Appendix B

PIKE LAKE
2012 AND 2016 AQUATIC PLANT SURVEY DATA TABLES

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Table B-1

PIKE LAKE POINT-INTERCEPT AQUATIC PLANT SURVEY DATA: JULY 9-12, 2012

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (1=Silt 2=Silt Sand 3=Sand 4=Sa	comments	Total Rake Fullness	*Myriophyllum spicatum*, Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus*, Curly-leaf pondweed	*Ceratophyllum demersum*, Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis*, Common waterweed	*Heteranthera dubia*, Water star-grass	*Myriophyllum sibiricum*, Northern water-milfoil	*Najas flexilis*, Slender naiad	*Najas marina*, Spiny naiad	*Nitella* sp., Nitella	*Nuphar variegata*, Spatterdock	*Nymphaea odorata*, White water lily	*Potamogeton foliosus*, Leafy pondweed	*Potamogeton gramineus*, Variable pondweed	*Potamogeton illinoensis*, Illinois pondweed	*Potamogeton natans*, Floating-leaf pondweed	*Potamogeton nodosus*, Long-leaf pondweed	*Potamogeton praelongus*, White-stem pondweed	*Potamogeton pusillus*, Small pondweed	*Potamogeton richardsonii*, Clasping-leaf pondweed	*Potamogeton robbinsii*, Fern pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Ranunculus aquatilis*, White water crowfoot	*Sagittaria latifolia*, Common arrowhead	*Schoenoplectus subterminalis*, Water bulrush	*Schoenoplectus tabernaemontani*, Softstem bulrush	*Stuckenia pectinata*, Sago pondweed	*Vallisneria americana*, Wild celery			
2	1	43.318196	-88.333628			Not Sampled																																
3	2	43.31814	-88.329745			Not Sampled																																
4	3	43.318128	-88.328968			Not Sampled																																
5	4	43.318117	-88.328191			Not Sampled																																
6	5	43.31764	-88.33442			Not Sampled																																
7	6	43.317629	-88.333643			Not Sampled																																
8	7	43.317618	-88.332867			Not Sampled																																
9	8	43.317606	-88.33209			Not Sampled																																
10	9	43.317595	-88.331313			Not Sampled																																
11	10	43.317584	-88.330537			Not Sampled																																
12	11	43.317572	-88.32976			Not Sampled																																
13	12	43.317561	-88.328984			Not Sampled																																
14	13	43.31755	-88.328207			Not Sampled																																
15	14	43.317538	-88.32743	2.5	1		2	2				1										1													1			
16	15	43.317073	-88.334435	2.5	2		3				2						3																					
17	16	43.317062	-88.333659	3.5	1		3				3						3																					
18	17	43.317051	-88.332882	4	1		2			1			3														1								1			
19	18	43.317039	-88.332105	3.5	1		2					1	3																	1							
20	19	43.317028	-88.331329	4	1		2						3		2		2																	1	3		
21	20	43.317017	-88.330552	3.5	2		3				3						3				2						2											
22	21	43.317005	-88.329776			Not Sampled																																
23	22	43.316994	-88.328999			Not Sampled																																
24	23	43.316983	-88.328222			Not Sampled																																
25	24	43.316971	-88.327446			Not Sampled																																
26	25	43.31696	-88.326669				3				3								3																2			
27	26	43.316518	-88.335227	2.5	4		2	1			2						3																		3	2		
28	27	43.316506	-88.334451	3.5	2		2	1			3																								1	1		
29	28	43.316495	-88.333674	3.5	2		3				3																											
30	29	43.316484	-88.332898	4	2		3				2						3																					
31	30	43.316472	-88.332121	4	2		2										3										2								1	1		
32	31	43.316461	-88.331344	4	1		3				3										2																	
33	32	43.31645	-88.330568	3.5	2		3				3						3				3																	
34	33	43.316438	-88.329791	3.5	2		3				3						3				3																	
35	34	43.316427	-88.329015	3	2		3				3																								3			
36	35	43.316416	-88.328238	3	2		2	1			3																								3			
37	36	43.316404	-88.327461	2.5	2		2			1	3																								3			
38	37	43.316393	-88.326685	2	2		2				3							1	2																3			
39	38	43.315951	-88.335243	4	2		2				3			1																								
40	39	43.315939	-88.334466	4	2		2				3			1																							1		
41	40	43.315928	-88.33369	4.5	2		3				3																											
42	41	43.315917	-88.332913	5	2		3				3						3																					
43	42	43.315905	-88.332137	5	2		2				1						3				2				2													
44	43	43.315894	-88.33136	4.5	2		2				3														2										2			
45	44	43.315883	-88.330583	4	2		3				3										3				2										2			
46	45	43.315871	-88.329807	3.5	2		3				3											2			3										2			
47	46	43.31586	-88.32903	3	2		2				3																								1			
48	47	43.315849	-88.328254	3.5	2		2			1	3														1			3									
49	48	43.315837	-88.327477	3	2		2	1		1	3																								3			
50	49	43.315826	-88.3267	2.5	2		3				3																											
51	50	43.315417	-88.337588	2.5	4		2				3										1															1		
52	51	43.315406	-88.336812	3	3		2				3										1																	
53	52	43.315395	-88.336035	4	2		2				3										1															1		
54	53	43.315384	-88.335258	4	2		2				3														1													
55	54	43.315372	-88.334482	5	2		2	1			3						2																					
56	55	43.315361	-88.333705	5.5	2		2				3																								1	1		
57	56	43.31535	-88.332929	5.5	2		2				2						2																					
58	57	43.315338	-88.332152	5.5	2		2							1			2																		3			
59	58	43.315327	-88.331375	5	2		2				3						3																		1			
60	59	43.315316	-88.330599	4	2		3				3										2														3			
61	60	43.315304	-88.329822	3.5	2		2				3										2														2			
62	61	43.315293	-88.329046	3.5	2		3				3																								3			
63	62	43.315282	-88.328269	3.5	2		3				3																								2			

Table B-1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1		sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (1=Silt 2=Silt Sand 3=Sand 4=Sa	comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybrid water-milfoil	Potamogeton crispus Curly-leaf pondweed	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Elodea canadensis, Common waterweed	Heteranthera dubia, Water star-grass	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Najas marina, Spiny naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton foliosus, Leafy pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton natans, Floating-leaf pondweed	Potamogeton nodosus, Long-leaf pondweed	Potamogeton praelongus, White-stem pondweed	Potamogeton pusillus, Small pondweed	Potamogeton richardsonii, Clasping-leaf pondweed	Potamogeton robbinsii, Fern pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Ranunculus aquatilis, White water crowfoot	Sagittaria latifolia, Common arrowhead	Schoenoplectus subterminalis, Water bulrush	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery	
64	63	43.31527	-88.327493	3.5	2		3				3																							2				
65	64	43.315259	-88.326716	3	2		2	1			3																			2								
66	65	43.314873	-88.339157	4.5	2		3				2						3																					
67	66	43.314862	-88.33838	5.5	2		3										3																					
68	67	43.31485	-88.337604	6	2		3										3																					
69	68	43.314839	-88.336827	5	2		2				3						3				1																	
70	69	43.314828	-88.33605	5.5	2		2				3																									1		
71	70	43.314816	-88.335274	6	2		2				3			2																					2	2		
72	71	43.314805	-88.334497	7	2		2										3							2											1			
73	72	43.314794	-88.333721	7.5	1		2										3							1														
74	73	43.314783	-88.332944	6.5	1		3										3																					
75	74	43.314771	-88.332168	7	2		2				1						3																		2			
76	75	43.31476	-88.331391	5	2		3				3																								2			
77	76	43.314749	-88.330614	4	2		3				3																								3			
78	77	43.314737	-88.329838	4.5	2		2				3					1																			1			
79	78	43.314726	-88.329061	4.5	2		2				3					1																			1			
80	79	43.314715	-88.328285	4	2		2				3																									1		
81	80	43.314703	-88.327508	3.5	2		2				3										1																	
82	81	43.314692	-88.326732	3	2		2	1			3											2			1												
83	82	43.314317	-88.339949	4	1		2				3																									1		
84	83	43.314306	-88.339172	6	2		2				1						3																					
85	84	43.314295	-88.338396			Not Sampled																																
86	85	43.314283	-88.337619			Not Sampled																																
87	86	43.314272	-88.336842			Not Sampled																																
88	87	43.314261	-88.336066			Not Sampled																																
89	88	43.314249	-88.335289	13	2		3	3																														
90	89	43.314238	-88.334513	7.5	2		2	2																														
91	90	43.314227	-88.333736	10	2		1		1					1																								
92	91	43.314216	-88.33296	8	2		3	2																											3			
93	92	43.314204	-88.332183	7	2		2										3																		2	1		
94	93	43.314193	-88.331406	6	2		2				3																									1		
95	94	43.314182	-88.33063	5	2		2				3																								1			
96	95	43.31417	-88.329853	4.5	2		3				3														2												
97	96	43.314159	-88.329077	4	3		3				3																											
98	97	43.314147	-88.3283	3.5	4		3				3														2												
99	98	43.314136	-88.327524	3.5	2		3				3																											
100	99	43.314125	-88.326747	3	2		2				3														1												
101	100	43.314113	-88.325971	3.5	2		3				3																								2			
102	101	43.31375	-88.339964	4.5	2		3				3																											
103	102	43.313739	-88.339188	14	2		3										3																					
104	103	43.313728	-88.338411			Not Sampled																																
105	104	43.313716	-88.337634			Not Sampled																																
106	105	43.313705	-88.336858			Not Sampled																																
107	106	43.313694	-88.336081			Not Sampled																																
108	107	43.313682	-88.335305			Not Sampled																																
109	108	43.313671	-88.334528			Not Sampled																																
110	109	43.31366	-88.333752			Not Sampled																																
111	110	43.313648	-88.332975			Not Sampled																																
112	111	43.313637	-88.332199	8.5	2		2										3																			1			
113	112	43.313626	-88.331422	7	2		3				3						3																			2			
114	113	43.313614	-88.330645	6	3		2				3																									1			
115	114	43.313603	-88.329869	4.5	3		3				3																											
116	115	43.313592	-88.329092	4	3		2				3														1												
117	116	43.31358	-88.328316	3.5	2		3				3																											
118	117	43.313569	-88.327539	3.5	3		3				3																											
119	118	43.313558	-88.326763	3	3		2				3														1												
120	119	43.313546	-88.325986	3	3		3				3																											
121	120	43.313535	-88.32521	3	2		2				3														1								3				
122	121	43.313524	-88.324433	2.5	2		2				3																								1			
123	122	43.313512	-88.323656	2	2		3				3																								2			
124	123	43.313194	-88.340756	3.5	2		2	1			3						1																					
125	124	43.313183	-88.33998	5	2		3				3																											

Table B-1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (1=Silt 2=Silt Sand 3=Sand 4=Sa	comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybrid water-milfoil	Potamogeton crispus Curly-leaf pondweed	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Elodea canadensis, Common waterweed	Heteranthera dubia, Water star-grass	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Najas marina, Spiny naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton foliosus, Leafy pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton natans, Floating-leaf pondweed	Potamogeton nodosus, Long-leaf pondweed	Potamogeton praelongus, White-stem pondweed	Potamogeton pusillus, Small pondweed	Potamogeton richardsonii, Clasping-leaf pondweed	Potamogeton robbinsii, Fern pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Ranunculus aquatilis, White water crowfoot	Sagittaria latifolia, Common arrowhead	Schoenoplectus subterminalis, Water bulrush	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
126	125	43.313172	-88.339203	12.5	3		3										3																				
127	126	43.313161	-88.338426			Not Sampled																															
128	127	43.313149	-88.33765			Not Sampled																															
129	128	43.313138	-88.336873			Not Sampled																															
130	129	43.313127	-88.336097			Not Sampled																															
131	130	43.313115	-88.33532			Not Sampled																															
132	131	43.313104	-88.334544			Not Sampled																															
133	132	43.313093	-88.333767			Not Sampled																															
134	133	43.313081	-88.332991			Not Sampled																															
135	134	43.31307	-88.332214	12.5	2		3	3																													
136	135	43.313059	-88.331438	7	2		3				3						3																		2	2		
137	136	43.313047	-88.330661	6	3		2				3																									1		
138	137	43.313036	-88.329884	4.5	2		3				3																											
139	138	43.313025	-88.329108	4	3		2	1			3																											
140	139	43.313013	-88.328331	4	2		3				3																											
141	140	43.313002	-88.327555	3.5	4		3				3																											
142	141	43.312991	-88.326778	3.5	3		3				3																											
143	142	43.312979	-88.326002	3	3		2				3														1												
144	143	43.312968	-88.325225	3	3		3				3																											
145	144	43.312957	-88.324449	3	2		3				3																								2			
146	145	43.312945	-88.323672	2	2		2	1			3																								3			
147	146	43.312934	-88.322895	1.5	1		2	1			3							2							1										2			
148	147	43.312627	-88.340772	3.5	2		2				3			1																							
149	148	43.312616	-88.339995	5	2		3				3																											
150	149	43.312605	-88.339219	8	3		2				1						3																					
151	150	43.312593	-88.338442			Not Sampled																															
152	151	43.312582	-88.337665			Not Sampled																															
153	152	43.312571	-88.336889			Not Sampled																															
154	153	43.31256	-88.336112			Not Sampled																															
155	154	43.312548	-88.335336			Not Sampled																															
156	155	43.312537	-88.334559			Not Sampled																															
157	156	43.312526	-88.333783			Not Sampled																															
158	157	43.312514	-88.333006			Not Sampled																															
159	158	43.312503	-88.33223			Not Sampled																															
160	159	43.312492	-88.331453	7	2		2				3			1																						2		
161	160	43.31248	-88.330676	6.5	2		2				3					1																			1	2		
162	161	43.312469	-88.3299	5	3		3				3																											
163	162	43.312458	-88.329123	4	3		3				3																											
164	163	43.312446	-88.328347	4	3		3				3																											
165	164	43.312435	-88.32757	4	4		3				3																											
166	165	43.312424	-88.326794	3.5	2		3				3																											
167	166	43.312412	-88.326017	3.5	3		3				3																											
168	167	43.312401	-88.325241	3	2		3				3																											
169	168	43.31239	-88.324464	3	3		3				3																											
170	169	43.312378	-88.323688	3	2		2				3																								1			
171	170	43.312367	-88.322911	2.5	2		3				3														3										2			
172	171	43.31206	-88.340787	4	2		3				3																											
173	172	43.312049	-88.34001	5.5	2		3				3						2																					
174	173	43.312038	-88.339234	10	3		2										2																				2		
175	174	43.312026	-88.338457			Not Sampled																															
176	175	43.312015	-88.337681			Not Sampled																															
177	176	43.312004	-88.336904			Not Sampled																															
178	177	43.311993	-88.336128			Not Sampled																															
179	178	43.311981	-88.335351			Not Sampled																															
180	179	43.31197	-88.334575			Not Sampled																															
181	180	43.311959	-88.333798			Not Sampled																															
182	181	43.311947	-88.333022			Not Sampled																															
183	182	43.311936	-88.332245			Not Sampled																															
184	183	43.311925	-88.331469	13.5	3		1									1				1																		
185	184	43.311913	-88.330692	6.5	2		2				3																								1			
186	185	43.311902	-88.329915	5	2		3				3																											
187	186	43.311891	-88.329139	4.5	3		3				3																											

Table B-1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (1=Silt 2=Silt Sand 3=Sand 4=Sa	comments	Total Rake Fullness	*Myriophyllum spicatum*, Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus*,Curly-leaf pondweed	*Ceratophyllum demersum*, Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas marina* ,Spiny naiad	*Nitella* sp., Nitella	*Nuphar variegata* ,Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton foliosus* , Leafy pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton nodosus* , Long-leaf pondweed	*Potamogeton praelongus* , White-stem pondweed	*Potamogeton pusillus* , Small pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton robbinsii* , Fern pondweed	*Potamogeton zosteriformis* , Flat-stem pondweed	*Ranunculus aquatilis* , White water crowfoot	*Sagittaria latifolia* , Common arrowhead	*Schoenoplectus subterminalis* ,Water bulrush	*Schoenoplectus tabernaemontani* , Softstem bulrush	*Stuckenia pectinata* , Sago pondweed	*Vallisneria americana* , Wild celery
188	187	43.311879	-88.328362	4.5	3		3				3																											
189	188	43.311868	-88.327586	5	3		2				3																								1			
190	189	43.311857	-88.326809	4.5	2		3				3																											
191	190	43.311845	-88.326033	4	2		3				3																											
192	191	43.311834	-88.325256	3.5	3		3				3																											
193	192	43.311822	-88.32448	3.5	3		3				3																											
194	193	43.311811	-88.323703	3	2		3				3																								2			
195	194	43.3118	-88.322927	2.5	2		2				3											2												2			
196	195	43.311493	-88.340802	4.5	2		3				3																											
197	196	43.311482	-88.340026	6	2		2				3						1								2											1	
198	197	43.311471	-88.339249	10	2		3	3																													
199	198	43.311459	-88.338473			Not Sampled																															
200	199	43.311448	-88.337696			Not Sampled																															
201	200	43.311437	-88.33692			Not Sampled																															
202	201	43.311425	-88.336143			Not Sampled																															
203	202	43.311414	-88.335367			Not Sampled																															
204	203	43.311403	-88.33459			Not Sampled																															
205	204	43.311392	-88.333814			Not Sampled																															
206	205	43.31138	-88.333037			Not Sampled																															
207	206	43.311369	-88.332261			Not Sampled																															
208	207	43.311358	-88.331484			Not Sampled																															
209	208	43.311346	-88.330708	7	2		3				3																											
210	209	43.311335	-88.329931	6.5	3		2				3					1																		2			
211	210	43.311324	-88.329154	6	2		2				3					2									2									1	2		
212	211	43.311312	-88.328378	6	3		2				3					1									1												
213	212	43.311301	-88.327601	6	3		2				3						2																	1			
214	213	43.31129	-88.326825	5	2		2	1			3					3																					
215	214	43.311278	-88.326048	4.5	2		3				3																											
216	215	43.311267	-88.325272	4	2		2				3						1								1												
217	216	43.311255	-88.324495	4	2		2				3																								1			
218	217	43.311244	-88.323719	3.5	2		3				3																								3			
219	218	43.311233	-88.322942	3	2		3	2			3																								3			
220	219	43.310937	-88.341594	3	2		3				3										2																
221	220	43.310926	-88.340818	4.5	2		3				3																											
222	221	43.310915	-88.340041	6	2		2				3						3																			1		
223	222	43.310904	-88.339265			Not Sampled																															
224	223	43.310892	-88.338488			Not Sampled																															
225	224	43.310881	-88.337712			Not Sampled																															
226	225	43.31087	-88.336935			Not Sampled																															
227	226	43.310858	-88.336159			Not Sampled																															
228	227	43.310847	-88.335382			Not Sampled																															
229	228	43.310836	-88.334606			Not Sampled																															
230	229	43.310825	-88.333829			Not Sampled																															
231	230	43.310813	-88.333053			Not Sampled																															
232	231	43.310802	-88.332276			Not Sampled																															
233	232	43.310791	-88.3315			Not Sampled																															
234	233	43.310779	-88.330723	14.5	3		1							1		1																					
235	234	43.310768	-88.329947	14	2		1	1																													
236	235	43.310757	-88.32917	10	2		2	3								1																		2			
237	236	43.310745	-88.328393	7	3		2				3						1								2										2		
238	237	43.310734	-88.327617	6	3		2				3																								1			
239	238	43.310722	-88.32684	5.5	2		2				3					1									2									1	2		
240	239	43.310711	-88.326064	5	2		3				3																											
241	240	43.3107	-88.325287	4.5	2		3				3																											
242	241	43.310688	-88.324511	4	2		3				3																								2			
243	242	43.310677	-88.323734	3.5	2		2				3																								1			
244	243	43.310666	-88.322958	3	2		3				3																								3			
245	244	43.31037	-88.34161	3.5	2		2				3										1																
246	245	43.310359	-88.340833	4.5	2		3				3																											
247	246	43.310348	-88.340057	6	2		2				1						3																					
248	247	43.310337	-88.33928			Not Sampled																															
249	248	43.310325	-88.338504			Not Sampled																															

Table B-1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (1=Silt 2=Silt Sand 3=Sand 4=Sa	comments	Total Rake Fullness	*Myriophyllum spicatum*, Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus* Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp. , Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas marina* , Spiny naiad	*Nitella* sp. , Nitella	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton foliosus* , Leafy pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton nodosus* , Long-leaf pondweed	*Potamogeton praelongus* , White-stem pondweed	*Potamogeton pusillus* , Small pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton robbinsii* , Fern pondweed	*Potamogeton zosteriformis* , Flat-stem pondweed	*Ranunculus aquatilis* , White water crowfoot	*Sagittaria latifolia* , Common arrowhead	*Schoenoplectus subterminalis* , Water bulrush	*Schoenoplectus tabernaemontani* , Softstem bulrush	*Stuckenia pectinata* , Sago pondweed	*Vallisneria americana* , Wild celery
250	249	43.310314	-88.337727			Not Sampled																															
251	250	43.310303	-88.336951			Not Sampled																															
252	251	43.310291	-88.336174			Not Sampled																															
253	252	43.31028	-88.335398			Not Sampled																															
254	253	43.310269	-88.334621			Not Sampled																															
255	254	43.310257	-88.333845			Not Sampled																															
256	255	43.310246	-88.333068			Not Sampled																															
257	256	43.310235	-88.332292			Not Sampled																															
258	257	43.310224	-88.331515			Not Sampled																															
259	258	43.310212	-88.330739			Not Sampled																															
260	259	43.310201	-88.329962			Not Sampled																															
261	260	43.31019	-88.329186			Not Sampled																															
262	261	43.310178	-88.328409	14	2																																
263	262	43.310167	-88.327633	12	3		1									1																					
264	263	43.310155	-88.326856	9.5	2		2	3						1																							
265	264	43.310144	-88.326079	7	2		2	1									3																		1			
266	265	43.310133	-88.325303	5	2		2			1	3																								1	1		
267	266	43.310121	-88.324526	4.5	2		3				3																								2			
268	267	43.31011	-88.32375	4	2		3				3																								3			
269	268	43.310099	-88.322973	3.5	2		2				3														1												
270	269	43.309815	-88.342402	2.5	3		2				3										2															1		
271	270	43.309803	-88.341625	3.5	2		2				2																											
272	271	43.309792	-88.340849	4.5	2		2				3																								1			
273	272	43.309781	-88.340072	6	2		2				3						1																		1			
274	273	43.30977	-88.339296			Not Sampled																															
275	274	43.309758	-88.338519			Not Sampled																															
276	275	43.309747	-88.337743			Not Sampled																															
277	276	43.309736	-88.336966			Not Sampled																															
278	277	43.309724	-88.33619			Not Sampled																															
279	278	43.309713	-88.335413			Not Sampled																															
280	279	43.309702	-88.334637			Not Sampled																															
281	280	43.30969	-88.33386			Not Sampled																															
282	281	43.309679	-88.333084			Not Sampled																															
283	282	43.309668	-88.332307			Not Sampled																															
284	283	43.309656	-88.331531			Not Sampled																															
285	284	43.309645	-88.330754			Not Sampled																															
286	285	43.309634	-88.329978			Not Sampled																															
287	286	43.309622	-88.329201			Not Sampled																															
288	287	43.309611	-88.328425			Not Sampled																															
289	288	43.3096	-88.327648			Not Sampled																															
290	289	43.309588	-88.326872	15.5	2																																
291	290	43.309577	-88.326095	8	1		3	3									2																				
292	291	43.309566	-88.325319	6	2		3				3						3																				
293	292	43.309554	-88.324542	5	2		2	2			3														1									2			
294	293	43.309543	-88.323766	4	2		2				3						1								1										1		
295	294	43.309532	-88.322989	3.5	6		2				2																										
296	295	43.309248	-88.342417	3	3		3				3																										
297	296	43.309236	-88.341641	3	2		2				2																										
298	297	43.309225	-88.340864	4.5	2		3				3																										
299	298	43.309214	-88.340088	6.5	2		3				3																										
300	299	43.309202	-88.339311			Not Sampled																															
301	300	43.309191	-88.338535			Not Sampled																															
302	301	43.30918	-88.337758			Not Sampled																															
303	302	43.309169	-88.336982			Not Sampled																															
304	303	43.309157	-88.336205			Not Sampled																															
305	304	43.309146	-88.335429			Not Sampled																															
306	305	43.309135	-88.334652			Not Sampled																															
307	306	43.309123	-88.333876			Not Sampled																															
308	307	43.309112	-88.333099			Not Sampled																															
309	308	43.309101	-88.332323			Not Sampled																															
310	309	43.309089	-88.331546			Not Sampled																															
311	310	43.309078	-88.33077			Not Sampled																															

Table B-1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (1=Silt 2=Silt Sand 3=Sand 4=Sa	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus*,Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas marina* , Spiny naiad	*Nitella* sp., Nitella	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton foliosus* , Leafy pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton nodosus* , Long-leaf pondweed	*Potamogeton praelongus* , White-stem pondweed	*Potamogeton pusillus* , Small pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton robbinsii* , Fern pondweed	*Potamogeton zosteriformis* , Flat-stem pondweed	*Ranunculus aquatilis* , White water crowfoot	*Sagittaria latifolia* , Common arrowhead	*Schoenoplectus subterminalis* , Water bulrush	*Schoenoplectus tabernaemontani* , Softstem bulrush	*Stuckenia pectinata* , Sago pondweed	*Vallisneria americana* , Wild celery
312	311	43.309067	-88.329993			Not Sampled																															
313	312	43.309055	-88.329217			Not Sampled																															
314	313	43.309044	-88.32844			Not Sampled																															
315	314	43.309033	-88.327664			Not Sampled																															
316	315	43.309021	-88.326887			Not Sampled																															
317	316	43.30901	-88.326111	7.5	1		3										3																				
318	317	43.308999	-88.325334	6.5	2		2									1	2																	3			
319	318	43.308987	-88.324558	5	2		2				2					1	3																	1			
320	319	43.308976	-88.323781	3.5	4																																
321	320	43.30868	-88.342433	3	3		2				2																										
322	321	43.308669	-88.341656	3.5	4																																
323	322	43.308658	-88.34088	5	2		3				3																										
324	323	43.308647	-88.340103	7	2		2	1			3					1																					
325	324	43.308635	-88.339327			Not Sampled																															
326	325	43.308624	-88.33855			Not Sampled																															
327	326	43.308613	-88.337774			Not Sampled																															
328	327	43.308602	-88.336997			Not Sampled																															
329	328	43.30859	-88.336221			Not Sampled																															
330	329	43.308579	-88.335444			Not Sampled																															
331	330	43.308568	-88.334668			Not Sampled																															
332	331	43.308556	-88.333891			Not Sampled																															
333	332	43.308545	-88.333115			Not Sampled																															
334	333	43.308534	-88.332338			Not Sampled																															
335	334	43.308522	-88.331562			Not Sampled																															
336	335	43.308511	-88.330785			Not Sampled																															
337	336	43.3085	-88.330009			Not Sampled																															
338	337	43.308488	-88.329232			Not Sampled																															
339	338	43.308477	-88.328456			Not Sampled																															
340	339	43.308466	-88.327679			Not Sampled																															
341	340	43.308454	-88.326903			Not Sampled																															
342	341	43.308443	-88.326126	7	2		2			1							3																				
343	342	43.308432	-88.32535	5.5	2		2				3															1								1			
344	343	43.30842	-88.324573	5	2		2	3			1			2	1	1										1								2	2		
345	344	43.308409	-88.323797	2.5	4																																
346	345	43.308113	-88.342448	3	2		3				3																										
347	346	43.308102	-88.341672	4	2		2				3										1				1								1			
348	347	43.308091	-88.340895	6	2		2	1			1					3																		2	1		
349	348	43.30808	-88.340119			Not Sampled																															
350	349	43.308068	-88.339342			Not Sampled																															
351	350	43.308057	-88.338566			Not Sampled																															
352	351	43.308046	-88.337789			Not Sampled																															
353	352	43.308034	-88.337013			Not Sampled																															
354	353	43.308023	-88.336236			Not Sampled																															
355	354	43.308012	-88.33546			Not Sampled																															
356	355	43.308001	-88.334683			Not Sampled																															
357	356	43.307989	-88.333907			Not Sampled																															
358	357	43.307978	-88.33313			Not Sampled																															
359	358	43.307967	-88.332354			Not Sampled																															
360	359	43.307955	-88.331577			Not Sampled																															
361	360	43.307944	-88.330801			Not Sampled																															
362	361	43.307933	-88.330024			Not Sampled																															
363	362	43.307921	-88.329248			Not Sampled																															
364	363	43.30791	-88.328471			Not Sampled																															
365	364	43.307899	-88.327695			Not Sampled																															
366	365	43.307887	-88.326918			Not Sampled																															
367	366	43.307876	-88.326142	6	2		3										3																		2			
368	367	43.307865	-88.325365	5.5	2		2				3						3																			1		
369	368	43.307853	-88.324589	4	5		2	2			3				1										1				1							3		
370	369	43.307558	-88.34324	2	2		2	1			3								2												1		2				
371	370	43.307546	-88.342463	3	2		2				3																				2		1				
372	371	43.307535	-88.341687	4	2		3				3																										
373	372	43.307524	-88.34091	7	2		3	3	2								3																		3			

Table B-1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (1=Silt 2=Silt Sand 3=Sand 4=Sa	comments	Total Rake Fullness	*Myriophyllum spicatum*, Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus*,Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas marina* ,Spiny naiad	*Nitella* sp.: Nitella	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton foliosus* , Leafy pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton nodosus* , Long-leaf pondweed	*Potamogeton praelongus* , White-stem pondweed	*Potamogeton pusillus* , Small pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton robbinsii* , Fern pondweed	*Potamogeton zosteriformis* ,Flat-stem pondweed	*Ranunculus aquatilis* , White water crowfoot	*Sagittaria latifolia* , Common arrowhead	*Schoenoplectus subterminalis* ,Water bulrush	*Schoenoplectus tabernaemontani* ,Softstem bulrush	*Stuckenia pectinata* , Sago pondweed	*Vallisneria americana* , Wild celery
374	373	43.307513	-88.340134	15	2		1			1																											
375	374	43.307501	-88.339357			Not Sampled																															
376	375	43.30749	-88.338581			Not Sampled																															
377	376	43.307479	-88.337805			Not Sampled																															
378	377	43.307467	-88.337028			Not Sampled																															
379	378	43.307456	-88.336252			Not Sampled																															
380	379	43.307445	-88.335475	8	2		2				3														1										2		
381	380	43.307434	-88.334699	4	4		2	2			3				1	1																				
382	381	43.307422	-88.333922	5.5	2		2	1			3														1											
383	382	43.307411	-88.333146	6	2		2				3														1									2	2		
384	383	43.3074	-88.332369	9.5	2		2	1	2		3						1																				
385	384	43.307388	-88.331593	13	2		3																				3										
386	385	43.307377	-88.330816	13.5	3		1			1						1																					
387	386	43.307366	-88.33004			Not Sampled																															
388	387	43.307354	-88.329263			Not Sampled																															
389	388	43.307343	-88.328487			Not Sampled																															
390	389	43.307332	-88.32771			Not Sampled																															
391	390	43.30732	-88.326934	13	2																																
392	391	43.307309	-88.326157	6	2		3				3																										
393	392	43.307297	-88.325381	4.5	1		2	1			3																									2	
394	393	43.306991	-88.343255	2.5	2		2	1			3								3							1									1	1	
395	394	43.306979	-88.342479	3	2		2				3		1								1											1			1		
396	395	43.306968	-88.341702	4	2		3				3																										
397	396	43.306957	-88.340926	6	2		3				3																										
398	397	43.306946	-88.340149	7	2		2	2		3																2										
399	398	43.306934	-88.339373	8.5	2		3	2		3																										
400	399	43.306923	-88.338596	14	2		3	3		2																										
401	400	43.306912	-88.33782			Not Sampled																															
402	401	43.3069	-88.337043			Not Sampled																															
403	402	43.306889	-88.336267	3.5	2		2	2			2				1	1																			2	
404	403	43.306821	-88.331608	5	2		2				3					1																			1	1	
405	404	43.30681	-88.330832	9.5	2			3		2																									3		
406	405	43.306799	-88.330055			Not Sampled																															
407	406	43.306787	-88.329279			Not Sampled																															
408	407	43.306776	-88.328502			Not Sampled																															
409	408	43.306765	-88.327726			Not Sampled																															
410	409	43.306753	-88.326949	13	2		1			1							1																				
411	410	43.306742	-88.326173	4.5	2		2				3														1											
412	411	43.306412	-88.342494	3	3		2				3																								1		
413	412	43.306401	-88.341718	4	2		2				3																								1		
414	413	43.30639	-88.340941	5	2		3				3																										
415	414	43.306378	-88.340165	5.5	2		2	1			3																								1		
416	415	43.306367	-88.339388	5.5	2		2	1			3																										
417	416	43.306356	-88.338612	5.5	2		3										3																				
418	417	43.306345	-88.337835	7	2		3			2							3																				
419	418	43.306333	-88.337059	5	2		2	1			1					2																			3		
420	419	43.306322	-88.336282	2.5	2		2				3																								1	1	
421	420	43.306254	-88.331624	4.5	2		2				3														1											1	
422	421	43.306243	-88.330847	5	2		2	1			3																										
423	422	43.306232	-88.330071			Not Sampled																															
424	423	43.30622	-88.329294			Not Sampled																															
425	424	43.306209	-88.328518			Not Sampled																															
426	425	43.306197	-88.327741			Not Sampled																															
427	426	43.306186	-88.326965	8	2		3										3																				
428	427	43.306175	-88.326188	3	2		2	1			3																										
429	428	43.305845	-88.34251	2	1		2				3												1												1		
430	429	43.305834	-88.341733	3.5	2		2				3																								1		
431	430	43.305823	-88.340957	4	2		3				3																										
432	431	43.305811	-88.34018	4.5	2		2				3																								1		
433	432	43.3058	-88.339404	4.5	2		2	1		1	3					1																			1		
434	433	43.305789	-88.338627	4.5	2		2				3														1											
435	434	43.305778	-88.337851	4	2		2	1			3														1											

Table B-1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (1=Silt 2=Silt Sand 3=Sand 4=Sa	comments	Total Rake Fullness	*Myriophyllum spicatum*, Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus* Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas marina* , Spiny naiad	*Nitella* sp., Nitella	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton foliosus* , Leafy pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton nodosus* , Long-leaf pondweed	*Potamogeton praelongus* , White-stem pondweed	*Potamogeton pusillus* , Small pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton robbinsii* , Fern pondweed	*Potamogeton zosteriformis* , Flat-stem pondweed	*Ranunculus aquatilis* , White water crowfoot	*Sagittaria latifolia* , Common arrowhead	*Schoenoplectus subterminalis* , Water bulrush	*Schoenoplectus tabernaemontani* , Softstem bulrush	*Stuckenia pectinata* , Sago pondweed	*Vallisneria americana* , Wild celery
436	435	43.305766	-88.337074	4	2		3				3																											
437	436	43.305755	-88.336298	2.5	3		2				3																								1			
438	437	43.305676	-88.330863	7	2		1	1									1																					
439	438	43.305664	-88.330086			Not Sampled																																
440	439	43.305653	-88.32931			Not Sampled																																
441	440	43.305642	-88.328533			Not Sampled																																
442	441	43.30563	-88.327757			Not Sampled																																
443	442	43.305619	-88.32698	6	2		3				3						3																					
444	443	43.305267	-88.341749	1.5	5		3				3																											
445	444	43.305256	-88.340972	3	2		2	1		1	3																											
446	445	43.305244	-88.340196	3	2		2	1			3																											
447	446	43.305233	-88.339419	3.5	2		2				3														1										1			
448	447	43.305222	-88.338643	3	2		2				3														1											1		
449	448	43.305211	-88.337866	3	2		2				3																								1			
450	449	43.305199	-88.33709	3	2		3				3																											
451	450	43.305188	-88.336313	2	2		2				3								1																3			
452	451	43.305109	-88.330878	4	2		3				3						2																					
453	452	43.305097	-88.330102			Not Sampled																																
454	453	43.305086	-88.329325			Not Sampled																																
455	454	43.305075	-88.328549			Not Sampled																																
456	455	43.305063	-88.327772			Not Sampled																																
457	456	43.305052	-88.326996	5	2		2				3						2								2										1	1		
458	457	43.304677	-88.340211	2	2		3				3																											
459	458	43.304666	-88.339435	3	2		3				3																											
460	459	43.304655	-88.338658	2.5	2		3				3																								2			
461	460	43.304643	-88.337882	2.5	2		2				3																								1			
462	461	43.304632	-88.337105	2.5	2		3				3																								2			
463	462	43.304542	-88.330894	3	2		3			1	3																								3			
464	463	43.30453	-88.330117	5.5	2		2				1						3																		1			
465	464	43.304519	-88.329341	11.5	2		3	3		2																											
466	465	43.304508	-88.328564	13	2		3			3																											
467	466	43.304496	-88.327788	7	2		2			2							2																			1		
468	467	43.304485	-88.327012	3.5	4		1				1					1																					
469	468	43.304065	-88.337121	2	1		1	1											1																	1		
470	469	43.303975	-88.330909	2.5	1		2	1			3						3																		1	1		
471	470	43.303963	-88.330133	3	1		2	1			3						3	3				1									3				1			
472	471	43.303952	-88.329356	3.5	2		2				3						1	3															1			1		
473	472	43.303941	-88.32858	4.5	1		2			1																2					3				2			
474	473	43.303929	-88.327804	3.5	2		3				3																											
475	474	43.303487	-88.33636	2.5	1		2	2		1							3		2													2						
476	475	43.303396	-88.330148			Not Sampled																																
477	476	43.303385	-88.329372			Not Sampled																																
478	477	43.303374	-88.328596			Not Sampled																																

Source: Washington County

Table B-2

SUMMARY STATISTICS FOR THE PIKE LAKE POINT-INTERCEPT AQUATIC PLANT SURVEY: JULY 9-12, 2012

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
1	**STATS**	Total vegetation	*Myriophyllum spicatum*, Eurasian water milfoil	*Potamogeton crispus*, Curly-leaf pondweed	*Ceratophyllum demersum*, Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis*, Common waterweed	*Heteranthera dubia*, Water star-grass	*Myriophyllum sibiricum*, Northern water-milfoil	*Najas flexilis*, Slender naiad	*Najas marina*, Spiny naiad	*Nitella* sp., Nitella	*Nuphar variegata*, Spatterdock	*Nymphaea odorata*, White water lily	*Potamogeton foliosus*, Leafy pondweed	*Potamogeton gramineus*, Variable pondweed	*Potamogeton illinoensis*, Illinois pondweed	*Potamogeton natans*, Floating-leaf pondweed	*Potamogeton nodosus*, Long-leaf pondweed	*Potamogeton praelongus*, White-stem pondweed	*Potamogeton pusillus*, Small pondweed	*Potamogeton richardsonii*, Clasping-leaf pondweed	*Potamogeton robbinsii*, Fern pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Ranunculus aquatilis*, White water crowfoot	*Sagittaria latifolia*, Common arrowhead	*Schoenoplectus subterminalis*, Water bulrush	*Stuckenia pectinata*, Sago pondweed	*Vallisneria americana*, Wild celery	sp1	sp2
2	Lake: Pike Lake																														
3	County: Washington																														
4	WBIC: 8583000																														
5	Survey Date: July 9-12, 2012																														
6	**INDIVIDUAL SPECIES STATS:**																														
7	**Frequency of occurrence within vegetated areas (%)**		19.79	1.06	7.77	81.27	0.71	1.41	3.53	1.77	8.48	23.67	1.41	2.47	0.35	6.36	1.41	0.35	0.71	13.07	1.77	1.77	0.35	0.35	1.41	0.35	1.77	37.46	16.25		
8	**Frequency of occurrence at sites shallower than maximum depth of plants**		19.51	1.05	7.67	80.14	0.70	1.39	3.48	1.74	8.36	23.34	1.39	2.44	0.35	6.27	1.39	0.35	0.70	12.89	1.74	1.74	0.35	0.35	1.39	0.35	1.74	36.93	16.03		
9	**Relative Frequency (%)**		8.3	0.4	3.3	34.3	0.3	0.6	1.5	0.7	3.6	10.0	0.6	1.0	0.1	2.7	0.6	0.1	0.3	5.5	0.7	0.7	0.1	0.1	0.6	0.1	0.7	15.8	6.9		
10	Relative Frequency (squared)	0.17	0.01	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00		
11	**Number of sites where species found**		56	3	22	230	2	4	10	5	24	67	4	7	1	18	4	1	2	37	5	5	1	1	4	1	5	106	46		
12	**Average Rake Fullness**	2.39	1.59	1.67	1.50	2.87	1.00	2.50	1.20	1.20	1.25	2.52	2.25	2.00	1.00	1.72	1.75	1.00	1.50	1.38	1.40	1.80	3.00	1.00	2.25	2.00	1.60	1.73	1.39		
13	**#visual sightings**																														
14	**present (visual or collected)**		present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present		
15																															
16	**SUMMARY STATS:**																														
17	**Total number of sites visited**	**288**																													
18	**Total number of sites with vegetation**	**283**																													
19	**Total number of sites shallower than maximum depth of plants**	**287**																													
20	**Frequency of occurrence at sites shallower than maximum depth of plants**	**98.61**																													
21	**Simpson Diversity Index**	**0.83**																													
22	**Maximum depth of plants (ft)****	**15.00**																													
23	**Number of sites sampled using rake on Rope (R)**	**0**																													
24	**Number of sites sampled using rake on Pole (P)**	**0**																													
25	**Average number of all species per site (shallower than max depth)**	**2.33**																													
26	**Average number of all species per site (veg. sites only)**	**2.37**																													
27	**Average number of native species per site (shallower than max depth)**	**2.04**																													
28	**Average number of native species per site (veg. sites only)**	**2.12**																													
29	**Species Richness**	**27**																													
30	**Species Richness (including visuals)**	**27**																													
31																															
32	****SEE "MAX DEPTH GRAPH" WORKSHEET TO CONFIRM**																														

Source: Washington County

Table B-3

PIKE LAKE POINT-INTERCEPT AQUATIC PLANT SURVEY DATA: JULY 12, 2016

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness		Potamogeton crispus , Curly-leaf pondweed	Ceratophyllum demersum , Coontail	Chara sp., Muskgrasses	Heteranthera dubia , Water star-grass	Lemna minor , Small duckweed	Myriophyllum sibiricum , Northern water-milfoil	Najas flexilis , Slender naiad	Najas guadalupensis, Southern naiad	Najas marina , Spiny naiad	Nuphar variegata , Spatterdock	Nymphaea odorata , White water lily	Potamogeton friesii , Fries' pondweed	Potamogeton gramineus , Variable pondweed	Potamogeton illinoensis , Illinois pondweed	Potamogeton natans , Floating-leaf pondweed	Potamogeton richardsonii , Clasping-leaf pondweed	Potamogeton zosteriformis , Flat-stem pondweed	Ranunculus aquatilis , White water crowfoot	Schoenoplectus acutus , Hardstem bulrush	Stuckenia pectinata , Sago pondweed	Stuckenia vaginata , Sheathed pondweed	Utricularia vulgaris , Common bladderwort	Vallisneria americana , Wild celery	Nitellopsis obtusa, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
2	1	43.318196	-88.333628	3	s	P		3		2	1	1		1						2											1	1					
3	2	43.31814	-88.329745			NONNAVIGABLE SHALLOW																															
4	3	43.318128	-88.328968			NONNAVIGABLE SHALLOW																															
5	4	43.318117	-88.328191			NONNAVIGABLE SHALLOW																															
6	5	43.31764	-88.33442	2	s	P		2		2										1	1															
7	6	43.317629	-88.333643	2.5	s	P		3		1											1											3				
8	7	43.317618	-88.332867	3	s	p		1			1									1											v				
9	8	43.317606	-88.33209	3.5	s	p		2			1									2				1							1				
10	9	43.317595	-88.331313	2.5	s	p		3		3										1								1			1				
11	10	43.317584	-88.330537	3	s	p		3		2																		1			1				
12	11	43.317572	-88.32976	2	s	p		2		2														1				1			1				
13	12	43.317561	-88.328984	2	s	p		3		2									v									1			2				
14	13	43.31755	-88.328207	2	s	p		3		2								v	v												2				
15	14	43.317538	-88.32743	4	s	p		3		3							2	v													3				
16	15	43.317073	-88.334435		s	p	NAVIGABLE SHALLOW																														
17	16	43.317062	-88.333659	3	s	p		2		2																					1				
18	17	43.317051	-88.332882	3	s	p		3		3																		1			1				
19	18	43.317039	-88.332105	3	s	p		2		1										1				1							1				
20	19	43.317028	-88.331329	3	s	p		1		1																					1				
21	20	43.317017	-88.330552	3	s	p		1		1																						1				
22	21	43.317005	-88.329776	3	s	p		1		1							1					v						1				1				
23	22	43.316994	-88.328999	2	s	p		3		3																		1				1				
24	23	43.316983	-88.328222	2	s	p		3		2							1		v									2				2				
25	24	43.316971	-88.327446	1	s	p		3		3				1														1				2				
26	25	43.31696	-88.326669	1.5	s	p		3		2																						3				
27	26	43.316518	-88.335227	3	s	p		1		2										1											1					
28	27	43.316506	-88.334451	3	s	p		1																												
29	28	43.316495	-88.333674	3	s	p		1		1							1																			
30	29	43.316484	-88.332898	4	s	p		1		1																						1				
31	30	43.316472	-88.332121	4	s	p		1		1																						1				
32	31	43.316461	-88.331344	4	s	p		1		1																						1				
33	32	43.31645	-88.330568	3	s	p		2		1																		1				1				
34	33	43.316438	-88.329791	3	s	p		1		1																		1				1				
35	34	43.316427	-88.329015	2.5	s	p		1		1																		1				1				
36	35	43.316416	-88.328238	2.5	s	p		1		1							1											1				1				
37	36	43.316404	-88.327461	2	s	p		1		1																		1								
38	37	43.316393	-88.326685	1	s	p		2		1																		1				2				
39	38	43.315951	-88.335243	4	s	p		3		3																						2				
40	39	43.315939	-88.334466	4	s	p		1		1							1															1				
41	40	43.315928	-88.33369	4	s	p		3		3							1											1				1				
42	41	43.315917	-88.332913	5	s	p		1		1																						1				
43	42	43.315905	-88.332137	5	s	p		1		1												v														
44	43	43.315894	-88.33136	4	s	p		1		1																		1				1				
45	44	43.315883	-88.330583	3	s	p		1		1																		1								
46	45	43.315871	-88.329807	4	s	p		2		1										2								1				1				
47	46	43.31586	-88.32903	3	s	p		1		1							1											1				1				
48	47	43.315849	-88.328254	3	s	p		1		1																		1				1				
49	48	43.315837	-88.327477	2	s	p		1		1																		1								
50	49	43.315826	-88.3267	2.5	s	p		2		2																						1				
51	50	43.315417	-88.337588	3	s	p		1		1																						1				
52	51	43.315406	-88.336812	3	s	p		1		1																						1				

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness		Potamogeton crispus , Curly-leaf pondweed	Ceratophyllum demersum , Coontail	Chara sp., Muskgrasses	Heteranthera dubia , Water star-grass	Lemna minor , Small duckweed	Myriophyllum sibiricum , Northern water-milfoil	Najas flexilis , Slender naiad	Najas guadalupensis , Southern naiad	Najas marina , Spiny naiad	Nuphar variegata , Spatterdock	Nymphaea odorata , White water lily	Potamogeton friesii , Fries' pondweed	Potamogeton gramineus , Variable pondweed	Potamogeton illinoensis , Illinois pondweed	Potamogeton natans , Floating-leaf pondweed	Potamogeton richardsonii , Clasping-leaf pondweed	Potamogeton zosteriformis , Flat-stem pondweed	Ranunculus aquatilis , White water crowfoot	Schoenoplectus acutus , Hardstem bulrush	Stuckenia pectinata , Sago pondweed	Stuckenia vaginata , Sheathed pondweed	Utricularia vulgaris , Common bladderwort	Vallisneria americana , Wild celery	Nitellopsis obtusa , Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
53	52	43.315395	-88.336035	4	s	p		1			1						1															1					
54	53	43.315384	-88.335258	4	s	p		1			1						1															1					
55	54	43.315372	-88.334482	5	s	p		2			2						1															1					
56	55	43.315361	-88.333705	5	s	p		1			1						1											1				1					
57	56	43.31535	-88.332929	5	s	p		1			1																					1					
58	57	43.315338	-88.332152	5	s	p		2																				1				2					
59	58	43.315327	-88.331375	4.5	s	p		1			1																					1					
60	59	43.315316	-88.330599	11	s	p		2			1						1											1									
61	60	43.315304	-88.329822	3.5	s	p		2			2						1											1				1					
62	61	43.315293	-88.329046	3.5	s	p		1			1																	1									
63	62	43.315282	-88.328269	3.5	s	p		1			1						1											1					1				
64	63	43.31527	-88.327493	3	s	p		1																									1				
65	64	43.315259	-88.326716	3	s	p		1			1																	1				1					
66	65	43.314873	-88.339157	4	s	p		3			1																					3					
67	66	43.314862	-88.33838	4	s	p		3			1																					3					
68	67	43.31485	-88.337604	5.5	s	p		1			1																					1					
69	68	43.314839	-88.336827	5.5	s	p		2			2																					1					
70	69	43.314828	-88.33605	5	s	p		1			1										1										1		1				
71	70	43.314816	-88.335274	6	s	p		2			1						1															1					
72	71	43.314805	-88.334497	6	s	p		2			1																	1				1			1		
73	72	43.314794	-88.333721	7	s	p		2			1									1												2					
74	73	43.314783	-88.332944	6.5	s	p		1			1																					1					
75	74	43.314771	-88.332168	5.5	s	p		1			1																					1					
76	75	43.31476	-88.331391	5	s	p		1			1						1											1				1					
77	76	43.314749	-88.330614	4	s	p		3			2																	1				2					
78	77	43.314737	-88.329838	4	s	p		1			1																										
79	78	43.314726	-88.329061	4	s	p		1			1																										
80	79	43.314715	-88.328285	3.5	s	p		1			1																										
81	80	43.314703	-88.327508	3	s	p		3			1																										
82	81	43.314692	-88.326732	3	s	p		3			3																										
83	82	43.314317	-88.339949	3.5	s	p		1			1										1																
84	83	43.314306	-88.339172	7.5	s	p																															
85	84	43.314295	-88.338396	17	s	r		1																								1					
86	85	43.314283	-88.337619	17	s	r																															
87	86	43.314272	-88.336842	19	s	r																															
88	87	43.314261	-88.336066	18	s	r		3			2																					1					
89	88	43.314249	-88.335289	10	s	r		1																								1					
90	89	43.314238	-88.334513	11	s	r											1											1				3					
91	90	43.314227	-88.333736	8	s	r		3																				1				3					
92	91	43.314216	-88.33296	8	s	r		3																								3					
93	92	43.314204	-88.332183	7	s	r		3																								3					
94	93	43.314193	-88.331406	6	s	r		3			2						1															1					
95	94	43.314182	-88.33063	5	s	r		1							1																						
96	95	43.31417	-88.329853	4	s	r		1			1																										
97	96	43.314159	-88.329077	4	s	r		1			1						1																				
98	97	43.314147	-88.3283	3	s	r		1			1																										
99	98	43.314136	-88.327524	3	s	r		1			1																							1			
100	99	43.314125	-88.326747	3	s	r		1			1																										
101	100	43.314113	-88.325971	3	s	r		1			1																	1				1					
102	101	43.31375	-88.339964	7	s	r		2			2																					1					
103	102	43.313739	-88.339188	13	s	r		1			1																					1					

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Potamogeton crispus*, Curly-leaf pondweed	*Ceratophyllum demersum*, Coontail	*Chara* sp., Muskgrasses	*Heteranthera dubia*, Water star-grass	*Lemna minor*, Small duckweed	*Myriophyllum sibiricum*, Northern water-milfoil	*Najas flexilis*, Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina*, Spiny naiad	*Nuphar variegata*, Spatterdock	*Nymphaea odorata*, White water lily	*Potamogeton friesii*, Fries' pondweed	*Potamogeton gramineus*, Variable pondweed	*Potamogeton illinoensis*, Illinois pondweed	*Potamogeton natans*, Floating-leaf pondweed	*Potamogeton richardsonii*, Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Ranunculus aquatilis*, White water crowfoot	*Schoenoplectus acutus*, Hardstem bulrush	*Stuckenia pectinata*, Sago pondweed	*Stuckenia vaginata*, Sheathed pondweed	*Utricularia vulgaris*, Common bladderwort	*Vallisneria americana*, Wild celery	*Nitellopsis obtusa*, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
104	103	43.313728	-88.338411	21	s	r																															
105	104	43.313716	-88.337634	30	s	r																															
106	105	43.313705	-88.336858	32	s	r																															
107	106	43.313694	-88.336081	18	s	r																															
108	107	43.313682	-88.335305	32	s	r																															
109	108	43.313671	-88.334528	12.5	s	r																															
110	109	43.31366	-88.333752	12	s	r																															
111	110	43.313648	-88.332975	12	s	r																											3				
112	111	43.313637	-88.332199	7.5	s	p		3																									1				
113	112	43.313626	-88.331422	6.5	s	p		1																													
114	113	43.313614	-88.330645	5.5	s	p		1																							1						
115	114	43.313603	-88.329869	5	s	p		1			1																										
116	115	43.313592	-88.329092	4	s	p		1			1																										
117	116	43.31358	-88.328316	3.5	s	p		1			1																										
118	117	43.313569	-88.327539	3	s	P																															
119	118	43.313558	-88.326763	3	s	P		1			1																										
120	119	43.313546	-88.325986	3	s	R		1			1																										
121	120	43.313535	-88.32521	3	s	R																					V									
122	121	43.313524	-88.324433	3	s	R		3			3																								1		
123	122	43.313512	-88.323656	2	s	R		2			2																						1				
124	123	43.313194	-88.340756	3.5	s	R		1			1																										
125	124	43.313183	-88.33998	5	s	R		3			2						1											1									
126	125	43.313172	-88.339203	19	s	R		1																								1					
127	126	43.313161	-88.338426	27	s	R																															
128	127	43.313149	-88.33765		s		DEEP																														
129	128	43.313138	-88.336873		s		DEEP																														
130	129	43.313127	-88.336097		s		DEEP																														
131	130	43.313115	-88.33532		s		DEEP																														
132	131	43.313104	-88.334544	33	s	R																															
133	132	43.313093	-88.333767	23	s	R		1													1																
134	133	43.313081	-88.332991	20	s	R																															
135	134	43.31307	-88.332214	19	s	R		1																								1					
136	135	43.313059	-88.331438	6	s	R		2			1																					2					
137	136	43.313047	-88.330661	5	s	P		1			1																										
138	137	43.313036	-88.329884	4.5	s	P		1			1																										
139	138	43.313025	-88.329108	4	s	P		1			1						1																				
140	139	43.313013	-88.328331	3.5	s	P		1			1																										
141	140	43.313002	-88.327555	4	s	P		3			3																										
142	141	43.312991	-88.326778	3	s	P		1			1																										
143	142	43.312979	-88.326002	3	s	P		1																													
144	143	43.312968	-88.325225	3	s	P		1			1																										
145	144	43.312957	-88.324449	3	s	P		1			1																										
146	145	43.312945	-88.323672	2	s	P		3																				1									
147	146	43.312934	-88.322895	2	s	P		1			3																										
148	147	43.312627	-88.340772	4	s	p		1			1																										
149	148	43.312616	-88.339995	4	s	P		3			1											1									1						
150	149	43.312605	-88.339219	6	s	P					1												1										3				
151	150	43.312593	-88.338442	28	s	R																															
152	151	43.312582	-88.337665				DEEP																														
153	152	43.312571	-88.336889	33	s	R																															
154	153	43.31256	-88.336112				DEEP																														

