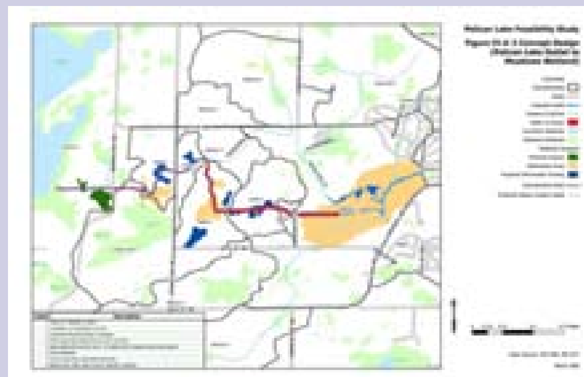
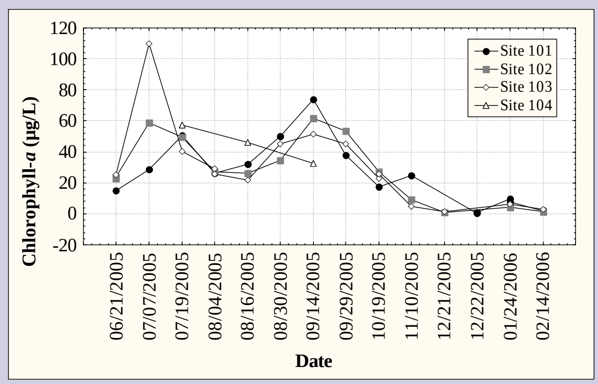
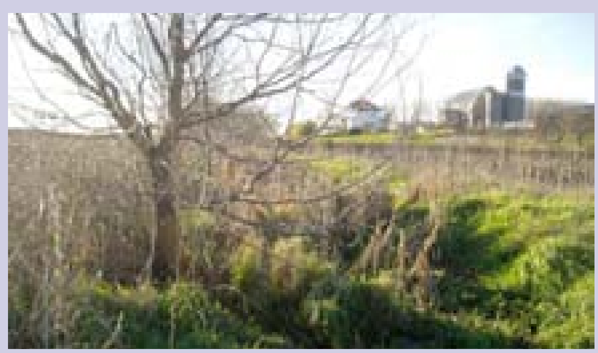
Pelican Lake Outlet Feasibility Study

Ducks Unlimited, Inc.

April 2006







EMMONS & OLIVIER RESOURCES

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Acknowledgements

This project was a cooperative effort between Ducks Unlimited, Inc. and the Minnesota Department of Natural Resources Division of Wildlife, with oversight provided by the Pelican Lake Work Group.

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Report Summary

Pelican Lake is a 4000-acre DNR-designated shallow lake located in Wright County, Minnesota. Since the early 1970s, Pelican Lake levels have generally been rising with record lake levels persisting from 2001 to the present. High lake levels have resulted in poor water quality, loss of important wildlife habitat, and localized flooding.

The Pelican Lake Outlet Feasibility Report incorporates the results and conclusions of a year-long study by Emmons & Olivier Resources, Inc. commissioned by Ducks Unlimited, Inc. and the Minnesota Department of Natural Resources, Division of Wildlife. The study objectives were to determine the role of groundwater-surface water interaction as related to high water levels on Pelican Lake, evaluate lake outlet alternatives, evaluate potential environmental impacts of the lake outlet, and develop a conceptual design and cost estimate for a preferred outlet alternative.

The following summarizes the key elements of this feasibility report:

Water Quality
In-lake water quality sampling was completed during 2005 and 2006 with prior sampling (2003) incorporated into the water quality analysis. Water quality sampling was completed to provide a more clear understanding of what factors are responsible for the decline in wildlife habitat in Pelican Lake. Water quality sampling was also completed to better understand the potential downstream impacts to Regal Creek and the Crow River, both of which are on the MPCA impaired waters list. Pelican Lake was found to be hypereutrophic with elevated concentrations of phosphorus and high turbidity (low transparency). Based on a limited number of winter sample events, water quality improves during the ice-on winter months.

Groundwater-Surface Water Interaction
Understanding the role of groundwater-surface water interaction as it relates to Pelican Lake water surface elevations is critical to understanding how lake levels can most effectively be managed. Groundwater monitoring was completed during 2005 with a system of shallow and deep wells around the shores of Pelican Lake. In all cases, groundwater elevations were found to be lower than Pelican Lake, indicating that Pelican Lake discharges into the groundwater. The groundwater outflow from Pelican Lake was computed based on soil hydraulic conductivities, hydraulic gradients, and the aerial extent of the shoreline fringe. Groundwater flow rates from Pelican Lake are estimated to be 1-6 cfs.

Pelican Lake Water Budget
Pelican Lake hydrology is driven by inputs (rainfall, surface runoff) and outputs (groundwater outflow, evapotranspiration, surface outflow). The Pelican Lake water budget suggests that high water conditions are being caused by a combination of persistently wet years, low permeability soils that limit outflow to groundwater, high watershed runoff due to clay soils, and a high percentage of impervious area (lake surface) that increases in size as conditions get wetter and the lake surface larger. The negative feedback created by this set

of conditions also results in the lake continuing to stay high for several years, even as annual precipitation returns to normal.

Alternatives Analysis

A three-year drawdown plan was developed to evaluate outlet options using a 5 cfs discharge rate during the summer months and a 12 cfs discharge rate during the winter months. The winter discharge rate was later increased to 21 cfs to ensure that the lake would be drawn down, even if wet conditions persisted. Using these discharge rates, a north alignment, through the City of Monticello and to the Mississippi River, and an east alignment, through the City of St. Michael and to the Crow River, were evaluated. An analysis of social-economic-environmental impacts and considerations was presented to the project Technical Work Group. The Technical Work Group deemed the east alignment, through the City of St. Michael, as the most feasible outlet and requested Emmons & Olivier Resources, Inc. to further study this alignment.

Conceptual Design of Preferred Outlet Alternative

The east alignment extends from the east shore of Pelican Lake a distance of 23,850 feet (about 4.5 miles) though the City of St. Michael to Regal Creek. An outlet weir would be constructed to maintain the lake elevation at 950.7 feet. A lift station with a 24-inch force-main pipe extended 900 feet into Pelican Lake would be constructed to facilitate temporary management drawdowns to an elevation of 944.0 feet. Most of the outlet channel would be designed as a meandering waterway with a natural stream channel and flood-prone fringe of wetland. Depending on land cost and land owner reception to project, several deep cuts could be substituted for pipes to limit the footprint of the outlet system. The lower-most section of the waterway would encompass the Meadows Wetland Restoration, a 180-acre wetland area that outfalls to Regal Creek. The waterway would include additional wetland restoration, stormwater ponding (to serve future development), and a fish barrier. The Meadows Wetland restoration, as described in this report, would largely mitigate environmental impacts of the project, while serving as a valuable open space amenity to the City of St. Michael.

Environmental Impacts

An Environmental Assessment Worksheet prepared for the Pelican Lake Outlet Project describes the potential environmental impacts in detail. The feasibility report includes a summary that outlines key environmental issues and recommends mitigation strategies. The primary environmental issues are changes to Pelican Lake plant communities and wildlife habitat, water quality impacts to Regal Creek and the Crow River, Pelican Lake fringe wetland impacts, downstream flooding near the Meadows Wetland, and erosion and channel scour within Regal Creek.

Project Cost Estimate

The total estimated project cost is 2.1 million dollars.

I. Introduction

A. History and Background

Pelican Lake is a 4,000-acre DNR-designated wildlife lake located in Wright County, Minnesota (Figure I.A-1). Once one of Minnesota's premier shallow lakes recognized for waterfowl production and hunting opportunities, Pelican Lake has experienced a decline in water quality and a loss in the extent and quality of plant communities that once supported important wildlife habitat. High water levels are believed to be the primary cause of this decline. High water levels have resulted in persistent and increased populations of rough fish, increased turbidity, and a shift from macrophytes to plankton-dominated plant communities within Pelican Lake. Collectively these and other factors have resulted in Pelican Lake changing from a "clear water state" to a "turbid state." This change has had profound, negative impacts on lake productivity for the waterfowl and shorebirds that historically used Pelican Lake as a migration stop over destination. The loss of important food sources associated with diverse macrophyte and invertebrate communities is believed to be the primary factor responsible for this decline. Sustained high water levels have also generated complaints from local communities, residents, and sportsmen requesting that lake levels be returned to pre-1980 elevations.

In early summer of 2005, the Pelican Lake Feasibility Study was initiated by Ducks Unlimited, Inc. in partnership with MN DNR, Division of Wildlife. The focus of the feasibility study was to evaluate probable causes of high water conditions, to evaluate alternatives for returning lake levels to pre-1980 levels, and to identify key environmental issues.

B. Project Goals

The over-arching goal of the Pelican Lake Restoration Project is to restore Pelican Lake as a premier waterfowl lake. The beneficiaries of this project are:

- The state of Minnesota and the surrounding community, in that the water quality improvements expected from this project will create a higher quality natural amenity than what exists now.
- Wildlife: Pelican Lake is one of the larger shallow lakes in this region, and, in its restored state, will provide improved habitat for resident and migratory waterfowl, shorebirds and other wildlife.
- Direct users of the lake: birders, sportsmen.
- Indirect users of the lake: birders and sportsmen further away, as the survival of wildlife will be improved.
- Townships and cities impacted by flooding will benefit from lower lake water levels.

The key objectives of the Pelican Lake Restoration Project are:

- Establish the normal water level (NWL) of Pelican Lake to an elevation of 950.7 feet.

- Provide for temporary drawdown to an elevation of 944.0 feet for lake management purposes.
- Through water level manipulation and rough fish elimination, shift existing plankton communities back to a macrophyte-dominated mosaic of submerged, floating leaf, and emergent plant communities.
- Reduce in-lake phosphorus concentrations to within normal range for ecoregion and lake class.

C. PUBLIC INVOLVEMENT

In the early stages of the project, the Pelican Lake Work Group was formed to provide guidance and input on Pelican Lake restoration efforts. The work group includes a broad cross section of local landowners, federal, state and local governmental officials, and representatives of townships, cities, Wright County, and the Crow River Organization of Water. The work group has met periodically to review results of this feasibility study and guide key elements of the project. Appendix A lists members of the Pelican Lake Work Group and includes meeting minutes and other public participation documents.

II. Pelican Lake Water Quality

Before the Pelican Lake Outlet Feasibility Study began, monitoring data were collected monthly during the summer of 2003.

In 2005 and 2006, in-lake water quality sampling was completed for the Pelican Lake Outlet Feasibility Study to establish the current water quality condition of the lake and to provide the basis for an analysis of downstream water quality impacts of a lake outlet. Data were collected bimonthly from June through September of 2005, and monthly from October 2005 through February 2006. This summer, fall, and winter sampling schedule was directed towards the downstream impacts analysis of a lake drawdown occurring throughout the year.

A. SAMPLING

There are four in-lake monitoring sites (Figure II.A-1): one in the middle of each basin (sites 101 through 103), and one in a shallow bay on the west side of the lake (site 104). Surface sampling occurred monthly during the growing season in 2003, at sites 101, 102, and 103. Site 104 was established in 2005 and was sampled monthly during the growing season, whereas the remainder of the sites (101 - 103) were sampled bimonthly during the growing season and monthly from October through February. Surface samples were taken with a PVC tube that integrated the sample over 0 to 1 meter depth, and bottom samples were taken approximately 0.5 meters above the lake bottom.

Non-detects were counted as half of the detection level for the purpose of the water quality data summaries.

Raw monitoring data are presented in Appendix B.

B. GROWING SEASON (JUNE THROUGH SEPTEMBER)

Pelican Lake is a hypereutrophic lake with a two-year average TP TSI of 77 and a two-year average chlorophyll-*a* and Secchi depth TSI of 71 (Table II.B-1). On average, total phosphorus (TP) concentrations were higher in 2003 than in 2005 (Figure II.B-1a). TP did not differ substantially among the sites (Figures II.B-1b and c), with site 104 being the exception.

Water quality data were compared to reference lake water quality data for the ecoregion in which Pelican Lake is located, the Central Hardwood Forests ecoregion (Table II.B-2). TP and TN are relatively high in Pelican Lake, with TP being proportionally higher, as evidenced by the low TN:TP. Chlorophyll concentrations are also higher than normal, which is likely the reason that both TSS and turbidity are also higher. More detailed statistics on the water quality parameters are provided in Table II.B-3.

The high chlorophyll-*a*, TSS, and turbidity, along with the low transparency, demonstrate the turbid nature of the water and support the theory that Pelican Lake is currently in a turbid, phytoplankton dominated state. The phosphorus is bound up mostly in phytoplankton, as indicated by the low soluble reactive phosphorus (SRP) concentrations. If the lake were in a clear, macrophyte dominated phase, the phosphorus would be bound up in macrophytes and associated periphyton.

TP concentrations changed throughout the season (Figure II.B-2). In 2003, water quality worsened throughout the growing season (Figures II.B-2a through c). In 2005, water quality at sites 101, 102, and 103 cycled together, with poorer water quality observed in mid-July and mid-September (Figures II.B-2d through f). The water quality at site 104 was independent of the other sites.

Due to its shallow depth and long fetch, the water column is well-mixed (Figure II.B-3). The lake may stratify intermittently, such as at Site 101 on July 7 and August 30 (Figure II.B-3a), but the lake is likely easily mixed by moderate winds. Since the water column is well mixed, there is no consistent difference between TP concentrations in the surface waters compared to the bottom waters (ANOVA, $p = 0.4$; Figure II.B-4).

Table II.B-1. Average growing season (June-Sept) Pelican Lake water quality parameters, by site.

Site	**TP average (mg/L)**		**Chlor-*a* average (µg/L)**		**Secchi average (m)**	
	2003	**2005**	**2003**	**2005**	**2003**	**2005**
101	0.173	0.143	97	40	0.43	0.48
102	0.172	0.123	97	40	0.45	0.51
103	0.159	0.137	82	44	0.43	0.55
104	--	0.172	--	45	--	0.48
average	*0.168*	*0.144*	*92*	*42*	*0.44*	*0.51*
2-year av	*0.156*		*67*		*0.47*	
2-year av TSI	77		71		71	

Table II.B-2. Average growing season (June-Sept) Pelican Lake water quality parameters, Sites 101 through 103.

Parameter	Mean	CHF* Interquartile Range for Reference Lakes†
TP (mg/L)	0.127	0.023 - 0.050
SRP (mg/L)	0.004	
TDP (mg/L)	0.026	
$NO_2^-/N0_3^-$-N (mg/L)	0.02	<0.01
$NH_3 + NH_4^+$-N (mg/L)	0.64	
TKN (mg/L)	2.92	<0.60 - 1.2
TN	2.94	
TN:TP	4	25 - 35
Turbidity (NTU)	19	<2
TSS (mg/L)	29	<1 - 2
BOD5 (mg/L)	3.6	
E.Coli (MPN/100mL)	32	
Chlor-*a* (µg/L)	38	5 - 22
Secchi (m)	0.5	1.5 - 3.2
pH	8.3	8.6 - 8.8
Conductivity	203	300 - 400

*CHF = Central Hardwood Forests ecoregion
†Data from MPCA 2005.

Table II.B-3. Average growing season mean (June-Sept) Pelican Lake water quality parameters, Sites 101 through 103.

Parameter	Valid N	Mean	Std.Dev.	Minimum	Lower Quartile	Median	Upper Quartile	Maximum
TP (mg/L)	24	0.127	0.030	0.086	0.102	0.122	0.154	0.191
SRP (mg/L)	24	0.004	0.003	0.002	0.002	0.003	0.004	0.013
TDP (mg/L)	9	0.026	0.005	0.019	0.021	0.027	0.028	0.032
$NO_2^-/N0_3^-$-N (mg/L)	20	0.02	0.00	0.02	0.02	0.02	0.02	0.02
$NH_3 + NH_4^+$-N (mg/L)	6	0.64	0.08	0.54	0.56	0.65	0.71	0.73
TKN (mg/L)	24	2.92	0.49	1.90	2.66	2.83	3.30	4.00
TN	20	2.94	0.53	1.92	2.58	2.85	3.39	4.02
TN:TP	24	4	17	21	23	27	30	24
Turbidity (NTU)	24	19	3	12	17	18	20	25
TSS (mg/L)	24	29	8	15	24	30	36	42
CBOD5 (mg/L)	24	3.6	0.9	1.7	3.1	3.6	3.9	5.6
E.Coli (MPN/100mL)	24	32	78	1	5	9	19	365
Chlor A (µg/L)	24	38	15	15	26	36	50	74
Secchi (m)	22	0.5	0.2	0.3	0.4	0.5	0.6	0.9
pH	24	8.3	0.3	7.6	8.2	8.4	8.5	8.8
Conductivity (µmhos/cm)	102	203	11	180	198	205	212	228

C. FALL AND WINTER (OCTOBER THROUGH FEBRUARY)

In-lake TP and chlorophyll concentrations dropped dramatically during the winter (Figure II.C-1a and c). Although TP concentrations dropped, soluble reactive phosphorus (SRP) concentrations increased slightly (Figure II.C-1b). SRP is composed of mostly dissolved inorganic phosphorus, and likely increased due to lower rates of primary production in the winter that are limited by temperature and/or light as opposed to by nutrients.

These lower nutrient concentrations during the fall and winter months indicate that a lake level drawdown that occurs mostly during fall and winter months will have less of an impact to downstream water quality conditions than a drawdown that would occur mostly during the summer months.

Statistics from the other monitored water quality parameters are presented in Table II.C-1. Winter nitrate concentrations remained well below 1 mg/L; winter nitrate concentration has shown to be inversely correlated with plant species richness, and lakes in which the winter nitrate concentration is below 1 to 2 mg/L have a better chance of supporting a healthy macrophyte community (James et al. 2005).

Table II.C-1. Average winter (Oct-Feb) Pelican Lake water quality parameters, Sites 101 through 103.

Parameter	Valid N	Mean	Std.Dev.	Minimum	Lower Quartile	Median	Upper Quartile	Maximum
TP (mg/L)	21	0.077	0.027	0.041	0.052	0.076	0.102	0.127
SRP (mg/L)	21	0.007	0.005	0.002	0.003	0.005	0.009	0.018
$NO_2^-/N0_3^-$-N (mg/L)	15	0.14	0.08	0.02	0.06	0.15	0.20	0.25
TKN (mg/L)	15	2.60	0.26	2.19	2.35	2.68	2.79	3.01
TN	15	2.74	0.28	2.31	2.51	2.70	3.04	3.13
TN:TP	21	24	4	17	21	24	27	30
Turbidity (NTU)	15	6.7	3.5	3.8	4.0	4.6	11.2	12.6
TSS (mg/L)	15	7.5	8.5	0.5	0.5	2.8	16.5	24.4
E.Coli (MPN/100mL)	15	7	16	1	1	1	5	61
Chlor-*a* (µg/L)	15	9	9	0	1	5	17	27
Secchi (m)	5	0.7	0.1	0.6	0.6	0.7	0.7	0.9
pH	15	7.2	0.4	6.5	7.0	7.2	7.6	7.7
Conductivity (µmhos/cm)	102	203	11	180	198	205	212	228

Dissolved oxygen (DO) remained relatively high throughout the water column through December (Figure II.C-2). During the December through February sampling events, the water surface was frozen, and a hole was drilled in the ice through which to take the water samples and measure the oxygen, temperature, and conductivity. In January lower DO concentrations were observed at the bottom of the lake, but the upper portion of the water column remained well-oxygenated. Air temperatures during the month of January were above average, and snow cover less than average. These conditions made it less likely that DO would reach very low concentrations during this winter.

D. Conclusions

1) Pelican Lake is currently in a turbid, phytoplankton-dominated phase, as evidenced by the high chlorophyll-*a*, TSS, and turbidity, along with the low transparency.

2) Lower nutrient concentrations during the fall and winter months indicate that a lake level drawdown that occurs mostly during fall and winter months will have less of an impact to downstream water quality conditions than a drawdown that would occur mostly during the summer months.

III. Pelican Lake Hydrology

A focus of the Pelican Lake Outlet Feasibility Study was to investigate the groundwater-surface water interactions in the Pelican Lake watershed, with the ultimate goal of providing recommendations to address the lake's high water levels. A groundwater investigation was initiated to determine if groundwater is a factor in the rising lake level. A water budget of the lake was also completed to guide the development of water level management recommendations.

A. Watershed Characteristics

The Pelican Lake watershed encompasses a land area of 11,700 acres. This watershed drains exclusively to Pelican Lake and, with few exceptions, is fully landlocked. At an elevation of 955.0 feet, Pelican Lake may outlet via a small drain tile (intended to flow into the lake) into County Ditch 21 near the outlet of School Lake. It is not known if this drain tile is functional under present conditions. The center of the watershed is dominated by Pelican Lake, which encompasses an area of 3000 to 4000 acres, depending on lake elevations. For example, when water levels are at 954.0 feet, Pelican Lake encompasses an area of approximately 4,100 acres. At an elevation of 950.0 feet, the area of Pelican Lake is 2,800 acres. Sizable areas of wetlands occur in the watershed and many of these have become part of Pelican Lake during recent years as the lake level has risen. It is not known what the extent and condition of tiles are within the Pelican Lake watershed, since no inventory of these features has been completed.

The landscape of the Pelican Lake watershed can be described as level to gently rolling around the east and north sides of Pelican Lake to moderately rolling on the west and south sides of the lake. Soils are formed of New Ulm loamy till parent material. Soils types within the Pelican Lake watershed are shown in Table III.A.1. In the vicinity of Pelican Lake, clay loam soil textures are dominant.

Land cover within the Pelican Lake watershed is shown in Figure II.A-1. The dominant land cover is row crop agricultural with significant areas of wetland and forest, especially along the south and west side of Pelican Lake. Although some large-lot, residential development is occurring within the watershed, most of the watershed remains rural. The most significant land cover change that impacts hydrology in the Pelican Lake watershed is increases or decreases in the surface area of Pelican Lake. When the surface area of Pelican Lake increases from 3000 to 4000 acres, watershed impervious surfaces increase by as much as 8.5%, a large increase that has direct impacts to Pelican Lake water levels.

Table III.A.1 Soil Hydrologic Properties in the Pelican Lake Watershed

Soil Name	Map Symbol	Hydrologic Group	Permeability (inches/hour)	K factor		Slope (%)
				Kw	Kf	
Canisteo clay loam	86	B/D	0.57 - 1.98	0.24	0.24	0 - 2
Lester loam	106C2	B	1.35 - 1.55	0.28	0.28	6 - 12
Lester loam	106D2	B	0.60 - 2.00	0.28	0.28	12 - 18
Lester loam	106E	B	0.60 - 2.00	0.28	0.28	18 - 25
Cordova clay loam	109	B/D	0.57 - 1.98	0.28	0.28	0 - 2
Glencoe clay loam, depressional	114	B/D	0.57 - 1.98	0.28	0.28	0 - 1
Lerdal silty clay loam	138	C	0.57 - 1.98	0.37	0.37	1 - 3
Nessel loam	235	B	0.60 - 2.00	0.28	0.28	1 - 3
Le Sueur clay loam	239	B	0.57 - 1.98	0.24	0.24	1 - 3
Mazaska silty clay loam	256	C/D	0.60 - 2.00	0.28	0.28	0 - 2
Biscay loam	392	B/D	6.00 - 20.00	0.28	0.28	0 - 2
Dorset sandy loam	406	B	6.00 - 20.00	0.20	0.20	0 - 2
Hamel loam	414	B/D	0.60 - 2.00	0.28	0.28	1 - 3
Houghton muck, depressional	523	A/D	0.20 - 6.00	-	-	0 - 1
Klossner muck, depressional	539	A/D	0.60 - 2.00	-	-	0 - 1
Hamel-Glencoe, depressional	740	B/D	0.60 - 2.00	0.28	0.28	0 - 3
Lester-Kilkenny complex, eroded	783C2	B/C	0.60 - 2.00	0.28	0.28	6 - 12
Lester-Storden complex, eroded	945D2	B	0.60 - 2.00	0.28	0.28	12 - 18
Canisteo-Glencoe, depressional	956	B/D	0.57 - 1.98	0.28	0.28	0 - 2
Udipsamments (cut and fill land)	1015	-	-	-	-	-
Udorthents, loamy (cut and fill land)	1016	-	-	-	-	-
Lester-Malardi complex	1023C	B	6.00 - 20.00	0.20 - 0.28	0.20 - 0.28	6 - 12
Lester-Malardi complex	1023D	B	6.00 - 20.00	0.20 - 0.28	0.20 - 0.28	12 - 18
Udorthents, wet substratum (fill land)	1027	-	-	-	-	-
Crowfork loamy sand	1035B	A	6.00 - 20.00	0.17	0.17	1 - 6
Crowfork loamy sand	1035C	A	6.00 - 20.00	0.17	0.17	6 - 12
Malardi-Hawick complex	1066B	A/B	20.00 - 40.00	0.20	0.20	1 - 6
Malardi-Hawick complex	1066C	A/B	20.00 - 40.00	0.20	0.20	6 - 12

Soil Name	Map Symbol	Hydrologic Group	Permeability (inches/hour)	K factor		Slope (%)
				Kw	Kf	
Malardi-Hawick complex	1066E	A/B	20.00 - 40.00	0.20	0.20	18 - 35
Klossner, Okoboji, and Glencoe soils, ponded	1080	B/D	0.20 - 6.00	0.28 - 0.32	0.28 - 0.32	0 - 1
Angus-Malardi complex	1087B	B	6.00 - 20.00	0.20 - 0.28	0.20 - 0.28	2 - 6
Angus-Cordova complex	1094B	B/D	0.60 - 2.00	0.28	0.28	0 - 5
Granby loamy fine sand, very wet	1099	A/D	6.00 - 20.00	0.17	0.17	0 - 1
Cordova loam	1156	B/D	0.60 - 2.00	0.28	0.28	0 - 2
Suckercreek fine sandy loam	1197	D	1.20 - 1.60	0.24	0.24	0 - 2
Muskego, Blue Earth, and Houghton soils, ponded	1203	A/D	0.60 - 6.00	0.28	0.28	0 - 1
Water, miscellaneous	1356	-	-	-	-	-
Angus loam	1362B	B	0.60 - 2.00	0.28	0.28	2 - 5
Southhaven loam	1368	B	6.00 - 20.00	0.24	0.24	0 - 2
Dorset-Two Inlets complex	1377B	A/B	20.00 - 40.00	0.15 - 0.20	0.15 - 0.20	2 - 6
Dorset-Two Inlets complex	1377C	A/B	20.00 - 40.00	0.15 - 0.20	0.15 - 0.20	6 - 12
Dorset-Two Inlets complex	1377D	A/B	20.00 - 40.00	0.15 - 0.20	0.15 - 0.20	12 - 20
Terril loam, moderately wet	1388B	B	0.60 - 2.00	0.24	0.24	2 - 6
Angus-Kilkenny complex	1408B	B/D	0.60 - 2.00	0.28	0.28	2 - 6
Belleville sandy loam	1443	B/D	6.00 - 20.00	0.20	0.20	0 - 2
Angus-Le Sueur complex	1901B	B	0.60 - 2.00	0.28	0.28	1 - 5
Water	W	-	-	-	-	-

B. GROUNDWATER HYDROLOGY

Background

A groundwater investigation was initiated to determine if groundwater is a factor in the rising lake level. Static water elevations for upper bedrock aquifers and quaternary aquifers were investigated to determine groundwater elevation in relation to the lake. Piezometers were installed around the perimeter of the lake to identify groundwater elevation and gradients. Hydraulic conductivity tests were conducted in three monitoring wells. Finally, the data were used to calculate the rate of flow between the lake and groundwater.

Piezometers and wells

Groundwater monitoring locations are shown on Figure III-B-1. Well design drawings are included in Appendix C.

Mini-piezometers were used to measure groundwater elevations (head) below the lake bed. Mini-piezometers are hollow tubes inserted into the soil that allow for the measurement of water elevations at distinct depths. Piezometers are hammered into the lakebed and the water level within the piezometer is compared to the water level of the lake. If groundwater measured within the piezometer is higher than the lake, groundwater is flowing into the lake (groundwater discharge). If groundwater levels within the piezometer are lower than the lake, water is flowing out of the lake (groundwater recharge). Mini-piezometers were installed at nine locations for the 2005 monitoring season.

Two inch shallow wells were installed at four locations along the shore to define groundwater elevations near the lake. Soil samples were collected at these sites to allow for the characterization of soils near the shoreline. Deep upland monitoring wells were installed at locations on the north, west, and south sides of the lake. Upland wells were installed to determine groundwater elevation near the lake and to identify and characterize subsurface soils.

Private wells in the vicinity of Pelican Lake were surveyed for depth to groundwater to define water table contours in the area of the lake.

Groundwater elevations and flow direction

Half inch piezometer, two inch well, and upland well readings taken in 2005 show that Pelican Lake is losing to groundwater (recharging). Data show that the loss changes over time, but that overall groundwater is consistently lower than the current lake surface elevation (Figure III.B-2).

Groundwater elevation contours were developed through the collection of water levels at residential wells in Quaternary aquifers together with elevations from the new upland monitoring wells. The regional Quaternary groundwater table is generally lower than the present water elevation of the lake, with possible exceptions along the west-southwest shore of the lake. Figure III.B-3 illustrates the generalized groundwater contours for the Pelican Lake area and the elevation of groundwater encountered at the new upland monitoring wells. The recorded groundwater elevations generally show groundwater gradients away from the lake (i.e. groundwater mounding due to groundwater recharge from Pelican Lake).

The uppermost bedrock aquifer in the area is the Franconia-Ironton-Galesville. Quaternary aquifers in the study region are believed to have connections to deeper bedrock aquifers via bedrock valleys inferred from depth to bedrock values listed in CWI logs. Groundwater elevations in Franconia-Ironton-Galesville wells are shown on Figure III.B-4. Comparison to the groundwater contours in Figure III.B-3 shows that groundwater elevations in the bedrock aquifers are close to but lower than groundwater elevations in surficial aquifers and the level of the lake. Groundwater flow is downward rather than upward.

The long-term relationship between lake levels and shallow groundwater elevations was analyzed by comparing lake level data to groundwater elevation data from nearby DNR observation wells. Figure III.B-5 shows data from 1978 through 2004. There is a correlation between changes in the lake levels and changes in the groundwater levels. The correlation coefficients between the Pelican Lake level and the Montrose well, and the Pelican Lake level and the Monticello well, were 0.377 and 0.431, respectively. While not conclusive, this provides some evidence that:

1. There is probably a hydrologic connection between the lake and groundwater.
2. The surface water/groundwater relationships and interactions observed recently have probably not changed significantly since 1978.

Hydraulic Conductivity

Hydraulic conductivity in areas surrounding the lake was determined through grain size analyses and slug tests. Grain size distribution curves and details about the analyses are included in Appendix C. Hydraulic conductivity was estimated using the program Size Perm®, which calculates the hydraulic conductivity based on grain size distribution and 10 different empirical formulas. Results are summarized in Table III.B-1.

Table III.B-1. Hydraulic Conductivity Calculated from Grain Size Analysis (cm/s)

Method	Site MW-1	Site MW-2	Site MW-3
Hazen	2.53E-02	1.10E-06	3.36E-02
Slichter	7.37E-03	2.17E-07	1.12E-02
Terzaghi	1.27E-02	3.09E-07	1.95E-02
Beyer	2.55E-02	8.24E-07	3.14E-02
Sauerbrei	1.46E-02	1.17E-06	1.91E-02
Kruger	2.49E-03	1.03E-06	2.76E-03
Kozeny	3.98E-03	2.38E-06	9.49E-03
Zunker	4.13E-03	1.46E-06	7.96E-03
Uma	1.46E+01	1.35E-03	1.67E+01
USBR	1.24E-02	2.11E-06	1.02E-02

Slug tests were conducted at MW-1, 2, and 3 by removing a volume of water using a bailer and recording how quickly water levels recovered. Water levels were recorded using a pressure transducer. Field data were analyzed using the Bower and Rice method and the computer program AQTESOLV. Details of the analyses are included in Appendix C. Results are summarized in Table III.B-2.

Table III.B-2. Hydraulic Conductivity Calculated from Slug Tests

Units	MW-1	MW-2	MW-3
cm/s	1.4×10^{-2}	1.8×10^{-5}	8.6×10^{-3}
ft/s	4.6×10^{-4}	6.9×10^{-6}	3.3×10^{-4}

Hydraulic conductivities values obtained for MW-1 and MW-3 are roughly four orders of magnitude greater than the near shore values obtained at site MW-2. The hydraulic conductivity calculated at site MW-2 is the most representative value for near shore conductivity encountered at mini-piezometer sites. Values of hydraulic conductivity for sites MW-1 and MW-3 are useful for understanding infiltration opportunities and will be beneficial in any future modeling activities.

Groundwater flux

Groundwater flux was quantified using lake-groundwater head differences collected at monitoring sites, hydraulic conductivity of soils encountered at monitoring sites, and groundwater-surface water interaction areas determined through the use of GIS soil type maps for the lake region.

Groundwater flux into or out of the lake is calculated using the formula:

$Q = KIA$

Where, Q = Flux in cubic feet/second
K= Hydraulic conductivity in feet/second
I = Hydraulic gradient (unitless)
A = Area in square feet

Site characteristics such as hydraulic gradient and hydraulic conductivity were assigned to regions with similar site characteristics such as soil type.

Hydraulic conductivity. Values of hydraulic conductivity were assigned based on observations of lithology made during the installation of piezometers at monitoring sites (Figure II.B-6). Regions of the lake lacking in monitoring sites were grouped based on the soil group and parent material of the soil within 100 feet of the lakeshore.

Hydraulic conductivity values measured in wells MW-1 and MW-3 were not used for this calculation because the wells are located too far from the lakeshore and the soils are not representative of those observed at other monitoring sites along the lakeshore. Hydraulic conductivity values measured in MW-2 were used where appropriate. Hydraulic conductivity values used for the calculations were used based on representative values for different soil types developed by Domenico and Schwartz (1998), which were consistent with the values calculated from the tests at MW-1, 2, and 3.

Hydraulic gradient. The vertical hydraulic gradient was calculated from measurements made using the mini-piezometers described above. Excessive amounts of organic material along the lake bottom and emergent vegetation may have introduced some error into relative head differences measured at mini-piezometers. This issue is minor due to the large number of piezometers illustrating a losing lake and the newly refined groundwater contours.

Surface Area. The area of groundwater-surface water interaction was calculated by creating a 100 foot wide perimeter around the lake. We assumed that almost all the surface water-groundwater interaction is taking place in the 100-foot buffer created around the littoral edge of the lake. Studies have shown that for uniform geology the rate of exchange between surface water and groundwater decreases exponentially with distance from shore. The exponent is a function of variables such as lakebed slope, upland slope, anisotropy, lake width, lake depth, and the thickness of the aquifer. To accurately define the rate of surface water and groundwater exchange requires an extensive study. The development of a more complex groundwater model would help define the areal extent and range of seepage rates.

Results. Details of the groundwater flux calculation are shown on Table III.B-3. The results suggest that water is flowing out of Pelican Lake to the groundwater at a rate of 1.9 cfs.

While the results of this analysis are reasonably accurate, groundwater/surface water interactions will vary over time and no measurement or calculation is entirely precise. The rate of water flow from Pelican Lake to the groundwater is likely in the range of 1 to 6 cfs. This is consistent with results of the Pelican Lake water budget described in Section III.C of this report.

Table III.B-3. Flux Calculations for Pelican Lake

Soil Type	Soil Group	K (ft/sec)	I	A (acres)	A (ft^2)	Q (ft^3/sec)
Angus loam, 2 to 5% slopes	B	3.2E-06	0.55	9.5	411642	7.2E-01
Angus-Cordova complex, 0 to 5% slopes	B	3.2E-06	0.16	0.2	10846	5.6E-03
Angus-Le Sueur complex, 1 to 5% slopes	B	3.2E-06	0.16	15.3	664769	3.4E-01
Belleville sandy loam, 0 to 2% slopes	B/D	1.8E-07	0.37	74.1	3226925	2.1E-01
Canisteo clay loam, moderately fine substratum, 0 to 2%	B/D	1.8E-07	0.05	3.8	166312	1.4E-03
Cordova clay loam, 0 to 2% slopes	B/D	1.8E-07	0.05	0.1	5532	4.6E-05
Cordova loam, 0 to 2% slopes	B/D	1.8E-07	0.05	70.8	3085311	2.5E-02
Glencoe clay loam, depressional, 0 to 1% slopes	B/D	1.8E-09	0.05	48.2	2101334	2.0E-04
Granby loamy fine sand, very wet, 0 to 1% slopes	A/D	1.8E-09	0.05	12.9	561924	5.4E-05
Hamel loam, 1 to 3% slopes	B/D	1.8E-07	0.00	2.6	113256	8.9E-05
Klossner, Okoboji, and Glencoe soils, ponded, 0 to 1%	A/D	1.8E-09	0.01	85.8	3737448	5.8E-05
Le Sueur clay loam, 1 to 3% slopes	B	3.2E-06	0.00	1.6	67518	9.7E-04
Lerdal silty clay loam, 1 to 3% slopes	C	3.2E-06	0.00	0.0	610	8.7E-06
Lester loam, 12 to 18% slopes, eroded	B	3.2E-06	0.16	4.9	213444	1.1E-01
Lester loam, 18 to 25% slopes	B	3.2E-06	0.16	2.4	103673	5.4E-02
Lester loam, 6 to 12% slopes, eroded	B	3.2E-06	0.16	16.6	723096	3.7E-01
Lester-Kilkenny complex, 6 to 12% slopes, eroded	B/C	3.2E-06	0.16	0.2	7797	4.0E-03
Lester-Storden complex, 12 to 18% slopes, eroded	B	3.2E-06	0.16	1.2	52272	2.7E-02
Muskego, Blue Earth, Houghton soils, ponded, 0 to 1%	A/D	1.8E-09	0.05	92.7	4038883	3.9E-04
Nessel loam, 1 to 3% slopes	B	1.8E-07	0.00	11.9	518016	4.1E-04
					Total:	**1.9**

Additional Study

Monitoring of groundwater levels in the south west vicinity of Pelican Lake will be beneficial to quantify the probable change in gradient caused by the installation of an artificial outlet. Wells should be installed and monitored prior to lowering the lake. Monitoring would also provide useful data for the development of a groundwater model for the lake area. The groundwater model could be used to determine potential wetland impacts caused by the lowering of the water table and could be used to refute or verify the concerns of I-94 construction as a cause for lake level change.

Continuous monitoring of lake and groundwater level would be beneficial understand the lake and groundwater response to precipitation events.

Conclusions

1) Groundwater elevations in the area of Pelican Lake are generally below the level of the lake. Groundwater is flowing out of the lake rather than into the lake.
2) The rate of groundwater flow out of the lake is slow, in the range of 1 to 6 cfs.

C. LAKE WATER BUDGET AND DRAWDOWN ANALYSIS

To gain a better understanding of the hydrology of Pelican Lake and to guide possible management options, a water budget analysis was completed. This water budget can be updated and refined as more precise data are collected.

Limitations

Water elevation data for Pelican Lake has not been recorded consistently over the time period that the water has been rising. A total of 78 lake elevation records exist between 1958 and 2003 (Figure III.C-1).

No continuous rainfall record exists for the Pelican Lake watershed. The two nearest rain gauges with consistent information are located in Buffalo and Elk River, approximately 6 miles southwest and 8.5 miles northeast of Pelican Lake, respectively (Figure III.C-2). These two rain gauges average 30.8 inches per year for the period 1958-2004 (Figure III.C-3).

Pelican Lake Water Budget

Groundwater

As described in Section II.B of this report, groundwater flux from Pelican Lake was calculated to be between 1 cfs and 6 cfs. For purposes of computing the Pelican Lake water budget, the low end of the range, 1 cfs, was chosen to account for the fact that lake levels were lower in 1999, the year to which the water budget was calibrated. 1999 was chosen because this year has the most complete lake level records.

Runoff

Soil survey and aerial photography were used to define Green-Ampt runoff parameters for the Pelican Lake watershed. The Green-Ampt runoff parameters were used in the runoff layer of the XP-SWMM hydrologic model with daily rainfall amounts averaged between rain gauges at Elk River and Buffalo and distributed in a SCS Type II distribution to estimate the amount of runoff generated by the Pelican Lake watershed. The watershed was broken up into two subwatersheds: the lake surface (100% delivery) and the surrounding upland. The results of this analysis concluded that the overall runoff coefficient of the lake surface and surrounding watershed is 0.33.

Monthly values of rainfall were averaged between the two aforementioned rain gauges. The monthly rainfall amount was multiplied by a runoff coefficient of 0.33 to estimate the inflow to the lake from surface water runoff.

As a check, the annual runoff in inches according to the Hydrology Guide for Minnesota is 5.1 inches. This works out as an annual runoff coefficient of 0.18. The watershed area to lake area ratio has varied over time from approximately 7:1 to 3:1. Including the lake surface as 100% runoff and calculating the runoff coefficient of the upland puts the upland coefficient between 0.04 and 0.22.

Evaporation

Average monthly values of evaporation from the lake surface, as reported in the Hydrology Guide for Minnesota, were used in the water budget. More accurate and detailed evaporation calculations were not possible due to lack of available data.

Water Budget

Several lake modeling approaches were considered (XP-SWMM, WATBUD) but due to the gaps in data discussed in the limitations section during the period of interest, a basic accounting approach was used to calculate the water budget.

Water budget calculations are shown in Table III.C-1. The first row in the table contains an identifying letter that is referred to in the second row to help readers step through the process. Columns C, E and F contain the monthly volumes entering or leaving the lake from runoff, evaporation and groundwater, respectively. Columns G and H show the net rate of water movement. (Positive indicates that the lake is gaining water in any given month.)

The rates into and out of Pelican Lake were distributed over monthly increments and entered into the hydraulic layer of XP-SWMM to convert the flow rates into or out of the lake into lake elevation data. Water budget results are shown in Figure III.C-4, where they are compared to recorded lake elevation data.

