Memorandum

Date: April 24, 2019

To: David Casper, Commissioner
Bruce Siebers, Commissioner
Kevin Coffey, Commissioner
Patrick Hennessey, Commissioner
John Sundelius, Commissioner
Brian Helminger, District Manager
Chad Giackino, Regulatory Compliance Manager

Copy: John Neumeier and John Sundelius, City of Kaukauna
Kent Taylor, Village of Little Chute
Joann Ashauer, Darboy Sanitary District No. 1
Danielle Block, Village of Kimberly
Racquel Shampo-Giese, Village of Combined Locks
Dawn Bartel, HOVMSD
Mike Gerbitz, Donohue & Associates

From: Tracey Webb, Donohue & Associates

Re: **2018 Annual Flow Summary**
Heart of the Valley Metropolitan Sewerage District

The following memorandum documents the analysis and observations of the 2018 clear water (inflow and infiltration) flow component of the overall HOVMSD wastewater flow.

HOVMSD SUSTAINABILTY PROGRAM

HOVMSD has implemented a self-regulated sustainability program to maintain, monitor, and regulate flow to the WWTP. The goal of the sustainability program is to maintain or extend the longevity of the WWTP and interceptor capacity by not increasing the existing level of clear water in the system and decreasing the clear water entering the system where possible.

Performance indicators provide a degree of insight to relative volume of clear water that is entering the system from the HOVMSD member communities and to the impacts of the clear water on the system. For the 2018 yearly evaluation, Donohue reviewed performance indicators from the following sources:

1. Observations at the HOVMSD wastewater treatment plant,
2. Analysis of the clear water components of flow through the Antecedent Moisture Model (AMM),
3. Analysis of the clear water components of flow identified in the Compliance Maintenance Annual Reports (CMAR) for each member community.

The following sections of the memorandum document the observations and analysis of the performance indicators listed above.

OBSERVATIONS AT HOVMSD WASTEWATER TREATMENT PLANT

The performance of the HOVMSD plant is ultimately the issue of greatest concern for the Wisconsin Department of Natural Resources (WDNR). If there are permit violations or steadily increasing secondary treatment diversion events and volumes, the WDNR may increase their oversight or impose/reinstate flow reduction mandates.

PLANT PERFORMANCE

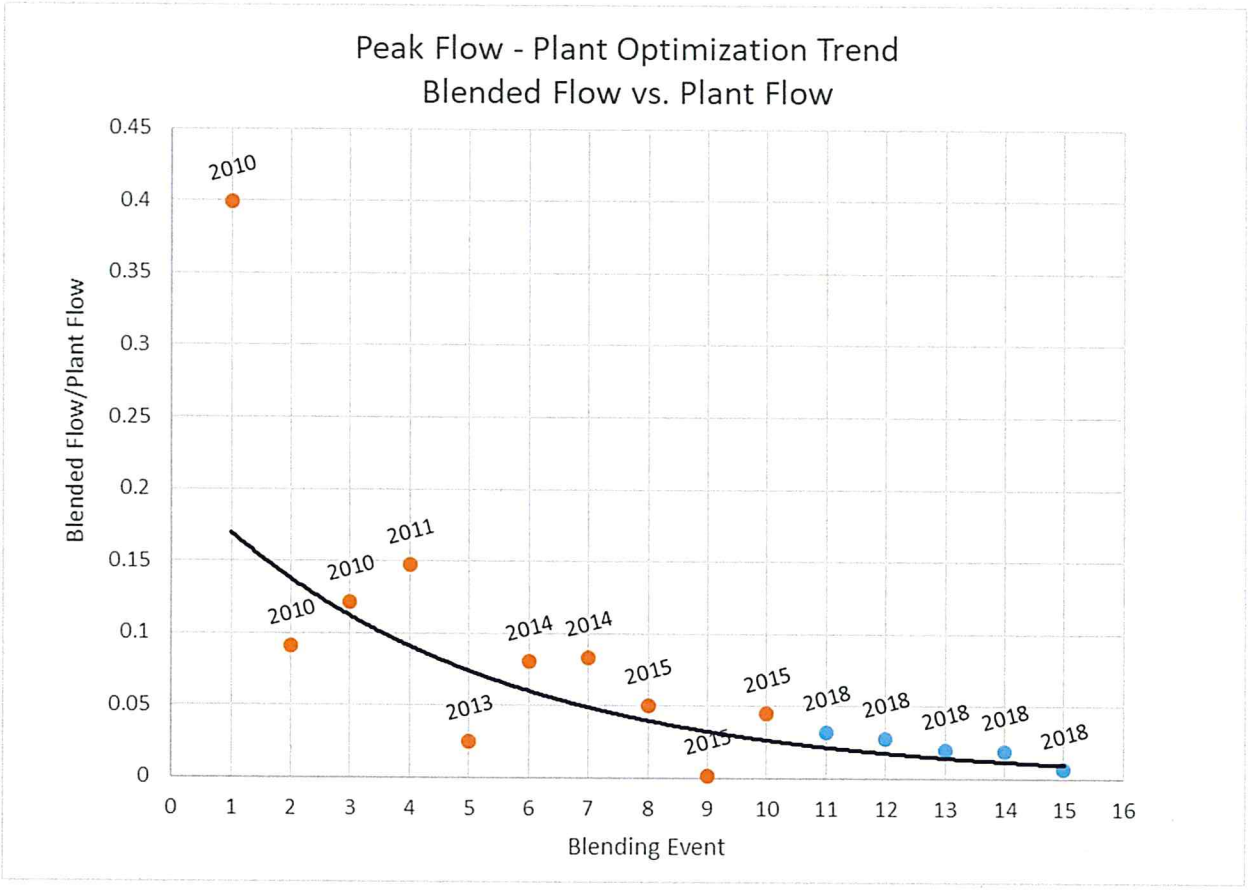
YEAR	PLANT FLOW (million gallons)	ANNUAL REPORTED PRECIPITATION (inches)	NUMBER OF SECONDARY TREATMENT DIVERSIONS	VOLUME OF DIVERTED FLOW (million gallons/year)
2010	2,391.17	32.25	3	16.618
2011	2,359.30	30.08	1	3.998
2012	1,844.61	17.89	0	0
2013	2,014.11	27.14	1	0.562
2014	2,079.44	29.34	2	3.549
2015	1,887.99	29.93	3	2.185
2016	2,020.67	27.71	0	0
2017	2,094.20	26.89	0	0
2018	**2,127.69**	**31.01**	**5**	**2.062**

In 2018, the annual precipitation as recorded by the rain gauge located at the plant was 31.01 inches. HOVMSD had five rainfall events that generated flows in excess of the plant capacity requiring the plant to utilize the secondary diversion facility to treat a total volume of 2.062 million gallons. Specific details of the plant's secondary treatment events are shown in the following table.

PLANT SECONDARY TREATMENT DIVERSION DETAILS

DATE	PLANT FLOW (million gallons)	FOX ENERGY PUMPING (million gallons)	VOLUME OF DIVERTED FLOW (million gallons/event)
July 14, 2010	30.824	2.240	12.304
July 15, 2010	21.535	2.045	1.954
August 11, 2010	19.408	0.832	2.360
April 26, 2011	27.177	0.763	3.998
	2012 - None		
April 10, 2013	22.526	2.221	0.562
April 14, 2014	21.435	0.050	1.718
May 12, 2014	21.958	1.505	1.831
June 15, 2015	15.934	3.277	0.800
September 8, 2015	15.346	2.453	0.027
December 14, 2015	30.390	1.877	1.358
	2016 – None		
	2017 – None		
May 4, 2018	**23.269**	**0**	**0.750**
June 18, 2018	**13.728**	**2.400**	**0.382**
August 28, 2018	**20.056**	**3.607**	**0.392**
September 4, 2018	**21.826**	**1.865**	**0.418**
October 10, 2018	**18.291**	**3.390**	**0.120**

It was observed that in 2018 the volume of blended flow per event was less than 1 million gallons for all five occurrences. Of the other ten blending events reported since 2010, only 3 others were below 1 million gallons. Per discussions with plant staff, it was noted that in 2018 operations staff were on alert in anticipation of high flows and ready to optimize flow through the plant during rain events. To further evaluate this condition, the volume of blended flow for an event was divided by the overall plant flow for that same event. The results are shown on the following graph, and illustrate that the facility has consistently reduced the ratio of blended flow to total plant flow. This is evidence that the operations staff have been instrumental in reducing the volume of blended flow discharge to the Fox River.



STORM EVENT IDENTIFICATION

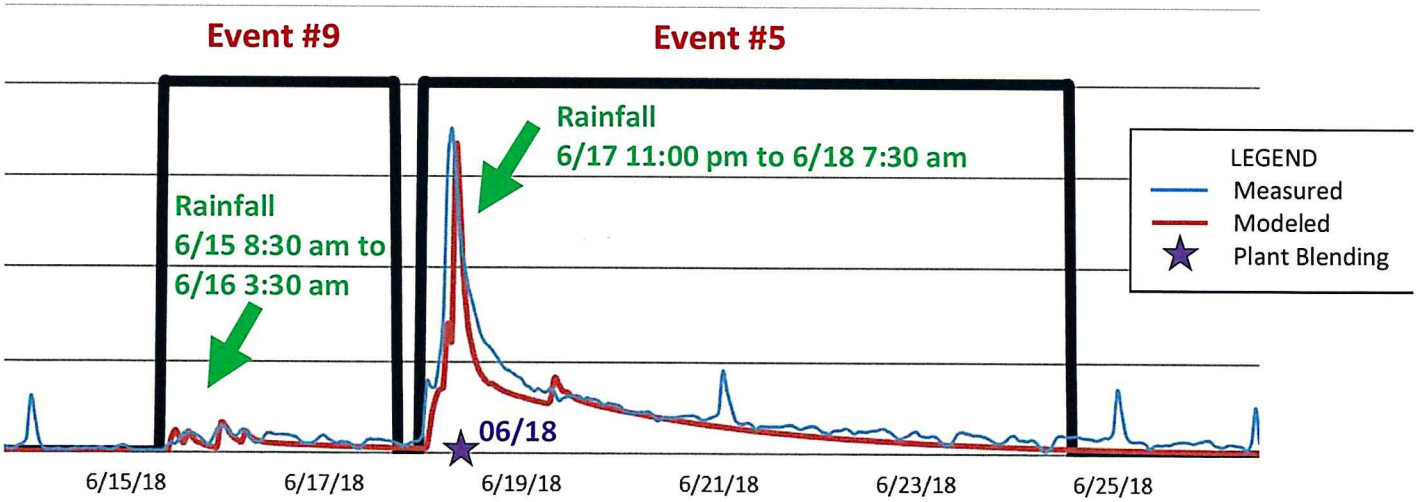
The top nine rainfall events in 2018 were identified and are summarized in the table below. Although measured rainfall may only be a few hours for a specific event, the flow evaluation period may extend several days beyond the point of last rain drop. An evaluated event period begins at the start of measured rainfall and ends when measured sewer flows return to prestorm conditions.