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	Potamogeton crispus , Curly-leaf pondweed	Ceratophyllum demersum , Coontail	Chara sp., Muskgrasses	Heteranthera dubia , Water star-grass	Lemna minor , Small duckweed	Myriophyllum sibiricum , Northern water-milfoil	Najas flexilis , Slender naiad	Najas guadalupensis, Southern naiad	Najas marina , Spiny naiad	Nuphar variegata , Spatterdock	Nymphaea odorata , White water lily	Potamogeton friesii , Fries' pondweed	Potamogeton gramineus , Variable pondweed	Potamogeton illinoensis , Illinois pondweed	Potamogeton natans , Floating-leaf pondweed	Potamogeton richardsonii , Clasping-leaf pondweed	Potamogeton zosteriformis , Flat-stem pondweed	Ranunculus aquatilis , White water crowfoot	Schoenoplectus acutus , Hardstem bulrush	Stuckenia pectinata , Sago pondweed	Stuckenia vaginata, Sheathed pondweed	Utricularia vulgaris , Common bladderwort	Vallisneria americana , Wild celery	Nitellopsis obtusa, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)		
155	154	43.312548	-88.335336				DEEP																														
156	155	43.312537	-88.334559				DEEP																														
157	156	43.312526	-88.333783	30	s	R																															
158	157	43.312514	-88.333006	30	s	R																															
159	158	43.312503	-88.33223	34	s	R		1		1																											
160	159	43.312492	-88.331453	7	s	R		3			2						1															1					
161	160	43.31248	-88.330676	7	s	R		1			1																			1		1					
162	161	43.312469	-88.3299	5	s	P		1			1																			1							
163	162	43.312458	-88.329123	4.5	s	P		1			1																										
164	163	43.312446	-88.328347	4	s	P		1			1																										
165	164	43.312435	-88.32757	4	s	P		1			1																										
166	165	43.312424	-88.326794	3	s	P		1			1																										
167	166	43.312412	-88.326017	3.5	s	P		1			1																										
168	167	43.312401	-88.325241	3	s	P		1			1																										
169	168	43.31239	-88.324464	3	s	P		1			1																										
170	169	43.312378	-88.323688	3	s	P		1			1																		1								
171	170	43.312367	-88.322911	2.5	s	P		1			1																		1								
172	171	43.31206	-88.340787	3.5	s	P		1			1																										
173	172	43.312049	-88.34001	5	s	P		1			1																										
174	173	43.312038	-88.339234	20	s	R																															
175	174	43.312026	-88.338457	22	S	R																															
176	175	43.312015	-88.337681	25	S	R																															
177	176	43.312004	-88.336904		S		DEEP																														
178	177	43.311993	-88.336128		S		DEEP																														
179	178	43.311981	-88.335351		S		DEEP																														
180	179	43.31197	-88.334575		S		DEEP																														
181	180	43.311959	-88.333798	34	S	R																															
182	181	43.311947	-88.333022	28	S	R																															
183	182	43.311936	-88.332245	20	S	R																															
184	183	43.311925	-88.331469	11	S	R		3																								1	2				
185	184	43.311913	-88.330692	5	S	P		1			1																					1					
186	185	43.311902	-88.329915	5	S	P		2			2											1															
187	186	43.311891	-88.329139	5	S	P		1			1																										
188	187	43.311879	-88.328362	4	S	P		1			1																										
189	188	43.311868	-88.327586	4.5	S	P		1			1						1																				
190	189	43.311857	-88.326809	4	S	P		1			1																										
191	190	43.311845	-88.326033	4	S	P		1			1																										
192	191	43.311834	-88.325256	3.5	S	P		1			1																										
193	192	43.311822	-88.32448	3	S	P		1			1																										
194	193	43.311811	-88.323703	3	S	P		1			1																										
195	194	43.3118	-88.322927	2.5	S	P		1			1																										
196	195	43.311493	-88.340802	4.5	S	P		2			1						1																				
197	196	43.311482	-88.340026	7	S	R					1														1							1	1				
198	197	43.311471	-88.339249	10	S	R		1													1							1								
199	198	43.311459	-88.338473	17	S	R																															
200	199	43.311448	-88.337696	32	S	R																															
201	200	43.311437	-88.33692				DEEP																														
202	201	43.311425	-88.336143				DEEP																														
203	202	43.311414	-88.335367				DEEP																														
204	203	43.311403	-88.33459				DEEP																														
205	204	43.311392	-88.333814				DEEP																														

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness		Potamogeton crispus , Curly-leaf pondweed	Ceratophyllum demersum , Coontail	Chara sp., Muskgrasses	Heteranthera dubia , Water star-grass	Lemna minor , Small duckweed	Myriophyllum sibiricum , Northern water-milfoil	Najas flexilis , Slender naiad	Najas guadalupensis, Southern naiad	Najas marina , Spiny naiad	Nuphar variegata , Spatterdock	Nymphaea odorata , White water lily	Potamogeton friesii , Fries' pondweed	Potamogeton gramineus , Variable pondweed	Potamogeton illinoensis , Illinois pondweed	Potamogeton natans , Floating-leaf pondweed	Potamogeton richardsonii , Clasping-leaf pondweed	Potamogeton zosteriformis , Flat-stem pondweed	Ranunculus aquatilis , White water crowfoot	Schoenoplectus acutus , Hardstem bulrush	Stuckenia pectinata , Sago pondweed	Stuckenia vaginata, Sheathed pondweed	Utricularia vulgaris , Common bladderwort	Vallisneria americana , Wild celery	Nitellopsis obtusa, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
206	205	43.31138	-88.333037				DEEP																														
207	206	43.311369	-88.332261				DEEP																														
208	207	43.311358	-88.331484	16	S	R		1																													
209	208	43.311346	-88.330708	6.5	S	P		1			1											1										1					
210	209	43.311335	-88.329931	6	S	P		1			1						1															1					
211	210	43.311324	-88.329154	5	S	P		1			1						1																				
212	211	43.311312	-88.328378	5	S	P		1			1						1														1						
213	212	43.311301	-88.327601	5	S	P		1			1																	1				1					
214	213	43.31129	-88.326825	5	S	P		1			1																										
215	214	43.311278	-88.326048	4.5	S	P		1			1						1											1									
216	215	43.311267	-88.325272	3.5	S	P		1			1						1																				
217	216	43.311255	-88.324495	3	S	P		1			1						1																				
218	217	43.311244	-88.323719	2.5	S	P		1			1																	1									
219	218	43.311233	-88.322942	3	S	P		1			1																	1									
220	219	43.310937	-88.341594	4	S	P																															
221	220	43.310926	-88.340818	5	S	P		1			1																	1									
222	221	43.310915	-88.340041	6	S	P		1			1																					1					
223	222	43.310904	-88.339265	18	S	R																															
224	223	43.310892	-88.338488	34	S	R																															
225	224	43.310881	-88.337712				DEEP																														
226	225	43.31087	-88.336935				DEEP																														
227	226	43.310858	-88.336159				DEEP																														
228	227	43.310847	-88.335382				DEEP																														
229	228	43.310836	-88.334606				DEEP																														
230	229	43.310825	-88.333829				DEEP																														
231	230	43.310813	-88.333053	31	S	R																															
232	231	43.310802	-88.332276	25	S	R																															
233	232	43.310791	-88.3315	26	S	R																															
234	233	43.310779	-88.330723	23	S	R		1			1						1														1					
235	234	43.310768	-88.329947	16	S	R																															
236	235	43.310757	-88.32917	8	S	P		2			1						1											1						1			
237	236	43.310745	-88.328393	6	S	P		1			1																	1				1					
238	237	43.310734	-88.327617	6	S	P		1									1											1			1						
239	238	43.310722	-88.32684	5.5	S	P		2			1																	1				2					
240	239	43.310711	-88.326064	5	S	P		1			1						1																				
241	240	43.3107	-88.325287	4.5	S	P		1			1																	1									
242	241	43.310688	-88.324511	4	S	P		1			1						1																		1		
243	242	43.310677	-88.323734	3.5	S	P		1			1																	1									
244	243	43.310666	-88.322958	2	S	P		1			1																	1									
245	244	43.31037	-88.34161	3.5	S	P		1			1																										
246	245	43.310359	-88.340833	4	S	P		1			1																										
247	246	43.310348	-88.340057	8	S	R		3			3																	1									
248	247	43.310337	-88.33928	19	S	R																															
249	248	43.310325	-88.338504	35	S	R																															
250	249	43.310314	-88.337727				DEEP																														
251	250	43.310303	-88.336951				DEEP																														
252	251	43.310291	-88.336174				DEEP																														
253	252	43.31028	-88.335398				DEEP																														
254	253	43.310269	-88.334621				DEEP																														
255	254	43.310257	-88.333845				DEEP																														
256	255	43.310246	-88.333068				DEEP																														

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	Potamogeton crispus , Curly-leaf pondweed	Ceratophyllum demersum , Coontail	Chara sp., Muskgrasses	Heteranthera dubia , Water star-grass	Lemna minor , Small duckweed	Myriophyllum sibiricum , Northern water-milfoil	Najas flexilis , Slender naiad	Najas guadalupensis, Southern naiad	Najas marina , Spiny naiad	Nuphar variegata , Spatterdock	Nymphaea odorata , White water lily	Potamogeton friesii , Fries' pondweed	Potamogeton gramineus , Variable pondweed	Potamogeton illinoensis , Illinois pondweed	Potamogeton natans , Floating-leaf pondweed	Potamogeton richardsonii , Clasping-leaf pondweed	Potamogeton zosteriformis , Flat-stem pondweed	Ranunculus aquatilis , White water crowfoot	Schoenoplectus acutus , Hardstem bulrush	Stuckenia pectinata , Sago pondweed	Stuckenia vaginata, Sheathed pondweed	Utricularia vulgaris , Common bladderwort	Vallisneria americana , Wild celery	Nitellopsis obtusa, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
257	256	43.310235	-88.332292				DEEP																														
258	257	43.310224	-88.331515	23	S	R														1								1									
259	258	43.310212	-88.330739	18	S	R																															
260	259	43.310201	-88.329962	23	S	R																															
261	260	43.31019	-88.329186	16	S	R																															
262	261	43.310178	-88.328409	13	S	R																															
263	262	43.310167	-88.327633	8	S	P		1																				1									
264	263	43.310155	-88.326856	7	S	P		2												1								1				1					
265	264	43.310144	-88.326079	6	S	P		1			1																	1				1					
266	265	43.310133	-88.325303	5	S	P		1			1						1											1				1					
267	266	43.310121	-88.324526	4	S	P		2				2																1									
268	267	43.31011	-88.32375	4	S	P		2			2																	1				1					
269	268	43.310099	-88.322973	3	S	P		3			3						1															1					
270	269	43.309815	-88.342402	2	S	P		1			1										V							1									
271	270	43.309803	-88.341625	3	S	P		1			1																										
272	271	43.309792	-88.340849	4	S	P		1			1										1																
273	272	43.309781	-88.340072	5.5	S	P		2			2																	1				1					
274	273	43.30977	-88.339296	29	S	R																															
275	274	43.309758	-88.338519				DEEP																														
276	275	43.309747	-88.337743				DEEP																														
277	276	43.309736	-88.336966				DEEP																														
278	277	43.309724	-88.33619				DEEP																														
279	278	43.309713	-88.335413				DEEP																														
280	279	43.309702	-88.334637				DEEP																														
281	280	43.30969	-88.33386				DEEP																														
282	281	43.309679	-88.333084				DEEP																														
283	282	43.309668	-88.332307				DEEP																														
284	283	43.309656	-88.331531	30	S	R																															
285	284	43.309645	-88.330754	30	S	R																															
286	285	43.309634	-88.329978	28	S	R																															
287	286	43.309622	-88.329201	27	S	R																															
288	287	43.309611	-88.328425	27	S	R																															
289	288	43.3096	-88.327648	25	S	R																															
290	289	43.309588	-88.326872	14	S	R																															
291	290	43.309577	-88.326095	8	S	R		1									1											1									
292	291	43.309566	-88.325319	5	S	P		1																													
293	292	43.309554	-88.324542	4	S	P		2			2																					1	1				
294	293	43.309543	-88.323766	3.5	S	P		1			1																	1									
295	294	43.309532	-88.322989	3	S	P		1			1																										
296	295	43.309248	-88.342417	2.5	S	P		1			1						1																				
297	296	43.309236	-88.341641	3	S	P		1			1																										
298	297	43.309225	-88.340864	4	S	P		1			1																										
299	298	43.309214	-88.340088	6	S	P		1																													
300	299	43.309202	-88.339311				DEEP																														
301	300	43.309191	-88.338535	35	S	R					1						1															1					
302	301	43.30918	-88.337758				DEEP																														
303	302	43.309169	-88.336982				DEEP																														
304	303	43.309157	-88.336205				DEEP																														
305	304	43.309146	-88.335429				DEEP																														
306	305	43.309135	-88.334652				DEEP																														
307	306	43.309123	-88.333876				DEEP																														

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	Potamogeton crispus , Curly-leaf pondweed	Ceratophyllum demersum , Coontail	Chara sp., Muskgrasses	Heteranthera dubia , Water star-grass	Lemna minor , Small duckweed	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis , Slender naiad	Najas guadalupensis, Southern naiad	Najas marina , Spiny naiad	Nuphar variegata , Spatterdock	Nymphaea odorata , White water lily	Potamogeton friesii , Fries' pondweed	Potamogeton gramineus , Variable pondweed	Potamogeton illinoensis , Illinois pondweed	Potamogeton natans , Floating-leaf pondweed	Potamogeton richardsonii , Clasping-leaf pondweed	Potamogeton zosteriformis , Flat-stem pondweed	Ranunculus aquatilis , White water crowfoot	Schoenoplectus acutus , Hardstem bulrush	Stuckenia pectinata , Sago pondweed	Stuckenia vaginata, Sheathed pondweed	Utricularia vulgaris , Common bladderwort	Vallisneria americana , Wild celery	Nitellopsis obtusa, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
308	307	43.309112	-88.333099				DEEP																														
309	308	43.309101	-88.332323				DEEP																														
310	309	43.309089	-88.331546				DEEP																														
311	310	43.309078	-88.33077				DEEP																														
312	311	43.309067	-88.329993				DEEP																														
313	312	43.309055	-88.329217				DEEP																														
314	313	43.309044	-88.32844	26	S	R																															
315	314	43.309033	-88.327664	19	S	R																															
316	315	43.309021	-88.326887	17	S	R																															
317	316	43.30901	-88.326111	7	S	P		2														1						1									
318	317	43.308999	-88.325334	5.5	S	P		3			1																	1				1					
319	318	43.308987	-88.324558	5	S	P		2			3																	1				3					
320	319	43.308976	-88.323781	4	S	P																															
321	320	43.30868	-88.342433	2	S	P		1			1																										
322	321	43.308669	-88.341656	3	S	P																															
323	322	43.308658	-88.34088	3.5	S	P		1			1																										
324	323	43.308647	-88.340103	14	S	R																															
325	324	43.308635	-88.339327	33	S	R																															
326	325	43.308624	-88.33855	33	S	R																															
327	326	43.308613	-88.337774				DEEP																														
328	327	43.308602	-88.336997				DEEP																														
329	328	43.30859	-88.336221				DEEP																														
330	329	43.308579	-88.335444				DEEP																														
331	330	43.308568	-88.334668				DEEP																														
332	331	43.308556	-88.333891				DEEP																														
333	332	43.308545	-88.333115				DEEP																														
334	333	43.308534	-88.332338				DEEP																														
335	334	43.308522	-88.331562				DEEP																														
336	335	43.308511	-88.330785				DEEP																														
337	336	43.3085	-88.330009				DEEP																														
338	337	43.308488	-88.329232				DEEP																														
339	338	43.308477	-88.328456				DEEP																														
340	339	43.308466	-88.327679				DEEP																														
341	340	43.308454	-88.326903	20	S	R																															
342	341	43.308443	-88.326126	12	S	R		3	1													1										3					
343	342	43.308432	-88.32535	8	S	R		2			2																	1				1					
344	343	43.30842	-88.324573	3.5	S	P		3			3			1																1	1					
345	344	43.308409	-88.323797	3.5	S	P		1			1																										
346	345	43.308113	-88.342448	2.5	S	P		1			1																										
347	346	43.308102	-88.341672	3.5	S	P		1			1																										
348	347	43.308091	-88.340895	8	S	P		2			3						1														1	1					
349	348	43.30808	-88.340119	18	S	R																															
350	349	43.308068	-88.339342				DEEP																														
351	350	43.308057	-88.338566				DEEP																														
352	351	43.308046	-88.337789				DEEP																														
353	352	43.308034	-88.337013				DEEP																														
354	353	43.308023	-88.336236				DEEP																														
355	354	43.308012	-88.33546	32	S	R																															
356	355	43.308001	-88.334683				DEEP																														
357	356	43.307989	-88.333907				DEEP																														
358	357	43.307978	-88.33313	27	S	R																															

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Heteranthera dubia* , Water star-grass	*Lemna minor* , Small duckweed	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton friesii* , Fries' pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis* , Flat-stem pondweed	*Ranunculus aquatilis* , White water crowfoot	*Schoenoplectus acutus* , Hardstem bulrush	*Stuckenia pectinata* , Sago pondweed	*Stuckenia vaginata*, Sheathed pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	*Nitellopsis obtusa*, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
359	358	43.307967	-88.332354				DEEP																														
360	359	43.307955	-88.331577				DEEP																														
361	360	43.307944	-88.330801	23	S	R																															
362	361	43.307933	-88.330024	28	S	R																															
363	362	43.307921	-88.329248	25	S	R																															
364	363	43.30791	-88.328471	21	S	R																															
365	364	43.307899	-88.327695	19	S	R																															
366	365	43.307887	-88.326918	13	S	R																															
367	366	43.307876	-88.326142	6	S	P		3			1										1												3					
368	367	43.307865	-88.325365	5	S	P		2			1																						2					
369	368	43.307853	-88.324589	3.5	S	P																															
370	369	43.307558	-88.34324	2	S	P		1			1								V								V	1									
371	370	43.307546	-88.342463	2.5	S	P		1			1									1																	
372	371	43.307535	-88.341687	3	S	P		1			1									1								2				3					
373	372	43.307524	-88.34091	6	S	P		3																													
374	373	43.307513	-88.340134	20	S	R																															
375	374	43.307501	-88.339357				DEEP																														
376	375	43.30749	-88.338581				DEEP																														
377	376	43.307479	-88.337805				DEEP																														
378	377	43.307467	-88.337028				DEEP																														
379	378	43.307456	-88.336252	33	S	R																															
380	379	43.307445	-88.335475	12	S	R																															
381	380	43.307434	-88.334699	6	S	R		1			1																										
382	381	43.307422	-88.333922	6	S	R		1									1			1												1					
383	382	43.307411	-88.333146	6	S	R		3			2																										
384	383	43.3074	-88.332369	12	S	R																															
385	384	43.307388	-88.331593	12	S	R		1																													
386	385	43.307377	-88.330816	15	S	R																1															
387	386	43.307366	-88.33004	26	S	R																															
388	387	43.307354	-88.329263	23	S	R																															
389	388	43.307343	-88.328487				DEEP																														
390	389	43.307332	-88.32771	10	S	R																															
391	390	43.30732	-88.326934	5	S	P		1													1																
392	391	43.307309	-88.326157	4	S	P		1			1																						2					
393	392	43.307297	-88.325381	2	S	P		1			1										1	1															
394	393	43.306991	-88.343255	2	S	P		1			1								1																		
395	394	43.306979	-88.342479	2.5	S	P		1			1																										
396	395	43.306968	-88.341702	4	S	P		1			1																										
397	396	43.306957	-88.340926	5	S	P		3			1																						3					
398	397	43.306946	-88.340149	6	S	P		2									1			2						1											
399	398	43.306934	-88.339373	11	S	R																															
400	399	43.306923	-88.338596	17	S	R																															
401	400	43.306912	-88.33782	22	S	R																															
402	401	43.3069	-88.337043				DEEP																														
403	402	43.306889	-88.336267	6	S	R		1			1																						1					
404	403	43.306821	-88.331608	5	S	P		3			2										1										1		2					
405	404	43.30681	-88.330832	9	S	R		1													1							1									
406	405	43.306799	-88.330055	18	S	R																															
407	406	43.306787	-88.329279				DEEP																														
408	407	43.306776	-88.328502				DEEP																														
409	408	43.306765	-88.327726	27	S	R											1																				

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Heteranthera dubia* , Water star-grass	*Lemna minor* , Small duckweed	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton friesii*, Fries' pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis* , Flat-stem pondweed	*Ranunculus aquatilis* , White water crowfoot	*Schoenoplectus acutus* , Hardstem bulrush	*Stuckenia pectinata* , Sago pondweed	*Stuckenia vaginata*, Sheathed pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	*Nitellopsis obtusa*, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
410	409	43.306753	-88.326949	13	S	R		1																													
411	410	43.306742	-88.326173	5	S	P		3			2									1																	
412	411	43.306412	-88.342494	3	S	P		1			1																					2					
413	412	43.306401	-88.341718	4	S	P		1			1																										
414	413	43.30639	-88.340941	5	S	P		3			1																	1				3					
415	414	43.306378	-88.340165	5.5	S	P		3			1						1											1				3					
416	415	43.306367	-88.339388	6	S	P		3																				1				3					
417	416	43.306356	-88.338612	6.5	S	P		3									1			2												3					
418	417	43.306345	-88.337835	7	S	P		3												1						1						3					
419	418	43.306333	-88.337059	5	S	P		3			1									3												1					
420	419	43.306322	-88.336282	3.5	S	P		1			1																										
421	420	43.306254	-88.331624	4	S	P		1			1									1												1					
422	421	43.306243	-88.330847	5	S	P		1			1																					1					
423	422	43.306232	-88.330071	15	S	R																															
424	423	43.30622	-88.329294				DEEP																														
425	424	43.306209	-88.328518	26	S	R																															
426	425	43.306197	-88.327741	24	S	R																															
427	426	43.306186	-88.326965	8	S	R		3	1											1												3					
428	427	43.306175	-88.326188	3.5	S	P		1			1																										
429	428	43.305845	-88.34251	2.5	S	P		3			1							V						V								3					
430	429	43.305834	-88.341733	2.5	S	P		1			1																										
431	430	43.305823	-88.340957	4	S	P		1			1																										
432	431	43.305811	-88.34018	4.5	S	P		1			1																	1									
433	432	43.3058	-88.339404	4	S	P		3			3																	1				1					
434	433	43.305789	-88.338627	4	S	P		3			2																	1				2					
435	434	43.305778	-88.337851	3.5	S	P																															
436	435	43.305766	-88.337074	3.5	S	P		2			2						1															1					
437	436	43.305755	-88.336298	2	S	P		3			3																										
438	437	43.305676	-88.330863	7	S	R		1			1																					1					
439	438	43.305664	-88.330086	20	S	R																															
440	439	43.305653	-88.32931				DEEP				1																										
441	440	43.305642	-88.328533	3	S	P		1																													
442	441	43.30563	-88.327757	22	S	R					1																										
443	442	43.305619	-88.32698	6	S	P		3			1									1												3					
444	443	43.305267	-88.341749	2	S	P		1			1																										
445	444	43.305256	-88.340972	3	S	P		1																													
446	445	43.305244	-88.340196	3	S	P		1																													
447	446	43.305233	-88.339419	3.5	S	P																															
448	447	43.305222	-88.338643	3	S	P		1			1																										
449	448	43.305211	-88.337866	3	S	P																															
450	449	43.305199	-88.33709	2.5	S	P		1			1								V																	
451	450	43.305188	-88.336313	2	S	P		2			2																	1									
452	451	43.305109	-88.330878	4.5	S	P		3			1																	V				3					
453	452	43.305097	-88.330102	20	S	R																						1									
454	453	43.305086	-88.329325	26	S	R																															
455	454	43.305075	-88.328549				DEEP																														
456	455	43.305063	-88.327772	23	S	R																															
457	456	43.305052	-88.326996	5	S	P		3			3									1												1					
458	457	43.304677	-88.340211	2	S	P		2			2																										
459	458	43.304666	-88.339435	2.5	S	P		1			1																										
460	459	43.304655	-88.338658	2.5	S	P		1			1																	1				1					

Table B-3 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	Potamogeton crispus , Curly-leaf pondweed	Ceratophyllum demersum , Coontail	Chara sp., Muskgrasses	Heteranthera dubia , Water star-grass	Lemna minor , Small duckweed	Myriophyllum sibiricum , Northern water-milfoil	Najas flexilis , Slender naiad	Najas guadalupensis, Southern naiad	Najas marina , Spiny naiad	Nuphar variegata , Spatterdock	Nymphaea odorata , White water lily	Potamogeton friesii , Fries' pondweed	Potamogeton gramineus , Variable pondweed	Potamogeton illinoensis , Illinois pondweed	Potamogeton natans , Floating-leaf pondweed	Potamogeton richardsonii , Clasping-leaf pondweed	Potamogeton zosteriformis , Flat-stem pondweed	Ranunculus aquatilis , White water crowfoot	Schoenoplectus acutus , Hardstem bulrush	Stuckenia pectinata , Sago pondweed	Stuckenia vaginata, Sheathed pondweed	Utricularia vulgaris , Common bladderwort	Vallisneria americana , Wild celery	Nitellopsis obtusa, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)
461	460	43.304643	-88.337882	2.5	S	P		1		1																						1					
462	461	43.304632	-88.337105	2	S	P		2		2						1												1									
463	462	43.304542	-88.330894	3	S	P		2		2						1												V				1					
464	463	43.30453	-88.330117	5.5	S	P		3		1										1												3					
465	464	43.304519	-88.329341	14	S	R																															
466	465	43.304508	-88.328564	17	S	R		1																								1					
467	466	43.304496	-88.327788	10	S	R		1		1				1																	1	1					
468	467	43.304485	-88.327012	3	S	P		1		1																						3					
469	468	43.304065	-88.337121	3.5	S	P		3		2				1						1								2			1						
470	469	43.303975	-88.330909	2	S	P		2		1							1		V								V	1									
471	470	43.303963	-88.330133	3	S	P		1		1								V									V					1					
472	471	43.303952	-88.329356	3.5	S	P		1		1										1	1																
473	472	43.303941	-88.32858	4	S	P		3		1																						3					
474	473	43.303929	-88.327804	4	S	P		3		2																		2				1					
475	474	43.303487	-88.33636			NONNAVIGABLE SHALLOW																																
476	475	43.303396	-88.330148	2.5	S	P		2		1				1						1												2					
477	476	43.303385	-88.329372	3	S	P		1										V										1				1					
478	477	43.303374	-88.328596	3	S	P		3		2																						2					

Source: Washington County

Table B-4

SUMMARY STATISTICS FOR THE PIKE LAKE POINT-INTERCEPT AQUATIC PLANT SURVEY: JULY 12, 2016

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	**STATS**	Total vegetation	Potamogeton crispus, Curly-leaf pondweed	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Heteranthera dubia, Water star-grass	Lemna minor, Small duckweed	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Najas guadalupensis, Southern naiad	Najas marina, Spiny naiad	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton friesii, Fries' pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton natans, Floating-leaf pondweed	Potamogeton richardsonii, Clasping-leaf pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Ranunculus aquatilis, White water crowfoot	Schoenoplectus acutus, Hardstem bulrush	Stuckenia pectinata, Sago pondweed	Utricularia vulgaris, Common bladderwort	Vallisneria americana, Wild celery	Nitellopsis obtusa, Starry stonewort	Unknown Chara 1	Chara 2 (basket chara)		
2	Lake-Pike Lake																												
3	County-Washington																												
4	WBIC																												
5	Survey Date-08/12/2016																												
6	**INDIVIDUAL SPECIES**																												
7	Frequency of occurrence within vegetated areas (%)		0.70	0.35	85.21	1.41	0.35	1.76	0.70	0.70	17.25		0.35	11.62	4.23	1.06		1.06	0.35	0.70		29.93	1.06	6.34	48.59	2.46	0.35		
8	Frequency of occurrence at sites shallower than maximum depth of plants		0.52	0.26	63.19	1.04	0.26	1.31	0.52	0.52	12.79		0.26	8.62	3.13	0.78		0.78	0.26	0.52		22.19	0.78	4.70	36.03	1.83	0.26		
9	Relative Frequency (%)		0.3	0.2	39.3	0.7	0.2	0.8	0.3	0.3	8.0		0.2	5.4	2.0	0.5		0.5	0.2	0.3		13.8	0.5	2.9	22.4	1.1	0.2		
10	Relative Frequency (squared)	0.24	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.01		0.00	0.00	0.00	0.00		0.00	0.00	0.00		0.02	0.00	0.00	0.05	0.00	0.00		
11	Number of sites where species found		2	1	242	4	1	5	2	2	49		1	33	12	3		3	1	2		85	3	18	138	7	1		
12	Average Rake Fullness	1.58	1.00	1.00	1.31	1.25	1.00	1.00	1.00	1.00	1.02		1.00	1.21	1.00	1.00		1.00	1.00	1.00		1.05	1.00	1.00	1.54	1.00	1.00		
13	#visual sightings											5	6		1	2	1				4	2			1				
14	present (visual or collected)		present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present		
15																													
16	**SUMMARY STATS:**																												
17	Total number of sites visited	383																											
18	Total number of sites with vegetation	284																											
19	Total number of sites shallower than maximum depth of plants	383																											
20	Frequency of occurrence at sites shallower than maximum depth of plants	74.15																											
21	Simpson Diversity Index	0.76																											
22	Maximum depth of plants (ft)**	35.00																											
23	Number of sites sampled using rake on Rope (R)	135																											
24	Number of sites sampled using rake on Pole (P)	249																											
25	Average number of all species per site (shallower than max depth)	1.60																											
26	Average number of all species per site (veg. sites only)	2.17																											
27	Average number of native species per site (shallower than max depth)	1.47																											
28	Average number of native species per site (veg. sites only)	1.99																											
29	Species Richness	22																											
30	Species Richness (including visuals)	25																											
31																													
32	**SEE "MAX DEPTH GRAPH" WORKSHEET TO CONFIRM																												
33																													
34																													

Source: Washington County

Appendix C

2,4-D CHEMICAL FACT SHEET

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2,4-D Chemical Fact Sheet

Formulations

2,4-D is an herbicide that is widely used as a household weed-killer, agricultural herbicide, and aquatic herbicide. It has been in use since 1946, and was registered with the EPA in 1986 and re-reviewed in 2005. The active ingredient is 2,4-dichloro-phenoxyacetic acid. There are two types of 2,4-D used as aquatic herbicides: dimethyl amine salt and butoxyethyl ester. Both liquid and slow-release granular formulations are available. 2,4-D is sold under the trade names Aqua-Kleen, Weedar 64 and Navigate (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

2,4-D is a widely-used herbicide that affects plant cell growth and division. It affects primarily broad-leaf plants. When the treatment occurs, the 2,4-D is absorbed into the plant and moved to the roots, stems, and leaves. Plants begin to die in a few days to a week following treatment, but can take several weeks to decompose. Treatments should be made when plants are growing.

For many years, 2,4-D has been used primarily in small-scale spot treatments. Recently, some studies have found that 2,4-D moves quickly through the water and mixes throughout the waterbody, regardless of where it is applied. Accordingly, 2,4-D has been used in Wisconsin experimentally for whole-lake treatments.

2,4-D is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Desirable native species that may be affected include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.

Post-Treatment Water Use Restrictions

There are no restrictions on eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Following the last registration review in 2005, the ester products require a 24-hour waiting period for swimming. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of 2,4-D (the time it takes for half of the active ingredient to degrade) ranges from 12.9 to 40 days depending on water conditions. In anaerobic lab conditions, the half-life has been measured up to 333 days. After treatment, the 2,4-D concentration in the water is reduced primarily through microbial activity, off-site movement by water, or adsorption to small particles in silty water. It is slower to degrade in cold or acidic water, and appears to be slower to degrade in lakes that have not been treated with 2,4-D previously.

There are several degradation products from 2,4-D: 1,2,4-benzenetriol, 2,4-dichlorophenol, 2,4-dichloroanisole, chlorohydroquinone (CHQ), 4-chlorophenol and volatile organics.

*The Wisconsin Department of Natural Resources provides equal opportunity in its employment, programs, services, and functions under an Affirmative Action Plan. If you have any questions, please write to Equal Opportunity Office, Department of Interior, Washington, D.C. 20240. This publication is available in alternative format (*large print, Braille, audio tape. etc.*) upon request. Please call (608) 267-7694 for more information.*

Impacts on Fish and Other Aquatic Organisms

Toxicity of aquatic 2,4-D products vary depending on whether the formulation is an amine or an ester 2,4-D. The ester formulations are toxic to fish and some important invertebrates such as water fleas (*Daphnia*) and midges at application rates; the amine formulations are not toxic to fish or invertebrates at application rates. Loss of habitat following treatment may cause reductions in populations of invertebrates with either formulation, as with any herbicide treatment. These organisms only recolonize the treated areas as vegetation becomes re-established.

Available data indicate 2,4-D does not accumulate at significant levels in the bodies of fish that have been tested. Although fish that are exposed to 2,4-D will take up some of the chemical, the small amounts that accumulate are eliminated after exposure to 2,4-D ceases.

On an acute basis, 2,4-D is considered moderately to practically nontoxic to birds. 2,4-D is not toxic to amphibians at application rates; effects on reptiles are unknown. Studies have shown some endocrine disruption in amphibians at rates used in lake applications, and DNR is currently funding a study to investigate endocrine disruption in fish at application rates.

As with all chemical herbicide applications it is very important to read and follow all label instructions to prevent adverse environmental impacts.

Human Health

Adverse health effects can be produced by acute and chronic exposure to 2,4-D. Those who mix or apply 2,4-D need to protect their skin and eyes from contact with 2,4-D products to minimize irritation, and avoid inhaling the spray. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with 2,4-D.

Concerns have been raised about exposure to 2,4-D and elevated cancer risk. Some (but not all) epidemiological studies have found 2,4-D associated with a slight increase in risk of non-Hodgkin's lymphoma in high exposure populations (farmers and herbicide applicators). The studies show only a possible association that may be caused by other factors, and do not show that 2,4-D causes cancer. The EPA determined in 2005 that there is not sufficient evidence to classify 2,4-D as a human carcinogen.

The other chronic health concern with 2,4-D is the potential for endocrine disruption. There is some evidence that 2,4-D may have estrogenic activities, and that two of the break-down products of 2,4-D (4-chlorophenol and 2,4-dichloroanisole) may affect male reproductive development. The extent and implications of this are not clear and it is an area of ongoing research.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

DNR PUB-WT-964 2012

Appendix D

DAM INFORMATION AND DISCUSSION OF THE ORIGINAL COURSE OF THE RUBICON RIVER

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Detailed Information for Dam PIKE LAKE

Dam Key Seq No	615	Field File No	66.15
Size	LARGE	NID	662
Popular Name		Former Name	

Location

County	Washington		
Latitude	43.321132	Longitude	-88.334607
Permitted TRS		**Located TRS**	
QQQ:SE QQ:NW Q:NW - Sec:23 T:10N R:18		QQ:NW Q:NW - Sec:23 T:10N R:18	

Contacts

Owner		**Alternate**	
Organization	HARTFORD PIKE LAKE ASSN.	Organization	
Name	John Jung	Name	

Waterbody

Drainage Basin (sq mi)	13.00		
Stream		**Impoundment**	
Local Name	TRIB. RUBICON RIVER	Local Name	PIKE LAKE
Row and Official Name		Row and Official Name	
Navigable?	non-navigable	Size (acres)	522.00
When was navigability determined?		Maximum Depth (ft)	45.00

Regulatory / Inspection

NR 333 Years	EAP:2014 IOM: HYD:2010 STAB: ZONE:		
Auth. Approval Desc	2WP1323	Regulatory Agency	WIDNR
Hazard Rating	Low	Estimated Hazard Rating	Low
Ferc. No		Exempt Issue Date	
Ferc. Inspection Year		License Expiration Year	

Construction Characteristics

Normal Storage (acre-ft)	1,040.00	Max Storage (acre-ft)	5,740.00
Structural Height (ft)	12.00	Hydraulic Height (ft)	2.00
Crest Length (ft)	200.00	Spillway Type	C
Discharge Through Principal Spillway (cfs)	617.00	Width/Diameter of Principal Spillway (ft)	10.00
Total Discharge Through All Spillways (cfs)	617.00	Total Width/Diameter of All Spillways (ft)	
Core Type		Position	
Foundation Type		Foundation Certainty	
Purposes	R	Structural Types	PG RE

BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Petition of the City of Hartford, Washington County, for an Order Regulating the Flow of Water From Pike Lake into the Rubicon River	))))	2-WP-1323

FINDINGS OF FACT AND ORDER

The city of Hartford filed a petition with the Commission on September 10, 1958 for an order regulating the flow of water from Pike Lake into the Rubicon River. Order issued.

Pursuant to due notice hearing was held on October 15, 1958 and an adjournment thereof on February 2, 1959 at Hartford before Examiner Maurice H. Van Susteren.

Appearances:

City of Hartford by

Arthur C. Snyder, city attorney
Hartford

In Support of the Petition:

National Dairy Products Corporation by

John H. Hoglund, attorney
Chicago, Illinois

Eugene Boudry
Bruce Boudry
Joyce Iussig, property owners, by

John B. McCarthy, attorney (Oct. 15, 1958)
West Bend

West Bend Aluminum Company by

John McCollow, attorney (Feb. 2, 1959)
West Bend

Appendix E

SEWRPC RIPARIAN BUFFER GUIDE NO. 1
"MANAGING THE WATER'S EDGE"

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Managing the Water's Edge

Making Natural Connections

Problem Statement:

Despite significant research related to buffers, there remains no consensus as to what constitutes optimal riparian buffer design or proper buffer width for effective pollutant removal, water quality protection, prevention of channel erosion, provision of fish and wildlife habitat, enhancement of environmental corridors, augmentation of stream baseflow, and water temperature moderation.

Southeastern Wisconsin Regional Planning Commission

Our purpose in this document is to help protect and restore water quality, wildlife, recreational opportunities, and scenic beauty.

This material was prepared in part with funding from the U.S. Environmental Protection Agency Great Lakes National Program Office provided through CMAP, the Chicago Metropolitan Agency for Planning.

Introduction

Perhaps no part of the landscape offers more variety and valuable functions than the natural areas bordering our streams and other waters.

These unique "riparian corridor" lands help filter pollutants from runoff, lessen downstream flooding, and maintain stream baseflows, among other benefits. Their rich ecological diversity also provides a variety of recreational opportunities and habitat for fish and wildlife. Regardless of how small a stream, lake, or wetland may be, adjacent corridor lands are important to those water features and to the environment.

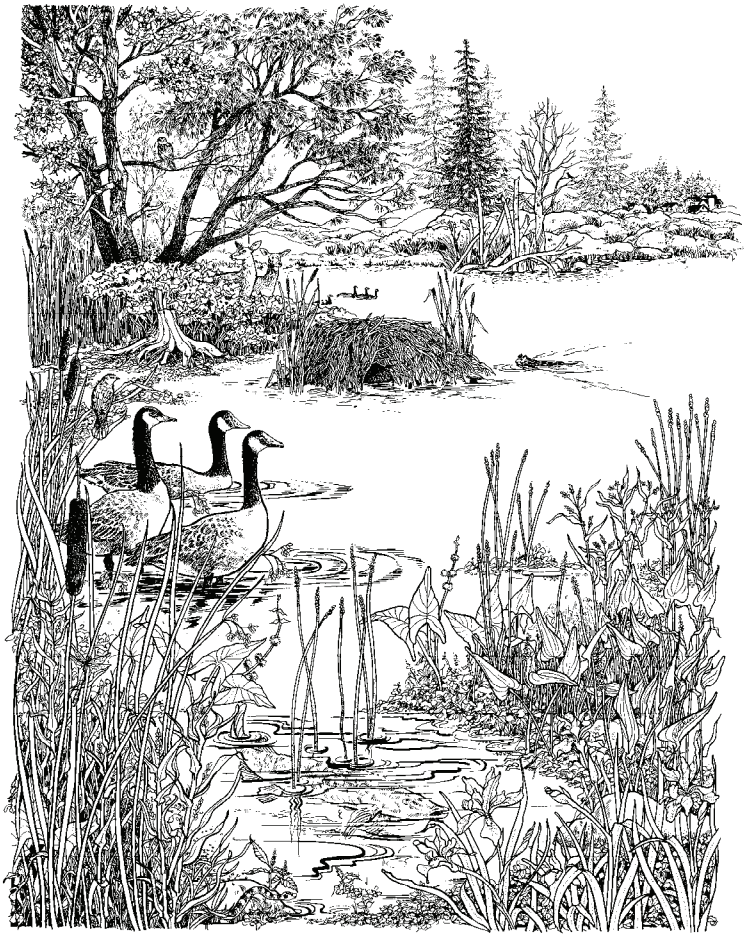
Along many of our waters, the riparian corridors no longer fulfill their potential due to the encroachment of agriculture and urban development. This publication describes common problems encountered along streamside and other riparian corridors, and the many benefits realized when these areas are protected or improved. It also explains what landowners, local governments, and other decision-makers can do to capitalize on waterfront opportunities, and identifies some of the resources available for further information. While much of the research examined here focuses on stream corridors, the ideas presented also apply to areas bordering lakes, ponds, and wetlands throughout the southern Lake Michigan area and beyond. This document was developed as a means to facilitate and communicate important and up-to-date general concepts related to riparian buffer technologies.

Riparian corridors are unique ecosystems that are exceptionally rich in biodiversity

Contents

What Are Riparian Corridors? Riparian Buffer Zones?

The word riparian comes from the Latin word *ripa*, which means bank. However, in this document we use riparian in a much broader sense and refer to land adjoining any water body including ponds, lakes, streams, and wetlands. This term has two additional distinct meanings that refer to 1) the "natural or relatively undisturbed" corridor lands adjacent to a water body inclusive of both wetland and upland flora and fauna and 2) a buffer zone or corridor lands in need of protection to "buffer" the effects of human impacts such as agriculture and residential development.

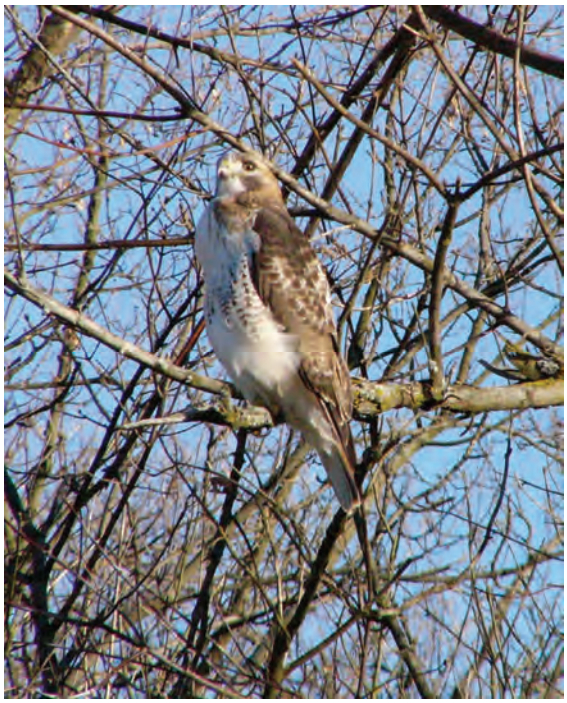


University of Wisconsin—Extension

The word buffer literally means something that cushions against the shock of something else (noun), or to lessen or cushion that shock (verb). Other useful definitions reveal that a buffer can be something that serves to separate features, or that is capable of neutralizing something, like filtering pollutants from stormwater runoff. Essentially, buffers and buffering help protect against adverse effects.

Riparian buffer zones function as core habitat as well as travel corridors for many wildlife species.

Riparian buffers are zones adjacent to waterbodies such as lakes, rivers, and wetlands that simultaneously protect water quality and wildlife, including both aquatic and terrestrial habitat. These zones minimize the impacts of human activities on the landscape and contribute to recreation, aesthetics, and quality of life. **This document summarizes how to maximize both water quality protection and conservation of aquatic and terrestrial wildlife populations using buffers.**

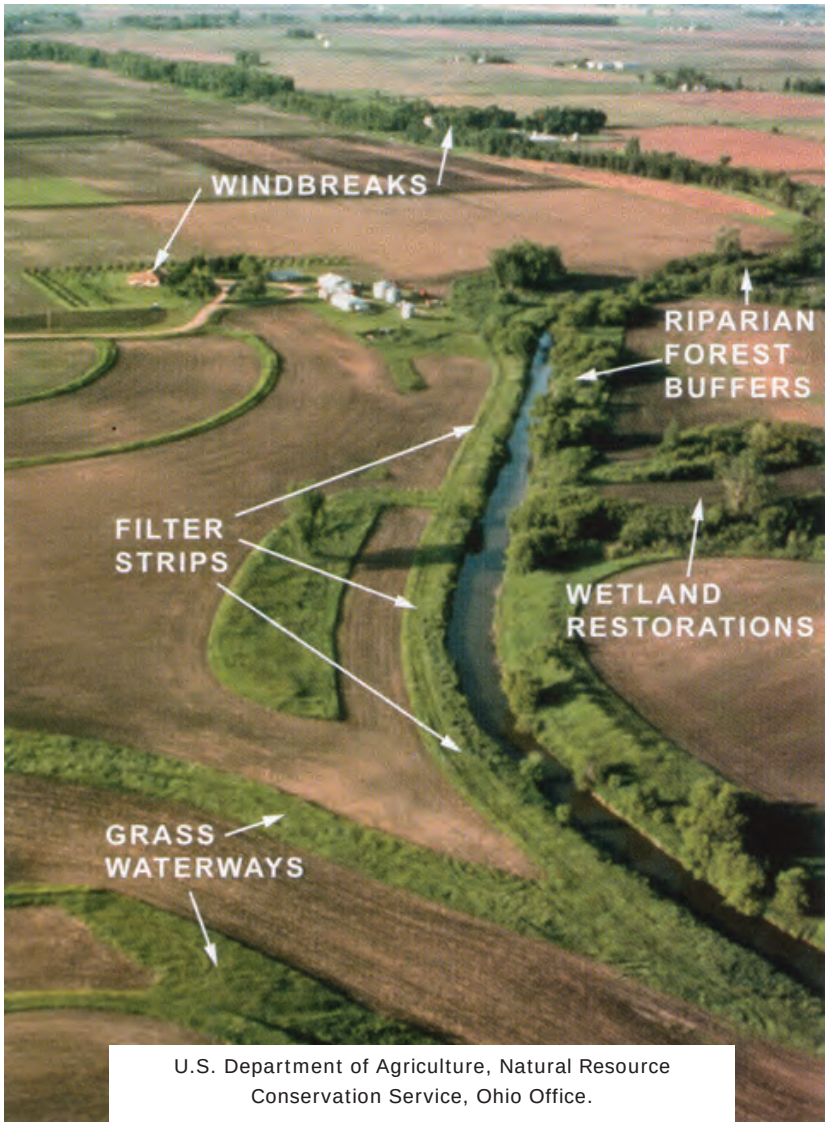


What Are Riparian Corridors? Riparian Buffer Zones?

Buffers **can** include a range of complex vegetation structure, soils, food sources, cover, and water features that offer a variety of habitats contributing to diversity and abundance of wildlife such as mammals, frogs, amphibians, insects, and birds. Buffers can consist of a variety of canopy layers and cover types including ephemeral (temporary-wet for only part of year) wetlands/seasonal ponds/spring pools, shallow marshes, deep marshes, wetland meadows, wetland mixed forests, grasslands, shrubs, forests, and/or prairies. Riparian zones are areas of transition between aquatic and terrestrial ecosystems, and they can potentially offer numerous benefits to wildlife and people such as pollution reduction and recreation.

In the water resources literature, riparian buffers are referred to in a number of different ways. Depending on the focus and the intended function of a buffer, or a buffer-related feature, buffers may be referred to as stream corridors, critical transition zones, riparian management areas, riparian management zones, floodplains, or green infrastructure.

It is important to note that within an agricultural context, the term buffer is used more generally to describe filtering best management practices most often at the water's edge. Other practices which can be interrelated may also sometimes be called buffers. These include grassed waterways, contour buffer strips, wind breaks, field border, shelterbelts, windbreaks, living snow fence, or filter strips. These practices may or may not be adjacent to a waterway as illustrated in the photo to the right. For example, a grassed waterway is designed to filter sediment and reduce erosion and may connect to a riparian buffer. These more limited-purpose practices may link to multipurpose buffers, but by themselves, they are not adequate to provide the multiple functions of a riparian buffer as defined here.



U.S. Department of Agriculture, Natural Resource Conservation Service, Ohio Office.

Beyond the Environmental Corridor Concept

The term "environmental corridors" (also known as "green infrastructure") refers to an interconnected green space network of natural areas and features, public lands, and other open spaces that provide natural resource value. Environmental corridor planning is a process that promotes a systematic and strategic approach to land conservation and encourages land use planning and practices that are good for both nature and people. It provides a framework to guide future growth, land development, and land conservation decisions in appropriate areas to protect both community and natural resource assets.

Environmental corridors are an essential planning tool for protecting the most important remaining natural resource features in Southeastern Wisconsin and elsewhere. Since development of the environmental corridor concept, there have been significant advancements in landscape ecology that have furthered understanding of the spatial and habitat needs of multiple groups of organisms. In addition, advancements in pollutant removal practices, stormwater control, and agriculture have increased our understanding of the effectiveness and limitations of environmental corridors. In protecting water quality and providing aquatic and terrestrial habitat, there is a need to better integrate new technologies through their application within riparian buffers.

SEWRPC has embraced and applied the environmental corridor concept developed by Philip Lewis (Professor Emeritus of Landscape Architecture at the University of Wisconsin-Madison) since 1966 with the publication of its first regional land use plan. Since then, SEWRPC has refined and detailed the mapping of environmental corridors, enabling the corridors to be incorporated directly into regional, county, and community plans and to be reflected in regulatory measures. The preservation of environmental corridors remains one of the most important recommendations of the regional plan. Corridor preservation has now been embraced by numerous county and local units of government as well as by State and Federal agencies. The environmental corridor concept conceived by Lewis has become an important part of the planning and development culture in Southeastern Wisconsin.

Beyond the Environmental Corridor Concept

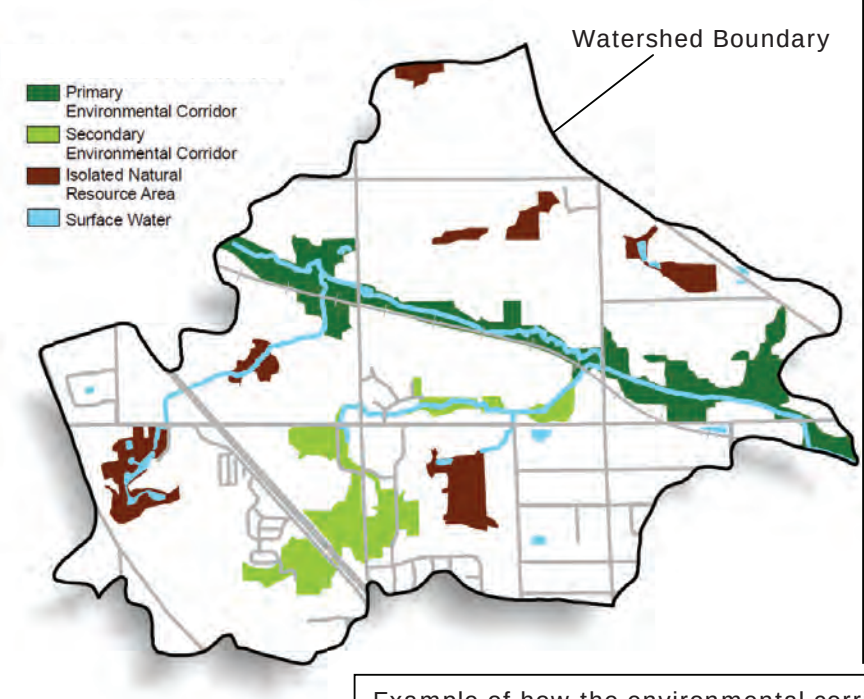
Environmental corridors are divided into the following three categories.

- **Primary environmental corridors** contain concentrations of our most significant natural resources. They are at least 400 acres in size, at least two miles long, and at least 200 feet wide.
- **Secondary environmental corridors** contain significant but smaller concentrations of natural resources. They are at least 100 acres in size and at least one mile long, unless serving to link primary corridors.
- **Isolated natural resource areas** contain significant remaining resources that are not connected to environmental corridors. They are at least five acres in size and at least 200 feet wide.

Key Features of Environmental Corridors

- Lakes, rivers, and streams
- Undeveloped shorelands and floodlands
- Wetlands
- Woodlands
- Prairie remnants
- Wildlife habitat
- Rugged terrain and steep slopes
- Unique landforms or geological formations
- Unfarmed poorly drained and organic soils
- Existing outdoor recreation sites
- Potential outdoor recreation sites
- Significant open spaces
- Historical sites and structures
- Outstanding scenic areas and vistas

Beyond the Environmental Corridor Concept

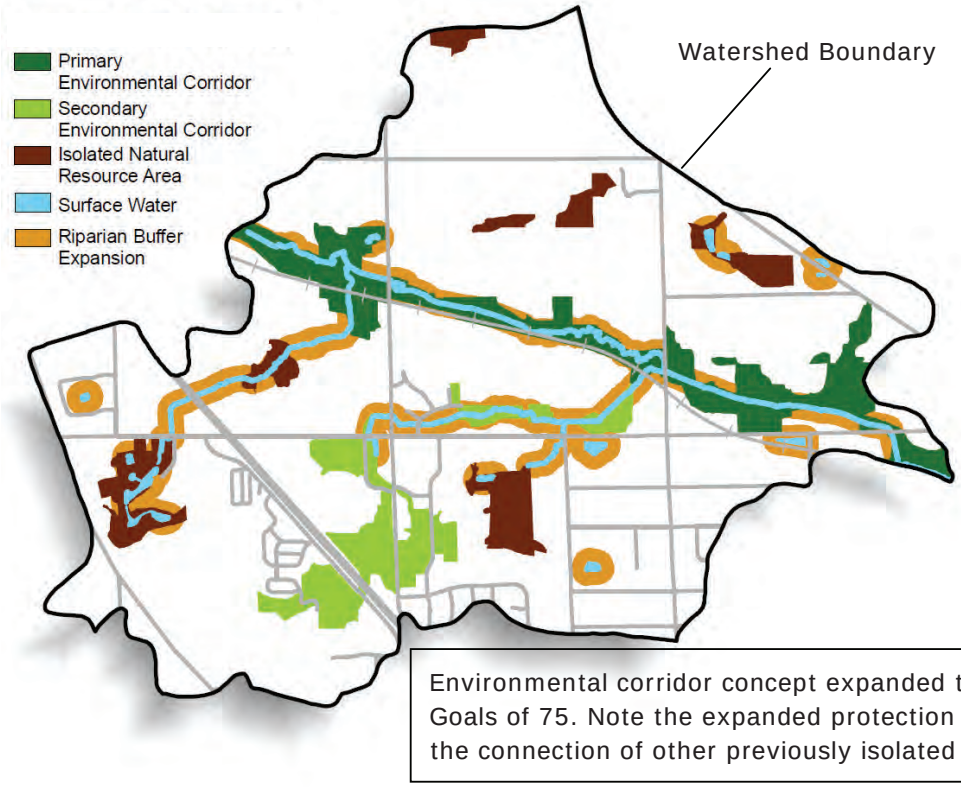


The Minimum Goals of **75** within a Watershed

75% minimum of total stream length should be naturally vegetated to protect the functional integrity of the water resources. (Environment Canada, How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great lakes Areas of Concern, Second Edition, 2004)

75 foot wide minimum riparian buffers from the top edge of each stream bank should be naturally vegetated to protect water quality and wildlife. (SEWRPC Planning Report No 50, A Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, December 2007)

Example of how the environmental corridor concept is applied on the landscape. For more information see "Plan on It!" series **Environmental Corridors: Lifelines of the Natural Resource Base** at http://www.sewrpc.org/SEWRPC/LandUse/EnvironmentalCorridors.htm



Environmental corridor concept expanded to achieve the Goals of 75. Note the expanded protection in addition to the connection of other previously isolated areas.

Habitat Fragmentation—The Need for Corridors

Southeastern Wisconsin is a complex mosaic of agricultural and urban development. Agricultural lands originally dominated the landscape and remain a major land use. However, such lands continue to be converted to urban uses. Both of these dominant land uses fragment the landscape by creating islands or isolated pockets of wetland, woodland, and other natural lands available for wildlife preservation and recreation. By recognizing this fragmentation of the landscape, we can begin to mitigate these impacts.

