LESSONS LEARNED IN PLAN DEVELOPMENT AND IMPLEMENTATION

COLLECTING SOILS DATA EARLY AND USING IT TO PLAN

2013

Waukesha County Storm Water Workshop

Alan Barrows

LESSONS LEARNED

Wet basins with low water levels

- Liner material?
- Leakage?
- Water budget?

LESSONS LEARNED

Infiltration basins with persistent ponded water

- Groundwater?
- Plugged or sealed bottom?
- Compaction?

LESSONS LEARNED

Wet basements

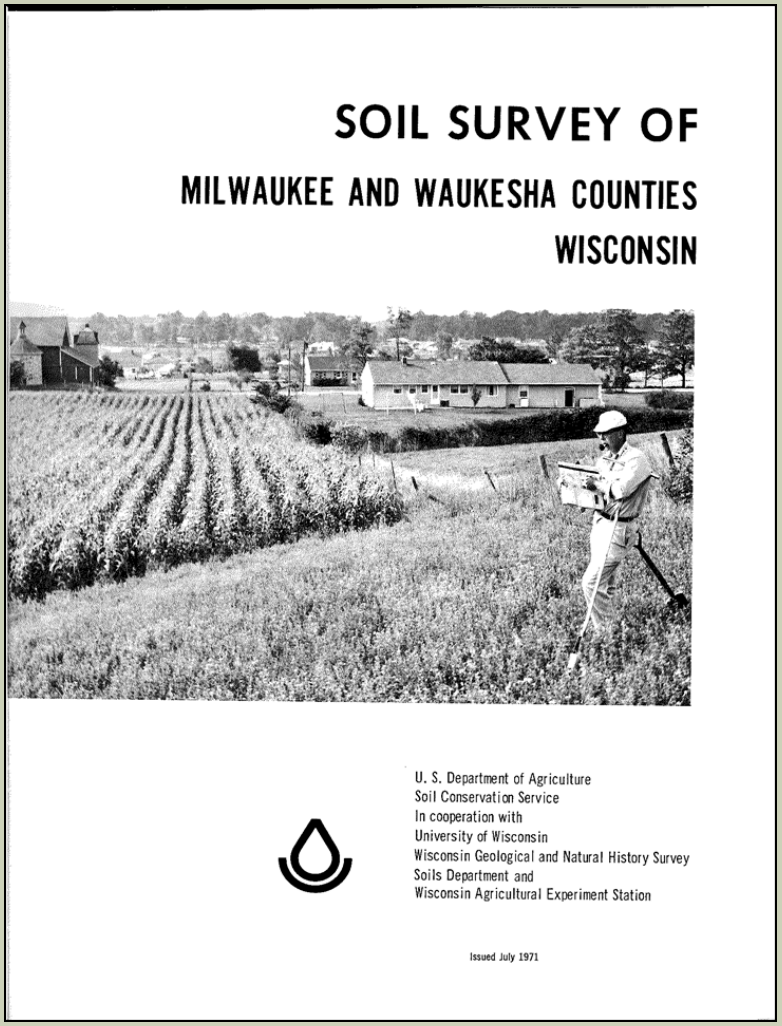
- High groundwater?
- Surface runoff?
- Poor drainage?

WHEN TO COLLECT SOILS INFORMATION

- Early in the site planning process
- After preliminary site screening
- Before lot layout
- Prior to preliminary storm water management planning

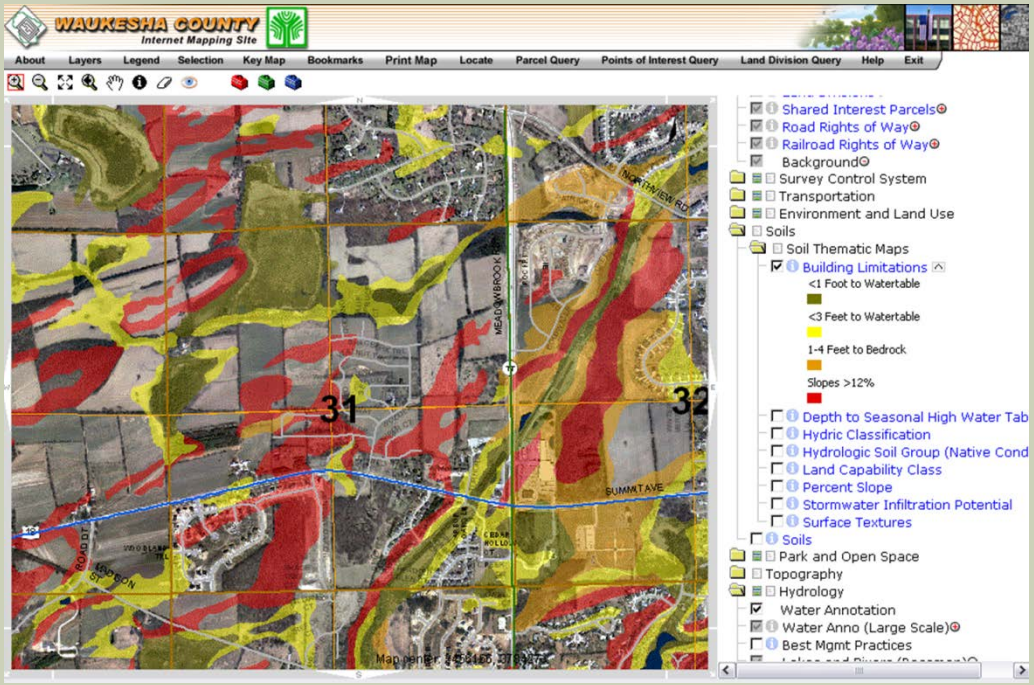
PRELIMINARY SITE SCREENING

- Soil survey information in Waukesha County has been available since the 1960's
- Provides an overview of the on-site soil conditions (to a depth of 60")



PRELIMINARY SITE SCREENING

Soil map units and attributes are available in GIS



Review the “thematic maps” showing the depth to seasonal high groundwater, risk for a wet basement, infiltration potential at a 4-foot depth & limitations to development

PRELIMINARY SITE SCREENING

Review historic aerial photos for evaluating prior land uses, drainage systems installed and evidence of wetness

