Memorandum

Date: March 13, 2018 (Draft)

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
Jeff Elrick, Village of Little Chute
Joann Ashauer, Darboy Sanitary District No. 1
Dave VanderVelden, Village of Kimberly
Racquel Shampo-Giese, Village of Combined Locks
Dawn Bartel, HOVMSD
Ed Nevers, Donohue & Associates

From: Tracey Webb, Donohue & Associates

Re: **2017 Annual Flow Summary**
Heart of the Valley Metropolitan Sewerage District

The following memorandum documents the analysis and observations of the 2017 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 2017 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	14.258
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

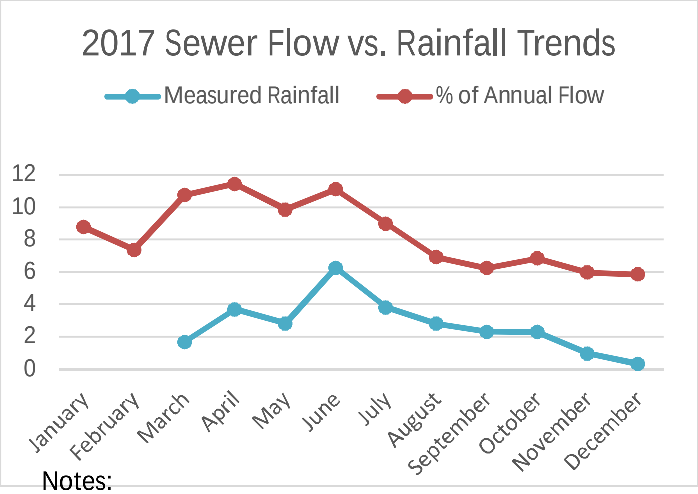
In 2017, HOVMSD was able to provide secondary treatment for the total influent volume during every rainfall event. There were no diversions in 2017. This is the second year in a row that the plant saw no diversions. The rain gauge located at the plant did not work properly. Therefore an average from the four community gauges was used to determine the reported precipitation of 26.89. In 2016 the annual reported precipitation was 27.71 inches which was slightly higher than the 26.89 inches in 2017.

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 28, 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			

Annual reported precipitation in 2017 was the lowest recorded in the last five years. While the actual treated plant flow for 2017 was the highest in the last five years.

MONTHLY SUMMARY OF RAINFALL AND PLANT FLOWS IN 2017			
MONTH	AVERAGE MONTHLY RAINFALL (inches)	PLANT MONTHLY FLOWS (million gallons)	MONTHLY PERCENT OF ANNUAL FLOW (%)
January	N/A	183.493	8.76 %
February	N/A	154.391	7.37 %
March	1.67 (partial)	224.799	10.73 %
April	3.68	239.329	11.43 %
May	2.81	206.521	9.86 %
June	6.26	232.395	11.10 %
July	3.82	188.142	8.98 %
August	2.80	144.717	6.91 %
September	2.30	130.601	6.24 %
October	2.29	143.016	6.83 %
November	0.95	124.659	5.95 %
December	0.31 (partial)	122.136	5.83 %
Annual Total	26.89	2,094.199	

Monthly rainfall and monthly plant flows were reviewed as shown in the table above. The data was plotted on the same graph, as shown on the left below. This shows the continued correlation between the amount of flow processed at the plant and the amount of measured rainfall. Reiterating that a reduction in I/I within the system can impact and reduce loads at the plant.



Notes:
1- Partial rainfall data available for March and December.
2- Last major snow melt occurred on March 7, 2017.

TOP 10 RAINFALL EVENTS IN 2017		
EVENT DATES	STORM DURATION (days)	RAINFALL AVERAGE (inches)
4/15 - 4/16	1.09	0.91
4/26 - 4/27	1.50	1.05
4/30 - 5/02	2.09	0.86
6/03 - 6/04	1.03	1.34
6/12 - 6/14	2.04	1.64
06/22 - 6/26	4.67	1.98
7/07 - 7/07	0.07	1.11
7/15 - 7/15	0.05	0.93
9/20 - 9/20	0.13	1.49
10/03 - 10/07	3.70	1.13

The highest recorded month was June. There were 3 separate significant rain events in June 2017.

The top ten rainfall events in 2017 were utilized in this evaluation. The criteria used to identify an event is a storm with an average measured rainfall of near or over one inch. Event durations are determined based on measured flows. The event period begins at the start of measured rainfall and ends when measured flows return to prestorm conditions. The top ten rainfall events are shown in the table on the right above.

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.

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.

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

Observations:

- Kaukauna, Kimberly, Little Chute and Darboy all showed improvement in annual peak flow reduction.
- Kaukauna continued to show an increase in reduction of annual peak flows in 2017. Their 3-year average peak flow improved significantly and is above the peak flow reduction goal.
- Kimberly showed an increase in peak flow reduction. The 3-year average with 2015, 2016 and 2017 show significant improvement as previous years are weighted down by 2014.
- Little Chute's annual peak flow percent reduction continues to show improvement since 2015 with results above the reference point for 2017. Their 3-year average peak flow also improved from last years.
- Combined Locks' annual peak flow reduction declined in 2017. The 3-year rolling average is generally stable but is showing some continual deterioration.
- Darboy continued to show an increase in reduction of annual peak flows. The three-year rolling average shows continued improvement but is still below the reference line.

MODEL ADJUSTMENTS FOR LANDFILLS

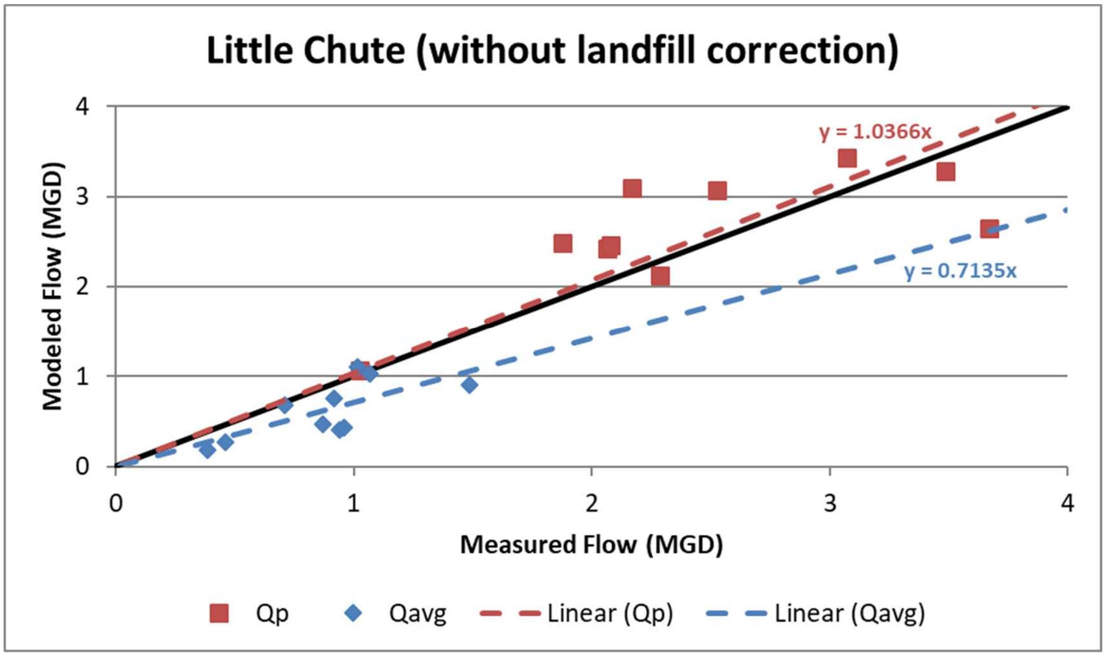
Donohue has estimated rainfall dependent inflow and infiltration (RDII) each year for each community as a whole using flow data collected at the metering stations. However, this does not provide a means of differentiating what portion of the RDII originates on residential, commercial, industrial, or municipal properties.

