Healthy Soil Systems in Disrupted Soil Systems

Ecology: The study of relationships between people, animals, and plants, and their environment (emphasis on interconnectedness)

Soil Carbon is the key driver for the nutritional status of plant, and therefore the mineral density in animals and people.

Soil Carbon is the key driver for soil moisture holding capacity (frequently the most limiting factor for production)

Soil Carbon is the key driver for farm profit (Ex: Christine Jones).

Soil Disturbances that Impact Soil Health:
Physical: Tillage, Compaction
Biological: Lack of Plant Diversity, Poor Grazing
Chemical: Misuse of Fertilizer, Pesticides, Manures & Soil Amendments

With loss of soil function air & water quality degrade

Unlock the SECRETS of the SOIL

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Regional Soil Health Specialist (AZ, CO, NM, UT)
Natural Resources Conservation Service
Healthy Soil Ecosystem vs Disrupted Soil Ecosystem

Ecology: The study of relationships between people, animals, and plants, and their environment (emphasis on interconnectedness)

The Detritusphere:
- Protects the agratusphere and the poroshpere from the sun, wind and rain
- Lowers temperature and evaporation
- Provides habitat and food for soil organisms
- Enhances biogeochemical nutrient cycling
- Builds soil structure and nutrient reserves

Soil Carbon is the key driver for the nutritional status of plant, and therefore the mineral density in animals and people.

Soil Carbon is the key driver for soil moisture holding capacity (frequently the most limiting factor for production)

Soil Carbon is the key driver for farm profit (Dr. Christine Jones).

Soil Disturbances that Impact Soil Health:
- Physical: Tillage, Compaction
- Biological: Lack of Plant Diversity, Over Grazing, fallow
- Chemical: Misuse of Fertilizer, Pesticides, Manures & Soil Amendments

With loss of soil function air & water quality degrade
Impact of Pesticides on Soil Health

- Impacts non-target organisms
  - not well understood
  - Fungicide takes out mycorrhizal fungi
- Pesticides simplify, not diversify
- May restrict crop rotation
- May restrict cover crop diversity

Impact of Fertilizer on Soil Health

- Short-circuits the rhizosphere & P cycle
- Depresses activity of natural N fixers
- Stimulates bacterial decomposition of SOM
- Excess N at risk for leaching or denitrification
- Increased soil salinity (Synthetic fertilizers are salts)

Impact of Manure on Soil Health

- Can add organic matter and carbon
- Build up of P to excessive levels
  - Greater than 100 ppm discourages plants from feeding mycorrhizal fungi
- Other issues: Heavy metals, Salts, Pathogens, Soil compaction from application/incorporation
"Why Monitor something if your NOT going to FIX it"

Why Monitor & Assess Soil Health?

Soil Health Indicators: Interpretation must help guide management recommendations
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Observations</th>
<th>least desired</th>
<th>most preferred</th>
<th>Indicator Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Structure/Tilth (0-12&quot;)</td>
<td>Powdery dry; crusts easily after rain; large hard clods; difficult to work</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>Soil Slaking</td>
<td>0-25% of aggregates remain</td>
<td>1</td>
<td>10</td>
<td>75-100% aggregates remain</td>
</tr>
<tr>
<td>Compaction (Penetrometer, Probe or Flag)</td>
<td>Cannot push wire flag into soil; penetrometer reading &gt; 300 psi at depth &lt; 3; hard pan stops vertical root growth, roots grow laterally.</td>
<td>1</td>
<td>10</td>
<td>Flag enters soil easily; can be pushed in to twice the plow depth, penetrometer reading &lt; 300 psi above 15&quot;. Roots grow down easily through soil.</td>
</tr>
<tr>
<td>Infiltration (2nd inch)</td>
<td>Water ponds; excessive runoff</td>
<td>1</td>
<td>10</td>
<td>No water ponding or runoff; water moves easily through soil.</td>
</tr>
<tr>
<td>Soil Erosion</td>
<td>Erosion &gt; 2 times &quot;T&quot; value</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>Soil pH</td>
<td>pH &lt; 5 or pH &gt; 8.5</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>Salinity - Ece</td>
<td>ECe &gt; 3 dS/m</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>Adequate N-P-K soil test levels</td>
<td>One or more soil test levels are deficient or excessive for planned crops and yield goals; may see signs of plant nutrient deficiency.</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>Crop Residue</td>
<td>0-25% of surface covered</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>Soil Smell</td>
<td>Swampy stagnant smell</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>Crop Condition</td>
<td>Uneven stand with poor yields; crop color light green to yellow</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>Earthworms (growing season)</td>
<td>0-1 worms per shovelful in top 12&quot; of soil; no casts or holes</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>*Respiration (Soilita Basal)</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
<tr>
<td>*Soil Health Index (Farley test)</td>
<td>2.5</td>
<td>1</td>
<td>10</td>
<td>Mostly granular; no crusting</td>
</tr>
</tbody>
</table>