Look for the telltale signs such as dark fields with light streaks

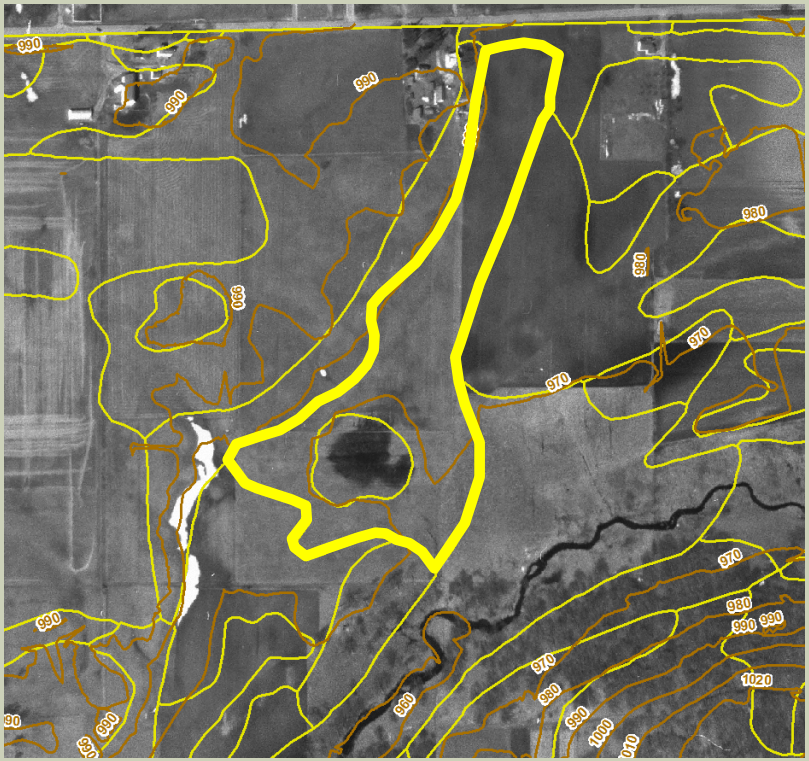
CONDUCT A SITE WALKTHROUGH

Look at how the property is positioned in the landscape

Identify where soil testing should be done for storm water management, erosion control, basements and on-site septic

CONDUCT A SITE WALKTHROUGH

Does the soil map units match the site topography and landscape position?



1963 aerial photo

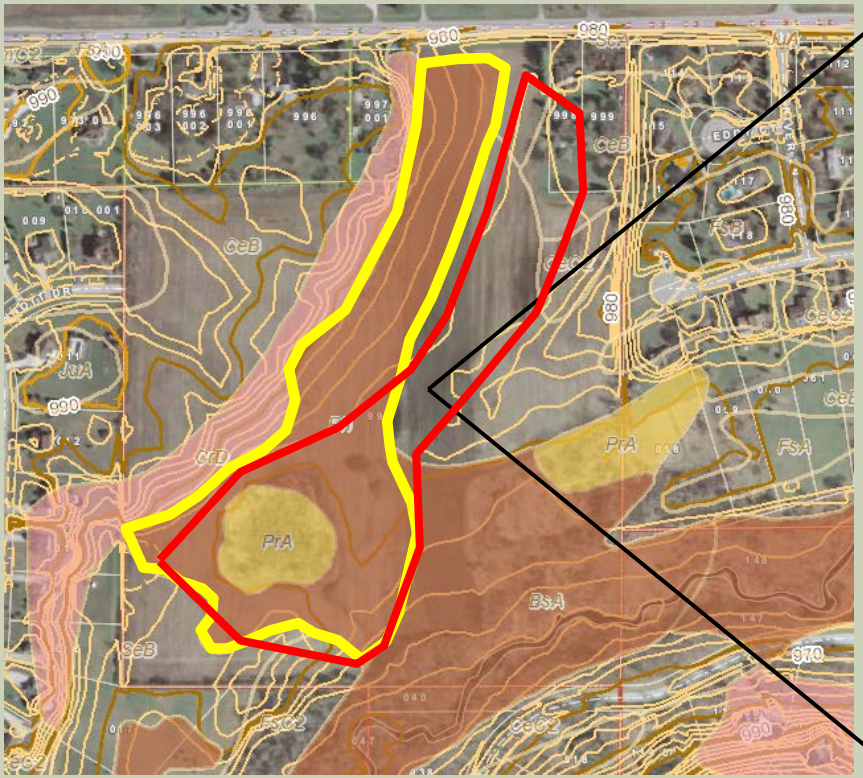
10-foot contour lines

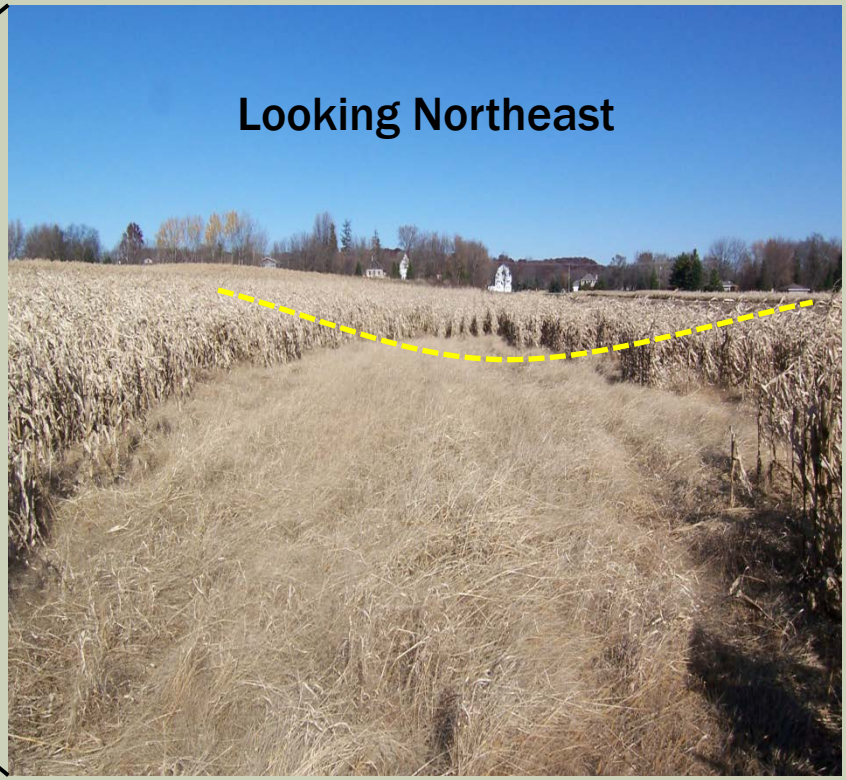
Highlighted soil map unit is a Pella Silt Loam (Ph)

Pellas are hydric soils are formed in low drainageways

CONDUCT A SITE WALKTHROUGH

Does the soil map units match the site topography and landscape position?