Table III.C-1. Pelican Lake Water Budget Calibration

		A	B	C	D	E	F	G	H
		Equals Average Rainfall Totals at Elk River and Buffalo	= **A** x 0.33	= **B** x Watershed Area (units converted)	Monthly Values from Hydrology Guide for Minnesota	**D** x Average Lake Surface Area	Monthly values from groundwater analysis	**C** - **E** - **F**	**G** (converted to CFS)
Year	Month	Average Precipitation (in)	Runoff (in)	Runoff Volume (ac-ft)	Monthly Evap (Inches)	Monthly Evap (AC FT)	Groundwater Outflow Volume (AC-FT)	Volume to Lake (AC-FT)/month	Average Monthly Flow Rate (cfs)
1999	Jan	1.05	0.34	337	0.36	82.8	60.4	193	3.2
1999	Feb	0.12	0.04	39	0.72	165.6	60.4	-187	-3.1
1999	Mar	1.60	0.53	515	1.5	345	60.4	110	1.8
1999	Apr	2.42	0.80	778	3.2	736	60.4	-19	-0.3
1999	May	6.32	2.09	2035	5	1150	60.4	825	13.7
1999	Jun	3.95	1.30	1272	5.8	1334	60.4	-122	-2.0
1999	Jul	5.52	1.82	1778	6.5	1495	60.4	222	3.7
1999	Aug	4.66	1.54	1501	5.4	1242	60.4	198	3.3
1999	Sep	2.29	0.75	736	3.6	828	60.4	-152	-2.5
1999	Oct	0.73	0.24	235	2.5	575	60.4	-400	-6.6
1999	Nov	0.36	0.12	116	1.1	253	60.4	-197	-3.3
1999	Dec	0.24	0.08	77	0.36	82.8	60.4	-66	-1.1
Total		29.2	9.7	9418	36.0	8289	724.4	405	6.7

Long-term Water Budget Results and Hydrologic Periods

Figure III.C-4 compares the modeling results to the recorded lake elevations. The modeled lake elevations mimic recorded lake elevations, supplying credibility to the modeling methods described in previous sections. Additionally, the model was able to show the increased water elevations with a constant groundwater outflow, which indicates that the system is rainfall dependant. A practical approach to reading this graph is to examine different periods of Pelican Lake water level history.

- The 1960s were considered a dry period for the Pelican Lake watershed with 7 of the 10 years receiving less than 28 inches of rainfall. The large dip in lake level shown during the 1960s is consistent with anecdotal evidence from adjacent landowners. Local landowners report that during the mid-1960s Pelican Lake water levels were very low.

- Both the model and the measured lake level records show a consistent rise in lake levels occurring starting in the early 1970s and lasting though the mid-late 1980s, at which point a dry period resulted in lake levels falling below 950.0 feet.

- From the end of the 1980s to the beginning of the 1990s, lake levels rebound and remain relatively high through the 1990s. Water levels were maintained in the mid-late 1990s by average rainfall years, receiving an average of 29.5 inches/year from 1994-2000.

- From the late 1990s to present, there has been a steady increase in lake level elevations, corresponding to increases in average annual precipitation. During the period 2001 through 2004, rainfall averaged 36.5 inches/year.

Pelican Lake Drawdown Analysis

The magnitude and timing of discharges from Pelican Lake are limited by a number of factors, including downstream flooding, increases in peak flow rates, streambank erosion, and water quality impacts.

To address these concerns, the drawdown analysis used a split winter-summer approach as shown in Figure III.C-5. The drawdown parameters identified by the Pelican Lake Work Group include:

1) Lower current lake level of approximately 954.0 feet to elevation of 950.7 feet.
2) Enable temporary management drawdowns to elevation of 944.0 feet.
3) The initial drawdown would be from 954.0 to 944 feet over a period of approximately 2.5 years.
4) Summer time discharge rates not to exceed 5 cfs.
5) Winter time discharge rates not to exceed 21 cfs.
6) The plan would stipulate closure of the outlet if discharges from Pelican Lake conflict with high flows or flooding problems in the City of St. Michael.

A Pelican Lake Management Plan would set forth the conditions of how the outlet would be operated, along with the roles and responsibilities of the entities involved in implementing the Pelican Lake Outlet Management Plan.

Figures III.C-6 through III.C-8 show a simulation of drawdowns under dry, average, and wet conditions starting in 2008 using the above parameters. The original drawdown scenario called for a 12 cfs winter and 5 cfs summer discharge rate. The winter discharge rate was increased to 21 cfs to shorten the initial drawdown time. Figure III.C-9 shows historic Pelican Lake levels as they would have been with these outlet parameters.

IV. Outlet Alternatives

A. INTRODUCTION

Two outlet alternatives were evaluated: an east alignment through the City of St. Michael into Regal Creek via County Ditch 21, and a north alignment through the City of Monticello to the Mississippi River via County Ditch 33. These two alignments are shown in Figure IV.A-1. A third alternative, the use of infiltration basins, was considered, but not found to be feasible due to low permeability soils and the lack of large depressions suitable for this approach in the vicinity of Pelican Lake.

The Pelican Lake Work Group evaluated the two alignments using a variety of environmental, economic, and social criteria. In evaluating the two outlet alignments with respect to these criteria, the following assumptions were used:

1) Discharge rates of 12 cfs during the winter months and 5 cfs during the summer months. (Winter discharge rates were later increased to 21 cfs for the preferred outlet alternative.)

2) Existing pipes that would convey flows from Pelican Lake were assumed to be upgraded to one standard pipe size with no change in pipe material.

3) Open channel sections were assumed to be capable of conveying a flow rate equal to 5 cfs and the local 2-year storm. The assumed channel geometry is a trapezoidal channel with a bottom width of 12 feet, a depth of 2 feet and 2:1 (horizontal:vertical) side slopes.

4) Gravity flow and pumping are evaluated for both alignments.

B. ALIGNMENT COMPARISON: EAST (ST. MICHAEL) ALIGNMENT AND NORTH (MONTICELLO) ALIGNMENT

The east and north alignments were compared through a series of tables completed for the feasibility study. This discussion is organized as follows:

- Table IV.B-1 Environmental Impacts: Impacts related to water quality, wetlands, flooding, and fish and wildlife habitat are compared.
- Table IV.B-2 Social Impacts: Social impacts focus on number of land owners, area of disturbance, and the public perception of flooding-related conflicts.
- Table IV.B-3 Economic Comparisons: Using the same design assumptions, the two outlet alternatives were evaluated for both a pump and no pump design.
- Table IV.B-4 Water Quality Considerations: Water quality considerations include both the potential impacts and the opportunities to mitigate these impacts. The availability of wetland restoration and other treatment opportunities is also included.

- Table IV.B-5 Hydrologic Considerations: Key hydrologic considerations include increases in peak discharge rates, downstream flooding, erosion, and storm sewer capacity constraints.
- Table IV.B-6 Wetland Considerations: Direct and indirect impacts to wetlands along the outlet alignments as well as opportunities to restore wetlands are considered.
- Table IV.B-7 Social Considerations: An interpretation of data presented in Table IV.B-2 is provided.

Table IV.B-1 Environmental Impacts

Environmental Impacts*	Alternatives	
	East Alignment	North Alignment
Water quality	M	H
Direct wetland (ac)	31	104
Indirect wetland (ac)	28	133
Restored wetland (ac)	350	0
Downstream flooding	L	H
Instream flooding	H	L
Fish and wildlife habitat	L	L

*Impacts ranked as high (H), medium (M), or low (L), or expressed as quantities

Table IV.B-2 Social Impacts

Social Impacts*	Alternatives	
	East Alignment	North Alignment
Total parcels affected**	14	19
Earth disturbance (ac)	20	23
Total project area (ac)	500	290
Real/perceived flooding problem	L	H

*Impacts ranked as high (H), medium (M), or low (L), or expressed as quantities.

**For east alignment through Meadows Wetland; for north alignment to proposed new stormwater outlet pipe

Table IV.B-3 Economic Comparisons

Economic Impacts*	Alternatives			
	East Alignment without Pumping	East Alignment with Pumping	North Alignment without Pumping	North Alignment with Pumping
One-time construction costs	$2,084,430	$2,161,151	$2,217,371	$2,274,430
Total	*$2,084,430*	*$2,161,151*	*$2,217,371*	*$2,274,430*
Annual costs				
Operation	0	$15,000	0	$15,000
Maintenance	$12,500	$10,500	$13,500	$12,500
Total	*$12,500*	*$25,500*	*$13,500*	*$27,500*

Table IV.B-4 Water Quality Considerations

Alignment	Pros	Cons
East	Opportunities for wetland treatment of outflow, currently unused by City of St. Michael	Regal Creek TMDL Crow River TMDLs
	Potential water quality benefit to Regal Creek, TMDL implementation opportunity	Mississippi River and Lake Pepin TMDLs
	Partnering opportunities with St. Michael, stormwater management	
North	No discharge to Regal Creek and therefore no conflicts with Regal Creek or Crow River TMDLs	Mississippi River and Lake Pepin TMDLs
		Limited water quality treatment options for outflow; existing flooding problems in Monticello, ponds and wetlands already at capacity

Table IV.B-5 Hydrologic Considerations

Alignment	Pros	Cons
East	Release of baseflow from Pelican Lake could lead to more stable flow regime, increased DO	Instream erosion in Regal Creek and at outfall to Crow: cost to repair is $200K
North	Potential opportunity to partner with Monticello in addressing stormwater management issues	JD33 does not have additional capacity. If ditch authority does not permit additional discharges, cost to increase pipe from 48 to 60 inches is $2 million

Table IV.B-6 Wetland Considerations

Alignment	Pros	Cons
East	Opportunity to restore up to 350 acres of degraded wetland	Potential for 31 acres of direct and 28 acres of indirect wetland impact
North		Limited opportunity to restore wetlands due to chronic flooding and limited available sites.
		Potential for 104 acres of direct and 133 acres of indirect wetland impact.

Table IV.B-7 Social Considerations

Alignment	Pros	Cons
East	Lower number of parcels affected and less earth disturbance	Wetland restoration elements substantially increase overall project area
	Flooding problems are not perceived as high	
North	More parcels and earth disturbance	Overall project area is smaller due to less emphasis on wetland restoration
	Long history of flooding in Monticello neighborhoods – potential public resistance to discharge of additional water through Monticello's stormsewer system	

The north outlet alternative has several constraints including limited channel capacity within County Ditch 33, high potential for flood-related conflicts, significant wetland impacts and higher costs attributed to depth of cut, and the need to retrofit existing storm sewer pipes. Constraints for the east alignment include wetland and flood-related impacts, in-stream scour, and erosion to Regal Creek. Both alignments have the potential to impact water quality in the Mississippi River; however, the east alignment would also discharge to Regal Creek and the Crow River, both of which are listed by the MPCA as impaired.

The east alignment has lower construction costs regardless of whether gravity flow or pumping is used. The east alignment also has fewer potential environmental impacts. The east alignment offers many opportunities to not only avoid or minimize environmental impacts, but to restore wetlands and eroded sections of Regal Creek. Many of these same improvements also have the potential to mitigate water quality impacts to receiving waters and to mitigate potential fringe wetland impacts of Pelican Lake. These opportunities are not generally available on the north alignment.

C. Recommendations

The east alignment was recommended for further evaluation. The Pelican Lake Work Group concurred with this recommendation and directed Emmons & Olivier Resources, Inc. to further evaluate the east alignment option.

V. Preferred Outlet Alternative

A. INTRODUCTION

This section describes the key design elements of the east alignment. The east alignment is shown in Figure IV.A-2. The east alignment conceptual design uses as design parameters the drawdown assumptions previously outlined in Section III of this report. The east alignment as described herein incorporates several design changes and improvements which are aimed at addressing specific issues that are outlined in Section IV of this report.

These design changes and improvements include:

Combined Gravity/Pump Outlet: As described in Section IV of this report, both gravity and pumping have been considered. Further evaluation suggests that a gravity outlet weir structure with an invert of 950.2 feet, combined with a portable or permanent pump provides the best overall outlet configuration. Primary factors in considering this outlet configuration are long term maintenance costs, environmental impacts of channel dredging in Pelican Lake, and the depth of cuts across private land east of Pelican Lake. A pumping option will enable more precise management of the outlet and provide a greater level of confidence that downstream flows can be regulated.

Diversion of Outlet Channel from Ditch 21 to Private Ditch: A major concern of the City of St. Michael is impacts on flooding in the vicinity of County Ditch 21 and County Ditch 9 and upstream of the Meadows Wetland. Diverting the outlet channel to an existing private ditch just east of Iffert Ave NE not only avoids directing new flows from Pelican Lake into existing flood prone areas, but redirects existing drainage area away from these flood prone areas.

Installation of Fish Barrier: Of major concern is that the outlet channel will provide a conduit for fish to reenter Pelican Lake after management drawdowns and/or fish toxicants are applied. The rerouting of the outlet along the private ditch provides an opportunity to install a velocity fish barrier due to higher gradients along this alternate route.

Meadows Wetland Restoration: Of significant concern is the potential water quality impacts to Regal Creek and the Crow River. The Meadows Wetland restoration will provide substantial pollutant removal and help to mitigate the potential water quality impacts of Pelican Lake discharges. The Meadows Wetland restoration will also substantially attenuate stormwater discharge rates to Regal Creek, thus reducing stream bank erosion potential.

B. EAST ALIGNMENT CONCEPTUAL DESIGN ELEMENTS

The following is a description of the key elements of the east alignment beginning at the outlet of Pelican Lake.

Stoplog weir: A stoplog weir will be constructed at the mouth of an existing private ditch that flows into Pelican Lake. The top of the weir is proposed to be three feet wide and set to an elevation of 950.2 feet. The weir will pass flows during normal operating periods (non-lake management drawdown periods), to manage the lake at an elevation of 950.7 feet, or 1.5 feet below the existing DNR OHW of 952.2 feet.

Lift Station: A lift station will be constructed at the existing edge of the eastern-most bay of Pelican Lake. A 24” intake will run from this point 900 feet into the lake and be set at an invert elevation of 942.0 feet. The lift station intake pipe will require placement of a structure within the lake bed to support the intake pipe at the proper invert elevation. A short 24” forcemain will outlet into the new channel on the downstream side of a weir.

Many pump configurations would be sufficient to accomplish the drawdown requirements stated in the Pelican Lake Outlet Management Plan and will be specified in the preliminary design. To achieve a constant flow rate, either two pumps will be used, or a single pump could fill a storage area and water could be slowly released through an orifice while the pump rests. Possible storage locations are School Lake or the wetland along the alignment to the west of Ibarra Avenue.

Waterway: The waterway would be constructed along the alignment shown in Figure IV.A-2. The profile of the channel with respect to existing elevations is shown in Figure IV.A-3. The waterway design would serve many functions beyond conveying flows from Pelican Lake. Channel geometry (Figure IV.A-4) would mimic stream type based on gradient, channel substrate, and hydrology from both Pelican Lake and local storm flows. The channel is sized to accommodate summertime discharge of 5 cfs, plus the additional flows generated by the 1.5-year event from the local watershed. The channel would also include a flood-prone area designed to accommodate local storms that exceed the 1.5-year event and up to the 100-year event. The slopes above the floodprone area would be a maximum of 3:1 with permanent buffers along the top of the waterway slopes. The floodprone area of the waterway is expected to have sufficient hydrology to support wet meadow wetland communities, while the waterway slopes and buffers would support native prairie, woodland and forest communities. Several sections of the waterway would require deep cuts that might be crossed more cost-effectively with pipes. From Pelican Lake to the edge of the Meadows Wetland, up to 16,700 LF of waterway would be created, a portion of which would utilize County Ditch 21. Within the Meadows Wetland Restoration, an additional 7,150 LF of waterway would be extended to the outlet (Regal Creek), for a total of 23,850 LF of new waterway.

Restored Wetlands: The waterway extends through wetlands along the northeast side of School Lake and passes through additional wetlands drained by a small private ditch west of the Meadows Wetland. Most of these wetlands are presently drained or partially drained. Where possible, the waterway grade will be designed to restore the pre-ditch runout elevation of these wetlands. Where appropriate, small control structures will be placed at these locations to restore wetland hydrology and provide for grade control in the waterway. Additional wetland areas will be created as riparian wetlands within the floodprone area of the waterway itself.

Velocity Fish Barrier: Where the waterway crosses Jamison Avenue, there is a relatively high gradient reach that might be suitable to construct a velocity fish barrier. This would be accomplished by replacing the existing culvert under Jamison Avenue with a larger culvert with a slope that achieves a velocity of 7 feet/second over a horizontal distance of at least 50 feet. This fish barrier would limit migration of fish up into Pelican Lake from the Crow River and other downstream water bodies.

Stormwater Facilities: Although much of the east alignment is yet to be developed, the City of St. Michael Comprehensive Plan does show areas adjoining the outlet alignment as low-density residential development or village mixed use. In anticipation of future stormwater management requirements and the need to protect the waterway and associated wetlands from stormwater discharges, stormwater ponding areas are identified in Figure IV.A-2. An estimated 32 acres of stormwater ponding is required to meet future development. These facilities would be constructed as development along the waterway occurs.

Meadows Wetland Restoration: The Meadows Wetland is located just upstream of the Regal Creek outfall. The Meadows Wetland was historically ditched, drained, and used for sod farming. Portions of the wetland were also used as pasture. The Meadows Wetland restoration would include placement of an outlet weir (Figure IV.A-5) to return the runout elevation to preditch conditions. The normal water elevation weir would be 3 feet in length and set to elevation of 923.0. A 20-foot weir would be set at 926 feet for outlet under periods of high water in the Meadows Wetland. The outlet weir would restore the wetland hydroperiod, provide water quality treatment to discharges from Pelican Lake, and attenuate downstream flows within Regal Creek where instream scour and erosion is a concern. Vegetation management would be implemented to remove reed canary grass and restore this wetland to a diverse mosaic of emergent marsh, wet meadow, and shrub swamp wetland communities. A total of approximately 180 acres of wetland would be partially or fully restored as part of the Meadows Wetland restoration.

Regal Creek Stabilization: Downstream of the Meadows Wetland, Regal Creek descends into the river valley of the Crow River. Within moderate gradient reaches, channel scour and stream bank erosion threaten Regal Creek and public and private infrastructure. The project would include stabilization of Regal Creek *before* discharges from Pelican Lake occur. Before additional flows are released from Pelican Lake, eroded sections of Regal Creek would be stabilized, emphasizing the use of bioengineering techniques where appropriate. The Regal Creek stabilization would also integrate stream bank buffers, storm water management and protection of natural areas and steep slopes along the creek corridor.

C. Construction Phasing Schedule

The project would be completed in phases designed to minimize the potential for downstream impacts. In general, work would commence in downstream areas first to provide for a minimum one-year establishment and stabilization period for Regal Creek and other disturbed areas. The following phasing schedule would be applied:

Table V.C-1. Construction Phasing Schedule

Phase	Description	Schedule
I	Restore Meadows Wetland (including construction of outlet weir and waterway within wetland)	Year 1
II	Stabilize lower reaches of Regal Creek with high erodibility potential	Year 2
III	Construct waterway upstream of Meadows Wetland	Year 2-3
IV	Construct pump station and force main to north side of School Lake	Year 3-4
V	Initial drawdown to approximately 950.7 feet	Year 5-6
VI	Management drawdown to approximately 944.0 feet	Year 7

D. PERMITS REQUIRED

The required permits range from Army Corps of Engineers permits to city permits (Table V.D-1).

Table V.D-1. Permits Required

Unit of government	Type of application
U.S. Army Corps of Engineers	Section 404 permit
MNDNR	Work in public waters
MPCA	401 certification
MPCA	NPDES construction
Wright County	Land Alteration Permit
City of St. Michael	Wetland Conservation Act
City of St. Michael	Grading and Excavation

VI. Environmental Impact Analysis

The following is a summary of the environmental issues identified in this study. These issues were identified through completion of an environmental assessment worksheet (EAW).

Following each issue is a summary of mitigation strategies and further investigation and data collection that might be ordered as part of permit conditions. Because of how interrelated these issues are, it is anticipated that most of the mitigation strategies described herein will be incorporated as part of permit conditions.

Issue #1: Conversion of wildlife habitat within Pelican Lake presently dominated by deep, open water lake and marsh to shallower, submerged, floating-leaf and emergent macrophytes-dominated communities.

Mitigation

While some species may be negatively impacted, especially on a short term basis, overall a significant net gain in wildlife habitat is anticipated to result from the restoration of Pelican Lake.

- Limit disturbance to upland and wetland areas during the spring nesting season.
- Strict sediment and erosion control.
- Where possible phase work to retain undisturbed areas to serve as a refuge for resident species.
- Placement of silt fences and other structures will be carefully evaluated to avoid creating physical barriers to species moving between different habitat areas.
- Protect shoreline areas and adjacent upland nesting cover through landowner education, conservation easements, and restoration efforts.
- Specific habitat features (e.g., nesting structures) will be incorporated into project design to fulfill specific habitat needs of species that might be impacted by lake management activities.

Further Investigation/Data Gathering

Evaluation of habitat needs and how Pelican Lake is meeting these needs might provide guidance for better quantifying potential impacts. Project design might potentially be able to accommodate habitat elements that fulfill specific habitat requirements.

Issue #2: Loss of existing fisheries in Pelican Lake

Mitigation

Pelican Lake supports a marginal game fish fisheries due to periodic winter kill. Because of the limited potential for Pelican Lake to support a viable sport fisheries, no mitigation is warranted.

Further Investigation/Data Gathering

None

Issue #3: Fisheries Impacts to Regal Creek due to Pelican Lake discharges.

Mitigation

See mitigation for issue #10

Further Investigation/Data Gathering

Flow and water quality monitoring, as described under the water quality discussion, would allow better quantification of impacts, or improvements, to fisheries in Regal Creek.

Issue #4: Fish Movement from Crow River/Regal Creek to Pelican Lake.

Under conditions where Pelican Lake is outletting as gravity flow over the weir and significant stormwater is being generated locally, fish movement between the Crow River and Pelican Lake via Regal Creek might be possible.

Mitigation

- Under normal conditions weirs at Pelican Lake and Meadows Wetland will block fish movement.
- Velocity barrier upstream of Meadows Wetland.

Further Investigation/Data Gathering

None

Issue #5: Temporary Impacts Related to Excavation and Placement of Structures within Pelican Lake

Excavation of a gravity flow outlet channel, placement of forcemain into Pelican Lake and associated footings, pilings, and other elements could result in temporary suspension of bottom sediments and loss of near-shore aquatic communities.

Mitigation

- During design phase of project, locate forcemain and outlet channel to minimize encroachment to aquatic vegetation.
- Time construction activities to winter time or low water periods
- Flotation silt curtains
- Restore aquatic vegetation impacted by excavation.

Further Investigation/Data Gathering

None

Issue #6: Impacts to Wetlands Downstream of Pelican Lake Outlet

The waterway and Meadows Wetland restoration will result in temporary impacts within existing wetlands due to excavation and placement of control structures.

Mitigation

- Excavation during low flow periods, preferably during winter months
- New channels and restored wetlands to be kept off line for minimum of one full growing season to achieve site stabilization.
- Existing culvert invert elevations will be maintained at crossings to assure that unintended drainage of wetlands does not occur.
- All wetland vegetation/grades will be restored and replanted.
- Standard erosion control measures (i.e., silt fence, cover crops, etc.) will be implemented.

Further Investigation/Data Gathering

None

Issue #7: Pelican Lake Fringe Wetland Impacts

An estimated 78.6 acres of wetlands could potently be impacted by permanently lowering Pelican Lake to an elevation of 950.7 feet. There are a variety of factors that might lower this estimate including changes in soil texture/structure due to prolonged inundation, groundwater inflow on the southwest shore of the lake, abandonment of old ditches/tiles, and the same climatic trends that are responsible for the present-day high water conditions on Pelican Lake.

Mitigation

- Public value credits from conversion of deep open water areas of Pelican Lake to submerged, floating leaf and emergent macrophyte communities.
- Public value credits from vegetation restoration in the wetlands surrounding Pelican Lake.
- Public value credits from vegetation restoration in the Meadows Wetland.
- Public value credits from establishment of upland buffers.
- New wetland credits from the waterway.

A total of 1,039.5 acres of potential wetland mitigation including 1019 acres wetland PVC, 10.1 acres of upland PVC and 10.4 acres of new wetland credit. It is anticipated that additional new wetland credit (equivalent) might be appropriate as allowed under the Minnesota Wetland Conservation Act for hydrologic restoration of partially drained wetlands.

Further Investigation/Data Gathering

- Complete a wetland function and value assessment of the existing wetland.
- Establish several nests of piezometers to monitor water levels on fringe areas of the wetland.
- Wetland Technical Evaluation Panel should agree on existing wetland boundary based on methodology presented in this EAW and verified in the field.
- Wetland Technical Evaluation Panel should agree on extent of potentially impacted wetland areas.

- Wetland Technical Evaluation Panel should agree on protocols for an on-site/off-site determination of potentially impacted wetland areas under existing and post-project conditions.

Issue #8: Changes and Reductions to Water Surface Use.

The existing public access might no longer provide boat access to Pelican Lake. A significant portion of Pelican Lake may not have water depths adequate for motor boat travel.

Mitigation

The DNR Public Access (now under water), will be put back into use as soon as conditions permit.

Further Investigation/Data Gathering

None

Issue #9: Erosion and Sedimentation along the Waterway through the Downstream Reaches of Regal Creek

Because of the excavation proposed and the potential for significant flows, erosion and sedimentation along the water way is a potential concern.

Mitigation

- A Stormwater Pollution Prevention Plan will be prepared as part of NPDES permit requirements.
- The outlet waterway and Meadows Wetland will be constructed and restored during winter frozen ground conditions. No hydraulic connections will be made from the lake to the water way or Regal Creek at this time.
- Appropriate erosion control measures, including silt fences, flotation curtains, and other devices will be installed prior to start of work.
- A minimum of one full growing season, following establishment of permanent vegetative cover, will be provided to fully stabilize the site.
- During the fall or winter following the second growing season, assuming all disturbed areas are fully stabilized, a hydraulic connection between the lake and the new stream channel will be installed.

Further Investigation/Data Gathering

None

Issue #9: Water Quality Impacts to Downstream Waters

The potential impacts to downstream water bodies (Regal Creek, Crow River, Mississippi River) are increased pollutant loads, such as total phosphorus, biochemical oxygen demand, fecal coliform, and higher water temperatures.

Mitigation

- Restoration of Meadows Wetland, which will treat the discharge from the outletted lake and improve its water quality
- Timing of the outletting – 86% of the lake's outflow during the initial drawdown period will be outletting during winter months. Water quality in the lake is better during winter months, and will have less of an impact on the water quality of downstream water bodies due to the cold temperatures and low rates of algal and plant production.
- Improvements in Pelican Lake water quality – The water quality of the lake is expected to improve due to this project, so that the water quality of the outlet's discharge during future management drawdowns will be better than the water quality today.
- Shade trees will be planted along the realigned channel where feasible to help maintain cooler water temperatures.

Further Investigation/Data Gathering

A flow-weighted monitoring station should be established permanently in the lower portion of Regal Creek to monitor flows for discharge rate and water quality parameters. At least one continuous tipping bucket rain gage should be installed upstream near the Meadows Wetland.

Issue #10: Increased Erosion and Scour to Regal Creek

A geomorphic assessment and hydrologic modeling confirm that Regal Creek has a high sensitively to erosion and that local stormwater discharges exceed channel capacity under existing conditions. Additional discharges from Pelican Lake would further stress sensitive areas in lower Regal Creek.

Mitigation

- Summer time discharges from Pelican Lake would be limited to maximum of 5 cfs. During winter, when local storm flows are non-existent or small, discharges up to 20 cfs would be allowed.
- Increase attenuation of storm flows to downstream reaches of Regal Creek through waterway and Meadows Wetland restoration.
- Stormwater ponding areas are identified for future growth areas of St. Michael to further limit peak flow rates.
- Comprehensive restoration and stabilization plan for the lower reach of Regal Creek.
- Stabilization of existing erosion sites and restoration of the Meadows Wetland would be completed in the initial phases of the project to stabilize Regal Creek before discharges to Pelican Lake are allowed.

Further Investigation/Data Gathering

Flow monitoring as previously described.

VII. Cost Estimate

A cost estimate was completed for the east alignment outlet option that contains more precise excavation estimates than the comparison. The total cost of designing and building the outlet as a pumping and gravity drain system is approximately $2.1 million dollars. The following assumptions were used in the derivation of this amount; for the entire cost analysis including north alignment costs, see Appendix E:

- Does not include land prices due to variability.
- $7/YD cost for excavation and onsite deposition.
- Design cost will be 20% of construction cost.
- The total cost for the pump and controls, pumphouse, intake, forcemain, and weir is $0.5 million.

VIII. References

James, C., J. Fisher, V. Russell, S. Collings, and B. Moss. 2005. Nitrate variability and hydrophyte species richness in shallow lakes. *Freshwater Biology* 50:1049-1063.

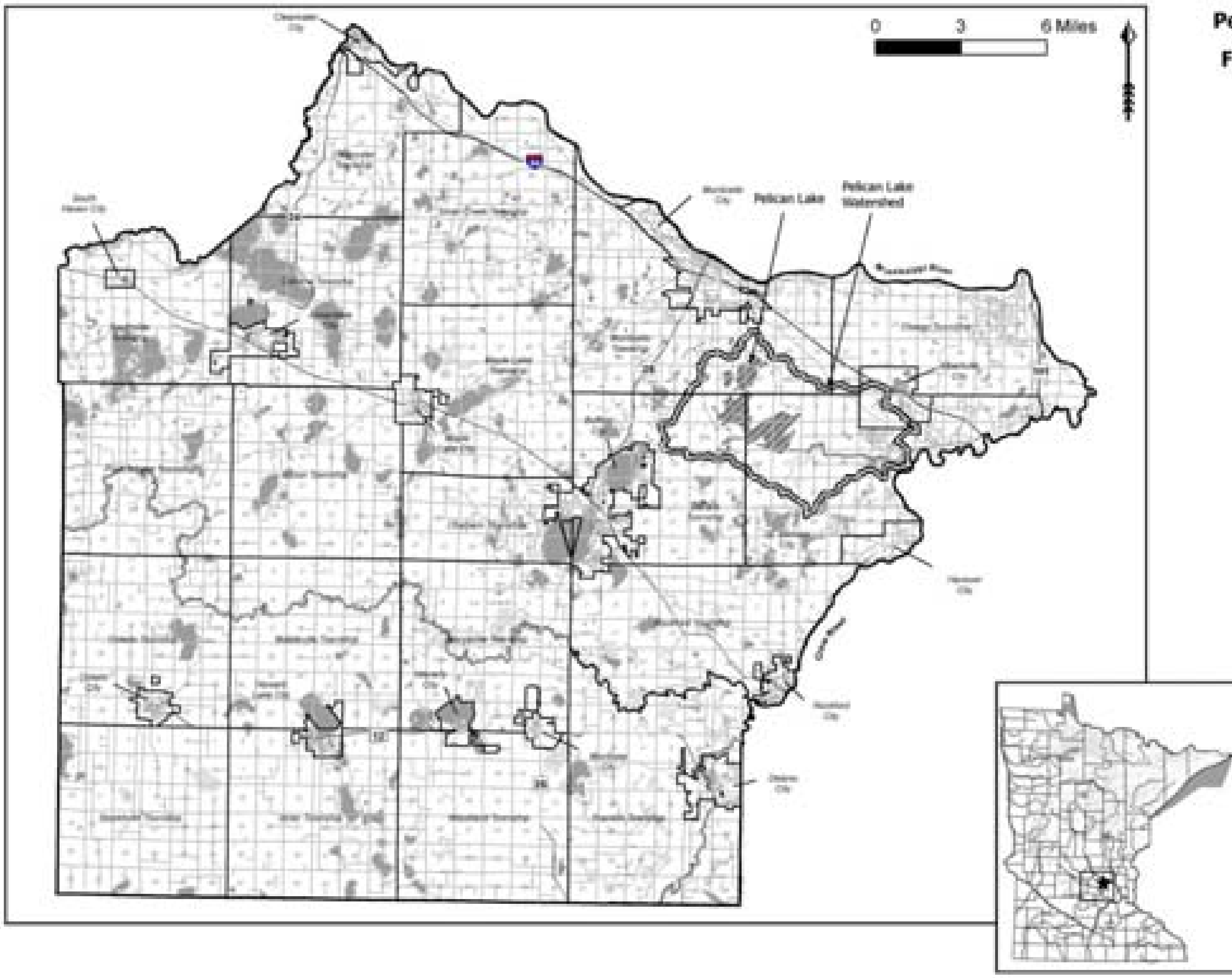
MPCA, 2005. Minnesota lake water quality assessment report: developing nutrient criteria, third edition. Minnesota Pollution Control Agency, September 2005.

MPCA, 1993. Selected water quality characteristics of minimally impacted streams from Minnesota's seven ecoregions. Sylvia McCollor and Steven Heiskary, Water Quality Division.

IX. Figures

Pelican Lake Feasibility Study

Figure I.A-1 Project Location Within Wright County, MN



Pelican Lake Watershed
Pelican Lake
Proposed Outlet
Wright County Boundary
Municipal Boundaries
Section Lines
Major Roads
Roads
Rivers
Lakes & Rivers
Wetlands

Data Sources: MN DNR, MN DOT

March 2006

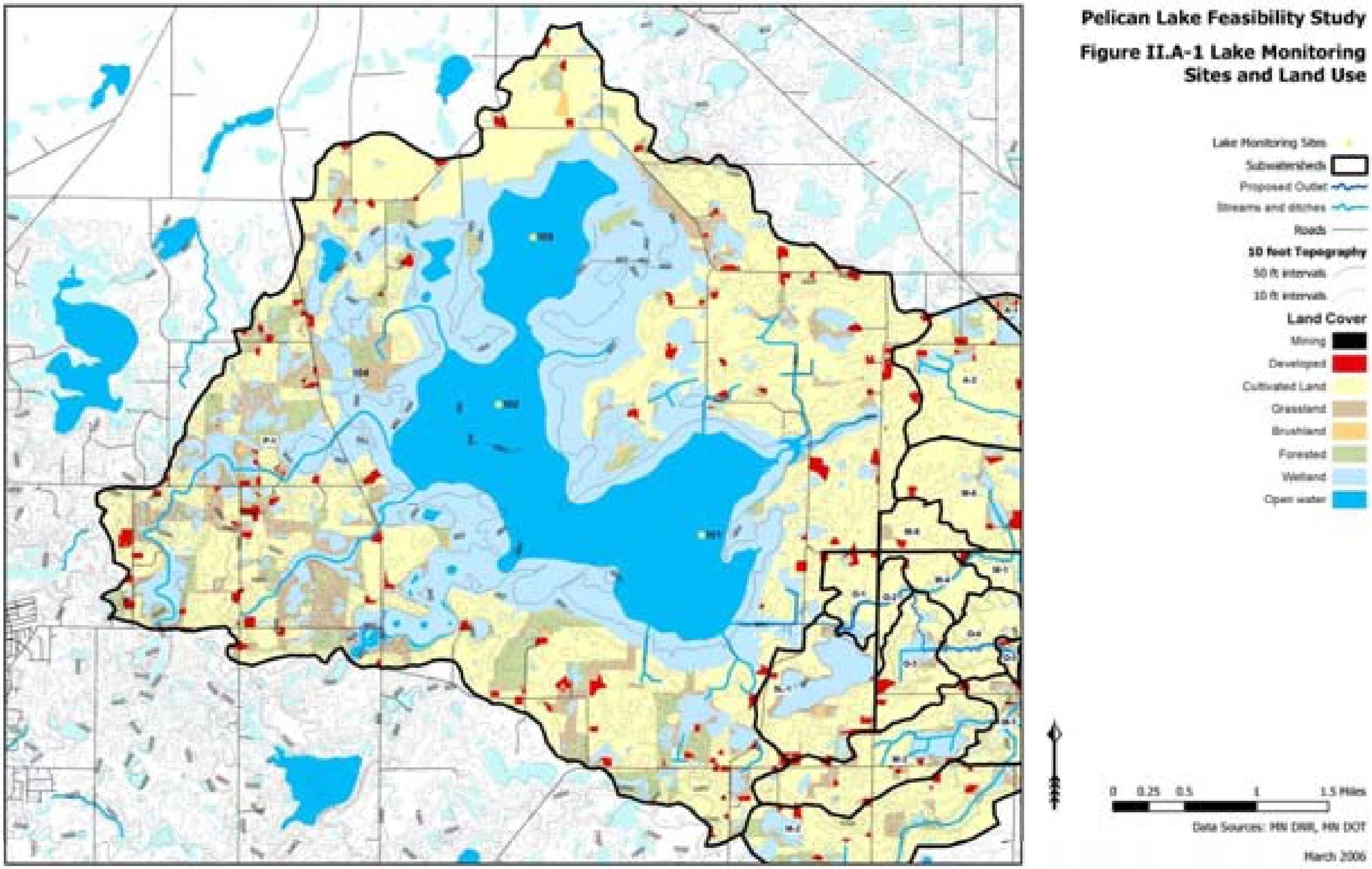

Pelican Lake Feasibility Study
Figure II.A-1 Lake Monitoring Sites and Land Use
Lake Monitoring Sites
Subwatersheds
Proposed Outlet
Streams and ditches
Roads
10 foot Topography
50 ft intervals
10 ft intervals
Land Cover
Mining
Developed
Cultivated Land
Grassland
Brushland
Forested
Wetland
Open water
0 0.25 0.5 1 1.5 Miles
Data Sources: MN DNR, MN DOT
March 2006

Figure II.B-1. In-lake TP growing season (June through September) means

Figure a.
2003 and 2005 averages

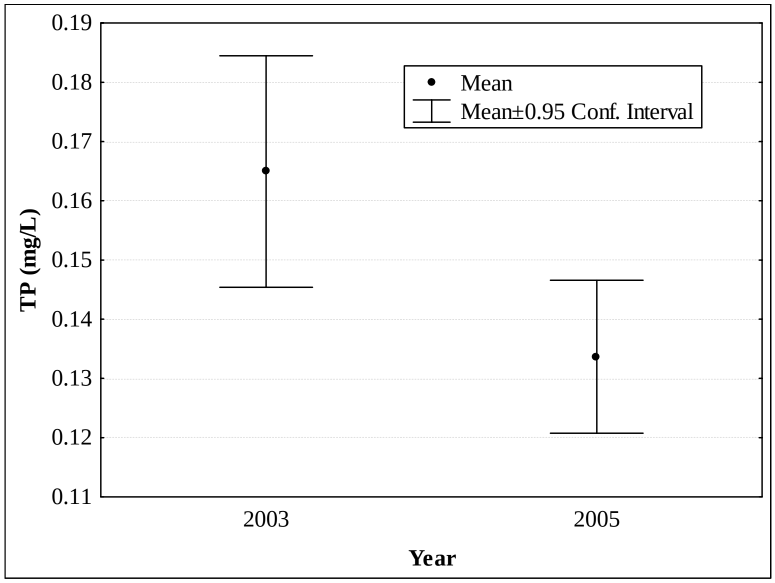


Figure b.
2003 data, categorized by site

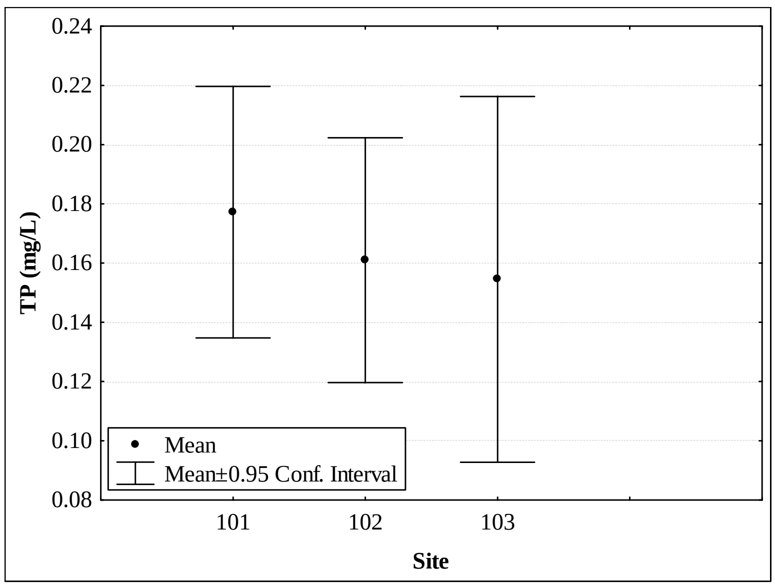


Figure c.
2005 data, categorized by site

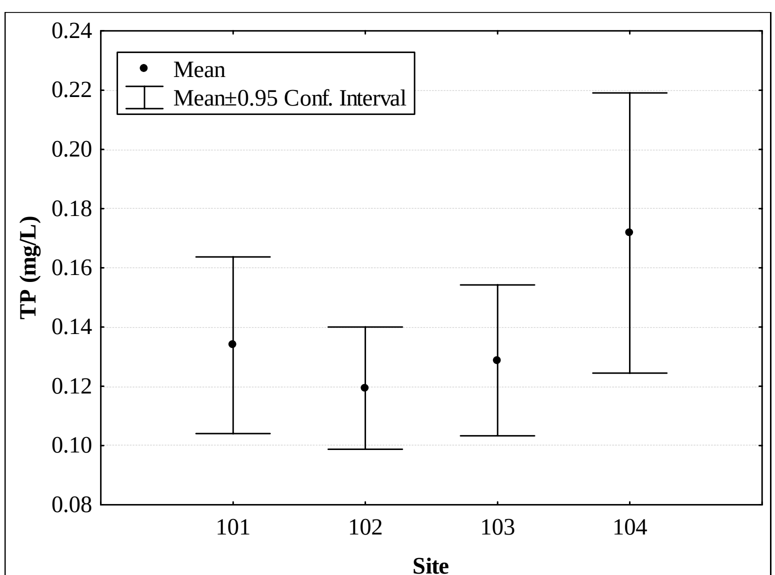
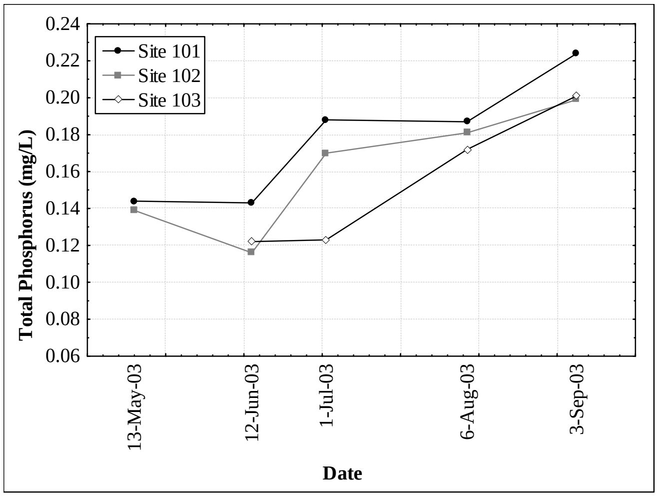


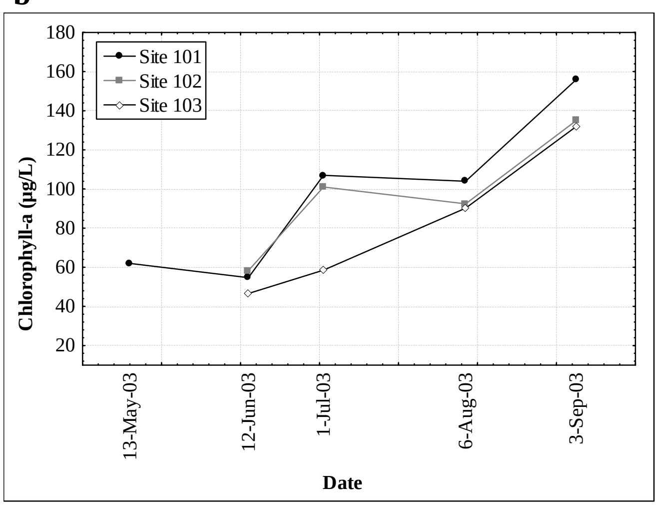
Figure II.B-2. In-lake water quality data, growing season (June through September), 2003 and 2005

2003

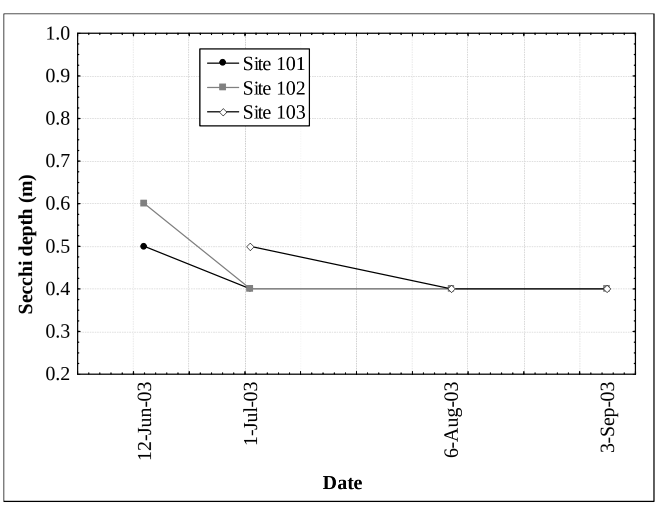
a



b

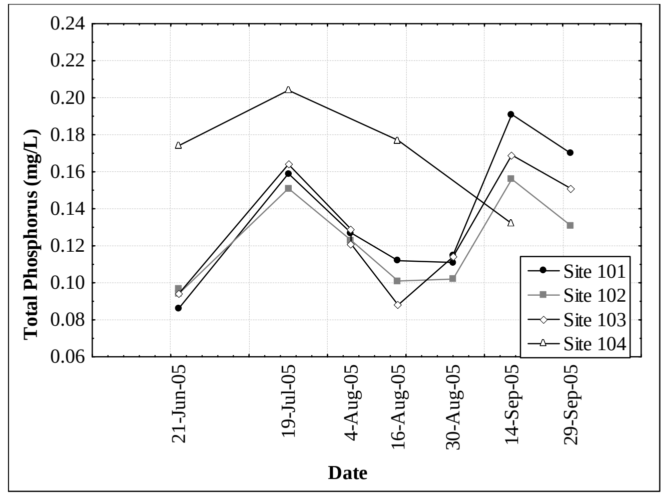


c

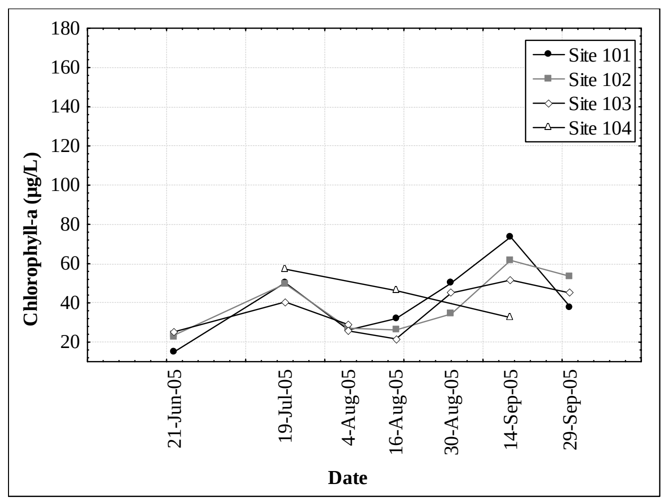


2005

d



e



f

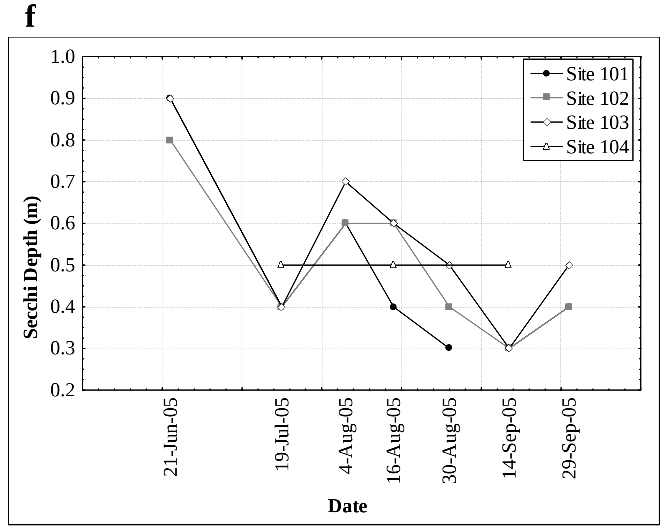


Figure II.B-3. Dissolved oxygen-depth profiles, June through September, 2005.

