



Recycle, Reuse, Repurpose, Regenerate

Soil Management Techniques to Improve Green Stormwater Infrastructure

*McGill Environmental Systems
Waverly, VA (804-834-8820)
New Hill, NC (919-362-1161)
Delway, NC (910-532-2539)*

Soil Ecosystem Challenges



Despite 90+ years of US research, soil erosion continues to be a serious issue, with an estimated cost of 400 billion US dollars worldwide.

*Soil loss rates from construction sites are **10 to 20 times** that of agricultural lands with **60%** of lost soils deposited into our aquatic systems, polluting them with nutrients, pesticides, and other contaminants*

Storm Water Challenges

850 billion gallons of untreated water are discharged into the nation's water bodies every year



As much as 90% of city surfaces are impervious, causing the US to lose some 5 BILLION tons of top soil each year to soil erosion



A one-inch rainfall event can drop upwards of 27,000 gallons of water per acre

Soil Ecosystem Challenges



“Soil erosion is second only to population growth as the biggest environmental problem the world faces.”

Dr. David Pimentel-Cornell University

The Natural Resources Conservation Service has recognized that soils with good infiltration and permeability can **significantly reduce** stormwater runoff rates and volumes...reducing sediment & nutrient runoff

Standard Erosion Control Practices



- Straw & Tack is the most economical and commonly used temporary erosion control method
- Hydro-seeding or hydro-mulching is a planting process that uses a slurry of seed and mulch
- Fiber mulch accelerates the growing process by maintaining moisture around the seeds thereby increasing the rate of germination

Nutrient pollution is one of America's most widespread and costly environmental and public health challenges.

-EPA's National Lakes Assessment

Standard Erosion Control Practices



Highway construction has historically been viewed as a major contributor of non-point source pollution. Non-point source pollution - or pollution such as surface runoff that cannot be linked to a particular source - is cited as being the **most prevalent cause of contamination in receiving waters in the United States**

Successful Erosion Control Practices



Sampson County Landfill during application



Sampson County Landfill after application

Compost blankets are typically applied at 1" to 2" depth used on slopes up to 2:1. The seed can be infused directly into the compost and applied by a blower truck. Compost blankets establish turf quicker reducing soil loss for better erosion control than more traditional methods.

Photo courtesy : Eco Express Solutions

Stormwater runoff is a leading pollutant of surface waters in the United States. -EPA

Successful Erosion Control Practices



River Landing Before



River Landing After

The use of surface applied organic amendments has been shown to reduce runoff and erosion through enhanced vegetation growth and soil quality characteristics.

Soil and Water Conservation Society

Photo courtesy : Eco Express Solutions

Successful Erosion Control Practices



***Compost blanket =
great results!***

**Hydro seeding & straw =
limited germination**

Results after ½-inch of rain, six weeks later

Source: Filtrexx International, LLC

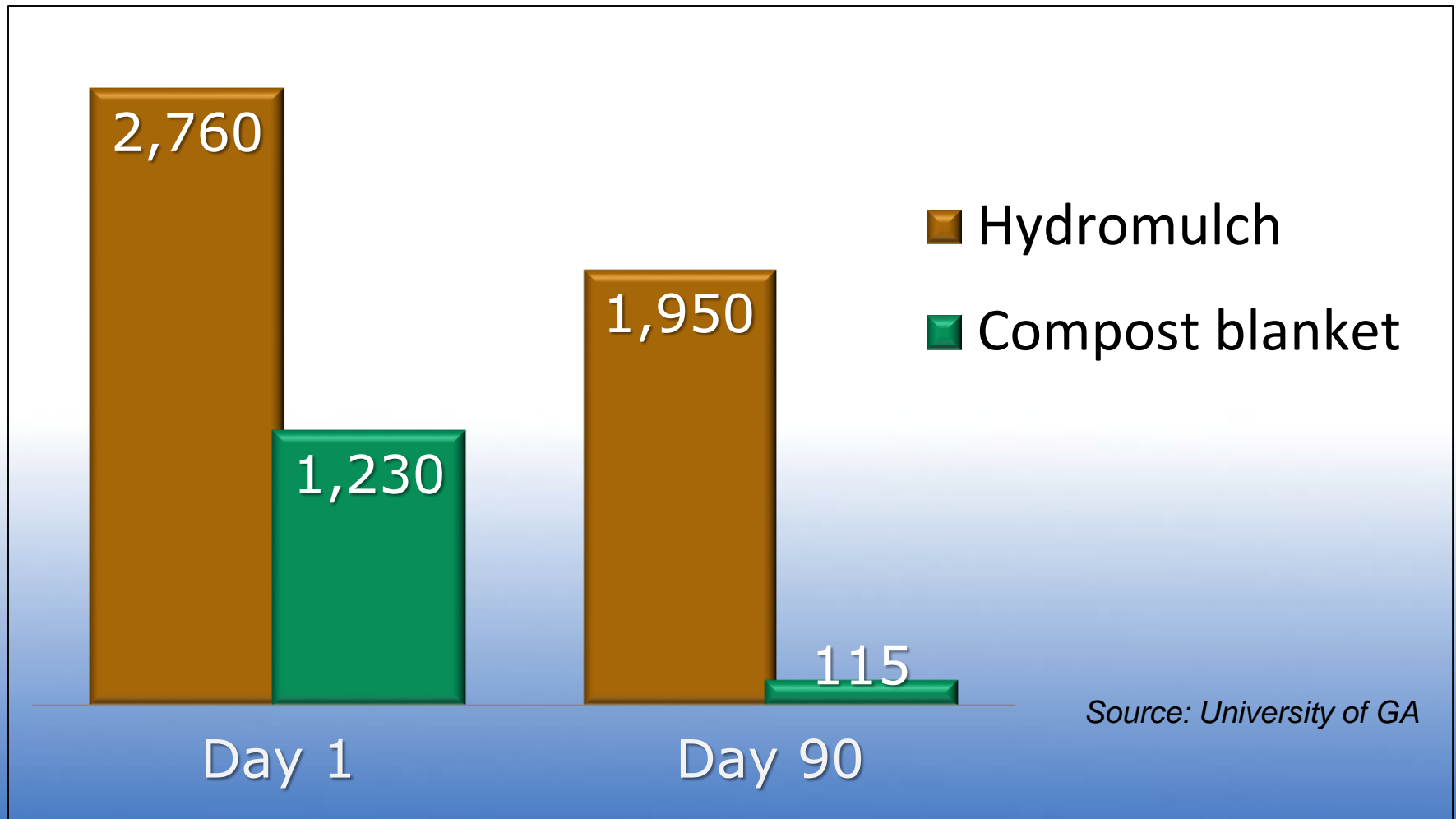
Successful Erosion Control Practices

<u>Type of Plot (Hwy Environment)</u>	<u>Vegetation Cover</u>	<u>Sediment Loss(kg/10m5) 1:3 slope</u>
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

Compost may also chemically bind some toxic substances, which suggests that it may have some application in bioremediation.

Source: Texas DOT

Successful Erosion Control Practices



Soil loss after two 3" storm events

Challenges of Unhealthy Soils



A Vicious Circle

Which one would **YOU** choose?



Clean Water?



Fertile Soils?

**What if we could have
Both!**

Benefits of Healthy Soil

Soil performs valuable functions: nourishing plants, absorbing and cleaning storm water. Restoring healthy soil is essential to protecting our water ways.

-Soils for Salmon Washington Organic Recycling Council



*Soil health is teeming with life and activity. It's rich in **organic matter**, insects, earthworms, air, water and nutrients. Healthy soil is a must for thick, strong Turfgrass.*

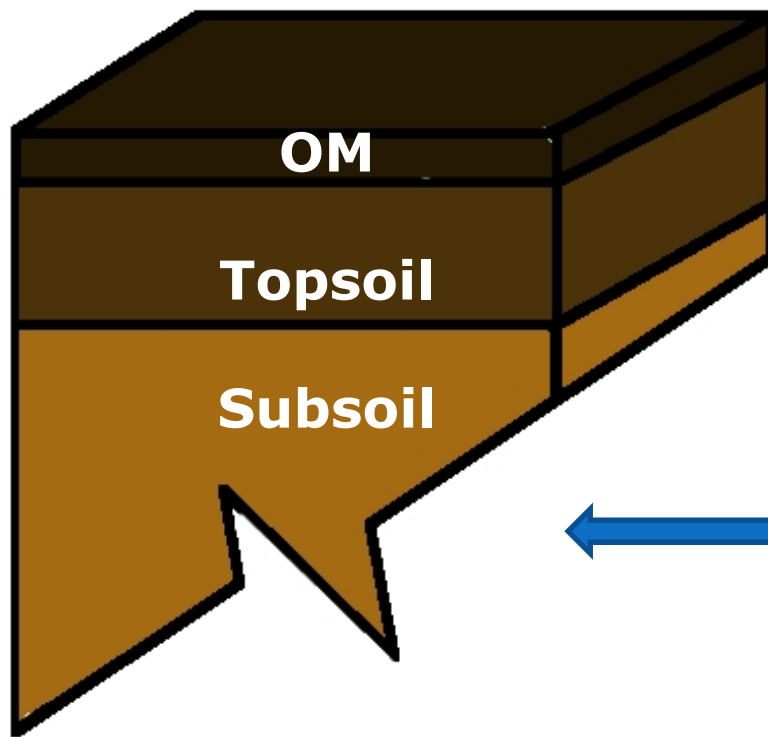
Susan McCabe-Colorado State University
Cooperative Extension, Denver

“When nature has work to be done, she creates a genius to do it.”

-Ralph Waldo Emerson

Benefits of Healthy Soil

Organic matter is vital to soil quality



← 0-2 inches – decaying biota

← 2-10 inches – supports plant life

- **5-10% organic matter**

- 40-45% minerals

- 25% air/gases

- 25% water

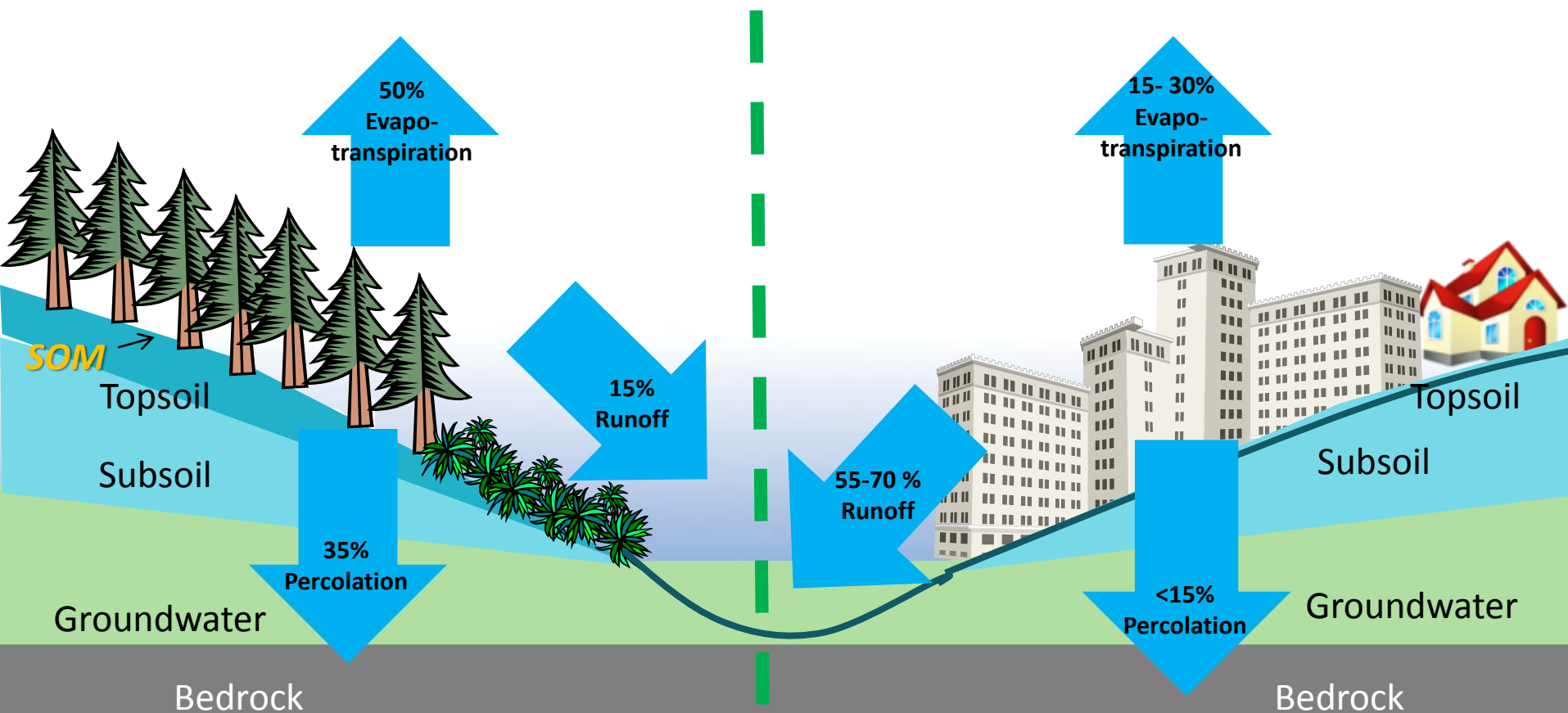
← 10-30 inches -- mostly mineral with inert properties, cannot sustain life and what is left after construction.

A good soil contains upwards to 1 TON of soil microbes per acre

Dr. Buz Klotz, Ph.D. USDA NRCS-March 2016

Benefits of Healthy Soil

The majority of the Soil's Organic Matter is present in the top 4" of soil

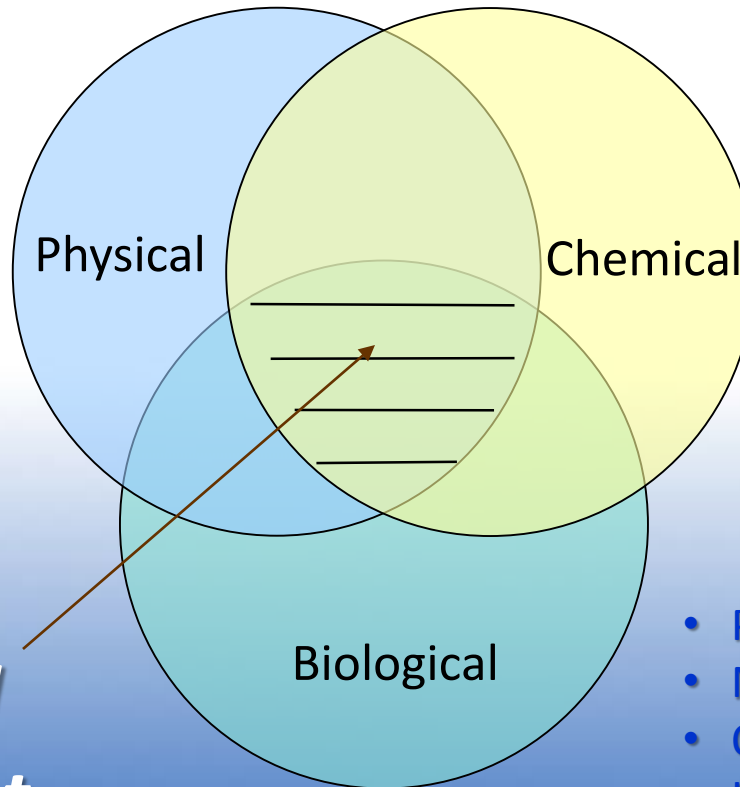


Healthy Environment

Damaged Environment

Benefits of Healthy Soil

- Root proliferation
- Water retention
- Water infiltration & transmission
- Aeration
- Erosion prevention



- Nutrient retention & release
- pH
- Energy (C) storage
- Toxicity prevention

- Pest suppression
- N mineralization
- OM decomposition
- Habitat protection

***Healthy Soil
Environment***

***Health implies management actions that leads to a condition or state,
Leading to something that can be done to change it in a positive trend.***

Importance of Soil Organic Matter



*One percent increase in SOM results in about **20,000 to 25,000** more gallons of available soil water per acre!*

In the US, irrigation consumes approximately 67% of fresh groundwater withdrawals.

**USDA's Natural Resources
Conservation Service
Kansas State's Ag Extension study**

Why Compost?



- *A humus-rich soil amendment made by the controlled biological decomposition of organic materials*
- *Made from organic residuals 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*
- *Effective in improving the biological, physical and chemical characteristics of soils*

Compost offers the most practical, economical and sustainable means to rebuild our topsoil layer & handles the most diversified amount of organic waste vs. other methods.

Why Compost?



When added to soil compost helps improve soil structure; sandy soils will hold water better while clays will drain faster. Compost also promotes a biologically **healthy soil** by providing food for earthworms, soil insects, and beneficial microorganisms.

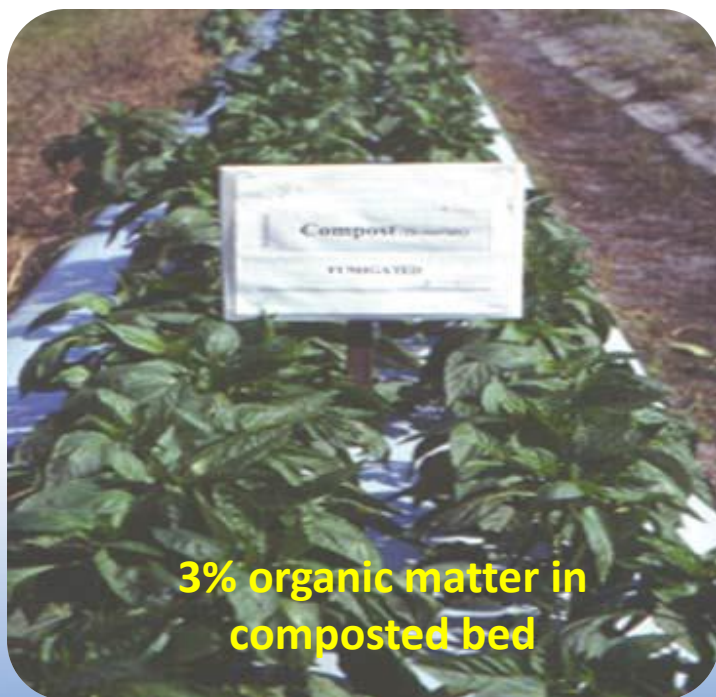
-Virginia Tech Cooperative Extension

The benefits of a **healthy turf** go beyond the obvious. As your *turf* grows, it helps the environment by stabilizing soil and reducing air pollution, noise, heat, dust, and glare.

-NCSU A&T Cooperative Extension

Soils stockpile 1500 gigatons of carbon in the Soil's Organic Matter, more than Earth's atmosphere and all the plants combined! ----Dance, 2008

Compost as a Soil Amendment



After a 10 year study, the use of 3% organic matter from compost resulted in 50% less fertilizer use.

—University of Florida Study by Dr. Monica Ozores-Hampton

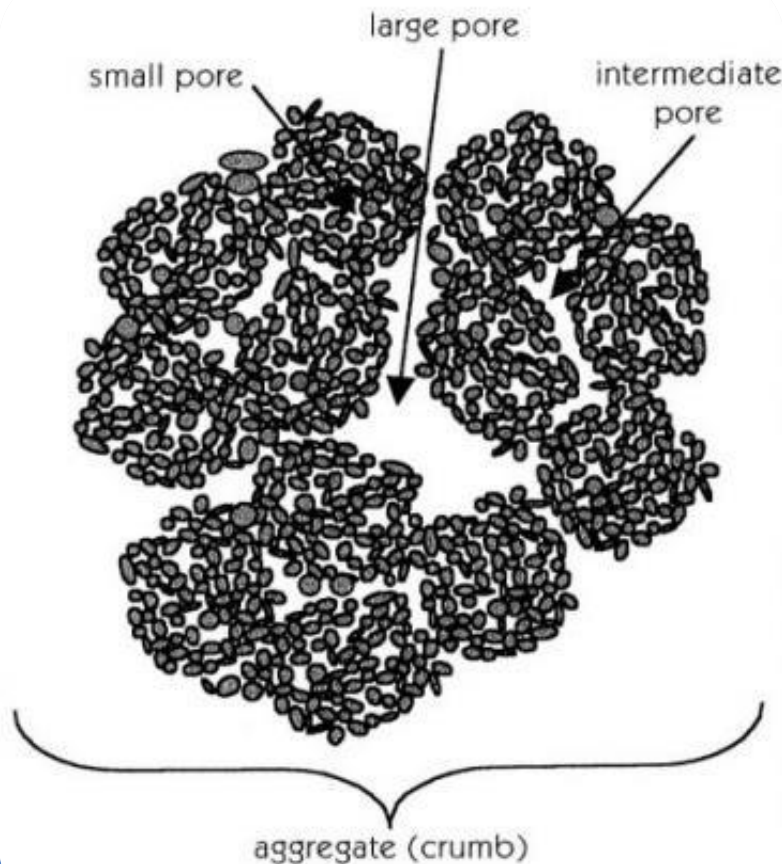
Compost as a Soil Amendment

Studies have shown that as much as 50% of the synthetic derived nitrogen applied to the soil will be leached out and the half that does reach the plants may do more harm than good. Other studies have shown that only 5-10% of the N makes it to the plant and the rest is wasted potentially causing damage to the environment. **-Alabama University**

Compost typically has a lower inorganic Nitrogen content converting it into a more stable less mobile form



Importance of Soil Organic Matter



- *A well aggregated soil has a range of pore sizes*
- *This medium size soil crumb is made up of many smaller ones*
- *Very large pores occur between the medium size aggregates*
- *SOM has less density than soil so it has more space for air and water storage.*

Compacted layers that exceed 300 psi will restrict root growth. Roots need a pore space greater than 0.1 mm to properly grow.

Compost as a Soil Amendment

Despite the application of considerably higher-than-needed phosphorus in five consecutive years of compost application, the study measured no significant increase in runoff phosphorus compared to a control treatment fertilized according to soil testing recommendations, because the high rates of compost increased infiltration and decreased runoff and erosion.

– VA Tech-Spargo et al. (2006)

An understanding of how compost use affects soil properties that influence nutrient transport is also important

Compost as a Soil Amendment

Using Compost to increase Soil's Organic Matter will improve the soil's Cation Exchange Capacity (CEC)

- CEC = total amount of cations soil can retain
- Soil Organic Matter is negatively charged, but binds both cations and anions
- The higher the soil CEC the greater ability it has to store plant nutrients – **which impacts the soil's long-term fertility**

Humus is a very well stabilized part of organic matter that has a great ability to retain nutrients in the soil

CEC?
The soil's capacity to absorb certain important nutrients. Higher the score the better.

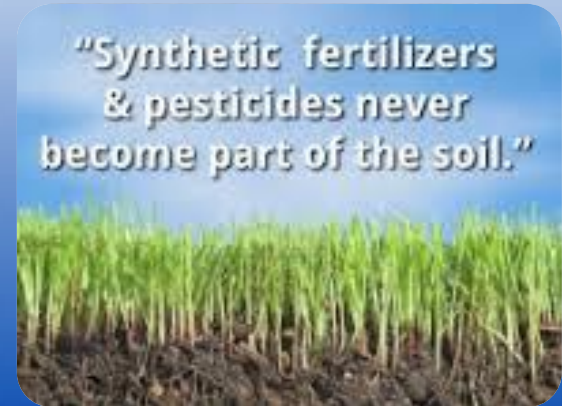
Compost as a Soil Amendment

The higher the solubility of nutrients, the higher the ability of plants and crops to uptake them, but also more potential water pollution through runoff. In soils amended with compost, only a small percentage of P and N is water soluble typically less than 1% of P and 5% of N.

–Longwood University

Compost's pollution reduction qualities led the EPA to include it in its menu of Storm Water BMPs

"Synthetic fertilizers & pesticides never become part of the soil."



Compost as a Soil Amendment

Runoff from vegetated test plots contained lower total masses of soluble phosphorus and potassium than was found in the runoff from un-vegetated plots. Again, the total mass of pollutants was much lower in runoff from test plots treated with compost than from conventionally-treated test plots.

— Iowa State University

Using compost to help establish vegetation can lead to reduce nutrient run-off



Not All Compost is the Same!



**Premium Compost
Makes A Difference!**

- ✓ 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

A Tightly-Controlled Indoor Manufacturing Environment

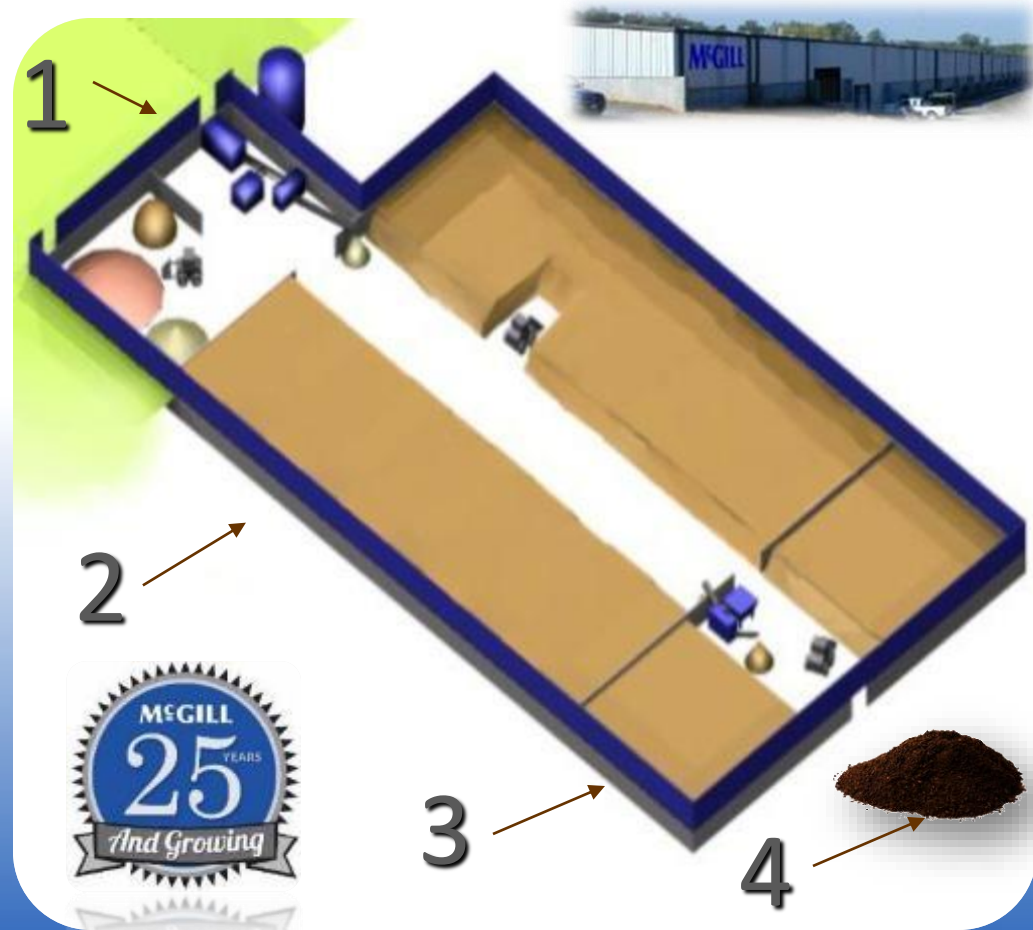


**Organic Recycling + Modern Composting =
A Sustainable System**



Rutgers' Modified Aerated Static Pile Process

1. Blending of Feedstocks at prescribed ratios
2. Specially designed aeration system
3. Curing & screening
4. Outdoor product storage for delivery of EPA Exceptional Quality Compost



Composting is a biological process and understood science

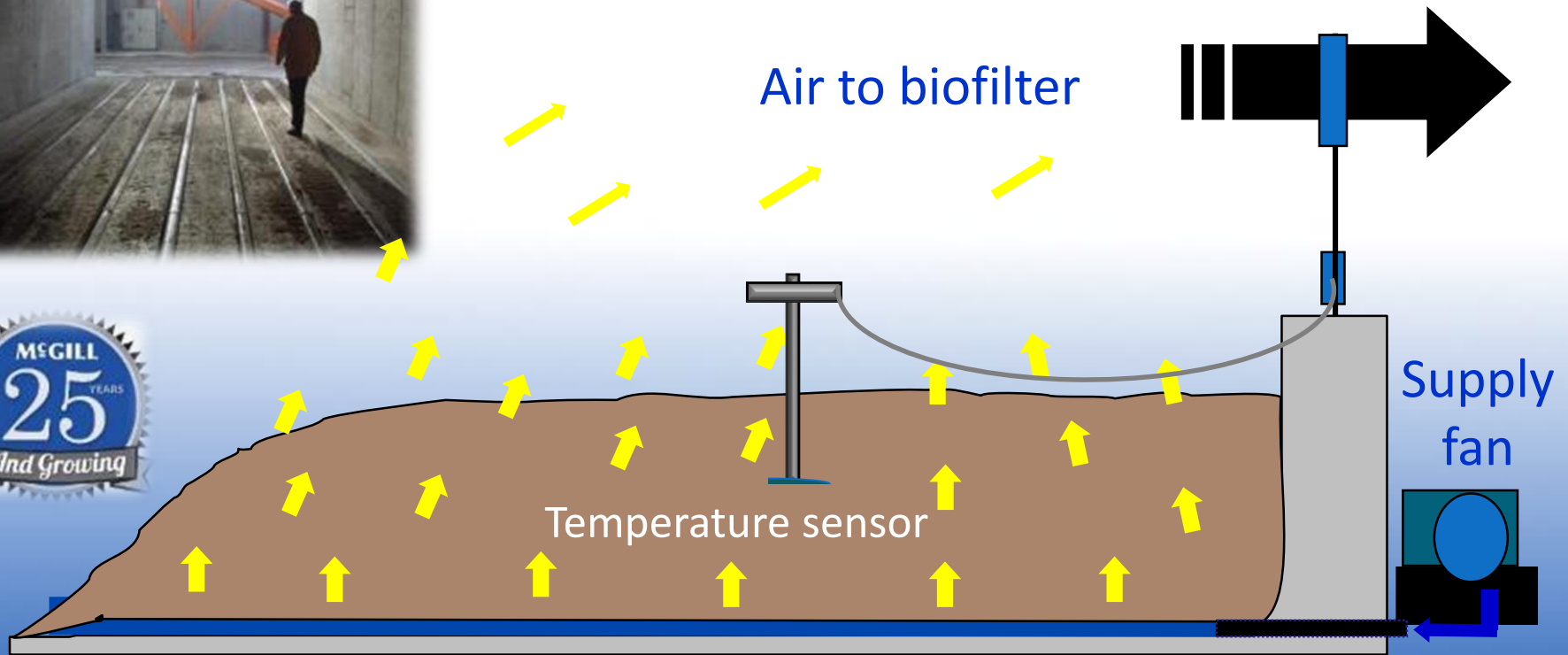
Rutgers' Modified Aerated Static Pile Process



How it works



Rutgers' Modified Aerated Static Pile Process



Constant Temperature Monitoring = A Consistent Product

Organic Biodegradable Residual Feedstocks

- ❖ The correlation between feedstock selection and the composting process will play a major role in the quality of the compost produced.
- ❖ Single feedstock composts, like yard waste compost, can be lower in nutrients possessing a higher C/N ratio that can “rob” the plant of needed carbon resulting in a temporary nitrogen deficiency in the soil.
- ❖ Utilizing a combination of green waste, food waste & biosolids in our blend, **results in a richer, more complete quality *Premium Compost***.
- ❖ McGill’ Proprietary Blend includes 2/3 green waste and a 1/3 blend of pre/post consumer food waste residuals and biosolids.

Feedstock Variety = Quality Compost

How is Compost Quality Determined?

US COMPOSTING COUNCIL
Seal of Testing Assurance

McGill Legroschaw
Lewis Flynn
PO Box 61
Harrells
NC 28444

Date Sampled/Received: 08 Mar. 02 / 19 Mar. 02

COMPOST TECHNICAL DATA SHEET

Unknown Soil Control Lab; 42 Morgan 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	% wet weight basis	% dry weight basis
Nitrogen	Total N	0.87	1.8
Phosphorus	P ₂ O ₅	0.82	1.7
Potassium	K ₂ O	0.28	0.58
Calcium	Ca	1.4	3.0
Magnesium	Mg	0.12	0.25
Moisture Content	% wet weight basis	52.2	
Organic Matter Content	% dry weight basis	54.2	
pH	units	6.74	
Soluble Salts	dS/m (mhos/cm)	6	
Particle Size	% under 0.5 mm, dw basis	97.0	
Stability Indicator (respiration)			Stability Rating:
CO ₂ Evolution	mg CO ₂ -C/g 0.01day	1.4	Very Stable
	mg CO ₂ -C/g 10days	0.7	
Maturity Indicator (biomass)			
Percent Emergence	average % of control	100	
Relative Seedling Vigor	average % of control	100	
Select Pathogens	FASSPAAL per US EPA Class A standard, 40 CFR § 101.10(a)	Pass	Fecal Coliform
Trace Metals	FASSPAAL per US EPA Class A standard, 40 CFR § 101.11, Tables 1 and 2	Pass	As, Cd, Cr, Cu, Pb, Hg, Mn, 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 Batch Number: Mar. -3-02 Laboratory Number: 10171312157
Analyst: Frank Shields



- ▶ 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

Specification Tool

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

OM % (dry wt.) Existing	Desired									
	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										



Always use a STA Certified Premium Compost

Nature is the New Standard

It is important that both quality soil and vegetation be viewed together as an essential part of a dynamic system used to control stormwater quantity and quality.



Green infrastructure *complements* grey infrastructure to provide a holistic approach to soil and water management

Nature is the New Standard

*Soils are highly complex systems that provide essential environmental benefits including biofiltration of pollutants, nutrients for plant growth, and the storage and slow release of storm flows. The ability of soil to effectively store and slowly release water is dependent on its properties—**texture, structure, organic matter content, and biota—as well as depth**. Plant roots, macro fauna, and microbes tunnel, excavate, penetrate, and physically and chemically bond soil particles to form stable aggregates that enhance soil structure and porosity. Soil properties are the principal factor controlling the fate of water in the hydrologic system. **Water loss, utilization, contamination, and purification are all affected by the soil** (Brady and Weil, 2007).*

Nature is the New Standard

*Soil amendments increase the soil's infiltration capacity and help reduce runoff from the site. They have the added benefit of changing physical, chemical, and biological characteristics so that **the soils become more effective at maintaining water quality**. Soil amendments, which include both soil conditioners and fertilizers, make the soil more suitable for the growth of plants and increase water retention capabilities.*

EPA Storm Water BMPs or “Integrated Management Practices”

****50% of the EPA's 15 stated BMPs can include compost use****

Nature is the New Standard

Both the US Green Building Council's LEED2 and the Sustainable Sites programs (SITES)3 now offer credits for the use of compost in projects seeking certification. These credits are offered due to the variety of benefits that compost provides in the landscape for the uses described below.

6.1 Storm Water Design: Quantity Control

6.2 Storm Water Design: Quality Control

7.1 Control and retain construction pollutants (EPA-530-F-97-042)

7.3 Restore soils disturbed during construction & Restore soils disturbed by previous development



**EDUCATION
PARTNER**



Include compost in your projects and realize these benefits and credits!

Initiatives in the United States



Building the **Soil** for Cleaner Water, Healthier Streams, Successful Landscapes, and Healthy Communities

.....preserving site topsoil and vegetation where possible, reducing compaction, and amending disturbed soils with compost to restore healthy soil functions.



“Before a newly constructed premise may be occupied, property owners must amend their soil with compost...”

Manufactured Engineered Soils



Option 1 - Install 6" of topsoil over 5,000 sq. ft.

Topsoil required = 93 cubic yards

Unit price to install & amend = \$30 per cubic yards installed-----TOTAL COST: \$2,790.00



Option 2 - Install 2 " compost over 5,000 sq. ft.

Compost required = 32 cubic yards

Unit price to install & amend = \$45 per cubic yards installed-----TOTAL COST: \$1,440.00

TOTAL SAVINGS using compost = \$1,350.00

Compost is often used as the source of organic matter in the engineered soil that is used to build these LID BMPs.

Initiatives in the United States

Executive Order 13514

It is therefore the policy of the US that Federal agencies shall increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and storm water management...

The Clean Water Framework, that affirms its comprehensive commitment to protecting the health of America's waters. The framework recognizes the importance of clean water and healthy watersheds to our economy, environment and communities, and emphasizes the importance of partnerships and coordination with states, local communities, stakeholders, and the public to protect public health and water quality...

Initiatives in the United States

MARIN CARBON PROJECT

Our vision is for landowners & land managers of Ag ecosystems to serve as stewards of soil health and to undertake carbon farming in a manner that can improve on-farm productivity and viability, enhance ecosystem functions, and stop and reverse climate change.

Soils hold onto more carbon than all the vegetables, animals, and minerals sitting atop them, making them an enormous “climate sink.” In fact, increasing soils’ carbon content by 0.4 percent annually through conservation and better management could stabilize humankind’s dangerous carbon emissions—and improve crop yields, too.

Initiatives in Virginia

Practice	Removal of TP by Runoff Reduction (RR, as %) (based upon 1 inch of rainfall)	Removal of TP by Treatment – Pollutant (EMC) Reduction (PR, as %)	Total Mass Load Removal of Total Phosphorus (TR, as %)
Rooftop Disconnection	25 or 50 ¹	0	25 or 50 ¹
Sheetflow to Vegetated Filter or Conserved Open Space 1	25 to 50 ¹	0	25 to 50 ¹
Sheetflow to Vegetated Filter or Conserved Open Space 2 ⁵	50 to 75 ¹	0	50 to 75 ¹
Grass Channel	10 to 20 ¹	15	23
Soil Amendments	Used to decrease runoff coefficient for turf cover at the site. See the design specs for Roof Disconnection, Sheet Flow to Vegetated Filter or Conserved Open Space, and Grass Channels		
Vegetated Roof 1	45	0	45
Vegetated Roof 2	60	0	60
Rainwater Harvesting	Up to 90 ^{3, 5}	0	Up to 90 ^{3, 5}
Permeable Pavement 1	45	25	59
Permeable Pavement 2	75	25	81
Infiltration 1	50	25	63
Infiltration 2	90	25	93
Bioretention 1	40	25	55
Bioretention 2	80	50	90
Urban Bioretention	40	25	55
Dry Swale 1	40	20	52
Dry Swale 2	60	40	76
Wet Swale 1	0	20	20
Wet Swale 2	0	40	40
Filtering Practice 1	0	60	60
Filtering Practice 2	0	65	65
Constructed Wetland 1	0	50	50
Constructed Wetland 2	0	75	75
Wet Pond 1	0	50 (45) ⁴	50 (45) ⁴
Wet Pond 2	0	75 (65) ⁴	75 (65) ⁴
Extended Detention Pond 1	0	15	15
Extended Detention Pond 2	15	15	31

States Organic Diversion Success

Four surrounding states reporting total amount of organics diverted to composting in 2012

- **South Carolina 246,624 tons**
- **Tennessee 500,000 tons**
- **Virginia 184,702 tons**
- **North Carolina 674,600 tons**



At the Macro level, interest is growing rapidly in diverting more organic waste streams to composting. This is particularly true with the source separated food scraps stream.

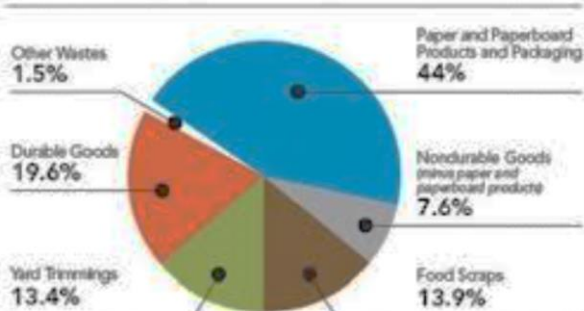
Federal Organic Diversion Goals

- Executive Order-diverting at least 50 percent of non-hazardous solid waste, including food and compostable material but not construction and demolition materials and debris, annually, and pursuing opportunities for net-zero waste or additional diversion opportunities
- **The USDA and the EPA joined calling for broad-based participation to achieve a 50% reduction in food waste by 2030.**



Sustainable Opportunities

Total U.S. Municipal Solid Waste Generation by Category



Source: United States Environmental Protection Agency, Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010. Adjusted to combine containers with packaging and paper and paperboard.

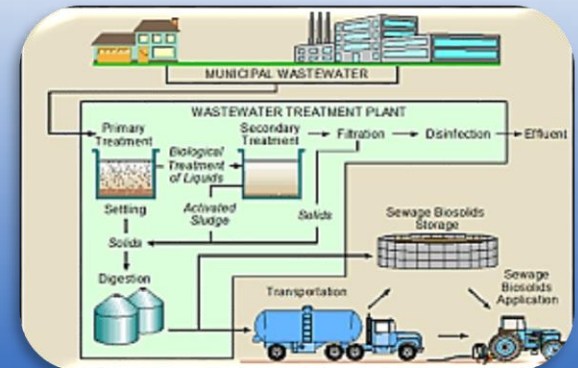
**Municipal solid waste
100 million + tons**



Industrial Waste 100's off millions tons

**60-70% of the
Municipal Solid Waste
stream is estimated to
be compostable!**

Source: USEPA



Biosolids 36 million tons

Agriculture waste 100's off millions tons

What Is Needed?

Advancing composting and **compost use** in the U.S. is a key sustainability strategy to create jobs, protect watersheds, reduce climate impacts, improve soil vitality, and build resilient local economies.



Institute for Local Self Reliance-
State of Composting in the US

Compost is the Economical and Sustainable Choice!

Changing regulations

- Water restrictions
- Nutrient management
- Storm water & erosion control



Sustainability mandates

- Carbon credits
- LEED
- Sustainable Sites
- Executive Order 13514
- Green purchasing

Economics

- Fertilizer prices rising
- Lime, pesticide value
- Reduced labor
- Reduced replacements

Certified STA Compost = Superior results!

I Appreciate Your Time and Interest!

Gary Gittere

Sales & Marketing Manager

McGill Premium Compost

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(M) 919-259-3666

www.mcgillsoilbuilder.com



Putting LIFE Back Into Your Soil!