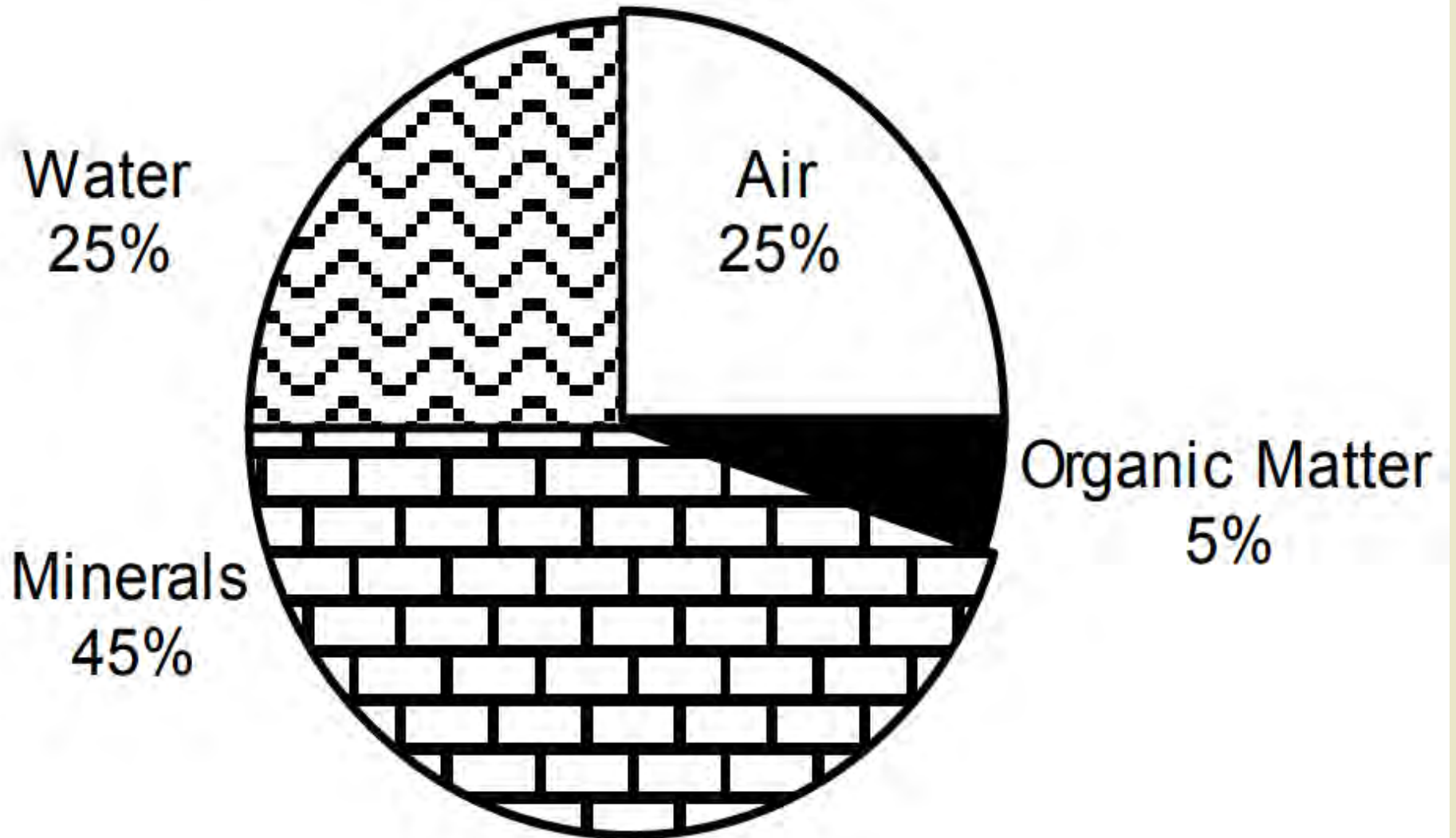




# Soils & BioChar

# Major Soil Components






# Soil Descriptors



- ▶ Texture: Relative proportion of sand, silt, and clay in the soil
- ▶ Structure: Forms the soil takes as particles clump together
- ▶ Peds: Structural units of soil (aggregates)
- ▶ **Bulk Density: A soil's weight per volume**
- ▶ Horizon: Layer of soil with somewhat uniform color, texture, and structure
- ▶ Profile: Vertical soil section showing layers of development



# Three Categories of Soil Properties

- ▶ Physical: texture (proportions of sand, silt and clay), structure, bulk density, moisture, infiltration, porosity
  - ▶ Chemical: nutrient content, salinity, pH, organic matter, mineral content (parent material)
  - ▶ Biological: activity of microbes (bacteria, fungi), biomass, biodiversity, biological activity
- 

# Soil Texture

- ▶ Relative proportions of sand, silt, and clay in the soil
- ▶ These proportions affect how soil feels to the touch, thus the term “texture”
  - ▶ Sand are the largest particles feel “gritty”
  - ▶ Silt are medium sized feel soft, silky or “floury”
  - ▶ Clay are the smallest sized particles feel “sticky”



# Sand

- ▶ Gritty feel
- ▶ Particles can be seen with the naked eye
- ▶ Hand sampling: No residue left on hand



# Silt

- ▶ Dry: Powdery smooth feel, flour-like
- ▶ Wet: Creamy slick, slippery feel
- ▶ No sticky or plastic feel
- ▶ Particles can be seen with a hand lens or microscope
- ▶ Hand sampling: Coats hand, able to brush off



# Clay

- ▶ Wet: Sticky, plastic feel
- ▶ Dry: Hard feel
- ▶ Particles can be seen with an electron microscope
- ▶ Hand Sampling: – Sticks to fingers

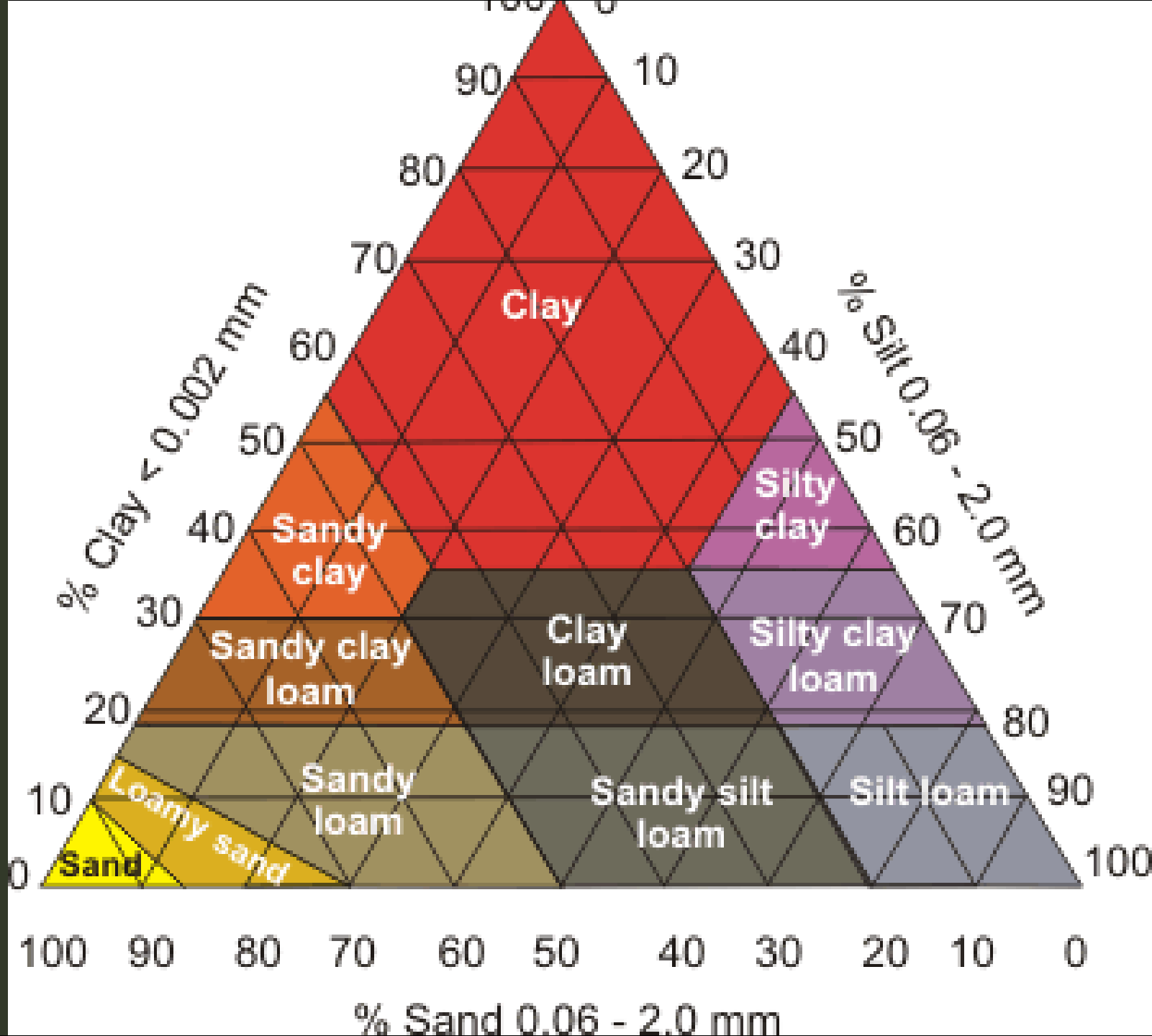


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# Soil Texture Classification

- ▶ The proportions of different sized mineral particles in the soil or the relative amount of sand, silt, and clay present in the soil expressed as percentages
- ▶ There are 12 textural class categories



# Soil Texture and Surface Area



As particle size decreases,  
surface area increases

For the same volume, clay has about  
10,000 times as much surface area as  
sand



Surface area has a big effect  
on:

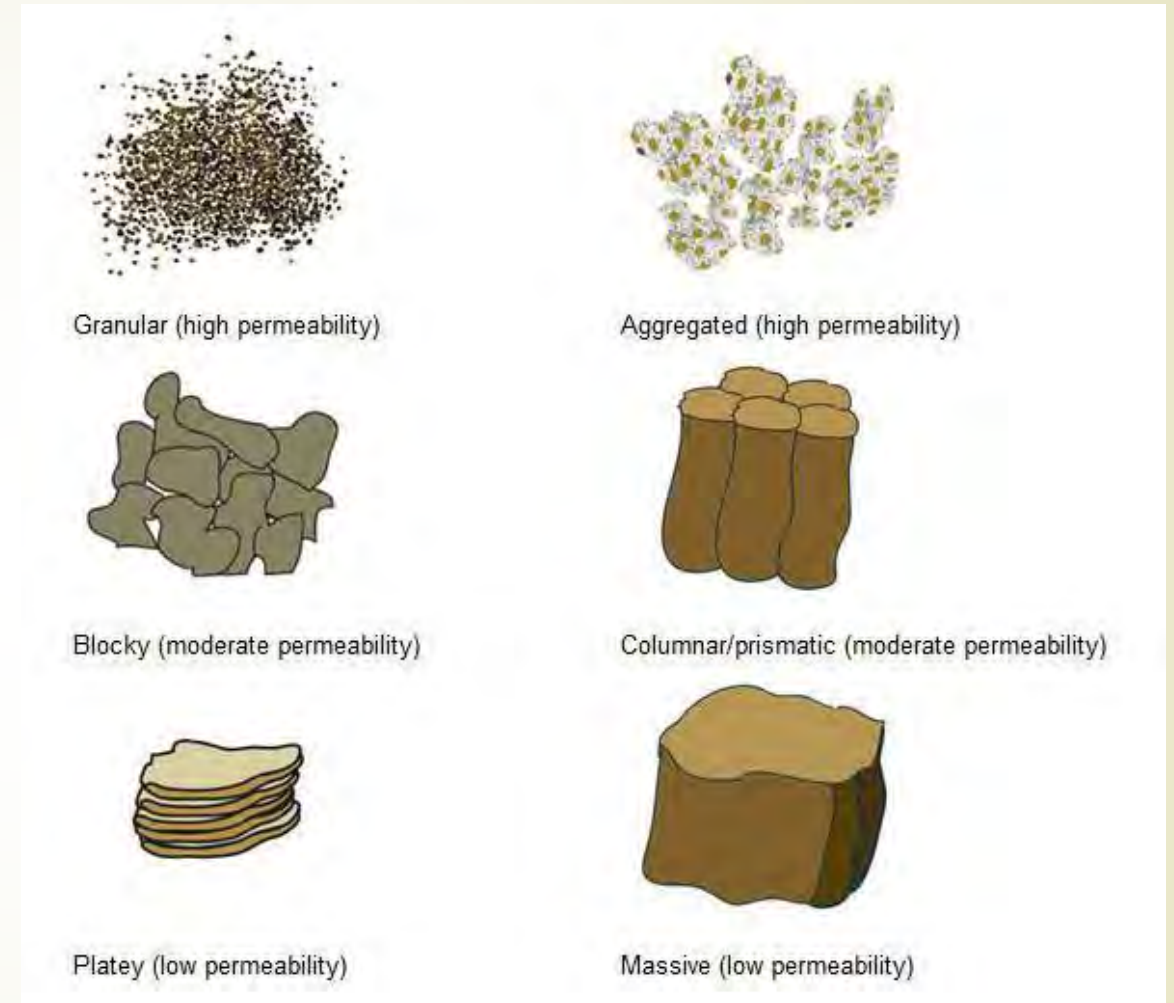
- Water holding capacity
- Chemical reactions
- Soil cohesion
- Ability to support microorganisms



A loam is a mixture of sand, silt  
and clay

# Soil Structure

- ▶ Secondary units or granules held together by organic substances, iron oxides, clays, carbonates, etc.
- ▶ Aggregate Stability - Ability of soil aggregates to resist disintegration when forces associated with tillage and water or wind erosion are applied. (NRCS, 2008)
  - ▶ Wet – resistance to raindrop impact and water erosion.
  - ▶ Dry – uses size distribution of dry aggregates as an indicator of resistance to abrasion and wind.



# Soil Aggregates



Aggregate Stability is an indicator of:

OM content  
Biological activity  
Nutrient cycling  
"soil quality"

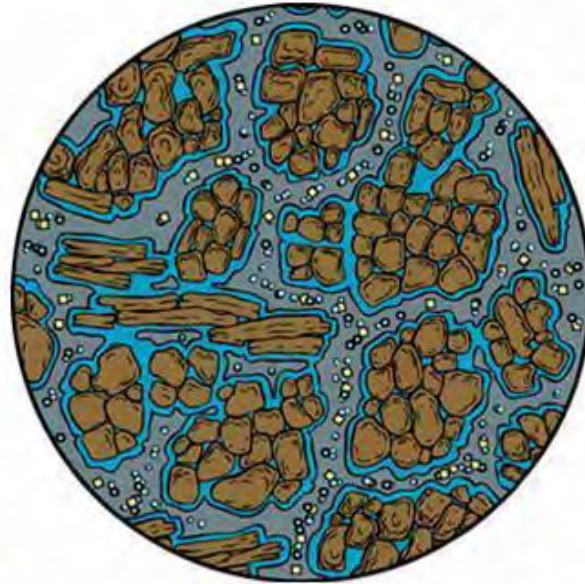


Important for many physical properties:

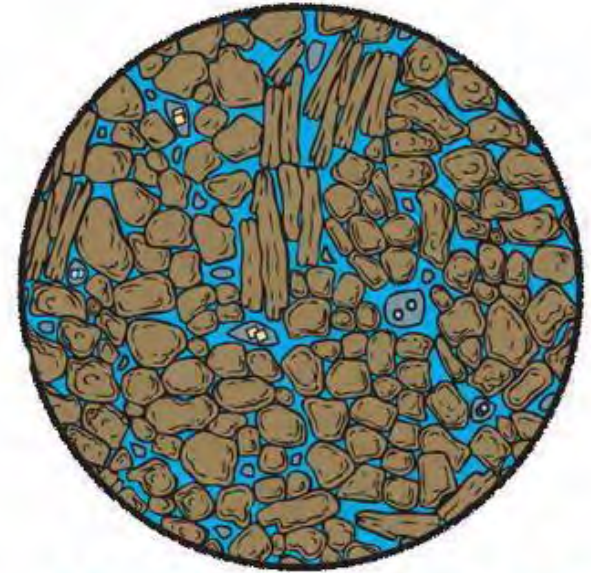
Infiltration and water movement  
Root penetration and growth  
Resistance to erosive forces of wind and water

# Bulk Density

- ▶ A measure of the amount of pore space in a soil.
  - ▶ Pore space is available to be filled with water (field capacity) or air
  - ▶ The lower the bulk density the more “light and airy” the soil
  - ▶ Lower bulk density is better for root penetration



**Lower bulk density**  
**Lower weight**  
**More pore space**



**Higher bulk density**  
**Higher weight**  
**Less pore space**

# Soil Additives

- ▶ Biochar
- ▶ Compost
- ▶ Mulch
- ▶ Fertilizers



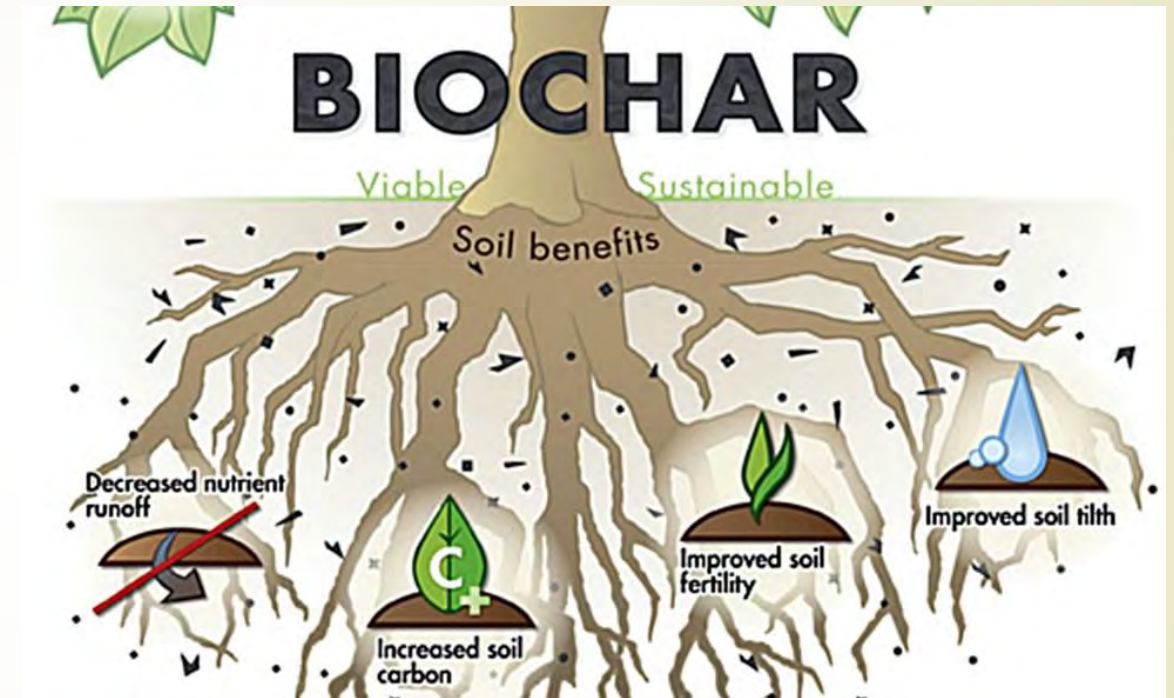
# Biochar and Soils

- ▶ Bio char is pyrolyzed organic mater – wood chips, leaf litter etc. made into a very stable form of carbon. Kind of like charcoal, but cleaner
  - ▶ Highly porous
  - ▶ Extremely long lasting (think thousands of years)



# Benefits of Biochar

- ▶ Organic
- ▶ Helps with
  - ▶ Physical limitations of soil – compaction
  - ▶ Biological limitations – space for rooting, habitat for microbes and surface area for nutrient exchange
- ▶ Permanent
- ▶ Helps other soil amendments work better
- ▶ Increases water storage of soils





# Impact on 3 Properties of Soil

- ▶ Physical
  - ▶ Creates pore space
  - ▶ Doesn't break down – compaction resistant
- ▶ Chemical
  - ▶ Nutrient exchange
  - ▶ Water holding capacity
- ▶ Biological
  - ▶ Low income housing for microbes



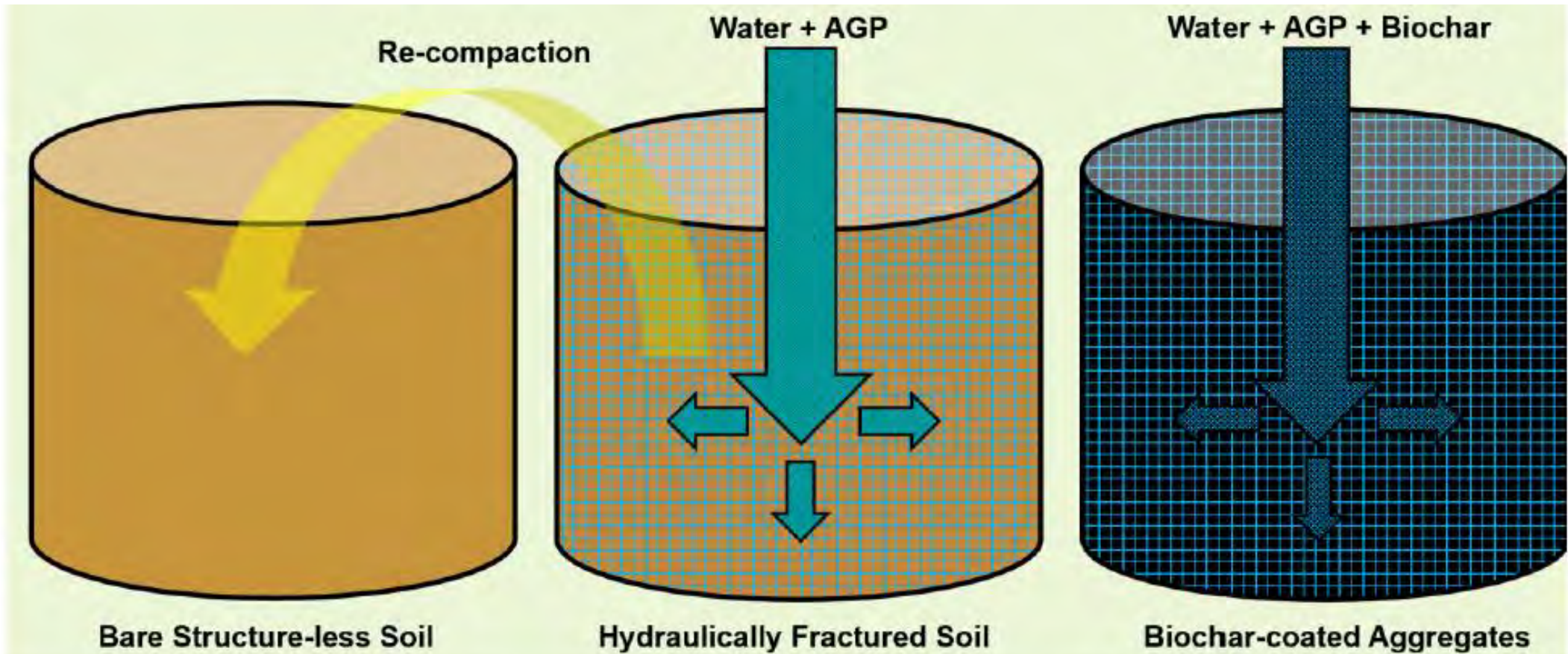


Figure 12. Injected biochar incrementally coats soil aggregates to alleviate compaction and provide nutrient and water exchange.



# Compost

- ▶ Decayed plant material has been dried
- ▶ Best used when soil is low in organic matter
- ▶ Typical C:N Ratio is 22:1
  - ▶ Higher carbon – decompose slowly and reduce available N (More mulchy)
  - ▶ Lower carbon – decompose quickly and release N too fast (Manure)
- ▶ Can be used as a liquid (compost tea)
- ▶ Or as a solid (soil amendment)
- ▶ Can have a large impact on all 3 soil characteristics (physical, chemical, biological)

# Compost Tea

## ► Pros

- Inexpensive
- Minimal site disturbance
- Potential soil microbes
- Can use existing application equipment
- Organic

## ► Cons

- Labor intensive to make – and must be made onsite
- Takes up space in shops
- Limited research – is it even effective?

# Compost Soil Amendment

## ▶ Pros

- ▶ Can help with pH issues
- ▶ Can be paired with decompaction
- ▶ Microbes stay in tact
- ▶ Organic
- ▶ Creates a premium product

## ▶ Cons

- ▶ Labor intensive
- ▶ Maximize site disturbance
- ▶ Equipment is large and expensive
- ▶ Material storage



# Mulch

## ▶ Pros

- ▶ Excellent water holding capacity
- ▶ Mitigate soil temp fluctuations
- ▶ Reduction of compaction
- ▶ Can break down to create "compost"

## ▶ Cons

- ▶ Max site disturbance
- ▶ Can run off/blow away
- ▶ Needs to be replenished
- ▶ Limited impact on biological



# Fertilizers

- Pros
  - No site disturbance
  - Inexpensive
  - Quick and profitable
  - Consistent product
- Cons
  - Limited impact to soil characteristic
  - One size fits all
  - Can push too much growth
  - “Pesticide perception”



# Gestalt Arboriculture?

- ▶ “The whole is greater than the sum of its parts.”
- ▶ True in arboriculture
  - ▶ Multiple services provides more than one service does





# Biochar Applications

- ▶ Add to fertilizer
  - ▶ Powder
  - ▶ Mix in with AGP and inject with fert
- ▶ Add to air tool work
  - ▶ Medium
  - ▶ Treat like compost
  - ▶ Can be used with other additives
    - ▶ C20?





# Air Tool Work

# Air Tool Work

- ▶ 1. Reasons we provide the service
- ▶ 2. How and why it works
- ▶ 3. Treatment Options
- ▶ 4. What's the Process?





# Why Provide Air Tool Services



Stem Girdling Roots



Planting Depth



Poor Soils



Compaction/construction Damage



Chlorosis



Legacy Trees

# Stem Girdling Roots

## ► Symptoms

- Visible roots circling the base
- Die back in the top/center of the crown
- Early fall color
- Flat sides on the trunk

## ► Why does this happen?

- Nursery stock
- Planting depth
- Species propensity



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# Soil Issues

- Physical

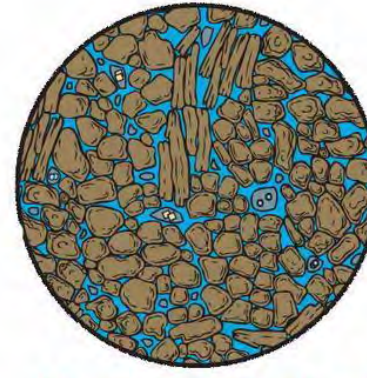
- Compaction or construction

- Chemical

- Biological



**Lower bulk density**  
**Lower weight**  
**More pore space**

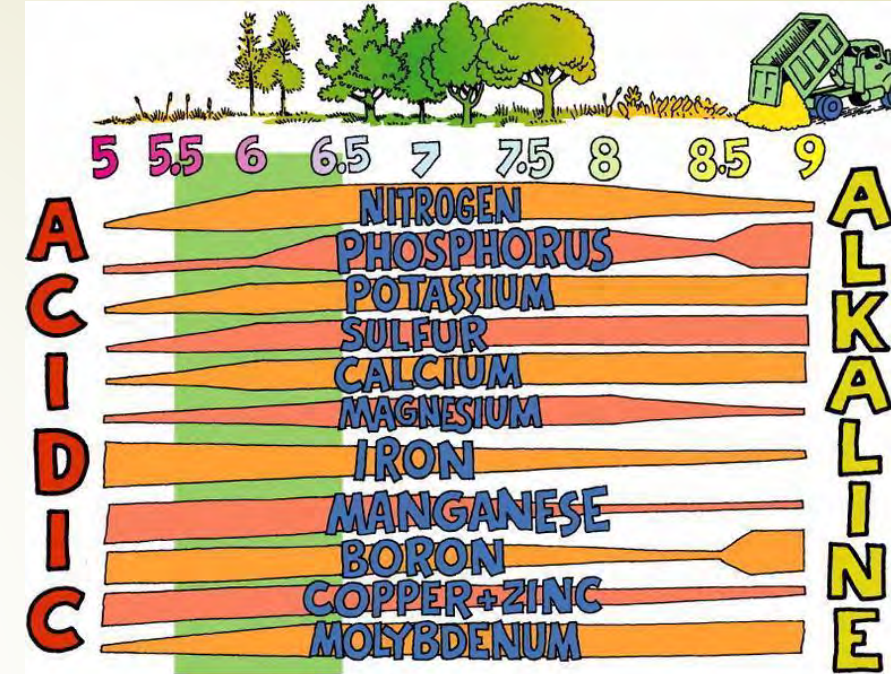


**Higher bulk density**  
**Higher weight**  
**Less pore space**



# Soil Issues

- Physical
  - Compaction or construction
- Chemical
  - Nutrient deficiencies
  - pH
- Biological



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# Soil Issues

- ▶ Physical
  - ▶ Compaction or construction
- ▶ Chemical
  - ▶ Nutrient deficiencies
  - ▶ pH
- ▶ Biological
  - ▶ Lack of organic matter





# Nutrient Deficiencies

# Soil Services

PHC Advanced Skills

Author: Chris Fields-Johnson, PhD



Photo: Chris Fields-Johnson



# Tree Care Truths

- Lack of mineral recycling
- Competition with turf
- Compacted soils
- Restricted root volume
- Warmer, drier soils
- Mechanical damage
- Lack of diversity
- Opportunistic pests/problems/stress



# TREE CARE TRUTHS

We often marvel at the differences in trees, but did you know most species struggle with the same challenges? This is true whether they are in Boston, Chicago, Orlando, Dallas or Seattle. Since 1880, we've focused on helping clients understand and act on these truths.

## LACK OF MINERAL RECYCLING & NUTRIENTS

Many homeowners clean up and dispose of leaves, twigs and bark, which does not allow those beneficial nutrients to be recycled in the soil. Additionally, turf grass is a strong and unnatural competitor with trees for water and minerals.



## SOLUTION

Adding nutrition with fertilization and proper mulching.

## COMPACTED SOILS

Foot traffic, lawnmowers, construction projects, etc. causes soil compaction, leading to stressed soil, crushed roots and restricted root growth and function.



## SOLUTION

## OPPORTUNISTIC PESTS

Combining competition from lawns and other plants, less-than-ideal growing sites and limited resources can create high levels of stress on trees. Some pests prefer to attack trees that are under stress.



# Comprehensive Soil Services

- Trees and Soils are Ecologically Interdependent
- Urban Development Disrupts Ecological Balance
- Soil Problems are the Most Frequent Causes of Decline
- Soil Formation and Ecology Depend on:
  - Geology
  - Climate
  - Vegetation
  - Time
  - Disturbance

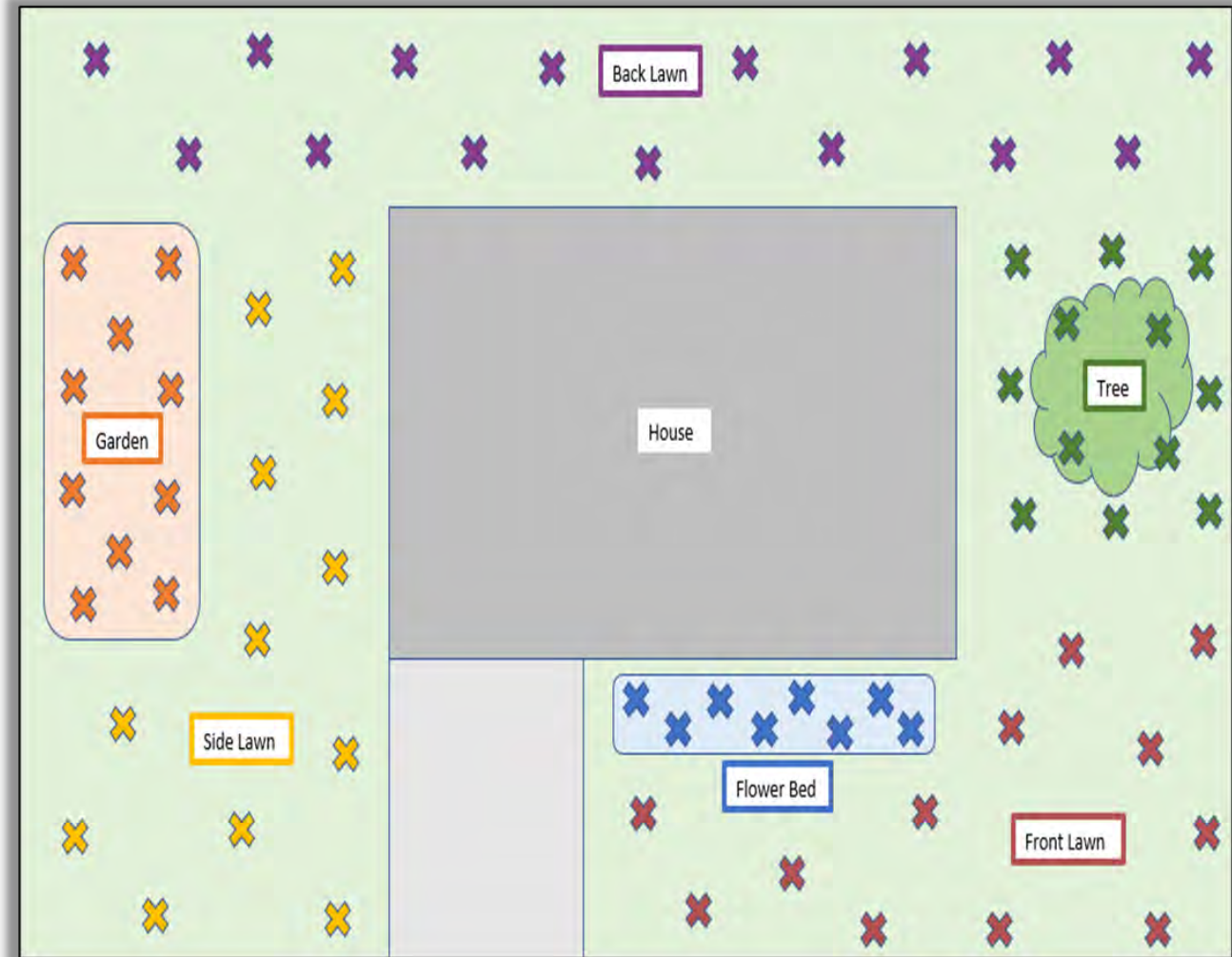


*This educational graphic was commissioned by the Morton Arboretum to depict mature mid-west root system based upon their research.*



- Collect with probe or spade.
- Turf: 3” deep, ornamentals 6”
- Remove turf, mulch, stones etc.
- Collect samples from distinct areas
- Take >10 cores randomly in each area
- Mix cores for each sample in a clean container and put in an approved soil bag

# Soil Subsampling



# Comprehensive Soil Services



Photo: Chris Fields-Johnson

## Subsample



Photo: Chris Fields-Johnson

## Aggregate Sample

## How to Submit a Soil Sample:

You will need the following items:

- Two ziplock bags
- USDA soil bag with filled out label
- Package to ship the sample

**Step 1:**  
Gather a quality soil sample (2 cups) and place in an approved soil sample bag and fold the top over several times.

**Step 2:**  
Place approved soil sample bag into a ziplock bag and seal it.

**Step 3:**  
Place the first ziplock bag into a second ziplock bag and seal.

**Step 4:**  
Place the double bagged sample inside the shipping package.

**Step 5:**  
Address to:  
Davey Plant and Soil Laboratory  
1500 N Mantua St  
Kent, OH 44240



*Spectrum Analytic*

1087 Jamison Road NW  
Washington Court House, OH 43160-8748

www.spectrumanalytic.com

**THE DAVEY TREE EXPERT CO-SOIL LAB**  
**PO BOX 5193**  
**KENT, OH 44240**

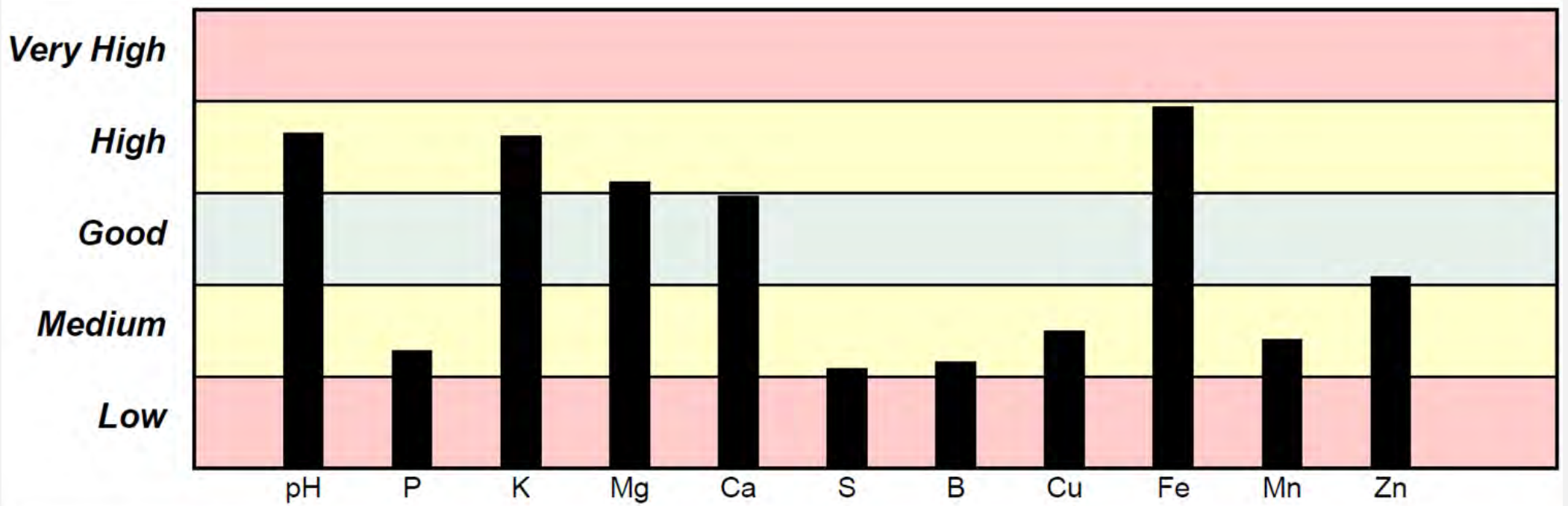
# Lab Results

Prepared For

Sample Information	
Sample Lab Number	Sampled Tested

Bed Soil for Trees

Analysis	Result	Optimal	Analysis	Result	Optimal
Soil pH	7.4	6.5-7.0	Sulfur	m3-ppm 11	20-40
Buffer pH			Boron	m3-ppm 0.9	1.7-2.6
Organic Matter	% 8.3		Copper	m3-ppm 1.3	Varies
CEC	10.1		Iron	m3-ppm 320	65-185
K Saturation	% 6.2	2.0-4.0	Manganese	m3-ppm 56	Varies
Mg Saturation	% 23.2	10-20	Zinc	m3-ppm 4.6	3.9-10.9
Ca Saturation	% 69.1	50-70	Sodium	m3-ppm 34	
Na Saturation	% 1.5	0-10	Soluble Salts	mmhos/cm 0.20	0.00-0.50
K/Mg Ratio	0.9		Nitrate-N	ppm 8	
Ca/Mg Ratio	5.8		Solvita CO2	index 4.58	
Phosphorus	m3-ppm 31	50-80	Solvita CO2, ppm	ppm 113.24	
Potassium	m3-ppm 294	140-240	Clay	% 21	
Magnesium	m3-ppm 321	160-300	Sand	% 62	
Calcium	m3-ppm 1867	1400-1900	Silt	% 16	
			Texture	Sandy Clay Loam	



Recommendations		Nutrients expressed in broadcast lbs/1000 sqft, except Fe (foliar) and Mn (row)										
Yr	Crop	CaCO3	N	P2O5	K2O	Mg	S	B	Cu	Fe	Mn	Zn
21	Linden/Basswood	0	3.4	1.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

Lime expressed in 100% pure CaCO3. Adjust accordingly. D=Dolomitic. C=Calcitic.

**Linden/Basswood:** Monitor and adjust nutrient program based on annual tissue analysis



Sub-angular Blocky

- Common Natural Sub-Soil Structure



Platy Compacted

- Common Urban Soil Structure with Low Organic Matter



Spongy

- Tillage with High Organic Matter



Penetrometer:

Relative resistance of soil to penetration

- Need moderate soil moisture
- < 100 PSI Optimal
- > 200 PSI Action Threshold
- > 300 PSI Severe Root Limitations



# Comprehensive Soil Services

## Topdressing

- Low Disturbance
- Common on Turf
- Fertilizer, Lime, Organics



## Vertical Mulching

- Med Disturbance
- Improve Deep Drainage
- Organics



# Soil Improvement

## Hydraulic Fracturing

- Low Disturbance
- Decompaction
- Deep Liquid Fertilizer, Organic Suspensions

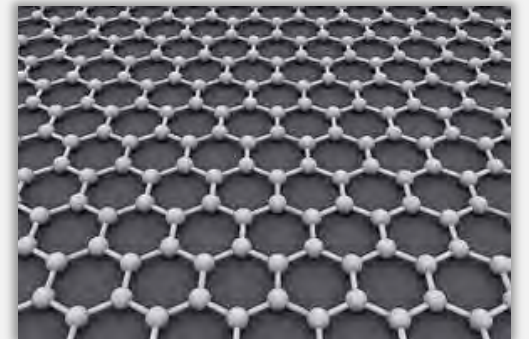
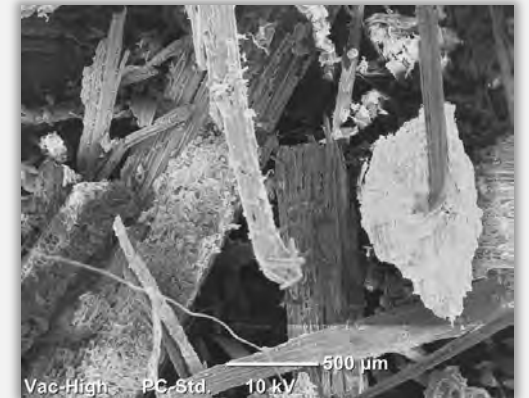


## Air Tillage

- High Disturbance
- Decompaction
- High Input of Organics



- **Good charcoal is resonant, refractory and burns without flame**
- **sp<sup>2</sup> C-C bonding: delocalized electrons**
  - **conduct electricity,**
  - **strongly resist compaction**
  - **facilitate electron transfer (catalytic)**
  - **resist decomposition**
- **Functional groups provide ion exchange:**
  - **100 cmolc<sup>+</sup> kg<sup>-1</sup> CEC**
  - **30 cmolc<sup>-</sup> kg<sup>-1</sup> AEC**
- **High Surface Area: 400 m<sup>2</sup> g<sup>-1</sup>**



Chip



Dust

Rice

Sand

- Wet Biochar to Eliminate Dust
- Wear a Dust Mask or Respirator



- Partially Decomposed Organic Material
  - Heated with biological activity
  - Ideally from tree leaf litter and manure
  - Class A Biosolids products are acceptable
  - Many different products on the market
  - Fully decomposes within about a year
- Not to be Used as Compost:
  - Peat moss and potting soil products
  - Topsoil
  - Wood or bark mulch

# Comprehensive Soil Services

## Topdressing Compost and Biochar

- Annual 1/4" compost applications
- Combined applications: blend biochar in with compost at 5% by volume
- Pellets with 10% biochar through lawn spreaders, 50lbs / 1,000 sqft
- Fresh compost through specialized spreaders
- Mulch blowers for large areas



# Comprehensive Soil Services

# Turf Renovation with Compost



Photo: Mike Holleran

Aug 16<sup>th</sup>, 2021



Photo: Mike Holleran

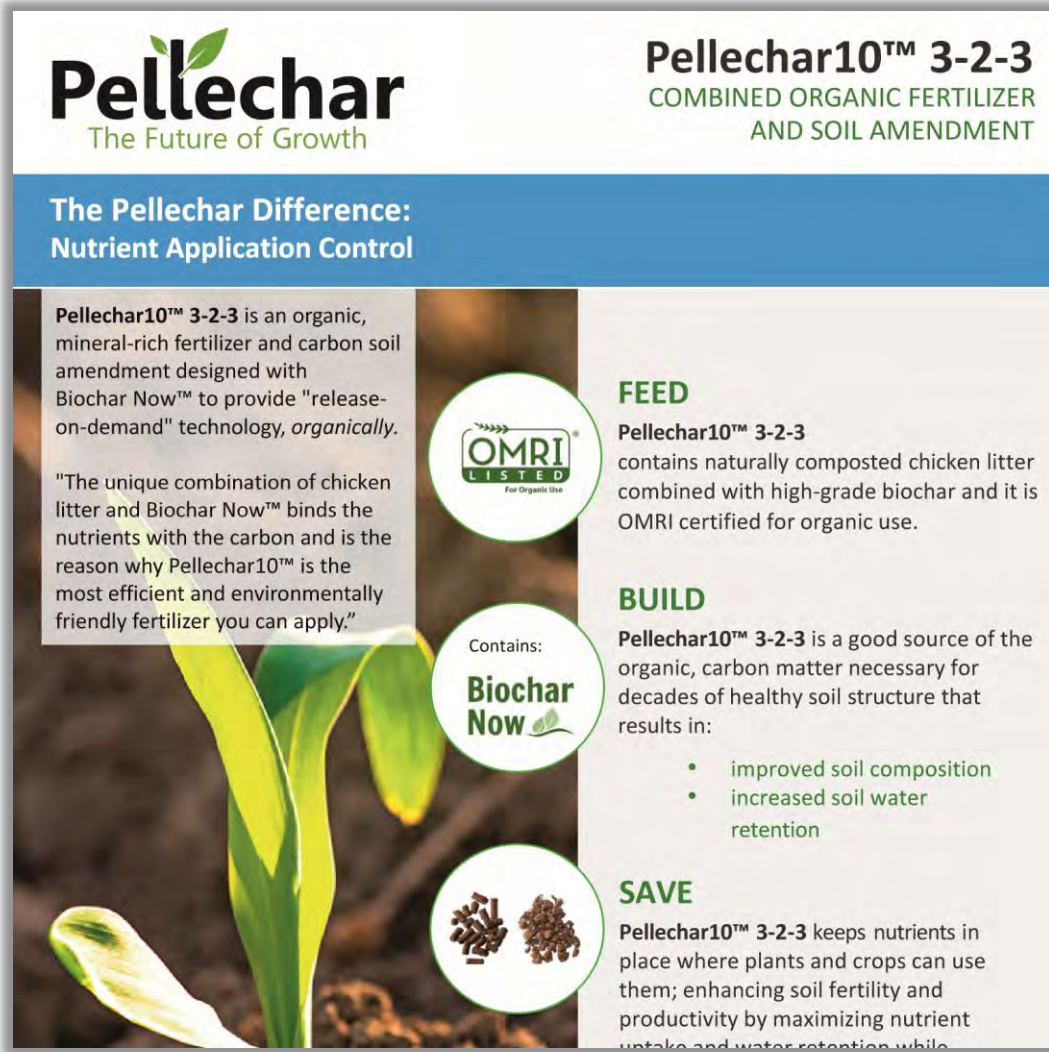
Aug 18<sup>th</sup>, 2021



Photo: Mike Holleran

Sept 20<sup>th</sup>, 2021





**Pellechar**  
The Future of Growth

**Pellechar10™ 3-2-3**  
COMBINED ORGANIC FERTILIZER  
AND SOIL AMENDMENT

**The Pellechar Difference:**  
Nutrient Application Control

Pellechar10™ 3-2-3 is an organic, mineral-rich fertilizer and carbon soil amendment designed with Biochar Now™ to provide "release-on-demand" technology, *organically*.

"The unique combination of chicken litter and Biochar Now™ binds the nutrients with the carbon and is the reason why Pellechar10™ is the most efficient and environmentally friendly fertilizer you can apply."

Contains:  
**Biochar Now**

**OMRI LISTED**  
For Organic Use

**FEED**  
Pellechar10™ 3-2-3 contains naturally composted chicken litter combined with high-grade biochar and it is OMRI certified for organic use.

**BUILD**  
Pellechar10™ 3-2-3 is a good source of the organic, carbon matter necessary for decades of healthy soil structure that results in:

- improved soil composition
- increased soil water retention

**SAVE**  
Pellechar10™ 3-2-3 keeps nutrients in place where plants and crops can use them; enhancing soil fertility and productivity by maximizing nutrient uptake and water retention while

- Provides organic matter
- Feeds soil microbes
- Biochar retains nutrients and stabilizes soil structure / decompaction
- Up to 5% by volume for site prep and planting
- 50lbs / 1,000 sqft topdressing
- Provides 1.5 lbs N / 1,000 sqft
- Provides other nutrients
- Lesco CarbonProG Comparable

## Soil Compacted from Mowing



1" Penetration with Survey Pin

# Comprehensive Soil Services

Same Soil after being  
Mulched for 7 Years



12"+ Penetration with Survey Pin

# Comprehensive Soil Services

Same Soil after being  
Mulched for 7 Years



12"+ Penetration with Survey Pin







# Comprehensive Soil Services

- Turf Care Annual Cultural Practice
- Reduce Compaction and Grow Roots
- **Begin with 3"+ Depth Core Aerification**
- Overseed with Desirable Turf Varieties
- Topdress with Compost + Biochar, Rake
  - 5-10% Biochar in Blend
  - Fresh and Pelletized Options
  - **1/4" Fresh, or 50lb / 1,000 sqft Pellets**

# Turf Renovation



Exposed surface area increases along with the flow of nutrients, water and air to the plant's roots.



This area soon becomes an area of advanced root growth.







# Comprehensive Soil Services

# Air Tools for Soil Renovation



**Running conduit and irrigation lines under existing roots.**

Images from Cary Hulse and Chris Cowles, Wetland Studies and Solutions, Washington, DC

## Procedure

- Pre-kill sod (sodcutter or proper herbicide)
- Loosen soil with air tools: 12+ inches deep
- Apply 1 ft<sup>3</sup> Biochar / 24 ft<sup>2</sup> (1/2" layer)
- Apply 1 ft<sup>3</sup> Compost / 12 ft<sup>2</sup> (1" layer)
- Mix amendments into soil with air tools
- Apply 1 ft<sup>3</sup> Wood Mulch / 6 ft<sup>2</sup> (2" layer)
- Water or Liquid Fert 1 qt / yd<sup>2</sup>
- Keep soil moist to encourage new fine root growth for the next growing season









## Air Compressor Selection



High Production:

- 375 CFM Compressor
- **1.5" air hose**
- High-capacity Airspade or Airknife



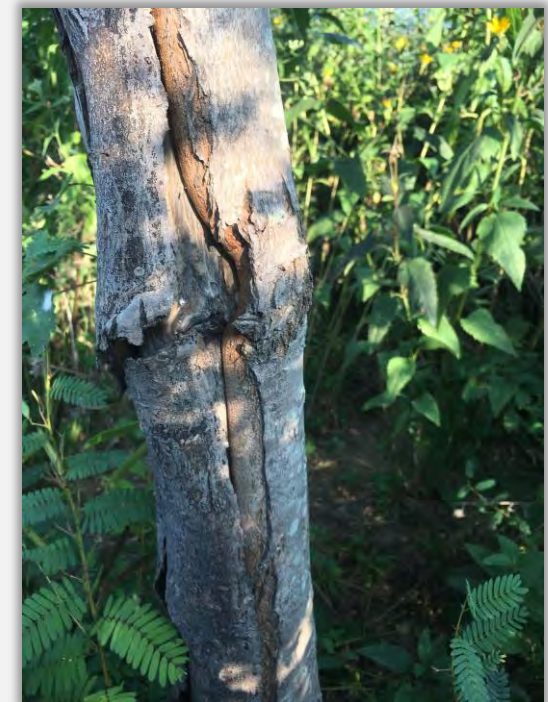




PPE for Air Tool Use: Long Sleeves, Ear Plugs and Muffs, Safety Glasses and Polycarbonate Face Shield, N95 Dust Mask or Respirator, Hardhat, Gloves, Boots

# Soil Renovation Results

Struggling red maple planting reinvigorated two growing seasons after treatment.



# Comprehensive Soil Services

# Soil Renovation Results

Specimen dogwoods with greatly improved canopy vigor and flowering after one growing season.



### RCX Objectives:

- Remove excess mulch and soil
- Expose root collar, buttress roots
- Remove stray materials from planting: straps, wire, etc.
- Remove girdling roots
- Remove adventitious roots
- Assess root decay
- Establish proper grade with drainage away from tree
- Leave the tree properly mulched out to an agreed-upon radius





Stem Girdling Root Damage

### RCX Tools:

- PPE for Air tool work + knee pads
- Air tool and compressor
- Reciprocating saw, battery operated
- Chisels and mallet
- Pruning saw, loppers, hand pruners
- Brushes
- Soil knife
- Masonry hammer
- Surveying pin



### RCX Process Tips:

- 185 CFM air compressor is usually sufficient, 375 CFM is faster
- Use air tool to contour the surrounding soil to **a suitable grade, don't leave a steep pit**
- Reciprocating saws are the best tools
- Girdling roots with more than  $\frac{1}{2}$  of their diameters imbedded in the base are inoperable: leave them alone
- Use survey pin and mallet to probe and sound for root decay, check undersides
- **Don't remove more than  $\frac{1}{6}$ <sup>th</sup> of roots at once**







# Comprehensive Soil Services

## Vertical Mulching

Use to get deep soil drainage and aeration

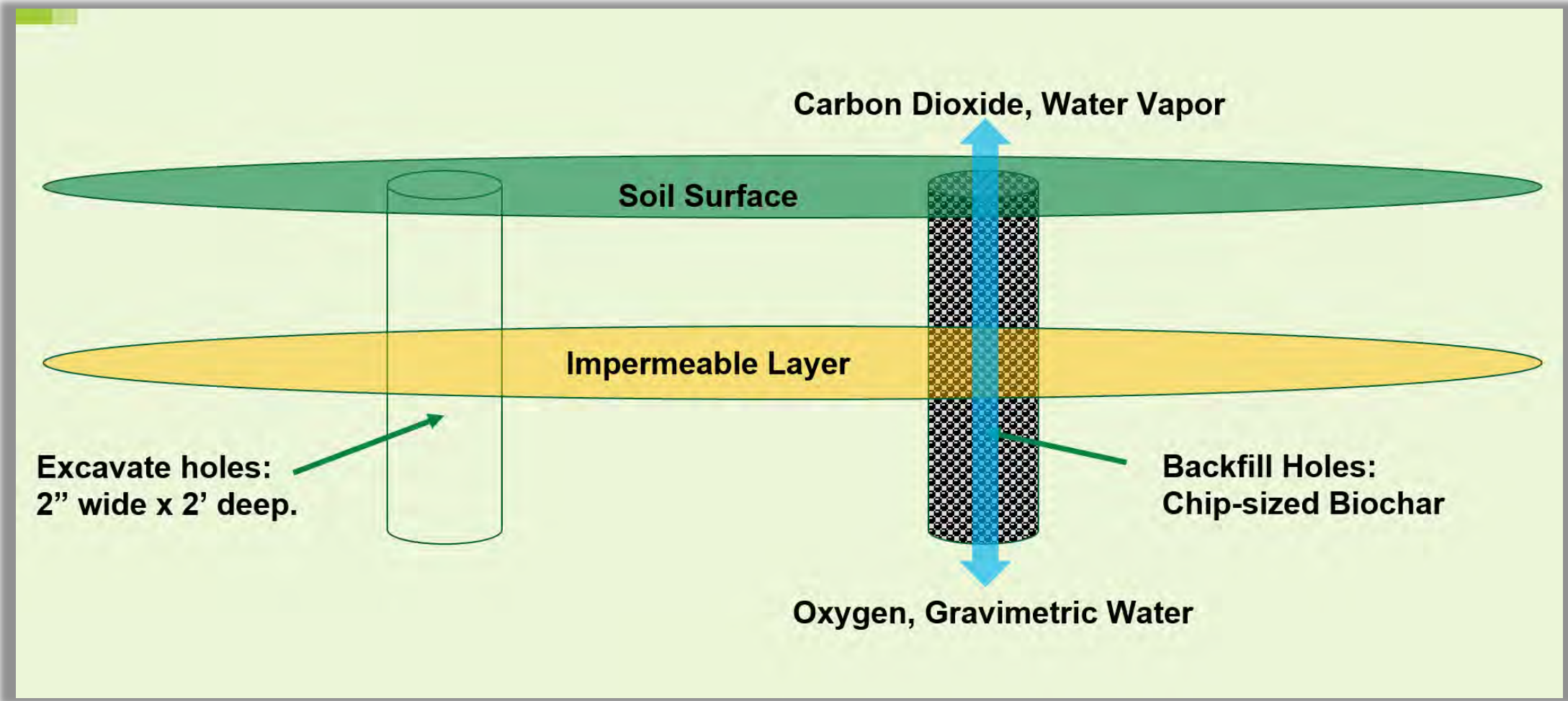
Procedure:

- **Dig 2” wide, 2’ - 3’ deep holes**
  - At least one hole per square yard
  - Deeper if needed to get positive drainage
  - **Use an 18” traffic cone to direct the blast**
- Air tool easier and safer than auger, 375 CFM Compressor
  - Air tool fractures soil, auger glazes soil
  - Less damage to roots & utilities with air tool
  - Can **use a 2” auger first, then blast hole with air tool**
- Fill holes with chip to rice-sized biochar
  - Use traffic cone as a funnel and use a stick to help settle the fill,
  - Do not plug the top of the fill with soil



Top Image from Gil Mitchell, Davey Institute  
Bottom Image from Davey Institute

# Vertical Mulching



Backfill to the surface. Dig past compacted layers.



Photo from Gil Mitchell, Davey Institute



# Scoop & Dump

- Spread 4" Compost
- Scoop-and-Dump 2'+ Depth
- Spread 1" Compost and 1/2" Biochar
- Till 6"+ Depth
- Plant Trees

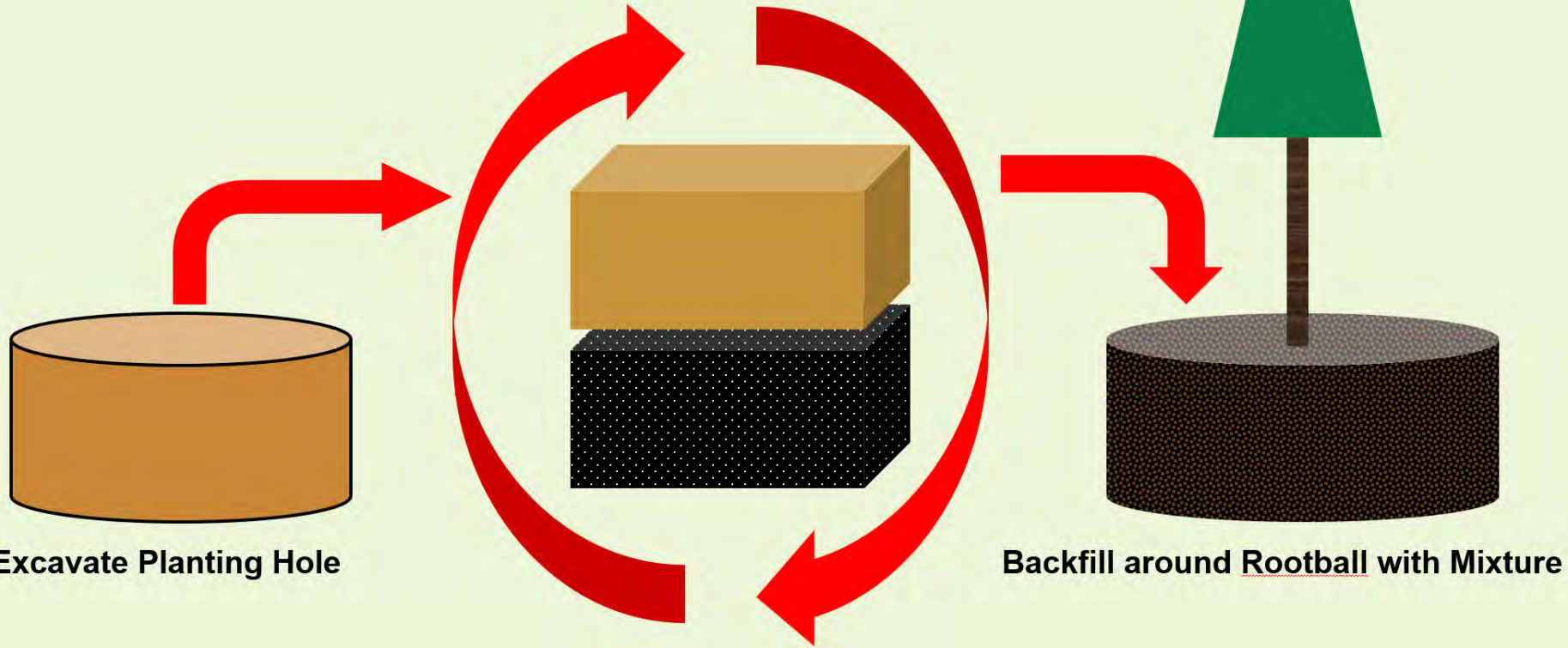


# Backfilling New Plantings

Adjust the amounts of compost and biochar added to the backfill according to the initial soil organic matter content test results.

Initial Soil Organic Matter	Compost to Add (by volume)	Biochar to Add (by volume)
4.1 - 5%+	5%	5%
3.1 - 4%	10%	10%
2.1 - 3%	15%	15%
1.1 - 2%	20%	20%
0 - 1%	25%	25%


## Backfilling Planted Trees



## Adams Earth

- Stable Organic Matter derived from Coal-like Minerals
- Feeds soil microbes
- Stabilizes soil structure / decompaction
- Provides micronutrients
- Improves nutrient use efficiency

**Biostimulants**



**Guaranteed Analysis**

Boron (B).....	.020%
Copper (Cu).....	.050%
.050% Chelated Copper (Cu)	
Iron (Fe).....	.100%
.100% Chelated Iron (Fe)	
Manganese (Mn).....	.050%
.050% Chelated Manganese (Mn)	
Zinc (Zn).....	.050%
.050% Chelated Zinc (Zn)	


Derived from  
EDTA Chelated Micronutrients of Copper, Iron,  
Manganese, Zinc, and complexed sugars of  
Boron

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**Non-Plant Food Ingredients**

Total Humic and Fulvic Acids.....	14.0%
4.1% Fulvic Acid	
8.2% Humic Acid	
1.2% Humic	
.5% Ulmic Acid	
L-Amino Acid Substrates*.....	44.5%
Soluble Kelp Extract.....	2.5%
Contains Auxin, Cytokinin and Gibberellin Hormones	
Plant Metabolites (Intermediate)**.....	16.5%
Carbohydrates.....	3.0%
Sarsaponins (Natural Wetting Agent).....	1.0%

Derived from Leonardite, Humic Acid, North  
Atlantic Ascophyllum Nodosum SeaWeed  
Extract (SWE), Simple and Complex



**AdamsEarth®** is an organic blend of humic and amino acids, North Atlantic Ascophyllum Nodosum SeaWeed Extract (SWE), natural sugars, vitamins and other organic compounds. The organic nutrients in **AdamsEarth®** will aid in the improvement of soil structure, rooting, and the uptake of N-P-K and minor elements.

**AdamsEarth®** contains several different sources of organic matter which will break down at varying times during the growing cycle, providing a longer period to aid in microbial feeding.

**AdamsEarth®** is a unique combination of humic acid, biostimulants, and micronutrients. The humic acid will assist in chelating nutrients tied up in the soil. North Atlantic Ascophyllum Nodosum SeaWeed Extract (SWE) improves rooting caused by auxin, cytokinin, and gibberellin hormones. The micronutrients will aid in the correction of soil deficiencies that may be caused by imbalances due to low or high pH.

Benefits of **AdamsEarth®**:

- Improves rooting mass with top growth.
- Chelates nutrients tied up in soils, such as phosphates and iron.
- Increases microbial activity.
- Increases plant vigor and chlorophyll production.
- Improves heat and cold tolerance.
- Releases tied-up soil nutrients, allowing them to be plant available.

Use **AdamsEarth®** when one or more of the following occurs:

■ Pre Stress Conditions	■ Poor Rooting
■ High Stress	■ Insect Damage
■ High Salts	■ Drought Conditions
■ Traffic and Wear	■ Compaction and Poor Drainage
■ High Disease Pressure	■ Poor Soil Structure

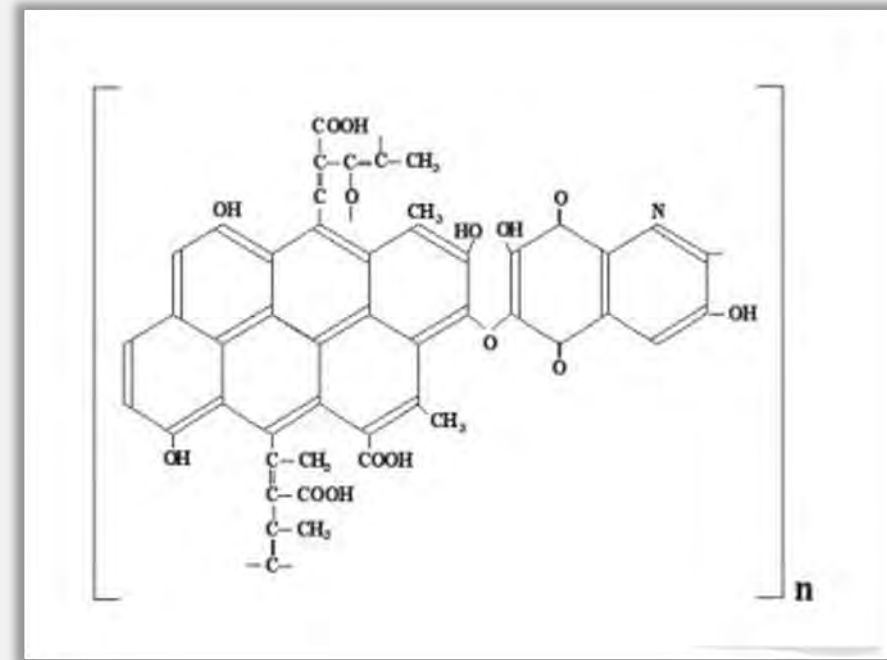
**\*L-Amino Acid Substrates**

**\*\*Plant Metabolites (Intermediate)**

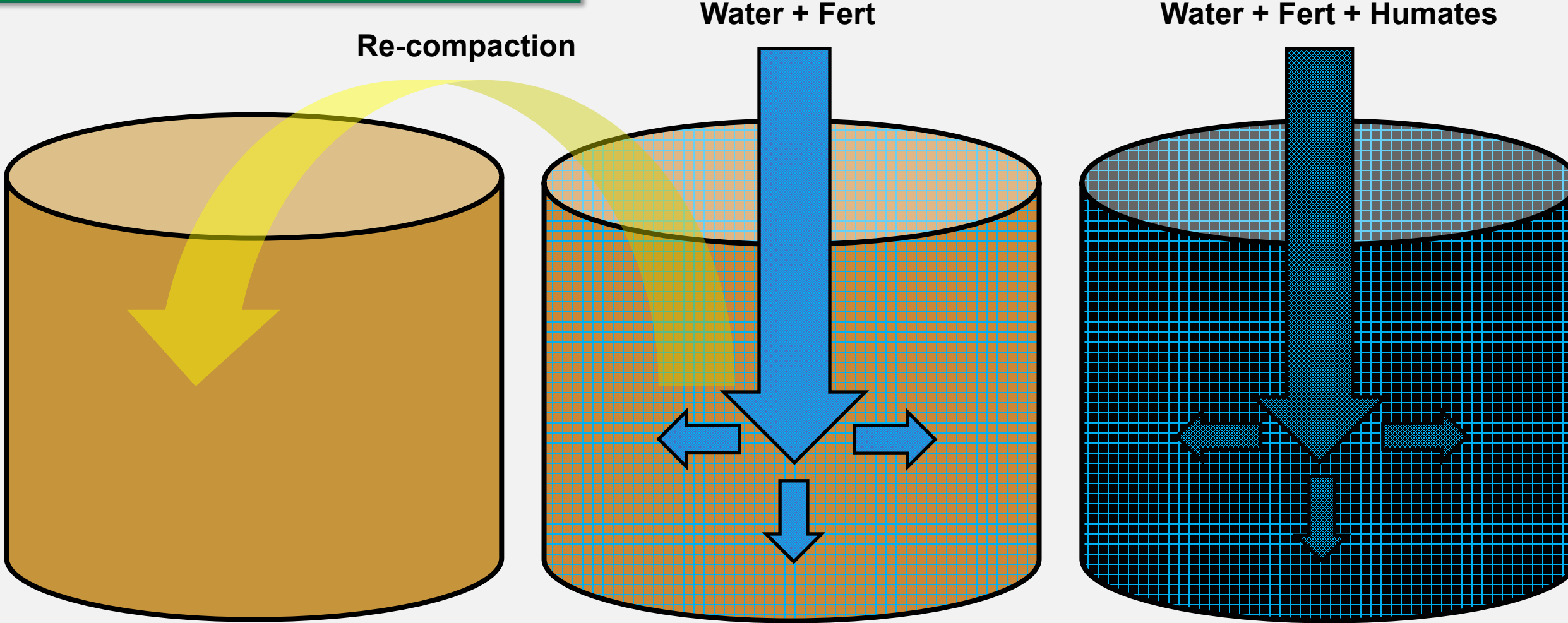


## Humates

- **Huge, stabilized carbon compounds**
  - Remnants of organic matter decomposition
  - Mostly carbon, hydrogen and oxygen, with little nutrition
  - **Benefits:**
    - Improved nutrient uptake
    - Stabilization/chelation of micronutrients
    - Improved microbial populations, especially fungi
  - They are **NOT** a fertilizer
  - Soluble and granular forms



# Soil Injection with Humates



Bare Structureless Soil


Hydraulically Fractured Soil

Humate-coated Aggregates

## Polyphosphite30

- Provides potassium
- Slow-release Phosphite
- Helps with resistance to heat and drought stress
- Stimulates plant defenses against **some** diseases
- Aids compartmentalization and wound closure

**Liquid Fertilizers**



**Guaranteed Analysis**

Soluble Potash (K<sub>2</sub>O) ..... 27.00%

**Derived from**  
Phosphorous Acid and Potassium Hydroxide

**PolyPhosphite 30™ (0-0-27)** is a pure Potassium PolyPhosphite fertilizer solution that is manufactured in a one step process by reacting Phosphorous Acid and Potassium Hydroxide in a patented high temperature, rapid cooling process. This unique manufacturing process of **PolyPhosphite 30™ (0-0-27)** produces a long 9 link chain, potassium polyphosphite molecule that ensures extended phosphite availability when it is in the plant. Phosphites stimulate the plant's natural defense mechanism. **PolyPhosphite 30™ (0-0-27)** translocates systemically within the plant, which means whether it is applied as a foliar or to the plant's roots, the **PolyPhosphite 30™ (0-0-27)** will move throughout the plant. **PolyPhosphite 30™ (0-0-27)** also contains potassium that will systemically move within the plant. The role of potassium is to enhance the strength of the plant's cell walls by activating multiple enzymes involved in plant growth, preventing loss of water and minimizing drought stress to the plant.

- Weight per gallon: 12.5 lbs. (5.67 kg)
- 7.03 lb per gallon of the active ingredients, mono- and di-potassium salts of Phosphorous Acid (56% by weight). Equivalent to 4.41 lb phosphorous acid per gallon
- Each gallon contains:  
3.38 lb Potassium  
3.75 lb Polyphosphite
- pH: 6.8-7.2

**Green-T**

### PolyPhosphite 30™ (0-0-27)

**Systemic Foliar Potassium Polyphosphite**  
Patented 9-link potassium polyphosphite manufacturing process ensures the longest lasting phosphite protection IN the plant

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**Directions for Use:**

**Greens, Tees and Fine Turf:** Apply 2.0 - 6.0 oz. of **PolyPhosphite 30™ (0-0-27)** with 1.5 - 2 gallons of water per 1,000 sq. ft. (0.7 - 2.0 gallons of **PolyPhosphite 30™ (0-0-27)** with 66 - 88 gallons of water per Acre) every 10 to 21 days throughout the growing season. This application shall provide 0.05 - 0.18 lb. of actual Potassium per 1,000 sq. ft.

**Fairways, Roughs, Sports Turf and Lawns:** Apply 1.0 - 1.5 gallons per Acre of **PolyPhosphite 30™ (0-0-27)** with 44 - 88 gallons of water per acre (3.0 - 4.4 oz. of **PolyPhosphite 30™ (0-0-27)** with 1 - 2 gallons of water per 1,000 sq. ft.) every 14 days throughout the growing season. This application shall provide 0.08 - 0.11 lb. of actual Potassium per 1,000 sq. ft.

**Fertigation:** **PolyPhosphite 30™ (0-0-27)** may be injected through fertigation systems. The systemic action of **PolyPhosphite 30™ (0-0-27)** allows foliar and root uptake within the turf plant. Inject the equivalent of 1 - 1.2 gallons of **PolyPhosphite 30™ (0-0-27)** per acre. Use the lower rate for weekly injections. Use higher injection rate when applying every 10 to 14 days or during higher stress conditions.

Application Rates for PolyPhosphite 30™ (0-0-27)					
Fluid Oz/ 1,000 sq. ft.	Gallons/ One Acre	ML/ 100 M <sup>2</sup>	L/HA Litre/ Hectare	Potassium/ 1,000 sq. ft.	Phosphite/ 1,000 sq. ft.
2.0	0.7	64	6	0.06	0.05
3.0	1.0	95	10	0.09	0.08
4.0	1.4	127	13	0.12	0.11
4.4	1.5	140	14	0.13	0.12
6.0	2.0	191	20	0.18	0.16

- Treatment 1, Spring:
  - Mix 64 oz Adams Earth and 32oz Polyphosphite30 / 100 gal.
  - Apply 1 Quart per square yard (calibrate! should be ~3 seconds)
  - Inject into soil where compaction is an issue, or to target roots under turf; otherwise a surface drench is okay
  - May repeat one or more additional times in summer, this rate incorporates low-water method
- Treatment 2, Fall:
  - Mix 10 lbs AGP and 64 oz Adams Earth / 100 gal.
  - Apply 1 Quart per square yard (calibrate! Should be ~3 seconds)
  - Inject into soil where compaction is an issue, or to target roots under turf; otherwise a surface drench is okay
  - No need to ever repeat, this new rate incorporates low-N and low-water methods

# Comprehensive Soil Services

## Premium Turf Programs

Turf App #	Granular Applications		Liquid Applications				Apply gal/1000 sqft	Nitrogen lbs/1000 sqft
	Dimension 12-0-0	Merit 12-0-3	Trimec	46-0-0	Adams Earth	PolyPhosphite30		
1	2.75 lbs/1000 sqft							0.33 lbs/1000 sqft
2			48 oz/100 gal	40 lbs/100 gal	2.5 gal/100 gal	1 gal/100 gal	2	0.37 lbs/1000 sqft
3			48 oz/100 gal	40 lbs/100 gal	2.5 gal/100 gal	1 gal/100 gal	2	0.37 lbs/1000 sqft
4		4.5 lbs/1000 sqft						0.54 lbs/1000 sqft
5			48 oz/100 gal	40 lbs/100 gal	2.5 gal/100 gal	1 gal/100 gal	2	0.37 lbs/1000 sqft
							<b>Total</b>	<b>1.98 lbs/1000 sqft</b>



Pre-emergent with N

Grub Control with N & K

Broadleaf Control

Urea Nitrogen

Micronutrients and Humates

Disease and Stress Management

+ Fall Aeration, Overseed, and Topdressing Compost



# Legacy Trees

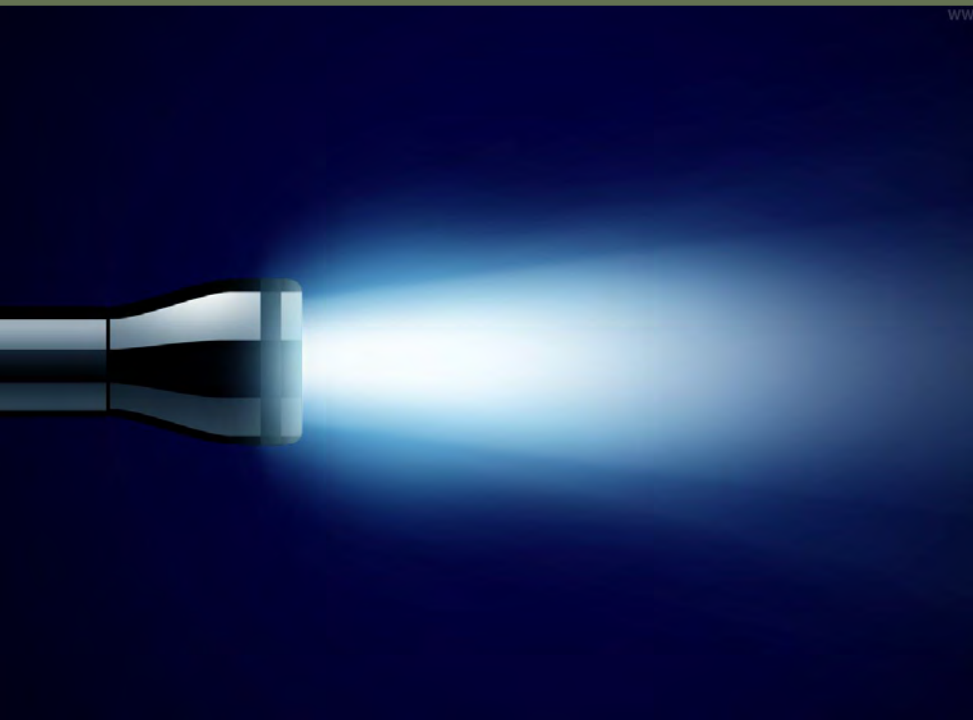
- ▶ Old trees on old sites
- ▶ Retrenching over mature trees
- ▶ “The only tree in my yard”
- ▶ Memorial Trees



# What Can We Do?

- ▶ Root Collar Excavation with the AIR-SPADE
  - ▶ Remove soil from the root collar
  - ▶ Remove stem girdling roots as necessary
  - ▶ Mulch
- ▶ Root Enhancement with the AIR-SPADE
  - ▶ Can be done in conjunction with Root Collar Excavation
  - ▶ Loosen soil in root zone
  - ▶ Incorporate organic matter, C20 bio char, or supplemental nutrients





## How do these services work?

- ▶ Pore space!
- ▶ Air expands pore spaces while moving over solid surfaces. This protects roots and allows us to get the soil out of the way.





## What advantages does this give us?

- ▶ Pore space
  - ▶ Air is a powerful decompaction tool
- ▶ Organic Matter additions deeper in the soil profile have more profound impacts.
  - ▶ Compost
  - ▶ C20
  - ▶ Bio char
- ▶ The key is in preventing re-compaction
  - ▶ Add mulch on top and inside soil profile
  - ▶ Minimize foot (or machine) traffic
  - ▶ Bio char



# Wrap Up

Process	How often	Fertility	Compaction	Product cost	Labor cost	Impact to property	Impact to Tree
Fertilization	Annual	High	Low		Low	Low	Moderate
Mulching	Every 2-3	Low	Moderate		Moderate	Moderate	Moderate
Root Excavation	Once or more	Low	Low		Moderate	Moderate	Very High
Root Enhancement	Every 3-5	Moderate	High		High	High	Very High
Product							
AGP	Annual	High	Low	Low			Moderate
Mulching	Every 2-3	Low	Moderate	Low			Moderate
C20	Annual	Moderate	Moderate	Moderate			High
Compost	Every 3-5	Moderate	Moderate	Moderate			Moderate
Biochar	Variable	Low	High	High	Variable		Very High