Irrigation and Water for Gardening

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Gardening Study Course II
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What We’ll Cover....

- Planting efficiently
- Water use and water saving factors
  - Amounts of water needed
  - Methods of watering
  - Water problems
    - Water quality and quantity
    - Water bans
- Current water issues
If you take care of your soil, the soil will take care of your plants.

- Plant available water depends on:
  - Soil structure & texture
  - Water infiltration rate
  - Soil organic matter
  - Soil type
  - Plant rooting depth

![Soil Composition Pie Chart](chart.png)

- 50% pore space
- 50% solid
- 25% Air
- 45% Mineral Matter
- 5% O.M.
USDA Soil Texture Classes

- **Particle size**
  - Sand = 2.0-0.05 mm
  - Silt = 0.05-0.002 mm
  - Clay = <0.002 mm

- **Characteristics**
  - Sand adds porosity
  - Silt adds body to the soil
  - Clay adds chemical & physical properties
Determining Soil Texture

- By feel
  - Gritty, smooth, sticky
- Using the jar method
  - Fill a 1-quart jar ¼ full of soil
  - Fill the jar with water to ¾ full
  - Add 1 teaspoon of dishwashing detergent
  - Shake very well to suspend soil
  - Place on a flat surface and allow soil to settle for 2 days
  - Measure % thickness of each layer relative to all
Checking Soil Drainage

- Perched water table
- Fragipan on upland soils
- Standing water after a rain

Photo credit: truebluesam.blogspot.com/2011/05/clay-pan-soils.html
Benefits of Using Compost

- Improves drainage & aeration of heavy clay soils
- Increases moisture-holding ability of sandy soils
- Increases earthworm & soil microbial activity that benefit plant growth
- Improves soil structure & makes it easier to work
- Contains nutrients needed for plant growth
Soil Properties

- Soils store 1.5”-2.5” of water per foot of depth (check county NRCS Soil Survey)
- Intake rate = 0.2”-2.0” per hour, rest is runoff
- Available Soil Moisture* = % of soil water between field capacity & permanent wilting point = ranges by crop from 25% to 75%
- Summer E.T. rate can be 0.25”+ per day
  - E.T. affected by radiation, humidity, air temperature, wind speed
- A 2-ft. deep soil at best holds a 9-15 day supply of available moisture for plants

References:  
* websoilsurvey.nrcs.usda.gov/app/  
** www.ces.ncsu.edu/depts/hort/hil/hil-33-e.html
# Available Water Holding Capacity for Several Soil Types

Reference: Midwest Vegetable Production Guide for Commercial Growers
http://www.btny.purdue.edu/pubs/id/id-56/

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Available Water Holding Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>In Inches per Inch of Soil</strong></td>
</tr>
<tr>
<td>Loamy fine sand</td>
<td>0.08-0.12</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>0.10-0.18</td>
</tr>
<tr>
<td>Loam</td>
<td>0.14-0.22</td>
</tr>
<tr>
<td>Silt loam</td>
<td>0.18-0.23</td>
</tr>
<tr>
<td>Clay loam</td>
<td>0.16-0.18</td>
</tr>
<tr>
<td>Drainage Class</td>
<td>Matrix</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Well</td>
<td>Bright red</td>
</tr>
<tr>
<td>Moderately well</td>
<td>Red</td>
</tr>
<tr>
<td>Somewhat poorly</td>
<td>Dull</td>
</tr>
<tr>
<td>Poorly</td>
<td>All gray</td>
</tr>
</tbody>
</table>
Color Indicates Drainage & Pans

Captina Silt Loam

Tonti Silt Loam

Scholten Gravelly Silt Loam
Most of the active root system for water uptake may be between 6”-12”
Basic Watering Facts

- Plants need 1”-1.5” of water per week
  - 624-935 gallons (83-125 cu.ft.) per 1,000 sq.ft.
- Can survive drought on half that rate
- Deep infrequent waterings are better than several light waterings
- Deeper roots require less supplemental irrigation
- Taller plants have deeper roots
  - Lowers tendency to wilt
  - Shades soil surface
  - Controls weeds by competition
  - Makes water “go farther”
When to Water

