MEMORANDUM STATE OF WISCONSIN

Date: January 24, 2019

To: Project File

From: Melissa J Markquart, P.E.
Soils and Materials Engineer, SWR-Madison

Subject: Soils Investigation
5845-01-78
USH 51
Roundabout at Roby Road/Deer Point Road, Stoughton
Dane County

General

This 1,440-ft project is located on the Urban Principal Arterial USH 51 in the City of Stoughton, at the intersection of Roby Road/Deer Point Drive. The scope of the project is to install a two-lane roundabout to improve the intersection's pattern of side road versus mainline right-angle crashes using HSIP funding. The existing roadway at this intersection has two 12-ft. driving lanes with shoulders consisting of 3-ft paved and 7-ft crushed aggregate (total = 10-ft.).

The purpose of this report is to convey soil findings and information for design and construction. The proposed roadway widens and realigns the current intersection to include soils that currently experience no overburden or are part of ditches in need of EBS and fill.

Existing Typical Section

Pavement structure consists of 9-inch doweled non-reinforced concrete pavement over 4-inch open graded crushed aggregate base course over 4-inch crushed aggregate base course.

Geology

The project lies near the terminus of the Green Bay Glacial Lobe where soils were deposited from glacial meltwater in outwash plains. At this intersection, any restrictive layer of bedrock, glacial till or ground water is expected to be greater than 6-feet.

Soils

The soils within the limits of the project area were mapped using the Web Soil Survey on the Natural Resources Conservation Service website. The area of the round-a-bout consists primarily of three soil types but four soil series are pictured on the attached map in Appendix A.

Two soil borings were done in October 2018 by the DOT Subsurface Exploration Unit Drill Crew. Both borings were advanced to 15-feet deep below the ground surface and soil identification was done off the auger by the drillers. No soil testing was done in the lab. Boring logs and boring location map is found in Appendix B.

Troxel Silt Loam (TrB), Batavia Silt Loam (BbA), and Kegonsa Silt Loam are well drained glacial outwash materials and are suitable for use as topsoil. Only Kegonsa is suitable for use as fill.

The WSS website reports that a restrictive layer is deeper than 2.0-meters, but *hard drilling at an elevation of about 910.0-ft at B-1 (south east quadrant)* was noted on the boring log B-1.

Soil qualities and engineering properties are listed below in Table 1.

Soil Qualities & Engineering Properties									
Soil Series	**DGI [1]**	**Frost Index**	**SSV[2]**	**Hydro Group**	**K [3]**	**AASHTO Classification [4]**	**Depth to Bedrock (cm)**	**Depth to Water Table (cm)**	**Expansion Value (%)**
Batavia Silt	12	F-3	4.24	B	150	A-6	>200	>200	20-30[6]
Troxel Silt	20	F-4	3	B	75	A-7-6	>200	>200	20-30
Kegonsa Silt	12	F-3	4.24	B	150	A-4	*>200*	*>200*	20-30
Dresden Silt [5]									

Notes:
1. Design Group Index
2. Soil Support Value
3. Modulus of subgrade reaction (pci), a parameter used in rigid pavements
4. As a number increases, the suitability of the soil for use in highway construction decreases. For example, A-4 soils are typically better for highway construction than A-7, though it is possible to use A-7 material in certain situations.
5. This series is shown on the soil map in Appendix A but is outside the project boundary.
6. A 7.5-ft. layer of fine-coarse sand & gravel with cobbles underlies the Batavia Silt. Typical expansion factors for silty sands is 15-25%.

Table 1.

Pavement Design Parameters

The following soil parameters in Table 2 below are recommended for use in design of the pavement structure. The parameters provided are in accordance with the WisDOT Pedological approach to pavement design outlined in the WisDOT *Geotechnical Manual.*

Soil Series	DGI	SSV without improvement	SSV with improvement
Batavia Silt	12	4.24	4.76
Troxel Silt	20	3	3.6
Kegonsa Silt	12	4.24	4.76

Table 2.

Conclusions and Recommendations

Site Stripping/Topsoil removal
Remove heavy sod including vegetation from the proposed roadway foundation. Remove all topsoil from underneath places of new embankment fill. Topsoil thicknesses at the two borings was 12-inches.

Long sequences of existing ditches and slopes are located where new pavement structure is proposed. EBS the top 12-inches from the bottom of the existing ditch areas to remove saturated soils and sediment deposits. Replace with well compacted common excavation fill.

Reuse of Onsite Soils
Based on data found on the WSS website, the only recommended reuse of Batavia and Troxel silt loams is as topsoil for seeding slopes. Kegonsa is rated as "fair" for use as fill and topsoil.

Materials Availability
All common roadbuilding materials are expected to be locally available.

Select materials
This project lies within the Subgrade Improvement Inclusion Area. Silt was identified in both borings therefore a subgrade improvement of either 12-inches of Select Crushed material over geogrid or 16-inches of Select Crushed is required particularly across the roundabout and the areas where ditches are buried by new construction/widening.

Compaction
This project will be constructed over two discrete and dissimilar conditions: one with consolidated soils and one without. Soils under the existing roadway have experienced many years of overburden and consolidation whereas the areas of widening and new alignment have seen no overburden since the last ice age. *Ensure WisDOT Standard Specifications for standard compaction is followed to match the old fill and base with the new fill and base to avoid differential settlement.*

Erosion Control
Slopes and channels should be protected as per Chapter 10 of the FDM. Open slopes should be top soiled, seeded, and mulched/e-matted as soon as possible to decrease the risk of erosion.

Fertilizer Type
Type B fertilizer is recommended for areas requiring topsoil, seeding, and mulch.

