Sampling Variability in Chesapeake Bay Wastewater Treatment Plant Discharges

EPA Region III

Trading and Offset Workgroup

Wednesday, January 15, 2014

Outline

- Need for reducing error from loads in reported WWTP discharges
  - Preferential sampling
  - Results from two plants
  - Can check weekly and monthly, but the allocation is for annual loads; would have to monitor (independently verify compliance) until exceedance.

- Assumptions
  - Two plants, other observations
  - Chesapeake Bay only
  - Applicable to trading

- Recommendations
  - Sampling frequency: 3 x Wk
    - Benefit: Use DMRs to determine credit need and also greater confidence meeting WLA.
    - Weekly flow weighted composite sample may be preferable since more affordable and practical.
  - Current calculation method used is more conservative.
    - Alternative methods acceptable if already in use
    - The conversion factor should be evaluated by the Wastewater Treatment WG.
  - Use sampled loads, not back-calculated, for monthly loads.

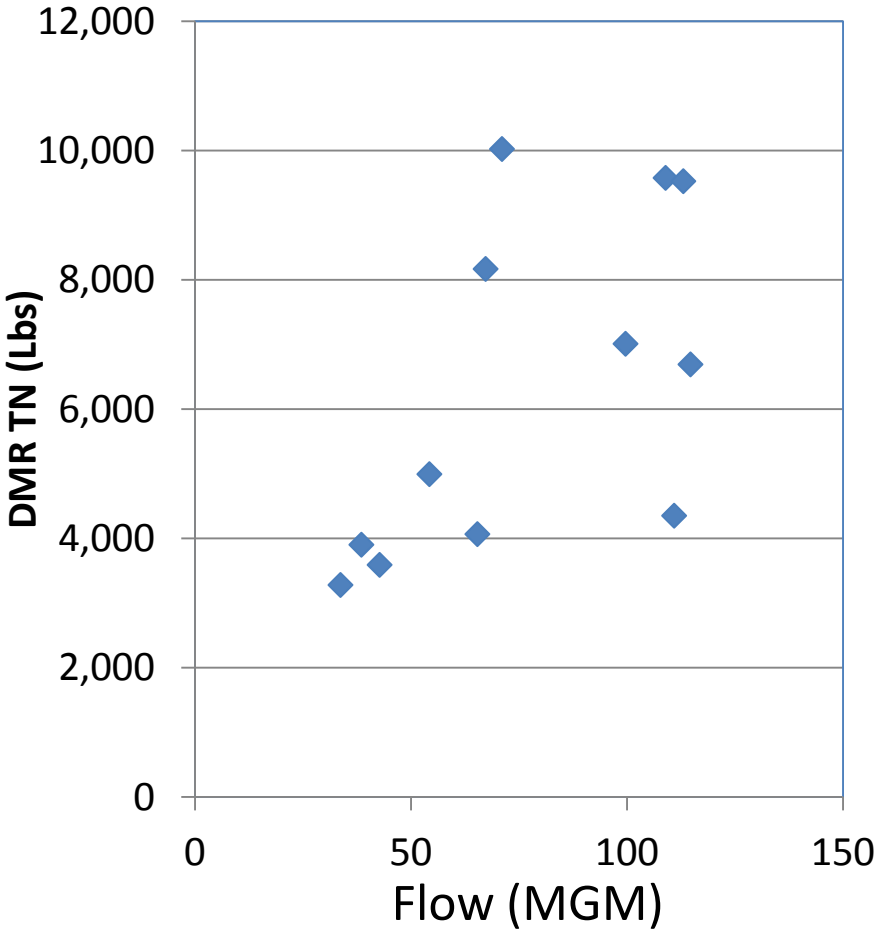
Need for Sampling Variability TM

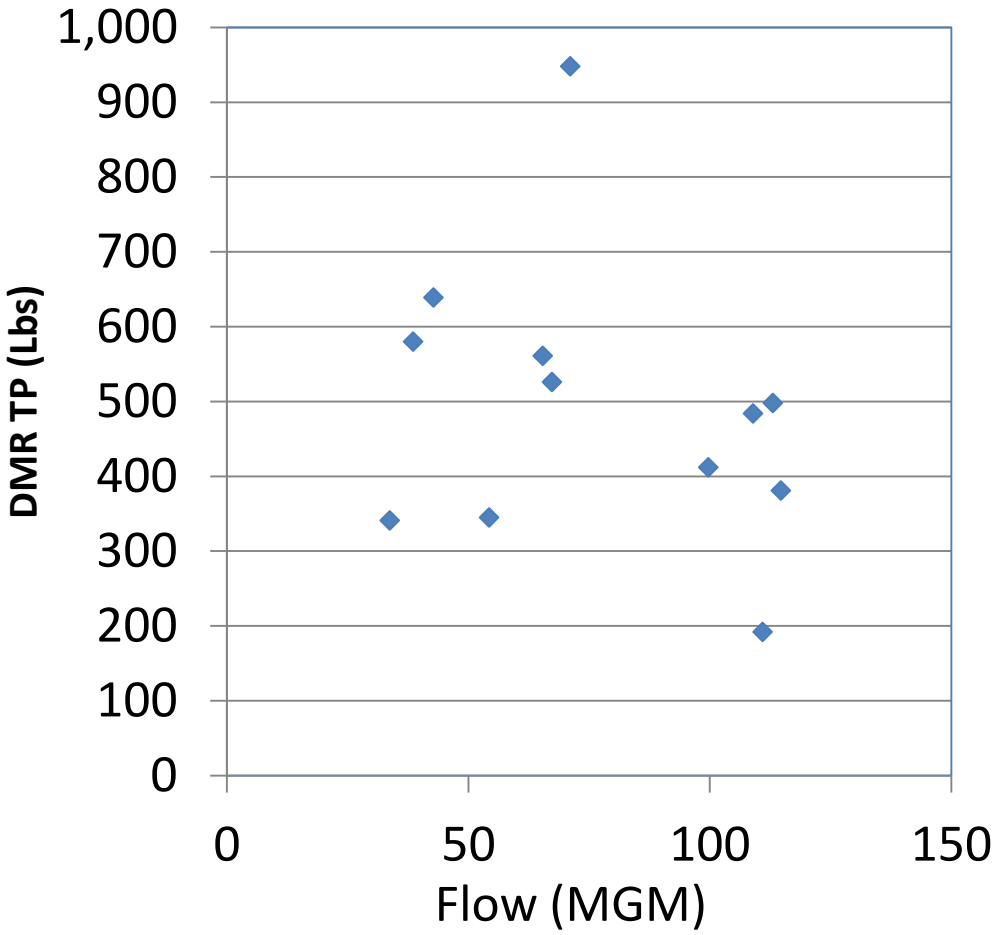
- Trading and offsets requires that the loads are measured accurately
- Permit allocations are for annual loads.
- Verifying compliance would require independent monitoring weekly and monthly until exceedance is reached. Not feasible.
- Therefore, reliant on accuracy in sampling and load calculation methods.

Observed Sources of Sampling Error

- Calculation methodology for producing an average monthly load
- Sampling at non-representative conditions, such as when performance is good
- Variability for unknown reasons

Unexplained Variability in Loads





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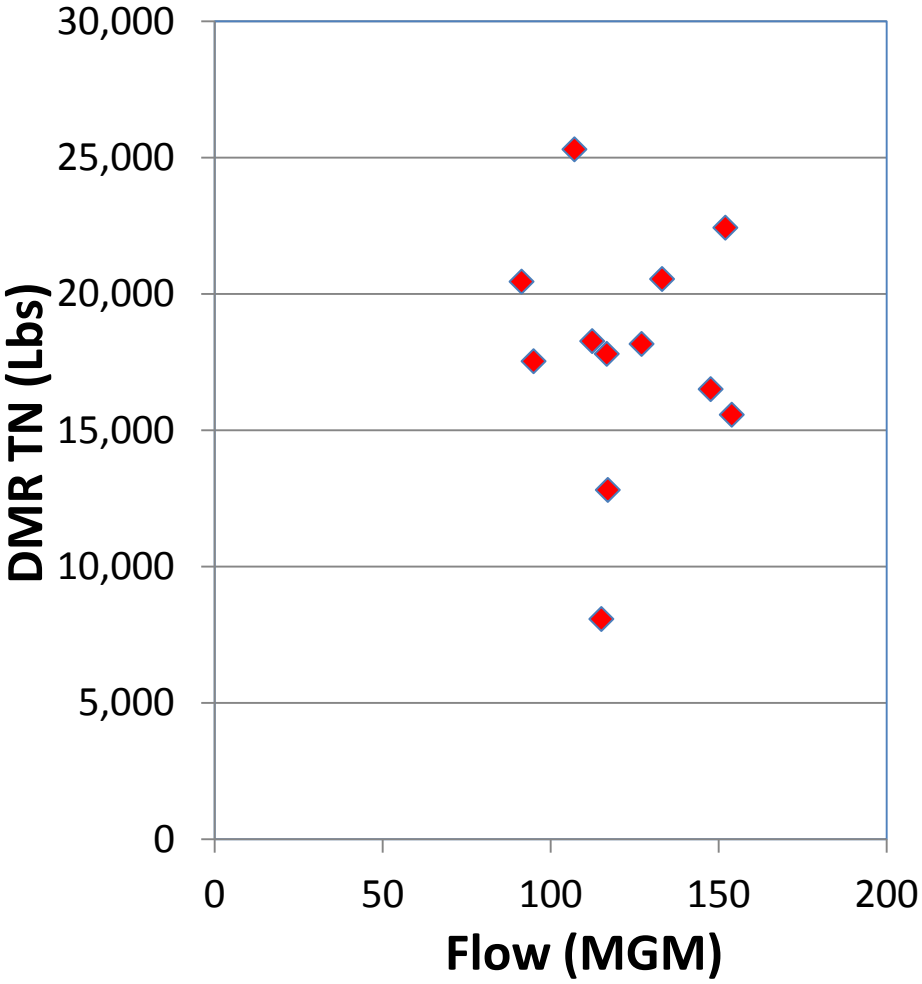
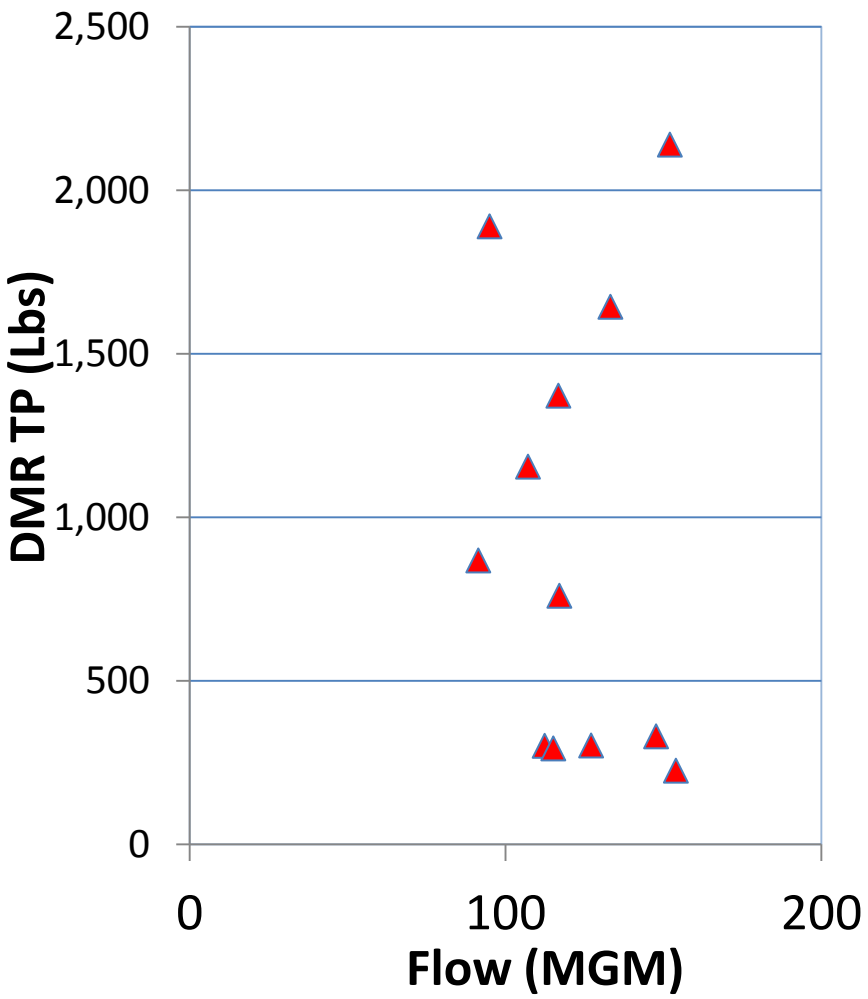




