Updated Trend Analysis for Petronila Creek Above Tidal Implementation-Plan (I-Plan) for Three Total Maximum Daily Loads for Chloride, Sulfate, and Total Dissolved Solids (TDS)
2007 - 2015

INTRODUCTION

The water quality data analysis that was conducted on three historic monitoring sites (Figure 1 – green dots) on the main stem as part of the 2014 I-Plan Revision included data from 1971 to 2012. Two sets of data graphs were created – one for the full date range and one from 2007 (date of the initial –Plan) to 2012. For this updated analysis, data collected in 2013 through 2015 have been added to the data set and the change in trends since 2007 have been noted.

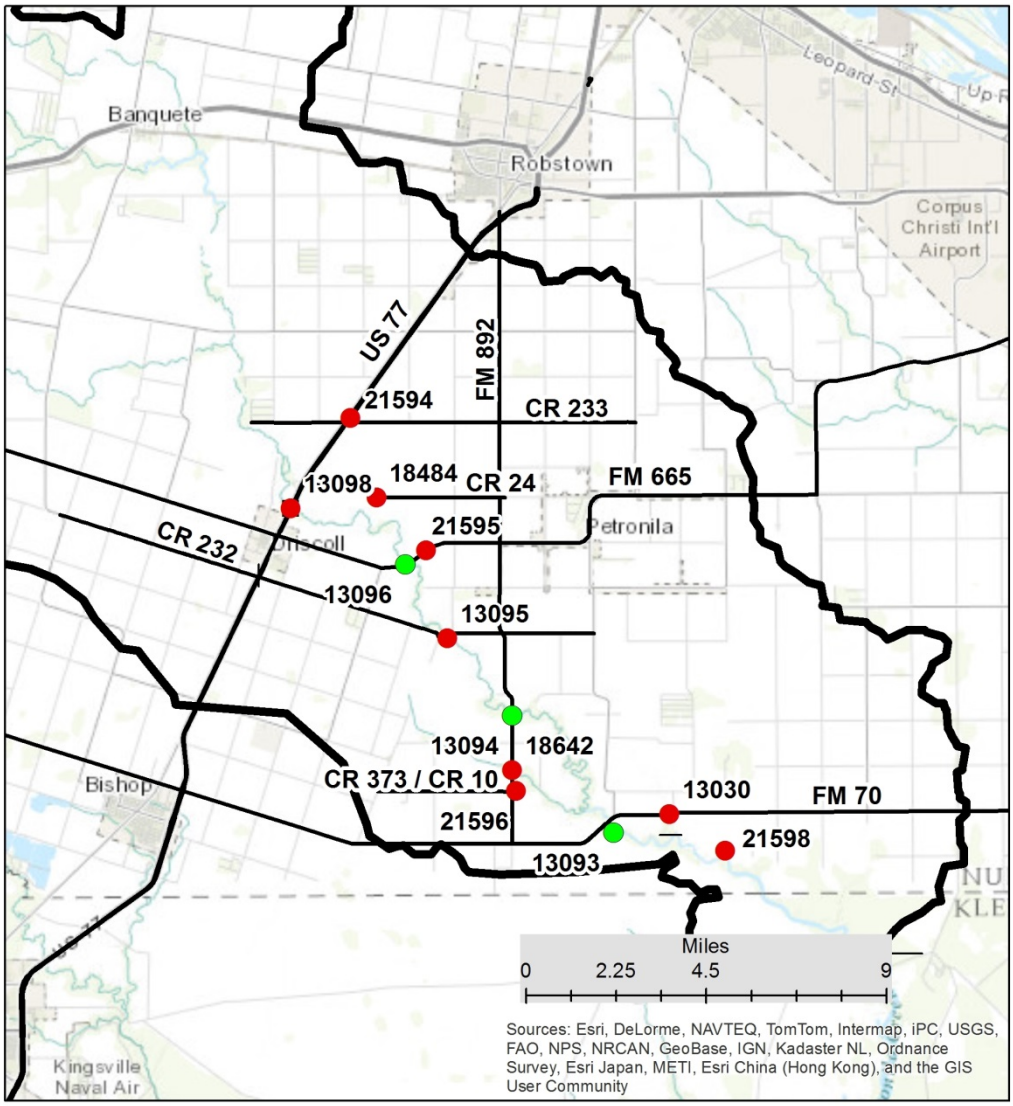


Figure 1. Monitoring Sites

Graphs of the chloride, sulfate, and TDS values measured on the tributaries in fiscal years 2015 and 2016 (Figure 1 – red dots) are also included in this report. Nine sites were monitored in 2015 and seven sites were monitored in 2016. Stations 13098 and 21595 were dropped

because the chloride, sulfate, and TDS concentrations were consistently below the standards. No statistical analysis was performed due to the short time frame.

It should be noted that the accuracy of the trend analysis increases with each additional year of monitoring. Ten years is an accepted minimum, but for the purpose of this update, Station 13093 has six years of data (beginning in 2010 because of no sampling in 2006 through 2009) and 13094 and 13096 each have 9 years of data. The trend analysis used the Excel graphing option to 'Add Trendline' to determine the R^2 value. The larger the absolute value, the greater the trend. Absolute values <0.05 are not considered to have a trend. The Excel 'Correlation' function was used to determine if rainfall played a role in concentrations values. The closer the absolute value is to 1, the greater the correlation. Rainfall recorded at Kingsville Naval Air Station (https://www.wunderground.com/history/airport/KNQI) was used for the analysis. It is the closest station with consistent information. The raw data is including in Appendix A.

