EVALUATION OF HIGH TDS CONCENTRATIONS IN THE MONONGAHELA RIVER

Prepared For:

Marcellus Shale Committee
115 VIP Drive, Suite 210
Northridge Office Plaza II
Wexford, Pennsylvania 15090

Prepared By:

Tetra Tech NUS, Inc.
Foster Plaza 7
661 Andersen Drive
Pittsburgh, Pennsylvania 15220

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EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (Tetra Tech) conducted a study to evaluate the potential causes of high Total Dissolved Solids (TDS) concentrations recently detected in the Monongahela River in southwestern Pennsylvania. From approximately June 2007 to October 21, 2008, exploration and production companies drilling for natural gas in the Marcellus Shale were disposing portions of their flow back and produced waters, which are high in TDS concentrations, at municipal sewage treatment plants that discharge their treated effluents into the Monongahela River. On October 21, 2008 the Pennsylvania Department of Environmental Protection (PADEP) directed these municipal treatment plants to significantly curtail the treatment of these wastewaters because of the elevated TDS levels in the Monongahela River. PADEP noted that the high concentrations of TDS in the flow back and produced waters could be contributing to the elevated TDS levels in the river.

Based on the results of the study, the following conclusions can be made:

- Drought conditions were occurring in the Monongahela River basin in October and November 2008, which decreased the amount of water in the river for dilution and increased the concentrations of constituents such as TDS, sulfates, and chlorides in the river.

- TDS and sulfate concentrations in the Monongahela River were near the maximum allowable levels upon entering Pennsylvania from West Virginia in October and November 2008; therefore, there was little to no assimilative capacity for TDS or sulfates in the river during that time period.

- Analysis of samples taken over the October through December time period indicate that the percent of chlorides in TDS did not change significantly after the exploration and production companies had stopped or significantly reduced disposal of flow back and produced water at the municipal treatment plants.

- The time for TDS components to travel from West Virginia to Pittsburgh can range from approximately 60 days under low-flow conditions like those in October and November 2008 to 4 days under high-flow conditions like those occurring in December 2008.

- Increasing flow rates in the river were the primary factor in significantly reducing TDS, chloride, and sulfate concentrations in December 2008.

- A long-term statistical trend analysis indicated that there is no statistically significant difference in the mass loadings of TDS in the Monongahela River over the last seven years.

- TDS and sulfate concentrations exceeded PADEP water quality criteria in October and November 2008, but were significantly below the water quality limits in December 2008. Concentrations of chlorides (the main component in flow back and produced waters) did not exceed the PADEP and EPA water quality criteria throughout the study period.

- Chlorides accounted for less than 10 percent of the total TDS concentrations detected in the Monongahela River from October to December 2008.

- The contributory TDS loading due to flow back and produced waters in the Monongahela River on October 22, 2008 was estimated at 6.7 percent, approximately 1 percent on November 25, 2008, and less than 1 percent on December 30, 2008.

In summary, the results of this study clearly indicate that discharges from natural gas exploration and production operations contributed only minimally to the total TDS concentrations and mass loadings in the Monongahela River during the time period the study was conducted. The main chemical component detected in the TDS concentrations and mass loadings was sulfate, which mostly likely is the result of mine drainage. The significant increase in the river's assimilative capacity in December indicates that controlled flow back and produced water discharges to the river could occur without exceeding water quality limits during most of the year when low-flow conditions do not occur.

INTRODUCTION

Tetra Tech NUS, Inc. (Tetra Tech) conducted a study to evaluate the potential causes of high Total Dissolved Solids (TDS) concentrations recently detected in the Monongahela River in southwestern Pennsylvania. From approximately June 2007 to October 21, 2008, exploration and production companies drilling for natural gas in the Marcellus Shale were disposing portions of their flow back and produced waters, which are high in TDS concentrations, at municipal sewage treatment plants that discharge their treated effluents into the Monongahela River. On October 21, 2008 the Pennsylvania Department of Environmental Protection (PADEP) directed that these municipal treatment plants to significantly curtail the treatment of these wastewaters because of the elevated TDS levels in the Monongahela River. PADEP noted that the high concentrations of TDS in the flow back and produced waters could be contributing to the elevated TDS levels in the river.

The study focused on evaluating flow data available from the United States Geologic Survey (USGS), both historic and recent concentration data collected by the USGS and PADEP, flow and concentration data provided by the municipal wastewater treatment plants, and flow and concentration data from PADEP Discharge Monitoring Reports (DMRs) for major permitted discharges to the Monongahela River.

This study report presents the findings of the evaluation and offers conclusions based on statistical analysis and graphical representations of the data collected. The section of river addressed in the study is shown on Figure 1.

FLOW DATA

The United States Army Corps of Engineers (USACE) controls a significant portion of the flow in the upper portion of the Monongahela River by controlling water releases from their Tygart Lake and Stonewall Jackson Lake reservoirs projects in Northern West Virginia. They also control flow in the Youghiogheny River, which discharges into the Monongahela River near river mile 16.

Flow data have been continuously measured by the USGS at two gaging stations (Masontown and Elizabeth) along the Monongahela River. Flow data from these two stations for the month of October over the past five years are presented on Figures 2 and 3 in Attachment A. The figures show that the daily and monthly average flow rates in October 2008 were much lower than historic flow rates. The flow rate at the Masontown gage was near the Q7-10 flow rate of 463 cubic feet per second (cfs) several times during the month; a Q7-10 flow rate was not available from the USGS for the Elizabeth gage. A Q7-10 flow rate is a statistical estimate of the lowest average flow that would occur during a 7-day period over an average time interval of 10 years. PADEP issued a drought watch for western Pennsylvania on

November 7, 2008. The USACE indicated during a discussion with Tetra Tech staff on November 11, 2008 that their three reservoir projects were all at or near drought conditions and water releases were being minimized in conformance with their standard release curve requirements. Therefore, there was a limited volume of additional water available in October 2008 to dilute the various sources of TDS being discharged to the Monongahela River.

To further evaluate the trends in Monongahela River flows, graphs of flow data for the Masontown and Elizabeth gages were prepared for the months of November and December over the past five years. These graphs are provided in Attachment A as Figures 4 through 7. The figures for November show a trend similar to the October figures with the daily and monthly average flow rates in November 2008 being much lower than historic flow rates. The November monthly average flow rates at both gages (1,660 cfs and 1,957 cfs, respectively) were greater than the October monthly flow rates (974 cfs and 1,227 cfs, respectively), but the percent increase in flow rates is much lower than historical data. These data indicate that low-flow conditions continued in the river through November 2008. The December monthly average flow rates at both gages (17,540 cfs and 18,370 cfs, respectively) were significantly greater than both the October and November monthly flow rates and were within the range of historical December data. Significant precipitation events occurred in December 2008 which allowed flow rates to rebound to near normal levels. These data indicate that significant additional water was flowing in the Monongahela River beginning in December to dilute TDS concentrations.

Another observation that is evident by review of the flow data shown on Figures 2 through 7 is that average monthly flow rates at these two stations are very similar during low-flow conditions even though the contributing drainage area for Elizabeth is approximately 900 square miles larger than Masontown's drainage area. Historically the average monthly flow rate at Masontown has been greater than the average monthly flow rate at Elizabeth. These data suggest that there may be significant water users (e.g., industry, power production, and municipal water authorities) in this portion of the watershed that are withdrawing water from the watershed and not returning it, thus reducing the amount of flow available for TDS dilution.

CONCENTRATION DATA

The TDS concentrations in the Monongahela River are primarily comprised of sulfate and to a lesser extent chloride and other chemical components. Approximately 60 percent of the TDS associated with Marcellus produced water is chlorides. Therefore, chloride is a good indicator chemical for measuring the impacts of flow back and produced water discharges on the Monongahela River. However, it should be noted that there are other sources of chlorides, such as mine drainage, industrial waste discharges, agricultural runoff and road salt runoff, that contribute to the total chloride concentrations detected in the Monongahela River.

PADEP secondary drinking water criteria for TDS, chloride, and sulfate are 500 milligrams/liter (mg/L), 250 mg/L, and 250 mg/L, respectively. Region 3 of the United States Environmental Protection Agency (EPA) also has an ecological-based water quality criterion for chloride, considering chronic exposure conditions, of 230 mg/L.

PADEP initiated collection of comprehensive sets of water quality data, including TDS, chloride, and sulfate concentrations, at various river miles along the Monongahela River on October 22, 2008. They subsequently collected nine additional rounds of data in November and December 2008 (i.e., November 5, 12, 19, 25 and December 4, 11, 18, 23, 30, 2008). These data sets are presented on Figures 8 through 17, respectively, in Attachment A. PADEP also collected data over a 2-day period (October 29 and 30, 2008) at the sample locations, but these data were not considered for this report because they were not collected on the same day. Figure 18 in Attachment A presents the chloride concentrations shown in Figures 8 through 17, but at a greater scale to better show concentration fluctuations. The locations of the nine municipal wastewater treatment plants that were being used by the exploration and production companies for the disposal of their flow back and produced water are also shown on Figures 8 through 18.

Figures 8 through 13 illustrate that TDS and sulfate concentrations at Point Marion, near the West Virginia border, were near the maximum acceptable levels (500 mg/L and 250 mg/L, respectively) upon entering Pennsylvania from October to early December 2008. Therefore, there was little to no assimilative capacity for TDS or sulfates in the river after entering Pennsylvania.

Figures 8 through 11 illustrate that TDS and sulfate concentrations increased significantly from Point Marion (river mile 90) to Ten Mile Creek (river mile 65). Figure 18 shows that chloride concentrations also increased in this reach of the river. None of the municipal treatment plants that were accepting produced water are located on this section of the river. Therefore, it appears that other sources of TDS, sulfates, and chlorides, such as mine drainage, were impacting this reach of the river. This trend changed in late November and continued through December, as shown on Figures 12 through 17. These changes are likely the result of increased flow in the river from precipitation events that occurred in late November and December, changes in discharges from permitted mines as noted in PADEP's November 25, 2008 letter to the West Virginia Department of Environmental Protection, and impacts from other significant water and wastewater discharges in the watershed.

It is also evident from a review of Figures 8 through 12 that TDS, chloride, and sulfate concentrations did not significantly change during the 30 days after the exploration and production companies stopped or significantly reduced disposal of the produced water at municipal treatment plants. TDS concentrations remained at approximately 700 to 900 mg/L between river mile 25 and river mile 70 during this time period, which exceeds the PADEP water quality criterion of 500 mg/L for TDS. Based on the capacities of the storage pools behind the six dams on the Monongahela River and flow rates under varying conditions (low-flow, normal flow, and high-flow), it was estimated that it would take between 4 days to 60 days for all stored water and new water entering this reach of the river to travel from Point Marion (river mile 90) to the Hot Metal Street Bridge (river mile 3.1). These calculations are provided in Attachment B. These flushing-time calculations were discussed with the USACE on January 5, 2009 and they generally agreed with the estimated time periods. Considering the flow data presented on Figures 2 through 7, it is evident that low-flow conditions were present in the river from October to early December 2008. Figures 6 and 7 show that significant precipitation events occurred after December 10, 2008 that dramatically increased flow rates in the river, returning flow rates to normal to high-flow conditions. Therefore, the flushing time in October and November 2008 was estimated to be nearly 60 days, but with the increased flow rates in December, the estimated flushing time decreased to approximately 4 days. Figures 13 through 17 show that TDS and sulfate concentrations, and to a lesser extent chloride concentrations, decreased dramatically in December as a result of the decreased loadings and flushing time. By December 18, 2008 (Figure 15), TDS concentrations had decreased to approximately 200 mg/L and sulfate concentrations were less than 100 mg/L.

As shown on Figure 18, chloride concentrations between river mile 90 and river mile 4.5 on the Monongahela River ranged from 12 to 65 mg/L on October 22, 2008. Considering the flow data and the chloride loading information, these should be the maximum chloride concentrations in the river and the chloride data presented on Figure 18 supports this hypothesis. Chloride concentrations measured between river mile 90 and river mile 3.1 on November 5 ranged from 16 to 56 mg/L and were similar to concentrations measured on November 25, which ranged from 11 to 58 mg/L. These consistent concentrations were expected based on the near steady-state low-flow conditions and the extended flushing time associated with this time interval. Chloride concentrations measured in this same reach of the river in December 2008 decreased significantly compared to October and November 2008 data. Concentrations measured on December 4, 2008 ranged from 12 to 52 mg/L and by the end of December the concentrations ranged from 5 to 16 mg/L. All of the measured chloride concentrations were well below the water quality criteria identified by PADEP and EPA. The decrease in chloride concentrations from October to December can be primarily attributed to an increase in river flow rates.

The changes in the proportions of constituents (chloride, sulfate, and other components) in the total TDS loading along the river from Point Marion to Pittsburgh for the ten sample dates are shown on Figures 19 through 28 in Attachment A. Data and trend lines are both presented on the figures, as are regression equations and correlation coefficients for the trend lines. Figures 19 through 24 show, with a few exceptions, that between October 22 and December 4, 2008, sulfates contributed approximately 50 percent of the TDS, chlorides contributed less than 10 percent of the TDS, and other components contributed to nearly 40 percent of the TDS. Figures 25 through 28 show that the percentage of sulfates decreased to approximately 40 percent of the TDS and the other components increased to approximately 50 percent. This change is probably the result of decreases in discharges from permitted mines as noted in PADEP's November 25, 2008 letter and increases in the river's flow rates. Discharges from mines typically have high sulfate concentrations.

The regression coefficients (R^2 values) for sulfate and other TDS components do not show a significant correlation between their loading percentages and river mile. However, the chloride percentages on October 22 through November 25 and on December 30 show good correlation when compared to river mile (R^2 values greater than 0.7). The trend in the percent of chlorides line gradually increases from approximately 3 percent at Point Marion to approximately 10 percent near Pittsburgh on October 22, November 5, and November 12, 2008. The data from November 19 and November 25 show a slightly different chloride trend. The chloride concentrations increase from approximately 3.5 percent at Point Marion to approximately 8 percent near Pittsburgh. The data from December 4 through December 23, which are presented on Figures 24 to 27, do not indicate significant correlation between chloride percent and river mile (i.e., R^2 values less than 0.7). This lack of correlation may reflect the dynamic changes that were occurring in the river as the result of decreased loadings and increased flow rates. The December 30 data, presented on Figure 28, shows good correlation (R^2 value greater than 0.7) between chloride percent and river mile. The trend in the percent of chlorides line gradually increases from approximately 4.6 percent at Point Marion to approximately 10 percent near Pittsburgh on December 30, 2008.

By comparing the data presented on Figures 19 through 28, it is evident that the percent of chloride in TDS did not change significantly after the exploration and production companies had stopped or significantly reduced disposal of flow back and produced water at the municipal treatment plants. It is also evident from these figures that approximately 90 percent of TDS loading is attributable to sulfates and other TDS components and less than 10 percent is attributable to chlorides.

STATISTICAL TREND ANALYSIS

To further evaluate the presence of high TDS concentrations in the Monongahela River, a statistical analysis was performed on time-series data sets for three monitoring locations (Point Marion, Charleroi, and Braddock) along the river to determine if there were any statistically significant trends. Data collected prior to June 2007, when exploration and production companies began to bring Marcellus flow back and produced waters in large quantities to the municipal treatment plants on the Monongahela River, were compared to data collected after that date.

The data sets used in the analysis and the results of the analysis are provided in Attachment C. Approximately seven years of TDS and sulfate concentration data for the three locations are included in the analysis. TDS, sulfates, and other TDS components, which includes chlorides, were included in the analysis. It should be noted that all available data were used for the evaluation, but the data set is relatively small for conducting these types of trend analyses, and therefore there is a degree of uncertainty associated with the analysis.

Concentration and flow rate information were used to calculate mass loading rates for each parameter and the statistical analyses were performed on the loading rates. Because the USGS does not maintain gages to measure flow rates at the three monitoring locations, flow rates had to be estimated. Flow rates for Point Marion were estimated from flow rates measured at the USGS Masontown gage and conversion factors developed from historical monthly flow rate data. Flow rates for Charleroi and Braddock were estimated from flow rates measured at Elizabeth and conversion factors based on historical monthly flow rate data. The approach for calculating the flow rates is provided in Attachment C.

The results of the analysis show that there are no statistically significant differences in the two sets of data for any of the parameters and that the recent concentration increases coincide with data from previous low-flow periods. For example, USGS measured a TDS concentration of 840 mg/L in November 2002 during low-flow conditions. This information indicates that natural conditions (i.e., low-flow rates) contributed significantly to the high TDS loading and that changes in the disposal of flow back and produced waters at municipal treatment plants by the exploration and production companies had little impact on the overall TDS loadings in the river.

A trend analysis was also conducted to determine whether sulfate concentrations as a percentage of TDS (sulfate/TDS) and the percentage of TDS not related to sulfates (1-sulfate/TDS) were increasing over time at Point Marion, Charleroi and Braddock. The concentrations were plotted over time to look for general upward or downward trends. The plots were also inspected for seasonality effects (i.e., patterns associated with data collection time) and the appropriate Mann-Kendall trend test was performed. This nonparametric test provides a quantitative and objective measure of the presence of trends. There is some uncertainty associated with the trend test due to the data not being collected in equally spaced time intervals; the data from Point Marion and Charleroi after June 2007 were collected more frequently than the data collected before June 2007. The Point Marion sulfate loadings as a percentage of TDS fluctuate up and down with an overall increasing trend. The Point Marion percentage of TDS not related to sulfates appears to have a downward trend and there does appear to be some slight fluctuation of TDS loadings not affected by sulfates. It is assumed that fluctuations are due to seasonal variations in river flow rates. Statistically significant trends were found for sulfate loadings as a percentage of TDS (increasing trend) and TDS not related to sulfates (decreasing trend). For the Charleroi sulfate loadings as a percentage of TDS and the TDS not related to sulfate loadings, no trends or seasonality are evident. Braddock sulfate loadings as a percentage of TDS appear to be randomly distributed with a slight increasing trend with no seasonality. For the TDS not related to sulfates loadings there appears to be a slight downward trend in loading over time with no seasonal effects. Statistically significant trends were found in the sulfate as percentage of TDS (upward trend) and percentage of TDS not related to sulfates (downward trend).

TDS CONTRIBUTIONS FROM MUNICIPAL TREATMENT PLANTS

PADEP identified nine municipal treatment plants on the Monongahela River that accepted produced water from exploration and production companies drilling for natural gas in the Marcellus Shale. As part of this study, flow back and produced water volumes received by the plants in August through December 2008 were collected. Total and average contributory TDS loadings to the river for the flow back and produced waters accepted at the plants were calculated based upon these data and the typical characteristics of flow back and produced water (see Attachment C). Because river flow was essentially at steady-state in October and November, the approximate travel time for each plant discharge to reach river mile 3.1 was calculated to provide an effective discharge date for the plant contributions at river mile 3.1. The conservative flushing time of 60 days, as detailed previously, and the location of each of the subject plants were used to calculate the effective discharge dates for the plant discharges. These calculations are included in Attachment D-1.

The TDS loading in the Monongahela River was calculated from the PADEP analytical data and average daily flow rate data from the USGS for October 22, November 25, and December 30, 2008. The PADEP analytical data used for the calculations are from the most downstream sample point available (river mile 4.5 for October 22 and river mile 3.1 for November 25 and December 30). A corresponding daily average flow rate for each location is conservatively calculated using the available USGS daily average flow rate at Elizabeth and the corresponding historical monthly adjustment factor as detailed previously in Attachment C.

The TDS loading in the Monongahela River as it enters Pennsylvania was calculated in a similar manner. The PADEP analytical data used for the calculation were from the Point Marion location at river mile 90. This station is the first sample location available after the river enters Pennsylvania and is located upstream from the municipal treatment plants identified by PADEP. A corresponding daily average flow rate for Point Marion was calculated by using the available USGS daily average flow rate at Masontown (river mile 82) and the corresponding historical monthly adjustment factor as detailed previously and shown in Attachment C.

The TDS loading calculations described above are shown in Attachment D-2. From these calculations and the daily average TDS loading attributed to flow back and produced water disposal through the municipal treatment plants (Attachment D-1), the contributory TDS loading due to flow and produced waters in the Monongahela River on October 22, 2008 was estimated at 6.7 percent, while the base load in the Monongahela River entering the state was estimated at 22.9 percent. This equates to an estimated 70.5 percent TDS load contribution by other sources within the State of Pennsylvania. The contributory source summary is shown in Attachment D-3.

The TDS loading calculations were also performed with the PADEP analytical data collected on November 25 and December 30, 2008. These dates have been selected as they are approximately 30 and 60 days after the plants stopped or limited their acceptance of flow back and produced waters. Five plants (California, Belle Vernon, Tri-County, Mon Valley and McKeesport) have continued to receive produced water at their facilities in limited quantities averaging a total of 22,870 gallons/day. In addition, on December 6, 2008 the Clairton plant began accepting an average of 37,000 gallons/day, 6 days per week. The TDS loading calculations for November 25, 2008 are shown in Attachment D-4. From these calculations, the contributory TDS loading due to flow back and produced waters in the Monongahela River on November 25, 2008 was estimated at 1.0 percent, while the base load in the Monongahela River entering the state was estimated at 16.8 percent. This equates to an estimated 82.2 percent TDS load contribution by other sources within the State of Pennsylvania. The contributory source summary is shown in Attachment D-5. The calculations for December 30, 2008 are shown in Attachment D-6. From these calculations, the contributory TDS loading due to flow back and produced waters in the Monongahela River on December 30, 2008 was estimated at 0.2 percent, while the base load in the Monongahela River entering the state was estimated at 27.2 percent. This equates to an estimated 72.5 percent TDS load contribution by other sources within the State of Pennsylvania. The contributory source summary is shown in Attachment D-7.

MONONGAHELA RIVER CHLORIDE AND TDS ASSIMILATIVE CAPACITY

The assimilative capacity of the Monongahela River with respect to chlorides and TDS was calculated under average flow conditions for multiple PADEP sample dates from October 22 through December 30, 2008. The calculation was performed using the 250 mg/L limit for chlorides, 500 mg/L limit for TDS, and the most downstream sample point available (river mile 4.5 for October 22 and river mile 3.1 for the remaining samples).

The assimilative capacity was calculated utilizing the PADEP concentration data and the corresponding daily average flow rate for that point. The flow rate was calculated by using the available USGS daily average flow rate at Elizabeth and the corresponding historical monthly adjustment factor as detailed previously and provided in Attachment C. Using these two parameters, the assimilative capacity for chlorides and TDS at the sample location using the average flow rates were calculated. The calculations are detailed in Attachment D-8 and the results are graphically depicted in Attachment D-9 and D-10.

The calculation demonstrates excess chloride assimilative capacity in the Monongahela River throughout the PADEP sampling period. Additionally, it can be seen that the Monongahela River did not have assimilative TDS capacity during the low-flow periods in October and November 2008, but TDS assimilative capacity did increase proportionally to flow throughout the month of December 2008. Therefore, during high-flow conditions, the data suggests that the Monongahela River would have assimilative capacity for both TDS and chlorides.

DISCHARGE MONITORING REPORTS

In an effort to quantify and characterize other possible contributors of TDS to the Monongahela River, Tetra Tech requested NPDES permits and monthly DMRs from PADEP for selected direct discharges located along the reach of the river covered by this study. The discharges to be examined were selected by identifying all direct discharges into the river using EPA Envirofacts, filtering the results to remove non-industrial and outdated permits, and identifying the remaining permits which may have significant flows and TDS contributions and that came from industrial (power, steel, chemical, mining) processes. A list of 33 discharges was generated and relevant discharge information was requested from PADEP. The list is included in Attachment E-1.

Of the 33 identified discharges, two were found to be inactive and information on one other could not be found, resulting in a final list of 30 remaining discharges. Of these 30 discharges, it was found that only two dischargers, the USACE Concrete Batch Plant and US Department of Energy (DOE) Bettis Plant, had monitored or were monitoring effluent TDS. Attachments E-2 and E-3 contain the permit and DMR information for these two discharges. Although several other discharges are required to monitor for specific TDS components, there was not enough information available from the retrieved documentation to adequately quantify TDS loadings.

CONCLUSIONS

Based on the results of the evaluation of high TDS concentrations in the Monongahela River from October through December 2008, the following conclusions can be made:

- Drought conditions were occurring in the Monongahela River basin in October and November 2008, which decreased the amount of water in the river for dilution and increased the concentrations of constituents such as TDS, sulfates, and chlorides in the river.

- TDS and sulfate concentrations in the Monongahela River at Point Marion, near the West Virginia border, were near the maximum allowable levels (500 mg/L and 250 mg/L, respectively) upon entering Pennsylvania in October and November 2008; therefore, there was little to no assimilative capacity for TDS or sulfates in the river during that time period.

- Analysis of samples taken over the October through December time period indicate that the percent of chloride in TDS did not change significantly after the exploration and production companies had stopped or significantly reduced disposal of flow back and produced water at the municipal treatment plants.

- The time for TDS components to travel from Point Marion to Pittsburgh varies depending on the flow conditions and can range from approximately 60 days under low-flow conditions like those in October and November 2008 to 4 days under high-flow conditions like those occurring in December 2008.

- Increasing flow rates in the river were the primary factor in significantly reducing TDS, chloride, and sulfate concentrations in December 2008

- A long-term statistical trend analysis was performed and indicated that there is no statistically significant difference in the mass loadings of TDS, sulfates or other TDS components in the Monongahela River over the last seven years. USGS measured a TDS concentration of 840 mg/L at Braddock on November 5, 2002 which is similar to TDS concentrations measured in the Monongahela River in 2008.

- TDS and sulfate concentrations exceeded PADEP water quality criteria in October and November 2008, but were significantly below the water quality limits in December 2008. Chloride concentrations did not exceed PADEP and EPA water quality criteria throughout the study period.

- Sulfates and other components of TDS account for approximately 90 percent of the TDS in the river and chlorides account for less than 10 percent of the TDS.

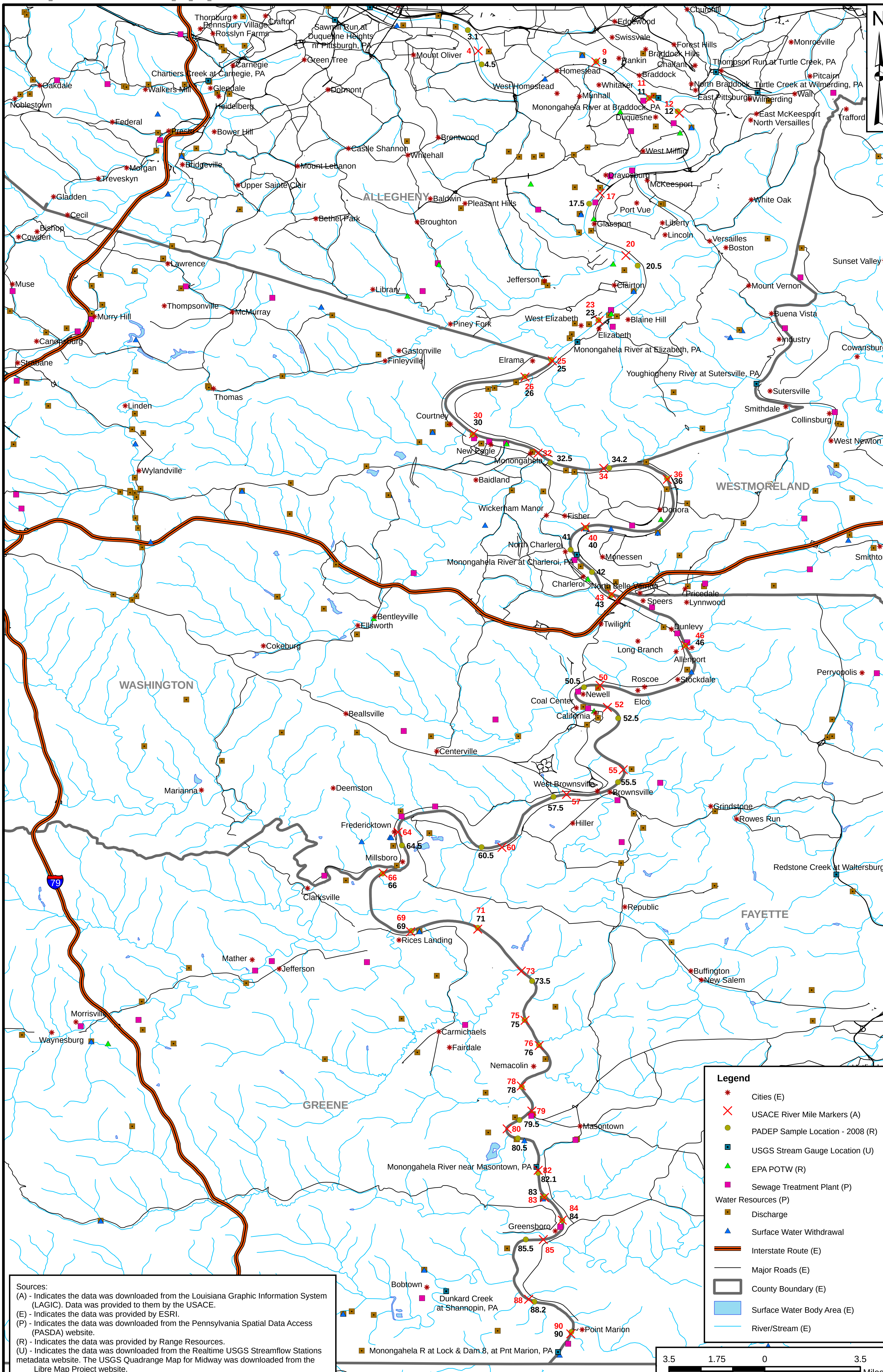
- The contributory TDS loading due to flow back and produced waters in the Monongahela River on October 22, 2008 was estimated at 6.7 percent, approximately 1 percent on November 25, 2008, and less than 1 percent on December 30, 2008. Therefore, the discharge of flow back and produced waters into the Monongahela River contributed only a very small percentage to the overall TDS loading in the river.

- A majority of the major permitted discharges to the river are not required to monitor TDS or the chemical components that make up TDS. Therefore, sufficient data are not available to quantify the contribution of these sources to the TDS load in the river.

In summary, the results of this study clearly indicate that discharges from natural gas exploration and production operations contributed only minimally to the total TDS concentrations and mass loadings in the Monongahela River during the time period the study was conducted. The main chemical component detected in the TDS concentrations and mass loadings was sulfate, which mostly likely is the result of mine drainage. The significant increase in the river's assimilative capacity in December indicates that controlled flow back and produced water discharges to the river could occur without exceeding water quality limits during most of the year when low-flow conditions do not occur.

ATTACHMENT A

FIGURES



Sources:
(A) - Indicates the data was downloaded from the Louisiana Graphic Information System (LAGIC). Data was provided to them by the USACE.
(E) - Indicates the data was provided by ESRI.
(P) - Indicates the data was downloaded from the Pennsylvania Spatial Data Access (PASDA) website.
(R) - Indicates the data was provided by Range Resources.
(U) - Indicates the data was downloaded from the Realtime USGS Streamflow Stations metadata website. The USGS Quadrange Map for Midway was downloaded from the Libre Map Project website.

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S. PAXTON	11/21/08
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A. STRASSNER	12/11/08
REVISED BY	DATE
S. PAXTON	12/11/08
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MONONGAHELA RIVER
HIGH TDS STUDY

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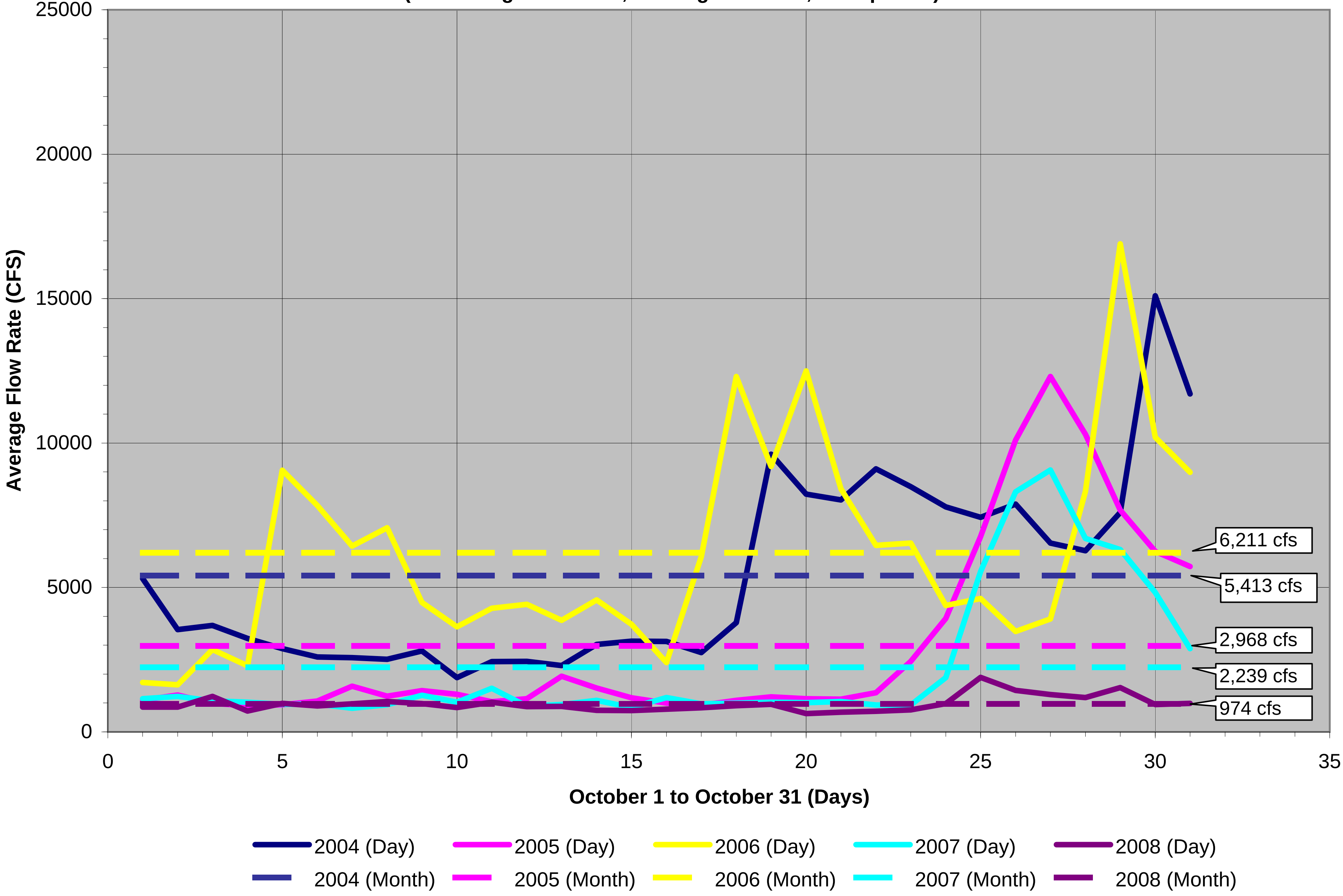
Figure 2
Comparison of Daily and Monthly Average October Flow Rates for the Monongahela River at Masontown, PA Over the Past Five Years
(USGS Gage 03072655, Drainage Area = 4,440 sq miles)



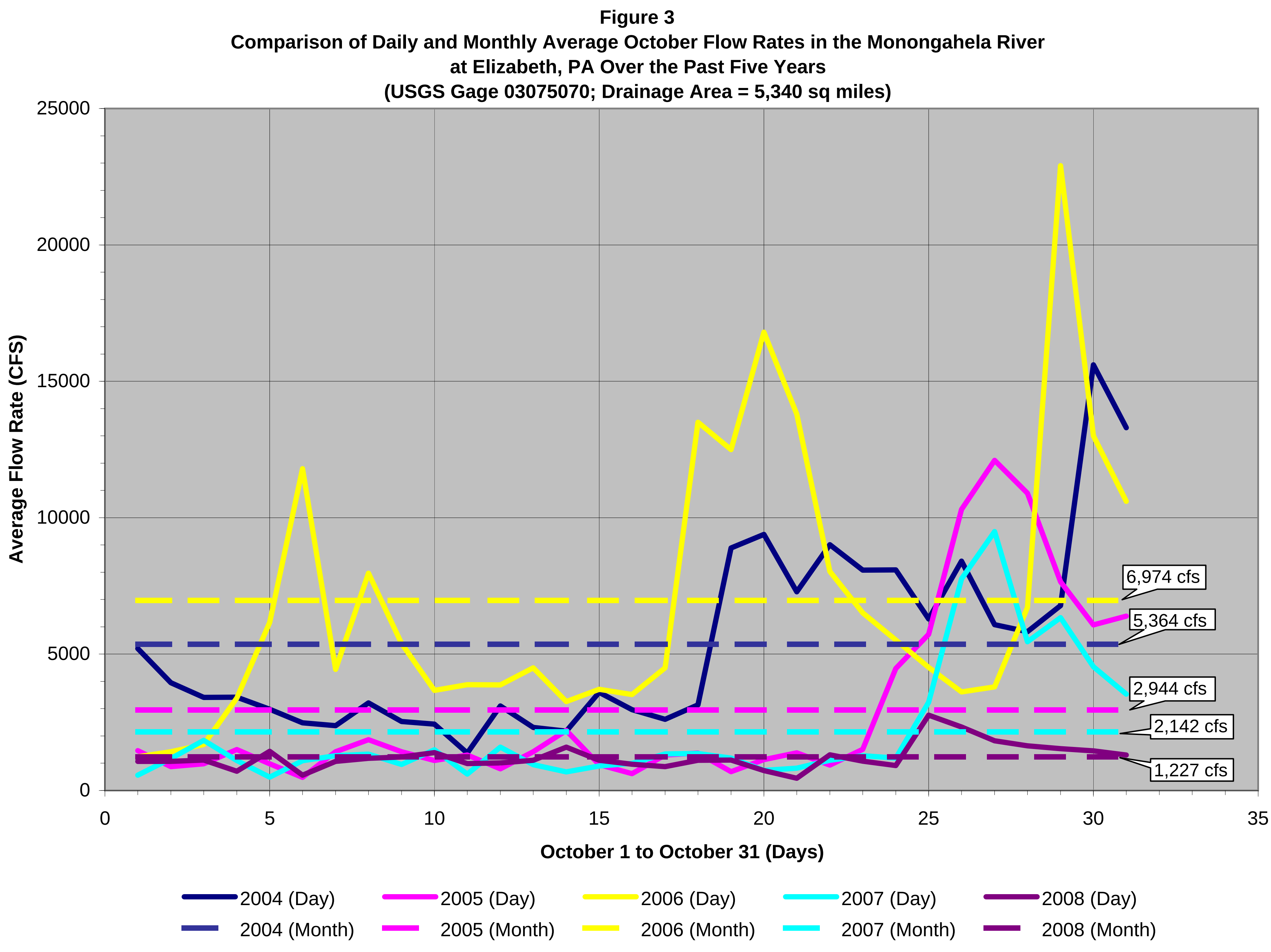


Figure 3
Comparison of Daily and Monthly Average October Flow Rates in the Monongahela River
at Elizabeth, PA Over the Past Five Years
(USGS Gage 03075070; Drainage Area = 5,340 sq miles)
Average Flow Rate (CFS)
October 1 to October 31 (Days)
6,974 cfs
5,364 cfs
2,944 cfs
2,142 cfs
1,227 cfs
2004 (Day)
2005 (Day)
2006 (Day)
2007 (Day)
2008 (Day)
2004 (Month)
2005 (Month)
2006 (Month)
2007 (Month)
2008 (Month)

Figure 4
Comparison of Daily and Monthly Average November Flow Rates for the Monongahela River at Masontown, PA Over the Past Five Years
(USGS Gage 03072655, Drainage Area = 4,440 sq miles)

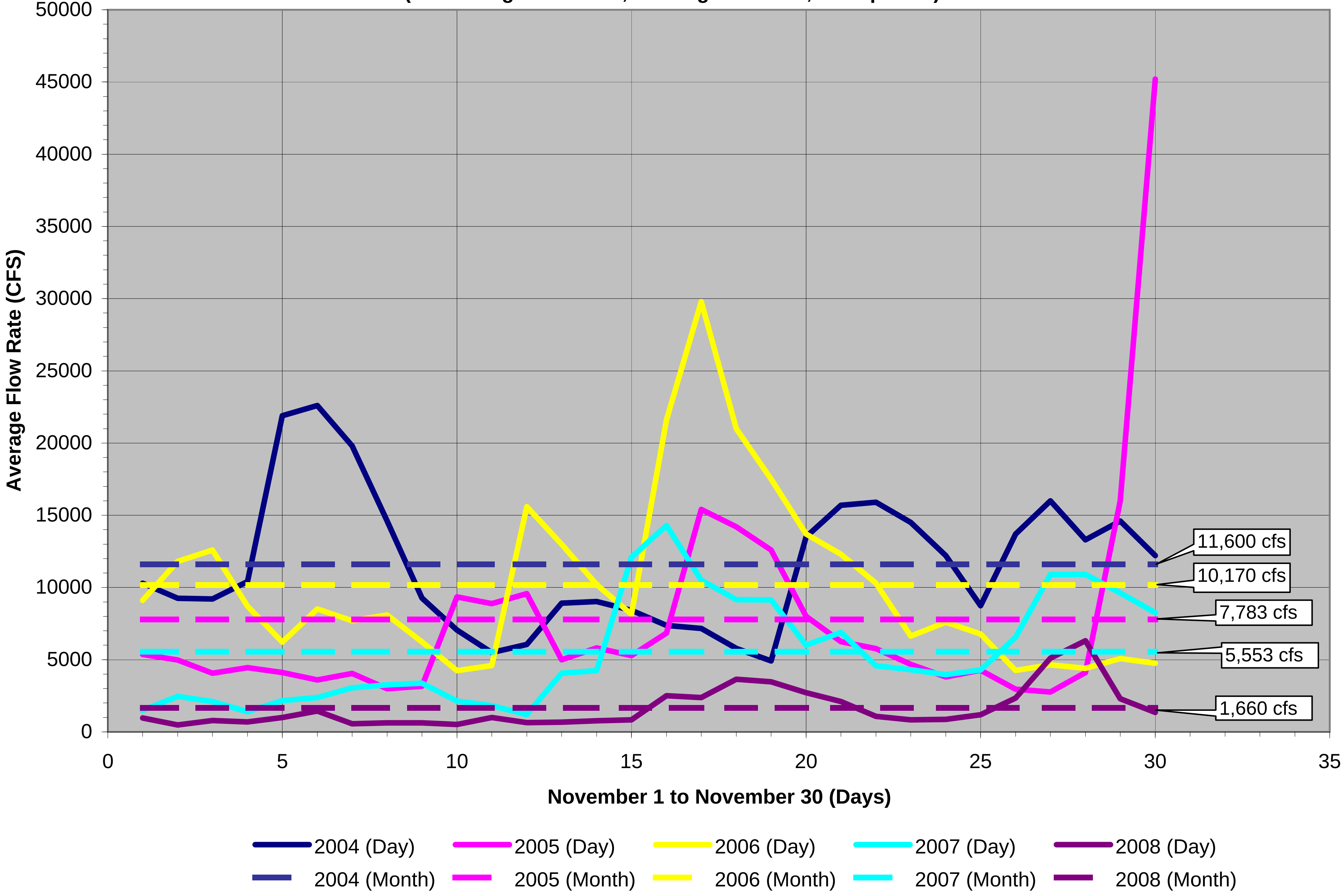


Figure 5
Comparison of Daily and Monthly Average November Flow Rates in the Monongahela River at Elizabeth, PA Over the Past Five Years
(USGS Gage 03075070; Drainage Area = 5,340 sq miles)

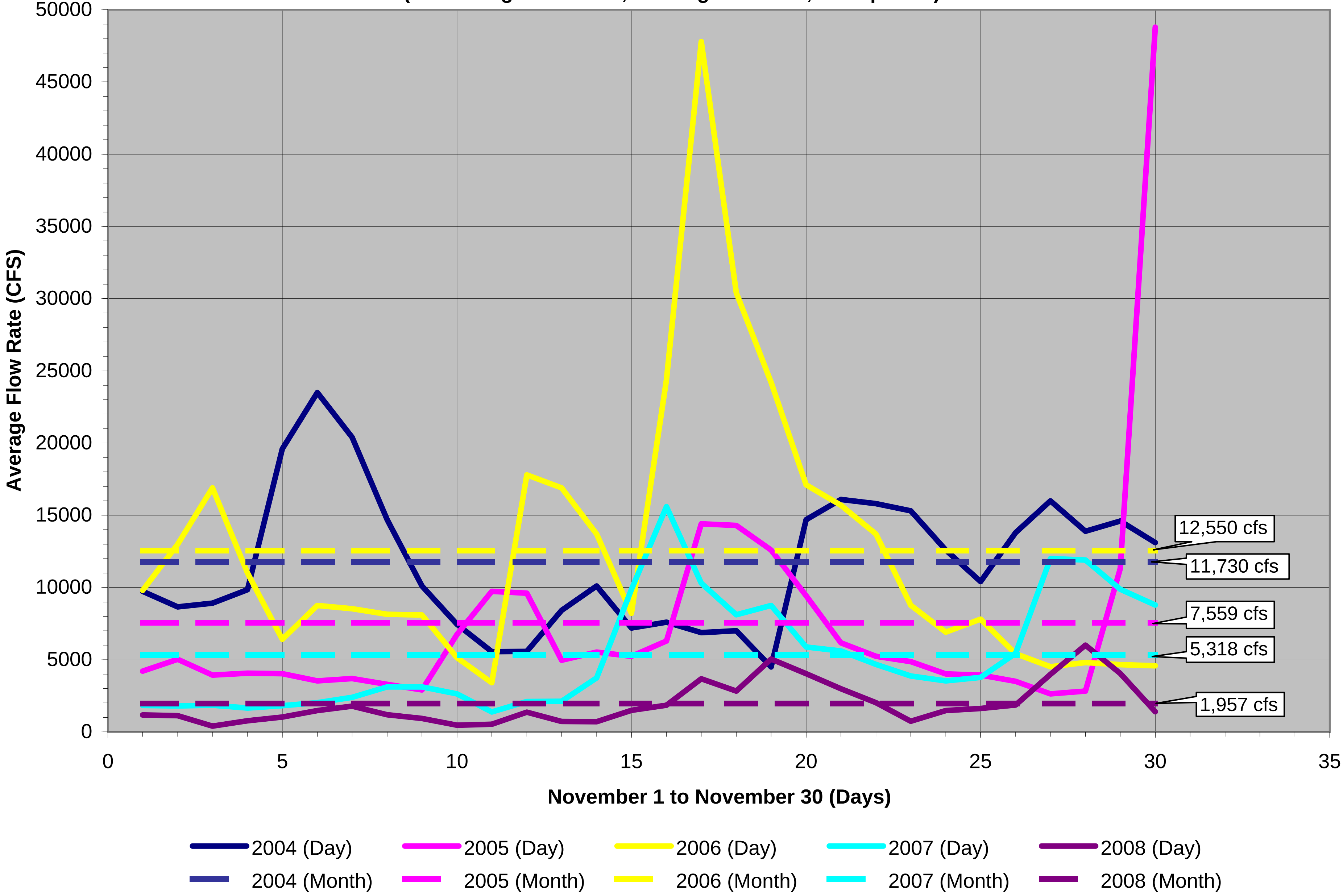


Figure 6
Comparison of Daily and Monthly Average December Flow Rates for the Monongahela River at Masontown, PA Over the Past Five Years
(USGS Gage 03072655, Drainage Area = 4,440 sq miles)

