LAKE VERMILION METAL and ANION ANALYSES in Surface Water

METAL/ANION →			Al	As*	B	Ca	Chloride	Cd*	Co	Cu*	Fe	Hg*	K	Mg	Mn	Na	Ni*	Nitrates	P (TP)	Pb*	Sulphate
			ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	ng/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L
Ideal			<200	<340 <10 drink	< 0.5	< 20	<120	< 0.72	<1.8 drink	< 1.3	< 1.0	< 144	< 164	< 1,000	< 0.05	< 250	< 52 continous	< 10 drink	< 0.0305	<0.065 <0.015 drink	< 600 < 10 rice
LOCATION	**Date**	**Collector**																			
Pike Bay, sw Hoodoo Pt	8.18.1983	MPCA																<0.01	0.05		
Pike Bay, sw Hoodoo Pt	8.17.1993	MPCA																	0.059		
Big Bay, near Spider Island	2008	CLMP+																			14.8
Trout Lake portage																					9.6
Frazer Bay, near 36 island																					12.7
Niles Bay, near Zups point																					12.5
Wakemup Bay, near Comet island																					6.8
unknown, by Gary Whitenack	5.30.14	VLA																			3.2 - 58.9
Big Bay, between Spider & Stonich	summer 2015	?																< 0.05	0.012		10.45 ave
Big Bay, between Spider & Stonich	5.08 - 9.15	?																			13.21 ave
Armstrong Bay	8.7.16	VLA ?				13.3															
Mud Creek Bay						13.0															
East Two Rivers/Tower harbor	7.31.17	VLA ?				26.9															
East Two Rivers/Tower harbor	8.16-10.16	NRRI				27.5 ave															
Hoodoo Pt						13.8															
West Two Rivers						19.0															
Pike Bay, sw Hoodoo Pt	7.7.15	MPCA																	0.023		
Cable Bay, east end	9.15.18	VLA				11.0															
East Two Rivers, Iron Ore bar bridge						28.5															
Pike River, above dam						15.9															
Pike River, below dam, under bridge						15.0															
Pike River, entering Pike Bay						15.9															
Stuntz Bay, north end						11.5															
Stuntz Bay, south end						11.1															
Trout River, as it empties into Vermilion						4.9															
West Two Rivers, south side of bridge						10.8															
Pike Bay, near Hoodoo, west of marked sunken island	7.1.19	MPCA																	0.023		10.9 ave
Pike Bay, east of Whiskey island	6.19-7.19	MPCA																	0.026		10.9 ave
Big Bay, nnw of Storich & sw of Spide	6.19-7.19	MPCA																	0.017		9.5 ave
Wakemup Bay, ese Center island	6.19-7.19	MPCA																			3.85 ave

LAKE VERMILION METAL and ANION ANALYSES in Surface Water

METAL/ANION →		Zn*	Alkalinity	Chl-a	Coliform	DO	pH	Secchi	TDS	TSS	GPS Location
		mg/L	mg/L	mg/L	cfu	mg/L	pH	feet	mg/L	mg/L	
Ideal		< 0.12	> 5 (20-200 typical)	< 20	0 drink	> 5.5 fish	6.5 - 8.5	varies	< 500	< 1,200 drink	
LOCATION	Date										
Pike Bay, sw Hoodoo Pt	8.18.1983			0.016		7.5	7.3	2.10			
Pike Bay, sw Hoodoo Pt	8.17.1993			0.00256			7.36	1.3			
Big Bay, near Spider Island	2008										
Trout Lake portage											
Frazer Bay, near 36 island											
Niles Bay, near Zups point											
Wakemup Bay, near Comet island											
unknown, by Gary Whitenack	5.30.14										
Big Bay, between Spider & Stonich	summer 2015			9.52		0.59 ?				1.2	
Big Bay, between Spider & Stonich	5.08 - 9.15										
Armstrong Bay	8.7.16						7.8				
Mud Creek Bay							7.7				
East Two Rivers/Tower harbor	7.31.17										
East Two Rivers/Tower harbor	8.16-10.16										
Hoodoo Pt											
West Two Rivers											
Pike Bay, sw Hoodoo Pt	7.7.15					7.57	8.02	4			
Cable Bay, east end	9.15.18						7.8				
East Two Rivers, Iron Ore bar bridge							7.5				
Pike River, above dam							8.0				
Pike River, below dam, under bridge							7.9				
Pike River, entering Pike Bay							7.9				
Stuntz Bay, north end							7.7				
Stuntz Bay, south end							7.7				
Trout River, as it empties into Vermilion							7.4				
West Two Rivers, south side of bridge							7.1				
Pike Bay, near Hoodoo, west of marked sunken island	7.1.19					8.63		5			
Pike Bay, east of Whiskey island	6.19-7.19					7.26					
Big Bay, nnw of Storich & sw of Spide	6.19-7.19			3.6				7.5			
Wakemup Bay, ese Center island	6.19-7.19										