- Rainfall less than 1” per week
  - Keep a record of rainfall received
  - Check soil moisture with long screwdriver
- Water in early morning.
  Let plant leaves dry before evening to prevent diseases
When to Water

- Your plants will tell you when they need water
  - Purple-blue wilting leaves
  - Grass that leaves footprints
  - Folded or rolled leaves

![Diagram showing signs of watering needs: Just rained, Getting dry, Time to water, Drought.]
What to Water

- Irrigate highly visible & intensively-managed areas first
- High priority to drought-sensitive plants
- Low priority to turf (less costly to replace)
Measuring Water Needs

- Catch cans
- 4-cycle timer
- Rain gauge
The Two Major Factors in Irrigation System Planning

1. How much **water** do you need?

2. How much **time** do you have?
Is a Rain Barrel Enough?

- 1” of rain from a 1,600 sq. ft. house roof = 1,000 gallons
- Elevation dictates pressure
  - 2.3 feet of head = 1 psi pressure

Photo credit: www.lakesuperiorstreams.org

55 gal.

850 gal. = 3.5 psi

31,000 gal. = 23 psi
Watering Mature Trees and Shrubs

- Most roots in top 12” of soil
- Root spread up to 4X tree crown spread
  - Varies by tree species
- Saturate 20% of root zone 12” deep
How Much Water for Trees?

- Gallons needed for 1” water per week = \( \frac{\text{Diameter} \times \text{Diameter}}{2} \)

- Example #1: 
  \[6 \text{ ft.} \times 6 \text{ ft.} = \frac{18 \text{ gal.}}{\text{wk.}}\]

- Example #2: 
  \[20 \text{ ft.} \times 20 \text{ ft.} = \frac{200 \text{ gal.}}{\text{wk.}}\]

Formula: \((\text{Dia.'} \times \text{Dia.'} \times 0.7854 \div 43,560 \text{ sq.ft./ac.}) \times 27,154 \text{ gal./ac.-in.})\)
Watering Trees

Soaker hose around drip line of tree

“Gender bender” to improve uniformity of water flow
Bucket & Jug Irrigation

- Labor-intensive
- Efficient water use
- Point-source application
- 0-2 psi system operating pressure
- Rates:
  - 2 GPH = 5/64” hole (put in bottom of bucket)
  - 5 GPH = 1/8” hole
Soaker Hose

- “Sweaty” hose
- Low pressure
- 1/2” - 5/8” dia.
- 0.1 - 1.0 GPH per foot
- Lasts 7-10 years
- Good for gardens, shrub beds
- Expensive on large areas
Micro-Sprinkler

- Good for landscape beds
- Uses more water than soaker hose
- More evaporation
- Wide range of spray patterns
  - Spray range is 1.5-6 ft.
- Not effective for frost control
Sprinkler Irrigation

- 1.5-8.5 GPM flow rate
- 4-7 GPM water supply/acre for irrigation
- 45-60 GPM/acre for frost control from 25°F-20°F.
- 25-45 psi system operating pressure
- Wind can disrupt coverage
- Equipment & labor tradeoff
- Cost = $500-$700/acre (??)
How a Sprinkler Waters

One sprinkler applies a lot of water close in and less water farther away, so watering is uneven.

When sprinklers are set so that patterns overlap, the entire area gets an even amount of water.
Check Sprinkler Overlap

**CORRECT**
- High uniformity
- No waste

**INCORRECT**
- Poor uniformity
- Inadequate irrigation

**INCORRECT**
- Poor uniformity
- Wasted water
Sprinkler Irrigation

Oscillating sprinkler covers 3,500 sq.ft. rectangle

Traveling sprinkler covers 16,500 sq.ft. variable path
Sprinkler Irrigation

Whirling-head sprinkler covers
5 to 50 ft. diameter

Rotary or impulse sprinkler covers
partial to full circles
Drip Irrigation 1

- Also known as:
  - Trickle irrigation
  - Micro-irrigation
  - Low-volume irrigation
Example Layout of Drip Irrigation System
Drip Irrigation

- 0.5-2.0 GPH flow rate per emitter
- 2-5 GPM/acre for water supply
- Point use gives less runoff, less evaporation, easier weed control, saves 30%-50% water
- Low pressure of 6-20 psi means smaller pumps & pipes
- Can fertilize through system
- Do field work while irrigating
Drip Irrigation

