Produce Safety ALLIANCE

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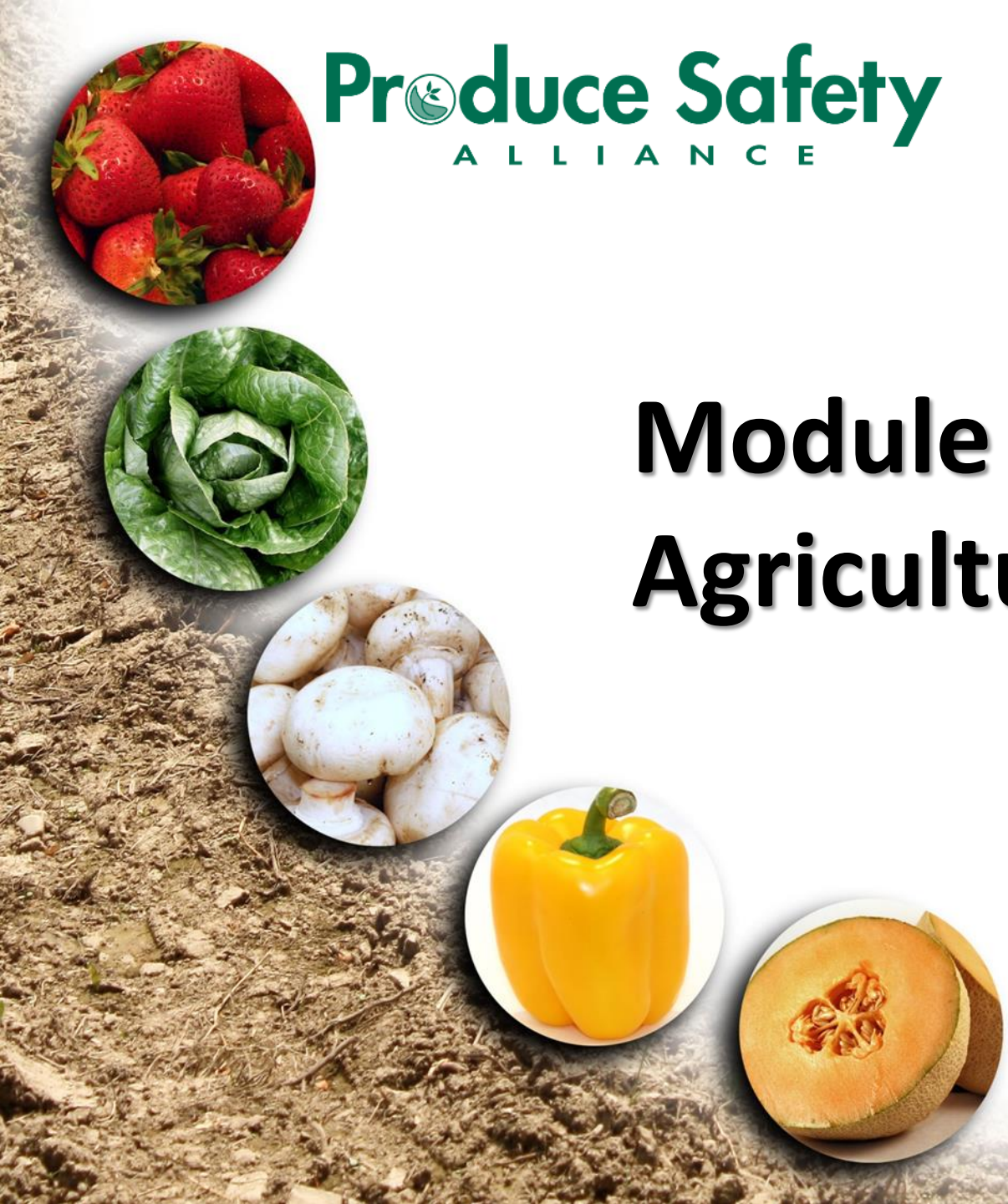

Produce Safety
ALLIANCE

Module 5: Agricultural Water

Two Sections on Water

- **Part I: Production Water**
  - Water used in contact with produce during growth
  - Irrigation, fertigation, foliar sprays, frost protection
- **Part II: Postharvest Water**
  - Water used during or after harvest

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Agricultural Water Quality

- All agricultural water must be safe and of adequate sanitary quality for its intended use
  - Applies to water used for purposes outlined in both Parts I and II of this module

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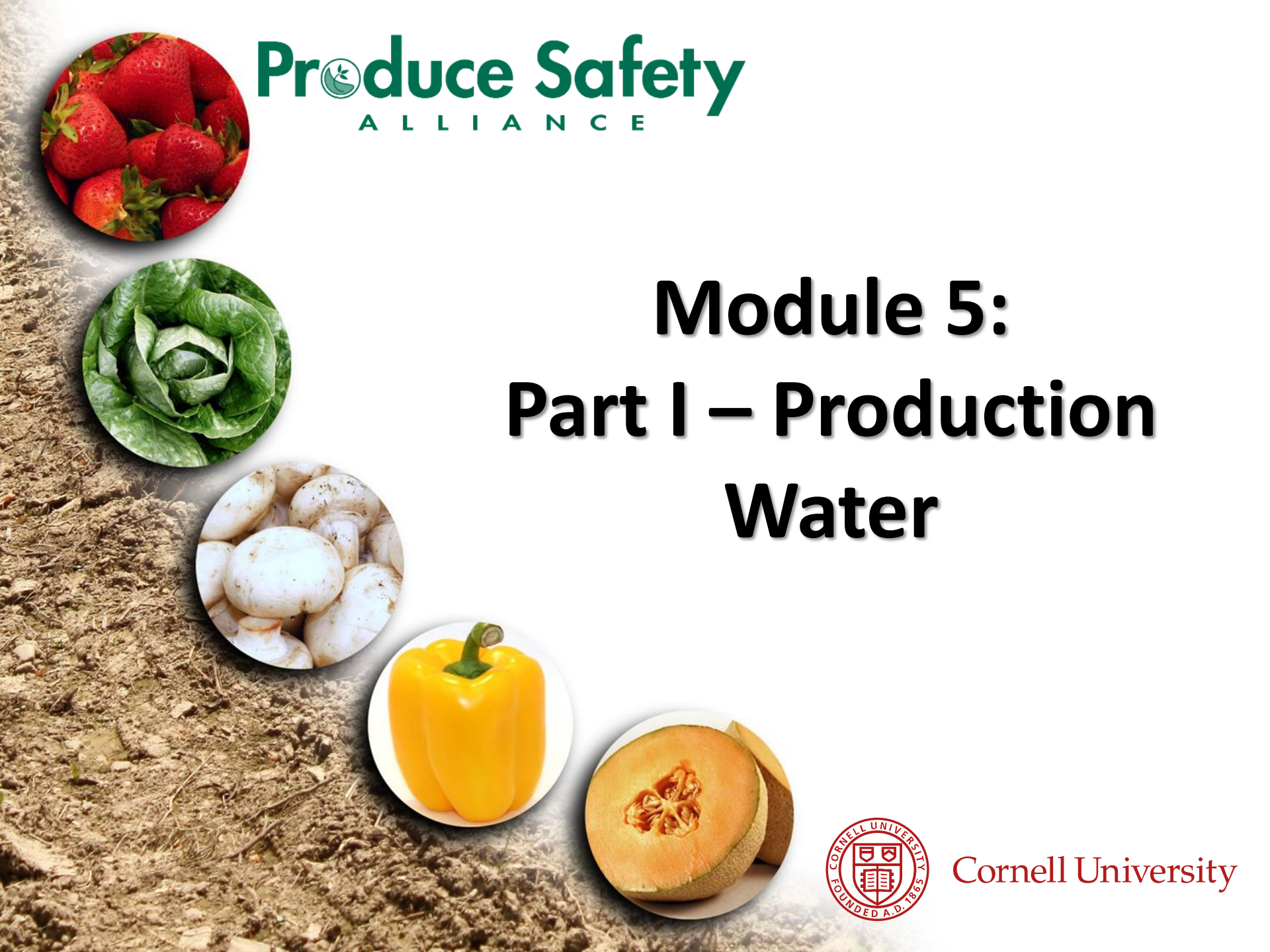
Helpful Definitions

- **Agricultural water** must be safe and of adequate sanitary quality for its intended use.
  - **Agricultural water** means water used in covered activities on covered produce where water is intended to, or is likely to, contact covered produce or food contact surfaces.
  - **Covered produce** means produce that is subject to the requirements of the Produce Safety Rule. The term "covered produce" refers to the harvestable or harvested part of the crop.