TOP RAINFALL EVENTS IN 2018

EVENT	RAIN DATES	RAINFALL DURATION	RAINFALL AVERAGE (inches)	* PLANT BYPASS OCCURRED ON	FLOW EVENT DATES	NO. OF DAYS AFTER RAINFALL FOR FLOW TO NORMALIZE
1	8/26 – 8/29 *	3.3 days	5.06	8/28	8/26 – 9/3	5
2	9/3 – 9/5 *	2.2 days	2.78	9/4	9/3 – 9/9	4
3	10/7 – 10/10 *	2.0 days	2.45	10/10	10/7 – 10/14	4
4	5/1 – 5/4 *	2.5 days	2.20	5/4	5/1 – 5/8	4
5	6/18 *	8 hours	2.02	6/18	6/18 – 6/24	6
6	7/25	3 hours	1.44		7/25 – 8/1	7
7	10/1	8 hours	0.81		10/1 – 10/3	2
8	05/09	15 hours	0.64		5/9 – 5/11	2
9	6/15	19 hours	0.65		6/15 – 6/17	2

Notes:
1- Rainfall data available from March 23, 2018 to December 14, 2018.
2- Last major snow melt occurred around April 26, 2018.

Figure 1: Kaukauna Measured vs. Modeled Flow – Event #9 and Event #5



Event 9
Rain Began:
6/15/18 8:30 am
Rain Ends:
6/16/18 3:30 am

Event 5
Primary Rainfall (2.23 inches)
Rain Began: 6/17/18 11:00 pm Rain Ends: 6/18/18 7:30 am
Secondary Rainfall (0.11 inches)
Rain Began: 6/19/18 5:00 am Rain Ends: 6/19/18 8:30 am

ANTECEDENT MOISTURE MODELING

Donohue previously used the antecedent moisture model with flow data from 2006-2008 and 50 years of rainfall and temperature data to:

- Calibrate the collection system performance,
- Predict the future plant flows and interceptor performance assuming there were no changes within the system to reduce clear water flow, and
- Extrapolate future plant flows and interceptor performance given completed efforts to reduce the clear water (inflow and infiltration) within the system.

The same model is now used on an annual basis to evaluate the yearly, incremental change in the overall system performance.

The member community scatter plots included at the end of the memorandum depict the AMM modeling results.

1. The results are presented as a comparison of the modeled flow versus the measured flow for given rainfall events.
2. The modeled flow is the flow that is predicted for a rainfall event based on the calibrated model.
3. The measured flow is the actual flow measured by a member community meter station for a rainfall event or the combined measured flow for a community with multiple meter stations.
4. The diagonal, heavy solid line represents the point at which the measured flow matches the modeled flow. This is the baseline (2006-2008 reference line) at the beginning of the program and the line to compare progress.
5. For points above the baseline, the modeled flow over-predicts the measured flow. Therefore, the sanitary sewer system is producing less flow than the model would have predicted for the given storm event. It is assumed that this represents clear water reduction progress.
6. For points below the baseline, an individual storm event produced a greater amount of flow than predicted. It is assumed that this represents more clear water in the system than at the point of original calibration.
7. A trend line is given for each year to summarize the analyzed storm events in that given year.
8. Trend line above the solid, baseline represents clear water reduction progress compared to baseline year.
9. Tread lines below the solid, baseline represent an increase in clear water in the sanitary sewer system compared to the baseline.
10. In an ideal, closed system where continual clear water reduction occurs, the annual tread lines would be increasing over the solid baseline.
11. Models adjusted for landfill leachate flows for Little Chute and Kaukauna communities.

The modeled flows represent the impact of peak flows. Communities continue to reduce the base flow component of their total flow by implementing projects such as repairs or replacement of cracked or damaged pipes, manholes, and connections in the sanitary sewer system. These sources of flow are true I/I sources but have a constant flow of water due to their location below groundwater or in/alongside the river. As a result, they appear to be part of the 'base' flow for the communities.

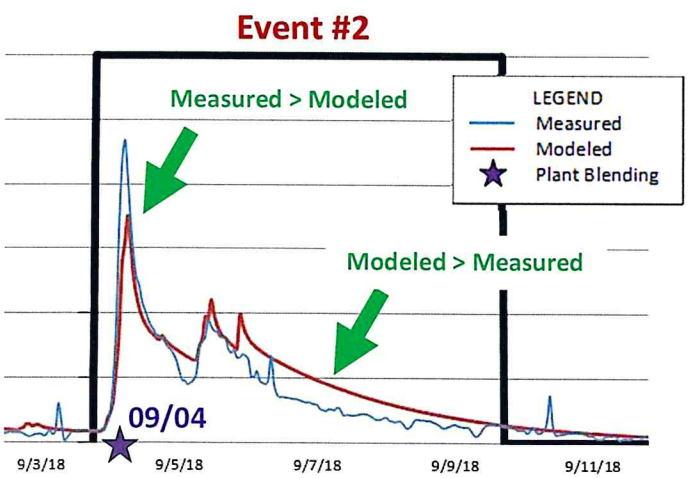
Three of the identified nine storm events were not included in the analysis and are not shown on the resultant figures included at the end of the memorandum.

- Storm Event #1 which began on August 26, 2018 was not included in the AMM flow analysis. The model was not calibrated to match the storm intensity conditions of this event.
- Storm Event #4 which began on May 1, 2018 was not included in the AMM flow analysis. The model was not calibrated to reflect the conditions during which this storm event took place, including lower temperatures and record setting snow falls in April. Also, a debris plug in the syphon caused interceptor back-ups during the storm event that impacted measured flows.
- Storm Event #6 which began on July 25, 2018 was not included in the AMM flow analysis. The model was not calibrated to reflect the conditions during which this storm event took place, an isolated highly intense storm event with dry soils.

Member community modeling results for the remaining seven storm events showing the *Annual Peak Flows* and *Three Year Rolling Averages of Peak Flows* are included at the end of this memorandum.

Observations of note are as follows:

- Darboy was the only community to show improvement in annual peak flow reduction which also is reflected as an improvement in Darboy's 3-year rolling average.
- Kaukauna, Kimberly, Combined Locks and Little Chute all showed greater measured flows during 2018's higher intensity storm events, Event #2 and Event #3, which was reflected by a decrease in the annual peak flow and 3-year rolling average performance for these communities.
- Model analysis did show that during smaller storm events such as Event #8 and Event #9. Kaukauna, Kimberly, Combined Locks and Little Chute had measured flows lower that the AMM modeled flows indicating a reduction of I/I in comparison to the base year. However lower volume events have a smaller influence on the overall trendline resultant.



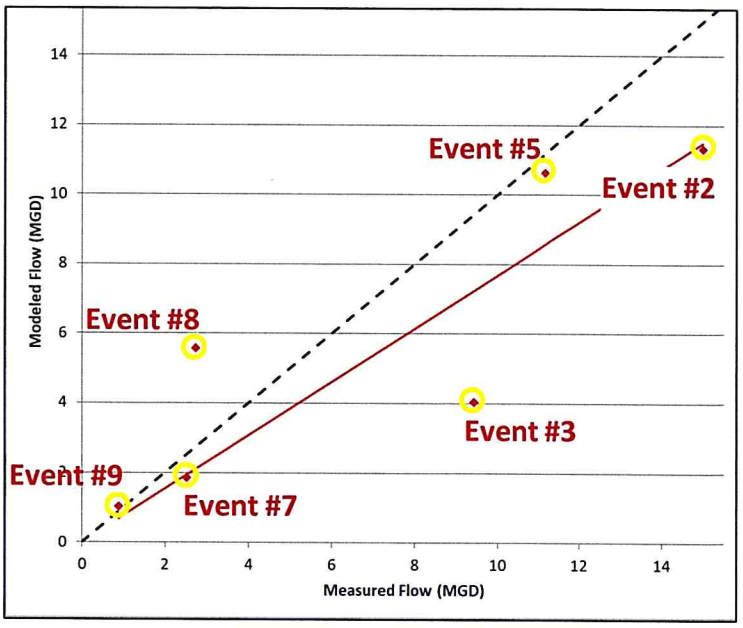


Figure 2 (left): Kaukauna Measured vs. Modeled Flow

Figure 3 (right): Kaukauna 2018 Annual Peak Trendline

MEMBER COMMUNITY CMAR DATA

WDNR requires that member communities and the district prepare annual CMARs and submit them to the WDNR by October of each year. The CMAR has sanitary sewer condition performance indicators that include:

- lift station failures
- sewer pipe failures
- sanitary sewer overflows
- basement backups
- number of complaints
- peaking factor ratio (peak monthly to annual daily average)
- peaking factor ratio (peak hourly to annual daily average)

Annual reported precipitation is provided by HOVMSD based on one regional recording station. Individual community rainfall gages are not used for the annual total precipitation values as they are not in service during frost/freezing susceptible times (late fall to early spring). A summary of the previous performance indicators and CMAR flow data/peaking factor ratios for each community are summarized in the following tables.

CMARs from the communities were reviewed to determine the trend in the performance indicators. CMAR summaries are given on the following pages. Observations of note are as follows:

- Sewer failures in 2018 were caused by system blockages or lift station equipment malfunction, not insufficient capacity.
- The average daily flow for 2018 increased for Kaukauna, Kimberly and Little Chute over the previous year.
- The average daily flows were the highest in the last 7-years for Kaukauna and Kimberly.
- The monthly peak flow occurred in April for all communities except Kaukauna. The second highest monthly peak flow occurred in May in Kimberly, Darboy and Combined Locks.
- Kaukauna had a monthly peak flow of 3.89 mgd in both May and October.
- The 2018 peak monthly flows increased for all communities, except Darboy.
- Peak hourly flows increased significantly in 2018 with more intense rain events while average daily flows had slight changes, resulting in the highest peaking factor ratios since 2010.

