

**WATERSHED PROJECT FINAL REPORT  
SECTION 319 NONPOINT SOURCE POLLUTION  
CONTROL PROGRAM**

Belle Fourche River Watershed Management  
and Project and Implementation Plan

*Prepared by*

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October 2005



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*by*

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October 12, 2005

This project was conducted in cooperation with the South Dakota Department of Environment and Natural Resources and the United States Environmental Protection Agency, Region VIII.

Grant # 99818504

## EXECUTIVE SUMMARY

PROJECT TITLE: Belle Fourche River Watershed Management and Project Implementation Plan

SECTION GRANT NUMBER(S): 99818504

PROJECT START DATE: June 2004

PROJECT COMPLETION DATE: September 2005

### FUNDING:

TOTAL EPA GRANT BUDGET: \$189,000

TOTAL MATCHING FUNDS BUDGET: \$268,000

TOTAL NONMATCHING FUNDS BUDGET: \$386,900

TOTAL BUDGET: \$843,900

### BUDGET REVISIONS:

Total 319 Funds did not Change

TOTAL EXPENDITURES OF EPA FUNDS: \$189,000

TOTAL 319 MATCHING FUNDS ACCRUED: \$260,757

TOTAL NONMATCHING FUNDS ACCRUED: \$364,086

TOTAL EXPENDITURES: \$813,843

The Belle Fourche River Watershed Management Project is sponsored by the Belle Fourche River Watershed Partnership (BFRWP) with strong support from agricultural organizations, federal and state agencies, local governments, South Dakota State University (SDSU), and South Dakota School of Mines and Technology (SDSM&T). This project began implementation of the best management practices (BMPs) identified in the Total Maximum Daily Load (TMDL) report for the Belle Fourche River. The goals of this project segment were:

- Begin the initial implementation of BMPs in the watershed to reduce total suspended solids (TSS).

- Develop a 10-year watershed strategic implementation plan to guide the long-term process to reduce TSS in a cost-effective manner.
- Conduct public education and outreach to stakeholders within the Belle Fourche River Watershed to codevelop the 10-year strategic plan.

The 10-year Belle Fourche River Watershed Strategic Implementation Plan was developed. The plan describes the approach and establishes a timeline to reduce the release of 12,000 acre-feet of nonused irrigation water to the surrounding water courses from the BFID. This reduction will reduce the resultant TSS concentrations in the Belle Fourche River. The plan includes a list of the BMPs needed to reach the required TSS levels of the Belle Fourche River. The plan contains a decision matrix that will be used to determine which BMPs should be implemented first.

A 5-year strategic plan for the BFID irrigation systems and management was developed and approved by the Bureau of Reclamation (BOR) and the South Dakota Department of Environment and Natural Resources (DENR). This plan incorporates continuous stage and water quality monitoring and focused discussion and planning work that took place between the BFID, SDSM&T, BOR, and consultants. The plan provides a guide for the BFID to accomplish the goal of implementing new initiatives for water conservation and reduce nonused water and improve irrigation efficiencies.

A consultant to the BFRWP worked with producers in the watershed. During the project, seven ranch units were analyzed and resource inventories on approximately 50,000 acres were completed. One of the conservation plans developed resulted in a 2005 EQIP contract. The contract includes one deep well for livestock, 72,300 linear feet of livestock pipelines, 18,000 gallons of livestock water tanks, 7,600 linear feet of cross-fencing and some hayland seeding. The grazing system includes over 13,000 acres on this ranch unit. In addition, the deep well may be used to provide livestock water to adjacent ranches in the future, which could result in providing livestock water to over 25,000 acres in the watershed.

Several public education and outreach events have been performed during this project segment in addition to the outreach described earlier. The Butte County, Lawrence County, and Elk Creek Conservation Districts each send out newsletters which include project updates. The BFRWP had four general meetings to provide updates on project work and progress being made. The BFRWP had a booth at the Pen of Three Show in Sturgis during the spring of 2005 to inform the public about specific project work and answer questions.

## **ACKNOWLEDGEMENTS**

The BFRWP would like to thank all those involved with this segment of the implementation of practices recommended from the Belle Fourche River Watershed TMDL. The efforts of all those involved from the following organizations are greatly appreciated and have been essential to the success of this project.

Belle Fourche Irrigation District

Butte County Conservation District

Cities of Sturgis, Belle Fourche, Spearfish, Whitewood, Lead, and Deadwood.

Corps of Engineers

Counties of Lawrence, Meade, and Butte

Elk Creek Conservation District

Individual Rancher, Farmers, Producers, and Landowners within the Watershed

Lawrence County Conservation District

Natural Resource Conservation Service

South Dakota Department of Environment and Natural Resources

South Dakota School of Mines and Technology

South Dakota State University

United States Geological Survey

United States Bureau of Reclamation

United States Environmental Protection Agency

United States Fish and Wildlife Service

United States Geological Survey

Wyoming Department of Environmental Quality

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## INTRODUCTION

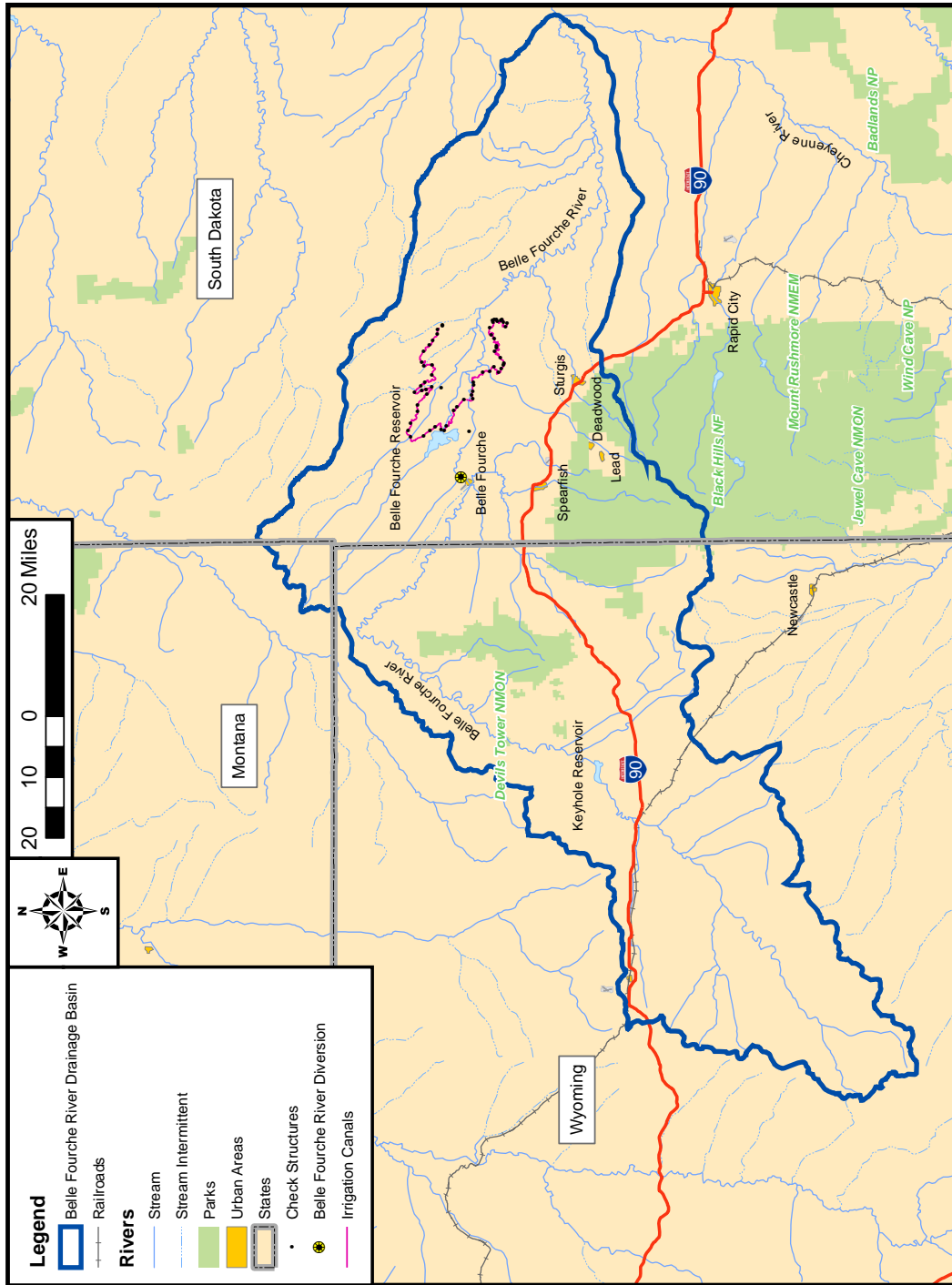
The Belle Fourche River is a natural stream that drains parts of Butte, Lawrence, and Meade Counties in South Dakota with the headwaters located in Wyoming. The river flows into the Cheyenne River (Figure 1) in southern Meade County and ultimately to the Missouri River. The Belle Fourche River Watershed is approximately 2,100,000 acres (3,300 square miles) in size in South Dakota and includes Hydraulic Units 10120201, 10120202, 10120203. The city of Spearfish (population 8,606) is the largest municipality located in the Belle Fourche River Watershed. Other small communities in the watershed include Deadwood (1,380), Lead (population 3,027), Sturgis (4,442), Belle Fourche (4,565), Fruitdale (62), Nisland (204), and Newell (646).

Land use in the watershed is predominantly grazing with some cropland. Wheat, alfalfa, native and tame grasses, and hay are the main crops and within the Belle Fourche Irrigation District (BFID) some corn is also grown. Some winter animal feeding areas are located in the watershed. Gold mining is conducted in some headwater areas of the watershed. Some of the watershed land is used for silviculture. Approximately 11 percent of the watershed is managed by the United States Forest Service and 4 percent is managed by the Bureau of Land Management.

The Belle Fourche River has five beneficial uses listed by the South Dakota Department of Environment and Natural Resources (DENR). The beneficial uses are fish and wildlife propagation, recreation, stock watering waters, warm-water permanent fish life propagation waters, limited contact recreation waters, immersion recreation waters, and irrigation waters.

The Belle Fourche River was identified in the 1998 and 2002 South Dakota 303(d) reports and the 2004 South Dakota Integrated Report as impaired by elevated total suspended solids (TSS) concentrations. According to the 2002 South Dakota Report to Congress (305(b) Water Quality Assessment), the Belle Fourche River from the Wyoming border to the Cheyenne River, South Dakota, failed to support its assigned uses due to high TSS. In this report, agricultural activities are deemed a likely source of occasional impairment. This report also states that a natural source of TSS may originate from erosion of extensive exposed shale beds that lie along the river's course and tributaries.

The Belle Fourche River Watershed Partnership (BFRWP) developed and completed an assessment project to determine the Total Maximum Daily Load (TMDL) for the Belle Fourche River. The project began during April 2001. The draft TMDL was completed during December 2003. Since that time the final TMDL has been submitted and approved by the Environmental Protection Agency (EPA).