Evaluation

- Selected two plants with daily discharges for analysis
  - Alexandria ASA Advanced WWTP (TN and TP daily)
  - Harrisburg City, Dauphin County WWTP (TP daily, TN weekly)

- Assessed:
  - the relationship among sampling frequency, accuracy of load estimates, and sampling costs
  - bias in average monthly loads using various calculation methods

Methods for Assessing Sampling Frequency

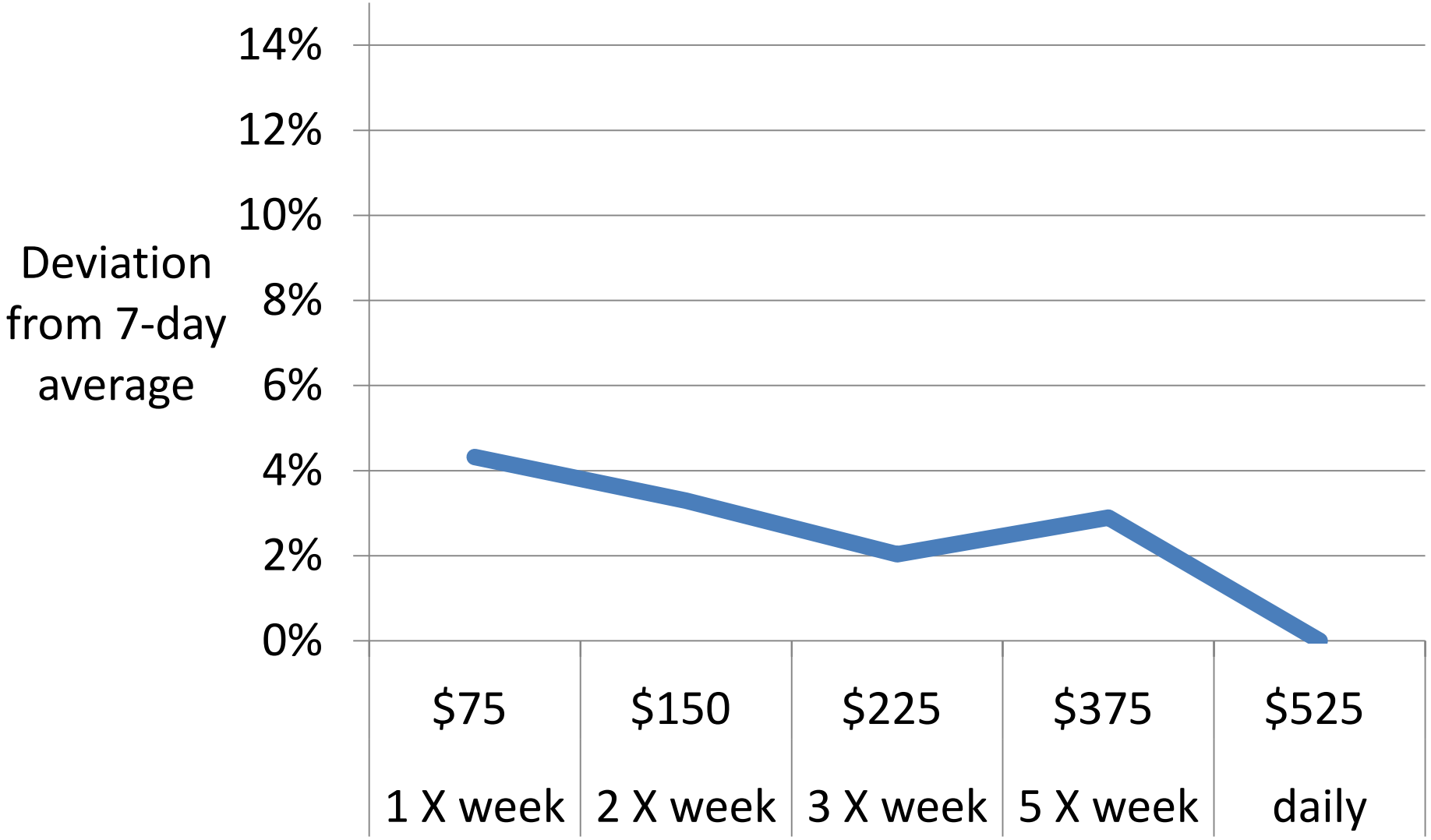
- Checked for seasonal influences
  - none readily apparent