LAKE VERMILION METAL and ANION ANALYSES in Surface Water

METAL/ANION →			Al	As*	B	Ca	Chloride	Cd*	Co	Cu*	Fe	Hg*	K	Mg	Mn	Na	Ni*	Nitrates	P (TP)	Pb*	Sulphate
			ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	ng/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L
Ideal			<200	<340 <10 drink	< 0.5	< 20	<120	< 0.72	<1.8 drink	< 1.3	< 1.0	< 144	< 164	< 1,000	< 0.05	< 250	< 52 continous	< 10 drink	< 0.0305	<0.065 <0.015 drink	< 600 < 10 rice
LOCATION	**Date**	**Collector**																			
Pike Bay, near Hoodoo, west of	5.00-7.19	MPCA																			11.27 ave
marked sunken island (10 yr ave)																					
Big Bay, Spider Island, sw edge	8.3.20	DNR				11.6								5.68					0.023		12.1
Trout Lake portage, sw side						9.6								4.33					0.020		7.9
Frazer Bay, nw of Breezy Pt						10.4								4.75					0.020		9.2
Niles Bay, mid-bay						9.0								4.01					0.040		7.2
Wakemup Bay, nw of Center Island																			0.027		4.6
East Two Rivers, Tower harbor, southside doc	9.25.20	VLA				49.2															
East Two Rivers, Iron Ore bar bridge, west						49.5															
East Two Rivers, snowmobile bridge south of Mesabi trail						46.2															
Pike River, east Hwy 169 & Wahsten bridge	9.29.20	MPCA																			
Pike Bay, sw Hoodoo Pt	10.8.20	MPCA																			
East Two Rivers, Tower harbor, southside doc	10.19.20	VLA				32.8															
East Two Rivers, Iron Ore bar bridge, west side						31.7															
East Two Rivers, snowmobile bridge south of Mesabi trail						31.9															
East Two Rivers, snowmobile bridge Mesabi Tr/Junction Rd						31.2															
Soudan monument culvert,draining Soudan mine & local storm run-off						127.0															
Tower waste water pond #3						57.9															
(dry, but snowing)																					
East Two Rivers, Tower harbor, southside doc	4.12.21	VLA				13.7															
East Two Rivers, snowmobile bridge south of Mesabi trail						13.2															
East Two Rivers, snowmobile bridge Mesabi Tr/Junction Rd						13.5															
Soudan monument culvert,draining Soudan mine & local storm run-off						23.6															
Tower waste water pond #3						55.2															
(after sevral days rain & melting snow)																					
East Two Rivers, Tower harbor, southside doc	6.18.21	VLA				39.1															
East Two Rivers, snowmobile bridge south of Mesabi trail						42.9															
East Two Rivers, snowmobile bridge Mesabi Tr/Junction Rd						37.3															
Soudan monument culvert,draining Soudan mine & local storm run-off						242.0															
Tower waste water pond #3						57.8															
Pike River, entrance to Pike Bay						18.7															
East Two Rivers, Tower harbor, by culvert	8.4.21	VLA				38.2							0.88	4.68	.0.540	11.6					
East Two Rivers, Your Boat Club dock						35.5															
East Two Rivers, midway betweenYBC & Pike Bay ent						22.7															

