Memo

To: Lance Holloway, Pete Wagner, Troy Smith, Kati Carberry

From: Darcy Sharp

Date: 2/13/2015

RE: Additional scenarios for the Lower Boise River AQUATOX model of the total phosphorus (TP)/periphyton relationship

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After the presentation of the January 2015 revision of the draft Lower Boise River (LBR) Total Phosphorus TMDL to the Lower Boise Watershed Council Technical Advisory Committee on January 21, 2015, there has been a request to evaluate the winter allocation for wastewater treatment facilities (WWTF), increasing it from 0.35 mg/L to 0.50 mg/L and also to 1.0 mg/L TP. I have run additional AQUATOX scenarios showing that although periphyton reductions are similar under all three reduction scenarios, this increase will cause additional exceedances of the Snake River-Hells Canyon TMDL TP target of 0.07 mg/L for May – September. The reason that a winter increase in effluent causes summer exceedances is the persistence of phosphorus in the aquatic environment.

The AQUATOX model is used to determine if the following allocations will reduce periphyton to meet a mean nuisance algae target of ≤ 150 mg^2/m:

- 0.1 mg/L TP May – September and 0.35 mg/L TP October – April for WWTFs, Industry, and Fish Hatcheries (PS)
- 0.07 mg/L TP tributaries, ground water, and unmeasured (NPS) without NPDES flows and loads
- Stormwater wet weather 42% load reduction (WLA)
- Stormwater dry weather 84% load reduction (WLA/LA based on Permittee estimates

Modeling this scenario (PS 0.1 Summer/ 0.35 Winter; NPS 0.07) showed that with these phosphorus reductions, the periphyton target will be met if the modeling results are evaluated based on monthly averages and averaged for the listed assessment units, as shown in Figures 1 and 2.

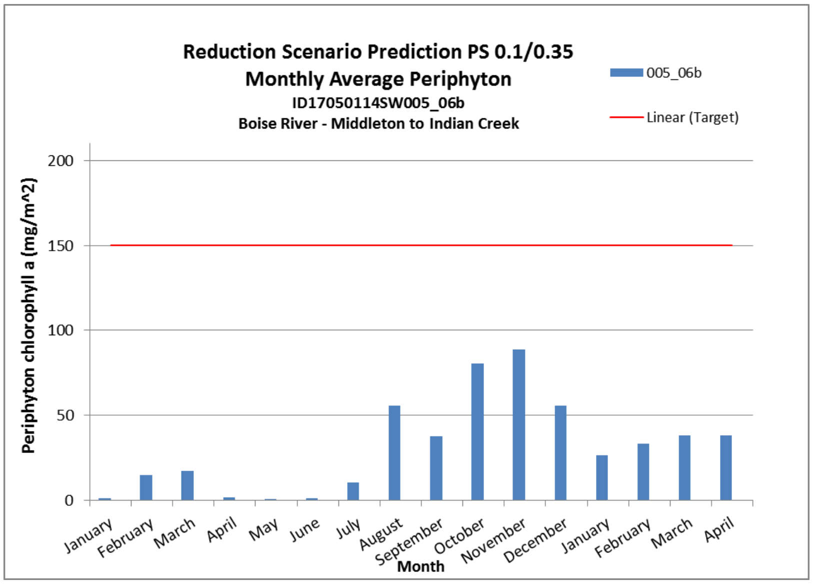


Figure 1. Monthly average periphyton for ID17050114SW005_06b for the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario.

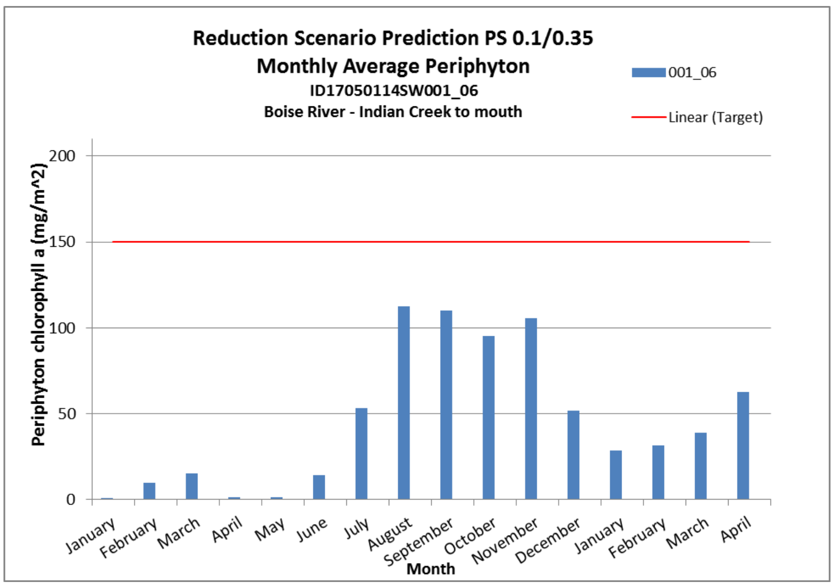


Figure 2. Monthly average periphyton for ID17050114SW001_06 for the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario.

These graphs show that the periphyton target is met year-round under this reduction scenario. It seems that there is more room to increase the winter point source allocation to 0.50 or 1.0 mg/L TP. However, averaging the model results as in Figures 1 and 2 are only part of the story. If the monthly averages are shown as a rolling 30-day average periphyton based on assessment unit, then the 150 mg/m^2 target is just barely met, as shown in Figures 3 and 4.