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Module 5: Part I – Production Water

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Learning Objectives

- Identify risks that impact the microbial safety of water sources
- Describe practices such as water application method and timing that can reduce those risks
- Adopt practices that limit impacts to the environment, soil quality, and wildlife habitat
- Describe the importance of water testing
- Describe FDA agricultural water quality criteria
- Describe actions that could be taken if agricultural water related risks are identified
- Identify records necessary to document agricultural water quality and use

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Agricultural water used for irrigation is a **major risk factor** in contamination of “high” risk or covered products, eaten raw e.g. leafy greens, melons.

Production Water Concerns

- Many factors impact the quality of water
- Many sources and uses of water on the farm
- Human pathogens can be introduced into water and contaminate produce during growing activities

Produce safety is impacted by all of these things!

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How do you know your water is safe?

Are you aware of what's happening upstream?

What is the risk here?

How safe is this water source?

First you need to look – audit yourself

Penn State 2012

Production Water Uses Include:

- Irrigation
- Fertigation
- Crop sprays
- Cooling
- Frost protection
- Dust abatement
- Other uses where water directly contacts produce

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Evaluating Risks Related to Production Water

Three main impact points for produce safety risks related to production water are:

1. Production water source and quality
   - Public water supply, ground water, surface water
   - Testing frequency and sampling location
2. Application method
   - Water that does not contact the harvestable portion
   - Water that contacts the harvestable portion of the crop
3. Timing of application
   - At planting or close to harvest

Probability of Contamination

Lower Risk → Higher Risk

Public Water Supply

Treated

Ground Water

Surface Water

Open to Environment

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Preventing Contamination of Water from Public Water Supplies

Public water supplies are treated to meet microbial drinking water standards, but distribution systems can introduce risks, therefore:

- Assess your connection to the public water supply and distribution system downstream
- Test the water if you have any concerns about the water source
- Have a back-up plan if you think water in the distribution system may be unsafe

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Preventing Contamination of Ground Water Sources

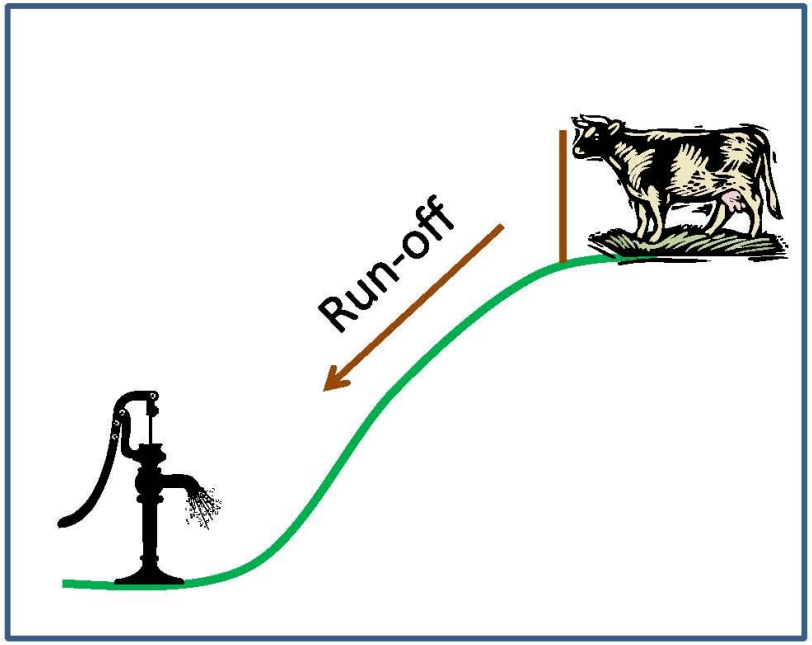
- Inspect well to ensure it is in good condition
- Inspect wellhead to ensure it is properly capped and elevated
- Be sure land slopes away from wellhead to prevent runoff contamination into the well
- Install backflow prevention devices

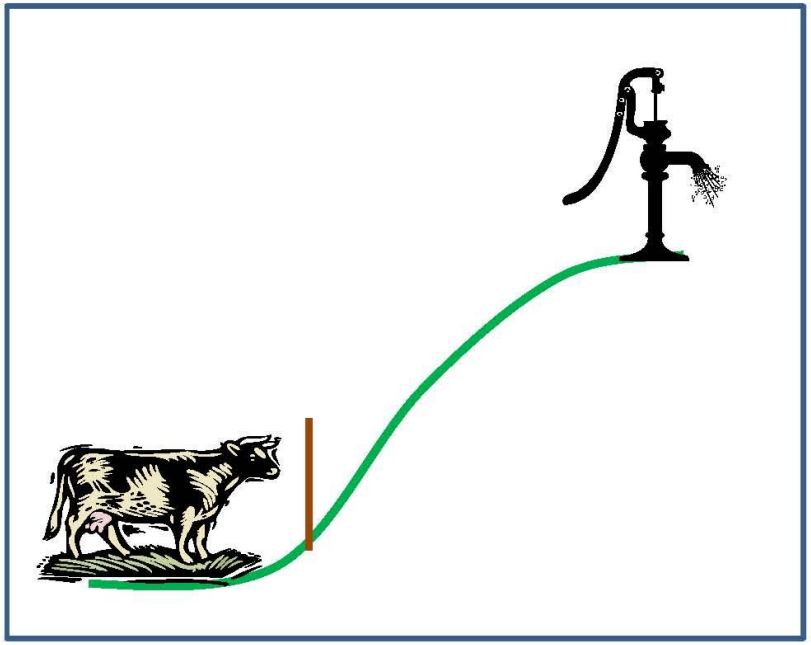
Contamination of Well (Ground) Water

- Can become contaminated by floods or heavy rains
- Can become contaminated if wells located too close to cesspools, septic tanks, agricultural sites, manure storage areas, or drainage fields
- Poorly maintained wells or pumps
- Livestock or other sources of pollutants in active well recharge area

From Penn State, 2012

Consider the topography of your site





Higher risk

Lower risk

Run off from higher elevations can contaminate wells

If you have a well…consider:

- Well location (in relation to pollution sources)
- Separation distances (from potential pollution sources)
- Surface water drains away
- Well casing (are there cracks or holes?)
- Well cap (vermin proof, screened vents, tamper proof)
- Well age (older wells may have problems)
- Well type (drilled wells vs. dug wells)
- Well depth (deeper wells are more protected)
- Accessible for repair, maintenance, testing, inspection

Safe Water Supply: What can you do?

Develop a well maintenance plan

- Keep the well area clean and accessible
- Keep pollutants as far away as possible and check for possible sources of contamination: septic systems; animal waste, including manure storage; storage, handling and use of chemicals, including pesticides
- If your well is ≥ 30-40 years, have the well examined by a water quality expert.