LAKE VERMILION METAL and ANION ANALYSES in Surface Water

METAL/ANION →		Zn*	Alkalinity	Chl-a	Coliform	DO	pH	Secchi	TDS	TSS	GPS Location
		mg/L	mg/L	mg/L	cfu	mg/L	pH	feet	mg/L	mg/L	
Ideal		< 0.12	> 5 (20-200 typical)	< 20	0 drink	> 5.5 fish	6.5 - 8.5	varies	< 500	< 1,200 drink	
LOCATION	**Date**										
Pike Bay, near Hoodoo, west of	5.00-7.19										
marked sunken island (10 yr ave)											
Big Bay, Spider Island, sw edge	8.3.20		43	0.0117			7.45	7.0	100		
Trout Lake portage, sw side			35	0.0131			7.39	6.0	82		
Frazer Bay, nw of Breezy Pt			38	0.0119			7.69	7.0	104		
Niles Bay, mid-bay			35	0.0196			7.77	6.0	76		
Wakemup Bay, nw of Center Island			26	0.0224				5.0	68		
East Two Rivers, Tower harbor, southside doc	9.25.20						7.7				
East Two Rivers, Iron Ore bar bridge, west							7.7				
East Two Rivers, snowmobile bridge south of Mesabi trail							7.7				
Pike River, east Hwy 169 & Wahsten bridge	9.29.20					7.37	7.62				
Pike Bay, sw Hoodoo Pt	10.8.20							5.0			
East Two Rivers, Tower harbor, southside doc	10.19.20						7.24				
East Two Rivers, Iron Ore bar bridge, west side							7.24				
East Two Rivers, snowmobile bridge south of Mesabi trail							7.34				
East Two Rivers, snowmobile bridge Mesabi Tr/Junction Rd							7.35				
Soudan monument culvert,draining Soudan mine & local storm ru							7.31				
Tower waste water pond #3							8.34				
(dry, but snowing)											
East Two Rivers, Tower harbor, southside doc	4.12.21						6.98				
East Two Rivers, snowmobile bridge south of Mesabi trail							7.06				
East Two Rivers, snowmobile bridge Mesabi Tr/Junction Rd							7.23				
Soudan monument culvert,draining Soudan mine & local storm ru							8.17				
Tower waste water pond #3							7.62				
(after sevral days rain & melting snow)											
East Two Rivers, Tower harbor, southside doc	6.18.21						7.9				
East Two Rivers, snowmobile bridge south of Mesabi trail							8.0				
East Two Rivers, snowmobile bridge Mesabi Tr/Junction Rd							7.7				
Soudan monument culvert,draining Soudan mine & local storm ru							7.8				
Tower waste water pond #3							8.2				
Pike River, entrance to Pike Bay							7.9				
East Two Rivers, Tower harbor, by culvert	8.4.21						?				
East Two Rivers, Your Boat Club dock							6.8				
East Two Rivers, midway betweenYBC & Pike Bay ent							7.0				