- Evaluated sampling frequencies of 1,2,3,5, and 7 samples per week by sub-sampling the DMR data from the two plants.
  - As the number of samples per week increases, the uncertainty decreases

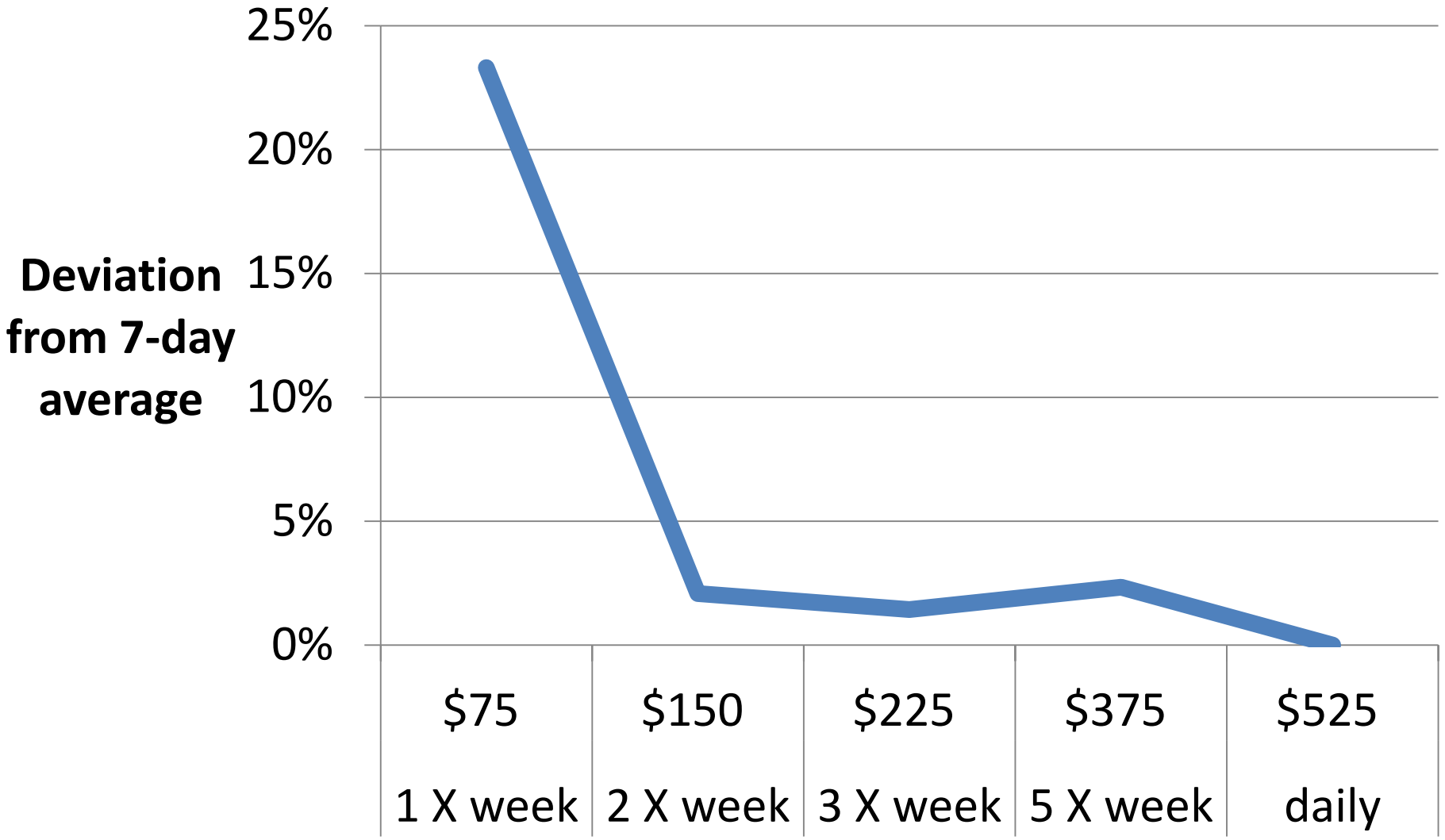
- Evaluated costs associated with increased sampling
  - Less than 5% error is achieved for both TN and TP if samples occur three times a week or more.