- Can automatically control
- Susceptible to clogging
- Must design system to carefully match equipment to elevation
  - 2.3 feet of head = 1 psi pressure
- Requires diligent management
- Cost = $1100 - $1500 for 1st acre;
  $750 - $1000/acre for rest
Wetting Patterns (Drip)

Cross Section of Soil Showing Wetted Areas

Surface Installation (dripline near soil surface)

Wetted Area Appearing on Soil Surface
- Sandy
- Loam
- Clay

Cross Section of Wetted Area in Soil
- Sandy 2' to 3'
- Loam 3' to 5'
- Clay 5' to 7'

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Drip Laterals & Emitters

Split water flow for low-use plants

Roll up & store laterals at end of season
Home Garden Drip Irrigation
Home Garden Drip Irrigation

Supply, pressure regulator & filter

Push barbed valve into hole

Layout & Connect

Push tape on & tighten collar nut
## Plant Water Requirements

(Design rates for southwest Missouri assuming no effective rainfall for >60 days.)

<table>
<thead>
<tr>
<th>Fruit Crop</th>
<th>Plant x Row Spacing, Ft.</th>
<th>Sq.Ft./Plant</th>
<th>Plants/Acre</th>
<th>Gal/Plant/Day</th>
<th>Gal/Acre/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>6 x 14</td>
<td>84</td>
<td>518</td>
<td>8</td>
<td>4144</td>
</tr>
<tr>
<td></td>
<td>18 x 26</td>
<td>468</td>
<td>93</td>
<td>42</td>
<td>3906</td>
</tr>
<tr>
<td>Peaches</td>
<td>15 x 20</td>
<td>300</td>
<td>145</td>
<td>28</td>
<td>4060</td>
</tr>
<tr>
<td></td>
<td>18 x 20</td>
<td>360</td>
<td>121</td>
<td>34</td>
<td>4114</td>
</tr>
<tr>
<td>Grapes</td>
<td>8 x 10</td>
<td>80</td>
<td>540</td>
<td>10</td>
<td>5440</td>
</tr>
<tr>
<td></td>
<td>8 x 16</td>
<td>128</td>
<td>340</td>
<td>16</td>
<td>5440</td>
</tr>
<tr>
<td>Blueberries</td>
<td>4 x 12</td>
<td>48</td>
<td>908</td>
<td>4</td>
<td>3632</td>
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</tbody>
</table>
## Plant Water Requirements

(Design rates for southwest Missouri assuming no effective rainfall for >60 days.)

<table>
<thead>
<tr>
<th>Fruit Crop</th>
<th>Gallons per 100 Feet of Row per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strawberries</td>
<td>50</td>
</tr>
<tr>
<td>Raspberries &amp; Blackberries</td>
<td>75</td>
</tr>
<tr>
<td>With mulch</td>
<td>100</td>
</tr>
<tr>
<td>Without mulch</td>
<td></td>
</tr>
</tbody>
</table>
# Plant Water Requirements

(Estimated design rates for southwest Missouri)

<table>
<thead>
<tr>
<th>Vegetable Crop (mature)</th>
<th>Gallons per 100 Feet of Row per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum for plant survival</td>
<td>100</td>
</tr>
<tr>
<td>Lettuce, spinach, onions, carrots, radishes, beets</td>
<td>200</td>
</tr>
<tr>
<td>Green beans, peas, kale</td>
<td>250</td>
</tr>
<tr>
<td>Tomatoes, cabbage, peppers, potatoes, asparagus, pole beans</td>
<td>300</td>
</tr>
<tr>
<td>Corn, squash, cucumbers, pumpkins, melons</td>
<td>400-600</td>
</tr>
</tbody>
</table>
Calculating Irrigation Water Needs

