

The importance of CT in drinking water systems

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waterstudies.

CENTRE FOR WATER RESOURCES STUDIES | DALHOUSIE UNIVERSITY

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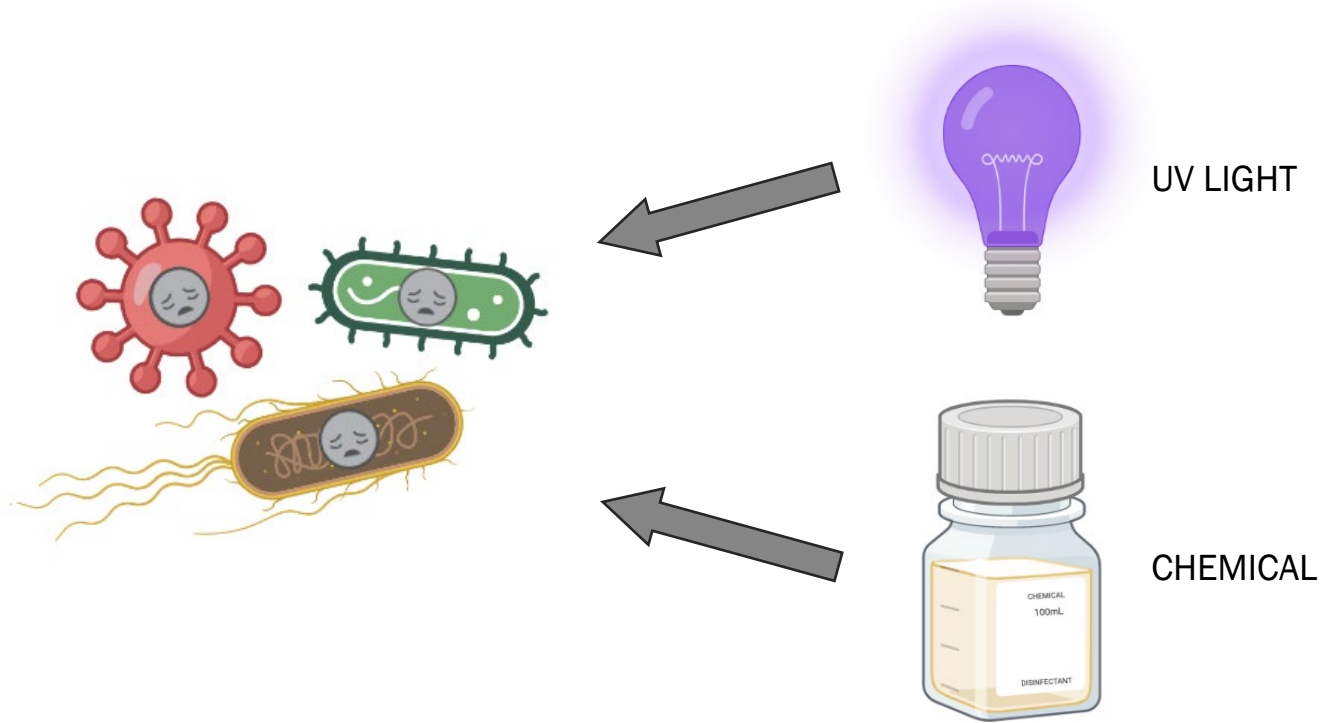
Outline

1. Understanding disinfection
2. The importance of CT
3. CT Workbooks

The background of the slide features a serene landscape with three wind turbines on a hillside, their forms reflected in a calm body of water. The entire scene is overlaid with a semi-transparent blue filter. A bright yellow rounded rectangle is centered on the slide, containing the title text.

Understanding Disinfection

What is disinfection?



Why is disinfection important?