The red polygon represents the actual bottom of the low drainageway

SOIL TESTING PROCEDURES

- Use the USDA soil classification system; SPS 385 procedures
- Soil evaluations must be done by a Certified Soil Tester (“CST”) or Professional Soil Scientist (“PSS”)
- Recommend using open-pit excavations for evaluating the soil profile whenever possible for a larger view and ability to orient the pit for the best sunlight exposure

SOIL TESTING PROCEDURES

- Thickness
- Color
- Mottles
- Redoximorphic features
- Textural class
- Structure
- Consistence

SOIL TESTING PROCEDURES

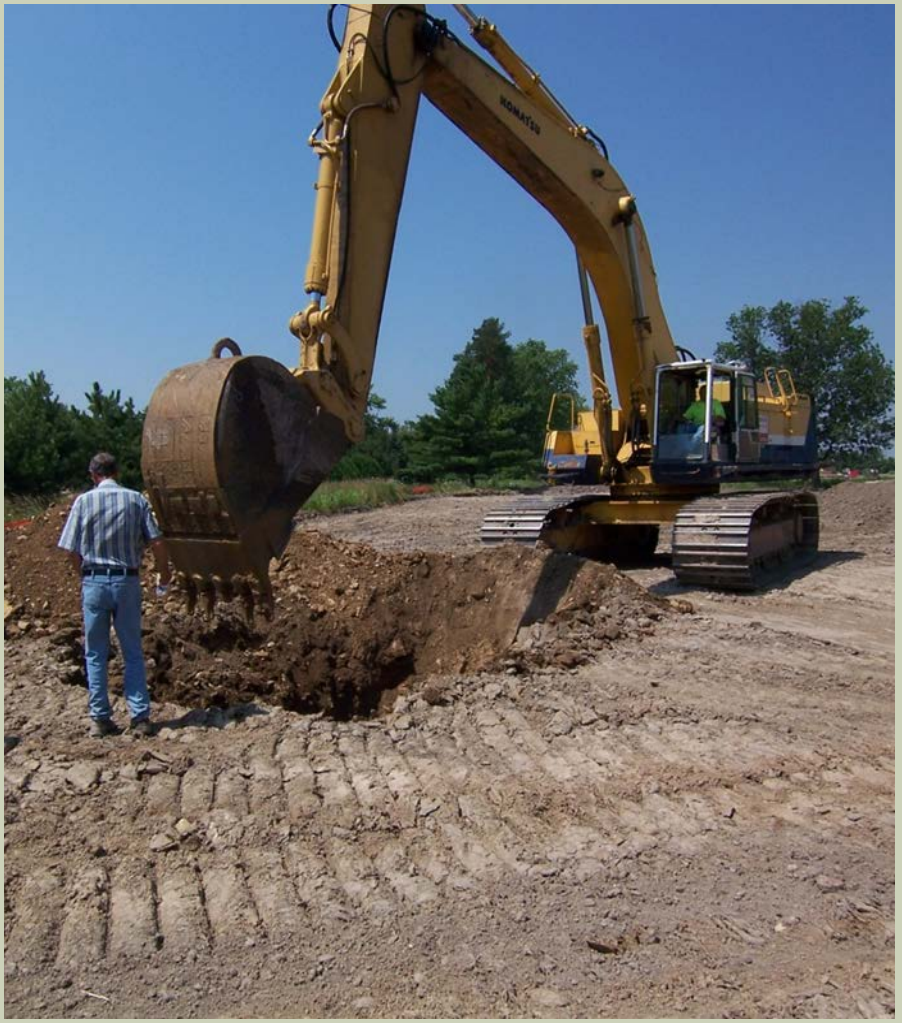
- Existence of roots
- Boundary description
- Soil saturation
- Observed groundwater
- Bedrock
- Disturbed or filled soils

WHERE TO COLLECT SOIL DATA

- For storm water management, distribute bioretention and infiltration BMPs throughout the site for large developments
- Within 50 feet of a basement
- As required for on-site septic

NUMBER OF SOIL TESTS NEEDED

- At least 2 soil test needed for siting a storm water management BMP
- At least 1 soil test needed for basement/water table separation (within 50’ of the foundation)
- Three soil tests needed for siting a on-site septic system