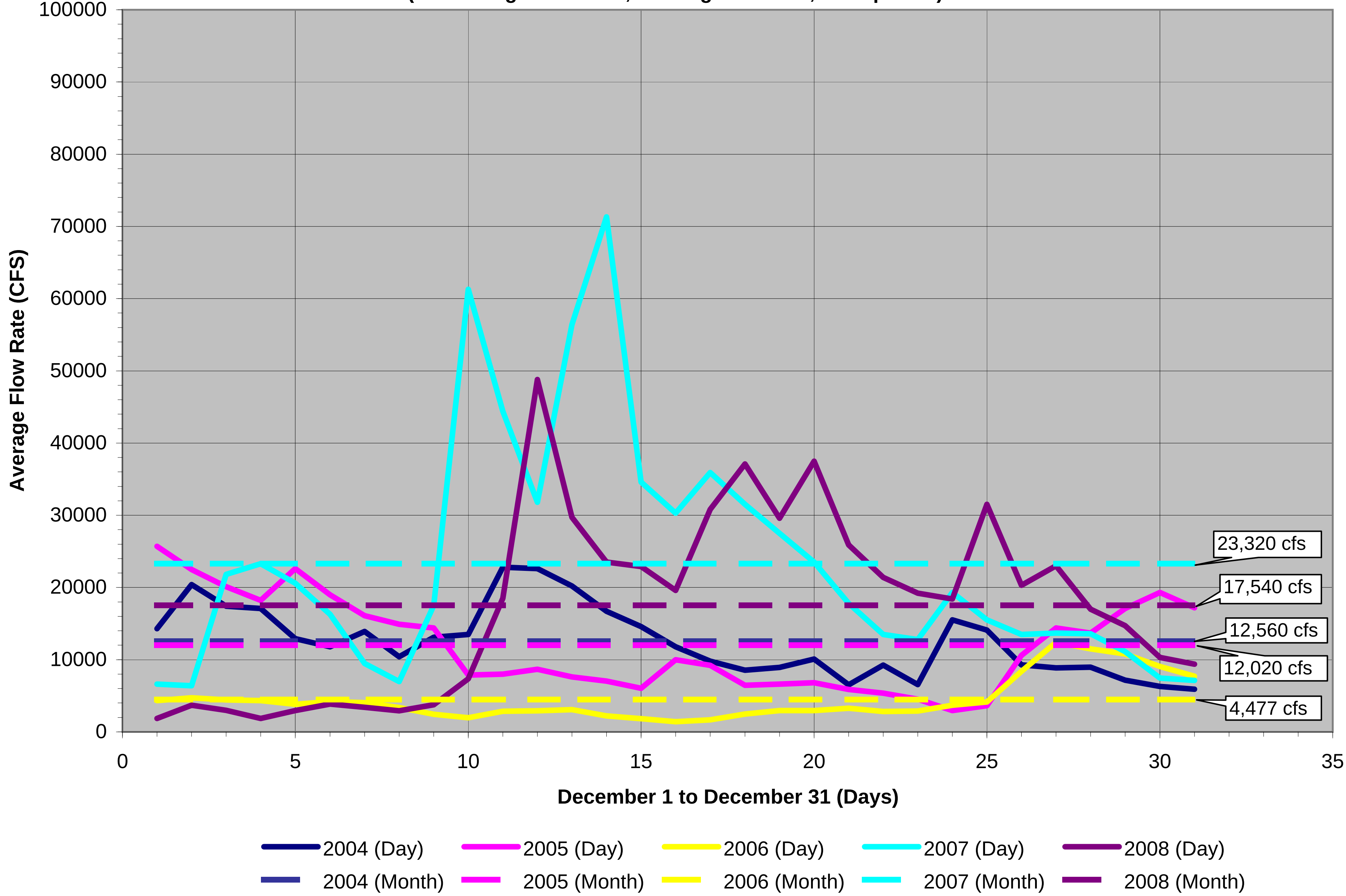
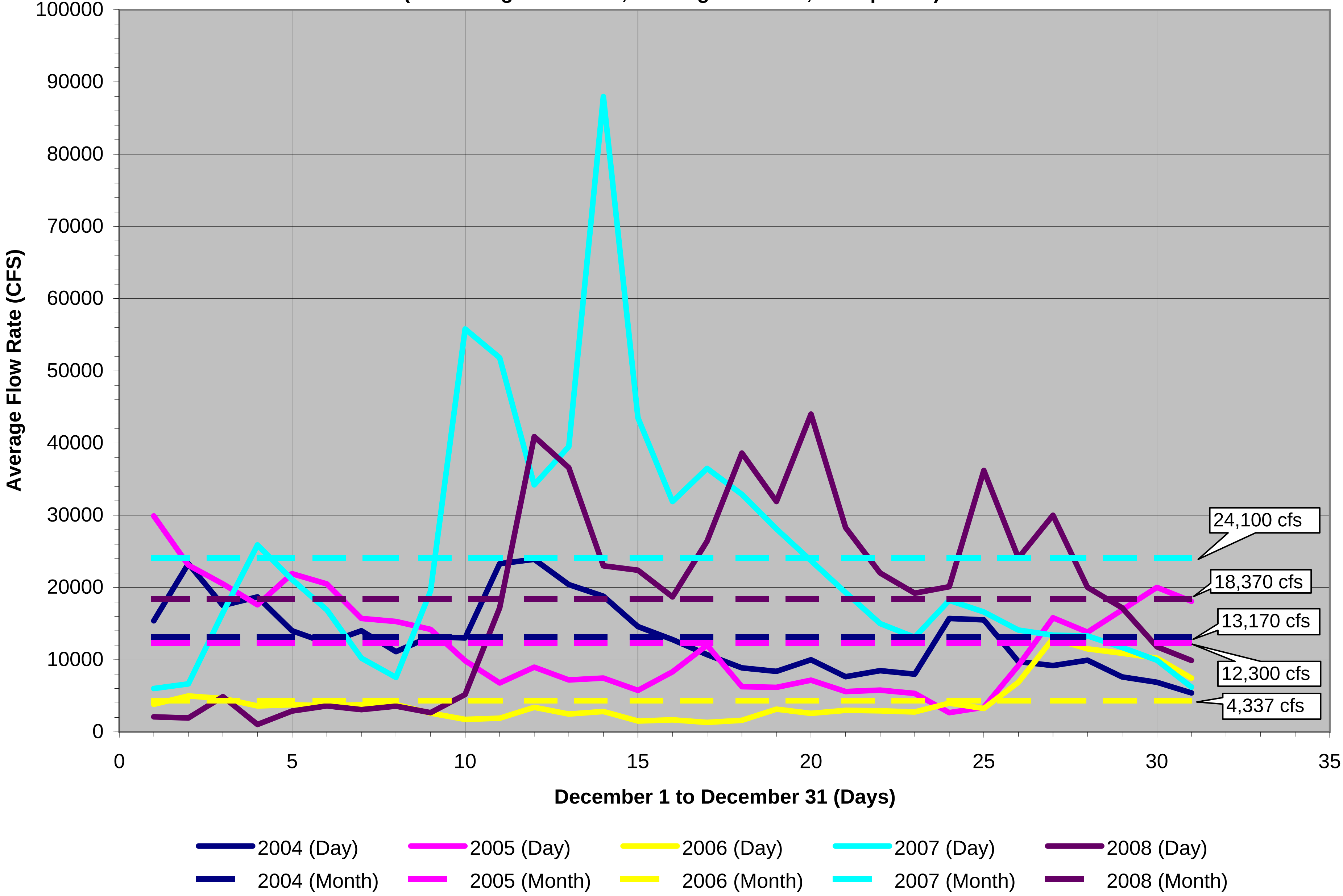


Figure 7
Comparison of Daily and Monthly Average December Flow Rates in the Monongahela River at Elizabeth, PA Over the Past Five Years
(USGS Gage 03075070; Drainage Area = 5,340 sq miles)



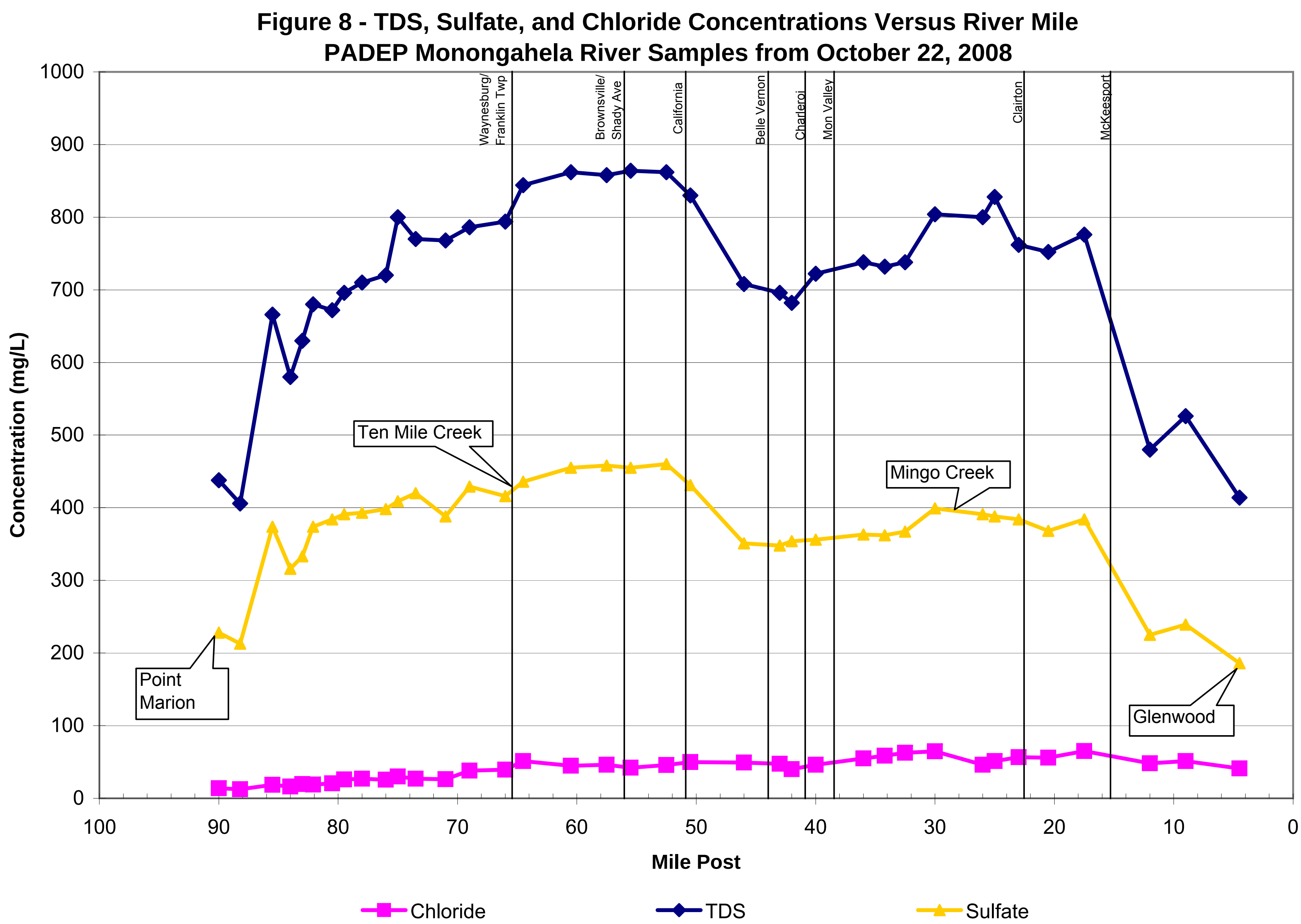


Figure 8 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from October 22, 2008
Concentration (mg/L)
Mile Post
1000
900
800
700
600
500
400
300
200
100
0
100
90
80
70
60
50
40
30
20
10
0
Waynesburg/ Franklin Twp
Brownsville/ Shady Ave
California
Belle Vernon
Charleroi
Mon Valley
Clairton
McKeesport
Ten Mile Creek
Mingo Creek
Point Marion
Glenwood
Chloride
TDS
Sulfate

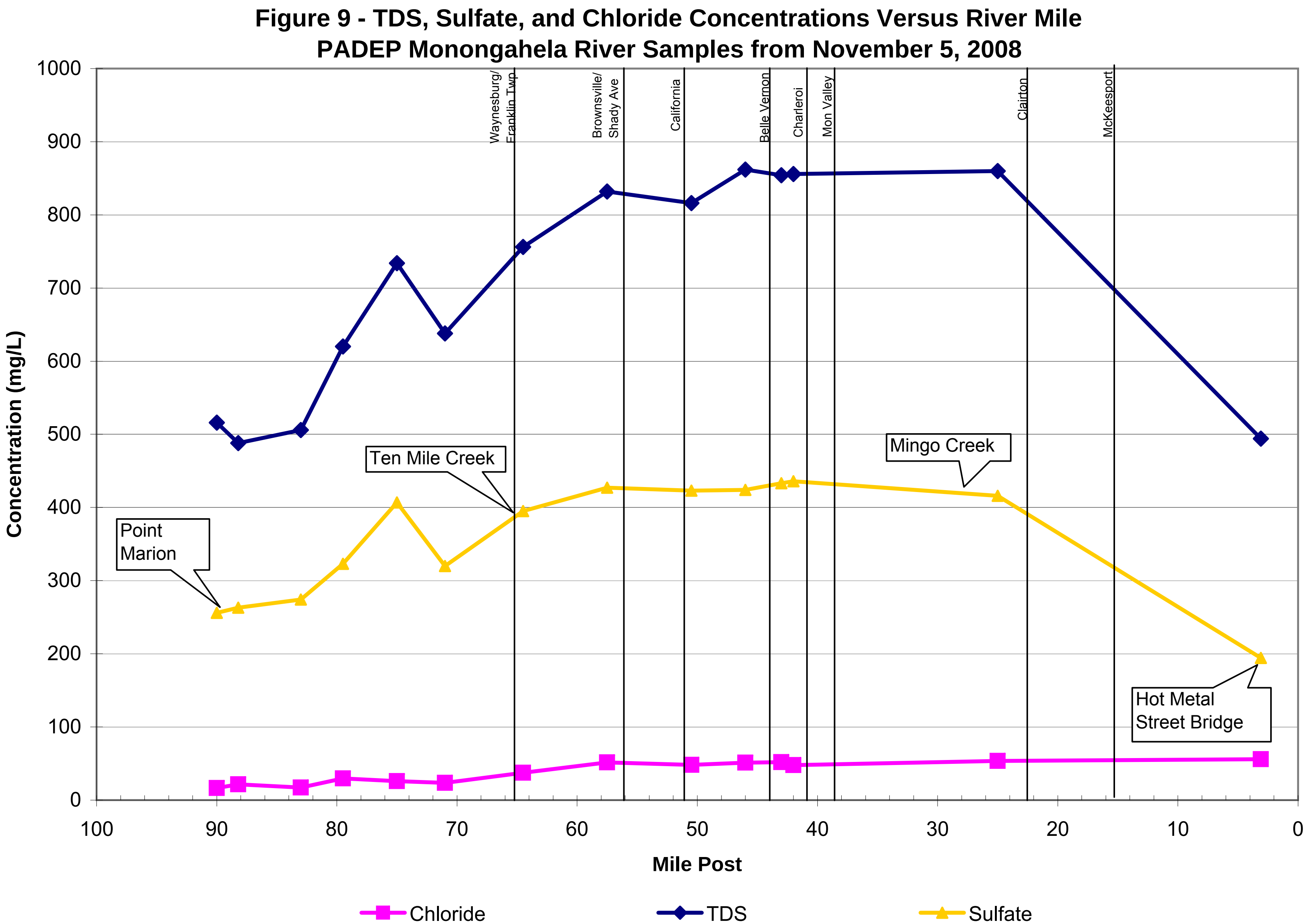
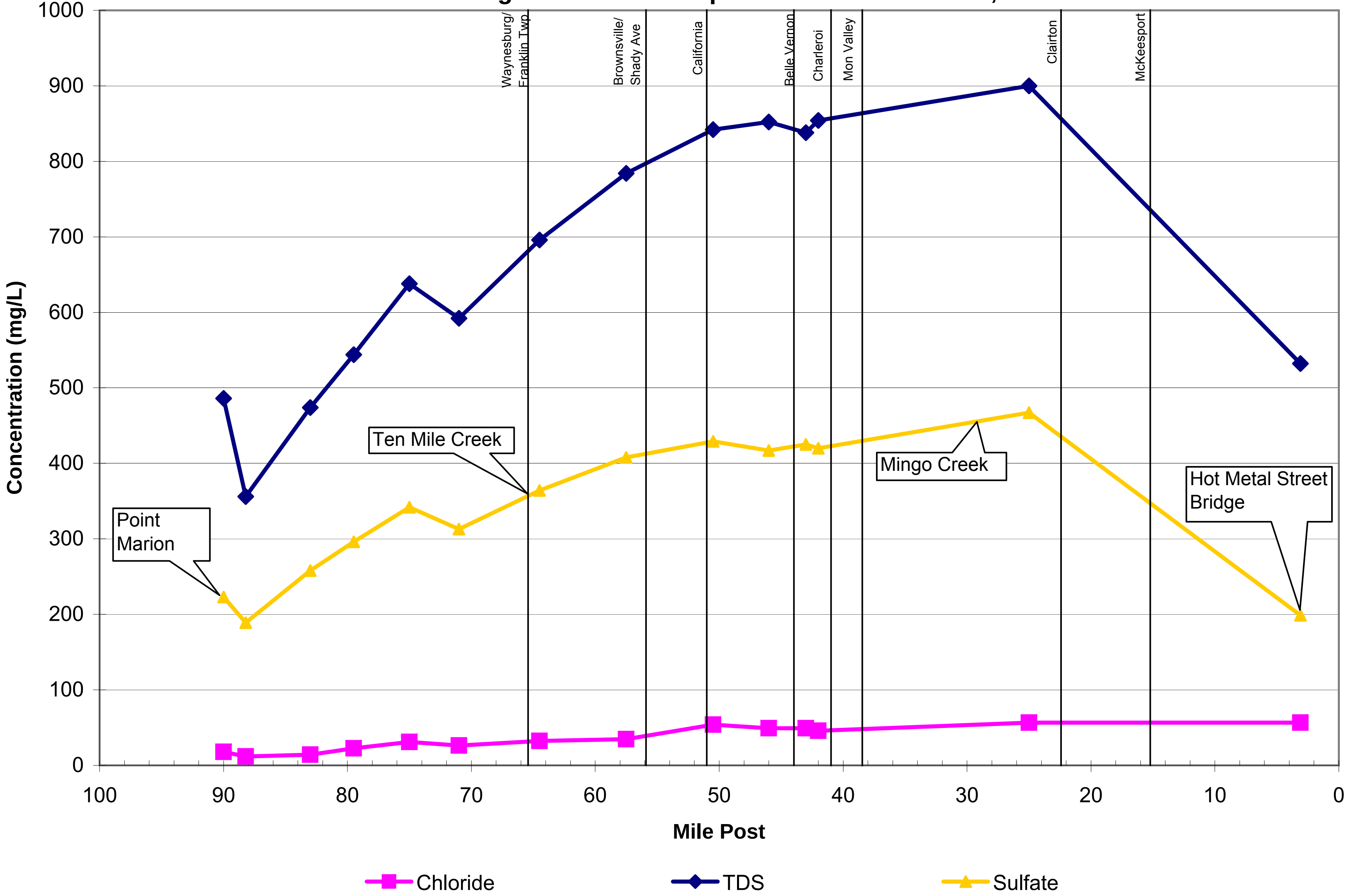


Figure 9 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from November 5, 2008
Concentration (mg/L)
1000
900
800
700
600
500
400
300
200
100
0
100
90
80
70
60
50
40
30
20
10
0
Mile Post
Waynesburg/ Franklin Twp
Brownsville/ Shady Ave
California
Belle Vernon
Charleroi
Mon Valley
Clairton
McKeesport
Point Marion
Ten Mile Creek
Mingo Creek
Hot Metal Street Bridge
Chloride
TDS
Sulfate

Figure 10 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from November 12, 2008



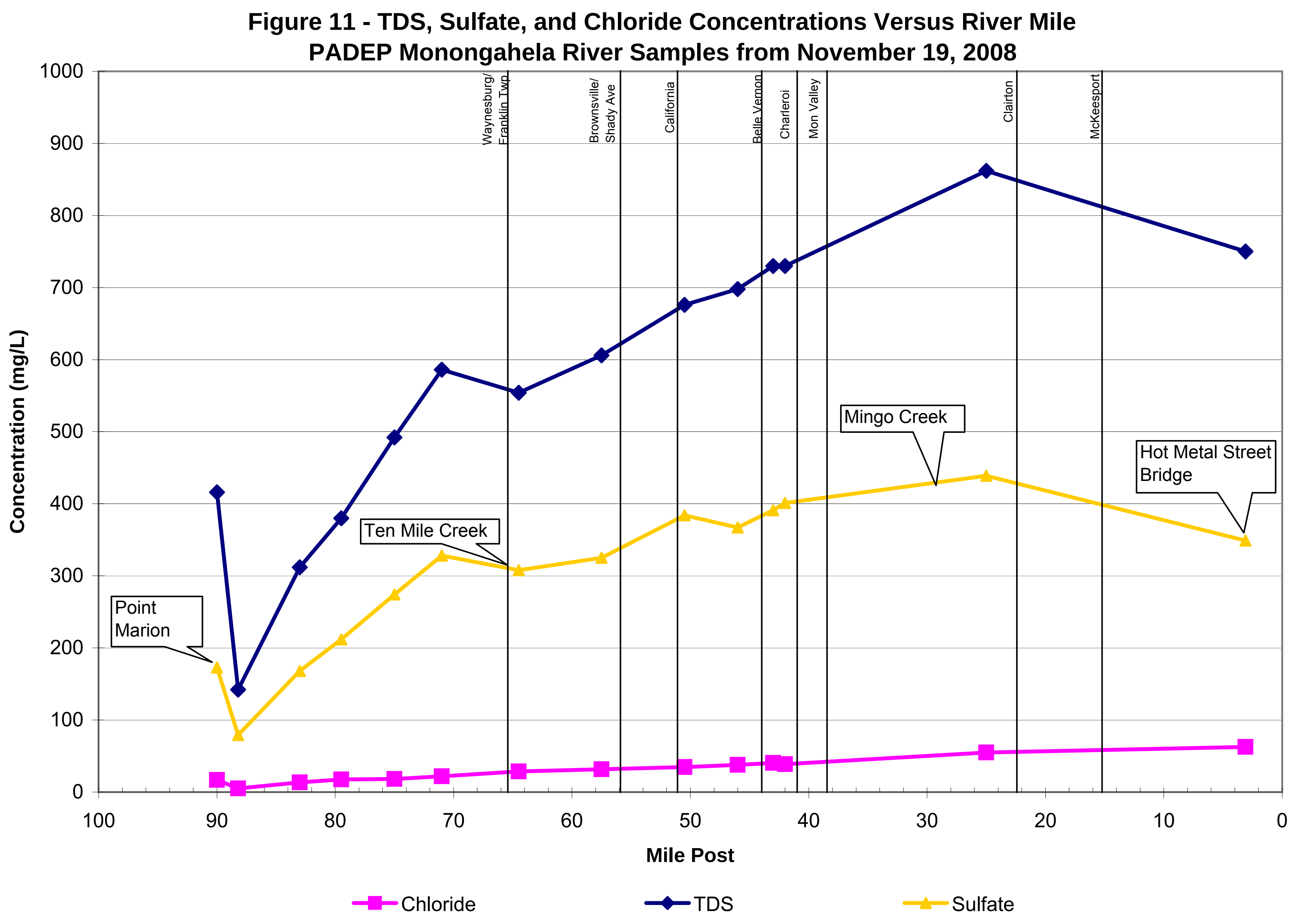
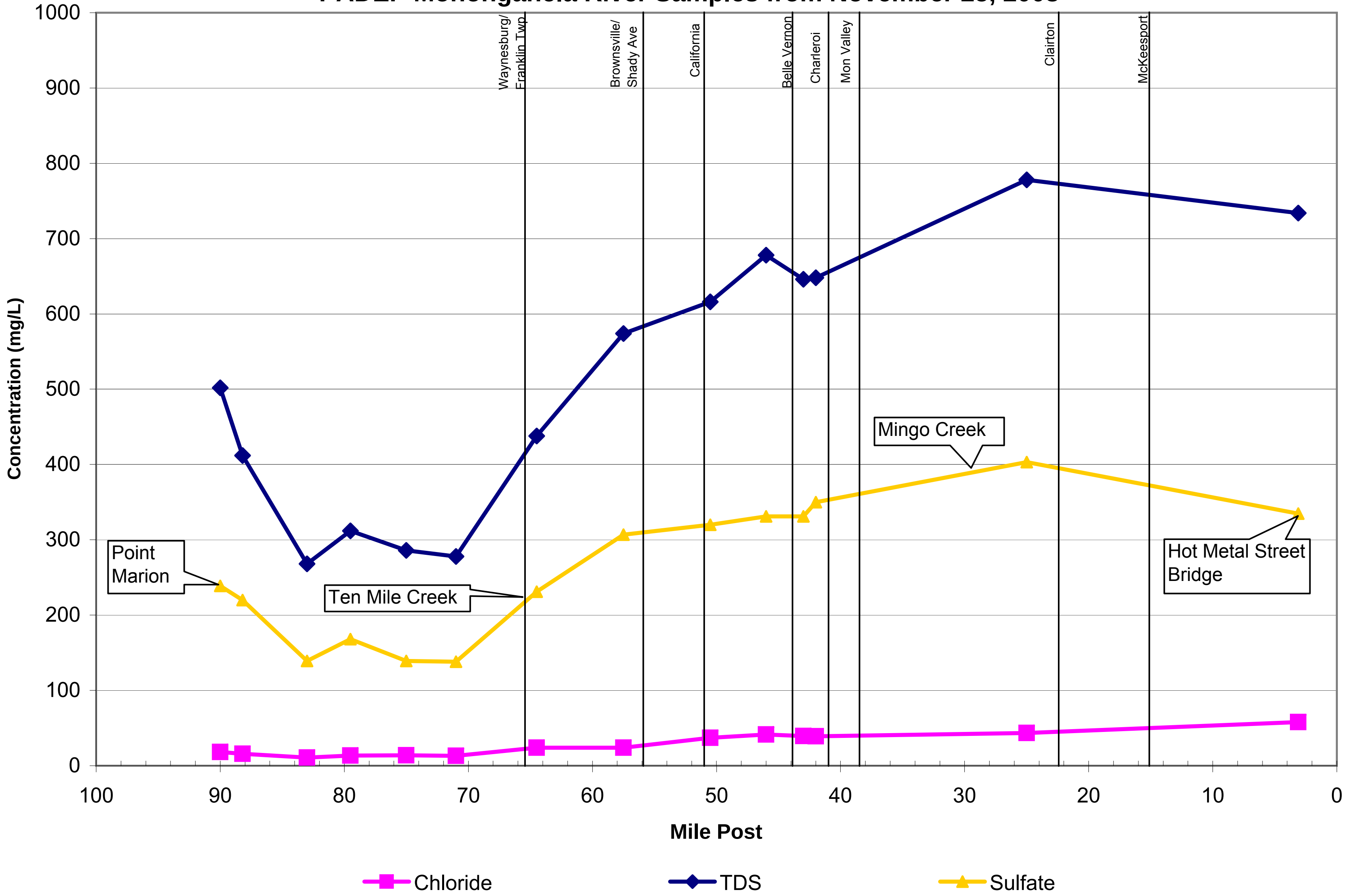


Figure 11 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from November 19, 2008
Concentration (mg/L)
Mile Post
1000
900
800
700
600
500
400
300
200
100
0
100
90
80
70
60
50
40
30
20
10
0
Waynesburg/ Franklin Twp
Brownsville/ Shady Ave
California
Belle Vernon
Charleroi
Mon Valley
Clairton
McKeesport
Point Marion
Ten Mile Creek
Mingo Creek
Hot Metal Street Bridge
Chloride
TDS
Sulfate

Figure 12 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from November 25, 2008



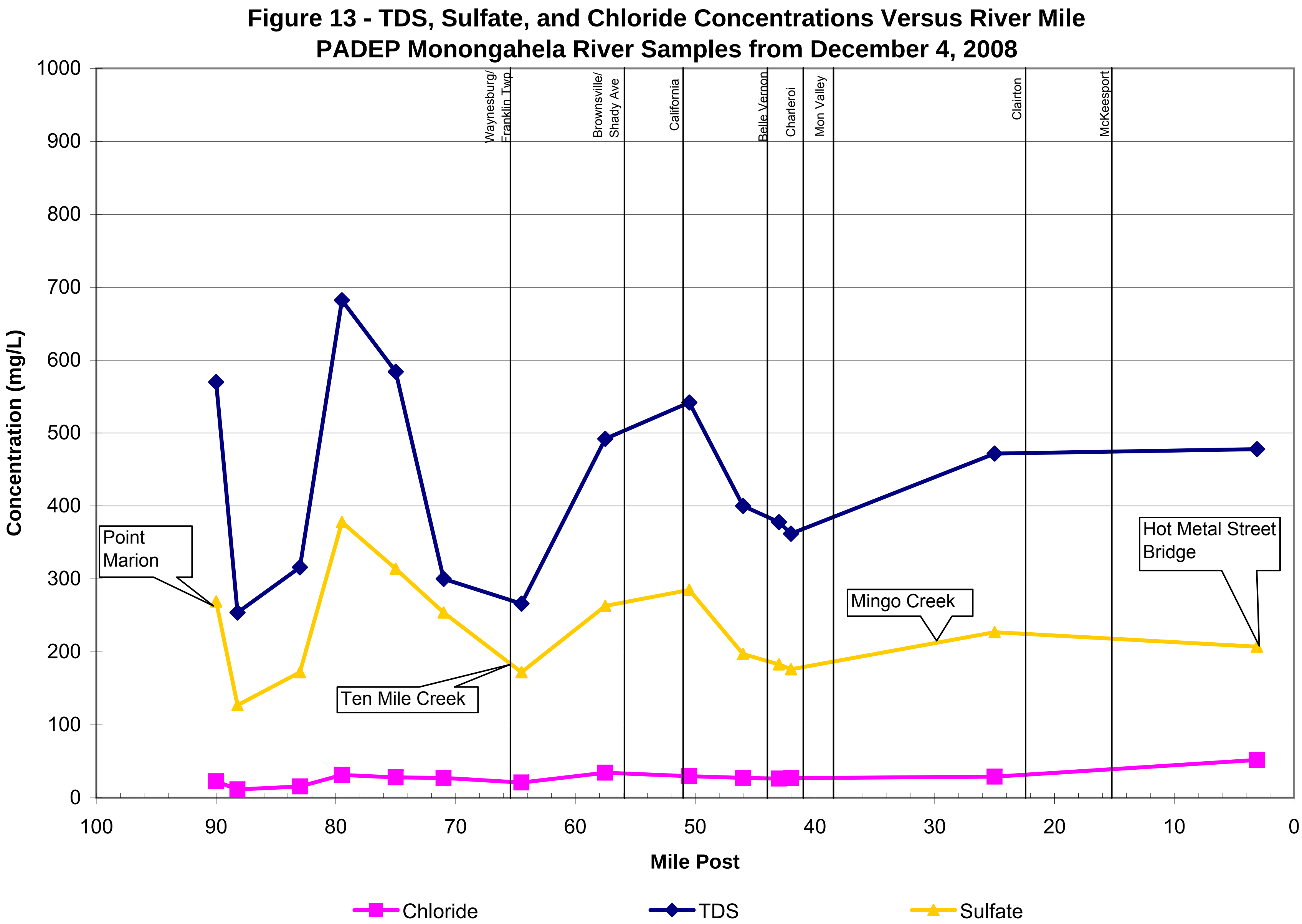


Figure 13 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from December 4, 2008
Concentration (mg/L)
1000
900
800
700
600
500
400
300
200
100
0
100
90
80
70
60
50
40
30
20
10
0
Mile Post
Waynesburg/ Franklin Twp
Brownsville/ Shady Ave
California
Belle Vernon
Charleroi
Mon Valley
Clairton
McKeesport
Point Marion
Ten Mile Creek
Mingo Creek
Hot Metal Street Bridge
Chloride
TDS
Sulfate

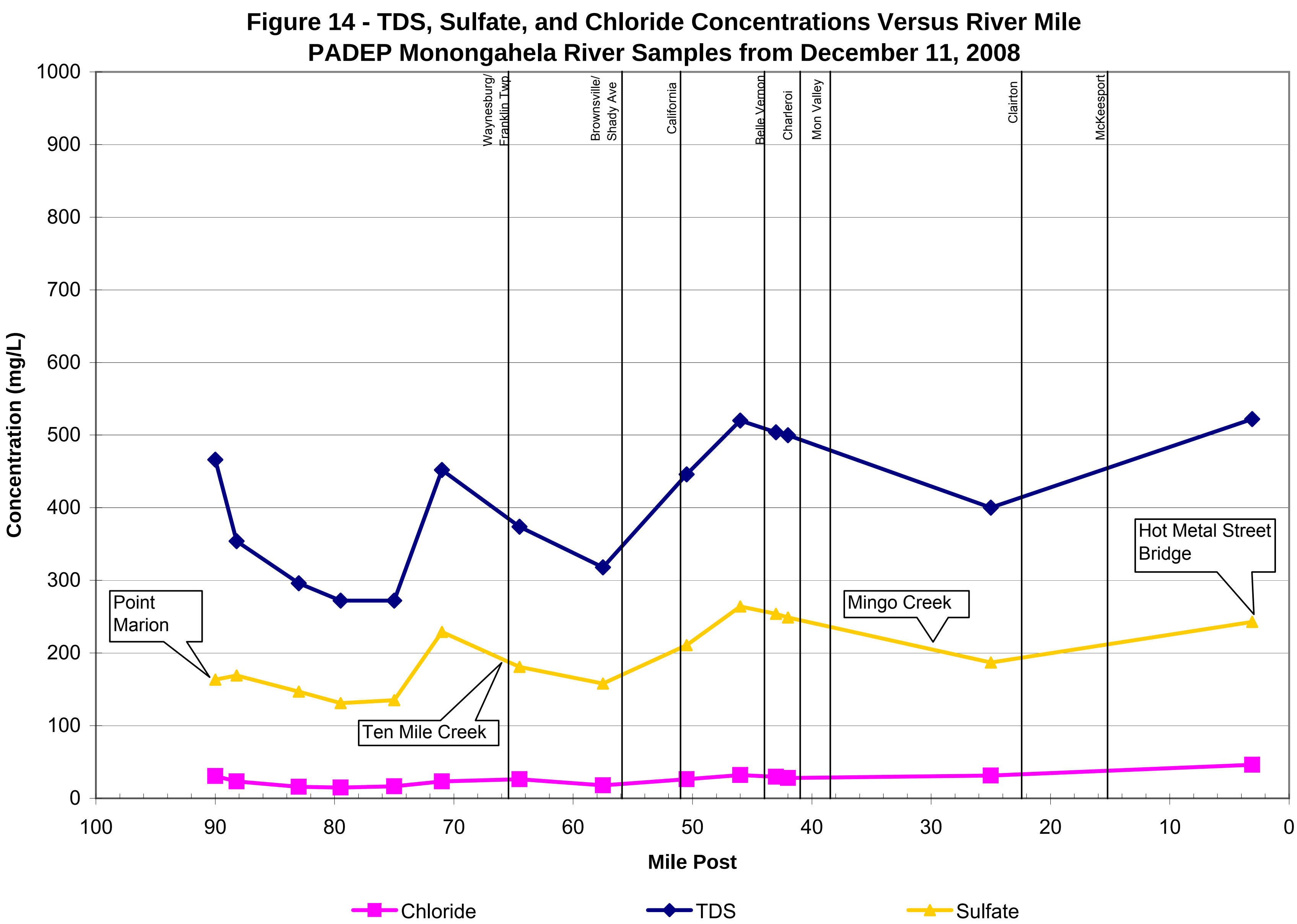


Figure 14 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from December 11, 2008
Concentration (mg/L)
1000
900
800
700
600
500
400
300
200
100
0
100
90
80
70
60
50
40
30
20
10
0
Mile Post
Waynesburg/ Franklin Twp
Brownsville/ Shady Ave
California
Belle Vernon
Charleroi
Mon Valley
Clairton
McKeesport
Point Marion
Ten Mile Creek
Mingo Creek
Hot Metal Street Bridge
Chloride
TDS
Sulfate

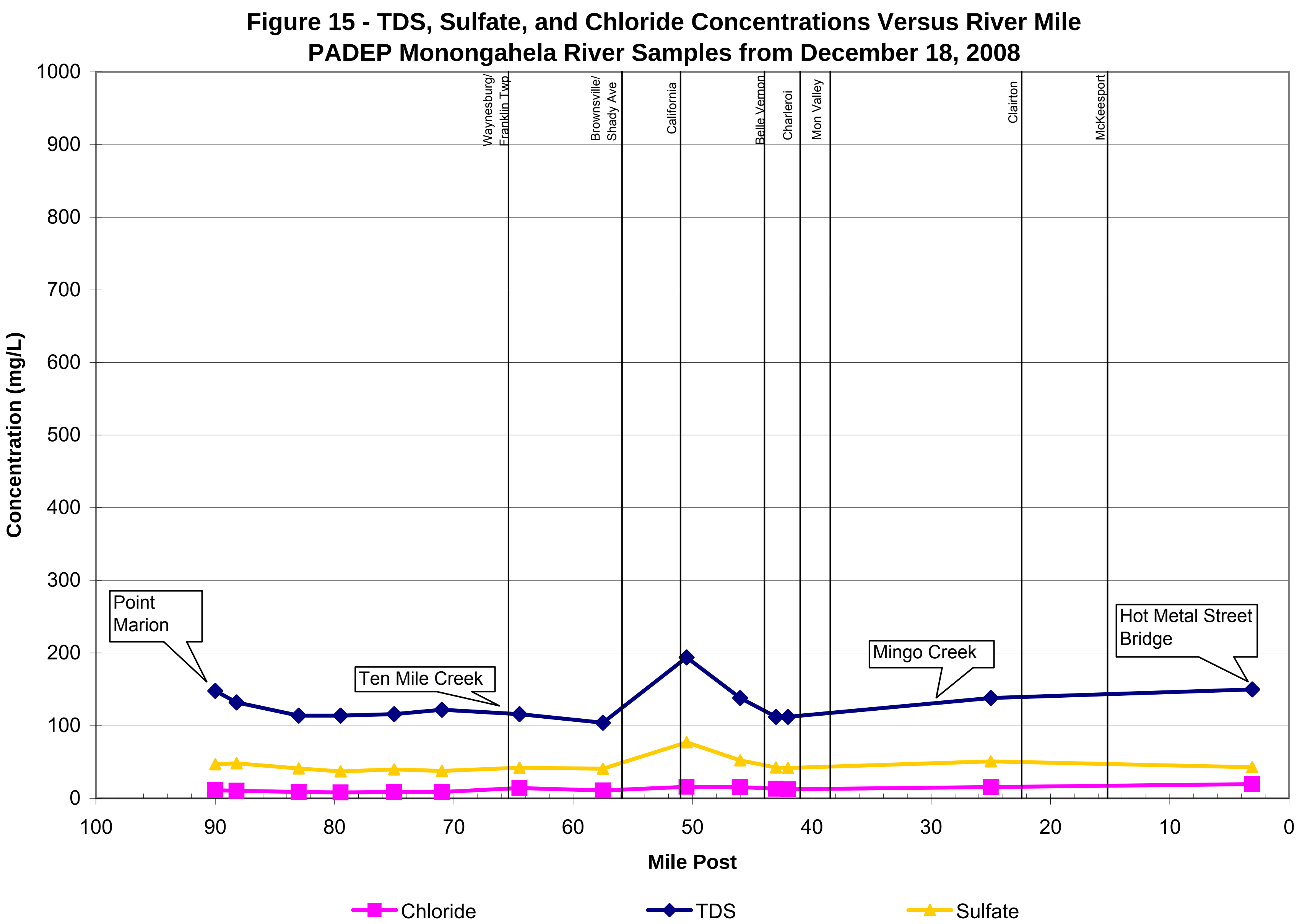


Figure 15 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from December 18, 2008
Concentration (mg/L)
1000
900
800
700
600
500
400
300
200
100
0
Waynesburg/ Franklin Twp
Brownsville/ Shady Ave
California
Belle Vernon
Charleroi
Mon Valley
Clairton
McKeesport
Point Marion
Ten Mile Creek
Mingo Creek
Hot Metal Street Bridge
100
90
80
70
60
50
40
30
20
10
0
Mile Post
Chloride
TDS
Sulfate

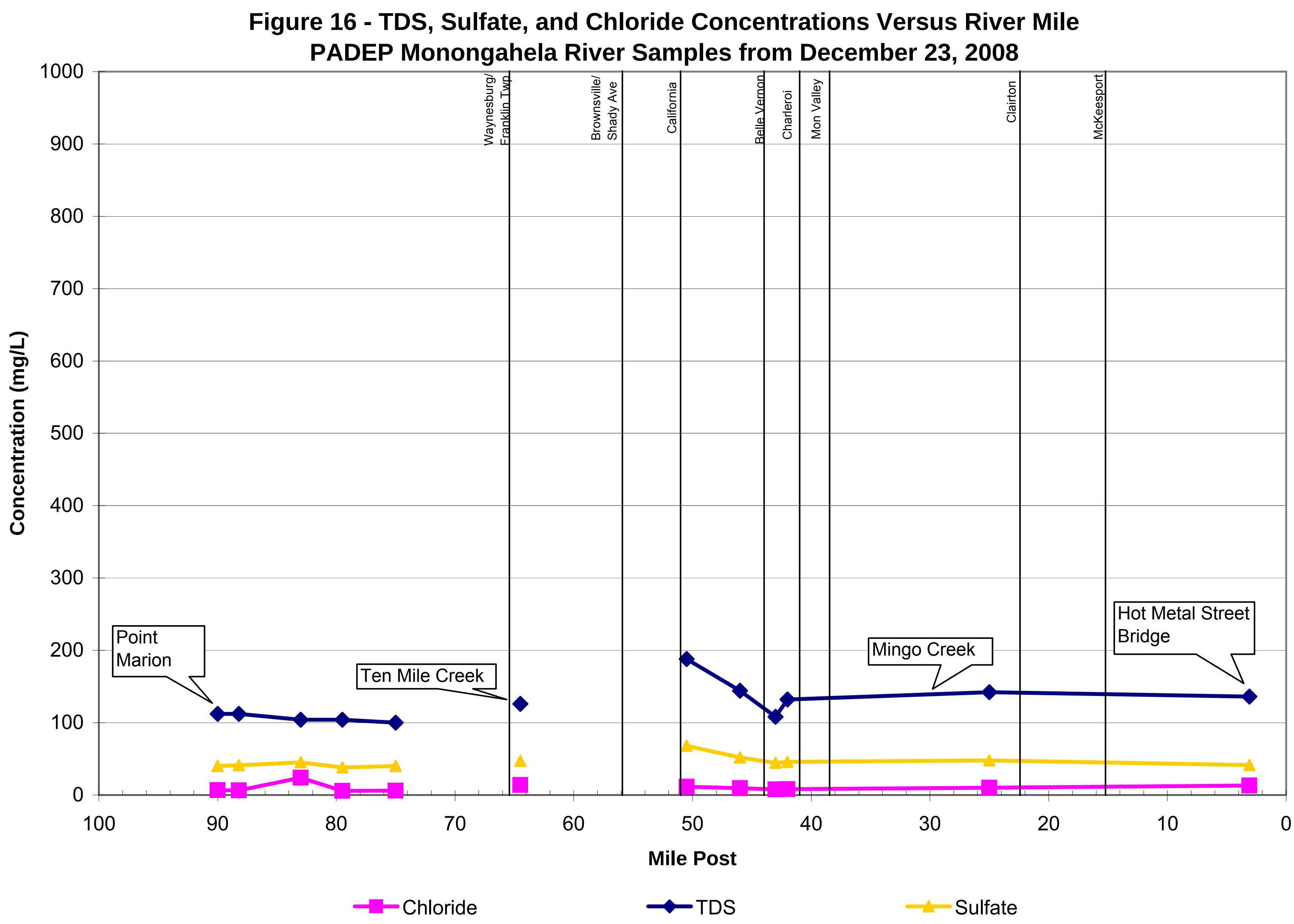


Figure 16 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from December 23, 2008
Concentration (mg/L)
1000
900
800
700
600
500
400
300
200
100
0
100
90
80
70
60
50
40
30
20
10
0
Mile Post
Waynesburg/ Franklin Twp
Brownsville/ Shady Ave
California
Belle Vernon
Charleroi
Mon Valley
Clairton
McKeesport
Point Marion
Ten Mile Creek
Mingo Creek
Hot Metal Street Bridge
Chloride
TDS
Sulfate

Figure 17 - TDS, Sulfate, and Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples from December 30, 2008

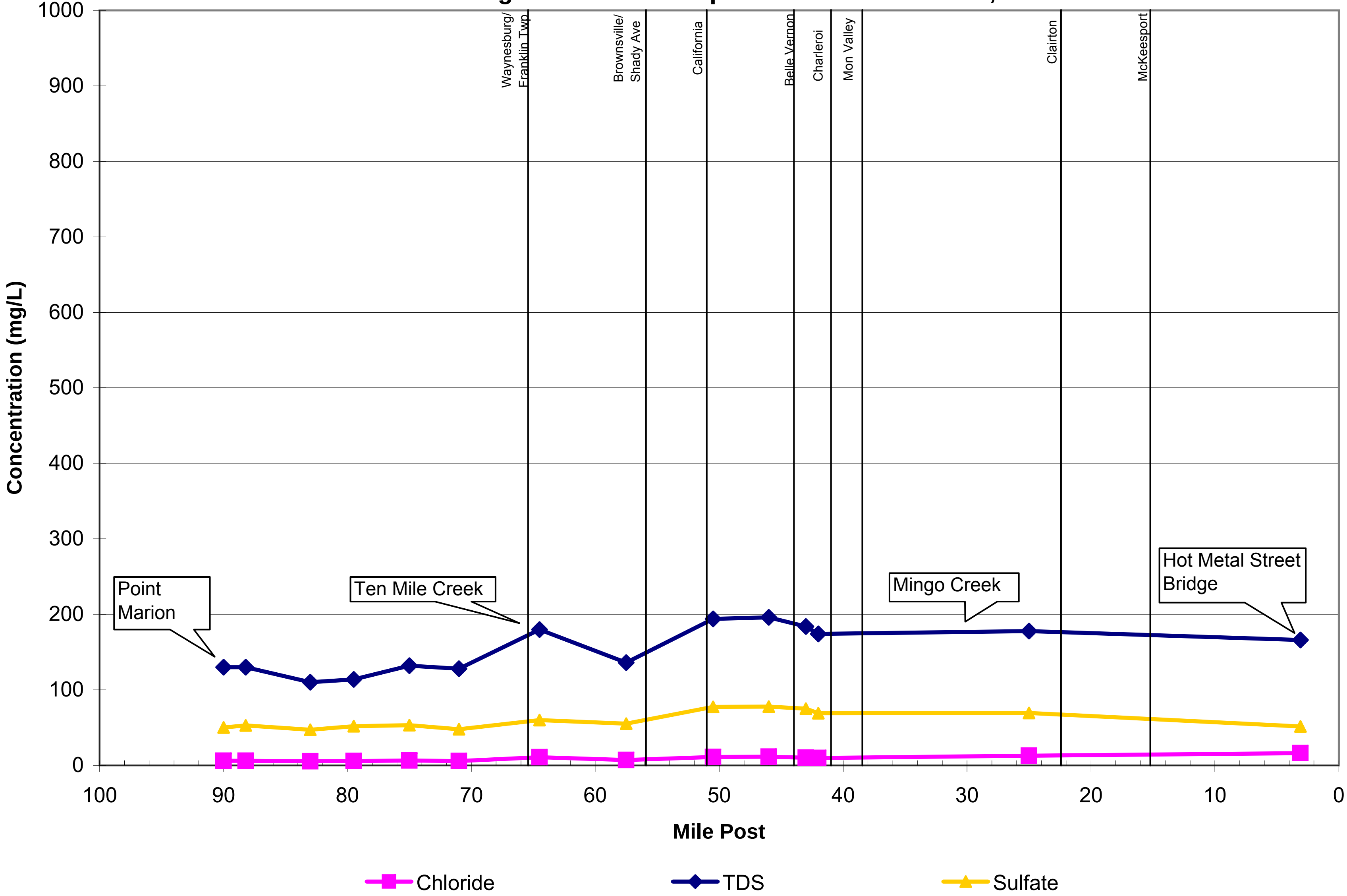
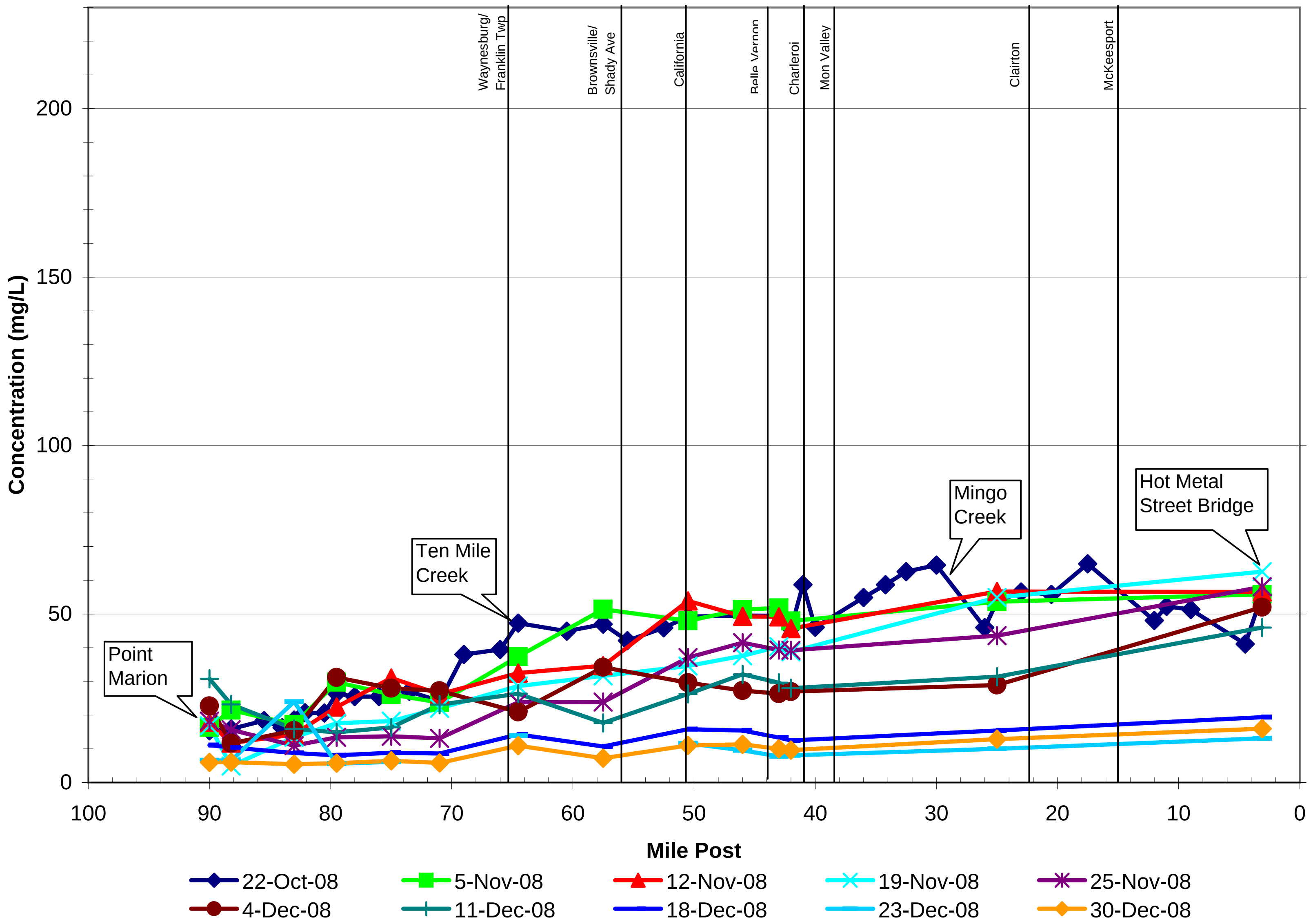


