Long Term 2 Enhanced Surface Water Treatment Rule Overview

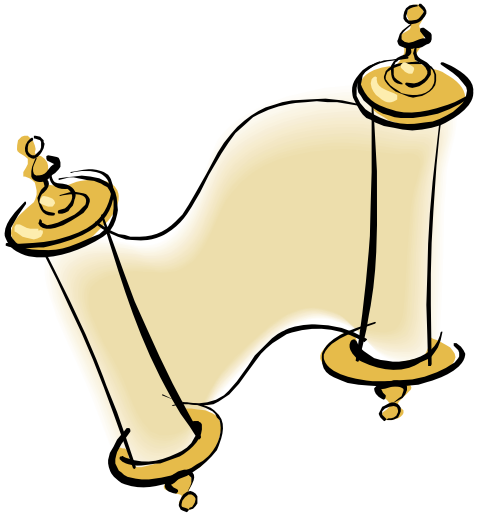
Session Content

- LT2ESWTR Purpose
- Rule Overview

- Source Water Monitoring
- Bin Classification/Mean Crypto Level
- Toolbox Treatment Options

Promulgation

- LT2 was published on January 5, 2006
  - Minor amendments were made on January 30 and February 6, 2006



Purpose of LT2ESWTR

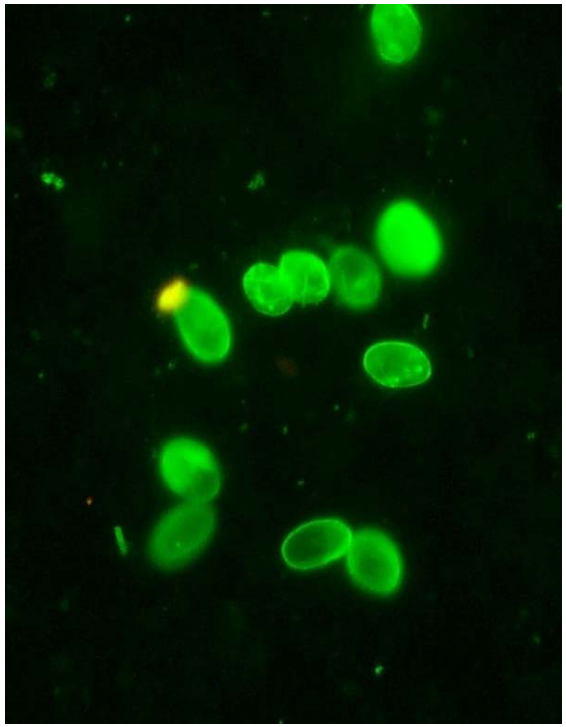
- Improve Public Health Protection
  - Reduce illness caused by *Crypto.* and other microorganisms
    - Targets additional *Crypto*. treatment to higher risk systems
  - Reduce risk from uncovered finished water storage reservoirs
  - Balance microbial protection and disinfection byproduct formation

Applicability

- All surface water and GWUDI systems
  - CWSs, NTNCWSs, TNCWSs
  - Wholesale systems
  - Filtered and unfiltered systems

Cryptosporidium (Crypto)

- Protozoan parasite
- Common in surface water
- Resistant to traditional disinfectants
- Can pass through filters
- Causes cryptosporidiosis
- Filtration and alternative disinfectants can remove and/or inactivate



Understanding “log”

- Refers to percent of organisms that are removed and/or inactivated by treatment or other measures

Log	% removal/inactivation
0.5-log	68.4%
1-log	90%
2-log	99%
3-log	99.9%
4-log	99.99%
5-log	99.999%

“Log” Removal Example 1

	System A	System B
Source Water	100,000 *Crypto* oocysts	100 *Crypto* oocysts
Crypto Reduction	2-log removal/ inactivation (99%)	2-log removal/ inactivation (99%)
Finished Water	1,000 *Crypto* oocysts	1 *Crypto* oocyst

Both systems provide the same level of *Crypto* removal/inactivation, but System B provides higher quality finished water

“Log” Removal Example 2

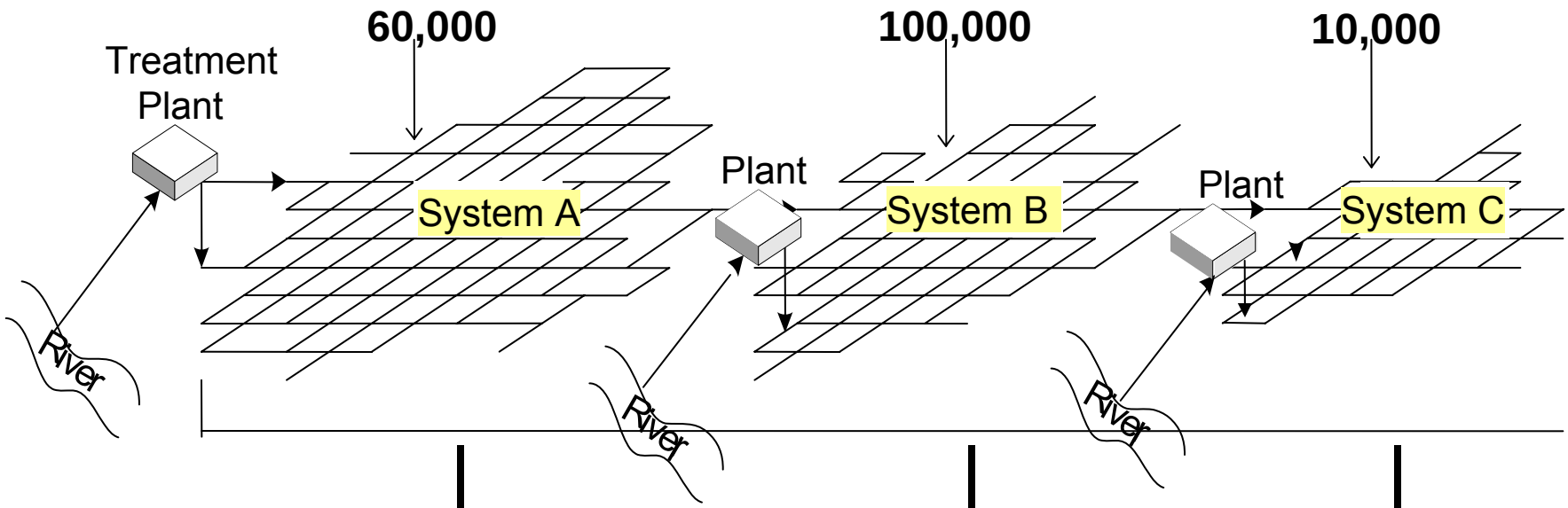
	System A	System B
Source Water	100,000 *Crypto* oocysts	100 *Crypto* oocysts
Crypto Reduction	5-log removal/ inactivation (99.999%)	2-log removal/ inactivation (99%)
Finished Water	1 *Crypto* oocyst	1 *Crypto* oocyst

Both systems provide the same public health protection, but System A must work harder!

Schedules

System has a surface or GWUDI source ***System serves population below*** ***OR*** ***System is a wholesaler in combined distribution system in which any system serves population below***	***Schedule number:***
>=100,000 people	1
50,000 to 99,999 people	2
10,000 to 49,999 people	3
<10,000	4

