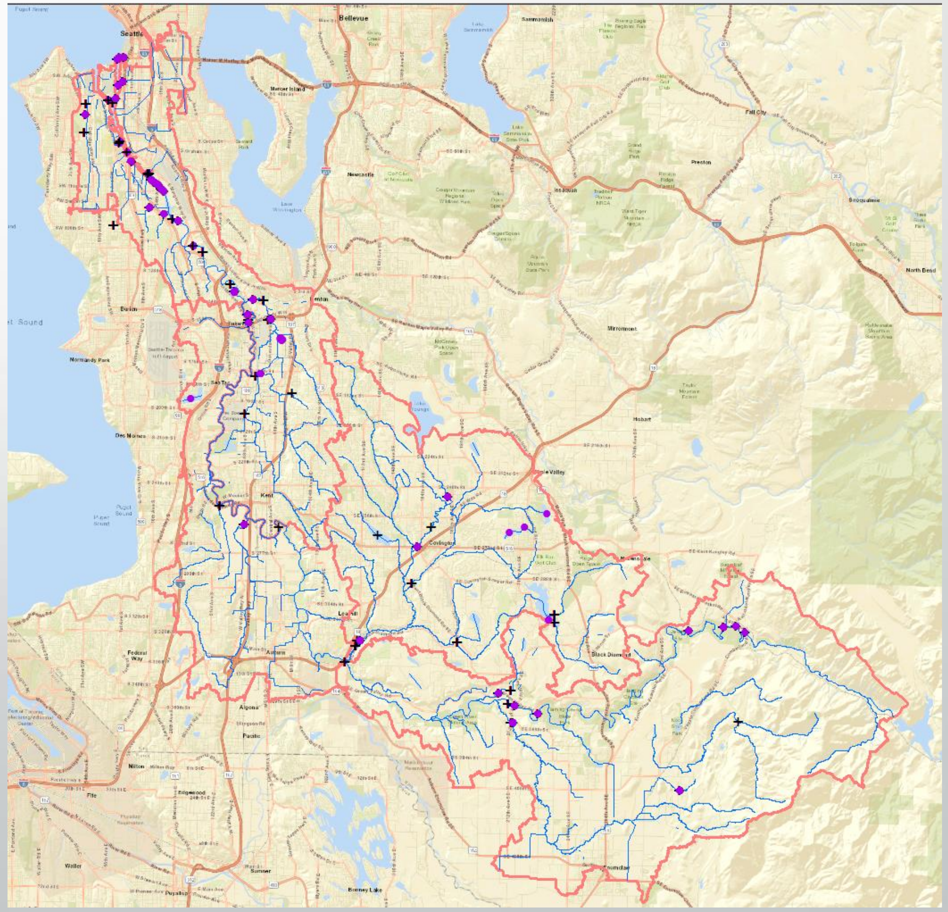
Empirical Loading Analysis

for Lower Duwamish Waterway (LDW) Pollutant Loading Assessment (PLA) Modeling

Objectives

- To provide time series pollutant concentration for Green-Duwamish Watershed model boundary.
- To evaluate the existing data at ~ River Mile 10 (upstream of LDW) for both watershed and receiving water modeling.
- To provide time series input for LDW receiving water model based on LDW lateral & upstream loading analysis and watershed modeling.
- To understand spatial distribution within the Green/Duwamish Watershed.

Surface Water Toxic and TSS Stations



Method

- Log_{10} (Pollutant) ~ Log_{10} (Discharge) regression
  - LOESS (locally weighted smoothing regression lines)
  - Linear
  - Second-order polynomial
  - Two intersecting straight lines (with a transition point)

  Pollutant: SS/SSC, TSS, Total PCB Congeners, cPAH, Arsenic (inorganic, total & dissolved), Copper and Zinc (total & dissolved), Phthalates (Bis-2-ethylhexyl; DEHP; BEHP)

- LOESS as the primary regression approach, others as the alternative if LOESS works improperly.

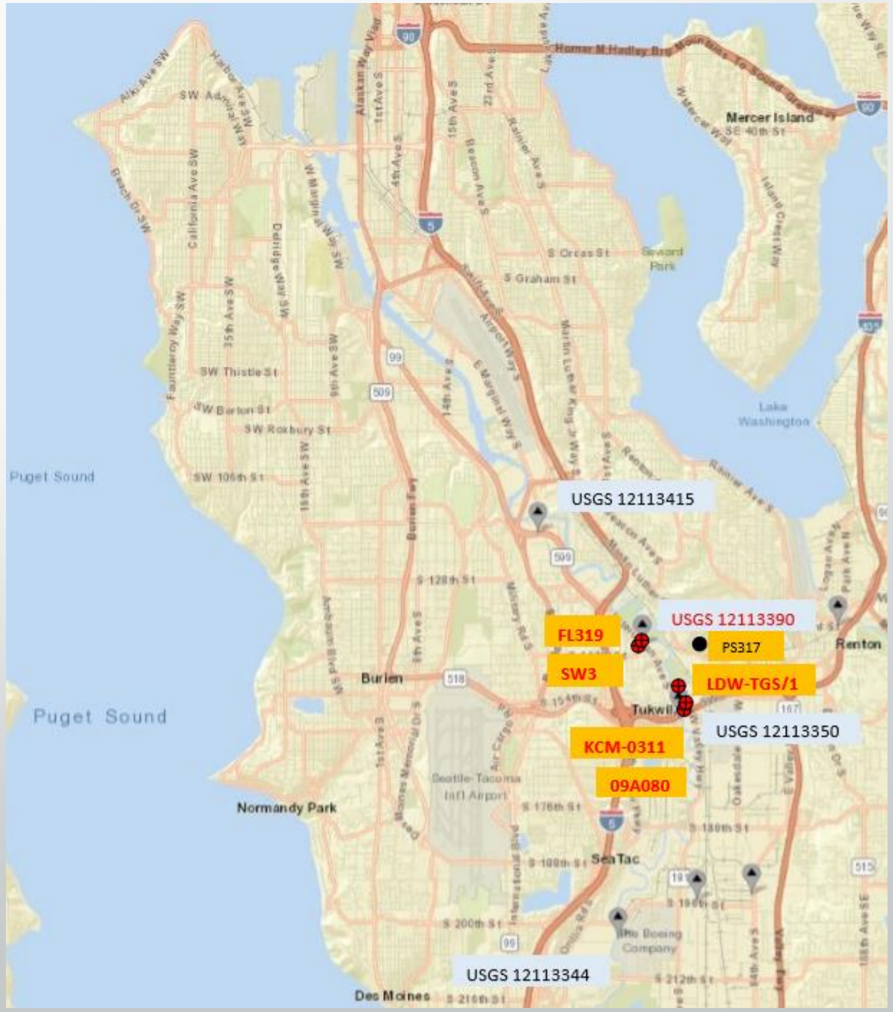
Method (Continued)

- Cap for Log10 (Pollutant) prediction at time series discharge (Q):
  - use Log10 (Pollutant) at min [Log10 (Discharge)], if Log10(Q) < min [Log10 (Discharge)]
  - use Log10 (Pollutant) at max [Log10 (Discharge)], if Log10(Q) > max [Log10 (Discharge)]
- Log scale → original scale for time series concentration
  - antilog, and then
  - times Duan's Bias Correction Factor (BCF).

Near the Dam and stations upstream of LDW

Main Pollutant Stations Near the Dam

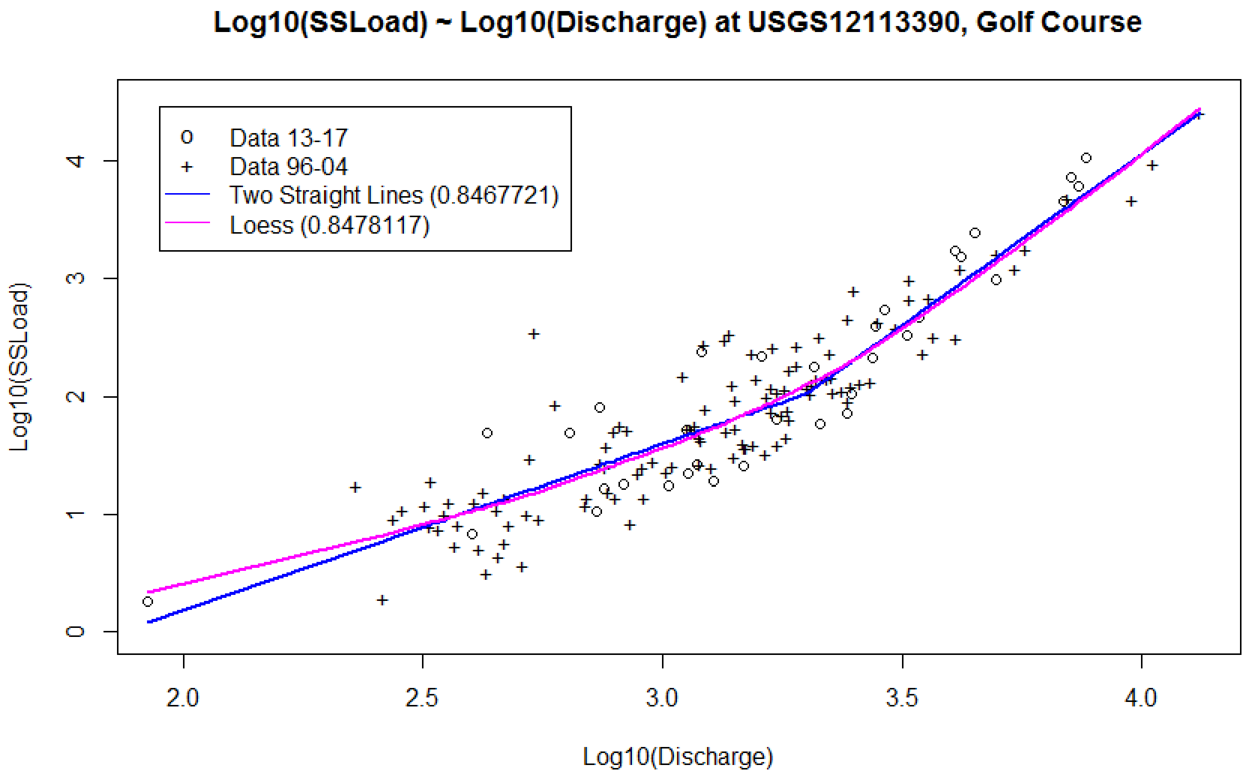
Pollutant Stations upstream of LDW

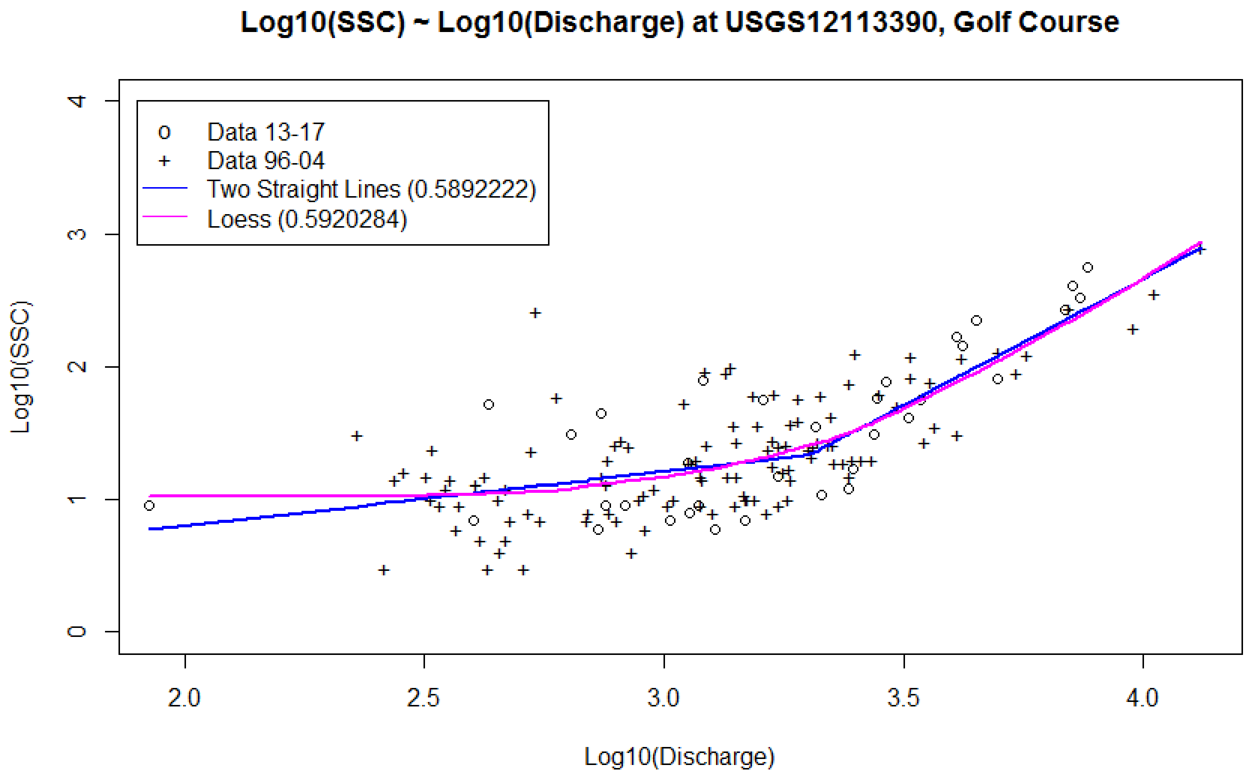


Preliminary Results

- At upstream of LDW around RM10, due to the complexity of runoff sources, most pollutant regressions need to be improved. Otherwise, the validated watershed model would have to be used alone to generate the time series concentration for receiving water model upstream boundary condition.
- Near the Dam regression results are acceptable except for the uncertainty at extreme events, such as very high and low discharges.
- Regression curves of Log10(Discharge) ~ Log10(SS load), Log10(SSC), Log10(TSS), Log10(Arsenic), Log10(Total Copper) are satisfactory.
- The impact of dilution and sediment bed solid/pollutant resuspension on the concentration during high flow is nonnegligible.
- Generally, near the Dam shows a lower concentration than upstream of LDW.

Suspended Solids Load (SSL) and Concentration (SSC) at USGS 12113390 Golf Course (~River Mile 10)

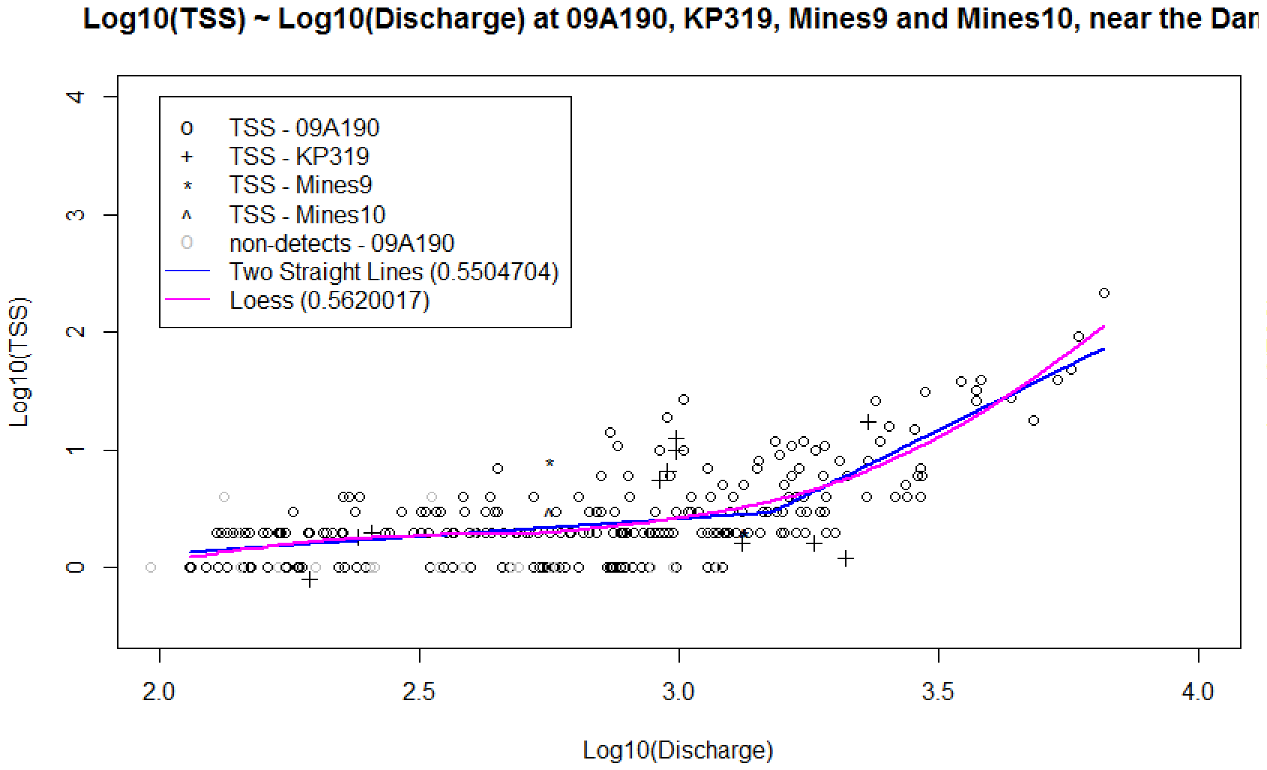


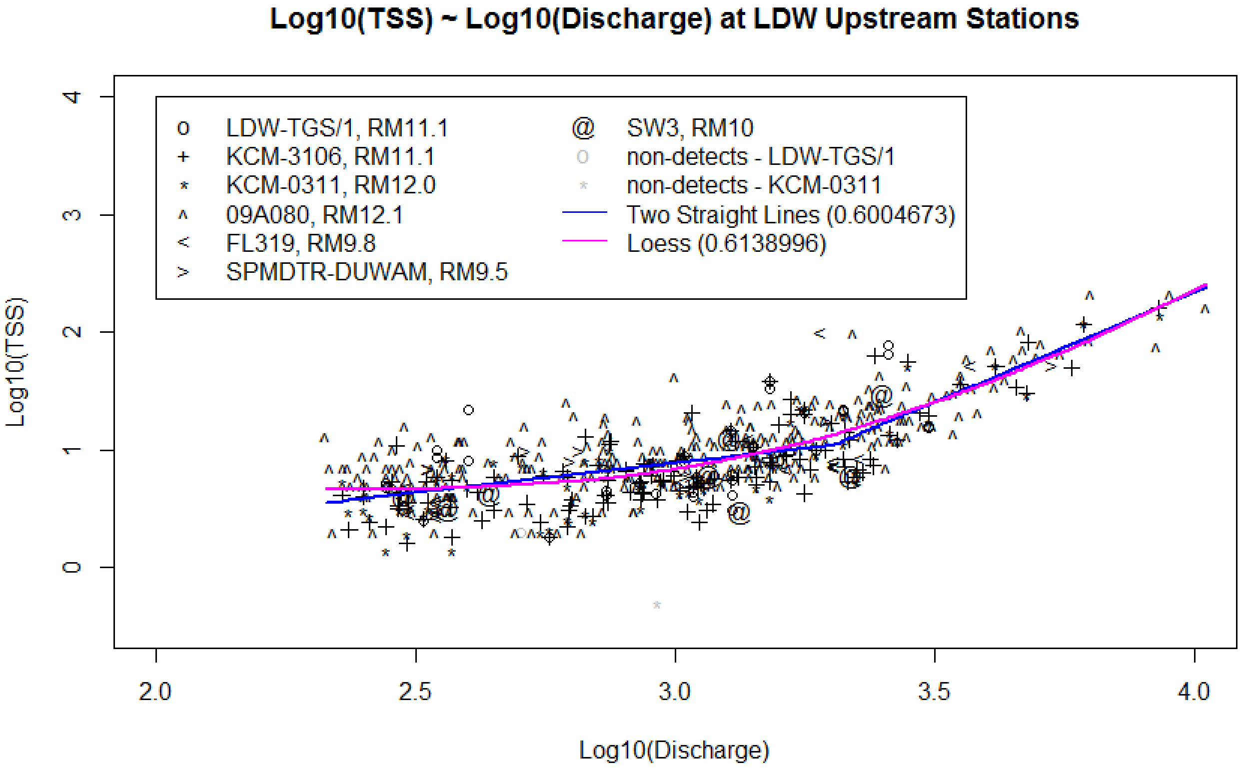


SS Load (MT/day) upstream of LDW, Discharge (cfs)

SSC (mg/L) Upstream of LDW (R-Square is listed in the plots)

TSS (mg/L)

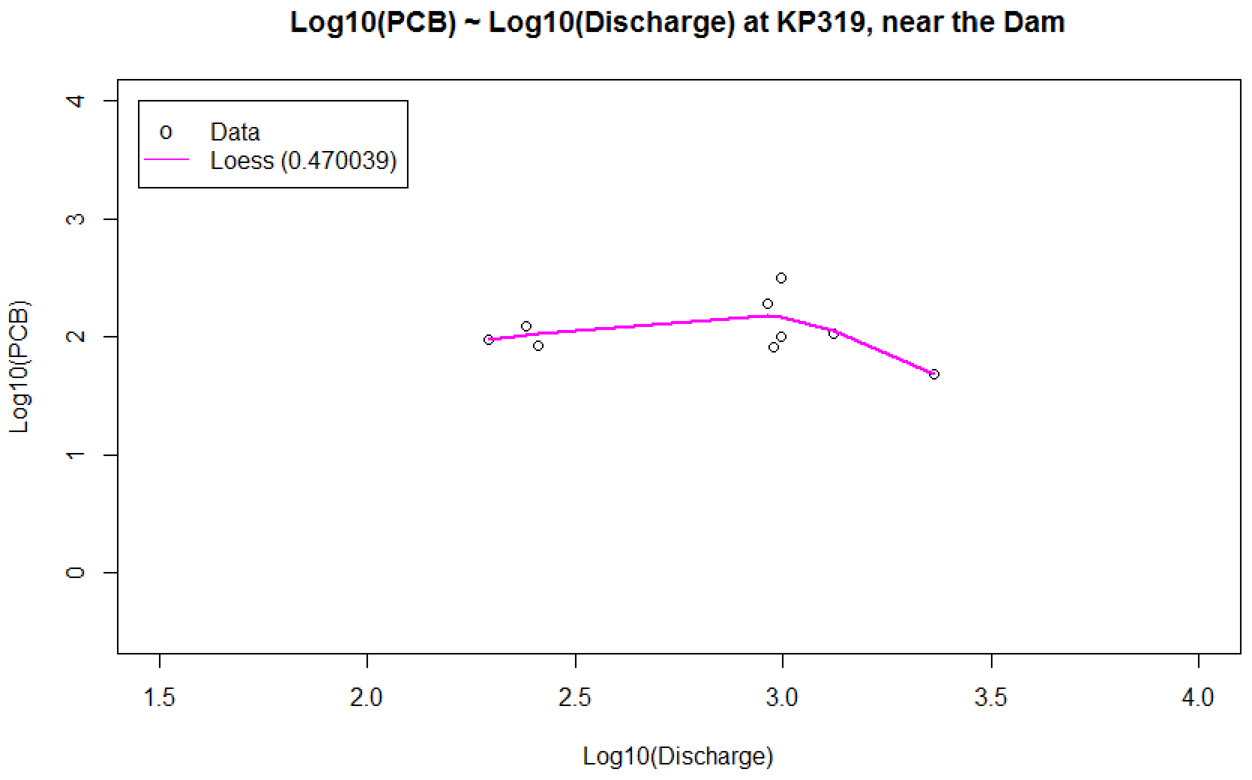


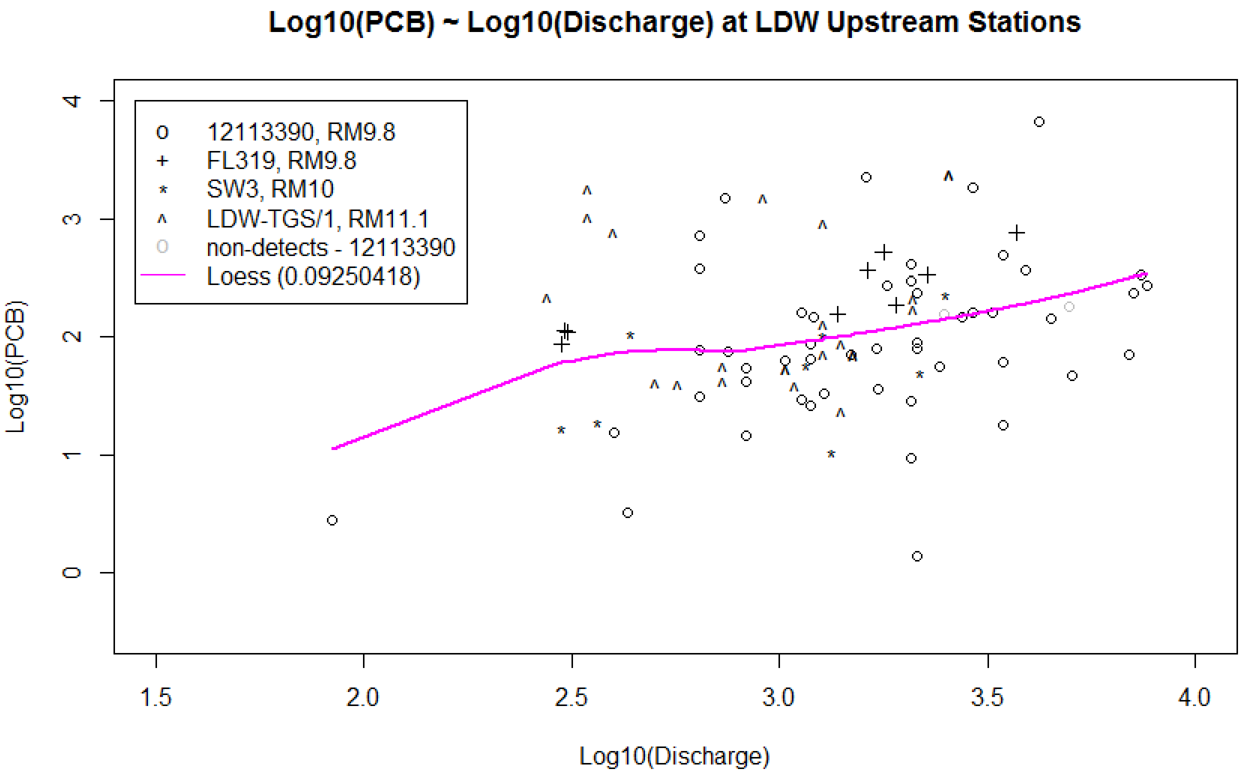


Near the Dam

Upstream of LDW

PCB (pg/L)

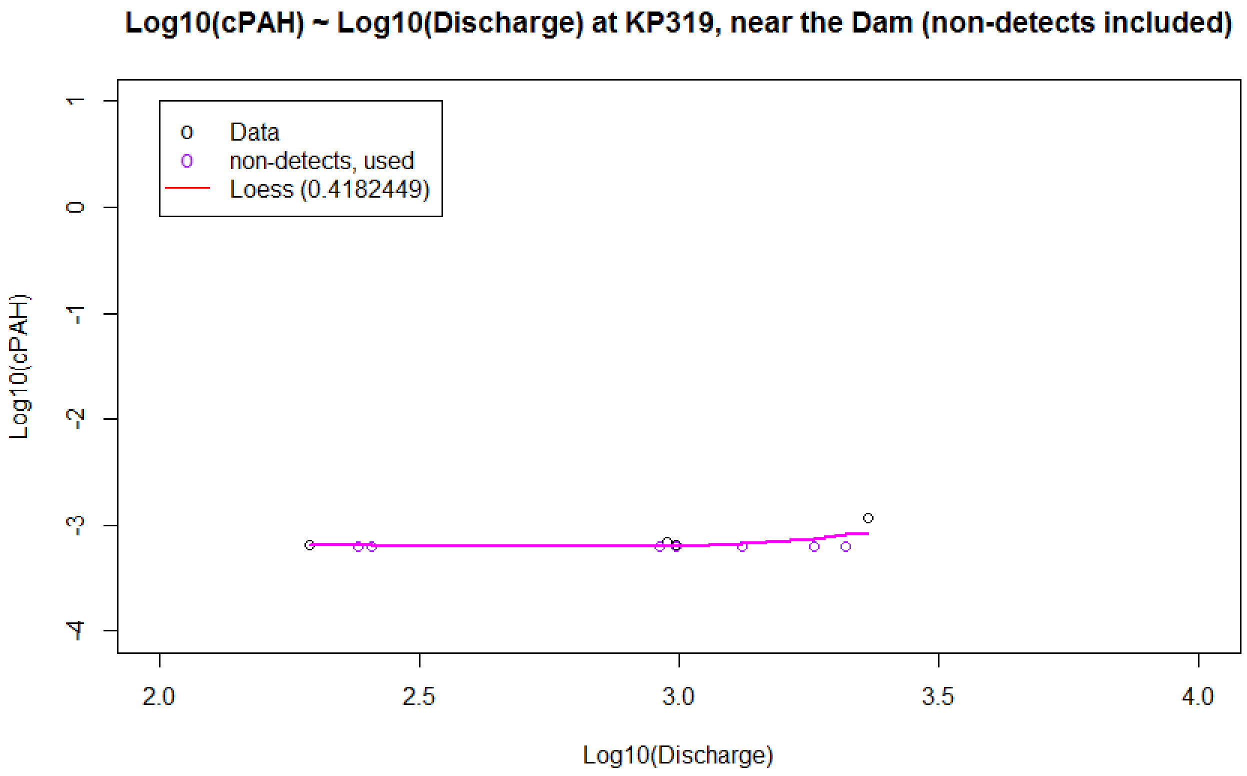


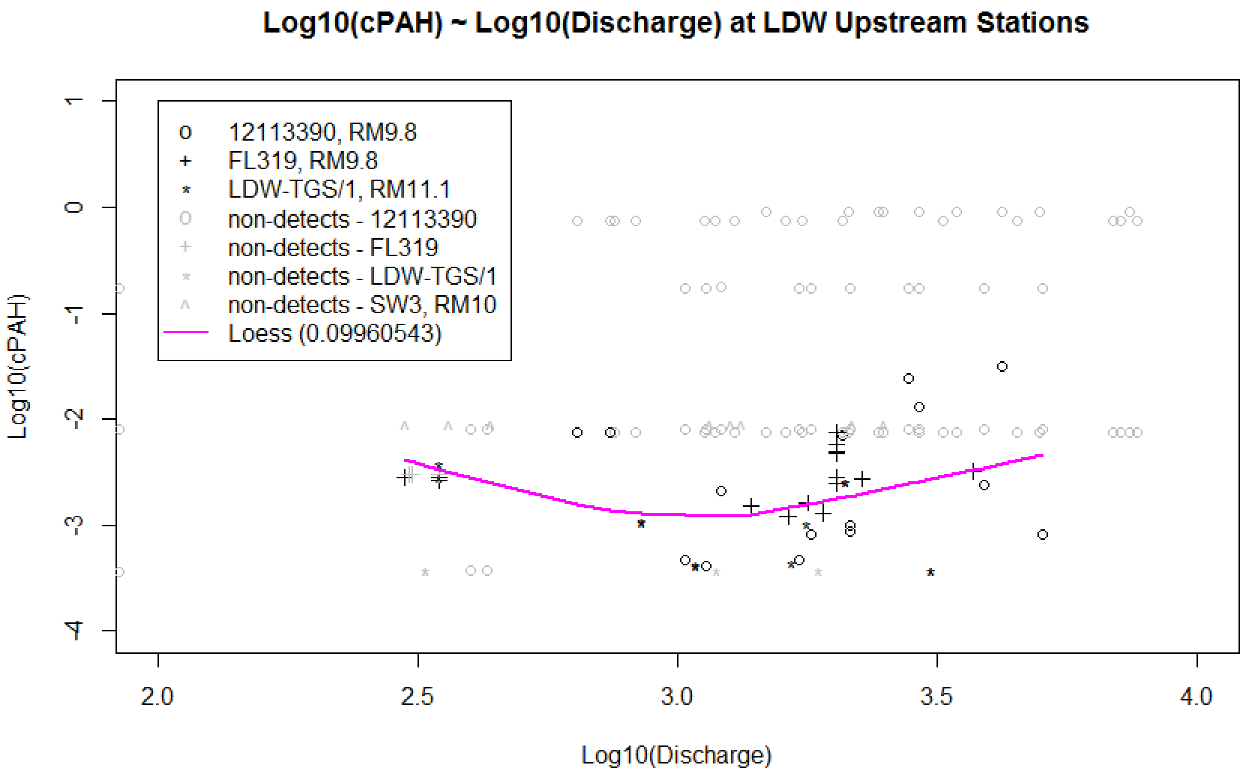


Near the Dam

Upstream of LDW

cPAH (µg/L)

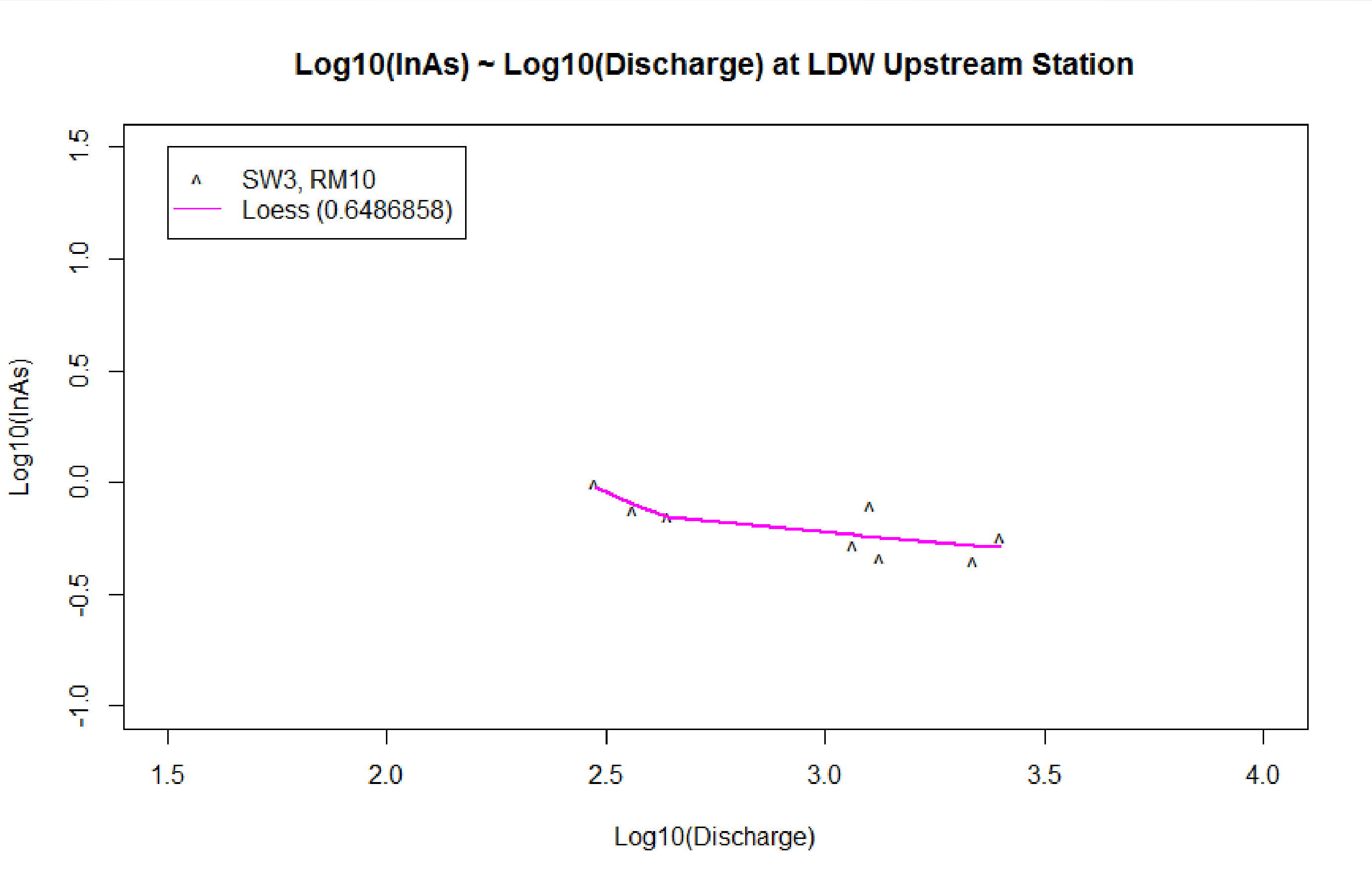




Near the Dam

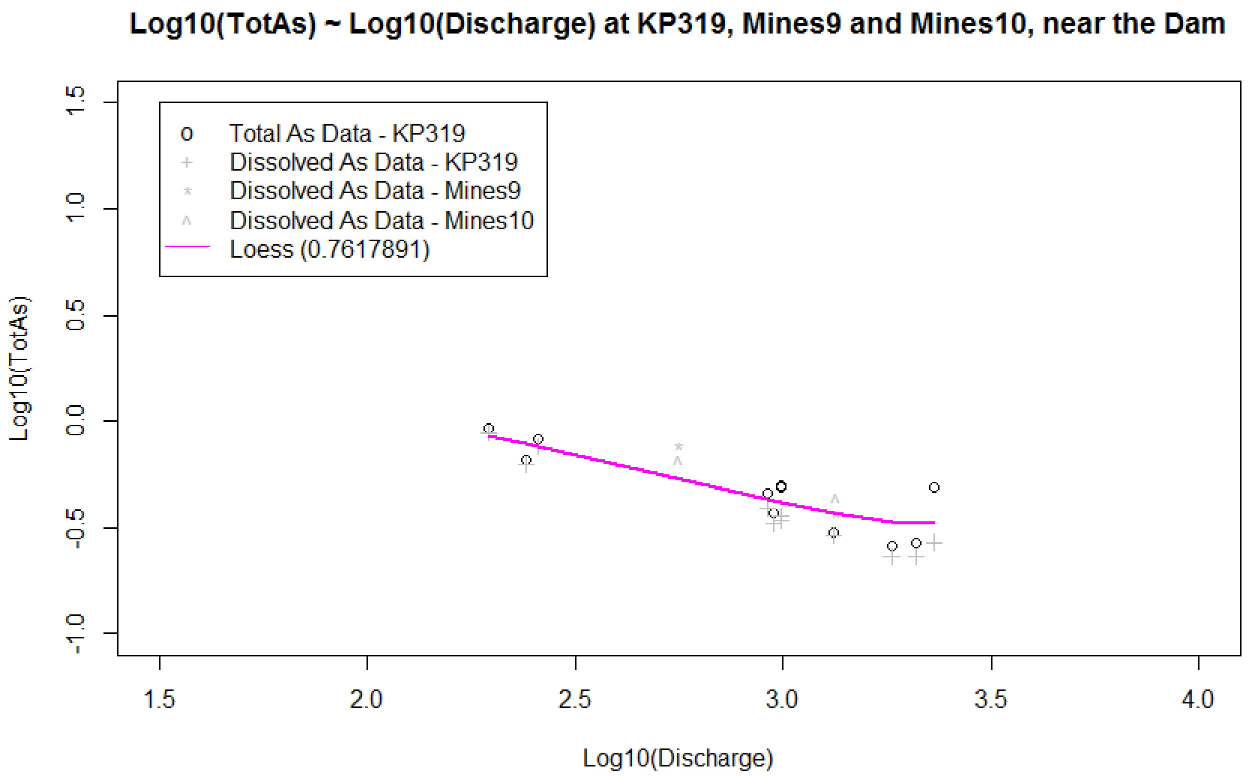
Upstream of LDW

Inorganic Arsenic (µg/L)

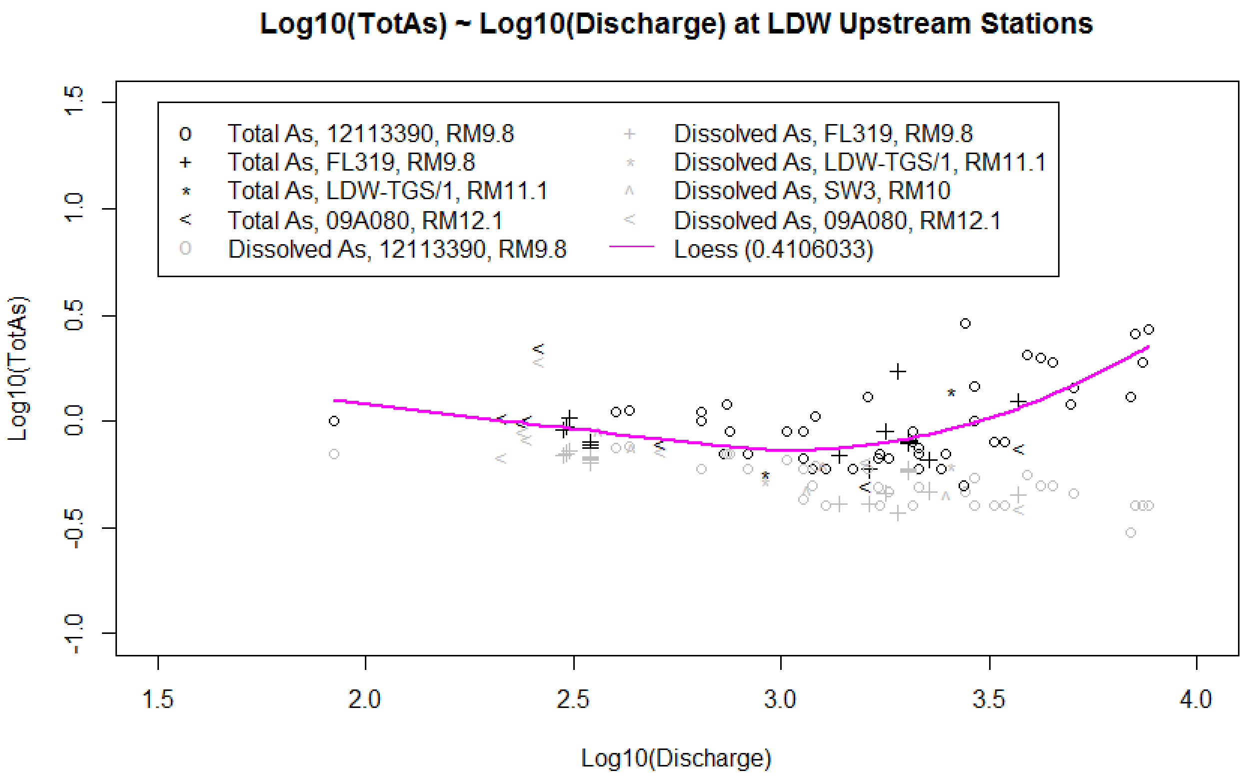


Upstream of LDW

Total Arsenic (µg/L)

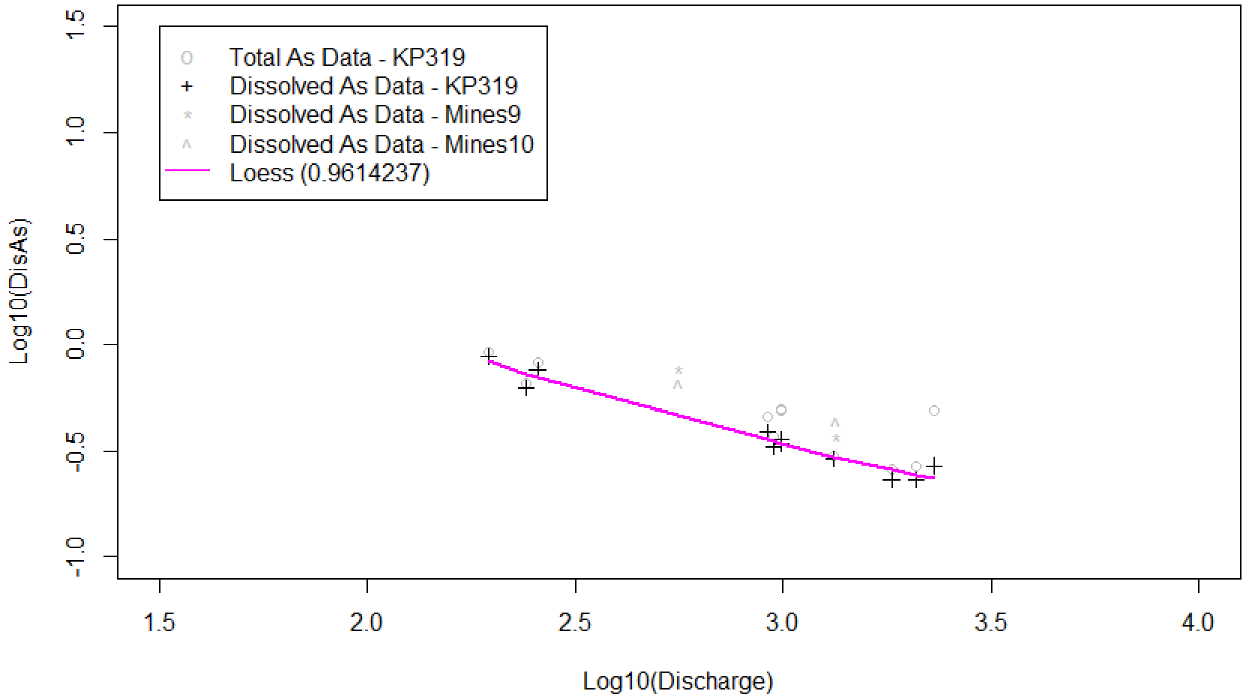


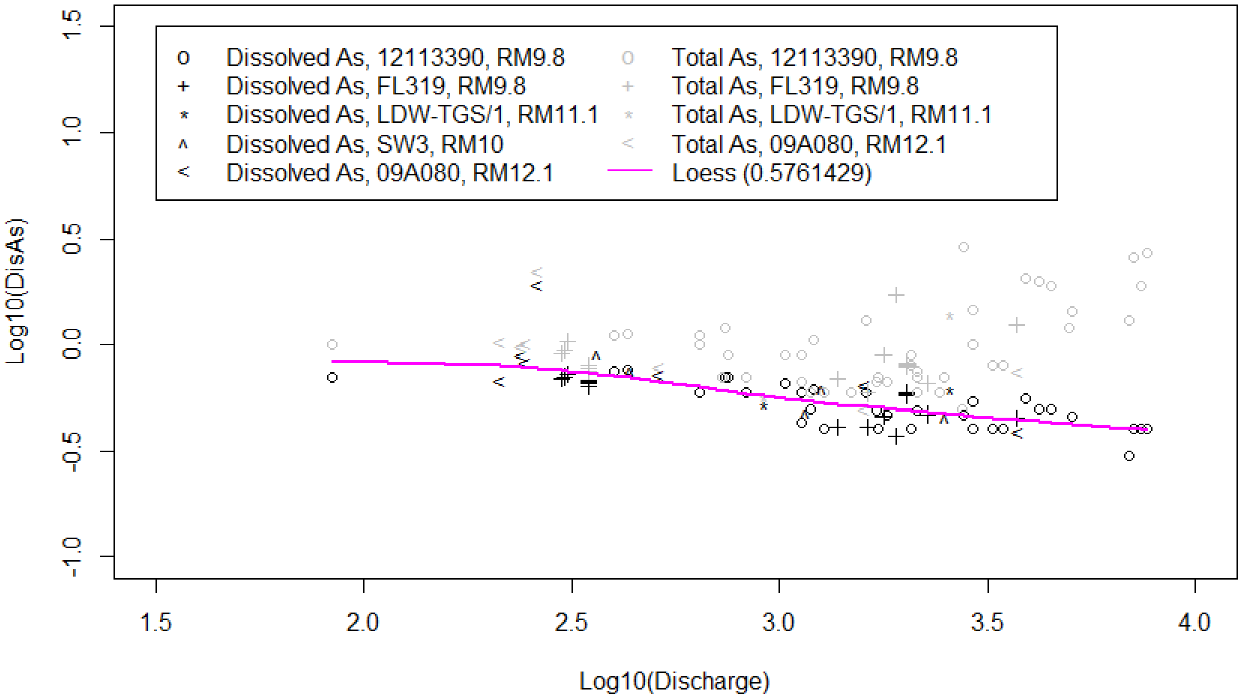
Near the Dam



Upstream of LDW

Dissolved Arsenic (µg/L)

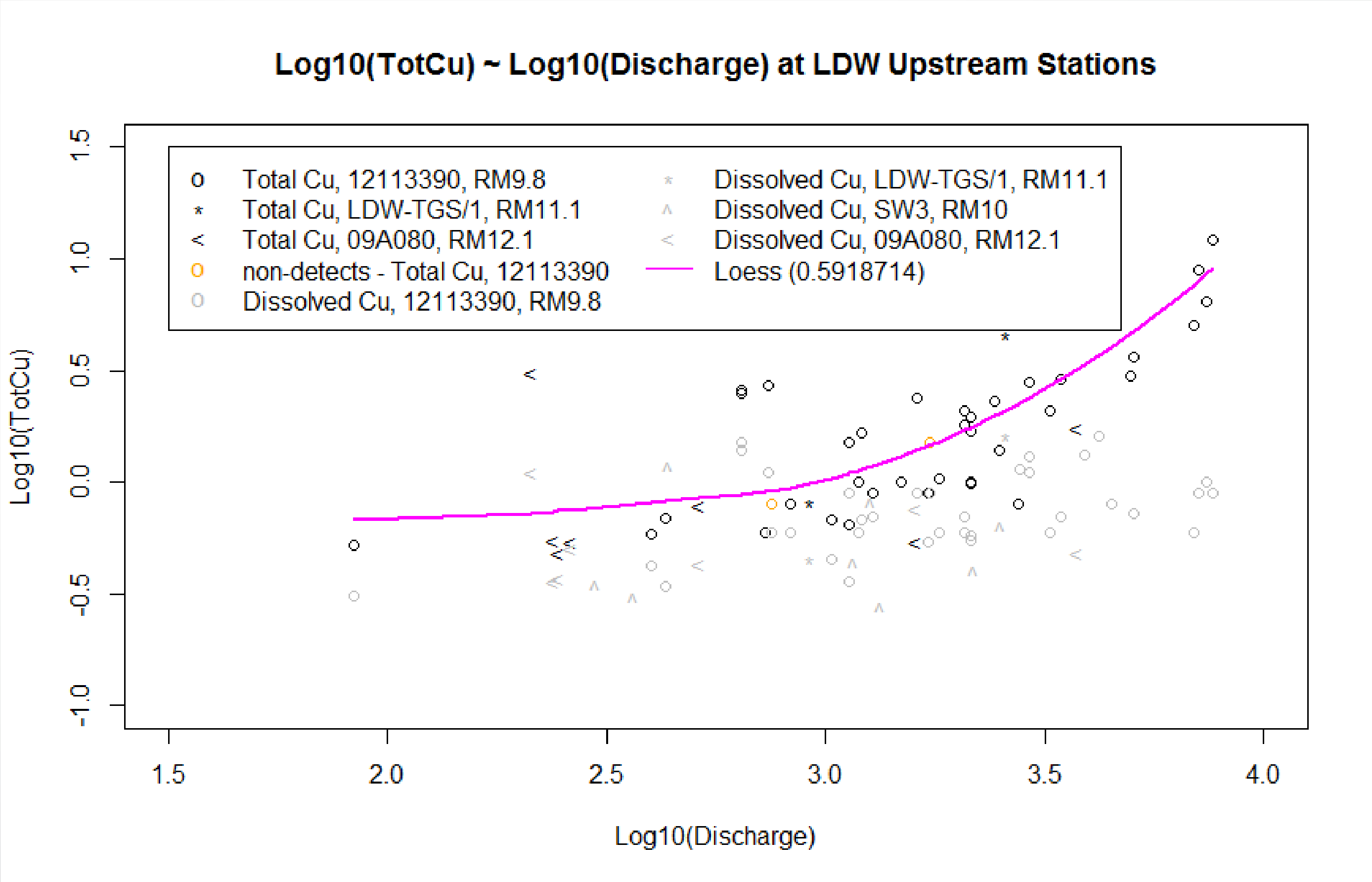




Near the Dam

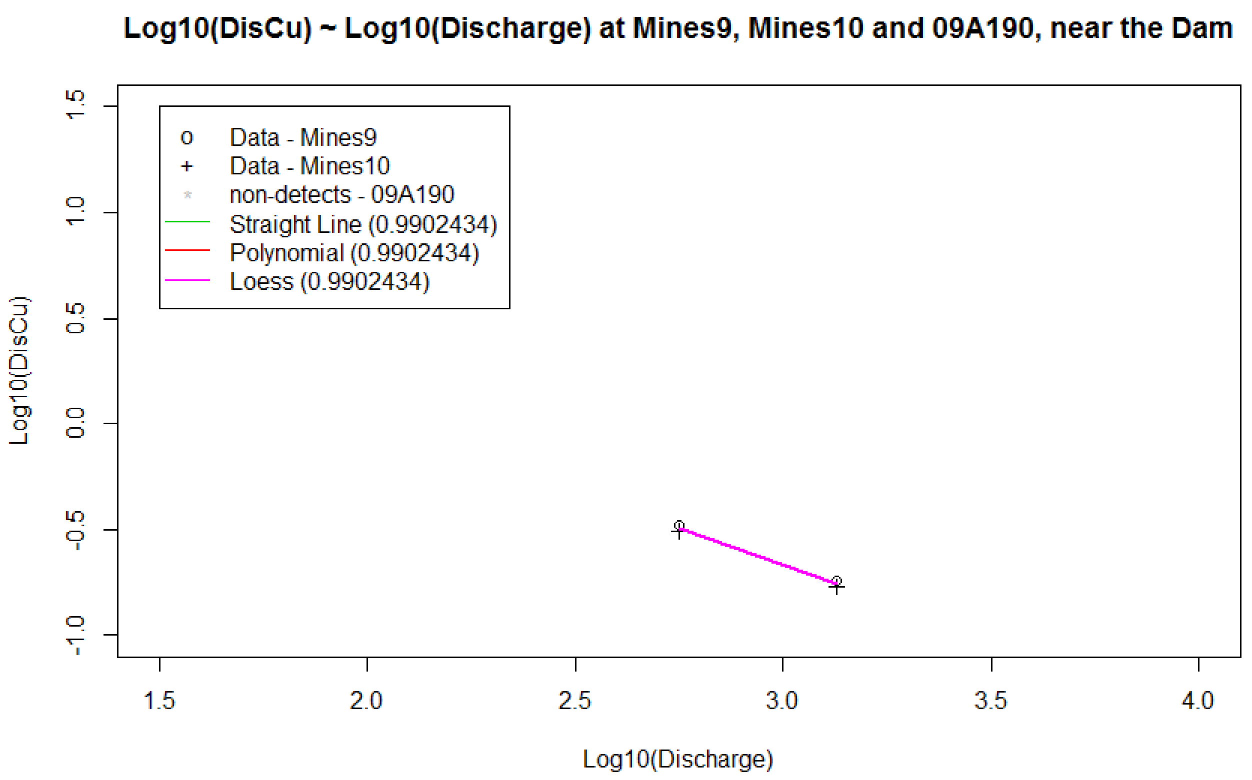
Upstream of LDW

Total Copper (µg/L)

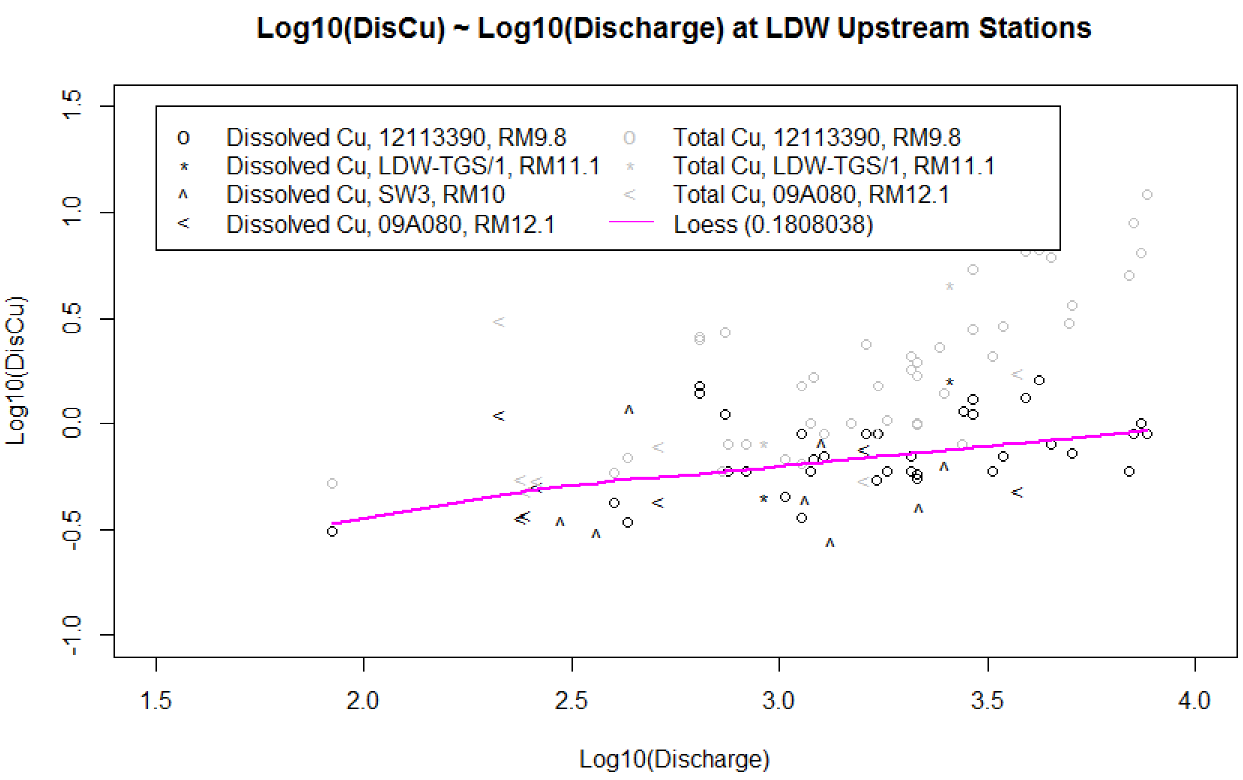


Upstream of LDW

Dissolved Copper (µg/L)

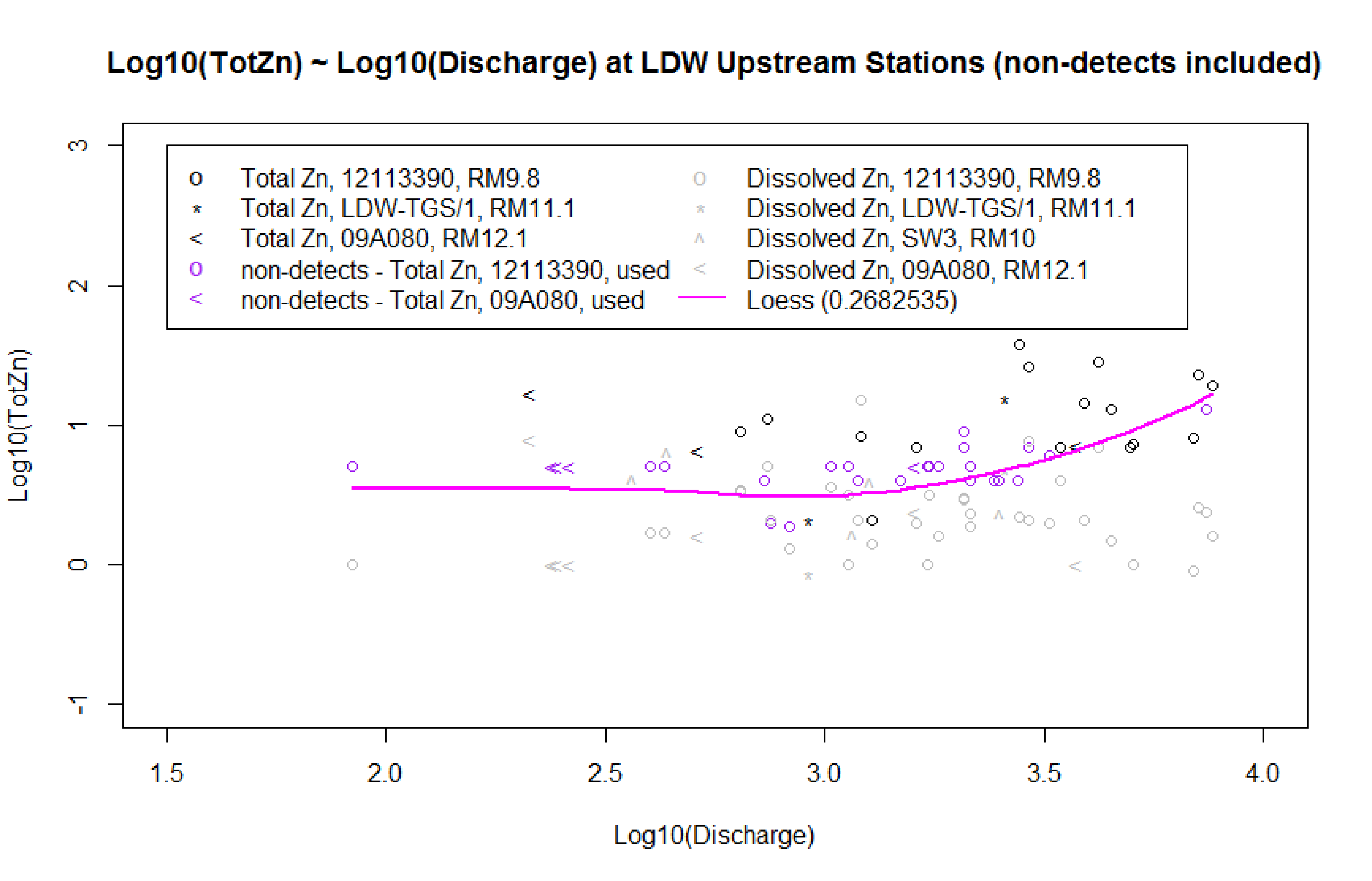


Near the Dam



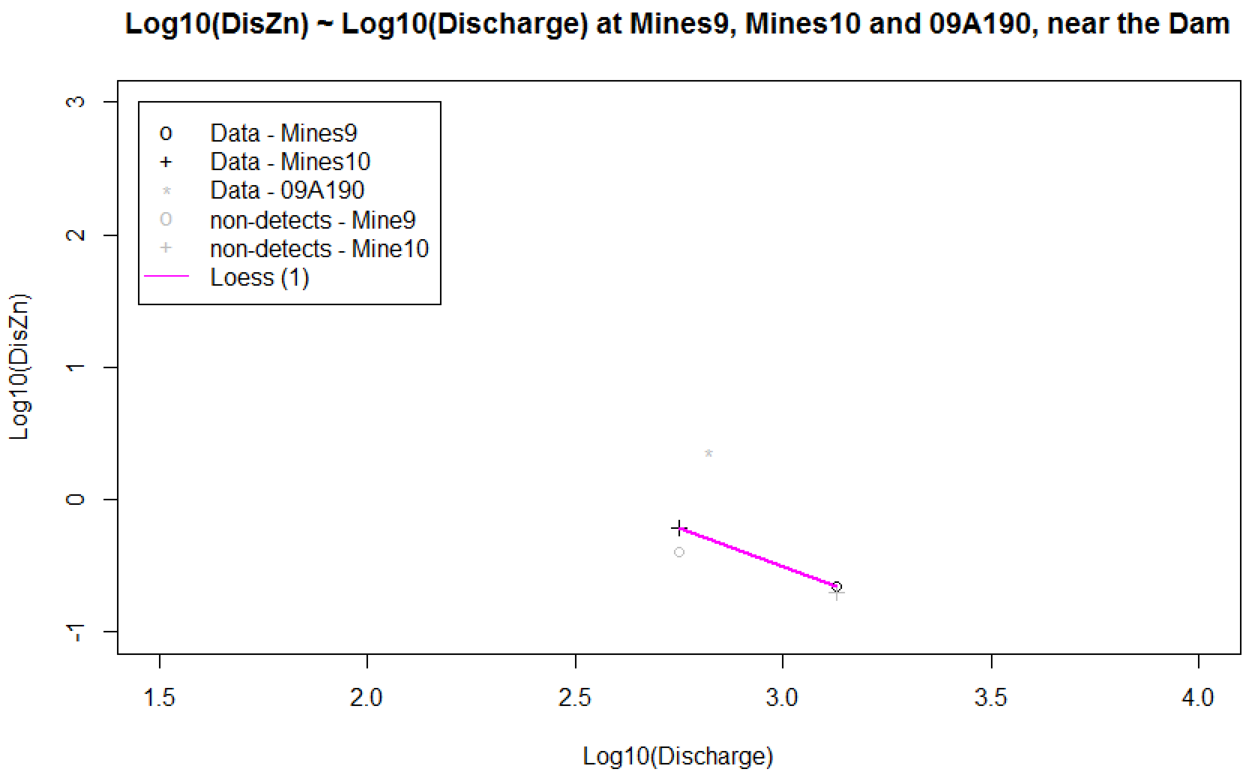
Upstream of LDW

Total Zinc (µg/L)

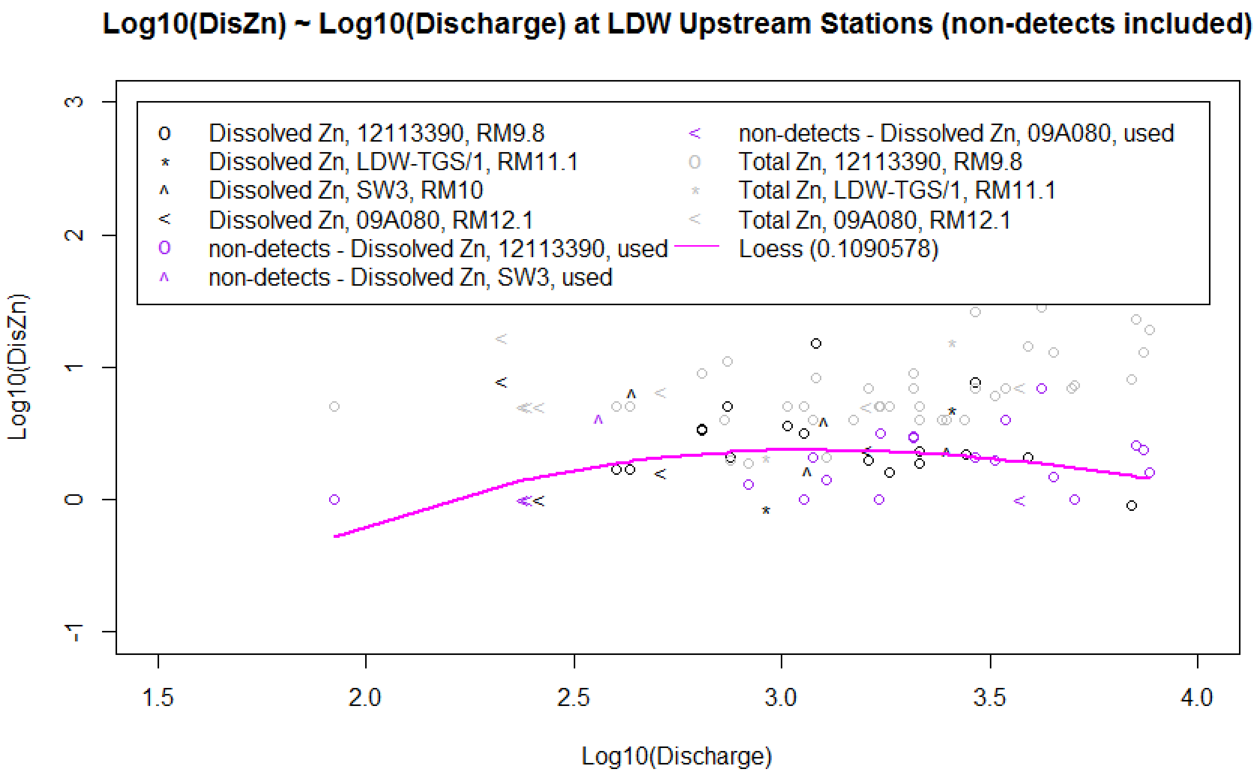


Upstream of LDW

Dissolved Zinc (µg/L)

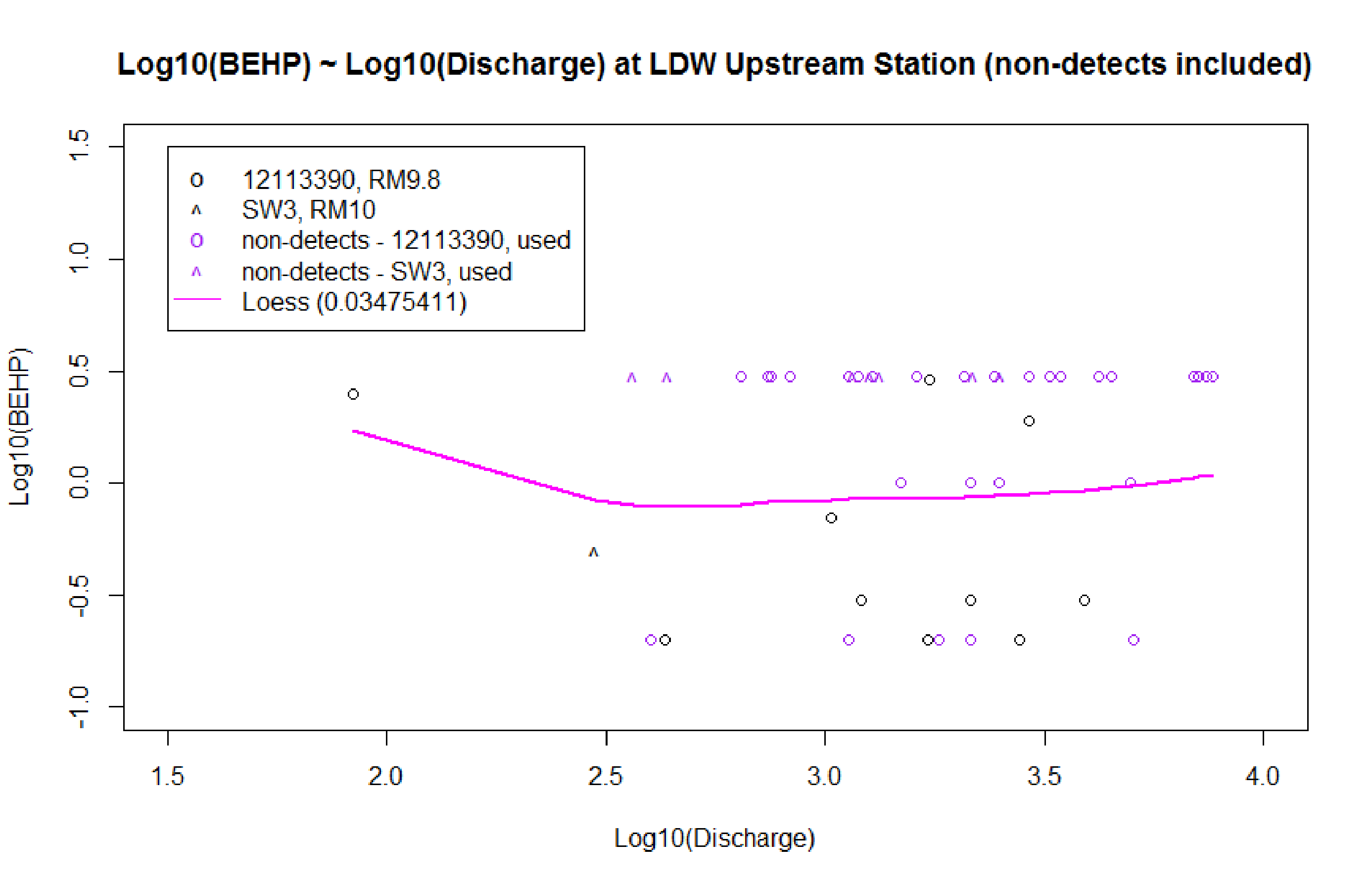


Near the Dam



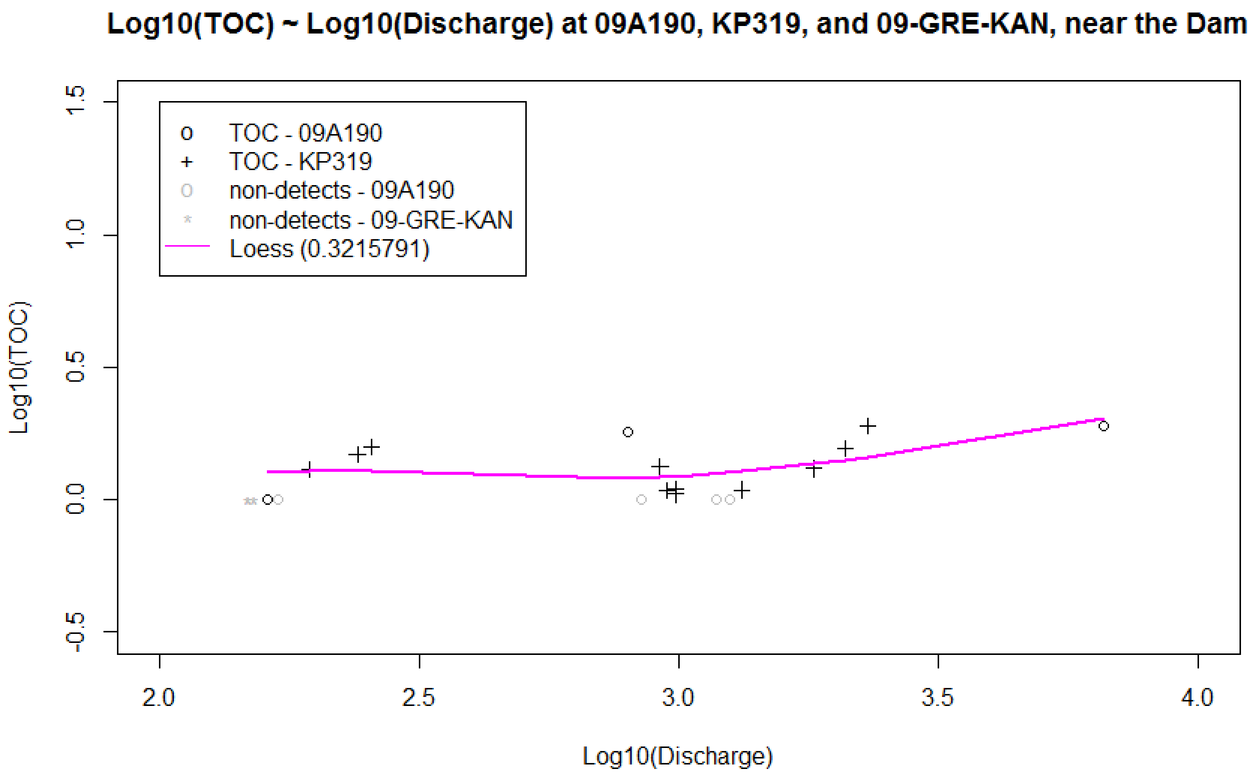
Upstream of LDW

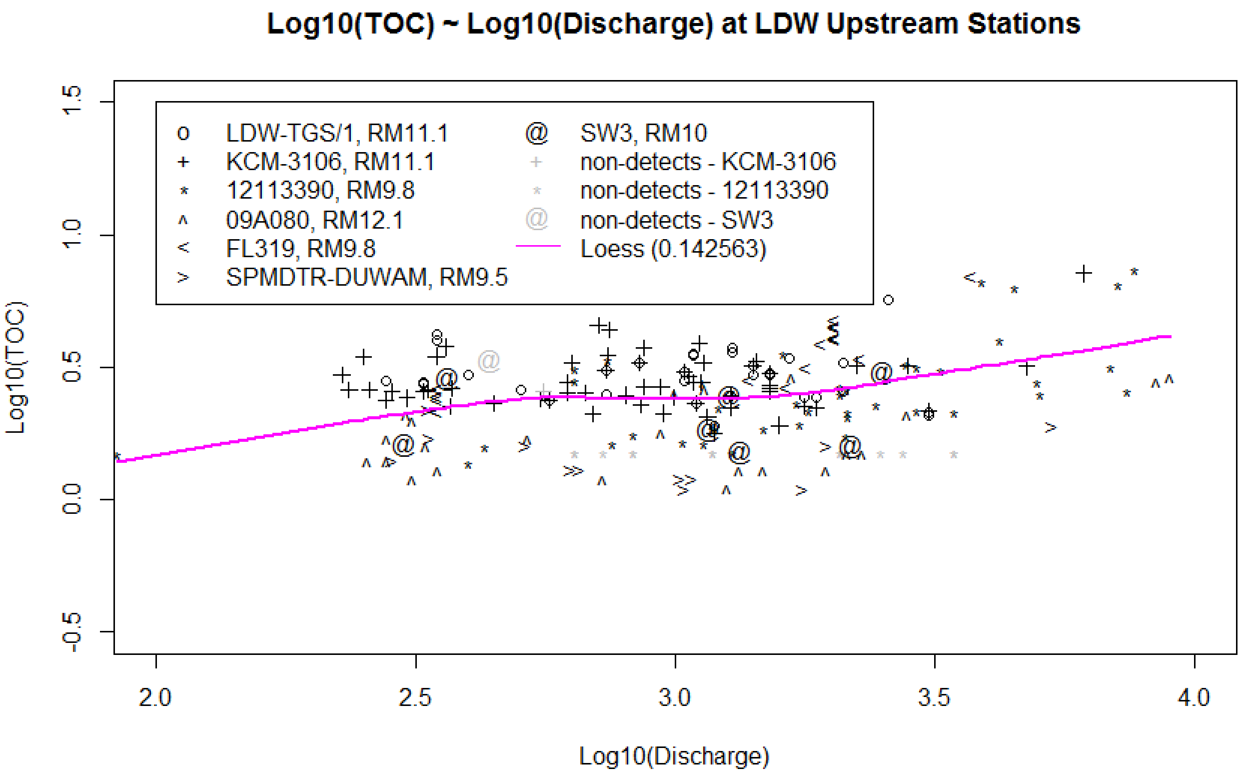
BEHP (µg/L)



Upstream of LDW

TOC (mg/L)

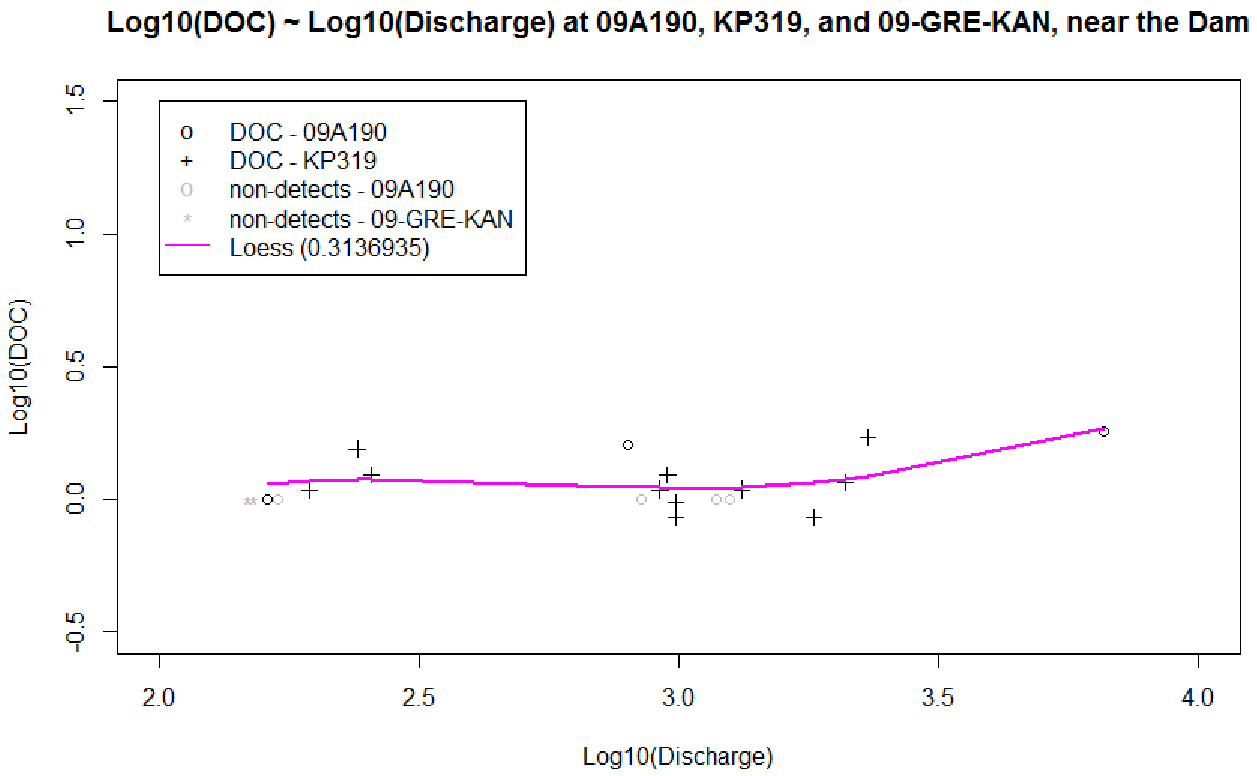


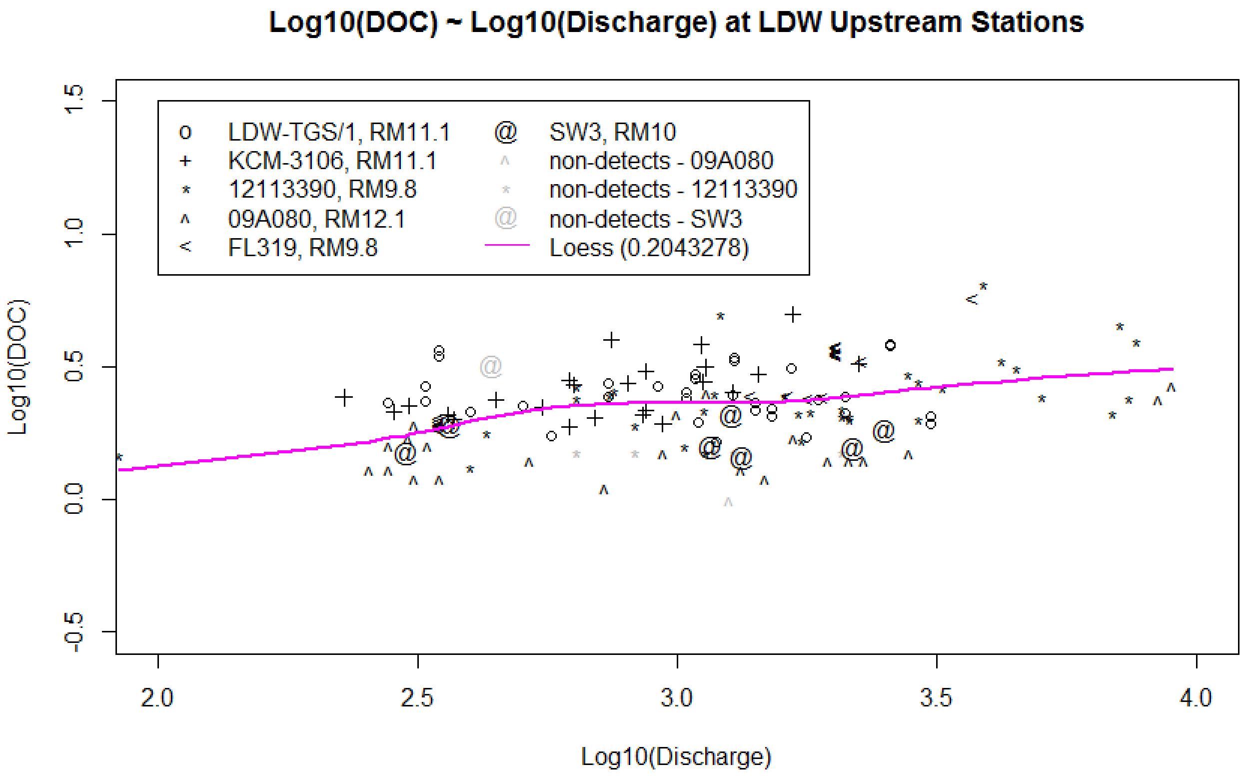


Near the Dam

Upstream of LDW

DOC (mg/L)





Near the Dam

Upstream of LDW

Next Steps

- Continue the regression analysis for all the stream/tributary surface water pollutant stations where designated pollutant concentration and measured or simulated discharge data are available.
- Work on LDW stormdrain regression analysis to provide time series pollutant concentration for receiving water modeling, as a supplement to Duwamish Subwatershed modeling.
- If it is possible, visit more complicated regression approach, such as multivariate regression, to incorporate the seasonal variations.