Figure 18 - Chloride Concentrations Versus River Mile
PADEP Monongahela River Samples



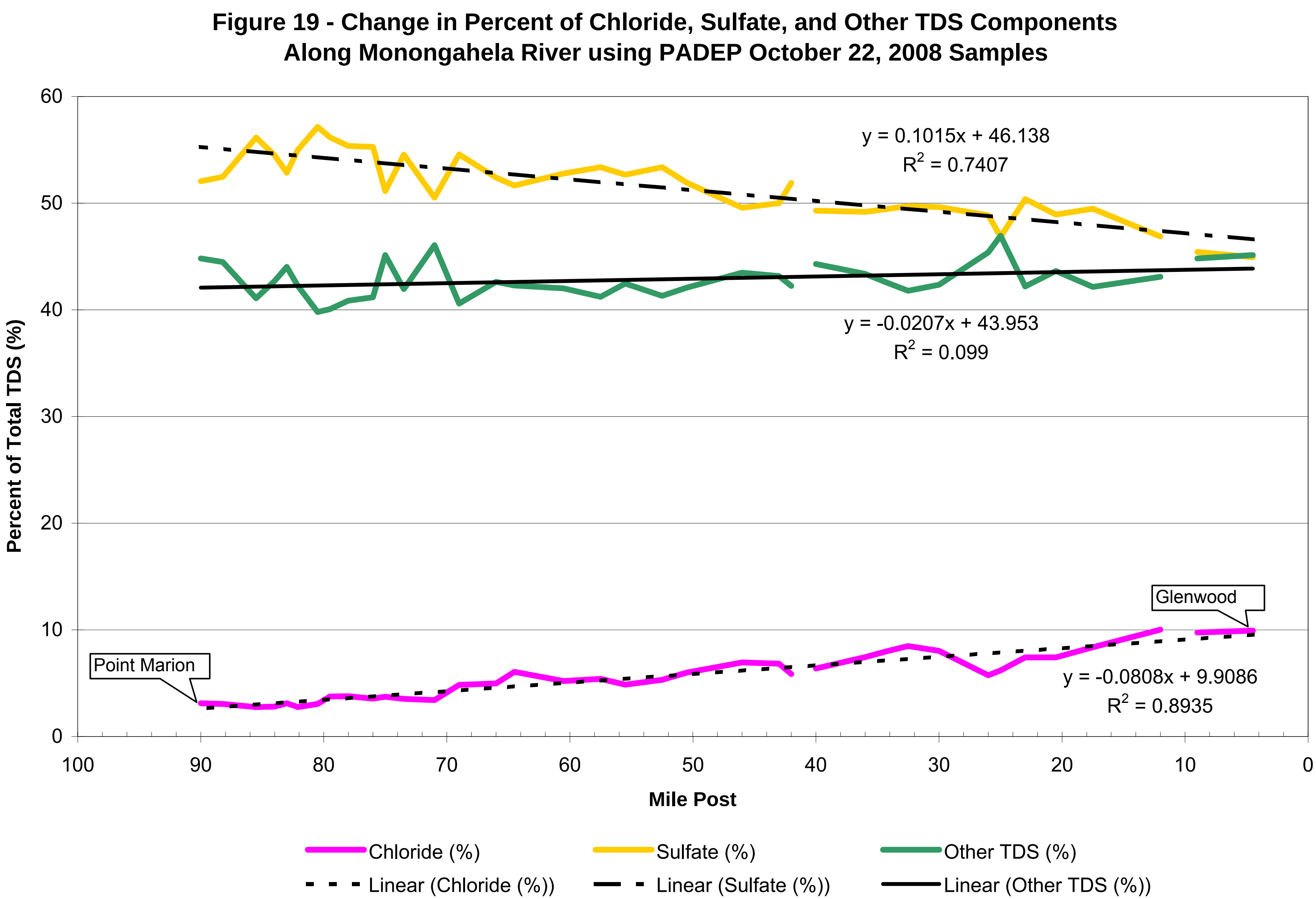
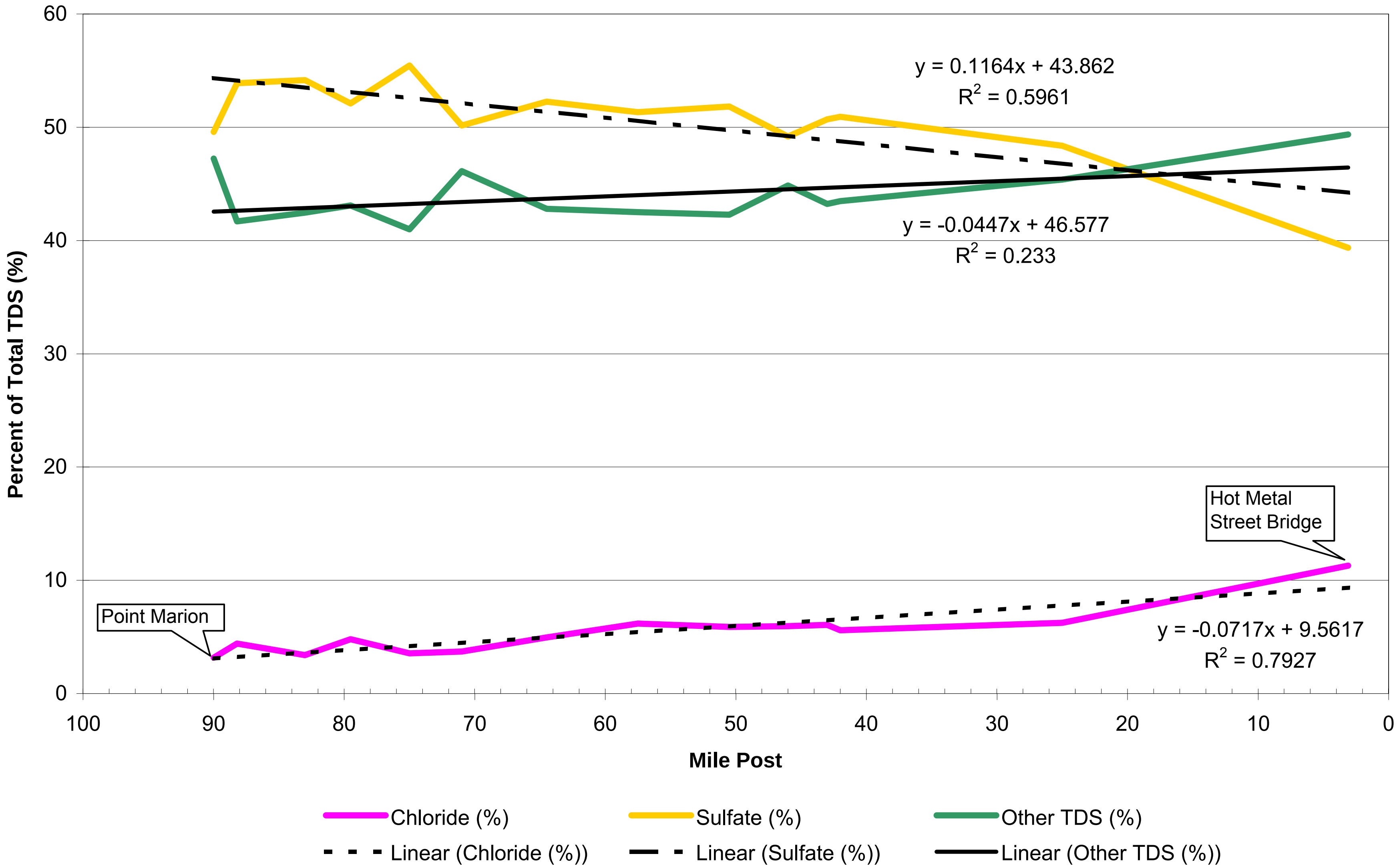


Figure 19 - Change in Percent of Chloride, Sulfate, and Other TDS Components
Along Monongahela River using PADEP October 22, 2008 Samples
Percent of Total TDS (%)
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0
Mile Post
y = 0.1015x + 46.138
R2 = 0.7407
y = -0.0207x + 43.953
R2 = 0.099
y = -0.0808x + 9.9086
R2 = 0.8935
Point Marion
Glenwood
Chloride (%)
Sulfate (%)
Other TDS (%)
Linear (Chloride (%))
Linear (Sulfate (%))
Linear (Other TDS (%))

Figure 20 - Change in Percent of Chloride, Sulfate, and Other TDS Components Along Monongahela River using PADEP November 5, 2008 Samples



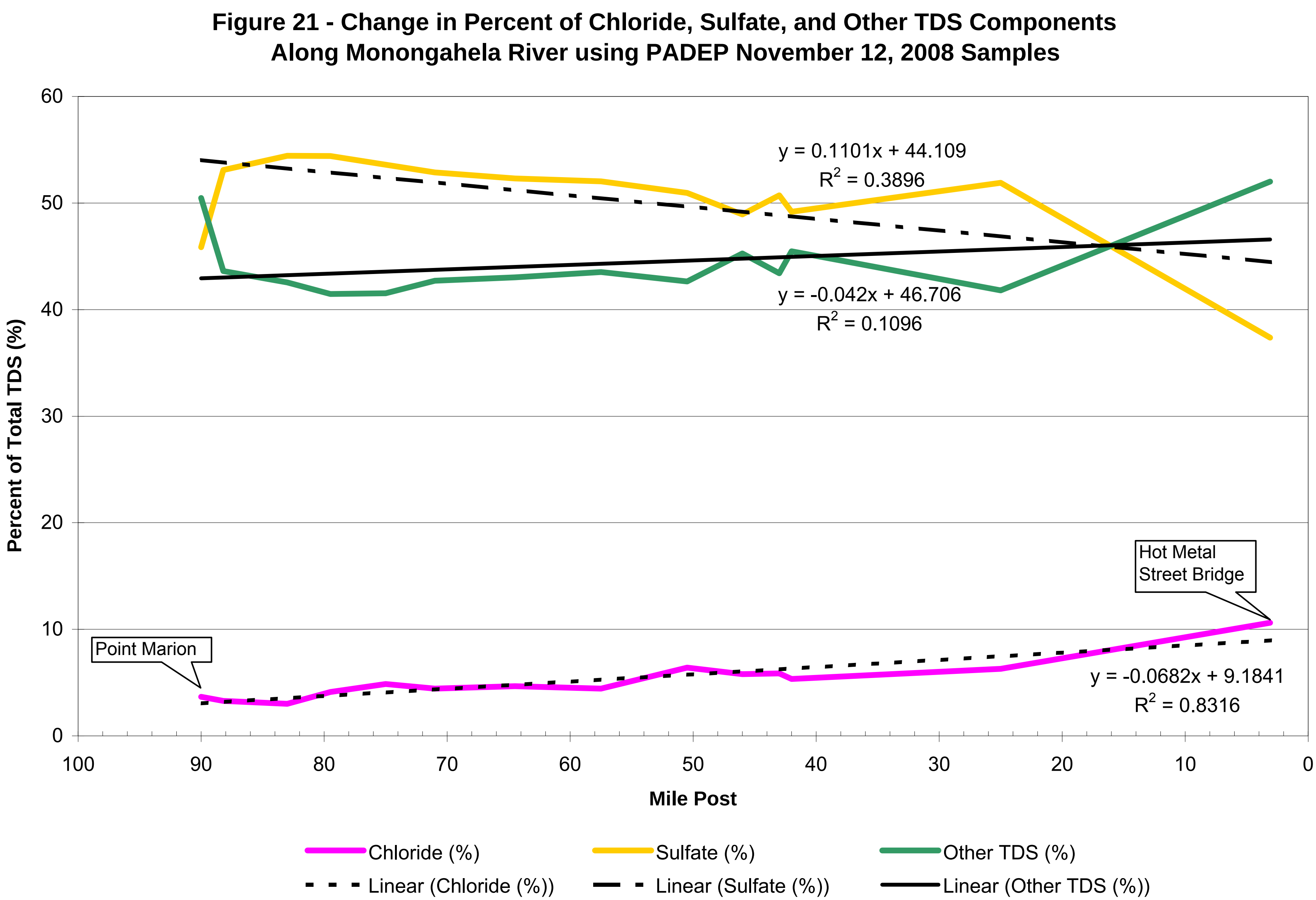


Figure 21 - Change in Percent of Chloride, Sulfate, and Other TDS Components
Along Monongahela River using PADEP November 12, 2008 Samples
Percent of Total TDS (%)
Mile Post
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0
y = 0.1101x + 44.109
R2 = 0.3896
y = -0.042x + 46.706
R2 = 0.1096
y = -0.0682x + 9.1841
R2 = 0.8316
Hot Metal
Street Bridge
Point Marion
Chloride (%)
Sulfate (%)
Other TDS (%)
Linear (Chloride (%))
Linear (Sulfate (%))
Linear (Other TDS (%))

Figure 22 - Change in Percent of Chloride, Sulfate, and Other TDS Components Along Monongahela River using PADEP November 19, 2008 Samples

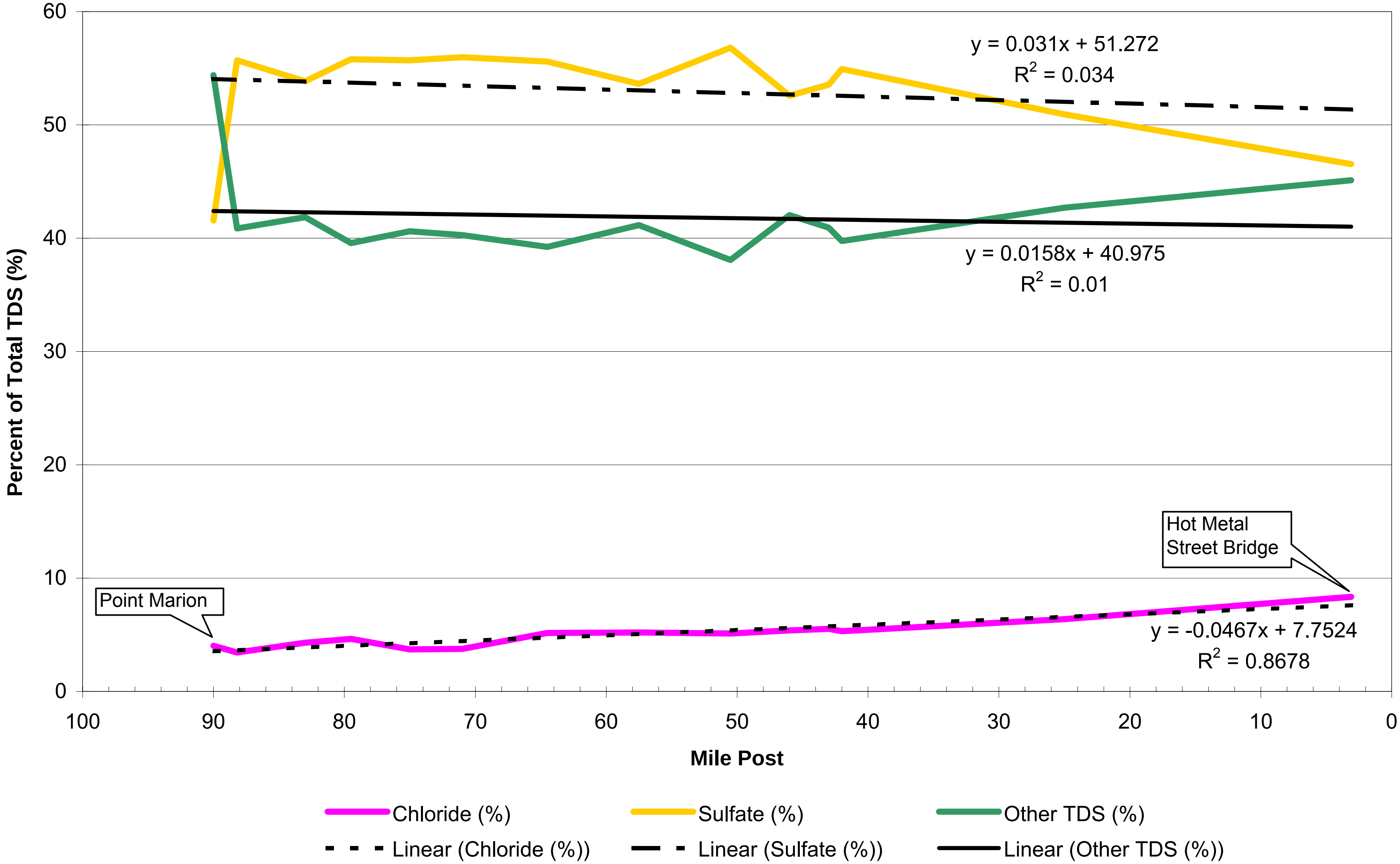
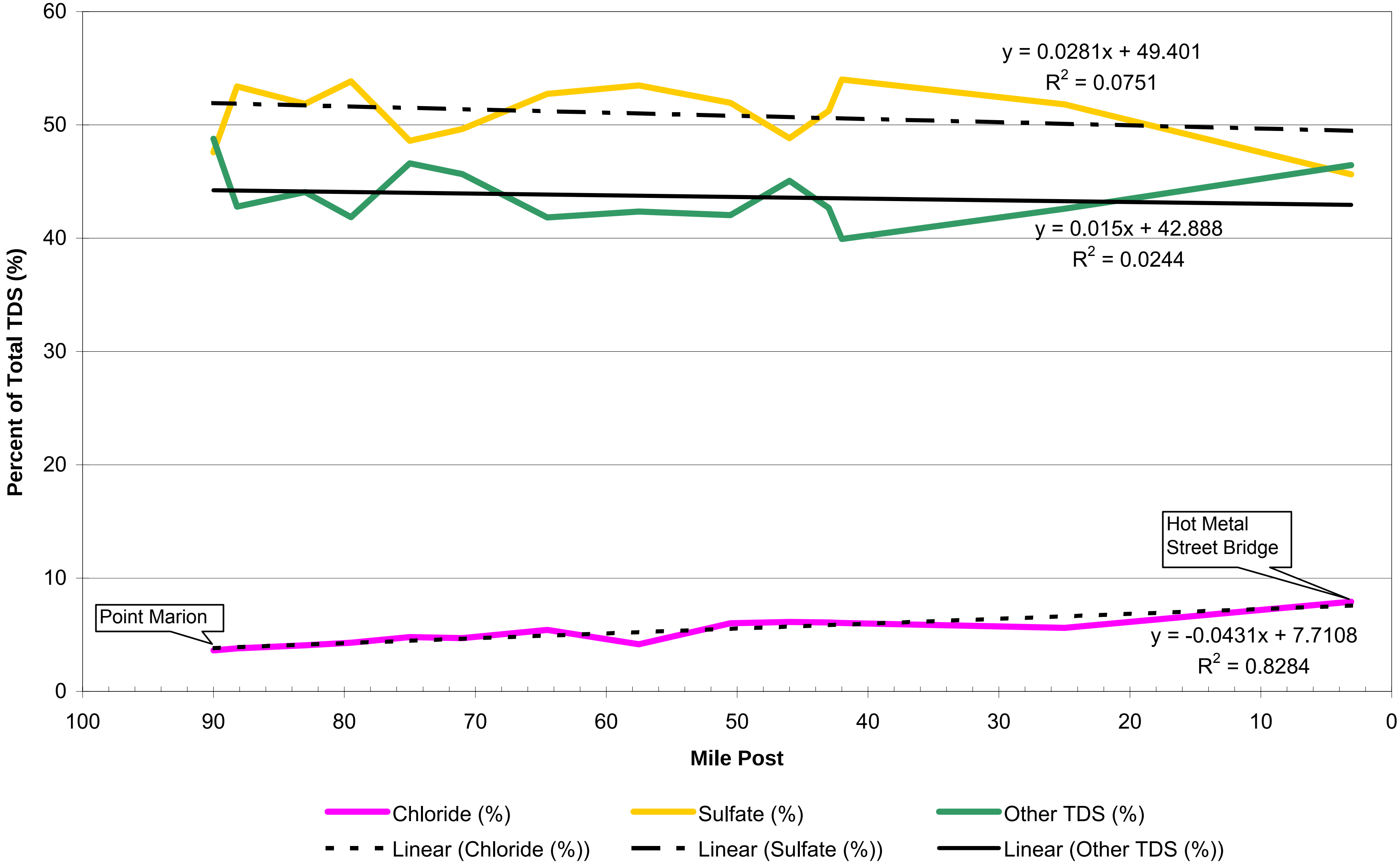


Figure 23 - Change in Percent of Chloride, Sulfate, and Other TDS Components Along Monongahela River using PADEP November 25, 2008 Samples



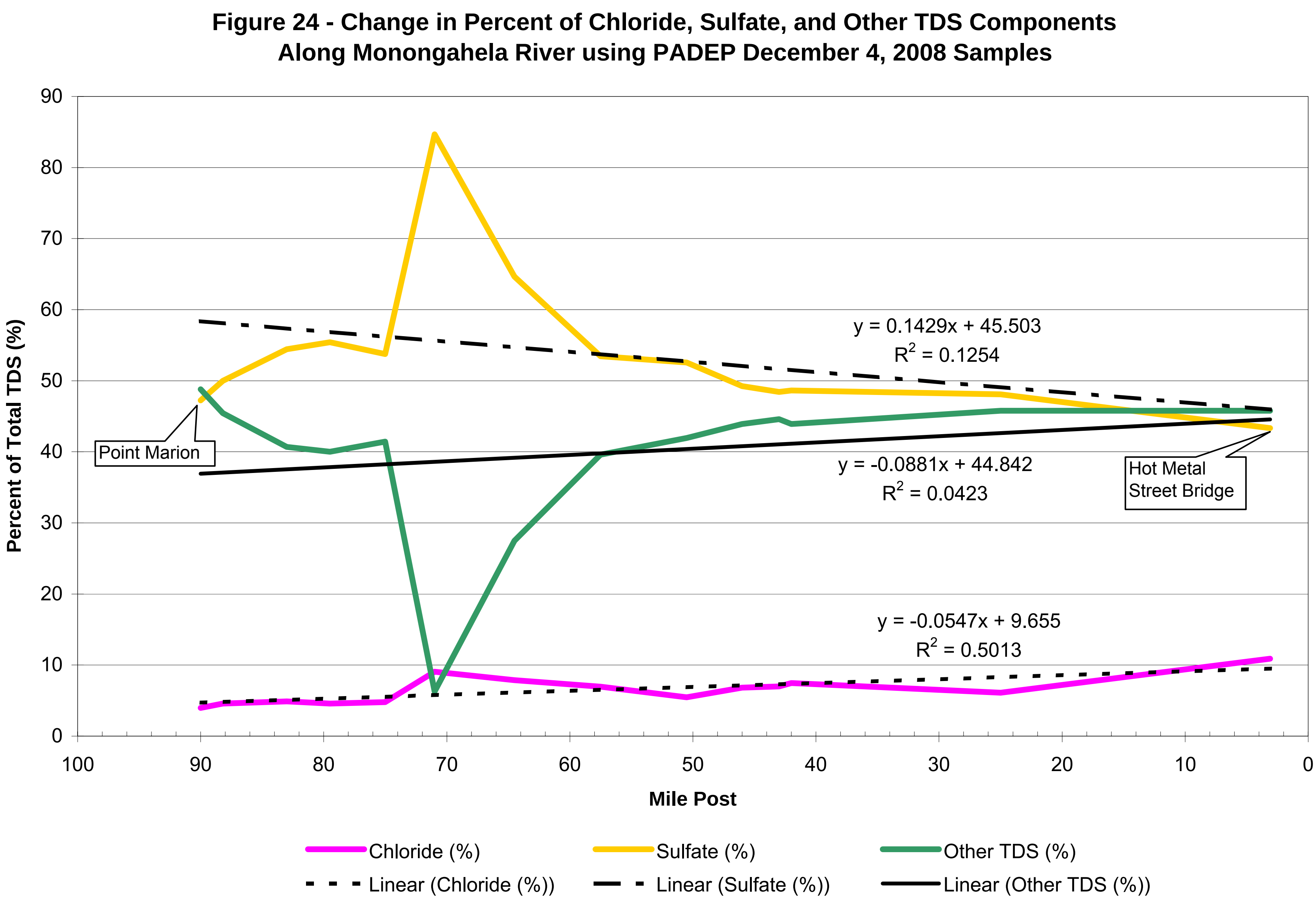


Figure 24 - Change in Percent of Chloride, Sulfate, and Other TDS Components
Along Monongahela River using PADEP December 4, 2008 Samples
Percent of Total TDS (%)
Mile Post
y = 0.1429x + 45.503
R^2 = 0.1254
y = -0.0881x + 44.842
R^2 = 0.0423
y = -0.0547x + 9.655
R^2 = 0.5013
Point Marion
Hot Metal Street Bridge
Chloride (%)
Sulfate (%)
Other TDS (%)
Linear (Chloride (%))
Linear (Sulfate (%))
Linear (Other TDS (%))

Figure 25 - Change in Percent of Chloride, Sulfate, and Other TDS Components Along Monongahela River using PADEP December 11, 2008 Samples

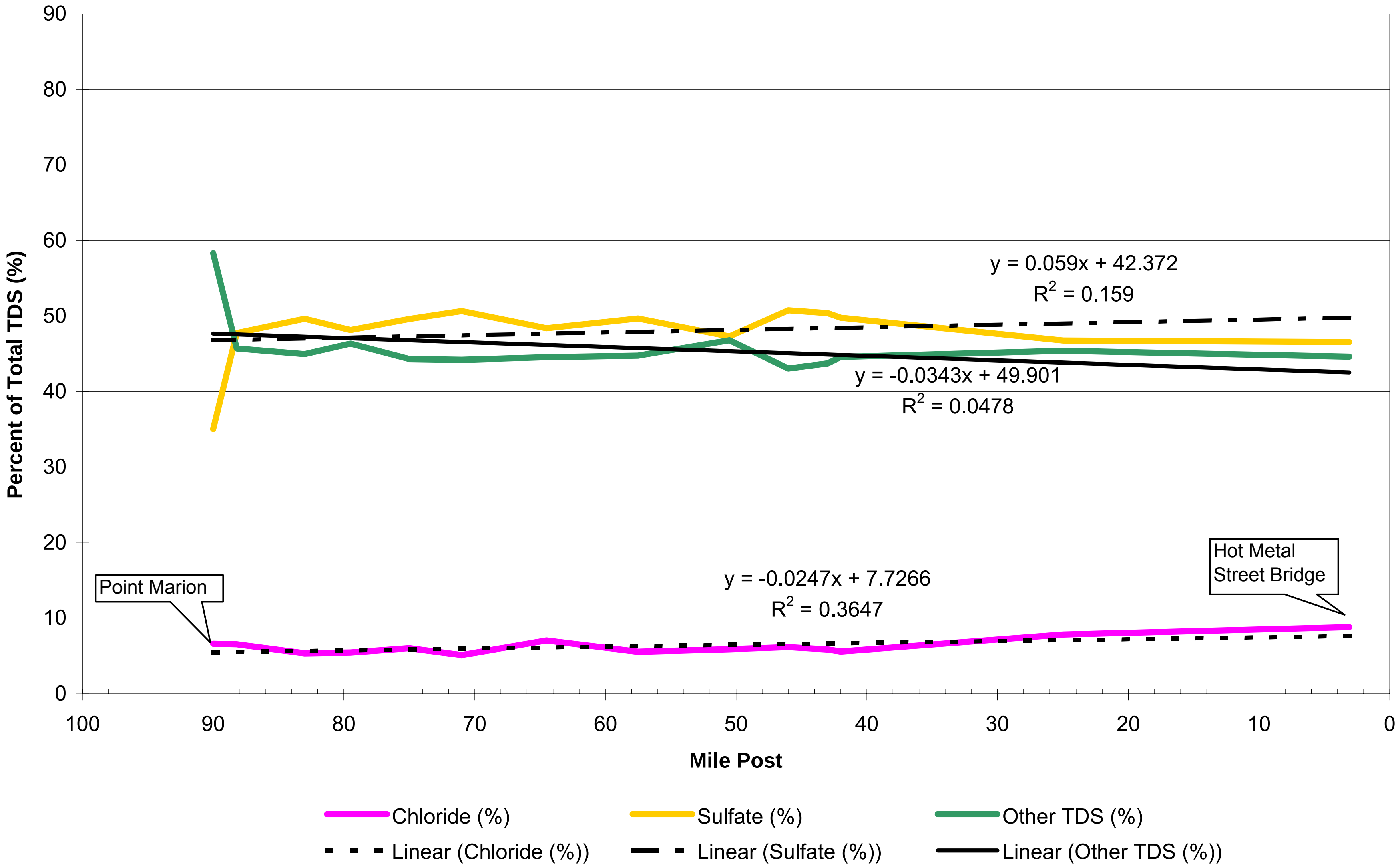
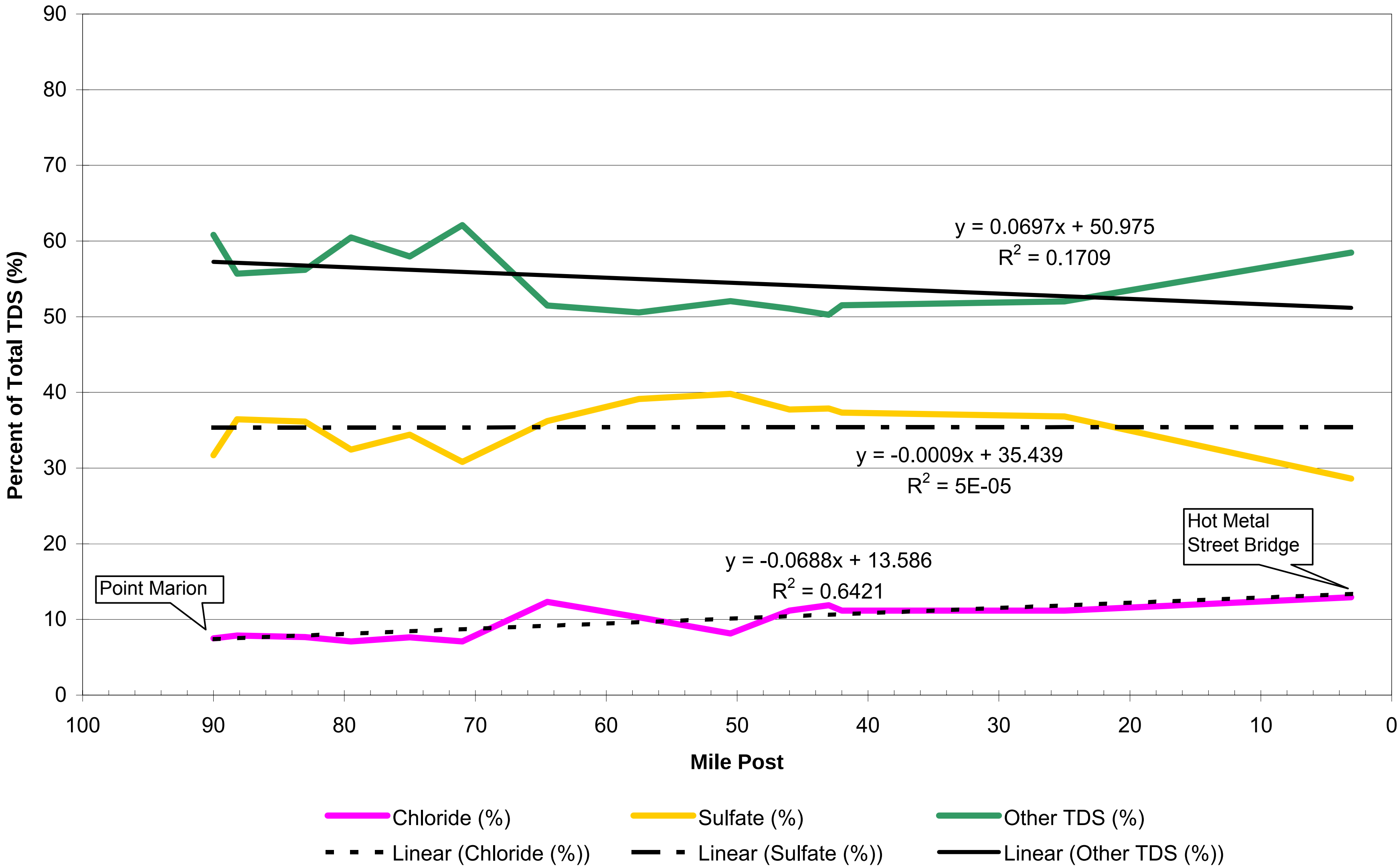


Figure 26 - Change in Percent of Chloride, Sulfate, and Other TDS Components Along Monongahela River using PADEP December 18, 2008 Samples



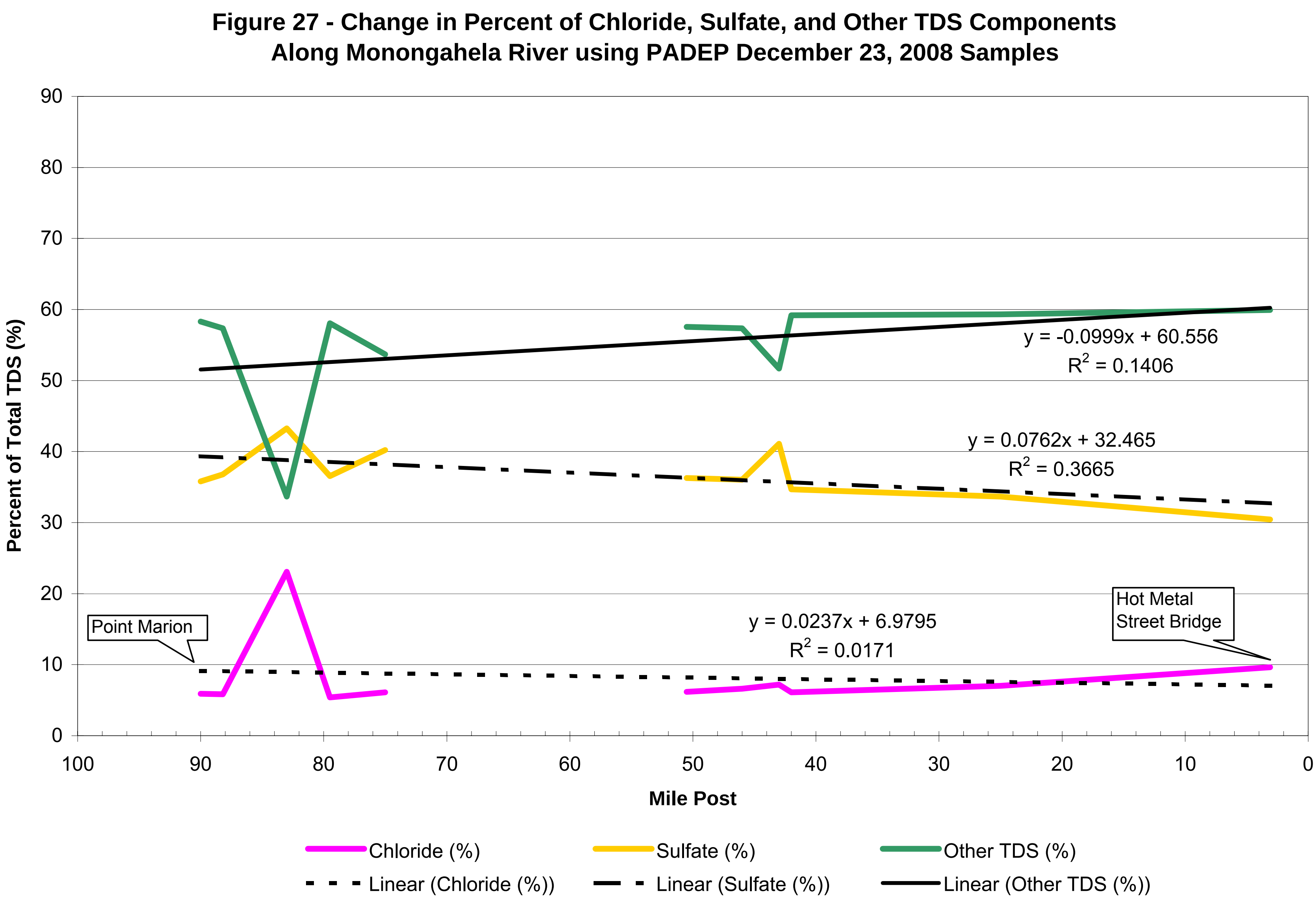
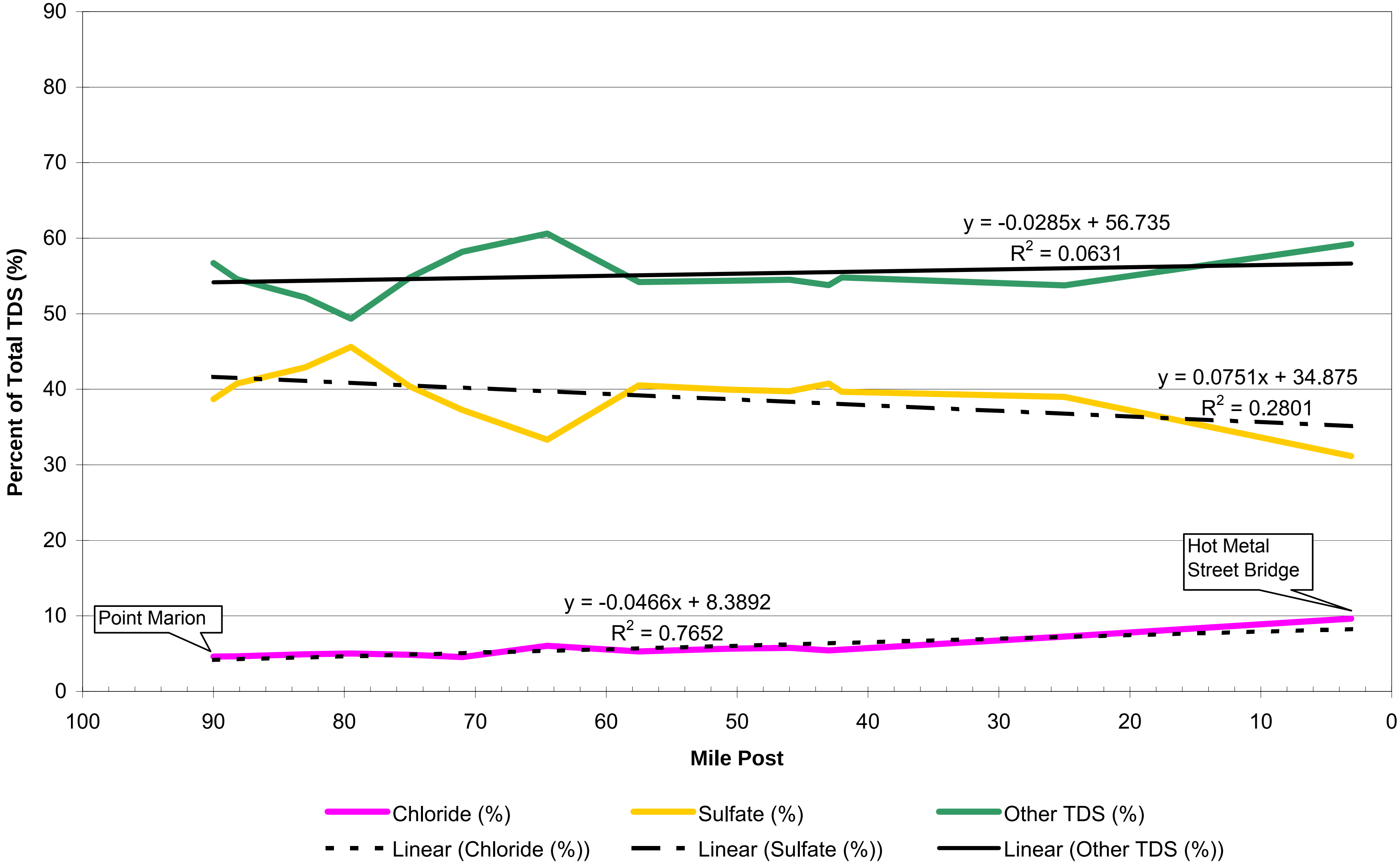


Figure 27 - Change in Percent of Chloride, Sulfate, and Other TDS Components
Along Monongahela River using PADEP December 23, 2008 Samples
Percent of Total TDS (%)
Mile Post
y = -0.0999x + 60.556
R2 = 0.1406
y = 0.0762x + 32.465
R2 = 0.3665
y = 0.0237x + 6.9795
R2 = 0.0171
Point Marion
Hot Metal
Street Bridge
Chloride (%)
Sulfate (%)
Other TDS (%)
Linear (Chloride (%))
Linear (Sulfate (%))
Linear (Other TDS (%))

Figure 28 - Change in Percent of Chloride, Sulfate, and Other TDS Components Along Monongahela River using PADEP December 30, 2008 Samples



ATTACHMENT B

FLUSHING TIME CALCULATION

Monongahela River Flushing Time Calculation

By: CAR　　Chkd: ALS

Date: 12/19/08　　Date: 12/19/08

Low Flow Conditions

Lock/Dam	River Mile (mi)	Pool Elev (ft)	River Width (ft)	Pool Volume (cubic feet)	Estimated Flow Rate (cfs)	Time To Empty Pool (days)
Emsworth	NA	710	NA			
Braddock	11.2	721.8	748	587202739.2	1700	4.00
No. 3	23.8	726.9	670	1058202288	1500	8.17
No. 4	41.5	743.5	535	923766096	1000	10.69
Maxwell	61.2	763	460	985121280	900	12.67
Grays Landing	82	778	576	401448960	700	6.64
Point Marion	90.8	797	667	749430528	500	17.35
Morgantown	102	814	410		**Total**	**59.51 days**

Normal Flow Conditions

Lock/Dam	River Mile (mi)	Pool Elev (ft)	River Width (ft)	Pool Volume (cubic feet)	Estimated Flow Rate (cfs)	Time To Empty Pool (days)
Emsworth	NA	710	NA			
Braddock	11.2	721.8	748	587202739.2	3300	2.06
No. 3	23.8	726.9	670	1058202288	3100	3.95
No. 4	41.5	743.5	535	923766096	2000	5.35
Maxwell	61.2	763	460	985121280	1900	6.00
Grays Landing	82	778	576	401448960	1700	2.73
Point Marion	90.8	797	667	749430528	1400	6.20
Morgantown	102	814	410		**Total**	**26.29 days**

High Flow Conditions

Lock/Dam	River Mile (mi)	Pool Elev (ft)	River Width (ft)	Pool Volume (cubic feet)	Estimated Flow Rate (cfs)	Time To Empty Pool (days)
Emsworth	NA	710	NA			
Braddock	11.2	721.8	748	587202739.2	24000	0.28
No. 3	23.8	726.9	670	1058202288	22000	0.56
No. 4	41.5	743.5	535	923766096	15000	0.71
Maxwell	61.2	763	460	985121280	14000	0.81
Grays Landing	82	778	576	401448960	10000	0.46
Point Marion	90.8	797	667	749430528	8000	1.08
Morgantown	102	814	410		**Total**	**3.92 days**

Notes:

Lock/Dam and pool data were taken from information available on USACE Pittsburgh District website (CELRPP 1130-1-27, May 2004).

Flow rates were estimated from data presented on USGS real-time website for Masontown and Elizabeth on the Monongahela River and Sutersville on the Youghiogheny River.

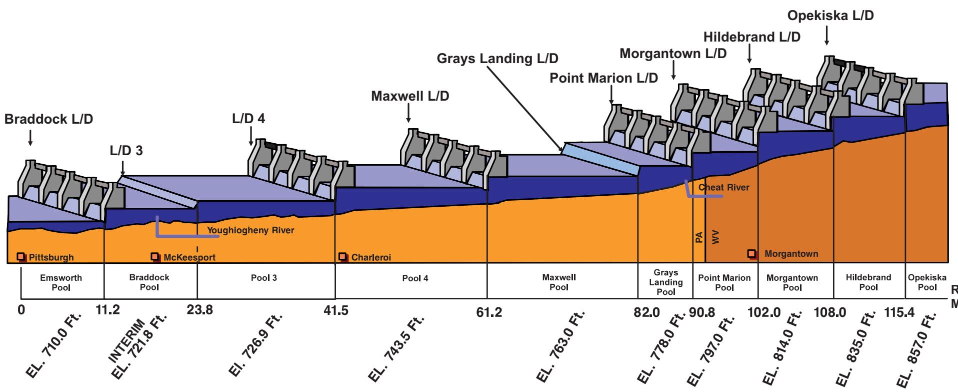
No suspension/deposition, adsorption/desorption, degradation (volatilization, biodegradation, etc.), or other fate and transport mechanisms were considered for this calculation.

The nine waste treatment plants accepting produce water discharge to the Monongahela River between river mile 15 and river mile 66. Other sources of TDS also discharge to the river in this reach.

Monongahela River Statistics

	Braddock	Lock 3	Lock 4	Maxwell	Grays Landing	Point Marion	Morgantown	Hildebrand	Opekiska
Location	Braddock, Pa.	Elizabeth, Pa.	Charleroi, Pa.	Brownsville, Pa.	Grays Landing, Pa.	Point Marion, Pa.	Morgantown, W.Va.	Morgantown, W.Va.	Fairmont, W.Va.
Placed in Operation	1905	1907	1932	1964	1996	1925 as Lock 8	1950	1959	1964
Dam Length	748'	670'	535'	460'	576'	667'	410'	530'	366'
Type of Dam	Gated	Fixed	Gated	Gated	Fixed	Gated	Gated	Gated	Gated
River Chamber	56' X 360'	56' X 360'		84' X 720'					
Land Chamber	110' X 720'	56' X 720'	56' X 720'	84' X 720'	84' X 720'	84' X 720'	84' X 600'	84' X 600'	84' X 600'

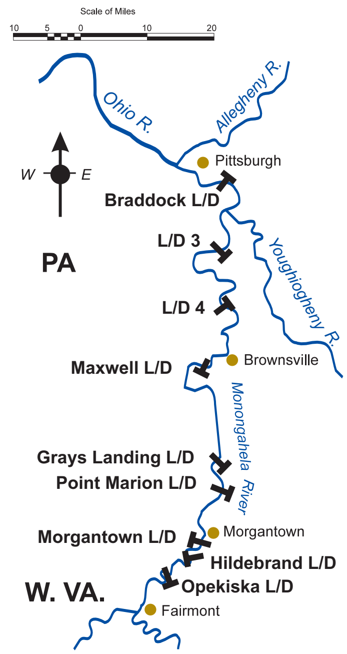
Monongahela River Existing River Profile



Welcome

The US Army Corps of Engineers welcomes you to the locks of the Monongahela River. This navigation system provides year round transportation on the Monongahela River between Pittsburgh, Pa. and Fairmont, W.Va. Visitors are welcome to tour the locks by calling 412-395-7650 to schedule tours ahead of time.

