

## Summary of 2018-2019 Performance of SSFL Distributed Stormwater Controls

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### Summary

Influent and effluent samples were obtained from seven distributed controls in the 009 watershed for up to 6 rains during the 2018-19 rain year at the SSFL. Total and filtered copper, total lead, TCDD, and TSS were detected for most of the samples, while total and filtered cadmium and mercury, and filtered lead were seldom detected.

The Woolsey directly affected the subwatersheds for two of the controls. The influent concentrations for the simple media filters (upper lot media filter and culvert modifications) directly affected and not directly affected by the fire were compared. Only total copper had a significant difference between these data sets, with non-affected locations (CM-9 and upper lot biofilter) having higher concentrations compared to the others, most likely due to the increased paved areas in these two drainage areas.

Various graphs and statistical analyses were used to compare the influent and effluent concentrations. The grouped box and whisker plots show that the combined results for the simple media filters had the lowest copper concentrations, while the other locations had similar concentrations to each other. The Southern Detention Bioswale had large and obvious increases in filtered copper concentrations in the effluent, as also noted during analyses of prior years' data. The Southern Detention Bioswale had much

greater influent median lead concentrations than the other locations, although one of the media filter samples had the greatest overall concentration. The lead removals at the bioswale location were also large and obvious. TCDD reductions through treatment at all of the locations were also obvious and large, with the exception of the single sample pair available at the Boeing Administration Area inlet filter. The single paired sample at that location does not allow any statistical analyses, but it is unlikely to provide significant reductions in influent concentrations. The bioswale had the largest median TSS influent concentration, while an influent and effluent media filter sample had the largest overall TSS concentration. The bioswale shows large and obvious TSS concentration reductions, along with the simple media filters, both likely due to the high influent concentrations compared to the other locations.

The probability plots and associated comparison statistical tests (paired one-tail T test or Wilcoxon Sign Rank test, depending on distribution characteristics) illustrate the overlap and similarities of the influent and effluent concentrations at the control locations. The following lists the locations and constituents that had statistically significant differences between influent and effluent sample concentrations:

- Lower Lot Biofilter system: lead ( $p = 0.04$ )
- South Detention Bioswale: cadmium ( $p = 0.04$ ); lead ( $p = 0.05$ ); and TSS ( $p = 0.05$ )
- Simple Media Filters combined: copper ( $p = 0.05$ ); lead ( $p = 0.05$ ); TCDD ( $p = 0.02$ ); and TSS ( $p = 0.04$ )

The media filter combined data set had the largest number of sample pairs (12). The statistical calculations are highly dependent on the number of observations available, making it more challenging to show significant differences with small data sets at the other stormwater control locations (3 to 5 sample pairs).

A few of these constituent-control combinations resulted in statistically significant regression relationships between influent and effluent concentrations: Lower Lot Biofilter for lead; South Detention Bioswale for lead; and Media Filters combined for copper and TSS.

An important measure of performance of these distributed controls in the 009 watershed is the reduction in the number of concentrations above the NPDES outfall permit limits with treatment, as summarized below:

Copper (PL = 13 ug/L)

South Detention Bioswale: 1 of 3 influent samples; 0 of 3 effluent samples

Lead (PL = 5.2 ug/L)

South Detention Bioswale: 2 of 3 influent samples; 0 of 3 effluent samples

Media Filters combined: 2 of 12 influent samples; 0 of 12 effluent samples

TCDD (PL = 2.8E-8 ug/L)

Lower Lot Biofilter: 4 of 4 influent samples; 1 of 4 effluent samples

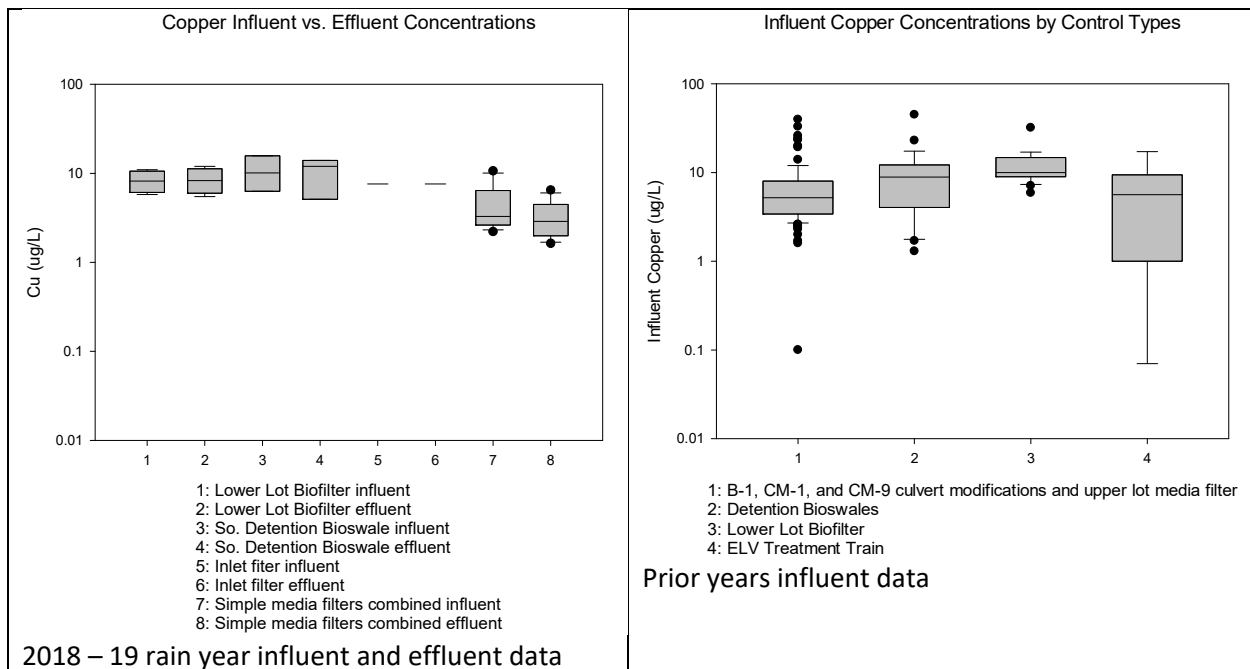
South Detention Bioswale: 3 of 3 influent samples; 0 of 3 effluent samples

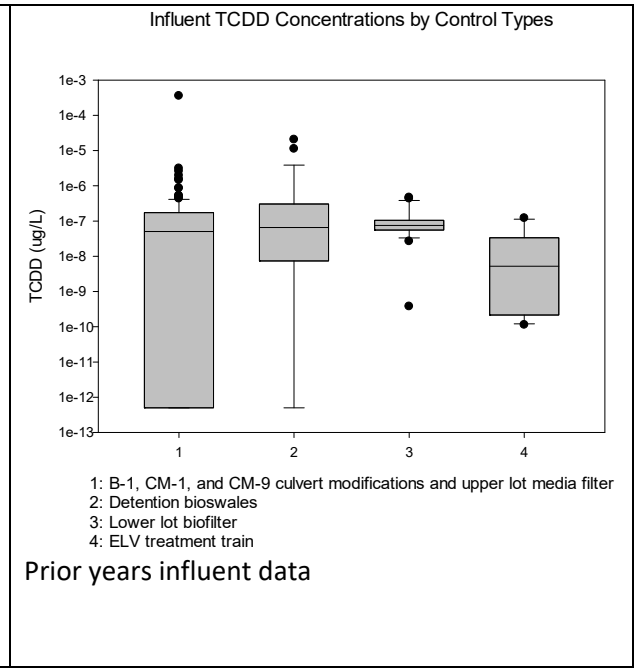
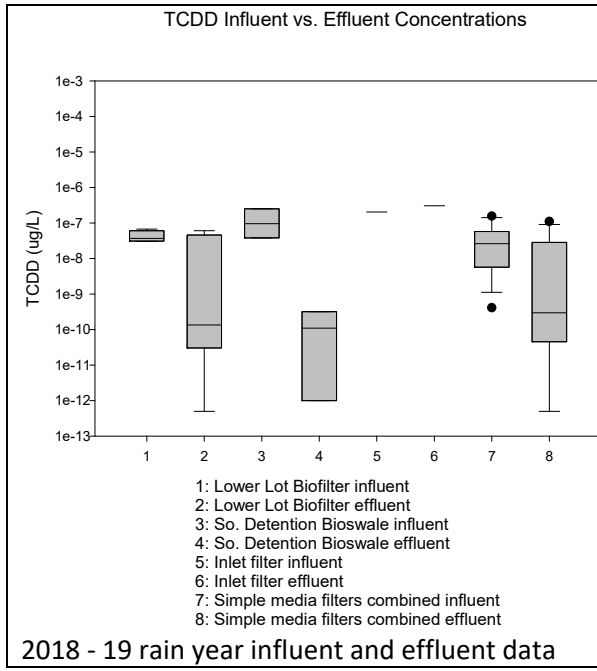
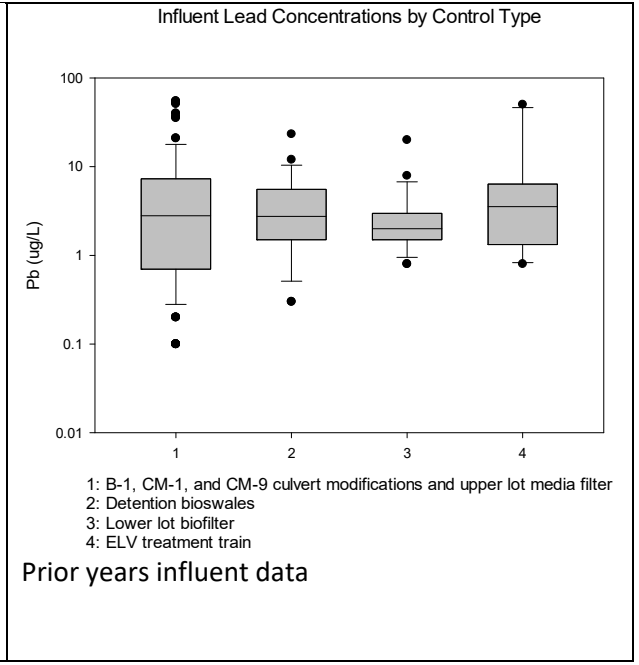
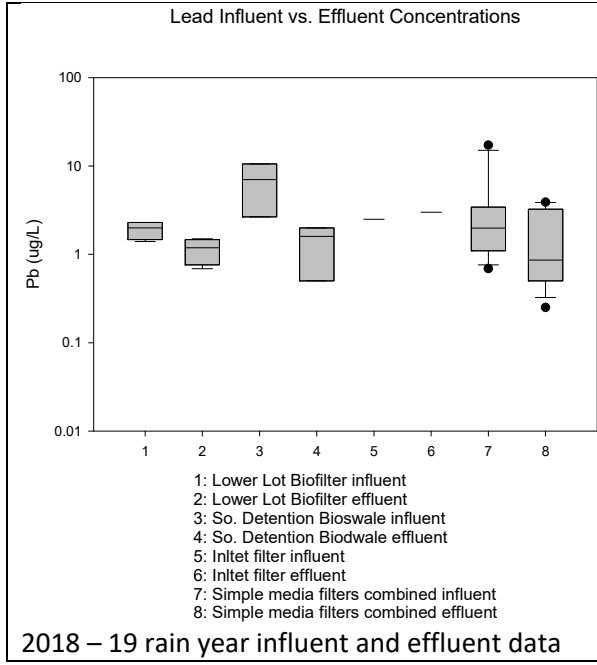
Boeing Admin Area inlet filter: 1 of 1 influent samples; 1 of 1 effluent samples

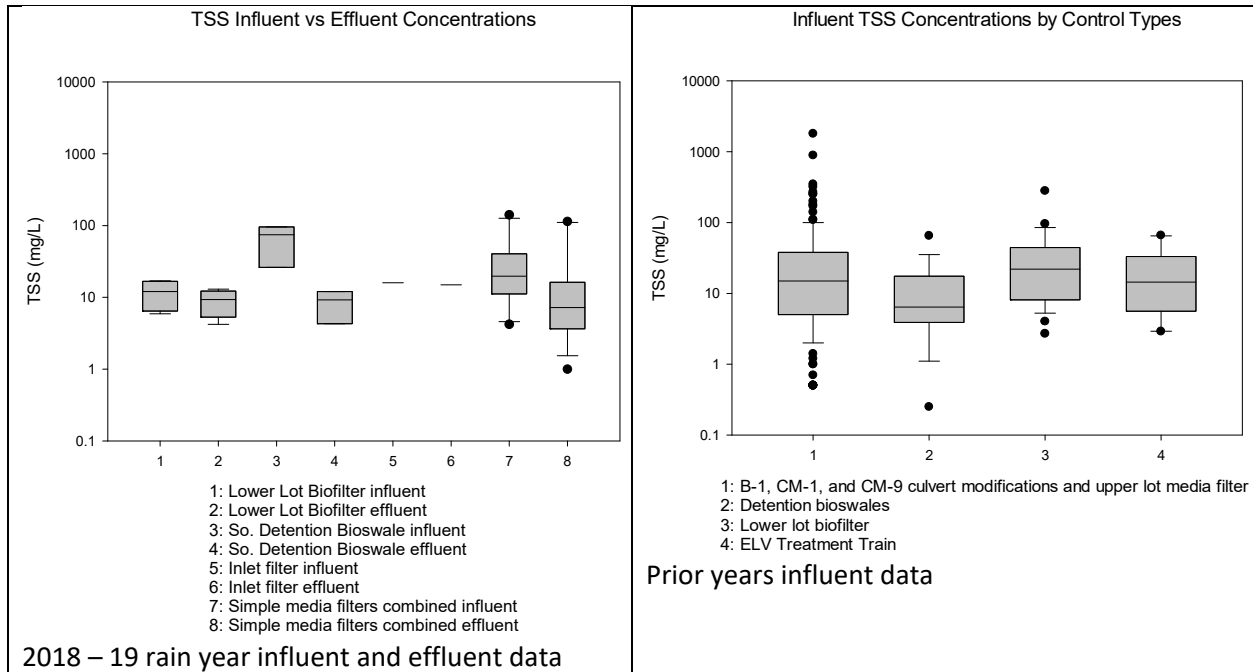
Media Filters combined: 7 of 12 influent samples; 3 of 12 effluent samples

Copper and lead influent concentrations exceeding the outfall NPDES permit limits were all reduced to concentrations below the permit limits. TCDD exceedance numbers were also reduced, but not all effluent samples were below the outfall permit limits.

The following box and whisker plots compare the 2018 – 19 influent and effluent concentrations with prior years influent concentrations. The prior years' data include many more observations, with some concentrations higher or lower than the fewer observations from this past year, as expected. When the influent concentrations on the box plots are compared, it is seen that the copper and TCDD concentrations are similar for both time periods for the same categories of controls. However, the current Southern Detention Bioswale influent TSS concentrations appear to be larger than for the prior year's bioswale TSS data. The bioswale lead influent concentrations may also be slightly greater than the prior year's bioswale influent lead concentrations. The current higher Southern Detention Bioswale TSS and lead concentrations may be because the prior bioswale concentration data are combined for both the Northern and Southern Detention Bioswales, and the Northern Bioswale influent concentrations were previously noted to be lower than the Southern Bioswale influent concentrations.







### 2018 – 19 Data Observations at Distributed Controls in the 009 Watershed

Influent and effluent samples were obtained from several distributed stormwater controls in watershed OF009 during the 2018-2019 rain year. The controls sampled were:

- CM-1 (6 events, but one event missing influent inflow sample)
- CM-3 (only one event, influent sample only; excessive debris hindered further sampling, as shown on the following picture)



**Figure 35. Sediment accumulated behind weir boards at CM-3.**

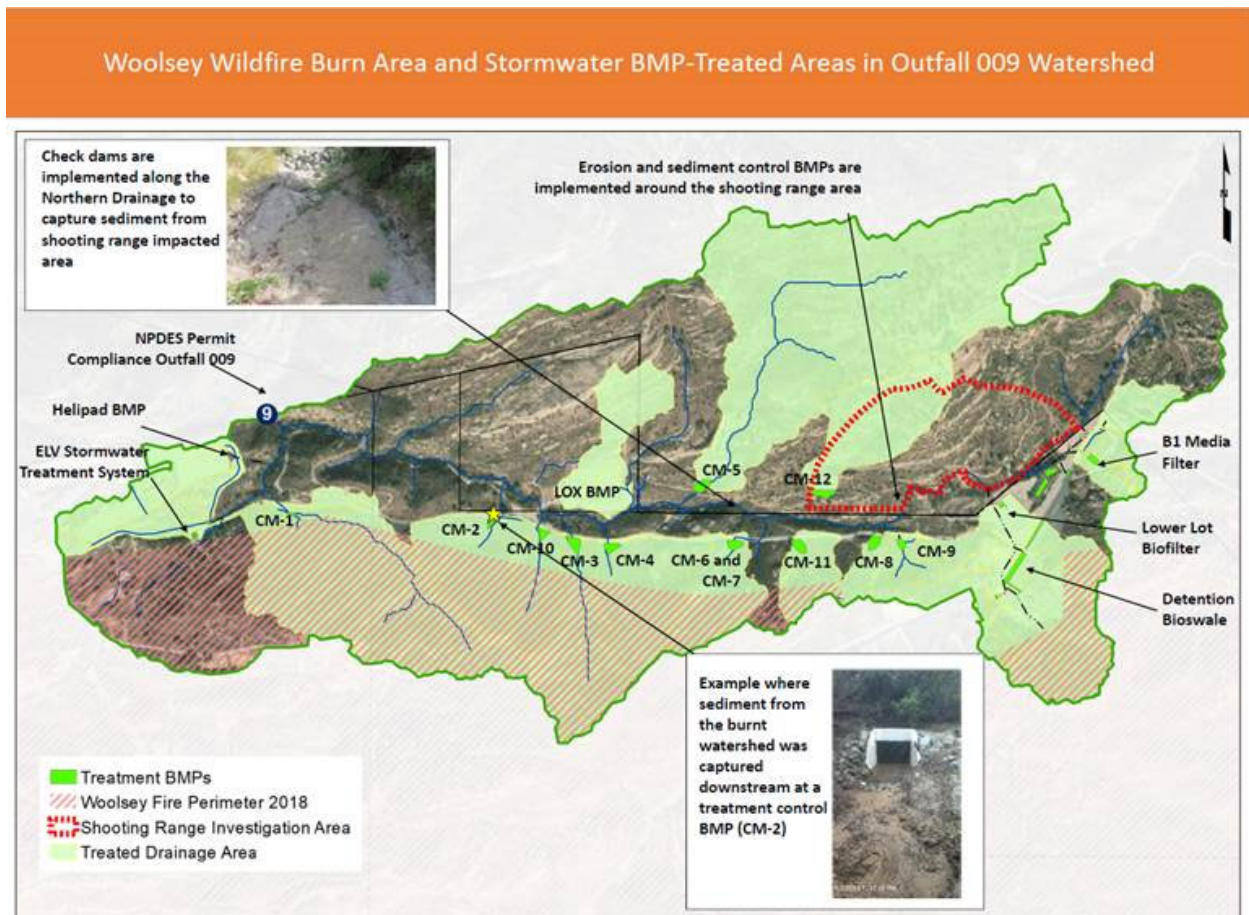
- CM-9 (2 events)
- Upper Lot media filter (5 events, but one with only effluent sample)
- Southern Detention Bioswale (3 events)
- Boeing Administration Area inlet filter (only one event sampled)

- Lower Parking Lot Biofilter system (four events but two did not have influent samples)

The following list the days when these samples were obtained, along with the total rain associated with the sampled event. Most of the samples were taken near the beginning of the flows from these events, before the total rain shown occurred.

- 11/29/2018 (1.17 inches over 2 days)
- 12/6/2018 (2.51 inches over 2 days)
- 1/14/2019 (5.68 inches over 5 days)
- 1/31/2019 (1.67 inches over 6 days)
- 2/14/2019 (3.12 inches over 7 days)
- 3/2/2019 (3.21 inches over 8 days)

The Woolsey Fire started on November 8, 2018 (about 3 weeks before the first site rains), so all of these samples were after the fire. Although the fire burnt about 80% of the SSFL site, only a southern fringe of the 009 watershed was burnt. Portions of CM-1 and CM-3 drainage areas were directly affected by the fire, as shown on the following map:

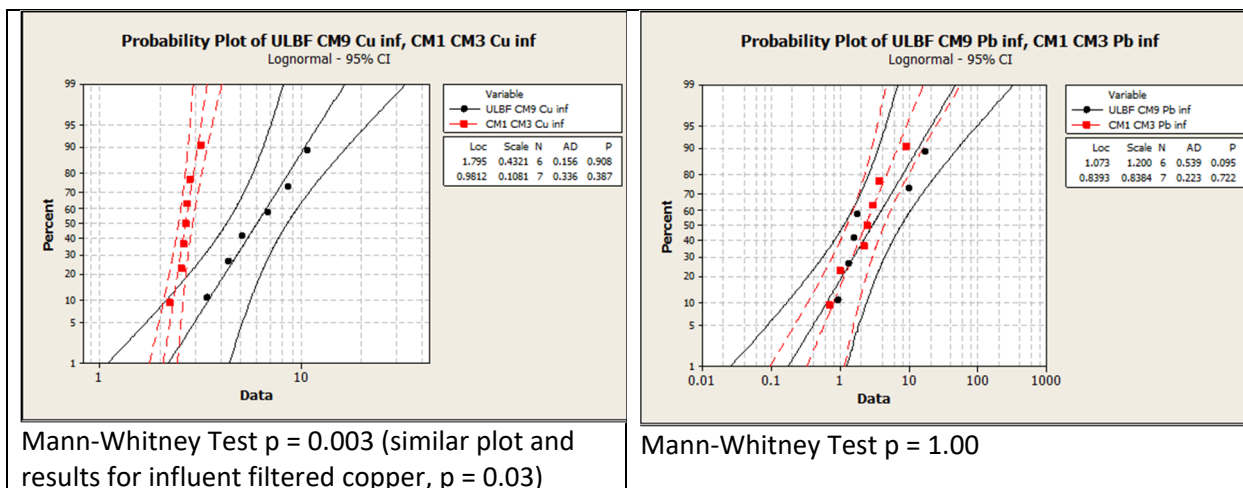


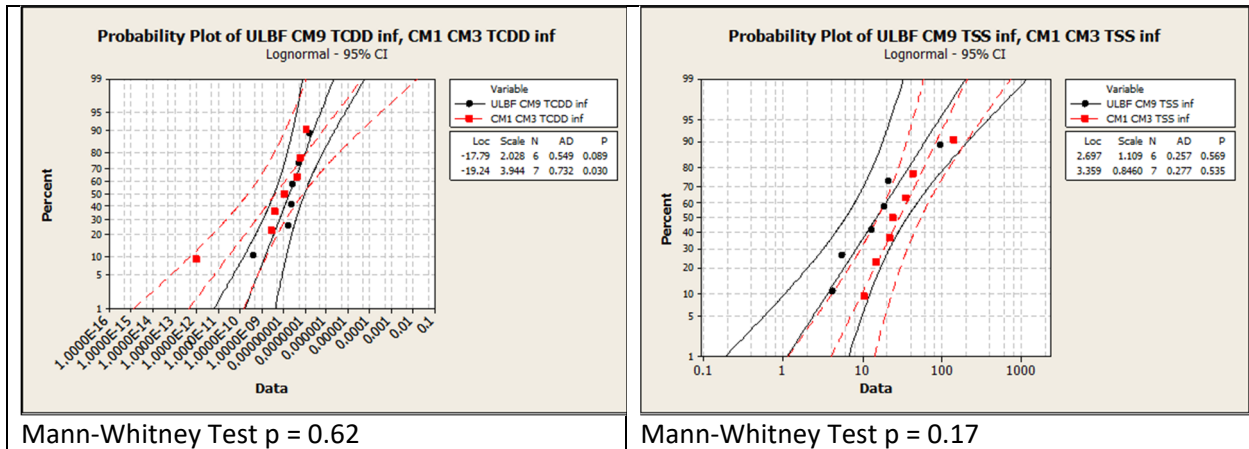
Constituents monitored at the influent and effluent locations included:

- Cadmium (total and filtered)
- Copper (total and filtered)
- Lead (total and filtered)
- Mercury (total and filtered)
- TCDD TEQ No DNQ
- TSS

A single event also had total and filtered nickel analyzed at most of the locations. Most of the cadmium (total and filtered), mercury (total and filtered), and filtered lead analyses were below the detection limits and were not statistically evaluated. If a constituent had a few non-detected values, one half of the detection limit was substituted for the analyses and graphs.

Also, several of the simple media filters (CM-1, CM-3, CM-9, and the upper lot media filter) data were combined due to similar treatment methods, and to increase the power and confidence of the analyses by increasing the sample numbers. As noted above, CM-1 and CM-3 had portions of their drainage areas burnt during the Woolsey Fire. Therefore, comparison tests were conducted contrasting CM-1 and CM-3 influent concentrations with CM-9 and the upper lot media filter influent concentrations. The following probability plots compare influent concentrations for these simple media filters directly affected by the fire (CM-1 and CM-3) compared to influent concentrations for the simple media filters not directly affected by the fire (upper lot media filter and CM-9):





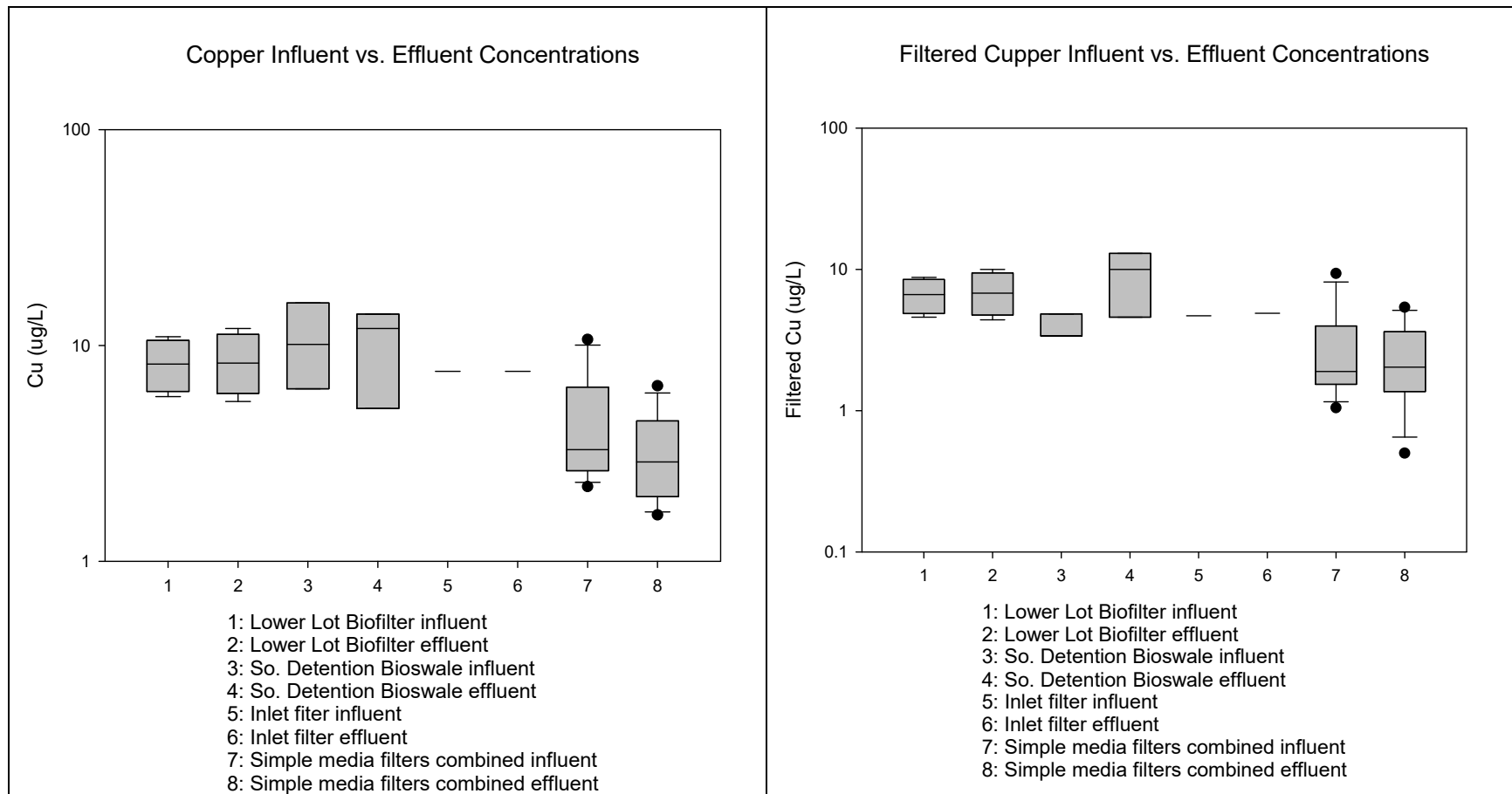
As shown on the above probability plots, and as indicated by the Mann-Whitney p values, only the copper influent concentrations were significantly different for these two data sets. The copper values were higher for the upper lot media filter and for CM-9, likely due to the large amount of paved areas draining to those controls. The TSS influent concentrations at CM-1 and CM-3 have apparent (but not significant) increases compared to the other two locations, likely due to increased erodible areas, and possibly effects associated with the fire. The statistical calculations are highly dependent on the number of observations available, making it more challenging to show significant differences with small data sets.

The following appendices present the results of the graphical and statistical analyses using these data. These are presented by constituent at the four control categories and include:

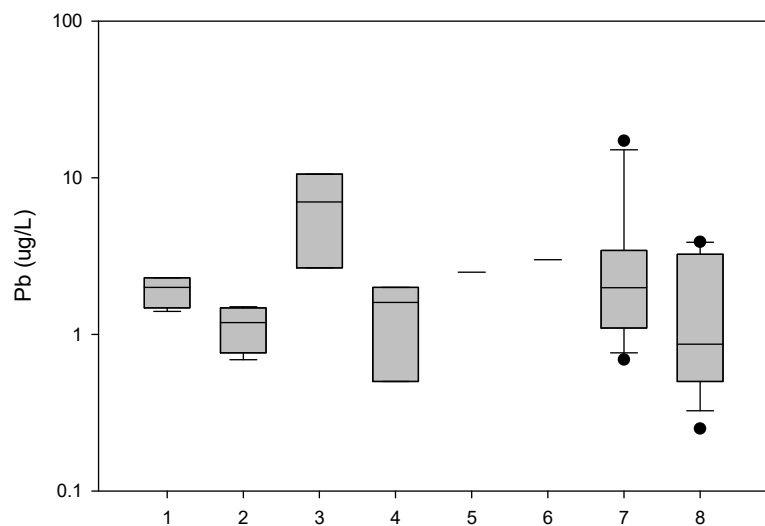
- group box and whisker plots to contrast the influent and effluent concentrations
- probability plots showing the distributions of influent and effluent concentrations (along with Wilcoxon Signed Rank test results showing the statistical significance of the differences in the influent and effluent paired samples). Paired Student's T tests were used if the data distribution was normal (based on Shapiro-Wilk test).
- scatterplots of influent vs. effluent concentrations, associated regression equations, and ANOVA analyses that show the calculated significance of the overall equation and equation coefficients



## Appendix A: Box Plots

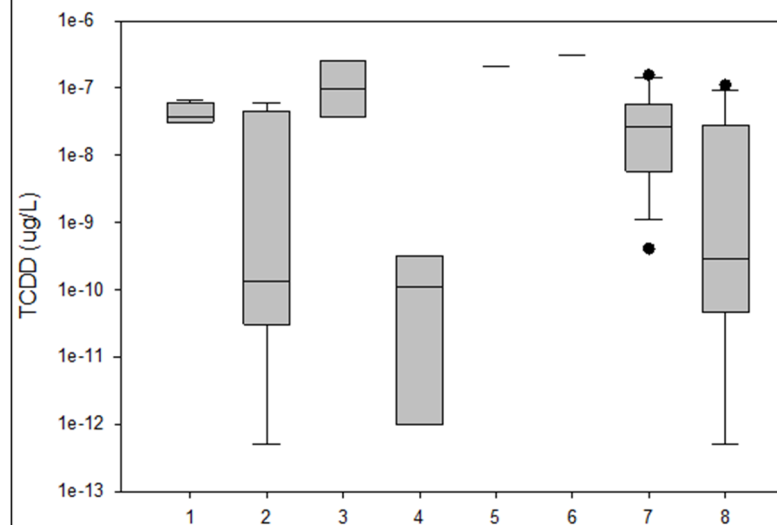


Lead Influent vs. Effluent Concentrations



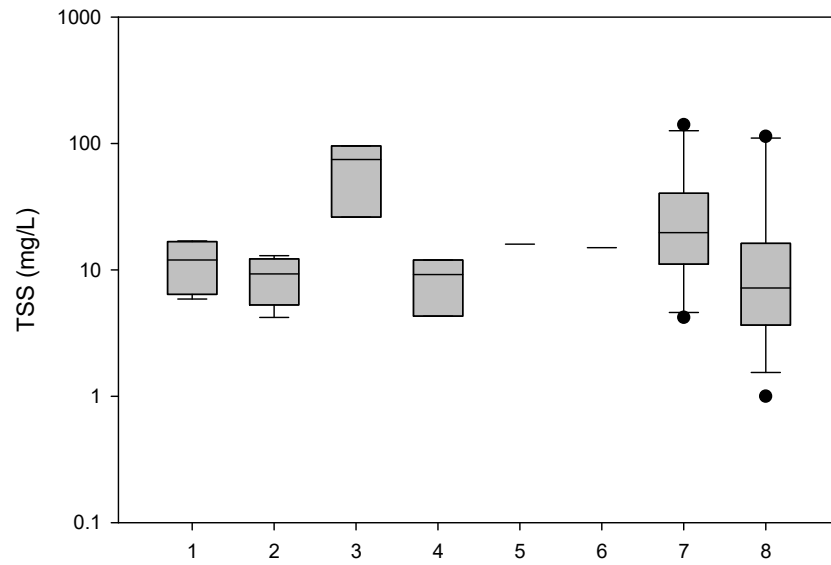
- 1: Lower Lot Biofilter influent
- 2: Lower Lot Biofilter effluent
- 3: So. Detention Bioswale influent
- 4: So. Detention Bioswale effluent
- 5: Inlet filter influent
- 6: Inlet filter effluent
- 7: Simple media filters combined influent
- 8: Simple media filters combined effluent

TCDD Influent vs. Effluent Concentrations



- 1: Lower Lot Biofilter influent
- 2: Lower Lot Biofilter effluent
- 3: So. Detention Bioswale influent
- 4: So. Detention Bioswale effluent
- 5: Inlet filter influent
- 6: Inlet filter effluent
- 7: Simple media filters combined influent
- 8: Simple media filters combined effluent

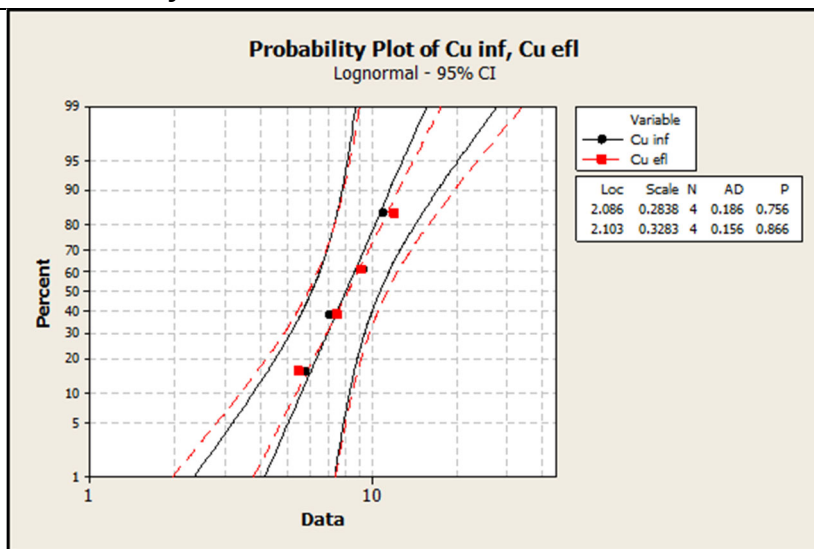
TSS Influent vs Effluent Concentrations



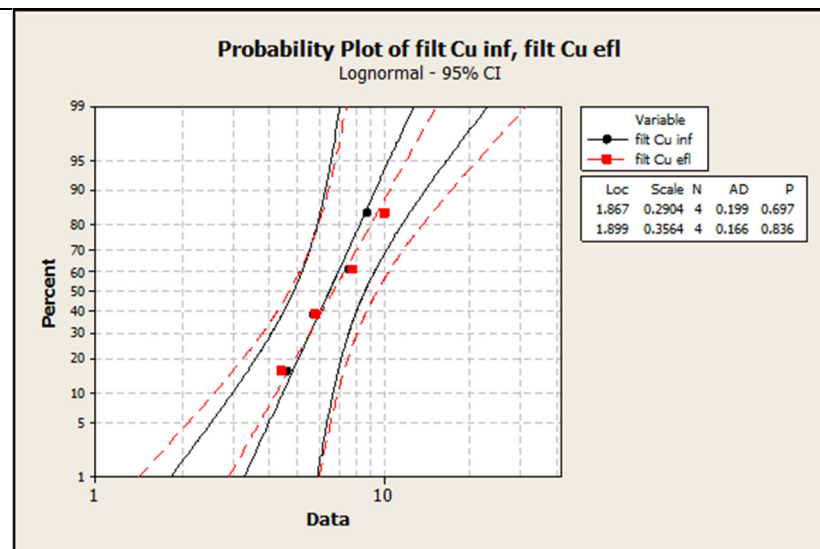
- 1: Lower Lot Biofilter influent
- 2: Lower Lot Biofilter effluent
- 3: So. Detention Bioswale influent
- 4: So. Detention Bioswale effluent
- 5: Inlet filter influent
- 6: Inlet filter effluent
- 7: Simple media filters combined influent
- 8: Simple media filters combined effluent

## Appendix B: Probability Plots

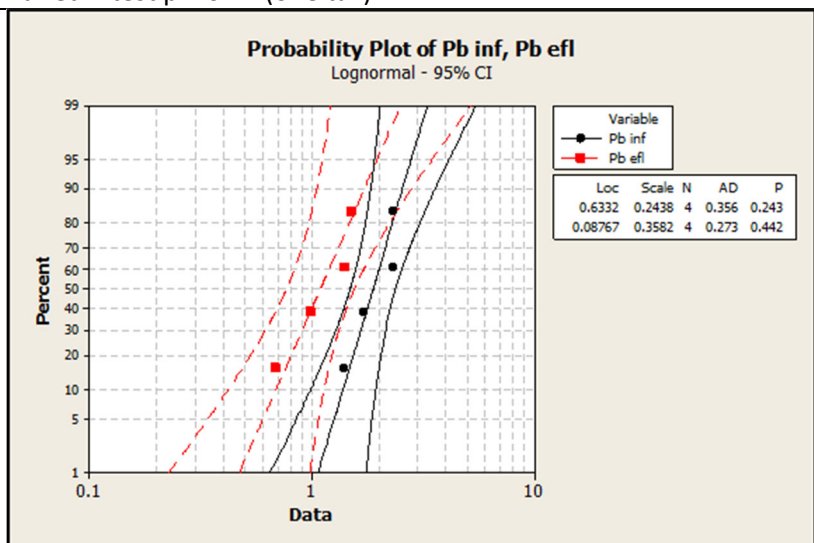
### Lower Lot Biofilter



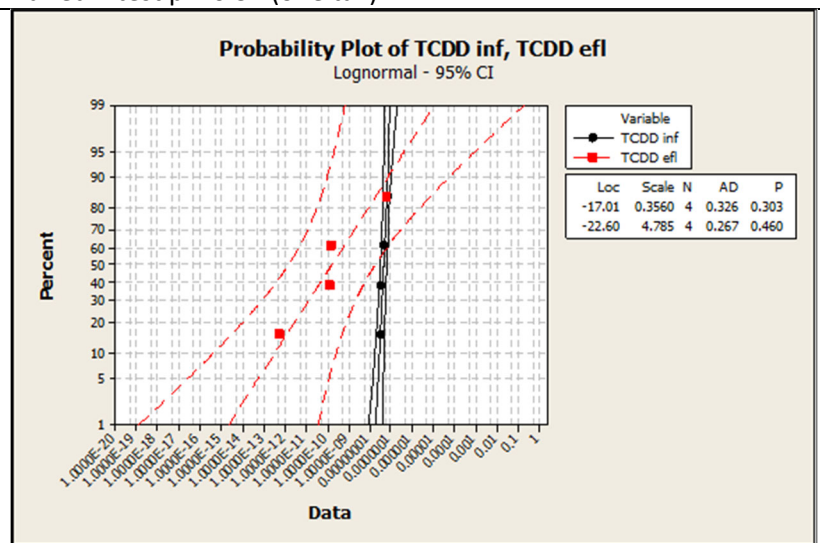
Paired T test  $p = 0.41$  (one tail)



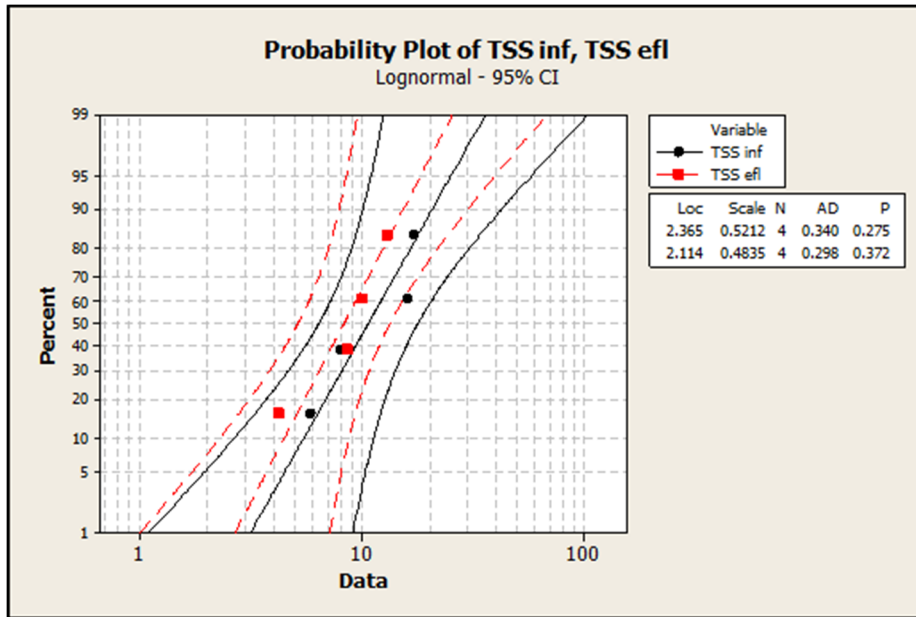
Paired T test  $p = 0.34$  (one tail)



Paired T test  $p = 0.04$  (one tail) statistically significant

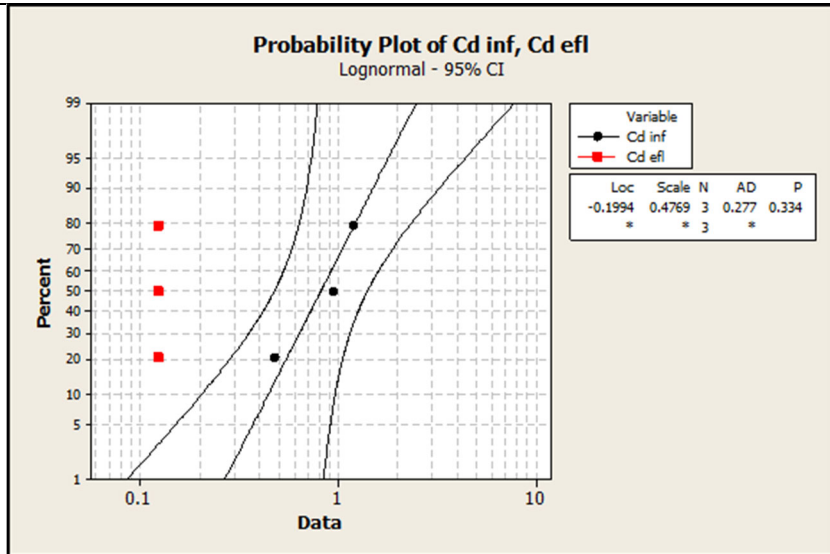


Paired T test  $p = 0.11$  (one tail)

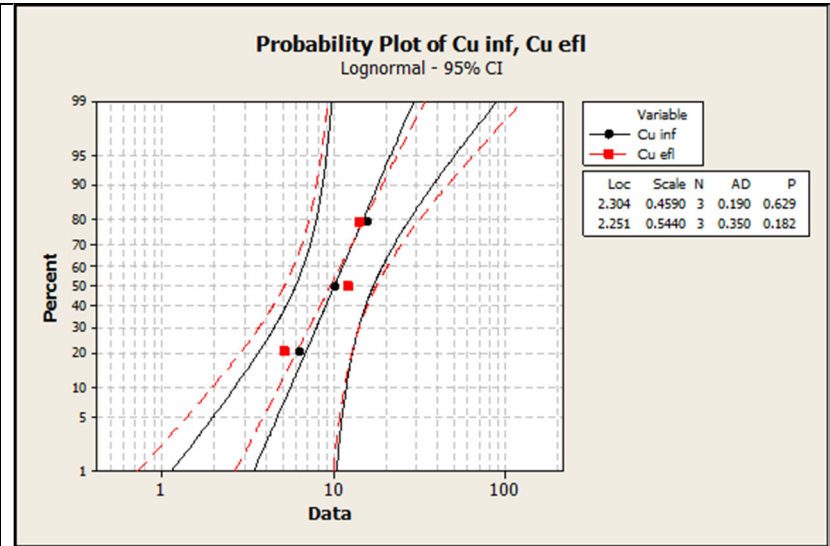


Paired T test  $p = 0.07$  (one tail)

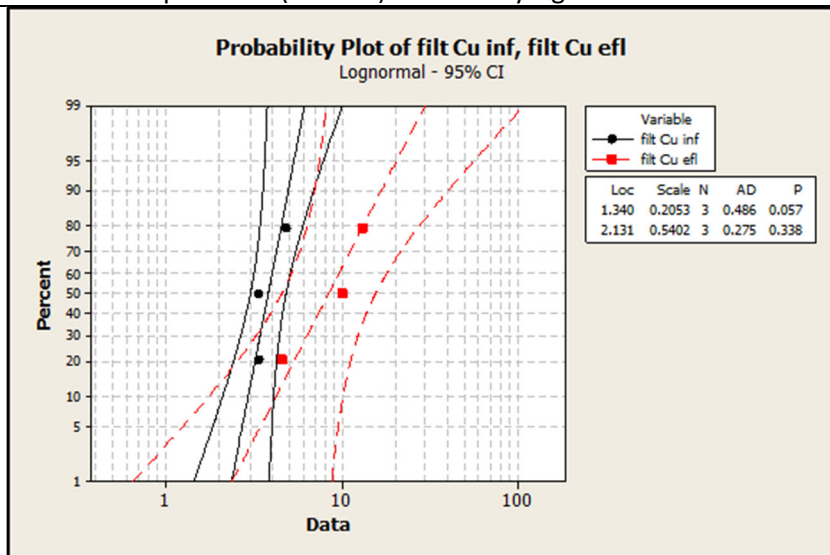
**South Detention Bioswale**



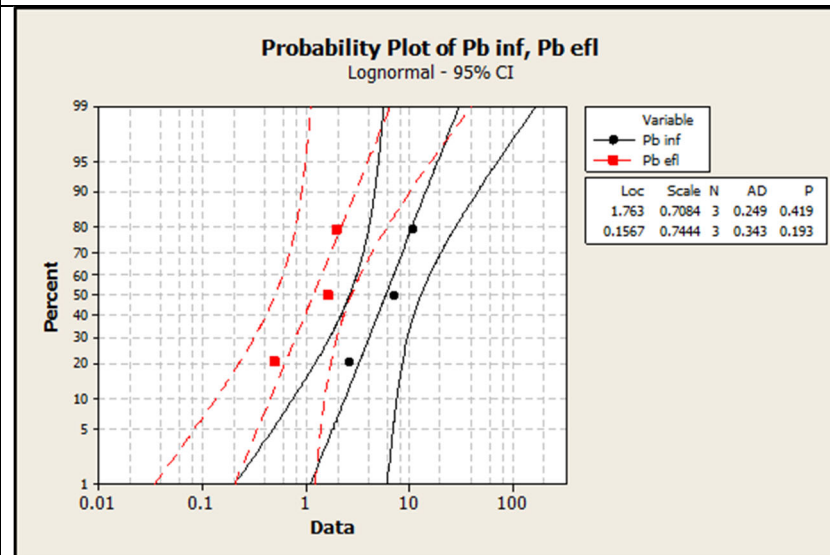
Paired T test  $p = 0.035$  (one tail) statistically significant



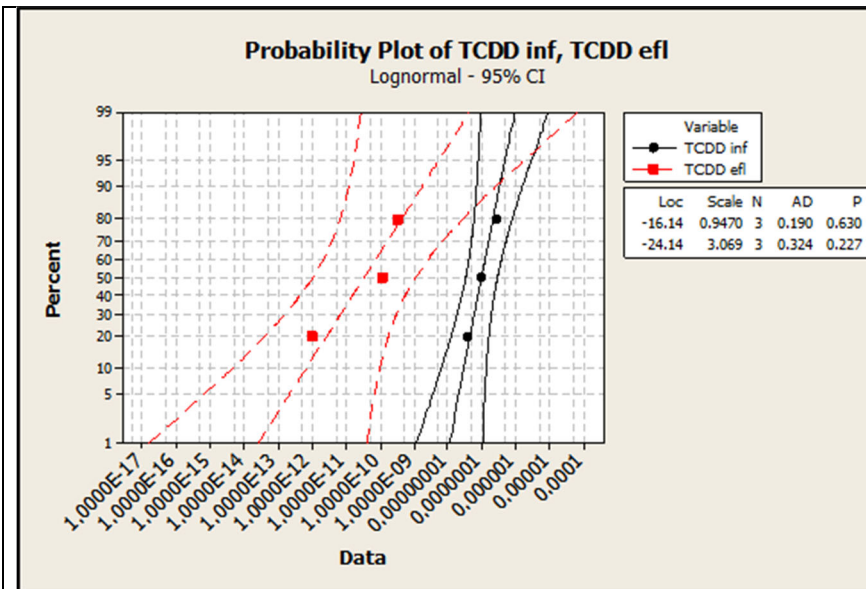
Paired T test  $p = 0.44$  (one tail)



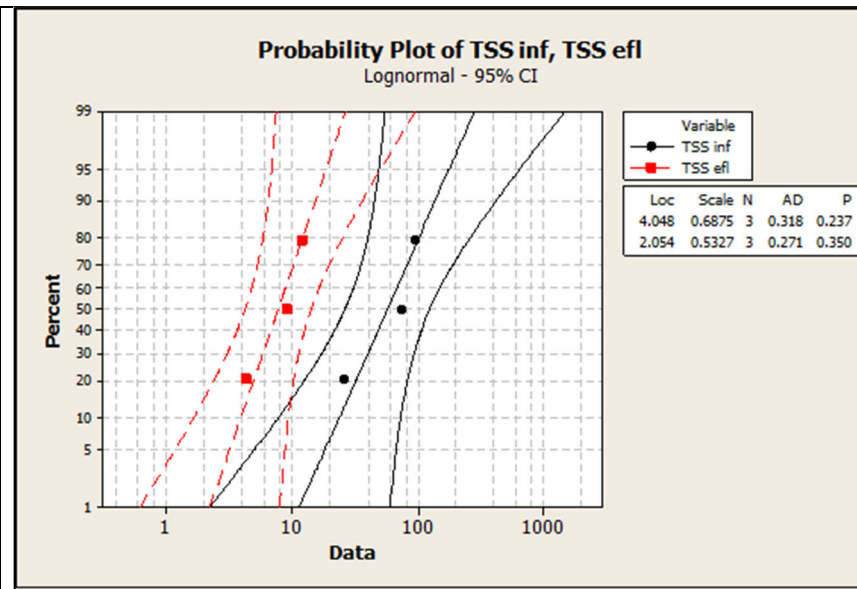
Paired T test  $p = 0.08$  (one tail)



Paired T test  $p = 0.05$  (one tail) statistically significant

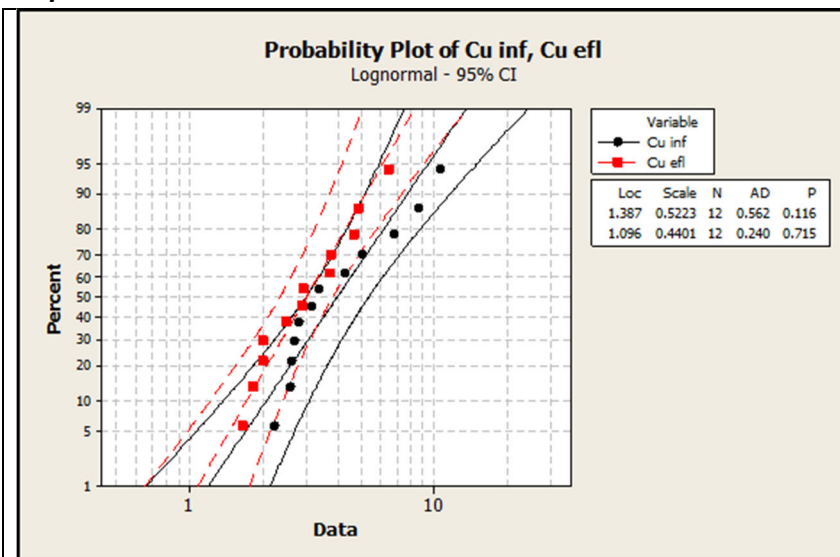


Paired T test p = 0.09 (one tail)

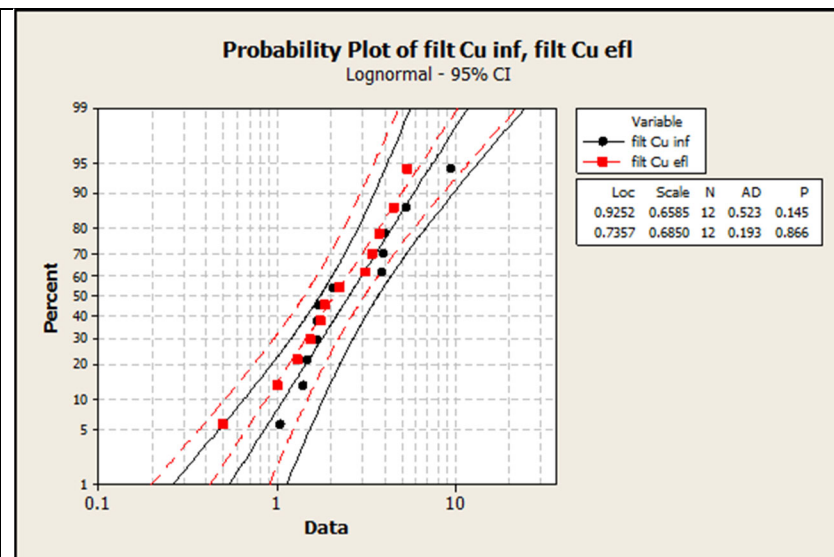


Paired T test p = 0.047 (one tail) statistically significant

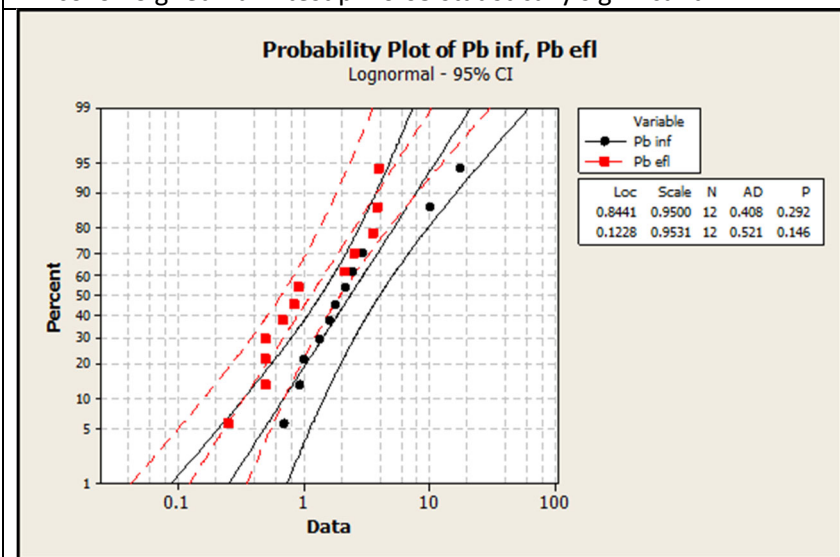
### Simple Media Filters Combined



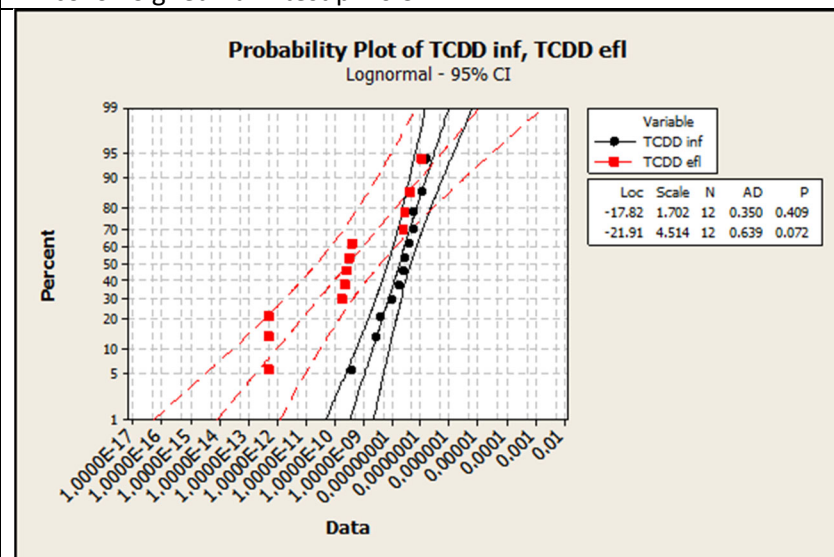
Wilcoxon Signed Rank test  $p = 0.05$  statistically significant



Wilcoxon Signed Rank test  $p = 0.34$

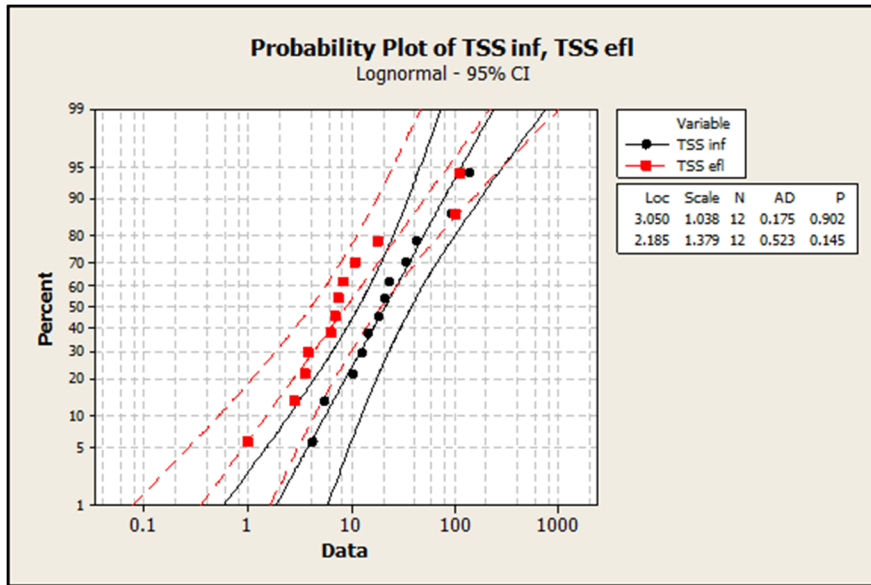


Wilcoxon Signed Rank test  $p = 0.05$  statistically significant



Wilcoxon Signed Rank test  $p = 0.02$  statistically significant

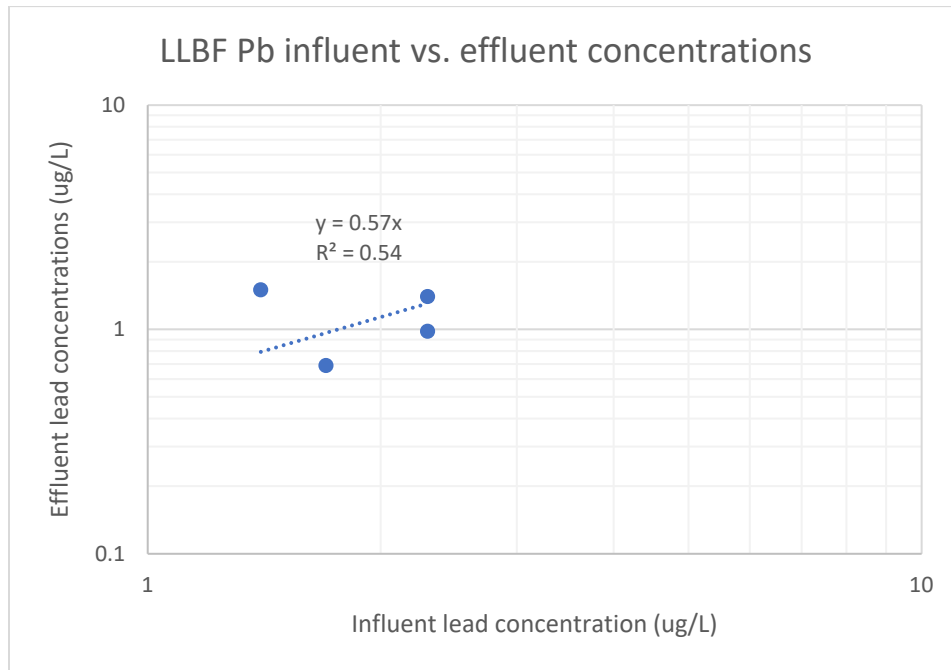




Wilcoxon Signed Rank test  $p = 0.04$  statistically significant

## Appendix C: Scatterplots and Regression Analyses for Statistically Significant Influent and Effluent Concentration Differences

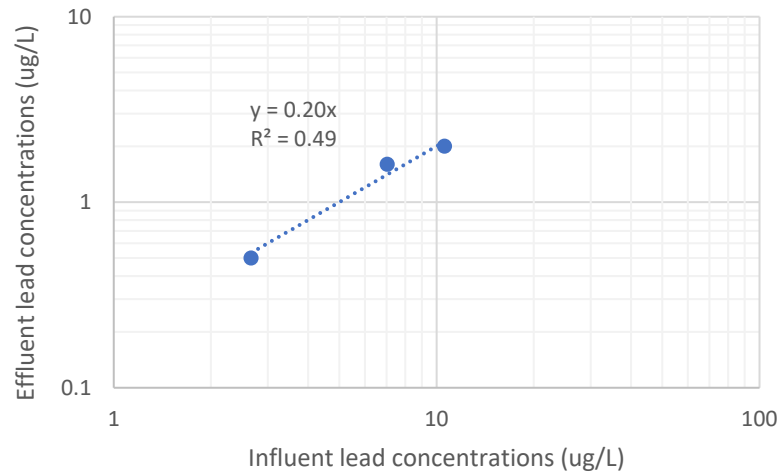
### Lower Lot Biofilter



ANOVA significance of regression  $F = 0.04$  (significant)

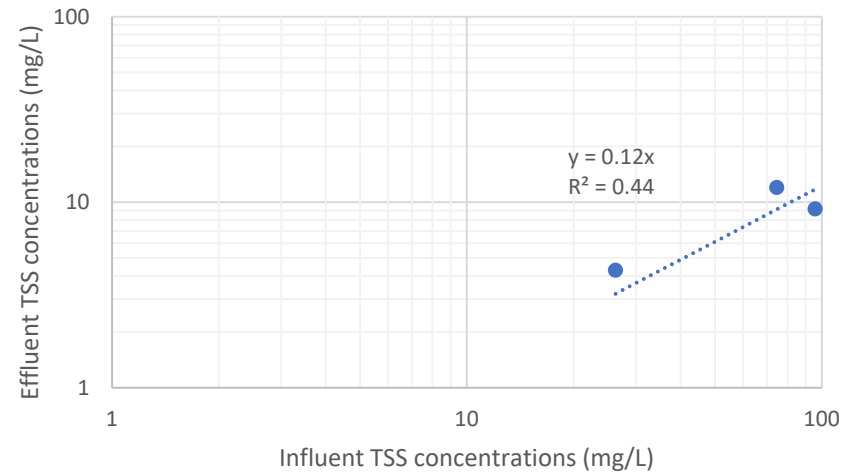
**South Detention Bioswale**

South Detention Bioswale Pb influent vs. effluent concentrations



ANOVA significance of regression  $F = 0.04$  (significant)

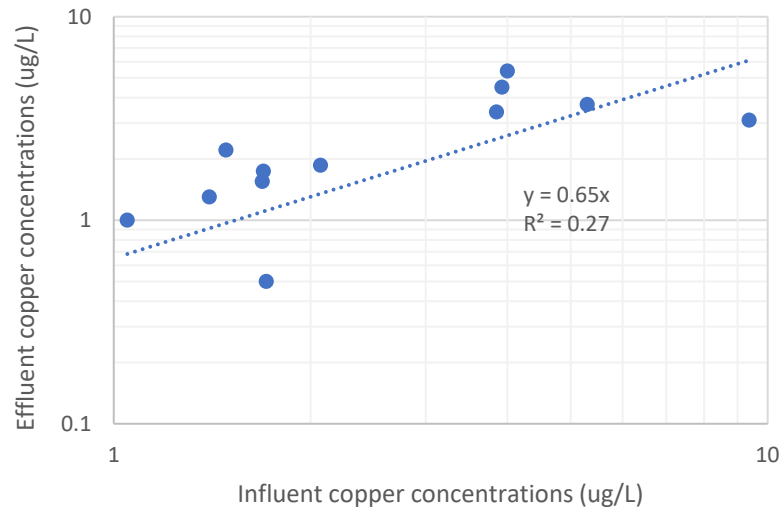
South Detention Bioswale TSS influent vs, effluent concentrations



ANOVA significance of regression  $F = 0.12$

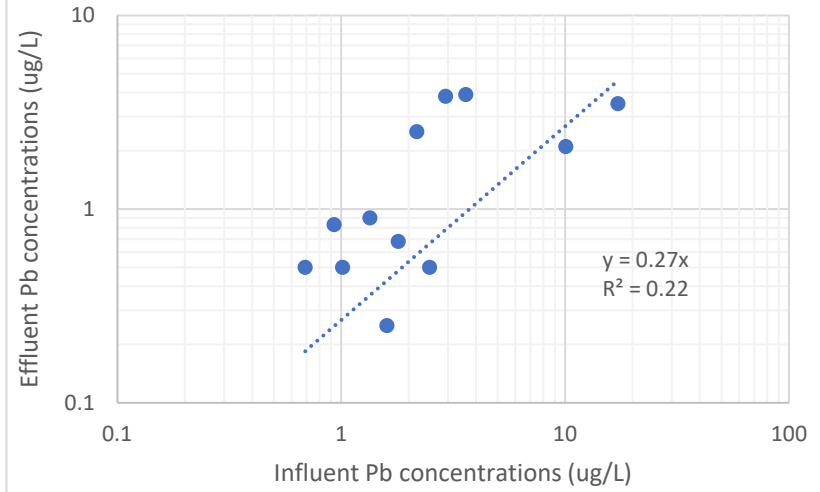
**Simple Media Filters Combined**

Simple Media Filters Combined Cu influent vs. effluent concentrations



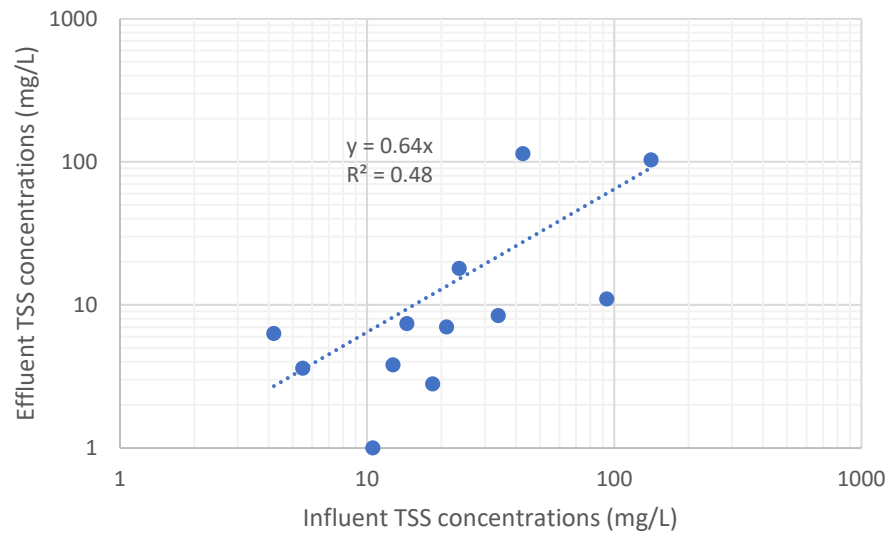
ANOVA significance of regression F = 0.05 (significant)

Simple Media Filters Combined Pb influent vs. effluent concentrations



ANOVA significance of regression F = 0.07

Simple Media Filters Combined TSS influent vs. effluent concentrations



ANOVA significance of regression  $F = 0.003$  (significant)