- 1” of water = 27,154 gallons per acre
- 1 acre = 43,560 sq. ft.
- 0.25”/day pan evaporation rate = 1.75”/week
- Formula for 1.5” of water per week:
  - Gallons/100 ft. of row/day = (66 x 80% of Pan Evaporation Rate x Row width in feet)
- Example for 5 twin rows 100 ft. long x 2 ft. wide
  - GPD/100 ft. = (66 x 0.25 x .80 x 2) = 26.4 gallons
  - Gallons per day = 26.4 x (5 beds x 2 plant rows) = 264 gallons per day = 1,848 gallons per week
  - 264 GPD ÷ (30 GPH/100 ft. drip tape) x 10 rows = 0.88 hours/day = 53 minutes/day
### Hours Required to Apply 1” of Water to Mulched Raised Bed

<table>
<thead>
<tr>
<th>Drip Tube Flow Rate</th>
<th>Width of Mulched Bed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 feet</td>
</tr>
<tr>
<td>Gallons per Hour per 100 feet run of drip tape</td>
<td>Gallons per Minute per 100 feet run of drip tape</td>
</tr>
<tr>
<td>16</td>
<td>0.27</td>
</tr>
<tr>
<td>18</td>
<td>0.30</td>
</tr>
<tr>
<td>20</td>
<td>0.33</td>
</tr>
<tr>
<td>24</td>
<td>0.40</td>
</tr>
<tr>
<td>30</td>
<td>0.50</td>
</tr>
<tr>
<td>36</td>
<td>0.60</td>
</tr>
<tr>
<td>40</td>
<td>0.67</td>
</tr>
<tr>
<td>42</td>
<td>0.70</td>
</tr>
<tr>
<td>48</td>
<td>0.80</td>
</tr>
</tbody>
</table>

- For a 2 foot width of mulch, the required hours are 8.0, 10.0, and 11.5 for drip rates of 16, 18, and 20 gallons per hour per 100 feet run of drip tape, respectively.
- For a 2.5 foot width, the required hours are 7.0, 8.5, and 10.5.
- For a 3 foot width, the required hours are 6.0, 8.0, and 9.5.

*Note: The table highlights the hours required for a 30 gallons per hour flow rate and a 2 foot width of mulch.*
Estimating Water Quantity

- **Household water demand**
  - GPM = Total count of toilets, sinks, tubs, hose bibs, etc. in home

- **Excess is available for irrigation**
  - Contact pump installer for capacity data

- **Is pressure tank large enough?**
  - Stay within cycle limits of pump, OR
  - Run the pump continuously
# Home Water Flow Rates

<table>
<thead>
<tr>
<th>Number of Bathrooms in Home</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>--</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>--</td>
<td>13</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>6</td>
<td>--</td>
<td>--</td>
<td>16</td>
<td>18</td>
</tr>
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</table>

Source: MU Guide G1801
## Pump Cycling Rate, Max.

<table>
<thead>
<tr>
<th>Horsepower Rating</th>
<th>Cycles/ Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25 to 2.0</td>
<td>20</td>
</tr>
<tr>
<td>3 to 5</td>
<td>15</td>
</tr>
<tr>
<td>7.5, 10, 15</td>
<td>10</td>
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</table>
# Pressure Tank Selection

<table>
<thead>
<tr>
<th>Tank Size, gallons</th>
<th>Average Pressure, psi*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Pumping Capacity, GPM</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>5</td>
</tr>
<tr>
<td>82</td>
<td>11</td>
</tr>
<tr>
<td>144</td>
<td>19</td>
</tr>
<tr>
<td>220</td>
<td>29</td>
</tr>
<tr>
<td>315</td>
<td>42</td>
</tr>
</tbody>
</table>

* Cut-in pressure + 10 psi = Avg. Pressure = Cut-out pressure - 10 psi
Pressure Tanks

Larger tank

OR

Variable speed pump controller

Multiple tanks
Water Source Quality

Good

- Well = check pH & hardness
- Municipal = may be expensive
- Spring = may not be dependable
- River or stream = depends on runoff
- Lake or pond water = sand filters
- Pump to tank on hill = limited use

Poor
Using Ponds for Irrigation

- Pond 8' deep, 100' dia. holds 280,000 gallons of water.
- One-half of water volume is usable for irrigation. Rest is seepage & evaporation.
- 20 GPM demand for 20 hrs/day uses 24,000 gal/day.
- Pond holds about 6-day water supply.
- Water is least available when most needed!!
Pond Water Quality

