

CITY OF MOLALLA WATER TREATMENT PLANT 	OHA Turbidity Monitoring And Surface Water Quality Data Form Reporting SOP	DATE ISSUED March-2018
		SOP #15

## Overview

The City of Molalla is required to report finished water turbidity on individual filters as well as combined turbidity on a continuous basis. We log this data on SCADA and report this data on the OHA Turbidity Monitoring Report. We are also required to calculate the required CT for the inactivation of Giardia, Viruses, etc. This information is gathered from the Residual Chlorine trend screen and grab samples. These calculations are completed on the OHA Surface Water Quality Data Form along with the “*Peak Hourly Demand Flow*” in GPM. Typically these reports are completed by the DRC or at minimum by an operator certified at the level of the treatment plant and reviewed by the DRC, exceptions can be made if indicated in the protocols for under-certified operators that are kept on file within the O&M manual. These reports need to be received by OHA no later than the 10<sup>th</sup> of the following month. The report can be sent to OHA in the following ways:

1. Fax Report to (971) 673-0694.  
For faxed data, please include a cover sheet with the number of pages including the cover, your name, and your phone number.
2. Email the report to: [dwp.dmce@state.or.us](mailto:dwp.dmce@state.or.us)
3. Mail the report to: Water Quality Reports  
PO Box 14350  
Portland, OR 97293-0350

## Turbidity Monitoring Data

Conventional Treatment Plants are required to report the finished water turbidity every 4 hours. Report CFE turbidity if operating both treatment plants. To retrieve the (4) hour turbidity readings during the times the operator is off duty you can find the data in the Effluent turbidity trend screen. If the filter is backwashing, filtering-to-waste, or offline you simply write “off” in the box for that time period. The data for the highest reading of the day is taken off the Treated Water Turbidity trend screen.

## Surface Water Quality Data and CT calculations

When gathering the daily “physicals” (temp, pH, turbidity) log the time of these samples onto the Surface Water Quality Data Form. For the Minimum Cl<sub>2</sub> at 1<sup>st</sup> user (C) you will need to find the lowest chlorine reading of that day, this data is collected from the Residual Chlorine trend screen. The chlorine Contact Time is 90 minutes, log this into the box for Contact Time (T). The Disinfection Contact time for our system is 90 minutes and was calculated from the results of our most recent Tracer study conducted in 2003. The tracer study is set to be updated as part of our Master Plan update in 2020. To calculate the actual CT, do a simple C x T, enter into the appropriate box. Take the data from you daily sample and log onto the Temp and pH boxes.

## CT Met Column and Log Requirement

Circle “0.5” Log Requirement in the upper right hand corner of the Turbidity Monitoring Report. Water Treatment Plants must achieve a total of 3-log removal/inactivation for Giardia, which is 99.9%. Our treatment plants have credit for 2.5 log removal. This is determined by OHA and can be found on the most recent Sanitary Survey. The Survey notes that a CPE (comprehensive performance evaluation) was done in 1993 for the old plant and 2002 for the new

