Disinfection Profiling and Benchmarking

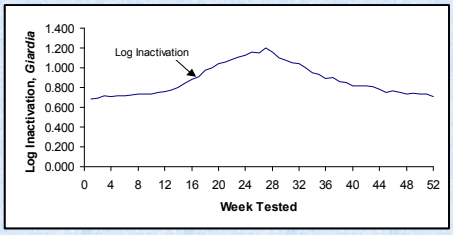
Disinfection Profiling and Benchmarking

- Important to balance disinfection and proper inactivation with Stage 1 DBPR requirements
  - Maintain proper inactivation but limit disinfection byproducts
  - Examine effects of disinfection practice modifications

Disinfection Profiling and Benchmarking

- Systems ≥ 10,000
  - Disinfection Profiling – April 2001
- This presentation focuses on systems < 10,000
  - Requirements are the same regardless of treatment technique

Example Disinfection Profile



Disinfection Profiling

- Weekly inactivations must be calculated for *Giardia*
- Weekly virus inactivations must also be calculated if using chloramines, chlorine dioxide, or ozone as primary disinfectant
- Applies to CWS and NTNC

LT1ESWTR 141.530 & 535

Disinfection Profiling

- State may waive disinfection profiling requirements if:
  - TTHMs < 0.064 mg/L
  - HAA5s < 0.048 mg/L
  - Warmest water temperature month
  - Max residence time
  - After January 1, 1998

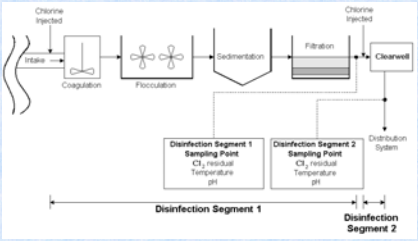
Disinfection Profiling

- Systems serving 500 - 9,999
  - Must begin collecting data no later than July 1, 2003
- Systems serving < 500
  - Must begin collecting data no later than January 1, 2004

Disinfection Profiling

- System must collect the following at peak hourly flow on same day of week at same location and time:
  - Residual disinfectant concentration
  - pH (if using chlorine)
  - Temperature
  - Contact time

Define Disinfection Segments



Disinfection Profiling

- Calculate *Giardia* inactivation ratio for each disinfection segment
  - 3 ($CT_{calc}/CT_{99.9}$)
- Calculate virus inactivation using method approved by the State

LT1ESWTR 141.534 and 535

Disinfection Benchmark

- Must calculate the benchmark if
  - System has developed a disinfection profile and
  - Plans on significant change to disinfection practices
- System must consult with State for approval prior to making changes

LT1ESWTR 141.540

Disinfection Benchmark

- Significant changes to disinfection practices:
  - Change to point of disinfection
  - Change to disinfectant used
  - Change of disinfection process
  - Any other modification identified by State

LT1ESWTR 141.541

Disinfection Benchmark

- Systems considering significant change:
  - Calculate & provide benchmark to State
  - Description of proposed change
  - Disinfection profile for *Giardia* and viruses (if required)

LT1ESWTR 141.542

Disinfection Benchmark

- Systems considering significant change (continued):
  - Analysis of how proposed change will affect current levels of disinfection
  - Any other State-requested information

LT1ESWTR 141.542

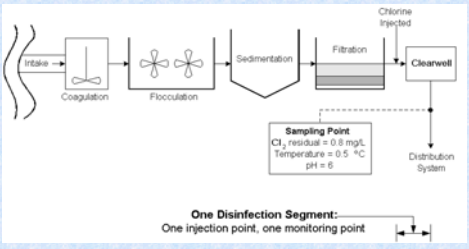
Disinfection Benchmark

- Benchmark calculated by:
  - Determining average monthly inactivation for each calendar month
  - The lowest monthly average value is the benchmark
  - Procedure is the same for *Giardia* and viruses

LT1ESWTR 141.543 and 141.544

Disinfection Profile and Benchmark Calculation Example

System Schematic: Disinfection Segments Defined



Data Collection

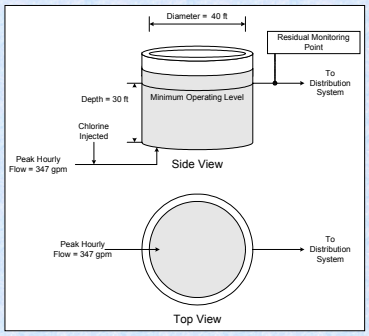
- Step 1. Determine the peak hourly flow.
  - From the raw water pump records the peak hourly flow is determined to be 347 gpm.