TOTAL SCORE
Soil Health Assessments: Use a "Soil Health Score Card" to record results

- Dig small pit: Observe Roots, Soil Structure, Texture, Compaction, Other (e.g., Soil Stratification, shallow water table, etc.)
- Infiltration & Aggregate Stability tests; Estimating Soil Moisture (Feel & Appearance)
- Lab Soil Analysis: OM, pH, N, P, K, ECe, SAR, CEC, other (e.g. nitrates, % lime)
- Lab Soil Food Web analysis (Bacteria:Fungal ratio; beneficial protozoa & nematodes, etc.); Solvita Respiration (indicator of soil biological activity)
- Soil Temperature (Surface & in Soil), ambient air temp.; Earthworms #; Brix meter, Haney Soil Test; and other tests that meet your unique cropping system
- Irrigation Water Mgt./Field Evaluations; tensiometer measurements, Other (e.g., Electrical Resistant Blocks, etc.); Lab Water Quality Analysis; Tissue Analysis
- Rain Simulator demonstrations
- Resources: Soil Health Bucket (field assessments); NRCS Soil Quality Indicators; NRCS Soil Quality Test Kit

Soil Health Management System:
1. Determine Available Water Quantity, Quality & Consumptive Use
2. Assess Soil Health & Fertility Baseline Conditions
3. Plant Cover Crop Mix (are Biological Primers that regenerate Soil Health)
4. Plant Diverse Crop Rotations (to reduce incidence of Pests/Diseases/Weeds)
5. Use No-Till/Minimum-Till (to reduce Physical Soil Disturbance)
6. Select Appropriate Irrigation System
7. Use an Irrigation Water Management Plan
8. Use an Integrated Pest Mgt. Plan (emphasis on Prevention, Avoidance, Monitoring & Suppression)
9. Assess/Monitor your SHMS & Adjust as Needed

Results

Healthy Soil have a high infiltration rate & water-stable aggregates

Healthy Soil Restores:
1. Rhizosphere (roots)
2. Water-Stable Macro Aggregates
3. Soil Porosity
4. Earthworms
5. Detritusphere (surface residues)

Carbon is the key driver of the nutrient-microbial recycling system.

Soil Health: The continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals & humans. Healthy soil enhances nutrient cycling, water infiltration/availability, filtering/buffering, physical stability/support & habitat for biodiversity.

Results

Healthy Plants

Healthy Soil

Healthy Food

Healthy/Productive Soil = Economic Sense

Use Soil Health Planning Principles to develop a SHMS: plant diversity, living roots (year-round), surface covered with residues & living plants, & minimal soil disturbance. (Consider grazing where applicable)

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IMPORTANT: Select appropriate Soil Health Assessment(s), based on your climate, soils, cropping systems and other considerations (e.g. drought, water availability, water quality, etc.). This is needed to evaluate the performance of your SHMS & to adjust it as needed to sustain/increase Soil Health & Productivity.
Ten Take-Away Points

1. Economies are intricately interconnected
2. Reduce the amount of welfare you are giving your economy - get everyone working!
3. Increase your cash flow of carbon currency for maximum production
4. Make capital investments of long term carbon (organic matter)
5. Solar energy is free - take advantage of every opportunity to capture it and boost your economy
6. Take advantage of the free resources you have in the air and the soil - nitrogen and other nutrients
7. Hire lots of tiny workers - miners, transporters, communicators, and protectors
8. Build and do not destroy infrastructure - you will really see your economy grow!
9. Protect your economy with soil armor
10. Diversity is so very important for a healthy economy - plants, roots, and soil biota

Carbonomic$ – The Wonderful Economy of the Soil

Keys To A Healthy SOIL!
Principles of using Soil Health Assessment for Management Decisions:

- Soil Health Assessment Report is a Management Guide, not a prescription
- Different mgmt approaches can mitigate same problem
- Management practices can affect multiple indicators
- Information from varied sources for management decisions: research, books, workshops, field days, local experience
- Adapt Soil Health Information to a management strategy to fits the field/farm
- Soil health changes slowly over time and effects can be additive

How do I use soil health assessment information?

