Memorandum

Date: July 13, 2020

To: Brian Helminger, Director, HOV

Copy: File

From: Gerbitz, Mike

Re: **Local Limits Program: Background and Potential Framework**
Local Limits / Memo 1

Abbreviations

AA	annual average
BOD	5-day biochemical oxygen demand
District	Heart of the Valley Sanitary District
HOV	Heart of the Valley Sanitary District
MD	maximum day
mgd	million gallons per day
mg/L	milligrams per liter
MM	maximum month
MS	meter station
NH3-N	ammonia nitrogen
Permit	WPDES permit
ppd	pounds per day
TSS	total suspended solids
TP	total phosphorus
WRRF	water resource recovery facility or wastewater treatment facility

Purpose

The purpose of this memorandum is to outline the motivation for a "local limits" program and offer a framework for how such a program could be implemented. For a large Sanitary District with a long history, 5 major municipal customers, and 10 metering stations, implementing such program is a complex matter. Nevertheless, for a rapidly growing District that owns a WRRF with little reserve capacity to accommodate service area growth, it is an extremely important matter.

Population

Planning for the WRRF as it is currently configured was completed circa Year 2008. The planning period was 20 years. The end of the planning period was Year 2028. The corresponding estimated population for the WRRF service area was 67,827. Table 1 shows the anticipated population distribution between the municipal entities.

Table 1 Design Year and Population

Design Year	2028
Design Population	67,827

Entity	Design Population	% of Total
Combined Locks	3,473	5.1%
Darboy	25,098	37.0%
Kaukauna	18,969	28.0%
Kimberly	6,898	10.2%
Little Chute	13,389	19.7%
Total	67,827	100.0%

Table 2 shows the estimated Year 2019 population throughout the service area based on municipality population estimates published by the Wisconsin Demographic Services Center (WDSC). The Darboy Sanitary District (Darboy) population is estimated using the HOV-provided number of customers and the average people per customer throughout the balance of the HOV service area (2.42 people per customer).

Table 2 Estimated 2019 Population of the HOV Service Area

Entity	Customers	2019 Population (WDSC)	People per Customer	2019 Population Estimate
Combined Locks	1,493	3,595	2.41	3,595
Darboy	4,672	N/A[1]	N/A[1]	11,325
Kaukauna	6,767	16,278	2.41	16,278
Kimberly	2,772	6,907	2.49	6,907
Little Chute	4,905	11,729	2.39	11,729
Total	20,609			49,834
Average[2]			2.42	

Notes

[1] Not available

[2] Average people per customer throughout the communities served by HOV

Table 3 compares design year populations with estimated Year 2019 populations. The current service area population is approximately 74% of the design population.

Table 3 Comparison of Design Population with Year 2019 Population

Entity	Design Population	2019 Population Estimate	% of Design Population
Combined Locks	3,473	3,595	103.5%
Darboy	25,098	11,325	45.1%
Kaukauna	18,969	16,278	85.8%
Kimberly	6,898	6,907	100.1%
Little Chute	13,389	11,729	87.6%
Total	67,827	49,834	73.5%

Capacity

Table 4 shows the flows and loadings the WRRF was designed to treat and produce Permit-compliant effluent for the requirements known or anticipated at the time of planning. These flows and loadings correspond to the design year population presented in Table 1. At the time of planning, the Permit did not include total maximum daily load (TMDL) limits for TSS or TP.

Table 4 WRRF Design Parameters

Parameter	AA	MM	NMD	PH
Flow (mgd)	8.5	11.9	26.4	60
BOD (ppd)	12,209	14,651		
TSS (ppd)	13,565	16,278		
NH3-N (ppd)	1,600	1,920		
TP (ppd)	339	407		

Notes
AA = Annual average
MM = Maximum month
NMD = Normal maximum day
PH = Peak hour

Historical Flows and Loadings

Historical flows and loadings received at the WRRF are shown in Figures 1 – 5. These flows were measured by the ultrasonic flow meter. These loadings were calculated using the flows measured by the ultrasonic flow meter. BOD and NH3 loadings have increased rather rapidly in recent years and are approaching the corresponding WRRF capacities.

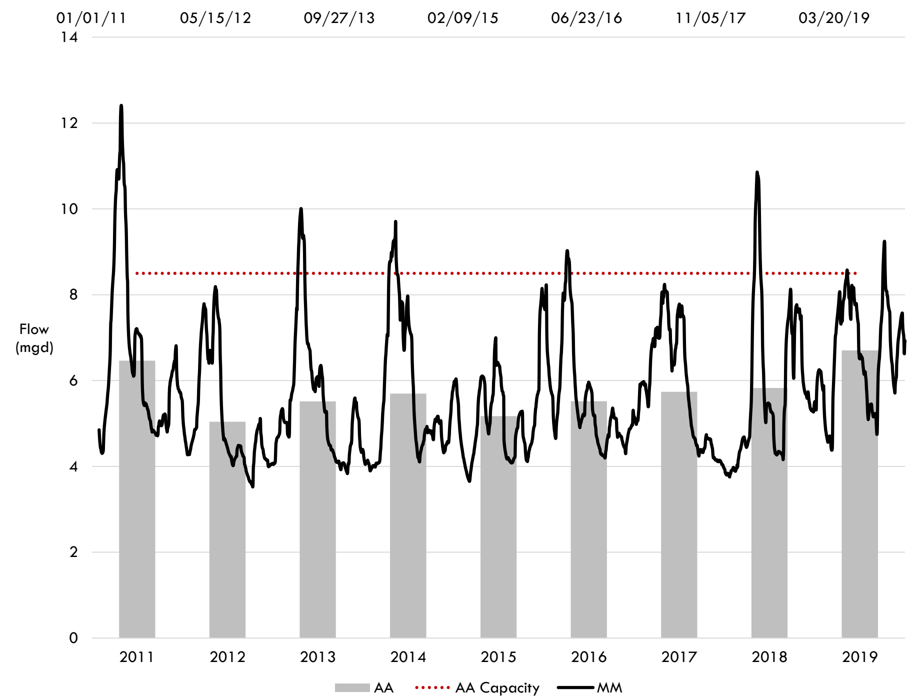

Figure 1 Historical Flows [ultrasonic meter]

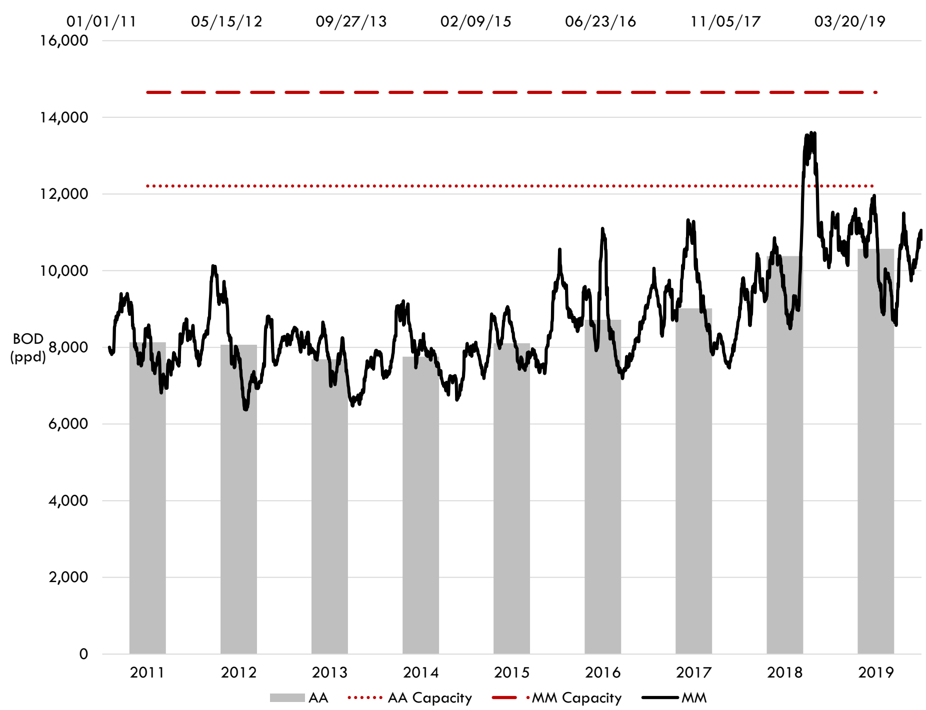

Figure 2 Historical BOD Loadings [ultrasonic meter]

