Region WCR **County** Buffalo **Date** 5.31.91 **Classification** LAC

Water Body: Mississippi River Backwaters

Discharger: Nelson POTW

If classified as Limited Forage Fish (LFF) or Limited Aquatic Life (LAL), check any of the following Use Attainability Analysis factors that apply:

_____ Naturally occurring pollutant concentrations prevent the attainment of use

✓ Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met

_____ Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place

_____ Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or operate such modification in a way that would result in the attainment of the use

_____ Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses

low flow

_____ Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact

naturally poor WQ.

Supporting Evidence included

✓ Biological Data (fish/invert)
✓ Chemical Data (temp, D.O., etc.)
✓ Physical Data (flow, depth, etc.)
✓ Habitat Description
✓ Site Description/Map
_____ Other:

Comments:

wetland → default LAC classification
- lack of flow + poor natural water quality

5/31/91 - Paul LaLiberte
9/2/94 - Paul LaLiberte

STREAM CLASSIFICATION OF A BACKWATER OF THE MISSISSIPPI RIVER NEAR THE NELSON POTW

May 31, 1991

Paul La Liberte

The Nelson POTW is a lagoon system that currently discharges to a backwater of the Mississippi River. As a result of problems meeting effluent limitations the POTW has entered facility planning and has requested that the Department determine effluent limits appropriate for continued use of their existing outfall at the same design flow (.034 mgd as a monthly average). The facility is currently regulated by categorical, secondary effluent limits. Since the POTW was built, the State has adopted administrative codes governing discharges to surface water based on a classification scheme (NR104 and NR102). This report summarizes the application of the revised codes to the Nelson POTW discharge site.

On two occasions, the Nelson site was evaluated by DNR staff (see attached report). The physical condition of the ice cover and general habitat types were observed. The effluent was dyed to trace flow direction. Conductivity, dissolved oxygen, current velocity and temperature measurements were taken.

The Nelson discharge flows into a heavily vegetated wetland backwater near the confluence of the Mississippi and Chippewa Rivers. The entire wetland complex is several square miles, is part of the Upper Mississippi River Wildlife Refuge and developed primarily as the result of the construction of Mississippi River Lock & Dam #4. Within the wetland complex are areas dominated by the influence of Mississippi River water, Chippewa River water and groundwater inflow. Habitat types include open backwater channels with continuous flow, open channels with seasonal flow, heavily vegetated wetlands and lowland forests.

The Nelson discharge is about one mile from the nearest areas with continuously measurable velocity (Big Lake). Under low flow conditions, the wetlands in the immediate vicinity of the outfall are dominated hydrologically and chemically by groundwater inflow and the Nelson discharge. A few areas of defined small, flow channels (eg 1 cfs) are present, but water in the wetland moves primarily by unchannellized flow. Water depth in the vicinity is generally less than one meter. Beavers have modified the area, further slowing the movement of groundwater and effluent out of the area and excluding the intrusion of river water at normal river stage.

At normal river stage, the area within one mile of the outfall provides limited habitat for aquatic life due to low oxygen levels which develop under the ice in winter and among the profuse emergent aquatic macrophyte beds which develop in the summer. Summer blooms of duckweed further restrict submerged aquatic plant oxygen production. About a mile to the south and the southeast, open water exists which has more flow and is subject to some wind induced mixing. Oxygen levels in these areas are better and sufficient to support diverse aquatic life at normal to low river stages. The Nelson effluent eventually reaches these open water areas. Some of the effluent is thought to

freeze as ice in the wetland during the winter with thaw and release taking place during the annual spring high river stage.

At elevated river stage, water depth near Nelson's outfall is deeper and more water is available to assimilate wastewater. The area supports northern pike spawning during a normal spring and walleye pike spawning during a spring with above normal river stages. In April of 1989 about 200 fish representing typical backwater species were found dead about 300 yds from the Nelson POTW outfall. It was estimated that the kill occurred in early April. At the time, it was concluded that the mortality occurred as the result of winterkill of fish isolated from freshwater inflows. It is unknown if the outfall played any role in the fishkill.

During the investigation on 2-19-91, the backwater complex was ice covered. Open water existed along the edge of the wetland where groundwater inflow maintained a band of open water ranging from 1' to 20' wide. The most significant area of groundwater inflow, as evidenced by the extent of open water was immediately southeast of the POTW lagoon (second cell). A school of small forage fish were observed in association with open water in this area. Isopods were observed within 100 yds of the outfall.

During the 3-23-91 investigation, an attempt was made to find an area in the wetland with velocity and flow sufficient to assimilate the Nelson discharge at the categorical, secondary level of treatment. It was concluded that no such sites existed within one third mile of the current discharge site. It was determined by the facility's consultant that suitable locations beyond this distance would not be cost-effective alternatives to meeting more restrictive limits at the existing discharge location.

CLASSIFICATION RECOMMENDATIONS

The receiving water for the Nelson POTW should receive a variable classification. During normal flow (control pool elevation at Wabasha - 669.0') conditions, the classification should be wetland, limited aquatic life (marginal surface water) in recognition of the lack of flow and associated poor natural water quality. During high river stage conditions (>669' at Wabasha), the classification should be wetland, warmwater sport fish community in recognition of seasonal higher flow and water quality and associated use of the area by sport fish. While use by sport fish would be primarily during spring spawning, use during high stage at other times may also occur.

cc Joe Ball WR-2

Interim Report On Mississippi River Water Quality Monitoring Surveys Collected Adjacent to the Municipal Wastewater Treatment System at Nelson, Wisconsin.

Authors: John F. Sullivan and Paul LaLiberte, Western District, WDNR, May 1991

The purpose of this report is to describe the results of late winter and early spring water quality monitoring investigations collected near Nelson's WWTP in 1991. The purpose of these investigations was to evaluate the receiving water characteristics, mixed zone, and effluent impacts during winter and early spring conditions. Additional evaluations are planned during summer low flow conditions. We are providing this information now since it may help in establishing appropriate effluent limits as part of the facility planning process now underway for the village of Nelson.

Summary of Receiving Water Characteristics

Effluent from Nelson's Wastewater Treatment System is discharged to a large wetland complex in Pool 4 of the Mississippi River just upstream (NW) of Big Lake (Figure 1 and 2). This wetland complex was is part of the Chippewa River delta which enters the Mississippi River a few miles upstream. The water level in the area is influenced by the operation of Lock and Dam 4 located several miles downstream. The area has a diverse flora consisting of submergent and emergent plants with some hardwood shrubs and small trees based on aerial photos and recent observations.

Water depths adjacent to the wastewater ponds are about 1 to 3 ft during control pool elevation (about 666.7 ft, Table 2). Water levels immediately adjacent to the second wastewater treatment pond appear to be influenced by a beaver dam. Water level fluctuations of 3 ft (or more) occur seasonally due to varying Mississippi River flows and stage levels associated with runoff events. Channelized flow is not present at the site due to heavy vegetation and shallow depths. Current velocity is likely minimal during low flow conditions. Wind and thermal gradients may play a large role in mixing the effluent through the wetland complex.

Groundwater inflows are common along the shoreline. These inflows provide pockets of open water during winter conditions and may be an important source of moderately oxygenated water to adjacent wetlands during winter periods. Groundwater inflows may dilute wastewater discharges from Nelson's municipal WWTP, especially during low flow conditions.

Serious oxygen depletion probably occurs throughout the wetland area during winter periods, especially years with heavy snow cover. These depletions are natural and are due to vegetation decay and sediment oxygen demand. This is commonly found in other backwater areas of the Mississippi River. DO levels in the summer would be expected show pronounced diurnal variations due to photosynthetic activity. Periods of near anaerobic conditions are possible during these conditions. Additional oxygen demand and nutrient enrichment impacts would arise from municipal wastewater loadings to adjacent wetlands.