- Disinfection protects public health
- Surface water and ground water (GUDI) can be exposed to contamination (humans, animals, waste, spills, etc.)
- Because of this, microorganisms that cause disease (pathogens) can be present in water
- Important to make sure these pathogens (bacteria, protozoa, and viruses) are killed so people don't get sick

Chlorine disinfection

- Most common disinfectant
- Types include:
 - Sodium hypochlorite (bleach) **Used in majority of systems**
 - Calcium hypochlorite
 - Chlorine gas

Disinfection requirements

- 3-log reduction of Giardia
 - *Kill 99.9%*
- 4-log reduction of Virus
 - *Kill 99.99%*
- Do not store chlorine for more than 90 days.



The Importance of CT

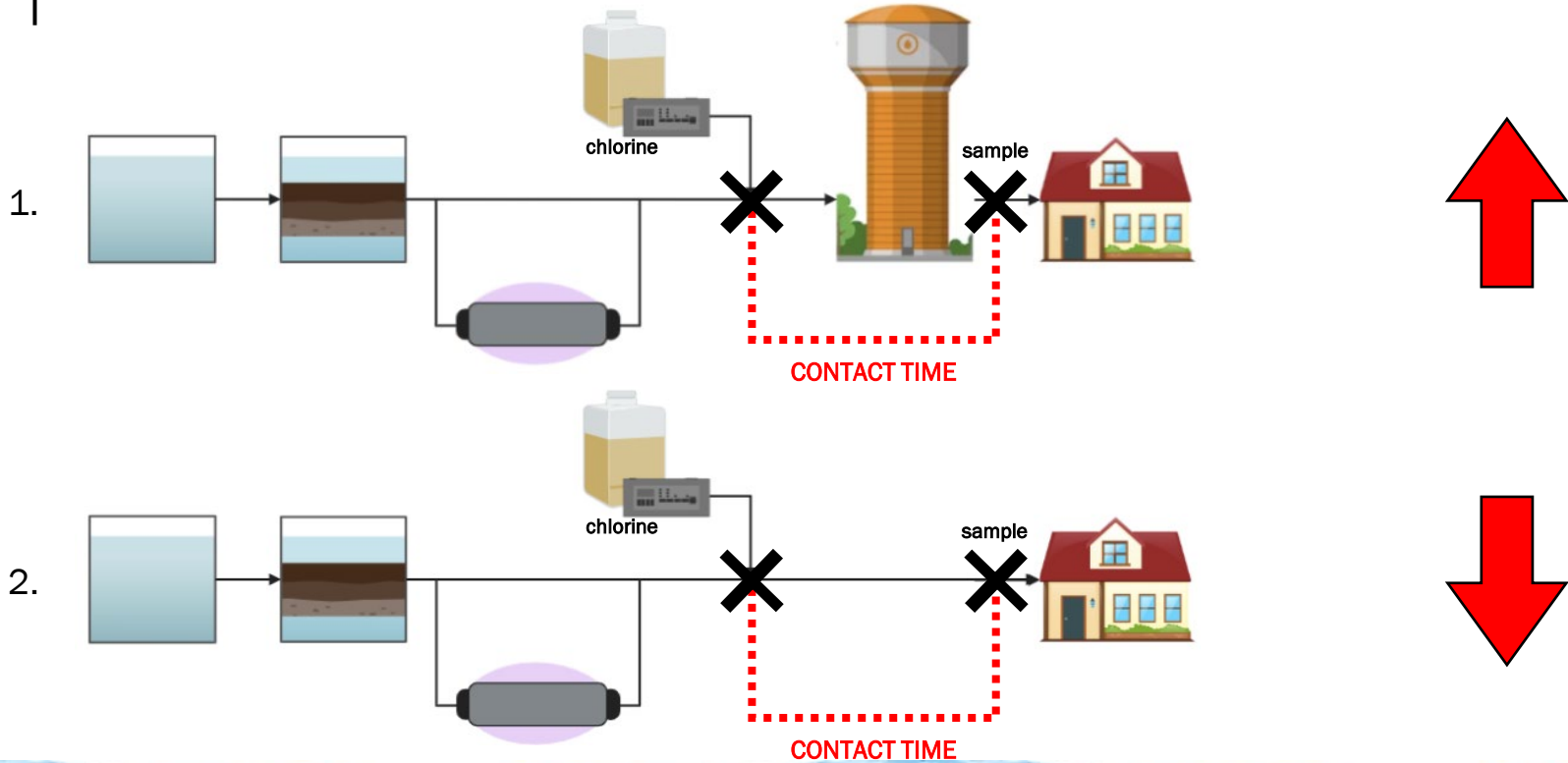
What is CT?

