TOPSOIL PRESERVATION INITIATIVE

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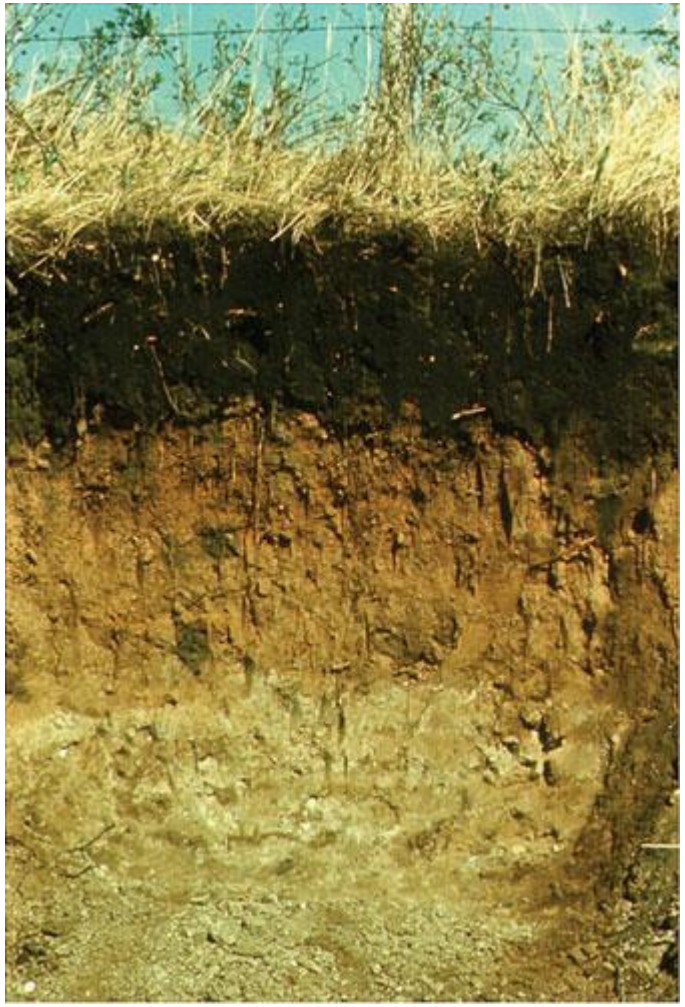
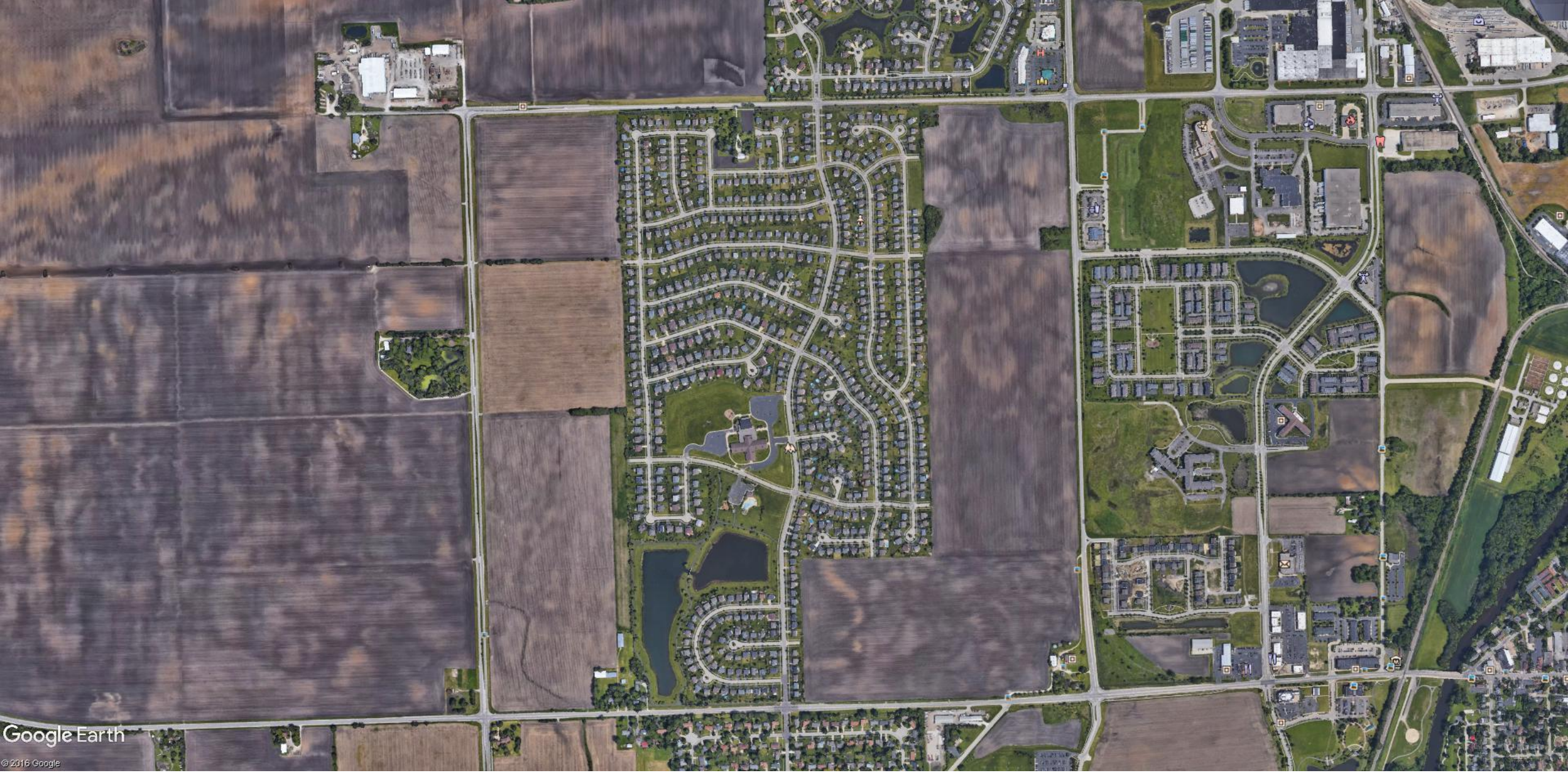


PRESENTATION OBJECTIVES

- Present overview of topsoil functions
- Examine rainfall from an infiltration perspective
- Recognize the runoff storage potential of topsoil
- Recommend topsoil preservation measures to reduce runoff volume
- Introduce BMP incentives to encourage topsoil preservation
- Identify needed legislative changes to implement



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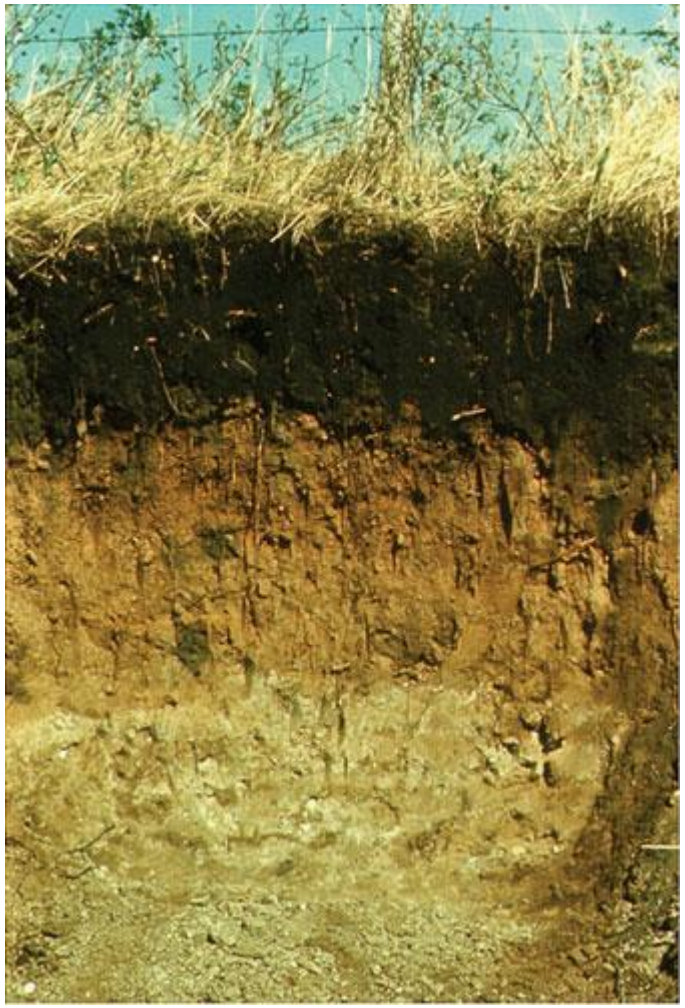
TYPICAL TOPSOIL DEPTHS IN OUR “PRARIE STATE”

RANGE FROM 10” TO 12”



WHAT HAPPENS TO THE STRIPPED TOPSOIL?


Google Earth

HAVE YOU EVER GIVEN THOUGHT TO THE IMPACTS OF THE MISSING NATURAL TOPSOIL?

TOPSOIL FUNCTIONS

1) Nutrient Cycling
2) Water Partitioning
3) Soil Respiration Enablement
4) Filtering and Buffering
5) Physical Stability and Support

NUTRIENT CYCLING FUNCTION

Topsoil provides the organic nutrients as well as other elements needed to support vegetative growth through the biogeochemical process of nutrient cycling.

- Stores Nutrients
- Moderates Nutrient Release
- Cycles Nutrients
- Facilitates Nutrient Transformation into Plant Available Forms

WATER PARTITIONING FUNCTION

Well-Functioning Soil:

- Facilitates Infiltration for Groundwater Recharge
- Promotes Percolation Flow
- Accommodates Water Storage
- Enables Plant Transpiration

The partitioned water carries with it dissolved solutes such as nitrogen, phosphorus, pesticides, and other nutrients or chemical compounds for use by plants and subsurface inhabiting animals.

SOIL RESPIRATION ENABLEMENT FUNCTION

Soil Respiration constitutes the carbon dioxide release from the soil structure.

- Dependent upon organic composition of soil
- Essential for micro-organisms to provide a diverse physical, chemical, and biological habitat

FILTERING AND BUFFERING FUNCTION

Topsoil

- Acts as filter to protect water quality
- Enables degradation of toxic compounds
- Buffers excess nutrient availability to plants and animals.

PHYSICAL STABILITY AND SUPPORT FUNCTION

Topsoil has the ability to:

- Maintain its porous structure essential for passage of air and water
- Form soil texture necessary for flexibly supporting root growth

PRIMARY TOPSOIL FUNCTIONAL SUSTAINABILITY FACTORS

- Extent of organic matter
- Depth of topsoil

EFFECTS OF SHALLOW TOPSOIL

Shallow Topsoil:

- Inhibits soil respiration
- Limits nutrient storage potential
- Limits rainfall infiltration
- Reduces water storage potential
- Inhibits vegetative root growth
- Inhibits thriving vegetation
- Requires more irrigation to support functions

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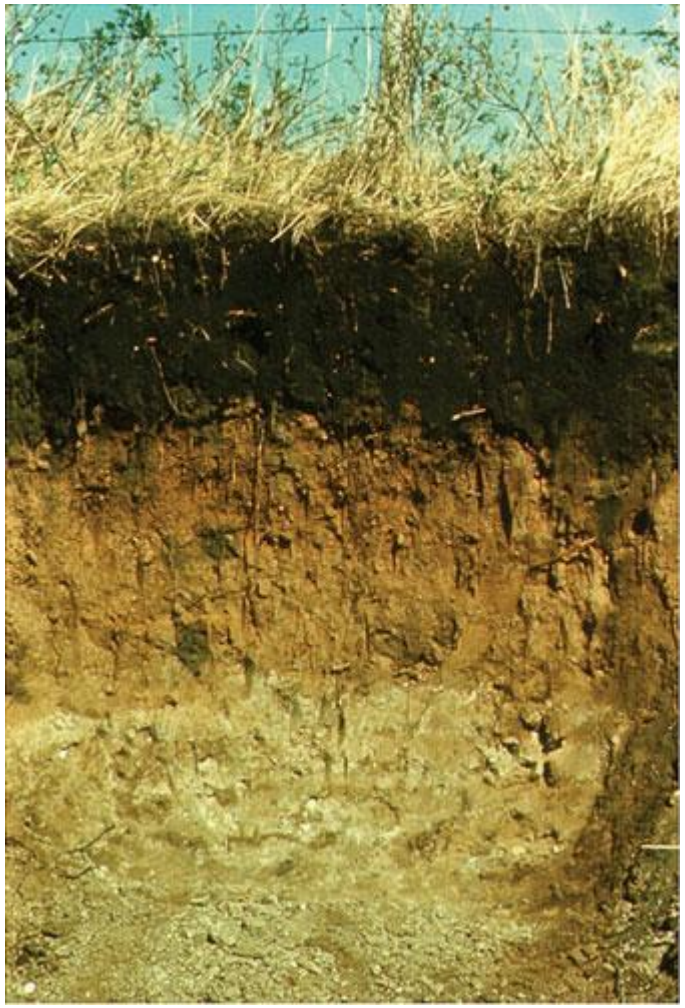
HYDROLOGIC SOIL CLASSIFICATION