MAIN STEM ANALYSIS

Chlorides – Standard 1,500 mg/l

Since 2012, the yearly average chloride concentration has been less than the previous year's average at all three stations. (Figure 2).

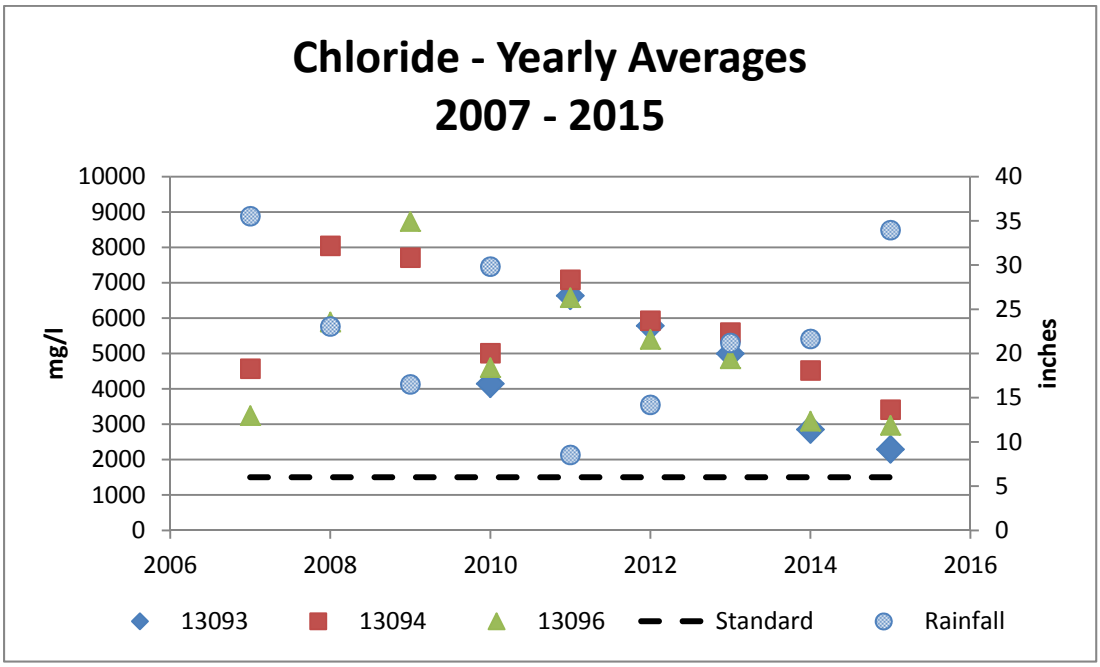


Figure 2. Chloride Yearly Averages

Statistical analysis of the data (Table 1) shows that there was an increasing trend in concentration levels at stations 13093 and 13096 and no trend at station 13094 from 2007 through 2012. With the additional three years of data, there are now decreasing trends at each station.

The analysis shows that there is an inverse relationship between rainfall and chloride concentrations at all stations.

Table 1: Statistical Analysis of Chloride Concentrations

Station	2007 thru 2012	2007 thru 2015	Rainfall Correlation
13093	Increasing: R^2 = 0.418	Decreasing: R^2 = 0.463	-0.85
13094	No Trend: R^2 = 0.002	Decreasing: R^2 = 0.288	-0.67
13906	Increasing: R^2 = 0.062	Decreasing: R^2 = 0.159	-0.69

Sulfate – Standard 500 mg/l

Since 2012, the yearly average sulfate concentration has been less than the previous year's average at all three stations. (Figure 3).

