

INTERIM WATER CONTROL MANUAL

LAC QUI PARLE PROJECT

**Lac qui Parle Reservoir and Marsh Lake Reservoir,
Including Marsh Lake Dam, Lac qui Parle Dam
Chippewa River Diversion Dam, and Watson Sag Weir**



**U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA**

Revised January 2017

Water Control Manual, Lac qui Parle Project



**Marsh Lake Dam
Looking Upstream
(Photos will be updated once project is complete)**



Looking at the downstream side of the Dam.

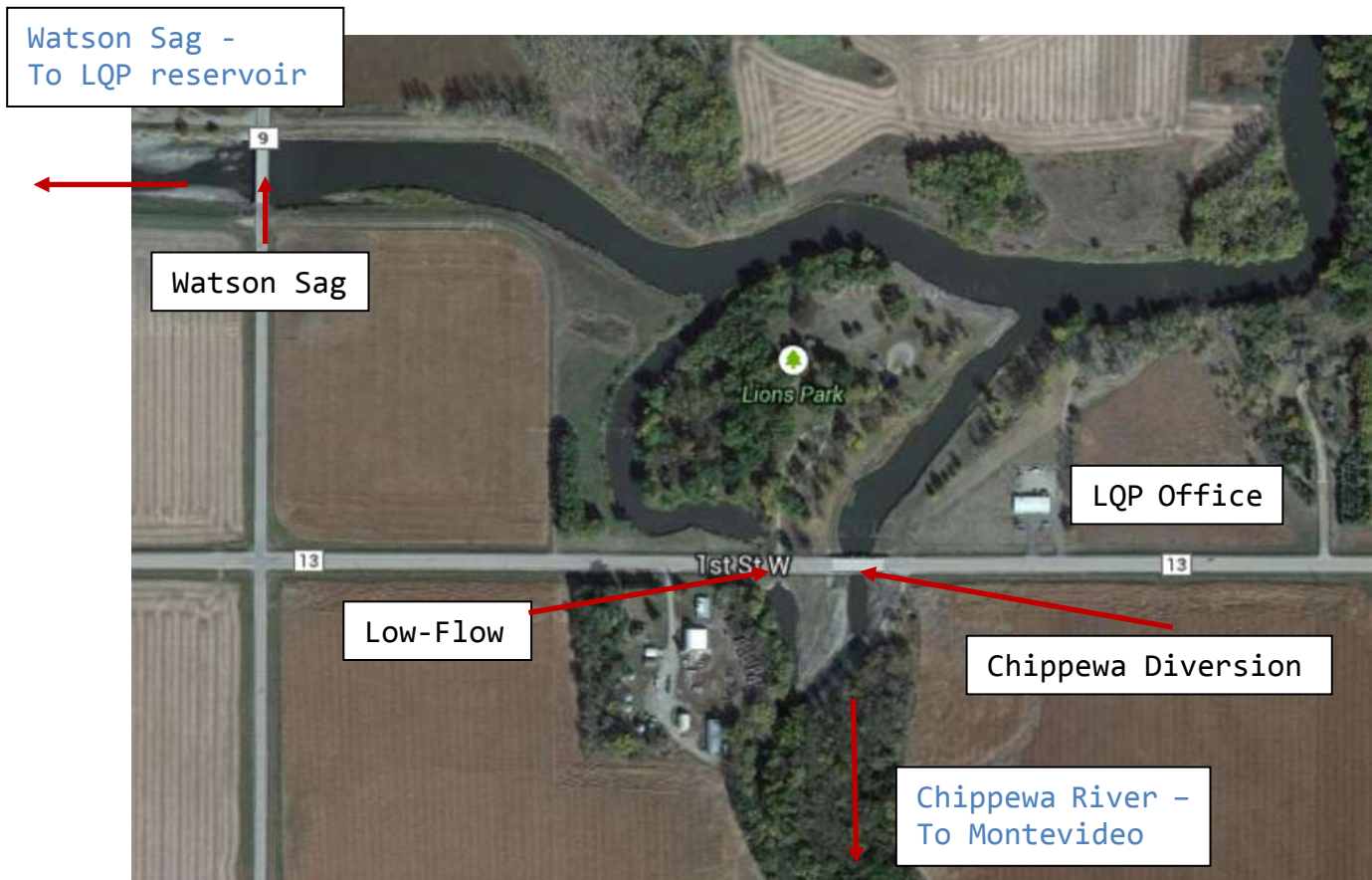


North is upstream.



Looking at the upstream side of the Dam.

Lac qui Parle Dam



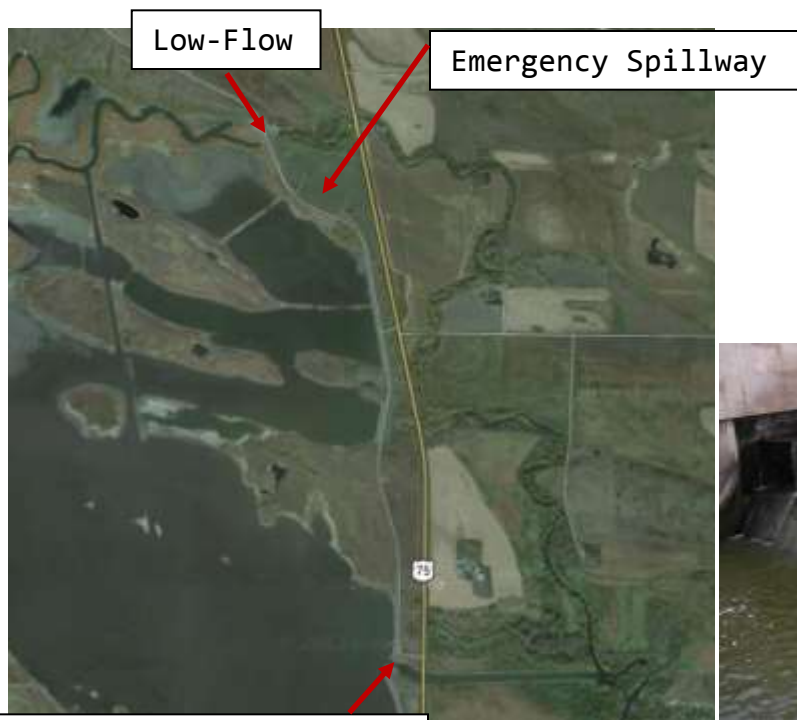
Chippewa Diversion Dam and Watson Sag Weir



Chippewa Diversion Dam



Watson Sag Weir



Leaf Gate



Low-Flow Outlet



Low-Flow Inlet

Highway 75 Dam

NOTICE TO USERS OF THIS MANUAL

Corps of Engineers regulations specify that this Water Control Manual will be published in loose-leaf form to facilitate modifications. In the future, only those sections, or parts thereof, requiring changes will be revised and replaced.

REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during normal business hours, contact Water Management by telephone at 651-290-5306. During non-duty hours, assistance can be obtained by contacting one of the following persons, in the order listed below.

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**Lac qui Parle Project
Minnesota River**

**U. S. Army Corps of Engineers
St. Paul District**

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Reference Datum

All elevations in this manual use the 1929 National Geodetic Vertical Datum (1929 NGVD) unless otherwise stated. To convert to NAVD88 add 0.67 feet to Marsh Lake, 0.71 feet to Chippewa Diversion, 0.49 feet to Lac qui Parle or 0.66 feet to Hwy75.

Metric Equivalents and Conversions

Length:

$$1 \text{ Centimeter} = 0.394 \text{ inches}$$

$$1 \text{ meter} = 3.28 \text{ feet}$$

$$1 \text{ kilometer} = 0.621 \text{ miles}$$

Area:

$$1 \text{ meter}^2 = 10.764 \text{ feet}^2$$

$$1 \text{ kilometer}^2 = 0.386 \text{ miles}^2$$

$$1 \text{ hectare} = 2.471 \text{ acres}$$

Volume:

$$1 \text{ meter}^3 = 35.31 \text{ feet}^3$$

$$1 \text{ meter}^3 = 1.308 \text{ yards}^3$$

$$1 \text{ meter}^3 = 0.81 \times 10^{-3} \text{ acre-feet}$$

Flow:

$$1 \text{ meter}^3/\text{second} = 35.31 \text{ feet}^3/\text{second}$$

Temperature:

$$(\text{Degrees Fahrenheit} - 32)/1.8 = \text{Degrees Celsius}$$

Pertinent Data (Also see Exhibit A)
Lac qui Parle Project
Lac qui Parle Dam/Lac qui Parle Reservoir
Marsh Lake Dam/Marsh Lake Reservoir
Type IV Project

Project Location: Lac qui Parle, Chippewa, Swift and Big Stone counties, Minnesota
7 miles northwest of Montevideo, Minnesota,
288.1 miles above the mouth of the Minnesota River,
Latitude 45° 01' 17", Longitude 95° 52' 05" (Lac qui Parle Dam)

Drainage Area Above Marsh Lake Dam is **2,890** square miles (includes Pomme de Terre River).
Drainage Area Above Lac qui Parle Dam is **4,105** square miles (does not include Chippewa River drainage).
Drainage Area Above the Chippewa River Diversion Dam is **2,070** square miles.

Data is in datum NGVD 29 (unless noted). To convert to NAVD88 add 0.67 feet to Marsh Lake, 0.71 feet to Chippewa Diversion, 0.56 feet to Lac qui Parle or 0.66 feet to Hwy75.

	Lac qui Parle Dam:	Marsh Lake Dam:	
Dam Type:	Rolled-Earth Filled	Rolled-Earth Filled	
Dam Length:	4,100 ± Feet	12,500 Feet	
Dam Height:	23-32 Feet	19.5 Feet at control structure	
Dam Top Width:	23 Feet (roadway)	10 Feet at control structure	
Dam Freeboard:	4.9 Feet (above full pool)	26 Feet on new alignment	
		5 Feet on new alignment for the SDF	
	Elevation (ft)	Capacity (Ac-ft)	Area (acres)
Lac qui Parle Reservoir:			
Gate Sills	922.70	---	---
Summer Conservation Pool (Mar 15-Sep 1*)	933.0	41,000	7,750
*Spring Conservation Pool (end of runoff–May 31)	933.5	44,750	8,050
Winter Conservation Pool (Oct 1-Mar 1)	934.0	48,500	8,350
Top of Flood Control Pool/Emergency Spillway	941.1	158,700	21,450
Flowage Easement Level	945.0	253,500	27,450
Top of Dam	946.0	281,500	28,850
Marsh Lake Reservoir:			
Drawdown Control Structure Sill	934.0	1,300	1,300
Notch in Service Spillway Crest	935.5	4,600	2,900
Conservation Pool / Service Spillway Crest	937.6	12,050	5,150
Emergency Spillway Crest	940.0	27,250	8,100

I - INTRODUCTION

1-01. Authorization. This manual was prepared in compliance with the following:

- a. Engineering Manual 1110-2-3600 titled "*Management of Water Control Systems*" dated 30 November 1987;
- b. Mississippi Valley Division Regulation DIVR 1110-2-240 titled "*Preparation of Water Control Manuals*" dated 01 January 1992;
- c. Engineering Regulation 1110-2-240 titled "*Water Control Management*" dated 30 May 2016, amended 08 October 1982, 30 April 1987, 01 March 1994, 18 November 2011 and 30 May 2016. Prior to this ER the manuals were titled "Reservoir Regulation Manuals". The ER changed the title to Water Control Manuals;
- d. Section 7 of the Flood Control Act of 1944, 22 December 1944.

This manual supersedes the previous manual dated November 2014, which superseded the August 1995 manual, which superseded the original manual dated July 1966. It incorporates changes to Marsh Lake Dam. The 1966 Reservoir Regulation Manual was initiated by letter, 800.2 (Reservoirs), UMSGW, Upper Mississippi Valley Division, 30 August 1948, Subject: "Manual of Regulation for Flood Control and Multiple Purpose Reservoirs." An interim reservoir regulation manual was submitted in November 1956.

1-02. Purpose and Scope. The purpose of this interim manual is to provide guidance and instruction for project personnel and to serve as a reference for others who may be involved with or affected by project regulation. The manual is for daily use by Water Management personnel for essentially all foreseeable conditions affecting the project. The scope of this manual covers all water control management activities as they relate to the hydraulic and hydrologic aspects of the project during construction of the Marsh Lake Ecosystem Features. The interim manual will be updated upon completion of the project. The updated manual is expected to be complete in 2019.

1-03. Related Manuals and Reports. Prior reports on flood control and improved navigation for the region date from 1849. Some of the information is included in annual reports of the Chief of Engineers. The early reports deal with investigations into the advisability of dredging, removal of obstructions, and construction of locks and dams on the Minnesota River, Lake Traverse, and the Red River of the North and tributary streams. In general, the early reports were favorable to dredging and the removal of obstructions but were unfavorable to the construction of locks and dams as aids to navigation.

- a. *Report of an exploration of the Territory of Minnesota in 1849*, Ex. Document No. 42, 31st Congress, Corps of Topographical Engineers, Captain John Pope, 1850.
- b. *Examination and Survey of the Minnesota River*, Ex. Document No. 76, 43rd Congress, 2nd Session, Corps of Engineers, Major G. K. Warren, 1866 – 1867.
- c. *Survey of Minnesota River, Big Stone Lake, and Lake Traverse*, House Document No. 75, 44th Congress, 1st Session, Corps of Engineers, Colonel T. N. Macomb, 1872.
- d. *Report on Reservoir at Foot of Big Stone Lake*, Senate Document No. 30, 48th Congress, 1st Session, Unfavorable recommendations as commerce did not justify cost of reservoir for navigation.
- e. *Preliminary Examination of Big Stone Lake and Lake Traverse*. House Document No. 71, 48th Congress, 2nd Session, (Unfavorable). This report examined the possibility of connecting the two lakes.
- f. *Red River of the North and Big Stone Lake*, House Document No. 127, 52nd Congress, 1st Session, Concluded that a reservoir at Big Stone Lake could aid navigation on the Mississippi River by increasing low flows.
- g. *Preliminary Examination of Big Stone Lake*, House Ex. Document No. 256, 53rd Congress, 3rd Session, Recommended a survey of Big Stone Lake and Lake Traverse for Reservoirs.
- h. *Survey of Big Stone Lake and Lake Traverse for Reservoirs*, House Document No. 134, 55th Congress, 2nd Session, 1897, Report includes plans for reservoir and estimate of cost, (Unfavorable, Recommended further study).
- i. *Preliminary Report on Survey of Big Stone Lake and Lake Traverse for Reservoirs*, House Document No. 675, 56th Congress, 1st Session, Progress Report, Final Report to be Made in 3 Years.

- j. *Survey Report on Reservoirs at Big Stone and Lake Traverse*, House Document No. 539, 58th Congress, 2nd Session, 1904 (Unfavorable Recommendation).
 - k. *Examination of the Bois de Sioux River, Lakes Traverse and Big Stone Lake*, House Document No. 493, 60th Congress, 1st Session, 1908. This report examined the possibility of diverting floodwaters from the Red River of the North basin into the Minnesota River (Report Unfavorable).
 - l. *Survey of Minnesota River for Upper Valley Navigation Reservoirs*, House Document No. 700, 62nd Congress 2nd Session, Recommended the construction of a 45-foot dam at Lac qui Parle with water power development to be operated as a navigation reservoir.
 - m. *Examination of Lake Traverse and Big Stone Lake*. House Document No. 199, 65th Congress, 1st Session, 1917. This report looked at flood control, water power, and the possibility of connecting and extending navigation on and between the lakes.
 - n. *First Biennial Report of the Commissioner of Drainage and Waters to the Governor of the State of Minnesota and the Legislature*, 1921, Presents plans of improvement for control of floods on the Minnesota River by means of 3 main stem reservoirs.
 - o. *Second Biennial Report of the Commissioner of Drainage and Waters to the Governor of the State of Minnesota and the Legislature*, 1923, Results of continuation of studies on plan in 1st Biennial Report.
 - p. *Minnesota River, Minnesota (Navigation, water power, flood control, and irrigation)*, House Document No. 230, 74th Congress, 1st Session. The prospective flood control benefits from three reservoirs (Big Stone Lake, Lac qui Parle, New Ulm) was not sufficiently general in character to warrant Federal participation, Proposed the Mendota Reservoir.
 - q. *Big Stone Lake Reservoir Project and Lac qui Parle Reservoir Project*, House Document No. 669, 76th Congress, 3rd Session, Reservoirs proposed to reduce the frequency of flooding in the upper portions of the Minnesota River Valley. A future reservoir is proposed near New Ulm, Minnesota in a tabulation of a comprehensive flood control plan.
- Report on Diversion of Flood Waters of Little Minnesota River into Lake Traverse*, Review of House Document No. 230, 74th Congress, 1st Session, Includes a study of flood problems on the Minnesota River from Browns Valley to Lac qui Parle Dam
- r. *Diversion of Floodwaters of Little Minnesota River into Lake Traverse*, U.S. Engineer Office, St. Paul, Minnesota, 17 September 1945.

- s. *Report on Survey of Minnesota River, Minnesota, For Flood Control and Allied Purposes*, Corps of Engineers, U.S. Army Office of the District Engineer, St. Paul, Minnesota, 3 January 1950.
- t. *Interim Reservoir Regulation Manual*, Lac Qui Parle Dam and Reservoir, Corps of Engineers, U.S. Army, Office of the District Engineer, St. Paul, Minn., November 1956.
- u. *Interim Report on Survey of Big Stone Lake-Whetstone River Project, Project Modifications*, Minnesota and North Dakota, U.S. Army Engineer District, St. Paul, Minnesota, Corps of Engineers, 2 Reports dated 30 January 1959 and 24 June 1960.
- v. *General Design Memorandum, Minnesota River, Minnesota, In the Interest of Navigation and Related Purposes*, U.S. Army Engineer District, St. Paul, Corps of Engineers, St. Paul, Minnesota, February 1961.
- w. *Phase 1 Report for Flood Control and Related Purposes, Minnesota River Basin*, Minnesota and South Dakota, Department of the Army, St. Paul District, Corps of Engineers, St. Paul, Minnesota, 8 March 1966.
- x. *Lac Qui Parle Reservoir and Minnesota River, Channel Improvement, Reservoir Regulation Manual*, U.S. Army Engineer District, St. Paul, Minnesota, Corps of Engineers, July 1966.
- y. *Water Supply and Water Quality Control Study, Minnesota River Basin Reservoirs*, Minnesota, South Dakota, Iowa, United States Department of the Interior, Federal Water Pollution Control Administration, July 1969.
- z. *Interim Survey Report, 9-Foot Navigation Channel Above Mile 14.7, Minnesota River*, Minnesota, Department of the Army, St. Paul District, Corps of Engineers, St. Paul, Minnesota, 30 January 1970.
- aa. *Report on Probable Maximum Floods and Standard Project Floods, Minnesota River Basin, Minnesota*, Department of the Army, St. Paul District, Corps of Engineers, St. Paul, Minnesota, June 1971.
- bb. *Flood Control, Big Stone Lake-Whetstone River, Minnesota-South Dakota, Design Memorandum No. 3*, Department of the Army, St. Paul District, Corps of Engineers, St. Paul, Minnesota, June 1973.
- cc. *Forecasting Rainfall and Snowmelt Runoff on Floods on Upper Midwest Watersheds*, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Lab Report No. 151, June 1974.

- dd. *Minnesota River Basin Report*, Southern Minnesota Rivers Basin Commission, February 1977.
 - ee. *Highway 75 Dam and Reservoir, Reservoir Regulation Manual*, Big Stone Lake-Whetstone River Project, Appendix B, Department of the Army, St. Paul District, Corps of Engineers, St. Paul, Minnesota, October 1979.
 - ff. *Upper Mississippi River Subbasins Study, Stage I, Report Alternatives*, Public Law 87-639, United States Department of Agriculture, Soil Conservation Service, and Department of the Army, St. Paul District, Corps of Engineers, January 1980.
 - gg. *Computer Simulation of Low Flow Conditions, Minnesota River*, Barr Engineering for U.S. Army Corps of Engineers, St. Paul District, 1980.
 - hh. *Operation and Maintenance Manual, Big Stone Lake-Whetstone River Flood Control*, U.S. Army Corps of Engineers, St. Paul District, December 1986, Draft.
 - ii. *Sedimentation Rates and Changing Water Quality - Pomme de Terre River Watershed*, West Central Minnesota, Geology Department, University of Minnesota, Morris, Minnesota, Dr. James Van Alstine, March 1987.
 - jj. *Problem Appraisal Report, Operation Plan Evaluation for Highway 75-Lac Qui Parle Reservoir*, U.S. Army Corps of Engineers, St. Paul District, September 1987.
 - kk. *Reservoir Operation Plan Evaluation (ROPE) Study for Highway 75-Lac Qui Parle Reservoirs, Minnesota River, Minnesota*, U.S. Army Corps of Engineers, St. Paul District, September 1989 Draft Report. A final ROPE report was not published; however recommendations were followed in later reports. See **Paragraph 1-03** (CACFDAS Report) in this manual.
- High water events in 1979, 1985 and 1986 peaked interest in reviewing the water control plans for the Highway 75 and Lac qui Parle Dam projects. A ROPE study was initiated and a draft ROPE report was published in September 1989. This report did not involve any technical/modeling analysis. A final ROPE report was not published.
- ll. *Dam Failure Planning Report, Marsh Lake Dam*, Minnesota River, Minnesota, U.S. Army Corps of Engineers, St. Paul District, August 1987.
 - mm. *Dam Failure Planning Report, Chippewa Dam*, Chippewa River, Minnesota, U.S. Army Corps of Engineers, St. Paul District, September 1987.
 - nn. *Emergency Action Plan, Lac Qui Parle Flood Control Project*, Corps of Engineers, St. Paul District, October 1988.

- oo. *Drought Contingency Plan (DCP), Big Stone Lake - Whetstone River, Highway 75 Dam, Lac Qui Parle Reservoir and Minnesota River - Channel Improvement, Reservoir Regulation Manual, Appendix, U.S. Army Corps of Engineers, St. Paul District, September 1992, Draft. A final DCP report was not published.*
- pp. *Minnesota River Assessment Project Report, Report to the Legislative Commission on Minnesota Resources, Minnesota Pollution Control Agency, January 1994.*
- qq. *The Great Flood of 1993, Post-Flood Report, Upper Mississippi River and Lower Missouri River Basins, U.S. Army Corps of Engineers, North Central Division, Main Report, September 1994.*
- rr. *Economic Analysis, Agricultural Flood Damages, Lac Qui Parle Flood Control Project, Gulf Engineers and Consultants, Incorporated, Project No. 22302401, Baton Rouge, Louisiana, Volume I: Main Report, Volume II: CACFDAS Output Data, Final Report, October 1994, (MODA, CEMVP-0000075631 and 75632). This report was published in support of the subsequent August 1995 Water Control Manual.*
- ss. *Environmental Assessment, Modification to Lac Qui Parle Reservoir Regulation Plan, Minnesota River, U.S. Army Corps of Engineers, St. Paul, District, Cover letter dated 22 December 1994.*
- tt. *Water Control Manual, Flood Control, Minnesota River, Lac Qui Parle Reservoir, Lac qui Parle Reservoir and Marsh Lake Reservoir Including Marsh Lake Dam, Lac qui Parle Dam, Chippewa River Diversion Dam and Watson Sag Weir, U.S. Army Corps of Engineers, St. Paul, District, Revised August 1995.*
- uu. *Minnesota River Basin, Reconnaissance Study, Section 905(b) Analysis, (WRDA of 1986), Minnesota, South Dakota, North Dakota, and Iowa, U.S. Army Corps of Engineers, St. Paul, District, December 2004.*
- vv. *Feasibility Report and Environmental Assessment, Marsh Lake Ecosystem Restoration Project, Minnesota River, Big Stone, Lac qui Parle, and Swift Counties, Minnesota, U.S. Army Corps of Engineers, St. Paul, District, Final Report, November 2011.*
- ww. *Water Control Manual, Flood Control, Minnesota River, Lac Qui Parle Reservoir, Lac qui Parle Reservoir and Marsh Lake Reservoir Including Marsh Lake Dam, Lac qui Parle Dam, Chippewa River Diversion Dam and Watson Sag Weir, U.S. Army Corps of Engineers, St. Paul, District, Revised November 2014.*

1-04. Project Owner. The United States government is the owner of the project.

1-05. Operating Agency. The U.S. Army Corps of Engineers, St. Paul District, Operations Division is responsible for the operation and maintenance of the Lac qui Parle Project (with the exception of Marsh Lake Dam ecosystem features). Regulation instructions for Lac qui Parle and Chippewa Diversion are provided by the Water Management and Hydrology Section, Engineering and Construction Division. The project is attended continuously during normal business hours by the Supervisory Park Manager and his staff. Gate operations are manual. The Operations Project Manager is in the Western Flood Control office in Fargo, North Dakota. The Park Manager, the Project Manager and the Minnesota Department of Natural Resources (MN DNR) can be reached at the below numbers (see **Table 1-1**). The MN DNR is responsible for the operation and maintenance of the Marsh Lake Dam ecosystem features (JPA agreement #76969), that includes the drawdown structure and rock ramp fishway.

Table 1-1 Project Office Points of Contact	
Name	Work Number
Lac Qui Parle Project, Supervisory Park Manager (operates the dam) 9055 1st Street West (Post Office Box 177) Watson, MN 56295-0177	320.269.6303
Operations Project Manager, Western Flood Control Office 15 South 21st Street, Room 102 Fargo, ND 58103-1435	701.232.1894
MN DNR – LQP Office 14047 20th St NW Watson, MN 56295	320.734.4450

1-06. Regulating Agency. The regulation of the Lac qui Parle Project is under the supervision of the Water Management and Hydrology Section within the Hydraulics and Hydrologic Branch, Engineering and Construction Division of the St. Paul District Corps of Engineers (Corps). The Corps is the owner of the project.

II - DESCRIPTION OF PROJECT

2-01. Location. Lac qui Parle is a French phrase meaning “lake that speaks”. Lac qui Parle Project is located on the Minnesota River in western Minnesota near the South Dakota state line. The project lies along the northeastern boundary of Lac qui Parle County and the southwestern boundaries of Chippewa, Swift, and Big Stone Counties **(Plate 2-1)**. The project is downstream of the headwaters of the Minnesota River at Big Stone Lake and Highway 75 reservoir **(Plate 2-2)**.

Marsh Lake Dam is 287 river miles above the mouth of the Minnesota River and is located near Appleton, Minnesota just downstream of the Pomme de Terre River. The dam forms Marsh Lake Reservoir when the project pool is below elevation 937.6 feet. Lac qui Parle Dam is approximately 7 miles northwest of Montevideo, Minnesota, and is 271 miles above the mouth of the Minnesota River. The reservoirs extend upstream for a distance of about 27 miles.

2-02. Purpose. The Lac qui Parle Project was authorized by the Flood Control Act of 1936 (22 June 1936) (Public Law 74-738). However, work on the project was started in October 1934 by the State of Minnesota as a Public Works Administration project. The 1936 Act authorized flood control as a federal project purpose. The above, and other project purposes assigned by Congress following completion of the project, are listed in **Table 2-1**.

The project was constructed as a joint state and federal project (see **Chapter 3**). It is now a federal project.

Marsh Lake Ecosystem Project

A feasibility report was published in November of 2011 regarding a Marsh Lake Ecosystem Restoration Project. The purpose of the Marsh Lake Ecosystem Restoration Project is to restore the aquatic and riparian ecosystems within the Marsh Lake project area. Impoundment of Lac qui

Parle and Marsh Lake, along with diversion of the Pomme de Terre River into Lac qui Parle, and other river regulation activities have significantly altered the ecosystem state.

**Table 2-1
Lac qui Parle Project
Authorized Purposes Assigned by Congress**

Authorized Purpose	Public Law No.	Description
Flood Control	74-738	Flood Control Act of 1936
Recreation and Surplus Water	78-534	Flood Control Act of 1944
Fish and Wildlife	85-624	The 1958 amendments to the Fish and Wildlife Coordination Act
Water Supply	92-500	Water Supply Act of 1958
Recreation	89-72	Federal Water Project Recreation Act of 1965
Water Quality	92-500	Federal Water Pollution Control Act Amendments of 1972
Threatened and Endangered Species	93-205	Endangered Species Act of 1973

In some circumstances, as at Marsh Lake, a return to pre-disturbance conditions may not be feasible. In those instances, “the goal is to partially or fully reestablish the attributes of a naturally functioning and self-regulating system.” The goal of this project is to return the Marsh Lake area ecosystem to a less degraded, more natural condition by restoring natural functions and processes. The original construction of the Marsh Lake Dam was intended to serve as a flood

damage reduction measure as well as a recreational feature to the region, primarily through the creation of a static pool on the river. The intended flood damage reduction benefits provided by the Marsh Lake Dam are minor due to effectiveness of the Lac qui Parle Dam immediately downstream. Marsh Lake is a popular recreation destination in the region. As with many projects constructed at the time, a full understanding of the ecology of the system was not of primary concern.

Since impoundment, Marsh Lake has undergone significant degradation of aquatic habitat due to a number of stressors including high sediment and nutrient loading, a fixed crest dam that prevents low seasonal water levels, high turbidity from wind-driven sediment resuspension, and abundant common carp that increase turbidity and graze off submersed aquatic vegetation and macroinvertebrates. Although Marsh Lake provides an open water area for migratory waterfowl to rest and islands for nesting colonial waterbirds, degradation of the aquatic ecosystem there limits habitat suitability for many species of fish and wildlife.

The underlying purpose and need for this project is to restore the degraded Marsh Lake ecosystem. The stated goal of the Marsh Lake Ecosystem Restoration Project is to “return the Marsh Lake area ecosystem to a less degraded and more natural condition by restoring ecosystem structure and functions.” The intent of the Marsh Lake ecosystem restoration project is to increase variability in ecosystem processes, restore a more natural water level regime, aquatic habitat connectivity, and a vegetated lake ecosystem state.

The objectives of the project are: 1) reduce sediment loading to Marsh Lake, 2) restore natural hydrologic fluctuations to Marsh Lake, 3) restore geomorphic and floodplain processes to the Pomme de Terre River, 4) reduce sediment resuspension in Marsh Lake, 5) increase emergent and submergent aquatic plants in Marsh Lake, 6) increase waterfowl and native fish habitat, 7) restore aquatic habitat connectivity between Marsh Lake, the Pomme de Terre River, and Lac Qui Parle, and 8) reduce aquatic invasive fish in Marsh Lake.

Additional details on the purpose and need of the project can be found in the Federal Environmental Assessment dated July 2011 or the Supplemental Environmental Assessment dated April 2016.

2-03. Physical Components.

a. General. The Lac qui Parle Project consists of: Marsh Lake Dam, Lac qui Parle Dam, the Chippewa River Diversion structures, and the Minnesota River Channel down to Granite Falls, Minnesota (**Plate 2-2** – will be updated once construction is complete).

Marsh Lake Dam divides the Lac qui Parle Reservoir into two sections when the Lac qui Parle pool is below approximately elevation 937.6 feet. The pool behind the dam is called Marsh Lake reservoir. Lac qui Parle Dam is downstream of Marsh Lake Dam. The pool behind the dam is called Lac qui Parle reservoir. When the Lac qui Parle pool reaches the same level as the Marsh Lake pool, Marsh Lake and Lac qui Parle become essentially one pool and the control shifts to Lac qui Parle Dam.

The Chippewa River Diversion Dam and the Watson Sag Weir divert high flows on the Chippewa River into Lac qui Parle Reservoir.

The Minnesota River channel project provides the necessary channel capacity for the drawdown of the Lac qui Parle Project.

b. Marsh Lake Dam. The Marsh Lake Dam is comprised of dredged earth fill totaling approximately 12,500 feet in length.

The original earth fill portion has a top width of 10 feet with a 1 on 3 side slope on the upstream and downstream sides. On the downstream side, the 1 on 3 side slope extends only to an elevation 5 feet below the top of the dam. Below this elevation, the slope changes to a 1 on 4 grade. The elevation of the top of the embankment ranges between elevation 948.6 feet and 952.6 feet. The maximum height of the dam is about 19.5 feet with an average top elevation of approximately 950.0 feet.

In 2017 a new embankment to the east will be created to allow for returning the Pomme de Terre back to its historic channel. The elevation of the new embankment will be 952.1 feet. Dam height will vary from ~2 feet to ~10 feet. The top width will be 26 feet which allows for an access road. The design grade for the new embankment will have a 5 foot freeboard for a SDF flood event. Rock rip-rap will be installed on the lake side to elevation 942 feet (matching existing elevation of rip-rap). A general plan and cross section are shown on **Plate 2-3** (will be updated after construction of the project is complete).

c. Marsh Lake Dam Service Spillway. The Marsh Lake Dam service spillway will be modified in 2017 to a fishway rock ramp. The concrete fixed crest spillway section (112 feet in width with a crest elevation of 937.6 feet) will remain but a notch will be cut into the middle of it (elevation 935.5 feet, width 30 feet). The fishway will start at the location of the fixed crest spillway and extend about 300 feet downstream at a 3% slope. Boulder weirs will be spaced 20 feet apart with each achieving individual 10-inch drops. The ramp will range in width from 150 feet at the dam, to 200 feet wide at the downstream edge and will be approximately 300 feet long. The downstream invert will tie into the river bed at elevation 925.5 ft. The ramp will tie into the existing bank on the east side. On the west side, the ramp will tie into a partially rip-rapped earthen (containment) embankment, 20 feet wide and with 1H:4V side slopes. 1,579 cubic yards of large (1.6 ft diameter and larger boulders for weirs) rock will be used in the fishway channel. Rip-rap and gravel bedding will be used to armor the fishway channel. Impervious fill will be used as

Water Control Manual, Lac qui Parle Project



f. Marsh Lake Dam Drawdown Structure. In 2017 a drawdown structure will be built. The drawdown structure will have six bays, which each contain two sluice gates. Each sluice gate will be 5 feet wide by 6 feet tall. The approach channel will lead to a flat crest slab which will be at elevation 934.0 feet (sill of sluice gates). The top elevation of the sluice gates will be 940.0 feet. Downstream of the sluice gates, the flow will pass over a sloping (1:4) slab down to elevation 927.0 where it will enter the energy 30-foot long dissipation slab set at a flat elevation of 927.0. The approach channel wing walls will include a 1:3 flare, while the outlet channel will flare at 1:5. A general plan and cross section are shown on **Plate 2-3** (will be updated after construction of the project is complete – see drawing in **Figure 2-3** for conceptual layout).

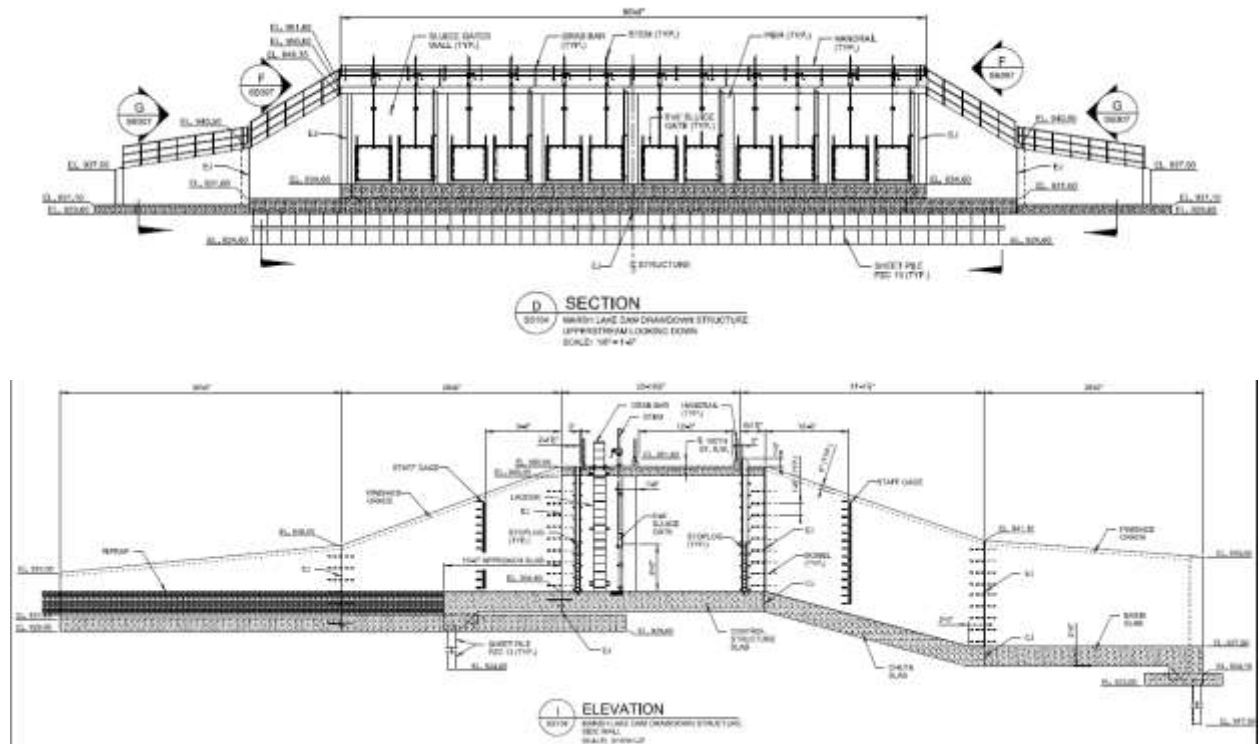


Figure 2-3: Plan for Marsh Lake Drawdown Structure. Datum is NAVD88.

g. Marsh Lake Dam Outflow Channel. The Marsh Lake Dam outflow channel extends for about 1,500 feet downstream from the spillways. The channel has a bottom width of 25 feet and 1 on 2 side slopes, bounded on both sides by dikes having a top elevation of 938.0 feet. A general plan and cross section are shown on **Plate 2-3**.

h. Marsh Lake Dam Boat Access. Located to the west of the drawdown structure is a boat access ramp that will be added in 2017. The 100-ft long dredge maintenance access ramp will extend from the top of the west embankment into Marsh Lake. Rock will be placed in a 33-inch thick layer on top of 12 inches of bedding material. The top 8 inches of the rip-rap will be chinked. The ramp will have a 15% slope and extend from the top of the embankment (949.4 ft) into the Marsh Lake bottom (934.4 ft)

i. Lac qui Parle Dam. The Lac qui Parle Dam is comprised of earth fill. The left bank section extends about 200 feet from the control structure to high ground. The right bank section descends from the control structure for about 250 feet to the emergency spillway section which is 2,500 feet in length. Beyond the spillway section, the top of the dam rises gradually over a distance of 1,000 feet to elevation 950.5 feet. The dam extends about another 700 feet before intercepting higher ground. The dam carries Chippewa County State Aid Highway (CSAH) No. 13 (Lac qui Parle CSAH No. 33) across the Minnesota River. The roadway is 23 feet wide. The total length of the dam, including the control structure and emergency spillway, is about 4,100 feet. A general plan and cross section are shown on **Plates 2-4 and 2-5**.

j. Lac qui Parle Dam Control Structure. The Lac qui Parle Dam control structure consists of a concrete curtain wall section and a fixed concrete spillway section (**Plate 2-4**). The curtain wall section is divided into four bays, numbered 1 through 4, beginning from the left bank. The spillway section is divided into eight bays, numbered 5 through 12. All bays have a span of 17 feet and all piers are 3 feet wide. The piers support a bridge over the control structure with a deck elevation of 946.2 feet.

Bays 1, 3, and 4 each have two 6.0- by 8.0-foot vertical lift gates with sill elevations at 922.7 feet. Bay No. 2 has three 4.0- by 4.0-foot vertical lift gates with sill elevations at 915.2 feet. These gates (Bay No. 2) are equipped with trash racks and are used for low flow regulation. The nine lift gates in the curtain wall section are numbered 1 through 9 beginning in bay No. 1.

In the spillway section, the crest elevation is 934.2 feet. Bays 5 through 7 are uncontrolled spillways with no gates. In bays 8 through 12, each bay has three sections of movable steel bulkheads. The bulkheads have a top elevation of 940.7 feet when they are in the sealed position and are 5.5 feet wide. The bulkheads are raised and lowered according to the operating plan.

k. Lac qui Parle Dam Stilling Basin. The stilling basin for Lac qui Parle Dam varies in length and floor elevation across the width of the structure. The stilling basin for bays 1 through 4 has a floor elevation of 914.2 feet with an end sill top elevation of 920.2 feet. The stilling basin for Bay No. 2 contains a baffle block with a top elevation of 921.7 feet. In bays 5 through 7, the basin has a floor elevation of 918.7 feet. In bays 8 through 12, the elevation of the floor is 923.2 feet. The length of the basin varies from 42 to 60 feet and the total width is 237 feet. A general plan and cross sections of the various bays are shown on **Plates 2-4 and 2-5**.

l. Lac qui Parle Dam Emergency Spillway. The emergency spillway section is capped with soil cement and a bituminous surfaced roadway and is 2500 feet long. A concrete core wall is keyed 3 feet into natural ground along the upstream edge of the spillway and has an average top elevation of 940.75 feet. The downstream slope of the spillway is paved with 1 foot of grouted riprap on a 1 on 2 slope with at least 6 feet of horizontal paving at the toe of the fill. The upstream slope is 1 on 3 and seeded. The spillway is not level. The low point has a crown elevation of about 941.2 feet. The original emergency spillway had a crown elevation of 941.1 feet. The road has been resurfaced which has raised the top elevation slightly. Elevation 941.1 is the top of the flood control pool. A general plan and cross section are shown on **Plate 2-4**.

m. Lac qui Parle Dam Outflow Channel. The Minnesota River channel was modified between Lac qui Parle Dam, (river mile 288.1) and Granite Falls, Minnesota, (river mile 245.0)

(Plate 2-6). The project consisted of rock and snag removal and cutoffs at various locations to increase the bankfull capacity of the channel.

n. Reservoirs. The Lac qui Parle Project incorporates two reservoirs for the storage of water for flood control and water conservation; namely, Lac qui Parle and Marsh Lake reservoirs. Lac qui Parle Reservoir extends in a northwesterly direction about 15.4 miles above the dam. Marsh Lake Reservoir flows into Lac qui Parle and extends about 7 miles northwest above Lac qui Parle Reservoir. The combined storage capacity of both reservoirs at the maximum design elevation of 941.1 feet is 157,800 acre-feet. Marsh Lake Reservoir has 12,050 acre-feet of storage at the conservation pool elevation of 937.6 feet. Lac qui Parle Reservoir has 41,000 acre-feet of storage at the conservation pool elevation of 933.0 feet.

o. Chippewa River Diversion Dam. The Chippewa Diversion dam diverts a portion of the floodwaters of the Chippewa River into the Lac qui Parle Reservoir. The dam is constructed of rolled earth fill and carries a 32-foot wide highway across the Chippewa River at elevation 950.3 feet. Total length of the dam, which includes the main control structure and a low water control culvert, is about 1,900 feet. Side slopes are 1 on 3 on the upstream side and 1 on 4 on the downstream side. The approach channel has a 40-foot bottom width at elevation 932.8 feet and side slopes of 1 on 2. A 1,200-foot dike on the left bank of the approach channel has a minimum top width of 10 feet and side slopes of 1 on 3 with a top elevation of 950.3 feet. A general plan and cross section are shown on **Plates 2-7 and 2-8**.

p. Chippewa River Diversion Dam Control Structure. The main control structure is a 5-span combination highway bridge and dam. Bays 1, 2, 4, and 5 have a fixed crest spillway elevation of 942.3 feet and are each 27 feet wide. The flow discharges onto a concrete apron at elevation 934.3 feet with a dentated end sill and baffles. Bay 3 provides the discharge control by means of a 27-foot wide Tainter gate. The top of the gate in the closed position is at elevation 942.3 feet which matches the crest elevation of the other bays. The gate's sill elevation is 932.9 feet. Discharge through the gate is onto a concrete apron at elevation 932.0 feet with an end baffle

at elevation 932.8 feet. The tainter gate is powered by an electric gate lifter but can also be operated by hand. The bridge on top of the control structure was rehabilitated in 1986. Portions of the bridge were constructed low and as a result the tainter gate can no longer achieve its maximum opening. The maximum gate opening is now 5.5 feet. A limit switch prevents the gate from impacting and damaging the bridge.

About 300 feet west of the right abutment of the control structure is a low-water control culvert which was the only means of passing low flows prior to the installation of the tainter gate in 1941. This culvert is a 4- by 4- by 90.4-foot concrete box type through the earth dike. The inlet is controlled by a 4- by 4-foot vertical lift gate protected by a trash rack. The entrance invert is at elevation 933.3 feet and the exit invert is at 932.8 feet. A general plan and cross section are shown on **Plates 2-7 and 2-8**.

q. Watson Sag Weir, Chippewa River Diversion Channel. The Chippewa River diversion channel passes some of the Chippewa River floodwaters into the Lac qui Parle Reservoir. It is an excavated channel about 3,500 feet in length with a bottom width of about 160 feet and side slopes of 1 on 3. The channel cuts through a part of a natural ridge which separates the Chippewa River from the abandoned glacial channel known as the Watson Sag. A six span (6 bays) combination highway bridge and spillway near the point of diversion controls the flow of water from the Chippewa River into the channel. Each bay is 27 feet wide. A rolled earth dike on the left bank of the channel is an extension of the Chippewa River Diversion Dam and serves to protect the railroad tracks adjacent to the channel from being flooded. The dike has a 10-foot top width and side slopes of 1 on 3 on the channel side and 1 on 4 on the landward side. The elevation of the top of the dike varies from 946.3 feet to 947.8 feet.

The spillway crest is at elevation 938.8 feet and discharge is onto a concrete apron at elevation 932.3 feet with a dentated end sill and baffles. The downstream channel bottom is at elevation 934.3 feet and the upstream approach bottom is 936.3 feet. The bridge deck is at elevation 950.0 feet. When the stage in Lac qui Parle reservoir is high enough and no flood flows are coming down the Chippewa River, the flow in the diversion channel will reverse and pass through the

Chippewa River Dam and down the Chippewa River channel. A general plan and cross section are shown on **Plate 2-7**.

2-04. Related Control Facilities.

a. General. There are two dams upstream of the Lac qui Parle Project called Big Stone Lake Dam and Highway 75 Dam. Both are incorporated into the Big Stone Lake-Whetstone River Project.

In 1935 Big Stone Lake was at an extremely low level after several years of extreme drought conditions. In that year, the Big Stone Lake - Whetstone River Project was initiated to maintain a better range of water levels on the lake and to utilize the immense storage capacity of the lake for flood control and water conservation. The project was constructed by the State of Minnesota under the Federal Emergency Relief Act and the Works Progress Administration. Later, high lake levels, acceleration of silt deposit in the lower end of the lake, and flood damages, justified additional improvements downstream from the outlet of Big Stone Dam. In 1958, the State of Minnesota, with some cost sharing by the State of South Dakota, constructed a steel sheet-pile dam (which serves as a silt barrier) in the Minnesota River between the outlet of Big Stone Lake and the mouth of the Whetstone River diversion channel. In addition, the Highway 75 Dam was completed in 1974. It provides 45,300 acre-feet of storage for the reduction of flood damages to downstream areas. The pool sustains open-water areas for waterfowl use in the national wildlife refuge which was established as part of the project. Highway 75 Dam has a drainage area of approximately 1,700 square miles. The locations of these structures are shown on **Plate 2-1**. See also **Paragraphs 3-04 and 4-10**.

b. Big Stone Lake Dam Outlet Structures. The dam has 8 slide gates each measuring 7 feet high and 10 feet-10 inches wide. There are also 2 low flow gates. One is 4 feet by 4 feet and the other is 18 inches in diameter. All slide gates discharge at elevation 960.7 feet, and the low flow orifices discharge at elevation 961.2 feet. The crest of the slide gates, when closed, is

elevation 964.7 feet. The dam is operated by the Minnesota Power and Light Company. Big Stone Lake Dam has a drainage area of approximately 1,160 square miles.

c. Highway 75 Dam Outlet Structures. The service spillway is a reinforced-concrete gravity weir that is 65 feet long, with a crest elevation of 947.3 feet. Discharge is controlled by an electrically operated Bascule leaf gate that can be raised to a normal conservation pool elevation of 952.3 feet. The stilling basin is 68 feet long with a floor at elevation 934.0 feet. The stilling basin has five baffle blocks with top surfaces at elevation 938.58 feet and an end sill with a top elevation of 936.9 feet. A discharge channel 0.5 mile in length with a bottom width of 55 feet and 1 on 3 side slopes connects the service spillway with the Minnesota River.

The emergency spillway for the Highway 75 dam is 715 feet long. The crest of the spillway is at elevation 956.6 feet and is 50 feet wide. A 1-foot deep v-shaped depression has been provided on the centerline of the emergency spillway crest and chute to concentrate any erosion in the center of the spillway and away from the training dikes constructed downstream from both ends of the spillway.

2-05. Real Estate Acquisition. Construction of the Lac qui Parle Reservoir was initiated early in 1936 as a Works Progress Administration project sponsored by the State of Minnesota. The operation of the project was transferred from the State to the Corps of Engineers on 7 September 1950. Land acquisition was completed by the Corps during March 1961.

The Corps has fee title to 518 acres for the dam, and easements on 19,859 acres for the reservoir. All of this area was conveyed to the United States by the State of Minnesota. In 1957, 60 acres were withdrawn from public lands for use by the Department of the Army. All of the land acquisition for the project is complete. Project lands are shown on **Plates 2-9 and 2-10** (will be updated after construction is complete). Flowage easements are to elevation 945.0 feet and are shown on **Plate 2-10**.

2-06. Public Facilities. Also see **Paragraphs 7-06 and 8-03.**

a. General. There are 3 public use facilities associated with the Lac qui Parle Project. The areas are referred to as Area A, B, and C. A brief description of each area can be found in the following paragraphs.

b. Area A, Marsh Lake Dam. The public use facilities at Marsh Lake Dam consist of a picnic area, shoreline fishing access, and privies. Area A is located adjacent to Marsh Lake Dam (**Plate 2-2**).

c. Area B, Lac qui Parle Dam. The facilities at Lac qui Parle Dam consist of a picnic area, drinking water, shoreline fishing access, fish cleaning facilities, handicap-accessible privies, and a playground. Area B is located adjacent to Lac qui Parle Dam (**Plate 2-2**).

d. Area C, Chippewa River Diversion Dam. The facilities at the Chippewa Diversion Dam consist of shoreline fishing sites, and access to hunting areas and hiking trails. Area C is located adjacent to the Chippewa Diversion Dam and the Watson Sag Weir (**Plate 2-2**).

e. Other. Lac qui Parle State Park is located on the right bank just upstream of Lac qui Parle Dam. The Minnesota River is part of the State's Wild and Scenic Rivers System and is also a state canoe route. There are 19 boat access sites surrounding the project.

Lions Park is located between Chippewa Diversion Dam and Watson Sag.

III - HISTORY OF PROJECT

3-01. Authorization. The Lac qui Parle Project was a Works Progress Administration endeavor sponsored by the State of Minnesota from 1936 through 1939. During 1941 to 1951, the Lac qui Parle Project was reconstructed by the Corps of Engineers for flood control, as authorized under the Flood Control Act of 1936 (22 June 1936) (see also **Table 2-1**).

The Marsh Lake Ecosystem Restoration Project was specifically authorized in the Water Resources Reform and Development Act of 2014.

3-02. Planning and Design. Following a series of floods on the Minnesota River, the State of Minnesota authorized a survey of the basin in 1909. Later, following the destructive flood of 1919, \$35,000 in state funds was appropriated for developing flood relief plans. The Lac qui Parle Project plan, developed by consulting engineer A.F. Meyer, presented in 1921 in the first biennial report of the Minnesota Department of Drainage and Waters (MDDW). The principle features of the Lac qui Parle Project are discussed in this report. The 1923 MDDW second biennial report elaborated further on the details of the proposed project.

The federal government authorized surveys of the Minnesota River basin in the River and Harbor Act of 1927 (21 January 1927) (Section 1) and the Flood Control Act of 1928 (15 May 1928) (Section 10). On 15 June 1932, in accordance with House Document (H.D.) 308, 69th Congress, 1st Session, the St. Paul District, U.S. Army Corps of Engineers submitted a report on the Minnesota River basin which included information on the proposed Lac qui Parle reservoir. [Note: This report was not published and was later revised and resubmitted on 24 November 1934 (see below)].

On 15 September 1933 the Minnesota Conservation Commission submitted the Lac qui Parle Project to the federal government, in essentially the same form as presented in the aforementioned 1921 and 1923 state biennial reports, as a prospective Federal Emergency Administration of

Public Works (FEAPW) project (FEAPW was renamed the Public Works Administration (PWA) in 1939). FEAPW/PWA projects were depression-era federal government spending programs for large public works projects such as dams, schools, hospitals etc. (hereafter referred to as PWA projects). On 14 October 1933 the Office of the Chief of Engineers (OCE) called for a report on the proposed PWA project within 30 days, subject: “Application for Flood Control Projects” E.D. 7040 (Warrier R.–Tenn. R. Cn.)-2. On 30 October 1933 a public hearing was held in Montevideo, MN at which little opposition to the project was noted. Attendees expressed a preference for conservation storage. A report from the St. Paul District on the state’s PWA application was submitted to St. Paul’s division office on 13 November 1933 (SP 8-6/1.2) which recommended a 30% federal participation. Subsequently a report was prepared by the division office and forwarded to the OCE on 07 December 1933 containing the same recommendation for federal participation (SP 8-6/1).

On 15 February 1934 the OCE requested by letter a brief concise report on river basins in the division to include flood control, irrigation and hydropower development. The St. Paul District submitted a report to division on 01 March 1934 on the Minnesota River basin that included the proposed Lac qui Parle Project. The report was forwarded to the OCE on 10 March 1934. It recommended that federal interest be limited to the employment of citizens on public works. In October 1934 the State of Minnesota started work on the Lac qui Parle Project as a PWA project.

On 24 November 1934 a revised version of the aforementioned 15 June 1932 report was submitted by the St. Paul District and was subsequently forwarded to Congress on 06 June 1935 and published as H.D. 230, 74th Congress, 1st Session. The report recommended the Lac qui Parle Project for flood control only and it stated that benefits were not sufficient to warrant federal participation.

On 05 September 1935 the State of Minnesota, Department of Conservation submitted the project as a federal Works Progress Administration (WPA) project. The WPA was a national program that conducted its own projects in cooperation with state and local governments, which provided

10%-30% of the costs. The project, however, was not submitted at that time to the National Emergency Council which, thru the Division of Applications and Information, was in charge of considering and recommending projects to the President for the allocation of funds. On 13 September 1935 a revised WPA project which included the Lac qui Parle project was submitted by the St. Paul District (WPA Review No. 218). It was forwarded and approved on 16 January 1936 by the President and Comptroller General.

The Flood Control Act of 1936 (22 June 1936) (Section 5, Minnesota River) references the Lac qui Parle project as submitted in the aforementioned 1934 report requested by the OCE. Construction under the supervision of the OCE was authorized but no funds were allocated. Federal funds were to be used only for flood control works while relocations (bridges etc.) were to be the responsibility of the local interests.

On 04 May 1936 the State of Minnesota started construction on the Chippewa Diversion Dam which was the first project component approved for the Lac qui Parle WPA project¹.

Marsh Lake Dam was completed under the WPA project prior to 15 Oct 1940. Construction was completed on improvements (overflow spillway west of dam, excavation of discharge channel below dam and earth dyke cutoff) on 19 Oct 1942.

The state was eventually reimbursed for work that they had done on the project, and in August and November of 1941 work on the Lac qui Parle emergency spillway was completed under contract from the St. Paul District.

The Marsh Lake feasibility study was completed in 2011. In 2015 the H&H design work was completed which included creating an unsteady RAS model of the channel to determine the specifics of the new fishway and drawdown structure. The Design Documentation Report for

¹ Exhibit D in old Water Control Manuals contains a report, dated 27 September 1948, that discusses construction under the PWA in starting in 1934, and construction under the WPA starting in 1936. However, the report does not include any reference to which specific parts of the project were constructed in 1934.

the project (specifically the H&H appendix) contains details on the design.

3-03. Construction. During 1922 or 1923, the Minnesota Game and Fish Commission constructed a small low-head dam at the lower end of Lac qui Parle Lake about 1.3 miles above the present dam and about 1/4 mile above the mouth of the Lac qui Parle River. Apparently the structure was utilized for conservation purposes only as the crest elevation was 925.96 feet. The structure was removed prior to the completion of the existing dam. This interest in flood control and water conservation in the Minnesota River Valley culminated in the Lac qui Parle reservoir project. In October 1934 the State of Minnesota started work on the Lac qui Parle Project as Public Works Administration (PWA) project and in the ensuing years continued to work on the Lac qui Parle Project under a different national program, the WPA.

The State of Minnesota completed its portion of the project's construction in 1939. The Department of the Army, under the aforementioned Flood Control Act of 1936, completed its portion of the project during the period of September 1941 through December 1951 except for land acquisition which was completed in March 1961. The project completed by the Army included improvements to Lac qui Parle Dam and spillway, Marsh Lake Dam, access roads and dike, alterations to the Great Northern Railway bridge, construction of a tainter gate at the Chippewa River Dam, and construction of 3 stage recorder houses. The project also included modifications to the Minnesota River between Lac qui Parle and Granite Falls, Minnesota, consisting of rock and snag removal and cutoffs at various locations to provide for increasing the bankfull capacity of the channel. An agreement between the Chicago, Milwaukee, St. Paul and Pacific Railroad Company and United States of America through the Secretary of the Army was signed on 7 June 1950. The project was transferred from the State of Minnesota to the United States on 7 September 1950. Operation of the project was assumed by the U. S. Army Corps of Engineers on 8 September 1950. Previous to the transfer, operation of the project had been under the direction of the Commissioner of Drainage and Waters, State of Minnesota.

The implementation of the Marsh Lake Restoration Project is anticipated to occur from 2016 to 2018. Details of when each part was started and completed will be added after construction is complete.

3-04. Related Projects. The Big Stone Lake - Whetstone River Project, located immediately upstream, is also used for flood control and water conservation. This project includes the Highway 75 Dam and reservoir. Refer to **Paragraph 2-04** and the Big Stone Lake - Whetstone River Project Reservoir Regulation Manuals for information about those projects. Also see **Paragraph 4-10**.

There are two hydropower dams downstream in the vicinity of Granite Falls, Minnesota (see **Paragraph 4-11**).

3-05. Modification to Regulations. The following is a summary of changes to the water control plan.

- a. **1939.** Following completion of the dam in 1939, the conservation pool elevation was set at 934.2 feet year-round.
- b. **1946.** The State of Minnesota lowered the conservation pool elevation to 932.0 feet in 1946 in an effort to provide more flood control storage for agriculture and alleviate problems in the downstream channel. That same year, following meetings with the Sport and Gun Club and agricultural interests, the conservation pool elevation was set at 931.2 feet.
- c. **1950.** The project was transferred to the Corps of Engineers in 1950 and a spring drawdown to elevation 926 feet was adopted.
- d. **1956 Interim Reservoir Regulation Manual.** An interim regulation manual was published in November 1956. See **Paragraph 1-01**.

- e. **1966 Reservoir Regulation Manual.** A final Reservoir Regulation Manual was published in July 1966. See **Paragraph 1-01**.
- f. **1968.** Starting in 1968, the pool was raised every fall to 934.2 feet, from 15 October to 15 November, and held there through the winter to help prevent fish kill. A spring drawdown to elevation 931.2 feet, or lower, was to occur between 15 January and 15 March.
- g. **1970.** In 1968 and 1969 there was insufficient inflow to raise the pool in the fall to elevation 934.2 feet in one month. As a result, in 1970 the regulation plan was changed to start the fall pool rise on 1 August.
- h. **1979.** In 1979 the summer conservation pool elevation was officially changed to a band of 932.75 to 933 feet. The winter pool conservation pool elevation remained at 934.2 feet.
- i. **1982.** In 1982 the spring drawdown period was changed to the period from 21 February to 10 March.
- j. **1986.** In September 1986 the pool level in Lac qui Parle reservoir was high, as it had been all spring and summer. Montevideo, MN was approaching flood stage and 2 inches of rain was forecasted. A decision was made to add 2 feet of fill to the top of the emergency spillway (raising it above elev. 941.1 ft.) to assist agricultural interests. In the end the pool level reached approximately 941.2 feet on 12 October. An after action review of this concluded that it set a bad precedent and should not be repeated in the future.
- k. **August 1995 Updated Water Control Plan.** High water in the summer of 1993 (see **Chapter 4**) revived interest in a review of the Lac qui Parle water control/regulation plan. Site visits and public meetings with Congressman David Minge (MN) and Corps personnel were held in Montevideo and New Ulm, MN on 03 June 1993 and in

Belle Plaine, MN on 07 July 1993. Internal Corps requirements for updating the July 1966 Reservoir Regulation Plan (see **Paragraph 1-03**), changing basin hydrology and public and agency comments prompted a technical review of the Lac qui Parle project operating plan.

1994 Reservoir Operation Plan Analysis included modeling with HEC-5 and the Computerized Agricultural Crop Flood Damage Assessment System (CACFDAS). In 1994 the Corps modeled Lac qui Parle/Marsh Lake reservoirs using the HEC-5 model to examine alternative operating plans. A report detailing the HEC-5 analysis was not published, although the Corps' files contain extensive notes related to the modeling. For additional details on the modeling see the 1994 Environmental Assessment titled: Modification to Lac Qui Parle Reservoir Regulation Plan, Minnesota River and the CACFDAS report (see **Paragraph 1-03**).

The HEC-5 model results were input into the CACFDAS model to assess the impacts of operation alternatives on flooding related to agriculture/crops. The CACFDAS modeling was done through a contract to Gulf Engineers and Consultants (GEC) from Baton Rouge, Louisiana.

Hydrologic records from nine flood years were used in the HEC-5 model to simulate the effects of different operating alternatives. The selected flood years were: 1965, 1969, 1972, 1979, 1984, 1986, 1992 and 1993. The flood years included large spring floods, multiple flood events, and summer floods. Discharge-area flooded relationships were developed by GEC for four reaches downstream from the dam to New Ulm, MN. The reaches were as follows (see Table 4 in the 1994 CACFDAS report, see **Paragraph 1-03**):

- a. Reach No. 1, LQP Dam (RM 288.1) to upstream of the Chippewa R. (RM 271.2),
Reference rating curve: USGS gage, LQP dam tailwater.
- b. Reach No. 2, RM 271.2 to upstream of the Yellow Medicine R. (RM 240.0),

Reference rating curve: USGS gage, Montevideo, MN.

- c. Reach No. 3, RM 240.0 to the Redwood County line (RM 233.3), Reference rating curve: USGS gage, New Ulm, MN, and
- d. Reach No. 4, RM 233.3 to the discontinued USGS gage at New Ulm (RM 146.82), Reference rating curve: USGS gage, New Ulm, MN.

The discharge-area flooded area curves from GEC were used in the HEC-5 model to develop nine flooded area hydrographs (for the aforementioned nine flood years) for each reach for selected operation alternatives. The outflow hydrograph from LQP dam was routed through each reach using Tatum routing coefficients obtained from the NWS's river forecast model. The output from the HEC-5 model was provided to GEC and input into the CACFDAS model to evaluate impacts to agriculture.

Sixty three operation alternatives were formulated and run in HEC-5. These were narrowed down to the following six alternatives: Nos. 2, 11, 20, 29, 47 and 56 plus the existing condition for analysis within CACFDAS (see Table 5 in the 1994 CACFDA report, see **Paragraph 1-03**). Target-based (e.g. river stages or damage levels) and rule-based (e.g. reservoir forecasted inflow/levels) regulation schedules were included in the formulation of alternatives. Variables included: assumed zero damage channel capacity, flood control drawdown levels, reservoir levels at which discharge was set to inflow and forecasted inflow window (0 to 14 days). Alternative No. 47 was adopted with the exception that the flood control drawdown was eliminated. The drawdown was eliminated both to reduce environmental impacts and because an analysis of the drawdown revealed that the volume of storage afforded by the drawdown was having no effect on the peak outflow from the dam during large floods (e.g. in 1969 or 1997). Alternative No. 47 minus the drawdown was incorporated into the August 1995 Water Control Manual.

The August 1995 Water Control Manual presented a plan with a summer conservation pool elevation of 933.0 ± 0.2 feet. The winter conservation pool elevation was set at

934.0 $\pm$ 0.2 feet (to reduce fish kill). The fall pool rise to this level occurs during the month of September. The spring drawdown level was set equal to the summer conservation pool elevation of 933.0 $\pm$ 0.2 feet. Analyses illustrated that the previous lower winter drawdown was causing environmental damage while not significantly reducing downstream flooding. The spring drawdown occurs from 1 March to 15 March. See **Chapter 7** for additional information.

- l. Post 1995 Fish Spawning.** Shortly after the 1995 Water Control Manual was completed the Minnesota Department of Natural Resources (MDNR) began requesting annually, when conditions were favorable, that the Lac qui Parle pool level be held at 933.5 feet after the spring runoff period until 01 June. This plan of operation improves the Walleye Pike spawn. Related public meetings were held on 15 September 2011 in the local DNR office and the plan was approved soon thereafter.
- m. Fish Spawning.** The 2014 Updated Water Control Plan permanently incorporated the changes to the manual for fish spawning. Lac qui Parle pool level will be held at elevation 933.5 feet after the spring runoff period until 01 June.
- n. Marsh Lake Dam Ecosystem Restoration.** The fishway was designed as a notched weir passive water control structure to allow for natural water level fluctuation and variability. It is anticipated that this new dam structure will serve to meet primary management goals for Marsh Lake. In the event goals in the Marsh Lake Ecosystem Restoration Plan are not attained with the fishway, an alternative drawdown structure has been integrated into the project allowing water levels to be actively manipulated as per recommendations by the adaptive management team. The Minnesota Department of Natural Resources will be responsible for all active water level management with consultation provided by other project partners. Full winter drawdowns may be considered to restructure fish populations within Marsh Lake. If a full winter drawdown is to be pursued, water levels would be lowered after the pelican nesting season, but early enough to allow other species of wildlife such as reptiles and

amphibians an opportunity to evacuate the system prior to freeze up. Alternatively, growing season drawdowns or partial drawdowns may be considered to stimulate the growth of submersed and emergent vegetation or provide additional food resources for migrating waterfowl. Full summer drawdowns would currently be avoided since they would be detrimental to the Pelican nesting islands on Marsh Lake.

Growing Season or Partial Drawdowns (April to September) – water level target of 938.0 - 936.0 ft. A maximum growing season drawdown to elevation 936.0 ft would result in exposing approximately 2,625 acres of lake bed.

Winter Drawdowns (September to February) - water level target elevation of 935.0 ft, leaving 2,425 acres of water in Marsh Lake, most of which would freeze to the bottom.

Management Goals:

1. Reduce sediment loading to Marsh Lake by restoring Pomme de Terre river to its original channel;
2. Restore a more natural hydrologic regime to Marsh Lake via notched weir structure;
3. Restore geomorphic and floodplain processes on Pomme de Terre River;
4. Reduce sediment resuspension and improve water clarity in Marsh Lake with a goal of 0.7 meters transparency per MPCA impairment standards for Western Cornbelt Plains;
5. Increase emergent vegetation coverage within Marsh Lake to 1,500 acres or ~30% of the basin;
6. Increase submersed aquatic vegetation within Marsh Lake to 3,000 acres or ~60% of the basin;
7. Improve fish and wildlife habitat through passive and active water level management. Initiate active management activities at the discretion of the adaptive management team or when Marsh Lake conditions fall below 50% of the numeric vegetation and water clarity goals listed here;

8. Restore aquatic habitat connectivity between Marsh Lake, Pomme de Terre River, and Lac qui Parle Lake;
9. Reduce abundance of aquatic invasive fish species in Marsh Lake to <40% by weight;
10. Increase diversity and abundance of native fish in Marsh Lake and Pomme de Terre River.

3-06. Principal Regulation Problems.

a. Reservoir Shoreline Erosion. Most of the shoreline erosion occurs along the clay banks which are located on the left bank approximately 3 miles upstream of Lac qui Parle Dam. The area is about 2,000 feet long with vertical drops of 15 feet in some locations. High reservoir levels greatly aggravate the erosion problems in this area.

b. Damage to Lac qui Parle State Park. The State Park is located on the right bank just upstream of Lac qui Parle Dam. When the reservoir reaches elevation 934 feet, shoreline erosion begins to be a problem. At elevation 935 feet, some of the park's trails are flooded. When the pool elevation gets to 936 feet and above, the park has substantial problems with loss of shoreline trees, damage to the swimming beach, and problems with the park's sewer system. As the pool exceeds elevation 936 feet, the park has to shut down its restroom facilities. Above elevation 937 feet, parking areas, picnic areas, and the swimming beach are inundated. At 938 feet, the boat access area is flooded, and above 939 feet the campground is under water.

c. Agricultural Damages. Agricultural damages occur downstream of the dam when local inflows plus releases from the dam exceed channel capacity. These damages include both crop losses and the inability to use the land (e.g. pastureland).

d. Chippewa Diversion Dam. The early reports that concern the Chippewa Diversion Project do not contain any rigid operation criteria. The July 1966 Reservoir Regulation Manual, Standing Instructions provides some operating rules related to the channel capacity downstream of the diversion dam. The August 1995 Water Control Manual included additional guidance based

on operation lessons learned over the course of the project's history. These 'lessons learned' are also included in this updated manual. Operation of the Chippewa River Diversion provides flood protection to downstream areas, including Montevideo, by diverting part of the Chippewa River flow into flood control storage in Lac qui Parle reservoir.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The Minnesota River basin lies mostly in the southern part of Minnesota but also includes small portions of Iowa and South Dakota (**Plate 2-1**). Its total drainage area is 16,900 square miles, of which 14,900 square miles are in Minnesota.

From its source in Big Stone Lake, the river flows southeast for 224 miles to Mankato where it turns and flows northeast 106 miles to its junction with the Mississippi River in St. Paul, Minnesota. The average fall of the stream bed over its entire length is about 0.8 feet per mile. Throughout its length the river flows between the high bluffs of a valley and meanders widely across the alluvium deposits. Below Mankato, MN, the valley is from one to three miles wide. The land is generally relatively flat to gently rolling and is nearly all cultivated.

In the upper northwest corner of the watershed, Big Stone Lake reservoir is formed by a natural lake with a concrete dam at the outlet. Big Stone Lake has a drainage area of 1,190 square miles of which the Little Minnesota River is a major portion. The Little Minnesota River forms the headwaters of the Minnesota River. The Whetstone River with a drainage area of 405 square miles, which is almost entirely within South Dakota, flows into Big Stone Lake just upstream of Big Stone Dam. The historic confluence was located downriver from the present day dam site.

The Highway 75 Dam is approximately 9 miles downstream from Big Stone Lake Dam. The Yellow Bank River enters the Highway 75 reservoir just upstream of the Highway 75 Dam.

Marsh Lake Dam is below the Highway 75 Dam. The Works Progress Administration constructed the Marsh Lake Dam and rerouted the Pomme de Terre River into Marsh Lake (just upstream of the Dam) between 1936 and 1939.

The Lac qui Parle Dam is downstream of Marsh Lake Dam. The Lac qui Parle River enters Lac qui Parle reservoir just above the dam from the south. The drainage area above the Lac qui Parle reservoir is 4,105 square miles. Water from a portion of the 2,070 square-mile Chippewa River

watershed is diverted at times to Lac qui Parle reservoir for flood control through the Chippewa River diversion project.

Lac qui Parle Lake, Marsh Lake, and the Minnesota River are the most prominent surface water features in the region. The average stream discharges from the Pomme de Terre and Lac qui Parle Rivers combined equal more than 30 percent of the average Minnesota River flow at the Lac qui Parle Dam. The Whetstone, Yellow Bank, and Chippewa Rivers contribute less than 10 percent of the average flow. A large artificial drainage network and huge extent of row-cropped land are the predominant watershed features.

4-02. Topography. The Minnesota River Valley is in a gently undulating prairie region with general elevations ranging from 700 to 1900 feet above sea level. The general topography of the basin is typically glacial characterized by gently rolling hills separated by level outwash plains. Throughout the valley are numerous depressions ranging from a few feet to about 30 feet below the surrounding prairie. These depressions contain lakes and wetlands some of which have been drained.

4-03. Geology and Soils. Most of the state is covered by glacial deposits (drift). Much of the land surface consists of features derived from the several different ice sheets that advanced and retreated from the state. During the Pleistocene Epoch, continental ice sheets covered the entire state, except for a small area in the extreme southeastern corner. The debris left by these ice sheets covered the original landscape to depths ranging from 100 feet to over 400 feet. The glacial till in the area of the Lac qui Parle Project is made up principally of clays containing a noticeable amount of sand and gravel. The surface soils of the watershed are dark loess. Existing prairie vegetation has developed over glacial till soils.

With the retreat of the last ice sheet (Keewatin) about 10,000 year ago, a huge lake (Glacial Lake Agassiz) began to form at the base of the melting glacier. Since the drainage system in the area had been filled by glacial drift, there was no place for this water to drain naturally. The rising water had to reach a height which would allow it to drain to the south. Before drainage in this

direction became possible, the lake reached a size, estimated from its ancient beach ridges, ranging from 100 to 200 miles in width and more than 600 miles in length.

When the outflow started, the general direction was southeast due to a flatiron shaped plateau known as the Coteau Des Prairies. The plateau is a morainal ridge extending from South Dakota in a southwesterly direction across Minnesota and into Iowa. The elevation of the crest of this ridge was nearly 2,000 feet above sea level. As the tremendous outflow from Lake Agassiz increased so did the erosion into the drift, creating the remarkable Valley of the Minnesota River. This ancient river channel ranged in width from 1 to 5 miles and 150 feet or more in depth and stretched over 330 miles from Big Stone Lake to the mouth. Outflows from Lake Agassiz extended from the lower end of the outlet at Ortonville, Minnesota, to the vicinity of Lac qui Parle. Sediments along this watercourse were eroded down to the Archean bedrock. The outlet which was formed is now occupied by Big Stone Lake and Lake Traverse. The formation of these lakes was caused by the alluvial deposits of the Whetstone and Little Minnesota Rivers after the drainage of Lake Agassiz was completed. When the draining of Lake Agassiz was completed, siltation of the main channel began. Tributary streams created alluvial fans where they entered the main stream. These tributary streams within or adjacent to the project were also created by the draining of the water from the melting ice sheet. However, erosion of these tributary valleys did not reach the Archean rock as it did in the main channel. Erosion stopped at depths of 40 - 50 feet below the present drift on a moraine of an earlier ice age which was composed of granite, syenite, and gneiss. Tributary streams entering from the south have their origin in the above mentioned Coteau Des Prairies, and these streams descend rapidly from the upland areas, some dropping as much as 500 feet in a few miles. The Lac qui Parle River drops 790 feet over 66-miles with the greatest fall of 250 feet occurring in an 8-mile reach near Canby, Minnesota. In the lowland plains adjacent to the main Minnesota River channel, the gradient is usually less than 2.0 feet per mile. In the lower 18 miles to the mouth the fall is about 14.0 feet per mile. Tributaries entering from the north, such as the Pomme de Terre and the Chippewa Rivers, are divided by north-south morainal hills which rise less than 75 feet above the water courses. Drainage in the upland regions of these streams is poorly defined with small lakes and marshy areas marking the water courses.

Between the Pomme De Terre and Chippewa River mouths are some ancient channels that are no longer part of the main river but are in the main Minnesota River Valley which carry flows only during periods of extreme floods. One of these abandoned channels is known as the Watson Sag and is now utilized in the Lac qui Parle Project for the Chippewa River Diversion Channel.

The prehistoric river which created the Minnesota River Valley was named the River Warren in honor of General G. K. Warren. General Warren explained the origin of the Valley in his report on the Examination and Survey of the Minnesota River published as Ex. Doc.#76, Forty-third Congress, Second Session, 1866-1867. General Warren's surveys, maps, descriptions, and discussions were considered a valuable contribution to science. The Minnesota River has had several names given it by the early explorers in the region. On one of the earliest maps of the region dated 1688, it was shown as the "Des Mascoutens Nadouscioux" or River of the Mascoutins after a tribe of Sioux Indians living in the Valley. Another map dated 1754 called it the River Saint Piene; however, the most complete map of the entire territory dated 1841 by the explorer J. N. Nicollet had it noted as the St. Peters River. By an act of Congress on 19 June 1852, the name was officially changed to "Minnesota River."

4-04. Sediment. There has been a large amount of sediment deposition in Marsh Lake reservoir since Marsh Lake Dam was completed. A study published by the University of Minnesota in 1987 (see **Paragraph 1-03**) indicated that approximately 105 centimeters of silt has been deposited at the mouth of the Pomme de Terre River (near the dam). Only one core sample was taken for the University study. One of the goals of the rerouting of the Pomme Terre River is to help reduce sediment and nutrient transport and resuspension by trapping sediments and nutrients in the natural floodplain.

There is a relatively narrow stretch of water upstream of Lac qui Parle Dam that extends upstream to where the valley channel widens (i.e. a neck) into the larger reservoir. Sediment settles in this neck area. The sill of the LQP Dam low-flow gate is at elevation 915.2 feet; however, the inlet grate has a sill elevation at 919.2 feet which limits low-flow control to this elevation. During the winter of 1976-77 the pool elevation ranged from 927.1 to 930 feet. During that period outflows

at the dam were nearly zero. In 1995 the elevation of the sandbar was estimated to be at elevation 928 feet thereby limiting drawdown at the dam and the ability to pass low-flow, to this elevation. As a result, sediment ranges and soundings were collected upstream of Lac qui Parle Dam during 05 to 07 August 1997 (see **Table 4-1**).

An estimate of the amount of storage volume lost to sedimentation is shown in **Table 4-1**. Also see **Paragraph 5-03**.

Table 4-1 Sediment Deposition Marsh Lake And Lac qui Parle Reservoirs				
Reservoir	Sediment Load Ac-Ft/Year¹	Number of Years²	Estimated Deposition Ac-Ft	Percent of Conservation Storage Lost³
Marsh Lake	60.5	56	3,388	28
Lac qui Parle ^{4, 5}	69.0	56	3,864	9
1. U.S. Army Corps of Engineers, General Design Memorandum No. 1, Supplement No. 2, Flood Control, Big Stone-Whetstone River, Page 3, 30 November 1979. Based on an observed Sediment rate of 0.05 ac-ft/sq. mi. for the Big Stone River. Also see the Reservoir Operation Plan Evaluation dated September 1989, Pages 75 and 103. 2. 1939 through 1994. 3. Marsh Lake Conservation Storage = 12,050 ac-ft = Storage Below Elevation 937.6 feet. Lac qui Parle Conservation Storage = 41,000 ac-ft = Storage Below Elevation 933.0 feet. 4. Sediment ranges and soundings were collected upstream of Lac qui Parle Dam during 05 to 07 August 1997. See St. Paul District Drawing Nos. M34-S-LQP-13/40 thru M34-S-LQP-13/51. 5. Other: Sediment surveys tied to range lines from Lac qui Parle Dam to Minnesota Falls were done in 1939. The maps are filed in the Corps' Real Estate files.				

4-05. Climate. The climate in the region is characterized by moderate precipitation and wide variations in temperature. The area is subject to cold winters and warm summers, typical of continental conditions in the temperate zone. The average length of the growing season, the interval between killing frosts, is about 150 days. The climate is favorable for wheat, corn, soy beans, and other small grains. Historical temperature, precipitation, and evaporation values at typical National Weather Service stations in and adjacent to the Minnesota River basin are shown in **Tables 4-2 and 4-3.**

a. Temperature. The average annual temperature is about 44 degrees Fahrenheit with average monthly temperatures varying between 12 degrees Fahrenheit in January and 74 degrees Fahrenheit in July. Extremes in temperatures which have been observed in the general area range from a low of -42 degrees Fahrenheit to 114 degrees Fahrenheit. Normal monthly temperatures (30-year average) for the National Weather Service gages at Milan and Redwood Falls, Minnesota are listed in **Table 4-2.** On average the first killing frost occurs on 22 September.

b. Precipitation. The mean annual precipitation over the basin is about 23.0 inches, with more than 75 percent of the precipitation falling during the months of April through September. Precipitation in the winter generally occurs as snow. Average monthly precipitation values for the National Weather Service gages at Milan and Redwood Falls, Minnesota are listed in **Table 4-2.**

c. Evaporation. Evaporation represents a major portion of the water lost from the reservoir during the period April through October. Evaporation from Lac qui Parle reservoir has been estimated to average about 30 inches per open water season. Average monthly pan evaporation for the National Weather Service gage at Fargo, North Dakota is listed in **Table 4-3.** Evaporation from lakes is less than pan evaporation due to cooler water temperatures. Typical pan evaporation coefficients for Minnesota range from 0.64 to 0.81.

d. Wind. The average wind speed in this area is about 10 miles per hour. The prevailing winds are from the northwest, but southeast winds are very common during the summer months. Wind speeds are usually highest during the afternoon and lowest at night.

Table 4-2
Normal Temperatures and Average Precipitation
At the National Weather Service Gages Milan, and Redwood Falls Minnesota
In Degrees Fahrenheit and Inches
For the Period of Record of 1981-2010

Month	Milan, MN		Redwood Falls, MN	
	Temperature	Precipitation	Temperature	Precipitation
January	14.1	0.76	12.9	0.64
February	19.5	0.68	18.6	0.92
March	31.9	1.40	30.2	1.61
April	47.4	2.40	45.6	2.79
May	59.9	2.80	58.6	3.40
June	68.7	3.72	68.2	4.46
July	72.7	3.92	72.6	3.64
August	70.3	3.16	70.5	3.66
September	61.6	3.16	61.3	3.16
October	48.4	2.43	48.4	2.24
November	32.3	1.13	32.7	1.43
December	17.9	0.58	18.0	0.77
<i>Annual</i>	<i>45.5</i>	<i>26.14</i>	<i>44.9</i>	<i>28.72</i>

Table 4-3
Average Pan Evaporation in Inches
For the National Weather Service Gage at Fargo, North Dakota
Period of Record 1963-80 (Gage Discontinued)

Month	Fargo, ND Airport	Month	Fargo, ND Airport
January	NA	July	8.43
February	NA	August	7.31
March	NA	September	4.95
April	3.64	October	3.29
May	7.15	November	NA
June	7.41	December	NA

Note: Typical pan evaporation coefficients for Minnesota range from 0.64 to 0.81. Reference: J.S. Gulliver, A.J. Erickson, P.T. Weiss (editors), 2010, Stormwater Treatment: Assessment and Maintenance, Evaporation and Evapotranspiration, University of Minnesota, St. Anthony Falls Hydraulic Laboratory, Minneapolis, Minnesota.

4-06. Storms and Floods. Floods of damaging proportions occur quite frequently in the Minnesota River Basin. Floods which occur as a result of melting snow during the spring breakup are more prevalent, although floods may also result from heavy summer rains extending over the watershed. The most destructive floods are those that affect the agricultural economy of the region. A brief description of some floods that have occurred in the upper reaches of the Minnesota River from Big Stone Lake to Montevideo, Minnesota follows. See **Plate 4-1** for a summary of peak discharges and elevations/stages.

a. April 1881. This flood was the result of excessive snowfall during the winter of 1880 - 1881. Below normal temperatures prevailed up to the end of April, followed by a high and sudden rise in temperature, a condition which produced rapid runoff. There is very little information on this flood except for old newspaper accounts and high water marks. A description of the 1881 flood at Saint Paul is contained on Pages 1754 - 1756 of the Annual Report of the Chief of Engineers wherein the major portion of the flood waters was attributed to the Minnesota River. The U.S. Geological Survey estimates the discharge at Mankato was about 110,000 cfs.

b. April 1897. The only evidence that there was a flood of high magnitude in the upper reaches of the river was a high water mark at Big Stone Lake. This high water mark indicates a flood stage only 0.26 foot lower than the maximum stage of record, established in April of 1952. There is no other information available.

c. April 1916. Rainfall during the fall of 1915 was above normal. The ground froze while saturated, a condition favorable for high runoff during the spring breakup. Snowfall during the winter averaged 4.8 inches in water content which is about normal. Flooding apparently originated on the Chippewa River where the discharge of 4,750 cfs occurred on 29 March. At Montevideo on 2 - 5 April, the flow was 7,540 cfs with a stage of 15.45 feet. Flows on the Chippewa did not recede very rapidly, and the discharge at Montevideo did not drop much below 3,000 cfs until the middle of June. Three flood crests occurred at Mankato, during March, April and July.

d. April 1917. Rain during the fall of 1916 averaged about 4.0 inches, followed by snow during the winter, averaging about 6.5 inches in water content. Again, as in 1916, this flood was apparently caused entirely by the Chippewa River. The crest at Montevideo occurred on 4 - 5 April with a flow of 10,000 cfs and a stage of 16.2 feet.

e. June 1919. Prior to the winter of 1918, rainfall had saturated the ground throughout the watershed. This was followed by abnormally heavy snowfall over the entire basin. Before any appreciable amount of runoff started in the basin above Montevideo, flooding was already occurring in the downstream reaches. Much of this flooding was attributed to ice and debris choking the main channel at many points. The runoff above Montevideo did not contribute much to this early flooding in the lower reaches, but all of the lower tributaries were flooding at this time. With the main river at stages above normal and the watershed already saturated, heavy rains fell in the upper reaches between 1 - 26 June, averaging approximately 7.0 inches with a maximum of 10.10 inches at Canby, Minnesota. The crest occurred at Montevideo on 25 June with a flow of 22,000 cfs and a stage of 19.4 feet, 5.4 feet above flood stage. This flood inundated about 106,000 acres of bottom lands from Big Stone Lake to the mouth of the river, resulting in a tremendous crop loss. This flood was the deciding factor in the planning of the Lac qui Parle flood control project.

f. May - June 1942. This flood marked the end of a period of about 20 years wherein no high flows had occurred on the Minnesota River after 1 May in the vicinity of Montevideo. A series of frequent storms of high intensity began in the last week of April and continued for several months. These storms covered widespread areas of the Minnesota River watershed producing recurrent high discharges on a number of the tributaries in the upper reaches of the basin. Rainfall during the period 25 - 30 April averaged 3.5 inches. May and June received an average of 8.0 inches and 3.5 inches. The Little Minnesota and the Whetstone River basins during this period received approximately 15.0 inches of rainfall. Flood flows from these streams filled Big Stone Lake to 0.1 foot above the upper limit of the flood control storage. Lac qui Parle reservoir was filled to elevation 940.0, or 1.1 feet below the top of the 2,500 foot emergency spillway.

