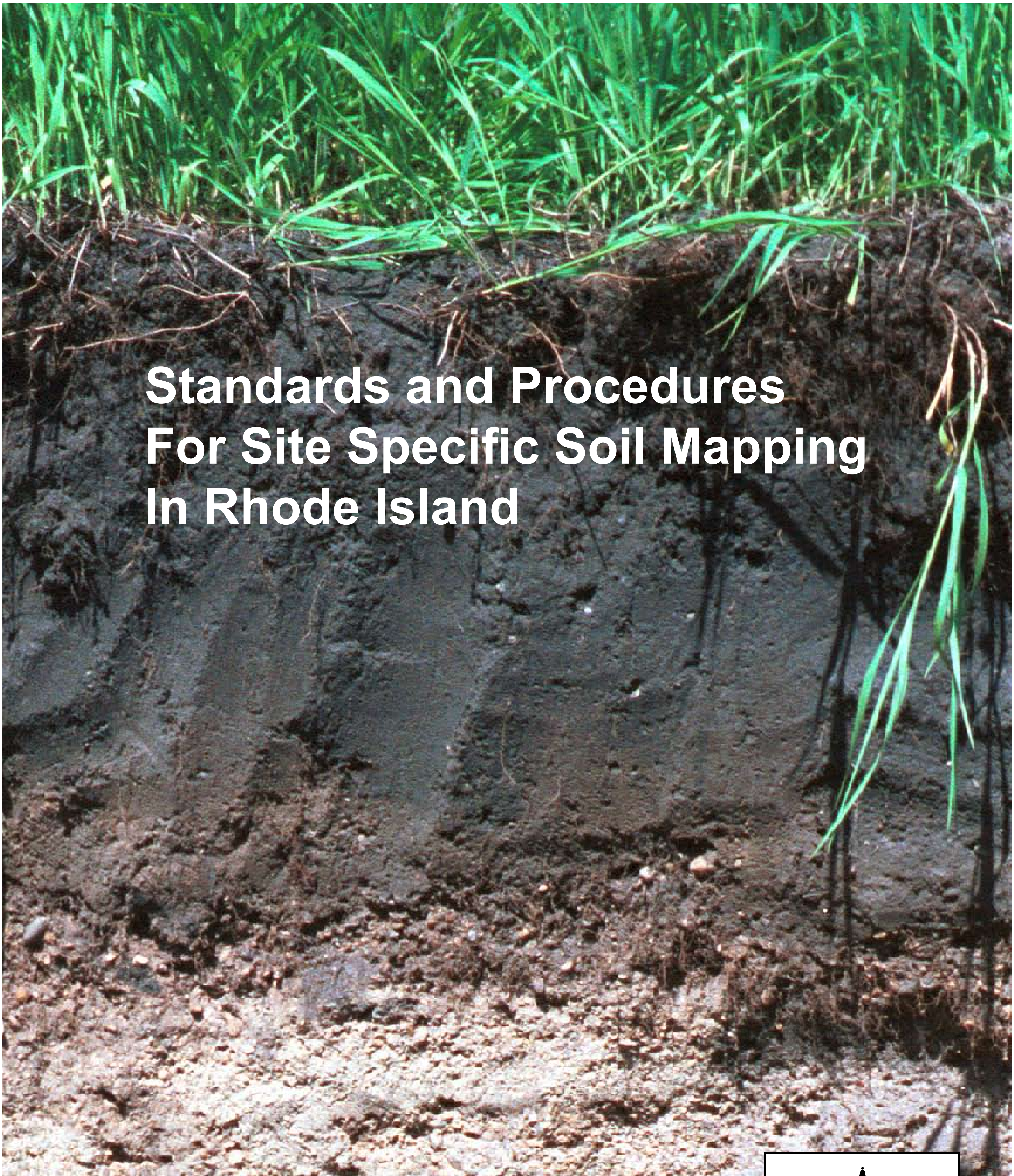
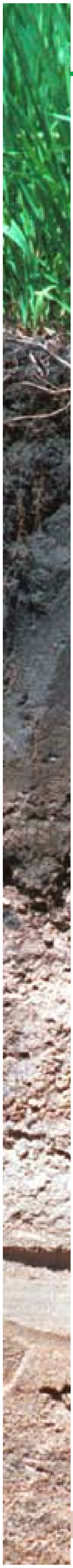


Standards and Procedures For Site Specific Soil Mapping In Rhode Island

University of Rhode Island Cooperative Extension
College of the Environment and Life Sciences
Department of Natural Resources Science, Kingston, RI

UNIVERSITY OF Rhode Island



Standards and Procedures for Site Specific Soil Mapping in Rhode Island
Final Draft October 2007

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RI Nonpoint Education for Municipal Officials

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This publication is available in pdf format at **http://www.uri.edu/ce/wq**

TABLE OF CONTENTS

1. SITE SPECIFIC SOIL SURVEYS

About Site Specific Soil Surveys

Site specific soil surveys are made at scales that allow detailed information about soil properties and characteristics to be accurately mapped. Such features include depth to water tables, presence of hydric soils, depth to bedrock or other restrictive layers, and other attributes that directly influence potential use of a property. These surveys, also known as high intensity soil surveys, provide reliable information that municipal officials, developers, and land owners need to accurately evaluate suitability of land for development. They provide a comprehensive assessment of a site for planning purposes and initial design. Results can be used, for example, to delineate drainage patterns and hydric soils, locate suitable sites for onsite wastewater treatment, layout building sites and roads, and identify high infiltration areas for stormwater system planning and design.

Site specific soil surveys are not meant to replace on-site testing for septic system design and wetland edge delineation. Rather, these maps bridge the gap between such specialized field investigations and the generalized Rhode Island soil survey mapping, which is intended for community planning and watershed assessment. Although commonly overlayed with development plans, state soil survey maps are not accurate at scales showing more detail than 1:15,840, and this use can lead to inaccurate assumptions and poor siting decisions. Ideally, site specific surveys would be conducted at the earliest stage of site assessment and planning so that results can be used to guide selection of the most suitable field test sites, including soil evaluation test pits for wastewater treatment, water table monitoring wells, and permeability testing for stormwater infiltration systems. Because site specific soil surveys are conducted using hand tools such as soil shovels and augurs, without the need for earth-moving equipment and related clearing and disturbance, these surveys are non-invasive and relatively low-cost. When used as a basis for more costly field testing, they also can result in more cost-effective site assessment. Perhaps most importantly, site specific soil mapping provides visual evidence of site constraints to document site design decisions. This can improve communication among all parties involved in the development process for more efficient project review and permitting.

Purpose of this Guide

The objective of this document is to establish a set of standard methods and procedures to follow when making site specific soil surveys in Rhode Island. This technical guide describes criteria for proper base maps, mapping scales, mapping protocols, and analysis of variability. The survey results are displayed in both table and map form using a “connotative” mapping legend which describes a number of soil properties and attributes including: depth to the seasonal high water table (SHWT); depth to restrictive layers such as dense till or bedrock; soil parent materials; slope; and surface texture. This descriptive mapping legend uses a numeric/alphabetic key to identify soil features in greater detail than possible with the Rhode Island Soil Survey, which classifies soil series map units based on fairly broad attributes. The appendices to this guide include example maps and supporting documentation, including intermediate map products used to illustrate the mapping process and final map examples to be included in the final soil survey report.

This document is designed for use by professional soil scientists with training and experience in field mapping soils. As a technical guide, knowledge of soil characteristics, classification, and mapping methods is assumed. For the sake of simplicity and brevity, supporting information on these soil elements is not included. A companion *Guide to Interpreting and Using RI Site Specific Soil Maps (in preparation)* will provide background information on soil features mapped and their influence on development suitability for those who review development plans and make land use decisions. This document demonstrates various methods for interpreting and presenting results to support management decisions.

2. SOIL SURVEY REPORT OVERVIEW

Survey results are presented in a report which should consist of the completed site specific soil survey map, supporting maps and documentation, and a brief narrative. Example maps and documentation to be included in the final report are provided in the appendices to this guide (and noted below).

Soil Survey Report Contents

All of the following elements should be included with each site specific soil survey report:

- The names of the soil scientists that conducted the field work and created the soils map, with documentation of professional standing as required by regulatory agencies.
- A (locus) map clearly indicating the location of the specific soil survey area.
- A recent orthophotograph of the survey area (highly recommended), which can be obtained at http://www.edc.uri.edu/rigis/orthosf/200304RIDOT/tif.html . (Appendix 1)
- A detailed topographic map (minimum 2' contour intervals) of the entire soil survey area. (Appendix 2)
- A map unit legend for the soil survey area indicating the soil property and attribute indicated in the connotative legend. (Appendix 13)
- A map showing the location of each soil observation. (Appendix 6)
- Field notes for every observation. (Appendix 12)
- Documentation of the degree of variability within soil mapping units. (Appendices 7 and 13)
- The complete site specific soil map. (Appendix 11)
- A narrative discussing site characteristics. This should include an overview of the site conditions, surficial geology, map unit variability, and the presence of limiting layers and hydric soils.

