Item 5C.
BCWMC 10-21-21

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Memorandum

To: Bassett Creek Watershed Management Commission
From: Barr Engineering Co. (Barr)
Subject: Item 5C: Sweeney Lake Chloride Sources
BCWMC October 21, 2021 Meeting Agenda
Date: October 14, 2021

Recommendation:

1. Review data and consider additional GIS analysis and loading estimates of individual chloride sources in the Sweeney Lake watershed The estimated range of cost to complete the GIS analysis and loading rate estimate of chloride sources in the Sweeney Lake watershed is between $5,000 and $10,000.

1.0 Executive Summary

At the August 2021 BCWMC meeting, Commissioners learned of the high chloride levels in Sweeney Lake and asked that chloride sources and reduction measures be reviewed at a future meeting. We analyzed chloride data from Sweeney Lake, chloride and conductivity data from the Sweeney Lake Branch (the creek that flows into Schaper Pond from the south), and land use information for the watershed. Results confirm that the Sweeney Lake Branch portion Sweeney Lake's watershed represents a significant portion of the overall chloride loading to the lake due to the higher density of impervious surface throughout the watershed (Figure 1). Results also confirm that reductions in chloride loading from the Sweeney Lake Branch of the watershed will also quickly lead to commensurate reductions in the chloride concentrations measured in Sweeney Lake following future implementation of management actions.

2.0 Background and Preliminary Analysis of Chloride Loading

Chloride levels in Sweeney Lake have become progressively higher within the last ten years, exceeding the 230 mg/L State standard, including a 284 mg/L annual average chloride concentration in 2020. As a result, Administrator Jester asked Barr to help frame and plan for discussion on reducing chloride loading to Sweeney Lake by evaluating the Sweeney Lake Branch stream monitoring data and recommending next steps for identifying and controlling the main sources of chloride in the Sweeney Lake watershed. This memorandum includes a detailed analysis of the available 2020 monitoring data, including mass balance estimates of chloride for the Sweeney Lake Branch stream station and Sweeney Lake.

Figure 1 shows the tributary area draining to the Sweeney Lake Branch water quality monitoring station, including land use delineations, and estimated impervious surfaces The imperviousness and proportion of higher density land use development (more impervious than single family residential) within the tributary area shown in Figure 1 is higher than the overall drainage to Bassett Creek. It is expected that the higher

density land use development corresponds with a higher proportion of salt (and associated chloride) loading due to contributions from private applicators, in addition to the road salt applied to the surrounding road surfaces by public entities.

The available 2020 monitoring data was the preliminary focus of analyzing chloride loading in the Sweeney Lake watershed, in addition to the 284 mg/L annual average chloride concentration in Sweeney Lake, which was used to estimate the average chloride mass for Sweeney Lake during 2020. Table 1 shows when samples were collected during 2020 and analyzed for chloride and specific conductance. Grab samples (indicated as GRAB in Table 1) were utilized during low flow conditions while several samples were composited and analyzed for storm events (indicated as COMP in Table 1). Table 1 also indicates the instantaneous discharge (for grab samples) or stormflow averages (for composites samples) of flow estimated for the respective sampling events.

Flow monitoring did not begin at the Sweeney Lake Branch station until May 8th and continuous measurements of specific conductance did not begin until June 19, 2020. Table 1 indicates that there is a positive correlation between chloride and specific conductance and negative correlation between chloride concentration and flow at the Sweeney Lake Branch monitoring station. The negative correlation between chloride and flow likely is the result of dilution during rainfall runoff events that are not associated with salt applications. Figure 2 shows the strong relationship between chloride and specific conductance, based on the monitoring data provided in Table 1. The statistical regression shown in Figure 2 was utilized to transform continuous flow (see Figure 3) and conductivity (see Figure 4) measurements from the Sweeney Lake Branch stream monitoring into incremental chloride loading estimates between May 8 and December 31, 2020. The incremental chloride loading estimates were transformed into cumulative estimates and plotted in Figure 5, which shows that the total estimated chloride loading at the Sweeney Lake Branch monitoring station is approximately 574,000 kg between May 8 and December 31, 2020. Figure 5 also shows that the total estimated chloride loading at the Sweeney Lake Branch monitoring station is approximately 343,000 kg between May 8 and September 8, 2020.