LAKE VERMILION METAL and ANION ANALYSES in Surface Water

METAL/ANION →			Al	As*	B	Ca	Chloride	Cd*	Co	Cu*	Fe	Hg*	K	Mg	Mn	Na	Ni*	Nitrates	P (TP)	Pb*	Sulphate
			ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	ng/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L
Ideal			<200	<340 <10 drink	< 0.5	< 20	<120	< 0.72	<1.8 drink	< 1.3	< 1.0	< 144	< 164	< 1,000	< 0.05	< 250	< 52 continous	< 10 drink	< 0.0305	<0.065 <0.015 drink	< 600 < 10 rice
LOCATION	**Date**	**Collector**																			
East Two Rivers, at Pike Bay entrance						16.9															
Big Bay, between Potato & Birch islands						11.4							1.36	5.48	0.041	4.73					
Wakemup Bay, Camp Vermilion dock						6.6							0.93	2.64	0.037	2.83					
(drought conditions)																					
Soudan Mine, required by MPCA	2021	Mine	7.4 ave						0.72 ave	0.0005	0.015 ave				2E-04						
(March, June, Sept)																					
Big Bay, near Spider Island	8.10.21	DNR				12.4								6.08							11.3
Trout Lake portage		(Sta. 1-5)				10.8								4.94							9.14
Frazer Bay, near 36 island						11.3								5.14							9.46
Niles Bay, near Zups point						9.7								4.26							7.45
Wakemup Bay, near Comet island						6.9								2.78							4.93
Lake Riley, Eden Prairie/Chanhassen	8.9.21 -	MPCA																			
for reference - one of worst AIS	10.25.21						102 - 110														
lakes in Twin Cities																					
E2 Rivers, east Tower harbor by culve	10.25.21	VLA				43.4					0.705	< 2.0	0.882	5.60	0.264	9.39			< 0.20	< 1.0	13.8
E2 Rivers by YourBoatClub (YBC) dock						41.7	30.9				0.662	< 2.0	1.15	5.31	0.302	8.8			< 0.20	< 1.0	12.9
Soudan Monument culvert						369.0	27.3				1.33	< 2.0	8.81	63.5	0.453	191			< 0.20	< 1.0	121.0
Pike River dam, under Hwy 77 bridge						18.4	890				0.616	< 2.0	2.52	17.1	0.276	8.81			< 0.20	< 1.0	44.8
(water level up 8" from drought)							18.5														
Soudan monument culvert,draining Soudan mine	5.11.22	VLA				61.7				0.43					0.14						
E2 River, Mesabi Tr west of Junction Rd		record high				14.7				<0.01					0.04						
E2 River, Tower harbor		water				15.7				<0.01					0.05						
E2 River, YBC dock						14.8				<0.01					0.05						
Pike River dam, under Hwy 77 bridge						6.5	5.3			<0.01					0.05						13.4

LAKE VERMILION METAL and ANION ANALYSES in Surface Water

METAL/ANION →		Zn*	Alkalinity	Chl-a	Coliform	DO	pH	Secchi	TDS	TSS	GPS Location
		mg/L	mg/L	mg/L	cfu	mg/L	pH	feet	mg/L	mg/L	
Ideal		< 0.12	> 5 (20-200 typical)	< 20	0 drink	> 5.5 fish	6.5 - 8.5	varies	< 500	< 1,200 drink	
LOCATION	**Date**										
East Two Rivers, at Pike Bay entrance							6.9				
Big Bay, between Potato & Birch islands											
Wakemup Bay, Camp Vermilion dock											
(drought conditions)											
Soudan Mine, required by MPCA	2021						7.1 - 7.2				
(March, June, Sept)											
Big Bay, near Spider Island	8.10.21		42	19.9			8.00		132		
Trout Lake portage			37	12.7			8.25		90		
Frazer Bay, near 36 island			38	15.6			8.14		88		
Niles Bay, near Zups point			33	17.6			7.83		76		
Wakemup Bay, near Comet island			24	13.4			7.64		56		
Lake Riley, Eden Prairie/Chanhassen	8.9.21 -					0.62	7.1 - 8.03	4.9	391		
for reference - one of worst AIS	10.25.21										
lakes in Twin Cities											
E2 Rivers, east Tower harbor by culve	10.25.21						6.6				
E2 Rivers by YourBoatClub (YBC) dock							6.7				
Soudan Monument culvert							7.1				
Pike River dam, under Hwy 77 bridge							6.8				
(water level up 8" from drought)											
Soudan monument culvert,draining Soudan mine	5.11.22						8.9				
E2 River, Mesabi Tr west of Junction Rd							8.1				
E2 River, Tower harbor							7.7				
E2 River, YBC dock							7.7				
Pike River dam, under Hwy 77 bridge											

