

SUMMARY REPORT

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Project: Monitoring of dissolved oxygen levels in selected backwater areas of the Upper Mississippi River during the winter of 1988-1989.

Period: December 14, 1988 - March 27, 1989

- Objective:
1. To determine the rate and extent of depletion of dissolved oxygen in selected back water areas of the Mississippi.
 2. To create a data base that may be used to design habitat improvements and then to later judge the effectiveness of such improvements.

INTRODUCTION

This report is not an attempt to summarize all the limnological data that is contained within the tables, but rather an effort to document general trends that are of importance. No attempt was made to hypothesize a cause for data irregularities, nor were they referenced in the manuscript unless they indicated impending water quality problems. The emphasis of this report is to document general trends which would indicate existing or eminent water quality problems.

Seven locations were monitored during the December 14, 1988 to March 27, 1989 period. The locations were selected because they had previously demonstrated water quality problems or were areas that were suspected of having poor water quality. The selected areas were: Big Lake - Pool 4, Long Lake and Belle Island areas of Pool 7, French Lake and I-90 in Pool 8, Gremore Lake, Pool 10 and McCartney Lake, Pool 11.

The winter of 1988-89 was one of above normal December and January temperatures and sporadic snow events (Thompson 1988 and 1989). The duration of the snow cover was generally short (Figure 10). The exception to this was March, when significant snow cover was present. The duration of snow cover during March was longer than in January or February. The greater depth of the March snows provided enough shading in some areas to inhibit photosynthesis. This was evident by rapid depletion of surface dissolved oxygen levels in some backwater areas.

METHODS

Sampling sites were established at each study area using previous site locations where possible. The sites were located by nearby landmarks. A hole (17.7 cm dia.) was drilled into the ice using a power auger. The hole was drilled to a depth just before breaking through the bottom surface of the ice. The hole was completed with an ice chisel. The use of the ice chisel prevented re-aeration and sediment disturbance by the auger blade.

Dissolved oxygen (DO) measurements were taken with either a Yellow Springs Instrument (YSI) model 54 or 57 DO meters. The meters were pre-calibrated each day by an air calibration technique (WDNR, 1983) at temperatures within the expected working range (0-4 degrees C). Field calibration checks were made at each site. Changes in calibration (drift) were noted. If the change was greater than +/- 0.1 mg/l the unit was then recalibrated at the site. A final calibration check was made at the end of each day using the current barometric pressure. The final calibration check was to estimate drift due to changes in the barometric pressure. A second YSI meter was present and used as a backup.

Conductivity was measured using a YSI model 33 S-C-T meter. The conductivity measurements correspond to depths at which the dissolved oxygen measurements were taken. The cell constant was checked monthly with standard KCl solution and ranged from 1.02-1.05 during the study period.

Current velocity was measured using a Marsh-McBirney 201D current meter. The unit was found to be functioning within acceptable limits based on calibration checks performed before and after the study period. Measurements were taken 10-20 cm below the bottom surface of the ice. The direction and current velocity was recorded. If the current velocity was less than 0.01 ft/sec the current was recorded as not detectable (ND).

All electronic equipment was housed in a heated box using a small catalytic heater. This eliminated problems with frozen probes and slow instrument response time.

Depths at which measurements were taken dependant on the total depth of the water column, if stratification was expected or the presents of flow. Water quality data were normally taken at top, mid, and bottom. The top was that strata which was located immediately below the bottom surface of the ice. Mid depth was located equa-distant from the water surface and the water/sediment interface. The bottom measurement was taken immediately above the water/sediment interface. In the case where shallow water and thick ice was present, only the top and bottom measurements were taken. If flowing water was present, which prevented stratification, only a mid-depth measurement was made.

RESULTS

Big Lake Area - Pool 4

The Big Lake area is located in Pool 4 of the Mississippi River above Alma, Wisconsin (Figure 2). Big Lake is a shallow, well vegetated, back water area that receives major inflows from the main channel of the Mississippi River through Indian and Catfish Sloughs at the western and eastern ends, respectively. Big Lake also receives minor inflows from the Chippewa River bottom lands and a small tributary along the northeastern shoreline.

The Big Lake area was monitored on three dates between January 12 and February 15 (Table 1). Sampling was initiated primarily to determine if DO problems existed during winter periods. The areas of most concern were the western portions of Big Lake and Rice Lake.

Current velocities and directions were also compiled in conjunction with the DO monitoring. Current measurements were used to establish general circulation patterns between the main portion of Big Lake and the western bays.

Dissolved oxygen levels that were encountered in Big Lake were all above 5 mg/l. The DO range for the study area was 17.0 mg/l at site 3D on January 25 to 6.9 mg/l at site 3E on January 12. Sites 3D and E were located in a shallow bay on the western end of Rice Lake (Figure 2). DO levels above 100% saturation, approximately 14.6 mg/l at 0 degrees C, indicated that localized photosynthetic activity may provide an important source of DO in this area. Serious DO depletions were not found in the western ends of Big Lake and Rice Lake. This was likely the result of the lack of substantial snow cover which allowed sufficient light for oxygen production by submerged macrophytes and/or algae.

The central areas of Big Lake where detectable current was present, yielded the most consistent DO values of any area that was monitored in this report. This consistency was attributed to the Indian Slough inflow which provides a large volume of water from the main channel of the Mississippi. The actual discharge of Indian Slough has not been determined but is expected to be several hundred cfs based on velocity and depth measurements made in Big Lake. The inflow from the main channel would be expected to carry higher DO levels which would mitigate oxygen demands from the sediments and plant respiration during periods of heavy snow cover.

Big Lake and Rice Lake would be expected to exhibit DO depletions in the western ends during periods of continuous snow cover due to their isolation from river currents. The central areas of the lake that receives appreciable river flow would not be expected to have significant oxygen problems, unless inflowing river water had low DO concentrations (i.e. < 5.0 mg/l) or if the volume of inflow was substantially reduced.

Long Lake Area - Pool 7

Long Lake is a narrow lake located between River mile 712 and 713 of Pool 7 about 1.5 miles below Lock and Dam 6 (Figure 3). Long Lake is part of a complex backwater system that includes Mud Lake, Round Lake, Second, Third Lakes and a tributary named Tank Creek.

The Long Lake complex was sampled on five dates during the period of January 16 to March 8. On January 16, stratification was evident in all the Long Lake sites (Table 2). This stratification continued for the duration of the sampling period. Serious DO depletion was evident in Long Lake on January 16.

Surface DO values below 3.5 mg/l and bottom DO concentrations ranging from 0 to 1.1 mg/l were typical on this date. The DO levels slowly rose during the sampling period indicating that the DO was likely consumed early in the winter period. Other areas such as Mud Lake, Tank Creek, Round Lake and the inflow from Second Lake all had DO values about 9 mg/l during the sample period.

Water movements in the Mud Lake area indicate Tank Creek and Third Lake outlet provide major freshwater inflows into this backwater area during normal river stage based on previous winter studies (Rogala and Sullivan, 1988) and this work. A generalized map of water circulation patterns is presented in Figure 4. In general, Long Lake receives water from Mud Lake during normal or falling river stages. A reverse circulation pattern is expected with rising river stage (i.e. Lock and Dam 6 tail) and was observed on February 14 based on current observation at Site 7.

In general, Long Lake exhibited low DO levels in comparison to Mud Lake and Round Lake. Areas not suffering from serious DO depletions were influenced by freshwater inflows and/or photosynthetic activity. The inflow which Long Lake receives from Mud Lake appears to be insignificant and unable to disrupt inverse thermal stratification. This inflow serves little more than to elevate surface DO at the southern end of Long lake, provided the inflow is well oxygenated.

French Lake Area - Pool 8

French Lake is a secluded backwater area located immediately south of the dike at Lock and Dam 7 and west of French Island (Figure 5). The north end of French Lake consists of shallow bays that extend northward from a deep dredge hole that resulted from the construction of the interstate highway in the mid-1960's. The maximum depth of this dredge hole is about 9.0 m. The southern area extends from the interstate bridge to the outflow of Round Lake. This area is much shallower than the northern portion, with depths ranging from 1.3 to 1.7 m at the monitoring sites.

French Lake experienced severe DO depletions and was most pronounced in early January and March (Table 3). This area had low DO levels (< 5 mg/l) extending from sites 1 to 5. In general, the variability in DO levels was attributed to the variance in the depth of the snow cover present which influenced photosynthetic oxygen input.

Site 2 exhibited the most severe and persistent DO problems. It was inversely stratified and anoxic from about 3 to 4 m to the bottom for most of the winter period (January-March). Due to its depth, site 2 was not significantly affected by photosynthetic activity. Initial sampling of this area in mid December revealed relatively low DO saturation levels (about 55%). This was unusual considering a large portion of area east of site 2 was free of ice during this time. The low DO saturation level was attributed to poor oxygen re-aeration during the fall period. The trees and hills adjacent to this body of water likely limited mixing during fall turnover.

The French Lake area experienced severe DO depletions on several sample dates. The depletion was also associated with fish kills consisting primarily of gizzard shad (Dorosoma cepedianum). The occurrence of dissolved oxygen depletion during the low precipitation winter of 1989 possible indicates long-term anoxia would occur over most of French Lake during a winter with deep and lasting snow cover.

I-90 Area - Pool 8

The I-90 site is located in the north end of the east channel of the Mississippi River just below Lock and Dam 7 (Figure 6). The area was created when material was dredged during the construction of the interstate system in the mid-1960's. The dredging activity resulted in the creation of a deep hole (approximately 8 m) at site 1 during normal pool elevation. The water depth at site 2, located immediately north of the interstate bridge, was about 1 m. Water exchange with the river occurs only from the south during typical winter tail elevations at Lock and Dam 7. The side channel cut to the north of site 1 has filled in with sand and no longer contributes water during low river flows.

The I-90 area was sampled on dates from January 11 to March 27 (Table 4). No detectable currents were observed at either site 1 or 2. The absence of flow and deep depth allowed the area at site 1 to inversely stratify. Inverse stratification continued for the duration of the winter period. A result of the stratification was a decline and subsequent loss of DO in the lower strata of site 1. This loss was most evident on the date of March 27 when water strata from 4.5 m to the bottom was anoxic. The oxygen depletion at site 1 was thought to be associated with sediment oxygen demands. Conversely the surface DO levels at site 1 were above 10.0 mg/l during the winter period and exceeded 100% saturation on February 22. The high surface DO encountered at the site was believed to be due to localized photosynthetic activity (algae). Site 2 was likely influenced by water exchange with the river.

The I-90 area experienced DO problems in the lower strata of the dredge hole. The level of depletion that was experienced during the winter of 1989, would indicate that severe DO depletions would occur during periods of deep persistent snow cover.

Belle Island Area - Pool 7

The Belle Island study area is located on the southern end of Lake Onalaska at the lower end of Pool 7. The study area consisted of two bays separated by an airport runway (Figure 7). The two bays differ greatly in their morphometric characteristics. The west bay is a highly vegetated, shallow area with deep, soft sediments. The largest accumulation of sediments was reported in the southeast end (Schellhaass et al. 1987). The eastern bay has a depth of 7 m. The difference in depth between the two bays resulted when dredge material was removed from the eastern bay and used to extend the airport runway onto Belle Island. This extension severely restricts water flow through the bays and the only exchange between them is a small culvert.

The two bays near Belle Island were sampled on 6 dates during the period of January 13th to March 21st. The DO levels were found to be relatively high in both areas during the winter period, but were quite variable. The west bay had DO levels that ranged from 4.4 mg/l to greater than 20.0 mg/l (Table 5). This large range was related to the amount of snow cover present. The west bay experienced no DO problems during this sample period. The east bay, site E1, exhibited DO levels of 4.0 mg/l or above throughout the water column during this period. The deep hole at site E1 did not exhibit the oxygen problems that were experienced in French Lake and I-90 areas (this report).

Both the east and west bays adjacent to Belle Island did not experience severe DO depletion during the 1989 winter period. The west bay can be significantly affected by deep snow cover as shown by data recorded in the winter of 87-88 (Rogala and Sullivan, 1988). The east bay had significantly higher DO levels than were recorded for the deep holes at French Lake or I-90. The elevated DO concentrations found in this area were probably a function of the morphometry of the area allowing for more thorough mixing during turnover and increased rates of re-aeration during the late fall.

Gremore Lake Area - Pool 10

Gremore Lake is located north of Prairie du Chien in a backwater area of Pool 10 (Figure 8). The lake can be characterized as a shallow, eutrophic body of water with a maximum depth of about 2 m at normal pool levels. A large area of relatively shallow water is present at the northern end. The lake does not receive any direct inflow of surface water (at normal levels) other than water exchange resulting from rising and falling pool levels. This exchange occurs at the southern end of the lake's outlet at Ambros Slough. Groundwater inflows are present along the northeastern shoreline.

Gremore Lake was sampled on five dates between January 6 and March 23 (Table 6). The surface DO levels ranged widely from 0 to above 20 mg/l. On January 20th and February 6th, DO levels were found to be above 5 mg/l at all sites. These also corresponded to some of the lowest recorded snow cover during the sample period. The most serious DO depletion problem occurred on March 9th when the surfaced readings were 0.5 mg/l or less for sites 1 through 5. The low DO levels were attributed to deep snow cover before and during the sample date. On the final sampling date, March 23, the surface DO readings had increased all sites. This increase was attributed to the loss of snow cover and the subsequent increase in photosynthetic activity.