PREVIOUS 5-YEAR COMPARISON
AVERAGE DAILY FLOW IN MGD

	Kaukauna	Kimberly	Little Chute	Combined Locks	Darboy
2014	2.60	0.75	1.45	0.36	1.06
2015	2.25	0.65	1.25	0.31	0.92
2016	2.41	0.76	1.36	0.32	0.82
2017	2.66	0.77	1.57	0.35	0.94
2018	2.85	0.84	1.56	0.35	0.92

Kaukauna

KAUKAUNA CMAR PERFORMANCE INDICATOR SUMMARY				
YEAR	NUMBER OF LIFT STATION FAILURES[1]	NUMBER OF SEWER PIPE FAILURES	NUMBER OF BASEMENT BACKUP OCCURRENCES	NUMBER OF COMPLAINTS
2010	0	1	0	27
2011	0	1	2	26
2012	0	0	3	32
2013	0	0	2	30
2014	0	0	0	27
2015	0	0	0	17
2016	0	0	0	0
2017	1	0	0	0
2018	1	0	0	0

[1]Kaukauna has five major (traditional) and two minor lift stations. One of the minor lift stations is a semi-public station at the softball fields/1000 Islands Park. The second minor lift station is manually operated to pump leachate from an old landfill. HOV is notified each time the landfill lift station is operated.

On March 6, 2018 the Bel Air Court lift station floats failed to trip the pumps, resulting in a SSO. The station had been inspected the previous day. Resetting the floats corrected the situation. The reason for the failure is unknown, but the City has scheduled daily inspections to check floats until a future upgrade project can be implemented that will include the addition of telemetry to the alarm system at this location. None of the 25 complaints filed in 2018 were found to be related to a City sanitary sewer issue.

KAUKAUNA CMAR PEAKING FACTOR RATIOS					
YEAR	ANNUAL REPORTED PRECIPITATION (inches)	ANNUAL AVERAGE DAILY FLOW (MGD)	PEAKING FACTOR RATIO (MONTHLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO (PEAK HOURLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO – TOP 10 AVERAGE (PEAK HOURLY: ANNUAL DAILY AVERAGE)
2010	32.25	3.07	1.60	6.58	4.47
2011	30.08	3.53	1.55	4.02	3.14
2012	17.89	2.36	1.44	6.79	3.69
2013	27.14	2.35	1.77	5.51	3.79
2014	29.34	2.60	1.57	6.99	4.19
2015	29.93	2.25	1.60	8.93	4.94
2016	23.59	2.41	1.61	5.19	3.34
2017	25.34	2.66	1.32	3.72	3.33
2018	27.37	2.85	1.37	7.88	5.32

Kaukauna experienced its highest recorded hourly flow of 22.43 mgd on August 28, 2018. Followed by its second highest of 21.12 on September 4, 2018.

Little Chute

LITTLE CHUTE CMAR PERFORMANCE INDICATOR SUMMARY				
YEAR	NUMBER OF LIFT STATION FAILURES	NUMBER OF SEWER PIPE FAILURES	NUMBER OF BASEMENT BACKUP OCCURRENCES	NUMBER OF COMPLAINTS
2010	NA	0	2	2
2011	NA	0	0	0
2012	NA	0	2	2
2013	NA	0	0	0
2014	NA	0	0	0
2015	NA	0	0	0
2016	NA	0	0	0
2017	NA	0	0	0
2018	NA	0	0	0

One complaint was filed but was found to be related to a private lateral blockage, not a City sewer issue.

LITTLE CHUTE CMAR PEAKING FACTOR RATIOS					
YEAR	ANNUAL REPORTED PRECIPITATION (inches)	ANNUAL AVERAGE DAILY FLOW (MGD)	PEAKING FACTOR RATIO (MONTHLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO (PEAK HOURLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO – TOP 10 AVERAGE (PEAK HOURLY: ANNUAL DAILY AVERAGE)
2010	32.25	1.46	1.66	9.49	5.31
2011	30.08	1.49	2.05	5.65	3.94
2012	17.89	1.16	1.50	5.20	3.71
2013	27.14	1.39	1.75	4.80	3.44
2014	29.34	1.45	1.67	6.01	4.00
2015	29.93	1.25	1.54	9.33	4.27
2016	25.22	1.36	1.65	4.68	3.08
2017	27.91	1.57	1.50	3.30	2.95
2018	27.54	1.56	1.77	6.79	4.58

Little Chute's highest recorded hourly flow for 2018 was 10.60 mgd on August 28, 2018.

Kimberly

KIMBERLY CMAR PERFORMANCE INDICATOR SUMMARY				
YEAR	NUMBER OF LIFT STATION FAILURES[1]	NUMBER OF SEWER PIPE FAILURES	NUMBER OF BASEMENT BACKUP OCCURRENCES	NUMBER OF COMPLAINTS
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	1	1
2016	0	0	0	0
2017	0	0	0	0
2018	0	1	3	1

[1]Kimberly had three lift stations in 2009 when the system was originally modeled. In 2018, Kimberly has one remaining lift station.

Only one complaint of the eleven files was related to a failure in the City sewer system. On February 20, 2018 a garbage bag blocks flow in the sanitary sewer, causing a backup occurrence that affected three structures.

KIMBERLY CMAR PEAKING FACTOR RATIOS					
YEAR	ANNUAL REPORTED PRECIPITATION (inches)	ANNUAL AVERAGE DAILY FLOW (MGD)	PEAKING FACTOR RATIO (MONTHLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO (PEAK HOURLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO – TOP 10 AVERAGE (PEAK HOURLY: ANNUAL DAILY AVERAGE)
2010	32.25	0.98	1.71	11.07	7.45
2011	30.08	0.84	2.39	8.36	5.19
2012	17.89	0.68	1.53	7.56	5.14
2013	27.14	0.68	2.00	6.62	4.69
2014	29.34	0.75	1.76	9.32	6.32
2015	29.93	0.65	1.46	14.25	5.96
2016	24.51	0.76	1.64	5.43	3.69
2017	27.59	0.77	1.56	6.83	4.56
2018	25.78	0.84	1.63	11.91	7.08

Kimberly's highest recorded hourly flow for 2018 was 9.95 mgd on September 4, 2018. This was the highest in eight years.

Combined Locks

COMBINED LOCKS CMAR PERFORMANCE INDICATOR SUMMARY				
YEAR	NUMBER OF LIFT STATION FAILURES	NUMBER OF SEWER PIPE FAILURES	NUMBER OF BASEMENT BACKUP OCCURRENCES	NUMBER OF COMPLAINTS
2010	NA	0	2	2
2011	NA	0	0	1
2012	NA	0	0	0
2013	NA	0	0	1
2014	NA	0	0	0
2015	NA	0	0	0
2016	NA	0	0	0
2017	NA	0	0	0
2018	NA	0	0	0

COMBINED LOCKS CMAR PEAKING FACTOR RATIOS					
YEAR	ANNUAL REPORTED PRECIPITATION (inches)	ANNUAL AVERAGE DAILY FLOW (MGD)	PEAKING FACTOR RATIO (MONTHLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO (PEAK HOURLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO – TOP 10 AVERAGE (PEAK HOURLY: ANNUAL DAILY AVERAGE)
2010	32.25	0.38	1.78	10.77	6.55
2011	30.08	0.38	2.13	6.65	4.24
2012	17.89	0.30	1.56	7.74	4.65
2013	27.14	0.34	1.83	6.26	4.03
2014	29.34	0.36	1.75	7.64	5.34
2015	29.93	0.31	1.79	12.04	5.72
2016	24.51	0.32	1.81	5.53	3.81
2017	27.59	0.35	1.51	6.61	4.20
2018	28.37	0.35	1.54	9.94	6.57

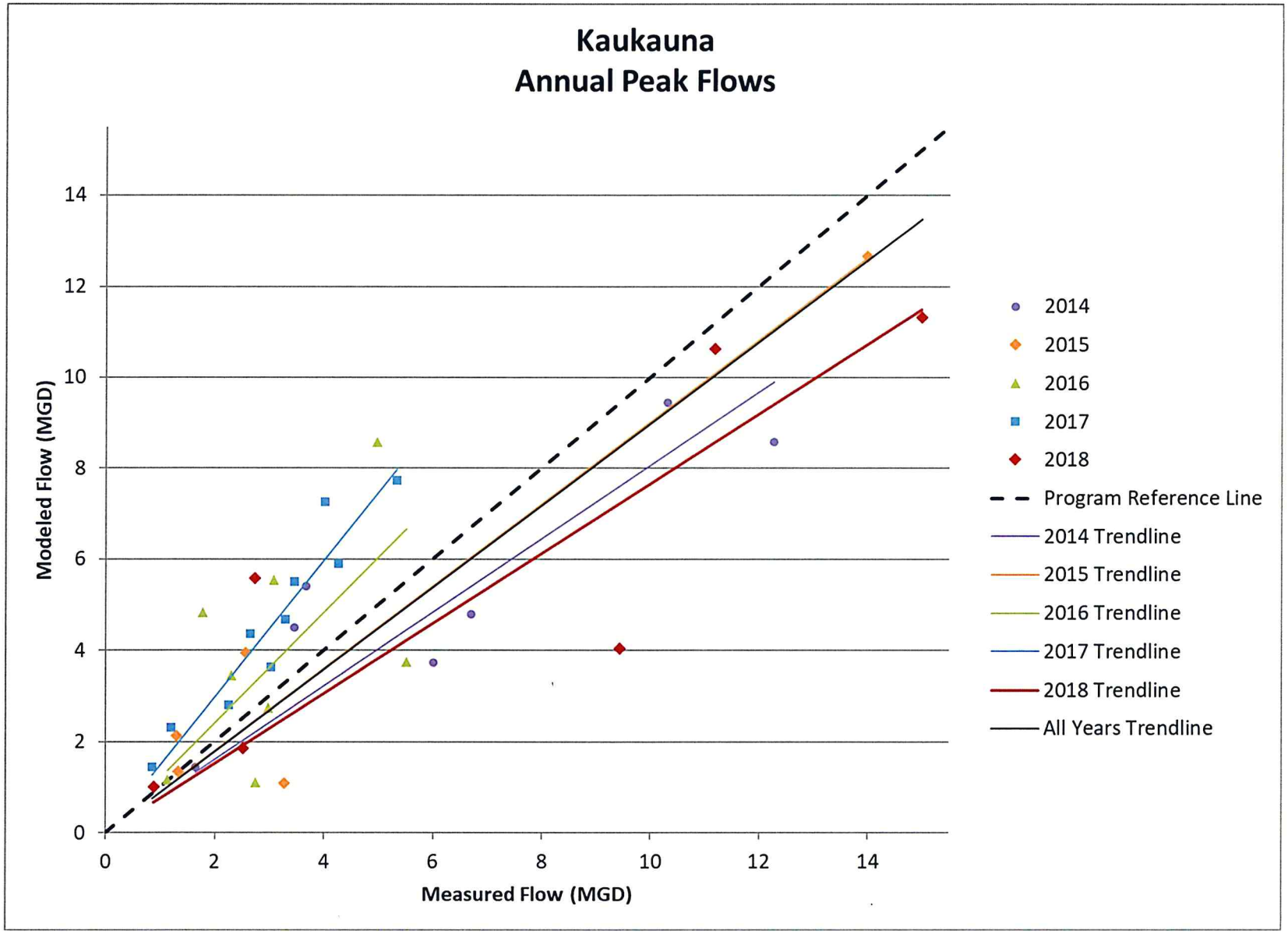
Combined Locks' highest recorded hourly flow for 2018 was 3.46 mgd on September 4, 2018.