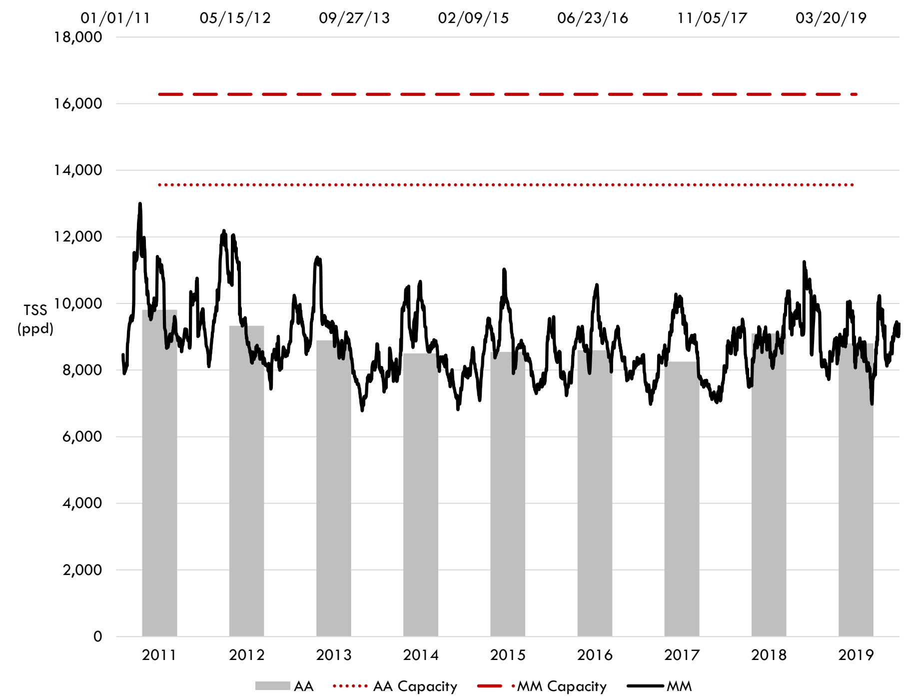

Figure 3 Historical TSS Loadings [ultrasonic meter]

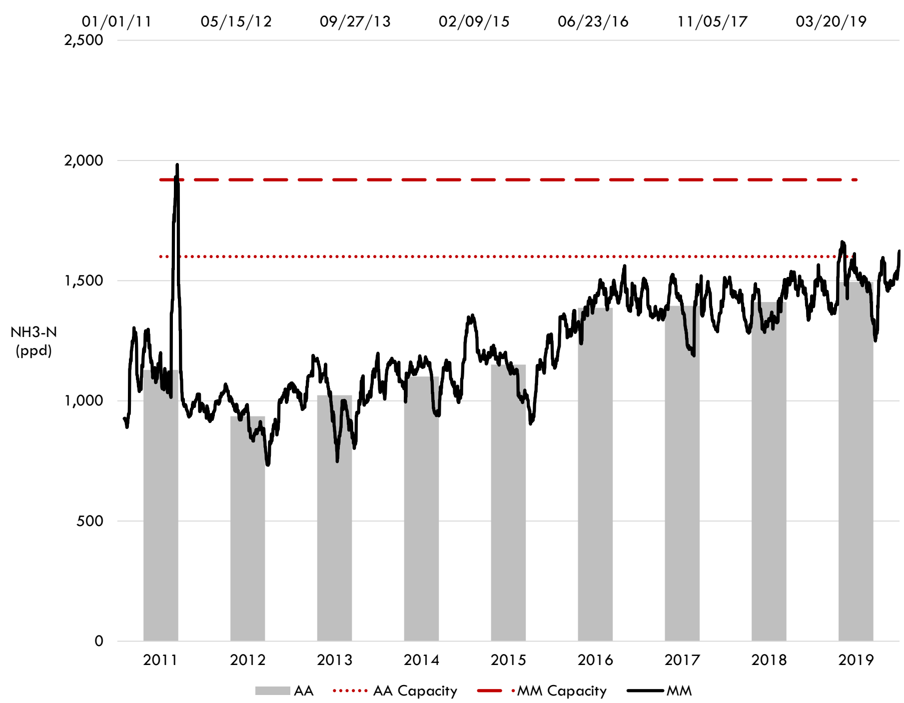

Figure 4 Historical NH3-N Loadings [ultrasonic meter]

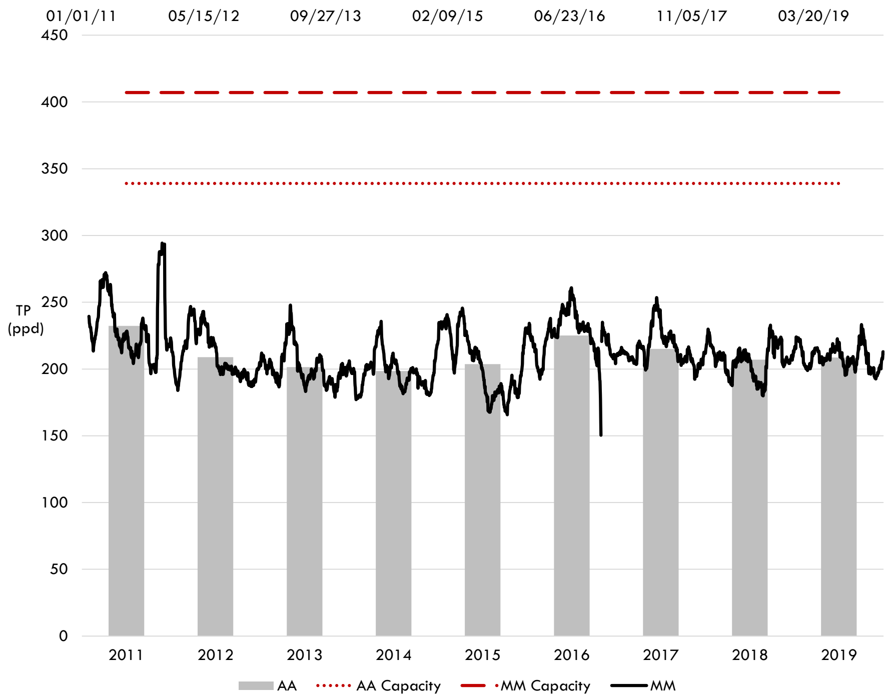

Figure 5 Historical TP Loadings [ultrasonic meter]

HOV has recently installed laser flow meters in the collection system and at the WRRF. On average, the laser meter at the WRRF measures roughly 11.6% more flow than the ultrasonic meter. Figures 6 and 7 show the historical BOD and NH3-N loadings *assuming* flows to the WRRF were 11.6% higher than those measured by the ultrasonic meter. With this *assumed* flow bias, historical BOD and NH3-N loadings are effectively at or slightly over the WRRF capacity for these parameters.

