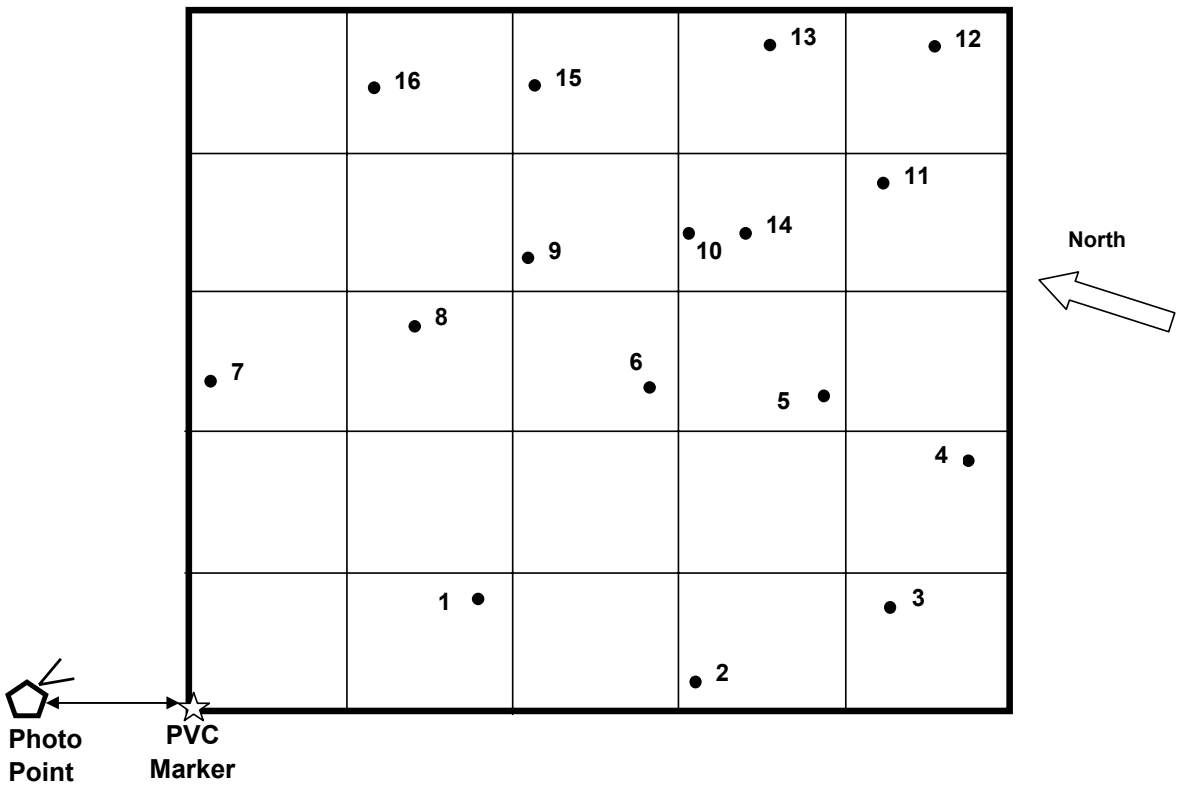


Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 5 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.57	3	
2	Overcup Oak (*Quercus lyrata*)	0.80	4	
3	Green Ash (*Fraxinus pennsylvanica*)	0.55	3	
4	Green Ash (*Fraxinus pennsylvanica*)	0.63	3	
5	Green Ash (*Fraxinus pennsylvanica*)	0.46	3	
6	Unknown	0.54	3	
7	Unknown	0.50	3	
8	Unknown	0.37	3	
9	Unknown	0.42	3	
10	Unknown	1.01	4	
11	Willow Oak (*Quercus phellos*)	0.62	3	
12	Unknown	0.39	3	
13	Green Ash (*Fraxinus pennsylvanica*)	0.39	3	
14	Green Ash (*Fraxinus pennsylvanica*)	0.55	3	
15	Unknown	0.60	3	
16	Swamp Chestnut Oak (*Quercus michauxii*)	0.54	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

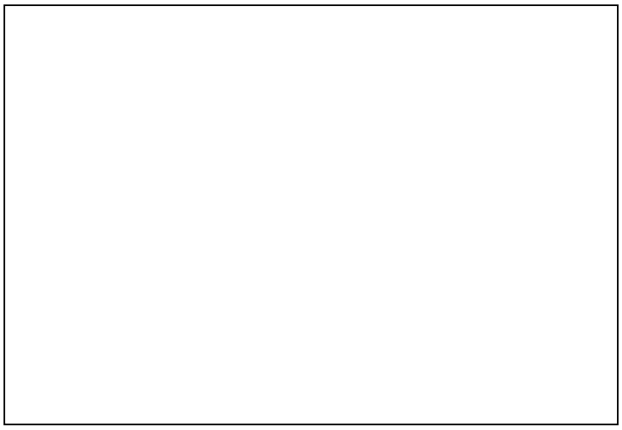
Species	Percent of Total
Overcup Oak (*Quercus lyrata*)	6.3%
Green Ash (*Fraxinus pennsylvanica*)	31.3%
Willow Oak (*Quercus phellos*)	6.3%
Swamp Chestnut Oak (*Quercus michauxii*)	6.3%
Unknown	50.0%

Density:

Total Number of Trees **16** / **0.025 acres** = **640** **trees / acre**

Survivability:

Total Number of Trees **16** / **16 trees** x **100** = **100** **% survivability**



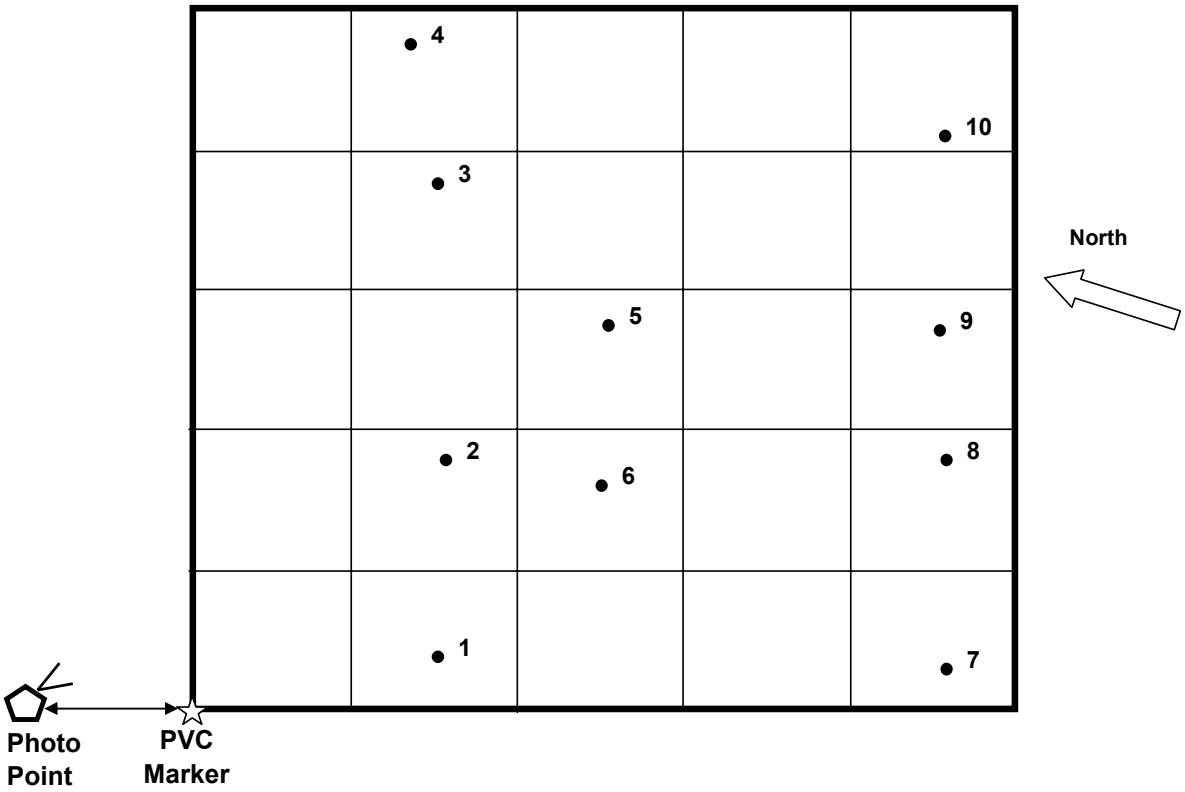
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 6 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Green Ash (*Fraxinus pennsylvanica*)	0.51	3	
2	Unknown	0.42	3	
3	Unknown	0.64	4	
4	Unknown	0.58	3	
5	Unknown	0.42	3	
6	Green Ash (*Fraxinus pennsylvanica*)	0.49	3	
7	Swamp Chestnut Oak (*Quercus michauxii*)	0.59	3	
8	Green Ash (*Fraxinus pennsylvanica*)	0.72	3	
9	Swamp Chestnut Oak (*Quercus michauxii*)	0.55	3	
10	Unknown	0.44	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