- Based on minimum infiltration rate through a soil's full 5 foot deep NRCS soil horizon after prolonged wetting

- Based on soil composition and soil properties – not vegetative cover.

Soil Surface Intake Rates



Subsurface Permeability

CHANGE IN RUNOFF VOLUME VS CHANGE IN CN

	Change in Runoff Volume (%)								
	-50%	-25%	-10%	-5%	Base	+5%	+10%	+25%	+50%
% CHANGE IN CN	-17%	-8%	-2%	-1%	0%	+1%	+2%	+7%	+13%
CHANGE IN CN	58.1	64.4	68.6	69.3	70	70.7	71.4	74.9	79.1

Source: Win-TR-20 Sensitivity
To Input Parameters

COMPARATIVE RUNOFF AND INFILTRATION FOR WILL CO., IL RAINFAILL EVENTS

FREQUENCY	24-HOUR RAINFALL INCHES	CN = 65 RUNOFF INCHES	INFILTRATE INCHES	CN = 70 RUNOFF INCHES	INFILTRATE INCHES	CN = 75 RUNOFF INCHES	INFILTRATE INCHES	CN = 80 RUNOFF INCHES	INFILTRATE INCHES	CN = 85 RUNOFF INCHES	INFILTRATE INCHES
2-YR	3.16	0.59	2.57	0.78	2.38	1.07	2.09	1.36	1.80	1.73	1.43
Infiltrate Red				0.19		0.29		0.29		0.37	
Av Red per CN				0.038		0.058		0.058		0.074	
5-YR	4.05	1.06	2.99	1.35	2.70	1.73	2.32	2.07	1.98	2.47	1.58
Infiltrate Red				0.29		0.38		0.34		0.40	
Av Red per CN				0.058		0.076		0.068		0.08	
10-YR	4.90	1.59	3.31	1.94	2.96	2.37	2.53	2.77	2.13	3.27	1.63
Infiltrate Red				0.35		0.43		0.40		0.50	
Av Red per CN				0.07		0.086		0.08		0.10	
50-YR	6.98	3.05	3.93	3.57	3.41	4.13	2.85	4.66	2.32	5.20	1.78
Infiltrate Red				0.52		0.56		0.53		0.50	
Av Red per CN				0.104		0.112		0.106		0.10	
100-YR	8.34	4.14	4.20	4.73	3.61	5.33	3.01	5.92	2.41	0.12	1.82
Infiltrate Red				0.59		0.60		0.60		0.59	
Av Red per CN				0.118		0.12		0.12		0.118	

RUNOFF INCREASE IS DUE TO INFILTRATION DECREASE AS CN INCREASES

FOR 50 YR STORM EVENT,

INFILTRATION DECREASES BY APPROXIMATELY 0.10 INCH PER EACH INCREASED CN VALUE

Source: TR-55
Bulletin 70 Rainfall

WHAT IS REQUIRED

FOR

RESPONSIBLE STEWARDSHIP

OF

TOPSOIL?

ANALYSIS METHODOLOGY

- Agricultural soil science based USDA Natural Resources Conservation Service (NRCS) publications

- Applies WHY ⟷ HOW Functional Analysis Principles of Value Engineering

SOIL BULK DENSITY

- Foundational soil property defining growth capability

$$\text{Soil Bulk Density grams/cm}^3 = \frac{\text{Dry Soil Weight grams}}{\text{Total Soil Volume } (V_T)\ \text{cm}^3}$$

SOIL POROSITY

- Ratio of volume of voids to total volume of soil

$$\text{Soil Porosity} = \frac{\text{Soil Void Volume } (V_V)}{\text{Total Soil Volume } (V_T)}$$

$$\text{Soil Porosity} = 1 - \frac{\text{Soil Bulk Density}(g/cm^3)}{2.65\ g/cm^3}$$

Where 2.65 is the default soil bulk density of most rock

OPTIMAL AGRICULTURAL SURFACE SOIL CONTENT (SILT - LOAM)

- 50% Solids
  - 45%+ Soil Particles
  - < 5% Organic Matter

- 50% Pore Space
  - 25% +/- Water
  - 25% +/- Air

Soil Bulk Density = 50% x 2.65 g/cm^3 = 1.33 g/cm^3)

COMPARATIVE SOILS BULK DENSITY & POROSITY (V_V/V_T)

SOIL TEXTURE	IDEAL BULK DENSITIES FOR PLANT GROWTH (grams/cm^3)	IDEAL PLANT GROWTH POROSITIES (Vv/Vt)	BULK DENSITIES THAT AFFECT ROOT GROWTH (grams/cm^3)	AFFECTED ROOT GROWTH POROSITIES (Vv/Vt)	BULK DENSITIES THAT RESTRICT ROOT GROWTH (grams/cm^3)	RESTRICTED ROOT GROWTH POROSITIES (Vv/Vt)
SANDS, LOAMY SANDS	< 1.60	>0.396	1.69	0.362	>1.80	< 0.321
SANDY LOAMS, LOAMS	<1.40	>0.472	1.63	0.385	>1.80	<0.321
SANDY CLAY LOAMS, CLAY LOAMS	<1.40	>0.472	1.60	0.396	>1.75	<0.340
OPTIMUM SILT LOAM (50% Solids, 50% Voids)	1.33	0.5	1.60	0.396	>1.75	<0.340
SILTS, SILT LOAMS	<1.40	>0.472	1.60	0.396	>1.75	<0.340
SILT LOAMS, SILTY CLAY LOAMS	<1.40	>0.472	1.55	0.415	>1.65	<0.377
SANDY CLAYS, SILTY CLAYS, CLAY LOAMS	<1.10	>0.585	1.49	0.438	>1.58	<0.403
CLAYS (> 45% CLAYS)	<1.10	>0.585	1.39	0.475	>1.47	<0 .445

LOOSE SURFACE SOILS

COMPACTED INORGANIC SOILS

NOTE HOW MUCH OF THE SOIL VOLUME CONSISTS OF PORE SPACE

RECOGNIZE THE SIGNIFICANT REDUCTION OF POROSITY DUE TO COMPACTION APPLIES TO THE DESIGN AND CONSTRUCTION OF ALL DETENTION FACILITIES!

OBSERVE THE SIMILARITY OF POROSITIES FOR PREDOMINANT TOPSOIL TEXTURES

Source: NRCS
Soil Bulk Density

COMPARATIVE SOILS NORMAL MOISTURE CONTENT

NRCS SOIL TEXTURE	IDEAL BULK DENSITIES FOR PLANT GROWTH (grams/cm^3)	IDEAL PLANT GROWTH POROSITIES (Vv/Vt)	BULK DENSITIES THAT AFFECT ROOT GROWTH (grams/cm^3)	AFFECTED ROOT GROWTH POROSITIES (Vv/Vt)	BULK DENSITIES THAT RESTRICT ROOT GROWTH (grams/cm^3)	RESTRICTED ROOT GROWTH POROSITIES (Vv/Vt)
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LOOSE SURFACE SOILS

COMPACTED INORGANIC SOILS

RECOGNIZE THAT A PORTION OF PORE SPACE IS OCCUPIED BY WATER

REMEMBER TOPSOIL FUNCTIONS LIKE A SPONGE

LESS THAN 10% FOR SAND

15% TO 25% FOR SANDY LOAMS, SANDY CLAY LOAMS, SILT LOAMS, AND SILTY CLAY

OFTEN GREATER THAN 30% FOR CLAYEY SOILS

NOW THINK IN TERMS OF THE VOLUME OF STORED WATER LOST WHEN 8 INCHES OF NATURAL TOPSOIL IS HAULED OFFSITE---NO LONGER AVAILABLE FOR PLANT RESPIRATION

AND WHEN THE REMAINING 4 INCHES OF REPLACED NATURAL TOPSOIL IS COMPACTED PRIOR TO SODDING

COMPARATIVE SOILS AVAILABLE VOID STORAGE

SANDY LOAMS, LOAMS	<1.40	>0.472	1.63	0.385	>1.80	<0.321
SANDY CLAY LOAMS, CLAY LOAMS	<1.40	>0.472	1.60	0.396	>1.75	<0.340
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LOOSE SURFACE SOILS

COMPACTED INORGANIC SOILS

THE REMAINING PORTION OF NATURAL PORE SPACE IS AIR SPACE Vv -Vw = Va

HISTORICALLY AVAILABLE TO STORE INFILTRATING RAINFALL

NOW THINK IN TERMS OF THE NATURAL VOLUME OF TOPSOIL THAT WAS THEORETICALLY AVAILABLE TO STORE INFILTRATING RAINFALL---UNTIL IT WAS HAUED AWAY

FROM NEW IMPERVIOUS SURFACES --- (22% TO 32%) X 12 " = 2.64" TO 3.84"

FROM STRIPPED PERVIOUS AREAS

(22% TO 32%) X 8" = 1.76" TO 2.56"

Add 8% X 4" = 0.32" DUE TO TOPSOIL COMPACTION

Add ADDITIONAL VOID LOSS DUE TO COMPACTION OF UNDERLYING SOIL

SOIL VOID STORAGE CAPACITY LIMITATIONS

- High water table
- Antecedent moisture condition
- Dense compaction

INFILTRATION IMPEDIMENTS TO EFFICIENT SOIL VOID STORAGE

- Soil surface tension
  - Mulch protection
  - Vegetative cover
- Soil permeability for air and water
  - Trapped air barrier
  - Texture dependent
  - Density dependent
  - Pore size
  - Pore continuity

INCREASED RUNOFF FROM URBAN DEVELOPMENT IS DUE TO LOST TOPSOIL VOID STORAGE

- Primarily Topsoil Removal
- Secondarily Soil Compaction

TOPSOIL PRESERVATION RECOMMENDATIONS

- 6” minimum topsoil replacement in all turf areas
- Incentify use of rain gardens and bioswales by reduced CN’s to 63
- Incentify 8” to 10” topsoil in passive use areas
- Use 12” of sandy or silty loam topsoil in swales
- Place 24” of Loam type topsoil in landscape footprint areas surrounding buildings and shrub or tree placement areas

TOPSOIL PRESERVATION RECOMMENDATIONS

- Specify use of Loam type topsoil for all imported topsoil
- Require topsoil types and thickness to be detailed on project civil and landscape plans and building permit
- Require site topsoil to be defined and handled by NRCS soil types
- Place first 2” of replaced topsoil on subgrade and disk it to a total of 8” depth to help overcome compaction due to heavy equipment during construction

PROPOSED CN REDUCTION TOPSOIL PRESERVATION BMP INCENTIVE BASIS

FREQUENCY	RAINFALL	RUNOFF	INFILTRATE	RUNOFF	INFILTRATE	RUNOFF	INFILTRATE	RUNOFF	INFILTRATE	RUNOFF	INFILTRATE
	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES
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FOR 50 YR STORM EVENT,

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PROPOSED CN REDUCTION TOPSOIL PRESERVATION BMP INCENTIVE:

FOR LOAMY TOPSOILS WITH POROSITY = 0.472

AND 25% MOISTURE CONTENT

Va = 0.472 - 0.25 = 0.22

0.22/0.10 = 2.2

=> JUSTIFIABLE CN REDUCTION OF 2.2 PER INCH OF ADDED TOPSOIL

PROPOSED CN REDUCTION TOPSOIL PRESERVATION BMP INCENTIVE

CN Reduction of 2.0 for each additional inch of topsoil placed above 6 inches

- Applied for a maximum of 6 additional inches
- Placement must be at least 12 inches above seasonal water table for full credit
- Apply 50% of CN reduction credit when placed only 6 inches above the water table

REQUIRED REGULATORY CHANGES

- Countywide Stormwater Management ordinances
  - To apply BMP CN reduction for rain gardens and bioswales
  - To apply BMP CN reduction Topsoil Preservation Incentive
- Municipal code or ordinance revisions
  - For above BMP CN reduction incentives
  - For requirement of 6” topsoil replacement depths
  - For all other topsoil preservation recommendations
- Incorporate LEED and Envision sustainability credits for topsoil preservation

RESPONSIBLE STEWARDSHIP

DEMANDS

TOPSOIL PRESERVATION