Gremore Lake did not have any consistent current patterns. Flowing water was detected on only two dates, March 9th and February 6th. An inflowing current was detected at site 11 on March 9th. An outflow was detected on February 6 at sites 5, 6, and 11. The appearance of this current was thought to be related to rising and falling pool levels due to the regulation of the river at Lock and Dam 9 and 10. The water exchange with the river may lower water temperature and increase surface DO at the southern end of Gremore Lake. An increase of turbidity was noted at sites 5 and 6 on February 6 when water was flowing out of the Lake. The reason for this turbidity increase was not established but may have been caused by a flow-induced resuspension of sediments.

Gremore Lake can quickly become anoxic during periods of thick snow cover (10 or more cm). The DO depletion is rapid and appears most pronounced at the northern end. However, this area has the ability to quickly recover from anoxia when snow cover is absent or minimal. This would indicate sufficient photosynthetic activity to support fish populations during very mild winters, but Gremore Lake may experience prolonged and severe DO depletion during winters of deep snow cover.

McCartney Lake - Pool 11

McCartney Lake is located in Pool 11 below Cassville, Wisconsin. The study area was located in the western (upstream) end of McCartney Lake (Figure 9). This area is a shallow, highly vegetated backwater area that consists of a series of flowing channels and isolated sloughs. Adjacent to these channels and sloughs are shallow ponds (sites 9, 5, 6 and 7), many of which have significant groundwater interactions along the northern shoreline.

McCartney Lake area was sampled on two dates, January 17 and February 10. DO values ranged from 14.8 mg/l to greater than 20.0 mg/l (Table 7). The concentrations and ranges of DO would indicate that the McCartney area will sustain high oxygen levels during a mild atypical winter period. Although serious DO depletions would be expected in sites 5, 6, 7, and 9, these depletions did not occur since snow cover was absent or minimal and resulted in pronounced photosynthetic activity at these sites.

The McCartney area appeared to be capable of sustaining acceptable levels of DO during the winter period. The level of flow into the area was sufficient (242 cfs at site 1 on February 10) to prevent stratification in the flowing channels. This flow may carry well oxygenated water from the main channel. This would become important during periods of increased snow cover. Areas which may have DO problems are the isolated sloughs and ponds, but this was not observed during the two sample dates.

CONCLUSION

Dissolved oxygen monitoring during the winter of 1988-89 has provided data on the response of the backwater during a low precipitation winter. Dissolved oxygen levels were elevated and quite variable in many of the monitored backwater areas. The elevation in DO levels was attributed to decreased snow cover which allowed for greater photosynthetic activity in areas with vegetation or algae. The variability in DO was attributed to the sporadic and short term snow accumulations that occurred during the sample period. Many of the areas did not exhibit DO problems until the persistent snows of March. Other areas were anoxic from the first sample date. The marked difference between areas were generally a response to flow patterns or the morphometric characteristic of the specific area.

Many of the areas monitored did experience short or long-term anoxia at one or more sites. The appearance of anoxic conditions during the low snow fall winter of 1988-89 would indicate severe oxygen problems during harsh winters of deep and persistent snow cover.

LITERATURE CITED

- Rogala, J. and J. F. Sullivan 1988. Monitoring of dissolved oxygen levels in selected backwater areas of the Upper Mississippi River during the winter of 1987-88. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.
- Schellhaass, S. and J. F. Sullivan 1987. A winter study of dissolved oxygen levels in selected backwaters of the Upper Mississippi River. Unpublished report. Wisconsin Department of Natural Resources, La Crosse, Wisconsin.
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- U.S. Army Corps of Engineers, 1989. Unpublished stage and discharge data. Hydraulics Section. U.S. Army Corps of Engineers, St. Paul District, St. Paul, Minnesota.
- Wisconsin Department of Natural Resources, 1983. Field procedures manual for water quality and compliance monitoring. Technical Services Section Madison, WI.