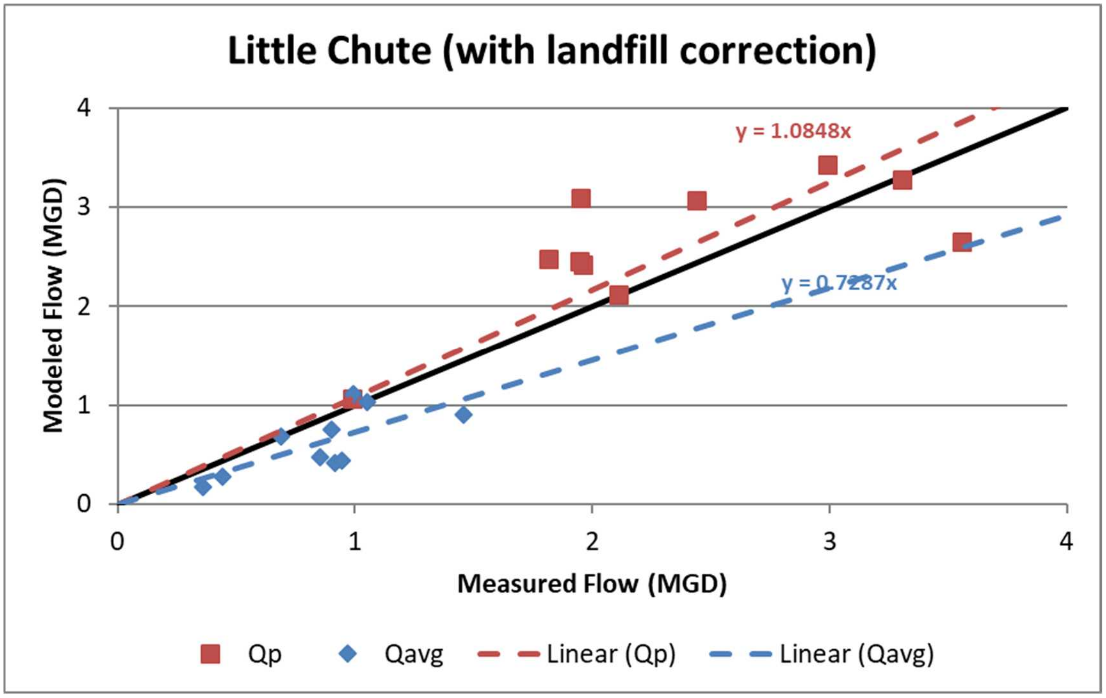
Previously collected data from the Outagamie Landfill in Little Chute and the Red Hills Landfill in Kaukauna was provided to Donohue. Review of this information indicated that there is a trend of increased leachate flow by the landfills to the HOV plant. This increase in landfill leachate may be offsetting reductions in rainfall dependent inflow and infiltration (RDII) from municipal improvements, and anticipated future increases will only amplify the potential impacts Therefore, Donohue was tasked with providing additional evaluation and analysis of the potential impacts of these locations.

In September 2017, additional flow monitoring was provided at the Outagamie Landfill. Information corresponding to flows during the rainfall event occurring on September 20, 2017 were collected for use in the evaluation of rainfall impacts and development of an RDII leachate model. This model was used to estimate rainfall-induced leachate produced by the landfills which was then subtracted from the measured flows along with the community wide baseflow to calculate the measured RDII flow used for comparison to the modeled RDII flow from the AMM analysis.

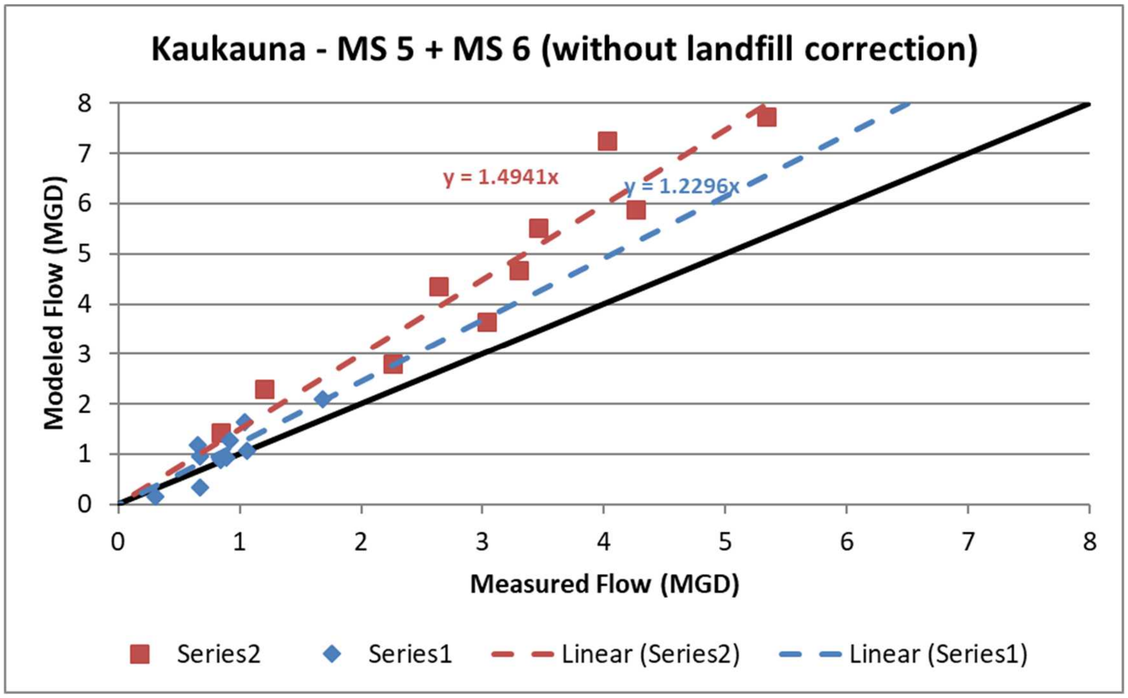
The following summarizes the landfill impacts on the 2017 I/I analysis. This analysis was also used to estimate leachate rainfall impacts for the previous 2013, 2014, 2015 and 2016 years. This updated analysis is reflected in the modeling results showing the *Annual Peak Flows* and *Three Year Rolling Averages of Peak Flows* for Little Chute and Kaukauna included at the end of this memorandum.

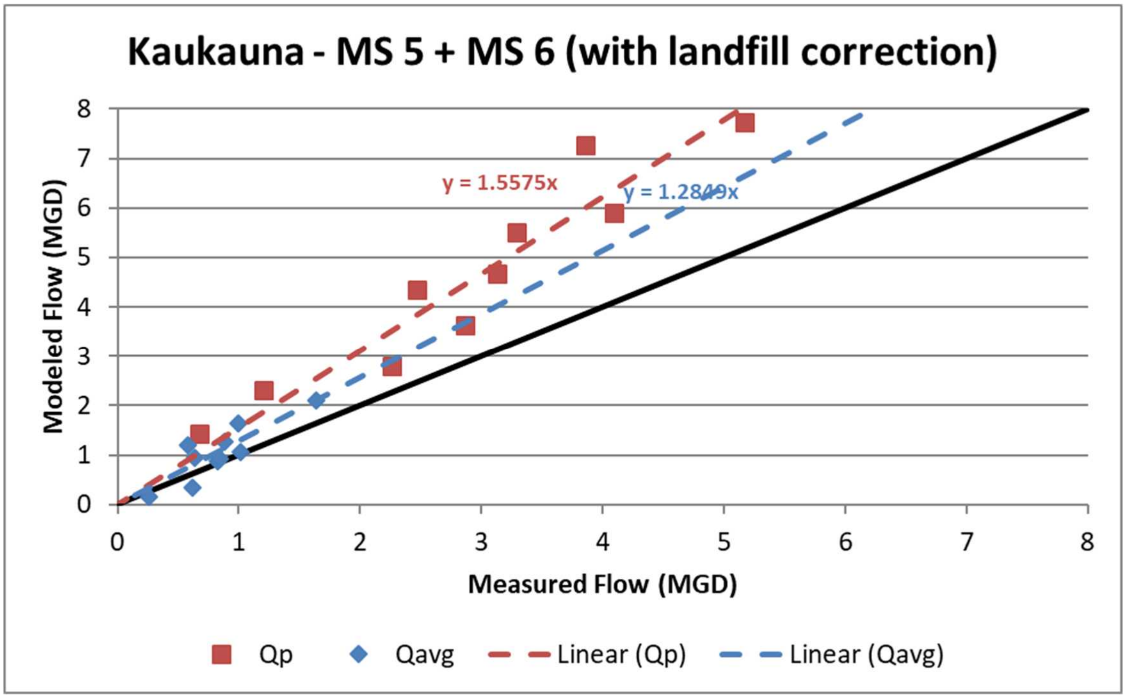
The Outagamie County Landfill is within the Little Chute service area. The rainfall-induced leachate produced by the landfill was subtracted from the measured RDII beginning this year. In order to see what effect this has on the analysis, graphs with and without the landfill correction are shown below. The I/I peak flow and volume reductions increased by 4% and 3%, respectively, when the landfill correction was made.