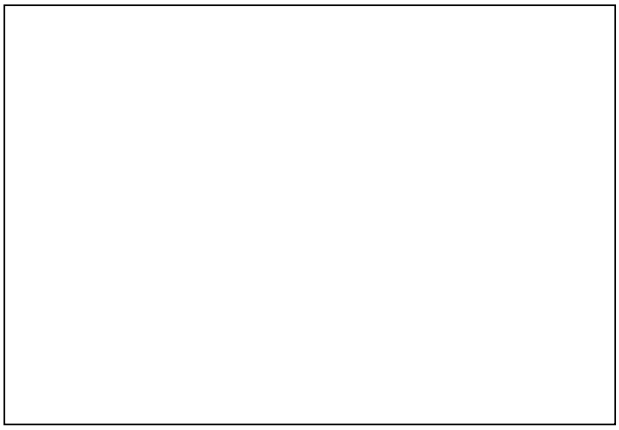
Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	30.0%
Swamp Chestnut Oak (*Quercus michauxii*)	20.0%
Unknown	50.0%

Density:

Total Number of Trees **10** / **0.025 acres** = **400** **trees / acre**

Survivability:

Total Number of Trees **10** / **10 trees** x **100** = **100** **% survivability**



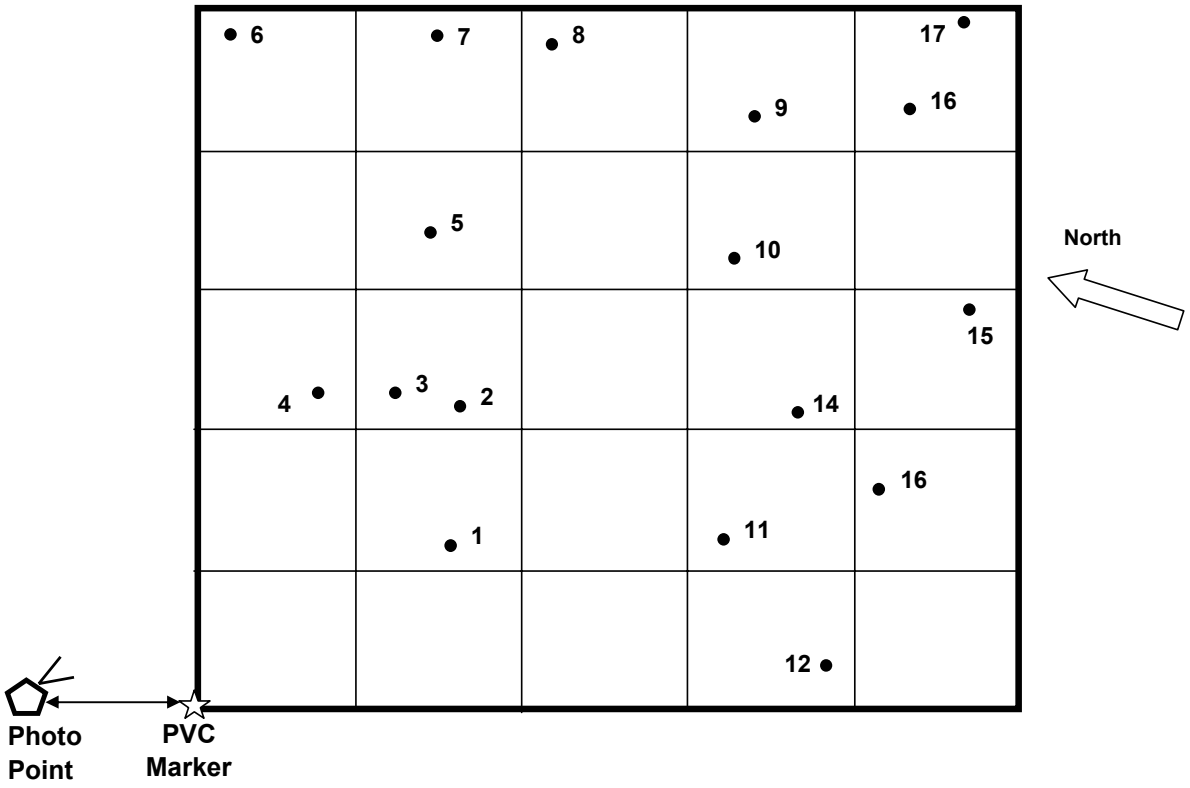
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 7 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.67	3	
2	Willow Oak (*Quercus phellos*)	0.51	3	
3	Unknown	0.60	3	
4	Unknown	0.62	3	
5	Unknown	0.64	3	
6	Unknown	0.37	4	
7	Unknown	0.65	3	
8	Unknown	0.54	3	
9	Unknown	0.65	4	
10	Unknown	0.69	4	
11	Unknown	0.54	4	
12	Unknown	0.60	3	
13	Unknown	0.43	3	
14	Unknown	0.67	3	
15	Unknown	0.33	3	
16	Unknown	0.60	3	
17	Green Ash (*Fraxinus pennsylvanica*)	0.58	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

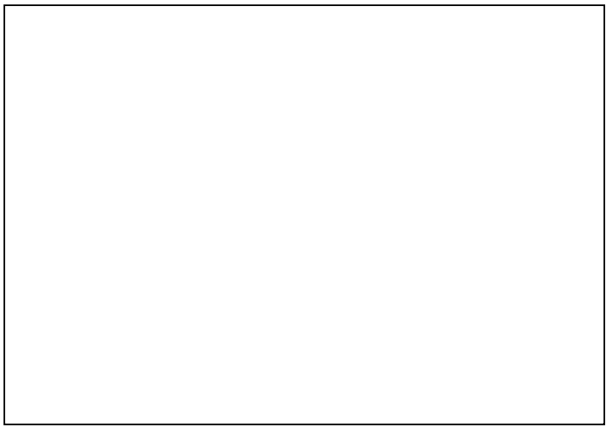
Species	Percent of Total
Willow Oak (*Quercus phellos*)	5.9%
Green Ash (*Fraxinus pennsylvanica*)	5.9%
Unknown	88.2%

Density:

Total Number of Trees **17** / **0.025 acres** = **680** **trees / acre**

Survivability:

Total Number of Trees **17** / **17 trees** x **100** = **100** **% survivability**



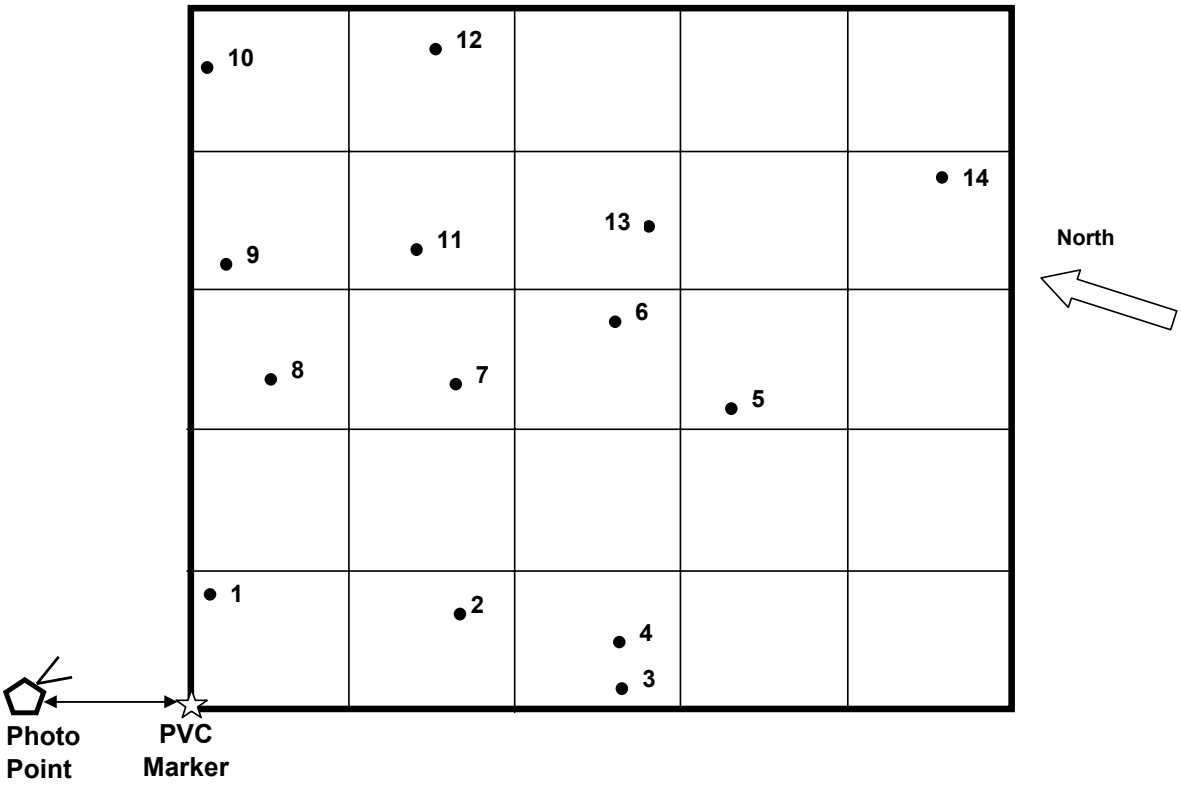
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 8 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.58	3	
2	Unknown	0.68	3	
3	Unknown	0.63	3	
4	Unknown	0.76	3	
5	Unknown	0.49	4	
6	Unknown	0.61	3	
7	Unknown	0.79	4	
8	Unknown	0.66	3	
9	Laurel Oak (*Quercus laurifolia*)	0.95	4	
10	Unknown	0.66	4	
11	Unknown	0.61	3	
12	Unknown	0.66	3	
13	Unknown	0.63	3	
14	Unknown	0.59	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Laurel Oak (*Quercus laurifolia*)	7.1%
Unknown	92.9%