Operation of the Lac qui Parle Dam held the mean daily discharge of the Minnesota River at Montevideo to 4,540 cfs on 6 - 8 June, approximately 0.5 foot below the flood stage of 14.0 feet.

g. April 1943. During the fall and winter months of 1942 - 1943, precipitation was somewhat above normal and temperatures were below normal. During the period 12 - 19 March, heavy snow and near-blizzard conditions occurred. This new snow had a high water content. Warmer weather followed with temperatures averaging about 80 degrees Fahrenheit in the latter part of March, causing rapid melting of the snow cover and a high runoff rate. Operation of Lac qui Parle Dam held the flood crest at Montevideo to 9,200 cfs on 4 - 5 April (stage 16.0 feet). However, the reach downstream from Montevideo to New Ulm was inundated from bluff to bluff. Several highway crossings on the main stem were overtopped, and buildings in the lowlands were partially submerged. In a low-lying residential area of Montevideo, three persons were drowned when their boat capsized in an attempt to retrieve some of their belongings. Many of the tributary streams attained new record flood stages during this period. Heavy precipitation, concentrated in the lower reaches, produced another flood in June which was the largest flood in the lower area since 1920. Relatively uniform flows from the operation of Big Stone and Lac qui Parle Dams of 1,200 to 2,000 cfs did not have any appreciable effect on the flood crests of the lower river.

h. March 1946. This flood was of minor importance and was produced mainly by the Lac qui Parle and Pomme De Terre Rivers. Operation of Lac qui Parle Dam held the peak flow at Montevideo to 5,380 cfs on 28 - 30 March with a crest stage of 14.25 feet. However, this was the fifth consecutive year that floods had occurred in the lower reach of the river, produced entirely by the tributary streams below Montevideo.

i. April, July 1947. Precipitation during the winter of 1946 - 1947 was below normal with March being the driest for the state since 1939. However, above normal rainfall during April 1947 averaged 3.5 inches over the watershed, and this was augmented by the snowmelt. This condition resulted in a flood similar in magnitude and characteristics to the spring flood of 1943. Floods of considerable magnitude occurred on the Little Minnesota, Whetstone, Yellow Bank,

Pomme de Terre and Lac qui Parle Rivers. Floodwaters on the Yellow Bank River overtopped U.S. Highway 75 near the head of Marsh Lake and eroded the shoulder of the roadway. Lac qui Parle reservoir was filled to its capacity and water overflowed the 2,500 foot emergency spillway at a depth of 0.1 foot. However, this outflow was not as great as the 1943 flood when the reservoir level was lower. During the early stages of the 1947 flood, a number of local farmers, in an attempt to prevent the flooding of their land downstream from the dam, placed some stop logs in the spillway of the Lac qui Parle Dam without proper authority. The gates in the dam were closed at the time. The discharge capacity of the dam was reduced, causing a higher level in the reservoir. The Minnesota River at Montevideo reached a peak flow of 8,500 cfs on 17 April and a stage of 15.95 feet, 0.3 foot lower than the 1943 peak. A residential area with about 50 homes was flooded. Heavy rains over the watershed between 3 and 5 July, averaging about 7.0 inches, again caused some flooding with crests generally below the April flood. Flooding on tributary streams below Montevideo produced a stage of 9.64 feet which was the highest flood of record at that time on the Redwood River at Marshall, Minnesota. Record flood at Marshall was in 2010 with a stage of 17.09 feet.

j. April 1951. Above normal precipitation occurred during the fall and winter months. Flooding started on most tributaries the first week in April. The Yellow Bank River overtopped U. S. Highway 75 near the head of Marsh Lake. Flood flows from the Pomme De Terre, Lac qui Parle, and Chippewa Rivers filled Lac qui Parle reservoir to within 1.2 feet (elevation 939.90 feet) of the crest of the emergency spillway section. Due to the anticipated high water, the pool at Lac qui Parle Dam had been lowered to elevation 929.5 feet. The highest flows were attributed to the Chippewa River Basin. The peak flow on the Minnesota River at Montevideo occurred on 11 April with a discharge of 12,200 cfs and a stage of 16.80 feet (**Table 4-4**). The operation of Lac qui Parle Dam caused a reduction of 0.17 feet in the stage at Montevideo. Tributary streams below Montevideo combined to produce a maximum discharge at Mankato of 66,600 cfs.

k. April 1952. Above normal rainfall occurred during the fall of 1951. Heavy snowfall fell during the winter months of 1951 - 1952 resulting in an accumulation of snow about twice the normal amount. The snow survey made in mid-March indicated a water content of about 4.0

inches. Drawdown of the pool at Lac qui Parle Dam was started in mid-February, and the pool was lowered to elevation 927.85 before the spring breakup. Temperatures rose sharply in early April, exceeding 50 degrees Fahrenheit on 7 April. The resultant runoff caused tributary streams to crest on 8 April. The crest on the Minnesota River at Lac qui Parle Dam and at Montevideo occurred on 10 April. Maximum outflow at Lac qui Parle Dam was 19,700 cfs and the peak stage was 0.85 feet above the crest of the 2,500 foot emergency spillway. The peak flow at Montevideo was 24,500 cfs with a stage of 20.02 feet, 6.0 feet above flood stage (**Table 4-4**). Fifty homes in a low lying area were evacuated. There was some damage to the dike on the diversion channel and to the emergency spillway. It was estimated that operation of the Lac qui Parle Dam resulted in less than 0.10 foot decrease in the stage at Montevideo. A secondary rise was caused by heavy local rains on 25 and 28 June, causing the Lac qui Parle pool to crest at an elevation of 936.0 by 30 June.

l. June 1953. Heavy rainfall during the latter part of April 1953 and continuing through May gradually filled the Lac qui Parle reservoir. In addition, excessive rainfall occurred on 16 and 25 June, causing a pool elevation in Lac qui Parle reservoir of 940.35 feet and a peak discharge at Montevideo of 9,770 cfs, (stage 16.1).

m. June 1957. Heavy rains during the period 14 May through 17 June filled Lac qui Parle reservoir to elevation 940.35 feet. Operation of the reservoir kept Montevideo below the flood stage of 14.0 feet during the period except for one day when a local rain of 7.5 inches fell in a 24 hour period. The maximum discharge at Montevideo occurred on 17 June with a flow of 5,500 cfs (stage 14.4).

n. April 1965. By 3 April 1965, the winter drawdown at Lac qui Parle had lowered the pool to elevation 929.22 feet. Snow surveys had shown a snow water content varying from 2 to 5 inches with an average over the basin of about 4 inches. Rainfall on 6 April averaged 1.6 inches over the basin. Temperatures near 50 degrees Fahrenheit started the melting within a week after the rainfall. The frost was still in the ground and the runoff was very high. On 14 April, the Lac

qui Parle pool crested at an elevation of 939.90 feet and remained above the conservation pool elevation of 931.2 feet until 4 May. The 14 foot flood stage at Montevideo was exceeded on 10 April, reaching a peak of 16.64 feet on 14 April (**Table 4-4**). Stages above flood stage were recorded at Montevideo until 27 April. Flood damage at Montevideo and other downstream localities was minor. The peak stage at Mankato was reached on 10 April. Since the travel time from Lac qui Parle Dam to Mankato is about seven days, the peak discharge from Lac qui Parle reservoir affected only the receding flows at Mankato.

o. Spring 1969. The water content of the snow in the headwaters of the Minnesota River Basin at the end of March 1969 was about 6 inches. The upper part of the basin received 1 to 1.5 inches of rain during 07 – 10 April just as the snowmelt runoff was reaching its peak. Conditions were such that severe flooding was inevitable. The peak discharge and pool elevation recorded at Lac qui Parle Dam were 29,400 cfs and 942.47 feet respectively. Montevideo's peak discharge was 35,100 cfs (**Table 4-4**).

p. 1979. A heavy snowpack resulted in a peak discharge and pool elevation at Lac qui Parle Dam of 10,600 cfs and 939.78 feet on 18 to 19 April (**Table 4-4**). Heavy rains in June resulted in the pool rising to near an elevation of 940 feet after falling to 934 feet after the spring runoff.

q. 1985. A heavy snowpack resulted in a peak discharge and pool elevation at Lac qui Parle Dam of 9,360 cfs and 939.40 feet on 25 March 1985 (**Table 4-4**).

r. 1986. A heavy snowpack resulted in a peak discharge and pool elevation at Lac qui Parle Dam of 13,200 cfs and 941.06 feet on 8 April 1986 (**Table 4-4**). Heavy rains through the summer kept the pool above an elevation 938 feet well into October. The pool reached a second peak elevation of 941.23 feet on 12 October.

s. 1993. By the end of April 1993, streamflow in the Minnesota River basin had been in the excessive range for 9 of the past 10 months. Wet antecedent conditions existed in the basin

dating back to 1991. As a result, heavy rains in May brought flooding to the Minnesota River Valley. Most of the severe flooding occurred downstream of Mankato. Agricultural flooding occurred all along the river for the entire summer. The peak discharge and pool elevation at the Lac qui Parle Dam was 10,200 cfs and 941.72 feet on 3 August (**Table 4-4**).

t. 1997. Most of Minnesota had six or more inches of rain in late October and November, 1996. Many areas had four or more inches of above normal precipitation. Prior to the 1997 snow melt, most of the Red River and upper Minnesota River basins had over six feet of snowfall. Some areas had over eight feet of snowfall with many areas experiencing two to three times the average snowfall. Over 40 percent of Red River basin (Minnesota portion) and the uppermost reaches of the Minnesota basin were in the 99th snowfall percentile (near or exceeding record snowfall). The spring snow melt was less than ideal. There were few mid- and late-winter melting days followed by large temperature fluctuations in early April. It was up to 10 degrees above normal in first week of the month and up to 20 degrees below normal in the second week of the month. In addition there was heavy early spring precipitation resulting in two or more inches of precipitation (rain and snow) in western Minnesota on April 5 and 6, 1997 (2 days) followed by below freezing temperatures causing a temporary delay in the runoff. The normal monthly April precipitation is approximately two inches for the region. The peak discharge and pool elevation recorded at Lac qui Parle Dam were 43,000 cfs and 944.13 feet respectively. The discharge is the record discharge. Montevideo's peak discharge was 47,500 cfs (**Table 4-4**).

u. 2001. Mid and late-November snows blanketed much of the state with a lasting snow cover that was to persist into the early spring. The seasonal snowfall totals exceeding 60 inches were common throughout western and southern Minnesota. 2000-2001 snowfall topped the historical average by approximately two feet in western Minnesota, and by more than 18 inches in most southern Minnesota counties. Snow water equivalent in the snow pack at the end of the season was three to five inches in many areas. While 2000-2001 snowfall was heavy in many communities, the snowfall totals were far less than the 72 to 96 inch totals that covered

most of the Red River basin and much of the upper Minnesota River basin in 1997. The winter of 2000-2001 provided very few mid and late-winter melting days. February was quite cold, finishing four to eight degrees below normal. March temperatures were three degrees below normal. The snow pack gradually diminished in depth throughout March, nevertheless snow water content did not change appreciably. Much of the melt water stayed on the landscape in the micro-relief. Extraordinarily heavy precipitation fell across much of Minnesota in April 2001. A broad swath of southwestern, central, east central, and northeastern Minnesota received over six inches of precipitation from April 1 to April 23, 2001. Precipitation totals surpassed the historical average by more than four inches in these areas. For many communities, all-time April monthly precipitation records were set before the month came to a close. The peak discharge and pool elevation recorded at Lac qui Parle Dam were 30,100 cfs and 943.67 feet respectively. Montevideo's peak discharge was 33,900 cfs (**Table 4-4**).

v. **2009.** Major early-spring flooding occurred during the latter half of March in the upper Minnesota River watershed. Precipitation totals for the fall season were far above long-term averages for many gages. Very cold temperatures arrived in December before a significant snow cover. The cold temperatures, along with a saturated soil profile, resulted in "concrete frost", an impervious layer highly conducive to runoff. Record-setting snowfall totals were reported in the area which made the snow season of 2008-2009 one of the snowiest ever in this region. The middle of March brought a ten-day period of relative warmth. For eight of the ten days, temperatures climbed approximately ten degrees above the historical average. The warm weather came in conjunction with heavy rain, resulted in increased snow melt. Precipitation totals in some portions of central Minnesota ranged from two to four inches for the period March 22 through March 25. In some locations, 24-hour precipitation totals for March 23 and March 24 set all-time records for those dates. The peak discharge and pool elevation recorded at Lac qui Parle Dam were 15,800 cfs and 942.56 feet respectively. Montevideo's peak discharge was 16,800 cfs (**Table 4-4**).

w. **2010.** Heavy October rains, a significant winter snow pack, and a rapid snow melt produced major flooding in the Minnesota River watershed. However, dry weather during the final weeks of March helped prevent even further damages. March monthly temperature averages were four to eleven degrees above the historical mean. Extreme temperature values for March ranged from a high of 78 degrees at various southern Minnesota locations on the 31st, to a low of -9 degrees at Roseau on the 1st. Record high maximum and minimum temperatures were set on the 14th, 15th, 18th, 30th, and 31st of March at various locations around the state which precipitated a rapid snow melt runoff. The peak discharge and pool elevation recorded at Lac qui Parle Dam were 21,200 cfs and 942.77 feet respectively. Montevideo's peak discharge was 24,400 cfs (**Table 4-4**).

x. **2011.** Significant flooding was reported across Minnesota during much of the month of April. River levels reached major flood stage along the Minnesota River and its tributaries. In some locations, peak river crests were among the highest ever recorded. The total volume of water that left the landscape and entered the river systems was enormous. If April precipitation had not been below average in west central Minnesota the flooding could have been much worse. The peak discharge and pool elevation recorded at Lac qui Parle Dam were 19,700 cfs and 942.55 feet respectively. Montevideo's peak discharge was 23,700 cfs (**Table 4-4**).

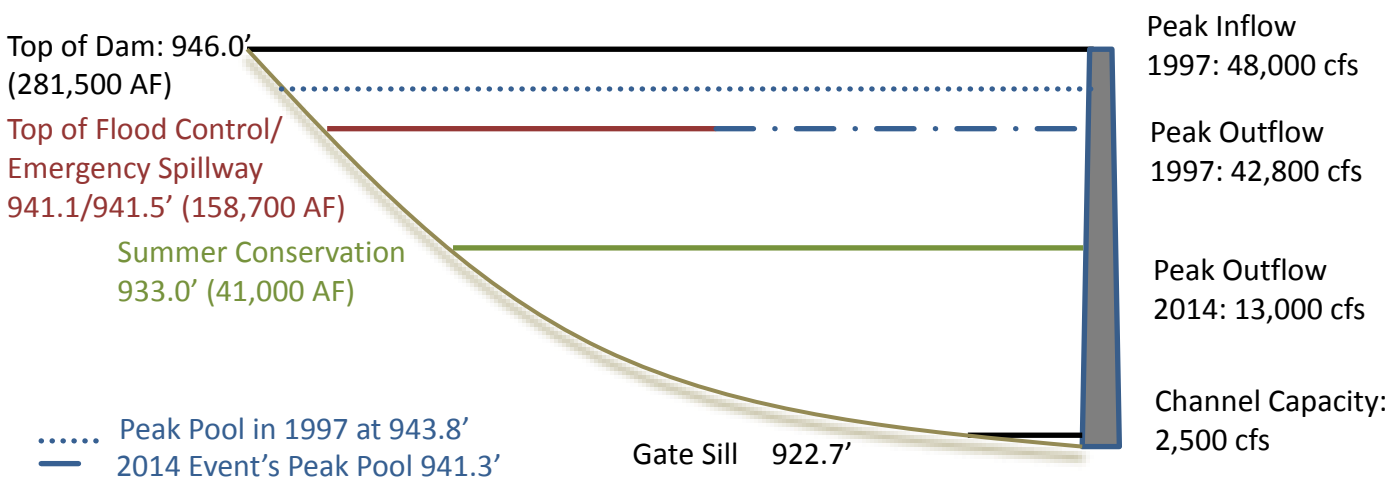
y. **2014.** June rains came in two waves. With the first wave inflow peaked at 6,800 cfs and outflow was slowly increased from 2,500 to 3,400 cfs. Channel capacity is 2,500 cfs yet farmers start having trouble at a higher flow. The pool peaked at elevation 940.6 feet and had started to fall (low point = elevation 940.2 feet) when a second wave of rain hit the basin. At this point there was little storage remaining (top of flood control is elevation 941.1 feet plus road raise). Outflows were increased as inflow increased. Peak inflow during the event was 13,300 cfs and a new summer record outflow of 13,000 cfs was set. The pool peaked at elevation 941.3 feet and stayed below the emergency spillway.

Montevideo crested at a stage of 17.48 feet on June 24 (flood stage is 14 feet; major flood stage is 17.5 feet).

Below are tables of when bulkheads were pulled and put back in:

LQP Openings during 2014 Summer Event		
<i>Date</i>	<i>Time</i>	<i>Opening</i>
June 19	0600 hours	11 feet on gates
June 19	0800 hours	11 feet on gates (gates are fully open)
June 19	1100 hours	Opened one bay
June 20	1000 hours	Opened one bay
June 22	1000 hours	Opened one bay
June 23	0830 hours	Opened one bay
June 23	1600 hours	Pulled only one bulkhead (two bulkheads remain in – all rest are pulled)

LQP Closings during 2014 Summer Event		
<i>Date</i>	<i>Time</i>	<i>Closed</i>
July 2	1000 hours	2 bulkheads in (total of 4 bulkheads in)
July 2	1400 hours	3 bulkheads in (total of 7 bulkheads in)
July 3	0930 hours	3 bulkheads in (total of 10 bulkheads in)
July 3	1400 hours	2 bulkheads in (total of 12 bulkheads in)
July 5		6 feet on gates
July 7	0900 hours	3 bulkheads in (total of 15 bulkheads in – all bulkheads are in)



Lac qui Parle Lake

4-07. Runoff Characteristics. Floods on the Minnesota River and its tributaries are caused by both snowmelt runoff and summer storms. Floods occurring as a result of melting snow can encompass the entire basin. During the spring breakup, a complicated factor to flooding can be ice jams forming in the river. Floods can also occur from heavy rains extending over the entire basin (e.g. 1919, 1944 and 1993) or from intense rainfall events that are local in nature. The mean monthly inflow and outflow for the project and the mean flow at Montevideo are presented in **Table 4-4**. Period of record for inflow is 1965 to 2015, outflow is 1940 to 2015 and Montevideo is 1910 to 2015. **Plates 4-2** through **4-5** are from the 1966 Water Control Manual. **Plate 4-2** shows precipitation-percent of runoff curves; while **Plates 4-3** through **4-5** show unit hydrographs.

Table 4-4 Lac qui Parle Project, Mean Flow in cfs												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inflow	185	200	540	1855	1435	1220	735	200	145	175	290	220
Outflow	135	180	470	1600	1250	1060	660	200	110	135	160	165
Montevideo	230	250	1120	3110	1800	1560	1300	650	395	430	455	340

Annual mean inflow and outflow for the project are presented on **Plate 4-6** and **Plate 4-7**. Monthly inflow and outflow duration is shown in **Plate 4-8 to 4-10**. Daily inflows use the ‘Project’ time series. Outflow data is from 1943 to 2015, inflow data is from 1965 to 2011. Maximum monthly inflows and outflows occur in April, May, and June from snowmelt and spring rain runoff, but most of the spring inflow is retained in the reservoir for flood risk mitigation purposes. As a result of this retention, monthly inflows generally exceed outflows during the spring as the reservoir is filling. In the summer, the highest evaporation losses occur, and outflows are reduced. Outflows are decreased in late fall as necessary to raise the reservoir level to provide an additional volume of water for fish over the winter (see **Chapter VII**). Monthly streamflow distributions for Minnesota River at Ortonville, near Lac qui Parle Dam and

Montevideo are provided on **Plate 4-11**. Monthly streamflow distributions for the tributaries of Yellow Bank, Chippewa, Pomme de Terre and LQP River are provided on **Plate 4-12**.

4-08. Water Quality.

Lac qui Parle reservoir is a shallow windswept lake located in the Minnesota River watershed. Water quality in the lake is relatively poor, characterized by appreciable quantities of dissolved minerals (like calcium and magnesium), frequently resuspended sediments, and excessive nutrients which often create nuisance blue-green algae blooms. Lac qui Parle is classified as a hypereutrophic lake, typical for a lake in the northern glaciated plains ecoregion. Lakes in this ecoregion are generally shallow, well mixed, hypereutrophic lakes whose watersheds are predominantly agricultural. Ninety-five percent of land use in Lac qui Parle's watershed is agricultural. Lack of proper conservation practices, wetland drainage, fragile and highly erodible soils, waste discharges, nutrient loading by birds, and internal nutrient recycling, all contribute to high nutrient loading in Lac qui Parle reservoir.

The lake's shallow depth and large surface area allow frequent wind mixing of the water column. During calm periods intermittent stratification can develop allowing phosphorous release from the sediments into the water column. Properly treated water from the Minnesota River is suitable for domestic use. See **Paragraphs 5-02, 7-07 and 8-04**.

4-09. Channel and Floodway Characteristics.

a. Main Stem and Tributaries. The Minnesota River channel was modified between Lac qui Parle Dam, (river mile 271) and Granite Falls, Minnesota, (river mile 239) (**Plate 2-6**). The project consisted of rock and snag removal and cutoffs at various locations to increase the bankfull capacity of the channel. The channel was designed to handle a 15-year recurrence interval event. A general plan and a typical cross section of the channel are shown on **Plate 2-6**.

The width of the flood plain varies from about 1/2 mile to 2 miles from Big Stone Lake to the Lac qui Parle Dam. Below the dam to the vicinity of New Ulm (river mile 146), the width is quite

uniform, varying between 3,000 and 4,000 feet. In regions containing granite outcrops, the valley suddenly widens to about 10,000 feet. The depth of the valley varies from 100 to 200 feet. Once flow leaves the banks of the river, it can spread quite rapidly to the valley walls due to the relatively flat topography of the flood plain between the bluffs.

The Lac qui Parle River has a slope of 12.7 feet per mile. The Pomme de Terre River is a tributary to Marsh Lake reservoir. The Pomme de Terre River has a slope of 2.5 feet per mile.

b. Environmental Conditions. Lac qui Parle and Marsh Lake are impounded natural lakes on the Minnesota River. The lakes were created by fluvial dams formed at the confluences of the Lac qui Parle and the Yellow Bank Rivers with the Minnesota River. The lakes formerly varied in stage in concert with river discharge, and nearly dried out in drought years. Prior to impoundment, the lakes supported extensive stands of emergent and submersed aquatic vegetation (SAV). The lakes historically provided and continue to provide a major staging area for thousands of migrating waterfowl and a highly productive fishery.

The State of Minnesota initiated the project for conservation of the abundant fish and wildlife resources. Since impoundment, the lakes have been continuously inundated (except for winter drawdowns) to at least an elevation range of 931.2 to 933.0 feet in Lac qui Parle (see **Paragraph 3-05**), and 937.6 feet in Marsh Lake (until the dam was modified in 2017). There has been a gradual deterioration in the quality of aquatic and wetland habitat resulting from sedimentation, littoral processes, nutrient loading, continuous inundation, and extended periods of high water. Long-duration high water events in recent years have killed much of the floodplain terrestrial vegetation in the reservoir area, even very old trees.

Marsh Lake has a history of providing good quality fish and wildlife habitat. Marsh Lake could once be considered one of Minnesota's top five waterfowl hunting destinations. Unfortunately, habitat conditions have deteriorated due to excessive nutrient inputs, sustained high water levels, and undesirable fish species. By restoring the Pomme de Terre River to its historic channel and

by modifying the Marsh Lake Dam infrastructure the goals of the ‘Marsh Lake Ecosystem Restoration Project’ (planned implementation in 2017 and 2018) are to:

1. Allow for greater fluctuations in water levels more characteristic of natural hydrographs;
2. Help control undesirable fish species by removing winter fish refuges and by restoring native fish passage and spawning areas;
3. Help promote healthy and diverse aquatic plant growth;
4. Help reduce sediment and nutrient transport and resuspension;
5. Provide options for active water level management to enhance habitat conditions.

Current conditions on Marsh Lake (i.e. prior to the ‘Marsh Lake Ecosystem Restoration Project’) are characterized as a shallow, turbid, and hyper-eutrophic lake system (about 3,000 of 5,000 acres are less than 3 feet deep). Because the Marsh Lake Dam has an elevated fixed crest, the continuous minimum water surface has disrupted natural period drying events. As a result, emergent aquatic plants that require exposed mudflat conditions to germinate from seed have declined in the lake. Loss of emergent and submersed aquatic plants has resulted in increased wind fetch. Wind induced wave action and nonnative carp re-suspend sediments and nutrients, blocking sunlight and reducing opportunity for submersed aquatic plant growth. Increased wave action severely eroded the shoreline, islands and points of Marsh Lake.

A key to restoring freshwater aquatic ecosystems within Marsh Lake is restoring a more natural hydrologic regime. On a river floodplain lake like Marsh Lake, a more natural hydrologic regime includes lower lake levels in some years to enable aquatic vegetation to re-establish. Elsewhere (namely, the pools in the Upper Mississippi River), variability in water levels has resulted in increased extent, diversity, and abundance of aquatic vegetation, increased food for waterfowl, and improved water quality conditions. A clear water system with more aquatic plants would favor native fishes over the non-native common carp.

Despite the deteriorating aquatic habitat and water quality conditions, Lac qui Parle still supports a popular, economically significant, and productive sport fishery. Walleye and northern pike are the most commonly creel fish. MNDNR’s status of the fishery as of 09/06/2011:

“Lac qui Parle Lake (LQP) is located in western Minnesota three miles southwest of Milan. The lake is an impoundment on the Minnesota River and Churchill Dam at its outlet is used to control water levels. LQP is a highly productive lake that measures 5,589 acres and has a maximum depth of 15 feet. The water level at LQP was 4-7 feet above normal from April-August of 2011 due to heavy runoff from its watershed. The flooded riparian areas provided excellent fish habitat which resulted in good natural reproduction by numerous game and forage fish species.

Lac qui Parle Lake has typically provided an abundant walleye population with fish present from a wide range of sizes. However, walleye numbers were low from 2007-09, even though high numbers of walleye fry and fingerlings had been stocked. Recently the population has rebounded to a moderate level with 16 walleye caught per gill net in 2011. The majority of the walleye were from the 2008, 2009, and 2010 year classes and they measured 12-20 inches. Fingerling stocking and natural reproduction have both made substantial contributions to the present walleye population. Excellent spawning conditions in 2011 resulted in a very strong natural 2011 walleye year class. These young walleye will substantially improve the overall walleye population during the next couple of years if sufficient forage is present to provide good growth. Natural reproduction has produced the two strongest year classes recorded at Lac qui Parle Lake (2001 and 2011). However, it has been inconsistent and the walleye population will continue to be supplemented as needed by stocking.

Crappie fishing has been very good during recent years, especially during winter. The crappie population increased substantially during the period of lower walleye abundance. During the winter of 2011-12 anglers were reporting good fishing for crappie measuring 10-15 inches, and also reported releasing numerous smaller fish. Crappie also experienced good reproduction on 2011 and numerous young-of-year crappie were noted during sampling.

High numbers of freshwater drum and white bass are often present. Although these are important forage species for walleye, they also compete for resources. Anglers are encouraged to harvest adult drum and white bass to reduce competition with walleye. Both species have a delicate white

flesh and provide excellent table fair. Their flavor can be improved further by trimming the reddish "mud line" meat from the fillets when cleaning. Excellent drum recipes can be located on the internet by searching "drum recipes".

A moderate bluegill population has developed during recent years and anglers occasionally report catching large bluegills from localized areas. Northern pike were moderately abundant with fish from the 2006-11 year classes present, including fish that exceeded 30 inches. Channel catfish were numerous with fish exceeding 20 inches. Very limited angling for channel catfish has been observed. Considering their high numbers and large sizes, catfish enthusiasts should consider a trip to Lac qui Parle Lake.”

A study to determine the in-stream flow needs for the Minnesota River is being conducted with the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency. The interim low flow release schedule may be modified to provide in-stream flow needed for aquatic life, recreational activities, water appropriations, and waste assimilation.

An interagency collaborative effort was begun in 1993 to plan for management of the Minnesota River. There is a need for more intensive management measures to rehabilitate wetland and aquatic habitat conditions in Marsh Lake. A Marsh Lake Ecosystem Restoration Project Feasibility Report and Environmental Assessment was completed in July 2011. The recommended plan consists of the following options: restore the Pomme de Terre River to its historic channel, construct drawdown structure and modify the Marsh Lake Dam (construct fishway).

4-10. Upstream Structures. There are two dams upstream of the Lac qui Parle Project called Big Stone Lake Dam and Highway 75 Dam. Both are incorporated into the Big Stone Lake-Whetstone River Project. Refer to **Paragraph 2-04** for details on these structures.

Big Stone Lake Dam has a drainage area of approximately 1,190 square miles. The dam is operated by the Minnesota Power and Light Company.

Highway 75 Dam has a drainage area of approximately 1,810 square miles. The dam is operated by the U.S. Army of Corps of Engineers.

4-11. Downstream Structures. There are two dams downstream of the Lac qui Parle Project. One is located at Granite Falls, Minnesota and the other is located 3.7 miles downstream near Minnesota Falls, Minnesota (see **Paragraphs 7-09, 7-10, 8-06 and 8-07**).

a. Granite Falls Dam. The Granite Falls Dam has a concrete gravity structure with 2.8 feet of flashboards on the crest of the overflow section. The overflow section has a nominal height of 21 feet and is 300 feet long. The dam has three turbines that produce a total of 1,180 kilowatts of power (two older units produce 470 kW together, and the new turbine (1986) produces 710 kW). The facility supplies about 35 percent of the electric demand for the city. The current maximum usable flow for hydropower at the plant is 900 cfs.

The dam was built in 1911 and is owned and operated by the City of Granite Falls. It is operated for hydroelectric power production and to provide an impoundment for the withdrawal of surface water for municipal use. The drainage area above Granite Falls is 6,370 square miles.

b. Minnesota Falls Dam. The Minnesota Falls Dam is primarily a concrete and granite masonry structure with earth embankments at each end. The dam has a maximum height of 18 feet and is 600 feet long. The dam was built by the Northern States Power (NSP) Company, which is now Xcel Energy, in 1905 for the production of hydroelectric power. After 1961 it was no longer operated for hydropower. The impounded water was used to cool a 47 kilowatt steam electric generating plant owned by NSP until the plant closed in 2004. The dam became obsolete and was removed in 2013.

4-12. Economic Data.

a. Population and Income. The Lac qui Parle reservoir and the downstream floodplain to New Ulm includes portions of seven counties: Chippewa, Lac qui Parle, Yellow Medicine,

Redwood, Renville, Nicollet, and Brown. **Table 4-5** displays the trends in population from 1980 to 2010 for the seven-county area along with the median family income. Figures for the State of Minnesota and for the U.S. as a whole are displayed as well for comparative purposes. Only Nicollet County grew in population over this period.

Table 4-5 Population and Median Income Counties Along The Minnesota River Compared to Minnesota and the United States						
Sample County or Area	Population				Median Income 1989	Median Income 2009
	1980	1990	2000	2010		
Brown	28,645	26,984	26,911	25,893	\$25,032	\$44,952
Chippewa	14,941	13,228	13,088	12,441	\$22,227	\$45,384
Lac qui Parle	10,592	8,924	8,067	7,259	\$21,646	\$44,782
Nicollet	26,920	28,076	29,771	32,727	\$30,491	\$57,122
Redwood	19,341	17,254	16,815	16,059	\$22,827	\$46,550
Renville	20,401	17,673	17,154	15,730	\$23,278	\$46,909
Yellow Medicine	13,653	11,684	11,080	10,438	\$21,537	\$46,226
Minnesota	4,076k	4,375k	4,919k	5,304k	\$30,909	\$55,621
United States	226,542k	248,710k	281,425k	308,746k	\$30,056	\$50,221

b. Agricultural. **Table 4-6** shows basis statistics on farms in the basin.

c. Industry. **Table 4-7** shows basis statistics on establishments in the basin.

Table 4-6
Agriculture Statistics by County from the 2012 Census.

<i>Item</i>	<i>Brown</i>	<i>Chippewa</i>	<i>Lac qui Parle</i>	<i>Nicollet</i>	<i>Redwood</i>	<i>Renville</i>	<i>Yellow Medicine</i>
Number of farms	1,055	674	852	764	1,163	1,061	885
Amount of cropland in the farms (acres)	296,379	310,612	407,869	249,992	489,626	589,089	364,471
Average estimated market value of land and buildings per farm (\$)	1,705,125	2,569,132	2,298,670	2,329,018	2,835,987	3,547,518	2,043,238
Market value of agricultural products sold (\$1,000)	382,917	333,231	311,757	386,630	518,362	710,346	322,796

d. Flood Damages. A primary authorized purpose for the Lac qui Parle project is reduction of downstream flood damages. Beneficiaries of the reservoir's flood control operation include the cities of Montevideo and Granite Falls and the agricultural properties within the floodplain between the dam and New Ulm, a distance of approximately 150 miles.

Montevideo and Granite Falls have experienced flooding in the past. The flood of 1969 is equated to the 100-year flood. The 1997 flood is the flood of record. Damage categories include residential, commercial, and public properties. Many cities along the Minnesota River now have permanent flood risk mitigation systems.

The magnitude of crop damage due to flooding depends on when the flood occurs during the growing season. Floods occurring before mid-April may cause little or no damage. Floods occurring after mid-April will cause damage to the extent that production operations may have to be repeated and delayed planting reduces ultimate crop yields. Mid-season floods are the most

devastating since total yield loss may occur with no chance to replant a crop to salvage an income from the affected acreage.

Table 4-7							
Number of Establishments (Industry) based on the 2012 County Business Patterns.							
<i>NAICS (North American Industry Classification System)</i>	<i>Brown</i>	<i>Chippewa</i>	<i>Lac qui Parle</i>	<i>Nicollet</i>	<i>Redwood</i>	<i>Renville</i>	<i>Yellow Medicine</i>
Agriculture, forestry, fishing and hunting.	1	6	1	6	4	5	2
Mining, quarrying, and oil and gas extraction.	2	1	0	1	1	1	2
Utilities	0	3	0	0	2	3	5
Construction	7	51	31	71	68	52	40
Manufacturing	5	26	12	49	31	24	19
Wholesale trade	10	16	12	35	37	29	16
Retail trade	20	56	38	76	73	68	49
Transportation and warehousing	7	19	10	33	28	44	21
Information	1	4	5	11	11	10	5
Finance and insurance	10	30	19	40	35	43	22
Real estate and rental and leasing	0	14	3	21	14	4	4
Professional, scientific and technical services	6	19	9	41	19	25	16
Management of companies and enterprises	0	3	0	4	1	2	1
Administrative and support and waste management and remediation services	4	14	5	27	14	12	9
Educational services	1	2	0	8	6	3	2
Health care and social assistance	9	39	15	76	38	33	27
Arts, entertainment and recreation	3	7	4	10	14	9	6
Accommodation and food services	11	29	13	52	39	31	24
Other services (except public administration)	22	66	26	80	83	68	47

V - DATA COLLECTION AND COMMUNICATION NETWORK

5-01. Hydrometeorological Stations.

a. Facilities. The regulation and proper operation of the project requires the collection and evaluation of several meteorological, hydraulic and hydrologic parameters. Pool and tailwater elevations, outflow, precipitation, wind, and air temperature are recorded at the project site. Data Collection Platforms (DCPs) are used for recording the pool and tailwater elevations at Lac qui Parle Dam, Marsh Lake Dam and Watson Sag Weir and the pool elevation at Highway 40. Wire weight gages are used to record stages at the Chippewa Diversion Dam and are also available at Watson Sag Weir and Highway 40. Equipment is also available at the project office for measuring the water content of snow, frost depth, and the lake ice thickness. Additional information is available at various Corps, U.S. Geological Survey (U.S.G.S.), and National Weather Service gages in the project area. **Plate 5-1** shows the data collection facilities at the Lac qui Parle Project. **Plate 5-2** shows various streamflow gage sites that are in the area including the control point at Montevideo, Minnesota. **Table 5-1** is a tabulation of the snow survey stations that are in the basin. **Plate 5-3** shows the locations of hydrometeorological stations in the Upper Minnesota River Basin. **Plate 5-4** (will be updated after construction of the project is complete) shows the locations of stations for the Lac qui Parle Project. **Plate 5-5** shows the snow survey sites in the project area and **Plate 5-6** (will be updated after construction of the project is complete) shows the water quality stations in the project area.

U.S.G.S. rating curves for the Minnesota River at Ortonville, MN; Yellow Bank River near Odessa, MN; Pomme de Terre River at Appleton, MN; Chippewa River near Milan, MN; Lac qui Parle River near Lac qui Parle, MN; Minnesota River near Lac qui Parle, MN; and Minnesota River near Montevideo, MN are provided in **Exhibit B** and **Plates 5-7** through **5-13**.

b. Reporting. The information needed to operate the dam and regulate the reservoir is provided to Water Management by the Project Resource Manager. Daily (8:00 a.m.) readings for

the pool, tailwater, and outflow are given, as well as precipitation and wind readings. The pool and tailwater elevations are also recorded by DCPs and transmitted via satellite directly to Water Management's Local Readout Ground Station (LRGS). At each DCP gage, the correspondence between the gage and DCP readings is checked visually by project personnel at regular intervals. Daily inflow to the reservoir is calculated by Water Management from the change in reservoir elevation and the outflow. In the winter and spring, snow depth, water content, frost depth, and lake ice thickness are reported weekly to Water Management. The snow survey is used to estimate the amount of water available for spring runoff. Frost depth readings provide information on the amount of infiltration expected. The snow and frost information are also provided to the National Weather Service and the State of Minnesota Climatology Office. Copies of the official site log sheets are copied to Water Management's folder on the district server.

MN DNR will inform Water Management of any gate changes (new setting and date/time).

c. Maintenance. The tailwater gage at Lac qui Parle Dam and the pool elevation gage at Marsh Lake Dam are maintained by the U.S.G.S. The National Weather Service (NWS) maintains the precipitation gage. The rest of the gages listed in **Table 5-1** are maintained by the Water Management gage crew and project personnel.

5-02. Water Quality Stations. See **Paragraphs 4-08, 5-06, 7-07 and 8-04.**

a. Facilities. The Corps has thirteen (13) water quality data-collection stations within the Lac qui Parle Project. Station locations are shown on **Plate 5-6**. Only 2 of the stations have a long term record (L1 and L4). Periodic measurements are taken at the other locations. *In situ* depth profiles of water temperature, dissolved oxygen, pH, and specific conductance are monitored electronically. In addition, water samples are collected and analyzed for nutrients such as total phosphorous and nitrogen species as well as suspended solids and chlorophyll a. Several of the stations in both Lac qui Parle and Marsh Lake sample for special studies and short term

intensive monitoring. Water quality data is collected by project personnel, water quality unit staff, and volunteers from the Lac qui Parle Lake Association. The stations are seasonal and are operated only as funding and resources allow.

b. Maintenance. The water quality equipment used at the Lac qui Parle Project is not permanently deployed in the field. A YSI multi-parameter sonde is kept at the District Office. The YSI sonde is used by Corps personnel and the local volunteers to monitor *in situ* water quality parameters. Maintenance is performed by both project personnel and Water Quality Unit staff.

Table 5-1 Snow Survey Sites Within the Lac qui Parle Project Area (See Plate 5-3)			
Number	Location	Number	Location
1.	Clara City, Minnesota	11.	Glenwood, Minnesota
2.	Granite Falls, Minnesota	12.	Cyrus, Minnesota
3.	Vesta, Minnesota	13.	Morris, Minnesota
4.	Tracy, Minnesota	14.	Wilmot, South Dakota
5.	Marshall, Minnesota	15.	Millbank, South Dakota
6.	Taunton, Minnesota	16.	Ortonville, Minnesota
7.	Marietta, Minnesota	17.	Appleton, Minnesota
8.	Lac qui Parle State Park, Minnesota		
9.	Benson, Minnesota		
10.	Sunburg, Minnesota		

5-03. Sediment Stations. A bathymetric survey was conducted in 2014 (see **Paragraph 4-04**). The USACE periodically surveys bathymetric cross-sections to determine changes in reservoir geometry in accordance with Engineer Manual EM 1110-2-4000, Sedimentation Investigations of Rivers and Reservoirs. Estimates of the sediment load for Lac qui Parle and Marsh Lake reservoirs are given in **Paragraph 4-04**.

5-04. Recording Hydrologic Data. Currently, the hydrometeorologic records collected are electronically transferred into data base files on the computer system in the Water Management Section and onto hard copy log sheets. The data from U.S.G.S. gages in the area are archived in the U.S.G.S. WATSTORE data base in Reston, Virginia. The daily precipitation data collected at the Chippewa Diversion Dam are archived by the National Climatic Data Center in Asheville, North Carolina.

a. Reservoir Elevation/Discharge and Streamflow Data. The Project Resource Manager obtains river and reservoir stage data from gages in the vicinity of the dams and other pertinent locations either in or adjacent to the Lac qui Parle reservoir project. The data is collected by recording and non-recording gages at frequencies varying with the conditions as determined by Water Management. Pool and tailwater readings are recorded at 8:00 a.m. daily unless otherwise directed by Water Management. The U.S.G.S. makes streamflow measurements as requested by the District Office. During flood conditions, the resource manager collects data from selected stations as requested by Water Management. Streamflow and stage data reports are transmitted according to **Paragraph 5-06**. Once the Corps Water Management System (CWMS) is fully operational (expected in FY17/FY18) the Project Resource Manager will only need to check the pool and tailwater gages occasionally to verify that the DCP is reading accurately instead of entering 8:00am reading for pool and tailwater elevations. Instead of entering outflow, every gate change will be recorded to the nearest 15 minutes. Gate changes should be entered into the system the same day the change was made.

b. Precipitation. The official precipitation gage is a Friez 24-hour, dual-traverse rain and snow gage, with 12-inch recording capacity. Records are published by the NWS as station “Watson 1 NE”. The gage is at the office near the Chippewa River Diversion Dam. The 24-hour precipitation is recorded at 8:00 a.m. Monday-Friday (with the exception of holidays) by the Project Resource Manager. Following weekends and holidays, the amount and the times of the weekend/holiday rainfall is taken from the Friez recording chart. See **Paragraph 5-06**. There

are tipping bucket rain gages at Lac qui Parle and Highway 75 Dam. The data is transmitted by a DCP to the Project Office and the Water Management Section.

c. Snow Depth And Moisture Content. During the winter, regular measurements of snowfall are made at 8:00 a.m. daily, (except weekends and holidays) by the Project Resource Manager. Snowfall for weekends and holidays is recorded on the first workday following the weekend or holiday. Water content of the snow is determined according to the instructions contained in Circular B, "Instructions for Climatological Observers". Measurements of the water content of the snow on the ground are made each day when any new snowfall has occurred, except Saturdays, Sundays, and holidays. Snow water content is also measured at weekly intervals, whether or not any new snow has fallen during the previous period.

The Resource manager reports "winter conditions" along with the normal reports on Monday mornings from the end of November until the end of March. The reports consist of the amount of snow on the ground, the water content of the snow, the thickness of the ice on the lake, and the ground frost depth.

d. Wind and Temperature. Daily readings of wind direction and velocity and maximum and minimum air temperature are recorded at 8:00 a.m. on workdays.

e. Water Quality Measurements. Raw water samples analyzed for nutrients and chlorophyll are processed at the field site and shipped to a Corps-approved laboratory for analysis. All chemical analyses follow the Environmental Protection Agency's (EPA) recommended or equivalent procedures. Lab results are then forwarded to the Water Quality Unit. The data is reviewed and entered into the District's web-based water quality data storage system. The information is used to assess current trophic conditions in the reservoir and to evaluate the effects of operational changes and watershed management options on reservoir water quality and quality of releases from the project.

Site personnel are asked, on occasion, to assist district office personnel or contractors to collect water samples and/or water quality measurements in the project area under the supervision of a qualified water quality expert.

f. Annual Snow Surveys. Prior to the spring breakup, the resource manager conducts a snow survey in the Minnesota River Basin. The survey is taken sometime during the last week of February or the first week of March when conditions warrant. Instructions as to the exact date to start the survey are issued by the Water Management Section of the District Office. If an appreciable amount of snow should fall after the survey has been completed, another survey may be required.

Prior to making the actual snow survey, the resource manager might conduct a snow reconnaissance in the basin to determine if a detailed snow survey is necessary. This windshield survey covers the general area of the snow survey sites. The resource manager drives through the area, making a visual inspection and stopping at appropriate locations to make a snow depth measurement. A report of this survey is forwarded to Water Management as soon as possible after completion.

During the annual snow survey, at least four samples are taken at each station. The average snow depth and water content of the snow in inches is recorded and transmitted to the District Office to analyze the probable runoff to be expected. In addition to the snow samples, notes are made on the general conditions of snow cover in fields, timbered areas, river channels, dry runs, and ditches both at the stations where measurements are made and between the stations. Frost depths are obtained from the frost tube near the Chippewa Diversion Dam, power company crews, construction crews, or anyone who may have occasion to penetrate the ground surface. Snow survey stations are shown on **Plate 5-5**. **Table 5-1** lists the permanent snow survey stations to be used each time a snow survey is requested.

g. Supplemental Readings. Extra readings of the precipitation gage or other gages are made whenever required by the District Office. When extra readings of the rain gage are made, the total rain that has fallen since the last regular observation time is to be reported. The regular 8:00 a.m. reading should always include all the precipitation since the previous day's 8:00 a.m. reading. Instructions pertaining to the transmission of special readings are contained in **Paragraph 5-06.**

5-05. Communication Network. The staff can transmit hydrologic data and information by computer, telephone, or via the United States mail. Streamflow, water level, rainfall and other pertinent data are received regularly from the project during normal regulation periods and daily during periods of flooding (see **Paragraph 5-07**).

The main method of transmitting data to the St. Paul District Office is to directly enter data into the dss files using a secure terminal and a dwindo program (Water Management's CRT program). Backup method is for the project office to call (or fax) the district office with the information.

5-06. Communication with Project.

a. Communications between the Regulating Office and the Project Office. Water Management communicates with the project via the telephone and email.

1. Weekly Log Sheet. CEMVP Form 405B, "Weekly Log Sheet" is used to record all pertinent data at the Lac qui Parle project, including gage readings noted or requested and local weather conditions. The sheet is scanned in and placed in the Water Management folder on the district server. The original is kept at the project office.

2. Water Quality Data. Water quality data is recorded on data sheets and e-mailed to the Water Quality Unit in the District office.

3. Emergency Reports. During floods or other emergencies, the Resource Manager enters data into Water Management's CRT program as soon after 8:00 a.m. as possible.

b. Communications between the Project Office and Others.

1. Daily Report to National Weather Service. Reports of daily Lac qui Parle project air temperatures, precipitation and Montevideo gage height are provided to the National Weather Service. The data is transmitted daily (except weekends and holidays) to the Weather Service Forecast Office in Chanhassen, Minnesota. The data is provided either by voice or direct computer entry (WXCORDER.org).

2. Recording Rain Gage Monthly Charts. Charts from the recording rain gage are removed and sent in on the first workday of each month. The charts are sent to the National Weather Service Forecast Office, 1733 Lake Drive West, Chanhassen, Minnesota.

3. Minnesota Department of Natural Resources (MN DNR). MN DNR operates the Marsh Lake Dam drawdown control structure. The Corps Water Management section oversees the regulation. All changes to the drawdown control structure sluice gates will be determined by Water Management. Once MN DNR has made the change, the new settings and date/time of the change will be sent to Water Management as confirmation (the same day as the change is made).

4. Granite Falls Powerplant. Reports of significant changes in outflow are made to Granite Falls Powerplant. Significant is usually considered to be 200-300 cfs or greater.

5. Others. Local residents are well-attuned to fluctuations in the lake level, and they have access to lake level information from the Resource Manager, either by telephone, in person, on the internet or through the local news media. Notifications of severe weather or impending unusual conditions would be handled through local law enforcement and civil defense authorities (see **Paragraph 5-08**).

5-07. Project Reporting Instructions. Every normal workday, LQP personnel input via remote computer the information required for daily regulation. Should more information be required, Water Management will contact the site by telephone.

5-08. Warnings. In the event of impending emergency conditions or advisories requiring interim gate changes Water Management will call the Resource Manager at the Lac qui Parle Project. **Paragraph 1-05** contains phone numbers for project personnel. Phone numbers for Water Management Personnel are listed on **page vii**. In the event of other emergencies affecting project regulation and concerns downstream, the officials listed in **Plate 5-14** will be contacted.

VI - HYDROLOGIC FORECASTS

6-01. General.

- a. **Role of Corps.** The Water Management section prepares flood forecasts of reservoir inflow/outflow and pool elevation for internal use during critical flood periods (see **Chapter 7.**) During non-critical periods of reservoir regulation, forecasts are not required for regulation. The Corps' forecasts may arise from either wet or dry conditions, and are used to assist the National Weather Service (NWS), Water Management regulators and the Project Resource Manager in their work. The St. Paul District may provide water quality data through its Water Quality Unit.
- b. **Role of Other Agencies.** The NWS River Forecast Center in Chanhassen, Minnesota is the official source for all stream-stage forecast information. The water quality divisions of the various state agencies within the St. Paul District forecast water quality conditions when warranted.

6-02. Flood Condition Forecasts and Modeling.

- a. **Requirements.**

National Weather Service (NWS) Model uses a six hour timestep.

Important gages to keep an eye on include outflow from Highway 75, Pool elevation at Marsh Lake, and flows on Pomme de Terre, Lac qui Parle, and Chippewa Rivers.

- b. **Methods.**

During floods, work with the NWS to determine desired outflow. Normal procedure until the Corps has non-excel models, is to ask NWS what they see for a peak inflow and peak pool elevation with current planned outflow. Adjust outflow as needed to keep the pool elevation at desired target.

6-03. Conservation Purpose Forecasts. Forecasts for water conservation purposes are not required for the Lac qui Parle Project.

6-04. Long Range Forecasts. Long-range forecasts of reservoir inflows and levels are not normally required for flood periods or conservation purposes as discussed in **Paragraphs 6-02 and 6-03**. Long range forecasts for drought conditions may be required depending upon the severity of the drought as discussed in **Paragraph 6-05**.

6-05. Drought Forecast. The Minnesota Department of Natural Resources and the NWS routinely monitor and report drought indicators. Drought forecasting of project inflow/outflow and pool elevations is not normally required since there are no significant municipal water supply or hydropower concerns and the low flow plan adequately meets fish and wildlife concerns. During drought conditions, the regulation of the project will be in accordance with the approved drought contingency plan for the project (see **Paragraphs 7-12 and 8-09**). For additional information see **Paragraph 1-03**.

VII - WATER CONTROL PLAN

7-01. General Objectives. The water control plan incorporates procedures that affect flood control performance, water conservation, recreation, and environmental conditions. It includes a provision for an autumn rise in Lac qui Parle reservoir to create enhanced conditions for fish survival during the winter. Conservation pool levels are maintained on both Lac qui Parle and Marsh Lake in the summer to facilitate recreation, and for fish and wildlife habitat requirements.

The water control plan presented in this document differs from the plan outlined in the July 1966 Reservoir Regulation Manual in the following respects:

1. The method of flood control has changed for both spring snowmelt floods and summer floods.
2. The maximum release rate from Lac qui Parle Dam for non-flood events has been increased from 1,500 to 2,500 cfs.
3. The minimum flow release from Lac qui Parle Dam has been increased from 14 cfs to 20 cfs for normal pool levels.
4. The new plan requires raising/opening the bulkheads during certain flood control situations.
5. Computer simulations of previous flood events show no major benefit in making a pre-flood drawdown to elevation 931.2, so the new plan has no such drawdown for flood control.

The water control plan differs from the plan outlined in the August 1995 Water Control Manual in the following respect:

6. Shortly after the 1995 Water Control Manual was completed the Minnesota Department of Natural Resources (MN DNR) began requesting annually, when conditions were favorable, that the Lac qui Parle pool level be held at 933.5 feet after the spring runoff period until 01 June. This plan of operation improves the walleye pike spawn. A public meeting on this issue was held on 15 September 2011 in the local MN DNR office.

The water control plan differs from the plan outlined in the November 2014 Water Control Manual in the following respect:

7. During FY2017-2018 the Marsh Lake Dam ecosystem restoration features will be constructed (see **Chapter 2** and **Chapter 3** for more details). The intent of the restoration is to increase variability in ecosystem processes, restore a more natural water level regime, aquatic habitat connectivity, and a vegetated lake ecosystem state.

- Water levels will be manipulated under two scenarios:
 - (1) Growing Season Drawdowns (April to August) – water level target of 936.0 ft. This would result in dewatering of approximately 2,625 acres of lake bed.
 - (2) Winter Drawdowns (August to March) - water level target of 935.0 ft, leaving 2,425 acres of water in Marsh Lake, most of which would freeze to the bottom.
 - The year after a growing season drawdown, maintain water levels (April thru August) up to but not exceeding the normal summer pool elevation (elevation 938.0 feet is the modeled with-project average annual water surface) utilizing the sluice gates recognizing maximum daily outflow restrictions. (Vegetation benefits after a growing season drawdown should be considered tenuous. As such we should encourage habitat gains achieved by reducing rapid water level fluctuations above normal summer pool.)
- The frequency, timing, and duration of drawdowns will be based on the response by aquatic vegetation and fish populations through the adaptive management plan. Winter drawdowns and growing season drawdowns may run into one another consecutively and thus the dates listed above are referenced as targets. See also MNDNR Marsh Lake Operation & Management Plan for additional information on when drawdowns will occur.

7-02. Constraints and Issues Related to the Water Control Plan. Some of the physical constraints and other issues related to the water control operations at the Lac qui Parle project include the following:

a. Lac qui Parle Dam Bulkheads. The spillway bulkheads are not equipped with mechanisms to raise or lower them. They are normally moved by a backhoe with a chain attached to the bucket. The bulkheads are difficult to move when there is water pressure against them. The water control plan has the potential to require raising or lowering the bulkheads during periods when the reservoir is at or near full flood control pool. See **Paragraph 7-05.c and 7-05.d** for information on when bulkheads are installed and removed.

b. Gates Jammed by Trees at Lac qui Parle Dam. Sometimes uprooted trees become lodged in the gates at Lac qui Parle Dam. The trees reduce the flow capacity of the gates and may also prevent them from being closed.

c. Aggradation above Lac qui Parle Dam. There is an area of deposition (sandbar) in the pool just upstream of Lac qui Parle Dam. Ice jams can form on this bar, causing large fluctuations in the pool level below the ice jam. The formation of this sand bar over the years has effectively raised the top-of-dead-storage level of Lac qui Parle from the low-flow inlet grate, which has a sill elevation at 919.2 feet, to approximately elevation 928 feet or higher. See **Paragraph 4-04.**

d. Lac qui Parle State Park, Minnesota Department of Natural Resources. The camp grounds at the state park, which is located west of the Lac qui Parle Dam, inundate at approximately elevation 939.0 feet.

e. Lac qui Parle Dam Emergency Spillway. The original Lac qui Parle emergency spillway has a low point (crest) elevation of 941.1 feet. Since then, bituminous overlays on the roadway have raised the emergency spillway crest. The raised spillway crest could also affect the

comparison of peak pool elevations between various floods for example when comparing the 1951 flood to the 1997 flood. Future overlays should be considered carefully as this has reduced (and will continue to reduce) the freeboard on the dam. During flood events when the emergency spillway is in use, some of the outflow from the dam has been observed to effectively bypass the tailwater gage. Some of the flow over the spillway travels thru the downstream trees/forest, making it difficult to include in discharge measurements. A cross section of the existing emergency spillway was taken and an excel spreadsheet was created to calculate flow over the emergency spillway. See **Table 7-1** and **Plate 7-1**.

Table 7-1 Lac qui Parle Emergency Spillway							
Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)
941.5	20	942.2	2,800	942.9	10,300	943.6	20,700
941.6	100	942.3	3,650	943	11,600	943.7	22,300
941.7	300	942.4	4,600	943.1	13,000	943.8	24,100
941.8	575	942.5	5,600	943.2	14,500	943.9	25,800
941.9	950	942.6	6,700	943.3	15,900	944	27,600
942	1,500	942.7	7,800	943.4	17,500		
942.1	2,100	942.8	9,000	943.5	19,000		

f. Marsh Lake Dam Drawdown Structure. The sill elevation of the drawdown structure is set at elevation 934.0 feet in order to achieve the maximum drawdown approaching elevation 935.0 feet. The sill will be set very near to the bottom of the lake bed, and the lake bed may limit the discharge through the structure when the sluice gates are opened. There is an expectation that the upstream sediment will erode and will not be an issue. The local sponsor of the project is aware of the potential problem and is prepared to do minor dredging after project completion if necessary.

g. Siltation at Chippewa River Diversion Dam . The pool/channel upstream of the Chippewa River Diversion Dam is subject to siltation, which sometimes blocks the low flow outlet. Under severe conditions the flow into the diversion dam inlet channel can be restricted, forcing more water over the Sag Weir.

h. Chippewa River Diversion - Tainter Gate . The Tainter gate at the diversion structure has no heater or de-icing equipment and its range of movement has been limited. The gate is closed in the winter and is frozen in place until it thaws in the spring. This can cause a delay in operation of the Tainter gate during an early snowmelt flood situation. The gate can be frozen in place both up and down. For example, the gate was wide open late into the fall of 1995 due to high flows and it froze in place in the wide open position. As a result, in March 1996 it was difficult to lower the gate during flood control operations. The county installed a new bridge over the Diversion Dam structure in the 1990s. The low chord of the new bridge is too low. As a result, the Tainter gate range of operation was reduced by one foot.

A River Analysis System (RAS) model was created in 2012 to determine flows through the Tainter gate. Elevations are in NGVD29. See **Plate 7-2 through 7-4**. U.S.G.S. tailwater curve (rating 3.0 created on 22 May 2012) can be seen in **Plate 7-5**.

i. Outflow Maximums . Rock placed downstream of the Dam is designed for specific maximum velocities. It is imperative that velocities are monitored to prevent scour. A spreadsheet was developed to monitor velocities with three levels of concern (low, medium and high) and scripted plots will be added to the Corps Water Management System (CWMS) for a quick daily look. Normal operation will be to monitor the daily plots in CWMS. If velocities are predicted to be above the low concern threshold the spreadsheet should be used. If velocities are predicted to be above the medium concern threshold Hydraulics should be consulted. See **Plate 7-6a** for Lac qui Parle maximum velocities.

7-03. Overall Plan for Water Control. Following the spring runoff event, the Lac qui Parle pool level is held at elevation 933.5 $\pm$.2 feet until 31 May. After 31 May the summer conservation pool elevation is 933.0 $\pm$.2 feet. Starting 15 May the outflow from Lac qui Parle Dam is regulated to maintain its spring/summer conservation elevation while not exceeding a release rate of 2,500 cfs. A minimum flow of 20 cfs is maintained for downstream water supply and pollution abatement. During the month of September, the pool is raised gradually to an elevation of 934.0 feet to reduce stress on the fish habitat (see **Paragraph 7-07**). See **Plate 7-6** for a graphical depiction of conservation elevations. Before freeze-up starts, typically during the month of October (depending on inflow and the agricultural harvest), the spillway bulkheads (bays 8-12) are put in the raised (open) position. The bulkheads have only two positions: open and closed. During years when the pool is above elevation 934.2 late in the fall, the bulkheads will be raised as soon as possible after the pool is down to the winter conservation elevation of 934.0 $\pm$.2 feet. The pool is then held at elevation 934.0 $\pm$.2 until the end of February. On 01 March each year, the lowering of the Lac qui Parle pool will begin, in order to bring the pool to conservation elevation 933.0 by 15 March to provide room for flood control storage. During dry years the pool would be lowered to only 933.5 feet. From then on until 15 May, the spring regulation schedule is in effect. After 15 May, the summer/fall regulation schedule is in effect. The bulkheads in bays 8-12 are typically placed in the lowered (closed) position on May 16.

Normal operation of Chippewa Diversion Dam is to split the flow coming down the Chippewa River between the Chippewa River (50%) and the Lac qui Parle Lake (50%) via the Watson Sag weir.

Normal operation of Marsh Lake Dam is natural flow over the service (also known as the fishway) and auxiliary (also known as the emergency) spillways. MN DNR will inform Water Management when they want a drawdown to occur. The plan should include the desired dates of the drawdown, the targeted drawdown elevation, along with desired/maximum rates of rise/fall. Water Management will attempt to follow the MN DNR's plan dependent on inflow to Lac qui Parle.

7-04. Standing Instructions to the Project Resource Manager . For information on data collection and transmission of reports, refer to **Chapter 5**. For procedures to be followed in the event of lost communications, refer to **Paragraph 7-5.h**. In the event of communication failure, the procedures outlined in this chapter should be followed as far as practicable until communications are re-established . See also standing instructions for each Dam in **Exhibit B**.

7-05. Water Management and Flood Control.

a. General . Floods in the area are of two types: spring floods caused by snowmelt (often with rainfall), and summer floods caused by periods of heavy or prolonged rainfall. For purposes of project regulation, the spring snowmelt flood period typically extends from 1 March through 15 May, and flooding after 15 May is typically considered to be in the summer flood period. The National Weather Service, River Forecast Center should be consulted during flood and drought periods to coordinate flow information between the two agencies.

1. Definitions :

a. Lac qui Parle Reservoir Inflow : The sum of: Minnesota River flow from Highway 75 Dam, **Diverted Flow** (see below), and tributary and local inflows to the reservoir. In actual practice, this is calculated by adding the average outflow to the change in storage over the period (storage equation).

b. Lac qui Parle Dam Discharge : The flow released from Lac qui Parle Dam, including flow from gates, spillway bays, and the emergency spillway .

c. Chippewa Diversion Inflow : The total flow in the Chippewa River immediately upstream of the diversion channel leading to the Watson Sag Weir.

d. Chippewa Diversion Dam Discharge : The flow released from the diversion dam downstream into the Chippewa River channel.

e. Diverted Flow : The flow diverted by the Chippewa Diversion Dam

through the Watson Sag Weir into Lac qui Parle reservoir .

f. Total Project Inflow : The sum of the **Lac qui Parle Reservoir Inflow** and the **Chippewa Diversion Inflow** through the Watson Sag weir.

g. Total Project Outflow : The sum of the **Lac qui Parle Dam Discharge** and the **Chippewa Diversion Dam Discharge**.

h. Lac qui Parle Dam Bulkheads : The **Lac qui Parle Dam Bulkheads** are in bays 8 through 12. The bulkheads are typically raised in the fall and lowered in the spring to assist with flood control.

2. Lac qui Parle Dam – Bays 1, 3 and 4 – Sluice Gates. Flow through the sluice gates is calculated via the equation $Q = CA\sqrt{64H}$ (where C = inlet coefficient, A = flow area, H = head measured from the top of the pool to the centroid of the gate opening and Q = flow). Looking at past gate settings and outflow, the C value ranges between 0.4 (normally when tailwater is above elevation 942.5 feet) and 0.5 (normally for low tailwater elevations). Flow is best estimated as 70 cfs per foot of opening for each gate. There are six sluice gates. Openings can range from zero to eight feet.

3. Lac qui Parle Dam – Weirs. The weirs in bays 5-7 have no bulkheads, while weirs in bays 8-12 can have bulkheads installed. Discharges per bay *WITHOUT* bulkheads can be seen in **Plates 7-7 to 7-11**. Discharges per bay *WITH* bulkheads can be seen in **Plates 7-12 to 7-14**.

4. Watson Sag Weir. The flow over the weir sometimes freezes which prevents or hinders the diversion of flow into Lac qui Parle reservoir.

To calculate flow, use the following weir equation: $Q = CLH^{3/2}$

Where C=3.85 and L = 6*27'.

For tailwater elevations below the spillway, $H = \text{Pool} - 938.8$. For tailwater elevations above the spillway, $H = \text{Pool} - \text{Tail}$. See **Plates 7-15 to 7-17**.

5. Marsh Lake Weir. Marsh Lake's service spillway is at elevation 937.6 feet with a 30' notch at elevation 935.5 feet, and its auxiliary spillway crest elevation is 940.0 feet. See **Plate 7-18** for flows. For tailwater elevations less than 937.6 feet, see **Plate 7-19**. For tailwater elevations greater than 938.8 feet see **Plate 7-20** and **7-21**.

6. Marsh Lake Drawdown Structure. Marsh Lake's drawdown structure has an upstream sill elevation of 934.0 feet and has twelve five feet wide by six feet high sluice gates. See **Plate 7-XX** and **7-XX** for flows (will be added once construction is complete).

$Q = N_g C A \sqrt{2gh}$ where $N_g = 10$, $C = 0.6$, A = area of opening, h = pool elevation – center of opening.

7. Elevation – Storage Curves. Lac qui Parle Reservoir's Elevation – Storage curve is located in **Exhibit D** and **Plate 7-22**. Marsh Lake Reservoir's Elevation – Storage curve is located in **Exhibit D** and **Plate 7-23**. Bathymetric maps of maps of Marsh Lake and Lac qui Parle are shown on **Plates 7-24 to 7-26**.

b. Regulation of the Chippewa River Diversion Dam Project. The Chippewa Diversion Dam diverts water from the Chippewa River over the Watson Sag Weir and down the Watson Sag channel into Lac qui Parle reservoir (**Plate 2-7**).

The Chippewa Diversion Dam has 5 bays. Bays 1, 2, 4 and 5 are fixed-crest spillways with a crest elevation of 942.3 feet. Each of these bays is 27 feet wide. Bay 3 contains a 27-foot wide Tainter gate which also has a top-of-gate elevation of 942.3 feet when closed which matches the fixed-crest elevation. The Sag Weir has six spillway bays with a fixed crest elevation of 938.8 feet. Each of these bays is 27 feet wide. See **Chapter 2 and Appendix A**. For constraints,

see **Paragraphs 7-02.f, 7-02.g and 7-05.a.4.**

1. Open-Water Season, Chippewa Diversion Dam Project. The flood-control operation of the Diversion Dam is the same for the entire open water season. An intermediate flow situation, for example during normal summer flows or early in the spring runoff, would have the Tainter gate partially open dividing the flow evenly between the Chippewa Diversion Dam and the Watson Sag Diversion Channel. "Intermediate flows" refers to Chippewa Diversion inflows of less than about 2,000 cfs (as measured at the Milan gage). The downstream channel capacity of the Chippewa River is 1,000 cfs. See **Table 7-2** for regulation notes and **Table 7-3** for gate setting based on desired flow.

Table 7-2 Chippewa Diversion Dam Project (including Watson Sag Weir) Regulation Notes	
Condition	Tainter Gate Operation
Open-Water Season, Increasing Inflows	
Chippewa Diversion inflow (Paragraph 7-05.3) is less than approximately 2,000 cfs (as measured at the Milan USGS gage).	The Tainter gate is partially open dividing the flow equally between the Chippewa Diversion Dam and the Watson Sag Weir.
The Chippewa Diversion inflow rises above 2,000 cfs.	The Tainter gate is incrementally lowered to maintain the Diversion Dam discharge at 1,000 cfs (the downstream channel capacity) as long as possible.
The Diversion Dam pool reaches elevation 942.3 feet causing flow to pass through the Diversion Dam spillway (bays no. 1, 2, 4 and 5) on either side of the Tainter gate.	Continue to close the Tainter gate (1,000 cfs total outflow) until the gate is fully closed, and all the flow through the Diversion Dam is then passing through the spillway sections and over the Tainter gate.
Open-Water Season, Decreasing Inflows (Recession)	
The inflow hydrograph is receding. The outflow at the Diversion Dam falls below 1,000 cfs,	The Tainter gate is raised to maintain the discharge at 1,000 cfs (downstream channel capacity).
Chippewa Diversion inflow falls below 2,000 cfs.	Normal operations resume. Evenly split flows between Diversion Dam and Watson Sag.
Note: The county installed a new bridge over the Diversion Dam structure in the 1990s. The low chord of the new bridge is too low. As a result the Tainter gate range of operation was reduced by one foot.	

As inflows rise above 2,000 cfs, the Tainter gate is incrementally lowered to maintain the

Diversion Dam discharge at 1,000 cfs as long as possible. As the gate is lowered and inflow continues to increase, the water level behind the diversion dam, and thus the flow over the Sag Weir, also continue to increase. When the Diversion Dam pool reaches elevation 942.3 feet, flow begins to pass through the Diversion Dam spillway (bays no. 1, 2, 4 and 5) on either side of the Tainter gate. This mode of regulation continues until the gate is fully closed, and all the flow through the Diversion Dam is then passing through the spillway sections and over the Tainter gate. The remainder of the inflow is diverted down the Watson Sag diversion channel.

Table 7-3 Tailwater is lower than spillway (spillway elevation is 942.3) Chippewa Diversion Gate Setting based on Desired Flow							
1,000 cfs				900 cfs		800 cfs	
Pool Elev.	Gate Setting	Pool Elev.	Gate Setting	Pool Elev.	Gate Setting	Pool Elev.	Gate Setting
941.8	5.5	943.0	2.5	941.0	5.5	940.4	5.5
942.0	5.0	943.2	2.0	941.2	5.0	940.6	5.0
942.2	4.5	943.4	1.5	941.5	4.5	940.8	4.5
942.4	4.0	943.5	1.0	941.8	4.0	941.0	4.0
942.6	3.5	943.9	0	942.3	3.5	941.4	3.5
942.8	3.0					942.3	3.0
700 cfs		600 cfs		500 cfs		Start with this gate opening	
Pool Elev.	Gate Setting	Pool Elev.	Gate Setting	Pool Elev.	Gate Setting	Q (cfs)	Gate Setting
939.8	5.5	938.9	5.5	938.7	4.5	400	2.0
939.9	5.0	939.3	5.0	938.9	4.0	300	1.5
940.0	4.5	939.4	4.5	939.0	3.5	200	1.0
940.2	4.0	939.5	4.0	939.2	3.0	100	0.5
940.5	3.5	939.7	3.5	939.6	2.5		
941.4	3.0	940.0	3.0	942.3	2.0		
942.5	2.5	942.3	2.5				

On the recession, when inflow is above 2,000 cfs, the Tainter gate is opened as

necessary to maintain a discharge of 1,000 cfs from the Chippewa Diversion Dam. Once inflow falls below 2,000 cfs operations are returned to normal, and the flow is evenly split again between Chippewa River Dam and Watson Sag.

If the low-flow gate is open, its discharge needs to be included in the division of flow. See Paragraph 7-05.b.3 for information on open water season minimum flows.

2. Winter Season, Chippewa Diversion Dam Project. As winter approaches, the Diversion Dam Tainter gate is set before freeze-up occurs (flows allowing), because there is no de-icing capability on the structure. The low-flow outlet is then used to control the outflows during the winter. Closing the gate may not be possible if river flows are high heading into the winter. See **Paragraph 7-02.g.** See **Paragraph 7-05.b.3** for information on winter season minimum flows.

3. Chippewa Diversion Dam Project, Regulation for Low-Flow Conditions. During the open water season, the minimum outflow from the Chippewa River Diversion Dam will be approximately one-half the Chippewa Diversion inflow. The remainder of the Chippewa flow is diverted through Watson Sag to provide for the needs of fish and wildlife (See **Paragraph 7-05.b.** and **Table 7-2**).

During a typical fall and heading into winter, a minimum flow of approximately 10 percent of the Chippewa River inflow is maintained down the Watson Sag channel to provide oxygenated water and suitable habitat for fish overwintering in the Watson Sag portion of Lac qui Parle Reservoir.

c. Spring Regulation of Lac qui Parle Dam, 1 March through 15 May. During the period **1 March through 15 May**, the spillway bulkheads (bay Nos. 8 thru 12) are typically in the raised (open) position where they have been since the previous fall.

Typically between 1 March and 15 March the pool at Lac qui Parle Dam will be drawn down from elevation 934.0 feet to elevation 933.0 in preparation for the spring runoff. As the spring runoff progresses, which typically begins in March or April and concludes by mid-May, the dam's gates will be adjusted to set discharge from the dam equal to inflow to hold pool elevation 933.0 feet in order to maintain as much flood control storage as possible.

Eventually the gates will be wide open and inflow will exceed the outflow capacity of the gates and the bulkhead bays. At that point the pool will rise, as will outflow from the dam, in an unrestricted manner until the stage at Montevideo approaches the major flood stage of 17 feet (approximately 13,000 cfs). At this point, and so long as flood control storage is available below the emergency spillway crest elevation of 941.1 feet, the gates and bulkheads are closed as necessary to maintain the stage at Montevideo at 17.0 feet (to minimize damage). If the pool is expected to exceed elevation 941.1 the dam will be fully open (all gates and bulkheads open) by the time the pool reaches that point to ensure the safety of the structure.

As flows recede, the gates and bulkheads are adjusted as necessary to hold the stage at Montevideo near, but not over, the 17 foot target stage to simultaneously evacuate flood control storage as soon as possible while minimizing downstream damage. The pool is lowered to elevation 933.5 feet. See **Table 7-4** for regulation notes.

d. Summer/Fall Regulation for Lac qui Parle Dam, 16 May Thru End of Agricultural Growing Season (or as needed thru 28 February). In a typical year, the bulkheads are installed (placed in the closed position) in Bays 8 thru 12 on or about 16 May. The bulkheads in the closed position assist with not exceeding the downstream agricultural damage target flow of 2,500 cfs. If the recession is occurring in mid-May, caution must be exercised in installing the bulkheads if that would again raise the pool over or near elevation 941.1 feet. There also may be safety concerns or physical constraints associated with trying to install the bulkheads if the pool level is high.

The pool is held at the conservation elevation of 933.5 +/- 0.2 feet until 01 June. Starting 01 June the conservation elevation returns to elevation 933.0 +/- 0.2 feet.

Table 7-4 Lac qui Parle Dam Regulation Schedule		
Date/Condition	Pool Elev. Feet	Notes
Lower to Summer Conservation – 01 Mar to 15 Mar.	Drawdown From 934.0 to 933.0/933.5	Discharge as necessary to achieve a uniform drawdown from elevation 934.0 to the conservation pool elevation of 933.0 by 15 March to prepare for spring runoff storage. If SWE is low or not present then drawdown to only 933.5.
Spring Runoff – Increasing Flows	Typically at or above 933.5	Discharge inflow when the pool is above 933.0 $\pm$ 0.2 to hold that elev. However, the gates and bulkheads are closed as necessary to not exceed a 17 ft. stage at Montevideo, IF storage is available. The dam must be fully open by the time the pool reaches elev. 941.1 for dam safety.
Spring Runoff – Decreasing Flows	933.5 +/- 0.2	As inflow recedes hold the 17 ft. stage at Montevideo to evacuate flood control storage.
Close Bulkheads – 16 May		In a typical year the bulkheads are installed on or about 16 May. Do not install if installation would increase the pool to 941.1 ft or higher. There may also be safety concerns or physical constraints with trying to install during high flows.
Summer Conservation – 16 May to 31 Aug.	933.5 +/- 0.2 933.0 +/- 0.2	Discharge inflow to hold pool elevation. Hold 933.5 following spring runoff until 31 May.
Ag season Flood – Increasing Flows	Below 938.0	Limit the discharge from the dam to 2,500 cfs or less to lessen damages to crop lands.
Ag season Flood – Increasing Flows	Above 938.0	Balance inflow, outflow and storage. The dam must be fully open (gates and bulkheads) by the time the pool reaches elevation 941.1 ft for dam safety.
Ag season Flood – Decreasing Flows	Above conservation elevation	On the recession, when the pool is below elevation 941.1 but above elevation 938.0; adjust the dam's outflow to allow the pool to fall expeditiously down to elevation 938.0 feet. Then discharge inflow or 2,500 cfs whichever is greater, until the pool is down to the conservation level of 933.0 feet.
Raise to Winter Conservation – 01 Sep to 30 Sep	934.0 +/- 0.2	Raise pool uniformly to elevation 934.0 between 01 September and 30 September.
Open Bulkheads		Before freeze-up raise the bulkheads.
Winter Conservation – 30 Sep to 01 Mar	934.0 +/- 0.2	Discharge inflow to hold pool elevation. If possible avoid discharging more than 1,000 cfs during freeze-up. Notify City of Granite Falls if outflow will exceed 1,000 cfs during freeze-up.
Minimum Flow	Above 932 ft 932 to 930 ft Below 930 ft	20 cfs, See Paragraph 7-05.g. for minimum flow info. 15 cfs 10 cfs

Reservoir regulation for summer and fall floods was formulated to reduce downstream agricultural and urban flood damages (see the CACFDAS report, **Paragraph 1-03**). 2,500 cfs was found to

be a reasonable compromise between downstream agricultural flooding and evacuating flood control storage expeditiously. When runoff conditions allow, the spillway bulkheads (bays 8-12) are installed (closed) on May 16, unless the pool is above elevation 934.2 feet, to assist with limiting outflows. Generally, during the period from 16 May until the end of the following February, the outflow is limited to 2,500 cfs for all pool levels between conservation pool and elevation 938.0 feet. For floods which raise the pool above elevation 938.0, the regulation objective is to fully utilize the remaining flood control storage to store the flood peak, if at all possible, and if not, then to have the dam fully open (all gates and bulkheads open) by the time the pool reaches crest of the emergency spillway (i.e. the top of flood control pool at 941.1 feet) to ensure the safety of the structure. These goals are reviewed and adjustments are made daily (at least) by following the instructions in **Table 7-5**.

Discussion of Optimizing Flood Control Storage Above Elevation 938.0 feet: The top of the flood control pool at Lac qui Parle reservoir is set at elevation 941.1 feet. For a given flood event, the peak pool elevation on Marsh Lake is usually higher than the peak on Lac qui Parle reservoir, from about 0.1 foot to more than 2 feet higher, depending on the type of flood. Floods which originate mostly above Marsh Lake Dam seem to have the higher differences, and floods in which all the tributaries are flooding have the lower differences. For estimating the available storage, the representative values (941.1 and 941.5 ft.) in **Table 7-5** were chosen. **Plates 7-27 through 7-31** show total flow from the dam for different pool and tailwater elevations.

e. Winter Lac qui Parle Conservation Level. Starting in early to mid-September, depending on the available inflow, the Lac qui Parle discharge will be reduced so as to uniformly raise the pool to elevation 934.0 by 30 September. After this, the pool will be held at elevation 934.0 ± 0.2 feet throughout the winter until the end of February. On 1 March, the spring regulation schedule begins. (see **Paragraph 7-05.c**). The actual dates may vary depending on inflow and conditions in the reservoir.

f. Lac qui Parle Freeze-up Period Flow Limitation. To the extent that these procedures

and runoff conditions allow, avoid discharging substantially more than 1,000 cfs during the initial winter freeze-up period. Also, notify the City of Granite Falls as soon as possible when discharges over 1,000 cfs are anticipated during this period.

Table 7-5 Lac qui Parle Dam 14-Day Inflow/Discharge Computation for Summer/Fall Floods 16 May through End of Agricultural Growing Season (or as needed thru 28 February) For use when the Pool Elevation is at or Above 938.0 feet	
Storage in Lac qui Parle Below Top of Flood Control at 941.1 feet: Storage in Marsh L. Below 941.5 feet (assumed elev. when LQP is at 941.1 ft) : Combined Storage in Both Reservoirs:	122,800 ac-ft <u>39,500 ac-ft</u> 162,300 ac-ft
The Following Calculation is Done Daily	Notes
1. Determine the flood control storage available above the current pool levels. Obtain the storage value for each reservoir, add together.	Subtract the total from 162,300 ac-ft and divide by 1.9835 to convert to cfs-days
2. Obtain an inflow hydrograph to LQP & Marsh L. reservoirs daily	The Corps may develop an inflow hydrograph and compare it to what the NWS RFC is using in their model.
3. Determine Outflow. There are two ways to determine needed outflow. If you are using the NWS inflow tell them your outflows and they can let you know what crest they are seeing. Increase outflows if needed. If you are using the Corps inflow or want to compute outflow yourself balance pool elevation with outflow. Keep in mind that the dam needs to be fully open (gates and bulkheads) by the time the pool reaches 941.1 feet.	Do not increase the discharge more than 2,000 cfs per day. If the required daily increase is more than 400 cfs do it in two or three equal steps.
4. On the recession, when the pool is below elevation 941.1 but above elevation 938.0; adjust the dam's outflow to allow the pool to fall expeditiously down to elevation 938.0 feet. Then discharge inflow or 2,500 cfs whichever is greater, until the pool is down to the conservation level (933.5 feet until 31 May then 933.0 feet).	Do not decrease the discharge more than 1,000 cfs per day. If the required daily decrease is more than 400 cfs do it in two or three equal steps.

g. Lac qui Parle Dam, Regulation for Dry Conditions. The reservoir will be operated during low water periods so as to provide required minimum flows downstream. The routine minimum discharge from Lac qui Parle Dam (interim schedule) is shown in **Table 7-4** relative to various pool levels. The minimum flows listed in the table are pending the outcome of an in-stream flow study which was recommended in the Reservoir Operation Plan Evaluation (ROPE) Study (see **Paragraph 1-03**). The values are interim recommendations from the St. Paul

District's Environmental Branch. As of 2016, an in-stream flow study had not been completed.

h. Marsh Lake Dam. The reservoir naturally releases flow over the rock weir fishway and all sluice gates are fully closed.

If Marsh Lake pool elevation suddenly bounces by more than 6 inches in a 24-hour period during April thru August the pool elevation will be returned to the previous elevation as quickly as possible utilizing the drawdown structure sluice gates, understanding that there will be maximum daily outflow restrictions. Water Management will give day-to-day instructions, if necessary, to MN DNR on gate settings. Water Management will determine gate settings after reviewing inflows (current and forecasted) to the project and following the below guidelines:

- 1. April 01 – May 14:** Although there is no channel capacity restriction for Lac qui Parle during this time period, increased inflow to Lac qui Parle could cause higher pool elevations on Lac qui Parle and/or downstream stages. Marsh Lake Dam's drawdown structure may be used to minimize the increase to Marsh Lake's pool if there is additional gate capacity at Lac qui Parle Dam to handle the increased inflow. If Lac qui Parle can open more gates to pass the flow from Marsh Lake's drawdown structure without the Lac qui Parle pool increasing then Marsh Lake's drawdown structure may be operated.
- 2. May 15 – August 31:** Channel capacity downstream of Lac qui Parle reservoir is 2,500 cfs during the growing season. Marsh Lake Dam's drawdown structure may be used to minimize the increase to Marsh Lake's pool if there is additional gate capacity at Lac qui Parle Dam to handle the increased inflow without exceeding an outflow of 2,500 cfs.

i. Marsh Lake Dam Drawdowns. MN DNR in coordination with partner agencies determines when a drawdown of Marsh Lake Dam is necessary. MN DNR will inform Water Management by February 15 (for growing season drawdowns – April to August) or no later than August 15 (for winter drawdowns – August to March) that a drawdown will be attempted. MN

DNR will submit a drawdown plan (dates, target elevation, desired rates of fall/rise and maximum rates of fall/rise) to Water Management one month prior to the start of a drawdown. MN DNR and Water Management will discuss one week prior to the start of the drawdown if conditions are favorable for the drawdown to occur (look at Marsh Lake Dam pool elevation, Lac qui Parle pool elevation, tributary inflows and forecasted inflows, along with calculating Marsh Lake Dam maximum outflow and fall rate during drawdown).

During the drawdown Water Management will give day-to-day instructions, if necessary, to MN DNR on gate settings. Water Management will determine gate settings after reviewing inflows to the project (Pomme de Terre River flow, Lac qui Parle River flow, Watson Sag flow and desired Marsh Lake Dam flow). Water Management will attempt to follow MN DNR's plan for drawdown, but the maximum daily outflow allowed from Marsh Lake Dam will vary depending on inflows, as LQP is limited to an outflow of 2,500 cfs during the growing season. During initial freeze-up LQP outflow is limited to 1,000 cfs (see section f above).

There are three different parts of a drawdown – drawdown, steady pool and raise. Each are described in more detail below:

1. **Drawing Down Marsh Lake.** Normal operation of gates will be to raise them above the water surface and allow the lake to drain. With a starting pool elevation of 938.3 feet (average pool) this results in a maximum outflow of 1,500 cfs and a maximum fall of 0.5 feet per day. One to two weeks prior to the start of the drawdown Water Management will use the current pool elevation and determine maximum outflow and fall rate. These will then be compared with MN DNR's plan. If either the maximum outflow or fall rate are too high, Water Management will determine gate settings.
 - a. **April – May 14 Drawdown.** LQP outflow will be increased in order to hold its conservation pool.
 - b. **May 15 – October Drawdown.** Lac qui Parle pool will be lowered to the bottom of its band before the drawdown starts. Outflow from LQP will remain at or below channel capacity (2,500 cfs). If the total tributary inflow (Watson

Sag flow plus Pomme de Terre River flow plus LQP River flow) is 1,500 cfs or less then LQP pool will stay in its band (see **Table 7-4**). If the total tributary inflow is 2,000 cfs then LQP pool will climb ~0.8 feet. If the total tributary inflow is 2,500 cfs then LQP pool will climb ~2.0 feet. Keep in mind the different starting elevations of LQP pool and coordinate with MN DNR to verify they are okay with how high LQP is predicted to climb. If they want a lower LQP pool, then Water Management will determine gate settings to reduce Marsh Lake outflow (which will increase the length of the drawdown).

- c. **Winter Drawdown.** There are no restrictions on LQP outflow after the growing season. However, drawdown needs to be completed prior to freeze-up. After freeze up it could cause dangerous ice conditions if there are large increases to outflow (either Marsh or LQP).
2. **Steady Pool.** Gates are fully open passing inflow. If a flood occurs Water Management may require gate changes so that Marsh Lake is passing only inflow dependent on the status of LQP. During floods there may be a bounce in Marsh Lake.
3. **Raising Marsh Lake.** Follow the MN DNR's plan for desired rate to raise the lake. Minimum Flow Requirement: If Pomme de Terre River flow plus Watson Sag flow plus LQP River flow is less than 20 cfs then Marsh outflow will need to equal the difference up to inflow (i.e. if the pool was lowered due to a drawdown, then the pool cannot be below the notch in the spillway and not releasing any water during droughts – a gate on the drawdown structure would need to be opened to the desired flow).

j. During Construction of Marsh Lake Dam Ecosystem Restoration.

Marsh Lake Dam features (Drawdown Structure and Fishway).

The drawdown structure will be constructed first so that no pumping is needed. A cofferdam system will be placed on the lakeside of the embankment to allow for construction of the drawdown structure. The first part of the cofferdam system will require installation of a cofferdam in the wet with a top elevation 940.0 feet (which is the top of the auxiliary spillway and is a 10% annual exceedance elevation). The area between this cofferdam and the existing embankment will then

be dewatered and a cofferdam will be constructed landward of the first cofferdam in the dry. This cofferdam will be constructed to elevation 950.5 feet (which is half a foot higher than the top of the Dam). See **Figure 7-1**.

After construction of the drawdown structure, the outlet channel will be excavated starting from structure and moving in a downstream direction to the point where it intersects the existing channel. Proceeding with excavation in a downstream direction from the structure will minimize the impacts downstream water levels will have on the excavation. See **Figure 7-2**.

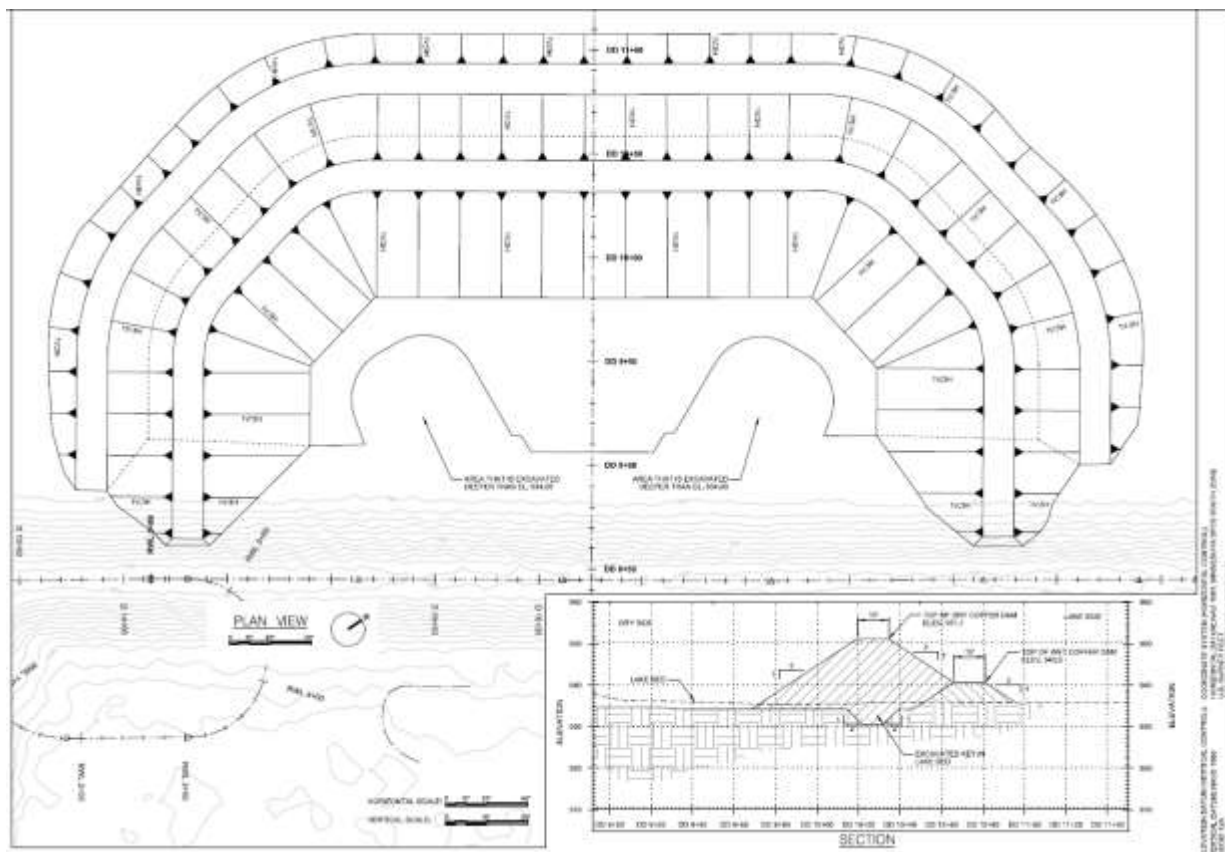


Figure 7-1: Cofferdam to construct Marsh Lake Dam Drawdown Structure (NAVD88)



Figure 7-2: Plans and Specs drawing of Marsh Lake Dam

Upon completion of the drawdown structure and its outlet channel the cofferdam will be removed and one-two cofferdams would be built surrounding the service spillway (including the dimensions for the new fishway). The contractor will determine if the cofferdams are needed and if so what elevation they will be built to (i.e. the risk they are willing to take on if the water level exceeds the elevation of the cofferdam/service spillway). During construction of the fishway inflow will pass through the drawdown structure. MN DNR will determine in coordination with USACE, if Marsh Lake will be held at conservation or if the pool will be drawn down. Gate settings will be determined by Water Management and relayed to MN DNR.

Before the Pomme de Terre River is diverted through the existing dam embankment both the new embankment and the restoration of the historical channel downstream of the current embankment need to be complete. Construction of the new embankment will not include crossing the Pomme de Terre River until the historic channel is ready to receive water. At that point there will be a critical day when the new embankment is tied into the existing embankment and the existing embankment can be breached in order to divert the Pomme de Terre River back into its historic channel. After the new embankment is tied into the existing embankment, the remainder of the existing embankment alignment east of the tie-in can be removed. The restoration of the Pomme de Terre River upstream of the current embankment can occur at any time. See **Figure 7-3** showing the different construction features.



Figure 7-3: Plans and Specs drawing showing the different Pomme de Terre features.

k. Emergency Conditions. In the event of failure of normal (telephone) communications, the Resource Manager and MN DNR will maintain contact with the District Office by any other means available, including alternate telephone services, or sending a messenger to the nearest point where communications are available.

If flooding conditions are also present, the primary objective will be to ensure the safety of the structures and to provide the most effective operation of the project by following the guidance in this chapter. During such emergency operation, the appropriate schedule in **Chapter 7** will be followed until contact with the District Office is reestablished. It will also be necessary for the Resource Manager to keep informed concerning effects of any reservoir releases on downstream damage centers.

If Water Management cannot be contacted at the District Office, call one of the regulators in order of preference as shown on the list on **Page viii**, near the front of this manual

7-06. Recreation. Recreation in the project area consists primarily of hunting, fishing, camping, canoeing, hiking and auto tour routes. A Minnesota State Park with picnic and camping facilities is located on the right bank, just upstream of Lac qui Parle Dam. See **Paragraphs 2-06 and 8-03**.

7-07. Water Quality. The winter conservation elevation of LQP is higher than summer conservation as fish and other aquatic life require adequate amounts of dissolved oxygen (DO) to survive. Stressed fish populations and winter fish kills can often be attributed to low levels of DO. Conditions contributing to low DO levels include:

1. Since DO is proportional to the water volume, low lake level means low water volume, which means low total DO.
2. Poor quality inflows fail to bring in adequate DO levels during the winter months.
3. Snow and ice cover reduce light penetration, and therefore photosynthetic DO production is reduced.

Of these parameters, the only one which can be easily affected through water management is the lake water volume. Holding the lake higher during the winter months creates a larger supply of DO for the critical winter months, reducing the chance of winter fishkill. See **Paragraphs 4-08, 5-02 and 8-04**. In addition, see **Paragraphs 2-02 and 3-05n** for information on Marsh Lake water quality.

