Phosphorus Optimization Plan Guidance Document

Wastewater treatment facilities (WWTFs) that discharge to the Lake Champlain watershed will receive a renewed Wastewater Discharge Permit in accordance with the permit issuance schedule outlined in the Vermont Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan. The new Wastewater Discharge Permits subject to the Lake Champlain Total Maximum Daily Load (TMDL), will have a requirement to create and implement a Phosphorus Optimization Plan (POP). This requirement may also be included in other Wastewater Discharge Permits subject to total phosphorus (TP) TMDL Waste Load Allocations or TP permit limits due to nutrient impairment.

This document is intended to provide the WWTF and/or its consultant guidance on what type of analysis should be included in the POP and Annual Report. Wastewater Discharge Permit language throughout the document will be "*italicized and in quotation marks".* The WWTF's Operations and Management (O&M) staff person from the Department of Environmental Conservation (DEC) Wastewater Program will be reviewing the POP and should be contacted for additional information. Contact information for Wastewater Program staff is available on the Department's website, using this hyperlink: http://dec.vermont.gov/watershed/wastewater/contacts.

I. Optimization Plan Goal:

"The Permittee shall develop or update (as appropriate), and submit to the Secretary a Phosphorus Optimization Plan (POP) to increase the WWTF's phosphorus removal efficiency by implementing optimization techniques that achieve phosphorus reductions using primarily existing facilities and equipment."

The intention of the POP is to outline the current and future measures that can be implemented by a WWTF to reduce TP in the effluent and determine if optimization is sufficient to satisfy Discharge Permit limits and requirements. The POP should evaluate removal of TP with existing infrastructure and within the WWTF's typical operating budget. The POP is not required to consider new tankage or significant new process equipment. In addition, no bond vote should be required to implement the POP.

II. Due Date:

The POP is due within 120 days of the date the Wastewater Discharge Permit is issued. WWTFs that have not yet received a renewed Discharge Permit may begin compiling data and putting together their POPs as soon as practical.

III. Qualified Professional:

The POP shall *"be developed by a qualified professional with experience in the operation and design of WWTFs in consultation with the WWTF."* The POP does not need to be developed by a Professional Engineer. In most cases, WWTF staff are qualified to develop their own optimization plans. The following are considered to be qualified professionals:

- WWTF operators;
- Municipal public works staff in consultation with the WWTF;
- Engineering or consulting firms with experience in wastewater treatment operation, design, and/or process, in consultation with the WWTF and/or town staff;
- Contract WWTF operators in consultation with the WWTF and/or town staff;
- Organizations or individuals that provide technical assistance, that are experienced in the operation, design, and/or process of wastewater treatment, in consultation with the WWTF and/or town staff.

IV. *Background:* Total Phosphorus Limit, Optimization Period, 80% Threshold and Phosphorus Elimination and Reduction Plan (PERP)

A. Total Phosphorus Permit Limits

Renewed Wastewater Discharge Permits will typically include two TP limits; a Monthly Average Concentration and an Annual Pound Limit.

1. Monthly Average Concentration Limit: This limit will likely carry over from the preceding permit. Most Discharge Permits will have a 0.8 mg/l limit for TP. However, this concentration limit may vary. For example, if the receiving stream for the WWTF is experiencing nutrient impairment, based on the Reasonable Potential Determination conducted when the permit is reissued, the WWTF may receive a stricter concentration limit. If the WWTF has a relatively low design flow, the concentration limit may be greater than 0.8 mg/l (see statute 10 V.S.A. § 1266a). Depending on the design flow of the WWTF, monitoring for TP will be required either monthly or weekly.

2. Annual Limit: This document will refer primarily to the Annual Limit. The Annual Limit is the pounds of TP that can be discharged in a 12-month period. The Annual Limit is set by the Waste Load Allocations created during a TMDL process. The TMDL specifies limits for WWTFs in specific Lake Champlain segments. Most Annual Limits are based upon a 0.2 mg/l TP concentration at a WWTF's design flow. For more information about how the Waste Load Allocations were determined, please visit the EPA's Phosphorus TMDLs for Vermont Segments of Lake Champlain document.

   Historically, compliance with the Annual Limit was calculated once per year, by comparing the amount of TP discharge in a calendar year (January 1st to December 31st) to the Annual Limit. This is no longer the case. In the renewed Discharge Permits, **compliance with the Annual Limit will be evaluated each month, by comparing TP discharged in the past 12-months (Running Total Annual Pounds) with the Annual Limit.** The actual TP discharged in this 12-month period is referred to the Running Total Annual Pounds. This calculation is shown in Section VI.B. of this document and on the WR-43-TP Worksheet, included as Appendix A.