The Red Hills Landfill is within the Kaukauna service area. The rainfall-induced leachate produced by the landfill was subtracted from the measured MS5 + MS6 RDII beginning this year. In order to see what effect this has on the analysis, graphs for with and without the landfill correction are shown below. Both the I/I peak flow and volume reduction increased by 3% when the landfill correction was made.





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:

PREVIOUS 4-YEAR COMPARISON
AVERAGE DAILY FLOW IN MGD

	Kaukauna	Kimberly	Little Chute	Combined Locks	Darboy
2013	2.35	0.68	1.39	0.34	1.02
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

- None of the communities had a basement backup or sewer complaint in 2017.
- Only one overflow was reported within the HOV system and it was caused by power and equipment failure, not capacity.
- The average daily flow for 2017 increased for all communities over the previous year.
- The average daily flows were the highest in the last 6-years for Kaukauna, Kimberly and Little Chute.
- The monthly peak flow occurred in April for Kimberly, Little Chute and Combined Locks. April had the second highest monthly peak flow for Kaukauna and Darboy.
- The 2017 peak monthly flows decreased for all communities in 2017, except Little Chute.
- For Kimberly and Combined Locks the peak hourly event occurred on July 7 and generated a peak hourly flow higher than the previous year, causing their Peak Hourly Ratio to increase.
- All communities, showed the June 22 event as the second highest peak hourly flow.
- For Little Chute the average daily flow was the highest since 2010 which produced the lowest peaking factor ratios during the comparison period.

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

[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 April 1, 2017 the Augustine lift station lost power due to a squirrel. The backup generator was started but ran out of fuel and was later found to have a faulty fuel gauge. During the period when there was no electricity there was an overflow into a nearby area. Since this occurrence the power has been restored and the generator fuel gauge has been replaced.

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

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

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

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	NA	0	0	0

[1]Kimberly has three lift stations. In 2013, one of the lift stations that serviced part of Kimberly mill was taken out of commission. In 2014, one lift station was eliminated. In 2015, one lift station was eliminated. The mill lift station that was previously decommissioned was eliminated. Kimberly has one remaining lift station.

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

Combined Locks

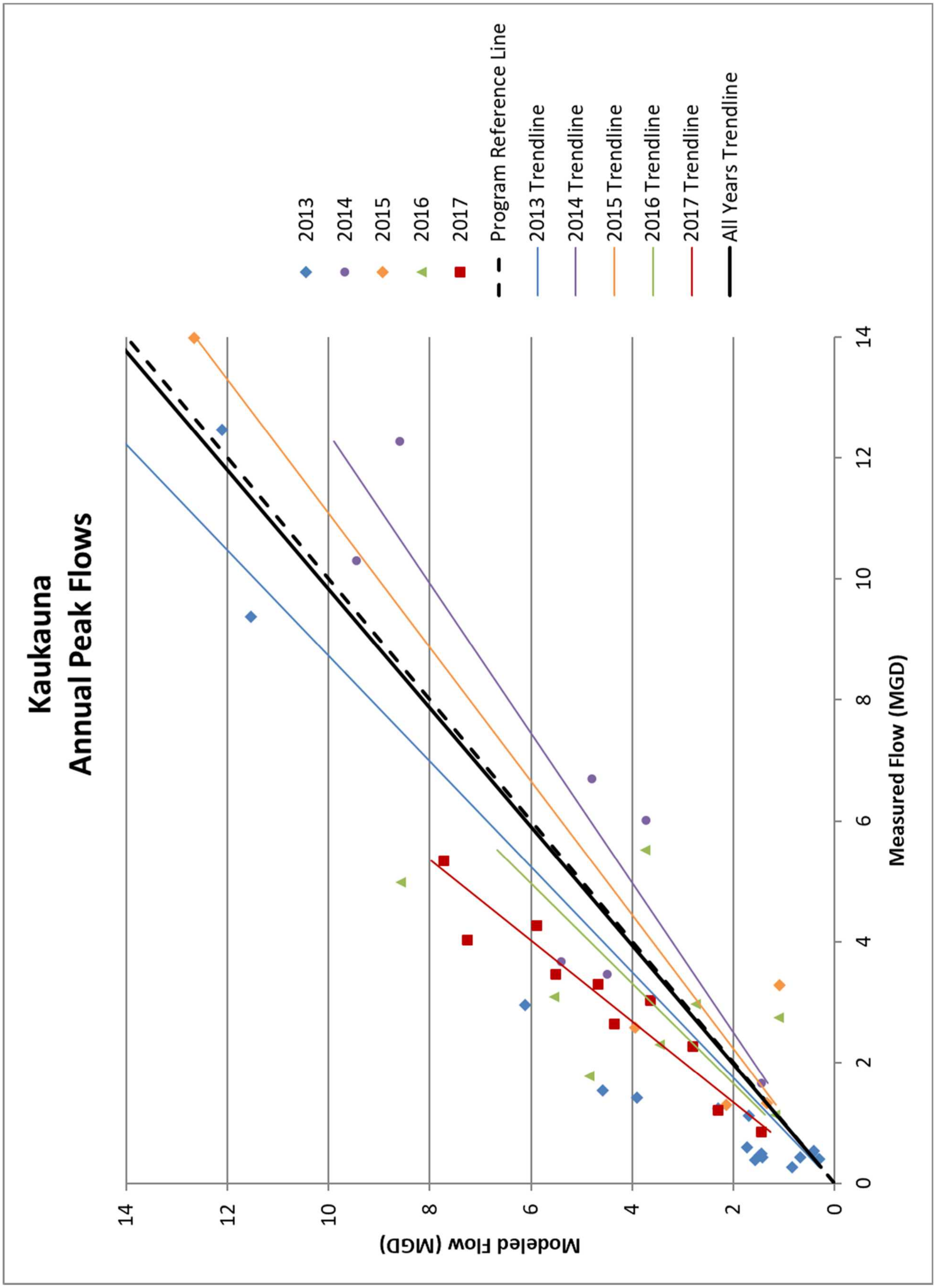
COMBINED LOCKS CMAR PERFORMANCE INDICATOR SUMMARY				
YEAR	NUMBER OF LIFT STATION FAILURES	NUMBER OF SEWER PIPE FAILURES	NUMBER OF BASEMENT BACKUP OCCURRENCES	NUMBER OF COMPLAINTS
2010	NA	0	2	2
2011	NA	0	0	1
2012	NA	0	0	0
2013	NA	0	0	1
2014	NA	0	0	0
2015	NA	0	0	0
2016	NA	0	0	0
2017	NA	0	0	0