Figure a.
Site 101

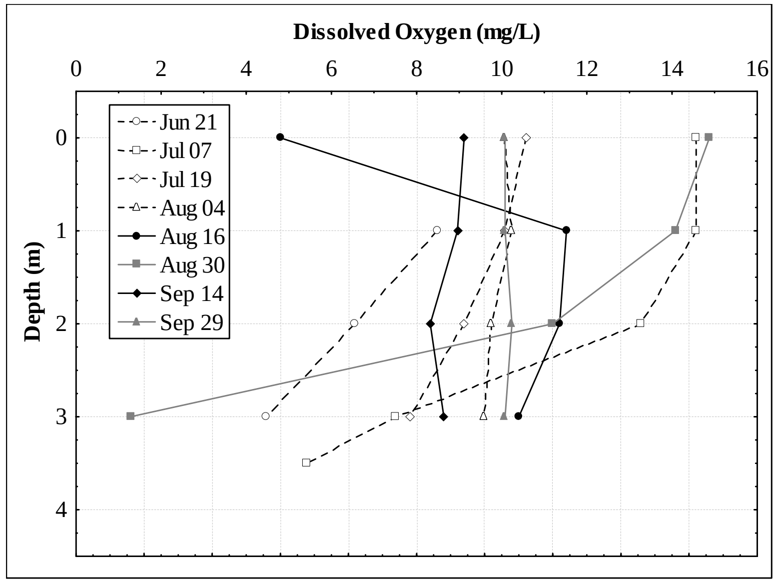


Figure b.
Site 102

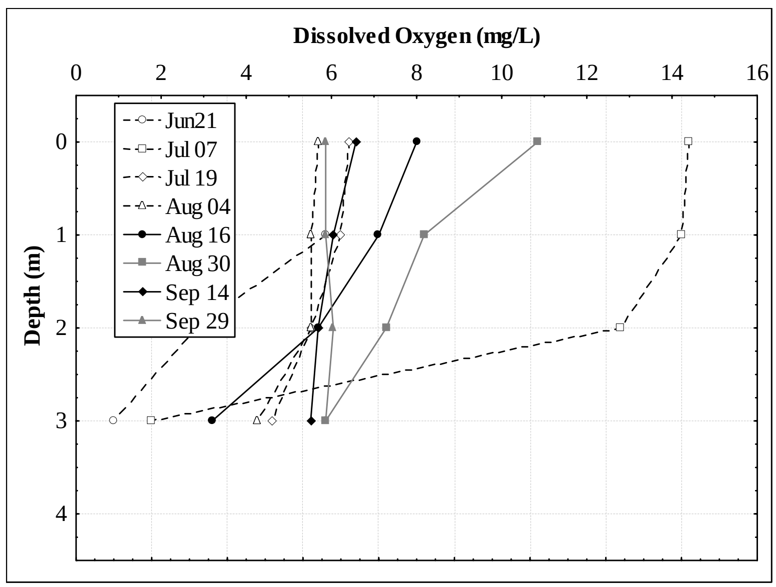


Figure c.
Site 103

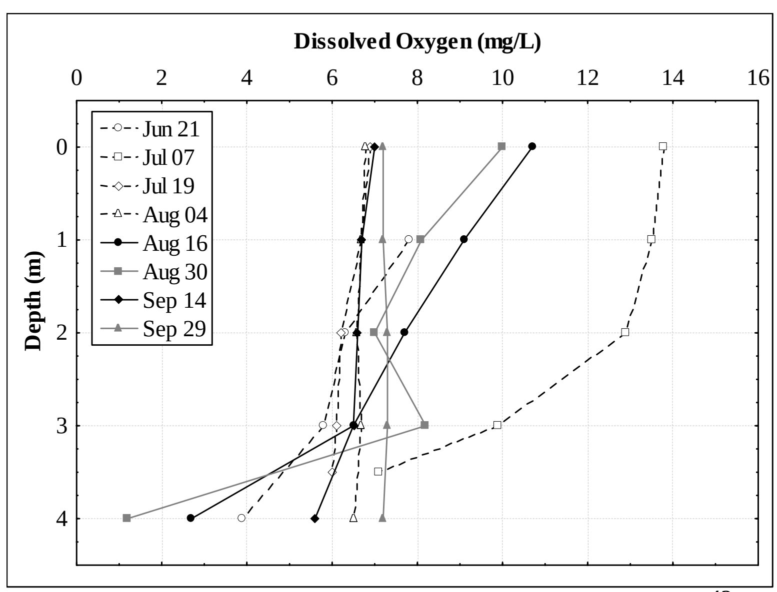


Figure II.B-4. In-lake surface vs. bottom TP concentrations

Figure a.
Site 101

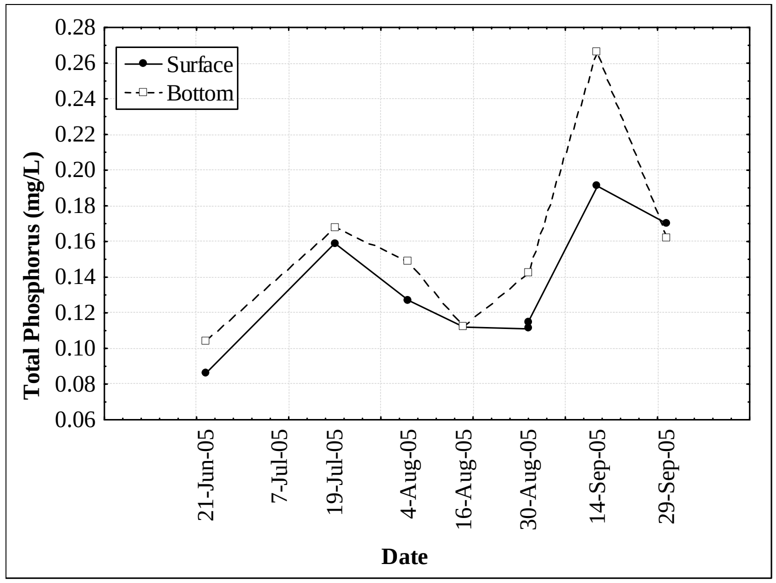


Figure b.
Site 102

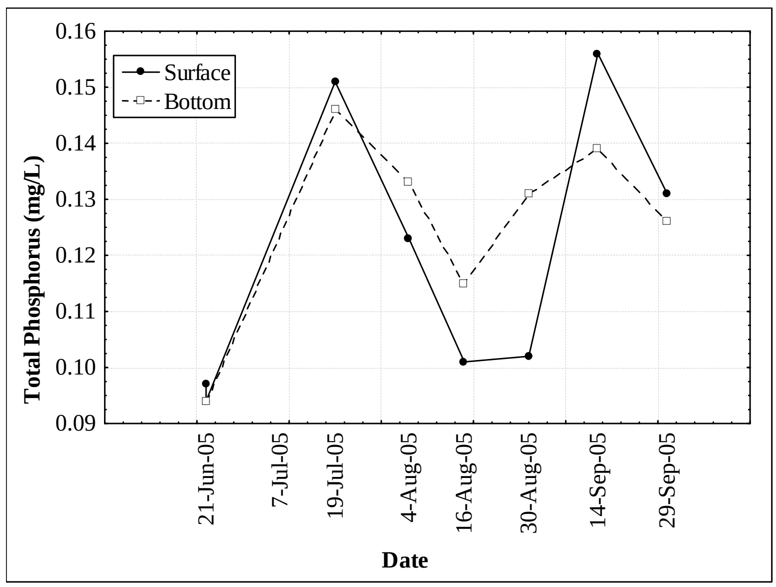


Figure c.
Site 103

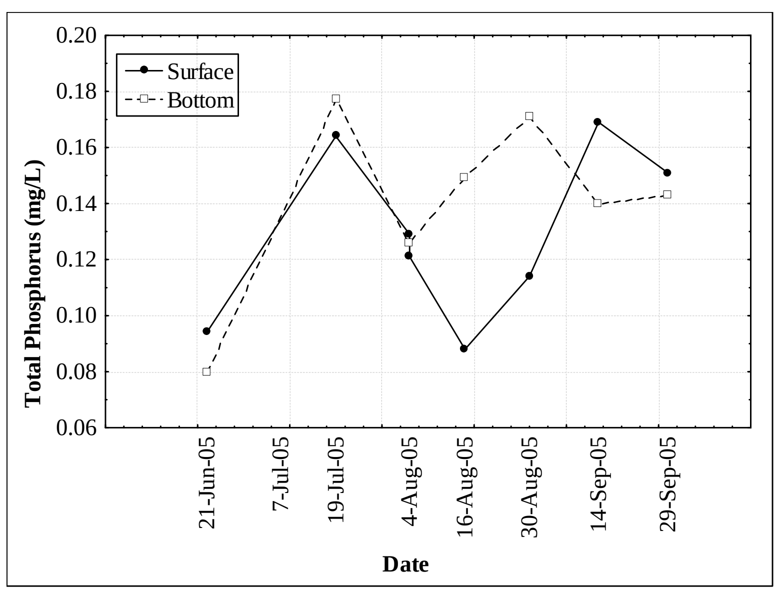


Figure II.C-1. In-lake water quality data, all surface water data

Figure a.
Total phosphorus

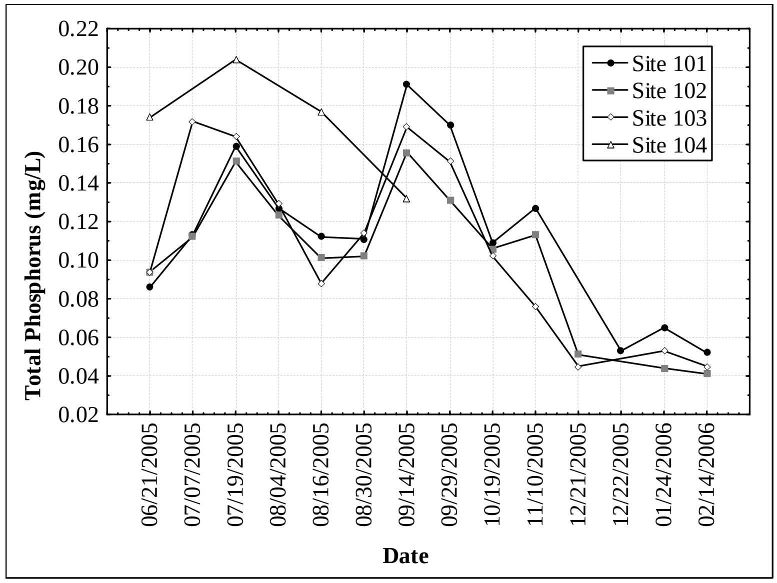


Figure b.
Soluble reactive phosphorus

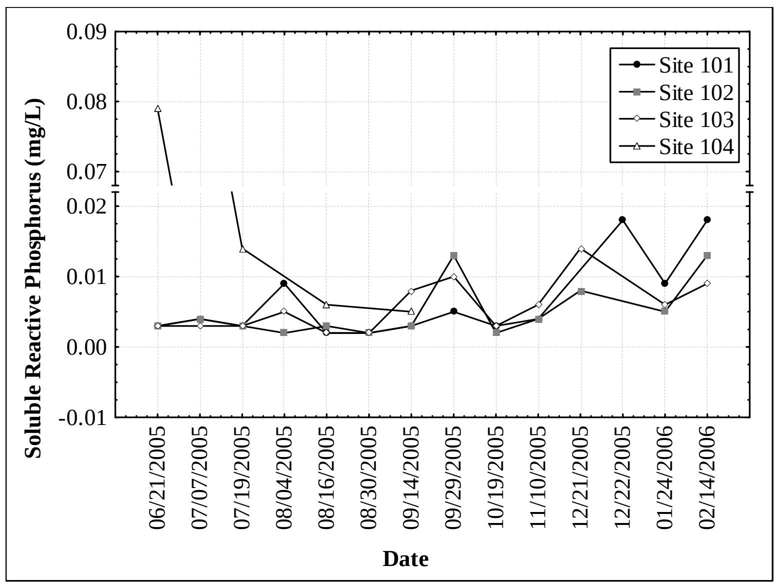


Figure c.
Chlorophyll-*a*

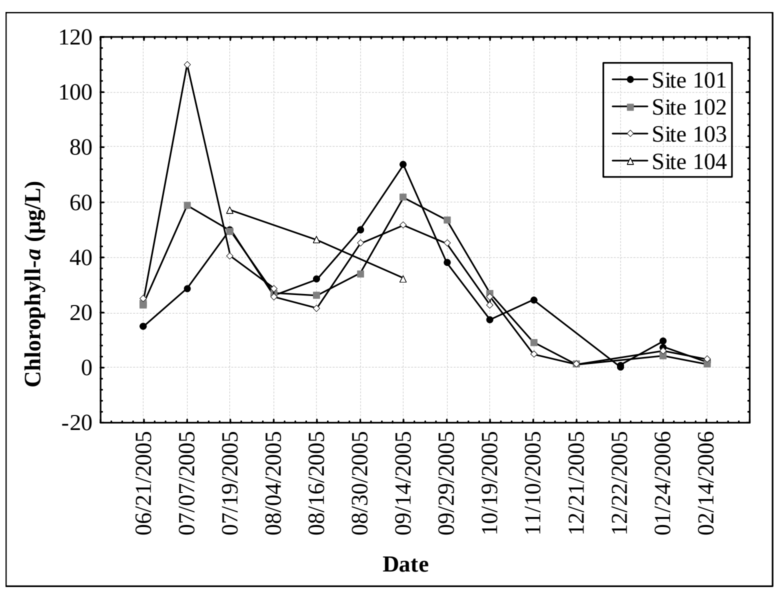


Figure II.C-2. Dissolved oxygen-depth profiles, October 2005 through February 2006

Figure a.
Site 101

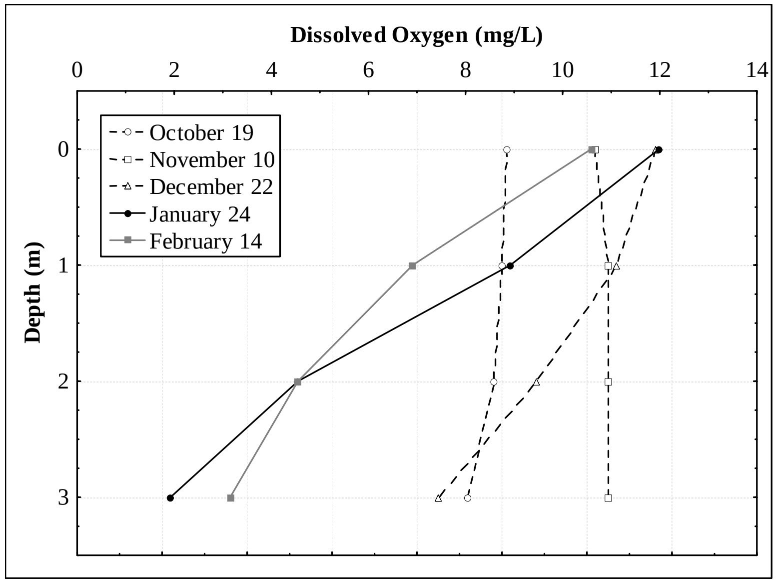


Figure b.
Site 102

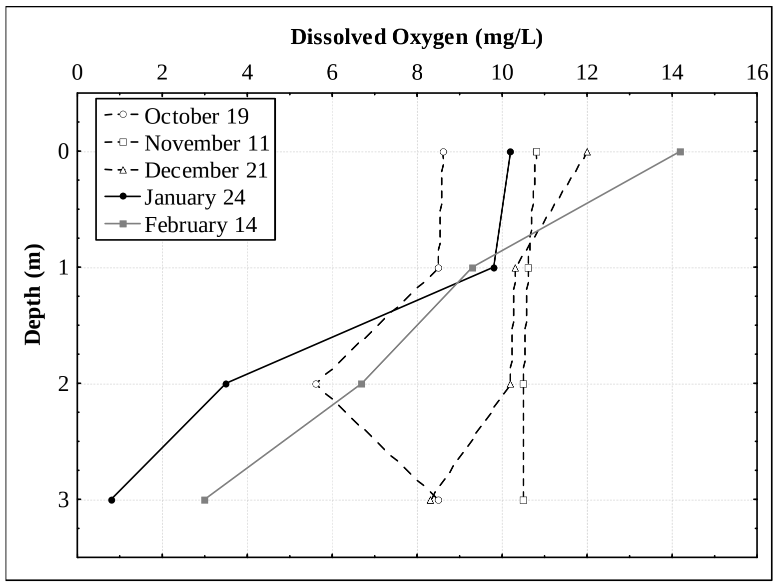


Figure c.
Site 103

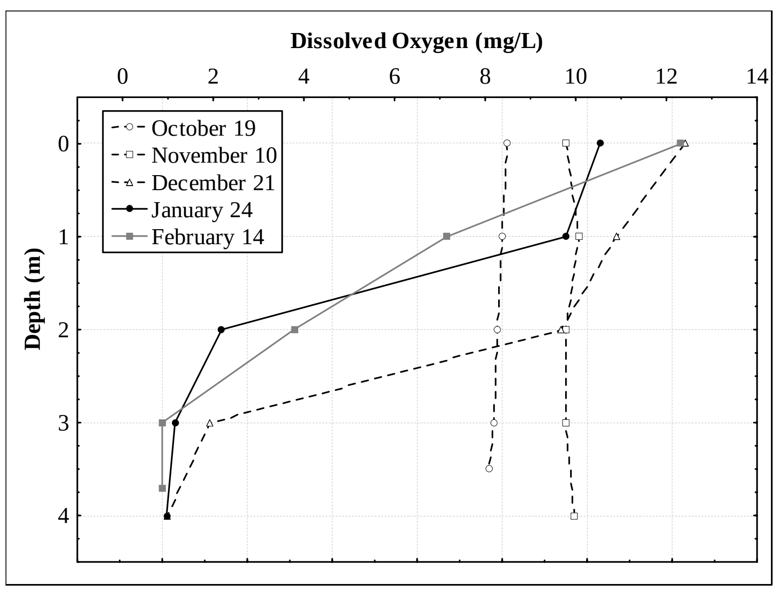


Figure III.B-1 Surficial Geology and Groundwater Monitoring Sites

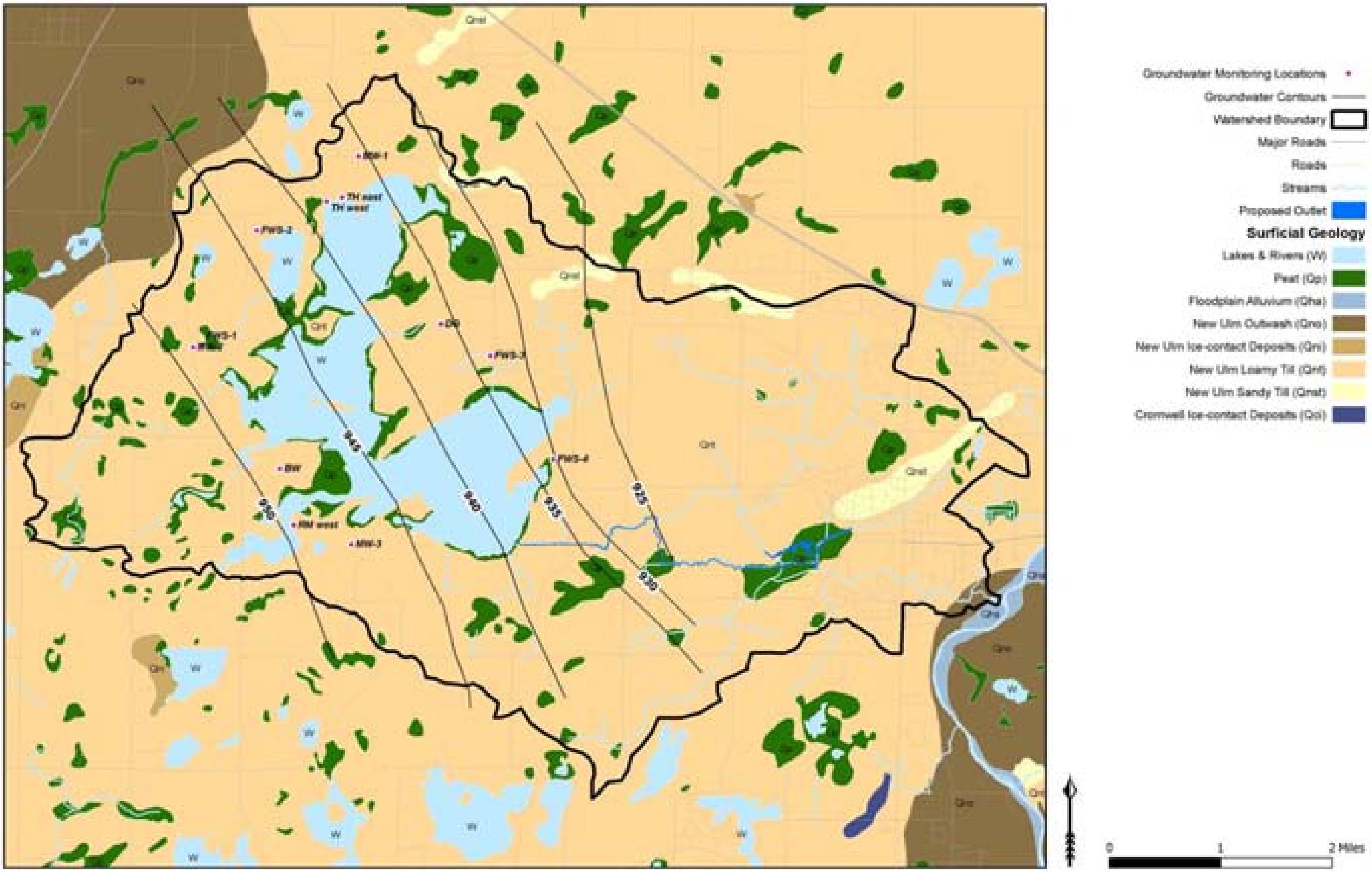
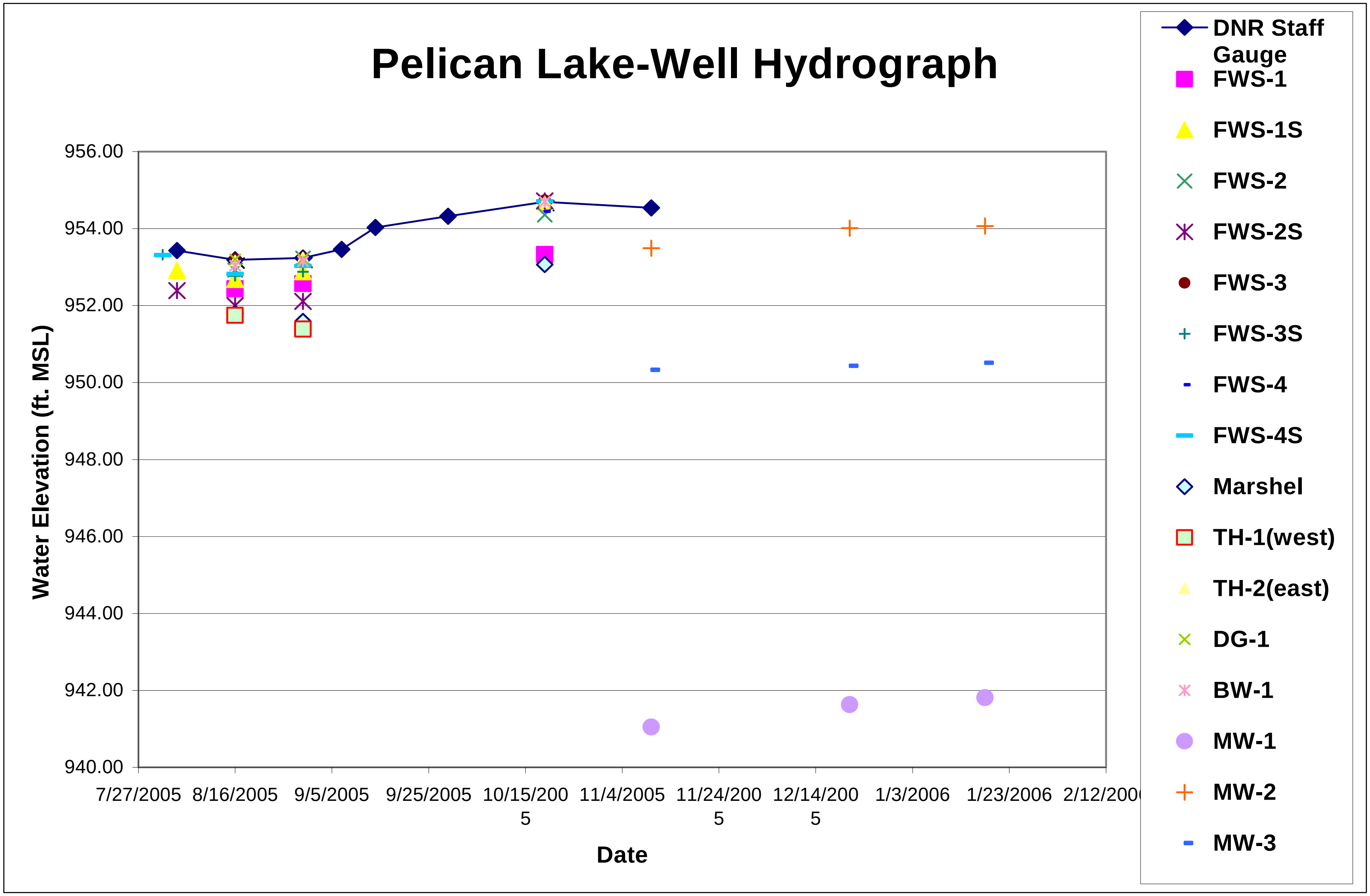
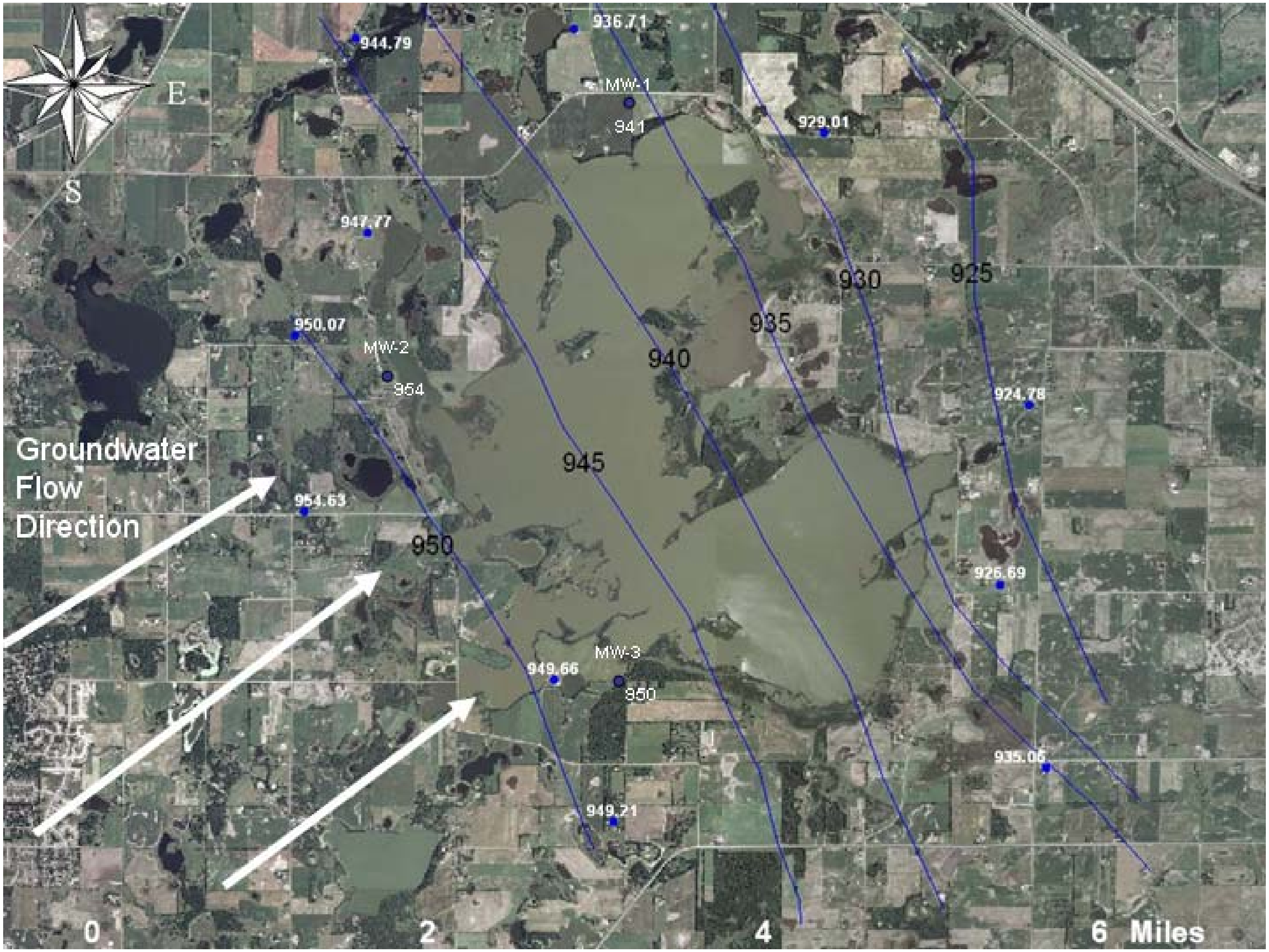


Figure III.B-2 Lake Surface and Groundwater Hydrograph



Well locations are identified in Figure III.B-1

Figure III.B-3 Regional Quaternary Groundwater Contours and Flow Direction



Private well elevations taken 8/26/05-9/1/05 by Minnesota DNR
Lake level 953.24 on 8/30/05 taken by EOR
Monitoring well elevations are averages of measurements taken from November 2005 to January 2006 by EOR

Figure III.B-4. Regional Franconia and Ironton Galesville Aquifer Static Water Elevations

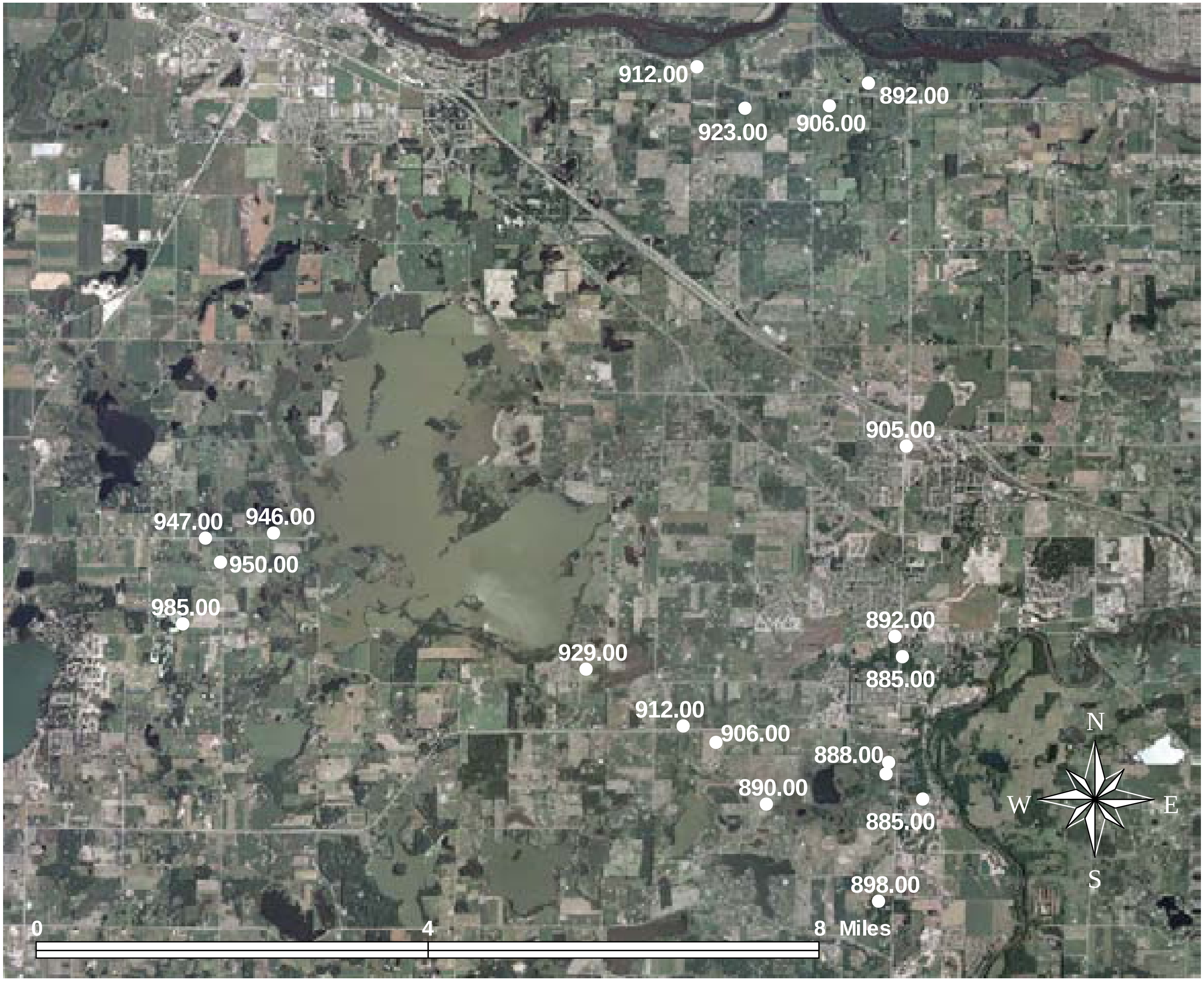
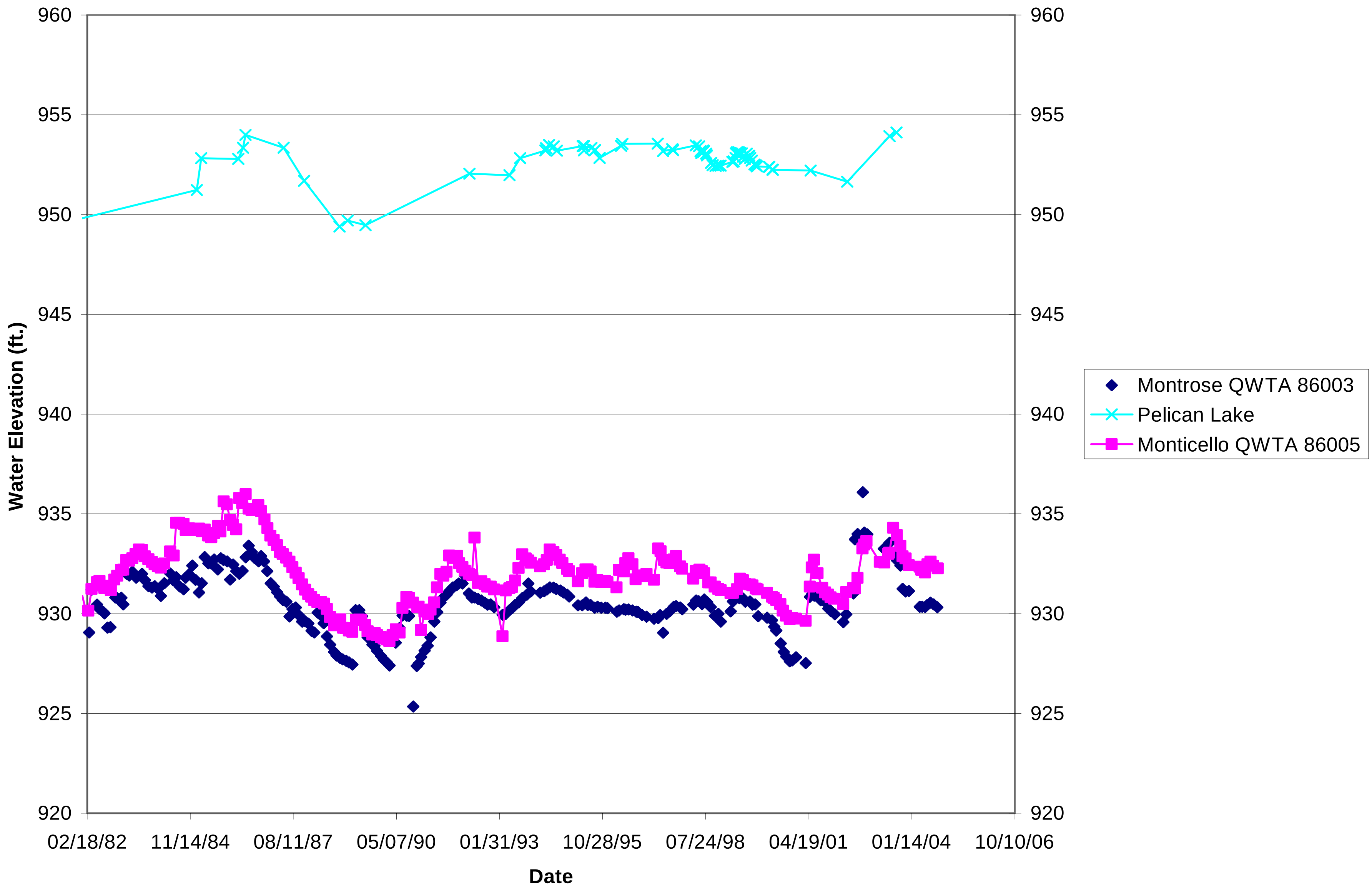