- Understand soil processes & management impacts
- Identify constraints through soil health assessment
- Select & implement appropriate management strategies
- Monitor change and adjust management
A. Soils Info.: Soil Series; Soil Texture (CEC, Base Saturation, ESP, ECe, pH); Soil Stratification; Root depth; depth to Water Table, % Slope, etc.
Soil Texture (CEC, Base Saturation, ESP)

Know Your Soils and their Productivity Potential

Soil horizons

A Horizon

B Zone of accumulation of soluble salts (subsoil)

C Weathered parent material (bedrock)

Gradational contact

Fresh parent material (bedrock)

Soil Structure

A Horizon (Healthy Soil)

Soil Particles

Clay

Silt

Sand

Soil Texture Triangle

Soil Structure

Prismatic

Platy

Granular

Columnar

Massive

Single Grain

Blocky

Granular
SOIL TEXTURE (% SAND, SILT & CLAY)

Clay particles (platelet shape)

Clay (flake shape)

 Soil Texture/Soil Series (e.g., Clay Loam/Aridisols)

% SOIL ORGANIC MATTER

Soil Humus is a major part of the SOM.

• Active Pool
• Slow Pool
• Passive Pool

This images is a SUPRAMOLECULAR cluster of many molecules that organized on their own without an outside influence.
Surface Area of a Sphere: \( A = 4\pi r^2 \) \((\pi \approx 3.14159)\). To illustrate the concept of surface area of soil particles, calculations are based on soil particles having a spherical shape.

e.g., **Sand = 1.0 mm dia.**
(8 sand particles can fit into the above cube; **Total Surface Area = 25 mm\(^2\)**)

e.g., **Silt = 0.025 mm dia.**
(512,000 silt particles can fit into the above cube; **Total Surface Area = 1,006 mm\(^2\)**)

e.g., **Clay = 0.001 mm dia.**
(8,000,000,000 clay particles can fit into the above cube; **Total Surface Area = 25,144 mm\(^2\)**)


**Soil Texture, Soil Structure, Aggregate Stability & Surface Area of Soil Particles**

- **SAND** (0.05 – 2.0 mm)
- **Silt** (0.002 – 0.05 mm)
- **CLAY** (< 0.002 mm)

**Massive**
Roundish peds that are loosely packed; can also be called crumb (ideal structure).

**Poor Aggregate Stability**

- % Soil Particles (NOTE: For illustration/calculation purposes, soil particles are spherical):
  - At 33.33% **Sand** (1 mm dia.), about 2.7 sand particles fit in the cube with a Clay loam texture; **Total Surface Area = 8.33 mm\(^2\)**
  - At 33.33% **Silt** (0.025 mm dia.), about 170,650 Silt particles fit in the above cube with a Clay loam texture; **Total Surface Area = 335.3 mm\(^2\)**
  - At 33.33% **Clay** (0.001 mm dia.), about 2,666,400,000 Clay particles fit in the above cube with a Clay loam texture; **Total Surface Area = 8,380.5 mm\(^2\)**

From the above, you can see that the Clay particles provide the majority of the surface area (i.e., 96.1%). Thus, the majority of the soil chemical & physical activity are associated with the clay fraction (e.g., CEC, pH, buffering, water-holding capacity (micro pores), organic carbon-soil mineral complexes, niches for soil microorganisms, etc.).

"rudy.garcia.2014"
Soil texture is important in determining maximum levels for:

- Drainage
- Water-holding capacity
- Aeration
- Erosion potential
- How much organic matter can accumulate
- Nutrient supply via CEC

### Table 1. General relationship of soil bulk density to root growth based on soil texture.

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Ideal bulk densities for plant growth (g/cm³)</th>
<th>Bulk densities that restrict root growth (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy</td>
<td>&lt; 1.60</td>
<td>&gt; 1.80</td>
</tr>
<tr>
<td>Silty</td>
<td>&lt; 1.40</td>
<td>&gt; 1.65</td>
</tr>
<tr>
<td>Clayey</td>
<td>&lt; 1.10</td>
<td>&gt; 1.47</td>
</tr>
</tbody>
</table>

A three inch diameter ring is hammered into the soil to collect bulk density samples.
Soil Texture/Soil Series (e.g., Clay Loam/Aridisols)

Comparing a **Very Coarse Sand** particle to a **Macro-Aggregate**

- **Very Coarse Sand**: 2.0 mm dia.
- **Macro-Aggregate**: 3.0 mm dia.