Density:

Total Number of Trees **14** / **0.025 acres** = **560** **trees / acre**

Survivability:

Total Number of Trees **14** / **14 trees** x **100** = **100** **% survivability**

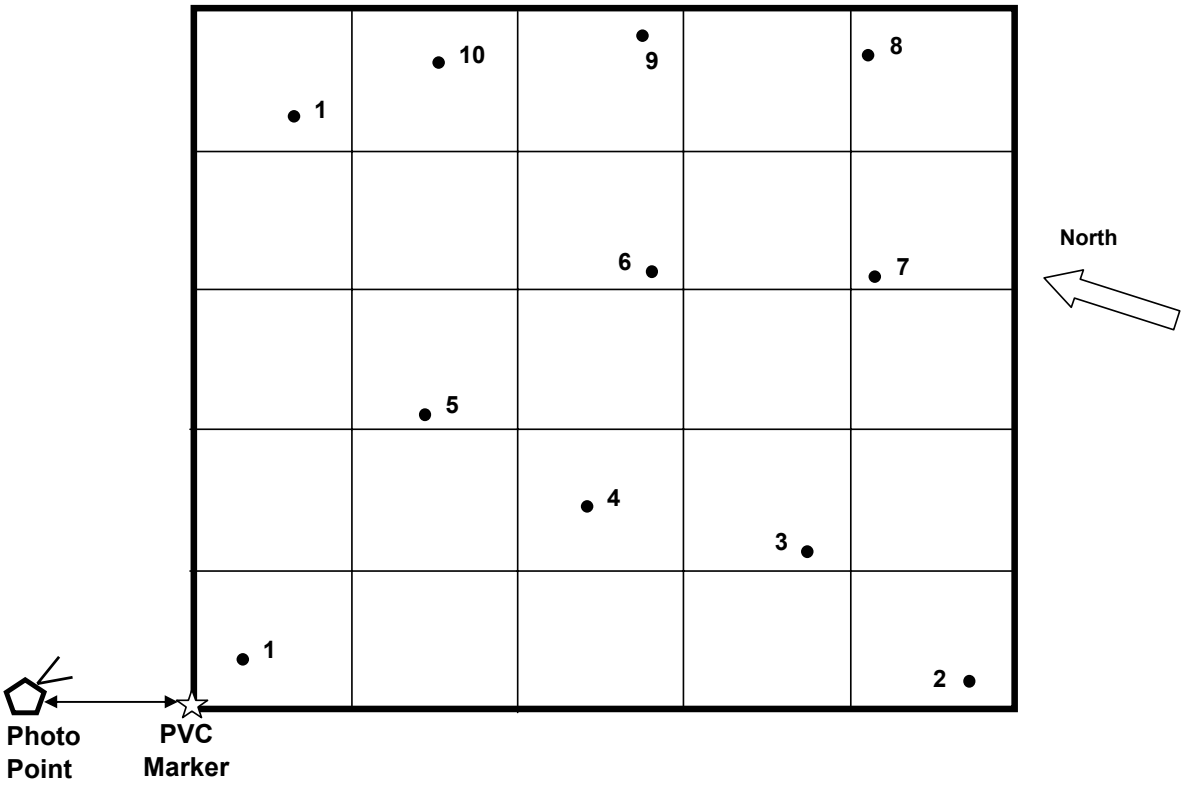
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 9 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Green Ash (*Fraxinus pennsylvanica*)	0.69	4	
2	Unknown	0.57	4	
3	Unknown	0.45	3	
4	Unknown	0.20	2	
5	Green Ash (*Fraxinus pennsylvanica*)	0.94	4	
6	Unknown	0.56	3	
7	Green Ash (*Fraxinus pennsylvanica*)	0.48	3	
8	Unknown	0.65	4	
9	Laurel Oak (*Quercus laurifolia*)	0.56	4	
10	Unknown	0.58	4	
11	Unknown	0.60	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

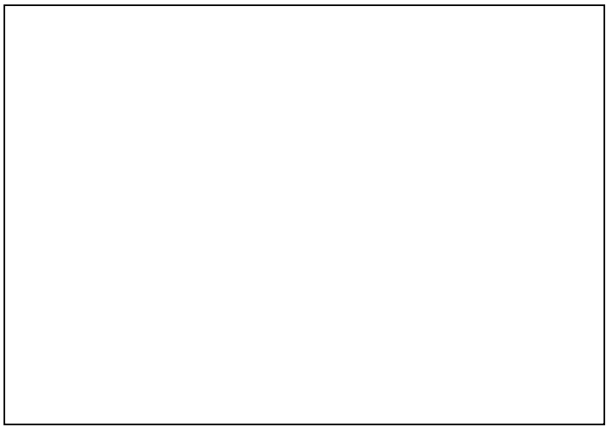
Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	27.3%
Laurel Oak (*Quercus laurifolia*)	9.1%
Unknown	63.6%

Density:

Total Number of Trees **11** / **0.025 acres** = **440** **trees / acre**

Survivability:

Total Number of Trees **11** / **11 trees** x **100** = **100** **% survivability**



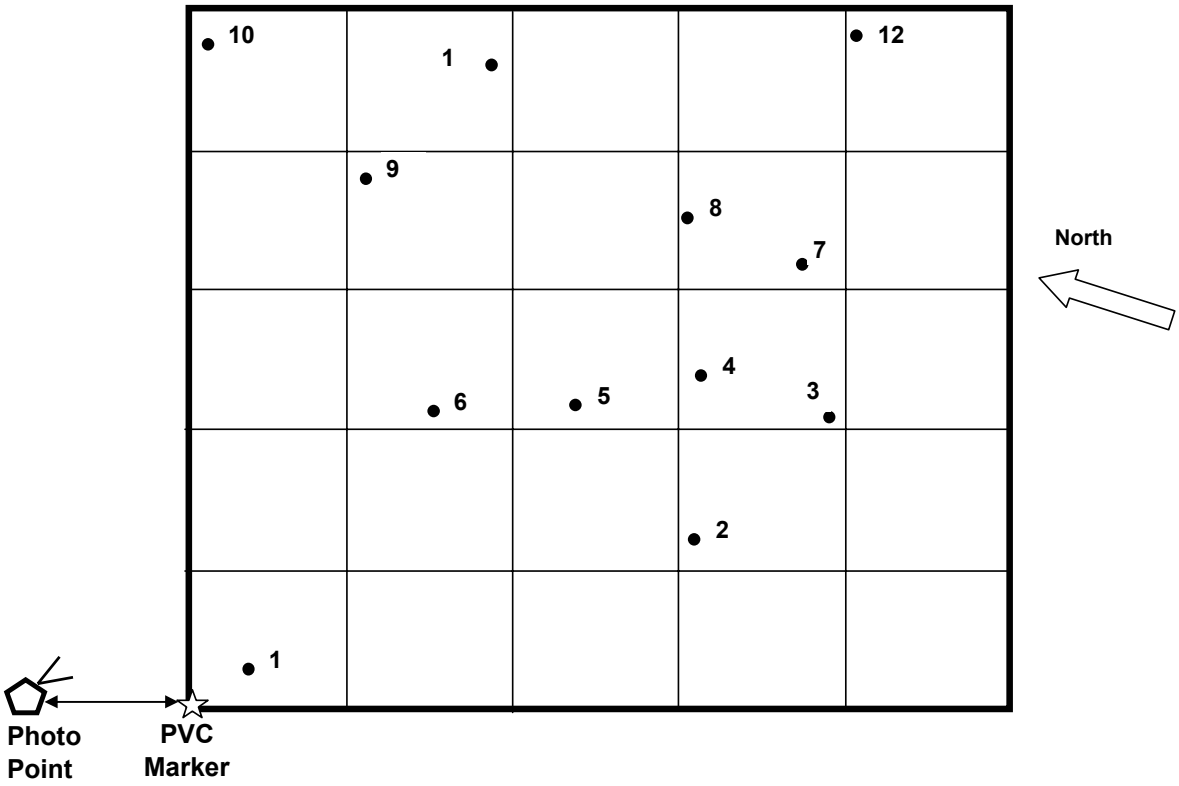
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 10 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.55	4	
2	Unknown	0.63	3	
3	Unknown	0.71	3	
4	Willow Oak (*Quercus phellos*)	0.59	3	
5	Unknown	0.81	4	
6	Willow Oak (*Quercus phellos*)	0.71	3	
7	Unknown	0.40	3	
8	Green Ash (*Fraxinus pennsylvanica*)	0.60	3	
9	Willow Oak (*Quercus phellos*)	0.54	4	
10	Unknown	0.75	4	
11	Green Ash (*Fraxinus pennsylvanica*)	0.56	4	
12	Unknown	0.72	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Willow Oak (*Quercus phellos*)	25.0%
Green Ash (*Fraxinus pennsylvanica*)	16.7%
Unknown	58.3%

Density:

Total Number of Trees **12** / **0.025 acres** = **480** **trees / acre**

Survivability:

Total Number of Trees **12** / **12 trees** x **100** = **100** **% survivability**