The existing water depths limit the effective fisheries habitat during control pool elevations. The area does provide important spawning habitat for northern and walleye pike during spring periods with high stage levels (about 2.5 ft

higher than control pool elevation) based on discussions with Ron Benjamin, Mississippi River Fisheries Supervisor.

Winter Survey - February 15, 1991

Participants: John Sullivan, Paul LaLiberte, and Ron Benjamin

A summary of information collected during a our recent winter survey is provided in Table 1. The Mississippi River stage at Wabasha was 667.19 ft msl which is near median values for February (Table 2). River flow at L/D 4 was about 12000 cfs.

The upper one-third of the effluent pipe was visible. A small area of open water extended out several feet from the shoreline. A small quantity of Rhodamine WT dye was added to the effluent to trace the movement of the effluent in the area of the outfall. The dye moved very slowly in southerly direction towards Site 4 (Figure 2). The actual velocity was not quantified, but it was likely less than 0.02 ft/s.

Dissolved oxygen levels were generally low (0.8-2.5 mg/l) throughout the area. Highest oxygen levels were found near a groundwater inflow upstream of the facility (Site 2) and at a site immediately adjacent to the outfall (Site 3). Higher DO levels were likely due to reaeration of groundwater inflows along shoreline areas. DO depletions were probably caused by natural oxygen demands (vegetation decay and SOD) as well as effluent BOD inputs.

Conductivity measurements were lowest (440-475 uS/cm) upstream of the facility at Sites 2, 3, and 8. These likely reflect areas that were not influenced by wastewater discharge which had substantially higher conductivity (1800 uS/cm). Elevated conductivity measurements (530 to 590 uS/cm) were attributed to direct wastewater additions. It is possible that infiltration of wastewater to groundwater and its resultant discharge (seepage) along the shoreline area may have also contributed to elevated conductivity measurements near Nelson's WWTP.

The relatively shallow depths and ice cover made it difficult to assess the aerial extent of wastewater discharges to the wetland during winter conditions.

Spring Survey - March 23, 1991

Participants: John Sullivan, Paul LaLiberte, & Dan Uhl, Davy Engineering

Results of information collected during this early spring survey are provided in Tables 3, 4, and 5. Mississippi River water levels at the Wabasha gauge were about 670.3 ft msl during the survey and were rising due to increasing inflows from the Chippewa River. This stage level is about 3 ft higher than median levels for March, but would be near median elevation for April (Table 2). River discharge at L/D 4 was about 77,000 cfs. The wetland complex adjacent to Nelson's WWTP was flooded with about 3 feet of water compared to the February survey. Ice was absent.

Dye tracing was performed to assess effluent mixing with the river during typical spring high water conditions (Table 3). Dye tracing at 100, 200, and

300 ft downstream of the outfall showed a typical longitudinal dispersion response (Figure 3). The mixed zone was predicted to extend about 450 ft downstream based on a regression of peak dye concentrations versus distance. No attempt was made to assess lateral dispersion. Peak dye concentrations moved at an average velocity of 0.07 ft/s. Water current measurements collected with an electronic current meter near the outfall indicated a velocity of 0 to 0.04 ft/s from the northwest. The velocity of the peak dye concentration is expected to be faster that the centroid of the dye distribution, the latter point being used to estimate mean time-of-travel. In addition, northwest winds (about 10 mph) may have resulted in faster surface currents during the dye survey and may explain the difference in velocity measurements.

Water samples were collected for nitrogen analysis at locations immediately above and below Nelson's outfall (Table 4). Ammonia nitrogen showed an obvious percentage increase beyond background (maximum of 50%), although the actual increase was small (0.12 mg/l). Ammonia nitrogen levels increased along the second wastewater pond shoreline and may indicate seepage of wastewater from the facility. Unfortunately, no conductivity measurements were taken during this sampling which would have confirmed this suspicion. Un-ionized ammonia nitrogen would have been less than the chronic standard (0.04 mg/l) due to relatively low pH and ammonia nitrogen levels. Problems with un-ionized ammonia nitrogen would be expected at higher pH during the summer months when photosynthetic activity is more intense. However, assimilation of ammonia nitrogen by aquatic plants and denitrification in the wetland complex may minimize these impacts.

Water current, water depths, temperature, and conductivity measurements (Table 5) were made in a transect across Pool 4 near Nelson, Wisconsin during the time of the dye study discussed above. The conductivity measurements indicate the Chippewa River was the dominant water mass influencing headwater conditions above Nelson's WWTP. Chippewa River water generally has a conductance of about 1/2 to 1/3 that found in the Mississippi River.

Conductivities showed an increasing trend approaching the Wisconsin shoreline. The higher levels near Nelson's WWTP are likely due to a combination of factors including wastewater discharge, wetland drainage/flushing, and groundwater discharges.

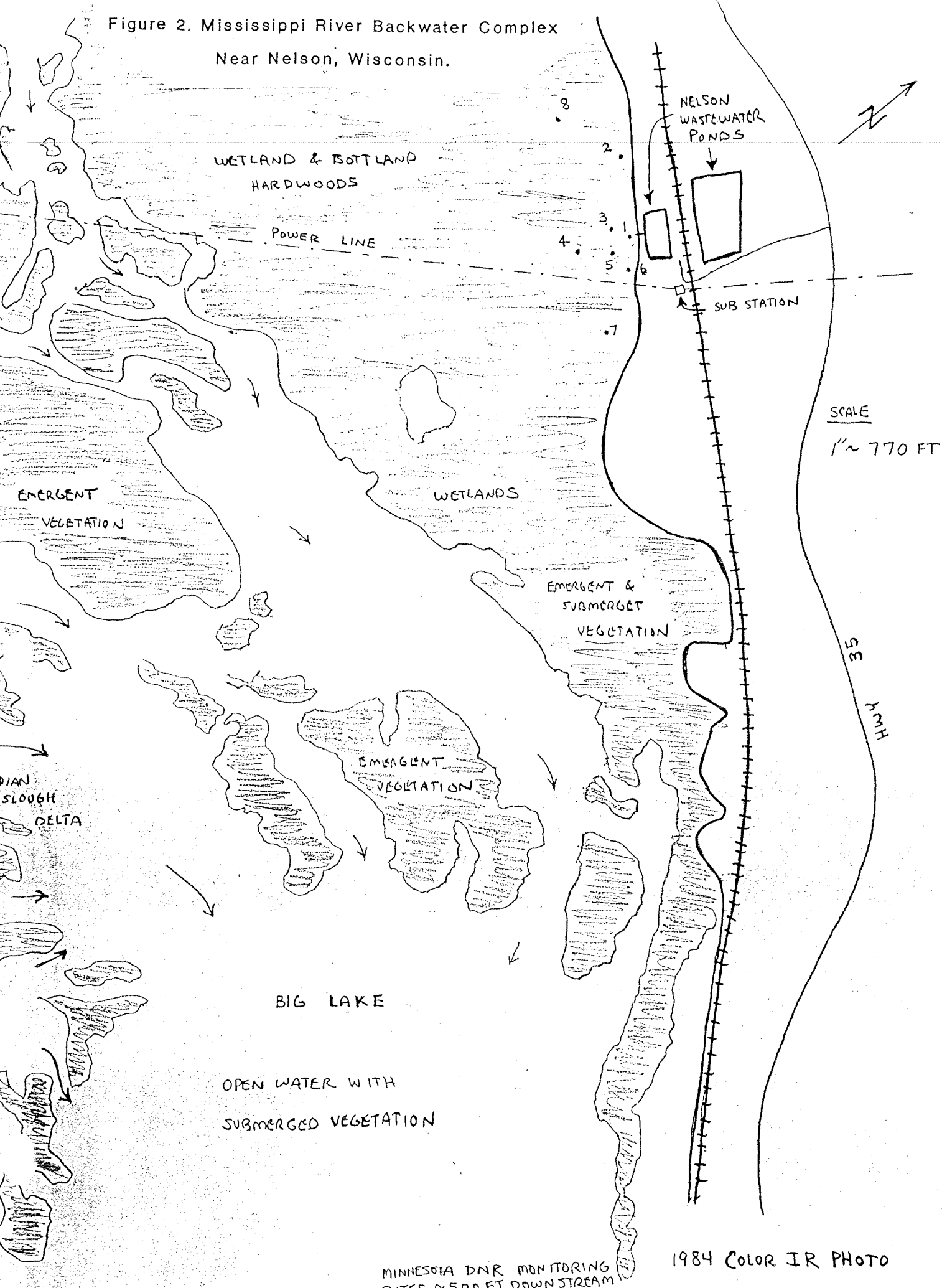
Water current measurements were generally low (<0.05 ft/s) near Nelson's WWTP. An exception was channelized flow that was found about 1600 ft southwest of the facility. The current velocity in this channel was 0.3 ft/s and likely represents a portion of the Chippewa River which passed through the first bridge located about 1500 ft west of Nelson on Hyw 25. Substantially lower velocities would be expected in this channel during more normal pool elevations. In addition, ice cover and summer vegetation would further restrict water movement. The expected low flows in this channel would not warrant secondary wastewater limits should the facility desire to relocate their effluent pipe to this channel.
Water quality data is also available for Big Lake from the Minnesota DNR. A summary of weekly measurements collected during recent summer and winter conditions is provided in Table 6. This lake receives substantial inflows from the Mississippi River via Indian Slough (about 750 cfs when Mississippi River discharge is 15,000 cfs), (COE data). As a result, serious DO depletion