**Soil Particle Comparisons:**
- e.g., at 2.0 mm dia.: 1 Very Coarse Sand particle/2.0 mm cube
- e.g., at 1.0 mm dia.: 8 Coarse Sand particles/2.0 mm cube
- e.g., at 0.5 mm dia.: 64 medium sand particles/2.0 mm cube
- e.g., at 0.25 mm dia.: 512 fine sand particles/2.0 mm cube
- e.g., at 0.1 mm dia.: 8,000 very fine sand particles/2.0 mm cube
- e.g., at 0.025 mm dia.: 512,000 silt particles/2.0 mm cube
- e.g., at 0.001 mm dia.: 8,000,000,000 clay particles/2.0 mm cube

Micro-Aggregate: 0.3 mm dia.
Calcareous Soils: Calcium and Magnesium Carbonates.
- Carbonates can be found throughout a soil profile or concentrated in the lower horizons due to downward leaching.
- The presence of carbonates in soil can affect soil productivity by influencing soil pH, structure, water-holding capacity and water flow.
- The pH of calcareous soils changes very little and is maintained near 8.

Caliche (Petrocalcic): Zone of high CaCO₃(s) that is laminated and sealed.

Crop Tolerance to Soil Lime

<table>
<thead>
<tr>
<th>Crop</th>
<th>Relative Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudangrass</td>
<td>Low to moderate</td>
</tr>
<tr>
<td>Forage Corn</td>
<td>Moderate</td>
</tr>
<tr>
<td>Sorghum</td>
<td>Low to Moderate</td>
</tr>
<tr>
<td>Cotton</td>
<td>Moderate to High</td>
</tr>
<tr>
<td>Alfalfa (general)</td>
<td>High</td>
</tr>
<tr>
<td>801S</td>
<td>High</td>
</tr>
<tr>
<td>WL 454HQ.RR</td>
<td>High</td>
</tr>
<tr>
<td>Bermudagrass (warm season)</td>
<td>Medium</td>
</tr>
<tr>
<td>Tall wheatgrass (cool season)</td>
<td>High</td>
</tr>
<tr>
<td>Wheat (cool season)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Forage Teff</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Understanding your Soils inherent properties (e.g. bulk density, surface area, etc.)

**Volume of a ball (2.5 in. dia.)**

\[ V = \frac{4}{3} \pi r^3 \]

- \( \pi = 3.14159 \)
- \( r = \text{radius} = 3.175 \text{ cm} \)
- \( V = \frac{4}{3} \times 3.14159 \times 3.175^3 \)
- \( V = 134.04 \text{ cm}^3 \)

**Ball Vol.** = 134.04 cm\(^3\)

**Vol. of Ball** = 134.04 cm\(^3\)

**Vol. of Box** = 256.05 cm\(^3\)

Ball occupies 52.35\% of the Box's volume

- **125,000 Silt particles (0.02 mm dia.)** fit in a 1.0 mm\(^3\) cube.
- **349,248,836 Clay particles (0.00142 mm dia.)** fit in a 1.0 mm\(^3\) cube.

Particle diameter:
- **Sand**: 2.0 – 0.05 mm
- **Silt**: 0.05 – 0.002 mm
- **Clay**: < 0.002 mm

- **256.05 cm\(^3\)** (Vol. = 256.05 cm\(^3\))

- **2.5 in. x 2.5 in. x 2.5 in. = 15.63 in\(^3\)**

- **6.35 cm x 6.35 cm x 6.35 cm = 256.05 cm\(^3\)**

- **About 1,471 BBs are contained in the ball**

- **BB = 4.5 mm dia.**

For Illustration/calculation purposes, soil particles are **spherical**: 1,462.65 Clay particles (0.00142 mm dia.) could fit into a spherical Silt particle with a 0.02 mm dia.
Inherent Properties:
Physical properties that usually cannot be changed without much difficulty
- Soil texture
- Type of clay
- Depth to bedrock

Dynamic Properties:
Management dependant properties that we do have the ability to change relatively easily
- Organic matter content
- Biological activity
- Aggregate stability
- Infiltration
- Soil fertility
- Soil reaction (pH)