Figure III.B-5. Regional Lakes and Well Hydrograph



Lake Elevations from Minnesota DNR website **http://www.dnr.state.mn.us/lakefind/index.html**
Groundwater Elevations from Minnesota DNR website **http://climate.umn.edu/ground_water_level/**

Figure III.B-6. Hydraulic Conductivity of Soils

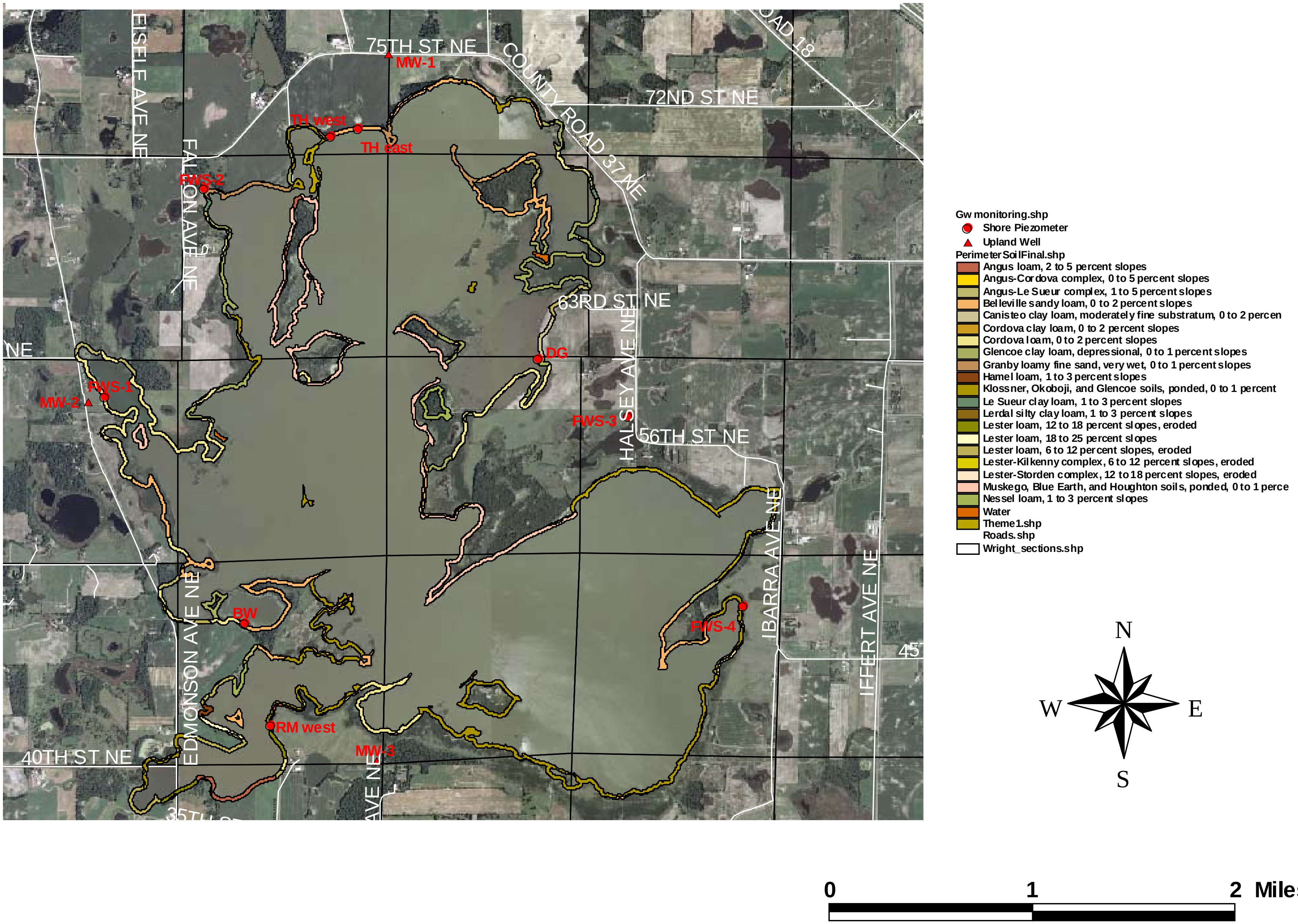


Figure III.C-1. Pelican Lake Historic Lake Levels

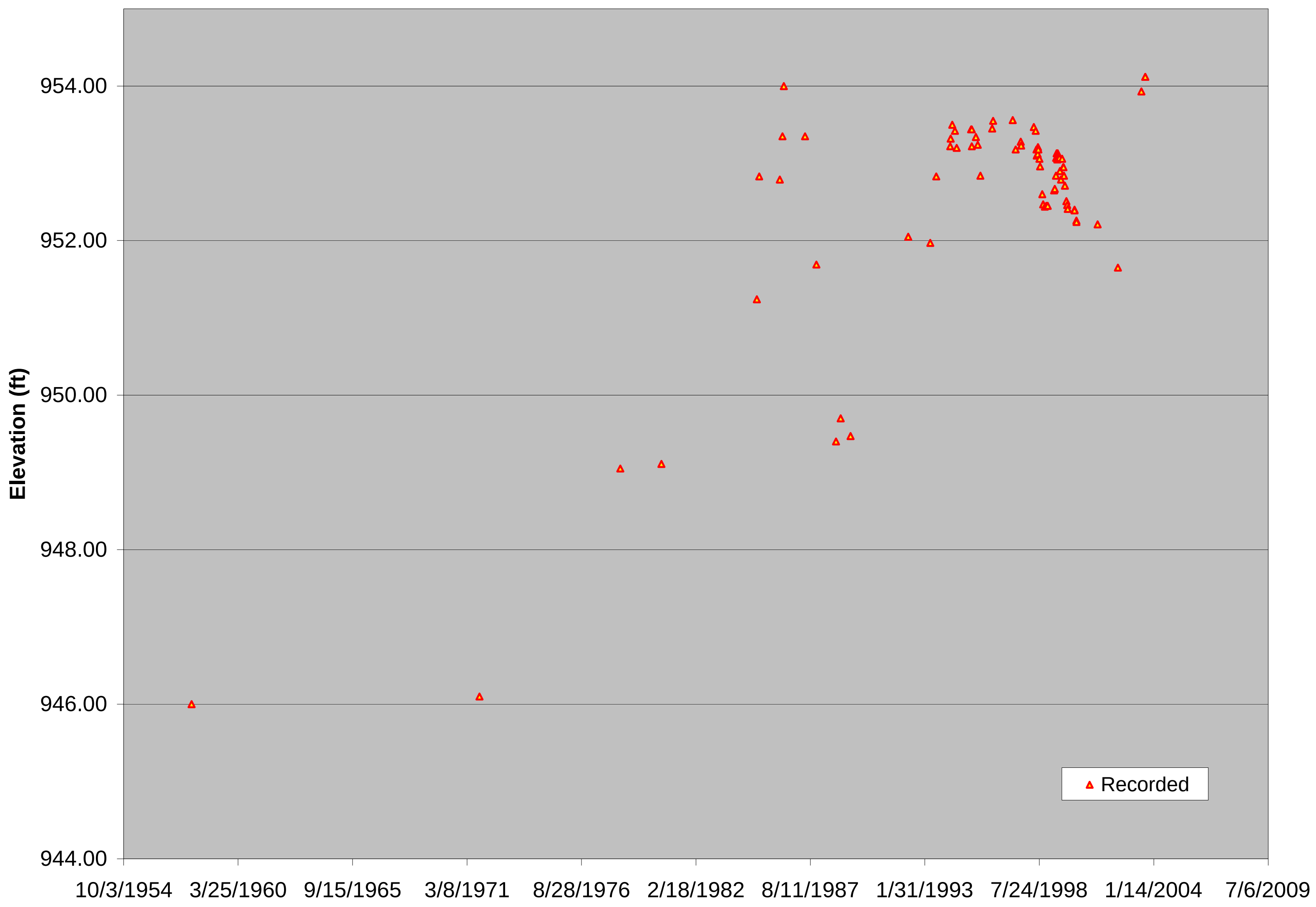


Figure III.C-2. Rain Gauge Locations (indicated by blue circles)

Figure III.C-3. Annual Rainfall Averaged Between Elk River and Buffalo Rain Gauges

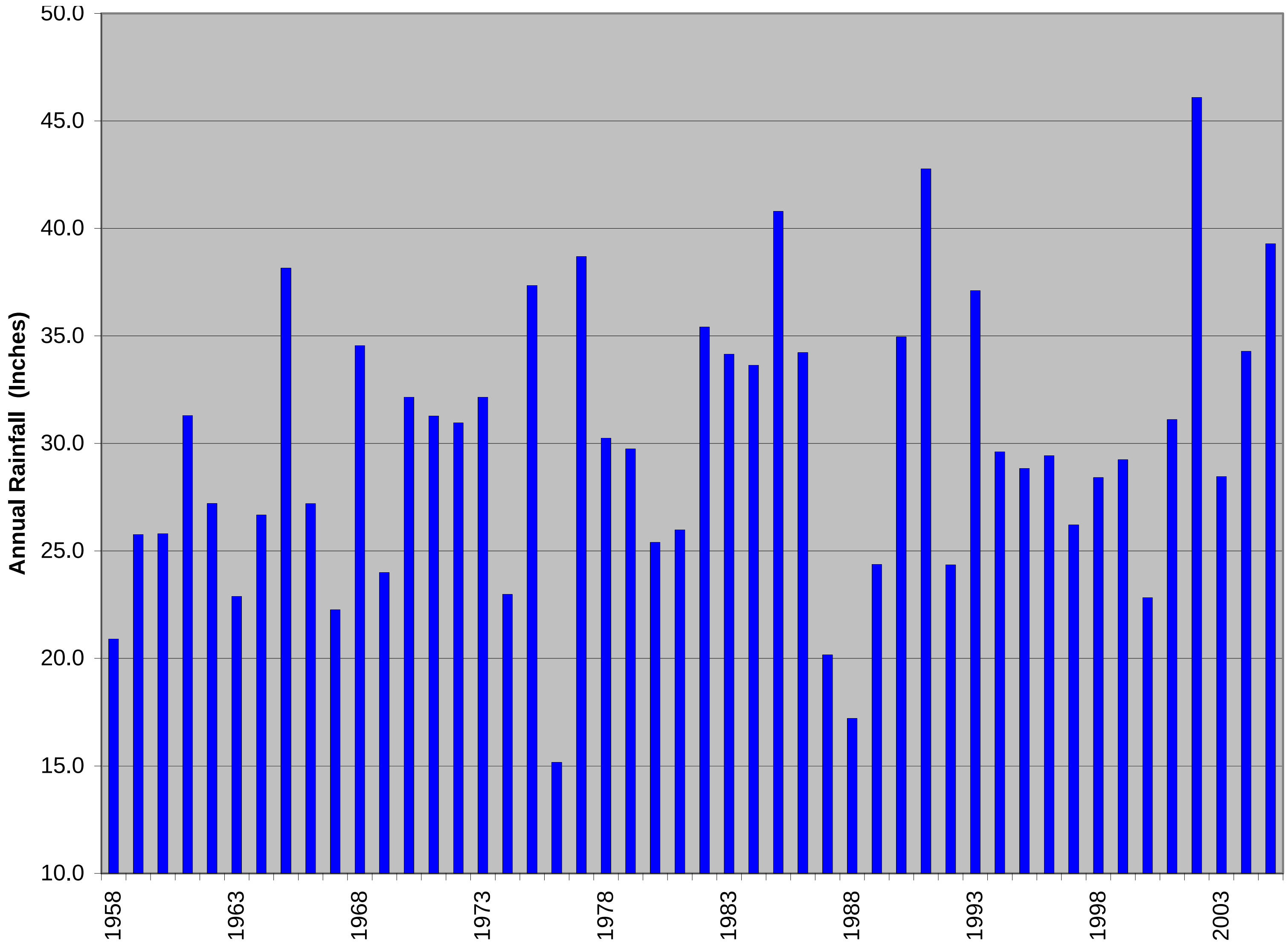


Figure III.C-4. Pelican Lake Long-term Water Budget

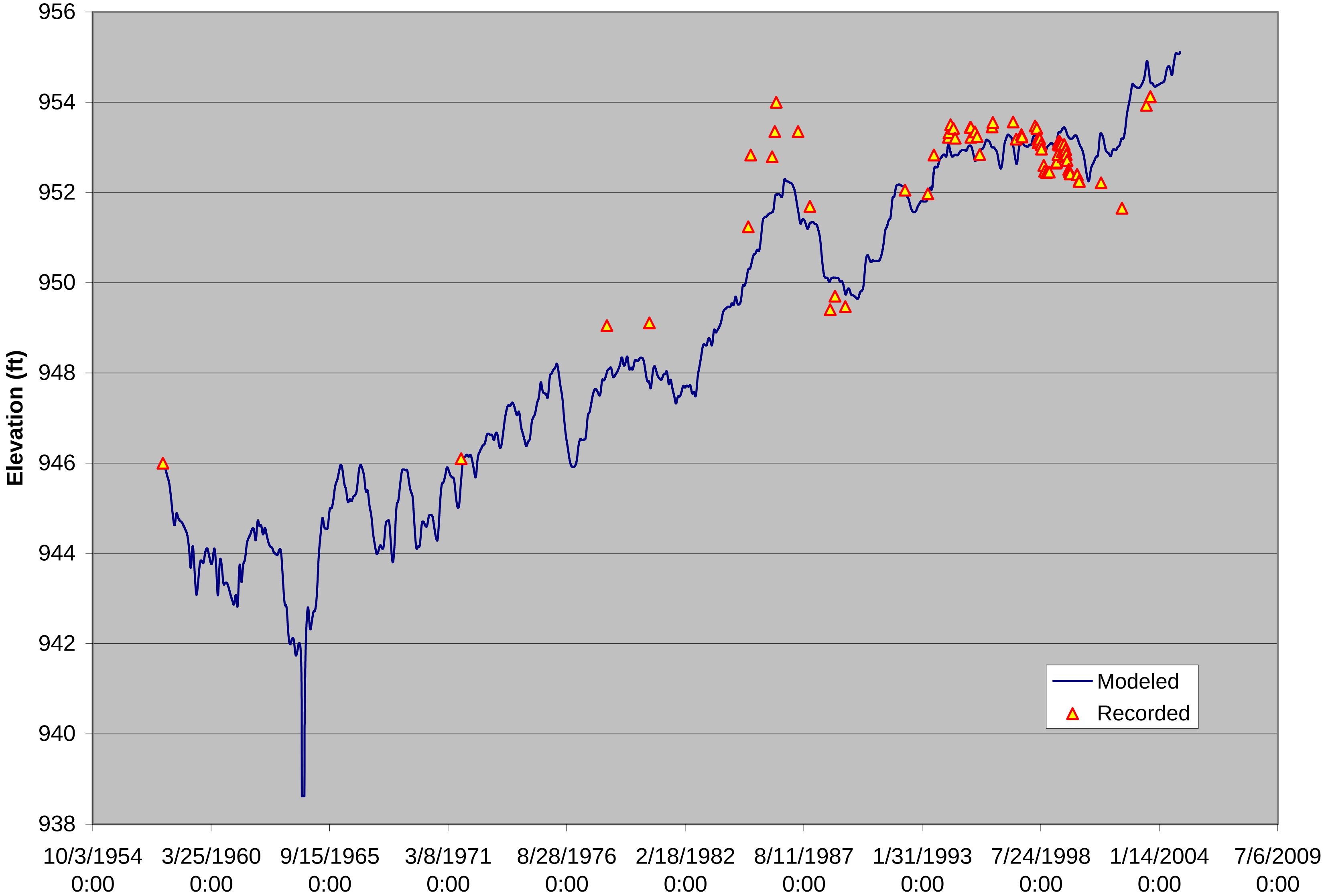


Figure III.C-5. Pelican Lake Drawdown Planning Chart

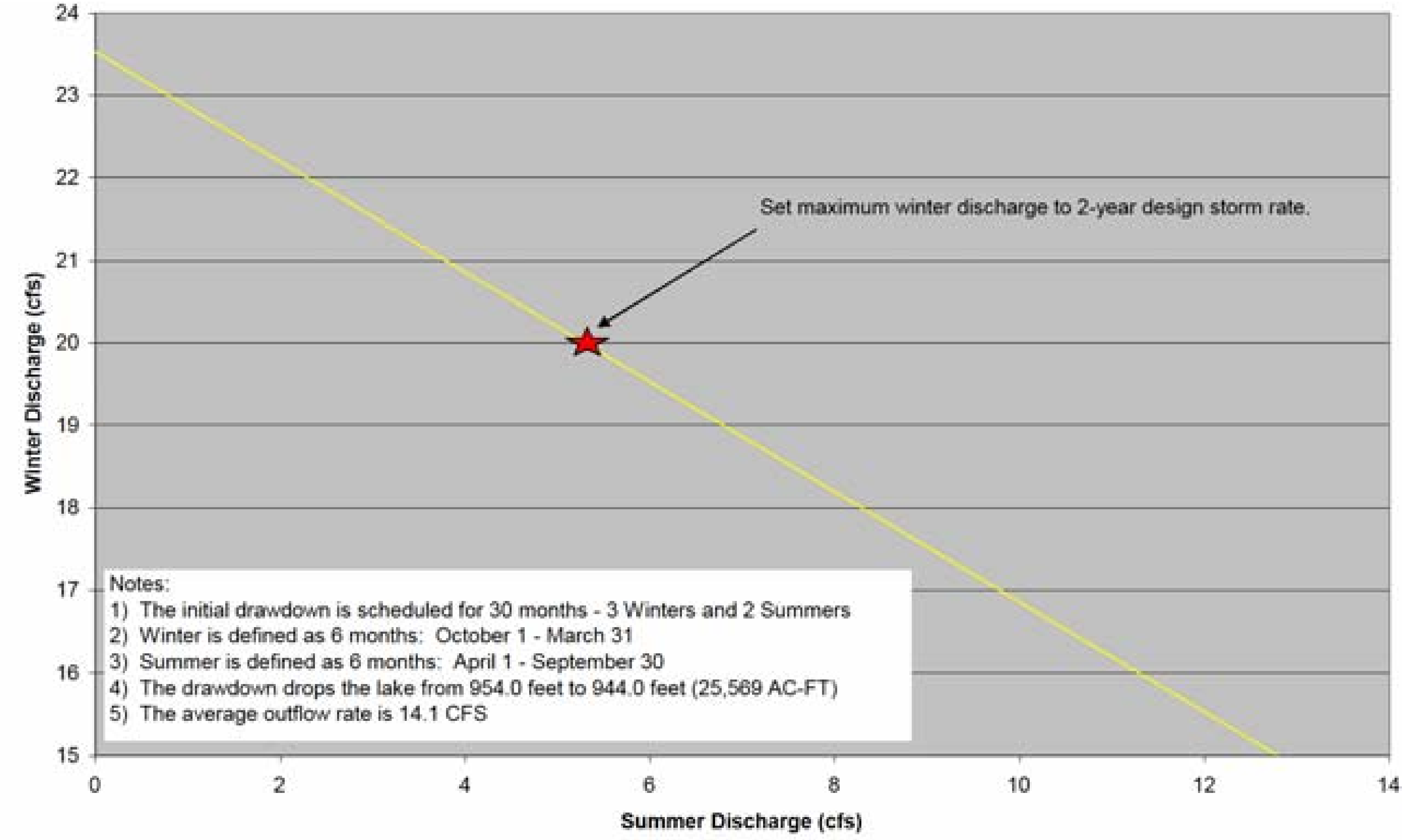


Figure III.C-6. Pelican Lake Drawdown Schedule for Dry Conditions

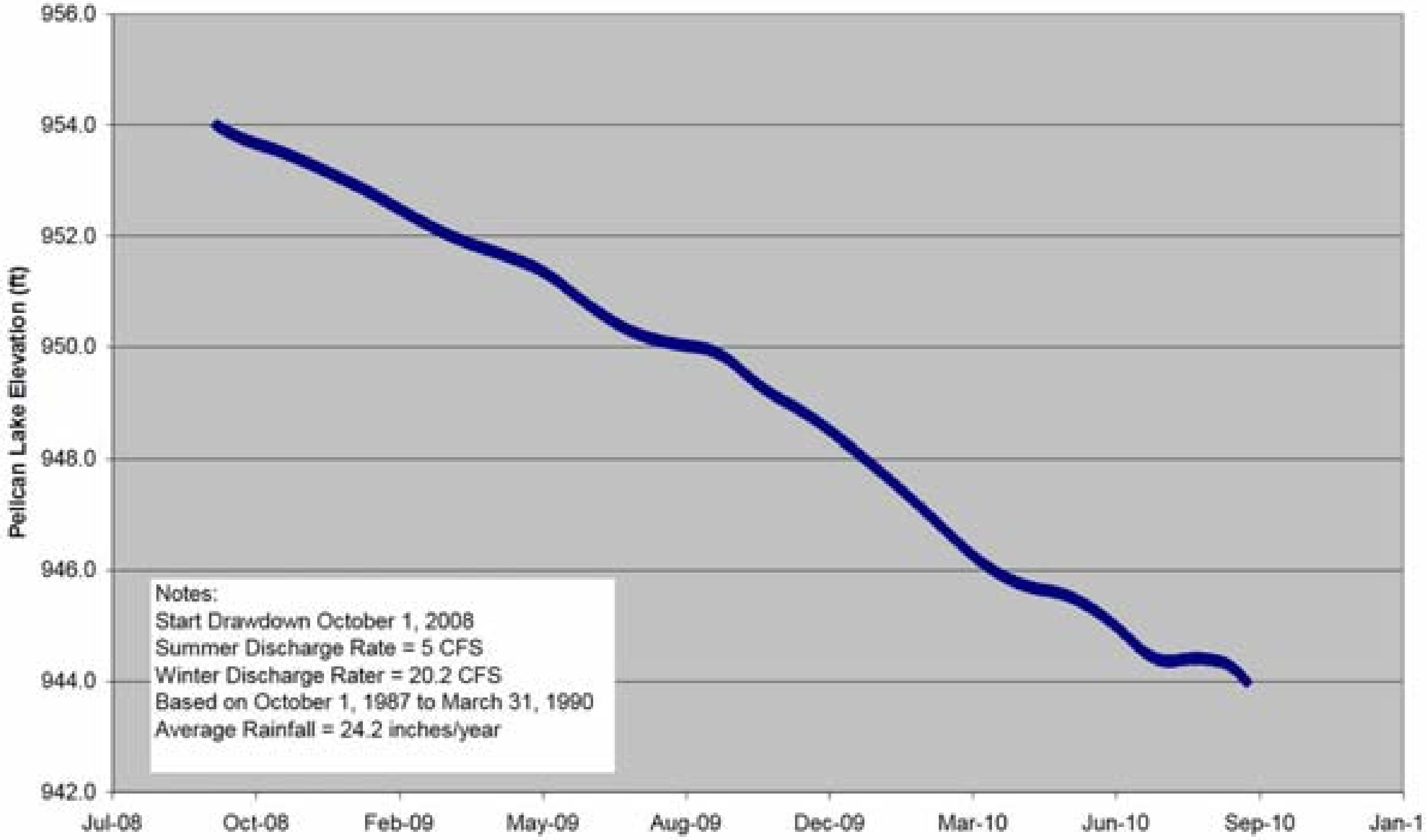


Figure III.C-7. Pelican Lake Drawdown Schedule for Average Conditions

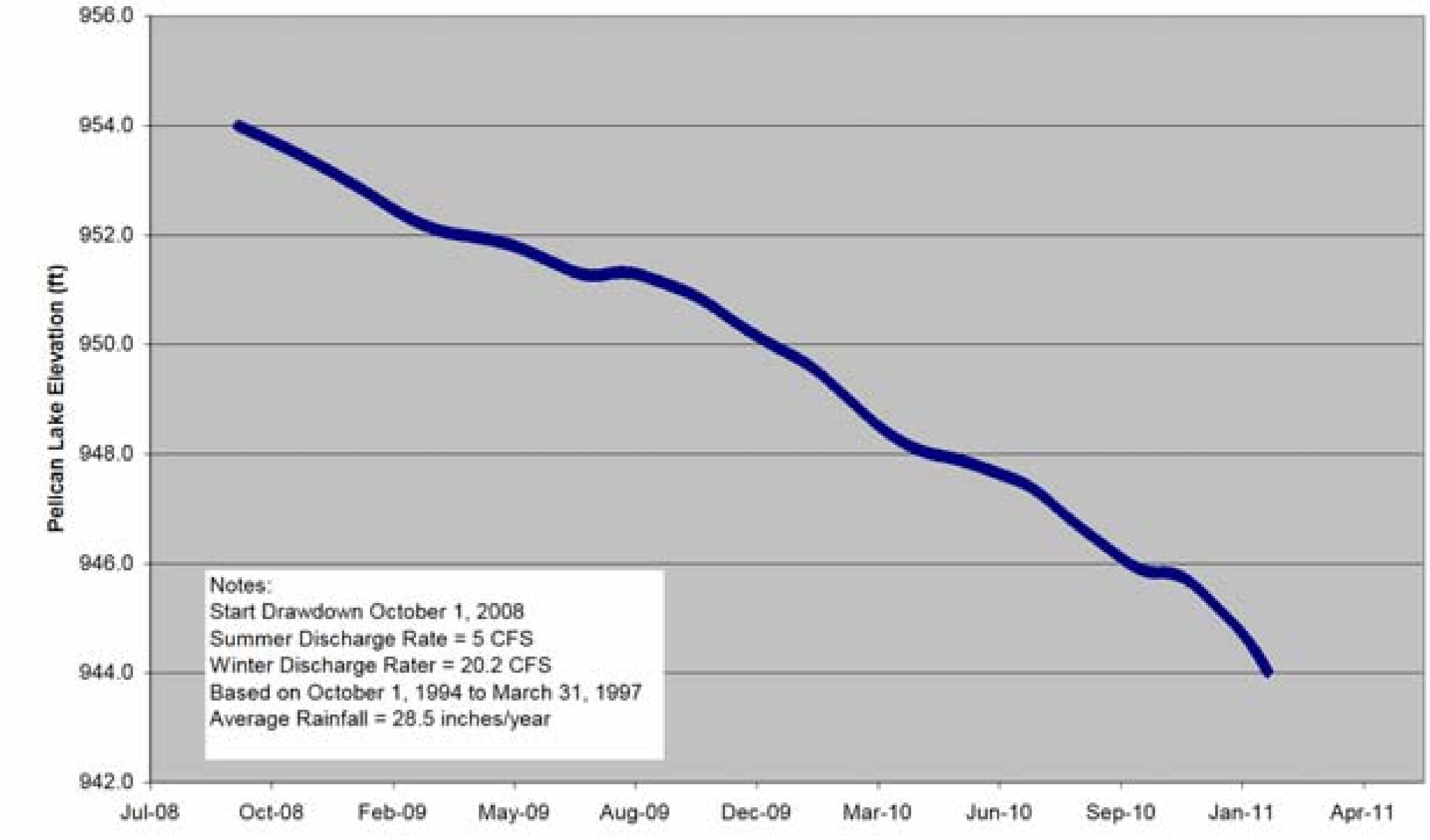


Figure III.C-8. Pelican Lake Drawdown Schedule for Wet Conditions

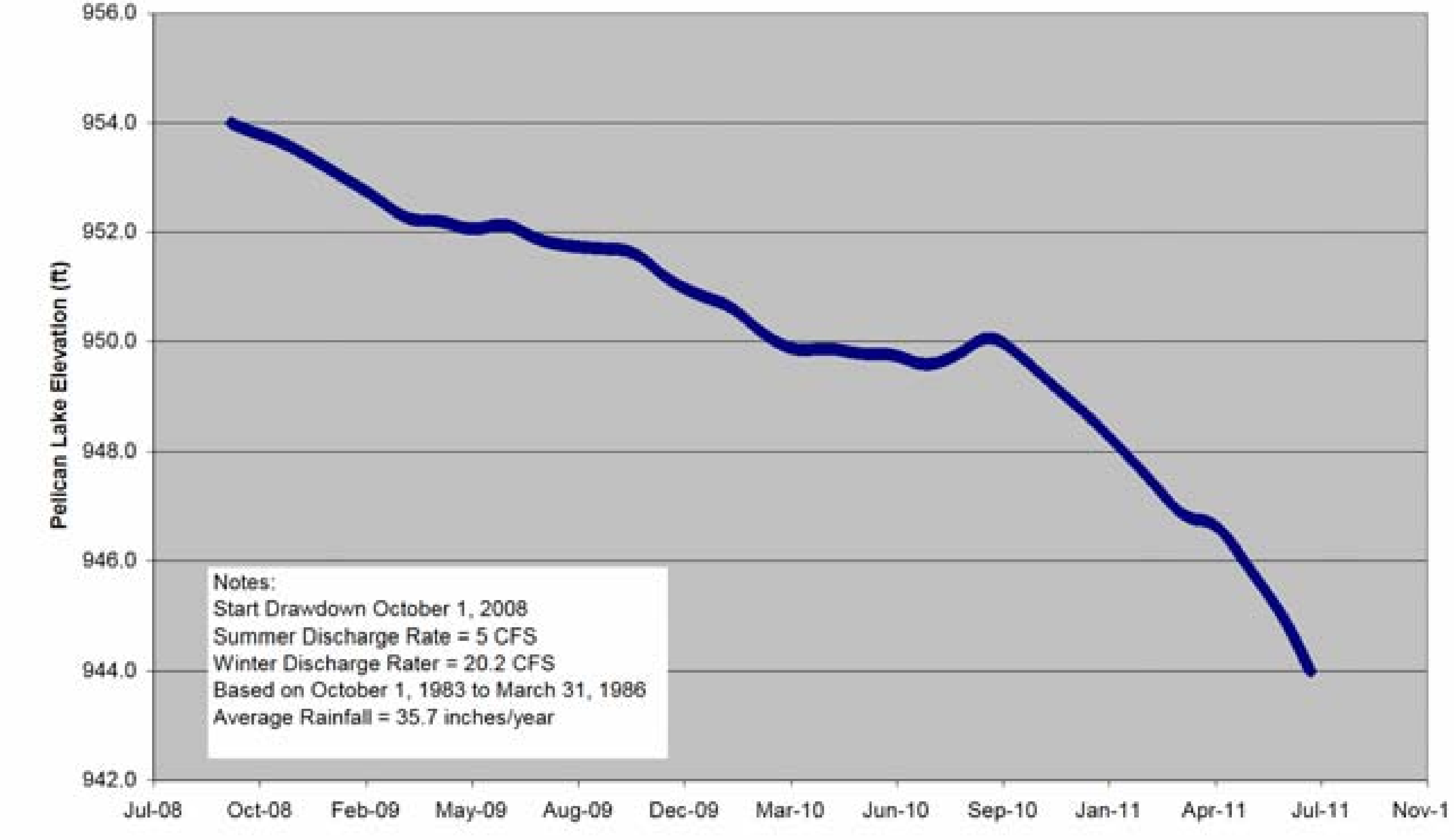
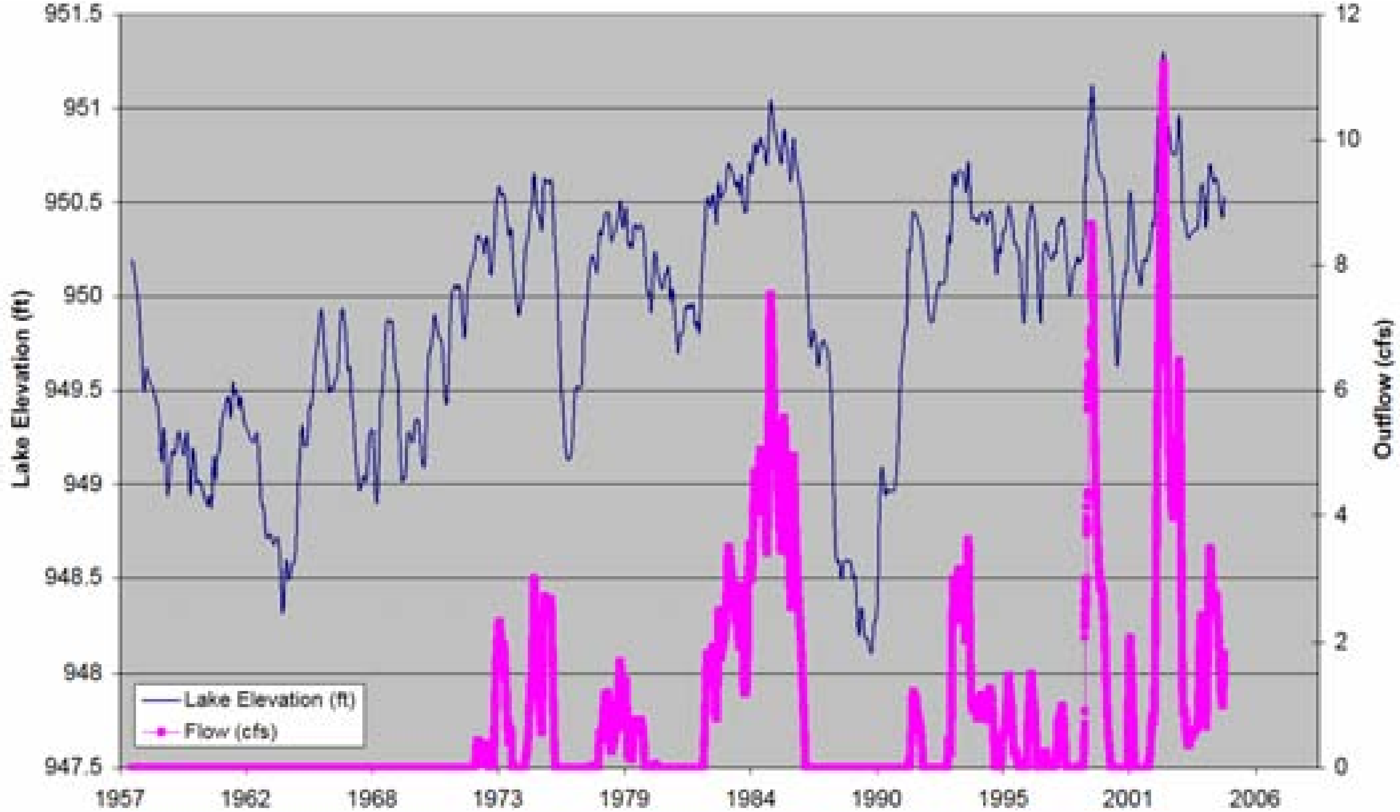


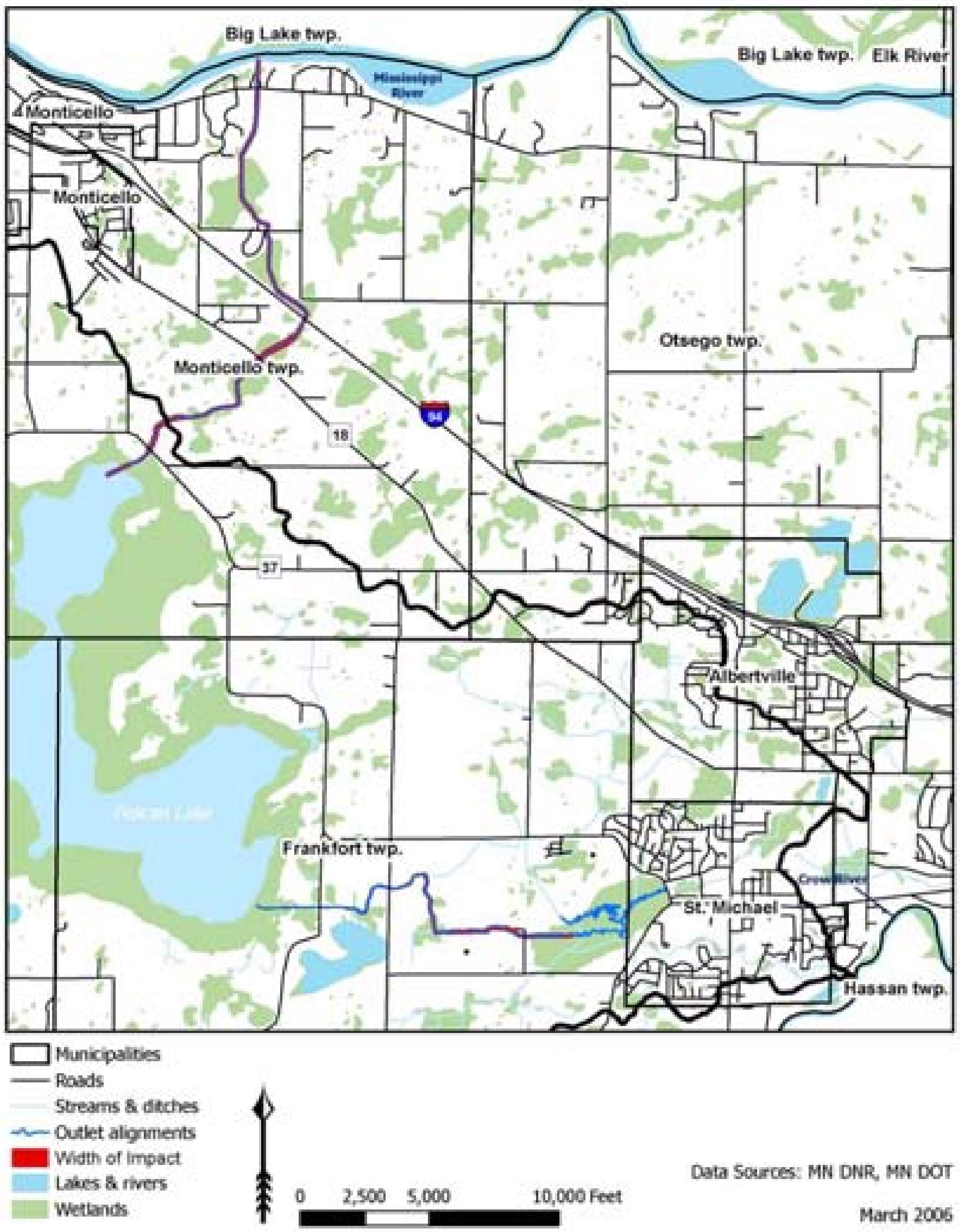
Figure III.C-9. Simulation of Historic Elevation and Ouflow



- 1) Theoretical operation based on historical water elevations since 1958
- 2) 3' sharpcrested weir with end contractions
- 3) Max Elevation = 951.3 Feet
- 4) Average Yearly Outflow = 487 AC-FT (0.67 CFS)
- 5) Maximum Flow = 11 CFS
- 6) Maximum Yearly Outflow = 3200 AC-FT
- *Actual outflows will be based on operating plan

Pelican Lake Feasibility Study

Figure IV.A-1
Outlet Alternatives



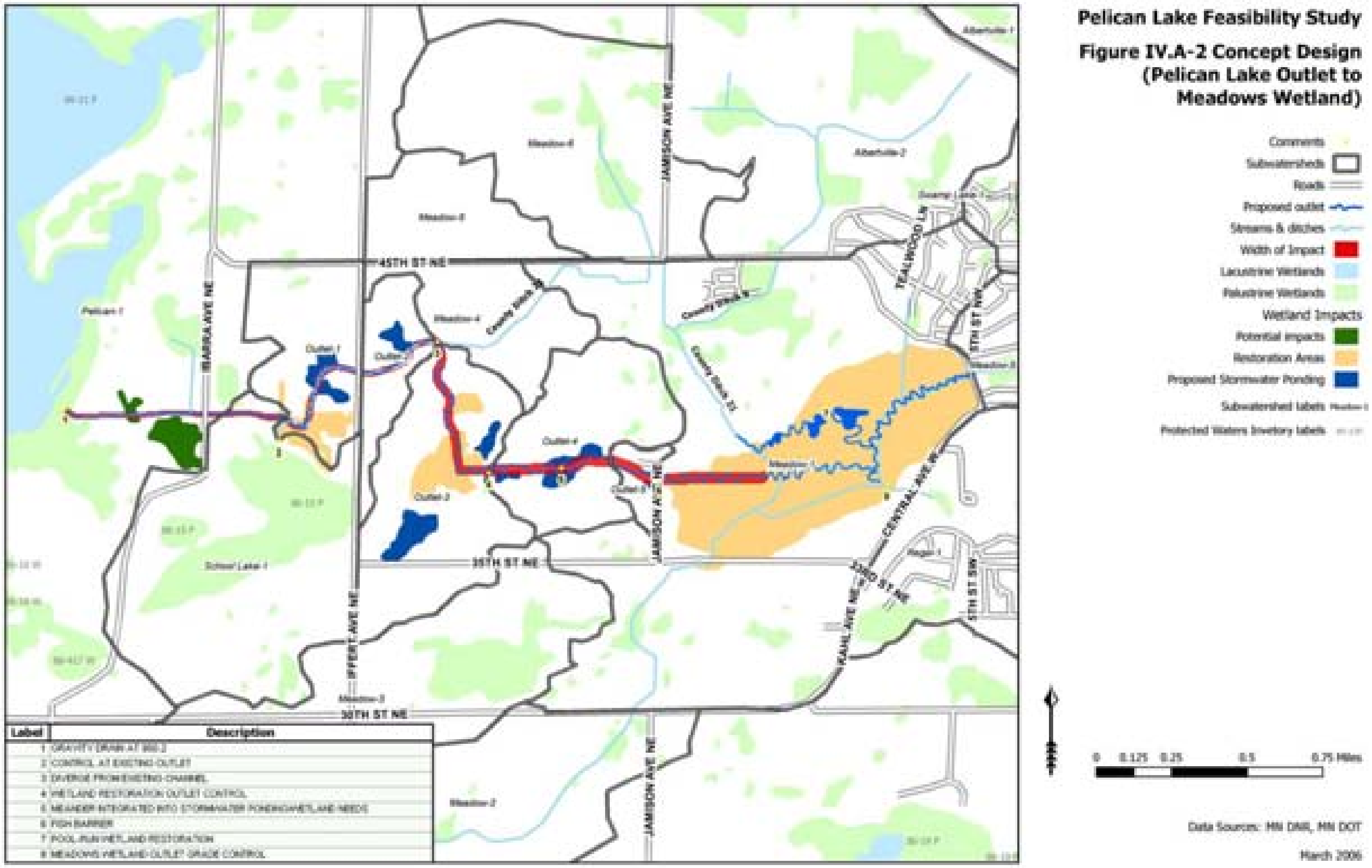

Pelican Lake Feasibility Study
Figure IV.A-2 Concept Design
(Pelican Lake Outlet to
Meadows Wetland)
Comments
Subwatersheds
Roads
Proposed outlet
Streams & ditches
Width of Impact
Lacustrine Wetlands
Palustrine Wetlands
Wetland Impacts
Potential impacts
Restoration Areas
Proposed Stormwater Ponding
Subwatershed labels
Protected Waters Inventory labels
45TH ST NE
35TH ST NE
30TH ST NE
JAMISON AVE NE
TEALWOOD LN
CENTRAL AVE NE
KAHL AVE NE
Label
Description
0 0.125 0.25 0.5 0.75 Miles
Data Sources: MN DNR, MN DOT
March 2006