problems have not been found in Big Lake during low flow periods. Water current dropped off noticeably during the winter which is likely due to reduced inflows from Indian Slough and the influence of ice cover. It is anticipated that future water velocities will be reduced in Big Lake due to the construction of a partial closing structure (30-50 % flow reduction) that will be installed at the upper end of Indian Slough in 1991 (Environmental Management Program Habitat Project). Conceivably, the reduced flows may make the upper end of Big Lake more susceptible to influences from Nelson's WWTP. However, based on the existing discharge location and relatively low flow (0.05 cfs), these impacts are expected to be minimal.

Future Work

A summer water quality survey is planned for July or August to define the spatial extent of water quality impacts during typical summer stage levels. The survey will likely consist of a effluent dye tracing, diurnal DO/temperature studies, and routine field and lab water chemistry measurements (conductance, pH, BOD5, nitrogen and phosphorus series). A summary report describing all monitoring activities would be completed later this fall.

Figure 2. Mississippi River Backwater Complex
Near Nelson, Wisconsin.



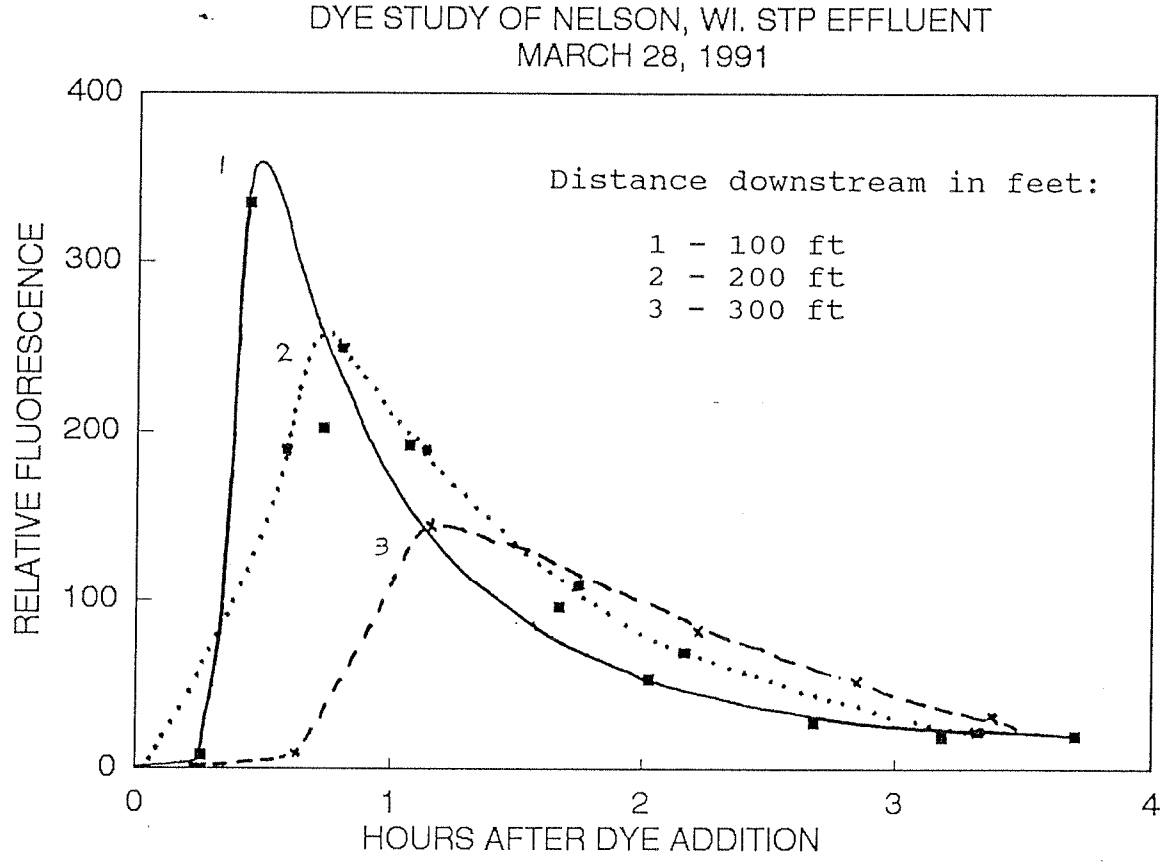


Figure 3. Results of effluent dye tracing at Nelson's Municipal Wastewater Treatment Plant in the backwater area of Pool 4, Mississippi River on March 28, 1991. 250 ml of Rhodamine WT dye added to effluent at 11:50. Samples represent surface grab samples collect 5 to 8 ft from the shoreline.

TABLE 1 - WATER QUALITY DATA COLLECTED IN THE MISSISSIPPI RIVER BACKWATER NEAR THE MUNICIPAL WASTEWATER TREATMENT FACILITY AT NELSON, WISCONSIN ON FEBRUARY 15, 1991.