- Grass filters sediment & nutrients
- Copper sulfate controls algae & slime
- No overhead irrigation on vegetables or fruits
Water Quality Analysis

- Inorganic solids = sand, silt
- Organic solids = algae, bacteria, slime
- Dissolved solids (<500 ppm)
  - Iron & Manganese
  - Sulfates & Chlorides
  - Carbonates (calcium)
- pH (5.8-6.8 preferred)
- Hardness (<150 ppm)
- E. coli bacteria

Resources:
soilplantlab.missouri.edu/soil/water.aspx
https://utextension.tennessee.edu/publications/Documents/SP740-B.pdf

PVC Casing
Steel Casing
# Plugging Potential of Drip Irrigation Systems

<table>
<thead>
<tr>
<th>Factor</th>
<th>Moderate (ppm)*</th>
<th>Severe (ppm)*</th>
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<tbody>
<tr>
<td>Physical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspended solids</td>
<td>50-100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Chemical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH**</td>
<td>7.0-7.5</td>
<td>&gt;7.5</td>
</tr>
<tr>
<td>Dissolved solids</td>
<td>500-2000</td>
<td>&gt;2000</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.1-1.5</td>
<td>&gt;1.5</td>
</tr>
<tr>
<td>Iron</td>
<td>0.1-1.5</td>
<td>&gt;1.5</td>
</tr>
<tr>
<td>Hardness***</td>
<td>150-300</td>
<td>&gt;300</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>0.5-2.0</td>
<td>&gt;2.0</td>
</tr>
</tbody>
</table>

* ppm = mg/L

** pH is unitless

*** Hardness: ppm = gpg x 17
Friction Loss Design

- Size piping for 1 psi or less pressure loss per 100 feet
  - Pipe diameter x 2 = 4X flow rate
- Pipe friction may replace pressure regulators on downhill runs
- Vary flowrate no more than 20% (+/- 10%) within each block of plants
- Manifolds attached to mainline...
  - at center if < 3% slope
  - at high point if 3+% slope

5 GPM 1”

20 GPM 2”
# Plastic Pipe Friction Loss

<table>
<thead>
<tr>
<th>GPM</th>
<th>0.75&quot;</th>
<th>1&quot;</th>
<th>1.5&quot;</th>
<th>2&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>2.8</td>
<td>0.8</td>
<td>0.1</td>
<td>--</td>
</tr>
<tr>
<td>10</td>
<td>11.3</td>
<td>3.0</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>15</td>
<td>21.6</td>
<td>6.4</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>20</td>
<td>37.8</td>
<td>10.9</td>
<td>1.3</td>
<td>0.4</td>
</tr>
<tr>
<td>25</td>
<td>--</td>
<td>16.7</td>
<td>1.9</td>
<td>0.6</td>
</tr>
<tr>
<td>30</td>
<td>--</td>
<td>--</td>
<td>2.7</td>
<td>0.8</td>
</tr>
</tbody>
</table>
Current Water Issues
that can affect gardening

- Good Agricultural Practices (GAPs)
  - Food safety
- Major Water Users law
  - File annual report with MoDNR if >100,000 GPD
- Waters of the United States (WOTUS)
  - Under litigation
- Rainwater harvesting
  - Illegal in some states
- Water conservation
  - Local shortages
Good Agricultural Practices - Irrigation Water

- Pathogens that contaminate the surface of produce are difficult to remove
- Irrigation water can be a vehicle for foodborne pathogens
  - E. coli 0157:H7 in spinach
  - Salmonella in peppers
- GAPs program looks at food safety practices
  - Irrigation water quality
  - Manure management
  - Worker hygiene
  - Harvesting, transportation & storage practices
Well Depletion

Static water table

High-capacity well

Existing wells

Initial cone of depression

Cone of depression

Long-term cone of depression
Waters of the United States (WOTUS)

- Clean Water Act of 1972 established regulated waters ("blue line" streams) by EPA and U.S. Army COE
- WOTUS rule blocked by federal court from starting 8/28/2015
  - Greatly differs from the proposed rule provided for public comment
  - COE believes EPA used flawed technical and scientific analysis in crafting the regulation
  - EPA failed to consult with state and local governments, confer with business stakeholders, comply with the requirements of the Regulatory Flexibility Act, or produce an accurate cost-benefit analysis.
  - Puts millions of additional acres of private land under federal control
  - Major parts of the rule remain largely incomprehensible to experts and laypeople
  - Landowners have no reliable way to know which of the water and land within that area will be regulated, yet they must still conform their activities to the new law.