Darboy

DARBOY CMAR PERFORMANCE INDICATOR SUMMARY				
YEAR	NUMBER OF LIFT STATION FAILURES	NUMBER OF SEWER PIPE FAILURES	NUMBER OF BASEMENT BACKUP OCCURRENCES	NUMBER OF COMPLAINTS
2010	NA	0	0	0
2011	NA	0	0	0
2012	NA	4	0	4
2013	NA	0	0	0
2014	NA	0	0	0
2015	NA	0	0	0
2016	NA	0	0	0
2017	NA	0	0	0
2019	NA	0	0	0

DARBOY CMAR PEAKING FACTOR RATIOS					
YEAR	ANNUAL REPORTED PRECIPITATION (inches)	ANNUAL AVERAGE DAILY FLOW (MGD)	PEAKING FACTOR RATIO (MONTHLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO (PEAK HOURLY: ANNUAL DAILY AVERAGE)	PEAKING FACTOR RATIO – TOP 10 AVERAGE (PEAK HOURLY: ANNUAL DAILY AVERAGE)
2010	32.25	0.95	1.19	3.60	2.93
2011	30.08	0.96	1.31	2.71	2.36
2012	17.89	0.94	1.11	3.29	2.45
2013	27.14	1.02	1.25	2.76	2.35
2014	29.34	1.06	1.27	2.99	2.29
2015	29.93	0.92	1.14	4.27	2.62
2016	24.64	0.82	1.43	2.82	2.50
2017	26.72	0.94	1.18	2.61	2.13
2018	28.37	0.92	1.17	3.93	2.81

Darboy's highest recorded hourly flow for 2018 was 3.63 mgd on May 4, 2018.


Kaukauna
Annual Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
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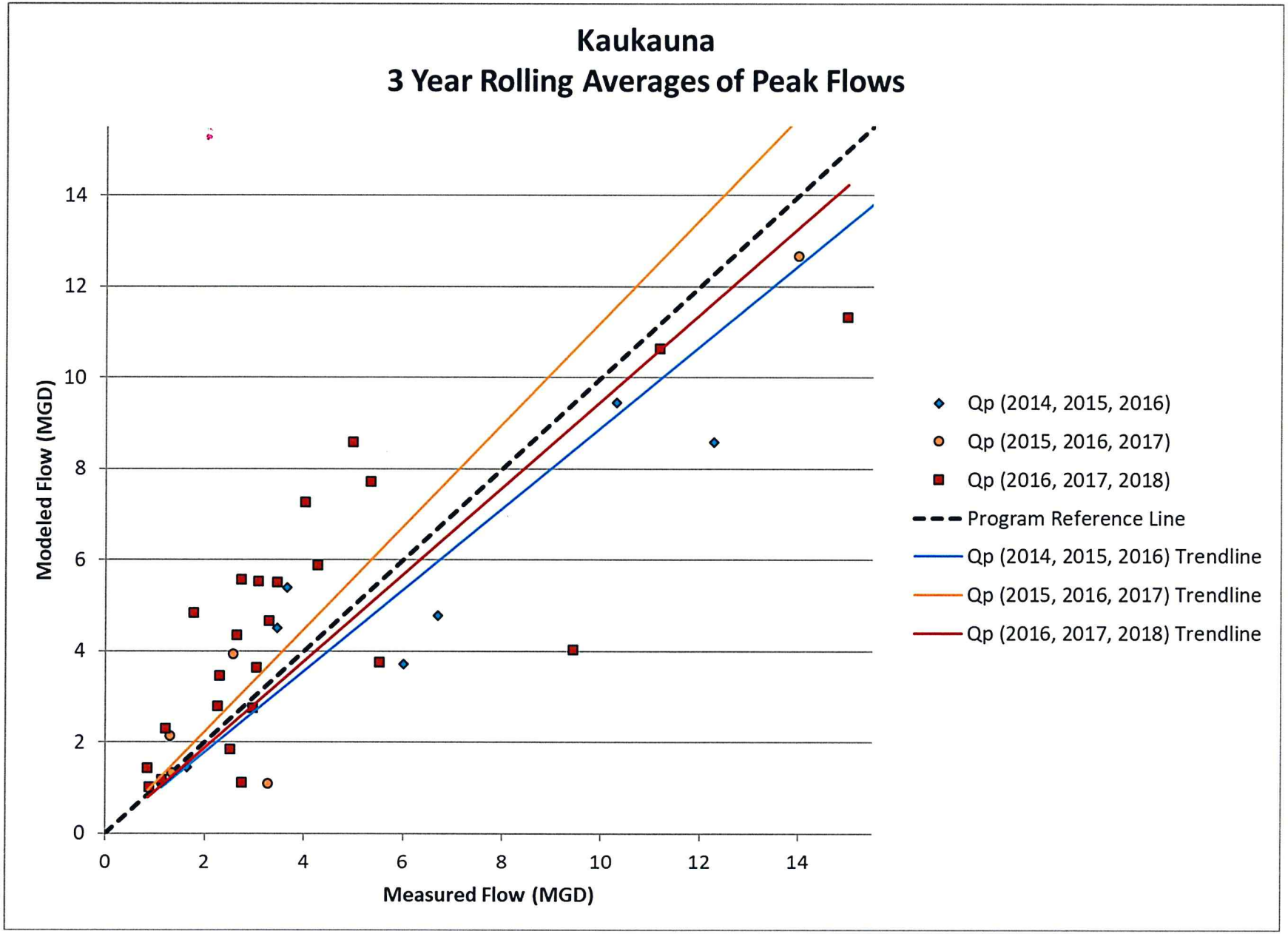
Program Reference Line
2014 Trendline
2015 Trendline
2016 Trendline
2017 Trendline
2018 Trendline
All Years Trendline


Kaukauna
3 Year Rolling Averages of Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0
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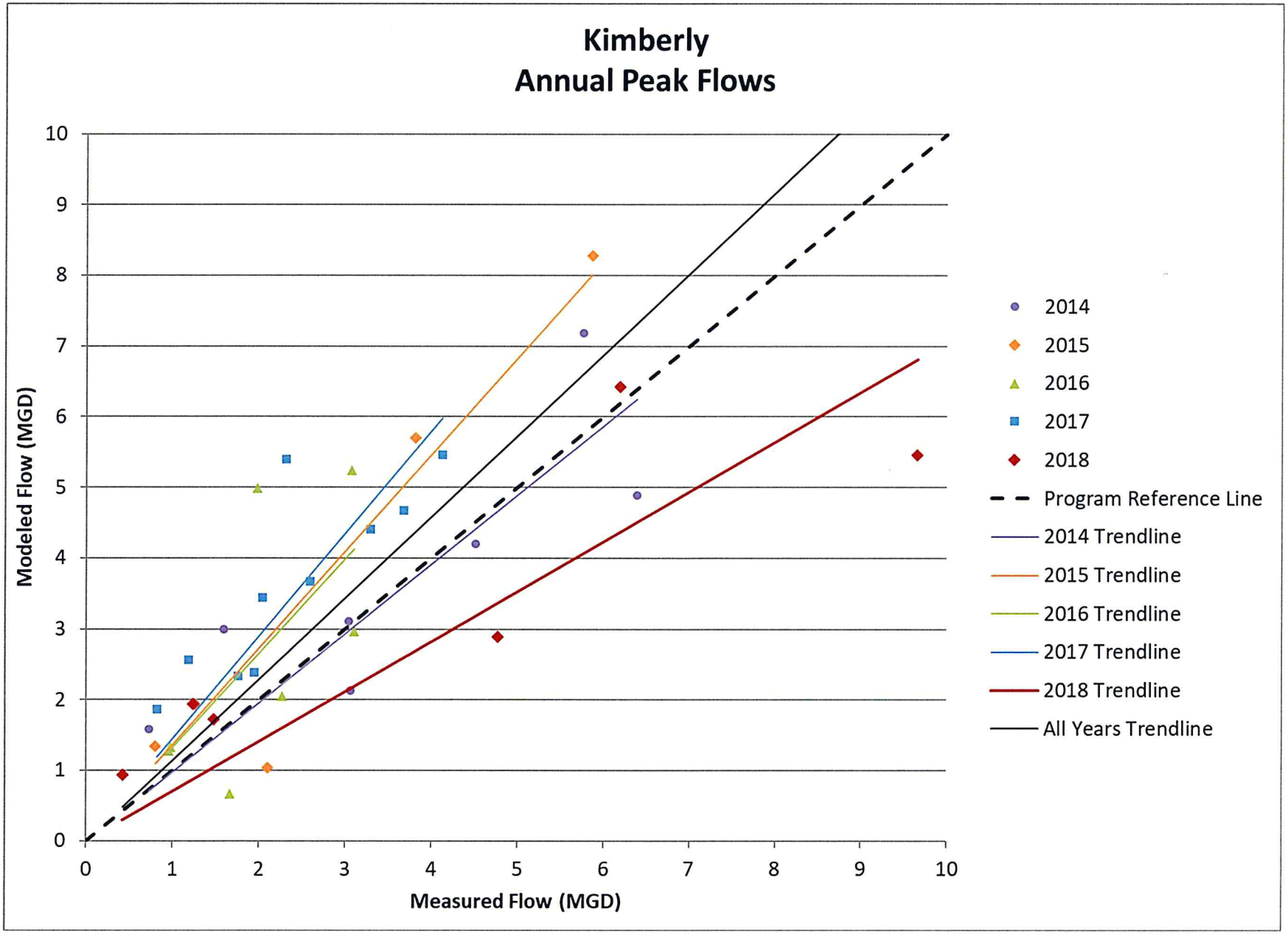
12
14
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Qp (2016, 2017, 2018)
Program Reference Line
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) Trendline
Qp (2016, 2017, 2018) Trendline