3. MAPPING SCALES

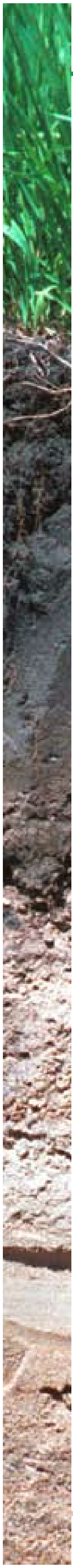
The mapping scale is dependent upon the size of the area being mapped, the use of the soil survey information, and the variability within mapping units. Soil survey maps created as a tool to plan for lot locations, roadways, sediment control structures, and potential placement of onsite wastewater treatment systems for large development are mapped at 1:2400. Individual lots less than a half an acre should be mapped at a scale of 1:600 or greater (i.e. 1:240). Lands with considerable soil variability should be mapped at finer scales than mentioned above to meet map unit variability standards.

4. TOPOGRAPHY AND OTHER FEATURES

A topographic site plan is used as a base map for the site specific soil survey (Appendix 1). An instrument survey, or a combination of instrument and aerial survey, of the existing land features is used to construct this plan. The plan includes topography with minimum 2' contour intervals, although 1' contours may be preferable for areas with little topographic relief. Permanent geographic features such as ponds, streams, rock walls, paths, and roads should be included on the map. These base maps are prepared by a licensed land surveyor or engineer and should be included as well as a survey of the property boundary.

5. SOIL MAPPING PROTOCOL

The topographic site plan is used to make an initial set of soil-landscape delineations. Landscape units are delineated in the field on the base map. Soil-landscape boundary lines are drawn by relating observed landscape features to defined control points on the base map (Appendices 3 and 4). These delineations are based on landscape attributes such as slope class and surface water flow-paths. For example, each drainageway and areas falling within the same slope class within the survey area are identified and delineated. The landscape is traversed and aerial photographs are consulted to identify areas within each landscape unit that may have different soils. These differences are often recognized by tonal variations in the photographs that identify differences in wetness or vegetation and help refine initial soil boundaries.



Soils within representative areas of each delineation are described to a depth of 48” or more. Notes are kept on the Site Specific Soil Survey Note Cards (Appendix 5). Each observation should be located on a separate map (Appendix 6) and included in the final report. For mapping scales of 1:2400, observations should be no more than 200’ apart. For mapping at larger scales, the distance between observations should be less (See Table 1).

Table 1. Recommended maximum distance between soil observations.

Mapping Scale	1:6000	1:2400	1:1200	1:600	1:480	1:240
Plan Scale Equivalent	1”= 500’ 1” = 20’	1” = 200’	1” = 100’	1” = 50’	1” = 40’	
Maximum distance between observations	500’	200’	100’	50’	40’	20’

6. MAP UNIT VARIABILITY

Soil variability is documented for each map unit on the soil survey legend. The number of observations necessary to determine map unit variability is calculated based upon the size of the largest delineation of each map unit (Table 2), with three soil observations as the minimum. The locations of the observations are randomly chosen within the largest delineation (Appendix 7). To select points for variability observations in large delineations, either the random transect approach can be used, or points can be randomly selected within a grid. At a minimum, 65% of the soils within a map unit should be the same as the named classification. Less than 10% of the map unit should have soils that have a more limiting SHWT or depth to restrictive layer class than the soil the delineation is named. In cases where these criteria are not met because the mapping scale does allow for further refinement of the soil survey delineations (scale is too small), the amount of variability should be noted in the map unit legend.

Table 2. Criteria for determining the number of observations necessary to document soil variability of each map unit.

Acres of largest delineation	1 or less	1-3	3-8	>8
Number of observations	3	4	5	7

7. MAPPING LEGEND

The connotative mapping legend symbolizes up to eight soil features and modifiers. A single number or capital letter is used to indicate each soil feature except that lower case letters are used to abbreviate coarse fragment modifiers. No commas or other separators are used between each symbol except for a forward slash dividing the eight elements into two equal parts.

The first four features indicated are: the parent materials; wetness class, also referred to as the range in depth to seasonal high water table (SHWT); range in depth to restrictive layer from the soil surface; and type of restriction either bedrock or densic materials. Parent material, wetness, and depth to restrictive layer classes are assigned a number (Tables 4, 5, and 6) in proper order. In cases where there are two parent materials, the second parent material should be shown in parentheses. Bedrock or densic materials are indicated with an “R” (bedrock) or “D” (densic), respectively, after the depth class.

The second component of the map unit symbol indicates four additional features: coarse fragment modifiers where applicable, classes of predominant soil parent material texture (Table 7), slope class (Table 9) and surface texture (Table 8) in this order.

The complete list of map unit symbols used in the soil mapping legend follows in Table 3 and in Appendix 8. A blank matrix for recording field observations, referred to as the Soil Descriptions Note Card, is provided in Appendix 5. A completed example is provided in Appendix 12. In addition to the features represented in the soil mapping legend, the matrix is used to record observations of other important features including landscape position, stoniness class, depth to iron concentrations and depth to depletions.

Table 3. Soil Mapping Legend – Components of the map unit symbol.

Parent Material	Depth to Seasonal High Water Table (Wetness Class)	Depth to Restrictive Layer	Bedrock or Densic Material	/	Coarse fragment modifier	Parent material texture	Slope class	Surface texture
#	#	#	L		l	#	L	#
1 - Outwash 2 - Ice Contact Stratified Deposits 3 - Dense Till 4 - Loose Till 5 - Alluvium 6 - Loess 7 - Eolian Sands 8 - Human Transported Materials (HTM) 9 - Organic Soil Materials 10 - Residuum	0 - 0" – 12" 1 - >12" – 24" 2 - >24" – 36" 3 - >36" – 48" 4 - >48"	1 - < 24" 2- 24" – 48" 3 - >48"	R - Bedrock D - Densic		gr - gravelly vgr - very gravelly xgr - extremely gravelly cb - cobbly vcb - very cobbly xcb - extremely cobbly sn - stony vsn - very stony xsn - extremely stony bd - bouldery vbd - very bouldery xbd - extremely bouldery	1 - Silt loam 2 - Loam 3 - Sandy loam 4 - Fine sandy loam 5 - Coarse sandy loam 6 - Loamy sand 7 - Loamy fine sand 8 - Loamy coarse sand 9 - Sand 10 - Fine sand 11 - Coarse sand 12 - Clay loam 13 - Silty clay loam	A - 0 – 3% B - >3 – 8% C - >8 – 15% D - >15 – 25% E - > 25%	1 - Silt loam 2 - Loam 3 - Sandy loam 4 - Fine sandy loam 5 - Coarse sandy loam 6 - Loamy sand 7 - Loamy fine sand 8 - Loamy coarse sand 9 - Sand 10 - Fine sand 11 - Coarse sand 12 - Clay loam 13 - Silty clay loam

= number, **L** = upper case letter, **l** = lower case letter

An **example** of a map unit would be: **322D/gr5C4**. The map unit symbols and corresponding soil features for this example are shown below.

Map unit symbol	**3**	**2**	**2**	**D**	**/**	**gr**	**5**	**C**	**4**
Description	**Dense Till**	**> 24" – 36"**	**>24" – 48"**	**Densic**		**gravelly**	**Coarse sandy loam**	**>8 – 15%**	**Fine sandy loam**
Soil Feature	Parent material	Depth to seasonal high water table	Depth to restrictive layer	Bedrock or densic		Coarse fragment modifier	Parent material texture	Slope class	Surface texture

In the example provided above for map unit **322D/gr5C4**, the soils have formed in dense till parent materials that are primarily gravelly coarse sandy loam. These soils have a water table between 24” and 36” from the soil surface. There is dense till between 24” and 48”. The slope is between 8 and 15% and the surface layer is fine sandy loam. Appendix 8 provides a detailed description of the map unit symbol.

Table 4. Parent material classes and associated symbols.
If there are dual parent materials, the overlying parent material is indicated in parentheses after the primary parent material. For example, if there is loess over outwash, the parent material symbol would be 1 (6). All mineral parent materials must be at least 16” thick to be assigned a class symbol. Organic Soil Materials must be at least 8” thick.

Outwash	1
Ice Contact Stratified Deposits	2
Dense Till	3
Loose Till	4
Alluvium	5
Loess	6
Eolian Sands	7
Human Transported Materials-HTM	8
Organic Soil Materials	9
Residuum	10

Table 5. Soil wetness classes.
Criteria for each class are provided in Appendix 9.

Wetness Class	0	1	2	3	4
Depth of SHWT	0 – 12”	12 – -24”	24 – 36”	36 – 48”	> 48”

Table 6. Restrictive layer classes.
Bedrock restrictive layers are indicated by an “R” and densic materials by a “D” after the restrictive layer class symbol.

Restrictive Layer Class	1	2	3
Depth to densic materials or rock	0” – 24”	>24” – 48”	> 48”

Table 7. Classification matrix for soil parent material, wetness, and restrictive layer classes. All restrictive layers are considered to be bedrock or densic materials. Bedrock is indicated by an “R” and densic materials by a “D” after the restrictive layer class symbol (not shown in the matrix).