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

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

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


Kaukauna
Annual Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0
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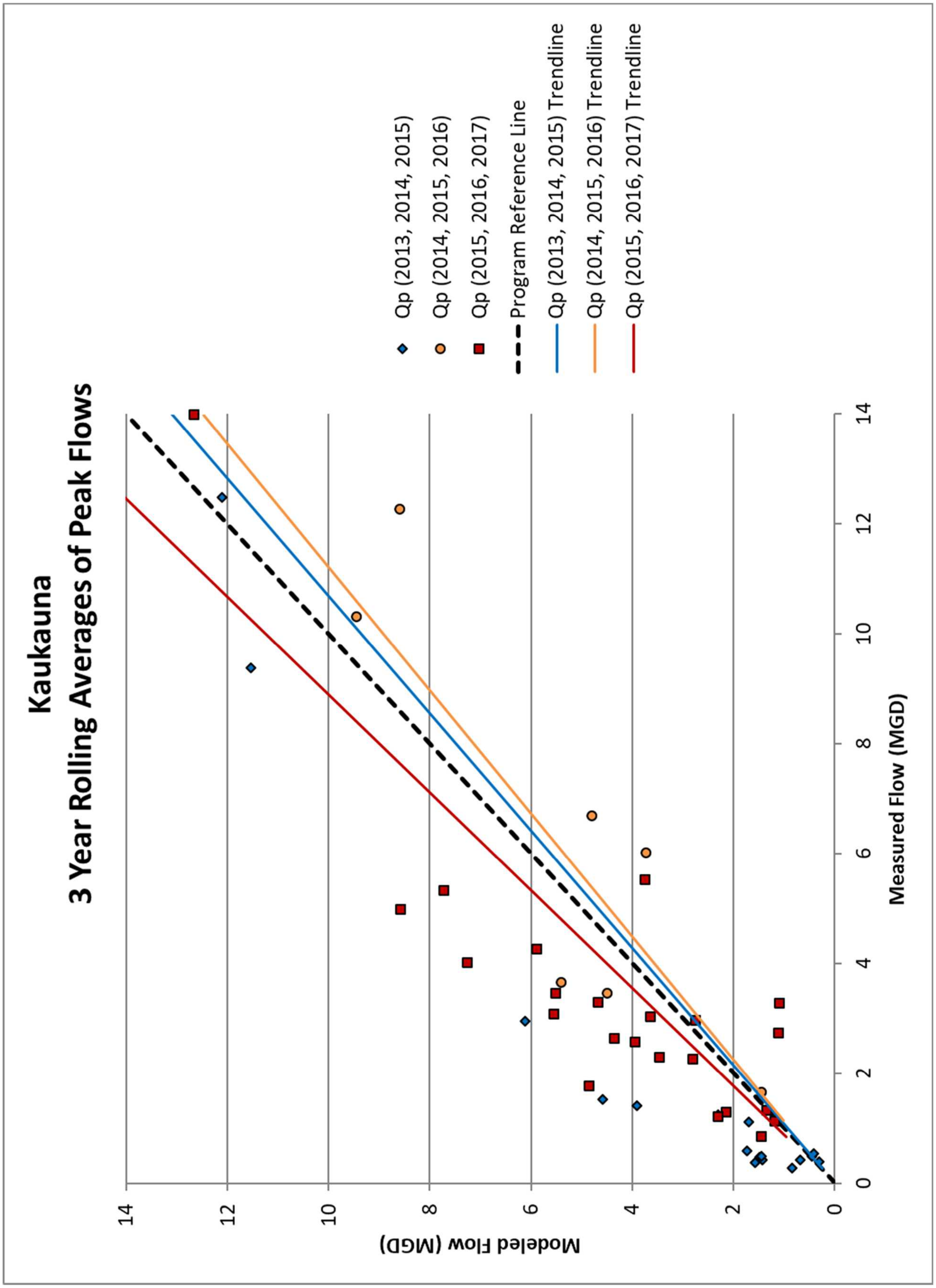
Program Reference Line
2013 Trendline
2014 Trendline
2015 Trendline
2016 Trendline
2017 Trendline
All Years Trendline


Kaukauna
3 Year Rolling Averages of Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
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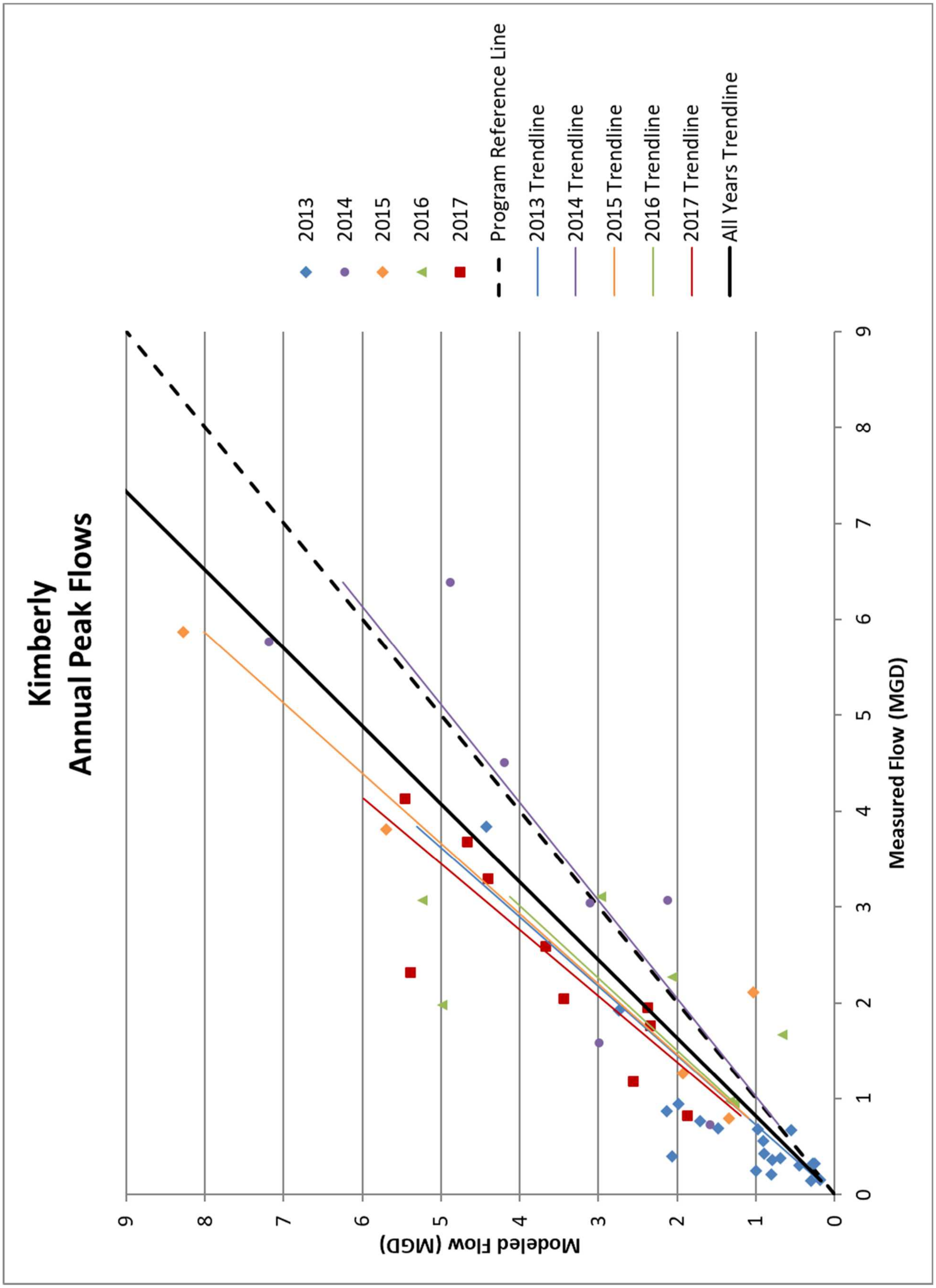
Qp (2013, 2014, 2015)
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Program Reference Line
Qp (2013, 2014, 2015) Trendline
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) Trendline