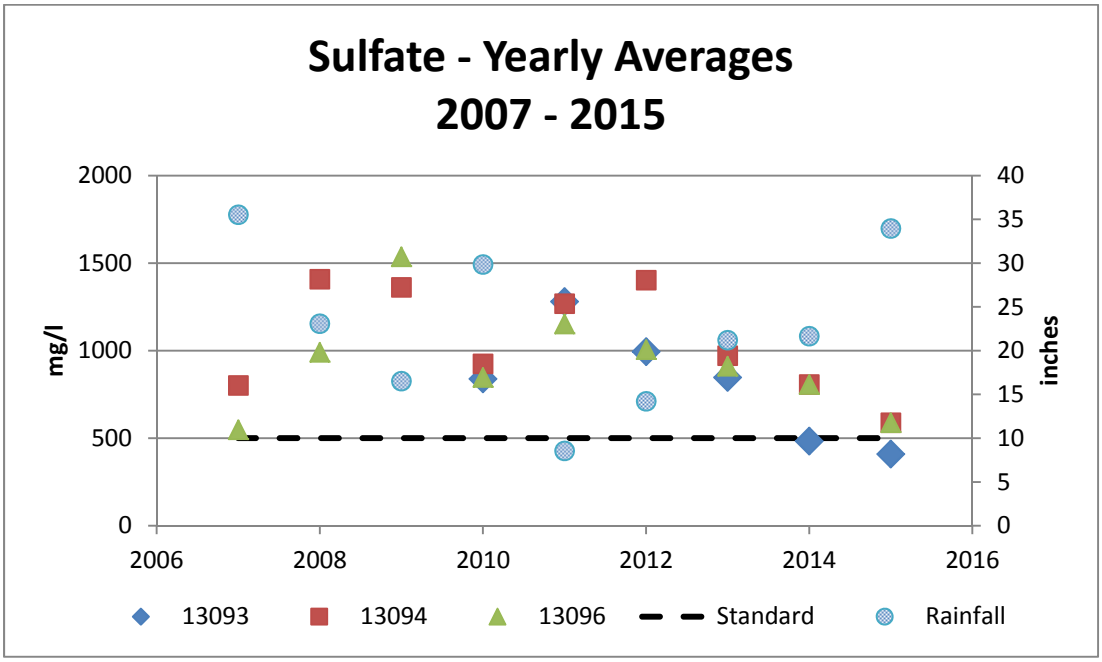


Figure 3. Sulfate Yearly Averages

Statistical analysis of the data (Table 2) shows that there was an increasing trend in concentration levels at all three stations from 2007 through 2012. With the additional three years of data, there are now decreasing trends at each station. The average yearly concentration at Station 13093 was below the 500 mg/l standard.

The analysis shows that there is an inverse relationship between rainfall and sulfate concentrations at all stations.

Table 2: Statistical Analysis of Sulfate Concentrations

Station	2007 thru 2012	2007 thru 2015	Rainfall Correlation
13093	Increasing: R^2 = 0.120	Decreasing: R^2 = 0.598	-0.80
13094	Increasing: R^2 = 0.189	Decreasing: R^2 = 0.194	-0.76
13906	Increasing: R^2 = 0.116	Decreasing: R^2 = 0.052	-0.77

TDS – Standard 4000 mg/l

Since 2011, the yearly average TDS concentration has been less than the previous year's average at all three stations. (Figure 4).

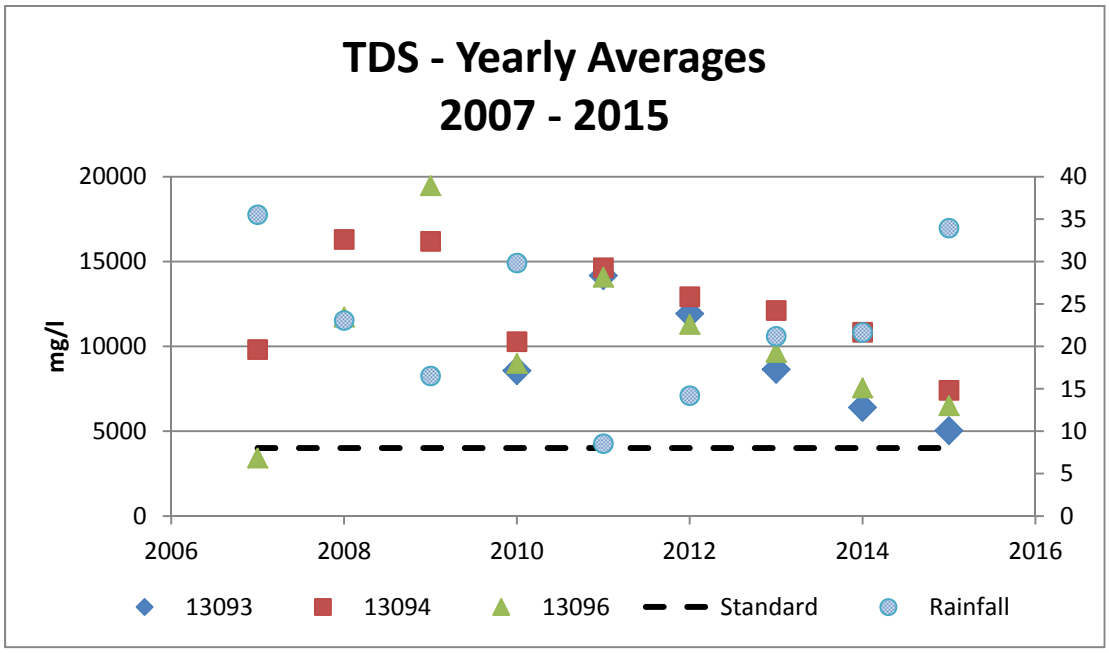


Figure 4. TDS Yearly Averages

Statistical analysis of the data (Table 3) shows that there was an increasing trend in concentration levels at stations 13093 and 13096 and no trend at 13094 from 2007 through 2012. With the additional three years of data, there are now decreasing trends at stations 13093 and 13094 and no trend at station 13096.

The analysis shows that there is an inverse relationship between rainfall and TDS concentrations at all stations.