**Figure 1.** Belle Fourche River Watershed.

During the 2004 winter, the BFRWP applied for and received a Clean Water Act Section 319 Grant to begin implementation of the Best Management Practices (BMPs) suggested in the TMDL for the Belle Fourche River. The project is supported by agricultural organizations, federal and state agencies, local governments, South Dakota State University (SDSU), and South Dakota School of Mines and Technology (SDSM&T).

This project segment included funding from local ranchers and farmers, BFRWP, Lawrence County, BFID, Wyoming Department of Environmental Quality (WYDEQ), National Resource Conservation Service (NRCS), Corps of Engineers, Bureau of Reclamation (BOR), United States Geological Survey (USGS), and the Clean Water Act Section 319 Grant. Two products of the implementation project were the Ten-Year Belle Fourche River Watershed Strategic Implementation Plan and the Five-Year Belle Fourche Irrigation District Water Conservation Plan. These two plans outline the activities that will be completed. Within the plans, the associated total suspended solids (TSS) and nonused water savings are presented for each action planned. Some of the BMPs recommended by the TMDL and 10-year plan installed during this project segment include one flow automation unit, replacing open irrigation ditches with pipeline, lining open irrigation ditches, installing pipelines to deliver water from the BFID system to the fields, installation of irrigation sprinkler systems within the BFID, and managed grazing. The BMPs installed are discussed in a later section of this report. These BMPs were installed in the South Dakota portion of the Belle Fourche River Watershed with the irrigation BMPs being installed in the BFID (Figure 2).

## **PROJECT GOALS AND OBJECTIVES**

The overall goal of the Belle Fourche River Watershed Management and Project Implementation Plan is to bring the Belle Fourche River and Horse Creek into compliance for TSS within 10 year years. To accomplish the goal, a 55 percent reduction in TSS is required to bring the Belle Fourche River into compliance with the water quality standards. A 41 percent reduction in TSS is required for Horse Creek.

This project had three objectives. These objectives included:

1. Implement BMPs to begin reducing TSS.
2. Create a 10-year watershed strategic implementation plan.
3. Conduct public education and outreach to stakeholders within the Belle Fourche River Watershed to codevelop the 10-year strategic implementation plan.

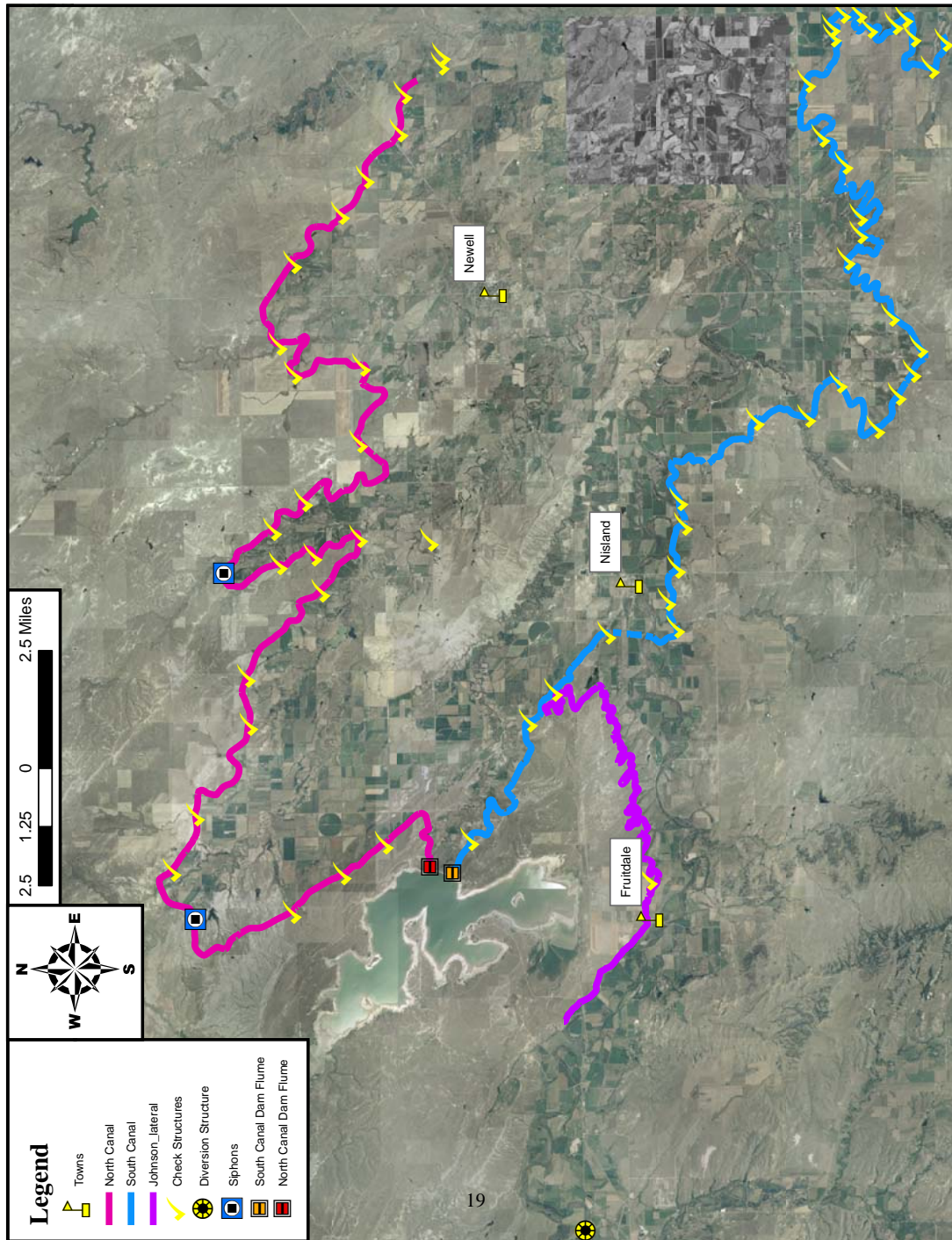


Figure 2. Belle Fourche Irrigation District.

## **PLANNED AND ACTUAL MILESTONES, PRODUCTS, AND COMPLETION DATES**

Objective 1 “Implement BMPs to Begin Reducing TSS” included two tasks which were to improve water management and implement grazing management units. The products that came out of this objective included one flow automation unit, replacing canals, laterals, and/or ditches with pipelines, lining canals or laterals, installing pipelines to deliver water from the BFID irrigation system to fields, installing two sprinkler irrigation systems, and irrigation efficiency demonstration projects. These BMPs are all discussed further in the Best Management Practices section. Pictures of some of the BMPs are shown in Figures 3, 4, and 5.

Objective 2 was to create a 10-year watershed strategic implementation plan. The Ten-Year Belle Fourche River Watershed Strategic Implementation Plan was completed in January of 2005. All of the recommendations from the Belle Fourche River TMDL were analyzed and the specific number or amount of each BMP that is needed to accomplish the goal of the TMDL were identified. A cost estimate for the total number or amount of each BMP was listed along with the estimated load reduction from the BMPs. Schedules were developed to implement the BMPs within 10 years (2005 through 2014). Additionally, a decision matrix was developed to be used to assist in deciding which BMPs should be implemented first (see Figure 6). In addition to the Ten-Year Belle Fourche River Watershed Strategic Watershed Implementation Plan, the Belle Fourche Irrigation District Water Conservation Plan was completed as part of this objective. Both plans are available at [www.bellefourchewatershed.org](http://www.bellefourchewatershed.org).

Objective 3 was to conduct public education and outreach to stakeholders within the Belle Fourche River Watershed to codevelop the 10-year strategic implementation plan. From this objective, at least ten major information activities were to take place. There were a total of 24 information activities which are further discussed in the Summary of Public Participation section of this report. Table 1 lists the project objectives along with their products, planned milestone completion date, and actual milestone completion date.

## **EVALUATION OF GOAL ACHIEVEMENT**

The project was successful as exemplified by:

- Implementation of several BMPs from the Belle Fourche River Watershed TMDL report.
- Completion of the Ten-Year Belle Fourche River Watershed Strategic Implementation Plan.
- Completing more than twenty education and outreach activities.

There were some tasks that were not completed when they were planned to be finished. The development of new funds was completed 1 month later than the planned completion date. This was caused by the extensive size of the planned grazing system delaying the completion date.



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**Figure 3.** Townsite Check Structure Flow Automation Unit.

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**Figure 4.** Irrigation Pipeline Delivering Water From the Belle Fourche Irrigation District System to a Field.



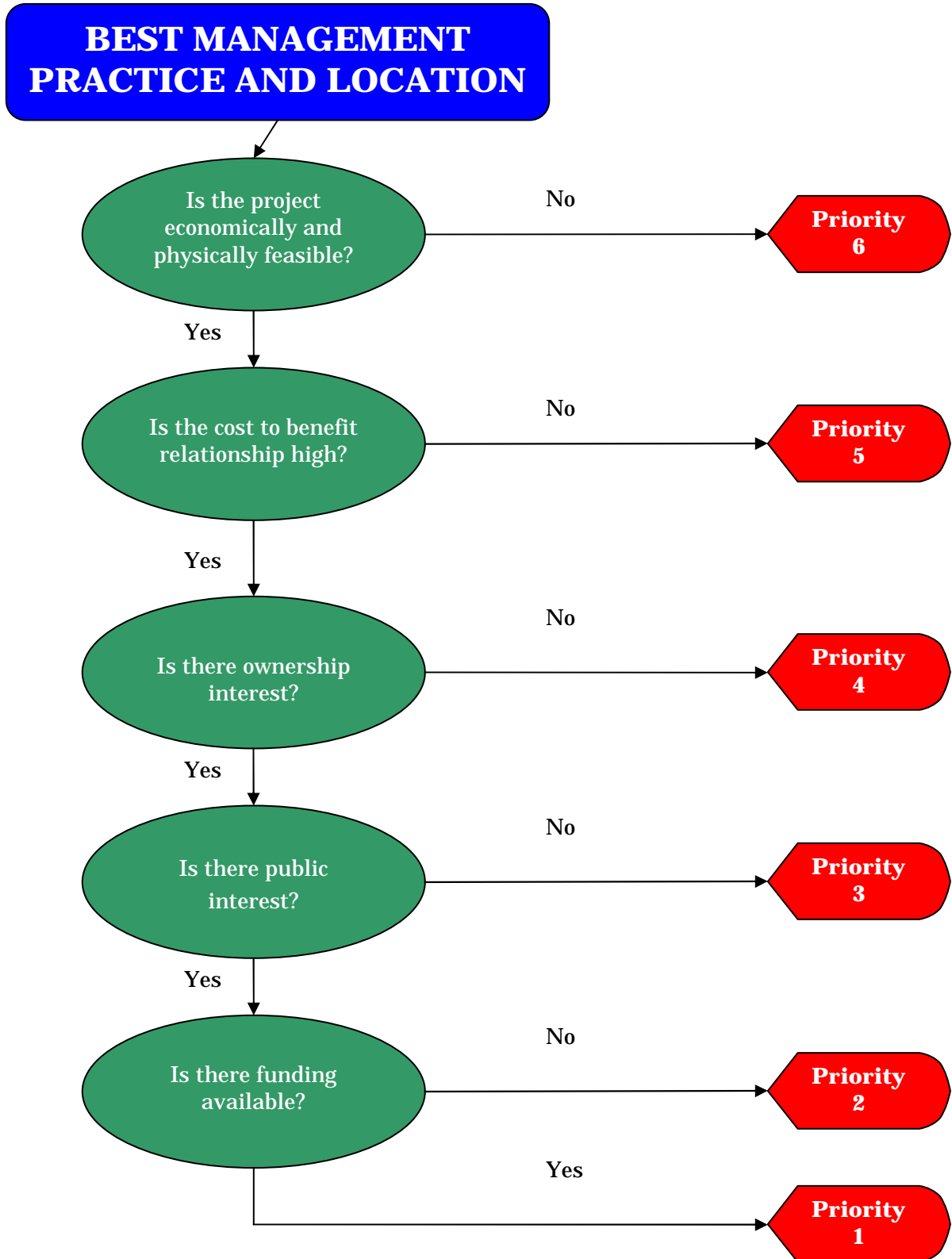
**Figure 5.** New irrigation Sprinkler System.

