WaterTalks Workshop
March 16th, 2016
Agricultural Water Treatment & FDA Rules
Today’s Topics

• Overview of FDA Rule for Agricultural Water

• How to Comply with New FDA Rule

• Why Treat Your Water and How

• How do We Deal With High Iron Waters
FDA Rule on Agricultural Water: Microbial Water Quality

• FDA Rule establishes two sets of criteria both based on presence of generic E. coli.

• E. coli can indicate presence of fecal contamination which is known to cause human illness in recreational water when ingested by humans.
Microbial Water Quality
First Criteria Set – Zero E. coli

• Water Uses with No detectable E. coli allowed:
  – Hand washing during and post harvest
  – Food contact surfaces
  – Direct produce contact during and post harvest
  – Ice with direct contact during and post harvest
  – Water used for sprout irrigation
Microbial Water Quality
Zero E. coli water

• *For water uses with No detectable E. coli – What if E. coli is detected???
• Use must be discontinued immediately and corrective actions taken before re-use.
• You must retest to validate you meet criteria.
• Rule also prohibits use of untreated surface water for any of these uses.
Microbial Water Quality
Second Criteria Set – Numerical E. coli

- Water Uses with Numerical E. coli levels:
  - Water directly applied to growing produce (excepting sprouts – see set #1)
  - Produce is defined as raw agricultural products, any food normally consumed in its raw or natural state
  - Exceptions: Asparagus, most beans and legumes, potatoes, sweet corn, pumpkins, peanuts, more.
Microbial Water Quality
Second Set – Based on Two Values:

• Geometric Mean (GM)
  <126 CFU / 100ml water generic E. coli
  - This is an average level of E. coli in several samples

• Statistical Threshold (STV)
  <410 CFU / 100ml water generic E. coli
  - Level at which 90% of samples are below the value
  - Reflects variability for adverse conditions
Microbial Water Quality
Second Criteria Set – FDA’s Intent:

- These Numerical criteria are intended as a water management tool for use in understanding the microbial water quality over time.

- Also intended for determining a long-term strategy for use of water sources during growing produce (other than sprouts.)
Microbial Water Quality
Second Criteria Set – E. Coli too high:

- If water does not meet these criteria, corrective actions are required as soon as is practicable, but no later than the following year.

- Upon initial testing, if your water does not meet criteria there is additional flexibility:
  - Allow time for microbes to die using a time interval between last irrigation and harvest
  - Allow time for microbes to die between harvest and end of storage or be removed by commercial washing
  - Treating the water
Testing Frequency Based on Water Source

- Untreated Surface Water – High Risk
- Directly applied to Produce:
  - Initial survey using 20 samples minimum, collected as close to harvest as is practicable over 2-4 year period
  - These results will be used to calculate GM and STV
  - Annual survey of 5 samples
  - The 5 new plus the most recent previous 15 will be used to calculate GM and STV
  - If you fail a test you go back to the 20 samples
Testing Frequency Based on Water Source

- Untreated Ground Water – Lower Risk
- Directly applied to Produce:
  - Initial survey using 4 samples minimum, collected as close to harvest as is practicable during the growing season or over 1 year period.
  - These results will be used to calculate GM and STV
  - Annual survey of 1 sample per year
  - The new sample plus the most recent previous 3 will be used to calculate GM and STV
Testing Frequency
Based on Water Source

- Untreated Ground Water – Lower Risk

- For No Detectable E. coli Criterion:
  - Initial survey using 4 samples minimum, collected as close to harvest as is practicable during the growing season or over 1 year period.
  - These results will be used to calculate GM and STV
  - Determine if the water can be used for this purpose
  - Annual survey of 1 sample per year
  - If any annual test fails the microbial quality criterion, farms must resume the 4 times per year testing
Testing Frequency
Based on Water Source

- Public Water Supplies:
  - There is no requirement to test agricultural water that is received from public water systems or supplies that meet requirements established in the rule. You must have copies of the documentation to prove it!
Final Rule on Produce Safety
21 CFR 112

- The rule went into effect on Jan 26th 2016
- Farm size is based on average produce sales over previous 3 years
- Farms with < $25,000 - Exempted
- Farms with $25,000 - $250,000 – Four Years
- Farms with $250,000 - $500,000 – Three Years
- All others – Two Years
Final Rule on Produce Safety
21 CFR 112

- The Bad News – If your water does not meet the criteria outlined above, you need to treat it or use another water source. This costs you money.
- The Good News – Compliance with FDA rules is not the only reason to treat your water. Most of the time there is an ROI for treating your irrigation water.
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Micro-Irrigation System
Treatment, Maintenance & Measurement
Micro-Irrigation Expanding Rapidly

• Why is there such rapid growth of “Micro-Irrigation” ... when Capital Investment is so High??

CA Method of Irrigation since 1978

Is the Reason??

- Cost of Water
- Availability of Water
- Access to New Farmland previously not able to irrigate

Drip adoption is increasing....