CT = Chlorine Concentration x Contact Time

↑
measured chlorine
residual (mg/L)

↑
time chlorine is
in contact with
water (min)

Contact time

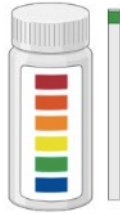


What affects CT?

CT = Chlorine Concentration x Contact Time



↓ = ↓ disinfection



↑ = ↓ disinfection



↓ = ↓ disinfection

What affects CT?

CT = Chlorine Concentration x Contact Time



↓ = ↑ contact time



↓ = ↓ contact time

How do I know if my CT value is safe?

1. Determine how much CT you need (CT_{REQUIRED})
2. Determine how much CT you have achieved (CT_{ACTUAL})
3. Make sure CT_{ACTUAL} is more than CT_{REQUIRED}

CT required: Not all pathogens are disinfected equally

CT Values for Inactivation of Viruses by Free Chlorine

Temperature (°C)	Log Inactivation					
	2		3		4	
	pH		pH		pH	
	6 to 9	10	6 to 9	10	6 to 9	10
0.5	6	45	9	66	12	90
5	4	30	6	44	8	60
10	3	22	4	33	6	45
15	2	15	3	22	4	30
20	1	11	2	16	3	22
25	1	7	1	11	2	15

CT units = min·mg/L

Source: USEPA (1991) Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources.

Viruses are readily inactivated by chlorine disinfection across a range of pH values and temperatures.

CT Required: Not all pathogens are disinfected equally

CT Log Inactivation Values for *Giardia* using Free Chlorine at 15°C

Free Chlorine Concentration mg/L	pH ≤ 6						pH = 6.5						pH = 7.0						pH = 7.5					
	Log Inactivation						Log Inactivation						Log Inactivation						Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	8	16	25	33	41	49	10	20	30	39	49	59	12	23	35	47	58	70	14	28	42	55	69	83
0.6	8	17	25	33	42	50	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86
0.8	9	17	26	35	43	52	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75	15	30	45	60	75	90
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76	15	31	46	61	77	92
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78	16	31	47	63	78	94
1.6	10	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79	16	32	48	64	80	96
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81	16	33	49	65	82	98
2	10	19	29	39	48	58	12	23	35	46	58	69	14	28	42	55	69	83	17	33	50	67	83	100
2.2	10	20	30	39	49	59	12	23	35	47	58	70	14	28	43	57	71	85	17	34	51	68	85	102
2.4	10	20	30	40	50	60	12	24	36	48	60	72	14	29	43	57	72	86	18	35	53	70	88	105
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88	18	36	54	71	89	107
2.8	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89	18	36	55	73	91	109
3	11	21	32	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91	19	37	56	74	93	111