Safe Water Supply: Public and Ground What can I do?

Pay attention to backflow prevention when using municipal water or drinkable well water systems.

If potable water (drinking water as defined by EPA) and waste water or non-potable water source (boiler or a hose in a wash-water bucket) are connected in some way, this is called a **cross-connection.**

When a cross-connection exists, there is the potential for **backflow**, contaminating the drinkable water system.

Backflow occurs when the **direction of flow** is reversed due to a change in pressures causing either **back-siphonage** or **backpressure backflow**.

Examples of Backflow

- **Back-siphonage** can occur when there is a loss of water pressure (negative water pressure) anywhere in the water supply system.
  - A back-siphonage can occur when a faucet hose is in contaminated or dirty water. If there is a pressure drop due to the use of a hydrant down the street, can cause the dirty water to backflow into the piping system and contaminate your drinkable water.

- **Back-pressure backflow** can occur when the pressure is greater than the supply source.
  - This can occur when there is a boiler or elevated tank connected directly to the drinkable or potable water source.

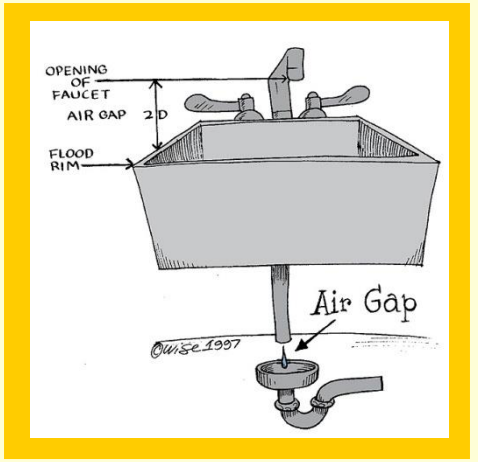
Backflow Prevention Devices

Reduced pressure backflow preventer

Double check valve

Pressure type vacuum breaker

Spring loaded vacuum breaker



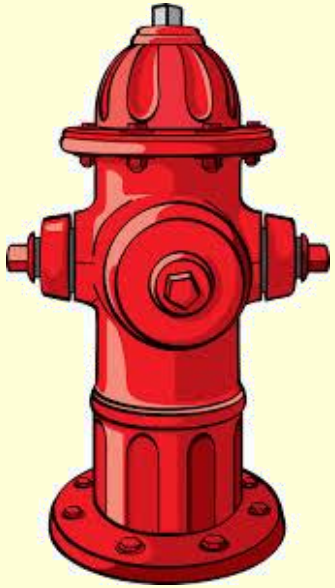
Air gap

Adapted from ***Retail Best Practices and Guide to Food Safety and Sanitation © 2003***

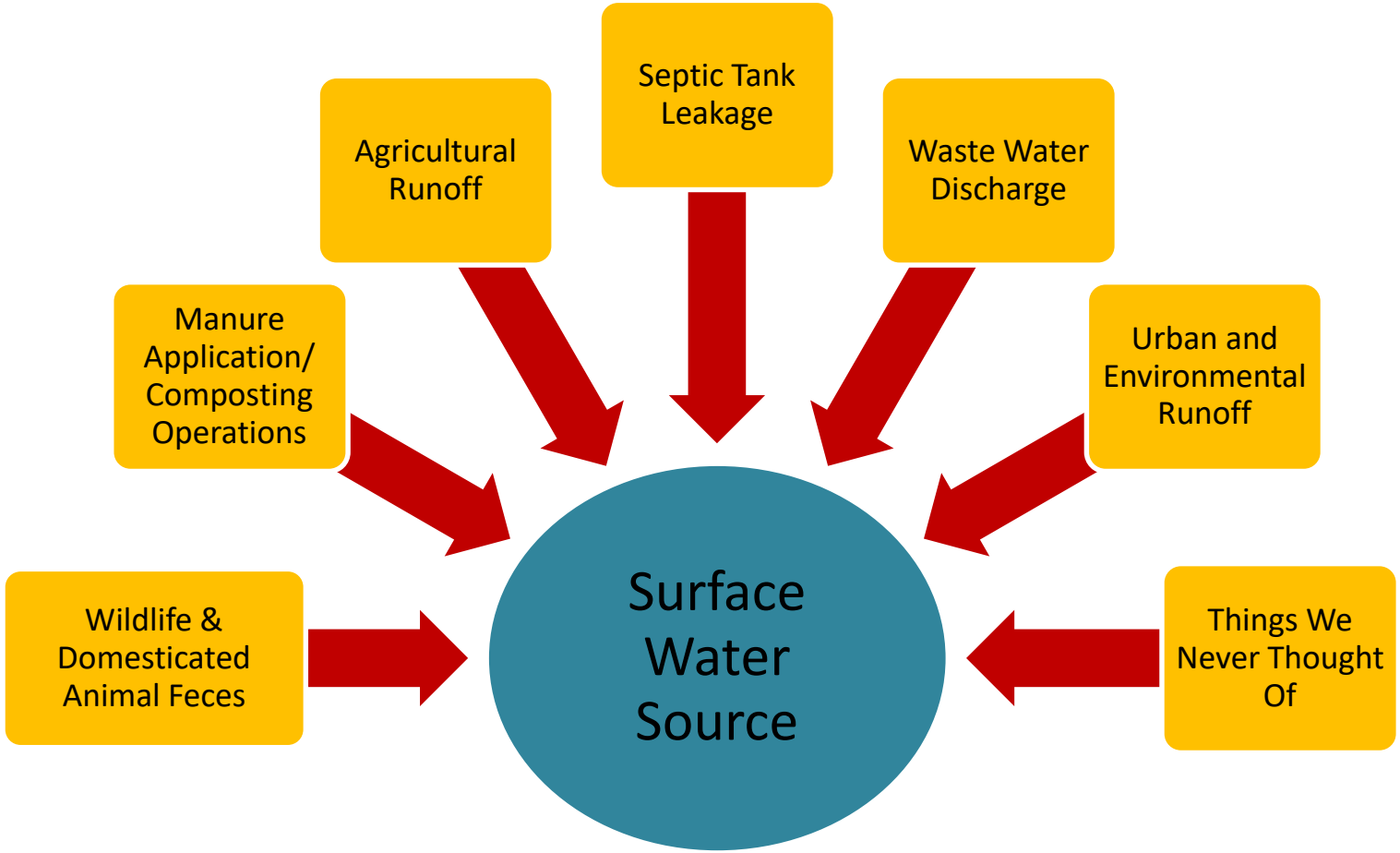
On Farm Water Sources: Water Hydrants

Hydrants – What Is Needed?

- Back flow preventer required
- Rental meter/back flow: $2000.00
- Return to Providence Water
  - Money returned minus water use
- Contact
  - Providence Water Supply Board
    - 401-521-6300 ext. 7279



Potential Sources of Surface Water Contamination



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Preventing Contamination of Surface Water Sources

- Assess nearby land use and upstream water activities to identify risks
  - Work with neighbors and local watershed groups to understand and minimize identified risks
- Assess and address runoff risks
  - Develop diversion ditches, berms or containments to minimize environmental runoff, runoff from manure and compost piles, or runoff from livestock feeding areas
- Monitor and control animal access to irrigation water sources where practical (e.g., irrigation reservoirs)

Methods of Irrigation

- Overhead (sprinkler)
  - Higher risk: A direct water application method resulting in contact with produce

- Flood (surface, furrow)
  - May avoid direct contact with produce
  - Consider risk of contact with contaminated soil during harvest or from splash
- Drip (trickle, subsurface, micro, under canopy)
  - Lower risk: Produce generally not in direct contact (except root crops), reduces foliar diseases, improves water use efficiency

Less Contact with Water = Lower Risk

A key question for evaluation of risk is:

"Is the water applied using a direct water application method?"