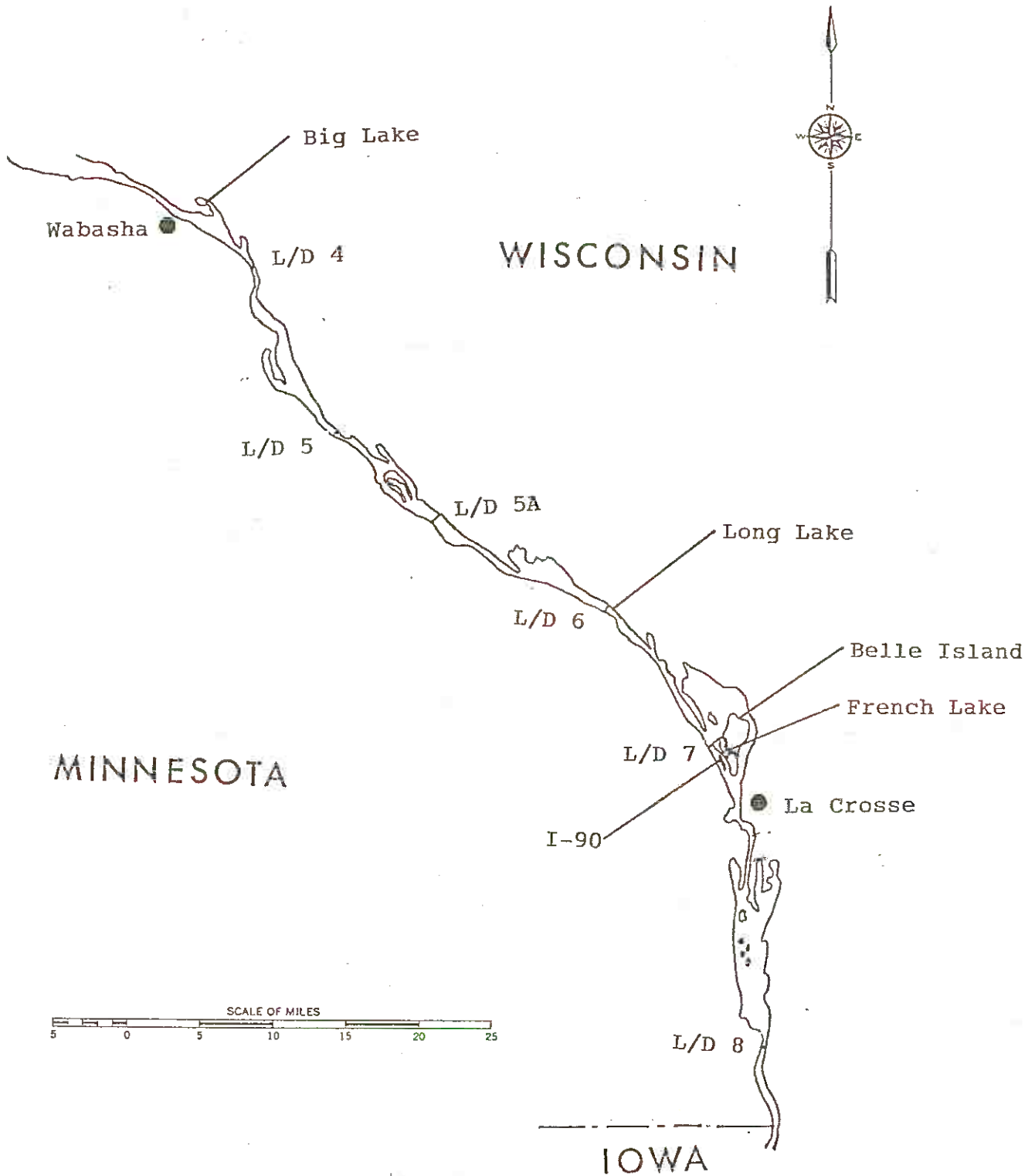


FIGURE 1 - Location of areas monitored on the Mississippi River, 1988 & 89

MINNESOTA

WISCONSIN

IOWA

L/D 9

Gremore Lake

Prairie du Chien

L/D 10

McCartney Lake

L/D 11



FIGURE 1 - Continued

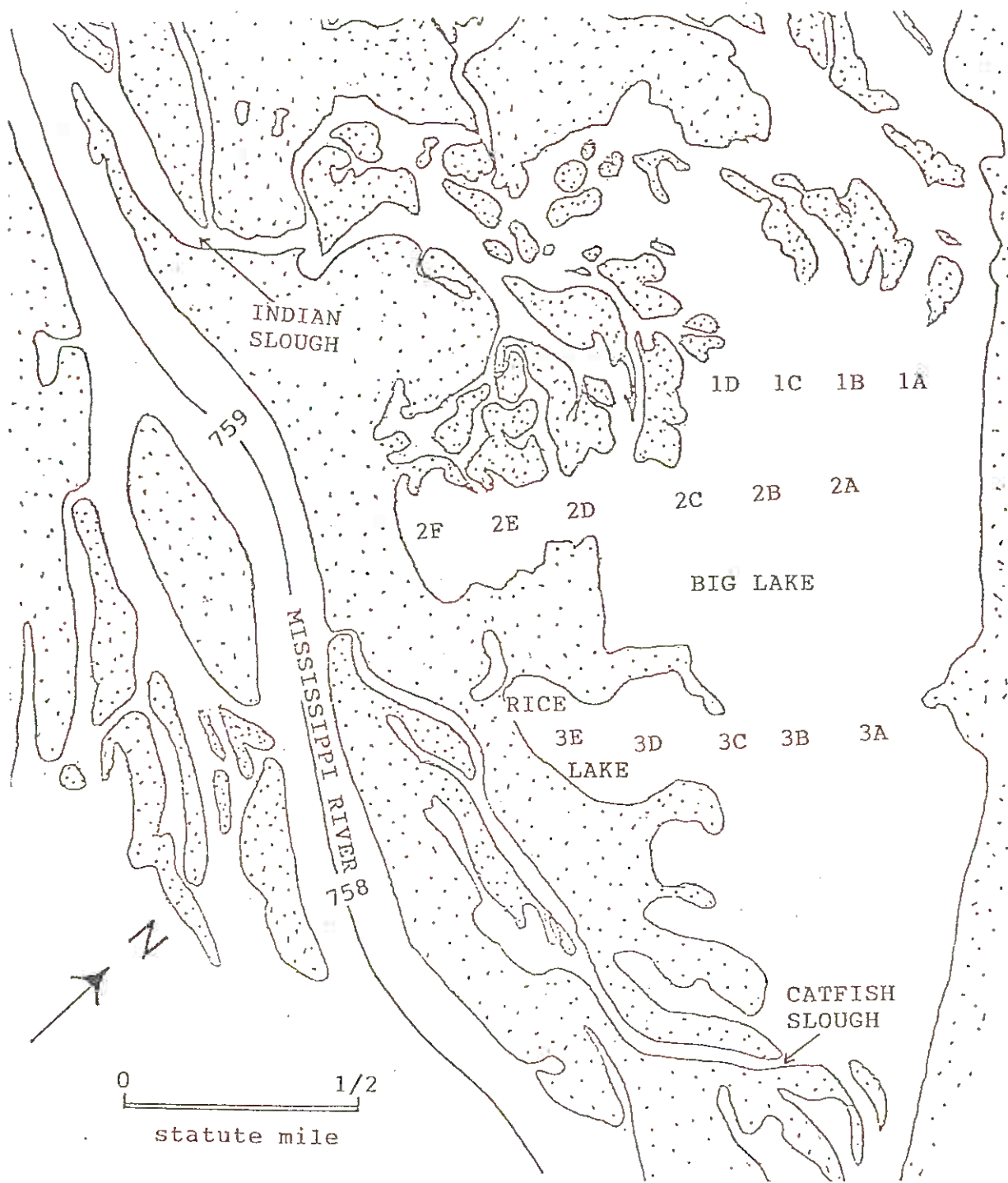


FIGURE 2 - Location of sampling sites in Big Lake, 1989

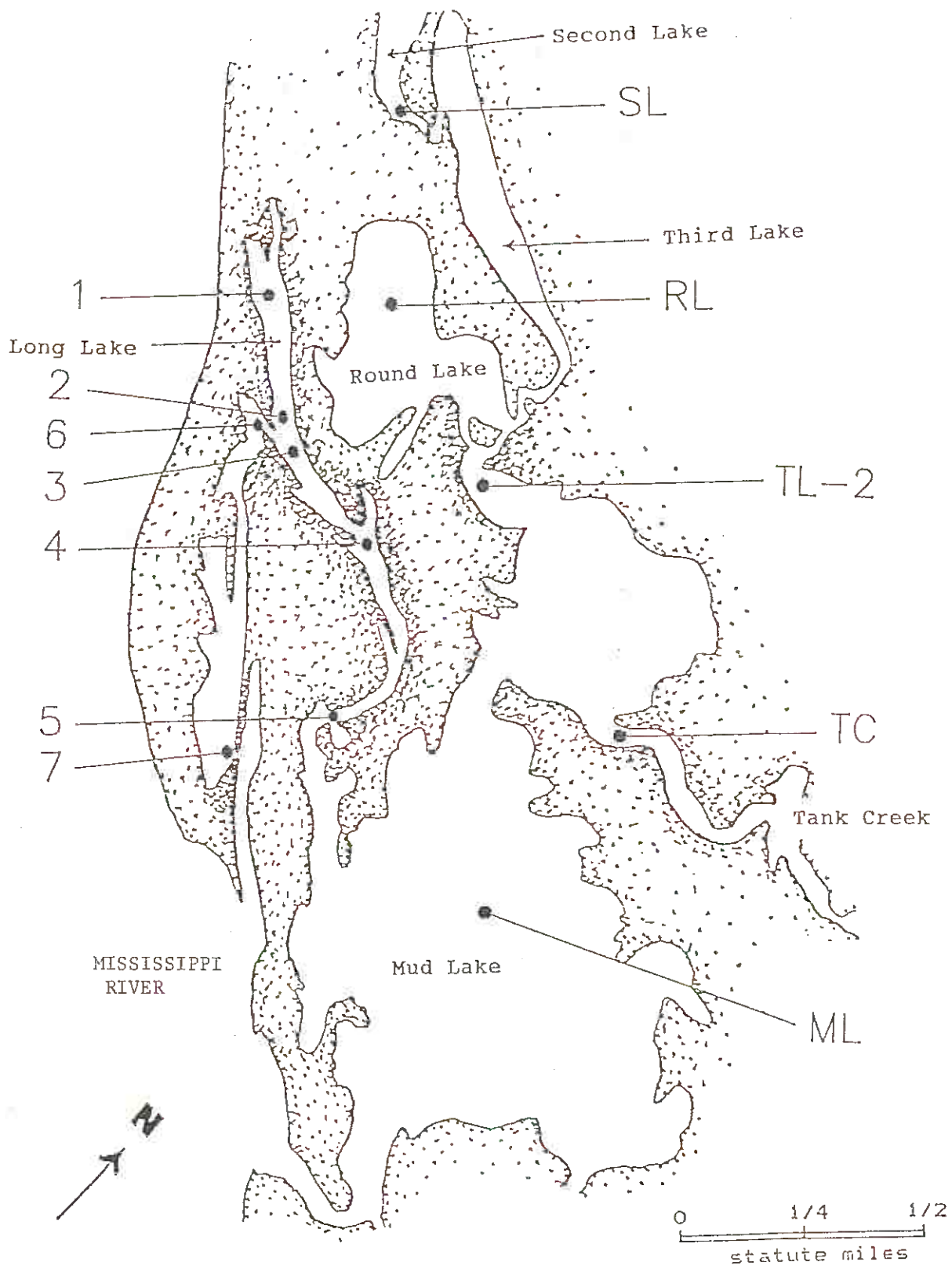


FIGURE 3 - Location of sampling sites in the Long Lake area, 1989

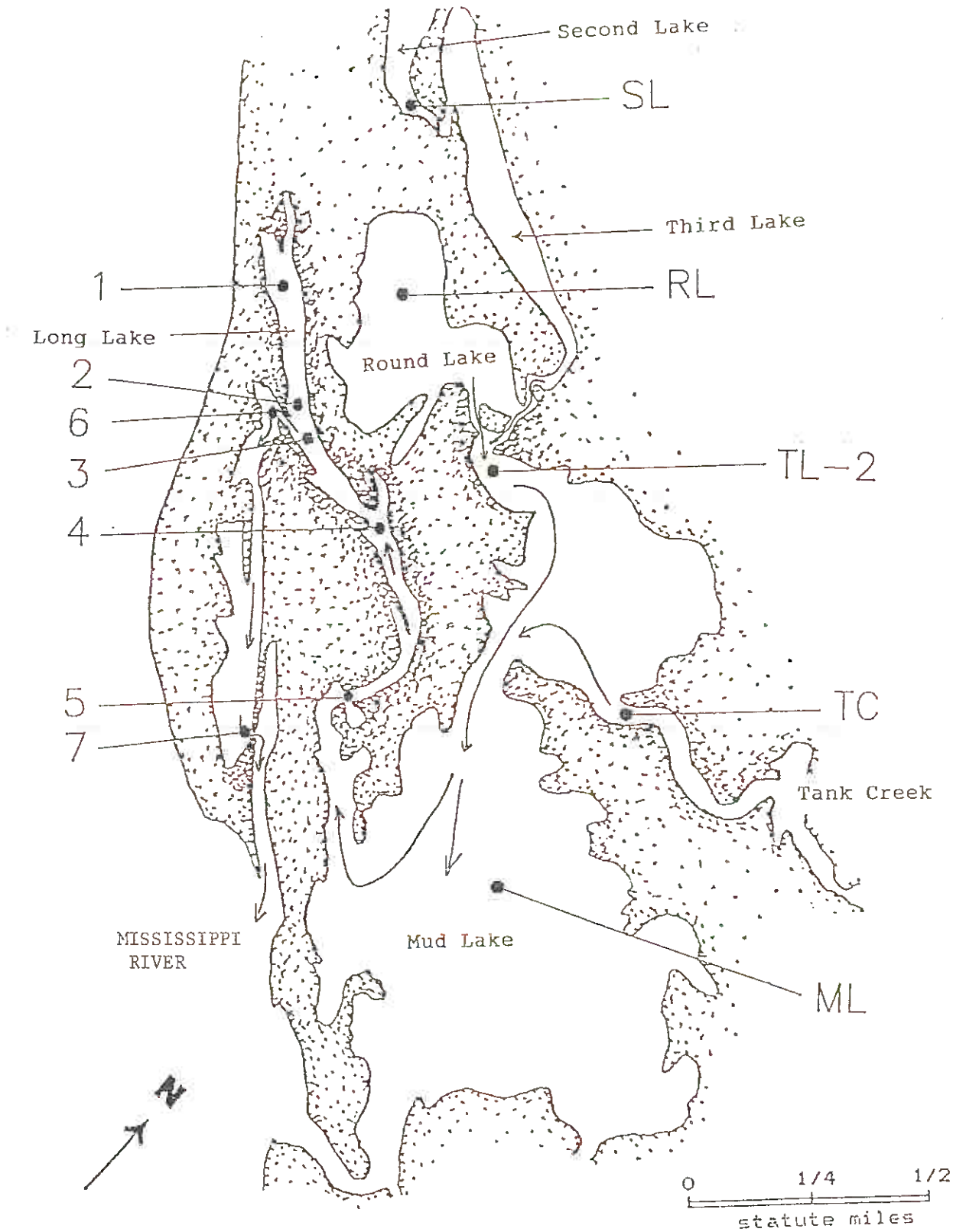


FIGURE 4 - Water circulation patterns in the Long Lake complex, 1988 & 89

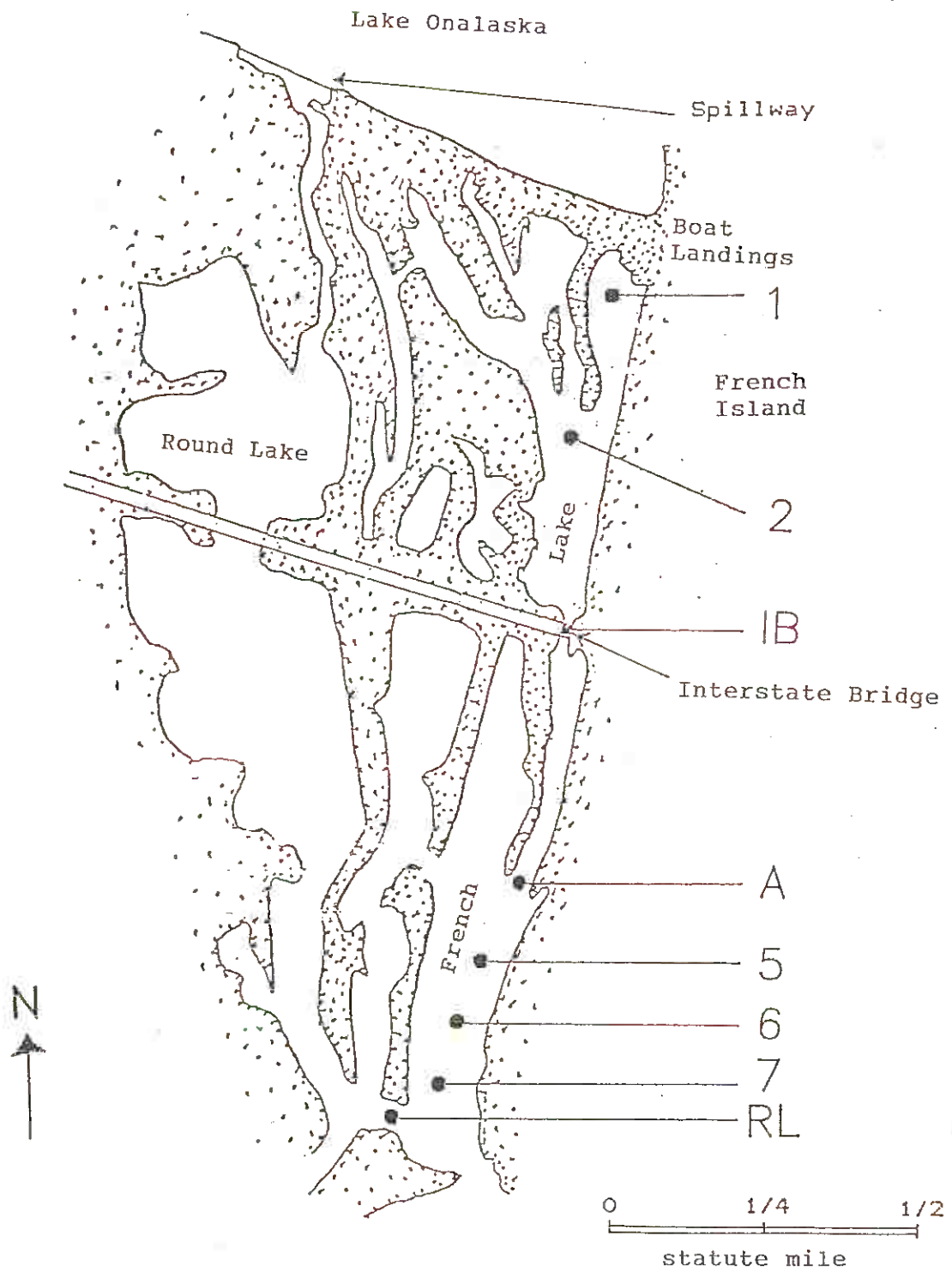


FIGURE 5 - Location of sampling sites in French Lake, 1988 & 89

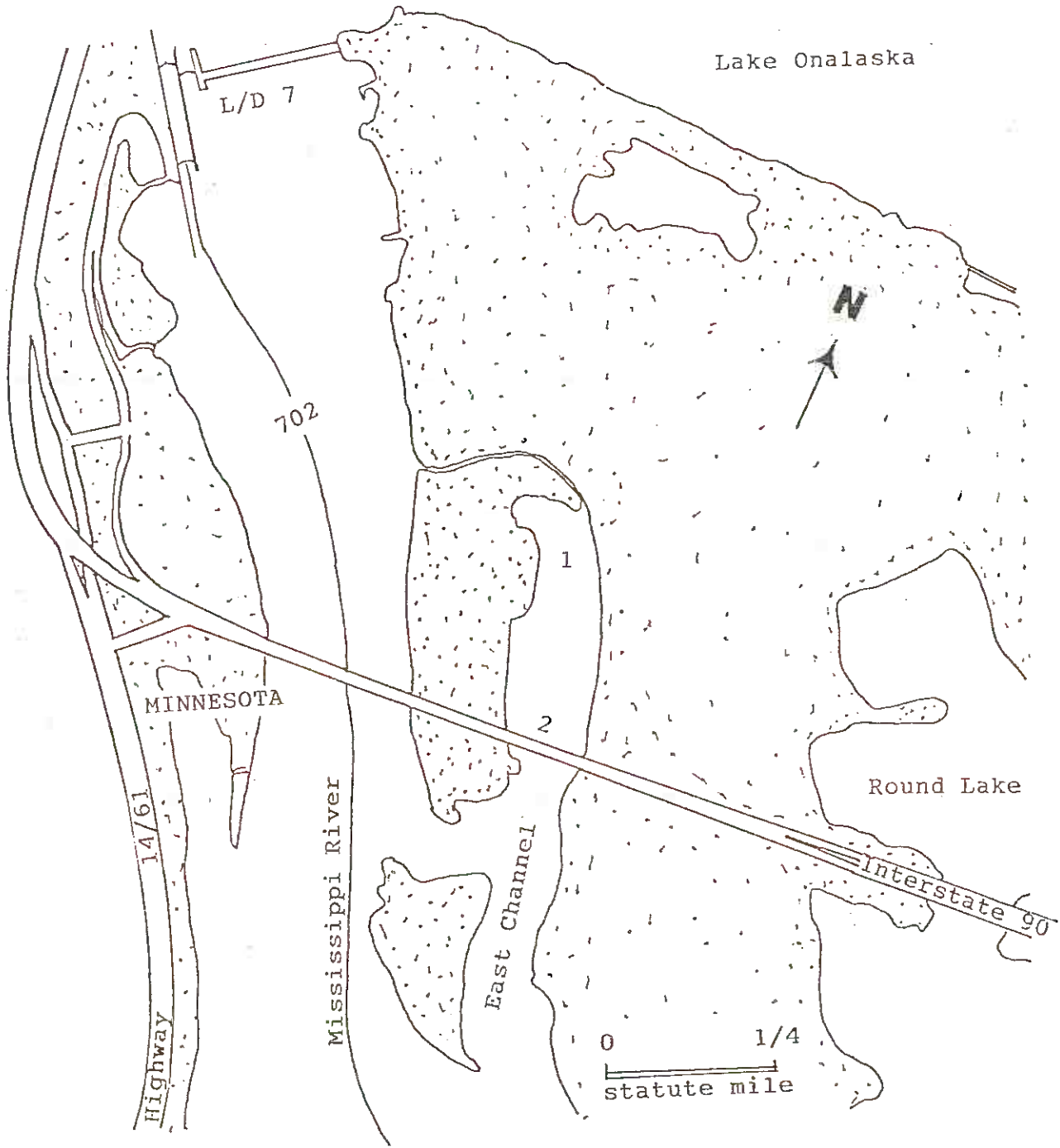


FIGURE 6 - Location of sampling sites in the I-90 area, 1989