New developments should incorporate water quality and wildlife enhancement or improvement objectives as design criteria by looking at the potential for creating linkages with adjoining lands and water features.

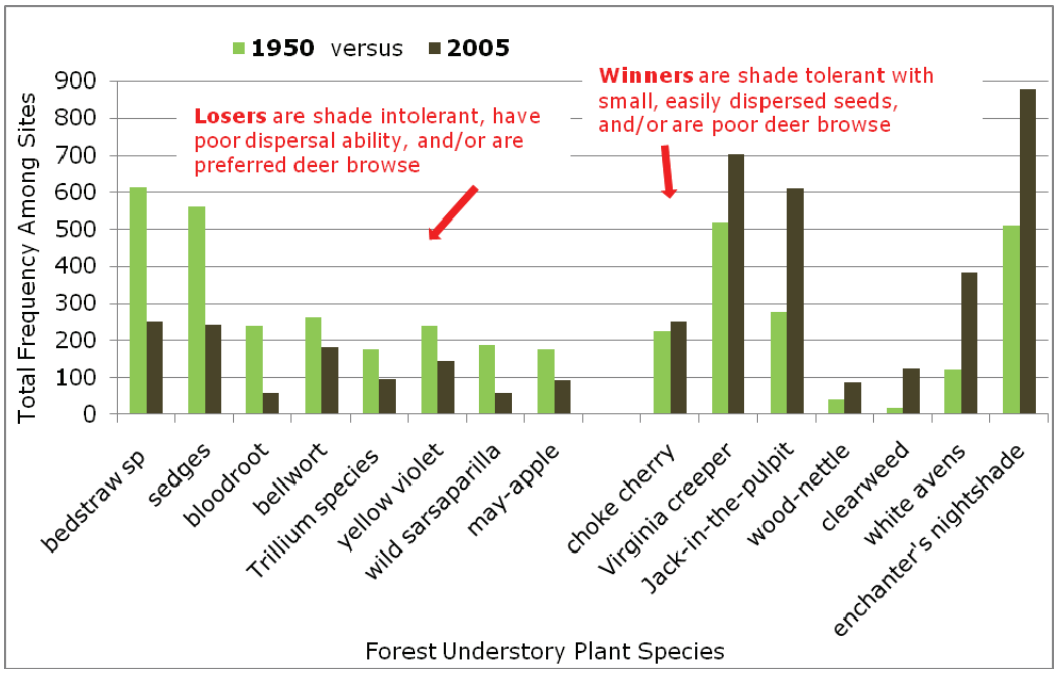
At the time of conversion of agricultural lands to urban uses, there are opportunities to re-create and expand riparian buffers and environmental corridors reconnecting uplands and waterways and restoring ecological integrity and scenic beauty locally and regionally. For example, placement of roads and other infrastructure across stream systems could be limited so as to maximize continuity of the riparian buffers. This can translate into significant cost savings in terms of reduced road maintenance, reduced salt application, and limited bridge or culvert maintenance and replacements. This simple practice not only saves the community significant amounts of money, but also improves and protects quality of life. Where necessary road crossings do occur, they can be designed to provide for safe fish and wildlife passage.

Overland travel routes for wildlife are often unavailable, discontinuous, or life endangering within the highly fragmented landscapes of Southeastern Wisconsin and elsewhere.

State Threatened Species: Blanding's turtle

Habitat Fragmentation—The Need for Corridors

Forest understory plant species abundance among stands throughout Southern Wisconsin



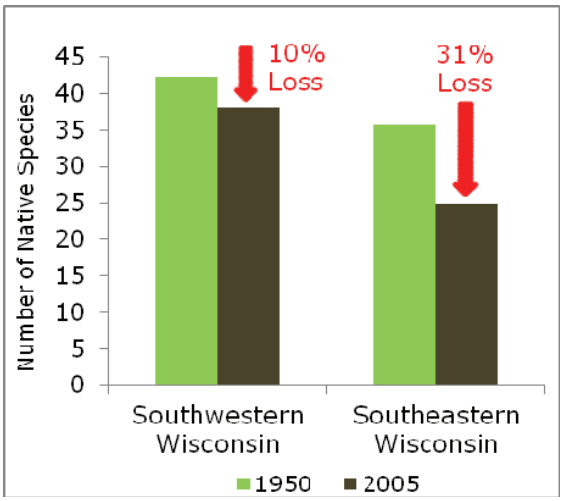
Forest fragmentation has led to significant plant species loss within Southern Wisconsin

(Adapted from David Rogers and others, 2008, Shifts in Southern Wisconsin Forest Canopy and Understory Richness, Composition, and Heterogeneity, Ecology, 89 (9): 2482-2492)

"...these results confirm the idea that large intact habitat patches and landscapes better sustain native species diversity. It also shows that people are a really important part of the system and their actions play an increasingly important role in shaping patterns of native species diversity and community composition. Put together, it is clear that one of the best and most cost effective actions we can take toward safeguarding native diversity of all types is to protect, enhance and create corridors that link patches of natural habitat."
Dr. David Rogers, Professor of Biology at the University of Wisconsin-Parkside

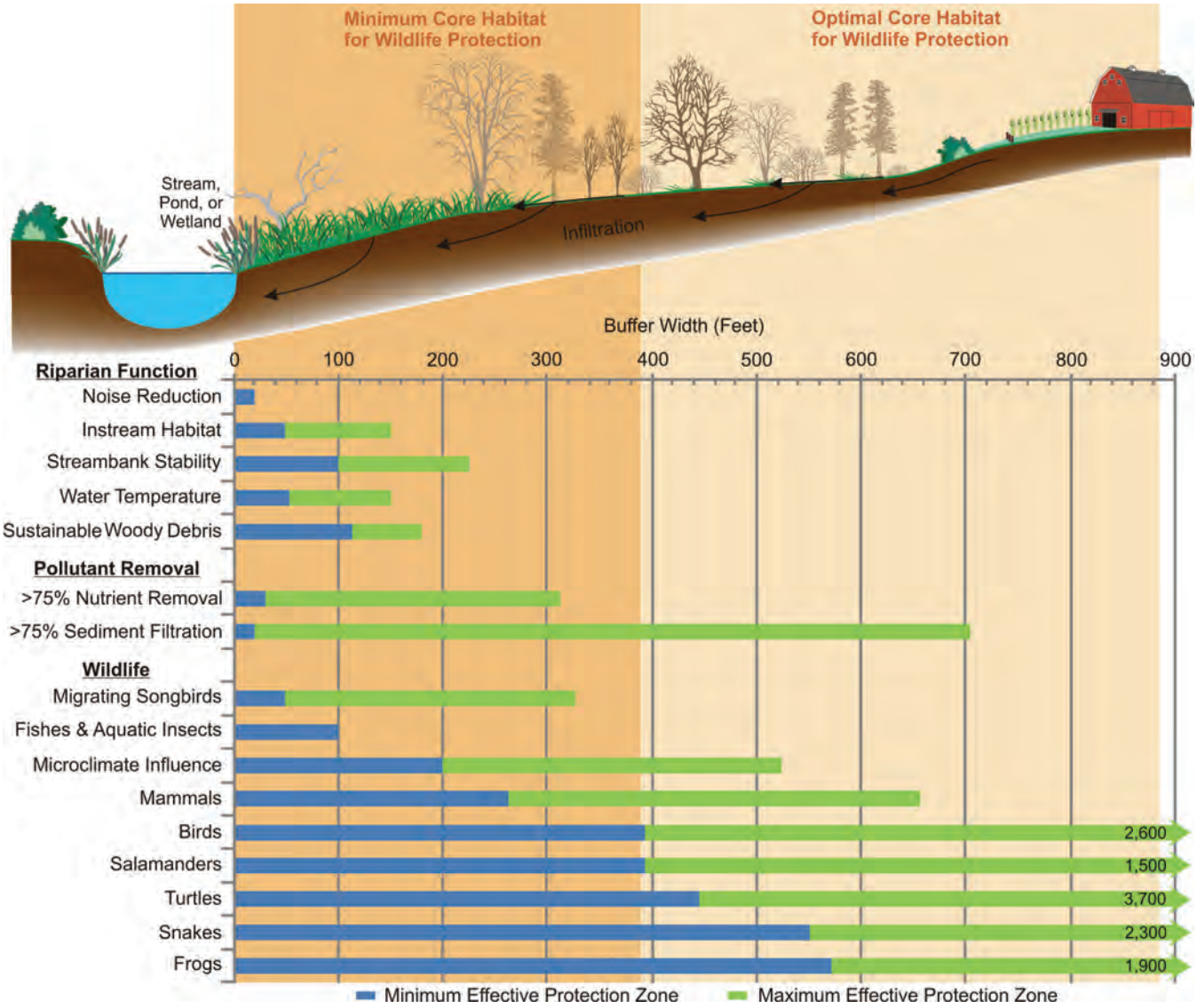
Since the 1950s, forests have increasingly become more fragmented by land development, both agricultural and urban, and associated roads and infrastructure, which have caused these forests to become isolated "islands of green" on the landscape. In particular, there has been significant loss of forest understory plant species over time (shrubs, grasses, and herbs covering the forest floor.) It is important to note that **these forests lost species diversity even when they were protected as parks or natural areas**.

One major factor responsible for this decline in forest plant diversity is that routes for native plants to re-colonize isolated forest islands are largely cut-off within fragmented landscapes. For example, the less fragmented landscapes in Southwestern Wisconsin lost fewer species than the more fragmented stands in Southeastern Wisconsin. In addition, the larger-sized forests and forests with greater connections to surrounding forest lands lost fewer species than smaller forests in fragmented landscapes.



Wider is Better for Wildlife

Why? Because buffer size is the engine that drives important natural functions like food availability and quality, access to water, habitat variety, protection from predators, reproductive or resting areas, corridors to safely move when necessary, and help in maintaining the health of species' gene pools to prevent isolation and perhaps extinction.



One riparian buffer size does not fit all conditions or needs. There are many riparian buffer functions and the ability to effectively fulfill those functions is largely dependent on width. Determining what buffer widths are needed should be based on what functions are desired as well as site conditions. For example, as shown above, water temperature protection generally does not require as wide a buffer as provision of habitat for wildlife. Based on the needs of wildlife species found in Wisconsin, the minimum core habitat buffer width is about 400 feet and the optimal width for sustaining the majority of wildlife species is about 900 feet. Hence, the value of large undisturbed parcels along waterways which are part of, and linked to, an environmental corridor system. The minimum effective buffer width distances are based on data reported in the scientific literature and the quality of available habitats within the context of those studies.

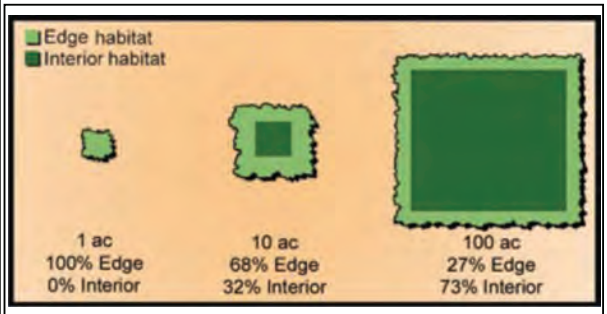
Wider is Better for Wildlife

Wildlife habitat needs change within and among species. **Minimum Core Habitat and Optimum Core Habitat distances were developed from numerous studies to help provide guidance for biologically meaningful buffers to conserve wildlife biodiversity.** These studies documented distances needed for a variety of biological (life history) needs to sustain healthy populations such as breeding, nesting, rearing young, foraging/feeding, perching (for birds), basking (for turtles), and overwintering/dormancy/hibernating. These life history needs require different types of habitat and distances from water, for example, one study found that Blanding's turtles needed approximately 60-foot-wide buffers for basking, 375 feet for overwintering, and up to 1,200 feet for nesting to bury their clutches of eggs. Some species of birds like the Blacked-capped chickadee or white breasted nuthatch only need about 50 feet of buffer, while others like the wood duck or great blue heron require 700-800 feet for nesting. Therefore, **understanding habitat needs for wildlife species is an important consideration in designing riparian buffers.**

Although *Ambystoma* salamanders require standing water for egg laying and juvenile development, most other times of the year they can be found more than 400 feet from water foraging for food.

Wisconsin Species	Mimimum Core Habitat (feet)	Optimum Core Habitat (feet)	Number of Studies
Frogs	571	1,043	9
Salamanders	394	705	14
Snakes	551	997	5
Turtles	446	889	27
Birds	394	787	45
Mammals	263	No data	11
Fishes and Aquatic Insects	100	No data	11
Mean	388	885	

This approach was adapted from *R.D. Semlitsch and J.R. Bodie, 2003, Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibian and Reptiles, Conservation Biology, 17(5):1219-1228*. These values are based upon studies examining species found in Wisconsin and represent mean linear distances extending outward from the edge of an aquatic habitat. The Minimum Core Habitat and Optimum Core Habitat reported values are based upon the mean minimum and mean maximum distances recorded, respectively. Due to a low number of studies for snake species, the recommended distances for snakes are based upon values reported by *Semlitsch and Bodie.*

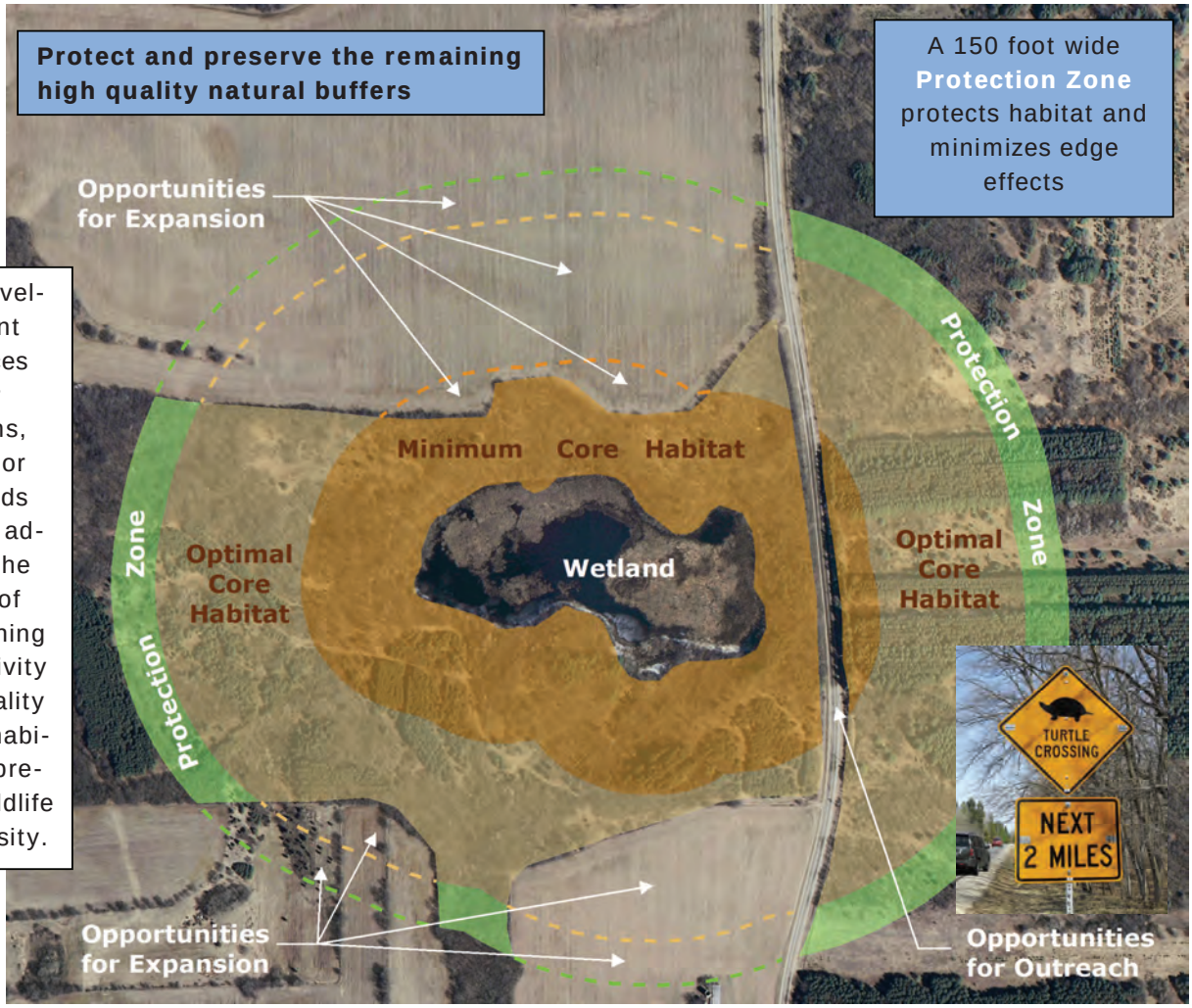


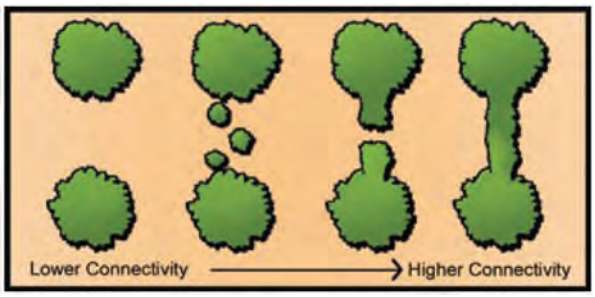
"***Large patches typically conserve a greater variety and quality of habitats, resulting in higher species diversity and abundance.***" *Larger patches contain greater amounts of interior habitat and less edge effects, which benefits interior species, by providing safety from parasitism, disease, and invasive species.*
(Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station)

Maintaining Connections is Key

Like humans, all forms of wildlife require access to clean water. Emerging research has increasingly shown that, in addition to water, more and more species such as amphibians and reptiles cannot persist without landscape connectivity between quality wetland and upland habitats. Good connectivity to upland terrestrial habitats is essential for the persistence of healthy sustainable populations, because these areas provide vital feeding, overwintering, and nesting habitats found nowhere else. Therefore, both aquatic and terrestrial habitats are essential for the preservation of biodiversity and they should ideally be managed together as a unit.

Land development practices near streams, lakes, or wetlands need to address the issue of maintaining connectivity with quality upland habitats to preserve wildlife biodiversity.

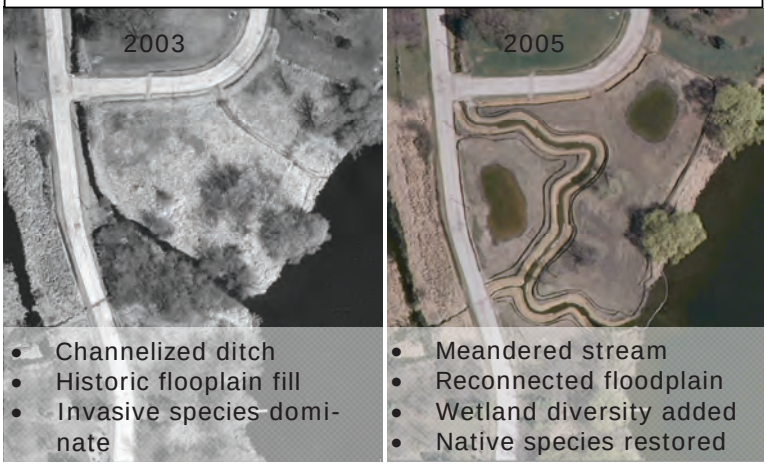




Increasing connectivity among quality natural landscapes (wetlands, woodlands, prairies) can benefit biodiversity by providing access to other areas of habitat, increasing gene flow and population viability, enabling recolonization of patches, and providing habitat (Bentrup 2008).

Basic Rules to Better Buffers

There are opportunities to improve buffer functions to improve water quality and wildlife habitat, even in urban situations



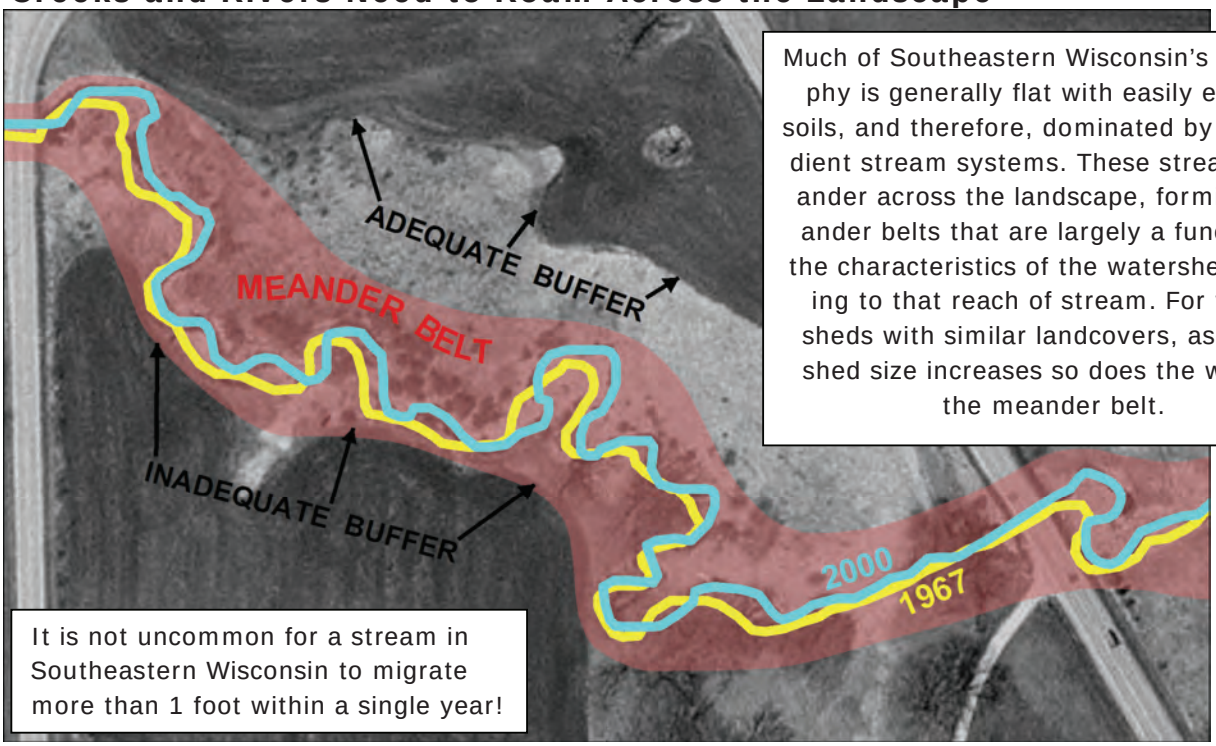
Protecting the integrity of native species in the region is an objective shared by many communities. The natural environment is an essential component of our existence and contributes to defining our communities and neighborhoods. Conservation design and open space development patterns in urbanizing areas and farm conservation programs in rural areas have begun to address the importance of maintaining and restoring riparian buffers and connectivity among corridors.

How wide should the buffer be? Unfortunately, there is no one-size-fits all buffer width adequate to protect water quality, wildlife habitat, and human needs. Therefore, the answer to this question depends upon the predetermined needs of the landowner and community objectives or goals.
As riparian corridors become very wide, their pollutant removal (buffering) effectiveness may reach a point of diminishing returns compared to the investment involved. However, the prospects for species diversity in the corridor keep increasing with buffer width. For a number of reasons, 400- to 800-foot-wide buffers are not practical along all lakes, streams, and wetlands within Southeastern Wisconsin. Therefore, communities should develop guidelines that remain flexible to site-specific needs to achieve the most benefits for water resources and wildlife as is practical.

Key considerations to better buffers/corridors:

- Wider buffers are better than narrow buffers for water quality and wildlife functions
- Continuous corridors are better than fragmented corridors for wildlife
- Natural linkages should be maintained or restored
- Linkages should not stop at political boundaries
- Two or more corridor linkages are better than one
- Structurally diverse corridors (e.g., diverse plant structure or community types, upland and wetland complexes, soil types, topography, and surficial geology) are better than corridors with simple structures
- Both local and regional spatial and temporal scales should be considered in establishing buffers
- Corridors should be located along dispersal and migration routes
- Corridors should be located and expanded around rare, threatened, or endangered species
- Quality habitat should be provided in a buffer whenever possible
- Disturbance (e.g. excavation or clear cutting vegetation) of corridors should be minimized during adjacent land use development
- Native species diversity should be promoted through plantings and active management
- Non-native species invasions should be actively managed by applying practices to preserve native species
- Fragmentation of corridors should be reduced by limiting the number of crossings of a creek or river where appropriate
- Restoration or rehabilitation of hydrological function, streambank stability, instream habitat, and/or floodplain connectivity should be considered within corridors.
- Restoration or retrofitting of road and railway crossings promotes passage of aquatic organisms

Creeks and Rivers Need to Roam Across the Landscape



Much of Southeastern Wisconsin's topography is generally flat with easily erodible soils, and therefore, dominated by low gradient stream systems. These streams meander across the landscape, forming meander belts that are largely a function of the characteristics of the watershed draining to that reach of stream. For watersheds with similar landcovers, as watershed size increases so does the width of the meander belt.

It is not uncommon for a stream in Southeastern Wisconsin to migrate more than 1 foot within a single year!

Healthy streams naturally meander or migrate across a landscape over time. Streams are transport systems for water and sediment and are continually eroding and depositing sediments, which causes the stream to migrate. When the amount of sediment load coming into a stream is equal to what is being transported downstream—and stream widths, depths, and length remain consistent over time—it is common to refer to that stream as being in a state of **"dynamic equilibrium."** In other words the stream retains its physical dimensions (equilibrium), but those physical features are shifted, or migrate, over time (dynamic).

Room to Roam

Riparian buffer widths should take into account the amount of area that a stream needs to be able to self-adjust and maintain itself in a state of dynamic equilibrium. … These are generally greater than any minimum width needed to protect for pollutant removal alone.

Streams are highly sensitive, and they respond to changes in the amounts of water and sediment draining to them, which are affected by changing land use conditions. For example, streams can respond to increased discharges of water by increased scour (erosion) of bed and banks that leads to an increase in stream width and depth—or "degradation." Conversely, streams can respond to increased sedimentation (deposition) that leads to a decrease in channel width and depth—or "aggradation."

Why Should You Care About Buffers?

Economic Benefits:

- Increased value of riparian property
- Reduced lawn mowing time and expense
- Increased shade to reduce building cooling costs
- Natural flood mitigation protection for structures or crops
- Pollution mitigation (reduced nutrient and contaminant loading)
- Increased infiltration and groundwater recharge
- Prevented loss of property (land or structures) through erosion
- Greater human and ecological health through biodiversity

Recreational Benefits:

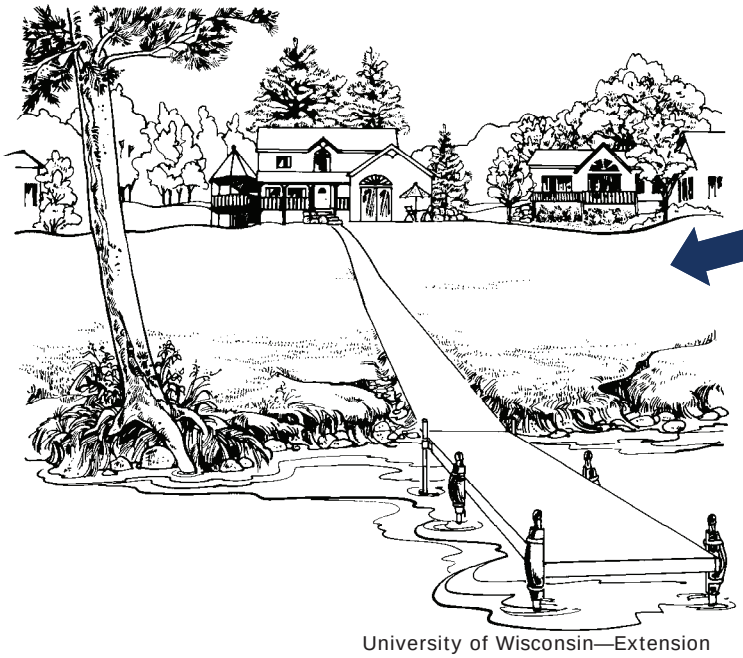
- Increased quality of the canoeing/kayaking experience
- Improved fishing and hunting quality by improving habitat
- Improved bird watching/wildlife viewing quality and opportunities
- Increased potential for expansion of trails for hiking and bicycling
- Opportunities made available for youth and others to locally reconnect with nature

Riparian buffers make sense and are profitable monetarily, recreationally, and aesthetically!

Social Benefits:

- Increased privacy
- Educational opportunities for outdoor awareness
- Improved quality of life at home and work
- Preserved open space/balanced character of a community
- Focal point for community pride and group activities
- Visual diversity
- Noise reduction

A Matter of Balance



University of Wisconsin—Extension

Although neatly trimmed grass lawns are popular, these offer limited benefits for water quality or wildlife habitat. A single house near a waterbody may not seem like a "big deal," but the cumulative effects of many houses can negatively impact streams, lakes, and wetlands.

All the lands within Southeastern Wisconsin ultimately flow into either the Mississippi River or the Great Lakes systems. The cumulative effects of agriculture and urban development in the absence of mitigative measures, ultimately affects water quality in those systems. Much of this development causes increases in water runoff from the land into wetlands, ponds, and streams. This runoff transports water, sediments, nutrients, and other pollutants into our waterways that can lead to a number of problems, including flooding that can cause crop loss or building damage; unsightly and/or toxic algae blooms; increased turbidity; damage to aquatic organisms from reduced dissolved oxygen, lethal temperatures, and/or concentrations of pollutants; and loss of habitat.

Riparian buffers are one of the most effective tools available for defending our waterways. Riparian buffers can be best thought of as forming a living, self-sustainable protective shield. This shield protects investments in the land and all things on it as well as our quality of life locally, regionally, and, ultimately, nationally. Combined with stormwater management, environmentally friendly yard care, effective wastewater treatment, conservation farming methods, and appropriate use of fertilizers and other agrichemicals, **riparian buffers complete the set of actions that we can take to minimize impacts to our shared water resources.**

Lakeshore buffers can take many forms, which require a balancing act between lake viewing, access, and scenic beauty. Lakeshore buffers can be integrated into a landscaping design that complements both the structural development and a lakeside lifestyle. Judicious placement of access ways and shoreline protection structures, and preservation or reestablishment of native vegetation, can enhance and sustain our use of the environment.

University of Wisconsin—Extension

Case Study—Agricultural Buffers

Agricultural nonpoint source pollution runoff continues to pose a threat to water quality and aquatic ecosystems within Wisconsin and elsewhere. In an effort to address this problem, the Wisconsin Buffer Initiative was formed with the goal of designing a buffer implementation program to achieve science-based, cost-effective, water quality improvements (report available online at http://www.soils.wisc.edu/extension/nonpoint/wbi.php).

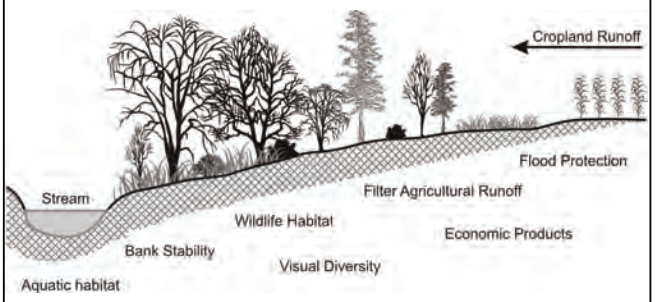
Challenge:
Buffers may take land out of cultivated crop production and require additional cost to install and maintain. Cost sharing, paid easements, and purchase of easements or development rights may sometimes be available to offset costs.

Benefits:
Buffers may offset costs by producing perennial crops such as hay, lumber, fiber, nuts, fruits, and berries. In addition, they provide visual diversity on the landscape, help maintain long-term crop productivity, and help support healthier fish populations for local enjoyment.

While it is true that riparian buffers alone may not always be able to reduce nutrient and sediment loading from agricultural lands, WBI researchers found that "...***riparian buffers are capable of reducing large percentages of the phosphorus and sediment that are currently being carried by Wisconsin streams. Even in watersheds with extremely high loads (top 10%), an average of about 70% of the sediment and phosphorus can be reduced through buffer implementation***." (*Diebel, M.J. and others, 2009, Landscape planning for agricultural nonpoint source pollution reduction III: Assessing Phosphorus and sediment reduction potential, Environmental Management, 43:69-83.*).

Federal and state natural resource agencies have long recognized the need to apply a wide range of Best Management Practices on agricultural lands to improve stream water quality. Although there are many tools available in the toolbox to reduce pollutant runoff from agricultural lands, such as crop rotations, nutrient and manure management, conservation tillage, and contour plowing, riparian buffers are one of the most effective tools to accomplish this task. Their multiple benefits and inter-connectedness from upstream to downstream make riparian buffers a choice with watershed-wide benefits.

Determine what benefits are needed.



The USDA in *Agroforestry Notes* (AF Note-4, January 1997) outlines a four step process for designing riparian buffers for Agricultural lands:

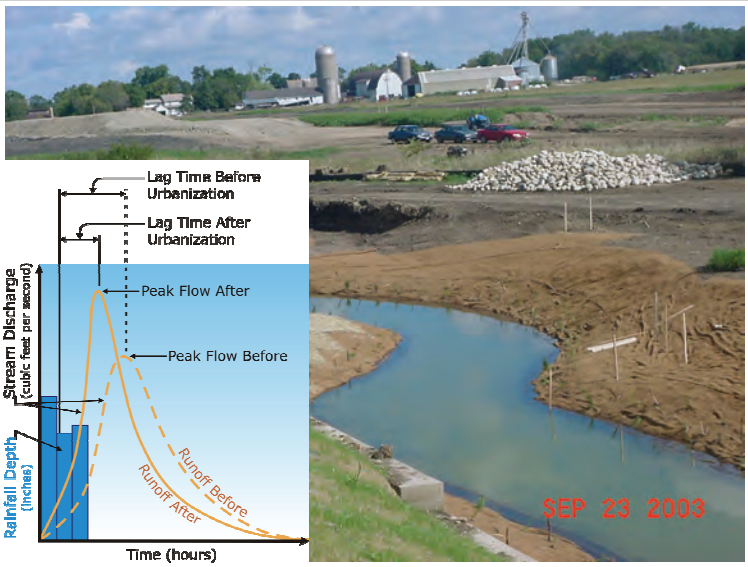
1-Determine what buffers functions are needed
2-Identify the best types of vegetation to provide the needed benefits
3-Determine the minimum acceptable buffer width to achieve desired benefits
4-Develop an installation and maintenance plan

Drain tiles can bypass infiltration and filtration of pollutants by providing a direct pathway to the water and "around" a buffer. This is important to consider in design of a buffer system which integrates with other agricultural practices.

Case Study—Urbanizing Area Buffers

When development occurs near a waterbody, the area in driveways, rooftops, sidewalks, and lawns increases, while native plants and undisturbed soils decrease. As a result, the ability of the shoreland area to perform its natural functions (flood control, pollutant removal, wildlife habitat, and aesthetic beauty) is decreased. In the absence of mitigating measures, one the consequences of urban development is an increase in the amount of stormwater, which runs off the land instead of infiltrating into the ground. Therefore, **urbanization impacts the watershed, not only by reducing groundwater recharge, but also by changing stream hydrology** through increased stormwater runoff volumes and peak flows. This means less water is available to sustain the baseflow regime. The urban environment also contains increased numbers of pollutants and generates greater pollutant concentrations and loads than any other land use. This reflects the higher density of the human population and associated activities, which demand measures to protect the urban water system.

Mitigation of urban impacts may be as simple as not mowing along a stream corridor or changing land management and yard care practices, or as complex as changing zoning ordinances or widening riparian corridors through buyouts.

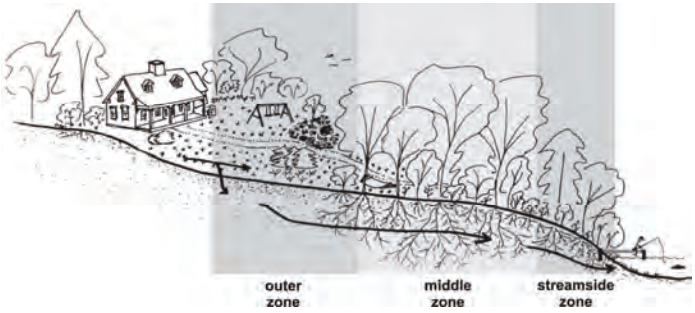


Comparison of hydrographs before and after urbanization. Note the rapid runoff and greater peak streamflow tied to watershed development. (Adapted from Federal Interagency Stream Restoration Working Group (FISRWG), Stream Corridor Restoration: Principles, Processes, and Practices, October 1998)

Challenge:
Urban development requires balancing flood protection, water quality protection, and the economic viability of the development.

Opportunities:
Buffers may offset costs by providing adequate space for providing long-term water quantity and water quality protection. In addition, they provide visual diversity on the landscape, wildlife habitat and connectedness, and help maintain property values.

Anatomy of an urban riparian buffer



The most effective urban buffers have three zones:

Outer Zone-Transition area between the intact buffer and nearest permanent structure to capture sediment and absorb runoff.

Middle Zone-Area from top of bank to edge of lawn that is composed of natural vegetation that provides wildlife habitat as well as improved filtration and infiltration of pollutants.

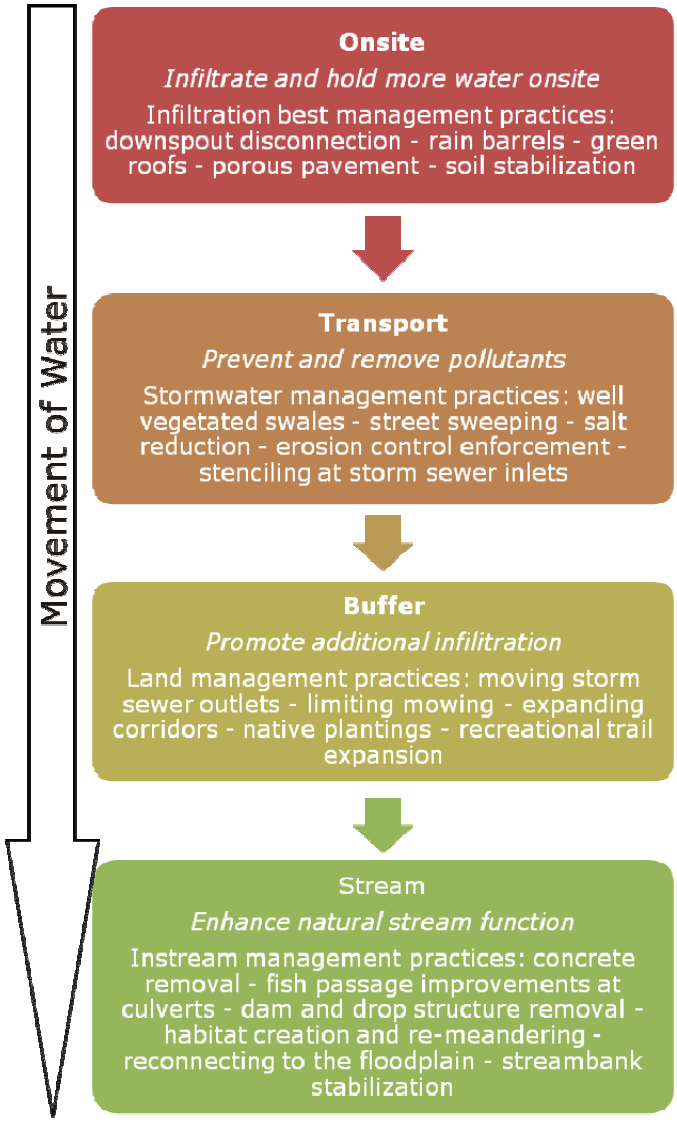
Streamside Zone-Area from the water's edge to the top of the bank or uplands that provides critical connection between water, wetland, and upland habitats for wildlife as well as protect streams from bank erosion

(Fact sheet No. 6 Urban Buffer in the series Riparian Buffers for Northern New Jersey)

Case Study—Urban Buffers

Placement of riparian buffers in established urban areas is a challenge that requires new and innovative approaches. In these areas, historical development along water courses limits options and requires balancing flood management protection versus water quality and environmental protection needs. Consequently, some municipalities have begun to recognize the connections between these objectives and are introducing programs to remove flood-prone structures and culverts from the stream corridors and allow recreation of the stream, restoring floodplains, and improving both the quality of life and the environment.

In urban settings it may be necessary to limit pollution and water runoff before it reaches the buffer.



Challenge:
There are many potential constraints to establishing, expanding, and/or managing riparian buffers within an urban landscape. Two major constraints to establishment of urban buffers include:

1) **Limited or confined space to establish buffers** due to encroachment by structures such as buildings, roadways, and/or sewer infrastructure;
2) **Fragmentation of the landscape** by road and railway crossings of creeks and rivers that disrupt the linear connectedness of buffers, limiting their ability to provide quality wildlife habitat.

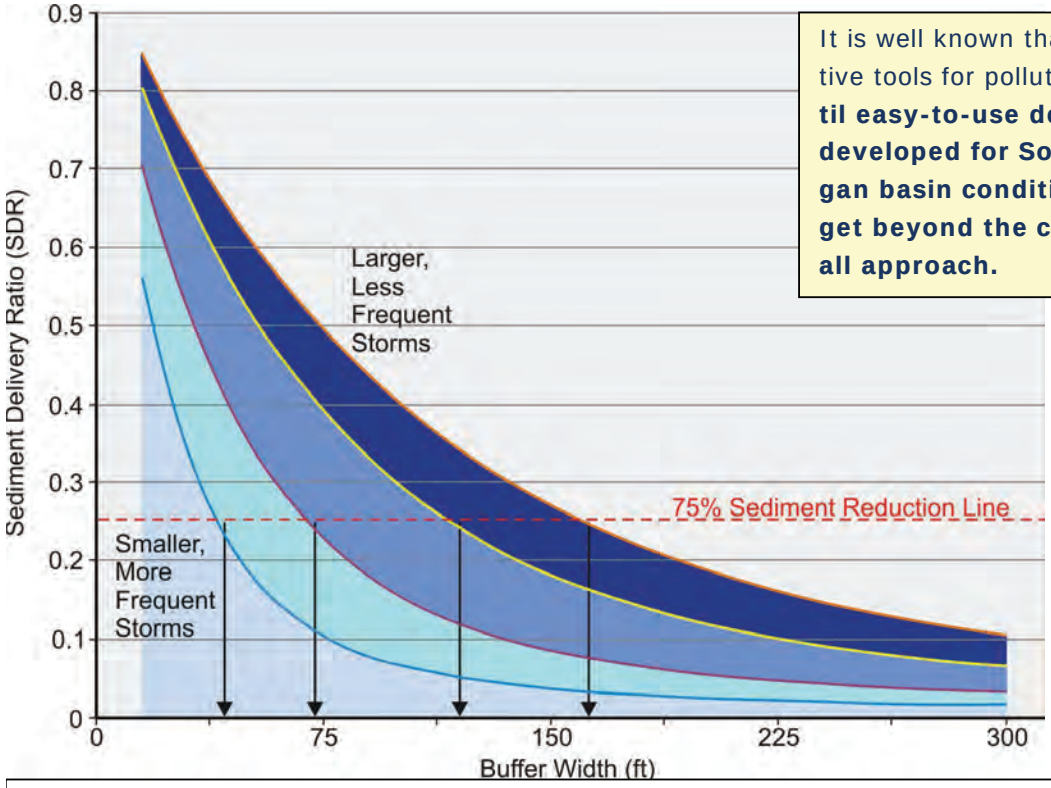
Much traditional stormwater infrastructure intercepts runoff and diverts it directly into creeks and rivers, bypassing any benefits of buffers to infiltrate or filter pollutants. This is important to consider in design of a buffer system for urban waterways, which begin in yards, curbsides, and construction sites, that are figuratively as close to streams as the nearest storm sewer inlet.

A Buffer Design Tool

Design aids are needed to help municipalities, property owners, and others take the "guesswork" out of determining adequate buffer widths for the purpose of water resource quality protection. While there are various complex mathematical models that can be used to estimate sediment and nutrient removal efficiencies, they are not easily applied by the people who need them including homeowners, farmers, businesses and developers.

To fill this gap, design aid tools are being developed using factors such as slope, soils, field length, incoming pollutant concentrations, and vegetation to allow the user to identify and test realistic buffer widths with respect to the desired percent pollutant load reduction and storm characteristics. By developing a set of relationships among factors that determine buffer effectiveness, the width of buffer needed to meet specific goals can be identified.

In the example below, 50-foot-wide buffers are necessary to achieve 75 % sediment removal during small, low intensity storms, while buffers more than 150 feet wide are necessary to achieve the same sediment reduction during more severe storms. Based on this information, decision-makers have the option of fitting a desired level of sediment removal into the context of their specific conditions. Under most conditions, a 75-foot width will provide a minimum level of protection for a variety of needs (SEWRPC PR No. 50, Appendix O.)



It is well known that buffers are effective tools for pollutant removal, but **until easy-to-use design aid tools are developed for Southern Lake Michigan basin conditions, we can never get beyond the current one size fits all approach.**

This generalized graph depicts an example of model output for an optimal buffer width to achieve a 75% sediment reduction for a range of soil and slope, vegetation, and storm conditions characteristic of North Carolina. *(Adapted from Muñoz-Carpena R., Parsons J.E.. 2005. VFSMOD-W: Vegetative Filter Strips Hydrology and Sediment Transport Modeling System v.2.x. Homestead, FL: University of Florida. http://carpena.ifas.ufl.edu/vfsmod/citations.shtml)*

Buffers Are A Good Defense

Today's natural resources are under threat. These threats are immediate as in the case of chemical accidents or manure spills, and chronic as in the case of stormwater pollution carrying everything from eroded soil, to fertilizer nutrients, to millions of drips from automobiles and other sources across the landscape. Non-native species have invaded, and continue to invade, key ecosystems and have caused the loss of native species and degradation of their habitats to the detriment of our use of important resources.

> ***"Riparian ecosystems are naturally resilient,*** *provide linear habitat connectivity, link aquatic and terrestrial ecosystems, and create thermal refugia for wildlife: all characteristics that can contribute to ecological adaptation to climate change."*
>
> *(N. E. Seavy and others, Why Climate Change Makes Riparian Restoration More Important Than Ever: Recommendations for Practice and Research, 2009, Ecological Restoration 27(3):330-338)*

A more subtle, but growing, concern is the case of stresses on the environment resulting from climate change. Buffers present an opportunity for natural systems to adapt to such changes by providing the space to implement protective measures while also serving human needs. **Because riparian buffers maintain an important part of the landscape in a natural condition, they offer opportunities for communities to adjust to our changing world.**

Well-managed riparian buffers are a good defense against these threats. In combination with environmental corridors, buffers maintain a sustainable reserve and diversity of habitats, plant and animal populations, and genetic diversity of organisms, all of which contribute to the long-term preservation of the landscape. Where they are of sufficient size and connectivity, riparian buffers act as reservoirs of resources that resist the changes that could lead to loss of species.

Refuge or protection from increased water temperatures as provided by natural buffers is important for the preservation of native cold-water, cool-water, and warm-water fishes and their associated communities.

Buffers Provide Opportunities

River, lake, and wetland systems and their associated riparian lands form an important element of the natural resource base, create opportunities for recreation, and contribute to attractive and well-balanced communities. These resources can provide an essential avenue for relief of stress among the population and improve quality of life in both urban and rural areas. Such uses also sustain industries associated with outfitting and supporting recreational and other uses of the natural environment, providing economic opportunities. Increasing access and assuring safe use of these areas enhances public awareness and commitment to natural resources. Research has shown that property values are higher adjoining riparian corridors, and that such natural features are among the most appreciated and well-supported parts of the landscape for protection.

We demand a lot from our riparian buffers!

Sustaining this range of uses requires our commitment to protect and maintain them.

Summary

The following guidance suggestions highlight key points to improve riparian corridor management and create a more sustainable environment.

Riparian corridors or buffers along our waters may contain varied features, but all are best preserved or designed to perform multiple important functions.

Care about buffers because of their many benefits. Riparian buffers make sense and are profitable monetarily, recreationally, aesthetically, as well as environmentally.

Enhance the environmental corridor concept. Environmental corridors are special resources which deserve protection. They serve many key riparian corridor functions, but in some cases, could also benefit from additional buffering.

Avoid habitat fragmentation of riparian corridors. It is important to preserve and link key resource areas, making natural connections and avoiding habitat gaps.

Employ the adage "wider is better" for buffer protection. While relatively narrow riparian buffers may be effective as filters for certain pollutants, that water quality function along with infiltration of precipitation and runoff and the provision of habitat for a host of species will be improved by expanding buffer width where feasible.

Allow creeks and rivers room to roam across the landscape. Streams are dynamic and should be buffered adequately to allow for natural movement over time while avoiding problems associated with such movement.

Consider and evaluate buffers as a matter of balance. Riparian buffers are a living, self-sustainable shield that can help balance active use of water and adjoining resources with environmental protection.

Agricultural buffers can provide many benefits. Riparian buffers in agricultural settings generally work well, are cost-effective, and can provide multiple benefits, including possibly serving as areas to raise certain crops.

Urban buffers should be preserved and properly managed. Though often space-constrained and fragmented, urban buffers are important remnants of the natural system. Opportunities to establish or expand buffers should be considered, where feasible, complemented by good stormwater management, landscaping, and local ordinances, including erosion controls.

A buffer design tool is needed and should be developed. Southeastern Wisconsin and the Southern Lake Michigan Basin would benefit from development of a specific design tool to address the water quality function of buffers. Such a tool would improve on the currently available general guidance on dimensions and species composition.

Buffers are a good defense. Combined with environmental corridors, riparian buffers offer a good line of defense against changes which can negatively impact natural resources and the landscape.

MORE TO COME

Future editions in a riparian buffer planning series are being explored with the intent of focusing on key elements of this critical land and water interface. Topics may include:

- Information sharing and development of ordinances to integrate riparian buffers into existing land management plans and programs
- Integration of stormwater management practices and riparian buffer best management practices
- Application of buffers within highly constrained urban corridors with and without brownfield development
- Installation of buffers within rural or agricultural lands being converted to urban uses
- Utilization of buffers in agricultural areas and associated drainage systems
- Integration of riparian buffers into environmental corridors to support resources preservation, recreation and aesthetic uses
- Preservation of stream courses and drainageways to minimize maintenance and promote protection of infrastructure
- Guidance for retrofitting, replacement, or removal of infrastructure such as dams and road crossings, to balance transportation, recreation, aesthetic, property value, and environmental considerations.
- Protection of groundwater recharge and discharge areas
- Protection of high quality, sensitive coastal areas, including preservation of recreational potential

MORE INFORMATION

This booklet can be found at http://www.sewrpc.org/RBMG-no1 . Please visit the website for more information, periodic updates, and a list of complementary publications.

* * *

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May 7, 2010

Appendix F

WISCONSIN'S HEALTHY LAKES IMPLEMENTATION PLAN

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Green Lake, Green Lake County - Lisa Rea

WISCONSIN'S HEALTHY LAKES IMPLEMENTATION PLAN

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The statewide Healthy Lakes initiative is a true, collaborative team effort. The Healthy Lakes Implementation Plan describes relatively simple and inexpensive best practices that lakeshore property owners can implement. The Plan also includes funding/accountability, promotion, and evaluation information so we can grow and adapt the Plan and our statewide strategy to implement it into the future. Working together, we can make Healthy Lakes for current and future generations.

Design and layout by Amy Kowalski, UWEX Lakes

INTRODUCTION

Wisconsin's lakes define our state, local communities, and our own identities. Fond memories of splashing in the water, seeing moonlight reflect off the lake, and catching a lunker last a lifetime. With over 15,000 lakes dotting the landscape, it's no surprise that fishing alone generates a $2.3 billion economic impact each year , and the majority of property tax base rests along shorelines in some of our counties. Unfortunately, we've learned through science that our love for lakes causes management challenges, including declines in habitat and water quality. In fact, the loss of lakeshore habitat was the number one stressor of lake health at a national scale. Lakes with poor lakeshore habitat tend to have poor water quality. Working together to implement *Wisconsin's Healthy Lakes Implementation Plan* (Plan), we can improve and protect our lakes for future generations to enjoy, as well.

This Plan identifies relatively simple habitat and water quality best practices that may be implemented on the most typical lakeshore properties in Wisconsin. We encourage do-it-yourselfers to use these practices but have also created a Wisconsin Department of Natural Resources (DNR) Lake Classification and Protection Grant *Healthy Lakes* sub-category for funding assistance. Furthermore, local partners like lake groups and counties may choose to integrate the Plan into their lake management, comprehensive planning, and shoreland zoning ordinance efforts.

It's important to consider this plan in the context of the lake and local community's management complexity. The best practices' effectiveness will increase cumulatively with additional property owner participation and depend on the nature and location of the lake. For example, if every property owner implemented appropriate Healthy Lakes best practices on a small seepage lake, also known as a pothole or kettle lake, within a forested watershed, the impact would be greater than on a large impoundment in an agricultural region of Wisconsin. Nevertheless, all lakes will benefit from these best practices, and even with limited impact, they are a piece of the overall lake management puzzle that lakeshore property owners can directly control. More lakeshore property owners choosing to implement Healthy Lakes best practices through time means positive incremental change and eventually success at improving and protecting our lakes for everyone.

GOALS AND OBJECTIVES

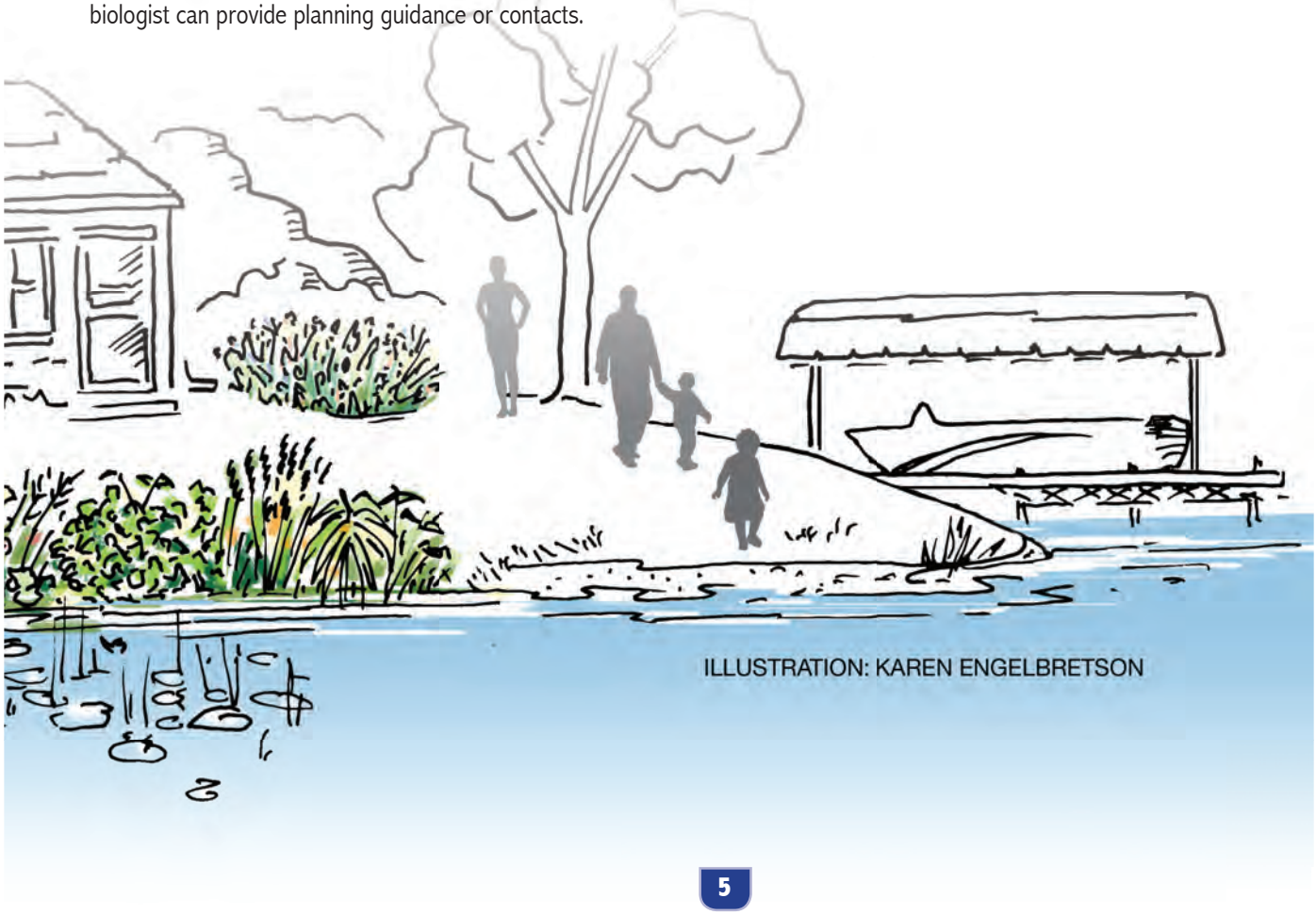
Wisconsin's Healthy Lakes Implementation Plan goal is to protect and improve the health of our lakes by increasing lakeshore property owner participation in habitat restoration and runoff and erosion control projects.