Kimberly
Annual Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0
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9
10
2014
2015
2016
2017
2018
Program Reference Line
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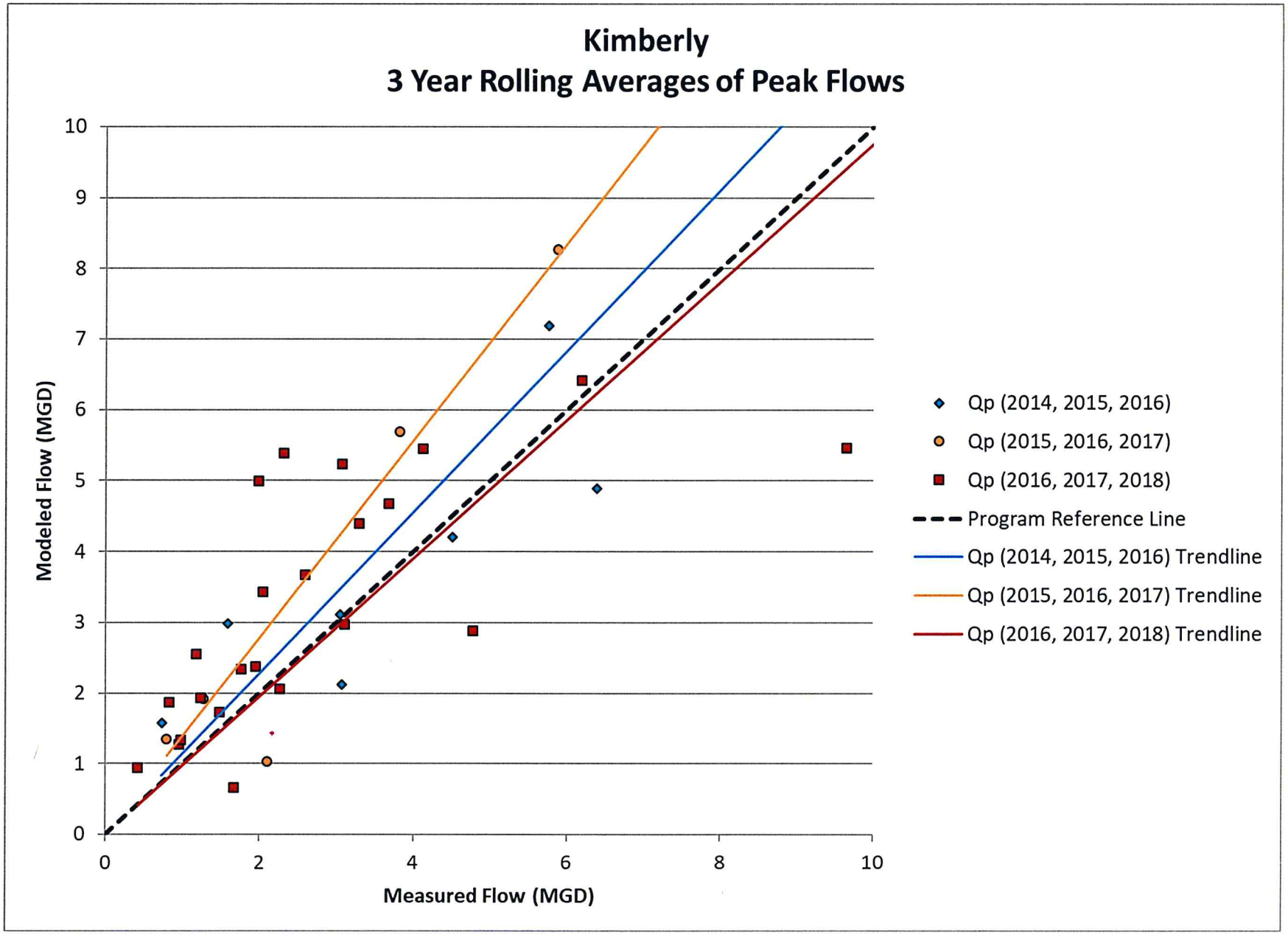
2015 Trendline
2016 Trendline
2017 Trendline
2018 Trendline
All Years Trendline