The project report was scheduled to be completed during June and was not completed until September. This was caused by delays in final billing.

## **BEST MANAGEMENT PRACTICES**

Installation of the BMPs suggested in the Belle Fourche River TMDL was initiated during this project segment. The BMP installation included funding from local ranchers and farmers, BFRWP, Lawrence County, BFID, WYDEQ, NRCS, Corps of Engineers, BOR, and USGS.

Some of the BMPs installed include one flow automation unit, replacing open irrigation ditch with pipeline, lining open irrigation ditches, installing pipelines to deliver water from the BFID system to the fields, installation of two irrigation sprinkler systems, and 3,000 acres of managed grazing. These BMPs resulted in an estimated 7 mg/L reduction in TSS (2.3 percent of the TMDL goal).



**Figure 6.** Best Management Practice Decision Matrix.

**Table 1. Planned Versus Actual Milestone Completion Dates**

<b>Belle Fourche River Watershed Partnership Implementation</b>	<b>Planned Milestone</b>	<b>Actual Milestone</b>
<b>Objective 1. Implement BMPs to Begin Reducing TSS</b>	<b>April 2005</b>	<b>April 2005</b>
Product 1. Improve Water Management	January 2005	June 2004
Product 2. Grazing Management Units	October 2004	May 2004
<b>Objective 2. Create a 10-Year Watershed Implementation Plan</b>	<b>May 2005</b>	<b>April 2005</b>
Product 3. Develop a 10-year Strategic Implementation Plan	May 2005	January 2005
Product 4. Develop a 5-year Strategic Plan for the BFID System	January 2005	January 2005
Product 5. Mew Implementation Funds	March 2005	April 2005
<b>Objective 3. Public Education and Outreach</b>	<b>March 2005</b>	<b>March 2005</b>
Product 6. Conduct Education and Outreach Programs	March 2005	March 2005
Monitoring Water Quality	October 2004	October 2004
Reports	June 2005	September 2005
Project Complete	June 2005	September 2005

The BMPs that were implemented are listed in Table 2. Figure 7 shows a student from SDSM&T downloading data from a flow automation unit (a BMP) located within the BFID. Two additional products of this project are the Ten-Year Belle Fourche River Watershed Strategic Implementation Plan and the Five-Year Belle Fourche Irrigation District Water Conservation Plan. These plans outline the work that will be completed during the next 10 years to meet the TMDL. The associated TSS and nonused water savings are presented for each BMP that is planned. New BMPs were not developed during this project.

**Table 2. BMPs Implemented**

<b>Best Management Practice</b>	<b>Amount Installed</b>	<b>Amount Planned</b>
Flow Automation Units	1	42
Portable Stage/Flow Measuring Devices	3	15
Line Open Canals and Laterals (Feet of Lining)	1,600	26,560
Replace Open Canals and Laterals With Pipeline (Feet of Pipeline)	2,000	25,000
Sprinkler Irrigation Systems	2	36
Install pipeline Projects Delivering Water From BFID to Fields (No. of Projects)	10	40
Managed Riparian grazing (Acres)	3,000	34,000

RSI-1498-05-013



**Figure 7.** Data Collection From Flow Automation Unit Used for Canal Operational Model.

## MONITORING RESULTS

Flow impact at the macro watershed level was analyzed using data from the monitoring stations listed in Table 3.

The stations are long-term flow measurement sites operated by USGS and DENR. The results of the BMPs installed to reduce the amount of nonused water discharging to the waterways in the irrigation district should be detectable at the Belle Fourche River sites near Sturgis and Elm Springs as well as at the Horse Creek site above Vale. The other sites allowed calculations of a water mass balance, adding to the precision of the analysis.

**Table 3. Water Quality Monitoring Data Locations Analyzed**

<b>Station Number</b>	<b>Common Name</b>
Storet ID 460130	Belle Fourche River in Belle Fourche, South Dakota
Storet ID 460681	Belle Fourche River Near Vale, South Dakota
Storet ID 460683	Belle Fourche River Near Vale, South Dakota
USGS 6428500	Belle Fourche River at Wyoming/South Dakota State Line
USGS 6436000	Belle Fourche River Near Fruitdale, South Dakota
USGS 6436760	Horse Creek Above Vale, South Dakota
USGS 6437000	Belle Fourche River Near Sturgis, South Dakota
USGS 6438000	Belle Fourche River Near Elm Springs, South Dakota

Turbidity, specific conductance, and temperature were measured on a continuous basis at Horse Creek above Vail to provide baseline data to measure water quality improvements due to the nonused water reduction BMPs implemented within the watershed. Comparisons over time were performed to measure the large-scale changes in water quality at three DENR water quality monitoring stations within the watershed.

### TMDL IMPLEMENTATION EFFECTIVENESS

All of the planned activities for this project segment were completed. The BMPs installed contributed to attaining the TMDL goal of beginning reductions of the TSS concentrations to levels meeting the South Dakota state standards. The BMPs implemented reduced the amount of nonused water from the BFID by an estimated 100 acre-feet. This resulted in an estimated TSS reduction of 0.5 mg/L in the Belle Fourche River.

## **BMP EFFECTIVENESS EVALUATIONS**

The current implementation project is monitoring changes in the water use by the BFID. At this time, no definite reduction in nonused water beyond the estimates is available.

## **SURFACE WATER QUALITY IMPROVEMENTS**

Installation of BMPs was initiated during 2004. Water chemistry and flow data are currently available through September 2004 from USGS and DENR. Thus, changes due to BMP implementation will not be evident in this data review. To document the base line conditions, the water quality data was calculated using a number of statistical methods. The stations evaluated are listed in Table 3.

There were other Storet ID sites in the watershed however, they were not all used because they had data for less than ten samples.

Using data from the sites grouped together and for each individual site, the following was calculated (see Appendix A through Appendix I for results):

- Descriptive statistics, sample mean, minimum, median, first and third quartile and maximum by month, year, decade, and station. These statistics were completed for discharge, turbidity, specific conductance (SC), TSS, fecal coliform, total dissolved solids (TDS), and suspended solids concentration (SSC).
- Kruskal-Wallis test for one-way design, tests the equality of medians for the population. This test is a generalization of the procedure used by the Mann-Whitney test, which offers a nonparametric alternative to the one-way analysis of variance. The Kruskal-Wallis hypotheses are as follows:  $H_0$ : the population medians are all equal,  $H_1$ : the population medians are not equal. The z-value indicates how the mean rank for a single group differs from the mean rank for all observations. Zero represents no difference. The Kruskal-Wallis test was calculated by month, year, decade, and station. The test was run for discharge, TSS, SSC, turbidity, TDS, and fecal coliform.
- Boxplots that show the median, first and third quartile and outliers were calculated by month, year, and decade for SSC, TSS, turbidity, fecal coliform, TDS, SC, and discharge.
- Fitted line plots showing a regression line, equation, the regression coefficient and 95 percent confidence interval were calculated for the following:
  - Turbidity versus discharge.
  - TDS versus specific conductance.
  - SSC versus turbidity.

- SSC versus discharge.

The sites that did not have enough data to analyze are identified in the Appendix with “Insufficient Data.”

### **Suspended Solid**

Suspended solids at the sites analyzed are trending towards a reduction. The Kruskal-Wallis test for TSS and SSC all have a downward trend. The z values for all sites decreases from a plus number in 1960-1970 (4.81 TSS, 0.72 SSC) to a negative number in 1980-2000 ( $z = -2.43$  TSS,  $z = -0.4$  SSC). The negative number indicates a decrease in concentration. The change is statistically significant. The differences between the stations are not statistically significant. The highest monthly medians occur in June and July for TSS and Turbidity. The highest median for SSC occurs in March. TSS and fecal coliform were the highest in 1968. SSC was not measured in 1968. The highest median for SSC occurred in 1957.

The SSC and the turbidity data, collected at the USGS 6436760 Horse Creek site above Vale, South Dakota, was analyzed to see the correlation between SSC and turbidity levels. The results of the analysis are shown in Appendix A through Appendix I. A linear and log-type regression of the data have R squared values over 0.90. This is significant because it shows that turbidity can be used to predict what the SSC levels are. This site is continuously monitoring turbidity levels and logging the values every 15 minutes. By using the regression analysis to predict what the SSC levels were, it is possible to see how the SSC levels change on a micro level. This data can then be used to help determine what BMPs will be most effective at lowering the TSS.

### **Dissolved Solids**

The Kruskal-Wallis test for TDS and SC is not statistically significant versus time. The highest TDS and SC value are at Belle Fourche River site at Sturgis and lowest at the Belle Fourche River site at the state line. The highest monthly median for TDS and SC occur in the December-January time frame. The highest yearly median for both TDS and SC occurred in 1957.

### **Trend Analysis**

A trend analysis was performed using Minitab statistical software and TSS, SSC, and fecal coliform concentration. The graphical results are presented in Appendix A. The graphs report the measure of accuracy for the analysis. The graph reports and equation for the trend in the form of  $y_t = \text{constant} - \text{slope using time as the exponent}$ . Three measures of accuracy are reported for the fitted model: Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and Mean Squared Deviation (MSD) for each of the simple forecasting and



smoothing methods. For all three measures, the smaller the value, the better the fit of the model. These statistics can be used to compare the fits of the different methods.

MAPE measures the accuracy of fitted time series values. It expresses accuracy as a percentage.

$$\text{MAPE} = \frac{\sum |(y_t - \hat{y}_t) / y_t|}{n} \times 100 \quad (y_t \neq 0)$$

where:

$y_t$  = actual value

$\hat{y}_t$  = the fitted value

$n$  = the number of observations.

MAD measures the accuracy of fitted time series values. It expresses accuracy in the same units as the data, which helps conceptualize the amount of error.

$$\text{MAD} = \frac{\sum_{t=1}^n |y_t - \hat{y}_t|}{n}$$

where:

$y_t$  = actual value

$\hat{y}_t$  = the fitted value

$n$  = the number of observations.