   As mentioned above, the Annual Limit is the amount of TP pounds that can be discharged in a 12-month period. Each month, the WWTF will be expected to sum the total pounds of TP discharged in the preceding 12-months and report this value as the Running Total Annual Pounds on the monthly eDMR submission. Compliance will be determined by comparing the Running Total Annual Pounds to the Annual Limit during the Wastewater Program's review of monthly eDMR submissions. Each month, the WWTF will be expected recalculate the Running Total Annual Pounds by accounting for the new month in the 12-month period. Here is an example for how to calculate Running Total Annual Pounds:

Month 1 Running Annual Pounds Calculation

Month	Total Monthly TP Pounds
August 2017	43.95
September	37.53
October	46.54
November	47.54
December	38.78
January 2018	36.19
February	53.71
March	51.71
April	50.04
May	49.12
June	37.53
July	43.95
August	53.71
September	51.71

Running Total Annual Pounds for 12-month period (July 2018 – August 2017) = 536.59 lbs

Month 2 Running Annual Pounds Calculation

Month	Total Monthly TP Pounds
~~August 2017~~	~~43.95~~
September	37.53
October	46.54
November	47.54
December	38.78
January 2018	36.19
February	53.71
March	51.71
April	50.04
May	49.12
June	37.53
July	43.95
August	53.71
September	51.71

Running Total Annual Pounds for 12-month period (August 2018 – September 2017) = 546.35 lbs

B. Optimization Period

The renewed Discharge Permits provide WWTFs a 12-month optimization period where the WWTF will not be subject to the TP permit limit (see Section IV.A. for a description of the permit limits). The intention of this 12-month period is for WWTFs to implement optimization strategies to lower their TP discharge in order to satisfy limits expressed in the Discharge Permit. These optimization strategies should be outlined in the POP.

C. 80% Threshold

To ensure a WWTF does not exceed the Annual Limit, an 80% provision is included in the renewed Discharge Permits. WWTFs will be granted a 12-month optimization period beginning the effective date of the renewed Discharge Permit. If after the 12-month optimization period, a WWTF's Running Total Annual Pounds reaches or exceeds 80% of the Annual Limit, the WWTF will be required to project whether or not their Running Total Annual Pounds of TP will exceed the Annual Limit during the permit term.

The WWTF shall submit the projection within 90 days of reaching or exceeding 80% of the Annual Limit. If the WWTF is not projected to exceed the Annual Limit within the permit term, the WWTF shall reassess and determine when it is projected to reach the Annual Limit prior to seeking permit renewal. That information shall be submitted with the new permit application.

If the WWTF is projected to exceed the Annual Limit during the permit term, the WWTF shall submit a Phosphorus Elimination and Reduction Plan within 6 months from the date of the projection. These scenarios are described further in Section V.C. of this document.

D. Phosphorus Elimination and Reduction Plan

If a WWTF is projected to exceed the Annual Limit at any time during the permit, the WWTF must submit a Phosphorus Elimination and Reduction Plan (PERP) to ensure compliance with the WWTF's Annual Limit. This document will be treated like a compliance schedule. The requirements of the PERP can be found in the Discharge Permit. The scenarios that trigger a WWTF into generating a PERP are outlined in Table 1 (see Section V.C.).

V. Plan Contents:

The POP should at a minimum, be composed of three major items: A. An evaluation of the WWTF and Collection System for phosphorus reduction potential (see Section V.A.); B. Based upon the evaluation, existing and future phosphorus optimization techniques suitable for the WWTF and trends of effluent TP in comparison to the 80% threshold and Annual Limit (see Section V.B.); C. Based upon the TP effluent trends, a determination of whether or not the WWTF will be in compliance with the Discharge Permit 80% threshold and Annual Limit (see Section V.C.).

A. WWTF and Collection System Phosphorus Evaluation

In the POP, provide a description of your WWTF and analysis of the phosphorus reduction potential of your WWTF and its users. **The WWTF and Collection System Evaluation section of the POP should at a minimum address the following items: 1. Plant Description, 2. Influent / Sidestream Characteristics, 3. Phosphorus in the Collection System, and 4. Phosphorus in the Process.** The items listed below each of the headings (Section V.A.1. – 4.) are recommendations to help you effectively evaluate the reduction potential of your WWTF and Collection System. You are not required to address the items listed below the headings, although it is strongly recommended.