Data Collection

- Step 2. Measure the chlorine residual, temperature, and pH (since chlorine is used) during peak hourly flow at the sampling point and at the same time.
  - Chlorine residual = 0.8 mg/L
  - Temperature = 0.5^{o}C
  - pH = 6

Data Collection

- Step 3. Measure the physical dimensions of the contact basin.



Volume Calculation

- Step 4. Calculate the volume
- Volume (V) = minimum water depth x cross-sectional area (B x r^2)
  - B = 3.14
  - radius (r) = diameter / 2
    - = 40 ft / 2 = 20 ft

Volume Calculation

- V = 30 ft x 3.14 x $(20\ ft)^2$ x (7.48 gal / ft^3)
- V = 282,000 gallons

Theoretical Detention Time Calculation

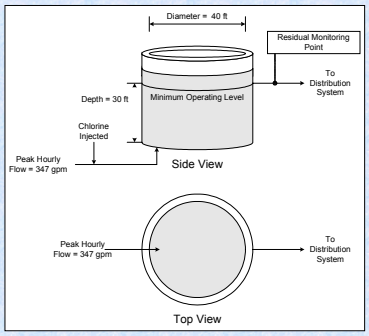
- Step 5. Calculate the Theoretical Detention Time (TDT).
  - TDT = V / Q
    - TDT = 282,000 gal / 347 gpm
    - TDT = 813 minutes

Baffling Factor Determination

- Step 6. Determine the baffling factor for the contact basin.

Baffling Factors

Baffling Condition	Baffling Factor	Baffling Description	Typical Unit Process
Unbaffled (mixed flow)	0.1	None; agitated basin; very low length to width ratio; high inlet and outlet flow velocities	Clearwell, storage tank, no perforated inlet or outlet, inlet or outlet submerged.
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles	Many conventional sedimentation basins. Storage tanks with two or three baffles.
Average	0.5	Baffled inlet or outlet with some intra-basin baffles	Some (few) sedimentation basins. Highly baffled storage tanks.
Superior	0.7	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir	Filters. Contact tanks with serpentine baffling.
Perfect (plug flow)	1.0	Very high length to width ratio (pipeline flow), perforated inlet, outlet, and intra-basin baffles	Sections of pipe ten times longer than their diameter.



Baffling Factor Determination

Baffling Condition	Baffling Factor	Baffling Description
Unbaffled (mixed flow)	0.1	None, agitated basin, very low length to width ratio, high inlet and outlet flow velocities.
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles.
Average	0.5	Baffled inlet or outlet with some intra-basin baffles.

Contact Time Calculation

- Step 7. Calculate the contact time of the disinfectant in the contact basin.
  - Contact Time (T) = TDT x BF
    - T = 813 min x 0.1
    - T = 81.3 minutes

CT_{calc} Calculation

- Step 8. Determine CT_{calc}.
  - CT_{calc} = C x T
    - C = 0.8 mg/L
    - T = 81.3 min
  - CT_{calc} = 0.8 mg/L x 81.3 min
  - CT_{calc} = 65.0 min-mg/L

$CT_{99.9}$ Determination

- Step 9. Locate CT table for 3-log *Giardia* inactivation based on water quality data.
  - Water Temperature = 0.5°C
  - Chlorine Residual = 0.8 mg/L
  - pH = 6.0

$CT_{99.9}$ Determination

- Step 10. Obtain $CT_{99.9}$ value.

Chlorine Concentration (mg/L)	Temperature <=0.5°C						
	pH						
	<=6.0	6.5	7.0	7.5	8.0	8.5	9.0
<=0.4	137	163	195	237	277	329	390
0.6	141	169	200	239	286	342	407
0.8	**145**	172	205	246	295	354	422
1	148	176	210	253	304	365	437
1.2	152	180	215	259	313	376	451

Giardia Log Inactivation Calculation

- Step 11. Calculate the *Giardia* log inactivation for the contact basin.
  - *Giardia* log inactivation
    = 3 x (CT_{calc} / $CT_{99.9}$)
    - CT_{calc} = 65.0 min-mg/L
    - $CT_{99.9}$ = 145 min-mg/L