EBS
Include EBS in the contract to avoid possible contract change orders. Calculate EBS at 5% of the surface area of the new widening to a depth of 12-inches below subgrade. Backfill EBS with Select Crushed material.

Appendix A

I. Field Boring Logs

II. Map with Boring Location

III. gINT Logs

DT1434 2/2007

FIELD BORING LOG

Wisconsin Department of Transportation

Boring No. B-1 SE	Structure ROADWAY	County DANE	Sheet 1 Of 1
Project 5845-01-08	Road USH 51 + ROBY RD INTERSECTION		
Station 10+65.39 RBT	Offset 44.46' Rt.	Surface Elevation 923.30	

N-429116.84 E-857106.37

GROUND WATER OBSERVATIONS

Streambed Elevation:	Time After Drilling:					
Water Elevation:	Depth to Water:					
Top of Well Elevation:						

MOISTURE: D = Damp, M = Moist, W = Wet

DRILLING METHOD: HS = Hollowstem, WA = Wash Ahead, RB = Rockbit, ST = Shelby Tube, SS = Splitspoon, DM = Drilling Mud, A = Auger, C = Coring, W = Wash, E = Easy, M = Medium, H = Hard

Unit 1 | Chief SKOLOS

Start 10-17-18 | Finish 10-17-18

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample and Recovery	Total Blows	VISUAL FIELD CLASSIFICATION AND REMARKS	Unconfined Strength	Boulders	Drilling Method
	M					TOPSOIL			A
						SILT SOME CLAY TRACE F-M SAND BROWN			E/M
						916.00			M
						F-C SAND + GRAVEL SOME SILT LT. BROWN WITH COBBLES			H
						908.3			
						E.O.B. B-1 15'			

5' 10' 15' 20' 25' 30' 35'

Checked By | Final | Boring No. B-1 SE

DT1434 2/2007

FIELD BORING LOG

Wisconsin Department of Transportation

Boring No. B-2 NW	Structure ROADWAY	County DANE	Sheet 1 Of 1
Project 5845-01-08	Road USH 51 + ROBY RD INTERSECTION		
Station 12+41.92 RBT	Offset 44.06' Rt.	Surface Elevation 921.10	

N-429212.81 E-856926.04

GROUND WATER OBSERVATIONS

Streambed Elevation:	Time After Drilling:					
Water Elevation:	Depth to Water:					
Top of Well Elevation:						

MOISTURE
D = Damp
M = Moist
W = Wet

DRILLING METHOD
HS = Hollowstem
WA = Wash Ahead
RB = Rockbit
ST = Shelby Tube
SS = Splitspoon
DM = Drilling Mud
A = Auger
C = Coring
W = Wash
E = Easy
M = Medium
H = Hard

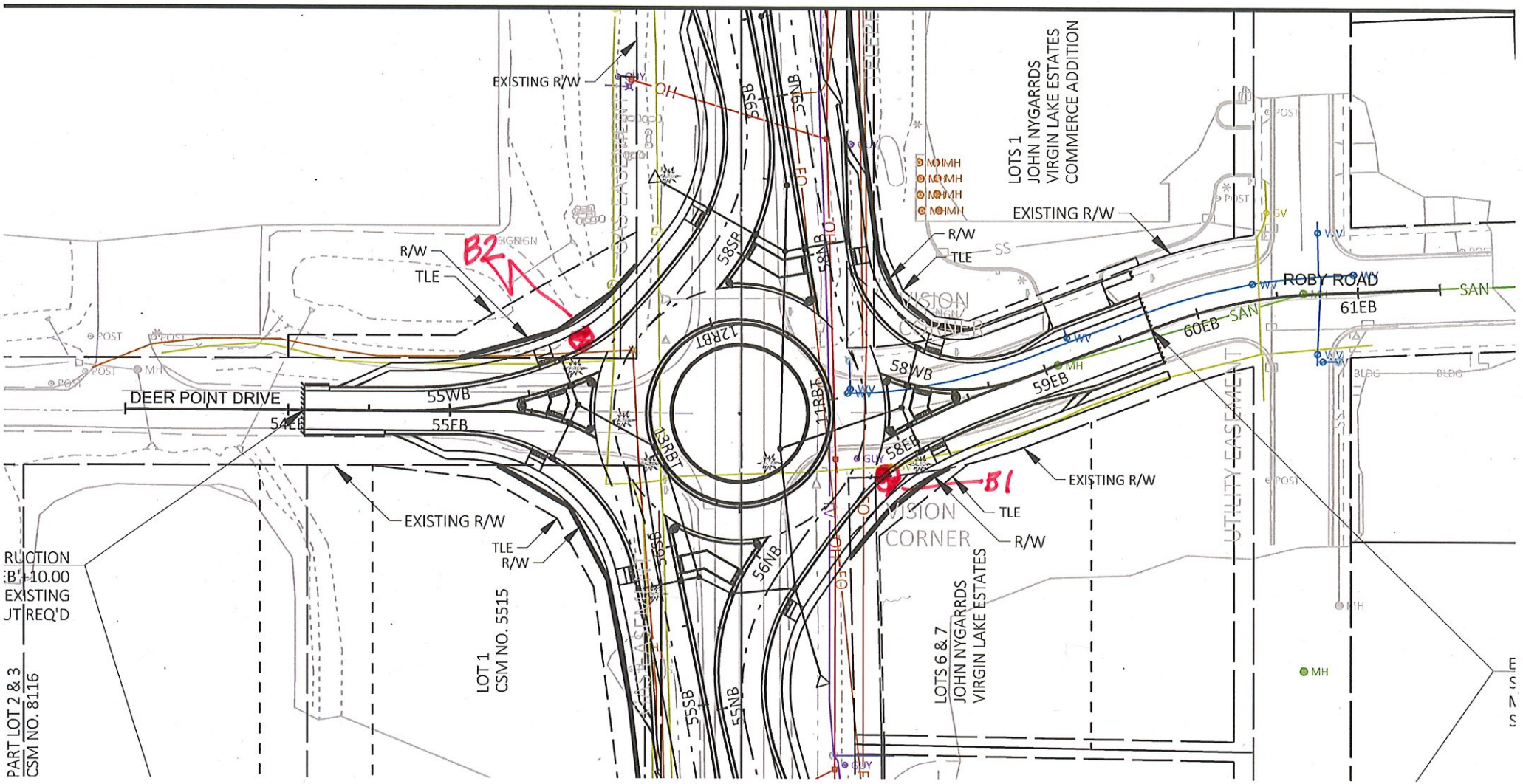
Unit 1
Chief SKOGS
Start 10-17-18
Finish 10-7-18