Figure IV.A-3. East Outlet Profile

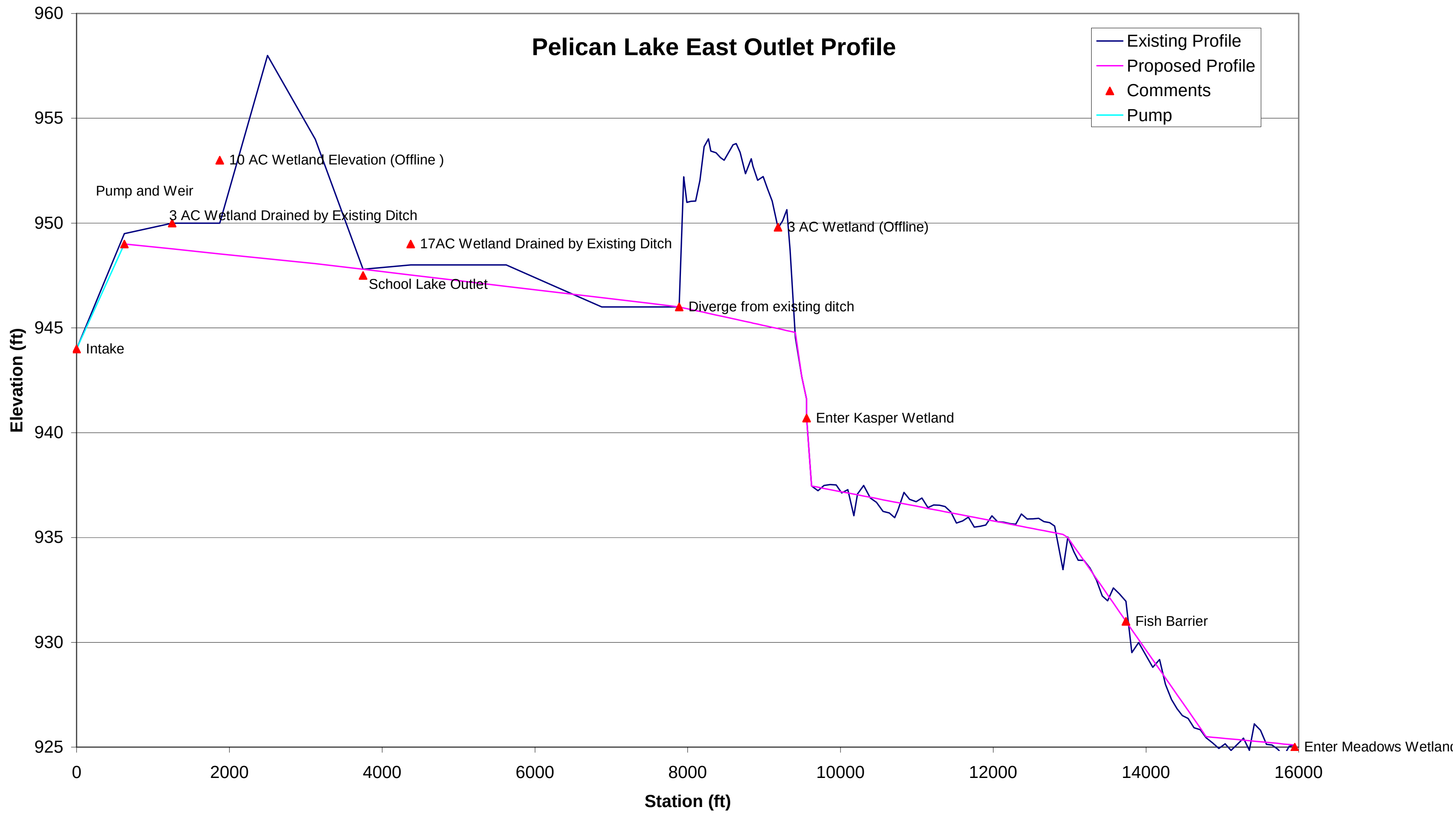


Figure IV.A-4. Typical Cross Section

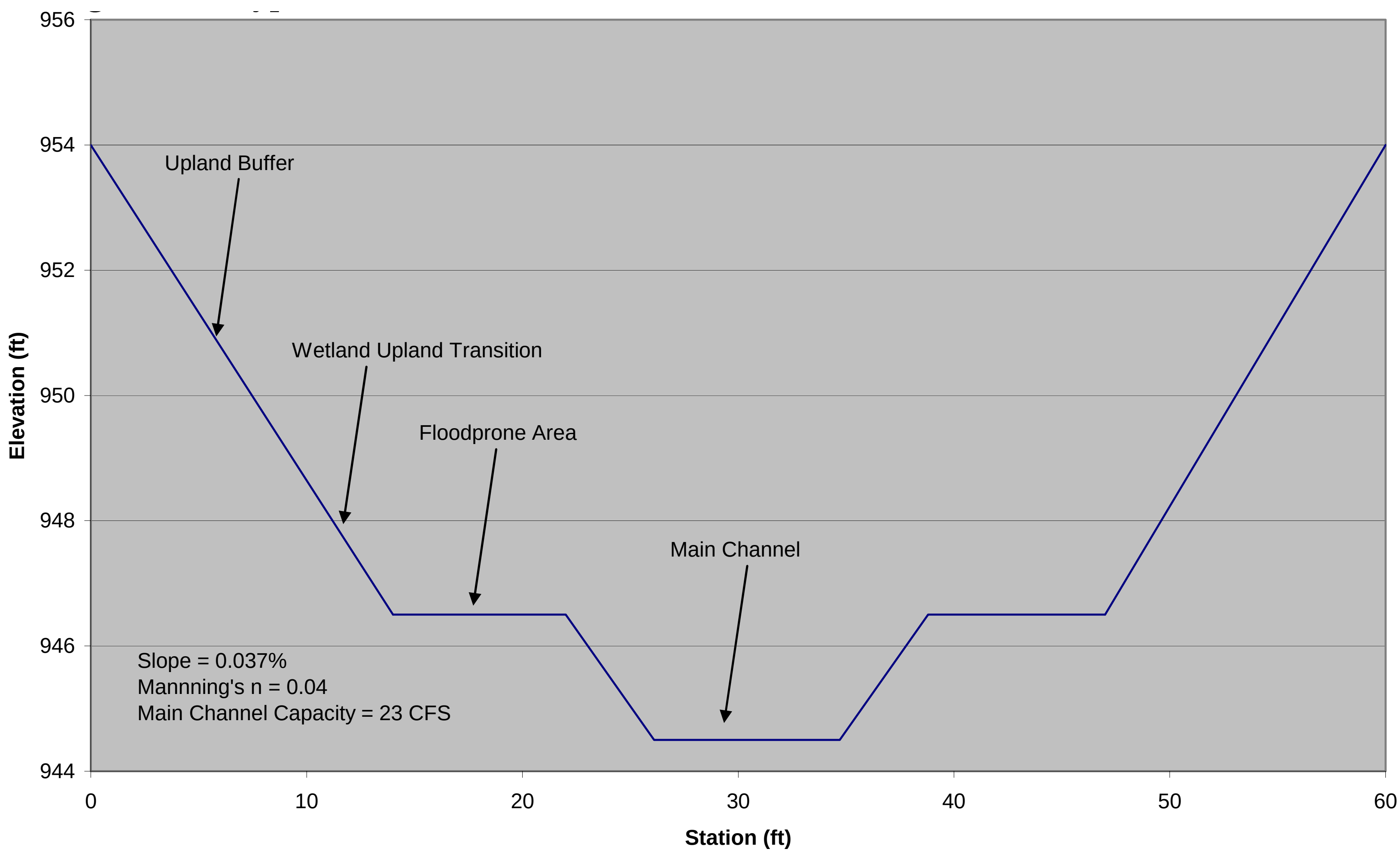
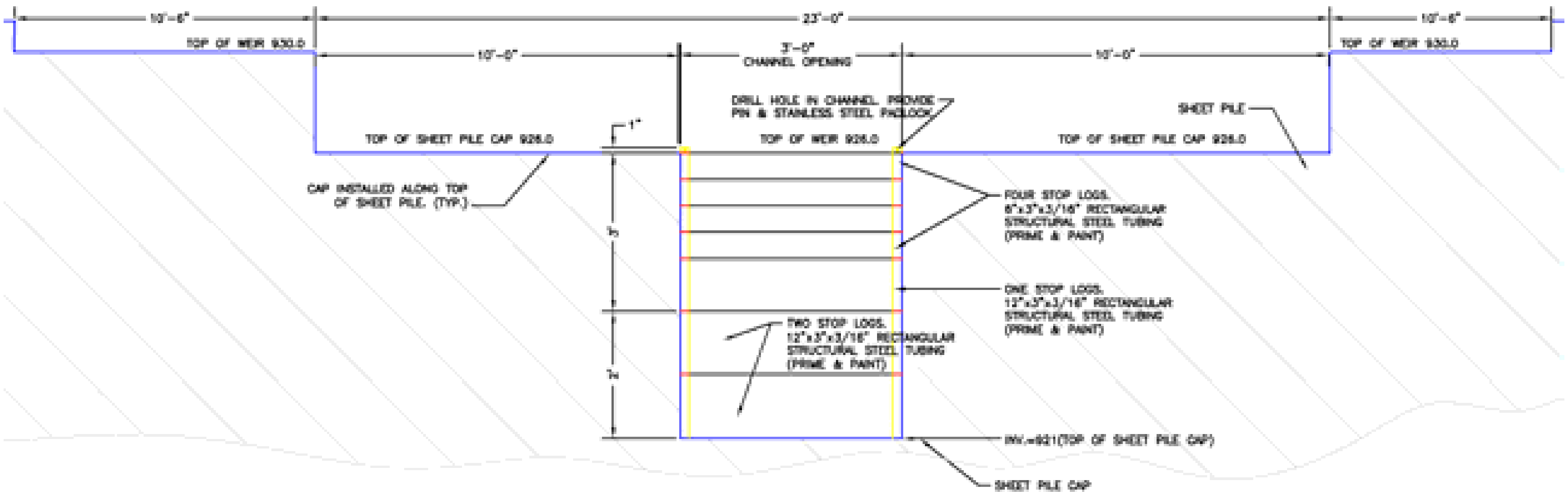
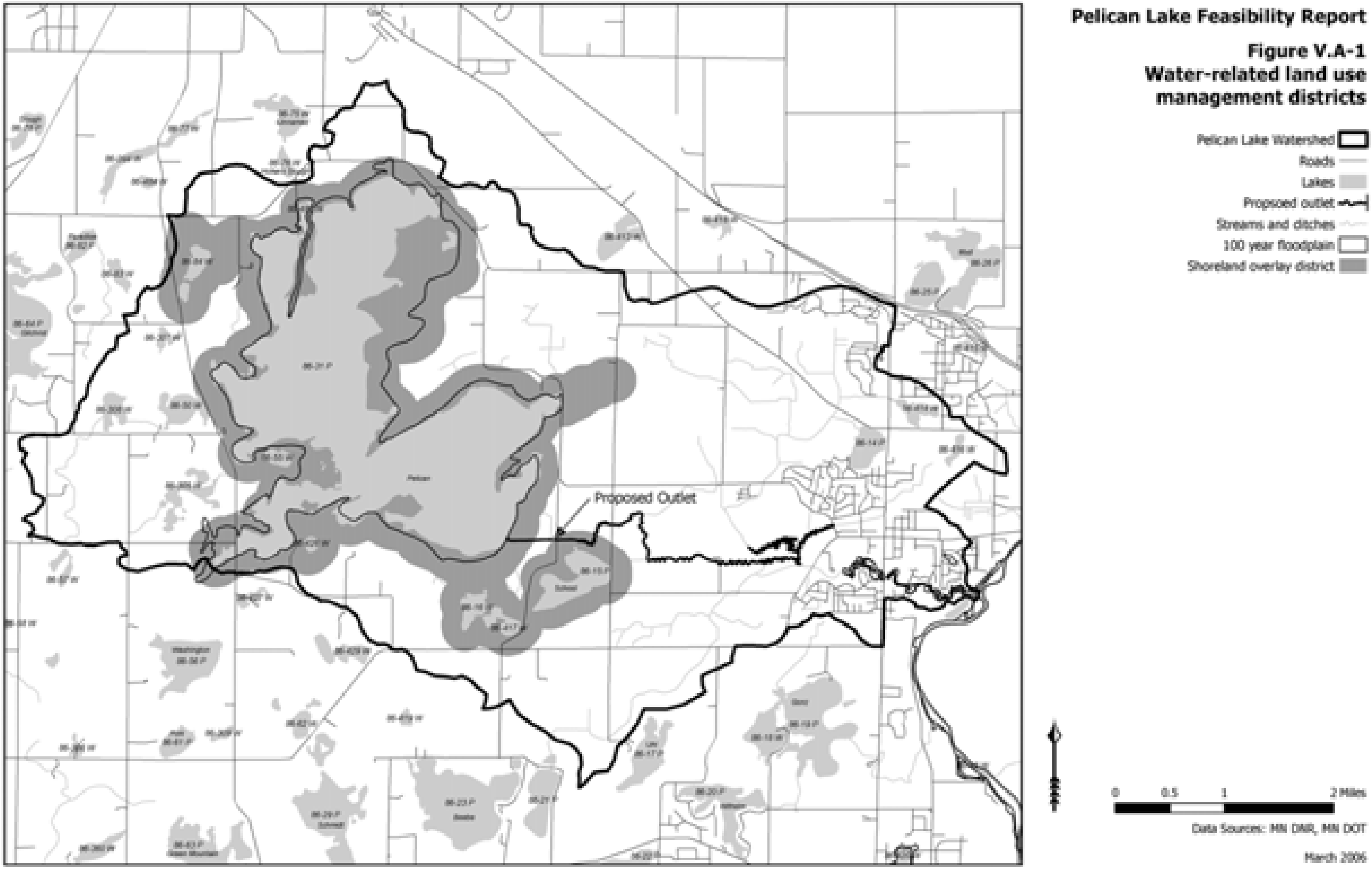


Figure IV.A-5. Meadows Wetland Outlet Weir





Pelican Lake Feasibility Report

Figure V.A-1
Water-related land use management districts


Pelican Lake Feasibility Study
Figure V.B-1
Lake Outlet Controls
200' new channel to connect lake to outlet weir under normal operation
2' stop log weir with normal operating elevation at 950.2
Pump and 25' forcemain to operate during lake management drawdowns
900' intake to operate during lake management drawdowns
Outlet Controls
Open Channel
New Channel
Pump
Weir
intake and force
0
100
200
400 Feet
Data Sources: MN DNR
March 2006

Figure VI.B-1. Important Elevations within Meadows Wetland -

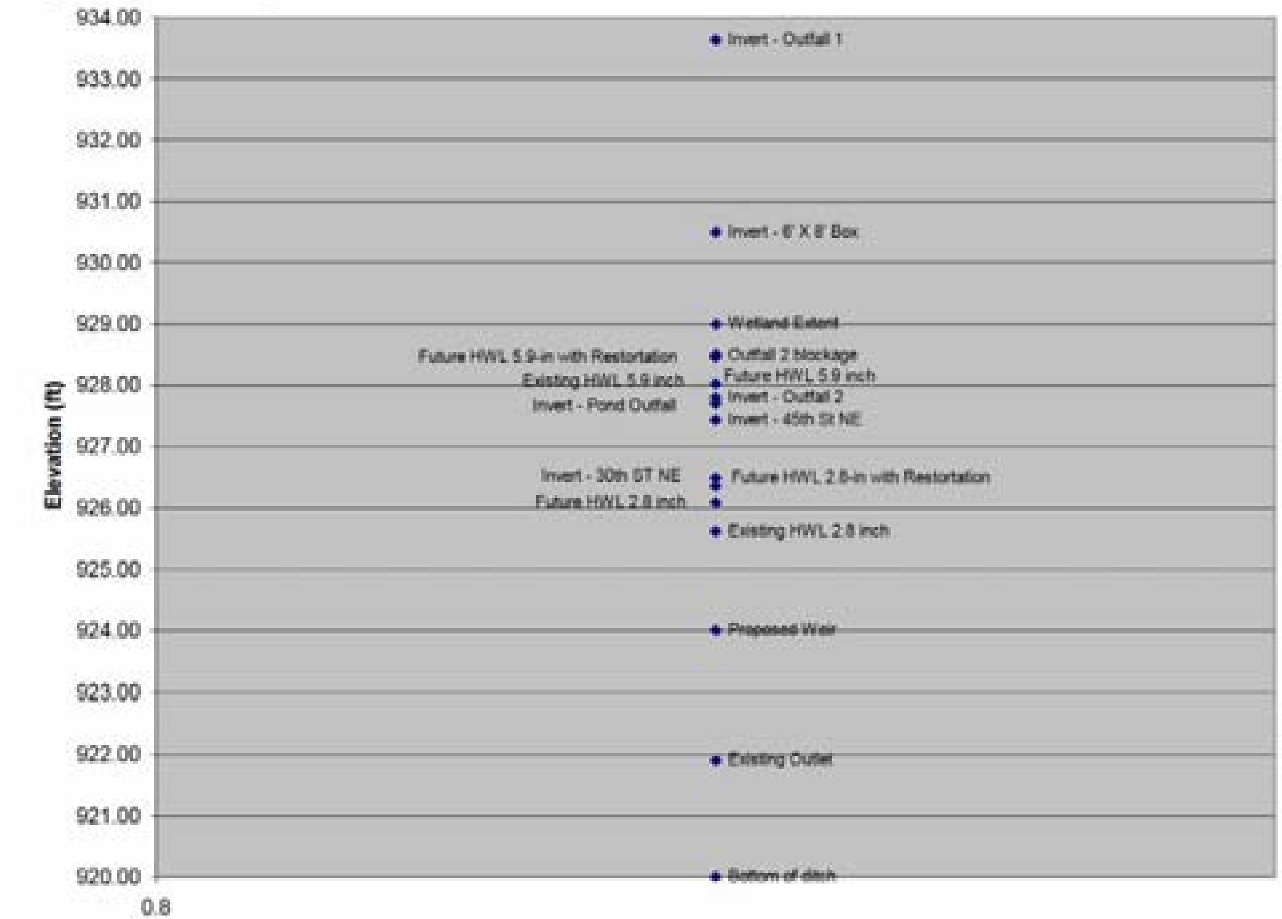


Figure VI.B-2. In stream Erosion Analysis for Regal Creek

Reach #1

Stream Morphology Parameters				Stream Bottom Substrate	
				Type	Percent by Type
Bankfull Width (ft)	9.25	Sinuosity	1.4	Silt/Clay	No
Bankfull Depth (ft)	2	Channel Slope (ft/ft)	0.00135	Sand	Substrate
Floodprone Width (ft)	45	Width/Depth Ratio	6.13	Gravel	Analysis
Mean Depth (ft)	1.51	Entrenchment Ratio	4.9	Cobble	
Maximum Depth (ft)	4	Stream Type	C4c-	Boulder	
X-Sectional Area (ft^2)	13.95	Channel Stability		Bedrock	
Rh at Bankfull (ft)	0.80	WP at Bankfull (ft)	17.4		

Impacts	Exceeds threshold by >10%	Exceeds by less than 10%	Equal to or less than threshhold	Thresholds: Shear Stress=0.075lbs/sf, Velocity=2.5ft/s

Erosion Potential Indicator	Modeled Condition			
	Existing	Future Conditions	Future Conditions with Lake Outlet	Future Conditions with Lake Outlet and Meadows Restoration
2-year Rainfall Peak Flow Rate (cfs)	81	120	140	94
2-year Rainfall Channel Velocity (ft/s)	2.70	2.73	2.76	2.70
2-year Shear Stress (lb/ft^2)	0.066	0.076	0.086	0.068

Reach #2

Stream Morphology Parameters				Stream Bottom Substrate	
				Type	Percent by Type
Bankfull Width (ft)	13.2	Sinuosity	1.48	Silt/Clay	9
Bankfull Depth (ft)	0.65	Channel Slope (ft/ft)	0.0028	Sand	22
Floodprone Width (ft)	37	Width/Depth Ratio	11.06	Gravel	69
Mean Depth (ft)	1.2	Entrenchment Ratio	2.8	Cobble	
Maximum Depth (ft)	1.3	Stream Type	C4	Boulder	
X-Sectional Area (ft^2)	15.75	Channel Stability		Bedrock	
Rh at Bankfull (ft)	1.04	WP at Bankfull (ft)	15.1		

Impacts	Exceeds threshold by >10%	Exceeds by less than 10%	Equal to or less than threshhold	Thresholds: Shear Stress=0.075lbs/sf, Velocity=2.5ft/s

Erosion Potential Indicator	Modeled Condition			
	Existing	Future Conditions	Future Conditions with Lake Outlet	Future Conditions with Lake Outlet and Meadows Restoration
2-year Rainfall Peak Flow Rate (cfs)	107	129	149	102
2-year Rainfall Channel Velocity (ft/s)	2.26	2.30	2.34	2.21
2-year Shear Stress (lb/ft^2)	0.082	0.089	0.096	0.077

Reach #3

Stream Morphology Parameters				Stream Bottom Substrate	
				Type	Percent by Type
Bankfull Width (ft)	14.6	Sinuosity	1.77	Silt/Clay	1
Bankfull Depth (ft)	0.88	Channel Slope (ft/ft)	0.00463	Sand	31
Floodprone Width (ft)	19.9	Width/Depth Ratio	32.4	Gravel	68
Mean Depth (ft)	0.45	Entrenchment Ratio	1.36	Cobble	
Maximum Depth (ft)	1.76	Stream Type	F4	Boulder	
X-Sectional Area (ft^2)	6.6	Channel Stability		Bedrock	
Rh at Bankfull (ft)	0.39	WP at Bankfull (ft)	16.8		

Impacts	Exceeds threshold by >10%	Exceeds by less than 10%	Equal to or less than threshhold	Thresholds: Shear Stress=0.075lbs/sf, Velocity=2.5ft/s

Erosion Potential Indicator	Modeled Condition			
	Existing	Future Conditions	Future Conditions with Lake Outlet	Future Conditions with Lake Outlet and Meadows Restoration
2-year Rainfall Peak Flow Rate (cfs)	108	130	150	102
2-year Rainfall Channel Velocity (ft/s)	2.99	3.17	3.31	2.86
2-year Shear Stress (lb/ft^2)	0.096	0.106	0.120	0.088

Figure VI.B-3 Regal Creek Erosion Analysis Reaches

Figure VI.C-1. Dissolved oxygen concentrations in Regal Creek.

Figure a
DO vs. TP

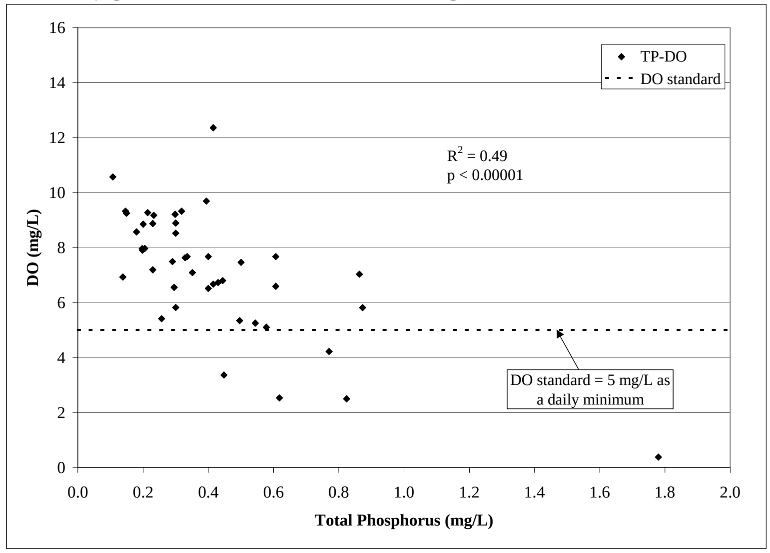


Figure b
DO vs. temperature

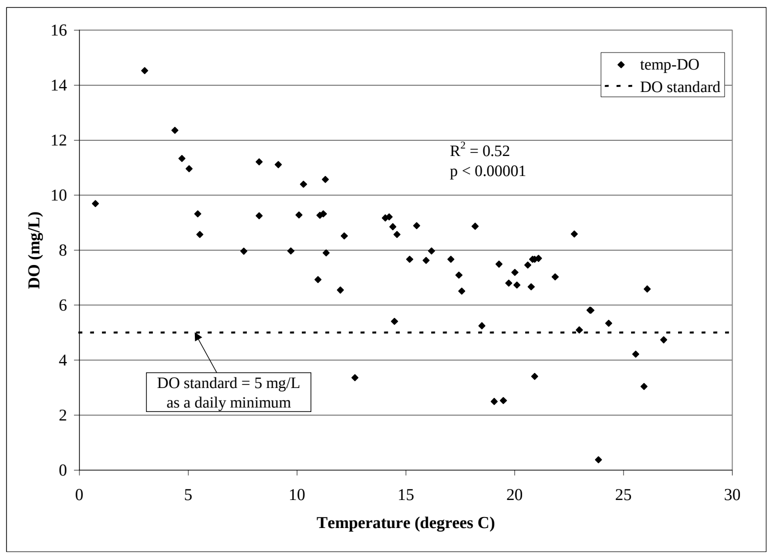


Figure c
Flow and DO over time

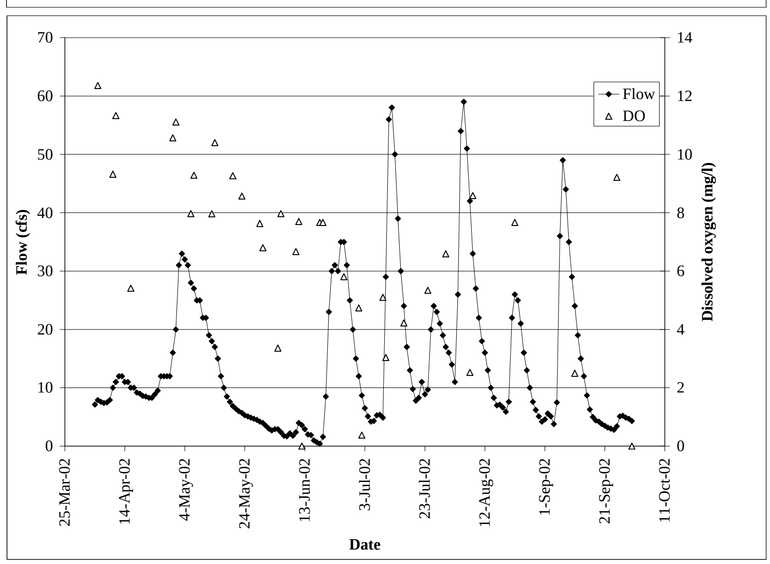


Figure VI.C-2. *E. Coli* concentrations and turbidity in Pelican Lake

Figure a.
***E. Coli* concentration**

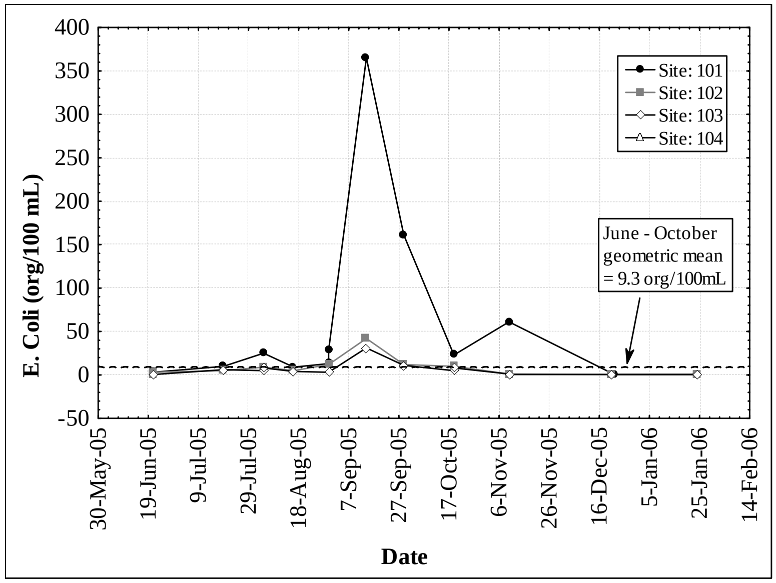
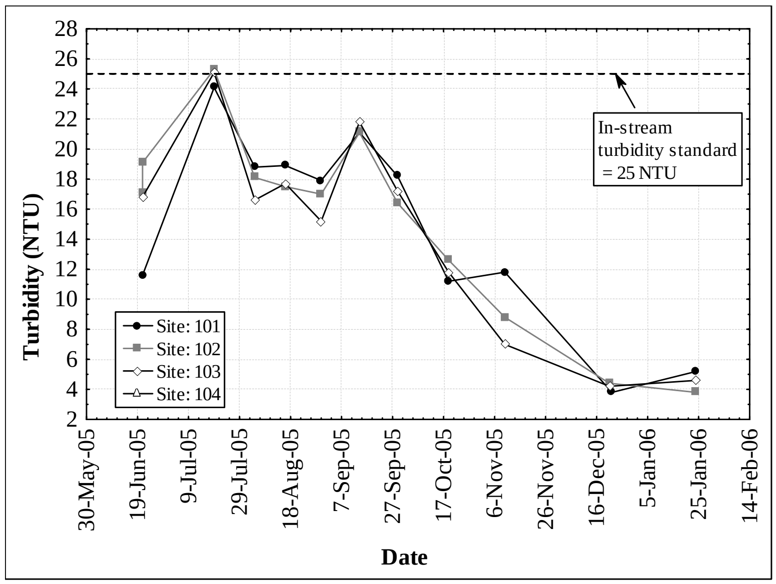
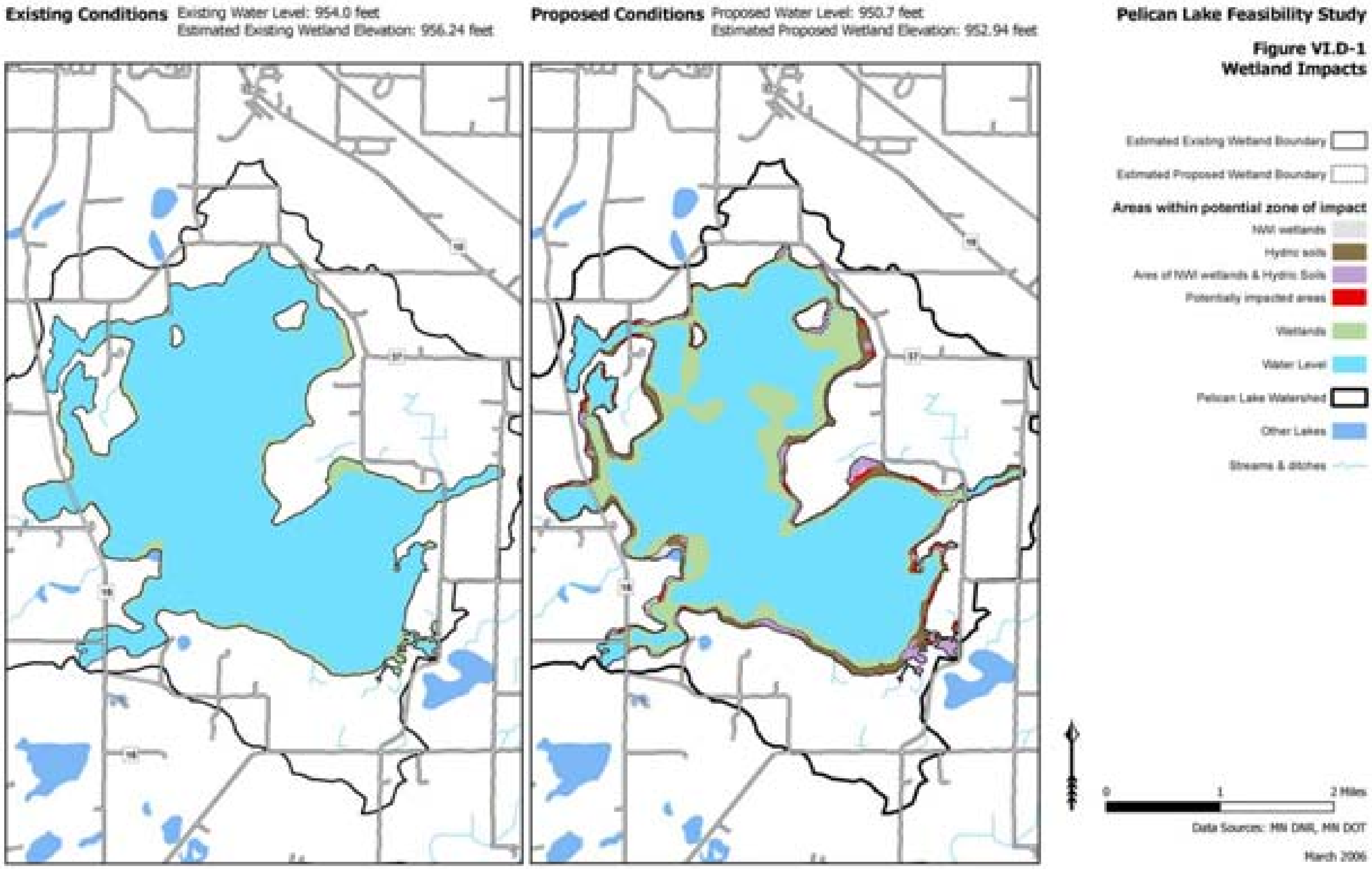
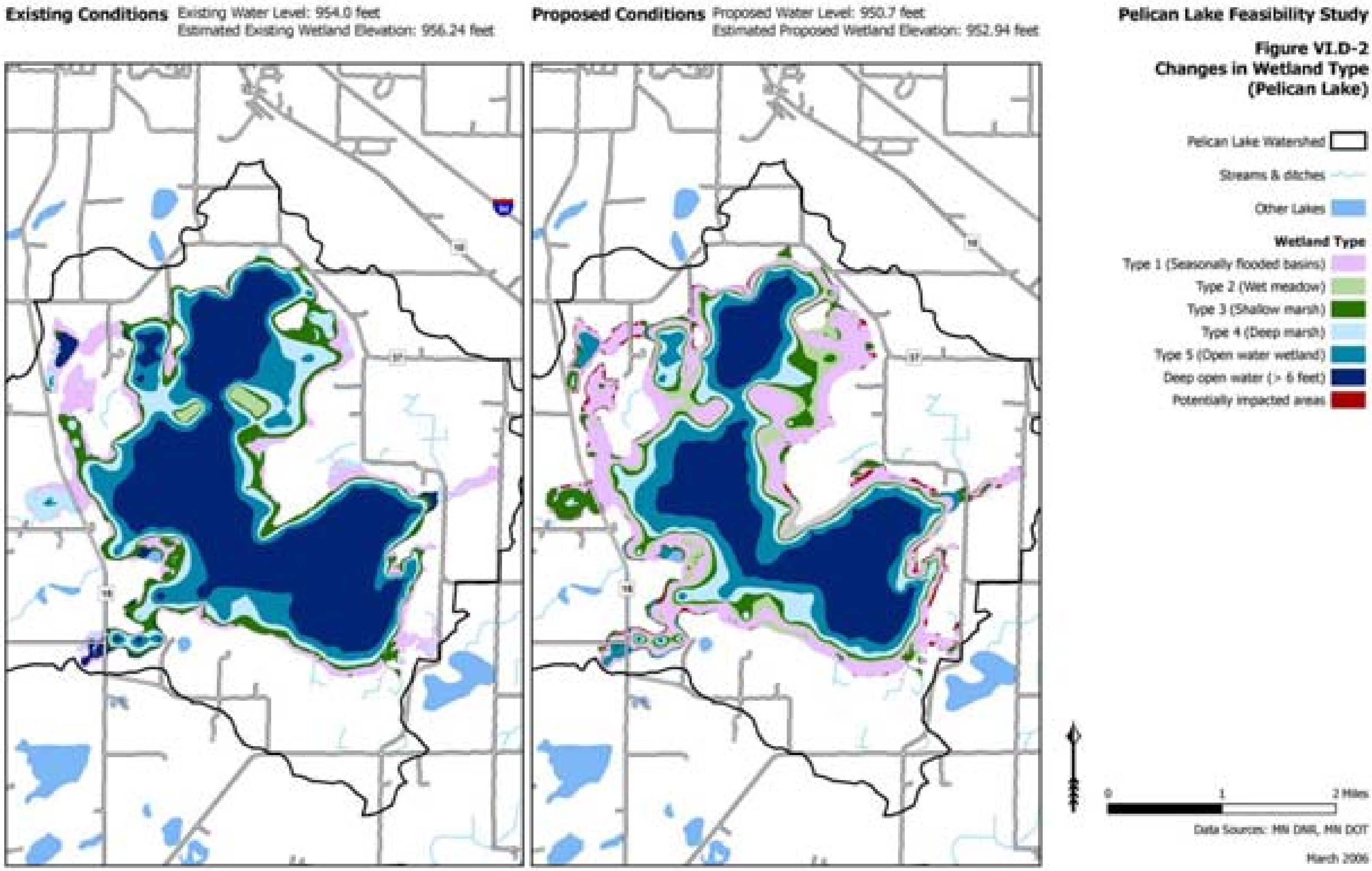
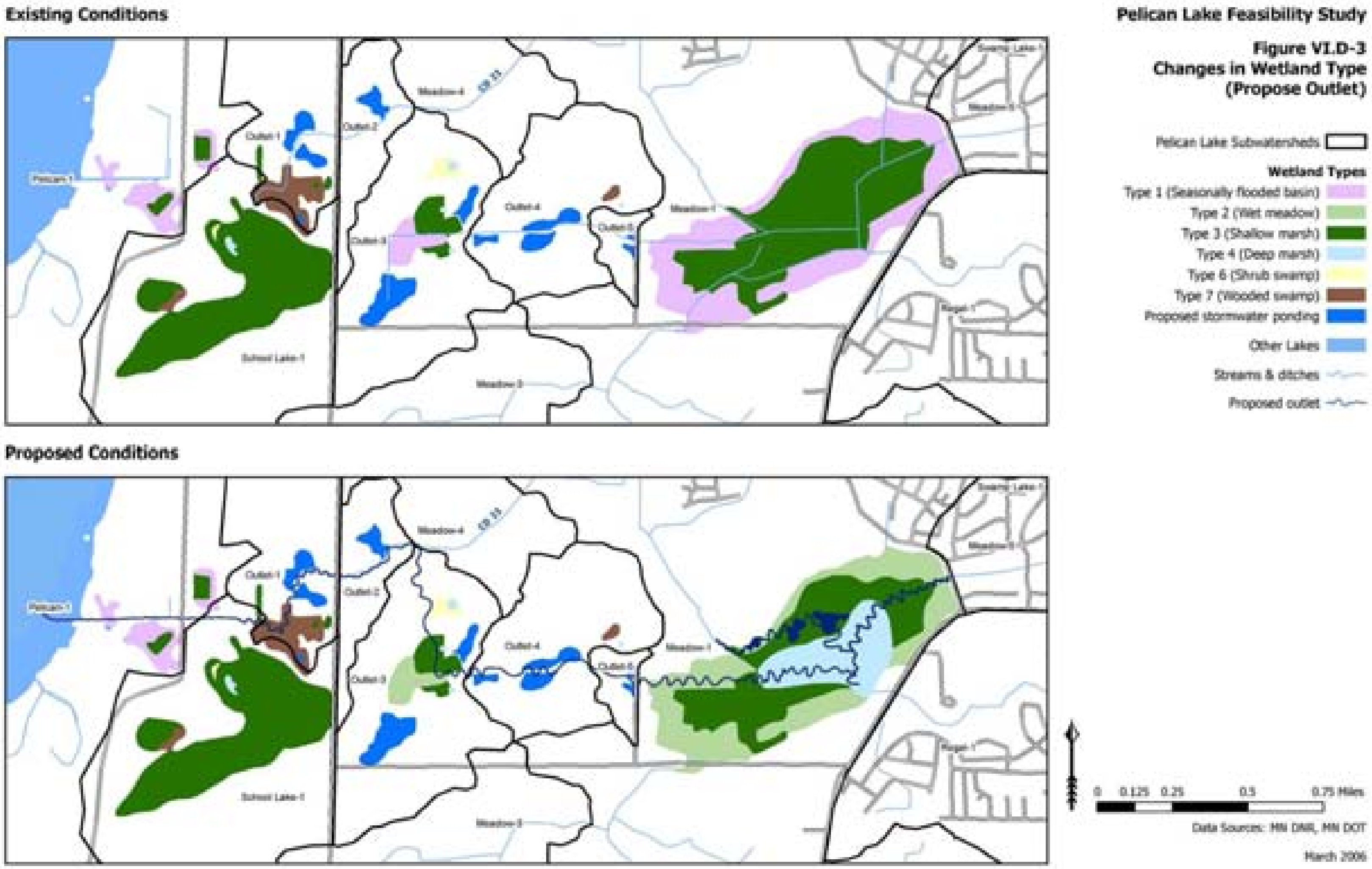


Figure b.
Turbidity




Existing Conditions
Existing Water Level: 954.0 feet
Estimated Existing Wetland Elevation: 956.24 feet
Proposed Conditions
Proposed Water Level: 950.7 feet
Estimated Proposed Wetland Elevation: 952.94 feet
Pelican Lake Feasibility Study
Figure VI.D-1
Wetland Impacts
Estimated Existing Wetland Boundary
Estimated Proposed Wetland Boundary
Areas within potential zone of impact
NWI wetlands
Hydric soils
Ares of NWI wetlands & Hydric Soils
Potentially impacted areas
Wetlands
Water Level
Pelican Lake Watershed
Other Lakes
Streams & ditches
0
1
2 Miles
Data Sources: MN DNR, MN DOT
March 2006


Existing Conditions
Existing Water Level: 954.0 feet
Estimated Existing Wetland Elevation: 956.24 feet
Proposed Conditions
Proposed Water Level: 950.7 feet
Estimated Proposed Wetland Elevation: 952.94 feet
Pelican Lake Feasibility Study
Figure VI.D-2
Changes in Wetland Type
(Pelican Lake)
Pelican Lake Watershed
Streams & ditches
Other Lakes
Wetland Type
Type 1 (Seasonally flooded basins)
Type 2 (Wet meadow)
Type 3 (Shallow marsh)
Type 4 (Deep marsh)
Type 5 (Open water wetland)
Deep open water (> 6 feet)
Potentially impacted areas
0
1
2 Miles
Data Sources: MN DNR, MN DOT
March 2006


Existing Conditions
Proposed Conditions
Pelican Lake Feasibility Study
Figure VI.D-3
Changes in Wetland Type
(Propose Outlet)
Pelican Lake Subwatersheds
Wetland Types
Type 1 (Seasonally flooded basin)
Type 2 (Wet meadow)
Type 3 (Shallow marsh)
Type 4 (Deep marsh)
Type 6 (Shrub swamp)
Type 7 (Wooded swamp)
Proposed stormwater ponding
Other Lakes
Streams & ditches
Proposed outlet
0 0.125 0.25 0.5 0.75 Miles
Data Sources: MN DNR, MN DOT
March 2006

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STATE OF MINNESOTA

Office Memorandum

DEPARTMENT Natural Resources - Wildlife

DATE: December 27, 1976

JAN 05 1977

PHONE: 296-2894

TO : Roger Lorenz

THRU : Don Carlson

FROM : Dave Vesall

BY : Roger Holmes R. Holmes

SUBJECT: Public Hearing - Game Lake Designation
Pelican Lake, Wright County

Attached is a copy of the proposed management plan for the designation of Pelican Lake in Wright County.