7-08. Fish and Wildlife. Most of Lac qui Parle and Marsh Lake lie within the Lac qui Parle Wildlife Management Area, which is administered by the Minnesota Department of Natural Resources. Immediately upstream is the Big Stone National Wildlife Refuge, which is administered by the U. S. Department of the Interior, Fish and Wildlife Service. These wildlife areas, plus the Minnesota River valley, form a natural corridor which traverses the region from northwest to southeast. This corridor offers an excellent opportunity for viewing and photographing the wildlife found there. Conservation groups have expressed concern that the water levels in Lac qui Parle reservoir not be operated exclusively for flood control to the detriment of fish and wildlife resources. See **Paragraphs 7-07 and 8-05**.

7-09. Water Supply. Granite Falls is the only community that is clearly dependent on Lac qui Parle outflows for its water supply. The Granite Falls water treatment plant has a capacity of 620 gallons per minute, (0.893 MGD) or 1.38 cfs. The city has two 300,000 gallon supply tanks, and a 275,000 gallon post-clarification tank for a total storage of 875,000 gallons. Average daily use is 275,000 gallons per day, with a high usage of 700,000 gallons per day. See **Paragraph 8-06**.

7-10. Hydroelectric Power. Hydroelectric Power is not an authorized purpose of the project.

7-11. Navigation. Navigation is not an authorized purpose of the project.

7-12. Drought Contingency Plans. The drought contingency plan is in draft form (dated September 1992) and is a stand-alone document (see **Paragraph 1-03 and 8-09**). Copies of the

plan are located at the Lac qui Parle Project Office at Watson, Minnesota, and in the District Water Management Section in St. Paul.

7-13. Flood Emergency Action Plans. The flood emergency action plan is a stand-alone document (dated October 1988) (see **Paragraphs 1-03, 5-08 and 8-10**). The plan is located at the Lac qui Parle Project Office at Watson, Minnesota, and in the District Water Management Section in St. Paul.

7-14. Other. See rest of manual.

7-15. Deviation from Normal Regulation. Unusual circumstances that require minor deviations from the normal regulation plan must be approved by the District Engineer and Division Commander. For deviations that become necessary with little advance notice, Water Management will obtain verbal approval from the District Engineer and the Division Commander, with supporting documentation provided as soon as possible after the fact. Under extreme emergency conditions, Water Management personnel may authorize necessary short-term changes until approval from higher authority is obtained.

a. Emergencies. Examples of some emergencies that can be expected to occur at a project are: drowning and other accidents, failure of the operation facilities, chemical spills, treatment plant failures and other temporary pollution problems. Water control actions necessary to abate the problem are taken immediately unless such action would create equal or worse conditions. Districts must inform their division office as soon as practicable. Prepare written confirmation of the deviation and description of the cause and furnish it to the division water control manager. Divisions may develop forms to facilitate the reporting of emergency deviations.

b. Unplanned Minor Deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulation plan, although they are not considered emergencies. Construction accounts for the major portion of these

incidents and typical examples include utility stream crossings, bridge work, and major construction contracts. Deviations are sometimes necessary to carry out maintenance and inspection of facilities. Requests for changes in release rates generally involve time periods ranging from a few hours to a few days. Each request is analyzed on its own merits. In evaluating the proposed deviation, consideration must be given to upstream watershed conditions, potential flood threat, condition of the lake, and alternative measures that can be taken. In the interest of maintaining good public relations, requests generally are complied with providing there are no foreseen adverse effects on the overall regulation of the project (or projects) for the authorized purposes. Approval for these minor deviations normally will be obtained from the division office by telephone. Written confirmation explaining the deviation and its cause will be furnished to the division water control manager.

- c. **Planned Deviations.** Each condition should be analyzed on its merits. Sufficient data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes, together with the district recommendation, will be presented by letter via email to the division for review and approval.

Periodic Inspections and Assessments: Every five years a periodic inspection (PI) is completed and every ten years a periodic assessment (PA) is completed. Three separate PIs occur for Lac qui Parle Project. One is for Lac qui Parle Dam and the Watson Sag Weir, one is for the Chippewa Diversion Dam and one is for Marsh Lake Dam. Following paragraphs describe regulation changes during PIs.

Lac qui Parle Dam and Watson Sag Weir PI change in regulation:

- Chippewa River at Milan flows are at or below 1,000 cfs.
- Lac qui Parle reservoir is at summer band.
- Around a week prior to the PI
 - Outflows will be ramped up and down so as not to impact in stream wildlife
 - Chippewa Diversion Tainter gate would be fully opened, allowing for removal of silt/debris at Watson Sag.
 - After removal, flows would return to 50/50 split between the Chippewa Diversion Dam and Watson Sag.
- During PI
 - Outflows will be ramped up and down so as not to impact instream aquatic life.
 - Chippewa Diversion Tainter gate would be fully opened allowing for PI.
 - Lac qui Parle Dam outflow would be reduced to minimum flow (20 cfs) during the PI.
- After PI
 - Outflows will be ramped up and down so as not to impact instream aquatic life.
 - Flows would return to 50/50 split between the Chippewa Diversion Dam and Watson Sag.
 - Outflow from Lac qui Parle Dam would return to normal. If necessary outflow would be greater than inflow in order to lower the pool back to summer band.

Chippewa Diversion Dam PI change in regulation:

- Chippewa River at Milan flows are at or below 2,000 cfs.
- During PI
 - Outflows will be ramped up and down so as not to impact instream aquatic life.
 - Chippewa Diversion Tainter gate would be fully closed allowing for PI.
 - Chippewa Diversion low water control culvert would be opened to 50 cfs.
- After PI
 - Outflows will be ramped up and down so as not to impact instream aquatic life.
 - Flow would return to normal 50/50 split.

Description of Marsh Lake steps for a PI will be added after construction.

7-16. Rate of Change. Guidelines for increasing outflow at Lac qui Parle Dam: no more than 2,000 cfs per day. If the required daily increase is more than 400 cfs, break up the increases into two or three equal steps.

Guidelines for decreasing outflow at Lac qui Parle Dam: no more than 1,000 cfs per day. If the required daily decrease is more than 400 cfs, break up the decreases into two or three equal steps.

VIII - EFFECT OF WATER CONTROL PLAN

8-01. General. The primary benefits from the project are derived from flood control. Agricultural and urban flood control benefits are realized along the Minnesota River and at Montevideo and Granite Falls, Minnesota. Secondary benefits include fish and wildlife and recreation.

8-02. Flood Control.

a. Spillway Design Flood.

1. Marsh Lake Dam. The spillway design flood for Marsh Lake Dam was estimated for the Dam Failure Planning Report (see **Paragraph 1-03**). The design flood was produced by reducing the Probable Maximum Precipitation hyetograph until the resulting event produced a peak reservoir stage with 3 feet of freeboard. The spillway design flood for Marsh Lake Dam results in a maximum outflow of 15,000 cfs and a maximum pool elevation of 947.1 feet.

2. Lac qui Parle Dam. Information on the spillway design flood for Lac qui Parle Dam is not available. See section b below.

3. Chippewa River Diversion Dam. The spillway design flood for the Chippewa Diversion Dam was estimated for the Dam Failure Planning Report (see **Paragraph 1-03**). The design flood was produced by reducing the Probable Maximum Precipitation hyetograph until the resulting event produced a peak reservoir stage for which the dam could be expected to sustain no damage. Since this dam has no emergency spillway, the spillway design elevation was chosen to be 944.0 feet. The spillway design flood results in a maximum outflow of 7,000 cfs and a maximum pool elevation of 944.0 feet (6 feet of freeboard). This is the combined outflow from the outlet and the diversion channel.

b. Probable Maximum Flood (PMF). The Lac qui Parle Project was constructed prior to the development of the current spillway design flood standards. The original design was not based upon PMF criteria. A PMF inflow hydrograph was developed for Lac qui Parle reservoir, Marsh Lake reservoir, and the Chippewa Diversion Dam for the *Emergency Plan* study (see **Paragraph 1-03**) and has been incorporated into this manual for comparative purposes.

Additional details on the PMF for Marsh Lake reservoir and the Chippewa Diversion can be found in the Dam Failure Planning Reports (see **Paragraph 1-03**). The PMF for each location was developed using a 15 June All-Season event.

1. Marsh Lake Dam. The computed peak inflow into Marsh Lake reservoir from the PMF is 109,000 cfs. Routing of the PMF through the reservoir resulted in a computed peak pool elevation of 952.0 feet (zero freeboard) and a maximum outflow through the spillway and over the dam (without dam failure) of 108,000 cfs. The PMF inflow hydrograph is presented on **Plate 8-1**.

2. Lac qui Parle Dam. The computed peak inflow into Lac qui Parle reservoir from the PMF is 124,000 cfs. Routing of the PMF through the reservoir resulted in a computed peak pool elevation of 946.5 feet and a maximum outflow through the spillway and over the dam (without dam failure) of 106,500 cfs. The PMF overtops the dam by 0.5 feet. The PMF inflow hydrograph is presented on **Plate 8-2**.

3. Chippewa River Diversion Dam. The computed peak inflow into Chippewa Diversion Dam pool from the PMF is 98,000 cfs. Routing of the PMF through the reservoir resulted in a computed peak pool elevation of 954.2 feet and a maximum outflow through the spillway and over the dam (without dam failure) of 98,000 cfs (inflow=outflow). This is the combined outflow from the outlet and the diversion channel. The PMF overtops the dam by 4.2 feet. The PMF inflow hydrograph is presented on **Plate 8-3**.

c. Standard Project Flood. The Standard Project Flood has not been developed for the drainage area above the Lac qui Parle Project. Key floods can be seen in **Paragraph 4-06**.

d. Intermediate Flood (IF). The intermediate flood (IF) is an event that is half way between the PMF and the spillway design flood.

1. Marsh Lake Dam. Routing of the IF through the reservoir resulted in a computed peak pool elevation of 949.6 feet. The computed peak inflow into Marsh Lake reservoir from the IF is 22,000 cfs.

2. Lac qui Parle Dam. Information on the IF for Lac qui Parle Dam is not available.

3. Chippewa River Diversion Dam. The computed peak inflow into Marsh Lake reservoir from the IF is 53,000 cfs. Routing of the IF through the reservoir resulted in a computed peak pool elevation of 951.8 feet.

8-03. Recreation. The current water control plan for the Lac qui Parle Project provides dependable and stable summer lake levels. This benefits resort owners, lakeshore residents, the state park, and area commerce. Stable summer levels reduce shoreline erosion and improve wildlife habitat. See also **Paragraphs 2-06 and 7-06.**

8-04. Water Quality. Releases from the Lac qui Parle Project can affect both the quantity and quality of water available for water supply in the Minnesota River. Presently, no known problems exist with using Minnesota River water for municipal use after treatment. The pool is raised to elevation 934 feet in the fall to conserve dissolved oxygen (DO). This provides additional oxygen for fish and other aquatic life between freeze-up and the spring thaw. The goal of winter pool-wide drawdowns is to create low DO conditions for purposes of controlling the carp population. See **Paragraphs 4-08, 5-02 and 7-07.**

8-05. Fish and Wildlife. The water control plan for Lac qui Parle reservoir includes achieving a target lake level of 933.5 feet, if possible, following spring runoff until May 1 at which time the target lake level is 933.0 feet. These target levels provide sufficient lake volume to provide for

aquatic habitat conditions during the growing season. The pool level is raised to elevation 934.0 feet in the fall to limit the potential for winterkill of fish.

The Marsh Lake ecosystem restoration includes three features, each chosen to improve the quality of the lake:

- Restore the Pomme de Terre River to its historic channel
 - ✓ Which will remove a major winter refuge area for common carp within Marsh Lake
 - ✓ Which will reconnect traditional spawning areas for native fishes from Lac qui Parle Lake/Reservoir
 - ✓ Which will help trap sediments and nutrients in the natural floodplain
- Modify the Marsh Lake Dam, construct fishway and notched weir structure
 - ✓ Which will restore connectivity for native fishes between Marsh Lake and Lac qui Parle Lake/Reservoir
 - ✓ Which will restore a more natural hydrologic regime within the Marsh Lake pool and promote aquatic plant growth and overall lake health
- Include an alternative drawdown water control structure feature
 - ✓ To provide the option for active water level management as needed to supplement enhancing habitat and water quality conditions

8-06. Water Supply. The project does not have sufficient storage available to be a dependable long-term source of surface water for downstream water utilities.

The City of Granite Falls is the only community in the immediate area that is dependent on Minnesota River water for water supply. The city has a water treatment plant that treats 620 gallons per minute (gpm) or 1.38 cfs daily. The utility has two 300,000 gallon supply tanks and a 275,000 gallon post-clarification tank for water storage. See **Paragraph 7-09**.

8-07. Hydroelectric Power. Hydropower is not an authorized purpose of the project.

8-08. Navigation. Navigation is not an authorized purpose of the project.

8-09. Drought Contingency Plans. The Drought Contingency Plan (DCP) provides a basic reference for water management decisions and responses to a water shortage in the Lac qui Parle basin induced by climatological droughts. The DCP includes a plan formulation process for the release of low flows and an interagency coordination matrix. The DCP is in draft form (dated September 1992) and is a stand-alone document (see **Paragraph 1-03 and 7-12**).

8-10. Flood Emergency Action Plans. The *Emergency Plan* outlines procedures to be followed under various emergency conditions. The report includes: an emergency identification plan, an emergency operations and repair plan, an emergency notification list, and an inundation map. The plan is dated October 1988 and is a stand-alone document (see **Paragraph 1-03 and 7-13**).

8-11. Frequencies. Inflow and outflow duration data can be found in **Chapter 4**.

a. Peak Annual Inflow Frequency. **Plate 8-4** shows the probability of a given maximum annual daily inflow into the Lac qui Parle Project. Daily inflows were computed using mean daily outflows and the change in pool elevation from 1940 through 1993.

b. Pool Stage/Elevation Frequency. The annual probability of a given project pool stage/elevation occurring at Lac qui Parle Dam is presented on **Plate 8-5**. This curve was developed for the period 1940 through 1993. The data used to develop the curve reflects the maximum project pool elevation recorded at Lac qui Parle Dam. The control shifts from Marsh Lake Dam to Lac qui Parle Dam, depending on the project pool elevations.

The annual probability of a given project pool stage/elevation occurring at Marsh Lake Dam is presented on **Plate 8-6**. This curve was developed for the period 1964 through 1993.

c. Discharge-Frequency Curves. **Table 8-1** lists discharge-frequency curves for various gages and the plates on which they can be found.

d. Key Control Points. The only control point below the project is at Montevideo, Minnesota. The project is regulated during flood periods for a target stage of 17 feet at U.S.G.S. gage No. 05311000 in Montevideo (see **Paragraph 7-05**).

8-12. Other Studies. See **Paragraph 1-03**.

a. Flood Forecasting. *Forecasting Rainfall and Snowmelt Runoff on Floods on Upper Midwest Watersheds*, University of Minnesota, St. Anthony Falls Hydraulic Lab, Report No. 151, June 1974. This report used SSARR (Streamflow Synthesis and Reservoir Regulation), HEC-1 (Flood Hydrograph Package), and the National Weather Service's River Forecast model to compare various flood forecasting techniques. The entire Minnesota River basin was modeled.

Table 8-1 Peak Annual Discharge-Frequency Curves in the Vicinity of the Lac qui Parle Project	
Plate Number	Description
8-7	U.S.G.S. Gage No. 05293000, Yellow Bank River near Odessa, Minnesota
8-8	U.S.G.S. Gage No. 05294000, Pomme de Terre River at Appleton, Minnesota
8-9	U.S.G.S. Gage No. 05300000, Lac qui Parle River near Lac qui Parle, Minnesota
8-10	U.S.G.S. Gage No. 05304500, Chippewa River near Milan, Minnesota
8-11	U.S.G.S. Gage No. 05292000, Minnesota River at Ortonville, Minnesota ¹
8-12	U.S.G.S. Gage No. 05301000, Minnesota River near Lac qui Parle ²
8-13	U.S.G.S. Gage No. 05311000, Minnesota River at Montevideo, Minnesota ³
1. The gage is 1300 feet downstream of the Big Stone Lake Dam. 2. The gage is 200 feet downstream of the Lac qui Parle Dam. 3. This is a control point for the Lac qui Parle Project.	

b. Low Flow Simulation. *Computer Simulation of Low Flow Conditions, Minnesota River*, Barr Engineering for U.S. Army Corps of Engineers, St. Paul District, 1980. This report discusses an HEC-3 model (Reservoir System Analysis for Conservation) that was developed to examine the effects of low flows in the Minnesota River valley.

c. Flood Flow Simulation and Damages. An HEC-5 model (Simulation of Flood Control and Conservation Systems) was developed as part of the effort to revise the 1966 reservoir regulation manual. Over 50 different operating plans for the Lac qui Parle Project were simulated. A detailed economic analysis was also done (see **Paragraph 1-03 and 4-12**).

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organization.

a. Corps of Engineers. The Corps of Engineers is the owner, operator, and regulator of the Lac qui Parle Project (with the exception of the ecosystem features at Marsh Lake Dam). The St. Paul District Water Management Section has direct day-to-day responsibility for the regulation of flows from Lac qui Parle Dam, Chippewa Diversion Dam and the Highway 75 Dam. The Western Flood Control Project Office has responsibility for the operation and maintenance of the project (see **Chapter V**).

b. Other Federal Agencies. The National Weather Service has the responsibility for all hydrologic forecasts within the Minnesota River Basin. The U.S. Geological Survey collects data on the discharges at various stations within this basin (see **Table 5-2**). The U.S. Fish and Wildlife Service, Soil Conservation Service, U.S. Geological Survey, and the U.S. Environmental Protection Agency all have an ongoing interest in the regulation of the Lac qui Parle Project.

c. State and County Agencies. The Minnesota Department of Natural Resources (MN DNR) has the responsibility for the regulation of the Marsh Lake Dam ecosystem features with day to day instruction from Water Management. The State and county agencies that have an interest in the regulation of the Lac qui Parle Project are listed in **Table 9-1**.

9-02. Interagency Coordination.

a. Local Press and Corps Bulletins. Information concerning the regulation of the Lac qui Parle Project is provided by the St. Paul District's Public Affairs Office (PAO) to the local news media in response to their requests. Additionally, the PAO provides news releases of an advisory nature to the local media regarding important aspects of project regulation. These releases do not provide the public with forecasts of river stages or flows. River forecasting is a Congressionally-mandated responsibility of the National Weather Service.

Table 9-1
Organizations With an Interest in Water Management Activities

NATIVE AMERICAN

Upper and Lower Sioux

FEDERAL

U.S. Army Corps of Engineers

U.S. Fish and Wildlife Service

U.S. Environmental Protection Agency

Federal Emergency Management Agency

MINNESOTA

Department of Natural Resources

Pollution Control Agency

Board of Water and Soil Resources

COUNTY

Big Stone County

Lac qui Parle County

Swift County

Chippewa County

Yellow Medicine County

Watershed Districts

OTHER

Minnesota Valley Partnership

b. National Weather Service. Current readings from the reservoirs are supplied to the National Weather Service on a weekly basis or as requested. These readings include snow depth/water content, frost depths, precipitation, discharges and reservoir levels. The National Weather Service uses this information in developing its spring runoff outlook and flood forecasts.

c. U. S. Geological Survey (U.S.G.S.). This agency receives data from its own and co-operative observer gages. For those sites that have flow data, U.S.G.S. measures the flow for different stream levels and maintains the rating curve.

d. Power Marketing Agency. Hydropower is not an authorized purpose of this project.

e. Minnesota Department of Natural Resources. MN DNR will inform Water Management of their desired drawdown elevation at Marsh Lake, along with the desired rise/fall rate and maximum rise/fall rate along with dates of drawdown. Instruction on new gate settings will be given to MN DNR by Water Management (Marsh Lake is part of a system and must be regulated as a system). Upon making a gate change all new settings along with date/time of the change are relayed to Water Management the same day of the change.

f. Other Federal, State or Local Agencies. Local interests include various recreation resources. Lac qui Parle State Park is located on the right bank just upstream of Lac qui Parle Dam. The Upper Minnesota River Watershed District is the ‘sponsor’ for the Marsh Lake Ecosystem Restoration Project.

9-03. Interagency Agreements. The Project Partnership Agreement (PPA) between the Department of the Army and Upper Minnesota River Watershed District for construction of the Marsh Lake Ecosystem Restoration Project was signed on June 20th, 2016.

9-04. Commissions, River Authorities, Compacts & Committees. Organizations and governments that have an interest in water management activities in the basin are listed in **Table 9-1**.

9-05. Reports. **Table 9-2** presents a listing of reports compiled by or for the Water Management Section regarding the regulation of the Lac qui Parle Project. These reports are prepared in accordance with Engineering Manual No. 1110-2-3600. Blank copies of the necessary forms are kept in the Water Management Section.

Table 9-2 Reports, Lac qui Parle Project		
Report Name	Date Required	Form Number
Compiled by Water Management		
Gage Records	As Needed	Computer Archived
Compiled by Field Office for the Water Management Center		
Monthly Log Sheet	End of Month	NCS-64
Snow Reports and Frost Reports	December 7 to	NCS-430
	March 30	NCS-58
Emergency Reports when Required or Requested	Daily, 0800	By Phone

EXHIBIT A

SUPPLEMENTARY PERTINENT DATA

LAC QUI PARLE PROJECT EXHIBIT A

General

Drainage Area (Excluding Chippewa River)	4,105 Square Miles
Drainage Area (Including Chippewa River)	6,175 Square Miles
Elevation of Pool Gage Zero (1929 NGVD) (Lac qui Parle, Marsh Lake, and Chippewa Div.)	900.00 Feet
Year of First Operation (State of Minnesota)	1939
Operation by Corps of Engineers began	8 September 1950

Lac qui Parle Reservoir

Maximum Pool Elevation and Date (Since Construction)	943.81 Feet: April 7, 1997
Conservation Pool Elevation	933.0 Feet
Full Pool Elevation	941.1 Feet
Capacity at Conservation Pool	41,000 Acre-Feet
Capacity at Full Pool (See Paragraph 7-05.d.)	162,300 Acre-Feet

Lac qui Parle Dam

Maximum discharge of record and year	42,900 cfs, 1997
Location in Miles above Mouth of MN River	271
Type	Rolled Earth Fill
Top of Dam Elevation	946.0 Feet
Length (Includes Emergency Spillway Section)	4,100± Feet
Freeboard Above Full Pool	4.9 Feet
Upstream Slope	1 on 3
Downstream Slope	1 on 4

Lac qui Parle Dam Control Structure

Type	Concrete
Length Between Abutments	237.0 Feet
Elevation of top of Abutments	946.7 Feet

PERTINENT DATA (continued)

LAC QUI PARLE PROJECT

Elevation of top of Piers	944.28 Feet
No. of Bays	12
No. of Gates (In Bays 1-4)	9

Lac qui Parle Dam Gates

Bays Nos. 1-4 inclusive	Slide Gates
Total Number of Gates	9

Sill Elevation, Bays 1, 3, and 4	922.7 Feet
Bays 1, 3, and 4	2-6'x8' Lift gates in each bay operated with a power unit or by hand

Sill Elevation, Bay 2	915.2 Feet
Bay 2 (Low Water Control)	3-4'x4' Lift gates operated with a power unit or by hand

Lac qui Parle Dam Fixed Crest Spillway

Bays Nos. 5-12	Concrete Fixed Crest
Crest Elevation	934.2 Feet
Length of Each Bay	17 Feet

Bays 5-7 inclusive	Uncontrolled
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Bays 8-12 inclusive	3 Steel Bulkhead Sections in each Bay
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Elevation Top of Bulkhead (Closed)	940.7 Feet
Bulkhead Size	5.5 L x 6.5 H Feet

PERTINENT DATA (continued)

LAC QUI PARLE PROJECT

Lac qui Parle Dam Stilling Basin

Type	Concrete
Length (Varies)	42 to 60 Feet
Width	237 Feet
Floor Elevation:	
Bays 8-12 incl.	923.2 Feet
Bays 5-7 incl.	918.7 Feet
Bays 1-4 incl.	914.2 Feet

Lac qui Parle Dam Emergency Spillway

Type	Earth fill with concrete core wall and bituminous surfaced roadway
Length	2,500 Feet
Crest Elevation	Varies, 941.45 to 941.91 Feet
Roadway Width	23.0 Feet
Upstream Embankment Slope	1 on 3
Downstream (Grouted Riprap)	1 on 2

Bridge Over Lac qui Parle Dam

Elevation of Roadway (Crown)	946.2 Feet
Elevation of Walkway	946.7 Feet
Roadway Width	23 Feet

Marsh Lake Reservoir

Maximum Pool Elevation and Date (Since Construction)	948.54: April 7, 1997
Conservation Pool Elevation	937.6 Feet
Emergency Spillway Elevation	940.0 Feet
Capacity at Conservation Pool	12,050 Acre-Feet
Capacity at Full Pool	27,250 Acre-Feet

PERTINENT DATA (continued)

LAC QUI PARLE PROJECT

Marsh Lake Dam

Location in Miles Above Mouth of MN River	287
Drainage Area	2,890 Square Miles
Type	Rolled earth fill
	Upstream slope riprapped to Elevation 942.0 Feet
Length	12,500 Feet
Top Elevation (Varies)	948.6 to 952.6 Feet
Maximum Height	19.5 Feet
Top Width	10.0 Feet (old embankment) 26.0 Feet (new embankment)

Marsh Lake Dam Service Spillway

Type	Concrete Gravity Overflow And Rock Weir
Length	112 Feet
Crest Elevation	937.6 Feet
Notch Elevation	935.5 Feet
Notch Width	30 Feet
Slope of Rock Fill Base (starting 20 feet from concrete overflow)	3%
Number of boulder weirs	12
Spacing of weirs	20 Feet
Vertical drop of each weir	0.6 Feet
Diameter of individual weir boulders	5 Feet
Number of boulders per weir	~34
Boulder “stick-up” above rip-rap base (min-max)	1 Foot to 3.5 Feet

Marsh Lake Dam Low Flow Outlet (Will be Filled with Concrete in 2017)

Type	Concrete Conduit
Size	2'x2' Square
Length	17 Feet
Control	2'x2' Vertical Lift Gate
Sill Elevation	932.6 Feet

PERTINENT DATA (continued)

LAC QUI PARLE PROJECT

Marsh Lake Dam Auxiliary Spillway

Type	Earth Fill-grouted riprap
Length	90 Feet
Crest Elevation	940.0 Feet

Marsh Lake Dam Drawdown Control Structure

Type	Concrete
Length	98.75 Feet
Top Elevation	950.0 Feet
Upstream Sill	934.0 Feet
Number of Bays	6
Gates per Bay	2
Size of Gates	5 Feet wide by 6 Feet high
Downstream sill elevation (slopes down at 1:4)	927.0 Feet

Chippewa River Diversion Dam

Location	On the Chippewa River near Watson, Minnesota
Location in Miles Above Mouth	11.3
Drainage Area	2,070 Square Miles
Type	Rolled Earth Fill
Total Length (includes dam and all dikes)	17,975 Feet
Top Elevation	950.3 Feet
Maximum Height	23.3 Feet
Top Width	32.0 Feet

Bridge Over Chippewa River Diversion Dam

Roadway Elevation	950.55 Feet
Roadway Width	23.0 Feet
Elevation Top of Abutments	950.3 Feet
Elevation Top of Curb	950.8 Feet
Elevation Low Concrete	947.8 Feet

PERTINENT DATA (continued)

LAC QUI PARLE PROJECT

Chippewa River Diversion Dam Control Structure

Type	Concrete, Modified Ogee
Length Between Abutments	147 Feet
Number of Bays	5
Length of Each Bay	27 Feet
Fixed Crest Elevation (Bays 1, 2, 4, and 5)	942.3 Feet
Tainter Gate (Bay No. 3)	27.0 Feet Wide - Operation With a portable electric unit (electric nut runner or by hand).
Gate Sill Elevation (Bay No. 3)	932.6 Feet
Elevation Top of Gate (Closed)	942.3 Feet
Stilling Basin Elevation (Bays 1, 2, 4, and 5)	934.3 Feet
Stilling Basin Elevation (Bay 3)	932.0 Feet

Chippewa River Diversion Dam Low Water Control Structure

Type	Concrete Conduit
Size	4 x 4 Feet
Length	90.4 Feet
Entrance Invert	933.3 Feet
Exit Invert	932.8 Feet
Gate (Vertical Slide)	4 x 4 Feet

Chippewa River (Watson Sag) Diversion Channel

Length	3,500 Feet
Bottom Width	160 Feet
Bottom Elevation	934.3 Feet
Side Slopes	1 on 3

Dike, Chippewa River (Watson Sag) Diversion Channel

Location	Left or South Bank of Diversion Channel
Type	Rolled Earth Fill
Top Elevation (Varies)	946.3 - 947.8 Feet
Top Width	10.0 Feet
Side Slope (Channel Side)	1 on 3
Side Slope (Land Side)	1 on 4

PERTINENT DATA (continued)

LAC QUI PARLE PROJECT

Chippewa River Diversion (Watson Sag) Weir

Type	Concrete, Modified Ogee
Length Between Abutments	177.0 Feet
Number of Bays	6
Length of Bays	27.0 Feet
Fixed Crest Elevation	938.8 Feet
Stilling Basin Elevation	932.3 Feet
Elevation of Gage Zero (1929 NGVD)	900.00 Feet

Bridge Over Weir Diversion (Watson Sag) Weir

Roadway Elevation	950.00 Feet
Roadway Width	23.0 Feet
Elevation Top of Abutments	949.8 Feet
Elevation Top of Curb	950.25 feet
Elevation Low Concrete	947.25 Feet

**STANDING INSTRUCTIONS TO THE PROJECT MANAGER
FOR WATER CONTROL
Exhibit B1**

**LAC QUI PARLE DAM AND RESERVOIR
MINNESOTA RIVER
Type IV Project**



**U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA**

January 2017

Lac qui Parle Dam and Reservoir
U.S. Army Corps of Engineers
St. Paul District

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Pertinent Data (Also see Exhibit A)
Lac qui Parle Project
Lac qui Parle Dam/Lac qui Parle Reservoir
Type IV Project

Project Location: Lac qui Parle, Chippewa, Swift and Big Stone counties, Minnesota
7 miles northwest of Montevideo, Minnesota,
271 miles above the mouth of the Minnesota River,
Latitude 45° 01' 17", Longitude 95° 52' 05" (Lac qui Parle Dam)

Drainage Area Above Lac qui Parle Dam is **4,105** miles.
Data is in datum NGVD 29. To convert to NAVD88 add 0.49 feet to Lac qui Parle.

Lac qui Parle Dam:

Dam Type:	Rolled-Earth Filled
Dam Length:	4,100 ± Feet
Dam Height:	23-32 Feet
Dam Top Width:	23 Feet (roadway)
Dam Freeboard:	4.9 Feet (above full pool)
Control Structure Type:	Reinforced Concrete
Control Structure Length:	237 Feet

Lac qui Parle Reservoir:	Elevation (ft)	Capacity (Ac-ft)	Area (acres)
Gate Sills	922.70	---	---
Summer Conservation Pool (Mar 15-Sep 1*)	933.0	41,000	7,750
*Spring Conservation Pool (end of runoff–May 31)	933.5	44,750	8,050
Winter Conservation Pool (Oct 1-Mar 1)	934.0	48,500	8,350
Top of Flood Control Pool/Emergency Spillway	941.1	158,700	21,450
Flowage Easement Level	945.0	253,500	27,450
Top of Dam	946.0	281,500	28,850

1) Background and Responsibilities

a. General Information

i. **Authorization for Preparation of this Manual:** These “Standing Instructions to the Project Manager for Water Control” for the Lac qui Parle Dam and Reservoir were prepared in compliance with instructions contained within DIVR 1110-2-240, specifically paragraph 5 and page A-9-12. A copy of the Lac qui Parle Reservoir and Marsh Lake Reservoir Water Control Manual (of which these instructions are an exhibit) must be kept at the Lac qui Parle Corps office. Any deviation from the instructions will require the advance approval of the US Army Corps of Engineers (USACE or Corps) St. Paul District Commander. This manual was prepared in compliance with the guidelines presented in:

1. Division Regulation, DIVR 1110-2-204, *Water Control Management, Reporting Current Conditions*, 5 August 1992.
2. Engineering Regulation ER 1110-2-240, *Water Control Management*, 30 May 2016, amended 8 October 1982, 30 April 1987 and 1 March 1994.
3. Engineering Manual EM 1110-2-3600, *Management of Water Control System*, 30 November 1987.

ii. **Project Location and Description:** Lac qui Parle Project is located on the Minnesota River in western Minnesota near the South Dakota state line. The project lies along the northeasterly boundary of Lac qui Parle County and the southwesterly boundaries of Chippewa, Swift, and Big Stone Counties (**Plate 2-1**). The project is downstream of the headwaters of the Minnesota River at Big Stone Lake and Highway 75 reservoir (**Plate 2-2**). Lac qui Parle Dam is approximately 7 miles northwest of Montevideo, Minnesota, and is 271 miles above the mouth of the Minnesota River. The reservoirs extend upstream for a distance of about 27 miles. The Dam consists of an earthen embankment, a control structure and an emergency spillway (details can be found in **Chapter 2**).

iii. **Project Owner and Operating Agency:** The U.S. Army Corps of Engineers, St. Paul District is responsible for the regulation of the Lac qui Parle Project. The United States government is the owner of the project. The U.S. Army Corps of Engineers, St. Paul District, Operations Division is responsible for the operation and maintenance of the Lac qui Parle Project. Regulation instructions for the project are provided by the Water Management and Hydrology Section, Engineering and Construction Division. The project is attended continuously during normal business hours by the Supervisory Park Manager and his staff. The Operations Project Manager is in the Western Flood Control office in Fargo, North Dakota.

iv. **Project Purposes:** The project was constructed as a joint state and federal project (see **Chapter 3**). It is now a federal project. The authorized purposes assigned by Congress are flood control, recreation and surplus water, fish and wildlife, water supply and water quality.

- v. **Project Constraints:** Principal regulation problems include reservoir shoreline erosion, damage of Lac qui Parle State Park, and agricultural damages. Details are in **Paragraph 3-06**. Constraints related to the water control plan include placement of the bulkheads, gates jammed by trees, aggradation above Lac qui Parle Dam, elevation of camp ground at Lac qui Parle State Park and elevation of Lac qui Parle emergency spillway. Details are in **Paragraph 7-02**.

b. Role of Project Manager

- i. **Normal Hydrometeorological Conditions (including floods and droughts):** The Project Manager will be instructed by Water Management in the St. Paul District office on a day-to-day basis for water control actions under normal hydrometeorological conditions.
- ii. **Emergency Conditions:** Conditions become emergency if needed to protect the safety of the structure, to avoid health hazards, or to avoid any other critical situation that may arise. The Project Manager will issue adequate warning or otherwise alert all affected interests to possible hazards caused by project regulation.

2) Hydrometeorological Data Collection and Reporting

- a. **Normal Hydrometeorological Conditions (including floods and droughts):** The information needed to operate the dam and regulate the reservoir is provided to Water Management by the Project Resource Manager. Daily (8:00 a.m.) readings for the pool elevation, tailwater elevation, and outflow are given, as well as precipitation and wind readings. Once Corps Water Management System (CWMS) is fully implemented (expected in FY17) staff at the Lac qui Parle Project Office will continue to enter precipitation but instead of entering the 0800-hour pool, tailwater and outflow readings the staff will record gate changes as they occur to the nearest 15 minutes. The pool and tailwater elevations are also recorded by Data Collection Platforms (DCPs) and transmitted via satellite directly to Water Management's Local Readout Ground Station (LRGS). At each DCP gage, the correspondence between the gage and DCP readings is checked visually by project personnel at regular intervals. Daily inflow to the reservoir is calculated by Water Management from the change in reservoir elevation and the outflow. Copies of the official site log sheets are copied to Water Management's folder on the district server.

In the winter, snow depth, water content, frost depth, and lake ice thickness are reported weekly to Water Management. The snow survey is used to estimate the amount of water available for spring runoff. Frost depth readings provide information on the amount of infiltration expected. The snow and frost information are also provided to the National Weather Service and the State of Minnesota Climatology Office.

- b. **Emergency Conditions:** The Project Manager will be informed by the District Office of regional hydrometeorological conditions that may impact the structure.

3) Water Control Action and Reporting

a. Low Hydrometeorological Conditions (droughts):

When the pool is above elevation 932 ft, minimum flow is 20 cfs.

When the pool is between elevation 932 ft and 930 ft, minimum flow is 15 cfs.

When the pool is below elevation 930 ft, minimum flow is 10 cfs.

- b. Normal Hydrometeorological Conditions:** Following the spring runoff event, the Lac qui Parle pool level is held at elevation 933.5 ± 2 feet until 31 May. Starting 15 May the outflow from Lac qui Parle Dam is regulated to maintain its spring/summer conservation elevation while not exceeding a release rate of 2,500 cfs. A minimum flow of 20 cfs is maintained for downstream water supply and pollution abatement. The bulkheads in bays 8-12 are typically placed in the lowered (closed) position on 16 May. The bulkheads have only two positions: open and closed. After 31 May the summer conservation pool elevation is 933.0 ± 2 feet. During the month of September, the pool is raised gradually to an elevation of 934.0 feet to reduce stress on the fish habitat (see **Paragraph 7-07**). See **Plate 7-6** for a graphical depiction of conservation elevations. Before freeze-up starts, typically during the month of October (depending on inflow and the agricultural harvest), the spillway bulkheads (bays 8-12) are put in the raised (open) position. During years when the pool is above elevation 934.2 late in the fall, the bulkheads will be raised as soon as possible after the pool is down to the winter level, 934.0 ± 2 . The pool is then held at elevation 934.0 ± 2 until the end of February. On 01 March each year, the lowering of the Lac qui Parle pool will begin, in order to bring the pool to conservation elevation 933.0 by 15 March to provide room for flood control storage. During dry years the pool would be lowered to only 933.5 feet. From then on until 15 May, the spring regulation schedule is in effect. Additional information is available in **Chapter 7**.

c. High Hydrometeorological Conditions (Floods):

- i. Spring Floods:** As the spring runoff progresses, which typically begins in March or April and concludes by mid-May, the dam's gates will be adjusted to set discharge from the dam equal to inflow to hold pool elevation 933.0 feet in order to maintain as much flood control storage as possible. Eventually the gates will be wide open and inflow will exceed the outflow capacity of the gates and the bulkhead bays. At that point the pool will rise, as will outflow from the dam, in an unrestricted manner until the stage at Montevideo approaches the major flood stage of 17 feet (approximately 13,000 cfs). At this point, and so long as flood control storage is available below the emergency spillway crest elevation of 941.1 feet, the gates and bulkheads are closed as necessary to maintain the stage at Montevideo at 17.0 feet (to prevent damage). If the pool is expected to exceed elevation 941.1 the dam will be fully open (all gates and bulkheads open) by the time the pool reaches that point to ensure the safety of the structure. As flows recede, the gates and bulkheads are adjusted as necessary to hold the stage at Montevideo near, but not over, the 17 foot target stage to simultaneously evacuate flood control storage as

soon as possible while minimizing downstream damage. The pool is lowered to elevation 933.5 feet.

- ii. Summer/Fall Floods:** Generally, during the period from 16 May until the end of the following February, the outflow is limited to 2,500 cfs for all pool levels between conservation pool and elevation 938.0 feet. For floods which raise the pool above elevation 938.0, the regulation objective is to fully utilize the remaining flood control storage to store the flood peak, if at all possible, and if not, then to have the dam fully open (all gates and bulkheads open) by the time the pool reaches crest of the emergency spillway (i.e. the top of flood control pool at 941.1 feet) to ensure the safety of the structure.
- d. Emergency Conditions:** The Project Manager may temporarily deviate from these Standing Instructions in the event it is necessary for emergency reasons to protect the safety of the structure, to avoid health hazards, or to avoid any other critical situation that may arise. Such action will be reported immediately to Water Management.
- e. Inquiries:** All significant inquiries received by the Project Manager from citizens, constituents or interest groups regarding water control procedures or actions must be referred to Water Management.
- f. Water Control Problems:** Water Management must be contacted immediately by the most rapid means available in the event an operational malfunction, erosion, or other incident occurs that could impact project integrity in general or water control capability in particular.
- g. Communication Outage:** In the event of failure of the computer system, field staff will maintain contact with Water Management by telephone and will continue to follow the water control actions within the Standing Instructions along with **Chapter 7** of the Water Control Manual.

**STANDING INSTRUCTIONS TO THE PROJECT MANAGER
FOR WATER CONTROL
Exhibit B2**

**MARSH LAKE DAM AND RESERVOIR
MINNESOTA RIVER
Type II Project**



**U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA**

January 2017

**Marsh Lake Dam and Reservoir
U.S. Army Corps of Engineers
St. Paul District**

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PERTINENT DATA

Note: The information presented below pertains to the proposed Marsh Lake Ecosystem Restoration Project which is planned for construction in 2016 – 2018. Specific feature information on elevations and configurations are based on the latest plans and specifications.

Location: The Marsh Lake Dam is located on the Minnesota River in western Minnesota. Lac qui Parle and Marsh Lake Reservoirs form boundaries for Lac qui Parle and Swift Counties.

Datum: All elevations use the 1929 National Geodetic Vertical Datum (1929 NGVD). To convert to NAVD88 add 0.67 feet to Marsh Lake.

Drainage Area: Drainage area above Marsh Lake dam is 2,890 sq miles.

Embankment:

Type	Rolled-Earth Filled
Total Length	12,500 feet
Crest	Elevation of 952.1 feet

Control Structure:

Type	Concrete
Length	97 feet total with five piers, each pier 2 ft wide and 15 ft tall.
Bays	6 bays with 12 sluice gates (2 each); each bay is 14 feet wide by 15 feet tall; each sluice gate is 5 feet wide by 6 feet tall.
Sill	Concrete, Elevation of 934.0 feet.
Crest/Top of Structure	Elevation of 950.0 feet

Fishway:

Type	Concrete (old spillway) & Rock ramp
Length	300 feet total (3% slope) with 12 curvilinear boulder weirs spaced 20 feet apart.
Crest	Elevation of 937.6 feet, width of 112 feet.
V-notch Crest	Elevation of 935.5 feet, width of 30 feet.

1) Background and Responsibilities

a. General Information

- i. **Authorization for Preparation of this Manual:** These “Standing Instructions to the Project Manager for Water Control” for the Marsh Lake Dam and Reservoir were prepared in compliance with instructions contained within DIVR 1110-2-240, specifically paragraph 5 and page A-9-12. A copy of the Lac qui Parle Reservoir and Marsh Lake Reservoir Water Control Manual (of which these instructions are an exhibit) must be kept at the MN DNR LQP office at all times. Request for deviations from these Standing Instructions shall be submitted by the MN DNR to the St. Paul District Commander. Proposed updates to the Standing Instructions shall be submitted to the Hydraulics and Hydrology Branch, Water Management and Hydrology Section who will coordinate with District offices. This manual was prepared in compliance with the guidelines presented in:

1. Division Regulation, DIVR 1110-2-204, *Water Control Management, Reporting Current Conditions*, 5 August 1992.
2. Engineering Regulation ER 1110-2-240, *Water Control Management*, 30 May 2016, amended 8 October 1982, 30 April 1987 and 1 March 1994.
3. Engineering Manual EM 1110-2-3600, *Management of Water Control System*, 30 November 1987.

- ii. **Project Location and Description:** The Marsh Lake Dam is located on the Minnesota River at the outflow of Marsh Lake in Lac qui Parle and Swift Counties, Minnesota. Major project features consist of a drawdown control structure, auxiliary (or emergency) spillway, rock ramp fishway, and embankments. The drawdown control structure uses sluice gates to control water levels in Marsh Lake with consideration to fishway operations and pool drawdowns. The drawdown control structure includes a concrete footing/sill, concrete abutments and wing walls, 6 bays with 2 sluice gates in each bay, stop log slots for maintenance, and a full length deck to allow operation of the sluice gates. The fishway is of a rock ramp design at a 3% slope with 12 boulder curvilinear weirs spaced at 20 foot intervals. The top of the fishway attaches to the original dam, which has been notched with a bottom elevation of 935.5 ft. See **Chapter 2** for plans and spec drawings of the features.

- iii. **Project Owner and Operating Agency:** The Minnesota Department of Natural Resources (MNDNR) is the owner and operating agency of all ecosystem features at the Marsh Lake Dam and Reservoir project (this includes the fishway and the drawdown control structure). The MNDNR is responsible for project O&M in accordance with the terms of the Joint Powers Agreement between the MNDNR and the Upper Minnesota River Watershed District originally dated 23, June, 2014 and amended on 13, July, 2016. The Upper Minnesota River Watershed District has a Project Partnership Agreement with the Corps of Engineers dated 20, June, 2016. References:

1. Code of Federal Regulations (33 CFR § 208.10)
2. DIVR 1130-2-304, *Maintenance by Local Interests*

Marsh Lake Dam is owned and operated by the Corps.

- iv. Project Purpose and Rules Guiding Operation of the Control Structure:** As explained in the Final Feasibility Report and Environmental Assessment (Feasibility Report) dated November, 2011 and the Supplemental Environmental Assessment (SEA) dated May, 2016, the purpose of the Ecosystem Restoration project is to return the Marsh Lake area ecosystem to a less degraded and more natural condition by restoring ecosystem structure and functions. The intent of the Ecosystem Restoration project is to increase variability in ecosystem processes, restore a more natural water level regime, aquatic habitat connectivity, and a vegetated lake ecosystem state (Feasibility Report, Section 1.4). The Feasibility Report further indicates that the Marsh Lake Dam will be operated in a manner compatible with the Lac qui Parle project's authorized purpose and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government (Feasibility Report, Section 11 item h). This document – the Standing Instructions to the Project Manager – is the operating plan referenced in the SEA.
- Water levels will be manipulated under three scenarios:
 - (1) Growing Season Drawdowns (April to August) – water level target of 936.0 ft. This would result in exposing approximately 2,625 acres of lake bed. Water level drawdowns below 936.0 ft should be avoided during the growing season drawdown to maintain open water around pelican nesting islands.
 - (2) Winter Drawdowns (August to March) - water level target of 935.0 ft, leaving 2,425 acres of water in Marsh Lake, most of which would freeze to the bottom.
 - The year after a growing season drawdown, maintain water levels (April thru August) up to but not exceeding the normal summer pool elevation (elevation 938.0 feet is the modeled with-project average annual water surface) utilizing the sluice gates recognizing maximum daily outflow restrictions. (Vegetation benefits after a growing season drawdown should be considered tenuous. As such we should encourage habitat gains achieved by reducing rapid water level fluctuations above normal summer pool.)
 - The frequency, timing, and duration of drawdowns will be based on the response by aquatic vegetation and fish populations through the adaptive management plan. Winter drawdowns and growing season drawdowns may run into one another consecutively and thus the dates listed above are referenced as targets. See also MNDNR Marsh Lake Operation & Management Plan for additional information on when drawdowns will occur.
- b. Role of Project Manager (Minnesota Department of Natural Resources)**
- i. Normal Hydrometeorological Conditions:** “Normal Hydrometeorological Conditions” as for the purposes of these instructions are defined as when there is

no drawdown going on. All gates are normally closed and regulation is by natural flow over the rock weir fishway. During floods the drawdown structure gates may be operated to minimize impact on high pool levels during the growing season. During releases, day-to-day instruction, if necessary, will come from MVP WM to ensure no flooding of land. No gate change is allowed without direction from MVP WM (Marsh Lake is part of a system and must be regulated as a system). The Project Manager will issue adequate warning or otherwise alert all affected interests to possible hazards caused by project regulation.

- ii. **Drawdown Hydrometeorological Conditions:** During drawdown conditions (the drawdown, holding the drawn down lake and raising the lake back up to conservation), the Project Manager is responsible for ensuring that the USACE District Office Water Management (MVP WM) has the most current gate settings, the target drawdown elevation, desired rate of fall/rise and maximum rate of fall/rise along with desired drawdown dates. During releases, day-to-day instruction, if necessary, will come from MVP WM to ensure no flooding of land. No gate change is allowed without direction from MVP WM (Marsh Lake is part of a system and must be regulated as a system). The Project Manager will issue adequate warning or otherwise alert all affected interests to possible hazards caused by project regulation.
- iii. **Emergency Conditions:** Conditions become emergency when necessary to protect the safety of the structure, to avoid health hazards, or to avoid any other critical situation that may arise. During Emergency Conditions the US Army Corps of Engineers gains control of any ecosystem features that affect the emergency condition. USACE will inform the Project Manager of any gate movements.

2) Hydrometeorological Data Collection and Reporting

- a. **Normal Hydrometeorological Conditions:**
 - i. All gages for the area are the responsibility of the US Army Corps of Engineers.
 - ii. A site visit by the Project Manager of all ecosystem features (to include the sluice gates) shall be conducted at least annually. When the drawdown structure sluice gates are open, weekly sites visits shall be conducted.
 - iii. Direction of gate changes will come from MVP WM. Once a gate change is made confirmation of the change (including time) must be made to MVP WM.
- b. **Drawdown Hydrometeorological Conditions:**
 - i. All gages for the area are the responsibility of the US Army Corps of Engineers.
 - ii. A site visit by the Project Manager of all ecosystem features (to include the sluice gates) shall be conducted at least weekly.
 - iii. Direction of gate changes will come from MVP WM. Once a gate change is made confirmation of the change (including time) must be made to MVP WM.

- c. **Emergency Conditions:** During Emergency Conditions the US Army Corps of Engineers gains control of any ecosystem features that affect the emergency condition. USACE will inform the Project Manager of any gate movements.

3) Water Control Action and Reporting

- a. **Normal Hydrometeorological Conditions:** The reservoir naturally releases flow over the rock weir fishway and all sluice gates are fully closed.

If Marsh Lake pool elevation suddenly bounces by more than 6 inches in a 24-hour period during April thru August the pool elevation will be returned to the previous elevation as quickly as possible utilizing the sluice gates, understanding that there will be maximum daily outflow restrictions. MVP WM will give day-to-day instructions, if necessary, to MN DNR on gate settings. MVP WM will determine gate settings after reviewing inflows (current and forecasted) to the project and following the below guidelines:

- i. **April 01 – May 14:** Although there is no channel capacity restriction for Lac qui Parle during this time period, increased inflow to Lac qui Parle could cause higher pool elevations on Lac qui Parle and/or downstream stages. Marsh Lake Dam's drawdown structure may be used to minimize the increase to Marsh Lake's pool if there is additional gate capacity at Lac qui Parle Dam to handle the increased inflow. If Lac qui Parle can open more gates to pass the flow from Marsh Lake's drawdown structure without the Lac qui Parle pool increasing then Marsh Lake's drawdown structure may be operated.
- ii. **May 15 – August 31:** Channel capacity downstream of Lac qui Parle reservoir is 2,500 cfs during the growing season. Marsh Lake Dam's drawdown structure may be used to minimize the increase to Marsh Lake's pool if there is additional gate capacity at Lac qui Parle Dam to handle the increased inflow without exceeding an outflow of 2,500 cfs.

- b. **Drawdown Hydrometeorological Conditions:** All sluice gate movements will be relayed to the Project Manager by MVP WM.

MN DNR in coordination with partner agencies determines when a drawdown of Marsh Lake Dam is necessary. MN DNR will inform MVP WM by February 15 (for growing season drawdowns) or by August 15 (for winter drawdowns) that a drawdown will be attempted. MN DNR will submit a drawdown plan (dates, target elevation, desired rates of fall/rise and maximum rates of fall/rise) to MVP WM one month prior to the start of a drawdown. MN DNR and MVP WM will discuss one week prior to the start of the drawdown if conditions are favorable for the drawdown to occur (look at Marsh Lake Dam pool elevation, Lac qui Parle pool elevation, tributary inflows and forecasted inflows, along with calculating Marsh Lake Dam maximum outflow and fall rate during drawdown).

During the drawdown MVP WM will give day-to-day instructions, if necessary, to MN DNR on gate settings. MVP WM will determine gate settings after reviewing

inflows to the project (Pomme de Terre River flow, Lac qui Parle River flow, Watson Sag flow and desired Marsh Lake Dam flow). MVP WM will attempt to follow MN DNR's plan for drawdown, but the maximum daily outflow allowed from Marsh Lake Dam will vary depending on inflows, as LQP is limited to an outflow of 2,500 cfs during the growing season. During initial freeze-up LQP outflow is limited to 1,000 cfs.

There are three different parts of a drawdown – drawdown, steady pool and raise. Each are described in more detail below:

- i. **Drawing Down Marsh Lake.** Normal operation of gates will be to raise them above the water surface and allow the lake to drain. With a starting pool elevation of 938.3 feet (average pool prior to ecosystem restoration) this results in a maximum outflow of 1,500 cfs and a maximum fall of 0.5 feet per day. One to two weeks prior to the start of the drawdown MVP WM will use the current pool elevation and determine maximum outflow and fall rate. These will then be compared with MN DNR's plan. If either are too high, MVP WM will determine gate settings.
 1. **April – May 14 Drawdown.** LQP outflow will be increased in order to hold its conservation pool.
 2. **May 15 – October Drawdown.** Lac qui Parle pool will be lowered to the bottom of its band before the drawdown starts. Outflow from LQP will remain at or below channel capacity (2,500 cfs). If the total tributary inflow (Watson Sag flow plus Pomme de Terre River flow plus LQP River flow) is 1,500 cfs or less then LQP pool will stay in its band. If the total tributary inflow is 2,000 cfs then LQP pool will climb ~0.8 feet. If the total tributary inflow is 2,500 cfs then LQP pool will climb ~2.0 feet. Keep in mind the different starting elevations of LQP pool and coordinate with MN DNR to verify they are okay with how high LQP is predicted to climb. If they want a lower LQP pool, then MVP WM will determine gate settings to reduce Marsh Lake outflow (which will increase the length of the drawdown).

LQP's conservation band:

 - a. 933.5 +/- 0.2 feet, following spring flooding till June 1
 - b. 933.0 +/- 0.2 feet, June 1 till September 1
 - c. 934.0 +/- 0.2 feet, October 1 till March 1
 3. **Winter Drawdown (End of October – freeze up).** Drawdown the pool after growing season and before freeze up when there are no restrictions on LQP outflow. After freeze up it could cause dangerous ice conditions if there are large increases to outflow (either Marsh or LQP).
- ii. **Steady Pool.** Gates are fully open passing inflow. If a flood occurs MVP WM may require gate changes so that Marsh Lake is passing only inflow dependent on the status of LQP. During floods there may be a bounce in Marsh Lake.
- iii. **Raising Marsh Lake.** Follow the MN DNR's plan for desired rate to raise the lake. Minimum Flow Requirement: If Pomme de Terre River flow plus Watson Sag flow plus LQP River flow is less than 20 cfs then Marsh outflow will need to equal the difference up to inflow (i.e. if the pool was lowered due to a drawdown,

then the pool cannot be below the notch in the spillway and not releasing any water during droughts – a gate on the drawdown control structure would need to be opened to the desired flow).

c. **During Construction of the Ecosystem Features:** During construction of the fishway inflow to Marsh Lake will pass through the drawdown structure. MNDNR and USACE will collaborate on whether water levels will be drawn down on Marsh Lake to facilitate construction activities and if so will develop and implement a cooperative plan (USACE will make the final decision). Gate settings will be determined by MVP WM and relayed to MN DNR.

d. **Emergency Conditions:** In case of an emergency (to protect the safety of the structure, to avoid health hazards, or to avoid any other critical situation that may arise) the US Army Corps of Engineers gains control of all sluice gates and any other ecosystem features that affect the emergency condition. All sluice gate movements will continue to be relayed to the Project Manager.

If Emergency Conditions occur during Drawdown Hydrometeorological Conditions water levels will be restored to that prior drawdown elevation within reason, as quickly as possible understanding that there will be maximum daily outflow restrictions unless otherwise agreed upon to abandon the drawdown attempt.

e. **Inquiries:** All responses to substantive inquiries received by the Project Manager from citizens, constituents or interest groups regarding water control procedures or actions should be coordinated with the MVP WM.

f. **Water Control Problems:** The sill elevation of the drawdown structure is set at elevation 934.0 feet in order to achieve the maximum drawdown approaching elevation 935.0 feet. The sill will be set very near to the bottom of the lake bed, and the lake bed may limit the discharge through the structure when the sluice gates are opened. There is an expectation that the upstream sediment will erode and will not be an issue. The local sponsor of the project is aware of the potential problem and is prepared to do minor dredging after project completion if necessary.

g. **Communication Outage:**

- **Normal Hydrometeorological Conditions:**

- Coordinate with staff at Lac qui Parle Corps office if communications with the District Office are down. Follow water control plan in the standing instructions and **Chapter 7**.

- **Drawdown Hydrometeorological Conditions:**

- Coordinate with staff at Lac qui Parle Corps office if communications with the District Office are down. Follow water control plan in the standing instructions and **Chapter 7**.

- **Emergency Conditions:**

- In case of an emergency the US Army Corps of Engineers gains control of all sluice gates and any other ecosystem features that affect the emergency condition. All sluice gate movements will be relayed to the Project Manager. If communications with the District are down, check with the Lac qui Parle Corps office for any instructions.

**STANDING INSTRUCTIONS TO THE PROJECT MANAGER
FOR WATER CONTROL
Exhibit B3**

**CHIPPEWA DIVERSION DAM AND WATSON SAG WEIR
CHIPPEWA RIVER/MINNESOTA RIVER BASIN
Type III Project**



**U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA**

January 2017

Chippewa Diversion Dam and Watson Sag Weir
U.S. Army Corps of Engineers
St. Paul District

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PERTINENT DATA

Chippewa River Diversion Dam

Location	On the Chippewa River near Watson,
Minnesota	
Location in Miles Above Mouth	11.3
Drainage Area	2,070 Square Miles
Type	Rolled Earth Fill
Total Length (includes dam and all dikes)	17,975 Feet
Top Elevation	950.3 Feet

DATUM: Data is in datum NGVD 29. To convert to NAVD88 0.71 feet to Chippewa Diversion Dam.

Chippewa River Diversion Dam Control Structure

Type	Concrete, Modified Ogee
Length Between Abutments	147 Feet
Number of Bays	5
Length of Each Bay	27 Feet
Fixed Crest Elevation (Bays 1, 2, 4, and 5)	942.3 Feet
Tainter Gate (Bay No. 3)	27.0 Feet Wide - Operation With a portable electric unit (electric nut runner or by hand).
Gate Sill Elevation (Bay No. 3)	932.6 Feet
Elevation Top of Gate (Closed)	942.3 Feet
Stilling Basin Elevation (Bays 1, 2, 4, and 5)	934.3 Feet
Stilling Basin Elevation (Bay 3)	932.0 Feet

Chippewa River Diversion Dam Low Water Control Structure

Type	Concrete Conduit
Size	4 x 4 Feet
Length	90.4 Feet
Entrance Invert	933.3 Feet
Exit Invert	932.8 Feet
Gate (Vertical Slide)	4 x 4 Feet

Chippewa River Diversion (Watson Sag) Weir

Type	Concrete, Modified Ogee
Length Between Abutments	177.0 Feet
Number of Bays	6
Length of Bays	27.0 Feet
Fixed Crest Elevation	938.8 Feet
Stilling Basin Elevation	932.3 Feet
Elevation of Gage Zero (1929 NGVD)	900.00 Feet

1) Background and Responsibilities

a. General Information

- i. **Authorization for Preparation of this Manual:** These “Standing Instructions to the Project Manager for Water Control” for the Chippewa Diversion Dam and Watson Sag weir were prepared in compliance with instructions contained within DIVR 1110-2-240, specifically paragraph 5 and page A-9-12. A copy of the Lac qui Parle Reservoir and Marsh Lake Reservoir Water Control Manual (of which these instructions are an exhibit) must be kept at the Lac qui Parle Corps office. Any deviation from the instructions will require the advance approval of the US Army Corps of Engineers (USACE or Corps) St. Paul District Commander. This manual was prepared in compliance with the guidelines presented in:
 1. Division Regulation, DIVR 1110-2-204, *Water Control Management, Reporting Current Conditions*, 5 August 1992.
 2. Engineering Regulation ER 1110-2-240, *Water Control Management*, 30 May 2016, amended 8 October 1982, 30 April 1987 and 1 March 1994.
 3. Engineering Manual EM 1110-2-3600, *Management of Water Control System*, 30 November 1987.
- ii. **Project Location and Description:** Lac qui Parle Project is located on the Minnesota River in western Minnesota near the South Dakota state line. The project lies along the northeasterly boundary of Lac qui Parle County and the southwesterly boundaries of Chippewa, Swift, and Big Stone Counties (**Plate 2-1**). The project is downstream of the headwaters of the Minnesota River at Big Stone Lake and Highway 75 reservoir (**Plate 2-2**). The Chippewa Diversion Dam is 11.3 miles above the mouth of the Chippewa River (joins the Minnesota River at Montevideo, Minnesota). The project features include the Chippewa Diversion Dam, a control structure, a diversion channel, a low-flow structure and the Watson Sag weir (details can be found in **Chapter 2**).
- iii. **Project Owner and Operating Agency:** The U.S. Army Corps of Engineers, St. Paul District is responsible for the regulation of the Lac qui Parle Project (of which the Chippewa Diversion Dam is part of). The United States government is the owner of the project. The U.S. Army Corps of Engineers, St. Paul District, Operations Division is responsible for the operation and maintenance of the Lac qui Parle Project. Regulation instructions for the project are provided by the Water Management and Hydrology Section, Engineering and Construction Division. The project is attended continuously during normal business hours by the Supervisory Park Manager and his staff. The Operations Project Manager is in the Western Flood Control office in Fargo, North Dakota.
- iv. **Project Purposes:** The project was constructed as a joint state and federal project (see **Chapter 3**). It is now a federal project. The authorized purposes assigned by Congress are flood control, recreation and surplus water, fish and wildlife, water supply and water quality.

- v. **Project Constraints:** Constraints related to the water control plan include siltation at the Diversion Dam and limitations to the tainter gate (no heater and limited movement). Details are in **Paragraph 7-02**.

b. Role of Project Manager

- i. **Normal Hydrometeorological Conditions (including floods and droughts):** The Project Manager will be instructed by Water Management in the St. Paul District office on a day-to-day basis for water control actions under normal hydrometeorological conditions.
- ii. **Emergency Conditions:** Conditions become emergency if needed to protect the safety of the structure, to avoid health hazards, or to avoid any other critical situation that may arise. The Project Manager will issue adequate warning or otherwise alert all affected interests to possible hazards caused by project regulation.

2) Hydrometeorological Data Collection and Reporting

- a. **Normal Hydrometeorological Conditions (including floods and droughts):** The information needed to operate the Chippewa Diversion Dam is provided to Water Management by the Project Resource Manager. Daily (8:00 a.m.) readings for the pool & tailwater elevations at both Chippewa Diversion Dam and Watson Sag weir, and outflow are given. Once Corps Water Management System (CWMS) is fully implemented (expected in FY17) staff at the Lac qui Parle Project Office will record gate changes as they occur to the nearest 15 minutes instead of entering the 0800-hour pool, tailwater and outflow readings. The pool and tailwater elevations are also recorded by Data Collection Platforms (DCPs) and transmitted via satellite directly to Water Management's Local Readout Ground Station (LRGS). At each DCP gage, the correspondence between the gage and DCP readings is checked visually by project personnel at regular intervals. Copies of the official site log sheets (data for the Chippewa Diversion Dam are part of the Lac qui Parle log sheets) are copied to Water Management's folder on the district server.
- b. **Emergency Conditions:** The Project Manager will be informed by the District Office of regional hydrometeorological conditions that may impact the structure.

3) Water Control Action and Reporting

- a. **Normal Hydrometeorological Conditions:** Normal operation of Chippewa Diversion Dam (when inflow is 2,000 cfs or less) is to split the flow coming down the Chippewa River between the Chippewa River (50%) and the Lac qui Parle Lake (50%) via the Watson Sag weir. Additional information available in **Chapter 7**.
- b. **High Hydrometeorological Conditions (Floods):** If inflows rise above 2,000 cfs, the tainter gate is incrementally lowered to maintain the Diversion Dam discharge at 1,000 cfs as long as possible. As the gate is lowered and inflow continues to

increase, the water level behind the diversion dam, and thus the flow over the Sag Weir, also continue to increase. When the Diversion Dam pool reaches elevation 942.3 feet, flow begins to pass through the Diversion Dam spillway (bays no. 1, 2, 4 and 5) on either side of the tainter gate. This mode of regulation continues until the gate is fully closed, and all the flow through the Diversion Dam is then passing through the spillway sections and over the tainter gate. The remainder of the inflow is diverted down the Watson Sag diversion channel. On the recession, when inflow is above 2,000 cfs, the tainter gate is opened as necessary to maintain a discharge of 1,000 cfs from the Chippewa Diversion Dam. Once inflow falls below 2,000 cfs operations are returned to normal, and the flow is evenly split again between Chippewa River Dam and Watson Sag.

- c. **Emergency Conditions:** The Project Manager may temporarily deviate from these Standing Instructions in the event it is necessary for emergency reasons to protect the safety of the structure, to avoid health hazards, or to avoid any other critical situation that may arise. Such action will be reported immediately to Water Management.
- d. **Inquiries:** All significant inquiries received by the Project Manager from citizens, constituents or interest groups regarding water control procedures or actions must be referred to Water Management.
- e. **Water Control Problems:** Water Management must be contacted immediately by the most rapid means available in the event an operational malfunction, erosion, or other incident occurs that could impact project integrity in general or water control capability in particular.
- f. **Communication Outage:** In the event of failure of the computer system, field staff will maintain contact with Water Management by telephone and will continue to follow the water control actions within the Standing Instructions along with **Chapter 7** of the Water Control Manual.

EXHIBIT C

WEEKLY LOG SHEET

MINNESOTA RIVER HEADWATERS

WEEKLY LOG SHEET

CORPS OF ENGINEERS

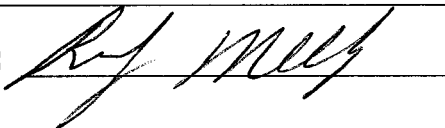
(PAGE 1 OF 2)

ST. PAUL DISTRICT

DATE: MAY 25, 2012

LOCATION	SAT. 19	SUN. 20	MON. 21	TUES. 22	WED. 23	THUR. 24	FRI. 25																																												
MN RIVER @ ORTONVILLE (FT)	1.91 "	1.92 "	1.90 "	1.88 "	1.87 "	1.89 "	1.89 "																																												
YELLOW BANK RIVER @ ODESSA (FT)	1.92 "	1.93 "	1.91 "	1.89 "	1.91 "	2.08 "	2.05 "																																												
HWY. 75 LOW FLOW GATE OPENING (FT)	3.5						3.5																																												
SERVICE SPILLWAY LEAF GATE ELEVATION	949.9						949.9																																												
LOW FLOW - POOL HWY. 75 (900.00)	950.02	950.03	950.05	950.04	950.03	950.13	950.15																																												
LOW FLOW - T.W. HWY. 75 (900.00)	942.46	942.48	942.53	942.54	942.55	942.58	942.59																																												
LOW FLOW - HEAD HWY 75 (FT)	7.56	7.55	7.52	7.50	7.48	7.55	7.56																																												
DISCHARGE (CFS) LOW FLOW - HWY 75	102	102	101	101	101	102	102																																												
SERVICE SPILLWAY HEAD - HWY 75 (FT)	.12	.13	.15	.14	.14	.23	.25																																												
DISCHARGE (CFS) SERVICE SPILLWAY	11	12	15	14	14	27	31																																												
TOTAL DISCHARGE (CFS) LEAF GATE/LOW FLOW	113	114	116	115	115	129	133																																												
PRECIPITATION HWY. 75 LAST 24 HRS. (INCHES)	.43	.06			.18	.80	.04																																												
PRECIPITATION LQP-P LAST 24 HRS. (INCHES)			1.00		.10	.09	.44																																												
WIND SPEED/DIRECTION	16 190°	15 355°	CALM	12 190°	12 1100°	6 40°	CALM																																												
TEMPERATURES (MIN/MAX/0800)	53 80 73	50 66 50	46 73 52	51 81 57	61 75 63	54 63 57	48 62 54																																												
WINTER WEATHER REPORT	FROST TUBE: _____ SNOW ON GROUND: _____ WATER CONTENT: _____ ICE ON LQP LAKE: _____																																																		
NOTES:	COMMENTS: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">DATE</th> <th style="width: 15%;">TIME</th> <th style="width: 15%;">SITE</th> <th style="width: 55%;">ACTION TAKEN</th> </tr> </thead> <tbody> <tr> <td>5-24</td> <td>1000</td> <td>LQP DAM</td> <td>OPENED GATE # 8 1ST.</td> </tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>							DATE	TIME	SITE	ACTION TAKEN	5-24	1000	LQP DAM	OPENED GATE # 8 1ST.																																				
DATE	TIME	SITE	ACTION TAKEN																																																
5-24	1000	LQP DAM	OPENED GATE # 8 1ST.																																																
METHOD USED: W = WIRE WEIGHT M = VOICE MODEM D = DCP (DATA COLLECTION PLATFORM) V = TAPE/STAFF VISUAL U = USGS WEB MEASUREMENTS USED: FT = FOOT CFS = CUBIC FEET PER SECOND Pool and tailwater readings begin at 900.00 elevation as noted in (), 1929 NGVD. LQP DAM BULKHEADS IN BAYS 8, 9, 10, 11, 12 READINGS TAKEN AT 8AM UNLESS NOTED.	LQP Dam pool and TW readings are verified with instrumentation weekly. All measurements are from DCP records unless otherwise noted.																																																		

SIGNATURE



MINNESOTA RIVER HEADWATERS

WEEKLY LOG SHEET

CORPS OF ENGINEERS

(PAGE 2 OF 2)

ST. PAUL DISTRICT

DATE: MAY 25, 2012

LOCATION	SAT. 19	SUN. 20	MON. 21	TUES. 22	WED. 23	THUR. 24	FRI. 25
MN RIVER @ MONTEVIDEO (FT)	5.98 "	6.19 "	6.19 "	6.34 "	6.34 "	6.42 "	6.43 "
MN RIVER FLOW (CFS)	1,170 "	1,270 "	1,270 "	1,330 "	1,330 "	1,360 "	1,360 "
POMME DE TERRE RIVER @ APPLETON (FT)	5.23 "	5.33 "	5.39 "	5.36 "	5.27 "	5.40 "	5.95 "
PDT RIVER FLOW (CFS)	230 "	250 "	263 "	257 "	238 "	265 "	401 "
LAC QUI PARLE RIVER @ LAC QUI PARLE (FT)	5.73 "	5.77 "	5.85 "	5.93 "	6.18 "	6.08 "	6.03 "
LQP RIVER FLOW (CFS)	120 "	127 "	141 "	156 "	206 "	185 "	175 "
MARSH LAKE DAM (900.00) -POOL		938.95	938.77	938.64	938.62	938.77	938.82
MARSH LAKE DAM (900.00) -T.W.		934.14	934.11	934.13	934.00	934.05	934.09
MARSH LAKE DAM TOTAL DISCHARGE							
MARSH LAKE CONDUIT OPENING (FT)	1.0						1.0
HWY. 40 BRIDGE @ MILAN (900.00)	933.53	933.52	933.61	933.51	933.51	933.51	933.56
LAC QUI PARLE DAM (900.00) -POOL			933.70	933.56	933.62	933.61	933.64
LAC QUI PARLE DAM (900.00) -T.W.	923.83 "	923.92 "	923.91 "	924.21 "	924.17 "	924.18 "	924.20 "
LQP DAM TW (CFS)	975 "	1000 "	997 "	1,080 "	1,070 "	1,070 "	1,080 "
TOTAL DISCHARGE							
LQP GATE SETTINGS GATE (FT) BAY							
1 1	0.0						0.0
2 1	0.0						0.0
3, 4, 5 2	0.0						0.6
6 3	0.0						0.0
7 3	0.0						0.0
8 4	4.0			5.0			5.0
9 4	7.0						7.0
15 BULKHEADS	DOWN						DOWN
CHIPPEWA RIVER @ MILAN (FT)	2.36 "	2.34 "	2.36 "	2.43 "	2.40 "	2.39 "	2.54 "
CHIPP. R. FLOW (CFS)	573 "	563 "	573 "	606 "	591 "	587 "	658 "
SAG WEIR -POOL(900.00)	939.22	939.33	939.33	939.38	939.37	939.36	939.44
CHIPPEWA RIVER DAMS							
SAG WEIR - T.W. (900.00)	936.63	936.89	936.88	937.00	936.98	936.95	937.15
CHIPPEWA RIVER DAMS							
TOTAL FLOW POOL READING (CFS)	294	284	296	326	293	290	357
CHIPP. TAINTER GATE -POOL (900.00)	939.42 "	939.40 "	939.38 "	939.46 "	939.46 "	939.43 "	939.64 "
CHIPP. TAINTER GATE -T.W. (900.00)	936.91 "	936.91 "	936.90 "	936.92 "	936.91 "	936.90 "	936.93 "
TOTAL DISCHARGE T.W. READING (CFS)	279 "	279 "	277 "	280 "	298 "	297 "	301 "
TAINTER GATE OPENING (FT)	2.5						2.5
LOW FLOW GATE OPENING (FT)	.5						0.5

CEMVP FORM 405B REVISED 10-01-99

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Ry Mely

EXHIBIT D

ELEVATION – STORAGE CURVE/TABLE

MARSH LAKE RESERVOIR And LAC QUI PARLE RESERVOIR

Introduction: CAUTION, There are two sets of tables in this Exhibit. One is for Marsh Lake Reservoir only and one is for Lac qui Parle Reservoir only.

Also see:

Plate 7-9: Elevation-Area-Storage Curves, Lac Qui Parle Reservoir

Plate 7-10: Elevation-Area-Storage Curves, Marsh Lake Reservoir

EXHIBIT D
MARSH LAKE RESERVOIR
ELEVATION – STORAGE CURVE/TABLE

THIS DATA DOES NOT INCLUDE LAC QUI PARLE RESERVOIR

Introduction

This section for Marsh Lake Reservoir contains a table that has been modified from the original data. The original table and graph can be found in the master Storage Tables for Reservoirs book. Two adjustments were made to the data.

The data as it was found originally on the computer-generated sheets did not have a smooth curve. The data was modified to create a smooth curve. Also the data as it was found originally was tabulated to the hundredth decimal place. A new table, as it appears here, was created which dropped the two decimal places. The table that follows contains data reflecting the changes in bold.

Marsh Lake Reservoir Only (smoothed)

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
932.0	0	3	5	8	10	13	15	18	20	23
932.1	25	28	30	33	35	38	40	43	45	48
932.2	50	53	55	58	60	63	65	68	70	73
932.3	75	78	80	83	85	88	90	93	95	98
932.4	100	103	105	108	110	113	115	118	120	123
932.5	125	128	130	133	135	138	140	143	145	148
932.6	150	153	155	158	160	163	165	168	170	173
932.7	175	178	180	183	185	188	190	193	195	198
932.8	200	203	205	208	210	213	215	218	220	223
932.9	225	228	230	233	235	238	240	243	245	248
933.0	250	261	271	282	292	303	313	324	334	345
933.1	355	366	376	387	397	408	418	429	439	450
933.2	460	471	481	492	502	513	523	534	544	555
933.3	565	576	586	597	607	618	628	639	649	660
933.4	670	681	691	702	712	723	733	744	754	765
933.5	775	786	796	807	817	828	838	849	859	870
933.6	880	891	901	912	922	933	943	954	964	975
933.7	985	996	1006	1017	1027	1038	1048	1059	1069	1080
933.8	1090	1101	1111	1122	1132	1143	1153	1164	1174	1185
933.9	1195	1206	1216	1227	1237	1248	1258	1269	1279	1290
934.0	1300	1319	1338	1357	1376	1395	1414	1433	1452	1471
934.1	1490	1509	1528	1547	1566	1585	1604	1623	1642	1661
934.2	1680	1699	1718	1737	1756	1775	1794	1813	1832	1851
934.3	1870	1889	1908	1927	1946	1965	1984	2003	2022	2041
934.4	2060	2079	2098	2117	2136	2155	2174	2193	2212	2231
934.5	2250	2269	2288	2307	2326	2345	2364	2383	2402	2421
934.6	2440	2459	2478	2497	2516	2535	2554	2573	2592	2611
934.7	2630	2649	2668	2687	2706	2725	2744	2763	2782	2801
934.8	2820	2839	2858	2877	2896	2915	2934	2953	2972	2991
934.9	3010	3029	3048	3067	3086	3105	3124	3143	3162	3181
935.0	3200	3228	3256	3284	3312	3340	3368	3396	3424	3452
935.1	3480	3508	3536	3564	3592	3620	3648	3676	3704	3732
935.2	3760	3788	3816	3844	3872	3900	3928	3956	3984	4012
935.3	4040	4068	4096	4124	4152	4180	4208	4236	4264	4292
935.4	4320	4348	4376	4404	4432	4460	4488	4516	4544	4572

Marsh Lake Reservoir Only (smoothed)

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
934.5	2250	2269	2288	2307	2326	2345	2364	2383	2402	2421
934.6	2440	2459	2478	2497	2516	2535	2554	2573	2592	2611
934.7	2630	2649	2668	2687	2706	2725	2744	2763	2782	2801
934.8	2820	2839	2858	2877	2896	2915	2934	2953	2972	2991
934.9	3010	3029	3048	3067	3086	3105	3124	3143	3162	3181
935.0	3200	3228	3256	3284	3312	3340	3368	3396	3424	3452
935.1	3480	3508	3536	3564	3592	3620	3648	3676	3704	3732
935.2	3760	3788	3816	3844	3872	3900	3928	3956	3984	4012
935.3	4040	4068	4096	4124	4152	4180	4208	4236	4264	4292
935.4	4320	4348	4376	4404	4432	4460	4488	4516	4544	4572
935.5	4600	4628	4656	4684	4712	4740	4768	4796	4824	4852
935.6	4880	4908	4936	4964	4992	5020	5048	5076	5104	5132
935.7	5160	5188	5216	5244	5272	5300	5328	5356	5384	5412
935.8	5440	5468	5496	5524	5552	5580	5608	5636	5664	5692
935.9	5720	5748	5776	5804	5832	5860	5888	5916	5944	5972
936.0	6000	6035	6070	6105	6140	6175	6210	6245	6280	6315
936.1	6350	6385	6420	6455	6490	6525	6560	6595	6630	6665
936.2	6700	6735	6770	6805	6840	6875	6910	6945	6980	7015
936.3	7050	7085	7120	7155	7190	7225	7260	7295	7330	7365
936.4	7400	7435	7470	7505	7540	7575	7610	7645	7680	7715
936.5	7750	7785	7820	7855	7890	7925	7960	7995	8030	8065
936.6	8100	8135	8170	8205	8240	8275	8310	8345	8380	8415
936.7	8450	8485	8520	8555	8590	8625	8660	8695	8730	8765
936.8	8800	8835	8870	8905	8940	8975	9010	9045	9080	9115
936.9	9150	9185	9220	9255	9290	9325	9360	9395	9430	9465
937.0	9500	9543	9585	9628	9670	9713	9755	9798	9840	9883
937.1	9925	9968	10010	10053	10095	10138	10180	10223	10265	10308
937.2	10350	10393	10435	10478	10520	10563	10605	10648	10690	10733
937.3	10775	10818	10860	10903	10945	10988	11030	11073	11115	11158
937.4	11200	11243	11285	11328	11370	11413	11455	11498	11540	11583
937.5	11625	11668	11710	11753	11795	11838	11880	11923	11965	12008
937.6	12050	12093	12135	12178	12220	12263	12305	12348	12390	12433
937.7	12475	12518	12560	12603	12645	12688	12730	12773	12815	12858
937.8	12900	12943	12985	13028	13070	13113	13155	13198	13240	13283
937.9	13325	13368	13410	13453	13495	13538	13580	13623	13665	13708

Marsh Lake Reservoir Only (smoothed)

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
938.0	13750	13813	13875	13938	14000	14063	14125	14188	14250	14313
938.1	14375	14438	14500	14563	14625	14688	14750	14813	14875	14938
938.2	15000	15063	15125	15188	15250	15313	15375	15438	15500	15563
938.3	15625	15688	15750	15813	15875	15938	16000	16063	16125	16188
938.4	16250	16313	16375	16438	16500	16563	16625	16688	16750	16813
938.5	16875	16938	17000	17063	17125	17188	17250	17313	17375	17438
938.6	17500	17563	17625	17688	17750	17813	17875	17938	18000	18063
938.7	18125	18188	18250	18313	18375	18438	18500	18563	18625	18688
938.8	18750	18813	18875	18938	19000	19063	19125	19188	19250	19313
938.9	19375	19438	19500	19563	19625	19688	19750	19813	19875	19938
939.0	20000	20073	20145	20218	20290	20363	20435	20508	20580	20653
939.1	20725	20798	20870	20943	21015	21088	21160	21233	21305	21378
939.2	21450	21523	21595	21668	21740	21813	21885	21958	22030	22103
939.3	22175	22248	22320	22393	22465	22538	22610	22683	22755	22828
939.4	22900	22973	23045	23118	23190	23263	23335	23408	23480	23553
939.5	23625	23698	23770	23843	23915	23988	24060	24133	24205	24278
939.6	24350	24423	24495	24568	24640	24713	24785	24858	24930	25003
939.7	25075	25148	25220	25293	25365	25438	25510	25583	25655	25728
939.8	25800	25873	25945	26018	26090	26163	26235	26308	26380	26453
939.9	26525	26598	26670	26743	26815	26888	26960	27033	27105	27178
940.0	27250	27328	27405	27483	27560	27638	27715	27793	27870	27948
940.1	28025	28103	28180	28258	28335	28413	28490	28568	28645	28723
940.2	28800	28878	28955	29033	29110	29188	29265	29343	29420	29498
940.3	29575	29653	29730	29808	29885	29963	30040	30118	30195	30273
940.4	30350	30428	30505	30583	30660	30738	30815	30893	30970	31048
940.5	31125	31203	31280	31358	31435	31513	31590	31668	31745	31823
940.6	31900	31978	32055	32133	32210	32288	32365	32443	32520	32598
940.7	32675	32753	32830	32908	32985	33063	33140	33218	33295	33373
940.8	33450	33528	33605	33683	33760	33838	33915	33993	34070	34148
940.9	34225	34303	34380	34458	34535	34613	34690	34768	34845	34923
941.0	35000	35090	35180	35270	35360	35450	35540	35630	35720	35810
941.1	35900	35990	36080	36170	36260	36350	36440	36530	36620	36710
941.2	36800	36890	36980	37070	37160	37250	37340	37430	37520	37610
941.3	37700	37790	37880	37970	38060	38150	38240	38330	38420	38510
941.4	38600	38690	38780	38870	38960	39050	39140	39230	39320	39410

Marsh Lake Reservoir Only (smoothed)

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
941.5	39500	39590	39680	39770	39860	39950	40040	40130	40220	40310
941.6	40400	40490	40580	40670	40760	40850	40940	41030	41120	41210
941.7	41300	41390	41480	41570	41660	41750	41840	41930	42020	42110
941.8	42200	42290	42380	42470	42560	42650	42740	42830	42920	43010
941.9	43100	43190	43280	43370	43460	43550	43640	43730	43820	43910
942.0	44000	44095	44190	44285	44380	44475	44570	44665	44760	44855
942.1	44950	45045	45140	45235	45330	45425	45520	45615	45710	45805
942.2	45900	45995	46090	46185	46280	46375	46470	46565	46660	46755
942.3	46850	46945	47040	47135	47230	47325	47420	47515	47610	47705
942.4	47800	47895	47990	48085	48180	48275	48370	48465	48560	48655
942.5	48750	48845	48940	49035	49130	49225	49320	49415	49510	49605
942.6	49700	49795	49890	49985	50080	50175	50270	50365	50460	50555
942.7	50650	50745	50840	50935	51030	51125	51220	51315	51410	51505
942.8	51600	51695	51790	51885	51980	52075	52170	52265	52360	52455
942.9	52550	52645	52740	52835	52930	53025	53120	53215	53310	53405
943.0	53500	53610	53720	53830	53940	54050	54160	54270	54380	54490
943.1	54600	54710	54820	54930	55040	55150	55260	55370	55480	55590
943.2	55700	55810	55920	56030	56140	56250	56360	56470	56580	56690
943.3	56800	56910	57020	57130	57240	57350	57460	57570	57680	57790
943.4	57900	58010	58120	58230	58340	58450	58560	58670	58780	58890
943.5	59000	59110	59220	59330	59440	59550	59660	59770	59880	59990
943.6	60100	60210	60320	60430	60540	60650	60760	60870	60980	61090
943.7	61200	61310	61420	61530	61640	61750	61860	61970	62080	62190
943.8	62300	62410	62520	62630	62740	62850	62960	63070	63180	63290
943.9	63400	63510	63620	63730	63840	63950	64060	64170	64280	64390
944.0	64500	64615	64730	64845	64960	65075	65190	65305	65420	65535
944.1	65650	65765	65880	65995	66110	66225	66340	66455	66570	66685
944.2	66800	66915	67030	67145	67260	67375	67490	67605	67720	67835
944.3	67950	68065	68180	68295	68410	68525	68640	68755	68870	68985
944.4	69100	69215	69330	69445	69560	69675	69790	69905	70020	70135
944.5	70250	70365	70480	70595	70710	70825	70940	71055	71170	71285
944.6	71400	71515	71630	71745	71860	71975	72090	72205	72320	72435
944.7	72550	72665	72780	72895	73010	73125	73240	73355	73470	73585
944.8	73700	73815	73930	74045	74160	74275	74390	74505	74620	74735
944.9	74850	74965	75080	75195	75310	75425	75540	75655	75770	75885

Marsh Lake Reservoir Only (smoothed)

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
945.0	76000	76125	76250	76375	76500	76625	76750	76875	77000	77125
945.1	77250	77375	77500	77625	77750	77875	78000	78125	78250	78375
945.2	78500	78625	78750	78875	79000	79125	79250	79375	79500	79625
945.3	79750	79875	80000	80125	80250	80375	80500	80625	80750	80875
945.4	81000	81125	81250	81375	81500	81625	81750	81875	82000	82125
945.5	82250	82375	82500	82625	82750	82875	83000	83125	83250	83375
945.6	83500	83625	83750	83875	84000	84125	84250	84375	84500	84625
945.7	84750	84875	85000	85125	85250	85375	85500	85625	85750	85875
945.8	86000	86125	86250	86375	86500	86625	86750	86875	87000	87125
945.9	87250	87375	87500	87625	87750	87875	88000	88125	88250	88375
946.0	88500	88635	88770	88905	89040	89175	89310	89445	89580	89715
946.1	89850	89985	90120	90255	90390	90525	90660	90795	90930	91065
946.2	91200	91335	91470	91605	91740	91875	92010	92145	92280	92415
946.3	92550	92685	92820	92955	93090	93225	93360	93495	93630	93765
946.4	93900	94035	94170	94305	94440	94575	94710	94845	94980	95115
946.5	95250	95385	95520	95655	95790	95925	96060	96195	96330	96465
946.6	96600	96735	96870	97005	97140	97275	97410	97545	97680	97815
946.7	97950	98085	98220	98355	98490	98625	98760	98895	99030	99165
946.8	99300	99435	99570	99705	99840	99975	100110	100245	100380	100515
946.9	100650	100785	100920	101055	101190	101325	101460	101595	101730	101865
947.0	102000	102130	102260	102390	102520	102650	102780	102910	103040	103170
947.1	103300	103430	103560	103690	103820	103950	104080	104210	104340	104470
947.2	104600	104730	104860	104990	105120	105250	105380	105510	105640	105770
947.3	105900	106030	106160	106290	106420	106550	106680	106810	106940	107070
947.4	107200	107330	107460	107590	107720	107850	107980	108110	108240	108370
947.5	108500	108630	108760	108890	109020	109150	109280	109410	109540	109670
947.6	109800	109930	110060	110190	110320	110450	110580	110710	110840	110970
947.7	111100	111230	111360	111490	111620	111750	111880	112010	112140	112270
947.8	112400	112530	112660	112790	112920	113050	113180	113310	113440	113570
947.9	113700	113830	113960	114090	114220	114350	114480	114610	114740	114870
948.0	115000	115150	115300	115450	115600	115750	115900	116050	116200	116350
948.1	116500	116650	116800	116950	117100	117250	117400	117550	117700	117850
948.2	118000	118150	118300	118450	118600	118750	118900	119050	119200	119350
948.3	119500	119650	119800	119950	120100	120250	120400	120550	120700	120850
948.4	121000	121150	121300	121450	121600	121750	121900	122050	122200	122350

Marsh Lake Reservoir Only (smoothed)

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
948.5	122500	122650	122800	122950	123100	123250	123400	123550	123700	123850
948.6	124000	124150	124300	124450	124600	124750	124900	125050	125200	125350
948.7	125500	125650	125800	125950	126100	126250	126400	126550	126700	126850
948.8	127000	127150	127300	127450	127600	127750	127900	128050	128200	128350
948.9	128500	128650	128800	128950	129100	129250	129400	129550	129700	129850
949.0	130000	130165	130330	130495	130660	130825	130990	131155	131320	131485
949.1	131650	131815	131980	132145	132310	132475	132640	132805	132970	133135
949.2	133300	133465	133630	133795	133960	134125	134290	134455	134620	134785
949.3	134950	135115	135280	135445	135610	135775	135940	136105	136270	136435
949.4	136600	136765	136930	137095	137260	137425	137590	137755	137920	138085
949.5	138250	138415	138580	138745	138910	139075	139240	139405	139570	139735
949.6	139900	140065	140230	140395	140560	140725	140890	141055	141220	141385
949.7	141550	141715	141880	142045	142210	142375	142540	142705	142870	143035
949.8	143200	143365	143530	143695	143860	144025	144190	144355	144520	144685
949.9	144850	145015	145180	145345	145510	145675	145840	146005	146170	146335
950.0	146500	146670	146671	146672	146673	146674	146675	146676	146677	146678
950.1	148200	148370	148540	148710	148880	149050	149220	149390	149560	149730
950.2	149900	150070	150240	150410	150580	150750	150920	151090	151260	151430
950.3	151600	151770	151940	152110	152280	152450	152620	152790	152960	153130
950.4	153300	153470	153640	153810	153980	154150	154320	154490	154660	154830
950.5	155000	155170	155340	155510	155680	155850	156020	156190	156360	156530
950.6	156700	156870	157040	157210	157380	157550	157720	157890	158060	158230
950.7	158400	158570	158740	158910	159080	159250	159420	159590	159760	159930
950.8	160100	160270	160440	160610	160780	160950	161120	161290	161460	161630
950.9	161800	161970	162140	162310	162480	162650	162820	162990	163160	163330
951.0	163500	163680	163860	164040	164220	164400	164580	164760	164940	165120
951.1	165300	165480	165660	165840	166020	166200	166380	166560	166740	166920
951.2	167100	167280	167460	167640	167820	168000	168180	168360	168540	168720
951.3	168900	169080	169260	169440	169620	169800	169980	170160	170340	170520
951.4	170700	170880	171060	171240	171420	171600	171780	171960	172140	172320
951.5	172500	172680	172860	173040	173220	173400	173580	173760	173940	174120
951.6	174300	174480	174660	174840	175020	175200	175380	175560	175740	175920
951.7	176100	176280	176460	176640	176820	177000	177180	177360	177540	177720
951.8	177900	178080	178260	178440	178620	178800	178980	179160	179340	179520
951.9	179700	179880	180060	180240	180420	180600	180780	180960	181140	181320

Marsh Lake Reservoir Only (smoothed)

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
952.0	181500	181675	181850	182025	182200	182375	182550	182725	182900	183075
952.1	183250	183425	183600	183775	183950	184125	184300	184475	184650	184825
952.2	185000	185175	185350	185525	185700	185875	186050	186225	186400	186575
952.3	186750	186925	187100	187275	187450	187625	187800	187975	188150	188325
952.4	188500	188675	188850	189025	189200	189375	189550	189725	189900	190075
952.5	190250	190425	190600	190775	190950	191125	191300	191475	191650	191825
952.6	192000	192175	192350	192525	192700	192875	193050	193225	193400	193575
952.7	193750	193925	194100	194275	194450	194625	194800	194975	195150	195325
952.8	195500	195675	195850	196025	196200	196375	196550	196725	196900	197075
952.9	197250	197425	197600	197775	197950	198125	198300	198475	198650	198825
953.0	199000	199195	199390	199585	199780	199975	200170	200365	200560	200755
953.1	200950	201145	201340	201535	201730	201925	202120	202315	202510	202705
953.2	202900	203095	203290	203485	203680	203875	204070	204265	204460	204655
953.3	204850	205045	205240	205435	205630	205825	206020	206215	206410	206605
953.4	206800	206995	207190	207385	207580	207775	207970	208165	208360	208555
953.5	208750	208945	209140	209335	209530	209725	209920	210115	210310	210505
953.6	210700	210895	211090	211285	211480	211675	211870	212065	212260	212455
953.7	212650	212845	213040	213235	213430	213625	213820	214015	214210	214405
953.8	214600	214795	214990	215185	215380	215575	215770	215965	216160	216355
953.9	216550	216745	216940	217135	217330	217525	217720	217915	218110	218305
954.0	218500	218705	218910	219115	219320	219525	219730	219935	220140	220345
954.1	220550	220755	220960	221165	221370	221575	221780	221985	222190	222395
954.2	222600	222805	223010	223215	223420	223625	223830	224035	224240	224445
954.3	224650	224855	225060	225265	225470	225675	225880	226085	226290	226495
954.4	226700	226905	227110	227315	227520	227725	227930	228135	228340	228545
954.5	228750	228955	229160	229365	229570	229775	229980	230185	230390	230595
954.6	230800	231005	231210	231415	231620	231825	232030	232235	232440	232645
954.7	232850	233055	233260	233465	233670	233875	234080	234285	234490	234695
954.8	234900	235105	235310	235515	235720	235925	236130	236335	236540	236745
954.9	236950	237155	237360	237565	237770	237975	238180	238385	238590	238795
955.0	239000	239210	239420	239630	239840	240050	240260	240470	240680	240890
955.1	241100	241310	241520	241730	241940	242150	242360	242570	242780	242990
955.2	243200	243410	243620	243830	244040	244250	244460	244670	244880	245090
955.3	245300	245510	245720	245930	246140	246350	246560	246770	246980	247190
955.4	247400	247610	247820	248030	248240	248450	248660	248870	249080	249290

Marsh Lake Reservoir Only (smoothed)

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
955.5	249500	249710	249920	250130	250340	250550	250760	250970	251180	251390
955.6	251600	251810	252020	252230	252440	252650	252860	253070	253280	253490
955.7	253700	253910	254120	254330	254540	254750	254960	255170	255380	255590
955.8	255800	256010	256220	256430	256640	256850	257060	257270	257480	257690
955.9	257900	258110	258320	258530	258740	258950	259160	259370	259580	259790
956.0	260000	260225	260450	260675	260900	261125	261350	261575	261800	262025
956.1	262250	262475	262700	262925	263150	263375	263600	263825	264050	264275
956.2	264500	264725	264950	265175	265400	265625	265850	266075	266300	266525
956.3	266750	266975	267200	267425	267650	267875	268100	268325	268550	268775
956.4	269000	269225	269450	269675	269900	270125	270350	270575	270800	271025
956.5	271250	271475	271700	271925	272150	272375	272600	272825	273050	273275
956.6	273500	273725	273950	274175	274400	274625	274850	275075	275300	275525
956.7	275750	275975	276200	276425	276650	276875	277100	277325	277550	277775
956.8	278000	278225	278450	278675	278900	279125	279350	279575	279800	280025
956.9	280250	280475	280700	280925	281150	281375	281600	281826	282051	282276
957.0	282500	282725	282950	283175	283400	283625	283850	284075	284300	284525
957.1	284750	284975	285200	285425	285650	285875	286100	286325	286550	286775
957.2	287000	287225	287450	287675	287900	288125	288350	288575	288800	289025
957.3	289250	289475	289700	289925	290150	290375	290600	290825	291050	291275
957.4	291500	291725	291950	292175	292400	292625	292850	293075	293300	293525
957.5	293750	293975	294200	294425	294650	294875	295100	295325	295550	295775
957.6	296000	296225	296450	296675	296900	297125	297350	297575	297800	298025
957.7	298250	298475	298700	298925	299150	299375	299600	299825	300050	300275
957.8	300500	300725	300950	301175	301400	301625	301850	302075	302300	302525
957.9	302750	302975	303200	303425	303650	303875	304100	304326	304551	304776
958.0	305000									

EXHIBIT D

LAC QUI PARLE RESERVOIR

ELEVATION – STORAGE CURVE/TABLE

THIS DATA DOES NOT INCLUDE MARSH LAKE RESERVOIR

This section for Lac qui Parle Reservoir contains a table that has been modified from the original data. The original table and graph can be found in the master Storage Tables for Reservoirs book. The data as it was found originally on the computer-generated sheets was tabulated to the hundredth decimal place. A new table, as it appears here, was created which dropped the two decimal places.