MSD is always computed using the same denominator,  $n$ , regardless of the model, so a comparison of MSD values across models. MSD is a more sensitive measure of an unusually large forecast error than MAD.

$$\text{MSD} = \frac{\sum_{t=1}^n |y_t - \hat{y}_t|}{n}$$

where:

$y_t$  = actual value

$\hat{y}_t$  = forecast value

$n$  = the number of forecasts.

SSC, TSS, and fecal coliform were evaluated to determine if a trend is evident. The median, third quartile and mean of each of the concentrations were evaluated. SSC, TSS, and fecal coliform all show a trend using the median, third quartile, and mean. The most robust trend is evident in the SSC median, third quartile and mean. The measures of accuracy are the best

and the plot of residuals does not indicate any systematic inconsistency. A trend is also evident in the TSS and fecal coliform. This trend is not as statically significant as the trend evident in the SSC data as documented by the measure of accuracy MAPE, MAD, and MSD. The residual plots for TSS and fecal show more positive residuals indicating the equation are less valid.

## **OTHER MONITORING**

Five water quality samples were collected from Drain Six located along the northern BFID irrigation canal. The samples were analyzed for pesticides, bacteria, alkalinity, conductivity, pH, total solids, TDS, TSS, volatile suspended solids, turbidity, calcium, magnesium, potassium, sodium, sodium adsorption ratio, ammonia nitrogen, total kjeldahl nitrogen, phosphorus, and total phosphorus. Based on the water quality data, the drain water was deemed acceptable for irrigation reuse. Because of low flows in the drain, the water is not currently being reused.

## **QUALITY ASSURANCE REPORTING**

The water quality samples were collected in accordance with the Standard Operating Procedures for Field Samplers, Tributary, and In-Lake Sampling Techniques. The majority of the water quality samples were collected by DENR and USGS, with the exception of the samples collected in the BFID at Drain Six. These organizations have quality assurance/quality control (QA/QC) programs that they followed.

## **RESULTS OF BMP OPERATION AND MAINTENANCE REVIEWS**

The NRCS; Farm Service Agency; and the Butte, Meade, and Elk Creek Conservation Districts, District Supervisors, and the BOR were responsible for ensuring that best management practices cost-shared with the Clean Water Act Section 319 Grant and South Dakota consolidated funds were installed, and all systems are operated and maintained properly for the duration of each contract. Compliance for BMPs installed using Clean Water Act Section 319 Grant funds followed NRCS EQIP criteria. These criteria are found in Section 515.113 of the EQIP program manual.

Any landowners and operators who did not maintain practices funded by this project for the length of the agreed contract are required to repay all cost-share funds and any liquidated damages incurred.

At this time all contract requirements are being fulfilled and no funds need to be repaid. Conservation district personnel, supported by the consultant acting on behalf of the BFRWP, were responsible for landowner contacts, developing landowner/producer mailing lists, keeping

records, submitting vouchers and reports, and recording cash and in-kind match. Where BOR funds are used, the BOR was responsible for ensuring the BMPs are operated and maintained for the life of the contract.

## **COORDINATION EFFORTS**

The Belle Fourche River Watershed Partnership has involved many organizations, people, and funding sources during this project. Some of the groups and/or organizations that the Partnership has involved during this project include local producers, ranchers and farmers; DENR, Butte, Meade, and Lawrence counties; BFID; local NRCS personnel; Corps of Engineers; BOR; USGS; United States Fish and Wildlife Service (USFWS); local towns in the watershed; WYDEQ; and local conservation districts. The groups have contributed time and/or money to the project and have been essential to project success.

The four voting members of the BFRWP (BFID, Elk Creek Conservation District, Butte County Conservation District, and Lawrence County Conservation District) were essential to this project. The BFID worked directly with the partnership to improve irrigation efficiency. This is one of the significant sources of TSS to the Belle Fourche River. By improving irrigation efficiency the amount of nonused water returning to intermittent streams and contributing TSS to the Belle Fourche River will be reduced. The BFID has worked with the BFRWP to install BMPs. The local conservation districts played an instrumental role in project education and outreach activities completed during the project. Table 4 lists the education and outreach activities.

## **COORDINATION EFFORTS FROM OTHER STATE AGENCIES**

The state agencies involved with this project included DENR, SDSM&T, SDSU, and WYDEQ.

- DENR provided guidance and assistance in finding additional funding sources for implementing BMPs.
- SDSM&T assisted with the field monitoring and writing the 5-Year Strategic Plan for the BFID System.
- SDSU helped educate producers about methods to improve irrigation efficiency.
- WYDEQ provided funds to help support USGS monitoring.

## **FEDERAL COORDINATION**

The federal agencies involved with this project included the NRCS, BOR, EPA, and USFWS. All of these groups are important to the success of this project.

NRCS personnel encouraged local producers and ranchers to install BMPs that will reduce the TSS concentrations in the Belle Fourche River and its tributaries. NRCS staff has a good working relationship with the operators within the watershed and a high level of trust. This has been instrumental in getting producers to spend their personal funds to install BMPs. Without NRCS and conservation district support and the willingness of individual producers to participate, the project would not be as successful. The following list includes other participating federal agencies and describes their efforts.

- BOR supported the project by assisting with the implementation of BMPs in the BFID.
- EPA, through DENR, provided the BFRWP with this grant.
- USFWS was involved in project meetings and planning. The service did not provide funding for the current project, but has since committed funds to the implementation of riparian BMPs.

## **USDA PROGRAMS**

The EQIP, Grassland Reserve Program (GSP), and Conservation Security Program (CSP) Conservation Reserve Program (CRP) played key roles in the installation of BMPs in the watershed. NRCS got the local producers involved, and provided funding through the EQIP program. Without this funding some of the BMPs would have been installed, but not nearly to the scale that was completed.

## **ACCOMPLISHMENTS OF AGENCY COORDINATION MEETINGS**

The Belle Fourche River Watershed Partnership had four meetings during this project segment (see Table 4 for dates). The meetings were essential for getting the different local, state, and federal groups together to brainstorm and keep the project on schedule. The groups present at these meetings included local producers, members of the Elk Creek Conservation District, Lawrence County Conservation District, Butte Conservation District, BFID, NRCS, DENR, USGS, BOR, and USFWS.

**Table 4. Summary of Education and Outreach Activities**

<b>Outreach</b>	<b>Type of Education and Outreach</b>	<b>Date Complete</b>	<b>Estimated Attendance</b>
1	Ditch Writer	December 2004	150
2	Pen of Three Information Booth	February 2005	60
3	BFID Public Meeting	April 2005	40
4	Conservation News (Lawrence County) Conservation District Newsletter	January 2005	285
5	Local Newspapers, Soil & Water Stewardship April 2005	April 2005	2,000
6	BFRWP Meeting	December 2004	20
7	BFRWP Meeting	July 2004	20
8	BFRWP Meeting	August 2004	20
9	BFRWP Meeting	March 2005	20
10	2005 Western South Dakota Hydrology Conference	April 2005	100
11, 12, 13	Three Bear Butte Echos Newsletters (From Elk Creek Conservation District)	January 2005	1,600
14, 15	Elk Creek Conservation District Public Meeting in Hereford and Union Center	February 2005	85
16	Butte and Lawrence County Fair	August 2004	2,000
17	Tour with Chamber of Commerce (Group from Europe)	August 2004	30
18	Newell Field and Ag	February 2005	400
19	Black Hills Multiple Use Coalition Meeting	February 2005	40
20	Belle Fourche Home and Ag Show	February 2005	1,500
21	Public Information Meeting at First Western Bank in Belle Fourche	March 2005	25
22	Black Hills Multiple Use coalition Meeting	April 2005	40
23	Black Hills Multiple Use coalition Meeting	June 2005	40
24	Black Hills Multiple Use coalition Meeting	July 2005	40

## **SUMMARY OF PUBLIC PARTICIPATION**

Public participation during public meetings exceeded expectations. The public participated in the installation of BMPs, public education and outreach, and the development of the 10-year watershed strategic implementation plan. Some of the public education and outreach that was completed in this project included sending newsletters as part of the BFID, Elk Creek Conservation District, Butte County Conservation District, and the Lawrence County Conservation District mailings. A preliminary Web site was developed by the consultant for the Partnership's education and outreach effort. The Web site has been upgraded during the next phase of implementation (*www.bellefourchewatershed.org*). Producers within the BFID were informed about BMPs that were being installed in the irrigation delivery system at a public meeting held by the BFID.

Partnership activities were printed in local newspaper articles for soil and water stewardship. A project update was given at the 2005 Western South Dakota Hydrology Conference. A Chamber of Commerce tour was given along with a group from Europe. Updates were made available at the Belle Fourche Home and Ag Show, a public information meeting in Belle Fourche, the Butte and Lawrence County Fair, Newell Field and Ag, and the Black Hills Multiple Use Coalition meetings.

Four BFRWP meetings were held which were open to the public. The people from the public that attended these meetings were able to voice their opinions and learn what projects the Partnership was working on. The type of education and outreach and date each was completed are listed in Table 4.

## **ASPECTS OF THE PROJECT THAT DID NOT WORK WELL**

The one aspect of the project that did not work as well as planned was the use of the flow automation unit during the first part of the 2005 irrigation season. The flow automation unit was installed on the Townsite check structure (see Figure 2) during June 2004. It was used successfully for the remainder of the 2004 irrigation season (through mid-September). The ditchrider that operated the automation unit during 2004 did not return for the 2005 irrigation season. The new ditchrider was not properly trained on how to use the automation unit until the second half of the 2005 irrigation season. To keep this problem from reoccurring, the BFID project manager was trained on how to operate the automation unit by the vendor. This will allow the project manager to train new ditchriders rather than relying on the vendor for training.

## **PROJECT BUDGET/EXPENDITURES**

The BFRWP received a \$189,000 EPA Grant to begin installation of the BMPs suggested in the Belle Fourche River Watershed TMDL report. All of the scheduled products were installed with no more than \$10,508 (5.6 percent of the grant total) being added or subtracted from any one product. The largest change in budget was adding approximately \$9,000 to the education and outreach programs and reducing the new implementation funding by approximately \$10,500. The actual matching funds were approximately \$7,000 less than what was budgeted. The total match was still over \$70,000 more than the funding from the Clean Water Act 319 Grant, and more than \$130,000 greater than required. The nonmatching dollars spent on this project were six percent less than what was budgeted. This was related mostly to less EQIP money being received than was anticipated. The planned and actual budgets are shown in Tables 5 and 6 respectively.

## **FUTURE ACTIVITY RECOMMENDATIONS**

The first segment of the Belle Fourche River Watershed Management Project was successful. The 10-year watershed strategic implementation developed during this project outlines the BMPs that should be installed within the watershed during the next 10 years. All of the BMPs that were planned for this project segment were completed on time and within the proposed budget.

During the next 10 years, additional projects are planned to finish installing the practices outlined in the Belle Fourche River Watershed TMDL and the 10-year watershed strategic implementation plan. This will ensure that the overall goal for the watershed is met, which is to comply with the TSS water quality standards for the Belle Fourche River. As additional TMDLs are completed for other lakes and tributaries in the watershed, implementation of TMDLs developed should be added to the Belle Fourche River Watershed project.