Depth to Restrictive Layer	Depth to the SHWT				
	0” – 12” (0)	**>12 –- 24” (1)**	**>24 –36” (2)**	**>36 – 48” (3)**	**>48” (4)**
			Outwash (1)		
<24” (1)	101	111	121	131	141
24– 48” (2)	102	112	122	132	142
>48” (3)	103	113	123	133	143
			Ice Contact Stratified Deposits (2)		
<24” (1)	201	211	221	231	241
24– 48” (2)	202	212	222	232	242
>48” (3)	203	213	223	233	243
			Dense Till (3)		
<24” (1)	301	311	321	331	341
24 – 48” (2)	302	312	322	332	342
>48” (3)	303	313	323	333	343
			Loose Till (4)		
<24” (1)	401	411	421	431	441
24 –- 48” (2)	402	412	422	432	442
>48” (3)	403	413	423	433	443
			Alluvium (5)		
<24” (1)	501	511	521	531	541
24 – 48” (2)	502	512	522	532	542
>48” (3)	503	513	523	533	543
			Loess (6)		
<24” (1)	601	611	621	631	641
24 – 48” (2)	602	612	622	632	642
>48” (3)	603	613	623	633	643
			Eolian Sands (7)		
<24” (1)	701	711	721	731	741
24 – -48” (2)	702	712	722	732	742
>48” (3)	703	713	723	733	743
			Human Transported Materials-HTM (8)		
<24” (1)	801	811	821	831	841
24 – -48” (2)	802	812	822	832	842
>48” (3)	803	883	823	833	843
			Organic Soil Materials (9)		
<24” (1)	901	-	-	-	-
24 – -48” (2)	902	-	-	-	-
>48” (3)	903	-	-	-	-
			Residuum (10)		
<24” (1)	1001	1011	1021	1031	1041
24 – -48” (2)	1002	1012	1022	1032	1042
>48” (3)	1003	10103	1023	1033	1043

Table 8. Predominant texture of the soil parent materials or surface layer.
The map unit symbol class is shown in this table. In cases where there is more than one textural class in the parent material, the texture class that makes up the majority of the layer is indicated. The surface layer is defined as the upper 10”.

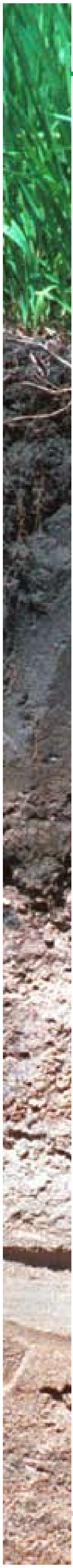
Silt Loam	1
Loam	2
Sandy Loam	3
Fine Sandy Loam	4
Coarse Sandy Loam	5
Loamy Sand	6
Loamy Fine Sand	7
Loamy Coarse Sand	8
Sand	9
Fine Sand	10
Coarse Sand	11
Clay Loam	12
Silty Clay Loam	13

Coarse fragment modifiers are added to classes when appropriate: gravelly (gr), very gravelly (vgr), extremely gravelly (xgr); cobbly (cb), very cobbly (vcb), extremely cobbly (xcb); stony (sn), very stony (vsn), extremely stony (xsn); bouldery (bd), very bouldery (vbd), or extremely bouldery (xbd).

Table 9. Slope classes and associated symbols.

0 – 3%	A
>3– 8%	B
>8 – 15%	C
>15 – 25%	D
>25%	E

In addition to map unit symbols, standard special symbols will be used to identify site and soil properties that are below what is allowed within the scale limits. Examples would be the locations of bedrock outcrops.



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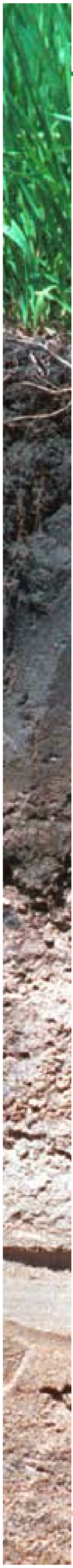


DEFINITIONS OF TERMS

Alluvium: stratified silts, sands, and gravels deposited by running water on floodplains or adjacent terraces above existing streams.

Average seasonal high water table: As defined here, the highest depth that water table frequents and remains at that depth for at least 14 consecutive days and/or 20 cumulative days in most years based on interpretations of hydromorphic features or actual water table measurements.

Common: (redoximorphic features): An abundance class where redoximorphic features represent from 2 to 20 percent of the observed surface area.

Dark: (surface, A, or Ap horizon) Soil conditions where moist colors are chromas 2 or less and values 3 or less.

Dense till: generally unstratified, heterogeneous mixture of clay, silt, sand, gravel, and boulders deposited directly by the ice with little or no transportation by water; at the base of the glacier. Materials have a moist consistence of firm to extremely firm in place. Dense till is often referred to as compact till, lodgment till, or basal till.

Densic materials: Unconsolidated materials that are compacted to such a degree (dense till) that water movement is restricted and water accumulates above.

Depleted Matrix: Color conditions of a soil horizon from which Fe has been removed by reduction and translocation to create colors of low chroma and high value. In some places the depleted matrix may change color upon exposure to air (reduced matrix); this phenomenon is included in the concept of Depleted Matrix.
The following combinations of value and chroma identify a depleted matrix:
1. Matrix value 4 or more and chroma 1 or less with or without other redoximorphic features; or
2. Matrix value 6 or more and chroma 2 or less with or without other redoximorphic features; or
3. Matrix value 4 or 5 and chroma 2 with 2 percent or more redoximorphic features.
For matrix color matching those on the color pages labeled “Gley,” refer to Gleyed Matrix definition.

Depletions: Bodies of low chroma (2 or less) having value 4 or more where Fe and/or Mn coatings have been removed as a result of reduced conditions and transport. See Vepraskas (1992) for more complete discussion.

Distinct: (redoximorphic features): A contrast color class where the redoximorphic features are easily observed relative to the matrix. Specific criteria for distinct features are described in Schoeneberger et al. (2002).

Eolian Sands: Coastal deposits of wind blown sand on dune like forms or adjacent landscapes.

Fe concentrations: Bodies of apparent accumulation of Fe oxides, hydroxides, and oxyhydroxides including masses, pore linings, nodules, and concretions. See Vepraskas (1992) for complete discussion.

Frequently flooded: A frequency class in which flooding is likely to occur, often under usual weather conditions (more than 50 percent chance in any year, or more than 50 times in 100 ears).

Frequently ponded: A frequency class in which ponding is likely to occur, often under usual weather conditions (more than 50 percent chance in any year, or more than 50 times in 100 years).

Gleyed Matrix: Color conditions of a soil horizon as a result prolonged periods of wetness where Fe has been reduced and removed, or where saturation with stagnant water has preserved a reduced state.

Gley colors include:
10Y, 5GY, 10GY, 10G, 5BG, 10BG, 5B, 10B, or 5PB with value 4 or more and chroma is 1; or
2. 5G with value 4 or more and chroma is 1 or 2; or
3. N with value 4 or more.
In some places the gleyed matrix may change color upon exposure to air (reduced matrix). This phenomenon is included in the concept of gleyed matrix.

Growing season: A time when the soil temperature is at or above 5oC (41oF), at a depth of 50 cm below the soil surface.

Hemic soil materials: Organic matter with a fiber content after rubbing ranging from greater than one sixth (by volume) to less than two fifths, excluding live roots. The soil horizon notation for hemic soil material is Oe.

Histic epipedon: A thick (generally between 8 and 16 inches thick) organic surface horizon of a mineral soil. Refer to Soil Survey Staff (2006) for a complete definition.

Human transported materials: any solid material moved into a pedon from a source area outside of the immediate vicinity by intentional human activity, usually with the aid of machinery, and without substantial reworking or displacement by natural forces

Hydric soil: A soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Ice contact stratified deposits: Stratified sands and gravels deposited in contact with the ice. Deposits are typically found on kames, kame terraces, eskers, and in moraine settings.

Loess: Wind blown deposits originally of glacial origin that are typically silt loam or silt in texture, containing significant amounts of fine and very fine sand.

Long duration: For purposes of this document, a duration class in which inundation for a single event ranges from 2 weeks to 1 month.

Loose till: generally unstratified, heterogeneous mixture of clay, silt, sand, gravel, and boulders deposited directly by the ice with little or no transportation by water. Materials have a moist consistence of friable to loose in place. Loose till is often referred to as friable till, ablation till, or melt-out till.

Many: (redoximorphic features): An abundance class where redoximorphic features represent >20 percent of the observed surface area.

Matrix color: Predominant soil color (as determined by 50 percent or more with two colors, or the highest percentage with more than two colors).

Mineral soil: Collection of soil horizons or layers comprised mostly of mineral material with a relatively low content of organic matter (less than 12 to 18 percent of organic carbon by dry weight, depending upon the clay content).

Mineral surface: Beginning of the mineral horizon portion of the soil.

Mucky: Mineral soil materials texture modifier indicating >5% organic carbon.

Outwash: Stratified sand and gravels swept out, sorted, and deposited beyond the glacial ice front by streams of melt water forming an outwash plain.

Parent material: As defined here, the unconsolidated and more or less chemically weathered mineral material which forms the landform the soils have developed on.

Prominent: (redoximorphic features): A contrast color class where the redoximorphic features are strongly contrasting relative to the matrix. Specific criteria for prominent features are described in Schoeneberger et al. (2002).

Redoximorphic features: Features formed by the processes of reduction, translocation, and/or oxidation of Fe and Mn. Formerly called mottles and low chroma colors. Redoximorphic features include masses, pore linings, nodules and concretions, depletions, depleted matrices, gleyed matrices, and reduced matrices. See Vepraskas (1992) for more complete discussion.

Reduced Matrix: Soil matrices that have low chroma and high value, but whose color changes in hue or chroma when exposed to air. See Vepraskas (1992) for complete discussion.

Residuum: Unconsolidated, weathered, or partly weathered mineral material that accumulates by disintegration of bedrock in place. See also saprolite, regolith, colluvium.