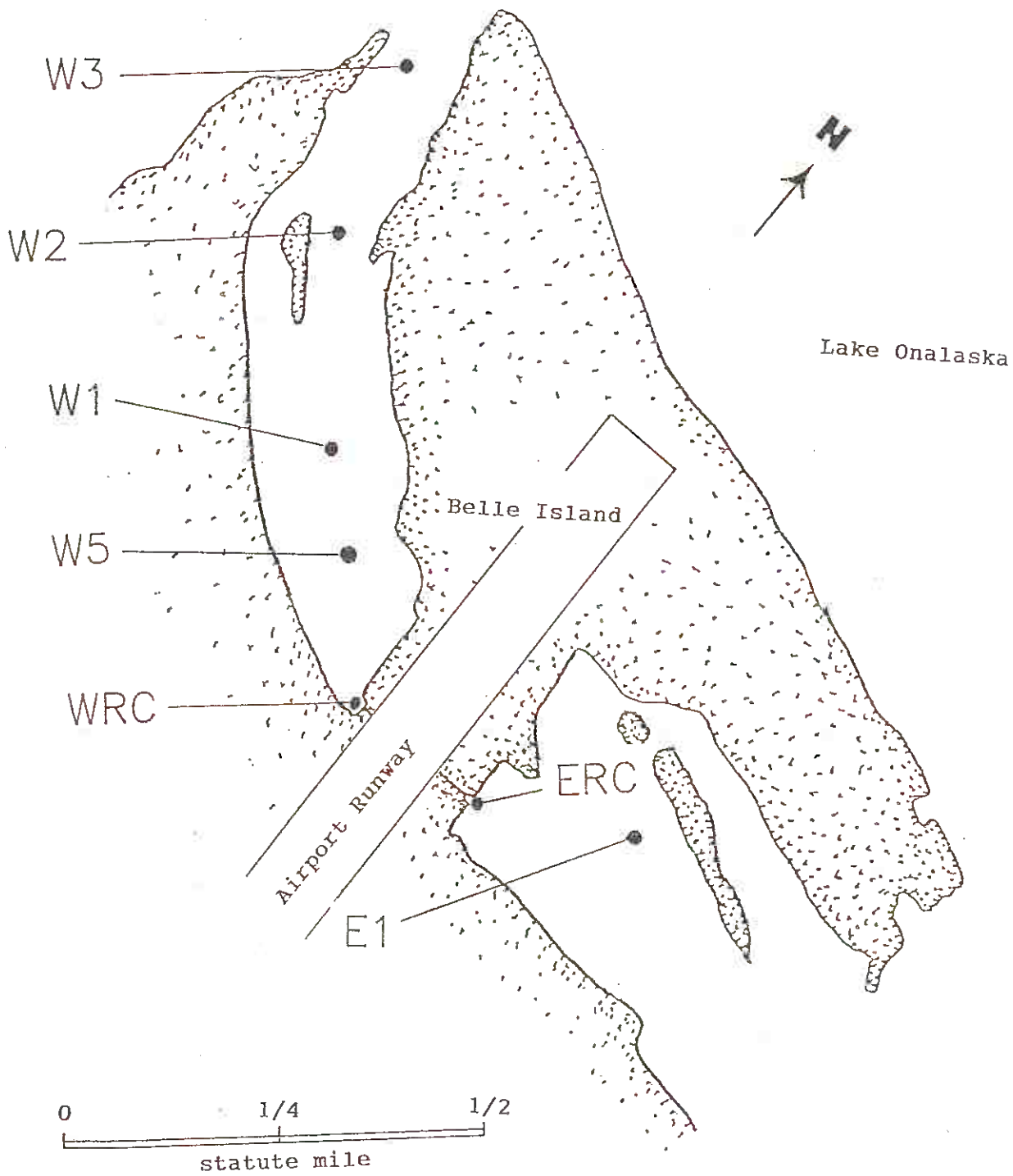


FIGURE 7 - Location of sampling sites in the Belle Island area, 1989

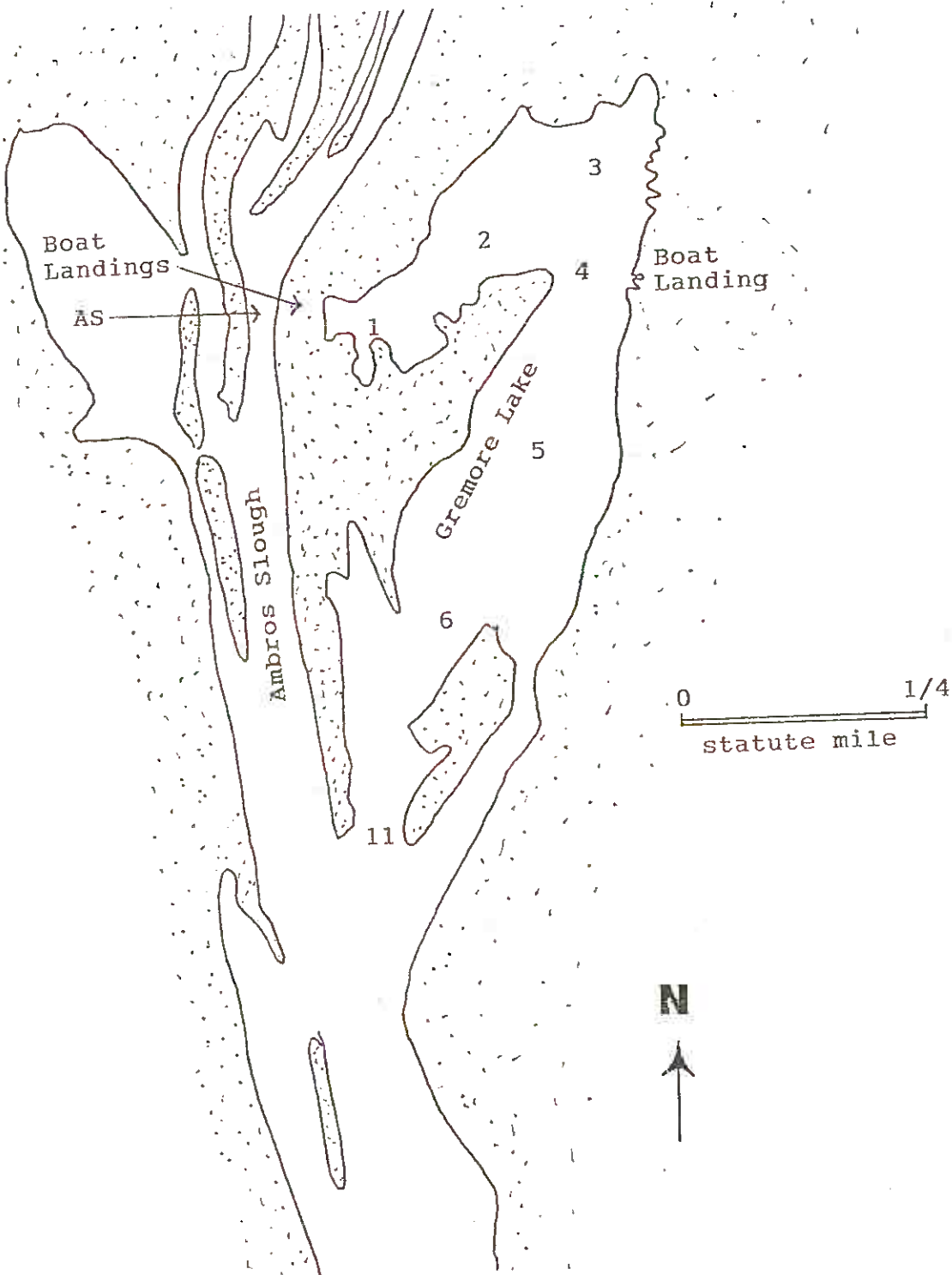


FIGURE 8 - Location of sampling site in the Gremore Lake area, 1989

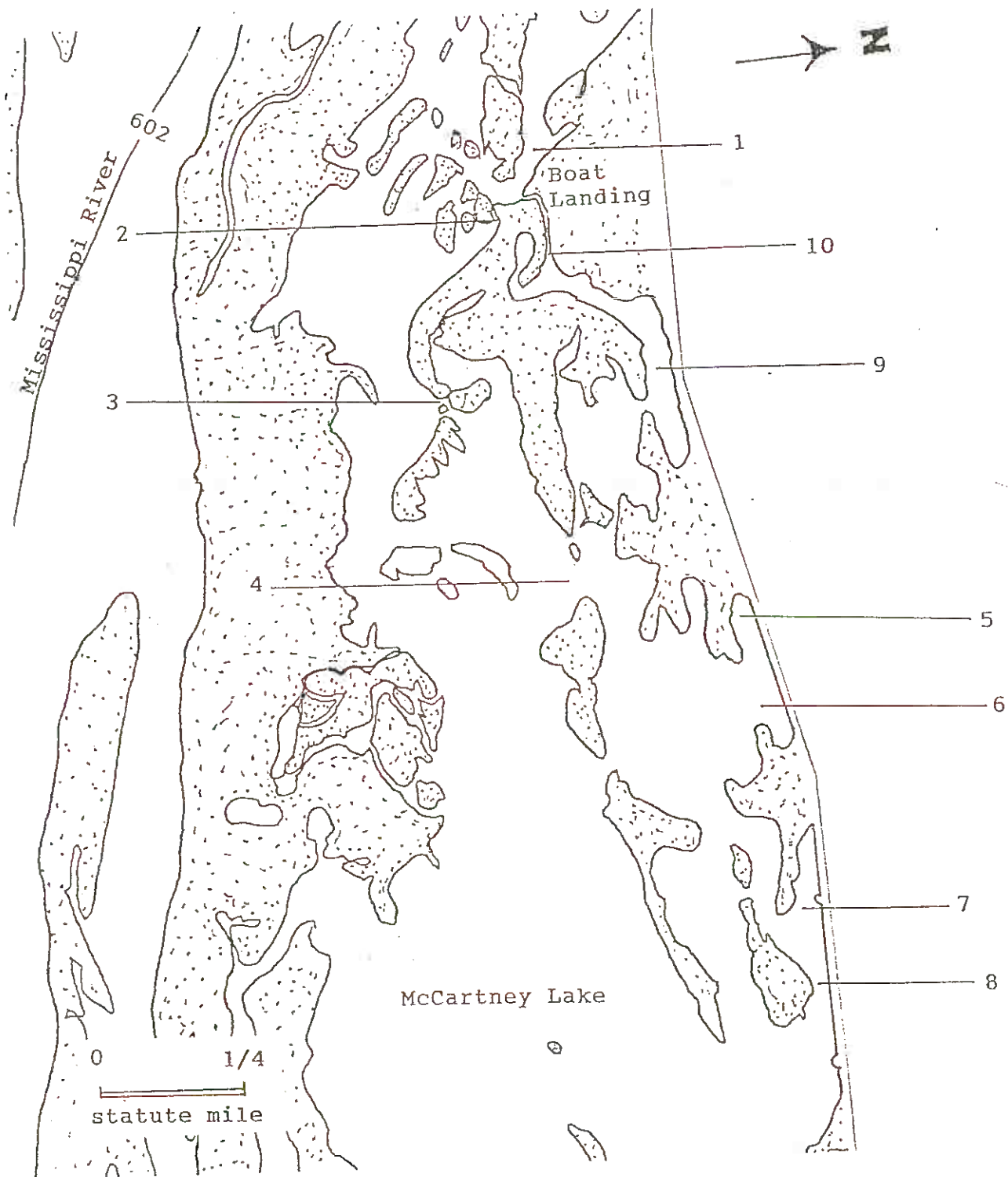


FIGURE 9 - Location of sampling sites in the McCartney Lake area, 1989

SNOW COVER

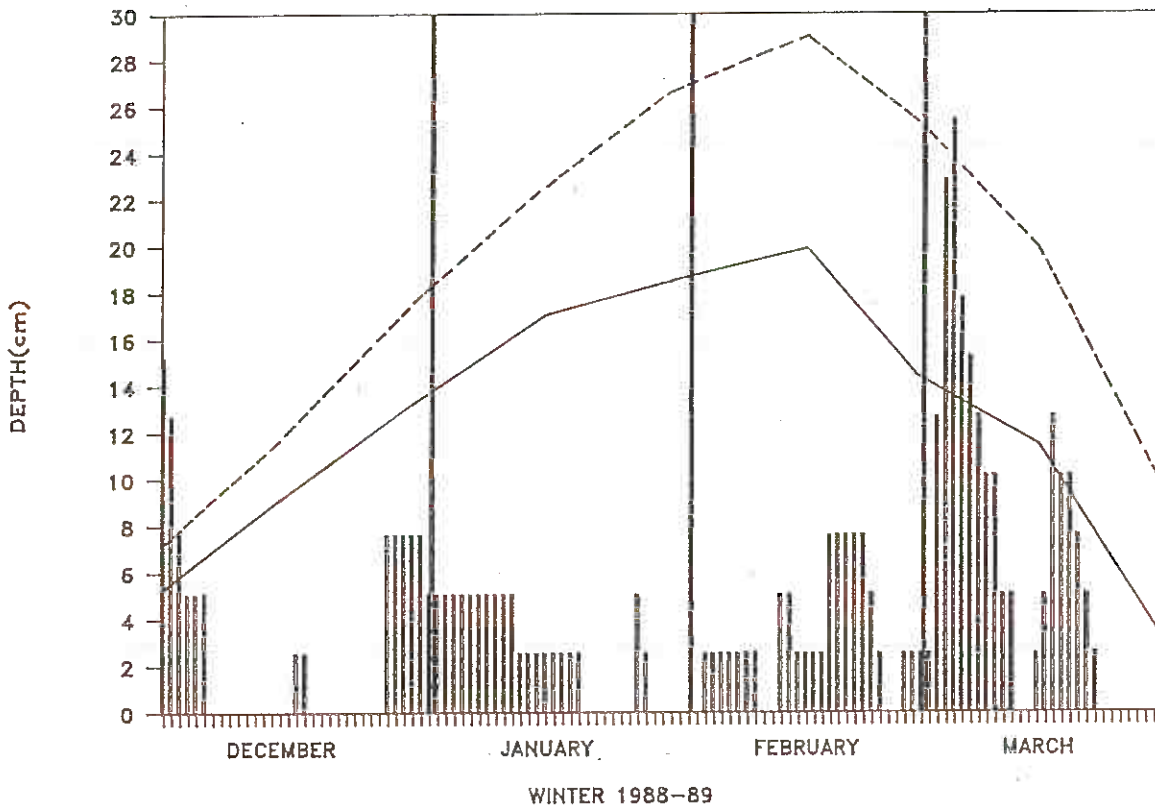


FIGURE 10 - Snow Cover: Dashed line depicts average snow cover in West Central Wisconsin and the solid line represents average snow cover in Southwestern Wisconsin during the period of 1961-1988. The bar portion represents the snow cover for the winter of 1988-89 as reported by the National Weather Service at the La Crosse Municipal Airport.

TABLE 1 - Water Quality Data Collected at the Big Lake Sites

Date	Time	Site #	Snow Depth (cm)	Ice Depth (cm)	Max. Depth (m)	Current		Temp C	D.D. (mg/l)	D.D. Drift (mg/l)	Cond. µmho/cm 25 C	Comments		
						Velocity (cm/s)	Direct. From							
1-12-89	1350	1A	2.5	33.0	0.8	ND	-	Mid	0.5	9.4	0.0	393	BP. 749mm at 730 BP. 734mm at 1800 Weather -11 Deg. C clear DO Meter - YSI 57 MB LAX Sampling crew - Bartsch, Benjamin River stage Wabasha MN 667.10 ft. The snow at all locations was compact	
	1415	1B	1.3	38.1	1.0	1.8	NW	Mid	0.0	13.6	0.0	371		
	1433	1C	0.0	31.8	1.3	3.0	NW	Top Mid Bot	0.0 0.0 0.0	15.7 15.7 15.6	-0.2	381 381 381		
	1450	1D	0.0	27.9	1.2	3.7	NW	Top Mid Bot	0.0 0.0 0.0	15.8 15.8 15.8	0.0	371 371 371		
	1312	2A	2.5	40.6	1.3	1.2	NW	Top Mid Bot	0.0 0.0 0.0	14.6 14.2 14.2	0.2	371 371 371		
	1300	2B	2.5	41.9	1.1	0.6	NW	Mid	0.0	13.9	0.0	371		=
	1435	2C	3.8	45.7	1.0	0.3	NW	Mid	0.5	14.8	0.0	383		=
	1420	2D	5.1	43.2	1.0	ND	-	Top Mid Bot	1.0 1.0 1.0	12.6 12.8 12.8	0.0	386 386 386		=
	1200	2E	5.1	47.0	1.1	ND	-	Top Mid Bot	0.0 0.5 1.0	14.4 13.8 12.6	0.2	390 403 405		=
	1140	2F	5.1	44.5	1.1	0.3	E	Top Mid Bot	0.0 0.0 1.0	13.8 13.2 13.2	0.0	371 351 367		=
	1625	3A	2.5	40.6	1.9	1.8	NNW	Top Mid Bot	0.0 0.0 0.0	13.8 13.6 13.6	0.2	361 361 361		
	1610	3B	1.3	39.4	1.5	1.8	NNW	Top Mid Bot	0.0 0.0 0.5	14.0 14.0 14.6	0.0	361 381 374		
	1555	3C	0.0	43.2	0.8	ND	-	Mid	0.5	13.8	-0.2	422		
	1545	3D	5.1	40.6	0.9	ND	-	Mid	0.5	11.6	0.2	508		
	1520	3E	2.5	38.1	0.8	ND	-	Mid	1.0	6.9	0.0	480	Final DO Calibration -0.1 mg/l	

TABLE 1 - Continued

Date	Time	Site #	Snow		Current			Temp C	D.O. (mg/l)	D.O. Drift (mg/l)	Cond. umho/cm 25 C	Comments		
			Depth (cm)	Ice Depth (cm)	Max. Ice Depth (m)	Velocity (cm/s)	Direct. From						Depth	
1-25-89	1308	1A	0.3	43.2	0.8	0.3	NW	Mid	0.0	11.8	0.1	371	BP. 749mm at 710, BP.744mm at 1900 Temp. 0 Deg. C Snowing D.O. Meter YSI 54 FISH LAX Sampling crew, Bartsch,Sullivan,Benja River stage Wabasha MN 667.16 ft.	
	1320	1B	1.3	47.0	1.0	2.4	W	Mid	0.0	12.3	0.0	400		
	1340	1C	1.3	30.5	1.3	3.0	W	Top Bot	0.0 0.0	13.0 12.8	0.0	390 390		
	1250	2A	2.5	40.6	1.4	2.4	NW	Top Bot	0.0 0.5	12.8 12.4	0.0	400 403		
	1240	2B	2.5	39.4	1.3	2.1	NW	Top Bot	0.5 0.5	12.8 12.6	0.0	393 393		
	1220	2C	0.3	50.8	1.1	0.6	NW	Top Bot	0.5 0.5	12.2 11.8	0.1	393 393		
	1205	2D	0.0	45.7	1.1	0.3	W	Top Bot	0.5 0.5	13.4 12.6	-0.1	393 393		
	1145	2E	0.0	53.3	1.1	ND	-	Top Bot	0.0 0.5	11.8 11.4	0.0	390 393		
	1125	2F	0.5	53.3	1.2	0.6	WSW	Top Bot	0.0 0.0	12.4 12.2	0.2	400 400		
	1350	3A	0.0	40.6	1.5	2.4	NW	Top Mid Bot	0.0 0.0 0.0	12.6 12.5 12.4	-0.2	400 400 400		
	1410	3B	0.0	38.1	1.3	2.7	NW	Top Bot	0.0 0.5	12.6 12.0	0.0	400 403		
	1420	3C	0.8	45.7	0.9	ND	-	Mid	0.0	14.0	0.0	381		
	1440	3D	0.0	50.8	0.9	ND	-	Mid	0.0	17.0	-0.1	420		
	1445	3E	0.0	43.2	1.0	ND	-	Mid	0.0	12.2	0.2	420		Final DO Calibration 0.2 mg/l

TABLE 1 - Continued

Date	Time	Site #	Snow Depth (cm)	Max. Ice Depth (cm)	Max. Ice Depth (m)	Current			Temp C	D.D. (mg/l)	D.D. Calc. Drift (mg/l)	Cond. umho/cm 25 C	Comments
						Velocity (cm/s)	Direct. From	Depth					
2-15-89	1127	1A	2.5	50.8	1.0	2.7	NW	Mid	0.0	9.0	-0.1	361	BP.745MM AT 720,BP.760MM AT 1530 Temp. -10.5 Deg.C sunny wind 10+ mph. D.O Meter YSI 54 EP Sampling crew - Bartsch,Von Ruden River stage Mabasha MN 667.28 ft.
	1143	1B	7.6	53.3	1.4	1.8	NW	Top Bot	0.0 0.0	10.6 10.2	0.0	381 381	
	1200	1C	7.6	25.4	1.4	3.4	NW	Mid	0.0	11.0	0.0	381	
	1109	2A	2.5	43.2	1.3	3.0	NW	Mid	0.0	10.8	0.3	381	
	1052	2B	3.8	50.8	1.3	1.8	NW	Top Bot	0.0 0.0	10.9 10.8	0.0	381 381	
	1037	2C	5.1	47.0	1.5	1.5	NW	Top Bot	0.5 0.5	11.2 11.0	0.2	364 364	
	1019	2D	2.5	48.3	1.2	ND	-	Mid	0.0	10.4	0.0	410	
	945	2E	2.5	62.2	1.0	ND	-	Top Bot	0.0 0.0	11.0 10.6	0.0	381 390	
	930	2F	2.5	58.4	0.9	0.6	NW	Top Bot	0.0 0.0	10.6 10.1	0.1	381 381	
	1127	3A	3.8	35.6	1.9	2.7	NW	Top Mid Bot	0.0 0.0 0.0	11.0 10.6 10.6	0.0	381 381 381	
	1315	3B	2.5	35.6	1.6	3.7	NW	Top Mid Bot	0.0 0.0 0.0	10.8 10.4 10.4	0.1	381 390 390	
	1300	3C	3.8	24.8	0.8	1.2	NW	Top Bot	0.0 0.0	9.2 9.2	0.0	381 390	
	1240	3D	-	48.3	1.2	ND	-	Mid	0.0	8.4	-0.2	449	
	1222	2E	7.6	48.3	0.8	0.3	NE	Top Bot	0.0 0.5	11.0 9.4	0.0	400 412	

ND - not detected

- - Not detected

= - YSI 54 EP was used in place of YSI 57 HQ LAX

Final DO Calibration -0.1 mg/l

TABLE 2 - Water Quality Data Collected at Sites in the Long Lake Area

Date	Time	Site #	Snow		Current			Temp C	D.O. (mg/l)	D.B. Calc. Drift (mg/l)	Cond. uaho/cm 25 C	Comments	
			Depth (cm)	Ice Depth (cm)	Max. Depth (m)	Velocity (cm/s)	Direct. From						Depth
1-16-89	930	1	6.4	30.5	1.2	-	-	Top	0.5	2.2	0.0	422	BP. 747mm at 810, BP. 740mm at 1430 Weather - Temp. 9.5 Deg.C overcast D.O. meter - YSI 54 FISH LAX Sampling crew - Bartsch, Sullivan River stage L/D & Tail 639.45 ft. The snow at all sites was compact
								Mid	2.5	1.9		402	
								Bot	3.0	1.5		405	
945	2	6.4	33.0	2.0	-	-	Top	1.0	3.3	0.0	424		
							Mid	2.0	2.4		418		
							Bot	3.0	0.5		431		
1000	3	6.4	35.6	3.5	ND	-	Top	0.5	1.7	0.1	441		
							Mid	2.5	1.1		429		
							Bot	3.0	0.3		457		
1111	4	6.4	38.1	2.3	0.6	S	Top	0.0	1.7	-0.2	449		
							Mid	2.0	0.6		473		
							Bot	4.0	0.2		494		
1130	5	6.4	25.4	0.5	1.2	S	Mid	0.0	3.0	0.0	420		
1015	6	6.4	30.5	1.7	0.6	E	Top	0.5	2.4	0.15	441		
							Mid	2.0	2.0		418		
							Bot	2.5	1.1		420		
1045	7	6.4	25.4	1.3	0.6	W	Top	0.0	6.8	0.0	439		
							Mid	0.0	6.0		439		
							Bot	2.0	0.4		455		
1150	ML	6.4	35.6	0.7	0.9	N	Top	0.0	10.5	-0.1	254		
							Bot	0.0	10.2		254		
1215	TC	0.0	12.7	0.6	2.1	E	Mid	0.0	11.1	0.0	234		
1230	TC-2	0.0	22.9	0.8	0.9	N	Mid	1.0	12.0	0.0	386		
1250	RL	6.4	31.8	1.9	-	-	Top	1.0	6.8	0.0	339		
							Mid	4.0	5.6		324		
							Bot	4.0	5.2		332		
1305	SL	0.0	0.0	0.6	18.9	NW	Mid	2.5	10.0	0.0	376	Final DO Calibration 0.0 mg/l	
1-31-89	930	1	7	33.0	1.3	-	-	Top	0.5	13.8	0.0	403	BP. 728mm at 815, 727mm at 1545 Weather 10 Deg.C Sunny D.O. meter - YSI 54 FISH LAX Sampling crew - Bartsch River stage L/D & Tail 639.72 ft.
								Mid	1.5	11.8		398	
								Bot	2.0	5.7		409	
1000	2	2.5	36.8	2.1	-	-	Top	0.5	2.3	0.0	345		
							Mid	2.5	1.8		394		
							Bot	3.0	1.4		422		
1120	3	2.5	41.9	4.0	0.3	E	Top	0.0	2.0	0.1	361		
							Mid	3.0	0.5		440		
							Bot	3.5	0.2		459		
1140	4	6.4	43.2	2.1	0.6	E	Top	0.0	2.3	0.0	351		
							Mid	2.0	1.6		418		
							Bot	4.0	0.3		460		
1240	5	7	27.9	0.6	1.2	S	Mid	0.0	4.1	0.2	351		