Figure 1. General relationship between soil moisture and texture.
B. Irrigation: System (e.g. Drip, Pipe, Sprinkler, etc.); Available Water (cfs/gpm); Water Quality (e.g., ECiw/SAR & Leaching Req.); Consumptive Use (ET), etc.
Available Irrigation (cfs/gpm; ECiw, SAR)

Select Plants adapted to your Climate (i.e., Temperature & Precipitation)

Net Irrigation Requirement = 48” for Pecans with mature cover

How many cubic feet per second (cfs) or gallons per minute (gpm) are available at the head gate? 1 cfs = 450 gpm
EXAMPLE: A 15” diameter Headgate with 2.35 ft. of head will produce 9.0 cfs (Cubic Feet per Second).  
9.0 cfs x 448.88 = 4,040 gpm.  
Note: cfs x 448.88 = gallons per minute (gpm); One gallon = 3.785 liters

<table>
<thead>
<tr>
<th>Diameter of Irrigation Headgate (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10”</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>cfs</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>4.23</td>
</tr>
<tr>
<td>3.9</td>
</tr>
<tr>
<td>3.52</td>
</tr>
<tr>
<td>3.4</td>
</tr>
<tr>
<td>2.63</td>
</tr>
<tr>
<td>2.03</td>
</tr>
</tbody>
</table>

NOTE: The Head (ft) is measured from the upstream water surface to the center of the Orifice INLET. The above values are based on a free discharging orifice connected to a culvert pipe that is 20 feet in length.

These cfs values were calculated using the USDA-NRCS Orifice Flow PROGRAM.
### Section 7 of 10: Soils Data Interpretation Table for IWM Planning