Sample No.	Moisture	Blows on Sampler 0/6	Blows on Sampler 6/12	Sample and Recovery	Total Blows	VISUAL FIELD CLASSIFICATION AND REMARKS	Unconfined Strength	Boulders	Drilling Method
	M					TOPSOIL			A
						SILT BROWN LITTLE F-M SAND LITTLE F-C GRAVEL			E/M
						5' 5'			
						SILT LITTLE F-M SAND TRACE F-M GRAVEL BROWN			
						SILT SOME CLAY TRACE F-M SAND BROWN			
						10' 10'			
						F-C SAND SILTY SOME F-C GRAVEL BROWN			M
						15' 15'			
						E.O.B. B-2 15'			
						20' 20'			
						25' 25'			
						30' 30'			
						35' 35'			

Checked By

Final

Boring No. B-2 NW


N
EXISTING R/W
R/W
TLE
B2
DEER POINT DRIVE
55WB
54EB
55EB
12RBT
13RBT
11RBT
58SB
59SB
59NB
58NB
58WB
59EB
58EB
B1
EXISTING R/W
TLE
R/W
56SB
56NB
55SB
55NB
LOT 1
CSM NO. 5515
LOTS 1
JOHN NYGARRDS
VIRGIN LAKE ESTATES
COMMERCE ADDITION
LOTS 6 & 7
JOHN NYGARRDS
VIRGIN LAKE ESTATES
VISION
CORNER
ROBY ROAD
60EB
61EB
SAN
UTILITY EASEMENT
PART LOT 2 & 3
CSM NO. 8116
RUCTION
B'+10.00
EXISTING
JT REQ'D
POST
MH
BLDG

WI Dept. of Transportation **3502 Kinsman Blvd.** **Madison, WI 53704**	WISDOT PROJECT ID: **5845-01-08** WISDOT STRUCTURE ID:			**BORING ID: 1** PAGE NO: **1 of 1**	
WISDOT PROJECT NAME: **USH 51 & Roby Rd**	CONSULTANT: **WISDOT**	CONSULTANT PROJECT NO:		LATITUDE:	LONGITUDE:
ROADWAY NAME:	DRILLING CONTRACTOR: **WISDOT**	DRILLING CONTRACTOR PROJECT NO:		NORTHING: **429116.84**	EASTING: **857106.37**
DATE STARTED: **10/17/18**	CREW CHIEF: **P. Skolos**	DRILL RIG: **Unit 1**		COORDINATE SYSTEM: **WCCS**	
DATE COMPLETED: **10/17/18**	LOGGED BY: **S. Hunter**	HOLE SIZE: **4 in**		HORIZONTAL DATUM: **WCCS Dane**	VERTICAL DATUM: **MSL**
COUNTY: **Dane**	LOG QC BY: **T. L. Petersen**	HAMMER TYPE: **Automatic**		STREAMBED ELEVATION: **NA**	
STATION / OFFSET	TOWNSHIP: / RANGE: / SECTION: / 1/4 SECTION: / 1/4 1/4 SECTION:			SURFACE ELEVATION: **923.3 ft**	

SAMPLE TYPE NUMBER	RECOVERY (in) (RQD)	Moisture	BLOW COUNTS (N VALUE)	Depth (ft)	Graphic	Soil / Rock Description and Geological Origin for Each Major Unit / Comments	USCS / AASHTO	Strength Qp (tsf)	Liquid Limit (%)	Plasticity Index (%)	Boulders	Drilling Method	Notes
				1		12" TOPSOIL, moist 1.0 — 922.3 SILT, brown, some clay, trace fine to medium sand, moist	ML						
				7.5		7.5 — 915.8 FINE TO COARSE SAND & GRAVEL, light brown, some silt, with cobbles, moist	GPS						
				15		15.0 — 908.3 End of Boring at 15.0 ft.							

WATER LEVEL & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: NMR	CAVE - IN DEPTH AT COMPLETION: NMR		WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: NMR	CAVE - IN DEPTH AFTER 0 HOURS: NMR		WET ☐ DRY ☐

NOTES: 1) Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.
2) NE = Not Encountered; NMR = No Measurement Recorded