Alexandria ASA Advanced WWTP in 2010 for TN

Alexandria ASA Advanced WWTP in 2010 for TP

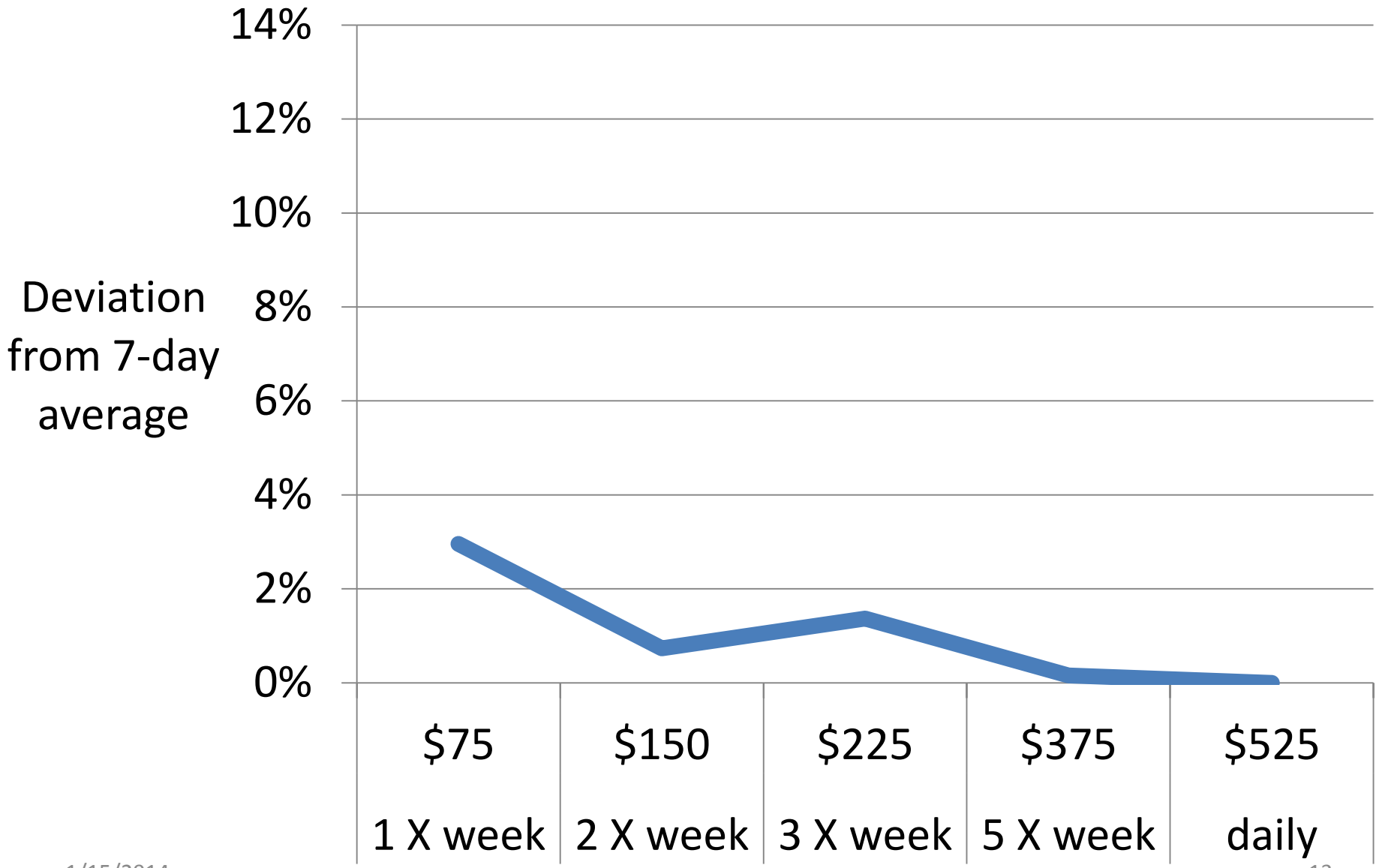


Alexandria ASA Advanced WWTP in 2009 for TN



Alexandria ASA Advanced WWTP in 2009 for TP

Harrisburg WWTP in 2010 for TP



Recommendation One

Sampling frequency of at least three times a week for both TN and TP would generate data sufficient to support load estimates for the purposes of a water quality trading program in the Chesapeake Bay Watershed. The three samples per week also would provide a higher degree of confidence that sources were in compliance with their WLA.