Kimberly
3 Year Rolling Averages of Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
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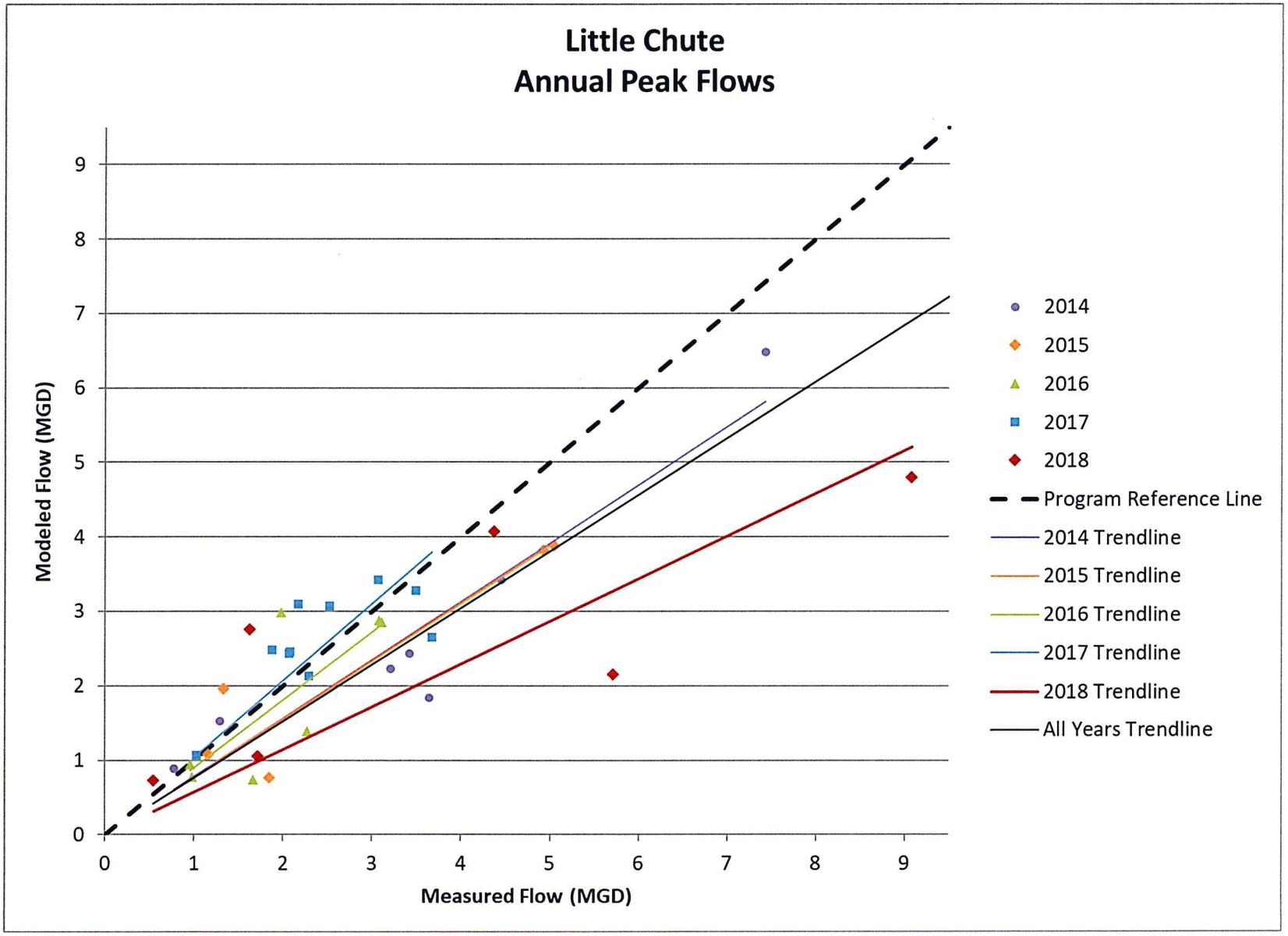
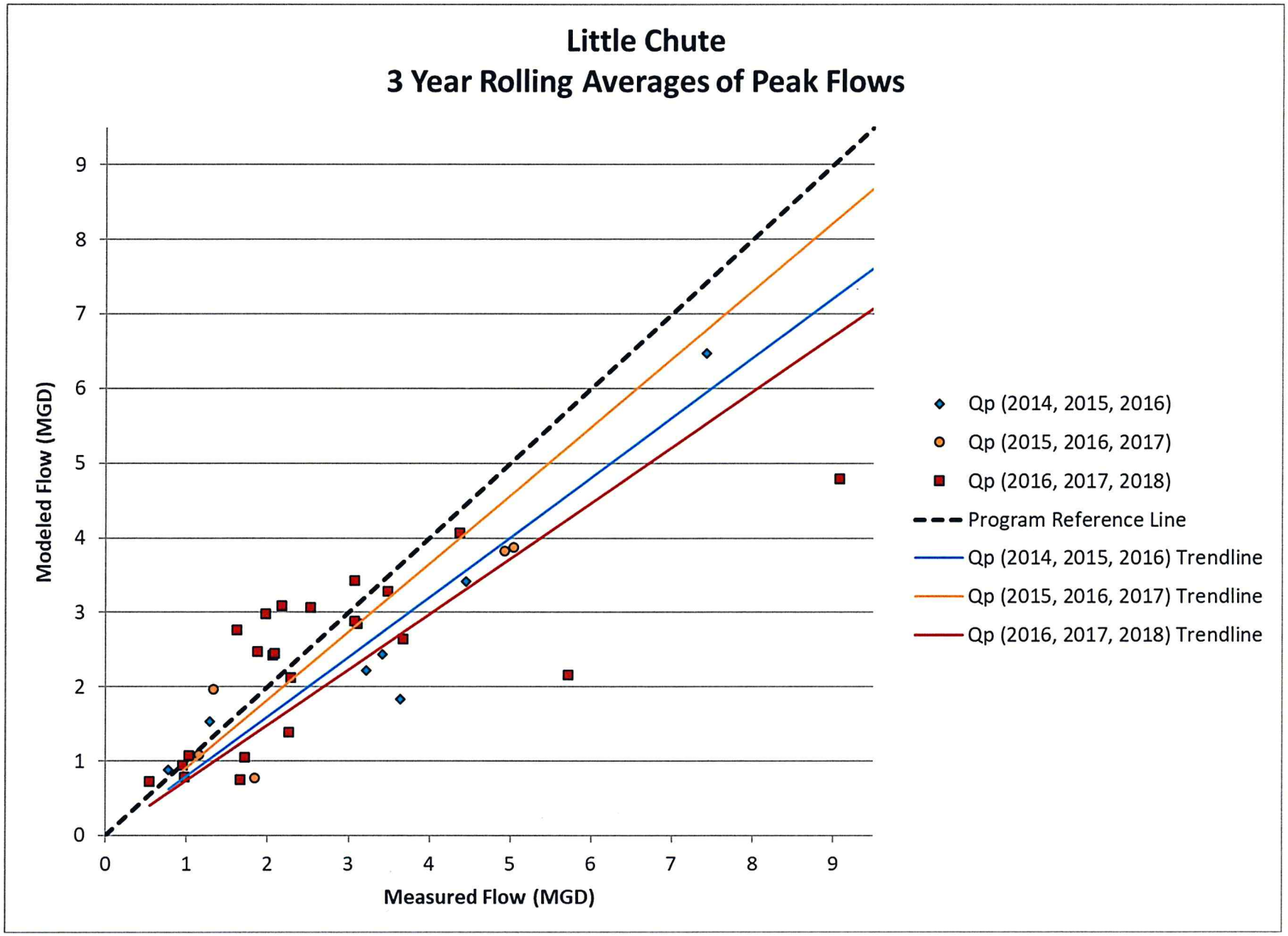
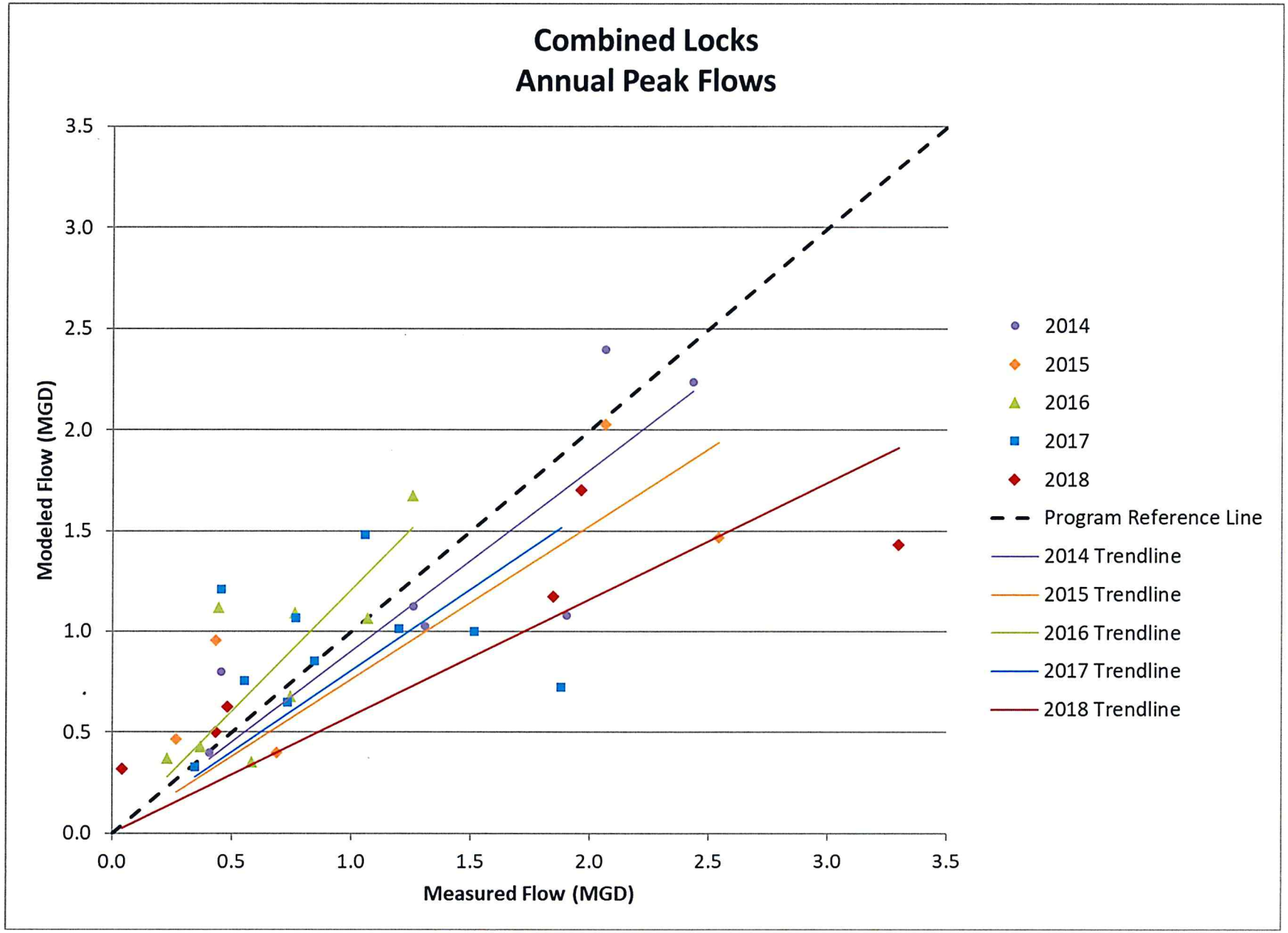
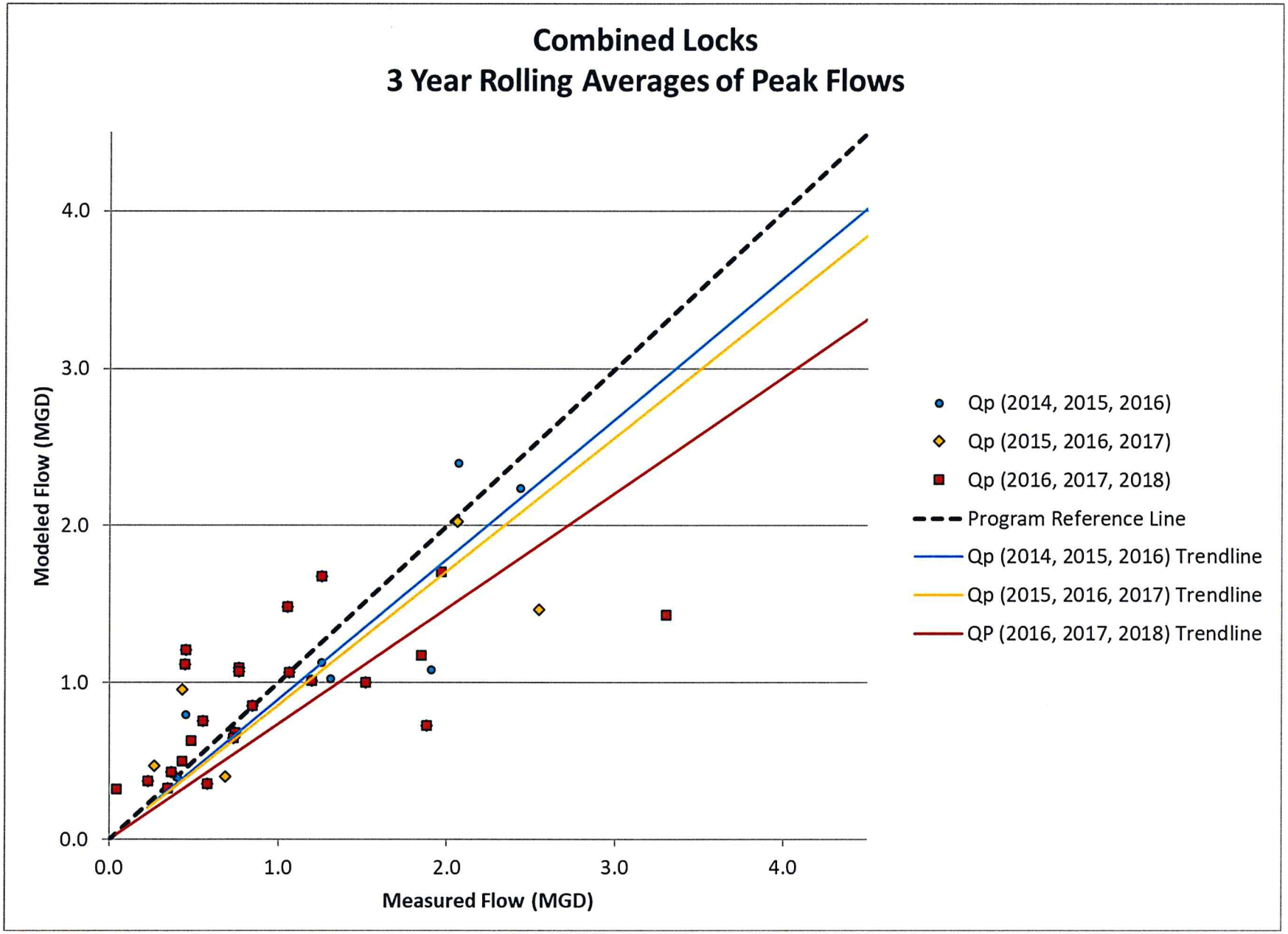
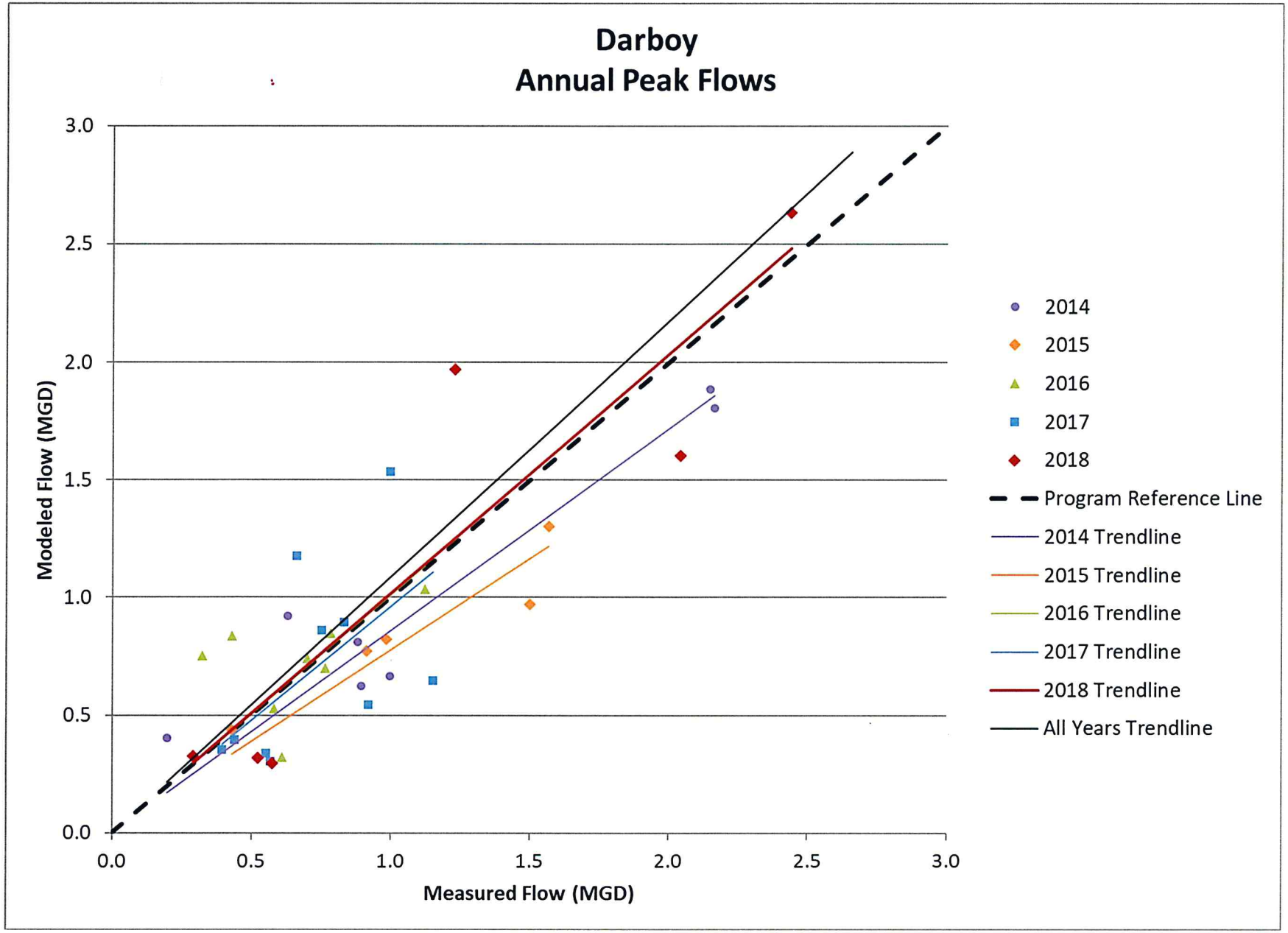
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Qp (2016, 2017, 2018)
Program Reference Line
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) Trendline
Qp (2016, 2017, 2018) Trendline