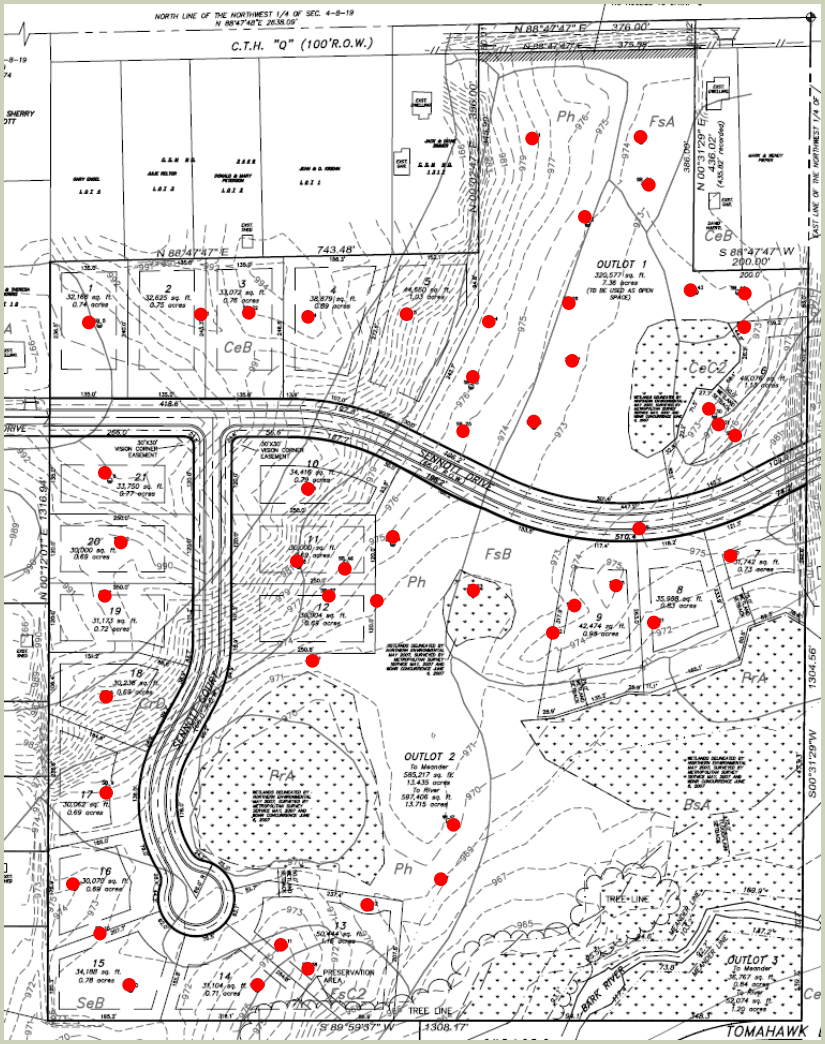
DEPTH OF THE SOIL TESTS

- At least 5 feet below the bottom of a storm water management BMP (8 – 10 feet deep)
- At least 8 feet deep for a basement
- 5 to 10 feet deep for on-site septic (depending on system type)

USING THE SOIL DATA

- Survey the locations of soil tests and the ground surface elevations in State Plane Coordinates, NAD 27, NGVD 29 (for Waukesha County)

- Illustrate the locations of the soil investigations on the site plan map with unique labels corresponding to the soil logs (● = test pit)



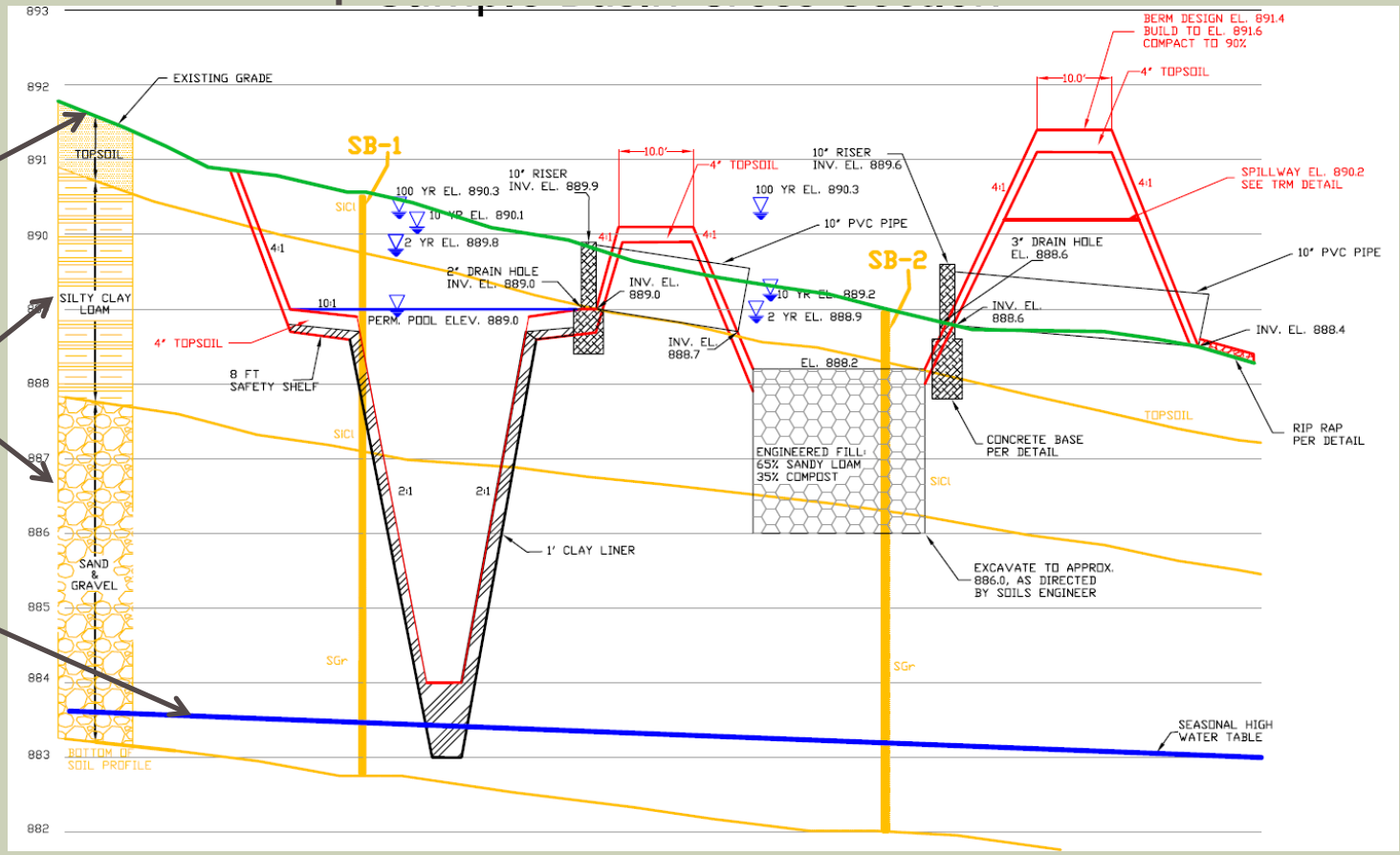
USING THE DATA

Illustrate the results of the investigations onto the storm water BMP cross-sections and profiles