LAKE VERMILION METAL and ANION ANALYSES in Surface Water

METAL/ANION →			Al	As*	B	Ca	Chloride	Cd*	Co	Cu*	Fe	Hg*	K	Mg	Mn	Na	Ni*	Nitrates	P (TP)	Pb*	Sulphate
			ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	ng/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	mg/L
Ideal			<200	<340 <10 drink	< 0.5	< 20	<120	< 0.72	<1.8 drink	< 1.3	< 1.0	< 144	< 164	< 1,000	< 0.05	< 250	< 52 continous	< 10 drink	< 0.0305	<0.065 <0.015 drink	< 600 < 10 rice
LOCATION	**Date**	**Collector**																			
Tower waste water pond #3	6.29.22	VLA	50	< 2.0	0.115	58.8	87.8	<0.0001	< 0.50	<0.0050	0.319	1.03	6.13	8.44	0.208	53.6	< 5.0	0.26	1.53	<0.0005	9.9
Soudan monument culvert,draining Soudan mine & local storm ru		water level	599	< 2.0	<0.100	159.0	368.00	<0.0001	15.6	0.4660	1.64	57.2	5.52	31.7	0.284	72.4	36.6	0.650	0.012	0.000917	94.8
E2 River, Mesabi Tr west of Junction Rd		1358.35'	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
E2 River, Tower Harbor			50	< 2.0	<0.100	24.8	7.38	<0.0001	< 0.50	<0.0050	0.541	1.17	<0.50	2.82	0.11	4.34	< 5.0	< 0.03	0.214	<0.0005	1.9
E2 River, YBC dock			50	< 2.0	<0.100	24.5	7.67	<0.0001	< 0.50	<0.0050	0.565	0.99	<0.50	2.79	0.137	4.00	< 5.0	< 0.03	0.029	<0.0005	1.9
E2 River, entrance to Pike Bay			82	< 2.0	<0.100	23.2	8.35	<0.0001	< 0.50	<0.0050	0.727	1.67	<0.50	3.49	0.139	4.61	< 5.0	< 0.03	0.033	<0.0005	3.2
W2 River, near Hwy 169 bridge			103	< 2.0	<0.100	19.8	6.74	<0.0001	< 0.50	<0.0050	1.90	3.71	3.21	2.05	0.133	3.21	< 5.0	0.04	0.035	<0.0005	3.0
Pike River, below dam under Hwy 77 bridge			182	< 2.0	<0.100	15.3	16	<0.0001	0.70	<0.0050	3.25	5.19	2.03	14.9	0.360	9.80	< 5.0	0.08	0.047	<0.0005	18.9
Stuntz Bay			< 50	< 2.0	<0.100	11.2	8.85	<0.0001	< 0.50	<0.0050	0.138	1.42	1.15	5.26	0.042	5.35	< 5.0	< 0.03	0.023	<0.0005	13.3
Cable Bay			< 50	< 2.0	<0.100	12.7	8.89	<0.0001	< 0.50	<0.0050	0.134	1.37	1.25	5.81	0.028	5.76	< 5.0	< 0.03	0.027	<0.0005	13.5
Big Bay, near Spider Island "hole"			< 50	< 2.0	<0.100	9.5	8.87	<0.0001	< 0.50	<0.0050	<0.100	1.23	1.25	4.08	0.013	5.76	< 5.0	< 0.03	0.027	<0.0005	13.5
Trout River, as it empties into Ver.			< 50	< 2.0	<0.100	3.9	3.85	<0.0001	< 0.50	<0.0050	<0.100	1.06	0.82	2.99	<0.010	3.22	< 5.0	< 0.03	0.013	<0.0005	6.4
Frazer Bay, nw Breezy Pt			< 50	< 2.0	<0.100	9.7	7.54	<0.0001	< 0.50	<0.0050	<0.100	0.74	0.98	3.1	<0.010	3.29	< 5.0	< 0.03	0.015	<0.0005	10.8
Niles Bay, mid bay			< 50	< 2.0	<0.100	11.5	6.91	<0.0001	< 0.50	<0.0050	<0.100	0.66	0.99	5.41	0.011	4.39	< 5.0	< 0.03	0.015	<0.0005	8.5
Wakemup Bay, nw of Center Island			< 50	< 2.0	<0.100	6.5	4.53	<0.0001	< 0.50	<0.0050	<0.100	0.63	0.91	2.59	<0.010	3.30	< 5.0	< 0.03	0.014	<0.0005	4.0
Black Bay, mid bay			234	< 2.0	<0.100	3.5	2.34	<0.0001	< 0.50	<0.0050	0.765	4.48	0.85	1.27	0.045	2.20	< 5.0	< 0.03	0.082	<0.0005	1.4
Wolf Bay, near Vermilion dam			< 50	< 2.0	<0.100	9.8	7.03	<0.0001	< 0.50	<0.0050	<0.100	0.58	1.01	4.28	0.017	4.55	< 5.0	< 0.03	0.017	<0.0005	8.9
8.1.2022																					