**Table 5. Budget for Individual Products**

EPA 319	Producer	BFRP	SD DENR (Water Rights)	Lawrence County	BFID	WY DEQ	SD DENR 106	NRCS Equip	COE	BOR	USGS	Total
<b>Objective 1. Implement BMPs</b>												
Product 1 Improve Water Management	\$0	\$135,000	\$0	\$0	\$60,000	\$0	\$0	\$86,000	\$0	\$75,000 <sup>(a)</sup>	\$0	\$356,000
Product 2 Grazing Management Units	\$0	\$34,000	\$0	\$0	\$0	\$0	\$0	\$65,000	\$0	\$0	\$0	\$99,000
<b>Objective 2. Create a 10-Year Watershed Strategic Implementation Plan</b>												
Product 3 Develop 10-Year Strategic Plan	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$20,000
Product 4 Develop 5-Year Strategic Plan for BFID System	\$0	\$10,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$80,000
Product 5 New Implementation Funding	\$62,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$62,000
<b>Objective 3. Public Education and Outreach</b>												
Product 6 Conduct Education and Outreach Programs	\$2,000	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$10,000 <sup>(b)</sup>	\$0	\$19,000
Monitoring Water Quality	\$35,000	\$0	\$5,800	\$5,900	\$4,400	\$5,900	\$67,500	\$0	\$5,900	\$2,900	\$74,600	\$207,900
<b>Total</b>	<b>\$189,000</b>	<b>\$169,000</b>	<b>\$5,800</b>	<b>\$5,900</b>	<b>\$64,400</b>	<b>\$5,900</b>	<b>\$67,500</b>	<b>\$151,000</b>	<b>\$5,900</b>	<b>\$87,900</b>	<b>\$74,600</b>	<b>\$843,900</b>

(a) Includes \$15,000 expended by SDSU on behalf of BOR.

(b) Includes \$10,000 expended by SDSU on behalf of BOR.



**Table 6. Actual Expenditures**

EPA 319	Producer	BFRP	SD DENR (Water Rights)	Lawrence County	BFID	WY DEQ	SD DENR 106	NRCS Equip	COE	BOR	USGS	Total
<b>Objective 1. Implement BMPs</b>												
Product 1 Improve Water Management	\$0	\$133,157	\$0	\$0	\$110,000	\$0	\$0	\$30,000	\$0	\$140,500 <sup>(a)</sup>	\$0	\$413,657
Product 2 Grazing Management Units	\$0	\$8,146	\$0	\$0	\$0	\$0	\$0	\$24,440	\$0	\$0	\$0	\$32,586
<b>Objective 2. Create a 10-Year Watershed Strategic Implementation Plan</b>												
Product 3 Develop 10-Year Strategic Plan	\$26,388.50	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$26,388.50
Product 4 Develop 5-Year Strategic Plan for BFID System	\$63,781.07	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$63,781.07
Product 5 New Implementation Funding	\$51,492.02	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$51,492.02
<b>Objective 3. Public Education and Outreach</b>												
Product 6 Conduct Education and Outreach Programs	\$11,219.56	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$10,000 <sup>(b)</sup>	\$0	\$21,219.56
Monitoring Water Quality	\$36,118.85	\$0	\$5,800	\$5,900	\$0	\$5,900	\$67,500	\$0	\$5,900	\$3,000	\$74,600	\$204,718.85
<b>Total</b>	<b>\$189,000</b>	<b>\$141,303</b>	<b>\$5,800</b>	<b>\$5,900</b>	<b>\$110,000</b>	<b>\$5,900</b>	<b>\$67,500</b>	<b>\$54,440</b>	<b>\$5,900</b>	<b>\$153,500</b>	<b>\$74,600</b>	<b>\$813,843</b>

(a) Includes \$15,000 expended by SDSU on behalf of BOR.

(b) Includes \$10,000 expended by SDSU on behalf of BOR.

## **APPENDIX A**

### **HISTORICAL DATA- MAP AND STATISTICAL ANALYSIS OF FLOW AND CHEMISTRY FOR ALL SITES**

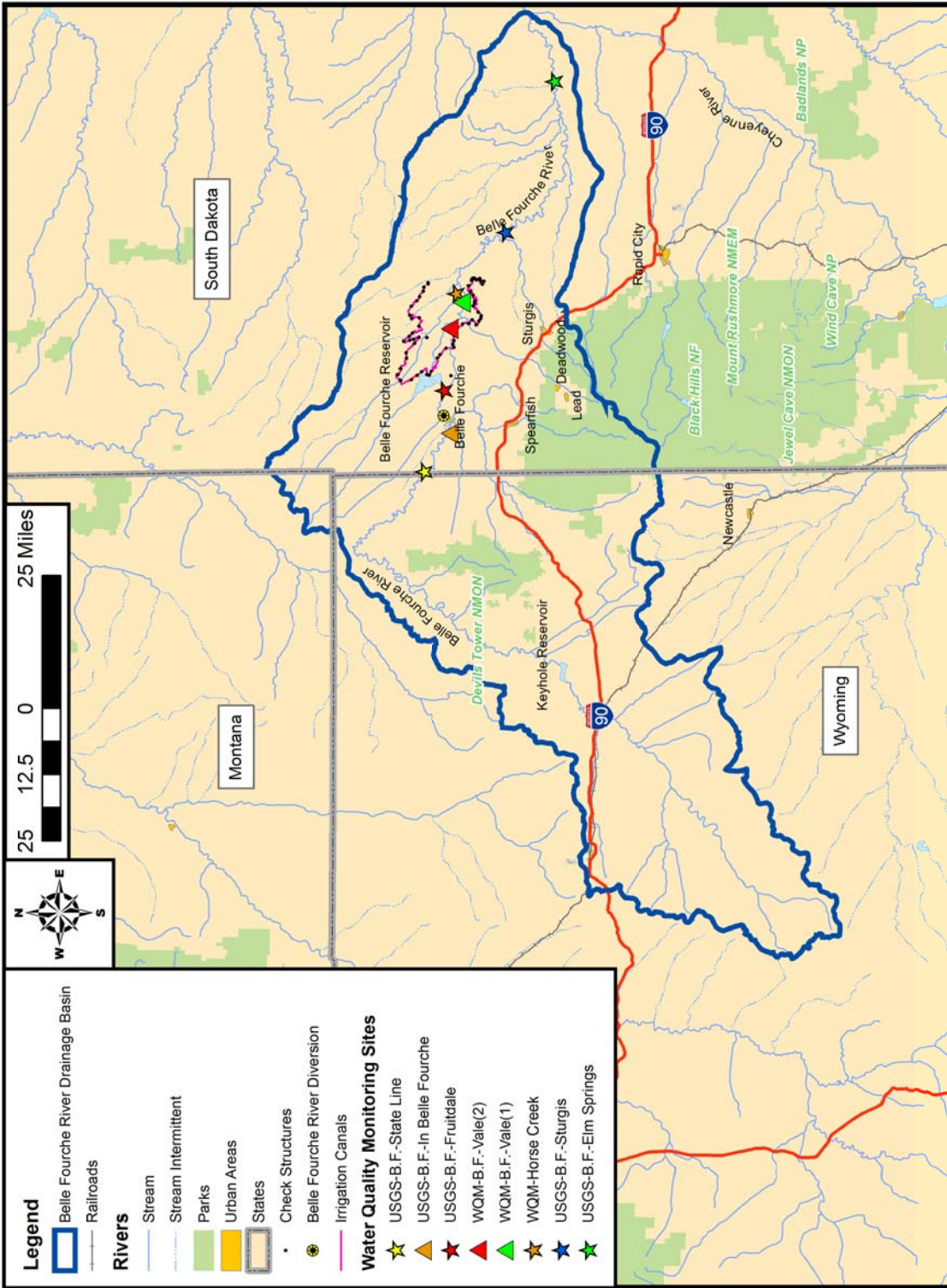
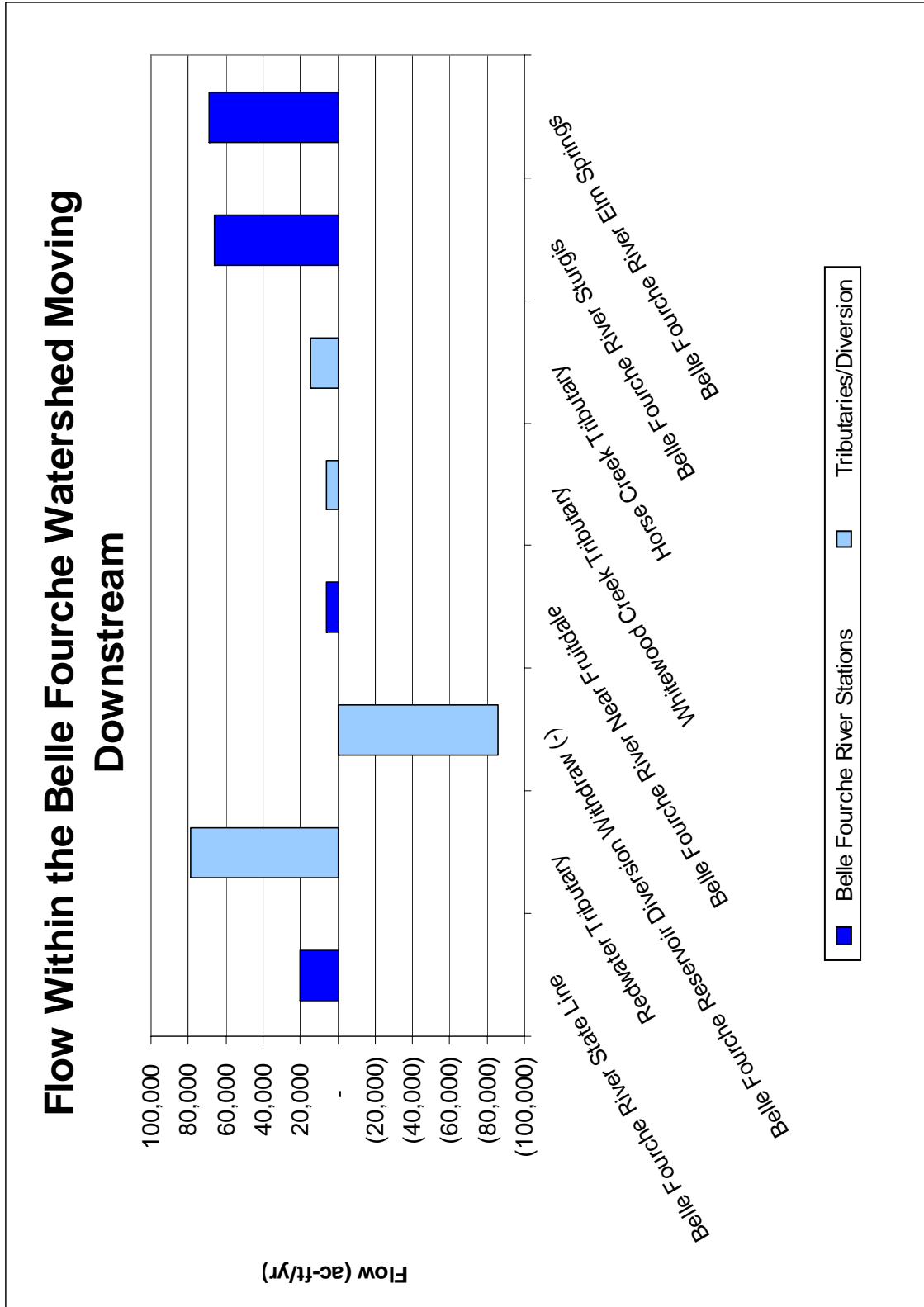


Figure A-1. Belle Fourche Watershed.