Lac qui Parle Reservoir Only
Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
923.4	0	21	42	63	83	104	125	146	167	188
923.5	208	229	250	271	292	313	333	354	375	396
923.6	417	438	458	479	500	521	542	563	583	604
923.7	625	646	667	688	708	729	750	771	792	813
923.8	833	854	875	896	917	938	958	979	1000	1021
923.9	1042	1063	1083	1104	1125	1146	1167	1188	1208	1229
924.0	1250	1275	1300	1325	1350	1375	1400	1425	1450	1475
924.1	1500	1525	1550	1575	1600	1625	1650	1675	1700	1725
924.2	1750	1775	1800	1825	1850	1875	1900	1925	1950	1975
924.3	2000	2025	2050	2075	2100	2125	2150	2175	2200	2225
924.4	2250	2275	2300	2325	2350	2375	2400	2425	2450	2475
924.5	2500	2525	2550	2575	2600	2625	2650	2675	2700	2725
924.6	2750	2775	2800	2825	2850	2875	2900	2925	2950	2975
924.7	3000	3025	3050	3075	3100	3125	3150	3175	3200	3225
924.8	3250	3275	3300	3325	3350	3375	3400	3425	3450	3475
924.9	3500	3525	3550	3575	3600	3625	3650	3675	3700	3725
925.0	3750	3780	3810	3840	3870	3900	3930	3960	3990	4020
925.1	4050	4080	4110	4140	4170	4200	4230	4260	4290	4320
925.2	4350	4380	4410	4440	4470	4500	4530	4560	4590	4620
925.3	4650	4680	4710	4740	4770	4800	4830	4860	4890	4920
925.4	4950	4980	5010	5040	5070	5100	5130	5160	5190	5220
925.5	5250	5280	5310	5340	5370	5400	5430	5460	5490	5520
925.6	5550	5580	5610	5640	5670	5700	5730	5760	5790	5820
925.7	5850	5880	5910	5940	5970	6000	6030	6060	6090	6120
925.8	6150	6180	6210	6240	6270	6300	6330	6360	6390	6420
925.9	6450	6480	6510	6540	6570	6600	6630	6660	6690	6720
926.0	6750	6783	6815	6848	6880	6913	6945	6978	7010	7043
926.1	7075	7108	7140	7173	7205	7238	7270	7303	7335	7368
926.2	7400	7433	7465	7498	7530	7563	7595	7628	7660	7693
926.3	7725	7758	7790	7823	7855	7888	7920	7953	7985	8018
926.4	8050	8083	8115	8148	8180	8213	8245	8278	8310	8343
926.5	8375	8408	8440	8473	8505	8538	8570	8603	8635	8668
926.6	8700	8733	8765	8798	8830	8863	8895	8928	8960	8993
926.7	9025	9058	9090	9123	9155	9188	9220	9253	9285	9318
926.8	9350	9383	9415	9448	9480	9513	9545	9578	9610	9643
926.9	9675	9708	9740	9773	9805	9838	9870	9903	9935	9968

Lac qui Parle Reservoir Only

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
927.0	10000	10040	10080	10120	10160	10200	10240	10280	10320	10360
927.1	10400	10440	10480	10520	10560	10600	10640	10680	10720	10760
927.2	10800	10840	10880	10920	10960	11000	11040	11080	11120	11160
927.3	11200	11240	11280	11320	11360	11400	11440	11480	11520	11560
927.4	11600	11640	11680	11720	11760	11800	11840	11880	11920	11960
927.5	12000	12040	12080	12120	12160	12200	12240	12280	12320	12360
927.6	12400	12440	12480	12520	12560	12600	12640	12680	12720	12760
927.7	12800	12840	12880	12920	12960	13000	13040	13080	13120	13160
927.8	13200	13240	13280	13320	13360	13400	13440	13480	13520	13560
927.9	13600	13640	13680	13720	13760	13800	13840	13880	13920	13960
928.0	14000	14040	14080	14120	14160	14200	14240	14280	14320	14360
928.1	14400	14440	14480	14520	14560	14600	14640	14680	14720	14760
928.2	14800	14840	14880	14920	14960	15000	15040	15080	15120	15160
928.3	15200	15240	15280	15320	15360	15400	15440	15480	15520	15560
928.4	15600	15640	15680	15720	15760	15800	15840	15880	15920	15960
928.5	16000	16040	16080	16120	16160	16200	16240	16280	16320	16360
928.6	16400	16440	16480	16520	16560	16600	16640	16680	16720	16760
928.7	16800	16840	16880	16920	16960	17000	17040	17080	17120	17160
928.8	17200	17240	17280	17320	17360	17400	17440	17480	17520	17560
928.9	17600	17640	17680	17720	17760	17800	17840	17880	17920	17960
929.0	18000	18050	18100	18150	18200	18250	18300	18350	18400	18450
929.1	18500	18550	18600	18650	18700	18750	18800	18850	18900	18950
929.2	19000	19050	19100	19150	19200	19250	19300	19350	19400	19450
929.3	19500	19550	19600	19650	19700	19750	19800	19850	19900	19950
929.4	20000	20050	20100	20150	20200	20250	20300	20350	20400	20450
929.5	20500	20550	20600	20650	20700	20750	20800	20850	20900	20950
929.6	21000	21050	21100	21150	21200	21250	21300	21350	21400	21450
929.7	21500	21550	21600	21650	21700	21750	21800	21850	21900	21950
929.8	22000	22050	22100	22150	22200	22250	22300	22350	22400	22450
929.9	22500	22550	22600	22650	22700	22750	22800	22850	22900	22950
930.0	23000	23055	23110	23165	23220	23275	23330	23385	23440	23495
930.1	23550	23605	23660	23715	23770	23825	23880	23935	23990	24045
930.2	24100	24155	24210	24265	24320	24375	24430	24485	24540	24595
930.3	24650	24705	24760	24815	24870	24925	24980	25035	25090	25145
930.4	25200	25255	25310	25365	25420	25475	25530	25585	25640	25695

Lac qui Parle Reservoir Only

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
930.5	25750	25805	25860	25915	25970	26025	26080	26135	26190	26245
930.6	26300	26355	26410	26465	26520	26575	26630	26685	26740	26795
930.7	26850	26905	26960	27015	27070	27125	27180	27235	27290	27345
930.8	27400	27455	27510	27565	27620	27675	27730	27785	27840	27895
930.9	27950	28005	28060	28115	28170	28225	28280	28335	28390	28445
931.0	28500	28560	28620	28680	28740	28800	28860	28920	28980	29040
931.1	29100	29160	29220	29280	29340	29400	29460	29520	29580	29640
931.2	29700	29760	29820	29880	29940	30000	30060	30120	30180	30240
931.3	30300	30360	30420	30480	30540	30600	30660	30720	30780	30840
931.4	30900	30960	31020	31080	31140	31200	31260	31320	31380	31440
931.5	31500	31560	31620	31680	31740	31800	31860	31920	31980	32040
931.6	32100	32160	32220	32280	32340	32400	32460	32520	32580	32640
931.7	32700	32760	32820	32880	32940	33000	33060	33120	33180	33240
931.8	33300	33360	33420	33480	33540	33600	33660	33720	33780	33840
931.9	33900	33960	34020	34080	34140	34200	34260	34320	34380	34440
932.0	34500	34565	34630	34695	34760	34825	34890	34955	35020	35085
932.1	35150	35215	35280	35345	35410	35475	35540	35605	35670	35735
932.2	35800	35865	35930	35995	36060	36125	36190	36255	36320	36385
932.3	36450	36515	36580	36645	36710	36775	36840	36905	36970	37035
932.4	37100	37165	37230	37295	37360	37425	37490	37555	37620	37685
932.5	37750	37815	37880	37945	38010	38075	38140	38205	38270	38335
932.6	38400	38465	38530	38595	38660	38725	38790	38855	38920	38985
932.7	39050	39115	39180	39245	39310	39375	39440	39505	39570	39635
932.8	39700	39765	39830	39895	39960	40025	40090	40155	40220	40285
932.9	40350	40415	40480	40545	40610	40675	40740	40805	40870	40935
933.0	41000	41075	41150	41225	41300	41375	41450	41525	41600	41675
933.1	41750	41825	41900	41975	42050	42125	42200	42275	42350	42425
933.2	42500	42575	42650	42725	42800	42875	42950	43025	43100	43175
933.3	43250	43325	43400	43475	43550	43625	43700	43775	43850	43925
933.4	44000	44075	44150	44225	44300	44375	44450	44525	44600	44675
933.5	44750	44825	44900	44975	45050	45125	45200	45275	45350	45425
933.6	45500	45575	45650	45725	45800	45875	45950	46025	46100	46175
933.7	46250	46325	46400	46475	46550	46625	46700	46775	46850	46925
933.8	47000	47075	47150	47225	47300	47375	47450	47525	47600	47675
933.9	47750	47825	47900	47975	48050	48125	48200	48275	48350	48425

Lac qui Parle Reservoir Only

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
934.0	48500	48575	48500	48585	48670	48755	48840	48925	49010	49095
934.1	49180	49265	49350	49435	49520	49605	49690	49775	49860	49945
934.2	50030	50115	50200	50285	50370	50455	50540	50625	50710	50795
934.3	50880	50965	51050	51135	51220	51305	51390	51475	51560	51645
934.4	51730	51815	51900	51985	52070	52155	52240	52325	52410	52495
934.5	52580	52665	52750	52835	52920	53005	53090	53175	53260	53345
934.6	53430	53515	53600	53685	53770	53855	53940	54025	54110	54195
934.7	54280	54365	54450	54535	54620	54705	54790	54875	55045	55215
934.8	55300	55385	55470	55555	55640	55725	55810	55895	55980	56065
934.9	56150	56235	56320	56405	56490	56575	56660	56745	56830	56915
935.0	57000	57085	57170	57255	57340	57425	57510	57595	57680	57765
935.1	57850	57935	58020	58105	58190	58275	58360	58445	58530	58615
935.2	58700	58785	58870	58955	59040	59125	59210	59295	59380	59465
935.3	59550	59635	59720	59805	59890	59975	60060	60145	60230	60315
935.4	60400	60485	60570	60655	60740	60825	60910	60995	61080	61165
935.5	61250	61335	61420	61505	61590	61675	61760	61845	61930	62015
935.6	62100	62185	62270	62355	62440	62525	62610	62695	62780	62865
935.7	62950	63035	63120	63205	63290	63375	63460	63545	63630	63715
935.8	63800	63885	63970	64055	64140	64225	64310	64395	64480	64565
935.9	64650	64735	64820	64905	64990	65075	65160	65245	65330	65415
936.0	65500	65595	65690	65785	65880	65975	66070	66165	66260	66355
936.1	66450	66545	66640	66735	66830	66925	67020	67115	67210	67305
936.2	67400	67495	67590	67685	67780	67875	67970	68065	68160	68255
936.3	68350	68445	68540	68635	68730	68825	68920	69015	69110	69205
936.4	69300	69395	69490	69585	69680	69775	69870	69965	70060	70155
936.5	70250	70345	70440	70535	70630	70725	70820	70915	71010	71105
936.6	71200	71295	71390	71485	71580	71675	71770	71865	71960	72055
936.7	72150	72245	72340	72435	72530	72625	72720	72815	72910	73005
936.8	73100	73195	73290	73385	73480	73575	73670	73765	73860	73955
936.9	74050	74145	74240	74335	74430	74525	74620	74715	74810	74905
937.0	75000	75105	75210	75315	75420	75525	75630	75735	75840	75945
937.1	76050	76155	76260	76365	76470	76575	76680	76785	76890	76995
937.2	77100	77205	77310	77415	77520	77625	77730	77835	77940	78045
937.3	78150	78255	78360	78465	78570	78675	78780	78885	78990	79095
937.4	79200	79305	79410	79515	79620	79725	79830	79935	80040	80145

Lac qui Parle Reservoir Only

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
937.5	80250	80355	80460	80565	80670	80775	80880	80985	81090	81195
937.6	81300	81405	81510	81615	81720	81825	81930	82035	82140	82245
937.7	82350	82455	82560	82665	82770	82875	82980	83085	83190	83295
937.8	83400	83505	83610	83715	83820	83925	84030	84135	84240	84345
937.9	84450	84555	84660	84765	84870	84975	85080	85185	85290	85395
938.0	85500	85615	85730	85845	85960	86075	86190	86305	86420	86535
938.1	86650	86765	86880	86995	87110	87225	87340	87455	87570	87685
938.2	87800	87915	88030	88145	88260	88375	88490	88605	88720	88835
938.3	88950	89065	89180	89295	89410	89525	89640	89755	89870	89985
938.4	90100	90215	90330	90445	90560	90675	90790	90905	91020	91135
938.5	91250	91365	91480	91595	91710	91825	91940	92055	92170	92285
938.6	92400	92515	92630	92745	92860	92975	93090	93205	93320	93435
938.7	93550	93665	93780	93895	94010	94125	94240	94355	94470	94585
938.8	94700	94815	94930	95045	95160	95275	95390	95505	95620	95735
938.9	95850	95965	96080	96195	96310	96425	96540	96655	96770	96885
939.0	97000	97120	97240	97360	97480	97600	97720	97840	97960	98080
939.1	98200	98320	98440	98560	98680	98800	98920	99040	99160	99280
939.2	99400	99520	99640	99760	99880	100000	100120	100240	100360	100480
939.3	100600	100720	100840	100960	101080	101200	101320	101440	101560	101680
939.4	101800	101920	102040	102160	102280	102400	102520	102640	102760	102880
939.5	103000	103120	103240	103360	103480	103600	103720	103840	103960	104080
939.6	104200	104320	104440	104560	104680	104800	104920	105040	105160	105280
939.7	105400	105520	105640	105760	105880	106000	106120	106240	106360	106480
939.8	106600	106720	106840	106960	107080	107200	107320	107440	107560	107680
939.9	107800	107920	108040	108160	108280	108400	108520	108640	108760	108880
940.0	109000	109125	109250	109375	109500	109625	109750	109875	110000	110125
940.1	110250	110375	110500	110625	110750	110875	111000	111125	111250	111375
940.2	111500	111625	111750	111875	112000	112125	112250	112375	112500	112625
940.3	112750	112875	113000	113125	113250	113375	113500	113625	113750	113875
940.4	114000	114125	114250	114375	114500	114625	114750	114875	115000	115125
940.5	115250	115375	115500	115625	115750	115875	116000	116125	116250	116375
940.6	116500	116625	116750	116875	117000	117125	117250	117375	117500	117625
940.7	117750	117875	118000	118125	118250	118375	118500	118625	118750	118875
940.8	119000	119125	119250	119375	119500	119625	119750	119875	120000	120125
940.9	120250	120375	120500	120625	120750	120875	121000	121125	121250	121375

Lac qui Parle Reservoir Only

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
941.0	121500	121630	121760	121890	122020	122150	122280	122410	122540	122670
941.1	122800	122930	123060	123190	123320	123450	123580	123710	123840	123970
941.2	124100	124230	124360	124490	124620	124750	124880	125010	125140	125270
941.3	125400	125530	125660	125790	125920	126050	126180	126310	126440	126570
941.4	126700	126830	126960	127090	127220	127350	127480	127610	127740	127870
941.5	128000	128130	128260	128390	128520	128650	128780	128910	129040	129170
941.6	129300	129430	129560	129690	129820	129950	130080	130210	130340	130470
941.7	130600	130730	130860	130990	131120	131250	131380	131510	131640	131770
941.8	131900	132030	132160	132290	132420	132550	132680	132810	132940	133070
941.9	133200	133330	133460	133590	133720	133850	133980	134110	134240	134370
942.0	134500	134635	134770	134905	135040	135175	135310	135445	135580	135715
942.1	135850	135985	136120	136255	136390	136525	136660	136795	136930	137065
942.2	137200	137335	137470	137605	137740	137875	138010	138145	138280	138415
942.3	138550	138685	138820	138955	139090	139225	139360	139495	139630	139765
942.4	139900	140035	140170	140305	140440	140575	140710	140845	140980	141115
942.5	141250	141385	141520	141655	141790	141925	142060	142195	142330	142465
942.6	142600	142735	142870	142735	143140	143275	143410	143545	143680	143815
942.7	143950	144085	144220	144355	144490	144625	144760	144895	145030	145165
942.8	145300	145435	145570	145705	145840	145975	146110	146245	146380	146515
942.9	146650	146785	146920	147055	147190	147325	147460	147595	147730	147865
943.0	148000	148140	148280	148420	148560	148700	148840	148980	149120	149260
943.1	149400	149540	149680	149820	149960	150100	150240	150380	150520	150660
943.2	150800	150940	151080	151220	151360	151500	151640	151780	151920	152060
943.3	152200	152340	152480	152620	152760	152900	153040	153180	153320	153460
943.4	153600	153740	153880	154020	154160	154300	154440	154580	154720	154860
943.5	155000	155140	155280	155420	155560	155700	155840	155980	156120	156260
943.6	156400	156540	156680	156820	156960	157100	157240	157380	157520	157660
943.7	157800	157940	158080	158220	158360	158500	158640	158780	158920	159060
943.8	159200	159340	159480	159620	159760	159900	160040	160180	160320	160460
943.9	160600	160740	160880	161020	161160	161300	161440	161580	161720	161860
944.0	162000	162155	162310	162465	162620	162775	162930	163085	163240	163395
944.1	163550	163705	163860	164015	164170	164325	164480	164635	164790	164945
944.2	165100	165255	165410	165565	165720	165875	166030	166185	166340	166495
944.3	166650	166805	166960	167115	167270	167425	167580	167735	167890	168045
944.4	168200	168355	168510	168665	168820	168975	169130	169285	169440	169595

Lac qui Parle Reservoir Only

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
944.5	169750	169905	170060	170215	170370	170525	170680	170835	170990	171145
944.6	171300	171455	171610	171765	171920	172075	172230	172385	172540	172695
944.7	172850	173005	173160	173315	173470	173625	173780	173935	174090	174245
944.8	174400	174555	174710	174865	175020	175175	175330	175485	175640	175795
944.9	175950	176105	176260	176415	176570	176725	176880	177035	177190	177345
945.0	177500	177655	177810	177965	178120	178275	178430	178585	178740	178895
945.1	179050	179205	179360	179515	179670	179825	179980	180135	180290	180445
945.2	180600	180755	180910	181065	181220	181375	181530	181685	181840	181995
945.3	182150	182305	182460	182615	182770	182925	183080	183235	183390	183545
945.4	183700	183855	184010	184165	184320	184475	184630	184785	184940	185095
945.5	185250	185405	185560	185715	185870	186025	186180	186335	186490	186645
945.6	186800	186955	187110	187265	187420	187575	187730	187885	188040	188195
945.7	188350	188505	188660	188815	188970	189125	189280	189435	189590	189745
945.8	189900	190055	190210	190365	190520	190675	190830	190985	191140	191295
945.9	191450	191605	191760	191915	192070	192225	192380	192535	192690	192845
946.0	193000	193165	193330	193495	193660	193825	193990	194155	194320	194485
946.1	194650	194815	194980	195145	195310	195475	195640	195805	195970	196135
946.2	196300	196465	196630	196795	196960	197125	197290	197455	197620	197785
946.3	197950	198115	198280	198445	198610	198775	198940	199105	199270	199435
946.4	199600	199765	199930	200095	200260	200425	200590	200755	200920	201085
946.5	201250	201415	201580	201745	201910	202075	202240	202405	202570	202735
946.6	202900	203065	203230	203395	203560	203725	203890	204055	204220	204385
946.7	204550	204715	204880	205045	205210	205375	205540	205705	205870	206035
946.8	206200	206365	206530	206695	206860	207025	207190	207355	207520	207685
946.9	207850	208015	208180	208345	208510	208675	208840	209005	209170	209335
947.0	209500	209665	209830	209995	210160	210325	210490	210655	210820	210985
947.1	211150	211315	211480	211645	211810	211975	212140	212305	212470	212635
947.2	212800	212965	213130	213295	213460	213625	213790	213955	214120	214285
947.3	214450	214615	214780	214945	215110	215275	215440	215605	215770	215935
947.4	216100	216265	216430	216595	216760	216925	217090	217255	217420	217585
947.5	217750	217915	218080	218245	218410	218575	218740	218905	219070	219235
947.6	219400	219565	219730	219895	220060	220225	220390	220555	220720	220885
947.7	221050	221215	221380	221545	221710	221875	222040	222205	222370	222535
947.8	222700	222865	223030	223195	223360	223525	223690	223855	224020	224185
947.9	224350	224515	224680	224845	225010	225175	225340	225505	225670	225835

Lac qui Parle Reservoir Only

Elevation in Feet (1929 NGVD) with Storage Capacity in Acre-feet

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
948.0	226000	226160	226320	226480	226640	226800	226960	227120	227280	227440
948.1	227600	227760	227920	228080	228240	228400	228560	228720	228880	229040
948.2	229200	229360	229520	229680	229840	230000	230160	230320	230480	230640
948.3	230800	230960	231120	231280	231440	231600	231760	231920	232080	232240
948.4	232400	232560	232720	232880	233040	233200	233360	233520	233680	233840
948.5	234000	234160	234320	234480	234640	234800	234960	235120	235280	235440
948.6	235600	235760	235920	236080	236240	236400	236560	236720	236880	237040
948.7	237200	237360	237520	237680	237840	238000	238160	238320	238480	238640
948.8	238800	238960	239120	239280	239440	239600	239760	239920	240080	240240
948.9	240400	240560	240720	240880	241040	241200	241360	241520	241680	241840
949.0	242000									

EXHIBIT E

STAGE-DISCHARGE TABLES

EXHIBIT E

STAGE-DISCHARGE TABLES

E-1. MINNESOTA RIVER AT ORTONVILLE, MINNESOTA,
U.S.G.S. GAGE NO. 05292000, RATING NO. 30.0

E-2. YELLOW BANK RIVER NEAR ODESSA, MINNESOTA,
U.S.G.S. GAGE NO. 05293000, RATING NO. 33.0

E-3. POMME DE TERRE RIVER AT APPLETON, MINNESOTA,
U.S.G.S. GAGE NO. 05294000, RATING NO. 37.0

E-4. LAC QUI PARLE RIVER NEAR LAC QUI PARLE,
MINNESOTA, U.S.G.S. GAGE NO. 05300000, RATING NO. 47.0

E-5. MINNESOTA RIVER NEAR LAC QUI PARLE, MINNESOTA,
U.S.G.S. GAGE NO. 05301000, RATING NO. 30.0

E-6. CHIPPEWA RIVER NEAR MILAN, MINNESOTA, U.S.G.S.
GAGE NO. 05304500, RATING NO. 31.0

E-7. MINNESOTA RIVER AT MONTEVIDEO, MINNESOTA,
U.S.G.S. GAGE NO. 05311000, RATING NO. 49.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05292000 MINNESOTA RIVER AT ORTONVILLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:011
 LATITUDE: 451744 LONGITUDE: 0962638 NAD27 DRAINAGE AREA:1160 CONTRIBUTING DRAINAGE AREA: DATUM:956.38 NGVD29

Date Processed: 2011-08-24 09:41 By mitton

Rating for Discharge (cfs)

RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 01-04-2008 @ 15:09:34 CST, Updated by mitton on 01-12-2008 @ 12:39:26 CST

RATING REMARKS: Change to Rating 27.0 below 1.60 ft.

OFFSET: 0.80

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
1.00	2.2*	2.4	2.6	2.9	3.1	3.4	3.6	3.9	4.1	4.4	2.5
1.10	4.7	5.0	5.3	5.7	6.0	6.3	6.7	7.0	7.4	7.7	3.4
1.20	8.1	8.5	8.9	9.3	9.7	10.1	10.6	11.0	11.5	11.9	4.3
1.30	12.4	12.8	13.3	13.8	14.3	14.8	15.3	15.8	16.4	16.9	5.0
1.40	17.4	18.0	18.6	19.1	19.7	20.3	20.9	21.5	22.1	22.7	5.9
1.50	23.3	24.0	24.6	25.2	25.9	26.6	27.2	27.9	28.6	29.3	6.7
1.60	30.0*	30.8	31.7	32.6	33.5	34.4	35.3	36.2	37.1	38.1	9.1
1.70	39.1	40.0	41.0	42.0	43.1	44.1	45.1	46.2	47.3	48.4	10.4
1.80	49.5	50.6	51.7	52.9	54.0	55.2	56.4	57.6	58.8	60.0	11.8
1.90	61.3	62.5	63.8	65.1	66.4	67.7	69.0	70.3	71.7	73.1	13.1
2.00	74.4	75.8	77.3	78.7	80.1	81.6	83.0	84.5	86.0	87.5	14.7
2.10	89.1	90.6	92.2	93.7	95.3	96.9	98.6	100	102	103	15.9
2.20	105	107	109	110	112	114	116	117	119	121	18.0
2.30	123	125	126	128	130	132	134	136	138	140	19.0
2.40	142	144	146	148	150	152	154	156	158	160	21.0
2.50	163	165	167	169	171	173	176	178	180	182	22.0
2.60	185	187	189	192	194	196	199	201	204	206	24.0
2.70	209	211*	213	215	217	220	222	224	226	229	22.0
2.80	231	233	235	238	240	242	244	247	249	251	23.0
2.90	254	256	258	261	263	266	268	270	273	275	24.0
3.00	278	280	283	285	288	290	293	295	298	300	25.0
3.10	303	305	308	310	313	316	318	321	324	326	26.0
3.20	329	332	334	337	340	342	345	348*	350	353	26.0
3.30	355	357	360	362	365	367	370	372	375	377	25.0
3.40	380	382	385	387	390	392	395	397	400	402	25.0
3.50	405	408	410	413	415	418	421	423	426	428	26.0
3.60	431	434	436	439	442	444	447	450	452	455	27.0
3.70	458	461	463	466	469	471	474	477	480	482	27.0
3.80	485	488	491	494	496	499	502	505	508	510	28.0
3.90	513	516	519	522	525	528	530	533	536	539	29.0
4.00	542*	545	548	551	554	557	560	563	566	569	30.0
4.10	572	575	579	582	585	588	591	594	597	600	32.0
4.20	604	607	610	613	616	619	623	626	629	632	31.0
4.30	635	639	642	645	648	652	655	658	661	665	33.0
4.40	668	671	675	678	681	684	688	691	694	698	33.0
4.50	701	705	708	711	715	718	721	725	728	732	34.0
4.60	735	739	742	745	749	752	756	759	763	766	35.0
4.70	770	773	777	780	784	787	791	794	798	802	35.0
4.80	805	809	812	816	819	823	827	830	834	838	36.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05292000 MINNESOTA RIVER AT ORTONVILLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:011
 LATITUDE: 451744 LONGITUDE: 0962638 NAD27 DRAINAGE AREA:1160 CONTRIBUTING DRAINAGE AREA: DATUM:956.38 NGVD29
 Date Processed: 2011-08-24 09:41 By mitton
 Rating for Discharge (cfs)
 RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 01-04-2008 @ 15:09:34 CST, Updated by mitton on 01-12-2008 @ 12:39:26 CST

RATING REMARKS: Change to Rating 27.0 below 1.60 ft.

OFFSET: 0.80

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
4.90	841	845	848	852	856	859	863	867	870	874	37.0
5.00	878	882	885	889	893	897	900	904	908	912	37.0
5.10	915	919	923	927	930	934	938	942	946	950	38.0
5.20	953	957	961	965	969	973	977	980	984	988	39.0
5.30	992	996	1000	1000	1010	1010	1020	1020	1020	1030	38.0
5.40	1030	1040	1040	1040	1050	1050	1060	1060	1060	1070	40.0
5.50	1070	1080	1080	1080	1090	1090	1100	1100	1100	1110	40.0
5.60	1110	1120	1120	1120	1130	1130	1140	1140	1150	1150	40.0
5.70	1150	1160	1160	1170	1170	1170	1180	1180	1190	1190	50.0
5.80	1200	1200	1200	1210	1210	1220	1220	1230	1230	1230	40.0
5.90	1240	1240	1250	1250	1260	1260	1260	1270	1270	1280	40.0
6.00	1280	1290	1290	1300	1300	1300	1310	1310	1320	1320	50.0
6.10	1330	1330	1340	1340	1340	1350	1350	1360	1360	1370	40.0
6.20	1370	1380	1380	1380	1390	1390	1400	1400	1410	1410	50.0
6.30	1420	1420	1430	1430	1430	1440	1440	1450	1450	1460	40.0
6.40	1460	1470	1470	1480	1480	1490	1490	1490	1500	1500	50.0
6.50	1510	1510	1520	1520	1530	1530	1540	1540	1550	1550	50.0
6.60	1560	1560	1570	1570	1580	1580	1590	1590	1600	1600	40.0
6.70	1600	1610	1610	1620	1620	1630	1630	1640	1640	1650	50.0
6.80	1650	1660	1660	1670	1670	1680	1680	1690	1690	1700	50.0
6.90	1700	1710	1710	1720	1720	1730	1730	1740	1740	1750	50.0
7.00	1750	1760	1760	1770	1770	1780	1780	1790	1790	1800	50.0
7.10	1800	1810	1810	1820	1820	1830	1830	1840	1840	1850	50.0
7.20	1850	1860	1860	1870	1870	1880	1880	1890	1890	1900	50.0
7.30	1900	1910	1910	1920	1930	1930	1940	1940	1950	1950	60.0
7.40	1960	1960	1970	1970	1980	1980	1990	1990	2000	2000	50.0
7.50	2010	2020	2020	2030	2030	2040	2040	2050	2050	2060	50.0
7.60	2060	2070	2070	2080	2080	2090	2100	2100	2110	2110	60.0
7.70	2120	2120	2130	2130	2140	2140	2150	2160	2160	2170	50.0
7.80	2170	2180	2180	2190	2190	2200	2210	2210	2220	2220	60.0
7.90	2230	2230	2240	2240	2250	2260	2260	2270	2270	2280	50.0
8.00	2280	2290	2290	2300	2310	2310	2320	2320	2330	2330	60.0
8.10	2340	2350	2350	2360	2360	2370	2370	2380	2390	2390	60.0
8.20	2400	2400	2410	2410	2420	2430	2430	2440	2440	2450	50.0
8.30	2450	2460	2470	2470	2480	2480	2490	2500	2500	2510	60.0
8.40	2510	2520	2520	2530	2540	2540	2550	2550	2560	2570	60.0
8.50	2570	2580	2580	2590	2600	2600	2610	2610	2620	2630	60.0
8.60	2630	2640	2640	2650	2660	2660	2670	2670	2680	2690	60.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05292000 MINNESOTA RIVER AT ORTONVILLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:011
 LATITUDE: 451744 LONGITUDE: 0962638 NAD27 DRAINAGE AREA:1160 CONTRIBUTING DRAINAGE AREA: DATUM:956.38 NGVD29
 Date Processed: 2011-08-24 09:41 By mitton
 Rating for Discharge (cfs)
 RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 01-04-2008 @ 15:09:34 CST, Updated by mitton on 01-12-2008 @ 12:39:26 CST

RATING REMARKS: Change to Rating 27.0 below 1.60 ft.

OFFSET: 0.80

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	Discharge (cfs)					(STANDARD PRECISION)					
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
8.70	2690	2700	2700	2710	2720	2720	2730	2730	2740	2750	60.0
8.80	2750	2760	2760	2770	2780	2780	2790	2800	2800	2810	60.0
8.90	2810	2820	2830	2830	2840	2840	2850	2860	2860	2870	70.0
9.00	2880	2880	2890	2890	2900	2910	2910	2920	2930	2930	60.0
9.10	2940	2940	2950	2960	2960	2970	2980	2980	2990	2990	60.0
9.20	3000	3010	3010	3020	3030	3030	3040	3050	3050	3060	60.0
9.30	3060	3070	3080	3080	3090	3100	3100	3110	3120	3120	70.0
9.40	3130	3140	3140	3150	3150	3160	3170	3170	3180	3190	60.0
9.50	3190	3200	3210	3210	3220	3230	3230	3240	3250	3250	70.0
9.60	3260	3270	3270	3280	3290	3290	3300	3310	3310	3320	70.0
9.70	3330	3330	3340	3350	3350	3360	3370	3370	3380	3390	60.0
9.80	3390	3400	3410	3410	3420	3430	3430	3440	3450	3450	70.0
9.90	3460	3470	3470	3480	3490	3490	3500	3510	3510	3520	70.0
10.00	3530	3530	3540	3550	3550	3560	3570	3570	3580	3590	60.0
10.10	3590	3600	3610	3620	3620	3630	3640	3640	3650	3660	70.0
10.20	3660	3670	3680	3680	3690	3700	3710	3710	3720	3730	70.0
10.30	3730	3740	3750	3750	3760	3770	3780	3780	3790	3800	70.0
10.40	3800	3810	3820	3820	3830	3840	3850	3850	3860	3870	70.0
10.50	3870	3880	3890	3890	3900	3910	3920	3920	3930	3940	70.0
10.60	3940	3950	3960	3970	3970	3980	3990	3990	4000	4010	80.0
10.70	4020	4020	4030	4040	4050	4050	4060	4070	4070	4080	70.0
10.80	4090	4100	4100	4110	4120	4120	4130	4140	4150	4150	70.0
10.90	4160	4170	4180	4180	4190	4200	4210	4210	4220	4230	70.0
11.00	4230	4240	4250	4260	4260	4270	4280	4290	4290	4300	80.0
11.10	4310	4320	4320	4330	4340	4350	4350	4360	4370	4380	70.0
11.20	4380	4390	4400	4410	4410	4420	4430	4440	4440	4450	80.0
11.30	4460	4470	4470	4480	4490	4500	4500	4510	4520	4530	70.0
11.40	4530	4540	4550	4560	4560	4570	4580	4590	4590	4600	80.0
11.50	4610	4620	4630	4630	4640	4650	4660	4660	4670	4680	80.0
11.60	4690	4690	4700	4710	4720	4730	4740	4750	4750	4760	70.0
11.70	4760	4770	4780	4790	4790	4800	4810	4820	4830	4830	80.0
11.80	4840	4850	4860	4860	4870	4880	4890	4900	4900	4910	80.0
11.90	4920	4930	4940	4940	4950	4960	4970	4970	4980	4990	80.0
12.00	5000	5010	5010	5020	5030	5040	5050	5050	5060	5070	80.0
12.10	5080	5090	5090	5100	5110	5120	5130	5130	5140	5150	80.0
12.20	5160	5170	5170	5180	5190	5200	5210	5210	5220	5230	80.0
12.30	5240	5250	5250	5260	5270	5280	5290	5300	5300	5310	80.0
12.40	5320	5330	5340	5340	5350	5360	5370	5380	5380	5390	80.0

4

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05292000 MINNESOTA RIVER AT ORTONVILLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:011

LATITUDE: 451744 LONGITUDE: 0962638 NAD27 DRAINAGE AREA:1160 CONTRIBUTING DRAINAGE AREA: DATUM:956.38 NGVD29

Date Processed: 2011-08-24 09:41 By mitton

Rating for Discharge (cfs)

RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by besavage on 01-04-2008 @ 15:09:34 CST, Updated by mitton on 01-12-2008 @ 12:39:26 CST

RATING REMARKS: Change to Rating 27.0 below 1.60 ft.

OFFSET: 0.80

EXPANDED RATING TABLE											
Gage height, feet	Discharge (cfs)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
12.50	5400	5410	5420	5430	5430	5440	5450	5460	5470	5480	80.0
12.60	5480	5490	5500	5510	5520	5520	5530	5540	5550	5560	90.0
12.70	5570	5570	5580	5590	5600	5610	5620	5620	5630	5640	80.0
12.80	5650	5660	5670	5670	5680	5690	5700	5710	5720	5720	80.0
12.90	5730	5740	5750	5760	5770	5780	5780	5790	5800	5810	90.0
13.00	5820	5830	5830	5840	5850	5860	5870	5880	5890	5890	80.0
13.10	5900	5910	5920	5930	5940	5940	5950	5960	5970	5980	90.0
13.20	5990	6000	6000	6010	6020	6030	6040	6050	6060	6060	80.0
13.30	6070	6080	6090	6100	6110	6120	6130	6130	6140	6150	90.0
13.40	6160	6170	6180	6190	6190	6200	6210	6220	6230	6240	90.0
13.50	6250	6260	6260	6270	6280	6290	6300	6310	6320	6330	80.0
13.60	6330	6340	6350	6360	6370	6380	6390	6400	6400	6410	90.0
13.70	6420	6430	6440	6450	6460	6470	6480	6480	6490	6500	90.0
13.80	6510	6520	6530	6540	6550	6560	6560	6570	6580	6590	90.0
13.90	6600*										

"*" indicates a rating descriptor point

Rating Type:		Rating Type: stage-discharge		A	Comments
ID	Starting Date	Ending Date			
30.0	10-01-2006 @ 00:00:00 CDT	02-21-2011 @ 23:59:59 CST		A	
30.0	02-22-2011 @ 00:00:00 CST	-----		W	

STATION:05293000 YELLOW BANK RIVER NEAR ODESSA, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073
 LATITUDE: 451337 LONGITUDE: 0962112 NAD27 DRAINAGE AREA:459 CONTRIBUTING DRAINAGE AREA: DATUM:953.34 NGVD29

Date Processed: 2011-08-24 09:42 By mitton

Rating for Discharge (cfs)

RATING ID: 33.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-28-2010 @ 14:00:58 CST, Updated by mitton on 01-11-2011 @ 16:48:05 CST

RATING REMARKS: OFFSET CHANGED FROM .40 TO 1.00

OFFSET: 1.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
1.20	1.0*	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.2	2.4	1.6
1.30	2.6	2.8	3.0	3.2	3.5	3.7	4.0	4.2	4.5	4.8	2.5
1.40	5.1	5.4	5.7	6.0	6.3	6.7	7.0	7.4	7.8	8.1	3.4
1.50	8.5	8.9	9.4	9.8	10.2	10.7	11.1	11.6*	12.1	12.6	4.6
1.60	13.1	13.6	14.1	14.7	15.2	15.8	16.4	17.0	17.6	18.2	5.7
1.70	18.8	19.5	20.1	20.8	21.4	22.1	22.8	23.6	24.3	25.0	7.0
1.80	25.8	26.5	27.3	28.1	28.9	29.7	30.6	31.4	32.3	33.1	8.2
1.90	34.0	34.9	35.8	36.8	37.7	38.6	39.6	40.6	41.6	42.6	9.6
2.00	43.6	44.6	45.7	46.8	47.8	48.9	50.0	51.2	52.3	53.4	11.0
2.10	54.6	55.8	57.0	58.2	59.4*	60.4	61.5	62.6	63.7	64.8	11.3
2.20	65.9	67.0	68.1	69.2	70.4	71.5	72.7	73.8	75.0	76.2	11.5
2.30	77.4	78.6	79.8	81.0	82.3	83.5	84.8	86.0	87.3	88.6	12.5
2.40	89.9	91.2	92.5	93.8	95.1	96.5	97.8	99.2	101	102	13.1
2.50	103	105	106	107	109	110	112	113	115	116	15.0
2.60	118	119	121	122	124	125	127	128	130	131	15.0
2.70	133	135	136*	137	139	140	142	143	145	146	14.0
2.80	147	149	150	152	153	155	156	158	159	161	15.0
2.90	162	164	165	167	168	170	171	173	174	176	15.0
3.00	177	179	180	182	184	185	187	188	190	192	16.0
3.10	193	195	196	198	200	201	203	205	206	208	17.0
3.20	210	211	213	215	216	218	220	221	223	225	17.0
3.30	227	228	230	232	234	235	237	239	241	242	17.0
3.40	244	246	248	250	251	253	255	257	259	261	18.0
3.50	262	264	266	268	270	272	274	275	277	279	19.0
3.60	281	283	285	287	289	291	293	295	296	298	19.0
3.70	300	302	304*	306	308	310	312	314	316	318	20.0
3.80	320	322	324	326	328	329	331	333	335	337	19.0
3.90	339	341	343	345	347	349	351	353	356	358	21.0
4.00	360	362	364	366	368	370	372	374	376	378	20.0
4.10	380	382	384	387	389	391	393	395	397	399	21.0
4.20	401	404	406	408	410	412	414	417	419	421	22.0
4.30	423	425	427	430	432	434	436	438	441	443	22.0
4.40	445	447	450	452	454	456	459	461	463	465	23.0
4.50	468	470	472	475	477	479	481	484	486	488	23.0
4.60	491	493	495	498	500	502	505	507	509	512	23.0
4.70	514	517	519	521	524	526	529	531	533	536	24.0
4.80	538	541	543	545	548	550	553	555	558	560	24.0
4.90	562	565	567	570	572	575	577	580	582	585	25.0

STATION:05293000 YELLOW BANK RIVER NEAR ODESSA, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073
 LATITUDE: 451337 LONGITUDE: 0962112 NAD27 DRAINAGE AREA:459 CONTRIBUTING DRAINAGE AREA: DATUM:953.34 NGVD29
 Date Processed: 2011-08-24 09:42 By mitton

Rating for Discharge (cfs)
 RATING ID: 33.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-28-2010 @ 14:00:58 CST, Updated by mitton on 01-11-2011 @ 16:48:05 CST

RATING REMARKS: OFFSET CHANGED FROM .40 TO 1.00

OFFSET: 1.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1
5.00	587	590	592	595	597	600	602	605	607	610	26.0
5.10	613	615	618	620	623	625	628	631	633	636	25.0
5.20	638	641	643	646	649	651	654	657	659	662	26.0
5.30	664	667	670	672	675	678	680	683	686	688	27.0
5.40	691	694	696	699	702	704	707	710	713	715	27.0
5.50	718	721	723	726	729	732	734	737	740	743	27.0
5.60	745	748	751	754	756	759	762	765	768	770	28.0
5.70	773	776	779	782	784	787	790	793	796	799	28.0
5.80	801	804	807	810	813	816	819	822	824	827	29.0
5.90	830	833	836	839	842	845	848	851	853	856	29.0
6.00	859	862	865	868	871	874	877	880	883	886	30.0
6.10	889	892	895	898	901	904	907	910	913	916	30.0
6.20	919	922	925	928	931	934	937	940	943	946	30.0
6.30	949	952	955	958	961	964	967	971	974	977	31.0
6.40	980	983	986	989	992	995	998	1000	1000	1010	30.0
6.50	1010	1010	1020	1020	1020	1030	1030	1030	1040	1040	30.0
6.60	1040	1050	1050	1050	1060	1060	1060	1060	1070	1070	30.0
6.70	1070	1080	1080	1080	1090	1090	1090	1100	1100	1100	40.0
6.80	1110	1110	1110	1120	1120	1120	1130	1130	1130	1140	30.0
6.90	1140	1140	1150	1150	1150	1160	1160	1160	1170	1170	30.0
7.00	1170	1180	1180	1180	1190	1190	1190	1200	1200	1200	40.0
7.10	1210	1210	1210	1220	1220	1220	1230	1230	1230	1240	30.0
7.20	1240	1240	1250	1250	1250	1260	1260	1260	1270	1270	30.0
7.30	1270	1280	1280	1280	1290	1290	1300	1300	1300	1310	40.0
7.40	1310	1310	1320	1320	1320	1330	1330	1330	1340	1340	30.0
7.50	1340	1350	1350	1350	1360	1360	1370	1370	1370	1380	40.0
7.60	1380	1380	1390	1390	1390	1400	1400	1400	1410	1410	40.0
7.70	1420	1420	1420	1430	1430	1430	1440	1440	1440	1450	30.0
7.80	1450	1460	1460	1460	1470	1470	1470	1480	1480	1480	40.0
7.90	1490	1490	1500	1500	1500	1510	1510	1510	1520	1520	40.0
8.00	1530	1530	1530	1540	1540	1540	1550	1550	1560	1560	30.0
8.10	1560	1570	1570	1570	1580	1580	1590	1590	1590	1600	40.0
8.20	1600	1600	1610	1610	1620	1620	1630	1630	1630	1630	40.0
8.30	1640	1640	1650	1650	1650	1660	1660	1670	1670	1670	40.0
8.40	1680	1680	1680	1690	1690	1700	1700	1700	1710	1710	40.0
8.50	1720	1720	1720	1730	1730	1740	1740	1740	1750	1750	30.0
8.60	1750	1760	1760	1770	1770	1770	1780	1780	1790	1790	40.0
8.70	1790	1800	1800	1810	1810	1810	1820	1820	1830	1830	40.0
8.80	1830	1840	1840	1850	1850	1850	1860	1860	1870	1870	40.0

STATION:05293000 YELLOW BANK RIVER NEAR ODESSA, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073
 LATITUDE: 451337 LONGITUDE: 0962112 NAD27 DRAINAGE AREA:459 CONTRIBUTING DRAINAGE AREA: DATUM:953.34 NGVD29
 Date Processed: 2011-08-24 09:42 By mitton
 Rating for Discharge (cfs)
 RATING ID: 33.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-28-2010 @ 14:00:58 CST, Updated by mitton on 01-11-2011 @ 16:48:05 CST

RATING REMARKS: OFFSET CHANGED FROM .40 TO 1.00

OFFSET: 1.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
8.90	1870	1880	1880	1890	1890	1890	1900	1900	1910	1910	50.0
9.00	1920	1920	1920	1930	1930	1940	1940	1940	1950	1950	40.0
9.10	1960	1960	1960	1970	1970	1980	1980	1990	1990	1990	40.0
9.20	2000	2000	2010	2010	2010	2020	2020	2030	2030	2040	40.0
9.30	2040	2040	2050	2050	2060	2060	2060	2070	2070	2080	40.0
9.40	2080	2090	2090	2090	2100	2100	2110	2110	2120	2120	40.0
9.50	2120	2130	2130	2140	2140	2150	2150	2150	2160	2160	50.0
9.60	2170	2170	2180	2180	2180	2190	2190	2200	2200	2210	40.0
9.70	2210	2210	2220	2220	2230	2230	2240	2240	2240	2250	40.0
9.80	2250	2260	2260	2270	2270	2280	2280	2280	2290	2290	50.0
9.90	2300	2300	2310	2310	2310	2320	2320	2330	2330	2340	40.0
10.00	2340	2350	2350	2350	2360	2360	2370	2370	2380	2380	50.0
10.10	2390	2390	2390	2400	2400	2410	2410	2420	2420	2430	40.0
10.20	2430	2440	2440	2440	2450	2450	2460	2460	2470	2470	50.0
10.30	2480	2480	2480	2490	2490	2500	2500	2510	2510	2520	40.0
10.40	2520	2530	2530	2540	2540	2540	2550	2550	2560	2560	50.0
10.50	2570	2570	2580	2580	2590	2590	2600	2600	2600	2610	40.0
10.60	2610	2620	2620	2630	2630	2640	2640	2650	2650	2660	50.0
10.70	2660	2660	2670	2670	2680	2680	2690	2690	2700	2700	50.0
10.80	2710	2710	2720	2720	2730	2730	2740	2740	2740	2750	40.0
10.90	2750	2760	2760	2770	2770	2780	2780	2790	2790	2800	50.0
11.00	2800	2810	2810	2820	2820	2830	2830	2840	2840	2850	50.0
11.10	2850	2850	2860	2860	2870	2870	2880	2880	2890	2890	50.0
11.20	2900	2900	2910	2910	2920	2920	2930	2930	2940	2940	50.0
11.30	2950	2950	2960	2960	2970	2970	2980	2980	2990	2990	50.0
11.40	3000	3000	3010	3010	3020	3020	3030	3030	3040	3040	50.0
11.50	3050	3050	3060	3060	3060	3070	3070	3080	3080	3090	40.0
11.60	3090	3100	3100	3110	3110	3120	3120	3130	3130	3140	50.0
11.70	3140	3150	3150	3160	3160	3170	3170	3180	3180	3190	60.0
11.80	3200	3200	3210	3210	3220	3220	3230	3230	3240	3240	50.0
11.90	3250	3250	3260	3260	3270	3270	3280	3280	3290	3290	50.0
12.00	3300	3300	3310	3310	3320	3320	3330	3330	3340	3340	50.0
12.10	3350	3350	3360	3360	3370	3370	3380	3380	3390	3390	50.0
12.20	3400	3400	3410	3420	3420	3430	3430	3440	3440	3450	50.0
12.30	3450	3460	3460	3470	3470	3480	3480	3490	3490	3500	50.0
12.40	3500	3510	3510	3520	3520	3530	3540	3540	3550	3550	60.0
12.50	3560	3560	3570	3570	3580	3580	3590	3590	3600	3600	50.0
12.60	3610	3610	3620	3630	3630	3640	3640	3650	3650	3660	50.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05293000 YELLOW BANK RIVER NEAR ODESSA, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073

LATITUDE: 451337 LONGITUDE: 0962112 NAD27 DRAINAGE AREA:459 CONTRIBUTING DRAINAGE AREA: DATUM:953.34 NGVD29

Date Processed: 2011-08-24 09:42 By mitton

Rating for Discharge (cfs)

RATING ID: 33.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by jlarson on 12-28-2010 @ 14:00:58 CST, Updated by mitton on 01-11-2011 @ 16:48:05 CST

RATING REMARKS: OFFSET CHANGED FROM .40 TO 1.00

OFFSET: 1.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
12.70	3660	3670	3670	3680	3680	3690	3690	3700	3710	3710	60.0
12.80	3720	3720	3730	3730	3740	3740	3750	3750	3760	3760	50.0
12.90	3770	3780	3780	3790	3790	3800	3800	3810	3810	3820	50.0
13.00	3820	3830	3830	3840	3850	3850	3860	3860	3870	3870	60.0
13.10	3880	3880	3890	3890	3900	3910	3910	3920	3920	3930	50.0
13.20	3930	3940	3940	3950	3960	3960	3970	3970	3980	3980	60.0
13.30	3990	3990	4000	4000	4010	4020	4020	4030	4030	4040	50.0
13.40	4040	4050	4050	4060	4070	4070	4080	4080	4090	4090	60.0
13.50	4100	4110	4110	4120	4120	4130	4130	4140	4140	4150	60.0
13.60	4160	4160	4170	4170	4180	4180	4190	4200	4200	4210	50.0
13.70	4210	4220	4220	4230	4230	4240	4250	4250	4260	4260	60.0
13.80	4270	4270	4280	4290	4290	4300	4300	4310	4310	4320	60.0
13.90	4330	4330	4340	4340	4350	4350	4360	4370	4370	4380	50.0
14.00	4380	4390	4390	4400	4410	4410	4420	4420	4430	4440	60.0
14.10	4440	4450	4450	4460	4460	4470	4480	4480	4490	4490	60.0
14.20	4500	4500	4510	4520	4520	4530	4530	4540	4550	4550	60.0
14.30	4560	4560	4570	4570	4580	4590	4590	4600	4600	4610	60.0
14.40	4620	4620	4630	4630	4640	4650	4650	4660	4660	4670	50.0
14.50	4670	4680	4690	4690	4700	4700	4710	4720	4720	4730	60.0
14.60	4730	4740	4750	4750	4760	4760	4770	4780	4780	4790	60.0
14.70	4790	4800	4810	4810	4820	4820	4830	4840	4840	4850	60.0
14.80	4850	4860	4870	4870	4880	4880	4890	4900	4900	4910	60.0
14.90	4910	4920	4930	4930	4940	4940	4950	4960	4960	4970	60.0
15.00	4970	4980	4990	4990	5000	5000	5010	5020	5020	5030	60.0
15.10	5030	5040	5050	5050	5060	5060	5070	5080	5080	5090	70.0
15.20	5100	5100	5110	5110	5120	5130	5130	5140	5140	5150	60.0
15.30	5160	5160	5170	5180	5180	5190	5190	5200	5210	5210	60.0
15.40	5220	5220	5230	5240	5240	5250	5260	5260	5270	5270	60.0
15.50	5280	5290	5290	5300	5310	5310	5320	5320	5330	5340	60.0
15.60	5340	5350	5360	5360	5370	5370	5380	5390	5390	5400	70.0
15.70	5410	5410	5420	5420	5430	5440	5440	5450	5460	5460	60.0
15.80	5470	5470	5480	5490	5490	5500	5510	5520	5520	5530	60.0
15.90	5530	5540	5540	5550	5560	5560	5570	5580	5580	5590	60.0
16.00	5590	5600	5610	5610	5620	5630	5630	5640	5650	5650	70.0
16.10	5660	5660	5670	5680	5680	5690	5700	5700	5710	5720	60.0
16.20	5720	5730	5740	5740	5750	5760	5770	5770	5780	5780	70.0
16.30	5790	5790	5800	5810	5810	5820	5830	5830	5840	5840	60.0
16.40	5850	5860	5860	5870	5880	5880	5890	5900	5900	5910	70.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05293000 YELLOW BANK RIVER NEAR ODESSA, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073

LATITUDE: 451337 LONGITUDE: 0962112 NAD27 DRAINAGE AREA:459 CONTRIBUTING DRAINAGE AREA: DATUM:953.34 NGVD29

Date Processed: 2011-08-24 09:42 By mitton
Rating for Discharge (cfs)
RATING ID: 33.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by jlarson on 12-28-2010 @ 14:00:58 CST, Updated by mitton on 01-11-2011 @ 16:48:05 CST

RATING REMARKS: OFFSET CHANGED FROM .40 TO 1.00

OFFSET: 1.00

EXPANDED RATING TABLE											
Gage height, feet	Discharge (cfs)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
16.50	5920	5920	5930	5940	5940	5950	5960	5960	5970	5980	60.0
16.60	5980	5990	5990	6000	6010	6010	6020	6030	6030	6040	70.0
16.70	6050	6050	6060	6070	6070	6080	6090	6090	6100	6110	60.0
16.80	6110	6120	6130	6130	6140	6150	6150	6160	6170	6170	70.0
16.90	6180	6190	6190	6200	6210	6210	6220	6230	6230	6240	70.0
17.00	6250	6250	6260	6270	6270	6280	6290	6290	6300	6310	60.0
17.10	6310	6320	6330	6330	6340	6350	6350	6360	6370	6370	70.0
17.20	6380	6390	6390	6400	6410	6410	6420	6430	6430	6440	70.0
17.30	6450	6450	6460	6470	6470	6480	6490	6490	6500	6510	60.0
17.40	6510	6520	6530	6530	6540	6550	6550	6560	6570	6580	70.0
17.50	6580	6590	6600	6600	6610	6620	6620	6630	6640	6640	70.0
17.60	6650	6660	6660	6670	6680	6680	6690	6700	6700	6710	70.0
17.70	6720	6730	6730	6740	6750	6750	6760	6770	6770	6780	70.0
17.80	6790	6790	6800	6810	6810	6820	6830	6840	6840	6850	70.0
17.90	6860	6860	6870	6880	6880	6890	6900	6900	6910	6920	70.0
18.00	6930	6930	6940	6950	6950	6960	6970	6970	6980	6990	70.0
18.10	7000	7000	7010	7020	7020	7030	7040	7040	7050	7060	70.0
18.20	7070	7070	7080	7090	7090	7100	7110	7110	7120	7130	70.0
18.30	7140	7140	7150	7160	7160	7170	7180	7180	7190	7200	70.0
18.40	7210	7210	7220	7230	7230	7240	7250	7260	7260	7270	70.0
18.50	7280	7280	7290	7300	7310	7310	7320	7330	7330	7340	70.0
18.60	7350	7350	7360	7370	7380	7380	7390	7400	7400	7410	70.0
18.70	7420	7430	7430	7440	7450	7450	7460	7470	7480	7480	70.0
18.80	7490	7500	7510	7510	7520	7530	7530	7540	7550	7560	70.0
18.90	7560	7570	7580	7580	7590	7600	7610	7610	7620	7630	70.0
19.00	7630	7640	7650	7660	7660	7670	7680	7690	7690	7700	80.0
19.10	7710	7710	7720	7730	7740	7740	7750	7760	7770	7770	70.0
19.20	7780	7790	7790	7800	7810	7820	7820	7830	7840	7850	70.0
19.30	7850	7860	7870	7880	7880	7890	7900	7900	7910	7920	80.0
19.40	7930	7930	7940	7950	7960	7960	7970	7980	7990	7990	70.0
19.50	8000*										

"*" indicates a rating descriptor point

Rating Type:		Rating Type: stage-discharge		
ID	Starting Date	Ending Date	A	Comments
33.0	05-05-2010 @ 01:00:00 CDT	02-23-2011 @ 23:59:59 CST	A	
33.0	02-24-2011 @ 00:00:00 CST	-----	W	

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05294000 POMME DE TERRE RIVER AT APPLETON, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:151
 LATITUDE: 451210 LONGITUDE: 0960120 NAD27 DRAINAGE AREA:905 CONTRIBUTING DRAINAGE AREA: DATUM:978.00 NGVD29
 Date Processed: 2011-08-24 09:39 By mitton
 Rating for Discharge (cfs)
 RATING ID: 37.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-30-2010 @ 12:26:26 CST, Updated by mitton on 01-12-2011 @ 13:28:32 CST

RATING REMARKS:

OFFSET: 2.50

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
3.40					14.3*	14.7	15.1	15.5	15.9	16.3	4.0
3.50	16.7	17.1	17.5	18.0	18.4	18.8	19.3	19.8	20.2	20.7	4.5
3.60	21.2	21.6	22.1	22.6	23.1	23.6	24.1	24.7	25.2	25.7	5.1
3.70	26.3	26.8	27.4	27.9	28.5	29.1	29.7	30.2	30.8	31.4	5.8
3.80	32.1	32.7	33.3	33.9	34.6	35.2	35.9	36.5	37.2	37.9	6.4
3.90	38.5	39.2	39.9	40.6	41.3	42.1	42.8	43.5	44.3	45.0	7.3
4.00	45.8	46.5	47.3	48.1	48.9	49.6	50.4	51.3	52.1	52.9	7.9
4.10	53.7	54.6	55.4	56.3	57.1	58.0	58.9	59.8	60.7	61.6	8.8
4.20	62.5	63.4	64.3	65.2	66.2	67.1	68.1	69.1	70.0	71.0	9.5
4.30	72.0	73.0	74.0	75.0	76.1	77.1	78.1	79.2	80.2	81.3	10.4
4.40	82.4	83.5	84.6	85.7	86.8	87.9	89.0	90.1	91.3	92.4	11.2
4.50	93.6	94.8	95.9	97.1	98.3	99.5	101	102	103	104	12.4
4.60	106	107	108	109	111	112	113	115	116	117	13.0
4.70	119	120	121	123	124	125	127	128	130	131	13.0
4.80	132	134	135	137	138	140	141	143	144	146	15.0
4.90	147	149	150	152	153	155	157	158	160	161	16.0
5.00	163	165	166	168	170	171	173	175	176	178	17.0
5.10	180	181	183	185	187	188	190	192	194	196	17.0
5.20	197	199	201	203	205	207	209	210	212	214	19.0
5.30	216	218	220	222	224	226	228	230	232	234	20.0
5.40	236	238	240	242	244	246	248	250	252	254	21.0
5.50	257	259	261	263	265	267	270	272	274	276	21.0
5.60	278	281	283	285	287	290	292	294	297	299	23.0
5.70	301	304	306	308	311	313	315	318	320	323	24.0
5.80	325	328	330	333	335	338	340	343	345	348	25.0
5.90	350	353	355	358	361	363	366	368	371	374	26.0
6.00	376	379	382	385	387	390	393	395	398	401	28.0
6.10	404	407	409	412	415	418	421	424	426	429	28.0
6.20	432	435	438	441	444	447	450	453	456	459	30.0
6.30	462	465	468	471	474	477	480	483	486	490	31.0
6.40	493	496	499	502	505	509	512	515	518	521	32.0
6.50	525	528	531	535	538	541	545	548	551	555	33.0
6.60	558	561	565	568	572	575	579	582	585	589	34.0
6.70	592	596	599	603	607	610	614	617	621	625	36.0
6.80	628	632	635	639	643	646	650	654	658	661	37.0
6.90	665	669	673	676	680	684	688	692	696	699	38.0
7.00	703	707	711	715	719	723	727	731	735	739	40.0
7.10	743	747	751	755	759	763	767	771	775	780	41.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05294000 POMME DE TERRE RIVER AT APPLETON, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:151
 LATITUDE: 451210 LONGITUDE: 0960120 NAD27 DRAINAGE AREA:905 CONTRIBUTING DRAINAGE AREA: DATUM:978.00 NGVD29
 Date Processed: 2011-08-24 09:39 By mitton
 Rating for Discharge (cfs)
 RATING ID: 37.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-30-2010 @ 12:26:26 CST, Updated by mitton on 01-12-2011 @ 13:28:32 CST

RATING REMARKS:

OFFSET: 2.50

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	Discharge (cfs)					(STANDARD PRECISION)					
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
7.20	784	788	792	796	800	805	809	813	817	822	42.0
7.30	826	830	834	839	843	847	852	856	860	865	43.0
7.40	869	874	878	883	887	891	896	900	905	910	45.0
7.50	914	919	923	928	932	937	942	946	951	956	46.0
7.60	960	965	970	974	979	984	989	993	998	1000	50.0
7.70	1010	1010	1020	1020	1030	1030	1040	1040	1050	1050	50.0
7.80	1060	1060	1070	1070	1080	1080	1090	1090	1100	1100	50.0
7.90	1110	1110	1120	1120	1130	1130	1140	1140	1150	1150	50.0
8.00	1160	1160	1170	1170	1180	1180	1190	1200	1200	1210	50.0
8.10	1210	1220	1220	1230	1230	1240	1240	1250	1260	1260	60.0
8.20	1270	1270	1280	1280	1290	1290	1300	1310	1310	1320	50.0
8.30	1320	1330	1330	1340	1340	1350	1360	1360	1370	1370	60.0
8.40	1380	1390	1390	1400	1400	1410	1410	1420	1430	1430	60.0
8.50	1440	1440	1450	1460	1460	1470	1470	1480	1490	1490	60.0
8.60	1500	1510	1510	1520	1520	1530	1540	1540	1550	1550	60.0
8.70	1560	1570	1570	1580	1590	1590	1600	1600	1610	1620	60.0
8.80	1620	1630	1640	1640	1650	1660	1660	1670	1680	1680	70.0
8.90	1690	1700	1700	1710	1720	1720	1730	1740	1740	1750	70.0
9.00	1760	1760	1770	1780	1780	1790	1800	1800	1810	1820	60.0
9.10	1820	1830	1840	1840	1850	1860	1860	1870	1880	1890	70.0
9.20	1890	1900	1910	1910	1920	1930	1940	1940	1950	1960	70.0
9.30	1960	1970	1980	1990	1990	2000*	2010	2010	2020	2030	70.0
9.40	2030	2040	2050	2050	2060	2060	2070	2080	2080	2090	70.0
9.50	2100	2100	2110	2120	2120	2130	2140	2140	2150	2160	60.0
9.60	2160	2170	2180	2180	2190	2200	2200	2210	2220	2230	70.0
9.70	2230	2240	2250	2250	2260	2270	2270	2280	2290	2290	70.0
9.80	2300	2310	2310	2320	2330	2340	2340	2350	2360	2360	70.0
9.90	2370	2380	2380	2390	2400	2410	2410	2420	2430	2430	70.0
10.00	2440	2450	2460	2460	2470	2480	2490	2490	2500	2510	70.0
10.10	2510	2520	2530	2540	2540	2550	2560	2570	2570	2580	80.0
10.20	2590	2600	2600	2610	2620	2620	2630	2640	2650	2650	70.0
10.30	2660	2670	2680	2680	2690	2700	2710	2720	2720	2730	80.0
10.40	2740	2750	2750	2760	2770	2780	2780	2790	2800	2810	70.0
10.50	2810	2820	2830	2840	2850	2850	2860	2870	2880	2890	80.0
10.60	2890	2900	2910	2920	2920	2930	2940	2950	2960	2960	80.0
10.70	2970	2980	2990	3000*	3000	3010	3020	3020	3030	3040	70.0
10.80	3040	3050	3060	3060	3070	3070	3080	3090	3090	3100	70.0
10.90	3110	3110	3120	3130	3130	3140	3150	3150	3160	3170	60.0

STATION:05294000 POMME DE TERRE RIVER AT APPLETON, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:151
 LATITUDE: 451210 LONGITUDE: 0960120 NAD27 DRAINAGE AREA:905 CONTRIBUTING DRAINAGE AREA: DATUM:978.00 NGVD29
 Date Processed: 2011-08-24 09:39 By mitton
 Rating for Discharge (cfs)
 Rating ID: 37.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-30-2010 @ 12:26:26 CST, Updated by mitton on 01-12-2011 @ 13:28:32 CST

RATING REMARKS:

OFFSET: 2.50

OFFSET: 2.50

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	Discharge (cfs)										
	(STANDARD PRECISION)										
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
11.00	3170	3180	3190	3190	3200	3210	3210	3220	3230	3230	70.0
11.10	3240	3250	3260	3260	3270	3280	3280	3290	3300	3300	70.0
11.20	3310	3320	3320	3330	3340	3340	3350	3360	3360	3370	70.0
11.30	3380	3380	3390	3400	3410	3410	3420	3430	3430	3440	70.0
11.40	3450	3450	3460	3470	3470	3480	3490	3500	3500	3510	70.0
11.50	3520	3520	3530	3540	3540	3550	3560	3570	3570	3580	70.0
11.60	3590	3590	3600	3610	3620	3620	3630	3640	3640	3650	70.0
11.70	3660	3660	3670	3680	3690	3690	3700	3710	3710	3720	70.0
11.80	3730	3740	3740	3750	3760	3770	3770	3780	3790	3790	70.0
11.90	3800	3810	3820	3820	3830	3840	3840	3850	3860	3870	70.0
12.00	3870	3880	3890	3900	3900	3910	3920	3930	3930	3940	80.0
12.10	3950	3950	3960	3970	3980	3980	3990*	4000	4010	4010	70.0
12.20	4020	4030	4040	4040	4050	4060	4070	4070	4080	4090	70.0
12.30	4090	4100	4110	4120	4120	4130	4140	4150	4150	4160	80.0
12.40	4170	4180	4180	4190	4200	4210	4210	4220	4230	4240	70.0
12.50	4240	4250	4260	4270	4270	4280	4290	4300	4300	4310	80.0
12.60	4320	4330	4330	4340	4350	4360	4370	4370	4380	4390	80.0
12.70	4400	4400	4410	4420	4430	4430	4440	4450	4460	4460	70.0
12.80	4470	4480	4490	4500	4500	4510	4520	4530	4530	4540	80.0
12.90	4550	4560	4570	4570	4580	4590	4600	4600	4610	4620	80.0
13.00	4630	4640	4640	4650	4660	4670	4670	4680	4690	4700	80.0
13.10	4710	4710	4720	4730	4740	4750	4750	4760	4770	4780	80.0
13.20	4790	4790	4800	4810	4820	4820	4830	4840	4850	4860	70.0
13.30	4860	4870	4880	4890	4900	4900	4910	4920	4930	4940	90.0
13.40	4950	4950	4960	4970	4980	4990	4990	5000	5010	5020	80.0
13.50	5030	5030	5040	5050	5060	5070	5070	5080	5090	5100	80.0
13.60	5110	5120	5120	5130	5140	5150	5160	5160	5170	5180	80.0
13.70	5190	5200	5210	5210	5220	5230	5240	5250	5250	5260	80.0
13.80	5270	5280	5290	5300	5300	5310	5320	5330	5340	5350	80.0
13.90	5350	5360	5370	5380	5390	5400	5400	5410	5420	5430	90.0
14.00	5440	5450	5450	5460	5470	5480	5490	5500	5510	5510	80.0
14.10	5520	5530	5540	5550	5560	5560	5570	5580	5590	5600	90.0
14.20	5610	5620	5620	5630	5640	5650	5660	5670	5680	5680	80.0
14.30	5690	5700	5710	5720	5730	5740	5740	5750	5760	5770	90.0
14.40	5780	5790	5800	5800	5810	5820	5830	5840	5850	5860	80.0
14.50	5860	5870	5880	5890	5900	5910	5920	5930	5930	5940	90.0
14.60	5950	5960	5970	5980	5990	6000*					

"" indicates a rating descriptor point

Rating Type:		Rating Type: stage-discharge		
ID	Starting Date	Ending Date	A	Comments
37.0	05-06-2010 @ 06:56:01 CDT	11-29-2010 @ 23:59:59 CST	A	
37.0	11-30-2010 @ 00:00:00 CST	-----	W	

STATION:05300000 LAC QUI PARLE RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073
 LATITUDE: 445943 LONGITUDE: 0955510 NAD27 DRAINAGE AREA:960 CONTRIBUTING DRAINAGE AREA: DATUM:946.98 NGVD29

Date Processed: 2011-08-24 09:40 By mitton

Rating for Discharge (cfs)

RATING ID: 47.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-29-2010 @ 13:33:41 CST, Updated by mitton on 02-05-2011 @ 12:20:23 CST

RATING REMARKS: Below stage of 1.0 rating is poorly defined.

OFFSET: 4.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
4.50					1.0*	1.1	1.2	1.4	1.5	1.7	1.3
4.60	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.3	3.5	3.8	2.2
4.70	4.0	4.3	4.6	4.9	5.2	5.5	5.9	6.2	6.6	7.0	3.4
4.80	7.4	7.8	8.2	8.7	9.1	9.6	10.1	10.6	11.1	11.6	4.8
4.90	12.2	12.7	13.3	13.9	14.5	15.1*	15.7	16.3	17.0	17.6	6.1
5.00	18.3	19.0	19.7	20.4*	21.0	21.7	22.4	23.1	23.8	24.6	7.0
5.10	25.3	26.1	26.9	27.7	28.5	29.3	30.1	30.9*	31.8	32.7	8.3
5.20	33.6	34.5	35.4	36.3	37.3	38.2	39.2	40.2	41.2	42.2	9.6
5.30	43.2	44.3	45.3	46.4	47.5	48.6	49.7	50.9*	52.0	53.1	11.0
5.40	54.2	55.4	56.5	57.7	58.9	60.1	61.3	62.5	63.8	65.0	12.1
5.50	66.3	67.6	68.9	70.2*	71.4	72.6	73.9	75.1	76.4	77.7	12.7
5.60	79.0	80.3	81.6	82.9	84.3	85.6	87.0	88.4	89.8	91.2	13.6
5.70	92.6	94.0	95.4	96.9*	98.3	99.8	101	103	104	106	14.4
5.80	107	109	111	112	114	115	117	119	120	122	17.0
5.90	124	125	127	129	130	132	134	136	137	139	17.0
6.00	141	143	144	146	148	150	152	154	156	158	18.0
6.10	159	161	163	165	167	169*	171	173	175	177	20.0
6.20	179	181	183	185	187	189	191	193	195	198	21.0
6.30	200	202	204	206	208	210	213	215	217	219	22.0
6.40	222	224	226	228	231	233	235	238	240	242	23.0
6.50	245	247	249	252	254	257*	259	261	263	265	22.0
6.60	267	269	271	274	276	278	280	282	285	287	22.0
6.70	289	291	294	296	298	300	303	305	307	309	23.0
6.80	312	314	316	319	321	323	326	328	330	333	23.0
6.90	335	338	340	342	345	347	350	352	354	357	24.0
7.00	359	362	364	367	369	372	374	377	379	382	25.0
7.10	384	387	389*	392	394	397	400	402	405	407	26.0
7.20	410	412	415	418	420	423	425	428	431	433	26.0
7.30	436	439	441	444	447	449	452	455	457	460	27.0
7.40	463	466	468	471	474	477	479	482	485	488	27.0
7.50	490	493	496	499	502	505	507	510	513	516	29.0
7.60	519	522	525	527	530	533	536	539	542	545	29.0
7.70	548	551	554	557	560	563	566	569	572	575	30.0
7.80	578	581	584	587	590	593	596	599	602	605	30.0
7.90	608	611	614	617	621	624	627	630	633	636	31.0
8.00	639	642	646	649	652	655	658	662	665	668	32.0
8.10	671	674	678	681	684	687*	690	693	696	699	32.0
8.20	703	706	709	712	715	718	721	724	727	730	30.0
8.30	733	736	739	742	746	749	752	755	758	761	31.0

STATION:05300000 LAC QUI PARLE RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073
 LATITUDE: 445943 LONGITUDE: 0955510 NAD27 DRAINAGE AREA:960 CONTRIBUTING DRAINAGE AREA: DATUM:946.98 NGVD29
 Date Processed: 2011-08-24 09:40 By mitton

Rating for Discharge (cfs)

RATING ID: 47.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-29-2010 @ 13:33:41 CST, Updated by mitton on 02-05-2011 @ 12:20:23 CST

RATING REMARKS: Below stage of 1.0 rating is poorly defined.

OFFSET: 4.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	.1
8.40	764	767	771	774	777	780	783	786	790	793	32.0
8.50	796	799	802	806	809	812	815	818	822	825	32.0
8.60	828	831	835	838	841	844	848	851	854	858	33.0
8.70	861	864	867	871	874	877	881	884	887	891	33.0
8.80	894	897	901	904	908	911	914	918	921	924	34.0
8.90	928	931	935	938	941	945	948	952	955	959	34.0
9.00	962	966	969*	973	976	980	984	988	991	995	37.0
9.10	999	1000	1010	1010	1010	1020	1020	1030	1030	1030	41.0
9.20	1040	1040	1040	1050	1050	1060	1060	1060	1070	1070	30.0
9.30	1070	1080	1080	1090	1090	1090	1100	1100	1110	1110	40.0
9.40	1110	1120	1120	1130	1130	1130	1140	1140	1150	1150	40.0
9.50	1150	1160	1160	1170	1170	1170	1180	1180	1190	1190	40.0
9.60	1190	1200	1200	1210	1210	1210	1220	1220	1230	1230	40.0
9.70	1230	1240	1240	1250	1250	1260	1260	1260	1270	1270	50.0
9.80	1280	1280	1280	1290	1290	1300	1300	1310	1310	1310	40.0
9.90	1320	1320	1330	1330	1330	1340	1340	1350	1350	1360	40.0
10.00	1360	1360	1370	1370	1380	1380	1390	1390	1400	1400	40.0
10.10	1400	1410	1410	1420	1420	1430	1430	1430	1440	1440	50.0
10.20	1450	1450	1460	1460	1470	1470	1480	1480	1480	1490	40.0
10.30	1490	1500	1500	1510	1510	1510	1520	1520	1530	1530	50.0
10.40	1540	1540	1550	1550	1560	1560	1560	1570	1570	1580	40.0
10.50	1580	1590	1590	1600	1600	1610	1610	1610	1620	1620	50.0
10.60	1630	1630	1640	1640	1650	1650	1660	1660	1670	1670	50.0
10.70	1680	1680	1690	1690	1690	1700	1700	1710	1710	1720	40.0
10.80	1720	1730	1730	1740	1740	1750	1750	1760	1760	1770	50.0
10.90	1770	1780	1780	1790	1790	1800	1800	1800	1810	1810	50.0
11.00	1820	1820	1830	1830	1840	1840	1850	1850	1860	1860	50.0
11.10	1870	1870	1880	1880	1890	1890	1900	1900	1910	1910	50.0
11.20	1920	1920	1930	1930	1940	1940	1950	1950	1960	1960	50.0
11.30	1970	1970	1980	1980	1990	1990	2000	2000	2010	2010	50.0
11.40	2020	2020	2030	2040	2040	2050	2050	2060	2060	2070	50.0
11.50	2070	2080	2080	2090	2090	2100	2100	2110	2110	2120	50.0
11.60	2120	2130	2130	2140	2140	2150	2150	2160	2170	2170	60.0
11.70	2180	2180	2190	2190	2200	2200	2210	2210	2220	2220	50.0
11.80	2230	2230	2240	2240	2250	2260	2260	2270	2270	2280	50.0
11.90	2280	2290	2290	2300	2300	2310	2320	2320	2330	2330	60.0
12.00	2340	2340	2350	2350	2360	2360	2370	2380	2380	2390	50.0
12.10	2390	2400	2400	2410	2410	2420	2430	2430	2440	2440	60.0

STATION:05300000 LAC QUI PARLE RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073
 LATITUDE: 445943 LONGITUDE: 0955510 NAD27 DRAINAGE AREA:960 CONTRIBUTING DRAINAGE AREA: DATUM:946.98 NGVD29
 Date Processed: 2011-08-24 09:40 By mitton

Rating for Discharge (cfs)
 RATING ID: 47.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-29-2010 @ 13:33:41 CST, Updated by mitton on 02-05-2011 @ 12:20:23 CST

RATING REMARKS: Below stage of 1.0 rating is poorly defined.

OFFSET: 4.30

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	Discharge (cfs)					(STANDARD PRECISION)					
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
12.20	2450	2450	2460	2460	2470	2480	2480	2490	2490	2500	50.0
12.30	2500	2510	2510	2520	2530	2530	2540	2540	2550	2550	60.0
12.40	2560	2570	2570	2580	2580	2590	2590	2600	2610	2610	60.0
12.50	2620	2620	2630	2630	2640	2650	2650	2660	2660	2670	50.0
12.60	2670	2680	2690	2690	2700	2700	2710	2720	2720	2730	60.0
12.70	2730	2740	2740	2750	2760	2760	2770	2770	2780	2790	60.0
12.80	2790	2800	2800	2810	2820	2820	2830	2830	2840	2850	60.0
12.90	2850	2860	2860	2870	2870	2880	2890	2890	2900	2900	60.0
13.00	2910	2920	2920	2930	2940	2940	2950	2950	2960	2970	60.0
13.10	2970	2980	2980	2990	3000	3000	3010	3010	3020	3030	60.0
13.20	3030	3040	3040	3050	3060	3060	3070	3080	3080	3090	60.0
13.30	3090	3100	3110	3110	3120	3120	3130	3140	3140	3150	70.0
13.40	3160	3160	3170	3170	3180	3190	3190	3200	3210	3210	60.0
13.50	3220	3230	3230	3240	3240	3250	3260	3260	3270	3280	60.0
13.60	3280	3290	3290	3300	3310	3310	3320	3330	3330	3340	70.0
13.70	3350	3350	3360	3360	3370	3380	3380	3390	3400	3400	60.0
13.80	3410	3420	3420	3430	3440	3440	3450	3460	3460	3470	60.0
13.90	3470	3480	3490	3490	3500	3510	3510	3520	3530	3530	70.0
14.00	3540	3550	3550	3560	3570	3570	3580	3590	3590	3600	70.0
14.10	3610	3610	3620	3630	3630	3640	3650	3650	3660	3670	60.0
14.20	3670	3680	3690	3690	3700	3710	3710	3720	3730	3730	70.0
14.30	3740	3750	3750	3760	3770	3770	3780*	3790	3790	3800	70.0
14.40	3810	3810	3820	3820	3830	3840	3840	3850	3860	3860	60.0
14.50	3870	3880	3880	3890	3900	3900	3910	3910	3920	3930	60.0
14.60	3930	3940	3950	3950	3960	3970	3970	3980	3990	3990	70.0
14.70	4000	4010	4010	4020	4030	4030	4040	4050	4050	4060	60.0
14.80	4060	4070	4080	4080	4090	4100	4100	4110	4120	4120	70.0
14.90	4130	4140	4140	4150	4160	4160	4170	4180	4180	4190	70.0
15.00	4200	4200	4210	4220	4220	4230	4240	4240	4250	4260	60.0
15.10	4260	4270	4280	4280	4290	4300	4300	4310	4320	4320	70.0
15.20	4330	4340	4340	4350	4360	4360	4370	4380	4390	4390	70.0
15.30	4400	4410	4410	4420	4430	4430	4440	4450	4450	4460	70.0
15.40	4470	4470	4480	4490	4490	4500	4510	4510	4520	4530	70.0
15.50	4540	4540	4550	4560	4560	4570	4580	4580	4590	4600	60.0
15.60	4600*	4610	4620	4620	4630	4640	4640	4650	4660	4660	70.0
15.70	4670	4680	4680	4690	4700	4700	4710	4710	4720	4730	60.0
15.80	4730	4740	4750	4750	4760	4770	4770	4780	4790	4790	70.0
15.90	4800	4810	4810	4820	4830	4830	4840	4850	4850	4860	70.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05300000 LAC QUI PARLE RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073

LATITUDE: 445943 LONGITUDE: 0955510 NAD27 DRAINAGE AREA:960 CONTRIBUTING DRAINAGE AREA: DATUM:946.98 NGVD29

Date Processed: 2011-08-24 09:40 By mitton

Rating for Discharge (cfs)

RATING ID: 47.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by jlarson on 12-29-2010 @ 13:33:41 CST, Updated by mitton on 02-05-2011 @ 12:20:23 CST

RATING REMARKS: Below stage of 1.0 rating is poorly defined.

OFFSET: 4.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
16.00	4870	4870	4880	4890	4890	4900	4910	4910	4920	4930	60.0
16.10	4930	4940	4950	4950	4960	4970	4970	4980	4990	4990	70.0
16.20	5000	5010	5010	5020	5030	5030	5040	5050	5050	5060	70.0
16.30	5070	5070	5080	5090	5090	5100	5110	5110	5120	5130	60.0
16.40	5130	5140	5150	5150	5160	5170	5170	5180	5190	5190	70.0
16.50	5200	5210	5210	5220	5230	5230	5240	5250	5260	5260	70.0
16.60	5270	5280	5280	5290	5300	5300	5310	5320	5320	5330	70.0
16.70	5340	5340	5350	5360	5360	5370	5380	5390	5390	5400	70.0
16.80	5410	5410	5420	5430	5430	5440	5450	5450	5460	5470	60.0
16.90	5470	5480	5490	5500	5500*	5510	5520	5530	5530	5540	80.0
17.00	5550	5560	5560	5570	5580	5590	5590	5600	5610	5620	70.0
17.10	5620	5630	5640	5650	5650	5660	5670	5680	5690	5690	80.0
17.20	5700	5710	5720	5720	5730	5740	5750	5750	5760	5770	80.0
17.30	5780	5790	5790	5800	5810	5820	5820	5830	5840	5850	70.0
17.40	5850	5860	5870	5880	5890	5890	5900	5910	5920	5920	80.0
17.50	5930	5940	5950	5960	5960	5970	5980	5990	6000	6000	80.0
17.60	6010	6020	6030	6030	6040	6050	6060	6070	6070	6080	80.0
17.70	6090	6100	6110	6110	6120	6130	6140	6140	6150	6160	80.0
17.80	6170	6180	6180	6190	6200	6210	6220	6220	6230	6240	80.0
17.90	6250	6260	6260	6270	6280	6290	6300	6300	6310	6320	80.0
18.00	6330	6340	6340	6350	6360	6370	6380	6380	6390	6400	80.0
18.10	6410	6420	6420	6430	6440	6450	6460	6460*	6470	6480	80.0
18.20	6490	6500	6510	6520	6530	6540	6550	6550	6560	6570	90.0
18.30	6580	6590	6600	6610	6620	6630	6640	6640	6650	6660	90.0
18.40	6670	6680	6690	6700	6710	6720	6730	6740	6740	6750	90.0
18.50	6760	6770	6780	6790	6800	6810	6820	6830	6840	6840	90.0
18.60	6850	6860	6870	6880	6890	6900	6910	6920	6930	6940	100
18.70	6950	6960	6960	6970	6980	6990	7000	7010	7020	7030	90.0
18.80	7040	7050	7060	7070	7080	7080	7090	7100	7110	7120	90.0
18.90	7130	7140	7150	7160	7170	7180	7190	7200	7210	7220	100
19.00	7230	7230	7240	7250	7260	7270	7280	7290	7300	7310	90.0
19.10	7320	7330	7340	7350	7360	7370	7380	7390	7400	7410	90.0
19.20	7410	7420	7430	7440	7450	7460	7470	7480	7490	7500	100
19.30	7510	7520	7530	7540	7550	7560	7570	7580	7590	7600	100
19.40	7610	7620	7630	7640	7640	7650	7660	7670	7680	7690	90.0
19.50	7700	7710	7720	7730	7740	7750	7760	7770	7780	7790	100
19.60	7800*	7810	7830	7840	7850	7870	7880	7890	7910	7920	140
19.70	7940	7950	7960	7980	7990	8000	8020	8030	8050	8060	130
19.80	8070	8090	8100	8110	8130	8140	8160	8170	8180	8200	140

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05300000 LAC QUI PARLE RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073
LATITUDE: 445943 LONGITUDE: 0955510 NAD27 DRAINAGE AREA:960 CONTRIBUTING DRAINAGE AREA: DATUM:946.98 NGVD29

Date Processed: 2011-08-24 09:40 By mitton
Rating for Discharge (cfs)
RATING ID: 47.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by jlarson on 12-29-2010 @ 13:33:41 CST, Updated by mitton on 02-05-2011 @ 12:20:23 CST

RATING REMARKS: Below stage of 1.0 rating is poorly defined.