P:\GINT\WISDOT GINT PROJECTS\GINT_1\5845-01-08 USH 51 & ROBY RD.GPJ USH 51 & Roby Rd 11/28/18

WI Dept. of Transportation **3502 Kinsman Blvd.** **Madison, WI 53704**	WISDOT PROJECT ID: **5845-01-08**			**BORING ID: 2**	
	WISDOT STRUCTURE ID:			PAGE NO: **1 of 1**	
WISDOT PROJECT NAME: **USH 51 & Roby Rd**	CONSULTANT: **WISDOT**	CONSULTANT PROJECT NO:		LATITUDE:	LONGITUDE:
ROADWAY NAME:	DRILLING CONTRACTOR: **WISDOT**	DRILLING CONTRACTOR PROJECT NO:		NORTHING: **429212.81**	EASTING: **856926.04**
DATE STARTED: **10/17/18**	CREW CHIEF: **P. Skolos**	DRILL RIG: **Unit 1**		COORDINATE SYSTEM: **WCCS**	
DATE COMPLETED: **10/17/18**	LOGGED BY: **S. Hunter**	HOLE SIZE: **4 in**		HORIZONTAL DATUM: **WCCS Dane**	VERTICAL DATUM: **MSL**
COUNTY: **Dane**	LOG QC BY: **T. L. Petersen**	HAMMER TYPE: **Automatic**		STREAMBED ELEVATION: **NA**	
STATION / OFFSET	TOWNSHIP: / RANGE: / SECTION: / 1/4 SECTION: / 1/4 1/4 SECTION:			SURFACE ELEVATION: **921.1 ft**	

Depth (ft)	Soil / Rock Description and Geological Origin for Each Major Unit / Comments	USCS / AASHTO
0	12" TOPSOIL, moist	
1.0	920.1	
1	SILT, brown, little fine to medium sand, little fine to coarse gravel, moist	
2		
3		ML
4		
5.0	916.1	
5	SILT, brown, little fine to medium sand, trace fine to medium gravel, moist	
6		ML
7		
8.0	913.1	
8	SILT, brown, some clay, trace fine to medium sand, moist	
9		ML
10		
11.5	909.6	
11	SILTY FINE TO COARSE SAND, brown, some fine to coarse gravel, moist	
12		SM
13		
14		
15.0	906.1	
15	End of Boring at 15.0 ft.	

SAMPLE TYPE NUMBER | RECOVERY (in) (RQD) | Moisture | BLOW COUNTS (N VALUE) | Graphic | Strength Qp (tsf) | Liquid Limit (%) | Plasticity Index (%) | Boulders | Drilling Method | Notes

WATER LEVEL & CAVE-IN OBSERVATION DATA

▽	WATER ENCOUNTERED DURING DRILLING: NMR	CAVE - IN DEPTH AT COMPLETION: NMR		WET ☐ DRY ☐
▼	WATER LEVEL AT COMPLETION: NMR	CAVE - IN DEPTH AFTER 0 HOURS: NMR		WET ☐ DRY ☐

NOTES: 1) Stratification lines between soil types represent the approximate boundary; gradual transition between in-situ soil layers should be expected.
2) NE = Not Encountered; NMR = No Measurement Recorded

P:\GINT\WISDOT GINT PROJECTS\GINT_13\5845-01-08 USH 51 & ROBY RD.GPJ USH 51 & Roby Rd 11/28/18

Appendix B

Web Soil Service Soil Report

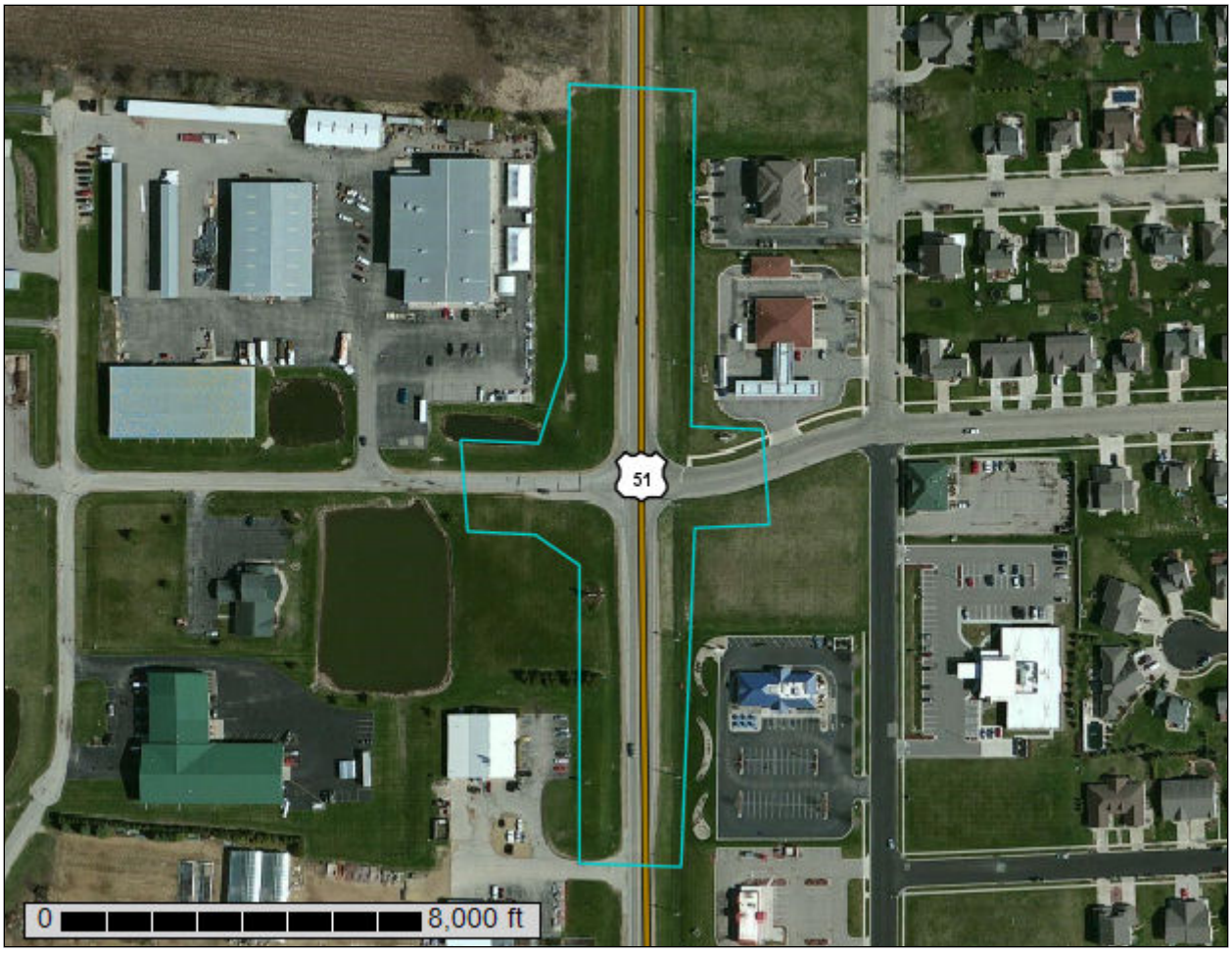
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Dane County, Wisconsin