**Figure A-2.** Belle Fourche River Watershed Water Budget.

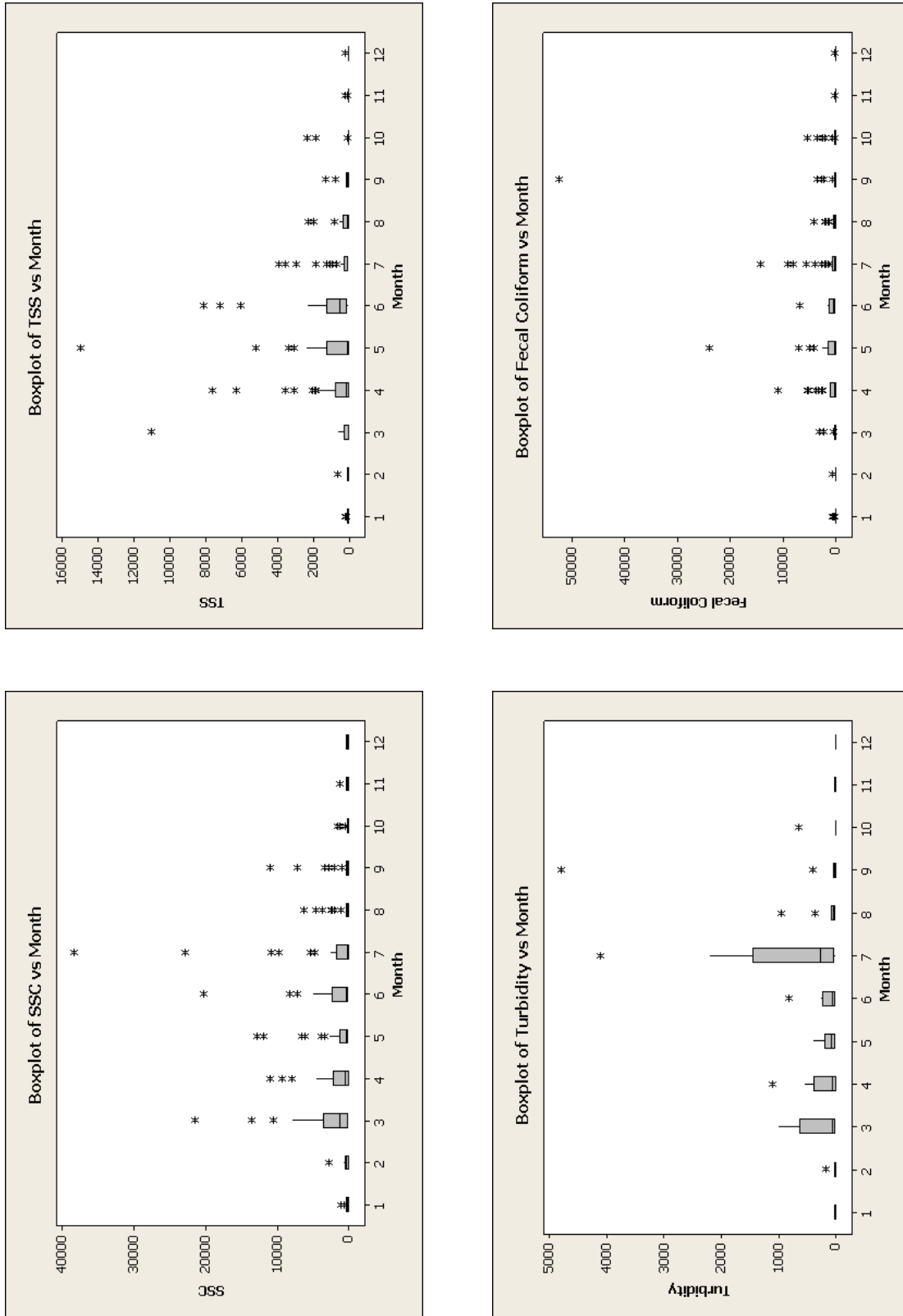
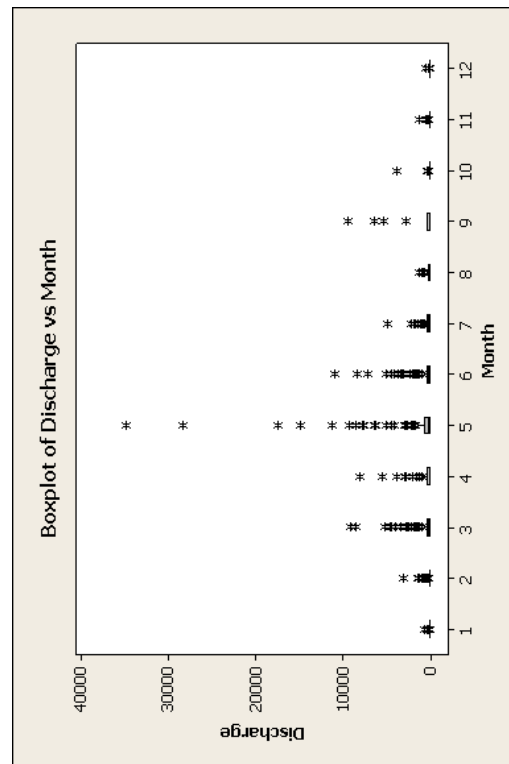
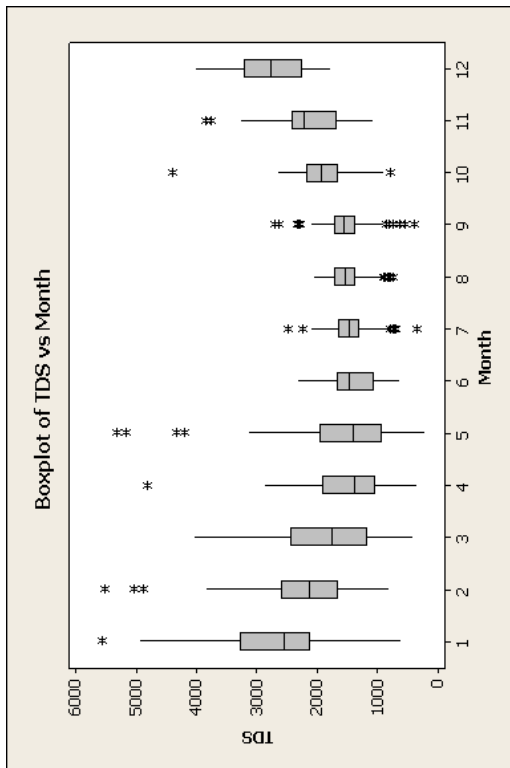
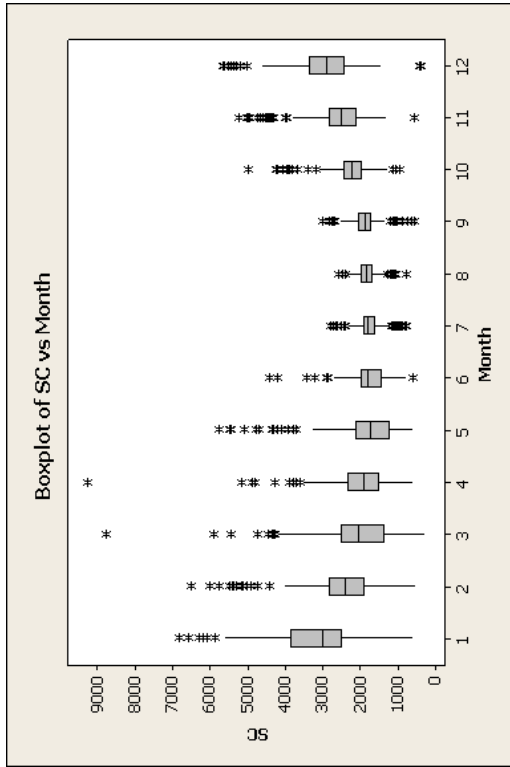


Figure A-3. Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for All Sites.



# INSUFFICIENT DATA

Figure A-4. Box Plot of TDS, SC, and Discharge Versus Month for All Sites.