OFFSET: 4.30

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
19.90	8210	8230	8240	8250	8270	8280	8300	8310	8320	8340	140
20.00	8350	8370	8380	8390	8410	8420	8440	8450	8460	8480	140
20.10	8490	8510	8520	8540	8550	8560	8580	8590	8610	8620	150
20.20	8640	8650	8660	8680	8690	8710	8720	8740	8750	8770	140
20.30	8780	8790	8810	8820	8840	8850	8870	8880	8900	8910	150
20.40	8930	8940	8960	8970	8990	9000*	9020	9040	9060	9070	160
20.50	9090	9110	9130	9150	9170	9190	9210	9230	9240	9260	190
20.60	9280	9300	9320	9340	9360	9380	9400	9420	9440	9460	190
20.70	9470	9490	9510	9530	9550	9570	9590	9610	9630	9650	200
20.80	9670	9690	9710	9730	9750	9770	9790	9810	9830	9850	200
20.90	9870	9890	9910	9930	9950	9970	9990	10000	10000	10000	230
21.00	10100	10100	10100	10100	10100	10200	10200	10200	10200	10300	200
21.10	10300	10300	10300	10300	10400	10400	10400	10400	10400	10500	200
21.20	10500	10500	10500	10500	10600	10600	10600	10600	10600	10700	200
21.30	10700	10700	10700	10700	10800	10800	10800	10800	10800	10900	200
21.40	10900	10900	10900	11000	11000	11000	11000	11000	11100	11100	200
21.50	11100	11100	11200	11200	11200	11200	11200	11300	11300	11300	200
21.60	11300	11400	11400	11400	11400	11400	11500	11500	11500	11500	300
21.70	11600	11600	11600	11600	11600	11700	11700	11700	11700	11800	200
21.80	11800	11800	11800	11800	11900	11900	11900	11900	12000	12000	200
21.90	12000	12000	12000	12100	12100	12100	12100	12200	12200	12200	200
22.00	12200	12300	12300	12300	12300	12300	12400	12400	12400	12400	300
22.10	12500	12500	12500	12500	12600	12600	12600	12600	12700	12700	200
22.20	12700	12700	12700	12800	12800	12800	12800	12900	12900	12900	200
22.30	12900	13000	13000	13000	13000	13100	13100	13100	13100	13200	300
22.40	13200	13200	13200	13300	13300	13300	13300	13400	13400	13400	200
22.50	13400	13500	13500	13500	13500	13500	13600	13600	13600	13600	300
22.60	13700	13700	13700	13700	13800	13800	13800	13800	13900	13900	200
22.70	13900	14000	14000	14000	14000	14100	14100	14100	14100	14200	300
22.80	14200	14200	14200	14300	14300	14300	14300	14400	14400	14400	200
22.90	14400	14500	14500	14500	14500	14600	14600	14600	14600	14700	300
23.00	14700	14700	14800	14800	14800	14800	14900	14900	14900	14900	300
23.10	15000	15000	15000	15000	15100	15100	15100	15200	15200	15200	200
23.20	15200	15300	15300	15300	15300	15400	15400	15400	15400	15500	300
23.30	15500	15500	15600	15600	15600	15600	15700	15700	15700	15800	300
23.40	15800	15800	15800	15900	15900	15900	15900	16000	16000	16000	300
23.50	16100	16100	16100	16100	16200	16200	16200	16300	16300	16300	200
23.60	16300	16400	16400	16400	16500	16500	16500	16500	16600	16600	300

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05300000 LAC QUI PARLE RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:073
LATITUDE: 445943 LONGITUDE: 0955510 NAD27 DRAINAGE AREA:960 CONTRIBUTING DRAINAGE AREA: DATUM:946.98 NGVD29
Date Processed: 2011-08-24 09:40 By mitton

Rating for Discharge (cfs)
 RATING ID: 47.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by jlarson on 12-29-2010 @ 13:33:41 CST, Updated by mitton on 02-05-2011 @ 12:20:23 CST

RATING REMARKS: Below stage of 1.0 rating is poorly defined.

OFFSET: 4.30

EXPANDED RATING TABLE											
Gage height, feet	Discharge (cfs)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
23.70	16600	16700	16700	16700	16700	16800	16800	16800	16900	16900	300
23.80	16900	16900	17000	17000	17000	17100	17100	17100	17100	17200	300
23.90	17200	17200	17300	17300	17300	17400	17400	17400	17400	17500	300
24.00	17500*										

"*" indicates a rating descriptor point

Rating Type:		Rating Type: stage-discharge		A	Comments
ID	Starting Date	Ending Date			
47.0	05-06-2010 @ 13:31:01 CDT	11-30-2010 @ 23:59:59 CST		A	
47.0	12-01-2010 @ 00:00:00 CST	-----		W	

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05301000 MINNESOTA RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
 LATITUDE: 450117 LONGITUDE: 0955205 NAD27 DRAINAGE AREA:4050 CONTRIBUTING DRAINAGE AREA: DATUM:900.00 NGVD29

Date Processed: 2011-08-24 09:39 By mitton

Rating for Discharge - TAILWATER (cfs)

RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
 Created by ddaly on 05-29-2011 @ 16:38:51 CDT, Updated by ddaly on 06-01-2011 @ 09:00:26 CDT

RATING REMARKS: Change of slope to lower end, positive adjustment 24-35 ft.

OFFSET: 19.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
20.00	3.6*	3.8	4.1	4.3	4.6	4.8	5.1	5.4	5.8	6.1	2.8
20.10	6.4	6.8	7.2	7.6	8.0	8.4	8.9	9.4	9.9	10.4	4.5
20.20	10.9	11.5	12.1	12.7	13.4	14.0	14.7	15.5	16.2	17.0	6.9
20.30	17.8	18.7	19.6	20.5	21.4	22.4	23.5	24.5	25.6	26.8	10.2
20.40	28.0*	29.0	30.0	31.0	32.1	33.2	34.3	35.5	36.7	37.9	11.2
20.50	39.2	40.4	41.8	43.1	44.5	45.9	47.4	48.9	50.4	52.0	14.4
20.60	53.6	55.2	56.9	58.7	60.4	62.2	64.1	66.0	67.9	69.9	18.4
20.70	72.0	74.0	76.2	78.3	80.6	82.8	85.2	87.5	90.0	92.5	23.0
20.80	95.0*	97.2	99.5	102	104	107	109	111	114	117	24.0
20.90	119	122	124	127	130	133	136	139	142	145	29.0
21.00	148	151	154	157	160	164	167	171	174	178	33.0
21.10	181	185	188	192	196	200	204	208	212	216	39.0
21.20	220*	224	228	233	237	242	246	251	255	260	45.0
21.30	265*	270	274	279	284	289	294	299	304	310	50.0
21.40	315*	319	324	328	333	337	342	346	351	355	45.0
21.50	360*	363	367	370	374	377	381	384	388	391	35.0
21.60	395*	398	401	404	407	410	413	416	419	422	30.0
21.70	425	428	431	434	437	440	443	446	449	452	30.0
21.80	455	459	462	465	468	471	474	478	481	484	32.0
21.90	487	490	494	497	500	503	507	510	513	517	33.0
22.00	520*	523	525	528	531	533	536	539	542	544	27.0
22.10	547	550	553	555	558	561	564	566	569	572	28.0
22.20	575	577	580	583	586	589	591	594	597	600	28.0
22.30	603	605	608	611	614	617	620	622	625	628	28.0
22.40	631	634	637	640	643	645	648	651	654	657	29.0
22.50	660*	662	665	667	670	672	675	677	680	682	24.0
22.60	684	687	689	692	694	697	699	702	704	707	25.0
22.70	709	712	714	717	719	721	724	726	729	731	25.0
22.80	734	736	739	741	744	746	749	751	754	756	25.0
22.90	759	761	764	766	769	772	774	777	779	782	25.0
23.00	784	787	789	792	794	797	799	802	804	807	26.0
23.10	810	812	815	817	820	822	825	827	830	833	25.0
23.20	835	838	840	843	845	848	851	853	856	858	26.0
23.30	861	863	866	869	871	874	876	879	882	884	26.0
23.40	887	889	892	895	897	900	902	905	908	910	26.0
23.50	913	916	918	921	923	926	929	931	934	937	26.0
23.60	939	942	944	947	950	952	955	958	960	963	27.0
23.70	966	968	971	974	976	979	982	984	987	990	26.0
23.80	992	995	998	1000	1000	1010	1010	1010	1010	1020	28.0

STATION:05301000 MINNESOTA RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
 LATITUDE: 450117 LONGITUDE: 0955205 NAD27 DRAINAGE AREA:4050 CONTRIBUTING DRAINAGE AREA: DATUM:900.00 NGVD29

Date Processed: 2011-08-24 09:39 By mitton

Rating for Discharge - TAILWATER (cfs)

RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
 Created by ddaly on 05-29-2011 @ 16:38:51 CDT, Updated by ddaly on 06-01-2011 @ 09:00:26 CDT

RATING REMARKS: Change of slope to lower end, positive adjustment 24-35 ft.

OFFSET: 19.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
23.90	1020	1020	1020	1030	1030	1030	1040	1040	1040	1040	30.0
24.00	1050	1050	1050	1050	1060	1060	1060	1060	1070	1070	20.0
24.10	1070	1080	1080	1080	1080	1090	1090	1090	1090	1100	30.0
24.20	1100	1100	1110	1110	1110	1110	1120	1120	1120	1120	30.0
24.30	1130	1130	1130	1140	1140	1140	1140	1150	1150	1150	30.0
24.40	1160	1160	1160	1160	1170	1170	1170	1170	1180	1180	20.0
24.50	1180	1190	1190	1190	1190	1200	1200	1200	1210	1210	30.0
24.60	1210	1210	1220	1220	1220	1220	1230	1230	1230	1240	30.0
24.70	1240	1240	1240	1250	1250	1250	1260	1260	1260	1260	30.0
24.80	1270	1270	1270	1280	1280	1280	1280	1290	1290	1290	20.0
24.90	1290	1300	1300	1300	1310	1310	1310	1310	1320	1320	30.0
25.00	1320	1330	1330	1330	1330	1340	1340	1340	1350	1350	30.0
25.10	1350	1350	1360	1360	1360	1370	1370	1370	1370	1380	30.0
25.20	1380	1380	1390	1390	1390	1390	1400	1400	1400	1410	30.0
25.30	1410	1410	1420	1420	1420	1420	1430	1430	1430	1440	30.0
25.40	1440	1440	1440	1450	1450	1450	1460	1460	1460	1460	30.0
25.50	1470	1470	1470	1480	1480	1480	1480	1490	1490	1490	30.0
25.60	1500	1500	1500	1510	1510	1510	1510	1520	1520	1520	30.0
25.70	1530	1530	1530	1530	1540	1540	1540	1550	1550	1550	30.0
25.80	1560	1560	1560	1560	1570	1570	1570	1580	1580	1580	30.0
25.90	1590	1590	1590	1590	1600	1600	1600	1610	1610	1610	20.0
26.00	1610	1620	1620	1620	1630	1630	1630	1640	1640	1640	30.0
26.10	1640	1650	1650	1650	1660	1660	1660	1670	1670	1670	30.0
26.20	1670	1680	1680	1680	1690	1690	1690	1700	1700	1700	30.0
26.30	1700	1710	1710	1710	1720	1720	1720	1730	1730	1730	30.0
26.40	1730	1740	1740	1740	1750	1750	1750	1760	1760	1760	40.0
26.50	1770	1770	1770	1770	1780	1780	1780	1790	1790	1790	30.0
26.60	1800	1800	1800	1800	1810	1810	1810	1820	1820	1820	30.0
26.70	1830	1830	1830	1840	1840	1840	1840	1850	1850	1850	30.0
26.80	1860	1860	1860	1870	1870	1870	1880	1880	1880	1880	30.0
26.90	1890	1890	1890	1900	1900	1900	1910	1910	1910	1920	30.0
27.00	1920	1920	1920	1930	1930	1930	1940	1940	1940	1950	30.0
27.10	1950	1950	1960	1960	1960	1970	1970	1970	1970	1980	30.0
27.20	1980	1980	1990	1990	1990	2000	2000	2000	2010	2010	30.0
27.30	2010	2010	2020	2020	2020	2030	2030	2030	2040	2040	30.0
27.40	2040	2050	2050	2050	2060	2060	2060	2070	2070	2070	30.0
27.50	2070	2080	2080	2080	2090	2090	2090	2100	2100	2100	40.0
27.60	2110	2110	2110	2120	2120	2120	2130	2130	2130	2130	30.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05301000 MINNESOTA RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
 LATITUDE: 450117 LONGITUDE: 0955205 NAD27 DRAINAGE AREA:4050 CONTRIBUTING DRAINAGE AREA: DATUM:900.00 NGVD29
 Date Processed: 2011-08-24 09:39 By mitton
 Rating for Discharge - TAILWATER (cfs)
 RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
 Created by ddaly on 05-29-2011 @ 16:38:51 CDT, Updated by ddaly on 06-01-2011 @ 09:00:26 CDT

RATING REMARKS: Change of slope to lower end, positive adjustment 24-35 ft.

OFFSET: 19.00

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
27.70	2140	2140	2140	2150	2150	2150	2160	2160	2160	2170	30.0
27.80	2170	2170	2180	2180	2180	2190	2190	2190	2200	2200	30.0
27.90	2200	2200	2210	2210	2210	2220	2220	2220	2230	2230	30.0
28.00	2230	2240	2240	2240	2250	2250	2250	2260	2260	2260	40.0
28.10	2270	2270	2270	2280	2280	2280	2280	2290	2290	2290	30.0
28.20	2300	2300	2300	2310	2310	2320	2320	2320	2320	2330	30.0
28.30	2330*	2330	2340	2340	2340	2350	2350	2350	2360	2360	40.0
28.40	2370	2370	2370	2380	2380	2380	2390	2390	2390	2400	30.0
28.50	2400	2400	2410	2410	2420	2420	2420	2430	2430	2430	40.0
28.60	2440	2440	2440	2450	2450	2460	2460	2460	2470	2470	30.0
28.70	2470	2480	2480	2480	2490	2490	2500	2500	2500	2510	40.0
28.80	2510	2510	2520	2520	2520	2530	2530	2530	2540	2540	40.0
28.90	2550	2550	2550	2560	2560	2560	2570	2570	2580	2580	30.0
29.00	2580	2590	2590	2590	2600	2600	2600	2610	2610	2620	40.0
29.10	2620	2620	2630	2630	2630	2640	2640	2640	2650	2650	40.0
29.20	2660	2660	2660	2670	2670	2670	2680	2680	2690	2690	30.0
29.30	2690	2700	2700	2700	2710	2710	2720	2720	2720	2730	40.0
29.40	2730	2730	2740	2740	2740	2750	2750	2760	2760	2760	40.0
29.50	2770	2770	2770	2780	2780	2790	2790	2790	2800	2800	30.0
29.60	2800	2810	2810	2820	2820	2820	2830	2830	2830	2840	40.0
29.70	2840	2850	2850	2850	2860	2860	2860	2870	2870	2880	40.0
29.80	2880*	2880	2890	2890	2900	2900	2910	2910	2920	2920	50.0
29.90	2930	2930	2940	2940	2950	2950	2960	2960	2970	2970	50.0
30.00	2980	2980	2990	2990	3000	3000	3010	3010	3020	3020	50.0
30.10	3030	3030	3040	3040	3050	3050	3060	3060	3070	3070	50.0
30.20	3080	3080	3090	3090	3100	3100	3110	3110	3120	3130	50.0
30.30	3130	3140	3140	3150	3150	3160	3160	3170	3170	3180	50.0
30.40	3180	3190	3190	3200	3200	3210	3210	3220	3220	3230	50.0
30.50	3230	3240	3240	3250	3250	3260	3260	3270	3270	3280	50.0
30.60	3280	3290	3300	3300	3310	3310	3320	3320	3330	3330	60.0
30.70	3340	3340	3350	3350	3360	3360	3370	3370	3380	3380	50.0
30.80	3390	3400	3400	3410	3410	3420	3420	3430	3430	3440	50.0
30.90	3440	3450	3450	3460	3460	3470	3470	3480	3490	3490	60.0
31.00	3500	3500	3510	3510	3520	3520	3530	3530	3540	3540	50.0
31.10	3550*	3560	3560	3570	3580	3580	3590	3600	3610	3610	70.0
31.20	3620	3630	3630	3640	3650	3650	3660	3670	3680	3680	70.0
31.30	3690	3700	3700	3710	3720	3720	3730	3740	3750	3750	70.0
31.40	3760	3770	3770	3780	3790	3800	3800	3810	3820	3820	70.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05301000 MINNESOTA RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023

LATITUDE: 450117 LONGITUDE: 0955205 NAD27 DRAINAGE AREA:4050 CONTRIBUTING DRAINAGE AREA: DATUM:900.00 NGVD29

Date Processed: 2011-08-24 09:39 By mitton

Rating for Discharge - TAILWATER (cfs)

RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
Created by ddaly on 05-29-2011 @ 16:38:51 CDT, Updated by ddaly on 06-01-2011 @ 09:00:26 CDT

RATING REMARKS: Change of slope to lower end, positive adjustment 24-35 ft.

OFFSET: 19.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
31.50	3830	3840	3850	3850	3860	3870	3870	3880	3890	3900	70.0
31.60	3900	3910	3920	3930	3930	3940	3950	3950	3960	3970	80.0
31.70	3980	3980	3990	4000	4010	4010	4020	4030	4040	4040	70.0
31.80	4050	4060	4070	4070	4080	4090	4100	4100	4110	4120	70.0
31.90	4120	4130	4140	4150	4160	4160	4170	4180	4190	4190	80.0
32.00	4200	4210	4220	4220	4230	4240	4250	4250	4260	4270	80.0
32.10	4280	4280	4290	4300	4310	4310	4320	4330	4340	4350	70.0
32.20	4350	4360	4370	4380	4380	4390	4400	4410	4420	4420	80.0
32.30	4430	4440	4450	4450	4460	4470	4480	4490	4490	4500	80.0
32.40	4510	4520	4530	4530	4540	4550	4560	4570	4570	4580	80.0
32.50	4590	4600	4600	4610	4620	4630	4640	4640	4650	4660	80.0
32.60	4670	4680	4690	4690	4700	4710	4720	4730	4730	4740	80.0
32.70	4750*	4760	4770	4780	4790	4800	4810	4820	4830	4840	100
32.80	4850	4860	4860	4870	4880	4890	4900	4910	4920	4930	90.0
32.90	4940	4950	4960	4970	4980	4990	5000	5010	5020	5030	100
33.00	5040	5050	5060	5070	5080	5090	5100	5110	5120	5130	100
33.10	5140	5150	5160	5170	5180	5190	5200	5210	5220	5230	100
33.20	5240	5250	5260	5270	5280	5290	5300	5310	5320	5330	100
33.30	5340	5350	5360	5370	5380	5390	5400	5410	5420	5430	100
33.40	5440	5450	5470	5480	5490	5500	5510	5520	5530	5540	110
33.50	5550	5560	5570	5580	5590	5600	5610	5620	5630	5640	100
33.60	5650	5660	5680	5690	5700	5710	5720	5730	5740	5750	110
33.70	5760	5770	5780	5790	5800	5810	5830	5840	5850	5860	110
33.80	5870	5880	5890	5900	5910	5920	5930	5940	5960	5970	110
33.90	5980	5990	6000	6010	6020	6030	6040	6050	6070	6080	110
34.00	6090	6100	6110	6120	6130	6140	6160	6170	6180	6190	110
34.10	6200*	6220	6240	6260	6280	6300	6320	6340	6360	6380	200
34.20	6400	6420	6440	6460	6480	6500	6520	6540	6560	6580	200
34.30	6600	6620	6640	6660	6680	6700	6720	6750	6770	6790	210
34.40	6810	6830	6850	6870	6890	6910	6940	6960	6980	7000	210
34.50	7020	7040	7060	7090	7110	7130	7150	7170	7200	7220	220
34.60	7240	7260	7280	7310	7330	7350	7370	7400	7420	7440	220
34.70	7460	7490	7510	7530	7550	7580	7600	7620	7650	7670	230
34.80	7690	7710	7740	7760	7780	7810	7830	7860	7880	7900	240
34.90	7930	7950	7970	8000	8020	8050	8070	8090	8120	8140	240
35.00	8170	8190	8210	8240	8260	8290	8310	8340	8360	8390	240
35.10	8410	8440	8460	8490	8510	8540	8560	8590	8610	8640	250
35.20	8660	8690	8710	8740	8770	8790	8820	8840	8870	8890	260
35.30	8920	8950	8970	9000	9030	9050	9080	9100	9130	9160	260

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05301000 MINNESOTA RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
LATITUDE: 450117 LONGITUDE: 0955205 NAD27 DRAINAGE AREA:4050 CONTRIBUTING DRAINAGE AREA: DATUM:900.00 NGVD29

Date Processed: 2011-08-24 09:39 By mitton
Rating for Discharge - TAILWATER (cfs)
RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
Created by ddaly on 05-29-2011 @ 16:38:51 CDT, Updated by ddaly on 06-01-2011 @ 09:00:26 CDT

RATING REMARKS: Change of slope to lower end, positive adjustment 24-35 ft.

OFFSET: 19.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
35.40	9180	9210	9240	9260	9290	9320	9340	9370	9400	9430	270
35.50	9450	9480	9510	9540	9560	9590	9620	9650	9670	9700	280
35.60	9730	9760	9780	9810	9840	9870	9900	9930	9950	9980	270
35.70	10000	10000	10100	10100	10100	10200	10200	10200	10200	10300	300
35.80	10300	10300	10400	10400	10400	10400	10500	10500	10500	10600	300
35.90	10600	10600	10700	10700	10700	10700	10800	10800	10800	10900	300
36.00	10900	10900	11000	11000	11000	11000	11100	11100	11100	11200	300
36.10	11200	11200	11300	11300	11300	11400	11400	11400	11500	11500	300
36.20	11500	11600	11600	11600	11600	11700	11700	11700	11800	11800	300
36.30	11800	11900	11900	11900	12000	12000	12100	12100	12100	12100	400
36.40	12200	12200	12200	12300	12300	12300	12400	12400	12400	12500	300
36.50	12500	12500	12600	12600	12600	12700	12700	12700	12800	12800	400
36.60	12900	12900	12900	13000	13000	13000	13100	13100	13100	13200	300
36.70	13200	13200	13300	13300	13300	13400	13400	13500	13500	13500	400
36.80	13600	13600	13600	13700	13700	13700	13800	13800	13900	13900	300
36.90	13900	14000	14000	14000	14100	14100	14100	14200	14200	14300	400
37.00	14300	14300	14400	14400	14500	14500	14500	14600	14600	14600	400
37.10	14700	14700	14800	14800	14800	14900	14900	15000	15000	15000	400
37.20	15100	15100	15200	15200	15200	15300	15300	15400	15400	15400	400
37.30	15500	15500	15600	15600	15600	15700	15700	15800	15800	15800	400
37.40	15900	15900	16000	16000	16000	16100	16100	16200	16200	16200	400
37.50	16300	16300	16400	16400	16500	16500	16500	16600	16600	16700	400
37.60	16700	16800	16800	16800	16900	16900	17000	17000	17100	17100	400
37.70	17100	17200	17200	17300	17300	17400	17400	17500	17500	17500	500
37.80	17600	17600	17700	17700	17800	17800	17900	17900	17900	18000	400
37.90	18000	18100	18100	18200	18200	18300	18300	18400	18400	18400	500
38.00	18500	18500	18600	18600	18700	18700	18800	18800	18900	18900	500
38.10	19000	19000	19100	19100	19200	19200	19200	19300	19300	19400	400
38.20	19400	19500	19500	19600	19600	19700	19700	19800	19800	19900	500
38.30	19900	20000	20000	20100	20100	20200	20200	20300	20300	20400	500
38.40	20400	20500	20500	20600	20600	20700	20700	20800	20800	20900	500
38.50	20900	21000	21000	21100	21100	21200	21200	21300	21300	21400	500
38.60	21400	21500	21500	21600	21700	21700	21800	21800	21900	21900	600
38.70	22000	22000	22100	22100	22200	22200	22300	22300	22400	22500	500
38.80	22500	22600	22600	22700	22700	22800	22800	22900	22900	23000	600
38.90	23100	23100	23200	23200	23300	23300	23400	23400	23500	23600	500
39.00	23600	23700	23700	23800	23800	23900	23900	24000	24100	24100	600
39.10	24200	24200	24300	24300	24400	24500	24500	24600	24600	24700	600

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05301000 MINNESOTA RIVER NEAR LAC QUI PARLE, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
LATITUDE: 450117 LONGITUDE: 0955205 NAD27 DRAINAGE AREA:4050 CONTRIBUTING DRAINAGE AREA: DATUM:900.00 NGVD29
Date Processed: 2011-08-24 09:39 By mitton

Rating for Discharge - TAILWATER (cfs)
 RATING ID: 30.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
 Created by ddaly on 05-29-2011 @ 16:38:51 CDT, Updated by ddaly on 06-01-2011 @ 09:00:26 CDT

RATING REMARKS: Change of slope to lower end, positive adjustment 24-35 ft.

OFFSET: 19.00

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	(STANDARD PRECISION)										
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
39.20	24800	24800	24900	24900	25000	25000	25100	25200	25200	25300	500
39.30	25300	25400	25500	25500	25600	25600	25700	25800	25800	25900	600
39.40	25900	26000	26100	26100	26200	26200	26300	26400	26400	26500	600
39.50	26500	26600	26700	26700	26800	26900	26900	27000	27000	27100	700
39.60	27200	27200	27300	27400	27400	27500	27500	27600	27700	27700	600
39.70	27800	27900	27900	28000	28100	28100	28200	28300	28300	28400	600
39.80	28400	28500	28600	28600	28700	28800	28800	28900	29000	29000	700
39.90	29100	29200	29200	29300	29400	29400	29500	29600	29600	29700	700
40.00	29800	29800	29900	30000	30000	30100	30200	30200	30300	30400	700
40.10	30500	30500	30600	30700	30700	30800	30900	30900	31000	31100	600
40.20	31100	31200	31300	31400	31400	31500	31600	31600	31700	31800	800
40.30	31900	31900	32000	32100	32100	32200	32300	32400	32400	32500	700
40.40	32600	32600	32700	32800	32900	32900	33000	33100	33200	33200	700
40.50	33300*										

"*" indicates a rating descriptor point

Rating Type:	Rating Type: stage-discharge
ID Starting Date	Ending Date A Comments
-----	-----
30.0 12-02-2010 @ 00:00:00 CST	----- W Started under ice-backwater conditions

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05304500 CHIPPEWA RIVER NEAR MILAN, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
 LATITUDE: 450630 LONGITUDE: 0954755 NAD27 DRAINAGE AREA:1880 CONTRIBUTING DRAINAGE AREA: DATUM:959.69 NGVD29

Date Processed: 2011-08-24 09:41 By mitton

Rating for Discharge (cfs)

RATING ID: 31.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by mitton on 02-11-2008 @ 17:12:13 CST, Updated by mitton on 06-02-2008 @ 16:24:27 CDT

RATING REMARKS: COPIED OVER FROM GAGE HEIGHT DD (GBM)

NO OFFSETS USED

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
0.10						1.0*	1.2	1.3	1.5	1.7	1.8
0.20	1.9	2.1	2.4	2.6	2.9	3.2	3.5	3.8	4.1	4.4	2.9
0.30	4.8	5.2	5.5	5.9	6.4	6.8	7.2	7.7	8.2	8.7	4.4
0.40	9.2	9.7	10.3	10.8	11.4	12.0	12.6	13.2	13.9	14.5	6.0
0.50	15.2	15.9	16.6	17.4	18.1	18.9	19.7	20.5	21.3	22.1	7.8
0.60	23.0	23.8	24.7	25.7	26.6	27.5	28.5	29.5	30.5	31.5	9.6
0.70	32.6	33.6	34.7	35.8	36.9	38.1	39.2	40.4	41.6	42.8	11.4
0.80	44.0	45.3	46.6	47.9	49.2	50.5	51.8	53.2	54.6	56.0	13.5
0.90	57.5	58.9	60.4	61.9	63.4	64.9	66.5	68.1	69.7	71.3	15.4
1.00	72.9	74.6	76.3	78.0	79.7	81.4	83.2	85.0	86.8	88.6	17.6
1.10	90.5	92.3	94.2	96.1	98.1	100	102	104	106	108	19.5
1.20	110	112	114	116	119	121	123	125	127	130	22.0
1.30	132	134	137	139	141	144	146	149	151	154	24.0
1.40	156	159	161	164	166	169	172	174	177	180	26.0
1.50	182	185	188	191	194	196	199	202	205	208	29.0
1.60	211	214	217	220	223	226	229	232	236	239	31.0
1.70	242	245	249	252	255	258	262	265	269	272	33.0
1.80	275	279	282	286	289	293	297	300	304	308	36.0
1.90	311	315	319	322	326	330	334	338	342	346	39.0
2.00	350	353	357	361	366	370	374	378	382	386	40.0
2.10	390	394	399	403	407	412	416	420	425	429	44.0
2.20	434	438	443	447	452	456	461	465	470	475	45.0
2.30	479	484	489	494	498	503	508	513	518	523	49.0
2.40	528	533	538	543	548	553	558	563	568	574	51.0
2.50	579	584	589	595	600*	605	610	615	620	626	52.0
2.60	631	636	641	646	652	657	662	668	673	678	53.0
2.70	684	689	695	700*	706	711	717	723	729	734	56.0
2.80	740	746	752	758	764	770	776	782	788	794	60.0
2.90	800*	806	812	818	824	831	837	843	849	855	62.0
3.00	862	868	874	881	887	894	900*	906	912	917	61.0
3.10	923	929	935	941	946	952	958	964	970	976	59.0
3.20	982	988	994	1000*	1010	1010	1020	1020	1030	1030	58.0
3.30	1040	1040	1050	1050	1060	1060	1070	1070	1080	1090	50.0
3.40	1090	1100	1100	1110	1110	1120	1120	1130	1140	1140	60.0
3.50	1150	1150	1160	1160	1170	1170	1180	1190	1190	1200	50.0
3.60	1200	1210	1210	1220	1230	1230	1240	1240	1250	1250	60.0
3.70	1260	1270	1270	1280	1280	1290	1290	1300	1310	1310	60.0
3.80	1320	1320	1330	1340	1340	1350	1350	1360	1370	1370	60.0
3.90	1380	1380	1390	1400	1400	1410	1410	1420	1430	1430	60.0

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05304500 CHIPPEWA RIVER NEAR MILAN, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
 LATITUDE: 450630 LONGITUDE: 0954755 NAD27 DRAINAGE AREA:1880 CONTRIBUTING DRAINAGE AREA:
 Date Processed: 2011-08-24 09:41 By mitton
 Rating for Discharge (cfs)
 RATING ID: 31.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by mitton on 02-11-2008 @ 17:12:13 CST, Updated by mitton on 06-02-2008 @ 16:24:27 CDT

RATING REMARKS: COPIED OVER FROM GAGE HEIGHT DD (GBM)

NO OFFSETS USED

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
4.00	1440	1440	1450	1460	1460	1470	1480	1480	1490	1490	60.0
4.10	1500*	1510	1510	1520	1520	1530	1540	1540	1550	1550	60.0
4.20	1560	1570	1570	1580	1580	1590	1600	1600	1610	1610	60.0
4.30	1620	1630	1630	1640	1640	1650	1660	1660	1670	1670	60.0
4.40	1680	1690	1690	1700	1710	1710	1720	1720	1730	1740	60.0
4.50	1740	1750	1760	1760	1770	1770	1780	1790	1790	1800	70.0
4.60	1810	1810	1820	1830	1830	1840	1840	1850	1860	1860	60.0
4.70	1870*	1880	1880	1890	1900	1910	1910	1920	1930	1940	70.0
4.80	1940	1950	1960	1970	1970	1980	1990	2000	2000	2010	80.0
4.90	2020	2030	2030	2040	2050	2060	2060	2070	2080	2090	80.0
5.00	2100	2100	2110	2120	2130	2130	2140	2150	2160	2170	70.0
5.10	2170	2180	2190	2200	2200	2210	2220	2230	2240	2240	80.0
5.20	2250	2260	2270	2280	2280	2290	2300	2310	2320	2320	80.0
5.30	2330	2340	2350	2360	2360	2370	2380	2390	2400	2410	80.0
5.40	2410	2420	2430	2440	2450	2460	2460	2470	2480	2490	90.0
5.50	2500	2510	2510	2520	2530	2540	2550	2560	2560	2570	80.0
5.60	2580	2590	2600	2610	2610	2620	2630	2640	2650	2660	90.0
5.70	2670	2670	2680	2690	2700	2710	2720	2730	2740	2740	80.0
5.80	2750	2760	2770	2780	2790	2800	2810	2810	2820	2830	90.0
5.90	2840	2850	2860	2870	2880	2890	2890	2900	2910	2920	90.0
6.00	2930*	2940	2950	2950	2960	2970	2980	2980	2990	3000	80.0
6.10	3010	3010	3020	3030	3040	3040	3050	3060	3070	3070	70.0
6.20	3080	3090	3100	3110	3110	3120	3130	3140	3140	3150	80.0
6.30	3160	3170	3170	3180	3190	3200	3210	3210	3220	3230	80.0
6.40	3240	3250	3250	3260	3270	3280	3280	3290	3300	3310	80.0
6.50	3320	3320	3330	3340	3350	3360	3360	3370	3380	3390	70.0
6.60	3390	3400	3410	3420	3430	3430	3440	3450	3460	3470	80.0
6.70	3470	3480	3490	3500	3510	3510	3520	3530	3540	3550	90.0
6.80	3560	3560	3570	3580	3590	3600	3600	3610	3620	3630	80.0
6.90	3640	3640	3650	3660	3670	3680	3690	3690	3700	3710	80.0
7.00	3720	3730	3730	3740	3750	3760	3770	3780	3780	3790	80.0
7.10	3800	3810	3820	3830	3830	3840	3850	3860	3870	3880	80.0
7.20	3880	3890	3900	3910	3920	3930	3930	3940	3950	3960	90.0
7.30	3970	3980	3980	3990	4000	4010	4020	4030	4030	4040	80.0
7.40	4050	4060	4070	4080	4090	4090	4100	4110	4120	4130	90.0
7.50	4140	4140	4150	4160	4170	4180	4190	4200	4200	4210	80.0
7.60	4220	4230	4240	4250	4260	4270	4280	4280	4290	4300	90.0
7.70	4310	4320	4330	4330	4340	4350	4360	4370	4380	4390	80.0
7.80	4390	4400	4410	4420	4430	4440	4450	4460	4460	4470	90.0

STATION:05304500 CHIPPEWA RIVER NEAR MILAN, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
 LATITUDE: 450630 LONGITUDE: 0954755 NAD27 DRAINAGE AREA:1880 CONTRIBUTING DRAINAGE AREA: DATUM:959.69 NGVD29
 Date Processed: 2011-08-24 09:41 By mitton
 Rating for Discharge (cfs)
 RATING ID: 31.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by mitton on 02-11-2008 @ 17:12:13 CST, Updated by mitton on 06-02-2008 @ 16:24:27 CDT

RATING REMARKS: COPIED OVER FROM GAGE HEIGHT DD (GBM)

NO OFFSETS USED

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	Discharge (cfs)					(STANDARD PRECISION)					
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
7.90	4480	4490	4500	4510	4520	4530	4530	4540	4550	4560	90.0
8.00	4570*	4580	4590	4590	4600	4610	4620	4630	4640	4650	80.0
8.10	4650	4660	4670	4680	4690	4700	4700	4710	4720	4730	90.0
8.20	4740	4750	4750	4760	4770	4780	4790	4800	4800	4810	80.0
8.30	4820	4830	4840	4850	4860	4860	4870	4880	4890	4900	90.0
8.40	4910	4920	4920	4930	4940	4950	4960	4970	4970	4980	80.0
8.50	4990	5000	5010	5020	5030	5030	5040	5050	5060	5070	90.0
8.60	5080	5090	5090	5100	5110	5120	5130	5140	5150	5160	80.0
8.70	5160	5170	5180	5190	5200	5210	5220	5230	5230	5240	90.0
8.80	5250	5260	5270	5280	5290	5290	5300	5310	5320	5330	90.0
8.90	5340	5350	5360	5360	5370	5380	5390	5400	5410	5420	90.0
9.00	5430	5430	5440	5450	5460	5470	5480	5490	5500	5500	80.0
9.10	5510	5520	5530	5540	5550	5560	5570	5580	5580	5590	90.0
9.20	5600	5610	5620	5630	5640	5650	5660	5660	5670	5680	90.0
9.30	5690	5700	5710	5720	5730	5740	5740	5750	5760	5770	90.0
9.40	5780	5790	5800	5810	5820	5830	5830	5840	5850	5860	90.0
9.50	5870	5880	5890	5900	5910	5920	5920	5930	5940	5950	90.0
9.60	5960	5970	5980	5990	6000	6010	6010	6020	6030	6040	90.0
9.70	6050	6060	6070	6080	6090	6100	6110	6110	6120	6130	90.0
9.80	6140	6150	6160	6170	6180	6190	6200	6210	6220	6220	90.0
9.90	6230	6240	6250	6260	6270	6280	6290	6300	6310	6320	100
10.00	6330	6330	6340	6350	6360	6370	6380	6390	6400	6410	90.0
10.10	6420	6430	6440	6450	6450	6460	6470	6480	6490	6500	90.0
10.20	6510	6520	6530	6540	6550	6560	6570	6580	6590	6590	90.0
10.30	6600	6610	6620	6630	6640	6650	6660	6670	6680	6690	100
10.40	6700	6710	6720	6730	6740	6740	6750	6760	6770	6780	90.0
10.50	6790	6800	6810	6820	6830	6840	6850	6860	6870	6880	100
10.60	6890	6900	6900	6910	6920	6930	6940	6950	6960	6970	90.0
10.70	6980	6990	7000	7010	7020	7030	7040	7050	7060	7070	100
10.80	7080	7090	7100	7100	7110	7120	7130	7140	7150	7160	90.0
10.90	7170	7180	7190	7200	7210	7220	7230	7240	7250	7260	100
11.00	7270	7280	7290	7300	7310	7320	7330	7340	7340	7350	90.0
11.10	7360	7370	7380	7390	7400	7410	7420	7430	7440	7450	100
11.20	7460	7470	7480	7490	7500	7510	7520	7530	7540	7550	100
11.30	7560	7570	7580	7590	7600	7610	7620	7630	7640	7650	100
11.40	7660	7670	7680	7690	7700	7700	7710	7720	7730	7740	90.0
11.50	7750	7760	7770	7780	7790	7800	7810	7820	7830	7840	100
11.60	7850	7860	7870	7880	7890	7900	7910	7920	7930	7940	100

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05304500 CHIPPEWA RIVER NEAR MILAN, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023

LATITUDE: 450630 LONGITUDE: 0954755 NAD27 DRAINAGE AREA:1880 CONTRIBUTING DRAINAGE AREA: DATUM:959.69 NGVD29
 Date Processed: 2011-08-24 09:41 By mitton
 Rating for Discharge (cfs)
 RATING ID: 31.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by mitton on 02-11-2008 @ 17:12:13 CST, Updated by mitton on 06-02-2008 @ 16:24:27 CDT

RATING REMARKS: COPIED OVER FROM GAGE HEIGHT DD (GBM)

NO OFFSETS USED

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	Discharge (cfs) (STANDARD PRECISION)										
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
11.70	7950	7960	7970	7980	7990	8000	8010	8020	8030	8040	100
11.80	8050	8060	8070	8080	8090	8100	8110	8120	8130	8140	100
11.90	8150	8160	8170	8180	8190	8200	8210	8220	8230	8240	100
12.00	8250*	8260	8270	8280	8290	8300	8310	8320	8330	8340	100
12.10	8350	8360	8360	8370	8380	8390	8400	8410	8420	8430	90.0
12.20	8440	8450	8460	8470	8480	8490	8500	8510	8520	8530	100
12.30	8540	8550	8560	8570	8580	8590	8600	8610	8620	8630	90.0
12.40	8630	8640	8650	8660	8670	8680	8690	8700	8710	8720	100
12.50	8730	8740	8750	8760	8770	8780	8790	8800	8810	8820	100
12.60	8830	8840	8850	8860	8870	8880	8890	8900	8910	8920	100
12.70	8930	8940	8950	8960	8970	8980	8990	9000	9010	9010	90.0
12.80	9020	9030	9040	9050	9060	9070	9080	9090	9100	9110	100
12.90	9120	9130	9140	9150	9160	9170	9180	9190	9200	9210	100
13.00	9220	9230	9240	9250	9260	9270	9280	9290	9300	9310	100
13.10	9320	9330	9340	9350	9360	9370	9380	9390	9400	9410	100
13.20	9420	9430	9440	9450	9460	9470	9480	9490	9500	9510	100
13.30	9520	9530	9540	9550	9560	9570	9580	9590	9600	9610	100
13.40	9620	9630	9640	9650	9660	9670	9680	9690	9700	9710	100
13.50	9720	9730	9740	9750	9760	9770	9780	9790	9800	9810	100
13.60	9820	9830	9840	9850	9860	9870	9880	9890	9900	9910	100
13.70	9920	9930	9940	9950	9960	9970	9980	9990	10000	10000	80.0
13.80	10000	10000	10000	10100	10100	10100	10100	10100	10100	10100	100
13.90	10100	10100	10100	10200	10200	10200	10200	10200	10200	10200	100
14.00	10200	10200	10200	10300	10300	10300	10300	10300	10300	10300	100
14.10	10300	10300	10300	10400	10400	10400	10400	10400	10400	10400	100
14.20	10400	10400	10400	10500	10500	10500	10500	10500	10500	10500	100
14.30	10500	10500	10500	10600	10600	10600	10600	10600	10600	10600	100
14.40	10600	10600	10700	10700	10700	10700	10700	10700	10700	10700	100
14.50	10700	10700	10800	10800	10800	10800	10800	10800	10800	10800	100
14.60	10800	10800	10900	10900	10900	10900	10900	10900	10900	10900	100
14.70	10900	11000	11000	11000	11000	11000	11000	11000	11000	11000	100
14.80	11000	11100	11100	11100	11100	11100	11100	11100	11100	11100	100
14.90	11100	11200	11200	11200	11200	11200	11200	11200	11200	11200	200
15.00	11300	11300	11300	11300	11300	11300	11300	11300	11300	11300	100
15.10	11400	11400	11400	11400	11400	11400	11400	11400	11400	11500	100
15.20	11500	11500	11500	11500	11500	11500	11500	11500	11500	11600	100
15.30	11600	11600	11600	11600	11600	11600	11600	11600	11700	11700	100
15.40	11700	11700	11700	11700	11700	11700	11700	11700	11800	11800	100

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U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05304500 CHIPPEWA RIVER NEAR MILAN, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:023
 LATITUDE: 450630 LONGITUDE: 0954755 NAD27 DRAINAGE AREA:1880 CONTRIBUTING DRAINAGE AREA: DATUM:959.69 NGVD29

Date Processed: 2011-08-24 09:41 By mitton
Rating for Discharge (cfs)
RATING ID: 31.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by mitton on 02-11-2008 @ 17:12:13 CST, Updated by mitton on 06-02-2008 @ 16:24:27 CDT

RATING REMARKS: COPIED OVER FROM GAGE HEIGHT DD (GBM)

NO OFFSETS USED

EXPANDED RATING TABLE											
Gage height, feet	Discharge (cfs)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
15.50	11800	11800	11800	11800	11800	11800	11800	11900	11900	11900	100
15.60	11900	11900	11900	11900	11900	11900	11900	12000	12000	12000	100
15.70	12000	12000	12000	12000	12000	12000	12100	12100	12100	12100	100
15.80	12100	12100	12100	12100	12100	12100	12200	12200	12200	12200	100
15.90	12200	12200	12200	12200	12200	12300	12300	12300	12300	12300	100
16.00	12300	12300	12300	12300	12400	12400	12400	12400	12400	12400	100
16.10	12400	12400	12400	12400	12500	12500	12500	12500	12500	12500	100
16.20	12500	12500	12500	12600	12600	12600	12600	12600	12600	12600	100
16.30	12600	12600	12700	12700	12700	12700	12700	12700	12700	12700	100
16.40	12700	12700	12800	12800	12800	12800	12800	12800	12800	12800	100
16.50	12800	12900	12900	12900	12900	12900	12900	12900	12900	12900	200
16.60	13000	13000	13000	13000	13000	13000	13000	13000	13000	13100	100
16.70	13100	13100	13100	13100	13100	13100	13100	13100	13200	13200	100
16.80	13200	13200	13200	13200	13200	13200	13200	13200	13300	13300	100
16.90	13300	13300	13300	13300	13300	13300	13300	13400	13400	13400	100
17.00	13400	13400	13400	13400	13400	13400	13500	13500	13500	13500	100
17.10	13500	13500	13500	13500	13500	13600	13600	13600	13600	13600	100
17.20	13600	13600	13600	13600	13700	13700	13700	13700	13700	13700	100
17.30	13700	13700	13700	13800	13800	13800	13800	13800	13800	13800	100
17.40	13800	13800	13900	13900	13900	13900	13900	13900	13900	13900	100
17.50	13900	14000	14000	14000	14000	14000	14000	14000	14000	14000	200
17.60	14100	14100	14100	14100	14100	14100	14100	14100	14100	14200	100
17.70	14200	14200	14200	14200	14200	14200	14200	14200	14300	14300	100
17.80	14300	14300	14300	14300	14300	14300	14300	14400	14400	14400	100
17.90	14400	14400	14400	14400	14400	14400	14500	14500	14500	14500	100
18.00	14500*										

"*" indicates a rating descriptor point

Rating Type:		Rating Type: stage-discharge			
ID	Starting Date	Ending Date	A	Comments	
31.0	01-01-2008 @ 00:00:00 CST	11-30-2010 @ 23:59:59 CST	A	Same as 30.0 below 4.7 ft and 29.0 above 4.7 ft.	
31.0	12-01-2010 @ 00:00:00 CST	-----	W	Same as 30.0 below 4.7 ft and 29.0 above 4.7 ft.	

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05311000 MINNESOTA RIVER AT MONTEVIDEO, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:173
 LATITUDE: 445600 LONGITUDE: 0954400 NAD27 DRAINAGE AREA:6180 CONTRIBUTING DRAINAGE AREA: DATUM:909.12 NGVD29

Date Processed: 2011-08-24 09:38 By mitton

Rating for Discharge (cfs)

RATING ID: 49.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 04-05-2008 @ 13:03:18 CDT, Updated by mitton on 09-11-2008 @ 16:02:20 CDT

RATING REMARKS: Same as rating 47.0 above 12.5 ft (gbm)

OFFSET: 0.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
1.00				30.0*	30.8	31.5	32.3	33.1	33.9	34.7	7.9
1.10	35.5	36.3	37.1	37.9	38.8	39.6	40.5	41.3	42.2	43.1	8.5
1.20	44.0	44.9	45.8	46.7	47.6	48.6	49.5	50.5	51.4	52.4	9.3
1.30	53.3	54.3	55.3	56.3	57.3	58.3	59.3	60.4	61.4	62.4	10.2
1.40	63.5	64.6	65.6	66.7	67.8	68.9	70.0	71.1	72.2	73.3	11.0
1.50	74.5	75.6	76.7	77.9	79.1	80.2	81.4	82.6	83.8	85.0	11.7
1.60	86.2	87.4	88.6	89.9	91.1	92.3	93.6	94.9	96.1	97.4	12.5
1.70	98.7	100	101	103	104	105	107	108	109	111	13.3
1.80	112	113	115	116	117	119	120	122	123	125	14.0
1.90	126	127	129	130	132	133	135	136	138	139	15.0
2.00	141	142	144	145	147	148	150	152	153	155	15.0
2.10	156	158	159	161	163	164	166	168	169	171	17.0
2.20	173	174	176	178	179	181	183	184	186	188	16.0
2.30	189	191	193	195	196	198	200	202	204	205	18.0
2.40	207	209	211	213	214	216	218	220	222	224	19.0
2.50	226	227	229	231	233	235	237	239	241	243	19.0
2.60	245	247	249	251	252	254	256	258	260	262	19.0
2.70	264	266	268	271	273	275	277	279	281	283	21.0
2.80	285	287	289	291	293	295	298	300	302	304	21.0
2.90	306	308	310	313	315	317	319	321	324	326	22.0
3.00	328	330	332	335	337	339	341	344	346	348	23.0
3.10	351	353	355	357	360	362	364	367	369	371	23.0
3.20	374	376	379	381	383	386	388	390	393	395	24.0
3.30	398	400	403	405	407	410	412	415	417	420	24.0
3.40	422	425	427	430	432	435	437	440	442	445	26.0
3.50	448	450	453	455	458	460	463	466	468	471	25.0
3.60	473	476	479	481	484	487	489	492	495	497	27.0
3.70	500*	503	505	508	511	513	516	519	522	524	27.0
3.80	527	530	532	535	538	541	543	546	549	552	28.0
3.90	555	557	560	563	566	569	571	574	577	580	28.0
4.00	583	586	588	591	594	597	600*	603	606	609	28.0
4.10	611	614	617	620	623	626	629	632	635	637	29.0
4.20	640	643	646	649	652	655	658	661	664	667	30.0
4.30	670	673	676	679	682	685	688	691	694	697	30.0
4.40	700*	703	706	708	711	714	717	720	722	725	28.0
4.50	728	731	734	737	739	742	745	748	751	754	29.0
4.60	757	759	762	765	768	771	774	777	780	782	28.0
4.70	785	788	791	794	797	800*	803	806	809	812	30.0
4.80	815	818	821	824	827	830	833	836	839	842	30.0

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05311000 MINNESOTA RIVER AT MONTEVIDEO, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:173
 LATITUDE: 445600 LONGITUDE: 0954400 NAD27 DRAINAGE AREA:6180 CONTRIBUTING DRAINAGE AREA: DATUM:909.12 NGVD29

Date Processed: 2011-08-24 09:38 By mitton

Rating for Discharge (cfs)

RATING ID: 49.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 04-05-2008 @ 13:03:18 CDT, Updated by mitton on 09-11-2008 @ 16:02:20 CDT

RATING REMARKS: Same as rating 47.0 above 12.5 ft (gbm)

OFFSET: 0.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
4.90	845	848	851	854	857	860	863	866	869	872	30.0
5.00	875	878	881	885	888	891	894	897	900*	903	31.0
5.10	906	909	912	916	919	922	925	928	931	934	31.0
5.20	937	941	944	947	950	953	956	959	963	966	32.0
5.30	969	972	975	979	982	985	988	991	995	998	31.0
5.40	1000	1000	1010	1010	1010	1020	1020	1020	1030	1030	30.0
5.50	1030	1040	1040	1040	1050	1050	1050	1060	1060	1060	40.0
5.60	1070	1070	1070	1080	1080	1080	1090	1090	1090	1100	30.0
5.70	1100	1100	1110	1110	1110	1120	1120	1120	1130	1130	30.0
5.80	1130	1140	1140	1140	1150	1150	1150	1160	1160	1160	40.0
5.90	1170	1170	1170	1180	1180	1180	1190	1190	1190	1200	30.0
6.00	1200	1200	1210	1210	1220	1220	1220	1230	1230	1230	40.0
6.10	1240	1240	1240	1250	1250	1250	1260	1260	1260	1270	30.0
6.20	1270	1270	1280	1280	1290	1290	1290	1300	1300	1300	40.0
6.30	1310	1310	1310	1320	1320	1320	1330	1330	1340	1340	30.0
6.40	1340	1350	1350	1350	1360	1360	1360	1370	1370	1380	40.0
6.50	1380	1380	1390	1390	1390	1400	1400	1400	1410	1410	40.0
6.60	1420	1420	1420	1430	1430	1430	1440	1440	1450	1450	30.0
6.70	1450	1460	1460	1460	1470	1470	1480	1480	1480	1490	40.0
6.80	1490	1490	1500	1500	1510	1510	1510	1520	1520	1520	40.0
6.90	1530	1530	1540	1540	1540	1550	1550	1550	1560	1560	40.0
7.00	1570	1570	1570	1580	1580	1590	1590	1590	1600	1600	30.0
7.10	1600	1610	1610	1620	1620	1620	1630	1630	1640	1640	40.0
7.20	1640	1650	1650	1660	1660	1660	1670	1670	1680	1680	40.0
7.30	1680	1690	1690	1690	1700	1700	1710	1710	1710	1720	40.0
7.40	1720	1730	1730	1730	1740	1740	1750	1750	1750	1760	40.0
7.50	1760	1770	1770	1770	1780	1780	1790	1790	1790	1800	40.0
7.60	1800	1810	1810	1820	1820	1820	1830	1830	1840	1840	40.0
7.70	1840	1850	1850	1860	1860	1860	1870	1870	1880	1880	40.0
7.80	1880	1890	1890	1900	1900	1910	1910	1910	1920	1920	50.0
7.90	1930	1930	1930	1940	1940	1950	1950	1960	1960	1960	40.0
8.00	1970	1970	1980	1980	1980	1990	1990	2000	2000	2010	40.0
8.10	2010	2010	2020	2020	2030	2030	2040	2040	2040	2050	40.0
8.20	2050	2060	2060	2070	2070	2070	2080	2080	2090	2090	50.0
8.30	2100	2100	2100	2110	2110	2120	2120	2130	2130	2130	40.0
8.40	2140	2140	2150	2150	2160	2160	2160	2170	2170	2180	40.0
8.50	2180	2190	2190	2200	2200	2200	2210	2210	2220	2220	50.0
8.60	2230	2230	2230	2240	2240	2250	2250	2260	2260	2270	40.0

STATION:05311000 MINNESOTA RIVER AT MONTEVIDEO, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:173
 LATITUDE: 445600 LONGITUDE: 0954400 NAD27 DRAINAGE AREA:6180 CONTRIBUTING DRAINAGE AREA: DATUM:909.12 NGVD29

Date Processed: 2011-08-24 09:38 By mitton

Rating for Discharge (cfs)

RATING ID: 49.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 04-05-2008 @ 13:03:18 CDT, Updated by mitton on 09-11-2008 @ 16:02:20 CDT

RATING REMARKS: Same as rating 47.0 above 12.5 ft (gbm)

OFFSET: 0.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
8.70	2270	2270	2280	2280	2290	2290	2300	2300	2310	2310	40.0
8.80	2310	2320	2320	2330	2330	2340	2340	2350	2350	2350	50.0
8.90	2360	2360	2370	2370	2380	2380	2390	2390	2400	2400	40.0
9.00	2400	2410	2410	2420	2420	2430	2430	2440	2440	2450	50.0
9.10	2450	2450	2460	2460	2470	2470	2480	2480	2490	2490	50.0
9.20	2500	2500	2510	2510	2510	2520	2520	2530	2530	2540	40.0
9.30	2540	2550	2550	2560	2560	2570	2570	2570	2580	2580	50.0
9.40	2590	2590	2600	2600	2610	2610	2620	2620	2630	2630	50.0
9.50	2640	2640	2640	2650	2650	2660	2660	2670	2670	2680	40.0
9.60	2680	2690	2690	2700	2700	2710	2710	2720	2720	2730	50.0
9.70	2730	2730	2740	2740	2750	2750	2760	2760	2770	2770	50.0
9.80	2780	2780	2790	2790	2800	2800	2810	2810	2820	2820	50.0
9.90	2830	2830	2840	2840	2850	2850	2860	2860	2860	2870	40.0
10.00	2870	2880	2880	2890	2890	2900	2900	2910	2910	2920	50.0
10.10	2920	2930	2930	2940	2940	2950	2950	2960	2960	2970	50.0
10.20	2970	2980	2980	2990	2990	3000	3000	3010	3010	3020	50.0
10.30	3020	3030	3030	3040	3040	3050	3050	3060	3060	3070	50.0
10.40	3070	3080	3080	3090	3090	3100	3100	3110	3110	3120	50.0
10.50	3120	3130	3130	3140	3140	3150	3150	3160	3160	3170	50.0
10.60	3170	3180	3180	3190	3190	3200	3200	3210	3210	3220	50.0
10.70	3220	3230	3230	3240	3240	3250	3250	3260	3260	3270	50.0
10.80	3270	3280	3280	3290	3290	3300	3300	3310	3310	3320	60.0
10.90	3330	3330	3340	3340	3350	3350	3360	3360	3370	3370	50.0
11.00	3380	3380	3390	3390	3400	3400	3410	3410	3420	3420	50.0
11.10	3430	3430	3440	3440	3450	3450	3460	3470	3470	3480	50.0
11.20	3480	3490	3490	3500	3500	3510	3510	3520	3520	3530	50.0
11.30	3530	3540	3540	3550	3550	3560	3570	3570	3580	3580	60.0
11.40	3590	3590	3600	3600	3610	3610	3620	3620	3630	3630	50.0
11.50	3640	3640	3650	3660	3660	3670	3670	3680	3680	3690	50.0
11.60	3690	3700	3700	3710	3710	3720	3730	3730	3740	3740	60.0
11.70	3750	3750	3760	3760	3770	3770	3780	3780	3790	3800	50.0
11.80	3800	3810	3810	3820	3820	3830	3830	3840	3840	3850	60.0
11.90	3860	3860	3870	3870	3880	3880	3890	3890	3900	3900	50.0
12.00	3910*	3920	3920	3930	3930	3940	3940	3950	3960	3960	60.0
12.10	3970	3970	3980	3980	3990	4000	4000	4010	4010	4020	50.0
12.20	4020	4030	4040	4040	4050	4050	4060	4070	4070	4080	60.0
12.30	4080	4090	4090	4100	4110	4110	4120	4120	4130	4140	60.0
12.40	4140	4150	4150	4160	4160	4170	4180	4180	4190	4190	60.0

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05311000 MINNESOTA RIVER AT MONTEVIDEO, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:173
 LATITUDE: 445600 LONGITUDE: 0954400 NAD27 DRAINAGE AREA:6180 CONTRIBUTING DRAINAGE AREA: DATUM:909.12 NGVD29

Date Processed: 2011-08-24 09:38 By mitton

Rating for Discharge (cfs)

RATING ID: 49.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 04-05-2008 @ 13:03:18 CDT, Updated by mitton on 09-11-2008 @ 16:02:20 CDT

RATING REMARKS: Same as rating 47.0 above 12.5 ft (gbm)

OFFSET: 0.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
12.50	4200*	4210	4220	4230	4240	4240	4250	4260	4270	4280	90.0
12.60	4290	4300	4310	4320	4320	4330	4340	4350	4360	4370	90.0
12.70	4380	4390	4400	4410	4420	4420	4430	4440	4450	4460	90.0
12.80	4470	4480	4490	4500	4510	4520	4530	4530	4540	4550	90.0
12.90	4560	4570	4580	4590	4600	4610	4620	4630	4640	4650	100
13.00	4660	4660	4670	4680	4690	4700	4710	4720	4730	4740	90.0
13.10	4750	4760	4770	4780	4790	4800	4810	4820	4830	4840	100
13.20	4850	4860	4870	4870	4880	4890	4900	4910	4920	4930	90.0
13.30	4940	4950	4960	4970	4980	4990	5000	5010	5020	5030	100
13.40	5040	5050	5060	5070	5080	5090	5100	5110	5120	5130	100
13.50	5140*	5160	5170	5190	5200	5220	5230	5250	5260	5280	150
13.60	5290	5310	5320	5340	5350	5370	5380	5400	5420	5430	160
13.70	5450	5460	5480	5490	5510	5520	5540	5560	5570	5590	150
13.80	5600	5620	5640	5650	5670	5680	5700	5720	5730	5750	170
13.90	5770	5780	5800	5810	5830	5850	5860	5880	5900	5910	160
14.00	5930	5950	5960	5980	6000	6010	6030	6050	6070	6080	170
14.10	6100	6120	6130	6150	6170	6180	6200	6220	6240	6250	170
14.20	6270	6290	6310	6320	6340	6360	6380	6390	6410	6430	180
14.30	6450	6460	6480	6500	6520	6540	6550	6570	6590	6610	180
14.40	6630	6640	6660	6680	6700	6720	6730	6750	6770	6790	180
14.50	6810	6830	6850	6860	6880	6900	6920	6940	6960	6980	180
14.60	6990	7010	7030	7050	7070	7090	7110	7130	7150	7170	190
14.70	7180	7200	7220	7240	7260	7280	7300	7320	7340	7360	200
14.80	7380	7400	7420	7440	7460	7480	7500	7520	7540	7560	200
14.90	7580	7600	7620	7640	7660	7680	7700	7720	7740	7760	200
15.00	7780	7800	7820	7840	7860	7880	7900	7920	7940	7960	200
15.10	7980	8000	8030	8050	8070	8090	8110	8130	8150	8170	210
15.20	8190	8210	8240	8260	8280	8300	8320	8340	8360	8390	220
15.30	8410	8430	8450	8470	8490	8520	8540	8560	8580	8600	210
15.40	8620	8650	8670	8690	8710	8730	8760	8780	8800	8820	230
15.50	8850	8870	8890	8910	8940	8960	8980	9000	9030	9050	220
15.60	9070	9100	9120	9140	9160	9190	9210	9230	9260	9280	230
15.70	9300	9330	9350	9370	9400	9420	9440	9470	9490	9510	240
15.80	9540	9560	9580	9610	9630	9660	9680	9700	9730	9750	240
15.90	9780	9800	9820	9850	9870	9900	9920	9950	9970	10000	220
16.00	10000	10000	10100	10100	10100	10100	10200	10200	10200	10200	300
16.10	10300	10300	10300	10300	10400	10400	10400	10400	10500	10500	200
16.20	10500	10500	10600	10600	10600	10600	10700	10700	10700	10800	300
16.30	10800	10800	10800	10900	10900	10900	10900	11000	11000	11000	200

STATION:05311000 MINNESOTA RIVER AT MONTEVIDEO, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:173
 LATITUDE: 445600 LONGITUDE: 0954400 NAD27 DRAINAGE AREA:6180 CONTRIBUTING DRAINAGE AREA: DATUM:909.12 NGVD29

Date Processed: 2011-08-24 09:38 By mitton

Rating for Discharge (cfs)

RATING ID: 49.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 04-05-2008 @ 13:03:18 CDT, Updated by mitton on 09-11-2008 @ 16:02:20 CDT

RATING REMARKS: Same as rating 47.0 above 12.5 ft (gbm)

OFFSET: 0.30

Gage height, feet	EXPANDED RATING TABLE										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
16.40	11000	11100	11100	11100	11100	11200	11200	11200	11300	11300	300
16.50	11300	11300	11400	11400	11400	11400	11500	11500	11500	11500	300
16.60	11600	11600	11600	11700	11700	11700	11700	11800	11800	11800	300
16.70	11900	11900	11900	11900	12000	12000	12000	12000	12100	12100	200
16.80	12100	12200	12200	12200	12200	12300	12300	12300	12400	12400	300
16.90	12400	12400	12500	12500	12500	12600	12600	12600	12600	12700	300
17.00	12700	12700	12800	12800	12800	12900	12900	12900	12900	13000	300
17.10	13000	13000	13100	13100	13100	13200	13200	13200	13200	13300	300
17.20	13300	13300	13400	13400	13400	13500	13500	13500	13500	13600	300
17.30	13600	13600	13700	13700	13700	13800	13800	13800	13900	13900	300
17.40	13900	14000	14000	14000	14000	14100	14100	14100	14200	14200	300
17.50	14200	14300	14300	14300	14400	14400	14400	14500	14500	14500	400
17.60	14600	14600	14600	14700	14700	14700	14800	14800	14800	14900	300
17.70	14900	14900	14900	15000	15000	15000	15100	15100	15100	15200	300
17.80	15200	15200	15300	15300	15300	15400	15400	15500	15500	15500	400
17.90	15600	15600	15600	15700	15700	15700	15800	15800	15800	15900	300
18.00	15900	15900	16000	16000	16000	16100	16100	16100	16200	16200	300
18.10	16200	16300	16300	16300	16400	16400	16500	16500	16500	16600	400
18.20	16600	16600	16700	16700	16700	16800	16800	16800	16900	16900	400
18.30	17000	17000	17000	17100	17100	17100	17200	17200	17200	17300	300
18.40	17300	17400	17400	17400	17500	17500	17500	17600	17600	17700	400
18.50	17700	17700	17800	17800	17800	17900	17900	18000	18000	18000	400
18.60	18100	18100	18100	18200	18200	18300	18300	18300	18400	18400	400
18.70	18500	18500	18500	18600	18600	18700	18700	18800	18800	18800	300
18.80	18800	18900	18900	19000	19000	19000	19100	19100	19200	19200	400
18.90	19200	19300	19300	19400	19400	19400	19500	19500	19600	19600	400
19.00	19600	19700	19700	19800	19800	19800	19900	19900	20000	20000	400
19.10	20000	20100	20100	20200	20200	20300	20300	20300	20400	20400	500
19.20	20500	20500	20500	20600	20600	20700	20700	20800	20800	20800	400
19.30	20900	20900	21000	21000	21100	21100	21200	21200	21300	21300	400
19.40	21300	21300	21400	21400	21500	21500	21600	21600	21700	21700	400
19.50	21700	21800	21800	21900	21900	22000	22000	22000	22100	22100	500
19.60	22200	22200	22300	22300	22400	22400	22400	22500	22500	22600	400
19.70	22600	22700	22700	22800	22800	22800	22900	22900	23000	23000	500
19.80	23100	23100	23200	23200	23300	23300	23400	23400	23400	23500	400
19.90	23500	23600	23600	23700	23700	23800	23800	23900	23900	24000	500
20.00	24000*	24000	24100	24100	24200	24200	24300	24300	24400	24400	500
20.10	24500	24500	24600	24600	24700	24700	24700	24800	24800	24900	400

STATION:05311000 MINNESOTA RIVER AT MONTEVIDEO, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:173
 LATITUDE: 445600 LONGITUDE: 0954400 NAD27 DRAINAGE AREA:6180 CONTRIBUTING DRAINAGE AREA: DATUM:909.12 NGVD29

Date Processed: 2011-08-24 09:38 By mitton

Rating for Discharge (cfs)

RATING ID: 49.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 04-05-2008 @ 13:03:18 CDT, Updated by mitton on 09-11-2008 @ 16:02:20 CDT

RATING REMARKS: Same as rating 47.0 above 12.5 ft (gbm)

OFFSET: 0.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
20.20	24900	25000	25000	25100	25100	25200	25200	25300	25300	25400	500
20.30	25400	25500	25500	25600	25600	25700	25700	25700	25800	25800	500
20.40	25900	25900	26000	26000	26100	26100	26200	26200	26300	26300	500
20.50	26400	26400	26500	26500	26600	26600	26700	26700	26800	26800	500
20.60	26900	26900	27000	27000	27100	27100	27200	27200	27300	27300	500
20.70	27400	27400	27500	27500	27600	27600	27700	27700	27800	27800	500
20.80	27900	27900	28000	28000	28100	28200	28200	28300	28300	28400	500
20.90	28400	28500	28500	28600	28600	28700	28700	28800	28800	28900	500
21.00	28900	29000	29000	29100	29100	29200	29300	29300	29400	29400	600
21.10	29500	29500	29600	29600	29700	29700	29800	29800	29900	30000	500
21.20	30000	30100	30100	30200	30200	30300	30300	30400	30400	30500	600
21.30	30600	30600	30700	30700	30800	30800	30900	30900	31000	31000	500
21.40	31100	31200	31200	31300	31300	31400	31400	31500	31600	31600	600
21.50	31700	31700	31800	31800	31900	31900	32000	32100	32100	32200	500
21.60	32200	32300	32300	32400	32500	32500	32600	32600	32700	32700	600
21.70	32800	32900	32900	33000	33000	33100	33200	33200	33300	33300	600
21.80	33400	33400	33500	33600	33600	33700	33700	33800	33900	33900	600
21.90	34000	34000	34100	34200	34200	34300	34300	34400	34500	34500	600
22.00	34600	34600	34700	34800	34800	34900	34900	35000	35100	35100	600
22.10	35200	35200	35300	35400	35400	35500	35500	35600	35700	35700	600
22.20	35800	35900	35900	36000	36000	36100	36200	36200	36300	36400	600
22.30	36400	36500	36500	36600	36700	36700	36800	36900	36900	37000	600
22.40	37000	37100	37200	37200	37300	37400	37400	37500	37600	37600	700
22.50	37700	37700	37800	37900	37900	38000	38100	38100	38200	38300	600
22.60	38300	38400	38500	38500	38600	38700	38700	38800	38900	38900	700
22.70	39000	39000	39100	39200	39200	39300	39400	39400	39500	39600	600
22.80	39600	39700	39800	39800	39900	40000	40000	40100	40200	40200	700
22.90	40300	40400	40400	40500	40600	40600	40700	40800	40900	40900	700
23.00	41000	41100	41100	41200	41300	41300	41400	41500	41500	41600	700
23.10	41700	41700	41800	41900	42000	42000	42100	42200	42200	42300	700
23.20	42400	42400	42500	42600	42700	42700	42800	42900	42900	43000	700
23.30	43100	43100	43200	43300	43400	43400	43500	43600	43600	43700	700
23.40	43800	43900	43900	44000	44100	44100	44200	44300	44400	44400	700
23.50	44500	44600	44600	44700	44800	44900	44900	45000	45100	45200	700
23.60	45200	45300	45400	45500	45600	45700	45700	45800	45900	45900	800
23.70	46000	46000	46100	46200	46300	46300	46400	46500	46600	46600	700
23.80	46700	46800	46900	46900	47000	47100	47200	47200	47300	47400	800
23.90	47500	47500	47600	47700	47800	47900	47900	48000	48100	48200	700

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:05311000 MINNESOTA RIVER AT MONTEVIDEO, MN TYPE:STREAM AGENCY:USGS STATE:27 COUNTY:173
 LATITUDE: 445600 LONGITUDE: 0954400 NAD27 DRAINAGE AREA:6180 CONTRIBUTING DRAINAGE AREA: DATUM:909.12 NGVD29

Date Processed: 2011-08-24 09:38 By mitton

Rating for Discharge (cfs)

RATING ID: 49.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by besavage on 04-05-2008 @ 13:03:18 CDT, Updated by mitton on 09-11-2008 @ 16:02:20 CDT

RATING REMARKS: Same as rating 47.0 above 12.5 ft (gbm)

OFFSET: 0.30

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs) (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
24.00	48200	48300	48400	48500	48500	48600	48700	48800	48900	48900	800
24.10	49000	49100	49200	49200	49300	49400	49500	49600	49600	49700	800
24.20	49800	49900	49900	50000	50100	50200	50300	50300	50400	50500	800
24.30	50600	50700	50700	50800	50900	51000	51100	51100	51200	51300	800
24.40	51400	51500	51500	51600	51700	51800	51900	51900	52000	52100	800
24.50	52200	52300	52400	52400	52500	52600	52700	52800	52800	52900	800
24.60	53000	53100	53200	53300	53300	53400	53500	53600	53700	53800	800
24.70	53800	53900	54000	54100	54200	54300	54300	54400	54500	54600	900
24.80	54700	54800	54800	54900	55000	55100	55200	55300	55400	55400	800
24.90	55500	55600	55700	55800	55900	56000	56000	56100	56200	56300	900
25.00	56400	56500	56600	56600	56700	56800	56900	57000	57100	57200	900
25.10	57300	57300	57400	57500	57600	57700	57800	57900	58000	58000	800
25.20	58100	58200	58300	58400	58500	58600	58700	58700	58800	58900	900
25.30	59000	59100	59200	59300	59400	59500	59600	59600	59700	59800	900
25.40	59900	60000	60100	60200	60300	60400	60500	60500	60600	60700	900
25.50	60800	60900	61000	61100	61200	61300	61400	61500	61500	61600	900
25.60	61700	61800	61900	62000	62100	62200	62300	62400	62500	62600	1000
25.70	62700	62800	62800	62900	63000	63100	63200	63300	63400	63500	900
25.80	63600	63700	63800	63900	64000	64100	64200	64300	64400	64400	900
25.90	64500	64600	64700	64800	64900	65000	65100	65200	65300	65400	1000
26.00	65500*										

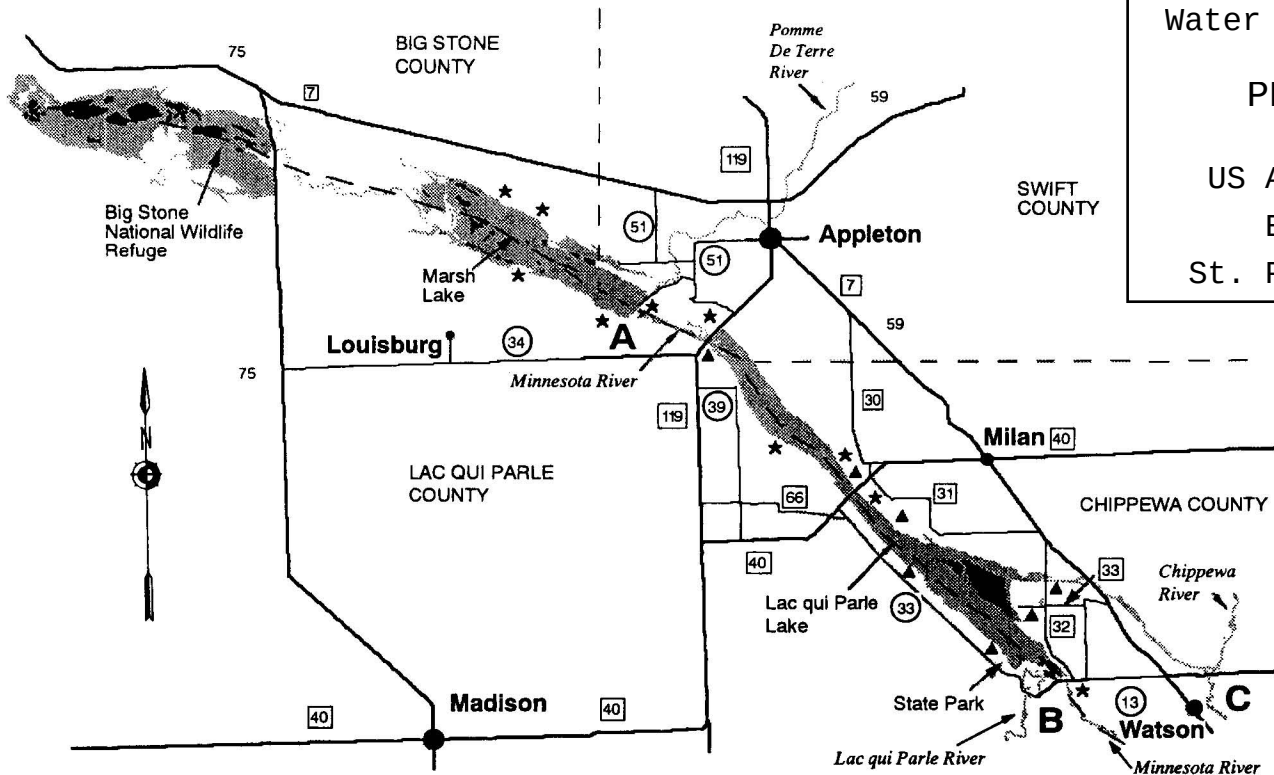
"*" indicates a rating descriptor point

Rating Type:		Rating Type: stage-discharge		A	Comments
ID	Starting Date	Ending Date			
49.0	10-11-2007 @ 00:00:00 CDT	10-19-2010 @ 23:59:59 CDT	-----	A	
49.0	10-20-2010 @ 00:00:00 CDT	-----		W	

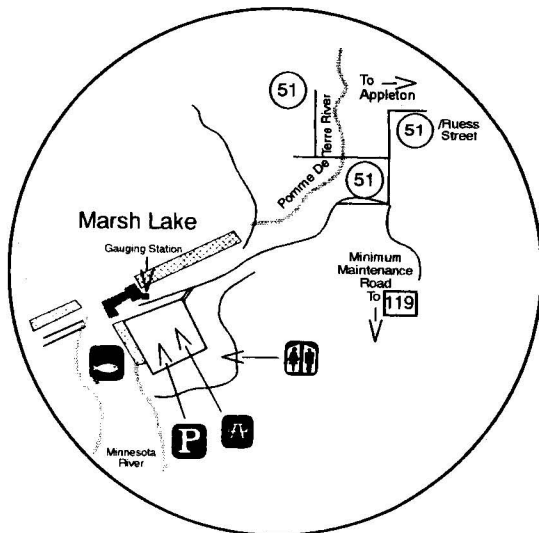


PROJECT MAP

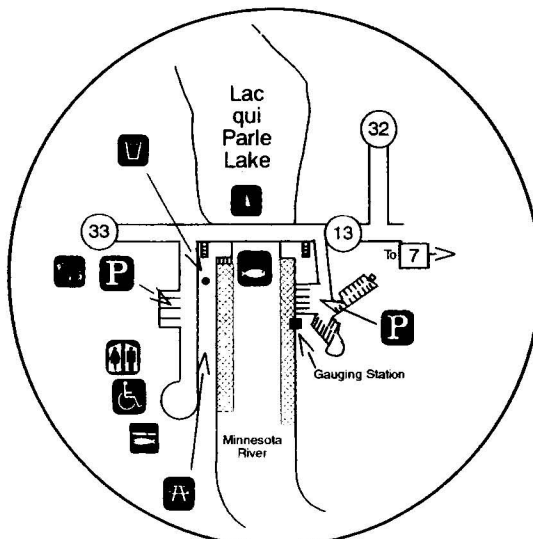
US Army Corps of
Engineers,
St. Paul District



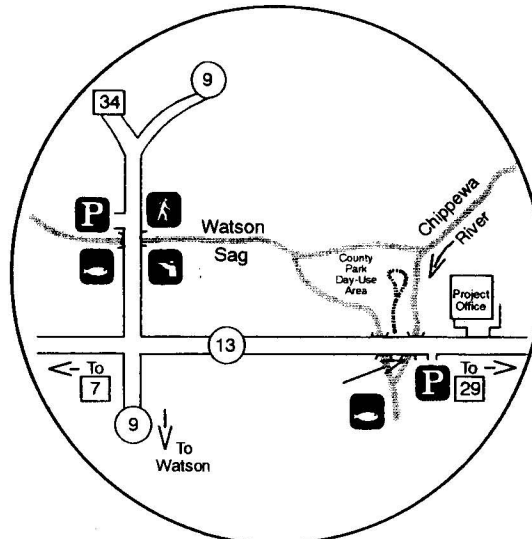
Area A



Area B

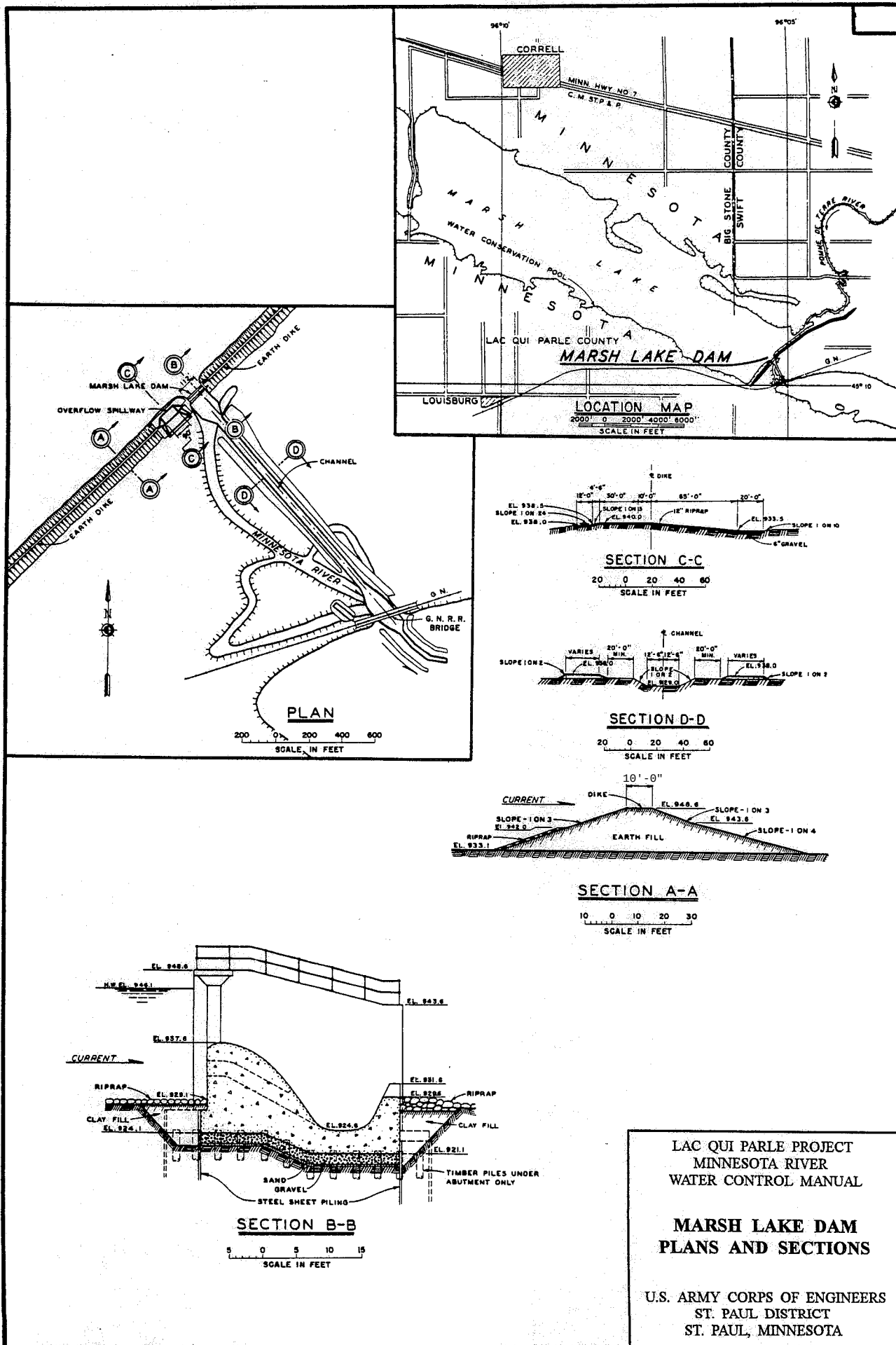


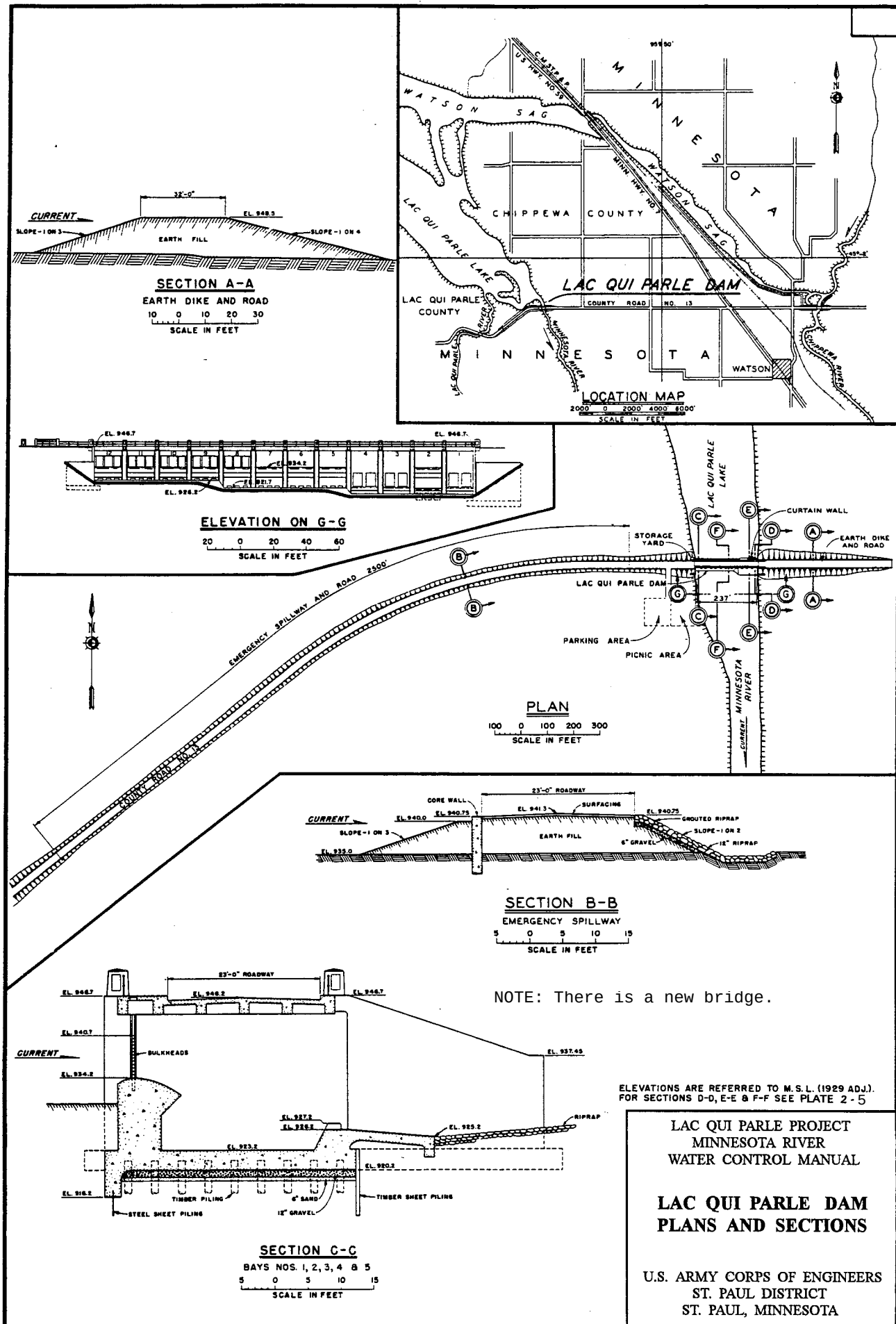
Area C



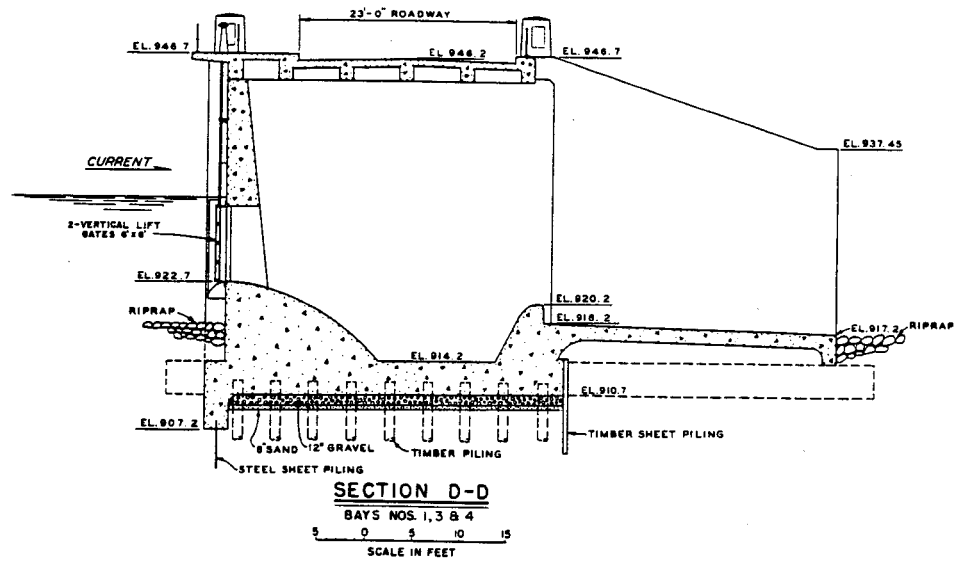
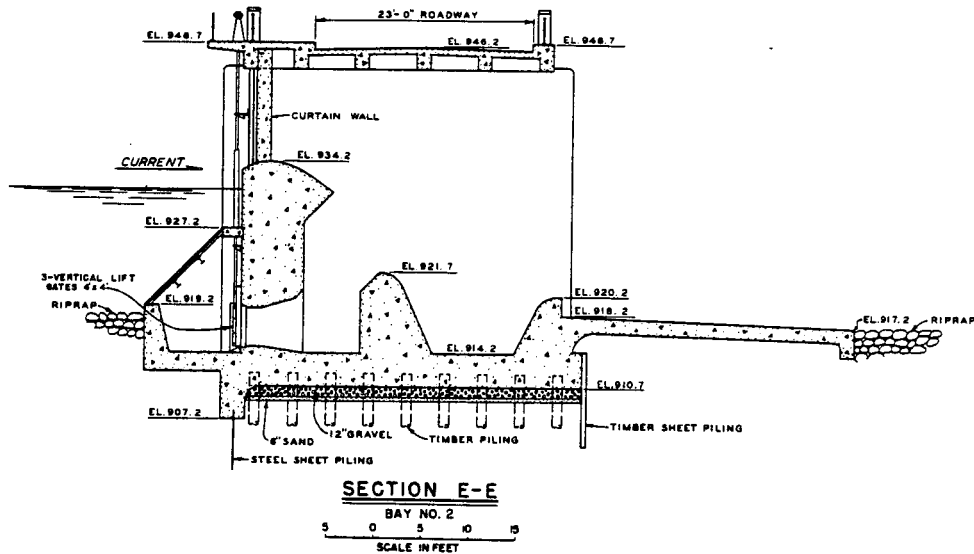
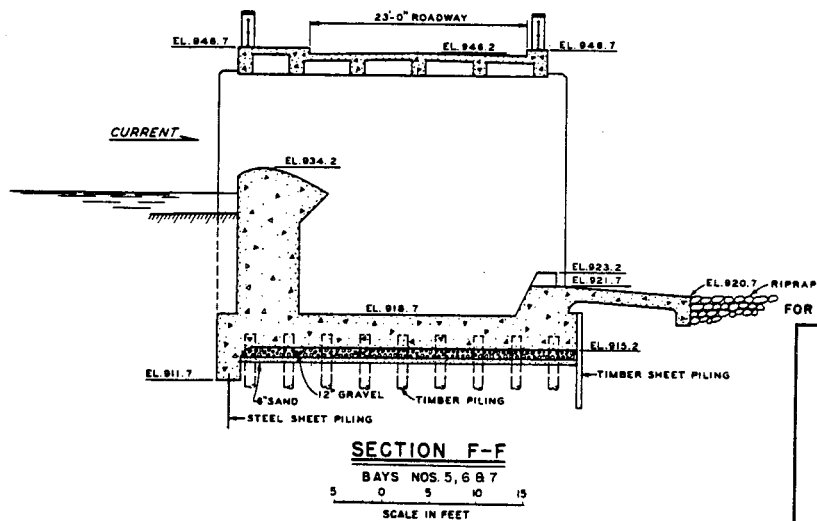
Legend

- | | | |
|-----------------------|------------------|----------------------|
| ▲ Boat Landing | 🚶 Hiking | 🎣 Tailwater Fishing |
| ★ Canoe Portage | 🏹 Hunting | 🛖 U.S. Route Marker |
| ● City | P Parking | Day-Use Areas |
| — County Line | 🎡 Playground | A - Marsh Lake |
| 🏰 Dam | 🌳 Picnic Area | B - Lac qui Parle |
| 🚰 Drinking Water | 🚻 Rest Rooms | C - Watson Sag Weir |
| 🐟 Fish Cleaning | 🛣 State Highway | |
| ♿ Handicap Facilities | ○ Secondary Road | |





NOTE: There is a new bridge.