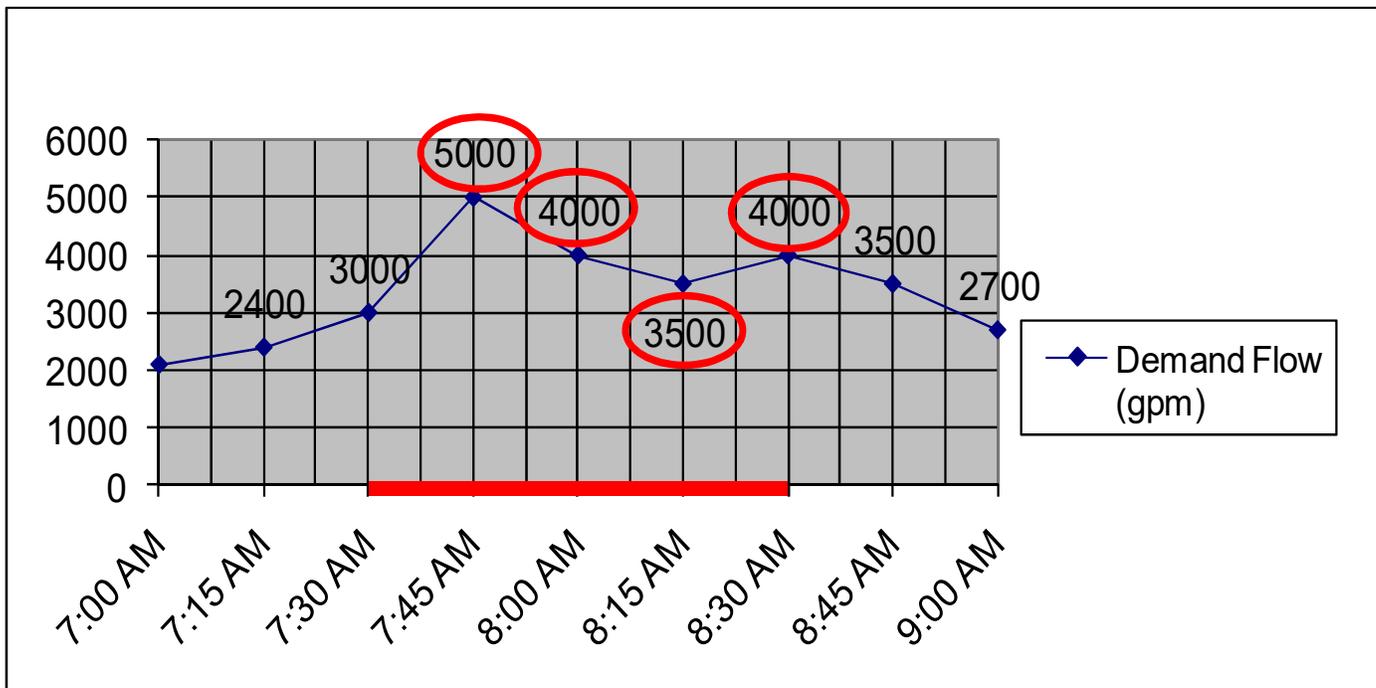
plant. OHA looked at things like the filter loading rate, our total treatment process, and manufactures specifications. Filters #3 & #4 are rated at 2.5 LRV at less than or equal to 1150 gpm, filter #1 @ 1400 gpm. The remaining .5 log is achieved by disinfection. Write “Yes” or “No” in the CT Met column. To find out whether CT was met use the following procedure: first find the required CT for the 0.5 log inactivation of Giardia using the attached CT Value Tables. Use the tables by following these guidelines: Round down for temperature, round up for pH, round up for chlorine residual. Or for more accurate CT use the Excel spreadsheet provided by OHA at

<http://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/DRINKINGWATER/MONITORING/Documents/turb-conv-direct.xls>

We must meet at minimum this required CT value to be in compliance. Our actual CT is the lowest chlorine reading of the day X 90. If our actual CT is greater than the required write “YES” for CT Met. Example: minimum residual for a day is 0.96. X90 = 86.4. This is greater than the CT we look up in the table for the day, therefore we CT was met.

**Peak Hourly Demand Flow**

This is the greatest volume of water passing through the system during any one hour in a consecutive 24 hr period. On a daily basis, use the Plant Flow trend screen and identify the hour within the 24 hr period that had the highest demand flow. Use at least (4) data points within that hour (i.e. 0745, 0800, 0815, and 0830), add the flow rates and divide by four. This will be your peak hourly demand flow. Please see example below.



**Note**

Complete the turbidity logs and CT calculations daily. If we exceed the turbidity limits or the CT has not been met you will need to contact the DRC and the DRC or designated operator will need to contact our regulatory agent at the Drinking Water Program (OHA DWP).