January 25, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

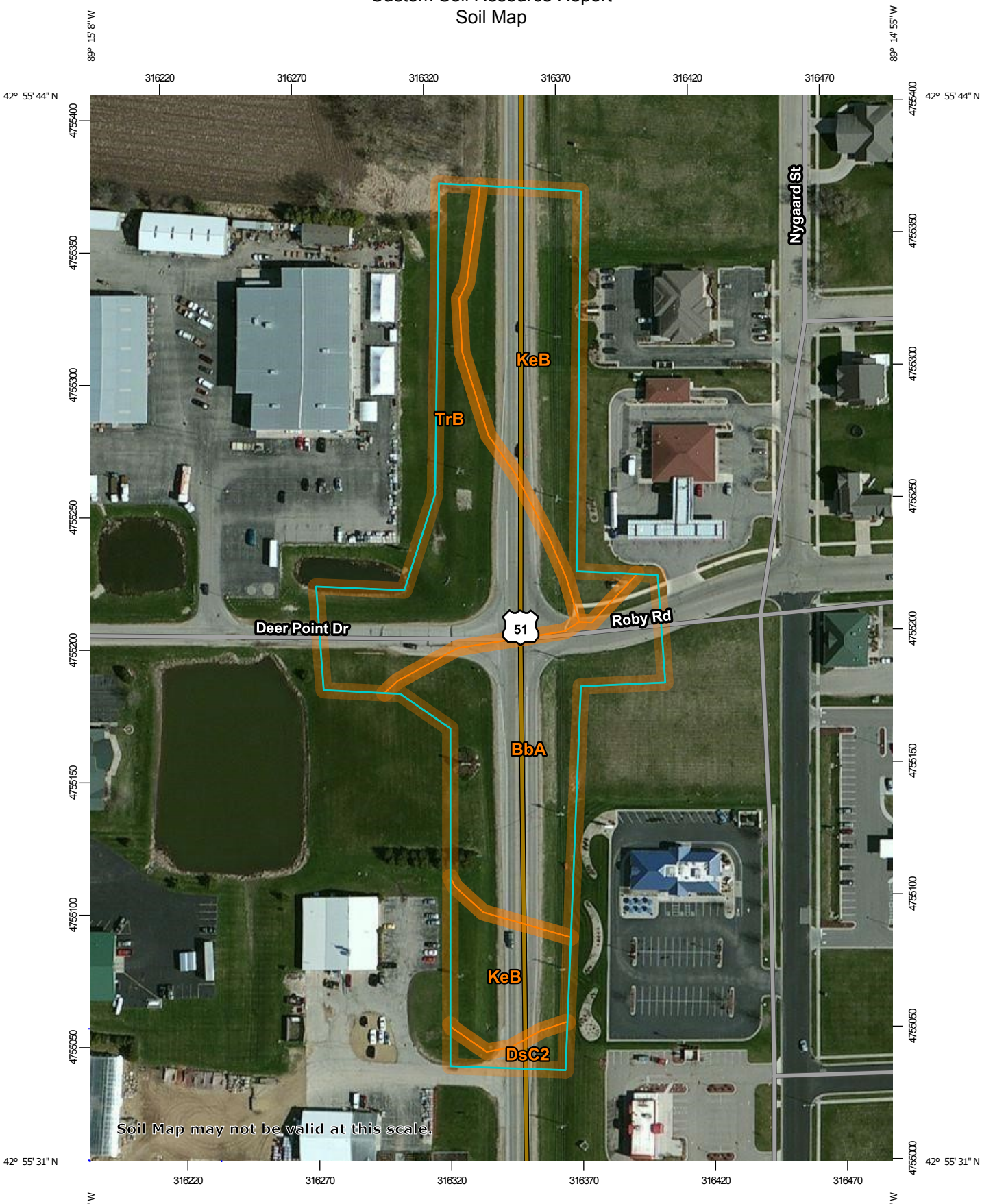
alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:1,960 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Dane County, Wisconsin
Survey Area Data: Version 17, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BbA	Batavia silt loam, gravelly substratum, 0 to 2 percent slopes	1.6	31.7%
DsC2	Dresden silt loam, 6 to 12 percent slopes, eroded	0.1	2.4%
KeB	Kegonsa silt loam, 2 to 6 percent slopes	1.8	35.3%
TrB	Troxel silt loam, 0 to 3 percent slopes	1.5	30.5%
Totals for Area of Interest		**5.0**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Dane County, Wisconsin