Tim Bremicker has done a large amount of work on this plan which should cover the needs for the public hearing and lake designation.

A hearing date and location should be forwarded to the Section of Wildlife at least three weeks before the hearing so that a legal notice can be prepared for the Director's signature and returned to your region for publication.

It is the region's responsibility to publish the legal notice in a legal Wright County newspaper seven days in advance of the hearing. A local news release should also be submitted. The region will also hold and prepare a transcript of the hearing.

If you have questions on the hearing or procedures, please let us know.

DV:rac
Att.

MANAGEMENT PLAN

Pelican Lake (86-31) Wright County
T120, 121 North, R24, 25 West, Section Various

Introduction

Pelican Lake, the second largest watered basin of Wright County, lies in the northeast corner of Wright County approximately 2 1/2 miles south of Monticello and four miles northeast of Buffalo. Its location adjacent to Interstate 94 provides easy accessibility from the seven county and St. Cloud metropolitan areas.

A public access is provided on the southwest bay along County Road 15. Numerous other quasi-public accesses are available since many landowners provide hunter access to the lake at no charge or a nominal charge during waterfowl seasons.

Pelican Lake has two classifications under Wright County Zoning ordinances, Natural Environmental and S-1 Special Protection. Present shoreline development is restricted primarily to farm dwellings. One private year-round lakeshore residence is located along the southwest bay.

Physical Characteristics

Pelican Lake is a meandered, Type V wetland (deep freshwater marsh) of 3,980 acres (Gazetteer of Meandered Lakes of Minnesota) with an existing watered area of 2,793 acres. It has approximately 30 miles of shoreline. According to the lake surveys of 1957 and 1976, the maximum depth is 9 1/2 feet with 30 percent of the lake basin 4 feet or less in depth. Dense emergent vegetation and shallow marsh-type bays constitute eight and nine percent of the lake basin acreage, respectively.

Surrounding topography is irregular. Along the north, south and west sides are many wooded knolls and marshes. However, to the east side agriculture is more intensive and, therefore, comparatively fewer wooded and marsh areas are found.

Inlets and Outlets

The lake surveys for the year 1949 indicated that there were no inlets or outlets. By 1976, eight artificial inlets and one artificial outlet had been constructed. The inlets all had negligible flows during summer surveys and apparently flow only during periods of significant run-off. The outlet is servicable only during periods of extreme high water and flows easterly to School Section Lake.

The eight constructed drainage inlets in conjunction with a wet weather cycle apparently have increased the ordinary high water level by 2 1/2 to 3 feet. This effect is shown by the fact that established stands of aspen, willow, and cottonwood are now flooded during spring months. A large oak along the south shore shows a high water line stain nearly a foot above the 1976 spring level.

BIOLOGICAL CONDITION

Past Conditions

Various biological surveys conducted on this lake indicate nearly stable conditions from 1949 to 1976 except for the increased water levels previously mentioned.

General bottom soil types and contours have remained stable over the past 27 years. Decayed vegetation over mineral soil predominates in the deeper portion whereas decaying vegetation over mud or muck is commonly found in the shallower back bays.

Turbidity was determined by use of a Secchi disk. In 1957 and 1976 readings taken under nearly indentical conditions indicated a light penetration of 1.2 feet and 1.4 feet respectively. This poor light penetration which adversely affects plant growth, was attributed to suspended fine-grained soils and blue green algae in both survey years.

Emergent vegetation has not changed drastically since 1949; however, it is now beginning to show effects of recent high water levels. Emergent plants, cattail, bullrush and others are beginning to thin out particularly in the middle lake area just north of the islands. Also arrowhead, a valuable waterfowl food, which was quite common in 1957 is now being replaced by white and yellow water lilies.

Submerged vegetation has also displayed a gradual decline in density and hardiness from 1949 to 1975. This trend, however, was reversed in 1976 due to a continual reduction in water levels (vs. normal increases) which resulted a fourfold increase in sago pondweed above 1957. Sago is considered one of the finest of waterfowl foods. Other pondweeds, such as floating leaf and clasping leaf although of lesser waterfowl food value, also displayed increases in 1976.

Wildlife and Recreational Use

The Minnesota Department of Natural Resources and resident waterfowlers consider Pelican Lake to be among the finest of waterfowl hunting lakes. This noteworthy regard is due to several important factors related to both pre-migration and migratory usage of Pelican Lake by waterfowl. Resident breeding waterfowl such as mallards, teal, and wood ducks are found in relative high densities; however, other species such as redheads and canvasbacks are commonly found. As the breeding season progresses, Pelican Lake begins to take on its most important biological function for resident waterfowl as a molting lake. Numerous adult male and female ducks, perhaps 1,000 to 1,500, utilize the extensive shoreline for both food and cover during the flightless stage. By providing this essential molt site, Pelican Lake reduces significantly the mortality losses for adult birds during this extremely vulnerable period.

As the summer progresses, juvenile birds maturing in other marsh areas begin to enter Pelican to feed and congregate prior to fall migration. Concentrations of 3,000-4,000 adult and juvenile waterfowl have been noted on Pelican just prior to the waterfowl hunting season.

Later in the fall substantial use of ~~the~~ Pelican is made by migrating mallards, canvasbacks, ringnecks, teal, lesser scaup, redheads, and baldpate ducks. Occasionally species such as White-Winged Scoter, and Old Squaw have been taken by hunters on Pelican. To further illustrate Pelican Lake's importance to waterfowl and waterfowling, 3,800 individual hunter visits and 19,000 hunter hours were tallied during the 1976 waterfowl season. With an average season density of 1 hunter per 30 acres, one can appreciate the high quality waterfowling experience the lake provides.

In additon to its traditional use by waterfowl throughout the year, this lake also provides essential breeding and migratory habitat for a great variety of non-game bird species.

In 1974, local resident observations indicated the presence of a resident colony of 10-15 paired western grebes. During the 1976 survey, 39 active western grebe nests were located. The presence of 175 adults on several occasions indicates that another colony may exist.

Double-crested cormorants have recently established a colony of 29 nests within several large cottonwoods on the west island of the middle lake. Breeding colonies of great blue herons, common egrets, and black-crowned night herons are also present.

For the 1976 survey period, 36 species of breeding birds were noted, of which six species are considered to have both state and local significance because of their relative scarcity statewide. Considering the diversity of bird life throughout the year, the lake's location and relative unaltered prairie marsh condition, Pelican Lake should become an extremely valuable nature area in years to come if adequately protected.

Further adding to the diversity of wildlife is the presence of many mammals and upland birds such as muskrats, mink, weasels, raccoon, fox, and white-tailed deer, pheasant, woodcock, ruffed grouse, herons, owls and numerous song birds.

Objectives

1. To protect and improve the natural and high quality environmental condition of the lake and current recreational utilization by designating Pelican Lake as a Game Lake.
2. To continue documenting the ecological relationships of the western grebe, herons, and cormorants and other bird species of special significance utilizing this lake.
3. To study the feasibility and desirability of stabilizing water levels, whereby vegetation and adjacent land uses would enhance the overall quality of the lake's wildlife habitats.
4. To provide permanent protection to the supporting wetlands through easement or fee acquisition by Department of Natural Resource with subsequent improvement for waterfowl nesting and brooding habitats.
5. Study the advisability of an outboard motor size limitation or band during the periods of undesirable usage.

Prepared By:

Tim Bremicker
Area Wildlife Manager

Approved By:

____

Henry Wulf
Regional Wildlife Supervisor

____

Roger Holmes, Chief
Section of Wildlife

ADMIN 1000

DEPARTMENT of Natural Resources - Waters

STATE OF MINNESOTA

Office Memorandum

TO : Pelican Lake (86-31) File

DATE: June 18, 1980

FROM : Dale E. Homuth DEH
Area Hydrologist

PHONE: 2605

SUBJECT: Summary of Lake History

8/12/20	Commissioner sends letter to Pelican Lake owners (c/o W. A. Gilchrist); recommends installation of 42-inch tile at a cost of $115,000. Further details missing.
8/21/20	One landowner (J. M. Lambrecht) responded that plans meet with owner's satisfaction.
9/27/20	Mr. Lambrecht writes to Commissioner, asking for copy of drainage laws, says County Board is willing to consider project.
6/49	Game lake survey made by Bureau of Planning.
6 & 7/57	Game lake survey done by Bureau of Planning. This report notes and describes six inlets and one outlet in the southeast corner of the southeast bay. Other notes indicate that this is in fact an inlet.
12/70	Article written by Mike Link in Conservation Volunteer requesting that something be done to protect the lake.
12/70	Note to Ken Reed from (KP-?); requesting topographic survey of outlet. Note says that water surface elevation was 953 in 1907 and 947 in 1958.
1/7/71	Official request for topographic survey of outlet and establishment of benchmarks made by Ken Reed.
2/71	Survey work done by Jones, Heuer, and Scherek. It appears they only established benchmarks at this time.
10/71	Survey work done to establish NOHW. Water surface elevation was 946.05. NOHW was estimated to be roughly 952.1 (based on hardwoods); OHW was estimated to be 948.7 (based on softwoods). Report was written up in draft form, but never officially written. Conversations with Mr. Fred Welderly (77-year-old farmer on west side) showed that lake was highest in 1915-1916, but never had an outlet. Fieldwork substantiates this.
7/10/72	Gindele Bros. wrote DNR requesting field inspection of high water problem. Said that 40 acres of their "deed land" was unusable now and sometimes in past. Said they were told they need a permit to build road across. Wanted information on permit for bridge. They were sent W-54 forms.
8/29/72	Field inspection of Gindele Farm Site by Roy Schultz (DOW) and Glen Fredell (C.O.). Notes say that Gindeles placed fill across bay during low water -- now there were complaints that fill blocked navigation.

Fill strip was to provide access to 50 acres on other side of bay. DOW and C.O. requested Gindeles to cut 8-foot wide channel through fill. The Gindele Bros. agreed, pending an official letter from DNR. Photos of fill were taken.

10/11/72 Letter sent from Hollenstein (Director, DOW) to Gindele Bros., repeating agreement to cut 8-foot channel and saying that any further fill needs a permit.

12-7-73 Letter from Hollenstein (Director, DOW) to Wright County Board denying their request to impose water surface use controls on boaters.

3/12/75 Memo from Reed to Hills (actually a rewrite of 10/71 draft memo). Reed gave five different possible OHWs: Cattail fringe = 946.7; Brush fringe = 947.4; Lake bank evidence = 952.5, 951.0, and 948.0. Reed concludes that OHW is 948.4.

2/22/77 Letter to Commissioner O'Donnell from Humphrey, regarding request from Donald Robinson of St. Michael to deepen and improve Pelican Lake.

3/18/77 Letter from Seinwill (Director, DOW) to Humphrey's Aide saying that lake is game lake and deepening would not improve it.

1/10/78 Letter from DOW to Albert Gindele denying his request to appropriate water from Pelican Lake due to possible adverse effects on waterfowl (P.A. #76-3514). was this me???

6/15/78 Memo to Hills from Bremicker asking if diking and level ditching of lakebed is legal.

6/20/78 Request by Hills to Cooper (DOW, St. Paul) to have someone determine if OHW has been determined or to do study if needed. Also, asked for legal response to Bremicker's 6/15/78 memo.

7/7/78 Survey crew determined water surface elevation to be 949.05.

5/7/80 Bremicker inspects and takes photos of Gindele dike and new dike.

5/30/80 Homuth and Bremicker ~~will be~~ inspect~~ing~~ed Gindele dike.

ls

Attachment

Pelican Lake (86-31) Water Surface and OHW Records

Water Surface Readings

Date	Source	Elevation
1909	USGS Quad	953
1958	USGS Quad	947
1958	USGS Quad	946
1961	USGS Quad	946
1971	DNR	946.05
1978	DNR	949.05
1980 - 6/24/8 - DNR		949.11

OHW Possibilities

Date	Basis	Elevation
1971	Cattail fringe	946.7
1971	Brush fringe	947.4
1971	Softwoods (cottonwood, willow)	948.7
1971	Hardwoods (oak, elm)	952.1
1971 (Determination made in 1975)	Beach evidence	952.5, 951.0 & 948.0
1971 (Determination made in 1975)	Newer growth evidence (Reed's OHW)	948.4

Meeting Notes (5-26-05)

Work Group Guidelines

- Involvement by everyone
- Consensus-based (note that there may be some decisions that need to be made where consensus is not an option)
- Contributions from members-collective knowledge (Discussion, facts, figures…)
- Meetings 2-4 over 1.5 years (agendas will be set but always open to any additional items requested to be included)
- Sub work group formed to draft a Restoration Plan
- Meeting Notes sent to Workgroup and sub workgroup by email or post

Waters at a Crossroads

(Historic photos provided by Wayne Kessler and Don Soderlund)

Borrowing land from our children, what will we leave them?

Pelican Lake historically magnet for waterfowl - rare resource

- Changes to landscape
    - Loss of wetlands
    - Agricultural practices
    - Development → Rural / → Urban (40-50 ac/day lost–choice of what is lost?)

Effects of changes

- More surface water being generated
- Water levels rising 1979 – 2003
- 53% increase in size of lake
- Loss of shallow lake character
- Loss of Vegetation, loss of diversity
- Disappearance of islands and surrounding vegetation beds
- Wave action

What are all the factors contributing to these changes? = 64 million $ question

What can be done to restore Pelican Lake to a functioning shallow lake?

- Look at the watershed scale- 13000 ac of drainage
    - Feasibility of emptying the glass - Outlet structure
    - Potential impacts to downstream neighbors
    - Crow River listed on Impaired Waters List
- Ducks Unlimited-RFP for feasibility study to answer the question/examine the possibilities
- Window of Opportunity!
    - Wetlands Rally
    - Governor concerned about the problem
    - Partnership to work towards the goal
    - Return what we borrowed from our children
    - Leave a Legacy! The choice is ours!

- DU Feasibility Survey
    - Request For Proposals
        - Due Date is June 7th, 2005
        - Put out before this meeting to keep project on fast track
        - Sent out to 7 firms-open to sending out to others
  - Final Report expected February/ March of 2006
  - Deliverables
        - Topographic survey - DU already has
        - Delineate Lake Watershed- verify or adjust borders
        -
        - Assessment of Outlet alternatives-

          2 obvious choices → Crow River/St Michael
          → North to Mississippi
        - Cost estimates for alternatives
        - Hydrologic model
        - Outlet maintenance/operation plan
        - Downstream impacts
        - Groundwater influence
        - Water quality-predict improvements
        - Wetland enhancement/restoration opportunities
        - Environmental Assessment Worksheet

- DU perspective
    - What is happening is a natural fluctuation
      (*Wayne Kessler commented that the historical photos were from the early 1900's and lake level was same as today- there was no agricultural ditching or tiling being done at that time.)*

    - MDNR Designated Wildlife Lake - MDNR has the authority to maximize benefits as long as no one else is harmed by action.

Issues/Discussion

City of St. Michael

- Downstream impacts   7000 ac. watershed
  + 13000 ac. watershed
  30000 acre drainage area
- Existing erosion problems + additional water
- Water quality/quantity (How to deal with a storm event like 2003?)
- Flooding
- Maintenance –How? Who? Problems in future?
- 1/3 of watershed in St Michael – rest is outside
- City not be funder
- Precedent for lake outlet within City
- Crow impaired
- St Michael's Meadows Wetland Restoration
    - City IDs wetland as a shallow lake
    - Serve as regional ponding for future development

Issues/Discussion con.

City of Albertville

- Will be a participant
- Echoes St Michael' concerns
- Ditches 9 & 21 – City take over storm water management plan ? storm water going to Pelican Lake
- Storm Water Utility funding already not meeting needs within City
- Come out to City Council Meeting to provide official with overview of project
- Conduct public meetings
- 2 Tier storm water system- do not impair existing drainage

- Other drainages of concern/consideration
  - County Ditch 9
  - Control dam over 35
  - School Lake Ditch 21

St Michael Meadows wetlands

- Part of feasibility study? May need further study
- Complex wetland system
- This project ahead of City of St Michaels
- It is in City's plan for future- need/ interest may not be at same point as DU study

MPCA

- Crow River impaired for turbidity-affects what can be discharged
- Pelican Lake's water quality rated as Poor because it is Phosphorus, 'P' rich
  - Fits levels for nutrient impairment
  - Additional runoff is issue
  - In lake recirculation and regeneration of 'P'
  - Vegetative invasives-ex. curly pond leaf
- Address water quality in conjunction with water levels

Benefits of Lake Management

- In-lake management - Help? Yes, but How much?
- Watershed management –improve quality and quantity
  - Hard to predict benefit
  - CREP (CRP & RIM)
  - WRP exists but needs more participants- is a voluntary program
- Surrounding wetland enhancement/ restoration
- MPCA could possibly help in determining additional loads to lake with another year of data collection (previous data was collected June-September 2003)
- TMDL (Total Maximum Daily Load) Study -requires Phase I modeling/budgeting of nutrients
- Lake not yet "listed"- additional data collection= possible listing! = more attention!
- Can Water Quality Monitoring be incorporated into DU RFP?
- Precedent of Swan Lake restoration - improved water quality
- Crow River TMDL Study scheduled for 2006
  - More water into River= concern
  - Timed release of benefit?

Issues/Discussion con.

- ? in there the option of more that one outlet?
- City of Monticello? Capacity? Ditch 33 not an option.
- New system to North? Would require 20 to 30' cut

Landowners

- Does project have potential to protect the Crow River?
- Started process of finding a solution to the Pelican Lake changes in 1985-86, then 90's & in 2003.
- Opinions range from
  - Frustration
  - Apathy
  - "Its about time!"
  - 99% supportive of project now
  - Let's make it a "Go! Go! Go!
- Mostly Large landowners and Ag around lake, which helps to protect it
- Need for $ to get project to completion
- Might be best to outlet the Lake to Mississippi River
- St Michael ditch currently in need of repair
- 1917-1921- New ditch study never completed, supported by Citizens except those on Lake back then

Fisheries

- Turbidity is a problem
- Fish composition approximately 90% Back bullhead and10% game fish
- Drawdown = benefits include
  - Reduction of fish
  - Aeration of soils
  - Ability to restock desirable fish
- Winter kill no longer happening because of depth of Lake
- Fish Barriers = benefit
- ? Does the public rely on Pelican Lake for Fishing
  - 3 years ago fishing was good
  - This year not much success
  - Seems to be only opportunistic use

Funding

- North American Wetlands Conservation Act Grants Program
- State Funding

Strong interest in Shallow Lake Management is high. Lets take advantage of this interest.

Some say the "stars are all beginning to align" so lets move forward on this project now!

Pelican Lake Work Group Meeting
5-26-05
Those in attendance were;

Bob Peterson
Paul Diedrich
Scott Gulp
Pete Scharber
Don Soderlund
Nicole Hansel-Welch
Margaret Leach
Jim Onstad
Pat Sawatzke
Kerry Saxton
Colleen Allen
Diane Sander
Evan Drivas
Ted Holker
Wayne Kessler
Steve Bot
Harland Heimstra
Mary Wetter
Leander Wetter
Vernon Florell
Tim Bremicker
Mitch Sladek Mitch.Sladek@dnr.state.mn.us
Richard Reller Richard.Reller@dnr.state.mn.us
Bob Wright
Mark Matuska
Mark Johnson
Roger Stradal
Kate Drewry
Dan Lais
Martha Reger
Michele Hanson
Fred Bengston

Pelican Lake Sub-Workgroup Meeting
Riverwood Inn, Gazebo Room
Albertville, MN
June 8, 2005
10:00 a.m. – 2:00 p.m.

Meeting Notes (6-8-05)

Introductions of attendees and Meeting Goal (Fred)

- Reach consensus on choosing a firm for this project **today**.
- Budget is an issue for consideration

Details of the Request for Proposal (Jon and Doug)

Few changes were made after discussion at last meeting (Example- Collecting 3 vs. 1 water quality sample)

Consultants who submitted proposals;

Houston Engineering
Liesch Associate
HDR Rngineering
Boonestroo, Rosene, Anderlik & Associates
Widseth, Smith Nolting and Assoc, Inc
Emmons and Olivier Resources, Inc.

Doug handed out a spreadsheet of projected costs submitted by each consultant

Information of note:

- Doug had several phone calls from consultants looking for additional details and clarification.
- Boonestroo and EOR both called Steve Botts, City of St Michael, for additional information

Discussion of criteria for selecting consultant

Based on cost alone can 2 highest bid proposals be eliminated from discussion?
Decision should be based on cost and qualification?
Keep in mind the proposals are estimates not "Costs not to exceed".
How did consultants specifically address the request in regards to groundwater?

Discussion of criteria for selecting **consultant (con.)**
Evan Drivas, MNNR Waters- Need useful data to determine amounts of groundwater and surface water flow into the Lake to determine size of outlet structure required

- Existing data available, lake levels, wells, permeability of sand, etc.
- Some consultants proposed computer modeling but that will still be just an
- Estimate of inflow-will not gain a lot from that exercise
- EOR Suggested additional shallow groundwater monitoring
- Lake Polaski-lessons learned could provide precedents for this project

Suggestion made to rank consultants from 1st choice to 6th choice based on individual sub-workgroup member's impressions of the proposals and knowledge of consultants qualifications

3 consultants fell out clearly above others

- EOR
- Houston
- Liesch

Criteria for Ranking

Sub-workgroup came up with following list and after discussion refined the list to include criteria in table below.

Cost
~~Reputation~~ –captured by other criteria
Experience
Expertise
Groundwater
Water Quality
~~Engineering~~ -not everyone had enough experience with all consultants to judge this
Stream Stabilization
Environmental Review

	EOR	Houston	Liesch
Cost	3	1	2
Experience	331	113	222
Expertise	11	22	32
Groundwater	111	333	222
Water Quality	22	31	13
Stream Stabilization	11111	33322	22232
Environmental Review	121	323	211
Total	28	44	38

(Note *Participants gave their 1st, 2nd 3rd choice for each category and provided rationale for their decision.
Not everyone at the table felt qualified to weigh in, and some only gave their rankings for part of the criteria list.)

Final Ranking of consultants

1st Emmons and Olivier Resources Inc.
2nd Leisch Associates
3rd Houston Engineering

- Additional discussion took place on which is the right firm amongst the top three.

- EOR
    - Came out being number one even though they were the most expensive of the final 3 consultants.
    - Included extra measure or collecting groundwater data.
    - Proposed using a better groundwater hydrology model.

- Is everyone comfortable going with EOR?
- Does everyone agree that our process was transparent and fair?
- Group said yes and felt consensus had been reached in decision to hire EOR.

Discussion about Project Details

At May 26th Workshop suggestion made to explore the possibility of time released out letting of Pelican Lake.

Requires monitoring through winter-water quality better in winter and more room in channel to release water

Cost for 5 additional water quality samples is $5000.00 to 9000.00

MWA (Peter) may help with involvement with additional sampling with experience volunteers

MPCA needs to collect all samples for first year to ensure Quality Assurance/Quality Control through February and then could turn over to volunteers (Peter should contact Steve Heistry at MPCA)

Need to tell consultant that October-February monitoring will be added as an addendum to initial Report so as not to delay.

Fred, Jon and Doug need to sit down with consultant and work out details of project.

Options for project (Which are important to include?)

EOR's Proposal

Task 1.3 Watershed Evaluation-wetland restoration or other benefits $3000.00
- Leave off unless someone else can fund this task

Task 3 Water Quality Assessment $?
- Additional sampling for zooplankton as indicator of ecological integrity
- Could EOR donate this service?
- Should macroinvertibrate and fish sampling be added?

Task 4.5 Evaluate Outlet under wet & future development conditions $5400.00
- Info might be necessary to get project permitted, this is doing equivalent of FEMA Flood Study-may be able to get FEMA $, this would typically be done through City of St Michael

Task 4.6 Evaluate Outlet Under Future Development Conditions $3120.00
- Not necessary but St Michael could benefit from having this done (cost effect to have it done during this project)

Task 5.2 Channel Stability Assessment $3380.00
- This optional survey work should be done.
- This is a key issue in regards to Crow –TMDL.
- City of St Michael may need info to solve existing erosion problems-City may want to pay for this task or cost share

Task 6 Environmental Review Scope and Meeting w/ agencies $1500.00
- Leave off- sub-workgroup and workgroup have agency representation and are already working closely on project

Task 8.1 Attend Technical Sub-committee meetings $1768.00
- Leave of at this time.

Total Estimated Cost for EOR's consulting = $74,766.00

- Fred will talk to Steve Bot, City of St Michael, about options the City may be interested paying for or cost sharing on.
- Dale noted that the contract should specify that this report becomes property of MDNR and DU.
- Work to begin in June.

Next Steps

- 1st get funding in place
- 2nd get contract in place
  - Fred, Doug and Jon Schneider will contact consultant to work out contract details
  - DU will need itemization costs with detailed modification of scope of services
- Email of support from Tim Bremicker or Dennis
- Notify consultants who were not selected for the contract- Doug Lipetzky will contact them.
- Maggie Leach, MPCA, will be contacted for any questions regarding Water quality sampling.
- If anyone knows of other potential funding sources please let Fred know.

Thanks to all for an open and transparent team process!

Pelican Lake Sub-Work Group Meeting
6-8-05
Those in attendance were;

Pete Scharber	St Michael	763-497-3949
Joe Jacobs	Wright SWCD	763-682-1970
Margaret Leach	MPCA	218-855-5018
Scott Glup	USFWS	320-693-2849
Jon Schnieder	DU	320-762-9916
Jim Onstad	USDA_NRCS	763-682-1933x3
Diane Sander	CROW	763-682-1933x3
Evan Drivas	MDNR_Waters	651-297-4604
Ted Holker	Landowner	763-295-2724
Steve Bot	City of St Michael	763-497-2041x122
Roger Stradal	MDNR_Waters	651-772-7938
Dale Homuth	MDNR_Waters	651-772-7922
Dean Flicker	MWA	763-263-0604
Michele Hanson	MDNR_Comm. Assist	651-772-6152
Fred Bengston	MDNR_Wildlife	320-255-4279x224
Doug Lipetzky	DU	701-355-3552
Larry Kruse	City of Albertville	763-497-3384

Pelican Lake Restoration Project
Work Group Meeting
September 22, 2005
Wright County Court House

Agenda:

1. Introductions
2. Outlet Study Objectives
3. Groundwater/ surface water interaction on Pelican Lake
4. Preliminary Results of In-lake Water Quality Monitoring
5. Comparison of Outlet Alterations and Recommendations

In Attendance:

Vernon Florell
Mike Zieske
Mark McNamara
Nicole Hansel-Welch
Wayne Kessler
Mark Matuska
Rick Reller
Paul Diedrich
Diane Sander
Kerry Saxton
Tim Bremicker
Pete Scharber
Jon Schneider
Dean Flicker
Evan Drivas
Steve Heiskary
Steve Bot
Roger Stradal
Gretchen Heaser
Doug Lipetzky
Ted Holker
Margaret Leach
Tony DeMars
Michele Hanson
Fred Bengston

10-10-05 MDH

Meeting Notes

1. Introductions and Meeting Overview

2. Outlet Study Objectives

(Reported by Tony Demars, Emmons and Olivier Resources)

- Restore historical hydrological conditions to Pelican Lake
- Provision for management of Lake water levels
- Avoid, minimize, mitigate for impacts (environmental and social)

3. Groundwater – Surface Water Interactions, Findings/Conclusions

(Report by Kelton Barr, Kelton Barr Consulting)

- **Installed Shoreline Piezometers**
  - Shoreline area is where most interchange of surface/groundwater occurs
  - Found several locations where lake water is moving into groundwater and several location of reverse (Head Differences Map 8-16-05/8-30-05)
  - August results suggested a *net outflow* - approximately 1cfs going out of Lake

- **Well levels around lake surveyed** (by Evan Drivas, MDNR Goundwater Unit)
  - Wells were 5 to 6 yrs old (1970 wells were rusted shut)
  - Depth to water in wells was 4-5 ft higher over last 5+ years
  - Groundwater enough higher to indicate a trend = Groundwater levels are higher
  - Highest groundwater levels are on the West/SW side of Lake at 954.63'
  - Lowest groundwater levels are on the East side of Lake at 924.78'
  - Pelican Lake water level is at 953.18'

- **Conclusions** (*with <u>limited</u> amount of data and timing of collection)
  - Groundwater aquifer appears to flow from the west of Lake toward Crow/Mississippi Rivers
  - There is not groundwater inflow into Lake

***Question asked** Has the construction of I94 been considered as a potential to block groundwater movement?
***Response** -KeltonBarr - it is hard to pin point those landuse changes to be the specific reason water levels are changing

4. Preliminary Water Quality Monitoring Results

(Reported by Tony Demars and Tom Miller, Emmons and Olivier Resources)

- **In-Lake Water Quality Sampling**
  - Every other week, mid June thru September
  - Monthly, October thru February
  - 3 main sampling sites (+one added in bay near Boat Access because of higher quality vegetation in bay area)

- **Results**

  Lake had high levels of Total Phosphorus, Clorophylla-a and turbity
  Lake had poor water clarity as demonstrated by Secchi Depth readings

Surface Watershed size, 14260 Acres

3.5ac of land/1ac of lake area = small watershed

***Tony Demars noted:**

- Improving water quality through watershed efforts may not be effective because of the small size of the watershed as compared to the surface area of Pelican Lake.

- The question had been raised whether the low water quality of Pelican Lake would impede the ability to discharge in order to restore lake levels to desired depth. He felt that water quality will be improved over time as historical Lake levels are restored so future discharges will improve over the long term.

6. Comparison/Evaluation of Outlet Alternatives and Group's Recommendations

4 options - evaluated for social, economic and environmental costs

East Alignment (St Michael outlet) w/out pumping
East Alignment (St Michael outlet) w/ pumping
North Alignment (Monticello outlet) w/out pumping
North Alignment (Monticello outlet) w/ pumping

Social Impacts

	East Alignment (through Meadows)	**North Alignment** (to proposed new storm water outlet pipe)
Total Parcels Affected*	14	19
Earth Disturbance (Ac)	20	23
Total Project Area (Ac)	500 (includes area of wetland restoration)	250
Real Perceived flooding problems	L	H

Economic Impacts/costs

- Initial comparisons showed that the North Alignment would cost slightly more that the East Alignment
- Annual costs would for Operation and Maintenance would be higher for each alignment if a pumping system was included in the final design/installation
- Actual costs could not be reported because is not enough detail for actual design and construction details available as yet
- Major costs for either alignment will come from excavation work

Environmental Impacts

Water Quality

Alignment	Pros	Cons
East	-Opportunities for wetland treatment of outflow -Area currently unused by St Michael	-Unnamed Tributary TMDL -Crow River TMDLs (Total Maximum Daily Loading limits to improve an impairment of water quality within a water body)
	-Potential water quality benefit for Unnamed Trib. -TMDL implementation opportunity	-Mississippi River and Lake Pepin TMDLs
	Partner opportunities with St Michael storm water management	
North	No discharge to St Michael unnamed tributary and therefore no conflicts with Unnamed Tributary or Crow River TMDLs	Mississippi River and Lake Pepin TMDLs
		-Limited Water Quality treatment options for outflow -Existing flooding problems in Monticello -Ponds and wetlands already at capacity

Note*

- Group is working with Minnesota Pollution Control Agency to determine if a lake outlet will be scrutinized as adding discharge to already Impaired Waters, eg. Crow River, Unnamed Tributary, Mississippi or Lake Pepin.
- In lake management of shallow lakes like Pelican may prove to be a strategy/BMP for improving water quality and TMDL attainment
- Problems w/ water quality could be mitigated in many ways such as controlling discharge rates and times, infiltrating, etc.

Hydrology

Alignment	Pros	Cons
East	Release of base flow from Pelican Lake could lead to: -More stable flow regime -Increased Dissolved Oxygen	In stream erosion in Regal Creek and at outfall to Crow River Cost to repair $200K
North	Potential opportunity to partner with Monticello in addressing existing storm water management issues	JD#33 does not have additional capacity If ditch authority does not permit additional discharges cost to increase pipe from 48 to 60 inches is $2 million.

Wetland Impacts

Alignment	Pros	Cons
East	-Opportunity to restore up to 350 acres of degraded wetland	-Potential for 31 acres of direct and 28 acres of indirect wetland and lake impacts (This may need to be mitigated for but the 350 acres of restoration should offset mitigation)
North		-Limited opportunity to restore wetlands due to chronic flooding and limited available sites -Potential for 104 acres of direct and 133 for indirect wetland impacts.

Additional Social Impacts

Alignment	Pros	Cons
East	Lower number of parcels affected and less earth disturbance	Wetland restoration elements substantially increase overall project area
	Flooding problems are not perceived as high	
North	More parcels and earth disturbance	Overall project area is smaller due to less emphasis on wetland restoration
		Long history of flooding in Monticello neighborhoods -potential public resistance to discharge of additional water through City's storm sewer system

Lake Water Levels

944' – Water level Lake will initially be lowered to
Note* Paul Diedrich, MDNR Fisheries, stated that the 944' elevation will will provide the best chance for successful fish management and regeneration of aquatic vegetation as water quality improves

948' Ordinary High Water - level Lake will be managed after project completion

5. Group's Recommendations (con.)

Purpose of meeting was:
Discuss the social, economic and environmental costs of the potential alignments.

(Note* Details of Design/engineering/mechanics will developed and discussed at a later date.)

Pump vs. No Pump?
Pumping does not materially change the solution (magnitude of difference not significant)
Pumps may reduce depths of excavation and thereby reduce potential wetland impacts.

Group decided to have all 4 Options remain on the table for now.

It was noted that there would be a gate/valve to control run out rates and provide opportunity to shut off flow as an option for meeting water quality requirements and controlling downstream flooding.

Opportunities for wetland restoration with the North Alignment do exist but properties would have to be purchased adding costs to the project.

Cost /Benefit- Investment in Restoring a resource of this value in close proximity of metro area will be of a big value over the nest 30-50 years. In addition the benefits to water quality will be of great value to the local communities as well as other downstream.

Land protection issues will be addressed though this process.

Steve Botts, St Michael Engineering Staff, City of St Michael would like a public meeting to be scheduled – discuss project specifics and issues of additional development around Pelican Lake- St Michael does not want to be the conveyor of all additionally generated storm water.

Group decided based upon current information that the East Alignment has the most opportunities and will work best.

Group directed Consultants (EOR) to proceed with work with East Alignment and final route for outflow from Pelican Lake.

Pelican Lake Restoration Feasibility Study

St. Michael City Council Work Session

Fred Bengtson (DNR) and Tony DeMars (EOR)
January 17, 2006

Update and Talking Points:

- **This study is being done with direction from a 40 member working group of local landowners, conservation groups, munincipalities and governmental agencies. MN-DNR and Ducks Unlimited are the primary funding organizations for the feasibility study.**

- **September 6, 2005 recommendations to Pelican Lake Restoration Project (PLRP) Work Group from St. Michael City Council to address City concerns including minimizing flooding (and other impacts) of Regal Creek, possible St. Michael meadows restoration without impact to existing homes, and assisting in erosion control measures on downstream sections of Regal Creek.**

- **September 22, 2005 PLRP Work Group meeting minutes and discussion of key points.**

- **PLRP concept plan (being drafted) and map (preliminary draft) for outletting Pelican Lake prepared by Emmons and Olivier Resources (EOR) with guidance from PLRP Work Group.**

- **Discuss EOR survey data and modeling for St. Michael Meadows restoration, Regal Creek stream bank stabilization, partitioning upstream portion of Regal Creek, and future conditions of surface water management in watershed.**

- **Preliminary water quality and groundwater data.**

- **EAW preparation, public meetings, and PLRP future direction.**

Minutes

Pelican Lake Restoration Project
Work Group meeting
2/2/2006
8:30AM to 12:30PM
Wright County Court House, Buffalo MN

The meeting of the work group was convened at 8:30 AM by Fred Bengtson, Area Wildlife Manager. The meeting objective was to review the summary data and recommendations from EOR regarding groundwater, water quality, Pelican Lake hydrology, drawdown capacity, east outlet alignment, design constraints, Environmental Assessment Worksheet (EAW) review process, and identify essential next steps.

Project Goals and Strategies – Tony DeMars of EOR reviewed

(A) Restore Pelican Lake to improve wildlife habitat and plant communities

(B) Shift the lake from a turbid to clear state

Primary strategies to accomplish these goals are:

1. Lower NWL of lake to reestablish shoreline emergent fringe
2. Periodic drawdowns to consolidate sediments and encourage wetland plant germination
3. Reduce in-lake phosphorous concentration through in lake treatments or watershed load reductions
4. Reduce rough fish populations via improved winter kill potential

The work group reconfirmed these goals and primary strategies.

Ground Water and Water Quality Findings: Andrea Plevan of EOR reviewed

Ground water data was collected from 4 monitoring locations. Data was collected on a bimonthly basis from June to Sept 2005, and monthly from Oct. to Feb. 2006. Lab analysis was conducted for total phosphorus (TP), soluble reactive phosphorus (SRP), TNK, nitrate, chlorophyll-a, biochemical oxygen demand (BOD), *E-Coli*, and total suspended solids (TSS), turbidity and pH.

Overall findings are that total phosphorus peaks in July and again in September (may be rain event effect from runoff) and that lake water quality is well below standards established for lakes of this size in this eco-region of state. Chlorophyll levels exceed standards established by PCA. *E-coli* is at o.k. levels except for the September reading in the eastern basin. Dissolved oxygen varies. The lake seems to stratify in levels of BOD and mixes often so that points or elevations of very low oxygen are not long-term. Water quality was improved in 2004 from 2003. Pelican Lake is hypereutrophic.

Pelican Lake will likely be added to the TMDL list in 2008. This project gives us an opportunity to address many of the issues and problems affecting water quality in Pelican Lake before the formal listing process. Again—Pelican Lake is in worse shape in most categories of measurement for lakes in this eco-region - central hardwoods - and that the water quality problems in the basin are significant.

Water quality goals established by MPCA are TP below .06 mg/l, Chl-a below 20ug/l and a secchi disk depth of over 1 meter.

Pelican Lake work group reconfirmed that a key objective of the project is to exceed the MPCA proposed water quality standards.

Andrea reviewed a similar project in Wisconsin. Big Muskego Lake Wisconsin was successful. Because of similarities, success should be expected for the Pelican lake Project.

Groundwater Monitoring - Tom Miller EOR

Ground water monitored by 3 pizometers and numerous wells.
Groundwater flow is from the SW to the NE with an observed significant gradient of 950 SEA LEVEL DATUM along southwest shore to about 926 sea level datum (SLD) along eastern and north eastern shore. Observed lake level of 954 SLD. - ground water is well below lake level. Pelican Lake's surface waters are not positively influenced by ground water. Pelican Lake is a significant lake to ground water discharge site with an annul flow of 2 to 9 cfs or about 3 to 4 inches per year. Ground water and surface water interaction sites are minimal in terms of the total lake surface or watershed.. Some infiltration discharge is possible but there is still a need to pump to meet drawdown objectives. Using just infiltration is cost prohibitive despite the fact that Pelican Lake is a ground water recharge site.

Data clearly indicates that Pelican Lake surface water elevations are influenced primarily by rainfall, evaporation and discharge to ground water. Water hydrology was discussed in detail as a result of confusing data surface Data presented indicated that lake levels from late 1980s to present have increased measurably (4+ feet) but yearly precipitation was stable to declining.