Locks and Dams 2, 3 and 4 on the Monongahela River in Allegheny, Washington and Westmoreland counties in southwestern Pennsylvania, are the three oldest currently operating navigation facilities on the Mon River. These locks experience the highest volume of commercial traffic on the entire Monongahela River navigation system and the pools created by these dams are also popular with recreational boaters.



CELRPP 1130-1-27
May 2004

The Monongahela River

Locks and Dam 4

Hildebrand Lock and Dam

US Army Corps of Engineers
Pittsburgh District

ATTACHMENT C

STATISTICAL ANALYSIS AND SUPPORTING CALCULATIONS

Comparison of TDS Loadings Before June 2007 After June 2007

To determine whether the mean TDS Loadings before June 2007 are equal to the mean TDS Loadings after June 2007 a standard, two-sample student's T-Test was performed. There are two assumptions for the T-Test: that the data distributions are roughly normal and that the variances of each group are equal. If the variances are not equal then the Satterthwaite's approximation should be used. Note that there are limitations associated with this analysis based on the small sample size and unequal spacing of the loadings as discussed in the statistical summary.

The normality of the data distributions was examined by reviewing normal probability plots, a boxplot, and a histogram of the combined data. If the data have the same distribution then the two data sets are concluded to represent the same population. On the normality plot if the data follow the same distribution then the loadings will be aligned and randomly distributed about the expected normal line. For the boxplots and histograms if the data sets come from one distribution then the data will be roughly symmetric with no breaks in loadings and no extreme loadings. The Shapiro-Wilk W test is used in testing for normality. If the W statistic is significant then the hypothesis that the respective distribution is normal should be rejected. A p-value is computed to verify this. If the computed p-value was greater than 0.05 then it was concluded that the data follow the distribution being tested. If the p-value was greater than 0.01 but less than 0.05 it was concluded that the data roughly follow the distribution being tested. A p-value less than 0.01 was concluded to indicate that the data do not follow the tested distribution.

The equal variance assumption was tested using Levene's test. If the p-value for this test was less than 0.05 it was concluded that the variance of the two data sets differ; otherwise the variances were concluded to be the same.

After evaluating the statistical characteristics described above, the T-Test was conducted. If the p-value for the T-Test was less than 0.05 it was concluded that the mean loadings after June 2007 are greater than the mean loadings before June 2007.

The raw data were plotted for all three locations. Upon inspection of the plots it was evident that the data followed a skewed distribution. Therefore tests of normality were conducted based on the log-transformed data. Table 1 contains the Shapiro Wilk Test output for all locations. From this table it can be seen that all p-values are greater than 0.05 indicating that the data follow a log-normal distribution. Having demonstrated that the data are log-normally distributed, it was appropriate to perform subsequent tests using the log-transformed data instead of the untransformed data.

Table 1

	Shapiro Wilk Statistic	**P-Value**	**Data Distribution**
Point Marion	0.9598	0.0876	Log-normal
Charleroi	0.979	0.5358	Log-normal
Braddock	0.983	0.7752	Log-normal

Point Marion Data Evaluation

Figure 1 is the normal probability plot of the combined Point Marion TDS Loadings. There does not appear to be any grouping of the data based on sample date. Although the data are roughly aligned with the expected normal line there are departures from the expected normal line in the upper and lower tails of the data. Figure 2 contains the boxplot and histogram of the combined data. The boxes (and hence the data) are roughly symmetric and the two data sets appear to be fairly evenly interspersed on the probability plot, therefore, the two data sets are concluded to come from the same population.

Figure 1

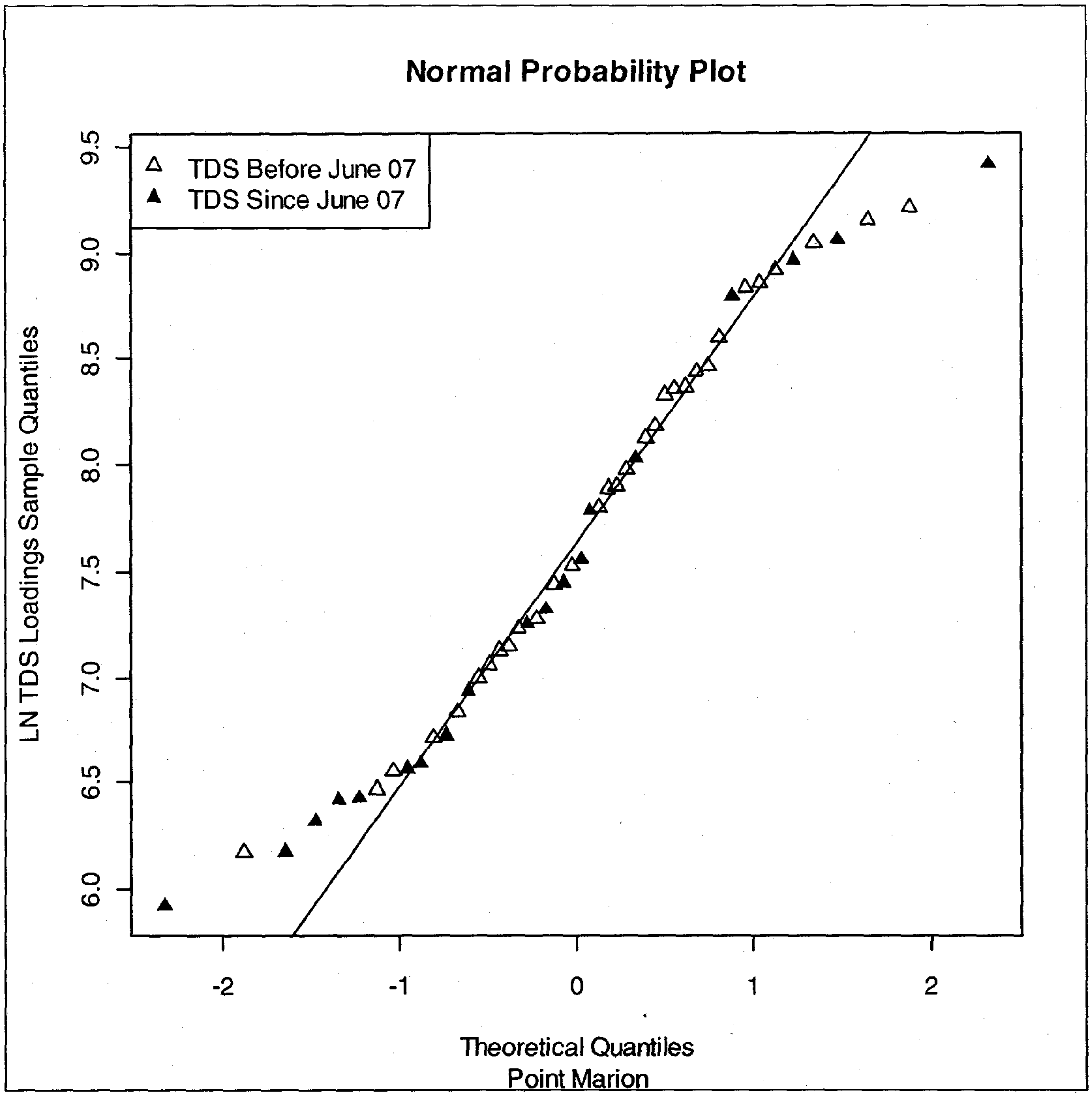

Normal Probability Plot
TDS Before June 07
TDS Since June 07
LN TDS Loadings Sample Quantiles
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
-2
-1
0
1
2
Theoretical Quantiles
Point Marion

Figure 2

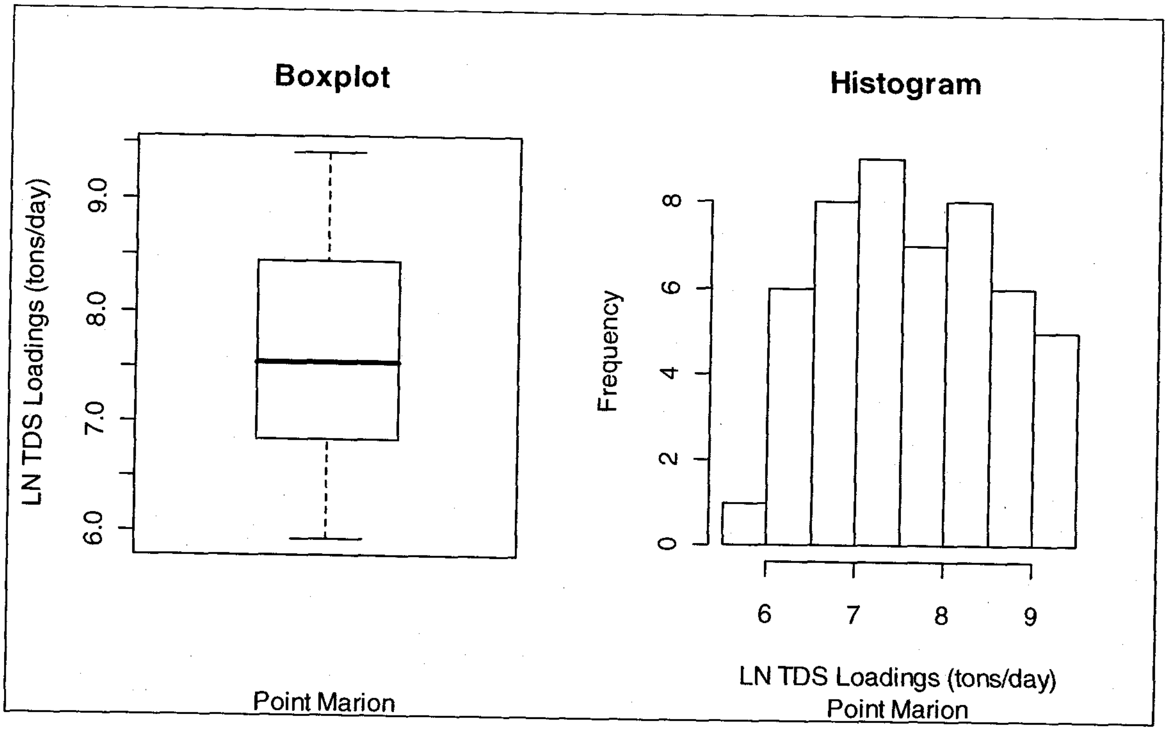


Figure 3 is the individual normal probability plots of the two log-transformed data sets for Point Marion. The data are roughly aligned with the expected normal line. Table 2 contains the Shapiro Wilk statistics output for the log-transformed data. The p-values are greater than 0.05 indicating that the data sets are log-normally distributed. Table 3 contains the Levene's equal variance test output. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal variances. The equal variance, two-sample T-test was then conducted. The results can be found in Table 4. From this table it can be seen that the p-value is 0.789. The T-statistic associated with the p-value is also presented. If the test-statistic is greater than the T-value associated with p-value of 0.05 then it is concluded that the mean loadings are not significantly different.

Figure 3

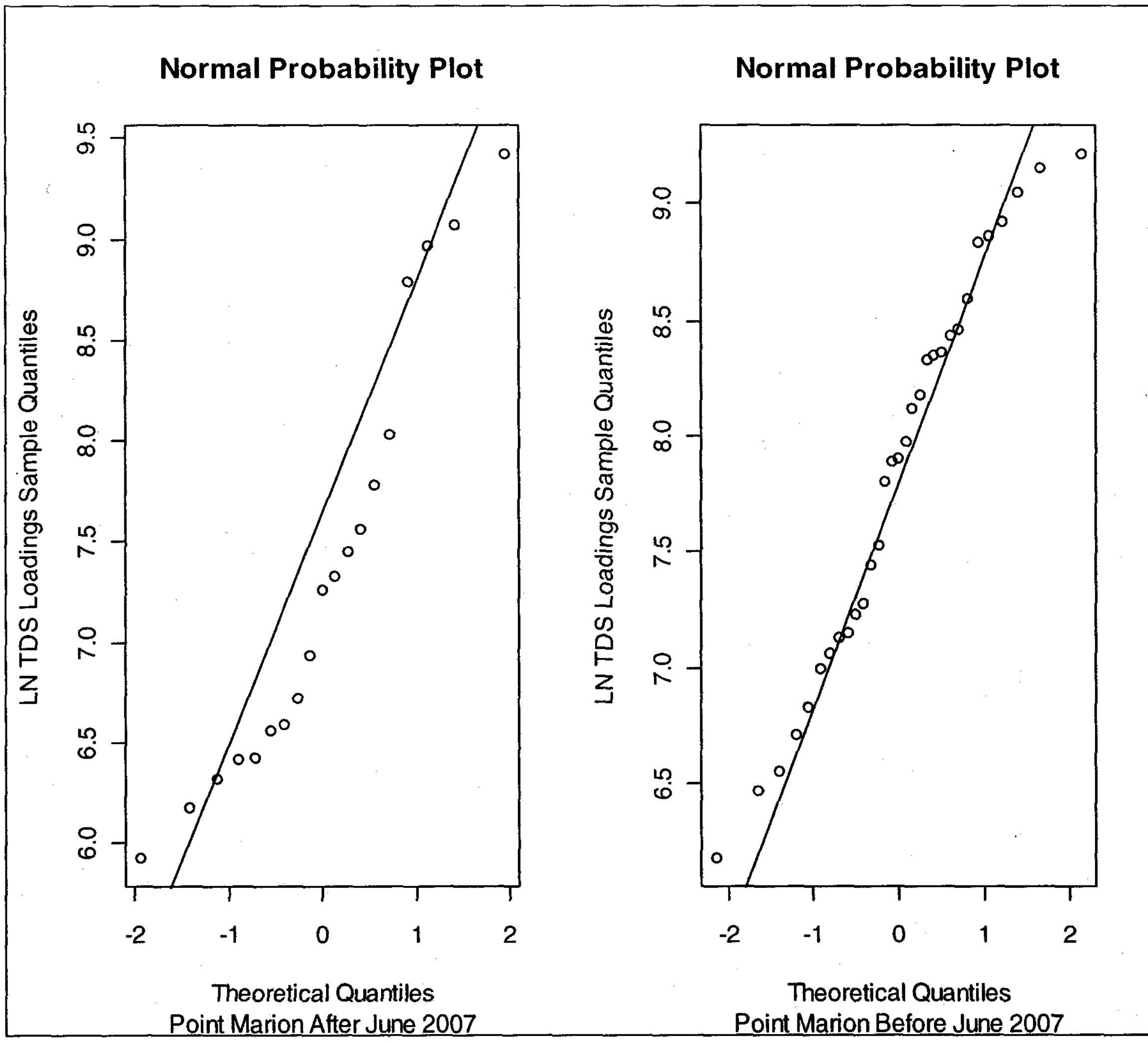


Table 2

Log-Normality Test			
	Shapiro Wilk's Statistic	**P-Value**	**Conclusion**
TDS After June 2007	0.9171	0.09989	Log-Normal
TDS Before June 2007	0.9624	0.3365	Log-Normal

Table 3

	Levene's Statistic	P-Value	Conclusion
Data After June 07 vs. Data Before June 07	0.8154	0.3710	Equal Variance

Table 4

Two Sample T Test		
T-Statistic	**P-Value**	**Conclusion**
-0.809	0.789	No Statistical Difference

Charleroi Data Evaluation

Figure 4 is the normal probability plot of the combined Charleroi TDS Loadings. Note that there does appear to be some curvature in the loadings meaning that there may be a slight departure from normality. There does not appear to be any grouping of the data based on sample date. Also the data roughly follow the expected normal line. Note that the two highest loadings are from sample dates after June 2007 and the two lowest are from dates before June 2007. Figure 5 contains the boxplot and histogram of the combined data. The data are slightly left skewed and there does not appear to be any separations of loadings. Therefore the two data sets are concluded to come from the same population.

Figure 4

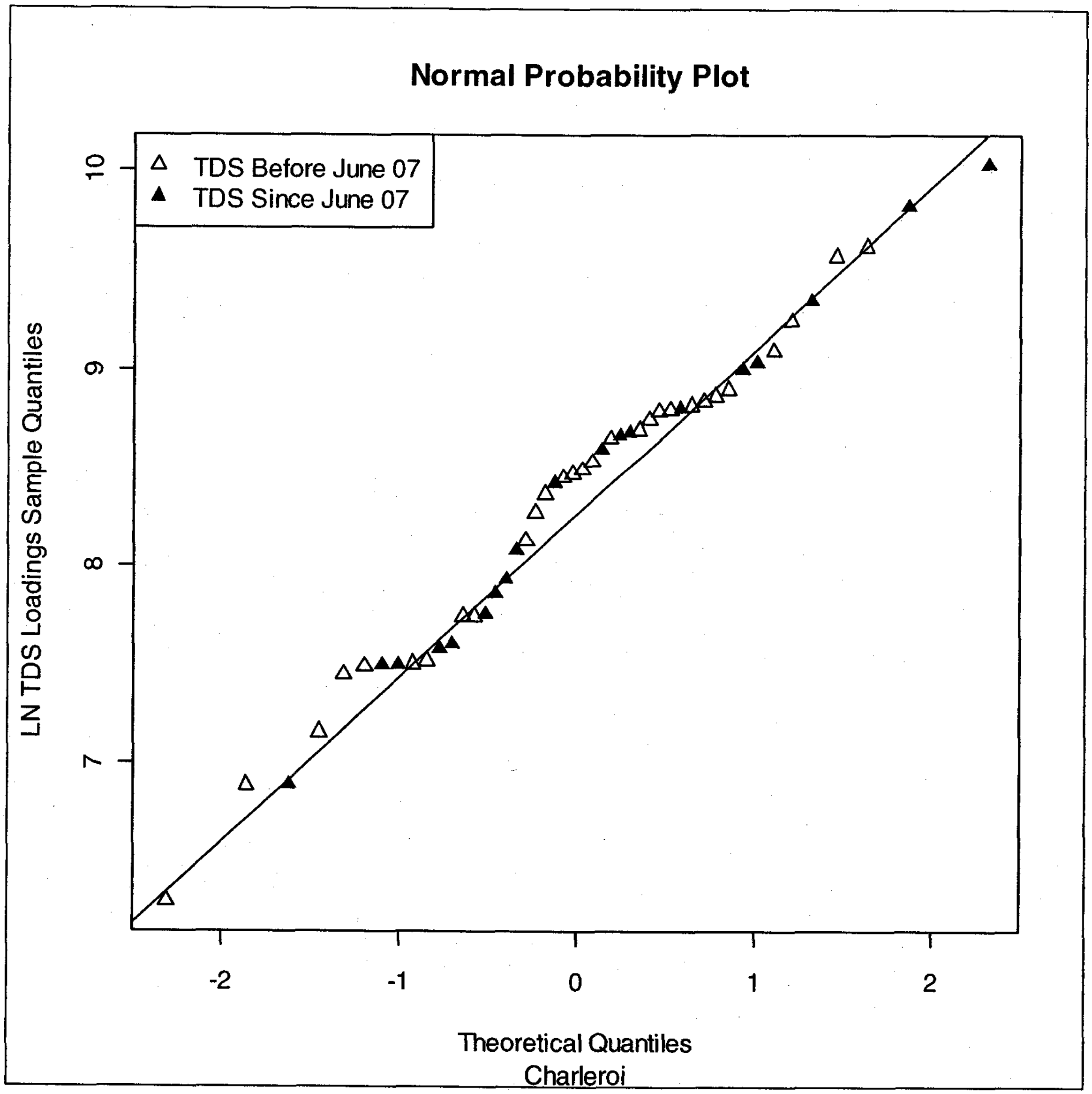


Figure 5

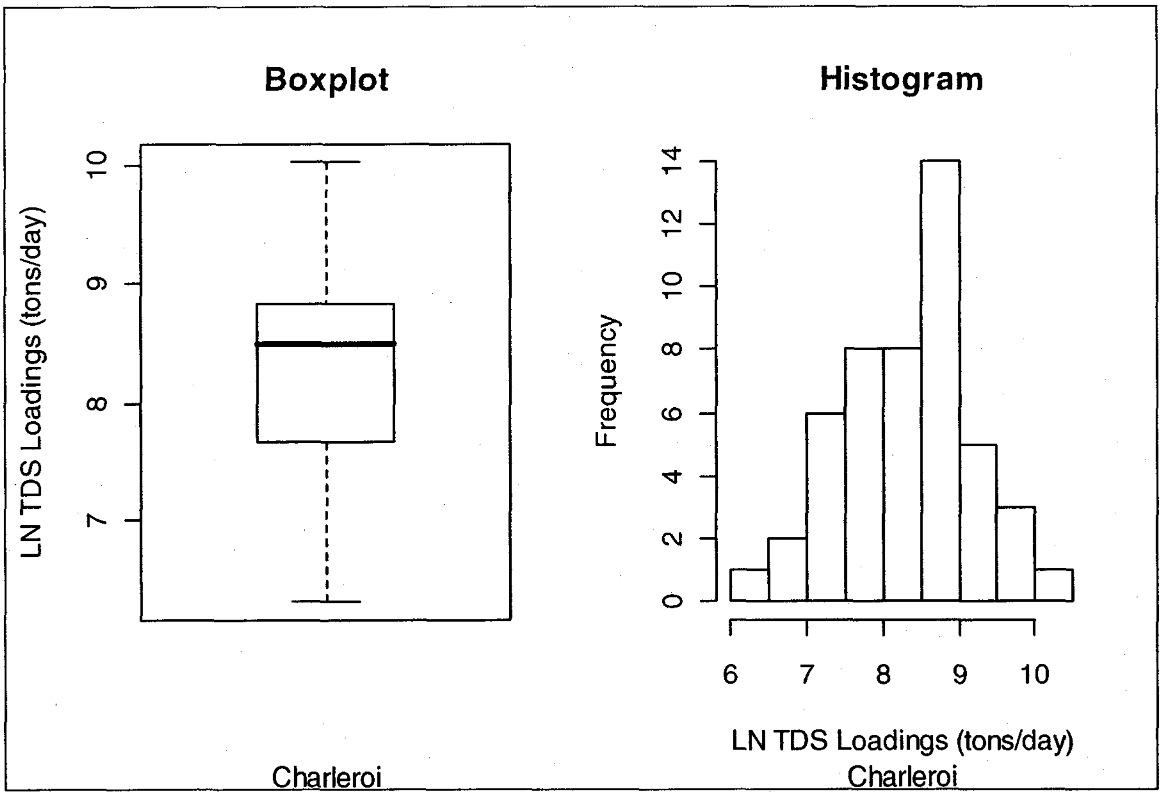


Figure 6 is the individual normal probability plots of the two log-transformed data sets for Charleroi. The data roughly follow the expected normal line. Table 5 contains the Shapiro Wilk statistics output for the log-transformed data. The p-values are greater than 0.05 indicating that the data sets follow a log-normal distribution. Table 6 contains the Levene's equal variance test output. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal variances. The equal variance, two sample T-test was then conducted. The results can be found in Table 7. The p-value is 0.262. Therefore it is concluded that the mean loadings are not different.

Figure 6

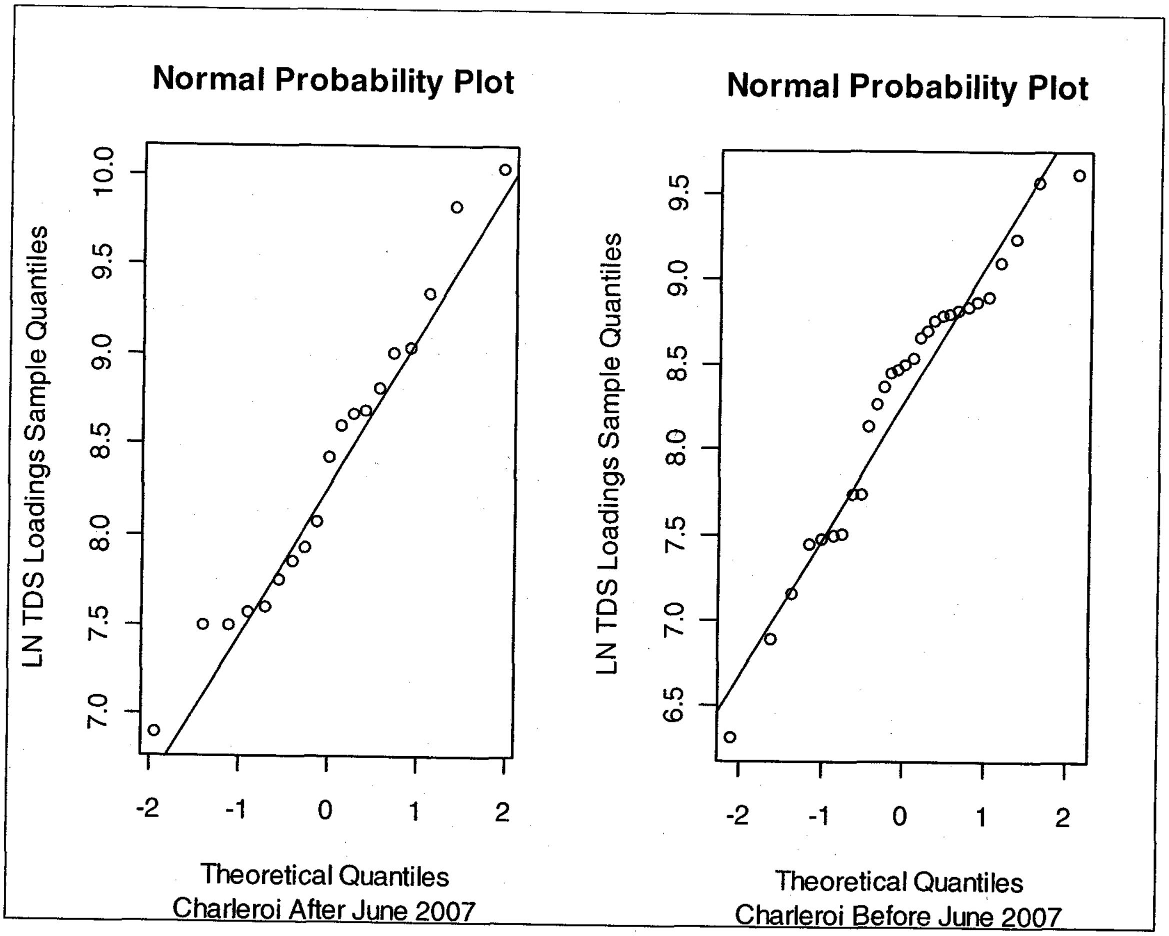


Table 5

	Log-Normality Test		
	Shapiro Wilk's Statistic	**P-Value**	**Conclusion**
TDS After June 2007	0.9663	0.7002	Log Normal
TDS Before June 2007	0.9475	0.1579	Log Normal

Table 6

	Levene's Statistic	**P-Value**	**Conclusion**
Data After June 07vs. Data Before June 07	0.2231	0.6389	Equal Variance

Table 7

Two Sample T-Test		
T-Statistic	**P-Value**	**Conclusion**
0.642	0.262	Not Statistically Different

Braddock Data Evaluation

Figure 7 is the normal probability plot of the combined Braddock TDS Loadings. There does not appear to be any grouping of the data based on sample date. Also the data are roughly aligned with the expected normal line. Note that the points left of center are below the line and the points to the right are above the line. This may indicate some departure from the log normal distribution. Figure 8 contains the boxplot and histogram of the combined data. The data are roughly symmetric and the two data sets appear to be fairly even interspersed. Therefore the two data sets are concluded to come from the same population.

Figure 7

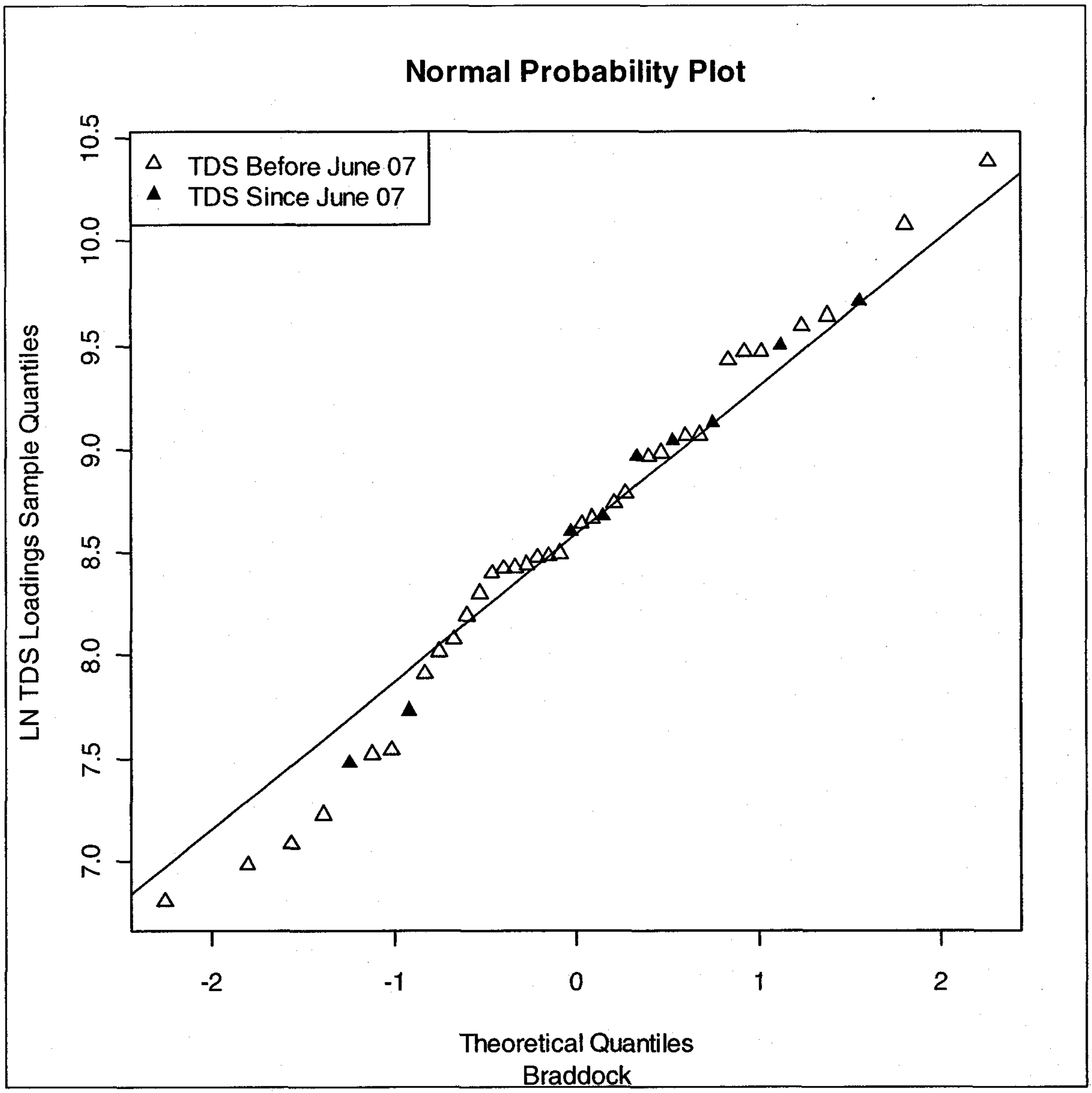


Figure 8

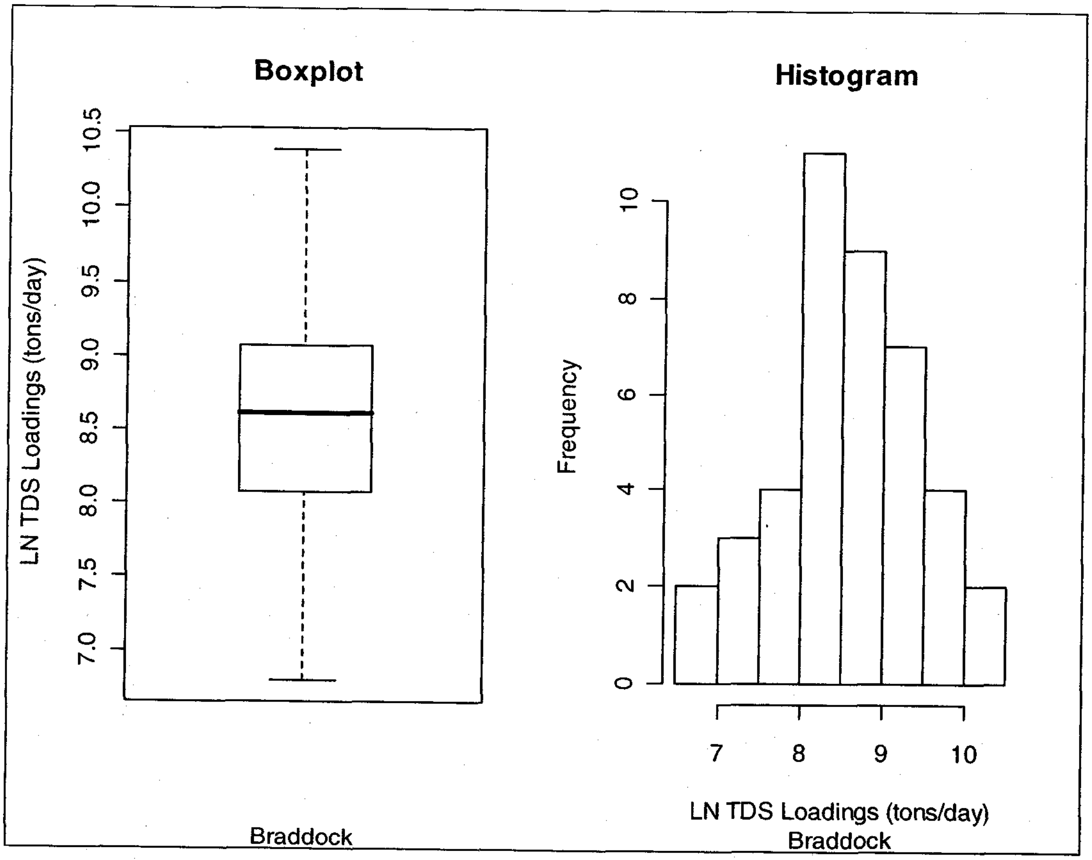


Figure 9 is the individual normal probability plots of the two log-transformed data sets for Braddock. From this figure it can be seen that the data are roughly aligned with the expected normal line. Table 8 contains the Shapiro Wilk statistics output for the log-transformed data. From this table it can be seen that the p-values are greater than 0.05 indicating that the data sets are indistinguishable from log-normal distributions. Table 9 contains the Levene's equal variance test output. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal variances. The equal variance, two sample T-test was then conducted. The results can be found in Table 10. From this table it can be seen that the p-value is 0.405. Therefore it is concluded that the mean loadings are not different.

Figure 9

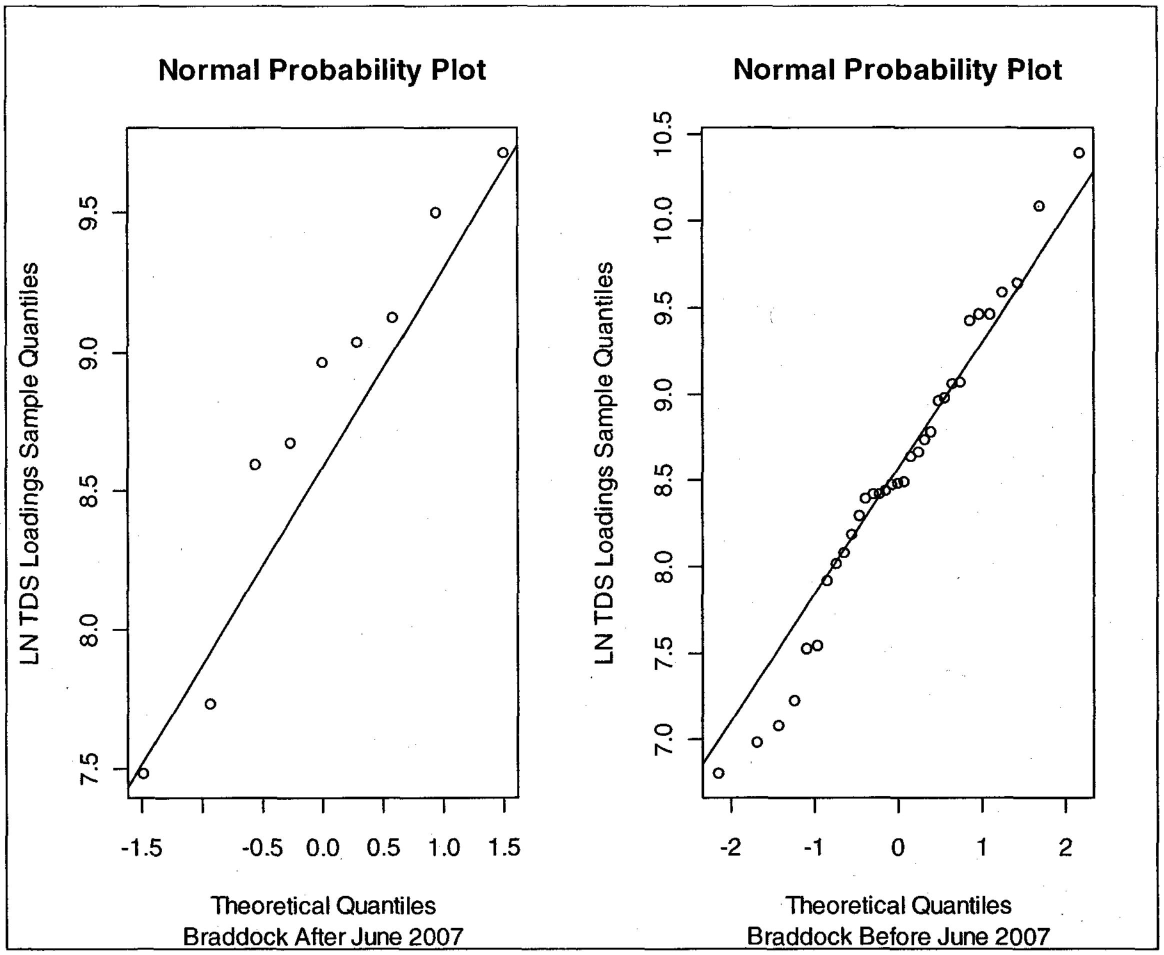


Table 8

Shapiro Wilk Statistic			
	Shapiro Wilk Statistic	**P-Value**	**Distribution**
TDS After June 2007	0.9262	0.4463	Log-normal
TDS Before June 2007	0.9798	0.7788	Log-normal

Table 9

	Levene's Statistic	P-Value	Conclusion
Data After June 07vs. Data Before June 07	0.4741	0.4951	Equal Variance

Table 10

Two Sample T Test		
T-Statistic	**P-Value**	**Conclusion**
0.241	0.405	Not Statistically Different

Comparison of Sulfate Loadings Before June 2007 After June 2007

To determine whether the mean Sulfate Loadings before June 2007 are equal to the mean Sulfate Loadings after June 2007 a standard, two-sample student's T-Test was performed. There are two assumptions for the T-Test: that the data distributions are roughly normal and that the variances of each group are equal. If the variances are not equal then the Satterthwaite's approximation should be used. Note that there are limitations associated with this analysis based on the small sample size and unequal spacing of the loadings as discussed in the statistical summary.

The normality of the data distributions was examined by reviewing normal probability plots, a boxplot, and a histogram of the combined data. If the data have the same distribution then the two data sets are concluded to represent the same population. On the normality plot if the data follow the same distribution then the loadings will be aligned and randomly distributed about the expected normal line. For the boxplots and histograms if the data sets come from one distribution then the data will be roughly symmetric with no breaks in loadings and no extreme loadings. The Shapiro-Wilk W test is used in testing for normality. If the W statistic is significant then the hypothesis that the respective distribution is normal should be rejected. A p-value is computed to verify this. If the computed p-value was greater than 0.05 then it was concluded that the data follow the distribution being tested. If the p-value was greater than 0.01 but less than 0.05 it was concluded that the data roughly follow the distribution being tested. A p-value less than 0.01 was concluded to indicate that the data do not follow the tested distribution.

The equal variance assumption was tested using Levene's test. If the p-value for this test was less than 0.05 it was concluded that the variance of the two data sets differ; otherwise the variances were concluded to be the same.

After evaluating the statistical characteristics described above, the T-Test was conducted. If the p-value for the T-Test was less than 0.05 it was concluded that the mean loadings after June 2007 are greater than the mean loadings before June 2007.

The raw data were plotted for all three locations. Upon inspection of the plots it was evident that the data followed a skewed distribution. Therefore all tests for normality were conducted based on log-transformed data. This transformation replaces the data values with their logarithms, with the expectation that the log-transformed values will more closely follow a normal distribution. Table 21 contains the Shapiro Wilk Test output for all locations. From this table it can be seen that all p-values are greater than 0.05 indicating that the data follow a log-normal distribution. Having demonstrated that the data are log-normally distributed, it was appropriate to perform subsequent tests using the log-transformed data instead of the untransformed data.

Table 11

	Shapiro Wilk Statistic	P-Value	Data Distribution
Point Marion	0.9707	0.2581	Log Normal
Charleroi	0.9799	0.573	Log Normal
Braddock	0.9611	0.1612	Log Normal

Point Marion Data Evaluation

Figure 10 is the normal probability plot of the combined Point Marion Sulfate Loadings. From this plot it can be seen that there does not appear to be any grouping of the data based on sample date. The higher and lower tails of the data are slightly lower and higher (respectively) than the expected line indicating that there might be a slight departure from normality. Also the data are aligned with the expected normal line. Figure 11 contains the boxplot and histogram of the combined data. From this plot it can be seen that the data are roughly symmetric. The two data sets appear to be fairly evenly interspersed throughout the range of the loadings. Based on these observations the two data sets are concluded to represent the same population.

Figure 10

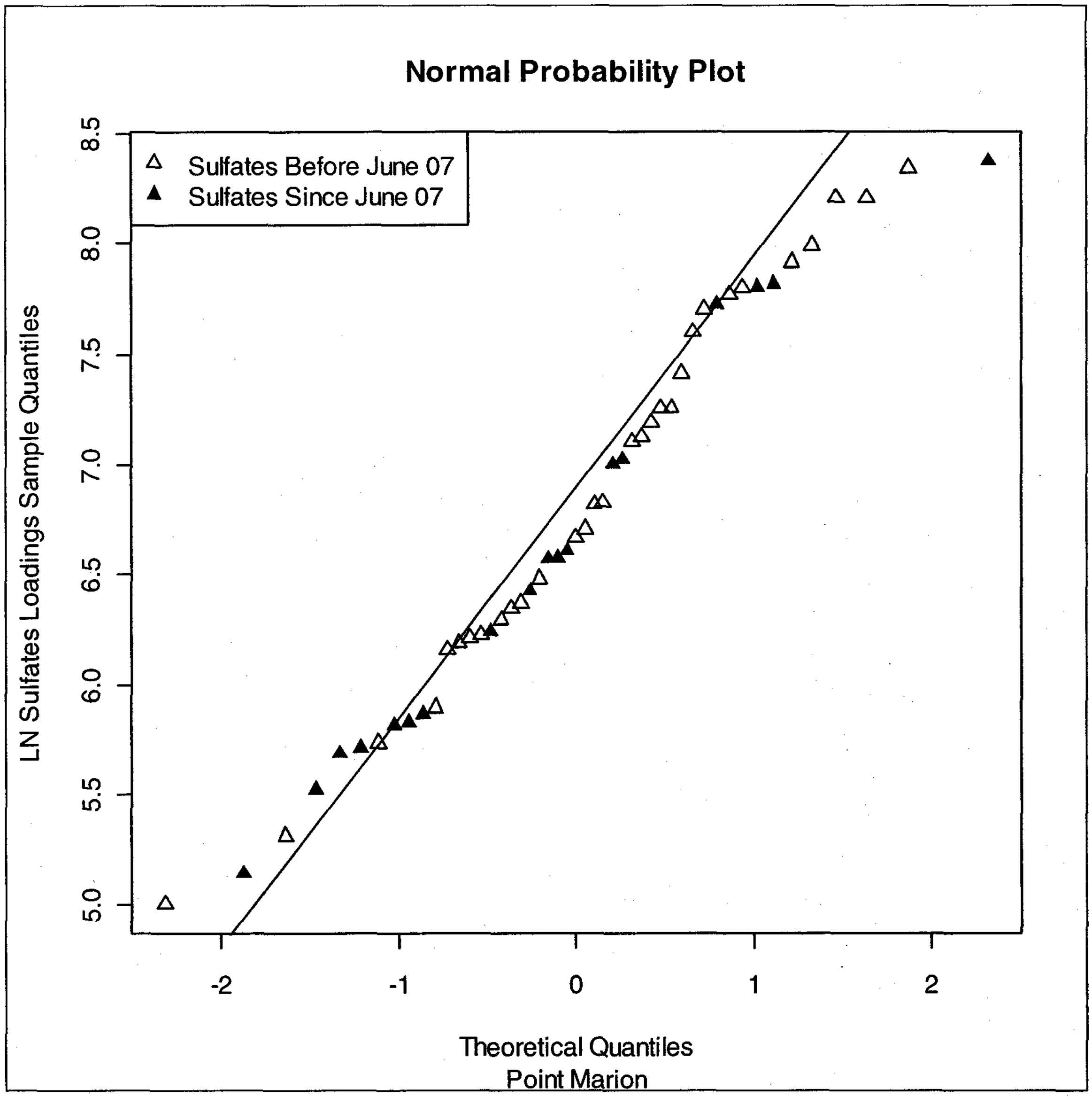


Figure 11

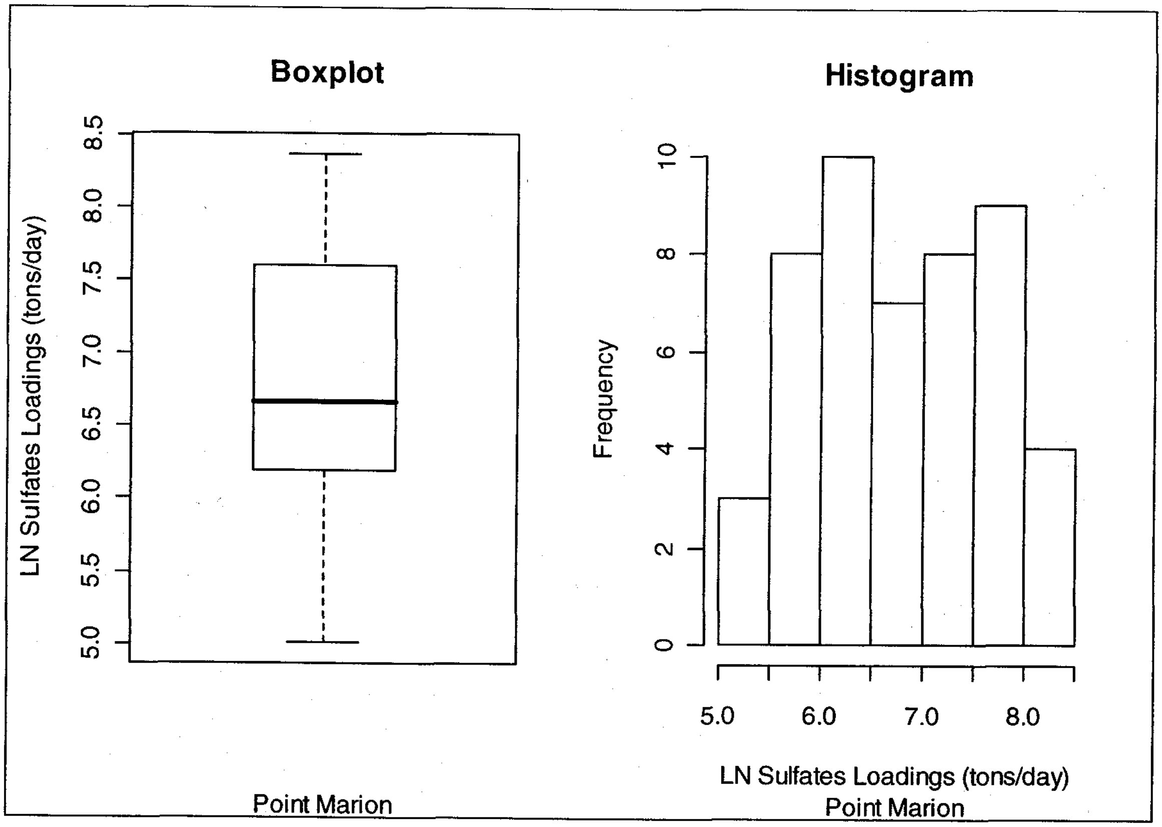


Figure 12 is the individual normal probability plots of the two log-transformed data sets for Point Marion. The data are roughly aligned with the expected normal line. Table 12 contains the Shapiro Wilk statistics for the log-transformed data. The p-values are greater than 0.05 indicating that the data set distributions are indistinguishable from log-normal distributions. Table 13 contains the Levene's equal variance test output. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal, or at least indistinguishable, variances. The equal variance, two sample T-test was then conducted. The results can be found in Table 14. The p-value is 0.841. The T-statistic associated with the p-value is also presented. If this test statistic is greater than that the T-value associated with 0.05 then it is concluded that the mean loadings are not different.