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>% Sand</th>
<th>% Silt</th>
<th>% Clay</th>
<th>CEC Range (meg/10g)</th>
<th>Bulk Density (g/cm³)</th>
<th>Soil Weight (Million lbs. per ac-ft)</th>
<th>Soil Solids % Vol.</th>
<th>Unavial able Water % Vol.</th>
<th>Available Water % Vol.</th>
<th>Soil Porosity at FC % Vol.</th>
<th>in/ft</th>
<th>in/ft</th>
<th>in/ft</th>
<th>in/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands</td>
<td>86.98</td>
<td>2.14</td>
<td>2.8</td>
<td>2 – 6</td>
<td>1.65</td>
<td>4.48</td>
<td>62.3</td>
<td>7.47</td>
<td>2.5</td>
<td>0.3</td>
<td>4.17</td>
<td>0.5</td>
<td>31.1</td>
<td>3.73</td>
</tr>
<tr>
<td>Loamy Sands</td>
<td>72.88</td>
<td>2.28</td>
<td>2.14</td>
<td></td>
<td>1.6</td>
<td>4.35</td>
<td>60.4</td>
<td>7.25</td>
<td>7.0</td>
<td>0.84</td>
<td>8.33</td>
<td>1.0</td>
<td>24.3</td>
<td>2.91</td>
</tr>
<tr>
<td>Fine Sands</td>
<td>86.98</td>
<td>2.14</td>
<td>2.8</td>
<td></td>
<td>1.65</td>
<td>4.48</td>
<td>1.65</td>
<td>4.48</td>
<td>61.5</td>
<td>7.38</td>
<td>10.2</td>
<td>1.22</td>
<td>10.4</td>
<td>1.25</td>
</tr>
<tr>
<td>V. F. Sands</td>
<td>86.98</td>
<td>2.14</td>
<td>2.8</td>
<td></td>
<td>1.65</td>
<td>4.48</td>
<td>1.6</td>
<td>4.35</td>
<td>1.6</td>
<td>4.35</td>
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<td>1.6</td>
<td>4.35</td>
</tr>
<tr>
<td>Loamy V. F. Sands</td>
<td>72.88</td>
<td>2.28</td>
<td>2.14</td>
<td></td>
<td>1.65</td>
<td>4.48</td>
<td>1.6</td>
<td>4.35</td>
<td>1.6</td>
<td>4.35</td>
<td>1.6</td>
<td>4.35</td>
<td>1.6</td>
<td>4.35</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>46.84</td>
<td>2.48</td>
<td>2.18</td>
<td></td>
<td>1.56</td>
<td>4.24</td>
<td>58.3</td>
<td>7.06</td>
<td>12.3</td>
<td>1.48</td>
<td>12.5</td>
<td>1.5</td>
<td>16.3</td>
<td>1.96</td>
</tr>
<tr>
<td>Fine Sandy Loam</td>
<td>46.84</td>
<td>2.48</td>
<td>2.18</td>
<td></td>
<td>1.56</td>
<td>4.24</td>
<td>1.56</td>
<td>4.24</td>
<td>1.56</td>
<td>4.24</td>
<td>1.56</td>
<td>4.24</td>
<td>1.56</td>
<td>4.24</td>
</tr>
<tr>
<td>V. F. Sandy Loam</td>
<td>46.84</td>
<td>2.48</td>
<td>2.18</td>
<td></td>
<td>1.53</td>
<td>4.16</td>
<td>1.42</td>
<td>3.86</td>
<td>1.42</td>
<td>3.86</td>
<td>1.42</td>
<td>3.86</td>
<td>1.42</td>
<td>3.86</td>
</tr>
<tr>
<td>Loam Silt Loam Silt</td>
<td>26.50</td>
<td>30.48</td>
<td>10.26</td>
<td>10 – 19</td>
<td>2 – 18</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
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<td>0.20</td>
</tr>
<tr>
<td>V. F. Sandy Loam</td>
<td>26.50</td>
<td>30.48</td>
<td>10.26</td>
<td>10 – 19</td>
<td>2 – 18</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
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</tr>
<tr>
<td>Sandy Clay Loam</td>
<td>46.78</td>
<td>2.26</td>
<td>22.36</td>
<td>15 – 30</td>
<td>1.4</td>
<td>3.8</td>
<td>50.2</td>
<td>6.02</td>
<td>20.0</td>
<td>2.4</td>
<td>18.3</td>
<td>2.2</td>
<td>11.5</td>
<td>1.38</td>
</tr>
<tr>
<td>Silty Clay Loam Clay</td>
<td>2 – 18</td>
<td>42.70</td>
<td>18.38</td>
<td>22 – 44</td>
<td>1.32</td>
<td>3.59</td>
<td>1.32</td>
<td>3.59</td>
<td>1.32</td>
<td>3.59</td>
<td>1.32</td>
<td>3.59</td>
<td>1.32</td>
<td>3.59</td>
</tr>
<tr>
<td>Clay</td>
<td>46.62</td>
<td>2.16</td>
<td>18.38</td>
<td>2 – 18</td>
<td>1.33</td>
<td>3.61</td>
<td>47.9</td>
<td>5.75</td>
<td>21.5</td>
<td>2.58</td>
<td>16.7</td>
<td>2.0</td>
<td>13.9</td>
<td>1.67</td>
</tr>
<tr>
<td>Silty Clay</td>
<td>2 – 18</td>
<td>42.58</td>
<td>25.85</td>
<td></td>
<td>1.23</td>
<td>3.34</td>
<td>2 – 44</td>
<td>3.34</td>
<td>2 – 44</td>
<td>3.34</td>
<td>2 – 44</td>
<td>3.34</td>
<td>2 – 44</td>
<td>3.34</td>
</tr>
</tbody>
</table>

- V – Very & F – Fine
- Particle diameter (mm) for Sand, Silt & Clay: Very Coarse Sand (2.0 – 1.0), Coarse Sand (1.0 – 0.5), Medium Sand (0.5 – 0.25), Fine Sand (0.25 – 0.1), Very Fine Sand (0.1 – 0.05), Silt (0.05 – 0.002) and Clay (< 0.002)
- Cation Exchange Capacity (CEC) taken from the Western Fertilizer Handbook, 2nd Ed., 1995
- Bulk Density (Ref. bulk density calculator @ Pedosphere.com)
- Unavailable Water (Ref. Figure 1-9 of the National Engineering Handbook; Section 15 – Irrigation)
- Available Water (Ref. NRCS Salinity Management for Soil & Water; Table 5.1, page 5.10)
- FC = Field Capacity.

**Note:** Soil structure is evaluated for its effect on downward movement of water: Single grain (rapid), Granular (rapid), Blocky (moderate), Prismatic (moderate), Platy (slow) and Massive (slow). The Soil Intake Family (typically 0.1 thru 2.0) is used in IWM field evaluations and irrigation system design. Irrigation Water Quality (i.e., Electrical Conductivity of Irrigation water (ECiw) in dS/m & Sodium Adsorption Ratio (SAR)) is evaluated for its potential detrimental effects on plant moisture availability and water infiltration. rudy.garcia.2008