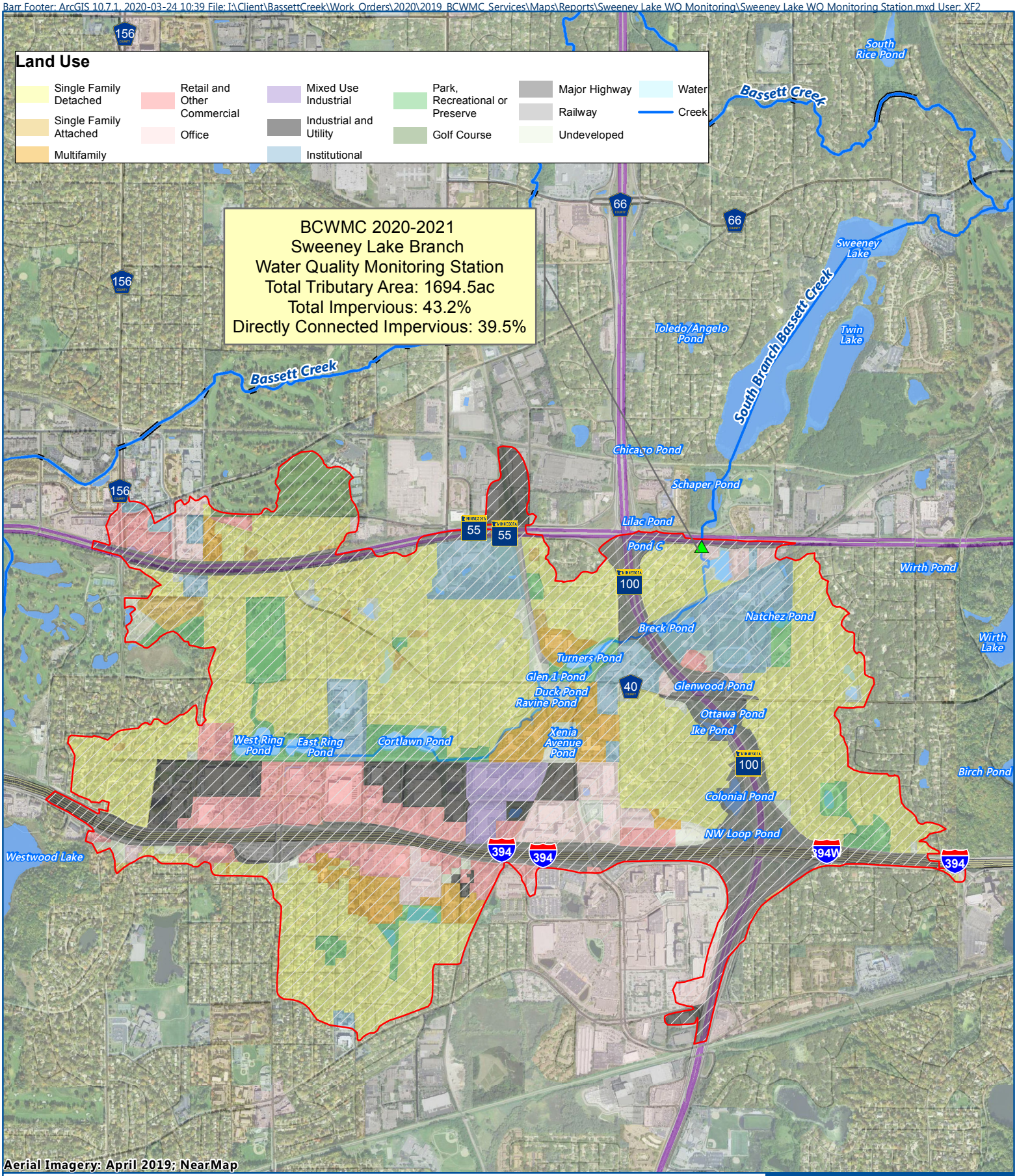
As previously indicated, the annual average chloride concentration in Sweeney Lake was 284 mg/L during 2020, which corresponds with an estimated average chloride mass of 276,000 kg for Sweeney Lake. Since the total estimated chloride loading at the Sweeney Lake Branch monitoring station between May 8 and September 8, 2020, is greater than average 2020 chloride mass for Sweeney Lake it is expected that the overall watershed drainage to Sweeney Lake was more than enough to flush the entire lake volume during that year. In addition, the loading estimates confirm that the Sweeney Lake Branch portion of the watershed represent a significant fraction of the overall chloride loading to Sweeney Lake. The results of this analysis also confirm that reductions in chloride loading from the Sweeney Lake Branch of the watershed will also quickly lead to commensurate reductions in the chloride concentrations measured in Sweeney Lake following future implementation of management actions.