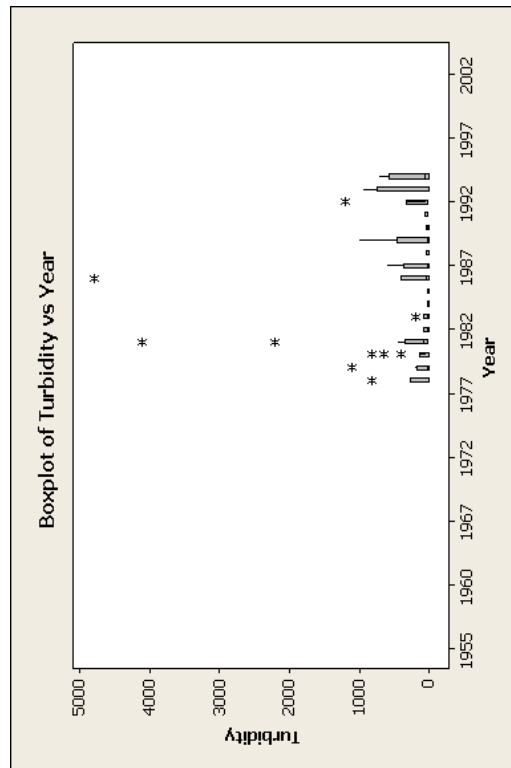
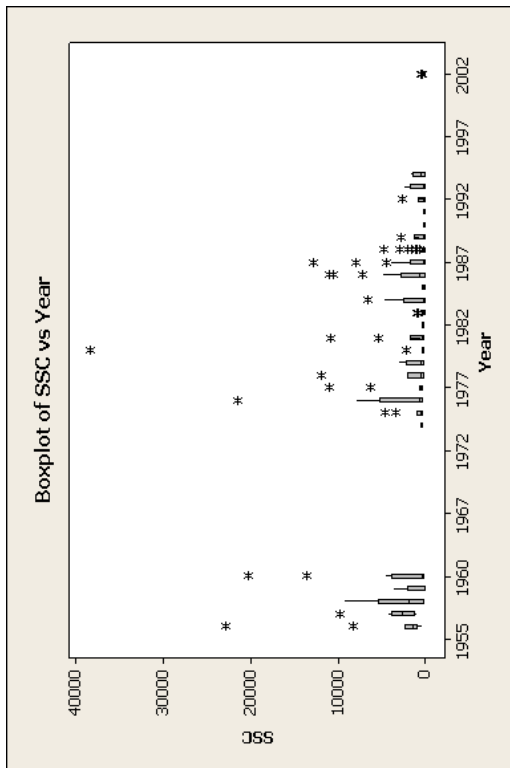
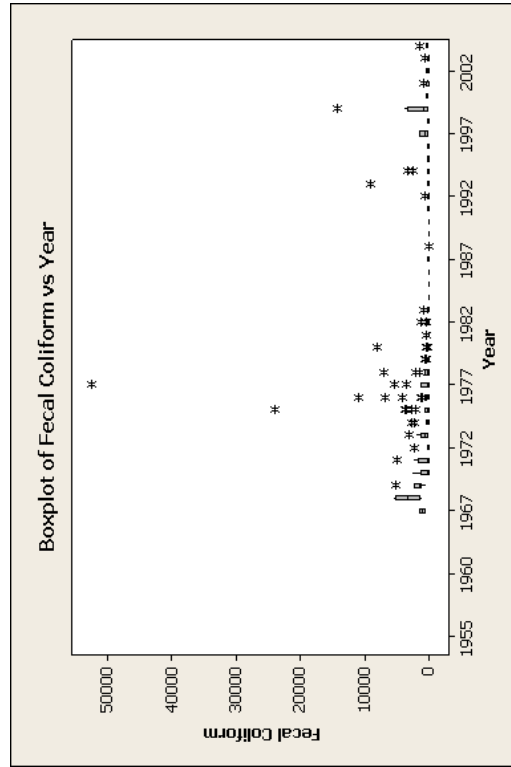
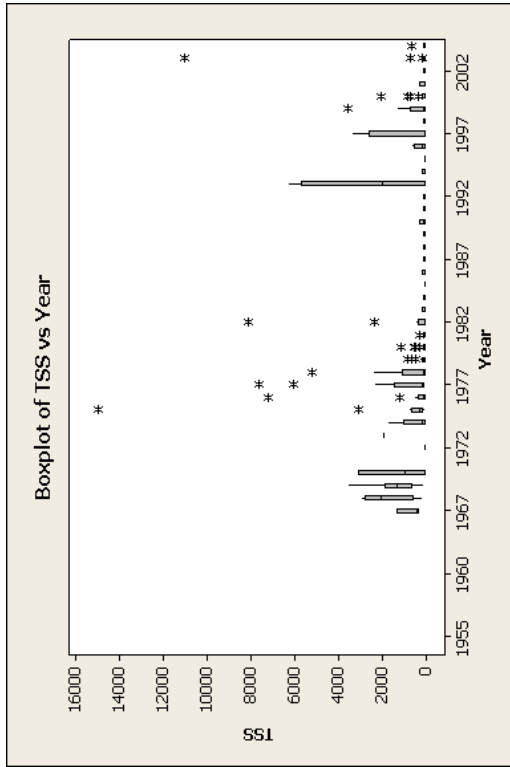
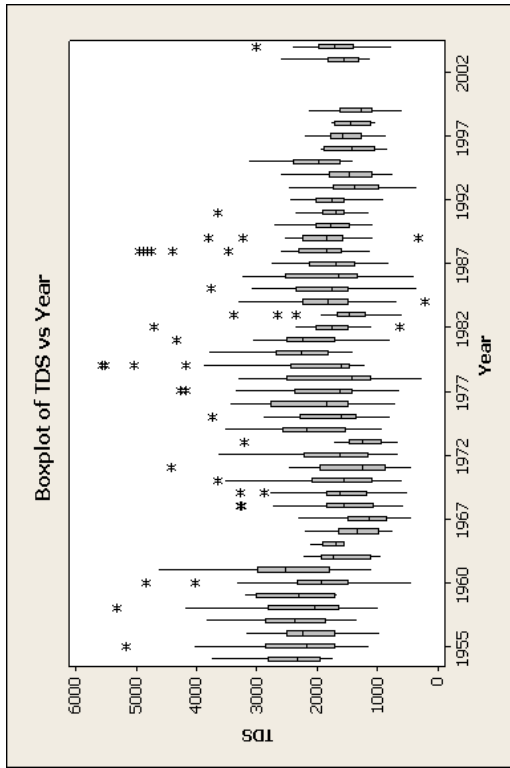
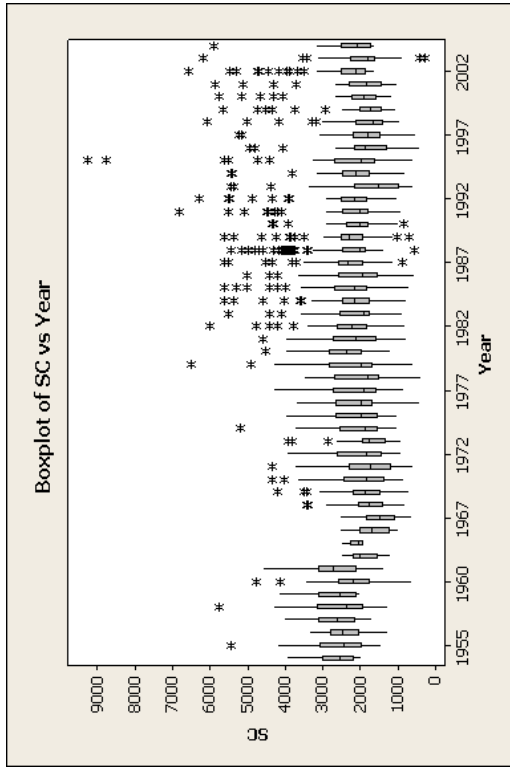
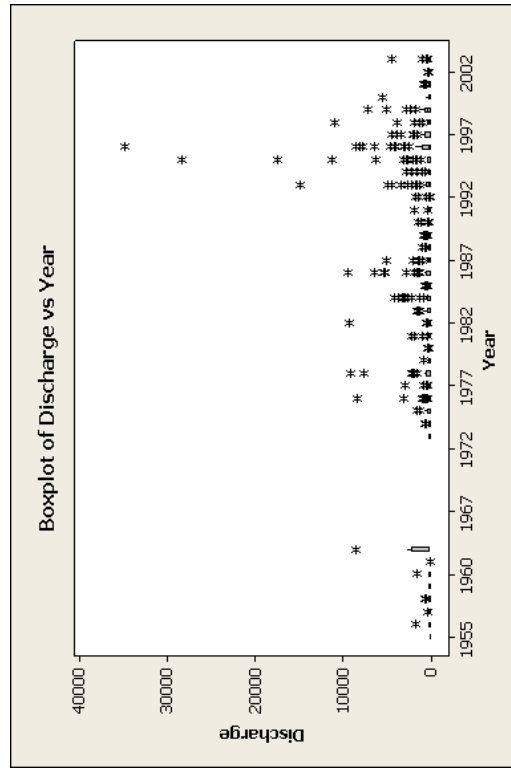


Figure A-5. Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Year for All Sites.