1. Plant Description:
   a. Provide a discussion of the existing treatment process;
   b. Provide a flow schematic or sketch the WWTF process;
   c. Outline the design criteria from engineering design documents or basis for final design documents. Include design flow, design BOD capacity, TSS design capacity, average wet weather flow, average annual flow.

2. Influent / Sidestream Characteristics:
   a. Discuss the influent characteristics of the WWTF.
   b. Describe variations of flow and influent loadings due to factors such as seasonality, infiltration, inflow, combined sewers.
   c. Describe the characteristics and frequency of septage / sludge / leachate and other liquid waste streams received by the WWTF.
   d. Describe the internal sidestreams associated with the WWTF, include the frequency in which sidestreams occur, where they are introduced to the process, and their characteristics.
   e. Present influent and sidestream phosphorus monitoring data.

3. Phosphorus in the Collection System:
   a. Describe dischargers that potentially contribute high concentrations of phosphorus or high-strength waste to the WWTF via the collection system.
   b. Describe sampling and data collected from dischargers defined by subpart 3.a.
   c. Describe sampling and data collected from pump stations or other sampling ports throughout the collection system.
   d. Describe sewer ordinance control measures for limiting phosphorus on incoming wastewater.

4. Phosphorus in the Process:
   a. Describe where phosphorus is monitored within the WWTF process.
   b. Present species of phosphorus identified throughout the WWTF process, such as soluble phosphorus, insoluble phosphorus, ortho-phosphate, total phosphorus, etc.
   c. Describe use of process control parameters to achieve optimal phosphorus removal, such as total suspended solids, soluble biochemical oxygen demand, volatile fatty acids, pH, alkalinity, oxidation reduction potential, mean cell residence time, dissolved oxygen, etc.
   d. Describe jar testing performed and/or identification of optimal precipitant and injection points.

B. Identify Phosphorus Optimization Techniques & Effluent Trends

Secondly, identify the phosphorus optimization techniques chosen for your WWTF and present effluent quality data in your POP.

1. Phosphorus Optimization Techniques:
   Use the findings from the WWTF and Collection System Phosphorus Evaluation (Section V.A.) to identify phosphorus optimization strategies suitable for your WWTF. Provide a detailed description of the identified optimization strategies in this section of the POP. Include future and existing measures already utilized by the WWTF for phosphorus removal.

   Present a timeline or implementation schedule for those optimization measures that have been deemed appropriate and necessary, but not yet implemented. Present a timeline of existing optimization measures implemented by the WWTF. Some optimization strategies may take a significant amount of planning, additional data collection, phosphorus mapping throughout the WWTF process, jar testing, etc. Present these details and findings in your description or implementation schedule.

   Optimization strategies may include:

   - Methods of operating the existing WWTF;
   - Equipment changes;
   - Operational process changes to enhance biological or chemical phosphorus removal;
   - Incorporation of anaerobic/anoxic zones;
   - Septage receiving policies and procedures;
   - Sidestream management; and
   - Sewer ordinance measures.

2. Correlating Phosphorus Loadings to Optimization Techniques:
   After identifying previous, existing and future optimization techniques suitable to your facility, document your progress by trending effluent phosphorus loadings in correlation with optimization techniques. If optimization has been employed prior to permit issuance, it would be beneficial to include past data to illustrate the benefit of past optimization efforts. This data should be presented in your POP and subsequent Annual Reports (Annual Reports are discussed in Section VI.A.).

Example 1 provides a case study that depicts the correlation of effluent TP loading and optimization techniques at a theoretical WWTF. In Example 1, this correlation is presented in the form of a graph with an accompanying narrative. This correlation in your POP is not required to be in the form of a graph, it can be a timeline or a table. Overall, the goal of this section is to document implementation of optimization strategies and track effluent TP loading.