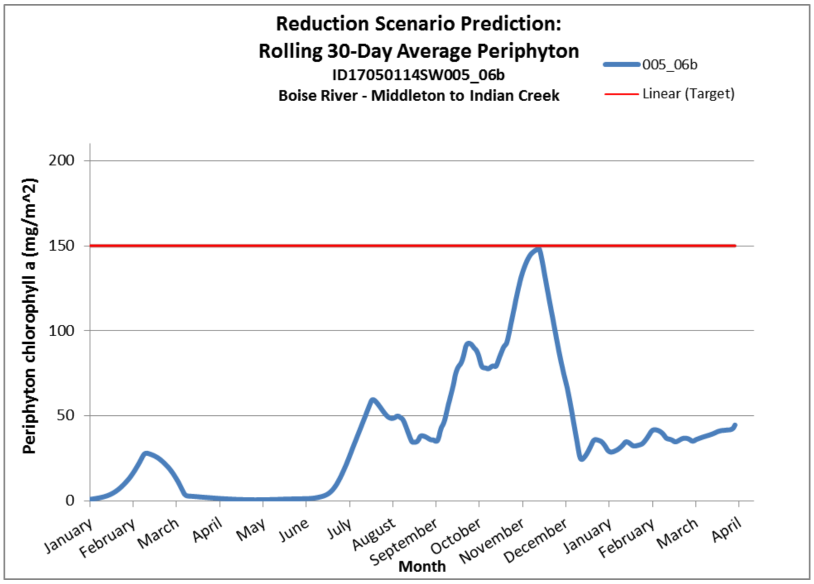


Figure 3. Rolling 30-day average periphyton for ID17050114SW005_06b for the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario.

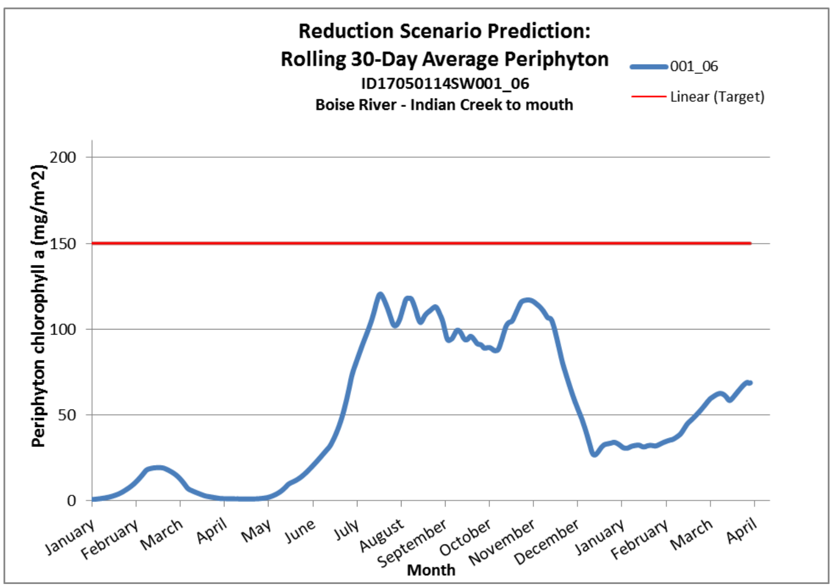
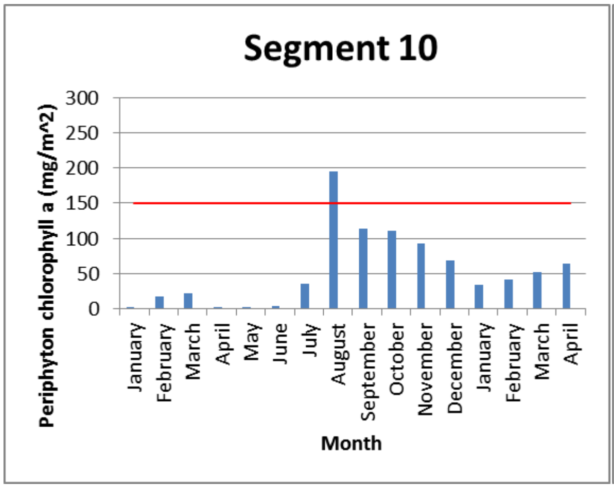


Figure 4. Rolling 30-day average periphyton for ID17050114SW001_06 for the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario.

Furthermore, if the periphyton target is evaluated based on more localized effects, there are exceedances in model segments 10 and 11 in August and September, as shown in Figure 5.



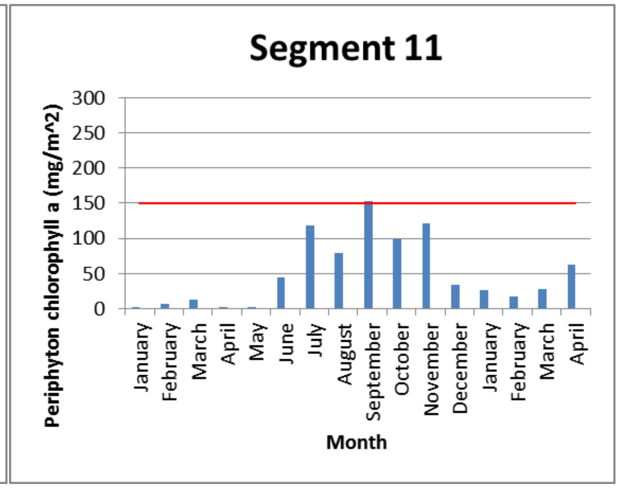


Figure 5. Monthly average periphyton exceedances for model segments 10 and 11 for the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario.

If the periphyton target were evaluated on daily predictions, it would be exceeded more than 10% of the time in model segment 10, as shown in Figure 6.

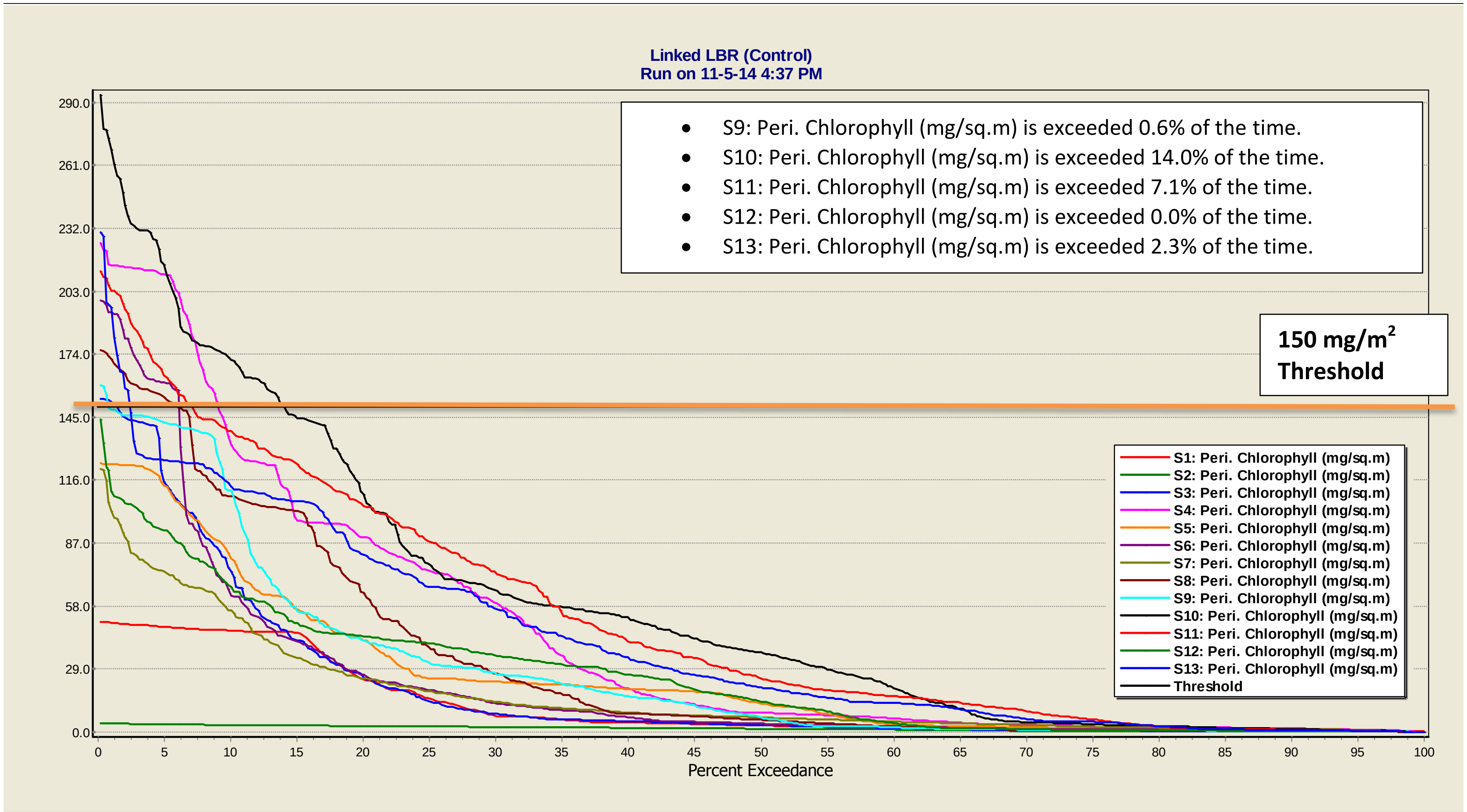


Figure 6. Predicted daily periphyton values for the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario compared to the year-round periphyton 150 mg/m^2 target.

Exceedances of the periphyton target are of great concern for environmental groups and EPA for several reasons:

1. The model predictions for periphyton have an overall absolute mean error of ± 61.5 mg/m^2
2. There are additional sources of model uncertainty as identified in Sections 3.3.3.4 and 3.3.3.5 of the AQUATOX modeling report. As a result, additional sources of TP mean these exceedances could be larger in magnitude.

3. These values are for the 2012-2013 water year, while other flow scenarios could increase periphyton exceedances under this reduction scenario.

In addition to the periphyton exceedances, the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario predicts some exceedances of the May to September 0.07 mg/L TP target at the mouth of the Boise River, as shown in Figure 7.

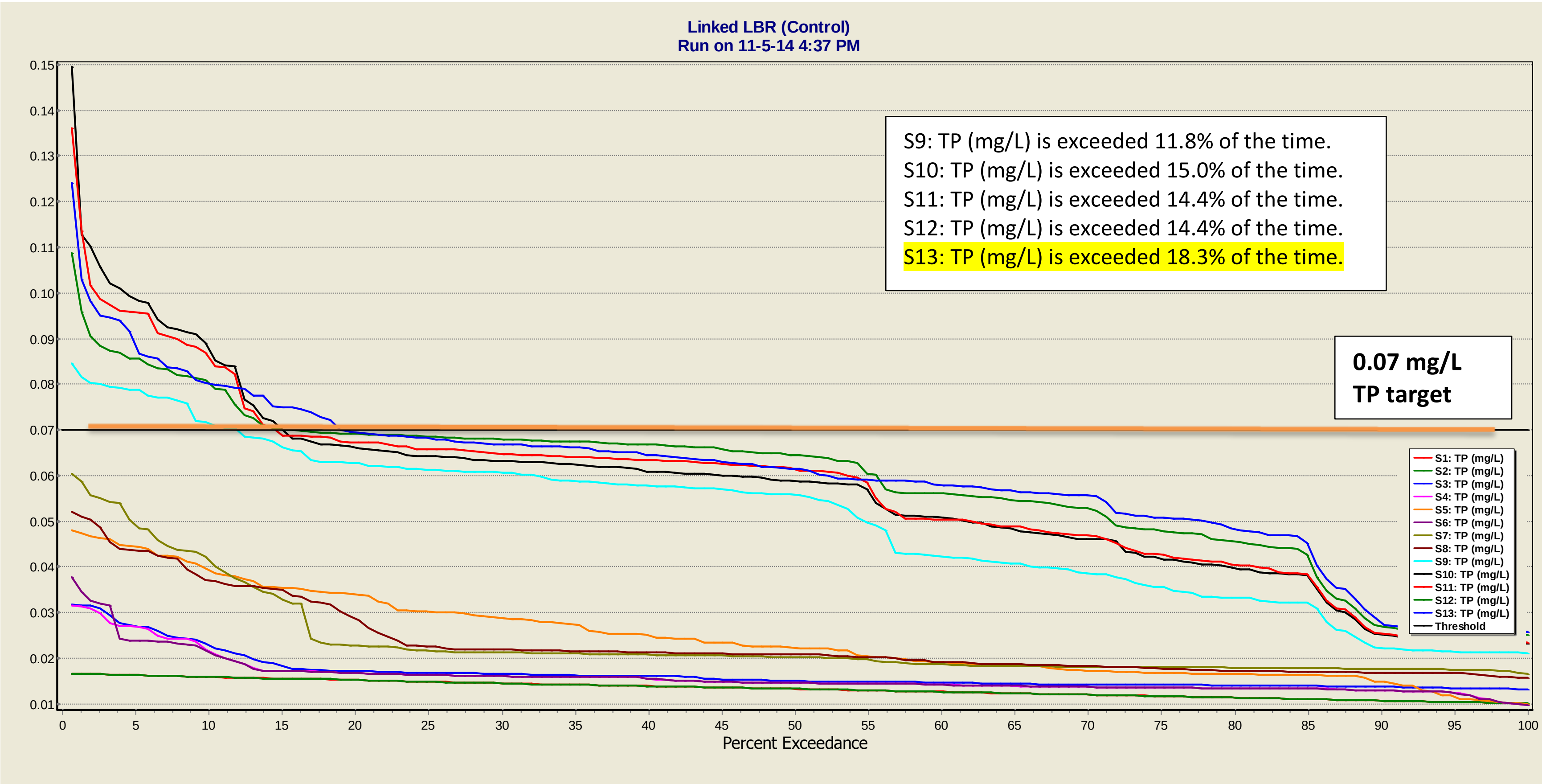


Figure 7. Daily May to September phosphorus exceedances of the 0.07 mg/L target predicted by the AQUATOX model scenario for the "PS 0.1 Summer/0.35 Winter; NPS 0.07".

These TP exceedances of the Snake River – Hells Canyon TMDL TM target of 0.07 mg/L May to September are of concern. Model prediction of TP concentration is accurate within ± 0.07 mg/L.

When I ran additional reduction scenarios with point source allocations reduced to 0.07 mg/L year-round, and 0.05 mg/L year-round—which is the approximate limit of technology—the additional scenarios showed a small net gain in environmental benefit for a large technological investment. As a way to summarize this, I plotted yearly average periphyton for existing conditions and all of the reduction scenarios, as shown in Figure 8.

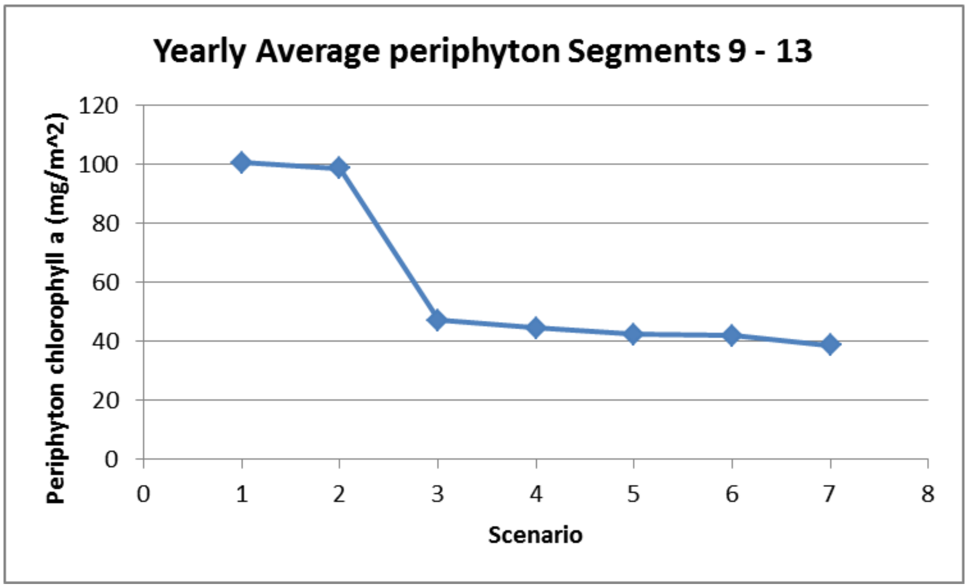
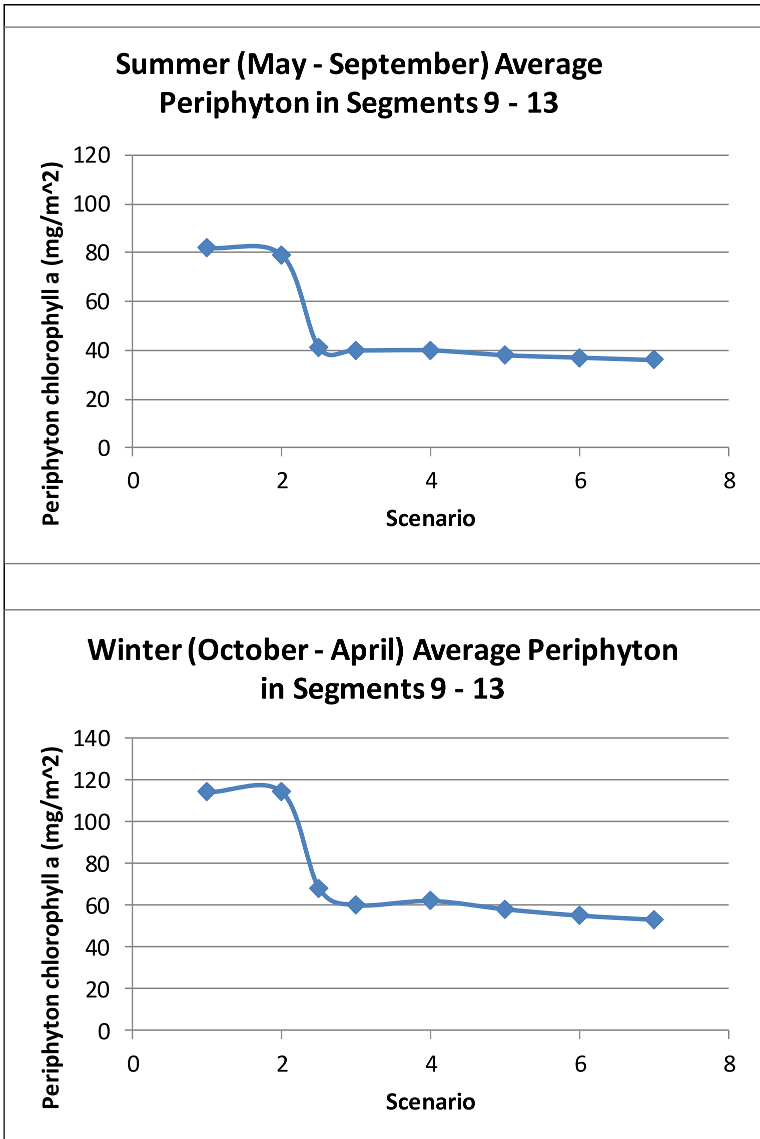


Figure 8. Summary of annual average periphyton for existing conditions in scenarios 1 and 2 and phosphorus reductions in scenarios 3 through 7.

In the modeling report, the difference of the annual average between Scenario 3, "PS 0.1 Summer/0.35 Winter; NPS 0.07", and Scenario 7 with point sources 0.05 year round, is only about 8 mg/m^2. This comparison of annual averages was intended as a quick way to show that there is not much environmental benefit in further phosphorus reductions beyond Scenario 3, but it masks the increase in localized periphyton exceedances. Furthermore, using annual averages is not how periphyton targets will be interpreted for the TMDL.

Members of the Lower Boise Watershed Council have asked DEQ to run additional scenarios with point sources increased to 0.50 mg/L and to 1.0 mg/L TP for October through April. They have also asked to see those results in a plot like Figure 8, but broken down by season instead of yearly. Their interest is to see if there is a "point of diminishing returns" at some effluent emission level greater than that shown in the TMDL reduction scenario (Scenario 3). In response to this request, I am providing results for "PS 0.1 Summer/1.0 Winter; NPS 0.07: as scenario 2.3 and "PS 0.1 Summer/0.50 Winter; NPS 0.07" as scenario 2.5 in Figure 9, broken out by season. The periphyton results in Figure 9 are averaged for all of model segments 9 through 13, which are roughly equivalent with the listed AUs.



Summer	Average Periphyton
1	82
2	79
2.3	41
2.5	40
3	40
4	38
5	37
6	36
7	36

Winter	Average Periphyton
1	114
2	114
2.3	68
2.5	60
3	62
4	58
5	55
6	53
7	47

Figure 9. Summary of seasonal average periphyton for existing conditions and reduction scenarios. Scenario 2.3 is "PS 0.1 Summer/0.50 Winter; NPS 0.07"; Scenario 2.5 is "PS 0.1 Summer/1.0 Winter; NPS 0.07" and Scenario 3 is recommended TMDL reduction scenario.

When averaged seasonally, there is little difference in periphyton reductions among the 0.35 mg/L, 0.5 mg/L, and 1.0 mg/L TP winter allocations for the point sources. This averaging masks where periphyton exceedances actually occur. Additionally, the major difference between existing conditions and any reduction scenario is that the TP reduction scenarios were modeled with equivalent reductions of nitrogen and carbon sources and organic detritus as described in Section 4.1 of the modeling report. Also, the nutrient reductions to tributaries and groundwater are a major component of the difference between existing conditions and any reduction scenario.

Monthly average periphyton values for the "PS 0.1 Summer/0.50 Winter; NPS 0.07" reduction scenarios are shown in Figures 10 and 11.

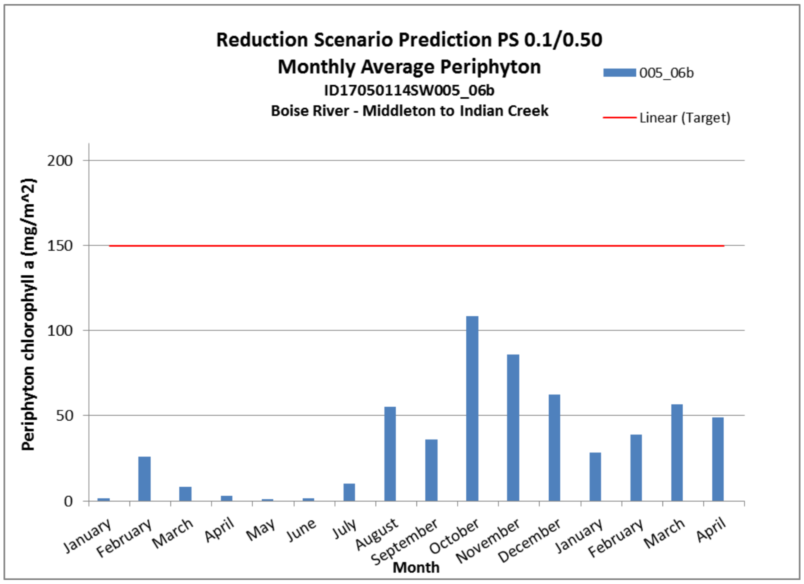


Figure 10. Monthly average periphyton for ID17050114SW005_06b for the "PS 0.1 Summer/0.50 Winter; NPS 0.07" reduction scenario.

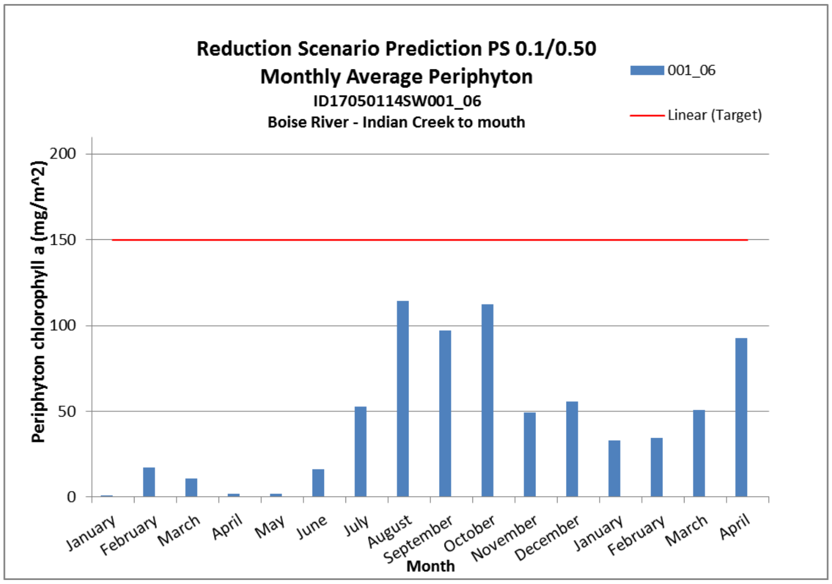


Figure 11. Monthly average periphyton for ID17050114SW001_06 for the "PS 0.1 Summer/0.50 Winter; NPS 0.07" reduction scenario.

Monthly averages meet the periphyton target for the listed assessment units under the "PS 0.1 Summer/0.50 Winter; NPS 0.07" reduction scenario.

Monthly average periphyton values for the "PS 0.1 Summer/1.0 Winter; NPS 0.07" reduction scenarios are shown in Figures 12 and 13.

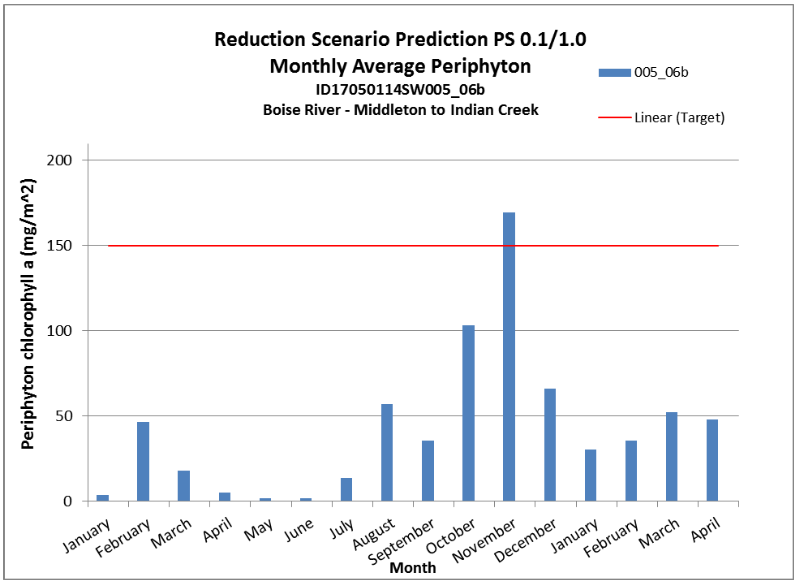


Figure 12. Monthly average periphyton for ID17050114SW005_06b for the "PS 0.1 Summer/1.0 Winter; NPS 0.07" reduction scenario.

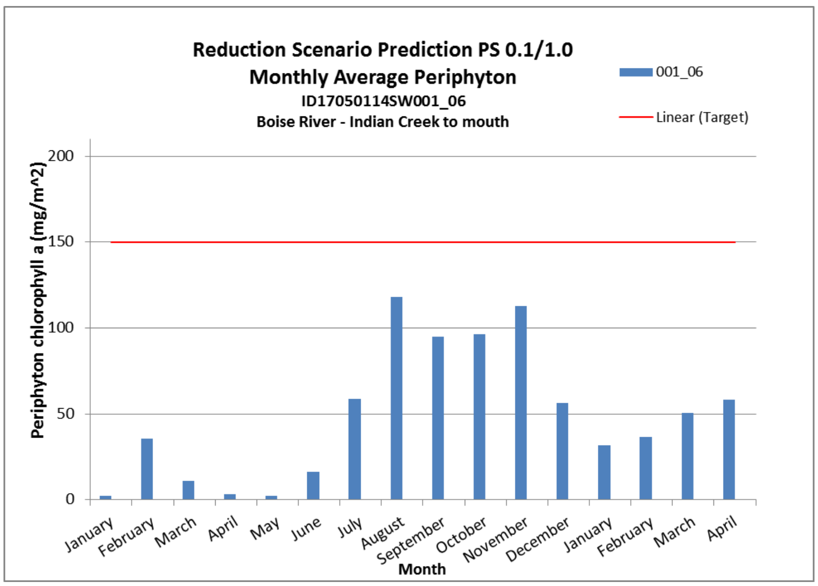


Figure 13. Monthly average periphyton for ID17050114SW001_06 for the "PS 0.1 Summer/1.0 Winter; NPS 0.07" reduction scenario.

Increasing the winter allocation to 1.0 mg/L TP results in periphyton exceedances for November, when averaged by month and AU.

Figures 14 through 16 are percent exceedance charts output by AQUATOX that show the daily exceedances of the 0.07 mg/L TP threshold for model segment 13 (near Parma). These are the daily TP values between May 1 and September 30, 2013.

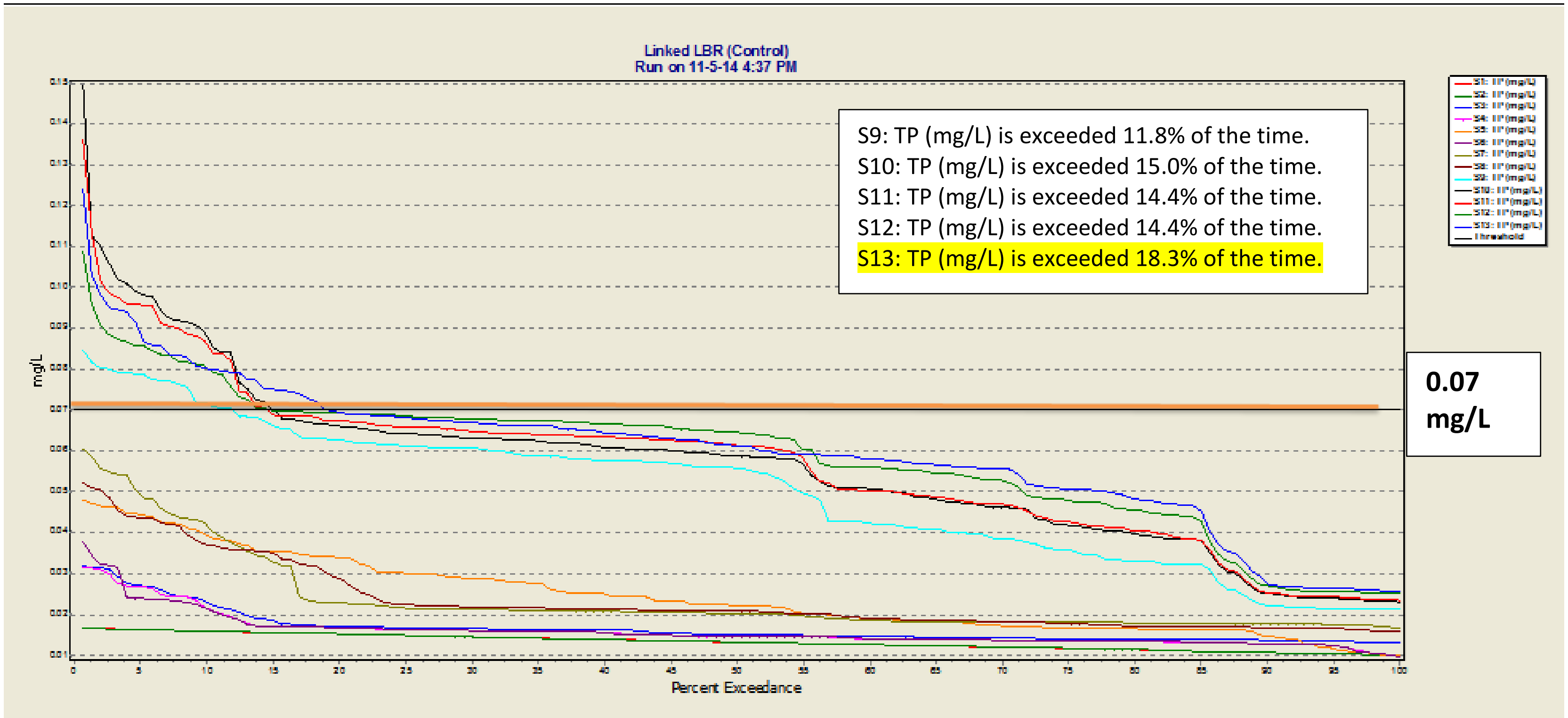


Figure 14. Daily May to September phosphorus exceedances of the 0.07 mg/L target predicted by the AQUATOX model for the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario.

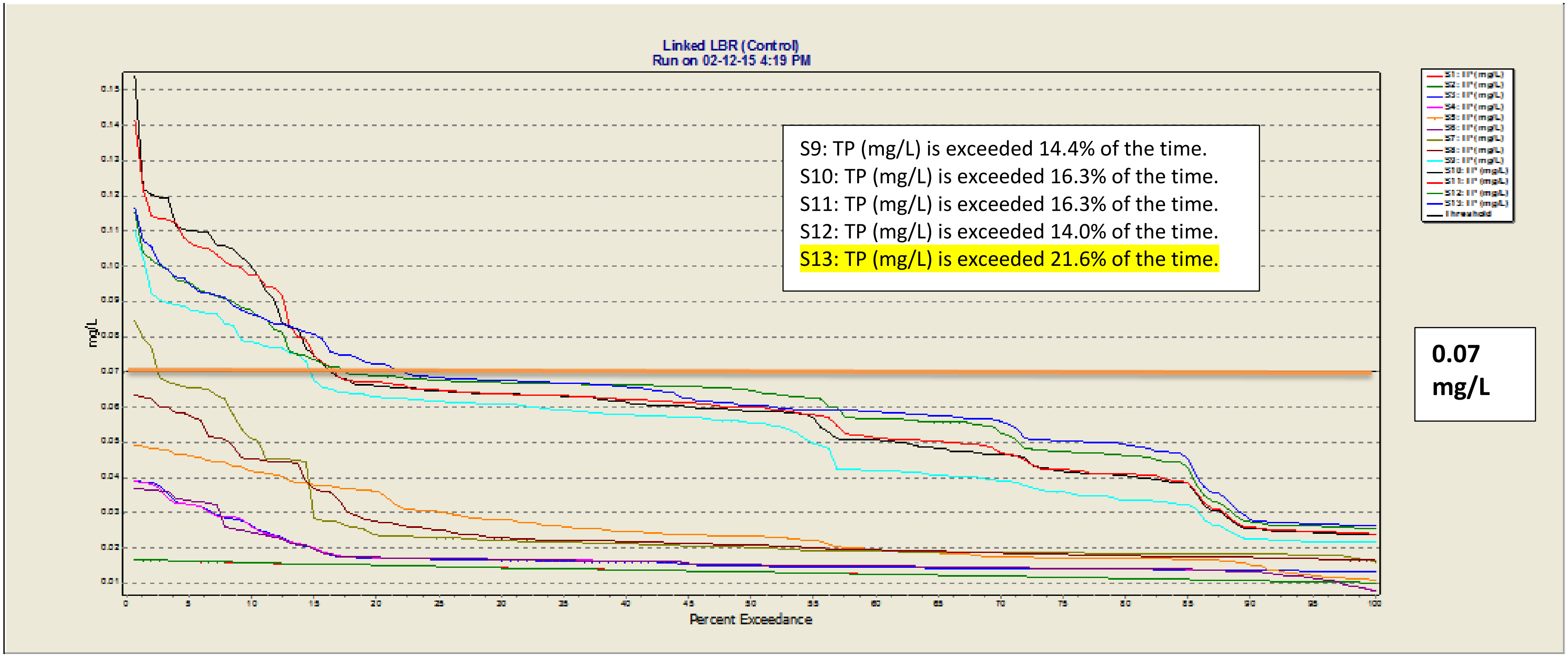


Figure 15. Daily May to September phosphorus exceedances of the 0.07 mg/L target predicted by the AQUATOX model for the "PS 0.1 Summer/0.50 Winter; NPS 0.07" reduction scenario.

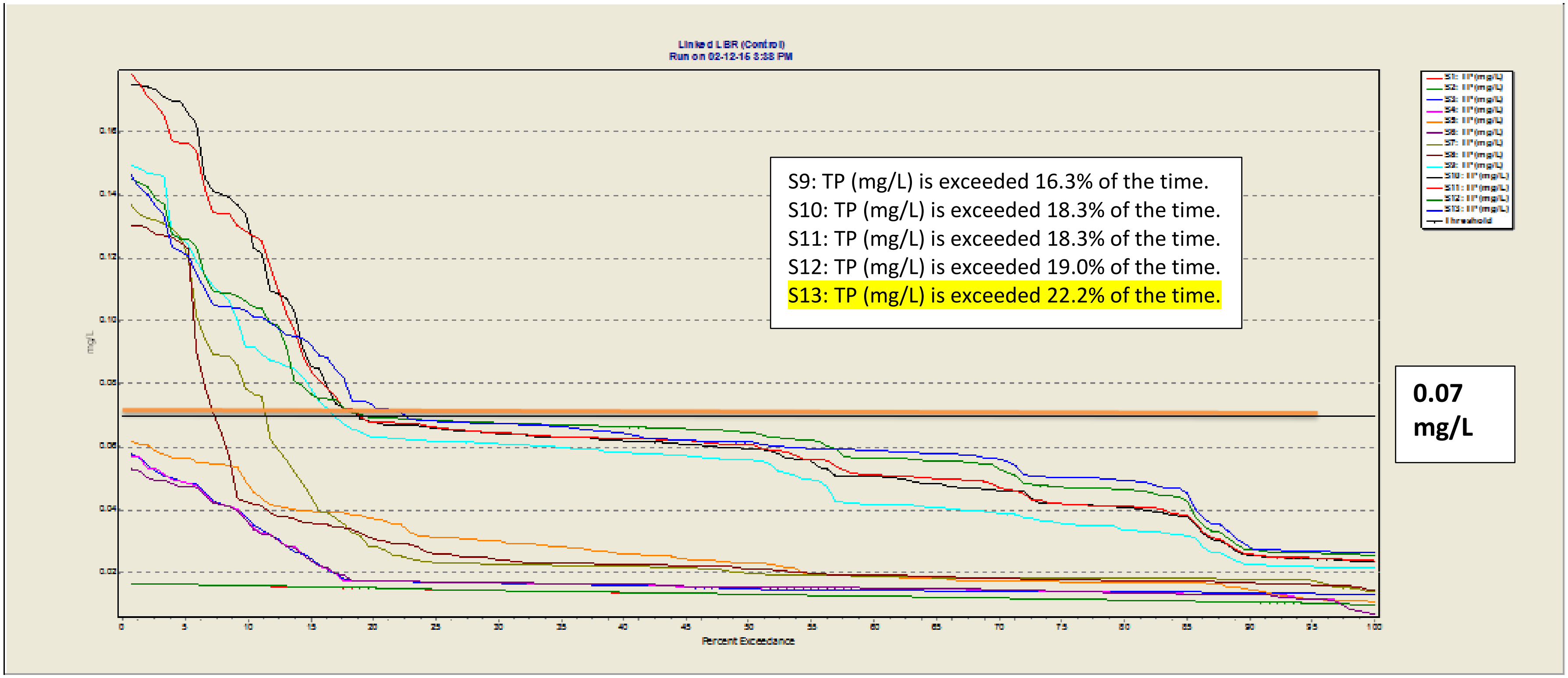


Figure 16. Daily May to September phosphorus exceedances of the 0.07 mg/L target predicted by the AQUATOX model for the "PS 0.1 Summer/1.0 Winter; NPS 0.07" reduction scenario.

Even though the phosphorus target was increased only during winter, the effects persisted into the May to September timeframe. These results illustrate the persistence of phosphorus in the aquatic environment. Each time the winter TP allocation is increased, the May to September TP exceedances increase.

My recommendation is that the "PS 0.1 Summer/0.35 Winter; NPS 0.07" reduction scenario will show the best combination of periphyton reductions year-round, with instream TP levels that are more likely to also achieve the 0.07 mg/L target at Parma from May 1 through September 30.