Table 3: Statistical Analysis of TDS Concentrations

Station	2007 thru 2012	2007 thru 2015	Rainfall Correlation
13093	Increasing: R^2 = 0.354	Decreasing: R^2 = 0.483	-0.88
13094	No Trend: R^2 = 0.008	Decreasing: R^2 = 0.226	-0.73
13906	Increasing: R^2 = 0.130	No Trend: R^2 = 0.030	-0.76

TRIBUTARY ANALYSIS

The following pages contain graphs of the chloride, sulfate, and TDS sampling results from FY 2015 and FY 2016. Conductivity vs previous 21-day rainfall graphs are also included. An inverse relationship between conductivity and rainfall are apparent at most sites (Table 4). No trend analysis was conducted because of the short time frame.

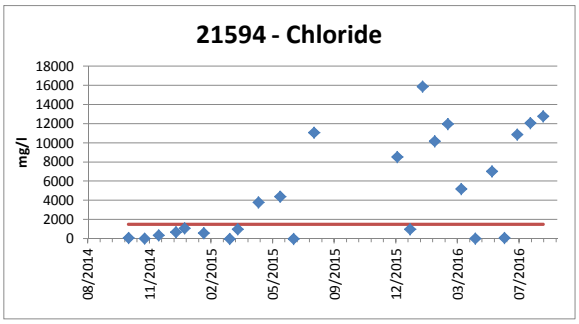
Table 4: Conductivity vs Previous 21-day rainfall

Station	Rainfall Correlation	Station	Rainfall Correlation
21594	-0.60	13098	-0.45
18484	-0.58	21595	-0.18
13095	-0.71	18642	-0.73
21596	-0.72	13030	-0.61
21598	-0.64		

RECOMMENDATIONS

Water quality sampling should be continued until at least 10 years of data are collected so that the trend analysis is more statistically valid.