Existing grade

Soil textures

Seasonal high water table

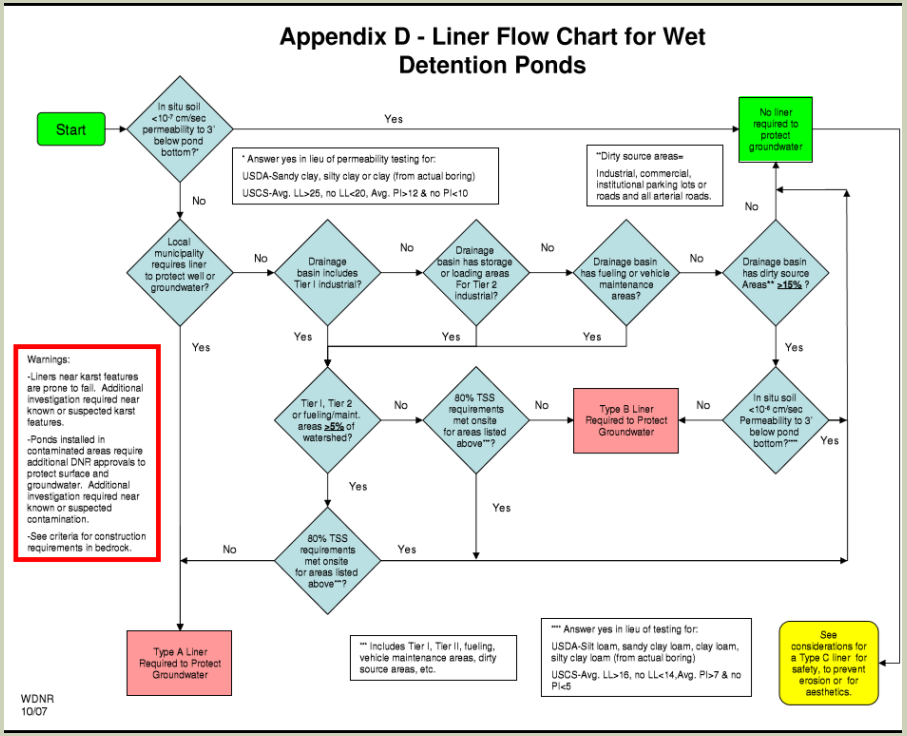


USING THE DATA

- Determine if a liner is needed in a wet detention basin
- Determine if on-site soils are suitable to be used as a liner
- Determine if soils are suitable for embankment material (non organic)

USING THE DATA

- WDNR Technical Standard for Wet Ponds (1001) Liner Criteria



Appendix D—Pond Liner Design, Decision Flowchart

Pond Liner Design Specifications for Three Levels of Liners

A. Type A Liners—for sites with the highest potential for groundwater pollution. They include:
- Clay (natural soil, not bentonite)
- High Density Polyethylene (HDPE)
- Geosynthetic Clay Liners (GCL)

1. Clay liner criteria (essentially the same as the clay below landfills but not as thick):
   a. 50% fines (200 sieve) or more.
   b. An in-place hydraulic conductivity of 1×10^{-7} cm./sec. or less.
   c. Average liquid limit of 25 or greater, with no value less than 20.
   d. Average PI of 12 or more, with no values less than 10.
   e. Clay installed wet of optimum if using standard Proctor, and 2% wet of optimum if using modified Proctor.
   f. Clay compaction and documentation as specified in NRCS Wisconsin Construction Specification 300, Clay Liners.
   g. Minimum thickness of two feet.
   h. Specify method for keeping the pool full or use of composite soils below liner.
2. HDPE liner criteria:
   a. Minimum thickness shall be 60 mils.
   b. Design according to the criteria in Table 3 of the NRCS 313, Waste Storage Facility technical standard.
   c. Install according to NRCS Wisconsin Construction Specification 202, Polyethylene Geomembrane Lining.
3. GCL liner criteria:
   a. Design according to the criteria in Table 4 of NRCS 313, Waste Storage Facility technical standard.
   b. Install according to NRCS Wisconsin Construction Specification 203, Geosynthetic Clay Liner.

B. Type B Liners—for sites with medium potential for groundwater pollution or where need for a full pool level is high. They include:
- All liners meeting Type A criteria
- Clay
- HDPE
- Polyethylene Pond Liner (PPL)

1. Clay liner criteria:
   a. 50% fines (200 sieve) or more.
   b. An in-place hydraulic conductivity of 1×10^{-6} cm./sec. or less.
   c. Average liquid limit value of 16 or greater, with no value less than 14.
   d. Average PI of 7 or more with no values less than 5.
   e. Clay compaction and documentation as specified in NRCS Wisconsin Construction Specification 204, Earthfill for Waste Storage Facilities.
   f. Minimum thickness of two feet.
   g. Specify method for keeping the pool full or use of composite soils below liner.
2. HDPE liner criteria:
   a. Minimum thickness shall be 40 mils.
   b. All other criteria same as for Type A HDPE liner.
3. PPL liner criteria:
   a. Minimum thickness shall be 30 mils.
   b. All other criteria same as for Type A HDPE liner.

C. Type C Liners—for sites with little potential for groundwater pollution or where the need for a full pool is less important. They include:
- All liners meeting Type A or B criteria
- Silts and clays
- HDPE (<40 mil)
- PPL (20-24 mil)
- PVC (30-40 mil)
- EPDM (45 mil)

1. Silt/Clay liner criteria:
   a. 50% fines (200 sieve), or 20% fines and a PI of 7.
   b. Soil compaction and documentation as specified in NRCS Wisconsin Construction Specification 204, Earthfill for Waste Storage Facilities.
   c. Minimum thickness of two feet.
   d. Specify method for keeping the pool full or use of composite soils below liner.

D. Liner Elevation—All liners must extend above the permanent pool up to the elevation reached by the 2-yr., 24-hour storm event.

E. For synthetic liners, follow the manufacturers' recommendations for installation.

WDNR 10/07

USING THE DATA

- Determine if the soil below an infiltration BMP meets the definition of "filtering layer"

  Minimum soil filtering & distance to bedrock/seasonal high groundwater:

  5 feet with 10% fines (#200 sieve)

  Comm., industrial, parking lots, arterials, etc.

  3 feet with 20% fines (#200 sieve)

  All other areas except roof runoff

- Determine the design infiltration rate for BMPs

  Use Table 2 of the Site Evaluation for Stormwater Infiltration technical standard (1002)

  Design infiltration rates range between .07 and 3.6 inches/hour.