BbA—Batavia silt loam, gravelly substratum, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: t918
Mean annual precipitation: 28 to 33 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 135 to 160 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Batavia, gravelly substratum, and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Batavia, Gravelly Substratum

Setting

Landform: Outwash plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Deep loess over loamy outwash

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 44 inches: silty clay loam
H3 - 44 to 50 inches: gravelly clay loam
H4 - 50 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B
Forage suitability group: High AWC, adequately drained (G095BY008WI)
Hydric soil rating: No

DsC2—Dresden silt loam, 6 to 12 percent slopes, eroded

Map Unit Setting

National map unit symbol: 2wspw
Elevation: 750 to 1,180 feet
Mean annual precipitation: 31 to 35 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 132 to 185 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Dresden, eroded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dresden, Eroded

Setting

Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy glaciofluvial deposits over calcareous sandy and gravelly outwash

Typical profile

Ap - 0 to 8 inches: silt loam
Bt1 - 8 to 25 inches: clay loam
2Bt2 - 25 to 30 inches: gravelly sandy clay loam
2C - 30 to 79 inches: stratified gravel to coarse sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: 29 to 40 inches to strongly contrasting textural stratification
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Forage suitability group: Mod AWC, adequately drained (G095BY005WI)

Hydric soil rating: No

Minor Components

Casco, eroded

Percent of map unit: 5 percent
Landform: Moraines
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Kegonsa

Percent of map unit: 5 percent
Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

KeB—Kegonsa silt loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: t93f
Mean annual precipitation: 28 to 33 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 135 to 160 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Kegonsa and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kegonsa

Setting

Landform: Outwash plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over sandy and gravelly outwash

Typical profile

H1 - 0 to 12 inches: silt loam
H2 - 12 to 29 inches: silt loam
H3 - 29 to 33 inches: sandy clay loam
H4 - 33 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 2 to 6 percent

Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Forage suitability group: High AWC, adequately drained (G095BY008WI)
Hydric soil rating: No

TrB—Troxel silt loam, 0 to 3 percent slopes

Map Unit Setting
National map unit symbol: 2wsqw
Elevation: 750 to 1,150 feet
Mean annual precipitation: 31 to 37 inches
Mean annual air temperature: 45 to 66 degrees F
Frost-free period: 110 to 185 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Troxel, wet substratum, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Troxel, Wet Substratum

Setting
Landform: Moraines, depressions
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Silty colluvium

Typical profile
Ap - 0 to 31 inches: silt loam
Bt - 31 to 54 inches: silty clay loam
BC - 54 to 79 inches: silt loam

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)

Depth to water table: About 36 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 12.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: B
Forage suitability group: High AWC, adequately drained (G095BY008WI)
Hydric soil rating: No

Minor Components

Elburn

Percent of map unit: 8 percent
Landform: Drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Plano

Percent of map unit: 7 percent
Landform: Till plains
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Chemical Properties

This folder contains a collection of tabular reports that present soil chemical properties. The reports (tables) include all selected map units and components for each map unit. Soil chemical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil chemical properties include pH, cation exchange capacity, calcium carbonate, gypsum, and electrical conductivity.

Chemical Soil Properties (5845-01-78)

This table shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Cation-exchange capacity is the total amount of extractable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Effective cation-exchange capacity refers to the sum of extractable cations plus aluminum expressed in terms of milliequivalents per 100 grams of soil. It is determined for soils that have pH of less than 5.5.

Soil reaction is a measure of acidity or alkalinity. It is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil.

Gypsum is expressed as a percent, by weight, of hydrated calcium sulfates in the fraction of the soil less than 20 millimeters in size. Gypsum is partially soluble in water. Soils that have a high content of gypsum may collapse if the gypsum is removed by percolating water.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Sodium adsorption ratio (SAR) is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. Soils that have SAR values of 13 or more may be characterized by an increased dispersion of organic matter and clay particles, reduced saturated hydraulic conductivity and aeration, and a general degradation of soil structure.

Chemical Soil Properties–Dane County, Wisconsin								
Map symbol and soil name	**Depth**	**Cation-exchange capacity**	**Effective cation-exchange capacity**	**Soil reaction**	**Calcium carbonate**	**Gypsum**	**Salinity**	**Sodium adsorption ratio**
	In	*meq/100g*	*meq/100g*	*pH*	*Pct*	*Pct*	*mmhos/cm*	
BbA—Batavia silt loam, gravelly substratum, 0 to 2 percent slopes								
Batavia, gravelly substratum	0-10	12-19	—	6.1-7.3	0	0	—	—
	10-44	14-19	—	5.1-6.5	0	0	—	—
	44-50	2.0-21	—	6.6-7.8	0	0	—	—
	50-60	0.0-3.2	—	7.4-8.4	0	0	—	—
DsC2—Dresden silt loam, 6 to 12 percent slopes, eroded								
Dresden, eroded	0-8	9.8-14	—	5.6-7.3	0	0	0.0-2.0	0
	8-25	14-19	—	5.6-7.3	0	0	0.0-2.0	0
	25-30	10-16	—	5.6-7.8	0	0	0.0-2.0	0
	30-79	0.5-0.5	—	7.4-8.4	0-20	0	0.0-2.0	0
KeB—Kegonsa silt loam, 2 to 6 percent slopes								
Kegonsa	0-12	9.4-15	—	5.1-7.3	0	0	—	—
	12-29	13-17	—	5.1-6.5	0	0	—	—
	29-33	13-17	—	6.1-7.8	0	0	—	—
	33-60	0.0-1.4	—	7.4-8.4	0	0	—	—
TrB—Troxel silt loam, 0 to 3 percent slopes								
Troxel, wet substratum	0-31	17-23	—	5.6-6.5	0	0	0.0-2.0	0
	31-54	19-28	—	5.6-6.5	0	0	0.0-2.0	0
	54-79	12-21	—	6.6-7.8	0	0	0.0-2.0	0

