



# **Microbial Toolbox**

**Michael J. Finn P.E.**

**EPA Office of Ground Water and Drinking Water**

**Drinking Water Protection Division**

**November 15, 2012**



# Outline

- Basis for required treatment
- Overview of toolbox tools
- Current information on existing toolbox tools



# Basis for Required Treatment

- The 1996 SDWA Amendments required EPA to address risk from *Cryptosporidium*.
- Source water monitoring identified systems that are more vulnerable to *Cryptosporidium* contamination. Systems may be required to provide additional treatment.
- Amount of additional treatment depends on the level of *Cryptosporidium* detected
  - Below 0.075 oocysts/liter no additional treatment (Bin 1)
  - 0.075 to < 1.0 oocysts/liter need 1.0 - 1.5 log additional treatment (Bin 2)
  - 1.0 to < 3.0 oocysts/ liter need 2.0 – 2.5 log additional treatment (Bin 3)
  - 3.0 or more oocysts/liter need 2.5 – 3.0 log additional treatment (Bin 4)



# Overview of Toolbox Tools

- Source Toolbox Components
  - Watershed Control Program
    - 0.5 log credit for filtered sources
    - Unfiltered systems not eligible for credit
  - Alternative Source/Intake Management
    - No prescribed credit
    - Simultaneous monitoring for treatment bin classification



# Overview of Toolbox Tools (continued)

- Pre-Filtration Toolbox Components
  - Pre-sedimentation basin with coagulation
    - 0.5 log-credit for systems achieving 0.5 log turbidity reduction or state approved criteria
    - Basins must be operated continuously with coagulant addition and all plant flow must pass through the basin
  - Two-Stage Lime Softening
    - 0.5-log credit for two-stage softening where chemical additional and hardness precipitation occur in both stages.
    - All plant flow must pass through both stages
  - Bank Filtration
    - 0.5-log credit for 25-foot setback; 1.0-log credit for 50-foot setback
    - Aquifer must be unconsolidated sand containing at least 10 percent fines; average turbidity in wells must be less than 1 NTU
    - Systems using wells followed by filtration when conducting source water monitoring must sample the well to determine bin classification and are not eligible for additional credit



# Overview of Toolbox Tools (continued)

- Treatment Performance Toolbox Components
  - Combined Filter Performance
    - 0.5-log credit for combined filter effluent turbidity  $\leq 0.15$  NTU in at least 95 % of measurements each month
  - Individual Filter Performance
    - 0.5-log credit (in addition to 0.5-log combined filter performance credit) if individual filter effluent turbidity  $\leq 0.15$  NTU in at least 95 % of samples each month in each filter and is never  $> 0.3$  NTU in two consecutive measurements in any filter
  - Demonstration of Performance
    - Credit awarded to unit process or treatment train based on a demonstration to the state with a state-approved protocol



# Overview of Toolbox Tools (continued)

- Additional Filtration Toolbox Options
  - Bag or Cartridge Filters (Individual)
    - Up to 2-log credit based on the removal efficiency demonstrated during challenge testing with a 1.0-log factor of safety
  - Bag or Cartridge Filters (In Series)
    - Up to 2.5-log credit based on the removal efficiency demonstrated during challenge testing with a 0.5-log factor of safety
  - Membrane Filtration
    - Log credit equivalent to removal efficiency demonstrated in challenge test for device if supported by direct integrity testing
  - Second Stage Filtration
    - 0.5-log credit for second separate granular media filtration stage if treatment train includes coagulation prior to first filter
  - Slow Sand Filters
    - 2.5-log credit as a secondary filtration step; 3.0-log credit as a primary filtration process; No prior chlorination for either option



# Overview of Toolbox Tools (continued)

- Inactivation Toolbox Components
  - Chlorine Dioxide
    - Log credit based on measured CT in relation to CT table
  - Ozone
    - Log credit based on measured CT in relation to CT table
  - UV
    - Log credit based on validated UV dose in relation to UV dose table
    - Reactor validation testing required to establish UV dose and associated operating conditions



# Summary of Toolbox Technology Usage

| Toolbox Options   | Percentage of systems using the tool* |
|---|---------------------------------------|
| Watershed Control Program                                 | 10.4%                                 |
| Alternative Intake/Source Management                      | 3.1%                                  |
| Pre-sedimentation basin with coagulation                  | 2.1%                                  |
| Two-Stage Lime Softening                                  | No information available              |
| River Bank Filtration                                     | 3.1%                                  |
| Combined Filter Performance/Individual Filter Performance | 37.5%/34.4%                           |
| Filter Optimization (?)                                   | 3.1%                                  |
| Demonstration of Performance                              | 3.1%                                  |
| Bag or Cartridge Filters (Individual or In series)        | 1.0%                                  |
| Membrane Filtration                                       | 15.6%                                 |
| Second Stage Filtration                                   | 1.0%                                  |
| Slow Sand Filters   | No information available              |
| Chlorine Dioxide  | 1.0%                                  |
| Ozone   | 2.1%                                  |
| UV  | 19.8%                                 |

\*Percentage of 96 PWSs using specific tools based on information obtained from the EPA Regions and States. Some PWS reports indicate they plan to use a particular tool or that they use a tool but not it's unclear whether they claim credit for LT2 compliance purposes.



# Current Information on Existing Toolbox Tools

- UV disinfection
  - New options for reactor validation
    - Some potential new challenge microorganisms have been identified (e.g., *Bacillus pumilus*)
    - Some studies have demonstrated that Computational Fluid Dynamics modeling can be effective for reactor validation
  - Medium pressure UV
    - Several studies have demonstrated lower UV doses required for virus inactivation with medium pressure UV than low pressure UV
    - Low wavelengths issues currently under investigation



# Current Information on Existing Toolbox Tools (continued)

- River Bank Filtration (RBF)
  - A household intervention epidemiology study of consumers (55+ years old) found that AGI risks still exist in water undergoing RBF and meeting all Federal, state and local standards
  - A study is exploring if it's scientifically feasible to demonstrate *Cryptosporidium* removal performance credit greater than 2-3 log



# Current Information on Existing Toolbox Tools (continued)

- Other toolbox tools with information to be evaluated
  - Intake Management – research on models used to determine best location and depth of intakes
  - Membrane Filtration – removals achieved are dependent on type of membrane, test organism, water quality and operational conditions. Applicability to ceramic membranes being investigated.
  - Slow Sand Filters – Pilot- and full-scale studies identified key design and operational parameters
  - Chlorine Dioxide – *Cryptosporidium* inactivation dependent on pH, temperature and microbial lineage
  - Ozone – at least one study has shown ozone to be an effective disinfectant for inactivation of *Cryptosporidium*



# Summary

- Information from 96 PWSs indicate that the most commonly used toolbox tools are: combined filter performance and individual filter performance, UV and membrane filtration
- Recent information on tool effectiveness is available or under development for UV and river bank filtration
- EPA is compiling information on effectiveness and implementation of ozone, alternative source/intake management, membrane filtration, slow sand filters and chlorine dioxide



**If you have any data and other information that would inform the review of the LT2 rule please send it to:**

Ken Rotert at:

[rotert.kenneth@epa.gov](mailto:rotert.kenneth@epa.gov)

or to César Cordero at:

[cordero.cesar@epa.gov](mailto:cordero.cesar@epa.gov)