USING THE DATA

- Determine if the on-site topsoil is suitable for being reused in infiltration BMPs

Sandy loam topsoil (.5 in/hr)

Silt loam topsoil (.13 in/hr)

Table 2: Design Infiltration Rates for Soil Textures Receiving Stormwater

Soil Texture[1]	Design Infiltration Rate Without Measurement inches/hour[2]
Coarse sand or coarser	3.60
Loamy coarse sand	3.60
Sand	3.60
Loamy sand	1.63
Sandy loam	0.50
Loam	0.24
Silt loam	0.13
Sandy clay loam	0.11
Clay loam	0.03
Silty Clay loam	0.04[3]
Sandy clay	0.04
Silty clay	0.07
Clay	0.07

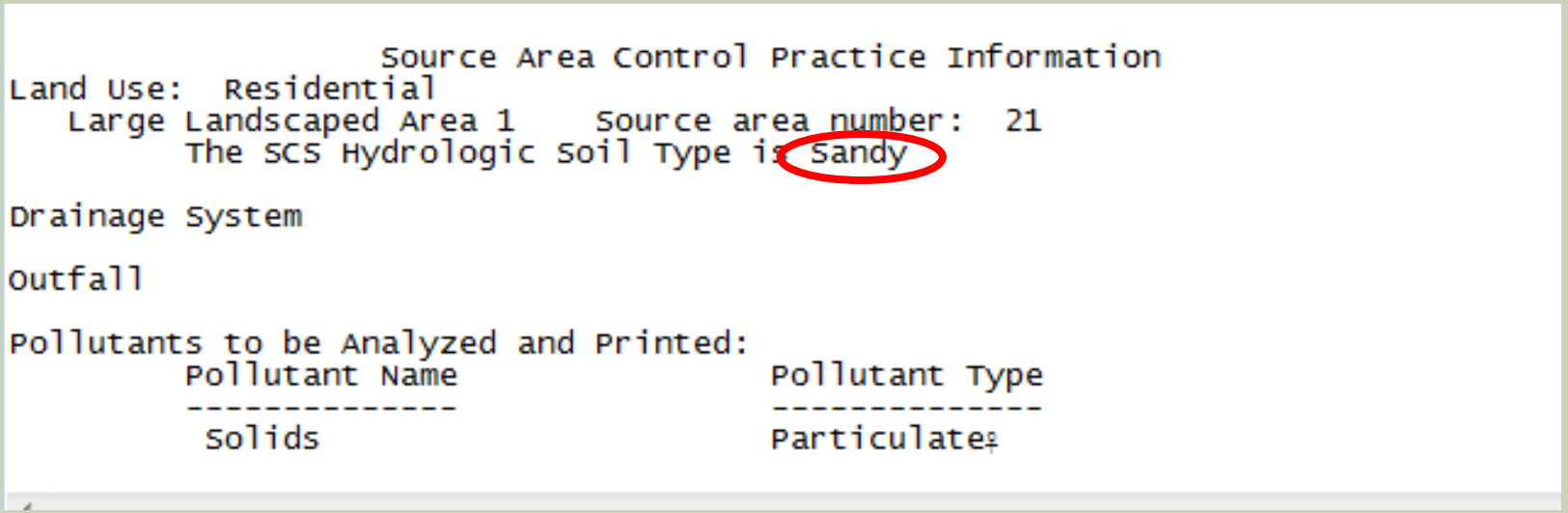
[1]Use sandy loam design infiltration rates for fine sand, loamy fine sand, very fine sand, and loamy fine sand soil textures.

[2] Infiltration rates represent the lowest value for each textural class presented in Table 2 of Rawls, 1998.

[3] Infiltration rate is an average based on Rawls, 1982 and Clapp & Hornberger, 1978.

USING THE DATA

- Use field collected soil data in SLAMM for water quality modeling by describing the soil texture of the source areas



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                    Source Area Control Practice Information
Land Use:  Residential
   Large Landscaped Area 1    Source area number:  21
         The SCS Hydrologic Soil Type is: Sandy

Drainage System

Outfall

Pollutants to be Analyzed and Printed:
         Pollutant Name                 Pollutant Type
         --------------                 --------------
          Solids                        Particulates
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USING THE DATA

- Use texture information for sizing sediment traps
  - Less than a 5 acre contributing watershed
  - Calculate the minimum surface area based upon soil texture

For coarse textured soils (loamy sand, sandy loam, and sand):
As (coarse) = 625 * Adr

For medium textured soils (loams, silt loams, and silt):
As (medium) = 1560 * Adr

For fine textured soils (sandy clay, silty clay, silty clay loam, clay loam, and clay):
As (fine) = 5300 * Adr

As = surface area of storage volume in square feet; Adr = contributory drainage area in acres

USING THE DATA

- Use texture information for sizing sediment basins
  - Watersheds 5 acres or larger

Surface area (Sa) = 1.2 * (qout / vs)

Where:
Sa = Treatment surface area measured at the invert of the lowest outlet of sediment basin (square feet)
qout = Peak outflow (cubic feet / second) during the 1-year, 24-hour design storm for the principal outlet
vs = Particle settling velocity (feet/second)
1.2 = EPA recommended safety factor.