- This assessment, in combination with concerns about preferential sampling, indicates that three or more samples per week are likely to decrease error below five percent for both TN and TP, even where preferential sampling is in use.

- EPA has determined that less than 5% error is a substantial improvement, and is acceptable at this time.

- NPDES-permitted facilities or aggregators could use discharge monitoring report monthly average load data to determine the number of credits required to offset loads for plants sampling three or more times per week.

Recommendation One (cont.)

- A weekly flow-weighted composite sample is an acceptable alternative to sampling three times a week but requires demonstration to be acceptable for use.

- “Composite sample” means a combination of individual samples obtained at hourly or smaller intervals over a time period. Either the volume of each individual sample is proportional to discharge flow rates or the sampling interval (for constant volume samples) is proportional to the flow rates over the time period used to produce the composite.

- This could increase the certainty of the calculated annual load, while at the same time remove any additional analysis costs.

- EPA believes that this alternative could be the preferable approach. Since there are numerous permittees with design flows less than 20 MGD and who may only operate seasonally, a composite sample may be more affordable and practical.

Methods for Calculating Average Monthly Loads

- Daily load (Lbs) = concentration (mg/L) * flow (MGD) * 8.345

- Current method:
  - Daily load (Lbs) = concentration (mg/L) * flow (MGD) * 8.344
  - Average monthly load (Lbs) = average of all calculated loads in a month (Lbs) * no. of days in a month

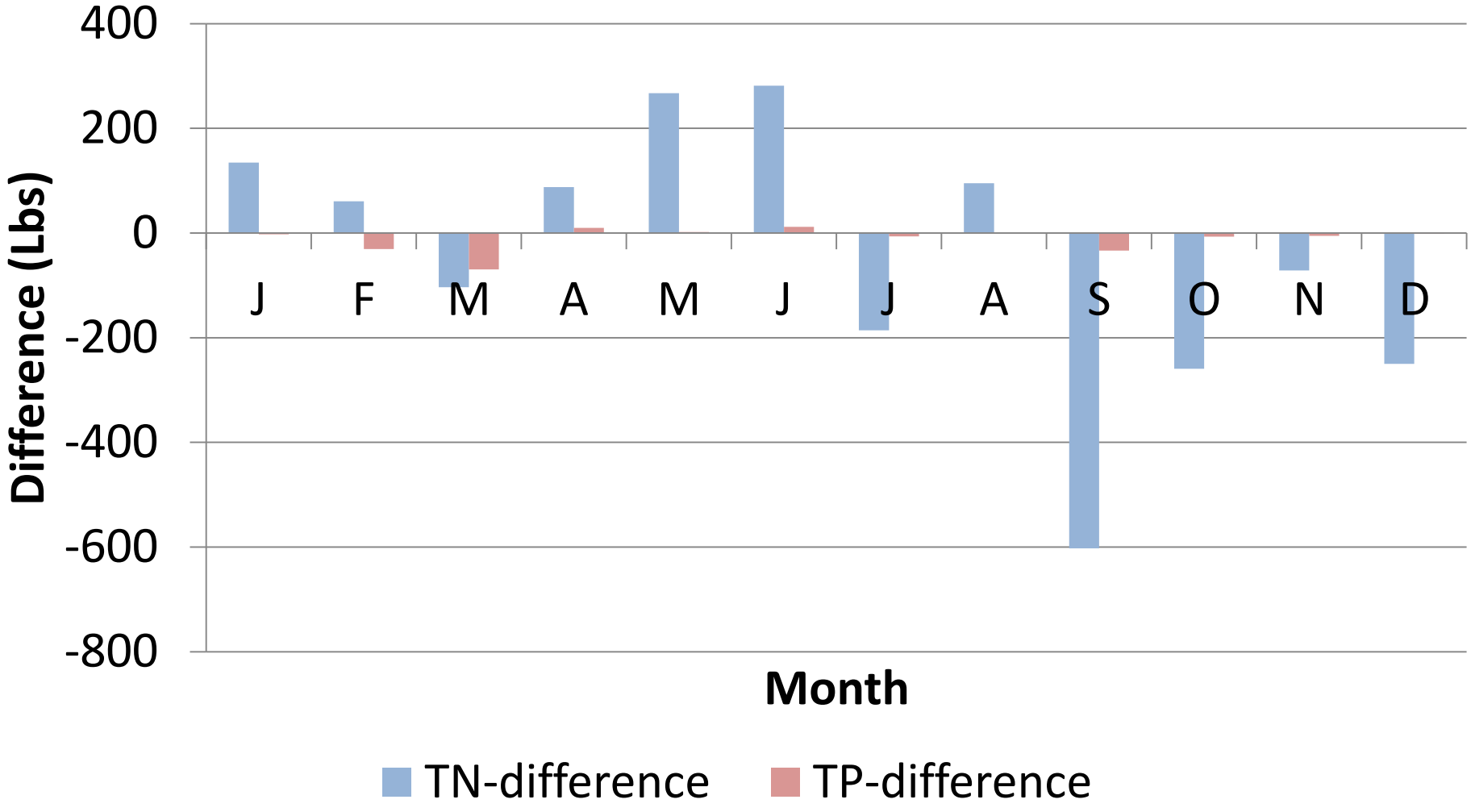
- Alternative method is to calculate the load after the concentration and flow are averaged for the month.
  - Average concentration for samples in a month
  - Average daily flow
  - Average Monthly Load (Lbs) = average concentration (mg/L) * average daily flow (MGD) * 8.344 * no. of days in month