Service Area Flows and Loadings

Table 5 shows historical flows and loadings from the five major municipal HOV customers as measured and calculated using the ultrasonic meter. Table 6 shows the percentage distributions of these flows and loadings, as well as the percentage distributions of the HOV service area populations. The ultrasonic-based loadings are shown in Figures 8 – 11. Little Chute exhibited significant BOD and NH3-N loading increases that were notably disproportionate to its population percentage. Kaukauna exhibited a significant BOD increase.

Loadings are calculated using flow and concentration data. Some of the loading variability from one year to the next could be attributed, at least in part, to flow metering accuracies and precipitation events that affect meter accuracies. HOV has recently taken an important, bold, and well-conceived action to address the accuracies associated with the ultrasonic meters. More than any other major municipal customer, Little Chute loadings are likely to increase significantly when the laser meter readings are used to calculate loadings (±30%).

Reviewing historical concentration data might provide insights related to historical loading data. These insights are independent of the type of flow meter or their accuracies at various flows. Figures 12 – 15 show *annual average* concentrations measured at each of the 10 metering stations. Concentrations measured at Little Chute MS2 exhibited dramatic BOD and NH3-N increases.

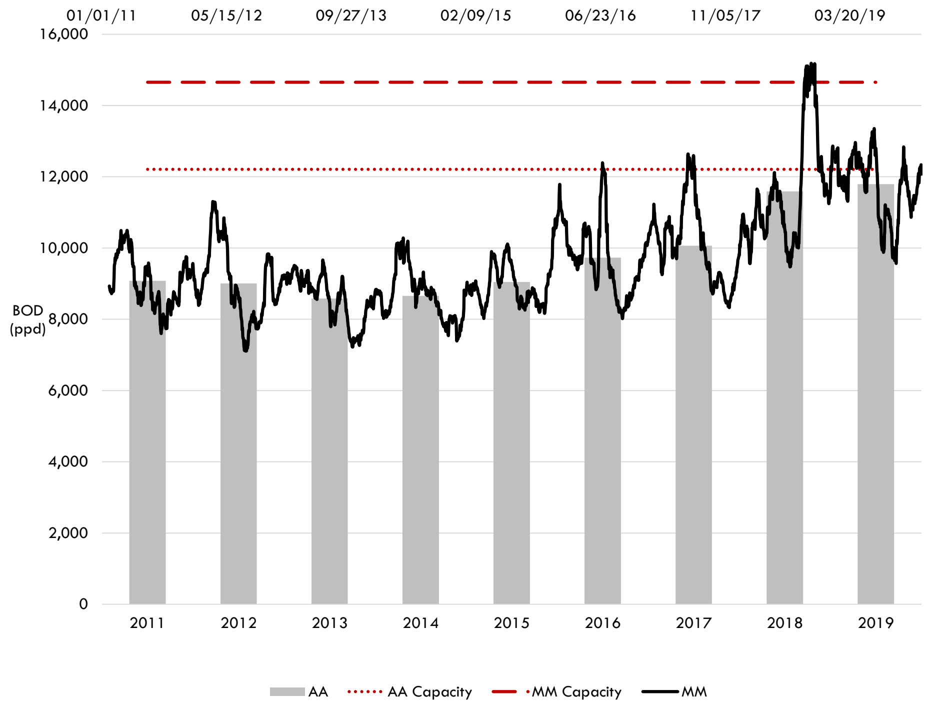

Figure 6 Historical BOD Loadings with an Assumed Laser Meter Bias [+11.6%]

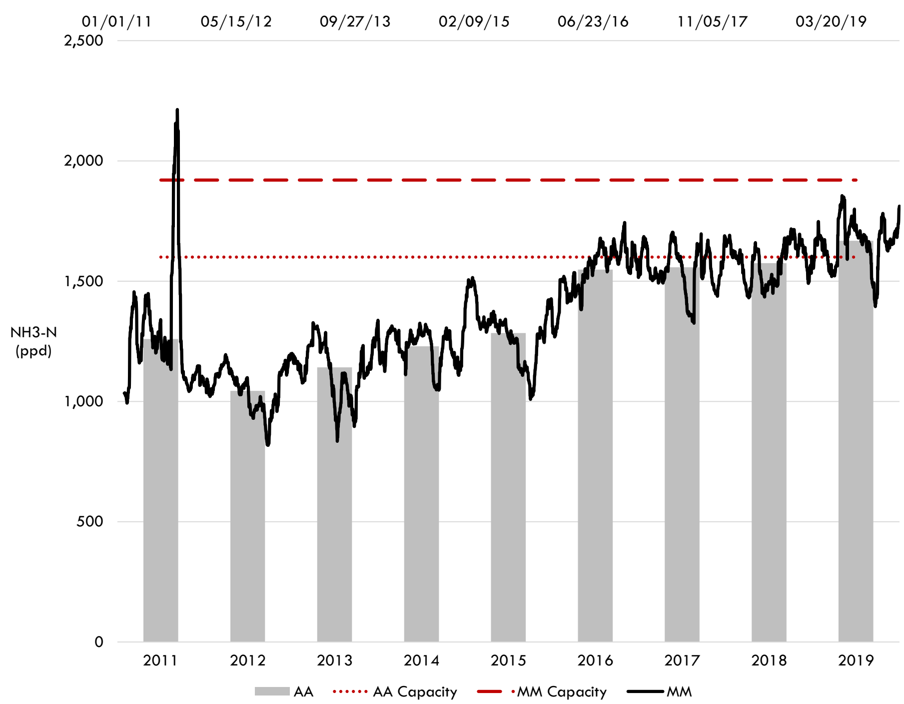

Figure 7 Historical NH3-N Loadings with an Assumed Laser Meter Bias [+11.6%]

Table 5 Historical Flows and Loadings from Major Municipal Customers [ultrasonic meter]

Flow (mgd)

Entity	2015	2016	2017	2018	2019
Combined Locks	0.35	0.32	0.34	0.34	0.42
Darboy	0.93	0.91	0.92	0.91	0.96
Kaukauna	2.26	2.06	2.17	2.28	2.76
Kimberly	0.77	1.38	1.51	0.80	1.81
Little Chute	1.50	0.74	0.75	1.44	0.89
Total	5.81	5.41	5.68	5.78	6.83

BOD (ppd)

Entity	2015	2016	2017	2018	2019
Combined Locks	619	584	688	614	776
Darboy	2,239	2,124	2,388	2,361	2,788
Kaukauna	2,292	2,486	2,816	3,056	3,382
Kimberly	1,095	1,343	1,235	1,377	1,345
Little Chute	2,161	2,828	3,058	4,144	4,619
Total	8,406	9,366	10,185	11,553	12,910

TSS (ppd)

Entity	2015	2016	2017	2018	2019
Combined Locks	755	619	786	668	801
Darboy	2,623	2,329	2,482	2,304	2,813
Kaukauna	2,955	2,845	3,191	3,393	3,745
Kimberly	1,335	1,482	1,282	1,546	1,271
Little Chute	2,409	3,207	3,422	3,066	3,447
Total	10,078	10,482	11,164	10,977	12,077

NH3-N (ppd)

Entity	2015	2016	2017	2018	2019
Combined Locks	76	76	80	78	85
Darboy	258	258	277	277	277
Kaukauna	369	435	401	388	401
Kimberly	126	126	126	129	139
Little Chute	324	324	485	532	646
Total	1,153	1,219	1,369	1,405	1,548