- Statewide objective: single-parcel participation in Healthy Lakes will increase 100% in 3 years (i.e. 2015 to 2017).
- Individual lake objective: lake groups or other partners may identify their own habitat, water quality, and/or participation goal(s) through a local planning and public participation process.
  - Partners may adopt this Plan, as is by resolution, or integrate the Plan into a complimentary planning process such as lake management or comprehensive planning.

Wisconsin's Healthy Lakes Implementation Plan, and the diversion and rock infiltration practices in particular, are not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design. Technical assistance and funding are still available for these sites; contact your county land and water conservation department or local DNR lakes biologist for more information.

The target audience for this Plan and implementation of the associated practices is lakeshore property owners, including: permanent and seasonal homeowners, municipalities, and businesses.

It will be necessary to do additional planning work to implement Wisconsin's Healthy Lakes Plan and, again, the level of effort will depend on the complexity of the lake and its local community. Planning could be as simple as site-specific property visits and development of design plans, to integrating the Plan into a broader and more comprehensive effort. Your lake group, county land and water conservation department, non-profit conservation association, UW-extension lakes specialist or local educator, and/or DNR lake biologist can provide planning guidance or contacts.



DEFINITIONS

Best practice: a working method, described in detail, which has consistently shown results.

Divert: redirect runoff water.

Habitat: where a plant or animal lives.

Infiltrate: soak into the ground.

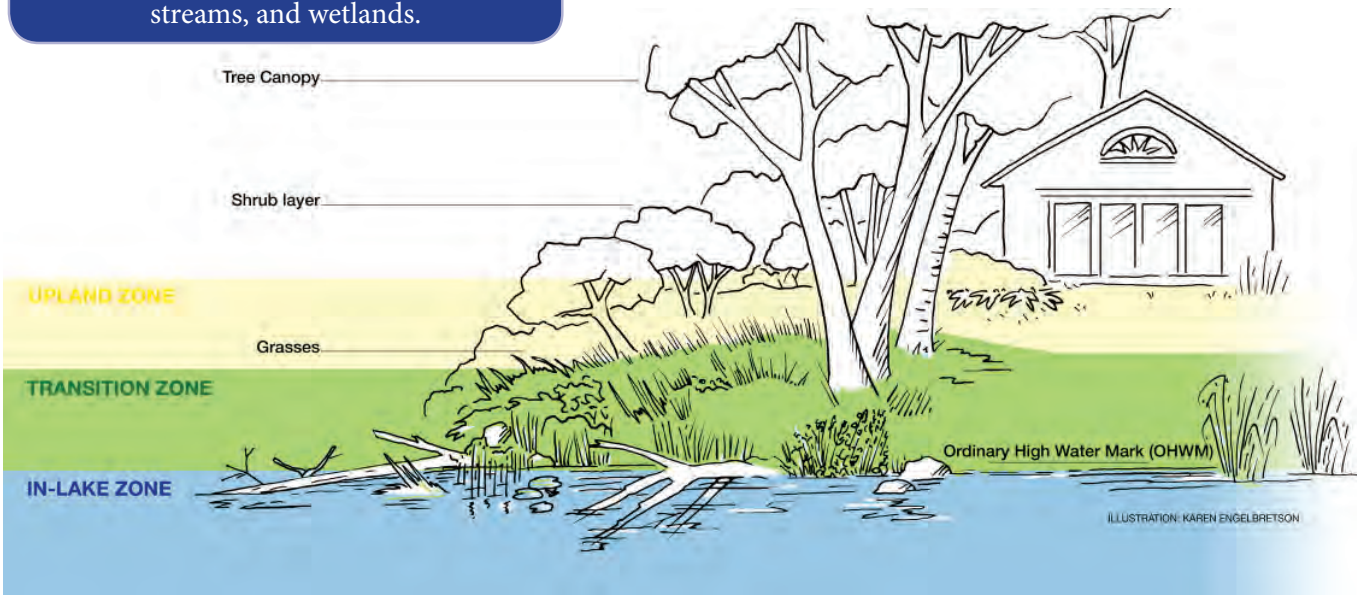
Installed: project cost that includes all materials, labor, and transportation.

Runoff: rain and snowmelt that doesn't soak into the ground and instead moves downhill across land and eventually into lakes, streams, and wetlands.

Wisconsin's Healthy Lakes Implementation Plan divides a typical lakeshore parcel into the following 3 management zones: 1) in-lake, 2) transition, and 3) upland (see illustration below). Best practices are identified for each zone. A team selected these practices based on customer feedback. These practices are:

- relatively simple and inexpensive to implement,
- appropriate for typical lakeshore properties, and
- beneficial to lake habitat and/or water quality.

The Plan also provides cost ranges and averages and technical, regulatory, and funding information for each practice. Fact sheets for each best practice support the Plan and provide more technical detail, and additional guidance is referenced if it currently exists. There is also a funding and administration FAQ fact sheet for those considering pursuing Healthy Lakes grants.



HEALTHY LAKES PLAN

Best practice descriptions follow. Each description defines the practice, identifies lake health benefits, provides cost ranges and averages based on recent projects, and identifies additional technical and regulatory information. The costs provided are installed costs, which include all materials, labor, and transportation but do not include technical assistance, including design and project management/administration work. Cost ranges are a result of geographic location, property conditions like soils and slopes, and contractor supply and proximity to the project site.

PRACTICE 1 | FISH STICKS

...large woody habitat structures that utilize whole trees grouped together resulting in the placement of more than one tree per 50 feet of shoreline. Fish Sticks structures are anchored to the shore and are partially or fully submerged.

Bony Lake, Bayfield County - Pamela Toshner

LAKE HEALTH BENEFITS	Improve fish and wildlife habitat Prevent shoreline erosion
COSTS	Range - $100-$1000 per cluster (3-5 trees), installed Average - Cost per unit (3-5 trees) averages $500, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Fish Sticks* http://tinyurl.com/healthylakes DNR Fish Sticks Best Practices Manual http://dnr.wi.gov (search for *Fish Sticks best practices*)
REGULATORY INFORMATION	DNR: **Habitat Structure - Fish Sticks General Permit** ($303 fee unless DNR grant-funded) Fish Sticks must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/cluster of 3-5 trees Fish Sticks may be a stand-alone grant activity only if the vegetation protection area (i.e. buffer) complies with local shoreland zoning. If not, the property owner must commit to leaving a 350 ft^2 area un-mowed at the base of the cluster(s) or implement native plantings (Practice 2).

PRACTICE 2 | 350 FT² NATIVE PLANTINGS

...template planting plans with corresponding lists of native plants suited to the given function of the plan. The 350 ft² area should be planted adjacent to the lake and include a contiguous area, rather than be planted in patches. Functions are based on the goals for the site. For example, one property owner may want to increase bird and butterfly habitat while another would like to fix an area with bare soil. Native planting functions include the following: lakeshore, bird/butterfly habitat, woodland, low-growing, deer resistant, and bare soil area plantings.

Green Lake, Green Lake County - Lisa Reas

LAKE HEALTH BENEFITS	Improve wildlife habitat Slow water runoff Promote natural beauty
COSTS	Range - $480-$2400 for 350 ft² area, installed Average - $1000 per 350 ft², installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *350 ft² Native Plantings* http://tinyurl.com/healthylakes 350 ft² Native Plantings Best Practices Manual
REGULATORY INFORMATION	DNR: an aquatic plant chemical control permit may be necessary if using herbicides in or adjacent to the lakeshore. Native plantings must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/350 ft² native plantings installed and implemented according to the technical requirements. Only one 350 ft² native planting per property per year is eligible for funding. The native plantings dimension must be 350 ft² of contiguous area at least 10 feet wide and installed along the lakeshore. Final shape and orientation to the shore are flexible.

PRACTICE 3 | DIVERSION PRACTICE

...includes a water bar, diverter, and broad-based dip. These practices use a berm or shallow trench to intercept runoff from a path or road and divert it into a dispersion area. Depending on the site, multiple diversion practices may be necessary.

http://awwatersheds.org

LAKE HEALTH BENEFITS	Divert runoff water.
COSTS	Range - $25-$3750, installed Average - $200, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Diversion Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Diversion practices must comply with the local shoreland and floodplain zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/diversion practice installed and implemented according to the technical requirements. Healthy Lakes diversion practice grant funding is not intended for large, heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

PRACTICE 3 | DIVERSION PRACTICE

...includes a water bar, diverter, and broad-based dip. These practices use a berm or shallow trench to intercept runoff from a path or road and divert it into a dispersion area. Depending on the site, multiple diversion practices may be necessary.

http://awwatersheds.org

LAKE HEALTH BENEFITS	Divert runoff water.
COSTS	Range - $25-$3750, installed Average - $200, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Diversion Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Diversion practices must comply with the local shoreland and floodplain zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/diversion practice installed and implemented according to the technical requirements. Healthy Lakes diversion practice grant funding is not intended for large, heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

PRACTICE 4 | ROCK INFILTRATION PRACTICE

...ian excavated pit or trench filled with rock that reduces runoff by storing it underground to infiltrate. A catch basin and/or perforated pipe surrounded by gravel and lined with sturdy landscape fabric may be integrated into the design to capture, pre-treat, and redirect water to the pit or trench. Pit and trench size and holding capacity are a function of the area draining to it and the permeability of the underlying soil.

Deer Lake, Polk County - Cheryl Clemens

LAKE HEALTH BENEFITS	Divert runoff water. Clean runoff water. Infiltrate runoff water.
COSTS	Range - $510-$9688 per rock infiltration practice, installed Average - $3800 per rock infiltration practice, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Rock Infiltration Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Rock infiltration practices must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/rock infiltration practice installed and implemented according to the technical requirements. Healthy Lakes rock infiltration practice grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

PRACTICE 5 | RAIN GARDEN

...a landscaped shallow depression with loose soil designed to collect roof and driveway runoff.

Shell Lake, Washburn County - Brent Edlin

LAKE HEALTH BENEFITS	Improve wildlife habitat. Divert runoff water. Clean runoff water. Infiltrate runoff water. Promote natural beauty.
COSTS	Range - $500-$9000 per rain garden, installed Average - $2500 per rain garden, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Rain Garden* http://tinyurl.com/healthylakes *Rain Gardens: A How-to Manual for Homeowners* http://dnr.wi.gov/topic/Stormwater/documents/RgManual.pdf
REGULATORY INFORMATION	DNR: none. Rain gardens must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/rain garden installed and implemented according to the technical requirements. Healthy Lakes rain garden grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

FUNDING AND ACCOUNTABILITY

Administrative details and the application process are described in detail in the DNR's Water Grant Application and Guidelines (http://dnr.wi.gov/ search for surface water grants) and the Healthy Lakes website (http://tinyurl/healthylakes) and *Administration and Funding FAQ* fact sheet.

Healthy Lakes grant funding highlights:

- 75% state share grant with a maximum award of $25,000, including up to 10% of the state share available for technical assistance and project management. Technical assistance and project management do not include labor and are based on the entire state share of the grant, not the best practice caps.
- 25% match from sponsors, participating property owners or other partners. The grant sponsor may determine individual property owner cost share rates, provided the state's share of the practice caps ($1000) and total grant award (75%) are not exceeded. The grant sponsor's match may include technical assistance and project management costs beyond the state's 10% share.
- Sponsor may apply on behalf of multiple property owners, and the property owners do not have to be on the same lake.
- Standard 2-year grant timeline to encourage shovel-ready projects.
- Landowners may sign a participation pledge to document strong interest in following through with the project.
- Standard deliverables, including a signed Conservation Commitment with operation and maintenance information and 10-year requirement to leave projects in place. Also:
  - Native plantings must remain in place according to local zoning specs if within the vegetation protection area (i.e. buffer).
  - Fish Sticks projects require a 350 ft^2 native planting at shoreline base or commitment not to mow, if the property does not comply with the shoreland vegetation protection area (i.e. buffer) specifications described in the local shoreland zoning ordinance.
- Standardized application and reporting forms and process.
- 10% of projects randomly chosen each year for self-reporting and/or professional site visits.

PROMOTION

Wisconsin's Healthy Lakes Implementation Plan will be supported and promoted as a statewide program. Lake groups, counties, towns, villages, cities, and other partners may choose to adopt and implement the Plan as is or to integrate into their own planning processes. Statewide promotion, shared and supported by all partners, includes the following:

- A Healthy Lakes logo/brand.
- A website with plan, practice, and funding detail to be housed on the Wisconsin Department of Natural Resources' and University of Wisconsin-Extension Lakes' websites. It may also include the following:
  - Link to science and supporting plans.
  - Shoreline restoration video.
  - How-to YouTube clips.
  - Tips on how to communicate and market healthy lakeshores.
  - Maps with project locations without personally identifiable information.

EVALUATION OF RESULTS

Wisconsin's Healthy Lakes Implementation Plan and results will be evaluated annually and updated in 2017, if warranted. Best practices may be modified, removed, or added depending on the results evaluation.

Lime Lake, Portage County - Robert Korth

The following information will be collected to support an objective evaluation:

- County and lake geographic distribution and participation in Healthy Lakes projects.
- Lakeshore property owner participation in Healthy Lakes projects, including numbers and locations of best practices implemented.
- Standardized Healthy Lakes grant project deliverable report including:
  - Numbers of Fish Sticks trees and clusters.
  - Dimensional areas restored.
  - Structure/floral diversity (i.e. species richness).
  - Impervious surface area and estimated water volumes captured for infiltration.

The results may be used to model nutrient loading reductions at parcel, lake, and broader scales and to customize future self-reporting options, like plant mortality and fish and wildlife observations, for lakeshore property owners.

ACKNOWLEDGEMENTS

Amy Kowalski

L to R: Patrick Goggin, Jane Malischke, Pamela Toshner, Carroll Schaal, Tom Onofrey, Dave Ferris

Wisconsin's Healthy Lakes Implementation Plan and corresponding technical information and grant funding are the results of a collaborative and participatory team effort. We would like to thank the staff, agency, business, and citizen partners, including *Advanced Lake Leaders*, who provided feedback for our team, including the many partners who completed a customer survey and provided valuable comments during the public review of proposed DNR guidance. We would like to express our gratitude to the following contributors and information sources, respectively: Cheryl Clemens, John Haack, Dave Kafura, Amy Kowalski, Jesha LaMarche, Flory Olson, Tim Parks, Bret Shaw, Shelly Thomsen, Scott Toshner, Bone Lake Management District, Maine Lake Smart Program, and Vermont Lake Wise Program.

We appreciate your continued feedback as our Healthy Lakes initiative evolves into the future. Please contact DNR Lake Biologist Pamela Toshner (715) 635-4073 or pamela.toshner@wisconsin.gov if you have comments or questions.

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Appendix G

IMPERVIOUS SURFACES

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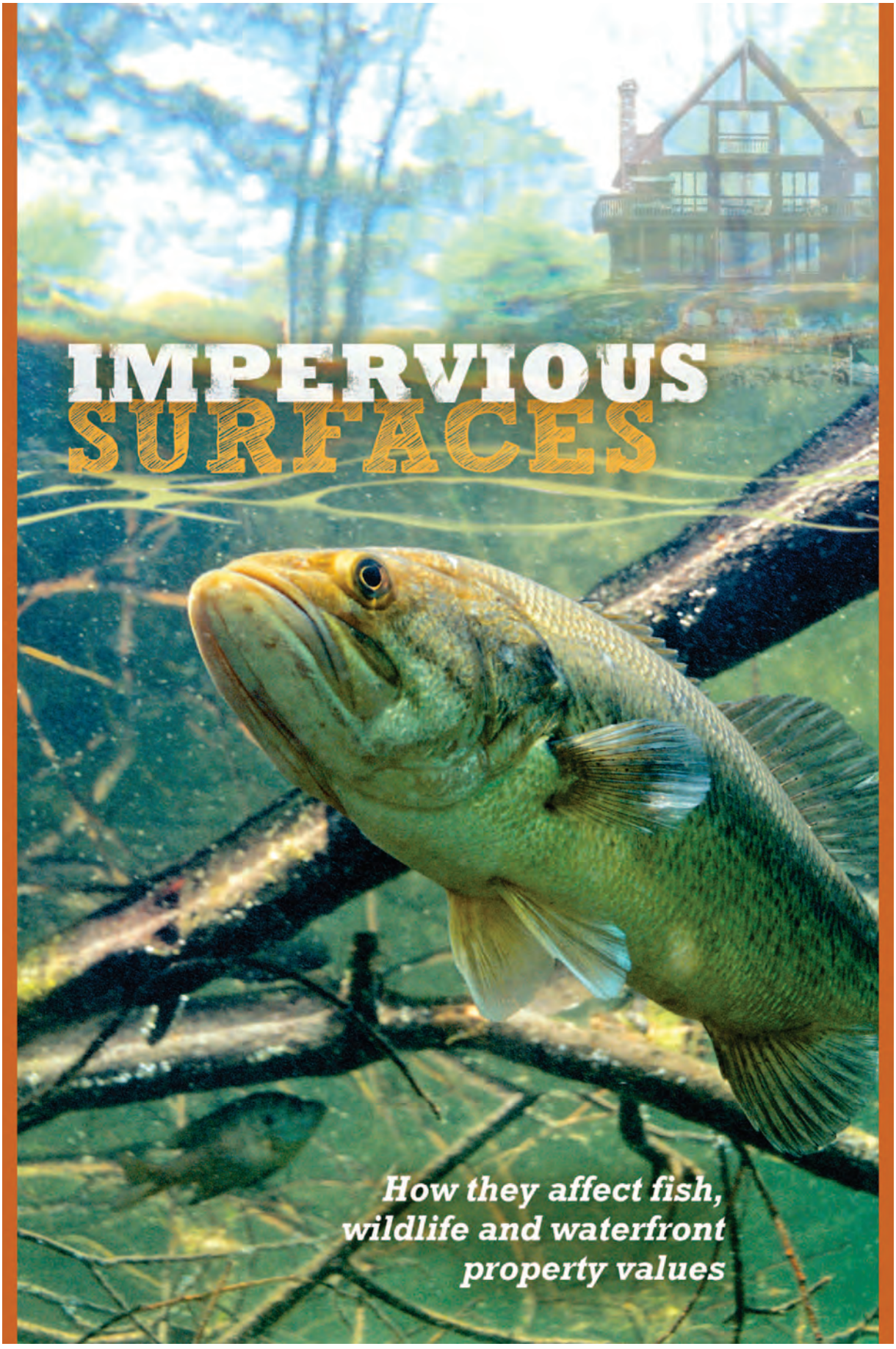

IMPERVIOUS
SURFACES
How they affect fish, wildlife and waterfront property values

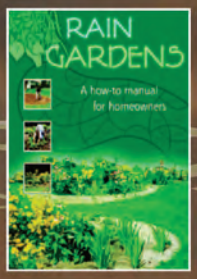
For how-to information about minimizing impervious surfaces and their effects, see the following valuable resources:

Controlling Runoff and Erosion from Your Waterfront Property: A Guide for Landowners.

www.burnettcounty.com/DocumentView.aspx?DID=119

*Lakescaping for Wildlife and Water Quality.*176 pages, $19.95, available at

www.mnbookstore.com
(800) 657.3757



Rain Gardens: A How-To Manual for Homeowners.

http://learningstore.uwex.edu/assets/pdfs/GWQ037.pdf

Photo by Jesse Kloempken

Healthy lakes, rivers, and streams are the basis for creating fond memories of time spent near the water. Memories of a crisp fall morning of walleye fishing or of entertaining friends and family on the evening shoreline would never be made if our lakes and streams couldn't support healthy fish or were covered in thick blankets of algae.

The health of our lakes and streams is a direct reflection of our actions as landowners. When we develop waterfront lots, trees and native plants are replaced by impervious (hard) surfaces. Driveways, rooftops, and other hard surfaces decrease the ability of the shoreland area to serve its natural functions. Fewer trees and native plants eliminate the food sources and shelter on which wildlife depend. Water can no longer soak into the ground, which increases stormwater runoff and carries pollutants to lakes and streams. Fish eggs die when they are covered in a blanket of silt from runoff and erosion. A decline in water quality often lowers property values and our enjoyment of lakes.

Although the effects of one lot's development may not result in a measurable change in the water quality of a lake or stream, the cumulative effects can be substantial.

Photo by Robert Korth

How do impervious surfaces IMPACT lakes and streams?

This publication was developed for waterfront property owners and local officials to help answer this question. It does not discuss all of the potential impacts of impervious surfaces; rather, it primarily focuses on impacts to:

1. Waterfront property values
2. Fishing
3. Wildlife

The decisions we make as individual landowners, whether small renovations or new development plans, have an additive effect on our waterbodies and the fish and wildlife that call these places home. For this reason, each and every property owner has a unique opportunity to help protect our lakes and streams.

What are impervious surfaces and how do they affect our waters?

Virtually any form of shoreland development leads to more impervious surfaces. Impervious surfaces are hard, man-made surfaces such as roof tops, driveways, parking areas, and patios that change the fate of precipitation–instead of soaking into the ground and being naturally filtered, water runs downhill directly into our lakes and streams.

Runoff from impervious surfaces washes pollutants such as sediments, nutrients, bacteria, car fluids and other chemicals into our lakes and streams. Runoff and the erosion it causes can be a serious problem for both the property owner and the lake. Gullies or large eroded channels are unsightly and may result in loss of property when soil is carried to the lake.

SHORELAND ZONING is in place to protect our lakes and rivers. Wisconsin Administrative Code NR 115 provides minimum standards for shoreland zoning. Many counties have chosen to adopt more protective standards. See your county zoning office for more information.

2

Photos by Jeffrey Strobel

Figure 1

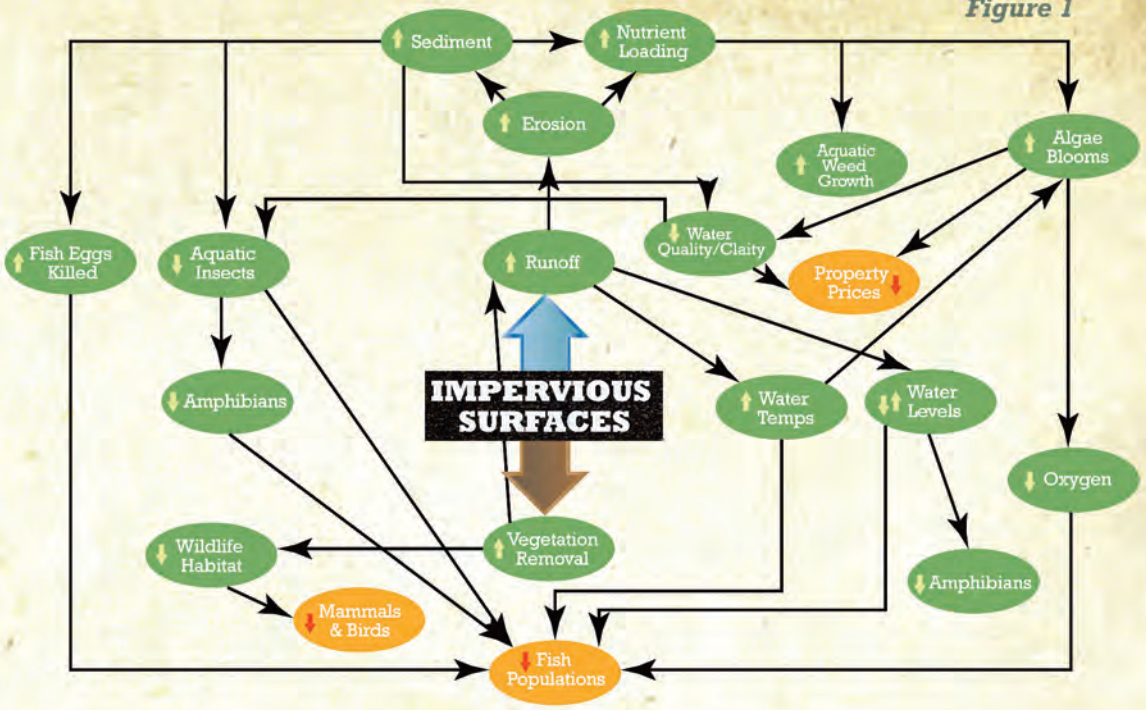


Figure 1: Impervious surfaces can cause a variety of negative impacts to lake and stream ecosystems. The orange ovals in this diagram illustrate the three areas of impact that are discussed in this publication and how they are intricately connected to the rest of the lake health. *For a comprehensive overview of how impervious surfaces affect waterbodies, see *Impacts of Impervious Cover on Aquatic Systems* from the Center for Watershed Protection.[1]

3 REASONS TO MINIMIZE IMPERVIOUS SURFACES

1 Waterfront Property Values

We are drawn to shoreland properties for a variety of reasons. Some of us enjoy playing in the water on a hot afternoon in July, while others enjoy ice fishing during the frost-nipping cold of January. Owning a shoreland property allows year-round access to the numerous recreational opportunities provided by lakes and rivers.

Often, people choose to purchase a waterfront property based on how they plan to enjoy the water – be it for enjoying the peaceful, natural setting or the abundant fishing, swimming, or boating opportunities. In fact, a UW-Extension survey found that enjoyment of peace and quiet, natural beauty, and hunting and fishing opportunities were the top three reasons people enjoyed lakes.[2]

Minimizing the presence of impervious surfaces in the shoreland area can help to ensure that many of these qualities we care about are preserved, helping to protect property investments.

While many opinions exist over what the perfect shoreline looks like, most of us agree that clear water is desirable. Studies have found that the market value of a waterfront property can decrease if the lake has cloudy or murky water.[3] Water clarity can be influenced by the presence of impervious surfaces in two ways. First, runoff increases erosion resulting in more soil being washed into the water, making our lakes, streams and rivers cloudy. Second, runoff from impervious surfaces carries additional phosphorus to the water. An unfertilized waterfront lot that has 20% impervious cover carries six times more phosphorus to the lake than an undeveloped lot of the same size (see **Figure 2**). This additional phosphorus can fuel algae growth in our waters, which lowers water clarity and overall aesthetics.

A recent study that tracked over 1,000 waterfront property sales in Minnesota found that when all other factors remained equal, properties on lakes with clearer water commanded significantly higher property prices.[3] A similar study conducted in Maine found that changes in water clarity of three feet can influence lakefront property prices by as much as $200 per frontage foot.[4] This means that a three foot increase in water clarity could increase the property value by as much as $20,000 on a lot with 100 feet of water frontage. Perhaps more important, the amount for an identical decrease in water clarity would decrease property values by significantly more than $20,000.[4]

Is gravel considered impervious?

A common question is whether gravel driveways or walkways are considered impervious surfaces. Non-compacted gravel "mulch", such as that used as landscaping material, is generally not considered impervious. On the otherhand, gravel used for driveways, parking lots, or other high-use becomes compacted. **After compaction, gravel driveways and parking areas will create runoff even during minor rain events.** If gravel is used, it should be free of clay and other fine particles to help prevent compaction and "clogging" of spaces between gravel particles.[5] ½ inch or ¾ inch "clear" crushed rock is a good choice for this application. "Clear" indicates that the gravel is virtually free of fine particles.

Figure 2

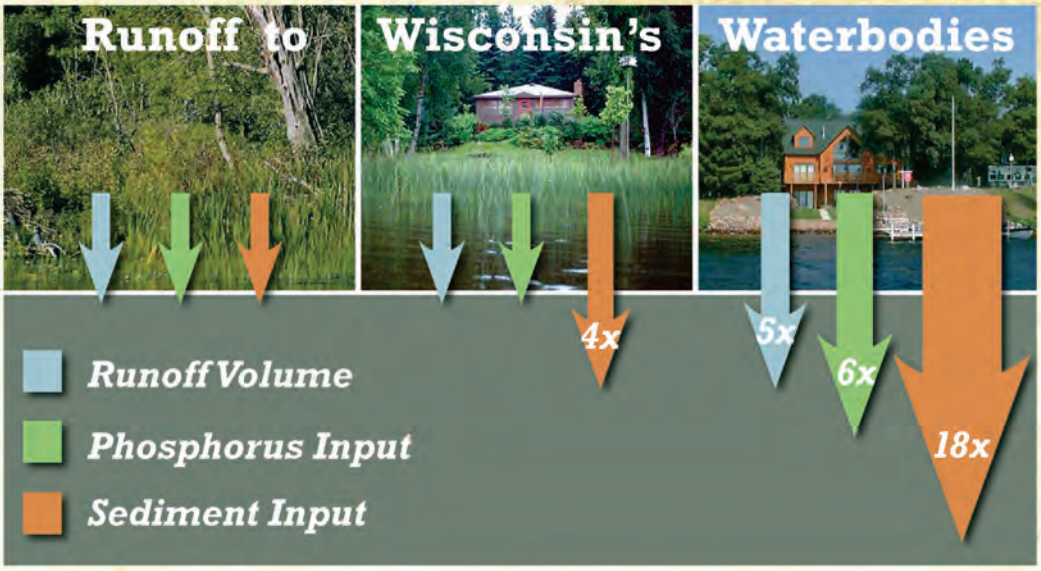


Figure 2: The far left picture above indicates a half-acre undeveloped shoreland lot characterized by minimal runoff, phosphorus, and sediment inputs. The middle picture portrays a typical 1940's shoreland development, with approximately 8% impervious surface coverage. The picture to the right has approximately 20% impervious surface coverage. Notice how sediment inputs drastically increase with impervious surface coverage.[6]

2 Fishing

Fishing gives us a chance to sit back, relax, and visit with friends and family all while waiting for the familiar tug of an unseen fish straining our fishing pole. Many of Wisconsin's lakes and rivers are prime destinations for walleye, bass, musky, or crappie fishing – making this a popular pastime for many of us.

Many of the fish anglers pursue are sensitive to changes in their environment. Runoff from impervious surfaces that carries sediments, nutrients and other pollutants into lakes and streams leads to decreased populations of those fish we enjoy catching.

This is largely because:

- More nutrients result in less oxygen in the water, which fish need to survive.
- More sediments and algae growth make it difficult for some predator species that hunt by sight to find their food.
- More sediments cover spawning beds utilized by fish such as smallmouth bass, walleye, and crappie, potentially inhibiting reproduction.[7]

Streams are particularly sensitive to the effects of impervious surfaces because of increased potential for flooding during storm events and low water levels during dry periods. Fluctuating water levels can degrade fish and amphibian habitat.[1] Another significant impact to streams is warm runoff coming from hot pavement and rooftops during warmer months. This increases stream temperatures, putting stress on fish that require cold water conditions, such as trout.[8]

Figure 3

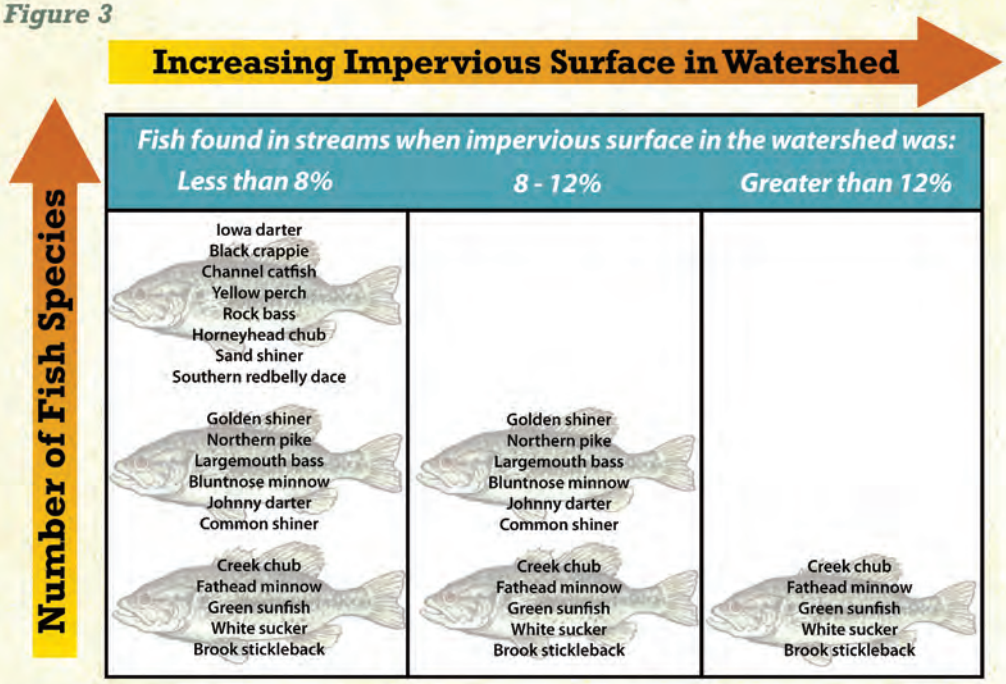


Figure 3: The number of different stream fish species declines as the effects of impervious surfaces kill off more sensitive species.[9]

Numerous studies on stream watersheds have shown that fish populations decline as impervious surface coverage increases. A study of 47 streams in south-eastern Wisconsin found that when impervious surfaces covered more than 8-12% of a watershed – the land that drains to the stream – poor quality fish populations and habitat were a result.[10] In watersheds with impervious surface coverage even slightly above 12% researchers found that the overall number of fish species plummeted (see **Figure 3**). The same study also indicated that impervious surfaces immediately adjacent to the water, especially within the first 150 feet, had a significant impact on streams.

What can you do to minimize the effects of impervious surfaces?

For more information on particular topics, see numbered resources below:

Minimize hard surfaces like rooftops and driveways on your property

- Share driveways with neighbors where possible
- Utilize narrow driveways
- Minimize building footprints- build "up" instead of "out"
- Remove unneeded hard surfaces, such as extra parking spots

Utilize pervious materials where possible

- Green roofs
- Mulch walkways
- Permeable pavers for walkways or driveways 1

Capture or infiltrate runoff

- Rain barrels
- Gutters & downspouts 1
- Rain gardens 2

Minimize fertilizer use

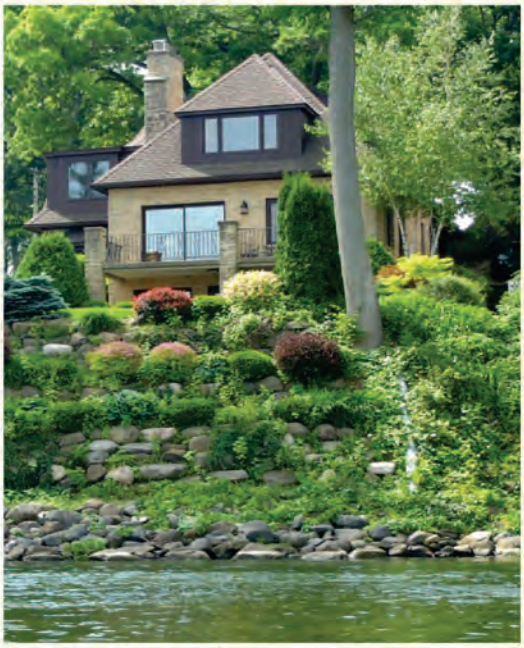
- Have soil tested first; are fertilizers needed?
- Minimize or eliminate use

Maintain or restore shoreline plants to slow runoff and provide habitat 3 4

- Maintain or restore at least a 35 foot wide shoreline buffer
- Let nature re-establish the shoreline!

Control erosion during construction and after development 5

Photo by Sarah Congdon



Where to Access/Obtain These Excellent Resources:

1 *Controlling Runoff and Erosion from Your Waterfront Property: A Guide for Landowners.* Available at **www.burnettcounty.com/DocumentView.aspx?DID=119**

2 *Rain Gardens: A How-To Manual For Homeowners.* DNR publication no.WT-776 2003, UW-Extension publication No. GWQ037. Available at **http://learningstore.uwex.edu/assets/pdfs/GWQ037.pdf**

3 *Lakescaping for Wildlife and Water Quality.* 176 pages, $19.95, available from the Minnesota Bookstore at **800-657-3757**. Wisconsin DNR staff recommend this book as the best detailed planning guide for shoreland restoration projects.

4 *The Shoreland Stewardship Series: Protecting and Restoring Shorelands.* Available at **http://clean-water.uwex.edu/pubs/pdf/protect.pdf**

5 *Erosion Control for Home Builders.* UW-Extension publication No. GWQ001 and Wisconsin DNR No. WT-457-96. Available at **www.bldgpermit.com/erosioncontrol.pdf**

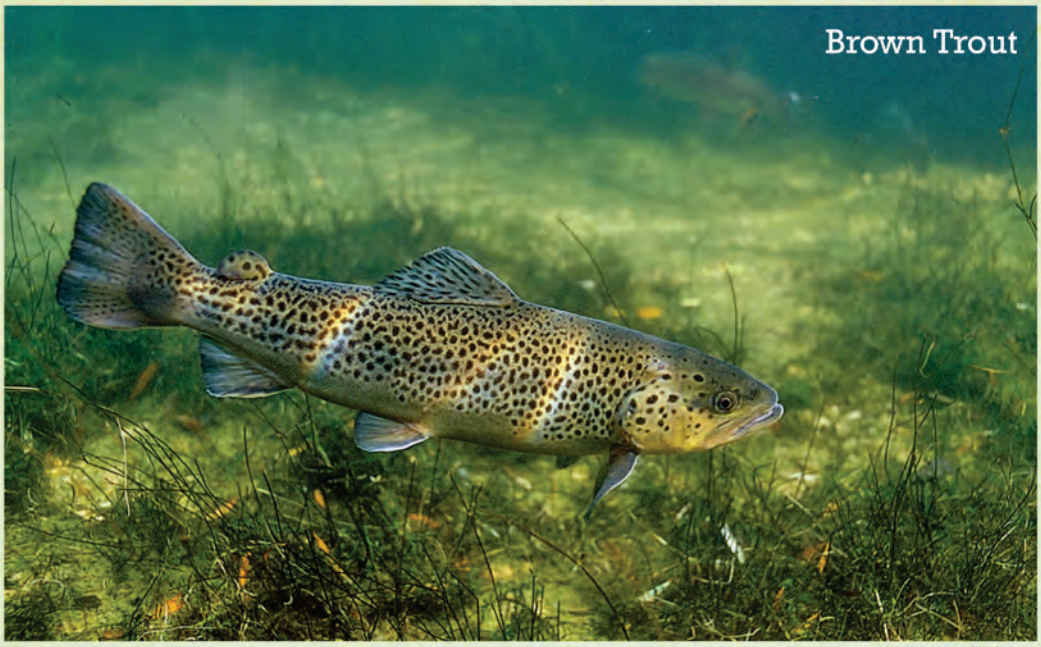


Photo by Eric Engbretson

Brook Trout and Brown Trout

Both brook trout and brown trout are found in many streams in Wisconsin, and require cold, clean water for survival. Both species are also sensitive to pollution and low oxygen conditions. A study conducted on 33 coldwater streams in Wisconsin and Minnesota found that when impervious surfaces covered more than 11% of a watershed, trout were eliminated from streams.[8]

Photo by Eric Engbretson

The brook trout is the only trout species native to Wisconsin's waters. Part of their diet is comprised of aquatic insects and small fish, whose populations are also negatively impacted by increased runoff and sedimentation.

The trend of more impervious surfaces leading to fewer fish species also holds true in lakes, though less is known about specific thresholds where fish begin to be impacted. A 2008 study of 164 Wisconsin lakes found that certain fish species tended to be less common in lakes surrounded by high levels of impervious surfaces than in lakes surrounded by minimal impervious surfaces. Some of these species included game fish, like smallmouth bass and rock bass, but also nongame species, such as blackchin shiners, blacknose shiners, and mottled sculpin.[11] Many of the smaller, nongame species serve as vital food sources for game fish such as walleye, smallmouth bass, and northern pike. Increased impervious surfaces, removal of aquatic vegetation, and installation of beaches all contribute to the destruction of near shore habitat for both larger fish and the smaller prey fish these predators depend on.[12] Fewer food options for game fish will likely lead to lower numbers of game species in the long run.

Walleye

Walleye are synonymous with northern Wisconsin's lakes and rivers. Impervious surfaces can reduce walleye reproduction through soil erosion, which leads to sedimentation. Although impervious surfaces aren't the only cause of sedimentation, when sediments cover spawning grounds, the spaces in between the rocks and gravel used as spawning grounds become blanketed with silt. This can quickly cause walleye eggs to die because of inadequate water flow and oxygen deprivation.[13, 14] Adult walleyes are often able to cope under these conditions. Harming the success of eggs and embryos puts the survival of a healthy walleye population at risk.[15]

Photo by Eric Engbretson

Walleye typically spawn between mid-April and early May in Wisconsin when spring runoff is highest. Rock and gravel covered bottoms are their preferred spawning grounds due to the requirements of their sensitive eggs.

3 Wildlife

Whether looking out the front window of a waterfront home or from the bow of a canoe, opportunities to observe shoreland wildlife are abundant. The shoreline is a busy place. Northern pike, bluegills, bass and other fish spawn in the shallow water along the shore. Loons, ducks, geese and other water birds nest along the banks. Wildlife such as frogs, otters and mink live there too. Shoreline areas – on land and into the shallow water – provide essential habitat for fish and wildlife that live in or near Wisconsin's lakes and rivers. Overdeveloped shorelands can't support the fish, wildlife and clean water that are so appealing to the people attracted to the shoreline.[16]

Impervious surfaces can be thought of as biological deserts where animals cannot find food or shelter, making them easy prey. Disturbed open spaces increase wildlife mortality rates and decrease their chances of successfully raising young.

Although it may seem obvious, the creation of impervious surfaces in the shoreland area removes essential habitat for numerous species. Driveways, cemented paths, buildings and other types of impervious surfaces make our shorelands less inviting to wildlife. These areas can be thought of as biological deserts where animals cannot find food or shelter, making them easy prey. Shoreland habitat fragmented by impervious surfaces, mowing, or brushing are generally avoided by wildlife. These disturbed open spaces increase wildlife mortality rates and decrease their chances of successfully raising young.[17]

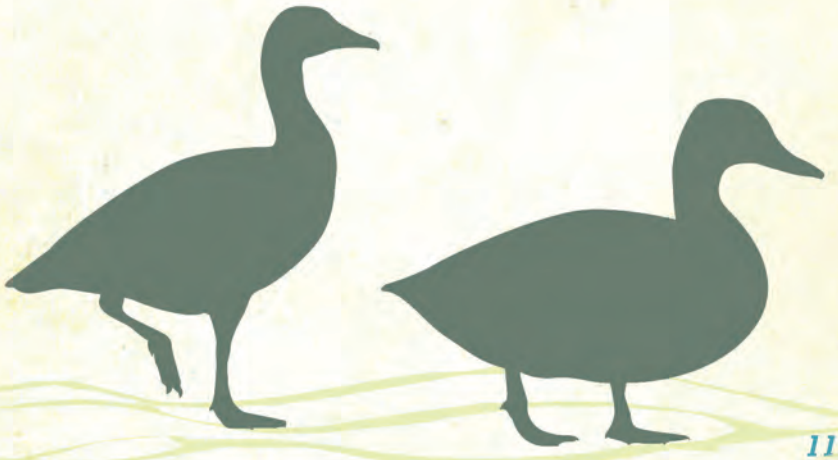
Habitat connectivity is key. Some animals like loons and frogs depend on habitat relatively close to the water. River otters, on the other hand, often choose denning sites in upland areas further from the water's edge.[18] By minimizing how much of the shorelines we develop with impervious surfaces and maintaining habitat connectivity, we maximize the potential for seeing the unique wildlife that so intimately depend on natural shoreland habitats.

In addition, the impact of impervious surfaces on wetlands can pose a risk to waterfowl. Wetlands provide critical breeding and feeding grounds for mallards as well as many other waterfowl species. Increased impervious surfaces can cause water level fluctuations in wetlands due to increased runoff volumes.[19] Rising water levels during the nesting season can make it difficult for ducklings to survive.[20]

Mallard

The familiar raspy "quack" of a mallard is a sound common to Wisconsin's water bodies. When we see mallards dabbling in ponds with a following of ducklings, they are often in search of aquatic insects. During the first two weeks of a mallard duckling's life, its diet is comprised almost exclusively of aquatic insects. The same dietary needs also hold true for many other species of ducks.[21] Research has shown that sedimentation tends to decrease aquatic insect densities.[22] Without an adequate food source, mallards will have to move elsewhere to raise their young.

Photo by Mark Lasnek



In place of impervious surfaces or manicured lawns, the maintenance or reestablishment of a shoreline vegetated buffer can have a positive impact on wildlife. The same types of plants that provide animals with cover often provide diverse food sources as well, especially for birds.[23] Dead trees (standing or on the ground) provide homes and cover for species such as wood ducks and ruffed grouse.

These three "layers" of vegetation provide the necessary habitat for species of all kinds. Only native vegetation should be planted in the shoreland buffer area and should include a variety of different species of grasses, shrubs, and trees. For more information on shoreland buffers, please see *The Shoreland Stewardship Series: Protecting & Restoring Shorelands*. This publication is available at county UW-Extension offices, and online at:

clean-water.uwex.edu/pubs/pdf/protect.pdf

Figure 4

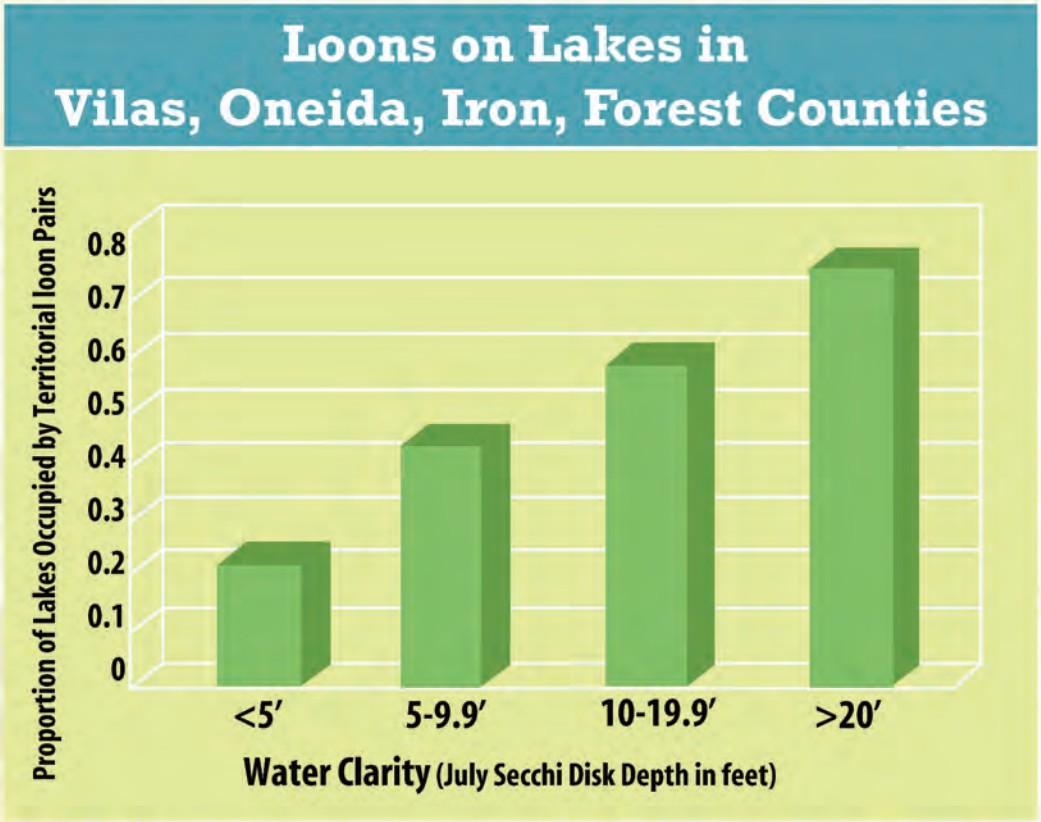


Figure 4: Loon pairs are decreasingly common as water clarity in northern Wisconsin lakes degrades. Shoreland development in southern Wisconsin has caused the loon to avoid these bodies of water because of poor water quality and habitat degradation.[24]

Common Loon

Common loons evoke a true sense of the Northwoods, famous for their primeval nighttime "laughter" heard echoing across lakes in Northern Wisconsin. Historically, loons have been pushed northward, in part due to the effects of shoreland development.[25] Loons can be impacted by runoff from impervious surfaces through reduced water clarity. Loons search for fish from the water's surface, making clear water key to finding food. Because of this, loon pairs appear to favor lakes with clearer water, as shown by **Figure 4**.[24] Additionally, nest predators like raccoons have been found to be more common on highly developed lakes. A recent study found that raccoons often raid northern Wisconsin loon nests in search of eggs. This naturally decreases the success of loon nests.[26]

Photo by Michele Woodford

Loons nest near the water on either solid ground or floating vegetation and often construct nests out of needles, leaves, or other materials.[25] It's easy to see how vulnerable these nests can be to predators like raccoons.

Photo by John Haack

Conclusion

An undeniable connection exists between the health of Wisconsin's lakes and streams and the decisions we make about our shoreland properties. Each property is part of a bigger picture – a living waterfront of plants, wildlife, fish and people that are all interconnected.

When we establish impervious surfaces on our properties, we decrease the ability of the shorelands to serve their natural functions. Specifically, removing trees and native plants eliminates unique habitat required by the shoreland wildlife we enjoy watching. Increased runoff carries pollutants to our lakes and streams. Fish spawning grounds become unproductive when they are blanketed in silt. Decreased water clarity can also affect us by lowering waterfront property values.

On the other hand, when we leave shorelands in a more natural state, we all can enjoy healthy lakes and streams. Clean water allows our children to safely swim and play along our shorelines. Shoreland habitat and excellent water quality provide us with ample opportunities for memorable fishing trips and entertaining wildlife watching. Let's all do our part to give future generations these same opportunities.

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Appendix H

HEY AND ASSOCIATES, INC.
EVALUATION OF ALTERNATIVES FOR RUBICON RIVER PHOSPHORUS INPUT DIVERSION

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Hey and Associates, Inc.

EVALUATION OF ALTERNATIVES FOR RUBICON RIVER PHOSPHORUS INPUT DIVERSION

Pike Lake, Washington County, Wisconsin

Prepared for:
Pike Lake Inland Lake Protection and Rehabilitation District

February 2010

PN: 08158

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INTRODUCTION

Pike Lake in Washington County is 522 acre glacial lake that receives drainage from an 11.5 square mile watershed (Figure 1). The Rubicon River, which drains 7.85 square miles, is the largest inlet tributary and contributes 56 percent of the annual water flow to the lake and 80 percent of the annual phosphorus inputs based on monitoring by the U. S. Geological Survey in 1999 and 2000. Of the phosphorus inputs 43 percent is delivered from the Village of Slinger Wastewater Treatment Plant and 37 percent is from nonpoint source pollution. In 1995 the Pike Lake Management District installed a diversion project in the Rubicon River to minimize nutrient mixing of the Rubicon River with the lake during low flow conditions when the treatment plant makes up much of the stream base flow. Between 1998 and 2000 during high flows the diversion plug washed out. The purpose of the following report is to evaluate alternatives to reducing phosphorus inputs from the Rubicon River into Pike Lake. Funding for this project was provided by the Wisconsin Department of Natural Resources through a Lake Planning Grant and from the Pike Lake Inland Lake Protection and Rehabilitation District.

PHYSICAL DESCRIPTION OF LAKE

Pike Lake (Figure 2) is a natural drainage lake formed about 10,000 years ago during the Wisconsinan glaciation. A low-head dam at the lake's outlet raises the lake surface about two feet higher than if there was no dam. The lake has a surface area of 522 acres; however, if the marsh along the north side of the lake is excluded from the lake area, the remaining open-water area is 459 acres. The maximum depth of the lake is 45 ft, its volume is 6,171 acre-ft, and its mean depth is 13.5 ft (Wisconsin Department of Natural Resources, 2001). Table 1 summarizes the physical characteristics of the lake.

Table 1
Physical Characteristics of Pike Lake (Source: SEWRPC)

Parameter	Measurement
Area of Lake	470 acres
Area of Total Drainage Area	7,966 acres
Lake Volume	6,942 acre-feet
Residence Time	1.1 years
Depth Area of Lake Less than Five Feet	39 percent
Area of Lake 10 to 30 Feet	34 percent
Area of Lake More than 30 Feet	27 percent
Mean Depth	14 feet
Maximum Depth	45 feet

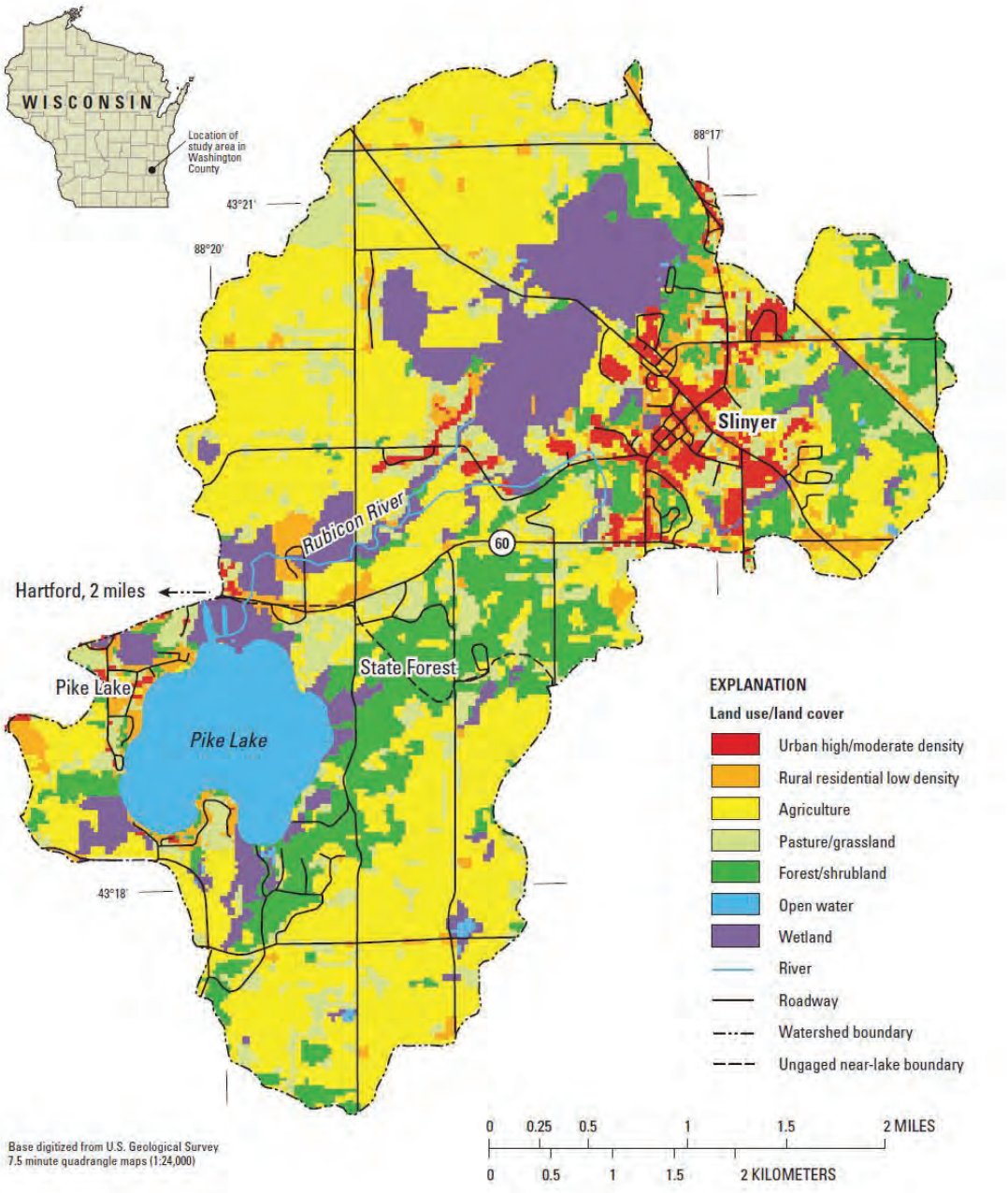


Figure 1.
Drainage basin of Pike Lake, Wis. Land use/land cover from WISCLAND geographic information coverage (Lillesand and others, 1998)(Source USGS).