DATE	TIME	SITE	SNOW DEPTH cm	ICE DEPTH cm	MAX DEPTH m	CURRENT VEL ft/s	CURRENT DIRECT (FROM)	DEPTH m	TEMP C	DO mg/l	COND @25 C uS/cm	COMMENTS
2-15-91	1020	1	8	34	0.6			TOP	0.0	4.1	570	BP. 744 AT 1000, 745 AT 1400. 50 FT WEST OF OUTFALL
	1040	2	8	8	0.3			TOP	1.0	6.4	440	20 FT FROM SHORE, 200 FT ABOVE OUTFALL GROUNDWATER INFLOW ALONG SHORELINE
	1050	3	8	38	0.6			TOP	0.0	0.8	475	FAR SLOUGH, MID POINT
	1115	4	8	0	0.3			TOP	1.0	1.0	590	400 FT SOUTH OF OUTFALL, GOOD CURRENT SEPTIC ODOR
	1130	5	8	20	0.4			TOP	0.5	2.4	590	200 FT SOUTH OF OUTFALL, SEPTIC ODOR
	1145	6	8	33	0.4			TOP	0.0	1.3	530	400 FT BELOW OUTFALL NEAR SHORE
	1210	7	8	13	0.2			TOP	1.2	2.2	530	SW OF POWER STATION
	1230	8									475	SEVERAL HUNDRED FT WEST OF OUTFALL BROKE THROUGH ICE WITH SLED
	1300	OUTFALL							3.0	1.2	1800	NELSON STP OUTFALL AT MANHOLE

ADDITIONAL NOTES: GOUNDWATER SEEPAGE COMMON ALONG SHORELINE. A BEAVER DAM WAS PRESENT IN AREA IMMEDIATELY ADJACENT TO SECOND WASTEWATER POND WHICH WAS INFLUENCING WATER LEVEL AND DRAINAGE PATTERNS IN THIS AREA. EFFLUENT APPEARED TO BE MOVING IN A A SW DIRECTION TOWARDS SITE 4 BASED ON DYE TRACING, ODOR, AND CONDUCTIVITY MEASUREMENTS.

Table 2. Stage duration table for the U.S. Corps of Engineers gauge in the Mississippi River at Wabasha, Minnesota. Data represent years 1972 to 1989. The datum is based on the 1912 adjustments.

PERCENT OF TIME AT OR ABOVE INDICATED ELEVATION

ELEV(FT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ALL YEAR
672.00			2.9	9.8	6.6	1.3			1.3	0.9			1.9
671.90			2.9	11.1	6.8	1.9	0.2		1.3	0.9			2.1
671.80			3.2	13.0	7.5	2.2	0.4	0.2	1.3	1.1			2.4
671.70			3.4	14.6	7.9	2.4	0.4	0.2	1.3	1.1			2.6
671.60			3.9	16.7	8.6	2.6	0.4	0.4	1.3	1.1			2.9
671.50			4.3	19.6	9.1	2.6	0.7	0.4	1.3	1.3			3.3
671.40			5.0	21.3	9.9	2.6	0.9	0.4	1.3	1.6			3.6
671.30			5.4	23.5	10.8	2.8	1.3	0.5	1.3	2.2			4.0
671.20			5.7	24.4	10.9	3.1	1.3	0.5	1.5	2.3			4.2
671.10			6.1	25.9	13.6	3.3	1.3	0.5	1.5	2.9			4.6
671.00			6.6	28.1	15.2	3.5	1.4	0.5	1.5	2.9			5.0
670.90			7.0	29.4	15.9	3.5	1.6	0.7	1.5	3.6			5.3
670.80			7.7	30.4	17.2	3.7	1.8	0.7	1.5	3.9			5.6
670.70			8.4	33.0	18.6	3.7	2.0	0.7	1.5	4.5			6.0
670.60			8.4	34.1	19.9	4.3	2.9	0.7	1.5	5.0			6.4
670.50			9.0	35.2	21.3	4.3	3.6	0.9	1.7	5.7			6.8
670.40			9.7	37.0	23.3	4.4	3.8	0.9	1.7	5.9			7.2
670.30			10.0	38.5	24.4	4.6	4.5	0.9	1.7	6.3			7.6
670.20			10.6	39.8	26.3	5.2	5.6	1.1	1.7	6.5			8.1
670.10			10.6	41.7	28.5	6.1	7.0	1.1	1.7	6.8			8.6
670.00			10.6	43.0	29.9	6.9	7.7	1.1	1.7	7.2			9.0
669.90	0.2		11.3	45.2	32.3	7.2	9.0	1.3	1.7	7.7	0.2	0.2	9.7
669.80	0.7		12.0	48.0	34.4	7.6	10.0	1.3	1.9	8.4	0.2	0.4	10.4
669.70	0.9		12.2	49.6	35.7	9.3	12.0	1.4	1.9	9.1	0.7	0.5	11.2
669.60	0.9		12.7	51.9	38.4	9.6	13.1	1.4	1.9	9.7	0.7	0.7	11.8
669.50	1.3	0.4	13.3	53.7	40.7	11.1	14.3	1.4	2.2	10.2	0.9	0.9	12.6
669.40	1.3	0.8	14.0	55.7	41.4	13.7	15.6	1.6	3.3	10.8	1.7	1.1	13.5
669.30	1.3	0.8	14.5	58.3	43.9	16.5	17.7	2.0	4.3	12.2	2.2	1.3	14.6
669.20	1.3	1.2	15.2	59.1	45.2	18.1	19.0	2.7	4.6	13.1	3.0	1.8	15.4
669.10	1.3	1.2	16.1	60.9	47.1	19.8	20.6	3.2	5.0	14.9	3.9	2.3	16.4
669.00	1.3	1.4	16.8	63.0	48.7	21.1	22.9	4.5	5.9	15.2	4.8	2.7	17.4
668.90	1.4	1.6	17.9	64.3	49.8	23.1	24.6	6.5	6.7	16.3	5.6	3.2	18.5
668.80	1.6	1.6	18.6	65.7	51.4	25.6	25.6	7.3	7.6	17.0	7.0	3.6	19.5
668.70	2.0	1.6	19.5	66.9	53.0	28.3	27.8	9.0	8.3	17.9	8.5	4.5	20.7
668.60	2.3	1.6	21.1	69.3	54.7	32.0	28.7	10.4	9.6	18.6	10.4	6.0	22.1
668.50	2.5	1.6	22.4	71.3	56.5	34.8	29.2	10.9	11.7	19.2	12.8	7.8	23.5
668.40	2.7	1.8	23.8	72.0	58.1	39.6	30.6	11.8	13.5	20.3	14.1	8.5	24.8
668.30	3.8	1.8	25.8	73.9	60.6	43.5	31.4	12.4	15.4	21.3	15.9	12.3	26.6
668.20	4.1	1.8	26.5	76.1	61.3	48.3	32.4	12.4	18.1	23.5	17.0	14.1	28.0
668.10	4.8	2.0	28.0	78.1	63.3	53.3	33.5	13.1	21.9	25.6	18.9	16.8	30.0
668.00	5.0	2.4	30.3	79.3	64.2	55.9	34.4	13.6	24.3	28.7	23.1	21.1	31.9
667.90	5.6	2.8	31.4	80.4	65.6	58.5	35.1	14.7	27.2	29.7	26.3	25.6	33.6
667.80	6.3	3.1	33.0	81.3	66.5	61.7	37.1	16.3	29.6	31.5	30.0	30.3	35.6
667.70	8.8	3.3	35.1	81.9	67.4	63.1	39.8	18.8	32.2	33.7	34.6	35.9	38.0
667.60	11.3	4.1	38.7	83.9	69.2	64.3	44.1	21.9	35.4	35.5	40.2	41.5	40.9
667.50	17.0	7.1	42.3	86.9	71.0	65.9	50.2	26.9	40.2	39.1	46.5	46.9	45.1
667.40	26.5	12.0	46.8	90.0	73.5	69.1	55.2	33.5	45.2	42.8	51.3	53.2	50.1
667.30	39.6	23.2	53.0	93.3	76.3	73.5	61.5	43.0	52.4	48.7	58.5	58.7	56.9
667.20	52.9	38.1	62.7	95.9	80.8	80.9	69.7	56.1	64.3	63.1	69.6	66.2	66.8
667.10	65.9	59.9	74.2	97.2	87.1	88.7	80.1	74.2	79.1	78.1	82.6	76.2	78.7
667.00	77.6	74.7	82.4	98.1	92.8	95.0	89.8	88.7	89.8	91.0	90.9	83.6	87.9
666.90	85.8	87.2	91.0	98.9	97.8	99.1	97.5	96.2	96.7	96.6	96.7	91.5	94.6
666.80	88.5	93.9	97.5	99.6	99.6	100.0	99.3	99.6	99.4	98.9	99.3	95.5	97.6
666.70	90.7	96.3	99.8	100.0	100.0	100.0	99.8	100.0	100.0	100.0	99.8	97.5	98.7
666.60	96.1	97.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.8	99.3
666.50	98.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.2	99.8
666.40	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.1	99.9
666.30	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.5	100.0
666.20	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.6	100.0
666.10	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.6	100.0
666.00	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.8	100.0