- Note that the conversion factor of 8.344 is consistent with the factor used by the Chesapeake Bay Program. Virginia uses 8.345 under the current general permit. Maryland uses 8.34. The 8.345 factor is recommended by the American Society of Civil Engineers and is commonly used in other EPA calculations for average daily load.

Alexandria ASA Advanced WWTP

		Loads calculated on a daily basis, then averaged for month		Loads calculated from monthly average concentration (mg/L) and monthly average flow (MGD)		Change from the current method	
Date	**Flow rate (MGD)**	**TN ave. monthly (Lbs)**	**TP ave. monthly (Lbs)**	**TN ave. monthly (Lbs)**	**TP ave. monthly (Lbs)**	**Percent difference-TN**	**Percent difference-TP**
Jan-2010	37.08	34,175	423	34,310	421	0.39%	-0.53%
Feb-2010	44.90	58,912	480	58,973	450	0.10%	-6.33%
Mar-2010	45.17	52,795	1,217	52,691	1,148	-0.20%	-5.70%
Apr-2010	36.94	45,225	810	45,313	820	0.19%	1.23%
May-2010	34.51	30,283	774	30,550	776	0.88%	0.26%
Jun-2010	33.04	22,600	698	22,882	710	1.25%	1.70%
Jul-2010	31.75	31,764	646	31,578	640	-0.58%	-0.96%
Aug-2010	30.67	28,567	371	28,662	371	0.33%	0.02%
Sep-2010	29.95	28,264	633	27,661	600	-2.13%	-5.26%
Oct-2010	34.23	29,903	978	29,644	971	-0.87%	-0.72%
Nov-2010	33.83	38,716	542	38,644	536	-0.19%	-1.05%
Dec-2010	31.54	33,963	307	33,713	305	-0.74%	-0.56%
Annual average	**35.30**	**-**	**-**	**-**	**-**	**-0.13%**	**-1.49%**
Annual total	**-**	**435,167**	**7,879**	**434,621**	**7,747**	**-**	**-**

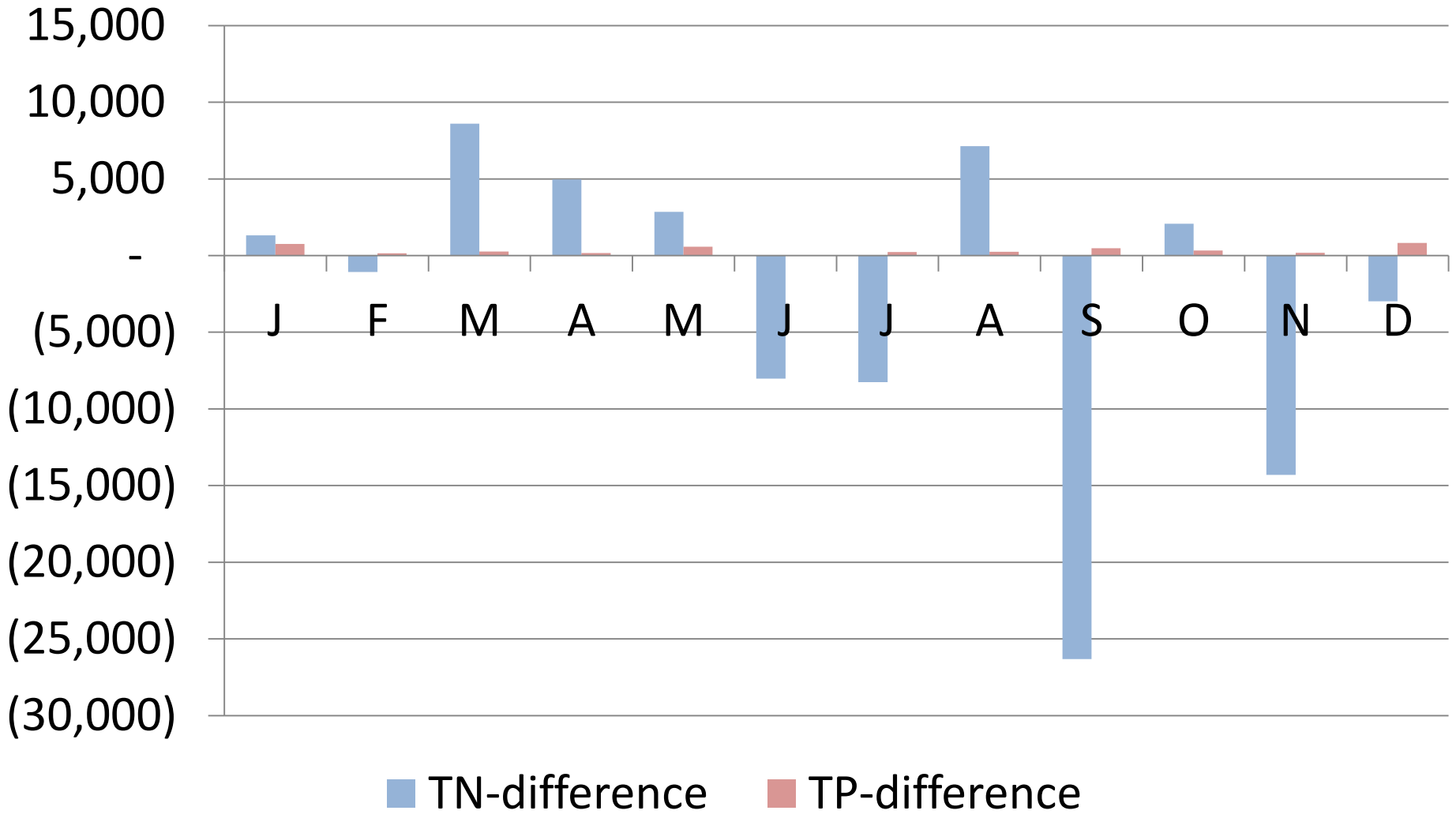
Difference in loads calculated two ways for the Alexandria ASA Advanced WWTP 2010