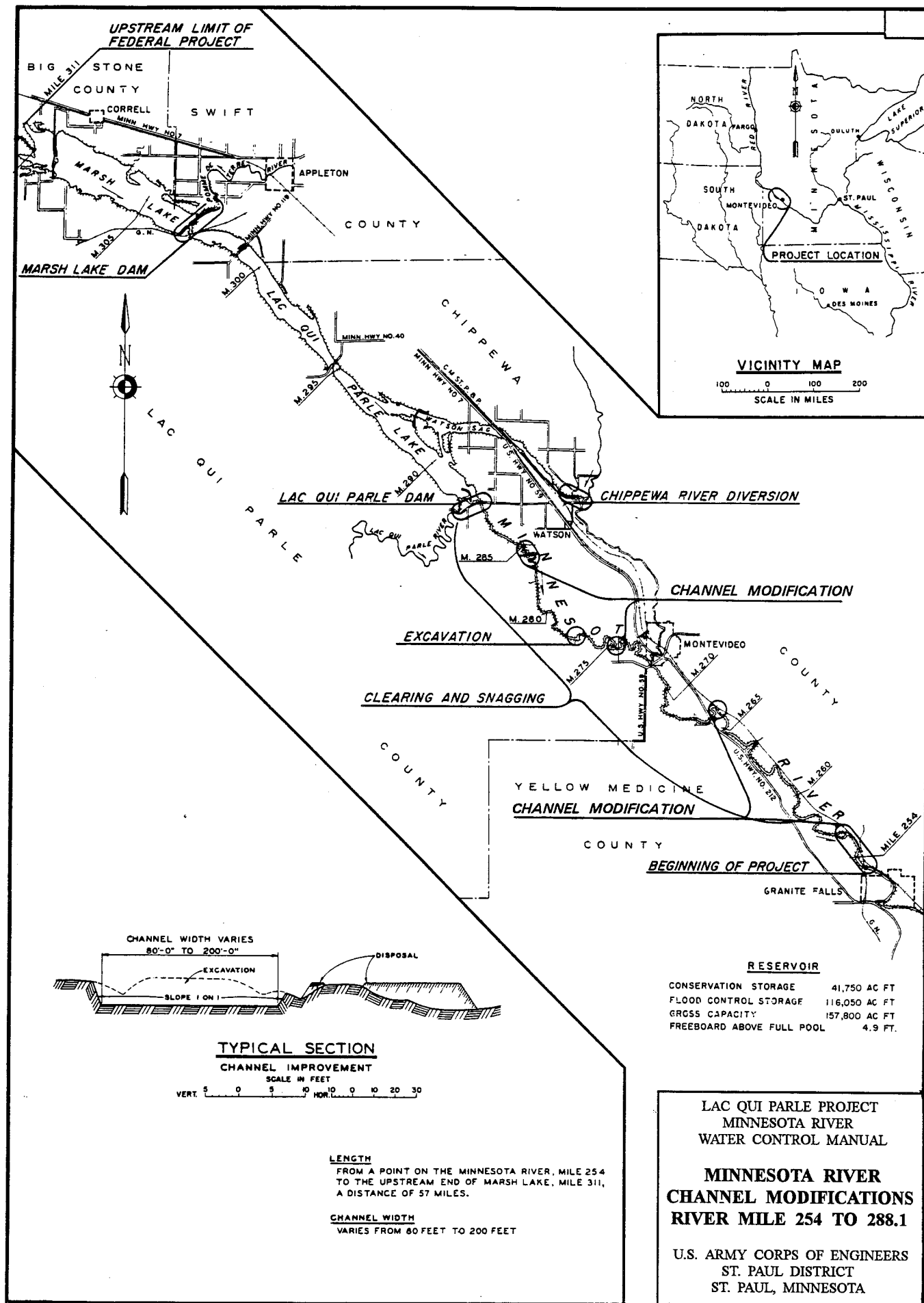


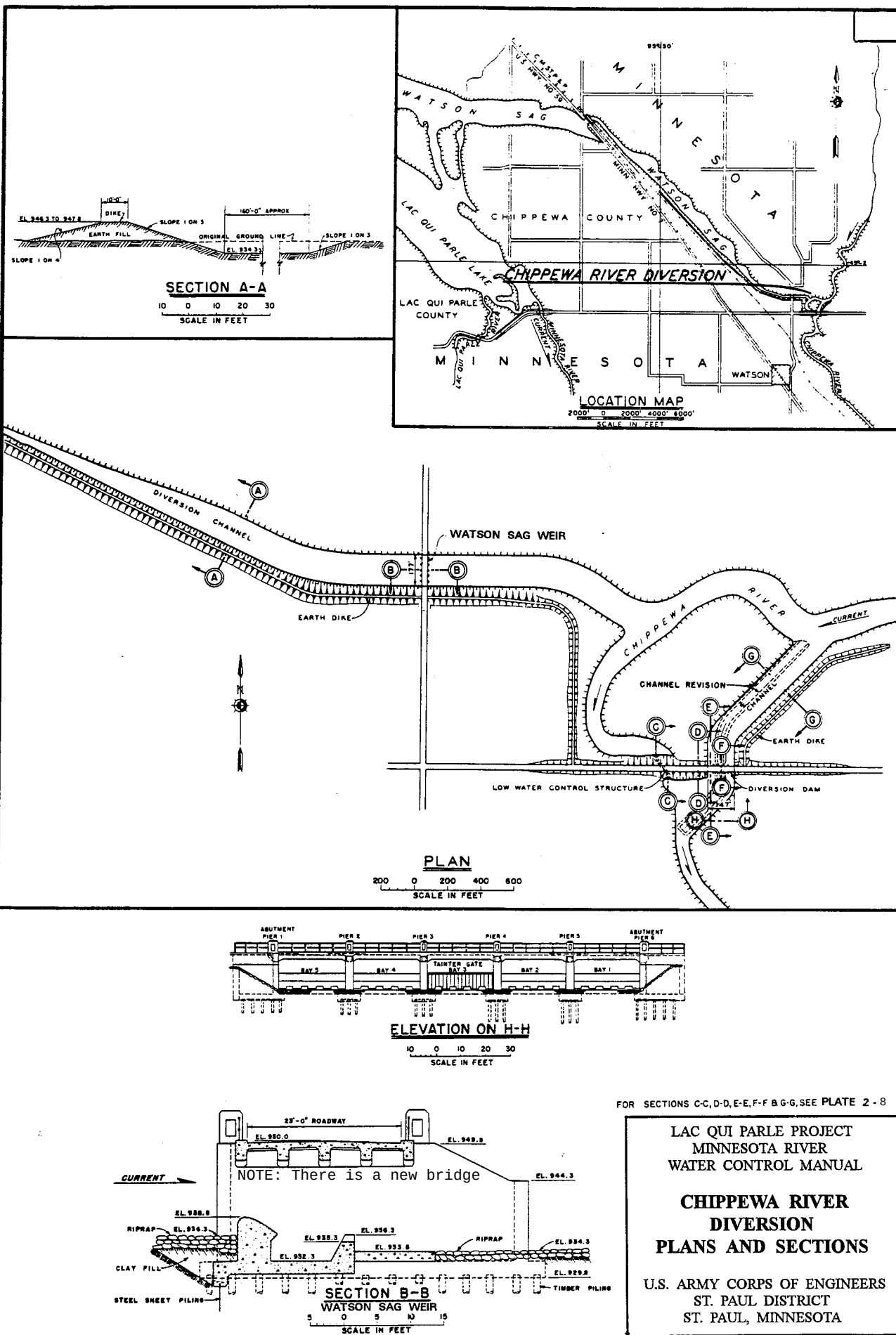
FOR LOCATION OF SECTIONS SEE PLATE 2 - 4

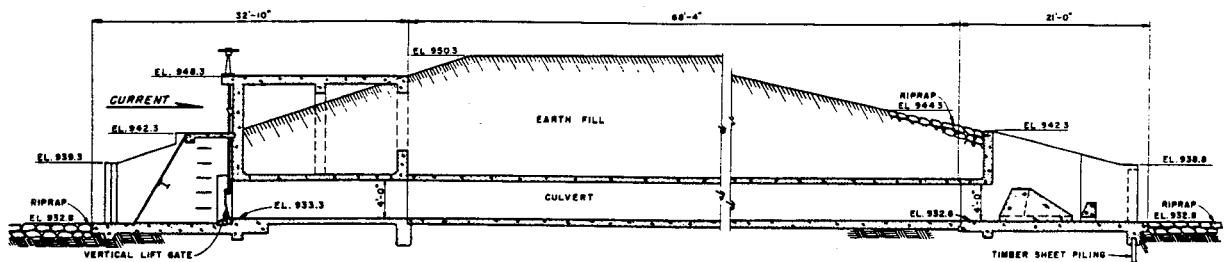
LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

**LAC QUI PARLE DAM
SECTIONS**

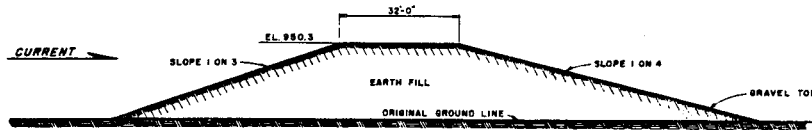
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA



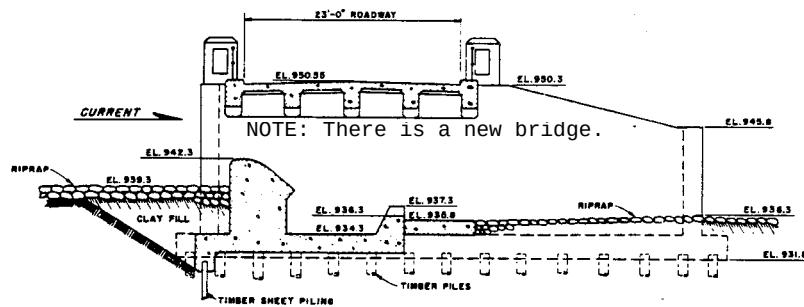




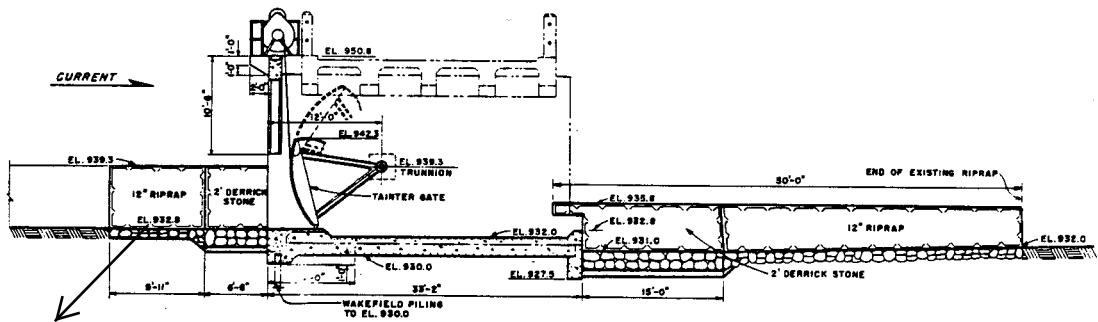
SECTION C-C
LOW WATER CONTROL STRUCTURE
SCALE IN FEET
0 5 10 15



SECTION D-D
SCALE IN FEET
10 0 10 20 30

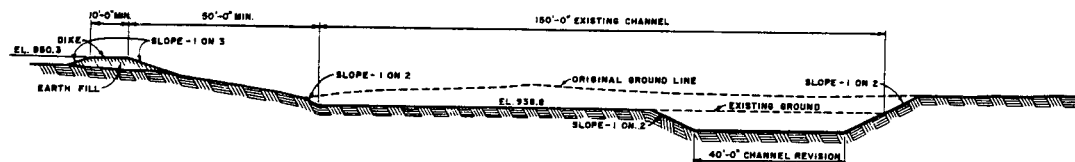


SECTION E-E
DIVERSION DAM
SCALE IN FEET
5 0 5 10 15



See Exhibit A

SECTION F-F
SCALE IN FEET
5 0 5 10 15



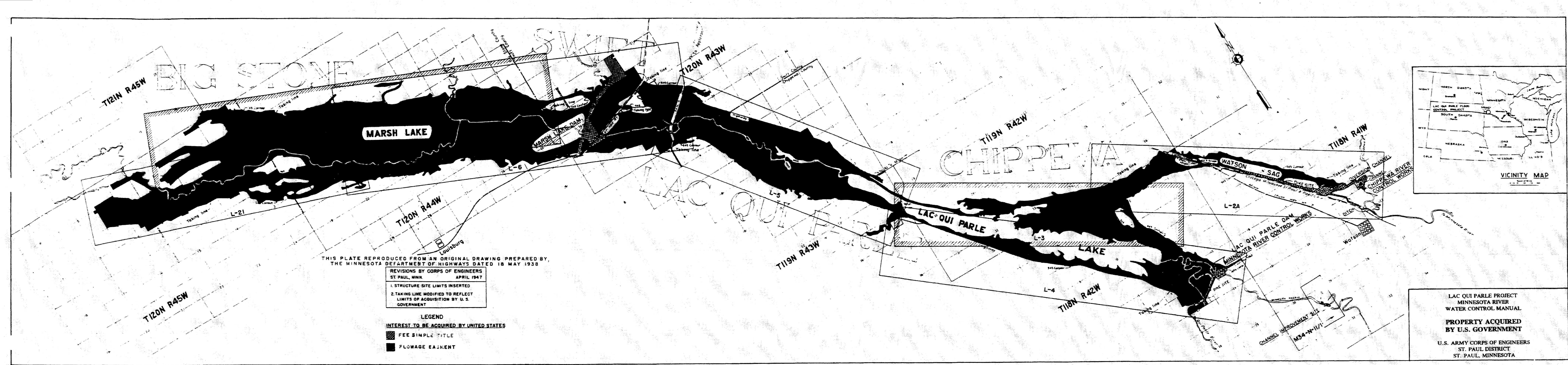
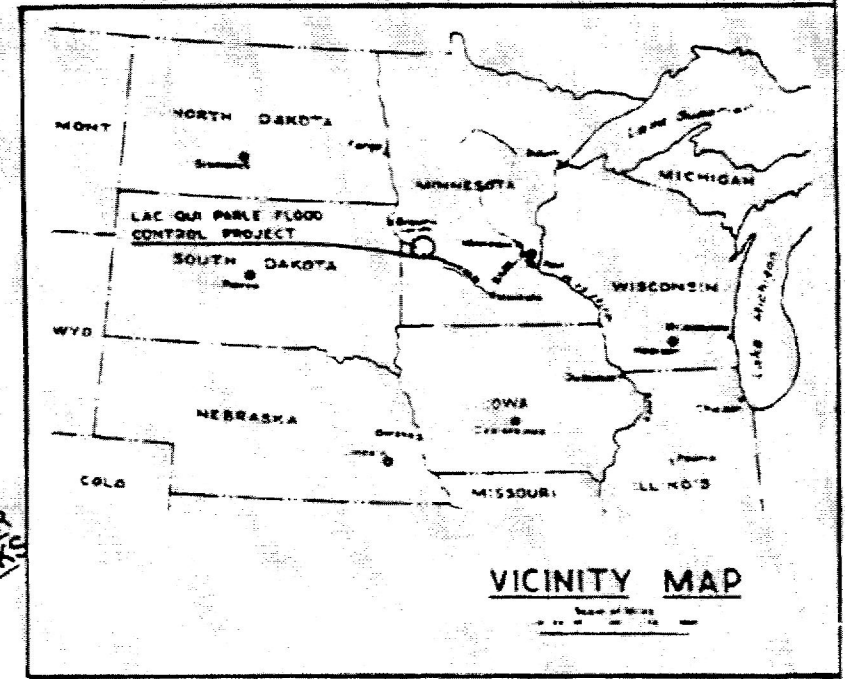
SECTION G-G
CHANNEL AND DIKE
SCALE IN FEET
10 0 10 20 30

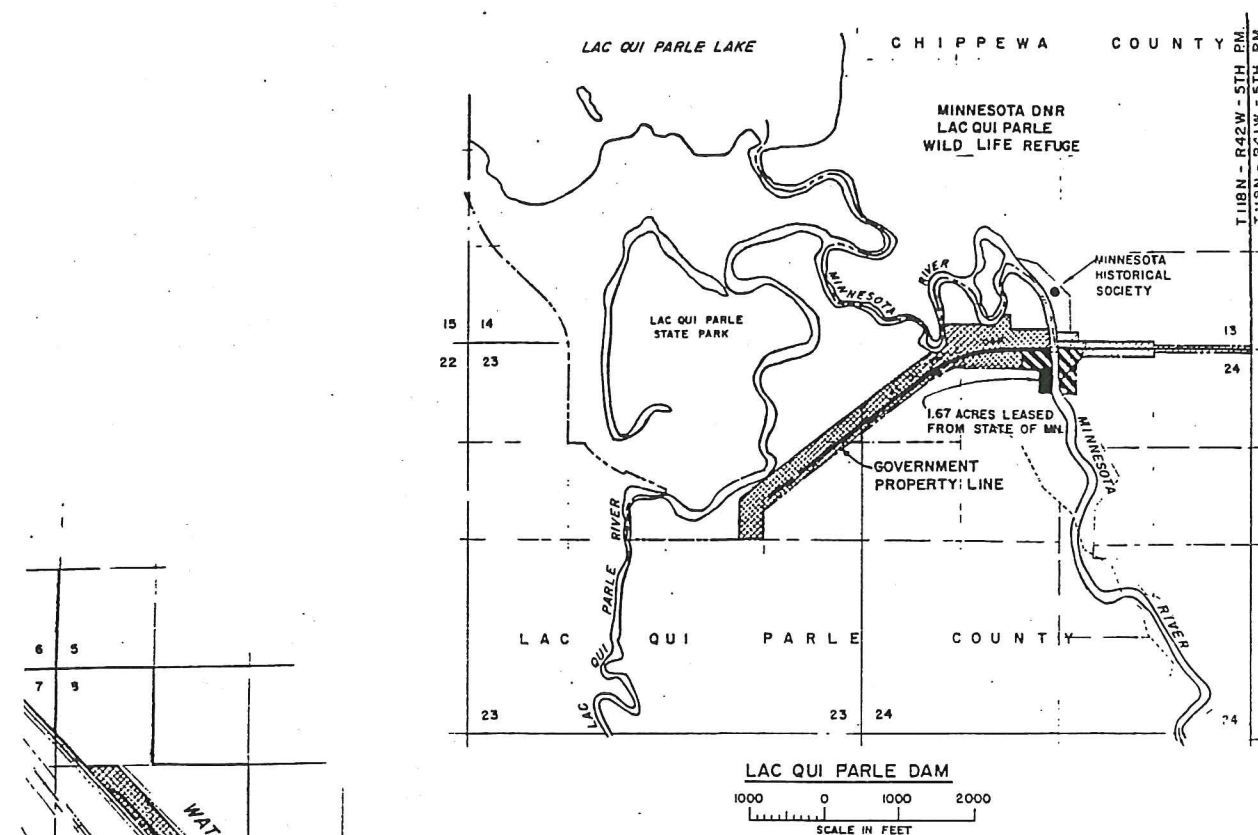
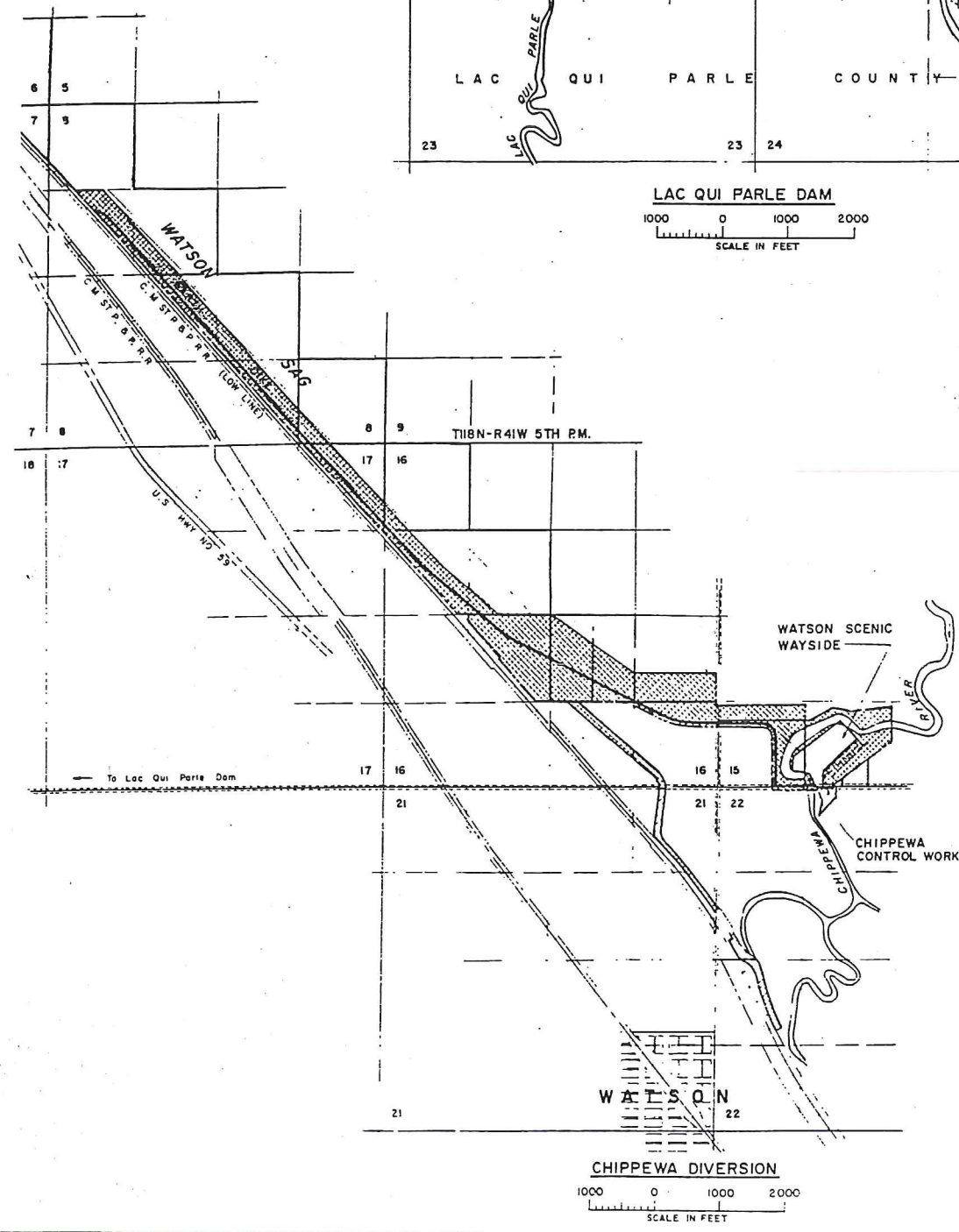
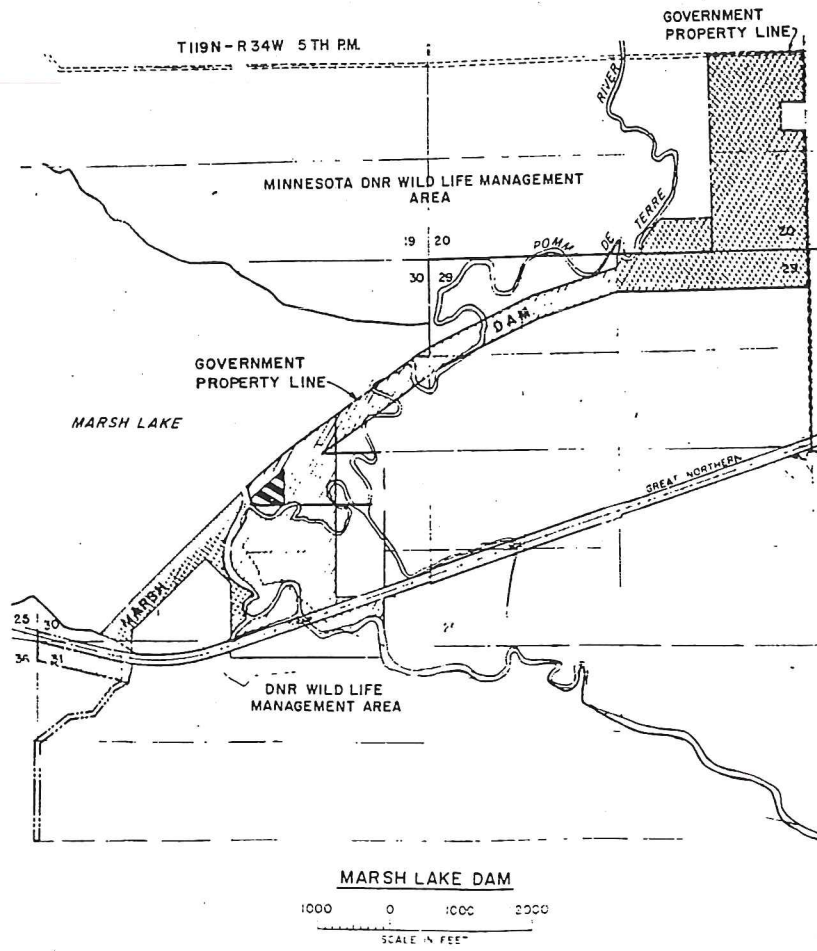
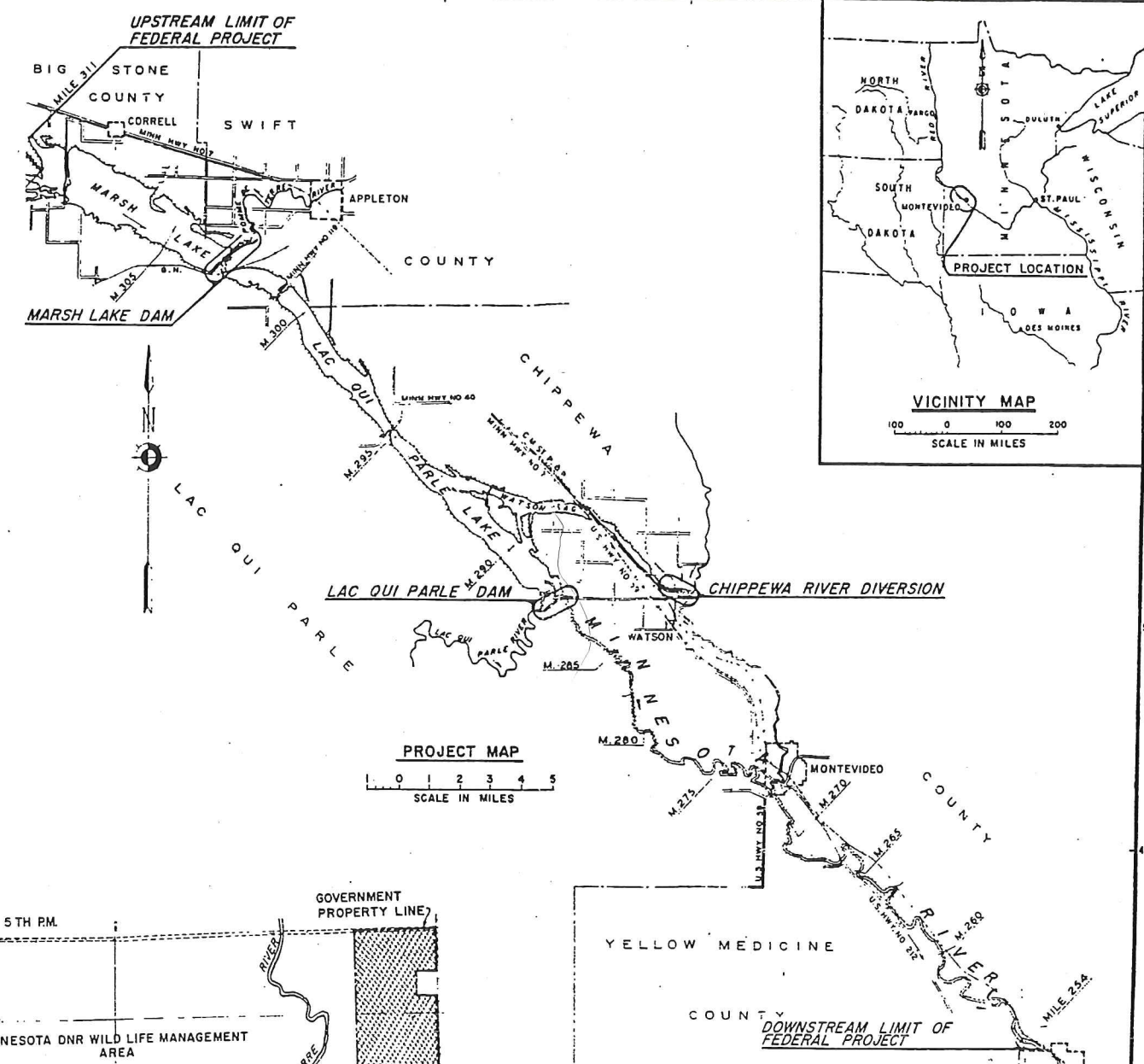
NOTE:
FOR LOCATION OF SECTIONS SEE PLATE 2-7
ELEVATIONS ARE REFERRED TO M.S.L.(1929 ADJ.)

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

CHIPPEWA RIVER DIVERSION
SECTIONS

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA





- LAND USE ALLOCATIONS FOR CORPS ADMINISTERED LANDS
- RECREATION-INTENSIVE USE
 - RECREATION-LOW DENSITY
 - WILDLIFE MANAGEMENT
 - PROJECT OPERATIONS

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

PROJECT REAL ESTATE

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

Plate 4-1

**Summary of Peak Discharges and Elevations/Stages at Lac qui
Parle Dam, and Montevideo, Minnesota For Selected Floods**

Lac qui Parle Dam ¹		Lac qui Parle Dam Pool		Montevideo, MN Gage ²		
Date	Peak Discharge	Date	Peak Elevation ³	Date	Peak Discharge	Peak Stage ⁴
4/10/1951	9,760 cfs	4/11/1951	939.90 ft	4/11/1951	12,200 cfs ⁵	16.80 ft
4/10/1952	19,700 cfs	4/10/1952	941.95 ft	4/10/1952	24,500 cfs ⁵	20.02 ft
4/14/1965	10,700 cfs	4/03/1965	939.90 ft	4/14/1965	12,900 cfs ⁵	16.64 ft
4/12/1969	29,400 cfs	4/13/1969	942.47 ft	4/12/1969	35,100 cfs ⁵	21.68 ft
4/18/1979	10,600 cfs	4/19/1979	939.78 ft	4/19/1979	12,200 cfs ⁵	16.21 ft
3/25/1985	9,360 cfs	3/25/1985	939.40 ft	3/26/1985	11,510 cfs ⁵	16.09 ft
4/08/1986	13,200 cfs	4/08/1986 10/12/1986	941.06 ft 941.23 ft	4/08/1986	13,990 cfs ⁵	17.26 ft
8/03/1993	10,200 cfs	8/03/1993	941.72 ft	8/04/1993	11,500 cfs ⁵	16.46 ft
4/06/1997	43,000 cfs ⁶	4/06/1997	944.13 ft ⁷	4/06/1997	47,500 cfs ⁵	23.90 ft
4/14/2001	30,100 cfs	4/14/2001	943.67 ft	4/14/2001	33,900 cfs ⁵	22.15 ft
3/28/2009	15,800 cfs	3/28/2009	942.56 ft	3/29/2009	16,800 cfs ⁵	18.27 ft
3/22/2010	21,200 cfs	3/22/2009	942.77 ft	3/23/2010	24,400 cfs ⁵	20.09 ft
4/06/2011	19,700 cfs	4/6/2011	942.55 ft	4/07/2011	23,700 cfs ⁵	19.76 ft
6/23/2014	12,900 cfs	6/23/2014	941.27 ft	6/25/2014	14,500 cfs ⁵	17.45 ft

1. U.S.G.S. Gage No. 05301000, 200 ft. downstream of the dam.

2. U.S.G.S. Gage No. 05311000, Gage Datum = 909.12 ft., 1929 NGVD adj., The construction of the dam was completed in 1939.

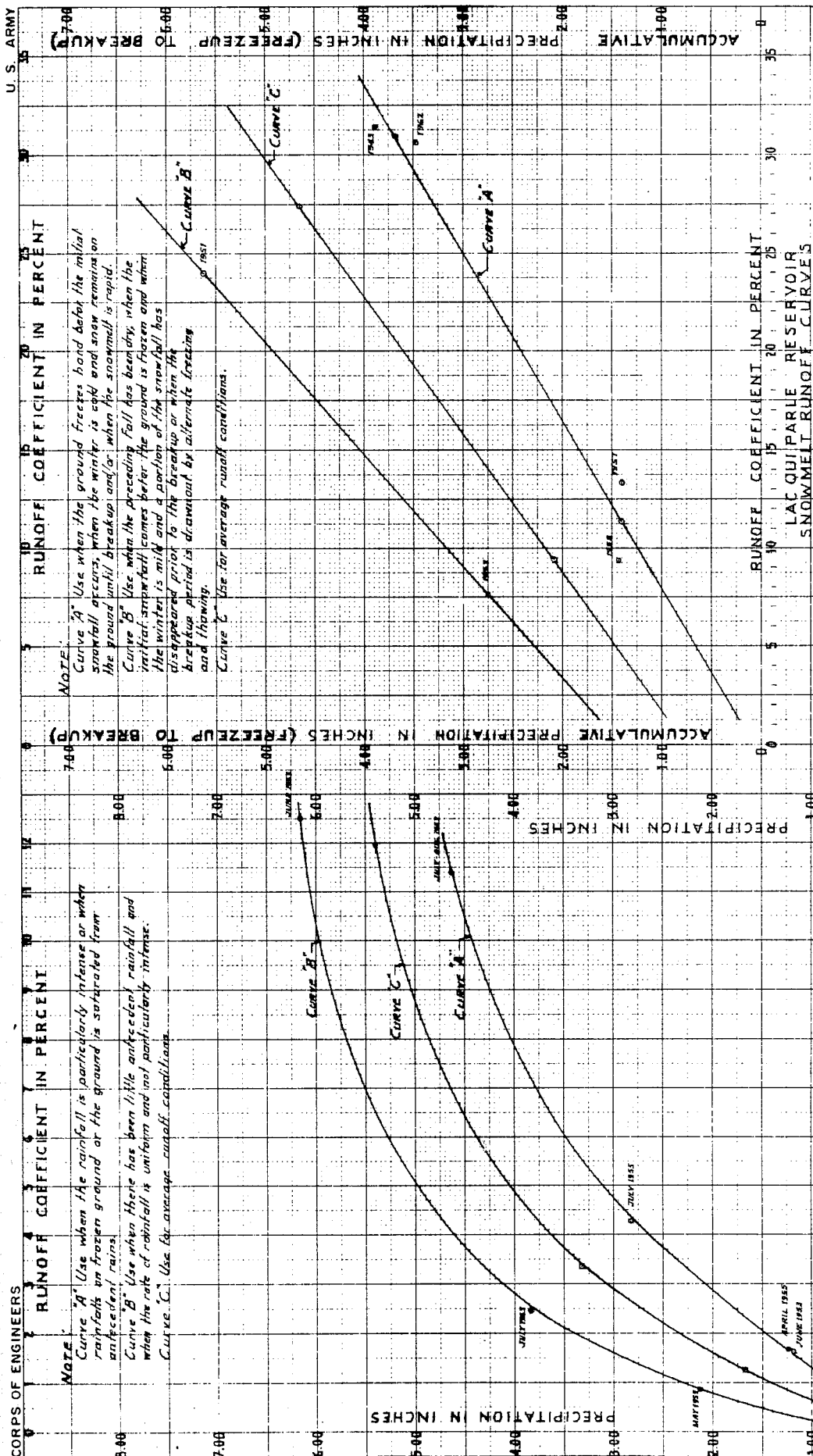
3. Corps Gage, 1929 NGVD Adjustment.

4. Project Control Point, Target Stage = 17 feet = approximately 13,000 cfs, National Weather Service Flood Stage = 14 feet.

5. Discharge affected by Regulation or Diversion, (See USGS Gage Notes).

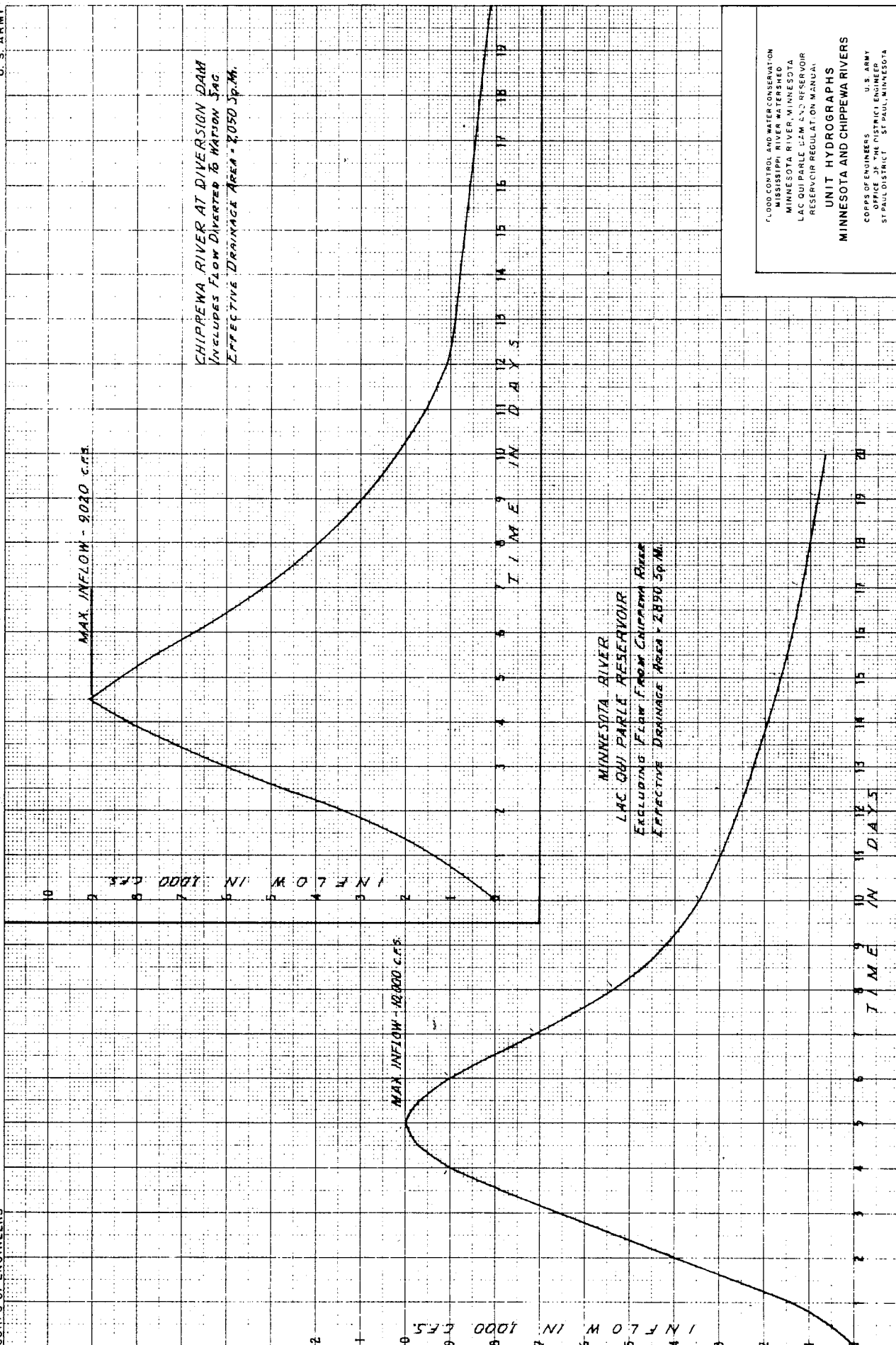
6. Discharge is a Historic Peak, and actually greater than indicated value. (See USGS Gage Notes).

7. The Leupold & Stevens recorder gage stopped working on 06 April 1997 when the water level rose above the floor of the gage house (see the paper recorder/strip chart). The Corps of Engineers later surveyed a high water mark at 944.13 feet inside of a telephone junction box near the dam. The dam operator estimated a peak pool elevation at 944.20 feet with a date of 07 April 1997 however the gage benchmark was later discovered to be 0.12 feet high. A peak date of 06 April seems more likely when correlated with the USGS records at the tailwater gage and at Montevideo. A peak pool elevation of 944.13 feet was adopted.



LOOD CONTROL AND WATER CONSERVATION
MISSISSIPPI RIVER WATERSHED
MINNESOTA RIVER, MINNESOTA
ACQUIPARLE DAM AND RESERVOIR
RESERVOIR REGULATION MANUAL
ENVELOPING CURVES

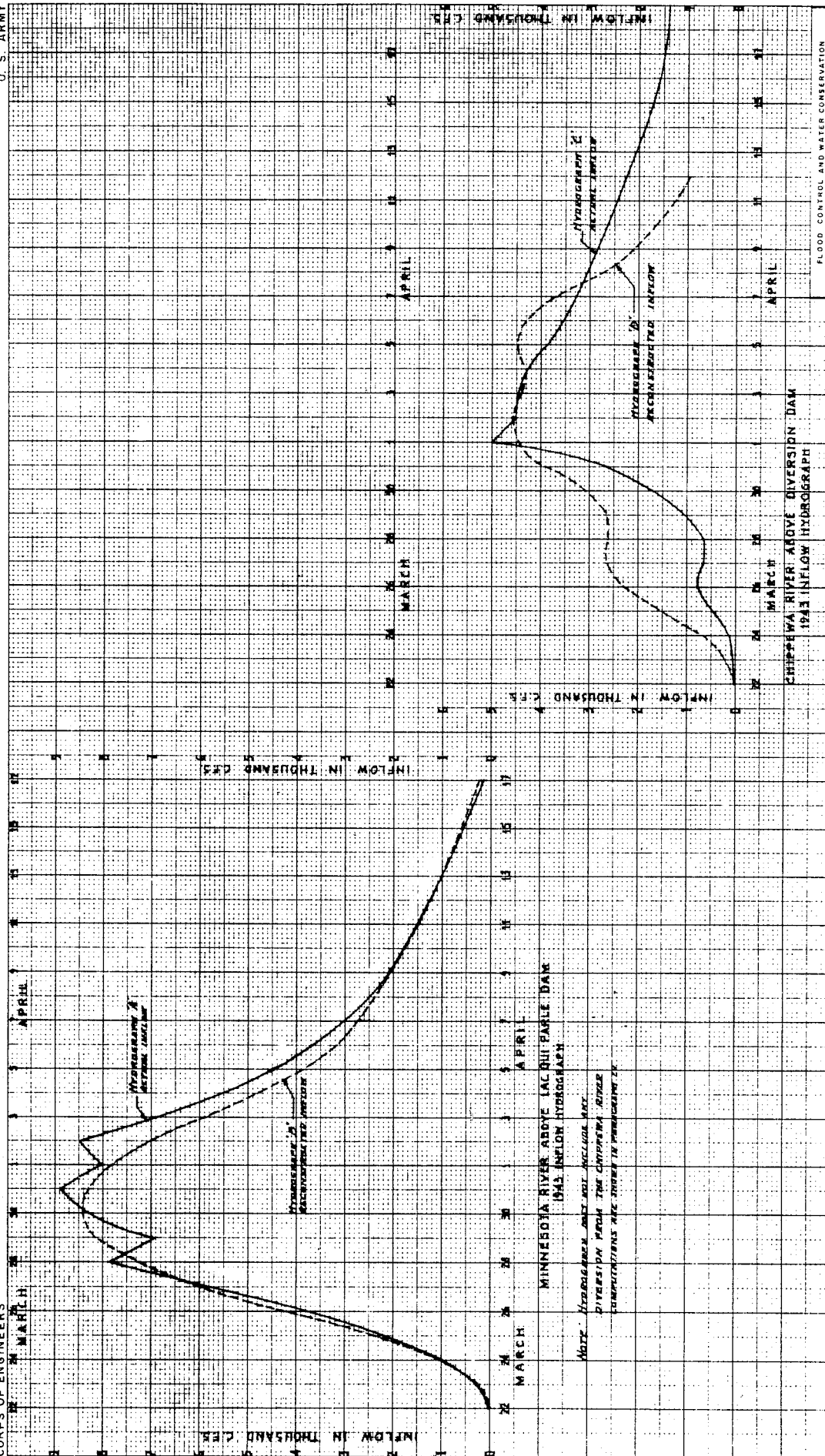
PRECIPITATION - PERCENT OF RUNOFF
FOR



FLOOD CONTROL AND WATER CONSERVATION
 MISSISSIPPI RIVER WATERSHED
 MINNESOTA RIVER, MINNESOTA
 LAC QUI PARLE DAM AND RESERVOIR
 RESERVOIR REGULATION MANUAL

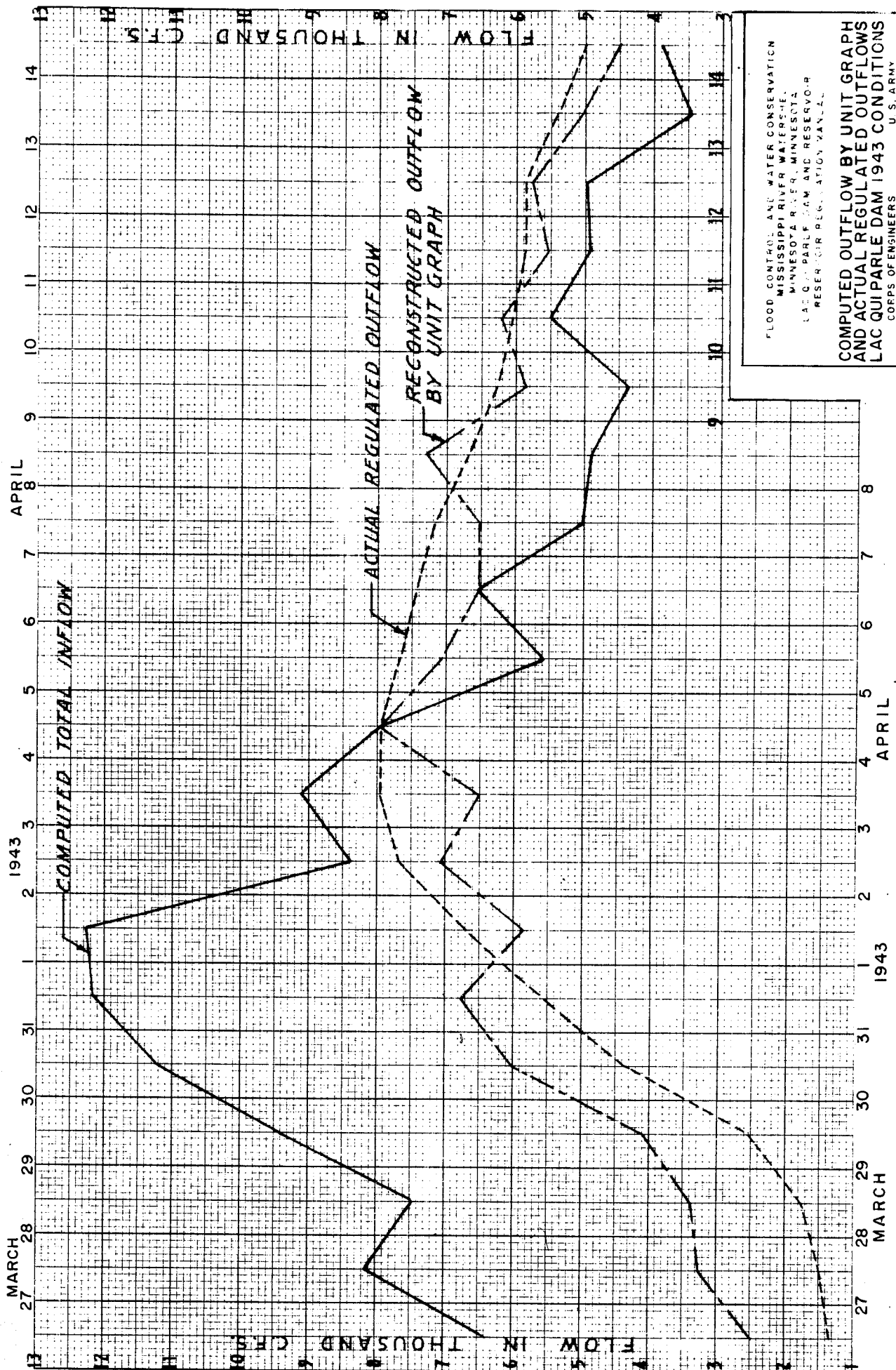
UNIT HYDROGRAPHS MINNESOTA AND CHIPREWA RIVERS

CORPS OF ENGINEERS U. S. ARMY
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 ST. PAUL DISTRICT ST. PAUL, MINNESOTA



FLOOD CONTROL AND WATER CONSERVATION
MISSISSIPPI RIVER WATERSHED
MINNESOTA RIVER, MINNESOTA
LAC OUI PARLE DAM AND RESERVOIR
RESERVOIR REGULATION MANUAL
INFLOW HYDROGRAPHS
MINNESOTA AND CHIPPEWA RIVERS
1943 CONDITIONS

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

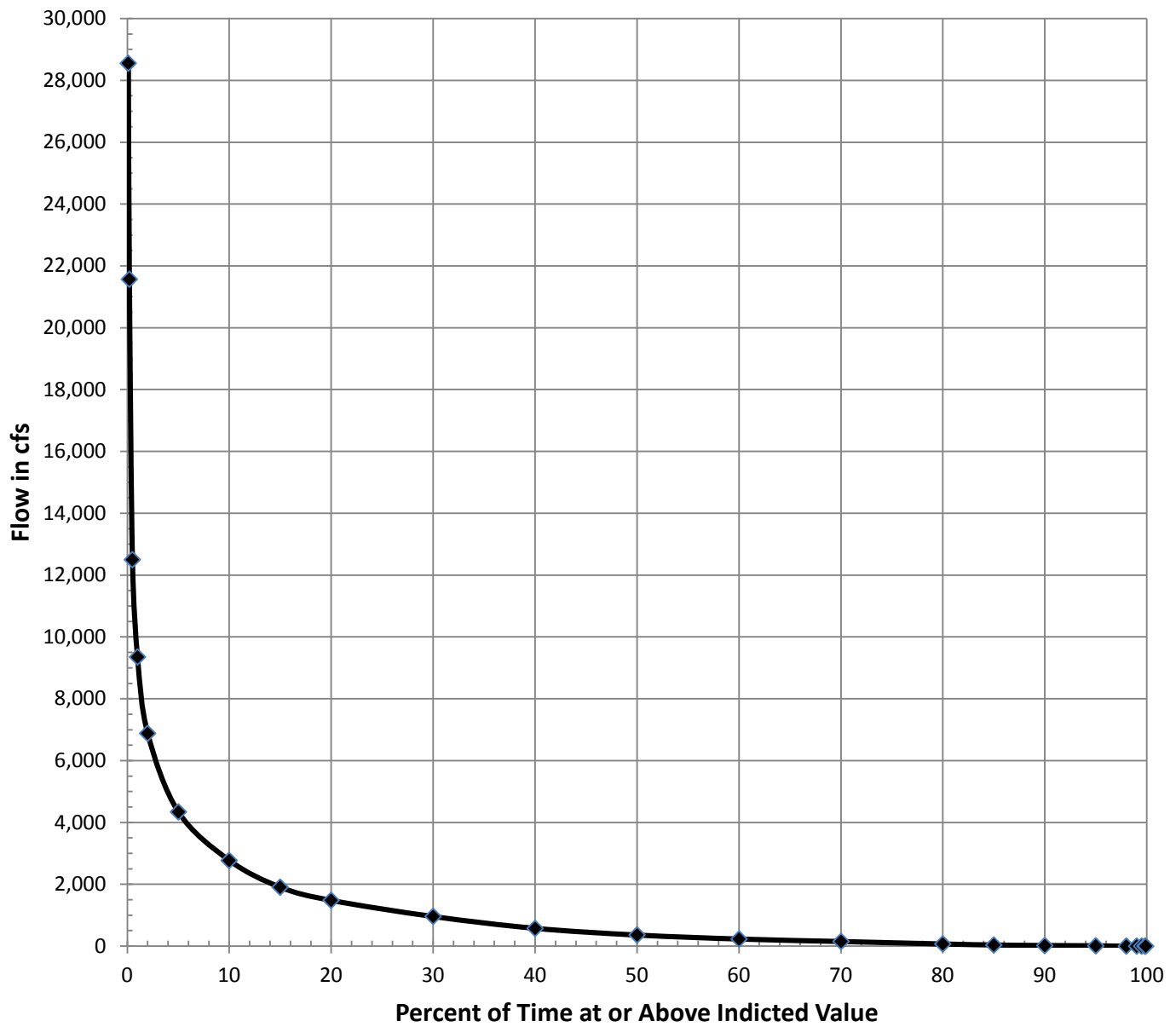


FLOOD CONTROL AND WATER CONSERVATION
MISSISSIPPI RIVER WATERSHED
MINNESOTA RIVER, MINNESOTA
LAC QUI PARLE DAM AND RESERVOIR
RESERVOIR REGULATION MANUAL

COMPUTED OUTFLOW BY UNIT GRAPH
AND ACTUAL REGULATED OUTFLOWS
LAC QUI PARLE DAM 1943 CONDITIONS
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

Lac qui Parle Parle Project

Reservoir Inflow - Duration



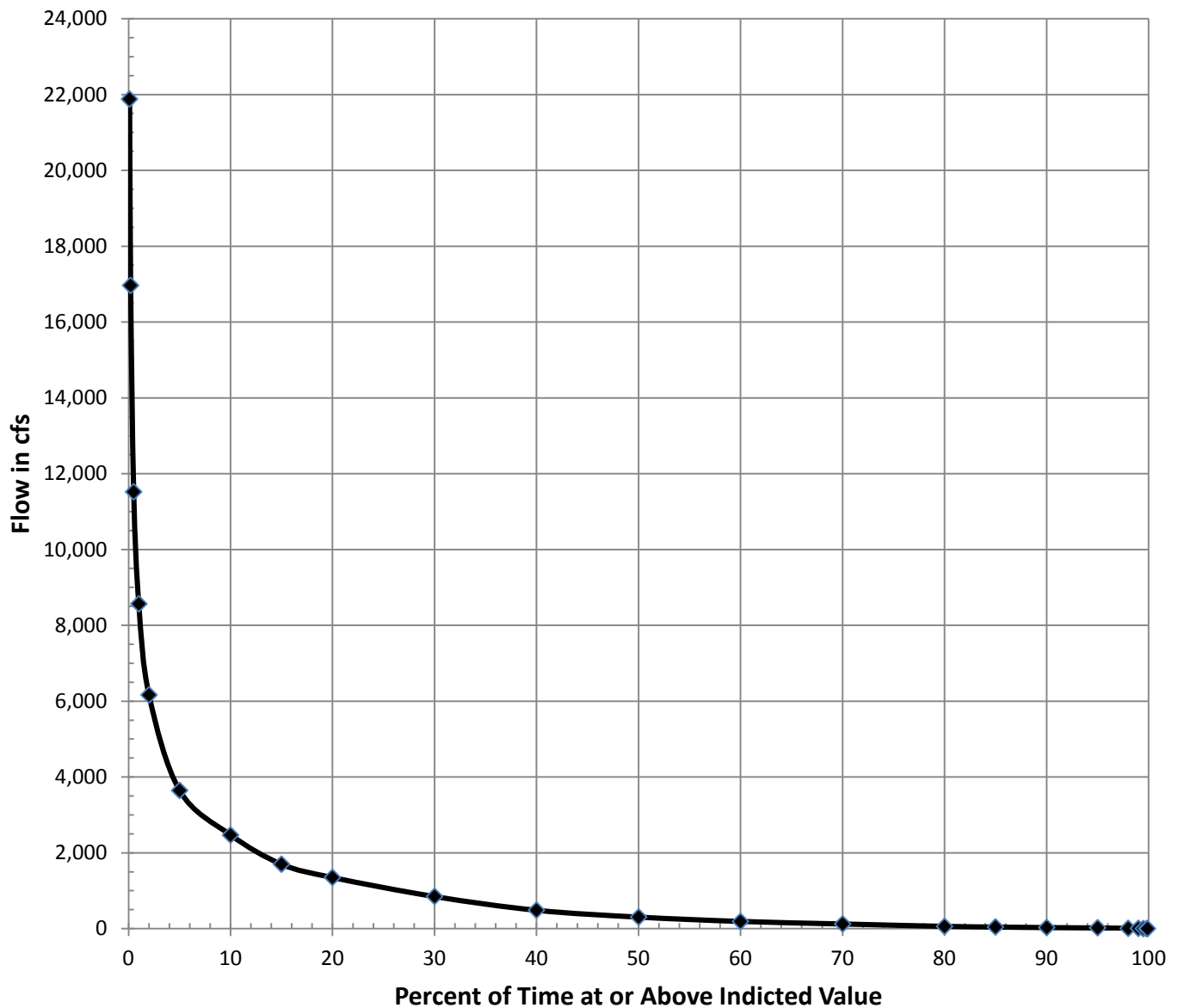
Period of Record (1965 to 2011)

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Minnesota River
Water Control Manual

**Reservoir
Inflow – Duration
(Annual)**

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

Lac qui Parle Parle Project Reservoir Outflow - Duration



Period of Record (1940 to 2015)

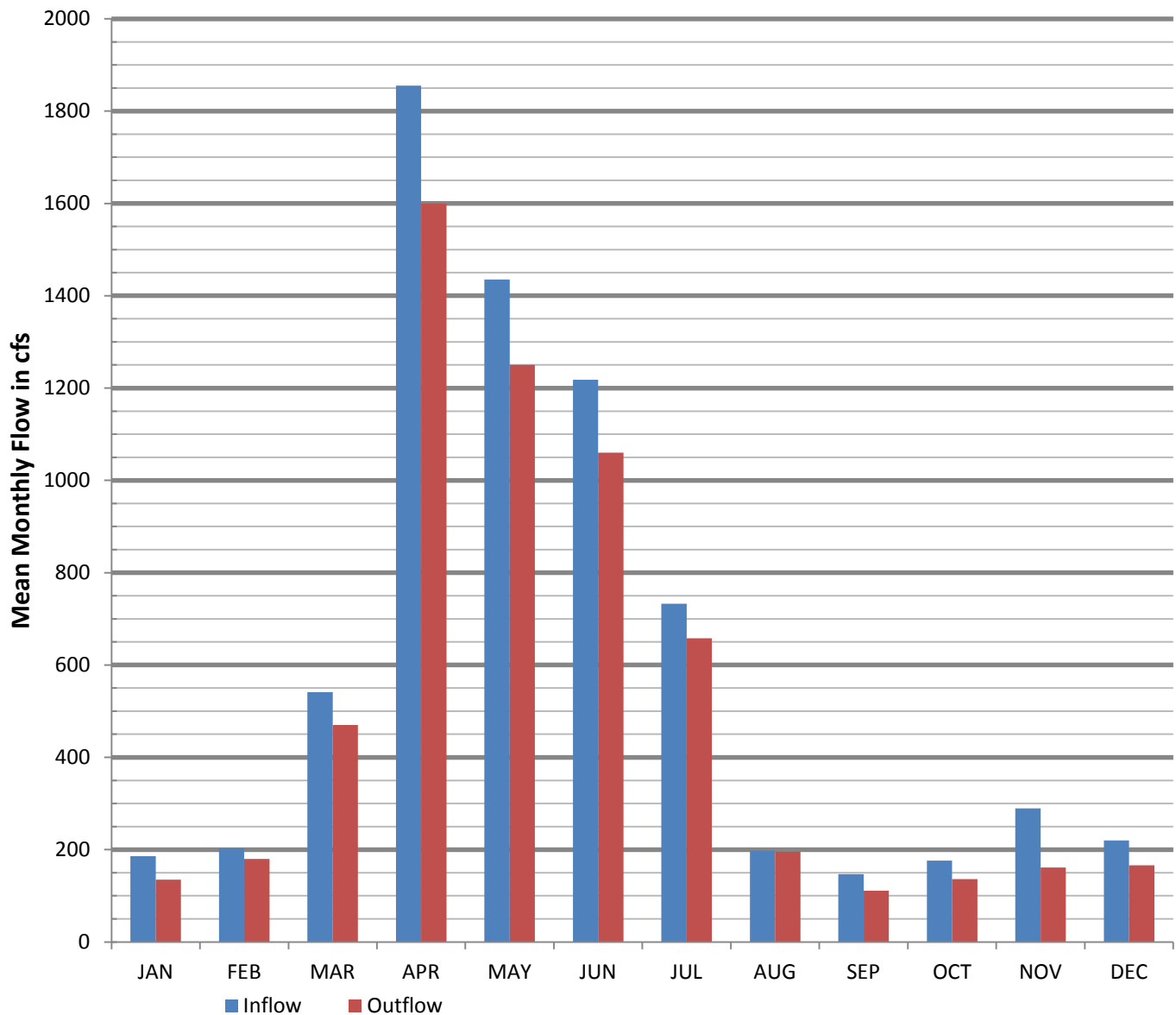
Lac Qui Parle Project
Minnesota River
Water Control Manual

**Reservoir
Outflow – Duration
(Annual)**

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

Lac qui Parle Project

Reservoir Monthly Inflow-Outflow



Period of Record for Inflow (1965 to 2015)
 Period of Record for Outflow (1940 to 2015)

Lac Qui Parle Project
 Minnesota River
 Water Control Manual

**Reservoir
 Inflow/Outflow – Duration
 (Annual)**

U. S. Army Corps of Engineers
 St. Paul District
 St. Paul, Minnesota

Plate 4-9
Lac Qui Parle Project, Reservoir Net Inflow – Duration Table
Years 1965 through 2011

Percent of Time at or Above Indicated Flow									
--	--	--	--	--	--	--	--	--	--

[illegible]

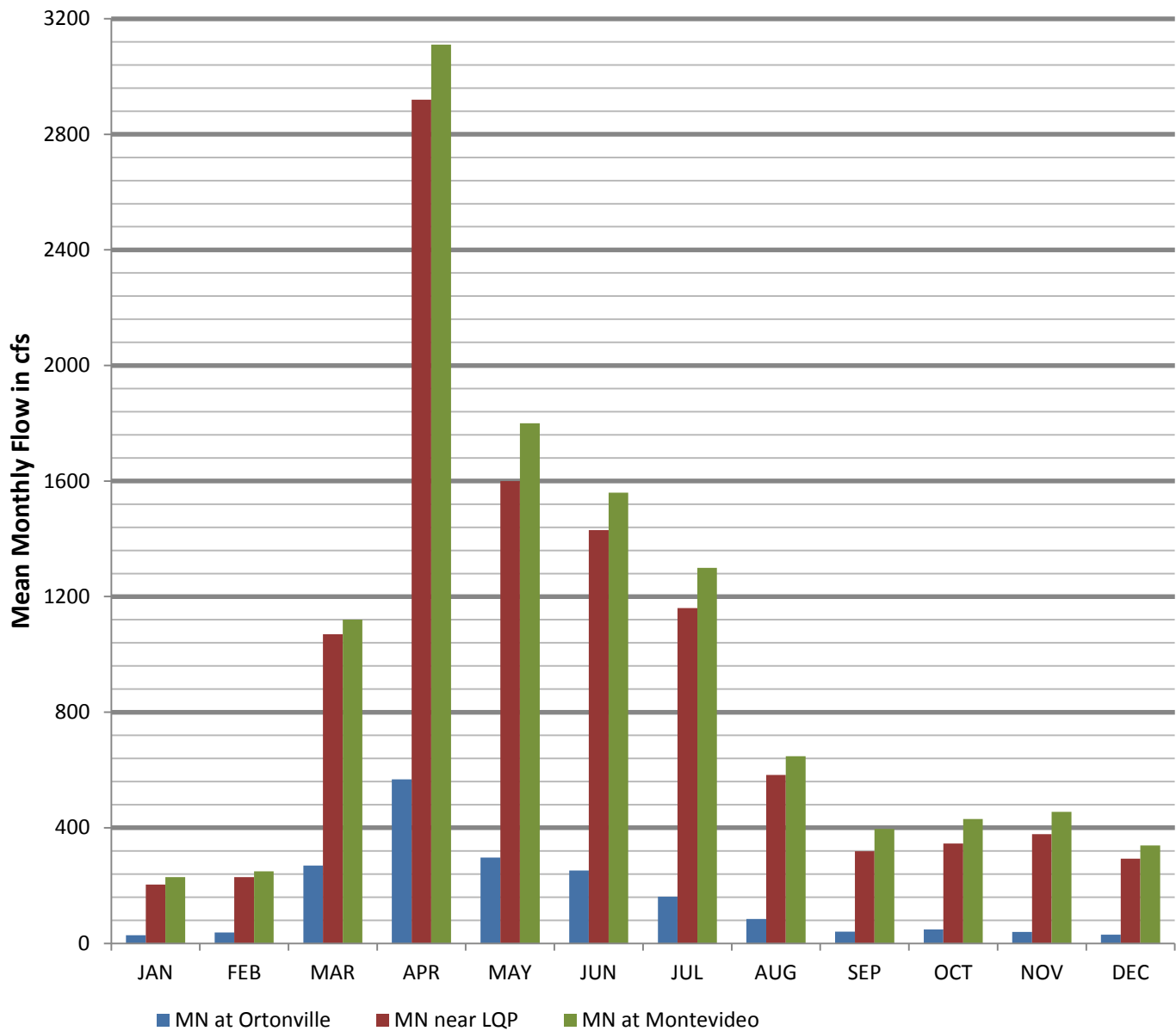
Plate 4-10
Lac Qui Parle Project, Reservoir Tailwater Outflow – Duration Table
Years 1940 through 2011

Percent of Time at or Above Indicated Flow	
100	100
90	100
80	100
70	100
60	100
50	100
40	100
30	100
20	100
10	100
0	100

[illegible]

U.S.G.S. Streamflow Sites on the Minnesota River

Monthly Streamflow Distribution



Period of Record for Ortonville (1938 to 2015)
 Period of Record for LQP (1943 to 2015)
 Period of Record for Montevideo (1910 to 2015)

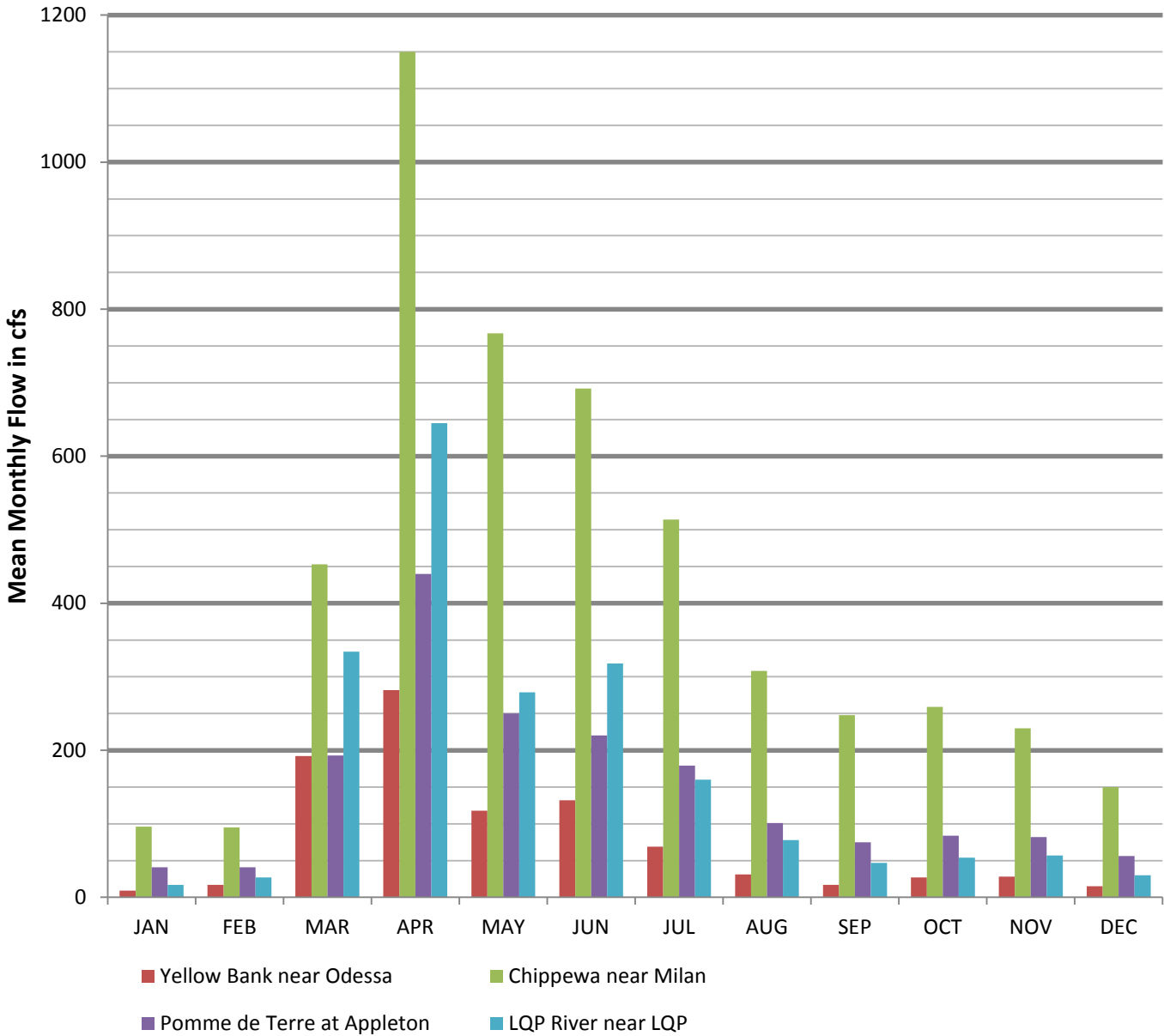
Lac Qui Parle Project
 Minnesota River
 Water Control Manual

**U.S.G.S. Streamflow Sites
 On the Minnesota River
 Monthly Distribution**

U. S. Army Corps of Engineers
 St. Paul District
 St. Paul, Minnesota

U.S.G.S. Streamflow Sites Tributary to the MN River

Monthly Streamflow Distribution



Period of Record for Odessa (1940 to 2015)
 Period of Record for Milan (1938 to 2015)
 Period of Record for Appleton (1932 to 2015)
 Period of Record for LQP (1911 to 2015)

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 Minnesota River
 Water Control Manual

**U.S.G.S. Streamflow Sites
 On the Minnesota River Tribs
 Monthly Distribution**

U. S. Army Corps of Engineers
 St. Paul District
 St. Paul, Minnesota

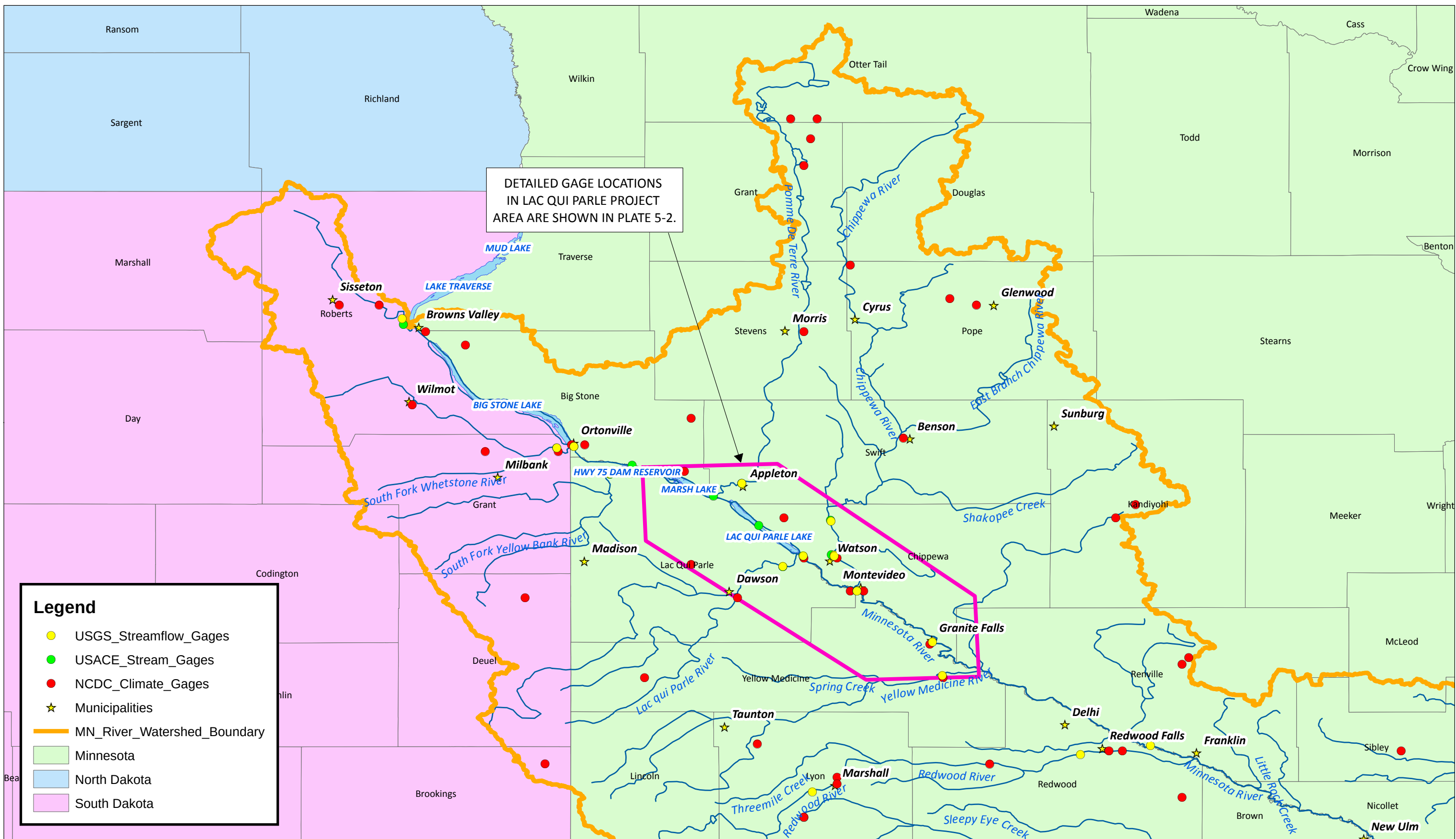
Plate 5-1
Lac qui Parle Project Hydrometeorological Stations Including Highway 75 Dam
(See Plate 5-2)

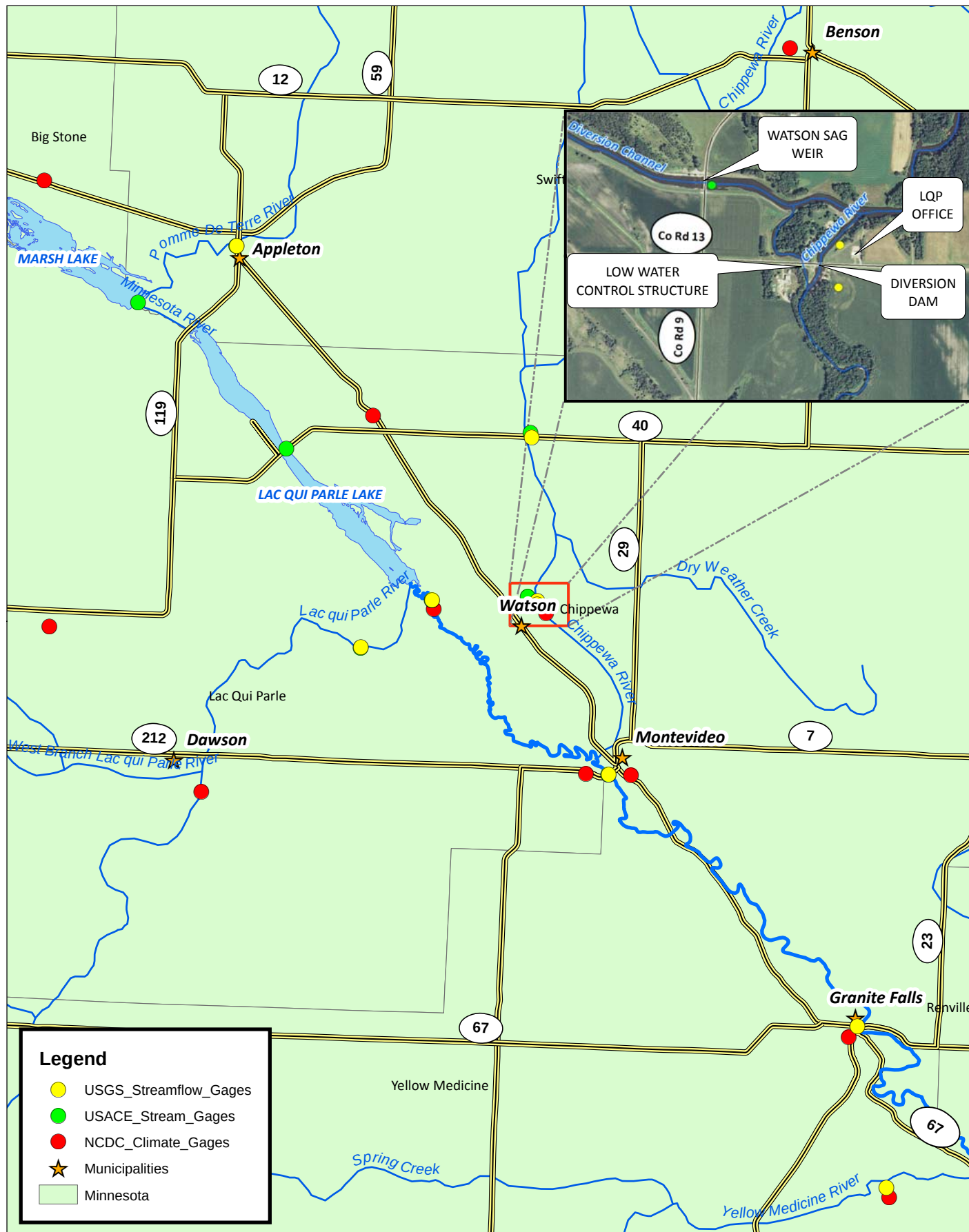
Location	Data Type	Equipment	Notes
Lac qui Parle Dam	Pool Elevation	Data Collection Platform and a Wire Weight Gage	Corps Gage
Lac qui Parle Dam	Tailwater Elevation	Data Collection Platform	USGS Gage
Lac qui Parle Dam	Ice Depth	Manual	Corps Gage
Lac qui Parle Dam	Precipitation	Tipping Bucket Gage	Corps Gage
Hwy 75 Dam, Low Flow	Precipitation	Data Collection Platform Tipping Bucket Gate	Corps Gage
Chippewa Diversion	Pool Elevation Tailwater Elev.	Data Collection Platform ¹ and Wire Weight Gages	Corps Gage Maintained by USGS
Chippewa Diversion	Precipitation	Recording Gage	NWS Gage
Chippewa Diversion	Air Temperature	Thermometer	Corps Gage
Chippewa Diversion	Windspeed/Dir.	Anemometer	Corps Gage
Chippewa Diversion	Snow Depth/Water Content	Snow Tube	Corps Gage
Chippewa Diversion	Frost Depth	Frost Tube	Corps Gage
Watson Sag Weir	Pool Elevation Tailwater Elev.	Data Collection Platform. ¹ And Wire Weight Gages	Corps Gage
Marsh Lake Dam	Pool Elevation Tailwater Elev.	Data Collection Platform ¹	Corps Gage
Highway 40 Bridge Over Lac qui Parle Pool near Milan, MN	Pool Elevation	Data Collection Platform and a Wire Weight Gage	Corps Gage
Highway 75 Dam Service Spillway	Pool Elevation	Data Collection Platform and a Wire Weight Gage	Corps Gage Maintained by USGS
Highway 75 Dam Service Spillway	Tailwater Elevation	Wire Weight Gage	Corps Gage Maintained by USGS
Highway 75 Dam Near Odessa (Low Flow)	Pool and Tailwater Elevation	Data Collection Platform ¹ and a Wire Weight Gage	Corps Gage At Low Flow Gate

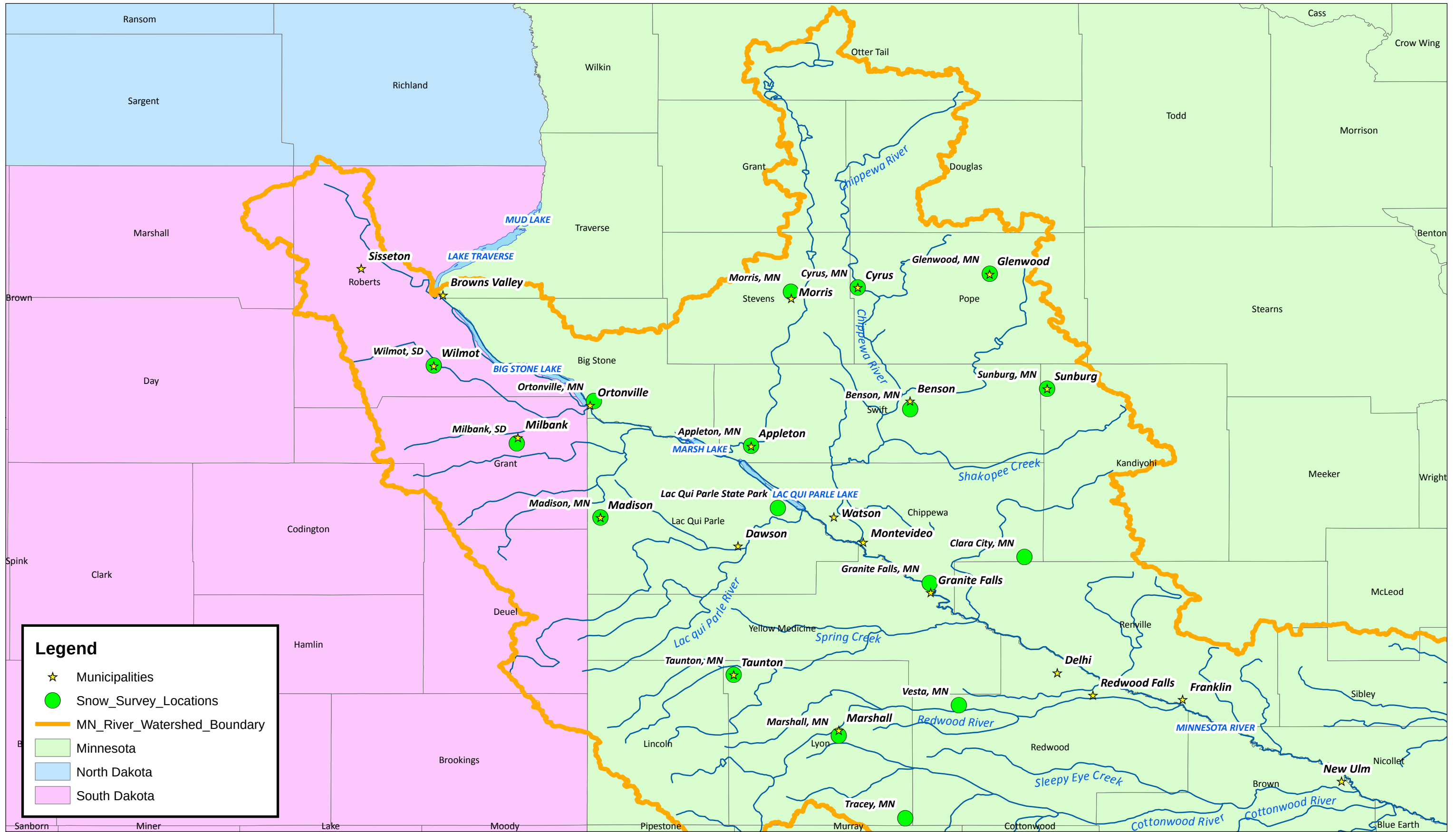
1. There is one Data Collection Platform (DCP) servicing both the pool and tailwater gages.