TABLE 3. RESULTS OF DYE STUDY COLLECTED ON NELSON'S MUNICIPAL WASTEWATER EFFLUENT ON MARCH 23, 1991. SAMPLES REPRESENT SURFACE WATER COLLECTED 5-8 FT FROM SHORE.

AT OUTFALL		50 FT BELOW OUTFALL		100 FT BELOW OUTFALL		150 FT BELOW OUTFALL		200 FT BELOW OUTFALL		300 FT BELOW OUTFALL	
TIME HRS.	DYE RF	TIME HRS.	DYE RF	TIME HRS.	DYE RF	TIME HRS.	DYE RF	TIME HRS.	DYE RF	TIME HRS.	DYE RF
		0:17	9	0.25	9						
		0.38	145	0.43	336	0.5	303	0.58	190	0.62	10
				0.73	202			0.8	249		
		0.98	171	1.07	192			1.13	190	1.16	146
		1.6	112	1.67	96			1.75	109		
		2.0	96	2.03	53	2.1	82	2.18	70	2.23	81
2.58	13			2.68	28					2.86	52
		3.12	45	3.18	19	3.23	23	3.32	23	3.38	31
		3.6	20	3.7	20	3.78	17				

TIME = HOURS AFTER DYE ADDITION
RF = RELATIVE FLUORESCENCE

DYE IN : 11:50
QUANTITY/TYPE : 250 ML RHODAMINE WT

TABLE 4. WATER QUALITY MONITORING RESULTS OF THE MISSISSIPPI RIVER BACKWATER AREA IMMEDIATELY ADJACENT TO THE NELSON, WI. MUNICIPAL WASTEWATER TREATMENT SYSTEM. SAMPLES COLLECTED ON MARCH 23, 1991.

PARAMETER	SITE LOCATION			
	SAMPLE 001 100 FT ABOVE OUTFALL	SAMPLE 002 AJACENT TO OUTFALL	SAMPLE 003 100 FT BELOW OUTFALL	SAMPLE 004 300 FT BELOW OUTFALL
TIME	1418	1425	1431	1442
NH3-N mg/l	0.22	0.27	0.30	.33
NO2+NO3-N mg/l	0.28	0.28	0.28	.28
TKN mg/l	1.1	1.2	1.2	1.2
TOTAL N mg/l	1.38	1.48	1.48	1.48
pH field su	6.3	6.3	6.3	6.3

NOTE: SURFACE SAMPLES COLLECTED ABOUT 5-8 FT FROM SHORE.

TABLE 5. WATER QUALITY DATA COLLECTED IN A TRANSECT ACROSS POOL 4, NEAR NELSON, WI ON MARCH 23, 1991. DISTANCE MEASUREMENTS ARE APPROXIMATE.

SITE LOCATION	CONDUCTIVITY uS/cm @ 25C	TEMP. C	DEPTH m	VELOCITY ft/s
20 FT FROM NELSON OUTFALL	165	1	0.8	0 - 0.04
50 FT FROM NELSON OUTFALL	145	1	1.2	0
80 FT FROM NELSON OUTFALL	127	2	0.8	0.01
1100 FT FROM NSP SUB STATION	115	2	1.1	0.03 - 0.05
1600 FT FROM NSP SUB STATION	102	2	1.3	0.36
HWY 25 BR #1 (1500 FT FROM NELSON)	110			
HWY 25 BR #2 (3600 FT FROM NELSON)	105			
HWY 25 BR #3 (6700 FT FROM NELSON)	102			
HWY 25 BR #4 (10000 FT FROM NELSON)	104			
W. SIDE OF MISS. R.(13900 FT FROM NELSON)	450			

TABLE 6. AVERAGE WATER QUALITY DATA FOR BIG LAKE, POOL 4 DURING ICE COVER AND SUMMER CONDITIONS. SUMMARY OF WEEKLY DATA COLLECTED BY MINNESOTA DNR AS PART OF OF THE FEDERAL LONG TERM RESOURCE MONITORING PROGRAM.

PERIOD	PARAMETER	SITE: M758.6Y NON-VEGETATED	SITE: M758.6X VEGETATED
ICE COVER 1990-91	DO mg/l	11.9	7.4
	TEMPERATURE C	0.3	0.5
	TURBIDITY NTU	4.7	9.5
	CONDUCTIVITY uS/cm	336	337
	CURRENT VEL. ft/s	0.10	0.07
	DEPTH m	1.5	1.0
JULY-AUGUST 1991	DO mg/l	6.5	5.8
	TEMPERATURE C	23.1	23.5
	TURBIDITY NTU	12	9
	CONDUCTIVITY uS/cm	261	233
	CURRENT VEL. ft/s	0.33	0.23
	DEPTH m	1.5	1.0