Restrictive layer: As defined here, a layer of bedrock, partially weathered bedrock, or densic materials that restricts water movement.

Sapric soil material: Organic matter that has a fiber content after rubbing of less than one sixth (by volume), excluding live roots. The soil horizon notation for sapric soil material is Oa.

Seasonal high water table: See Average seasonal high water table.

Soil surface: For purposes of this document, the reference point (0) for depth measurements is the top of the uppermost soil horizon including O horizons.

Sulfidic materials: As defined here, the presence of hydrogen sulfide gas as identified by a rotten egg smell.

Till: Unsorted glacial materials of various sizes deposited directly by the glacier.

Very dark: (surface, A, or Ap horizon): Soil conditions where moist colors are chromas 2 or less and values less than 3.

Very long duration: This is a duration class in which inundation for a single event is greater than 1 month.

RESOURCES

1. Web Links for Soil Mapping and Research

University of Rhode Island, College of the Environment and Life Sciences

Laboratory of Soil Pedology and Environmental Science, URI Natural Resources Science Department
http://www.nrs.uri.edu/labs/stolt/index.htm

RI Nonpoint Education for Municipal Officials (NEMO) http://www.uri.edu/ce/wq/NEMO/index.htm

USDA Natural Resources Conservation Service (NRCS)

NRCS Rhode Island Office, Rhode Island Soil Survey Program
http://www.ri.nrcs.usda.gov/technical/soils.html

NRCS Soil Data Mart http://soildatamart.nrcs.usda.gov/

NRCS Web Soil Survey http://websoilsurvey.nrcs.usda.gov/app/

Soil Information for the New England Region

New England Soils http://nesoil.com/

Soil Science Society of Southern New England http://nesoil.com/ssssne/

Soil Science Society of Northern New England http://www.sssnne.org/

New Hampshire Office of Energy and Planning. Site specific soil mapping in New Hampshire and Vermont.
http://www.nh.gov/oep/resourcelibrary/referencelibrary/s/soilmapping/

2. Standards and Qualifications for Professional Soil Scientists

The Soil Science Society of America establishes minimum requirements for certified professional soil Scientists through the American Registry of Certified Professionals in Agronomy, Crops and Soils (ARC-PACS). The Soil Science Society of Southern New England (SSSSNE), with members drawn primarily from Rhode Island, Massachusetts and Connecticut, also maintains a registry of recognized professional soil scientists. Minimum standards and qualifications for professional soil scientists established by these organizations is summarized below.

Soil Science Society of America
(American Registry of Certified Professionals in Agronomy, Crops and Soils /ARCPACS)
https://www.soils.org/certifications/cpss-cpsc/

Certified Professional Soil Scientist /Classifier
Pass both the Fundamentals of Soil Science and Professional Practice Examinations. Have at least 5 years experience with at least a Bachelor of Science Degree majoring in soil science, 3 years with an MS or Ph.D. Document education and experience with transcripts and supporting references. Sign and agree to uphold the ARCPACS Code of Ethics. Once certified, earn 40 hours of continuing education (CEUs) every two-years and pay an annual maintenance fee.

Soil Science Society of Southern New England
http://nesoil.com/ssssne/registry2006.htm

Professional Soil Scientist Member Status
I. Requires Bachelor of Science degree with thirty semester-hours, or equivalent, in biological, physical, chemical, and earth sciences, including at least fifteen semester-hours of soil science courses meeting the following distribution, and approval of the Board of Directors
A. A minimum of three credits in Soil Genesis, Classification, Morphology, and Mapping; and
B. The remaining soil science courses in at least three of the following six categories:
1. Introductory Soil Science
2. Soil Chemistry/Fertility
3. Soil Physics
4. Soil Microbiology/Biochemistry
5. Soil Survey Interpretations/Soils and Land Use/Soils and the Environment
6. Independent Study/Seminar/Geology (three-credit maximum). Course(s) must be related to soil science; and

II. Requires three years of professional experience, or equivalent, in soil science that meets the approval of the Board of Directors.

APPENDICES

Appendix 1: Orthophotograph of soil survey area.

Appendix 2: Contour map of soil survey area.

Appendix 3: Examples of landscape unit delineations (in process) based on contour line patterns and spacing.

Appendix 4: Complete delineations of landscape units based on contour line patterns and spacing.

Appendix 5: Soil descriptions note card.

Appendix 6: Map showing location of soil observations.

Appendix 7: Map showing location of additional soil observations to document variability.

Appendix 8: Components of the map unit symbol.

Appendix 9: Soil wetness classes and criteria.

Appendix 10: Key to the soil orders.

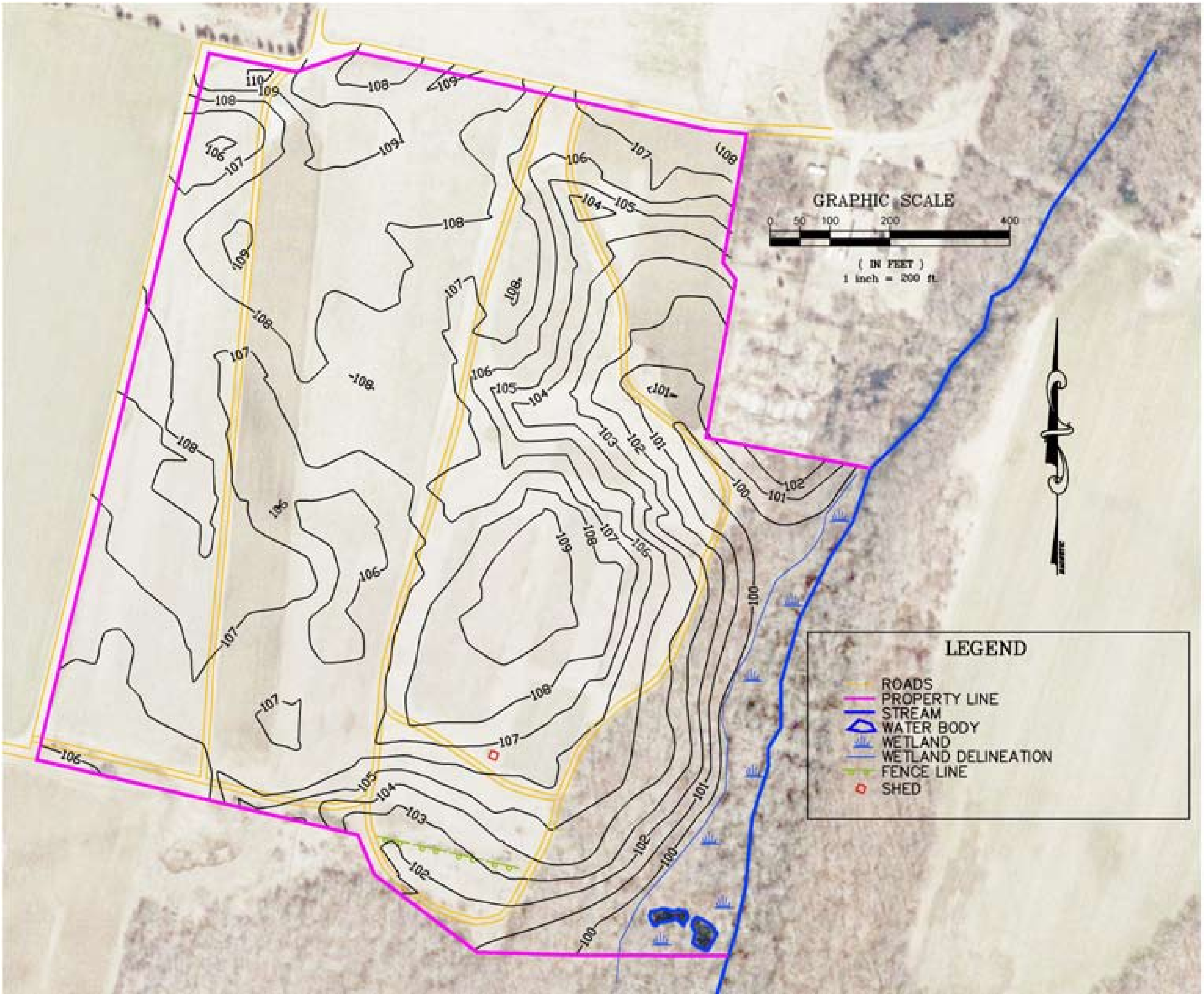
Appendix 11: Complete site specific soil survey for demonstration area.

Appendix 12: Soil observations table for the demonstration site specific soil survey.