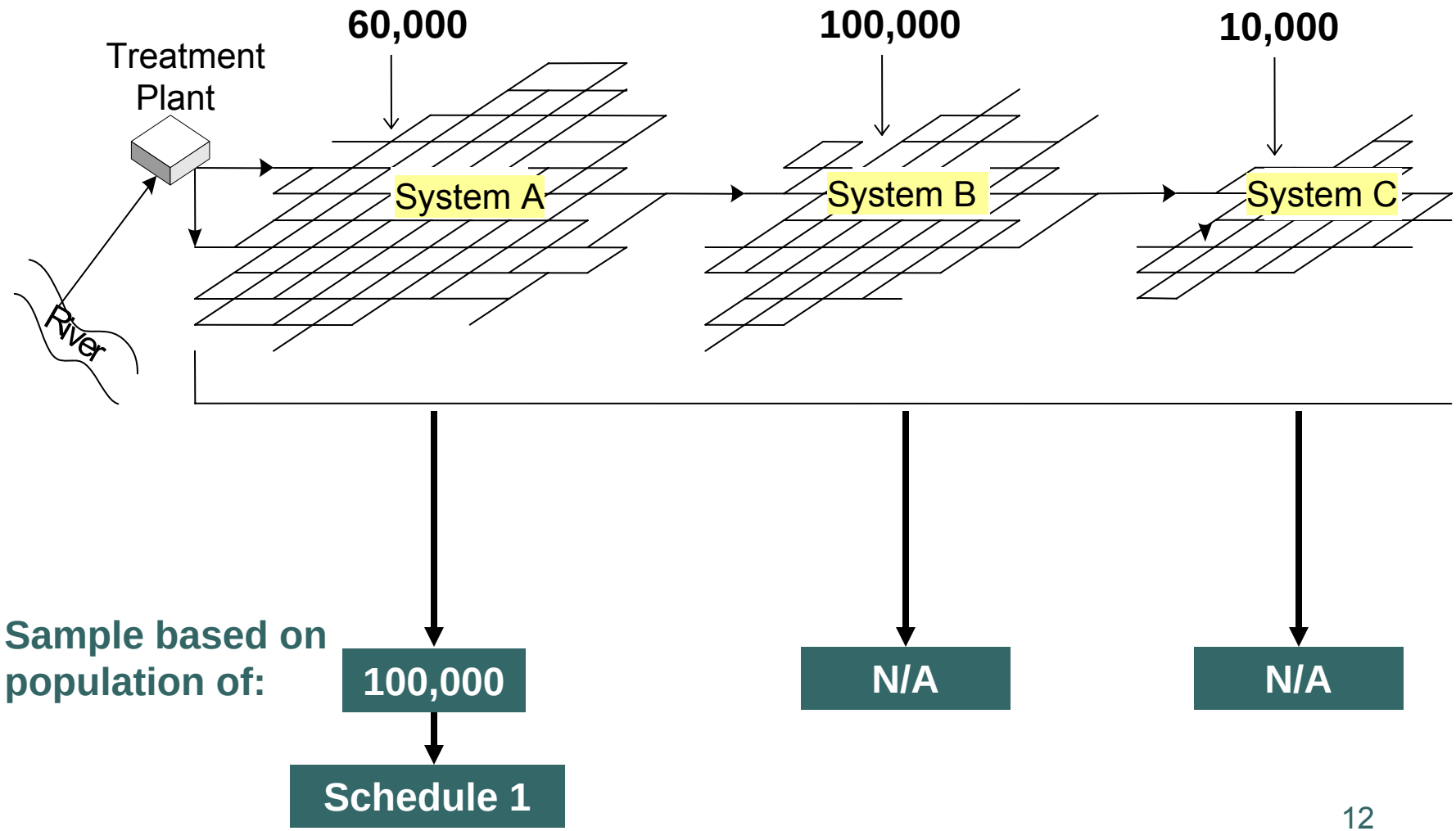
Combined Distribution Systems



Sample based on population of:

100,000	100,000	10,000
Schedule 1	Schedule 1	Schedule 3

Combined Distribution Systems



Key Provisions:

- Source Water Monitoring
- Treatment
- Profiling and Benchmarking
- Cover or treat uncovered finished water storage
- Sanitary Surveys

Key Provisions: Source Water Monitoring

- Filtered systems on Schedules 1, 2 or 3
  - *Cryptosporidium*
  - *E. coli* and turbidity - potential future indicators
- Filtered systems on Schedule 4
  - *E. coli* only unless *Cryptosporidium* monitoring is triggered
- Unfiltered systems
  - *Cryptosporidium* (in addition to sampling already taking place)

Key Provisions: Treatment

- Filtered Systems
  - Additional treatment for highest-risk systems
    - Bin classification based on source monitoring results
    - “Microbial toolbox” of options
- Unfiltered systems
  - Two or three log inactivation
    - Based on source monitoring results
  - Two disinfectants
    - Chlorine, Chloramines, Chlorine Dioxide, Ozone, UV
    - Each separately achieve total required inactivation for either virus, *Crypto*, or *Giardia*

Key Provisions: Profiling and Benchmarking

- Balancing the impact of Stage 2 DBPR and *Crypto* requirements
- If altering disinfection
  - Develop profile for *Giardia lamblia*
  - Calculate benchmark
- Requirements go into effect upon completion of initial monitoring

Key Provisions: Uncovered Finished Water Reservoirs

- Notify state
  - April 1, 2008
- Cover reservoir
- Treat discharge
  - Inactivation/removal
    - 4-log virus
    - 3-log Giardia
    - 2-log Crypto
- Compliance deadline
  - April 2009

Key Provisions: Sanitary Surveys

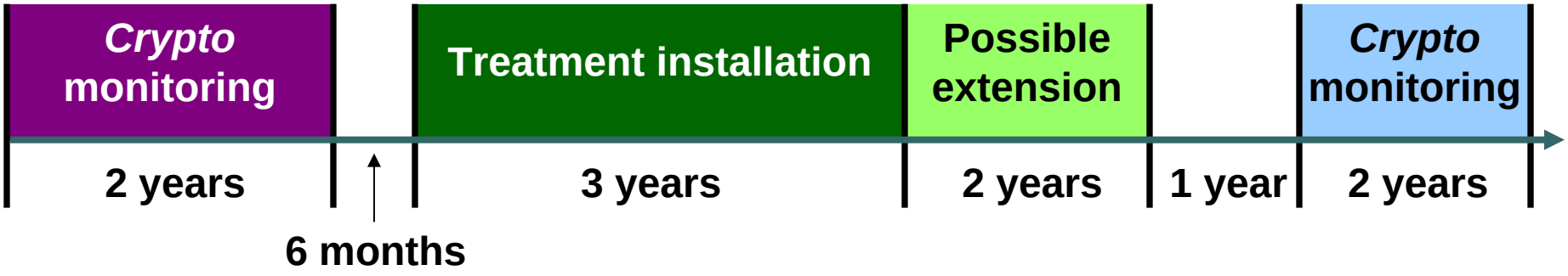
- Significant deficiencies identified in sanitary survey report
  - Respond within 45 days
  - How and on what schedule deficiency will be addressed
  - Correct on schedule approved by EPA
- Significant changes to watershed after monitoring could trigger additional treatment

Monitoring/Treatment Process

1. Initial Round Source Water Monitoring
2. Bin Classification or Mean Crypto Level
3. Choose Toolbox Option(s)
4. Install Treatment
5. Second Round Source Water Monitoring

LT2 Implementation Timeline

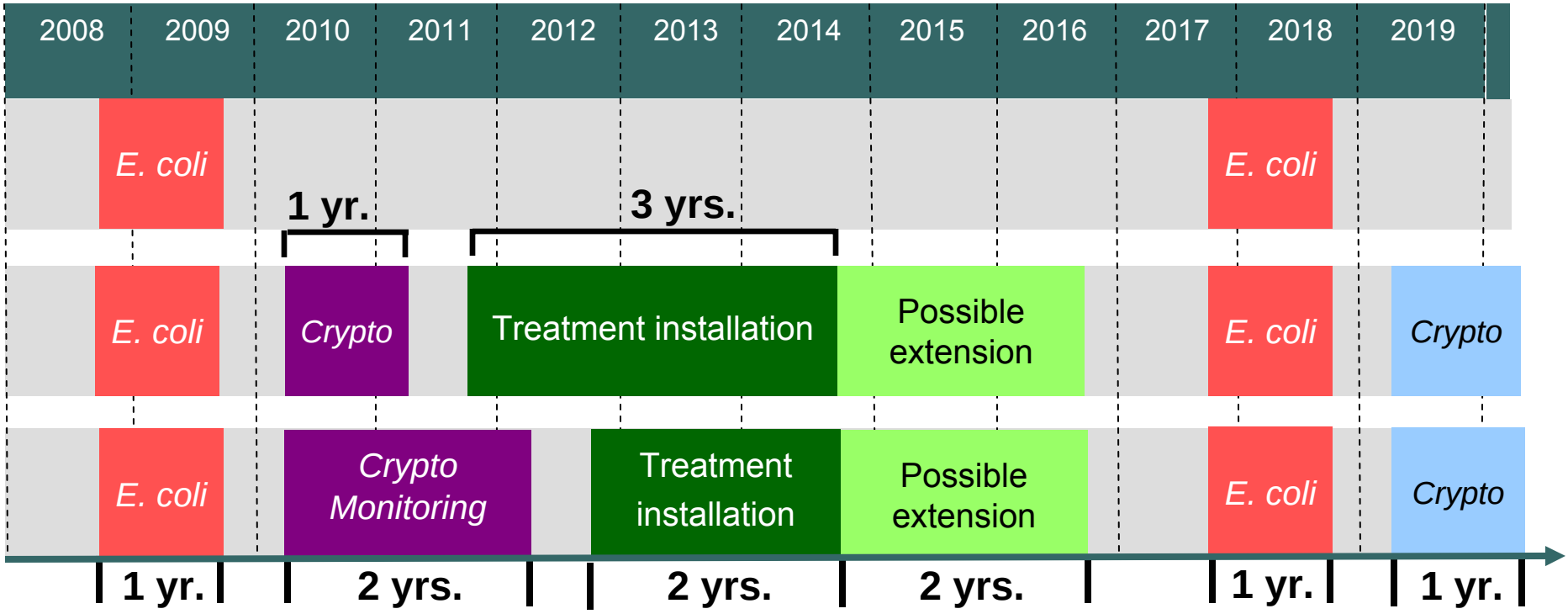
- Schedules 1, 2, and 3



Schedule	Start *Crypto* Monitoring
1	October, 2006
2	April, 2007
3	April, 2008

LT2 Implementation Timeline

- Schedule 4



Choose Option: Report to EPA

- Three months prior to initial monitoring date
  - Submit sampling plan
  - Submit intent to grandfather
  - Submit intent to install max treatment