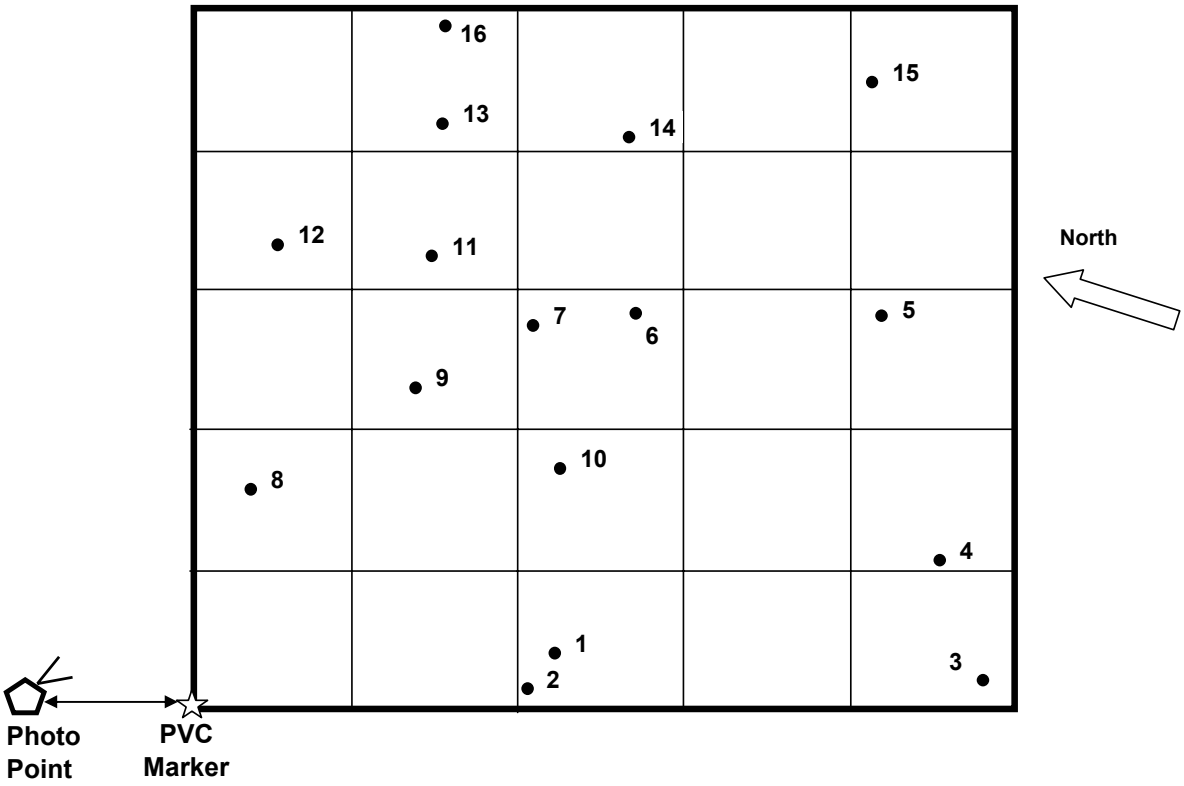
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 11 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Overcup Oak (*Quercus lyrata*)	0.67	4	
2	Unknown	0.60	4	
3	Unknown	0.63	4	
4	Unknown	0.86	4	
5	Unknown	0.53	4	
6	Unknown	0.60	4	
7	Unknown	0.40	3	
8	Unknown	0.66	3	
9	Green Ash (*Fraxinus pennsylvanica*)	0.50	4	
10	Unknown	0.56	4	
11	Unknown	0.62	4	
12	Unknown	0.48	4	
13	Unknown	0.56	4	
14	Unknown	0.59	4	
15	Unknown	0.56	4	
16	Unknown	0.57	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

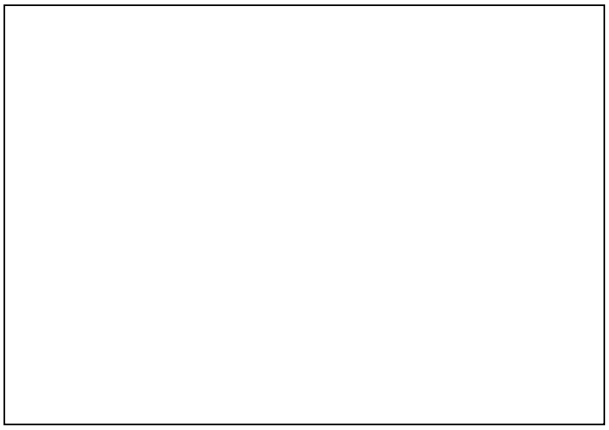
Species	Percent of Total
Overcup Oak (*Quercus lyrata*)	6.3%
Green Ash (*Fraxinus pennsylvanica*)	6.3%
Unknown	87.5%

Density:

Total Number of Trees **16** / **0.025 acres** = **640** **trees / acre**

Survivability:

Total Number of Trees **16** / **16 trees** x **100** = **100** **% survivability**



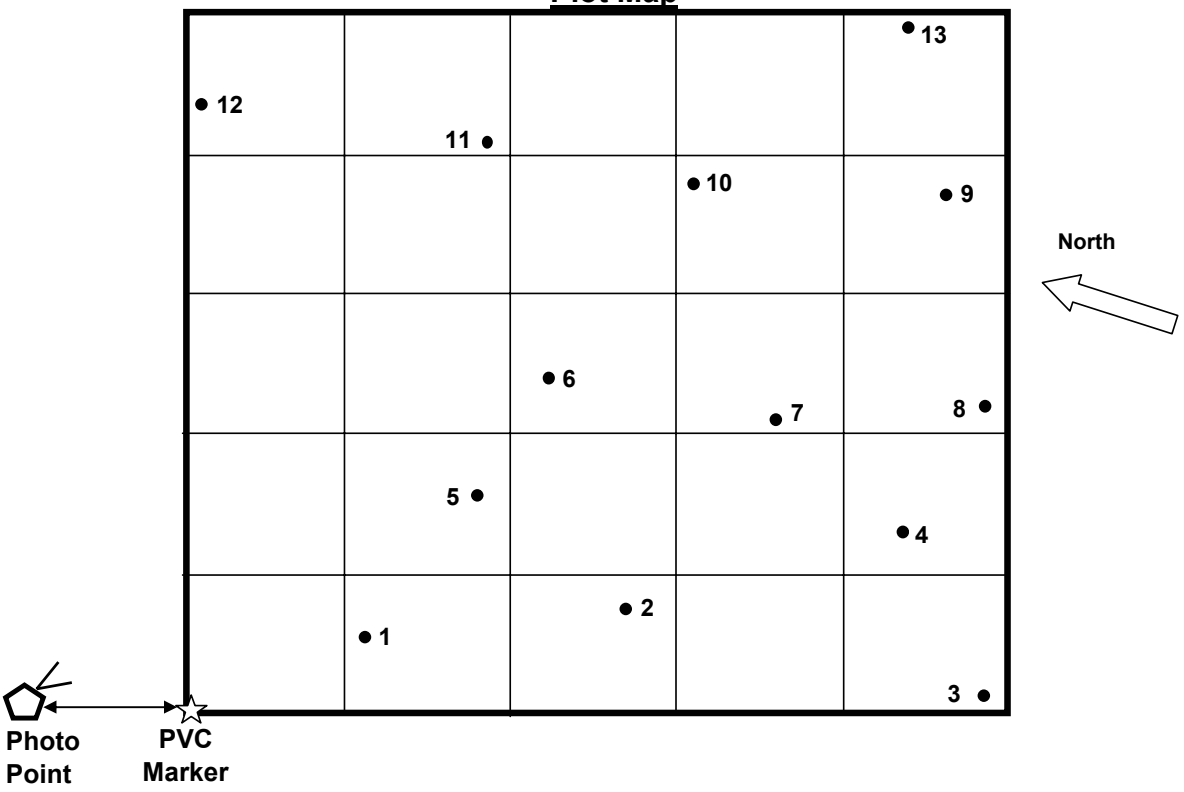
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 12 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.70	4	
2	Unknown	0.75	2	
3	Unknown	0.66	3	
4	Unknown	0.66	3	
5	Unknown	0.50	4	
6	Green Ash (*Fraxinus pennsylvanica*)	0.63	4	
7	Unknown	0.55	3	
8	Unknown	0.60	4	
9	Unknown	0.64	3	
10	Unknown	0.56	3	
11	Unknown	0.65	4	
12	Unknown	0.65	4	
13	Green Ash (*Fraxinus pennsylvanica*)	0.52	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	15.4%
Unknown	84.6%

Density:

Total Number of Trees							
13	**/**	**0.025 acres**	**=**	**520**	**trees / acre**		

Survivability:

Total Number of Trees								
13	**/**	**13**	**x**	**100**	**=**	**100**	**% survivability**	