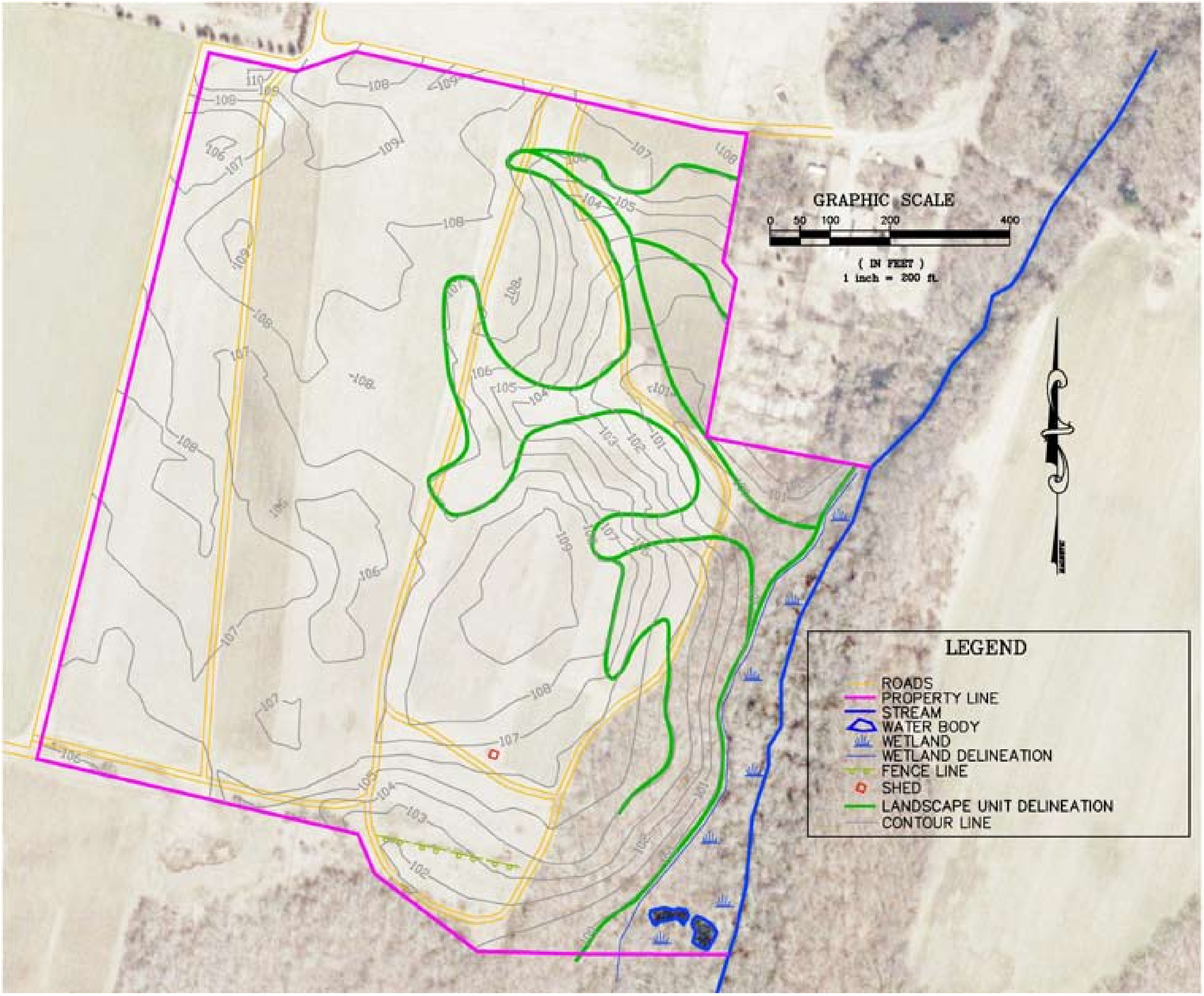
Appendix 13: Map unit descriptions and variability assessment for the site specific soil survey demonstration map.

Appendix 1. Orthophotograph of soil survey area.

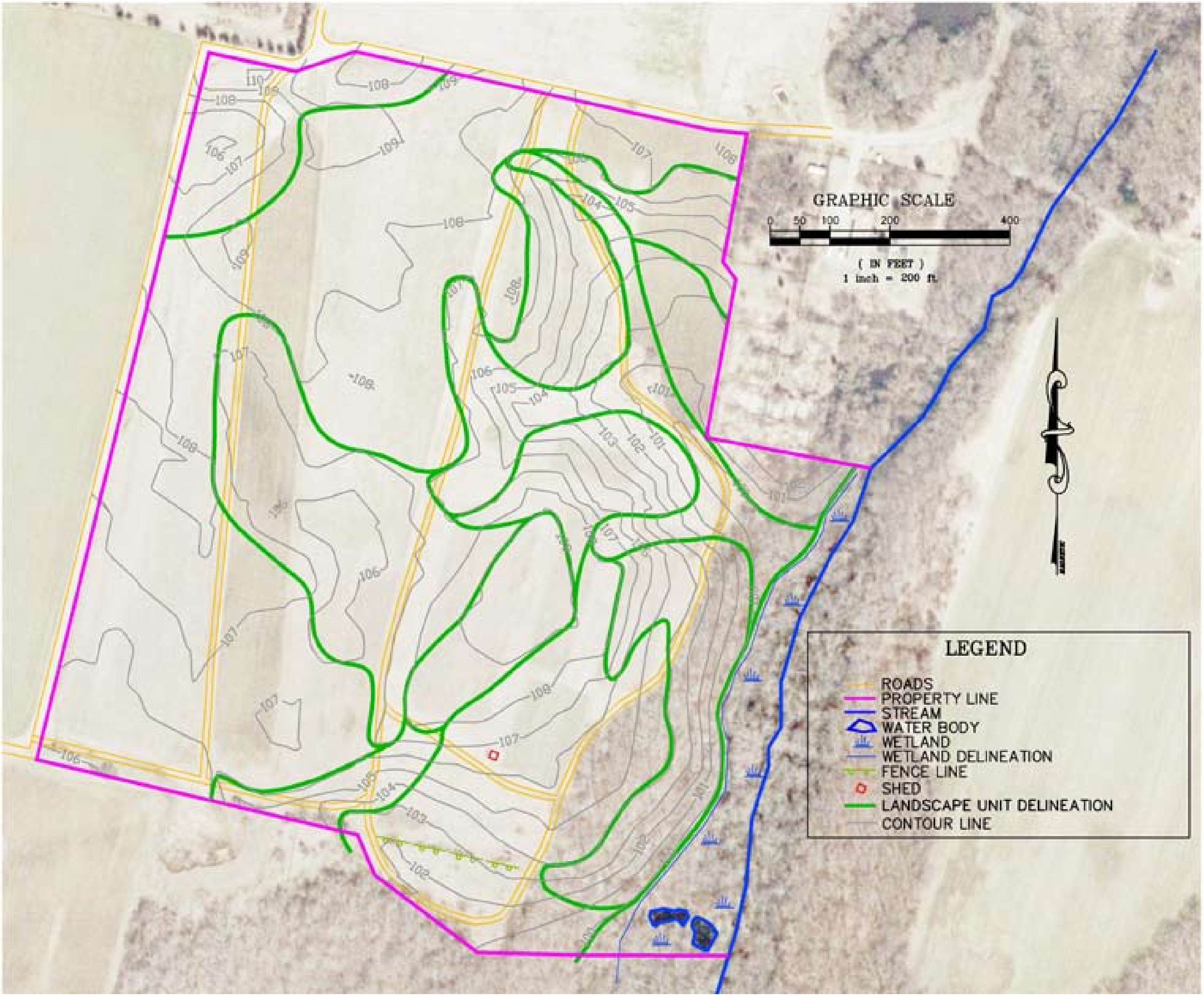
Appendix 2. Contour map of soil survey area.



Appendix 3. Examples of landscape unit delineations (in process) based on contour line patterns and spacing.



Appendix 4. Complete delinations of landscape units based on contour line patterns and spacing.