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties (5845-01-78)

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell

potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Dane County, Wisconsin														
Map unit symbol and soil name	**Pct. of map unit**	**Hydrologic group**	**Depth**	**USDA texture**	**Classification**		**Pct Fragments**		**Percentage passing sieve number—**				**Liquid limit**	**Plasticity index**
					Unified	**AASHTO**	**>10 inches**	**3-10 inches**	**4**	**10**	**40**	**200**		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
BbA—Batavia silt loam, gravelly substratum, 0 to 2 percent slopes														
Batavia, gravelly substratum	100	B	0-10	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	95-98-100	25-33-40	9-13-16
			10-44	Silty clay loam, silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	95-98-100	90-95-100	30-38-45	11-17-22
			44-50	Sandy loam, gravelly clay loam	SC	A-6	—	0- 3- 5	80-88-95	70-80-90	40-65-90	20-48-75	15-31-46	NP-14-28
			50-60	Coarse sand, sand, gravelly coarse sand	SP-SM	A-3	—	0- 5- 10	30-65-100	30-65-100	10-53-95	2- 7- 12	0-0 -19	NP-0 -2

Engineering Properties–Dane County, Wisconsin														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
DsC2—Dresden silt loam, 6 to 12 percent slopes, eroded														
Dresden, eroded	90	B	0-8	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	88-95-100	73-83-88	32-39-45	12-15-18
			8-25	Clay loam	CL	A-6, A-7-6	0- 0- 0	0- 0- 0	90-95-100	89-95-100	85-94-100	73-81-90	36-41-46	19-22-25
			25-30	Gravelly sandy clay loam, very gravelly loam, loam	GC	A-2-6, A-6	0- 0- 0	0- 2- 3	47-64-100	44-63-100	36-54-92	20-31-55	29-35-40	13-17-21
			30-79	Very gravelly sand, gravelly sand, stratified gravel to coarse sand	SP-SM	A-1-b	0- 0- 0	4-12- 23	35-55-79	32-53-78	18-30-46	4- 7- 11	0-0 -0	NP
KeB—Kegonsa silt loam, 2 to 6 percent slopes														
Kegonsa	100	B	0-12	Silt loam	CL	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	90-95-100	70-80-90	20-25-30	5-8 -10
			12-29	Silty clay loam, silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	90-95-100	85-90-95	30-38-45	10-15-20
			29-33	Loam, clay loam, sandy clay loam	CL	A-6	0- 0- 0	0- 0- 0	90-95-100	80-90-100	65-83-100	30-55-80	30-38-45	10-15-20
			33-60	Gravelly coarse sand	SW	A-1-b	—	0- 3- 5	40-63-85	35-60-85	15-25-35	0- 3- 5	0-0 -14	NP

Engineering Properties–Dane County, Wisconsin														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
TrB—Troxel silt loam, 0 to 3 percent slopes														
Troxel, wet substratum	85	B	0-31	Silt loam	ML	A-7-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	97-100-100	90-96-100	37-42-48	13-15-18
			31-54	Silty clay loam, silt loam	CL	A-7-6	0- 0- 0	0- 0- 0	83-96-100	83-96-100	78-95-100	74-91-100	35-41-47	17-21-25
			54-79	Silt loam	CL	A-6	0- 0- 0	0- 0- 0	79-92-100	78-92-100	72-91-100	59-77-88	26-34-38	9-16-19

Physical Soil Properties (5845-01-78)

This table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates in the table are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity (Ksat) is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change.

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The content of organic matter in a soil can be maintained by returning crop residue to the soil.

Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and Ksat. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the "National Soil Survey Handbook."

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Reference:
United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. (http://soils.usda.gov)

Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Physical Soil Properties–Dane County, Wisconsin														
Map symbol and soil name	**Depth**	**Sand**	**Silt**	**Clay**	**Moist bulk density**	**Saturated hydraulic conductivity**	**Available water capacity**	**Linear extensibility**	**Organic matter**	**Erosion factors**			**Wind erodibility group**	**Wind erodibility index**
										Kw	**Kf**	**T**		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
BbA—Batavia silt loam, gravelly substratum, 0 to 2 percent slopes														
Batavia, gravelly substratum	0-10	-10-	-68-	18-23- 27	1.10-1.25-1.40	4.00-9.00-14.00	0.22-0.23-0.24	0.0- 1.5- 2.9	1.0- 2.0-3.0	.43	.43	4	6	48
	10-44	- 9-	-61-	25-30- 35	1.55-1.60-1.65	4.00-9.00-14.00	0.18-0.20-0.22	3.0- 4.5- 5.9	0.0- 0.5-1.0	.43	.43			
	44-50	-30-	-43-	3-27- 40	1.70-1.75-1.80	4.00-23.00-42.00	0.05-0.08-0.11	0.0- 1.5- 2.9	0.0- 0.5-1.0	.28	.37			
	50-60	-91-	- 7-	0- 3- 5	1.30-1.55-1.80	141.00-141.00-141.00	0.02-0.03-0.04	0.0- 1.5- 2.9	0.0- 0.3-0.5	.02	.10			
DsC2—Dresden silt loam, 6 to 12 percent slopes, eroded														
Dresden, eroded	0-8	20-22- 27	50-55- 62	18-23- 25	1.26-1.36-1.46	4.23-9.17-14.11	0.20-0.22-0.24	1.5- 2.1- 2.7	2.0- 3.0-4.0	.32	.32	3	6	48
	8-25	20-21- 45	28-48- 53	27-31- 35	1.31-1.44-1.56	4.23-9.17-14.11	0.15-0.18-0.20	2.4- 3.1- 3.9	0.0- 0.5-1.0	.37	.37			
	25-30	48-57- 68	2-18- 28	20-25- 30	1.58-1.62-1.65	4.23-9.17-14.11	0.08-0.13-0.18	0.9- 1.7- 3.1	0.0- 0.3-0.5	.10	.24			
	30-79	85-90- 95	1- 7- 14	1- 3- 4	1.57-1.63-1.69	141.14-423.42-705.00	0.02-0.03-0.04	0.0- 0.0- 0.1	0.0- 0.1-0.1	.02	.02			