**Contact**

CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 0.5° C

Chlorine Concentration		PH < 6						PH = 6.5						PH = 7.0					
mg/L < =		Log Inactivations						Log Inactivations						Log Inactivations					
		0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
0.4		23	46	69	91	114	137	27	54	82	109	136	163	33	65	98	130	163	195
0.6		24	47	71	94	118	141	28	56	84	112	140	168	33	67	100	133	167	200
0.8		24	48	73	97	121	145	29	57	86	115	143	172	34	68	103	137	171	205
1		25	49	74	99	123	148	29	59	88	117	147	176	35	70	105	140	175	210
1.2		25	51	76	101	127	152	30	60	90	120	150	180	36	72	108	143	179	215
1.4		26	52	78	103	129	155	31	61	92	123	153	184	37	74	111	147	184	221
1.6		26	52	79	105	131	157	32	63	95	126	158	189	38	75	113	151	188	226
1.8		27	54	81	108	135	162	32	64	97	129	161	193	39	77	116	154	193	231
2		28	55	83	110	138	165	33	66	99	131	164	197	39	79	118	157	197	236
2.2		28	56	85	113	141	169	34	67	101	134	168	201	40	81	121	161	202	242
2.4		29	57	86	115	143	172	34	68	103	137	171	205	41	82	124	165	206	247
2.6		29	58	88	117	146	175	35	70	105	139	174	209	42	84	126	168	210	252
2.8		30	59	89	119	148	178	36	71	107	142	178	213	43	86	129	171	214	257
3		30	60	91	121	151	181	36	82	109	145	181	217	44	87	131	174	218	261

Chlorine Concentration		PH < 7.5						PH = 8.0						PH = 8.5					
mg/L < =		Log Inactivations						Log Inactivations						Log Inactivations					
		0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
0.4		40	79	119	158	198	237	46	92	139	185	231	277	55	110	165	219	274	329
0.6		40	80	120	159	199	239	48	95	143	191	238	286	57	114	171	228	285	342
0.8		41	82	123	164	205	246	49	98	148	197	246	295	59	118	177	236	295	354
1		42	84	127	169	211	253	51	101	152	203	253	304	61	122	183	243	304	365
1.2		43	86	130	173	216	259	52	104	157	209	261	313	63	125	188	251	313	376
1.4		44	89	133	177	222	266	54	107	161	214	268	321	65	129	194	258	323	387
1.6		46	91	137	182	228	273	55	110	165	219	274	329	66	132	199	265	331	397
1.8		47	93	140	186	233	279	56	113	169	225	282	338	68	136	204	271	339	407
2		48	95	143	191	238	286	58	115	173	231	288	346	70	139	209	278	348	417
2.2		50	99	149	198	248	297	59	118	177	235	294	353	71	142	213	284	355	426
2.4		50	99	149	199	248	98	60	120	181	241	301	361	73	145	218	90	363	435
2.6		51	101	152	203	253	304	61	123	184	245	307	368	74	148	222	296	370	444
2.8		52	103	155	207	258	310	63	125	188	250	313	375	75	151	226	301	377	452
3		53	105	158	211	263	316	64	127	191	255	318	382	77	153	230	307	383	460

## CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 5.0° C

Chlorine Concentration		PH < 6						PH = 6.5						PH = 7.0					
mg/L < =	Log Inactivations						Log Inactivations						Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	16	32	49	65	81	97	20	39	59	78	98	117	23	46	70	93	116	139	
0.6	17	33	50	67	83	100	20	40	60	80	100	120	24	48	72	55	119	143	
0.8	17	34	52	69	86	103	20	41	61	81	102	122	24	49	73	97	122	146	
1	18	35	53	70	88	105	21	42	63	83	104	125	25	50	75	99	124	149	
1.2	18	36	54	71	89	107	21	42	64	85	106	127	25	51	76	101	127	152	
1.4	18	36	55	73	91	109	22	43	65	87	108	130	26	52	78	103	129	155	
1.6	19	37	56	74	93	111	22	44	66	88	110	132	26	53	79	105	132	158	
1.8	19	38	57	76	95	114	23	45	68	90	113	135	27	54	81	108	135	162	
2	19	39	58	77	97	116	23	46	69	92	115	138	28	55	83	110	138	165	
2.2	20	39	59	79	98	118	23	47	70	93	117	140	28	56	85	113	141	169	
2.4	20	40	60	80	100	120	24	48	72	55	119	143	29	57	86	115	143	172	
2.6	20	41	61	81	102	122	24	49	73	97	122	146	29	58	88	117	146	175	
2.8	21	41	62	83	103	124	25	49	74	99	123	148	30	59	89	119	148	178	
3	21	42	63	84	105	126	25	50	76	101	126	151	30	61	91	121	152	182	

Chlorine Concentration		PH < 7.5						PH = 8.0						PH = 8.5					
mg/L < =	Log Inactivations						Log Inactivations						Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	28	55	83	111	138	166	33	66	99	132	165	198	39	79	118	157	197	236	
0.6	29	57	86	114	143	171	34	68	102	136	170	204	41	81	122	163	203	244	
0.8	29	58	88	117	146	175	35	70	105	140	175	210	42	84	126	168	210	252	
1	30	60	90	119	149	179	36	72	108	144	180	216	43	87	130	173	217	260	
1.2	31	61	92	122	153	183	37	74	111	147	184	221	45	89	134	178	223	267	
1.4	31	62	94	125	156	187	38	76	114	151	189	227	46	91	137	183	228	274	
1.6	32	64	96	128	160	192	39	77	116	155	193	232	47	94	141	187	234	281	
1.8	33	65	98	131	163	196	40	79	119	159	198	238	48	96	144	191	239	287	
2	33	67	100	133	167	200	41	81	122	162	203	243	49	98	147	196	245	294	
2.2	34	68	102	136	170	204	41	83	124	165	207	248	50	100	150	200	250	300	
2.4	35	70	105	139	174	209	42	84	127	169	211	253	51	102	153	204	255	306	
2.6	36	71	107	142	178	213	43	86	129	172	215	258	52	104	156	208	260	312	
2.8	36	72	109	145	181	217	44	88	132	175	219	263	53	106	159	212	265	318	
3	37	74	111	147	184	221	45	89	134	179	223	268	54	108	162	216	270	324	

Chlorine Concentration		PH < 9.0					
mg/L < =	Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	65	130	195	260	325	390	
0.6	68	136	204	271	339	407	
0.8	70	141	211	281	352	422	
1	73	146	219	291	364	437	
1.2	75	150	226	301	376	451	
1.4	77	155	232	309	387	464	
1.6	80	159	239	318	398	477	
1.8	82	163	245	326	408	489	
2	83	167	250	333	417	500	
2.2	85	170	256	341	426	511	
2.4	87	174	261	348	435	522	
2.6	89	178	267	355	444	533	
2.8	91	181	272	362	453	543	
3	92	184	276	368	460	552	

Note: CT = CT for 3-log inactivation, or 99.9% removal

Chlorine Concentration		PH < 9.0					
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mg/L < =	Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0
0.4	47	93	140	186	233	279
0.6	49	97	146	194	243	291
0.8	50	100	151	201	251	301
1	52	104	156	208	260	312
1.2	53	107	160	213	267	320
1.4	55	110	165	219	274	329
1.6	56	112	169	225	281	337
1.8	58	115	173	230	288	345
2	59	118	177	235	294	353
2.2	60	120	181	241	301	361
2.4	61	123	184	245	307	368
2.6	63	125	188	250	313	375
2.8	64	127	191	255	318	382
3	65	130	195	259	324	389