Harrisburg WWTP

		Loads calculated on a daily basis, then averaged for month		Loads calculated from monthly average concentration (mg/L) and monthly average flow (MGD)		Change from the current method	
Date	**Flow (MGD)**	**TN ave. monthly (Lbs)**	**TP ave. monthly (Lbs)**	**TN ave. monthly (Lbs)**	**TP ave. monthly (Lbs)**	**Percent difference-TN**	**Percent difference-TP**
Jan-2010	26.9	111,849	10,089	113,175	10,844	1.19%	7.48%
Feb-2010	23.5	98,371	8,815	97,297	8,968	-1.09%	1.73%
Mar-2010	30.1	104,557	9,317	113,159	9,580	8.23%	2.83%
Apr-2010	21.7	100,427	9,609	105,380	9,770	4.93%	1.67%
May-2010	24.8	99,425	9,409	102,277	9,985	2.87%	6.13%
Jun-2010	19.8	116,528	9,455	108,497	9,456	-6.89%	0.00%
Jul-2010	19.8	110,261	8,335	102,002	8,567	-7.49%	2.78%
Aug-2010	19.2	85,296	8,323	92,436	8,571	8.37%	2.97%
Sep-2010	18.4	125,507	7,523	99,195	8,009	-20.96%	6.45%
Oct-2010	22.0	120,327	8,726	122,401	9,054	1.72%	3.76%
Nov-2010	19.5	106,089	7,667	91,791	7,852	-13.48%	2.41%
Dec-2010	21.9	108,538	8,628	105,550	9,448	-2.75%	9.51%
Annual average	**22.3**	**-**	**-**	**-**	**-**	**-2.11%**	**3.98%**
Annual total	**-**	**1,287,175**	**105,896**	**1,253,159**	**110,102**	**-**	**-**

Difference in loads calculated two ways for the Harrisburg WWTP 2010



Calculation Methodology Results

- Greater difference for TN than TP simply because loads are higher for TN
- September 2010 had double the amount of flow. That outlier show the current method reflects the greater load.
- Results show the current methods have a slight bias towards higher load estimations
- Suggests that the current calculation methodology for loads is valid for its intended purpose

Recommendation Two

The current calculation methodology for loads is valid for its intended purpose.

- Loads should be calculated as follows:
  1. Daily load (Lbs) = concentration (mg/L) * flow (MGD) * 8.345
  2. Average monthly load (Lbs) = average of all loads in a month * no. of days in a month

- EPAs suggests that the Chesapeake Bay Partnerships' Wastewater Treatment Workgroup evaluate whether the factor 8.344 should be changed to 8.345

- Where jurisdictions have a history of using a different and previously accepted calculation method and/or conversion factor, then the jurisdictions' alternative method will be acceptable to maintain consistency in comparisons of loads over time.

Recommendation Three

EPA expects that the monthly load is calculated using the actual discharge and concentration as sampled.

- Concentration values should not be used when those concentration values were derived from loads (pounds).

- Rather, the sampled concentration data should be used in the monthly load calculation.

EPA Oversight

- EPA has stated it will review all permits Bay significant dischargers and for any new or increased dischargers.

- These recommendations apply only to the Chesapeake Bay watershed and are applicable only to plants where trading and offsets credits are generated or purchased.

Current Regulations and Guidance

- Chesapeake Bay 2010 TMDL Section 10
- Chesapeake Bay 2010 TMDL Appendix S
- Water Quality Trading Policy, 2003
- Water Quality Treading Toolkit for NPDES Permit Writers 2007
- Clean Water Act and federal and local Water Quality Standards Programs
- Effluent limits and reasonable potential analysis
  - Existing sources: 40 CFR 122.44(d)(1)(vii)
  - New sources: 40 CFR 122.33(d)(1)(vii)