Figure 12

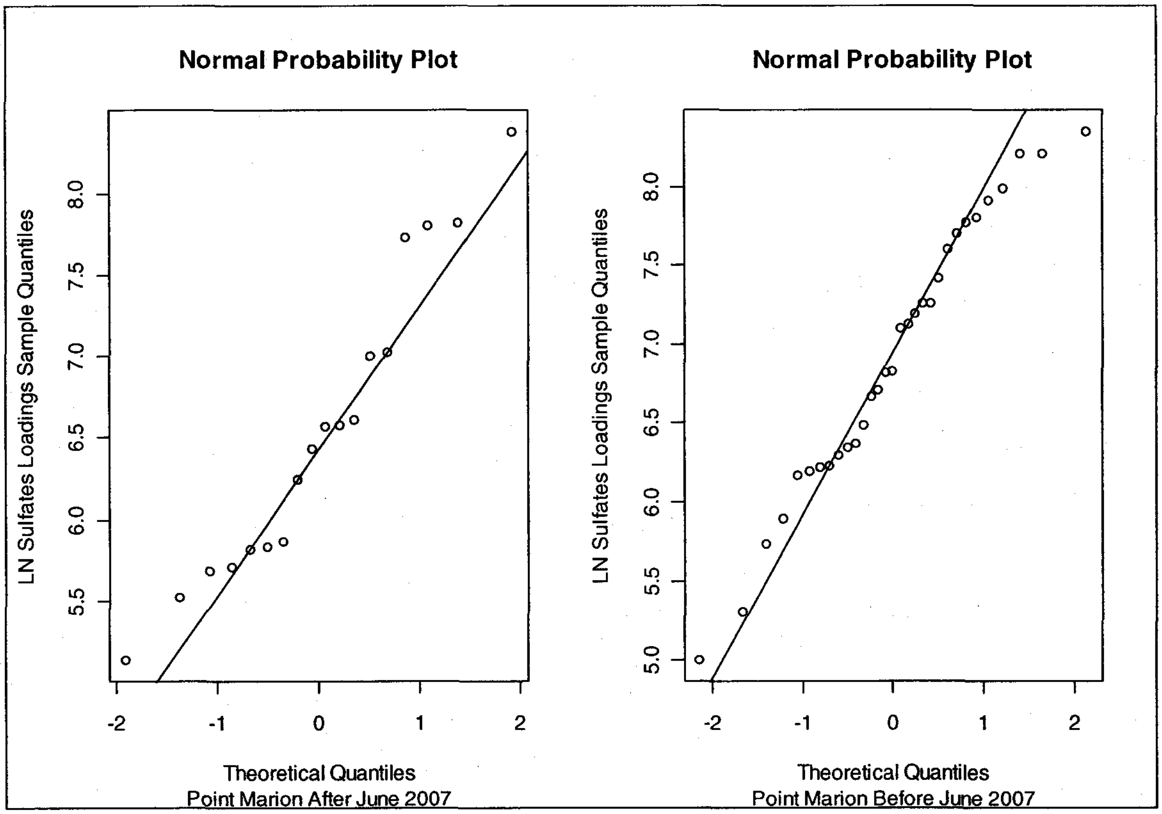


Table 12

Log Normal Test			
	Shapiro Wilk's Statistic	**P-Value**	**Conclusion**
Sulfates After June2007	0.9413	0.3047	Log Normal
Sulfates Before June 2007	0.9719	0.5732	Log Normal

Table 13

	Levene's Statistic	**P-Value**	**Conclusion**
Data After June 07 vs. Data Before June 07	0.0029	0.9571	Equal Variance

Table 14

Two Sample T Test		
T-Statistic	**P-Value**	**Conclusion**
-1.010	0.841	Not Statistically Different

<u>Charleroi Data Evaluation</u>

Figure 13 is the normal probability plot of the combined Charleroi Sulfate Loadings. There does not appear to be any grouping of the data based on sample date. Note that the two highest loadings are after June 2007. The data are roughly aligned with the expected normal line. There are five lower loadings below the expected normal line coming from both data sets, indicating there might be a slight departure from normality. Figure 14 contains the boxplot and histogram of the combined data. The data are roughly symmetric and there does not appear to be any clustering of data according data set. Therefore the two data sets are concluded to come from the same population.

Figure 13

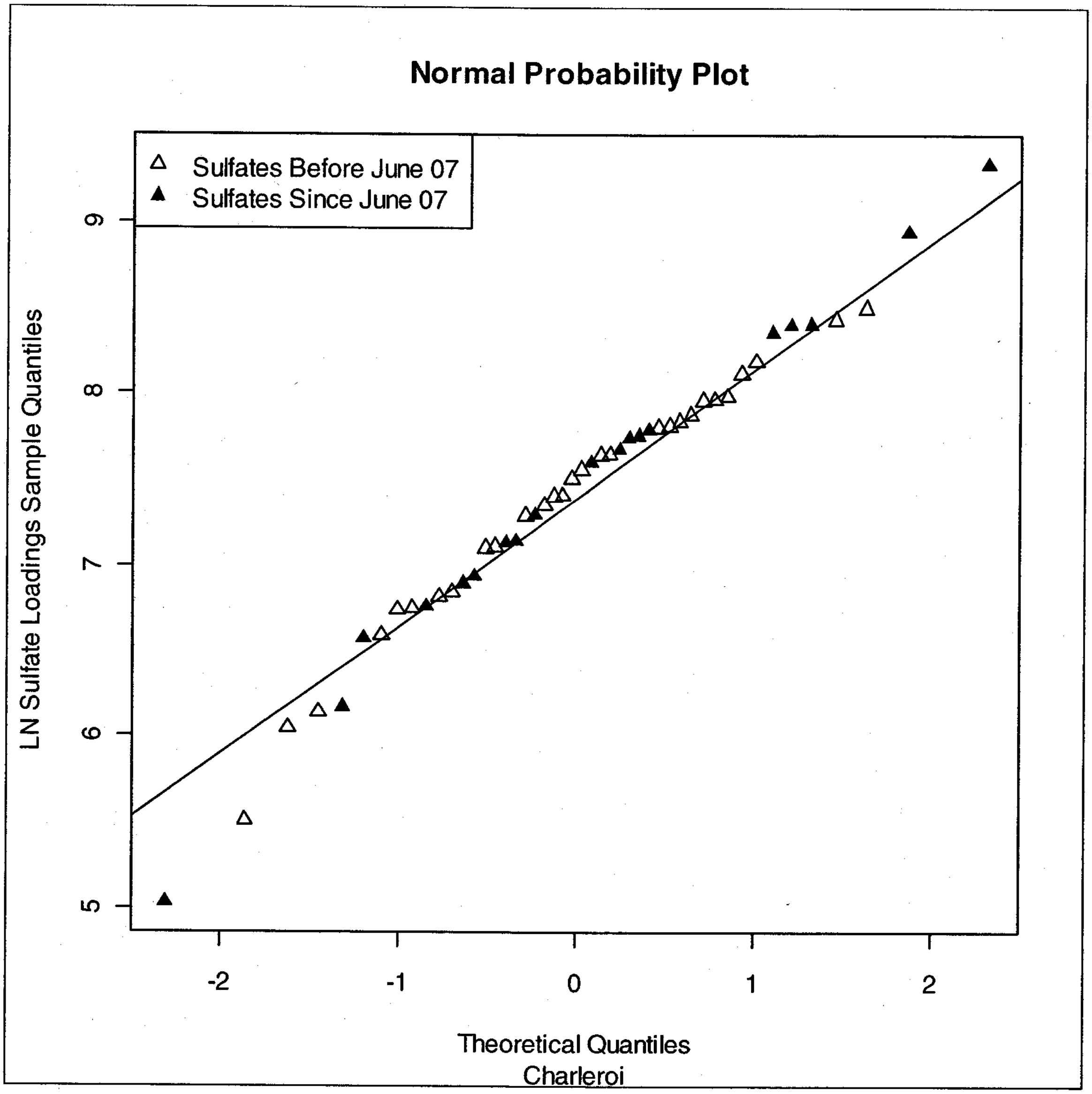


Figure 14

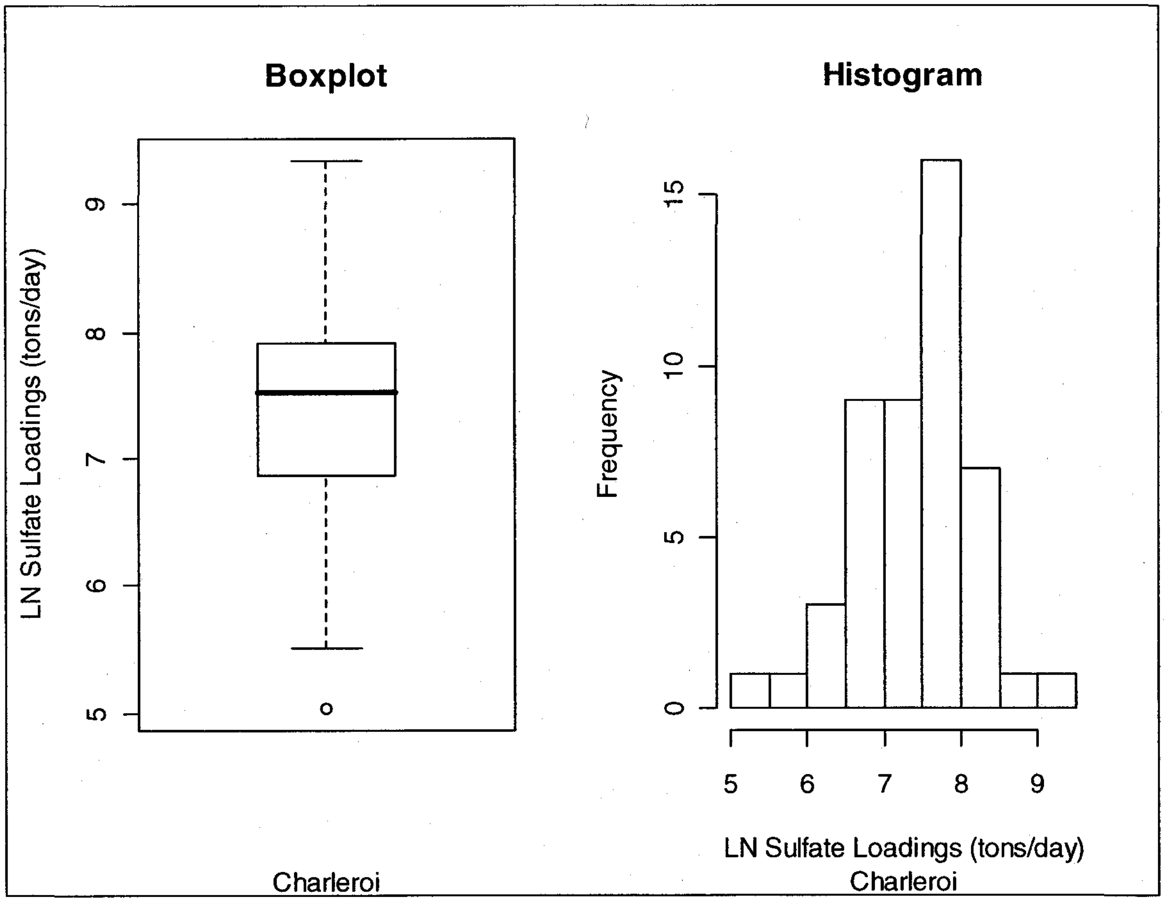


Figure 15 is the individual normal probability plots of the two log-transformed data sets for Charleroi. From this figure it can be seen that the data are well aligned with the expected normal line. Table 15 contains the Shapiro Wilk statistics output for the log-transformed data. From this table it can be seen that the p-values are greater than 0.05 indicating that the data set distributions are indistinguishable from log-normal distributions. Table 16 contains the Levene's equal variance test results. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal, or at least indistinguishable, variances. The equal variance, two sample T-test was then conducted. The results can be found in Table 17. The p-value is 0.105, therefore it is determined that the mean loadings are not different.

Figure 15

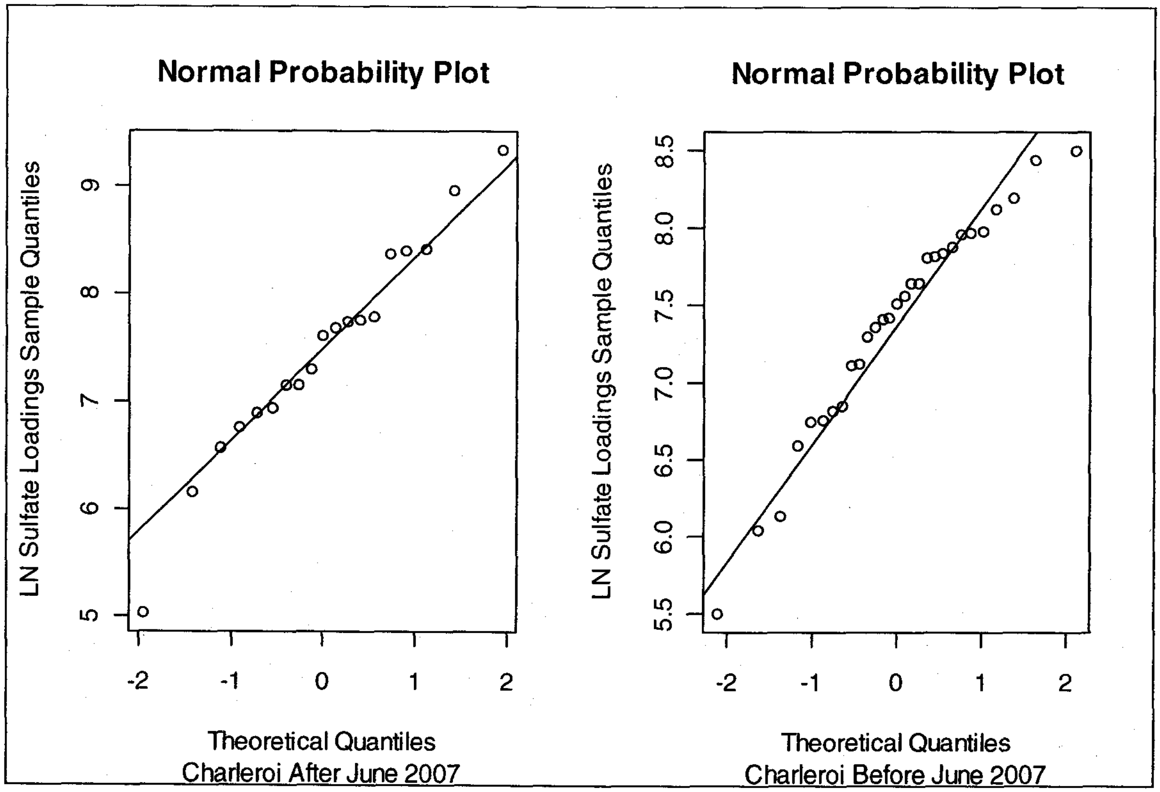


Table 15

Log-Normal Test			
	Shapiro Wilk's Statistic	P-Value	Conclusion
Sulfates After June2007	0.9758	0.8835	Log Normal
Sulfates Before June 2007	0.953	0.2184	Log Normal

Table 16

	Levene's Statistic	P-Value	Conclusion
Data After June 07 vs. Data Before June 07	1.6884	0.2003	Equal Variance

Table 17

Two Sample T-Test		
T-Statistic	P-Value	Conclusion
1.274	0.105	Not Statistically Different

Braddock Data Evaluation

Figure 16 is the normal probability plot of the combined Braddock Sulfate Loadings. The data are roughly aligned with the expected normal line. There are some departures from linearity in the lower loadings. This departure indicates that there might be some departures from log-normality. Note that the Sulfate Loadings from June 2007 are concentrated in the middle of the loadings. Figure 17 contains the boxplot and histogram of the combined data. From this plot it can be seen that the data are roughly symmetric and there do not appear to be any extreme loadings. Therefore the two data sets are concluded to come from the same population.

Figure 16

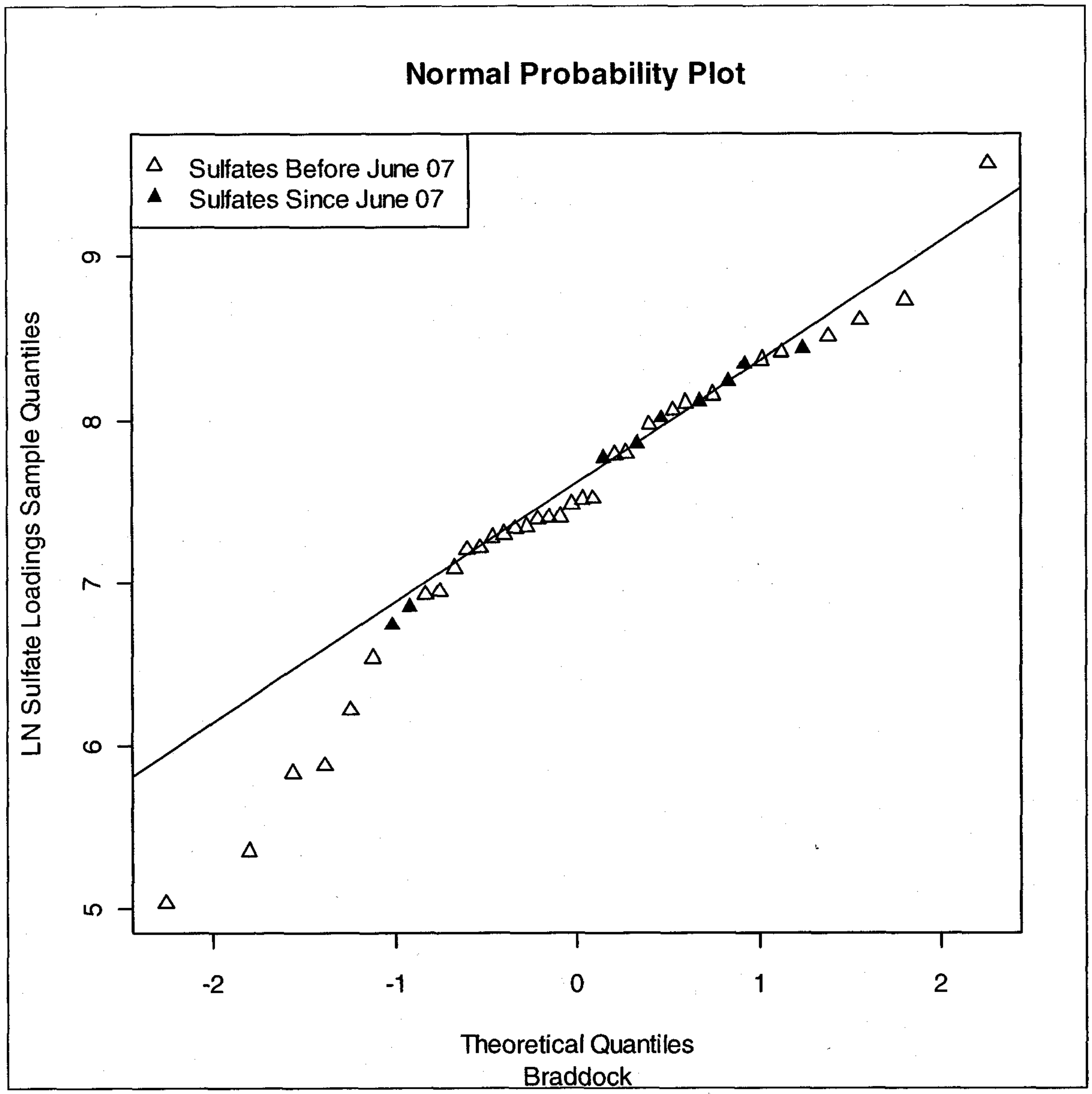

Normal Probability Plot
Sulfates Before June 07
Sulfates Since June 07
LN Sulfate Loadings Sample Quantiles
5
6
7
8
9
-2
-1
0
1
2
Theoretical Quantiles
Braddock

Figure 17

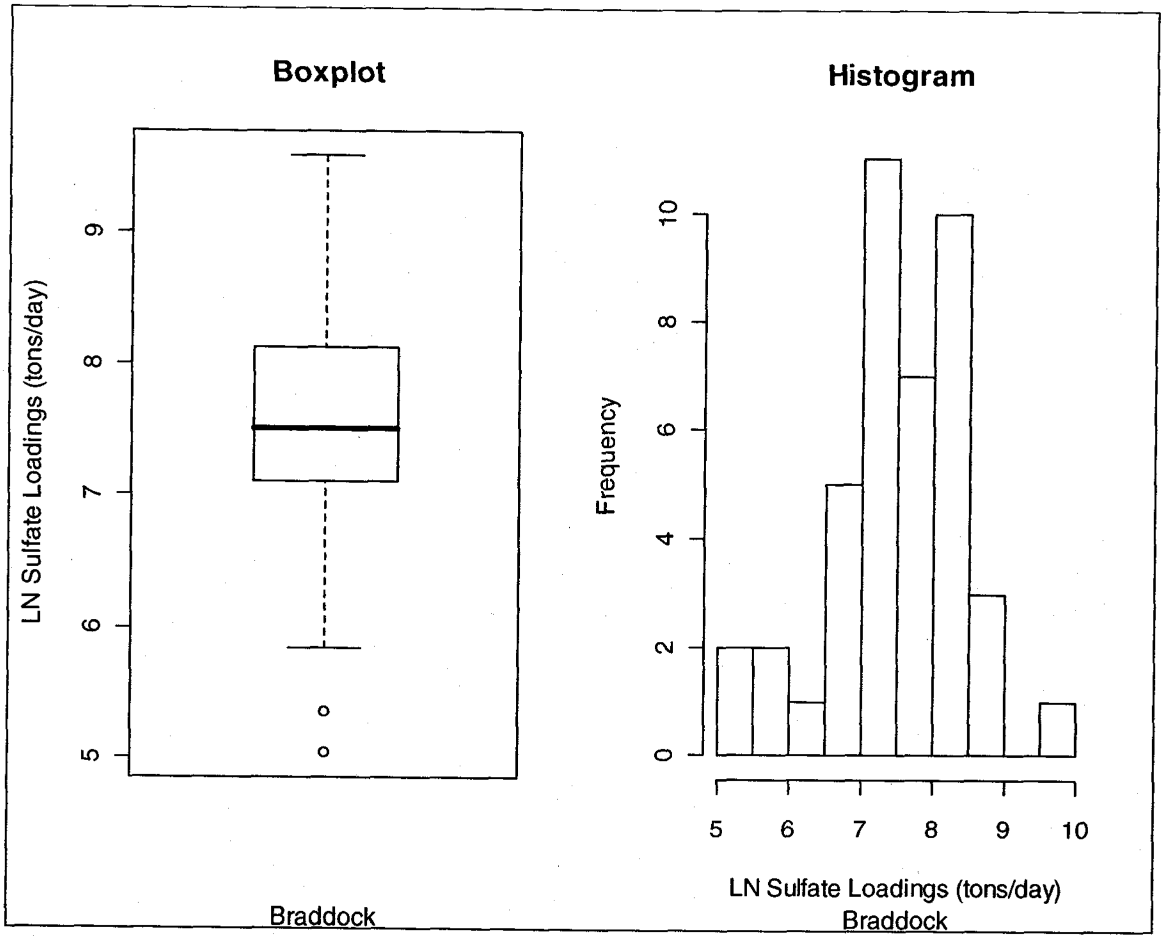


Figure 18 is the individual normal probability plots of the two log-transformed data sets for Braddock. From this figure it can be seen that the data are roughly aligned with the expected normal line. There are two points in the After June 2007 data that have lower loadings then the expected normal line. This indicates that there may be a slight departure from log-normality. Note that this departure can be seen in both data sets. Table 18 contains the Shapiro Wilk statistics output for the log-transformed data. From this table it can be seen that the p-values for before 07 is greater than 0.05 indicating that the data set is log-normally distributed. The p-value for the After June 07 data is 0.04995 indicating that the data set is roughly log-normally distributed. Table 19 contains the Levene's equal variance test results. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal, or at least indistinguishable, variances. The equal variance, two sample T- test was then conducted. The output results can be found in Table 20. From this table it can be seen that the p-value is 0.343. Therefore it is concluded that the mean loadings are not different.

Figure 18

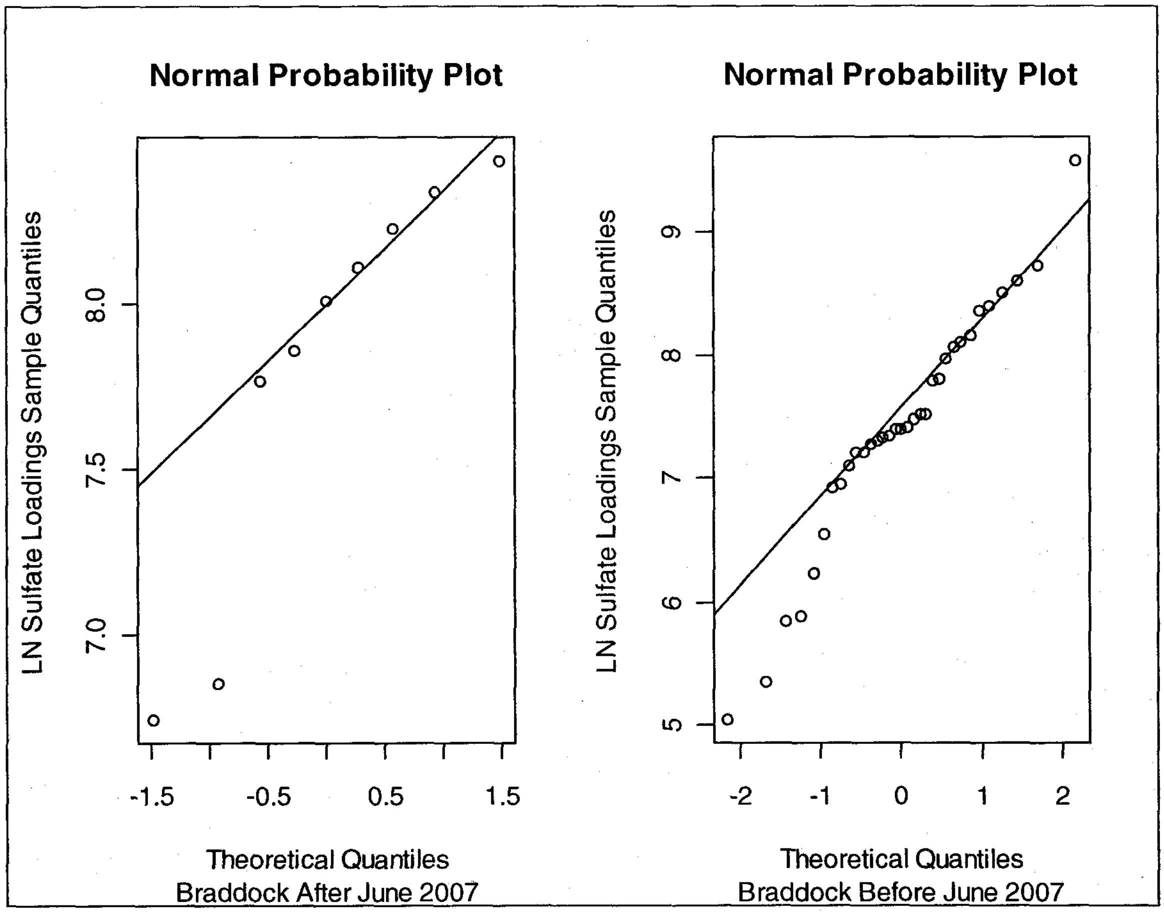


Table 18

Normality Test			
	Shapiro Wilk's Statistic	**P-Value**	**Conclusion**
Sulfates After June2007	0.8343	0.04995	Roughly Log Normal
Sulfates Before June 2007	0.9623	0.2998	Log Normal

Table 19

	Levene's Statistic	**P-Value**	**Conclusion**
Data After June 07 vs. Data Before June 07	1.0171	0.3193	Equal Variance

Table 20

Two Sample T Test		
T-Statistic	**P-Value**	**Conclusion**
0.407	0.343	Not Statistically Different

Comparison of TDS Loadings – Sulfate Loadings Before June 2007 and After June 2007

To determine whether the mean TDS Loadings – Sulfate Loadings before June 2007 are equal to the mean TDS Loadings – Sulfate Loadings after June 2007 a standard, two-sample student's T-Test was performed. There are two assumptions for the T-Test: that the data distributions are roughly normal and that the variances of each group are equal. If the variances are not equal then the Satterthwaite's approximation should be used. Note that there are limitations associated with this analysis based on the small sample size and unequal spacing of the loadings as discussed in the statistical summary.

The normality of the data distributions was examined by reviewing normal probability plots, a boxplot, and a histogram of the combined data. If the data have the statistically indistinguishable distributions then the two data sets are concluded to represent the same population. On the normality plot if the data follow the same distribution then the loadings will be aligned and randomly distributed about the expected normal line. For the boxplots and histograms if the data sets come from one distribution then the data will be roughly symmetric with no breaks in loadings and no extreme loadings. The Shapiro-Wilk W test is used to test for normality. If the W statistic is significant then the hypothesis that the respective distribution is normal should be rejected. A p-value was computed to verify this. If the computed p-value was greater than 0.05 then it was concluded that the data follow the distribution being tested. If the p-value was greater than 0.01 but less than 0.05 it was concluded that the data roughly follow the distribution being tested. A p-value less than 0.01 was concluded to indicate that the data do not follow the tested distribution.

The equal variance assumption was tested using Levene's test. If the p-value for this test was less than 0.05 it was concluded that the variance of the two data sets differ; otherwise the variances were concluded to be the same, or at least indistinguishable.

After evaluating the statistical characteristics described above, a one-sided T-Test was conducted. If the p-value for the T-Test was less than 0.05 it was concluded that the mean loadings after June 2007 are greater than the mean loadings before June 2007.

The raw data were plotted for all three locations. Upon inspection of the plots it was evident that the data followed a skewed distribution. Therefore all tests were conducted based on log-transformed data. This transformation replaces the data values with their logarithms, with the expectation that the log-transformed values will more closely follow a normal distribution. Table 21 contains the Shapiro Wilk Test output for all locations. From this table it can be seen that all p-values are greater than 0.05 indicating that the data follow distributions that are indistinguishable from a log-normal distribution.

Table 21

	Shapiro Wilk Statistic	P-Value	Data Distribution
Point Marion	0.9637	0.1342	Log Normal
Charleroi	0.9524	0.04998	Roughly Log Normal
Braddock	0.9855	0.8637	Log Normal

Point Marion Data Evaluation

Figure 19 is the normal probability plot of the combined Point Marion TDS Loadings – Sulfate. The two data sets are well interspersed over the entire loading range. The data are roughly aligned with the expected normal line. Figure 20 contains the boxplot and histogram of the combined data. From this plot it can be seen that the data are roughly symmetric and there does not appear to be any clustering of loadings according to data set. Based on these observations the two data sets are concluded to represent the same population.

Figure 19

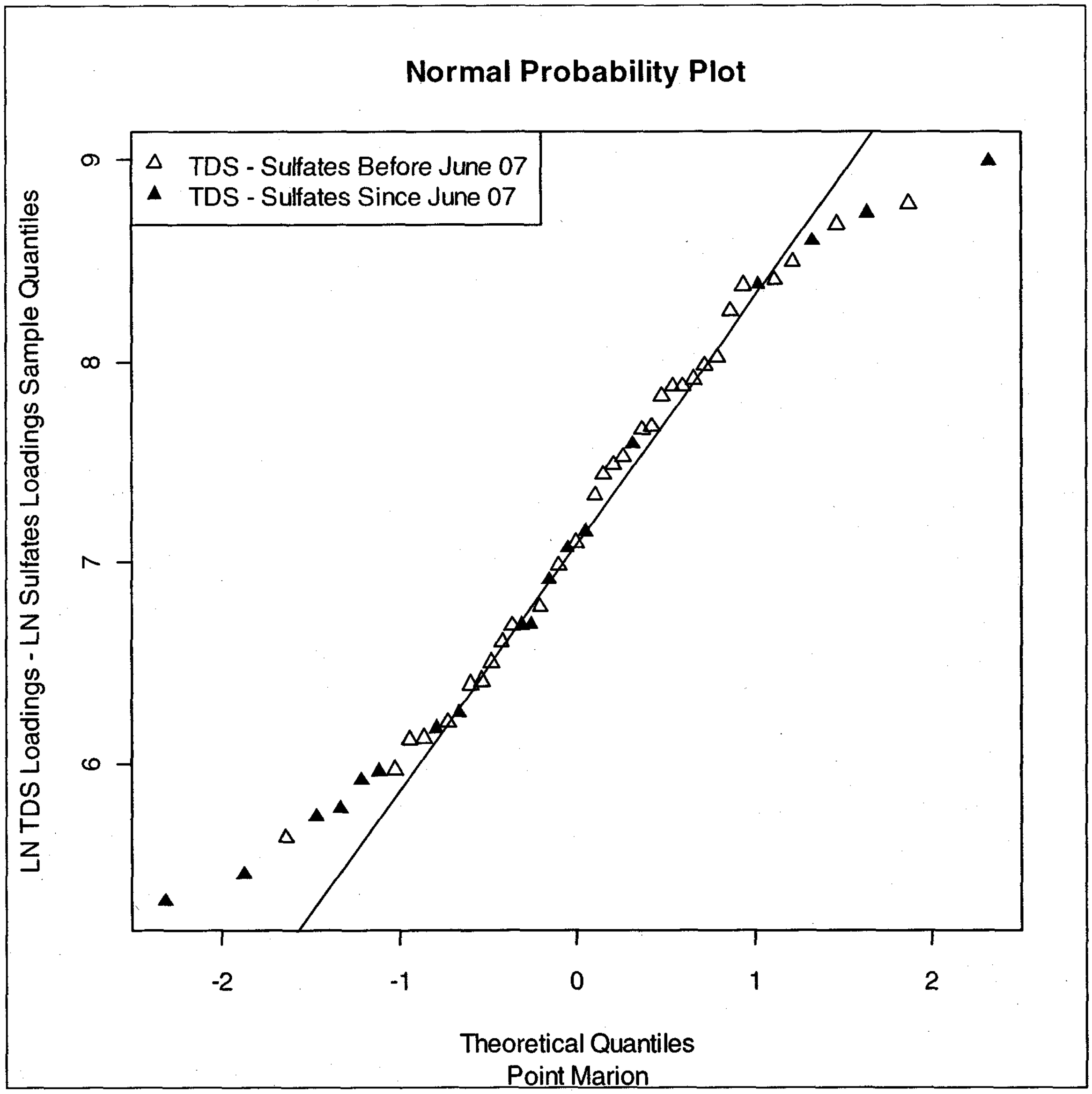

Normal Probability Plot
TDS - Sulfates Before June 07
TDS - Sulfates Since June 07
LN TDS Loadings - LN Sulfates Loadings Sample Quantiles
9
8
7
6
-2
-1
0
1
2
Theoretical Quantiles
Point Marion

Figure 20

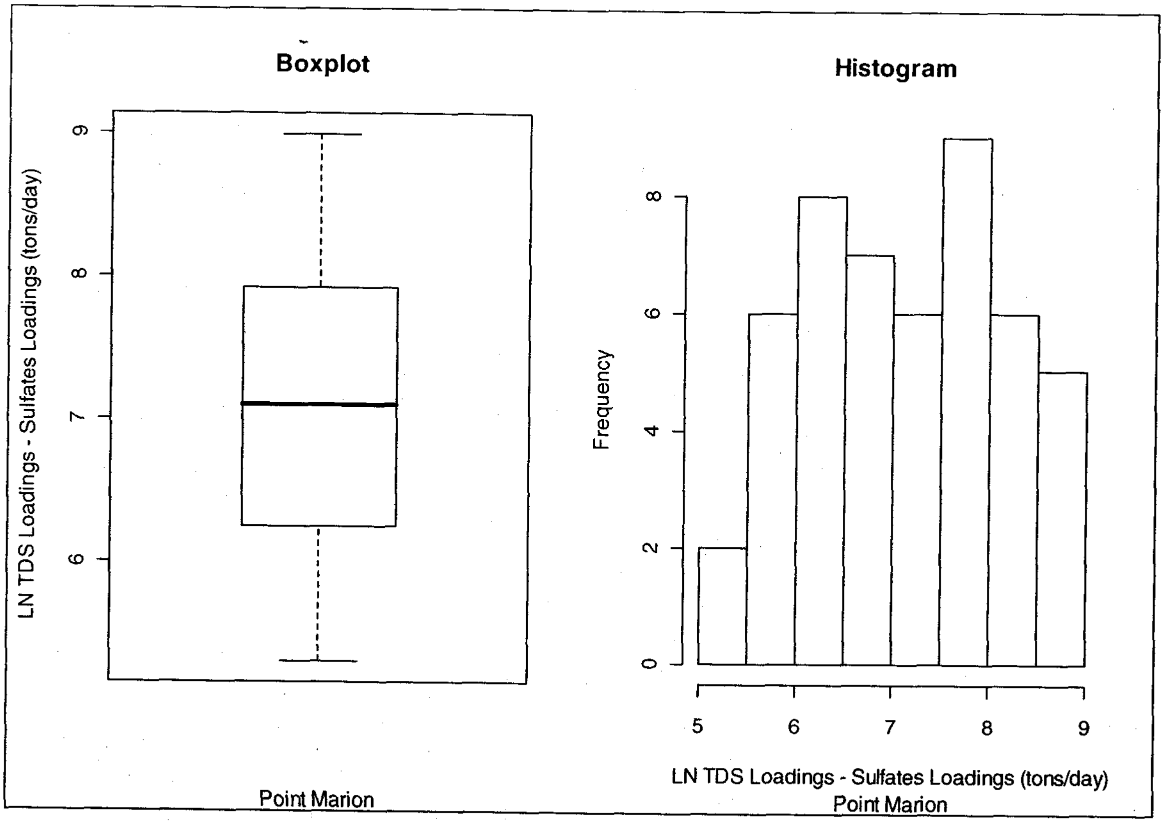


Figure 21 is the individual normal probability plots of the two log-transformed data sets for Point Marion. The data both roughly aligned with the expected normal line. There are two loadings from the After June 2007 data set that slightly deviate from the expected normal line indicating that there might be a slight departure from normality. Table 22 contains the Shapiro Wilk statistics for the log-transformed data. The p-values are greater than 0.05 indicating that the data set distributions are indistinguishable from log-normal distributions. Table 23 contains the Levene's equal variance test outputs. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal, or at lest indistinguishable, variances. The equal variance two sample T-test was then conducted. The results can be found in Table 24. From this table it can be seen that the p-value is 0.668. The T-statistic associated with the p-values are also presented. If the test statistic is greater than that the T-value associated with 0.05 then the null hypothesis is rejected. This is the case, therefore it is concluded that the mean loadings are not different.

Figure 21

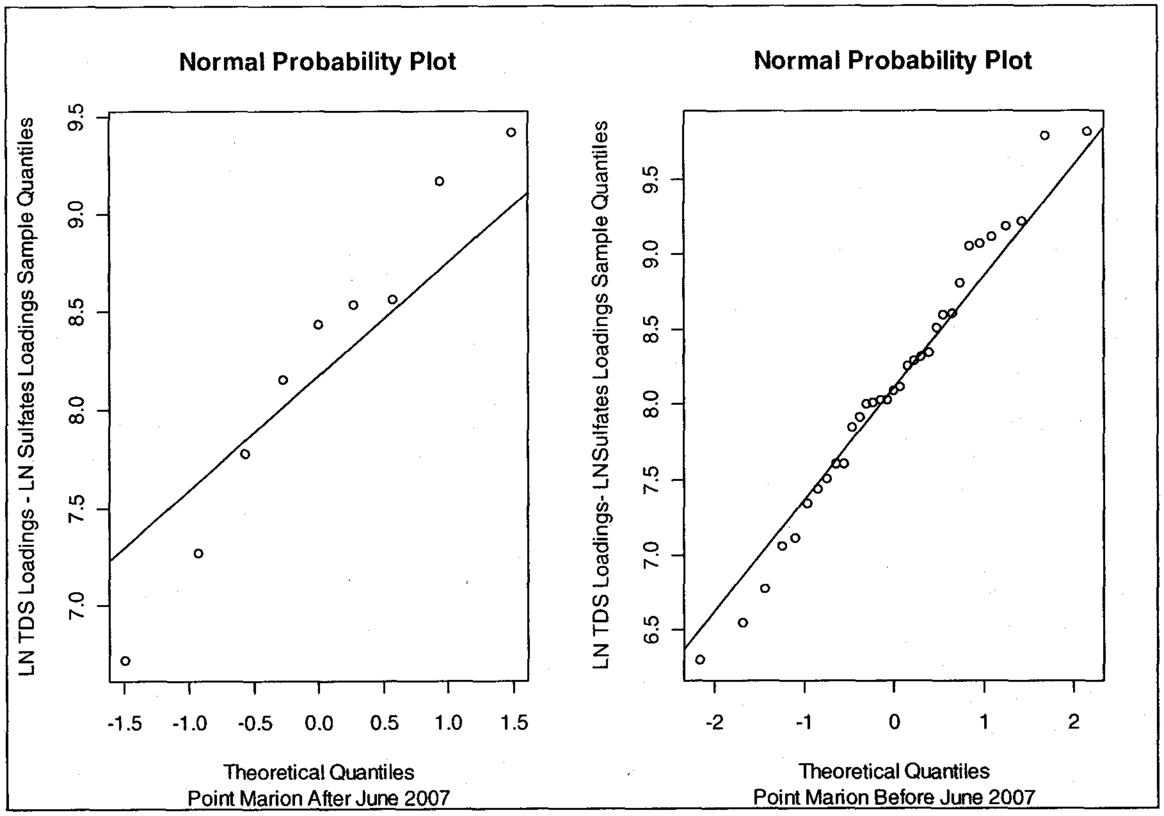


Table 22

Log-Normal Test			
	Shapiro Wilk 's Statistic	**P-Value**	**Conclusion**
TDS LOADINGS - SULFATE LOADINGS After June 2007	0.918	0.1193	Log Normal
TDS LOADINGS - SULFATE LOADINGS Before June 2007	0.958	0.2586	Log Normal

Table 23

	Levene's Statistic	**P-Value**	**Conclusion**
Data After June 07 vs. Data Before June 07	1.6244	0.2088	Equal Variance

Table 24

Two Sample T Test		
T-Statistic	P-Value	Conclusion
-0.436	0.668	Not Statistically Different

Charleroi Data Evaluation

Figure 22 is the normal probability plot of the combined Charleroi TDS Loadings – Sulfate Loadings. The two data sets are well interspersed across the entire loading range and there is no significant clustering in either data set. Also, the data are fairly well aligned with the expected normal line with some systematic deviations (undulating data set superposed on straight line). Figure 23 contains the boxplot and histogram of the combined data. From this plot it can be seen that the data are roughly symmetric and there do not appear to be any clustering or extreme values. Based on these observations the two data sets are concluded to represent the same population.

Figure 22

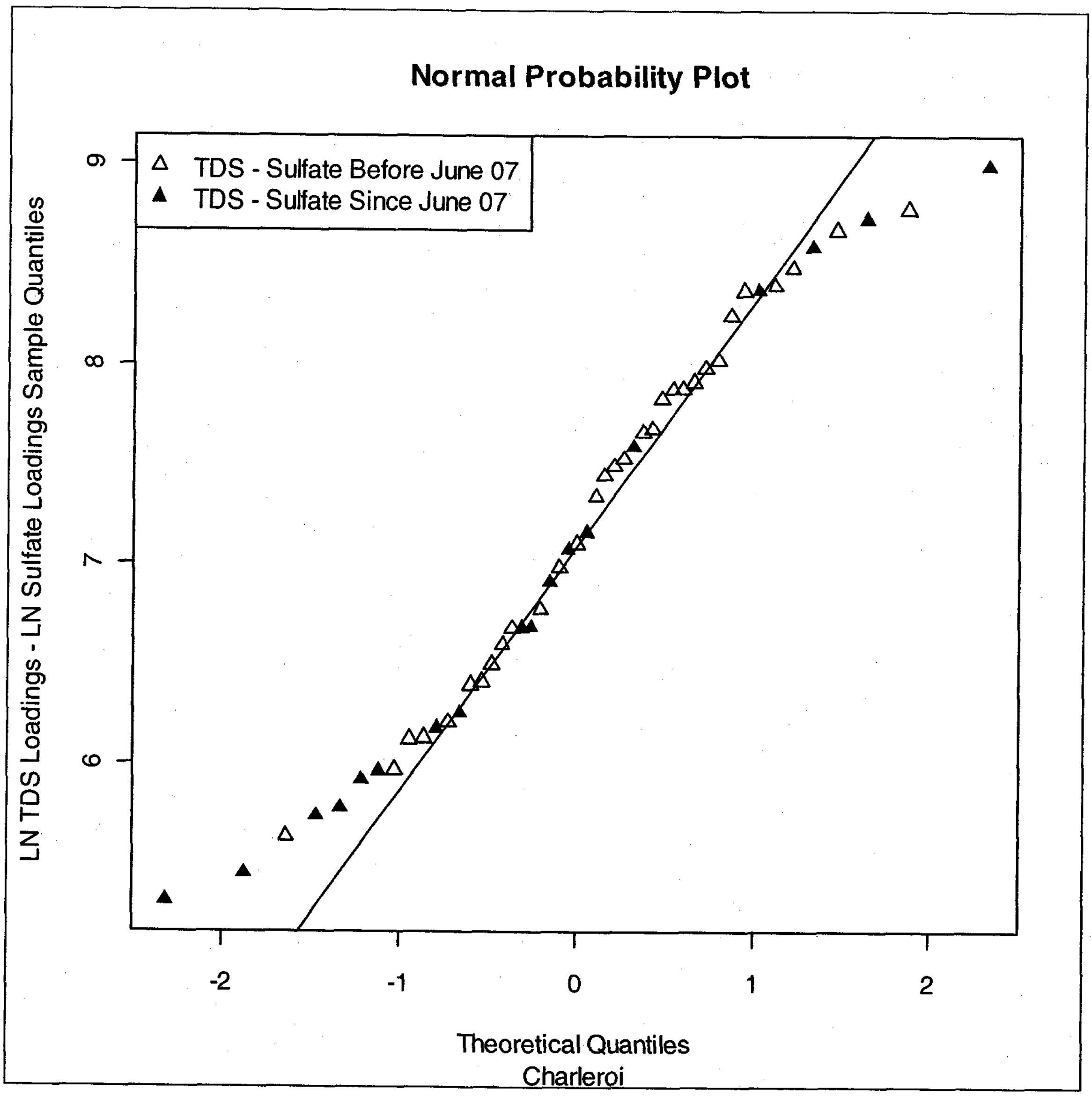


Figure 23

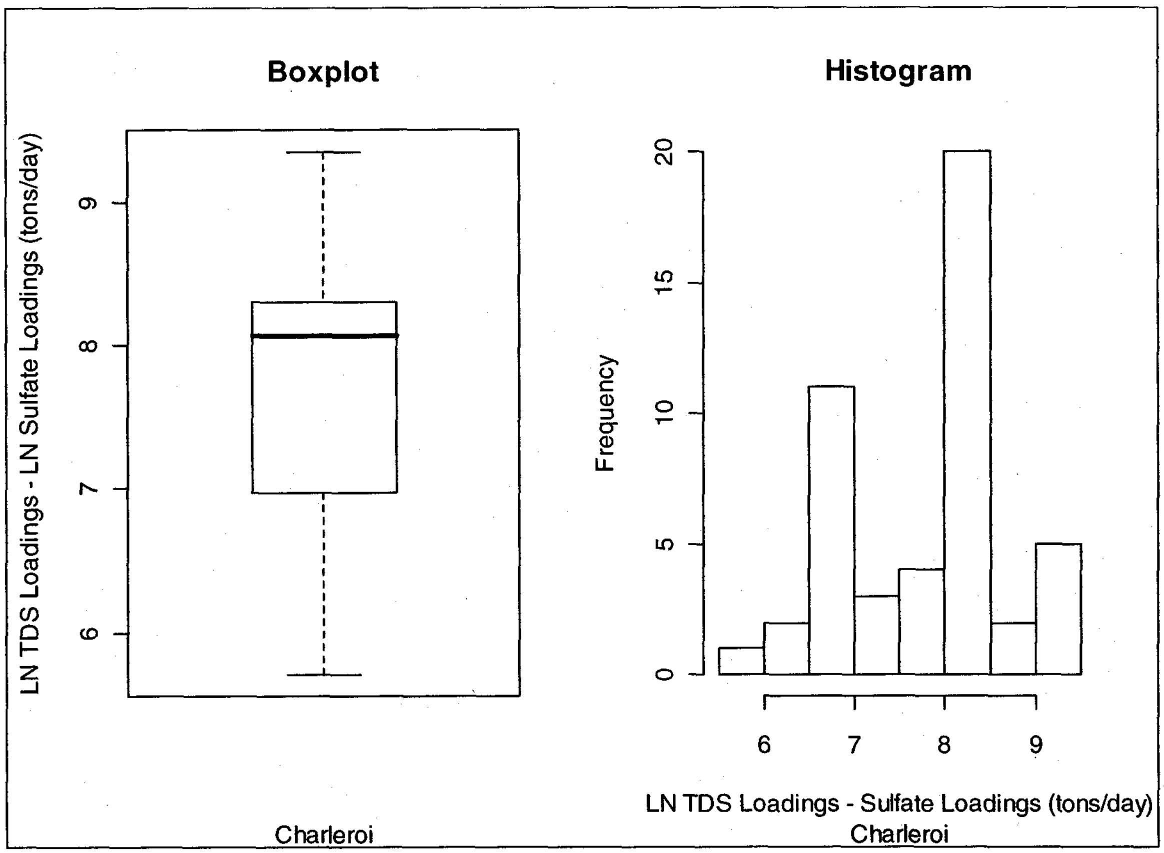


Figure 24 is the individual normal probability plots of the two log-transformed data sets for Charleroi. From this figure it can be seen that the data are roughly aligned with the expected normal line. Table 25 contains the Shapiro Wilk statistics for the log-transformed data. From this table it can be seen that the p-values are greater than 0.05 indicating that the data set distributions are indistinguishable from log-normal distributions. Table 26 contains the Levene's equal variance test results. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal, or at least indistinguishable, variances. The equal variance, two sample T-test was then conducted. The results can be found in Table 27. From this table it can be seen that the p-value is 0.437. Therefore it is determined that the mean loadings are not different.