Particle settling velocities (Vs) shall be based on representative soil class as follows:
Soil Class 1: vs = 1.2*10-3 ft/sec
Soil Class 2: vs = 7.3*10-5 ft/sec
Soil Class 3: vs = 1.2*10-5 ft/sec

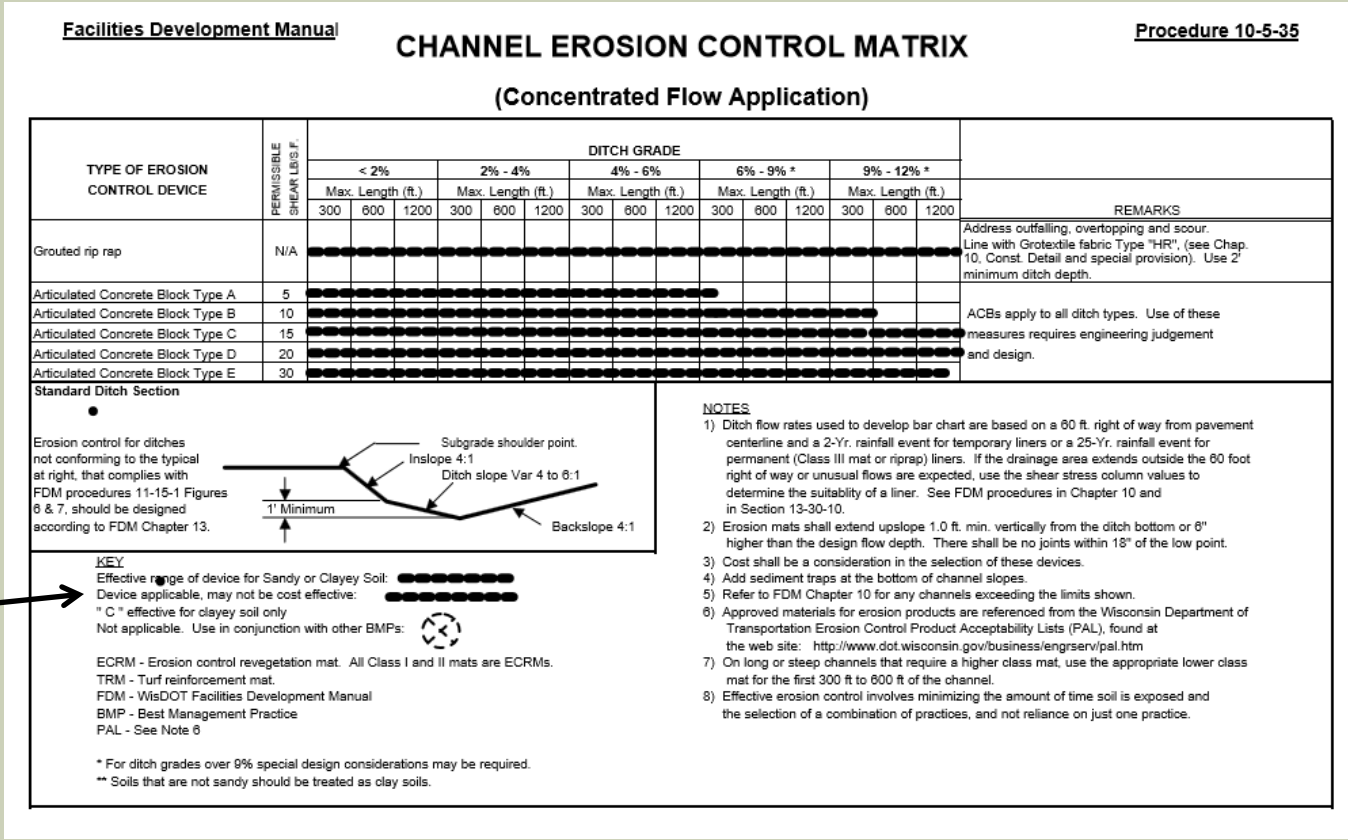
Soil Class 1 includes sand, loamy sand, and sandy loam.
Soil Class 2 includes loam, silt, and silt loam aggregates as transported in runoff.
Soil Class 3 includes clay loam, silty clay, and clay aggregates as transported in runoff.

USING THE DATA

- Use texture information for selecting erosion matting

WisDOT Product Acceptability List

Texture codes



Facilities Development Manual

CHANNEL EROSION CONTROL MATRIX

(Concentrated Flow Application)

Procedure 10-5-35

TYPE OF EROSION CONTROL DEVICE	PERMISSIBLE SHEAR LBS/ S.F.	DITCH GRADE < 2% Max. Length (ft.) 300 / 600 / 1200	2% - 4% Max. Length (ft.) 300 / 600 / 1200	4% - 6% Max. Length (ft.) 300 / 600 / 1200	6% - 9% * Max. Length (ft.) 300 / 600 / 1200	9% - 12% * Max. Length (ft.) 300 / 600 / 1200	REMARKS
Grouted rip rap	N/A	●	●	●	●	●	Address outfalling, overtopping and scour. Line with Grotextile fabric Type "HR", (see Chap. 10, Const. Detail and special provision). Use 2' minimum ditch depth.
Articulated Concrete Block Type A	5	●	●	●			ACBs apply to all ditch types. Use of these measures requires engineering judgement and design.
Articulated Concrete Block Type B	10	●	●	●	●		
Articulated Concrete Block Type C	15	●	●	●	●	●	
Articulated Concrete Block Type D	20	●	●	●	●	●	
Articulated Concrete Block Type E	30	●	●	●	●	●	

Standard Ditch Section

Erosion control for ditches not conforming to the typical at right, that complies with FDM procedures 11-15-1 Figures 6 & 7, should be designed according to FDM Chapter 13.

KEY

Effective range of device for Sandy or Clayey Soil: ●●●●●●●●

Device applicable, may not be cost effective: ●●●●●●●●●●

" C " effective for clayey soil only

Not applicable. Use in conjunction with other BMPs: (X)

ECRM - Erosion control revegetation mat. All Class I and II mats are ECRMs.
TRM - Turf reinforcement mat.
FDM - WisDOT Facilities Development Manual
BMP - Best Management Practice
PAL - See Note 6

* For ditch grades over 9% special design considerations may be required.
** Soils that are not sandy should be treated as clay soils.

NOTES

1) Ditch flow rates used to develop bar chart are based on a 60 ft. right of way from pavement centerline and a 2-Yr. rainfall event for temporary liners or a 25-Yr. rainfall event for permanent (Class III mat or riprap) liners. If the drainage area extends outside the 60 foot right of way or unusual flows are expected, use the shear stress column values to determine the suitablity of a liner. See FDM procedures in Chapter 10 and in Section 13-30-10.
2) Erosion mats shall extend upslope 1.0 ft. min. vertically from the ditch bottom or 6" higher than the design flow depth. There shall be no joints within 18" of the low point.
3) Cost shall be a consideration in the selection of these devices.
4) Add sediment traps at the bottom of channel slopes.
5) Refer to FDM Chapter 10 for any channels exceeding the limits shown.
6) Approved materials for erosion products are referenced from the Wisconsin Department of Transportation Erosion Control Product Acceptability Lists (PAL), found at the web site: http://www.dot.wisconsin.gov/business/engrserv/pal.htm
7) On long or steep channels that require a higher class mat, use the appropriate lower class mat for the first 300 ft to 600 ft of the channel.
8) Effective erosion control involves minimizing the amount of time soil is exposed and the selection of a combination of practices, and not reliance on just one practice.