TABLE 2 - Continued

Date	Time	Site #	Snow Depth (cm)	Ice Depth (cm)	Max. Depth (m)	Current			Temp C	D.O. (mg/l)	D.O. Calb. Drift (mg/l)	Cond. µmho/cm 25 C	Comments
						Velocity (cm/s)	Direct. From	Depth					
1-31-89	1015	6	1.3	35.6	1.5	0.3	E	Top	0.0	2.3	0.1	351	
								Mid	2.0	1.8		418	
								Bot	2.5	1.3		420	
	1045	7	1.3	34.3	1.4	0.9	W	Top	0.0	3.8	0.2	410	
								Mid	0.0	3.5		420	
Bot								0.0	2.8		439		
1310	HL	0.0	29.2	0.6	3.0	NW	Mid	0.0	16.4	-0.2	264		
1400	SL	0.0	0.0	0.7	18.3	NW	Mid	3.0	9.2	0.0	352	?	
1425	RL	0.0	33.0	1.8	-	-	Top	3.5	8.6	-0.1	329		
							Mid	4.0	7.8		349	Final DO Calibration 0.0 mg/l	
2-14-89	1015	1	4.4	40.6	1.3	ND	-	Top	0.5	18.2	-0.1	422	BP 753mm at 830, BP 752mm at 1600 Weather - overcast Sampling crew - Bartsch. DO meter - YSI 54 EP River stage L/D & Tail 639.87 ft.
								Mid	2.5	14.0		411	
								Bot	2.5	12.9		411	
	1045	2	4.4	45.7	2.1	ND	-	Top	1.0	5.7	0.0	443	
								Mid	2.5	4.8		429	
								Bot	3.0	1.7		431	
	1205	3	4.4	48.3	3.8	ND	-	Top	0.5	4.5	-0.2	441	
								Mid	3.0	2.2		422	
								Bot	4.0	0.0		460	
	1225	4	5.1	48.3	2.3	ND	-	Top	0.5	10.0	0.0	412	
								Mid	1.5	4.7		453	
								Bot	4.0	0.0		485	
	1250	5	6.4	27.9	0.6	ND	-	Mid	0.0	8.8	-0.1	357	
	1100	6	5.7	41.3	1.4	ND	-	Top	1.5	4.2	0.3	416	
								Mid	2.5	2.7		411	
								Bot	2.5	2.5		429	
	1140	7	4.4	39.4	1.4	0.3	E	Top	0.0	12.0	0.0	390	
								Mid	0.0	11.4		390	
								Bot	0.5	7.8		403	
	1310	HL	2.5	41.9	0.8	0.6	NW	Mid	0.0	10.5	-0.3	234	
	1430	SL	0.0	0.0	0.7	17.7	W	Mid	2.5	11.8	0.0	367	
	1400	RL	3.8	38.1	1.9	-	-	Top	0.5	13.2	0.3	374	
								Mid	3.5	11.8		363	
								Bot	4.0	11.0		358	
	1330	TC	2.5	17.8	0.5	9.1	E	Mid	0.0	9.8	0.2	234	Final DO Calibration -0.3 mg/l

TABLE 2 - Continued

Date	Time	Site #	Snow		Current			Temp C	D.O. (mg/l)	D.O. Calc. Drift (mg/l)	Cond. µmho/cm 25 C	Comments	
			Depth (cm)	Ice (cm)	Max. Depth (m)	Velocity (cm/s)	Direct. From						Depth
2-28-89	1025	1	2.5	44.5	1.3	-	-	Top	0.5	20.0	0.1	441	BP 744mm at 845, BP 747mm at 1530 Weather - Temp. 8 Deg. C, Partly clou D.O. Meter - YSI 54 EP Sampling crew - Bartsch River stage L/D & Tail 639.68 ft.
								Bot	2.0	19.6		437	
	1045	2	2.5	54.0	2.1	0.6	NW	Top	1.0	6.6	0.0	395	
								Mid	2.5	7.4		411	
								Bot	3.0	4.1		440	
	1206	3	7.0	52.1	3.8	0.3	SE	Top	0.5	6.5	0.2	383	
								Mid	3.0	0.4		422	
								Bot	4.0	0.0		443	
	1230	4	10.2	52.1	2.2	0.3	SW	Top	0.0	8.9	0.2	351	
								Mid	1.5	4.3		407	
								Bot	4.0	0.0		460	
	1250	5	4.4	30.5	0.6	0.3	S	Mid	0.0	11.0	0.0	351	
	1100	6	5.1	45.7	1.3	ND	-	Top	0.5	6.7	0.0	383	
								Mid	2.5	3.2		402	
Bot								3.0	2.7		422		
1130	7	5.7	45.7	1.4	0.6	SW	Top	0.0	9.8	0.1	429		
							Bot	0.0	9.6		429		
1313	ML	1.3	43.2	0.8	0.6	NW	Mid	0.0	12.6	0.0	244		
1411	SL	0.0	0.0	0.6	11.6	W	Mid	2.5	12.7	0.0	358		
1355	RL	2.5	41.9	1.7	-	-	Top	1.0	11.4	-0.1	386		
							Mid	0.4	11.2		423		
							Bot	3.0	11.4		387		
1340	TD	0.0	11.4	0.6	11.3	E	Mid	0.0	11.8	0.0	244	Final DO Calibration -0.1 mg/l	
3-8-89	1200	1	20.3	47.0	1.3	-	-	Top	0.5	14.8	-0.1	441	BP.755mm at 800, BP.755mm at 1355 DO Meter - YSI 54 EP. Sampling crew - Bartsch River stage L/D & Tail 639.62 ft.
								Bot	2.5	12.6		447	
	1139	2	22.2	52.1	2.1	-	-	Top	0.5	7.7	-0.2	374	
								Mid	1.5	4.8		435	
								Bot	3.5	2.2		424	
	1050	3	20.3	55.9	3.7	ND	-	Top	0.5	6.5	0.2	374	
								Mid	3.0	1.8		440	
								Bot	4.0	0.0		477	
	1030	4	27.9	55.9	2.2	ND	-	Top	0.0	2.2	0.2	381	
								Mid	1.5	3.8		416	
								Bot	4.0	0.0		494	
	1110	6	21.6	47.0	1.3	ND	-	Top	0.5	7.0	0.0	374	
								Mid	1.5	3.9		407	
								Bot	3.0	1.9		422	

ND - Not detected
- - No data
T - Trace

TABLE 3 - Water Quality Data Collected at the French Lake Sites

Date	Time	Site #	Snow Depth	Ice (cm)	Max. Depth (m)	Velocity (cm/s)	Current		Temp C	D.O. (mg/l)	D.O. Calb. Drift (mg/l)	Cond. µmho/cm 25 C	Comments	
							Direct. From	Depth (m)						
12-14-88	1100	1	T	10.2	0.5	-	-	Top	0.5	>20.0	-	383	BP. 733µm at 1000, BP. 736µm at 1235 Weather - Overcast DO Meter YSI 57 MR LAX	
								Bot	0.5	>20.0	422			
	1135	2							0.3	2.0	7.6	-	400	Sampling crew - Sullivan, Huebsch River stage L/D 7 Tail 630.74 ft. Large area of open water still present near site 2 - along east shoreline
									0.9	2.0	7.4	400		
									1.5	2.0	7.3	400		
									2.1	2.0	7.2	400		
									2.7	2.0	7.1	400		
									3.4	2.0	7.1	400		
									4.0	2.0	7.1	400		
									4.6	2.0	7.1	400		
									6.1	2.0	7.1	400		
									7.6	2.0	7.1	400		
	9.1	2.5	6.2	411										
	9.8	3.0	1.7	457	Final DO Calibration -1.1 µg/l									
1-11-89	1308	1				ND	-	Top	1.0	5.0	-0.1	471	BP. 745µm at 1200, BP. 741µm at 1700 Temp. -1 Deg. C overcast DO Meter YSI 54 EP	
								Bot	1.0	4.7	471			
	1332	2	T	26.7	9.8				0.0	1.0	1.5	0.15	414	Sampling crew - Sullivan, Bartsch River stage L/D 7 Tail 631.23 ft. The snow at all sites was compact
									1.5	1.5	1.5	407		
									3.0	2.0	0.0	409		
									4.6	2.0	0.0	418		
									6.1	3.0	0.0	431		
									7.6	4.0	0.0	434		
									9.1	4.0	0.0	485		
	1400	1B	T	27.3	2.0	0.6	N		Top	1.0	4.9	0.0	414	
									Mid	1.0	3.8	424		
									Bot	2.0	2.4	418		
	1420	A		3.8	29.2	1.4	0.3	N	Top	1.0	2.8	0.0	424	
									Mid	1.5	2.6	426		
									Bot	1.5	2.5	426		
	1435	5		5.1	30.5	1.3	ND		Top	1.0	3.9	-0.2	424	
									Mid	1.0	3.4	433		
									Bot	1.0	3.3	433		
	1450	7		5.1	35.6	1.6	0.3	S	Top	0.5	10.8	0.0	383	
									Mid	1.0	4.9	395		
									Bot	1.0	3.9	414		
	1505	RL		0.0	14.6	1.1	7.6	N	Mid	0.5	14.8	0.0	381	Final DO Calibration -0.2 µg/l

TABLE 3 - Continued

Date	Time	Site #	Snow Depth (cm)	Ice Depth (cm)	Current			Depth (m)	Temp C	D.O. (mg/l)	D.O. Calb. Drift (mg/l)	Cond. µmho/cm 25 C	Comments
					Max. Depth (m)	Velocity (cm/s)	Direct. From						
1-24-89	1305	1	T 30.5	0.9	ND	-	Top	0.5	>20.0	-0.2	460	BP. 754µm at 930, BP. 751µm at 1400 Temp. -4 Deg. C DD meter - YSI 54 FISH LAX	
							Bot	1.0	>20.0		452		
	1250	2	0.0 20.3	8.8	-	-	0.0	1.5	5.1	0.3	435	Sampling crew - Bartsch River stage L/D 7 Tail 631.58 ft.	
							1.5	1.5	4.7		435		
							3.0	2.0	4.1		437		
							4.6	3.0	0.5		422		
							6.1	3.5	0.0		424		
							7.6	4.0	0.0		426		
							8.8	4.0	0.0		434		
	1235	1B	0.0 27.9	1.9	-	-	Top	1.0	6.4	0.0	414		
							Mid	1.0	5.5		424		
							Bot	1.5	5.3		416		
	1210	A	0.0 24.1	1.5	ND	-	Top	1.0	9.6	0.0	433		
							Mid	1.0	9.2		433		
							Bot	1.0	8.7		433		
	1200	5	T 35.6	1.6	ND	-	Top	1.0	13.1	0.1	414		
							Mid	1.0	12.8		424		
							Bot	1.0	12.4		424		
	1135	7	1.3 38.1	1.6	ND	-	Top	0.5	16.2	0.0	383		
						Mid	1.0	16.0		386			
						Bot	1.0	15.9		386			
1115	RL	0.0 0.0	1.3	9.8	N	Mid	0.5	16.0	-0.1	374	Final DO Calibration 0.1 mg/l		
2-7-89	930	1	1.9 36.8	0.9	-	-	Top	0.5	13.6	0.3	460	BP. 747µm at 815, BP. 745µm at 1500 Weather - Clear Temp. -15 Deg. C at 80 DD meter - YSI 54 FISH LAX	
							Bot	1.0	13.2		471		
	1015	2	0.6 29.2	0.7	-	-	0.0	1.0	7.6	-0.1	433	Sampling crew - Bartsch River stage L/D 7 Tail 631.58 ft.	
							1.5	1.5	4.6		442		
							3.0	3.5	0.6		415		
							4.6	3.5	0.0		424		
							6.1	4.0	0.0		426		
							7.6	4.0	0.0		434		
							8.5	4.0	0.0		460		
	1030	1B	1.9 33.0	1.8	0.3	S	Top	1.0	8.7	0.0	424		
							Mid	1.5	8.3		426		
							Bot	1.5	6.3		426		
	1045	A	0.6 29.8	1.5	ND	-	Top	0.5	18.0	0.0	393		
							Mid	1.0	11.8		414		
							Bot	1.5	8.8		426		
	1115	5	1.3 38.1	1.7	ND	-	Top	0.5	16.2	0.0	383		
							Mid	1.0	15.4		377		
							Bot	1.0	10.5		424		
	1135	7	2.5 44.5	1.7	0.3	S	Top	0.5	14.4	0.0	383		
						Mid	0.5	14.4		393			
						Bot	1.0	14.2		395			
1150	RL	1.9 10.2	0.9	13.7	N	Mid	0.0	14.5	-0.1	371	Final DO Calibration 0.2 mg/l		

TABLE 3 - Continued

Date	Time	Site #	Snow Depth (cm)	Ice Depth (cm)	Max. Depth (m)	Current			Depth (m)	Temp C	D.O. (mg/l)	D.O. Calb. Drift (mg/l)	Cond. µmho/cm 25 C	Comments
						Velocity (cm/s)	Direct. From	From						
2-23-89	1331	1	6.4	40.6	1.0	-	-	Top	0.5	3.4	0.0	441	BP.761mm at 1020, BP. 759mm at 1431 Weather Temp. -18 Deg. C clear sky DD meter - YSI 54 EP Sampling crew - Bartsch River stage L/D 7 Tail 631.74 ft.	
								Bot	1.5	15.2		453		
	1120	2	6.4	34.3	9.1	-	-	0.0	0.5	3.4	0.0	451		
								1.5	3.0	0.4	431			
								3.0	3.0	0.0	440			
								4.6	3.0	0.0	440			
								6.1	3.5	0.0	450			
								7.6	4.0	0.0	451			
								9.1	4.0	0.0	468			
	1152	1B	0.6	36.8	2.4	ND	-	Top	0.5	1.0	0.0	441		
								Mid	3.0	0.3	422			
								Bot	3.5	0.0	441			
	1210	A	7.6	38.1	1.4	0.3	S	Top	0.5	13.6	0.0	383		
								Mid	0.5	11.0	422			
								Bot	2.5	2.7	411			
1231	5	6.4	45.7	1.6	ND	-	Top	0.0	13.8	0.1	390			
							Mid	0.5	12.6	393				
							Bot	2.0	3.9	418				
1250	7	6.4	46.4	1.7	ND	-	Top	0.0	13.6	0.0	400			
							Mid	0.5	12.2	393				
							Bot	1.5	7.5	407				
1309	RL	0.0	7.0	1.8	19.2	W	Mid	0.5	13.8	0.0	383	Final DO Calibration -0.2 mg/l		
3-7-89	1131	1	-	43.8	0.9	-	-	Top	0.0	0.7	0.1	478	BP.757mm at 800, BP.755mm at 1615 Weather Temp. -4 Deg. C Sunny DD meter - YSI 54 EP Sampling crew - Bartsch River stage L/D 7 Tail 631.45 ft.	
								Bot	1.0	0.5	490			
	1148	2	19.1	38.1	8.8	-	-	0.0	0.5	0.7	0.2	441		
								1.5	3.5	0.3	433			
								3.0	4.0	0.0	434			
								4.6	4.0	0.0	451			
								6.1	4.0	0.0	460			
								7.6	4.0	0.0	477			
								8.5	4.0	0.0	477			
	1212	1B	6.4	36.8	2.6	ND	-	Top	1.0	0.4	-0.1	433		
								Mid	3.5	0.0	433			
								Bot	4.0	0.0	477			
	1246	A	17.8	43.2	1.4	ND	-	Top	0.5	5.2	0.2	431		
								Mid	1.0	0.6	443			
								Bot	3.0	0.0	449			
1309	5	16.5	50.2	1.7	ND	-	Top	0.5	11.6	0.1	403			
							Mid	1.5	8.4	416				
							Bot	2.0	2.5	437				