Nelson

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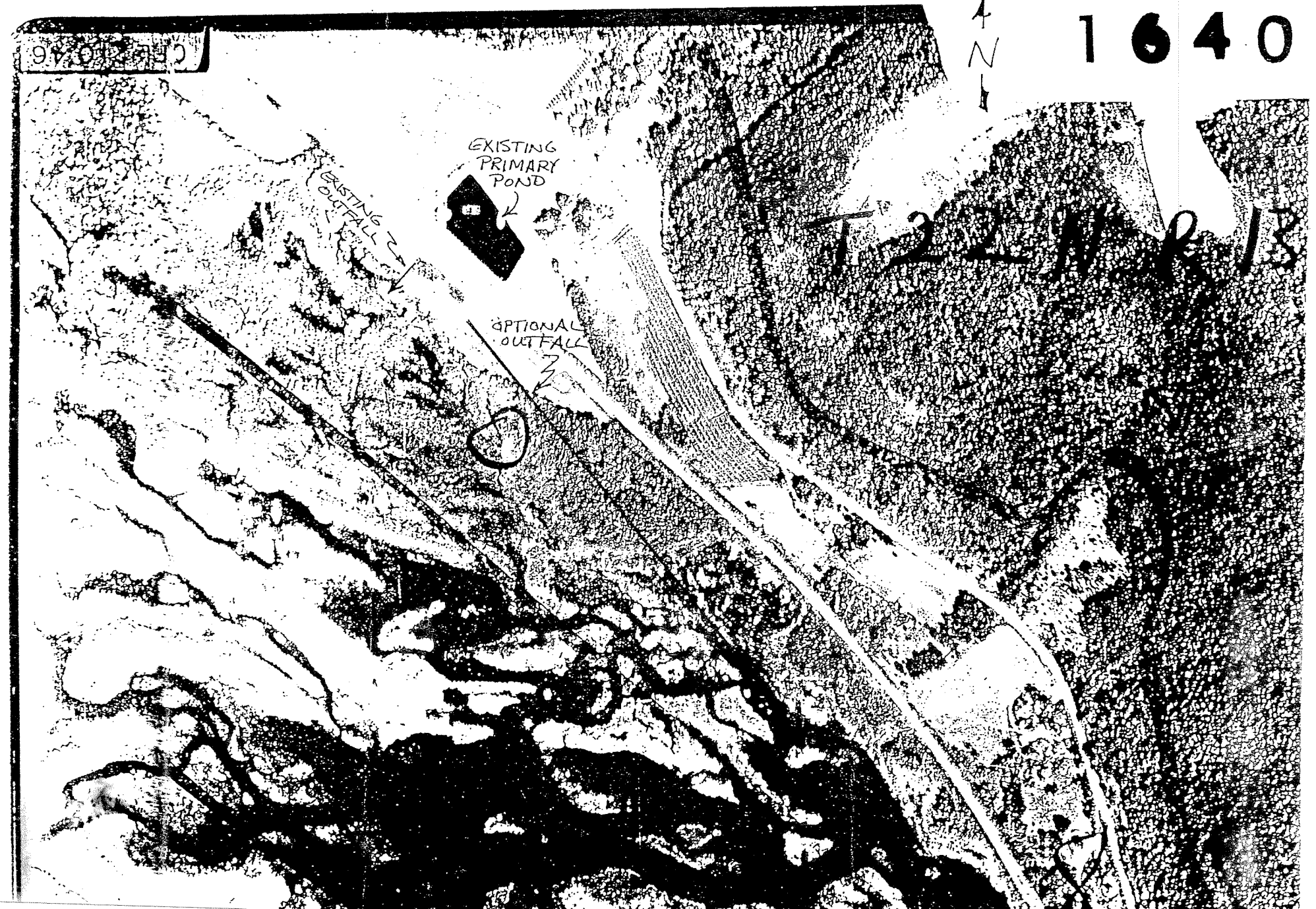

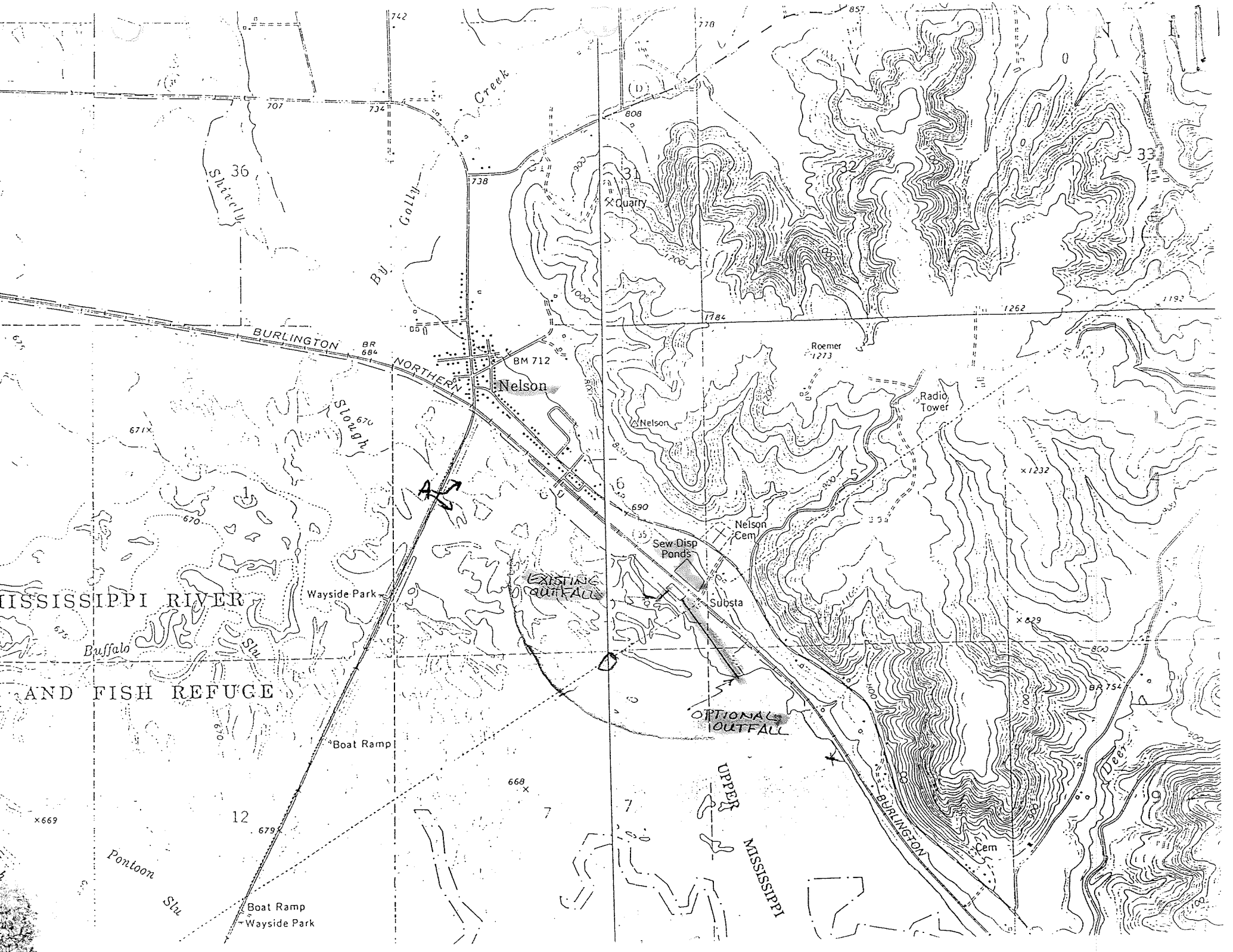
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Creek
Bu. Golly
BURLINGTON NORTHERN
BR 684
BM 712
Nelson
Slough
Quarry
Roemer
Radio Tower
Nelson
Nelson Cem
Sew Disp Ponds
Substa
EXISTING OUTFALL
OPTIONAL OUTFALL
Wayside Park
ISSISSIPPI RIVER
AND FISH REFUGE
Buffalo Slu
Boat Ramp
Pontoon Slu
Boat Ramp
Wayside Park
UPPER MISSISSIPPI
BURLINGTON
Cem
Deer
BR 754
36
31
32
33
1
12
7
9

EVALUATION OF DYE STUDY RESULTS AND PROJECTED IMPACT FROM
NELSON WWTP DISCHARGE TO A WETLAND BACKWATER OF THE MISSISSIPPI RIVER
September 2, 1994
Paul La Liberte

BACKGROUND:

As part of facility planning, the Nelson WWTP is evaluating the option of wastewater storage with discharges of 2-3 weeks duration during spring and fall. To aid in evaluation of this discharge proposal, the Department asked that the facility conduct a dye study at the proposed discharge rate. The purpose of the dye study was to define the area of wastewater influence under conditions of transition between a non-flowing backwater (low stage condition) and a flowing channel (high stage). Two target river stages at Wabasha (668' and 670') were selected by Department staff to represent typical transition conditions expected during the spring and fall.