Note: CT = CT for 3-log inactivation, or 99.9% removal

### CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 10° C

Chlorine Concentration mg/L < =	PH < 6						PH = 6.5						PH = 7.0					
	Log Inactivations						Log Inactivations						Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
0.4	12	24	37	49	61	73	15	29	44	59	73	88	17	35	52	69	87	104
0.6	13	25	38	50	63	75	15	30	45	60	75	90	18	36	54	71	89	107
0.8	13	26	39	52	65	78	15	31	46	61	77	92	18	37	55	73	92	110
1	13	26	40	53	66	79	16	31	47	63	78	94	19	37	56	75	93	112
1.2	13	27	40	53	67	80	16	32	48	63	79	95	19	38	57	76	95	114
1.4	14	27	41	55	68	82	16	33	49	65	82	98	19	39	58	77	97	116
1.6	14	28	42	55	69	83	17	33	50	66	83	99	20	40	60	79	99	119
1.8	14	29	43	57	72	86	17	34	51	67	84	101	20	41	61	81	102	122
2	15	29	44	58	73	87	17	35	52	69	87	104	21	41	62	83	103	124
2.2	15	30	45	59	74	89	18	35	53	70	88	105	21	42	64	85	106	127
2.4	15	30	45	60	75	90	18	36	54	71	89	107	22	43	65	86	108	129
2.6	15	31	46	61	77	92	18	37	55	73	92	110	22	44	66	87	109	131
2.8	16	31	47	62	78	93	19	37	56	74	93	111	22	45	67	89	112	134
3	16	32	48	63	79	95	19	38	57	75	94	113	23	46	69	91	114	137

Chlorine Concentration mg/L < =	PH < 7.5						PH = 8.0						PH = 8.5					
	Log Inactivations						Log Inactivations						Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
0.4	21	42	63	83	104	125	25	50	75	99	124	149	30	59	89	118	148	177
0.6	21	43	64	85	107	128	26	51	M	102	128	153	31	61	92	122	153	183
0.8	22	44	66	87	109	131	26	53	79	105	132	158	32	63	95	126	158	189
1	22	45	67	89	112	134	27	54	81	108	135	162	33	65	98	130	163	195
1.2	23	46	69	91	114	137	28	55	83	111	138	166	33	67	100	133	167	200
1.4	23	47	70	93	117	140	28	57	85	113	142	170	34	69	103	137	172	206
1.6	24	48	72	96	120	144	29	58	87	116	145	174	35	70	106	141	176	211
1.8	25	49	74	98	123	147	30	60	90	119	149	179	36	72	108	143	179	215
2	25	50	75	100	125	150	30	61	91	121	152	182	37	74	111	147	184	221
2.2	26	51	M	102	128	153	31	62	93	124	155	186	38	75	113	150	188	225
2.4	26	52	79	105	131	157	32	63	95	127	158	190	38	77	115	153	192	230
2.6	27	53	80	107	133	160	32	65	97	129	162	194	39	78	117	156	195	234
2.8	27	54	82	109	136	163	33	66	99	131	164	197	40	80	120	159	199	239
3	28	55	83	111	138	166	34	67	101	134	168	201	41	81	122	162	203	243

Chlorine Concentration		PH < 9.0					
mg/L < =	Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	35	70	105	139	174	209	
0.6	36	73	109	145	182	218	
0.8	38	75	113	151	188	226	
1	39	78	117	156	195	234	
1.2	40	80	120	160	200	240	
1.4	41	82	124	165	206	247	
1.6	42	84	127	169	211	253	
1.8	43	86	130	173	216	259	
2	44	88	133	177	221	265	
2.2	45	90	136	181	226	271	
2.4	46	92	138	184	230	276	
2.6	47	94	141	187	234	281	
2.8	48	96	144	191	239	287	
3	49	97	146	195	243	292	