Kimberly
Annual Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
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2016
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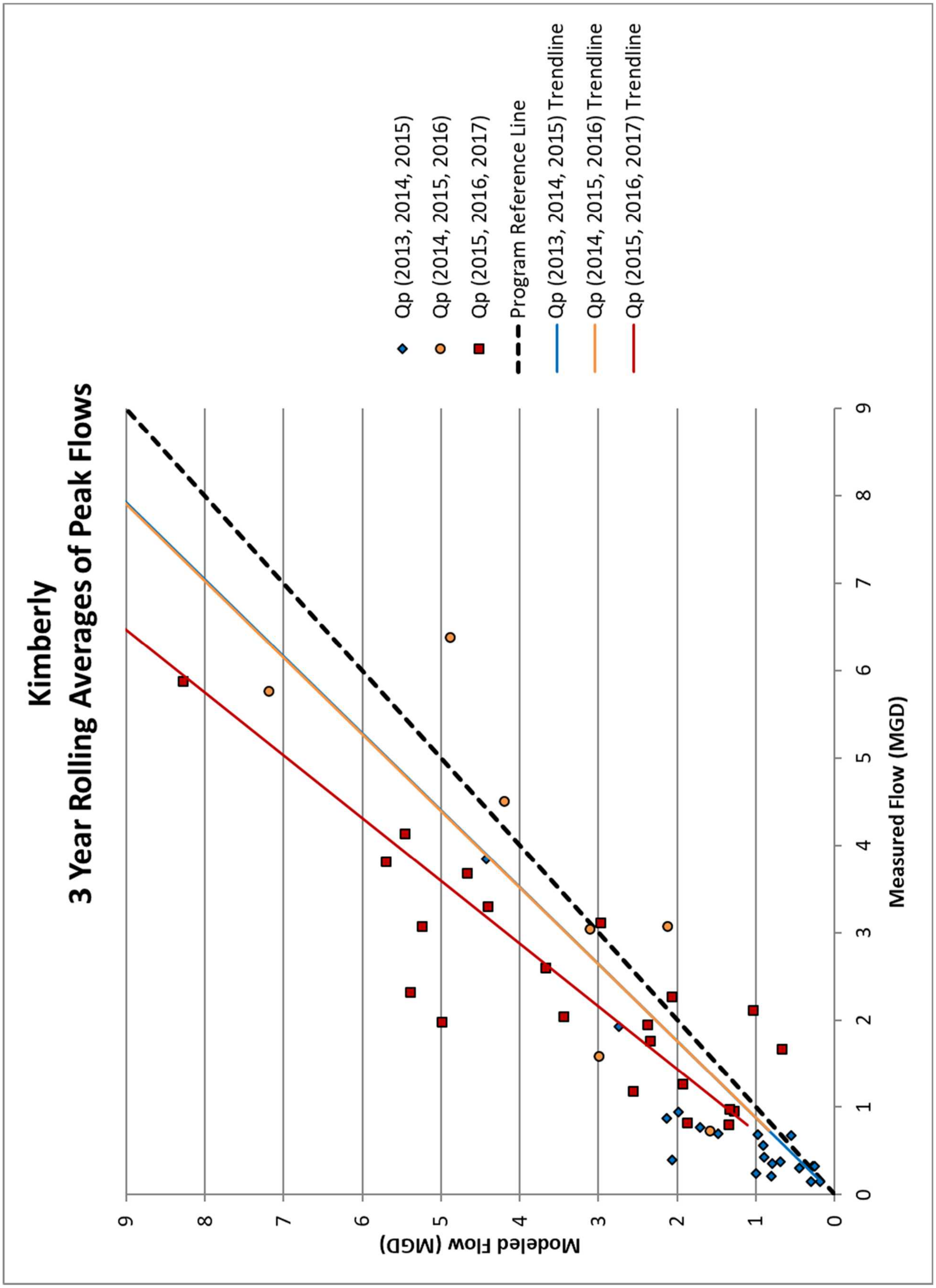
Program Reference Line
2013 Trendline
2014 Trendline
2015 Trendline
2016 Trendline
2017 Trendline
All Years Trendline


Kimberly
3 Year Rolling Averages of Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
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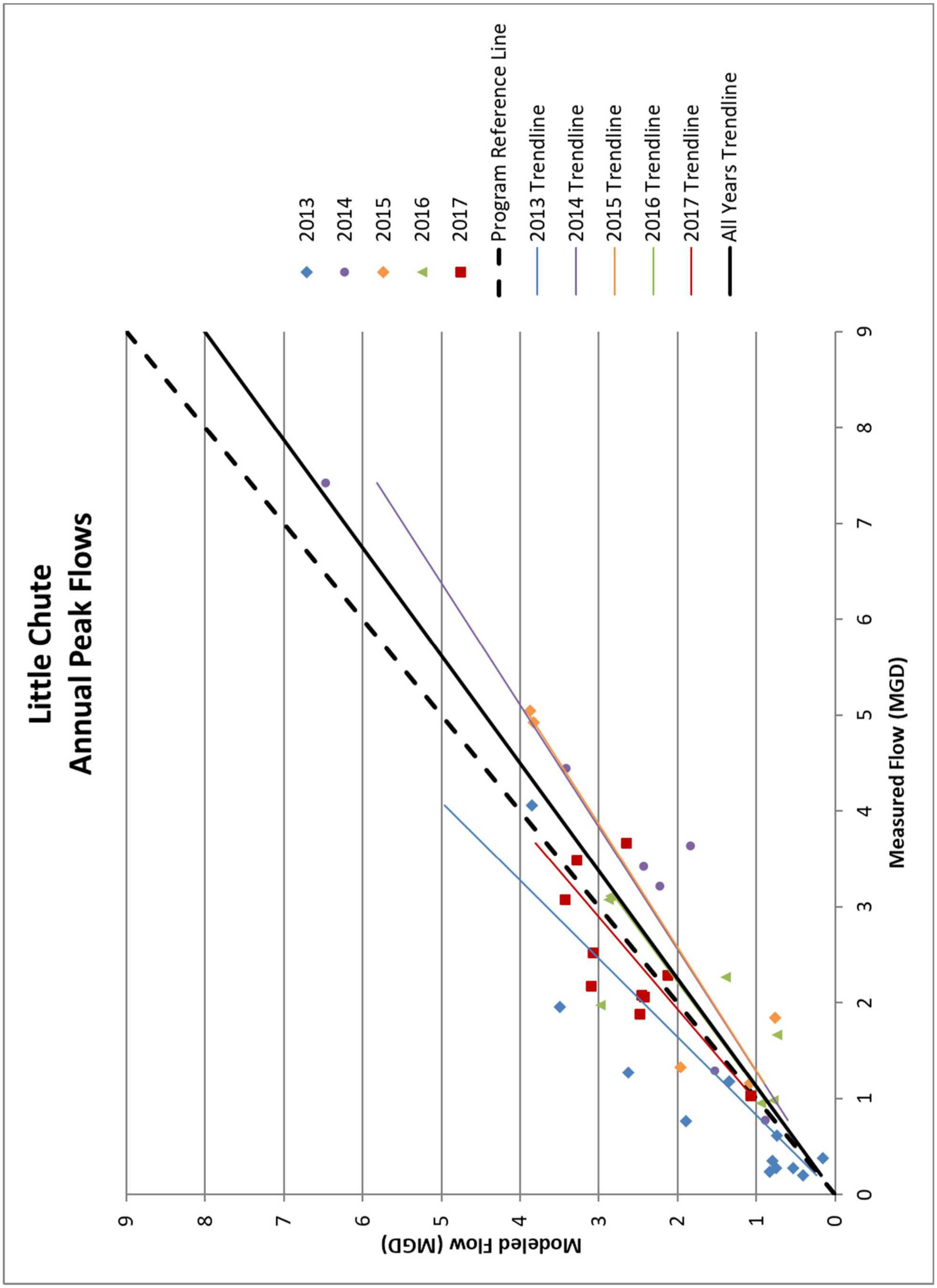
Qp (2013, 2014, 2015)
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Program Reference Line
Qp (2013, 2014, 2015) Trendline
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) Trendline