- If the answer is "never", the risk from water is very low
- If the answer is "yes", the type of commodity, quality of the water and the timing of the application should be reviewed to assess risks

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Pathogens on Produce May Die Off Over Time

- Environmental conditions can influence die-off rates including
  - Desiccation (drying out)
  - Sunlight (ultraviolet irradiation)
  - Temperature and humidity
  - Starvation and competition
- Some pathogens may be ‘protected’ on the plant and survive for extended periods of time
- Under some conditions, pathogens can even regrow on a plant so avoiding contamination is best

Inspect Agricultural Water Sources and Water Distribution Systems

- Water can be contaminated at the source, or it can become contaminated in the distribution system
- Mapping all water distribution systems is recommended
- Water sources and distribution systems must be inspected at least annually
- Must keep water sources free of debris, trash, domesticated animals, and other hazards

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Evaluating Water Quality: Use of Microbial Water Quality Profiles

- Testing is the only way to quantitatively evaluate the microbial quality of the water
- The water quality profile can help you:
  - Understand the long-term quality of source water
  - Understand appropriate uses for each source
  - Determine if corrective measures are needed if the microbial water quality profile exceeds numerical GM and STV criteria in the FSMA Produce Safety Rule

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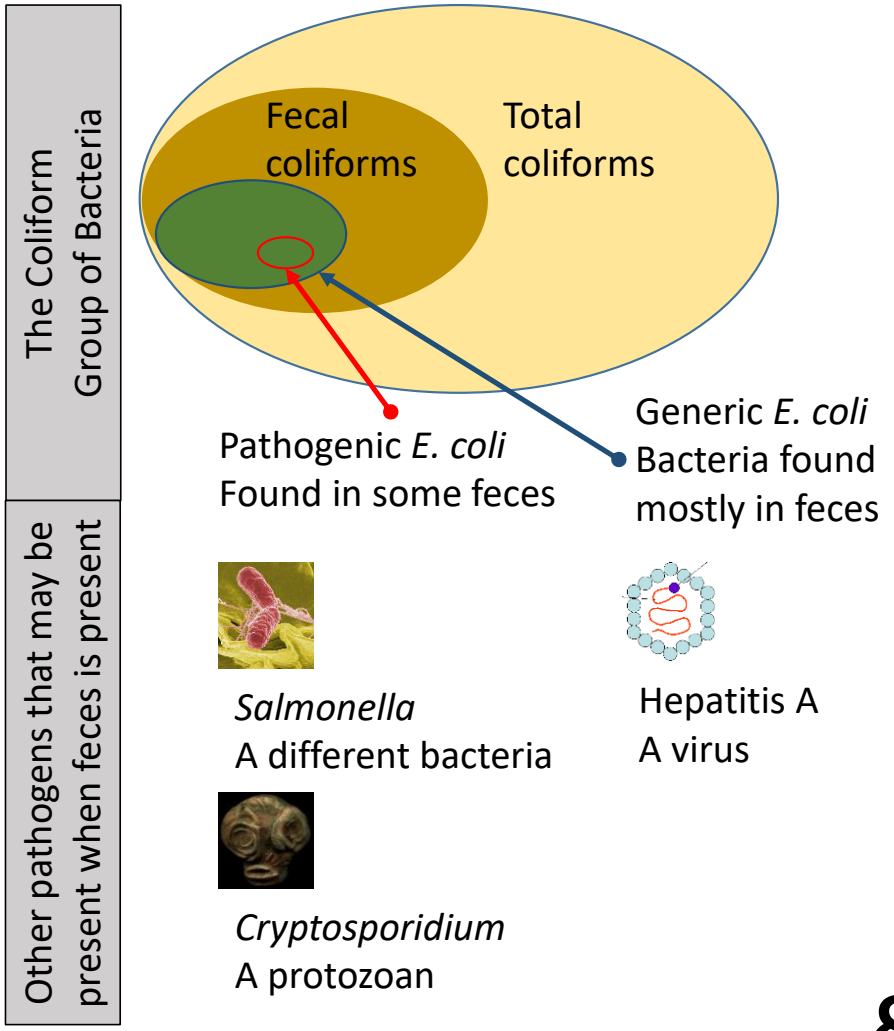
Generic *E. coli* is an Established Indicator

- Generic *Escherichia coli (E. coli)* is an indicator of fecal contamination
- *E. coli* is not a direct measure of the presence of human pathogens
- *E. coli* is the indicator used to measure water quality in the FSMA Produce Safety Rule



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Water Quality Criteria for Water Used During Growing Activities

- Apply to water used with a direct water application method to covered produce
- Each source of production water must be tested to evaluate whether its water quality profile meets the following criteria:
  - **126 or less** colony forming units (CFU) generic *E. coli* per 100 mL water geometric mean (GM)

AND

  - **410 or less** CFU generic *E. coli* per 100 mL water statistical threshold value (STV)

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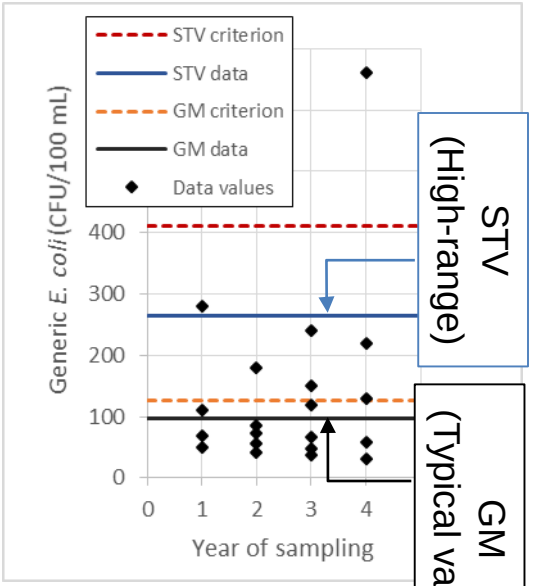
Geometric Means and Statistical Threshold Values

- Test results must be used to calculate Geometric Means and Statistical Threshold Values to compare to water quality criteria in the FSMA Produce Safety Rule
  - The geometric mean (GM) is a log-scale average, the "typical" value
  - The statistical threshold value (STV) is a measure of variability, the estimated "high range" value (approximated 90th percentile)
  - In the image to the right, both the GM and the STV values for the data meet criteria
- Tools are available to assist in calculating these values



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Agricultural Water: Growing Activities, Irrigation

- **Generic E.coli standard** - untreated ground or surface water for direct application to covered produce pre-harvest
  - Geometric mean (GM): ≤ 126 CFU/100ml
    - Central tendency of water quality distribution
  - Statistical Threshold Value (STV): ≤ 410 CFU/100ml
    - Measure of variability due to rainfall, high river stage – adverse conditions

Requirements for Public Water Sources

Source	Testing Requirement
Public Water Supply	Copy of test results or current certificates of compliance

- With appropriate documentation, there is no requirement to test water that meets the requirements for public water supplies.

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Microbial Water Quality Profile: Survey of Ground Water Sources

Source	Initial and Annual Testing Requirement
Ground	4 or more times during the growing season or over the period of a year 1 or more samples rolled into profile every year after initial year

- Profile samples must be representative of use and must be collected as close in time as practicable to, but before, harvest

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Microbial Water Quality Profile: Survey of Surface Water Sources

Source	Initial and Annual Testing Requirement
Surface	20 or more times over a period of 2 to 4 years 5 or more samples rolled into profile every year after initial survey

- Profile samples must be representative of use and must be collected as close in time as practicable to, but before, harvest

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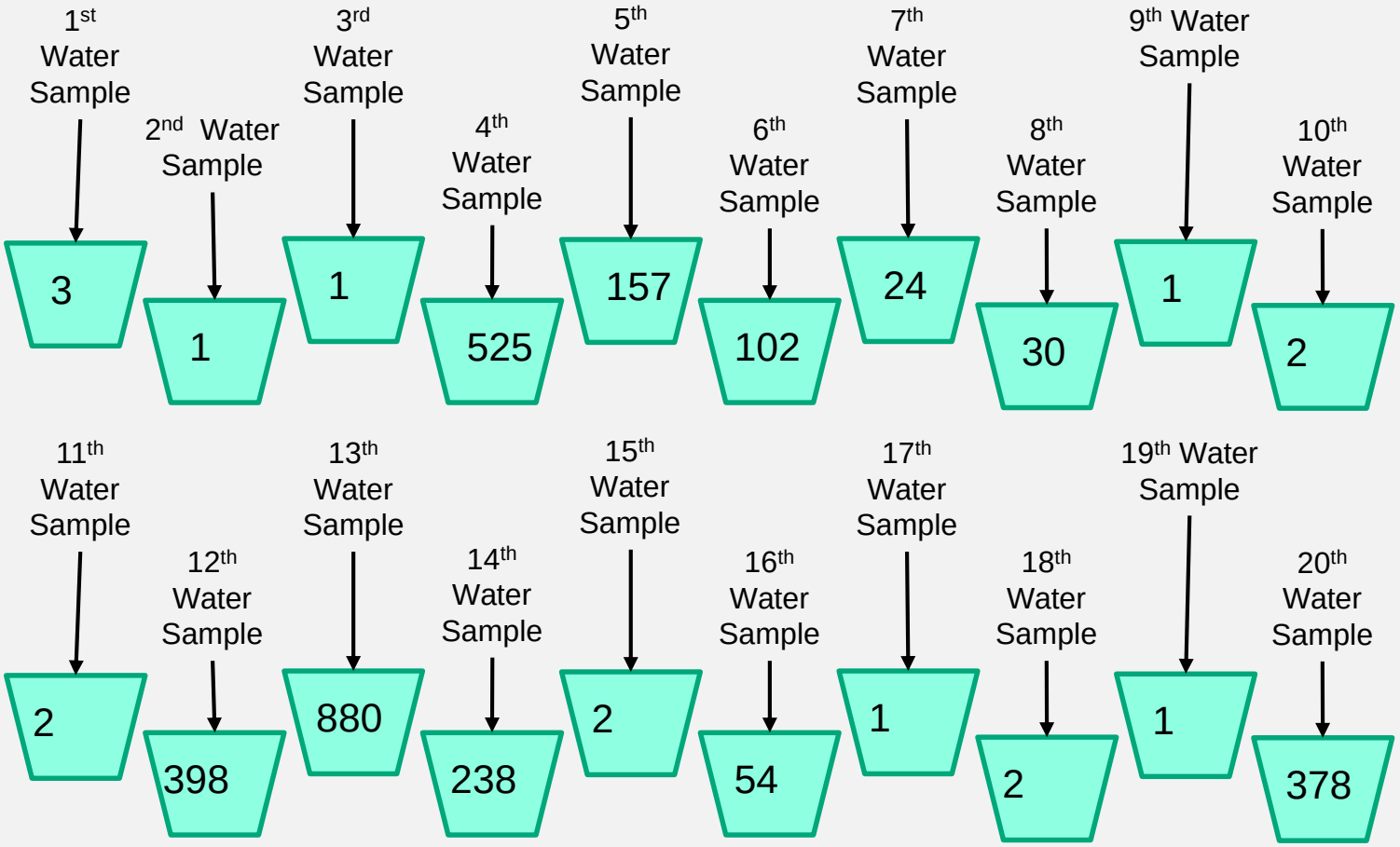
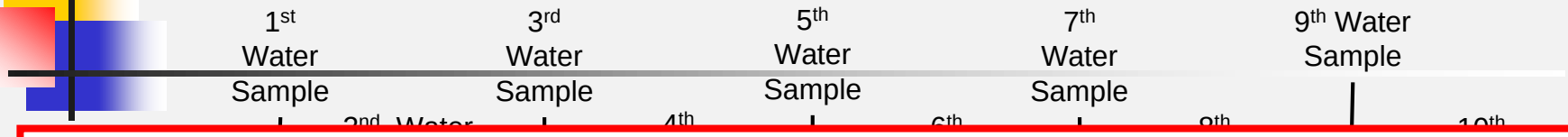
Establishing a Water Quality Profile - Example



20 water samples collected over 2 years

Thanks to Michelle Danyluk – University of Florida

Establishing a Water Quality Profile - Example

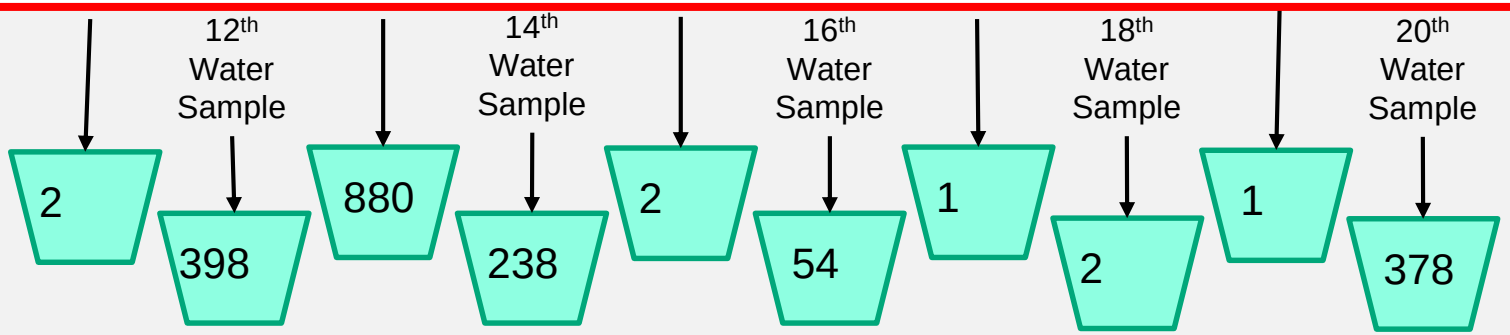


Geometric mean (GM) =

15.3 MPN/100 ml

Statistical Threshold Value (STV) =

407.5 MPN/100 ml



20 water samples collected over 2 years

Agricultural Water: Growing Activities, Irrigation

- **Generic E.coli standard** –
  - Geometric mean (GM): ≤ 126 CFU/100ml
    - Central tendency of water quality distribution
  - Statistical Threshold Value (STV): ≤ 410 CFU/100ml
    - Measure of variability
- How do you figure this out for your water source(s)?
  - **Water calculator:** **http://ucfoodsafety.ucdavis.edu/Agricultural_Water_299/**

Where Do I Collect Samples?

- **Surface water and ground water:**
  - Take a representative sample appropriate for the water source

- **Municipal/public water supply:**
  - No sample required if testing reports obtained from the water utility, treatment plant, or lab
  - Optional sampling at different points in the distribution system can be useful

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How Do I Collect Samples?

- Follow all sample submission instructions from the laboratory
- A sterile bottle must be used to collect samples
- Do not rinse bottle before sampling
- In a distribution system, allow the water to run before sampling in order to collect a representative sample

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Where Do I Go For Testing?

- Find a lab that is certified by state and local environmental agencies, or third-party accreditors
- Be certain the lab can provide the test you need
  - Quantitative analysis using Method 1603 (modified mTEC)
  - Upper limit of test high enough to measure your water quality and calculate profile statistics
- Be sure the lab provides sampling instructions
  - Labs should provide instructions for acceptable sampling containers, hold times, storing, and transport expectations

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Water Safety by Testing

Where can you go to get water tested?

- RIDOH water testing
- Private, certified testing labs
- www.health.ri.gov/find/labs/privatewelltesting/
- www.health.ri.gov/find/labs/analytical/index.php

Results must be quantitative for surface water

- No > or < a value
- No presence or absence
- Only a number

Corrective Measures

- Three types of corrective measures are allowed if the microbial water quality profile does not meet water quality criteria:
  1. Apply a time interval for microbial die off
     i. Between last application and harvest
     ii. Between harvest and the end of storage and/or removal during activities such as commercial washing
  2. Re-inspect the water system, identify problems, and make necessary changes and confirm effectiveness
  3. Treat the water

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Corrective Measure: Water Application and Timing

- Risks from production water may be reduced by maximizing the time between last application and harvest
- One option for a corrective measures is to use a microbial die-off rate of 0.5 log per day between last application and harvest for up to four consecutive days

This is important if your initial water quality profile does not meet GM and STV criteria!

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Examples

- GM=156, STV=407
  - Rule: GM ≤ 126; Log_{10} 126 = 2.1
  - Log_{10} 156=2.2
  - 2.2-2.1= 0.1 log reduction needed
  - **Option 1**: 0.5 log reduction/day, 1 day pre-harvest interval needed
  - **Option 2**: Hold for validated procedure, like washing to get 0.1 log reduction

Examples

- GM=20; STV= 540
  - Rule STV ≤ 410; Log_{10} 410 = 2.6
  - Log_{10} 540 = 2.7
  - 2.7 – 2.6 = 0.1 log reduction/100 ml needed
  - **Option 1**: 0.5 log reduction/day, 1 day pre-harvest interval needed
  - **Option 2**: Hold for validated procedure, like washing to get 0.1 log reduction

Examples

- GM=500, STV=2400
  - Rule:
    - GM ≤ 126; Log_{10} 126 = 2.1
    - STV ≤ 410; Log_{10} 410 = 2.6
  - Log_{10}500=2.7; Log_{10}2400 = 3.4
  - 2.7-2.1=0.6; 3.4-2.6=0.8 log reduction needed
  - **Option 1**: 0.5 log reduction/day, 2 days pre-harvest interval needed
  - **Option 2**: Hold for validated procedure, like washing to get 0.8 log reduction

Examples

- GM=20; STV= 540
  - Rule STV ≤ 410; Log_{10} 410 = 2.6
  - Log_{10} 540 = 2.7
  - 2.7 – 2.6 = 0.1 log reduction/100 ml needed
  - **Option 1**: 0.5 log reduction/day, 1 day pre-harvest interval needed
  - **Option 2**: Hold for validated procedure, like washing to get 0.1 log reduction

Agricultural Water: Growing Activities, Irrigation

- **Water calculator:** http://ucfoodsafety.ucdavis.edu/Agricultural_Water_299/

Corrective Actions Needed? Unintentional Water Contact

- Broken Emitters and Other Water Application Issues
  - What is known about the quality of the water? How close is harvest?
- Human Mistakes
  - Spray applications accidentally mixed with untreated surface water
  - Forgetting to turn off irrigation pumps, may result in in-field flooding

- Flood Events
  - If the produce has come in contact with flood water from overflowing streams or open bodies of water, it is considered adulterated by the FDA and cannot be used for food
  - Contact with flood water that is not part of a natural disaster may be subject to provisions of the FSMA Produce Safety Rule

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Addressing Flooding

Irene 2011—help us to prepare for next time!

Resources for best practices when produce fields are flooded:

- **Guidance for Industry: Evaluating the Safety of Flood-affected Food Crops for Human Consumption**
  - Go to https://www.fda.gov/
  - Click on Food
  - Click on Guidance
  - Compliance and Regulatory Information
  - Click on Guidance Documents and then search for flood guidance

- **Guidance on**: flood waters contacting and NOT contacting edible portions of crops, assessment of fields before replanting and avoid cross-contamination after flooding

Addressing Flooding

- Flooded crop production areas - potential microbial hazards.
- Soil tests are recommended, especially if:
  - nearby animal production operation
  - a sewage treatment plant or sewers.
- Safety assessment of flood –affected crops – microbial contamination?
- Fresh fruits and vegetables inundated by flood waters and cannot adequately be cleaned – destroyed.

Corrective Measure: Re-Inspection and Corrective Actions

- If there is a problem with your water, be cautious until you know more!
- Re-inspect water system for contamination sources
  - Manure runoff, migratory birds, septic tank leaching
- Use corrective actions that address contamination sources under your control
  - Keep in mind state, county, and federal regulations
- Implement strategies to prevent contamination from happening
- Confirm that the changes were effective

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Corrective Measure: Treating Production Water

- Any chemicals used to treat water must be EPA registered and labeled for intended use
- Non-chemical treatments, called pesticide devices by EPA, may be used if they adequately reduce microbial risks
  - Filter units, UV light units, ozonator units
- You should avoid water treatments that may have negative environmental and soil quality impacts
- You must keep records of all treatment monitoring done

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Microbial Water Quality Profile: Surface Water

START:
Establish initial water quality profile
At least 20 samples over 2-4 years

ANNUALLY AFTER START:
Collect at least 5 samples for analysis
Insert annual data into rolling data set

IF YOUR WATER CHANGES:
If the water quality profile no longer represents the quality of the water source, establish a new profile

IF YOUR PROFILE DOES NOT MEET GM OR STV CRITERIA:
As soon as practicable and no later than the following year, discontinue use of the water unless an allowed corrective measure is applied

ALLOWED CORRECTIVE MEASURES:

1. Apply a time interval to allow die-off (before harvest or end of storage) or removal
2. Re-inspect the water system, identify problems, and make necessary changes
3. Treat the water

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Microbial Water Quality Profile: Ground Water

START:
Establish initial water quality profile
At least **4 samples over 1 year**

ANNUALLY AFTER START:
Collect at least **1 sample** for analysis
Insert annual data into rolling data set

IF YOUR WATER CHANGES:
If the water quality profile no longer represents the quality of the water source, establish a new profile

IF YOUR PROFILE DOES NOT MEET GM OR STV CRITERIA:
As soon as practicable and no later than the following year, discontinue use of the water unless an allowed corrective measure is applied

ALLOWED CORRECTIVE MEASURES:

1. Apply a time interval to allow die-off (before harvest or end of storage) or removal
2. Re-inspect the water system, identify problems, and make necessary changes
3. Treat the water

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Water Quality Criteria: RI GAP Agricultural Water

Right now, RI GAP requires testing of agricultural water:

- **Surface**
  - **Frequency - least once a year, just prior to the beginning of the season or harvest.**
- **Ground**
  - **Frequency – two times near or before harvest of high risk produce at a peak harvest time.**
- **Corrections – same at PSR**

Reviewing Test Results

- If your water test results are higher than expected, take action as soon as possible!
  - Investigate water sources for possible causes
    - Manure application and run-off
    - Fecal contamination from wildlife, migratory birds
    - Incorrect/inadvertent cross connections
    - Wellhead impacts
- Implement practices to reduce risks

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Evaluating Risks: Example 1

What Is Your Water Source?

Surface

How Do You Apply Water?

Overhead
Applied using a direct water application method

When Do You Apply Water?

Near Harvest

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Evaluating Risks: Example 2

What Is Your Water Source?	How Do You Apply Water?	When Do You Apply Water?
Surface	Drip Not a direct water application method for this crop	Near harvest Irrigated up to and during harvest

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Agricultural Water Example

Water Source	Crop	Application Purpose	Application Method	Is this Agricultural Water?
Pond	Squash	Irrigation	Overhead	Yes, if summer squash (no for winter squash since it is not covered produce)

Step 1: Is this crop covered produce?

Answer: For Summer Squash, yes and for Winter Squash, no

Step 2: Is a direct application method used?

Answer: Yes, because the water is intended to, or likely to, contact covered produce

Step 3: Is this Agricultural Water?

Answer: Yes, for summer squash
No, for winter squash

SUPPLEMENTAL MATERIAL

Is this Agricultural Water?

Lettuce

Overhead irrigation

SUPPLEMENTAL MATERIAL

Is this Agricultural Water?

Citrus

Drip irrigation

SUPPLEMENTAL MATERIAL

Is this Agricultural Water?

Apples

Pesticide application

SUPPLEMENTAL MATERIAL

Is this Agricultural Water?

Strawberries

Trickle

SUPPLEMENTAL MATERIAL

Is this Agricultural Water?

Potatoes

Overhead Irrigation

SUPPLEMENTAL MATERIAL

Is this Agricultural Water?

Carrots

Drip irrigation

SUPPLEMENTAL MATERIAL

Recordkeeping

- Keep required records such as:
  - Findings of the inspection of water system
  - Water test results
  - Monitoring of water treatments
  - Corrective measures taken, if any
  - Scientific data or information to support compliance including treatment, calculations, and testing
  - Scientific data or information to support alternative indicators, criteria, or sampling frequencies

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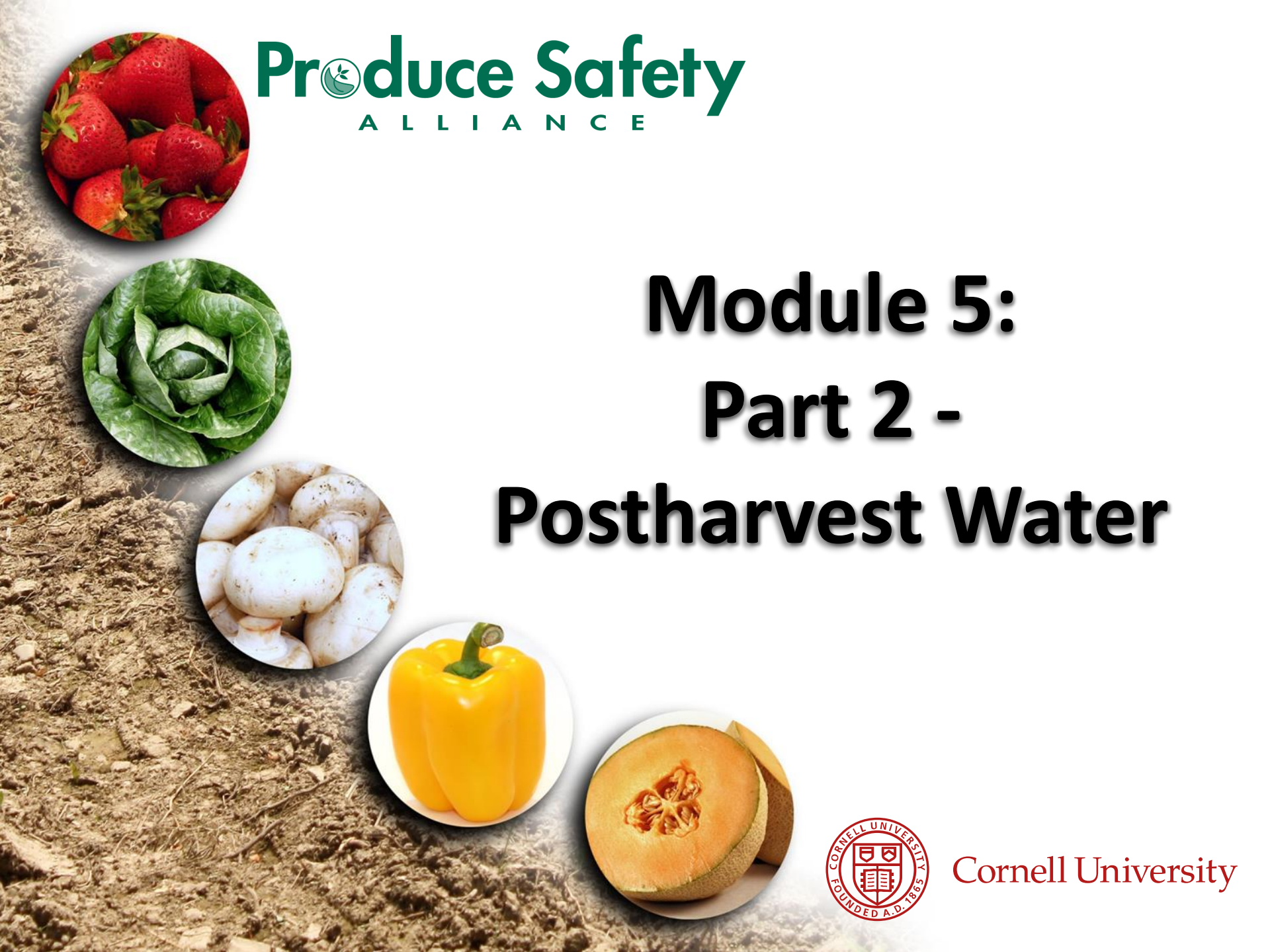
Summary

- Contaminated agricultural water has been implicated in some foodborne outbreaks associated with fresh produce
- Knowing the water quality through long-term testing will help establish management practices for appropriate use of the water
- If the water IS NOT applied by a direct application method to the harvestable portion of the crop, the risks are lower
- Extend time between last application of water and harvest to reduce risks, if water quality is a concern
- Treating water is an option to reduce risks
- Keep copies of all water test results
- Document all water management practices



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Module 5: Part 2 - Postharvest Water

Cornell University

Learning Objectives

- Understand the required quality of water for harvest and postharvest activities
- Identify ways water may become contaminated
- Describe cross-contamination and infiltration
- Understand the purpose of using antimicrobial products, including sanitizers
- Describe practices to maintain and monitor the quality of water used in postharvest activities
- Identify records needed to properly document and monitor water quality
- Describe corrective actions to use if postharvest water is outside microbial criteria

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Why Focus On Postharvest Water?

- Cannot eliminate every food safety risk in the field
- Postharvest water has the potential to spread contamination widely

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Many Postharvest Water Uses

- Rinsing/washing
- Commodity movement (i.e., dump tanks/flumes)
- Cooling
- Ice making
- Postharvest fungicide and wax
- Handwashing
- Cleaning and sanitizing

Postharvest Water Management

- Water
  - Must know initial quality and intended use
  - How water interacts with a treatment, if used
- Antimicrobial products, including sanitizers
  - Adding a sanitizer to water is NOT intended to "wash" the product, but instead to prevent cross-contamination
  - Must be labeled for intended use, such as in water or for contact with fruits and vegetables
  - Many sanitizers available, including organic options

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Cross-Contamination

- Pathogens may be introduced by other produce, non-produce material in or on harvest containers, water, food contact surfaces, or other sources
- Anything that comes in contact with produce could result in cross-contamination including:
  - Worker's hands
  - Worker clothing
  - Produce containers
  - Packing tables, conveyor belts
  - Water
  - Tools

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Water Quality Criterion for Harvest and Postharvest Activities

- Water used for the following must have no detectable generic *E. coli* per 100 mL sample
  - Direct contact with covered produce during or after harvest
  - Direct contact with food contact surfaces
  - To make ice
  - For handwashing
- Untreated surface water may not be used for these purposes

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Water Quality Criteria: RI GAP Postharvest

RI GAP requires use of potable water for:

- **Ice for cooling**
- **Drinking**

What is Required for Testing Untreated Ground Water and Public Water Supply Sources Used for Postharvest Uses?

Source	Testing Requirements
Untreated Ground Water	4 or more times during the growing season or over the period of a year 1 or more tests per year after initial year
Public Water Supply	Copy of test results or current certificates of compliance

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Single Pass Water

- Must not have detectable generic *E. coli* in 100 mL sample
- Produce Safety Rule does not require water treatment
- Antimicrobial products, such as sanitizers, can be added as a commonly recommended Good Agricultural Practice
  - May reduce the buildup of microorganisms (biofilms) in equipment and on food contact surfaces

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Recirculated and Batch Water

- Must have no detectable generic *E. coli* in 100 mL sample at the beginning of use and maintain safe and adequate sanitary quality throughout use
- Treatment is not required but can be used to maintain water quality and reduce cross-contamination risks
- Any antimicrobial product used in the water must be labeled for use with fruits and vegetables
- A schedule must be established for changing batch water or a process in place for minimizing the build-up of organic material in the water

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Key Water Quality Variables

- Quality at start of use
  - No detectable generic *E.coli* in 100 mL of sample
- pH
  - Can impact the effectiveness of antimicrobial treatments
- Temperature
  - Must be monitored to minimize potential for infiltration
- Turbidity
  - Can be used to manage water change schedule

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Monitoring pH

- Water pH can affect the efficacy of sanitizers, especially chlorine
- There are many ways to monitor pH
  - e.g., pH test strips, handheld pH meters, and titration kits
- Adding chlorine and other sanitizers may change the pH of water
  - You must monitor treatment
  - You should adjust pH as needed based on the optimal pH range for effective use of your sanitizer

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Temperature

- Temperature differences between produce and bulk tank water may cause infiltration
  - If bulk tank (postharvest) water is contaminated, pathogens can enter the produce with infiltrating water, resulting in a food safety risk
  - Temperature must be monitored to minimize potential infiltration risk
- Temperature can also affect the efficacy of the antimicrobial products, including sanitizers

If postharvest water temperature is too high and pH is too low, toxic chlorine may 'gas off' and become a health hazard for workers

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Background on Infiltration Risk for Susceptible Produce

- Infiltration can increase with deeper submersion and longer contact time
- Wounded or bruised fruit can have a greater risk of infiltration
- Infiltration risks can be higher when the produce is warmer than the tank water

Photo shows colored dye from water moving into produce pulp due to infiltration.

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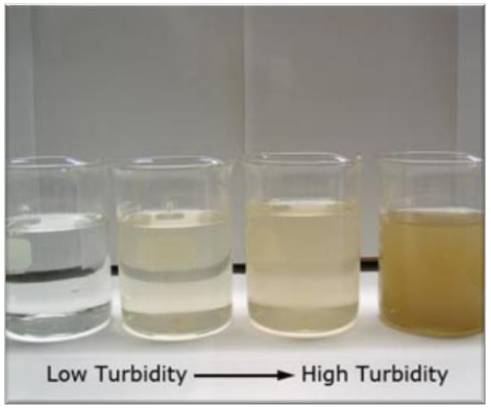
Turbidity

- Turbidity can be used as an indication of when you should change your water
  - Monitor your water and change when you reach your set limit
- Methods to monitor turbidity
  - Turbidity meter, Secchi disk method
- Turbid water may reduce treatment effectiveness
  - Need to add more sanitizer to maintain effectiveness
  - Turbidity can affect accuracy of sanitizer and pH readings



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When Should I Change My Water?

- Post-harvest water must be managed, including changing water when necessary
- Water changing schedules should consider:
  - Organic load (soil, leaves, decaying or damaged product)
  - Turbidity measurements
  - Volume of produce
  - Type of produce
  - Product flow and operating conditions
  - Type of antimicrobial product
  - Type of equipment

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Disposal of Used Water

- Waste water from produce washing or cooling must be disposed of properly so that it does not serve as a source of contamination to covered produce and fields used to grow covered produce
- Handwashing stations should have catch basins if not connected to a drain
- Check state, local and EPA regulations on discharging water into sewers, leach fields, and/or surface waters

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Choosing an Antimicrobial Product, Including Sanitizers

- Chlorine sanitizers are commonly used
  - Affordable and available
  - Corrosive, highly reactive
- Many non-chlorine chemical options
  - Ozone, peroxyacetic acid, hydrogen peroxide, etc.
- Organic formulations are available
  - Tsunami, Spectrum, Sanidate, VigorOx 15 F&V, etc.
  - Check with organic certifier
- Must be labeled for use on produce

Follow the Label!

- Always read and follow label instructions
- You must use the product only as labeled
  - Direct contact with produce vs. food contact surface
- You should use the correct amount of antimicrobial product (in ppm or other measurement)
- Understand factors that affect efficacy
  - Temperature, pH, sunlight, and how it is affected by organic load

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ULTRA CLOROX® BRAND REGULAR BLEACH (EPA Reg. No. 5813-50)
[REGISTERED AS Clorox® Regular-Bleach]
FOR FRUIT & VEGETABLE WASHING
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Thoroughly clean all fruits and vegetables in a wash tank. Prepare a sanitizing solution of 25 ppm available chlorine. After draining the tank, submerge fruit or vegetables for 2 minutes in a second wash tank containing the recirculating sanitizing solution. Spray rinse vegetables with the sanitizing solution prior to packaging. Rinse fruit with potable water only prior to packaging.

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Monitoring Antimicrobial Treatments Including Sanitizer Levels

- Each sanitizer will have specific ways to monitor its levels
  - Use the right monitoring tools
  - May be automated or manual
- Any water treatment, including use of sanitizer, must be monitored during treatment
- Check with the supplier if you have any questions
- Monitoring can include tools such as Oxidation-Reduction Potential (ORP) sensors

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Examples of SOPs for Postharvest Water Management

- Monitoring and adding antimicrobial product
- Monitoring and modifying pH
- Monitoring water and pulp temperatures
- Monitoring turbidity and changing/adding water
- Calibrating thermometers and sensors

Examples of When Corrective Actions Are Needed

- Monitoring indicates that water sanitation procedures are not working
  - Antimicrobial treatment is below the effective level
  - Sanitizer inventory is used faster than expected
  - pH readings are not in correct range
- Workers report a problem
- Monitoring and recordkeeping sheets are not correct

Recordkeeping

- Helps document all water management activities
  - Water quality tests, antimicrobial product use, monitoring, and corrective actions
- Allows management to see that monitoring practices are being completed and working properly
  - Monitoring sanitizer levels, pH, turbidity, water changes, etc.
- Identifies patterns/trends to determine the best practices OR when problems tend to arise

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Summary

- Postharvest water management can help prevent a small contamination event from becoming a BIG one
- For harvest and postharvest uses, use only water that has no detectable generic *E. coli* in 100 mL water sample
- Consider adding a sanitizer to postharvest water
- Develop SOPs for key water management steps
- Monitor key variables of both the water and any sanitizer used to ensure postharvest water quality
- Take corrective actions when needed
- Keep detailed records

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