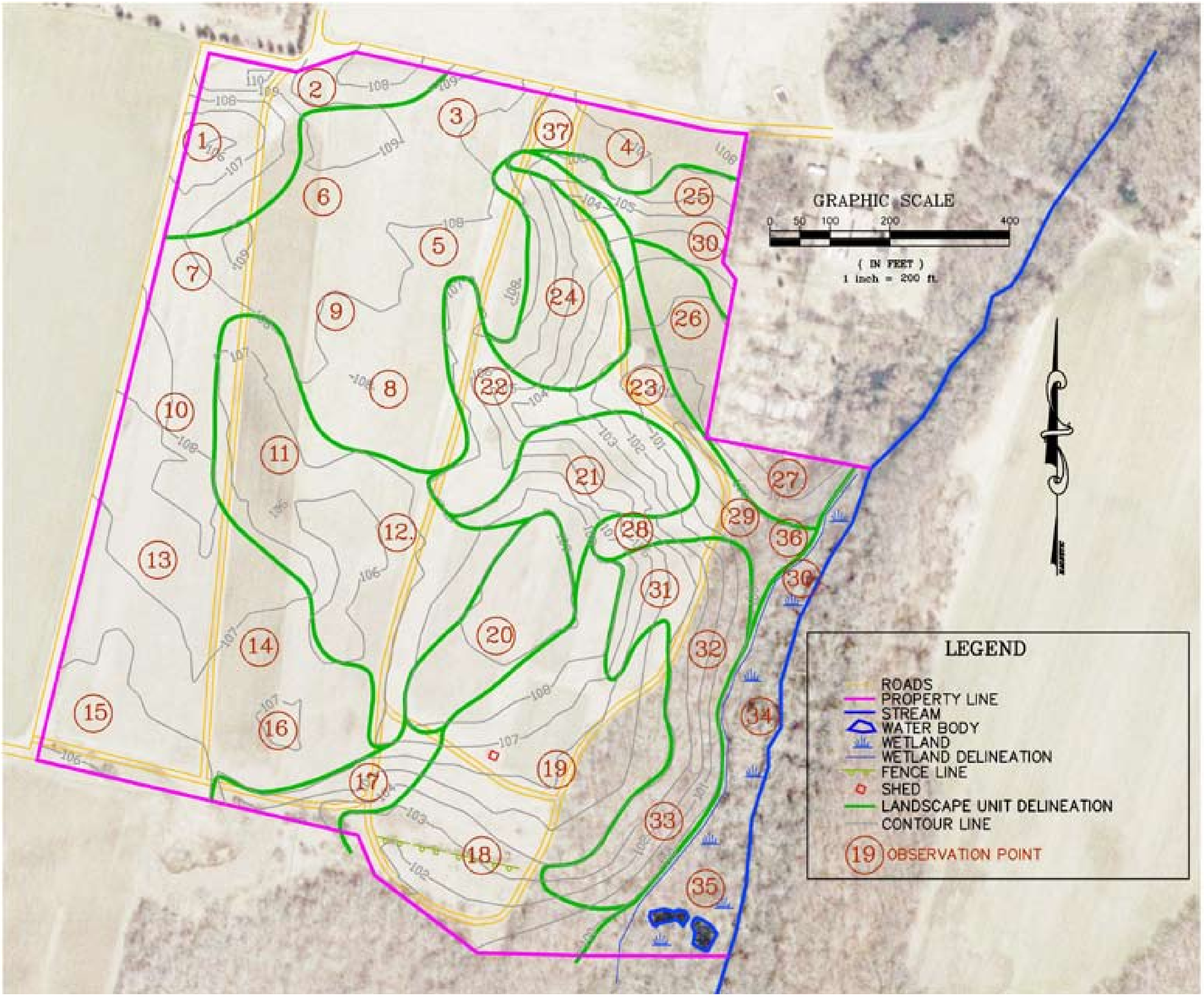


Appendix 5. Soil descriptions note card.

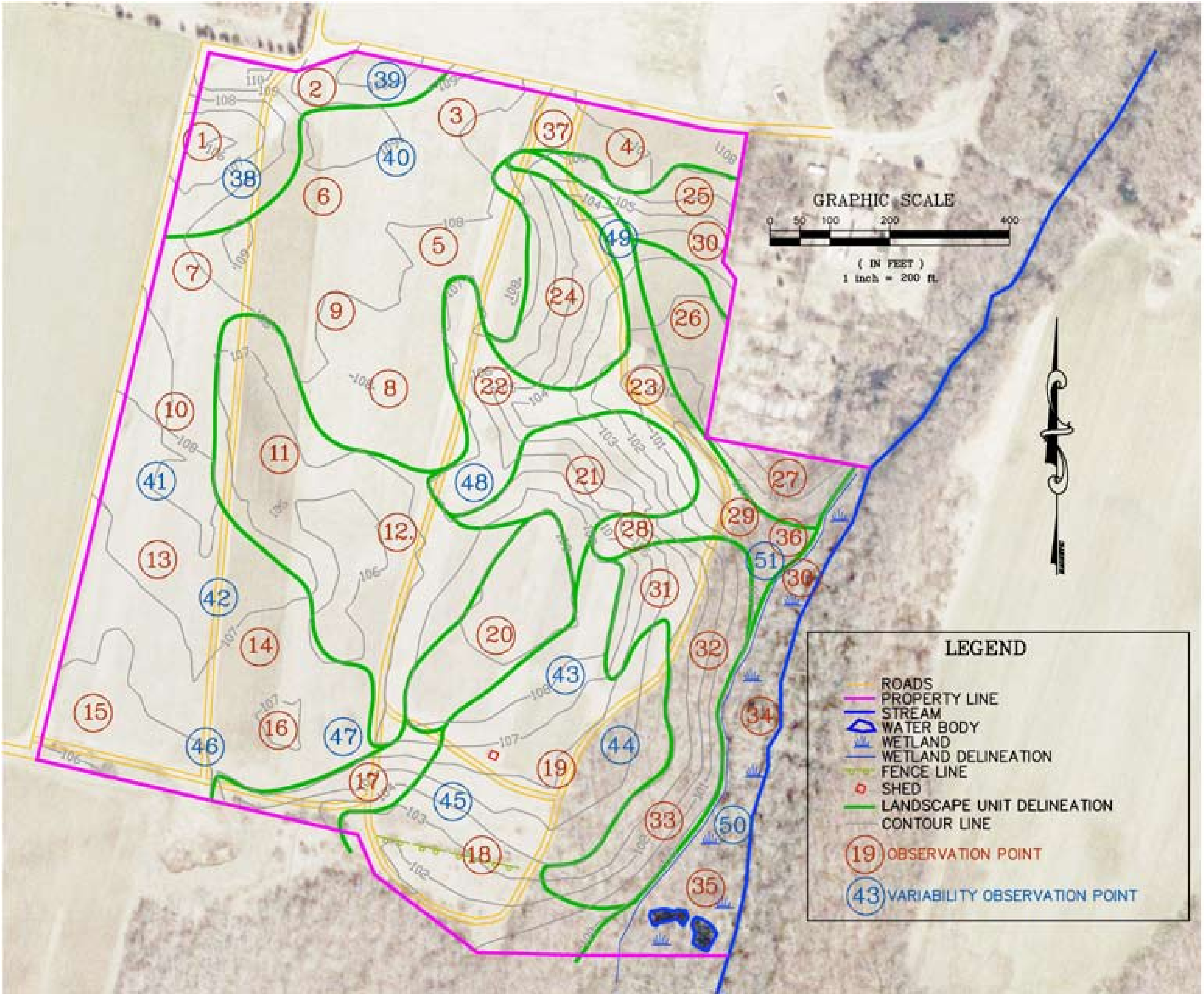
Soil Scientists______________________ **Soil Survey Area:** __________

Observation I.D and Date	Landscape position	Slope %	Parent Material	Surface Texture	Parent Material Texture	Stoniness Class	Depth to Bedrock or Densic Materials *inches*	Depth to Fe Concentrations *inches*	Depth to Depletions *inches*	Wetness Class	Mapping Unit

Appendix 6. Maps showing location of soil observations.



Appendix 7. Map showing location of additional soil observaations to document variability.



Appendix 8. Components of the map unit symbol.

An **example** of a map unit would be: **322D/gr5C4 or ###L/l#L#**, where **#** = number, **L** = upper case letter, **l** = lower case letter

Parent Material	Depth to Seasonal High Water Table (Wetness Class)	Depth to Restrictive Layer	Bedrock or Densic Material	/	Coarse fragment modifier	Parent material texture	Slope class	Surface texture
#	**#**	**#**	**L**		**l**	**#**	**L**	**#**
1 - Outwash 2 - Ice Contact Stratified Deposits 3 - Dense Till 4 - Loose Till 5 - Alluvium 6 - Loess 7 - Eolian Sands 8 - Human Transported Materials (HTM) 9 - Organic Soil Materials 10 - Residuum	0 - 0" – 12" 1 - >12" – 24" 2 - >24" – 36" 3 - >36" – 48" 4 - >48"	1 - < 24" 2- 24" – 48" 3 - >48"	R - Bedrock D - Densic		gr - gravelly vgr - very gravelly xgr - extremely gravelly cb - cobbly vcb - very cobbly xcb - extremely cobbly sn - stony vsn - very stony xsn - extremely stony bd - bouldery vbd - very bouldery xbd - extremely bouldery	1 - Silt loam 2 - Loam 3 - Sandy loam 4 - Fine sandy loam 5 - Coarse sandy loam 6 - Loamy sand 7 - Loamy fine sand 8 - Loamy coarse sand 9 - Sand 10 - Fine sand 11 - Coarse sand 12 - Clay loam 13 - Silty clay loam	A - 0 – 3% B - >3 – 8% C - >8 – 15% D - >15 – 25% E - > 25%	1 - Silt loam 2 - Loam 3 - Sandy loam 4 - Fine sandy loam 5 - Coarse sandy loam 6 - Loamy sand 7 - Loamy fine sand 8 - Loamy coarse sand 9 - Sand 10 - Fine sand 11 - Coarse sand 12 - Clay loam 13 - Silty clay loam

Appendix 9. Soil Wetness Classes and Criteria (adapted from NEHSTC, 2004; US Corp of Engineers, 1991).

Wetness Class 0: Soils meeting one of these criteria are considered to have a wetness class of 0 and a SHWT of <12" from the soil surface.

I. All Histisols;

II. Any mineral soil: a) frequently ponded or flooded for a long or very long duration during the growing season; b) flooded daily by tides; or c) having sulfidic materials within 12 inches of the soil surface.

III. Any mineral soil with a histic epipedon.

IV. Any mineral soil with at least 4" of sapric or hemic soil materials and within 12" have a layer with matrix chroma of 2 or less.

V. All Entisols and Inceptisols having a dark or very dark surface having within 12" of the mineral surface a layer having a matrix value of 5 or more and a chroma of 2 or less.

VI. All Entisols and Inceptisols with a matrix chroma 2 or less that extends to a depth of 20" below the top of the mineral surface that have a dark A or Ap horizon (with or without an O horizon) that is directly underlain by a horizon with a matrix value of less than 4, and within 12 inches of the top of the mineral soil material or directly underlying an A or Ap horizon, whichever is shallower, 2 percent or more redox imorphic features that extend to either: a) a depth of 20 inches below the top of the mineral soil material; or b) a depleted or gleyed matrix.

VII. Spodosols with either: 1) an E and Bh (or Bhs) horizon that are at least 2 "thick, or 2) if plowed or disturbed a Bh or Bhs horizon that extends below 12" from the mineral soil surface.