Note: CT = CT for 3-log inactivation, or 99.9% removal

### CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 15° C

Chlorine Concentration		PH < 6						PH = 6.5						PH = 7.0					
mg/L < =	Log Inactivations						Log Inactivations						Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	8	16	25	33	41	49	10	20	30	39	49	59	12	23	35	47	58	70	
0.6	8	17	25	33	42	50	10	20	30	40	50	60	12	24	36	48	60	72	
0.8	9	17	26	35	43	52	10	20	31	41	51	61	12	24	37	49	61	73	
1	9	18	27	35	44	53	11	21	32	42	53	63	13	25	38	50	63	75	
1.2	9	18	27	36	45	54	11	21	32	43	53	64	13	25	38	51	63	76	
1.4	9	18	28	37	46	55	11	22	33	43	54	65	13	26	39	52	65	78	
1.6	9	19	28	37	47	56	11	22	33	44	55	66	13	26	40	53	66	79	
1.8	10	19	29	38	48	57	11	23	34	45	57	68	14	27	41	54	68	81	
2	10	19	29	39	49	58	12	23	35	46	58	69	14	28	42	55	69	83	
2.2	10	20	30	39	50	59	12	23	35	47	58	70	14	28	43	57	71	85	
2.4	10	20	30	40	51	60	12	24	36	48	60	72	14	29	43	57	72	86	
2.6	10	20	31	41	51	61	12	24	37	49	61	73	15	29	44	59	73	88	
2.8	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89	
3	11	21	32	42	53	63	13	25	38	51	63	76	15	30	46	61	76	91	

Chlorine Concentration		PH < 7.5						PH = 8.0						PH = 8.5					
mg/L < =	Log Inactivations						Log Inactivations						Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	14	28	42	55	69	83	17	33	50	66	83	99	20	39	59	79	98	118	
0.6	14	29	43	57	72	86	17	34	51	68	85	102	20	41	61	81	102	122	
0.8	15	29	44	59	73	88	18	35	53	70	88	105	21	42	63	84	105	126	
1	15	30	45	60	75	90	18	36	54	72	90	108	22	43	65	87	108	130	
1.2	15	31	46	61	77	92	19	37	56	74	93	111	22	45	67	89	112	134	
1.4	16	31	47	63	78	94	19	38	57	76	95	114	23	46	69	91	114	137	
1.6	16	32	48	64	80	96	19	39	58	77	97	116	24	47	71	94	118	141	
1.8	16	33	49	65	82	98	20	40	60	79	99	119	24	48	72	96	120	144	
2	17	33	50	67	83	100	20	41	61	81	102	122	25	49	74	98	123	147	
2.2	17	34	51	68	85	102	21	41	62	83	103	124	25	50	75	100	125	150	
2.4	18	35	53	70	88	105	21	42	64	85	106	127	26	51	M	102	128	153	
2.6	18	36	54	71	89	107	22	43	65	86	108	129	26	52	78	104	130	156	
2.8	18	36	55	73	91	109	22	44	66	88	110	132	27	53	80	106	133	159	
3	19	37	56	74	93	111	22	45	67	89	112	134	27	54	81	108	135	162	

Chlorine Concentration		PH < 9.0					
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mg/L < =	Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0
0.4	23	47	70	93	117	140
0.6	24	49	73	97	122	146
0.8	25	50	76	101	126	151
1	26	52	78	104	130	156
1.2	27	53	80	107	133	160
1.4	28	55	83	110	138	165
1.6	28	56	85	113	141	169
1.8	29	58	87	115	144	173
2	30	59	89	118	148	177
2.2	30	60	91	121	151	181
2.4	31	61	92	123	153	184
2.6	31	63	94	125	157	188
2.8	32	64	96	127	159	191
3	33	65	98	130	163	195

Note: CT = CT for 3-log inactivation, or 99.9% removal

### CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 20° C

Chlorine Concentration		PH < 6						PH = 6.5						PH = 7.0					
mg/L < =	Log Inactivations						Log Inactivations						Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	6	12	18	24	30	36	7	15	22	29	37	44	9	17	26	35	43	52	
0.6	6	13	19	25	32	38	8	15	23	30	38	45	9	18	27	36	45	54	
0.8	7	13	20	26	33	39	8	15	23	31	38	46	9	18	28	37	46	55	
1	7	13	20	26	33	39	8	16	24	31	39	47	9	19	28	37	47	56	
1.2	7	13	20	27	33	40	8	16	24	32	40	48	10	19	29	38	48	57	
1.4	7	14	21	27	34	41	8	16	25	33	41	49	10	19	29	39	48	58	
1.6	7	14	21	28	35	42	8	17	25	33	42	50	10	20	30	39	49	59	
1.8	7	14	22	29	36	43	9	17	26	34	43	51	10	20	31	41	51	61	
2	7	15	22	29	37	44	9	17	26	35	43	52	10	21	31	41	52	62	
2.2	8	15	22	29	37	44	9	18	27	35	44	53	11	21	32	42	53	63	
2.4	8	15	23	30	38	45	9	18	27	36	45	54	11	22	33	43	54	65	
2.6	8	15	23	31	38	46	9	18	28	37	46	55	11	22	33	44	55	66	
2.8	8	16	24	31	39	47	9	19	28	37	47	56	11	22	34	45	56	67	
3	8	16	24	31	39	47	10	19	29	38	48	57	11	23	34	45	57	68	

Chlorine Concentration		PH < 7.5						PH = 8.0						PH = 8.5					
mg/L < =	Log Inactivations						Log Inactivations						Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	10	21	31	41	52	62	12	25	37	49	62	74	15	30	45	59	74	89	
0.6	11	21	32	43	53	64	13	26	39	51	64	77	15	31	46	61	77	92	
0.8	11	22	33	44	55	66	13	26	40	53	66	79	16	32	48	63	79	95	
1	11	22	34	45	56	67	14	27	41	54	68	81	16	33	49	65	82	98	
1.2	12	23	35	46	58	69	14	28	42	55	69	83	17	33	50	67	83	100	
1.4	12	23	35	47	58	70	14	28	43	57	71	85	17	34	52	69	86	103	
1.6	12	24	36	48	60	72	15	29	44	58	73	87	18	35	53	70	88	105	
1.8	12	25	37	49	62	74	15	30	45	59	74	89	18	36	54	72	90	108	
2	13	25	38	50	63	75	15	30	46	61	76	91	18	37	55	73	92	110	
2.2	13	26	39	51	64	77	16	31	47	62	78	93	19	38	57	75	94	113	
2.4	13	26	39	52	65	78	16	32	48	63	79	95	19	38	58	77	96	115	
2.6	13	27	40	53	67	80	16	32	49	65	81	97	20	39	59	78	98	117	
2.8	14	27	41	54	68	81	17	33	50	66	83	99	20	40	60	79	99	119	
3	14	28	42	55	69	83	17	34	51	67	84	101	20	41	61	81	102	122	

Chlorine Concentration		PH < 9.0					
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mg/L < =	Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0
0.4	18	35	53	70	88	105
0.6	18	36	55	73	91	109
0.8	19	38	57	75	94	113
1	20	39	59	78	98	117
1.2	20	40	60	80	100	120
1.4	21	41	62	82	103	123
1.6	21	42	63	84	105	126
1.8	22	43	65	86	108	129
2	22	44	66	88	110	132
2.2	23	45	68	90	113	135
2.4	23	46	69	92	115	138
2.6	24	47	71	94	118	141
2.8	24	48	72	95	119	143
3	24	49	73	97	122	146

Note: CT = CT for 3-log inactivation, or 99.9% removal

## CT VALUES FOR INACTIVATION OF GIARDIA CYSTS BY FREE CHLORINE AT 25° C

Chlorine Concentration		PH < 6						PH = 6.5						PH = 7.0					
mg/L < =	Log Inactivations						Log Inactivations						Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	4	8	12	16	20	24	5	10	15	19	24	29	6	12	18	23	29	35	
0.6	4	8	13	17	21	25	5	10	15	20	25	30	6	12	18	24	30	36	
0.8	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	
1	4	9	13	17	22	26	5	10	16	21	26	31	6	12	19	25	31	37	
1.2	5	9	14	18	23	27	5	11	16	21	27	32	6	13	19	25	32	38	
1.4	5	9	14	18	23	27	6	11	17	22	28	33	7	13	20	26	33	39	
1.6	5	9	14	19	23	28	6	11	17	22	28	33	7	13	20	27	33	40	
1.8	5	10	15	19	24	29	6	11	17	23	28	34	7	14	21	27	34	41	
2	5	10	15	19	24	29	6	12	18	23	29	35	7	14	21	27	34	41	
2.2	5	10	15	20	25	30	6	12	18	23	29	35	7	14	21	28	35	42	
2.4	5	10	15	20	25	30	6	12	18	24	30	36	7	14	22	29	36	43	
2.6	5	10	16	21	26	31	6	12	19	25	31	37	7	15	22	29	37	44	
2.8	5	10	16	21	26	31	6	12	19	25	31	37	8	15	23	30	38	45	
3	5	11	16	2	27	32	6	13	19	25	32	38	8	15	23	31	38	46	

Chlorine Concentration		PH < 7.5						PH = 8.0						PH = 8.5					
mg/L < =	Log Inactivations						Log Inactivations						Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	7	14	21	28	35	42	8	17	25	33	42	50	10	20	30	39	49	59	
0.6	7	14	22	29	36	43	9	17	26	34	43	51	10	20	31	41	51	61	
0.8	7	15	22	29	37	44	9	18	27	35	44	53	11	21	32	42	53	63	
1	8	15	23	30	38	45	9	18	27	36	45	54	11	22	33	43	54	65	
1.2	8	15	23	31	38	46	9	18	28	37	46	55	11	22	34	45	56	67	
1.4	8	16	24	31	39	47	10	19	29	38	48	57	12	23	35	46	58	69	
1.6	8	16	24	32	40	48	10	19	29	39	48	58	12	23	35	47	58	70	
1.8	8	16	25	33	41	49	10	20	30	40	50	60	12	24	36	48	60	72	
2	8	17	25	33	42	50	10	20	31	41	51	61	12	25	37	49	62	74	
2.2	9	17	26	34	43	51	10	21	31	41	52	62	13	25	38	50	63	75	
2.4	9	17	26	35	43	52	11	21	32	42	53	63	13	26	39	51	64	77	
2.6	9	18	27	35	44	53	11	22	33	43	54	65	13	26	39	52	65	78	
2.8	9	18	27	36	45	54	11	22	33	44	55	66	13	27	40	53	67	80	
3	9	18	28	37	46	55	11	22	34	45	56	67	14	27	41	54	68	81	

Chlorine Concentration		PH < 9.0					
mg/L < =	Log Inactivations						
	0.5	1.0	1.5	2.0	2.5	3.0	
0.4	12	23	35	47	58	70	
0.6	12	24	37	49	61	73	
0.8	13	25	38	50	63	75	
1	13	26	39	52	65	78	
1.2	13	27	40	53	67	80	
1.4	14	27	41	55	68	82	
1.6	14	28	42	56	70	84	
1.8	14	29	43	57	72	86	
2	15	29	44	59	73	88	
2.2	15	30	45	60	75	90	
2.4	15	31	46	61	77	92	
2.6	16	31	47	63	78	94	
2.8	16	32	48	64	80	96	
3	16	32	49	65	81	97	

Note: CT = CT for 3-log inactivation, or 99.9% removal