TABLE 3 - Continued

Date	Time	Site #	Snow Depth (cm)	Ice Depth (cm)	Max. Depth (m)	Current		Depth (m)	Temp C	D.O. (mg/l)	D.O. Calb. Drift (mg/l)	Cond. µmho/cm 25 C	Comments
						Velocity (cm/s)	Direct. From						
3-7-89	1330	7	20.3	53.3	1.6	ND	-	Top	0.0	10.6	0.2	410	
								Mid	1.0	8.3		414	
								Bot	1.0	7.5		414	
	1357	RL	0.6	10.8	1.8	19.2	W	Mid	0.0	13.0	0.1	400	Final DO Calibration -0.3 mg/l
3-22-89	1343	1	4.4	44.5	0.8	-	-	Top	1.5	7.8	0.0	-	BP. 752mm at 1000, BP. 749mm at 1450 Weather Temp. -1 Deg. C Sunny DO meter - YSI 54 EP Sampling crew - Bartsch River stage L/D 7 Tail 631.31 ft.
								Bot	1.5	1.9		-	
	1326	2	3.8	36.8	8.7	-	-	0.0	0.5	7.5	-0.2	-	
1.5								2.0	0.0	-			
3.0								4.0	0.0	-			
4.6								4.0	0.0	-			
6.1								4.0	0.0	-			
7.6								4.0	0.0	-			
8.5								4.0	0.0	-			
1150	1B	2.5	35.6	1.7	ND	-	Top	0.5	1.4	0.0	-		
							Mid	1.5	0.0		-		
							Bot	2.5	0.0		-		
1215	A	3.2	41.9	1.4	ND	-	Top	0.0	1.8	0.0	-		
							Mid	0.5	0.6		-		
							Bot	2.0	0.0		-		
1233	5	4.4	50.8	0.0	ND	-	Top	0.5	5.0	0.1	-		
							Mid	0.5	0.9		-		
							Bot	1.0	0.0		-		
1250	7	4.4	54.6	1.6	ND	-	Top	0.5	8.4	0.2	-		
							Mid	0.5	6.8		-		
							Bot	1.0	3.3		-		
	1310	RL #	0.0	0.0	0.3	4.6	W	Mid	1.0	12.7	0.0	-	Final DO Calibration -0.3 mg/l

- Site was located on the edge of the flowing water, north of original site
 - - No data
 ND - Not detected
 T - Trace

TABLE 4 - Water Quality Data Collected at the I-90 Sites

Date	Time	Site #	Snow		Current			Depth (m)	Temp C	D.O. (mg/l)	D.O. Calb. Drift (mg/l)	Cond. uho/cm 25 C	Comments
			Depth (cm)	Ice (cm)	Max. Depth (m)	Velocity (cm/s)	Direct. From						
1-11-89	1530	1	5.1	29.8	7.9	-	-	0.0	1.0	9.2	0.0	377	BP. 745 at 1200, BP.741 at 1700 Temp. 30 Deg.F overcast D.O. Meter YSI 54 EP Sampling crew - Bartsch,Sullivan, River stage L/D 7 tail 631.23 ft. The snow at all sites was compact
								1.5	1.0	9.1		377	
								3.0	1.0	9.0		377	
								4.6	1.0	8.9		377	
								6.1	1.5	8.7		370	
								7.6	2.0	4.1		382	
1550	2	5.1	35.6	1.7	ND	-	Top	0.5	13.8	0.0	383	Final DO Calibration -0.2 mg/l	
							Mid	1.0	11.2		386		
							Bot	1.0	10.6		386		
1-26-89	910	1	5.1	34.9	7.9	ND	-	0.0	0.5	8.6	0.0	383	BP.748mm at 800, BP. 749mm at 1100 Weather Temp.-6 Deg. C clear D.O Meter YSI 54 FISH LAX Sampling crew - Bartsch,Crawley River stage L/D 7 tail 631.46 ft.
								1.5	0.5	8.3		383	
								3.0	0.5	7.8		393	
								4.6	1.0	7.2		395	
								6.1	1.5	3.7		398	
								7.6	2.0	1.5		400	
940	2	5.1	43.2	1.1	ND	-	Top	0.0	15.2	0.0	390	Final DO Calibration 0.0 mg/l	
							Mid	0.0	14.8		390		
							Bot	0.5	13.4		383		
2-7-89	1245	1	0.6	40.0	8.8	ND	-	0.0	0.5	14.2	-0.1	403	BP. 747mm at 815, BP.745mm at 1500 Weather - Sunny Temp. -15 Deg. C D.O. Meter YSI 54 FISH LAX Sampling crew - Bartsch River stage L/D 7 tail 631.76 ft.
								1.5	1.0	13.0		395	
								3.0	1.0	8.1		395	
								4.6	1.5	4.0		389	
								6.1	2.0	2.2		391	
								7.6	2.5	0.7		394	
								8.5	3.0	0.2		440	
1315	2	1.3	48.3	1.1	ND	-	Top	0.0	15.0	0.0	400	Final DO Calibration 0.2 mg/l	
							Mid	0.5	14.3		393		
							Bot	0.5	14.7		393		
2-22-89	1030	1	6.4	47.0	9.0	-	-	0.0	0.0	17.2	-0.1	390	BP. 753mm at 845, BP.754mm at 1600 Weather - Sunny Temp. -14 Deg. C DO Meter YSI 54 EP Sampling crew - Bartsch River stage L/D 7 tail 631.45 ft.
								1.5	0.5	14.7		403	
								3.0	1.0	6.7		405	
								4.6	1.5	2.6		407	
								6.1	2.0	1.9		400	
								7.6	2.5	0.0		465	
								8.8	3.5	0.0		588	
1100	2	6.4	57.2	1.1	ND	-	Top	0.0	13.0	-0.1	381	Final DO Calibration 0.0 mg/l	
							Bot	0.5	12.5		374		

TABLE 4 - Continued

Date	Time	Site #	Snow depth (cm)	Ice Depth (cm)	Max. Depth (m)	Current			Temp C	D.O. (mg/l)	D.O. Calb. (mg/l)	Cond. usho/cm 25 C	Comments									
						Velocity (cm/s)	Direct. From	Depth (m)														
3-7-89	1421	1	17.8	49.5	8.8	-	-	0.0	0.0	13.0	0.0	410	BP.757mm at 800, BP.755mm at 1615 Weather Temp. -4 Deg. C , Sunny DO Meter - YSI 54 EP Sampling crew - Bartsch River stage L/D 7 tail 631.45 ft.									
								1.5	1.0	9.4	405											
								3.0	2.0	3.3	409											
								4.6	2.0	2.1	418											
								6.1	2.5	0.0	411											
								7.6	3.5	0.0	493											
								8.5	4.0	0.0	605											
								2	19.1	59.7	1.1	ND		-	Top	0.0	12.2	0.0	410			
															Bot	0.5	9.8	0.0	403			
																			Final DO Calibration -0.3 ug/l			
3-27-89	1421	1	0.0	33.7	10.4	ND	-	0.0	1.0	10.2	0.0	-	BP.738mm at 1330, BP.738mm at 1530 Weather Temp. 24.5 Deg. C Partly clo DO Meter - YSI 54 FISH LAX Sampling crew - Bartsch, Crawley River stage L/D 7 tail 635.04 ft.									
								1.5	1.0	9.8	-											
								3.0	2.0	3.8	-											
								4.6	2.0	1.5	-											
								6.1	2.5	0.0	-											
								7.6	3.0	0.0	-											
								9.1	4.0	0.0	-											
								10.4	4.0	0.0	-											
										1445	2	0.0		40.0	2.1	ND	-	Top	0.0	10.8	0.0	-
																	Mid	1.0	9.6	-	-	
								Bot	1.0	4.6	-	Final DO Calibration 0.1 ug/l										

ND - Not detected
- - No data

TABLE 5 - Water Quality Data Collected at the Belle Island Sites

Date	Time	Site #	Snow Depth (cm)	Ice Depth (cm)	Max. Depth (m)	Current		Depth (m)	Temp C	D.O. (mg/l)	D.O. Calib. Drift (mg/l)	Cond. µmho/cm 25 C	Comments
						Velocity (cm/s)	Direct. From						
1-13-89	1120	W1	5.1	30.5	0.6	ND	-	Mid	0.5	12.5	0.0	412	BP. 757 at 1030, BP.760 at 1430 Weather clear, Temp. -4 Deg. C DO Meter - YSI 54 FISH LAX Sampling crew - Bartsch River stage L/D 7 Pool 638.88 ft. The snow at all sites was compact
	1140	W2	5.1	30.5	0.9	0.6	NW	Mid	0.5	12.8	0.0	393	
	1215	W3	5.1	40.6	1.8	ND	-	Top	0.0	16.0	0.0	390	
								Mid	0.5	15.4	383		
								Bot	0.5	13.6	383		
	1100	W5	5.1	34.3	0.6	ND	-	Mid	0.0	13.3	0.0	420	
	1330	E1	6.4	35.6	7.0	ND	-	0.0	1.0	12.3	0.0	367	
								0.9	1.5	11.7	361		
								1.8	1.5	11.6	370		
								2.7	1.5	11.6	370		
3.7								1.5	11.6	370			
4.6								1.5	11.4	370			
5.5								1.5	11.4	370			
6.4								1.5	10.9	389			
7.0	1.5	10.7	389										
1400	ERC	0	0.0	0.4	4.6	W	Mid	0.5	8.4	0.0	460	Final DO Calibration 0.3 mg/l	
1-23-89	1025	W1	T	33.0	0.7	ND	-	Mid	0.5	>20.0	0.0	383	BP. 745mm at 830, BP.745mm at 1400 Temp. 1.5 Deg. C DO Meter - YSI 54 FISH LAX Sampling crew - Bartsch River stage L/D 7 Pool 638.98 ft.
	1045	W2	T	33.0	1.0	0.3	N	Mid	0.5	19.8	0.0	383	
	1105	W3	0.0	48.3	1.7	ND	-	Top	0.0	16.9	-0.1	351	
								Mid	0.5	16.8	355		
								Bot	0.5	16.6	355		
	930	W5	T	38.1	0.6	ND	-	Mid	0.5	>20.0	0.2	355	
	1045	E1	1.3	38.1	7.0	-	-	0.0	0.5	13.0	0.1	383	
								0.9	1.0	11.8	377		
								1.8	1.5	11.4	370		
								2.7	1.5	11.0	370		
3.7								1.5	10.8	370			
4.6								1.5	10.5	379			
5.5								1.5	10.4	379			
6.4								1.5	10.4	379			
7.0	1.5	10.2	389										
1200	ERC	0.0	0.0	0.5	3.0	W	Mid	1.0	15.7	0.1	471		
1000	WRC	0.0	0.6	0.2	0.3	NE	Mid	1.0	16.9	0.0	461	Final DO Calibration -0.2 mg/l	

TABLE 5 - Continued

Date	Time	Site #	Snow		Max.		Current		Temp C	D.D. (mg/l)	D.D. Calb. Drift (mg/l)	Cond. µmho/cm 25 C	Comments
			Depth (cm)	Ice (cm)	Depth (m)	Velocity (cm/s)	Direct. From	Depth (m)					
2-2-89	1235	W1	3.8	34.3	0.7	-	-	Mid	1.5	>20.0	-0.2	352	BP. 753 at 920, BP.752 at 1400 Weather snowing Temp.-13 Deg. C YSI 54 FISH LAX DO Meter Sampling crew - Bartsch River stage L/D 7 Pool 639.12 ft.
	1250	W2	3.8	35.6	1.0	ND	-	Mid	1.5	18.6	0.0	352	
	1305	W3	3.8	47.0	2.6	ND	-	Top	0.0	14.6	0.0	361	
								Mid	1.0	13.8		367	
								Bot	1.0	13.6		377	
	1220	W5	3.8	34.3	0.7	ND	-	Mid	0.5	>20.0	0.3	335	
	1050	E1	3.8	43.2	6.1	-	-	0.0	1.0	12.5	0.0	377	
								0.9	1.5	12.5		370	
								1.8	1.5	12.2		379	
								2.7	1.5	11.7		379	
								3.7	1.5	11.2		379	
								4.6	1.5	10.7		379	
								5.5	1.5	10.4		389	
								6.1	1.5	10.1		389	
	1120	ERC	T	1.3	0.6	1.5	W	Mid	1.0	17.8	0.1	424	Final DO Calibration -0.2 µg/l
2-13-89	1040	W1	5.1	38.1	0.7	-	-	Mid	0.5	>20.0	0.0	403	BP. 738 at 845, BP.738 at 1445 Weather - Temp. .5 Deg. C, snowing Do Meter YSI 54 EP Sampling crew - Bartsch River stage L/D 7 Pool 639.05 ft.
	1050	W2	5.1	43.2	1.0	ND	-	Top	0.5	16.8	-0.1	403	
								Bot	1.0	16.4		414	
	1105	W3	5.1	55.9	2.3	-	-	Top	0.0	13.9		371	
								Mid	0.5	13.5		374	
								Bot	1.0	12.8		395	
	1015	W5	5.1	43.2	0.8	ND	-	Mid	0.0	>20.0	0.0	361	
	1215	E1	4.4	50.8	5.5	-	-	0.0	0.0	16.5	-0.2	390	
								0.9	1.5	16.4		379	
								1.8	1.5	16.4		389	
								2.7	1.5	16.1		389	
								3.7	1.5	16.0		389	
								4.6	1.5	15.8		389	
								5.2	1.5	15.4		398	
												398	Final DO Calibration -0.1 µg/l