Irrigated Acres by Method: California
USDA Farm and Ranch Irrigation Survey

<table>
<thead>
<tr>
<th>Year</th>
<th>Sprinkler</th>
<th>Gravity</th>
<th>Drip</th>
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<tbody>
<tr>
<td>1978</td>
<td>2.14</td>
<td>6.35</td>
<td>0.19</td>
</tr>
<tr>
<td>1984</td>
<td>1.9</td>
<td>5.77</td>
<td>0.45</td>
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<tr>
<td>1988</td>
<td>1.75</td>
<td>5.59</td>
<td>0.36</td>
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<tr>
<td>1994</td>
<td>1.85</td>
<td>5.19</td>
<td>0.93</td>
</tr>
<tr>
<td>1998</td>
<td>1.53</td>
<td>5.82</td>
<td>1.02</td>
</tr>
<tr>
<td>2003</td>
<td>1.72</td>
<td>5.26</td>
<td>1.72</td>
</tr>
<tr>
<td>2008</td>
<td>1.37</td>
<td>4.19</td>
<td>2.34</td>
</tr>
<tr>
<td>2013</td>
<td>1.67</td>
<td>4.53</td>
<td>2.783</td>
</tr>
</tbody>
</table>

% change since 2008
- Sprinkler: 22%
- Gravity: 8%
- Drip: 19%
Micro-Irrigation Expanding Rapidly

• Why is there such rapid growth of “Micro-Irrigation” ... when Capital Investment is so High ??

... Because it generates greater Returns

– Crop Yield -- Crop Quality -- Plant Growth
– Plant health – improved disease and pest control
– Plant health – Improved nutrient management
– Improved weed control
– Farming and operations management, and automation
But ... there are “The Effects of Time”

- University Study of 458 Systems over 10 years
  - Most Nowhere near the original Design Performance
  - Yields Suffer ... and thus Returns Suffer
  - Incredibly expensive to Remove and Replace Systems

Measure → Remediate → Maintain → Measure

Maintain → Measure →
Directly tied to Yield / Returns

Good Uniformity    Good Efficiency    Good Yield

Good Uniformity    Poor Efficiency    Good Yield

Poor Uniformity    Poor Efficiency    Good Yield

Poor Uniformity    Poor Efficiency    Poor Yield

**DISTRIBUTION UNIFORMITY (DU)**
Equal Distribution of Water throughout the Entire Irrigated Block

**IRRIGATION EFFICIENCY (IE)**
All of the Water that is Applied to the Irrigated Block is used Beneficially
How can we Measure DU?
(Cal Poly Methodology)

- 40 acres
- 3rd Leaf Almonds
- Micro-Irrigation
DU = \frac{\text{Avg of Lowest ¼ of Readings}}{\text{Avg of All Readings}}

36 Readings

Overall Avg = 1.0"

0.90"
0.96"
1.06"
1.12"

DU = 90

Overall Avg = 1.0"
0.70"
0.86"
1.16"
1.42"

DU = 70
NDVI Imagery

Normalized Difference Vegetation Index
So Why should we Care about DU?

**DISTRIBUTION UNIFORMITY (DU)**
Equal Distribution of Water

**IRRIGATION EFFICIENCY (IE)**
Water used Beneficially

**CROP HEALTH**
Yield / Return via University Research

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<table>
<thead>
<tr>
<th>Study</th>
<th>Water to Yield decrease ratio</th>
<th>Effects begin:</th>
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</thead>
<tbody>
<tr>
<td>Cal Poly - SLO¹</td>
<td>1% : 2% (.75 ton/acre)</td>
<td>Below 92%</td>
</tr>
<tr>
<td>UN Food &amp; Agricultural Organization (with U.C. Davis)²</td>
<td>1% : 1% 1% : 1.5%</td>
<td>Below 80%</td>
</tr>
<tr>
<td>Cal State Fresno³</td>
<td>2% : 1%</td>
<td>Below 80%</td>
</tr>
</tbody>
</table>
Leading Causes of Poor DU

- System Design and Layout
- System Filtration
- Clogging over Time
  - Clogging from Mineral Deposits
  - Clogging from Bio-fouling
  - Clogging from Root Intrusion

Remediate – Maintain – Measure
Routine Maintenance is Required
Biological Fouling (Bio-Slime)
Mineral Scale
Bio-Fouling Remediation

**DU Score 65**

**BEFORE**
Bio-Fouling Remediation

**DU Score 65**

**BEFORE**

**DU Score 90**

**AFTER**
Maintenance Program for Mineral Scale

**WITH**

Calcium Carbonate

**WITHOUT**

Iron Precipitate
Irrigation System Maintenance Program

- Saving Water
- Improving Crop Health/Quality
- Optimizing Nutrition Program
- Extending Irrigation System’s Life
Account – Parent Account (CPS Branch or Taylor Made)
Account – Customer (such as Campos Brothers)
Property – Geographic and Interconnections (such as the I5 Ranch)
Site → Filter Station or Well or Irrigation Pump System

Water Source
• Well
• District Water
• Reservoir

Typical Micro-Irrigation System

Chemical Injection

Sand Filters
• FlowMeter with Integrated “Flow-Paced” Operation  

- Flow-Paced Chemical Dosage  
- Improved Accuracy and Control  
- Precise Treatment Program
A Well-Designed Chemical Treatment Program

FDA Compliance or Biological Challenge

- Chlorine Dioxide
- Chelated Copper
- Sodium Chlorite
- Sodium Hypochlorite
- PAA (Peroxyacetic Acid)
- Hydrogen Peroxide
A Well-Designed Chemical Treatment Program
Iron or other Mineral Challenge

- Sodium Hypochlorite or other oxidizers combined with aeration in a reservoir and or filtration
- Chelants and Sequestrants
- Polymers for Transport
A Well-Designed Chemical Treatment Program
Iron or other Mineral Challenge

• Three Main Strategies for Dealing with Iron:
  • Oxidation and Precipitation
  • Filtration – ex) Greensand
  • Make the iron soluble and transport it
A Well-Designed Chemical Treatment Program
Iron or other Mineral Challenge

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QUESTIONS ??