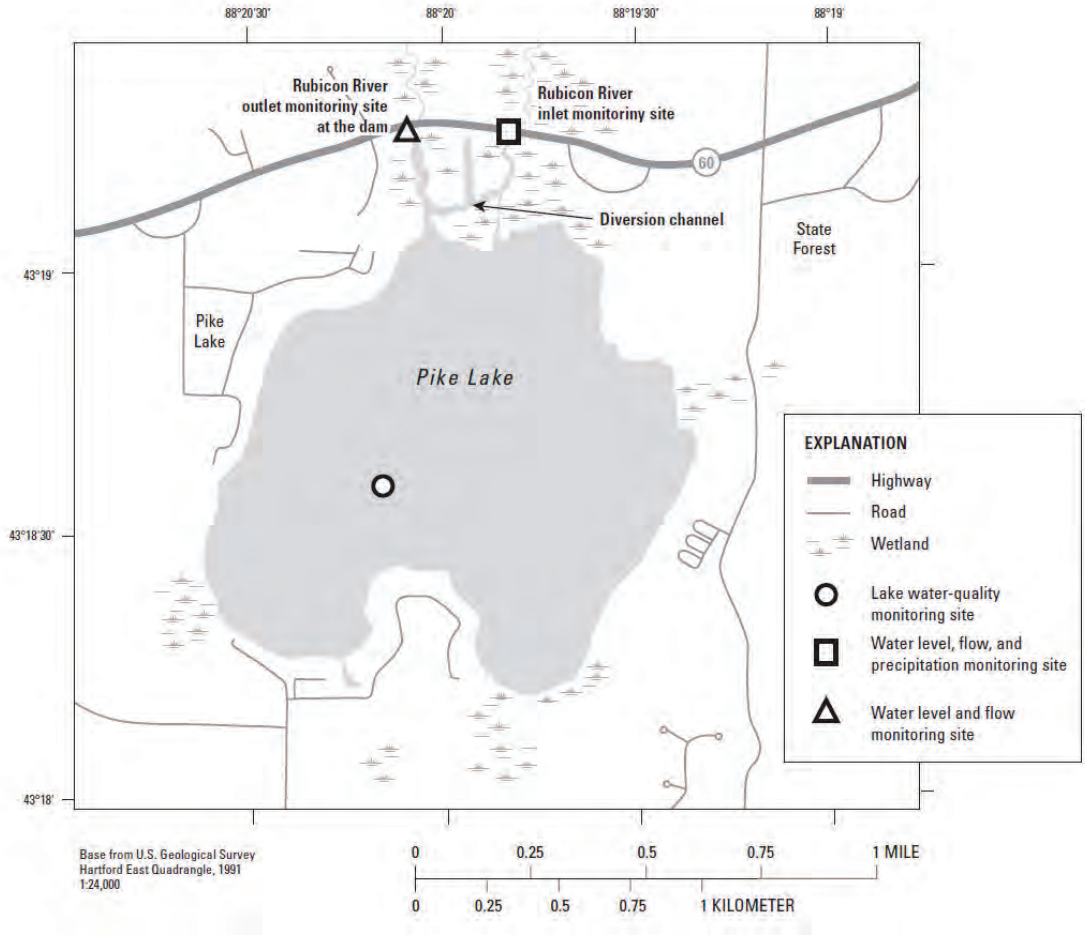


Figure 2.
Locations and types of data-collection sites at or near Pike Lake, Wis. (Source USGS)

DESCRIPTION OF WATERSHED

Pike Lake has one primary inlet and outlet formed by the Rubicon River, as shown on Figure 1. The River enters the Lake from the north through a natural channel which flows in a southerly direction, through a wetland complex, into the main lake basin. The Rubicon River leaves Pike Lake through a natural channel located approximately 400 feet west of the inlet, flowing northerly and westerly through the City of Hartford. The area of the watershed upstream of the State Highway 60 crossing of the Rubicon River is 7.95 square miles. The headwaters of the Rubicon River drain about a 1-square mile marsh just northwest of Slinger. The river flows in a generally southwesterly direction toward Pike Lake and receives effluent from the Slinger Wastewater Treatment Plant (WWTP).

Two intermittent, unnamed tributary streams also enter the Lake from the southeast and southwest, respectively; the southeastern-most tributary is locally known as Glasgow Creek. In addition, a number of springs and small streams enter the Lake from the east. The

Rubicon River eventually drains to the Rock River about 35 miles downstream, within Dodge County.

Land use in the Pike Lake watershed is a mix of agriculture, urban, forest, and wetland. Land use/land cover for the lake's watershed is summarized in Table 2.

Table 2
Land Use Pike Lake Watershed 2000 (Source: SEWRPC)

Land Use	Area (acres)	Percent of Total
Residential	945	11.9
Commercial	68	0.9
Industrial	62	0.8
Governmental and Institutional	98	1.2
Transportation, Communication, and Utilities	585	7.3
Recreational	127	1.6
Agricultural and Other Open Lands	3,739	46.9
Wetlands	1,030	12.9
Woodlands	773	9.7
Surface Water	514	6.5
Quarry	25	0.3
Total	**7,966**	**100.0**

HISTORIC LAKE WATER QUALITY

Based on the water quality parameters of total phosphorus, chlorophyll a, and water clarity (secchi disk transparency) Pike Lake can be considered to have good to fair water quality. The lake is classified as mesotrophic, or moderately nutrient rich. A detailed discussion of the water quality of the lake can be found in *A Lake Management Plan for Pike Lake Washington County Wisconsin*, prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in 2005. As part of the lake management plan SEWRPC identified that phosphorus was the limiting nutrient that controlled algae growth in Pike Lake.

Pike Lake has been monitored intermittently for water quality from 1973 through the present. Figures 3 through 5 illustrate the trends in available data for total phosphorus, chlorophyll a, and Secchi disk transparency. The data represents surface conditions at the deepest spot in the lake. The location of the sampling site is illustrated in Figure 2.

Total phosphorus concentrations for the 35-year record average 23 ug/l, slightly higher than the level of 20 ug/l recommended by SEWRPC in the Commissions adopted regional water quality management plan to prevent nuisance algae blooms. The data shows unusually high phosphorus concentration in 1993 and 1994 which are unexplained. With the exception of the peaks in the early 1990's, generally phosphorus concentrations in the lake do not show any dramatic increases over time.

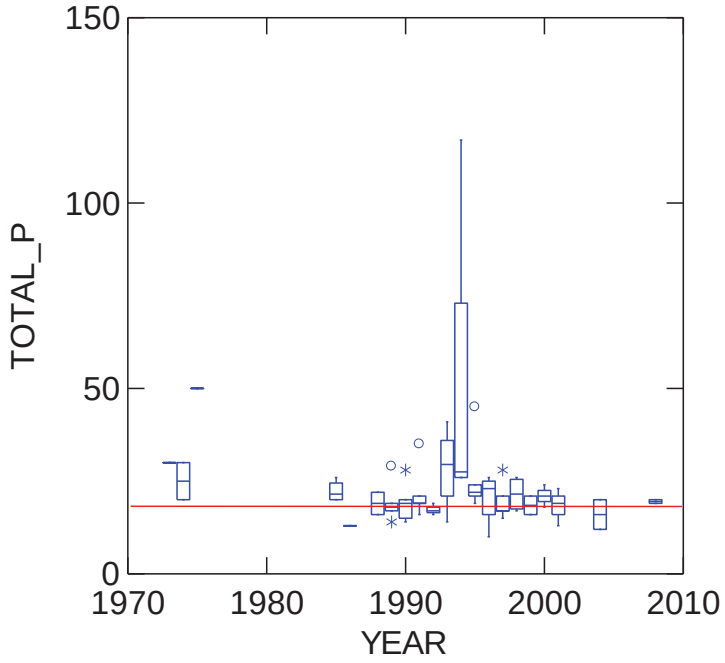


Figure 3
Annual Ranges of Total Phosphorus Concentration in ug/l
(Source: WDNR, USEPA STORET)

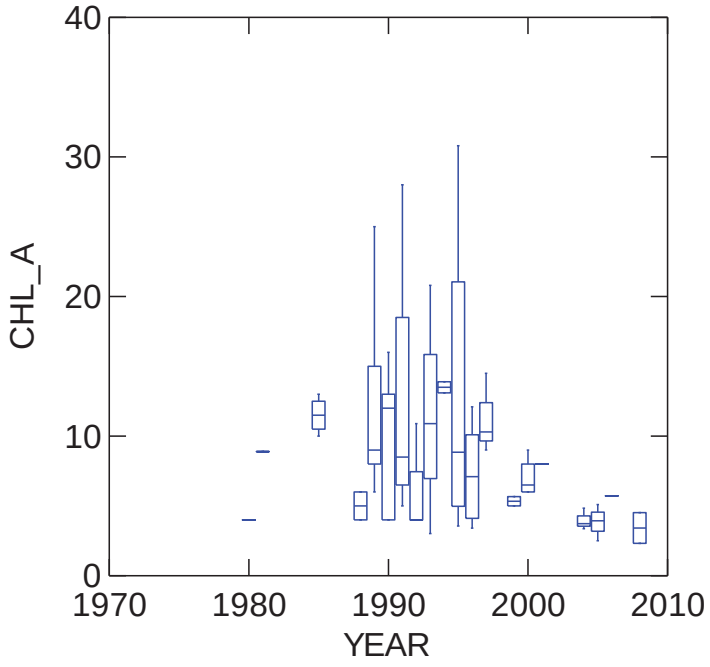


Figure 4
Annual Ranges of Chlorophyll a Concentration in ug/l
(Source: WDNR, USEPA STORET)

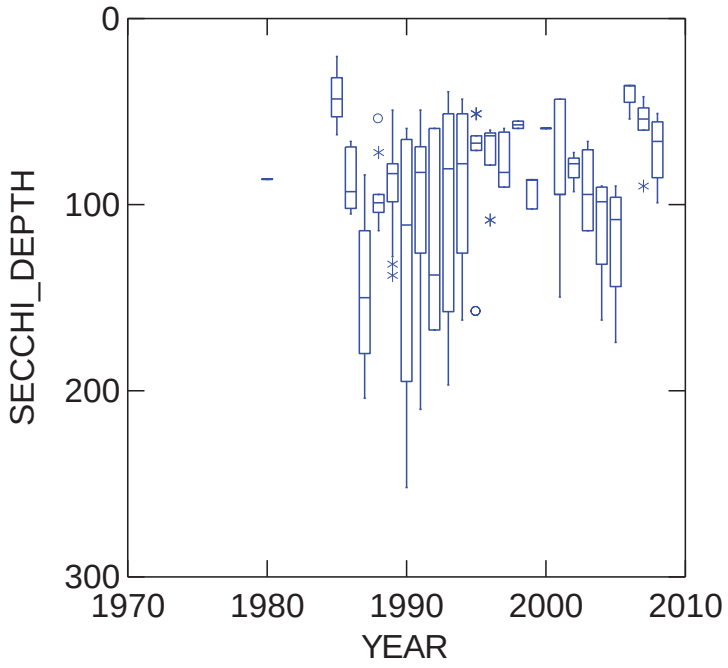


Figure 5
Annual Ranges of Secchi Transparency Depth in Inches
(Source: WDNR, USEPA STORET)

Chlorophyll a concentrations in Pike Lake, for the 28-year period of record, average 8.83 ug/l, indicating relatively low levels of planktonic algal growth in the center of the lake. Ranges in chlorophyll a concentrations decline after 1995 possible due the installation of the diversion project (Figure 4). Calendar years 2004 through 2008 illustrate the lowest range of chlorophyll a concentrations for the period of record.

Water clarity in Pike Lake, for the 28-year period of record, ranged from 20.4 to 252 inches, with a mean of 92.9 inches (7.75-feet). The data provides some interesting trends. While the ranges of lowest annual values have not generally declined, the frequency of clearer days has declined from the late 1980's/ early 1990's to the present. Trends in changes in water clarity do not follow the same trends as chlorophyll a and total phosphorus concentrations. The general theory is that higher total phosphorus concentrations result in higher populations of algae as indicated by the presence of chlorophyll a, resulting in poorer water clarity. The trends in Pike Lake raise the question, is the decline in water clarity due to other causes than algae growth and could it be due to increased suspended sediment levels. Data on suspended sediment is not available to answer this question.

SUMMARY OF USGS 1999-2000 RUBICON RIVER DIVERSION STUDY

In 1998 to 2000 the U.S. Geological Survey conducted a detailed water quality monitoring program to describe the water quality and hydrology of Pike Lake, quantify sources of phosphorus including the effects of short-circuiting of inflows as the result of the 1995 diversion project, and determine how changes in phosphorus loading should affect the water quality of the lake (Rose, et al., 2004). Measuring all significant water and phosphorus sources and estimating lesser sources was the method used to construct detailed water and phosphorus budgets. Table 3 summarizes the average annual water budget by percent of annual flow for the inflow and outflow for the lake. As we majority of inflow and outflow at Pike Lake is through the Rubicon River.

Table 3
Pike Lake Annual Water Budget by Percent Annual Flow for 1999 and 2000
(Source: USGS)

Inflows		Outflows	
Source	**Percent of Annual Flow**	**Source**	**Percent of Annual Flow**
Rubicon River	55	Rubicon River outlet	87
Ungaged near-lake surface inflow	20	Evaporation	13
Precipitation	17	-	-
Ground water	7	-	-

Total input of phosphorus to the lake was about 3,500 pounds in 1999 and 2,400 pounds in 2000. About 80 percent of the phosphorus was from the Rubicon River, about half of which came from the watershed and half from a waste-water treatment plant in Slinger, Wisconsin. Inlet-to-outlet short-circuiting of phosphorus is facilitated by a meandering segment of the Rubicon River channel through a marsh at the north end of the lake. It is estimated that 77 percent of phosphorus from the Rubicon River in monitoring year 1999 and 65 percent in monitoring year 2000 was short-circuited to the outlet without entering the main body of the lake.

Simulations using water-quality models within the Wisconsin Lake Model Suite (WiLMS) indicated Pike Lake's response to 13 different phosphorus-loading scenarios. These scenarios included a base "normal" year (2000) for which lake water quality and loading were known, six different percentage increases or decreases in phosphorus loading from controllable sources, and six different loading scenarios corresponding to specific management actions. Model simulations indicate that a 50-percent reduction in controllable loading sources would be needed to achieve a mesotrophic classification with respect to phosphorus, chlorophyll a, and Secchi depth (an index of water clarity). Model simulations indicated that short-circuiting of phosphorus from the inlet to the outlet was the main reason the water quality of the lake is good relative to the amount of loading from the Rubicon River and that changes in the percentage of inlet-to-outlet short-circuiting have a significant influence on the water quality of the lake.

DESCRIPTION OF SLINGER WASTEWATER TREATMENT PLAN

The Village of Slinger in 1950 installed a wastewater treatment plant on the Rubicon River upstream of Pike Lake. In 1981 the plant was expanded and today the sewage treatment facility has a hydraulic design capacity of 0.76 million gallons per day (MGD) on an average annual flow basis. The plant is an oxidation ditch design with clarification and chlorination. The current the flow rate is approximately 0.60 MGD on an average annual basis.

In 2001, the Village of Slinger completed preparation of a wastewater facilities plan to determine the best means of upgrading and expanding the Village's sewage treatment plant. In 2002, a sewage treatment plant facility plan amendment and sewage treatment plant capacity re-rating analysis was prepared for the Village of Slinger. The analysis indicated that the plant capacity could be increased to about 1.5 MGD with mechanical equipment modifications. Improvements to the plant which are currently underway will cost approximately $9 million. Part of the improvements - new influent pumps, fine bar screening, new grit remover, washer and compactor and SCADA system - were completed in 2004. Under construction are a new three ring oxidation ditch, two new clarifiers, ultraviolet disinfection system, and an additional sludge storage tank, increasing the sludge storage capacity to 1.76 million gallons.

On October 1, 2008 the Wisconsin Department of Natural Resource issued a renewed permit for the treatment plant which expires on September 30, 2013. The permit, located in Appendix A of this report, establishes standards for the effluent discharge. For biological oxygen demand (BOD), total suspended solids (TSS), and total phosphorus the effluent standards as follows:

- Biological oxygen demand (BOD) 30 mg/l (daily max), 15 mg/l (Monthly average)
- total suspended solids (TSS) 30 mg/l (daily max), 15 mg/l (Monthly average)
- total phosphorus 1 mg/l (Monthly average)

In 1999/2000 the USGS estimated that the Village of Slinger treatment plant discharged approximately 1,161 pounds per year of total phosphorus, or 39.3 percent of Pike Lake's annual phosphorus input (Rose, et al, 2004).. In the Rubicon River the treatment plant makes up approximately 8% of the annual flow and 49.9% of the annual total phosphorus load. The USGS estimated that elimination of the treatment plant discharge would reduce in-lake phosphorus concentrations by 21.6% and a 100% increase in discharge would increase in-lake phosphorus concentrations by 26.4%.

NEED FOR ABATEMENT OF PHOSPHORUS INPUTS

Pike Lake today has in-lake phosphorus concentrations above the level of 20 ug/l recommended by SEWRPC in the Commissions adopted regional water quality management plan to prevent nuisance algae blooms. The USGS in their report titled *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) identified that proposed doubling of the size of the Village of Slinger wastewater treatment plant could increase in lake phosphorus concentrations by 26.4% to as high as 35 ug/l, resulting in a 15.1% increase in chlorophyll a and 5.3% reduction in water clarity. Figure 6 illustrates the total phosphorus concentrations at the Rubicon River inlet to

Pike Lake at STH 60 for 1999 and 2000. Inflow total phosphorus concentrations at Highway 60 were measured to range from 58 to 756 ug/l, with a mean of 202 ug/l. During the two year study period an average of 2,325 pounds of phosphorus per year entered Pike Lake from the Rubicon River and 2091 pounds exited the lake through the outlet. Figure 7 illustrated the net inflow and outflow of phosphorus on individual days of the study year. To reduce in-lake total phosphorus concentrations to below the SEWRPC recommended level of 20 ug/l, assuming no inlet short-circuiting, existing inputs levels need to be reduced by 72% and future levels with the expansion of the treatment plant in Slinger by as much as 85%. Figure 8 illustrates the predicted trophic status of Pike Lake if no action is taken to control inputs of phosphorus (SEWRPC, 2005). Without mitigation measure SEWRPC predicts that Pike Lake will fall further into the impaired classification. The alternatives section of this report will evaluate alternatives available to reduce phosphorus inputs to Pike Lake from the Rubicon River.

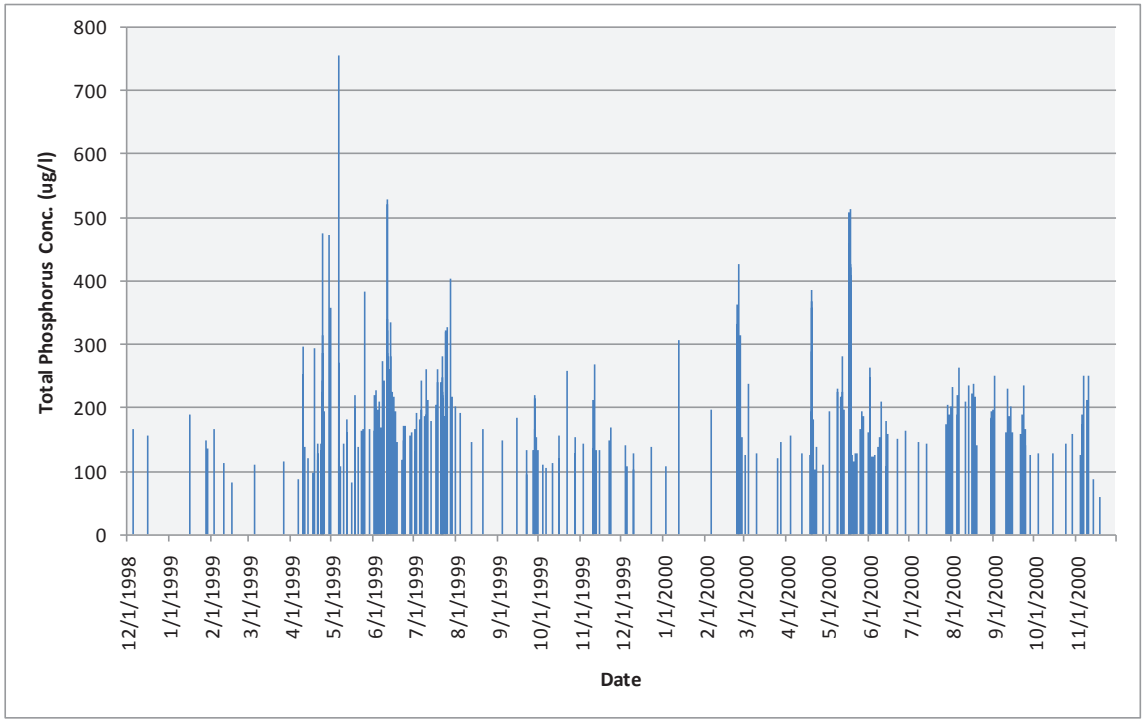


Figure 6
Total Phosphorus Concentrations Rubicon River Inlet to Pike Lake 1999 to 2000
(Source: USGS)

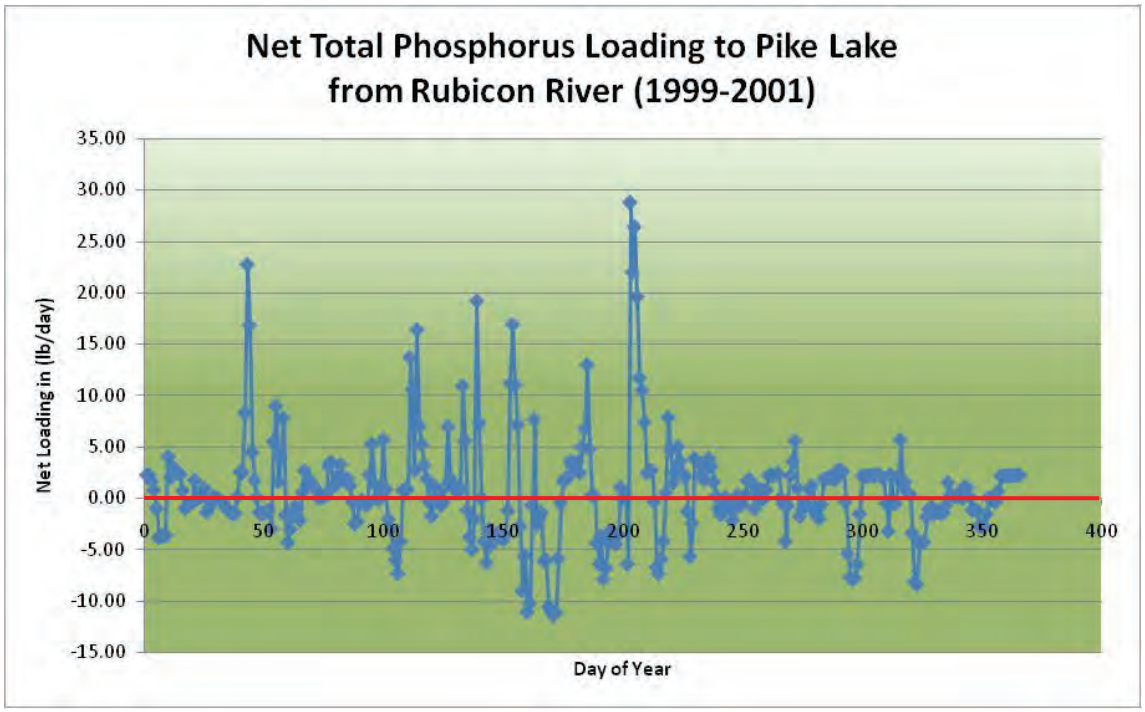
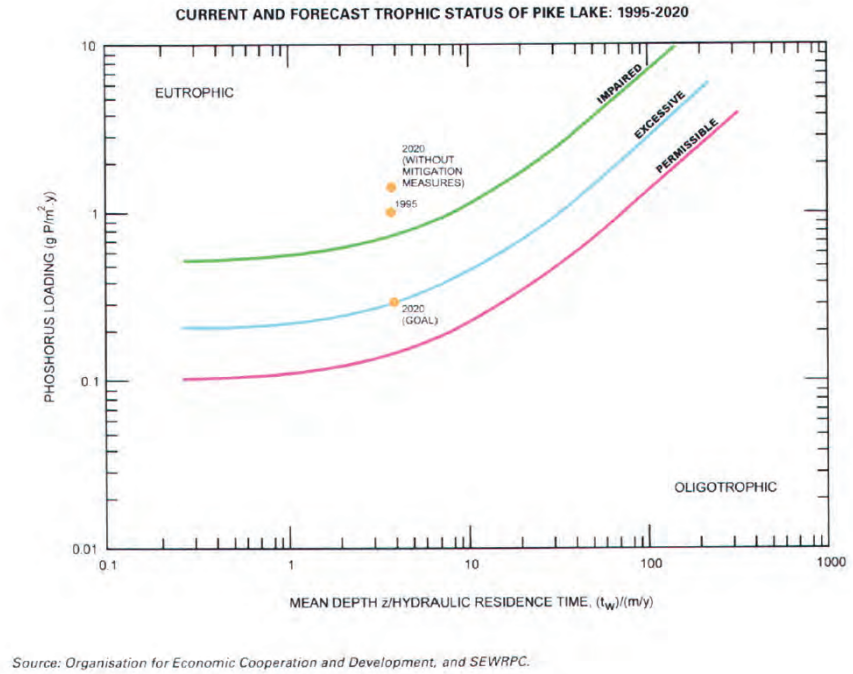


Figure 7
Daily Net Total Phosphorus Inputs and Outputs at Rubicon River 1999-2001



Source: Organisation for Economic Cooperation and Development, and SEWRPC.

Figure 8
Current and Forecasted Trophic Status of Pike Lake
(Source: SEWRPC)

HISTORY OF 1995 DIVERSION PROJECT

The major tributary to Pike Lake is the Rubicon River, which flows under State Highway 60 into the marsh at the north of the lake about 0.2 miles east of the lake's outlet (Figure 7). The area of the watershed upstream of the State Highway 60 crossing of the Rubicon River is 7.95 square miles. The River enters the Lake from the north through a natural channel which flows in a southerly direction, through a wetland complex, into the main lake basin. The Rubicon River leaves Pike Lake through a natural channel located approximately 400 feet west of the inlet, flowing northerly and westerly through the City of Hartford.

The Rubicon River channel, in the wetland complex, has undergone several changes in the last 60 years. Figure 7 illustrates the configuration of the inlet channel from 1941 through the present. As can be seen in the 1941 and 1950 aerials, the Rubicon River entered from the northeast and quickly curved to the west and exited the lake to the northwest. During these early years the base flow of the river had limited direct contact with the lake and needed to flow through approximately 150 feet of wetland to reach the lake. In the early 1960's a project to create lake access from the north was undertaken. This project illustrated in the 1963 aerial cut a wide deep channel through the marsh into the lake creating a diversion of flow of the Rubicon River more directly into the lake. In the 1980 aerial we see that the channel to west is beginning to become plugged with emergent wetland vegetation and most of the Rubicon River flow is going through the new man-made breach. By 1990 the western channel is completely blocked with vegetation and in 1995 all of the Rubicon River flow is directly into the lake.

In the fall of 1995, the new inflow channel to the lake was plugged and a diversion channel was constructed through the marsh at the north end of the lake connecting the inflow channel with the outflow channel to enhance the natural short-circuiting of high nutrient inflow to the outlet that existed prior to the 1960's (Figure 8). During flooding of 1997 and 1998 the plug began to wash away and in the 2000 and 2005 aerials we can see the start of an opening in the marsh fringe to the lake.

In July 2007 a survey by Hey and Associates of the Rubicon River channel identified that all of the flow of the river was flowing through the breach into the lake and no flow was going to the west towards the outlet. The westerly channel from the breach to the outlet was blocked by a beaver dam and the channel was filled with organic sediment (Figure 9). The survey found little evidence of the 1995 plug. All of the core clay material was gone and only a few pieces of the rip-rap were found. The channel bottom in the breach was solid and made up of clay. There was no evidence that the plug settled into the sediment and it appeared that plug was washed into the lake, likely by the large floods in June 1997 and August 1998, which both exceed 100-year frequency flows.

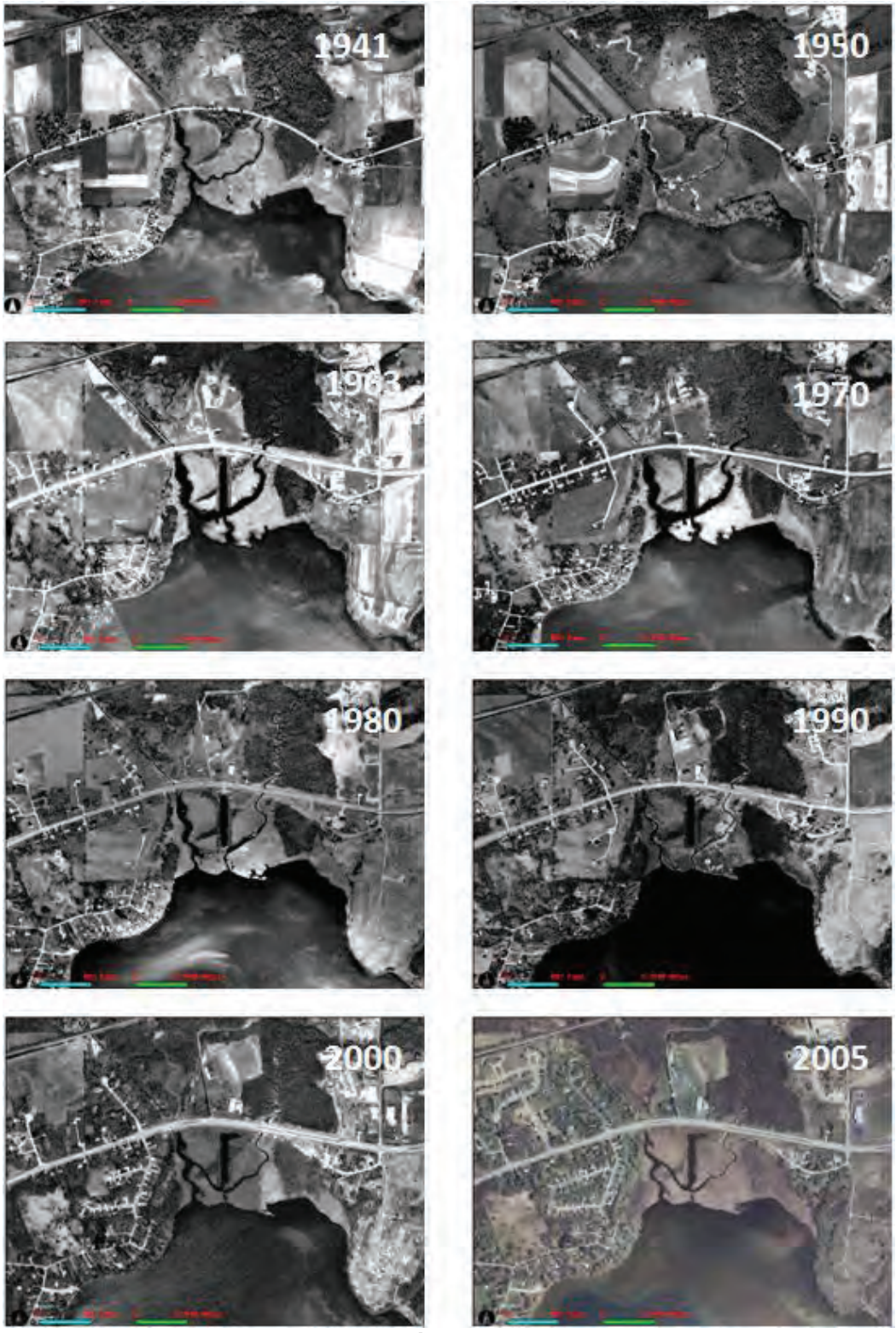


Figure 7
Pike Lake Inlet Aerial Photographs 1941 through 2005
(Source: Washington County)

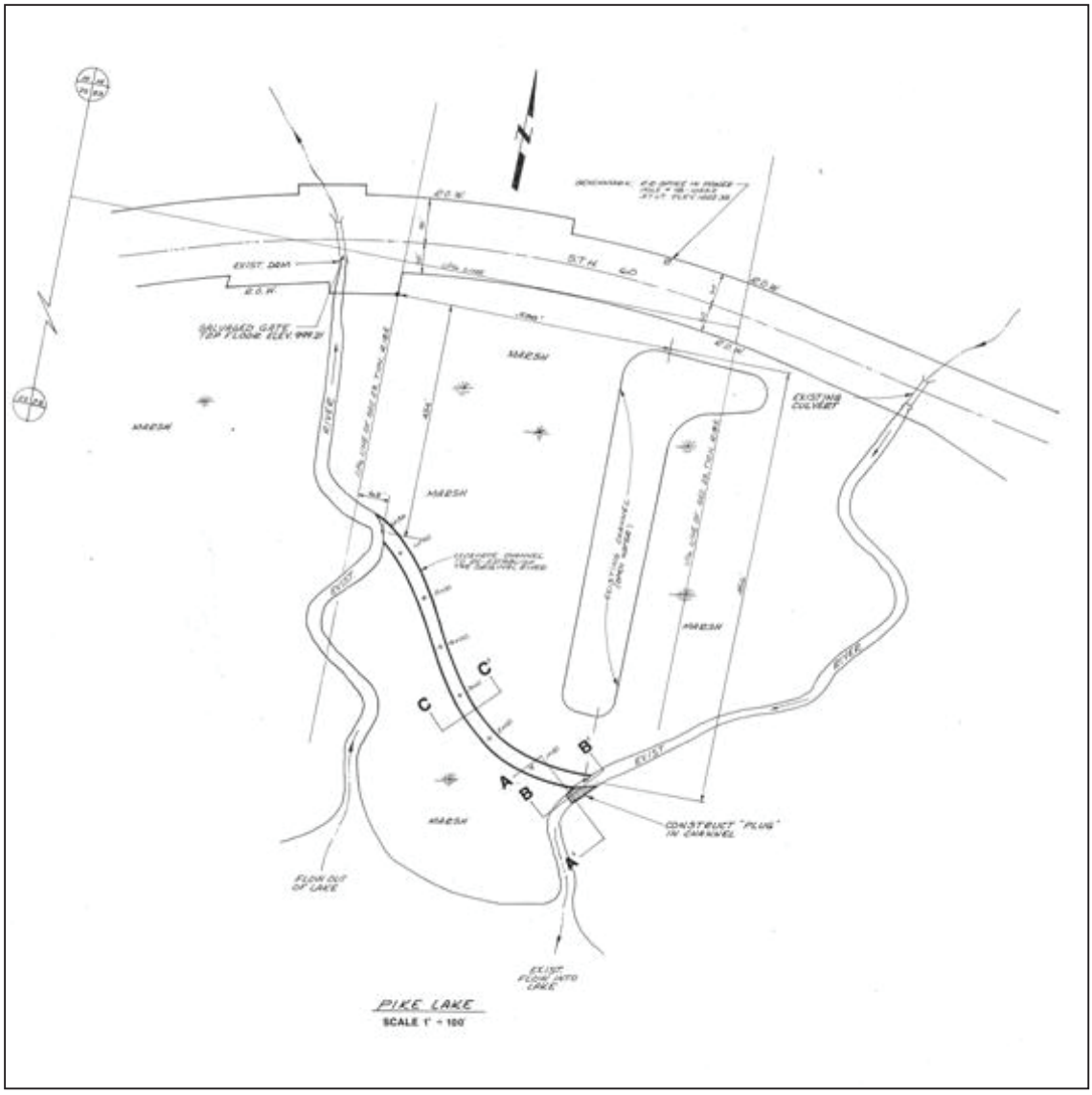


Figure 8
1995 Rubicon River Re-Diversion Project Plans
(Source: R. A. Smith National)

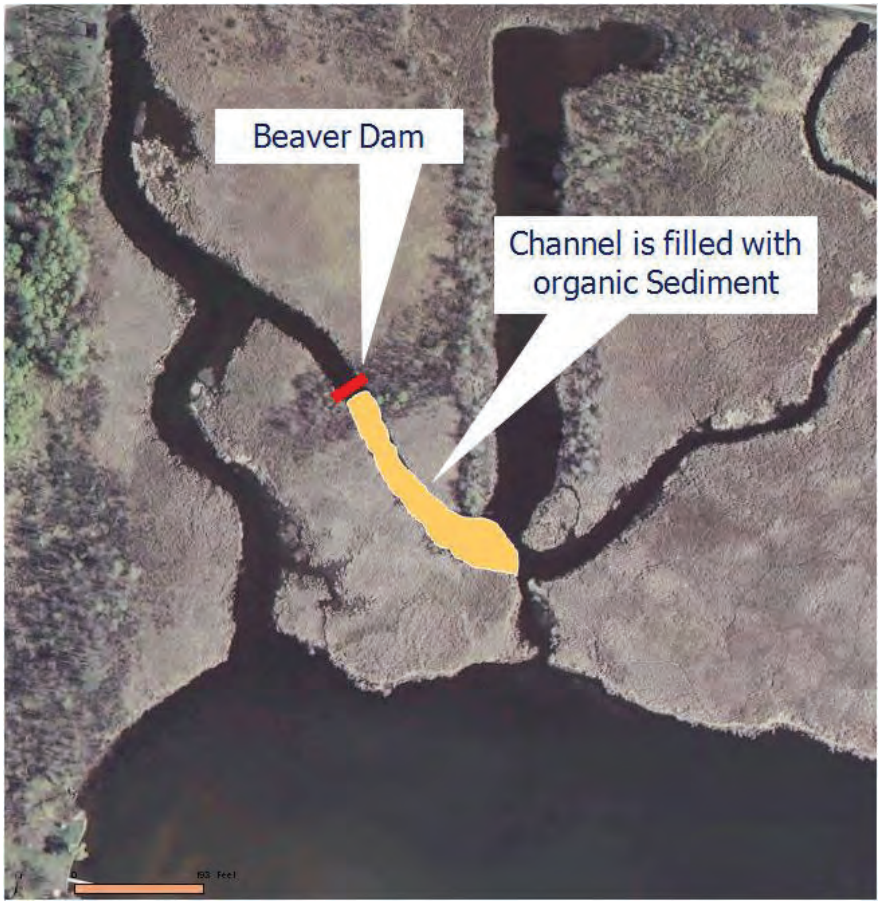


Figure 9 Location of Channel Blockage September 2007

EVALUATION OF ALTERNATIVES TO REDUCE PHOSPHORUS INPUTS FROM RUBICON RIVER

Alternatives to reduce total phosphorus inputs to Pike Lake from the Rubicon River fall into three broad categories:

- Source controls, to prevent pollutants from entering the stream
- Trapping of pollutants already in the river upstream of the lake
- Diversion options, to reduce the opportunity of pollutants from mixing with the main body of the lake

Source Controls

Source controls are pollution treatment practices that prevent contaminants from entering the Rubicon River and eventually Pike Lake.

Watershed Nonpoint Source Controls

Concept – Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants (point sources), comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. These pollutants include:

- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;
- Oil, grease, and toxic chemicals from urban runoff and energy production;
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks;
- Salt from irrigation practices and acid drainage from abandoned mines;
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems;

In the 2000 USGS study (Rose, et al., 2004) it was estimated that 2,441 pounds of phosphorus enter Pike Lake on an annual basis. Of this total amount 1,410.5 pounds, or 57.6%, is the result of nonpoint source pollution. Within the Rubicon River watershed 897 pounds per year, or 46.3%, of the total phosphorus input is from nonpoint sources. Table 4 summarizes the distribution of phosphorous inputs by land use (assuming no inlet short-circuiting). We see that the major source of phosphorus inputs (40.3% total and 35.0% to the Rubicon River) is from agriculture.

Table 4
Distribution of Phosphorous Inputs to Pike Lake by Land Use –2000[1]
(Source: USGS)

Land Use	Rubicon River		Total Lake Watershed	
	Pounds per Year	Percent of total	Pounds per Year	Percent of total
Urban	34.2	1.8	49.8	2.0
Agriculture	677.3	35.0	986.5	40.3
Pasture/grassland	95.7	4.9	139.4	5.7
Forest/wetland/open water	89.8	4.6	130.8	5.3
Precipitation on lake	-	-	60.0	2.4
Groundwater	-	-	44.0	1.8
Total NPS Sources	**897**	**46.3**	**1,410.5**	**57.6**
Slinger Wastewater Treatment Plant	1,039	53.7	1,039	42.4
Total all sources	**1,936**	**100.0**	**2,449.5**	**100.0**

[1] The above number does not include the estimated 65% inlet short-circuiting experienced in 2000. Slight difference in total loading is due to rounding of numbers.

SEWRPC in *A Lake Management Plan for Pike Lake Washington County Wisconsin* outlines a number of recommended nonpoint source controls for the Pike Lake watershed. In the management plan SEWRPC recommends a reduction of 25% in urban and rural nonpoint-sourced pollutants plus streambank erosion control, construction site erosion control, and onsite sewage disposal system management be achieved. A 25% reduction in existing nonpoint source pollution would result in a 353 pound per year reduction in phosphorus inputs from the entire watershed and 224 pound per year reduction from the Rubicon River watershed. This action would reduce the total phosphorus input to the lake from 2,450 pounds per year to 2,097 pounds per year or a total reduction of 14.4%.

Advantages – Implementation of nonpoint source pollution controls would achieve a large percentage of the needed 20% reduction in existing phosphorus source to the lake. Implementing these practices watershed wide would help reduce the nutrient inputs not only from the Rubicon River but also the watershed area south of STH 60.

Disadvantages – Agricultural runoff makes up 53% of the total phosphorus inputs to Pike Lake (Rose, et al., 2004). Nonpoint source pollution is generally exempt from the enforcement actions of the state and federal Clean Water Act, and therefore implementation of controls is predominantly voluntary. While cost share incentives from state and federal agencies have been available for over forty years to implement agricultural nonpoint source practices, many agricultural land owners have been reluctant to implement nonpoint source control practices such as manure storage or conservation tillage. There are no guarantees that implementation of the agricultural nonpoint source recommendations in lake management plan will ever be implemented.

Costs - Cost will vary depending on the individual practices implemented by each landowner.

Diversion of Slinger Wastewater to Hartford Treatment Plant

Concept – If the discharge of the Village of Slinger wastewater treatment plant was completely eliminated existing total phosphorus inputs to Pike Lake could be reduced by 1,039 pounds per year, a 42.4% reduction in total phosphorus input (Rose, et al., 2004). To eliminate the Slinger discharge the wastewater from the Village could be diverted to the City of Hartford treatment plant. The diversion would take place through the installation of a force main sewer from the existing Slinger plant to the Hartford plant. One potential route for the force main is illustrated in Figure 10.

Figure 10
Potential Route for Force Main to Connect Slinger Wastewater Treatment Plant to Hartford
(5.94 miles of Force Main)

Advantages – Elimination of the Village of Slinger treatment plant discharge would reduce total phosphorus inputs to Pike Lake by 42.4%.

Disadvantages – The predominant disadvantage of this alternative would be cost. Cost would include construction of 5.9 mile force main to move the waste from Slinger to Hartford and loss of the capital investment in the Slinger treatment plant. The diversion would cause the Hartford treatment plant, which currently has a design capacity of 3.6 MGD and 2003 average flows of 2.2 MGD, to have to be increased it size. The Village of Slinger is in the process of implementing over $10.3 million in improvements to expand the capacity of their plant from 0.76 MGD to 1.5 MGD. Slinger has recently been issued a discharge permit from the State of Wisconsin that allows operation of the new plant through 2013. It is politically unlikely that the Village of Slinger would indorse this alternative at this time.

Costs – Cost of a new force main could exceed $3 million. Loss of capital investment in the existing Slinger treatment plant is unknown but could exceed $25 million. Cost to expand the Hartford treatment plant is unknown.

Extension of Slinger Wastewater Treatment Plant Discharge Downstream of Pike Lake

Concept – Extending the discharge of the Village of Slinger wastewater treatment plant from its existing location to location downstream of Pike Lake would eliminate 1,039 pounds per year of phosphorus from entering the lake. This action would reduce annual phosphorus inputs by approximately 42.4%. Figure 11 illustrates a potential route for the new discharge pipe. This proposed route is located along the railroad right-a-way owned the Wisconsin Department of Transportation. The elevation at the current outfall is approximately 1.022 feet above sea level. The potential new outfall is a an elevation of 990 feet above sea level allowing a 32-foot drop potentially allowing a gravity feed pipe. The length of pipe needed is 12,360 feet (3.35 miles).

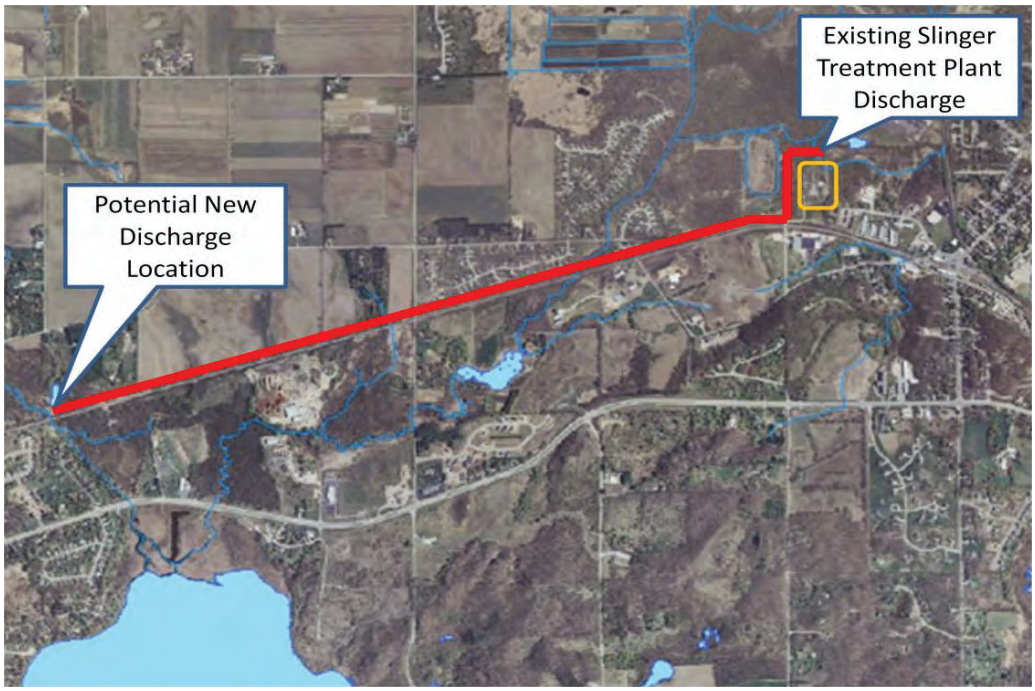


Figure 11
Potential Route for Extension of Village of Slinger Treatment Plant Outfall

Advantages – This alternative would completely eliminate the discharge of the Village of Slinger treatment plant, resulting in the elimination of 1,039 pounds per year of phosphorus from entering the lake under existing conditions and potentially 2,740 pounds per year when the new treatment plant reaches its full capacity.

Disadvantages – The main disadvantage would be cost for extending the existing discharge point 3.35 miles to the west.

Costs – Approximately $1.9 million (12,360 of pipe and 62 manholes).

Advanced Phosphorus Removal at Slinger Treatment Plant

Concept – Typical wastewater influent phosphorus concentration is 6.0 mg/l. In conventional wastewater treatment; only about 20 to 30% of the phosphorus is removed from the waste stream (Henze et al, 1995). Additional phosphorus can be removed through the implementation of advanced biological phosphorus removal and/or chemical phosphorus removal.

In the biological phosphorus removal, the main actors are bacteria known as polyphosphate accumulating organisms (PAOs) whose ability to take up large amounts of phosphorus from phosphates by exposing them to alternating anaerobic and anoxic/aerobic conditions is exploited.

In chemical phosphorus removal, a metal salt (usually aluminium and iron salts) is used to convert the dissolved inorganic phosphorus compounds in the wastewater into a low solubility metal phosphate which can be removed in the subsequent sedimentation stage of an activated sludge process.

Additional phosphorus removal can be achieved when the above methods are combined with tertiary filtration such as sand filtration or other tertiary removal processes. The following are typical total phosphorus effluent limits that can be reached with advanced phosphorus removal (Lancaster, 2008):

Achievable NPDES TP Permit Limits with Advanced Phosphorus Removal:

- Secondary systems w/o filtration
  - Biological removal 0.75 mg/L
  - Chemical removal 0.50 mg/L
- Secondary systems with sand filtration 0.20 mg/L
- Tertiary chemical processes
  - Ballasted flocculation 0.10 mg/L
  - Tertiary filtration 0.10 mg/L
  - Dissolved air floatation 0.20 mg/L
  - Solids contact 0.10 mg/L
  - Membranes 0.05 mg/L

The advantages of the different advanced phosphorus removal methods include:

- Biological phosphorus removal
  - Lower operating cost
  - Less sludge production
  - Easier to operate
  - Safer
- Chemical phosphorus removal
  - More reliable
  - Lower concentrations possible
  - Smaller footprint
- Tertiary chemical phosphorus removal
  - Even lower concentrations possible

The disadvantages of the different advanced phosphorus removal methods include:

- Biological phosphorus removal
  - Potential for phosphorus release from sludge
  - Larger footprint
  - Less reliable
  - Dependent on certain carbon sources (VFAs)
- Chemical phosphorus removal
  - High sludge production
  - High operating costs (chemical use)
- Tertiary chemical processes
  - High capital costs
  - High operating cost (chemical use, power consumption)

Today the current Slinger wastewater treatment plant receives influent with total phosphorus concentrations typically between 1.2 and 5.2 mg/l/. Effluent concentrations achieved form treatment typically range from 0.1 to 1.1 mg/l, averaging about 0.6 mg/l (Village of Slinger). If the average phosphorus concentration in the effluent was reduced from 0.6 to 0.2 mg/l through the use of biological or chemical phosphorus removal combined with sand filtration the annual phosphorus loading from the plant under current conditions (1,039 pounds per year) could be reduced to 343 pounds per year a 67% reduction. Through this action, total in-lake phosphorus inputs would be reduced by 28.4% under current conditions.

Under future condition as the Slinger treatment plant expands to double its average daily flow capacity, from 0.76 MGD to 1.5MGD, the reductions by using advanced phosphorus removal becomes even more important. Table 5 summarizes the potential changes in total phosphorus inputs to Pike Lake assuming the treatment plant is operating at full capacity, nonpoint source inputs do not change, and the average effluent total phosphorus concentration is either 0.6 mg/l total phosphorus or 0.2 mg/l. Without implementation of advanced phosphorus removal the total phosphorus inputs to Pike Lake as the plant discharge doubles could increase by 48%. With advanced phosphorus removal the total phosphorus inputs to Pike Lake would decrease by 33% under current conditions and by 17% when the new wastewater treatment plant reaches its full design capacity.

Table 5

Effects of Different Effluent Total Phosphorus Concentrations on Pike Lake Inputs Under Existing and Proposed Village of Slinger Treatment Plant Flow Capacities

Treatment Plant Average Daily Flow (MGD)	Effluent Conc. Total P (mg/l)	Effluent Annual P Loading (lb/yr)	NPS Loading (2000)(lb/yr)	Total Loading to Lake (lb/yr)	Percent change from Existing
0.76	0.6	1388.1	1410.5	2798.6	-
1.50	0.6	2739.7	1410.5	4150.2	+48.3
0.76	0.2	462.7	1410.5	1873.2	-33.3
1.50	0.2	913.2	1410.5	2323.7	-17.0

The new Village of Slinger wastewater treatment plan has been designed to allow integration of advanced phosphorus removal in the future.

Advantages – Advanced phosphorus removal could reduce existing total phosphorus inputs to Pike Lake by 33% and prevent phosphorus inputs from increasing in the future as the volume of effluent increases as the new plant goes on line. Under this alternative, even as the treatment plant reaches full capacity in the future the phosphorus loadings to the lake will be less than they are today by as much as 17%.

Disadvantages – Disadvantages include the following:

- Increased capital cost to add biological or chemical phosphorus removal and sand filters.
- Increased cost of annual plant operation and maintenance
- Increase volume of sludge to be disposed of annually

Costs – (unknown at this time until consultant meets with Village of Slinger Public Works staff)

Trapping Pollutants Upstream

The following section will discuss alternatives that are designed to trap pollutants that are already in the Rubicon River before they have an opportunity to enter Pike Lake.

Alum Injection Upstream of Lake

Concept – The process of adding aluminum sulfate salt, otherwise known as alum, to stormwater is called alum injection. Alum causes fine particles to coalesce (or flocculate) into larger particles (USEPA, 2009). Alum injection can help meet downstream pollutant load reductions by reducing concentrations of fine particles and soluble phosphorus.

Alum treatment systems generally consist of three parts, a flow-weighted dosing system, storage tanks that provide alum to the doser, and a downstream pond that allows the alum, pollutants and sediments to settle out (Kurz, 1998). When injected into stormwater or stream flow, alum forms the harmless precipitates aluminum phosphate and aluminum hydroxide. These precipitates combine with heavy metals and phosphorus and sink into the sediment in a stable, inactive state (WEF, 1992). The collected mass of alum precipitates, pollutants and sediments is commonly referred to as floc. Dosage rates, which range from 5 to 10 mg of Al per liter, are determined on a flow-weighted basis (Harper, 1996).

It's important to dispose of the floc that settles in downstream basins because it contains high concentrations of dissolved chemicals, as well as viable bacteria and viruses (Kurz, 1998). In addition to the settling pond, a separate floc collection pump-out facility should be installed to reduce the chance of re-suspension and transport of floc to receiving waterbodies. The facility's pumps dispose of the floc into a sanitary sewer system, a nearby upland area, or a sludge drying bed. Pumping into a sanitary sewer system requires a permit, however. The quantity of sludge produced at a site can be as much as 0.5 percent of the volume of water treated (Gibb et al., 1991).

Operation and maintenance for alum treatment is critical. Some typical items include:

- Routine inspection and repair of equipment, including the doser and pump-out facility.
- A trained operator should be on-site to adjust the dosage of alum and other chemicals, and possibly to regulate flows through the basin.
- Floc stored on-site in drying beds will need to be disposed of regularly.
- The settling basin must be dredged periodically to dispose of accumulated floc.

Limited performance data of alum injection is available in Table 1. One study (Harper and Herr, 1996) found high removal rates for total suspended solids (TSS), total phosphorus (TP) and fecal coliform bacteria. Another study (Carr, 1998) showed mixed results on total phosphorus and ortho-phosphorus.

Table 6
Literature Values of Alum Injection Removal Rates

Study	TSS	TP	Dis.-P	TN	Fecal Coliform Bacteria	Heavy Metals	Zinc	NH3
Harper and Herr, 1996	95-99	85-95	90-95	60-70	99	50-90	-	-
Carr, 1998	-	37	42	52.2	-	-	41	24.5

If we assume a total phosphorus removal rate of 80%, an upstream alum injection system could reduce the existing phosphorus inputs from the Rubicon River by 1,549 pounds per year to 387 pounds per year, and total lake inputs from 2,449 pounds per year to 900.7 pounds per year, a 63% reduction.

Advantages – This alternative if properly designed could reduce total phosphorus inputs from both point and nonpoint sources of pollution.

Disadvantages – Disadvantages include:

- Capital cost to install alum injection system
- Need to construct a settling pond to collect the floc
- Need to dispose of floc
- Need for a professional operator for the system

Costs – Construction costs for alum treatment systems range from $135,000 to $400,000, depending on the watershed size. Operation and maintenance costs, including routine and chemical inspections, range from $6,500 to $25,000 per year (Harper and Herr, 1996).

Wetland Treatment Systems

Concept –Constructed wetlands are water quality treatment practices that incorporate wetland plants in a shallow pool. As stormwater runoff flows through the wetland, pollutant removal is achieved by settling and biological uptake. While natural wetlands can sometimes be used to treat stormwater runoff that has been properly pretreated, stormwater wetlands are fundamentally different from natural wetland systems. Stormwater wetlands are designed specifically for the purpose of treating stormwater runoff, are designed to encourage sheet flow through the system, and typically have less biodiversity than natural

wetlands both in terms of plant and animal life. There are several design variations of the stormwater wetland, each design differing in the relative amounts of shallow and deep water, and dry storage above the wetland. Typical pollutant removal efficiencies for constructed wetlands is shown in Table 7.

Table 7.
Typical Pollutant Removal Rates of Wetlands (%) (Winer, 2000)

Pollutant	Stormwater Treatment Practice Design Variation			
	Shallow Marsh	ED Wetland[1]	Pond/Wetland System	Submerged Gravel Wetland[1]
Total Suspended Solids	83±51	69	71±35	83
Total Phosphorus	43±40	39	56±35	64
Total Nitrogen	26±49	56	19±29	19
Nitrite/nitrate	73±49	35	40±68	81
Metals	36 - 85	(-80) - 63	0 - 57	21 - 83
Bacteria	761	NA	NA	78

[1] Data based on fewer than five data points

To work effectively constructed wetlands need to consume about 3% to 5% of the land that drains to them. The Rubicon River watershed above Pike Lake is 7.85 square miles (5,088 acres) in size. To meet this design criteria a constructed wetland for treatment of the Rubicon River above Pike Lake would need to be between 153 and 254 acres in size.

Advantages – Constructed wetland act in a passive manner and require little annual maintenance. The wetland areas provide other benefits such as open space, wildlife habitat and aesthetics.

Disadvantages – The treatment practice consumes large geographic areas of land. Typically need to be built in low topographical areas to allow water to drain into and out of them by gravity. These areas are typically natural wetlands that need to be disturbed in the construction process. Permitting of constructed wetlands in Wisconsin is very difficult.

Costs – Cost of constructed wetlands can be $ 57,100 for a 1 acre-foot facility, $ 289,000 for a 10 acre-foot facility, and $ 1,470,000 for a 100 acre-foot facility (Brown and Schueler, 1997). Using these costs a constructed wetland to treat the entire Rubicon Rive system would be between $2,250,000 and $3,700,000.

Diversion Options

Diversion alternatives are practices that are designed to take pollutants that are already in the Rubicon River and diverting them around Pike Lake.

New channel along STH 60

Concept – The USGS study *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) documented that short-circuiting of the inflow of the Rubicon River to the outlet can provide reductions in the percent of phosphorus that enters Pike Lake. During the two year study the USGS estimated that the short-circuiting project implemented in 1995 provided a 65% reduction in phosphorus loading to Pike Lake. Unfortunately recent blockages of the diversion channel and erosion of new channel in the location of the old wetland breach are not allowing all of the flow of the Rubicon River to discharge directly into the lake. Reestablishing of a diversion of the Rubicon River could reduce phosphorus inputs to Pike Lake.

Figure 12 illustrates a plot of the percent of total phosphorus inputs to Pike Lake from the Rubicon River by average daily flow in cubic feet per second (cfs). From this graph we see for example, to reduce annual loading of total phosphorus by 70% we would need to bypass all flow events below 60 cfs. To bypass these flows into the bypass channel a diversion weir would need to be installed to force low-flows into the bypass and allow higher flows to enter the lake.

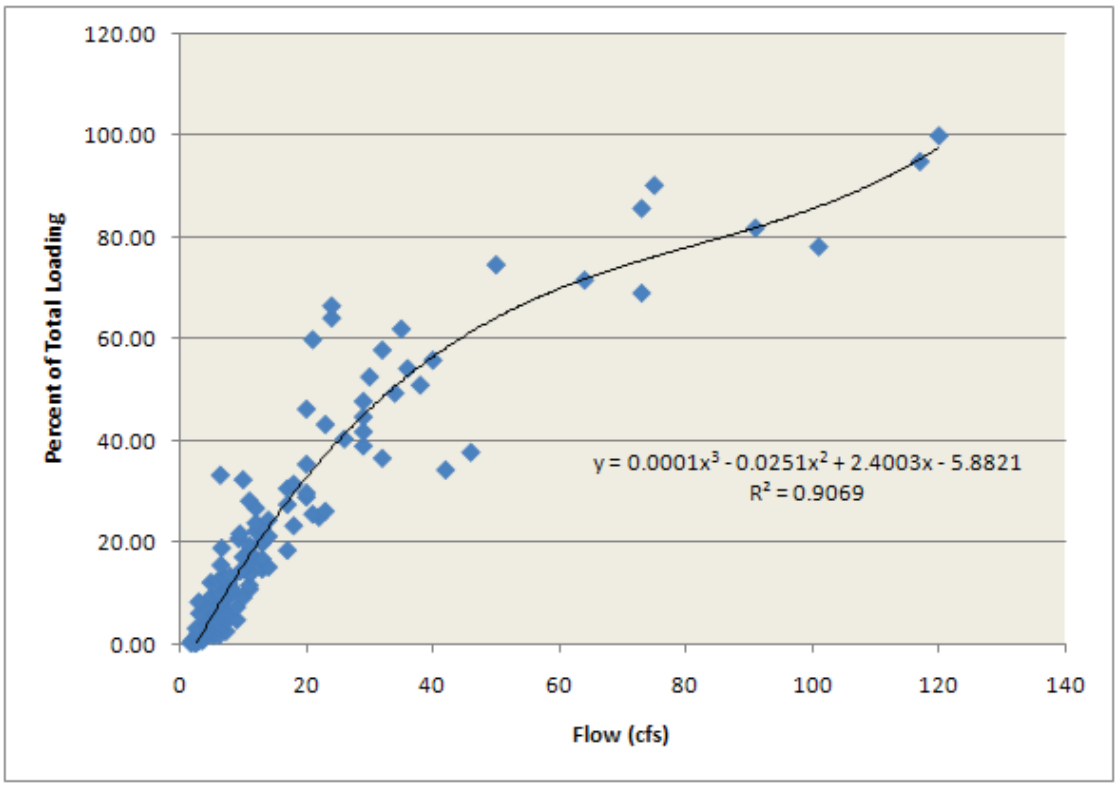


Figure 12
Plot of the Percent of Total Phosphorus Inputs to Pike Lake from the Rubicon River by Average Daily Flow

Construction of a new bypass channel along STH 60 would need to be located either north or south of the highway. Figure 13 illustrates two potential routes for the channel. A channel to the north of the highway would need to cross 4 private properties, cut through a hill 10-12 feet high, have a top with at its widest point of 77-feet, and have a length of approximately 1,250 feet. A channel south of the highway would be located in mapped wetland owned by the Town of Hartford. The channel would need to be 4 feet deep and have a length of approximately 1,100 feet.

Figure 13
Potential Routes for Diversion Channel along STH 60

Advantages – A properly designed diversion channel could restore the short-circuiting of the Rubicon River that took place prior to the 1960's. A channel designed to bypass the first 60 cfs of flow could reduce the total phosphorus inputs from the Rubicon River by 70% and total loading to the lake under existing conditions by 55.3%.

Disadvantages – A channel located north of STH 60 would require a channel that would be cut through four private properties, have a maximum cut depth of 10- to 12-feet, a channel width at its widest point of 77-feet, and disturb 0.4 acres of wetland. The channel would consume much of the front area of each developed lot and would completely eliminate the parking lot on the Timlin's property.

A channel south of STH 60 would disturb 0.9 acres of wetland.

Figure 14 illustrates the percent of annual flow into Pike Lake from the Rubicon River attributed by each range of flow in cfs. We see from this graph that if we bypass the first 60 cfs of flow, we would reduce the annual input of water from the river by approximately 70%, and total flow to the lake by 38.3%

Costs – Assuming a cost of $75/foot for channel construction, a channel north of STH 60 with a diversion weir would cost approximately $119,000 and south of the highway

approximately $107,500. These costs do not include design, permitting or acquisition of easements.

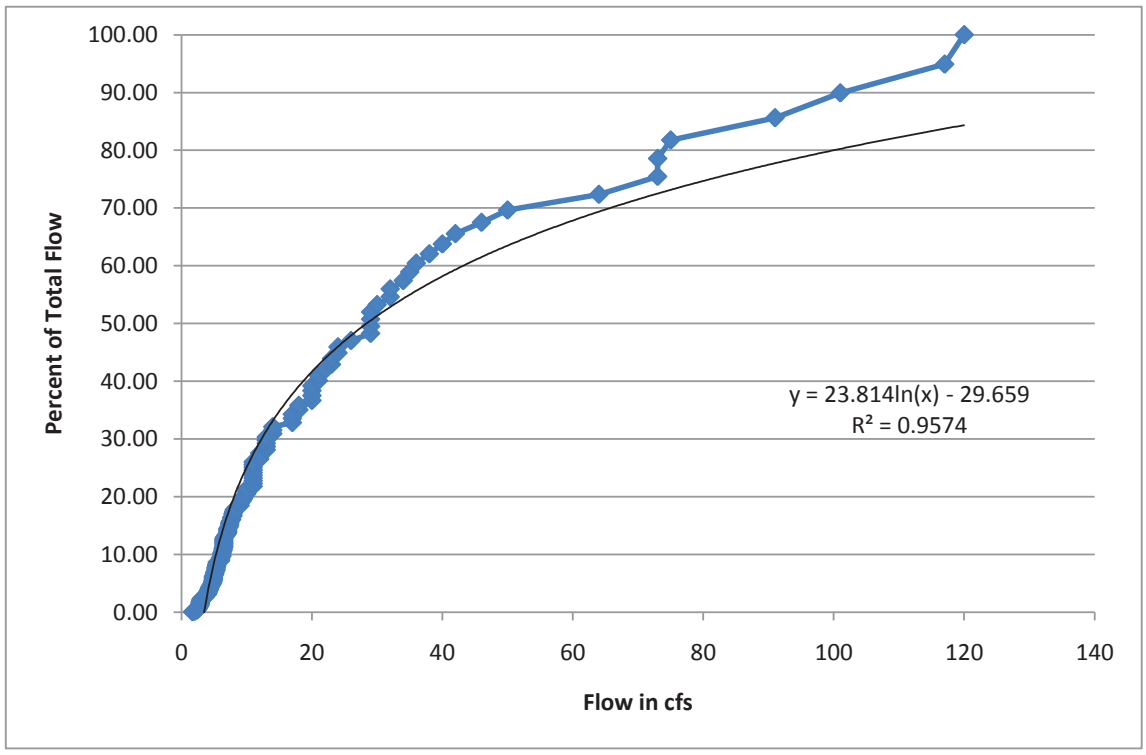


Figure 14
Percent of Annual Flow into Pike Lake from the Rubicon River Attributed by Each Range of Flow in Cubic Feet per Second (cfs)

Replacement of the Channel Plug in the Marsh on North End of Lake

Concept - The USGS study *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) documented that short-circuiting of the inflow of the Rubicon River to the outlet can provide reductions in the percent of phosphorus that enters Pike Lake. During the two year study the USGS estimated that the short-circuiting project implemented in 1995 provided a 65% reduction in phosphorus loading to Pike Lake. Unfortunately recent blockages of the diversion channel and erosion of new channel in the location of the old wetland breach are not allowing all of the flow of the Rubicon River to discharge directly into the lake. Reestablishing of a diversion of the Rubicon River could reduce phosphorus inputs to Pike Lake.

Under this alternative the original plug placed in 1995 would be replaced. The beaver dam in the diversion channel, which is causing sediment to accumulate in the channel, would be removed and the existing sediment in the channel would be allowed to scour downstream.

The 1995 plug was constructed with a compacted clay plug and 12-inch rip-rap on the lake side of the structure. Assuming that structure was constructed to specification, we see that even an engineered earthen structure is prone to damage during flood events that exceed the 100-year frequency.

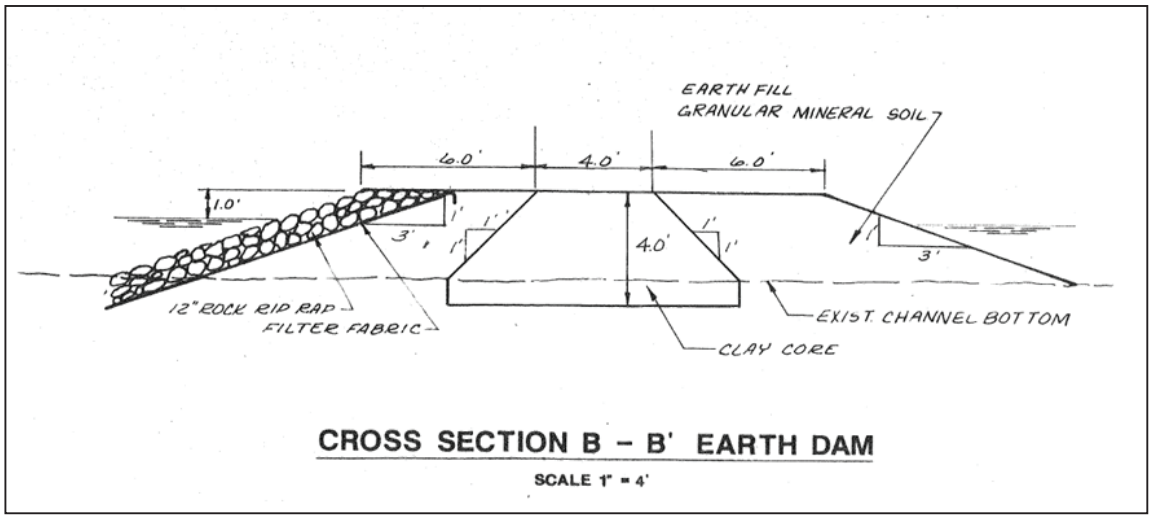


Figure 15
Cross Section of Wetland Plug Installed in 1995
(Source: R. A. Smith National)

To replace the plug there are several options:

- Replace the 1995 earthen structure, understanding that it may be damaged during another major flood event.
- Replace the plug with a structure that could withstand major floods such as a sheet-pile wall.
- Replace the structure with a low cost structure that likely fail in large flood events but would be easily replaced. Figure 16 illustrates a low cost alternative structure made out of steel cable and wire mesh fencing, called a “Cable Dam”.

Cable dams have been described as man-made beaver dams. They are designed to trap debris and over time become very compact with material creating a structure that inhibits water flow and resembles a beaver dam. They are low cost to construct and can be assembled without heavy construction equipment.

Advantages – the advantage of replacing the plug is it could utilize the existing diversion channel that was constructed in 1995. The previous study by USGS illustrated that the diversion channel combined with the plug could short-circuit 65% of the Rubicon River phosphorus loadings.

Disadvantages – Disadvantages of replacing the plug include:

- Potential disturbance to the marsh areas near the plug during construction.

- Aesthetics would be a concern if a sheet-pile or other man-made material was used to construct the structure.
- Installation of this practice may provide disincentive to implementing other upstream source controls, as public may perceive this is all that is need to protect the lake.

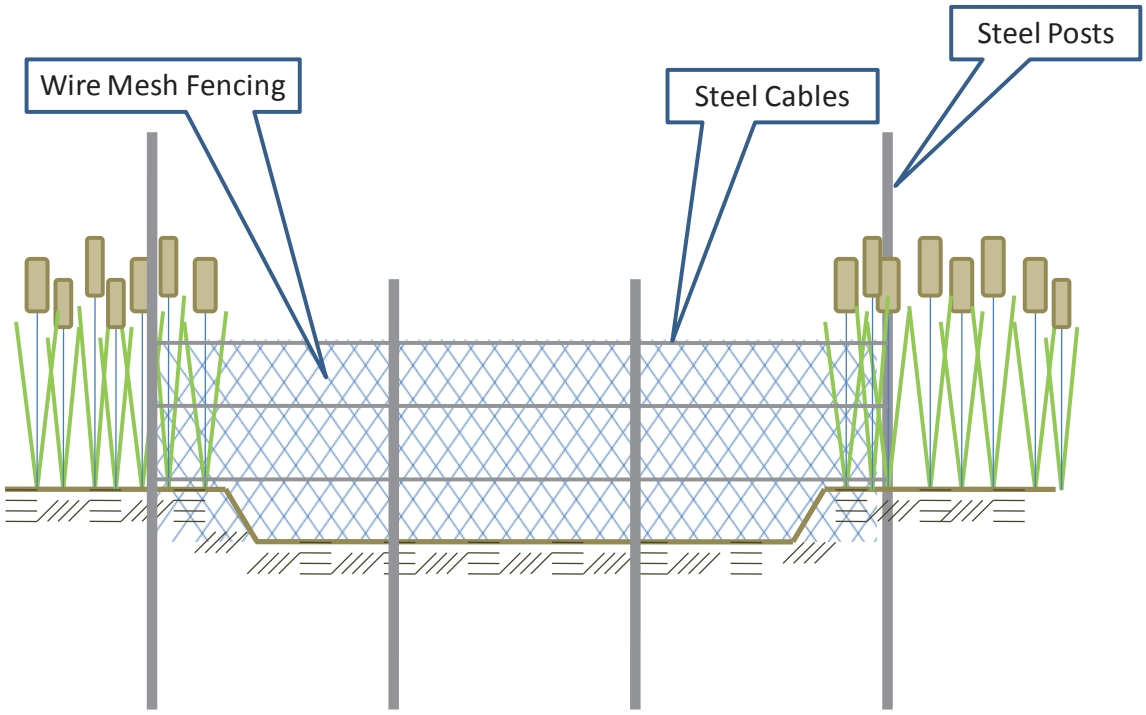


Figure 16
Cross-Section Cable Dam

Costs – Cost for the plug replacement will vary depending on the type of structure used. The following are cost estimates for three types of structures:

• 1995 style earthen plug	$50,000 to $75,000
• Steel sheet pile plug (60-feet)	$25,000 to $50,000
• Cable Dam	$ 2,500 to $7,500

RECOMMENDATIONS

Pike Lake today has in-lake phosphorus concentrations above the level of 20 ug/l recommended by SEWRPC in the Commissions adopted regional water quality management plan to prevent nuisance algae blooms. The USGS in their report titled *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) identified that proposed doubling of the size of the Village of Slinger wastewater treatment plant could increase in lake phosphorus concentrations by 26.4% to as high as 35 ug/l, resulting in a 15.1% increase in chlorophyll a and 5.3% reduction in water clarity. To reduce in-lake total phosphorus concentrations to below the SEWRPC

recommended level of 20 ug/l, assuming no inlet short-circuiting, existing inputs levels need to be reduced by 72% and future levels with the expansion of the treatment plant in Slinger by as much as 85%. Without mitigation measure SEWRPC predicts that Pike Lake will fall further into the impaired classification.

Phosphorus is entering Pike Lake from a variety of sources with the most important being nonpoint source pollution (57.6%) and the Slinger Wastewater Treatment Plant (42.4%). A review of management alternatives shows that control of any one source alone will not achieve the needed reductions in phosphorus inputs to the lake. Therefore the following series of recommendations are made to achieve the proposed reduction goals. Implementation of all of the recommendations will be needed to protect Pike Lake. Implementation of only one will not achieve the needed in-lake phosphorus levels.

Recommendation 1: Nonpoint Source Controls in watershed

In the 2000 USGS study (Rose, et al., 2004) it was estimated that 2,441 pounds of phosphorus enter Pike Lake on an annual basis. Of this total amount 1,410.5 pounds, or 57.6%, is the result of nonpoint source pollution. Within the Rubicon River watershed 897 pounds per year, or 46.3%, of the total phosphorus input is from nonpoint sources. The major source of nonpoint source pollution phosphorus inputs (40.3% total and 35.0% to the Rubicon River) is from agriculture.

SEWRPC in *A Lake Management Plan for Pike Lake Washington County Wisconsin* outlines a number of recommended nonpoint source controls for the Pike Lake watershed. In the management plan SEWRPC recommends a reduction of 25% in urban and rural nonpoint-sourced pollutants plus streambank erosion control, construction site erosion control, and onsite sewage disposal system management be achieved. A 25% reduction in existing nonpoint source pollution would result in a 353 pound per year reduction in phosphorus inputs from the entire watershed and 224 pound per year reduction from the Rubicon River watershed. This action would reduce the total phosphorus input to the lake from 2,450 pounds per year to 2,097 pounds per year or a total reduction of 14.4%.

Implementation of nonpoint source pollution controls would achieve a percentage of the needed 72% reduction in existing phosphorus sources to the lake. Implementing these practices watershed wide would help reduce the nutrient inputs not only from the Rubicon River but also the watershed area south of STH 60. The Washington County Land Conservation Department should take the lead in working with agricultural land owners in implementing agricultural runoff controls. The Pike Lake Inland Lake Protection and Rehabilitation District should consider developing a cost share funding program to assist with the implementation of nonpoint sources control practices when state or federal assistance is not available.

Recommendation 2: Advanced Phosphorus Removal at Slinger Treatment Plant

Typical wastewater influent phosphorus concentration is 6.0 mg/l. In conventional wastewater treatment; only about 20 to 30% of the phosphorus is removed from the waste stream (Henze et al, 1995). Additional phosphorus can be removed through the implementation of advanced biological phosphorus removal and/or chemical phosphorus removal.

Today the current Slinger wastewater treatment plant receives influent with total phosphorus concentrations typically between 1.2 and 5.2 mg/l/. Effluent concentrations achieved form treatment typically range from 0.1 to 1.1 mg/l, averaging about 0.6 mg/l (Village of Slinger). If the average phosphorus concentration in the effluent was reduced from 0.6 to 0.2 mg/l through the use of biological or chemical phosphorus removal combined with sand filtration the annual phosphorus loading from the plant under current conditions (1,039 pounds per year) could be reduced to 343 pounds per year a 67% reduction. Through this action, total in-lake phosphorus inputs would be reduced by 28.4% under current conditions.

Under future condition as the Slinger treatment plant expands to double its average daily flow capacity, from 0.76 MGD to 1.5MGD, the reductions by using advanced phosphorus removal becomes even more important. Without implementation of advanced phosphorus removal the total phosphorus inputs to Pike Lake as the plant discharge doubles could increase by 48%. With advanced phosphorus removal the total phosphorus inputs to Pike Lake would decrease by 33% under current conditions and by 17% when the new wastewater treatment plant reaches its full design capacity. The current Wisconsin water quality regulations do not require treatment below 1 mg/l, the WDNR is considering new stream and lake water quality standards that could allow discharge requirements below the 1 mg/l level. Regardless of the actions by the state on new phosphorus standards, the Village of Slinger should install advanced phosphorus removal to protect Pike Lake.

Recommendation 3: Replacement of the Channel Plug with Cable Dam

The USGS study *Water Quality, Hydrology, and the Effects of Changes in Phosphorus Loading to Pike Lake, Washington County, Wisconsin, with Special Emphasis on Inlet-to-Outlet Short-Circuiting* (Rose, et al., 2004) documented that short-circuiting of the inflow of the Rubicon River to the outlet can provide reductions in the percent of phosphorus that enters Pike Lake. During the two year study the USGS estimated that the short-circuiting project implemented in 1995 provided a 65% reduction in phosphorus loading to Pike Lake. Unfortunately recent blockages of the diversion channel and erosion of a new channel in the location of the old wetland breach are not allowing all of the flow of the Rubicon River to discharge directly into the lake. Reestablishing of a diversion of the Rubicon River could reduce phosphorus inputs to Pike Lake. The use of an earthen plug or sheet piling could be effective, however would require access by heavy equipment and have high costs. At this time a cable dam is recommended for its low cost and minimal disturbance to the existing marsh area.

Recommendation 4: Continued Management of Beavers in the Rubicon River.

In July 2007 a survey by Hey and Associates of the Rubicon River channel identified that all of the flow of the river was flowing through the breach into the lake and no flow was going to the west towards the outlet. The westerly channel from the breach to the outlet was blocked by a beaver dam. In 2008 the beaver dam was removed by a local resident. Beaver are well established in the Rubicon River system and could return to the Inlet of Pike Lake, again causing a blockage of flow. Annually a survey of the Rubicon River at the north end of Pike Lake should be conducted to determine if beaver have returned and are constructing structures that are impeding flow. The beaver should be removed by trapping. Information on trapping regulations can be found at the Wisconsin DNR website at: www.dnr.wi.gov/org/land/wildlife/trap/.

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Appendix A
On October 1, 2008 the Wisconsin Department of Natural Resource Permit for Slinger Waste Water Treatment Plant

WPDES PERMIT

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

PERMIT TO DISCHARGE UNDER THE WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM

Slinger Wastewater Treatment Facility

is permitted, under the authority of Chapter 283, Wisconsin Statutes, to discharge from a facility located at
280 Hartford Road, Slinger WI 53086
to

a tributary to the Rubicon River in Washington County

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

The permittee shall not discharge after the date of expiration. If the permittee wishes to continue to discharge after this expiration date an application shall be filed for reissuance of this permit, according to Chapter NR 200, Wis. Adm. Code, at least 180 days prior to the expiration date given below.

State of Wisconsin Department of Natural Resources
For the Secretary

By _____
Timothy Thompson
Basin Engineer

_____
Date Permit Signed/Issued

PERMIT TERM: EFFECTIVE DATE - October 01, 2008 **EXPIRATION DATE - September 30, 2013**

TABLE OF CONTENTS

1 Influent Requirements

1.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
701	Influent 24 hour sampler intake located at a point prior to bar screening and before the addition of any side stream.

1.2 Monitoring Requirements

The permittee shall comply with the following monitoring requirements.

1.2.1 Sampling Point 701 - INFLUENT PLANT

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Continuous	Continuous	
BOD_5, Total		mg/L	3/Week	24-Hr Flow Prop Comp	
Suspended Solids, Total		mg/L	3/Week	24-Hr Flow Prop Comp	
Phosphorus, Total		mg/L	2/Month	24-Hr Flow Prop Comp	
Nickel, Total Recoverable		µg/L	Quarterly	24-Hr Flow Prop Comp	The influent sample shall be taken on the day before the effluent sample. Also see the notes for effluent zinc and copper monitoring in Section 2.
Zinc, Total Recoverable		µg/L	Quarterly	24-Hr Flow Prop Comp	The influent sample shall be taken on the day before the effluent sample. Also see the notes for effluent zinc and copper monitoring in Section 2.

2 Surface Water Requirements

2.1 Sampling Point(s)

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
001	Effluent 24 hour sampler intake located at a point after the UV system but before the Parshall flume. Grab samples shall be collected from the reaeration steps.

2.2 Monitoring Requirements and Effluent Limitations

The permittee shall comply with the following monitoring requirements and limitations.

2.2.1 Sampling Point (Outfall) 001 - EFFLUENT

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Flow Rate		MGD	Continuous	Continuous	
BOD_5, Total	Daily Max	30 mg/L	3/Week	24-Hr Comp	
BOD_5, Total	Monthly Avg	15 mg/L	3/Week	24-Hr Comp	
Suspended Solids, Total	Daily Max	30 mg/L	3/Week	24-Hr Comp	
Suspended Solids, Total	Monthly Avg	20 mg/L	3/Week	24-Hr Comp	
Nitrogen, Ammonia (NH_3-N) Total	Daily Max	17 mg/L	2/Week	24-Hr Comp	Year round limit
Nitrogen, Ammonia (NH_3-N) Total	Weekly Avg	6.4 mg/L	2/Week	24-Hr Comp	April limit
Nitrogen, Ammonia (NH_3-N) Total	Weekly Avg	2.6 mg/L	2/Week	24-Hr Comp	May-September limit
Nitrogen, Ammonia (NH_3-N) Total	Weekly Avg	9.1 mg/L	2/Week	24-Hr Comp	October limit
Nitrogen, Ammonia (NH_3-N) Total	Weekly Avg	10 mg/L	2/Week	24-Hr Comp	November-March limit
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	2.6 mg/L	2/Week	24-Hr Comp	April limit
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	1.0 mg/L	2/Week	24-Hr Comp	May-September limit
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	3.6 mg/L	2/Week	24-Hr Comp	October limit
Nitrogen, Ammonia (NH_3-N) Total	Monthly Avg	4.1 mg/L	2/Week	24-Hr Comp	November-March limit
pH Field	Daily Max	9.0 su	Daily	Grab	
pH Field	Daily Min	6.0 su	Daily	Grab	

Monitoring Requirements and Effluent Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Dissolved Oxygen	Daily Min	4.0 mg/L	5/Week	Grab	
Fecal Coliform	Geometric Mean	400 #/100 ml	Weekly	Grab	May-September only
Phosphorus, Total	Monthly Avg	1.0 mg/L	3/Week	24-Hr Comp	
Nickel, Total Recoverable		µg/L	Quarterly	24-Hr Flow Prop Comp	The effluent sample shall be taken on the day after the influent sample. If possible, the effluent sample should be on a day when a chronic WET sample is taken.
Zinc, Total Recoverable		µg/L	Quarterly	24-Hr Flow Prop Comp	The effluent sample shall be taken on the day after the influent sample. If possible, the effluent sample should be on a day when a chronic WET sample is taken.
Chloride	Weekly Avg	605 mg/L	4/Month	24-Hr Flow Prop Comp	Monitoring shall be done on four consecutive days each month. Also see section 2.2.1.4
Acute WET		TU_a	Quarterly	24-Hr Flow Prop Comp	Twice during permit term. See section 2.2.1.3 for listed quarters
Chronic WET	Daily Max	1.0 rTU_c	Quarterly	24-Hr Flow Prop Comp	See section 2.2.1.3 for potential removal of limit.

2.2.1.1 Average Annual Design Flow

The average annual design flow of the permittee's wastewater treatment facility is 1.5 MGD.

2.2.1.2 Sample Analyses

Samples shall be analyzed using a method which provides adequate sensitivity so that results can be quantified, unless not possible using the most sensitive approved method.

2.2.1.3 Whole Effluent Toxicity (WET) Testing

Primary Control Water: Since the receiving water may be near or at zero flow upstream of the discharge during various times of the year, moderately hard laboratory water may be used for control water.

Instream Waste Concentration (IWC): 100%

Dilution series: At least five effluent concentrations and dual controls must be included in each test.

- **Acute:** 100, 50, 25, 12.5, 6.25% and any additional selected by the permittee.
- **Chronic:** 100, 30, 10, 3, 1% (if the IWC $\leq$30%) or 100, 75, 50, 25, 12.5% and any additional selected by the permittee.

WET Testing Frequency: Tests are required during the following quarters.

- **Acute:** July-September 2010; January-March 2012
- **Chronic:** The quarterly monitoring and limit of 1.0 rTUc shall continue beginning from the first quarter of 2009. The limit may be discontinued if there are no chronic toxicity failures within the first eight quarters of monitoring (ending at the fourth quarter of 2010) and subsequent monitoring frequency may be reduced to once per year.

Reporting: The permittee shall report test results on the Discharge Monitoring Report form, and also complete the "Whole Effluent Toxicity Test Report Form" (Section 6, "*State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition*"), for each test. The original, complete, signed version of the Whole Effluent Toxicity Test Report Form shall be sent to the Biomonitoring Coordinator, Bureau of Watershed Management, 101 S. Webster St., P.O. Box 7921, Madison, WI 53707-7921, within 45 days of test completion. The original Discharge Monitoring Report (DMR) form and one copy shall be sent to the contact and location provided on the DMR by the required deadline.

Determination of Positive Results: An acute toxicity test shall be considered positive if the Toxic Unit - Acute (TU_a) is greater than 1.0 for either species. The TU_a shall be calculated as follows: If $LC_{50} \geq 100$, then $TU_a = 1.0$. If LC_{50} is < 100, then $TU_a = 100 \div LC_{50}$. A chronic toxicity test shall be considered positive if the Relative Toxic Unit - Chronic (rTU_c) is greater than 1.0 for either species. The rTU_c shall be calculated as follows: If $IC_{25} \geq$ IWC, then $rTU_c = 1.0$. If $IC_{25} <$ IWC, then $rTU_c =$ IWC $\div IC_{25}$.

Additional Testing Requirements: Within 90 days of a test which showed positive results, the permittee shall submit the results of at least 2 retests to the Biomonitoring Coordinator on "Whole Effluent Toxicity Test Report Forms". The retests shall be completed using the same species and test methods specified for the original test (see the Standard Requirements section herein).

2.2.1.4 Chloride Variance – Implement Source Reduction Measures

This permit contains a variance to the water quality-based effluent limit (WQBEL) for chloride granted in accordance with s. NR 106.83(2), Wis. Adm. Code. As conditions of this variance the permittee shall (a) maintain effluent quality at or below the interim effluent limitation specified in the table above, (b) implement the chloride source reduction measures, including, but not limited to, the measures specified below, and (c) perform the actions listed in the compliance schedule. (See the Schedules of Compliance section herein.):

--Submit a plan to continue to identify and quantify sources of chloride to the sewer system. Specifically, the plan should define procedures for identification and sampling of chloride for industries, for Hillside Sanitary District, and for newer subdivisions – As part of the 6/30/09 annual report.

--Implement the plan above – during remainder of permit term.

--Continue to educate customers on the impacts of chloride from residential softeners, recommend periodic tune-ups for softeners, and emphasize the importance of increasing softener efficiency.

--Track daily acceptance of domestic septic tank and holding tank hauled waste – on discharge monitoring reports

--Conduct quarterly monitoring on hauled domestic waste for chloride. The sample shall be a composite of equal portions from each truckload of waste. Holding tank waste and septic tank waste may be commingled for the samples – on discharge monitoring reports, beginning in the first quarter of 2009.

-- In the event of a request for acceptance of hauled commercial or industrial waste, conduct an analysis for chloride of the proposed discharge prior to an agreement to accept the waste.

3 Land Application Requirements

3.1 Sampling Point(s)

The discharge(s) shall be limited to land application of the waste type(s) designated for the listed sampling point(s) on Department approved land spreading sites or by hauling to another facility.

Sampling Point Designation	
Sampling Point Number	**Sampling Point Location, WasteType/Sample Contents and Treatment Description (as applicable)**
002	Aerobically digested, gravity thickened, liquid sludge, sampled from the discharge end of the sludge mixing pump.

3.2 Monitoring Requirements and Limitations

The permittee shall comply with the following monitoring requirements and limitations.

3.2.1 Sampling Point (Outfall) 002 - Sludge

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Arsenic Dry Wt	Ceiling	75 mg/kg	Annual	Grab	
Arsenic Dry Wt	High Quality	41 mg/kg	Annual	Grab	
Cadmium Dry Wt	Ceiling	85 mg/kg	Quarterly	Grab	
Cadmium Dry Wt	High Quality	39 mg/kg	Quarterly	Grab	
Copper Dry Wt	Ceiling	4,300 mg/kg	Quarterly	Grab	
Copper Dry Wt	High Quality	1,500 mg/kg	Quarterly	Grab	
Lead Dry Wt	Ceiling	840 mg/kg	Quarterly	Grab	
Lead Dry Wt	High Quality	300 mg/kg	Quarterly	Grab	
Mercury Dry Wt	Ceiling	57 mg/kg	Quarterly	Grab	
Mercury Dry Wt	High Quality	17 mg/kg	Quarterly	Grab	
Molybdenum Dry Wt	Ceiling	75 mg/kg	Quarterly	Grab	
Nickel Dry Wt	Ceiling	420 mg/kg	Quarterly	Grab	
Nickel Dry Wt	High Quality	420 mg/kg	Quarterly	Grab	
Nitrogen, Ammonium (NH_4-N) Total		Percent	Annual	Grab	
Nitrogen, Total Kjeldahl		Percent	Annual	Grab	
Phosphorus, Total		Percent	Annual	Grab	
Potassium, Total Recoverable		Percent	Annual	Grab	
Phosphorus, Water Extractable		Percent	Annual	Grab	
Selenium Dry Wt	Ceiling	100 mg/kg	Quarterly	Grab	
Selenium Dry Wt	High Quality	100 mg/kg	Quarterly	Grab	
Solids, Total		Percent	Quarterly	Grab	

Monitoring Requirements and Limitations					
Parameter	**Limit Type**	**Limit and Units**	**Sample Frequency**	**Sample Type**	**Notes**
Zinc Dry Wt	Ceiling	7,500 mg/kg	Quarterly	Grab	
Zinc Dry Wt	High Quality	2,800 mg/kg	Quarterly	Grab	
PCB Total Dry Wt	Ceiling	50 mg/kg	Once	Grab	See section 3.2.1.5
PCB Total Dry Wt	High Quality	10 mg/kg	Once	Grab	"See section 3.2.1.5

Other Sludge Requirements	
Sludge Requirements	**Sample Frequency**
List 3 Requirements – Pathogen Control: The requirements in List 3 shall be met prior to land application of sludge.	**Annual**
List 4 Requirements – Vector Attraction Reduction: The vector attraction reduction shall be satisfied prior to, or at the time of land application as specified in List 4.	**Annual**

3.2.1.1 List 2 Analysis

If the monitoring frequency for List 2 parameters is more frequent than "Annual" then the sludge may be analyzed for the List 2 parameters just prior to each land application season rather than at the more frequent interval specified.

3.2.1.2 Changes in Feed Sludge Characteristics

If a change in feed sludge characteristics, treatment process, or operational procedures occurs which may result in a significant shift in sludge characteristics, the permittee shall reanalyze the sludge for List 1, 2, 3 and 4 parameters each time such change occurs.

3.2.1.3 Multiple Sludge Sample Points (Outfalls)

If there are multiple sludge sample points (outfalls), but the sludges are not subject to different sludge treatment processes, then a separate List 2 analysis shall be conducted for each sludge type which is land applied, just prior to land application, and the application rate shall be calculated for each sludge type. In this case, List 1, 3, and 4 and PCBs need only be analyzed on a single sludge type, at the specified frequency. If there are multiple sludge sample points (outfalls), due to multiple treatment processes, List 1, 2, 3 and 4 and PCBs shall be analyzed for each sludge type at the specified frequency.

3.2.1.4 Sludge Which Exceeds the High Quality Limit

Cumulative pollutant loading records shall be kept for all bulk land application of sludge which does not meet the high quality limit for any parameter. This requirement applies for the entire calendar year in which any exceedance of Table 3 of s. NR 204.07(5)(c), is experienced. Such loading records shall be kept for all List 1 parameters for each site land applied in that calendar year. The formula to be used for calculating cumulative loading is as follows:

[(Pollutant concentration (mg/kg) x dry tons applied/ac) ÷ 500] + previous loading (lbs/acre) = cumulative lbs pollutant per acre

When a site reaches 90% of the allowable cumulative loading for any metal established in Table 2 of s. NR 204.07(5)(b), the Department shall be so notified through letter or in the comment section of the annual land application report (3400-55).

3.2.1.5 Sludge Analysis for PCBs

The permittee shall analyze the sludge for Total PCBs one time during **2009**. The results shall be reported as "PCB Total Dry Wt". Either congener-specific analysis or Aroclor analysis shall be used to determine the PCB concentration. The permittee may determine whether Aroclor or congener specific analysis is performed. Analyses shall be performed in accordance with Table EM in s. NR 219.04, Wis. Adm. Code and the conditions specified in Standard Requirements of this permit. PCB results shall be submitted by January 31, following the specified year of analysis.

3.2.1.6 Lists 1, 2, 3, and 4

List 1 **TOTAL SOLIDS AND METALS** See the Monitoring Requirements and Limitations table above for monitoring frequency and limitations for the List 1 parameters
Solids, Total (percent)
Arsenic, mg/kg (dry weight)
Cadmium, mg/kg (dry weight)
Copper, mg/kg (dry weight)
Lead, mg/kg (dry weight)
Mercury, mg/kg (dry weight)
Molybdenum, mg/kg (dry weight)
Nickel, mg/kg (dry weight)
Selenium, mg/kg (dry weight)
Zinc, mg/kg (dry weight)

List 2 **NUTRIENTS** See the Monitoring Requirements and Limitations table above for monitoring frequency for the List 2 parameters
Solids, Total (percent)
Nitrogen Total Kjeldahl (percent)
Nitrogen Ammonium (NH4-N) Total (percent)
Phosphorus Total as P (percent)
Phosphorus, Water Extractable (as percent of Total P)
Potassium Total Recoverable (percent)

List 3
PATHOGEN CONTROL FOR CLASS B SLUDGE

The permittee shall implement pathogen control as listed in List 3. The Department shall be notified of the pathogen control utilized and shall be notified when the permittee decides to utilize alternative pathogen control.

The following requirements shall be met prior to land application of sludge.

Parameter	Unit	Limit
Fecal Coliform*	MPN/gTS or CFU/gTS	2,000,000
OR, ONE OF THE FOLLOWING PROCESS OPTIONS		
Aerobic Digestion	Air Drying	
Anaerobic Digestion	Composting	
Alkaline Stabilization	PSRP Equivalent Process	

***** The Fecal Coliform limit shall be reported as the geometric mean of 7 discrete samples on a dry weight basis.

List 4
VECTOR ATTRACTION REDUCTION

The permittee shall implement any one of the vector attraction reduction options specified in List 4. The Department shall be notified of the option utilized and shall be notified when the permittee decides to utilize an alternative option.

One of the following shall be satisfied prior to, or at the time of land application as specified in List 4.

Option	Limit	Where/When it Shall be Met
Volatile Solids Reduction	≥38%	Across the process
Specific Oxygen Uptake Rate	≤1.5 mg O_2/hr/g TS	On aerobic stabilized sludge
Anaerobic bench-scale test	<17 % VS reduction	On anaerobic digested sludge
Aerobic bench-scale test	<15 % VS reduction	On aerobic digested sludge
Aerobic Process	>14 days, Temp >40°C and Avg. Temp > 45°C	On composted sludge
pH adjustment	>12 S.U. (for 2 hours) and >11.5 (for an additional 22 hours)	During the process
Drying without primary solids	>75 % TS	When applied or bagged
Drying with primary solids	>90 % TS	When applied or bagged
Equivalent Process	Approved by the Department	Varies with process
Injection	-	When applied
Incorporation	-	Within 6 hours of application

3.2.1.7 Daily Land Application Log

Daily Land Application Log		
Discharge Monitoring Requirements and Limitations The permittee shall maintain a daily land application log for biosolids land applied each day when land application occurs. The following minimum records must be kept, in addition to all analytical results for the biosolids land applied. The log book records shall form the basis for the annual land application report requirements**.**		
Parameters	**Units**	**Sample Frequency**
DNR Site Number(s)	Number	Daily as used
Outfall number applied	Number	Daily as used
Acres applied	Acres	Daily as used
Amount applied	As appropriate * /day	Daily as used
Application rate per acre	unit */acre	Daily as used
Nitrogen applied per acre	lb/acre	Daily as used
Method of Application	Injection, Incorporation, or surface applied	Daily as used

*gallons, cubic yards, dry US Tons or dry Metric Tons

4 Schedules of Compliance

4.1 Chloride Target Value

As a condition of the variance to the water quality based effluent limitation(s) for chloride granted in accordance with s. NR 106.83(2), Wis. Adm. Code, the permittee shall perform the following actions.

Required Action	Date Due
Annual Chloride Progress Report: Submit an annual progress report, that shall indicate the chloride source reduction measures have been implemented, with supporting documentation. This report shall also contain a plan to continue to identify and quantify sources of chloride to the sewer system, as noted in Section 2.2.1.4 of this permit. Note that the interim limitation of 605 mg/l, weekly average, remains enforceable until new enforceable limits are established in the next permit issuance. The first annual chloride progress report is to be submitted by the Date Due.	06/30/2009
Annual Chloride Progress Report #2: Submit a chloride progress report.	06/30/2010
Annual Chloride Progress Report #3: Submit a chloride progress report.	06/30/2011
Annual Chloride Progress Report #4: Submit a chloride progress report.	06/30/2012
Final Chloride Report: Submit a final report documenting the success in meeting the chloride target value of 450 mg/l, weekly average, as well as the anticipated future reduction in chloride sources and chloride effluent concentrations. This report shall also include proposed target values and source reduction measures for negotiations with the department if the permittee intends to seek a renewed chloride variance per s. NR 106.83, Wis. Adm. Code, for the reissued permit. Note that the target value is the benchmark for evaluating the effectiveness of the chloride source reduction measures, but is not an enforceable limitation under the terms of this permit.	06/30/2013

4.2 Development of Local Limits for Metal Pollutants

In order to protect the quality of effluent wastewater and sludge produced at the WWTP, the permittee shall amend its current sewer use ordinance (SUO) to include local limits for metal pollutants by implementing the following actions.

Required Action	Date Due
Develop local limits for metal pollutants : Develop and submit for Department review, local limits for metals - cadmium, chromium, copper, lead, nickel, and zinc. In developing the local limits, a procedure for allocation of maximum allowable headworks loadings shall be used.	12/31/2009
Sewer Use Ordinance Amendment: : Submit for the Department's review, a draft of an amendment proposal to the Village's Sewer Use Ordinance (SUO) to include the approved local limits for metal pollutants. The SUO amendment proposal shall include adequate legal authority language to ensure implementation of the approved local limits	06/30/2010
Complete action:: Complete all actions necessary for the development of the local limits and the SUO amendment. Implement amended SUO.	12/31/2010

5 Standard Requirements

NR 205, Wisconsin Administrative Code: The conditions in ss. NR 205.07(1) and NR 205.07(2), Wis. Adm. Code, are included by reference in this permit. The permittee shall comply with all of these requirements. Some of these requirements are outlined in the Standard Requirements section of this permit. Requirements not specifically outlined in the Standard Requirement section of this permit can be found in ss. NR 205.07(1) and NR 205.07(2).

5.1 Reporting and Monitoring Requirements

5.1.1 Monitoring Results

Monitoring results obtained during the previous month shall be summarized and reported on a Department Wastewater Discharge Monitoring Report. The report may require reporting of any or all of the information specified below under 'Recording of Results'. This report is to be returned to the Department no later than the date indicated on the form. When submitting a paper Discharge Monitoring Report form, the original and one copy of the Wastewater Discharge Monitoring Report Form shall be submitted to the return address printed on the form. A copy of the Wastewater Discharge Monitoring Report Form or an electronic file of the report shall be retained by the permittee.

All Wastewater Discharge Monitoring Reports submitted to the Department should be submitted using the electronic Discharge Monitoring Report system. Permittees who may be unable to submit Wastewater Discharge Monitoring Reports electronically may request approval to submit paper DMRs upon demonstration that electronic reporting is not feasible or practicable.

If the permittee monitors any pollutant more frequently than required by this permit, the results of such monitoring shall be included on the Wastewater Discharge Monitoring Report.

The permittee shall comply with all limits for each parameter regardless of monitoring frequency. For example, monthly, weekly, and/or daily limits shall be met even with monthly monitoring. The permittee may monitor more frequently than required for any parameter.

An Electronic Discharge Monitoring Report Certification sheet shall be signed and submitted with each electronic Discharge Monitoring Report submittal. This certification sheet, which is not part of the electronic report form, shall be signed by a principal executive officer, a ranking elected official or other duly authorized representative and shall be mailed to the Department at the time of submittal of the electronic Discharge Monitoring Report. The certification sheet certifies that the electronic report form is true, accurate and complete. Paper reports shall be signed by a principal executive officer, a ranking elected official, or other duly authorized representative.

5.1.2 Sampling and Testing Procedures

Sampling and laboratory testing procedures shall be performed in accordance with Chapters NR 218 and NR 219, Wis. Adm. Code and shall be performed by a laboratory certified or registered in accordance with the requirements of ch. NR 149, Wis. Adm. Code. Groundwater sample collection and analysis shall be performed in accordance with ch. NR 140, Wis. Adm. Code. The analytical methodologies used shall enable the laboratory to quantitate all substances for which monitoring is required at levels below the effluent limitation. If the required level cannot be met by any of the methods available in NR 219, Wis. Adm. Code, then the method with the lowest limit of detection shall be selected. Additional test procedures may be specified in this permit.

5.1.3 Recording of Results

The permittee shall maintain records which provide the following information for each effluent measurement or sample taken:

- the date, exact place, method and time of sampling or measurements;

- the individual who performed the sampling or measurements;
- the date the analysis was performed;
- the individual who performed the analysis;
- the analytical techniques or methods used; and
- the results of the analysis.

5.1.4 Reporting of Monitoring Results

The permittee shall use the following conventions when reporting effluent monitoring results:

- Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 0.1 mg/L, report the pollutant concentration as < 0.1 mg/L.

- Pollutant concentrations equal to or greater than the limit of detection, but less than the limit of quantitation, shall be reported and the limit of quantitation shall be specified.

- For the purposes of reporting a calculated result, average or a mass discharge value, the permittee may substitute a 0 (zero) for any pollutant concentration that is less than the limit of detection. However, if the effluent limitation is less than the limit of detection, the department may substitute a value other than zero for results less than the limit of detection, after considering the number of monitoring results that are greater than the limit of detection and if warranted when applying appropriate statistical techniques.

5.1.5 Compliance Maintenance Annual Reports

Compliance Maintenance Annual Reports (CMAR) shall be completed using information obtained over each calendar year regarding the wastewater conveyance and treatment system. The CMAR shall be submitted by the permittee in accordance with ch. NR 208, Wis. Adm. Code, by June 30, each year on an electronic report form provided by the Department.

In the case of a publicly owned treatment works, a resolution shall be passed by the governing body and submitted as part of the CMAR, verifying its review of the report and providing responses as required. Private owners of wastewater treatment works are not required to pass a resolution; but they must provide an Owner Statement and responses as required, as part of the CMAR submittal.

A separate CMAR certification document, that is not part of the electronic report form, shall be mailed to the Department at the time of electronic submittal of the CMAR. The CMAR certification shall be signed and submitted by an authorized representative of the permittee. The certification shall be submitted by mail. The certification shall verify the electronic report is complete, accurate and contains information from the owner's treatment works.

5.1.6 Records Retention

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by the permit, and records of all data used to complete the application for the permit for a period of at least 3 years from the date of the sample, measurement, report or application. All pertinent sludge information, including permit application information and other documents specified in this permit or s. NR 204.06(9), Wis. Adm. Code shall be retained for a minimum of 5 years.

5.1.7 Other Information

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or correct information to the Department.

5.2 System Operating Requirements

5.2.1 Noncompliance Notification

- The permittee shall report the following types of noncompliance by a telephone call to the Department's regional office within 24 hours after becoming aware of the noncompliance:
  - any noncompliance which may endanger health or the environment;
  - any violation of an effluent limitation resulting from an unanticipated bypass;
  - any violation of an effluent limitation resulting from an upset; and
  - any violation of a maximum discharge limitation for any of the pollutants listed by the Department in the permit, either for effluent or sludge.

- A written report describing the noncompliance shall also be submitted to the Department's regional office within 5 days after the permittee becomes aware of the noncompliance. On a case-by-case basis, the Department may waive the requirement for submittal of a written report within 5 days and instruct the permittee to submit the written report with the next regularly scheduled monitoring report. In either case, the written report shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times; the steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance; and if the noncompliance has not been corrected, the length of time it is expected to continue.

NOTE: Section 292.11(2)(a), Wisconsin Statutes, requires any person who possesses or controls a hazardous substance or who causes the discharge of a hazardous substance to notify the Department of Natural Resources **immediately** of any discharge not authorized by the permit. The discharge of a hazardous substance that is not authorized by this permit or that violates this permit may be a hazardous substance spill. To report a hazardous substance spill, call DNR's 24-hour HOTLINE at **1-800-943-0003**

5.2.2 Flow Meters

Flow meters shall be calibrated annually, as per s. NR 218.06, Wis. Adm. Code.

5.2.3 Raw Grit and Screenings

All raw grit and screenings shall be disposed of at a properly licensed solid waste facility or picked up by a licensed waste hauler. If the facility or hauler are located in Wisconsin, then they shall be licensed under chs. NR 500-536, Wis. Adm. Code.

5.2.4 Sludge Management

All sludge management activities shall be conducted in compliance with ch. NR 204 "Domestic Sewage Sludge Management", Wis. Adm. Code.

5.2.5 Prohibited Wastes

Under no circumstances may the introduction of wastes prohibited by s. NR 211.10, Wis. Adm. Code, be allowed into the waste treatment system. Prohibited wastes include those:

- which create a fire or explosion hazard in the treatment work;
- which will cause corrosive structural damage to the treatment work;
- solid or viscous substances in amounts which cause obstructions to the flow in sewers or interference with the proper operation of the treatment work;
- wastewaters at a flow rate or pollutant loading which are excessive over relatively short time periods so as to cause a loss of treatment efficiency; and
- changes in discharge volume or composition from contributing industries which overload the treatment works or cause a loss of treatment efficiency.

5.2.6 Unscheduled Bypassing

Any unscheduled bypass or overflow of wastewater at the treatment works or from the collection system is prohibited, and the Department may take enforcement action against a permittee for such occurrences under s. 283.89, Wis. Stats., unless:

- The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;
- There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
- The permittee notified the Department as required in this Section.

Whenever there is an unscheduled bypass or overflow occurrence at the treatment works or from the collection system, the permittee shall notify the Department within 24 hours of initiation of the bypass or overflow occurrence by telephoning the wastewater staff in the regional office as soon as reasonably possible (FAX, email or voice mail, if staff are unavailable).

In addition, the permittee shall within 5 days of conclusion of the bypass or overflow occurrence report the following information to the Department in writing:

- Reason the bypass or overflow occurred, or explanation of other contributing circumstances that resulted in the overflow event. If the overflow or bypass is associated with wet weather, provide data on the amount and duration of the rainfall or snow melt for each separate event.
- Date the bypass or overflow occurred.
- Location where the bypass or overflow occurred.
- Duration of the bypass or overflow and estimated wastewater volume discharged.
- Steps taken or the proposed corrective action planned to prevent similar future occurrences.
- Any other information the permittee believes is relevant.

5.2.7 Scheduled Bypassing

Any construction or normal maintenance which results in a bypass of wastewater from a treatment system is prohibited unless authorized by the Department in writing. If the Department determines that there is significant public interest in the proposed action, the Department may schedule a public hearing or notice a proposal to approve the bypass. Each request shall specify the following minimum information:

- proposed date of bypass;
- estimated duration of the bypass;

- estimated volume of the bypass;
- alternatives to bypassing; and
- measures to mitigate environmental harm caused by the bypass.

5.2.8 Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control which are installed or used by the permittee to achieve compliance with the conditions of this permit. The wastewater treatment facility shall be under the direct supervision of a state certified operator as required in s. NR 108.06(2), Wis. Adm. Code. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training as required in ch. NR 114, Wis. Adm. Code, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

5.3 Surface Water Requirements

5.3.1 Permittee-Determined Limit of Quantitation Incorporated into this Permit

For pollutants with water quality-based effluent limits below the Limit of Quantitation (LOQ) in this permit, the LOQ calculated by the permittee and reported on the Discharge Monitoring Reports (DMRs) is incorporated by reference into this permit. The LOQ shall be reported on the DMRs, shall be the lowest quantifiable level practicable, and shall be no greater than the minimum level (ML) specified in or approved under 40 CFR Part 136 for the pollutant at the time this permit was issued, unless this permit specifies a higher LOQ.

5.3.2 Appropriate Formulas for Effluent Calculations

The permittee shall use the following formulas for calculating effluent results to determine compliance with average limits and mass limits:

Weekly/Monthly average concentration = the sum of all daily results for that week/month, divided by the number of results during that time period.

Weekly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the week.

Monthly Average Mass Discharge (lbs/day): Daily mass = daily concentration (mg/L) x daily flow (MGD) x 8.34, then average the daily mass values for the month.

5.3.3 Visible Foam or Floating Solids

There shall be no discharge of floating solids or visible foam in other than trace amounts.

5.3.4 Percent Removal

During any 30 consecutive days, the average effluent concentrations of BOD_5 and of total suspended solids shall not exceed 15% of the average influent concentrations, respectively. This requirement does not apply to removal of total suspended solids if the permittee operates a lagoon system and has received a variance for suspended solids granted under NR 210.07(2), Wis. Adm. Code.