VIII. Psammaquents that have either: 1) a layer 4 to 8 inches thick of slightly to well-decomposed organic soil material and/or a mucky A or Ap horizon, and are directly underlain by a layer with 2 percent or more redoximorphic features; or 2) beginning within 10 inches of the top of the mineral soil material and directly underlying a dark A or Ap horizon (with or without an O horizon) is a horizon with a with a matrix color due to wetness of chroma 3 or less, value 4 or more, with 2 percent or more redoximorphic features; or 3) beginning within 15 inches of the top of the mineral soil material and directly underlying a thick, very dark A or Ap horizon there is a horizon with a matrix color due to wetness of chroma 3 or less, value 3 or more, with 2 percent or more redoximorphic features.

IX. All Entisols and Inceptisols that have one of the following: 1) beginning within 10 inches of the top of the mineral soil material and directly underlying a dark A or Ap horizon (with or without an O horizon) a horizon with 5 percent or more depletions, and within 20 inches of the top of the mineral soil material there is a horizon with a depleted or gleyed matrix; or 2) beginning within 15 inches of the top of the mineral soil material and directly underlying a thick, very dark Ap horizon a horizon with 5 percent or more depletions and within 20 inches of the top of the mineral soil material there is a horizon with a depleted or gleyed matrix; or 3) soils that have a very dark A or Ap horizon less than 10 inches thick (with or without an O horizon) that are directly underlain by a horizon with a matrix color due to wetness of chroma 3 or less, with 10 percent or more redoximorphic features; and within 6 inches of the top of the mineral soil material have 2 percent or more redoximorphic features; and within 18 inches of the top of the mineral soil material have 2 percent or more redox depletions.

Wetness Class 1: Soils meeting the following criterion are considered to have a wetness class of 1 and a SHWT between a depth of 12” and 24” from the soil surface.

All mineral soils with common or many distinct or prominent redoximorphic features between a depth of 12” and 24” from the soil surface.

Wetness Class 2: Soils meeting the following criterion are considered to have a wetness class of 2 and a SHWT between a depth of 24” and 36” from the soil surface.

All mineral soils with common or many distinct or prominent redoximorphic features between a depth of 24” and 36” from the soil surface.

Wetness Class 3: Soils meeting the following criterion are considered to have a wetness class of 3 and a SHWT between a depth of 36” and 48” from the soil surface.

All mineral soils with common or many distinct or prominent redoximorphic features between a depth of 36” and 48” from the soil surface.

Wetness Class 4: Soils meeting the following criterion are considered to have a wetness class of 4 and a SHWT at a depth >48” from the soil surface.

All mineral soils with common or many distinct or prominent redoximorphic features at a depth of >48” from the soil surface.

Appendix 10. Key to the Soil Orders (adapted from Soil Survey Staff, 2006). See Soil Survey Staff (2006) for definition of terms.

Soils that have organic soil materials that meet one or more of the following:
a. Constitute two-thirds or more of the total thickness of the soil to a densic, lithic, or paralithic contact and have no mineral horizons or have mineral horizons with a total thickness of 10 cm or less; or
b. Are saturated with water for 30 days or more per year in normal years (or are artificially drained), have an upper boundary within 40 cm of the soil surface, and have a total thickness of either: (1) 60 cm or more if three-fourths or more of their volume consists of moss fibers or if their bulk density, moist, is less than 0.1 g/cm3; or (2) 40 cm or more if they consist either of sapric or hemic materials, or of fibric materials with less than three-fourths (by volume) moss fibers and a bulk density, moist, of 0.1 g/cm3 or more.

Histosols,

Other soils that have a spodic horizon with all of the following characteristics:
a. One or more of the following: (1) A thickness of 10 cm or more; or (2) An overlying Ap horizon; or (3) Cementation in 50 percent or more of each pedon; or (4) A coarse-loamy, loamy-skeletal, or finer particle size class; and
b. An upper boundary within the following depths from the mineral soil surface: either (1) Less than 50 cm; or (2) Less than 200 cm if the soil has a sandy particle size class in at least some part between the mineral soil surface and the spodic horizon; and
c. A lower boundary as follows: (1) Either at a depth of 25 cm or more below the mineral soil surface or at the top of a densic, lithic, paralithic contact,

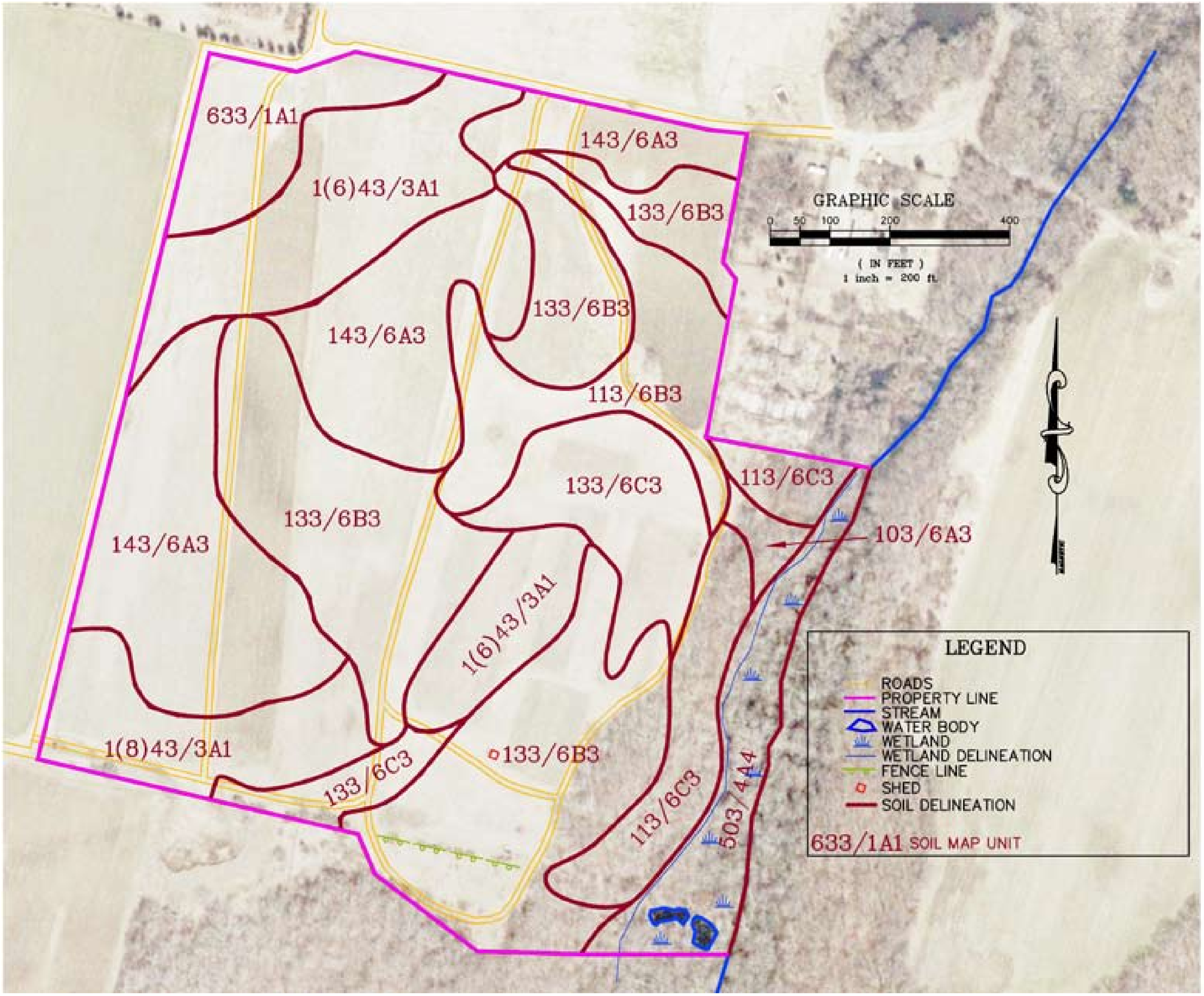
Spodosols,

Other soils that have either:
1. A cambic horizon with its upper boundary within 100 cm of the mineral soil surface and its lower boundary at a depth of 25 cm or more below the mineral soil surface; or
2. No sulfidic materials within 50 cm of the mineral soil surface; and both: a. In one or more horizons between 20 and 50 cm below the mineral soil surface, either an n value of 0.7 or less or less than 8 percent clay in the fine-earth fraction; and b. a histic or umbric epipedon;

Inceptisols,

All other soils:
Entisols.

Appendix 11. Complete site specific soil survey for demonstration area. This example soil survey is for demonstration purposes only.