Little Chute
Annual Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
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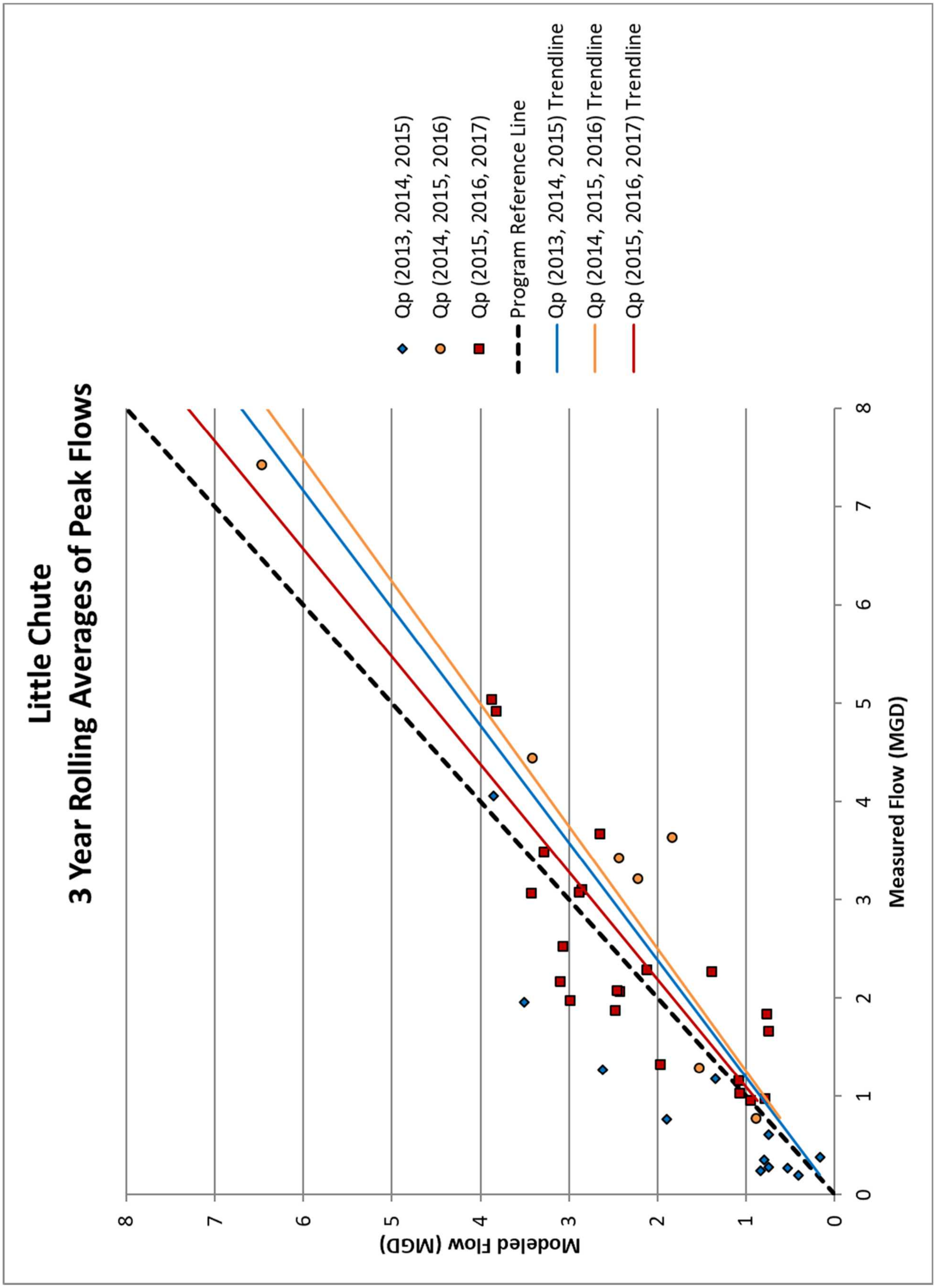
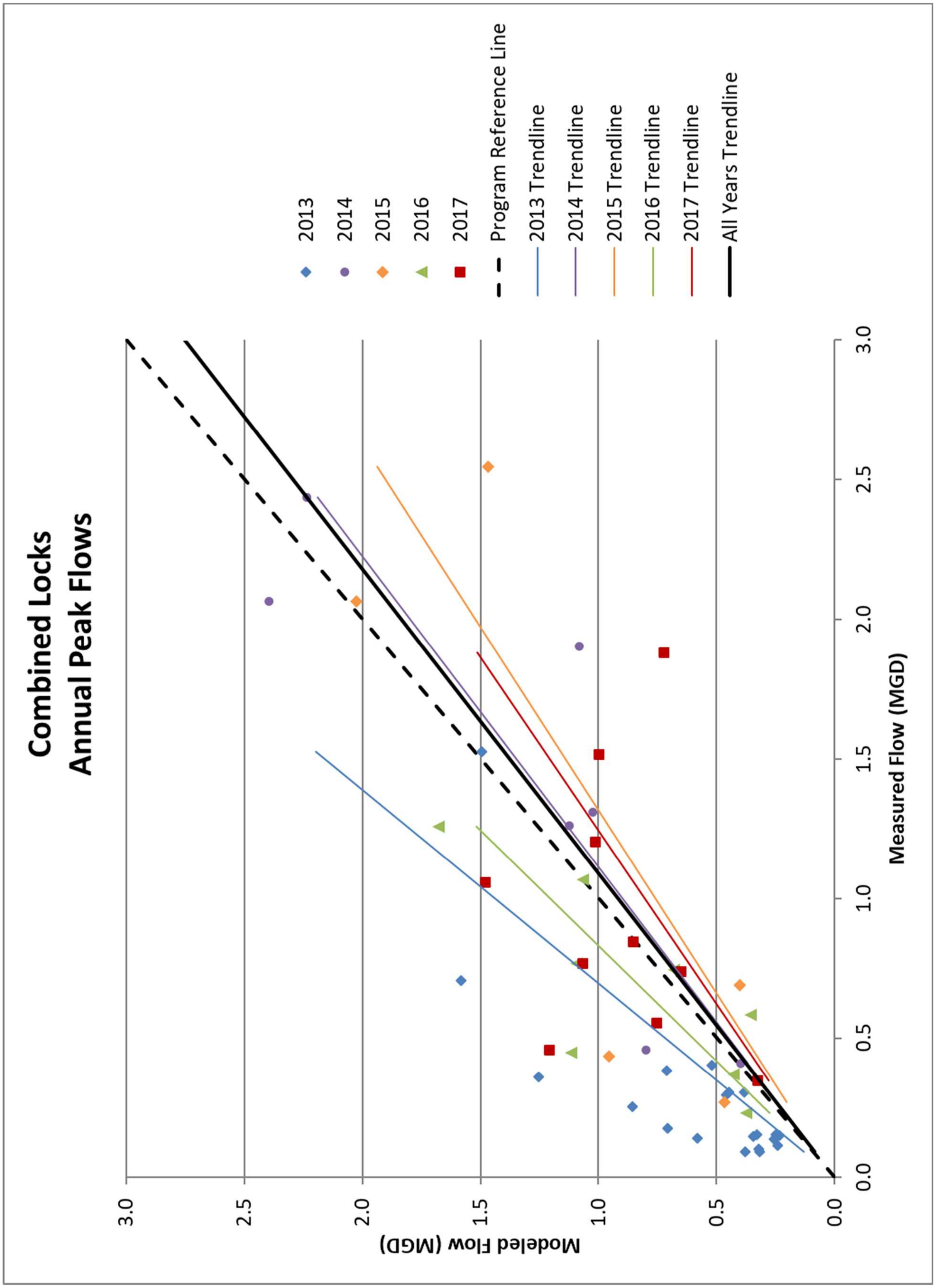
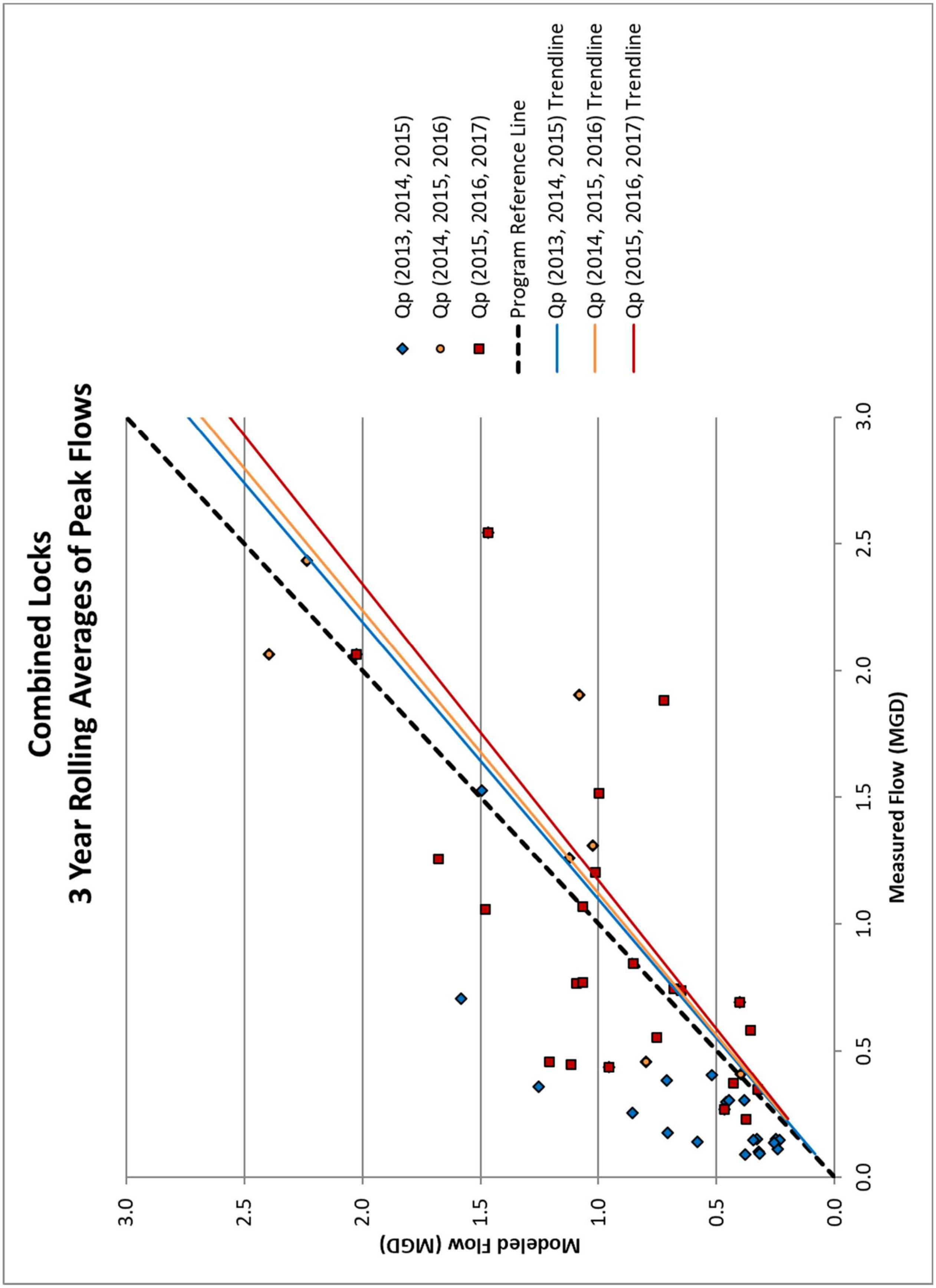