3.0 Detailed Chloride Source Assessment and Recommendation

The preliminary results of the Sweeney Branch stream monitoring confirm that this portion of the Sweeney Lake watershed is a significant source of chloride to Sweeney Lake and the downstream Bassett Creek system. Through past work with Minnesota Pollution Control Agency, Barr has developed specific methodology for estimating the magnitude of individual sources of chloride that allow for targeting management practices in an urbanized watershed. It is recommended that the Commission Engineer and Administrator complete a GIS analysis and loading estimates of individual chloride sources in the Sweeney Lake watershed and report back to the Commission. The estimated range of cost to complete the GIS analysis and loading rate estimate of chloride sources in the Sweeney Lake watershed is between $5,000 and $10,000.

Table 1: Results of 2020 Sweeney Lake Branch monitoring.

Sample Name	Sampled Date	End Sampling	Chloride ion (mg/L)	Sp Conductance (uS/cm)	Flow (cfs)
GRAB	3/6/20 16:30	3/6/20 16:30	303.2		
GRAB	3/12/20 17:00	3/12/20 17:00	277		
COMP	5/23/20 13:55	5/24/20 09:28	162.1		
COMP	6/6/20 23:21	6/8/20 05:09	170.4		
COMP	6/18/20 20:51	6/20/20 10:41	154.9		
GRAB	6/25/20 06:50	6/25/20 06:50	295	1553	2.81
GRAB	7/24/20 08:00	7/24/20 08:00	271	1464	2.42
COMP	8/9/20 13:02	8/10/20 00:11	157	929	18.48
COMP	8/10/20 00:33	8/11/20 03:14	103	635	22.08
COMP	8/12/20 18:23	8/14/20 01:29	141	839	7.46
GRAB	8/21/20 10:30	8/21/20 10:30	258	1345	2.18
COMP	8/31/20 09:02	9/2/20 06:47	185	1097	5.92
GRAB	9/28/20 06:30	9/28/20 06:30	37.7		
COMP	10/12/20 00:08	10/12/20 13:02	158	1138	20.37
GRAB	10/30/20 09:35	10/30/20 09:35	258	1560	3.25
COMP	11/9/20 19:43	11/12/20 12:02	304		4.07
GRAB	11/30/20 09:00	11/30/20 09:00	333	1786	3.68
GRAB	12/22/20 09:30	12/22/20 09:30	348	1815	1.97


Land Use
Single Family Detached
Single Family Attached
Multifamily
Retail and Other Commercial
Office
Mixed Use Industrial
Industrial and Utility
Institutional
Park, Recreational or Preserve
Golf Course
Major Highway
Railway
Undeveloped
Water
Creek
BCWMC 2020-2021
Sweeney Lake Branch
Water Quality Monitoring Station
Total Tributary Area: 1694.5ac
Total Impervious: 43.2%
Directly Connected Impervious: 39.5%
Bassett Creek
South Rice Pond
Sweeney Lake
South Branch Bassett Creek
Twin Lake
Toledo/Angelo Pond
Chicago Pond
Schaper Pond
Lilac Pond
Pond C
Wirth Pond
Natchez Pond
Breck Pond
Wirth Lake
Turners Pond
Glen 1 Pond
Duck Pond
Ravine Pond
Glenwood Pond
Ottawa Pond
Ike Pond
Xenia Avenue Pond
West Ring Pond
East Ring Pond
Cortlawn Pond
Birch Pond
Colonial Pond
NW Loop Pond
Westwood Lake
394
394W
66
55
100
40
156
Aerial Imagery: April 2019; NearMap
Water Quality Monitoring Location
Tributary Area
Ponds and Wetlands
Open Channel
Culvert or Bridge
N
0
1,500
3,000
Feet
Bassett Creek Watershed Management Commission
BCWMC 2020-2021
Sweeney Lake Branch
Water Quality
Monitoring Station
FIGURE 1