TABLE 5 - Continued

Date	Time	Site #	Snow		Current			Depth (m)	Temp C	D.O. (mg/l)	D.O. Calb. Drift (mg/l)	Cond. µmho/cm 25 C	Comments
			Depth (cm)	Ice (cm)	Max. Depth (m)	Velocity (cm/s)	Direct. From						
2-27-89	1310	W1	2.5	43.2	0.8	ND	-	Mid	0.5	12.8	-0.1	412	BP.742 AT 1146, BP. 739 AT 1530 Weather - Temp. -7 Deg. C, Sunny Do Meter YSI 54 EP Sampling crew - Bartsch River stage L/D 7 Pool 638.96 ft. Snow at all sites was compact
	1325	W2	3.8	44.5	1.0	ND	-	Top	0.0	12.8	0.0	390	
								Bot	0.5	10.2		403	
	1340	W3	2.5	59.7	1.5	0.0	W	Top	0.0	13.0	-0.2	381	
								Mid	0.0	12.8		381	
								Bot	0.5	12.2		383	
	1255	W5	2.5	49.5	0.7	-	-	Mid	0.0	12.7	0.1	429	
	1416	E1	2.5	54.6	6.4	ND	-	0.0	0.5	15.7	-0.2	383	
								0.9	0.5	15.8		393	
								1.8	1.0	16.3		386	
2.7								1.0	17.7		386		
3.7								1.5	15.2		389		
4.6								1.5	15.0		398		
5.5								1.5	14.0		398		
6.1	2.0	11.3		400									
1445	ERC	0.0	5.1	0.5	2.1	W	Mid	1.0	15.9	0.0	424	Final DO Calibration -0.1 mg/l	
3-21-89	1305	W1	3.2	44.5	0.6	-	-	Mid	0.5	5.2	0.3	-	BP.753 at 1030, BP.753 at 1600 Weather - Temp. -6 Deg. C, Sunny Do Meter YSI 54 EP Sampling crew - Bartsch River stage L/D 7 Pool 638.98 ft. The snow at all sites was compact
	1322	W2	3.8	43.2	1.0	-	-	Top	0.5	4.7	-0.3	-	
								Bot	0.5	4.0		-	
	1336	W3	4.4	66.0	2.1	ND	-	Top	0.0	7.6	0.0	-	
								Mid	0.0	7.0		-	
								Bot	0.5	4.3		-	
	1245	W5	3.8	50.8	0.8	-	-	Mid	0.0	4.4	0.0	-	
	1400	E1	3.8	54.6	5.8	ND	-	0.0	0.5	5.7	0.0	-	
								0.9	0.5	6.8		-	
								1.8	1.0	11.2		-	
2.7								1.5	12.0		-		
3.7								1.5	11.6		-		
4.6								1.5	10.2		-		
5.5	2.0	4.0		-									
1430	ERC	0.0	2.5	0.4	0.1	W	Mid	0.0	7.4	0.0	-	Final DO Calibration -0.3 mg/l	

ND - Not detected
T - Trace
- - No data

TABLE 6 - Continued

Date	Time	Site #	Snow Depth (cm)	Ice Depth (cm)	Max. Depth (m)	Current		Temp C	D.O. (mg/l)	D.O. Drift (mg/l)	Cond. umho/cm 25 C	Comments			
						Velocity (cm/s)	Direct. From								
2-6-89	1030	1	3.8	24.1	0.6	-	-	Mid	1.0	>20.0	0.0	546	BP.752mm at 800, BP.750mm at 1520 Weather sunny 0 Deg.F Calm D.O. Meter - YSI 54 FISH LAX Sampling crew - Bartsch, Sullivan River stage at McGregor IA, 612.29 ft		
	1044	2	3.8	16.5	0.9	-	-	Top Bot	0.5 1.0	11.2 10.7	0.0	527 527			
	1056	3	3.8	17.8	1.1	-	-	Top Bot	0.5 0.5	8.2 8.1	0.2	518 518			
	1109	4	3.8	17.8	1.5	-	-	Top Mid Bot	0.5 0.5 0.5	6.2 6.0 6.0	0.0	527 527 537			
	1123	5	3.8	17.8	1.5	0.9	N	Top Mid Bot	0.5 0.5 0.5	9.3 9.0 9.0	-0.1	537 537 546			
	1145	6	3.8	16.5	1.3	0.9	N	Top Mid Bot	0.5 1.0 1.0	4.2 3.7 3.6	-0.1	518 508 508			
	1158	11	3.8	19.1	1.5	0.6	N	Top Mid Bot	0.0 0.5 0.5	18.8 11.0 10.0	0.1	537 479 489			
	1220	AS	3.8	38.1	2.0	0.9	N	Top Mid Bot	0.0 0.0 0.0	18.4 18.4 18.4	0.0	400 410 410			
	Final DO Calibration 0.4 mg/l														
	2-21-89	1115	1	7.9	29.2	0.6	-	-	Mid	0.5	15.4	-0.1		613	BP.742mm at 830; BP.743mm at 1600 Weather partly cloudy D.O. Meter - YSI 54 EP Sampling crew - Bartsch, Walke River stage at McGregor IA, ND DATA
		1130	2	7.9	22.9	1.0	-	-	Top Bot	0.5 1.5	6.5 2.2	0.0		556 555	
		1148	3	7.1	27.4	-	ND	-	Top Bot	0.5 1.0	8.1 4.5	0.0		556 584	
		1203	4	7.6	25.4	1.6	ND	-	Top Mid Bot	0.5 1.0 2.0	7.0 4.6 1.0	0.3		566 565 564	
		1221	5	7.9	25.4	1.5	ND	-	Top Mid Bot	0.0 0.5 1.5	8.6 6.7 2.1	-0.2		556 585 592	
		1240	6	6.9	27.2	1.3	ND	-	Top Mid Bot	0.5 0.5 1.0	15.0 9.8 6.6	0.1		470 585 574	
1300		11	8.1	24.1	1.5	ND	-	Top Mid Bot	0.0 0.5 1.5	14.9 13.5 5.6	-0.2	410 460 546			
1318		AS	6.9	46.4	2.0	1.2	N	Top Mid Bot	0.0 0.0 0.0	13.6 12.9 12.4	0.0	400 420 420			
Final DO Calibration -0.1 mg/l															

TABLE 6 - Continued

Date	Time	Site #	Snow Depth (cm)	Ice Depth (cm)	Max. Depth (m)	Current		Temp C	D.O. (mg/l)	D.O. Drift (mg/l)	Cond. umho/cm 25 C	Comments		
						Velocity (cm/s)	Direct. From							
3-9-89	946	1	10.8	27.9	0.4	-	-	Mid	0.0	0.5	0.3	820	BP.757mm at 800, BP.745mm at 1430 Weather Temp. -1 Deg. C Partly cloudy DO Meter - YSI 54 EP and 57 HQ LAX Sampling crew - Bartsch River stage at McGregor IA, 611.71 ft	
	1000	2	10.2	26.7	0.8	-	-	Top Bot	0.5 1.0	0.0 0.0	0.0	652 697		
	1018	3	10.2	33.0	0.0	ND	-	Top Bot	0.5 0.2	0.0 0.0	0.0	681 688		
	1037	4	8.9	31.8	1.4	ND	-	Top Mid Bot	0.5 1.5 3.0	0.0 0.0 0.0	-0.1	633 648 669		
	1055	5	11.4	29.8	1.5	-	-	Top Mid Bot	0.5 1.5 3.5	0.5 0.4 0.0	0.0	546 592 675		=
	1130	6	10.8	31.8	1.3	ND	-	Top Mid Bot	0.0 1.0 3.0	12.2 9.0 1.2	0.2	439 471 616		=
	1155	11	10.2	30.5	1.4	0.6	S	Top Mid Bot	0.0 0.0 2.0	12.4 12.4 2.3	-0.2	469 469 546		=
	1223	AS	11.4	49.5	2.0	0.3	N	Top Mid Bot	0.0 0.5 1.0	10.2 9.2 2.8	0.0	429 422 452		Final DO Calibration -0.4 mg/l NR
3-23-89	1240	1	0.0	26.7	0.7	-	-	Top Bot	1.5 3.0	11.8 9.5	0.1	-		BP.749mm at 800, BP.746mm at 1630 Weather 7 Deg. C Partly cloudy D.O. Meter - YSI 54 EP Sampling crew - Bartsch River stage at McGregor IA, 612.94 ft
	1304	2	0.0	26.7	1.1	-	-	Top Bot	1.5 3.0	7.8 5.4	0.1	-		
	1323	3	0.0	27.9	1.2	ND	-	Top Mid Bot	2.5 3.0 3.0	14.5 15.3 10.0	0.0	-		
	1337	4	0.0	27.3	1.7	ND	-	Top Mid Bot	2.5 3.0 3.5	11.7 12.4 1.1	0.0	-		
	1356	5	0.0	26.0	1.7	ND	-	Top Mid Bot	2.5 2.5 4.0	7.9 11.2 0.0	0.0	-		
	1412	6	0.0	29.2	1.5	ND	-	Top Mid Bot	2.0 2.5 4.0	8.2 8.5 0.0	0.0	-		
	1430	11	0.0	26.7	1.6	ND	-	Top Mid Bot	1.5 3.0 3.0	10.4 10.4 6.4	-0.1	-		
	1501 1480	AS	0.0	40.6	2.2	4.3	N	Top Mid Bot	0.5 0.5 0.5	6.3 6.2 6.2	0.1	-	Final DO Calibration -0.2 mg/l	

ND - Not detected
- - No data
T - Trace

TABLE 7 - Water Quality Data Collected at Sites in the McCartney Lake Area

Date	Time	Site #	Snow Depth (cm)	Max. Depth (m)	Current		Temp C	D.D. (µg/l)	D.D. Calib. Drift (µg/l)	Cond. umho/cm 25 C	Comments		
					Velocity (cm/s)	Direct. From							
1-17-89	1040	1	0.0	35.0	4.1	3.7	NW	Top	0.0	14.8	0.0	390	BP. 744µm at 720, BP. 739µm at 1700 Weather - Clear sky D.D. meter YSI 54 FISH LAX. Sampling crew - Bartsch, Welke
								Mid	0.0	15.0		390	
								Bot	0.0	14.9		390	
1105	2	2	0.0	25.4	1.2	1.8	WNW	Top	0.0	15.3	-0.2	390	
								Bot	0.0	15.3		390	
1140	3	3	0.0	30.5	0.9	3.4	SW	Mid	0.0	15.5	0.2	390	
1205	4	4	0.0	29.2	1.8	2.7	NW	Top	0.0	15.6	0.0	390	
								Mid	0.0	15.6		390	
								Bot	0.0	15.6		400	
1230	5	5	0.0	12.7	0.4	-	-	Mid	3.0	>20.0	0.0	633	
1240	6	6	0.0	20.3	0.5	-	-	Mid	1.0	>20.0	0.0	697	
1300	7	7	0.0	22.9	0.6	-	-	Mid	3.0	>20.0	0.0	484	
1375	8	8	0.0	22.9	1.5	3.4	WNW	Top	0.0	16.2	0.1	400	
								Mid	0.5	16.2		403	
								Bot	0.5	16.1		403	
1355	9	9	0.0	25.4	0.8	ND	-	Mid	1.0	16.8	0.2	471	
1410	10	10	0.0	12.7	0.3	5.8	W	Mid	0.5	16.8	0.0	383	Final DD Calibration -0.2 µg/l
2-10-89	1010	1	-	43.2	3.4	2.1	NW	Top	0.0	16.4	0.1	400	BP. 752µm AT 720, BP. 753µm AT 1530 Weather - clear sky DD Meter YSI 54 FISH LAX Sampling crew - Bartsch, Sullivan, Milk
								Mid	0.0	16.4		400	
								Bot	0.0	16.3		400	
1200	3	3	-	17.8	0.9	4.0	SW	Top	0.0	16.9	0.0	400	Snow depth was estimated between 3.8 and 6.3 cm
								Mid	0.0	17.0		400	
								Bot	0.0	17.0		400	
1218	4	4	-	33.0	1.9	3.0	SW	Top	0.0	17.4	-0.2	400	Discharge at site 1 was 242 cfs
								Mid	0.0	17.4		400	
								Bot	0.0	16.7		410	
1319	5	5	-	18.2	0.6	-	-	Top	2.0	16.0	0.1	673	
								Bot	2.5	>20.0		671	
1305	6	6	-	12.7	0.5	-	-	Top	1.0	15.4	0.0	697	
								Bot	1.0	15.6		697	
1340	7	7	-	36.5	0.6	-	-	Mid	0.5	17.4	-0.1	460	
1355	8	8	-	19.1	1.3	3.4	N	Top	0.0	16.8	0.0	410	
								Mid	0.0	17.0		410	
								Bot	0.0	17.0		410	
1140	9	9	-	25.4	0.8	ND	-	Top	0.0	17.3	0.1	429	
								Bot	1.0	15.4		452	
1120	10	10	-	7.6	0.3	5.5	W	Mid	0.0	17.0	0.0	400	
1100	11	11	-	25.4	0.9	1.2	-	Mid	0.0	17.2	0.0	-	Final DD Calibration -0.3 µg/l

ND - Not detected
- - No data