Mapping Hydrologic Soil Groups in the Field

Creating a HSG key for Site Specific Soil Mapping

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Topics

- What are HSG and problems
- Method of mapping HSG in the field
- Incorporation of HSG into site specific soil mapping manual

Hydrologic Soil Groups Defined

- Hydrologic soil group (HSG) refers to the classification of soils based on their runoff-producing characteristics.
  - Wetness characteristics
  - water transmission after prolonged wetting
    - Permeability (Ksat)
    - depth to seasonal high water table
    - depth to very slowly permeable layers

(USDA NRCS Part 630 Hydrology National Engineering Handbook (NEH) (210-IV-NEH, January 2009)

Soils and Their HSGs

- Soils are assigned to 4 hydrologic groups and 3 dual groups.
  - Group A - high infiltration rate when wet, low runoff potential.
  - Group B - moderate infiltration, low runoff potential.
  - Group C - slow infiltration, higher runoff potential.
  - Group D - very slow infiltration rate, highest runoff potential.
  - The dual groups are A/D, B/D, and C/D.
    - These are used for certain wet soils that can be adequately drained.
    - The leading letter refers to the drained condition and the second letter is the un-drained condition.

Determination of HSG for Soil Surveys

- Soil scientists, using soil properties and their best judgments in the field, assigned the current HSGs
- Rainfall-runoff data or infiltrometer plots were used to determine the infiltration rates for smaller watersheds
- Profiles were compared to other previously classified profiles and like soils were selected for the same HSG.
  - The premise is that runoff of similar soils will act the same during storm events.

National Engineering Handbook Standards (2009)

- NEH assigns HSGs by comparing unclassified soil with classified soil characteristics
- Classes are based on being thoroughly wet, not frozen, bare soil surface and maximum swelling of expansive clays
- The newer HSGs are based on the old qualitative data

Table 7–1 Criteria for assignment of hydrologic soil group (HSG)

Depth to water impermeable layer 1/	Depth to high water table 2/	K_{sat} of least transmissive layer in depth range	K_{sat} depth range	HSG 3/
<50 cm [<20 in]	—	—	—	D
50 to 100 cm [20 to 40 in]	<60 cm [<24 in]	>40.0 µm/s (>5.67 in/h)	0 to 60 cm [0 to 24 in]	A/D
		>10.0 to ≤40.0 µm/s (>1.42 to ≤5.67 in/h)	0 to 60 cm [0 to 24 in]	B/D
		>1.0 to ≤10.0 µm/s (>0.14 to ≤1.42 in/h)	0 to 60 cm [0 to 24 in]	C/D
		≤1.0 µm/s (≤0.14 in/h)	0 to 60 cm [0 to 24 in]	D
	≥60 cm [≥24 in]	>40.0 µm/s (>5.67 in/h)	0 to 50 cm [0 to 20 in]	A
		>10.0 to ≤40.0 µm/s (>1.42 to ≤5.67 in/h)	0 to 50 cm [0 to 20 in]	B
		>1.0 to ≤10.0 µm/s (>0.14 to ≤1.42 in/h)	0 to 50 cm [0 to 20 in]	C
		≤1.0 µm/s (≤0.14 in/h)	0 to 50 cm [0 to 20 in]	D
>100 cm [>40 in]	<60 cm [<24 in]	>10.0 µm/s (>1.42 in/h)	0 to 100 cm [0 to 40 in]	A/D
		>4.0 to ≤10.0 µm/s (>0.57 to ≤1.42 in/h)	0 to 100 cm [0 to 40 in]	B/D
		>0.40 to ≤4.0 µm/s (>0.06 to ≤0.57 in/h)	0 to 100 cm [0 to 40 in]	C/D
		≤0.40 µm/s (≤0.06 in/h)	0 to 100 cm [0 to 40 in]	D
	60 to 100 cm [24 to 40 in]	>40.0 µm/s (>5.67 in/h)	0 to 50 cm [0 to 20 in]	A
		>10.0 to ≤40.0 µm/s (>1.42 to ≤5.67 in/h)	0 to 50 cm [0 to 20 in]	B
		>1.0 to ≤10.0 µm/s (>0.14 to ≤1.42 in/h)	0 to 50 cm [0 to 20 in]	C
		≤1.0 µm/s (≤0.14 in/h)	0 to 50 cm [0 to 20 in]	D
	>100 cm [>40 in]	>10.0 µm/s (>1.42 in/h)	0 to 100 cm [0 to 40 in]	A
		>4.0 to ≤ 10.0 µm/s (>0.57 to ≤1.42 in/h)	0 to 100 cm [0 to 40 in]	B
		>0.40 to ≤4.0 µm/s (>0.06 to ≤0.57 in/h)	0 to 100 cm [0 to 40 in]	C
		≤0.40 µm/s (≤0.06 in/h)	0 to 100 cm [0 to 40 in]	D