Free Chlorine Concentration mg/L	pH = 8.0						pH = 8.5						pH ≤ 9.0					
	Log Inactivation						Log Inactivation						Log Inactivation					
	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3	0.5	1	1.5	2	2.5	3
≤ 0.4	17	33	50	66	83	99	20	39	59	79	98	118	23	47	70	93	117	140
0.6	17	34	51	68	85	102	20	41	61	81	102	122	24	49	73	97	122	146
0.8	18	35	53	70	88	105	21	42	63	84	105	126	25	50	76	101	126	151
1	18	36	54	72	90	108	22	43	65	87	108	130	26	52	78	104	130	156
1.2	19	37	56	74	93	111	22	45	67	89	112	134	27	53	80	107	133	160
1.4	19	38	57	76	95	114	23	46	69	91	114	137	28	55	83	110	138	165
1.6	19	39	58	77	97	116	24	47	71	94	118	141	28	56	85	113	141	169
1.8	20	40	60	79	99	119	24	48	72	96	120	144	29	58	87	115	144	173
2	20	41	61	81	102	122	25	49	74	98	123	147	30	59	89	118	148	177
2.2	21	41	62	83	103	124	25	50	75	100	125	150	30	60	91	121	151	181
2.4	21	42	64	85	106	127	26	51	77	102	128	153	31	61	92	123	153	184
2.6	22	43	65	86	108	129	26	52	78	104	130	156	31	63	94	125	157	188
2.8	22	44	66	88	110	132	27	53	80	106	133	159	32	64	96	127	159	191
3	22	45	67	89	112	134	27	54	81	108	135	162	33	65	98	130	163	195

Giardia inactivation is pH and temperature dependent

CT Required: Not all pathogens are disinfected equally

CT Log Inactivation Values for *Cryptosporidium* using Chlorine Dioxide

Log Inactivation	Water Temperature (°C)										
	0.5	1	2	3	5	7	10	15	20	25	30
0.25	159	152	139	128	107	90	69	45	29	19	12
0.50	318	304	279	256	215	180	139	90	58	37	24
1.00	636	609	558	511	429	361	278	179	116	75	48
1.50	954	913	837	767	644	541	416	269	174	112	73
2.00	1271	1217	1115	1022	859	721	555	359	232	150	97
2.50	1589	1521	1394	1278	1073	901	694	449	290	187	121
3.00	1907	1826	1673	1533	1288	1082	833	538	348	225	145

Just use UV.

CT Actual: calculated from your systems performance

$$CT = \text{Chlorine } \underline{C} \text{oncentration} \times \text{Contact } \underline{T} \text{ime}$$

↑
measured chlorine
residual (mg/L)

↑
time chlorine is
in contact with
water (min)

CT compliance

- CT_{ACTUAL} **must** be calculated every day
- CT_{REQUIRED} **must** be determined every day
- The ratio of $CT_{\text{ACTUAL}} / CT_{\text{REQUIRED}}$ **must** be calculated every day
 - *CT ratio must be equal to or more than 1*

The background of the slide features a serene landscape with three wind turbines silhouetted against a blue sky. They are situated on a dark, forested hillside that is reflected in a calm body of water in the foreground. The overall color palette is a monochromatic blue, creating a clean and professional aesthetic.

CT Workbooks



INSTRUCTIONS FOR CT VALUE ELSIPOGTOG

2023

Using the tab labelled 'Sampling Data':

1. Input date sample was collected in '**Date**' column
2. Input measured chlorine residual of sample from contact point into '**Chlorine Residual**' column
3. Input flow rate of storage outlet in '**Tank Outlet Flow**' column
* Make sure flow rate units are in m^3/day
4. Input temperature measured at the chlorine contact point in '**Temperature**' column
5. Input pH measured at the chlorine contact point in '**pH**' column
6. Input volume of water in storage tank at the time of sampling in '**Tank Volume**' column

Using the tab labelled 'Actual CT':

1. Record the value calculated in the '**CT Actual**' column in your logbook
2. If the cells from '**Chlorine Residual**', '**CT Ratio (Giardia)**', '**Log Reduction (Giardia)**', '**CT Ratio (Virus)**', '**Log Reduction (Virus)**' turn **red**, corrective action is required.
3. If cells turn **yellow**, corrective action may be required.
5. If cells turn **green**, no action is required.
6. Record any actions taken in your logbook.

All inputted data should match the data recorded in logbooks.