LAKE VERMILION METAL and ANION ANALYSES in Surface Water

METAL/ANION →		Zn*	Alkalinity	Chl-a	Coliform	DO	pH	Secchi	TDS	TSS	GPS Location
		mg/L	mg/L	mg/L	cfu	mg/L	pH	feet	mg/L	mg/L	
Ideal		< 0.12	> 5 (20-200 typical)	< 20	0 drink	> 5.5 fish	6.5 - 8.5	varies	< 500	< 1,200 drink	
LOCATION	**Date**										
Tower waste water pond #3	6.29.22	<0.0200	167	NA			7.6	x	344	< 2.0	47.48.50N, 92.15.25W
Soudan monument culvert,draining Soudan mine & local storm ru		0.0433	74	NA			7.6	NA	1110	12.2	47.48.49N, 62.14.26W
E2 River, Mesabi Tr west of Junction Rd		x	x	x	x	x	x	x	x	x	x
E2 River, Tower Harbor		<0.0200	81	< 1.67			7.5	7.5	118	< 1.4	47.48.14 N, 92.16.52W
E2 River, YBC dock		<0.0200	10	< 1.25			7.4	B	120	< 1.4	47.48.19 N, 92.17.18W
E2 River, entrance to Pike Bay		<0.0200	68	6.01			6.6	4.5	108	2.6	47.45.29 N, 92.17.39W
W2 River, near Hwy 169 bridge		<0.0200	56	NA			6.4	NA	132	2.2	47.45.29 N, 92.17.39W
Pike River, below dam under Hwy 77 bridge		<0.0200	74	NA			7.5	NA	210	2.8	47.45.29 N, 92.17.39W
Stuntz Bay		<0.0200	43	10.7			7.5	5.0	96	2.8	47.49.51N, 92.14.32W
Cable Bay		<0.0200	43	7.68			7.4	6.0	98	1.9	47.50.45N, 92.12.03W
Big Bay, near Spider Island "hole"		<0.0200	37	6.69			7.4	7.5	94	< 1.4	47.52.00N, 92.17.28W
Trout River, as it empties into Ver.		<0.0200	31	7.34			6.8	13.0	50	< 2.0	47.54.51N, 92.19.34W
Frazer Bay, nw Breezy Pt		<0.0200	56	8.01			7.6	9.0	82	< 2.0	? N, 92.27.24W
Niles Bay, mid bay		<0.0200	43	7.48			7.4	8.5	66	< 2.0	47.53.32N, 92.30.32W
Wakemup Bay, nw of Center Island		<0.0200	31	3.34			6.8	12.0	50	< 1.4	47.55.23N, 92.36.49W
Black Bay, mid bay		<0.0200	25	6.94			6.2	2.0	68	< 1.4	47.57.30N, 92.28.28W
Wolf Bay, near Vermilion dam		<0.0200	37	7.48			7.2	8.0	76	2.0	47.57.23N, 92.28.28W
8.1.2022											