1/ An impermeable layer has a K_{sat} less than 0.01 µm/s [0.0014 in/h] or a component restriction of fragipan; duripan; petrocalcic; orstein; petrogypsic; cemented horizon; densic material; placic; bedrock, paralithic; bedrock, lithic; bedrock, densic; or permafrost.

2/ High water table during any month during the year.

3/ Dual HSG classes are applied only for wet soils (water table less than 60 cm [24 in]). If these soils can be drained, a less restrictive HSG can be assigned, depending on the K_{sat}.

Issues

- New standards for assigning HSG are based on the USDA NRCS Part 630 Hydrology National Engineering Handbook (2009)
- Makes criteria for the standard application of the HSG difficult to apply because soils with similar characteristics are grouped in the same HSG without much field testing.
- Judgment between soil scientists can vary greatly, and HSGs are assigned from already classified profiles which could have been classified incorrectly
- Detailed requirements for the standard classification are lacking in the older Handbooks (which is what current standards are based off)
- RI Soil Survey assigned HSGs by comparing the Ksat, depth to restrictive layer, and depth to high water table with the requirements for each HSG

Issues with Relying on HSG in County/State Soil Surveys

- Mapping scale is much larger than that needed to make appropriate land use decisions for small developments, LID, BMPs, etc.
- Discrepancies exist between soil surveys (e.g., Plymouth County vs. RI Soil Survey table.)
- These differences have large consequences on potential land use
- Smaller ***site specific*** classification would solve issue of widespread inconsistencies/relying on inaccurate larger scale mapping of HSG.

Soil Series	**RI HSG**	**Plymouth County HSG**
Poquonock	C	B
Udorthents	D	B

Why Incorporate HSG Into Site Specific Mapping?

- Site specific mapping shows detailed information about important soil properties to aid municipal officials in decision making to accurately survey the suitability of land for development
- These maps can be applied to onsite waste water systems, stormwater planning and design, and planning building sites and roads.
- Provides visual confirmation of site constraints which lead to better decision making
- Guides in selecting the most suitable field test sites, water table monitoring well placement, permeability testing and test pit evaluations for wastewater treatment
- Typically at a scale of 1:2400, 1:600 or greater, depending on the intended use of the map, allowing for more detailed picture of area.