This section in your POP will serve as a measure of complying with the following condition in your Wastewater Discharge Permit: *"Within 120 days of permit issuance, the Permittee shall develop or update (as appropriate), and submit to the Secretary a Phosphorus Optimization Plan (POP) to increase the WWTF's phosphorus removal efficiency by implementing optimization techniques that achieve phosphorus reductions using primarily existing facilities and equipment."*

C. Project Compliance with Permit Limit and Determine Next Steps

The final step in creating your POP is to determine if your WWTF's Running Total Annual Pounds is consistently below or is projected to exceed the 80% TP threshold. Include the findings of this determination in your POP. Use the scenarios outlined in Table 1 on page 9 of this document as a guide to determine the next steps for your WWTF. The scenarios in Table 1 are consistent with the requirements of the "*Phosphorus Elimination/Reduction Plan"* condition in the Discharge Permit.

Table 1: TP Compliance Scenarios

Scenario 1: **Running Total Annual Pounds is consistently below 80% threshold.**	Scenario 2: **Running Total Annual Pounds is currently projected to reach or exceed 80% and cannot consistently remain below 80% threshold.**	Scenario 3: **After 12-month optimization period Running Total Annual Pounds will consistently exceed 80% threshold and is projected to exceed Annual Limit during the permit term.**
Step 1: Describe current optimization strategies in POP. Continue operating under current optimization strategies to remain under the 80% permit threshold. **Step 2:** Begin planning for future if influent flow or phosphorus concentration and/or loading is expected to increase.	**Step 1:** Describe current and additional optimization strategies in POP. Provide an implementation schedule for the planning and implementation of optimization strategies to bring effluent TP below 80% threshold. **Step 2:** If after the 12-month optimization period, the WWTF's Running Total Annual Pounds reach or exceed 80%, based on the WWTF's current operations and expected future loadings, project whether it will exceed its permit limit during the permit term. This projection should be submitted within 90 days of reaching or exceeding 80% threshold. **Step 3:** <u>If the facility is not projected to exceed its permit limit within the permit term</u>, reassess when it is projected to reach its permit limit prior to seeking permit renewal and submit that information with the next permit application. <u>If the loading is expected to exceed the permit limit</u>, **see Scenario 3**	**At this point, Steps 1 – 3 presented in Scenario 2 should be complete.** If based upon the projection, the facility is projected to exceed its permit limit during the permit term, the Permittee shall submit a PERP within 6 months from the date of submittal of the projection plan. The PERP shall be submitted to ensure the WWTF continues to comply with its Annual Limit. The requirements of the PERP are presented in the "*Phosphorus Elimination/Reduction Plan*" condition of the Discharge Permit.

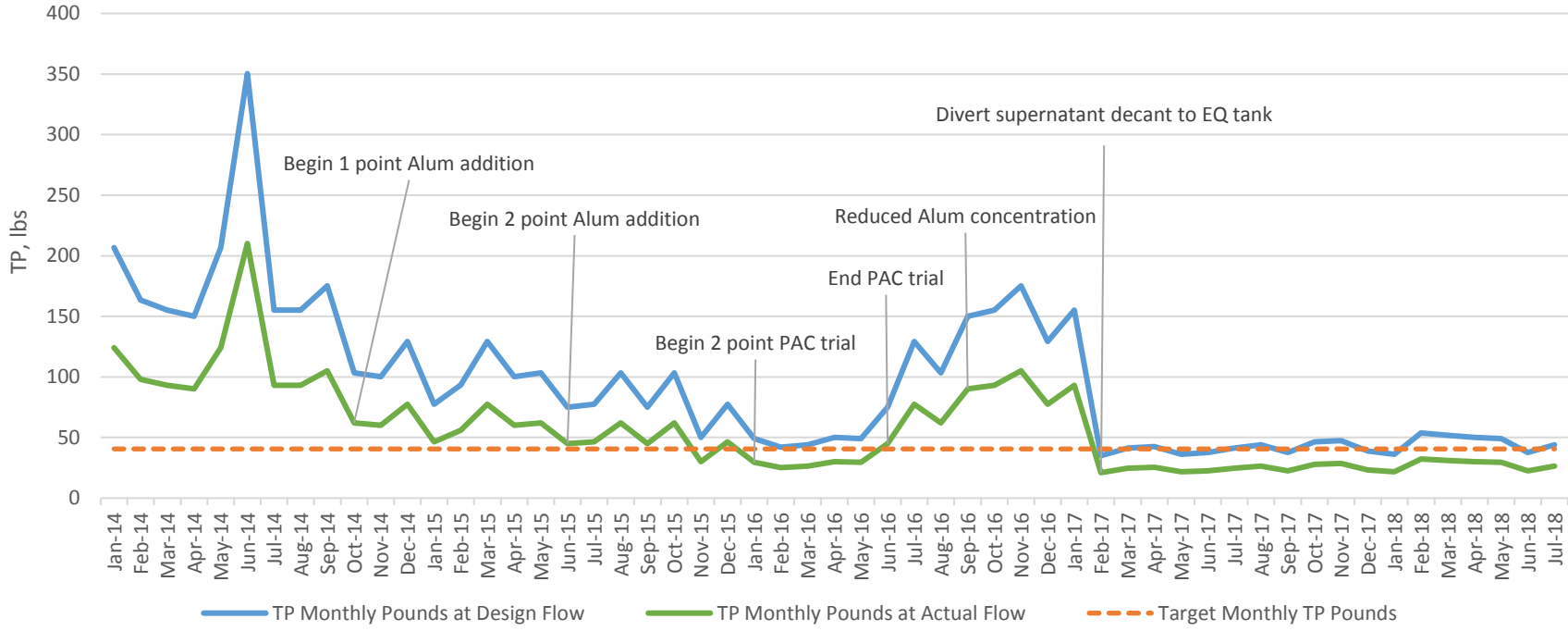
Example 1: Phosphorus Optimization Trends

This example correlates optimization strategies performed at a conventional activated sludge WWTF with effluent total phosphorus data. The Facility has been operating through July 2018. While these exact trends are not required, they serve as examples that would satisfy the Section V.B.2. of the POP.

Figure 1 depicts effluent TP load at design flow (1.0 MGD) and actual flow (0.6 MGD). In this Figure, effluent TP is expressed as total monthly pounds. This WWTF calculated a target monthly effluent goal to evaluate the effectiveness of optimization and to draw comparisons to their 80% permit threshold. Their target monthly TP load is simply 80% of their rolling permit limit, divided by 12 months. As described in Section IV., the permit limit is based on a rolling 12-month period.

Table 1: Fictional WWTF TP	
Design Flow (MGD)	1.00
Actual Flow, Annual Average (MGD)	.600
Permit Limit (lbs)	609
80% of Permit Limit (lbs)	487
Monthly Target (lbs/month)	40.6

Figure 1: Monthly Total Phosphorus Discharges in Pounds



In Figure 2, the WWTF portrays Running Total Annual Pounds, for the previous 12 months. The Running Total Annual Pounds is the sum of 12 months' worth of TP loadings. Expressing the TP data in this manner is an effective way to track WWTF TP loading in comparison to the 12-month rolling TP limit. By doing this, the WWTF can project how many pounds of TP they can discharge the forthcoming month. The WWTF can also calculate a target TP concentration. The target TP concentration will largely be influenced by the effluent flow, since flow has such a significant impact on the total pounds of TP discharged.

Figure 2: Running Total Annual Pounds of Total Phosphorus

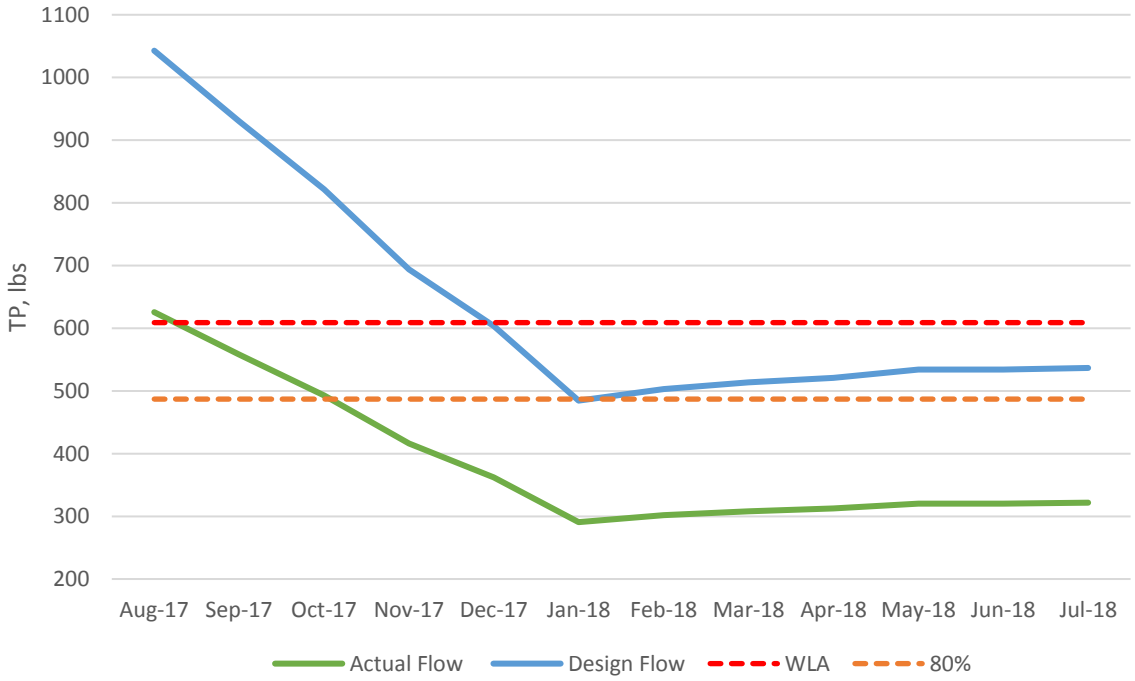


Figure 2 illustrates the influence effluent flow can have on a WWTF's loading. As influent flow to the WWTF increases and TP loading begins to reach or exceed the 80% threshold, this fictional WWTF may trigger the requirement to generate a projection and submit a PERP in the future, if further optimization is no longer viable (see Section IV.D. for more information about PERPs). The PERP for the WWTF may include a plan to further optimize to consistently maintain loadings below 80%. Or, if optimization is no longer viable, the PERP may include a plan to upgrade the WWTF upgrade for TP removal or limit TP discharge of users and industries.

Overall, the contents presented within Example 1 depict a clear timeline of optimization strategies that correlates to the WWTF's TP loading. For now, it is clear the WWTF can consistently remain under their 80% threshold. The WWTF will continue to provide optimization updates in the Annual Reports, submitted each December.

VI. Total Phosphorus Reporting

This section of the guidance document describes the reporting required to the DEC Wastewater Program.

A. Phosphorus Optimization Plan - Annual Report:

The Wastewater Discharge Permit requires the Permittee to submit an annual report as an attachment to December's electronic Discharge Monitoring Report (eDMR). The report should be submitted electronically via the ANR Online reporting system. The intention of the Annual Report is to the document implementation of optimization strategies identified in the POP; document additional optimization strategies implemented as the WWTF that were not identified in the original POP; and finally, evaluate effectiveness of optimization strategies.

The following items are required of your Annual Report:

1. *"The optimization techniques implemented under the POP during the previous year."* – The Annual Report shall identify the strategies identified by the POP, implemented by the WWTF. Also, take this time to outline any additional optimization strategies that have been implemented or are being planned at the WWTF, that are not outlined in the POP.

2. *"A determination of whether the techniques are performing as expected."* – Evaluate the phosphorus optimization techniques implemented at the WWTF. Report whether or not the optimization strategies have been effective and performing as expected. Outline any changes or adjustments that may be made to further enhance the optimization techniques.

   One way to determine whether or not your optimization strategies are effective is by setting TP load and concentration targets, similar to the scenario described in Example 1.

3. *"The phosphorus discharge trends relative to the previous year."* – Present effluent TP trends for the past year or more. Trends such as those presented in Example 1 can satisfy this condition.

B. Other Total Phosphorus Reporting – Discharge Monitoring Reports

Your Wastewater Discharge Permit requires TP to be reported in the following ways:

1. Monthly Average Concentration – Calculate this by summing all of the measured TP discharges (mg/l) during the month and divide by the number of measured discharges TP discharges during the month to get the monthly average TP concentration. Report this number monthly, on your WR-43 and DMR. See *A.* on the *Total Phosphorus Reporting Worksheet*.

2. Total Monthly Pounds – Calculate this by multiplying the monthly average TP concentration by the average daily flow for the month by the number of days in the month the WWTF discharged in the month by 8.34. See *D.* on the *Total Phosphorus Reporting Worksheet*.

3. Running Total Annual Pounds – Calculate this by summing the Total Monthly Pounds for the preceding 12-months. See *E.* on the *Total Phosphorus Reporting Worksheet.*

4. Comparison of Running Total Annual Pounds to Annual Permit Limit – Calculate this by dividing Running Total Annual Pounds by the Annual Permit Limit and multiplying the quotient by 100 to get the percentage of current Running Total Annual Pounds to the Annual Permit Limit. See *G.* on the *Total Phosphorus Reporting Worksheet*.

Appendix A – Total Phosphorus Reporting Worksheet (WR-43 TP)