Pelican Lake is 4000 acres in size but it has a relatively small watershed of 11, 700 acres or about 18 mi square. The rainfall data for Elk River and Buffalo were combined and averaged. Some suggested that rainfall data was below amounts observed. Residents are aware of many very significant local rainfall events in Pelican Lake area often during the

1990s. In addition some work group members suggested that because the watershed has been altered significantly that rainfall from the larger watershed is flowing into the lake from previously dry or reconstructed ditches.

Subsequent to the February 2nd work group meeting, Tony DeMars of EOR re-calculated the data regarding the water budget for Pelican Lake. Modeled (calculated) results for lake levels fit very well for observed values. See Tom Miller's attachment.

Drawdown Plan

Drawdown objective is to lower the lake from 954 SLD (current elevation) periodically and temporarily to 944 SLD with winter and summer discharge periods. Pelican Lake OHW of 952.2 SLD, with no lake outlet, the water level management objective is to ensure that Pelican Lake water levels do not exceed 950.7 SLD (the rule that permits land locked lakes to be lowered no more than 1.5 feet below the OHW (952.2 SLD)). In addition, temporary drawdowns to meet water quality, wildlife and recreational objectives will periodically occur to water levels from 944 SEA LEVEL DATUM to 948 SLD. Periodic drawdowns will occur over a three-year period with an estimated flow of 5cfs in the summer months and12 cfs in winter months.

Alignment and Design Feature of the Outlet

Preferred outlet alignment is east to St. Michael from Pelican Lake to County Ditch 21 to Regal Creek and then the North Fork of the Crow River.

A number of key concerns exist regarding in channel flows must be addressed to minimize stream erosion and flooding potential near or in St. Michael. Other concerns are cost of construction, easements for the control structure and channel, storm water infra structure, excavation or pumping.

Preliminary design:

Outlet design A-gravity only system appears to be less cost effective than a pumping system. Channel excavation with a pumping system would require 74,000 CY vs. 254,000 CY for channel excavation with similar draw down capacities. Cost of pumping system is estimated at about $2.1 million and the cost of a gravity system is about $3.6 million.

Preferred option is to construct a channel with an 8-foot bottom and 10-foot flood shelf thru School Section Lake and Ditch 21 alignment from about 1/3 of the distance from lake divert alignment south to another private ditch. Continue to use open ditch and stream but use pipe near the meadows wetland area in St. Michael. This approach would cut off about 200 acres of flood plain wetlands.

The meadows wetlands would be restored including some meander in the meadow wetland stream. A new 88' culvert would provide a water control at 921.9 SLD along with a sheet-piling weir at the outlet on County Road 37. Concern was expressed about the potential bounce in water levels in the meadows wetland and it was acknowledged that more understanding of this system is advisable. The objective is to minimize the impact to the meadows wetlands by water level management from Pelican Lake.

Regal Creek flows thru a valuable flood plain forest. The gradient increases substantially as it flows to the Crow River, and as a result, the natural tendency for the creek bank is to erode. Channel armoring will be essential in this reach.

Review of Environmental Impacts

Several major issues were identified:

DOW and FAW need to determine the cost and benefits for a 2-year versus a 3-year draw down regime. In addition, DNR must reach consensus regarding the application of the rule that only allows the lowering of a landlocked lake level permanently by 1.5 feet if it has no established outlet. This internal discussion occurred on February 9th.

This discussion resulted in the following objective statement:

Pelican Lakes established OHW is 952.2 SLD. Application of the rule may permit a permanent lowering to 950.7 SLD. It will be the objective of the DNR to ensure that Pelican Lake surface levels do not exceed 950.7 SLD.

Preliminary design measurements indicate that Regal Creek can accommodate about 12 cfs in its present conditions.

Water quality Impacts

Periodic drawdowns to temporary water levels between 948 SEA LEVEL DATUM and 944 SLD will occur to meet water quality and plant community objectives. Pelican Lake project will likely improve water quality.

Pelican Lake will likely be listed as impaired water with specific TMDL in 2008

Lake water quality improvements will be achieved by drawdowns that will re establish submerged and emerged plants. In addition, wetlands will be improved as a result of the project. Wetland restoration along the outlet alignment will be a significant contributor to improving the water quality for discharged waters.

TP loads delivered downstream will be reduced in the future if project to restore Pelican Lake includes wetland restoration project at the Meadows, more benefits will be achieved if other wetland sites can be improved.

Regal Creek is impaired for aquatic life and stressed for DO. Crow River is impaired for aquatic recreation and aquatic life with stressor for fecal colliform and turbidity and Fish IBI, Mississippi River is impaired for aquatic recreation, fecal coli form, Mercury and PCBs

Pelican Lake currently has very high phosphorus (TP and SRP) and thus very high blue green algae population. This results in high BOD when algae die, and lowered DO. Lowered water levels with greater amounts of aquatic vegetation will result in lower TP, lower algae population and thus lower BOD. In addition, wetland restoration will mitigate the water temperature but lowering water temperature and allowing for more DO in water.

Although Pelican has a high e- coli, it spikes for a short time in an east bay, fecal coli form stays below the standard set for lakes in the central hardwoods- Pelican at about 9.3 org per 100ml versus the standard of 15 org/100 ml. Fecal coli form is not an issue.

Turbidity—High algae content in lake. This will be reduced substantially by in lake water management. In stream standard is 25 NTV. In addition, wetland restoration will lessen turbidity, as solids will settle out in flow to Crow River.

Fish IBI – Currently the flash of flows limit the IBI. Management prescriptions for discharges from Pelican Lake should even out flows, and therefore fish IBI should improve.

Fringe Wetland Impacts – calculations

-COE (Manuel of 87-) allows for an 8 day growing seasons or point of inundation. Soil capillary suction in the range of .4 feet – 2 feet in height with a mean of 1.4 feet
-Estimated boundary of vegetation is 966.24 SLD feet
-Future wetlands is 950.24 SLD feet
-OHW is 952.2 SLD
-This results in an impact of about 132 acres of wetlands.
-Wetlands impacted will likely cover the full range of authorities and jurisdiction for WCA, COE and DNR.

Regal Creek

Erosion potential along Regal Creek from the increased flow and timing of discharges is high without restoration of the Meadows Wetlands.

Lower reach of Regal Creek is a bad situation. This can be addressed by channel alterations including bank stabilization, re-meandering and armoring the bank. Grade control is necessary as to reduce water velocity. Regal Creek also needs better stream buffer and likely some reshaping or re-sloping the banks to address the increased discharges from Pelican Lake.

Environmental Review Process

1. Submit draft EAW (EOR to DNR on February 10th).
2. DNR internal review and reformatting March 3 (completion date)
3. Draft EAW released to partners and public

4. Public Input meeting held to review the draft EAW (mid March)
5. EAW submitted to the EQB DNR as RGU.- April 1
6. EAW requires 30-day public comment period- April 1 to April 30
7. Decision to prepare an EIS should be made 30 days after the 30-day public comment period or May 30.

Next steps

-DNR decides applications to water level management objectives as a result of established OHW on landlocked lakes and the current 1.5 foot rule regarding permanent OHW lowering (done February 9, 2006)
-Finalize draft EAW
-Public meeting on draft EAW
-Public meetings on final EAW held in local vicinity
-Submit water quality sampling report to MNPCA in February
-Monitor ground water thru March 2006
-Monitor Regal Creek flows
-Develop better assessment of wetland impacts

Submitted 2/13/2006
Timothy Bremicker
Regional Wildlife

APPENDIX B: WATER QUALITY DATA

Table 1. Pelican Lake Water Quality Chemistry Data

Date	Site	Depth (m)	Sample type	pH	Secchi (m)	Turbidity (NTU)	TSS (mg/L)	$CBOD_5$ (mg/L)	BOD_5 (mg/L)	$NH_3 + NH_4^+$- N (mg/L)	$NO_2^-/N0_3^-$- N (mg/L)	TKN (mg/L)	SRP (mg/L)	TDP (mg/L)	TP (mg/L)	E.Coli (MPN/100mL)	Chlor-a (µg/L)	Water surface	Physical Condition	Color	Aquatic plants	Odor
06/21/2005	101	0 - 1		8.37	0.9	11.6	16.0	2.6			<0.030	2.36	<0.005		0.086	3	15.1	Calm	High algae	Green	None	None
06/21/2005	101	3											0.006		0.104							
06/21/2005	102	0 - 1	Field duplicate	8.50		17.1	19.5	3.2			<0.030	2.89	<0.005		0.097	1	22.8					
06/21/2005	102	0 - 1		8.58	0.8	19.1	19.5	2.9			<0.030	2.74	<0.005		0.094	3	23.6	Calm	High algae	Green	None	None
06/21/2005	102	3											<0.005		0.094							
06/21/2005	103	0 - 1		8.51	0.9	16.8	14.5	2.6			<0.030	2.47	<0.005		0.094	<1	25.3	Calm	High algae	Green	None	None
06/21/2005	103	4											0.005		0.080							
06/21/2005	104	0 - 1											0.079		0.174							
07/07/2005	101	0.4		8.66	0.6	12.3	25.0	7.2			<0.030	3.14	0.004		0.113	9	28.8	Moderate waves	Definite algae	Green	Minimal	None
07/07/2005	101	3											0.003		0.139							
07/07/2005	102	0.4		8.87	0.6	14.1	28.0	9.8			<0.030	3.15	0.004		0.112	3	58.9	White caps	Definite algae	Green	Minimal	None
07/07/2005	102	3											0.003		0.138							
07/07/2005	103	0.4		8.96	0.5	21.3	32.7	17.1			<0.030	4.66	0.003		0.172	2	110	Moderate waves	Definite algae	Green	Minimal	None
07/07/2005	103	3.5											0.005		0.144							
07/19/2005	101	0 - 1		8.41	0.4	24.1	36.6		4.10	0.603	<0.030	3.49	0.003	0.027	0.159	10	50.3	Moderate waves	Definite algae	Green	None	None
07/19/2005	101	3											<0.003		0.168							
07/19/2005	102	0 - 1		8.53	0.4	25.3	36.5		5.64	0.695	<0.030	3.41	0.003	0.028	0.151	5	49.7	Small waves	Definite algae	Green	None	None
07/19/2005	102	3											<0.003		0.146							
07/19/2005	103	0 - 1		8.49	0.4	25.1	38.7		4.73	0.558	<0.030	3.33	0.003	0.028	0.164	6	40.5	Small waves	High algae	Green	None	None
07/19/2005	103	3.5											0.003		0.177							
07/19/2005	104	0 - 1			0.5					0.855	<0.030	3.39	0.014	0.063	0.204		57.2					
08/04/2005	101	0 - 1		8.56	0.6	18.8	36.0	3.08				2.66	0.009		0.127	25	26.2	White caps	Definite algae	Green	Minimal	None
08/04/2005	101	3											0.006		0.149							
08/04/2005	102	0 - 1		8.43	0.6	18.1	25.0	3.15				3.26	<0.003		0.123	9	27.1	White caps	Definite algae	Green	Minimal	None
08/04/2005	102	3											0.009		0.133							
08/04/2005	103	0 - 1		8.34	0.7	16.6	23.0	2.87				3.09	0.005		0.129	5	28.9	White caps	Definite algae	Green	Minimal	None
08/04/2005	103	0 - 1	Field duplicate	8.25	0.7	16.6	24.7	1.68				2.73	<0.003		0.121	8	25.7					
08/04/2005	103	4											0.010		0.126							
08/16/2005	101	0 - 1		8.45	0.4	18.9	27.3	3.62			<0.030	2.67	<0.003	0.030	0.112	9	32.0	Small waves	Definite algae	Green	Minimal	None
08/16/2005	101	3											0.004	0.037	0.112							
08/16/2005	102	0 - 1		8.30	0.6	17.5	25.0	3.12			<0.030	2.67	0.003	0.032	0.101	5	26.2	Calm	Definite algae	Green	Minimal	None
08/16/2005	102	3											0.003	0.033	0.115							
08/16/2005	103	0 - 1		8.82	0.6	17.7	20.5	3.37			<0.030	2.65	<0.003	0.025	0.088	4	21.6	Calm	Definite algae	Green	Minimal	None
08/16/2005	103	4											<0.003	0.04	0.149							
08/16/2005	104	0 - 1			0.5						<0.030	3.39	0.006	0.066	0.177		46.3	Calm	Definite algae	Green	Slight	None
08/30/2005	101	0 - 1		8.30	0.3	17.9	29.5	3.55			<0.030	2.27	<0.003		0.111	13	50.1	Small waves	High algae	Green	Slight	None
08/30/2005	101	3											<0.003		0.142							
08/30/2005	101	0 - 1	Field duplicate	8.44		17.9	27.0	3.89			<0.030	2.36	<0.003		0.115	28	50.2					

Date	Site	Depth (m)	Sample type	pH	Secchi (m)	Turbidity (NTU)	TSS (mg/L)	$CBOD_5$ (mg/L)	BOD_5 (mg/L)	$NH_3 + NH_4^+$-N (mg/L)	$NO_2^-/N0_3^-$-N (mg/L)	TKN (mg/L)	SRP (mg/L)	TDP (mg/L)	TP (mg/L)	E.Coli (MPN/100mL)	Chlor-a (µg/L)	Water surface	Physical Condition	Color	Aquatic plants	Odor
08/30/2005	102	0 - 1		8.42	0.4	17.0	30.0	4.13			<0.030	1.90	<0.003		0.102	12	34.3	Small waves	High algae	Green	Slight	None
08/30/2005	102	3											<0.003		0.131							
08/30/2005	103	0 - 1		8.37	0.5	15.2	31.0	3.90			<0.030	2.77	<0.003		0.114	3	45	Small waves	High algae	Green	Slight	None
08/30/2005	103	4											<0.003		0.171							
09/14/2005	101	0 - 1		7.56	0.3	21.1	37.5	3.15		0.730	<0.030	3.21	0.003	0.019	0.191	365	73.6	Moderate waves	High algae	Green	Slight	None
09/14/2005	101	2.5											0.003		0.266							
09/14/2005	102	0 - 1		8.06	0.3	21.1	35.7	3.83		0.536	<0.030	3.51	0.003	0.020	0.156	42	61.7	White caps	High algae	Green	Slight	None
09/14/2005	102	2.5											0.003		0.139							
09/14/2005	103	0 - 1		8.01	0.3	21.8	38.8	3.57		0.710	<0.030	3.57	0.008	0.021	0.169	31	51.7	Moderate waves	Definite algae	Green	Minimal	None
09/14/2005	103	3.5											0.003		0.140							
09/14/2005	104	0 - 1			0.5					0.557	<0.030	2.65	0.005	0.032	0.132		32.5	Small waves	Definite algae	Green	Minimal	None
09/29/2005	101	0 - 1		7.84	0.4	18.2	41.8	5.50			<0.030	4.00	0.005		0.170	161	38.0	White caps	Definite algae	Green	Minimal	None
09/29/2005	101	3											0.005		0.162							
09/29/2005	102	0 - 1		7.84	0.4	16.4	34.1	3.75			<0.030	3.14	0.013		0.131	12	53.5	White caps	Definite algae	Green	Minimal	None
09/29/2005	102	3											0.003		0.126							
09/29/2005	103	0 - 1		7.84	0.5	17.2	36.0	3.75			<0.030	3.01	0.01		0.151	11	45.0	White caps	Definite algae	Green	Minimal	None
09/29/2005	103	4											0.01		0.143							
10/19/2005	101	0 - 1		7.68	0.7	11.2	16.5	3.40			0.053	2.58	0.003		0.109	23	17.4	Small waves	Definite algae	Green-brown	Minimal	None
10/19/2005	101	3											0.003		0.098							
10/19/2005	102	0 - 1		7.61	0.6	12.6	21.0	4.87			0.061	2.29	<0.003		0.106	10	27.0	Moderate waves	Definite algae	Green-brown	Minimal	None
10/19/2005	102	3											<0.003		0.091							
10/19/2005	103	0 - 1		7.60	0.7	11.8	17.0	3.64			0.056	2.45	0.003		0.102	5	22.8	Small-moderate waves	Definite algae	Green-brown	Minimal	None
10/19/2005	103	0 - 1	Field duplicate	7.60		11.8	16.0	3.50			0.059	2.43	<0.003		0.100	8	25.8					
10/19/2005	103	3											0.003		0.090							
11/10/2005	101	0 - 1		7.6	0.6	11.8	24.4	13.0			0.121	3.01	0.004		0.127	61	24.6	Moderate waves	Some algae	Green	None	None
11/10/2005	101	3											0.005		0.106							
11/10/2005	102	0 - 1		7.6	0.9	8.8	13.2	2.94			0.149	2.45	0.004		0.113	1	9.3	White caps	Some algae	Green	None	None
11/10/2005	102	3											0.004		0.078							
11/10/2005	103	0 - 1		7.7		7.0	7.0	1.22			0.124	2.19	0.006		0.076	1	5.0	Mod waves - white caps	Some algae	Green	None	None
11/10/2005	103	0 - 1	Field duplicate	7.6		6.6	8.0	1.75			0.147	2.43	0.01		0.080	<1	4.9					
11/10/2005	103	4											0.005		0.068							
12/21/2005	102	0 - 1		6.8		4.40	2.6	1.89			0.203	2.35	0.008		0.051	<1	1.10	Ice	Clear	Clear	None	None
12/21/2005	103	0 - 1		6.5		4.20	2.8	1.68			0.197	2.29	0.014		0.045	<1	1.20	Ice	Clear	Clear	None	None
12/22/2005	101	0 - 1		6.6		3.80	1.2	1.72			0.072	2.72	0.018		0.053	<1	0.40	Ice	Clear	Clear	None	None
12/22/2005	101	0 - 1	Field duplicate	6.6		3.60	1.6	1.65			0.093		0.018		0.047	<1	0.90					
01/24/2006	101	0.1	Field duplicate	7.2		4.8	2.8		3.4		0.182	2.76	0.014		0.059	<1	9.6	Ice				
01/24/2006	101	0.1		7.2		5.2	1.6		3.4		0.175	2.88	0.009		0.065	<1	7.6	Ice				
01/24/2006	102	0.1		7.2		3.8	<1.0		2.7		0.248	2.70	0.005		0.044	<1	4.3	Ice				
01/24/2006	103	0.1		7.2		4.6	2.8		3.3		0.254	2.79	0.006		0.053	<1	6.1	Ice				
02/14/2006	101	0 - 1	Field duplicate	7.1		4.0	<1.0	1.6			0.163	2.91	0.015		0.051	<1	2.1					
02/14/2006	101	0 - 1		7.0		4.2	<1.0	2.1			0.165	2.95	0.018		0.052	<1	2.3	Ice				
02/14/2006	102	0 - 1		7.3		3.8	<1.0	2.0			<0.030	2.68	0.013		0.041	<1	1.3	Ice				
02/14/2006	103	0 - 1		7.1		4.0	<1.0	1.9			0.227	2.69	0.009		0.045	<1	3.1	Ice				

Table 2. Pelican Lake Temperature, Conductivity, and Dissolved Oxygen Depth Profile Data

Date	Time	Site	Depth (m)	Temp (°C)	Specific Conductivity (µS/cm)	DO (mg/L)
06/21/2005	13:00	101	1	23.3	198	6.3
06/21/2005	13:00	101	2	22.6	198	5.1
06/21/2005	13:00	101	3	22.0	199	3.8
06/21/2005	12:00	102	1	23.4	191	7.3
06/21/2005	12:00	102	2	23.1	192	5.6
06/21/2005	12:00	102	3	23.0	192	4.5
06/21/2005	11:00	103	1	23.4	180	7.8
06/21/2005	11:00	103	2	23.1	181	6.3
06/21/2005	11:00	103	3	23.0	180	5.8
06/21/2005	11:00	103	4	22.8	183	3.9
07/07/2005	10:25	101	0	22.8	200	10.1
07/07/2005	10:25	101	1	22.8	200	10.1
07/07/2005	10:25	101	2	22.6	200	9.3
07/07/2005	10:25	101	3	22.1	200	5.7
07/07/2005	10:25	101	3.5	22.1	200	4.4
07/07/2005	11:15	102	0	23.6	200	12.1
07/07/2005	11:15	102	1	23.5	200	12.0
07/07/2005	11:15	102	2	23.3	200	11.2
07/07/2005	11:15	102	3	22.0	200	5.0
07/07/2005	11:55	103	0	24.0	182.1	13.8
07/07/2005	11:55	103	1	23.9	182	13.5
07/07/2005	11:55	103	2	23.8	182.7	12.9
07/07/2005	11:55	103	3	23.1	184.7	9.9
07/07/2005	11:55	103	3.5	22.4	193	7.1
07/19/2005	11:10	101	0	25.5	194	7.6
07/19/2005	11:10	101	1	25.4	194	7.3
07/19/2005	11:10	101	2	25.3	194	6.7
07/19/2005	11:10	101	3	25.1	196	5.9
07/19/2005	10:40	102	0	25.4	191	7.6
07/19/2005	10:40	102	1	25.4	191	7.5
07/19/2005	10:40	102	2	25.3	191	7.1
07/19/2005	10:40	102	3	25.2	192	6.6
07/19/2005	10:05	103	0	25.7	188	6.9
07/19/2005	10:05	103	1	25.7	188	6.7
07/19/2005	10:05	103	2	25.7	188	6.2
07/19/2005	10:05	103	3	25.7	189	6.1
07/19/2005	10:05	103	3.5	25.7	189	6.0
07/19/2005	12:00	104	0	25.3	197	8.6
07/19/2005	12:00	104	1	25.1	198	7.5
08/04/2005	10:15	101	0	26.0	206	7.3
08/04/2005	10:15	101	1	26.1	206	7.4
08/04/2005	10:15	101	2	26.1	206	7.1
08/04/2005	10:15	101	3	26.1	206	7.0

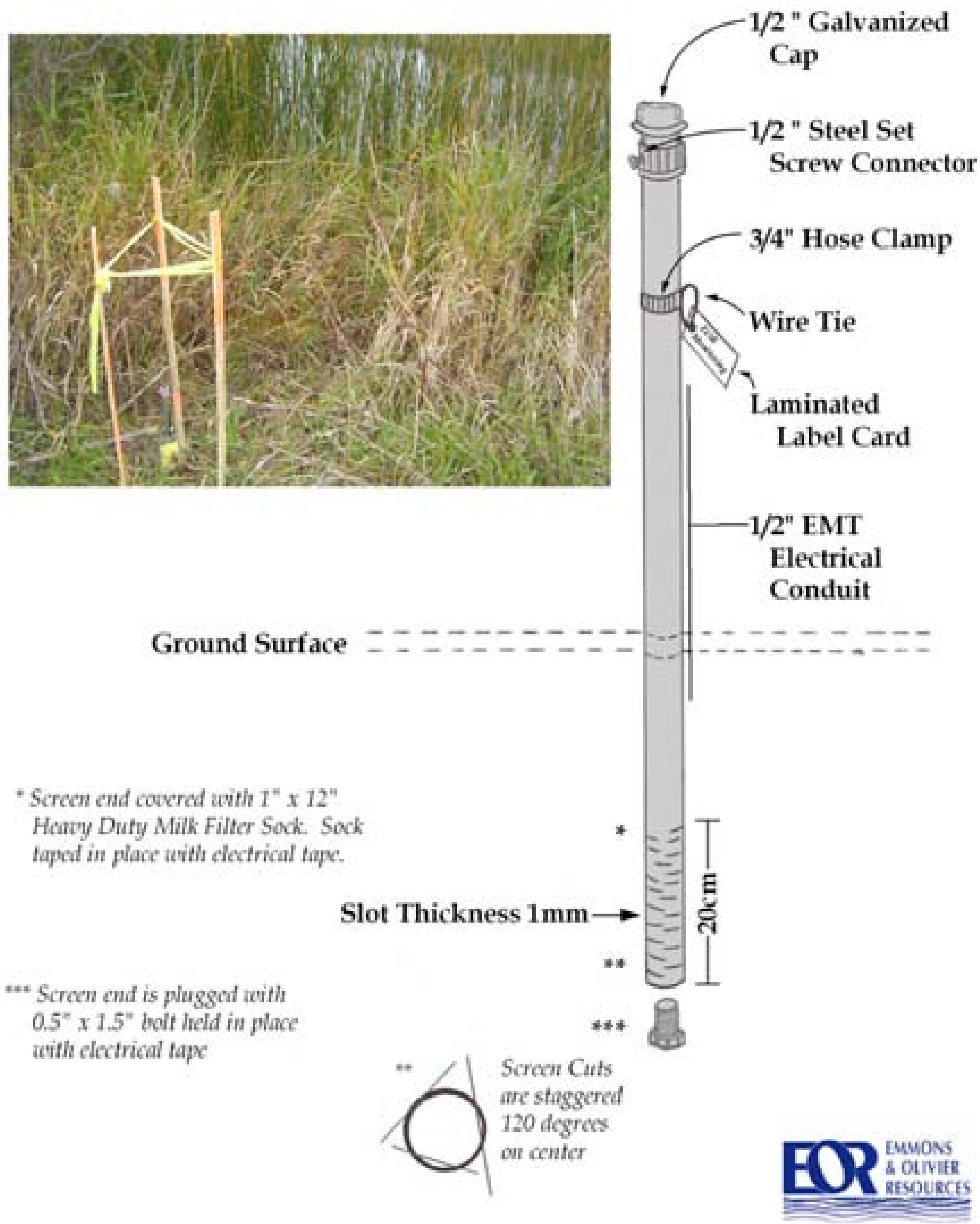
Date	Time	Site	Depth (m)	Temp (°C)	Specific Conductivity (µS/cm)	DO (mg/L)
08/04/2005	11:20	102	0	25.9	206	7.2
08/04/2005	11:20	102	1	25.9	206	7.1
08/04/2005	11:20	102	2	25.9	206	7.1
08/04/2005	11:20	102	3	25.8	207	6.4
08/04/2005	12:15	103	0	26.1	206	6.8
08/04/2005	12:15	103	1	26.1	206	6.7
08/04/2005	12:15	103	2	26.1	206	6.6
08/04/2005	12:15	103	3	26.1	206	6.7
08/04/2005	12:15	103	4	25.7	207	6.5
08/16/2005	09:45	101	0	23.2	214	4.0
08/16/2005	09:45	101	1	23.1	214	8.2
08/16/2005	09:45	101	2	22.8	215	8.1
08/16/2005	09:45	101	3	22.7	216	7.5
08/16/2005	10:35	102	0	23.6	216	8.5
08/16/2005	10:35	102	1	22.9	215	8.0
08/16/2005	10:35	102	2	22.4	216	7.2
08/16/2005	10:35	102	3	22.0	219	5.8
08/16/2005	11:15	103	0	23.9	212	10.7
08/16/2005	11:15	103	1	23.2	213	9.1
08/16/2005	11:15	103	2	22.5	216	7.7
08/16/2005	11:15	103	3	22.4	217	6.5
08/16/2005	11:15	103	4	22.4	217	2.7
08/16/2005	11:45	104	0	24.5	213	10.4
08/16/2005	11:45	104	1	21.9	215	7.4
08/30/2005	09:25	101	0	22.7	213	10.3
08/30/2005	09:25	101	1	22.6	213	9.8
08/30/2005	09:25	101	2	22.2	214	8.0
08/30/2005	09:25	101	3	21.6	223	1.8
08/30/2005	10:35	102	0	22.3	216	10.1
08/30/2005	10:35	102	1	22.2	216	8.6
08/30/2005	10:35	102	2	22.1	217	8.1
08/30/2005	10:35	102	3	21.9	219	7.3
08/30/2005	11:15	103	0	22.7	218	10.0
08/30/2005	11:15	103	1	22.3	219	8.1
08/30/2005	11:15	103	2	22.2	220	7.0
08/30/2005	11:15	103	3	22.0	220	8.2
08/30/2005	11:15	103	4	21.8	228	1.2
09/14/2005	10:30	101	0	20.8	206	6.7
09/14/2005	10:30	101	1	20.8	206	6.6
09/14/2005	10:30	101	2	20.8	206	6.2
09/14/2005	10:30	101	3	20.7	206	6.4
09/14/2005	11:15	102	0	20.6	205	7.7
09/14/2005	11:15	102	1	20.6	205	7.4
09/14/2005	11:15	102	2	20.6	205	7.2
09/14/2005	11:15	102	3	20.6	205	7.1

Date	Time	Site	Depth (m)	Temp (°C)	Specific Conductivity (µS/cm)	DO (mg/L)
09/14/2005	12:15	103	0	21.2	208	7.0
09/14/2005	12:15	103	1	21.1	208	6.7
09/14/2005	12:15	103	2	21.1	208	6.6
09/14/2005	12:15	103	3	21.1	208	6.5
09/14/2005	12:15	103	4	20.7	208	5.6
09/14/2005	12:45	104	0	20.7	182	7.2
09/14/2005	12:45	104	1	20.7	182	7.2
09/29/2005	09:45	101	0	15.5	201	7.3
09/29/2005	09:45	101	1	15.6	201	7.3
09/29/2005	09:45	101	2	15.6	201	7.4
09/29/2005	09:45	101	3	15.5	201	7.3
09/29/2005	10:30	102	0	15.5	201	7.3
09/29/2005	10:30	102	1	15.6	201	7.3
09/29/2005	10:30	102	2	15.6	201	7.4
09/29/2005	10:30	102	3	15.6	201	7.3
09/29/2005	11:15	103	0	15.7	203	7.2
09/29/2005	11:15	103	1	16.0	203	7.2
09/29/2005	11:15	103	2	16.1	203	7.3
09/29/2005	11:15	103	3	16.1	203	7.3
09/29/2005	11:15	103	4	16.1	203	7.2
10/19/2005	09:15	101	0	12.6	201	8.1
10/19/2005	09:15	101	1	12.6	201	8.0
10/19/2005	09:15	101	2	12.6	201	7.8
10/19/2005	09:15	101	3	12.6	201	7.2
10/19/2005	09:45	102	0	12.4	200	8.6
10/19/2005	09:45	102	1	12.4	200	8.5
10/19/2005	09:45	102	2	12.4	200	5.6
10/19/2005	09:45	102	3	12.4	200	8.5
10/19/2005	10:20	103	0	12.6	201	8.1
10/19/2005	10:20	103	1	12.7	201	8.0
10/19/2005	10:20	103	2	12.6	201	7.9
10/19/2005	10:20	103	3	12.6	201	7.8
10/19/2005	10:20	103	3.5	12.6	201	7.7
11/10/2005	11:00	101	0	7.0	202	10.2
11/10/2005	11:00	101	1	7.0	202	10.5
11/10/2005	11:00	101	2	7.0	202	10.5
11/10/2005	11:00	101	3	7.0	202	10.5
11/10/2005	11:45	102	0	6.9	202	10.8
11/10/2005	11:45	102	1	6.9	202	10.6
11/10/2005	11:45	102	2	6.9	202	10.5
11/10/2005	11:45	102	3	6.9	202	10.5
11/10/2005	12:15	103	0	7.3	204	9.5
11/10/2005	12:15	103	1	7.2	206	9.8
11/10/2005	12:15	103	2	7.2	206	9.5
11/10/2005	12:15	103	3	7.2	206	9.5

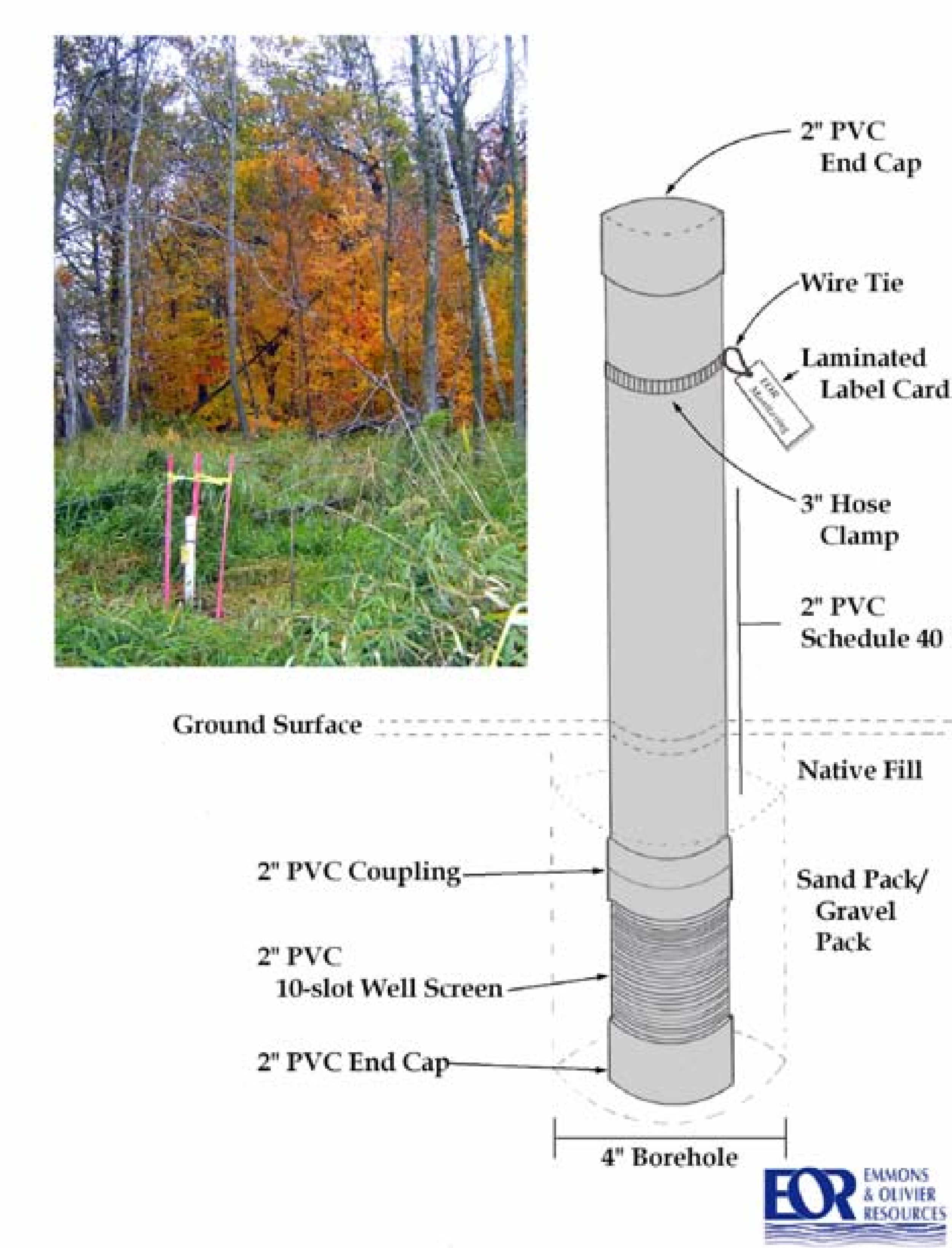
Date	Time	Site	Depth (m)	Temp (°C)	Specific Conductivity (µS/cm)	DO (mg/L)
11/10/2005	12:15	103	4	7.3	208	9.7
12/21/2005	13:10	102	0	0.5	239	12.0
12/21/2005	13:10	102	1	0.8	229	10.3
12/21/2005	13:10	102	2	1.4	225	10.2
12/21/2005	13:10	102	3	2.6	228	8.3
12/21/2005	14:15	103	0	0.2	198	12.3
12/21/2005	14:15	103	1	0.7	228	10.7
12/21/2005	14:15	103	2	1.3	249	9.4
12/21/2005	14:15	103	3	2.2	226	1.1
12/21/2005	14:15	103	4	2.9	228	0.1
12/22/2005	10:00	101	0	0.4	230	11.6
12/22/2005	10:00	101	1	0.8	229	10.7
12/22/2005	10:00	101	2	1.5	234	8.8
12/22/2005	10:00	101	3	2.2	237	6.5
01/24/2006	13:30	101	0	0.5		11.7
01/24/2006	13:30	101	1	2.5		8.2
01/24/2006	13:30	101	2	2.9		3.2
01/24/2006	13:30	101	3	3.6		0.2
01/24/2006	09:45	102	0	2.5	249	10.2
01/24/2006	09:45	102	1	2.3		9.8
01/24/2006	09:45	102	2	3.0		3.5
01/24/2006	09:45	102	3	4.2		0.8
01/24/2006	11:00	103	0	0.7		10.3
01/24/2006	11:00	103	1	2.2		9.5
01/24/2006	11:00	103	2	3.6		1.4
01/24/2006	11:00	103	3	4.4		0.3
01/24/2006	11:00	103	4	4.4		0.1
02/14/2006	13:30	101	0	0.4	254	10.1
02/14/2006	13:30	101	1	2.8	240	5.9
02/14/2006	13:30	101	2	3.3	237	3.2
02/14/2006	13:30	101	3	3.9	241	1.6
02/14/2006	10:00	102	0	0.6	264	14.2
02/14/2006	10:00	102	1	2.6	244	9.3
02/14/2006	10:00	102	2	3.7	240	6.7
02/14/2006	10:00	102	3	4.3	242	3.0
02/14/2006	11:30	103	0	0.5	248	12.2
02/14/2006	11:30	103	1	2.9	236	6.7
02/14/2006	11:30	103	2	3.7	236	3.1
02/14/2006	11:30	103	3	4.2	241	0.0
02/14/2006	11:30	103	3.7	4.5	244	0.0

DESIGN OF WELLS AND PIEZOMETERS

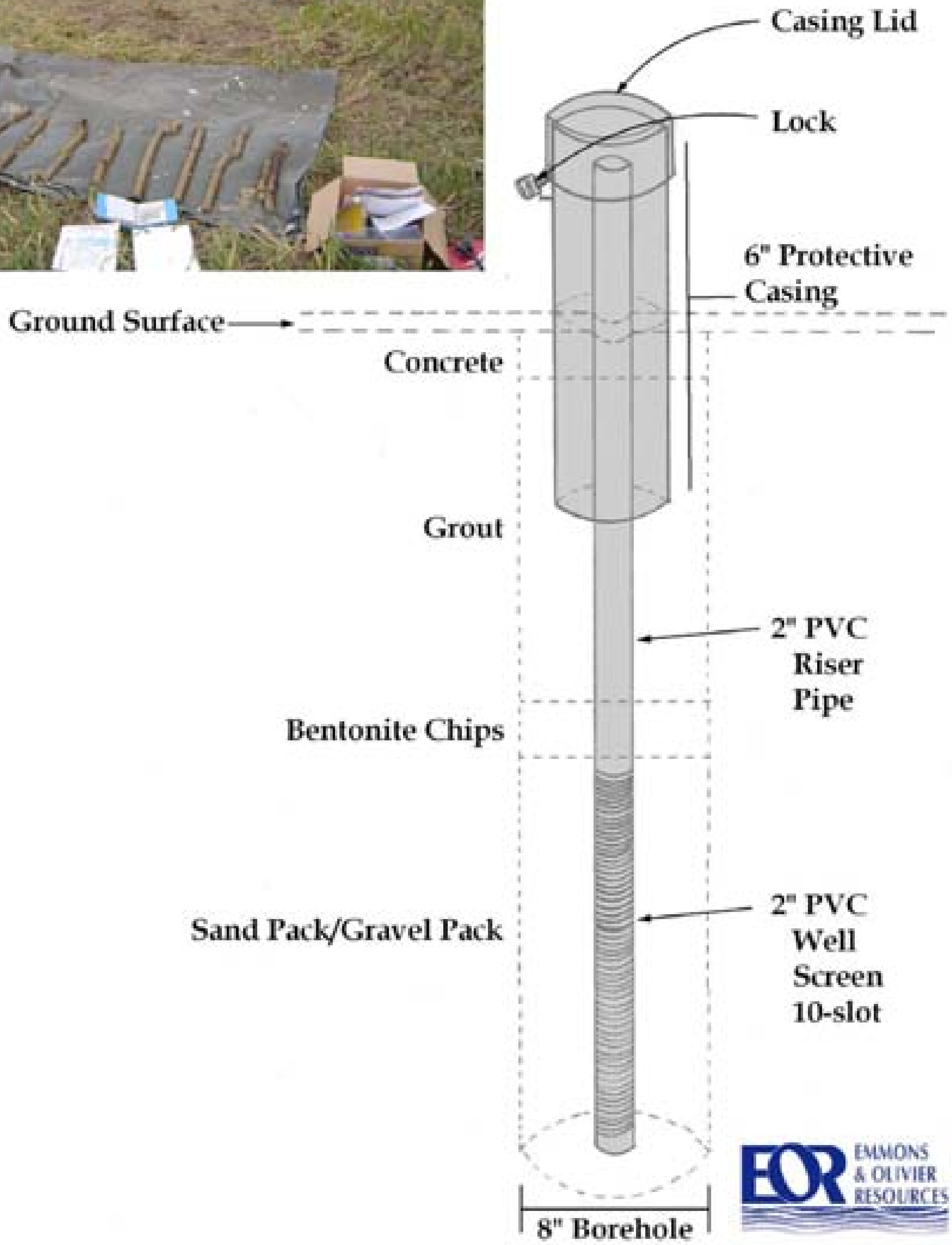
Half-inch mini-piezometer



Two-inch Shallow Well Design



Upland Well Design



EMMONS & OLIVIER RESOURCES

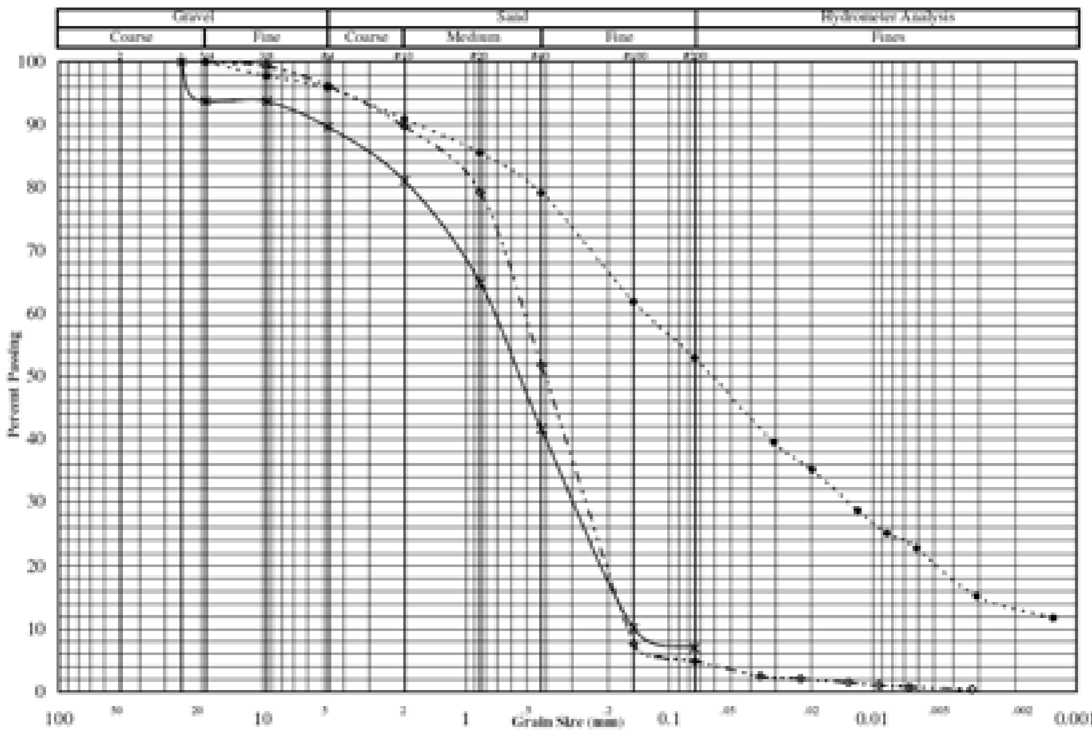
GRAIN SIZE ANALYSES

Grain Size Distribution ASTM D422

Job No. : 5550

Project:	Pelican Lake	Test Date:	11/17/05
Reported To:	Emmons and Olivier Resources, Inc.	Report Date:	11/23/05

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
*		MW-1	42.5 - 44.5	Bag	Sand w/Silt & w/a Little Gravel, Medium Grained (SP-SM)
●		MW-2	12.5 - 14.0	Bag	Sandy Lean Clay w/a Little Gravel (CL)
◇		MW-3	22.5 - 29.5	Bag	Sand w/a trace of Gravel, Fine to Medium Grained (SP)



Other Tests

	*	●	◇
Liquid Limit			
Plastic Limit			
Plasticity Index			
Water Content	12.6		
Dry Density (pcf)			
Specific Gravity	2.65*	2.67*	2.65*
Porosity			
Organic Content			
pH			
Shrinkage Limit			
Penetrometer			
Qu (psf)			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	271.0	281.6	464.9
2"			
1.5"			
1"	100.0		
3/4"	93.7	100.0	100.0
3/8"	93.7	97.8	99.3
#4	89.6	95.9	96.2
#10	81.1	90.9	89.7
#20	64.9	85.5	79.2
#40	41.6	79.2	51.8
#100	10.1	61.9	7.6
#200	7.0	52.9	4.9

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

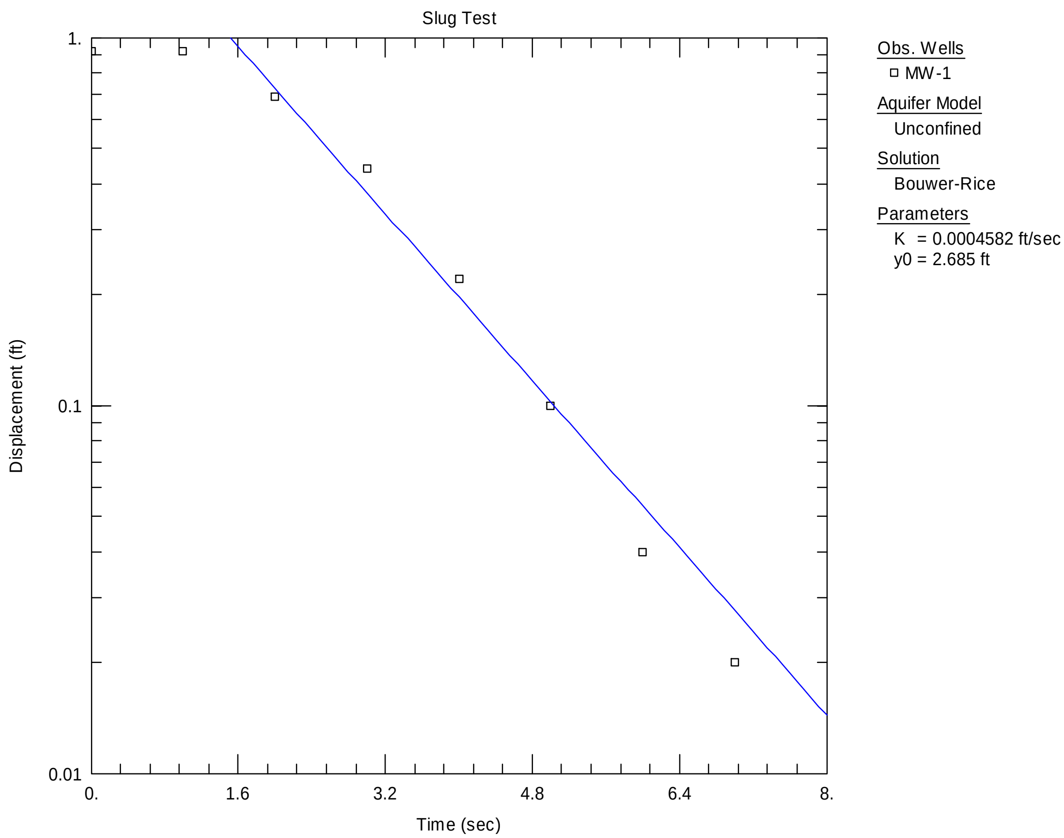
Remarks:

9301 Bryant Ave. South, Suite 107

SOIL ENGINEERING TESTING, INC.