TP (ppd)

Entity	2015	2016	2017	2018	2019
Combined Locks	14	15	16	14	15
Darboy	53	52	54	52	54
Kaukauna	64	70	65	66	70
Kimberly	26	29	25	26	27
Little Chute	48	63	64	58	64
Total	205	228	223	216	231

Table 6 Historical Flow and Loading Distribution as % of Total [ultrasonic meter]

Flow Entity	2015	2016	2017	2018	2019	% of Total Current Population
Combined Locks	6.0%	5.9%	5.9%	5.9%	6.2%	7.2%
Darboy	16.0%	16.9%	16.3%	15.7%	14.0%	22.7%
Kaukauna	39.0%	38.0%	38.2%	39.5%	40.4%	32.7%
Kimberly	13.3%	25.5%	26.5%	13.9%	26.4%	13.9%
Little Chute	25.8%	13.7%	13.2%	25.0%	13.0%	23.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

BOD Entity	2015	2016	2017	2018	2019	% of Total Current Population
Combined Locks	7.4%	6.2%	6.8%	5.3%	6.0%	7.2%
Darboy	26.6%	22.7%	23.4%	20.4%	21.6%	22.7%
Kaukauna	27.3%	26.5%	27.7%	26.4%	26.2%	32.7%
Kimberly	13.0%	14.3%	12.1%	11.9%	10.4%	13.9%
Little Chute	25.7%	30.2%	30.0%	35.9%	35.8%	23.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TSS Entity	2015	2016	2017	2018	2019	% of Total Current Population
Combined Locks	7.5%	5.9%	7.0%	6.1%	6.6%	7.2%
Darboy	26.0%	22.2%	22.2%	21.0%	23.3%	22.7%
Kaukauna	29.3%	27.1%	28.6%	30.9%	31.0%	32.7%
Kimberly	13.2%	14.1%	11.5%	14.1%	10.5%	13.9%
Little Chute	23.9%	30.6%	30.7%	27.9%	28.5%	23.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

NH3-N Entity	2015	2016	2017	2018	2019	% of Total Current Population
Combined Locks	6.6%	6.2%	5.8%	5.6%	5.5%	7.2%
Darboy	22.3%	21.1%	20.3%	19.7%	17.9%	22.7%
Kaukauna	32.0%	35.7%	29.3%	27.6%	25.9%	32.7%
Kimberly	10.9%	10.3%	9.2%	9.2%	9.0%	13.9%
Little Chute	28.1%	26.6%	35.4%	37.8%	41.7%	23.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

TP Entity	2015	2016	2017	2018	2019	% of Total Current Population
Combined Locks	6.8%	6.5%	7.1%	6.5%	6.6%	7.2%
Darboy	25.7%	22.7%	24.1%	23.9%	23.6%	22.7%
Kaukauna	31.2%	30.5%	29.0%	30.5%	30.2%	32.7%
Kimberly	12.6%	12.8%	11.2%	12.2%	11.9%	13.9%
Little Chute	23.6%	27.5%	28.6%	26.9%	27.7%	23.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