Previous rules/guidance – Tributaries and Adjacent Wetlands
Absent case-specific “significant nexus” finding, only perennial and intermittent tributaries (blue lines) and adjacent wetlands (green shapes) deemed jurisdictional.
(Note: light blue shapes designate freshwater ponds.)
New WOTUS Rule – More Automatically Regulated “Tributaries”
Ephemeral tributaries (red lines) deemed jurisdictional without further analysis.
Ditches also regulated if “excavated in” or “relocated” a tributary.
Note: This map does not show jurisdictional ditches and may not include all ephemeral tributaries
New WOTUS Rule – Automatically Regulated Adjacent Waters
Includes all “waters”—including wetlands—that lie even partially within a 100-foot buffer (pink shading) around all perennial, intermittent and ephemeral streams.
New WOTUS Rule – More Automatically Regulated Adjacent Waters
Includes all “waters”—including wetlands—where any part is within the 100-year floodplain and not more than 1,500 feet from a tributary. Light green shading shows the 1,500-feet zone and hash marks show the known FEMA Flood Zone maps (which may be out-of-date or may not be relied upon by the Corps). Absent definitive flood zone information from the Corps, any water partially within the light green shading is a possible “adjacent water.”
New WOTUS Rule – Maybe Regulated “Significant Nexus” Waters
Water/wetlands even partially within 4,000 feet (about ¾ mile) of a tributary can be regulated on a “significant nexus” finding. Orange shading shows land outside the possible adjacency zone but within the 4,000 feet zone.

Even without mapping around jurisdictional ditches, the area of possible regulation covers the entire map.
## Missouri WOTUS Zones

<table>
<thead>
<tr>
<th>Missouri</th>
<th>Acres</th>
<th>Share of Total Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Acres in State</td>
<td>44,692,943</td>
<td></td>
</tr>
<tr>
<td>Acres within 100-ft buffer (adjacent)</td>
<td>3,869,667</td>
<td>7%</td>
</tr>
<tr>
<td>Acres within 1,500-ft buffer (possibly adjacent)</td>
<td>4,1172,874</td>
<td>92%</td>
</tr>
<tr>
<td>Acres within 4,000-ft buffer (subject to “significant nexus” finding)</td>
<td>44,549,122</td>
<td>99.7%</td>
</tr>
</tbody>
</table>
Water Harvesting

- Illegal in some western states
- Possible in MO
  - 0.62 gal./sq. ft./inch of rain
  - 41” rain/year
  - 70% efficiency
  - 18 gal./sq. ft / per year
Water Conservation Measures (Indoors)

a. Repair faucet & toilet leaks
b. Install toilet dams on older units
c. Avoid unnecessary toilet flushing
d. Take short showers instead of baths (8-10 gallons vs. 30-50 gallons)
e. Use low-flow shower head (50% less water, with more velocity)
Water Conservation Measures (Indoors)

f. Turn off shower when shampooing or soaping

gh. Run only full loads in dishwasher & clothes washer (20-50 gallons/cycle)

h. Install faucet aerators (50% less water)

i. Turn off faucet when shaving, brushing teeth, handwashing dishes

j. Limit use of the hot tub/spa/Jacuzzi
Irrigation Resources on the Web

- Irrigation System Planning & Management Links
  extension.missouri.edu/webster/irrigation.aspx

- USDA NRCS Web Soil Survey
  websoilsurvey.sc.egov.usda.gov/App/
Questions??

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Web: extension.missouri.edu/webster

Program Complaint Information
To file a program complaint you may contact any of the following:

University of Missouri
- MU Extension AA/EEO Office
  109 F. Whitten Hall, Columbia, MO 65211
- MU Human Resources Office
  130 Heinkel Bldg, Columbia, MO 65211

USDA
- Office of Civil Rights, Director
  Room 326-W, Whitten Building
  14th and Independence Ave., SW
  Washington, DC 20250-9410

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