Figure 24

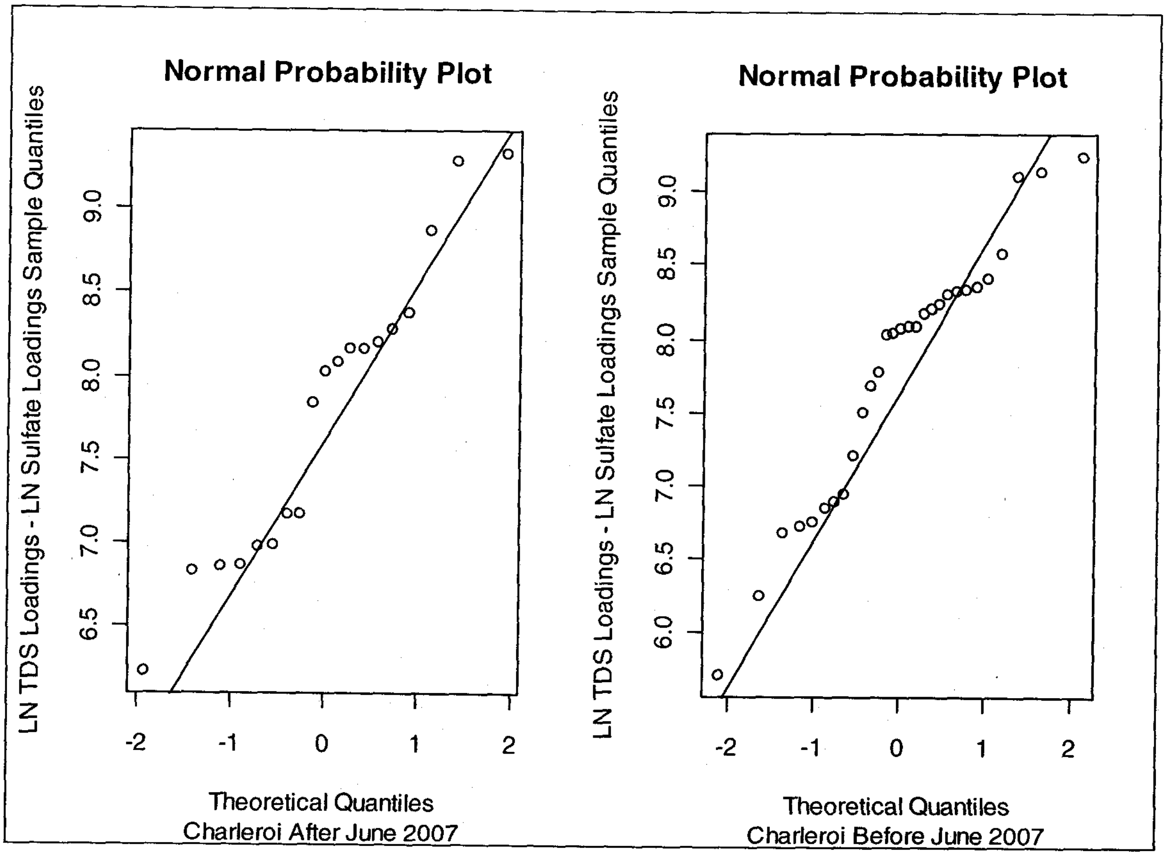


Table 25

Log Normal Test			
	Shapiro Wilk's Statistic	**P-Value**	**Conclusion**
TDS LOADINGS - SULFATE LOADINGS After June 2007	0.9402	0.2664	Log Normal
TDS LOADINGS - SULFATE LOADINGS Before June 2007	0.9428	0.1186	Log Normal

Table 26

	Levene's Statistic	**P-Value**	**Conclusion**
Data After June 07vs. Data Before Jun 07	0.0494	0.825	Equal Variance

Table 27

Two Sample T-Test		
T-Statistic	**P-Value**	**Conclusion**
0.158	0.437	Not Statistically Different

Braddock Data Evaluation

Figure 28 is the normal probability plot of the combined Braddock TDS Loadings - Sulfates. The two data sets are well interspersed and well aligned with the theoretical normal line. Figure 29 contains the boxplot and histogram of the combined data. The data are roughly symmetric and there does not appear to be any clustering of loadings according to data set. Therefore the two data sets are concluded to represent the same population.

Figure 28

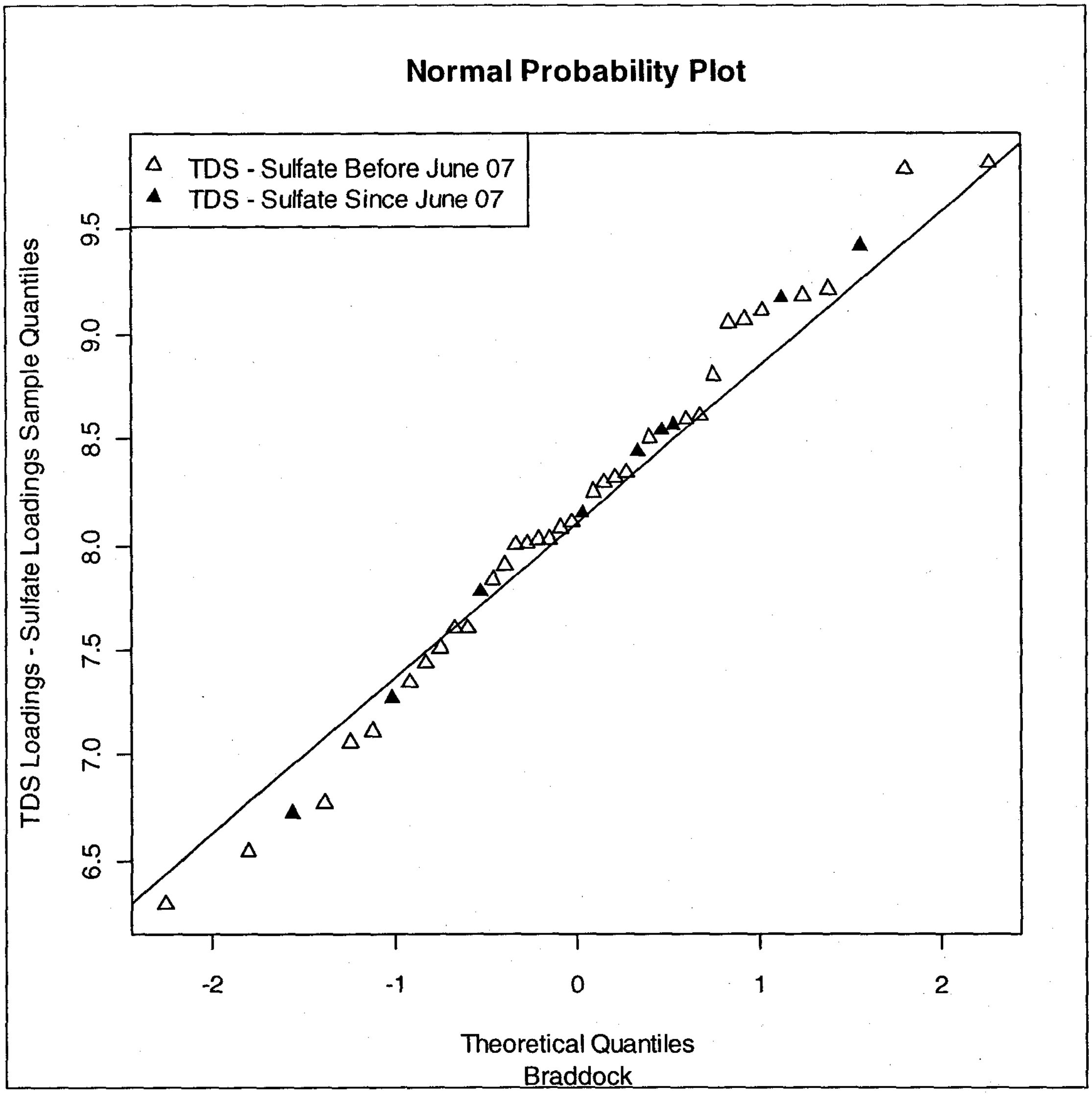


Figure 29

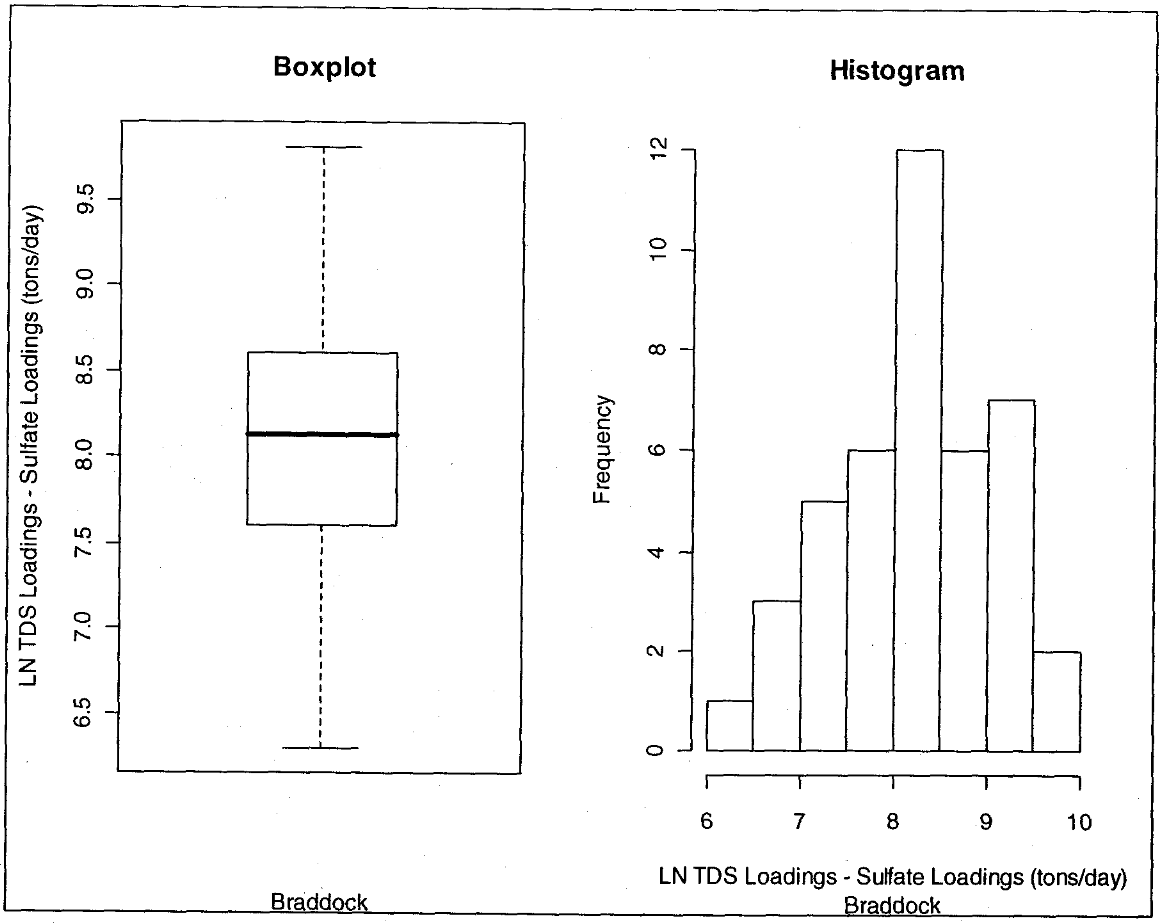


Figure 30 contains the individual normal probability plots of the two log-transformed data sets for Braddock. The data are well aligned with the theoretical normal line. Table 31 contains the Shapiro Wilk statistics for the log-transformed data. The p-values are greater than 0.05 indicating that the data set distributions are indistinguishable from log-normal distributions. Table 32 contains the Levene's equal variance test results. The p-value for this test is greater than 0.05 so it is concluded that the data sets have equal, or at least indistinguishable, variances. The equal variance, two sample T- test was then computed. The results can be found in Table 33. From this table it can be seen that the p-value is 0.447. Therefore it is concluded that the mean loadings are not different.

Figure 30

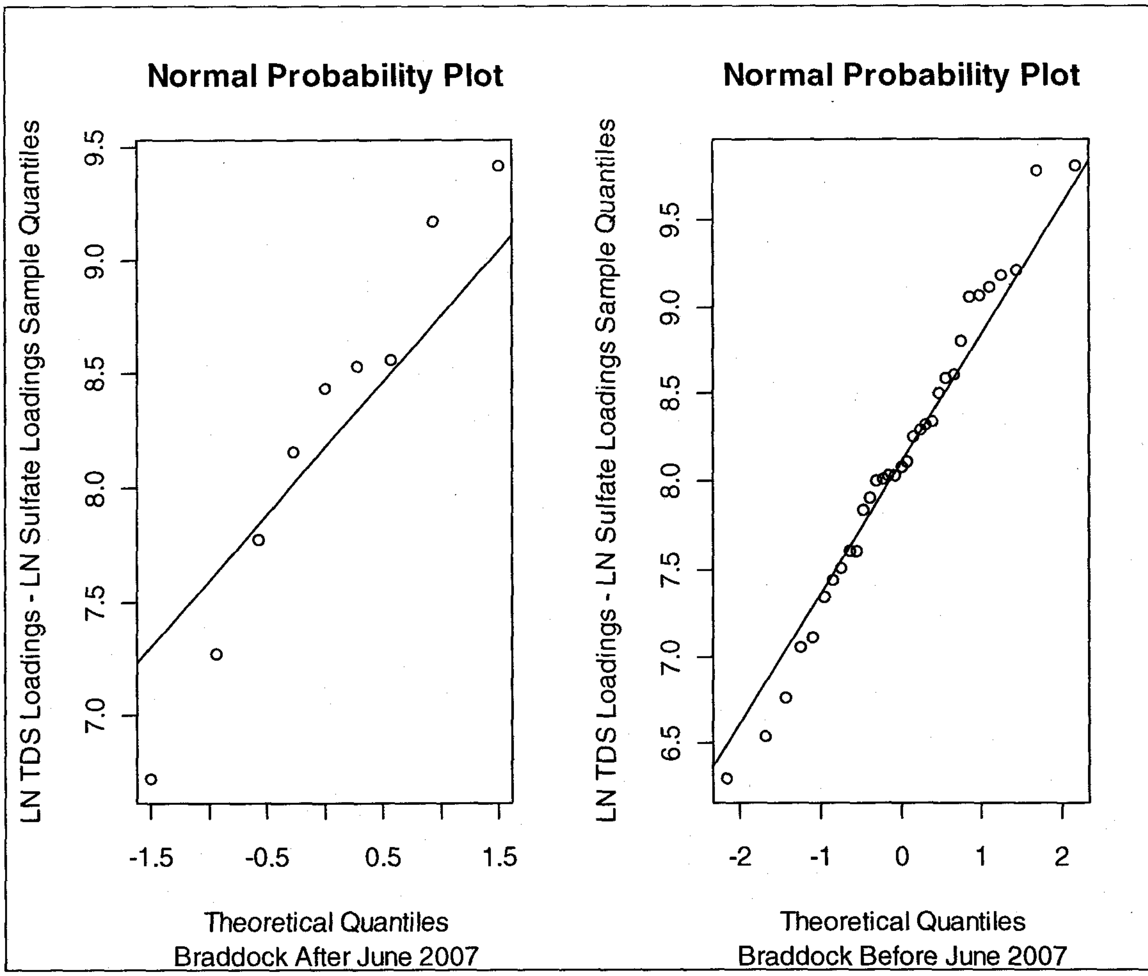


Table 31

Normality Test			
	Shapiro Wilk's Statistic	**P-Value**	**Conclusion**
TDS LOADINGS - SULFATE LOADINGS After June 2007	0.9645	0.844	Log Normal
TDS LOADINGS - SULFATE LOADINGS Before June 2007	0.9844	0.906	Log Normal

Table 32

	Levene's Statistic	P-Value	Conclusion
Recent Data vs. Data Before June 07	3e-04	0.9865	Equal Variance

Table 33

Two Sample T Test		
T-Statistic	**P-Value**	**Conclusion**
0.135	0.447	Not Statistically Different

Trend Analysis

To determine whether the sulfate loadings as a percentage of TDS (Sulfate/TDS), and the percentage of TDS loadings not related to Sulfates (1-Sulfate/TDS) were increasing over time at Point Marion, Charleroi, and Braddock a statistical analysis was conducted. First the loadings were plotted over time to look for general upward or downward trends. After inspection of the time plots for general trends the plots were also inspected for seasonality effects (i.e., patterns associated with data collection time). After the visual inspection the appropriate Mann-Kendall trend test was performed. Gilbert states that for multiple observations per time period (i.e., monthly) a summary statistic such as the median for each time period can be computed and then apply the Mann-Kendall test to the medians (Gilbert 1987). This nonparametric test provides a quantitative and objective measure of the presence of trends. As discussed in the statistical summary there is some uncertainty associated with the trend test due to the data not being collected in equally spaced time intervals and the data from Point Marion and Charleroi after June 2007 collecting multiple observations from several months.

Figure 28 is a plot of the Point Marion Sulfate loadings as a percentage of TDS over time. The data appear to be fluctuating up and down with an overall increasing trend. Figure 29 is a plot of the Point Marion percentage of TDS not related to Sulfates over time. From this plot there appears to be a slight downward trend in loading over time and there does appear to be some slight fluctuation of TDS Loadings not affected by Sulfates. It is assumed that fluctuations observed in Figures 28 and 29 are due to seasonal variations in river flow rates.

Figure 28

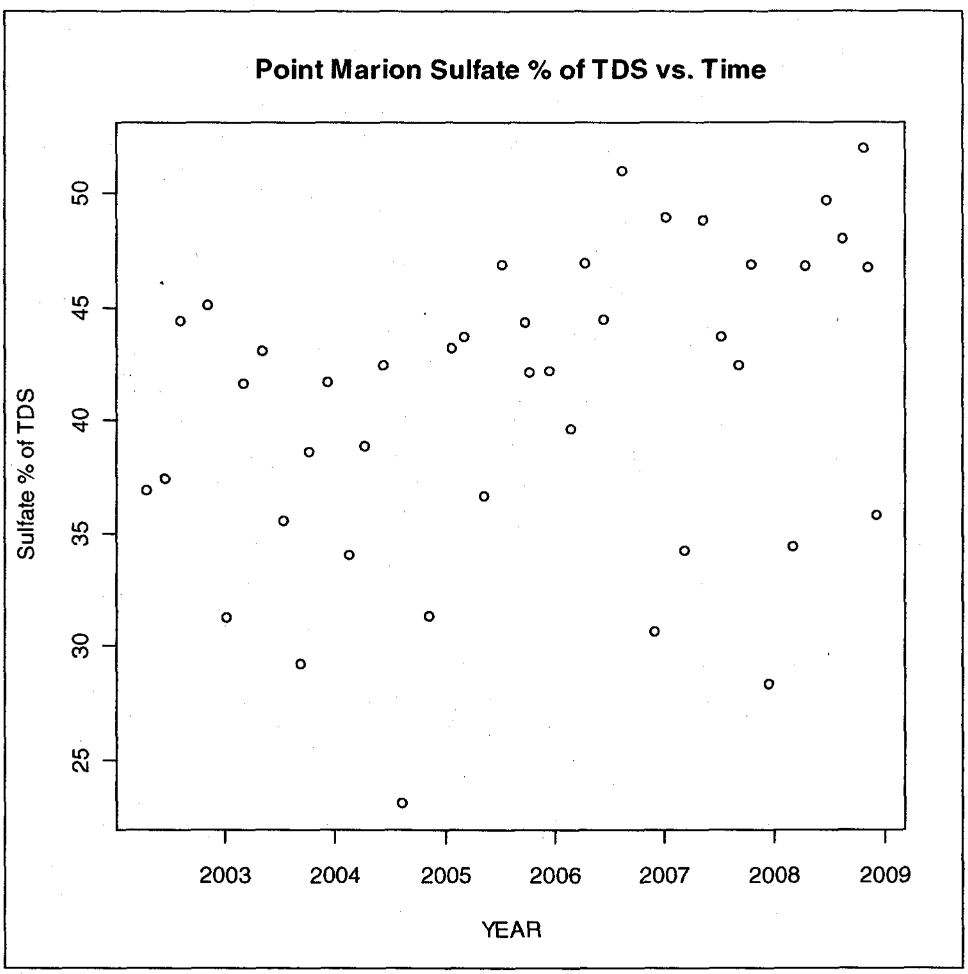
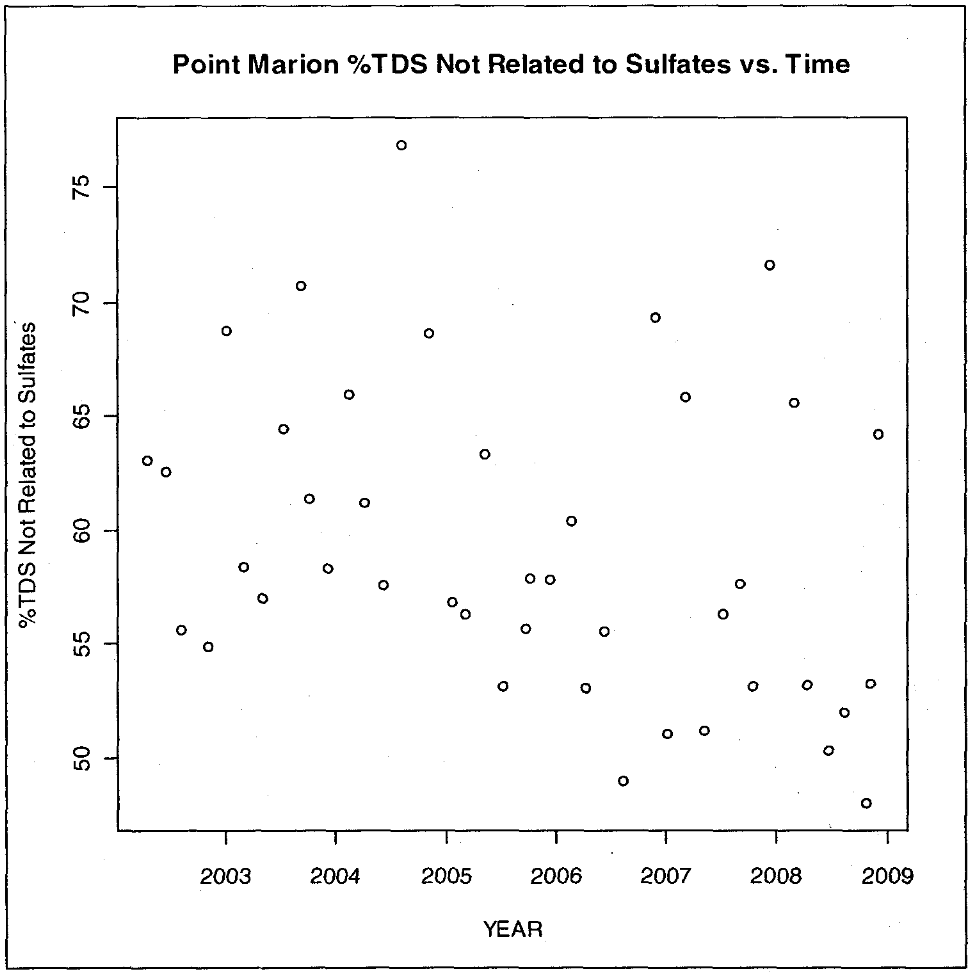


Figure 29



The Seasonal Kendall test was not used for this analysis because there are not loadings for each month for all years that the data spans. Therefore the Mann Kendall Trend test (normal approximation) was used to test for overall trends. The starting hypothesis is that there is no trend and the burden of proof is on the data to show otherwise. The p-value is the probability that the hypothesis is true given the data. If the p-value was less than 0.05 then it was concluded that the hypothesis is false and that there is a trend. Table 31 contains the test statistics, p-values, and conclusions for the Mann Kendall Trend tests for both Point Marion data sets. From the table it can be seen that the p-values for both tests are 0.0054335, therefore trends are evident in the Sulfate as Percentage of TDS and Percentage of TDS not related to Sulfates.

Table 31

Mann Kendall Trend Test Point Marion			
	Z Statistic	**P-Value**	**Conclusion**
Sulfate % TDS	8.05	0.0054335	Upward Trend
%TDS Not Related to Sulfate	-8.05	0.0054335	Downward Trend

Figure 30 is a plot of the Charleroi Sulfate loadings as a percentage of TDS over time. No trends or seasonality are evident. Figure 31 is a plot of the Charleroi percentage of TDS not related to Sulfates over time. From this plot there does not appear to be any trend in loading over time or any seasonal effects.

Figure 30

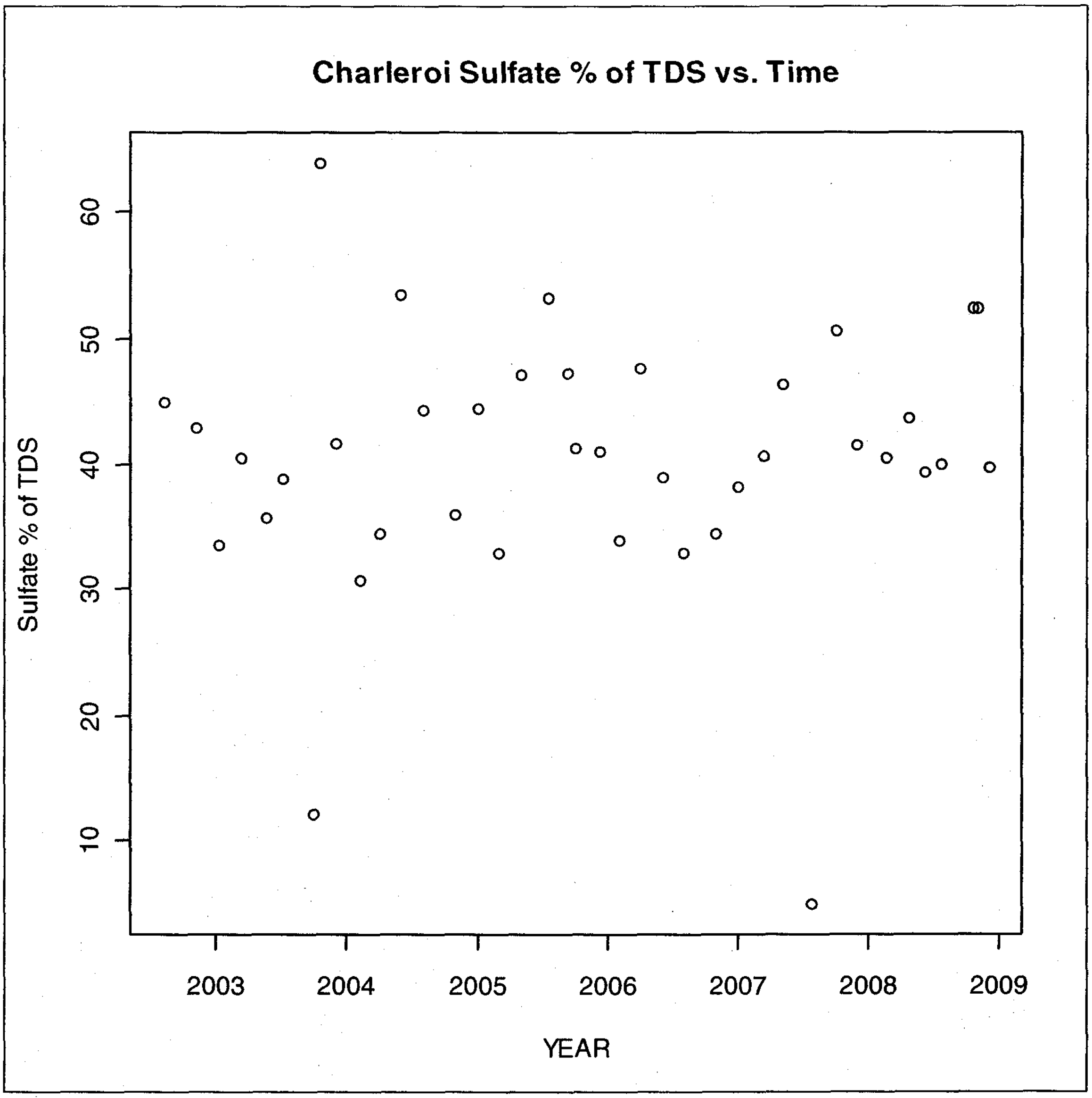
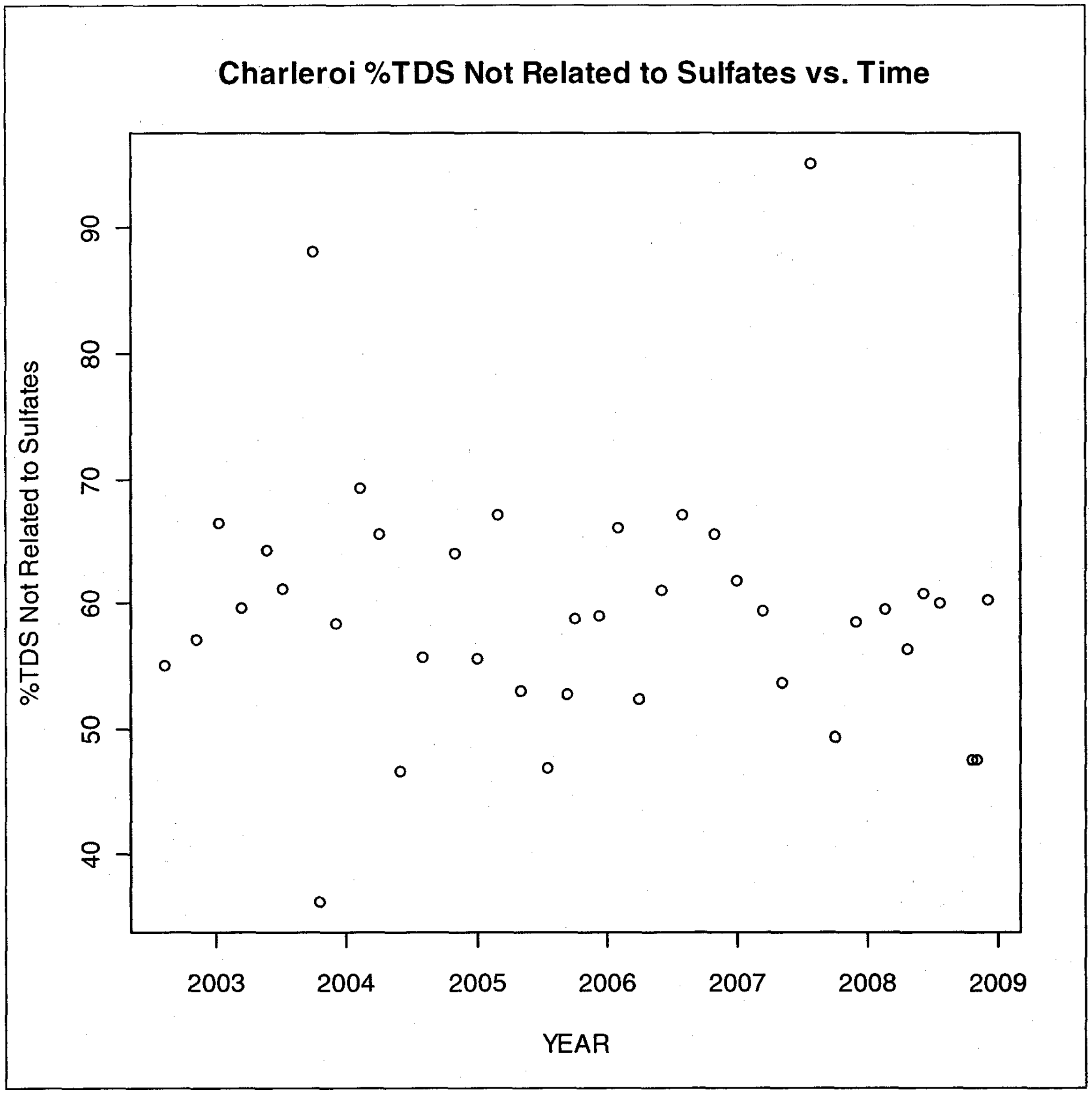

Charleroi Sulfate % of TDS vs. Time
Sulfate % of TDS
10
20
30
40
50
60
2003
2004
2005
2006
2007
2008
2009
YEAR

Figure 31



Neither data set for Charleroi exhibited any seasonality effects so the Mann Kendall trend test was used to statistically determine whether a trend is present. The p-value is the probability that the hypothesis is true given the data. If the p-value is less than 0.05 then it was concluded that the hypothesis is false and that there is a trend. Table 32 contains the test statistics, p-values, and conclusions for the Mann Kendall Trend tests for both Charleroi data sets. From the table it can be seen that the p-values for both tests are 0.24907, therefore no trends are seen in the Sulfate as Percentage of TDS and Percentage of TDS not related to Sulfates.

Table 32

Mann Kendall Trend Test Charleroi			
	Z Statistic	P-Value	Conclusion
Sulfate	0.6774	0.24907	No Trend
TDS-Sulfate	-0.6774	0.24907	No Trend

Figure 32 is a plot of the Braddock loadings as a percentage of TDS over time. The data appear to be randomly distributed with a slight increasing trends with no temporal patterns and hence no seasonality. Figure 33 is a plot of the Braddock percentage of TDS not related to Sulfates over time. From this plot there appears to be a slight downward trend in loading over time with no temporal patterns and or seasonal effects.

Figure 32

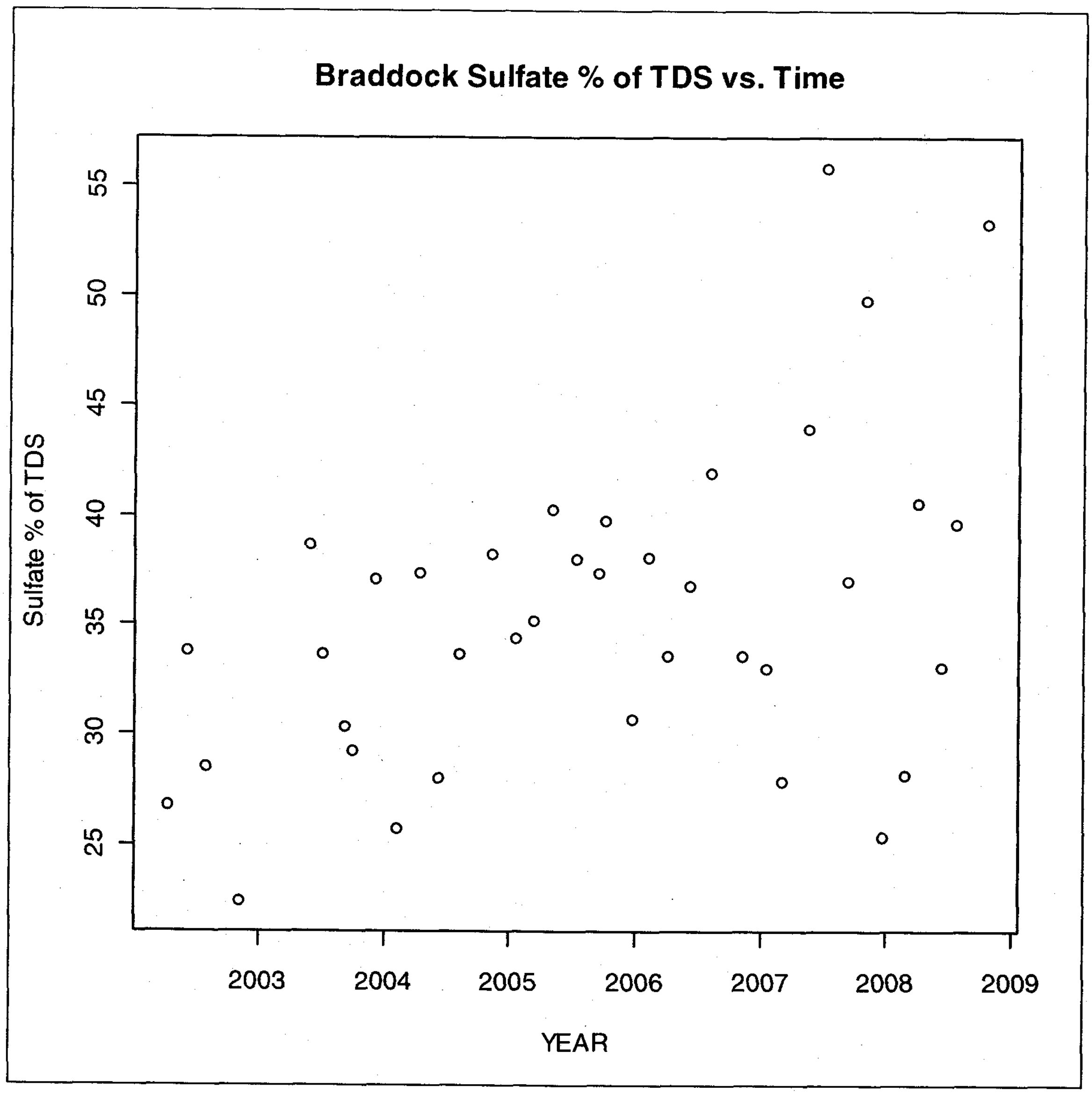
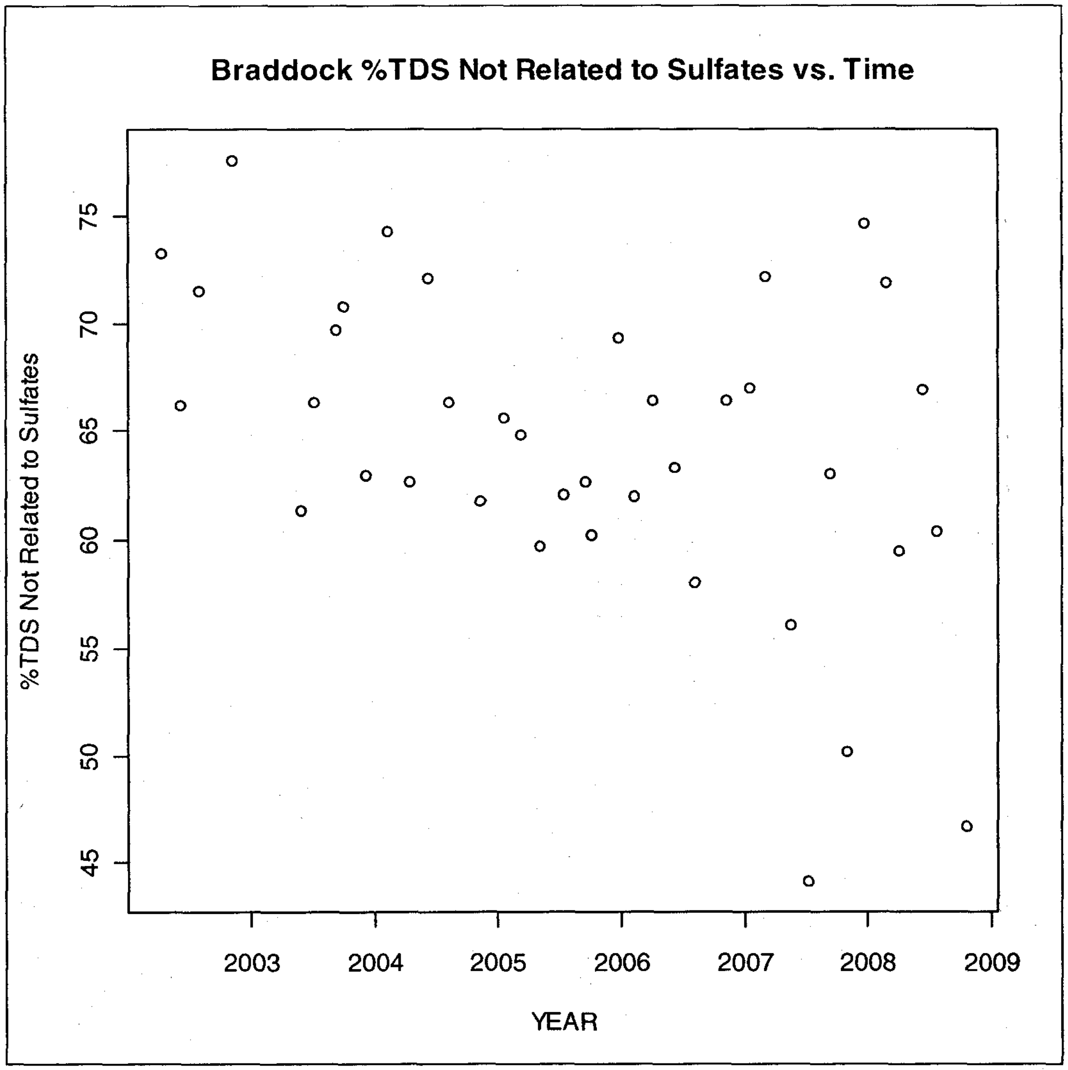


Figure 33



Neither data set for Braddock exhibited any seasonality effects so the Mann Kendall trend test was used to statistically determine if a trend is present. The hypothesis is that there is no trend. The p-value is the probability that the hypothesis is true given the data. If the p-value is low (less than 0.05) then it was concluded that the hypothesis is false and there is a trend. Table 33 contains the test statistics, p-values, and conclusions for the Mann Kendall Trend tests for both Braddock data sets. From the table it can be seen that the p-values for both tests are 0.009684, therefore trends are seen in the Sulfate as Percentage of TDS and Percentage of TDS not related to Sulfates. Sulfates as Percentage of TDS has an upward trend and Percentage of TDS not related to Sulfates has a downward trend.

Table 33

Mann Kendall Trend Test Braddock			
	Z Statistic	**P-Value**	**Conclusion**
Sulfate	2.34	0.009684	Upward Trend
TDS-Sulfate	-2.34	0.009684	Downward Trend

Statistical Summary

A statistical analysis was carried out to determine if the TDS Loadings, Sulfate Loadings, or the Difference between TDS and Sulfate Loadings before June 2007 are statistically different from loadings after June 2007. The analysis was completed for three locations: Point Marion, Charleroi, and Braddock. The statistical analysis consisted of visual comparisons of the data (boxplots, normal probability plots, and histograms) as well as an appropriate hypothesis test. For the visual comparisons the data was examined to see if there were groupings of loadings based on sample date which would indicate that the loadings are not all equal and that there is some connection between the sample date and loading. The data was also visually examined for separations of loadings which would indicate that the separated loadings are not equal. From the statistical analysis the TDS Loadings, Sulfate Loadings, and the difference between the TDS and Sulfate Loadings before and after 2007 are not statistically different. Note that there are some limitations to the datasets. The data sets are limited in size and the data was not collected in equally spaced time intervals. For Point Marion there are 31 loadings from before June 2007 and 19 loadings from after June 2007. There are 29 loadings from Charleroi before June 2007 and 19 loadings after June 2007. For Braddock there are 33 loadings before June 2007 and 9 loadings after June 2007. For Point Marion and Charleroi the data from after June 2007 has several loadings collected over a two month period while the data sets from before June 2007 is spread out over time. Conclusions for each analysis are presented below.

<u>TDS Loadings</u>

- Point Marion
  - Visual comparison shows that there does not appear to be any grouping of loadings based on sample date and there is no indication of separations of loadings.
  - The formal statistical hypothesis test concludes that mean loadings before June 2007 and after June 2007 are not statistically different (alpha 0.05).
- Charleroi
  - Visual comparison does not show any grouping of the loadings based on sample date and there is no indication of separation of loadings.
  - The formal statistical hypothesis test concludes that the mean loadings before June 2007 and after June 2007 are not statistically different (alpha 0.05).
- Braddock
  - Visual comparisons show no indication of grouping of loadings based on sample date and there is no indication of separation of loadings.
  - Formal statistical hypothesis test concludes that mean loadings are not different (alpha 0.05).

Sulfate Loadings

- Point Marion
  - Visual comparison does not show any grouping of loadings based on sample date and there is no indication of separations of loadings.
  - The formal statistical hypothesis test concludes that mean loadings before June 2007 and after June 2007 are not statistically different (alpha 0.05).
- Charleroi
  - Visual comparison does not show any grouping of loadings based on sample date and there is no indication of separation of loadings.
  - The formal statistical hypothesis test concludes that mean loadings before June 2007 and after June 2007 are not statistically different (alpha 0.05).
- Braddock
  - Visual comparisons show no indication of grouping of loadings based on sample date and there is no indication of separation of loadings.
  - Formal statistical hypothesis test concludes that mean loadings are not different (alpha 0.05).

Difference between TDS and Sulfate Loadings

- Point Marion
  - Visual comparison does not show any grouping of loadings based on sample date and there is no indication of separations of loadings.
  - The formal statistical hypothesis test concludes that mean loadings before June 2007 and after June 2007 are not statistically different (alpha 0.05).
- Charleroi
  - Visual comparison does not show any grouping of the loadings based on sample date and there is no indication of separation of loadings.
  - The formal statistical hypothesis test concludes that mean loadings before June 2007 and after June 2007 are not statistically different (alpha 0.05).
- Braddock
  - Visual comparisons show no indication of grouping of loadings based on sample date and there is no indication of separation of loadings.
  - Formal statistical hypothesis test concludes that mean loadings are not statistically different (alpha 0.05).

Monongahela River Flow Rate Calculation

By: CAR — Checked By: ALS
Date: 01/06/09 — Date: 01/07/09

Purpose: Determine method for estimating flow rates in the Monongahela River at Point Marion, Charleroi, and Braddock using data available from gages at Masontown and Elizabeth. The Masontown and Elizabeth gages are the only USGS gages that provide daily flow data for the Monongahela River. The flow rate data for Point Marion, Charleroi, and Braddock are required to evaluate TDS data collected by the PADEP in October, November, and December 2008. The flow rates in the Monongahela River are controlled by the U.S. Army Corps of Engineers. They are also impacted by industrial withdrawals and discharges, mine discharges, and municipal treatment plant discharges. The various controls and impacts on the river make flow rate estimation difficult without extensive information and modeling. The following approach simplifies the estimation process using flow statistics for the river. The results are considered estimates and the accuracy should be sufficient for the TDS study.

(1) Point Marion

A gage was installed and monitored at Point Marion from 1936 to 1955. The next closest gage on the river is at Masontown. This gage has been monitored from 1939 to the present. Mean monthly statistics from the USGS for both gages are provided below. The months of October, November, and December were selected because they coincide with the TDS data collected by the PADEP.