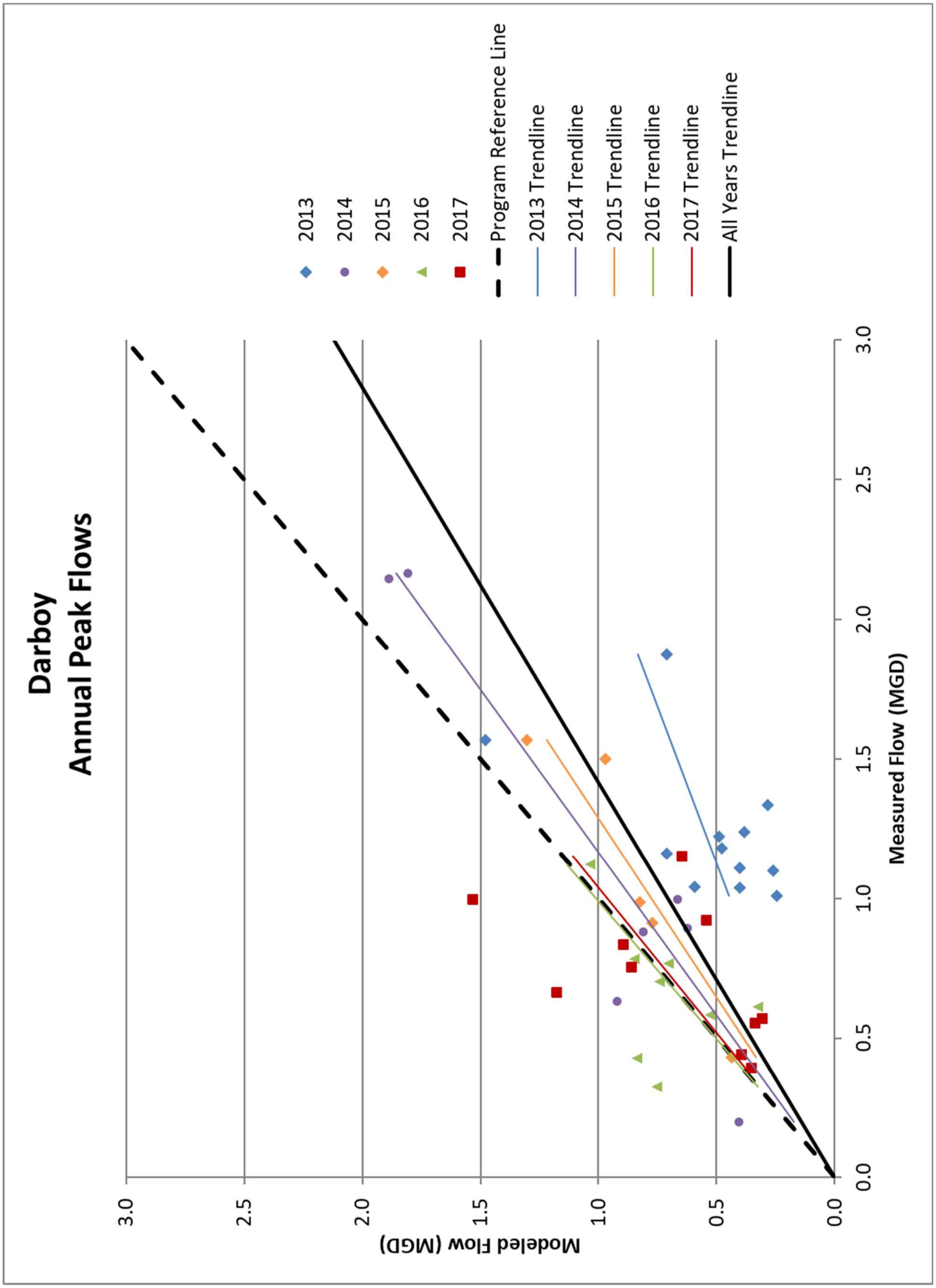
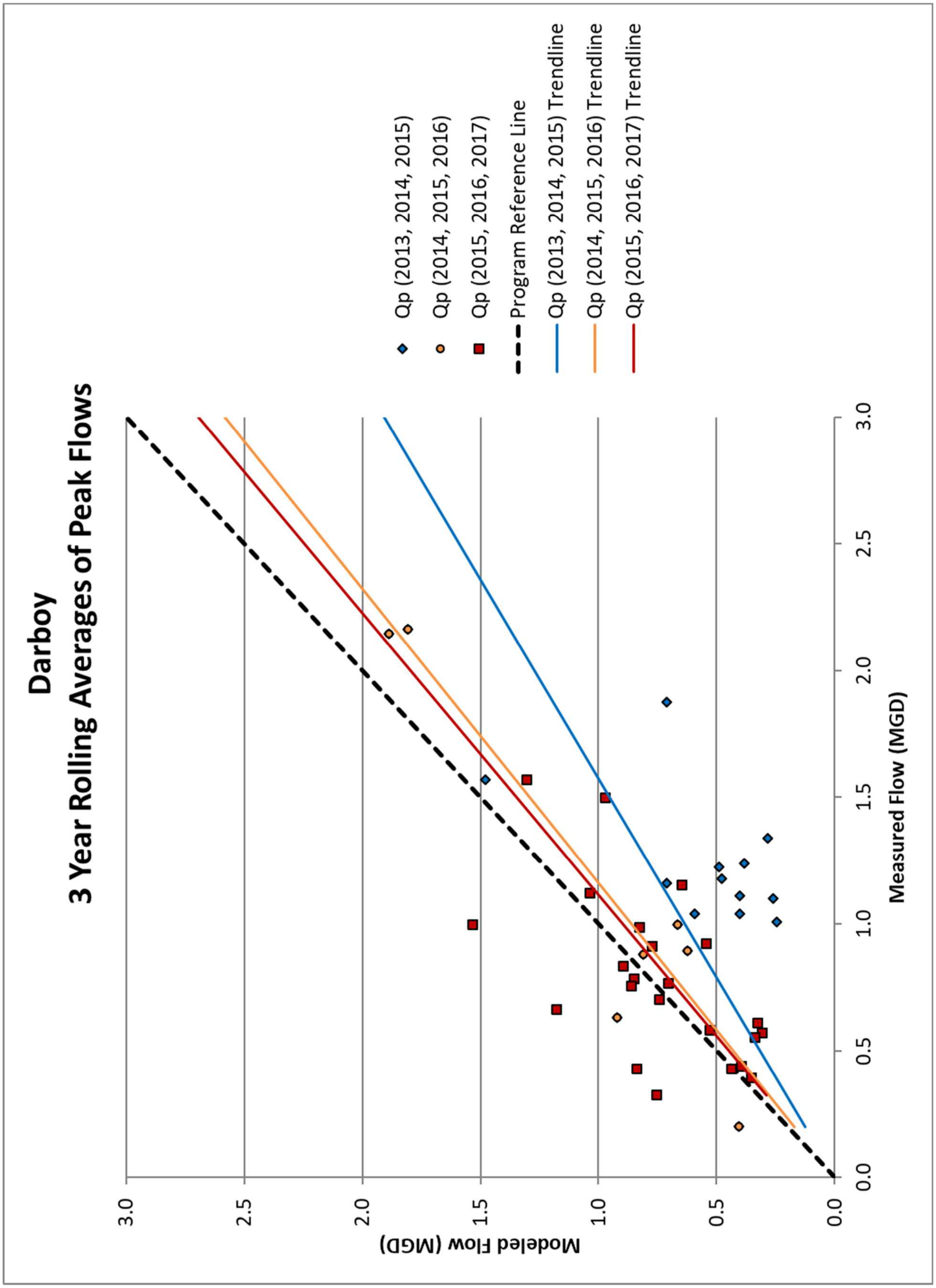
2013
2014
2015
2016
2017
Program Reference Line
2013 Trendline
2014 Trendline
2015 Trendline
2016 Trendline
2017 Trendline
All Years Trendline