5.3.5 Chloride Notification

The permittee shall notify the Department in writing of any proposed changes which may affect the characteristics of the wastewater, which results in an increase in the concentration of chloride, under the authority of sections 283.31(4)(b) and 283.59(1), Stats. This notification shall include a description of the proposed source of chlorides and the anticipated increase in concentration. Following receipt of the notification, the Department may propose a modification to the permit.

5.3.6 Fecal Coliforms

The limit for fecal coliforms shall be expressed as a monthly geometric mean.

5.3.7 Seasonal Disinfection

Disinfection shall be provided from May 1 through September 30 of each year. Monitoring requirements and the limitation for fecal coliforms apply only during the period in which disinfection is required. Whenever chlorine is used for disinfection or other uses, the limitations and monitoring requirements for residual chlorine shall apply. A dechlorination process shall be in operation whenever chlorine is used.

5.3.8 Whole Effluent Toxicity (WET) Monitoring Requirements

In order to determine the potential impact of the discharge on aquatic organisms, static-renewal toxicity tests shall be performed on the effluent in accordance with the procedures specified in the *"State of Wisconsin Aquatic Life Toxicity Testing Methods Manual, 2nd Edition" (PUB-WT-797*, November 2004) as required by NR 219.04, Table A, Wis. Adm. Code). All of the WET tests required in this permit, including any required retests, shall be conducted on the *Ceriodaphnia dubia* and fathead minnow species. Receiving water samples shall not be collected from any point in contact with the permittee's mixing zone and every attempt shall be made to avoid contact with any other discharge's mixing zone.

5.3.9 Whole Effluent Toxicity (WET) Identification and Reduction

Within 60 days of a retest which showed positive results, the permittee shall submit a written report to the Biomonitoring Coordinator, Bureau of Watershed Management, 101 S. Webster St., PO Box 7921, Madison, WI 53707-7921, which details the following:

- A description of actions the permittee has taken or will take to remove toxicity and to prevent the recurrence of toxicity;

- A description of toxicity reduction evaluation (TRE) investigations that have been or will be done to identify potential sources of toxicity, including some or all of the following actions:

  (a) Evaluate the performance of the treatment system to identify deficiencies contributing to effluent toxicity (e.g., operational problems, chemical additives, incomplete treatment)
  (b) Identify the compound(s) causing toxicity
  (c) Trace the compound(s) causing toxicity to their sources (e.g., industrial, commercial, domestic)
  (d) Evaluate, select, and implement methods or technologies to control effluent toxicity (e.g., in-plant or pretreatment controls, source reduction or removal)

- Where corrective actions including a TRE have not been completed, an expeditious schedule under which corrective actions will be implemented;

- If no actions have been taken, the reason for not taking action.

The permittee may also request approval from the Department to postpone additional retests in order to investigate the source(s) of toxicity. Postponed retests must be completed after toxicity is believed to have been removed.

5.3.10 Exceedance of a Whole Effluent Toxicity (WET) Limit

In the event of a WET limit exceedance, the permittee shall submit the following (within 30 days of test end):

- the findings of a toxicity reduction evaluation (TRE) or other investigation to identify the cause(s) of the toxicity;
- actions the permittee has taken or will take to mitigate the impact of the discharge, to correct the noncompliance, and to prevent the recurrence of toxicity;
- where corrective actions including a TRE have not been completed, an expeditious schedule under which corrective actions will be implemented; and
- if no actions have been taken, the reason for not taking action.

5.3.11 Whole Effluent Toxicity (WET) and Chloride Source Reduction Measures

Acute whole effluent toxicity testing requirements and acute whole effluent toxicity limitations may be held in abeyance by the department until chloride source reduction actions are completed, according to s. NR 106.89, Wis. Adm. Code, if either:

- the permittee can demonstrate to the satisfaction of the department that the effluent concentration of chloride exceeds 2,500 mg/L, or
- the permittee can demonstrate to the satisfaction of the department that the effluent concentration of chloride is less than 2,500 mg/L, but in excess of the calculated acute water quality-based effluent limitation, and additional data are submitted which demonstrate that chloride is the sole source of acute toxicity.

Chronic whole effluent toxicity testing requirements and chronic whole effluent toxicity limitations may be held in abeyance by the department until chloride source reduction actions are completed, according to s. NR 106.89, Wis. Adm. Code, if either:

- the permittee can demonstrate to the satisfaction of the department that the effluent concentration of chloride exceeds 2 times the calculated chronic water quality-based effluent limitation, or
- the permittee can demonstrate to the satisfaction of the department that the effluent concentration of chloride is less than 2 times the calculated chronic water quality-based effluent limitation, but in excess of the calculated chronic water quality-based effluent limitation, and additional data are submitted which demonstrate that chloride is the sole source of chronic toxicity.

Following the completion of chloride source reduction activities, the department shall evaluate the need for whole effluent toxicity monitoring and limitations.

5.4 Land Application Requirements

5.4.1 Sludge Management Program Standards And Requirements Based Upon Federally Promulgated Regulations

In the event that new federal sludge standards or regulations are promulgated, the permittee shall comply with the new sludge requirements by the dates established in the regulations, if required by federal law, even if the permit has not yet been modified to incorporate the new federal regulations.

5.4.2 General Sludge Management Information

The General Sludge Management Form 3400-48 shall be completed and submitted prior to any significant sludge management changes.

5.4.3 Sludge Samples

All sludge samples shall be collected at a point and in a manner which will yield sample results which are representative of the sludge being tested, and collected at the time which is appropriate for the specific test.

5.4.4 Land Application Characteristic Report

Each report shall consist of a Characteristic Form 3400-49 and Lab Report, unless approval for not submitting the lab reports has been given. Both reports shall be submitted by January 31 following each year of analysis.

The permittee shall use the following convention when reporting sludge monitoring results: Pollutant concentrations less than the limit of detection shall be reported as < (less than) the value of the limit of detection. For example, if a substance is not detected at a detection limit of 1.0 mg/kg, report the pollutant concentration as < 1.0 mg/kg .

All results shall be reported on a dry weight basis.

5.4.5 Monitoring and Calculating PCB Concentrations in Sludge

When sludge analysis for "PCB, Total Dry Wt" is required by this permit, the PCB concentration in the sludge shall be determined as follows.

Either congener-specific analysis or Aroclor analysis shall be used to determine the PCB concentration. The permittee may determine whether Aroclor or congener specific analysis is performed. Analyses shall be performed in accordance with the following provisions and Table EM in s. NR 219.04, Wis. Adm. Code.

- EPA Method 1668 may be used to test for all PCB congeners. If this method is employed, all PCB congeners shall be delineated. Non-detects shall be treated as zero. The values that are between the limit of detection and the limit of quantitation shall be used when calculating the total value of all congeners. All results shall be added together and the total PCB concentration by dry weight reported. **Note**: It is recognized that a number of the congeners will co-elute with others, so there will not be 209 results to sum.
- EPA Method 8082A shall be used for PCB-Aroclor analysis and may be used for congener specific analysis as well. If congener specific analysis is performed using Method 8082A, the list of congeners tested shall include at least congener numbers 5, 18, 31, 44, 52, 66, 87, 101, 110, 138, 141, 151, 153, 170, 180, 183, 187, and 206 plus any other additional congeners which might be reasonably expected to occur in the particular sample. For either type of analysis, the sample shall be extracted using the Soxhlet extraction (EPA Method 3540C) (or the Soxhlet Dean-Stark modification) or the pressurized fluid extraction (EPA Method 3545A). If Aroclor analysis is performed using Method 8082A, clean up steps of the extract shall be performed as necessary to remove interference and to achieve as close to a limit of detection of 0.11 mg/kg as possible. Reporting protocol, consistent with s. NR 106.07(6)(e), should be as follows: If all Aroclors are less than the LOD, then the Total PCB Dry Wt result should be reported as less than the highest LOD. If a single Aroclor is detected then that is what should be reported for the Total PCB result. If multiple Aroclors are detected, they should be summed and reported as Total PCBs. If congener specific analysis is done using Method 8082A, clean up steps of the extract shall be performed as necessary to remove interference and to achieve as close to a limit of detection of 0.003 mg/kg as possible for each congener. If the aforementioned limits of detection cannot be achieved after using the appropriate clean up techniques, a reporting limit that is achievable for the Aroclors or each congener for the sample shall be determined. This reporting limit shall be reported and qualified

indicating the presence of an interference. The lab conducting the analysis shall perform as many of the following methods as necessary to remove interference:

3620C – Florisil	3611B - Alumina
3640A - Gel Permeation	3660B - Sulfur Clean Up (using copper shot instead of powder)
3630C - Silica Gel	3665A - Sulfuric Acid Clean Up

5.4.6 Land Application Report

Land Application Report Form 3400-55 shall be submitted by January 31, following each year non-exceptional quality sludge is land applied. Non-exceptional quality sludge is defined in s. NR 204.07(4), Wis. Adm. Code.

5.4.7 Other Methods of Disposal or Distribution Report

The permittee shall submit Report Form 3400-52 by January 31, following each year sludge is hauled, landfilled, incinerated, or when exceptional quality sludge is distributed or land applied.

5.4.8 Approval to Land Apply

Bulk non-exceptional quality sludge as defined in s. NR 204.07(4), Wis. Adm. Code, may not be applied to land without a written approval letter or Form 3400-122 from the Department unless the Permittee has obtained permission from the Department to self approve sites in accordance with s. NR 204.06 (6), Wis. Adm. Code. Analysis of sludge characteristics is required prior to land application. Application on frozen or snow covered ground is restricted to the extent specified in s. NR 204.07(3) (l), Wis. Adm. Code.

5.4.9 Soil Analysis Requirements

Each site requested for approval for land application must have the soil tested prior to use. Each approved site used for land application must subsequently be soil tested such that there is at least one valid soil test in the four years prior to land application. All soil sampling and submittal of information to the testing laboratory shall be done in accordance with UW Extension Bulletin A-2100. The testing shall be done by the UW Soils Lab in Madison or Marshfield, WI or at a lab approved by UW. The test results including the crop recommendations shall be submitted to the DNR contact listed for this permit, as they are available. Application rates shall be determined based on the crop nitrogen recommendations and with consideration for other sources of nitrogen applied to the site.

5.4.10 Land Application Site Evaluation

For non-exceptional quality sludge, as defined in s. NR 204.07(4), Wis. Adm. Code, a Land Application Site Request Form 3400-053 shall be submitted to the Department for the proposed land application site. The Department will evaluate the proposed site for acceptability and will either approve or deny use of the proposed site. The permittee may obtain permission to approve their own sites in accordance with s. NR 204.06(6), Wis. Adm. Code.

5.4.11 Class B Sludge: Fecal Coliform Limitation

Compliance with the fecal coliform limitation for Class B sludge shall be demonstrated by calculating the geometric mean of at least 7 separate samples. (Note that a Total Solids analysis must be done on each sample). The geometric mean shall be less than 2,000,000 MPN or CFU/g TS. Calculation of the geometric mean can be done using one of the following 2 methods.

Method 1:

Geometric Mean = $(X_1 \times X_2 \times X_3 \ldots \times X_n)^{1/n}$

Where X = Coliform Density value of the sludge sample, and where n = number of samples (at least 7)

Method 2:

Geometric Mean = antilog[(X_1 + X_2 + X_3 …+ X_n) ÷ n]
Where X = $\log_{10}$ of Coliform Density value of the sludge sample, and where n = number of samples (at least 7)
Example for Method 2

Sample Number	Coliform Density of Sludge Sample	$\log_{10}$
1	6.0×10^5	5.78
2	4.2×10^6	6.62
3	1.6×10^6	6.20
4	9.0×10^5	5.95
5	4.0×10^5	5.60
6	1.0×10^6	6.00
7	5.1×10^5	5.71

The geometric mean for the seven samples is determined by averaging the $\log_{10}$ values of the coliform density and taking the antilog of that value.
(5.78 + 6.62 + 6.20 + 5.95 + 5.60 + 6.00 + 5.71) ÷ 7 = 5.98
The antilog of 5.98 = 9.5×10^5

5.4.12 Class B Sludge - Vector Control: Injection

No significant amount of the sewage sludge shall be present on the land surface within one hour after the sludge is injected.

6 Summary of Reports Due

FOR INFORMATIONAL PURPOSES ONLY

Description	Date	Page
Chloride Target Value -Annual Chloride Progress Report	June 30, 2009	10
Chloride Target Value -Annual Chloride Progress Report #2	June 30, 2010	10
Chloride Target Value -Annual Chloride Progress Report #3	June 30, 2011	10
Chloride Target Value -Annual Chloride Progress Report #4	June 30, 2012	10
Chloride Target Value -Final Chloride Report	June 30, 2013	10
Development of Local Limits for Metal Pollutants -Develop local limits for metal pollutants	December 31, 2009	10
Development of Local Limits for Metal Pollutants -Sewer Use Ordinance Amendment	June 30, 2010	10
Development of Local Limits for Metal Pollutants -Complete action	December 31, 2010	10
Compliance Maintenance Annual Reports (CMAR)	by June 30, each year	12
General Sludge Management Form 3400-48	prior to any significant sludge management changes	18
Characteristic Form 3400-49 and Lab Report	by January 31 following each year of analysis	18
Land Application Report Form 3400-55	by January 31, following each year non-exceptional quality sludge is land applied	19
Report Form 3400-52	by January 31, following each year sludge is hauled, landfilled, incinerated, or when exceptional quality sludge is distributed or land applied	19
Wastewater Discharge Monitoring Report	no later than the date indicated on the form	11

Report forms shall be submitted to the address printed on the report form. Any facility plans or plans and specifications for municipal, industrial, industrial pretreatment and non industrial wastewater systems shall be submitted to the Bureau of Watershed Management, P.O. Box 7921, Madison, WI 53707-7921. All other submittals required by this permit shall be submitted to:
Southeast Region - Waukesha, 141 NW Barstow St., Room 180, Waukesha, WI 53188

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Appendix I

BOATING ORDINANCE FOR TOWN OF HARTFORD (PIKE LAKE INCLUDED)

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ORDINANCE NO. 92-3

AN ORDINANCE REGULATING WATER TRAFFIC, RAFTS/STRUCTURES, BOATING AND WATER SPORTS, UPON THE WATERS OF PIKE LAKE WHICH INCORPORATES SECTIONS OF ORDINANCE NO. 90-4 AND 91-4.
THE TOWN BOARD OF THE TOWN OF HARTFORD, WASHINGTON COUNTY, WISCONSIN ORDAINS AS FOLLOWS:

SECTION 1. APPLICABILITY AND ENFORCEMENT The provisions of this ordinance shall apply to the waters and to persons, vessels, objects, or things upon the waters of Pike Lake within the jurisdiction of the Town of Hartford as prescribed by the Department of Natural Resources, which waters are described as follows: a meandered Lake in the Township 10 North of Range 18 East, Town of Hartford, Washington County, Wisconsin. The provisions of this Ordinance shall be enforced by all Officers of the Town of Hartford, Washington County, Wisconsin.

SECTION 2. STATE BOATING AND WATER SAFETY LAWS ADOPTED.
The Statutory provisions described and defining regulations with respect to the water traffic, boats, boating and related water activities in the following enumerated sections of the Wisconsin State Statutes, exclusive of any provisions therein relating to the penalties to be imposed or the punishment for violation of said Statutes, are hereby adopted and by reference made a part of this Ordinance as if fully set forth herein. Any act required to be performed or prohibited by the provisions of any Statute incorporated by reference herein is required or prohibited by this Ordinance.
30.50 (Definitions)
30.51 (Operations of Unnumbered Boats Prohibited)
30.52 (Certificate of Number)
30.53 (Identification Number to be Displayed on Boat: Certificate to be Carried)
30.54(2) (Transfer of Ownership of Numbered Boat)
30.55 (Notice of Abandonment or Destruction of Boat or Change of Address)
30.60 (Classification of Motor Boats)
30.61 (Lighting Equipment)
30.62 (Other Equipment)
30.64 (Patrol Boats Exempt from Certain Traffic Regulations)
30.65 (Traffic Rules)
30.66 (Speed Restrictions)
30.67 (Accidents and Accident Reports)
30.68 (Prohibited Operation)
30.68 (1) (a) (Operating while under the influence of an intoxicant)
30.68 (a) (b) (Operating with alcohol concentration at or above specified levels)
30.684(5) (Refusal to take chemical test)
30.69 (Water Skiing)
30.70 (Skin Diving)
30.71 (Boats Equipped with Toilets)

SECTION 3. PUBLIC SWIMMING ZONES.
(a) All beaches used by the public shall be identified by markers placed by the owners of such beach. The marker size, design, placement and symbols are to be as prescribed by the Wis. Admin. Code NR 5.09.
(b) No boat of any description shall be allowed in an area so marked.
(c) (Am. Ord. 77-3) Any party desiring to designate an area as a public swimming zone shall obtain a permit from the Town Board of the Town of Hartford prior to the placement of the required markers.
(d) (Am. Ord. 77-4) This subsection does not apply in the case of an emergency, or to a patrol or rescue craft.

SECTION 4. SPEED RESTRICTIONS.
(a) Creating Hazardous Wake or Wash. No persons shall operate a motorboat so as to approach or pass another boat in such a manner as to create a hazardous wake or wash.

(b) Hours. No person shall operate a motorboat at a speed in an excess of a slow-no-wake speed between the hours of 8:00 P.M., or legal sunset, whichever comes sooner, to 10:00 A.M., except that on Saturdays, Sundays and Holidays no person shall operate a motorboat at a speed in excess of slow-no-wake speed between the hours of 6:00 P.M. and 10:00 A.M.
(c) Slow-no-Wake Areas. No person shall operate a motorboat at a speed greater than slow-no-wake within 150 feet from the shoreline and in areas which have been designated and posted for such speed with regulatory markers. The Town Board, in cooperation with the Pike Lake Protection District may, from time to time, identify and have marked as slow-no-wake areas such portions of the lake in which, due to shallowness of water, vegetation growth, lake bottom conditions or other factors, the slow-no-wake speed restrictions should be imposed in order to protect water quality or the health, safety and general welfare of lake users.

SECTION 5. ADDITIONAL TRAFFIC RULES. In addition to the traffic rules in Sec. 30.65 of the Wisconsin Statutes adopted in Section 2 of this Ordinance, the following rules shall apply to vessels using the waters covered by this Ordinance.
(a) Right of Way of Sailboats. Boats propelled by muscular power shall yield the right of way to sailboats when necessary to avoid risk or collision.

SECTION 6. RAFTS AND STRUCTURES.
Rafts shall be restricted to riparian land owners (and owners of easements to the lake will be allowed one raft/structure per easement right-of-way). One raft/structure only to be placed so as not to interfere with neighbors right-of-way.
(a) Permit Required. No person shall place a raft/structure in the lake without first obtaining a permit from the Town Board of the Town of Hartford. The fee for the initial permit is $10 and thereafter $5.00 annually. The applicant shall identify the location of the raft/structure and also provide proof of liability insurance coverage.
(b) Permit. A permit issued under this section shall be given a number. It will be the owners responsibility to then obtain a 2 inch size decal with the number that has been assigned and affix it to the raft so that it can be properly seen above the water line.
(c) Size of Raft/Structure. The size of the raft/structure shall not exceed 10 feet by 10 feet with a minimum of 12 inches freeboard above the water line and not to exceed 24 inches of freeboard.
8 inch minimum reflectorized white sides around the total perimeter with reflectors positioned one in each corner.
(d) Placement. A raft/structure must be placed within 150 feet from the shoreline.
(e) Removal. The raft/structure must be removed by November 1 of each year and may not be replaced before April 1 annually.

SECTION 7. SWIMMING REGULATIONS.
(a) Distance from Shore and Boats. No person shall swim more than 150 feet from the shore or more than 30 feet from an anchored raft/structure unless he is accompanied by a suitable boat.
(b) Hours Limited. No person shall swim more than 50 feet from the shore line or a pier or more than 30 feet from an accompanying boat between one hour after legal sunset and one hour before legal sunrise.

SECTION 8, WATER SKIING, SURF BOARD AND SIMILAR DEVICES.
(a) Persons in Boat. No person shall operate a boat for the purpose of towing a person on water skis, surf boards, or similar devices or permit himself to be towed for such purpose unless there are 2 persons in such boat.
(b) (Am Ord. 8102) Hours. No Person shall operate a boat for the purpose of towing a water skier, surfboard, or similar device between the hours of 8:00 P.M., or legal sunset, whichever comes first, except that on Saturdays, Sundays and Holidays no person shall operate a boat for the purpose of towing a water skier, surfboard, or similar device between the hours of 6:00 P.M. and 10:00 A.M.
(c) No person shall water ski, aquaplane or otherwise be towed by a boat, or wind surf, without wearing a U.S. Coast Guard approved type life preserver.
(d) No person shall operate a boat for the purpose of towing a water skier, surfboard or similar device within 150 feet of a canoe or anchored boat.

SECTION 9. RACES, REGATTAS, SPORTING EVENTS, AND EXHIBITIONS.
(a) Permit Required. No person shall direct or participate in any public boat race, regatta, water ski meet or other water sporting event or exhibition unless such event has been authorized by the Town Board of Hartford and a permit issued therefore by the Water Safety Patrol Officer.
(b) Permit. A permit issued under this section shall specify the course or area of water to be used by participants in such event and the permitee shall be required to place markers, flags or buoys approved by the Water Safety Patrol Officer designating the specified area. Permits shall be issued only if in the opinion of the Water Safety Patrol Officer the proposed use of the water can be carried out safely and without danger or substantial obstruction to other vessels or persons using the lake. Permits shall be valid only for the hours and area specified thereon. In the event that the Water Safety Patrol Officer denies a permit under this section, the applicant shall have the right to seek a review of the denial with the Town Board of the Town of Hartford within 48 hours of said denial.

SECTION 10. LITTERING OF WATERS PROHIBITED. No person shall deposit, place or throw from any boat, raft, pier, platform or similar structure any cans, bottles, debris, refuse, garbage, solid or liquid waste into the waters of the lake.

SECTION 11. MARKERS AND NAVIGATING AIDS.
(a) Duty of Water Safety Patrol Officer. The Water Safety Patrol Officer is authorized and directed to place and maintain suitable markers, navigation aids, and signs in such areas of the Lake as shall be appropriate to advise the public of the provisions of this Ordinance and to post and maintain a copy of this document at all public access points within the jurisdiction of the Town. Any person aggrieved by the placement of markers, aids or signs by the Water Safety Patrol Officer shall have the right to petition the Town Board of the Town of Hartford for a review of the placement.
(b) Standard Markers. All markers placed upon the water of Pike Lake
shall comply with the regulations of the Department of Natural Resources.
(c) Interference with Markers Prohibited. No person shall without authority remove, damage or destroy or moor or fasten (except to mooring buoys)
any water-craft to any buoy, beacon or marker placed in the waters of the Lake by the authority of the United States, State or Town or by any private person pursuant to the provisions of this Ordinance.

SECTION 12. SUBORDINATE OFFICERS. In the absence of the Water Safety Patrol Officer, any subordinate Water Safety Patrol Officer may act in his stead in every instance in this Ordinance.

SECTION 13. DEPOSIT SCHEDULE. Every police officer of Water Safety Patrol Officer or subordinate Water Safety Patrol Officer issuing a citation for violation of this ordinance shall indicate on the citation the amount of the deposit, including the penalty assessment and court costs, that the alleged violator may make in lieu of court appearance. The amount of the deposit shall be determined in accordance with the State of Wisconsin Revised Uniform Deposit and Bail Schedule for Conservation, Boating, Snowmobile and ATV Violations, which is hereby adopted by reference and made a part hereof.

SECTION 14. PENALTIES. Any person violating the provisions of this Ordinance shall forfeit not more than $350.00 for the first offense and shall forfeit not more than $500.00 upon conviction of the same offense a second or subsequent time within one year.

SECTION 15. SEVERABILITY. If any provision of this ordinance is determined to be invalid or unconstitutional, or if the application of this Ordinance to any person or circumstance is invalid or unconstitutional, such invalidity or unconstitutionality will not affect the other provisions or applications of this ordinance which can be given effect aside from the invalid or unconstitutional provision or application.

SECTION 16. PUBLICATION. This ordinance shall, in accordance with §60.80(2), Stats., take effect the day after its publication as a Class 1 notice under Ch. 985, Stats.

2-10-92

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Appendix J

INFORMATION FOR PREVENTING TRANSMISSION AND INTRODUCTION OF AQUATIC INVASIVE SPECIES

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FOR MORE INFORMATION

If you would like more information about aquatic invasive species, the problems they cause, regulations to prevent their spread, or methods and permits for their control, contact one of the following offices:

Wisconsin Department Of Natural Resources
888-WDNRINFO
DNR.WI.GOV search "Aquatic Invasives"

University of Wisconsin- Extension
(715) 346-2116
WWW.UWSP.EDU/CNR/UWEXLAKES

Wisconsin Sea Grant
(608) 262-0905
WWW.SEAGRANT.WISC.EDU
WWW.PROTECTYOURWATERS.NET

Thanks to the following for supporting educational efforts on aquatic invasive species:

- *U.S. Fish and Wildlife Service*
- *Great Lakes Indian Fish and Wildlife Commission*
- *National Park Service*

The Wisconsin Department of Natural Resources provides equal opportunity in its employment, programs, services, and functions under an Affirmative Action Plan. If you have questions, please write to Equal Opportunity Office, Department of Interior, Washington D.C. 20240.

This publication is available in alternative format (large print, Braille, audiotape, etc.) upon request. For information call 608-267-7893.

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Environmental Resources Center, UW-Extension

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Sea Grant, UW-Extension, DNR

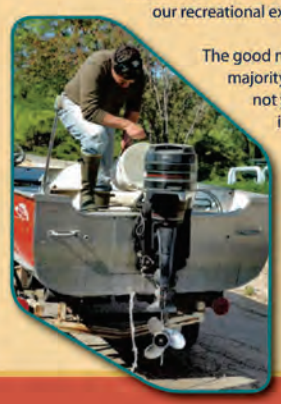
STOP Aquatic HITCHHIKERS

ENJOYING THE GREAT OUTDOORS

Enjoying the great outdoors is important to many of us. Boating, fishing, hunting, and wildlife watching are traditions that we want to preserve for our children and their children. Today, these traditions are at risk. Aquatic invaders such as zebra mussels, purple loosestrife, Eurasian water-milfoil, bighead and silver carp, threaten our valuable waters and recreation. These and other non-native, or exotic, plants and animals do not naturally occur in our waters and are called invasive species because they cause ecological or economic harm.

These invasive species can get into lakes, rivers, and wetlands by "hitching" rides with anglers, boaters, and other outdoor recreationists, who transport them from one waterbody to another.

Once established, these "aquatic hitchhikers," can harm native fisheries, degrade water quality, disrupt food webs and reduce the quality of our recreational experiences.



The good news is that the majority of waters are not yet infested with invasive species and by taking the necessary steps you can help protect our valuable waters.

If you think you have found an INVASIVE SPECIES:

REPORT NEW SIGHTINGS

If you suspect a new infestation of an invasive plant or animal, save a specimen and report it to a local Department of Natural Resources or Sea Grant office. Wisconsin has "ID" cards, websites, and volunteer monitoring networks to help you identify and report invasive species.

CONSULT YOUR NATURAL RESOURCE AGENCY

Do-it-yourself control treatments may be illegal and can make matters worse by harming native fish, wildlife, and plants. Before attempting to control an invasive species or add new plants along your shoreline, contact your local Department of Natural Resources office. DNR staff can provide recommendations and notify you what permits are required.

DNR.WI.GOV search "Aquatic Invasives"

STOP AQUATIC HITCHHIKERS

IS A NATIONAL CAMPAIGN THAT HELPS RECREATIONAL USERS TO BECOME PART OF THE SOLUTION TO STOP THE TRANSPORT AND SPREAD OF AQUATIC INVASIVE SPECIES.

IN WISCONSIN IT IS THE LAW...

Aquatic hitchhikers can spread in many ways such as on recreational equipment, and in water. Fortunately, there are a few simple actions you can take to prevent them from spreading.

INSPECT boats, trailers, and equipment

REMOVE all attached aquatic plants, animals, and mud before launching and before leaving the water access.

Many invasive species spread by attaching themselves to boats, trailers, and equipment and "hitching a ride" to another waterbody. Therefore, Wisconsin law requires that you remove these aquatic hitchhikers before you launch your boat or leave the access area.

DRAIN all water from your boat, motor, bilge, live wells, bait containers and all equipment before leaving the water access.

Many types of invasive species are very small and easily overlooked. In fact, some aquatic hitchhikers, like zebra mussel larvae, are invisible to the naked eye. To prevent the transport of these aquatic hitchhikers drain water from all equipment before you leave the access area.

For more information visit:
DNR.WI.GOV and search "bait laws"

Draining ballast water and lake or river water can prevent the spread of aquatic invasive species and fish diseases, like VHS.

NEVER MOVE plants or live fish away from a waterbody.

In Wisconsin, it is illegal to transport any aquatic plants, mud, live fish or live fish eggs away from any state waterbody. This includes live gamefish and roughfish, like gizzard shad. There are exceptions for minnows obtained from a Wisconsin licensed bait dealer or registered fish farm, which may be transported away live and used again:

- ***On the same waterbody, or***
- ***On any other waterbody if no lake or river water, or other fish were added to their container***

BUY minnows from a Wisconsin licensed bait dealer.

For more information on collecting your own minnows visit:
DNR.WI.GOV and search "VHS Prevention"

DISPOSE of unwanted bait and other animals or aquatic plants in the trash.

When possible, dispose of unwanted bait in the trash at access points. Never release them into the environment.

If possible, dispose of ALL unwanted bait (including earthworms) in a trash can at the boat landing or access point. Otherwise, take them home and dispose of them by placing them in the trash, composting them, or using them in a garden as fertilizer. Likewise, other aquatic plants or animals that you collect, or buy in a pet store, should NEVER be released into the wild.

WISCONSIN REGULATION

Wisconsin has several laws to prevent the spread of aquatic invasive species and the fish disease Viral Hemorrhagic Septicemia (VHS). Failure to follow Wisconsin law can result in fines up to or exceeding **$2000**. Don't be caught unaware!

ADDITIONAL STEPS:

Although not required by WI law, additional steps are highly recommended, particularly if you are transporting a boat and/or equipment from one waterbody to another. Additional steps include:

SPRAY, RINSE, or DRY boats and recreational equipment to remove or kill species that were not visible when leaving a waterbody. Before transporting to another water: ***Spray/rinse with high pressure, and/or hot tap water (above 104° F or 40° C), especially if moored for more than a day. OR Dry for at least five days.***

DISINFECT boats and recreational equipment to kill species and fish diseases that were not visible when leaving a waterbody. Many aquatic hitchhikers can survive out of water for some period of time. ***To prevent their spread, you can sanitize your boat, trailer or equipment by washing it with a mixture of 2 Tbs of household bleach per 1 gallon of water.***

OTHER WATER USES:

Don't get caught spreading aquatic invasive plants or animals! Wisconsin laws, as highlighted above, can apply to many types of water activities, not just boating and fishing. Although these activities might not seem dangerous, they CAN establish and spread invasive species. It is important you follow the steps above for all water activities in order to prevent the spread of aquatic invasive species. These activities include:

- ***Using personal watercraft***
- ***Shore and fly-fishing***
- ***Sailing***
- ***Scuba Diving***
- ***Waterfowl hunting***

FAILURE TO FOLLOW WISCONSIN LAWS CAN LEAD TO FINES.

For additional information contact your local DNR staff or visit:
DNR.WI.GOV

Protect Your Boat

Zebra mussels attach to a variety of materials, including fiberglass, aluminum, wood, and steel and may damage a boat's finish. Veligers are extremely small and can be drawn into engine passages. Once they settle out in the engine cooling system, they can grow into adults and may block intake screens, internal passages, hoses, seacocks, and strainers. The best ways for boat owners to avoid these types of damage are:

- **Use a boatlift** to completely remove the watercraft from the water when not in use.
- **Run your boat regularly** if it is moored in zebra mussel infested waters. Run the engine at least twice a week at slow speeds (about 4-½ mph) for 10 to 15 minutes. Monitor engine temperatures – if you notice an increase, it may mean that zebra mussels are clogging your cooling system. Immediately inspect the system and remove any zebra mussels. The end of boating season is also a good time to inspect and clean the cooling system.

- **Lift the motor out of the water between uses if mooring.** Fully discharge any water that may still remain in the lower portion of the cooling system.
- **Tip down the motor and discharge the water when leaving a waterbody** to reduce the likelihood of transporting veligers (in water) to another waterbody.
- **Clean your boat and equipment.** Physically remove (scrape) adult mussels from your boat, trailer, and equipment by hand. Young zebra mussels and veligers may be too small to see. Wash your boat with high-pressure hot water (use water >104˚F if possible). Use high-pressure cold water if hot water is not available. *(Avoid pressure washing classic wooden boats or others not made of metal.)*
- **Apply anti-fouling paints or coatings to the hull and the engine's cooling system** to prevent zebra mussel attachment. It is best to purchase these from an area boat dealer or your local marina. Anti-fouling paints that are copper based can be used in Wisconsin, and typically need to be reapplied every one to two years. In-line strainers can also be installed in the engine's cooling system.
- **Use motor "muffs", also known as motor flushers, to remove zebra mussels and other materials from your boat engine or personal watercraft.** Clamp the motor flusher onto the lower unit over the cooling inlets on either side of the motor, and screw the nozzle of your garden hose into it. Run the boat engine for approximately 10 minutes or as suggested by the manufacturer.

Amy Bellows, WI DNR

Special note of caution for anglers

Dispose of unwanted bait in the trash - do not transfer bait or water from one waterbody to another. Larval zebra mussels or other invasive species could be present in the water with the bait.

Help prevent aquatic hitchhikers from catching a ride on your boat or equipment:

- ✓ **Inspect** and **remove** aquatic plants and animals,
- ✓ **Drain** water,
- ✓ **Dispose** of unwanted bait in the trash,
- ✓ **Rinse** with hot and/or high-pressure water, OR
- ✓ **Dry** for 5 days.

Clean Boats . . . Clean Waters

For a list of known zebra mussel infested waters, visit:
www.dnr.wi.gov/org/water/wm/GLWSP/exotics/zebra.html

The Wisconsin Department of Natural Resources provides equal opportunity in its employment, programs, services, and functions under an Affirmative Action Plan. If you have any questions, please write to Equal Opportunity Office, Department of Interior, Washington, D.C. 20240.

This publication is available in alternative format (large print, Braille, audiotape, etc.) upon request. Please call 608/267-7694 for more information.

Cover photo: L. Pohlod. Inset: Great Lakes Sea Grant Network
Designed by L. Pohlod, Blue Sky Design, LLC *PUB-WT-383 2004*

Zebra Mussel Boater's Guide

Zebra mussel identification and life cycle

Mature zebra mussels look like small D-shaped clams. Their yellowish-brown shells have alternating light and dark stripes.

Ohio Sea Grant

Zebra mussels can reach a maximum of 2 inches in length, though most are smaller than an inch. They are typically found attached to solid objects, often growing in large clusters.

Ontario Ministry of Natural Resources

Amy Bellows, WI DNR

Zebra mussels begin as eggs, then develop into free-swimming larvae (called **veligers**), which are microscopic. The veliger photos shown above were taken with the aid of a microscope. Veligers are spread by currents; after about three weeks, they settle out and firmly attach themselves to hard surfaces, where they grow into adults. Their lifespan is typically three to five years. They begin to reproduce after a year or two - females can release up to one million eggs per year!

James Lubner, University of Wisconsin Sea Grant

What do zebra mussels do?

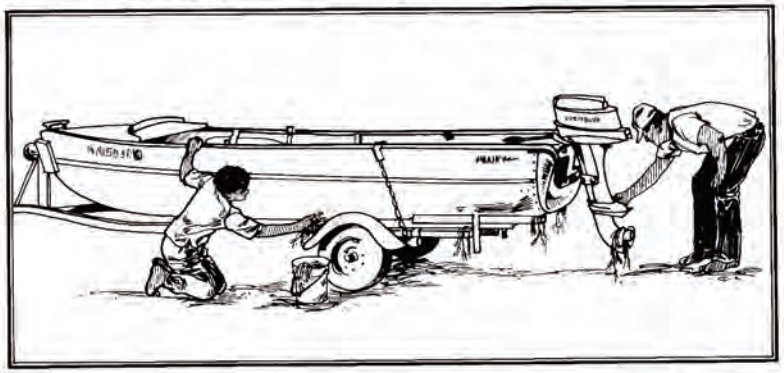
Zebra mussels are **filter feeders** that can filter large volumes of water (up to 1 Liter/day). In some cases they can filter the whole volume of a lake in a few months. They remove plankton – tiny plants and animals – from the water. What they eat (and what they don't eat) ultimately ends up on the lake or river bottom. Plankton is an important food source for young fish, native mussels, and other aquatic organisms. Zebra mussels may concentrate this food at the bottom, leaving open water species with **less to eat**!

Because they are so good at filtering, zebra mussels often **make water clearer**. This may force **light-sensitive fish**, like salmon and walleye, into deeper water to seek shelter from the sun. Increased light penetration allows aquatic plants to grow in deeper water and spread to a larger area. This may help smaller fish to survive by giving them places to hide, but makes it harder for large, predatory fish to find food. **Thicker plant growth** may also cause problems for boaters and anglers.

Don Schloesser, Great Lakes Science Center, National Biological Services

Zebra mussels cause people additional problems. They **clog water intakes and pipes** – large water users on the Great Lakes spent $120 million from 1989 to 1994 to combat zebra mussels. They also **attach to piers, boatlifts, boats, and motors**, which can cause damage requiring costly repair and maintenance. Even when they die, their **sharp shells** wash up on beaches, creating foul odors and cutting the feet of swimmers.

How can I help prevent the spread of zebra mussels?



Microscopic veligers may be carried in livewells, bait buckets, bilge water – any water that's transported to another waterbody. They can also travel in currents to downstream waters. Adults can attach to boats or boating equipment that are moored in the water. They frequently attach to aquatic plants, which themselves may hitch a ride on boats and equipment. For these reasons, it is important to take the following steps to prevent the spread of zebra mussels and other aquatic invasive species while boating:

Before moving your boat from one water body to another:

- ✓ **Inspect** and **remove** aquatic plants, animals, and mud from your boat, trailer, and equipment,
- ✓ **Drain** all water from your equipment (boat, motor, bilges, transom wells, live wells, etc.),
- ✓ **Dispose** of unwanted bait in the trash, not in the water,
- ✓ **Rinse** your boat and equipment with hot (> 104°F) and/or high pressure water, particularly if moored for more than one day, OR
- ✓ **Dry** your boat and equipment thoroughly (in the sun) for five days.

Pressure washing note:

Avoid pressure washing classic and wooden boats, along with canoes and kayaks that are not made of metal. These types of boats should be drained, cleared of all plant and animal materials, and left in the sun to dry completely.

Effective May 2002, Section 30.715, WI Act 16 prohibits launching a boat or placing a boat or trailer in navigable waters if it has aquatic plants or zebra mussels attached.

Appendix K

REED CANARY GRASS MANAGEMENT GUIDE

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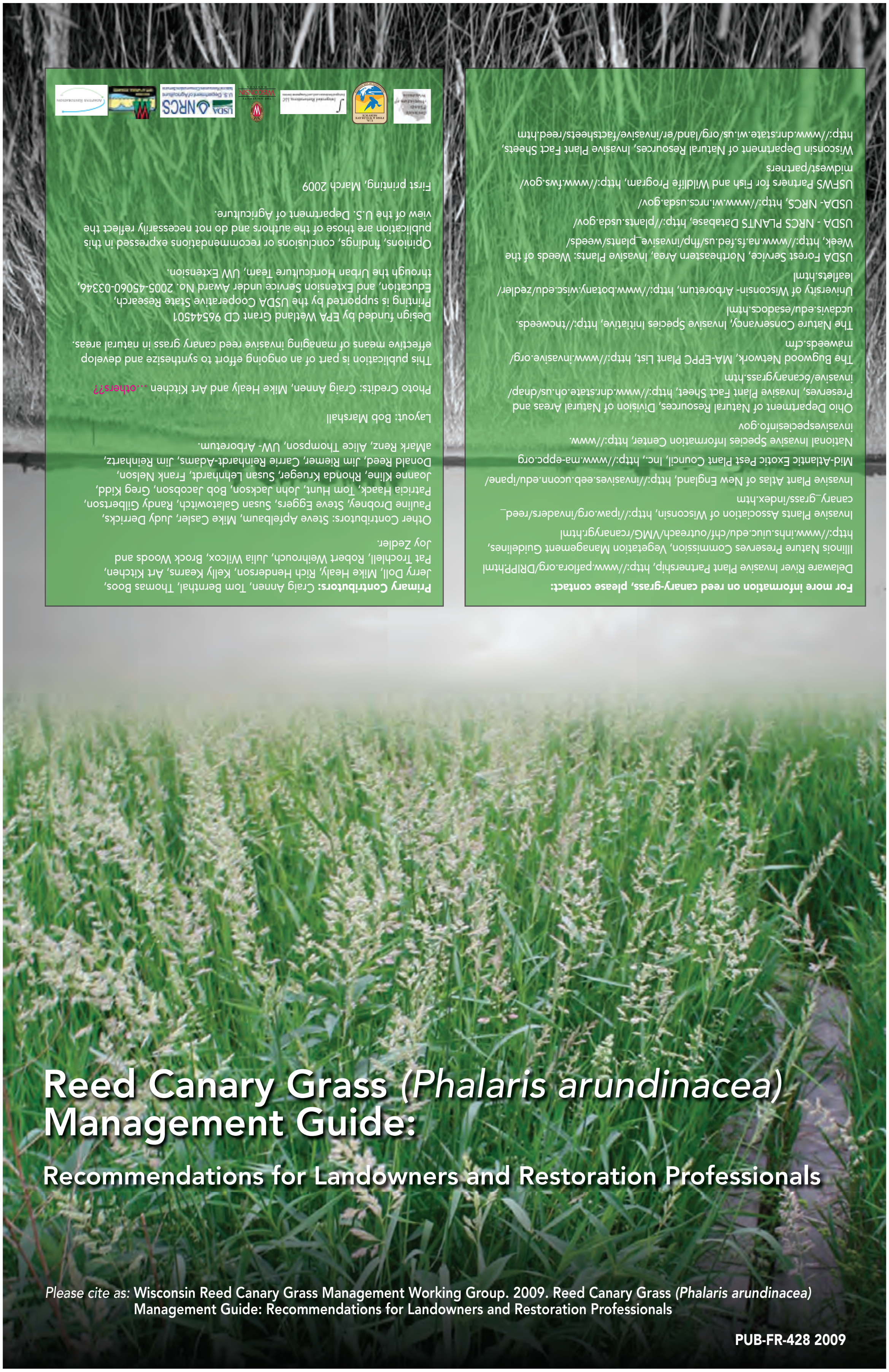

For more information on reed canary-grass, please contact:

Delaware River Invasive Plant Partnership, http://www.paflora.org/DRIPP.html

Illinois Nature Preserves Commission, Vegetation Management Guidelines, http://www.inhs.uiuc.edu/chf/outreach/VMG/rcanarygr.html

Invasive Plants Association of Wisconsin, http://ipaw.org/invaders/reed_canary_grass/index.htm

Invasive Plant Atlas of New England, http://invasives.eeb.uconn.edu/ipane/

Mid-Atlantic Exotic Pest Plant Council, Inc., http://www.ma-eppc.org

National Invasive Species Information Center, http://www.invasivespeciesinfo.gov

Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Invasive Plant Fact Sheet, http://www.dnr.state.oh.us/dnap/invasive/6canarygrass.htm

The Bugwood Network, MA-EPPC Plant List, http://www.invasive.org/maweeds.cfm

The Nature Conservancy, Invasive Species Initiative, http://tncweeds.ucdavis.edu/esadocs.html

University of Wisconsin- Arboretum, http://www.botany.wisc.edu/zedler/leaflets.html

USDA Forest Service, Northeastern Area, Invasive Plants: Weeds of the Week, http://www.na.fs.fed.us/fhp/invasive_plants/weeds/

USDA - NRCS PLANTS Database, http://plants.usda.gov/

USDA- NRCS, http://www.wi.nrcs.usda.gov/

USFWS Partners for Fish and Wildlife Program, http://www.fws.gov/midwest/partners

Wisconsin Department of Natural Resources, Invasive Plant Fact Sheets, http://www.dnr.state.wi.us/org/land/er/invasive/factsheets/reed.htm

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Photo Credits: Craig Annen, Mike Healy and Art Kitchen ...others??

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Recommendations for Landowners and Restoration Professionals

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RCG in Flower

INTRODUCTION

How to use this manual?

This guide walks you through the steps you can take to manage reed canary grass. Please start at the beginning and see TABLE 1 for a summary of treatment options that can be used. TABLE 2 will help you conduct a site assessment and decide which techniques are best suited to your budget and situation, and TABLE 3 lists native species that may provide competition for reed canary grass during restoration and management efforts

Reed canary grass (hereafter RCG) is a threat to the ecological integrity of countless wetlands across Wisconsin. Bernthal and Hatch (2008) found that 1 in 7 wetland acres in their southern and south-central Wisconsin study area were heavily dominated or co-dominated by RCG, and approximately 500,000 acres of wetlands in the entire state are infested. Reversing this pattern will require a large-scale, long-term, cooperative effort from scientists, policy makers, agency professionals, contractors, and non-profit organizations. It will also require cooperation from landowners. Consider taking an active role in the stewardship of our natural heritage through your actions to reduce RCG and promote native biodiversity in Wisconsin's wetlands!

This Reed Canary Grass Management Guide provides a template for local-scale RCG abatement, and it summarizes our current understanding of invasion biology and management tactics for RCG.. It is our intention to periodically update this information as new results from ongoing research contributes to our understanding of this species

What is the impact of RCG?

The impacts of reed canary grass on the habitats it invades are many. RCG greatly reduces botanical and biological diversity by homogenizing habitat structure and environmental variability (both of which correlate with species richness), alters hydrology by trapping silt and constricting waterways, and limits tree regeneration in riparian forests by shading and crowding out seedlings. RCG also decreases retention time of nutrients and carbon stored in wetlands, accelerating turnover cycles and reducing the carbon sequestration capabilities characteristic of diverse plant communities. Although its effects on wildlife are not yet entirely clear, preliminary data suggest that habitat specialist species (including several listed and protected species) are more adversely affected by reed canary grass dominance than habitat generalists.

Reed canary grass monotype(s)

LIFE CYCLE OF REED CANARY GRASS

Reed canary grass is an aggressive, cool-season RCG is an aggressive, cool-season perennial grass that invades and dominates a variety of wetland types. Invasion typically occurs after disturbance from erosion, sedimentation, nutrient enrichment, road salt inflows, hydrological instability or modification, and restoration efforts that expose bare ground and increase high light availability. RCG responds positively to nutrient inputs, either as fertilizer or nonpoint agricultural runoff. Recently, it was discovered that the presence of multiple disturbances, characteristic of many of Wisconsin's wetlands, can interact to accelerate the pace of invasion and native species displacement. Because of its vigorous growth in wet soils, RCG has been intentionally planted since the early 1900's by livestock producers for forage and seed production, and it has been used for erosion control and soil stabilization.

RCG reproduces by seed, by stem fragments, and by underground horizontal stems (rhizomes). Field populations have a high degree of genetic variability, and it has been estimated that more than 115 artificially-selected reed canary grass genotypes have been developed. There is no rapid way to determine the genetic origin of a particular RCG stand, although the presence of green or purple panicles (grass flowers) in mid-June point to the existence of different genotypes within the stand. This species is both drought and flood tolerant. Growth and productivity peak twice during the growing season, first in late spring and again in late summer. These growth peaks are under separate genetic control, with leaf and inflorescence growth dominating in the spring and stem and rhizome growth dominating during the late summer peak.

RCG is one of the first wetland plants to emerge in the spring, enabling it to shade out native species that emerge later in the growing season. RCG can stay

continued

Some caption here.

Some caption here.

Some caption here.

Reed Canary Grass Life History *continued*

green and actively growing well past the first killing frost in autumn. Once established, RCG is capable of rapid clonal expansion, which is enhanced by high nutrient and light availability. Species with clonal growth mechanisms expand either by employing a phalanx strategy, where tillers mass into an impenetrable clone expanding over short distances, or a guerilla strategy, where the parent plant forms long rhizomes and new tillers emerge at a distance from the parent clone. RCG uses both the phalanx and guerilla strategies. It more typically spreads by vegetative shoots arising from shallow rhizomes which can extend over 10 feet per year and form a thick impenetrable mat below the soil surface. These rhizomes have numerous dormant buds that represent the primary mechanism for resurgence when above-ground growth is removed. Rapid expansion, early growth, and the mulching effect of a dense litter layer all interact to facilitate the decline of native species. Few native species can persist indefinitely within a dense clone of RCG. To make matters worse, seeds and vegetative fragments readily float, making streams and ditch networks effective dispersal corridors, especially during periods of flooding. RCG seed is also dispersed by humans and wildlife, as the seed adheres readily to moist skin or fur, and is transported in clothing, equipment, and vehicles.

Some members of the genus *Carex* begin active growth in early spring and will compete with RCG for light, nutirents and space.

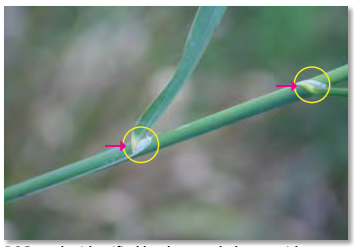
For a RCG seed to germinate, or for a vegetative fragment to become rooted, a disturbance that creates a bare space is initially required. Seed germination is bimodal, peaking in March-May and again in June-July. Seedlings are vulnerable to management treatments and inter-specific competition until they become well-established. New seedlings allocate most of their growth to accumulating underground reserves and developing tillers during the first growing season, generally only needing a single growing season to become established. Once established, RCG emerges in the spring from rhizome reserves accumulated during the previous growing season. By using both new energy from photosynthesis and reserve energy from rhizomes for spring growth, RCG quickly towers over most other species, preempting all available space and light. Since most spring growth occurs aboveground, the rhizome becomes depleted of starch until flowering. After flowering, rhizomes elongate and tiller. Then, , in late summer, the plants store energy in the rhizome for over-wintering.

RCG is biennial with respect to flowering. Like many cool-season perennial grasses, development of flowering stems requires vernalization (a combination of short day photoperiod and cold temperatures). The new stems that develop from seed or rhizome buds require two years to develop panicles. Flowering stems often comprise only about 15% of the total stem density per unit area. In spite of this, seed production in monotypic stands can exceed several hundred seeds per plant, and seed can remain viable in the soil for several years. Seed subject to prolonged inundation, however, can lose viability in as few as 2 years.

MANAGEMENT CONSIDERATIONS

Understanding the adversary is a key for management. Following recommendations from this guide does not guarantee control and/or eradication of RCG. Site-specific conditions and timing variables are likely to influence results. Here are a few important points to remember when considering a management program for this species:

1. RCG is persistent and tenacious due to three its prolific seed rain and dispersal, robust vegetative growth, and dense network of underground rhizomes with thousands of dormant buds. Therefore, techniques used to suppress above-ground vegetative growth need to be paired with techniques that address the underground rhizomes and seed bank. Neglecting any one component can lead to frustration. Annen (2008) provides a detailed overview of rhizome bud bank persistence and how to incorporate accessory treatments into your management program.
2. RCG often invades native plant communities that are under stress or have been disturbed by past farming practices. When designing a management strategy, be sure to consider the probable cause(s) of the RCG invasion. Underlying conditions such as high nutrient levels in the soil, excessive sedimentation, or off-site factors should be addressed, if feasible, in a site-specific treatment plan.
3. Timing is important, so try to time your treatment to achieve multiple benefits. Mowing, burning or herbiciding with grass-specific chemicals after reed canary grass has achieved some growth in the late spring will reduce or eliminate seed development, allow release of native vegetation to compete with subsequent re-growth, and drain rhizome carbohydrate reserves at a time when they are already being depleted. These same practices applied later in the growing season may be much less effective.
4. Be persistent. Once you start a management effort, do not allow RCG to recover by suspending your management efforts for a growing season. if you are forced to select alternative management measures due to weather conditions, machinery breakdown or other unforeseen obstacles, try to do something to interrupt its growth each year. Generally, you will need to treat the site for a minimum of 3 to 5 years.
5. Sites with diverse vegetation at the onset of management tend to respond more positively to treatments than monotypic stands. The primary goal is to replace RCG with a diversity of native species. If your resources are limited, it may be better to focus management in mixed stands of RCG and native species. Timing management practices to favor an existing native plant community, along with interseeding additional species, can reverse RCG dominance in as little as 2 to 3 years. Once re-established, the native plant community will compete for sunlight, suppressing the RCG seed bank and re-growth from its dormant bud bank. In contrast, formerly cropped sites with few residual native plants or seed often have other invasive species present, have higher management costs, and require more years of treatment to establish a desirable replacement plant community.
6. Finally, practice adaptive management. No one recipe works under all conditions. Keep in mind that the techniques, tools and materials presented here do not include all available management options. Chemical formulations, for instance, are constantly changing, with new products introduced every year. After applying a series of treatments, monitor the plant community response and be willing to change your techniques when conditions favor a different approach. Suppression of RCG may result in other invasive or undesirable species attempting to colonize the site. Learn from your experiences and share them with others.



RCG can be identified by the rounded stem with prominent ligule or papery membrane at the base of its leaves.

RCG prooduces seeds that float and stick to skin, fur, clothing and footwear.

Remember:

- If using a chemical management technique, be sure to read and follow all labeling instructions. It is a violation of federal law to use an herbicide in a manner inconsistent with its labeling.
- Federal, state and local permits may be required when performing restoration work in wetlands or along waterways. Contact your local DNR office or county zoning administrator before initiating reed canary grass management work
- It is easy to spread reed canary grass seeds, rhizomes or other plant parts to new locations. Be sure to clean equipment, clothes and footwear before leaving a site.

For more information on reed canary grass, there is a list of resources and readings in the back.

TABLE #1 – Management Practices

Treatment	Effect	Should use	Could use	Should not use	Comments
Burning 	• Removes biomass and litter; may kill seeds on soil • Reduces available nitrogen over multiple burns • Releases seed bank of desirable/undesirable species • Stimulates dormant buds of RCG, rhizomes re-sprout • Can jumpstart growing season by warming soil	• To reduce RCG in late spring after RCG is active but before natives break dormancy • To force RCG to re-sprout and use reserves from rhizomes • Use in combination with other practices	• To remove thatch prior to a planting/seeding of desirable natives • To remove thatch and prompt early spring sprouting of RCG, which can then be treated with glyphosate or sethoxydim	• In fall to control RCG in short term; RCG benefits from high light conditions after fire • In early spring in mixed vegetation sites; RCG growth is encouraged by increased light, unless you plan to combine with another treatment • On organic sites if very dry	• Jumpstart occurs if burn done in fall or spring • No research on critical density of RCG that can be controlled by burning alone • Early burns will stimulate RCG; timing and frequency critical
Excavation 	• Removes rhizomes and seed bank • Removes sediment and nutrients • Alters hydrology	• Where material can be pushed to fill drainage ditches or where it can be moved off site; where deeper water is desired • During winter, to reduce soil compaction • During summer when wet sites are dry	• To remove alluvium over native wetland soils	• If there is no soil disposal site. • If compaction is an issue • If you don't want a deep-water marsh. • If there is a high-quality remnant plant community in area	• May cause soil compaction • RCG will rapidly re-colonize disposed soil; use caution when selecting a disposal site • Additional treatments will be necessary on drier sites • Seed with natives afterwards, except in the deepest water, or if a rich native seed bank exisits • May require special permits
Tree/shrub planting 	• When woody species overtop RCG, shade slows its growth • May change plant community • Adds structure to habitat	• Where herbaceous vegetation cannot gain a competitive advantage	• Where landscape is receiving RCG seed inputs • Where inflows can't be diverted • To connect existing woody patches	• Where management goal is to maintain grassland habitat	• Apply herbicide/mulch around newly planted trees/shrubs • Conifers may be the most effective at shading RCG • Need to control RCG for 3-5 years to allow trees to establish
Grazing 	• Reduces biomass in spring • Causes disturbance • Allows seedling establishment (good/bad) • Adds nutrients to system	• In highly disturbed sites to reduce RCG biomass • In fall, after a prescribed burn (RCG regrowth more palatable)	• To reduce biomass and height before herbicide treatment • To reduce seed production • Lightly, to sustain diversity	• During wet conditions in spring where trampling and compaction can damage a site • If there is a high-quality remnant plant community in area	• Effective at suppression only • Use proper stocking rates to prevent overgrazing of desirable species
Mowing & harvesting (haying) 	• Removes biomass and nutrients • Reduces RCG height • Similar to fire (promotes seed establishment, stimulates plant growth by increasing light)	• To reduce biomass before herbicide treatment • To remove P from site • Before RCG seed heads appear • To prepare for herbicide application	• As a substitute for fire (though not quite the same) • To change fire behavior by reducing fuel height	• Where tussocks and microtopography will be damaged • When grassland bird nesting habitat will be impacted. • If site is too wet for equipment	• On high quality sites, avoid use during growing season • Mow before RCG seed heads appear (boot to late boot stage)* to prevent seed production
Mowing without harvesting	• Reduces RCG height • Increases light—promotes competition • Depletes rhizome reserves • Creates dry biomass for fire	• To prepare for herbicide application • To stress RCG • When harvesting equipment is unavailable	• To change fire behavior by reducing fuel height	• Where tussocks and microtopography will be damaged • When grassland bird nesting habitat will be impacted. • If site is too wet for mower	• Mow before RCG seed heads appear (boot to late boot stage)* to prevent seed production • May impede establishment of natives, due to remaining mat of vegetation
Herbicide: broad spectrum (i.e. glyphosate, imazapyr) 	• Reduces plant height • Increases light—promotes competition • Depletes rhizome reserves • Creates dry biomass for fire	• On sites without native plants prior to reseeding. • To dry out RCG in order to burn • In late summer for maximum translocation to roots	• For treating clones within areas of natives • As an initial herbicide treatment on monotypic stands of RCG • If RCG height precludes use of other herbicides • In early spring or late fall, when RCG is live, but other plants dormant • On wet sites, with a surfactant approved for aquatic use	• On sites with desirable native plants actively growing • Soon after mowing/burning • When amphibians are on site (unless using Rodeo + a surfactant approved for aquatic use, as Roundup formulation can have negative effects on amphibians)	• Should be part of a continued control strategy, where natives are later introduced • Multiple treatments may be necessary • May need a permit for application on wetlands • Rhizome translocation less effective if temperature >70°F • Other treatments may influence herbicide effectiveness • Add ammonium sulfate to tank mix if water is hard
Herbicide: grass-specific (i.e. sethoxydim or fluazifop)	• Suppresses growth of most grasses • Releases native plant community (except for grasses)	• On sites with desirable, native, non-grass species • When active growth resumes after burning/ mowing, when RCG is 6-12" tall	• Following other herbicide treatments to control residual or re-emerging RCG	• For immediate eradication • If standing water is present • On sites with desirable grasses • When RCG is >12" tall	• Apply with surfactant/crop oil • > one treatment required • Effectiveness of sethoxydim is reduced by UV light • Add a water conditioner or acidifier if water is hard
Tillage 	• Exposes rhizomes to light; might activate dormant buds • Fragments rhizomes and may increase RCG density • Can contribute to erosion	• In combination with herbicide treatment (makes dormant rhizome buds respond to chemical control) • On monotypic, damaged sites to prepare for crop production	• To prepare a seedbed • To reduce RCG seed bank	• Where microtopography must be maintained. • Where RCG is mixed with desirable natives • On wet sites, where soil could become compacted, or equipment can get stuck • If offsite impacts are possible (sedimentation/erosion)	• For most effective control, combine with another treatment • Depth should be 4-6" to target RCG rhizomes • Till in spring or early summer • Repeated tillage can be effective if conducted every four weeks.
Altering hydrology 	• Prolongs/increases water levels • Prevents RCG seed germination • Kills RCG rhizomes	• If new water depth is > 12" • If high water can be maintained through the growing season.	• To promote the growth of emergent plants such as native cattail, burr-reed and bulrush species	• If new water depth is < 12" or site seasonally dries out • If other invasives are nearby (*Typha* x glauca, *Phragmites*)	• High water can promote growth of other invasives (*Typha* x glauca, *Phragmites*) if present in the area • May require special permits
Mulching / solarization with plastic or fabric 	• Non-selective treatment; shades out all plants • Kills adult plants • Kills RCG rhizomes	• For small, isolated RCG clones • For 1-3 consecutive years • On patches with high edge:area ratio, to facilitate recolonization by soil fauna	• To facilitate seeding or planting of natives	• Where desirable natives are mixed with RCG • For abatement on large sites • If native species are present • In areas with microtopography	• Resurgence from seedbank may occur when tarping removed • May have adverse effects on soil microorganisms • May alter soil chemistry • Not always an effective treatment

RCG= Reed canarygrass * For a description of growth stages see the bulletin, *Growth and Staging of Wheat, Barley and Wild Oat* at http://plantsci.missouri.edu/cropsys/growth.html

TABLE #2 – Site Assessment

Amount of RCG present[1]	Site characteristics/vegetation (recent <25 years)	Hydrology[2]	Inputs[3]	Tree Planting	Burn*	Excavate[4]*	Graze	Mow[5]	Broad-Spectrum Herbicide[6]	Grass-specific Herbicide[7]*	Tillage/ Farming	Raise water levels[8]	Seeding[9]
RCG Monotypes	< 25 years since tillage/farming, uniform topography[a]	Normally wet	High/low	E	2	2			2	2		1	1
		Seasonally dry		1	1	1	1	1	1	2	1		1
	> 25 years since tillage/farming or no ag history, uneven topography[b]	Normally wet	High/low	E	2					2		1	2
		Seasonally dry	Low		1			2		2			2
			High	2	1		2	2		2			2
	Shrub or forest edge[c]	Normally wet	High/low	E	2			1	2	2			2
		Seasonally dry		1	2			1	2	2			1
RCG Mixtures	Mixed with non-native grasses and/or weedy forbs	Normally wet	High/low	E	2	2			2	2		1	1
		Seasonally dry		1	1	1	1	1	1	2	1		1
	Mixed with native grasses	Normally wet	High/low		2				spot-spray	spot-spray			2
		Seasonally dry			1			2	spot-spray	spot-spray			2
	Mixed with native sedges, rushes and forbs	Normally wet	High		2					2			2
			Low		2					2			2
		Seasonally dry	High/low		1			1		1			2
	Mixed with shrub or forest matrix[d]	Normally wet	High/low	E						2			2
		Seasonally dry		1						1			2
	Discreet linear strips or clumps of RCG within a desirable native plant community				1			1	spot-spray	spot-spray			1

KEY TO TABLE

1 = Suitable treatment

2 = May be a suitable treatment, site conditions need to dictate treatment(s) methods

E = Experimental treatment

Superscripts

1- Monotypic stands contain >75% RCG with few other (often ruderal) species.

2- Hydrology- *Normally wet* refers to saturation and inundation for all or most of the growing season. *Seasonally dry* allows for access and treatment for a significant portion of the growing season.

3- Input refers to sediment, flooding, nutrient and stormwater inputs.

4- Excavated RCG sod and rhizomes should be placed on existing monotypic RCG stands, used in ditch filling or spread on cropland where it can be controlled. Check for any required state and local permits before starting and follow with a native seed mix tailored to the sites hydrology.

5- Mowing includes either harvesting and bailing or leaving clippings in place. To avoid negative impacts of mowing on nesting birds, be sure to consult a grassland bird specialist before selecting a mowing date.

6- Broad spectrum herbicides that have been experimentally tested or are currently being tested for RCG control include glyphosate, imazapyr, and amitrole.

7- Grass specific herbicide should not be applied to open water or areas where standing water is present. Consult herbicide label for application instructions.

8- To be effective, water levels should be raised > than 1 foot above RCG crown buds for more than 3 months of the growing season for more than one growing season.

9- Seeding- Reference the seed list and seeding should typically be used with other treatments.
a- Sites with uniform topography lack microtopographic features.
b- Sites with uneven topography possess microtopographic features (springs, seeps, boulders, tussocks, internal drainage channels, snags, downed logs, etc.) and may harbor suppressed native plant communities or remnant native seed banks.
c- Shrub or forest edge refers to the RCG population existing on the edge of the shrub or forest wetland
d- Shrub or forest matrix refers to the RCG population existing within the shrub or wetland wetland with a patchy distribution

** refers to the potential need for local, state and/or federal permitting*

NOTE: *Optimal results will be obtained by using two or more treatments in combination over a period of years, combined with active reseeding of native species. Site conditions should dictate the treatment(s) methods. Always read the herbicide label before application.*

SPECIES RECOMMENDED FOR REED CANARY GRASS REPLACEMENT

Introduction

Management activities that create bare ground (e.g. removing trees, constructing scrapes, re-contouring wetlands, using nonselective herbicides) should be reseeded quickly, as RCG can rapidly colonize these sites after the disturbance. When reseeding for RCG abatement, your goal should be to create a closed canopy of herbaceous species as quickly as possible, before RCG can re-establish. Research has shown that a closed herbaceous canopy will filter sunlight, increasing the amount of far-red (FR) light reaching the soil surface. As transmission of far-red light increases (relative to blue light), the percentage of RCG seeds that germinate decreases. Furthermore, RCG displays very low establishment rates and low seedling aggressiveness under light-limited conditions. The ideal endpoint planting, therefore, is one that exhibits a complex, multi-species herbaceous canopy that is vertically and phenologically layered. The best way to ensure this is to plant a diverse mixture of different shape and forms variable species from different functional guilds (e.g., sedges, rushes, cool- and warm-season grasses, and forbs).

***Helenium autumnale* is an effective sompetitor.**

Purpose of this Species List

We recommend species that have potential to coexist with RCG in situations where the latter is under stress from management treatment. Proactive re-vegetation with a diversity of native species should be a component of any RCG abatement project. Research has demonstrated that competition from established native species augments and accelerates RCG management efforts. Restoring hydrology, fire regime, etc., is important, but the idea that these will facilitate passive immigration and reestablishment of native vegetation generally lacks empirical support because the present landscape is often too fragmented for adequate gene flow between existing natural areas.

Guidelines for Planting

Seeding rates – Seed bare ground at high rates, 7 to 10 pounds/acre (60 – 100 seeds/ft^2) and augment seeding with plugs of live plants where feasible after RCG propagules have been eliminated. RCG monocultures should also be seeded at this rate after management efforts have significantly weakened RCG resurgence capacity. **Note:** do not rely on a one-time treatment to adequately manage a RCG monotype. Mixed stands can be inter-seeded at a lower rate, 4 to 7 pounds/acre (40 – 60 seeds/ft^2), depending on your budget and the density and composition of native species already present. Consider augmenting seedings with live plants (plugs), rhizome fragments (sedges), rooted tubers (emergent plants), or even entire tussocks or sod transplants if a suitable (non-protected) donor site is available. Plugs should also be used in areas prone to erosion where seeds can easily be washed away. When plugging, keep in mind that animal browsing, dry weather, and transplant shock can reduce establishment. You may have to install browsing exclosures around plugs and water them regularly during the first growing season. Dip plugs in rooting hormone immediately prior to planting to improve establishment.

Timing and Site Preparation – Timing and Site Preparation – Generally, sowing seed in late fall/winter (frost seeding) favors establishment of most forbs, sedges, and cool-season grasses, while spring seeding favors establishment of warm-season grasses. Plugs of most species should be planted in spring to take advantage of wet spring weather and to ensure they have one complete growing season to prepare for overwintering (consult with your local seed distributor if you are unsure of when to plug certain species). To frost seed, one proven method is to burn the site after the first hard frost and broadcast seed onto bare ground. If possible, use a cultipacker to mend the sown seed to the soil surface. Subsequent freezing and thawing of the soil will work the seed to proper depth over the winter. An advantage of frost seeding is that seed does not have to be stratified prior to planting. A disadvantage is that weather conducive to stratification cannot be ensured. For sites that have been re-contoured, ask the contractor or agency representative to include microtopographic features. Increasing microtopography will add diversity to the microhabitats available to species and promote canopy complexity. If feasible, consider installing a passive water control gate to stabilize water levels during plant establishment and to increase long-term management capability.

Adaptive Seeding – Species vary in their planting on a budget, design Species vary in their germination requirements, and site conditions can vary considerably by year. Consider boosting initial high-density plantings with multiple-year seedings at reduced planting densities. This is a way to hedge your bets against adverse conditions during any single growing season, and it will help to recharge the native species seed bank. You may also need to adopt a mosaic planting strategy for sites that are still being actively managed during seedling establishment or if bare ground persists.

continued

Recommended Native Species *continued*

Financial Considerations – Compare prices! Costs can vary substantially among local nurseries. Plugs, rootstock, rooted tubers, and rhizome fragments are considerably more expensive than seeds. To achieve a high-diversity planting on a budget, design your seed mix to include one dominant (matrix) species, a few subdominant species and a few species of intermediate abundance, with most species present in rare or uncommon abundance. Try to imitate this natural pattern in your seed mix. This approach reduces costs because the matrix and sub-dominant species are relatively inexpensive while the less common species are often the most expensive. Keep in mind that differing germination requirements of individual species and rapid establishment of aggressive native species (e.g. Panicum virgatum) can make this goal difficult to achieve in a practical setting. If you are on a tight annual budget, one strategy is to spread out costs with consecutive-year reseedings. However, doing this may lead to increased costs for weed control because less space will be occupied by desirable native species. Frank Egler's "Initial Floristic Composition Model" predicts that the most diverse endpoint community will be the one with the most native propagules present at the outset (bare ground stage). Thus, an ounce of prevention (initial seeding at a high rate) is worth a pound of cure (consecutive years of chemical and mowing costs required to suppress secondary weed outbreaks).

Cool-Season Cover Crops/Companion Crops – Realistically, it will take several years for a native planting to mature to the point of canopy closure. RCG and/or other weeds can quickly (re)establish during the interim, particularly if there is off-site impact and propagule influx from adjacent non-treated areas. One way to forestall subsequent infestations (and associated abatement costs) is by planting a rapidly establishing cover crop or companion crop along with your native species mixture. Cover crops are typically annual species (e.g., annual ryegrass (*Lolium multiflorum*), or beggarticks (*Bidens* sp.)), whereas companion crops are short-lived perennials (e.g., Virginia wild rye (*Elymus virginicus*) or Canada wild rye (*Elymus canadensis*)). In theory, cover crops and companion crops reduce competition from weeds while native perennials are establishing. Cover crop seed is available from most native seed nurseries and also from local farm seed suppliers. When purchasing cover crops from local farm seed dealers, be sure to request certified weed-free seed. NOTE: do not include cover crop seeding densities when tabulating seeding rates for a planting.

Other Considerations – Sedges of the genera *Carex* and *Scirpus* (now called *Schoenoplectus, Bolboschoenus, Isolepis*, or *Trichophorum*) can be difficult to establish, particularly at sites with flashy or variable hydrology. Consider using a mix of seeds and plugs of these taxa. Alternatively, some sedge species can be propagated from rhizome fragments. Also, recent research has shown that ***Carex achenes*** have limited storage life. Sow *Carex* seeds in the same growing season you collect them, or, if ordering seeds from a nursery, inquire about the collection date for the seed lot you are ordering. For sites with variable hydrology, consider planting species that are adapted to grow in more than one hydrologic regime or species with plastic morphological responses to water level variations (e.g. *Polygonum amphibium*) so that RCG cannot take advantage of fluctuating water level disturbances to recolonize a site. When collecting seed, remember to increase your seeding rate (by at least 50%) because site-collected seed typically has a lower germination rate (lower titer or PLS-pure live seed) than nursery seed. Use of PLS seed in plantings has been shown to make a big difference in germination of desired endpoint species. If not used immediately, store any seed in a cool, dry location that is not exposed to direct sunlight or extreme temperature fluctuations. Plugs, sprigs, or live plants should be set out as soon as possible. If this is not possible, store in damp peat moss or sand in a cool location away from direct sunlight or follow instructions and recommendations from the supplier. Try to collect or purchase seeds from source populations that are located as close to the planting site as possible. Most seed nurseries keep records of seed genotype and label their seed lots with this information. If your goal is not ecological restoration of a native plant community, contact your local USDA-Natural Resources Conservation Service for alternative seeding options.

RCG is one of the first wetland plants to green up in the spring.

Some caption here.

RCG re-growth following one glyphosate herbicide application. It will take multiple growing seasons of management actions to reduce RCG.

GUIDELINES FOR USING TABLE 3 TO CUSTOMIZE SEED MIXTURES

- ✔ Phenology mix (5 early species, 5 mid, 5 late season time of peak productivity).
- ✔ Use a low Graminoid/Forb ratio (1:4 or lower) to maximize canopy closure.
- ✔ Use a minimum of three late successional species.
- ✔ Use a minimum of 15 species (50% early successional, 25% mid successional, and 25% late successional).
- ✔ A complex canopy with mixed height and variable leaf morphology should be implicit in seed designs.
- ✔ Consider cool season and early emerging annual species to accelerate canopy closure and provide competition for seedling RCG.
- ✔ For woody species, employ protective shelters and tall, mature stock. Consider a tree-planting mix that includes evergreens to provide early and late-season shade.

Key

Species ranking: 1 = highly recommended/high importance; 2 = moderate importance; 3 = low importance or importance unknown

Phenology: Early (April – May peak productivity), Mid (June – mid July peak productivity), Late (mid July – September peak productivity).

Trees: Trees should be taller than RCG, 1" minimum dbh is recommended. Use of a weed barrier and deer/rodent protection is also recommended.

Successional Stage: Early (25-50% bare ground, many weedy or short-lived species present), Mid (10-25% bare ground, self seeders common, a few species often dominate), Late (0-10% bare ground, many conservative species are present, plant community is stable with few canopy gaps).

Hydrology

Mesic plant community type:

Deep, well-drained to moderately well-drained soils with moderate permeability and high available water capacity. These are typically mineral soils with no equipment limitations throughout the growing season.

Wet-mesic plant community type:

Deep, somewhat poorly-drained soils with moderately slow permeability and a seasonal high water table to within 1 ft of the surface for part of the growing season. Soils are mineral or shallow organic with moderate equipment limitations during the growing season.

Wet plant community type:

Deep poorly-drained to somewhat poorly-drained soils with slow permeability and a seasonal high water table at or near the surface for much of the growing season. Soils can be mineral or deep organic with severe equipment limitations for most of the growing season.

TABLE #3a – Species recommended for reed canary grass replacement

Latin name	Common name	Species Preferred Ranking	Successional Stage			Phenology	Hydrology	Geographic Area	Comments
			Early	Mid	Late				
Grasses									
Calamagrostis canadensis	Canada blue-joint	1			x	mid	wet/wet mesic	statewide	rhizomatous
Cinna arundinacea	Wood reed	3		x	x	mid	mesic	more common south	semi shade-- may be good in tree planting areas, prefers loam soils
Cinna latifolia	Drooping wood reed	3		x	x	mid	mesic	more common north	semi shade-- may be good in tree planting areas, prefers loam soils
Echinochloa muricata	Coastal barnyardgrass	1	x			mid	wet mesic	statewide	annual; use as cover crop
Echinochloa walteri	American barnyardgrass	1	x			mid	wet mesic	statewide	annual; use as cover crop
Elymus canadensis	Canada wild rye	1	x			early-mid	mesic	more common south	semi shade-- may be good in tree planting areas
Elymus riparius	Riparian wild rye	1	x			early-mid	wet mesic	more common south	semi shade-- may be good in tree planting areas
Elymus virginicus	Virginia wild rye	1	x			early-mid	wet mesic	more common south	semi shade-- may be good in tree planting areas
Glyceria canadensis	Rattlesnake grass	2	x	x		mid	wet/wet mesic	more common north	can be difficult to establish
Glyceria grandis	Reed manna grass	2	x	x		mid	wet/wet mesic	statewide	shorelines, shallow water
Glyceria striata	Fowl manna grass	2	x	x		mid	wet/wet mesic	more common south	shorelines, shallow water
Leersia oryzoides	Rice cut-grass	1	x	x		late	wet	statewide	does well in organic soils
Muhlenbergia racemosa	Wild timothy	1	x	x		early-mid	wet mesic	statewide, less common southwest	may be resistant to grass-specific herbicide, prefers loamy soils
Panicum virgatum	Switch grass	3		x		late	wet mesic/mesic	statewide	bimodal, prefers sandy soils
Poa palustris	Fowl meadow-grass	2	x	x		early	wet mesic	more common south	statewide
Spartina pectinata	Prairie cord grass	1			x	mid	wet mesic/mesic	statewide	Try to use plugs, rhizomatous, prefers mineral soils

Latin name	Common name	Species Preferred Ranking	Successional Stage			Phenology	Hydrology	Geographic Area	Comments
			Early	Mid	Late				
Other Graminoids									
Bolboschoenus fluviatilis	River bulrush	1		x	x	mid	wet/wet mesic	statewide	Rhizomatous, tolerates standing water
Carex annectens	Yellow head fox sedge	1	x	x		early	wet/wet mesic	statewide	
Carex atherodes	Hairy-leaved lake sedge	2			x	early	wet	statewide	use on wetter sites
Carex bebbii	Bebb's oval sedge	2		x	x	early	wet mesic/mesic	statewide	use on drier sites
Carex comosa	Porcupine sedge	2			x	early	wet/wet mesic	statewide	
Carex crinita	Fringed sedge	2		x	x	early	wet mesic	more common north	common generalist
Carex emoryi	Emory's sedge	3			x	early	wet mesic	statewide	
Carex hystericina	Bottlebrush sedge	2		x	x	early	wet/wet mesic	statewide	common generalist
Carex lacustris	Lake sedge	1		x	x	early	wet/wet mesic	statewide	wettest sites, rhizomatous
Carex pellita	Broad-leaved wooly sedge	2		x		early	wet/wet mesic	statewide	rhizomatous, use vegetative plugs
Carex rostrata	Beaked sedge	2			x	early	wet mesic	northern	
Carex scoparia	Broom sedge	2	x	x		early	wet/wet mesic	statewide	common generalist
Carex stipata	Common fox sedge	1	x	x		early	wet/wet mesic	statewide	common generalist
Carex stricta	Tussock sedge	1			x	early	wet/groundwater	statewide	use plugs or very fresh seed; rhizomatous
Carex trichocarpa	Hairy-fruit lake sedge	1			x	early	mesic/wet mesic, wet	southern and north-western WI	rhizomatous, use vegetative plugs
Carex tuckermanii	Tuckerman's sedge	2		x		early	forest	statewide	shade tolerant
Carex utriculata	Common yellow lake sedge	2			x	early	wet/wet mesic	southern	wettest sites, rhizomatous
Carex vulpinoidea	Brown fox sedge	1	x	x		early	wet mesic	statewide	common generalist
Juncus effusus	Soft rush	1		x		early	wet	statewide	
Scirpus atrovirens	Dark green bulrush	1	x	x		mid	wet/wet mesic	statewide	establishes well from seed
Scirpus cyperinus	Woolgrass	1		x	x	mid	wet/wet mesic	statewide	slow growing, tolerates standing water
Schoenoplectus tabernaemontani	Softstem bulrush	2		x	x	mid	wet	statewide	tolerates standing water, prefers silty/clay soils

Latin name	Common name	Species Preferred Ranking	Successional Stage			Phenology	Hydrology	Geographic Area	Comments
			Early	Mid	Late				
Forbs									
Angelica atropurpurea	Angelica	3		x	x	early	wet/groundwater	statewide	monocarpic perennial
Apocynum sibiricum	Clasping dogbane	1	x	x		mid	mesic/wet mesic	statewide	clonal, grows in patches
Asclepias incarnata	Swamp milkweed	1		x		mid	wet mesic	statewide	likes occasional disturbance
Aster firmus	Shiny-leaved aster	1	x	x	x	late	mesic/wet mesic	south and east WI	rhizomatous
Aster lanceolatus	Marsh aster	1		x		late	mesic/wet mesic	statewide	rhizomatous
Aster novae-angliae	New England aster	1		x		late	mesic/wet mesic	south and east WI	establishes well from seed
Aster puniceus	Swamp aster	1	x	x	x	late	wet/wet mesic	statewide	rhizomatous
Bidens cernuus	Nodding bur marigold	1	x			mid	wet mesic	statewide	annual
Bidens frondosa	Common beggars-ticks	1	x			mid	wet mesic	statewide	annual
Hasteola suaveolens	Sweet Indian plantain	2		x	x	mid	mesic/wet mesic	southern WI	spreads from seed
Cicuta maculata	Water hemlock	2		x		mid	wet/wet mesic	statewide	perennial
Eupatorium maculatum	Spotted Joe pye weed	1		x	x	mid	wet/wet mesic	statewide	establishes well from seed
Eupatorium perfoliatum	Common boneset	1		x	x	mid	wet/wet mesic	statewide	establishes well from seed
Euthamia graminifolia	Grass-leaved goldenrod	1		x	x	mid-late	wet mesic/mesic	statewide	rhizomatous
Helenium autumnale	Sneezeweed	1		x	x	mid	wet/wet mesic	statewide	establishes well from seed
Helianthus giganteus	Tall sunflower	1		x	x	late	wet mesic	more common north	important for wildlife, rhizomatous
Helianthus grosseserratus	Sawtooth sunflower	1		x	x	late	wet/wet mesic	more common southern	may dominate your planting, rhizomatous
Heracleum maximum	Cow parsnip	3		x	x	early	wet mesic/mesic	statewide	semi shade-- may be good in tree planting areas
Hypericum pyramidatum	Giant St.John's wort	2		x	x	mid	wet mesic/mesic	statewide	semi shade or full sun
Impatiens capensis	Jewelweed/touch-me-not	1	x			early	wet/wet mesic	statewide	annual, semi shade or sun
Lycopus americanus	American water horehound	3	x			mid	wet/wet mesic	statewide	does not persist without disturbance
Lycopus uniflorus	Northern bugleweed	2				mid	wet/wet mesic	statewide	can persist without disturbance
Mentha arvensis	Wild mint	2	x	x		mid	wet/wet mesic	statewide	establishes well from seed
Mimulus ringens	Monkey flower	3	x			mid	wet mesic/mesic	statewide	establishes well from seed
Monarda fistulosa	Bergamot	1	x	x	x	mid	wet mesic/mesic	statewide	establishes well from seed
Penthorum sedoides	Ditch stonecrop	3	x			mid	wet mesic/mesic	statewide	establishes well from seed
Polygonum amphibium	Water smartweed	2	x	x		mid-late	wet/wet mesic	statewide	comes in on its own, not usually planted
Polygonum pensylvanicum	Pennsylvania knotweed	2	x			mid-late	wet/wet mesic	statewide	annual
Pycnanthemum virginianum	Common mountain mint	2		x	x	mid	wet/wet mesic/ mesic	more common south	long-lasting, rhizomatous

Latin name	Common name	Species Preferred Ranking	Successional Stage			Phenology	Hydrology	Geographic Area	Comments
			Early	Mid	Late				
Forbs *continued*									
Ratibida pinnata	Yellow coneflower	1	x	x		mid	wet mesic/mesic	statewide, not as common north	good self seeder, colorful
Rudbeckia hirta	Black-eyed Susan	1	x			mid	wet mesic/mesic	statewide	establishes well from seed
Rudbeckia laciniata	Wild golden glow	1	x	x		mid	wet mesic	statewide	may have advantage in light shade
Rudbeckia triloba	Brown-eyed Susan	1	x			mid	wet mesic	east and southeast	establishes well from seed
Rumex orbiculatus	Water dock	2			x	mid	wet/wet mesic	statewide	grows in very wet sites, prefers organic or loamy soils
Silphium perfoliatum	Cup plant	1		x	x	mid-late	wet mesic/mesic	south and west	establishes well from seed, may dominate a planting
Solidago gigantea	Giant goldenrod	1	x	x		late	wet mesic/mesic	statewide	may dominate; rhizomatous
Solidago riddellii	Riddell's goldenrod	3		x		late	wet/wet mesic	more common south	Requires alkaline soils
Stachys palustris	Hedge nettle	2		x	x	mid-late	wet/wet mesic	statewide	
Verbena hastata	Blue vervain	1	x			mid	wet/wet mesic/ mesic	statewide	establishes well from seed
Vernonia fasciculata	Ironweed	2		x	x	mid-late	wet mesic/mesic	statewide	slow to establish

TABLE #3b – Tree and shrub species recommended for reed canary grass replacement

Latin name	Common name	Species Preferred Ranking	Phenology	Hydrology	Geographic Area	Comments
Trees/shrubs (rootstock) (Trees should be taller than RCG, 1" minimum dbh is recommended. Use of a weed barrier and deer/rodent protection is also recommended.)						
Abies balsamea	Balsam fir	1	early-mid	wet/wet mesic	northern	not preferred deer food
Acer rubrum	Red maple	2	early-mid	wet mesic/mesic	statewide	Slow-growing, mineral soils
Acer saccharinum	Silver maple	1	early-late	flood tolerant	more common south	Fast-growing, weak limbs, mineral soils
Alnus incana subsp.rugosa	Speckled alder	1	early-mid	wet/wet mesic	statewide but more common north	invasive to uplands
Cephalanthus occidentalis	Buttonbush	2	early	wet/wet mesic	more common south	Can grow in shallow water
Cornus amomum	Silky dogwood	1	early-mid	wet/wet mesic	statewide	browsed heavily by deer
Cornus racemosa	Grey dogwood	2	early-mid	wet mesic/mesic	more common south	mineral soils, can be invasive
Cornus stolonifera	Red-osier dogwood	1	early-mid	wet/wet mesic	statewide	browsed heavily by deer
Fraxinus nigra	Black ash	3	early-late	wet/wet mesic	more common north	emerald ash borer concern keep <10% of trees planted. Better for wet sites.
Fraxinus pennsylvanica	Green ash	2	early-late	wet mesic/mesic	statewide	emerald ash borer concern keep <10% of trees planted
Ilex verticillata	Winterberry	1	shade tolerant	wetmesic/ mesic	more common north	Good for songbirds, prefers sandy/loamy soils
Larix laricina	Tamarack	1	early-late	wet/wet mesic	more common north	sensitive to flooding, does well in organic soils
Physocarpus opulifolius	Common ninebark	1	mid-late	wet mesic/mesic	more common south	somewhat drier sites, mineral soils
Picea glauca	White spruce	1	late	wet mesic/mesic	northern	not preferred deer food
Picea mariana	Black spruce	1	late	wet/wet mesic	northern	not preferred deer food, prefers acidic soils
Pinus strobus	White pine	3	late	wet mesic-mesic	statewide, more common north	Protect from deer browse, somewhat drier sites
Populus balsamifera	Balsam poplar	1	early-mid	wet/wet mesic	northern	
Populus deltoides	Cottonwood	1	early-mid	flood tolerant	statewide	invasive to uplands
Populus grandidentata	Bigtooth aspen	1	early-mid	wet mesic/mesic	statewide	somewhat drier sites, invasive to uplands
Populus tremuloides	Quaking aspen	2	early-mid	wet mesic/mesic	statewide	invasive to uplands
Quercus bicolor	Swamp white oak	1	late	wet mesic/mesic	southern	somewhat flood tolerant (short duration flooding)
Rhamnus alnifolia	Native buckthorn	2	mid	wet/wet mesic	Door County, north	Prefers mineral soils with high ph
Ribes americanum	Black currant	2	early-mid	wet/wet mesic	statewide	shade tolerant shrub
Salix nigra	Black willow tree	1	early-mid	wet/wet mesic	statewide	
Salix sp. (Bebb's, discolor, exigua)	Willows (Bebb's, pussy, sandbar)	1	early-mid	wet/wet mesic	statewide	some species can be invasive, especially s.exigua
Sambucus canadensis	Elderberry	1	mid	wet/wet mesic	statewide	good wildlife shrub, good in organic soils
Spiraea alba/tomentosa	Meadowsweet/ steeplebush	2	mid	wet/wet mesic	statewide but more common north	common in fens/groundwater wetlands, bogs
Viburnum lentago	Nannyberry	1	mid	wet mesic/mesic	more common south	clonal
Viburnum opulus subsp. trilobum	High bush cranberry	2	mid	wet mesic/mesic	statewide	shade tolerant shrub, mineral soils

TABLE #3b – Tree and shrub species recommended for reed canary grass

Following are examples of 15-species seed mixes. You may want to add or substitute additional species to your mix to compensate for changes in hydrology, climate and other site conditions affecting seed germination.

Wet Meadow 1	Wet Meadow 2	Sedge Meadow	Low Forest
Asclepias incarnata	*Asclepias incarnata*	*Asclepias incarnata*	*Acer saccharinum*
Aster puniceus	*Bidens cernuus*	*Aster firmus*	*Calamagrostis canadensis*
Bidens frondosa	*Calamagrostis canadensis*	*Bolboschoenus fluviatilis*	*Carex comosa*
Calamagrostis canadensis	*Carex stricta*	*Calamagrostis canadensis*	*Carex lacustris*
Carex scoparia	*Carex vulpinoidea*	*Carex comosa*	*Cinna arundinacea*
Carex stipata	*Cicuta maculata*	*Carex lacustris*	*Cinna latifolia*
Cicuta maculata	*Echinochloa muricata*	*Carex stricta*	*Cornus stolonifera*
Elymus canadensis	*Elymus virginicus*	*Carex vulpinoidea*	*Elymus virginicus*
Eupatorium maculatum	*Eupatorium perfoliatum*	*Elymus virginicus*	*Eupatorium maculatum*
Helianthus giganteus	*Glyceria grandis*	*Eupatorium maculatum*	*Fraxinus nigra*
Leerzia oryzoides	*Helenium autumnale*	*Impatiens capensis*	*Muhlenbergia mexicana*
Rudbeckia hirta	*Monarda fistulosa*	*Juncus effusus*	*Populus tremuloides*
Scirpus cyperinus	*Ratibida pinnata*	*Pycnanthemum virginianum*	*Rudbeckia laciniata*
Solidago gigantea	*Scirpus atrovirens*	*Rudbeckia laciniata*	*Scirpus cyperinus*
Spartina pectinata	*Verbena hastata*	*Scirpus cyperinus*	*Viburnum lentago*

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Appendix L

WDNR Grants

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Lake Classification and Local Ordinance Development Grants
NR 191.30, Wis. Admin. Code

Overview:
Lake Classification projects will be conducted by counties to study the characteristics of lakes and assign them into different management classifications for the purpose of implementing lakes-based protection activities. Protection activities may be regulatory (such as improved Shoreland), land or lake use ordinances, or other best management practices or protection activities for protecting and improving water quality or aquatic habitats. Lake classification projects can be used to implement the prescribed management activities.

Development of local regulations or ordinance projects will be conducted by any unit of local government to protect or improve a lake's water quality or its natural ecosystem. Lake Classification and Local Ordinance Development projects can be funded separately or jointly. Because of their similar nature, these two grant project types are combined into one grant subprogram. Although technically "management" grants by statute, the activities associated with each are fundamentally planning and, therefore, the DNR has grouped them in with other planning grants with application deadline of Dec. 10 each year.

Lake Classification

Purpose:
Lake Classification grants provide financial opportunities for Wisconsin counties to assist in lake protection efforts. Using existing and collected lake data, county lakes with similarities can be grouped to assist in the administration of shoreland zoning or land and water conservation programs.

Eligible Projects

Classification:

- Data collection, analysis using GIS, and mapping to place waters in classes. Types of data may include lake size, depth, shape, and water quality, watershed size, potential nonpoint pollution sources, land uses and development patterns, recreational uses, fish and wildlife habitat, etc.
- Objective setting for the classification system.
- Investigation and selection of appropriate classification criteria.
- Investigation and assignment of appropriate protection and management tools. All projects must propose lake protection activities for each classification.
- Assist the DNR in setting lake water quality standards.

Note: Projects may not result in lowering existing state minimum standards designed to protect lakes.

Protection and Implementation:

- Development of educational materials and training programs to improve the understanding and compliance with the lake classification.
- Compliance monitoring and enforcement.
- Technical assistance to landowners to comply and implement protection activities.
- Developing or improving administrative procedures and processes.
- Ordinance development: zoning, watercraft regulation, construction site erosion control, public water access, piers and moorings, etc.
- Adoption of policies which encourage management of waters based on the specific needs of each waterbody.
- Implementation of alternative management tools: purchase of land or development rights, conservation easements, development of individual lake and watershed plans, etc.

NOTE: A county must have adopted a lake classification system prior to the date of application to be eligible for an implementation grant.

Ineligible Projects:
Projects not eligible for funding under this subchapter include water safety patrols.

Note: Lake Classification projects may be conducted to assist the department in setting lake water quality standards. However, any proposal for the classification of lakes to be used in setting lake water quality standards or for enacting requirements for the implementation of water quality standards based on new or existing classifications only become effective when adopted by the department as rules under s. 281.15, Wis. Stats.

Local Ordinance Development

Purpose:
Lake Ordinance development grants are intended for local governments and lake districts to create or improve regulations that will protect or improve a lake's water quality or its natural ecosystem.

Eligible Projects:
To be eligible for funding consideration, all projects must include the development of an ordinance to be presented for adoption by the local governing board with an assessment of the administration and enforcement capacity and cost to implement the ordinance. Land use planning alone is not an eligible activity.

Types of ordinances may include: boating or lake use, conservancy, wetland, shoreland, floodplain, construction erosion control, stormwater control or other ordinances with water quality or lake protection benefit. Boating ordinances that assist in managing the recreational use of surface waters should be focused on addressing the environmental impacts of lake use rather than just safety concerns.

Typical activities and eligible project costs include:

- Review and evaluation of an existing regulation or ordinance effectiveness, including necessary surveys.
- Mapping of environmental features, land use planning, and related activities as needed limited to what is necessary to the development of the proposed regulation. These activities should not be the main focus of the projects.
- Legal fees to develop regulation or ordinance language.
- Public meetings and materials, printing, postage, surveys, mailing, and similar costs related to community education on the need for and implementation of an ordinance or regulation.
- Training of officials and citizens for compliance and enforcement of an existing or new regulation or ordinance.
- Labor costs required to carry out activities identified in the grant agreement provided they require additional staff or increased hours of existing staff. Costs of additional staff positions or increased staff hours shall be based on management unit rates for the position including salary, fringe benefits and other items determined to be appropriate by the DNR.
- Other costs determined by the DNR to be necessary to carry out the development of a regulation or ordinance.

Legal fees incurred in appealing DNR decisions are not reimbursable costs. Lake associations and nonprofit conservation organizations do not have regulatory authority and therefore are not eligible for ordinance development projects unless there are clear commitments from the regulatory authority to the project. The management unit that is adopting the ordinance should be the sponsor.

If the project is an ordinance update or upgrade project specific to s. NR 115 Wisconsin's Shoreland Protection Program, s. NR 117 Wisconsin's City and Village Shoreland-Wetland Protection Program or s. NR 118 Standards for Lower St. Croix Scenic Waterway, it will need to be reviewed and certified by DNR staff. You can search the DNR staff directory under contacts on the DNR home page using "Shoreland Zoning" in the subject box to find the appropriate person to conduct the review and certification. It's recommended that you make this contact before you begin your application. Appropriate DNR staff should be advised of the process from the start of any shoreland ordinance project. For all other ordinance development projects local adoption or DNR approval is not required. However, the proposed regulation must be presented to the county or town board for adoption.

Routine ordinance enforcement is not an eligible cost for any grant in this subsection**.** However, site inspections and enforcement can be eligible for local ordinance development projects or lake classification if it is proposed as developing or enhancing the enforcement process. The project might create and test new forms or procedures such as compliance audits, automated record keeping or explore new information management technologies. A report on the "findings" of this element is a deliverable.

Funding Possibilities:
Maximum amount of grant is 75% of the total project costs, not to exceed $50,000.

Lake Management Planning Grants
Section 281.68, Wis. Stats., NR 190, Wis. Admin. Code

Overview:
Lake management planning grants are intended to provide financial assistance to eligible applicants for the collection, analysis, and communication of information needed to conduct studies and develop management plans to protect and restore lakes and their watersheds. Projects funded under this subprogram often become the basis for implementation projects funded with Lake Protection grants. There are two categories of lake management planning grants: small-scale and large-scale.

Small Scale Lake Planning
NR 190, Wis. Admin. Code

Purpose:
Small-scale projects are intended to address the planning needs of lakes where education, enhancing lake organizational capacity, and obtaining information on specific lake conditions are the primary project objectives. These grants are well suited for beginning the planning process, conducting minor plan updates, or developing plans and specification for implementing a management recommendation.

Eligible Projects:
- Specific monitoring and assessment projects. Collect and report chemical, biological, and physical data about lake ecosystems for a Tier I assessments, Tier II diagnostic or Tier III project evaluation.
    - Tier I if initial basic monitoring is needed to assess the general condition or health of the lake.
    - Tier II if an assessment has been conducted and more detailed data collection is needed to diagnose suspected problems and identify management options.
    - Tier III if the monitoring and assessment will be used to evaluate the effectiveness of a recently implemented project or lake management strategy.
- Collecting and disseminating existing information about lakes for the purpose of broadening the understanding of lake use, Lake Ecosystem conditions and lake management techniques.
- Conducting workshops or trainings needed to support planning or project implementation.
- Projects that will assist management units as defined in s. NR191.03 (4) & s. NR 190.003 (4) the formation of goals and objectives for the management of a lake or lakes.

Ineligible Projects:
Projects not specifically mentioned above.

Funding Possibilities:
Maximum amount of grant funding is 67% of the total project costs, not to exceed $3,000.

(see next page for Large Scale Projects)

Large Scale Projects
NR 190, Wis. Admin. Code

Purpose:
Large-scale projects are intended to address the needs of larger lakes and lakes with complex and technical planning challenges. The result will be a lake management plan; more than one grant may be needed to complete the plan.

Eligible Projects:
- Collection of new or updated, physical, chemical and biological information about lakes or lake ecosystems.
- Definition and mapping of Lake Watershed boundaries, sub-boundaries and drainage system components.
- Descriptions and mapping of existing and potential land conditions, activities and uses within lake watersheds that may affect the water quality of a lake or its ecosystem.
- Assessments of water quality and of fish, aquatic life, and their habitat.
- Institutional assessment of lake protection regulations - review, evaluation or development of ordinances and other local regulations related to the control of pollution sources, recreational use or other human activities that may impact water quality, fish and wildlife habitat, natural beauty or other components of the lake ecosystem.
- Collection of sociological information through surveys or questionnaires to assess attitudes and needs and identify problems necessary to the development of a long-term lake management plan.
- Analysis, evaluation, reporting and dissemination of information obtained as part of the planning project and the development of management plans.
- Development of alternative management strategies, plans and specific project designs, engineering or construction plans and specifications necessary to identify and implement an appropriate lake protection or improvement project.

Ineligible Projects:
Any project not specified above.

Funding Possibilities:
Maximum amount of grant funding is 67% of the total project costs, not to exceed $25,000. Multiple grants in sequence may be used to complete a planning project, not to exceed $100,000 for each lake. The maximum grant award in any one year is $50,000 for each lake. If phasing is necessary, all phases should be fully identified and a timeline identified in the initial application.

Lake Protection Grant Program
Sections 281.69 and 281.71, Wis. Stats., NR 191, Wis. Admin. Code

Overview:
Lake protection and classification grants assist eligible applicants with implementation of lake protection and restoration projects that protect or improve water quality, habitat or the elements of lake ecosystems. There are four basic Lake Protection subprograms:

a) Fee simple or Easement Land Acquisition
b) Wetland and Shoreline Habitat Restoration
c) Lake Classification and Local Ordinance Development
d) Lake Plan implementation

Land/Easement Acquisition
NR 191.10, Wis. Admin. Code

Purpose:
Grants under this subprogram are intended for the acquisition of property or property rights (also called easements) to protect lakes and their ecosystems. Land acquisition projects are reviewed and processed by DNR environmental grant specialists. All other types of surface water protection grant projects are reviewed by DNR Lake and River Grant Coordinators. A list of environmental grant specialists appears in the front of this guide.

Eligible Costs:
- The fair market value of the property as determined by DNR-approved appraisals
- Cost of appraisal(s)
- and survey fees
- Relocation payments
- Land stabilization
- Title insurance and gap insurance
- Recording fees
- Historical and cultural assessments (if required by the DNR)
- Baseline documentation for natural resources (required for conservation easements)
- Environmental inspections and audits
- Attorney fees not to exceed $2,000
- Closing costs
- Building demolition may be an eligible cost based on the degree to which the demolition contributes to lake protection or restoration.

Ineligible Costs:
- Acquisition of any property that is subject to a reversionary right or has restrictions or covenants which would prevent the property from being managed for purposes consistent with this grant program
- Land acquired through eminent domain or condemnation; projects where landowners were not treated fairly and negotiations were not conducted on a willing buyer-willing seller basis
- Acquisition of land on which a dam is located
- Environmental clean-up costs
- Brokerage fees paid by the buyer
- Real estate transfer taxes
- Any other cost not identified as eligible above

Funding Possibilities:
Maximum amount of grant funding is 75% of total costs, not to exceed $200,000.

Wetland and Shoreline Habitat Restoration
NR 191.20, Wis. Admin. Code

Purpose:
Wetland and shoreland habitat restoration grants are intended to provide financial assistance to protect or improve the water quality or natural ecosystem of a lake by restoring adjacent degraded wetlands or tributary to lakes. Shoreline habitat restoration grants are intended to provide financial assistance, including incentive payments, to owners of developed lake front lots to re-establish riparian habitat.

Eligible Projects:

- Development of plans, specifications and environmental assessment, including pre- and post-engineering and design costs.
- Construction, earth moving, or structure removal costs.
- Native plant stock or seeds for re-establishing vegetation.
- Incentive payments per landowner not to exceed $250.
- Public meetings and education and promotional materials, mailing and similar costs related to the distribution of information about restoration.
- Necessary monitoring in order to measure success in achieving the ecologic function of restoration activities.
- Purchase of fee simple or easement land acquisition on which wetland restoration activities will take place. The cost of preparing and filing deed restrictions on the property where restoration will take place.
- Labor costs required to carry out activities identified in the grant agreement including technical assistance.
- Other costs determined by the DNR as necessary to carry out a successful wetland or shoreline habitat restoration.
- Water regulatory permits required for the project. Reasonable planning, engineering and design costs necessary to complete the permit application incurred within 12 months prior to the application deadline become eligible for reimbursement for projects awarded a grant.
- Technical assistance provided to individuals seeking building permits if the intent is to improve the site's habitat conditions or comply with mitigation conditions.

Ineligible Projects:

- Environmental cleanup,
- Stairs
- Walkways
- Piers
- Costs of actual restoration that is intended to comply with a regulatory action, including wetland or shoreland mitigation projects.

Funding Possibilities:
Maximum amount of grant funding is 75% of the total project costs, not to exceed $100,000

Lake Management Plan Implementation
NR 191.40, Wis. Admin. Code

Purpose:
Lake management plan implementation grant provides financial assistance to eligible applicants that have completed a lake management plan to implement the plan's DNR-approved recommendations.

Eligible Projects:
Typical projects will include watershed or shoreland best management practices (BMPs) for nonpoint source pollution control or in-lake restoration actions like an alum treatment. s. NR 154, Wis. Admin.

Code, Best Management Practices (BMP) and Cost Share Conditions, provide DNR grant policy on the implementation of 42 nonpoint source pollution control practices. These have been established in partnership with other state and federal agencies and approved by the US Environmental Protection Agency as part of the State's Nonpoint Source Program Management Plan. Adherence to these BMPs assures eligibility for federal cost-share funds and the ability to use state-funded projects as match Clean Water Act Section 319 funds received by the DNR.

Providing grant funding for lake restoration activities that improve the recreational or environmental values of a lake are defined as natural resource enhancement services under s. NR 1.91, Wis. Admin. Code. Grant funding for these services can only be provided for lake and river projects where the public has been afforded a minimum level of public boating access as defined in s. NR 1.91(4) d. Typical projects funded by surface water grants that fall into this category are "in-water" activities such as aeration, aquatic plant management, alum treatments, bio-manipulation, drawdown, fish stocking and fishery rehabilitation, habitat restoration, and hypolimnetic withdrawal. An additional eligibility requirement for funding these activities is that the sources or causative factors of the problems to be remediated should have been or very likely will be controlled prior to implementation.

Habitat improvement or protection activities or any other type of project that will work toward protecting or improving lakes and lake ecosystems may be eligible as long as the recommendation presented in the lake management plan has been officially approved by the DNR. An application for all necessary permits must be filed with the DNR by the date on which a grant application is submitted.

Eligible Costs:

- Construction, labor, materials, supplies, laboratory costs related to eligible activities.
- Planning and engineering, landscape or construction design plans and specifications that is necessary to determine appropriate options and recommendations for lake protection improvement.
- Other costs as approved by the DNR and necessary for implementing a recommendation in an approved lake management plan.

Ineligible Project Costs:
Any project not specified above.

Funding Possibilities:
Grants are based on 75% of the total eligible project costs not to exceed the maximum grant amount of $200,000.

Healthy Lakes Projects
NR 190, Wis. Admin. Code

Purpose:
The Healthy Lakes grants are a sub-set of Plan Implementation Grants intended as a way to fund increased installation of select best management practices (BMPs) on waterfront properties without the burden of developing a complex lake management plan. Details on the select best practices can be found in the Wisconsin Healthy Lakes Implementation Plan and best practice fact sheets.

Eligible Projects:
Eligible best practices with pre-set funding limits are defined in the Wisconsin Healthy Lakes Implementation Plan, which local sponsors can adopt by resolution and/or integrate into their own local planning efforts. By adopting the Wisconsin Healthy Lakes Implementation Plan, your lake organization is immediately eligible to implement the specified best practices. Additional technical information for each of the eligible practices is described in associated factsheets.

The intent of the Healthy Lakes grants is to fund shovel-ready projects that are relatively inexpensive and straight-forward. The Healthy Lakes grant category is not intended for large, complex projects, particularly those that may require engineering design. All Healthy Lake grants have a standard 2-year timeline.

Ineligible Projects:
Any project not specified in the Wisconsin Healthy Lakes Implementation Plan.

Eligible Costs:
Best practices in the Wisconsin Healthy Lakes Implementation Plan are defined for each of 3 zones on a typical developed lake shore residential lot identified.

- Zone 1 (shallow near shore water) includes fish sticks, a practice that places trees in the water to improve fish and aquatic life habitat and protect shorelines;
- Zone 2 (transition) includes various 350 square foot native planting plots and diversion practices to improve habitat and slow runoff;
- Zone 3 (upland) includes rain gardens, diversion practices and rock infiltration practices as eligible best practices to manage runoff from structures and other impervious surfaces.

Technical assistance costs may be reimbursed not to exceed 10% of the state share of project costs.

Funding Possibilities:
Maximum amount of grant funding is 75% of the total project cost, not to exceed $25,000. Grants run for a 2-year time period. Maximum costs per practice are also identified in the Wisconsin Healthy Lakes Implementation Plan.

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Appendix M

BOARD OF COMMISSIONERS OF PUBLIC LANDS LOAN PROGRAM FACT SHEETS

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BOARD OF COMMISSIONERS OF PUBLIC LANDS 1848

Managing Wisconsin's trust assets for public education

Douglas La Follette, *Secretary of State*
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Tia Nelson, *Executive Secretary*

Fact Sheet - General Obligation Loans

Eligible Borrowers:	Wisconsin towns, villages, cities, counties, school districts, technical college districts, public inland lake protection and rehabilitation districts, town sanitary districts, metropolitan sewerage districts, metropolitan sewerage systems, joint sewerage systems, consortiums, cooperative educational service agencies (CESAs), federated public library systems, and drainage districts.
Loan Process:	Simple and transparent, with funds available 30-45 days from initial application.
Loan Security:	Loans become a general obligation of the borrower and require the borrower to levy a tax sufficient to make principal and interest payments when due.
Loan Purpose:	Loans of 10 years or less may be made to facilitate the performance of any power or duty of the borrowing municipality, including operations and maintenance. Loans greater than 10 years are restricted to the financing or refinancing of public purpose projects including "the acquisition, leasing, planning, design, construction, development, extension, enlargement, renovation, rebuilding, repair or improvement of land, waters, property, highways, buildings, equipment, or facilities", or any purpose otherwise allowed by law.
Economic Development Lending:	BCPL is a major source of funding for economic development projects throughout the State of Wisconsin including pass-through loans for private development, funding development incentives, TID infrastructure loans, land acquisition and development for business parks, and others. BCPL flexibility in the repayment schedule if projections are not met is critical to many borrowers.
Payments:	Annual payments are due March 15 each year. Loans funded between September 1 and March 14 do not have a payment scheduled for the following March 15. BCPL can provide custom amortization schedules for projects that may take time to generate expected revenues, or that need coordination with other debt payment schedules.
Prepayment:	Prepayments are allowed without penalty between January 1 and August 31 each year, with 30 days prior written notice. This flexibility is extremely valuable, as future budget priorities are difficult to forecast. Many finance directors get stuck with higher rate bonds and are forced to wait years prior to refunding. This is never a problem if you borrow from BCPL.
Terms:	1 year to 20 year fixed rate loans.

Current Rates:

Loan Term	
1-2 Years	2.50%
3-5 years	3.00%
6-10 years	3.25%
11-20 years	3.75%

Rate Lock:	Market-based interest rates are locked at the time of application for a period of 60 days at no cost to Borrower. This rate also remains locked following final board approval and throughout the 4-month draw period, which helps provides financial stability during the entire loan process.
Fees:	No application fees, origination fees or prepayment fees. No fees period!
Best Part:	Interest earned by BCPL is distributed to communities statewide for the funding of public school library materials. Check out the BCPL website to see the annual contribution made to your school district. This annual payment effectively reduces local tax levies by providing schools another source of funding. How many bankers or bond dealers can say that?

BOARD OF COMMISSIONERS OF PUBLIC LANDS
1848

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Fact Sheet - Revenue Obligation Loans

Eligible Borrowers:	Wisconsin towns, villages, cities, counties, school districts, technical college districts, public inland lake protection and rehabilitation districts, town sanitary districts, metropolitan sewerage districts, metropolitan sewerage systems, joint sewerage systems, consortiums, cooperative educational service agencies (CESAs), federated public library systems, drainage districts.
Loan Process:	Simple and transparent, with funds available as soon as 30-60 days. Revenue loans have greater documentation and underwriting requirements than general obligation loans, and may require a slightly longer time period to complete the loan process.
Loan Security:	Loans are secured by a pledge and assignment of the revenues generated by a specific project. These revenues may include tax increments allocated to the borrower for project costs within a tax incremental district. A failure by the borrower to remit loan payments when due requires BCPL interception of state aid payments.
Loan Purpose:	Loans may be made for the financing or refinancing of a project as defined by Wis. 67.04 (ar): the acquisition, leasing, planning, design, construction, development, extension, enlargement, renovation, rebuilding, repair or improvement of land, waters, property, highways, buildings, equipment, or facilities.
Payments:	Annual payments are due March 15 each year. Loans funded between September 1 and March 14 do not have a payment scheduled for the following March 15. Amortization schedules are normally calculated to include equal annual payments, but BCPL can provide custom amortization schedules for projects that may take time to generate expected revenues, or that need coordination with other debt payment schedules.
Prepayment:	Prepayments are allowed without penalty between January 1 and August 31 each year, with 30 days prior written notice. This flexibility is extremely valuable, as future budget priorities are difficult to forecast. Many finance directors get stuck with higher rate bonds and are forced to wait years prior to refunding. This is never a problem if you borrow from BCPL.
Terms:	1 year to 30 year fixed rate loans.
Rates:	Interest rates are locked at the time of application. Rates will vary depending on the risk assessment from BCPL transaction underwriting including a review of the strength and stability of the pledged revenues, along with other risk factors.
Underwriting:	Loans secured by a pledge of tax increment allocations are limited to an amount so that annual payments would not exceed 80% of the shared revenue received by the borrower in the year prior to the loan application. Underwriting criteria on other loan and project types will vary.
Fees:	No application fees, origination fees or prepayment fees. No fees period!
Best Part:	Interest earned by BCPL is distributed to communities statewide for the funding of public school library materials. Check out the BCPL website to see the annual contribution made to your school district. This annual payment effectively reduces local tax levies by providing schools another source of funding. How many bankers or bond dealers can say that?