Soil Compaction Prevention, Correction, & Mitigation

2012 Clean Water Summit
Green Infrastructure for Clean Water: The Essential Role of Soil
Minnesota Landscape Arboretum
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Agenda

• Definitions
• Specifications
• Measurements
• BMPs
• Design elements
• Post Construction Maintenance
Similar Terminology

- Subsoiling
- Ripping
- Deep ripping
- Contour ripping
- Remediation ripping
- Decompaction
- Deep tillage

Constant problems
Subsoiling Benefits

- Mitigates soil structure damage due to construction activities
- Prevents burial of construction debris
- Reconnects subsoil to topsoil
- Increase storm water abstraction
- Increase rooting depth potential of Minnesota native plant species
- Reduce wind erosion (increase soil roughness)
- Reduce water erosion
Evidence of Compaction
Ag Definition

• Deep ripping involves disturbing the soil below the normal cultivation layer without inversion to break up traffic-induced or naturally occurring compaction layers.

• The effectiveness of deep ripping depends on soil texture, soil profile, soil moisture content, compaction depth, compaction extent and ripper tine spacing.

• Where deep ripping is effective it can increase root penetration, plant access to soil nutrients, water infiltration and plant available water.

• Deep ripping is not a permanent cure for compaction, if the cause of the compaction continues to occur (eg. traffic).
Reality. Prevention Best Medicine

• Soil compaction cannot be eliminated by the application of soil additives, ameliorants and chemicals. Massive, structureless soil [due to construction activities] must be broken down physically by deep ripping (Hamza and Anderson, 2005). The cost of deep ripping compacted soils is usually high because it involves high-energy input (Kirby and Palmer, 1992).
Mn/DOT Definition

- Subsoiling shall be required to **reduce soil compaction in all areas where turf establishment is shown on the Plan.**
- Subsoiling shall be performed by the prime or excavating contractor and shall occur after topsoil placement (**typical, but always documented exceptions**).
Vegetated areas to be ripped
• At the time the topsoil covering is placed, the subsoil shall be in a loose, friable condition for a uniform depth of at least 75 mm (3 inches), and there shall be no erosion rills or washouts in the subsoil surface exceeding 75 mm (3 inches) in depth. To achieve this condition scarification of the subsoil will be required as directed by the Engineer, wherever the subsoil has been compacted by equipment operation or has become dried out and crusted, and where necessary to obliterate erosion rills.
Process

• The contractor shall schedule a 15 meter (50 foot), two directional test and demonstrate competence to the Engineer prior to continuing operations. The Engineer shall identify the test area. Subsoiled areas shall be loosened to less than 1400 kPa (200 psi) to a depth of 500 mm (20 inches) of the inplace and top soil. When directed by the Engineer, the Contractor shall verify that the subsoiling work conforms to the specified depth. To test for conformance, the Contractor shall use a cone penetrometer that meets standard ASAE Soil Testing Specifications of a 20 mm (13/16 inch) insertion rate per second.

• After obtaining approval by the Engineer that the equipment and methods are sufficient to perform the work, the Contractor may proceed and complete the subsoiling operation. Work done without the Engineers approval will be considered as unauthorized work.
Measuring/measurements

- A stick
- Infiltration
- California Bearing Ratio
- Penetrometer/logger
Depth Tester
# Guide for Estimating Soil Strengths

<table>
<thead>
<tr>
<th>Estimated Consistency by:</th>
<th>Correlates to:</th>
<th>CBR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feel</strong></td>
<td><strong>Sight</strong></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Person is wet</td>
<td>0</td>
</tr>
<tr>
<td>Very soft</td>
<td>Person standing sinks more than 3 inches</td>
<td>&lt;0.4</td>
</tr>
<tr>
<td>Soft</td>
<td>Person walking sinks about 2 to 3 inches</td>
<td>0.4 – 0.8</td>
</tr>
<tr>
<td>Medium</td>
<td>Person walking sinks about 1 inch</td>
<td>0.8 – 1.6</td>
</tr>
<tr>
<td>Stiff</td>
<td>Pickup truck ruts about 0.5 to 1 inch</td>
<td>1.6 – 3.2</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>Loaded dump truck ruts 1 to 3 inches</td>
<td>3.2 – 6.4</td>
</tr>
<tr>
<td>Hard</td>
<td>Insignificant ruts from loaded dump truck</td>
<td>&gt;6.4</td>
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</tbody>
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Compaction Analysis
Soil Compaction

- Compaction can be both good (necessary) and bad

- Design planning
- Construction planning
- Maintenance Planning

- Avoidance
- Minimization
- Decompaction
  - Vegetative
  - Chemical
  - Mechanical

- Equipment must fit the location
Decompaction BMPs

- Avoidance
- Minimize
- Mitigate
Avoidance BMPs

- Winter (frozen soils)
- Prevent access
- Ruin/Confine damage only to certain areas
ATV Damage
Protect at least the dripline
Wetland Boundary

No Refueling Zone
Frozen Ground
Access and Operations
KEEP OFF
INfiltration Area