Gage	USGS Gage Number	Period of Record	Drainage Area (sq. mi.)	River Mile	Mean Monthly Discharge (cfs) October	November	December		
Point Marion	3063000	1936-1955	2720	90.8	2000	3070	5760		
Masontown	3072655	1939-2007	4440	82	3500	6900	10900		
				Ratio	**0.57**	**0.44**	**0.53**	Average Ratio	**0.51**

Note: Mean Monthly Discharge taken from USGS National Water Information System, Surface Water Monthly Statistics for Pennsylvania. See attached printouts from the USGS website.

Conclusion: Based on the information available from the USGS, daily average flow rates can be estimated at Point Marion by using measured flow rates at Masontown and the month-specific ratios estimated in the table above. The average ratio will not be used.

(2) Charleroi

(a) A gage was installed and monitored at Charleroi from 1933 to 1976. The gage is located approximately half way between the Masontown and Elizabeth gages. These gages have been monitored since 1939 and 1933, respectively, to the present. Mean monthly statistics from the USGS for the three gages are provided below. The months of October, November, and December were selected because they coincide with the TDS data collected by the PADEP.

Gage	USGS Gage Number	Period of Record	Drainage Area (sq. mi.)	River Mile	Mean Monthly Discharge (cfs) October	November	December		
Masontown	3072655	1939-2007	4440	82	3500	6900	10900		
Charleroi	3075000	1933-1976	5213	41.5	3040	5820	11300		
Elizabeth	3075070	1933-2007	5340	23.8	3680	7060	11500		
		Charleroi-to-Masontown Ratio			**0.87**	**0.84**	**1.04**	Average Ratio	**0.92**
		Charleroi-to-Elizabeth Ratio			**0.83**	**0.82**	**0.98**	Average Ratio	**0.88**

Note: Mean Monthly Discharge taken from USGS National Water Information System, Surface Water Monthly Statistics for Pennsylvania. See attached printouts from the USGS website.

Conclusion: The ratios estimated for Charleroi are nearly identical. Data from either the Masontown or Elizabeth gage could be used to estimate the flow at Charleroi. However, because Charleroi is closer to the Elizabeth gage and the drainage areas are similar, it is recommended that the Charleroi-to-Elizabeth ratios be used. The daily average flow rates can be estimated at Charleroi by using measured flow rates at Elizabeth and the month-specific ratios estimated in the table above. The Charleroi-to-Masontown and average ratios will not be used.

(b) Additional ratios are required for Charleroi to finalize the data set to be used to evaluate statistical trends in the TDS data. The following table summarizes the mean monthly statistics for the months of January, March, May, and July.

Gage	USGS Gage Number	Period of Record	Drainage Area (sq. mi.)	River Mile	Mean Monthly Discharge (cfs) January	March	May	July
Charleroi	3075000	1933-1976	5213	41.5	14200	18000	9460	3880
Elizabeth	3075070	1933-2007	5340	23.8	13700	18000	10200	4460
		Charleroi-to-Elizabeth Ratio			**1.04**	**1.00**	**0.93**	**0.87**

Note: Mean Monthly Discharge taken from USGS National Water Information System, Surface Water Monthly Statistics for Pennsylvania. See attached printouts from the USGS website.

Conclusion: The daily average flow rates can be estimated at Charleroi by using measured flow rates at Elizabeth and the month-specific ratios estimated in the table above.

(3) Braddock

A gage was installed and monitored at Braddock from 1939 to 2003. The next closest gage on the river is at Elizabeth. This gage has been monitored since 1933 to the present. Mean monthly statistics from the USGS for both gages are provided below. The months of October, November, and December were selected because they coincide with the TDS data collected by the PADEP.

Gage	USGS Gage Number	Period of Record	Drainage Area (sq. mi.)	River Mile	Mean Monthly Discharge (cfs)				
					October	November	December		
Braddock	3085000	1939-2003	7337	11.2	5295	9240	15310		
Elizabeth	3075070	1933-2007	5340	23.8	3680	7060	11500		
				Ratio	**1.44**	**1.31**	**1.33**	Average Ratio	**1.36**

Note: Mean Monthly Discharge taken from USGS National Water Information System, Surface Water Monthly Statistics for Pennsylvania. See attached printouts from the USGS website.

Conclusion: Based on the information available from the USGS, daily average flow rates can be estimated at Braddock by using measured flow rates at Elizabeth and the month-specific ratios estimated in the table above. The average ratio will not be used.

USGS Surface-Water Monthly Statistics for Pennsylvania

The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, click here.

USGS 03063000 Monongahela R at Lock & Dam 8, at Pnt Marion, PA

Available data for this site Time-series: Monthly statistics GO

	Output formats
Fayette County, Pennsylvania Hydrologic Unit Code 05020003 Latitude 39°43'37", Longitude 79°54'42" NAD27 Drainage area 2,720 square miles Gage datum 782.50 feet above sea level NGVD29	HTML table of all data Tab-separated data Reselect output format

00060, Discharge, cubic feet per second,	
	Monthly mean in cfs (Calculation Period: 1936-10-01 -> 1955-09-30)

YEAR	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1936										622.7	2,084	5,138
1937	18,920	7,827	5,939	7,138	5,948	4,181	892.5	1,971	2,227	7,372	3,630	6,436
1938	4,111	7,804	7,382	5,762	7,275	4,850	1,192	1,243	586.3	487.7	1,139	3,482
1939	4,637	15,900	7,975	10,840	841.1	3,287	3,322	1,216	596.7	820.7	787.2	2,270
1940	2,181	9,696	7,313	12,620	4,563	6,132	2,666	812.8	1,483	1,132	4,134	4,455
1941	6,089	1,999	5,200	2,919	936.2	5,780	2,563	2,209	1,980	743.0	2,429	3,243
1942	3,293	6,011	6,756	3,797	3,161	2,358	1,947	6,990	2,653	4,523	8,738	10,390
1943	10,470	9,074	9,126	5,469	4,791	1,469	3,057	3,986	1,214	537.5	2,048	1,515
1944	4,366	6,202	12,590	8,166	4,711	3,886	783.0	588.6	729.8	4,398	2,066	10,140
1945	10,640	9,901	14,870	3,918	5,243	2,805	1,079	3,085	7,838	2,031	7,372	6,613
1946	5,605	7,478	5,999	2,070	5,436	5,859	1,178	707.3	385.4	513.8	765.0	2,516
1947	7,907	3,025	6,844	2,594	3,079	2,978	1,481	1,689	1,854	552.2	1,831	2,391
1948	5,705	11,350	9,529	11,330	6,015	3,430	5,412	3,201	2,085	1,197	3,523	12,430
1949	10,940	11,810	6,316	4,629	2,009	751.3	1,911	2,097	773.7	1,080	3,907	8,865
1950	11,000	13,560	10,640	4,104	5,260	7,608	2,706	1,244	2,596	1,858	5,918	10,500
1951	9,041	12,720	8,044	9,110	4,213	6,690	2,959	797.1	719.0	539.3	3,379	8,956
1952	13,630	5,800	7,365	5,640	6,462	922.3	860.6	1,133	626.1	580.8	559.9	2,449
1953	8,445	7,105	6,915	6,639	5,336	625.6	946.7	982.5	575.9	453.9	355.0	960.1
1954	4,022	2,000	7,516	3,572	2,254	1,226	2,280	4,518	1,451	8,554	3,586	6,626
1955	5,822	12,070	14,880	2,861	2,017	1,171	799.3	1,067	708.3			
Mean of monthly Discharge	7,730	8,490	8,480	5,960	4,190	3,470	2,000	2,080	1,640	2,000	3,070	5,760

** No Incomplete data have been used for statistical calculation

USGS Surface-Water Monthly Statistics for Pennsylvania

The statistics generated from this site are based on approved daily-mean data and may not match those published by the USGS in official publications. The user is responsible for assessment and use of statistics from this site. For more details on why the statistics may not match, click here.

USGS 03072655 Monongahela River near Masontown, PA

Available data for this site Time-series: Monthly statistics GO

Greene County, Pennsylvania Hydrologic Unit Code 05020005 Latitude 39°49'30", Longitude 79°55'23" NAD27 Drainage area 4,440 square miles Gage datum 769 feet above sea level NGVD29	**Output formats** HTML table of all data Tab-separated data Reselect output format

00060, Discharge, cubic feet per second,	
	Monthly mean in cfs (Calculation Period: 1939-01-01 -> 2007-09-30)

YEAR	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1939	7,767	27,490	14,610	18,490	2,546	7,088	7,045	2,217	905.9	1,695	1,769	4,201
1940	2,824	15,490	14,120	23,180	9,071	11,040	5,566	2,230	3,081	1,970	7,942	8,055
1941	10,210	3,781	9,875	7,106	2,580	11,860	5,657	4,966	3,520	1,363	4,183	5,795
1942	5,825	10,390	12,900	7,824	7,813	3,893	2,936	12,340	4,741	7,844	13,540	18,390
1943	16,960	15,810	15,980	11,490	8,736	2,690	5,657	5,825	1,623	861.0	3,699	2,703
1944	7,281	11,920	22,160	15,760	9,362	7,131	1,347	859.5	1,059	7,300	4,379	16,850
1945	15,520	19,100	24,570	7,757	9,991	5,295	2,024	4,590	12,380	3,544	12,880	10,150
1946	10,830	12,180	11,040	3,781	10,650	10,320	2,285	973.3	481.7	764.4	1,222	4,821
1947	14,440	4,899	12,450	6,504	6,867	5,620	3,273	3,053	2,752	854.7	3,860	4,456
1948	10,000	19,940	16,100	19,090	11,420	6,696	9,249	5,415	3,066	2,418	6,022	21,640
1949	20,110	18,980	11,350	8,815	3,949	2,059	4,184	2,941	1,101	1,777	6,781	15,150
1950	18,070	22,120	19,240	8,281	10,070	12,200	4,580	1,813	5,963	3,237	9,481	17,990
1951	17,240	20,340	13,600	16,350	8,209	12,370	4,640	1,167	1,107	735.0	5,566	14,750
1952	24,690	9,396	13,540	11,890	12,250	2,077	1,563	1,891	830.6	731.5	1,186	5,426
1953	15,620	13,140	13,700	13,080	10,090	1,372	1,399	1,716	644.1	439.2	369.4	2,006
1954	8,245	4,676	14,640	7,319	4,522	3,415	3,412	9,123	2,416	14,070	6,234	12,690
1955	9,410	20,420	24,960	6,138	3,967	3,373	1,380	3,836	889.4	1,423	3,636	4,078
1956	5,852	28,870	20,750	11,520	14,390	12,130	7,426	15,120	3,342	2,255	4,090	18,860
1957	16,900	23,070	8,712	12,570	2,632	2,234	1,884	666.5	743.5	2,438	3,382	16,830
1958	10,340	10,110	12,220	15,650	15,270	3,906	13,240	12,990	2,210	1,785	4,059	5,088
1959	13,910	13,360	9,813	11,060	6,184	2,467	1,144	1,445	991.0	2,367	6,298	13,380
1960	14,510	10,700	10,190	15,360	8,796	2,938	1,433	2,864	4,595	2,084	5,214	4,219
1961	7,484	18,060	25,290	17,440	9,589	11,450	4,826	5,829	1,536	2,765	7,758	11,770

1962	14,220	13,440	20,860	14,890	2,693	4,323	1,464	934.5	909.4	2,880	13,320	7,645
1963	9,179	8,706	37,830	4,300	4,227	8,226	2,073	3,118	2,070	689.0	3,769	6,087
1964	12,130	6,509	21,410	15,310	2,955	3,642	1,719	1,550	949.8	1,698	2,995	12,560
1965	16,020	9,905	16,060	18,610	2,754	926.2	941.4	592.4	808.4	1,142	1,119	1,648
1966	5,168	16,090	8,309	12,110	10,080	1,159	676.3	1,267	2,128	3,526	3,153	8,261
1967	4,465	8,525	33,400	7,622	21,330	2,421	2,698	2,296	1,796	3,884	5,538	11,280
1968	9,059	7,554	14,430	7,179	16,640	5,996	845.9	2,201	1,089	1,231	6,417	8,144
1969	8,639	8,440	6,242	10,430	5,901	1,353	4,794	5,187	2,273	2,149	4,023	10,090
1970	12,680	13,820	12,580	18,850	2,930	2,290	2,643	2,827	2,065	2,381	7,566	15,030
1971	14,820	19,810	12,310	3,806	10,710	3,373	1,445	3,688	12,470	2,791	5,920	11,440
1972	15,530	17,890	19,600	19,890	9,601	12,350	8,464	3,048	1,351	4,628	15,020	26,520
1973	6,713	12,740	9,728	20,030	10,350	4,148	1,483	2,843	1,795	3,809	9,924	16,560
1974	21,500	9,771	11,880	10,700	7,806	18,720	2,660	1,625	5,142	2,355	5,319	14,180
1975	16,430	18,730	16,640	12,830	13,960	5,235	2,165	5,132	5,242	4,825	5,156	9,710
1976	15,330	14,210	8,349	5,889	3,298	2,174	4,938	1,317	1,093	14,060	5,600	8,292
1977	1,840	11,720	17,270	9,526	5,581	2,529	3,583	4,773	1,787	6,961	7,898	12,300
1978	14,270	4,031	19,150	8,270	12,520	5,521	10,740	5,907	2,253	2,039	4,446	25,450
1979	22,100	19,000	17,590	10,330	11,370	3,024	3,228	5,563	7,476	15,260	8,154	9,039
1980	7,299	7,848	18,300	16,120	11,980	11,710	5,336	14,190	2,065	1,936	7,418	8,035
1981	4,698	17,900	11,630	12,670	13,090	22,100	3,139	1,586	4,031	3,507	4,233	10,750
1982	12,350	15,780	19,400	7,053	1,836	8,248	5,579	2,309	2,665	2,680	5,734	10,410
1983	4,827	9,251	14,360	17,590	16,710	3,828	2,004	1,289	866.9	2,371	9,063	13,220
1984	5,078	13,590	17,690	19,000	8,996	1,723	6,768	6,509	2,183	4,454	11,190	14,760
1985	5,529	14,340	15,540	8,280	9,026	7,793	6,076	1,809	971.2	3,037	29,580	13,090
1986	7,179	26,060	14,900	6,904	3,828	2,239	8,262	1,419	2,253	4,441	18,300	12,580
1987	9,138	9,382	6,192	17,550	4,747	3,084	1,373	921.5	2,601	1,936	3,107	10,950

1988	8,861	10,970	11,910	7,033	9,286	1,343	813.9	786.7	2,502	1,882	7,836	7,218
1989	13,580	19,490	20,600	10,750	22,250	14,600	8,274	6,548	4,103	9,044	9,747	4,411
1990	17,890	15,810	6,699	11,050	13,390	7,713	7,611	2,311	4,298	7,430	4,433	20,500
1991	21,190	16,280	19,910	11,570	2,703	1,015	1,135	1,381	1,139	1,130	2,670	14,040
1992	8,461	12,220	16,300	9,228	6,472	2,790	7,525	3,717	1,936	1,231	3,543	13,750
1993	8,649	6,956	26,230	16,120	3,484	1,948	1,083	790.7	2,301	2,923	10,950	13,910
1994	20,970	30,880	28,720	18,240	12,700	1,847	4,251	8,722	3,134	1,134	2,063	6,982
1995	10,790	11,500	8,997	4,790	12,260	3,785	1,384	3,721	877.0	1,382	6,143	9,812
1996	21,340	17,790	19,420	10,440	29,230	5,292	11,590	11,610	9,824	9,248	13,060	15,430
1997	8,207	9,613	21,370	5,922	12,130	5,005	2,042	3,102	2,620	2,262	10,320	8,392
1998	17,450	16,780	17,760	12,030	10,820	14,510	6,294	2,693	1,844	1,892	1,211	2,496
1999	18,410	8,561	18,800	9,903	4,961	1,299	845.5	794.6	853.5	2,280	4,562	7,962
2000	3,953	19,620	9,264	15,780	6,268	6,685	4,536	4,357	5,181	2,942	2,723	6,622
2001	7,415	15,470	10,500	11,480	8,140	7,288	7,955	4,044	2,309	1,620	1,540	4,627
2002	9,418	5,567	12,610	17,830	15,110	4,864	4,564	1,552	1,541	4,289	10,690	11,860
2003	9,141	14,510	19,090	10,400	15,810	16,750	7,921	5,721	12,870	7,097	20,900	14,440
2004	12,050	15,900	18,560	17,780	12,020	10,370	3,875	3,745	7,121	5,413	11,600	12,560
2005	17,040	12,160	17,440	10,900	9,663	2,258	2,935	1,842	1,296	2,968	7,783	12,020
2006	18,270	7,662	5,598	13,830	5,534	7,595	7,399	1,448	2,279	6,211	10,170	4,477
2007	13,450	10,520	18,470	15,170	4,507	1,487	4,601	5,127	1,656			
Mean of monthly Discharge	12,000	14,000	16,000	12,100	9,140	5,940	4,170	3,790	2,900	3,500	6,900	10,900

** No Incomplete data have been used for statistical calculation

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USGS Surface-Water Monthly Statistics for Pennsylvania

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USGS 03075000 Monongahela River at Charleroi, PA

Available data for this site Time-series: Monthly statistics GO

	Output formats
Westmoreland County, Pennsylvania Hydrologic Unit Code 05020005 Latitude 40°08'58", Longitude 79°54'06" NAD27 Drainage area 5,213.00 square miles Gage datum 735.33 feet above sea level NGVD29	HTML table of all data Tab-separated data Reselect output format

00060, Discharge, cubic feet per second,	
	Monthly mean in cfs (Calculation Period: 1933-10-01 -> 1976-09-30)

YEAR	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1933										1,137	4,215	12,170
1934	14,230	3,210	20,510	10,220	3,015	1,345	1,337	2,172	910.8	1,430	3,905	6,076
1935	16,270	12,110	18,880	12,730	17,260	5,541	3,244	11,000	5,401	1,328	5,260	9,948
1936	17,890	19,900	34,710	15,170	3,124	1,009	4,296	1,501	581.0	2,085	5,360	10,390
1937	37,480	13,500	11,240	14,780	11,480	7,168	2,799	3,671	3,813	13,640	6,513	11,810
1938	8,130	15,110	15,100	10,970	14,490	8,485	4,002	2,751	1,336	869.1	2,498	5,965
1939	8,770	31,000	16,740	21,140	2,951	7,488	7,471	2,280	1,098	1,724	1,853	4,230
1940	3,233	16,280	15,690	26,500	9,112	12,290	6,184	2,524	3,127	1,960	8,255	8,616
1941	10,910	4,347	10,270	7,609	2,791	13,890	5,829	5,071	3,800	1,513	4,557	6,011
1942	6,276	11,790	15,070	9,435	8,783	4,352	3,331	12,330	5,334	8,888	14,750	21,170
1943	19,230	17,160	17,150	13,610	10,540	3,651	6,152	6,503	1,941	753.5	3,735	2,720
1944	7,793	12,100	25,230	17,450	10,540	7,576	1,622	937.0	1,068	8,063	4,490	18,370
1945	17,760	20,920	29,030	9,070	11,310	5,999	2,319	4,926	13,300	4,128	13,820	11,280
1946	12,000	12,810	12,440	4,786	11,640	12,430	2,651	1,311	621.8	991.9	1,425	5,075
1947	16,050	5,849	13,160	7,370	8,487	6,949	4,321	3,797	2,842	903.7	4,166	4,752
1948	10,810	20,480	17,490	22,370	12,280	7,222	9,883	5,995	3,265	2,705	6,210	22,570
1949	22,400	20,520	12,770	10,090	4,522	2,430	4,513	3,159	1,337	1,899	6,715	15,490
1950	20,370	25,780	20,740	9,493	10,610	12,780	5,448	2,044	7,022	3,513	10,750	21,270
1951	19,150	23,020	15,350	18,860	9,811	13,710	5,225	1,252	1,227	667.6	5,592	15,050
1952	26,960	11,160	15,430	13,490	14,510	2,727	1,865	2,012	897.0	842.7	1,291	5,682
1953	16,790	13,900	14,620	14,470	11,330	1,578	1,590	1,783	713.0	474.9	400.5	2,052
1954	8,256	4,842	15,160	7,948	5,018	3,694	3,459	9,218	2,610	15,380	6,550	13,680
1955	10,230	22,540	28,730	6,917	4,736	4,317	1,699	4,099	933.2	1,424	3,831	4,304

1956	6,345	33,110	23,780	13,680	16,440	13,580	8,816	17,890	4,106	2,544	4,287	20,290
1957	17,900	25,210	10,280	14,240	3,296	2,408	2,202	811.6	866.6	2,569	3,577	17,600
1958	11,550	10,730	13,160	16,290	17,940	4,227	13,570	13,900	2,445	2,019	4,099	5,495
1959	15,740	15,260	10,720	12,220	7,636	3,039	1,392	1,639	1,068	2,313	6,183	13,830
1960	16,400	11,760	10,960	17,270	9,320	3,421	1,801	3,044	4,797	2,271	5,255	4,040
1961	7,969	19,910	27,600	19,780	10,390	12,040	5,452	6,268	1,821	2,872	8,184	12,490
1962	15,260	14,630	23,300	17,520	3,062	4,447	1,539	978.0	984.3	2,829	13,280	7,773
1963	9,874	9,159	41,930	4,868	4,410	8,618	2,145	3,092	2,211	836.6	3,689	6,183
1964	11,980	6,942	24,050	17,070	3,865	4,111	2,032	1,890	1,046	2,014	3,142	13,160
1965	17,290	10,970	17,140	19,620	3,603	1,125	1,049	813.2	1,072	1,295	1,454	1,991
1966	5,845	18,720	9,492	13,550	11,990	1,414	914.9	1,451	2,301	3,894	3,478	9,142
1967	4,662	9,417	38,970	9,588	24,980	2,777	3,101	2,634	1,961	3,967	5,981	12,060
1968	10,300	8,760	16,470	8,181	18,440	6,929	996.5	2,305	1,124	1,354	6,680	8,994
1969	9,358	9,372	6,675	11,940	6,851	1,461	5,867	5,598	2,266	2,085	4,181	11,220
1970	14,890	15,690	14,690	22,450	3,878	2,849	2,884	2,965	2,130	2,409	8,293	16,740
1971	16,760	23,090	13,440	4,478	12,230	3,510	1,659	3,860	12,730	2,843	5,861	12,930
1972	17,100	20,210	24,580	23,680	10,510	13,730	9,433	3,022	1,398	4,568	15,230	29,760
1973	6,912	13,990	10,870	22,890	12,100	4,684	1,683	2,881	1,964	3,916	10,430	18,710
1974	25,780	10,740	12,910	12,260	8,551	20,560	3,603	2,059	6,335	2,597	5,293	15,800
1975	18,650	22,300	19,110	14,730	15,160	5,645	2,319	5,323	6,625	5,193	5,511	10,620
1976	17,640	15,450	8,625	6,858	3,604	2,321	5,283	1,774	1,115			
Mean of monthly Discharge	14,200	15,400	18,000	13,700	9,460	6,270	3,880	4,060	2,870	3,040	5,820	11,300

** No Incomplete data have been used for statistical calculation

USGS Surface-Water Monthly Statistics for Pennsylvania

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USGS 03075070 Monongahela River at Elizabeth, PA

Available data for this site Time-series: Monthly statistics GO

Allegheny County, Pennsylvania Hydrologic Unit Code 05020005 Latitude 40°15'44", Longitude 79°54'05" NAD27 Drainage area 5,340 square miles Gage datum 717.90 feet above sea level NGVD29	**Output formats** HTML table of all data Tab-separated data Reselect output format

00060, Discharge, cubic feet per second,	
	Monthly mean in cfs (Calculation Period: 1933-10-01 -> 2007-09-30)

YEAR	Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1933										1,137	4,215	12,170
1934	14,230	3,210	20,510	10,220	3,015	1,345	1,337	2,172	910.8	1,430	3,905	6,076
1935	16,270	12,110	18,880	12,730	17,260	5,541	3,244	11,000	5,401	1,328	5,260	9,948
1936	17,890	19,900	34,710	15,170	3,124	1,009	4,296	1,501	581.0	2,085	5,360	10,390
1937	37,480	13,500	11,240	14,780	11,480	7,168	2,799	3,671	3,813	13,640	6,513	11,810
1938	8,130	15,110	15,100	10,970	14,490	8,485	4,002	2,751	1,336	869.1	2,498	5,965
1939	8,770	31,000	16,740	21,140	2,951	7,488	7,471	2,280	1,098	1,724	1,853	4,230
1940	3,233	16,280	15,690	26,500	9,112	12,290	6,184	2,524	3,127	1,960	8,255	8,616
1941	10,910	4,347	10,270	7,609	2,791	13,890	5,829	5,071	3,800	1,513	4,557	6,011
1942	6,276	11,790	15,070	9,435	8,783	4,352	3,331	12,330	5,334	8,888	14,750	21,170
1943	19,230	17,160	17,150	13,610	10,540	3,651	6,152	6,503	1,941	753.5	3,735	2,720
1944	7,793	12,100	25,230	17,450	10,540	7,576	1,622	937.0	1,068	8,063	4,490	18,370
1945	17,760	20,920	29,030	9,070	11,310	5,999	2,319	4,926	13,300	4,128	13,820	11,280
1946	12,000	12,810	12,440	4,786	11,640	12,430	2,651	1,311	621.8	991.9	1,425	5,075
1947	16,050	5,849	13,160	7,370	8,487	6,949	4,321	3,797	2,842	903.7	4,166	4,752
1948	10,810	20,480	17,490	22,370	12,280	7,222	9,883	5,995	3,265	2,705	6,210	22,570
1949	22,400	20,520	12,770	10,090	4,522	2,430	4,513	3,159	1,337	1,899	6,715	15,490
1950	20,370	25,780	20,740	9,493	10,610	12,780	5,448	2,044	7,022	3,513	10,750	21,270
1951	19,150	23,020	15,350	18,860	9,811	13,710	5,225	1,252	1,227	667.6	5,592	15,050
1952	26,960	11,160	15,430	13,490	14,510	2,727	1,865	2,012	897.0	842.7	1,291	5,682
1953	16,790	13,900	14,620	14,470	11,330	1,578	1,590	1,783	713.0	474.9	400.5	2,052
1954	8,256	4,842	15,160	7,948	5,018	3,694	3,459	9,218	2,610	15,380	6,550	13,680
1955	10,230	22,540	28,730	6,917	4,736	4,317	1,699	4,099	933.2	1,424	3,831	4,304

1956	6,345	33,110	23,780	13,680	16,440	13,580	8,816	17,890	4,106	2,544	4,287	20,290
1957	17,900	25,210	10,280	14,240	3,296	2,408	2,202	811.6	866.6	2,569	3,577	17,600
1958	11,550	10,730	13,160	16,290	17,940	4,227	13,570	13,900	2,445	2,019	4,099	5,495
1959	15,740	15,260	10,720	12,220	7,636	3,039	1,392	1,639	1,068	2,313	6,183	13,830
1960	16,400	11,760	10,960	17,270	9,320	3,421	1,801	3,044	4,797	2,271	5,255	4,040
1961	7,969	19,910	27,600	19,780	10,390	12,040	5,452	6,268	1,821	2,872	8,184	12,490
1962	15,260	14,630	23,300	17,520	3,062	4,447	1,539	978.0	984.3	2,829	13,280	7,773
1963	9,874	9,159	41,930	4,868	4,410	8,618	2,145	3,092	2,211	836.6	3,689	6,183
1964	11,980	6,942	24,050	17,070	3,865	4,111	2,032	1,890	1,046	2,014	3,142	13,160
1965	17,290	10,970	17,140	19,620	3,603	1,125	1,049	813.2	1,072	1,295	1,454	1,991
1966	5,845	18,720	9,492	13,550	11,990	1,414	914.9	1,451	2,301	3,894	3,478	9,142
1967	4,662	9,417	38,970	9,588	24,980	2,777	3,101	2,634	1,961	3,967	5,981	12,060
1968	10,300	8,760	16,470	8,181	18,440	6,929	996.5	2,305	1,124	1,354	6,680	8,994
1969	9,358	9,372	6,675	11,940	6,851	1,461	5,867	5,598	2,266	2,085	4,181	11,220
1970	14,890	15,690	14,690	22,450	3,878	2,849	2,884	2,965	2,130	2,409	8,293	16,740
1971	16,760	23,090	13,440	4,478	12,230	3,510	1,659	3,860	12,730	2,843	5,861	12,930
1972	17,100	20,210	24,580	23,680	10,510	13,730	9,433	3,022	1,398	4,568	15,230	29,760
1973	6,912	13,990	10,870	22,890	12,100	4,684	1,683	2,881	1,964	3,916	10,430	18,710
1974	25,780	10,740	12,910	12,260	8,551	20,560	3,603	2,059	6,335	2,597	5,293	15,800
1975	18,650	22,300	19,110	14,730	15,160	5,645	2,319	5,323	6,625	5,193	5,511	10,620
1976	17,640	15,450	8,625	6,858	3,604	2,321	5,283	1,774	1,115	15,040	6,385	9,456
1977	2,249	13,050	20,580	11,960	6,871	2,634	4,208	5,694	2,178	7,619	8,454	14,480
1978	16,710	4,799	22,550	10,460	15,130	6,230	12,000	6,545	2,365	1,667	4,348	27,960
1979	25,490	22,550	22,190	11,770	12,610	3,359	3,014	5,988	7,942	16,770	8,633	9,480
1980	7,947	8,248	20,470	18,620	12,940	13,060	6,170	15,020	2,358	2,026	7,325	8,542
1981	5,552	19,650	12,510	15,740	13,720	24,840	3,642	1,749	4,563	3,675	4,469	11,350

1982	13,950	17,370	21,770	7,754	2,128	9,923	5,832	2,490	2,753	2,784	5,779	10,990
1983	5,172	10,190	15,820	20,710	19,870	4,721	2,557	1,563	1,086	2,582	9,451	15,070
1984	5,771	14,500	19,560	22,300	10,740	2,325	7,325	6,656	2,466	4,625	11,480	15,800
1985	6,082	15,530	17,140	10,290	9,541	8,966	6,577	2,130	1,101	2,965	33,750	14,900
1986	8,140	29,840	17,020	8,018	4,631	2,582	9,067	1,715	2,344	4,977	19,280	14,050
1987	9,635	10,060	6,636	20,300	5,936	3,636	1,693	1,181	2,855	2,198	3,244	11,100
1988	9,475	12,620	13,390	7,833	9,970	1,671	1,078	999.9	2,700	1,779	7,341	7,500
1989	14,020	21,300	22,660	12,390	23,840	14,160	7,887	6,742	4,617	9,485	9,865	4,533
1990	19,320	17,940	7,521	11,850	13,990	8,751	8,835	2,699	5,135	8,391	5,127	22,230
1991	23,420	18,170	21,100	13,450	3,355	1,266	1,249	1,480	1,270	1,269	2,833	14,140
1992	9,106	12,340	17,530	9,962	7,250	3,213	7,604	4,418	2,275	1,446	4,096	14,130
1993	9,589	7,748	28,040	16,820	4,090	2,454	1,298	979.7	2,517	3,246	11,250	14,270
1994	23,490	33,170	31,530	19,410	13,040	2,227	4,310	8,981	3,325	1,395	2,356	7,839
1995	12,490	11,200	10,430	5,165	15,980	3,949	1,772	3,169	1,052	1,523	6,173	9,871
1996	26,760	19,600	22,150	11,430	33,610	6,129	12,640	12,390	10,050	8,737	13,820	16,420
1997	8,349	10,160	23,980	6,127	12,770	4,978	1,758	3,260	2,502	2,172	10,350	8,453
1998	18,500	17,950	19,010	12,620	11,290	15,180	6,917	2,641	1,850	1,834	1,173	2,306
1999	20,240	8,784	20,480	11,260	5,322	1,405	936.8	832.0	875.2	2,183	4,508	8,240
2000	3,806	22,860	9,937	17,110	6,388	6,766	4,402	4,579	4,896	2,892	2,531	6,462
2001	7,312	16,350	11,220	12,470	8,351	7,972	8,060	4,074	2,258	1,583	1,458	4,485
2002	9,310	5,587	14,480	18,590	16,850	5,341	4,446	1,607	1,494	4,024	10,260	12,080
2003	10,010	16,290	21,170	10,810	17,570	18,180	8,873	5,917	13,070	7,128	24,360	15,520
2004	14,190	19,070	20,420	20,240	13,060	11,160	4,004	3,924	9,129	5,364	11,730	13,170
2005	21,110	13,310	19,710	11,880	9,897	2,589	2,975	1,825	1,277	2,944	7,559	12,300
2006	19,760	8,196	6,012	14,100	5,827	7,944	7,756	1,638	2,280	6,974	12,550	4,337
2007	14,570	10,950	21,300	16,360	4,486	1,525	4,319	5,567	1,641			

Mean of monthly Discharge	13,700	15,300	18,000	13,600	10,200	6,470	4,460	4,090	3,100	3,680	7,060	11,500
** No Incomplete data have been used for statistical calculation												

MONONGAHELA RIVER BASIN

03085000 MONONGAHELA RIVER AT BRADDOCK, PA
(Pennsylvania Water-Quality Network Station)

LOCATION.--Lat 40°23'28", long 79°51'30", Allegheny County, Hydrologic Unit 05020005, near right bank on river guide wall 300 ft upstream from dam at lock 2 at Braddock, 1,700 ft downstream from Turtle Creek, and 11.2 mi upstream of confluence with Allegheny River.

DRAINAGE AREA.--7,337 mi^2.

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--October 1938 to current year. Monthly discharge only for some periods, published in WSP 1305.

GAGE.--Water-stage recorder and fixed-crest concrete dam control with streamward lock chamber usable as floodway during high flow since 1951. Datum of gage is 709.66 ft above National Geodetic Vertical Datum of 1929 (U.S. Army Corps of Engineers benchmark). Prior to Aug. 13, 1951, at site 700 ft upstream, and Aug. 13, 1951 to Nov. 8, 1990 at present site at datum 2.50 ft lower.

REMARKS.--No estimated daily discharges. Records fair. Flow regulated by locks and hydroelectric plants, since January 1925 by Deep Creek Reservoir (station 03076000), since 1926 by Lake Lynn, since May 1938 by Tygart Lake (station 03055500), since December 1942 by Youghiogheny River Lake (station 03077000), and since April 1989 by Stonewall Jackson Lake, combined capacity, 779,000 acre-ft. Figures of daily discharge include slight diversion from Beaver Run Reservoir in the Kiskiminetas River Basin to the borough of Jeannette in the Monongahela River Basin. U.S. Army Corps of Engineers satellite telemetry at station.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of Mar. 18, 1936 reached a stage of 38.8 ft from floodmarks, discharge, 210,000 ft^3/s.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2002 TO SEPTEMBER 2003
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4290	13300	10600	18800	6300	26200	8200	5370	22000	4650	9460	9670
2	2940	11100	11100	49000	7860	22900	10400	5530	40300	3570	7400	21800
3	2200	9950	9930	41200	8700	27300	13000	5960	34700	3520	5920	30100
4	2340	8090	10600	42500	14700	30700	12700	6570	65700	4520	7420	33300
5	3660	7740	7380	36100	27900	28200	14000	10200	50700	4870	7180	39200
6	2310	8830	7370	28700	21500	50300	16000	16500	39800	4530	5490	29300
7	2030	13900	7230	26300	20200	60800	17600	19700	35200	4990	5210	17400
8	2520	15900	4880	20500	18200	47400	29600	20700	47000	19500	6330	12500
9	2470	12100	6000	16000	14600	46300	33000	35500	38200	38400	5870	11200
10	2470	11500	6510	16300	9940	52900	31500	66100	30600	36900	9910	9010
11	2620	10900	4800	14100	9200	40700	32500	67500	24100	43500	9860	7950
12	3710	9550	5530	13400	8640	33300	31500	53400	19000	34600	8900	6200
13	3580	14100	11600	11800	7440	29900	28400	41800	14200	22900	10400	4420
14	4960	12800	27600	11700	6590	38900	23400	43500	16600	17900	9990	4820
15	3920	11400	36800	11000	5940	45200	22100	38900	22400	13300	8670	4630
16	6330	11400	24800	8730	6080	39800	17500	34100	23600	10900	7020	6100
17	8700	13000	21400	5560	6480	40500	15300	27600	21000	9280	6480	5900
18	10900	22300	17800	6510	6690	39900	11000	22000	25100	7210	7130	6600
19	9280	19400	16500	3990	8500	33200	8210	18900	25300	8220	10600	14900
20	7360	20500	17200	4870	9960	27600	6430	19200	23500	6450	10400	42900
21	7020	20600	36500	4940	9350	24700	6940	17500	28300	6060	6710	28500
22	7270	17200	27900	5660	14300	26400	7640	15600	27100	5320	4680	24200
23	6750	13300	20400	6160	64100	23800	7720	14500	20600	4930	3500	24800
24	5150	12200	20200	6740	90400	17600	8420	20500	16200	6080	4320	25800
25	6010	10200	17100	5400	46700	15900	7820	20900	10900	5520	3860	20400
26	4630	9890	22300	3710	36800	16100	8050	18100	8490	4900	3370	16800
27	4060	11300	19000	4880	37400	12200	6080	12700	7470	4450	5270	13000
28	6290	9470	15300	4710	31800	9770	7100	11800	5930	3050	16700	12300
29	5710	9410	13400	4950	---	8270	4870	8840	5100	7100	10000	16600
30	8780	9590	12900	5220	---	5580	5720	8230	4670	8220	8970	14800
31	13800	---	13600	5660	---	8570	---	9570	---	6460	10500	---
TOTAL	164060	380920	484230	445090	556270	930890	452700	717270	753760	361800	237520	515100
MEAN	5292	12700	15620	14360	19870	30030	15090	23140	25130	11670	7662	17170
MAX	13800	22300	36800	49000	90400	60800	33000	67500	65700	43500	16700	42900
MIN	2030	7740	4800	3710	5940	5580	4870	5370	4670	3050	3370	4420
CFSM	0.72	1.73	2.13	1.96	2.71	4.09	2.06	3.15	3.42	1.59	1.04	2.34
IN.	0.83	1.93	2.46	2.26	2.82	4.72	2.30	3.64	3.82	1.83	1.20	2.61

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1939 - 2003, BY WATER YEAR (WY)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	5295	9240	15310	17040	20690	23980	18800	14370	9442	6403	5836	4812
MAX	23130	42130	37600	36150	43120	54500	39180	40310	30240	15620	23720	18290
(WY)	1980	1986	1973	1952	1956	1963	1940	1996	1981	1958	1956	1971
MIN	1200	971	2748	3389	6387	8042	6473	3352	2107	1765	1531	1005
(WY)	1954	1954	1954	1977	1954	1969	1971	1982	1965	1966	1957	1946

ATTACHMENT D

LOADING CALCULATIONS

By: BPM
Date: 01/07/09

Checked By: CAR
Date: 1/12/2009

Summary of POTWs

Avg. Produced Water TDS: 60,000 mg/l

Monongahela River POTWs (Identified by PADEP)

Month	Waynesburg (RMI 66)	Franklin (Tri County) (RMI 66)	Brownsville (RMI 57)	California Boro (RMI 52)	Belle Vernon (RMI 45)	Charleroi (RMI 42)	Mon Valley (RMI 40)	Clairton (RMI 24)	McKeesport (RMI 17)	Monthly Totals	
August 2008											
Produced Water Accepted Volume (gal)	2,529,506	3,253,931	90,720	0	0	10,743,704	243,500	354,790	151,200	17,367,351	gallons
Loading (lbs TDS)	1,266,524	1,629,243	45,424	0	0	5,379,373	121,920	177,643	75,706	8,695,833	lbs
Avg. Daily Volume (gal/day)	81,597	104,966	2,926	0	0	346,571	7,855	11,445	4,877	560,237	gallons/day
Avg. Daily Loading (lbs/day TDS)	40,856	52,556	1,465	0	0	173,528	3,933	5,730	2,442	280,511	lbs/day
Percent of Monthly Total	14.6%	18.7%	0.5%	0.0%	0.0%	61.9%	1.4%	2.0%	0.9%	100.0%	
September 2008											
Produced Water Accepted Volume (gal)	1,760,770	2,524,800	170,940	333,270	441,230	9,760,058	424,900	262,800	609,920	16,288,688	gallons
Loading (lbs TDS)	881,618	1,264,167	85,590	166,868	220,924	4,886,861	212,747	131,584	305,387	8,155,746	lbs
Avg. Daily Volume (gal/day)	56,799	81,445	5,514	10,751	14,233	314,841	13,706	8,477	19,675	525,442	gallons/day
Avg. Daily Loading (lbs/day TDS)	29,387	42,139	2,853	5,562	7,364	162,895	7,092	4,386	10,180	271,858	lbs/day
Percent of Monthly Total	10.8%	15.5%	1.0%	2.0%	2.7%	59.9%	2.6%	1.6%	3.7%	100.0%	
October 2008 (through October 21)											
Produced Water Accepted Volume (gal)	998,890	2,205,200	229,325	568,680	609,020	6,311,056	407,900	638,300	331,950	12,300,321	gallons
Loading (lbs TDS)	500,144	1,104,144	114,823	284,738	304,936	3,159,946	204,236	319,597	166,207	6,158,771	lbs
Avg. Daily Volume (gal/day)	47,566	105,010	10,920	27,080	29,001	300,526	19,424	30,395	15,807	585,730	gallons/day
Avg. Daily Loading (lbs/day TDS)	23,816	52,578	5,468	13,559	14,521	150,474	9,726	15,219	7,915	293,275	lbs/day
Percent of Monthly Total	8.1%	17.9%	1.9%	4.6%	5.0%	51.3%	3.3%	5.2%	2.7%	100.0%	
October 22 through October 31, 2008											
Produced Water Accepted Volume (gal)	0	35,000	0	55,200	64,290	0	54,880	0	19,330	228,700	gallons
Loading (lbs TDS)	0	17,525	0	27,639	32,190	0	27,478	0	9,679	114,510	lbs
Avg. Daily Volume (gal/day)	0	3,500	0	5,520	6,429	0	5,488	0	1,933	22,870	gallons/day
Avg. Daily Loading (lbs/day TDS)	0	835	0	1,316	1,533	0	1,308	0	461	5,453	lbs/day
Percent of Monthly Total	0.0%	15.3%	0.0%	24.1%	28.1%	0.0%	24.0%	0.0%	8.5%	100.0%	
November 2008											
Produced Water Accepted Volume (gal)	0	105,000	0	165,600	192,870	0	164,640	0	57,990	686,100	gallons
Loading (lbs TDS)	0	52,574	0	82,916	96,570	0	82,435	0	29,036	343,530	lbs
Avg. Daily Volume (gal/day)	0	3,500	0	5,520	6,429	0	5,488	0	1,933	22,870	gallons/day
Avg. Daily Loading (lbs/day TDS)	0	2,504	0	3,948	4,599	0	3,925	0	1,383	16,359	lbs/day
Percent of Monthly Total	0.0%	15.3%	0.0%	24.1%	28.1%	0.0%	24.0%	0.0%	8.5%	100.0%	
December 2008											
Produced Water Accepted Volume (gal)	0	108,500	0	171,120	199,299	0	170,128	729,429	59,923	1,438,399	gallons
Loading (lbs TDS)	0	54,326	0	85,680	99,789	0	85,183	365,225	30,003	720,206	lbs
Avg. Daily Volume (gal/day)	0	3,500	0	5,520	6,429	0	5,488	23,530	1,933	46,400	gallons/day
Avg. Daily Loading (lbs/day TDS)	0	2,587	0	4,080	4,752	0	4,056	17,392	1,429	34,296	lbs/day
Percent of Monthly Total	0.0%	7.5%	0.0%	11.9%	13.9%	0.0%	11.8%	50.7%	4.2%	100.0%	

Worst Case River Flow Rate	1.5	miles per day									
Miles from Sample Point	62.9	62.9	53.9	48.9	41.9	38.9	36.9	20.9	13.9		
POTW transport time (days)	41.9	41.9	35.9	32.6	27.9	25.9	24.6	13.9	9.3		
October 22, 2008											
Effective Discharge Date	9/10/2008	9/10/2008	9/16/2008	9/19/2008	9/24/2008	9/26/2008	9/27/2008	10/8/2008	10/12/2008		
Loading Contribution	29,387	42,139	2,853	5,562	7,364	162,895	7,092	15,219	7,915	280,426	lbs/day
November 25, 2008											
Effective Discharge Date	10/14/2008	10/14/2008	10/20/2008	10/23/2008	10/28/2008	10/30/2008	10/31/2008	11/11/2008	11/15/2008		
Loading Contribution	23,816	52,578	5,468	1,316	1,533	0	1,308	0	1,383	87,403	lbs/day
December 30, 2008											
Effective Discharge Date	11/18/2008	11/18/2008	11/24/2008	11/27/2008	12/2/2008	12/4/2008	12/5/2008	12/16/2008	12/20/2008		
Loading Contribution	0	2,587	0	4,080	4,752	0	4,056	17,392	1,429	34,296	lbs/day

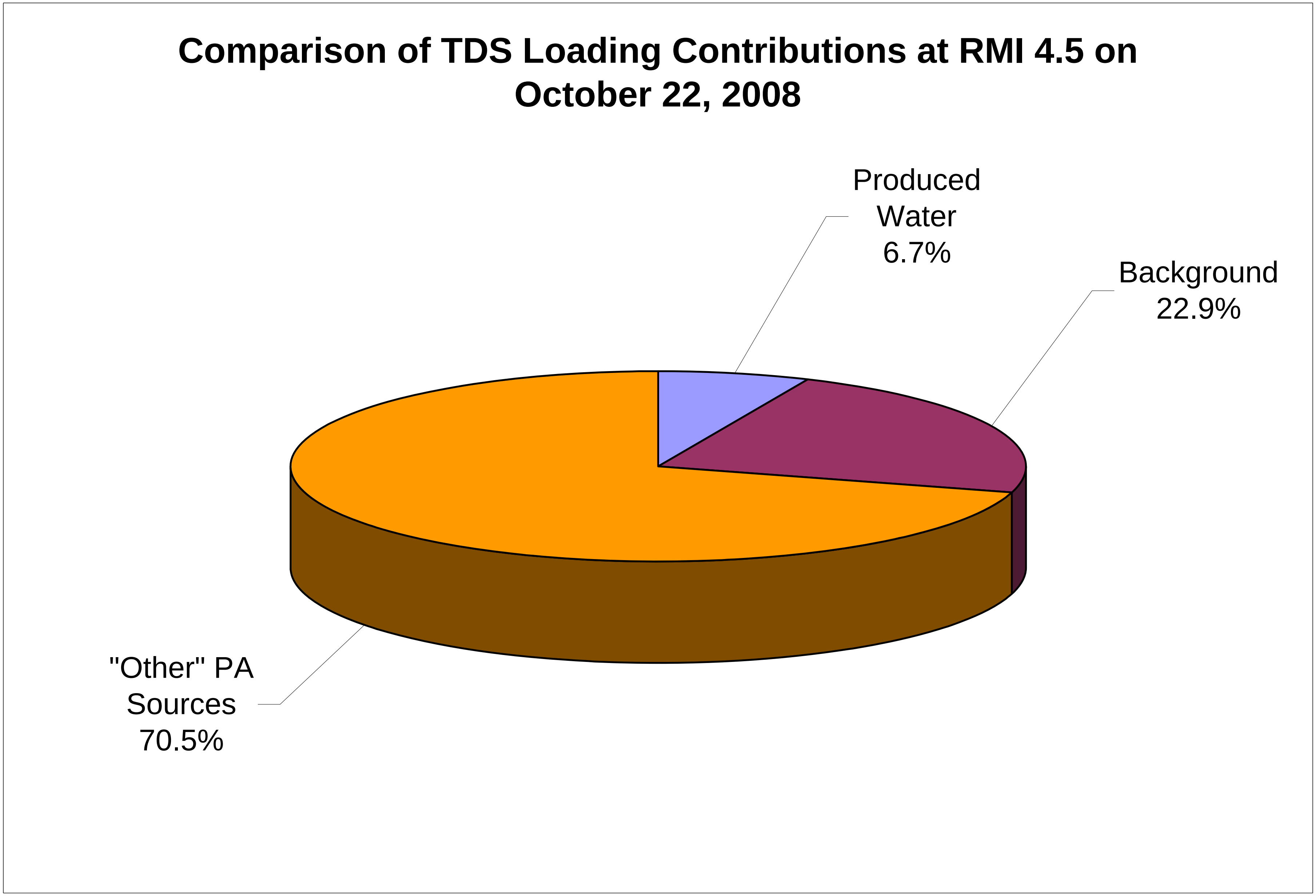
By: BPM		Checked By:	CAR
Date: 01/07/09		Date:	1/12/2009