Plate 5-2
Streamflow Stations in the Vicinity of the Lac qui Parle Project
(see Plate 5-1)

Gage No./Owner	Drainage Area Sq. Mi.	River and Location	Notes
U.S.G.S. 05291000	389	Whetstone R. Near Big Stone City SD	Flows Into Big Stone Lake
U.S.G.S. 05292000	1,160	Minnesota R. at Ortonville MN	1300 ft downstream of the Big Stone Lake Dam
U.S.G.S. 05293000	459	Yellow Bank River Near Odessa MN	4.5 miles upstream From the Mouth
U.S.G.S. 05294000	905	Pomme de Terre R. at Appleton MN	8.0 miles upstream From the Mouth
U.S.G.S. 05300000	960	Lac qui Parle R Near Lac qui Parle MN	0.5 Miles SW of Lac qui Parle, MN
U.S.G.S. 05301000	4,050	Minnesota R. Near Lac qui Parle MN	200 ft downstream of the Lac qui Parle Dam
U.S.G.S. 05304500	1,880	Chippewa River Near Milan MN	5.5 Miles East of Milan, MN
U.S.G.S. 05304995	2,050	Chippewa R. (HW) Above Co. Rd. 13 Near Watson, MN	Pool gage at the Chippewa Diversion Dam
U.S.G.S. 05305000	2,050	Chippewa R. (TW) Near Watson, MN	Tailwater gage at the Chippewa Diversion Dam
U.S.G.S. 05311000	6,180	Minnesota River at Montevideo MN	400 ft downstream of the Chippewa River The Control Point for LQP Dam







Legend

 Municipalities



 Snow_Survey_Locations



 MN_River_Watershed_Boundary



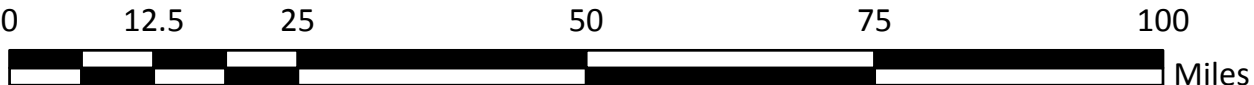
 Minnesota



 North Dakota

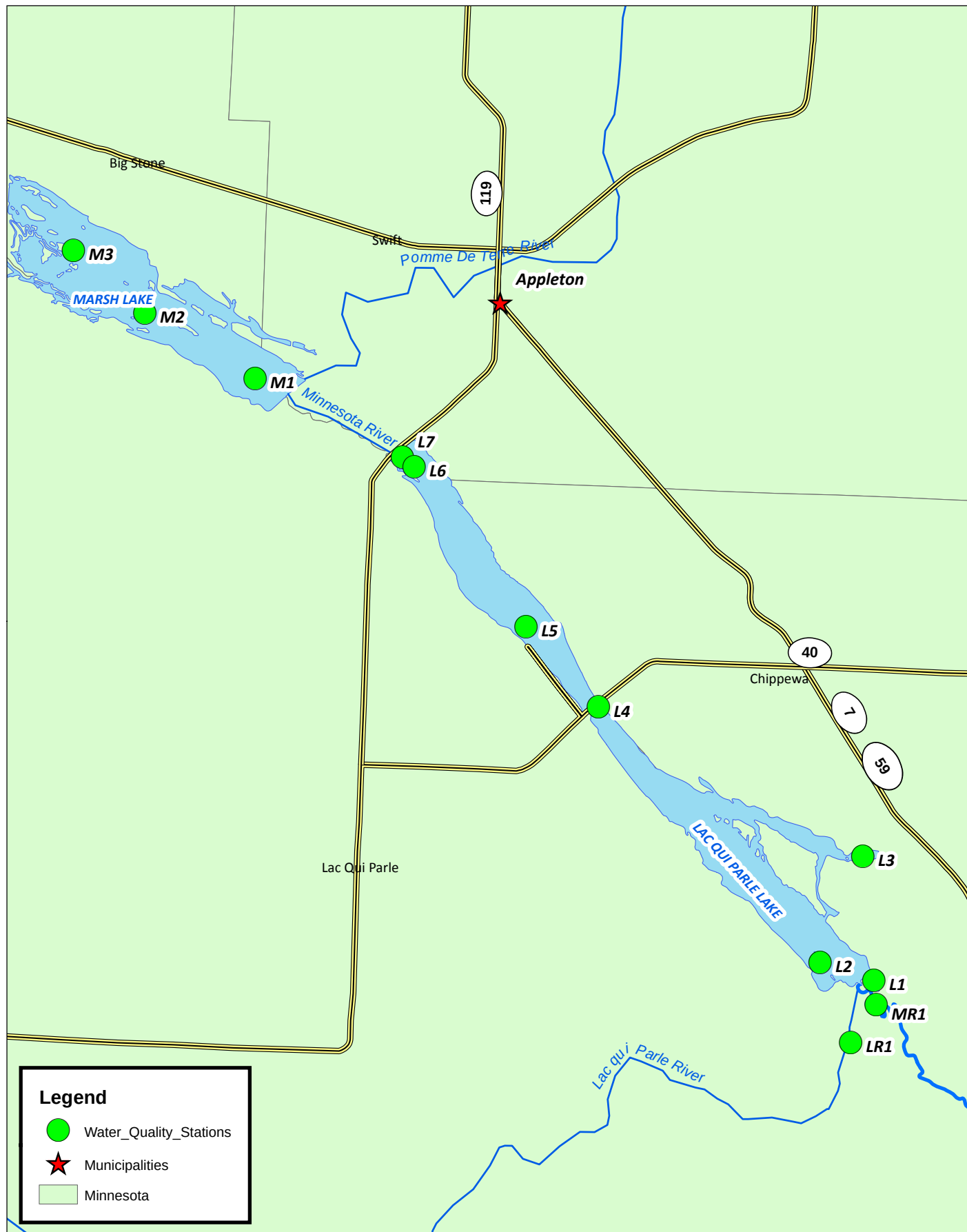


 South Dakota

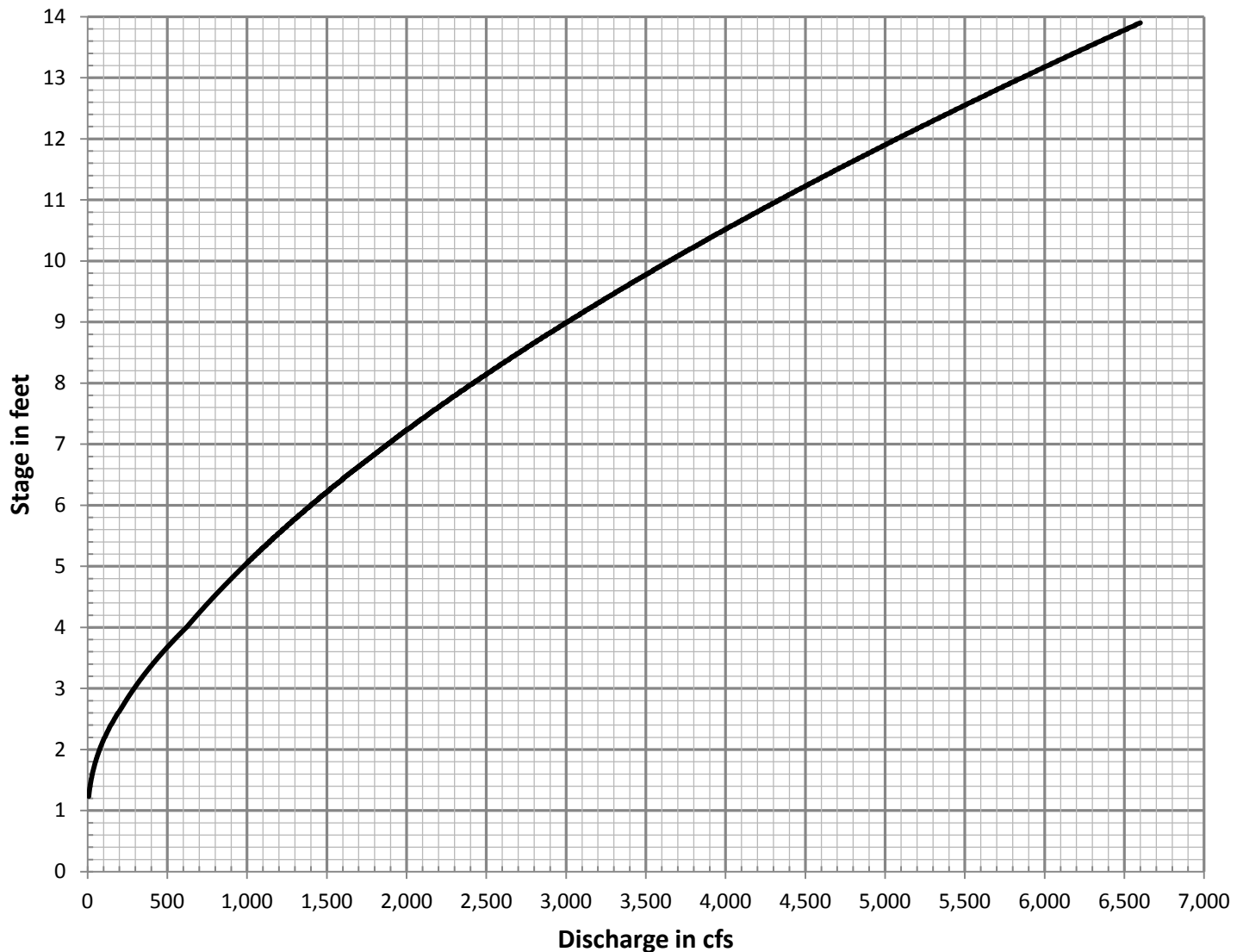


LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL





**Minnesota River at Ortonville, MN
U.S.G.S. Gage 05292000
Stage-Discharge Rating Curve**



Rating Curve Number 31.1
Starting 13 August 2012
Gage Datum in NGVD29 is 956.38 feet

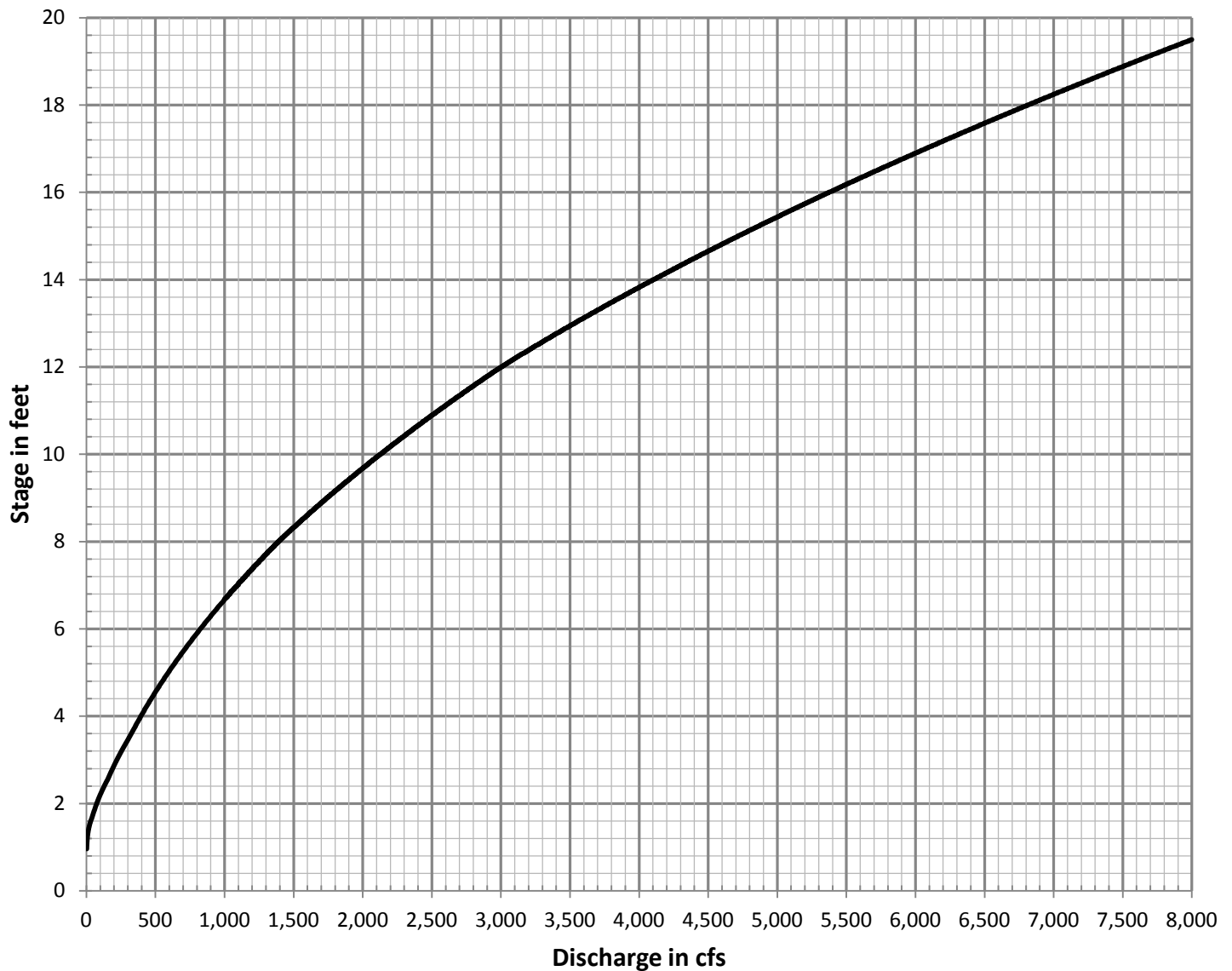
See Exhibit E for tables corresponding to this plate

Lac Qui Parle Project
Minnesota River
Water Control Manual

Rating Curve
U.S.G.S. Gage No. 05292000
Minnesota River
At Ortonville, Minnesota

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

**Yellow Bank River near Odessa, MN
U.S.G.S. Gage 05293000
Stage-Discharge Rating Curve**



Rating Curve Number 34.0
Starting 13 August 2012
Gage Datum in NGVD29 is 953.34 feet

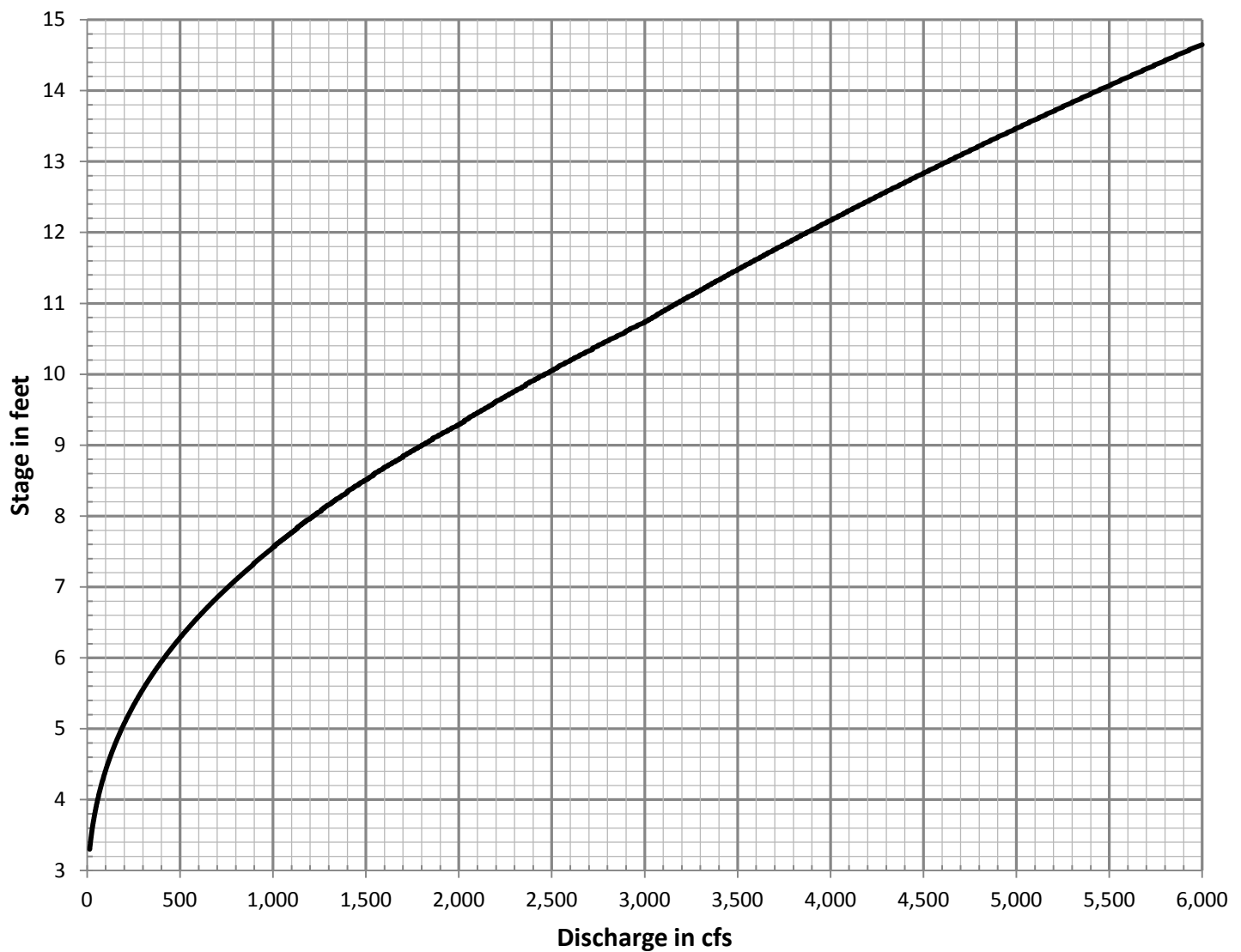
See Exhibit E for tables corresponding to this plate

Lac Qui Parle Project
Minnesota River
Water Control Manual

Rating Curve
U.S.G.S. Gage No. 05293000
Yellow Bank River
Near Odessa, Minnesota

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

Pomme de Terre River at Appleton, MN
U.S.G.S. Gage 05294000
Stage-Discharge Rating Curve



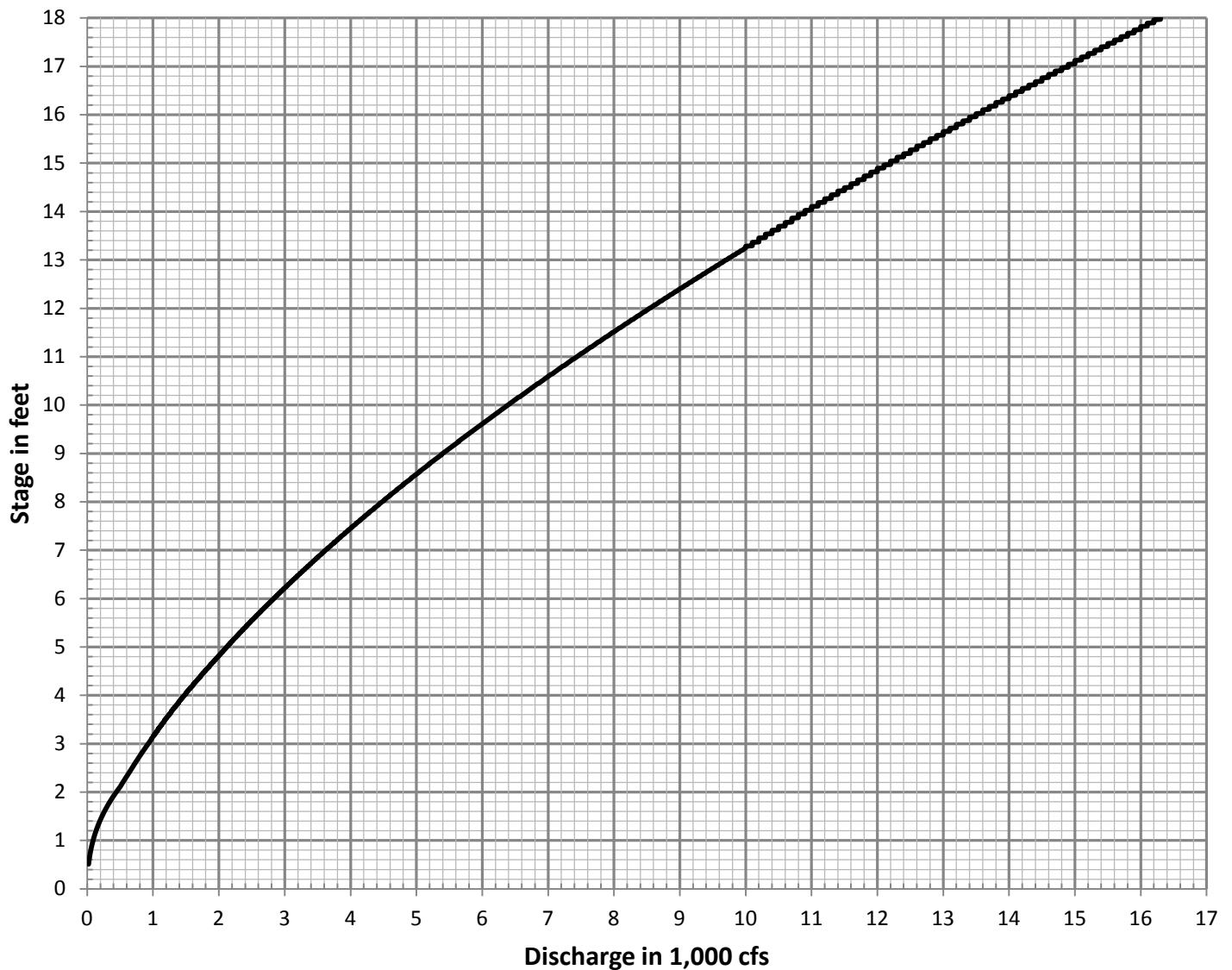
Rating Curve Number 37.0
Starting 1 April 2012
Gage Datum in NGVD29 is 978.00 feet
See Exhibit E for tables corresponding to this plate

Lac Qui Parle Project
Minnesota River
Water Control Manual

Rating Curve
U.S.G.S. Gage No. 05294000
Pomme de Terre River
At Appleton, Minnesota

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

**Chippewa River near Milan, MN
U.S.G.S. Gage 05304500
Stage-Discharge Rating Curve**



Rating Curve Number 32.0
Starting 3 August 2012
Gage Datum in NGVD29 is 959.69 feet

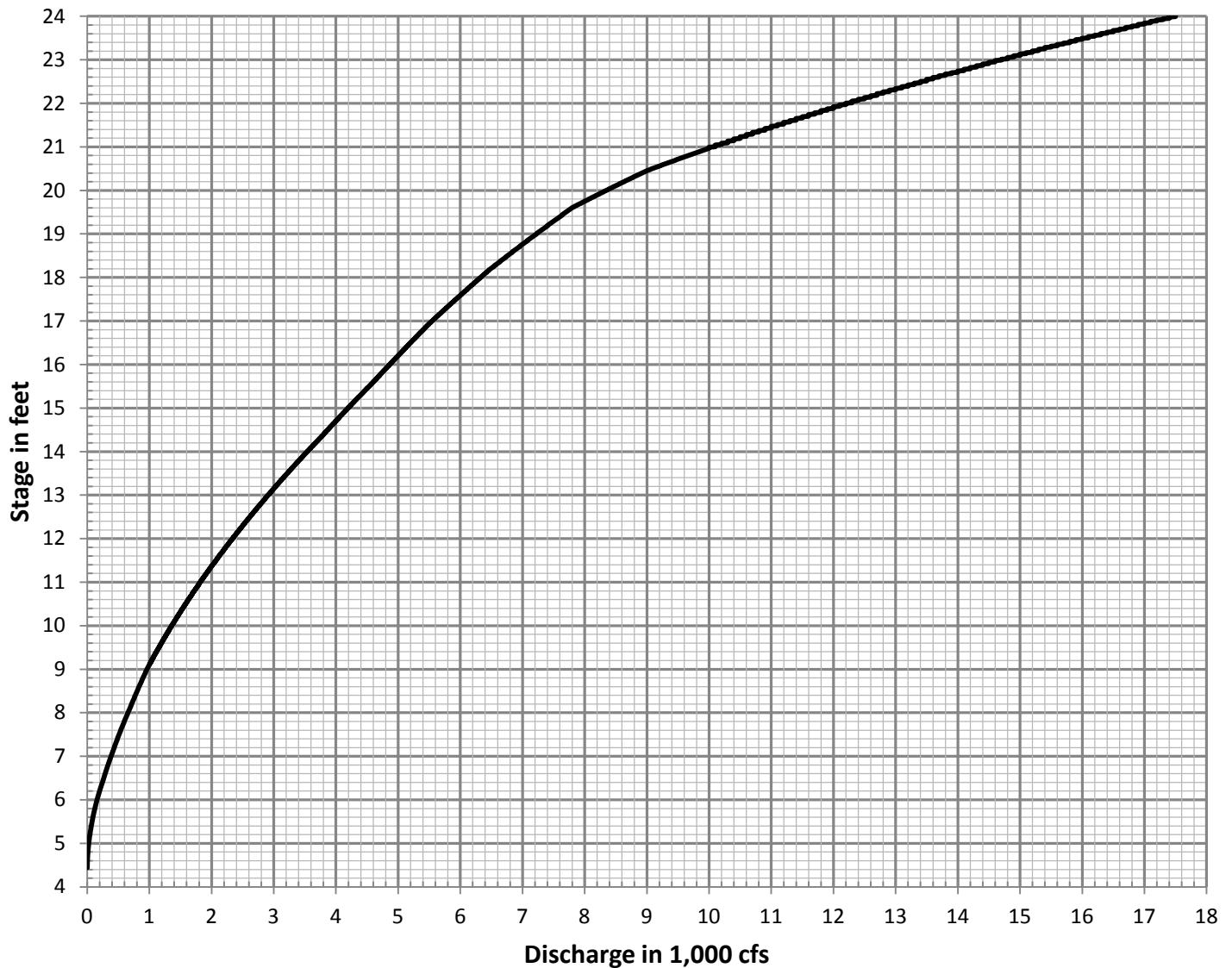
See Exhibit E for tables corresponding to this plate

Lac Qui Parle Project
Minnesota River
Water Control Manual

Rating Curve
U.S.G.S. Gage No. 05304500
Chippewa River
Near Milan, Minnesota

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

Lac qui Parle River near Lac qui Parle, MN
U.S.G.S. Gage 05300000
Stage-Discharge Rating Curve



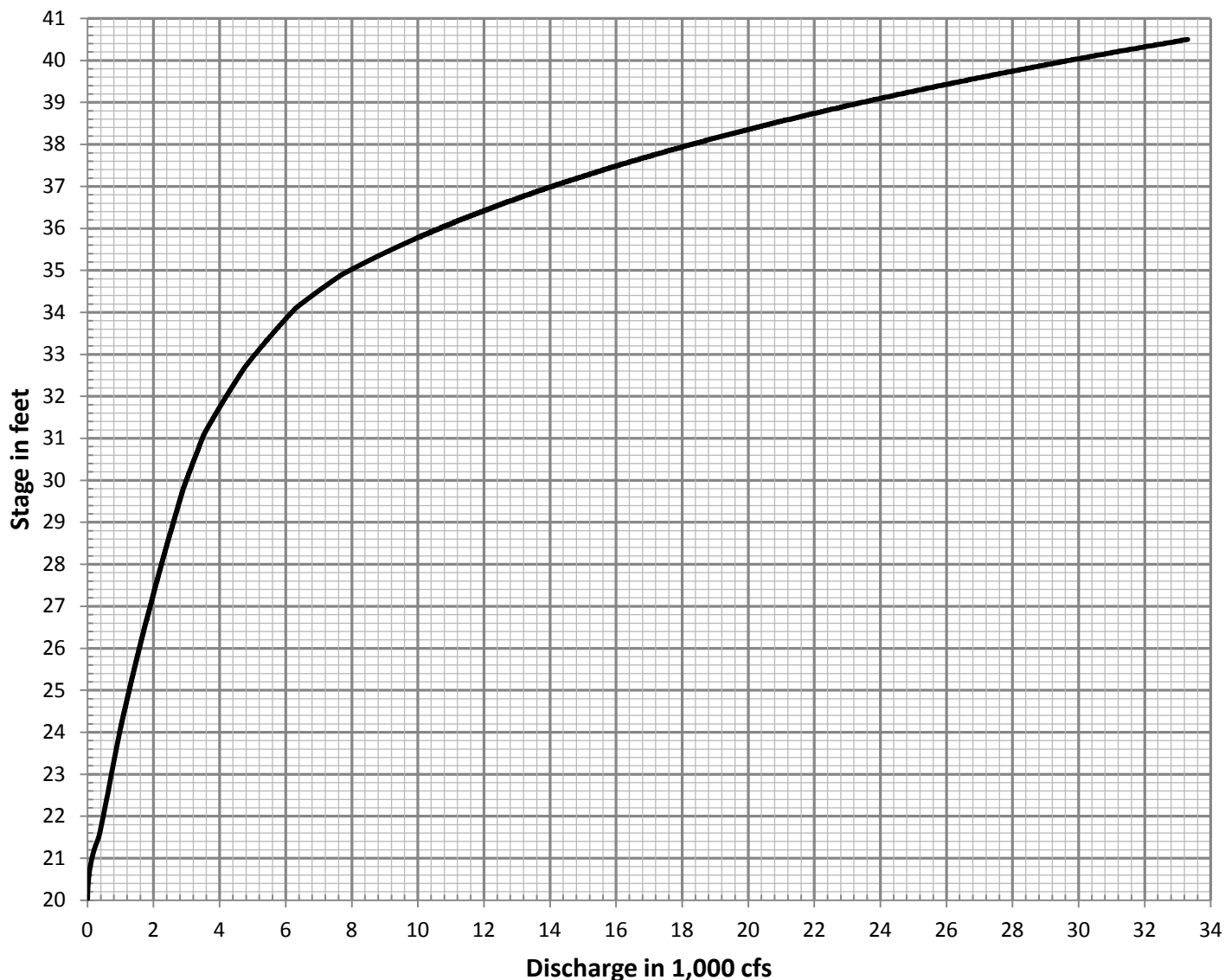
Rating Curve Number 47.0
Starting 13 August 2012
Gage Datum in NGVD29 is 951.98 feet
See Exhibit E for tables corresponding to this plate

Lac Qui Parle Project
Minnesota River
Water Control Manual

Rating Curve
U.S.G.S. Gage No. 05300000
Lac qui Parle River
Near Lac qui Parle, Minnesota

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

Minnesota River near Lac qui Parle, MN
U.S.G.S. Gage 05301000
Stage-Discharge Rating Curve



Rating Curve Number 30.0
Starting 3 August 2012
Gage Datum in NGVD29 is 900.00 feet

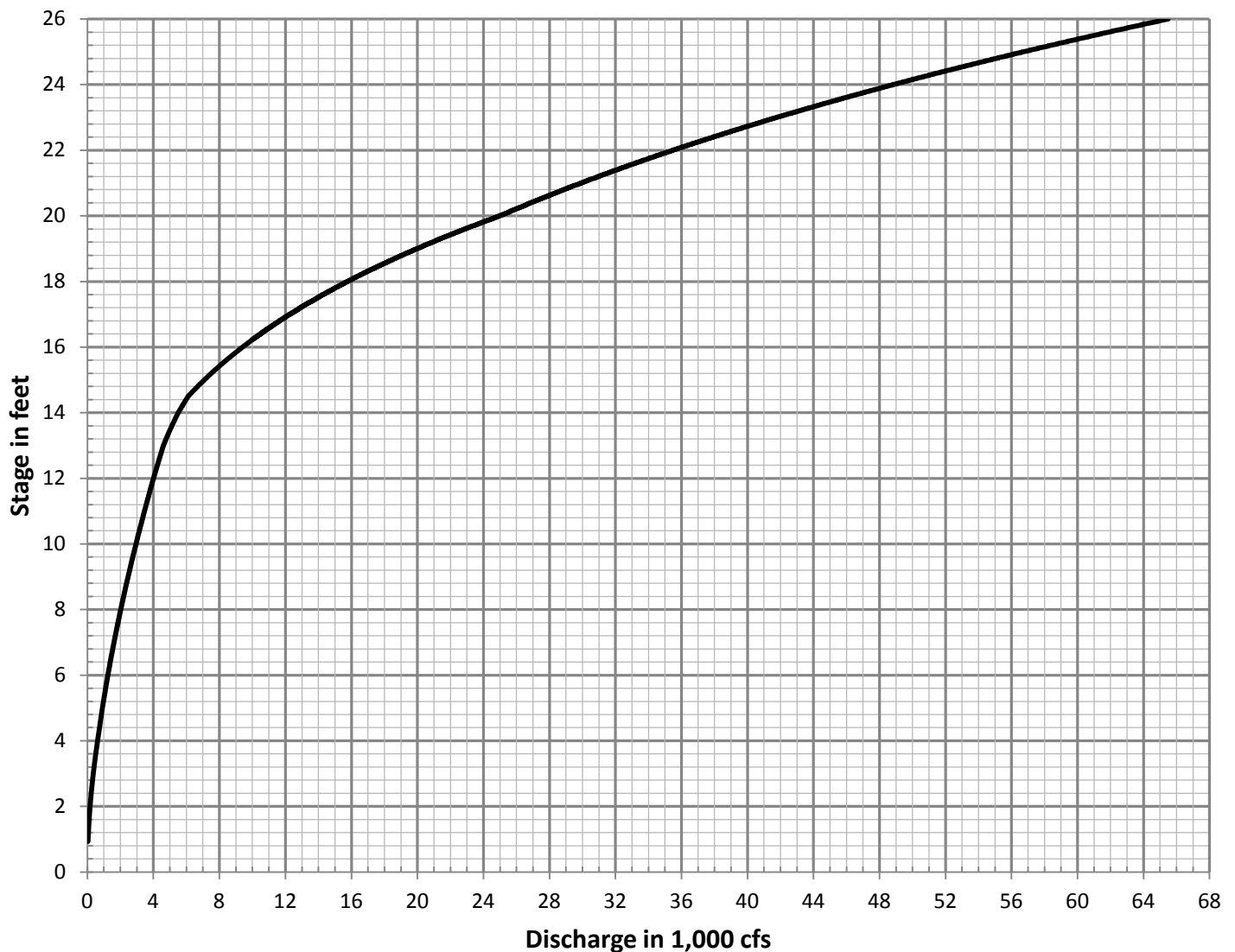
See Exhibit E for tables corresponding to this plate

Lac Qui Parle Project
Minnesota River
Water Control Manual

Rating Curve
U.S.G.S. Gage No. 05301000
Minnesota River
Near Lac qui Parle, Minnesota

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

Minnesota River at Montevideo, MN
U.S.G.S. Gage 05311000
Stage-Discharge Rating Curve



Rating Curve Number 50.0
Starting 3 August 2012
Gage Datum in NGVD29 is 909.12 feet

See Exhibit E for tables corresponding to this plate

Lac Qui Parle Project
Minnesota River
Water Control Manual

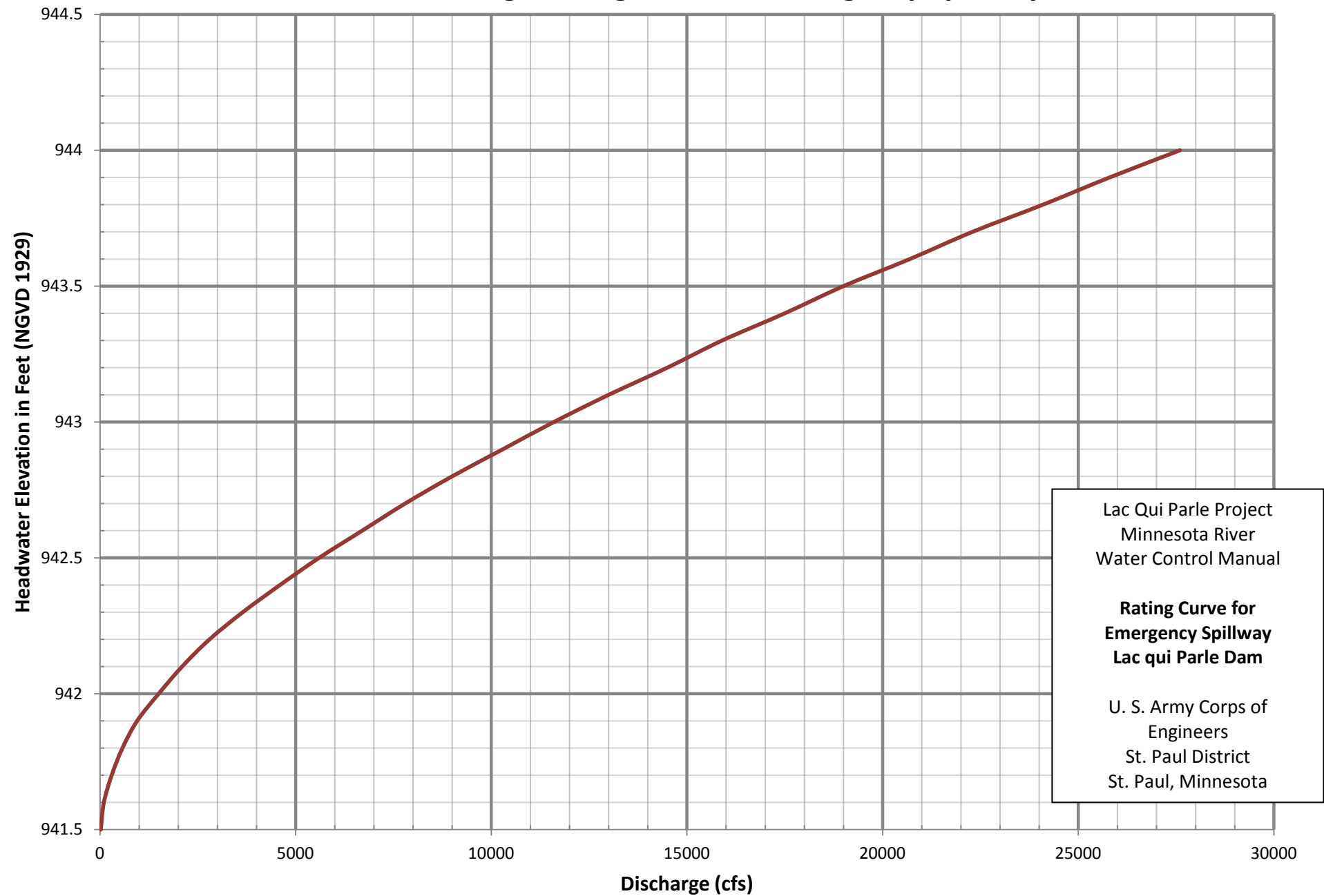
Rating Curve
U.S.G.S. Gage No. 05311000
Minnesota River
At Montevideo, Minnesota

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

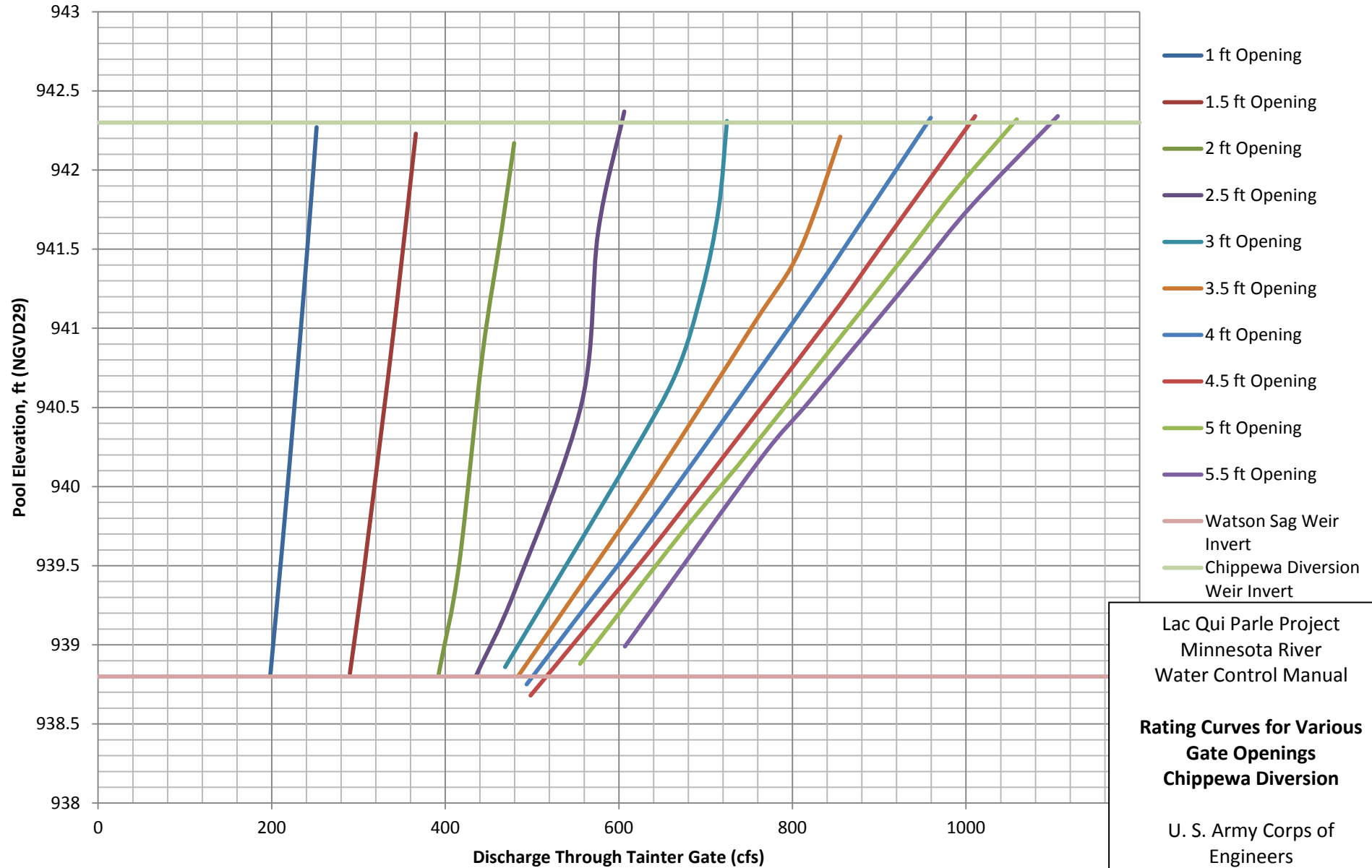
Plate 5-14
Points of Contact for Emergency Notification

Point of Contact	Telephone Numbers	
	Work	Home
Lac qui Parle County, MN Civil Defense Director, 24 Hr County Sheriff, 24 Hr	612.598.3720 612.598.3720	612.598.7751 612.598.7751
Chippewa County, MN Civil Defense Director, 24 Hr County Sheriff, 24 Hr	612.269.8808 612.269.2121	612.269.5070 612.269.5247
Yellow Medicine County, MN Civil Defense Director, County Sheriff, 24 Hr	612.564.3134 612.564.2130	612.843.4604 612.564.3583
Montevideo, MN Police and Fire Dept., 24 Hr Emer. Services Coord., 24 Hr	612.269.8808 612.269.2121	612.269.5070 612.269.5247
Granite Falls, MN Police and Fire Dept., 24 Hr Emer. Services Coord., 24 Hr	612.564.2129 612.564.2129	----- 612.564.3920
Granite Falls, MN Hydropower Plant	612.564.2530	-----
Minnesota Div. Emergency Man. Minnesota Statewide Emergency	612.649.5451 1.800.422.0798	24 Hours 24 Hours
Note: Phone Nos. for Water Management, District, and project personnel are listed in Paragraph 1-05.		

Lac qui Parle Dam
Elevation-Discharge Rating Curve for Emergency Spillway



Chippewa Diversion Tainter Gate Rating Curve Based on HEC-RAS Model for months May-November (Low Flow Culvert Opening = 0.5ft)



Model Location: \\mvd\mvp\ECH\Water_Control_Files\Reservoir_Projects\LacQuiParle_Reservoir_Project\Water_Control_Manual\Models\RAS\ChippewaDiv_WatsonS.prj

Lac Qui Parle Project
Minnesota River
Water Control Manual

**Rating Curves for Various
Gate Openings
Chippewa Diversion**

U. S. Army Corps of
Engineers
St. Paul District
St. Paul, Minnesota

Plate 7-3
Tailwater is lower than spillway (spillway elevation is 942.3)
Chippewa Diversion flow based on Gate Opening

1 ft Gate Opening		1.5 ft Gate Opening		2 ft Gate Opening		2.5 ft Gate Opening	
Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)
938.8	200	938.8	290	938.8	390	938.8	435
939.4	210	939.3	300	939.5	415	939.3	480
939.9	215	939.7	310	940.8	440	940.5	555
940.5	225	940.3	325	941.6	465	941.6	575
941.5	240	941.1	345	942.2	480	942.3	605
942.3	250	942.2	365				
3 ft Gate Opening		3.5 ft Gate Opening		4 ft Gate Opening		4.5 ft Gate Opening	
Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)
938.9	470	938.8	485	938.8	495	938.7	500
940.2	610	939.5	575	939.2	550	939.1	565
940.7	665	940.1	645	939.8	635	393.7	655
941.2	695	941.0	755	941.2	820	941.1	845
941.8	715	941.5	810	941.6	870	941.5	900
942.3	725	942.2	855	942.3	960	942.3	1010
5 ft Gate Opening		5.5 ft Gate Opening					
Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)				
938.9	555	939.0	605				
393.7	675	940.2	765				
940.2	750	940.5	820				
941.2	925	941.3	940				
941.8	985	941.8	1005				
942.3	1060	942.3	1105				

Plate 7-4
Tailwater is lower than spillway (spillway elevation is 942.3)
Chippewa Diversion flow over weirs/tainter gate

Total flow over the four fixed weirs

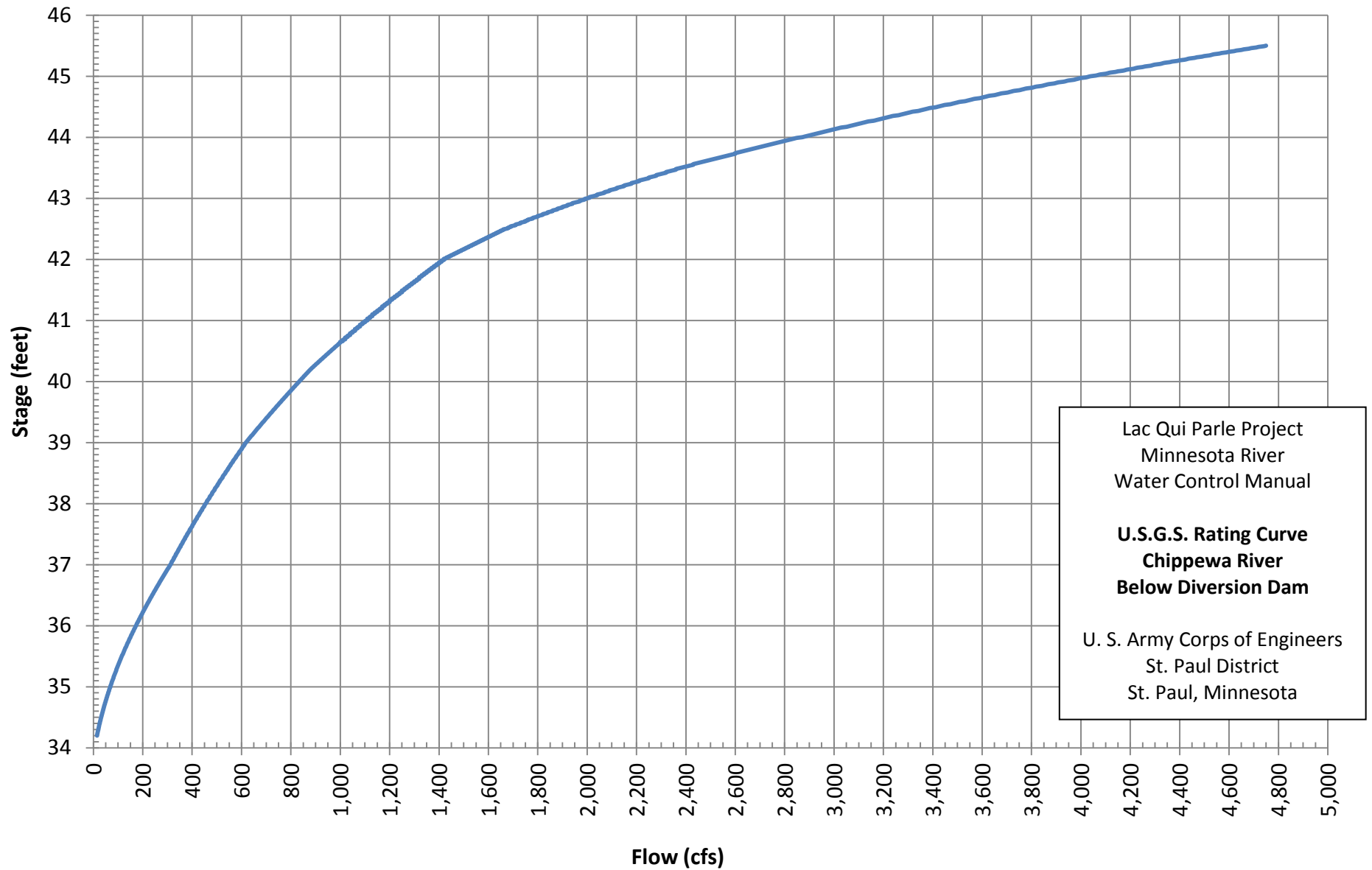
Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)
942.3	0	942.9	195	943.5	545	944.1	1005
942.4	15	943.0	245	943.6	615	944.2	1090
942.5	35	943.1	300	943.7	690	944.3	1175
942.6	70	943.2	355	943.8	765	944.4	1265
942.7	105	943.3	415	943.9	840	944.5	1360
942.8	145	943.4	480	944.0	920	944.6	1450

Flow over the tainter gate

Elev.¹	Q (cfs)	Elev.	Q (cfs)	Elev.	Q (cfs)	Elev.	Q (cfs)
942.3	0	942.9	40	943.5	115	944.1	210
942.4	5	943.0	50	943.6	130	944.2	225
942.5	10	943.1	60	943.7	145	944.3	245
942.6	15	943.2	75	943.8	160	944.4	265
942.7	20	943.3	85	943.9	175	944.5	280
942.8	30	943.4	100	944.0	190	944.6	300

¹Elevation for the flow over the tainter gate is the pool elevation – the gate opening. Example: The pool is at elevation 944.0 feet and the gate is open 1 foot, therefore the elevation is 943.0 with a flow over the tainter gate of 50 cfs. Total flow over the weirs and tainter gate is 50 cfs + 920 cfs = 970 cfs.

U.S.G.S. Rating Curve (rating 3.0 created on 22 May 2012)
Chippewa River Below Diversion Dam

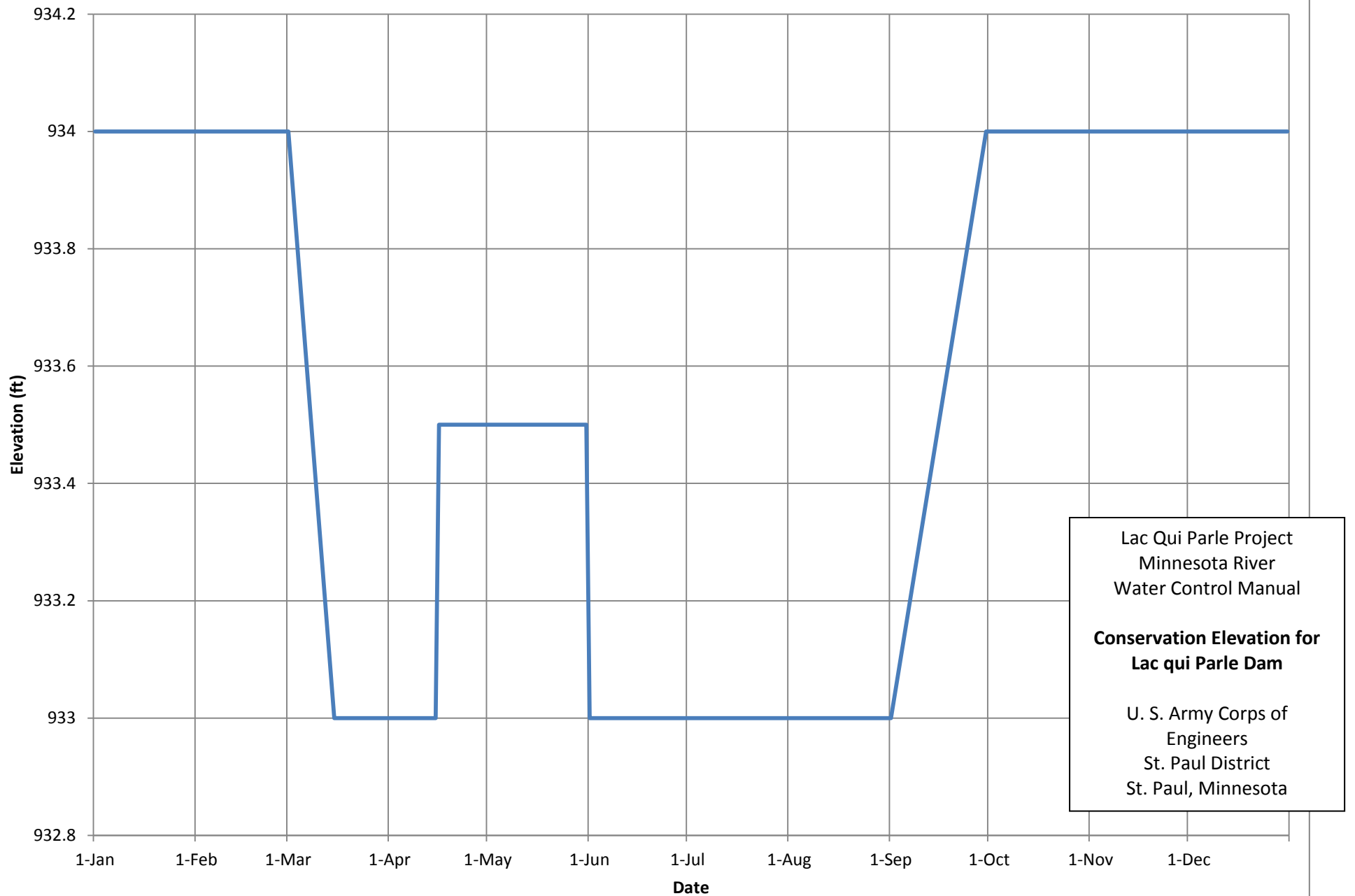


Lac Qui Parle Project
Minnesota River
Water Control Manual

U.S.G.S. Rating Curve
Chippewa River
Below Diversion Dam

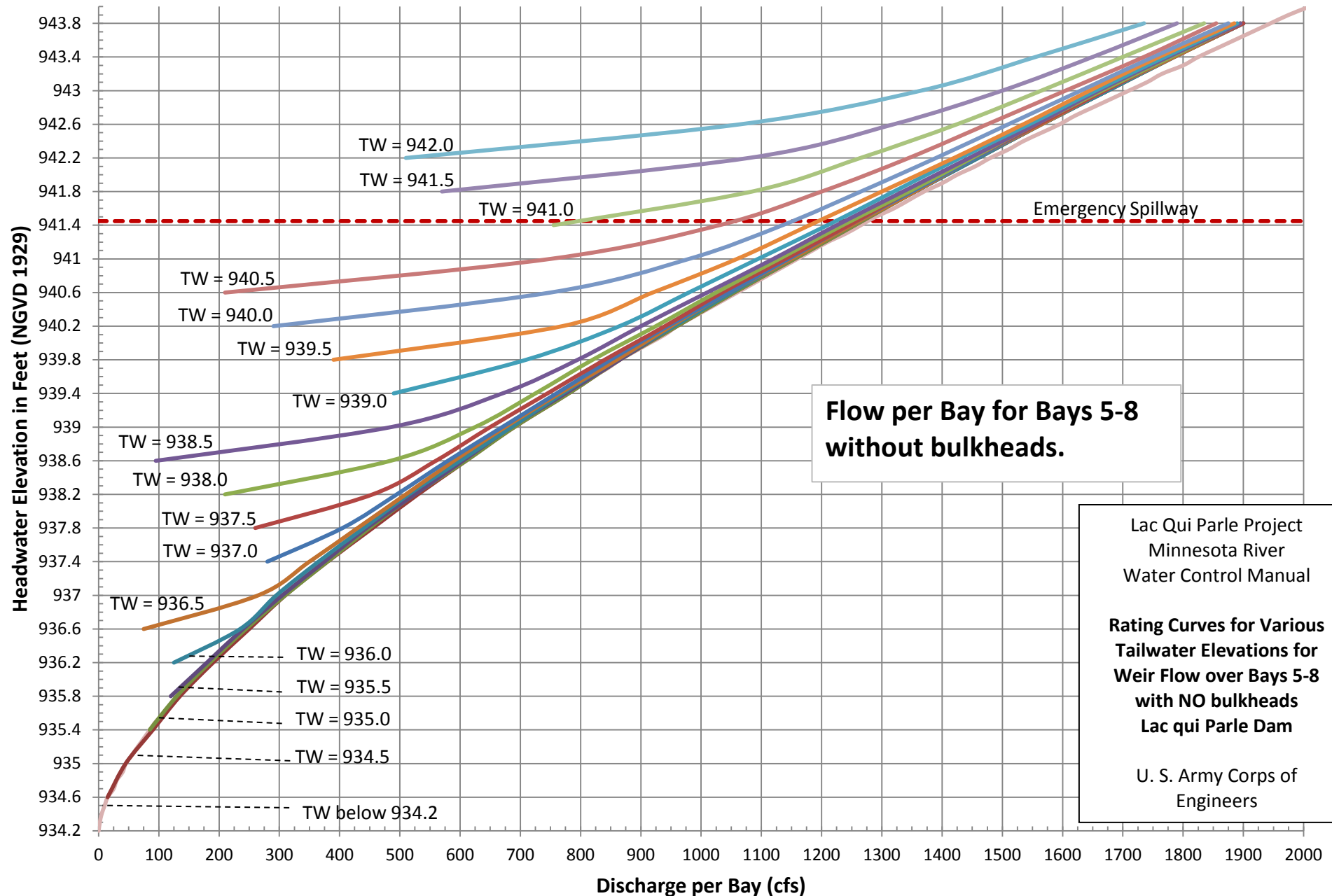
U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

Lac qui Parle Reservoir Conservation Elevation



Lac qui Parle Dam Weir Flow

Elevation-Discharge Rating Curves for Various Tailwater Elevations



Lac qui Parle Dam Weir Flow

Elevation-Discharge Rating Curves for Various Tailwater Elevations

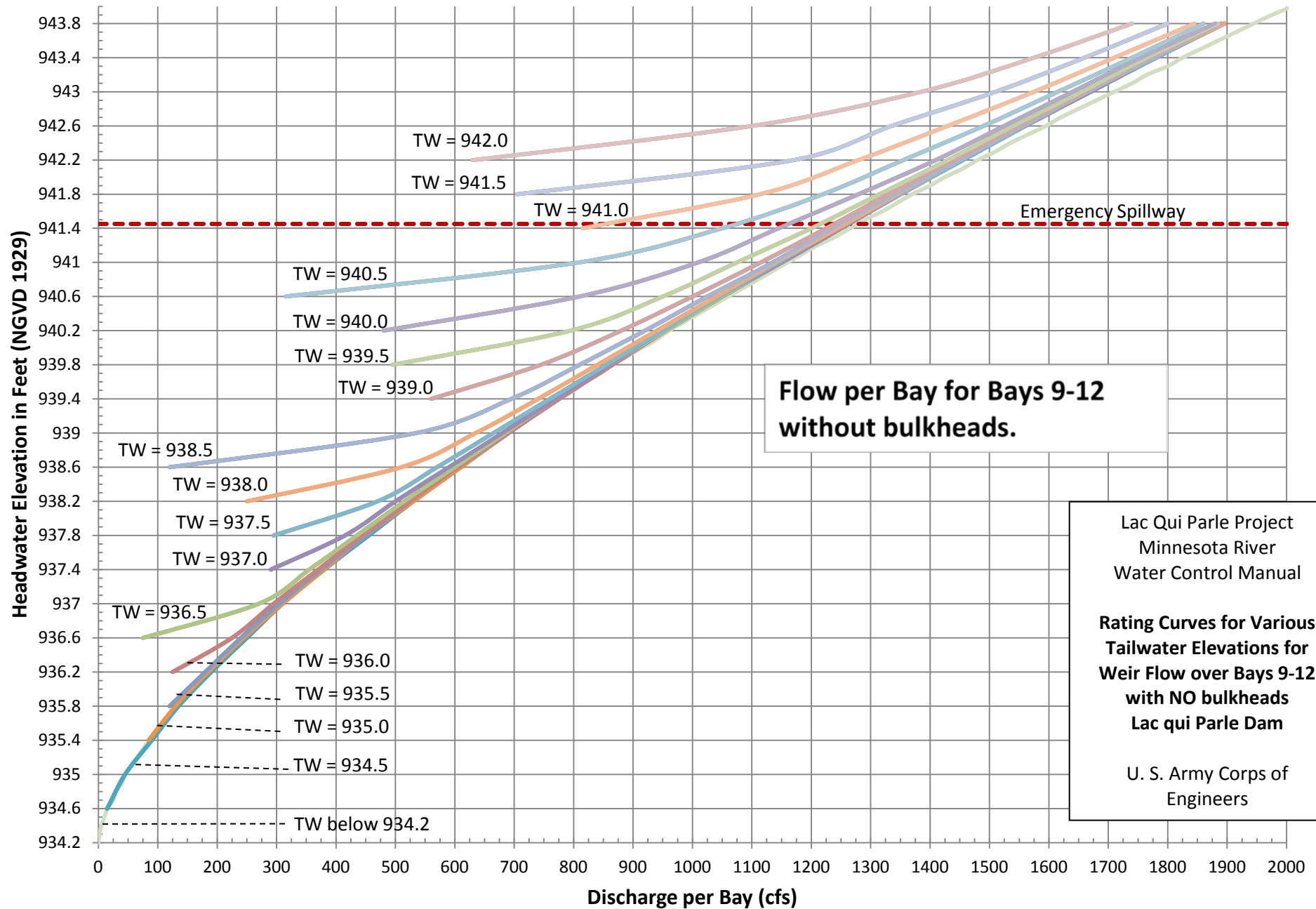


Plate 7-9
Lac qui Parle Bays 5-12: No Bulkheads
When Tailwater is less than elevation 934.2 feet

Pool Elev (ft)	Q (cfs) per Bay	Pool Elev (ft)	Q (cfs) per Bay	Pool Elev (ft)	Q (cfs) per Bay	Pool Elev (ft)	Q (cfs) per Bay
934.2	0	936.7	260	939.2	730	941.7	1,345
934.3	2	936.8	275	939.3	755	941.8	1,370
934.4	5	936.9	290	939.4	775	941.9	1,400
934.5	10	937	305	939.5	800	942	1,425
934.6	15	937.1	325	939.6	820	942.1	1,455
934.7	25	937.2	340	939.7	845	942.2	1,480
934.8	30	937.3	360	939.8	865	942.3	1,510
934.9	40	937.4	375	939.9	890	942.4	1,535
935	45	937.5	390	940	915	942.5	1,565
935.1	55	937.6	410	940.1	940	942.6	1,595
935.2	65	937.7	430	940.2	960	942.7	1,620
935.3	75	937.8	445	940.3	985	942.8	1,650
935.4	85	937.9	465	940.4	1,010	942.9	1,680
935.5	95	938	485	940.5	1,035	943	1,710
935.6	110	938.1	505	940.6	1,060	943.1	1,740
935.7	120	938.2	525	940.7	1,085	943.2	1,765
935.8	130	938.3	545	940.8	1,110	943.3	1,800
935.9	145	938.4	565	940.9	1,135	943.4	1,825
936	160	938.5	585	941	1,160	943.5	1,855
936.1	170	938.6	605	941.1	1,185	943.6	1,885
936.2	185	938.7	625	941.2	1,210	943.7	1,915
936.3	200	938.8	645	941.3	1,240	943.8	1,945
936.4	215	938.9	665	941.4	1,265	943.9	1,975
936.5	230	939	690	941.5	1,290	944	2,010
936.6	245	939.1	710	941.6	1,320		

Plate 7-10
Lac qui Parle Bays 5-12: No Bulkheads
Discharge per Bay in cfs
When Tailwater is between elevation 934.5 and 938.0 feet

[illegible]

Plate 7-11
Lac qui Parle Bays 5-12: No Bulkheads
Discharge per Bay in cfs
When Tailwater is between elevation 938.5 and 942.0 feet

Pool Elev (ft)	Tailwater Elevation (ft)							
	938.5	939.0	939.5	940.0	940.5	941.0	941.5	942.0
938.6	95							
939	485							
939.4	670	490						
939.8	795	710	390					
940.2	900	865	770	290				
940.6	1010	980	920	750	210			
941	1120	1095	1060	980	750			
941.4	1225	1210	1180	1135	1030	755		
941.8	1335	1320	1300	1265	1200	1085	570	
942.2	1445	1430	1420	1390	1345	1265	1080	510
942.6	1555	1545	1535	1510	1475	1425	1320	1065
943	1660	1655	1645	1630	1605	1565	1500	1365
943.4	1775	1770	1760	1750	1735	1700	1650	1555
943.8	1895	1890	1885	1875	1855	1835	1790	1735

Lac qui Parle Dam Weir Flow

Elevation-Discharge Rating Curves for Various Tailwater Elevations

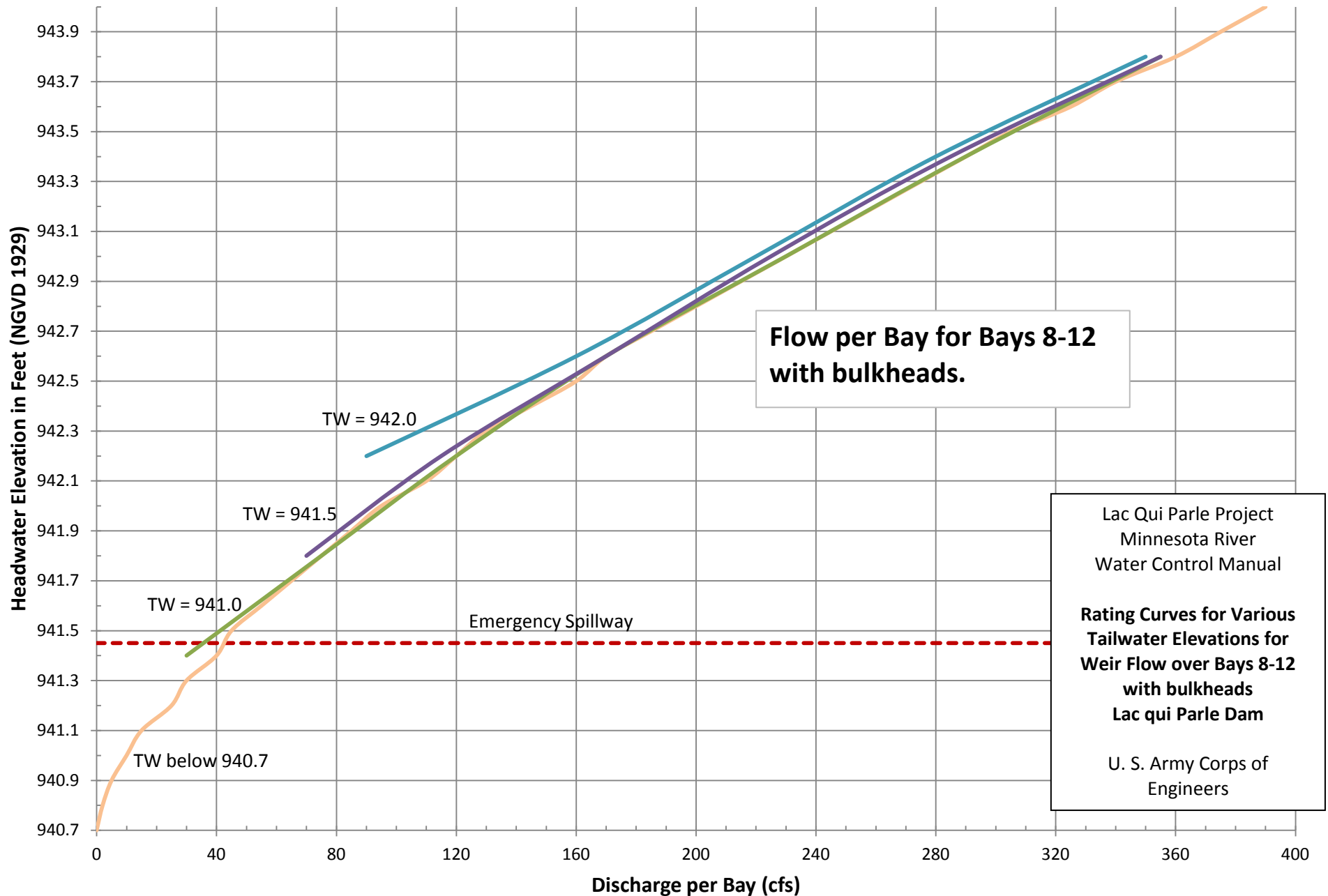


Plate 7-13
Lac qui Parle Bays 8-12: With Bulkheads
When Tailwater is less than elevation 940.7 feet

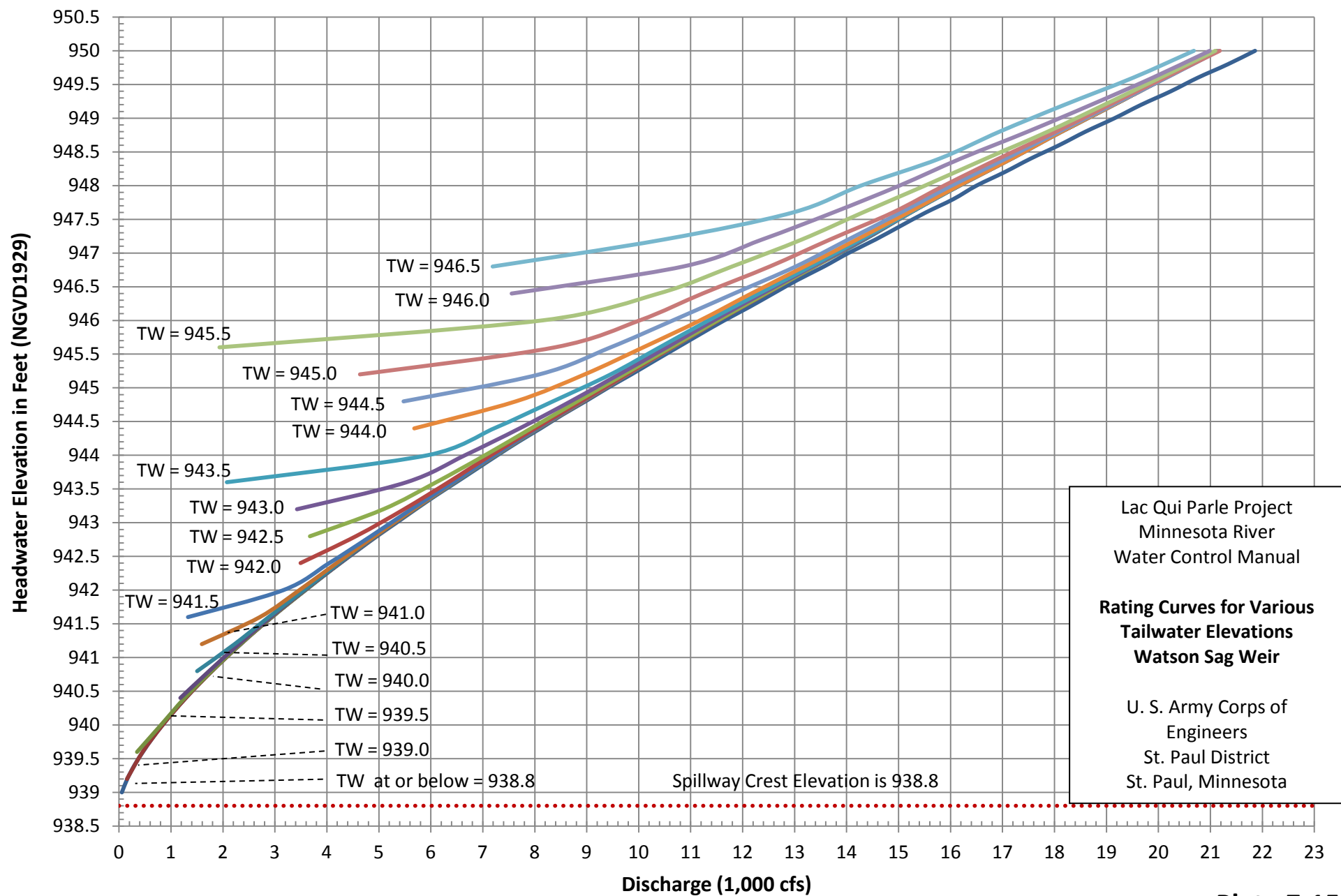
Pool Elev (ft)	Q (cfs) per Bay	Pool Elev (ft)	Q (cfs) per Bay	Pool Elev (ft)	Q (cfs) per Bay	Pool Elev (ft)	Q (cfs) per Bay
940.7	0	941.6	55	942.5	160	943.4	290
940.8	2	941.7	65	942.6	170	943.5	305
940.9	5	941.8	75	942.7	185	943.6	325
941	10	941.9	85	942.8	200	943.7	340
941.1	15	942	95	942.9	215	943.8	360
941.2	25	942.1	110	943	230	943.9	375
941.3	30	942.2	120	943.1	245	944	390
941.4	40	942.3	130	943.2	260		
941.5	45	942.4	145	943.3	275		

Plate 7-14
Lac qui Parle Bays 8-12: With Bulkheads
Discharge per Bay in cfs
When Tailwater is greater than elevation 940.7 feet

Pool Elev (ft)	Tailwater Elevation (ft)		
	941.0	941.5	942.0
941.4	30		
941.8	75	70	
942.2	120	115	90
942.6	170	170	160
943	230	225	220
943.4	290	285	280
943.8	355	355	350

Watson Sag Weir

Elevation-Discharge Rating Curves for Various Tailwater Elevations



Lac Qui Parle Project
Minnesota River
Water Control Manual

**Rating Curves for Various
Tailwater Elevations
Watson Sag Weir**

U. S. Army Corps of
Engineers
St. Paul District
St. Paul, Minnesota

Plate 7-16
Tailwater is lower than spillway (spillway elevation is 938.8)
Watson Sag Rating based on Pool Elevation

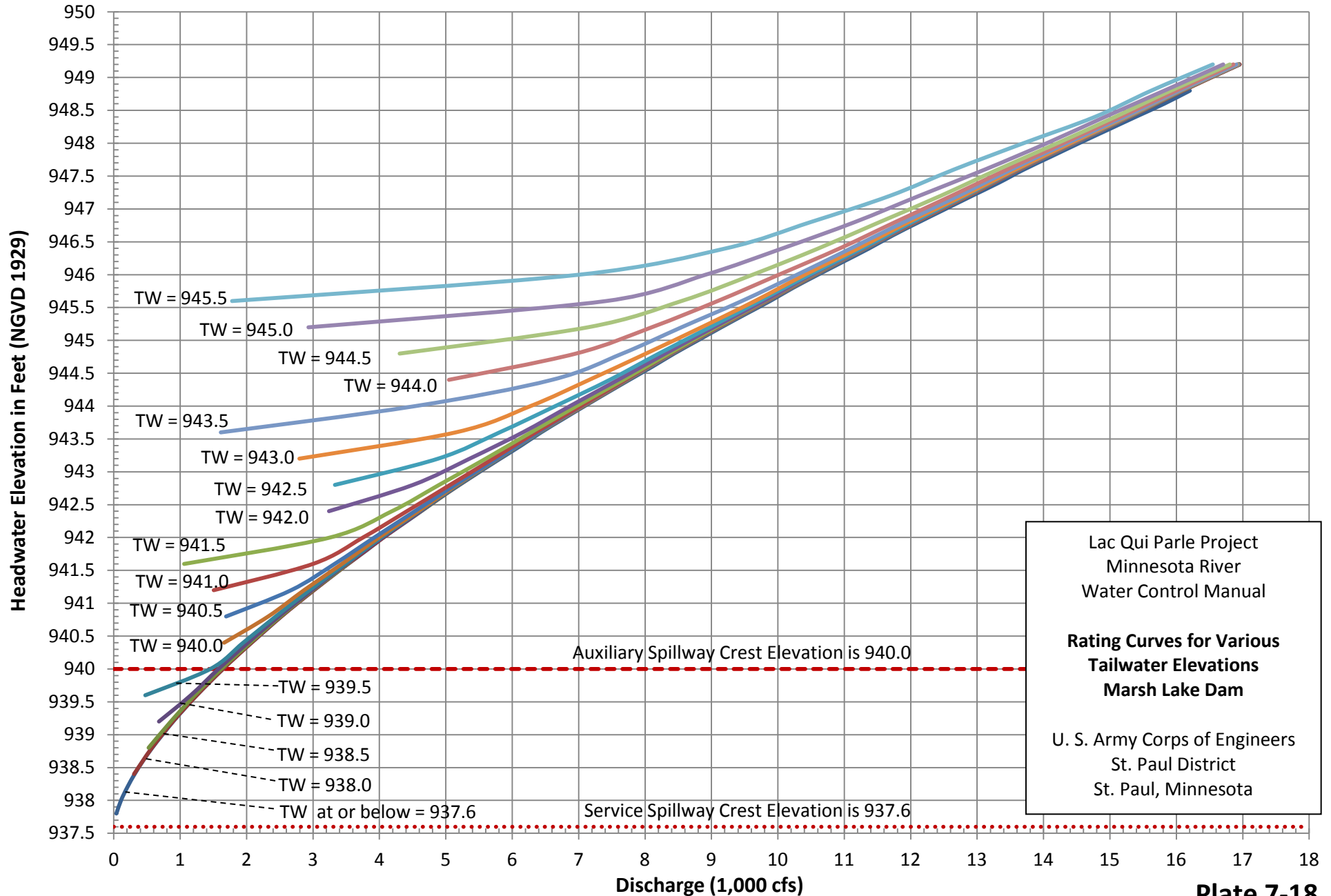
Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)	Pool Elev.	Q (cfs)
938.8	0	941.7	3,080	944.6	8,710	947.5	16,005
938.9	20	941.8	3,240	944.7	8,940	947.6	16,280
939.0	55	941.9	3,405	944.8	9,165	947.7	16,560
939.1	100	942.0	3,570	944.9	9,395	947.8	16,840
939.2	160	942.1	3,740	945.0	9,630	947.9	17,120
939.3	220	942.2	3,910	945.1	9,860	948.0	17,405
939.4	290	942.3	4,085	945.2	10,100	948.1	17,690
939.5	365	942.4	4,260	945.3	10,335	948.2	17,975
939.6	445	942.5	4,440	945.4	10,575	948.3	18,265
939.7	535	942.6	4,620	945.5	10,815	948.4	18,550
939.8	625	942.7	4,805	945.6	11,060	948.5	18,840
939.9	720	942.8	4,990	945.7	11,305	948.6	19,135
940.0	820	942.9	5,180	945.8	11,550	948.7	19,430
940.1	925	943.0	5,370	945.9	11,800	948.8	19,725
940.2	1,035	943.1	5,560	946.0	12,050	948.9	20,020
940.3	1,145	943.2	5,755	946.1	12,300	949.0	20,320
940.4	1,260	943.3	5,955	946.2	12,555	949.1	20,620
940.5	1,380	943.4	6,155	946.3	12,810	949.2	20,920
940.6	1,505	943.5	6,355	946.4	13,070	949.3	21,220
940.7	1,635	943.6	6,560	946.5	13,325	949.4	21,525
940.8	1,765	943.7	6,765	946.6	13,585	949.5	21,830
940.9	1,900	943.8	6,975	946.7	13,850	949.6	22,140
941.0	2,035	943.9	7,185	946.8	14,115	949.7	22,445
941.1	2,175	944.0	7,395	946.9	14,380	949.8	22,755
941.2	2,320	944.1	7,610	947.0	14,645	949.9	23,065
941.3	2,465	944.2	7,825	947.1	14,915	950.0	23,380
941.4	2,615	944.3	8,045	947.2	15,185	950.1	23,690
941.5	2,765	944.4	8,265	947.3	15,455	950.2	24,005
941.6	2,920	944.5	8,490	947.4	15,730	950.3	24,325

Plate 7-17
Tailwater is above the spillway (spillway elevation is 938.8)
Watson Sag Rating based on Head

Head (feet)	Q (cfs)	Head (feet)	Q (cfs)	Head (feet)	Q (cfs)	Head (feet)	Q (cfs)
0.1	20	2.6	2,615	5.1	7,185	7.6	13,070
0.2	55	2.7	2,765	5.2	7,395	7.7	13,325
0.3	100	2.8	2,920	5.3	7,610	7.8	13,585
0.4	160	2.9	3,080	5.4	7,825	7.9	13,850
0.5	220	3.0	3,240	5.5	8,045	8.0	14,115
0.6	290	3.1	3,405	5.6	8,265	8.1	14,380
0.7	365	3.2	3,570	5.7	8,490	8.2	14,645
0.8	445	3.3	3,740	5.8	8,710	8.3	14,915
0.9	535	3.4	3,910	5.9	8,940	8.4	15,185
1.0	625	3.5	4,085	6.0	9,165	8.5	15,455
1.1	720	3.6	4,260	6.1	9,395	8.6	15,730
1.2	820	3.7	4,440	6.2	9,630	8.7	16,005
1.3	925	3.8	4,620	6.3	9,860	8.8	16,280
1.4	1,035	3.9	4,805	6.4	10,100	8.9	16,560
1.5	1,145	4.0	4,990	6.5	10,335	9.0	16,840
1.6	1,260	4.1	5,180	6.6	10,575	9.1	17,120
1.7	1,380	4.2	5,370	6.7	10,815	9.2	17,405
1.8	1,505	4.3	5,560	6.8	11,060	9.3	17,690
1.9	1,635	4.4	5,755	6.9	11,305	9.4	17,975
2.0	1,765	4.5	5,955	7.0	11,550	9.5	18,265
2.1	1,900	4.6	6,155	7.1	11,800	9.6	18,550
2.2	2,035	4.7	6,355	7.2	12,050	9.7	18,840
2.3	2,175	4.8	6,560	7.3	12,300	9.8	19,135
2.4	2,320	4.9	6,765	7.4	12,555	9.9	19,430
2.5	2,465	5.0	6,975	7.5	12,810	10.0	19,725

Plot will be updated once construction is complete

Marsh Lake Dam Elevation-Discharge Rating Curves for Various Tailwater Elevations



Lac Qui Parle Project
Minnesota River
Water Control Manual

**Rating Curves for Various
Tailwater Elevations
Marsh Lake Dam**

U. S. Army Corps of Engineers
St. Paul District
St. Paul, Minnesota

Table will be updated once construction is complete.

Plate 7-19 Marsh Lake Dam Service Spillway When Tailwater is less than elevation 937.6 feet							
Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)
937.8	40	941	2,765	944.2	7,425	947.4	13,330
938	110	941.2	3,015	944.4	7,765	947.6	13,705
938.2	205	941.4	3,270	944.6	8,110	947.8	14,120
938.4	315	941.6	3,530	944.8	8,440	948	14,535
938.6	440	941.8	3,800	945	8,795	948.2	14,960
938.8	580	942	4,060	945.2	9,150	948.4	15,385
939	735	942.2	4,345	945.4	9,515	948.6	15,815
939.2	895	942.4	4,630	945.6	9,885	948.8	16,205
939.4	1,070	942.6	4,910	945.8	10,230	949	16,640
939.6	1,250	942.8	5,205	946	10,605	949.2	17,080
939.8	1,445	943	5,510	946.2	10,990	949.4	17,525
940	1,645	943.2	5,820	946.4	11,375	949.6	17,925
940.2	1,855	943.4	6,135	946.6	11,735	949.8	18,375
940.4	2,075	943.6	6,435	946.8	12,125	950	18,830
940.6	2,300	943.8	6,760	947	12,525		
940.8	2,525	944	7,090	947.2	12,925		
Marsh Lake Dam Auxiliary Dam Spillway When Tailwater is less than elevation 940.0 feet							
Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)	Pool Elev (ft)	Q (cfs)
940.2	25	942.8	1350	945.4	3615	948	6515
940.4	75	943	1495	945.6	3815	948.2	6765
940.6	135	943.2	1650	945.8	4025	948.4	7010
940.8	205	943.4	1805	946	4235	948.6	7265
941	290	943.6	1965	946.2	4445	948.8	7520
941.2	380	943.8	2135	946.4	4665	949	7775
941.4	475	944	2305	946.6	7885	949.2	8035
941.6	585	944.2	2480	946.8	5105	949.4	8300
941.8	695	944.4	2660	947	5335	949.6	8565
942	815	944.6	2840	947.2	5565	949.8	8835
942.2	940	944.8	3030	947.4	5795	950	9105
942.4	1070	945	3220	947.6	6035		
942.6	1205	945.2	3415	947.8	6275		

Table will be updated once construction is complete.

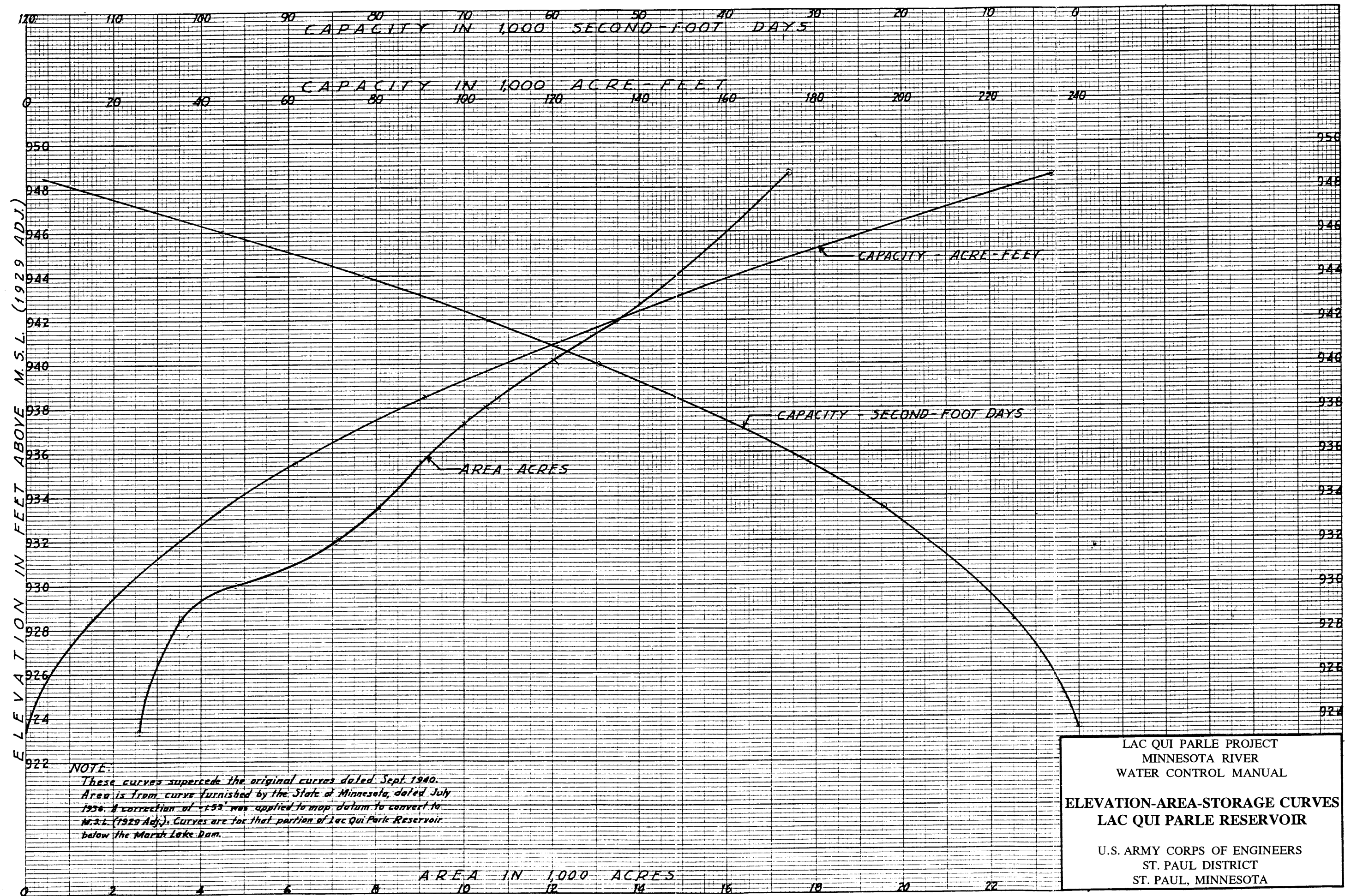
Plate 7-20
Marsh Lake Dam Service Spillway
Discharge for when Tailwater is over 938.8 feet

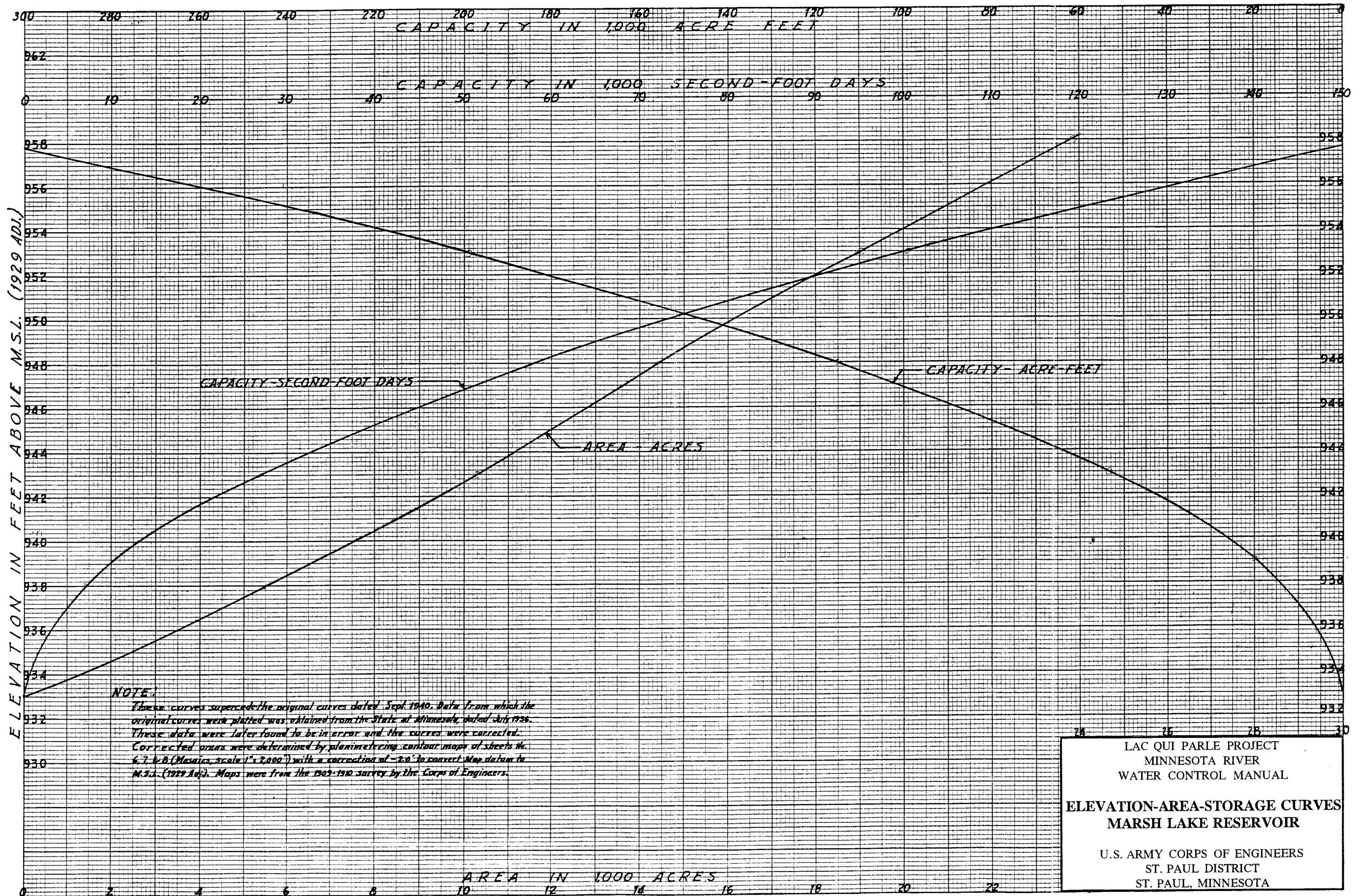
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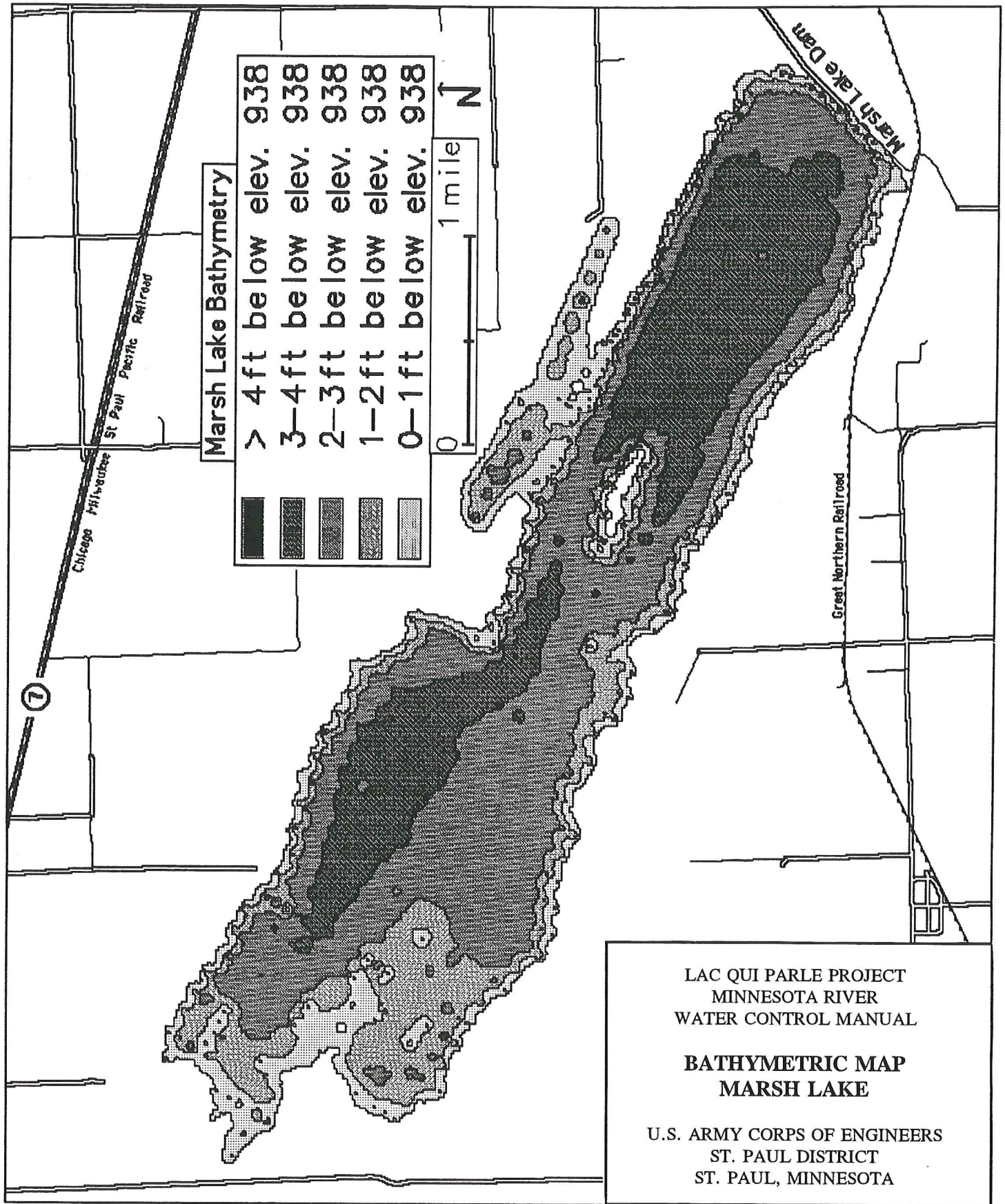
Table will be updated once construction is complete.