Previous work at the discharge site has described a 473 acre wetland consisting of about 50% dense emergent vegetation and 50% shallow open water (see large outlined area on attached map). At lower river stages, some of the emergent vegetation beds have exposed, saturated soil. This area is known to experience little unidirectional flow during normal and low river stages. The emergent vegetation minimizes wind-induced wave action. The lack of water movement allows the development of high temperature and low dissolved oxygen, which resulted in a recommended classification of limited aquatic life under these conditions. South of the outlined area on the map, some channels originating at bridges on HWY 25 carry measurable velocity at normal river stage. This water, as well as wind-induced wave action, helps to maintain higher oxygen levels in the backwater areas outside the outlined area. The 473 acre wetland within the outlined area was previously classified as capable of supporting warmwater fish and aquatic life at <u>above normal</u> river stage, when flood waters induce flow through the area. The classification indicated a river stage of 669' for the transition point between classifications.

DYE STUDY RESULTS:

The dye study was conducted by Davy Engineering. Effluent was delivered at a rate of 275 GPM via a centrifugal pump. At a river stage of 671.1', 500 ml of dye was dumped and observed to follow the shore and extend out from the shore approximately 50'. Movement of debris in the water provided evidence of velocity in the area. It was estimated that the track of the plume would take it 500 feet south to where it joined the large open water area called Big Lake. The stage was 3.7' above the annual median stage for the site (667.4').

A second study continually fed dye via a peristaltic pump at a stage of 669.98. The resultant plume was monitored with a fluorometer and mapped. Water samples were analyzed for conductivity, pH and ammonia. The dye was shown to flow through a 2.1 acre shallow bay to a second 4.1 acre bay (see small outlined area on map). While the 14 hr study documented flow through the first bay, it was concluded before dye reached the second bay. The effluent disbursed throughout the first bay before approaching the second bay. The study documented a 3:1 dilution was attained once the effluent had flowed through the 2.1 acre wetland. Using this relationship, it was estimated that an approximate 8.8:1 dilution would be attained once the effluent flowed through both bays.

At a stage of 668.3', the wetland was examined by canoe. It was determined that a physically isolated area with no flowing channels surrounded the outfall site. The isolated area consisted of the two shallow open water bays previously mentioned and covered an estimated 6.2 acres. The only way for effluent to leave the area at this stage was to flow through mats of soil/vegetative matter, which serves as the peripheral barrier. Two areas of lowest elevation were identified around the periphery of the 6.2 acre isolated backwater. These areas would be the first to allow passage of fish at higher

stages. By looking at these low spots, it was estimated that passages large enough for minnows would develop at a stage of around 669'. Outlets for larger fish likely occur around a stage of 669.5'. Since no outlet from the 2 bays near the outfall existed at a stage of 668.3', a dye study was not performed.

STREAM CLASSIFICATION:

The field work done during study indicates that the wetland in the vicinity of the Nelson WWTP outfall becomes hydrologically isolated from the rest of the river at stages below 669'. If the stage remains below this level for a significant length of time, conditions of very low dissolved oxygen would be expected even in the absence of an outfall. Therefore, a classification of limited aquatic life is appropriate for the two bays near the outfall (6.2 acres of open water) at stages below 669'. This classification may also be true of other portions of the 473 acre wetland complex, but this evaluation focused on the area affected by the effluent. At stages of 669' and above, hydrologic connections with the rest of the river would be expected and additional wind-induced wave action might occur. Therefore the classification for the open water portions of the entire area (473 acres) should be warmwater fish and aquatic life at stages of 669' and above.

The time of year also plays a role in the attainable use of the wetland. On 6-2-94, the river had recently dropped to 668.3' and the portion of the wetland receiving the wastewater was cut off from the rest of the river. Fish were still present in the area including a largemouth bass about 15" long. Later in the summer, the area holding the fish becomes inhospitable due to low dissolved oxygen. This also happens under ice in the winter. Fish trapped in the cutoff backwater when the river falls below 669' would not be expected to survive unless the river rose again before the onset of low DO conditions, allowing escape.

STAGE DURATION ANALYSIS:

Stage duration information was obtained from the U.S. Army Corps of Engineers gauge in the Mississippi River at Wabasha, Minnesota (years 1972-1989). This was the same gauge used as a reference during the dye study. The values of particular interest in this study summarized in the following table, expressed in percent of time the river was at or above the stage. The stage duration data indicates that, based on stage alone, the 6.2 acre wetland near the Nelson WWTP would be classified as limited aquatic life 83% of the time on an annual basis and about half the time during April and May.

MISSISSIPPI RIVER STAGE DURATION DATA IN PERCENT					
STAGE	671.1'	670'	669.5'	669'	668.3'
JANUARY			1.3	1.3	3.8
FEBRUARY			.4	1.4	1.8
MARCH	6.1	10.6	13.3	16.8	25.8
APRIL	25.9	43	53.7	63	73.9
MAY	3.3	29.9	40.7	48.7	60.6
JUNE	1.3	6.9	11.1	21.1	43.5
JULY	.5	7.7	14.3	22.9	31.4
AUGUST	1.5	1.1	1.4	4.5	12.4
SEPTEMBER	2.9	1.7	2.2	5.9	15.4
OCTOBER		7.2	10.2	15.2	21.3
NOVEMBER			.9	4.8	15.9
DECEMBER			.9	2.7	12.3
ANNUAL	4.6	9	12.6	17.4	26.6

COMPLIANCE WITH WATER QUALITY STANDARDS:

At stages of 671' and above, the receiving water behaves more like a river than a wetland. While the portion of the $Q_{7,10}$ flow of the Mississippi River flowing through the Nelson discharge area is unknown, it is reasonable to assume it is sufficient to assimilate a discharge of 275 GPM of wastewater which has received secondary treatment. There would be an effluent plume along the shore where water quality standards might not be met, but this is true of all streambank discharges. However, since this stage occurs only 13-26% of the time in the spring and less than 3% of the time in the fall, it provides an insufficient opportunity for discharge.

To determine compliance with water quality criteria for ammonia at a stage of 670', the mean of the temperature (20 C) and pH (8.4 su) data gathered during the dye study was used along with the dilution data. A total ammonia nitrogen value of 0.04 MG/L was documented in an area of the wetland unaffected by the dye. This value was used as the natural background concentration. These data yield a chronic criterion of 0.45 MG/L total ammonia nitrogen. Based on a 2.1 acre area providing a 3:1 dilution ratio, the dilution and mixing zone size for a 275 GPM discharge from Nelson at several effluent ammonia concentrations was estimated. The mixing zone is the area within which the criteria are exceeded. This evaluation assumes that the rest of the wetland provides dilution proportional to the 2.1 acres studied with dye. The estimates appear in the following table. The open water area of the classified wetland is estimated to be 50% of the total, or 236 acres.

To more completely assess the potential for impact to the functional uses of the receiving water, the 1985 EPA one hour average concentration for ammonia was used to define an acute mixing zone. This was not done for regulatory purposes, since it is not Department practice to develop municipal effluent ammonia limits based on acute toxicity. Using the pH and temperature values mentioned above, an acute criterion of 2.8 mg/l total ammonia was indicated. The same dilution characteristics described above were applied and the results also appear in the following table.

ESTIMATES OF NECESSARY DILUTION AND MIXING ZONE SIZE

EFFLUENT TOTAL AMMONIA (MG/L)	NECESSARY DILUTION	MIXING ZONE	
		SIZE IN ACRES	% OF AVAILABLE OPEN WATER
EPA ONE HOUR CONCENTRATION (2.8 MG/L TOTAL AMMONIA NITROGEN)			
4.4	1.6:1	1.1	.5
10	2.7:1	1.9	.8
20	6:1	3.8	1.6
30	10:1	5.7	2.4
40	13:1	7.6	3.2
WI CHRONIC CRITERION (0.45 MG/L TOTAL AMMONIA NITROGEN)			
4.4	10:1	7	3
10	24:1	15	7
20	48:1	30	14
30	72:1	45	22
40	96:1	60	28

At an effluent total ammonia concentration of 10 MG/L, the acute mixing zone would encompass the first bay. At effluent concentrations of 20 and 30 MG/L, the acute mixing zone would extend into the second bay. At an effluent concentration of 40 MG/L, the acute mixing zone would extend beyond the second bay. The chronic mixing zone would extend beyond the second bay at all effluent ammonia concentrations examined (more than 6.2 acres needed to dilute to meet the chronic criterion). Using this analysis at stage 670', around a quarter of the open water area in the 473 acre wetland would be above the chronic ammonia criterion at effluent concentrations of 30-40 MG/L .