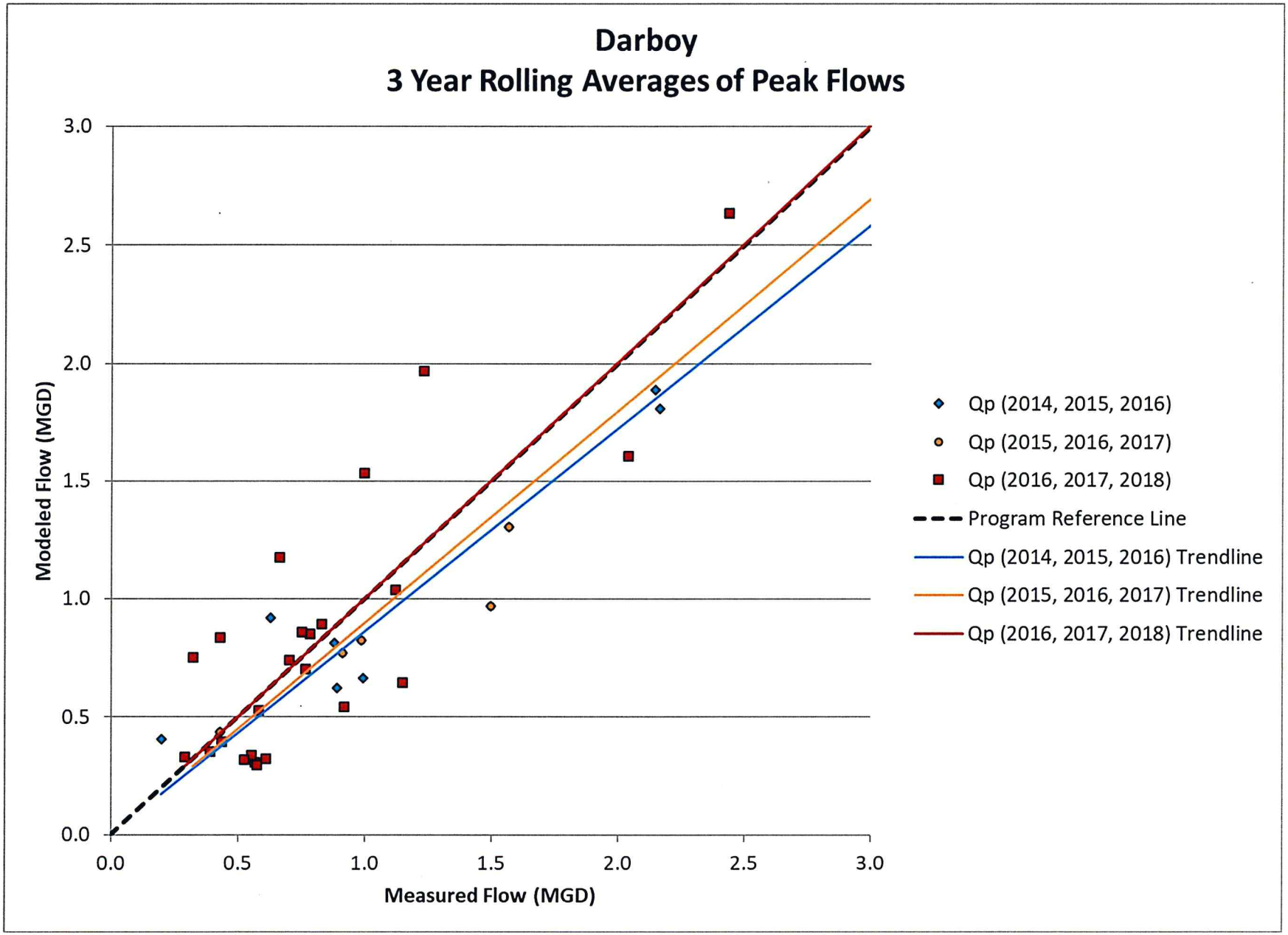

Little Chute
Annual Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0
1
2
3
4
5
6
7
8
9
2014
2015
2016
2017
2018
Program Reference Line
2014 Trendline
2015 Trendline
2016 Trendline
2017 Trendline
2018 Trendline
All Years Trendline


Little Chute
3 Year Rolling Averages of Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0
1
2
3
4
5
6
7
8
9
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Qp (2016, 2017, 2018)
Program Reference Line
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) Trendline
Qp (2016, 2017, 2018) Trendline


Combined Locks
Annual Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
2014
2015
2016
2017
2018
Program Reference Line
2014 Trendline
2015 Trendline
2016 Trendline
2017 Trendline
2018 Trendline


Combined Locks
3 Year Rolling Averages of Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0.0
1.0
2.0
3.0
4.0
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Qp (2016, 2017, 2018)
Program Reference Line
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) Trendline
QP (2016, 2017, 2018) Trendline


Darboy
Annual Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
2014
2015
2016
2017
2018
Program Reference Line
2014 Trendline
2015 Trendline
2016 Trendline
2017 Trendline
2018 Trendline
All Years Trendline


Darboy
3 Year Rolling Averages of Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Qp (2016, 2017, 2018)
Program Reference Line
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) Trendline
Qp (2016, 2017, 2018) Trendline

Heart of the Valley Metropolitan Sewerage District

Member Community Compliance Maintenance Annual Report: Peaking Factor Ratios

January 2010- December 2018

Metric	Kaukauna									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Average daily flow in MGD	3.07	3.53	2.36	2.35	2.60	2.25	2.41	2.66	2.85	
Peak monthly flow in MGD	4.92	5.50	3.39	4.16	4.08	3.59	3.90	3.50	3.89	
Month of peak monthly flow in MGD	July	April	March	April	April	December	March	June	May	
Peak hourly flow in MGD	20.20	14.22	16.03	12.94	18.16	20.12	12.52	9.90	22.43	
Peaking factor ratio Peak Monthly:Annual Daily Avg	1.60	1.55	1.44	1.77	1.57	1.60	1.61	1.32	1.37	
Peaking factor ratio Peak Hourly:Annual Daily Avg	6.58	4.02	6.80	5.51	6.99	8.93	5.19	3.72	7.88	
Top 10 peak hourly flow in MGD: 1	20.20	14.22	16.03	12.94	18.16	20.22	12.52	9.90	22.43	8/28
2	18.90	12.50	10.74	12.93	15.95	20.12	11.37	9.33	21.12	9/4
3	18.04	12.30	9.66	9.98	14.62	17.42	8.33	9.20	17.57	6/18
4	17.76	11.40	8.67	9.40	10.70	8.31	7.65	9.16	17.34	5/4
5	10.78	10.19	7.38	8.45	10.66	8.28	7.34	8.89	15.33	10/9
6	10.64	10.19	7.26	7.33	7.99	8.01	6.90	8.62	14.15	
7	10.58	10.18	7.02	7.22	7.92	7.71	6.75	8.55	11.53	
8	10.43	10.04	6.76	7.01	7.67	7.64	6.68	8.51	11.10	
9	10.01	9.98	6.76	6.90	7.67	6.76	6.57	8.30	10.71	
10	9.77	9.95	6.75	6.87	7.57	6.68	6.50	8.24	10.29	
Peaking factor ratio Ave Top 10 Peak Hourly:Annual Daily Avg	4.47	3.14	3.69	3.79	4.19	4.94	3.34	3.33	5.32	

Peak monthly flow is the highest average rate for any given calendar month

Peak hourly flow is the highest average rate for any four consecutive 15-minute reporting intervals