The decision to drop stations 13098 and 21595 for FY 2016 was based on the first six samples collected in FY 2016. Later samples started to increase in concentrations. These two stations should be considered again for future sampling.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mg/l
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09/2015
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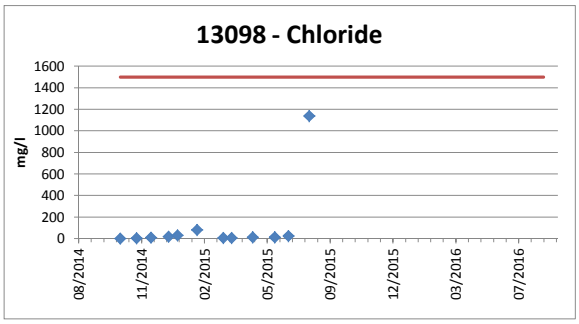
07/2016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mg/l
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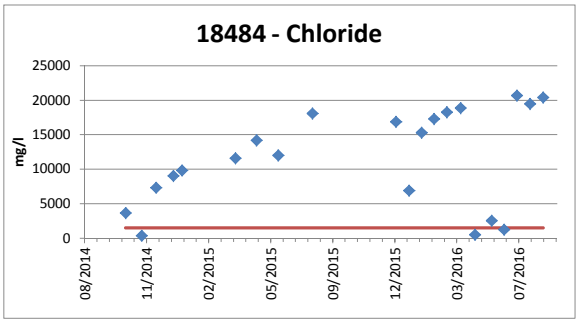
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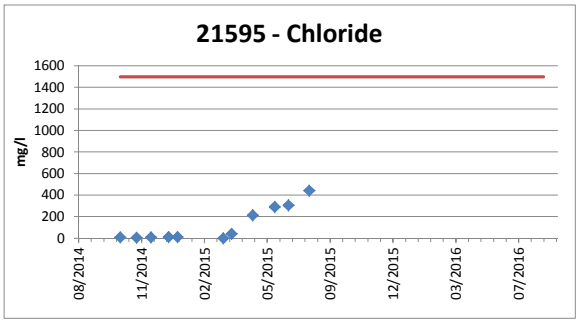
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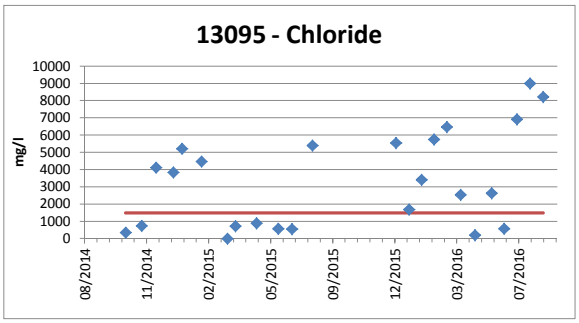
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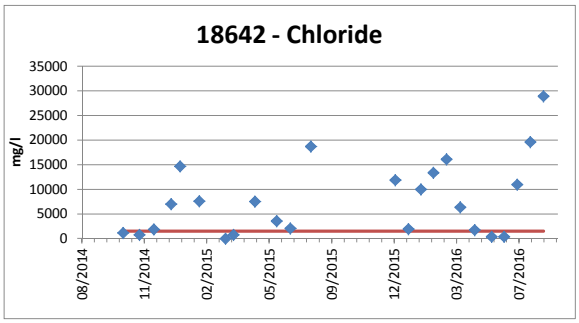
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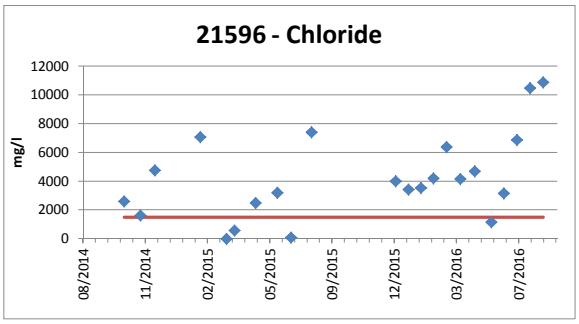
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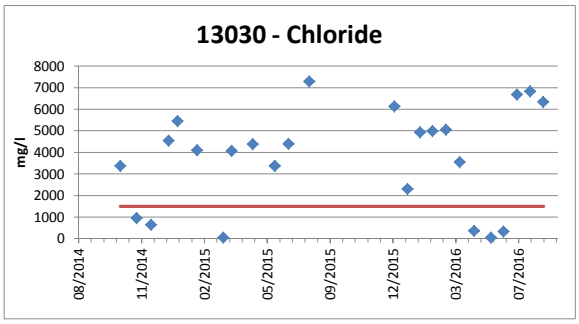
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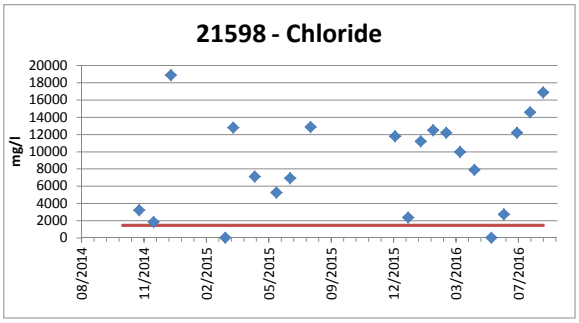
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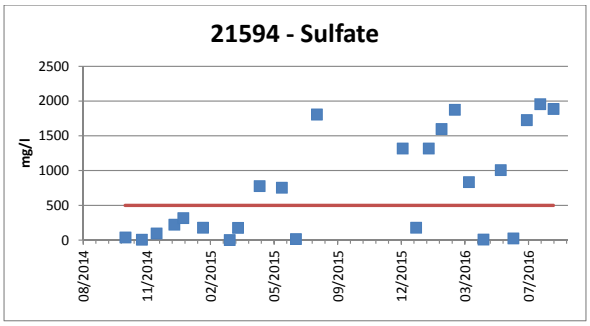
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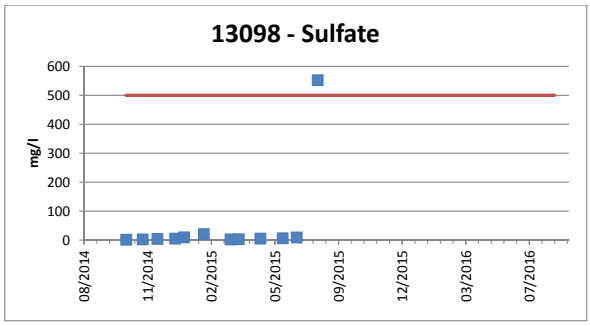
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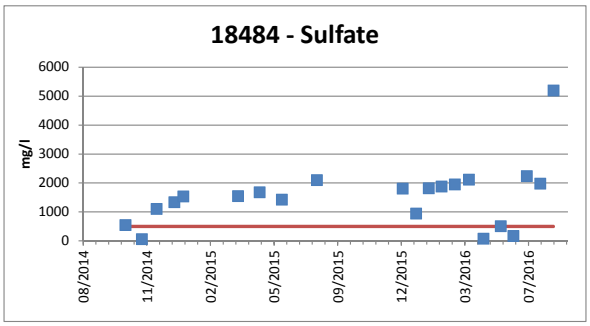
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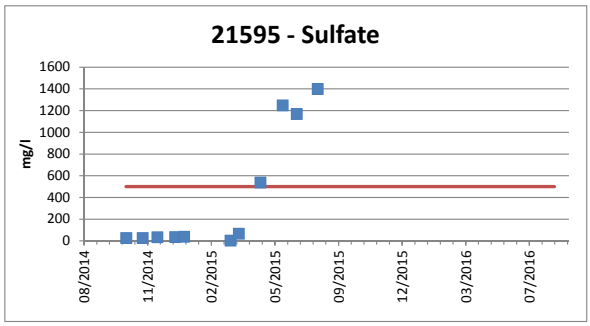