WATER ANALYSES MONITORING

Species	Symbol	Notes	Concern Levels
Aluminum	Al	natural component of local bedrock, low pH (from acid rain) can assist in its deposition, low concentrations not known to be toxic to aquatic life, known to control toxic algal blooms by cutting off nutrients such as P	> 200 ug/L (MAR) 50-200 ug/L (NSDWR)
Arsenic*	As	natural component of local bedrock, inorganic As is a carcinogen and	> 5 ug/L (CWAG)
		highly toxic	> 10 ug/L (MDH) - drinking water > 340 ug/L (EPA) - aquatic life
Boron	B	released from rocks and soils through weathering, dietary supplement for green algae	> 0.5 mg/L (MAR) > 100 mg/L toxic
Cadmium*	Cd	usually an atmospheric or mining contaminant, no beneficial effect on human health, toxic in large quantities	> 0.10 mg/L (ATSDR) >0.72 mg/L (EPA)
Calcium	Ca	possible natural component from local bedrock and waste water, levels > 20 ppm may aid in zebra mussel shell growth	> 20 mg/L (MAISRC)
Chlorophyll-a	Chl-a	a specific chlorophyll used in photosythesis, usually a measure of algae quantity in water	> 20 mg/L nuisance > 30 mg/L severe (MPCA)
Chloride	Chloride	usually from de-icing road salts, a pollutant which threatens fish and aquatic life, 1 tsp of salt (NaCl) permanently pollutes 5 gal of water	> 120 mg/L (CWQG) >230 mg/L (EPA) - aquatic life
Cobalt	Co	natural component of local bedrock, no longer mined in US, essential element required for good health (component of vitamin B12), toxic in high levels (affects heart and lungs)	> 1.8 ug/L (Quest Diagnostics) (risk of systemic toxicity)
Copper*	Cu	usually from geologic deposits or rock/soil erosion, toxic to aquatic organisms, may aid in zebra mussel control	>1.3 mg/L (NSDWR)(EPA)

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Species	Symbol	Notes	Concern Levels
Iron	Fe	natural component of local bedrock, low pH can assist in its deposition, contibutes to browner water, can combine with toxins such as Pb and As so that they become more mobile	> 0.3 mg/L (NSDWR) > 1.0 mg/L (EPA) - aquatic life
Lead*	Pb	usually an atmospheric contaminant, harmful to heart, kidneys, and reproductive systems if ingested	> 0.015 mg/L (NSDWR)(EPA) (drinking water) >0.065 mg/L (EPA) - aquatic life
Magnesium	Mg	natural component of local bedrock, a component of hardness and the metal in Chl-a, Mg and Ca together deterrmine water hardness, a diagnostic measure in the Minntac EIS	> 1,000 mg/L (LennTech) (as an oxide; aquatic toxicity)
Manganese	Mn	natural component of local bedrock, toxic to aquatic life in large amounts, > 0.05 ppm known to disrupt photosynthesis in starry stoneworts	> 0.05 mg/L (NSDWR) > 0.430 mg/L (CWQG)
Mercury*	Hg	usually an atmospheric contaminant, toxic to fish and humans in large quantities, biomagnifier and bioaccumulator in food chain	> 26 ng/L (CWQG) >144 ng/L (ATSDR)(EPA)
Nickel*	Ni	usually a particulate in lake sediments from weathering of rocks and minerals, essential trace element for aquatics but toxic at higher concentrat	> 52 ug/L contin concentration (EPA) >470 ug/L max concentration (EPA)
Nitrate	NO3	source of nitrogen (food) for algae and plant life, usually from fertilizers animal waste, and human sewage	>10 mg/L (ATSDR) (drinking water)
Nitrite	NO2	source of nitrogen (food) for algae and plant life, usually from fertilizers animal waste, and human sewage	>1 mg/L (ATSDR) (drinking water)
Polyfluoroaky Substances	PFAS	polyfluorooctanic acid (PFOA) and polyflourooctane sulfonic acid (PFOS) are PFA's which are called "forever" chemicals since they break down very slowly; exposure to certain levels has been associated with decreased fertility, developmental effects, increased risk of some cancers, effects to	70 ng/L (EPA) (drinking water)