Avg. Produced Water TDS	60,000	mg/L
Analytical Data from PADEP for October 22, 2008		
TDS at RMI 90.0	438	mg/L
TDS at RMI 4.5	414	mg/L
Average Discharge Data from USGS for October 22, 2008		
Monongahela River at Masontown	716	cfs
Masontown to Point Marion Adjustment Factor 0.57	408	cfs
	35,261,568	ft^3/day
	263,756,529	gal/day
Monongahela River at Elizabeth	1,310	cfs
Elizabeth to Braddock Adjustment Factor 1.44	1,886	cfs
	162,984,960	ft^3/day
	1,219,127,501	gal/day

$$\text{Loading}\ \frac{\text{lbs}}{\text{day}} \quad \left[\frac{y\ \text{mg}}{\text{L}}\right]\left[\frac{z\ \text{gal}}{\text{day}}\right]\left[\frac{1\ \text{kg}}{1{,}000{,}000\ \text{mg}}\right]\left[\frac{2.205\ \text{lb}}{\text{kg}}\right]\left[\frac{3.785\ \text{L}}{\text{gal}}\right]$$

Where:
y = TDS concentration
z = flow rate

Calculated Loadings at RMI 90.0 on October 22, 2008		
Total Dissolved Solids	964,166	lbs/day
Calculated Loadings at RMI 4.5 on October 22, 2008		
Total Dissolved Solids	4,212,345	lbs/day
Average Produced Water Loadings on October 22, 2008		
Total Dissolved Solids	280,426	lbs/day
Calculated Flowback/Produced Water Percent Contribution to Total TDS at RMI 4.5 on October 22, 2008	6.7%	
Calculated Percent Contribution of Background TDS from RMI 90.0 at RMI 4.5 on October 22, 2008	22.9%	
Calculated "Other" PA Sources Percent Contribution to Total TDS at RMI 4.5 on October 22, 2008	70.5%	


Comparison of TDS Loading Contributions at RMI 4.5 on October 22, 2008
Produced Water 6.7%
Background 22.9%
"Other" PA Sources 70.5%

By: BPM		Checked By:	CAR
Date: 01/07/09		Date:	1/12/2009

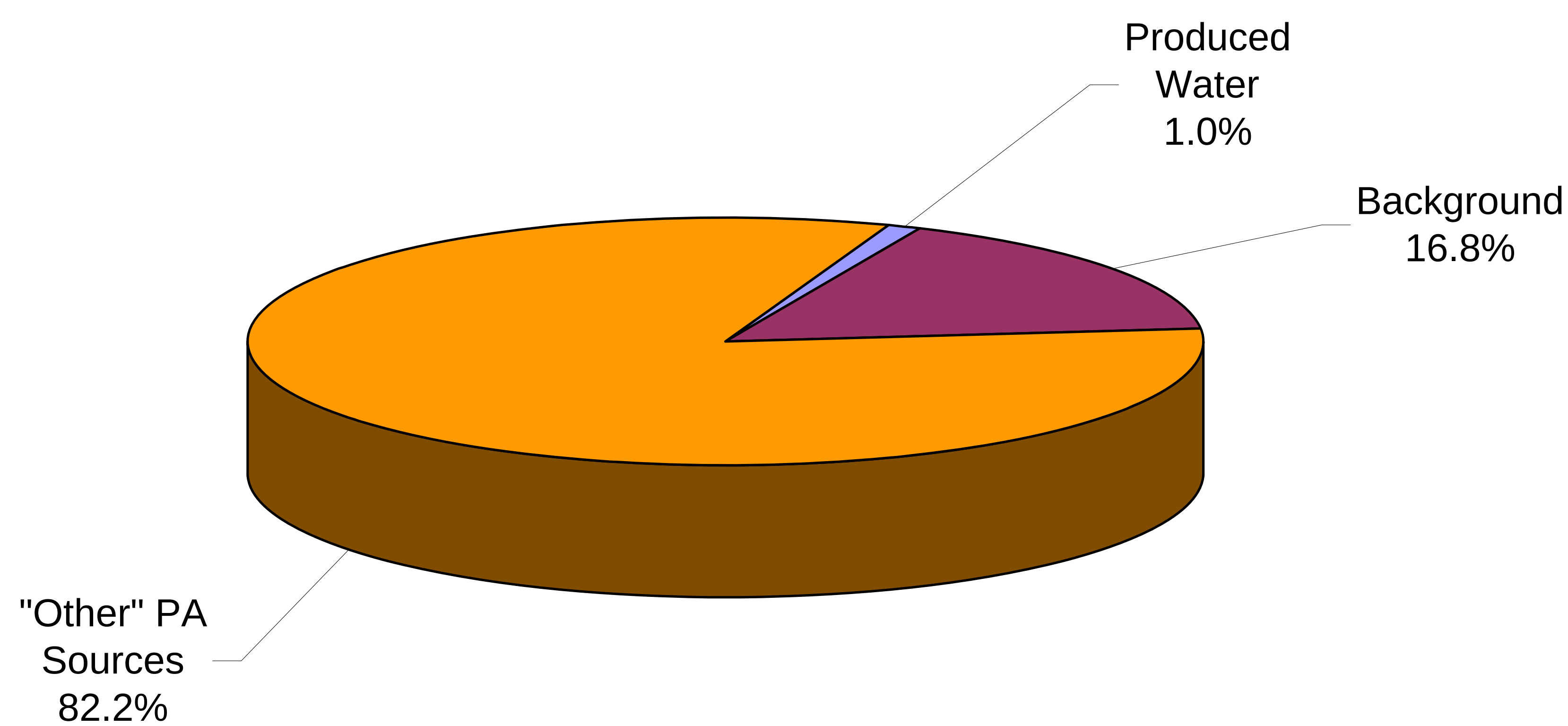
Avg. Produced Water TDS	60,000	mg/L
Analytical Data from PADEP for November 25, 2008		
TDS at RMI 90.0	502	mg/L
TDS at RMI 3.1	734	mg/L
Average Discharge Data from USGS for November 25,2008		
Monongahela River at Masontown	1190	cfs
Masontown to Point Marion Adjustment Factor 0.44	524	cfs
	45,239,040	ft^3/day
	338,388,019	gal/day
Monongahela River at Elizabeth	1,630	cfs
Elizabeth to Braddock Adjustment Factor 1.31	2,135	cfs
	184,489,920	ft^3/day
	1,379,984,602	gal/day

$$\text{Loading}\ \frac{\text{lbs}}{\text{day}} \quad \left[\frac{y\ \text{mg}}{\text{L}}\right]\left[\frac{z\ \text{gal}}{\text{day}}\right]\left[\frac{1\ \text{kg}}{1{,}000{,}000\ \text{mg}}\right]\left[\frac{2.205\ \text{lb}}{\text{kg}}\right]\left[\frac{3.785\ \text{L}}{\text{gal}}\right]$$

Where:
y = TDS concentration
z = flow rate

Calculated Loadings at RMI 90.0 on November 25, 2008		
Total Dissolved Solids	1,417,729	lbs/day
Calculated Loadings at RMI 3.1 on November 25, 2008		
Total Dissolved Solids	8,453,660	lbs/day
Average Produced Water Loadings on November 25, 2008		
Total Dissolved Solids	87,403	lbs/day
Calculated Flowback/Produced Water Percent Contribution to Total TDS at RMI 3.1 on November 25, 2008	1.0%	
Calculated Percent Contribution of Background TDS from RMI 90.0 at RMI 3.1 on November 25, 2008	16.8%	
Calculated "Other" PA Sources Percent Contribution to Total TDS at RMI 3.1 on November 25, 2008	82.2%	

Comparison of TDS Loading Contributions at RMI 3.1 on November 25, 2008



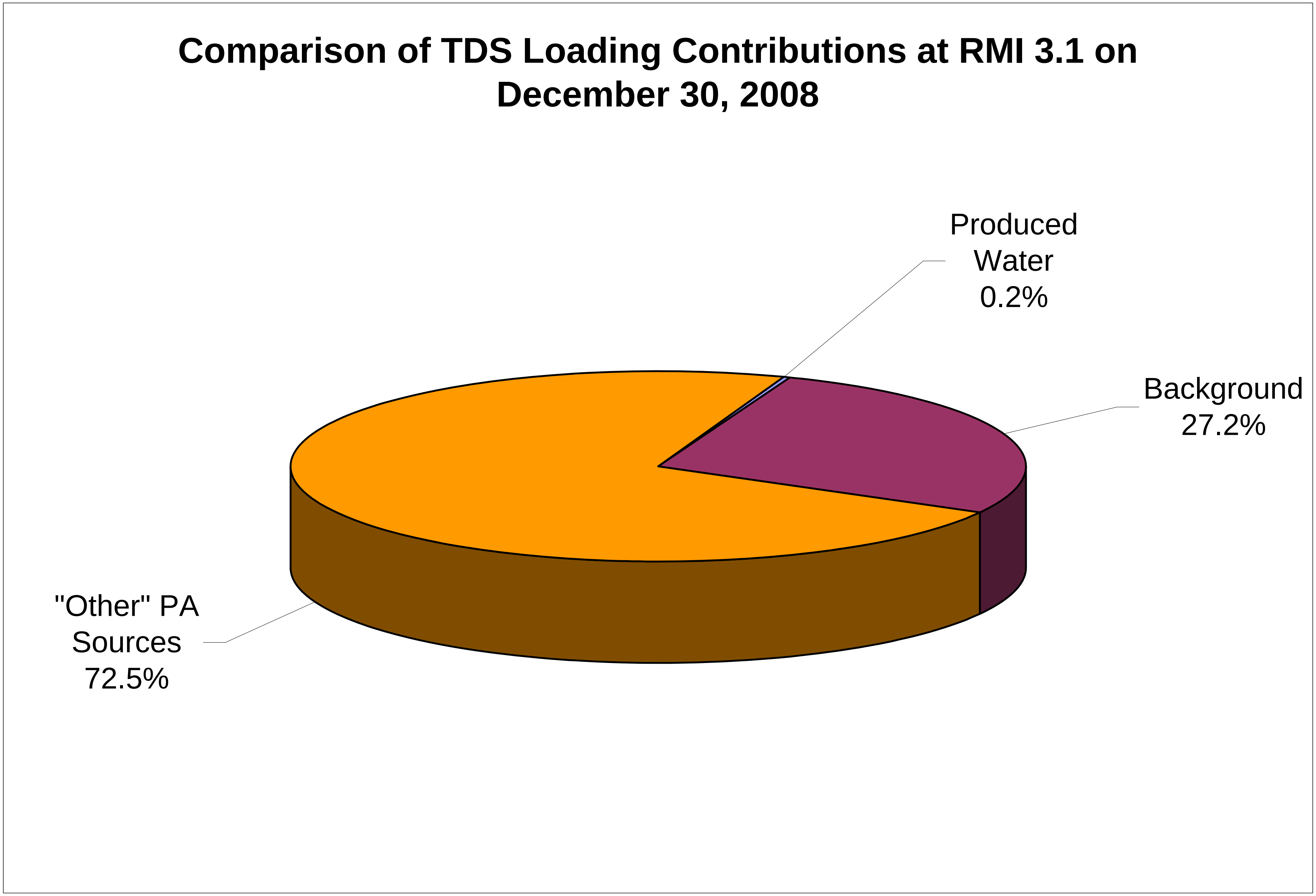
By: BPM	Checked By:	CAR
Date: 01/07/09	Date:	1/12/2009

Avg. Produced Water TDS	60,000	mg/L
Analytical Data from PADEP for December 30, 2008		
TDS at RMI 90.0	130	mg/L
TDS at RMI 3.1	166	mg/L
Average Discharge Data from USGS for December 30,2008		
Monongahela River at Masontown	10,300	cfs
Masontown to Point Marion Adjustment Factor 0.53	5459	cfs
	471,657,600	ft³/day
	3,527,998,848	gal/day
Monongahela River at Elizabeth	11,800	cfs
Elizabeth to Braddock Adjustment Factor 1.33	15,694	cfs
	1,355,961,600	ft³/day
	10,142,592,768	gal/day

$$\text{Loading}\ \frac{\text{lbs}}{\text{day}} \quad \left[\frac{y\ \text{mg}}{\text{L}}\right]\left[\frac{z\ \text{gal}}{\text{day}}\right]\left[\frac{1\ \text{kg}}{1{,}000{,}000\ \text{mg}}\right]\left[\frac{2.205\ \text{lb}}{\text{kg}}\right]\left[\frac{3.785\ \text{L}}{\text{gal}}\right]$$

Where:
y = TDS concentration
z = flow rate

Calculated Loadings at RMI 90.0 on December 30, 2008		
Total Dissolved Solids	3,827,774	lbs/day
Calculated Loadings at RMI 3.1 on December 30, 2008		
Total Dissolved Solids	14,051,787	lbs/day
Average Produced Water Loadings on December 30, 2008		
Total Dissolved Solids	34,296	lbs/day
Calculated Flowback/Produced Water Percent Contribution to Total TDS at RMI 3.1 on December 30, 2008	0.2%	
Calculated Percent Contribution of Background TDS from RMI 90.0 at RMI 3.1 on December 30, 2008	27.2%	
Calculated "Other" PA Sources Percent Contribution to Total TDS at RMI 3.1 on December 30, 2008	72.5%	


Comparison of TDS Loading Contributions at RMI 3.1 on
December 30, 2008
Produced Water 0.2%
Background 27.2%
"Other" PA Sources 72.5%

By: BPM
Date: 01/07/09

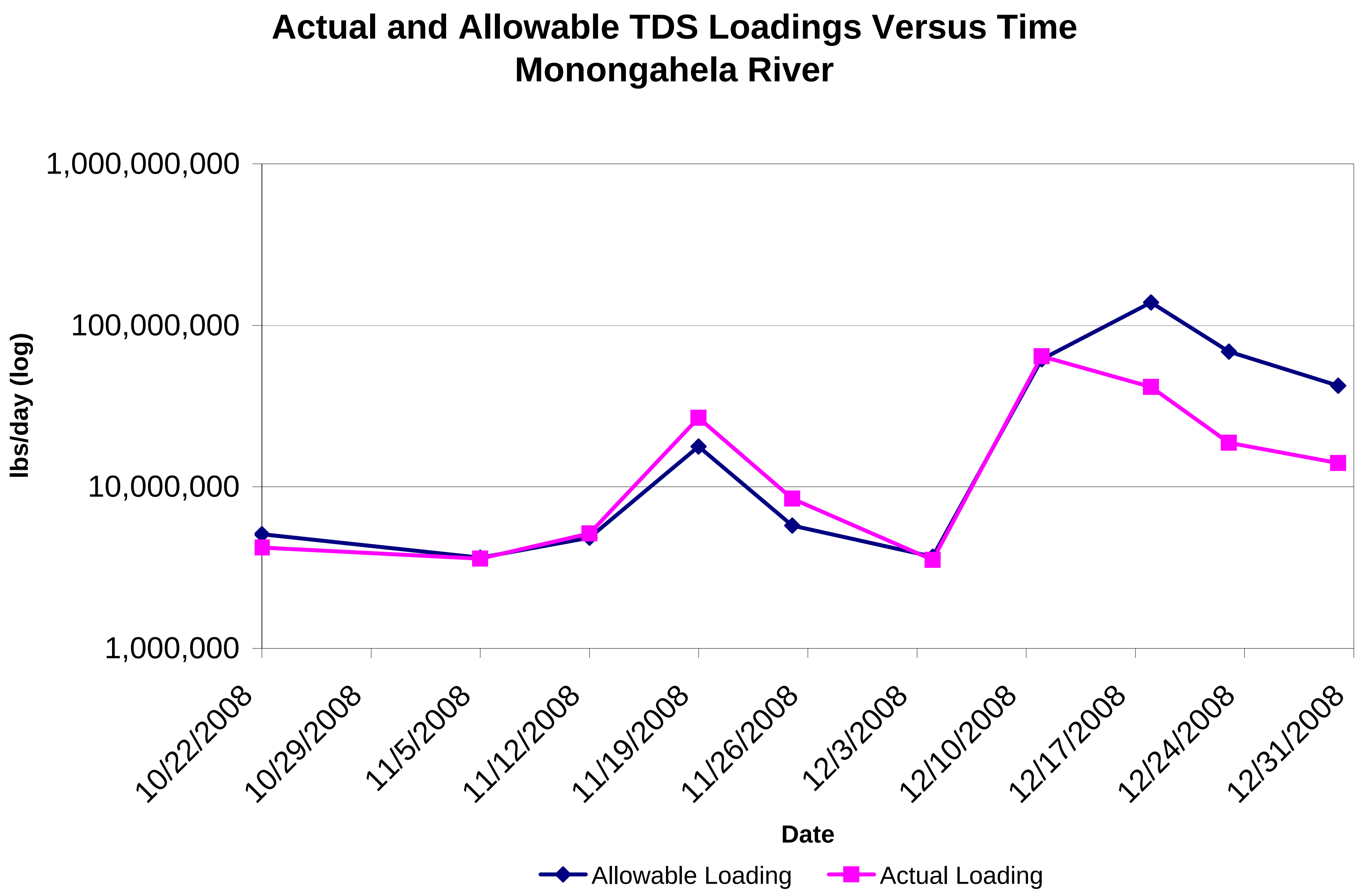
Checked By: ALS
Date: 1/12/09

$$\text{Loading } \frac{\text{lbs}}{\text{day}} \quad \left[\frac{\text{y mg}}{\text{l}}\right]\left[\frac{\text{z gal}}{\text{day}}\right]\left[\frac{\text{1 kg}}{\text{1,000,000}}\right]\left[\frac{\text{2.205 lb}}{\text{kg}}\right]\left[\frac{\text{3.785 l}}{\text{gal}}\right]$$

Where:
y = TDS concentration

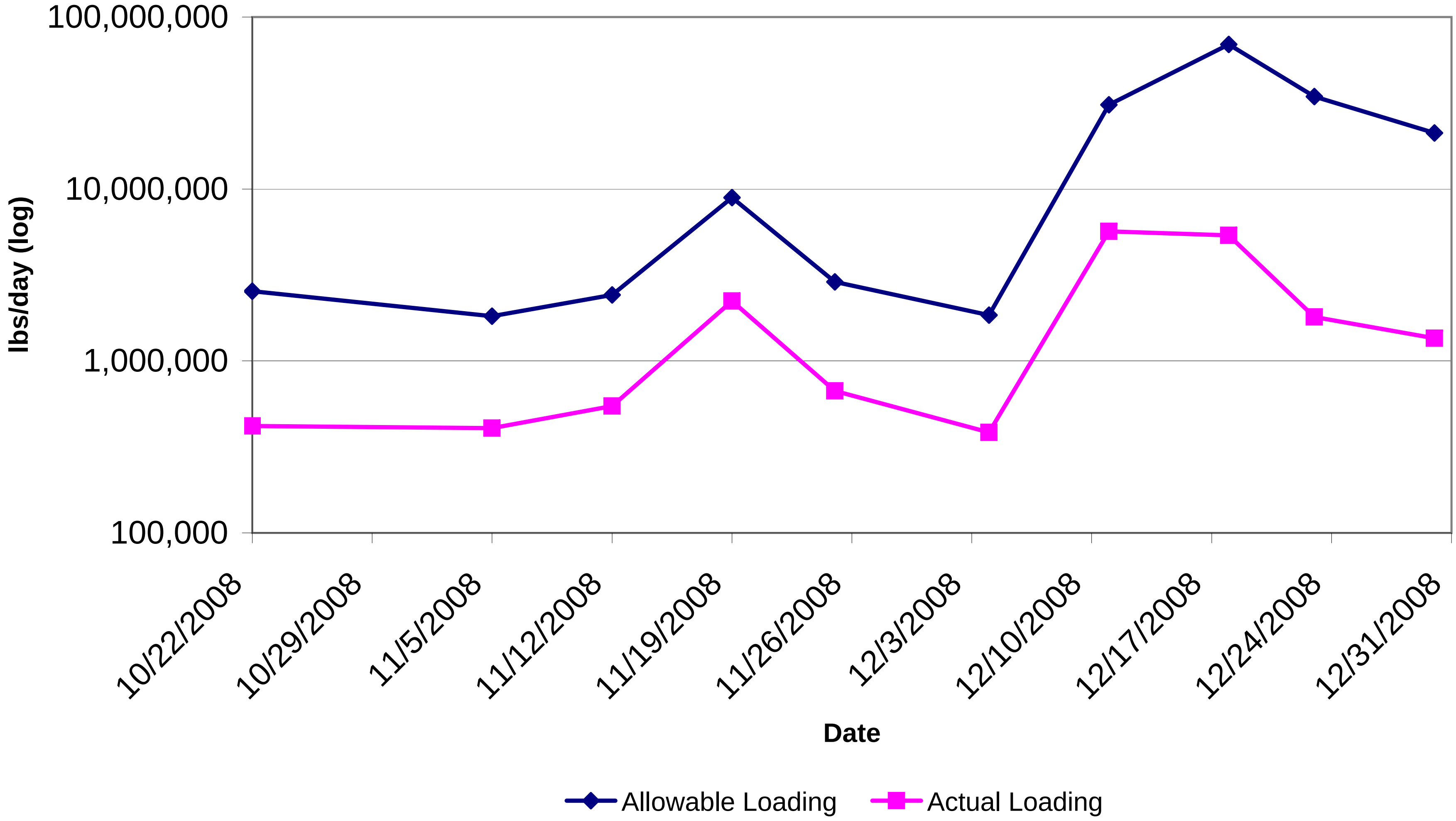
Baseline Calcs Date	Location	Average Flow Rate on Date of Sample (cfs)	ft³/day	gpd	Actual Cl- mg/L	Target Cl- mg/L	Allowable Cl- Load (lbs/day)	Actual Cl- (lbs/day)	Actual TDS mg/L	Target TDS mg/L	Allowable TDS Load (lbs/day)	Actual TDS (lbs/day)
22-Oct-08	RMI 4.5	1,886	162,984,960	1,219,127,501	41.1	250	2,543,405	418,136	414	500	5,086,809	4,211,878
5-Nov-08	RMI 3.1	1,349	116,579,520	872,014,810	55.8	250	1,819,241	406,055	494	500	3,638,482	3,594,820
12-Nov-08	RMI 3.1	1,795	155,062,080	1,159,864,358	56.5	250	2,419,767	546,867	532	500	4,839,534	5,149,264
19-Nov-08	RMI 3.1	6,602	570,447,360	4,266,946,253	62.6	250	8,901,917	2,229,040	750	500	17,803,833	26,705,750
25-Nov-08	RMI 3.1	2,135	184,489,920	1,379,984,602	58.1	250	2,878,993	669,078	734	500	5,757,986	8,452,723
4-Dec-08	RMI 3.1	1,370	118,359,360	885,328,013	52	250	1,847,016	384,179	478	500	3,694,031	3,531,494
11-Dec-08	RMI 3.1	22,876	1,976,486,400	14,784,118,272	46	250	30,843,367	5,675,179	522	500	61,686,733	64,400,950
18-Dec-08	RMI 3.1	51,338	4,435,603,200	33,178,311,936	19.4	250	69,218,253	5,371,336	150	500	138,436,507	41,530,952
23-Dec-08	RMI 3.1	25,536	2,206,310,400	16,503,201,792	13.1	250	34,429,805	1,804,122	136	500	68,859,609	18,729,814
30-Dec-08	RMI 3.1	15,694	1,355,961,600	10,142,592,768	16	250	21,159,984	1,354,239	166	500	42,319,968	14,050,229

**Based upon Tri-County (3500 gallons/day), California Boro (5520 gallons/day), Belle Vernon (6429 gallons/day), Mon Valley (5488 gallons/day), and McKeesport (1,933 gallons/day) POTWs accepting an average of 20,937 gallons/day of produced water in November 2008 & December 2008. Clairton POTW began excepting 37,000 gallons/day, 6-days / week, on December 8, 2008.*



Actual and Allowable TDS Loadings Versus Time
Monongahela River
lbs/day (log)
1,000,000,000
100,000,000
10,000,000
1,000,000
10/22/2008
10/29/2008
11/5/2008
11/12/2008
11/19/2008
11/26/2008
12/3/2008
12/10/2008
12/17/2008
12/24/2008
12/31/2008
Date
Allowable Loading
Actual Loading

Actual and Allowable Chloride Loadings Versus Time
Monongahela River



ATTACHMENT E

DMR SUMMARY

DMR Data Summary

August through November 2008

NPDES	Name	DMR's Available	Month	Avg. Flow (MGD)	Max. Flow (MGD)	Information Copied	Notes
PA0219177	Dana Mining Company	Aug, Sep, Oct, Nov	Aug-08	< 0.001	< 0.001	Pollution Report Summary	only treat domestic wastewater
			Sep-08	< 0.001	< 0.001		
			Oct-08	< 0.001	< 0.001		
			Nov-08	< 0.001	< 0.001		
PA0219410	Warwick Mine Aquaculture	Aug, Sep, Oct	Aug-08	0.72	0.78	Pollution Report Summary; NPDES Public Notice	monitor TSS, CBOD, Ammonia-Nitrogen, Fe, Mang., pH
			Sep-08	0.37	0.78		
			Oct-08	0.65	1.24		
PA0219380	Mypodiamond Inc.	Sep, Oct, Nov	Sep-08	0.0424	0.0864	Pollution Report Summary	non-contact cooling water, boiler blowdown, floor drains, stormwater, water from processing synthetic diamonds; monitor flow, Cu, Zinc, Temp, pH, O&G, & TSS
			Oct-08	0.0285	0.0432		
			Nov-08	0.0456	0.0864		
PA0218863	Fayette Energy Facility	Aug, Sep, Oct	Aug-08	see note	see note	Pollution Report Summary and DMR	recorded flows for 6 different outfalls; approx. 2 mgd total discharge (avg & max very similar)
			Sep-08	see note	see note		
			Oct-08	see note	see note		
PA0002941	Hatfields Ferry Power Station	Under Litiagation; no reports available					
PA0216470	Consolidation Coal Company	Delinquent since April 2003				Pollution Report Summary	monitor total residual chlorine (disinfection)
PA0216461	Consolidation Coal Company	Inactive					
PA0205800	Southwestern Pennsylvania Water Authority	Delinquent since Feb-08				Pollution Report Summary	No report since Feb-08; '07 max flow ~0.5 MGD; monitor TSS Fe, Al, Mang., TR Chlorine, pH
PA0003042	Welland Chemical, Inc	Inactive					
PA0001562	Severstal	Aug, Sep	Aug	see note	see note	Pollution Report Summary, August and Septembers DMRs	5 outfalls; approx. 15 MGD total discharge (avg & max very similar). Monitor Temp, pH, Oil & Grease, Flow, Zinc, TSS, and Lead.
			Sep	see note	see note		
PA0218502	Concrete Batch Plant	Aug, Sep, Oct	Aug-08	see note	see note	N/A	flow monitored for 3 outfalls, total avg. daily ranged from 0.14 to 0.36 mgd; total max. daily ranged from 8.2 to 12.9 mgd; TDS monitored at Outfall 101, avg. range of 355 to 785 and max range of 560 to 1200 mg/l
			Sep-08	see note	see note		
			Oct-08	see note	see note		
PA0022004	FlexSys	Aug, Sep, Oct	Aug-08	0.0345	0.04	Pollution Report Summary and DMR	4 permitted outfalls; only 1 reported in DMRs; Outfall S03 listed as AMD but not reported; Carbon Disulfide limits of 1.0 and 2.0 mg/l (avg & max)
			Sep-08	0.0376	0.0413		
			Oct-08	0.036	0.039		
PAS236101	Dyno Nobel	3rd Quarter 2008	3Q08	8 gpm	8 gpm	Pollution Report Summary	Insignificant contaminant concentrations
PA0091391	Spartech Polycom	Aug, Oct	Aug-08	0	0	Pollution Report Summary	Only stormwater in August & October (no process water)
			Oct-08	0	0		
PA0204293	Spartech Polycom	Aug, Sep	Aug-08	0	0	Complete Pollution Report	Only stormwater in August & September (no process water); process water is contact cooling water
			Sep-08	0	0		
PA0218791	Victory Hollow	Aug, Sep, Oct	Aug-08	0.003	0.052	Pollution Report Summary	Dredge operations; Manganese limits of 2 (avg) and 4 (max) mg/l; Monitor & report flourides & sulfates for Outfall 002 (no flow during reporting periods)
			Sep-08	0	0		
			Oct-08	0	0		
PA0002895	Allegheny Energy	Aug, Sep	Aug-08	see note	see note	August and September DMRs	Recorded flows for 12 different outfalls; approx. 370 MGD total discharge (avg & max very similar). Some of the parameters tested are; Temp, pH, Oil
			Sep-08	see note	see note		
PAS216103	Therm O Rock	Delinquent since 2007				Statement of Basis	no report since 3Q07; Nitrate + Nitrite monitoring (<1 mg/L)
PA0001571	Orion Power	Aug, Sep	Aug-08	< 68	< 435	Pollution Report Summary and DMR	9 permitted outfalls; monitor temp., pH, O&G, Chlorine (residual), TSS
			Sep-08	< 10.7	< 64		
PA0000272	PA American Water	Aug, Sept	Aug-08	0.357	0.36	Pollution Report Summary and DMR	only 1 permitted outfall; avg and max limits for total manganese (1 & 2 mg/l) and total aluminum (0.8 and 1.6 mg/l)
			Oct-08	0.5	0.67		
PA0000507	Eastman Chemical	Aug, Sep, Oct, 3Q08	Aug-08	0.0371	0.0525	August 2008 DMR & 3Q08 DMR; Pollution Report Summary	Outfall 1- monthly, ion exchange regeneration effluent; Outfalls 2-23- fluoride max of 7 mg/L in 10/08, much less flow, quarterly
			Sep-08	0.0495	0.1777		
			Oct-08	0.0204	0.0254		
PA0025852	Marathon Ashland	Aug, Sep, Oct, Nov, 3Q08	Aug-08	0.0021	0.004	Pollution Report Summary	Treated groundwater (003), SW, load rack wash water, hydrostatic test water; monitor TSS, BTEX, VOCs, Fe, O&G, pH
			Sep-08	0.0002	0.0002		
			Oct-08	0.0003	0.0003		
			Nov-08	0.0002	0.0002		
			3Q08	0.0043	0.0086		
PAP122331	Eastman Chemical	Permit and DMRs not found					
PA0090271	Orion Power	Aug, Sept, Oct	Aug	0.041	0.049	Pollution Report Summary	No salts of TDS tested.
			Sep	0.044	0.055		
			Oct	0.04	0.044		

DMR Data Summary

August through November 2008

NPDES	Name	DMR's Available	Month	Avg. Flow (MGD)	Max. Flow (MGD)	Information Copied	Notes
PA0098001	Koppers	Aug, Oct	Aug	0.25	0.67	Pollution Report Summary	Iron and Zinc are the primary parameters tested. Concentrations are very dilute.
			Oct	0.016	0.21		
PA0004472	US Steel Clairton	Sep, Aug	Aug	see note	see note	August and September DMRs	monitor pH, TSS, Iron, Mn, Flow. Recorded flows for 9 different outfalls; approx. 105 MGD total discharge (avg & max very similar)
			Sep	see note	see note		
PA0000914	US DOE- Bettis	Aug, Sept, Oct	Aug-08	0.095	0.329	Pollution Report Summary, 007 permit analytical results	TDS = 1550 mg/L in outfall PRS, but TDS not monitored; monitor TSS, O&G, Temp, pH, VOCs, Dissolved Iron (7 mg/L max limit)
			Sep-08	0.094	0.586		
			Oct-08	0.113	0.76		
PA0004081	CP Industries	Aug, Sept, Oct, Nov	Aug-08	0.0017	0.0033	Pollution Report Summary; NPDES Fact Sheet	Contact and SW; monitor TSS O&G, pH
			Sep-08	0.0057	0.0073		
			Oct-08	0.0028	0.0044		
			Nov-08	0.0039	0.005		
PA0217387	BOC Gases	Aug, Sep, Oct, Nov	Aug	10	12	Summary sheet for NPDES permit copied.	Of TDS constiuents only residual Cl monitored; monitor Temp, pH, Oil & Grease, Flow, Zinc, TSS, Cl, and Lead. Average maxium concentration over 4 months is ~ 0.09 mg/L
			Sep	10	12		
			Oct	10	12		
			Nov	10	12		
PA0094510	US Steel Corp (Edgar Thompson)	Aug, Sep, Oct	Aug	see note	see note	Pollution Report Summary. Aug, Sep, and Oct DMRs.	Of TDS constiuents only residual Cl monitored; monitor Temp, pH, Oil & Grease, Flow, Zinc, TSS, Cl, and Lead. Recorded flows for 6 different outfalls; approx. 300 MGD total discharge (avg & max very similar)
			Sep	see note	see note		
			Oct	see note	see note		
PA0218081	Whemco Steel Castings	Aug, Sep, Oct, 3Q08	Aug-08	0.1	0.336	Pollution Report Summary	7 outfalls; all SW but 006 (non-contact cooling water) & 106 (contact quench); SW Qtrly for Zinc and pH (no flow)
			Sep-08	0.096	0.318		
			Oct-08	0.11	0.4		
PA0096792	Techs Industries	Aug, Sept, Oct, Nov	Aug-08	0.009	0.031	Pollution Report Summary	non-contact cooling and SW; monitor Temp, pH, TSS, O&G
			Sep-08	0.0223	0.0383		
			Oct-08	0.018	0.031		
			Nov-08	0.022	0.025		
PA0006131	Almono LP	Inactive					

PERMITTEE NAME/ADDRESS *(Include Facility Name/Location if Different)*
NAME U.S. Army Corps of Engineers
ADDRESS Pittsburgh District
1000 Liberty Avenue
Pittsburgh, PA 15222-4186

FACILITY Charleroi Lock & Dam
LOCATION Charleroi, Washington County

NATIONAL POLLUTANT DISCHARGE ELIMINATIONS SYSTEM (NPDES)
DISCHARGE MONITORING REPORT (DMR)

Form Approved.
OMB No. 2040-0004

PA0218502	101
PERMIT NUMBER	DISCHARGE NUMBER

	MONITORING PERIORD						
	YEAR	MO	DAY		YEAR	MO	DAY
FROM	2008	10	1	TO	2008	10	31

Note: Read instructions before completing this form.

PARAMETERS		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MAXIMUM	UNITS			
Flow	SAMPLE MEASUREMENT	0.193	4.138						0	N/A	continuous
	PERMIT REQUIREMENT	MONITOR	& REPORT	MGD						2/MONTH	MEASURED
Total Suspended Solids	SAMPLE MEASUREMENT						12		0	2	GRAB
	PERMIT REQUIREMENT						50	MG/L		2/MONTH	GRAB
Total Dissolved Solids	SAMPLE MEASUREMENT					685	690		0	2	GRAB
	PERMIT REQUIREMENT					MONITOR	& REPORT	MG/L		2/MONTH	GRAB
Oil and Grease	SAMPLE MEASUREMENT					< 5.0	< 5.0		0	2	GRAB
	PERMIT REQUIREMENT					15.0	30.0	MG/L		2/MONTH	GRAB
MBAS	SAMPLE MEASUREMENT					< 0.10	< 0.10		0	2	GRAB
	PERMIT REQUIREMENT					MONITOR	& REPORT	MG/L		2/MONTH	GRAB
Aluminum	SAMPLE MEASUREMENT					0.12	0.17		0	2	GRAB
	PERMIT REQUIREMENT					4.0	8.0	MG/L		2/MONTH	GRAB
Iron	SAMPLE MEASUREMENT					0.12	0.12		0	2	GRAB
	PERMIT REQUIREMENT					2	4	MG/L		2/MONTH	GRAB

NAME/TIELE PRINCIPAL EXECUTIVE OFFICER

KIRK A. McWILLIAMS
Contracting Officer's
Representative

TYPED OR PRINTED

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those directly responsible for gathering the information, the information submitted is, to the best of may knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Kirk A. McWilliams

TELEPHONE		DATE		
724	684-7462	DEC	04	2008
AREA CODE	NUMBER	YEAR	MO	DAY

COMMENTS AND EXPLANATIONS OF ANY VIOLATIONS (Reference all attachements hear)

EPA Form 3320-1 (rev. 3/99) Prvious editions may be used.

NOTE: YOUR PERMIT WILL EXPIRE ON SEP 17 2008. PLEASE SUBMIT YOUR RENEWAL APPLICATION BY MAR 20 2008.

FACT SHEET/STATEMENT OF BASIS NPDES PA0218502

Prepared by: Kareen A. Milcic

Date: March 3, 2001 Outfall 001, 002

Phone: 412-442-4000

(ES) U. S. Army Corps of Engineers (MUN) Charleroi

(AF) Left Bank Concrete Batch Plant (CO) Washington

****

The U. S. Army Corps of Engineers (USACOE) submitted an NPDES permit application for a temporary concrete batch plant. The plant will be constructed on the left bank of the Monongahela River (RMI 41.4). The facility will produce concrete for construction of a river wall, upper and lower guard walls, middle wall and land wall for the Charleroi lock and dam.

The USACOE is purchasing a temporary work area easement from the landowner of the project area. The site had previous uses during which the elevation of the site was raised with coal refuse and fill. Coal refuse is also stockpiled on the site. There are other piles of scrap (metal, wood, vehicle parts) rubbish, debris, concrete slab, etc. The USACOE solicited bids for the removal of the coal refuse pile and other miscellaneous site clearing (October 2000). It is the intent of the Corps to remove the existing refuse and other wastes to enable the Corps to grade the site for the concrete batch plant.

Since the site is contaminated with coal wastes, storm water runoff associated with the removal of the debris and waste, as well as construction activities must be collected and treated. The NPDES permit contains interim effluent limitations and monitoring requirements for the storm water runoff from these activities. The effluent limitations for this source are those typically applied to mining sites (40 CFR 434). All storm water runoff (during this interim period) must be collected and treated.

The Erosion and Sedimentation Control Plan was submitted to the Washington County Conservation District. The District reviewed the plan and recommend the plan be approved. The appropriate Part C Conditions will be placed in the permit for storm water runoff associated with site development of an industrial property.

Concrete Batch Plant

Wastewater associated with the concrete batch plant include the following sources:

1. Aggregate rinse, 168,000 gallons/day;

2. Truck and mix drum clean out 500 gallons/day;

3. Storm water runoff from a 10 year 24 hour storm event 200,403 gallons/day.

The plant is proposed to operate 8 hrs/day, 18 days/month, 216 days/year. The long term average discharge rate is 0.105 mgd. The maximum daily discharge rate is 0.369 mgd.

This is the second concrete batch plant constructed for the Lower Mon River Project. The same technology based effluent limits contained in the Duquesne Batch Plant NPDES permit will be placed in this permit. The limits are:

Parameter	Average Monthly (mg/l)	Instant. Maximum (mg/l)
Total Suspended Solids		50.0
Total Dissolved Solids	Monitor and Report	
Oil and Grease	15.0	30.0
MBAS	Monitor and Report	
Aluminum	4.0	8.0
Iron	2.0	4.0
Manganese	1.0	2.0
pH	not less than 6.0 nor greater than 9.0	

****

The storm water runoff discharges associated with construction activities are to be collected and treated. Interim limits (Page 2a) are contained in the permit. These limits apply for the period of beginning of construction (after the refuse pile has been removed) until commencement of the batch plant operations. A termination condition has been placed in Part C of the permit.

The coal refuse pile removal will be regulated by the Mining Office. Activities authorized under ths permit may not begin until the refuse pile is removed.

Process related wastewater and storm water runoff will be collected, treated and discharged through Internal Monitoring Point 101 (IMP 101).

IMP 201 shall consist solely of uncontaminated storm water.

Outfall 001 shall consist of those sources previously monitored at IMPs 101 and 201.

Outfall 002 shall consist solely of uncontaminated storm water runoff.

ADDENDUM TO FACT SHEET/STATEMENT OF BASIS

By letter dated June 29, 2001 the USACOE submitted comments on the draft permit. The Department has met with the Corps on numerous occasions to discuss this permit, without reaching a mutually acceptable resolution. Therefore, the Department offers the following responses to the Corps comments.

The USACOE commented on storm water runoff during construction activities stating "Outfall 001 is not a point source discharge for storm water runoff from construction activities, and therefore, doesn't require monitoring during construction. The interim monitoring required on Page 2a of 14 will be undertaken once the sedimentation basins begin to receive storm water runoff, which will be after pavement construction around the basins. Note that the storm water runoff during construction activities is handled under the Erosion and Sedimentation Control (E&SC) Plan that was approved by the Washington County Conservation District (WCCD). Reference Contract Drawing 103/2, (Attachment B) for a plan view of the overall Erosion and Sediment control Plan and refer to contract Drawing 4/6, (Attachment B) for location of Outfall 002. The approved E&SC Plan includes filter fabric and super silt fence, rock filters, rock-stabilized construction entrances, and a rock-lined channel, as shown on Contract Drawing 103/2. These provisions meet the requirements of Title 25, DEP Chapter 102 Rules and Regulations for erosion and sediment control."

The requirement to collect and treat storm water runoff during construction activities was placed in the permit because the site is contaminated with coal wastes. Conventional erosion and sedimentation controls are not adequate to treat the runoff form this site. Conventional treatment (chemical adjustment and sedimentation) is the standard treatment technology that is employed throughout the mining industry.

To further its position that the storm water runoff cannot be treated the Corps stated that, "Condition C-7 requires that storm water runoff during construction activities be directed to the sedimentation basin and discharged via Outfall 001. This requirement cannot be complied with. The existing surface drainage patterns carry runoff away from the planned locations of the sedimentation basins. Also, the site must be graded consistent with the final top of pavement grades, which precludes grading most of the site toward the sedimentation basins. Additionally, the sedimentation basins are not part of the approved E&SC Plan, and will not be constructed until after much of the disturbance from construction has occurred. Furthermore, the tops of the sedimentation basins, inlets/catch basins, and manholes are set to coincide with the final pavement surface; therefore, these structures will not receive storm runoff until the adjoining pavement is constructed. Accordingly, the interim monitoring required on Page 2a of 14 will not be undertaken until the sedimentation basins begin to receive storm water runoff, which will be after pavement construction around the basins. This monitoring will continue until the batch plant is put into service, at which time the final effluent monitoring specified on Page 2b of 14 will be initiated."

In response to these comments, the Department modified the applicable time frame of the interim effluent limitations. The interim effluent limitations on Page 2a of the NPDES permit are effective from the date the sedimentation basins and river access road are built or ten weeks from the beginning of construction, whichever is less.

The Corps commented on the inclusion of internal monitoring point 201 in the NPDES permit stating that "There is no Internal Outfall 201 to be monitored. Figure 3 - Line Drawing and Water Balance, in the NPDES Part I Permit Application should not have shown an Internal Outfall 201. (Note that Figure 3 2 will be revised and Internal Outfall 201 will be deleted from the Line Drawing). In Figure 3, the storm water runoff of 387,800 gpd entering the system downstream of Outfall 101 represents the cumulative runoff from areas outside the Batch Plant area (excluding contributions to Outfall 002). This runoff enters Inlets Nos. 1 through 4 and combines with runoff and treated process wastewater from the Batch Plant area at several different points downstream of Internal Outfall 101 (Manhole No. 1). The discharge from the Batch Plant area is appropriately monitored at Internal Outfall 101, while the combined discharge is monitored at Final Outfall 001. Therefore, the effluent monitoring indicated on Page 2c of 14 is not applicable, nor necessary."

In response to this comment, the IMP is deleted from the permit. The stormwater runoff entering into this conveyance system will be monitored at Outfall 001. To ensure that the storm water runoff from the silt is uncontaminated the storm water condition of the permit (C-5) is modified to require routine sweeping of the river access road, parking lot and staging areas that contribute storm water runoff from the site.

KM:jms:kld

Summary of Bettis Atomic Lab. - NPDES Application Data
Outfalls listed below (NCCW + Process Water + SWRO)

Pollutant	Discharge 001 Conc. Avg. (mg/l)	Discharge 002 Conc. Avg. (mg/l)	Discharge 007 Conc. Avg. (mg/l)	Influent Conc. Max. (mg/l)
Flow (MGD)	0.116 (SWRO)	0.05 (SWRO)	0.036 (SWRO)	0.163
CBOD5 Day	2	5	2	<1
TSS	1	<1	<1	1
TDS	309	339	1550	2020
NH3 as N	0.14	0.14	0.37	0.42
O&G	<1.0	<1.0	<1	<1
TRC	<0.2	<0.2	<0.2	<0.2
Temperature °C	14	19	14	14
pH (S.U)	8.0	8.1	8.1	7.3
Fecal Coliform (per 100 ml)	43	20	27	<10
Fluoride	1.05	0.831	0.233	0.19
NO2-NO3	1.38	0.937	1.02	0.24
Phosphorus (as P)	0.32	0.134	<0.01	<0.01
Sulfate	95.33	97	151	167
Antimony (T)	<0.1	<0.1	<0.1	<0.1
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Copper (T)	0.024	0.013	<0.01	0.221
Lead (T)	<0.1	<0.1	<0.1	<0.1
Nickel (T)	<0.01	<0.01	<0.01	0.015
Selenium (T)	<0.005	<0.005	<0.005	<0.005
Zinc (T)	0.304	0.083	0.012	0.019
Cyanide (Free)	0.002	0.002	<0.001	<0.001
Phenols, Total	0.002	1×10^{-7}	0.002	<0.001
Aluminum (T)	0.129	$<8 \times 10^{-6}$	<0.1	<0.1
Barium (T)	0.036	2×10^{-6}	0.074	0.076
Boron (T)	0.093	0.00001	0.104	0.137
Iron (T)	0.142	7×10^{-6}	0.015	0.194
Iron (Dissolved)	0.033	1×10^{-6}	0.01	<0.01
Manganese (T)	0.014	8×10^{-6}	<0.01	<0.01
Chloroform	0.005	<0.005	<0.005	<0.013
Tetrachloroethylene	<0.005	<0.005	<0.005	0.365
Trichloroethylene	<0.005	<0.005	<0.005	0.025
1,2-Dichloroethylene	---	---	Check DMRs	---

NOTES:

1. BAT limits do not apply in this permit. However, for Outfall # 007 previous NPDES limits were based on the treatment technology and are considered BAT/BPJ limits.
2. Please refer to the DMR Summary for comparison with the NPDES limits.

POLLUTION REPORT

Existing

polrep1.doc

I. Project Description:

A. NPDES Application/Permit No. **PA 0000914 –A1**

Part II Permit No. **WQM # 0297202 Amendment No. 1**

B. Applicant: **U.S. Department of Energy** Municipality: **West Mifflin Borough**

Facility: **Bettis Atomic Power Laboratory** County: **Allegheny**

C. Type of Waste: [ ] Sewage [x] Industrial [ ] Mine [x] Storm water

D. Source and Characteristics:

001 & 002: NCCW + CT Boiler Blowdown + Test Loop Water + Process water + Storm Water Run-off.

Outfall # 007: – Treated Ground Water.

Outfalls # 003, 005, 006 & 008: – Uncontaminated Storm Water Run-off .

E. U.S.G.S. Quad(s): **Glassport**

attach "ADDITIONAL OUTFALLS" page, if necessary

F. Outfall No.: **001**

G. Latitude (or in. N): **40°21′30"** Longitude (or in. W): **79°53′45"**

II. Water Uses and Criteria

A. Receiving waters: **Bull Run – 001, 003 & 005; Northeast stream – 002, 007 & 008; Thompson Run - 006** Stream code: **Intermittent** RMI: **N/A**

Drainage area **N/A** mi^2, Yield **N/A** cfs/mi^2, Flow **N/A** ft^3/s

Based on data from: **Previous Pollution Report**

Elevation: ______ ft, Slope: ______ ft/ft, Chapter 93 classification: **WWF**

Exceptions to standard uses:

Add: **None**

Delete: **None**

Impoundment:

Exceptions to specific criteria:

Add: **None**

Delete: **None**

Special uses:

B. Secondary waters: **Thompson Run** Stream code: **37211** RMI: **1.5 (from 001)**

Drainage area **5.46** mi^2 Yield **0.1** cfs/mi^2, Flow **0.55** ft^3/s

Based on data from: **Previous Pollution Report (B-12 Pigeon Creek @ Monongahela River; B-6 for D.A.**

Elevation: ______ ft, Slope: ______ ft/ft, Chapter 93 classification: **WWF**

Exceptions to standard uses:

Add: **None**

Delete: **None**

Impoundment:

Exceptions to specific criteria:

Add: **None**

Delete: **None**

Special uses:

C. Downstream PWS location: **Western PA Water Company** RMI: **-**

Stream name: ______ Distance from discharge: **~9** Miles

Stream flow at intake: ______ ft^3/s, Intake: ______ Mgd

Note: WQ modeling was done at the confluence of Bull Run and Northeast stream to Thompson Run.