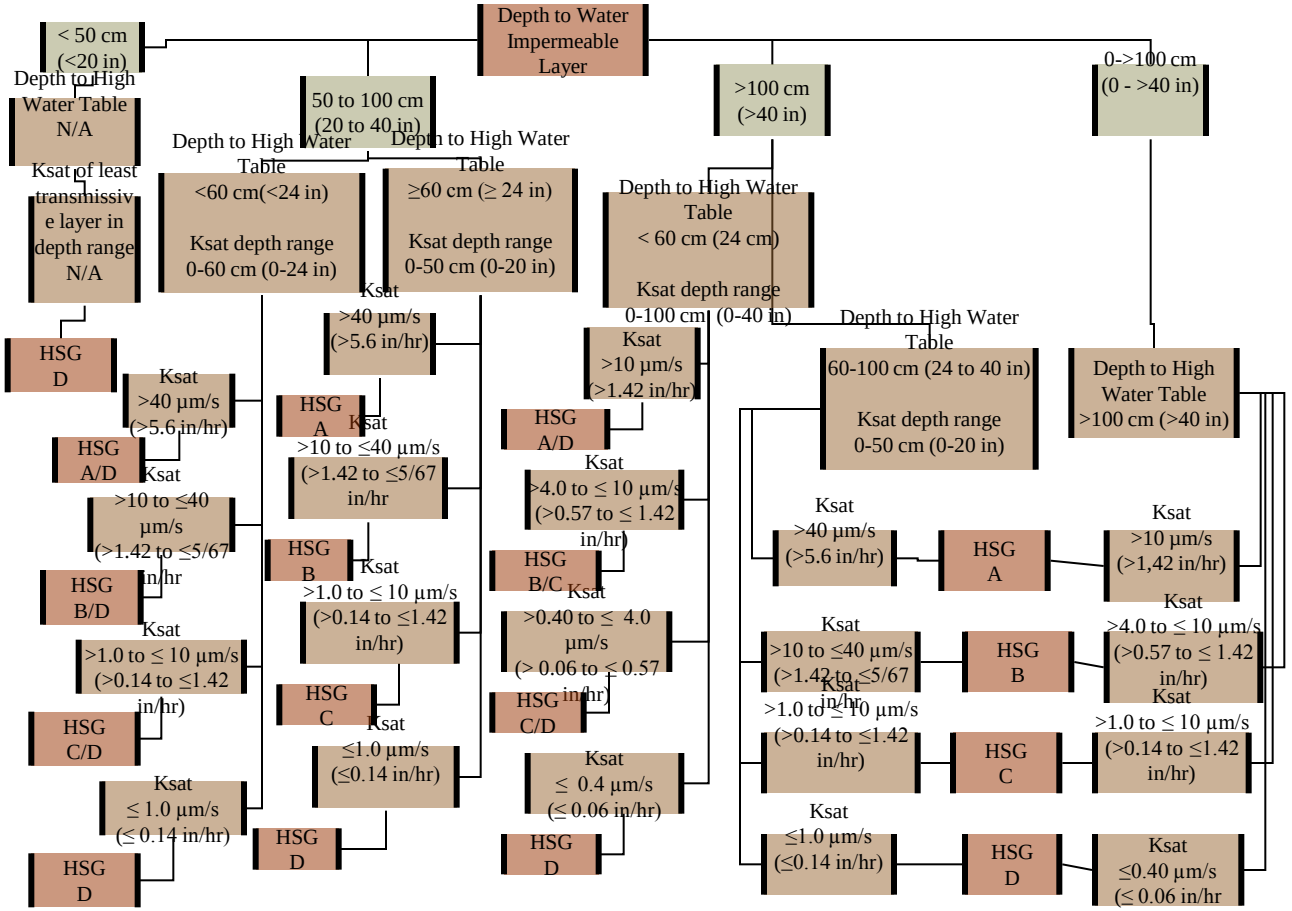
Procedure

- The Ksats have been incorporated into a flow chart which helps to key out the HSG most identifiable with specific Ksat values
- Depth to SHWT indicated by SSSM in RI correspond to the depths in the 2009 NEH
- Depth up to 48 inches is used instead of 40 inches (outlined in the NEH)
- Depth to Restrictive layer in SSSM guide does not comply with the 2009 NEH manual
- Categories for each manual are not off by much, the NEH guidelines will be referenced for HSG determination.
- A key has been developed that can be used with the SSSM field guide. The key will aid in the determination of the HSG using the 2009 NEH.

Hydrologic Soil Group Flow Chart

Ksat- Saturated Hydraulic Conductivity of the least transmissive layer
HSG-Hydrologic Soil Group

(based on Plymouth County, Soil Survey (MA) Ksat data, NRCS "cheat sheet" and classification of HSG by NEH)



HSG "Cheat Sheet" NRCS-USDA

*This is a general guide. Bulk density of the soil may alter the defined rates

Texture	Textural Class	Permeablility Class	Permeability Rate(Ksat)	
			in/hr	µm/sec
Gravel	N/A	Very Rapid	>20.0	>141.14
Course Sand				
Course Sandy Loam	Moderately Course	Moderately Rapid	2.0-6.0	141.14-42.34
Sandy Loam				
Loamy Fine Sand				
Find Sandy Loam				
Very fine sandy loam	Medium	Moderate	0.6-2.0	4.23-14.11
Loam				
Silt Loam				
Silt				
Clay Loam	Moderate Fine	Moderate Slow	0.2-0.6	1.41-4.23
Sandy Clay Loam				
Silty Clay Loam				
Sandy Clay Loam	Fine	Slow	0.06-0.2	0.42-1.41
Silty Clay				
Clay <60%				
Clay >60%	Fine Very Fine	Very Slow	<0.06	<0.42
Claypan				