Bloomington, Minnesota 55420-3436

Hydraulic Conductivity from Aqtesolv® Analysis



Data Set: X:\Clients_Private\199_Ducks_Unlimited\01_Pelican_Lake_Feasibility_Study\05_Data Collection\Hydrogeology-Hydrology\Upland Wells\slug tests\MW-1 bouwer-rice.aqt
Title: Slug Test
Date: 01/27/06
Time: 16:05:46

PROJECT INFORMATION

Company: Emmons and Olivier Resources
Client: Ducks Unlimited/MnDNR
Project: Pelican Lake
Location: MW-1 (TH)
Test Date: 12/21/05
Test Well: MW-1

AQUIFER DATA

Saturated Thickness: 10.5 ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: : MW-1

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.92 ft
Static Water Column Height: 10.5 ft
Casing Radius: 0.08 ft
Wellbore Radius: 0.3 ft
Well Skin Radius: 0.3 ft
Screen Length: 10. ft
Total Well Penetration Depth: 7. ft

No. of Observations: 8

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
1.	0.92	4.	0.22	7.	0.02
2.	0.69	5.	0.1	8.	0.
3.	0.44	6.	0.04		

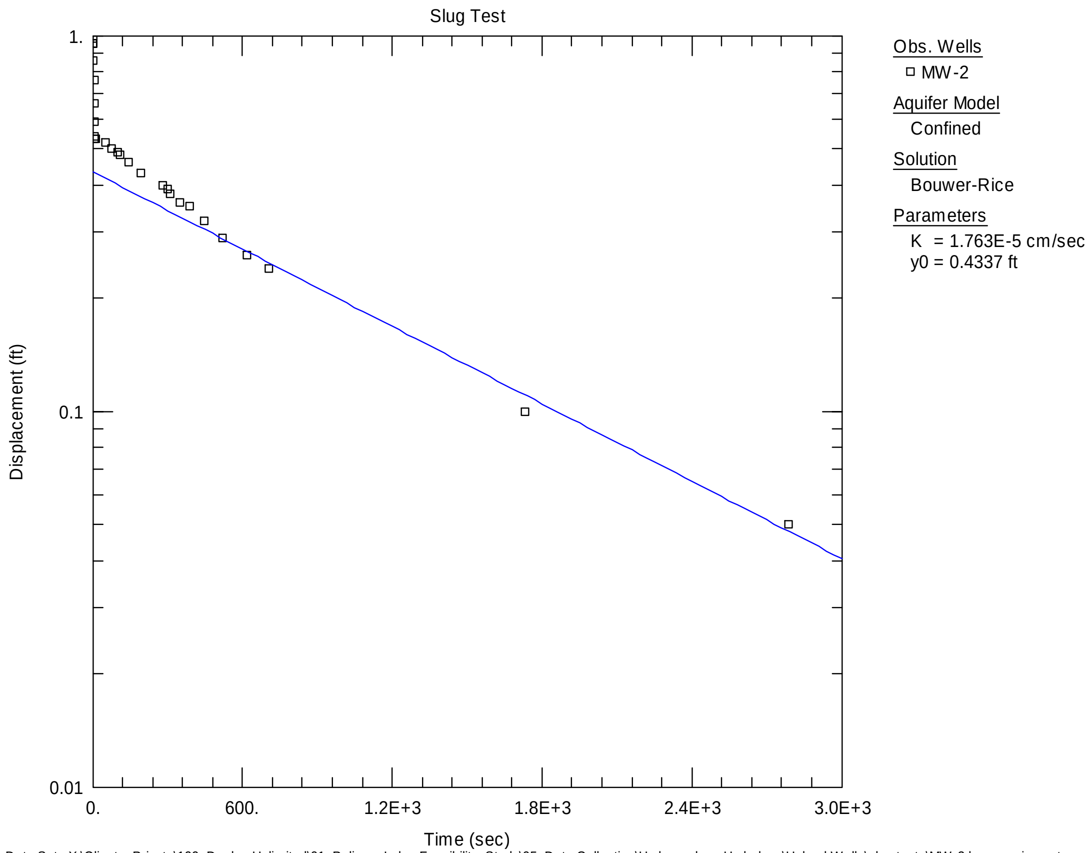
SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
Shape Factor: 2.192

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0004582	ft/sec
y0	2.685	ft



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Title: Slug Test
Date: 01/27/06
Time: 16:08:23

PROJECT INFORMATION

Company: Emmons and Olivier Resources
Client: Ducks Unlimited/MnDNR
Project: Pelican Lake
Location: MW-2 (FWS)
Test Date: 12/21/05
Test Well: MW-2

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: : MW-2

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.95 ft
Static Water Column Height: 10. ft
Casing Radius: 0.08 ft
Wellbore Radius: 0.3 ft
Well Skin Radius: 0.3 ft
Screen Length: 10. ft
Total Well Penetration Depth: 9. ft

No. of Observations: 27

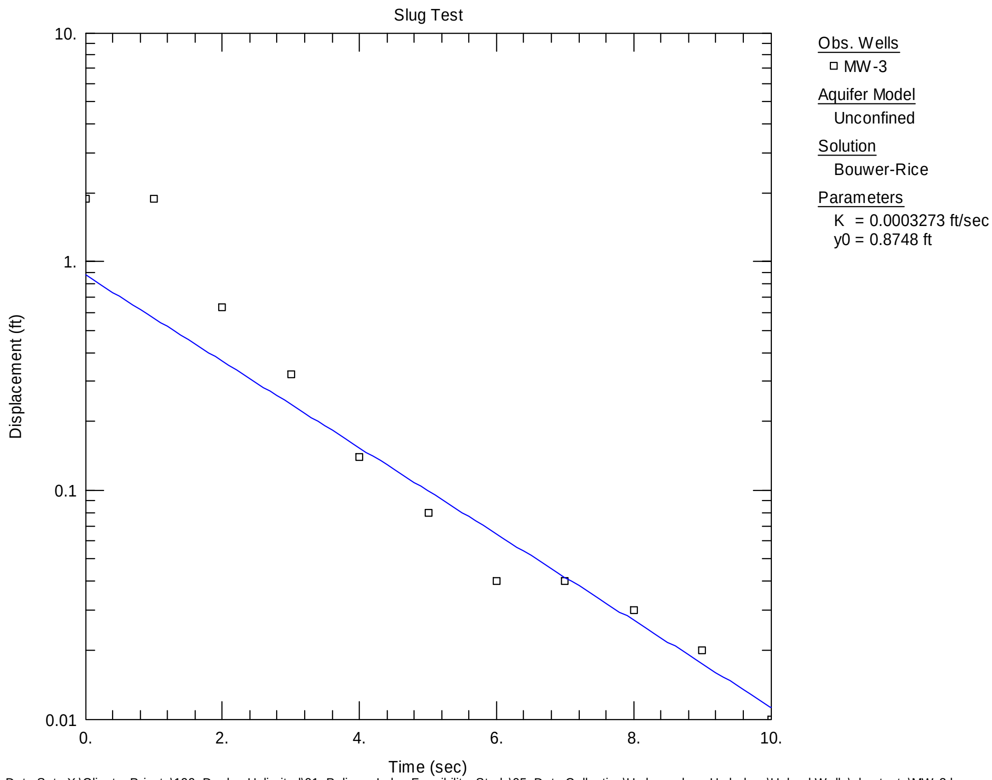
Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
1.	0.95	10.	0.53	312.	0.38
2.	0.98	50.	0.52	348.	0.36
3.	0.95	78.	0.5	389.	0.35
4.	0.86	98.	0.49	446.	0.32
5.	0.76	110.	0.48	522.	0.29
6.	0.66	142.	0.46	618.	0.26
7.	0.59	192.	0.43	704.	0.24
8.	0.54	282.	0.4	1731.	0.1
9.	0.53	300.	0.39	2787.	0.05

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
Shape Factor: 2.288

VISUAL ESTIMATION RESULTS



Data Set: X:\Clients_Private\199_Ducks_Unlimited\01_Pelican_Lake_Feasibility_Study\05_Data Collection\Hydrogeology-Hydrology\Upland Wells\slug tests\MW-3 bouwer-rice.aqt
Title: Slug Test
Date: 01/27/06
Time: 16:09:53

PROJECT INFORMATION

Company: Emmons and Olivier Resources
Client: Ducks Unlimited/MnDNR
Project: Pelican Lake
Location: MW-3 (RM)
Test Date: 12/21/05
Test Well: MW-2

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: : MW-3

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.89 ft
Static Water Column Height: 10. ft
Casing Radius: 0.08 ft
Wellbore Radius: 0.3 ft
Well Skin Radius: 0.3 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 10

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
1.	1.89	5.	0.08	9.	0.02
2.	0.63	6.	0.04	10.	0.01
3.	0.32	7.	0.04		
4.	0.14	8.	0.03		

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
Shape Factor: 2.352

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0003273	ft/sec

Appendix D. Shear Stress Analysis

Erosion potential for regal creek was determined from results of the XP-SWMM model of Regal Creek's main channel. The model was run for the 2-year 24-hour event, an event that is very important for defining channel geometry and erosion potential.

This analysis represents a scenario in which the lake is still outletting at 20 cfs during a 2-year storm. It is likely that the pumps would be shut down or the outlet weir elevation raised to prevent the lake from outletting during wet periods. The conditions of an outlet shutdown will be based on an outlet operating plan to be created during the preliminary design phase.

The shear stress calculation was based on the following equation:

$$\tau = \gamma R S_f$$

where

τ = average shear stress (lb/ ft^2)
γ = specific weight of water = 62.4 lb/ft^3
R = hydraulic radius (ft)
S_f = Energy Grade Line (EGL) slope

The hydraulic radius for each reach was calculated by the XP-SWMM model. Due to variation in the cross-sectional areas, non-uniform flow was assumed in the ravine and the Energy Grade Line (EGL) slope, S_f, was used in the shear stress calculation for each channel section, instead of the channel slope. The EGL slope was calculated from the water surface levels (i.e. Hydraulic Grade Line) and maximum velocity from the XP-SWMM results, using the following equation (Chang, 1988):

$$S_f = \frac{\{[WS + (2 / g) \times V^2]_{upstream} - [WS + (2 / g) \times V^2]_{downstream}\}}{L}$$

where

S_f = Energy Grade Line (EGL) slope
WS = water surface level (ft)
g = 32.2 ft/s^2
V = maximum velocity (ft/s)
L = section length (ft)

The maximum velocity represents the average cross-sectional velocities at maximum flow and is applied to the entire selection. To obtain upstream and downstream velocities, maximum velocities were averaged between sections.

To account for variations in local and instantaneous velocities, the following equation was used to determine the maximum shear stress (Chang, 1988):

$$\tau_{max} = 1.5\tau$$

where

τ_{max} = maximum shear stress (lb/ ft^2)
τ = average shear stress (lb/ ft^2)

The safety factor for each reach was calculated by the following equation:

$$FS = \tau_{perm} / \tau_{max}$$

where

FS = factor of safety
τ_{perm} = permissible shear stress threshold (lb/ ft^2)

Results

Table 1 shows the results of the shear stress analysis. The findings indicate that the meadows wetland restoration will result in reduction of future condition flows to existing condition rates. This flow reduction of the 2-year event will translate into decreased erosion within Regal Creek.

Erosion Magnitude

The preceding discussion dealt with the presence or absence of erosion. It does not address the extent to which erosion might occur for a given flow. If the thresholds presented in Table 2 are exceeded, erosion should be expected to occur. In reality, even when those thresholds are not exceeded, some minor erosion in a few select locations may occur. The extent to which this minor erosion could become a significant concern depends in large measure on the duration of the flow, and upon the ability of the stream to transport those eroded sediments.

Table 1. Results of Shear Stress Analysis

Reach #1

Stream Morphology Parameters				Stream Bottom Substrate Type	Percent by Type
Bankfull Width (ft)	9.25	Sinuosity	1.4	Silt/Clay	No
Bankfull Depth (ft)	2	Channel Slope (ft/ft)	0.00135	Sand	Substrate
Floodprone Width (ft)	45	Width/Depth Ratio	6.13	Gravel	Analysis
Mean Depth (ft)	1.51	Entrenchment Ratio	4.9	Cobble	
Maximum Depth (ft)	4	Stream Type	C4c-	Boulder	
X-Sectional Area (ft^2)	13.95	Channel Stability		Bedrock	
Rh at Bankfull (ft)	0.80	WP at Bankfull (ft)	17.4		

Impacts	Exceeds threshold by >10%	Exceeds by less than 10%	Equal to or less than threshhold	Thresholds: Shear Stress=0.075lbs/sf, Velocity=2.5ft/s

Erosion Potential Indicator	Modeled Condition: Existing	Future Conditions	Future Conditions with Lake Outlet	Future Conditions with Lake Outlet and Meadows Restoration
2-year Rainfall Peak Flow Rate (cfs)	81	120	140	94
2-year Rainfall Channel Velocity (ft/s)	2.70	2.73	2.76	2.70
2-year Shear Stress (lb/ft^2)	0.066	0.076	0.086	0.068

Reach #2

Stream Morphology Parameters				Stream Bottom Substrate Type	Percent by Type
Bankfull Width (ft)	13.2	Sinuosity	1.48	Silt/Clay	9
Bankfull Depth (ft)	0.65	Channel Slope (ft/ft)	0.0028	Sand	22
Floodprone Width (ft)	37	Width/Depth Ratio	11.06	Gravel	69
Mean Depth (ft)	1.2	Entrenchment Ratio	2.8	Cobble	
Maximum Depth (ft)	1.3	Stream Type	C4	Boulder	
X-Sectional Area (ft^2)	15.75	Channel Stability		Bedrock	
Rh at Bankfull (ft)	1.04	WP at Bankfull (ft)	15.1		

Impacts	Exceeds threshold by >10%	Exceeds by less than 10%	Equal to or less than threshhold	Thresholds: Shear Stress=0.075lbs/sf, Velocity=2.5ft/s

Erosion Potential Indicator	Modeled Condition: Existing	Future Conditions	Future Conditions with Lake Outlet	Future Conditions with Lake Outlet and Meadows Restoration
2-year Rainfall Peak Flow Rate (cfs)	107	129	149	102
2-year Rainfall Channel Velocity (ft/s)	2.26	2.30	2.34	2.21
2-year Shear Stress (lb/ft^2)	0.082	0.089	0.096	0.077

Reach #3

Stream Morphology Parameters				Stream Bottom Substrate Type	Percent by Type
Bankfull Width (ft)	14.6	Sinuosity	1.77	Silt/Clay	1
Bankfull Depth (ft)	0.88	Channel Slope (ft/ft)	0.00463	Sand	31
Floodprone Width (ft)	19.9	Width/Depth Ratio	32.4	Gravel	68
Mean Depth (ft)	0.45	Entrenchment Ratio	1.36	Cobble	
Maximum Depth (ft)	1.76	Stream Type	F4	Boulder	
X-Sectional Area (ft^2)	6.6	Channel Stability		Bedrock	
Rh at Bankfull (ft)	0.39	WP at Bankfull (ft)	16.8		

Impacts	Exceeds threshold by >10%	Exceeds by less than 10%	Equal to or less than threshhold	Thresholds: Shear Stress=0.075lbs/sf, Velocity=2.5ft/s

Erosion Potential Indicator	Modeled Condition: Existing	Future Conditions	Future Conditions with Lake Outlet	Future Conditions with Lake Outlet and Meadows Restoration
2-year Rainfall Peak Flow Rate (cfs)	108	130	150	102
2-year Rainfall Channel Velocity (ft/s)	2.99	3.17	3.31	2.86
2-year Shear Stress (lb/ft^2)	0.096	0.106	0.120	0.088

Table 2. Permissible shear or tractive stresses for selected lining materials[1]

From Erosion Assessment Report (FIScH Engineering, 2001)

Boundary Category	***Boundary Type***	***Permissible Shear Stress (lbs/sq.ft)***	***Permissible Velocity (ft/s)***
Soils	Fine colloidal sand	.02 - .03	1.5
	Sandy loam (noncolloidal)	.03 - .04	1.75
	Alluvial silt (noncolloidal)	.045 - .05	2
	Silt loam (noncolloidal)	.045 - .05	1.75 – 2.25
	Firm loam	.075	2.5
	Fine gravels	.075	2.5
	Stiff clay	.26	3 – 4.5
	Alluvial silt (colloidal)	.26	3.75
	Graded loam to cobbles	.38	3.75
	Graded silts to cobbles	.43	4
	Shales and hardpan	.67	6
Gravel/Cobble	1-inch	0.33	2.5 – 5
	2-inch	0.67	3 – 6
	6-inch	2.0	4 – 7.5
	12-inch	4.0	5.5 – 12
Vegetation	Class A Turf	3.7	6 – 8
	Class B Turf	2.1	4 - 7
	Class C Turf	1.0	3.5
	Long Native Grasses	1.2 – 1.7	4 – 6
	Short Natives & Bunch Grass	0.7 - .95	3 – 4
	Reed Plantings	0.1-0.6	N/A
	Hardwood Tree Plantings	0.41-2.5	N/A
Temporary Degradable RECP's	Jute Net	0.45	1 – 2.5
	Straw with Net	1.5 – 1.65	1 – 3
	Coconut Fiber with Net	2.25	3 – 4
	Fiber Glass Roving	2.00	2.5 – 7
Non-Degradable RECP's	Unvegetated	3.00	5 – 7
	Partial Establish	4.0-6.0	7.5 – 15
	Fully Vegetated	8.00	8 – 21
Riprap	6 – inch d_{50}	2.5	5 – 10
	9 – inch d_{50}	3.8	7 – 11
	12 – inch d_{50}	5.1	10 – 13
	18 – inch d_{50}	7.6	12 – 16
	24 – inch d_{50}	10.1	14 – 18
Soil Bioengineering	Reed fascine	0.6-1.25	5
	Coir Roll	3 - 5	8
	Vegetated Coir Mat	4 - 7	9.5
	Live Brush Mattress (initial)	0.4	4
	Live Brush Mattress (grown)	3.90-4.60	12
	Brush Layering (initial/grown)	1.1-6.25	12
	Live Fascine	1.25-3.10	6 – 8
	Live Willow Stakes	2.10-3.10	3 – 6

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

Appendix E. Cost Analysis Tables

East Alignment - With Pump - Final Estimate														
Line No.	MNDOT Reference	Base Bid Item	Units	Unit Price	Site Quantity				Price					
					Reach #1	Reach #2	Reach #3	Reach #4	Reach #1	Reach #2	Reach #3	Reach #4	Subtotal
1.1	2021.501	Mobilization	Lump	$36,000.00	0.50	0.20	0.20	0.10	$18,000	$7,200	$7,200	$3,600	$36,000
1.2	2101.502	Clearing	Tree	$135.00					$0	$0	$0	$0	$0
1.3	2105.501	Common Excavation	CY	$5.00					$0	$0	$0	$0	$0
1.4	2501.511	48" RCP - Class 4	LF	$136.80	105.00				$14,364	$0	$0	$0	$14,364
1.5	2501.511	60" RCP - Class 4	LF	$207.30	75.00	60.00			$15,548	$12,438	$0	$0	$27,986
1.6	2501.511	78" RCP - Class 4	LF	$373.20					$0	$0	$0	$0	$0
1.7		Skimmer grates	Each	$1,607.00	1.00				$1,607	$0	$0	$0	$1,607
1.8		Weir	Each	$75,000.00	1.00				$75,000	$0	$0	$0	$75,000
1.9	2105.511	Common Channel Excavation	CY	$5.00	67590.70	12509.64	4951.26		$337,954	$62,548	$24,756	$0	$425,258
1.11	2105.701	On-site Embankment	CY	$2.00	67590.70	12509.64	4951.26		$135,181	$25,019	$9,903	$0	$170,103
1.12	2105.801	Off-site Disposition	CY	$3.50					$0	$0	$0	$0	$0
1.13	2511.502	Erosion Control (Bank Stabilization)	LF	$200.00				1000.00	$0	$0	$0	$200,000	$200,000
1.14	2511.505	Erosion Control (Reinforce Existing Structures)	Each	$2,000.00				8.00	$0	$0	$0	$16,000	$16,000
1.15	2573.502	Silt Fence, Heavy Duty	LF	$2.95	19000.00	12000.00	9000.00		$56,050	$35,400	$26,550	$0	$118,000
1.16	2573.602	Temporary Rock Construction Entrance	Each	$1,300.00	2.00	2.00	2.00		$2,600	$2,600	$2,600	$0	$7,800
1.17	2575.501	Seeding	Acre	$2,000.00	12.74	2.97	2.01		$25,482	$5,933	$4,027	$0	$35,443
1.18	2575.511	Mulch Material, Type 3	Ton	$155.00	25.48	5.93	4.03		$3,950	$920	$624	$0	$5,494
1.19	2575.519	Disc Anchoring	Acre	$45.00	12.74	2.97	2.01		$573	$134	$91	$0	$797
1.20	2575.523	Erosion Control Blanket, MNDOT Category 5	SY	$3.80					$0	$0	$0	$0	$0
1.21		Traffic Control	Each	$2,500.00	2.00		1.00	3.00	$5,000	$0	$2,500	$7,500	$15,000
1.22	2577.505	Live Stake	Each	$2.10					$0	$0	$0	$0	$0
1.23		Pump intake	LF	$30.00	1000.00				$30,000	$0	$0	$0	$30,000
1.24		Pump station - structure	Each	$175,000.00	1.00				$175,000	$0	$0	$0	$175,000
1.25		Pump station - pumps and control panel	Each	$25,000.00	1.00				$25,000	$0	$0	$0	$25,000
1.26		Forcemain	LF	$50.00	50.00				$2,500	$0	$0	$0	$2,500
1.27		Generator	Each	$40,000.00	1.00				$40,000	$0	$0	$0	$40,000
1.28		Access route	SY	$8.00	1300.00				$10,400	$0	$0	$0	$10,400
								Construction Cost	$974,209	$152,192	$78,251	$227,100	$1,431,752
								Design Cost (20% of Construction)	$194,842	$30,438	$15,650	$45,420	$286,350
								Contingency (20%)	$233,810	$36,526	$18,780	$54,504	$343,620
								Total Cost	**$1,402,860**	**$219,157**	**$112,681**	**$327,024**	**$2,061,722**

East Alignment W/O Pump

Line No.	MNDOT Reference	Base Bid Item	Units	Unit Price	Site Quantity Reach #1	Site Quantity Reach #2	Site Quantity Reach #3	Site Quantity Reach #4	Price Reach #1	Price Reach #2	Price Reach #3	Price Reach #4	Subtotal
1.1	2021.501	Mobilization	Lump	$36,000.00	0.50	0.20	0.20	0.10	$18,000	$7,200	$7,200	$3,600	$36,000
1.2	2101.502	Clearing	Tree	$135.00					$0	$0	$0	$0	$0
1.3	2105.501	Common Excavation	CY	$5.00					$0	$0	$0	$0	$0
1.4	2501.511	48" RCP - Class 4	LF	$31.30	105.00				$3,287	$0	$0	$0	$3,287
1.5	2501.511	60" RCP - Class 4	LF	$78.60	75.00	60.00			$5,895	$4,716	$0	$0	$10,611
1.6	2501.511	78" RCP - Class 4	LF	$373.20					$0	$0	$0	$0	$0
1.7		Skimmer grates	Each	$1,607.00	1.00				$1,607	$0	$0	$0	$1,607
1.8		Weir	Each	$75,000.00	1.00				$75,000	$0	$0	$0	$75,000
1.9	2105.511	Common Channel Excavation	CY	$5.00	111944.25	12509.64	4951.26		$559,721	$62,548	$24,756	$0	$647,026
1.10	2105.701	On-site Embankment	CY	$2.00	111944.25	12509.64	4951.26		$223,889	$25,019	$9,903	$0	$258,810
1.11	2105.801	Off-site Disposition	CY	$3.50					$0	$0	$0	$0	$0
1.12	2511.502	Erosion Control (Bank Stabilization)	LF	$200.00				1000.00	$0	$0	$0	$200,000	$200,000
1.13	2511.505	Erosion Control (Reinforce Existing Structures)	Each	$2,000.00				8.00	$0	$0	$0	$16,000	$16,000
1.14	2573.502	Silt Fence, Heavy Duty	LF	$2.95	19000.00	12000.00	9000.00		$56,050	$35,400	$26,550	$0	$118,000
1.15	2573.602	Temporary Rock Construction Entrance	Each	$1,300.00	2.00	2.00	2.00		$2,600	$2,600	$2,600	$0	$7,800
1.16	2575.501	Seeding	Acre	$2,000.00	17.98	4.31	2.50		$35,960	$8,620	$5,000	$0	$49,580
1.17	2575.511	Mulch Material, Type 3	Ton	$155.00	35.96	8.62	5.00		$5,574	$1,336	$775	$0	$7,685
1.18	2575.519	Disc Anchoring	Acre	$45.00	17.98	4.31	2.50		$809	$194	$113	$0	$1,116
1.19	2575.523	Erosion Control Blanket, MNDOT Category 5	SY	$3.80					$0	$0	$0	$0	$0
1.20		Traffic Control	Each	$2,500.00	2.00		1.00	3.00	$5,000	$0	$2,500	$7,500	$15,000
1.21	2577.505	Live Stake	Each	$2.10					$0	$0	$0	$0	$0
								Construction Cost	$993,391	$147,634	$79,396	$227,100	$1,447,521
								Design Cost (20% of Construction)	$198,678	$29,527	$15,879	$45,420	$289,504
								Contingency (20%)	$238,414	$35,432	$19,055	$54,504	$347,405
								Total Cost	**$1,430,483**	**$212,592**	**$114,331**	**$327,024**	**$2,084,430**

East Alignment - With Pump

Line No.	MNDOT Reference	Base Bid Item	Units	Unit Price	Site Quantity Reach #1	Site Quantity Reach #2	Site Quantity Reach #3	Site Quantity Reach #4	Price Reach #1	Price Reach #2	Price Reach #3	Price Reach #4	Price Subtotal
1.1	2021.501	Mobilization	Lump	$36,000.00	0.50	0.20	0.20	0.10	$18,000	$7,200	$7,200	$3,600	$36,000
1.2	2101.502	Clearing	Tree	$135.00					$0	$0	$0	$0	$0
1.3	2105.501	Common Excavation	CY	$5.00					$0	$0	$0	$0	$0
1.4	2501.511	48" RCP - Class 4	LF	$31.30	105.00				$3,287	$0	$0	$0	$3,287
1.5	2501.511	60" RCP - Class 4	LF	$78.60	75.00	60.00			$5,895	$4,716	$0	$0	$10,611
1.6	2501.511	78" RCP - Class 4	LF	$373.20					$0	$0	$0	$0	$0
1.7	2105.511	Common Channel Excavation	CY	$5.00	60163.04	12509.64	4951.26		$300,815	$62,548	$24,756	$0	$388,120
1.8	2105.701	On-site Embankment	CY	$2.00	60163.04	12509.64	4951.26		$120,326	$25,019	$9,903	$0	$155,248
1.9	2105.801	Off-site Disposition	CY	$3.50					$0	$0	$0	$0	$0
1.10	2511.502	Erosion Control (Bank Stabilization)	LF	$200.00				1000.00	$0	$0	$0	$200,000	$200,000
1.11	2511.505	Erosion Control (Reinforce Existing Structures)	Each	$2,000.00				8.00	$0	$0	$0	$16,000	$16,000
1.12	2573.502	Silt Fence, Heavy Duty	LF	$2.95	19000.00	12000.00	9000.00		$56,050	$35,400	$26,550	$0	$118,000
1.13	2573.602	Temporary Rock Construction Entrance	Each	$1,300.00	2.00	2.00	2.00		$2,600	$2,600	$2,600	$0	$7,800
1.14	2575.501	Seeding	Acre	$2,000.00	12.74	2.97	2.01		$25,482	$5,933	$4,027	$0	$35,443
1.15	2575.511	Mulch Material, Type 3	Ton	$155.00	25.48	5.93	4.03		$3,950	$920	$624	$0	$5,494
1.16	2575.519	Disc Anchoring	Acre	$45.00	12.74	2.97	2.01		$573	$134	$91	$0	$797
1.17	2575.523	Erosion Control Blanket, MNDOT Category 5	SY	$3.80					$0	$0	$0	$0	$0
1.18		Traffic Control	Each	$2,500.00	2.00		1.00	3.00	$5,000	$0	$2,500	$7,500	$15,000
1.19	2577.505	Live Stake	Each	$2.10					$0	$0	$0	$0	$0
1.20		Pump intake	LF	$30.00	1050.00				$31,500	$0	$0	$0	$31,500
1.21		Pump station - structure including intake structure	Each	$200,000.00	1.00				$200,000	$0	$0	$0	$200,000
1.22		Pump station - pumps and control panel	Each	$25,000.00	1.00				$25,000	$0	$0	$0	$25,000
1.23		Forcemain	LF	$50.00	4042.00				$202,100	$0	$0	$0	$202,100
1.24		Generator	Each	$40,000.00	1.00				$40,000	$0	$0	$0	$40,000
1.25		Access route	SY	$8.00	1300.00				$10,400	$0	$0	$0	$10,400
								Construction Cost	$1,050,978	$144,470	$78,251	$227,100	$1,500,799
								Design Cost (20% of Construction)	$210,196	$28,894	$15,650	$45,420	$300,160
								Contingency (20%)	$252,235	$34,673	$18,780	$54,504	$360,192
								Total Cost	**$1,513,408**	**$208,037**	**$112,681**	**$327,024**	**$2,161,151**

North Alignment W/O Pump

Line No.	MNDOT Reference	Base Bid Item	Units	Unit Price	Site Quantity Reach #1	Site Quantity Reach #2	Site Quantity Reach #3	Site Quantity Reach #4	Price Reach #1	Price Reach #2	Price Reach #3	Price Reach #4	Price Subtotal
1.1	2021.501	Mobilization	Lump	$36,000.00	0.50	0.20	0.20	0.10	$18,000	$7,200	$7,200	$3,600	$36,000
1.2	2101.502	Clearing	Tree	$135.00					$0	$0	$0	$0	$0
1.3	2105.501	Common Excavation	CY	$5.00					$0	$0	$0	$0	$0
1.4	2501.511	48" RCP - Class 4	LF	$31.30	50.00	50.00			$1,565	$1,565	$0	$0	$3,130
1.5	2501.511	60" RCP - Class 4	LF	$207.30					$0	$0	$0	$0	$0
1.6	2501.511	78" RCP - Class 4	LF	$373.20					$0	$0	$0	$0	$0
1.7		Skimmer grates	Each	$1,607.00	1.00				$1,607	$0	$0	$0	$1,607
1.8		Weir	Each	$75,000.00	1.00				$75,000	$0	$0	$0	$75,000
1.9	2105.511	Common Channel Excavation	CY	$5.00	96871.50	43869.38	7920.00	8910.00	$484,358	$219,347	$39,600	$44,550	$787,854
1.10	2105.701	On-site Embankment	CY	$2.00	96871.50	43869.38	7920.00	8910.00	$193,743	$87,739	$15,840	$17,820	$315,142
1.11	2105.801	Off-site Disposition	CY	$3.50					$0	$0	$0	$0	$0
1.12	2511.502	Erosion Control (Bank Stabilization)	LF	$50.00					$0	$0	$0	$0	$0
1.13	2511.505	Erosion Control (Reinforce Existing Structures)	Each	$500.00					$0	$0	$0	$0	$0
1.14	2573.502	Silt Fence, Heavy Duty	LF	$2.95	14000.00	6000.00	12000.00	12000.00	$41,300	$17,700	$35,400	$35,400	$129,800
1.15	2573.602	Temporary Rock Construction Entrance	Each	$1,300.00	2.00	2.00	2.00	2.00	$2,600	$2,600	$2,600	$2,600	$10,400
1.16	2575.501	Seeding	Acre	$2,000.00	11.88	4.04	1.52	1.65	$23,765	$8,081	$3,030	$3,306	$38,182
1.17	2575.511	Mulch Material, Type 3	Ton	$155.00	23.76	8.08	3.03	3.31	$3,684	$1,253	$470	$512	$5,918
1.18	2575.519	Disc Anchoring	Acre	$45.00	11.88	4.04	1.52	1.65	$535	$182	$68	$74	$859
1.19	2575.523	Erosion Control Blanket, MNDOT Category 5	SY	$3.80					$0	$0	$0	$0	$0
1.20	2577.505	Live Stake	Each	$2.10					$0	$0	$0	$0	$0
1.21		Traffic Control	Each	$2,500.00	2.00	1.00	1.00	3.00	$5,000	$2,500	$2,500	$7,500	$17,500
								Construction Cost	$851,156	$348,166	$106,708	$115,363	$1,421,392
								Design Cost (20% of Construction)	$170,231	$69,633	$21,342	$23,073	$284,278
								Contingency (20%)	$306,416	$125,340	$38,415	$41,531	$511,701
								Total Cost	**$1,327,803**	**$543,139**	**$166,465**	**$179,966**	**$2,217,372**

North Alignment - With Pump

Line No.	MNDOT Reference	Base Bid Item	Units	Unit Price	Site Quantity Reach #1	Site Quantity Reach #2	Site Quantity Reach #3	Site Quantity Reach #4	Price Reach #1	Price Reach #2	Price Reach #3	Price Reach #4	Subtotal
1.1	2021.501	Mobilization	Lump	$36,000.00	0.50	0.20	0.20	0.10	$18,000	$7,200	$7,200	$3,600	$36,000
1.2	2101.502	Clearing	Tree	$135.00					$0	$0	$0	$0	$0
1.3	2105.501	Common Excavation	CY	$5.00					$0	$0	$0	$0	$0
1.4	2501.511	48" RCP - Class 4	LF	$31.30	50.00	50.00			$1,565	$1,565	$0	$0	$3,130
1.5	2501.511	60" RCP - Class 4	LF	$78.60					$0	$0	$0	$0	$0
1.6	2501.511	78" RCP - Class 4	LF	$373.20					$0	$0	$0	$0	$0
1.7	2105.511	Common Channel Excavation	CY	$5.00	46579.50	43869.38	7920.00	8910.00	$232,898	$219,347	$39,600	$44,550	$536,394
1.8	2105.701	On-site Embankment	CY	$2.00	46579.50	43869.38	7920.00	8910.00	$93,159	$87,739	$15,840	$17,820	$214,558
1.9	2105.801	Off-site Disposition	CY	$3.50					$0	$0	$0	$0	$0
1.10	2511.502	Erosion Control (Bank Stabilization)	LF	$200.00					$0	$0	$0	$0	$0
1.11	2511.505	Erosion Control (Reinforce Existing Structures)	Each	$2,000.00					$0	$0	$0	$0	$0
1.12	2573.502	Silt Fence, Heavy Duty	LF	$2.95	14000.00	6000.00	12000.00	12000.00	$41,300	$17,700	$35,400	$35,400	$129,800
1.13	2573.602	Temporary Rock Construction Entrance	Each	$1,300.00	2.00	2.00	2.00	2.00	$2,600	$2,600	$2,600	$2,600	$10,400
1.14	2575.501	Seeding	Acre	$2,000.00	7.47	4.04	1.52	1.65	$14,949	$8,081	$3,030	$3,306	$29,366
1.15	2575.511	Mulch Material, Type 3	Ton	$155.00	14.95	8.08	3.03	3.31	$2,317	$1,253	$470	$512	$4,552
1.16	2575.519	Disc Anchoring	Acre	$45.00	7.47	4.04	1.52	1.65	$336	$182	$68	$74	$661
1.17	2575.523	Erosion Control Blanket, MNDOT Category 5	SY	$3.80					$0	$0	$0	$0	$0
1.18	2577.505	Live Stake	Each	$2.10					$0	$0	$0	$0	$0
1.19		Traffic Control	Each	$2,500.00	2.00	1.00	1.00	3.00	$5,000	$2,500	$2,500	$7,500	$17,500
1.20		Pump intake	LF	$30.00	1000.00				$30,000	$0	$0	$0	$30,000
1.21		Pump station - structure	Each	$200,000.00	1.00				$200,000	$0	$0	$0	$200,000
1.22		Pump station - pumps and control panel	Each	$25,000.00	1.00				$25,000	$0	$0	$0	$25,000
1.23		Forcemain	LF	$50.00	3500.00				$175,000	$0	$0	$0	$175,000
1.24		Generator	Each	$40,000.00	1.00				$40,000	$0	$0	$0	$40,000
1.25		Access route	SY	$8.00	500.00				$4,000	$0	$0	$0	$4,000
								Construction Cost	$886,125	$348,166	$106,708	$115,363	$1,456,361
								Design Cost (20% of Construction)	$177,225	$69,633	$21,342	$23,073	$291,272
								Contingency (20%)	$319,005	$125,340	$38,415	$41,531	$524,290
								Total Cost	**$1,382,354**	**$543,139**	**$166,465**	**$179,966**	**$2,271,923**