Intent to Install Maximum Treatment

- Letter due 3 months before required to begin monitoring
- System knows source is poor quality
- Filtered systems
  - 5.5-log removal/inactivation
- Filtration avoidance
  - 3-log inactivation
- Can opt for this after monitoring starts

Grandfathering

- Equivalent Data
  - Locations
  - Timing
  - Methods
- Not “all or nothing”
  - Can replace or supplement monitoring data

Grandfathering: Implementation

- Normal source water conditions
- Can grandfather *Crypto* data without *E. coli* or turbidity data
- *Cannot* grandfather *E. coli* and/or turbidity data without corresponding *Crypto* data
- Replace the unapproved data
  - EPA must approve schedule for additional monitoring

Grandfathering – Letter of Intent

- Letter due 3 months before the system is required to begin monitoring
  - # of previously collected results
  - Dates of first and last samples
  - Whether additional monitoring is needed
- Submit electronically to EPA site: https://intranet.epa.gov/lt2/protected/

Grandfathering Results and Certification

- Due 2 months after monitoring date
- Submit results
- Certify that:
  - Report includes all results from the monitoring period
  - Samples are representative of source water
  - Source has not changed
- Describe location
- Lab analyzing *Crypto* samples must certify that it has met QA requirements

Source Water Monitoring

Source Water Monitoring

- Filtered Systems
  - Schedules 1, 2, and 3
    - *Cryptosporidium*, *E. coli* and turbidity
    - Minimum of monthly for 24 months
  - Schedule 4
    - *E. coli* biweekly for 12 months
    - E. coli levels trigger *Crypto.* monitoring:
      - >50/100 mL flowing stream (annual mean)
      - >10/100 mL lake/reservoir (annual mean)
    - *Cryptosporidium* sampling
      - 24 samples over 12 or 24 months

Source Water Monitoring

- Unfiltered Systems
  - Schedules 1, 2, and 3
    - *Cryptosporidium*
    - Monthly for 24 months
  - Schedule 4
    - *Crypto.* 24 samples over 12 or 24 months
    - No *E. coli* option

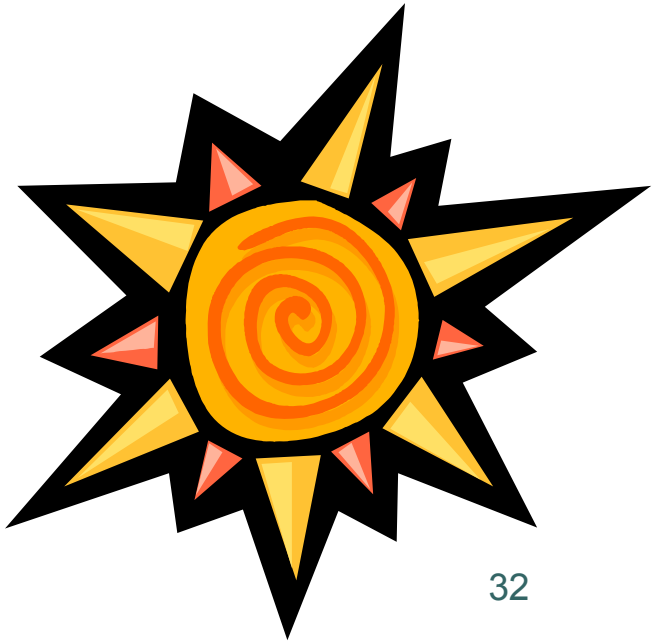
Sampling Plan

Due three months prior to initial monitoring date

- Sample Schedule
  - Specific calendar dates when samples will be collected
  - >10k submit electronically to EPA
    - https://intranet.epa.gov/lt2/protected/
  - <10k submit to state
- Sample Locations
  - Must describe sampling locations in relation to source, treatment, and recycle flows

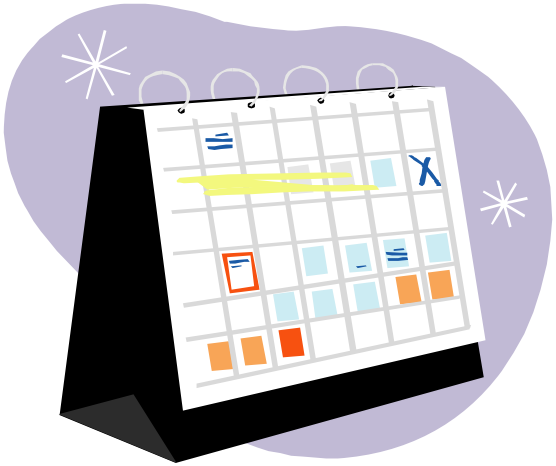
Seasonal Systems – Sampling Schedule

- Sample in months the plant operates
- If operating < 6 months a year
  - Collect at least 6 evenly spaced samples in months of operation
- Sample for 2 years
- EPA or state has flexibility



Sampling Schedule

- May be one or more per month
  - Seasonally representative
  - Unbiased
- Set actual calendar dates
- Arrange with laboratory
- 5-day window



Sampling Schedule

- 5-day window
  - Systems must sample within a 5-day period
    - Within 2 days before, that day, or 2 days after date indicated in the sample schedule
  - Example: Sample schedule has system sampling on the 15th of every month

February 2007						
S	M	T	W	Th	F	S
11	12	13	14	15	16	17

Sampling Schedule

- 5-day window

Sample within 5 days UNLESS

Sample collector would be in danger or delay cannot be avoided

System must sample as close to scheduled date as possible

No data obtained due to circumstances beyond system's control

System must resample within 21 days of learning of problem

Sampling Location

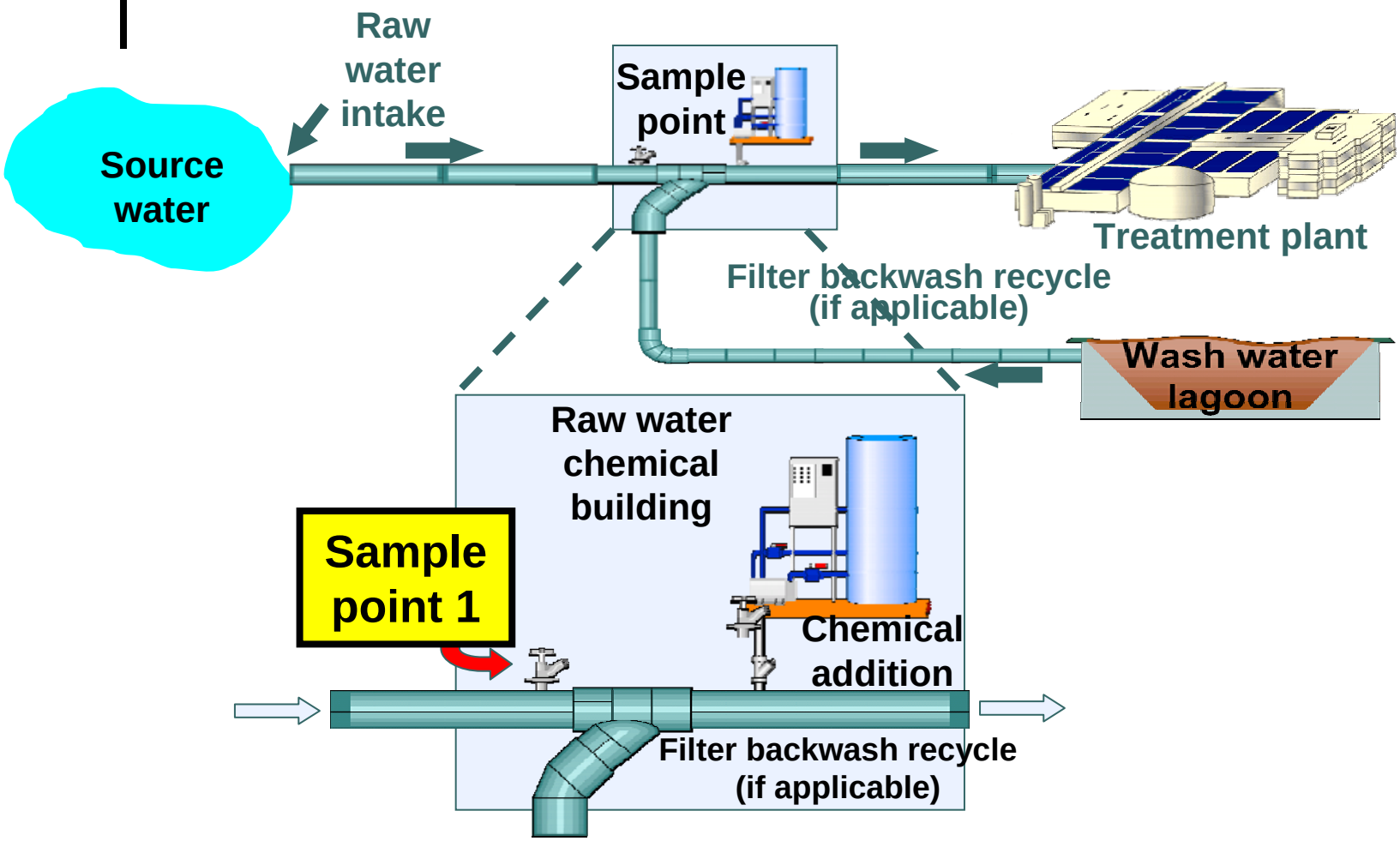
- Representative of source water *Crypto* levels
- Prior to chemicals and/or recycle streams
- Systems with multiple sources
  - Collect after blending