Little Chute
3 Year Rolling Averages of Peak Flows
Modeled Flow (MGD)
Measured Flow (MGD)
0
1
2
3
4
5
6
7
8
Qp (2013, 2014, 2015)
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Program Reference Line
Qp (2013, 2014, 2015) Trendline
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) 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
2013
2014
2015
2016
2017
Program Reference Line
2013 Trendline
2014 Trendline
2015 Trendline
2016 Trendline
2017 Trendline
All Years Trendline


Combined Locks
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 (2013, 2014, 2015)
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Program Reference Line
Qp (2013, 2014, 2015) Trendline
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) 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
2013
2014
2015
2016
2017
Program Reference Line
2013 Trendline
2014 Trendline
2015 Trendline
2016 Trendline
2017 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 (2013, 2014, 2015)
Qp (2014, 2015, 2016)
Qp (2015, 2016, 2017)
Program Reference Line
Qp (2013, 2014, 2015) Trendline
Qp (2014, 2015, 2016) Trendline
Qp (2015, 2016, 2017) Trendline

Heart of the Valley Metropolitan Sewerage District

Member Community Compliance Maintenace Annual Report: Peaking Factor Ratios

January 2011- December 2017

Metric	2011	2012	2013	2014	2015	2016	2017	2011	2012	2013	2014	2015**	2016	2017	2011	2012	2013	2014	2015	2016	2017	2011	2012	2013	2014*	2015	2016***	2017	2011	2012	2013	2014*	2015	2016****	2017
Average daily flow in MGD	3.53	2.36	2.35	2.60	2.25	2.41	2.66	0.84	0.68	0.68	0.75	0.65	0.76	0.77	1.49	1.16	1.39	1.45	1.25	1.36	1.57	0.38	0.30	0.34	0.36	0.31	0.32	0.35	0.96	0.94	1.02	1.06	0.92	0.82	0.94
Peak monthly flow in MGD	5.50	3.39	4.16	4.08	3.59	3.90	3.50	2.01	1.04	1.37	1.32	0.95	1.25	1.20	3.05	1.73	2.43	2.42	1.93	2.25	2.37	0.80	0.47	0.63	0.63	0.56	0.57	0.53	1.26	1.04	1.27	1.35	1.05	1.18	1.11
Month of peak monthly flow in MGD	April	March	April	April	ecembe	March	June	April	March	April	April	Decembe	March	April	April	March	April	April	ecembe	March	April	April	March	April	April	ecembe	March	April	April	March	April	April	ecembe	March	March
Peak hourly flow in MGD	14.22	16.03	12.94	18.16	20.12	12.52	9.90	7.05	5.11	4.52	6.99	9.32	4.14	5.26	8.42	6.02	6.66	8.73	11.66	6.37	5.20	2.51	2.33	2.15	2.73	3.75	1.75	2.31	2.61	3.10	2.82	3.18	3.93	2.32	2.46
Peaking factor ratio Peak Monthly:Annual Daily Avg	1.55	1.44	1.77	1.57	1.60	1.61	1.32	2.39	1.53	2.00	1.76	1.46	1.64	1.56	2.05	1.50	1.75	1.67	1.54	1.65	1.50	2.13	1.56	1.83	1.75	1.79	1.81	1.51	1.31	1.11	1.25	1.27	1.14	1.43	1.18
Peaking factor ratio Peak Hourly:Annual Daily Avg	4.02	6.80	5.51	6.99	8.93	5.19	3.72	8.36	7.56	6.62	9.32	14.25	5.43	6.83	5.65	5.20	4.80	6.01	9.33	4.68	3.30	6.65	7.74	6.26	7.64	12.04	5.53	6.61	2.71	3.29	2.76	2.99	4.27	2.82	2.61
Top 10 peak hourly flow in MGD: 1	14.22	16.03	12.94	18.16	20.22	12.52	9.90	7.05	5.11	4.52	6.99	9.32	4.14	5.26	8.42	6.02	6.66	8.73	11.66	6.37	5.20	2.51	2.33	2.15	2.73	3.75	1.75	2.31	2.61	3.10	2.82	3.18	3.93	2.32	2.46
2	12.50	10.74	12.93	15.95	20.12	11.37	9.33	4.62	4.83	4.07	6.77	6.55	3.82	4.48	6.42	5.91	5.62	8.13	6.63	5.57	5.19	1.77	2.01	1.92	2.58	2.90	1.57	1.79	2.58	2.78	2.67	2.80	2.76	2.29	2.08
3	12.30	9.66	9.98	14.62	17.42	8.33	9.20	4.47	4.46	3.91	6.22	4.47	3.11	3.88	6.07	5.44	5.49	7.12	6.19	4.83	5.00	1.59	1.64	1.51	2.44	2.58	1.33	1.64	2.52	2.72	2.51	2.75	2.45	2.14	2.00
4	11.40	8.67	9.40	10.70	8.31	7.65	9.16	4.32	4.07	3.78	5.18	2.97	2.91	3.85	6.01	4.45	5.44	6.25	5.61	3.86	4.88	1.58	1.37	1.37	2.44	1.36	1.15	1.63	2.26	2.38	2.45	2.41	2.28	2.08	1.98
5	10.19	7.38	8.45	10.66	8.28	7.34	8.89	4.14	3.17	3.15	4.93	2.86	2.69	3.24	5.61	3.92	4.98	5.34	4.49	3.85	4.71	1.54	1.17	1.24	1.78	1.32	1.11	1.35	2.18	2.10	2.44	2.37	2.22	2.06	1.95
6	10.19	7.26	7.33	7.99	8.01	6.90	8.62	4.10	2.81	2.75	3.89	2.68	2.47	3.10	5.51	3.63	4.27	5.11	4.07	3.84	4.64	1.53	1.16	1.22	1.77	1.28	1.05	1.33	2.16	2.06	2.33	2.27	2.18	2.02	1.95
7	10.18	7.02	7.22	7.92	7.71	6.75	8.55	4.05	2.77	2.64	3.84	2.62	2.35	2.95	5.49	3.43	4.00	4.96	4.04	3.54	4.31	1.49	1.14	1.21	1.54	1.26	1.04	1.23	2.14	2.03	2.26	2.18	2.15	1.94	1.91
8	10.04	6.76	7.01	7.67	7.64	6.68	8.51	3.98	2.66	2.58	3.70	2.55	2.31	2.94	5.10	3.41	3.83	4.59	3.61	3.43	4.26	1.41	1.11	1.14	1.32	1.14	1.04	1.19	2.12	1.98	2.21	2.17	2.14	1.92	1.91
9	9.98	6.76	6.90	7.67	6.76	6.57	8.30	3.63	2.44	2.35	2.95	2.51	2.23	2.86	5.04	3.34	3.77	3.99	3.53	3.35	4.22	1.30	1.08	1.04	1.29	1.11	1.01	1.13	2.08	1.96	2.17	2.15	2.01	1.92	1.91
10	9.95	6.75	6.87	7.57	6.68	6.50	8.24	3.37	2.44	2.26	2.93	2.49	2.14	2.58	5.00	3.32	3.69	3.87	3.47	3.30	3.99	1.27	0.99	1.00	1.24	1.10	0.99	1.07	2.05	1.96	2.15	2.09	1.99	1.91	1.90
Peaking factor ratio Ave Top 10 Peak Hourly:Annual Daily	3.14	3.69	3.79	4.19	4.94	3.34	3.33	5.19	5.14	4.69	6.32	5.96	3.69	4.56	3.94	3.71	3.44	4.00	4.27	3.08	2.95	4.24	4.65	4.03	5.34	5.72	3.81	4.20	2.36	2.45	2.35	2.29	2.62	2.50	2.13

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

*Note: 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.
**Note: Data from 6/9/15 17:30 to 6/11/15 14:00 at the Kimberly meter station was omitted from analysis.
Data on the table represents the highest monthly and peak hourly flows rates outside of the maintenance time period.
***Note: No Combined Locks data available until 1/15/16
****Note: Darboy data omitted until 2/9/16 because suspect it erroneous