EFFLUENT LIMIT RECOMMENDATIONS:

Discharge at rates up to 275 gpm can occur from the Nelson WWTP under the following conditions:

1. **When the river stage is below 669' at Wabasha and effluent limits conform to a classification of limited aquatic life.** At stages of 669' and lower the wetland receiving water would become isolated from the rest of the river and have poor water quality even in the absence of an effluent.

2. **When the river stage is above 671' at Wabasha and effluent limits conform to a secondary level of treatment.** This is in recognition that at this high stage, most of the riparian floodway contains flowing water and the discharge would receive adequate dilution. A substantial effort would be necessary to determine the fraction of the total river flow which is available for mixing with the Nelson effluent at this stage. The availability of adequate river flow is evident enough at this flood stage that determining the proportion available for mixing near Nelson so that detailed limits calculations can be made is not appropriate. Since this stage is present less than 5% of the time, it does not present a viable discharge option anyway.

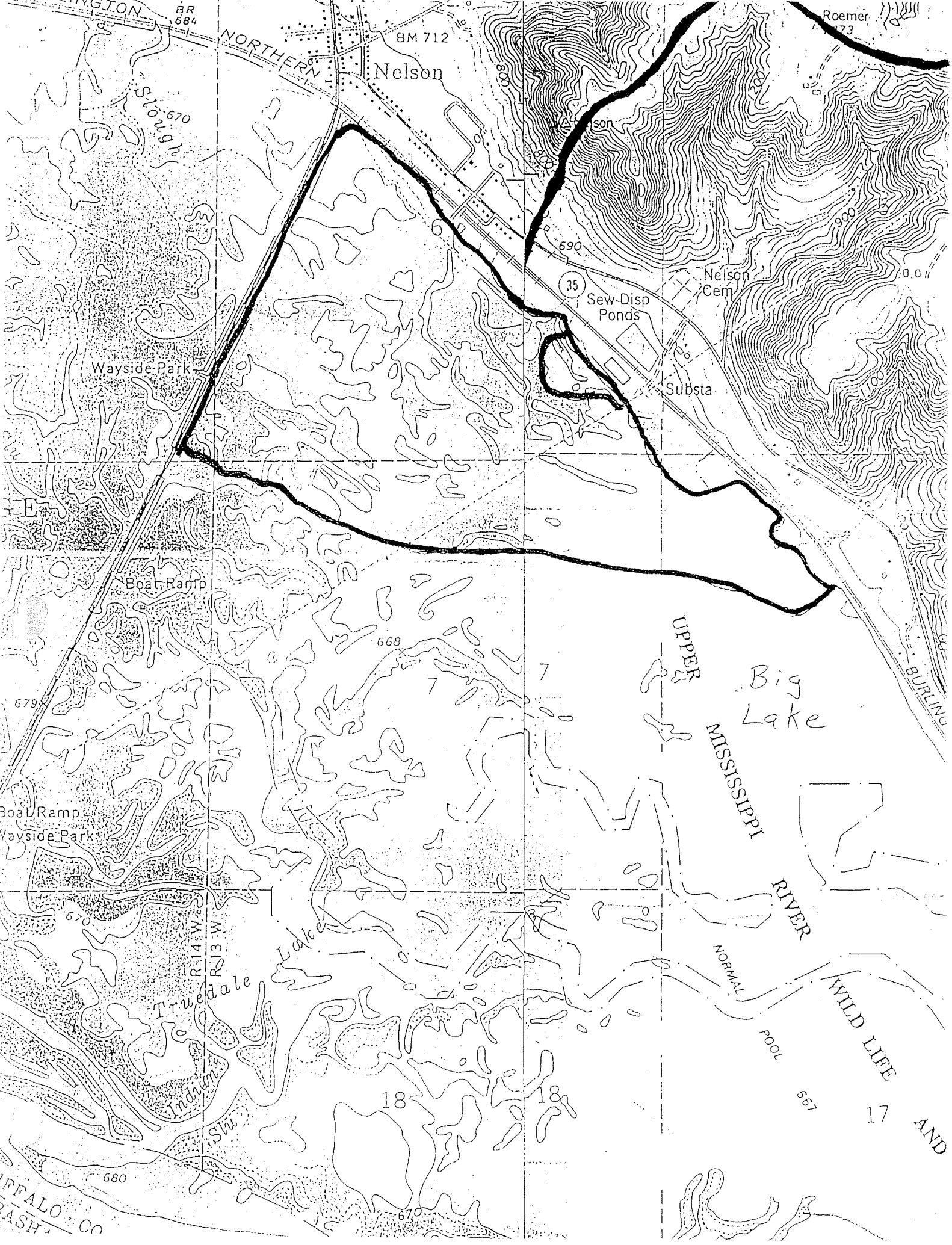
3. **When the river stage is between 668.9' and 671' at Wabasha and effluent limits conform to a classification of limited aquatic life and include a total ammonia nitrogen limit of 4.4 mg/L.** The ammonia limit recognizes the use of the area by warmwater fish at this stage and is based on a 10:1 dilution ratio reflective of discharge to an open water body without unidirectional flow. In this situation, the mixing zone for chronic toxicity is estimated to encompass the entire 6.2 acre open water wetland near the outfall (3% of the available open water in the complex). The final acute value mixing zone is estimated at 1.1 acres in size.

NR103 CONSIDERATIONS:

The Nelson WWTP discharge has existed at the site for many years. The wetland receiving water has no doubt been somewhat modified by the presence of the discharge. The current facility planning options include 1) Increasing the discharge rate and making it seasonal (as described above) and 2) discharge to groundwater on an upland site near the wetland. Since the existing situation and both alternatives have potential to influence the wetland, the project is considered "wetland dependant".

The groundwater alternative would result in changing the discharge from a continuous, direct discharge to the wetland to a continuous discharge into the groundwater. The effluent would be expected to mix with some groundwater and then emerge into the wetland along the shore. This should result in less hydrologic impact on the wetland due to a more diffuse introduction of wastewater. It should also provide additional removal of pollutants such as phosphorus as the effluent flows through the soil. This alternative has less potential to adversely affect the wetland than either the current condition or the proposed storage/discharge proposal.

The storage of wastewater with higher rate discharges during some weeks has potential to adversely affect the function values of the wetland. The effluent limit recommendations listed above are professional estimates of the level of treatment needed to minimize upsetting wetland function based on current regulatory practice. Because they are estimates, some additional impact to wetland function may still occur even if they are met. For this reason, seasonal storage and discharge to the wetland in conformance with the above limitations cannot be allowed under NR103 if the groundwater disposal option is found to be a "practicable alternative" as defined in NR103.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BM 712
Nelson
Roemer
Slough
670
690
800
900
1000
Nelson Cem
35
Sew-Disp Ponds
Substa
Wayside Park
Boat Ramp
668
679
7
UPPER
Big Lake
MISSISSIPPI
RIVER
NORMAL
POOL
WILD LIFE
AND
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BURLING