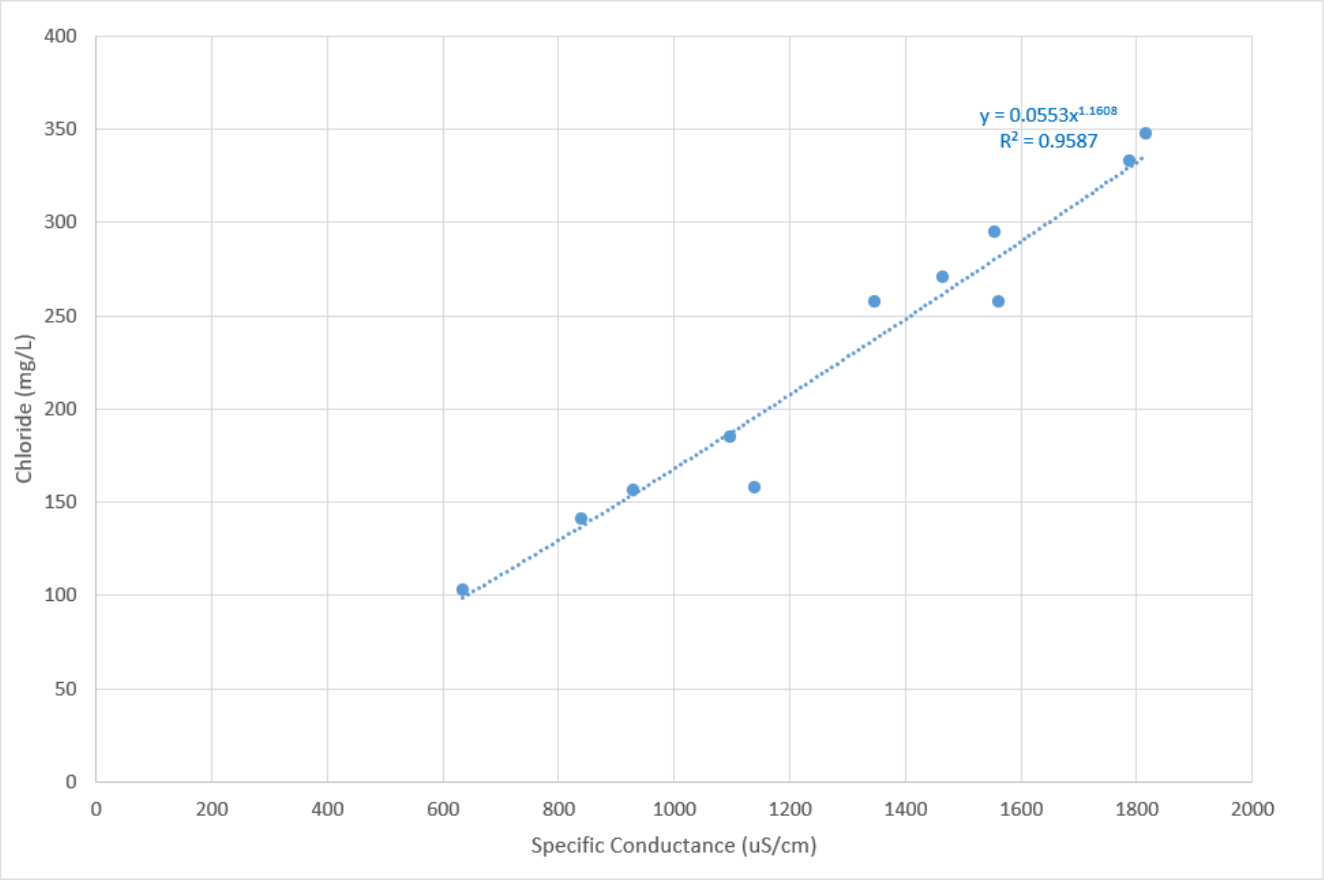


Figure 2: Chloride and specific conductance regression—2020 Sweeney Lake Branch monitoring.

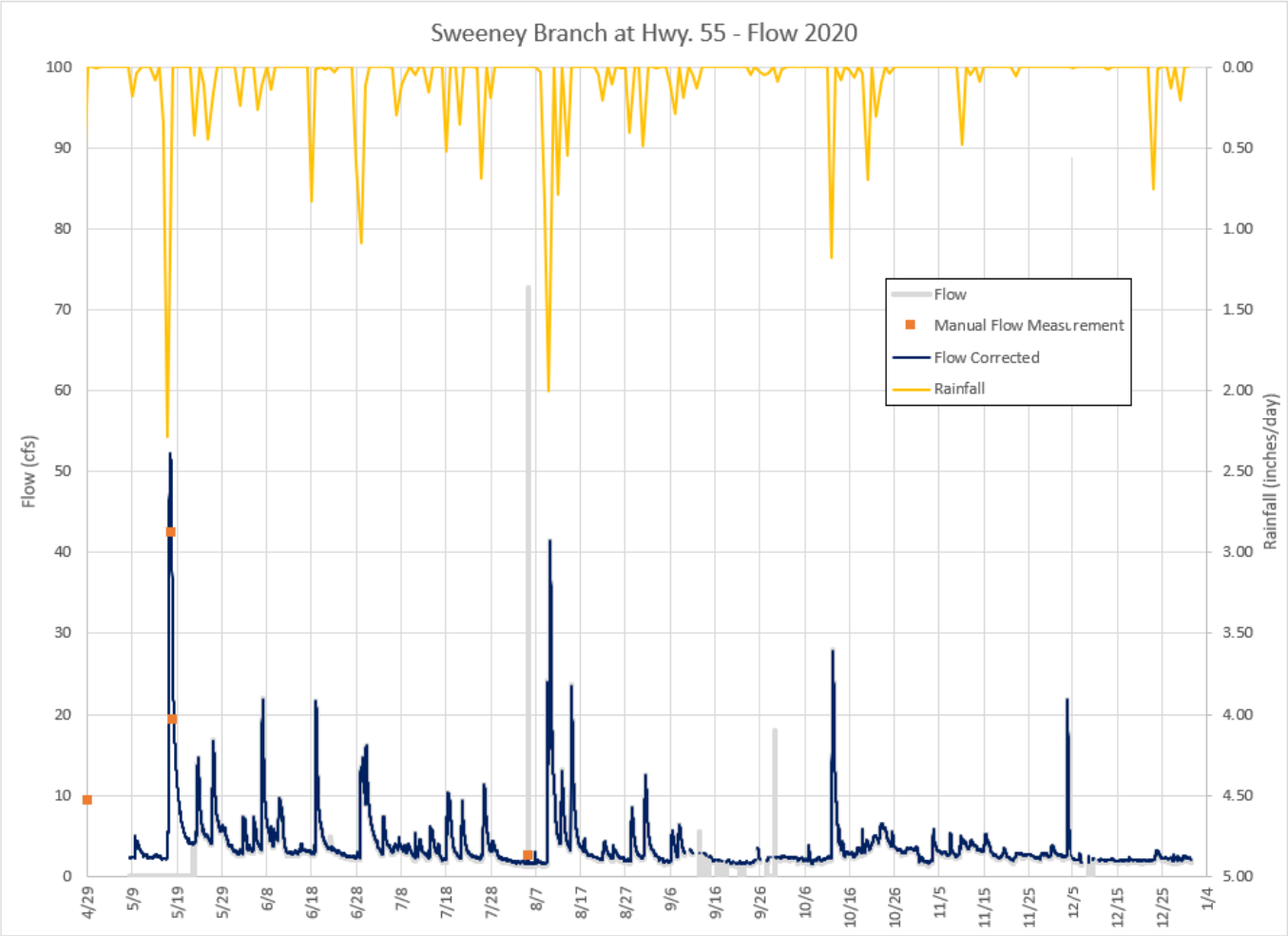


Figure 3: 2020 Sweeney Lake Branch flow monitoring.

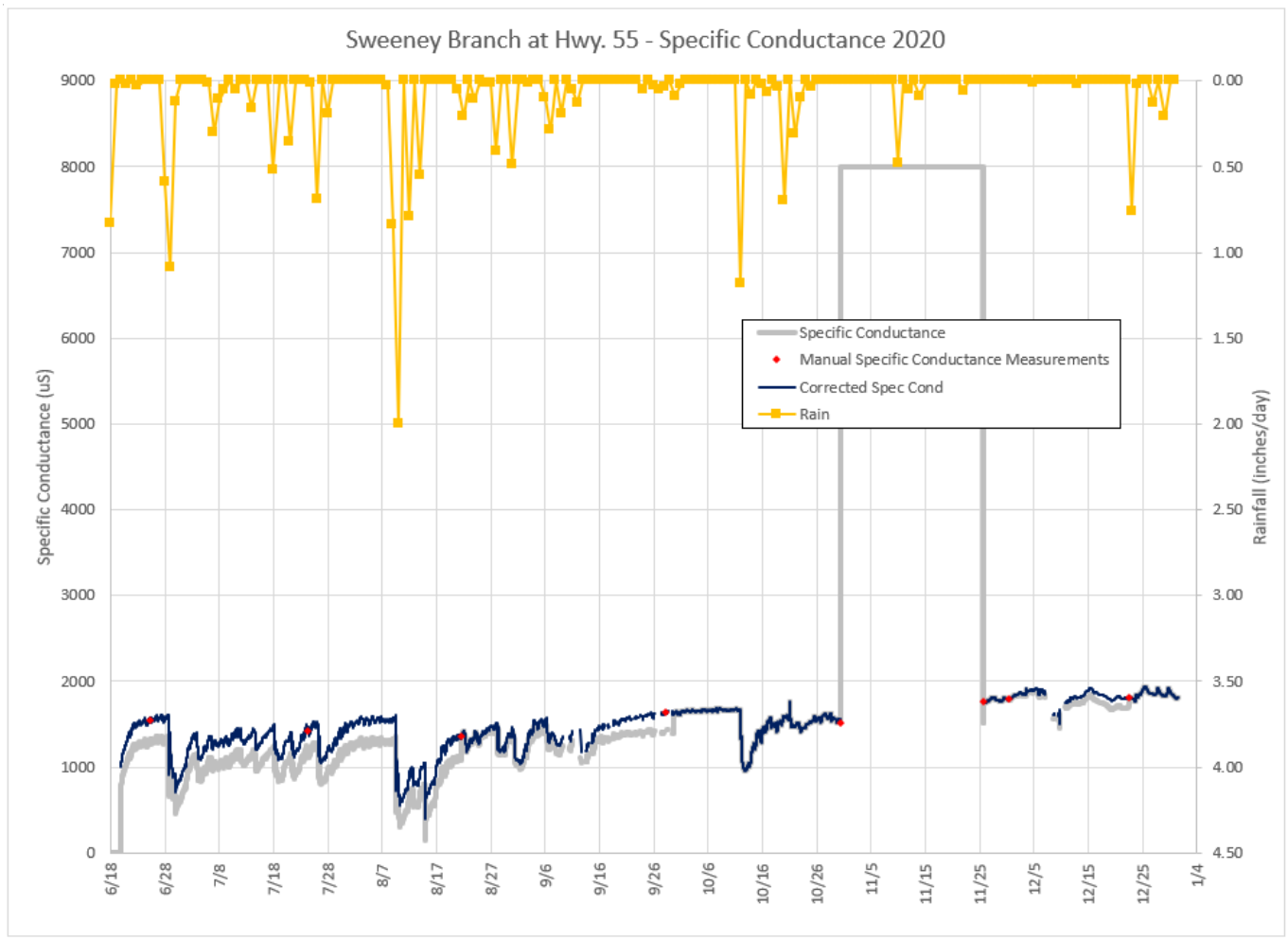


Figure 4: 2020 Sweeney Lake Branch specific conductance monitoring.