Key to Mapping HSG

- Outlines each step and how the HSG falls within the guidelines
- From there, the HSG can be used in TR 55 for the best and most practical decision for LID management
- meant to be used in conjunction with the SSSM guide so determination of HSG can become an addition to derived map unit symbols determined in the field by soil scientists

Soil Characteristics Included:

- Depth to seasonal high water table
- Depth to restrictive layer
- Parent material texture (related to Ksat)
- Presence of bedrock or densic material

Key to Determining Hydrologic Soil Groups Based on Soil Properties Used in Site Specific Soil Mapping

Though parent material, coarse fragments, slope, and surface texture are important soil characteristics to be noted, these properties are not used to figure the HSG. The presence of bedrock or densic material should also be noted. A key to the alpha numeric code used in this table is provided in Table 6. It is the same key used in the Standards and Procedures for Site Specific Soil Mapping.

Depth to Seasonal High Water Table	Depth to Restrictive Layer	Parent Material Texture	HSG
0 or 1	1 or 2	gr, 6, 8, 9, 10, 11	A/D
0 or 1	1 or 2	3, 5, 7	B/D
0 or 1	1 or 2	1, 2, 4, 12, 13, Sandy Clay Loam, Silt	C/D
0 or 1	1 or 2	Sandy Clay Loam	D
2, 3, 4	1 or 2	gr, 6, 8, 9, 10, 11	A
2, 3, 4	1 or 2	3, 5, 7	B
2, 3, 4	1 or 2	1, 2, 4, 12, 13, Sandy Clay Loam, Silt	C
2, 3, 4	1 or 2	Sandy Clay Loam	D
0 or 1	3	gr, 3, 5, 6, 7, 8, 9, 10 11,	A/D
0 or 1	3	1, 2, 4, 12, 13, Silt, Sandy Clay Loam	B/D
0 or 1	3	Sandy Clay Loam,	C/D
2 or 3	3	gr, 6, 8, 9, 10, 11	A
2 or 3	3	3, 5, 7	B
2 or 3	3	1, 2, 4, 12, 13, Silt, Sandy Clay Loam	C
2 or 3	3	Sandy Clay Loam	D
4	N/A	gr, 3, 5, 6, 7, 8, 9, 10 11,	A
4	N/A	1, 2, 4, 12, 13, Silt, Sandy Clay Loam	B
4	N/A	Sandy Clay Loam	C

Map Units	HSG	Map Units	HSG
633/1A1	C	623/1A1	A/D
1(6)43/3A1	A	402/gr4B3	A/D
143/6A3	A	513/12A3	A/D

Key to Components of the Map Unit Symbol Used in Determining Hydrologic Soil Groups

(depth to seasonal high water table, depth to restrictive layer, parent material texture)

Depth to Seasonal High Water Table (Wetness Class)		Depth to Restrictive Layer (Bedrock or Densic Material)		Parent Material Texture	
0	0"-12"	1	< 24"	1	Silt loam
1	≥ 12"-24"	2	24"-48"	2	Loam
2	> 24"-36"	3	> 48"	3	Sandy loam
3	> 36"-48"			4	Fine sandy loam
4	> 48"			5	Coarse sandy loam
				6	Loamy sand
				7	Loamy fine sand
				8	Loamy coarse sand
				9	Sand
				10	Fine sand

Discussion

- Adding HSG classification to SSSM provides accurate information for site planning and design to support decisions by designers, developers, land owners and local officials.
- Incorporating HSG into the SSSM ensures that all land use restrictions are identified and measures can be taken to avoid, remediate, or accommodate for such challenges in early stages of project planning
  - Most land owners refer only to the RI Soil Survey which is not recommended for use at scales < 15,840
- Including HSG in the SSSM supports use of the new RI Storm Water standards

Questions?

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