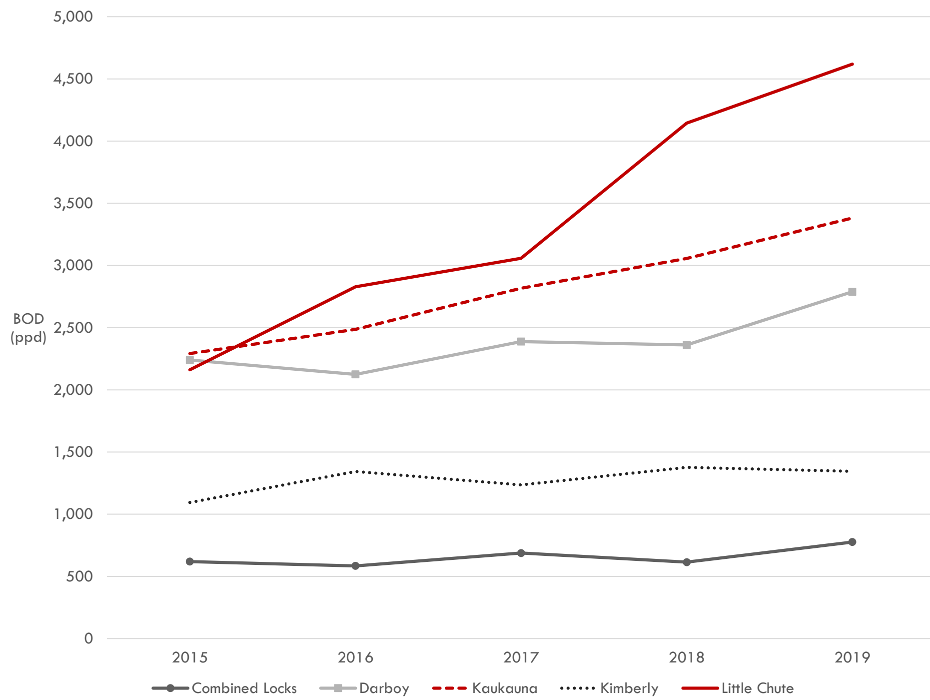

Figure 8 Historical BOD Loading Distribution

Figure 9 Historical TSS Loading Distribution

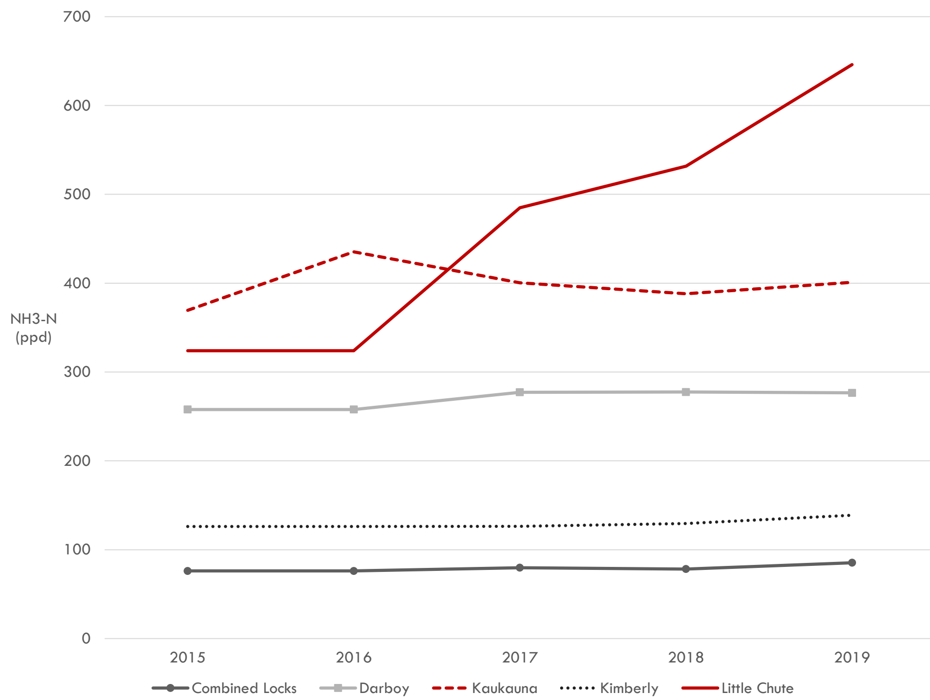

Figure 10 Historical NH3-N Loading Distribution

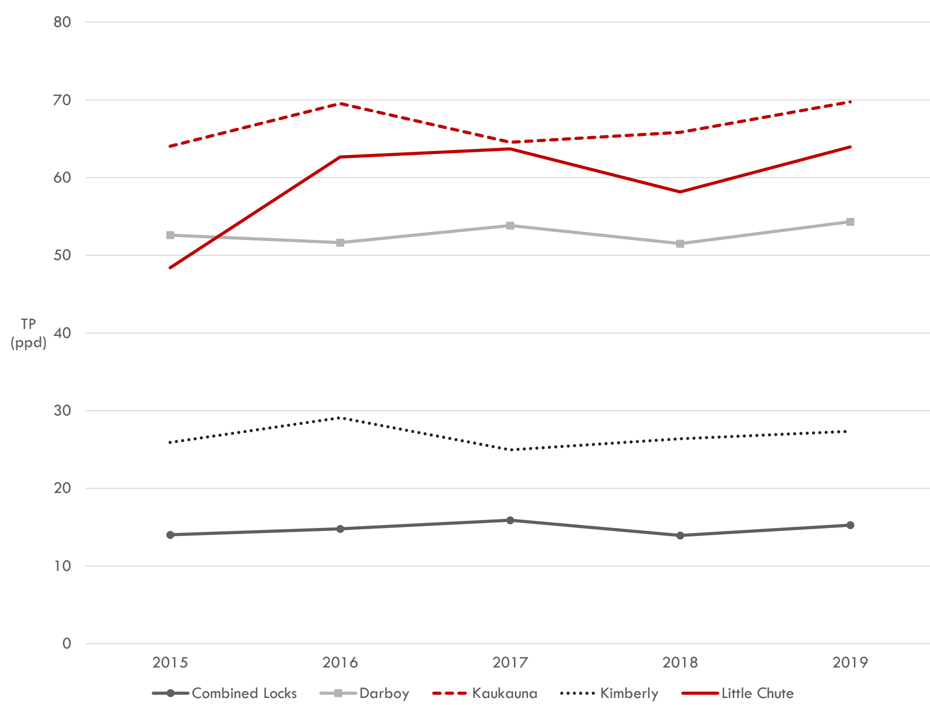

Figure 11 Historical TP Loading Distribution

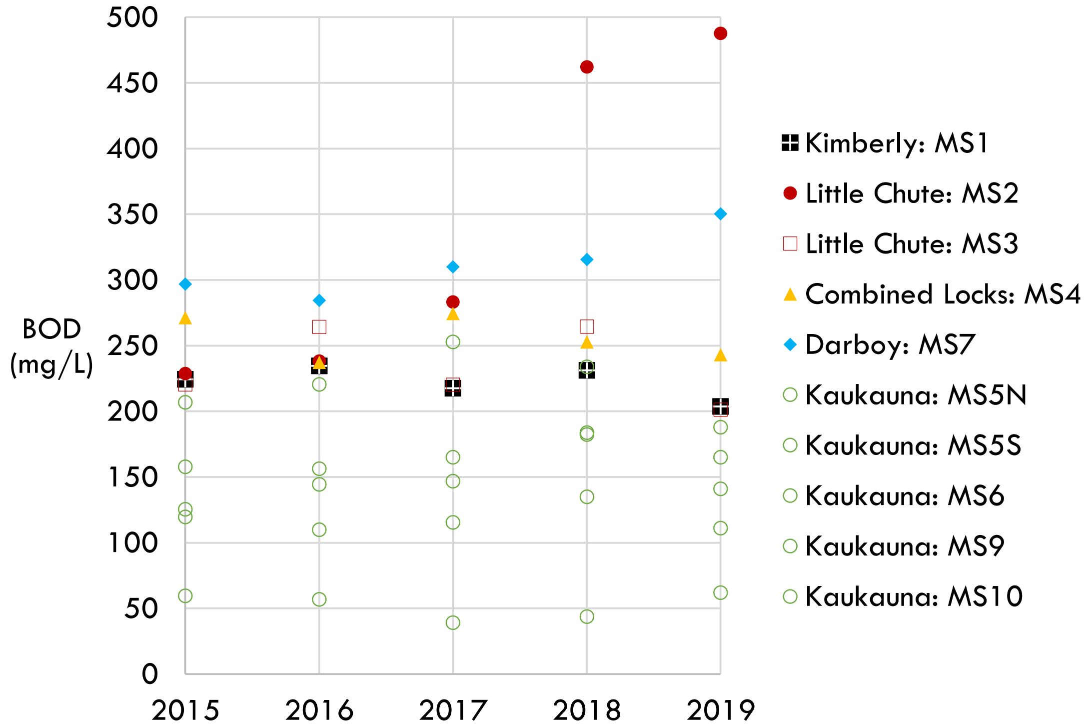

Figure 12 Measured BOD Concentrations

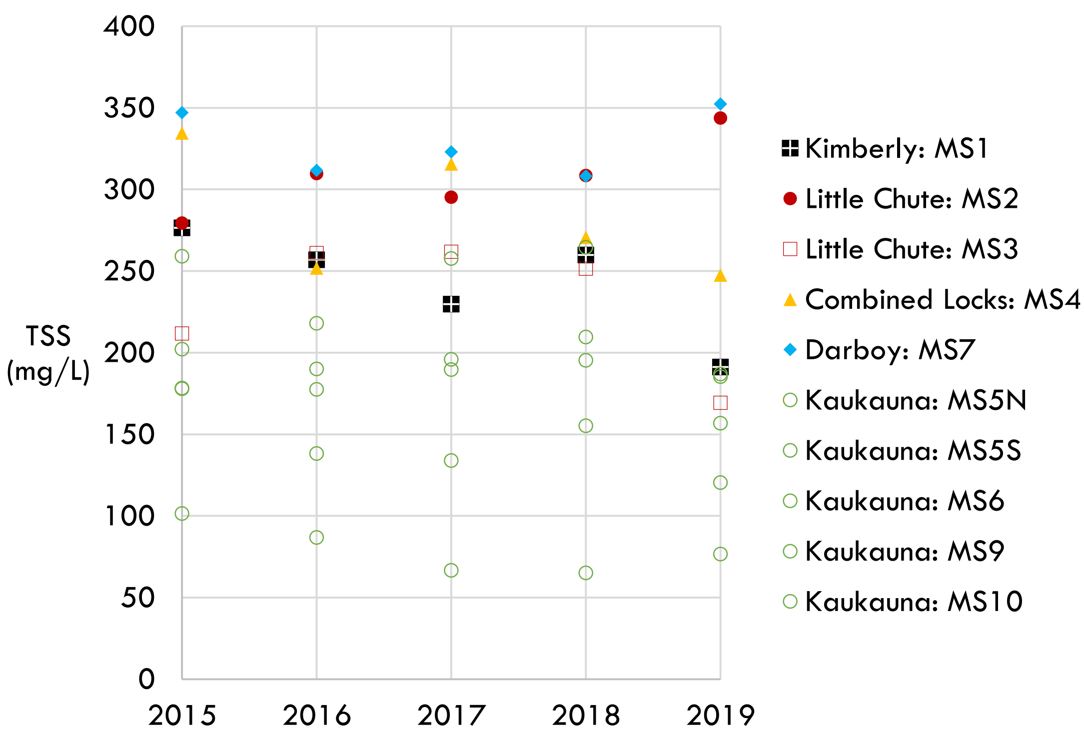

Figure 13 Measured TSS Concentrations

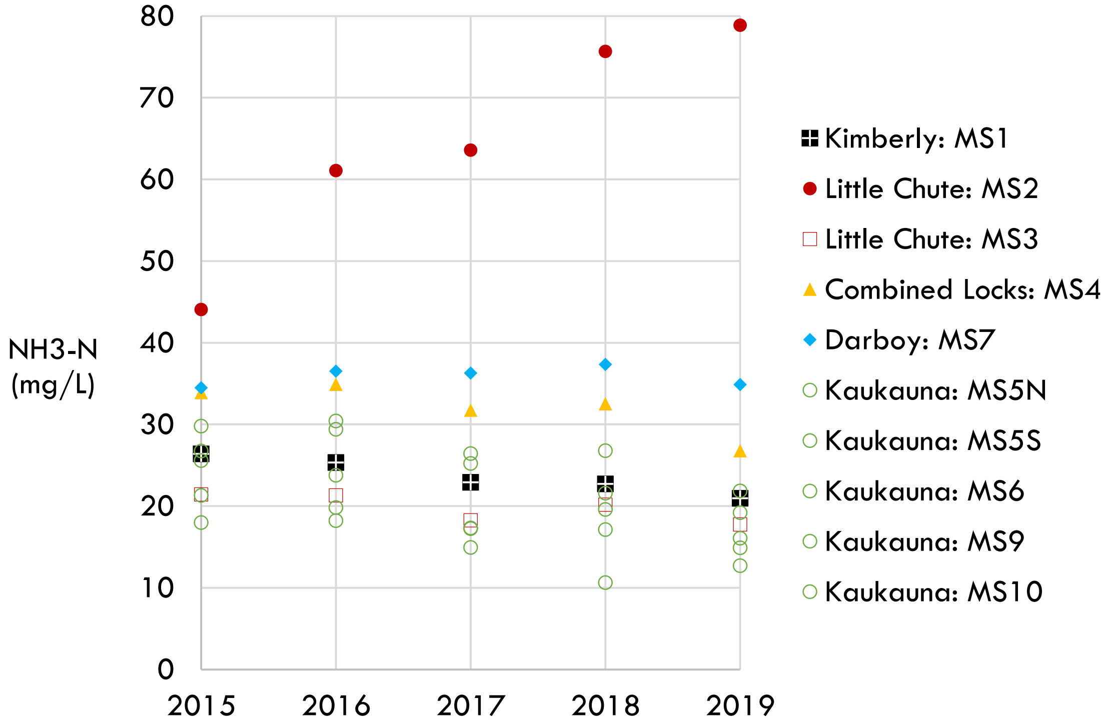

Figure 14 Measured NH3-N Concentrations

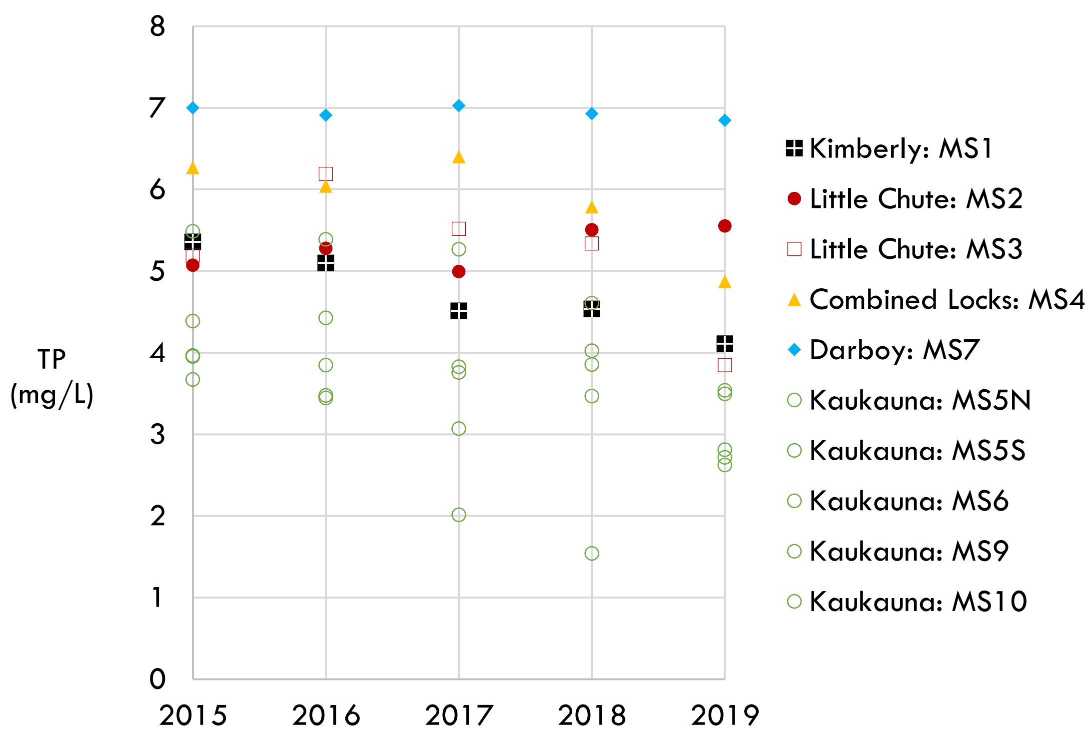

Figure 15 Measured TP Concentrations

Wastewater Concentrations

For a host of reasons, the strength of domestic wastewater varies: between communities and between watersheds within communities. The values in Table 7 illustrate the wide range of concentrations found in domestic wastewater throughout the United States (Metcalf and Eddy, 2014). The *annual average* BOD and NH3-N concentrations measured at Little Chute MS2 exceed the maximum values listed in Table 7.

Table 7 Range of Concentrations (mg/L) Expected in Domestic Wastewater (United States)

Parameter	Weak	Med	Strong
BOD	133	200	400
TSS	130	195	398
NH3-N	14	20	41
TP	3.7	5.6	11

Table 8 shows concentrations corresponding to the WRRF design parameters presented previously (Table 4). These concentrations assuming an influent flow of 8.5 mgd.

Table 8 Concentrations Corresponding to WRRF Design Parameters

Parameter	AA	MM