Giardia Log Inactivation Calculation

- *Giardia* log inactivation
  = 3 x $\frac{65.0 \text{ min-mg/L}}{145 \text{ min-mg/L}}$
- ***Giardia* log inactivation = 1.34**

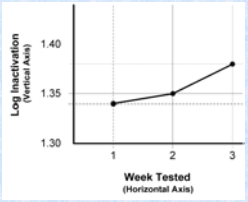
Disinfection Profile Development for *Giardia*

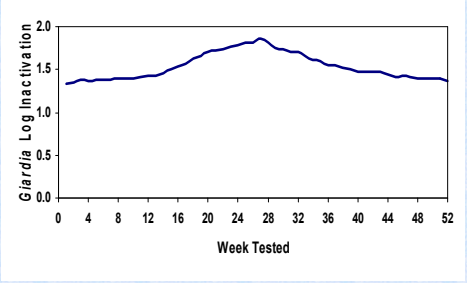
- Step 12. Calculate the *Giardia* log inactivations once per week on the same day of the week for one year.

Month	Week	Log Inact. *Giardia*	Month	Week	Log Inact. *Giardia*
JAN	1	1.34	JULY	27	1.86
	2	1.35		28	1.82
	3	1.38		29	1.76
	4	1.37		30	1.74
FEB	5	1.38	AUG	31	1.71
	6	1.38		32	1.70
	7	1.39		33	1.66
	8	1.40		34	1.61
MARCH	9	1.40	SEP	35	1.60
	10	1.40		36	1.55
	11	1.41		37	1.56
	12	1.42		38	1.52
	13	1.43		39	1.51
APRIL	14	1.46	OCT	40	1.47
	15	1.50		41	1.48
	16	1.54		42	1.47
	17	1.57		43	1.47
MAY	18	1.64	NOV	44	1.45
	19	1.66		45	1.41
	20	1.70		46	1.43
	21	1.72		47	1.41
JUNE	22	1.74	DEC	48	1.40
	23	1.77		49	1.40
	24	1.79		50	1.40
	25	1.82		51	1.40
	26	1.81		52	1.37

Disinfection Profile Development for *Giardia*

- Step 13. Plot the Disinfection Profile.





Disinfection Benchmark Calculation for *Giardia*

- Step 14. Calculate the average *Giardia* log inactivation for each month.

Disinfection Benchmark Calculation for *Giardia*

- Ave. Log Inactivation

$$= \frac{\text{(Sum of Weekly Log Inactivation Values)}}{\text{(Number of Weekly Values per Month)}}$$

Disinfection Benchmark Calculation for *Giardia*

- For January:
  - Ave. log inactivation

$$= \frac{1.34 + 1.35 + 1.38 + 1.37}{4 \text{ values}}$$

  - Ave. log inactivation = 5.44 / 4
  - **Ave. log inactivation = 1.36**

Disinfection Benchmark Calculation for *Giardia*

- Summary of monthly average *Giardia* log inactivations calculated for the year:

January	1.36	July	1.79
February	1.39	August	1.67
March	1.41	September	1.55
April	1.52	October	1.47
May	1.68	November	1.42
June	1.79	December	1.39

Disinfection Benchmark Calculation for *Giardia*

- Step 15. Identify the month with the lowest monthly average *Giardia* log inactivation. The average *Giardia* log inactivation for that month is the disinfection benchmark for *Giardia*.

Disinfection Benchmark Calculation for *Giardia*

January	**1.36**	July	1.79
February	1.39	August	1.67
March	1.41	September	1.55
April	1.52	October	1.47
May	1.68	November	1.42
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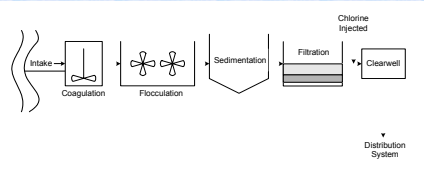
- The disinfection benchmark for *Giardia* is 1.36 log inactivations.

Evaluation of Results

- The disinfection benchmark for *Giardia* is 1.36 log inactivations.
- System is conventional plant
  - State grants 2.5 log *Giardia* removal credit
  - System must achieve 0.5 log *Giardia* inactivation through disinfection

Options for Compliance



Remember…

- Systems must achieve the required *Giardia* and virus inactivations through disinfection
- Systems must also develop a disinfection strategy that complies with the Stage 1 DBPR
- The disinfection profile and benchmark are helpful tools