Physical Soil Properties–Dane County, Wisconsin														
Map symbol and soil name	**Depth**	**Sand**	**Silt**	**Clay**	**Moist bulk density**	**Saturated hydraulic conductivity**	**Available water capacity**	**Linear extensibility**	**Organic matter**	**Erosion factors**			**Wind erodibility group**	**Wind erodibility index**
										Kw	**Kf**	**T**		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
KeB—Kegonsa silt loam, 2 to 6 percent slopes														
Kegonsa	0-12	-14-	-71-	12-15- 18	1.35-1.45-1.55	4.00-9.00-14.00	0.22-0.23-0.24	0.0- 1.5- 2.9	2.0- 3.5- 5.0	.43	.43	3	5	56
	12-29	- 9-	-63-	24-28- 32	1.55-1.60-1.65	4.00-9.00-14.00	0.18-0.20-0.22	3.0- 4.5- 5.9	0.0- 0.5- 1.0	.49	.49			
	29-33	-53-	-19-	24-28- 32	1.55-1.60-1.65	4.00-9.00-14.00	0.15-0.17-0.19	0.0- 1.5- 2.9	0.0- 0.3- 0.5	.43	.43			
	33-60	-93-	- 7-	0- 1- 2	1.30-1.75-2.20	141.00-141.00-141.00	0.02-0.03-0.04	0.0- 1.5- 2.9	0.0- 0.3- 0.5	.05	.10			
TrB—Troxel silt loam, 0 to 3 percent slopes														
Troxel, wet substratum	0-31	5- 7- 20	59-70- 75	20-24- 27	1.28-1.34-1.39	4.23-9.17-14.11	0.22-0.23-0.24	2.4- 3.2- 4.1	3.0- 4.0- 5.0	.37	.37	5	6	48
	31-54	4- 7- 20	50-63- 71	25-30- 35	1.31-1.40-1.49	4.23-9.17-14.11	0.15-0.18-0.20	2.9- 4.4- 5.7	0.2- 0.6- 1.0	.43	.43			
	54-79	23-27- 35	50-50- 62	15-23- 27	1.50-1.52-1.55	4.23-9.17-14.11	0.14-0.19-0.22	1.3- 2.7- 3.8	0.2- 0.3- 0.5	.49	.49			

Water Features

This folder contains tabular reports that present soil hydrology information. The reports (tables) include all selected map units and components for each map unit. Water Features include ponding frequency, flooding frequency, and depth to water table.

Water Features (5845-01-78)

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. The water features table indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on

observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table. The kind of water table, apparent or perched, is given if a seasonal high water table exists in the soil. A water table is perched if free water is restricted from moving downward in the soil by a restrictive feature, in most cases a hardpan; there is a dry layer of soil underneath a wet layer. A water table is apparent if free water is present in all horizons from its upper boundary to below 2 meters or to the depth of observation. The water table kind listed is for the first major component in the map unit.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Map unit symbol and soil name	Hydrologic group	Surface runoff	Most likely months	Water table			Ponding			Flooding	
				Upper limit	Lower limit	Kind	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*		*Ft*				
GrC2—Griswold silt loam, 6 to 12 percent slopes, eroded											
Griswold, eroded	B	Medium	Jan-Dec	—	—	—	—	—	None	—	None
SeB2—Saybrook silt loam, 2 to 6 percent slopes, eroded											
Saybrook	C		Jan-Dec	—	—	—	—	—	None	—	None

Water Features (5845-01-78)

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. The water features table indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table. The kind of water table, apparent or perched, is given if a seasonal high water table exists in the soil. A water table is perched if free water is restricted from moving downward in the soil by a restrictive feature, in most cases a hardpan; there is a dry layer of soil underneath a wet layer. A water table is apparent if free water is present in all horizons from its upper boundary to below 2 meters or to the depth of

observation. The water table kind listed is for the first major component in the map unit.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Map unit symbol and soil name	Hydrologic group	Surface runoff	Most likely months	Water table			Ponding			Flooding	
				Upper limit	Lower limit	Kind	Surface depth	Duration	Frequency	Duration	Frequency
				Ft	*Ft*		*Ft*				
BbA—Batavia silt loam, gravelly substratum, 0 to 2 percent slopes											
Batavia, gravelly substratum	B		Jan-Dec	—	—	—	—	—	None	—	None
DsC2—Dresden silt loam, 6 to 12 percent slopes, eroded											
Dresden, eroded	B		Jan-Dec	—	—	—	—	—	None	—	None
KeB—Kegonsa silt loam, 2 to 6 percent slopes											
Kegonsa	B		Jan-Dec	—	—	—	—	—	None	—	None
TrB—Troxel silt loam, 0 to 3 percent slopes											
Troxel, wet substratum	B		Jan-Feb	—	—	—	—	—	None	—	None
			Mar-May	3.0-6.0	6.0	Apparent	—	—	None	—	None
			Jun-Dec	—	—	—	—	—	None	—	None

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf