Preventing and Mitigating Soil Compaction Due to Foot Traffic

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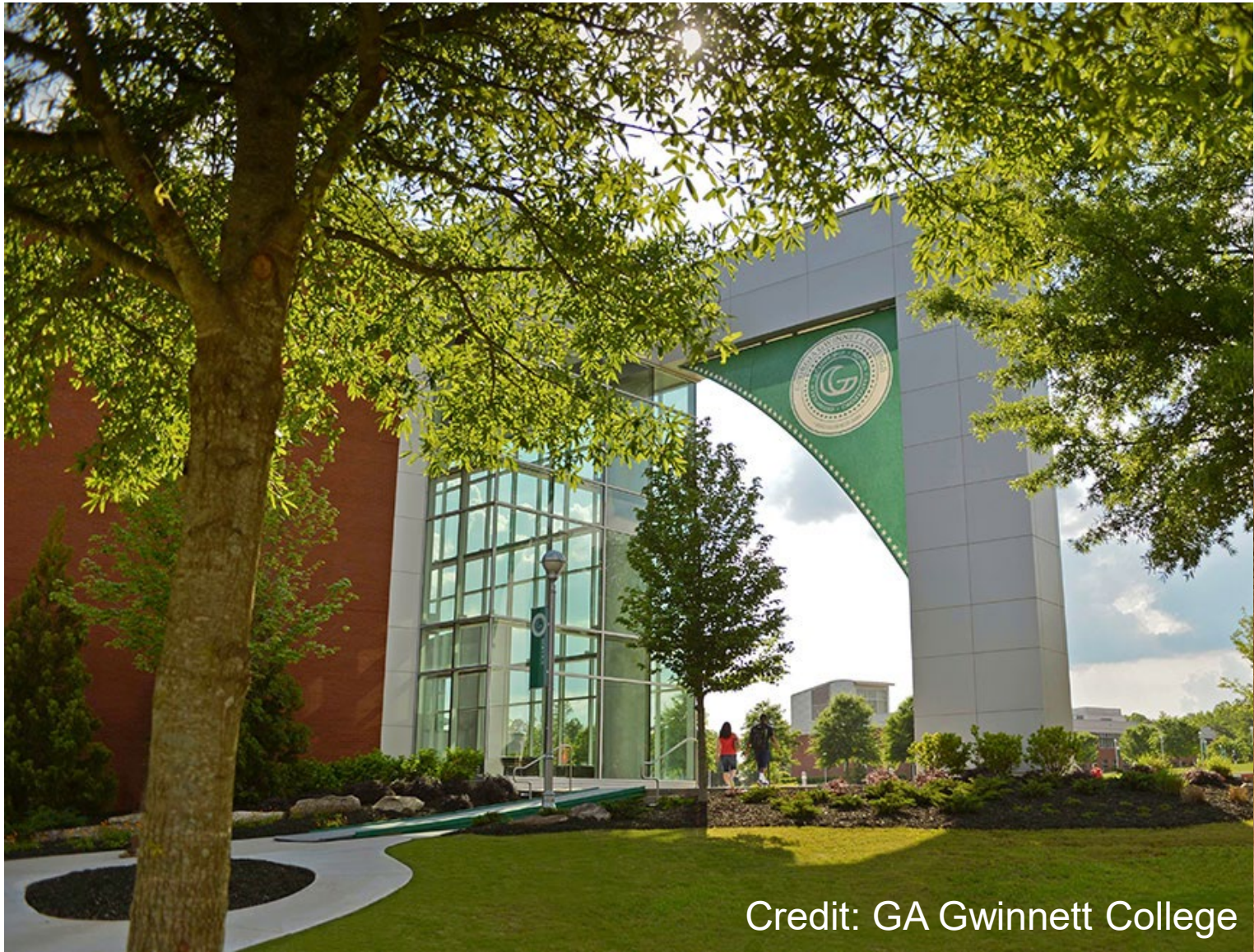
2022 GTC Campus Tree Conference

Georgia Gwinnett College

UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

Soil? Don’t You Mean Dirt?

- Soil - not a dirty word
- Soil matters



Campus Challenges *(Notably in Urban Areas)*

Heat Island Effect

Health & Well-Being Concerns

Stormwater Management

Noise Pollution

Safety/ Crime

Safe Walking

Shade

Soil Disturbance

Energy Costs

Parking

Green Space

Outdoor Classrooms

Plant Health

Equity/ Social Justice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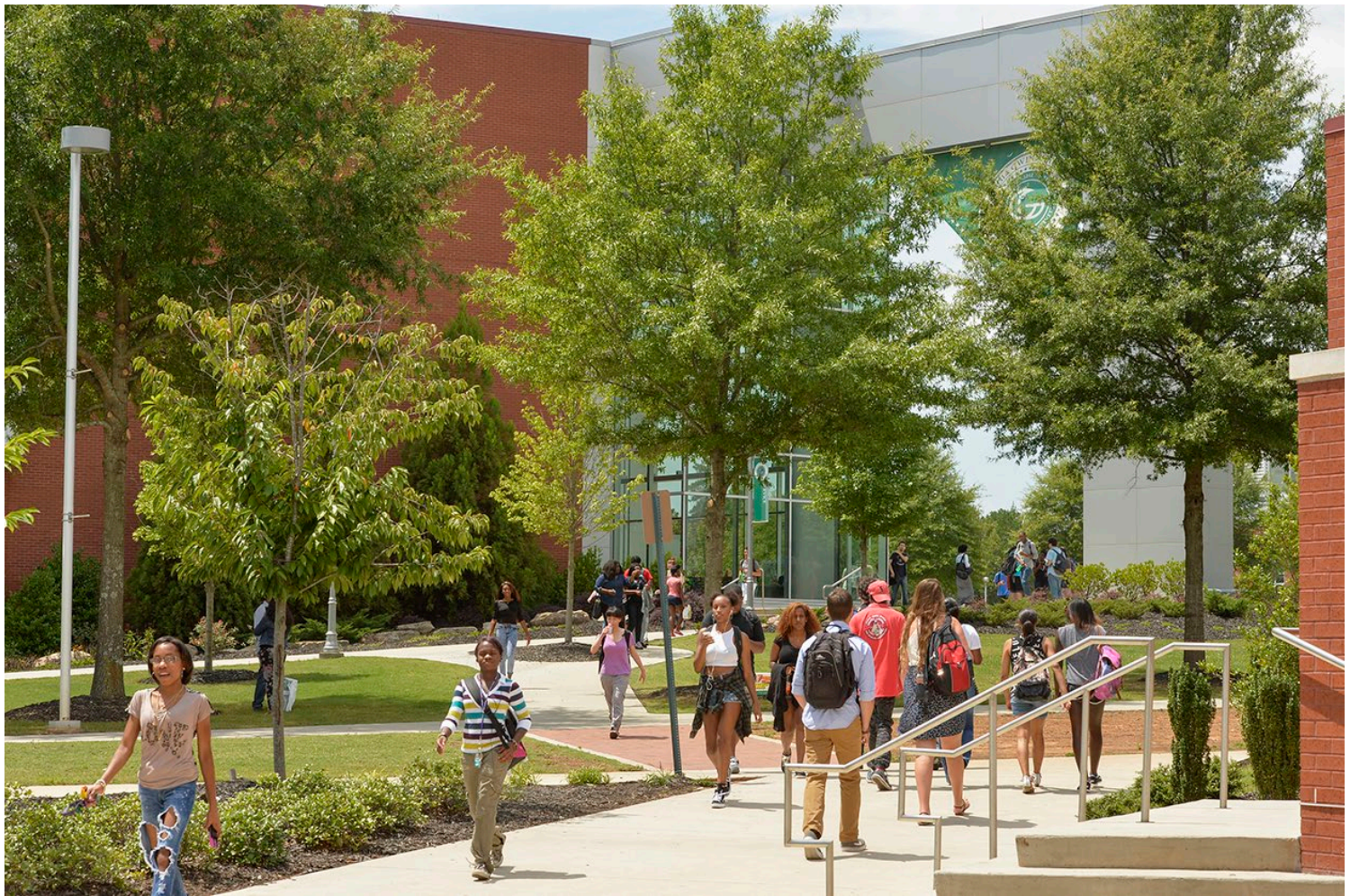
What Trees Require for Health & Growth

(A few of the most vital)

CO_2

O_2



K

P

Ca

Mg

N

S

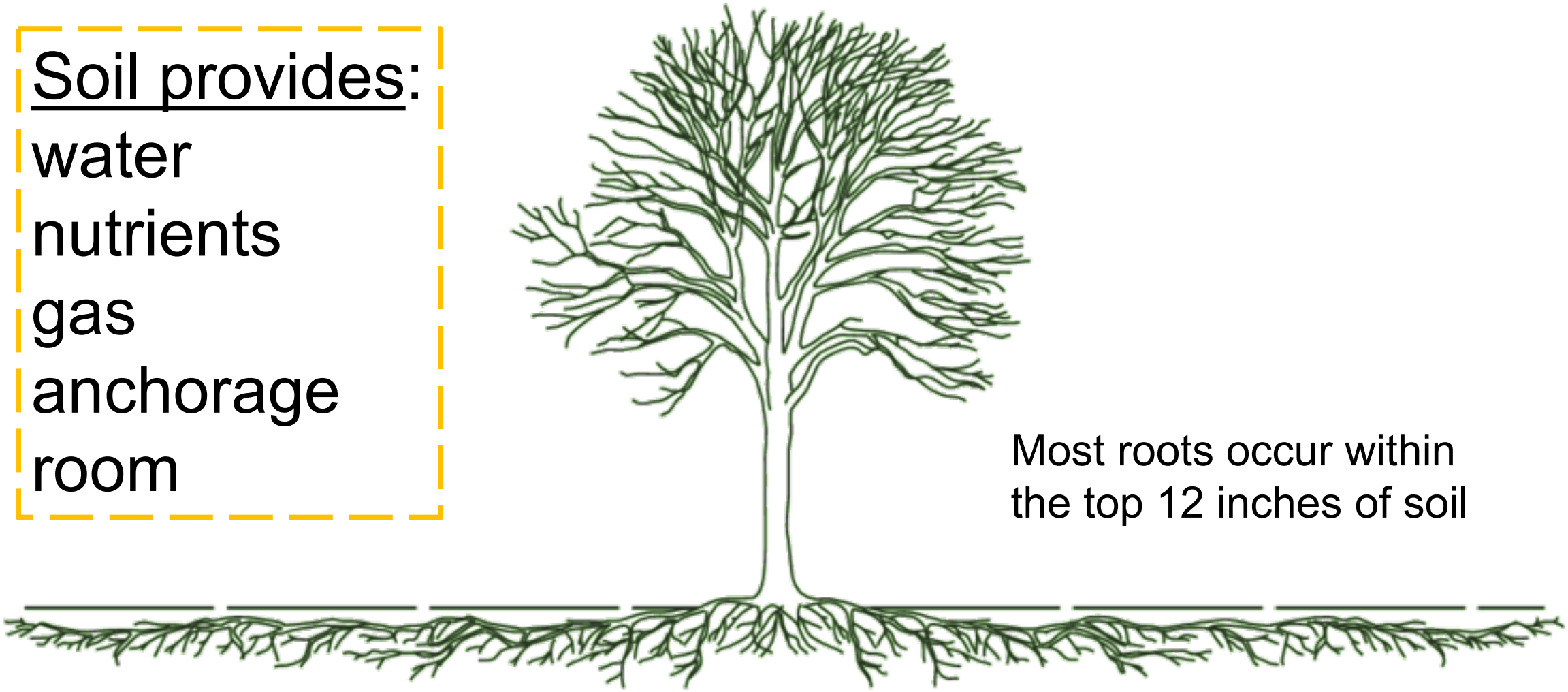
Zn

Mn

Fe

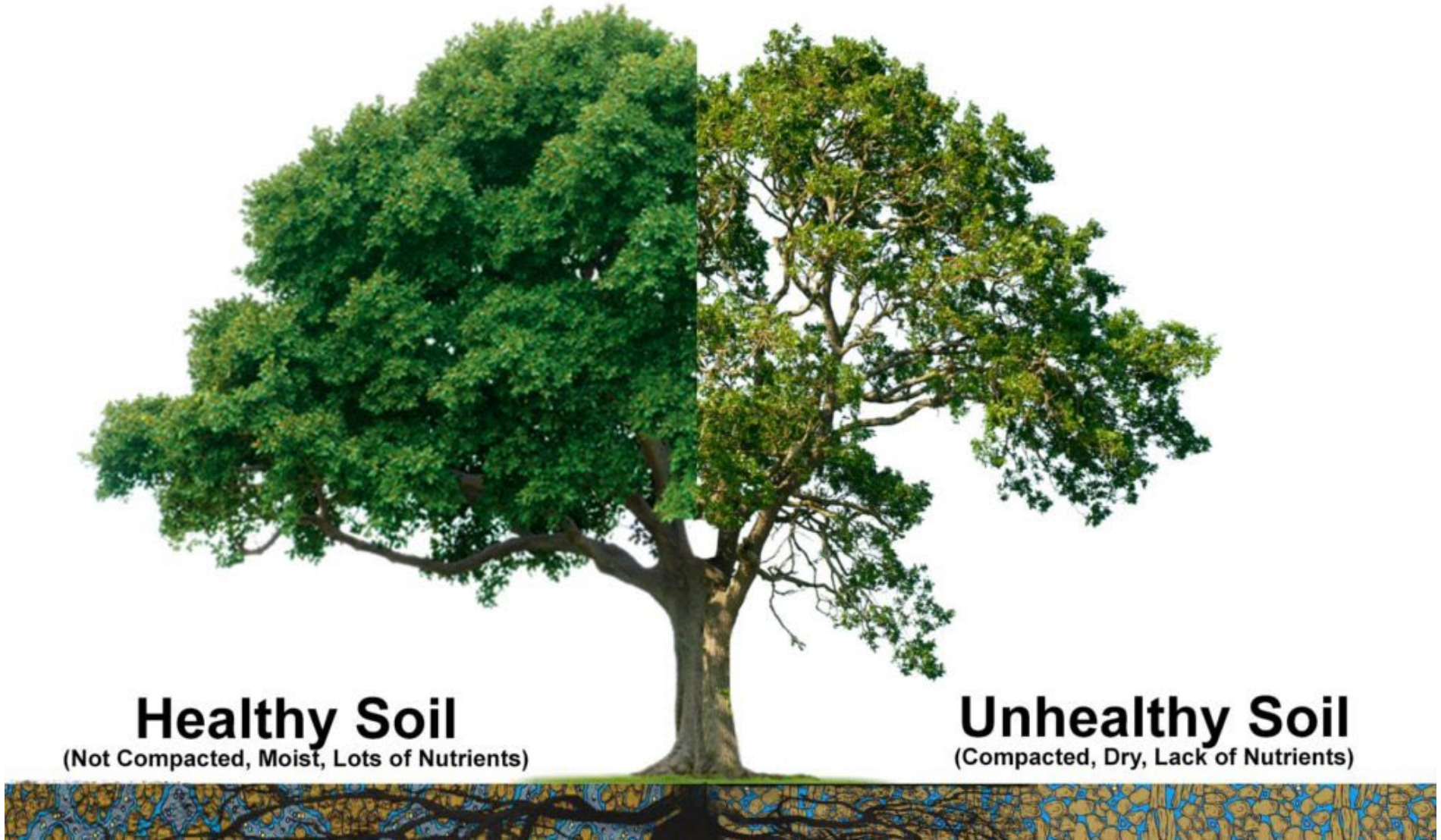
Importance of Roots in Tree Health

Soil provides:
water
nutrients
gas
anchorage
room



Most roots occur within the top 12 inches of soil

Tree Health Tied to Soil Health



Tree Health Challenge on College Campuses:

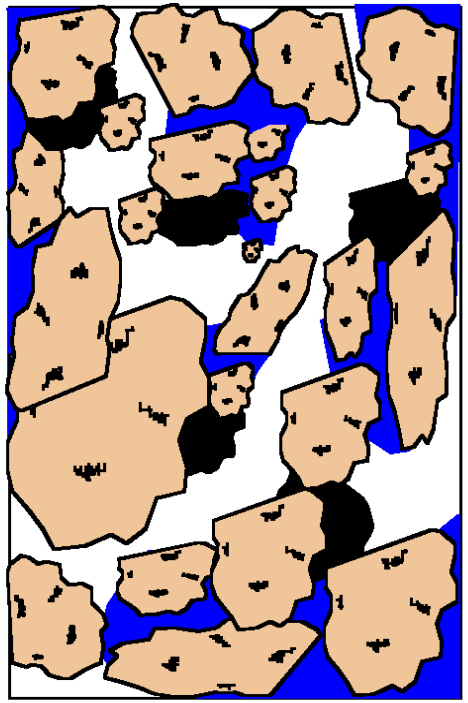
SOIL COMPACTION

Compaction Described

Ideal soil:
45% solid
25% air
25% water
5% OM

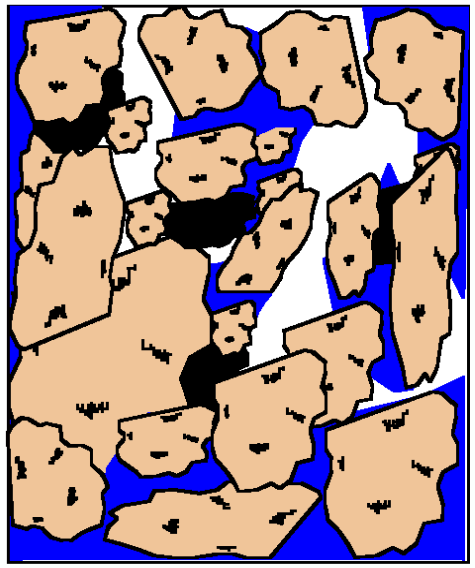
50% pore space

Undisturbed



1.32 g/cm3
45% solid
50% Pores

Compacted



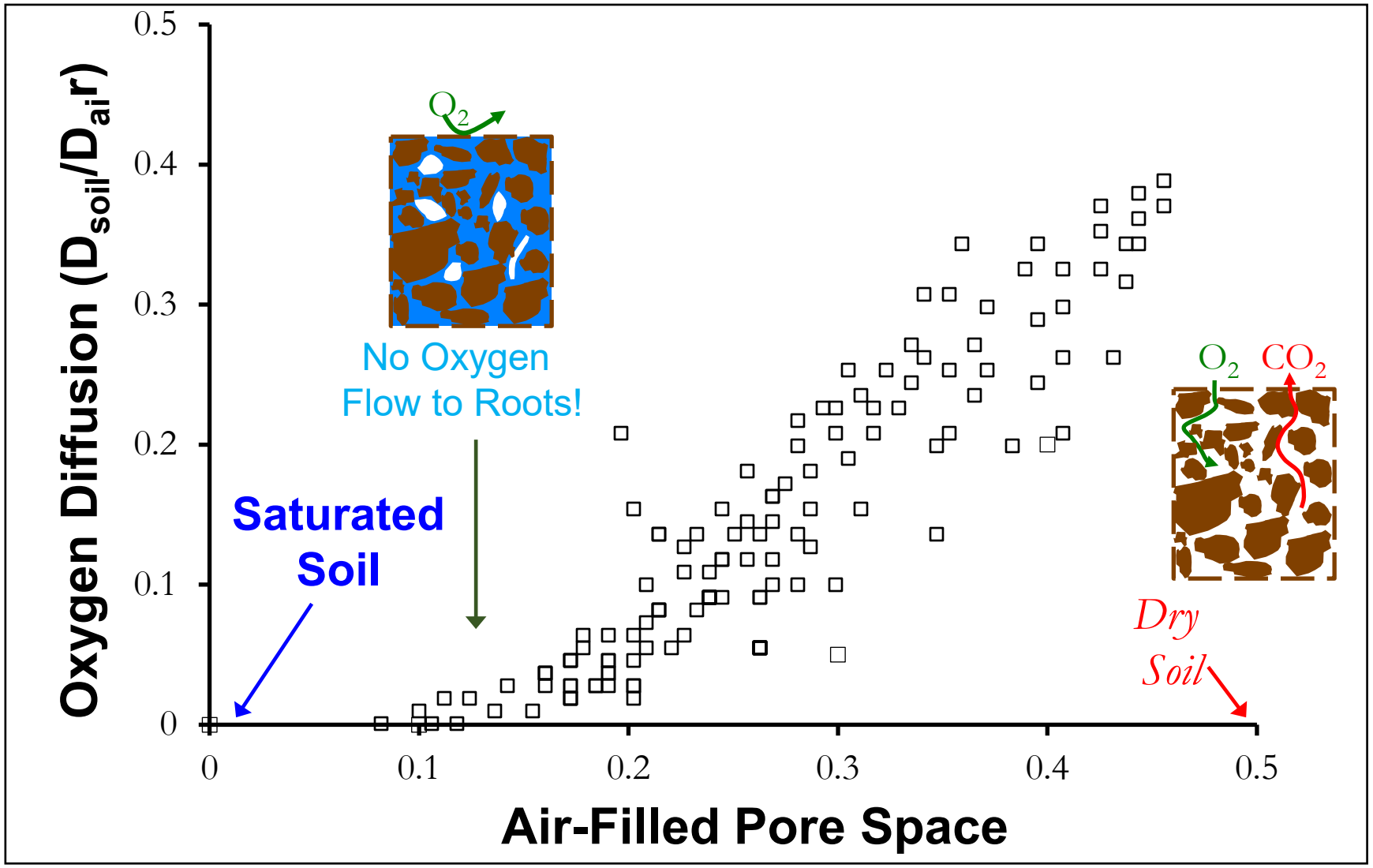
1.60 g/cm3
60% Solid
40% Pores

Compacted soil:

- ↓ **pore space/ aeration**
- ↓ **water movement**
- ↑ **bulk density***

* Bulk density values vary based on soil texture

Gas Exchange: Essential for Roots

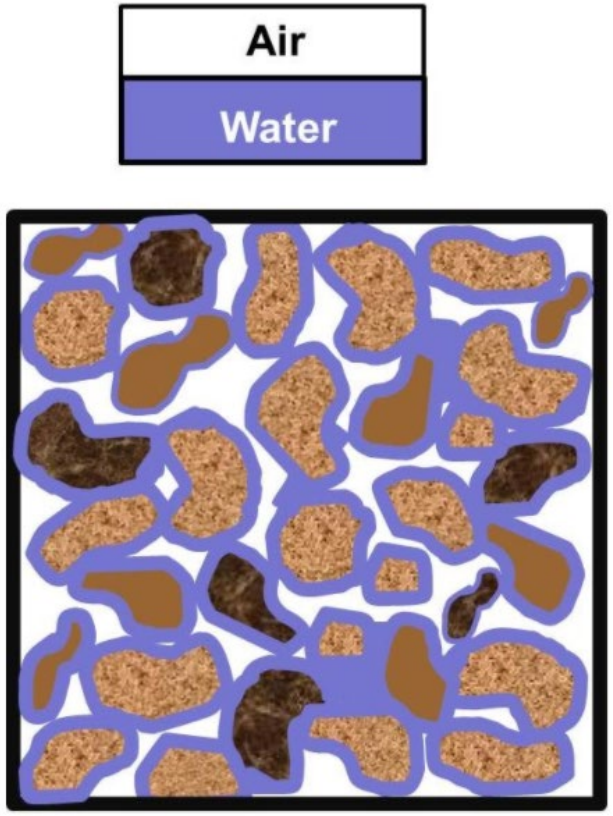


Adapted from Vomocil and Flocker, 1961

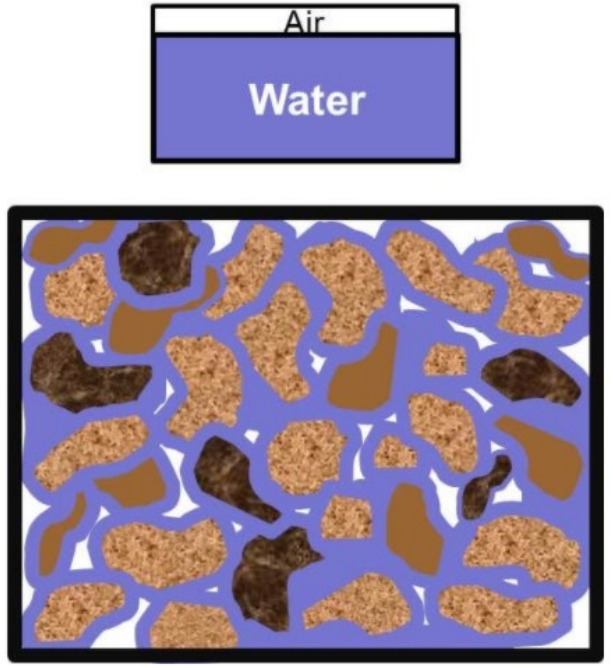
Graphic courtesy of L.A. Morris

Compaction: Decreased Gas Exchange & Decreased Water Movement

undisturbed soil

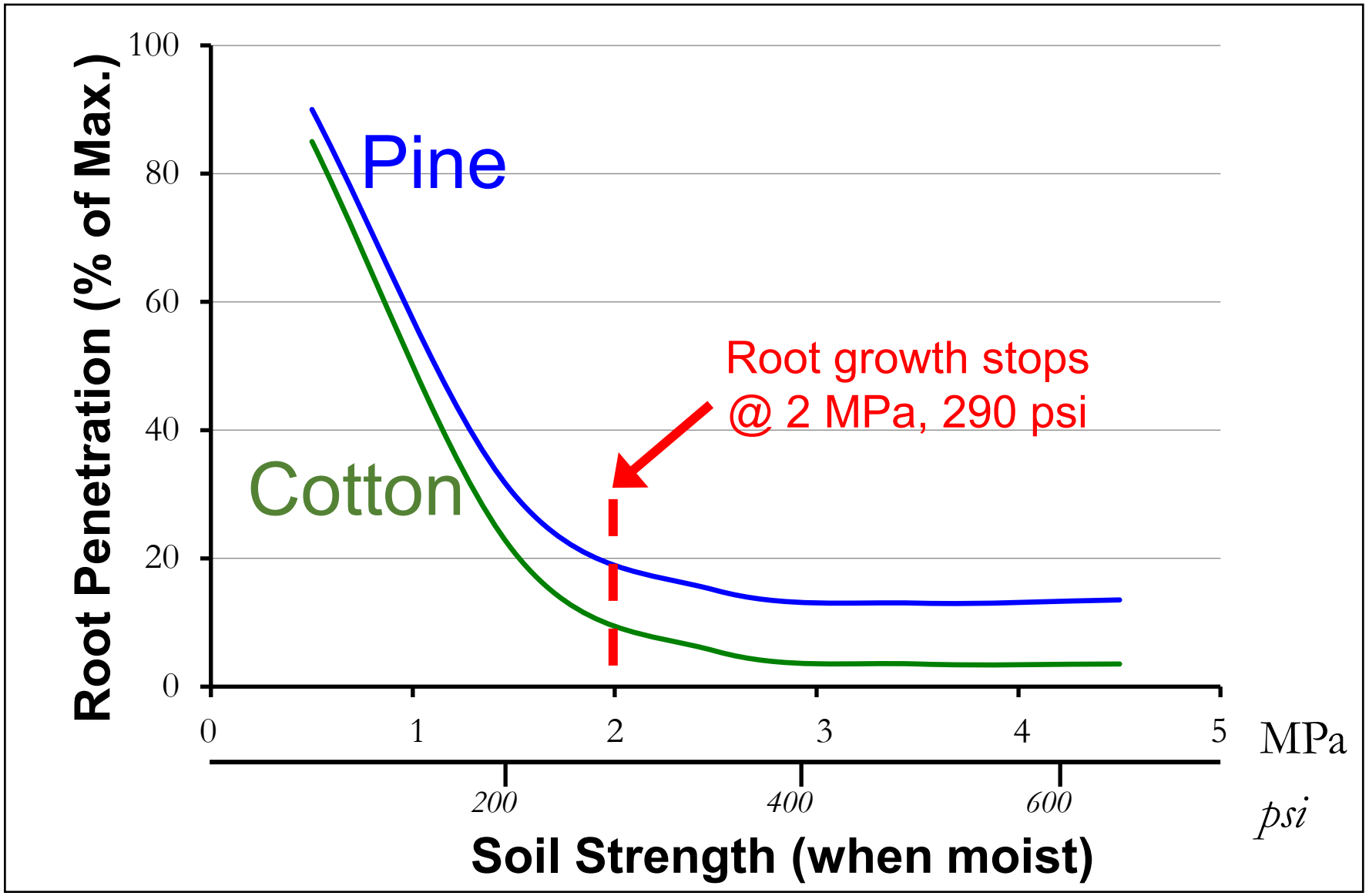


compacted soil



roots need gas exchange and water movement

Soil Strength Affects Root Growth

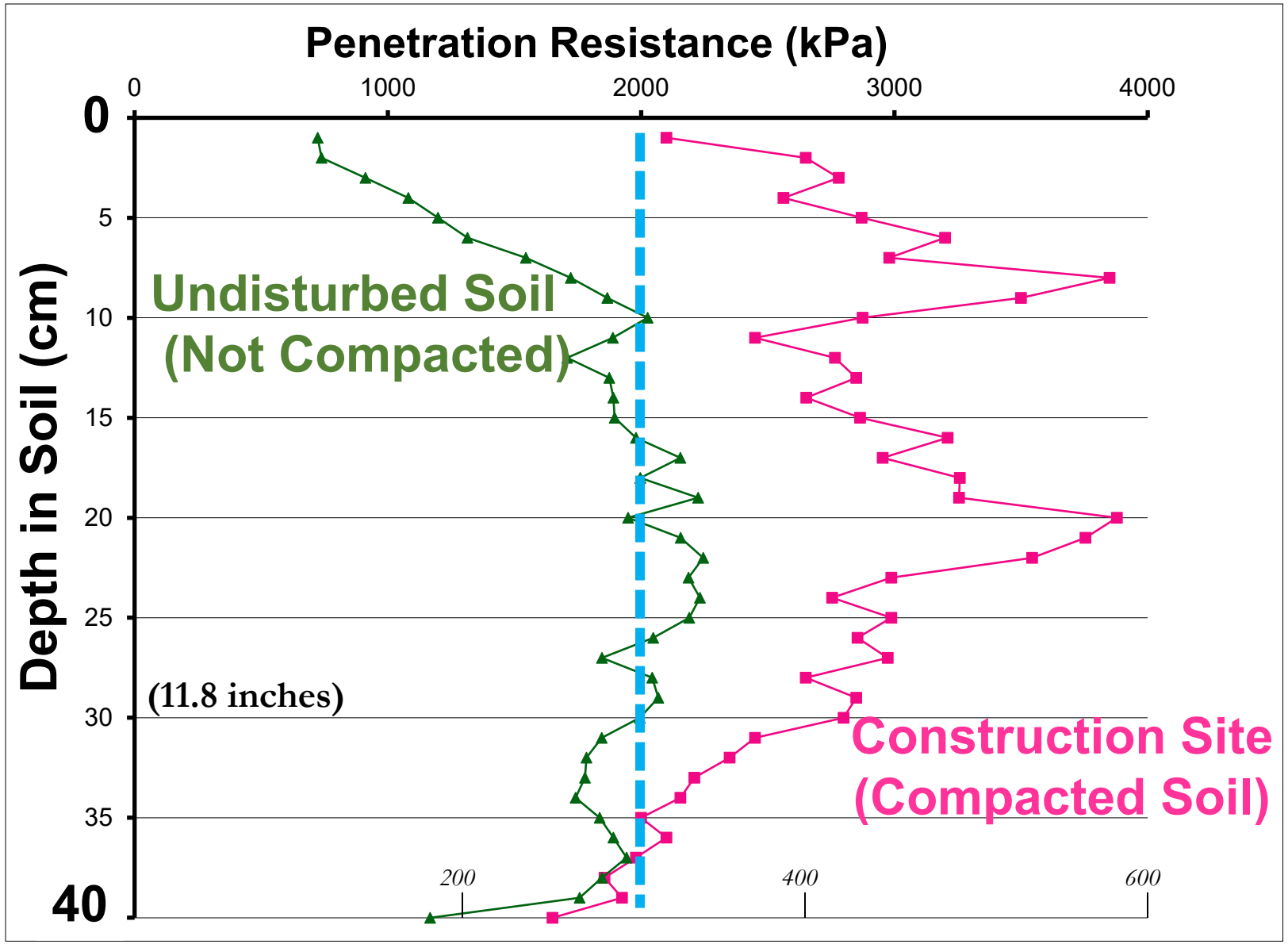


Adapted from Taylor and Barr, 1991; Greacen and Sands, 1980

Graphic courtesy of L.A. Morris

measuring soil strength: cone penetrometer

Example of Compaction



Root Growth Limited at 2000 kPa/ 2 MPa

Graphic courtesy of L.A. Morris

Soil Compaction Signs

- Increased surface runoff
- Pooling of water
- Reduced plant growth
- Exposed soil and/ or soil crusting
- Limited soil animal activity
- Hard soil
- Surface root exposure

Credit: Bob Vila

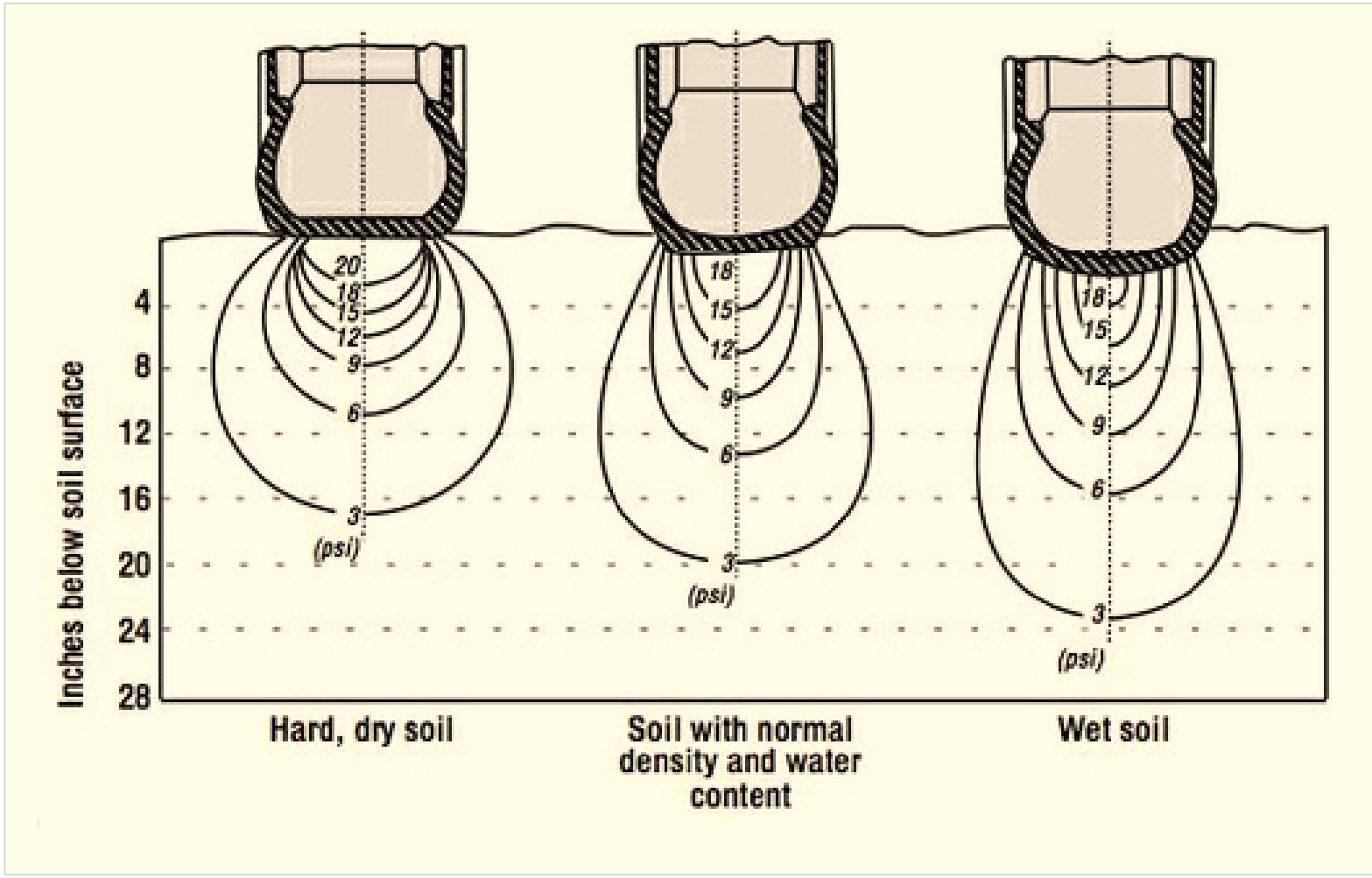
Credit: Chicago Tribune

Compaction: Two Types

Deep compaction:

- Heavy equipment
- Depth: up to 2 feet (or more)

Compaction increased when soil is wet

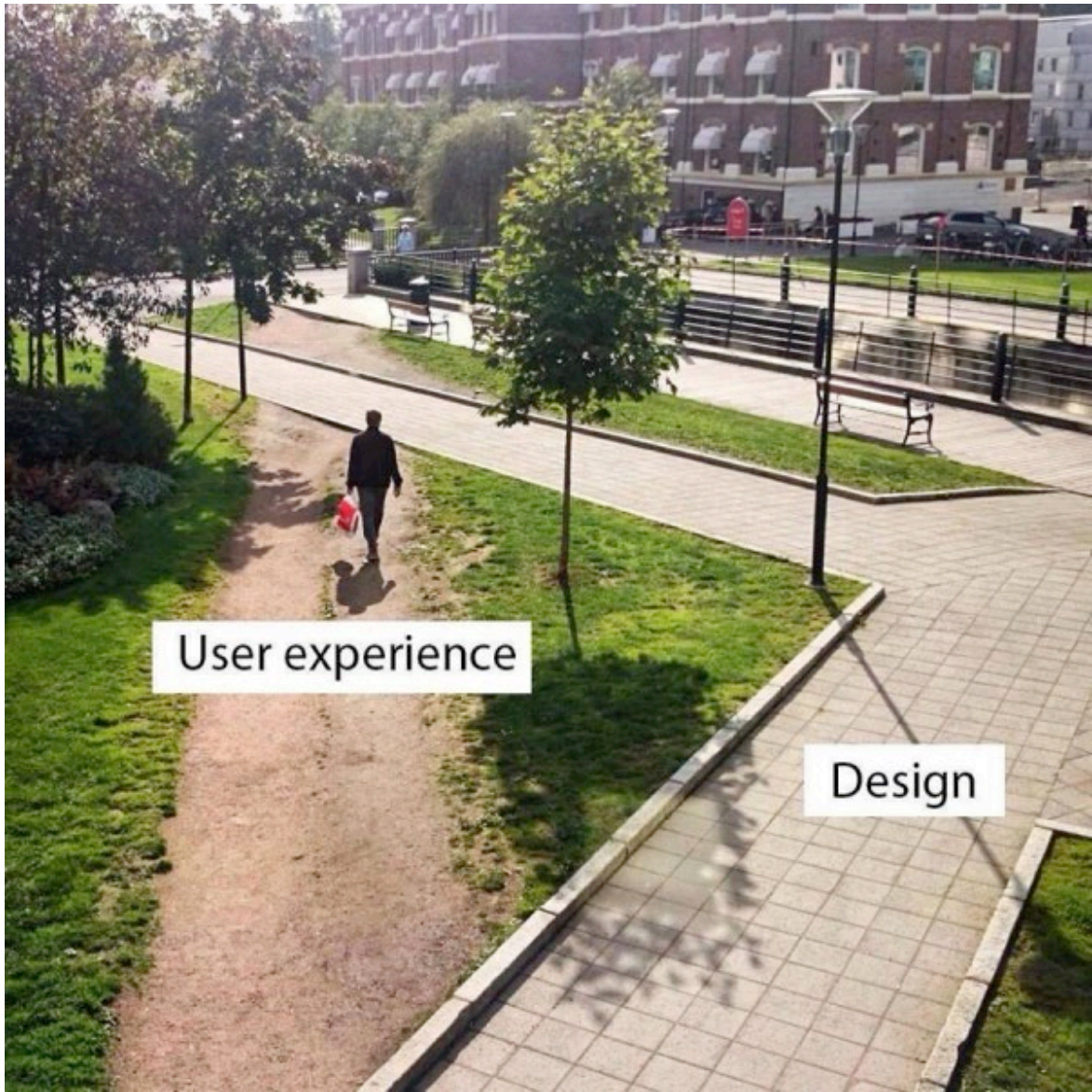


Compaction: Two Types

Surface compaction:

- Foot traffic
- Depth: soil surface to approx. 6 inches

Compaction increased when soil is wet



Preventing or Ameliorating Surface Compaction

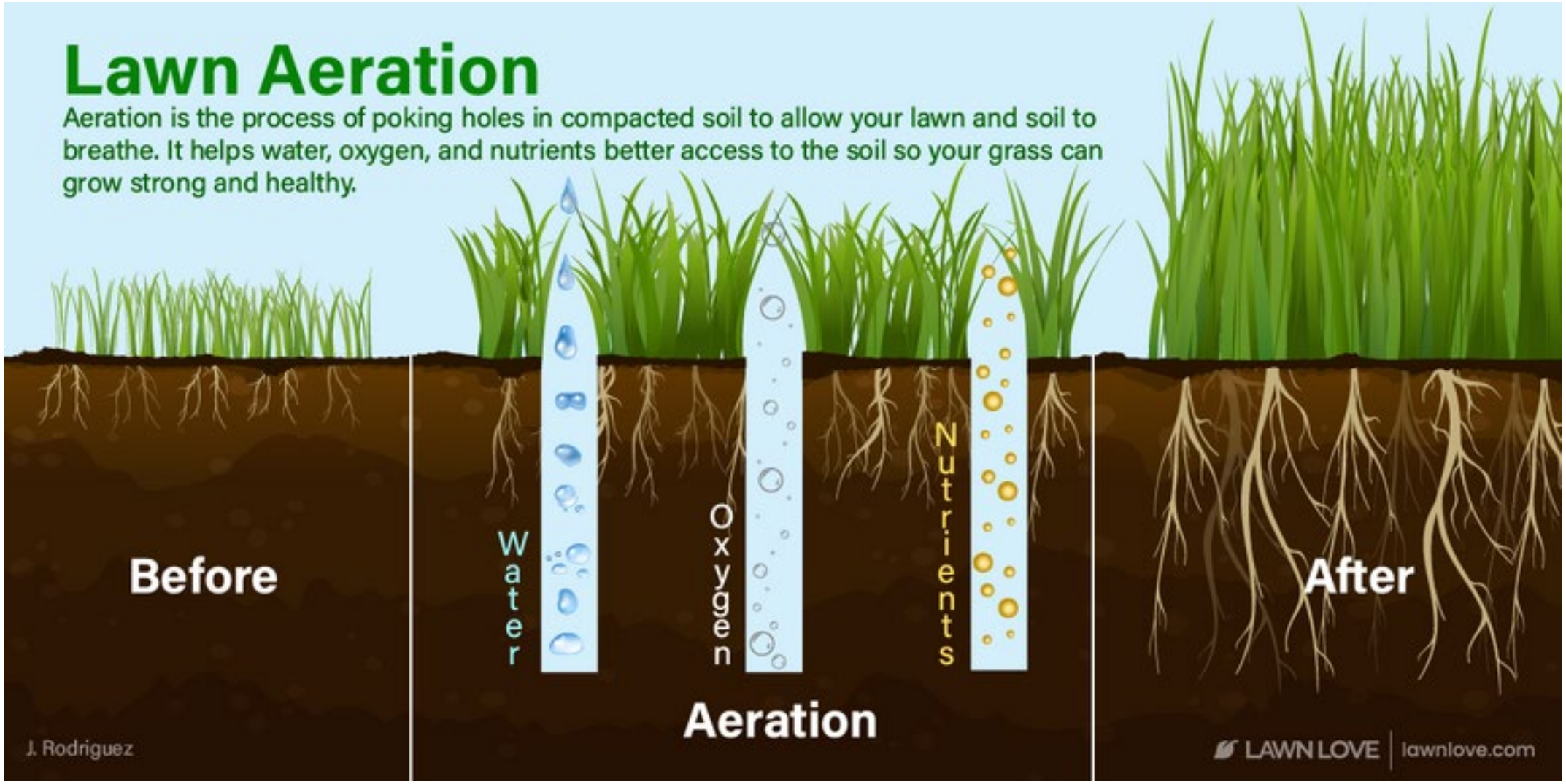
COMPACTION IS DIFFICULT TO CORRECT,

BUT NOT IMPOSSIBLE TO CORRECT

1. Anticipate & Address Compaction in High Use Areas

Confine Traffic

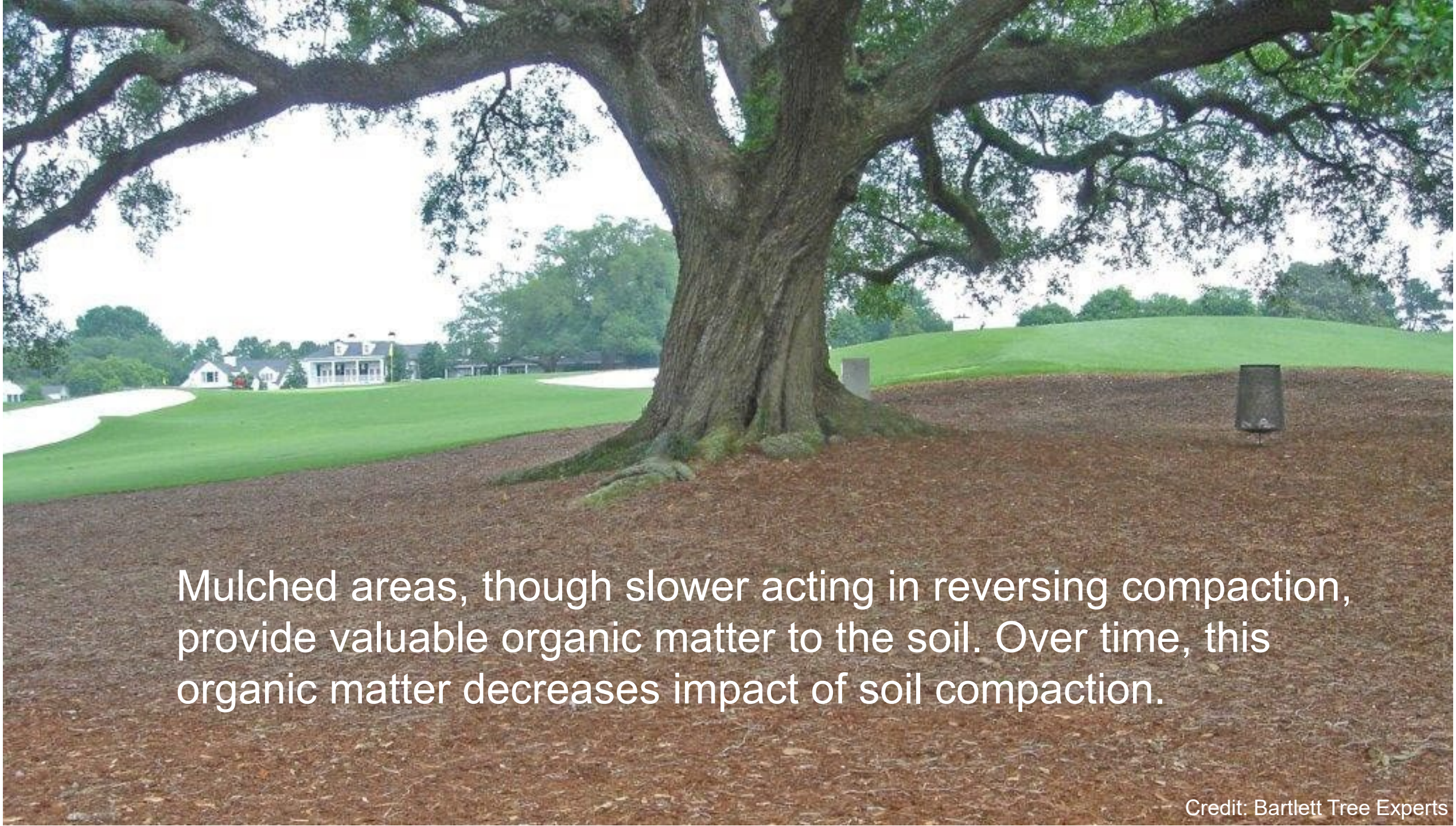
Aerate Soil


Lawn Aeration
Aeration is the process of poking holes in compacted soil to allow your lawn and soil to breathe. It helps water, oxygen, and nutrients better access to the soil so your grass can grow strong and healthy.
Before
Water
Oxygen
Nutrients
Aeration
After
J. Rodriguez
LAWN LOVE | lawnlove.com

Add Mulched Areas

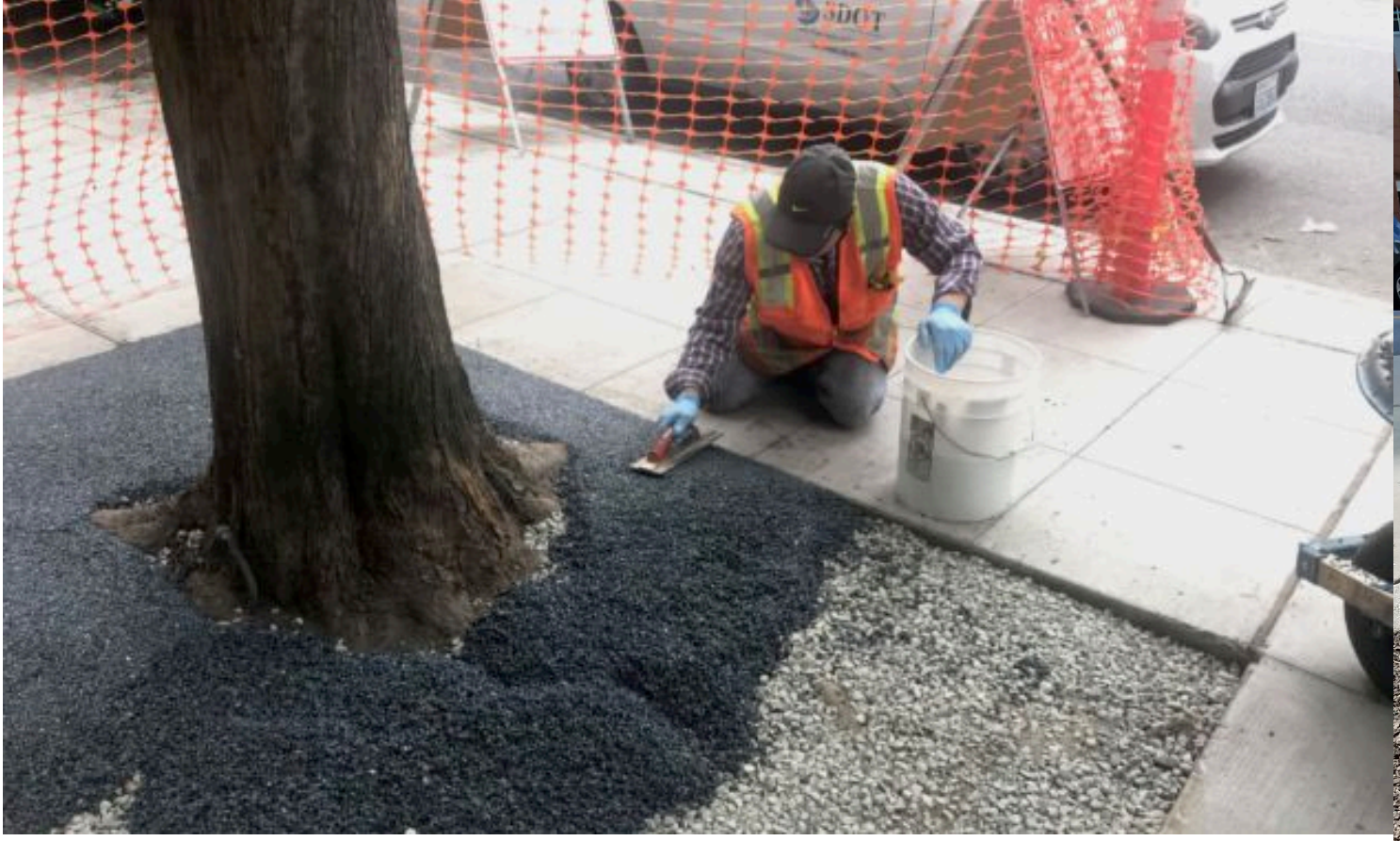
2 - 4 inches of chunky mulch (large, irregular bark or wood mulch)

Credit: Gwinnett Daily Post



Mulched areas, though slower acting in reversing compaction, provide valuable organic matter to the soil. Over time, this organic matter decreases impact of soil compaction.

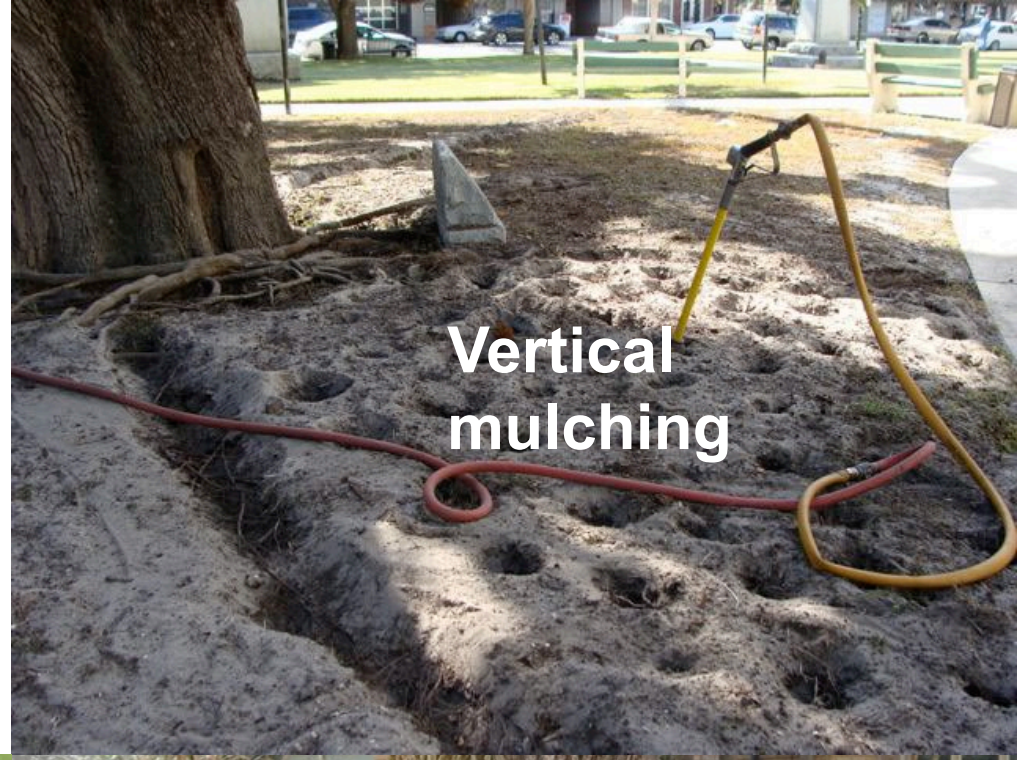
Credit: Bartlett Tree Experts



Permeable pavement protects the soil surface and allows water infiltration

Other Methods

- Air-spading/ Air tillage
- Vertical mulching
- Radial trenching
- Rototilling (hardpan can develop)



2. Barriers

- Discourage traffic in certain areas


City of Greenville, SC
barriers to protect soil.
Silva cells are under sidewalk.

3. Covering Soil

- Silva cells ($$$, but effective to protect and increase soil volume)
- Suspended pavement


City of Greenville, SC café’ area
Permeable pavers over Silva Cells

Resources: Bulk Density

Soil Texture	Ideal Bulk Density (BD) g/cm3	Marginal BD g/cm3	Restrictive BD g/cm3
Sands, loamy sands	<1.60	1.69	>1.80
Sandy loams, loams	<1.40	1.63	>1.80
Sandy clay loams, loams, clay loams	<1.40	1.60	>1.75
Silts, silt loams	<1.30	1.60	>1.75
Silt loams, silty clay loams	<1.40	1.55	>1.65
Sandy clays, silty clays, some clay loams (35-45% clay)	<1.10	1.49	>1.58
Clays (>45% clay)	<1.10	1.39	>1.47

Source: *Soil Quality Test Guide.* USDA, 1999

Steps for measuring soil bulk density: http://soilquality.org.au/factsheets/bulk-density-measurement

Thank You!

Resources:

NRCS Urban Soil Primer: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052835.pdf

Virginia Tech: Soil Profile Rebuilding: https://www.urbanforestry.frec.vt.edu/SRES/

More Information:

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