Instructions

Input Sampling Data

Actual CT

Required CT for Giardia

Required CT for Viruses

Giardia Graph

Virus Graph

A	B	C	D	E	F	G
DATE	CHLORINE RESIDUAL (mg/L)	TANK OUTLET FLOW (m³/d)	TEMPERATURE (°C)	pH	TANK VOLUME (m³)	
2022-03-08	1.45	1383.35	5.00	7.70	947.5	
2022-04-13	0.65	1383.35	10.00	7.70	947.5	
2022-04-26	1.36	1383.35	15.00	7.70	947.5	
2022-04-26	1.4	1383.35	19.00	7.70	947.5	
2022-05-02	1.79	1383.35	5.00	7.70	947.5	
2022-05-09	1.49	1383.35	10.00	7.70	947.5	
2022-05-09	1.3	1383.35	15.00	7.70	947.5	
2022-05-17	1.38	1383.35	19.00	7.70	947.5	
2022-05-17	1.4	1383.35	5.00	7.70	947.5	
2022-10-21	1.93	1383.35	10.00	7.70	947.5	
2022-10-21	1.9	1383.35	15.00	7.70	947.5	
2022-11-22	1.2	1383.35	19.00	7.70	947.5	
2022-12-12	1.27	1383.35	5.00	7.70	947.5	

Volume of water in tank
SCADA

Instructions Input Sampling Data Actual CT Required CT for Giardia Required CT for Viruses Giardia Graph Virus Graph



INSTRUCTIONS FOR CT VALUE ELSIPOGTOG

2023

Using the tab labelled 'Sampling Data':

1. Input date sample was collected in 'Date' column
2. Input measured chlorine residual of sample from contact point into 'Chlorine Residual' column
3. Input flow rate of storage outlet in 'Tank Outlet Flow' column
* Make sure flow rate units are in m^3/day
4. Input temperature measured at the chlorine contact point in 'Temperature' column
5. Input pH measured at the chlorine contact point in 'pH' column
6. Input volume of water in storage tank at the time of sampling in 'Tank Volume' column

Using the tab labelled 'Actual CT':

1. Record the value calculated in the 'CT Actual' column in your logbook
2. If the cells from 'Chlorine Residual', 'CT Ratio (Giardia)', 'Log Reduction (Giardia)', 'CT Ratio (Virus)', 'Log Reduction (Virus)' turn **red**, corrective action is required.
3. If cells turn **yellow**, corrective action may be required.
5. If cells turn **green**, no action is required.
6. Record any actions taken in your logbook.

All inputted data should match the data recorded in logbooks.

Instructions

Input Sampling Data

Actual CT

Required CT for Giardia

Required CT for Viruses

Giardia Graph

Virus Graph

A	B	C	D	E	F	G	H	I	J	K	L	M
Date	Tank Volume (m ³)	Peak Flow (m ³ /d)	Contact Time (min)	Free Chlorine Residual (mg/L)	pH	Temp	Baffling Factor	CT Actual (mg-min/L)	CT Ratio (Virus)	Log reduction (Virus)	CT Ratio (Giardia)	Log Reduction (Giardia)
08-Mar-22	947.5	1383.35	986.30	1.45	7.70	5.00	0.3	429.04	53.63	214.52	1.97	5.92
13-Apr-22	947.5	1383.35	986.30	0.65	7.70	10.00	0.3	192.33	32.05	128.22	1.41	4.23
26-Apr-22	947.5	1383.35	986.30	1.36	7.70	15.00	0.3	402.41	100.60	402.41	3.74	11.21
26-Apr-22	947.5	1383.35	986.30	1.40	7.70	19.00	0.3	414.25	103.56	414.25	5.06	15.17
02-May-22	947.5	1383.35	986.30	1.79	7.70	5.00	0.3	529.64	66.21	264.82	2.36	7.08
09-May-22	947.5	1383.35	986.30	1.49	7.70	10.00	0.3	440.88	73.48	293.92	2.86	8.57
09-May-22	947.5	1383.35	986.30	1.30	7.70	15.00	0.3	384.66	96.16	384.66	3.60	10.79
17-May-22	947.5	1383.35	986.30	1.38	7.70	19.00	0.3	408.33	102.08	408.33	4.99	14.98
17-May-22	947.5	1383.35	986.30	1.40	7.70	5.00	0.3	414.25	51.78	207.12	1.91	5.74
21-Oct-22	947.5	1383.35	986.30	1.93	7.70	10.00	0.3	571.07	95.18	380.71	3.56	10.67
21-Oct-22	947.5	1383.35	986.30	1.90	7.70	15.00	0.3	562.19	140.55	562.19	4.97	14.90
22-Nov-22	947.5	1383.35	986.30	1.70	7.70	19.00	0.3	355.07	88.77	355.07	4.43	13.30
12-Dec-22	947.5	1383.35	986.30	1.70	7.70	5.00	0.3	375.78	46.97	187.89	1.76	5.29
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Baffling factor refers to how well the water mixes during the contact time