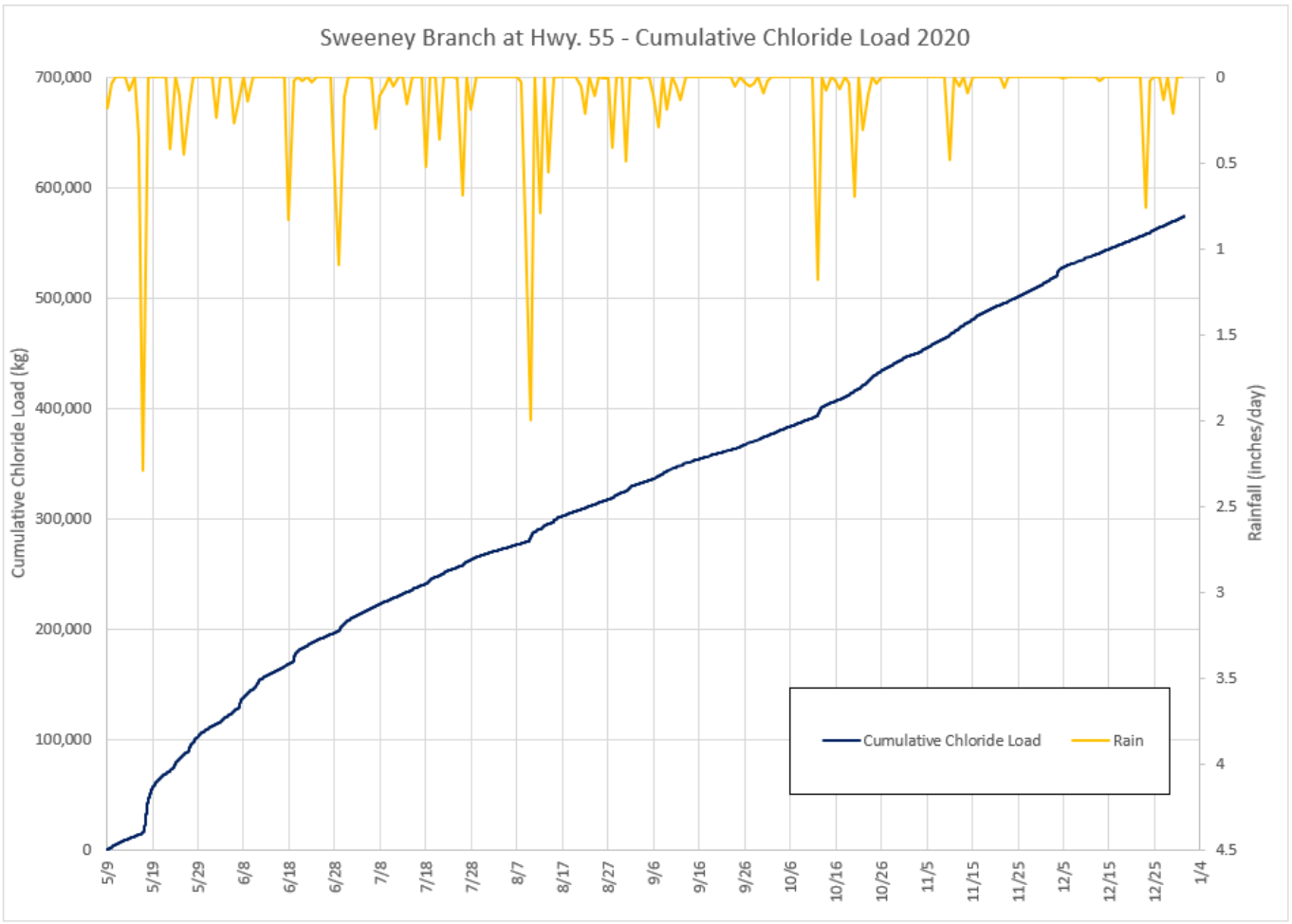


Figure 5: Cumulative chloride load estimates based on 2020 Sweeney Lake Branch monitoring.