Soil Amendments for ESC and SW Inspectors

3 Hour Continuing Education Course

DEQ Virginia Department of Environmental Quality

Module 2

Compost and other Soil Amendments

DEQ Virginia Department of Environmental Quality

Module 2a

Soil Fertility and Plant Nutrition

N-P-K and pH

- N – Nitrogen ➔ Leaf growth/Protein
- P – Phosphorus ➔ Root growth/Protein/DNA/ Energy
- K – Potassium ➔ Energy/Flowering
- pH – Acidity/Alkalinity ➔ Availability of nutrients, break down of contaminants in the soil and sometimes toxicity of some elements

Plant nutrition: The essential nutrients

Biotic Nutrients	Nitrogen	-	Protein	Essential macro
	Sulphur	-	Protein	Essential macro
	Phosphorus	-	Protein	Essential macro
Basic Nutrients	Calcium	+	Metabolic	Essential macro
	Magnesium	+	Metabolic	Essential macro
	Potassium	+	Metabolic	Essential macro
	Sodium*	+	Metabolic	Beneficial
Minor Nutrients	Iron	+	Regulatory	Essential
	Manganese	+	Regulatory	Essential
	Copper	+	Regulatory	Essential
	Zinc	+	Regulatory	Essential
	Boron*	0	Regulatory	Essential
Incidental Nutrients	Aluminium*	+		Beneficial
	Nickel*	+		Essential
	Molybdenum	-		Essential
	Cobalt			Essential
	Silicon	0		Beneficial
	Selenium	-		Beneficial
	Chlorine*	-		Essential

* may reach toxic/detrimental levels

a.k.a. micronutrients

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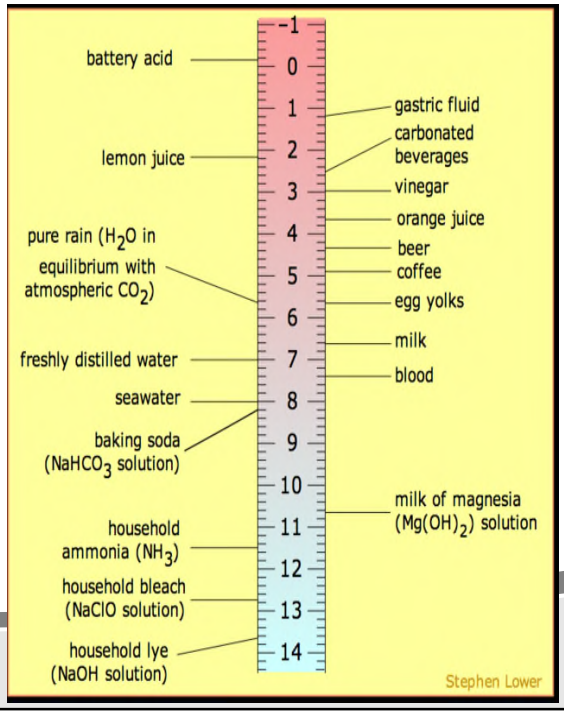
pH



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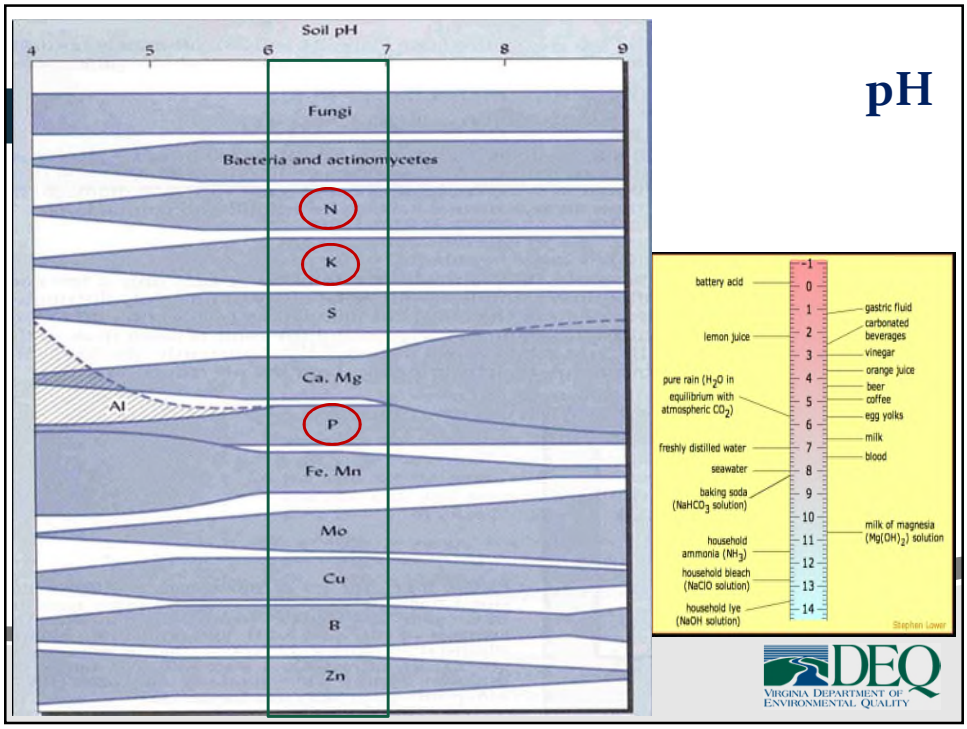
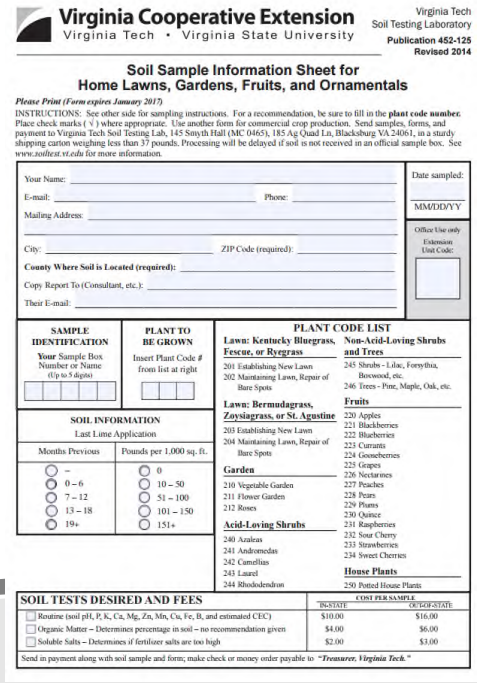


pH

Soil Testing

- Soil texture, pH and nutrient content should be determined before application of lime and fertilizer
- Soil samples are sent for testing
- Small fee
- Saves time, money
- Will help to establish vegetation correctly



Virginia Cooperative Extension
Virginia Tech • Virginia State University

Virginia Tech Soil Testing Laboratory
Publication 452-125 Revised 2014

Soil Sample Information Sheet for Home Lawns, Gardens, Fruits, and Ornamentals

Please Print (Form expires January 2017)

INSTRUCTIONS: See other side for sampling instructions. For a recommendation, be sure to fill in the **plant code number.** Place check marks (√) where appropriate. Use another form for commercial crop production. Send samples, forms, and payment to Virginia Tech Soil Testing Lab, 145 Smyth Hall (MC 0465), 185 Ag Quad Ln, Blacksburg VA 24061, in a sturdy shipping carton weighing less than 37 pounds. Processing will be delayed if soil is not received in an official sample box. See www.soiltest.vt.edu for more information.

Your Name:
E-mail: Phone:
Mailing Address:
City: ZIP Code (required):
County Where Soil is Located (required):
Copy Report To (Consultant, etc.):
Their E-mail:

Date sampled: MM/DD/YY

Office Use only
Extension Unit Code:

SAMPLE IDENTIFICATION
Your Sample Box Number or Name (Up to 5 digits)

PLANT TO BE GROWN
Insert Plant Code # from list at right

SOIL INFORMATION
Last Lime Application

Months Previous	Pounds per 1,000 sq. ft.
–	0
0 – 6	10 – 50
7 – 12	51 – 100
13 – 18	101 – 150
19+	151+

PLANT CODE LIST

Lawn: Kentucky Bluegrass, Fescue, or Ryegrass
201 Establishing New Lawn
202 Maintaining Lawn, Repair of Bare Spots

Lawn: Bermudagrass, Zoysiagrass, or St. Agustine
203 Establishing New Lawn
204 Maintaining Lawn, Repair of Bare Spots

Garden
210 Vegetable Garden
211 Flower Garden
212 Roses

Acid-Loving Shrubs
240 Azaleas
241 Andromedas
242 Camellias
243 Laurel
244 Rhododendron

Non-Acid-Loving Shrubs and Trees
245 Shrubs - Lilac, Forsythia, Boxwood, etc.
246 Trees - Pine, Maple, Oak, etc.

Fruits
220 Apples
221 Blackberries
222 Blueberries
223 Currants
224 Gooseberries
225 Grapes
226 Nectarines
227 Peaches
228 Pears
229 Plums
230 Quince
231 Raspberries
232 Sour Cherry
233 Strawberries
234 Sweet Cherries

House Plants
250 Potted House Plants

SOIL TESTS DESIRED AND FEES

	COST PER SAMPLE IN-STATE	COST PER SAMPLE OUT-OF-STATE
☐ Routine (soil pH, P, K, Ca, Mg, Zn, Mn, Cu, Fe, B, and estimated CEC)	$10.00	$16.00
☐ Organic Matter – Determines percentage in soil – no recommendation given	$4.00	$6.00
☐ Soluble Salts – Determines if fertilizer salts are too high	$2.00	$3.00

Send in payment along with soil sample and form; make check or money order payable to *"Treasurer, Virginia Tech."*

So, what's in that soil test report?

- Available from various labs. Usually cost $10 to $20 per sample for simple tests; can be much expensive. Be alert for "voodoo prescriptions" !
- Typically report pH, OM, and dilute acid extractable P, Ca, Mg, K and Na. You can also ask for soluble salts and extractable micronutrients (Zn, Mn, Fe, etc.)

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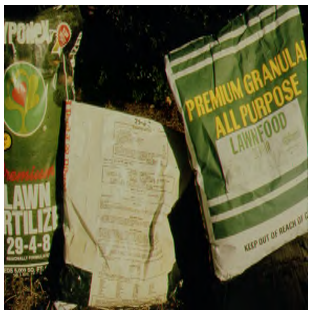
Soil Amendments

Need to be based on soil analysis!



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Soil Amendments

Lime

Gypsum or Sulfur containing fertilizer

Nutrients and organic matter

- Fertilizers
- Compost

Types of lime

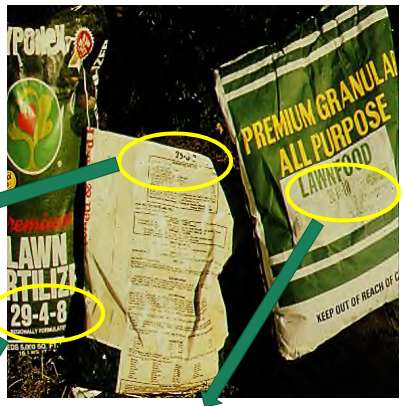
- Lime comes in various forms and in various qualities.
- For garden spreaders it may be pelletized
- For large applications it is finely ground stone:
  - More Calcium (Ca) → more effective
  - Dolomitic limestone (with magnesium) is more effective — CCE
  - The finer → the more effective — ECCE

ECCE 45% - 110% … bigger is better

CCE=Calcium Carbonate Equivalent

Fertilizers

- All different types
- But always listed are N-P-K
- Numbers are % by weight



20-3-3
20% Nitrogen
3% Phosphorus
3% Potassium

29-4-8
29% Nitrogen
4% Phosphorus
8% Potassium

20-10-10
20% Nitrogen
10% Phosphorus
10% Potassium

Lawn fertilizer in Virginia now has 0% Phosphorus, except "starter" fertilizer

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Other fertilizers

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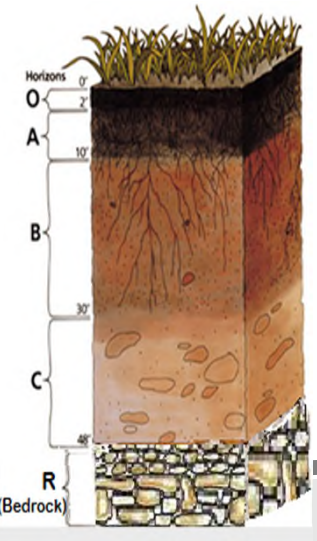
Module 2b.

Organic Matter

Soil Organic Matter



Also known as ***Humus.*** It is the dark brown to black complex decomposition product of organic matter turnover in soils. It is typically reported as ***organic matter content*** in soil testing programs. In a soil profile it typically occurs in the O profile (O = Organic) and is leached out into the A profile.

Soil Organic Matter

Organic Matter in the soil:

- Opens soil up: increases infiltration
- Binds soil particles together: decreases erosion
- Binds nutrients: improves fertility
- Feeds microorganisms: improves overall soil health

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Enemies of Soil Organic Matter

- Stockpiling
- Heat
- Drought
- Lack of vegetation
- Lack of litter (mulch)
- Texture (sandy soils)

MS-2

MS-1

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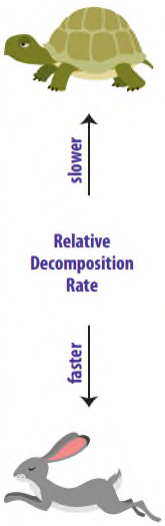
C/N Ratio

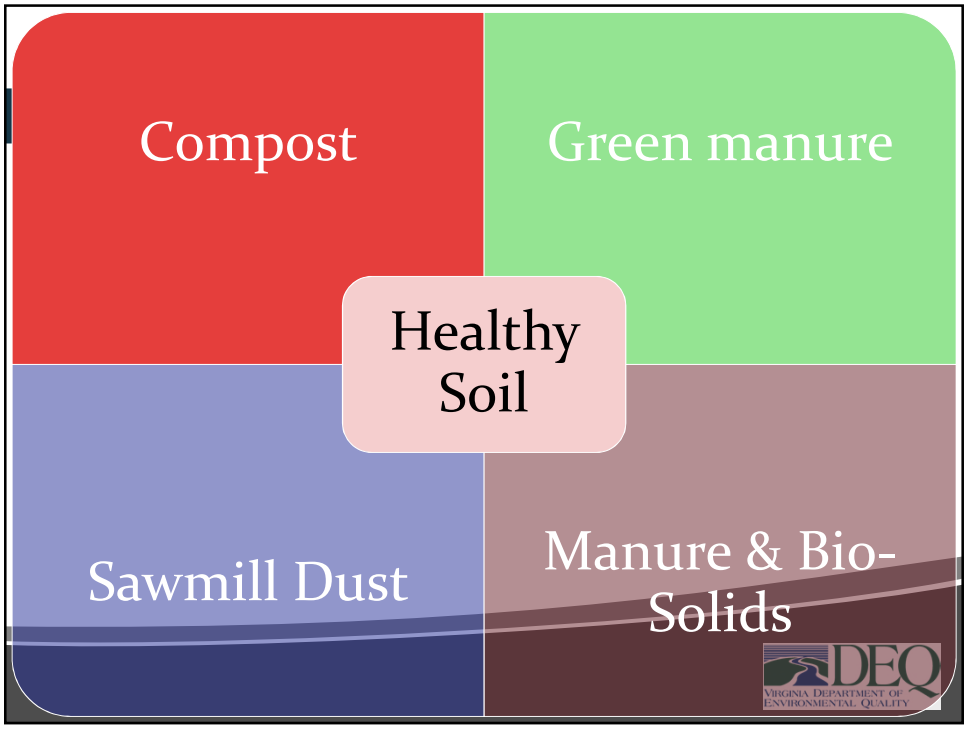
C/N Ratio or Carbon/Nitrogen Ratio

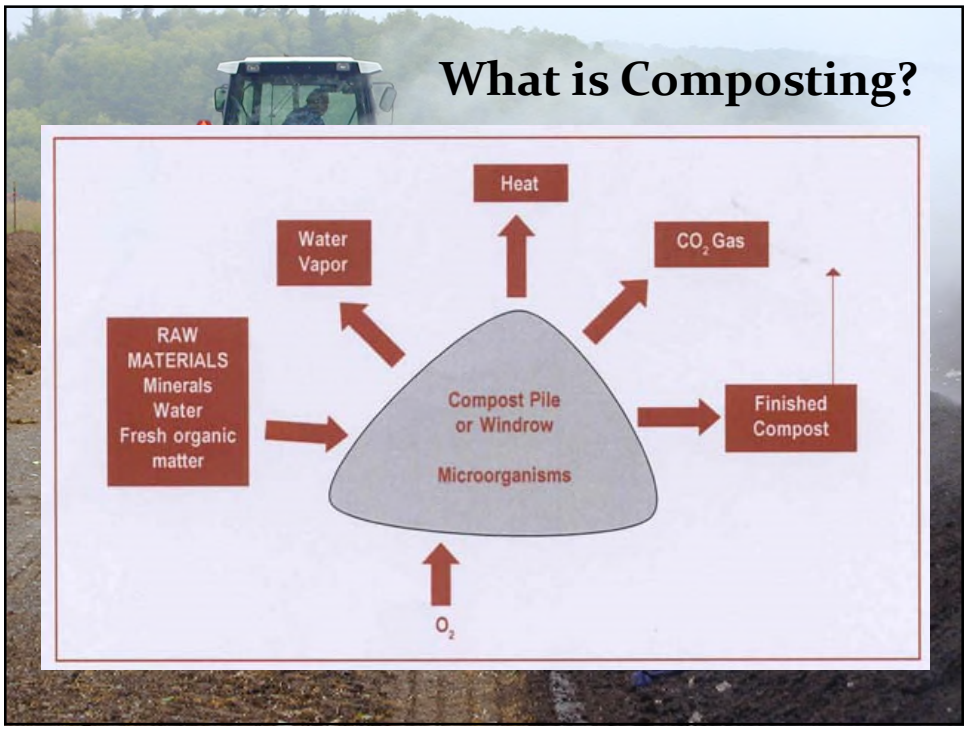
In natural world somewhere between 25 and 30 to 1

Table 1. Carbon to nitrogen ratios of crop residues and other organic materials

Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
Ideal Microbial Diet	**24:1**
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



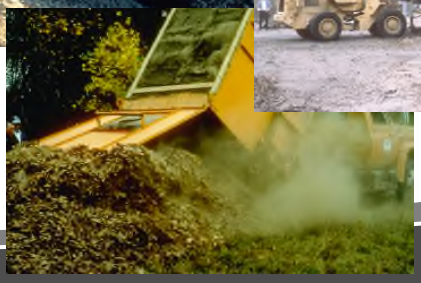

Compost
Green manure
Healthy Soil
Sawmill Dust
Manure & Bio-Solids
DEQ
Virginia Department of Environmental Quality


What is Composting?
Heat
Water Vapor
CO_2 Gas
RAW MATERIALS
Minerals
Water
Fresh organic matter
Compost Pile or Windrow
Microorganisms
Finished Compost
O_2

Raw Materials (Feedstock)

N source (biosolids)

C source (yardwaste)



Bulking agent (woodchips)

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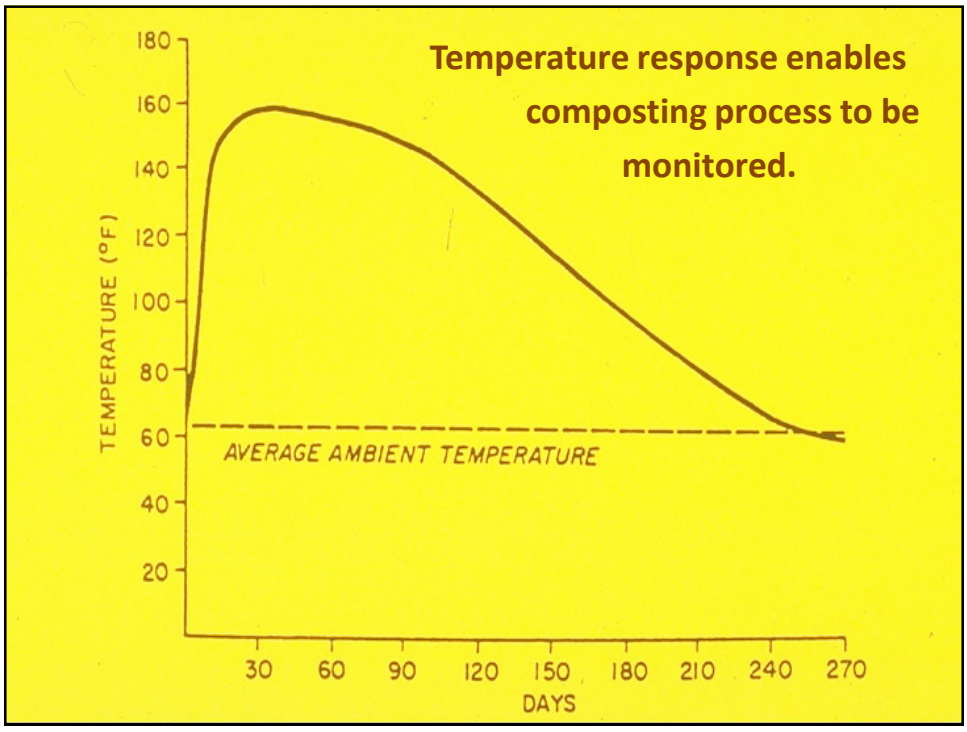

Compost Quality Properties

- Chemical
  - Volatile solids/organic matter/organic carbon
  - pH, cation exchange capacity
  - Soluble salts/electrical conductivity
  - Nutrients – N, P, K, S, etc.
  - Pollutants – heavy metals, POPs
- Physical
  - Particle size, bulk density
  - Moisture content/water holding capacity
  - Inert materials – glass, plastic, rocks, etc.

VIRGINIA DEQ STORMWATER DESIGN SPECIFICATION No. 4

SOIL COMPOST AMENDMENT

VERSION 2.0

July 1, 2013

Table 4.1: Stormwater Functions of Soil Compost Amendments [1]

Stormwater Function	HSG Soils A and B		HSG Soils C and D	
	No CA [2]	With CA	No CA	With CA
Annual Runoff Volume Reduction (RR)				
Simple Rooftop Disconnection	50%	NA [3]	25%	50%
Filter Strip	50%	NA [3]	NA [4]	50%
Grass Channel	20%	NA [3]	10%	30%
Total Phosphorus (TP) EMC Reduction[4] by BMP Treatment Practice	0		0	
Total Phosphorus (TP) Mass Load Removal	Same as for RR (above)		Same as for RR (above)	
Total Nitrogen (TN) EMC Reduction by BMP Treatment Practice	0		0	
Total Nitrogen (TN) Mass Load Removal	Same as for RR (above)		Same as for RR (above)	
Channel Protection & Flood Mitigation	**Partial.** Designers can use the RRM spreadsheet to adjust the curve number for each design storm for the contributing drainage area, based on annual runoff volume reduction achieved.			

[1] CWP and CSN (2008), CWP (2007)
[2] CA = Compost Amended Soils,
[3] Compost amendments are generally not applicable for A and B soils, although it may be advisable to incorporate them on mass-graded B soils to maintain runoff reduction rates.
[4] Filter strips in HSG C and D should use composted amended soils to enhance runoff reduction capabilities. See Stormwater Design Specification No. 2: Sheetflow to Vegetated Filter Strip or Conserved Open Space.

Compost Amendment and Soil Testing

Test before and after

- Before:
  - Test 1 foot below the proposed amendment area
  - 1 test per 5,000 square feet
  - Test for bulk density, pH, salts and nutrients
- After:
  - At least one week after compost has been incorporated
  - Additional nutritional requirements, pH, organic matter

Compost and Incorporated Depth

Table 4.3. Short-Cut Method to Determine Compost and Incorporation Depths

	Contributing Impervious Cover to Soil Amendment Area Ratio [1]			
	IC/SA = 0 [2]	IC/SA = 0.5	IC/SA = 0.75	IC/SA = 1.0 [3]
Compost (in) [4]	2 to 4 [5]	3 to 6 [5]	4 to 8 [5]	6 to 10 [5]
Incorporation Depth (in)	6 to 10 [5]	8 to 12 [5]	15 to 18 [5]	18 to 24 [5]
Incorporation Method	Rototiller	Tiller	Subsoiler	Subsoiler

Notes:

[1] IC = contrib. impervious cover (sq. ft.) and SA = surface area of compost amendment (sq. ft.)

[2] For amendment of compacted lawns that do not receive off-site runoff

[3] In general, IC/SA ratios greater than 1 should be avoided, unless applied to a simple rooftop disconnection

[4] Average depth of compost added

[5] Lower end for B soils, higher end for C/D soils

Specifications

a) 100% of the material must pass through a half inch screen

b) The pH of the material shall be between 5.5 and 8.5.

c) Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight

d) The organic matter content shall be >35%

e) Soluble salt content shall be less than 6.0 mmhos/cm

f) Must be mature and stable per the appropriate test(s) as specified by STA

g) Carbon/nitrogen ratio shall be less than 25:1

h) Must meet USEPA part 503 levels for heavy metals

i) The compost should have an optimum dry bulk density ranging from 40 to 50 lbs/ft^3. However, certain fully mature coarse textured composts may be lower.

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Compost amendments are not recommended where:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain runoff reduction rates.
- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10%.
- Existing soils are saturated or seasonally wet.
- Application would harm roots of existing trees (keep amendments outside the tree drip line).
- The downhill slope runs toward an existing or proposed building foundation.
- The contributing impervious surface area exceeds the surface area of the amended soils.

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Preparation of a Good Seedbed

Four Key Components of Soil Composition

HARVEST

A Better Way to Specify Compost Need?

#Cubic yards/acre of compost needed to increase % of organic matter

OM % (dry wt.)	Desired									
Existing	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0.0	25	50	75	100	125	150	175	200	225	250
0.5		25	50	75	100	125	150	175	200	225
1.0			25	50	75	100	125	150	175	200
1.5				25	50	75	100	125	150	175
2.0					25	50	75	100	125	150
2.5						25	50	75	100	125
3.0							25	50	75	100
3.5								25	50	75
4.0									25	50
4.5										25
5.0										

US Composting Council — Strive for 5%

Always use a STA Certified Premium Compost

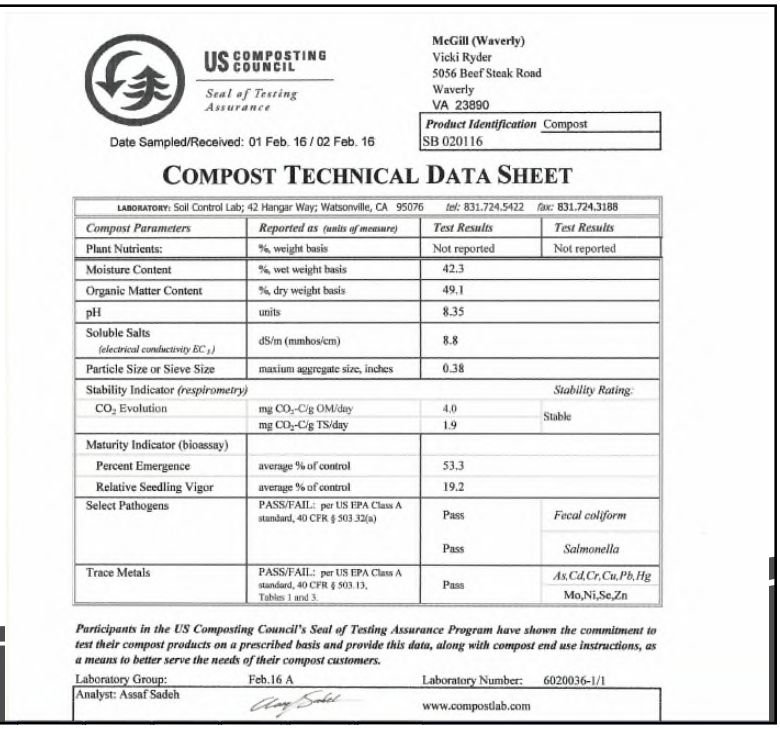
DEQ Virginia Department of Environmental Quality

How is Compost Quality Determined?

COMPOST TECHNICAL DATA SHEET

- *Total nutrients*
- *pH levels*
- *Organic matter content*
- *Dry & wet moisture content*
- *Heavy metals levels*
- *Particle size*
- *Existing pathogens & more*

USCC's Seal of Testing Assurance Program



US COMPOSTING COUNCIL
Seal of Testing Assurance

McGill (Waverly)
Vicki Ryder
5056 Beef Steak Road
Waverly
VA 23890

Product Identification: Compost
SB 020116

Date Sampled/Received: 01 Feb. 16 / 02 Feb. 16

COMPOST TECHNICAL DATA SHEET

LABORATORY: Soil Control Lab; 42 Hangar Way; Watsonville, CA 95076 tel: 831.724.5422 fax: 831.724.3188

Compost Parameters	Reported as (units of measure)	Test Results	Test Results
Plant Nutrients:	%, weight basis	Not reported	Not reported
Moisture Content	%, wet weight basis	42.3	
Organic Matter Content	%, dry weight basis	49.1	
pH	units	8.35	
Soluble Salts (electrical conductivity EC_1)	dS/m (mmhos/cm)	8.8	
Particle Size or Sieve Size	maxium aggregate size, inches	0.38	
Stability Indicator (respirometry)			Stability Rating:
CO_2 Evolution	mg CO_2-C/g OM/day	4.0	Stable
	mg CO_2-C/g TS/day	1.9	
Maturity Indicator (bioassay)			
Percent Emergence	average % of control	53.3	
Relative Seedling Vigor	average % of control	19.2	
Select Pathogens	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.32(a)	Pass	*Fecal coliform*
		Pass	*Salmonella*
Trace Metals	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3.	Pass	*As,Cd,Cr,Cu,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.

Laboratory Group: Feb.16 A
Laboratory Number: 6020036-1/1
Analyst: Assaf Sadeh
www.compostlab.com

LABORATORY: Soil Control Lab; 42 Hangar Way; Watsonville, CA 95076	tel: 831.724.5422	fax: 831.724.3188	
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Particle Size or Sieve Size	maxium aggregate size, inches	0.38	
Stability Indicator *(respirometry)*			*Stability Rating:*
CO_2 Evolution	mg CO_2-C/g OM/day	4.0	Stable
	mg CO_2-C/g TS/day	1.9	
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Plant Nutrients:	%, weight basis	%, wet weight basis	%, dry weight basis
Nitrogen	Total N	1.6	2.8
Phosphorus	P_2O_5	2.7	4.8
Potassium	K_2O	0.53	0.92
Calcium	Ca	3.3	5.8
Magnesium	Mg	0.26	0.45
Moisture Content	%, wet weight basis	42.3	
Organic Matter Content	%, dry weight basis	49.1	
pH	units	8.35	
Soluble Salts *(electrical conductivity $EC_{1:1}$)*	dS/m (mmhos/cm)	8.8	
Particle Size or Sieve Size	% under 9.5 mm, dw basis	100.0	
Stability Indicator *(respirometry)*			*Stability Rating:*
CO_2 Evolution	mg CO_2-C/g OM/day	4.0	Stable
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Laboratory Group: Feb.16 A
Laboratory Number: 6020036-1/1
Analyst: Assaf Sadeh
www.compostlab.com

DEQ VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Magnesium	Mg	0.26	0.45
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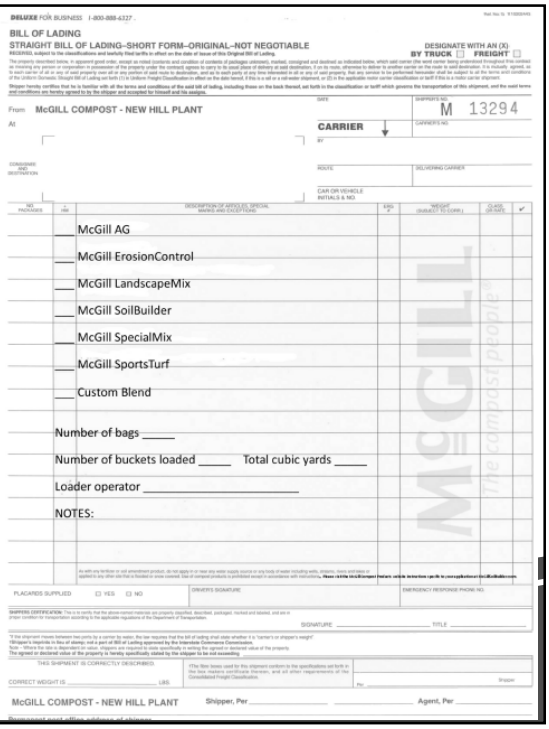
Organic Matter Content	%, dry weight basis	49.1	
pH	units	8.35	
Soluble Salts *(electrical conductivity $EC_{1:1}$)*	dS/m (mmhos/cm)	8.8	
Particle Size or Sieve Size	% under 9.5 mm, dw basis	100.0	
Stability Indicator *(respirometry)*			*Stability Rating:*
CO_2 Evolution	mg CO_2-C/g OM/day	4.0	Stable
	mg CO_2-C/g TS/day	1.9	

Organic matter >35%
C/N <25:1 → 49.1 : 2.8 or 17.5 : 1

DEQ VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY



BILL OF LADING

STRAIGHT BILL OF LADING–SHORT FORM–ORIGINAL–NOT NEGOTIABLE

DESIGNATE WITH AN (X)
BY TRUCK ☐ FREIGHT ☐

From McGILL COMPOST - NEW HILL PLANT

CARRIER

M 13294

___ McGill AG
___ McGill ErosionControl
___ McGill LandscapeMix
___ McGill SoilBuilder
___ McGill SpecialMix
___ McGill SportsTurf
___ Custom Blend

Number of bags _____

Number of buckets loaded _____ Total cubic yards _____

Loader operator _____

NOTES:

McGILL COMPOST - NEW HILL PLANT Shipper, Per _____ Agent, Per _____

Not All Compost is the Same!

- Lumps, clumps
- Inconsistent color
- Still steaming or hot to the touch
- Offensive odor
- May still contain visible sticks or twigs

Poor quality compost

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Not All Compost is the Same!

- ✓ A dark uniform color with a consistent texture
- ✓ A pleasing, soil-like aroma
- ✓ Finer screening with no sticks, twigs or foreign matter for a consistent product
- ✓ Free of Pathogens and Weed Seeds

Premium Compost Makes A Difference!

The ESCH and Compost

No mention!

But mentions the following soil amendments:

- Peat(moss)
- Sand
- Vermiculite
- Raw Manure
- Thoroughly rotted sawdust
- Treated sewage sludge (biosolids)

Erosion Control for the Future?

- Seed infused directly into the compost and applied by blower truck
- Compost blankets are typically applied at 1" to 2" depth up to 2:1 slopes
- Some companies sell compost blankets ➔ establish turf quicker reducing soil loss for better erosion control than traditional methods

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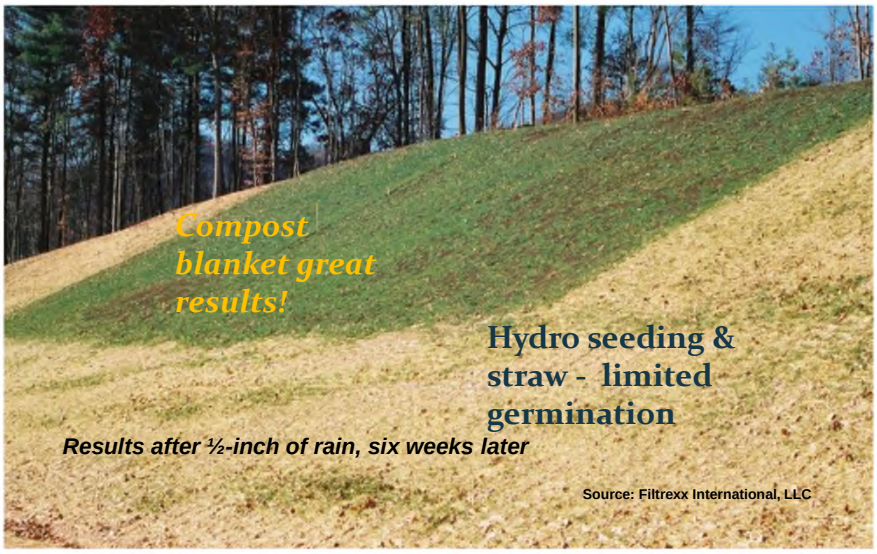
Erosion Control for the Future?



Erosion Control for the Future?

Type of Plot (Hwy Environment)	Vegetation Cover	Sediment Loss(kg/10m5) 1:3 slope
Compost on Sand	92%	3.88
Compost on Clay	99%	.34
Wood Chips w/Terra Tack SC on Sand	48%	11.27
Wood Chips w/Terra Tack SC on Clay	95%	.15
Wood Chips w/RMB Plus on Sand	50%	10.97
Wood Chips w/RMB Plus on Clay	57%	.30

The compost plots produced 92% vegetation cover on sand and 99% vegetation cover on clay!

Source: Texas DOT

Green Manure

Green manure = Sacrificial crop that will be plowed under

MS-1 ➔ when an area is at final grade it needs to be stabilized within 7 days!

Now:

What to do when it is the wrong season?

1. Mulch
2. Annual ≈ green manure

Annual rye, Cereal rye
Oats, Sorghum
Red Clover, Buckwheat

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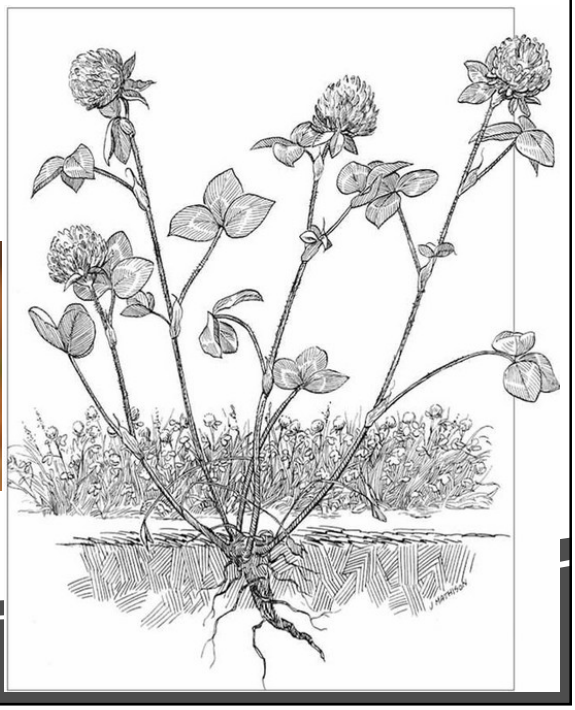
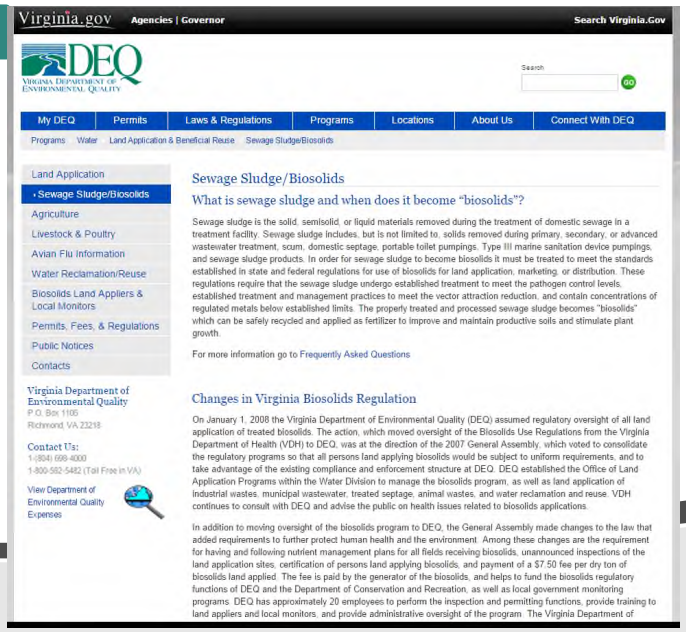
Red Clover



Biosolids



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Saw Dust

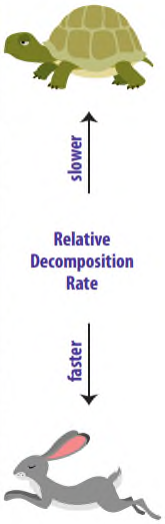
In natural world somewhere between 25 and 30 to 1

Fresh saw dust 100+:1

That is why we want well rotted saw dust, or be aware that we might need to add nitrogen fertilizer!

Table 1. Carbon to nitrogen ratios of crop residues and other organic materials

Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
Ideal Microbial Diet	**24:1**
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



Take home message

- While not the panacea, organic matter in the soil is very important,
- Organic matter is:
  - The glue that keeps the soil together
  - Keeps the soil open
  - Is the key to soil fertility (see also the next module)
  - Feeds soil life

Take home message

Good Inspectors:

- Need to be situationally aware of soil fertility and organic matter
- Be able to apply some flexibility when it comes to application of organic matter to a site
- Know that soil testing is often the route to successful revegetation and stabilization