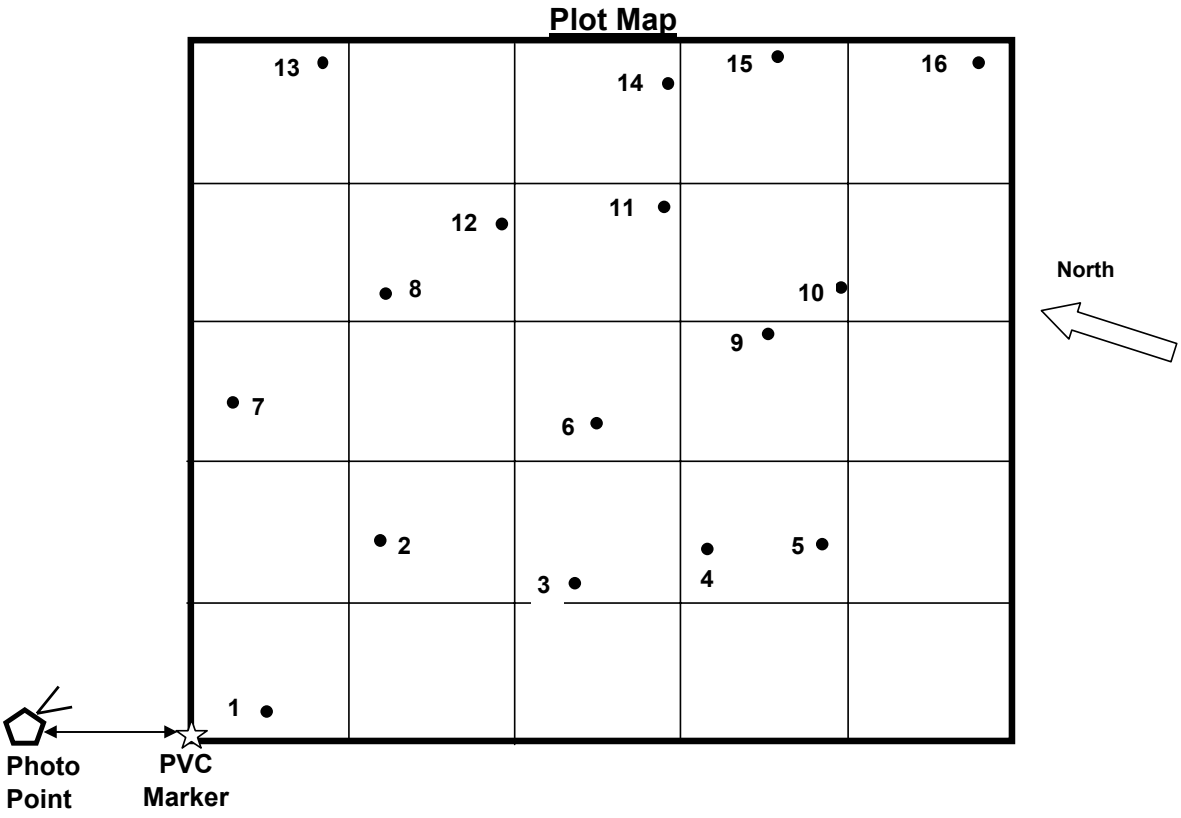
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 13 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.54	4	
2	Unknown	0.54	3	
3	Unknown	0.60	4	
4	Unknown	0.55	4	
5	Unknown	0.58	3	
6	Unknown	0.47	4	
7	Unknown	0.49	4	
8	Unknown	0.55	4	
9	Unknown	0.68	4	
10	Green Ash (*Fraxinus pennsylvanica*)	0.42	4	
11	Green Ash (*Fraxinus pennsylvanica*)	0.33	3	
12	Unknown	0.63	3	
13	Unknown	0.45	4	
14	Overcup Oak (*Quercus lyrata*)	0.46	4	
15	Unknown	0.58	3	
16	Unknown	0.71	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

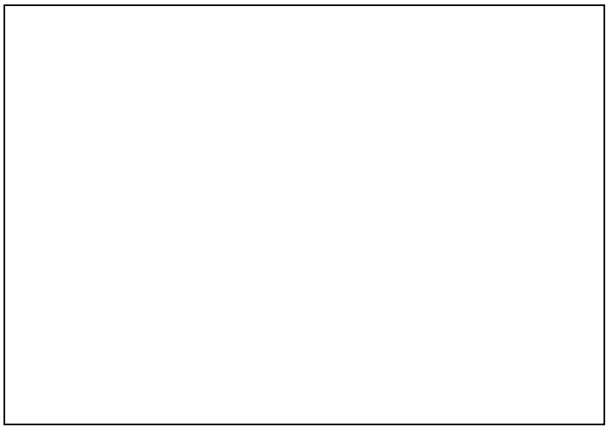
Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	12.5%
Overcup Oak (*Quercus lyrata*)	6.3%
Unknown	81.3%

Density:

Total Number of Trees **16** / **0.025 acres** = **640** **trees / acre**

Survivability:

Total Number of Trees **16** / **16** x **100** = **100** **% survivability**



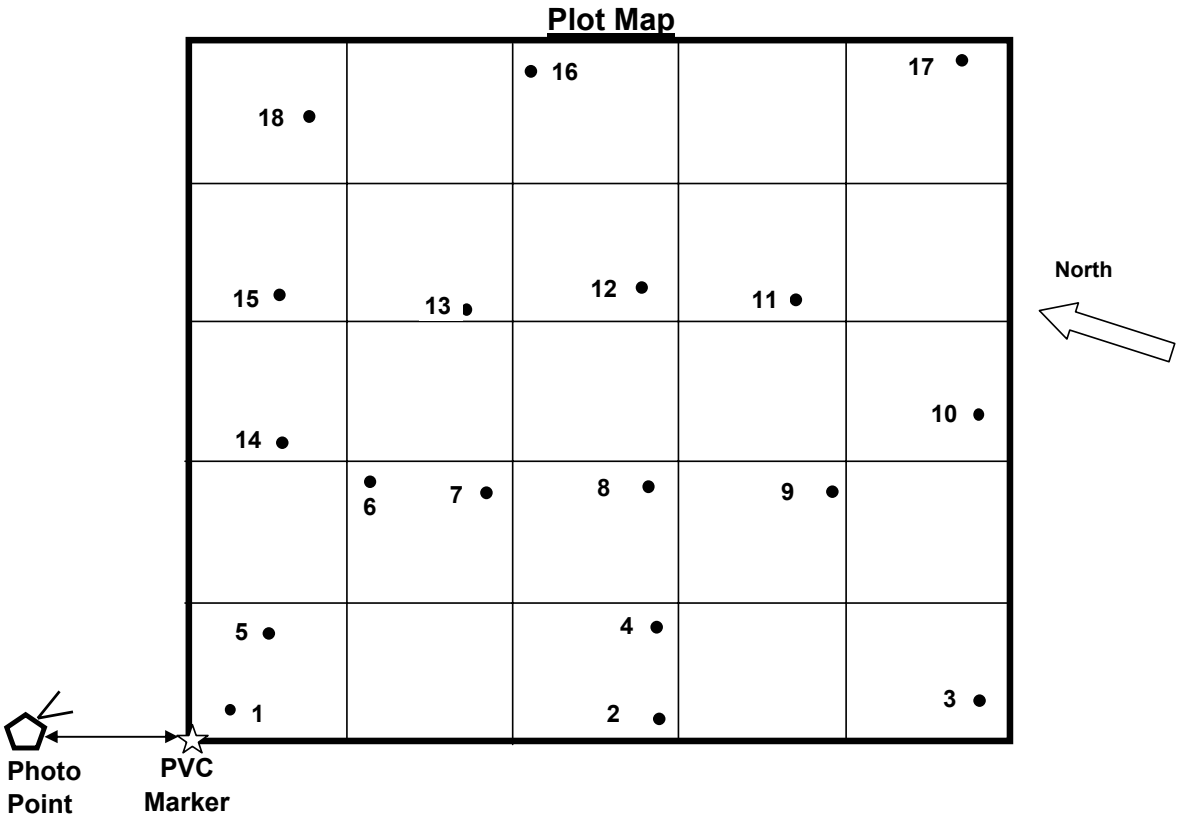
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 14 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Cherrybark Oak (*Quercus pagoda)*	0.72	4	
2	Unknown	0.51	3	
3	Unknown	0.59	4	
4	Unknown	0.66	4	
5	Unknown	0.61	4	
6	Unknown	0.59	4	
7	Unknown	0.62	4	
8	Unknown	0.65	4	
9	Unknown	0.59	3	
10	Unknown	0.53	3	
11	Unknown	0.72	4	
12	Unknown	0.49	3	
13	Unknown	0.54	4	
14	Unknown	0.30	3	
15	Overcup Oak (*Quercus lyrata*)	0.40	4	
16	Unknown	0.61	4	
17	Overcup Oak (*Quercus lyrata*)	0.30	4	
18	Unknown	0.2	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

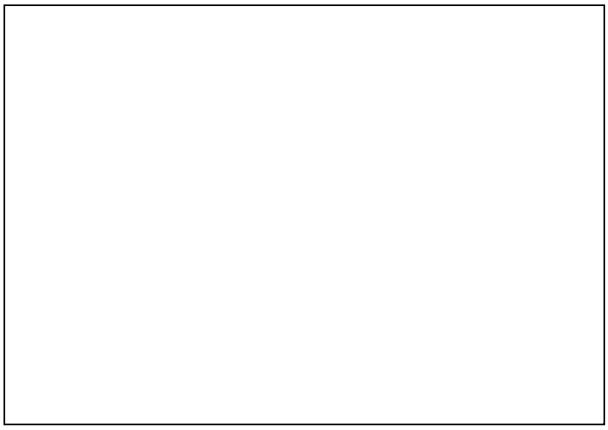
Species	Percent of Total
Cherrybark Oak (*Quercus pagoda*)	5.6%
Overcup Oak (*Quercus lyrata*)	11.1%
Unknown	83.3%

Density:

Total Number of Trees **18** / **0.025 acres** = **720** **trees / acre**

Survivability:

Total Number of Trees **18** / **18** x **100** = **100** **% survivability**



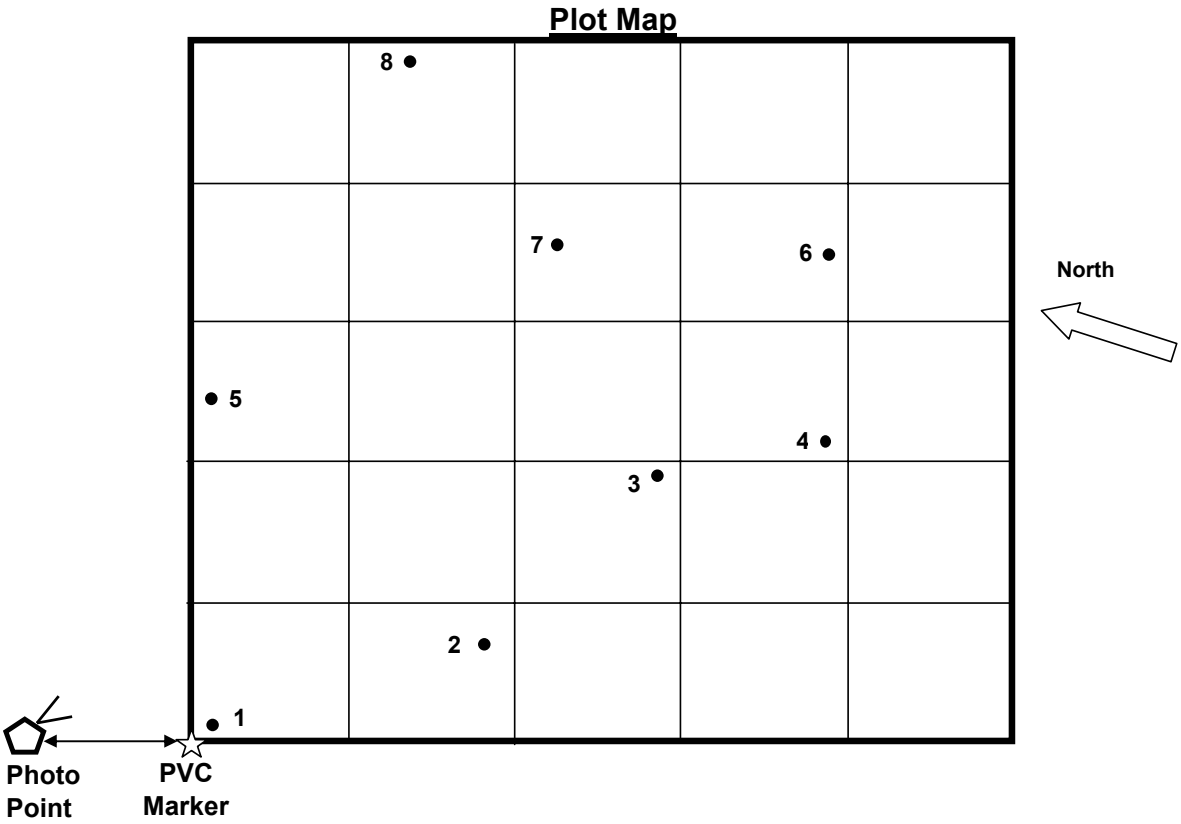
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 15 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.67	4	
2	Unknown	0.56	4	
3	Unknown	0.65	4	
4	Laurel Oak (*Quercus laurifolia)*	0.58	3	
5	Unknown	0.30	4	
6	Unknown	0.51	3	
7	Unknown	0.43	3	
8	Unknown	0.67	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

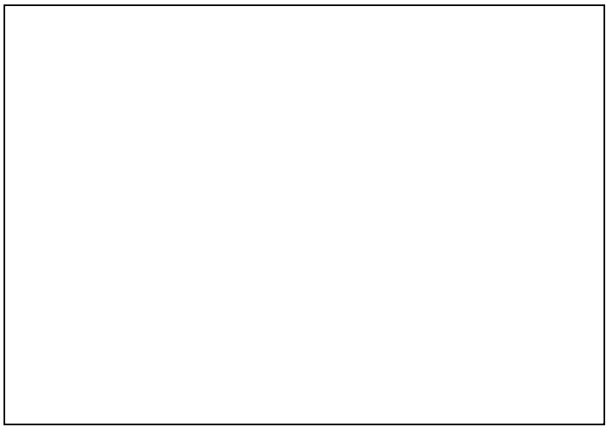
Species	Percent of Total
Laurel Oak (*Quercus laurifolia*)	12.5%
Unknown	87.5%

Density:

Total Number of Trees **8** / **0.025 acres** = **320** **trees / acre**

Survivability:

Total Number of Trees **8** / **8** x **100** = **100** **% survivability**



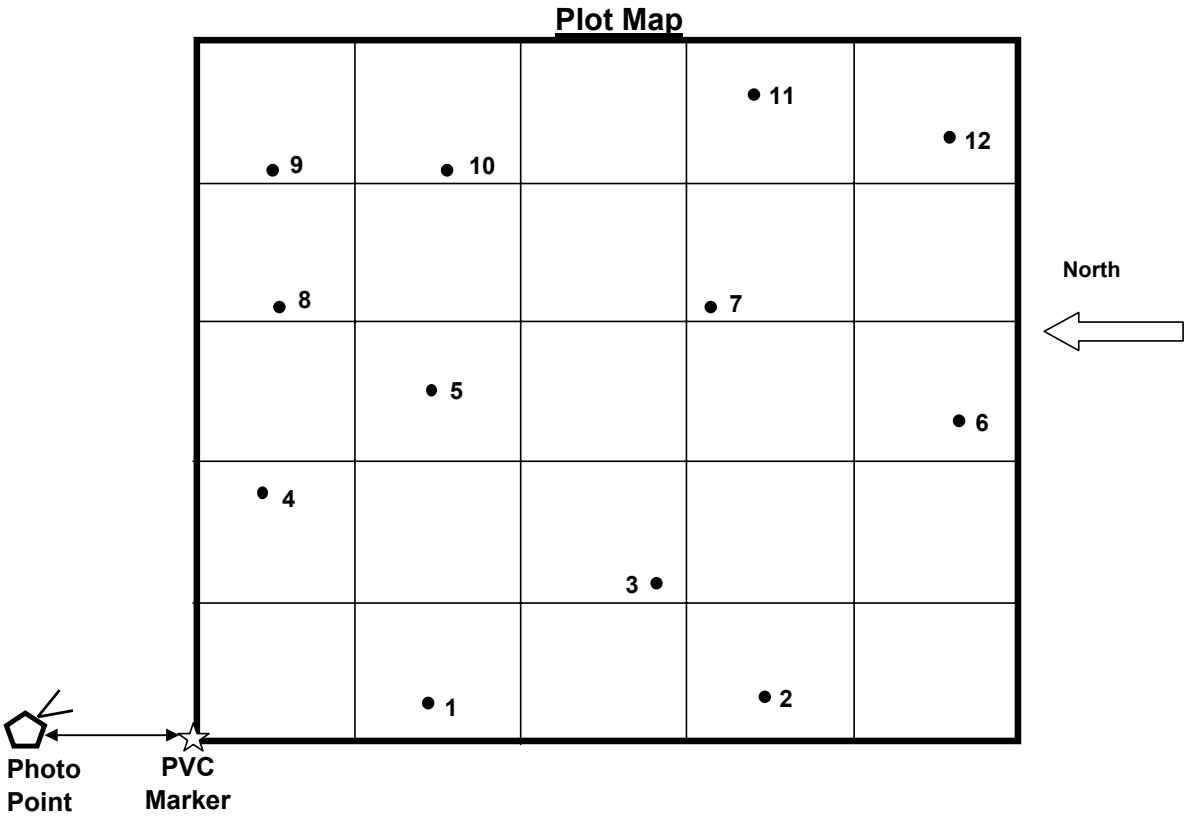
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 16 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Willow Oak (*Quercus phellos)*	0.87	4	
2	Unknown	0.54	4	
3	Willow Oak (*Quercus phellos)*	0.47	3	
4	Unknown	0.55	3	
5	Unknown	0.55	4	
6	Unknown	0.64	4	
7	Unknown	0.59	3	
8	Unknown	0.52	3	
9	Unknown	0.50	3	
10	Unknown	0.66	3	
11	Unknown	0.65	3	
12	Willow Oak (*Quercus phellos)*	0.33	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Willow Oak (*Quercus phellos*)	25.0%
Unknown	75.0%

Density:

Total Number of Trees							
12	/	0.025 acres	=	**480**	trees / acre		

Survivability:

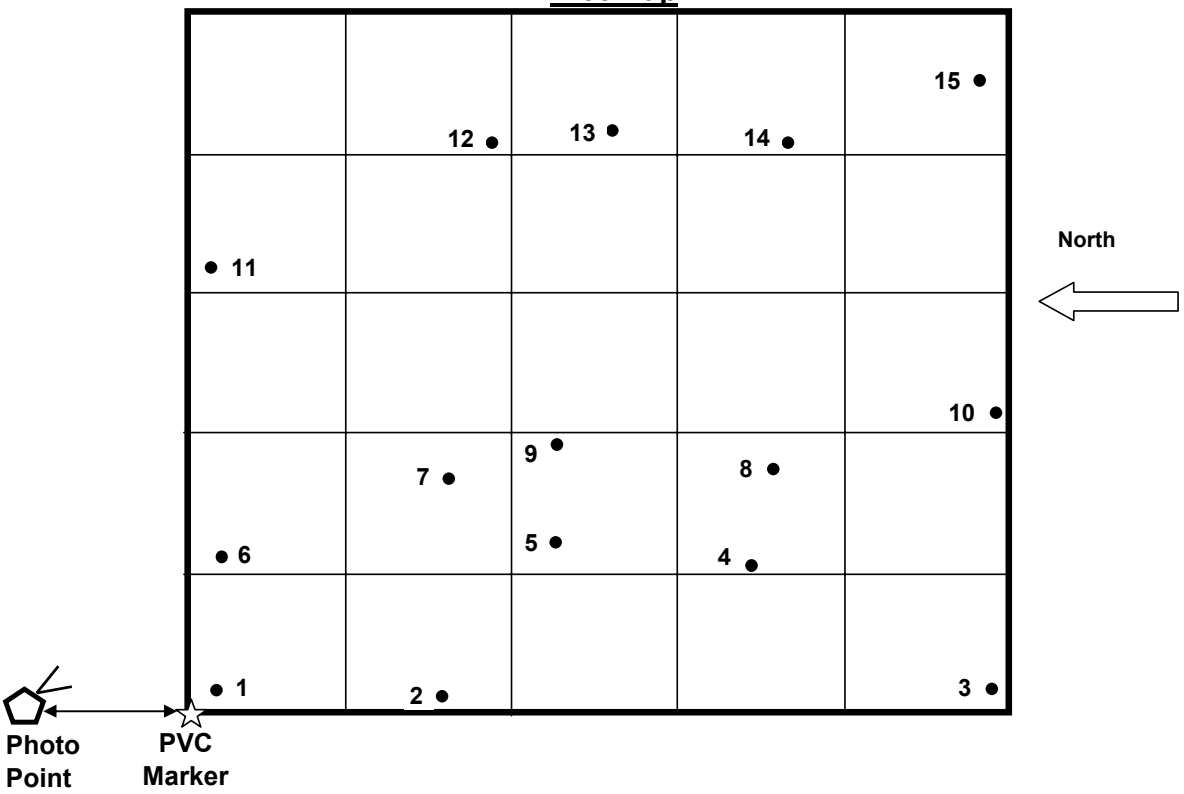
Total Number of Trees							
12	/	12	x	100	=	**100**	% survivability

Previous **Current**

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 17 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Green Ash (*Fraxinus pennsylvanica*)	0.61	4	
2	Unknown	0.87	4	
3	Green Ash (*Fraxinus pennsylvanica*)	0.46	4	
4	Green Ash (*Fraxinus pennsylvanica*)	0.40	2	
5	Unknown	0.72	3	
6	Unknown	0.54	4	
7	Unknown	0.92	4	
8	Green Ash (*Fraxinus pennsylvanica*)	0.69	4	
9	Green Ash (*Fraxinus pennsylvanica*)	0.39	4	
10	Unknown	0.41	3	
11	Green Ash (*Fraxinus pennsylvanica*)	0.60	4	
12	Unknown	0.47	4	
13	Green Ash (*Fraxinus pennsylvanica*)	0.65	4	
14	Green Ash (*Fraxinus pennsylvanica*)	0.46	4	
15	Green Ash (*Fraxinus pennsylvanica*)	0.55	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

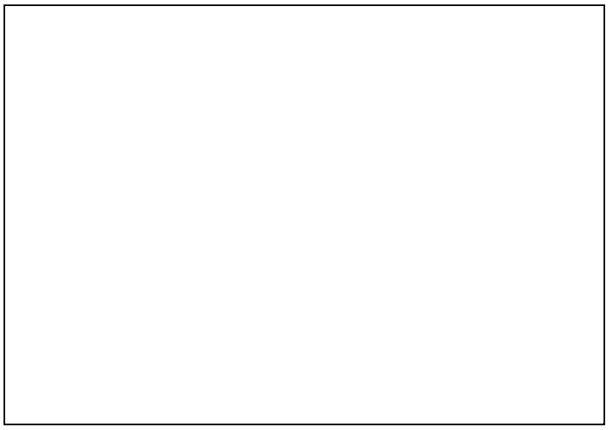
Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	60.0%
Unknown	40.0%

Density:

Total Number of Trees **15** / **0.025 acres** = **600** **trees / acre**

Survivability:

Total Number of Trees **15** / **15** x **100** = **100** **% survivability**



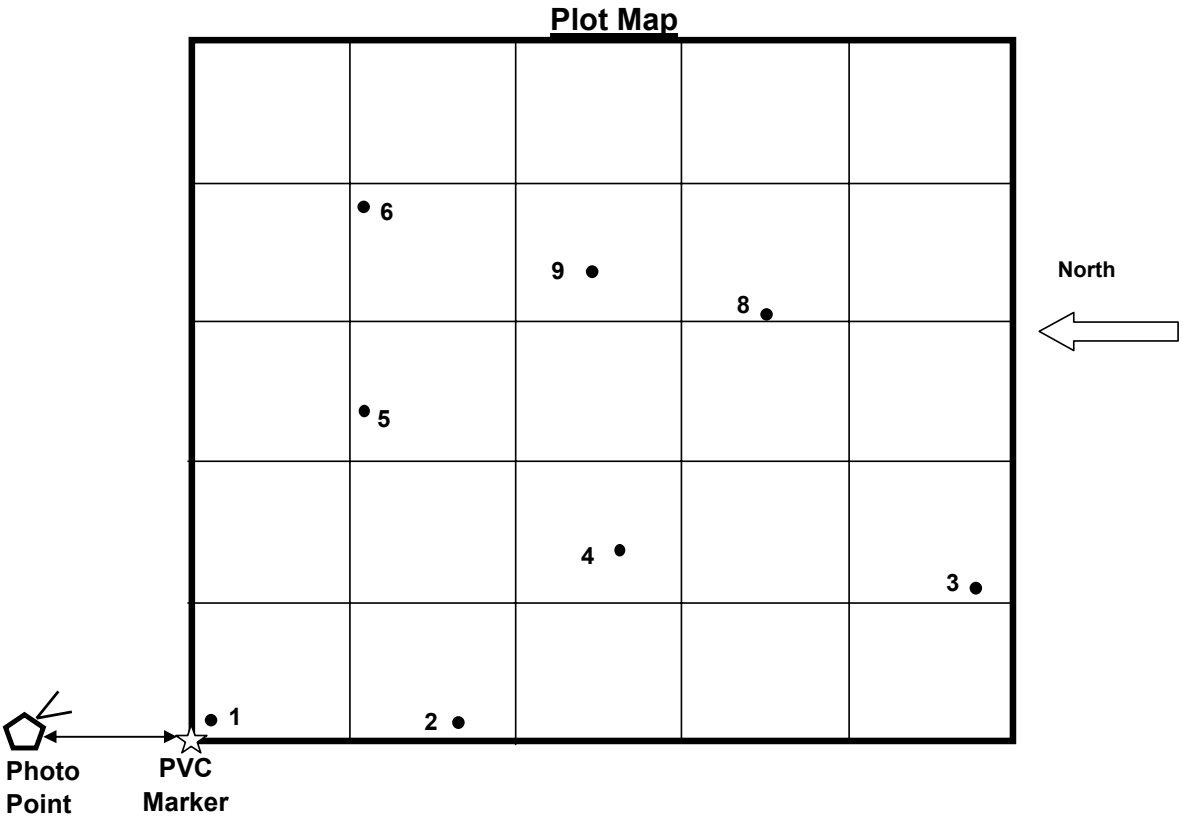
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 18 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.51	4	
2	Unknown	0.50	4	
3	Unknown	0.63	4	
4	Unknown	0.61	4	
5	Unknown	0.56	4	
6	Unknown	0.46	4	
7	Unknown	0.72	3	
8	Unknown	0.91	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

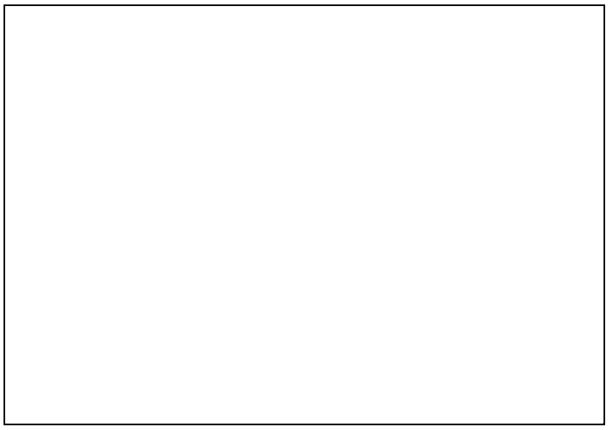
Species	Percent of Total
Unknown	100.0%

Density:

Total Number of Trees **8** / **0.025 acres** = **320** **trees / acre**

Survivability:

Total Number of Trees **8** / **8** x **100** = **100** **% survivability**



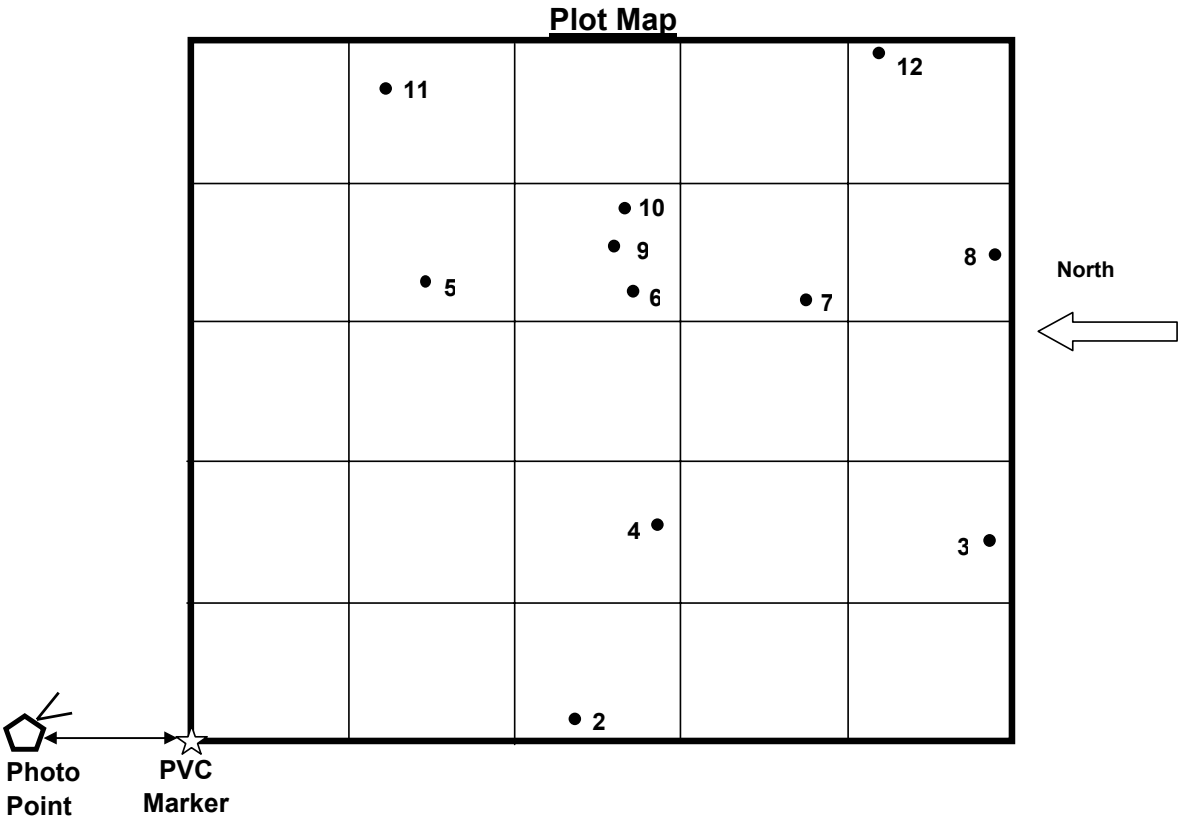
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 19 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Willow Oak (*Quercus phellos)*	0.74	1	
2	Green Ash (*Fraxinus pennsylvanica*)	0.51	4	
3	Unknown	0.79	4	
4	Willow Oak (*Quercus phellos)*	0.32	3	
5	Willow Oak (*Quercus phellos)*	0.63	3	
6	Unknown	0.63	4	
7	Green Ash (*Fraxinus pennsylvanica*)	0.47	4	
8	Unknown	0.59	4	
9	Green Ash (*Fraxinus pennsylvanica*)	0.82	4	
10	Water Tupelo (*Nyssa aquatica)*	0.66	4	
11	Unknown	0.54	4	
12	Unknown	0.48	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	25.0%
Willow Oak (*Quercus phellos*)	25.0%
Water Tupelo (*Nyssa aquatica*)	8.3%
Unknown	41.7%

Density:

Total Number of Trees **12** / **0.025 acres** = **480** **trees / acre**

Survivability:

Total Number of Trees **12** / **12** x **100** = **100** **% survivability**

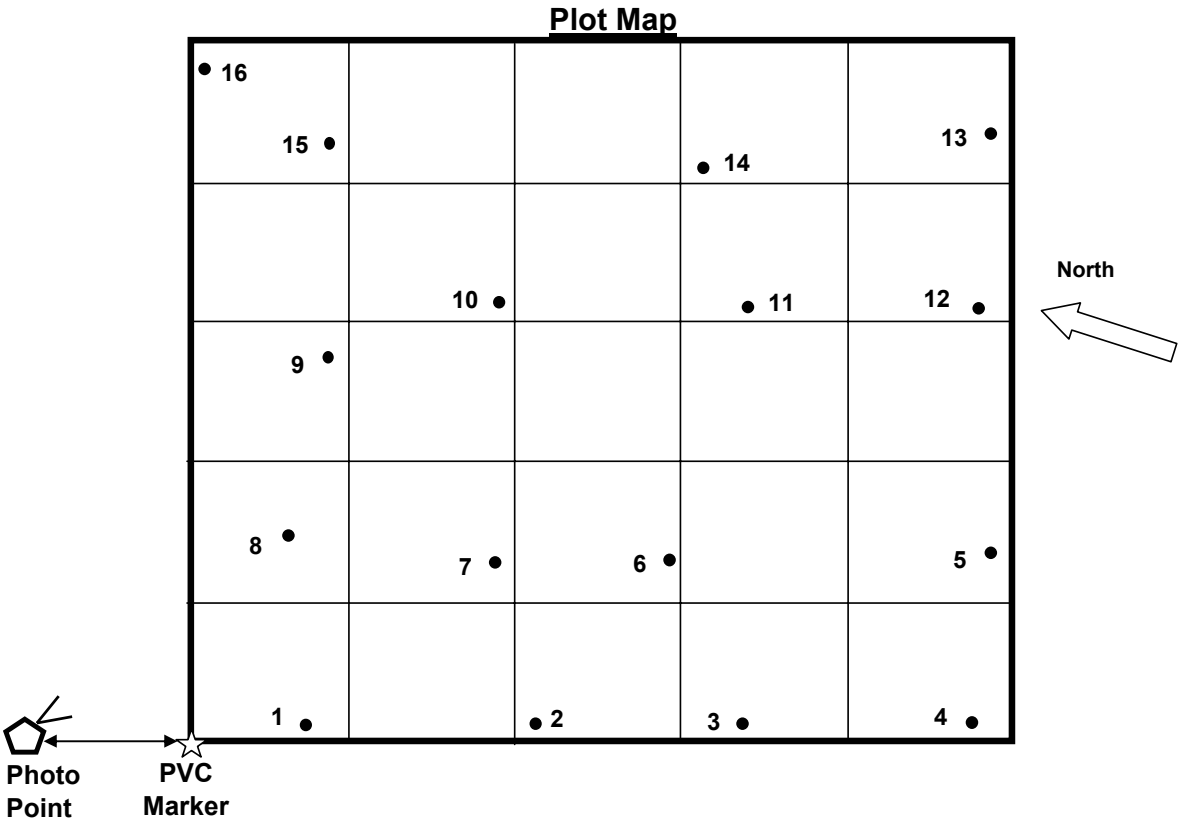
Previous

Current

Vegetation Monitoring Worksheet

Site: Brown **Plot:** 20 **Date:** 2/5/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.58	3	
2	Unknown	0.58	4	
3	Unknown	0.37	3	
4	Unknown	0.51	4	
5	Green Ash (*Fraxinus pennsylvanica*)	0.49	4	
6	Green Ash (*Fraxinus pennsylvanica*)	0.35	4	
7	Unknown	0.54	4	
8	Green Ash (*Fraxinus pennsylvanica*)	0.43	4	
9	Unknown	0.58	4	
10	Green Ash (*Fraxinus pennsylvanica*)	0.43	4	
11	Green Ash (*Fraxinus pennsylvanica*)	0.44	4	
12	Unknown	0.76	4	
13	Unknown	0.27	4	
14	Unknown	0.97	4	
15	Unknown	0.59	4	
16	Green Ash (*Fraxinus pennsylvanica*)	0.40	4	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

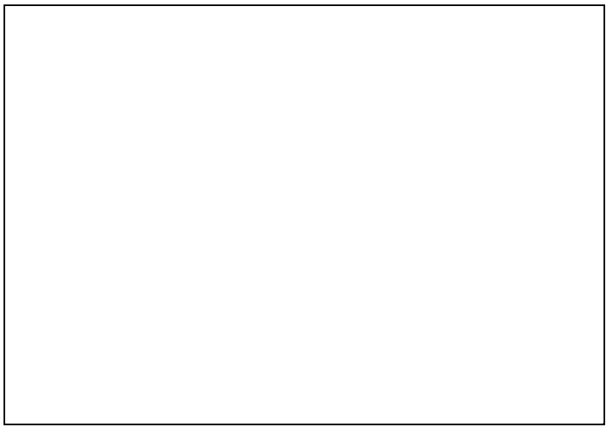
Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	37.5%
Unknown	62.5%

Density:

Total Number of Trees **16** / **0.025 acres** = **640** **trees / acre**

Survivability:

Total Number of Trees **16** / **16** x **100** = **100** **% survivability**



Previous

Current

Appendix C

Permanent Photo Documentation Points

Photo Point 1A: View looking east, towards vegetation plot #1. 2/5/07 – As-Built

Photo Point 1B: View looking northeast, toward vegetation plot #5. 2/5/07 – As-Built

Photo Point 2: View looking north, toward vegetation plot # 3. 2/5/07 – As-Built

Photo Point 3: View looking north, vegetation plot #9 on left. 2/5/07 – As-Built

Photo Point 4: View looking north, toward vegetation plot #17. 2/5/07 – As-Built

Photo Point 5: View looking north, on far east of the project site. 2/5/07 – As-Built

Photo Point 6: View looking south, toward vegetation plot #20. 2/5/07 – As-Built

Photo Point 7: View looking south. 2/5/07 – As-Built