USING THE DATA

- Use to determine a seed mix for vegetating construction sites
  - Sec 630 of the WisDOT Facilities Development Manual

630.2.1.5.1.1.2 Mixture

(1) The contractor shall select a seed mixture or mixtures that meet with the engineer's approval, and unless specified otherwise in the contract, shall conform to the following:

1. Use seed mixture No. 10 where average loam, heavy clay, or moist soils predominate.
2. Use seed mixture No. 20 where light, dry, well-drained, sandy, or gravelly soils predominate and for all high cut and fill slopes generally exceeding 6 to 8 feet, except where using No. 70.
3. Use seed mixture No. 10 or No. 20 on all ditches, inslopes, median areas, and low fills, except where using No. 30 or No. 70.
4. Use seed mixture No. 30 for medians and on slopes or ditches generally within 15 feet of the shoulder where a salt-tolerant turf is preferred.
5. Use seed mixture No. 40 in urban or other areas where a lawn type turf is preferred.
6. Use seed mixture No. 60 only on areas, the contract designates or the engineer specifies. Use it as a cover seeding for newly graded wet areas or as a nurse crop for specified wetland seed mixtures. The contractor shall not apply it to flooded areas.
7. Use seed mixture Nos. 70 and 70A on slopes and upland areas the contract designates or the engineer specifies. Use seed mixture No. 70 on loamy soils and seed mixture No. 70A on sandy soils.
8. Use seed mixture No. 75 where native grasses are desired for erosion control.
9. Use seed mixture No. 80 on inslopes where a salt tolerant seed mix containing native grasses is desired.

USING THE DATA

- Use to determine appropriate trench dewatering practice
  - WDNR Technical Standard 1061

Figure 2: Dewatering Practice Selection Matrix

Type of Dewatering Practice	Soil and Particle Size Classification			Notes
	Coarse to Medium Particles *Sand, Loamy Sands, and Sandy Loams*	Medium to Fine Particles *Loams, Silt Loams, and Silts*	Fine to Very Fine Particles *Clay Loams, Silty Clays and Clay*	
Geotextile Bags				
Type I	▬	● ● ● ● ● ● ● ● ● ● ●		
Type II	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	▬	● ● ● ● ● ● ● ● ● ● ● ●	
Gravity Based Settling				
Sediment Tank (Portable)	▬	● ● ● ● ● ● ● ● ● ● ●		
Sediment Trap (Temporary)	▬	● ● ● ● ● ● ● ● ● ● ●		Use Standard 1063 Sediment Trap
Sediment Basin (Temporary)	▬	▬	● ● ● ● ● ● ● ● ● ● ●	Use Standard 1064 Sediment Basin
Wet Detention Basin (Perm)	▬	▬	▬	Use Standard 1001 Wet Detention Basin
Passive Filtration				
Filter Tank (Portable)	▬	▬	● ● ● ● ● ● ● ● ● ● ●	Use according to manufacturer's recommendations
Filter Basin	▬	▬	● ● ● ● ● ● ● ● ● ● ● ●	See WisDOT Standard Specifications
Vegetative Filter	▬	▬	▬	Effectiveness depends upon the width of the filter and the runoff rate of flow. See Standard 1054 for design guidelines.
Pressurized Filtration				
Portable Sand Filter	▬	● ● ● ● ● ● ● ● ● ● ● ●	● ● ● ● ● ● ● ● ● ● ● ●	The contractor shall provide a certification sheet from the manufacturer specifiying performance of the device based on soil type and pumping rate.
Wound Cartridge Units	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	▬	▬	
Membranes & Micro-filtration	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■	Very effective but high maintenance requirements
Other Practices				
Sanitary Sewer Discharge	▬	▬	▬	
Pump Truck	▬	▬	▬	Transported to treatment facility
Alternative Method				Discuss with regulatory authority

Key:
Effective range of device: ▬
Device applicable but may not be cost effective: ■ ■ ■ ■
Effective range with addition of polymer: ● ● ● ● ● ● ●

Notes:
(1) The effectiveness of many practices can be enhanced through the use of polymer mixture.
(2) Soil classification shall be done in accordance to an accepted method (i.e. USDA, AASHTO)

USING THE DATA

- Completing "Form A" for determining the depth to seasonal high water table and minimum basement floor elevation

Form A - Seasonal High Groundwater Determination Report

Project/Plat Name: _____ Date: _____

Project Location (PLS/CSM#): _____

Stamp, Sign & Date Here

The following table summarizes my interpretation of the soil profile evaluations conducted on the above noted site. The purpose of this report is to demonstrate compliance with a Waukesha County ordinance requirement to maintain basement floor elevations at least 1 foot above the seasonal high water table. I understand that the definition for seasonal high water table means the upper limit of the zone of soil saturation caused by underlying groundwater at its highest level. I certify that the information presented in this report represents my best professional judgment in estimating seasonal high water table based on soil and site evaluations in accordance with the procedures contained in Chapter SPS 385 Wisconsin Administrative Code.

Interpreters Signature: _____

Interpreters Printed Name/Credentials/Lic. #: _____

Interpreters Company Name/Address: _____

Site Benchmark/Elevation (Co. Stds.): _____

References: _____

_____

_____

Lot #	Soil Observ. (#)	Surface Elev. (NGVD 29)	Bottom Elev. of Soil Profile	Soil Map Unit Symbol (NRCS)	Elevation of Seasonal High Water Table	Depth to Seasonal High Water Table (Feet)	Proposed Basement Floor Elevation	Notes: List information used to determine seasonal high water table, including any soil color pattern exemptions under SPS 385.30(3) for a basement floor proposed less than 1-foot above redoximorphic features shown in the referenced soil evaluation reports.

COLLECTING SOILS DATA EARLY AND USING IT TO PLAN

Questions?

Other uses for soils data?