It never changes

A	B	C	D	E	F	G	H	I	J	K	L	M
Date	Tank Volume (m ³)	Peak Flow (m ³ /d)	Contact Time (min)	Free Chlorine Residual (mg/L)	pH	Temp	Baffling Factor	CT Actual (mg-min/L)	CT Ratio (Virus)	Log reduction (Virus)	CT Ratio (Giardia)	Log Reduction (Giardia)
08-Mar-22	947.5	1383.35	986.30	1.45	7.70	5.00	0.3	429.04	53.63	214.52	1.97	5.92
13-Apr-22	947.5	1383.35	986.30	0.65	7.70	10.00	0.3	192.33	32.05	128.22	1.41	4.23
26-Apr-22	947.5	1383.35	986.30	1.36	7.70	15.00	0.3	402.41	100.60	402.41	3.74	11.21
26-Apr-22	947.5	1383.35	986.30	1.40	7.70	19.00	0.3	414.25	103.56	414.25	5.06	15.17
02-May-22	947.5	1383.35	986.30	1.79	7.70	5.00	0.3	529.64	66.21	264.82	2.36	7.08
09-May-22	947.5	1383.35	986.30	1.49	7.70	10.00	0.3	440.88	73.48	293.92	2.86	8.57
09-May-22	947.5	1383.35	986.30	1.30	7.70	15.00	0.3	384.66	96.16	384.66	3.60	10.79
17-May-22	947.5	1383.35	986.30	1.38	7.70	19.00	0.3	408.33	102.08	408.33	4.99	14.98
17-May-22	947.5	1383.35	986.30	1.40	7.70	5.00	0.3	414.25	51.78	207.12	1.91	5.74
21-Oct-22	947.5	1383.35	986.30	1.93	7.70	10.00	0.3	571.07	95.18	380.71	3.56	10.67
21-Oct-22	947.5	1383.35	986.30	1.90	7.70	15.00	0.3	562.19	140.55	562.19	4.97	14.90
22-Nov-22	947.5	1383.35	986.30	1.20	7.70	19.00	0.3	355.07	88.77	355.07	4.43	13.30
12-Dec-22	947.5	1383.35	986.30	1.27	7.70	5.00	0.3	375.78	46.97	187.89	1.76	5.29
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
00-Jan-00	0	0.00	#DIV/0!	0.00	0.00	0.00	0.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Instructions |
 Input Sampling Data |
 Actual CT |
 Required CT for Giardia |
 Required CT for Viruses |
 Giardia Graph |
 Virus Graph |
 Data Sources +

A blue-tinted landscape featuring a row of wind turbines on a hill in the background, with a calm lake in the foreground reflecting the scene. A bright yellow rounded rectangle is centered in the middle of the image, containing the text.

Woliwon!
Wela'lin!