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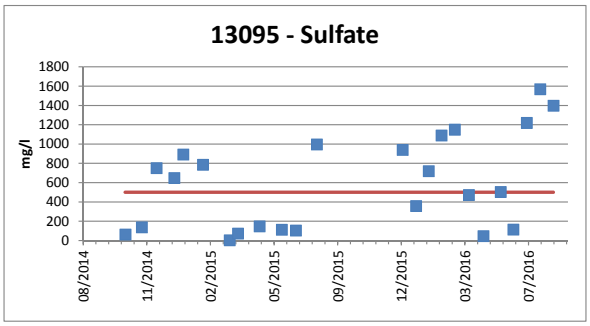
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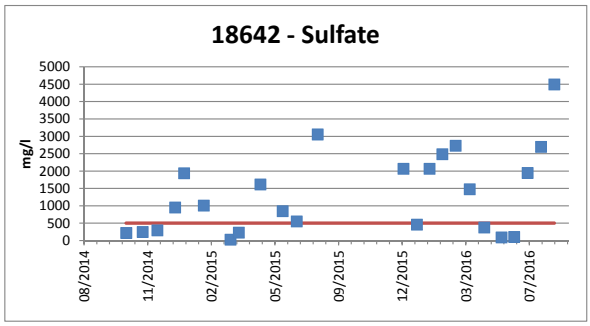
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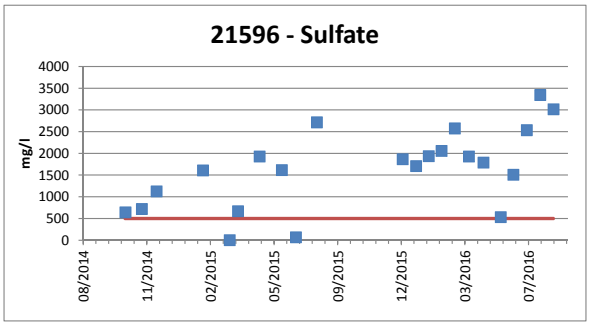
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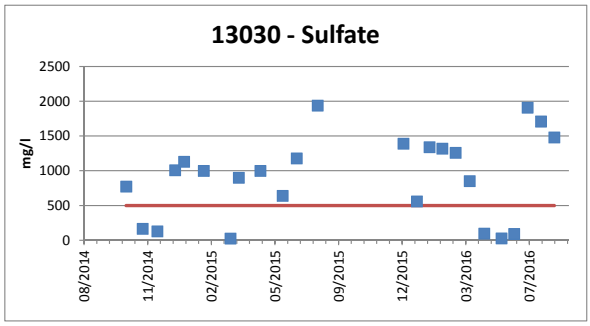
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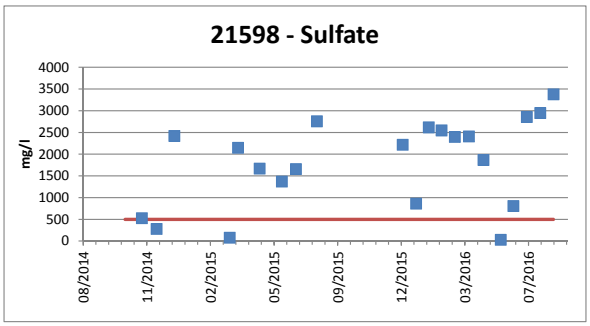
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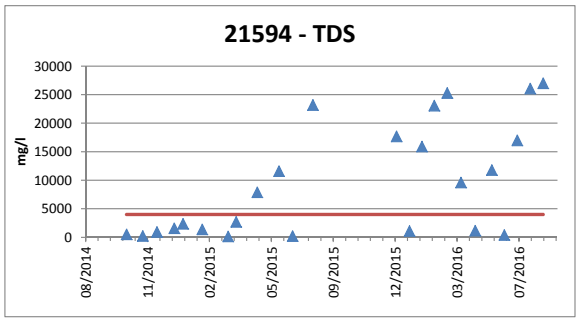
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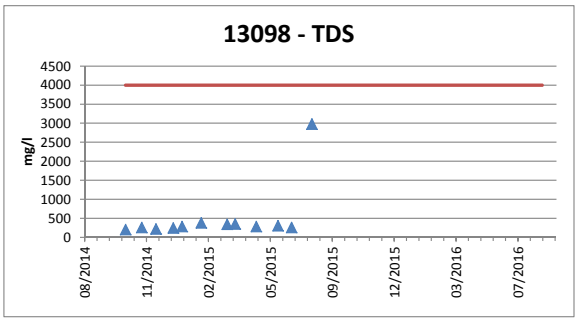
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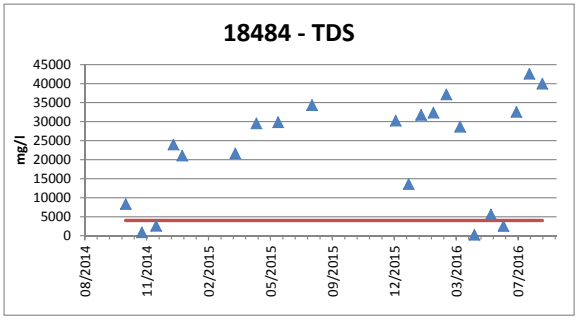
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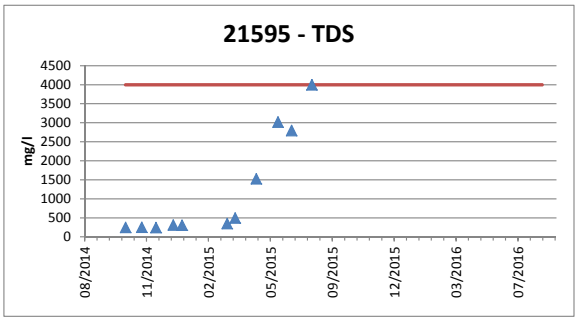
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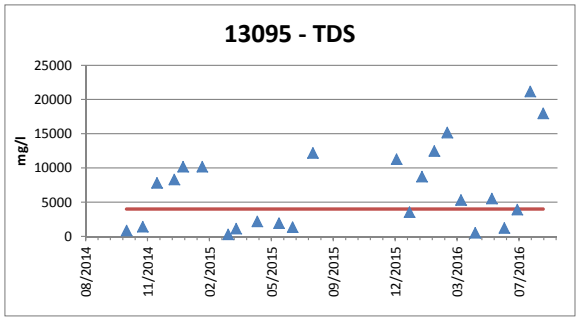
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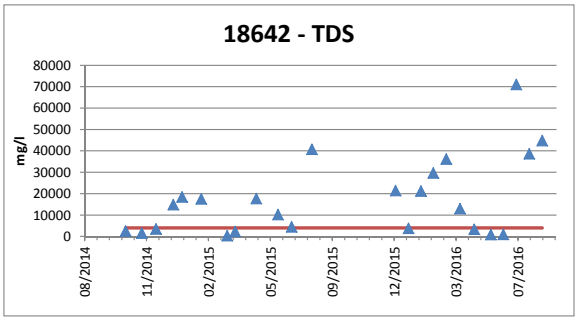
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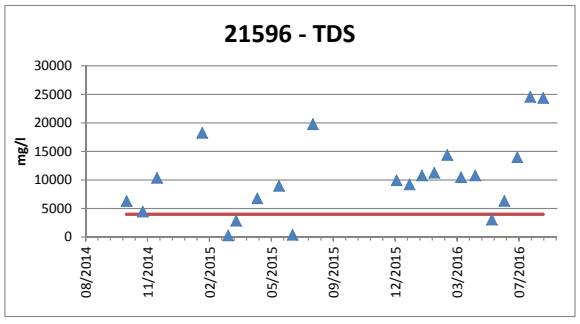
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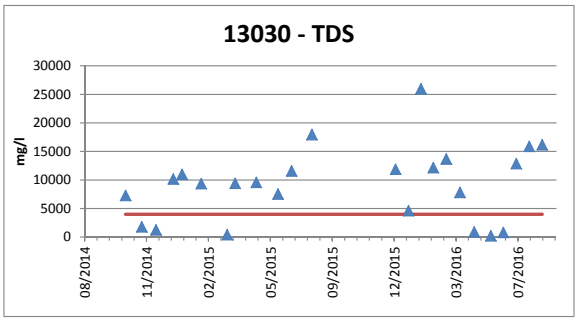
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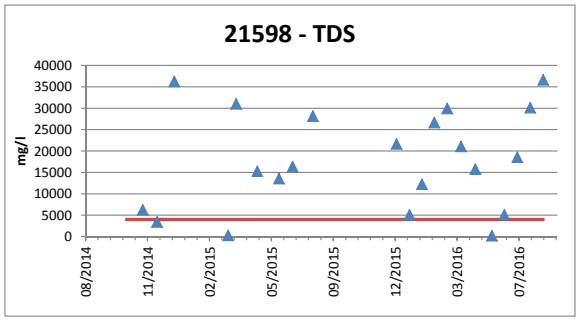
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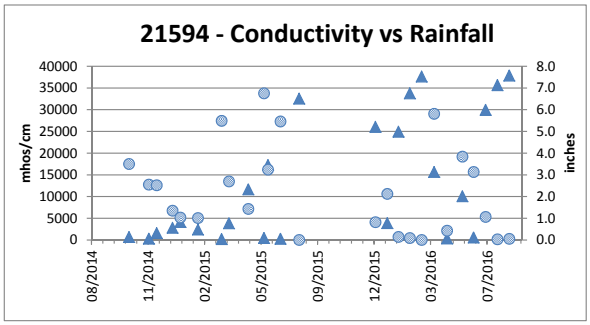
21594 - Conductivity vs Rainfall
mhos/cm
inches
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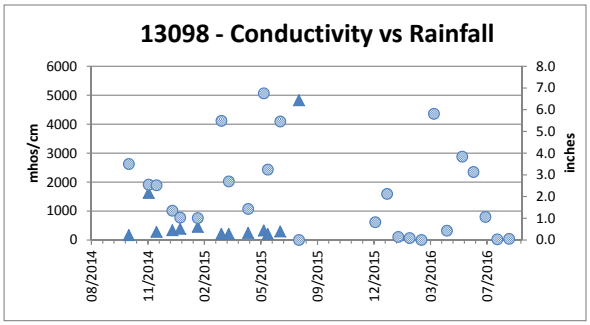
02/2015
05/2015
09/2015
12/2015
03/2016
07/2016


13098 - Conductivity vs Rainfall
mhos/cm
inches
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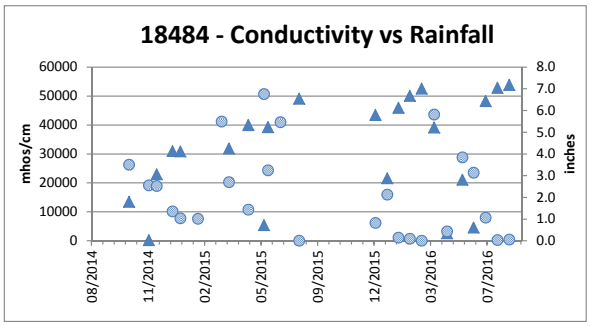
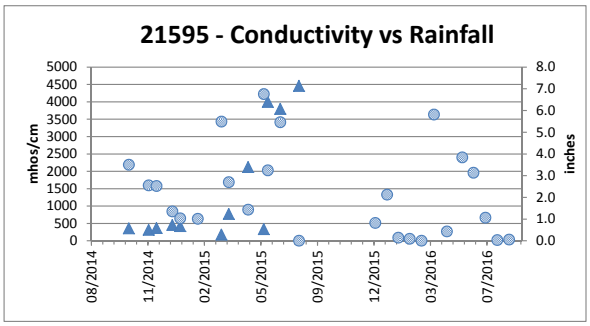
07/2016


18484 - Conductivity vs Rainfall
mhos/cm
inches
08/2014
11/2014
02/2015
05/2015
09/2015
12/2015
03/2016
07/2016


21595 - Conductivity vs Rainfall
mhos/cm
inches
08/2014
11/2014
02/2015
05/2015
09/2015
12/2015
03/2016
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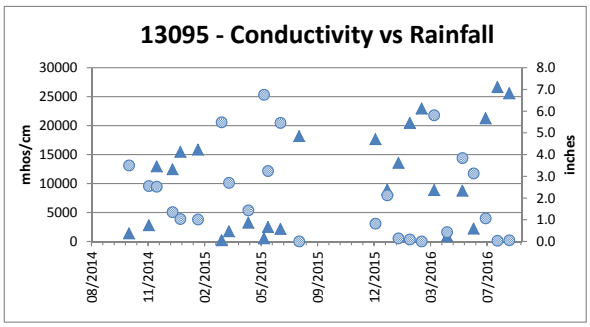
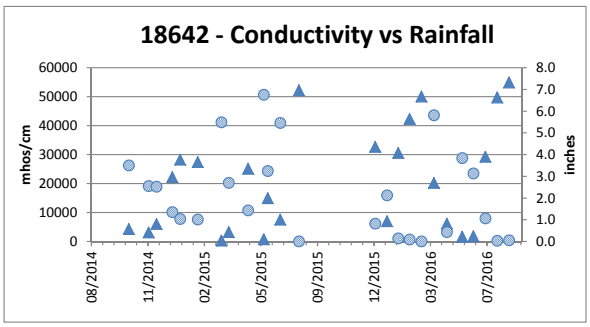
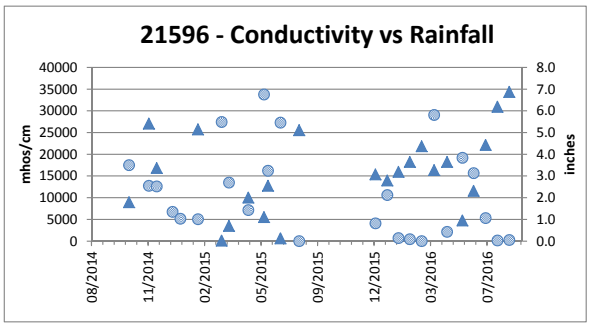
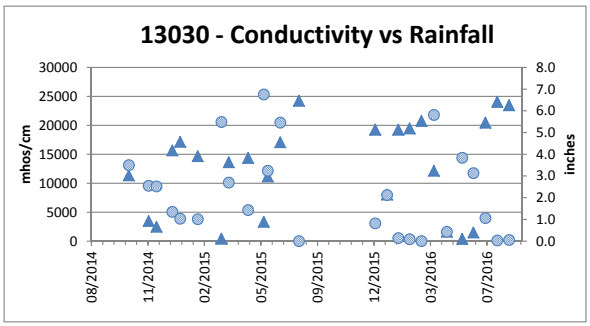
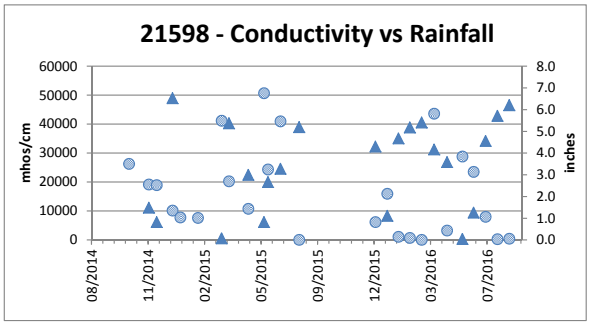

13095 - Conductivity vs Rainfall
mhos/cm
inches
08/2014
11/2014
02/2015
05/2015
09/2015
12/2015
03/2016
07/2016


18642 - Conductivity vs Rainfall
mhos/cm
inches
08/2014
11/2014
02/2015
05/2015
09/2015
12/2015
03/2016
07/2016


21596 - Conductivity vs Rainfall
mhos/cm
inches
08/2014
11/2014
02/2015
05/2015
09/2015
12/2015
03/2016
07/2016


13030 - Conductivity vs Rainfall
mhos/cm
inches
08/2014
11/2014
02/2015
05/2015
09/2015
12/2015
03/2016
07/2016


21598 - Conductivity vs Rainfall
mhos/cm
inches
08/2014
11/2014
02/2015
05/2015
09/2015
12/2015
03/2016
07/2016