Heart of the Valley Metropolitan Sewerage District

Member Community Compliance Maintenance Annual Report: Peaking Factor Ratios

January 2010- December 2018

Metric	Kimberly									
	2010	2011	2012	2013	2014	2015 [1]	2016	2017	2018 [2]	
Average daily flow in MGD	0.98	0.84	0.68	0.68	0.75	0.65	0.76	0.77	0.84	
Peak monthly flow in MGD	1.68	2.01	1.04	1.37	1.32	0.95	1.25	1.20	1.36	
Month of peak monthly flow in MGD	July	April	March	April	April	December	March	April	April	
Peak hourly flow in MGD	10.90	7.05	5.11	4.52	6.99	9.32	4.14	5.26	9.95	
Peaking factor ratio Peak Monthly:Annual Daily Avg	1.71	2.39	1.53	2.00	1.76	1.46	1.64	1.56	1.63	
Peaking factor ratio Peak Hourly:Annual Daily Avg	11.07	8.36	7.56	6.62	9.32	14.25	5.43	6.83	11.91	
Top 10 peak hourly flow in MGD: 1	10.90	7.05	5.11	4.52	6.99	9.32	4.14	5.26	9.95	9/4
2	10.02	4.62	4.83	4.07	6.77	6.55	3.82	4.48	9.67	8/28
3	9.71	4.47	4.46	3.91	6.22	4.47	3.11	3.88	6.84	5/4
4	8.04	4.32	4.07	3.78	5.18	2.97	2.91	3.85	6.66	6/18
5	7.66	4.14	3.17	3.15	4.93	2.86	2.69	3.24	5.42	10/9
6	6.06	4.10	2.81	2.75	3.89	2.68	2.47	3.10	5.28	
7	5.33	4.05	2.77	2.64	3.84	2.62	2.35	2.95	4.02	
8	5.27	3.98	2.66	2.58	3.70	2.55	2.31	2.94	3.92	
9	5.22	3.63	2.44	2.35	2.95	2.51	2.23	2.86	3.79	
10	5.07	3.37	2.44	2.26	2.93	2.49	2.14	2.58	3.61	
Peaking factor ratio Ave Top 10 Peak Hourly:Annual Daily Avg	7.45	5.19	5.14	4.69	6.32	5.96	3.69	4.56	7.08	

Peak monthly flow is the highest average rate for any given calendar month
Peak hourly flow is the highest average rate for any four consecutive 15-minute reporting intervals

1 Data from 6/9/15 17:30 to 6/11/15 14:00 at the Kimberly meter station was omitted from analysis.
2 Kimberly data omitted from 7/20/18 00:45 to 7/27/18 7:45 because suspect to erroneous

Heart of the Valley Metropolitan Sewerage District

Member Community Compliance Maintenance Annual Report: Peaking Factor Ratios

January 2010- December 2018

Metric	Little Chute									
	2010	2011	2012	2013	2014	2015	2016	2017	2018 [1]	
Average daily flow in MGD	1.46	1.49	1.16	1.39	1.45	1.25	1.36	1.57	1.56	
Peak monthly flow in MGD	2.42	3.05	1.73	2.43	2.42	1.93	2.25	2.37	2.76	
Month of peak monthly flow in MGD	July	April	March	April	April	December	March	April	April	
Peak hourly flow in MGD	13.86	8.42	6.02	6.66	8.73	11.66	6.37	5.20	10.60	
Peaking factor ratio Peak Monthly:Annual Daily Avg	1.66	2.05	1.50	1.75	1.67	1.54	1.65	1.50	1.77	
Peaking factor ratio Peak Hourly:Annual Daily Avg	9.49	5.65	5.20	4.80	6.01	9.33	4.68	3.30	6.79	
Top 10 peak hourly flow in MGD: 1	13.86	8.42	6.02	6.66	8.73	11.66	6.37	5.20	10.60	8/28
2	12.20	6.42	5.91	5.62	8.13	6.63	5.57	5.19	10.18	9/4
3	11.10	6.07	5.44	5.49	7.12	6.19	4.83	5.00	8.93	5/4
4	8.66	6.01	4.45	5.44	6.25	5.61	3.86	4.88	7.09	10/9
5	7.39	5.61	3.92	4.98	5.34	4.49	3.85	4.71	7.04	10/10
6	5.25	5.51	3.63	4.27	5.11	4.07	3.84	4.64	5.81	
7	5.01	5.49	3.43	4.00	4.96	4.04	3.54	4.31	5.60	
8	4.75	5.10	3.41	3.83	4.59	3.61	3.43	4.26	5.58	
9	4.67	5.04	3.34	3.77	3.99	3.53	3.35	4.22	5.52	
10	4.67	5.00	3.32	3.69	3.87	3.47	3.30	3.99	5.14	
Peaking factor ratio Ave Top 10 Peak Hourly:Annual Daily Avg	5.31	3.94	3.71	3.44	4.00	4.27	3.08	2.95	4.58	

Peak monthly flow is the highest average rate for any given calendar month
Peak hourly flow is the highest average rate for any four consecutive 15-minute reporting intervals

1 Little Chute data omitted from 2/23/18 15:45 to 4/10/18 10:00 because suspect to erroneous

Heart of the Valley Metropolitan Sewerage District

Member Community Compliance Maintenance Annual Report: Peaking Factor Ratios

January 2010- December 2018

Metric	Combined Locks									
	2010	2011	2012	2013	2014 [1]	2015	2016 [2]	2017	2018 [3]	
Average daily flow in MGD	0.38	0.38	0.30	0.34	0.36	0.31	0.32	0.35	0.35	
Peak monthly flow in MGD	0.68	0.80	0.47	0.63	0.63	0.56	0.57	0.53	0.54	
Month of peak monthly flow in MGD	July	April	March	April	April	December	March	April	April	
Peak hourly flow in MGD	4.13	2.51	2.33	2.15	2.73	3.75	1.75	2.31	3.46	
Peaking factor ratio Peak Monthly:Annual Daily Avg	1.78	2.13	1.56	1.83	1.75	1.79	1.81	1.51	1.54	
Peaking factor ratio Peak Hourly:Annual Daily Avg	10.77	6.65	7.74	6.26	7.64	12.04	5.53	6.61	9.94	
Top 10 peak hourly flow in MGD: 1	4.13	2.51	2.33	2.15	2.73	3.75	1.75	2.31	3.46	9/4
2	3.19	1.77	2.01	1.92	2.58	2.90	1.57	1.79	3.44	8/28
3	3.18	1.59	1.64	1.51	2.44	2.58	1.33	1.64	2.98	5/4
4	3.17	1.58	1.37	1.37	2.44	1.36	1.15	1.63	2.26	6/18
5	2.79	1.54	1.17	1.24	1.78	1.32	1.11	1.35	2.22	10/9
6	1.96	1.53	1.16	1.22	1.77	1.28	1.05	1.33	2.18	
7	1.85	1.49	1.14	1.21	1.54	1.26	1.04	1.23	1.75	
8	1.65	1.41	1.11	1.14	1.32	1.14	1.04	1.19	1.60	
9	1.61	1.30	1.08	1.04	1.29	1.11	1.01	1.13	1.50	
10	1.59	1.27	0.99	1.00	1.24	1.10	0.99	1.07	1.49	
Peaking factor ratio Ave Top 10 Peak Hourly:Annual Daily Avg	6.55	4.24	4.65	4.03	5.34	5.72	3.81	4.20	6.57	

Peak monthly flow is the highest average rate for any given calendar month
Peak hourly flow is the highest average rate for any four consecutive 15-minute reporting intervals

1 Data from 7/9/14 9:00 to 7/15/14 16:45 at Combined Locks and Darboy meter stations was omitted from analysis. Interceptor maintenance caused surcharging at meter station.

2 No Combined Locks data available until 1/15/16

3 Data from 5/4/18 6:30 am to 5/4/18 9:30 am at Combined Locks and Darboy meter stations was omitted from analysis. Interceptor maintenance caused surcharging at meter station.

Heart of the Valley Metropolitan Sewerage District

Member Community Compliance Maintenance Annual Report: Peaking Factor Ratios

January 2010- December 2018

Metric	Darboy									
	2010	2011	2012	2013	2014 [1]	2015	2016 [2]	2017	2018 [3]	
Average daily flow in MGD	0.95	0.96	0.94	1.02	1.06	0.92	0.82	0.94	0.92	
Peak monthly flow in MGD	1.13	1.26	1.04	1.27	1.35	1.05	1.18	1.11	1.08	
Month of peak monthly flow in MGD	July	April	March	April	April	December	March	March	April	
Peak hourly flow in MGD	3.43	2.61	3.10	2.82	3.18	3.93	2.32	2.46	3.63	
Peaking factor ratio Peak Monthly:Annual Daily Avg	1.19	1.31	1.11	1.25	1.27	1.14	1.43	1.18	1.17	
Peaking factor ratio Peak Hourly:Annual Daily Avg	3.60	2.71	3.29	2.76	2.99	4.27	2.82	2.61	3.93	
Top 10 peak hourly flow in MGD: 1	3.43	2.61	3.10	2.82	3.18	3.93	2.32	2.46	3.63	5/4
2	3.34	2.58	2.78	2.67	2.80	2.76	2.29	2.08	3.56	8/28
3	3.24	2.52	2.72	2.51	2.75	2.45	2.14	2.00	2.96	6/18
4	2.82	2.26	2.38	2.45	2.41	2.28	2.08	1.98	2.92	9/4
5	2.82	2.18	2.10	2.44	2.37	2.22	2.06	1.95	2.43	4/22
6	2.76	2.16	2.06	2.33	2.27	2.18	2.02	1.95	2.18	
7	2.70	2.14	2.03	2.26	2.18	2.15	1.94	1.91	2.08	
8	2.37	2.12	1.98	2.21	2.17	2.14	1.92	1.91	2.08	
9	2.35	2.08	1.96	2.17	2.15	2.01	1.92	1.91	2.06	
10	2.09	2.05	1.96	2.15	2.09	1.99	1.91	1.90	2.05	
Peaking factor ratio Ave Top 10 Peak Hourly:Annual Daily Avg	2.93	2.36	2.45	2.35	2.29	2.62	2.50	2.13	2.81	

Peak monthly flow is the highest average rate for any given calendar month
Peak hourly flow is the highest average rate for any four consecutive 15-minute reporting intervals

1 Data from 7/9/14 9:00 to 7/15/14 16:45 at Combined Locks and Darboy meter stations was omitted from analysis. Interceptor maintenance caused surcharging at meter station.

2 Darboy data omitted until 2/9/16 because suspect it erroneous

3 Data from 5/4/18 6:30 am to 5/4/18 9:30 am at Combined Locks and Darboy meter stations was omitted from analysis. Interceptor maintenance caused surcharging at meter station.