BOD	172	207
TSS	191	230
NH3-N	22.6	27.1
TP	4.8	5.7

Table 9 shows historical annual average flows (ultrasonic meter) and concentrations measured at the WRRF. It also lists the annual average design concentrations corresponding to the WRRF design parameters. Historical annual average BOD and NH3-N concentrations consistently exceed the design concentrations.

Table 9 Historical Flows and Concentrations Measured at the WRRF

Parameter	Design	2015	2016	2017	2018	2019
Flow (mgd)	8.5	5.2	5.5	5.7	5.8	6.7
BOD (ppd)	172	199	198	200	233	203
TSS (ppd)	191	207	196	184	207	167
NH3-N (ppd)	22.6	28.3	32.0	31.5	32.3	28.6
TP (ppd)	4.8	5.0	5.1	4.8	4.8	4.0

Legend

(shaded)	Exceeds design concentration

Local Concentration Limits

The WRRF is an important and valuable asset for HOV and all entities within its service area. Constructing an equivalent new WRRF would cost between $130 – 170MM. It was last upgraded with the intention that it would provide reliable Permit compliance through the Year 2028 and for a service area with 67,827 residents.

In recent years, the WRRF has received average and maximum-month BOD and NH3-N loadings close to or above its corresponding capacities. These increasing loadings are undoubtedly attributed, in part, to a service area that is economically strong and an excellent place to live, work, and visit. Nevertheless, these relatively high BOD and NH3-N loadings occurred when its estimated service area population is less than 75% of its design population.

A close inspection of major municipal customer loadings reveals that much of the recent BOD and NH3-N loading increases are attributed to a single major municipal customer: Little Chute. In the last five years, its BOD loading has increased 2,500 ppd and its NH3-N loading increased 320 ppd. These increases are roughly equivalent to loadings associated with 10,000 residents.

Prohibitive Concentrations

SEC 4.01 GENERAL PROHIBITIONS of the District's Sewer Use and User Charge Ordinance (Ordinance) includes an important provision: "No Person shall discharge wastes to a public sewer which cause, or are capable of causing either alone or in combination with other substances: In the opinion of the Director, excessive District collection and treatment costs, or use of a disproportionate share of the District's facilities." This provision seems to foreshadow and provide a means to address what has occurred in recent years: a single customer using a disproportionate share of the WRRF capacity. The language is subjective.

The District might be wise to consider [1] preserving the Director's discretion to make the above determination and [2] adding more direct and specific supplemental language in SEC 4.02 SPECIFIC PROHIBITIONS. The example language below, which could amend the current SEC 4.02 language, prohibits all wastes containing conventional wastewater parameters twice that of *strong* domestic wastewater.

(k) Wastewater containing more than 800 mg/L of BOD, 800 mg/L of TSS, 80 mg/L of NH3-N, 20 mg/L of TP, and 750 mg/L of chlorides.

Excessive Concentrations

In general, the existing Sewer Service Charges specific to the WRRF (excluding the collection system) provide revenue for existing debt payments, the replacement fund, operating expenses, maintenance expenses, and small-scale capital improvements related to and at the WRRF. Each major municipal customer is charged based on the volume, BOD loading, TSS loading, NH3-N loading, TP loading, and chloride loading discharged to the HOV collection system as measured at the 10 metering stations. There is no charge or *surcharge* for using a disproportionate fraction of the WRRF capacity and hastening the need for a capacity-related expansion, supplemental WRRF, or new WRRF. This large capital cost would be borne by all HOV customers.

The District might be wise to consider a *supplemental* charge or *surcharge* aimed at customers that are using a disproportionate share of the WRRF capacity and reflecting the *capacity-related* cost of their disproportionate use. The surcharge could be applied when *monthly average* wastewater concentrations at a metering station exceed the generally-accepted definition of "strong" domestic wastewater: 400 mg/L of BOD, 400 mg/L of TSS, 40 mg/L of NH3-N, and 10 mg/L of TP. The revenue produced by this capacity-related surcharge could be retained in the replacement fund to off-set the future cost of a capacity-related expansion, supplemental WRRF, or new WRRF.

Figures 16 – 20 illustrate when this surcharge *would* have been applied in the past had they been in effect. Each of figure shows historical BOD concentrations measured at the various meter stations. The solids and dashed lines represent running averages that approximate historical monthly averages. A community *would* have received a BOD surcharge whenever these lines exceed 400 mg/L.

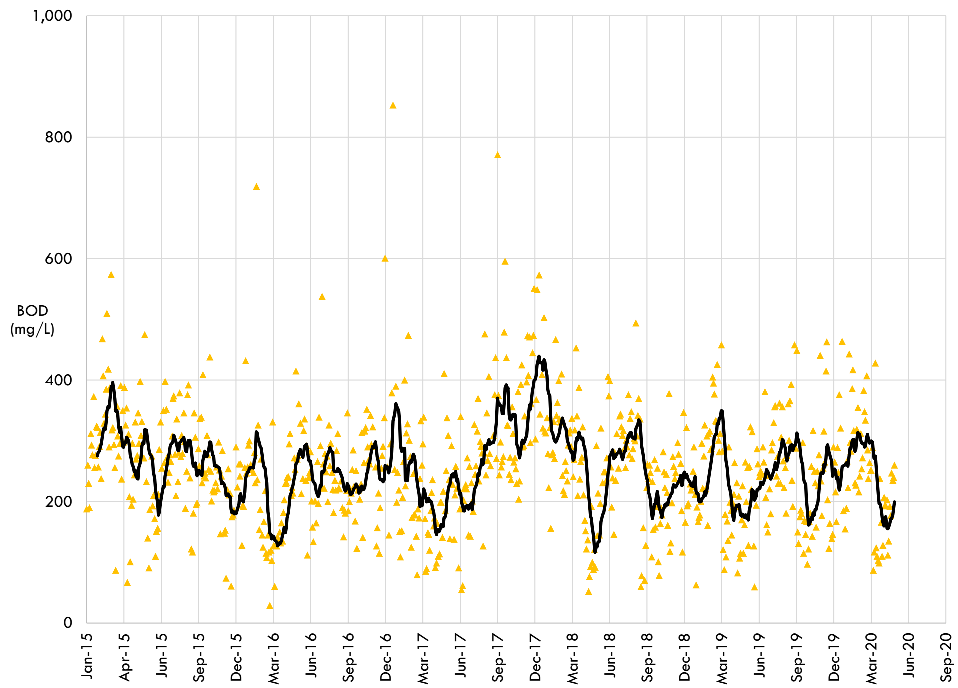

Figure 16 Historical BOD Concentrations and Monthly Averages for Combined Locks

The running average exceeds 400 mg/L for a short duration in early 2018. Combined Locks may have received one or several capacity-related surcharges for BOD during that period.

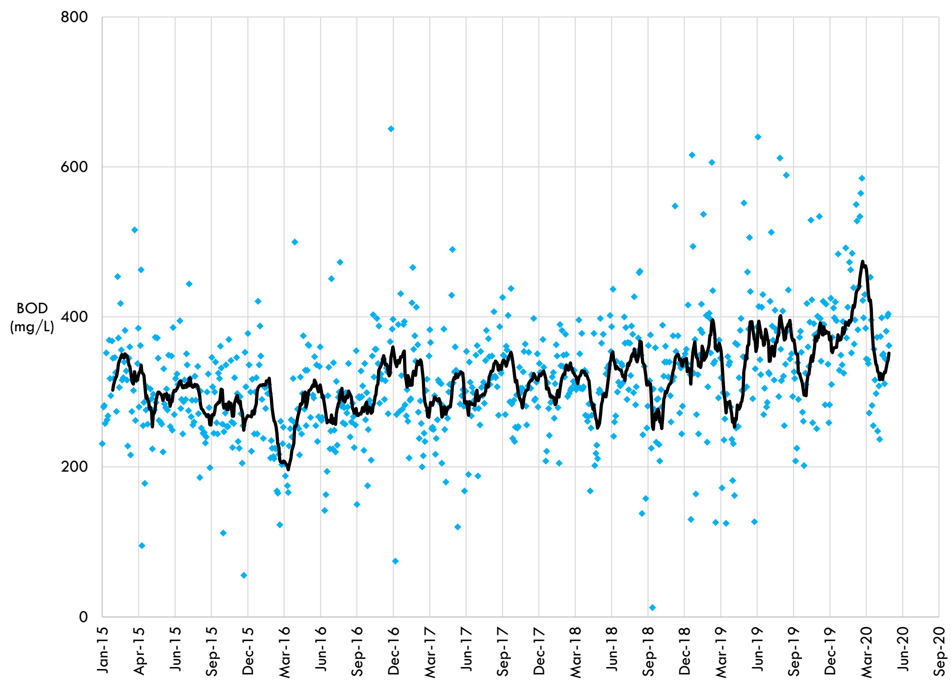

Figure 17 Historical BOD Concentrations and Monthly Averages for Darboy

The running average exceeds 400 mg/L for a short duration in late 2019/early 2020. Darboy may have received one or several capacity-related surcharges for BOD during that period.

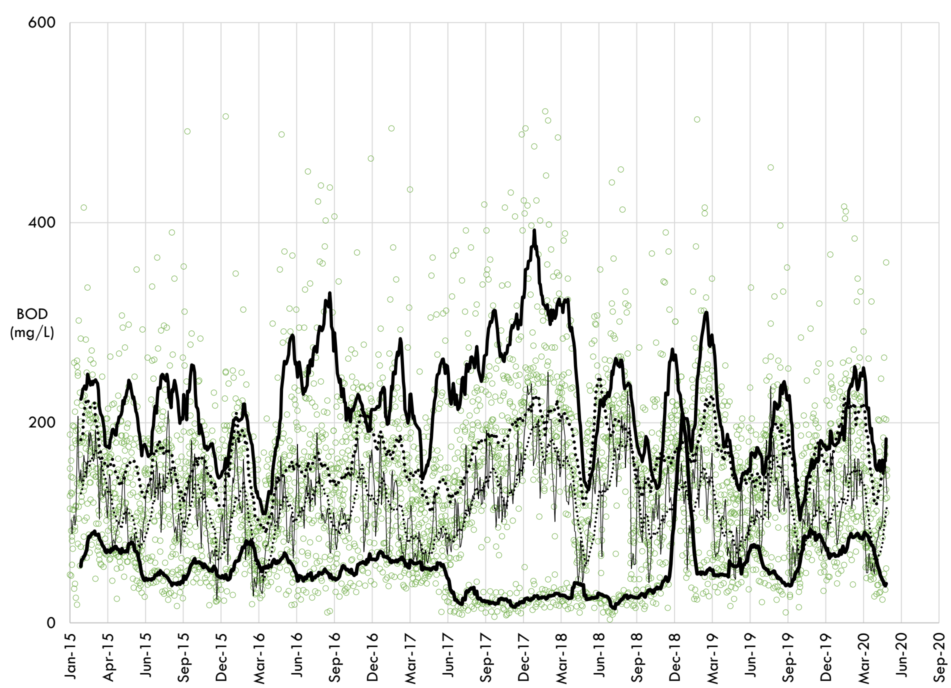

Figure 18 Historical BOD Concentrations and Monthly Averages for Kaukauna

Kaukauna has five metering stations. The five running-average lines correspond to the five metering stations. None of the running average lines exceed 400 mg/L and Kaukauna would not have received a capacity-related surcharge for BOD.

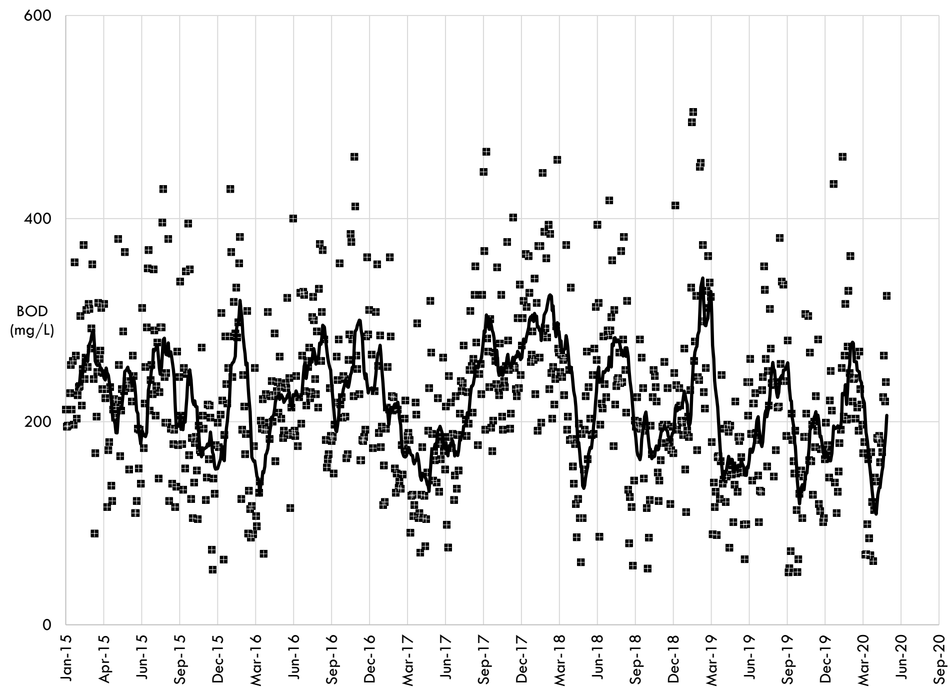

Figure 19 Historical BOD Concentrations and Monthly Averages for Kimberly

The running-average line never exceeds 400 mg/L. Kimberly would have never received a capacity-related surcharge for BOD.

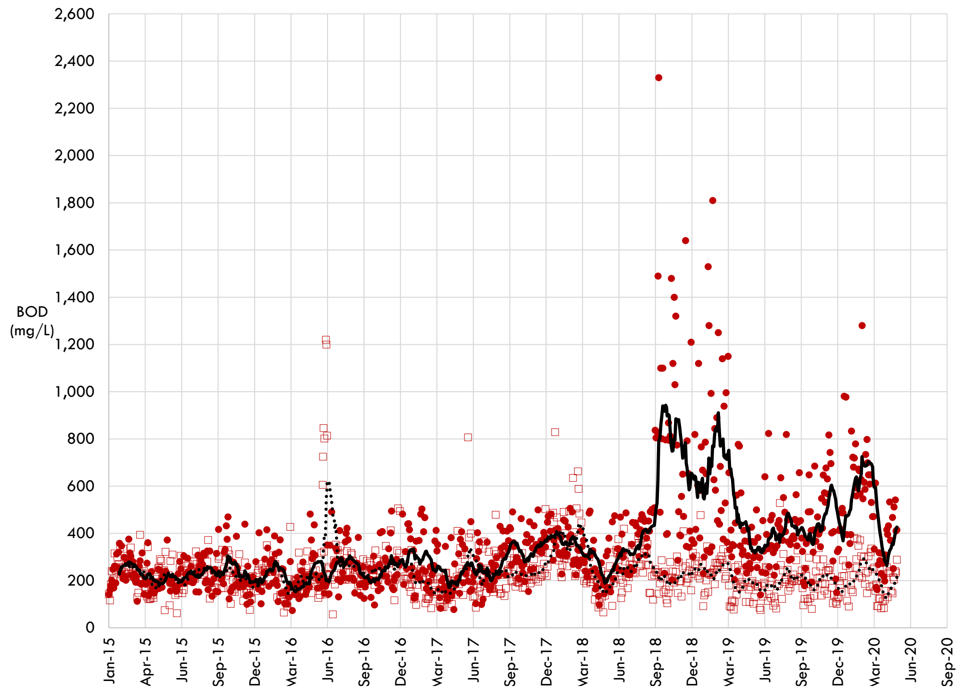

Figure 20 Historical BOD Concentrations and Monthly Averages for Little Chute

Little Chute has two metering stations. The two running-average lines correspond to the two metering stations. Both running average lines exceed 400 mg/L: MS2 regularly in 2018 and 2019, and MS3 for a brief period in 2016. Little Chute would have received capacity-related surcharges for BOD during these periods.

The BOD figures (Figures 16 -20) illustrate when BOD surcharges would have been applied in the past and suggest the frequency they might be applied in the future assuming all dischargers continue to operate as they have. More generally, the purpose of the preceding figures is to foster thought, provide perspective, and “seed” meaningful and productive discussions. Donohue can and will assemble and present additional information if HOV feels it would be helpful to developing or implementing a local limits program. We welcome an opportunity to provide additional assistance.