WATER ANALYSES MONITORING

		the immune system, reduced vaccine response, hormonal interferences, and increased cholesterol levels	
Phosphorous	P/TP	most likely from fertilizers and failing septic systems, aids in increasing nutrients for algae growth, commonly reported as total phosphorous (TP) ortho-phosphorous represents P that is readily available for use by algae; reducing non-native plants (eg Eurasian milfoil) will help lower P levels	10-20 ug/L (CWQG-mesotrophic) > 30.5 ug/L (MPCA, historical)
Species	**Symbol**	**Notes**	**Concern Levels**
Potassium	K	natural component of local bedrock, aids plant growth (starry stoneworts favor an environment of 1.0 to 1.5 ppm), essential nutrition element	> 164 mg/L (Health Canada)
Sodium	Na	usually from de-icing road salts, a pollutant which threatens fish and aquatic life, 1 tsp of salt (NaCl) permanently pollutes 5 gal of water	> 250 mg/L
Sulphate	SO^4	most likely from the oxidation of iron sulfide during mining, aids in the methylation of mercury which increases the toxicity of mercury in fish, harmful to aquatic vegetation including wild rice	> 600 mg/L (MAR) > 250 mg/L (NSDWR) > 10 mg/L wild rice (MAR)
Zinc*	Zn	usually an atmospheric or mining contaminant, can lead to adverse health effects, not known as a carcinogen	> 0.120 mg/L (EPA) (chronic aquatic life) > 5 mg/L (NSDWR)
pH	pH	measure of acidity or alkalinity, measured 1-14 where 1 is very acidic (hydrochloric acid) , 7 is neutral (water, tears) and 14 is very alkaline (sodium hyroxide)	outside a range of 6.0 - 9.0 (MAR) 6.5 - 8.5 (NSDWR)
Alkalinity	TA	measures water's ability to neutralize acid and maintain a stable pH level amount of sulfuric acid needed to bring the pH to 4.2, indicates sensitivity to acid rain, waters with a high TA are better to maintain a fairly constant pH, sometimes expressed as TA	< 10 mg/L CaCO3 equiv (EPA) 20-200 mg/L typical

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Coliform	-	fecal coliform bacteria are indicators of possible sewage contamination, could be from failed septic systems, feed lots, etc	> 0 cfu/100ml (EPA)-drinking water
Dissolved Oxygen	DO	measures amount of oxygen available to aquatic life, cold water holds more oxygen than warm water; DO levels less than 3-4 mg/L usually do not sustain fish life although carp can survive at 1 mg/L (walleye prefer greater than 5 mg/L but can survive at 2 mg/L for a short time)	< 5.5 mg/L (EPA 4/1986 AR1236)

Species	**Symbol**	**Notes**	**Concern Levels**
Hardness	-	amount of dissolved calcium (Ca) and magnesium (Mg) in water	(USGS) soft: 0-60 mg/L CaCO3 medium: 61-120 mg/L hard: 121-180 mg/L very hard: > 180 mg/L
Sechi	-	measure of water clarity, is considered an indirect measurement of algae or suspended sediment in the water, one of the 3 measures to characterize the trophic (nutrients available) status of the water; other 2 measures are chlorophyll-a and total phosphorous (TP)	varies
Total Dissolved Solids	TDS	suspended solids present in a water solution, typically inorganic salts anc small amounts of organic matter (Ca, Mg, K, and Na cations & carbonate, sulphate and nitrate anions), TDS changes the mineral content of water potentially harming aquatic life	> 500 mg/L (EPA)(NSDWR)
Total Suspende Solids	TSS	suspended solids (typically < 2 micron inorganic, bacteria, and algae particles) which influence transparency, color, and overall water health, high levels may decrease DO levels	> 1,200 mg/L (drinking water)

WATER ANALYSES MONITORING

*EPA Priority Pollutants, as of Dec 2014

References

ATSDR - Agency for Toxic Substance and Disease Registry
CWQG - Canadian Water Quality for Protection of Aquatic Life
EPA - US Environmental Protection Agency
HSDB - Hazard Substance Data Bank
MAISRC - Univ MN /MN Aquatic Invasive Species Research Center
MAR - MN Administration Rules, Sect 7050.0220
MDH - MN Dept Health
MPCA - MN Pollution Control Agency
NSDWR - National Secondary Drinking Water Regulations (EPA)
USGS - United States Geological Survey

Craig Beveroth 5.26.2022