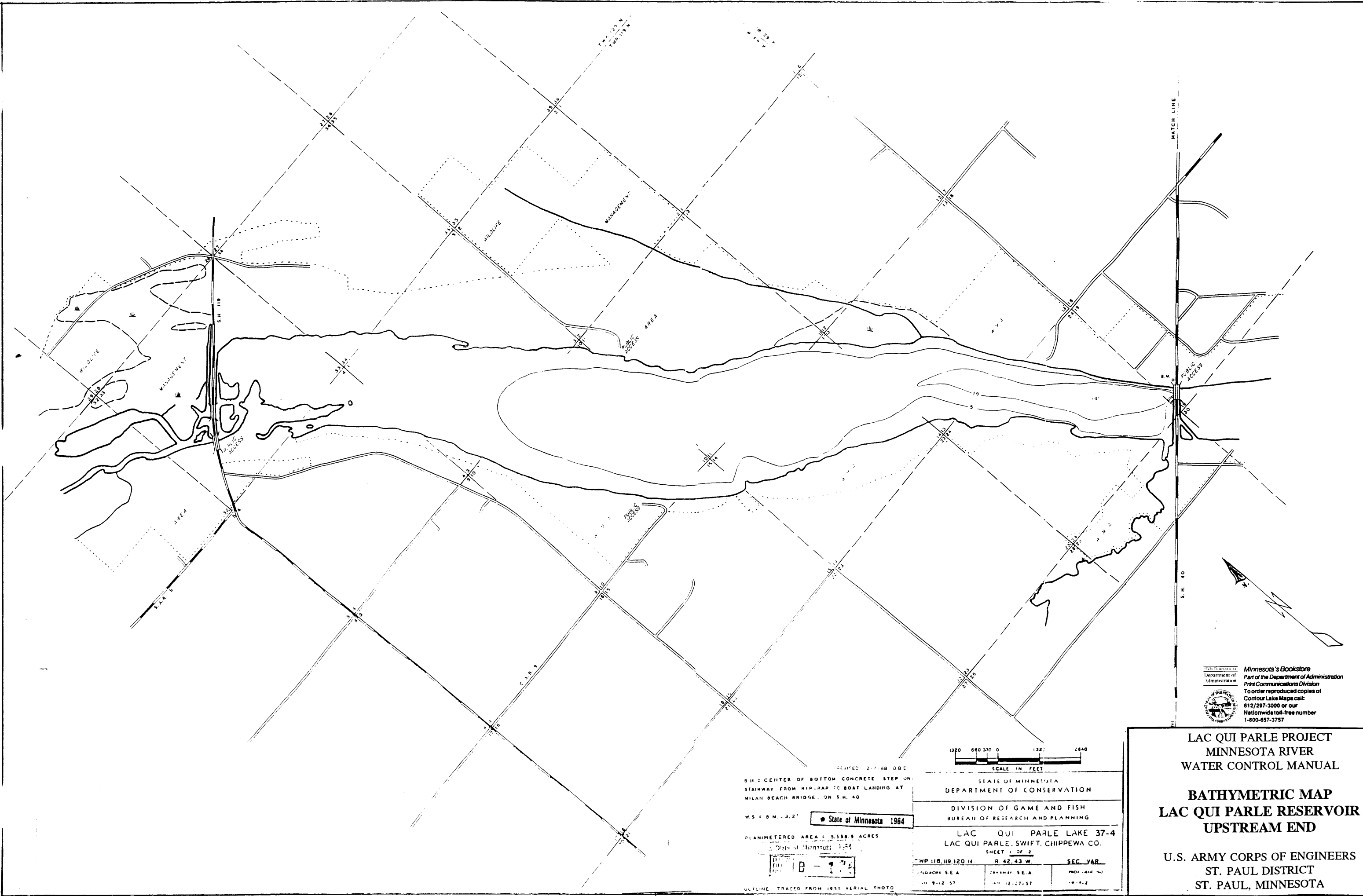
Plate 7-21
Marsh Lake Dam Service Spillway
Discharge for when Tailwater is over 938.8 feet

Pool Elev (ft)	Tailwater Elevation (ft)							
	942.0	942.5	943.0	943.5	944.0	944.5	945.0	945.5
942.4	3,240							
942.8	4,505	3,330						
943.2	5,360	4,885	2,795					
943.6	6,160	5,810	5,150	1,610				
944	6,870	6,650	6,275	4,540				
944.4	7,595	7,470	7,160	6,600	5,045			
944.8	8,305	8,210	8,015	7,660	6,960	4,305		
945.2	9,035	8,975	8,850	8,550	8,100	7,140	2,930	
945.6	9,790	9,725	9,655	9,460	9,095	8,550	7,415	1,780
946	10,510	10,475	10,405	10,290	10,015	9,620	8,910	7,000
946.4	11,280	11,260	11,205	11,100	10,930	10,610	10,065	9,210
946.8	12,030	12,015	11,965	11,895	11,765	11,530	11,155	10,490
947.2	12,820	12,810	12,785	12,720	12,615	12,450	12,125	11,685
947.6	13,595	13,585	13,575	13,515	13,445	13,310	13,115	12,650
948	14,420	14,405	14,400	14,350	14,290	14,205	14,045	13,695
948.4	15,260	15,255	15,240	15,215	15,155	15,075	14,920	14,770
948.8	16,065	16,065	16,050	16,040	15,995	15,915	15,815	15,620
949.2	16,935	16,935	16,920	16,910	16,860	16,805	16,705	16,550
949.6	17,770	17,765	17,755	17,745	17,710	17,640	17,585	17,475
950	18,660	18,660	18,650	18,640	18,600	18,545	18,510	18,395









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STAIRWAY FROM RIP-RAP TO BOAT LANDING AT
MILAN BEACH BRIDGE, ON S.H. 40
W.S. = 8 M. - 3.2'
PLANIMETERED AREA = 5,588.9 ACRES
State of Minnesota 1964
B-174
OUTLINE TRACED FROM 1955 AERIAL PHOTO

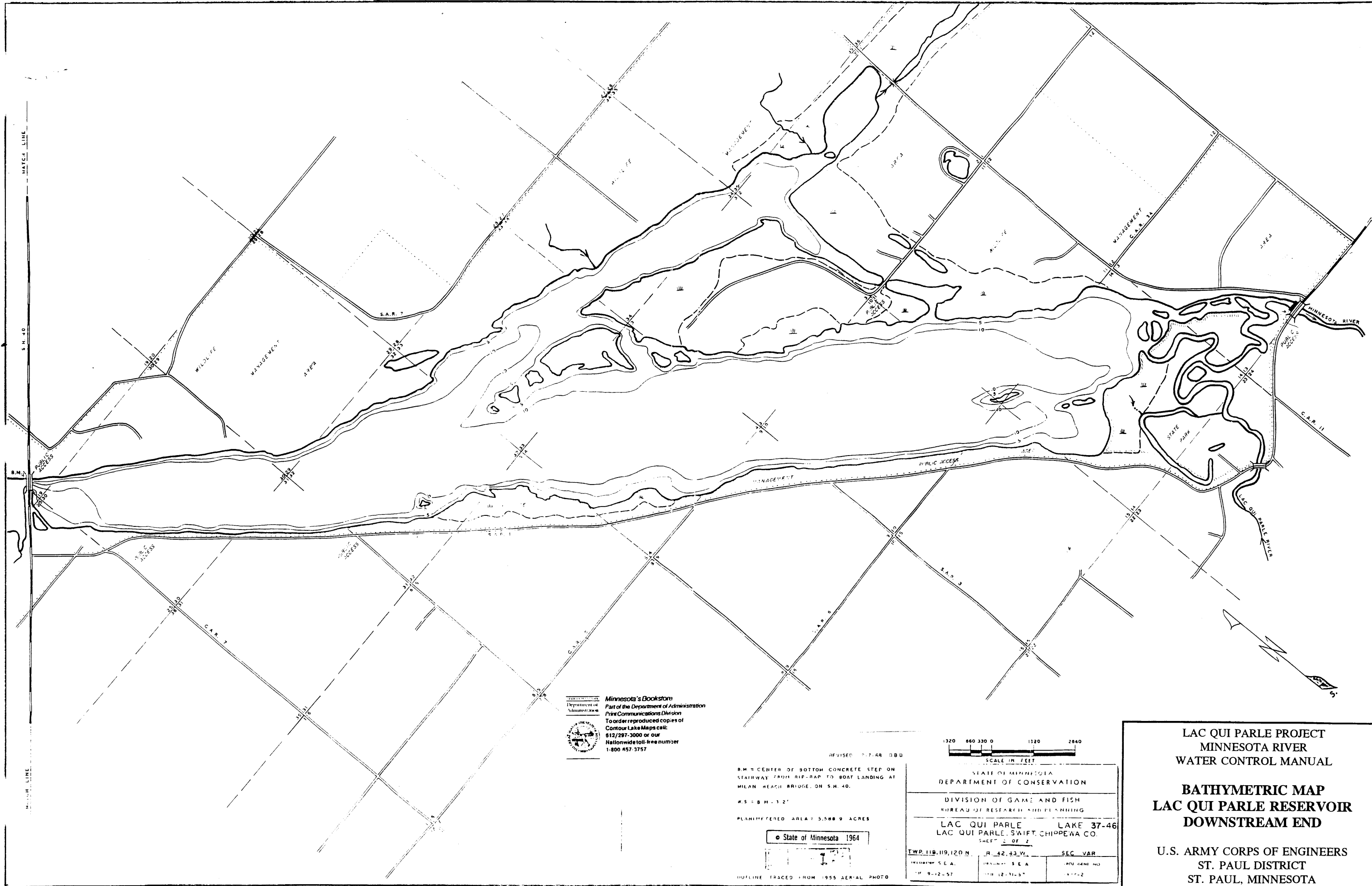


STATE OF MINNESOTA
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LAC QUI PARLE LAKE 37-4
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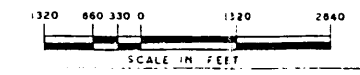
BATHYMETRIC MAP
LAC QUI PARLE RESERVOIR
UPSTREAM END

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State of Minnesota 1964
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STATE OF MINNESOTA
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SHEET 2 OF 2
TWP. 119, 119, 120 N. R. 42, 43, 44 W.
SECTION 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

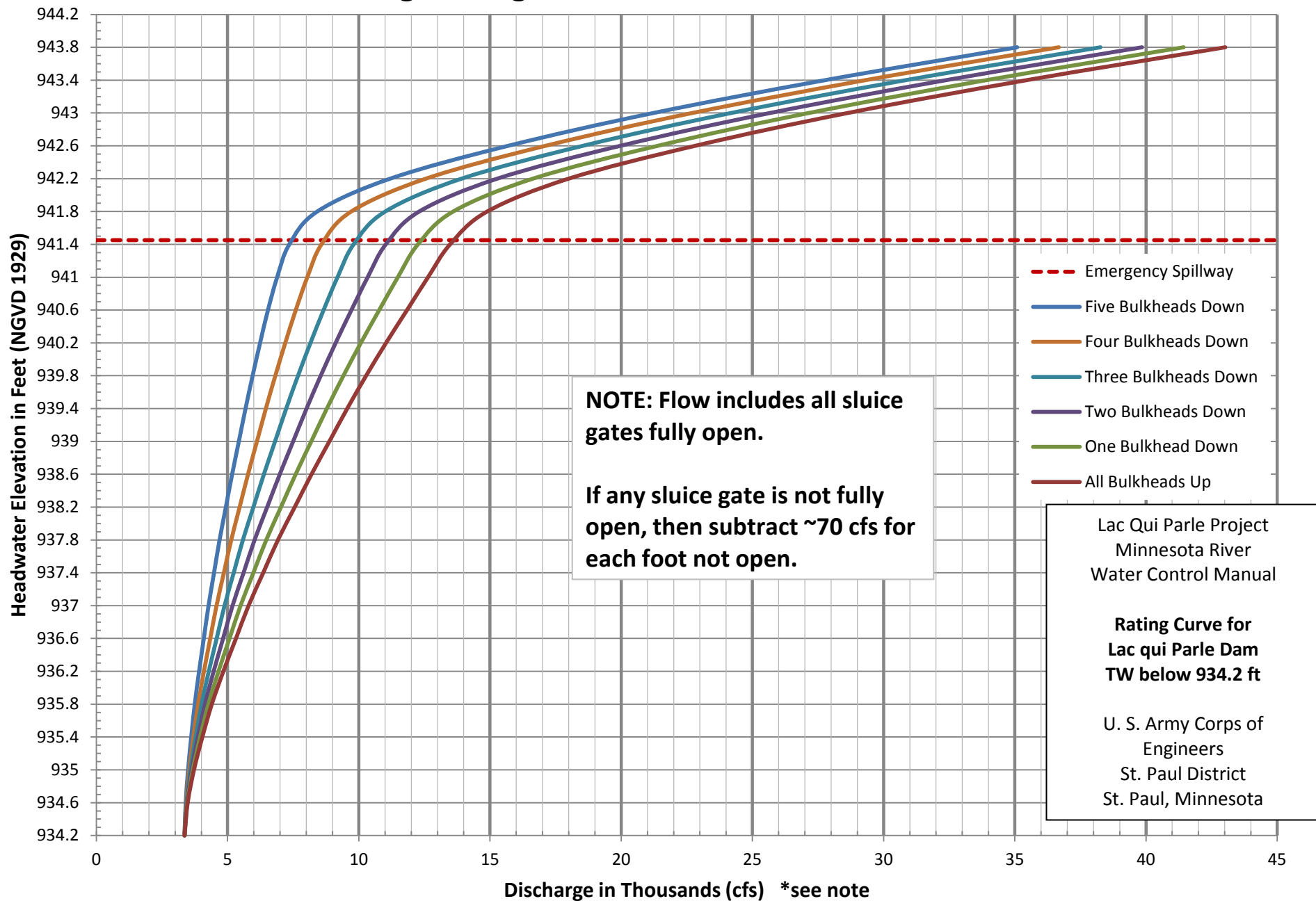
LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

**BATHYMETRIC MAP
LAC QUI PARLE RESERVOIR
DOWNSTREAM END**

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

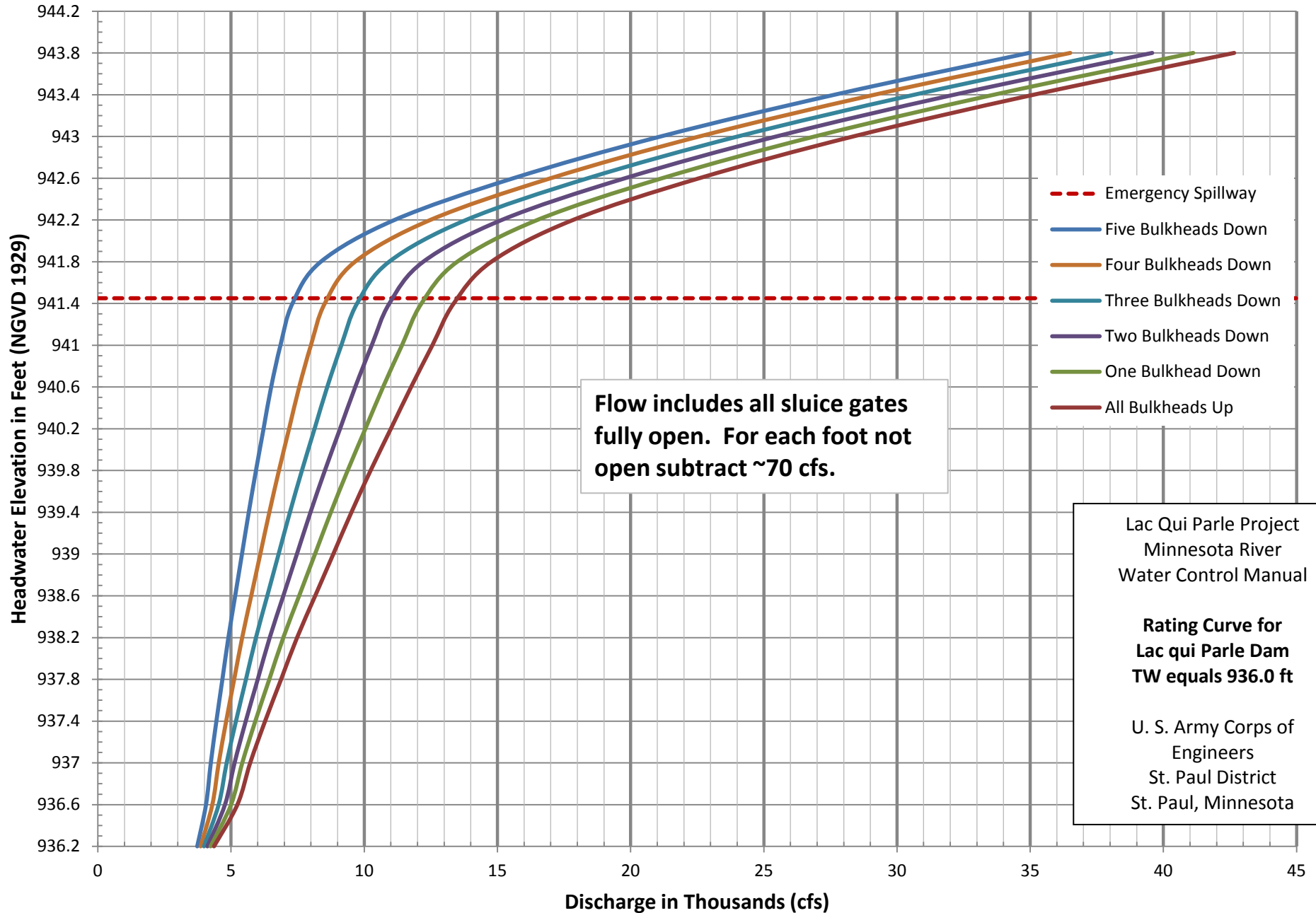
Lac qui Parle Dam Total Flow

Elevation-Discharge Rating Curves: Tailwater below elevation 934.2 feet



Lac qui Parle Dam Total Flow

Elevation-Discharge Rating Curves: Tailwater equals 936.0 feet



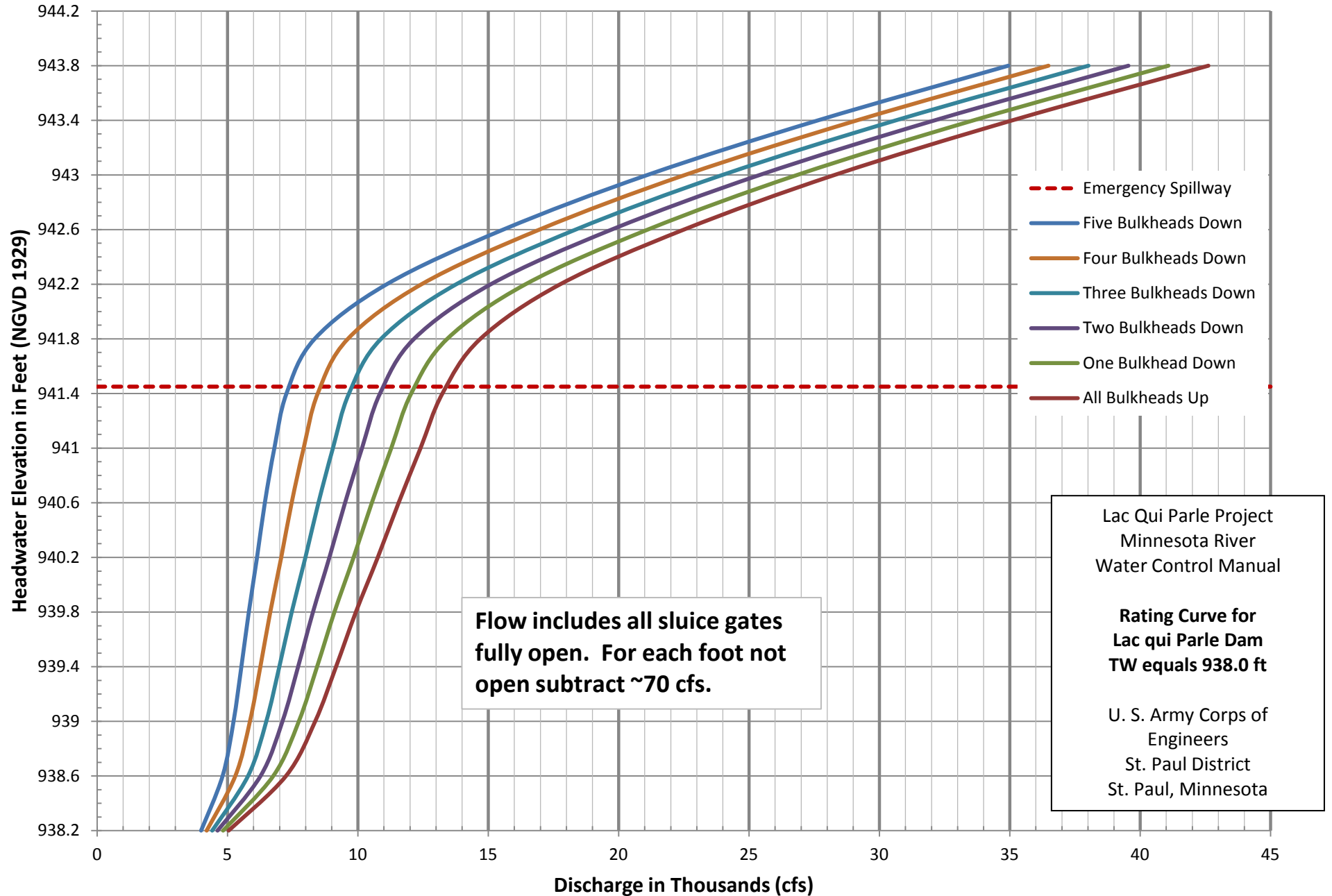
Lac Qui Parle Project
Minnesota River
Water Control Manual

**Rating Curve for
Lac qui Parle Dam
TW equals 936.0 ft**

U. S. Army Corps of
Engineers
St. Paul District
St. Paul, Minnesota

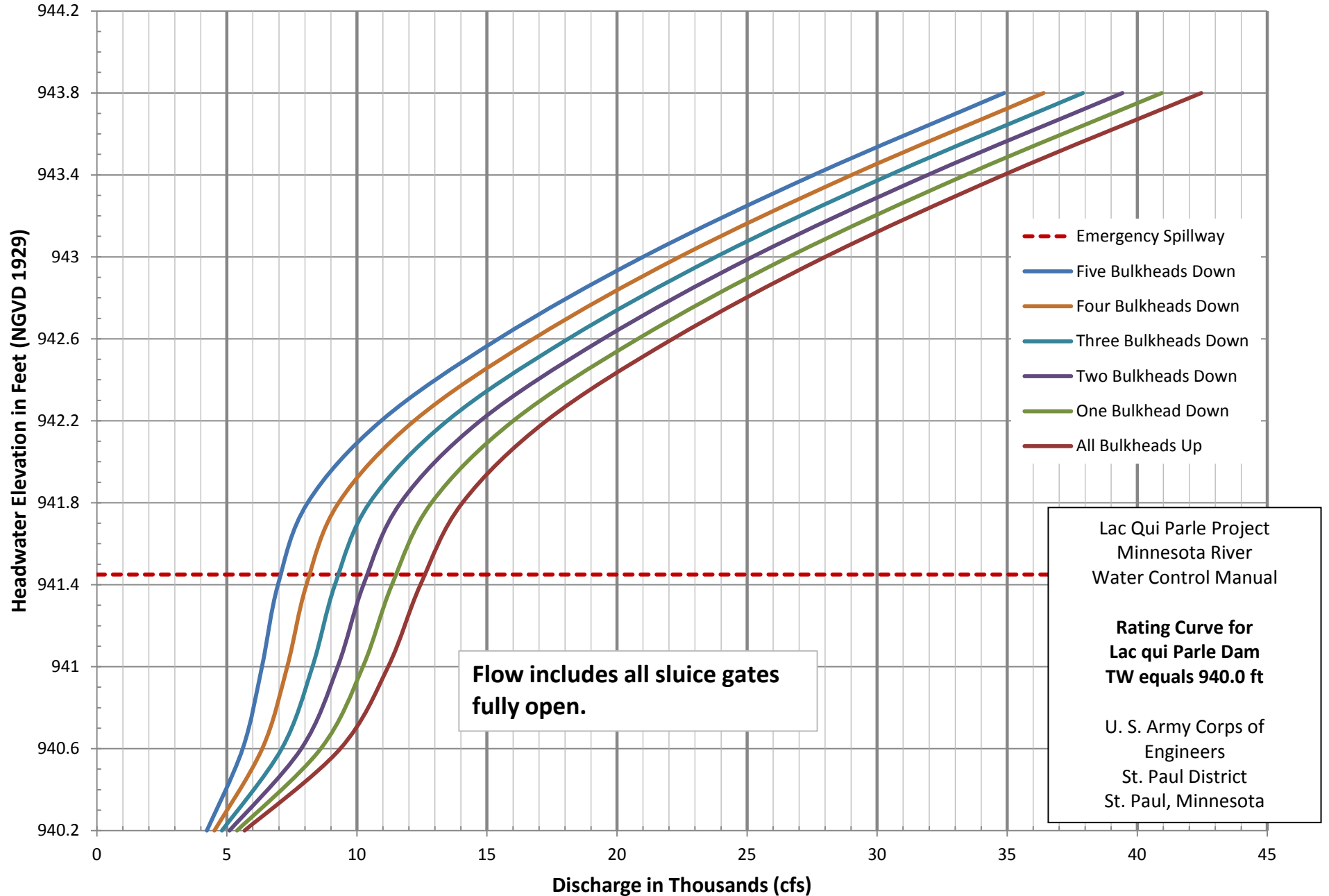
Lac qui Parle Dam Total Flow

Elevation-Discharge Rating Curves: Tailwater equals 938.0 feet



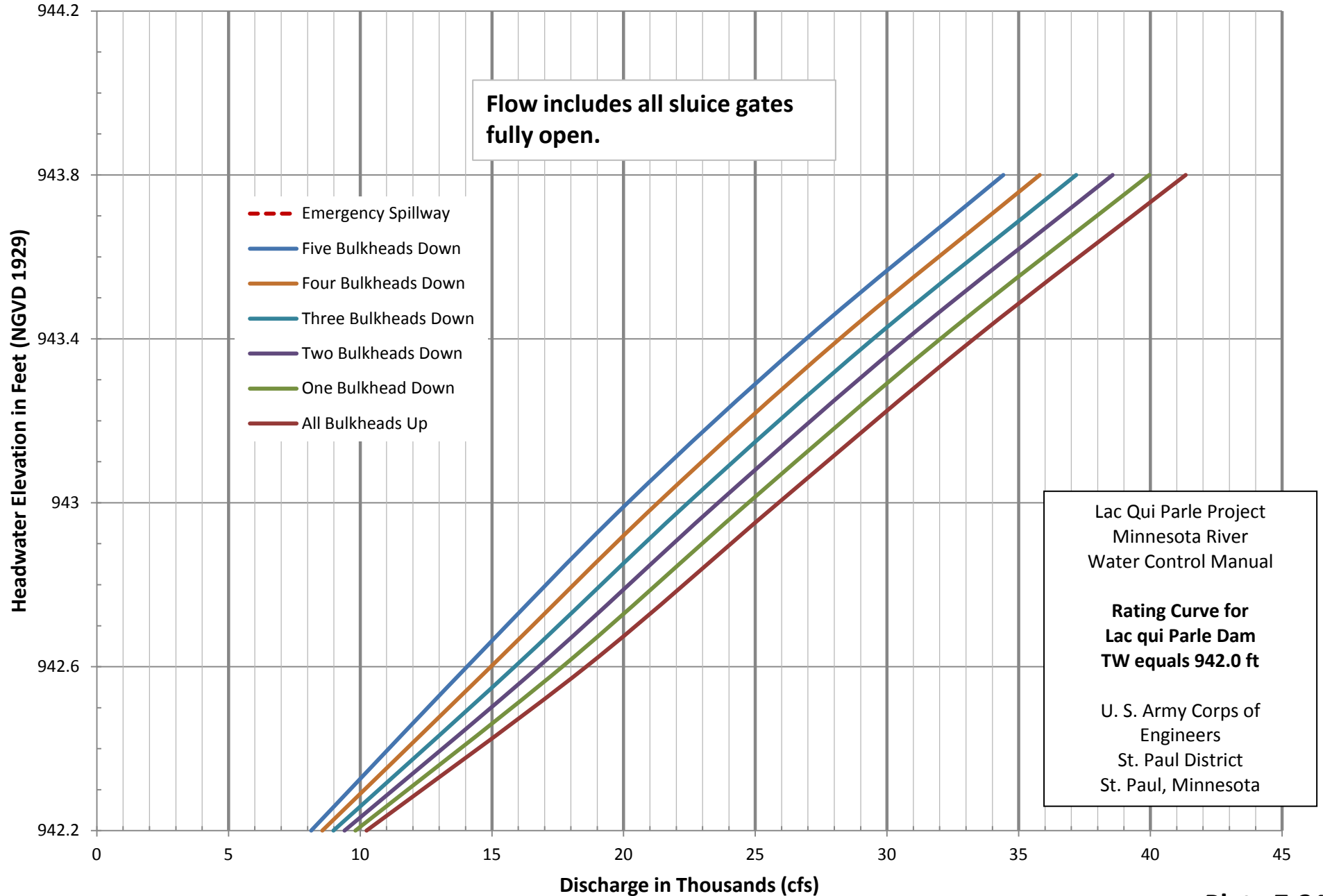
Lac qui Parle Dam Total Flow

Elevation-Discharge Rating Curves: Tailwater equals 940.0 feet

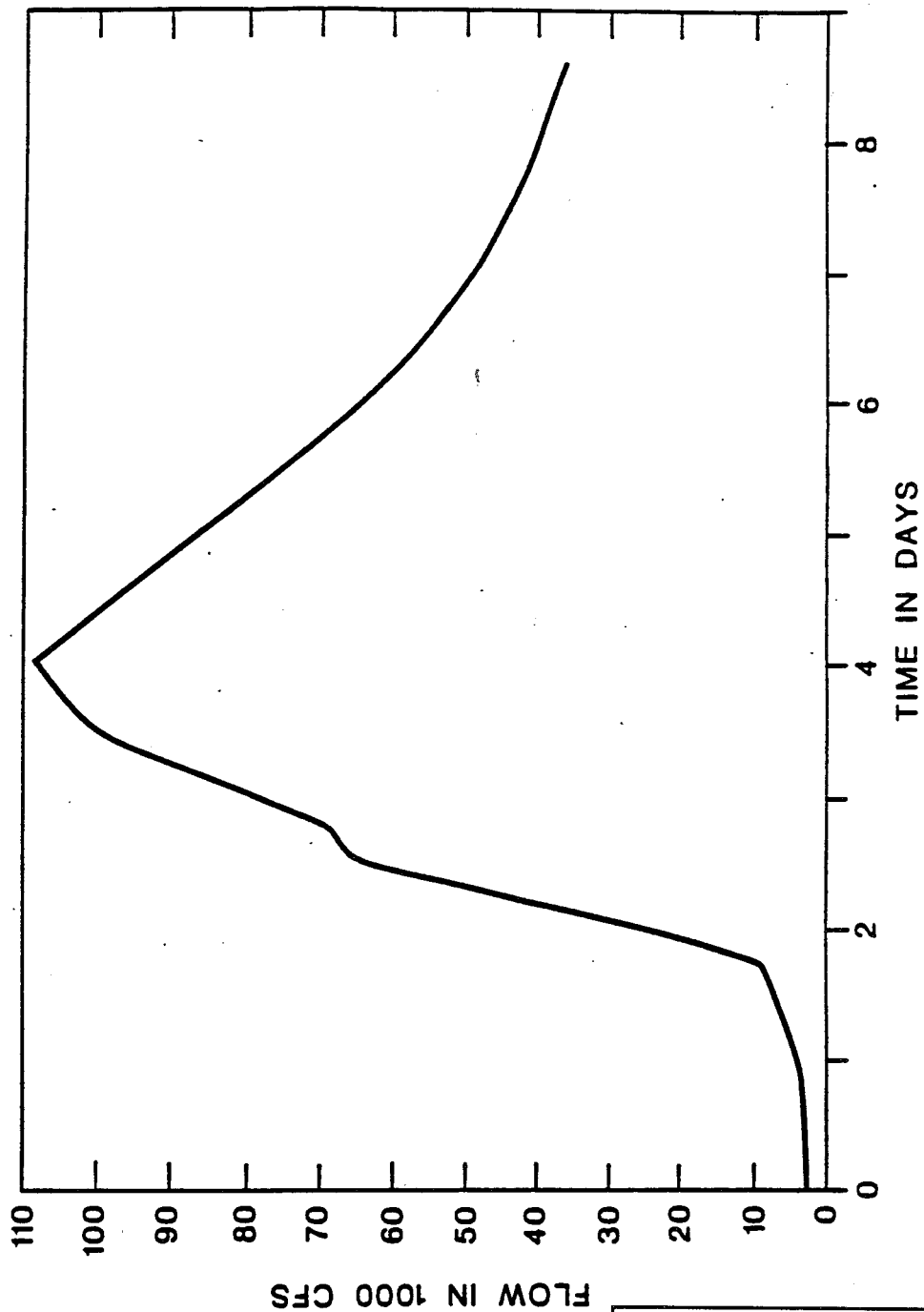


Lac qui Parle Dam Total Flow

Elevation-Discharge Rating Curves: Tailwater equals 942.0 feet



PROBABLE MAXIMUM FLOOD INFLOW HYDROGRAPH

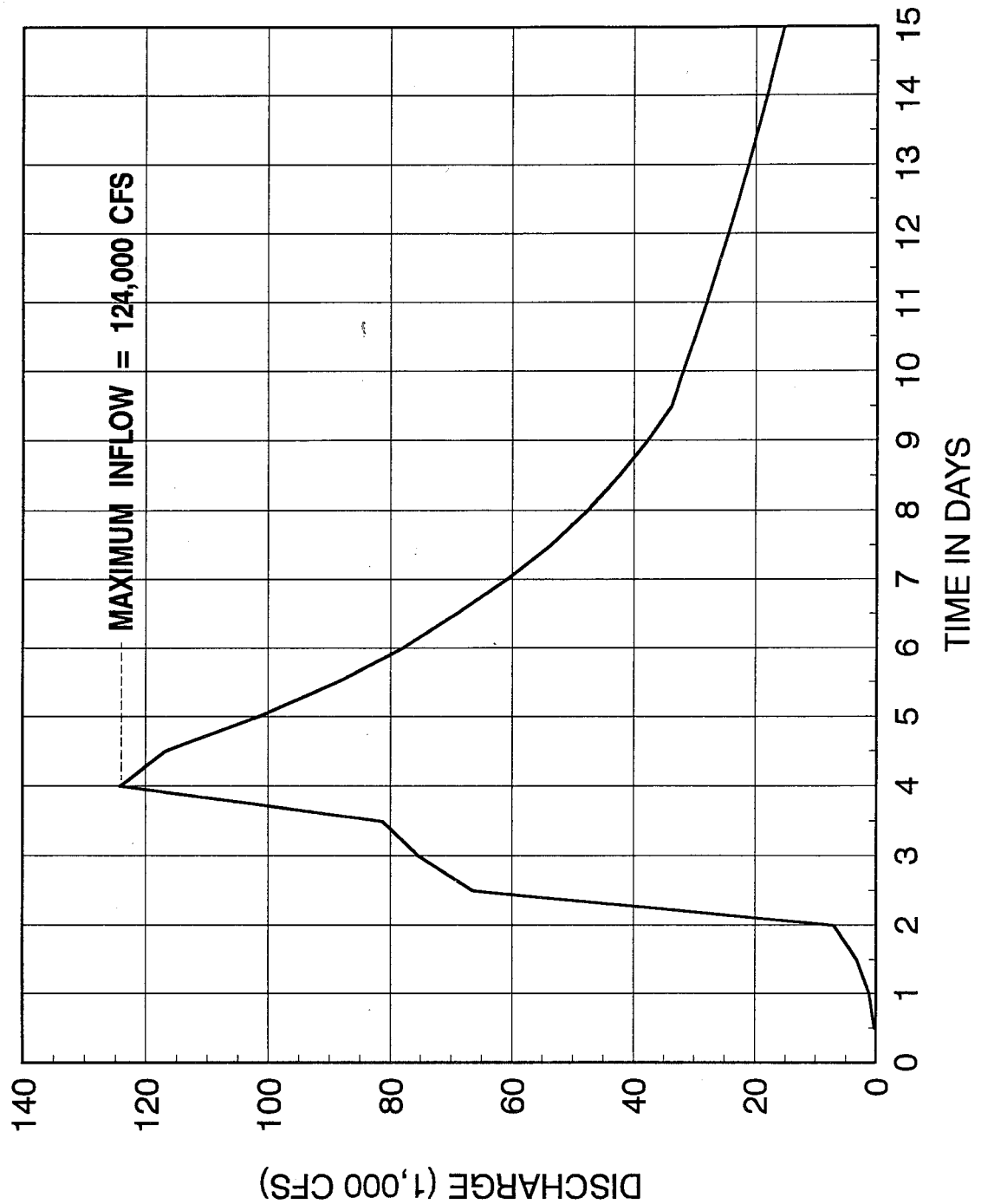


LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

**PMF INFLOW HYDROGRAPH
MARSH LAKE RESERVOIR**

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

LAC QUI PARLE RESERVOIR PROBABLE MAXIMUM FLOOD INFLOW HYDROGRAPH

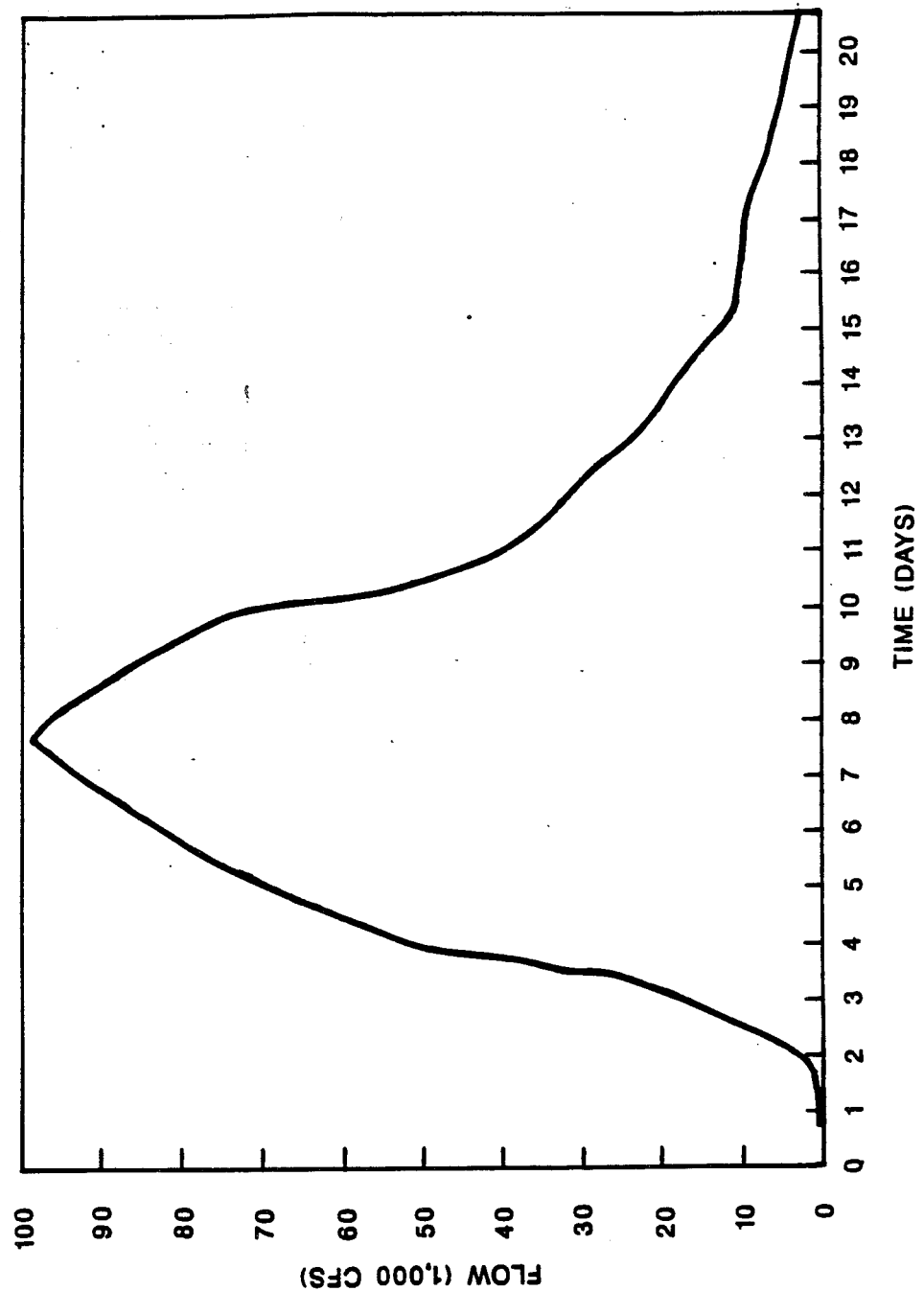


LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

PROBABLE MAXIMUM FLOOD INFLOW HYDROGRAPH LAC QUI PARLE RESERVOIR

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

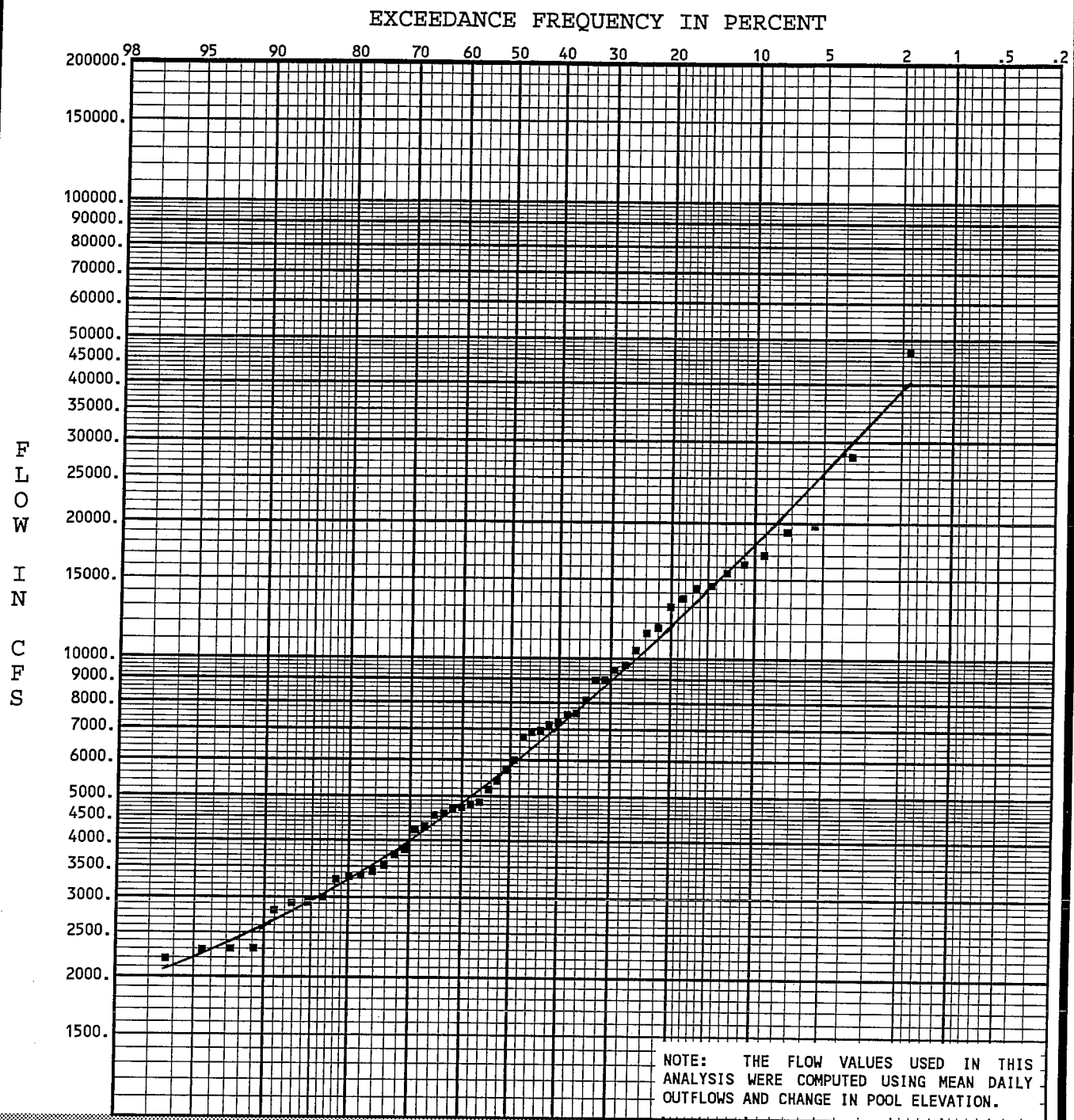
PROBABLE MAXIMUM FLOOD INFLOW HYDROGRAPH



LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

**PMF INFLOW HYDROGRAPH
CHIPPEWA RIVER
DIVERSION DAM**

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA



ANNUAL PEAK INFLOW-FREQUENCY CURVE

LAC QUI PARLE RESERVOIR

WATER YEARS IN RECORD 1940 - 1993

BASIN AREA = 4,050 SQUARE MILES

WEIBULL PLOTTING POSITIONS

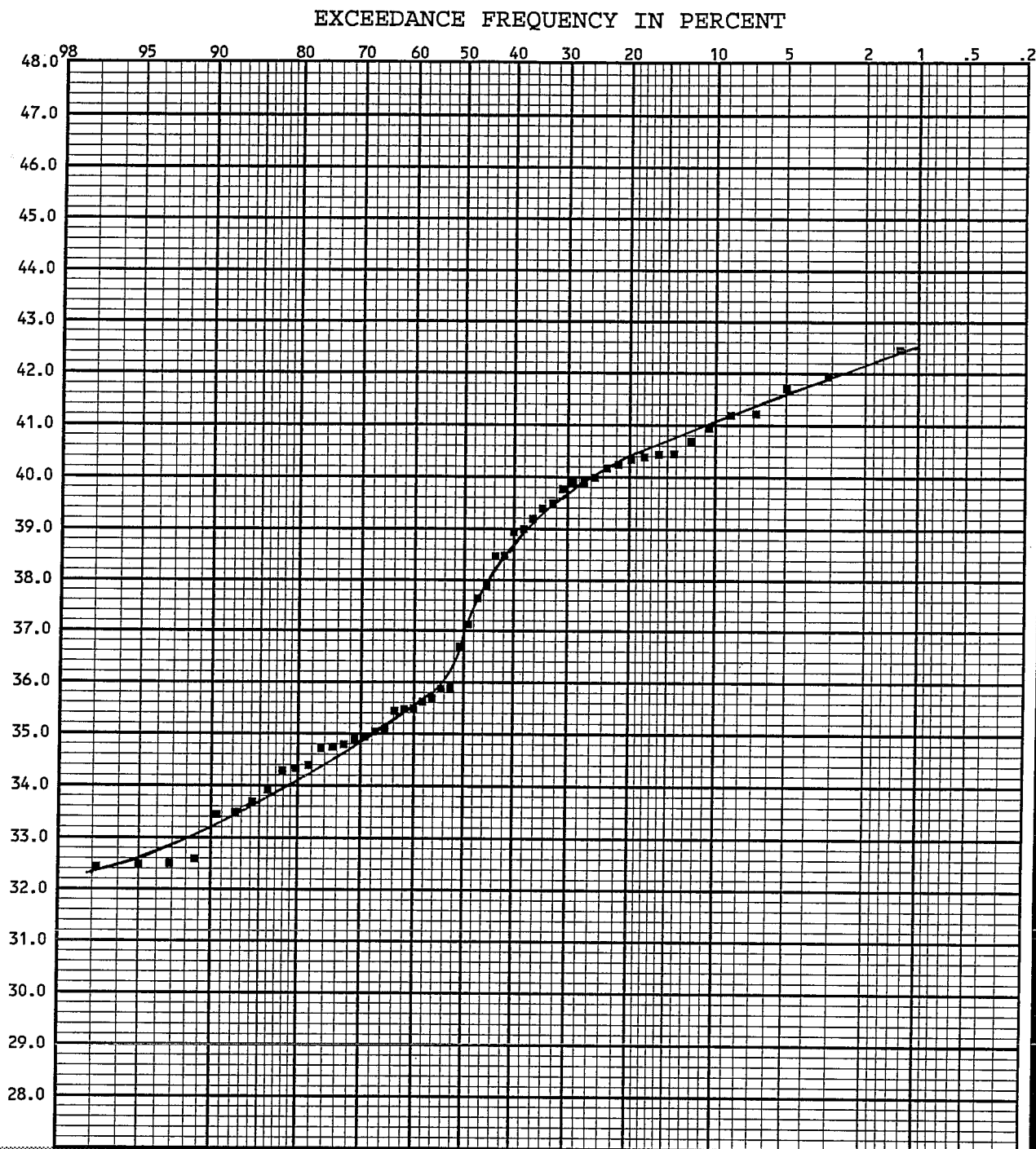
GRAPHICAL ANALYSIS

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

**ANNUAL INFLOW - FREQUENCY
LAC QUI PARLE PROJECT**

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

STAGE
IN
FEET



STAGE-FREQUENCY CURVE

ANNUAL INSTANTANEOUS PEAKS

WATER YEARS IN RECORD 1940 - 1993

GAGE ZERO = 900.00 FEET (NGVD 1929)

Basin Area = 4,050 SQ MI

MEDIAN PLOTTING POSITIONS

GRAPHICAL ANALYSIS

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

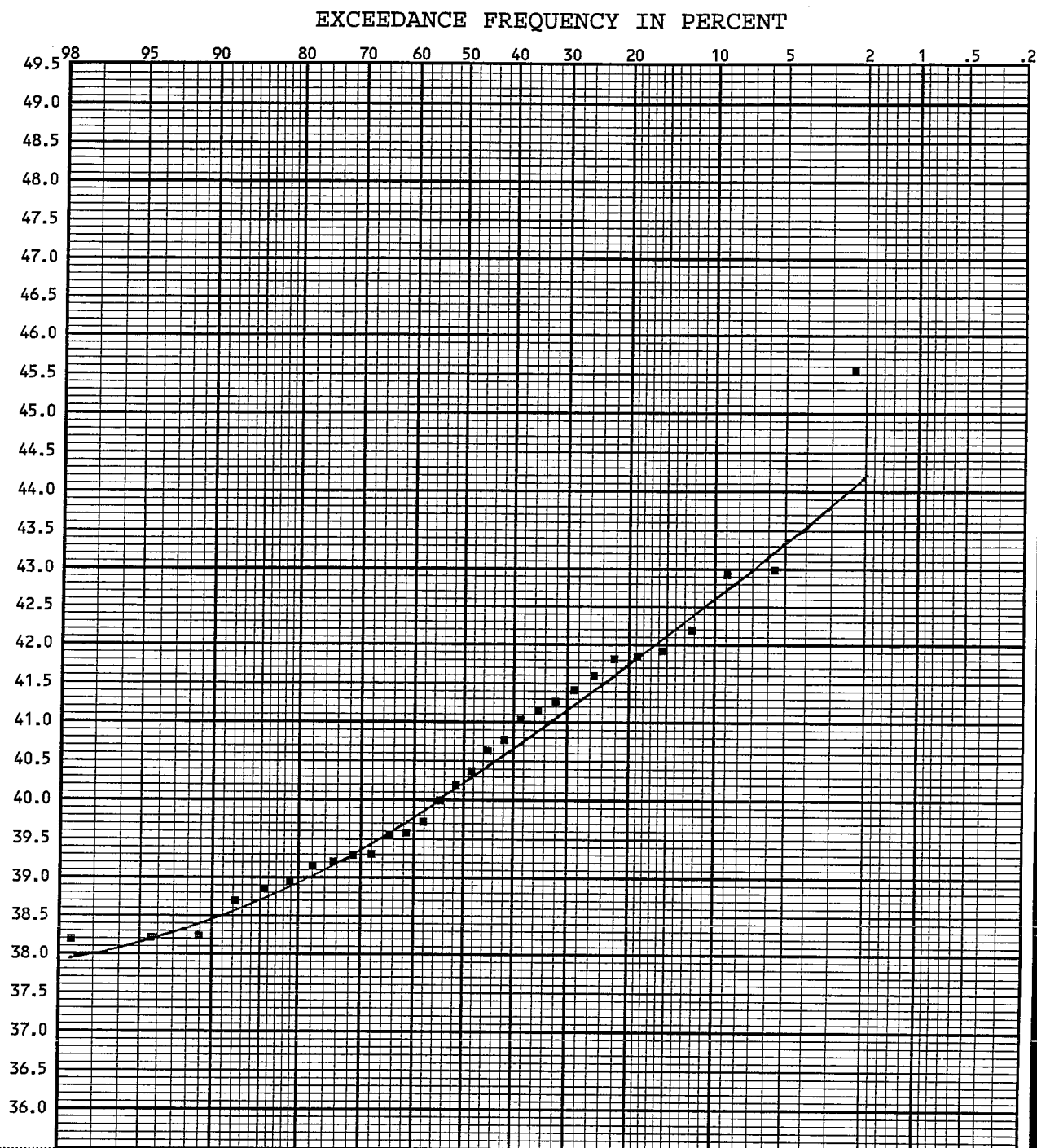
**STAGE - FREQUENCY
LAC QUI PARLE RESERVOIR**

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

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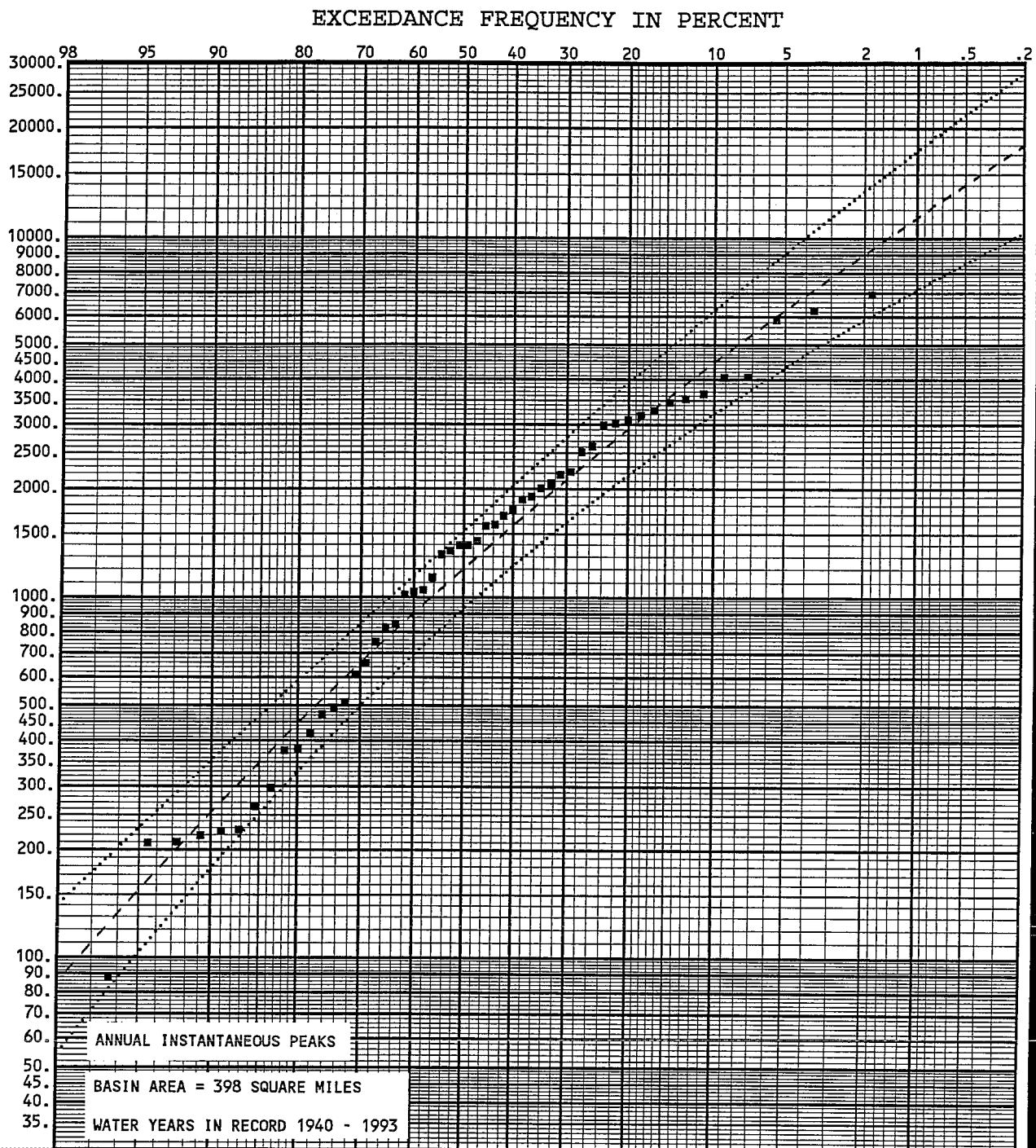
STAGE-FREQUENCY CURVE
 ANNUAL INSTANTANEOUS PEAKS
 WATER YEARS IN RECORD 1964 - 1993
 GAGE ZERO = 900.00 FEET (NGVD 1929)
 BASIN AREA = 2,800 SQ MI
 MEDIAN PLOTTING POSITIONS
 GRAPHICAL ANALYSIS

LAC QUI PARLE PROJECT
 MINNESOTA RIVER
 WATER CONTROL MANUAL

**STAGE - FREQUENCY
 MARSH LAKE RESERVOIR**

 U.S. ARMY CORPS OF ENGINEERS
 ST. PAUL DISTRICT
 ST. PAUL, MINNESOTA

FLOW
IN
CFS



- Flow Frequency (with Exp. Prob.)
- Weibull Plotting Positions
- 5% and 95% Confidence Limits

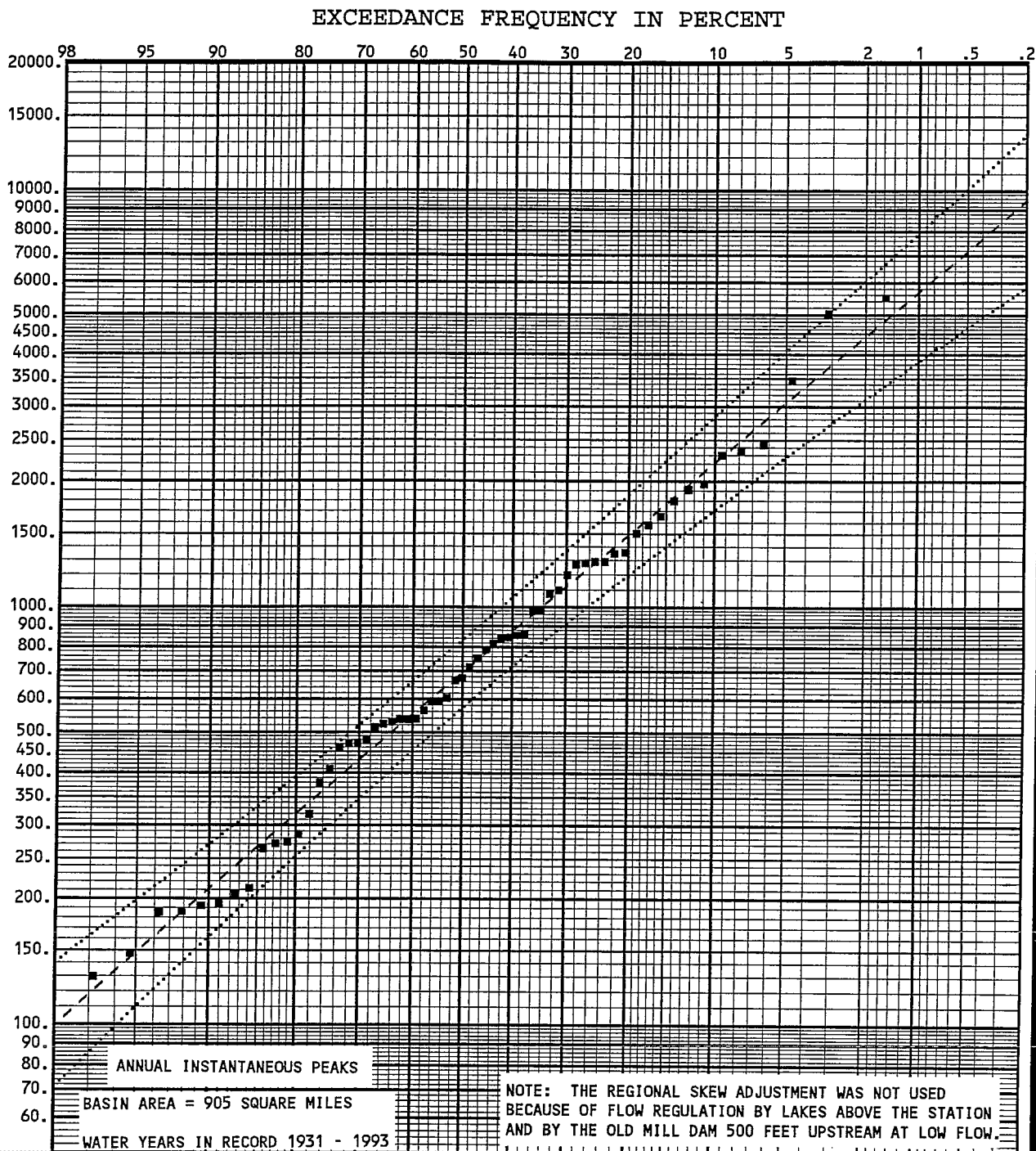
FREQUENCY STATISTICS		NUMBER OF EVENTS	
LOG TRANSFORM OF FLOW, CFS			
MEAN	3.0492	HISTORIC EVENTS	0
STANDARD DEV	.4779	HIGH OUTLIERS	0
SKEW	-.5819	LOW OUTLIERS	0
REGIONAL SKEW	-.2000	ZERO OR MISSING	0
ADOPTED SKEW	-.3817	SYSTEMATIC EVENTS	54

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

DISCHARGE - FREQUENCY
U.S.G.S. GAGE NO. 05293000
YELLOW BANK RIVER
NEAR ODESSA, MINNESOTA

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

FLOW
IN
CFS



- Flow Frequency (with Exp. Prob.)
- Weibull Plotting Positions
- 5% and 95% Confidence Limits

FREQUENCY STATISTICS

LOG TRANSFORM OF FLOW, CFS

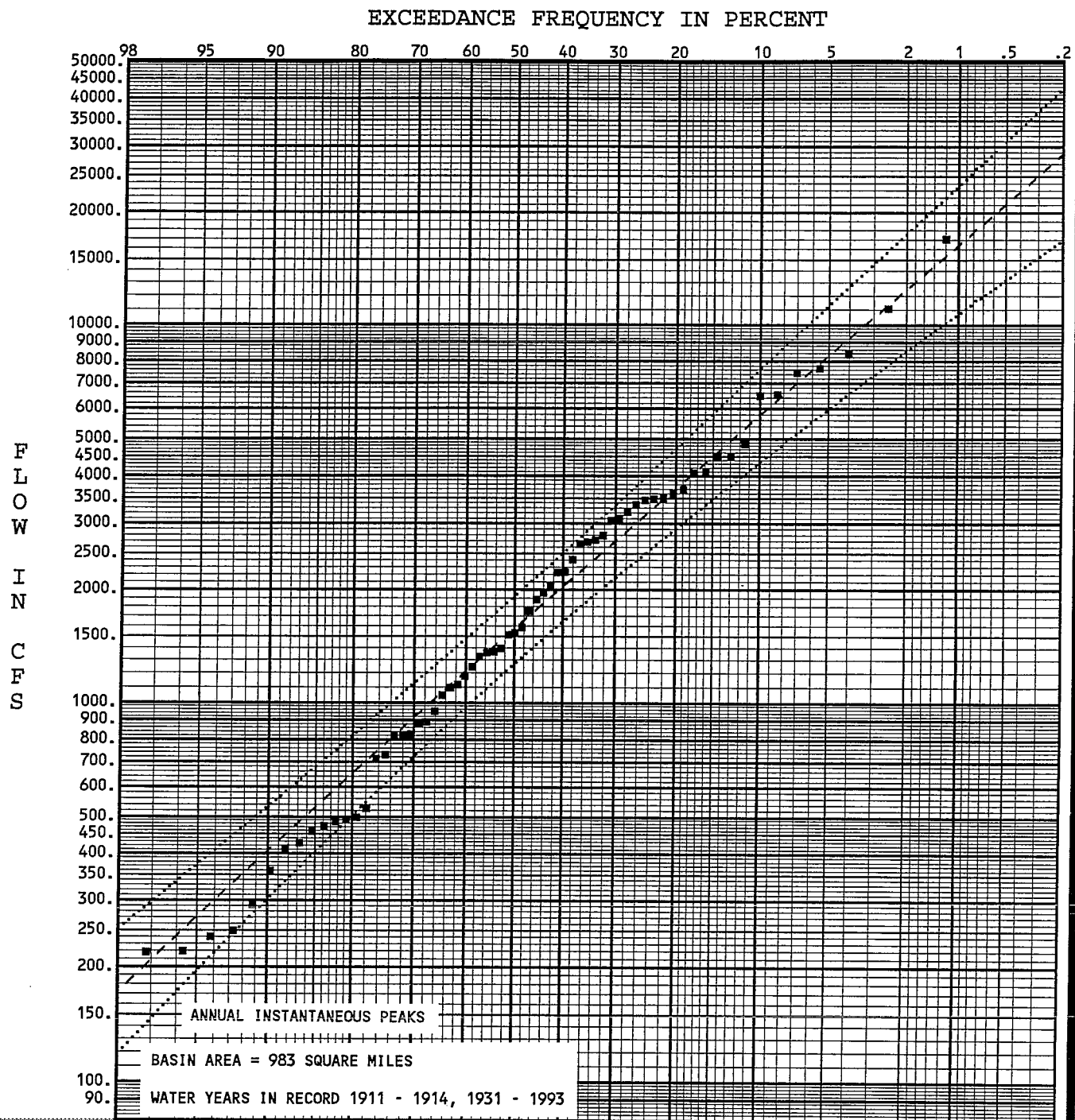
NUMBER OF EVENTS

MEAN	2.8372	HISTORIC EVENTS	0
STANDARD DEV	.3904	HIGH OUTLIERS	0
SKEW	-.0698	LOW OUTLIERS	0
REGIONAL MAP SKEW	--	ZERO OR MISSING	0
ADOPTED SKEW	-.0698	SYSTEMATIC EVENTS	63

**LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL**

**DISCHARGE - FREQUENCY
U.S.G.S. GAGE NO. 05294000
POMME DE TERRE RIVER
AT APPLETON, MINNESOTA**

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA



--- Flow Frequency (with Exp. Prob.)

■ Weibull Plotting Positions

..... 5% and 95% Confidence Limits

FREQUENCY STATISTICS

LOG TRANSFORM OF FLOW, CFS

NUMBER OF EVENTS

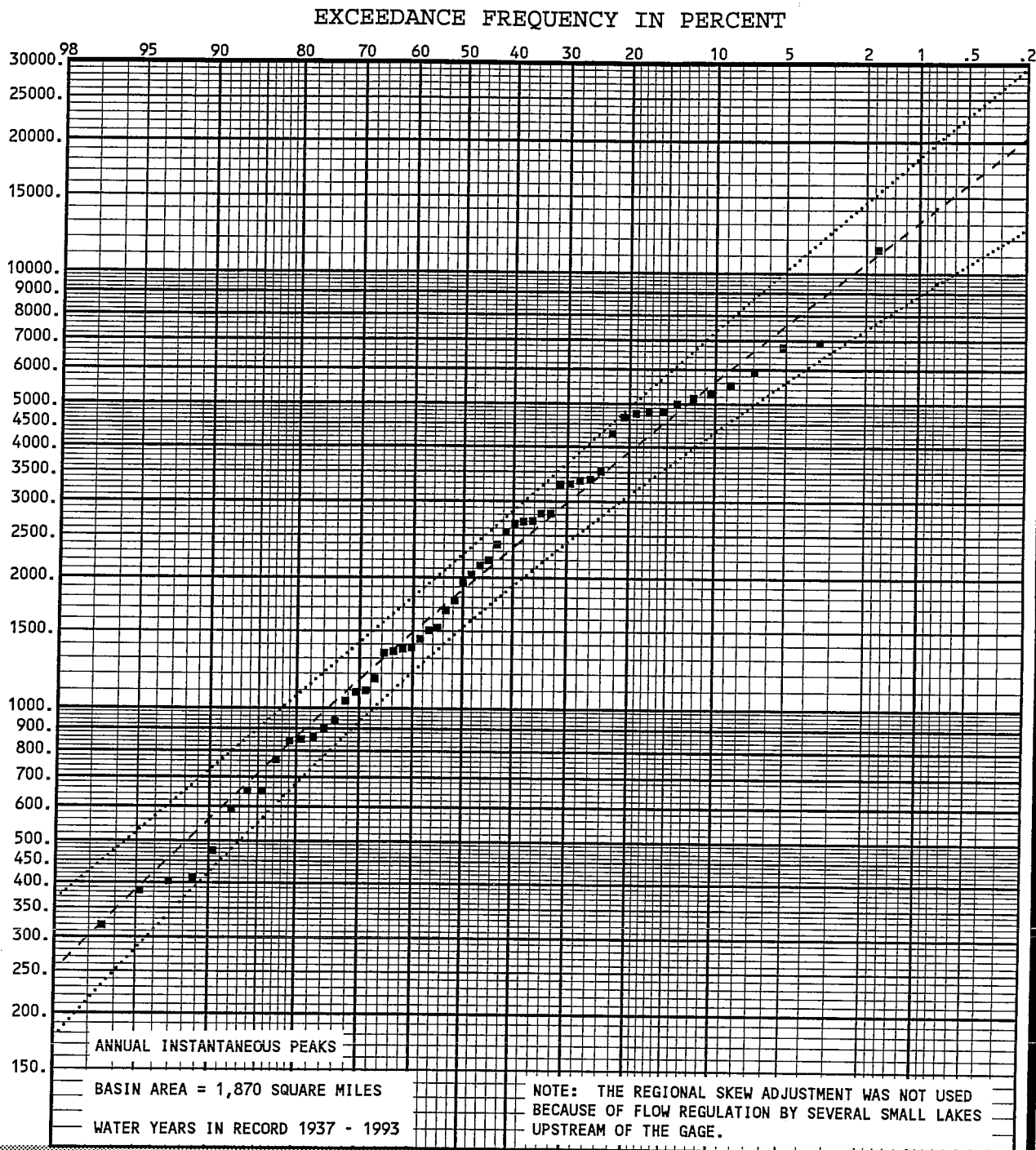
MEAN	3.1898	HISTORIC EVENTS	1
STANDARD DEV	.4413	HIGH OUTLIERS	0
SKEW	-.0453	LOW OUTLIERS	0
REGIONAL SKEW	-.2000	ZERO OR MISSING	1
ADOPTED SKEW	-.0988	SYSTEMATIC EVENTS	66
		HISTORIC PERIOD(1911-1993)	83

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

DISCHARGE - FREQUENCY
U.S.G.S. GAGE NO. 05300000
LAC QUI PARLE RIVER NEAR
LAC QUI PARLE, MINNESOTA

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

FLOW
IN
CFS



--- Flow Frequency (with Exp. Prob.)

■ Weibull Plotting Positions

..... 5% and 95% Confidence Limits

FREQUENCY STATISTICS

LOG TRANSFORM OF FLOW, CFS

NUMBER OF EVENTS

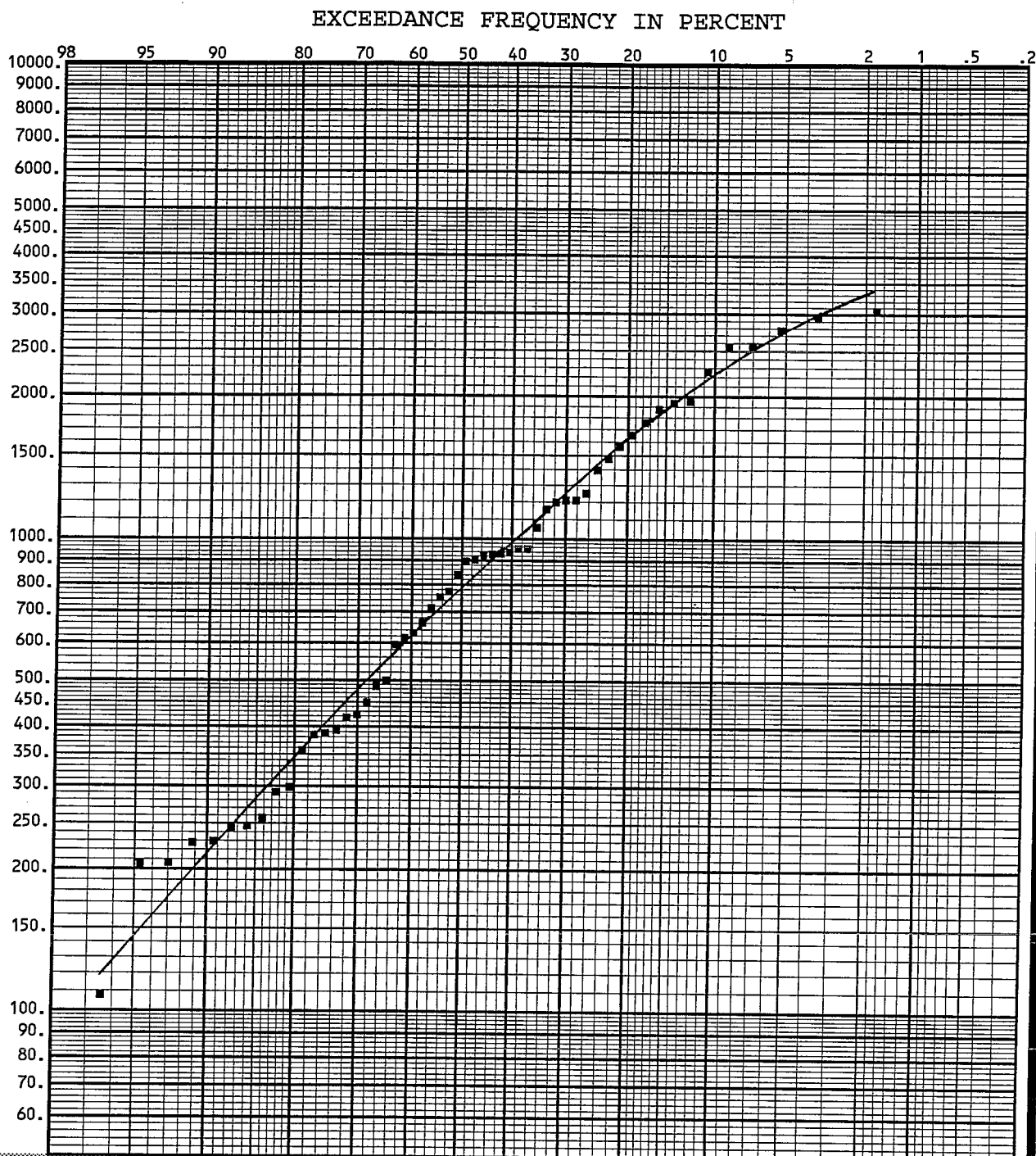
MEAN	3.2588	HISTORIC EVENTS	1
STANDARD DEV	.3834	HIGH OUTLIERS	0
SKEW	-.2132	LOW OUTLIERS	0
REGIONAL MAP SKEW	--	ZERO OR MISSING	0
ADOPTED SKEW	-.2132	SYSTEMATIC EVENTS	56
		HISTORIC PERIOD(1937-1993)	57

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

DISCHARGE - FREQUENCY
U.S.G.S. GAGE NO. 05304500
CHIPPEWA RIVER
NEAR MILAN, MINNESOTA

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

FLOW
IN
CFS



DISCHARGE-FREQUENCY CURVE
ANNUAL INSTANTANEOUS PEAKS
MINNESOTA RIVER AT ORTONVILLE, MINNESOTA
WATER YEARS IN RECORD 1938 - 1993
USGS GAGE NUMBER 05292000
BASIN AREA = 1,160 SQ MI
WEIBULL PLOTTING POSITIONS
GRAPHICAL ANALYSIS

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL

**DISCHARGE - FREQUENCY
MINNESOTA RIVER
AT ORTONVILLE, MN**

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

DISCHARGE FREQUENCY CURVE

RETURN INTERVAL (YEARS)

2

5

10

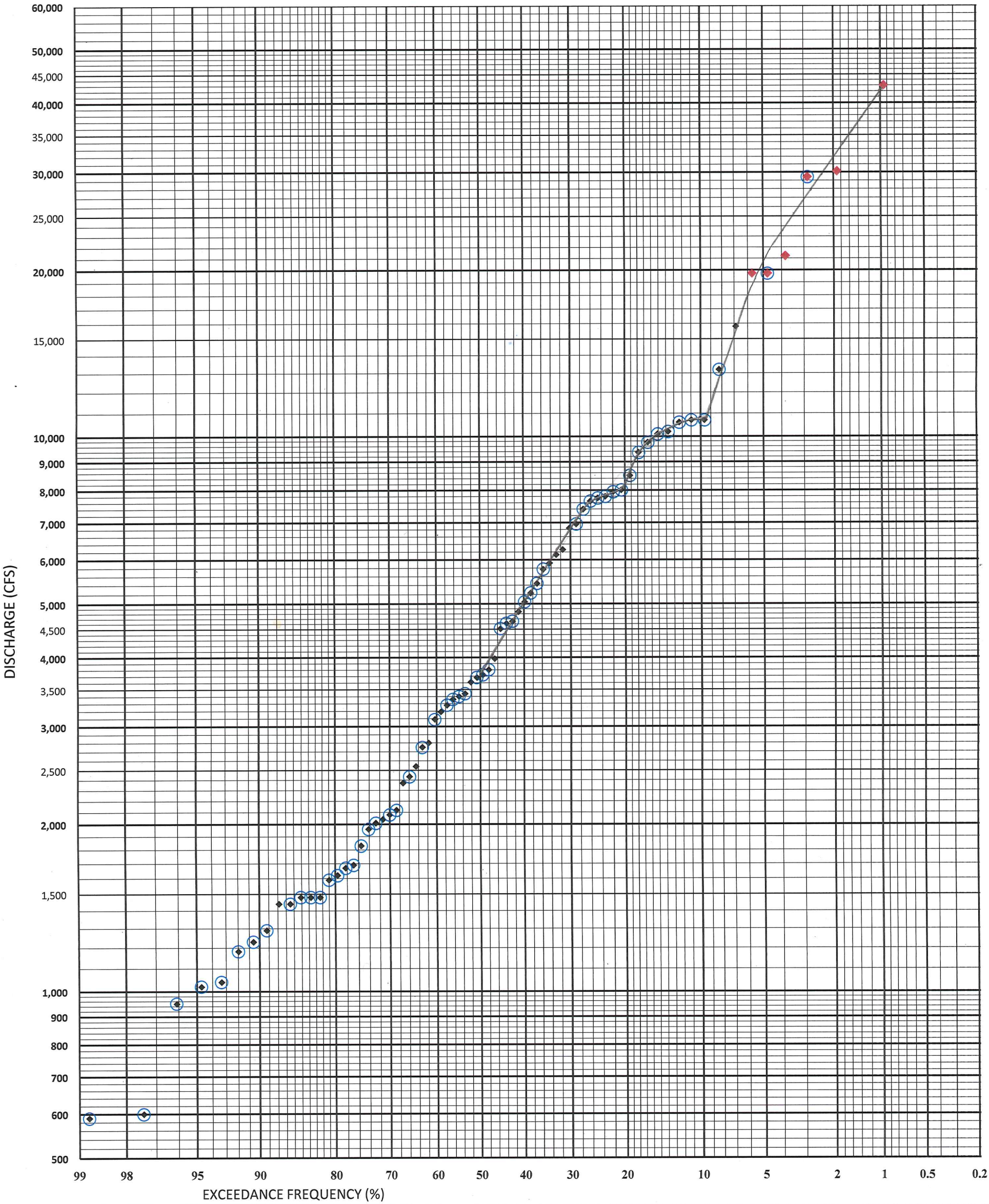
20

50

100

200

500



LEGEND

- ◆ Weibull Plotting Positions: 1940 - 2013
Historic Period of 1910 - 2013
- ◆ Event Plotting Position Adjusted to Reflect Historic Period
- Prior to 1995 Updates to Lac qui Parle Operating Plan
- Graphical: Regulated Flow Frequency Curve

SUMMARY STATISTICS

SOLUTION : Graphical
DISTRIBUTION : Weibull
PLOTTING POSITIONS : Weibull
MEAN :
STANDARD DEVIATION :
STATION SKEW :
REGIONAL SKEW :
WEIGHTED SKEW :
ADOPTED SKEW :

NUMBER OF EVENTS

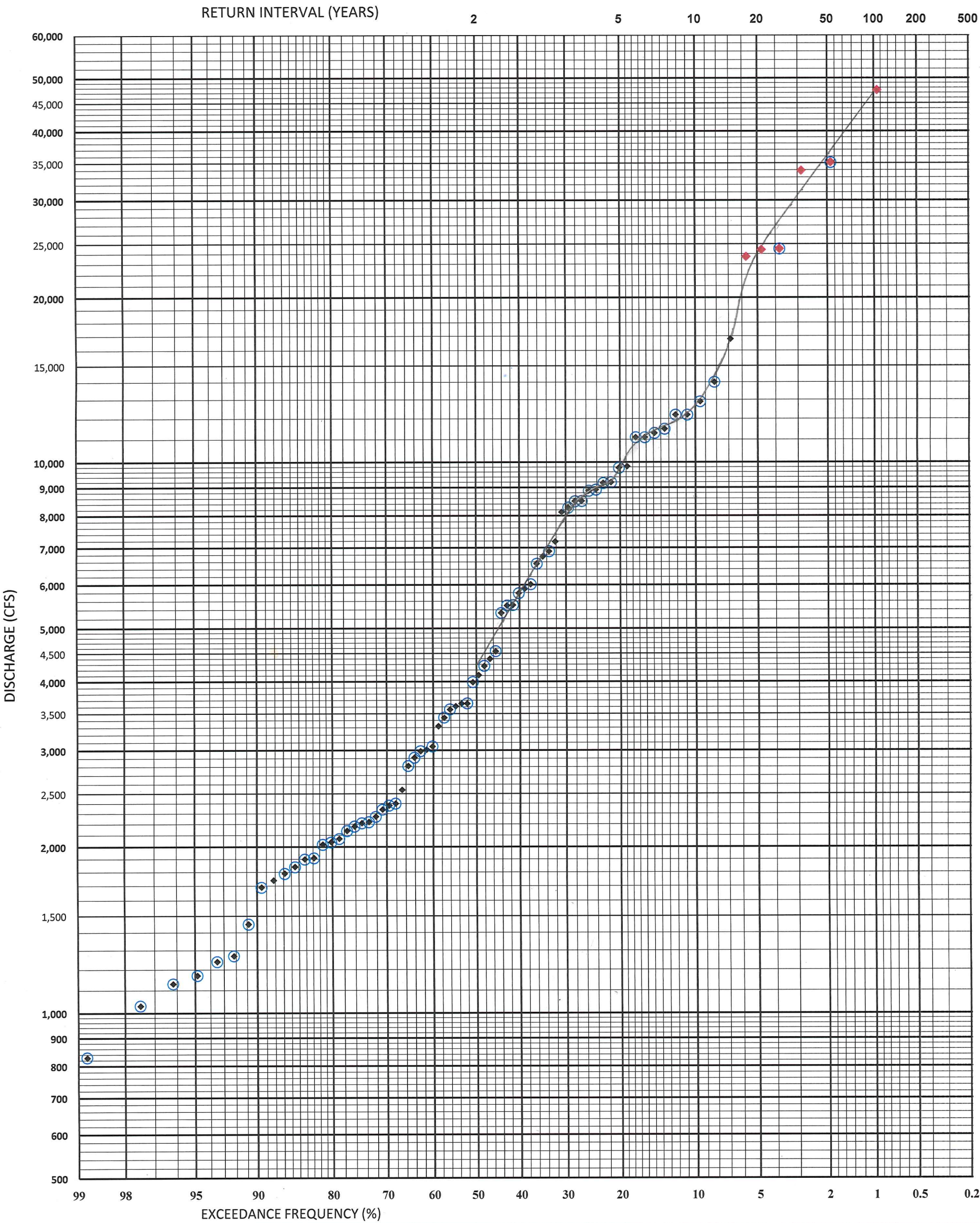
HISTORIC EVENTS :
HIGH OUTLIERS :
LOW OUTLIERS :

YEARS

SYSTEMATIC RECORD : 74
HISTORIC RECORD : 104
EQUIVALENT RECORD :

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL
**DISCHARGE-FREQUENCY
MINNESOTA RIVER
NEAR LAC QUI PARLE, MN**
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

DISCHARGE FREQUENCY CURVE



LEGEND

SUMMARY STATISTICS

- ◆ Weibull Plotting Positions: 1938 - 2013
Historic Period of 1910 - 2013
- ◆ Event Plotting Position Adjusted to Reflect Historic Period
- Prior to 1995 Updates to Lac qui Parle Operating Plan
- Graphical: Regulated Flow Frequency Curve

SOLUTION : Graphical
DISTRIBUTION :
PLOTTING POSITIONS : Weibull
MEAN :
STANDARD DEVIATION :
STATION SKEW :
REGIONAL SKEW :
WEIGHTED SKEW :
ADOPTED SKEW :

NUMBER OF EVENTS
HISTORIC EVENTS :
HIGH OUTLIERS :
LOW OUTLIERS :
YEARS
SYSTEMATIC EVENTS : 76
HISTORIC PERIOD : 104

LAC QUI PARLE PROJECT
MINNESOTA RIVER
WATER CONTROL MANUAL
**DISCHARGE-FREQUENCY
MINNESOTA RIVER
AT MONTEVIDEO, MN**
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA