

2021 PRIOR LAKE OUTLET SYSTEM ANNUAL OPERATIONS REPORT



PRIOR LAKE-SPRING LAKE
WATERSHED DISTRICT

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INTRODUCTION

The Prior Lake Outlet Structure and Outlet Channel were constructed in 1983 under DNR permit 79-6016 to address high lake level issues on Prior Lake, which does not have a natural outlet. The Prior Lake Outlet Channel (PLOC) is utilized by the Prior Lake-Spring Lake Watershed District (District or PLSLWD) in managing lake levels on Prior Lake, as well as a trunk stormwater system for the Cities of Prior Lake and Shakopee, and the Shakopee Mdewakanton Sioux Community. The 7-mile long PLOC has been divided into eight management segments. Segment 1 is on the southern end beginning at the Prior Lake Outlet Structure, while Segment 8 is on the northern end and flows into the Minnesota River in Shakopee.

To address current needs and plan for future development in the watershed, the District finalized a Memorandum of Agreement (MOA) in 2007 with the Cities of Prior Lake and Shakopee, and the Shakopee Mdewakanton Sioux Community for the operation, maintenance, and use of the Prior Lake Outlet Channel. The MOA is updated regularly and was last updated in 2019. This group of cooperators oversees the overall operation of the PLOC, while the District administers the day-to-day operations. In the early 2000's, the cooperators determined that the channel and outlet had worked well since their inception, but they could operate more efficiently if modified in several places, reducing long term maintenance and enhancing the environment. Acknowledging that the PLOC is used as a stormwater conveyance system and is not solely a natural conveyance, the cooperators' focus is to manage the easements of the channel and the channel itself to maintain hydrologic capacity, reduce maintenance needs, provide long-term stability, and improve water quality. Secondary benefits include increased aesthetics, improved habitat and consistency with city and county plans for parks and greenways.

OUTLET STRUCTURE

HISTORY

The Prior Lake Outlet Structure was originally constructed in 1982 and has been operated since 1983. The original design of the structure required manual operation to open and close gates to regulate the flow. This design posed safety concerns for staff operating the structure during high water levels. Additionally, inefficiencies in the structure's design meant that the 36-inch outlet pipe connected to the structure did not reach its maximum flow of 65 cfs until lake levels had well surpassed the outlet elevation. Over the years, the structure had also developed wear and required minor maintenance.

Given these conditions, a replacement structure was pursued by the District and installed in 2010 (Figure 1). The new design has increased the efficiency of discharging water by allowing the outlet pipe to reach capacity sooner. It also provides safer conditions for staff during inspections and maintenance and is self-operating which reduces overall operations and maintenance costs. A schematic of the outlet structure is provided in Attachment A.



FIGURE 1 OUTLET STRUCTURE

MAINTENANCE AND OPERATION

Operation of the Prior Lake Outlet Structure is governed by the DNR-approved Prior Lake Outlet Control Structure Management Policy and Operating Procedures (Operating Procedures) dated October 2004 and approved February 2005. This plan specifies a review procedure that is to be repeated every 3 years and last occurred in 2017. Changes primarily addressed guidance for opening the low-flow gate and removed old language that referred to the old outlet structure.

Additionally, an Operation, Inspection and Maintenance Manual was drafted and adopted in September 2011 for the Prior Lake Outlet Structure. The purpose of this secondary manual is to establish guidelines and practices to provide existing and future District staff with the knowledge of how to properly operate, inspect and maintain the structural and operational components of the outlet to maximize the life and effectiveness of the structure. The manual includes a table of recommended inspection items along with the recommend frequency of inspection. These recommendations will be reviewed periodically by District staff to determine if the frequency is appropriate based on findings in the field and the manual will be updated accordingly.

The new structure requires minimal maintenance to operate. Once Prior Lake reaches 902.5', water starts spilling over the accordion shaped weir located inside the trash rack. Maintenance includes visual inspections, greasing gates, and removing debris from the trash rack. Removing vegetation and other debris from the trash rack is the most time-consuming and labor-intensive task (Figure 2). When the structure is operating (Prior Lake is greater than 902.45'), the structure will be inspected no less than once a week, and as much as twice per day, depending on the lake level and amount of vegetation getting caught on the trash rack. Inspections and debris removal are typically conducted by PLSLWD staff. During times when water is high and large amounts of vegetation are getting caught on the track rack, the City of Prior Lake staff have helped remove vegetation to ensure the Outlet Structure was not blocked.



FIGURE 2 REMOVING VEGETATION FROM OUTLET STRUCTURE

Excluding 2009, the Prior Lake Outlet Structure had flow, at least partially, every year since 1999. The year 2019 had the greatest volume of water flowing through the system since the structure's establishment in 1983. This was partially due to the more efficient design of the new Outlet Structure; however, the primary factor was the duration of continuous discharge which was significantly greater than in previous years.

During 2021 operations, the Prior Lake Outlet Structure performed well throughout the 52 days that water discharged from the lake (see Attachment B), April 7 through May 13, and from May 21 through June 4.

At certain lake levels, the low-flow gate allows more water through the outlet structure, resulting in the lake level lowering more quickly and creating more storage (see Attachment C). The low-flow was not operated in 2021 due to low water levels and shortage of precipitation. The stage-discharge relationship curve is used to calculate flows and water quantities leaving Prior Lake. (see Figure 3).

In its 52 days of discharge during 2020, an estimated 0.37 feet of vertical volume was eliminated through the Prior Lake Outlet Structure (see Attachment D). Prior Lake *theoretically* could have reached 902.99' without operating the outlet structure. Attachment D is provided for comparison between years on the overall usage of the Prior Lake Outlet Structure.

The numbers shown are calculated based on the most accurate information available. They are not exact and are intended for yearly comparisons only. Attachments E and F show daily Prior Lake elevations. Attachment F also includes Pike Lake daily average water levels which are highly correlated to Prior Lake water levels.



FIGURE 3 – OPENING THE LOW-FLOW GATE

OUTLET PIPE

The Outlet Pipe leads from the Outlet Structure to the beginning, or “daylight,” of the outlet channel (Figure 4). It is buried underground for approximately 2075 feet, with 5 manholes and 7 access points (Figure 5).

MAINTENANCE

The entire length of the pipe is televised every two years to look for potential damage, areas in need of repair, blockages and accumulated debris, and to assess whether the pipe is reaching full hydraulic capacity.

Chemical grouting was completed in 2018. 120 leaks were sealed, but it was originally estimated to only have 50. As the original leaks were sealed, it forced other leaks to start due to more pressure. Visu-sewer documented all the seals with video.



FIGURE 4 THE “DAYLIGHT”: BEGINNING OF THE OUTLET CHANNEL

In 2020, American Environmental televised the pipe revealing the lake outlet pipe is in good to fair condition, but multiple cracks and fractures were found in some segments. Several options will be weighed to decide the best course of action. Some of these options include sealing the joints that fail pressure tests, lining the pipe, a combination of those two, or pipe bursting. The outlet pipe will be televised and assed in 2022.



FIGURE 5 MAP OF OUTLET PIPE

OUTLET CHANNEL

The MOA cooperators' goals of the outlet channel include maintain hydrologic capacity, reduce maintenance needs, provide long-term stability, improve water quality, increase aesthetics, provide improved habitat and provide consistency with city and county plans for parks and greenways. Several of these goals have been met, but the channel will always require maintenance.

MAINTENANCE

While the Outlet Structure is in full operation and discharging water, the District is required to perform regular inspections (at least once per week) of the Outlet Structure and the Outlet Channel in accordance with the Operating Procedures. Inspections look for debris or any other issues along the channel or at the structure. Debris, downed trees, and other material are removed when they pose a risk, such as flooding or erosion. When debris is too difficult for PLSLWD staff to remove, the party in charge of that culvert, or land, will be contacted to address the issue.

A detailed report of this year's outlet channel inspections can be found in Attachment B. Below is a summary of maintenance projects that have been completed each year:

- 2006
 - Work completed on Segment 1 in 2006 consisted of bank stabilizations, increased native plantings and a creation of a spillway between Upper and Lower Jeffers Ponds.
- 2007
 - A basin was excavated and sinuosity was added to the channel in Segment 5c prior to entering Dean Lake during the early portion of 2007.
- 2009
 - Replacement of an undersized culvert on the northern end of Segment 8.
- 2010
 - Finalization of work in several segments including reshaping banks
 - Toe stabilization and weir reinforcements in Segment 7a.
 - Toe stabilization, bank protections and flow realignment in Segment 3.
 - Built up the channel bed and reconnected it to the floodplain in Segment 2.
- 2012
 - Site checks were made throughout 2012 to ensure stability against erosion and vegetation establishment within the areas of previous work in Segments 2, 3, and 7a.
- 2013
 - Three failing culverts were replaced between Segments 3 and 4B (Pike Lake Road, Jackson Trail, and Gonyea field crossing).
 - Vegetation along the channel was managed for herbaceous invasives by EOR and woody invasives by Applied Ecological Services. Garlic mustard was hand cut in Segments 3-8. Small populations of common burdock were cut in Segments 4A, 4B, and 8. Black locust, common buckthorn, and Tatarian honeysuckle suckers and seedlings were treated in segments 1, 3, 4A, 5C, 6, and 7A.
- 2014 – Prior Lake flooding occurred
 - Garlic mustard was hand cut with a weed cutter in segments 3-7 by EOR.
 - Wild Parsnip was hand cut with a weed cutter in segment 1 by EOR (only location wild parsnip was found).

- A foliar spray was applied for woody invasives (black locust, common buckthorn, and honeysuckle) in segments 1, 3, 4a, 5c, 6, and 7a by AES.
- 2015
 - Garlic mustard was hand cut by EOR on May 15 in segments 3 through 8.
 - EOR released flea beetles on June 26 in Segment 7 to treat the leafy spurge in that segment.
 - Downed trees were removed from the channel by WHR.
 - Segment 4A was realigned by Sunram to protect field road from eroding (EOR design). Trees replaced by Scott Soil and Water Conservation District (SWCD).
 - The Shakopee Mdewakanton Sioux Community replaced the KiciYapi culvert in Segment 3 (Bolton and Menk design).
 - USFWS removed the field road crossing near the parking lot north of Highway 101. This crossing had experienced damage many times and was restored the area to a native flood plain instead of replacing the crossing again.
- 2016
 - EOR hand-cut garlic mustard in Segments 3-7.
 - A site visit with EOR and Minnesota Department of Agriculture determined beetle establishment in Segment 7 was successful, but too low to capture and redistribute beetles to more sites. Another assessment will be completed in 2017.
 - In Segment 1, AES spot-treated wild parsnip, locust and thistle and removed locust and silver poplar.
 - AES treated a large patch of garlic mustard on the north and south side of County Road 16 (Segments 4 and 5).
 - A large purple loosestrife plant was removed from Segment 4A by AES.
 - All manhole benches in the outlet pipe were reconstructed (smoothed) by IBA Manhole.
 - Kes Field Crossing culvert (Figure 6), Gonyea culvert, and Pike Lake Park stream crossing repaired by Nadeau Companies.
 - The remaining downed trees and woody debris were removed by WHR.
- 2017
 - Segment 1 – Locust foliar, parsnip rosette, and thistle spot treatment
 - Segment 2 – Buckthorn foliar treatment, larger than ½" diameter cut/treated
 - Segment 4a – Buckthorn scouting/treating (foliar treat small individuals, cut/treated larger as needed); pulled loosestrife
 - Segment 4b - Buckthorn scouting/treating (foliar treat small individuals, cut/treated larger as needed); spot treat thistle northern half – especially pasture
 - CR 16 – Garlic mustard treatment; pulled loosestrife
- 2018
 - Outlet Pipe – Chemical grouting to seal 120 leaks
 - Segment 1 – Wild parsnip treatment
 - Segment 3 – Scouted for garlic mustard, but no plants were found.
 - Segment 4 – Five purple loosestrife and 11 wild parsnip plants were treated.



FIGURE 6 KES FIELD CROSSING REPAIR IN 2016

- Segment 5 – Six purple loosestrife plants treated.
- Segment 7 – Released purple loosestrife and leafy spurge beetles and weevils.
- Ice dam on Gonyea culvert steam jetted by City of Shakopee staff due to flooding.
- 2019
 - Removed beaver dam near the inlet to Pike Lake.
 - Inspections were conducted for Quarry Lake pumping/drawdown into Outlet Channel.
 - Bank Erosion work
 - Jedlicki construction completed the FEMA bank erosion project from 2014 flood in Segments 1, 2, 3, 4, and 7 – more detail in section below
 - Additional bank erosion repair, that was *not* funded by FEMA, was completed while doing FEMA repairs in Segments 3 and 4.
 - Emergency bank stabilization in KiciYapi camp completed by SMSC.
 - Maintained opening and closing of Outlet Structure gates for bank erosion project.
 - Culvert Maintenance
 - Cleared ice jams at culverts along the channel during snowmelt.
 - Emergency culvert repair at KiciYapi culvert completed by SMSC.
 - Beaver buster grate installed at Jeffers Pass culvert.
 - Repaired crushed culvert at Kes Driveway which was likely damaged during the bank erosion repair project.
 - Vegetation Maintenance
 - **Segment 1** - Three wild parsnip populations and garlic mustard were treated by AES. The City of Prior Lake staff mowed the dense patch of wild parsnip. Foliar treatments for herbaceous and woody invasive plants were conducted by AES.
 - **Segment 2** - Foliar treatments for woody invasive species were conducted by AES.
 - **Segment 3** - EOR scouted for garlic mustard in the Kici Yapi area previously managed by hand-pulling efforts, but no plants were found. Foliar treatments for woody invasive species were conducted by AES staff.
 - **Segment 4** - Foliar treatments for herbaceous and woody invasive plants were conducted by AES staff. Two large patches of garlic mustard and eight wild parsnip plants were treated by AES.
 - **Segment 5** - Foliar treatments for herbaceous invasive plants were conducted by AES. One purple loosestrife plant was found and subsequently hand removed by EOR staff.
 - **Segment 6** - Foliar treatments for herbaceous invasive plants were conducted by AES.
 - **Segment 7** - Foliar treatments for herbaceous and woody invasive plants were conducted by AES. Over 1,000 leafy spurge flea beetles were collected by EOR and PLSLWD staff from a known population west of Deans Lake and were released in four separate locations where dense patches of leafy spurge were found.
- 2020
 - Culvert replaced under driveway at outlet of Pike Lake
 - Map vegetation density in Upper Jeffers Pond
 - Installed carp tracking PIT tag reading stations at the inlet and outlet of Pike Lake
 - Final repairs were made to the FEMA bank erosion projects
 - Outlet pipe televised
 - Security cameras installed at outlet structure
 - Vegetation Maintenance

- **Segment 1 -**
 - Three wild parsnip populations were treated by AES staff in June & July, including the area just north of Jeffers Pass NW, the area east of Chickadee Landing on Jeffers Pond Elementary property, and at the east and west sides of the channel just north of Fountain Hills Road. In addition, the wild parsnip population located southwest of the intersection of Jeffers Pass NW and Eagle Creek Avenue was treated in June/July
 - Black locust sapling treatment in October
 - Two Siberian elm trees were cut down near Chickadee Landing and were placed within Jeffers Pond for turtle loafing logs
 - Japanese hedge parsley was hand-removed by AES in late September/early October
- **Segment 2 –**
 - Garlic mustard in Pike Lake Park was treated by AES staff in late May/early June
 - Foliar treatments for woody invasive species were conducted by AES staff in October
- **Segment 3 –**
 - EOR scouted for garlic mustard in the Kici Yapi area previously managed by hand-pulling efforts. Two garlic mustard plants were found in May 2020 and were hand-pulled
 - No other herbaceous management was conducted in 2020
 - Foliar treatments for woody invasive species were conducted by AES staff in October
- **Segment 4 –**
 - Foliar treatments for herbaceous invasive species were conducted by AES staff in late May/early June for garlic mustard and June/July for wild parsnip. One purple loosestrife plant and one Japanese hedge parsley plant was hand-clipped in late August/early September
 - Foliar treatments for woody invasive species were conducted by AES staff in October
- **Segment 5 -**
 - Foliar treatments for garlic mustard were conducted by AES staff in late May/ early June
 - Purple loosestrife plants in Segment 5C were treated by AES in July
 - The phragmites patch in Segment 5C was treated by AES staff in late September/early October
- **Segment 6 –**
 - Foliar treatments for herbaceous invasive species were conducted by AES staff in June/July
- **Segment 7 –**
 - Foliar treatments for garlic mustard were conducted by AES staff in late May/early June and purple loosestrife in July. Additional purple loosestrife plants were hand-clipped in late September
 - Foliar treatments for woody invasive species were conducted by AES staff in October
 - Hand-pulling of invasive species from the rare plant community in Segment 7A was completed by EOR & AES staff in July/August
 - Several hundred leafy spurge flea beetles were collected by EOR staff from a known population west of Deans Lake and were released in two separate locations where dense patches of leafy spurge were found. The beetle collection and release were conducted on July 2

- **2021**

- Driveway and culvert removed in connection with Permit 20.02 Strauss Driveway (Figure 7)
- Kes field road culvert removed in connection with the Pike Lake Landing Development
- Installed carp tracking PIT tag reading stations at the Daylight pond and at the inlet of Pike Lake
- Conducted trap netting fish surveys in Upper and Lower Jeffers Ponds.
- Security cameras maintained at outlet structure
- Vegetation maintenance

Segment 1 -

- May 21: Natural Shore Technologies cut garlic mustard along the walking path south of Fountain Hills Road
- June 22 & August 20: Three wild parsnip populations were managed by EOR and PLSLWD staff, including the area just north of Jeffers Pass NW, the area east of Chickadee Landing on Jeffers Pond Elementary School property, the east and west sides of the channel just north of Fountain Hills Road, and the city-owned parcel at the southwest quadrant of Jeffers Pass NW and Eagle Creek Avenue. All plants were dug up with a shovel, bagged, and removed from the site
- Late July/early August: Herbaceous invasive treatments by RES
- Mid-September: Woody invasive foliar treatments by RES

▪ **Segment 2 –**

- May 21: Natural Shore Technologies attempted to cut garlic mustard in this segment but could not access the park due to construction. EOR staff hand-pulled several dozen plants on May 15 downstream of the last culvert crossing at Pike Lake Park
- Late July/early August: Herbaceous invasive treatments by RES
- Mid-September: Buckthorn foliar treatments by RES

▪ **Segment 3 –**

- May 15: During the channel inspection, EOR scouted for garlic mustard in the Kici Yapi area previously managed by hand-pulling efforts. Several garlic mustard plants were found and hand-pulled
- Late July/early August: Herbaceous invasive treatments by RES
- Mid-September: Woody invasive foliar treatments by RES

▪ **Segment 4 –**

- May 21: Natural Shore Technologies cut garlic mustard at known locations between Pike Lake Trail and County Road 16
- June 22 & August 20: EOR staff dug up wild parsnip from the known location downstream of Pike Lake Trail. The plants were bagged and removed from the site
- Late July/early August: Herbaceous invasive treatments by RES
- Mid-September: Buckthorn foliar treatments by RES

▪ **Segment 5 -**

- May 21: Natural Shore Technologies cut garlic mustard at Segment 5A
- Late July/early August: Herbaceous invasive treatments by RES including the purple loosestrife near the sediment pond in Segment 5C



FIGURE 7 STRAUSS DRIVEWAY AND CULVERT REMOVAL IN 2021

- August 13: EOR staff hand-pulled purple loosestrife plants along the flow channel in Segment 5A and the adjacent eastern stormwater pond where new plants were discovered in 2021
- **Segment 6 –**
 - Late July/early August: Herbaceous invasive treatments by RES
- **Segment 7 –**
 - May 21: Natural Shore Technologies cut garlic mustard at Segment 7A & 7B
 - Late July/early August: Herbaceous invasive treatments by RES including purple loosestrife along the channel at previous known locations
 - July 1: Several hundred leafy spurge flea beetles were collected by EOR staff from a population discovered west of the intersection of Valley Park Drive and Innovation Blvd (Figure 54). The beetles were released at two separate locations where dense patches of leafy spurge were found
 - August 13: EOR staff hand-pulled purple loosestrife plants immediately downstream of Highway 169 where new plants were discovered in 2021. These plants are likely the result of seed dispersal from the stormwater pond located immediately west of the PLOC. The stormwater pond discharges directly to the PLOC immediately downstream of Highway 169
 - Mid-September: Buckthorn foliar treatments by RES

MONITORING

Monitoring along the outlet channel in 2021 consisted of water quantity (flow), water quality (chemistry), vegetation surveys, and erosion monitoring (Figure 8). Some of this monitoring is funded by the MOA cooperators, and some is done for other programs or entities.

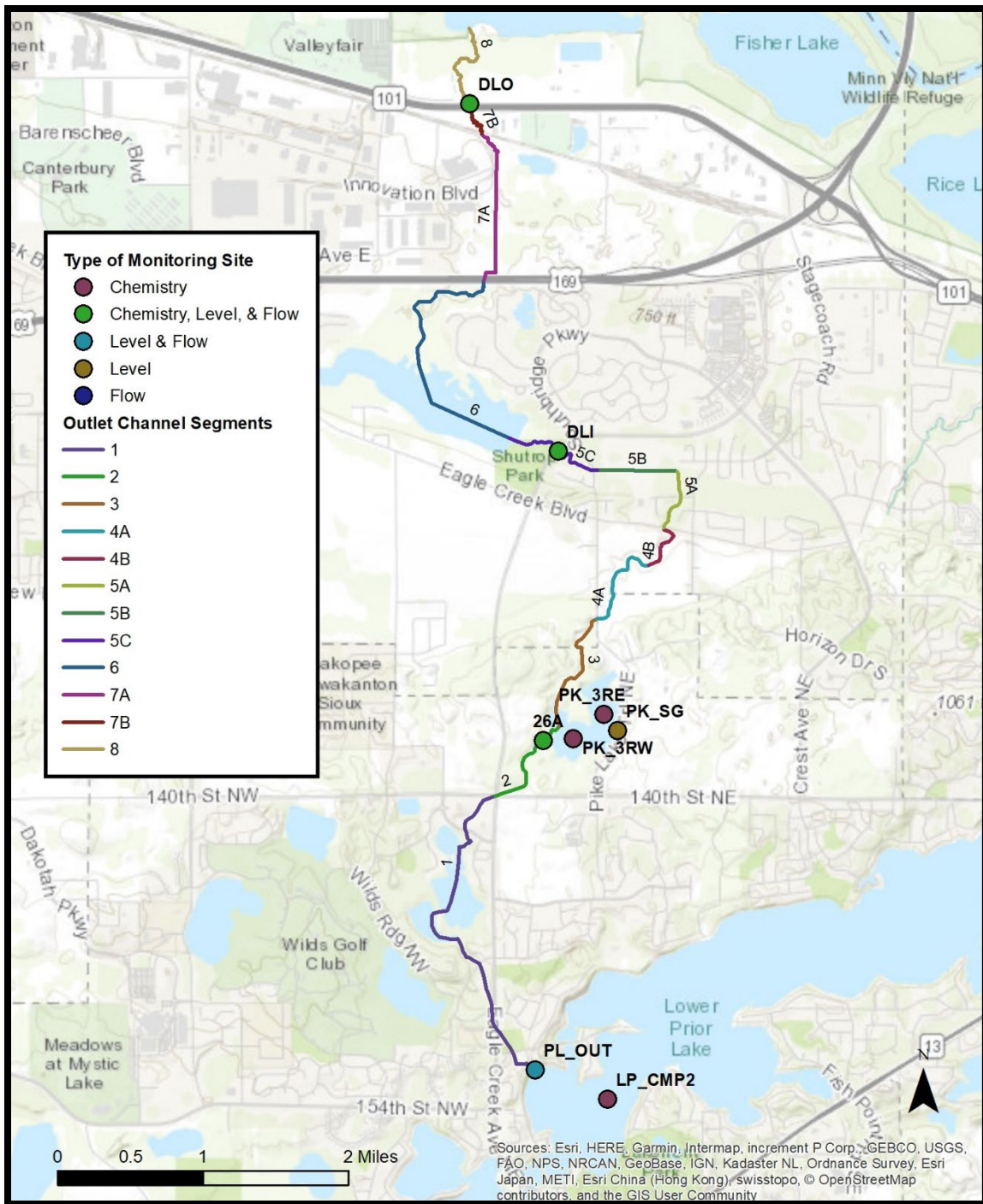


FIGURE 8 – PLOC MONITORING LOCATIONS

MONITORING SITES

From the beginning of the channel to the end, water quality, water level, and flow are collected by a collaboration of several organizations (Table 1).

LP_CMP2: Water quality samples at this site are taken every two weeks by a Citizen-Assisted Monitoring Program volunteer. This water quality data represents the water quality at the very beginning of the channel. Samples are taken every 2 weeks for chlorophyll-A, total Kjeldahl nitrogen, total phosphorus, Secchi depth and some physical observations.

PL_OUT: This site is located at the Prior Lake Outlet Structure. An automated level logger is connected to the structure and records water levels every 15 minutes. The data is then sent remotely to the PLSLWD website every hour to update the hydrograph and discharge graph. Flow measurements are taken at the end of the outlet pipe, so by comparing flows to lake levels, we can calculate a relationship of lake level and flow. See Attachment F for the annual hydrograph and discharge graph.

26A, DLI, and DLO: These three sites are spaced evenly along the outlet channel. Scott SWCD collected biweekly water quality samples at 26A, DLI, and DLO. Samples include temperature, dissolved oxygen, pH, conductivity, turbidity, Secchi tube, total phosphorus, orthophosphorus, nitrite + nitrate, total Kjeldahl nitrogen, total suspended solids, total volatile suspended solids, and chloride data (Table 2).

PK_3RW and PK_3RE: Three Rivers Park District monitored lake water quality at two sites on Pike Lake, PK_3RW (west bay of Pike Lake) and PK_3RE (east bay of Pike Lake). Samples are collected bimonthly and analyzed at Three Rivers Park District's laboratory. Parameters that are sampled include temperature, dissolved oxygen, pH, conductivity, Secchi, Chlorophyll-a, total phosphorus, soluble reactive phosphorus, total nitrogen, and chlorides. Results for these sites can be found on the PLSLWD website.

PK_SG: This site is located on the very east side of Pike Lake. An automated level logger was connected to a DNR-surveyed staff gauge. The level logger records water levels every 15 minutes and then sends the data remotely to the PLSLWD website every hour to update the hydrograph. Flow measurements are not taken at this site. See Attachment F for the annual hydrograph.

TABLE 1 DESCRIPTION OF MONITORING SITES

Site	Waterbody Type	Location	Monitored By	Type of Monitoring
LP_CMP2	Lake	SW end of Lower Prior Lake in deep spot	Citizen Assisted Monitoring Program (CAMP) Volunteer	Lake Water Quality
PL_OUT	Lake	Prior Lake Outlet Structure	PLSLWD Staff	Lake level and flow
26A	Stream	Prior Lake Outlet Channel in Pike Lake Park	PLSLWD and SWCD Staff	Stream chemistry, water level, and flow
PK_3RW	Lake	West bay of Pike Lake	Three Rivers Park District	Lake Water Quality
PK_3RE	Lake	East bay of Pike Lake	Three Rivers Park District	Lake Water Quality
PK_SG	Lake	Pike Lake Staff Gauge on east side of lake	PLSLWD	Lake Level
DLI	Stream	Prior Lake Outlet Channel at Hwy 21 before entering Dean Lake	Scott SWCD	Stream chemistry, water level, and flow
DLO	Stream	Prior Lake Outlet Channel at Hwy 101 near end of channel	PLSLWD and Scott SWCD	Stream chemistry, water level, and flow

MONITORING DATA

Water level is recorded every 15 minutes at four points along the channel. Flow is shown to increase as water travels downstream from the Outlet Structure to the end of the PLOC. This increase is due in part to runoff in the PLOC watershed, but also influences from groundwater seeps mostly starting downstream of County Road 16.

Water chemistry samples are taken every two weeks at each of the stream monitoring sites. The following table shows the averages in 2021. The water quality is quite good along the channel, but it is clearest and best at the end. In 2021, it was noticed that most of the chemistry data was higher than more recent years. It is possibly due to the lower volume of water, which can lead to higher concentrations in some parameters.

TABLE 2 – 2020 WATER QUALITY OF STREAM SITES (ANNUAL AVERAGE)

Site	CL mg/L	COND uS/cm	DO mg/L	PH units	Nitrates mg/L	Temp C	TP mg/L	Turbidity NTRU	TSS mg/L	T TUBE cm	VSS mg/L
26A	111	635	8.63	7.82	0.28	14.8	0.136	10	14.4	>78*	3.7
DLI	57	660	5.87	7.39	0.31	14.85	0.064	7	8	>85*	3
DLO	201	936	7.11	7.46	0.36	13.3	0.049	3	4.3	>98*	2.1

*average includes some readings that were >100. The >100 was changed to 100 for purposes of finding an average.

PRECIPITATION

Precipitation can highly affect water quality and water levels. Precipitation was not consistently recorded at the PLSLWD office due to staff not being in the office because of COVID. Instead, precipitation values were used from the Prior Lake Public Works weather station located near CR 13 and CR 21, with 20.63" of recorded rainfall. Precipitation in 2021 was 39% below the 1991-2020 average of 33.8" provided by the National Climatic Data Center. The precipitation data is summarized in Attachment G.

VEGETATION AND EROSION MONITORING

The Prior Lake Outlet Channel has been routinely inspected twice annually to document the channel condition, survey debris and log jams, and inspect culverts and road crossings for obstructions of flow. Starting in the fall of 2017, a vegetation assessment was conducted concurrently with the channel condition inspection to assess previously managed areas for invasive plant species and document any satellite populations of invasive species growing within the PLOC easements. Following the assessment, recommendations have been provided to address certain populations of invasive species growing along the channel.

EOR assessed the PLOC on foot from Segment 1 to Segment 7 on May 12 and October 8, with target invasive species surveys conducted on August 13 and September 1. Segment 8, which is under management by the United States Fish & Wildlife Service, was not assessed. Segment 5B was also not assessed due to construction of the Segment 5 Re-Meandering Project where significant site grading had occurred in 2021. For the spring and fall assessments, a series of photographs were taken in each segment to characterize the condition of the outlet channel, assess any new areas of bank erosion (Figure 9), and document any obstructions to flow such as fallen trees, debris piles, or culvert blockages.

These reports can be found on the PLSLWD website with a summary of recommendations for continued channel and vegetation management in 2021.



FIGURE 9 BOULDER TOE BANK STABILIZATION IN SEGMENT 7A

PERMITS

In 2020, the District had two open permits along the PLOC:

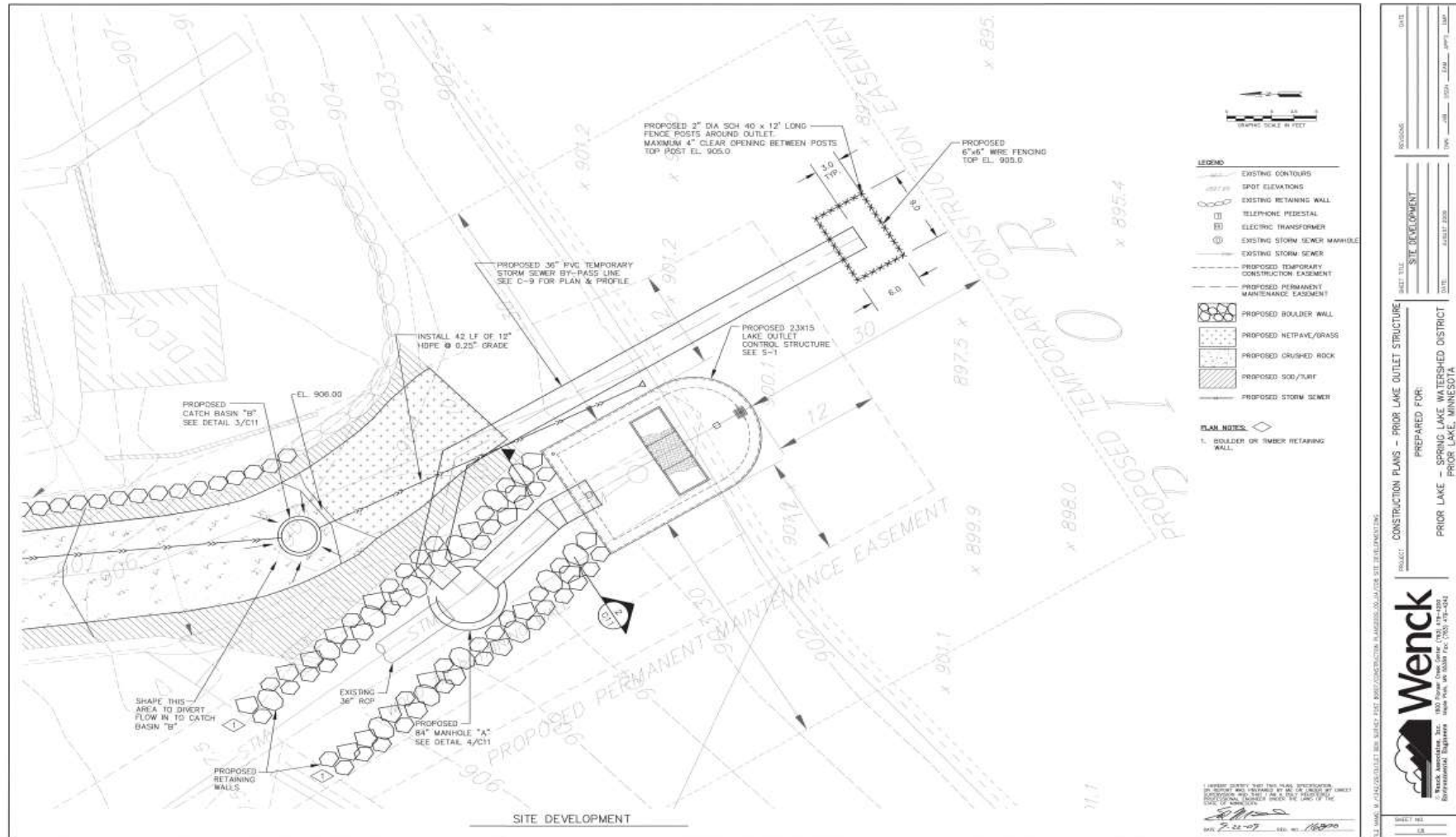
- Permit #20.02 *Pike Lake Culvert*: Culvert replaced; the District has completed final inspection is in the process of closing out the permit.
- Permit #20.04 *Strauss Driveway*: Culvert and driveway have been removed creating an open channel. The permit is still open awaiting final vegetation establishment.

EASEMENTS

The District holds drainage easements along most of the Outlet Channel. An easement allows the District to access and maintain the channel and the land within the easement area. For example, because of damage in the channel by the 2014 flood, bank repair was needed along much of the channel. During the preparatory review process for this work, it had come to light that some of the easements are inaccurate and need to be amended. This could be because the channel has shifted over time, or due to errors in the legal description when it was originally established. Although the existing easements may be erroneous, the District retains prescriptive rights along the channel.

No easements were amended in 2021. There are still many locations along the channel that need easements or alignment amendments, but the Cooperators have generally accepted that we won't pursue easement purchases or amendments until the landowner changes hands or development occurs. A spreadsheet exists in the PLSLWD files that describes each potential easement purchase or amendment.

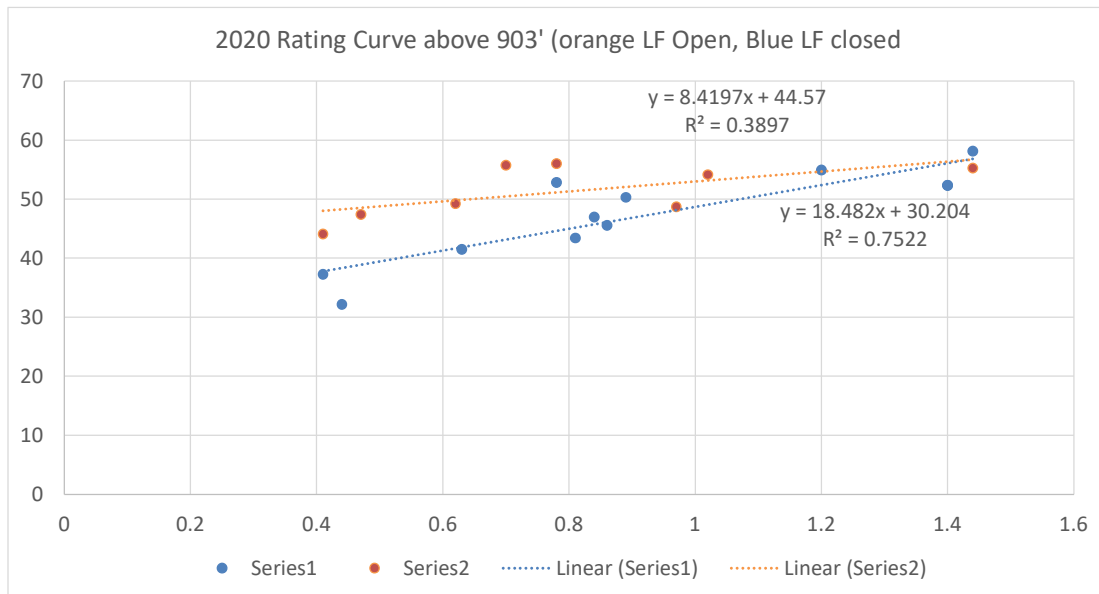
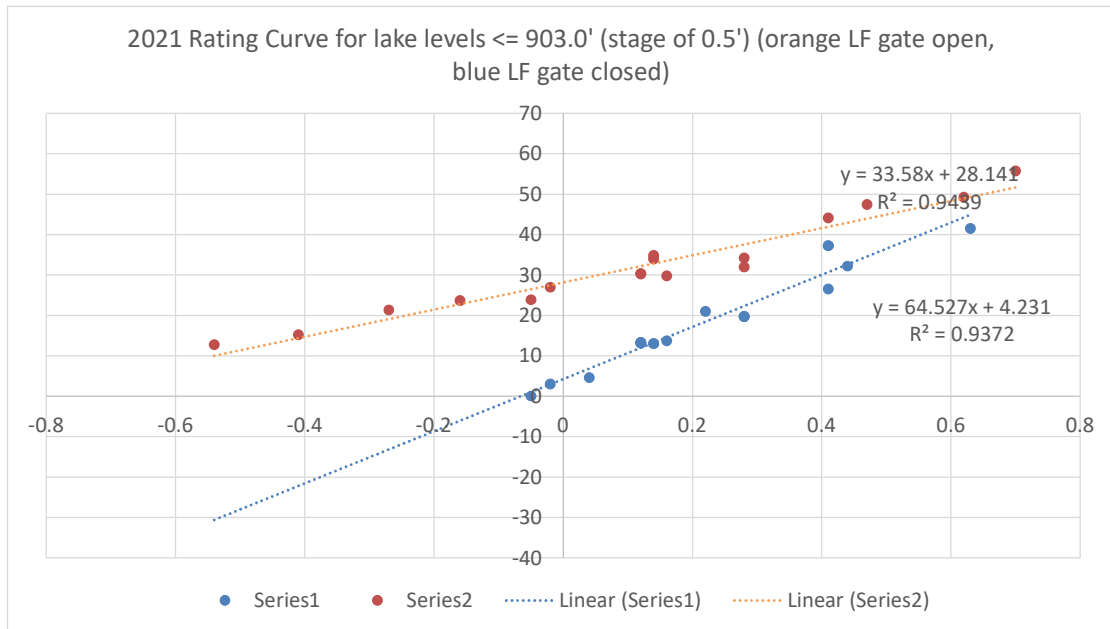
Attachment A. Prior Lake Outlet Structure Diagram



Attachment B. Annual Outlet Channel Operations Summary

Date	Elevation	Outlet Activity	Inspections/Channel Activity
3/2/2021	901.56	Inspection	Pre-melt Channel inspection. Fish winterkills in Jeffers Ponds and Pike Lake.
3/18/2021	901.60	Inspection	Post-melt Channel inspection. Strauss driveway removed. Erosion control blanket installed. Installed carp tracking stations in daylight pond and channel above Pike Lake.
3/23/2021		Inspection	Channel inspection. Pike Lake 4.2'.
4/7/2021	902.48	Inspection	Channel inspection
4/26/2021		Inspection	Channel Inspection. Ridge Creek remander under contruction. Pike Lake Development constuction.
5/14/2021		Inspection	Segment 1 and 2 Inspection
5/19/2021	902.40	Inspection	Channel inspection
6/7/2021		Inspection	Vegetation Maintenance at Outlet Structure. Intermittant flow.
6/21/2021	902.18	Inspection	Channel inspection. No flow conditions.
7/16/2021	901.65	Inspection	Channel inspection Segments 1-4a. No flow.
7/21/2021		Inspection	Channel inspection Segments 4b-8. No flow.
9/4/2021		Tour	PLOC Tour hosted by PLSLWD
9/23/2021	900.70	Inspection	Channel inspection. No flow.
10/12/2021	900.66	Inspection	Channel inspection No flow.
11/2/2021		Inspection	Channel inspection No flow.

Attachment C. Stage-Discharge Relationship



Attachment D. Volumes Discharged from Prior Lake

Volumes Discharged from the Prior Lake Outlet and Associated Elevations								
Year	Volume Discharged (ac*ft)	Depth Eliminated from Lake (ft)	Min Elevation for the Year	Date of Min Elevation	Max Elevation for the Year	Date of Max Elevation	Max Elevation <i>without</i> Outlet	Annual Rainfall
2021	700	0.37	900.58	10/1/2021	902.62	4/28/2021	902.99	20.63
2020	8841	4.53	900.57	12/2/2020	902.59	5/27/2020	907.12	32.63
2019	21468	10.40	902.02	12/19/2019	903.93	3/30/2019	914.33	39.95
2018	11785	5.98	902.00	9/16/2018	903.32	6/26/2018	909.30	34.52
2017	11942	6.00	902.35	8/13/2017	903.56	5/29/2017	909.56	32.4
2016	9351	4.80	900.57	8/9/2016	902.59	12/1/2016	907.39	36.74
2015	3043	1.60	901.09	3/20/2015	902.91	12/21/2015	904.51	35.74
2014	12028	6.10	900.1	3/28/2014	906.16	6/30/2014	912.26	36.44
2013	7609	3.93	900.25	3/28/2013	903.95	7/22/2013	907.88	33.25
2012	5751	3.00	900.48	12/6/2012	903.59	6/25/2012	906.59	30.57
2011	20314	9.93	900.87	12/28/2011	903.95	4/5/2011	913.88	26.07
2010	1110	0.59	899.38	1/14/2010	902.78	12/23/2010	903.37	37.23
2009	0	0.00	898.98	9/30/2009	900.44	4/29/2009	900.44	27.41
2008	4993	2.61	900.28	12/29/2008	902.90	5/8/2008	905.51	23.88
2007	1395	0.74	900.55	8/10/2007	902.78	4/23/2007	903.52	28.59
2006	4331	2.27	900.50	12/14/2006	903.27	4/7/2006	905.54	27.77
2005	2299	1.21	900.71	1/18/2005	903.10	10/18/2005	904.31	38.02
2004	13	0.01	900.50	4/15/2004	902.79	7/12/2004	902.80	32.96
2003	5921	3.08	900.62	12/30/2003	903.17	5/23/2003	906.25	23.00
2002	9520	4.88	900.70	3/4/2002	903.60	9/10/2002	908.48	41.96
2001	8692	4.47	901.04	12/28/2001	904.28	5/7/2001	908.75	28.52
2000	80	0.04	901.52	2/20/2000	903.00	7/11/2000	903.04	26.09
1999	6240	3.24	902.00	11/25/1999	904.78	5/27/1999	908.02	33.29
1998			902.05	1/1/1998	903.90	4/13/1998		35.00
1997	4150	2.18	901.20	2/28/1997	902.90	4/21/1997	905.08	32.36
1996			900.77	11/4/1996	902.98	4/10/1996		26.52
1995			902.26	9/26/1995	903.25	3/30/1995		30.62
1994	1760	0.93	901.90	9/7/1994	903.05	10/24/1994	903.98	35.28
1993	10000	5.12	902.00	3/9/1993	904.49	7/14/1993	909.61	36.40
1992	8331	4.29	899.95	2/19/1992	903.16	10/12/1992	907.45	35.86
1991			898.11	4/1/1991	900.92	6/13/1991		
1990			895.46	4/24/1990	899.38	8/10/1990		
1989			895.49	11/27/1989	897.15	4/3/1989		
1988			896.90	11/11/1988	899.63	1/1/1988		
1987			899.63	12/31/1987	901.54	3/6/1987		
1986			901.22	2/14/1986	903.96	5/15/1986		
1985			902.23	9/12/1985	903.93	4/25/1985		
1984			901.75	10/9/1984	903.60	6/24/1984		
1983	Outlet Installed		901.76	1/17/1983	905.68	7/20/1983		
1982			900.06	3/24/1982	902.56	5/21/1982		
1981			898.91	7/31/1981	899.88	9/17/1981		
1980			899.92	12/29/1980	902.60	4/18/1980		
Average	6312 (when operated)	3.23 (when operated)	900.37		902.85		906.44	32.00
Unless otherwise noted, data is taken from annual Prior Lake Outlet operations reports								
<i>Italicized rainfall data is from MN Climatology office for 115N, 22W, 15 Prior Lake; all other rainfall as recorded at PLSLWD Office</i>								
<i>Italicized lake level data is from PLSLWD Historic Volunteer Collected Lake Level Data</i>								

Attachment E. 2021 Prior Lake Elevations and Precipitation

Elevation		Precipitation	
Average	901.69	Yearly Total	20.63
Minimum	900.57	Max 1 Day	1.94
Maximum	902.59		

Daily Average Lake Level is calculated from an automated logger located on the outside of the trash barrier on the Outlet Structure.

Staff Gage is located under Highway 21 Wagon Bridge on pillar. The automated logger is calibrated to the staff gauge readings.

Precipitation values are recorded from the Prior Lake public works weather station located near Eagle Creek Ave SE and Adelman St SE.

Date	Daily Average Lake Level	Staff Gage	Precipitation
1/1			0.02
1/2			0.02
1/3			0.07
1/4			0.01
1/5			0.00
1/6			0.00
1/7			0.00
1/8			0.00
1/9			0.00
1/10			0.00
1/11			0.00
1/12			0.00
1/13			0.00
1/14			0.19
1/15			0.27
1/16			0.01
1/17			0.00
1/18			0.00
1/19			0.00
1/20			0.02
1/21			0.00
1/22			0.00
1/23			0.00
1/24			0.09
1/25			0.00
1/26			0.00
1/27			0.00
1/28			0.00
1/29			0.00
1/30			0.00
1/31			0.01
2/1			0.00
2/2			0.00
2/3			0.00
2/4			0.00
2/5			0.00
2/6			0.00
2/7			0.00
2/8			0.00
2/9			0.00

Date	Daily Average Lake Level	Staff Gage	Precipitation
2/10			0.00
2/11			0.00
2/12			0.00
2/13			0.00
2/14			0.00
2/15			0.00
2/16			0.00
2/17			0.00
2/18			0.00
2/19			0.00
2/20			0.00
2/21			0.00
2/22			0.07
2/23			0.00
2/24			0.01
2/25			0.00
2/26			0.00
2/27			0.00
2/28			0.09
3/1			0.01
3/2			0.00
3/3			0.00
3/4			0.00
3/5			0.00
3/6			0.00
3/7			0.00
3/8			0.00
3/9			0.00
3/10			0.50
3/11			0.01
3/12			0.00
3/13			0.00
3/14			0.00
3/15			0.00
3/16			0.22
3/17			0.02
3/18			0.00
3/19			0.00
3/20			0.00
3/21			
3/22			0.00
3/23			0.54
3/24			0.85
3/25			0.00
3/26			0.00
3/27			0.18
3/28			0.00
3/29			0.00
3/30			0.00
3/31			0.00
4/1			0.00

Date	Daily Average Lake Level	Staff Gage	Precipitation
4/2			0.00
4/3			0.00
4/4			0.00
4/5			0.31
4/6	902.36		0.19
4/7	902.44	902.48	0.35
4/8	902.48		0.14
4/9	902.51		0.09
4/10	902.54		0.00
4/11	902.55		0.00
4/12	902.56		0.15
4/13	902.57		0.02
4/14	902.58		0.03
4/15	902.58		0.00
4/16	902.58		0.00
4/17	902.58		0.00
4/18	902.58		0.01
4/19	902.57		0.00
4/20	902.56		0.00
4/21	902.56		0.00
4/22	902.55		0.00
4/23	902.55		0.09
4/24	902.55		0.01
4/25	902.54		0.02
4/26	902.56		0.15
4/27	902.56		0.39
4/28	902.59		
4/29	902.58		0.00
4/30	902.57		0.00
5/1	902.56		0.00
5/2	902.55		0.00
5/3	902.54		0.00
5/4	902.52		0.00
5/5	902.51		
5/6	902.51		0.01
5/7	902.49		0.00
5/8	902.48		0.00
5/9	902.47		0.00
5/10	902.45		
5/11	902.44		
5/12	902.43		
5/13	902.42		
5/14	902.40		
5/15	902.40		
5/16	902.39		
5/17	902.38		
5/18	902.37		
5/19	902.37	902.40	0.29
5/20	902.40		0.08
5/21	902.44		0.54
5/22	902.45		0.00

Date	Daily Average Lake Level	Staff Gage	Precipitation
5/23	902.45		0.00
5/24	902.45		0.16
5/25	902.47		0.57
5/26	902.45		0.00
5/27	902.48		1.01
5/28	902.50		0.03
5/29	902.48		0.00
5/30	902.47		0.02
5/31	902.46		0.00
6/1	902.45		0.00
6/2	902.44		0.00
6/3	902.43		0.00
6/4	902.42		0.00
6/5	902.40		0.00
6/6	902.38		0.00
6/7	902.36		0.00
6/8	902.35		0.00
6/9	902.34		0.00
6/10	902.32		0.00
6/11	902.30		0.03
6/12	902.26		0.00
6/13	902.23		0.00
6/14	902.24		0.00
6/15	902.21		0.00
6/16	902.16		0.00
6/17	902.13		0.08
6/18	902.11	902.18	0.00
6/19	902.07		0.00
6/20	902.05		0.10
6/21	902.02		0.00
6/22	901.98		0.00
6/23	901.95		0.00
6/24	901.93		0.00
6/25	901.91		0.00
6/26	901.89		0.34
6/27	901.90		0.00
6/28	901.92		0.45
6/29	901.92		0.02
6/30	901.90		0.00
7/1	901.87		0.00
7/2	901.84		0.00
7/3	901.82		0.00
7/4	901.79		0.00
7/5	901.77		0.00
7/6	901.77		0.83
7/7	901.84		0.15
7/8	901.81		0.00
7/9	901.79		0.00
7/10	901.76		0.00
7/11	901.74		0.00
7/12	901.71		0.00

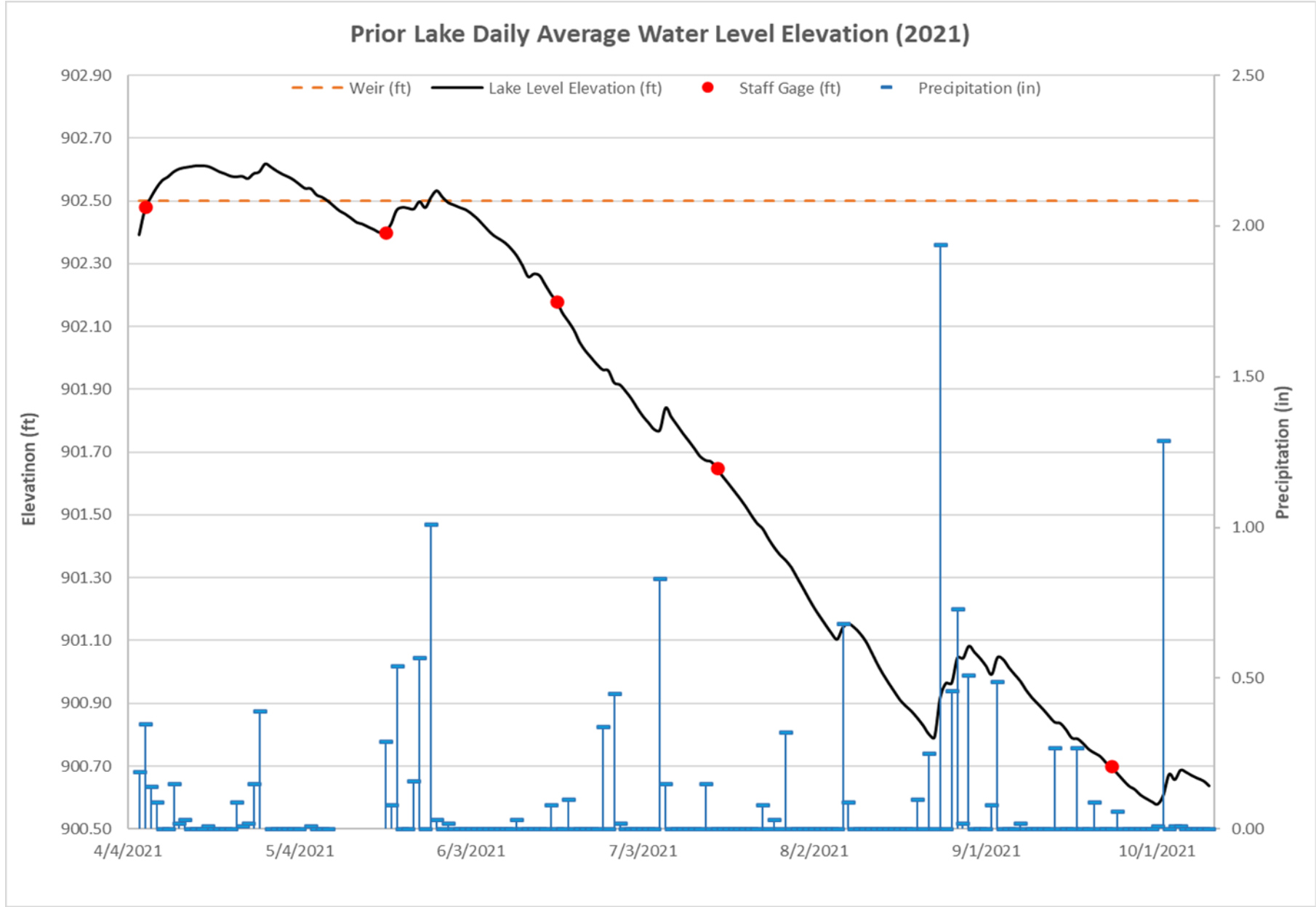
Date	Daily Average Lake Level	Staff Gage	Precipitation
7/13	901.69		0.00
7/14	901.67		0.15
7/15	901.67		0.00
7/16	901.65		0.00
7/17	901.62		0.00
7/18	901.60		0.00
7/19	901.58		0.00
7/20	901.55		0.00
7/21	901.53		0.00
7/22	901.50		0.00
7/23	901.47		0.00
7/24	901.46		0.08
7/25	901.42		0.00
7/26	901.40		0.03
7/27	901.37		0.00
7/28	901.36		0.32
7/29	901.33		0.00
7/30	901.30		0.00
7/31	901.27		0.00
8/1	901.24		0.00
8/2	901.20		0.00
8/3	901.18		0.00
8/4	901.15		0.00
8/5	901.12		0.00
8/6	901.10		0.00
8/7	901.14		0.68
8/8	901.15		0.09
8/9	901.14		0.00
8/10	901.12		0.00
8/11	901.10		0.00
8/12	901.06		0.00
8/13	901.03		0.00
8/14	900.99		0.00
8/15	900.96		0.00
8/16	900.94		0.00
8/17	900.91		0.00
8/18	900.89		0.00
8/19	900.87		0.00
8/20	900.85		0.10
8/21	900.83		0.00
8/22	900.80		0.25
8/23	900.79		0.00
8/24	900.92		1.94
8/25	900.96		0.00
8/26	900.97		0.46
8/27	901.04		0.73
8/28	901.04		0.02
8/29	901.08		0.51
8/30	901.06		0.00
8/31	901.04		0.00
9/1	901.02		0.00

Date	Daily Average Lake Level	Staff Gage	Precipitation
9/2	900.99		0.08
9/3	901.05		0.49
9/4	901.04		0.00
9/5	901.01		0.00
9/6	900.99		0.00
9/7	900.97		0.02
9/8	900.94		0.00
9/9	900.92		0.00
9/10	900.90		0.00
9/11	900.88		0.00
9/12	900.86		0.00
9/13	900.84		0.27
9/14	900.84		0.00
9/15	900.82		0.00
9/16	900.79		0.00
9/17	900.79		0.27
9/18	900.77		0.00
9/19	900.75		0.00
9/20	900.74		0.09
9/21	900.73		0.00
9/22	900.71		0.00
9/23	900.69	900.70	0.00
9/24	900.68		0.06
9/25	900.66		0.00
9/26	900.64		0.00
9/27	900.63		0.00
9/28	900.61		0.00
9/29	900.60		0.00
9/30	900.59		0.00
10/1	900.58		0.01
10/2	900.61		1.29
10/3	900.67		0.00
10/4	900.63		0.01
10/5	900.62		0.01
10/6	900.61		0.00
10/7	900.60		0.00
10/8	900.59		0.00
10/9	900.58		0.00
10/10	900.57		0.00
10/11			0.00
10/12			0.00
10/13			0.04
10/14			0.00
10/15			0.00
10/16			0.00
10/17			0.00
10/18			0.00
10/19			0.00
10/20			0.50
10/21			0.05
10/22			0.00

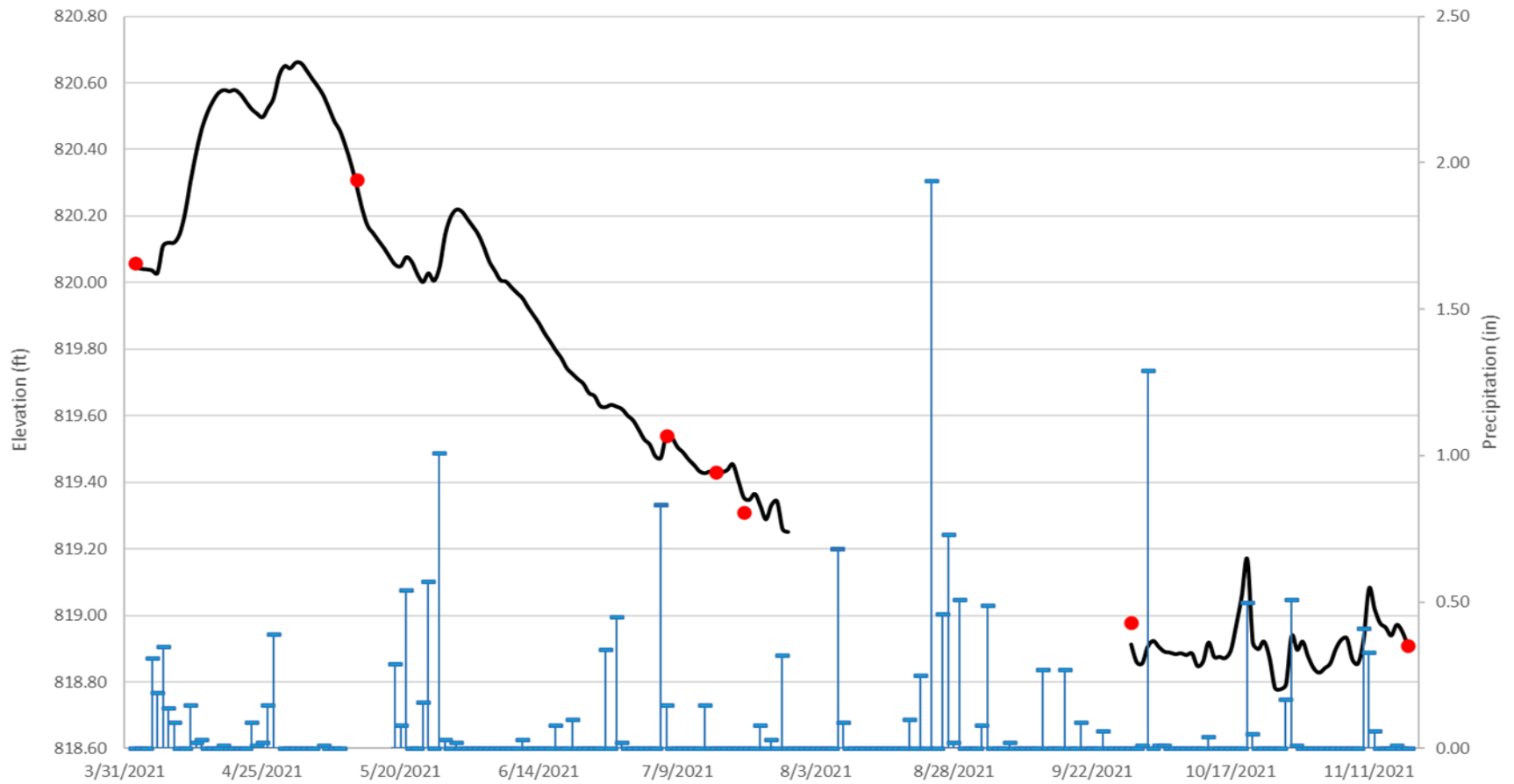
Date	Daily Average Lake Level	Staff Gage	Precipitation
10/23			0.00
10/24			0.00
10/25			0.00
10/26			0.00
10/27			0.17
10/28			0.51
10/29			0.01
10/30			0.00
10/31			0.00
11/1			0.00
11/2			0.00
11/3			0.00
11/4			0.00
11/5			0.00
11/6			0.00
11/7			0.00
11/8			0.00
11/9			0.00
11/10			0.41
11/11			0.33
11/12			0.06
11/13			0.00
11/14			0.00
11/15			0.00
11/16			0.01
11/17			0.00
11/18			0.00
11/19			0.00
11/20			0.00
11/21			0.00
11/22			0.00
11/23			0.00
11/24			0.00
11/25			0.00
11/26			0.00
11/27			0.00
11/28			0.00
11/29			0.00
11/30			0.01
12/1			0.17
12/2			0.00
12/3			0.01
12/4			0.00
12/5			0.01
12/6			0.00
12/7			0.00
12/8			0.00
12/9			0.02
12/10			0.00
12/11			0.03
12/12			0.04

Date	Daily Average Lake Level	Staff Gage	Precipitation
12/13			0.06
12/14			0.00
12/15			0.32
12/16			0.03
12/17			0.00
12/18			0.00
12/19			0.00
12/20			0.00
12/21			0.00
12/22			0.00
12/23			0.01
12/24			0.00
12/25			0.00
12/26			0.00
12/27			0.00
12/28			0.00
12/29			0.00
12/30			0.00

Attachment F.



Pike Lake Daily Average Water Level Elevation (2021)



Attachment G. Summary of Precipitation within PLSLWD

Month	2021* Rain Gauge Readings (inches)	PLSLWD 2021 YTD (in.)
Jan	0.71	0.71
Feb	0.17	0.88
Mar	2.33	3.21
Apr	1.95	5.16
May	2.71	7.87
Jun	1.02	8.89
Jul	1.56	10.45
Aug	4.78	15.23
Sep	1.28	16.51
Oct	2.60	19.11
Nov	0.82	19.93
Dec	0.70	20.63
Year Total	20.63	inches

*measurements recorded by:

Prior Lake Public Works - KMNPRIOR35

NOAA Prior Lake, MN 30yr mo avg**	NOAA Prior Lake, MN 30yr YTD avg
0.95	0.95
1.02	1.97
1.88	3.85
3.13	6.98
4.33	11.31
4.78	16.09
4.25	20.34
4.56	24.90
3.22	28.12
2.72	30.84
1.71	32.55
1.25	33.80
33.8	inches

** NOAA 30 Climate Normals in

Prior Lake, MN for the years 1991-2020

Monthly % Deviation***	Monthly Numeric Deviation	YTD % Deviation	YTD Numeric Deviation
-25.3%	-0.24	-25.3%	-0.24
-83.3%	-0.85	-55.3%	-1.09
23.9%	0.45	-16.6%	-0.64
-37.7%	-1.18	-26.1%	-1.82
-37.4%	-1.62	-30.4%	-3.44
-78.7%	-3.76	-44.7%	-7.20
-63.3%	-2.69	-48.6%	-9.89
4.8%	0.22	-38.8%	-9.67
-60.2%	-1.94	-41.3%	-11.61
-4.4%	-0.12	-38.0%	-11.73
-52.0%	-0.89	-38.8%	-12.62
-44.0%	-0.55	-39.0%	-13.17
		-39.0%	-13.17

***Deviation is calculated by the difference between the current year PLSLWD average and the 30 year NOAA Climate Normals