    or
  - Collect samples from each source and composite

Sampling Location

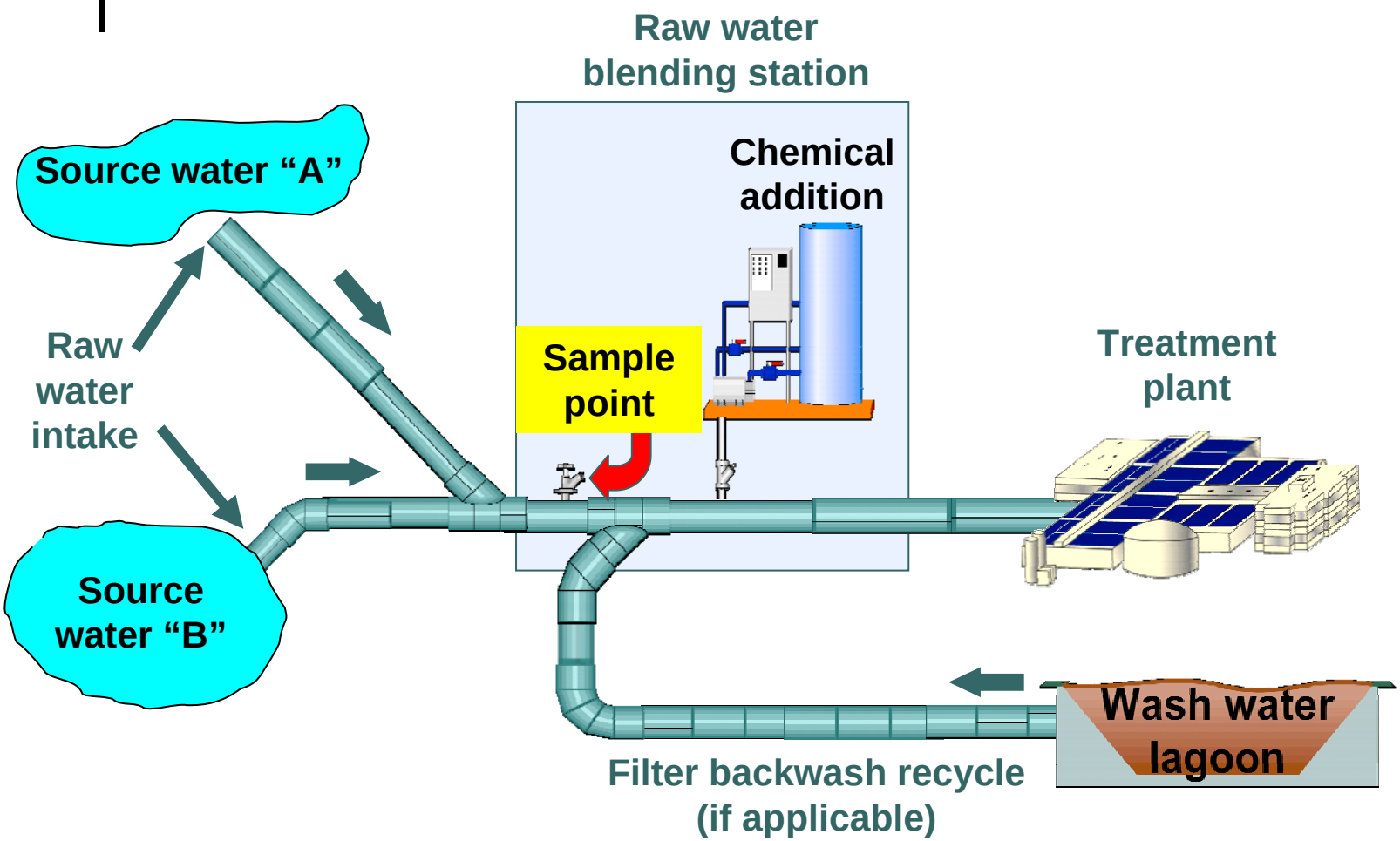
- Unique locations
  - If no sampling tap prior to chemical addition or recycle flows:
    - Install new tap
    - Collect as close to intake as possible, at similar depth and distance from shore
    - Discontinue chemical addition until undetectable

Sampling Location



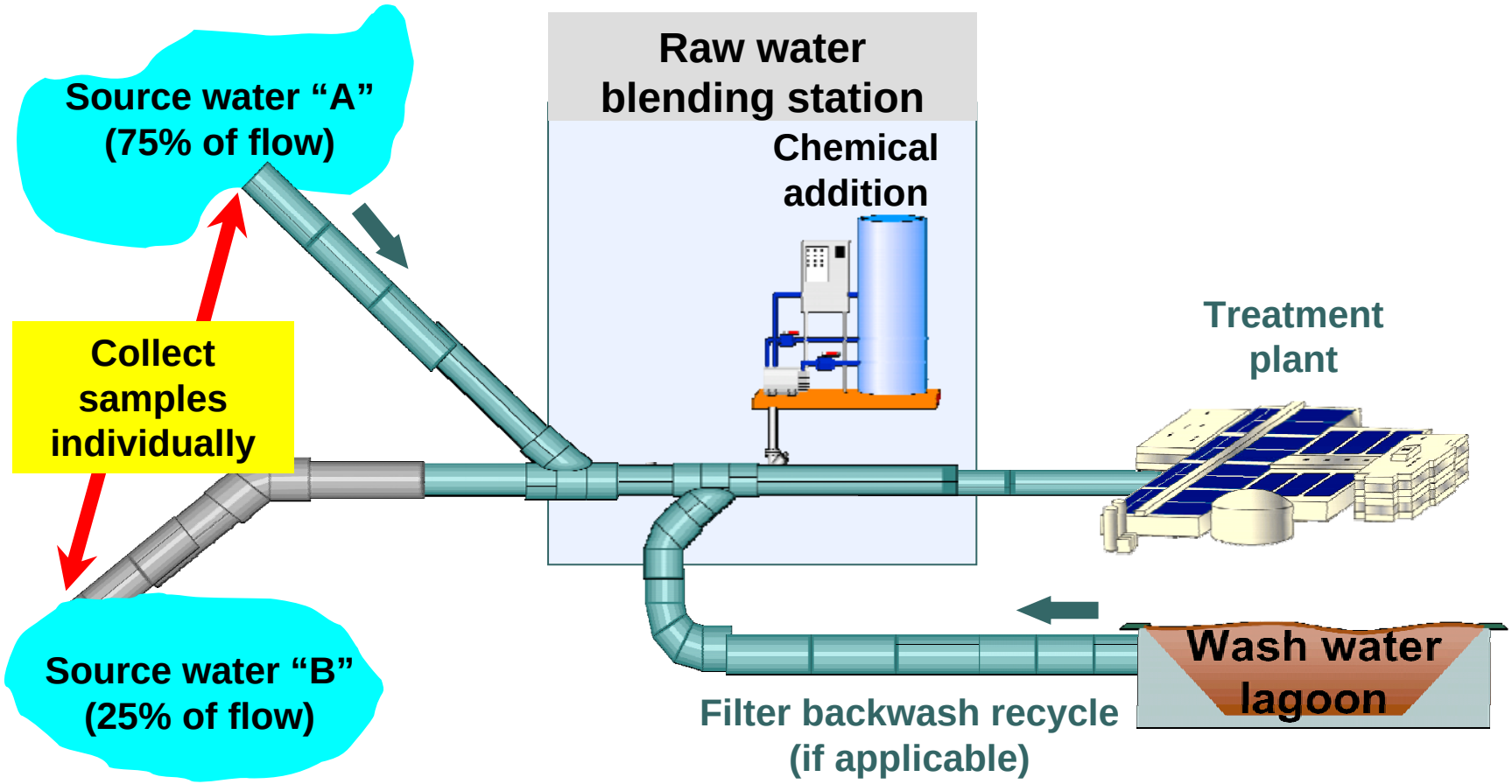
Before Chemical Treatment & Filter Backwash Recycle

Sampling Location



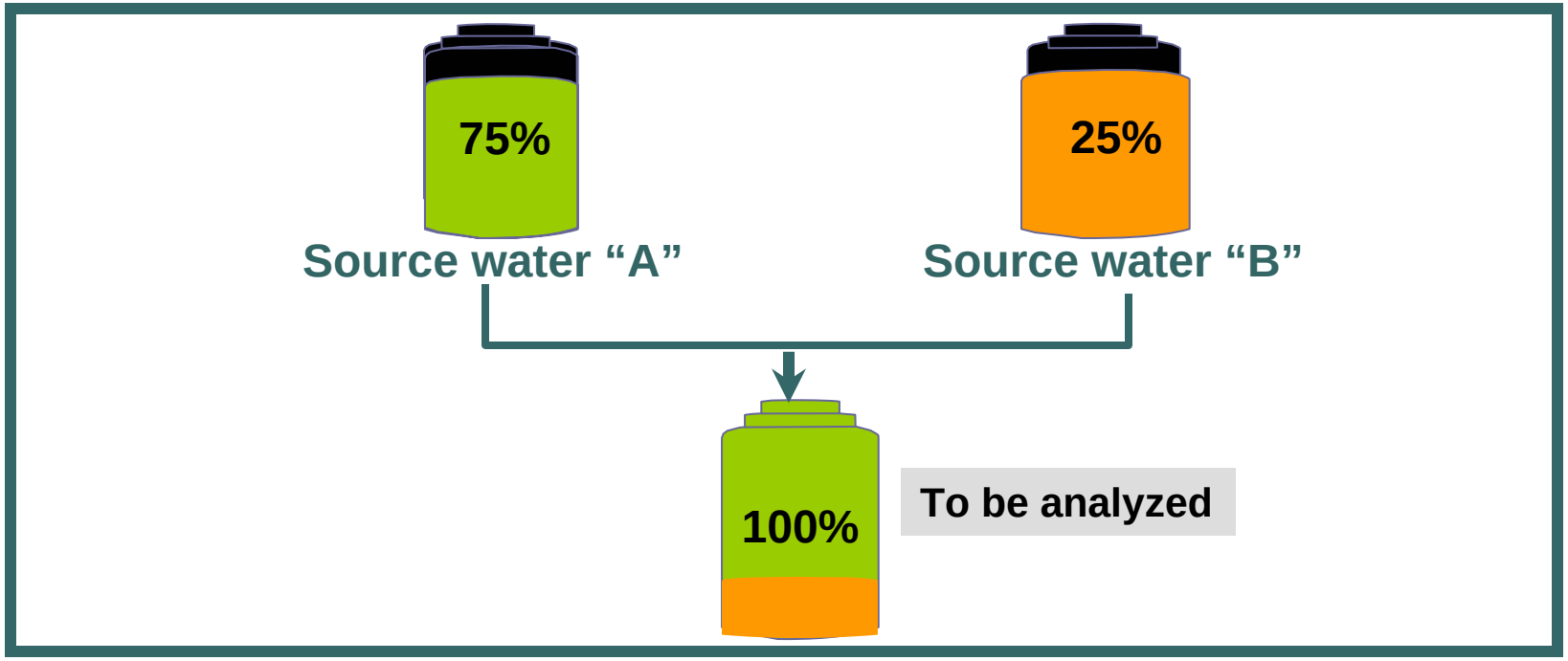
Plant with Multiple Sources: Sample Tap

Sampling Location

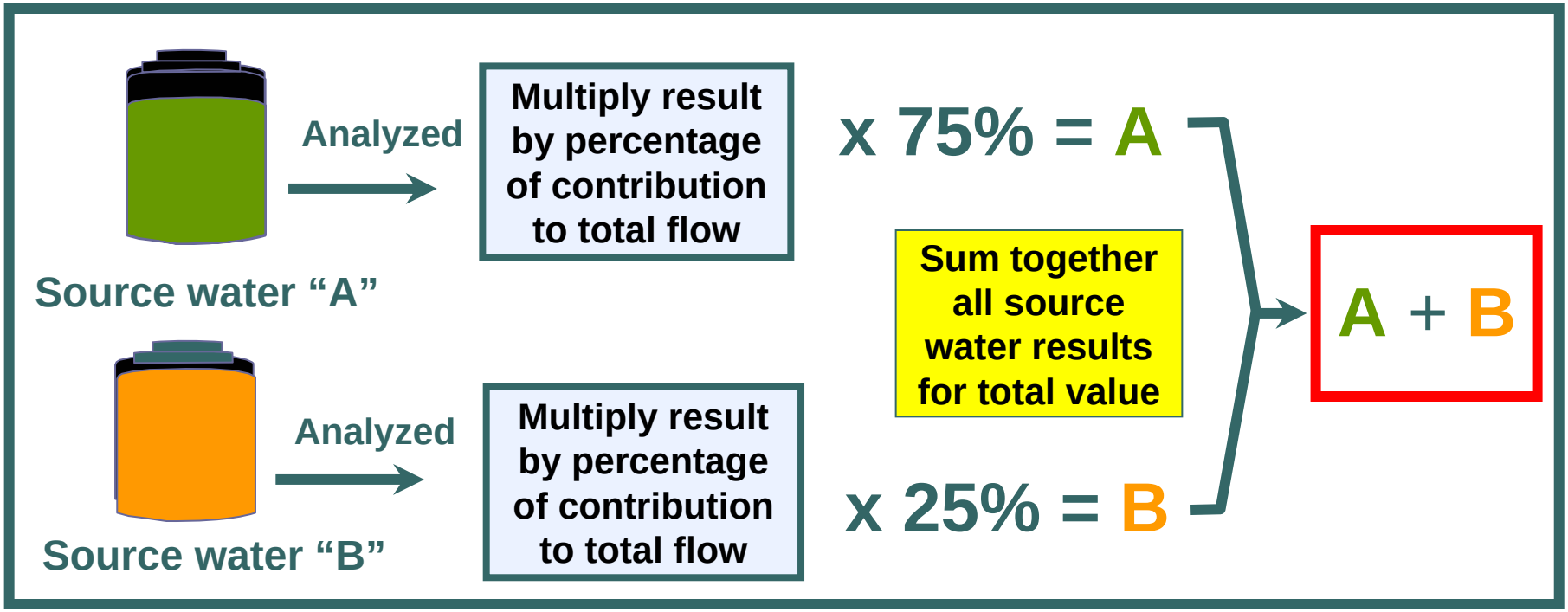


Plant with Multiple Sources: No Sample Tap

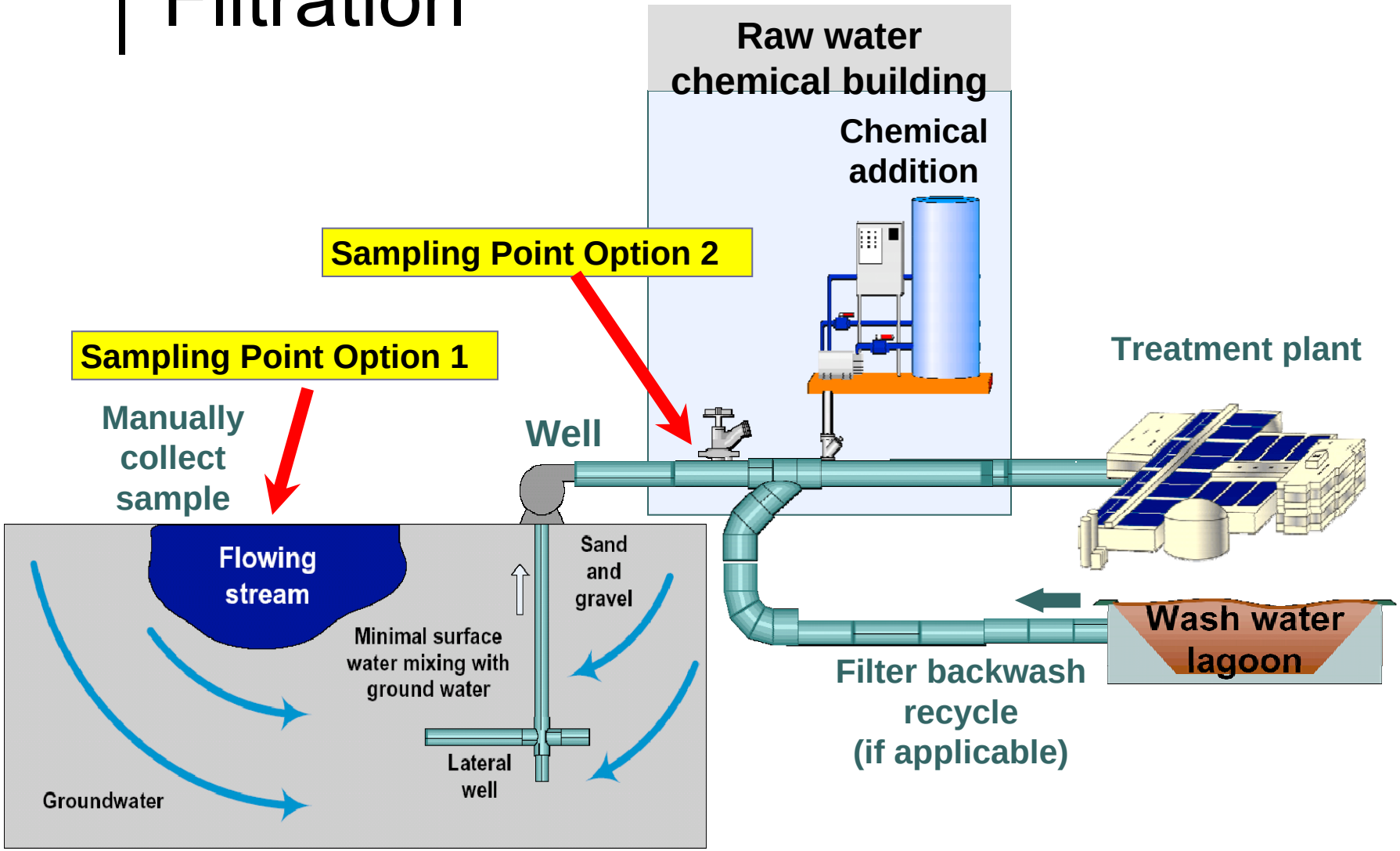
Plant With Multiple Sources: Compositing



Plant With Multiple Sources: Weighted Average



Sampling Locations: Bank Filtration



Sampling Methods and Labs

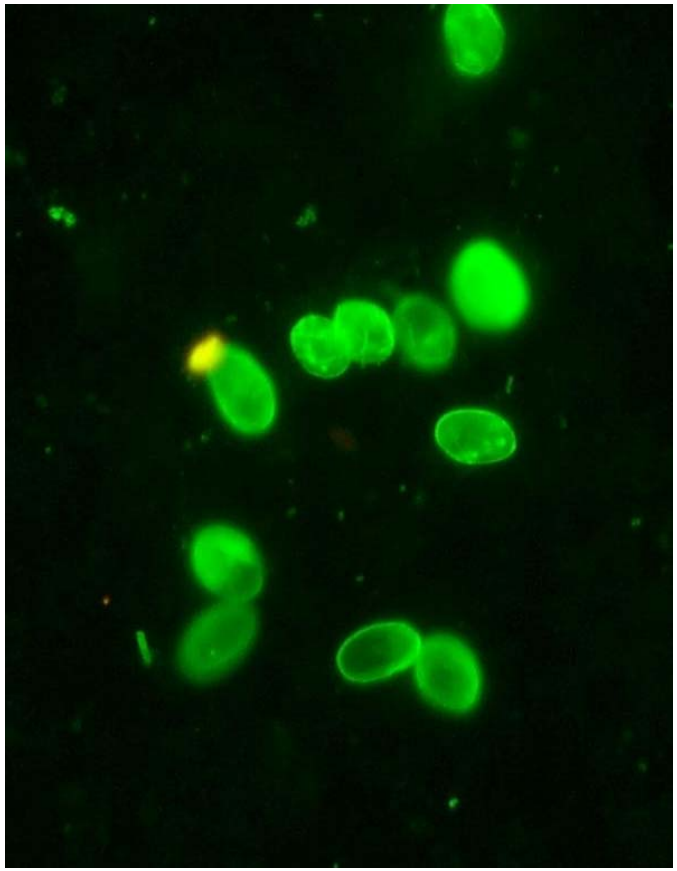
Approved Labs

- Updated list of laboratories approved for *Cryptosporidium* analysis:
  - http://www.epa.gov/safewater/disinfection/lt2/lab_aprvlabs.html

- No *Cryptosporidium* labs in Alaska

Analytical Methods

- *Crypto*
  - Methods 1623 or 1622
  - 10L in bulk or filtered
  - 2 ml packed pellet
  - 2 filters
  - To lab at <20˚C
  - Lab must process within 96 hours of sample time
  - Matrix spike samples (bulk only)

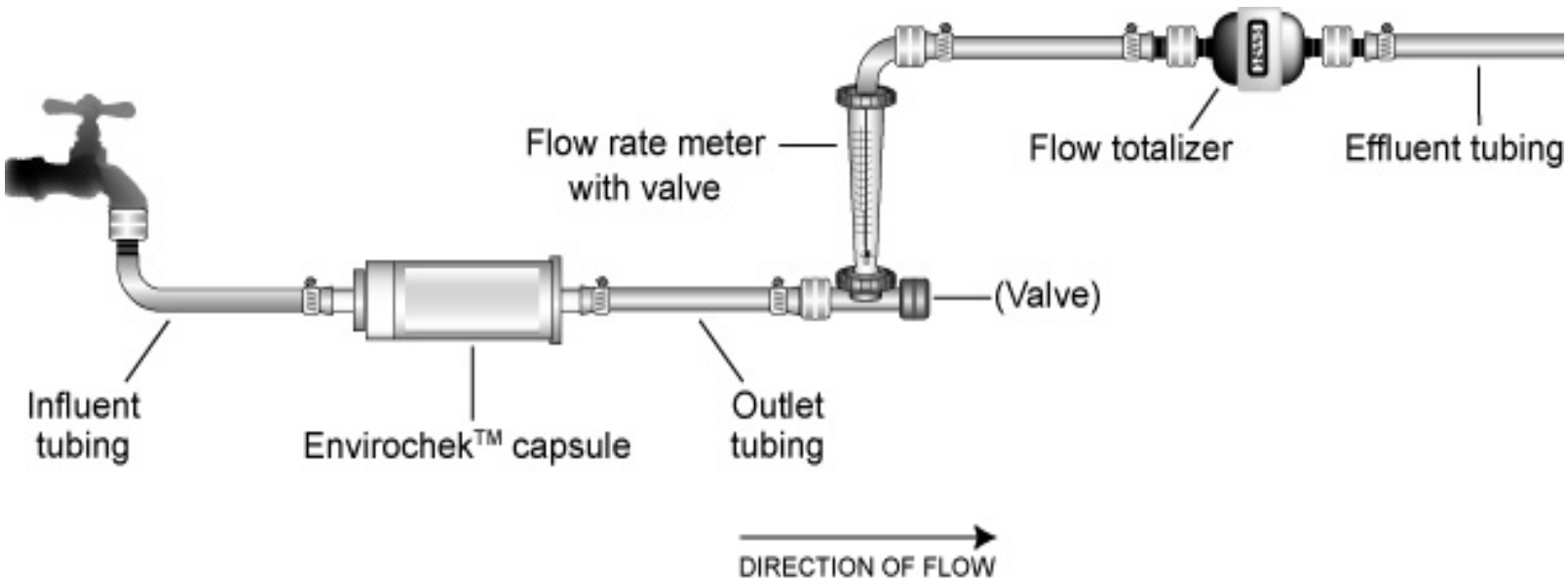


Analytical Methods

- *E. coli*
  - Enumeration, not presence/absence
  - Sample volume = 100 mL
  - To lab within 30 hours
  - State approval of additional holding time
    - 48 hours
    - Colilert reagent method
  - To lab at 0˚C-10˚C

Bulk Water Samples

Filtration



Small equipment, easy to set-up and handle,
10L samples at 2-4 L/min

Filta-Max® filters

Matrix Spike Samples

- Required by the analytical methods
  - Does not affect sample validity or results!
- Collect from same location as field sample
  - Split stream or collected sequentially
  - Every 20 samples
  - Within 10% of field sample volume
- Critical QA step
  - Matrix: water characteristics
  - Spike: oocysts added to evaluate recoveries
  - EPA will use information in future

Turbidity: Raw Water

E. coli Grab Sample

Reporting: *Crypto* Results

- PWS and facility ID
- Sample location and date
- Sample type (field or matrix spike)
- Sample volume filtered
- Was 100% of filtered volume examined
- Number of oocysts

Lab reports results to the DCTS

Reporting: *E. coli* Results

- PWS and facility ID
- Sample location and date
- Analytical method number and type
- Source type
- *E. coli*/100 mL
- Turbidity

Results reported to the DCTS by lab or system

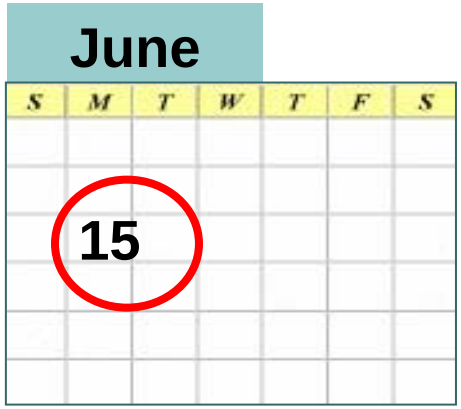
(If unable to report electronically, report by method approved by EPA or state)

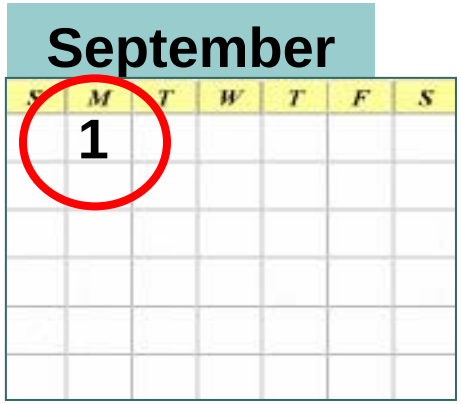
Electronic Submission of Results

- Laboratories must electronically enter results using
  - Web-based manual entry forms
  - XML files from laboratory information management systems (LIMS)
- Systems review and verify results on-line
- If a system believes there is an error
  - Flag results
  - Confer with lab
  - Mark the result as contested and petition EPA or the state to invalidate the sample

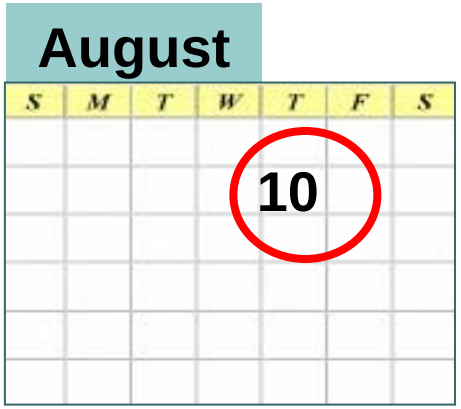
Reporting Analytical Results: Examples

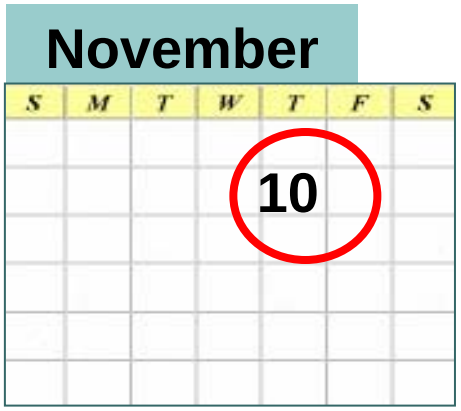
Sample taken on:





Report results by:





Next Step – Analyze Data

- Filtered systems (that monitor *Cryptosporidium*)
  - Calculate *Cryptosporidium* bin concentration
    - Bin classification
- Unfiltered Systems
  - Calculate mean *Cryptosporidium* level
    - Inactivation requirements

Calculating *Cryptosporidium* Level

- At least monthly for two years
  - 24-47 samples
- Seasonal

→ **Highest arithmetic mean of all samples over any 12 consecutive months**

- More than monthly for two years
  - 48 or more samples
- Bimonthly for one year
  - Schedule 4 systems
- Unfiltered

→ **Arithmetic mean of all samples**

If sampling frequency varies, calculate monthly average first, then average months

Example #1

- **System A is a filtered system that serves 8,000 and collects two samples each month for 12 months. All are 10 liter samples**
  - 21 samples were non-detects
  - Three samples had results of
    - 1 oocyst in 10 L
    - 2 oocysts in 10 L
    - 3 oocysts in 10 L

What is the *Cryptosporidium* bin concentration?

April	0	0
May	1 OOCYST	0
June	0	2 OOCYSTS
July	0	0
August	0	3 OOCYSTS
September	0	0
October	0	0
November	0	0
December	0	0
January	0	0
February	0	0
March	0	0

Example #1

- 1 oocysts in 10 L = 0.1oocysts/liter
- 2 oocysts in 10 L = 0.2 oocysts/liter
- 3 oocyst in 10 L = 0.3 oocyst/liter

Bin concentration
= (0.6) / (24)
= 0.025 oocysts/liter

April	0	0
May	0.1 OOCYSTS/L	0
June	0	0.2 OOCYSTS/L
July	0	0
August	0	0.3 OOCYSTS/L
September	0	0
October	0	0
November	0	0
December	0	0
January	0	0
February	0	0
March	0	0

Example #2A

- **System B is a filtered system that serves 12,000 and collects one sample each month for 24 months.**
  - 22 samples were non-detects
  - One sample in August of Year 1 has 2 oocysts/10L
  - One sample in July of Year 2 has 1 oocyst/10L

What is the *Cryptosporidium* bin concentration?

April	0
May	0
June	0
July	0
August	0.2 OOCYSTS/L
September	0
October	0
November	0
December	0
January	0
February	0
March	0
April	0
May	0
June	0
July	0.1 OOCYSTS/L
August	0
September	0
October	0
November	0
December	0
January	0
February	0
March	0

Example #2A

- Highest 12 month period is August Year 1 – July Year 2

Bin concentration

= (0.3) / (12)

= 0.025 oocysts/liter

April	0	
May	0	
June	0	
July	0	
August	0.2 OOCYSTS/L	
September	0	
October	0	
November	0	
December	0	
January	0	
February	0	
March	0	
April	0	
May	0	
June	0	
July	0.1 OOCYSTS/L	
August	0	
September	0	
October	0	
November	0	
December	0	
January	0	
February	0	
March	0	

Example #2B

- What if system was unfiltered?
- Calculation based on mean *Cryptosporidium* level of all months

Mean *Crypto* Level

= (0.3) / (24)

= 0.0125 oocysts/liter

April	0	
May	0	
June	0	
July	0	
August	0.2 OOCYSTS/L	
September	0	
October	0	
November	0	
December	0	
January	0	
February	0	
March	0	
April	0	
May	0	
June	0	
July	0.1 OOCYSTS/L	
August	0	
September	0	
October	0	
November	0	
December	0	
January	0	
February	0	
March	0	

Bin Classification for Filtered Systems

Inactivation Requirements for Unfiltered Systems

Bin Classification (filtered) or Level of Inactivation (unfiltered)

- Filtered Systems
  - Classified into one of four bins
    - Based on bin concentration
    - Bins 2-4 require additional *Cryptosporidium* treatment
- Unfiltered Systems
  - *Cryptosporidium* inactivation requirement
    - Based on mean *Cryptosporidium* level
    - 2-log or 3-log inactivation

Bin Classification – Filtered Systems

Bin	Crypto-sporidium Bin Concen-tration	Additional Treatment Requirements			Total Treatment Requirements for Alternative Filtration
		Conven-tional	Direct	Slow Sand and DE	
1	<0.075 oocysts/L	No additional treatment required			No additional treatment
2	0.075 to <1.0 oocysts/L	1-log additional	1.5-log additional	1-log additional	4.0-log **total**
3	1.0 to <3.0 oocysts/L	2-log additional	2.5-log additional	2-log additional	5.0-log **total**
4	>=3.0 oocysts/L	2.5-log additional	3-log additional	2.5-log additional	5.5-log **total**

Cryptosporidium Inactivation Requirements for Unfiltered Systems

Mean Cryptosporidium Level	*Cryptosporidium Inactivation Requirements*
<=0.01 oocysts/L	2-log inactivation
>0.01 oocysts/L	3-log inactivation

Two disinfectants required.
Each must separately achieve inactivation requirements for either *Giardia*, *Cryptosporidium*, or viruses

Example #3

- **System C is a filtered system serving 25,000 that collects one sample per month for 24 months. Results were non-detect other than:**
  - **In Year 1**
    - May 0.2
    - June 0.1
    - July 0.2
    - August 0.4
  - **In Year 2**
    - May 0.1
    - June 0.3
    - July 0.1
    - Sept. 0.4

What is the bin concentration and bin classification?

Month	Oocysts/liter
April	0
May	0.2
June	0.1
July	0.2
August	0.4
September	0
October	0
November	0
December	0
January	0
February	0
March	0
April	0
May	0.1
June	0.3
July	0.1
August	0
September	0.4
October	0
November	0
December	0
January	0
February	0
March	0

Example #3

- Highest 12 month period is July Year 1 – June Year 2

Bin concentration

= (1.0) / (12)

= 0.083 oocysts/liter

- Bin classification
  - 0.083 oocysts/liter puts system into Bin 2

Month	Oocysts/liter	
April	0	
May	0.2	
June	0.1	
July	0.2	
August	0.4	
September	0	
October	0	
November	0	
December	0	
January	0	
February	0	
March	0	
April	0	
May	0.1	
June	0.3	
July	0.1	
August	0	
September	0.4	
October	0	
November	0	
December	0	
January	0	
February	0	
March	0	

Reporting Bin Classification or Mean *Cryptosporidium* Level

- Report classification/level to the state no later than 6 months after completion of initial monitoring
- Report must include:
  - Summary of source water monitoring data
  - Calculation procedure used for classification

Treatment

Toolbox Options

Additional Filtration

Source Water Protection and Management

Treatment Performance

Inactivation

Pre-filtration

Toolbox Options

Source Protection and Management

- Watershed control programs
  - 0.5-log credit
- Alternative source/intake management
  - No prescribed credit

Toolbox Options

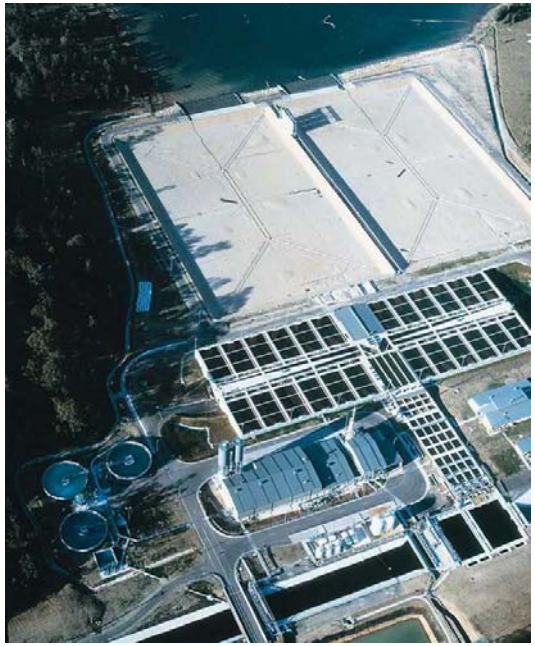
Prefiltration

- Presedimentation basin with coagulation
  - 0.5-log credit
- Two-stage lime softening
  - 0.5-log credit
- Bank filtration
  - 0.5-log credit

Toolbox Options

Treatment Performance

- Combined filter performance
  - 0.5-log credit
- Individual filter performance
  - 0.5-log credit
- Demonstration of performance
  - State approved credit



Toolbox Options

Additional Filtration

- Bag and cartridge filters individual
  - Up to 2.0-log credit
- Bag and cartridge in series
  - Up to 2.5-log credit
- Membrane filtration
  - Demonstration
- Second stage filtration
  - 0.5-log credit
- Slow sand filters
  - 2.5-log credit as secondary
  - 3.0-log credit as primary

Toolbox Options

Inactivation

- Chlorine dioxide
  - Based on measured CT
- Ozone
  - Based on measured CT
- UV
  - Based on validated UV dose

Treatment Installation

- Schedule 1 – April 1, 2012
- Schedule 2 – October 1, 2012
- Schedule 3 – October 1, 2013
- Schedule 4 – October 1, 2014

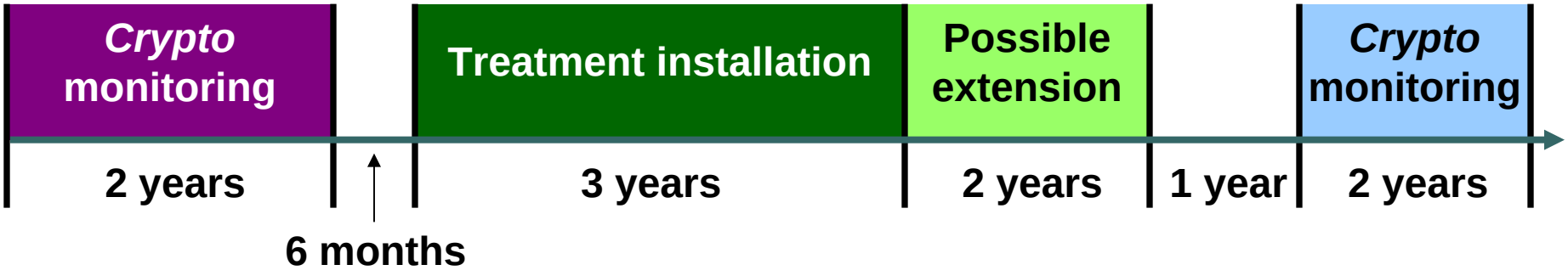
- State can allow up to 2 additional years

Second Round of Monitoring

- Subsequent source water monitoring
  - 6 years after
    - initial bin classification (filtered systems)
    - determination of mean *Crypto* levels (unfiltered systems)
- Can lead to bin reclassification

LT2 Implementation Timeline

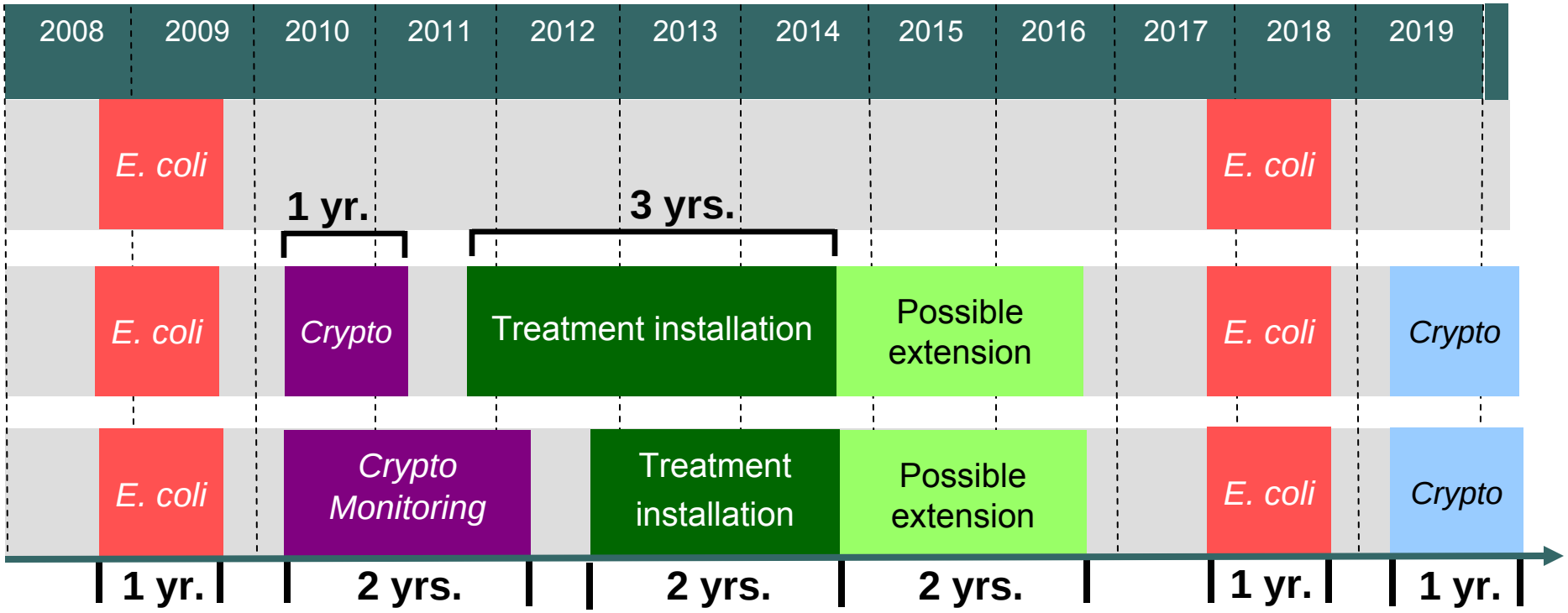
- Schedules 1, 2, and 3



Schedule	Start *Crypto* Monitoring
1	October, 2006
2	April, 2007
3	April, 2008

LT2 Implementation Timeline

- Schedule 4



IPMC and DCTS

- Information Processing & Management Center (IPMC)
  - Centralized location for Source Water Monitoring submissions
  - Receives, sorts, scans, and performs data entry into DCTS
  - Checks submissions for completeness

Mailing Address:

Stage 2 DBPR & LT2ESWTR IPMC

P O Box 98

Dayton, OH 45401

Fax Number:

937-586-6557

E-mail:

stage2mdbp@epa.gov

IPMC and DCTS

- Data Collection & Tracking System (DCTS)
  - Component of IPMC
  - Database that tracks and stores information
  - Systems can enter Source Water Monitoring Schedule
  - Labs electronically upload *Crypto, E. coli*, and turbidity samples for LT2ESWTR monitoring
  - CDX/DCTS step-by-step registration

Additional Resources

Additional Resources

- EPA's Web site: www.epa.gov/safewater/disinfection/lt2/
- Fact Sheets (source water monitoring, laboratory, data collection & tracking)
- Quick Reference Guides for Schedule 1–4 systems
- LT2ESWTR Implementation Guidance Manual
- Draft Simultaneous Compliance Guidance Manual for Stage 2 Rules
- Source Water Monitoring Guidance for PWSs

On-line Laboratory/Sampling Resources

- Approved Labs
  - http://www.epa.gov/safewater/disinfection/lt2/lab_aprvlabs.html

- Online Sampling Module
  - http://www.epa.gov/safewater/disinfection/lt2/compliance.html

Questions??

Toolbox Options

Inactivation

- Chlorine dioxide
  - Based on measured CT
- Ozone
  - Based on measured CT
- UV
  - Based on validated UV dose

Chlorine Dioxide and Ozone

- Ozone quite effective
  - 1 log *Crypto* inactivation @ 0.5º C
    - CT = 24 min mg/L
  - Required monitoring
    - CT
    - Bromate9090 (MCL = 0.010 mg/L)
- Chlorine dioxide less effective
  - 1 log *Crypto* inactivation @ 0.5º C
    - CT = 637 min mg/L
  - Required monitoring
    - CT
    - Chlorite (MCL = 1.0 mg/L)
      - Daily entry point monitoring
      - Monthly distribution system monitoring
      - Follow-up in distribution if exceedance
    - Chlorine Dioxide (MRDL = 0.8)
      - Daily entry point

UV Dose Table

Log Credit	*Crypto*	*Giardia*	Virus
	mJ/cm^2		
0.5	1.6	1.5	39
1.0	2.5	2.1	58
1.5	3.9	3.0	79
2.0	5.8	5.2	100
2.5	8.5	7.7	121
3.0	12	11	143
3.5	15	15	163
4.0	22	22	186

UV Equipment Validation

- LT2 requires that all UV equipment be validated
- Validation includes:
  - Flow rate, UV intensity, UV absorbance
  - Lamp “status”, lamp fouling/aging/failure, sensor uncertainty
  - Inlet/outlet piping, velocity profile
  - Full-scale testing
- State will determine specific

UV Equipment Monitoring

- Monitoring is required:
  - Flow rate
  - UV Intensity
  - Lamp status
  - Other parameters designated by State
- Sensors must be periodically calibrated
- Must stay within validated conditions 95% of the time