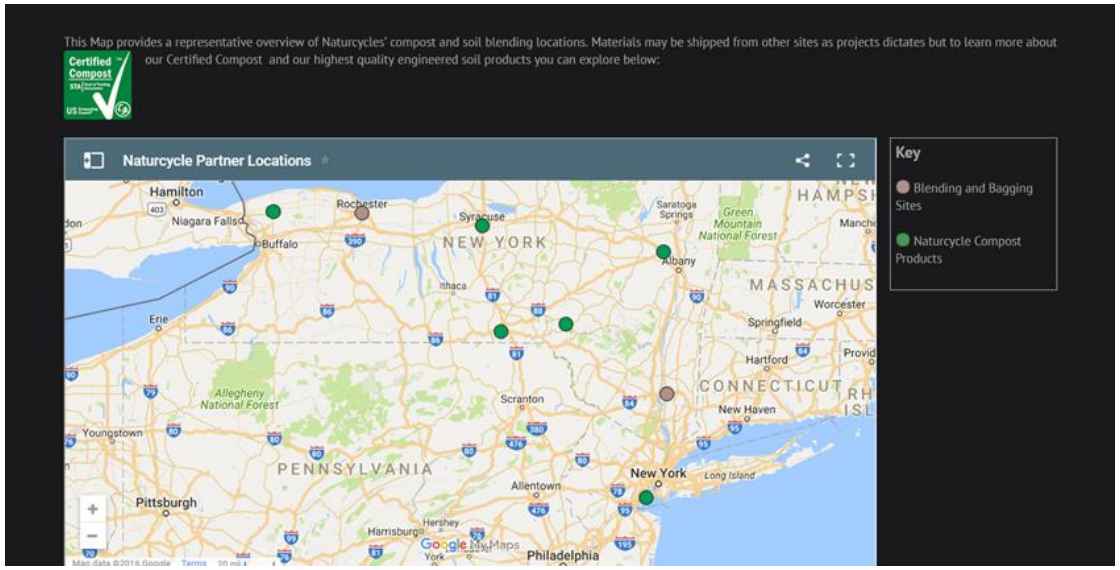
Engineered Soils and Performance Design

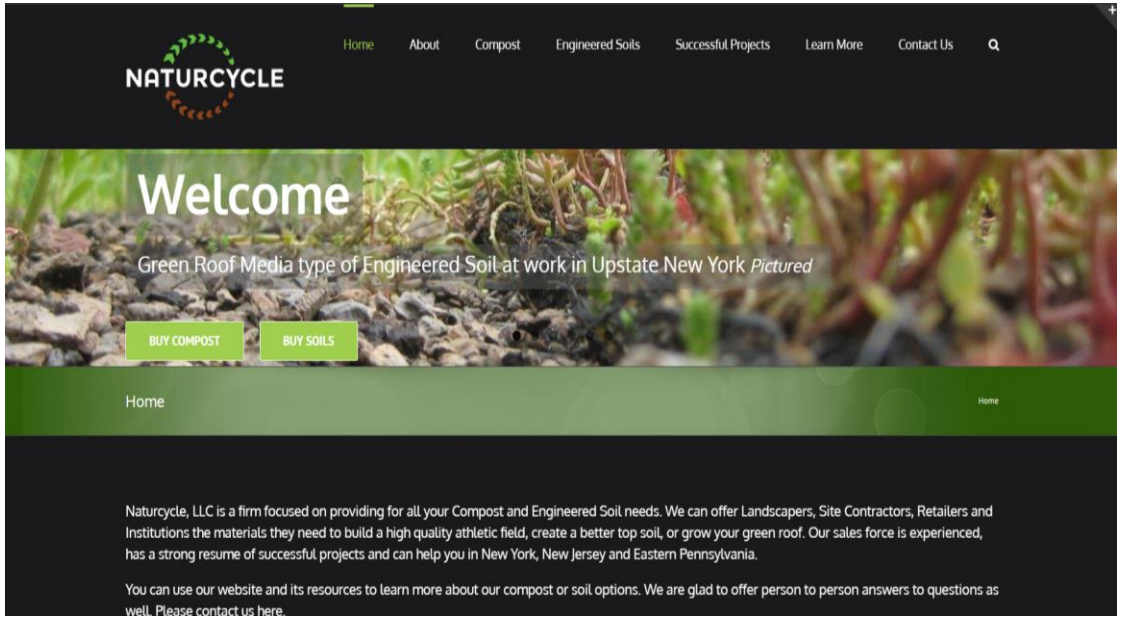
By Charles Duprey,
President

Of Naturcycle, LLC

April 11, 2019

Randolph Center, VT
VORS Conference





Naturcycle, LLC

- is working with people like you in "Restoring Earth."
- Broker compost for a number of municipal and private compost producers around New York State.
- Provide expertise in compost use and sourcing.
- Manufactures a variety of quality engineered soils like Green Roof Media, Bio-Retention Mixes and many other blends from multiple NYS Sites.
- Offers value engineering on a variety of soil or compost designs

www.naturcycle.com

Overview

- Green Infrastructure
- Compost Defined and the USCC STA Program
- Engineered Soils
- Performance Designs
- Review

What is Green Infrastructure?

Green infrastructure is an approach to water management that protects, restores, or mimics the natural water cycle.

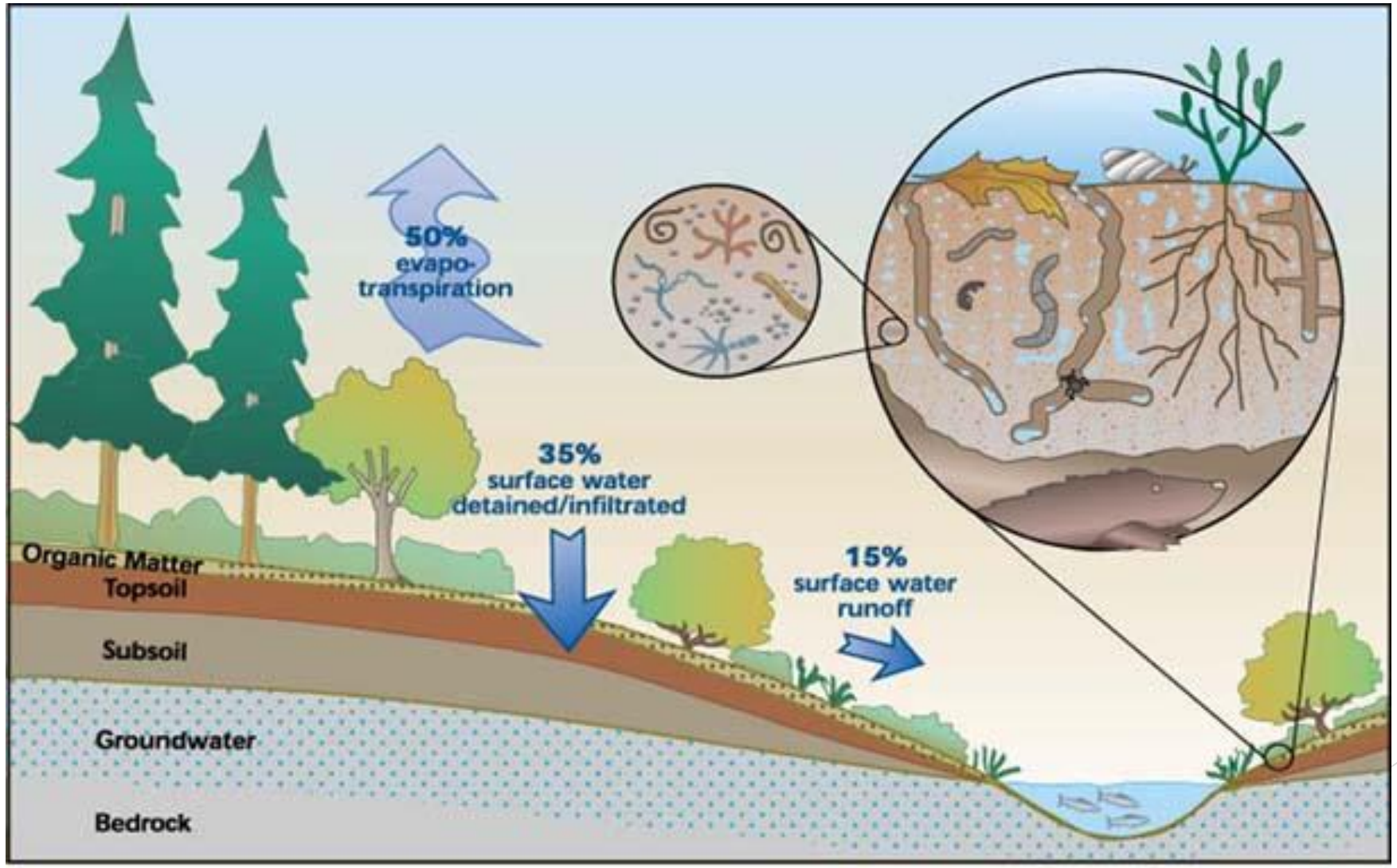
America's Rivers Assoc "Rivers Connect Us"

….green infrastructure reduces and treats stormwater at its source while delivering environmental, social, and economic benefits.

US EPA www.epa.gov/green-infrastructure/what-green-infrastructure

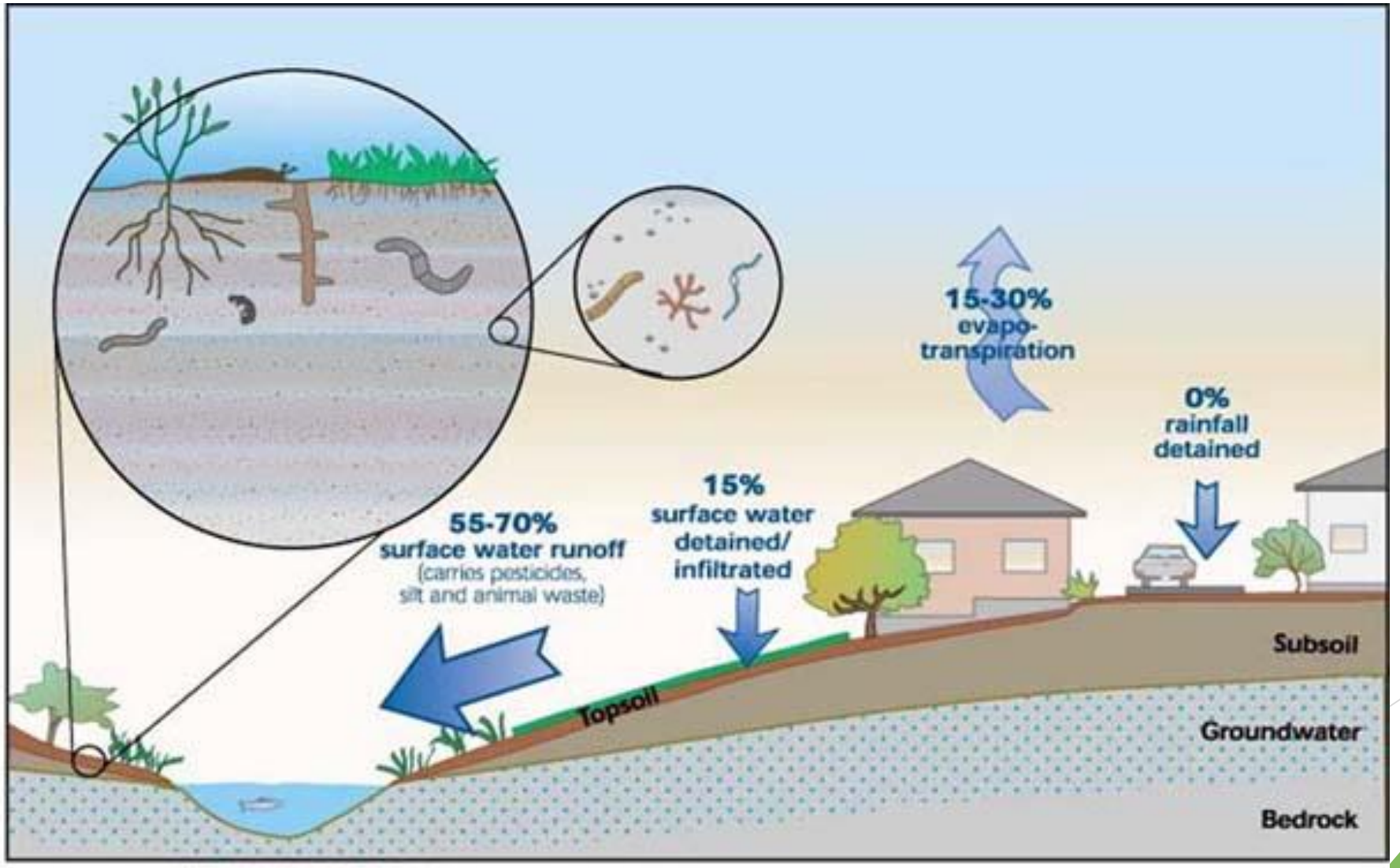
Trying to Mimic Nature by "Restoring Earth"

This is the “Natural” Cycle of Water

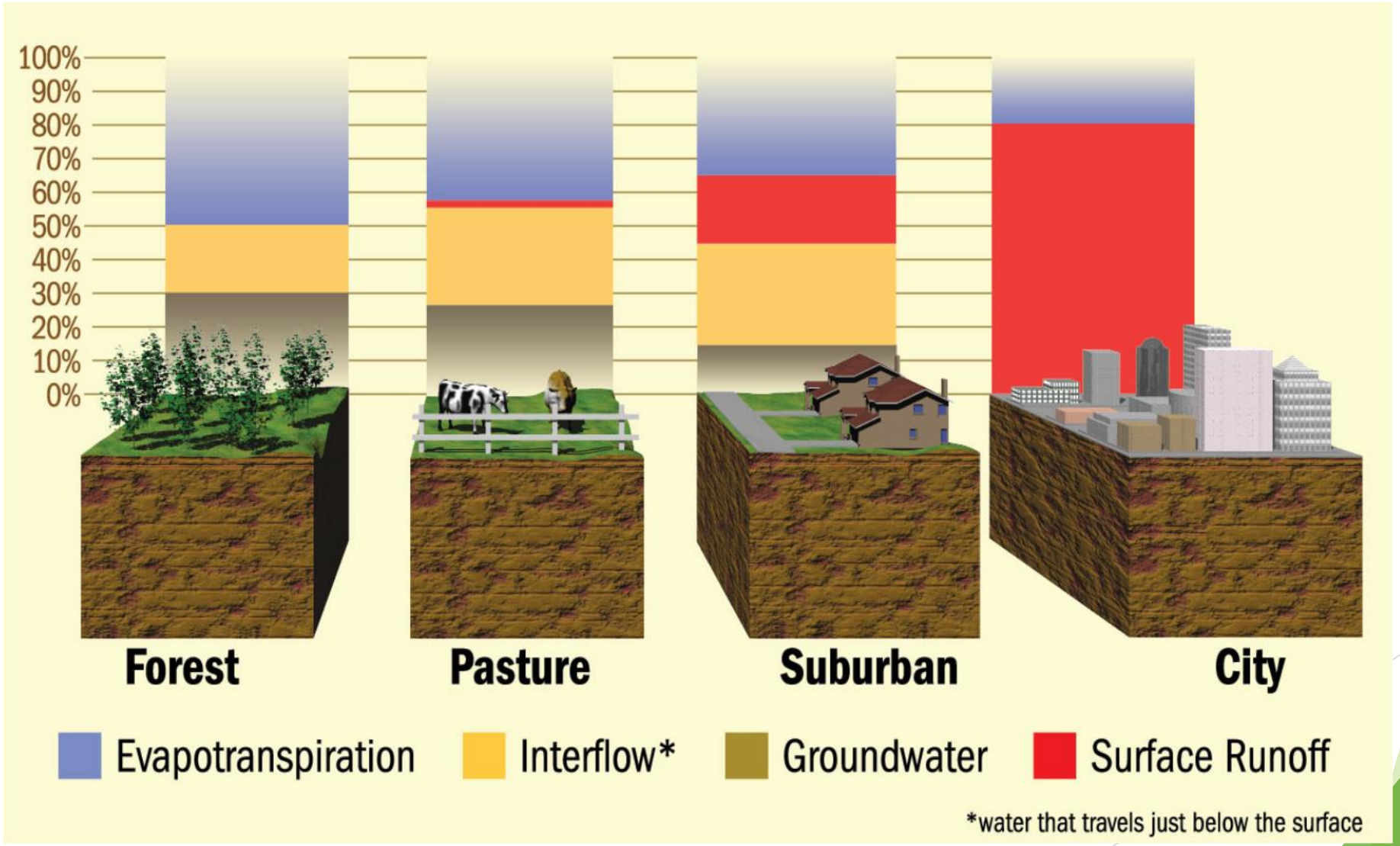


Native Soil

Our current environments…

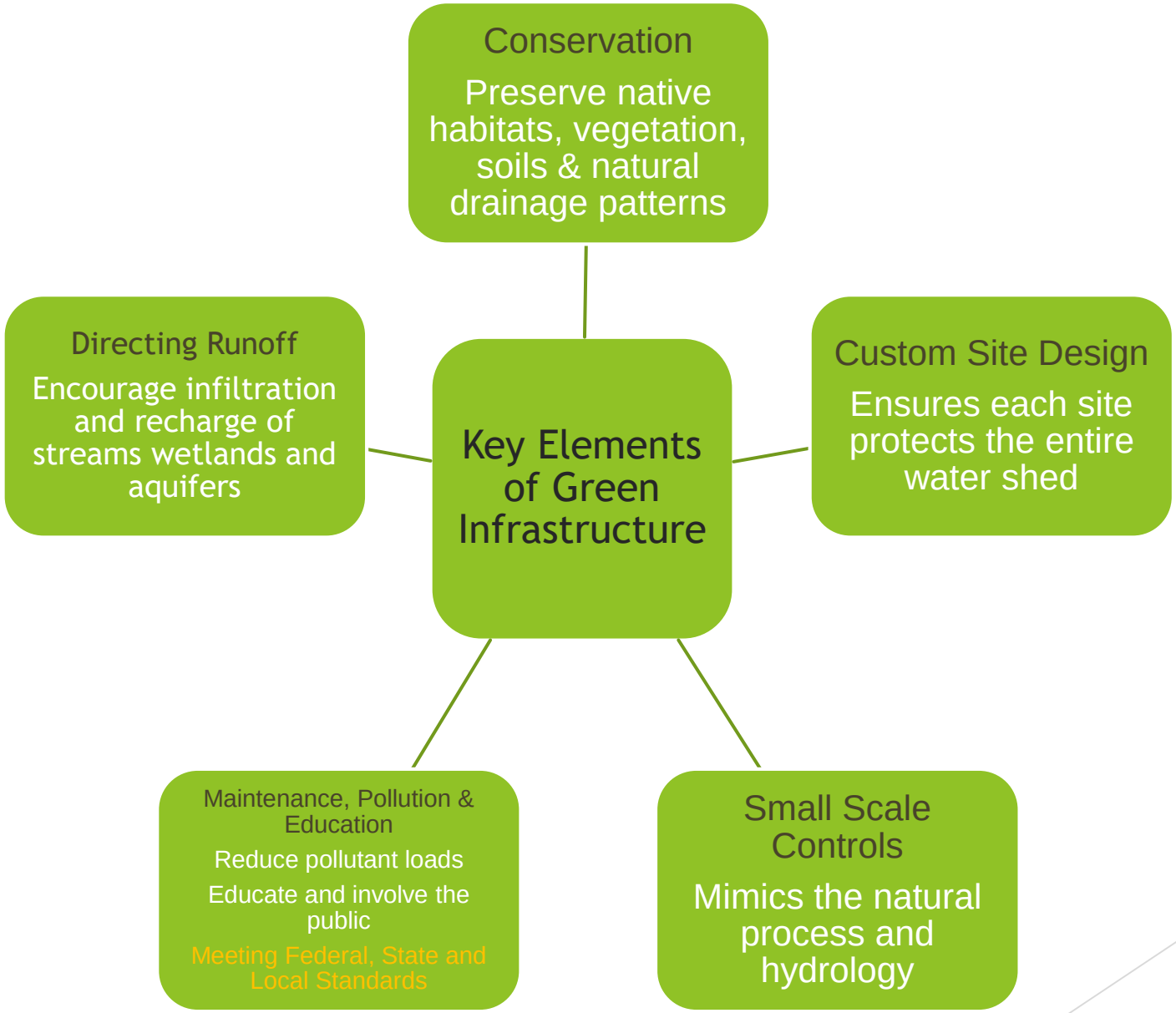


Storm Water Hydrology Comparison



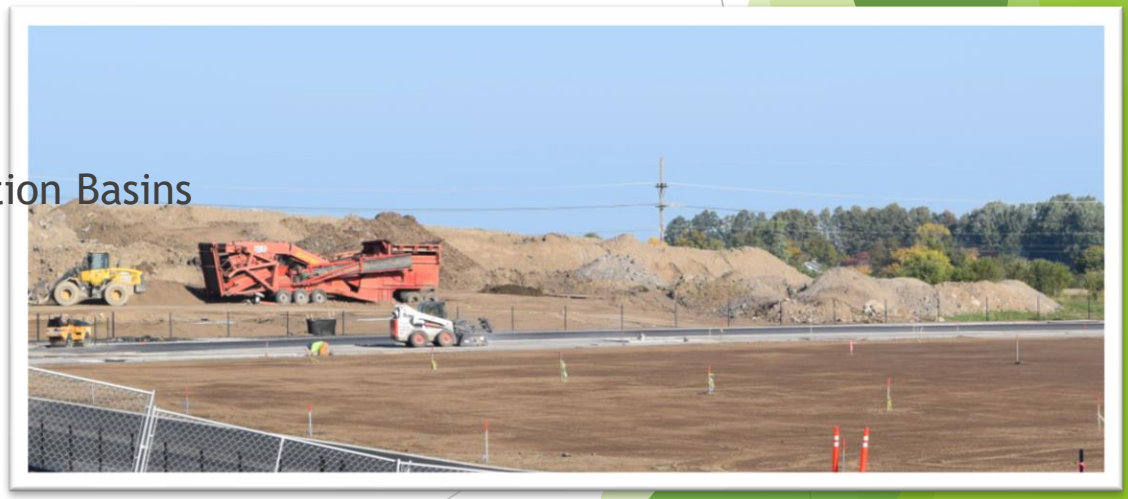
Source: Sego Jackson -2001

These keys allow us to mimic the Natural Cycle with Green Infrastructure



All these Key Elements use and need COMPOST…

- **Conservation –**
  - Restore habits with engineered soils or compost
  - Amend soils in place with compost reduce impact
- **Directing Runoff**
  - Compost Blankets
  - Compost Berms
- **Small Scale Controls**
  - Green Roofing
  - Rain Gardens
- **Custom Site Design**
  - Infiltration vs Retention Basins
  - Planting selection



This is just a small sampling of how compost is crucial to Green Infrastructure

What is Compost ? - Compost Defined

- A humus-rich soil amendment made by the controlled biological decomposition of organic materials
- Made from organic wastes like yard trimmings, organic by-products, industrial residuals, food scraps, animal manures, biosolids.
- Must go through an aerobic heating process to be biologically stable and mature.
- Can improve biological, physical and chemical characteristics of soils

What is good compost? Look for STA

- Stable – low biological activity level (Respirometry vs Solvita)
- Mature – aged for optimum plant growth (Bioassay)
- Nutrient content – N, P, K (high percentage in slow release form)
- Organic matter content – 30-70%
- Moisture content
- pH – 6.0-8.0
- Soluble Salts - < 5 mmhos/cm

US Composting Council
Seal of Testing Assurance

Certified Compost™
STA | Seal of Testing Assurance
US Composting Council®

Good Parameters and USCC Seal of Testing Assurance Participation

US COMPOSTING COUNCIL
Seal of Testing Assurance

Delaware County DPW
Andy Zuk
32230 Hwy 10
Walton, NY 13856
607-865-2128

Product Name: **Naturcycle Compost "D"**
Sample Date: **5/9/16**
Receive Date: **5/12/16**
A & L Lab Number: **85335**
A & L Report Number: **F16133-6022**

COMPOST TECHNICAL DATA SHEET

A & L Great Lakes Laboratories, Inc. 3505 Conestoga Drive Fort Wayne IN 46808

Compost Parameters	*Method*	*Reported as (units of measure)*	*Test Results*	*Test Results*
Plant Nutrients:		%, weight basis	%, wet weight basis	%, dry weight basis
Nitrogen	TMECC 04.02-D	Total N	1.03	1.46
Phosphorus	TMECC 04.03-A	P_2O_5	0.45	0.64
Potassium	TMECC 04.04-A	K_2O	0.37	0.53
Calcium	TMECC 04.05-CA	Ca	2.34	3.33
Magnesium	TMECC 04.05-MG	Mg	0.21	0.30
Moisture Content	TMECC 03.09-A	%, wet weight basis	29.64	
Organic Matter Content	TMECC 05.07-A	%, dry weight basis	68.16	
pH	TMECC 04.11-A	pH units	7.4	
Soluble Salts *(electrical conductivity EC_5)*	TMECC 04.10-A	dS/m (mmhos/cm)	5.00	
Particle Size	TMECC 02.02-B	% < 9.5 mm (3/8 in.), dw basis	100.00	
Stability Indicator *(respirometry)*				
CO_2 Evolution	TMECC-05.08-B	mg CO_2-C/g OM/day	2	Stable
		mg CO_2-C/g TS/day	4	
Maturity Indicator (bioassay)				
Percent Emergence	TMECC 05.05-A	average % of control	100	
Relative Seedling Vigor	TMECC 05.05-A	average % of control	99	
Select Pathogens	TMECC 07.01-B	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.32(a)	PASS	*FecalColiform*
Trace Metals	TMECC 04.06	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3.	PASS	*As, Cd, Pb, Hg, Mo, Ni, Se, Zn*

Participants in the US Composting Council's Seal of Testing Assurance Program have shown the commitment to test their compost products on a prescribed basis and provide this data, along with compost end use instructions, as a means to better serve the needs of their compost customers.

US COMPOSTING COUNCIL
Seal of Testing Assurance

Village of Endicott WWTP
Philip Grayson
1009 E Main Street
Endicott, NY 13700
607-757-2457

Product Name: **Naturcycle Compost "E"**
Sample Date: **9/7/16 4:00 PM**
Receive Date: **9/9/16**
A & L Lab Number: **87796**
A & L Report Number: **F16253-6019**

COMPOST TECHNICAL DATA SHEET

A & L Great Lakes Laboratories, Inc. 3505 Conestoga Drive Fort Wayne IN 46808

Compost Parameters	*Method*	*Reported as (units of measure)*	*Test Results*	*Test Results*
Plant Nutrients:		%, weight basis	%, wet weight basis	%, dry weight basis
Nitrogen	TMECC 04.02-D	Total N	1.07	2.70
Phosphorus	TMECC 04.03-A	P_2O_5	2.00	5.02
Potassium	TMECC 04.04-A	K_2O	0.16	0.40
Calcium	TMECC 04.05-CA	Ca	1.21	3.04
Magnesium	TMECC 04.05-MG	Mg	0.10	0.25
Moisture Content	TMECC 03.09-A	%, wet weight basis	60.23	
Organic Matter Content	TMECC 05.07-A	%, dry weight basis	72.14	
pH	TMECC 04.11-A	pH units	5.6	
Soluble Salts *(electrical conductivity EC_5)*	TMECC 04.10-A	dS/m (mmhos/cm)	2.79	
Particle Size	TMECC 02.02-B	% < 9.5 mm (3/8 in.), dw basis	96.58	
Stability Indicator *(respirometry)*				
CO_2 Evolution	TMECC-05.08-B	mg CO_2-C/g OM/day	1	Very Stable
		mg CO_2-C/g TS/day	2	
Maturity Indicator (bioassay)				
Percent Emergence	TMECC 05.05-A	average % of control	100	
Relative Seedling Vigor	TMECC 05.05-A	average % of control	100	
Select Pathogens	TMECC 07.01-B	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.32(a)	PASS	*FecalColiform*
Trace Metals	TMECC 04.06	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3.	PASS	*As, Cd, Pb, Hg, Mo, Ni, Se, Zn*

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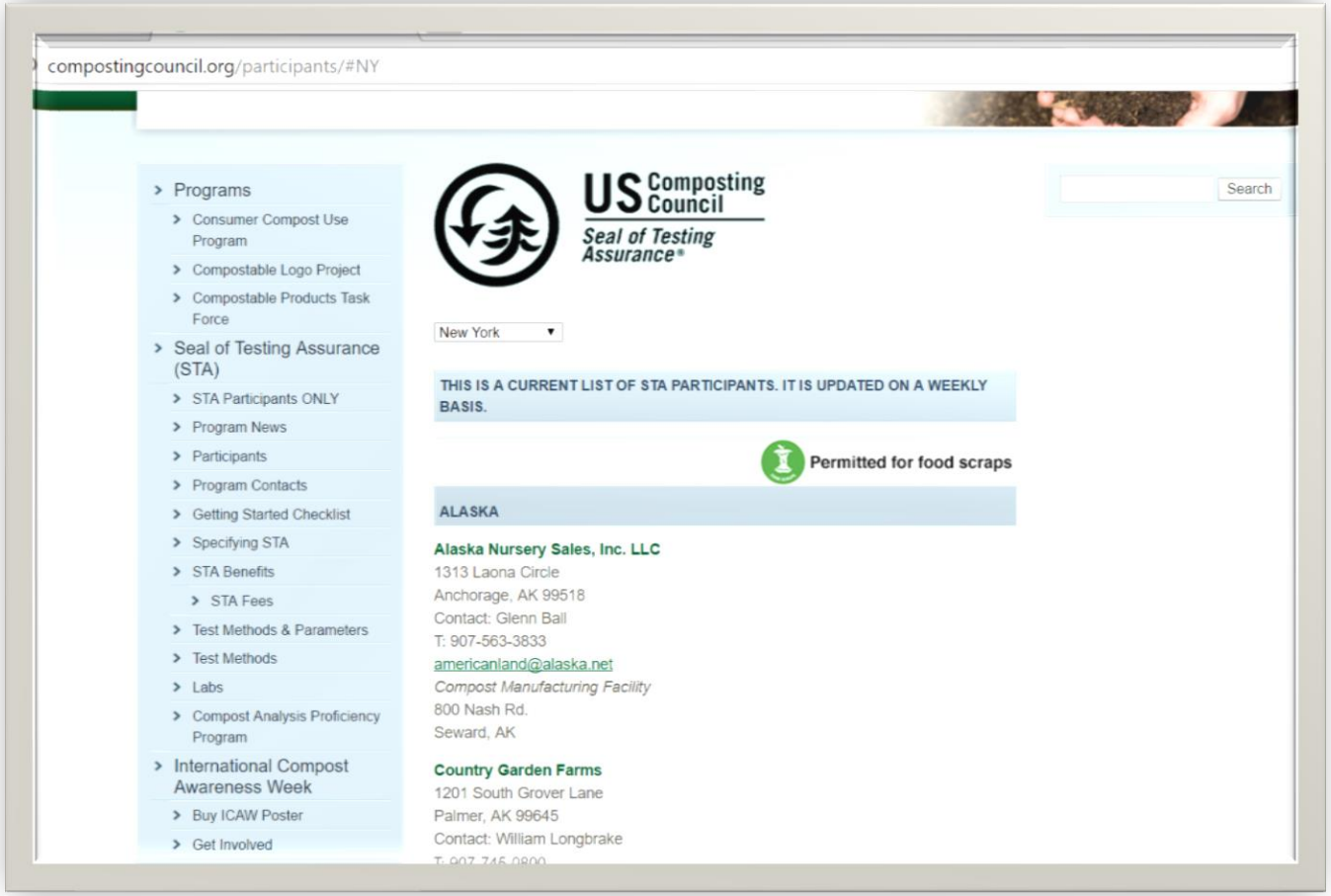
Composting Council & Seal of Testing Assurance Program *compostingcouncil.org*



- Nationwide Trade group
  - 700 plus Members
  - 300 Products in STA
- Sets independent standards and created the TMECC to standardize compost analysis Nationwide in 1999
- **NYS DOT Specs call for STA**

Engineered Soils

- A manufactured soil product made from a variety of inert materials and an organic amendments
  - Examples
    - Washed, Sized Natural Sand
    - Crushed, or Natural Stone products
    - Expanded Aggregates
    - Compost, Peat, other OM sources
    - Washed fine products, like silt or clay
- Based around detailed, replicable testing methodology (IE Some labs test things their own way)
- Can be tailored to meet plant or stormwater needs

Creating Engineered soils with Compost

- Soil type drives the level of required amendment. For Simplification we can break soils into two categories

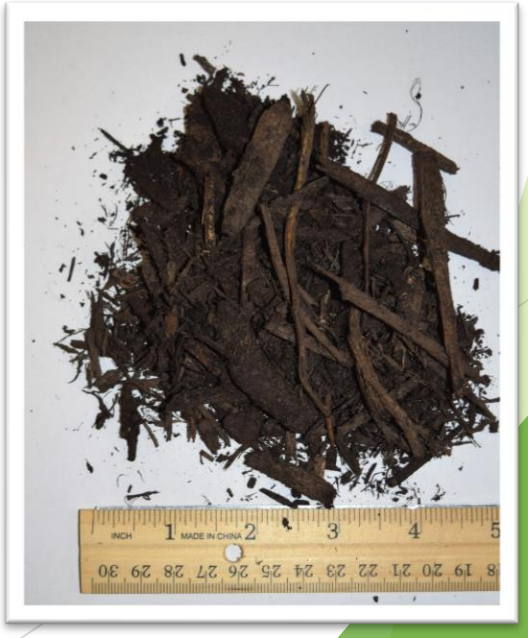
- Loam Soils (Average Density of 2600 lbs/ cu yd)
  - To raise the soil organic matter 1% in the overall final soil you need to add 1.5 Cubic yards of Compost (a ½" layer) and till to a depth of 6 inches per 1000 square feet.

- Sand/High Clay Soils (Average Density 3000 lbs / cu yd
  - To raise the soil organic matter 1% in the overall final soil you need to ad 1.75 Cubic yards of Compost (a 2/3" layer) and till to a depth of 6 inches per 1000 square feet

Assumptions

- **A Compost with at least 60% Organic Matter by LOI**

- **A compost with a density of 900 lbs / cu yd**



Engineered Soils from a Specifier standpoint

- allow for manufactured soils in specs (sometimes prohibited)
- Remind contractors and installers of lead times (months not weeks)
- Train Landscape Architects and other professionals what to ask and look for
- Have standardized component programs and focus on final blended materials

Performance Designs

- Focusing on final soil characteristics
- Specify capable laboratories and testing agencies to speed process
- Should include a check on the inputs like existing ASTM or TMECC standards
- Quality Control Testing as part of specification (usually based on volume to assure compliance)
- Based around ranges achievable and comparable to USDA Soil Types
- Physical Samples can be a helpful tool before actual delivery
- Designed to achieve a goal, infiltration, retention, plant growth, low Nutrient,

Naturcycle Example for Battery Park Authority

E. Clay – Soil particles sized below 0.002 millimeters

As Designed Parameters for Engineered Soil A:

A. ≤ 10% Gravel - Less than 10% retained of the total sample on the No. 10 Sieve by ASTM F1632 Method B

B. 60 to 70% Sand
20 to 30% Silt
5 to 10% Clay
As tested by ASTM F1632 Method B

C. Sand Fraction shall contain less than 10% Very Fine Sand defined as smaller tha No. 270 Sieve as part of ASTM F1632

D. > 2.0 K/Sat in Inches per Hour – at least 2 inches per hour with compaction energy modified to 5.75 foot pound per square inch by ASMT E2399

E. pH range 7.2 to 6.5 by ASTM D4972

F. 4 to 5.0 % Organic Matter by Loss on Ignition by ASTM F1647

New York State Department of Transportation September 1, 2018 Specification

2 Micron	0 to 20

2. Topsoil -Lawn

-The pH of the material shall be between 5.5 and 7.6.

-The organic content shall be not less than 6% or more than 12%

Gradation:	
Sieve Size	Percent Passing by Weight
1 inch	100
No. 10	90 to 100
No. 40	45 to 80
No. 200	25 to 70
2 Micron	5 to 35

NYS DOT allows for a soil amendment plan to achieve performance goal

- Add % of compost by volume to achieve final soil organic matter target without re-testing
- Requires STA Compost participation and or tested to TMECC Standards. That's how you can do this state wide with many different soils and composts
- An expert in the field like a soil laboratory, compost producer or soil scientist can calculate a recommended rate
- It does not address infiltration, nutrients or other important Bio-retention factors

Infiltration

- Lab verse Field analysis
  - Directly relates to compaction
  - ASTM F1815 is a common analysis for Saturated Hydraulic Conductivity should be paired with compaction rate ASTM D698 like 85% at proctor
- Sand particle shape effects results often (Rounded vs angular)

Further example - Green Roof Media as a performance media

- Green Roof media is a mix of in-organic lightweight materials and organic matter
- It is intended to be “Soil” Less
- Mainly researched from European designs
- Highly specialized blends of lightweight aggregates, sand and compost
- Only the highest quality compost is used
- Yes, I know its an engineered soil!

FLL Guidelines – Green Roof Media Performance Based Characteristics

Summary of selected FLL* guidelines for green roof media.

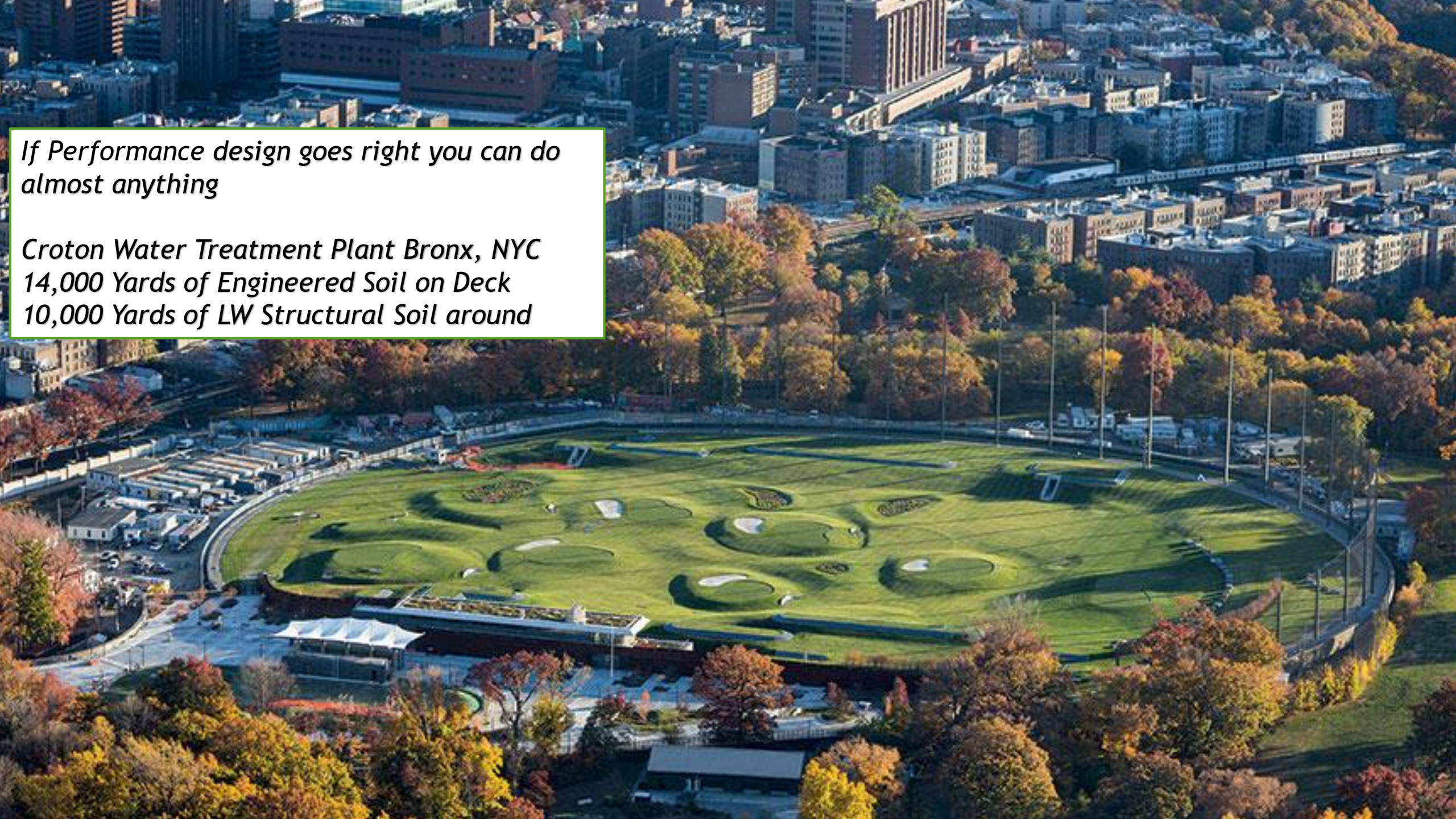
Analysis	Unit	Intensive	Single-Course Extensive	Multi-Course Extensive	Drainage Course
Particle size distribution					
< 0.063 mm	mass %	≤20	≤10	≤15	≤10
Water and air management					
Maximum water holding capacity	vol %	45 - 65	20 - 65	35 - 65	-
Air-filled porosity at max water holding capacity	vol %	≥10	≥10	≥10	-
Water permeability Kf	cm/s	0.0005 - 0.05	0.1 - 0.67	0.001 - 0.12	≥0.3
	in/min	0.0118 - 1.18	2.36 - 15.8	0.024 - 2.83	≥7.08
pH value and salt					
pH CaCl2	-	6.0 - 8.5	6.0 - 8.5	6.0 - 8.5	6.0 - 8.5
salt (water extract)	g(KCl)/L	≤2.5	≤3.5	≤3.5	≤2.5, ≤3.5
Organic Matter	g/L	≤90	≤40	≤65	-
Nutrients					
P_2O_5 (CAL)	mg/L	≤200	≤200	≤200	-
K_2O (CAL)	mg/L	≤700	≤700	≤700	-
Mg ($CaCl_2$)	mg/L	≤200	≤200	≤200	-
NO_3 + NH_4 ($CaCl_2$)	mg/L	≤80	≤80	≤80	-

**Forschungsgesellschaft Landschaftsentiwicklung Landschaftsbau (FLL). 2008. Guidelines for the Planning Execution and Upkeep of Green-Roof Sites*

Never just specify ASTM E2399 !!! Need more parameters like OM, Infiltration, pH ect..

Ignoring the list of performance guidelines and specifying only one ASTM E2399

Only specifying the dead weight of the material when saturated ignores the other keys to success (Mulch/Potting Media meets this)



If Performance design goes right you can do almost anything

Croton Water Treatment Plant Bronx, NYC
14,000 Yards of Engineered Soil on Deck
10,000 Yards of LW Structural Soil around

What performance design allows for..

- Regional, Local Differences
  - Washed Sand vs Unwashed Sand Sources
  - Varying Compost addition levels
  - Addresses Varying Compost Types
  - Opens door to residuals
  - Allows for localized source solutions, like a crushed stone dust from a quarry in Southern VT verse a washed natural sand in Burlington VT

Review

- Green Infrastructure
- Compost Defined and the STA Program
- Engineered Soils
- Performance Designs
- Questions?

Questions?

Thank You for your time today.

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