Appendix 12. Soil observations table for the site specific soil survey demonstration. Observatons 38 -51 were recorded to assess map unit avariability

Soil Scientist: ____________________ **Soil Survey Area:** ________

Observation I.D and Date	Landscape position	Slope %	Parent Material	Surface Texture	Parent Material Texture	Stoniness Class	Depth to Bedrock or Densic Materials *inches*	Depth to Fe Concentrations *inches*	Depth to Depletions *inches*	Wetness Class	Mapping Unit
1	SUM	3	LS	SIL	SIL	NS	>48	38	38	3	633/1A1
2	BS	4	LS	SIL	SIL	NS	>48	40	40	3	633/1A1
3	N/A	1	LS/OW	SIL	SL	NS	>48	-	--	4	1(6)43/3A1
4	N/A	3	OW	SL	LS	NS	>48	-	-	4	143/6A3
5	N/A	2	OW	SL	SL	NS	>48	-	-	4	143/3A3
6	N/A	0	LS/OW	SIL	LS	NS	>48	46	-	4	1(6)33/6A1
7	N/A	2	LS/OW	SIL	SL	NS	>48	-	-	4	1(6)43/3A1
8	N/A	0	OW	SL	LS	NS	>48	-	-	4	143/6A3
9	N/A	1	OW	SL	LS	NS	>48	-	-	4	143/6A3
10	N/A	2	OW	SL	SL	NS	>48	-	-	4	143/3A3
11	N/A	3	OW	SL	LS	NS	>48	40	-	3	133/6B3
12	SH	4	OW	SL	LS	NS	>48	42	-	3	133/6B3
13	N/A	1	OW	SL	LS	NS	>48	-	-	4	143/6A3
14	N/A	0	OW	SL	SL	NS	>48	46	-	4	143/3A3
15	N/A	2	HTM /OW	SIL	SL	NS	>48	-	-	4	1(8)43/3A1
16	N/A	1	HTM/ OW	SIL	SL	NS	>48	-	-	4	1(8)43/3A1
17	BS	9	OW	SL	LS	NS	>48	41	-	3	133/6C3
18	BS	4	OW	SL	LS	NS	>48	42	-	3	133/6B3
19	BS	3	OW	SL	LS	NS	>48	43	-	3	133/6B3

Soil Scientist:______________________ **Soil Survey Area:**________

Observation I.D and Date	Landscape position	Slope %	Parent Material	Surface Texture	Parent Material Texture	Stoniness Class	Depth to Bedrock or Densic Materials *inches*	Depth to Fe Concent-rations *inches*	Depth to Depletions *inches*	Wetness Class	Mapping Unit
20	SUM	0	LS/OW	SIL	LS	NS	>48	-	-	4	1(6)43/3A1
21	BS	9	OW	SL	SL	NS	>48	39	-	3	133/6C3
22	FS	5	OW	SL	LS	NS	>48	14	18	1	113/6B3
23	FS	4	OW	SL	LS	NS	>48	15	19	1	113/6B3
24	BS	7	OW	SL	LS	NS	>48	37	-	3	133/6B3
25	BS	5	OW	SL	LS	NS	>48	37	-	3	133/6B3
26	BS	3	OW	SL	SL	NS	>48	16	16	1	113/6B3
27	BS	8	OW	SL	LS	NS	>48	22	22	1	113/6C3
28	FS	9	OW	SL	LS	NS	>48	40	40	3	133/6C3
29	TS	2	OW	SL	LS	NS	>48	6	10	0	103/6A3
30	TS	0	AL	FSL	FSL	NS	>48	5	11	0	103/6B3
31	BS	8	OW	SL	LS	NS	>48	41	-	3	133/6C3
32	BS	9	OW	SL	SL	NS	>48	14	14	1	113/3C3
33	BS	9	OW	SL	LS	NS	>48	15	15	1	113/6C3
34	TS	0	AL	FSL	LFS	NS	>48	6	6	0	503/4A4
35	TS	0	AL	FSL	FSL	NS	>48	8	8	0	503/4A4
36	TS	1	OW	SL	LS	NS	>48	7	7	0	103/6A3
37	N/A	3	OW	SL	LS	NS	>48	-	-	4	143/6A3
38	BS	4	LS	SIL	SIL	NS	>48	46	46	3	633/1A1

Soil Scientist:______________________ **Soil Survey Area:**________

Observation I.D and Date	Landscape position	Slope %	Parent Material	Surface Texture	Parent Material Texture	Stoniness Class	Depth to Bedrock or Densic Materials *inches*	Depth to Fe Concent-rations *inches*	Depth to Depletions *inches*	Wetness Class	Mapping Unit
39	SUM	2	LS	SIL	SIL	NS	>48	37	45	3	633/1A1
40	N/A	0	LS/OW	SIL	SL	NS	>48	-	--	4	1(6)43/3A1
41	N/A	2	OW	SL	LCS	NS	>48	-	-	4	143/8A3
42	N/A	1	OW	SL	LS	NS	>48	-	-	4	143/6A3
43	BS	4	OW	SL	LS	NS	>48	47	-	3	133/6B3
44	BS	3	OW	SL	LS	NS	>48	37	37	3	133/6B3
45	BS	4	OW	SL	LS	NS	>48	36	36	3	133/6B3
46	N/A	0	HTM /OW	SIL	SL	NS	>48	-	-	4	1(8)43/3A1
47	N/A	1	HTM /OW	SIL	LS	NS	>48	-	-	4	1(8)43/6A1
48	FS	3	OW	SL	LS	NS	>48	20	20	1	113/6B3
49	FS	5	OW	SL	LS	NS	>48	14	18	1	113/6B3
50	TS	0	AL	FSL	FSL	NS	>48	6	6	0	503/4A4
51	TS	1	OW	SL	LS	NS	>48	9	9	0	103/6A3

Landscape Positions: summit (SUM), shoulder (SH), backslope (BS), footslope (FS), toeslope (TS), and non-applicable (N/A).
Parent Materials: outwash (OW), loess (LS), loess over outwash (LS/OW), human-transported materials over outwash (HTM/OW), and alluvium (AL).
Textures: silt loam (SIL), fine sandy loam (FSL), sandy loam (SL), loamy sand (LS), loamy fine sandy (LFS), and loamy coarse sand (LCS).
Stoniness Class: non-stony (NS).

Appendix 13. Map unit descriptions and variability assessment for the site specific soil survey demonstration map.

103/6A3— Soils occur in the toeslope position of drainageways at the lower part of the outwash plain landscape. The average seasonal high water table is less than 12” from the soil surface. Surface and near surface horizons have sandy loam textures. Subsoil textures are loamy sand. Slopes are less than 3%. Within the soil survey area, these soils are of minimal extent.

113/6B3— Soils occur within the upper portion of the primary drainageway of the survey area. Soils have formed in outwash deposits. Surface and near-surface textures are sandy loam. Most of the subsoil textures are loamy sand. This map unit also includes small areas where sandy loam materials are also encountered in the subsoil. The average seasonal high water table ranges from 12 to 24” from the soil surface. Slopes range between 3 and 8%.

113/6C3— Soils occur on backslope positions adjacent to drainageways and floodplains. Soils have formed in outwash deposits. Surface and near-surface textures are sandy loam. Most of the subsoil textures are loamy sand. This map unit also includes small areas where sandy loam materials are also encountered in the subsoil. The average seasonal high water table ranges from 12 to 24” from the soil surface. Slopes are 8 to 15%.

133/6B3— Soils occur on the sloping or more undulating portions of the outwash plane. The texture of the surface and near-surface horizons is sandy loam. The deeper outwash materials are primarily loamy sand. This map unit also includes small areas where sandy loam materials are also encountered in the subsoil. Evidence of a seasonal water table occurs between 36 to 48” from the soil surface. Slopes are between 3 and 8%.

133/6C3— Soils occur on the sloping or more undulating portions of the outwash plane. The texture of the surface and near-surface horizons is sandy loam. The deeper outwash materials are primarily loamy sand. This map unit also includes small areas where sandy loam materials are also encountered in the subsoil. Evidence of a seasonal water table occurs between 36 and 48” from the soil surface. Slopes are between 8 and 15%.

143/6A3— Soils occur on flat outwash plain landforms. The outwash is sandy loam in the surface and near-surface horizons and primarily loamy sand in the lower solum and deeper regolith. This map unit also includes small areas where sandy loam and loamy coarse sand materials are encountered in the subsoil. In most cases evidence of a seasonal water table is greater than 48”. This map unit also includes small areas where the average seasonal high water table is within 36” of the soil surface. All slopes are less than 3%.

1(6)43/3A1— Soils occur on flat outwash plain landforms which are covered in a moderately thick (30 to 48”) cap of loess. The loess is silt loam in texture. The underlying outwash is sandy loam or loamy sand. In most cases the average seasonal water table is greater than 48”. This map unit also includes small areas where the average seasonal high water table is within 36” of the soil surface. All slopes are less than 3%.

1(8)43/3A1— Soils formed in human transported materials (HTM) deposited from on-site over outwash parent materials. The HTM is silt loam in texture and between 30 and 48” in thickness. Underlying the HTM is outwash materials with a sandy loam and loamy sand texture. The average seasonal high water table is greater than 48” below the soil surface. All slopes are less than 3%.

503/4A4— Soils formed on floodplain landscapes. The alluvial parent materials are primarily fine sandy loam with some soils having a loamy fine sand texture. Surface and near-surface horizons are fine sandy loam. The average seasonal high water table is between 0 and 12” below the soil surface. Slopes are 3% or less.

633/1A1— Soils, found on summits and backslopes, have formed in loess parent materials that are greater than 48” thick. Surface and subsurface horizons are silt loam in texture. The average seasonal high water table is between 36 and 48” below the soil surface. Slopes are 3% or less.

Variability Assessment

Additional soil observations were made in the largest of the map units having the same parent material, wetness class, and depth to restrictive layer to assess the amount of variability (see variability points on observation map; Appendix 7). The number of total observations necessary to assess variability for each map unit was determined from Table 2. The locations of these points were randomly chosen. At least 65% of the observations within each of the map units examined had the same classification based on parent material, wetness class, and depth to restrictive layer. The variations in the soils within each map unit are discussed in the map unit legend.