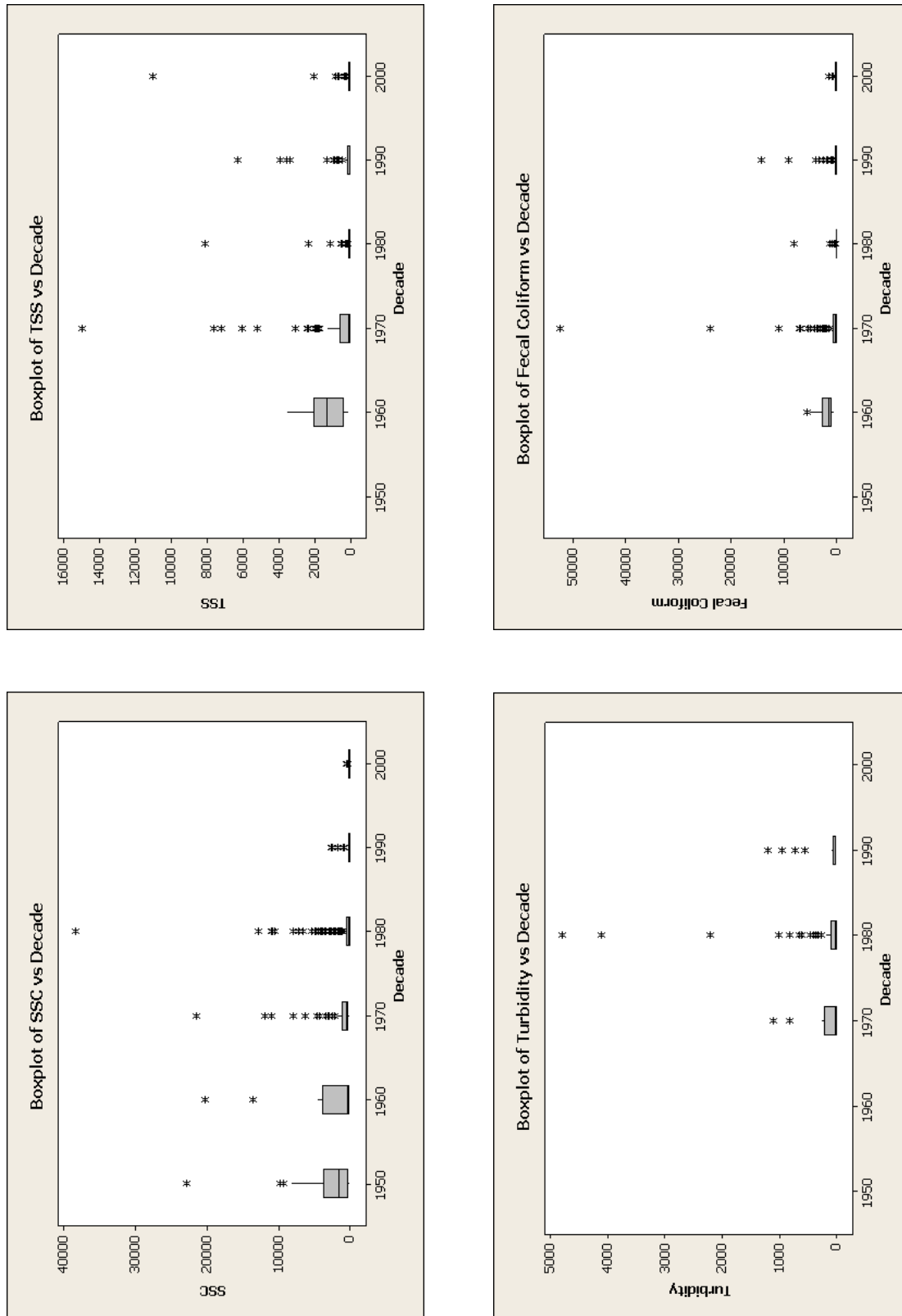


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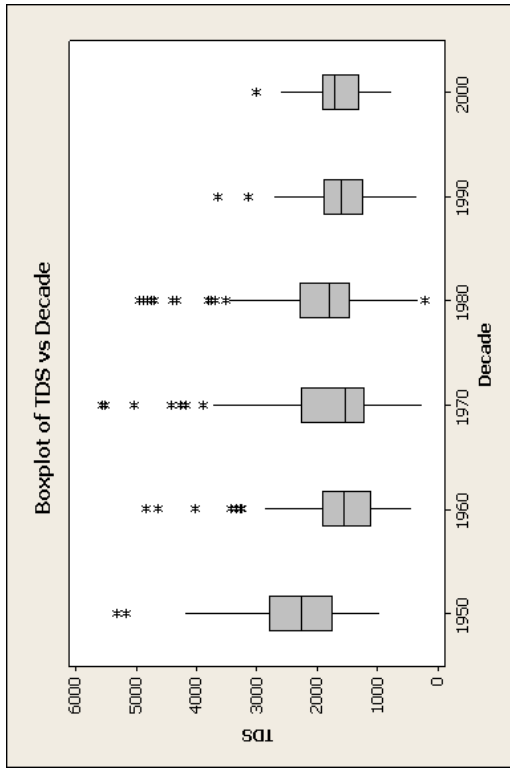
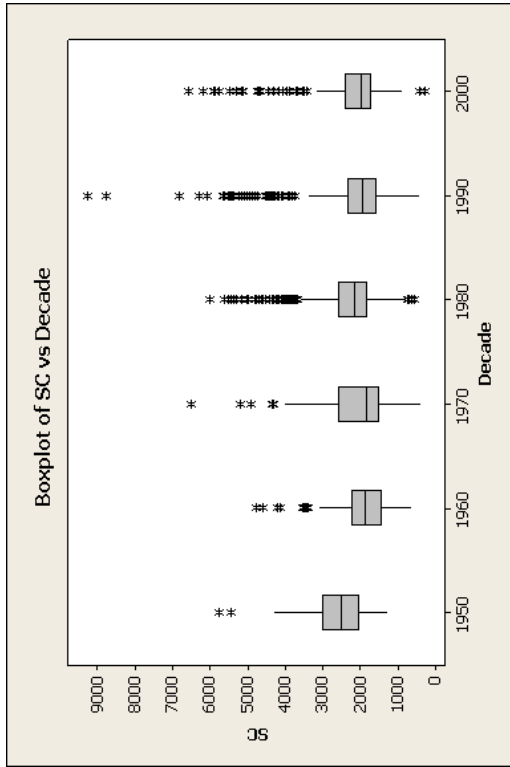


**Figure A-6.** Box Plot of TDS, SC, and Discharge Versus Year for All Sites.

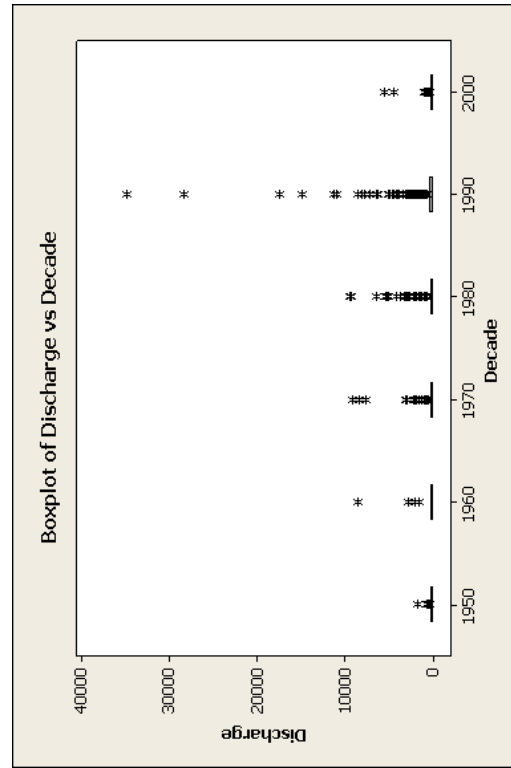




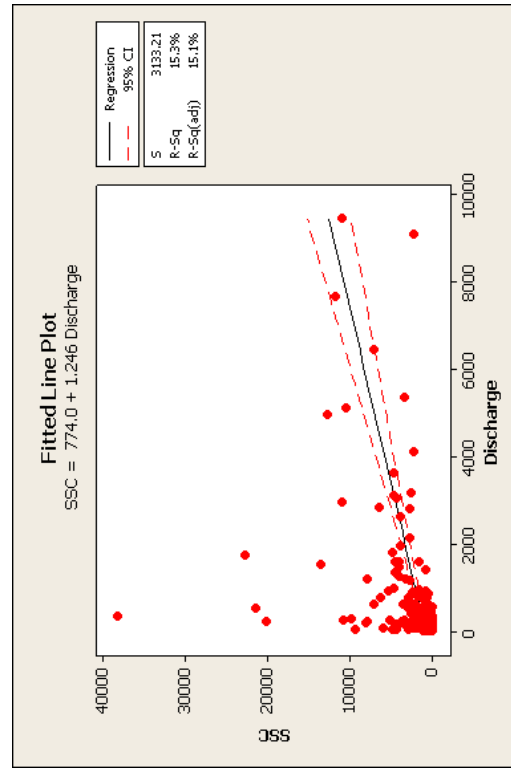
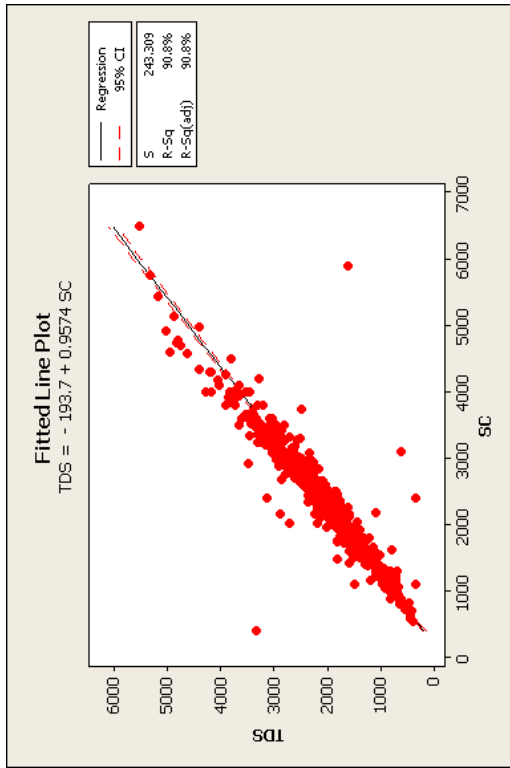
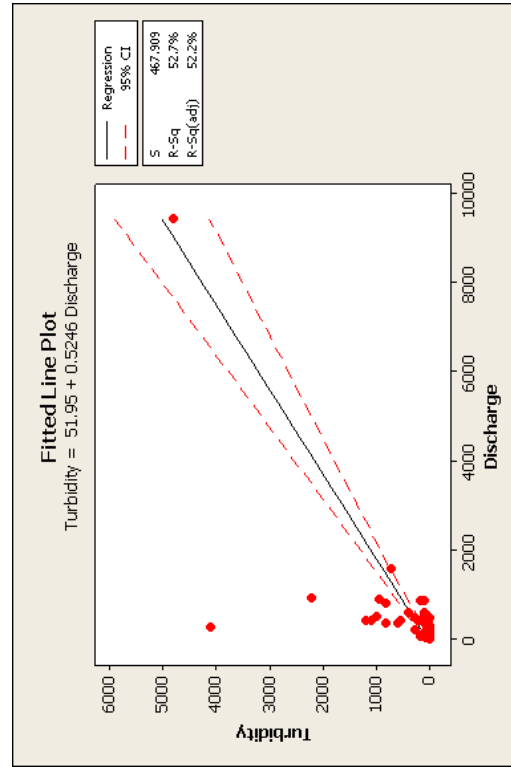
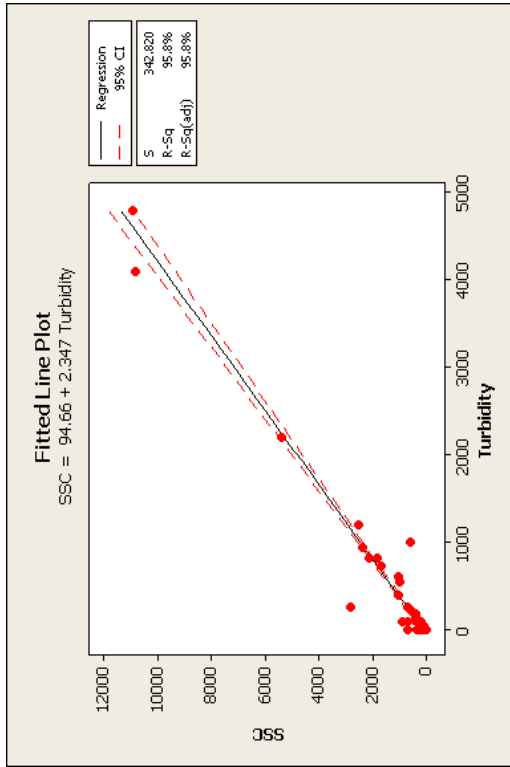
**Figure A-7.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Decade for All Sites.



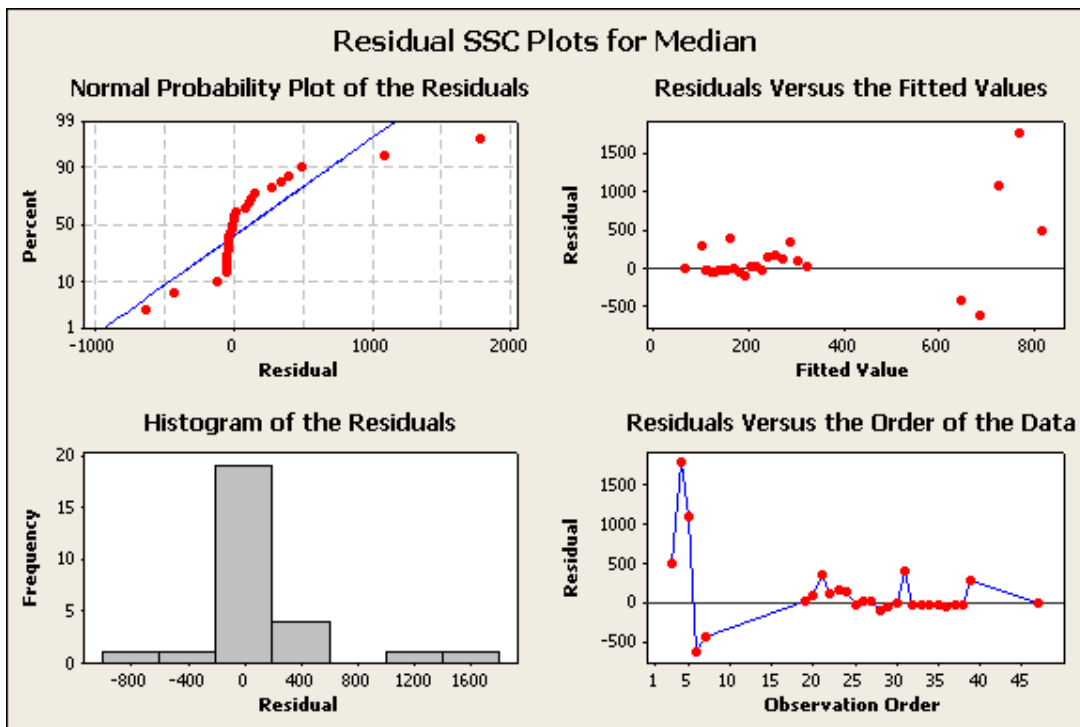
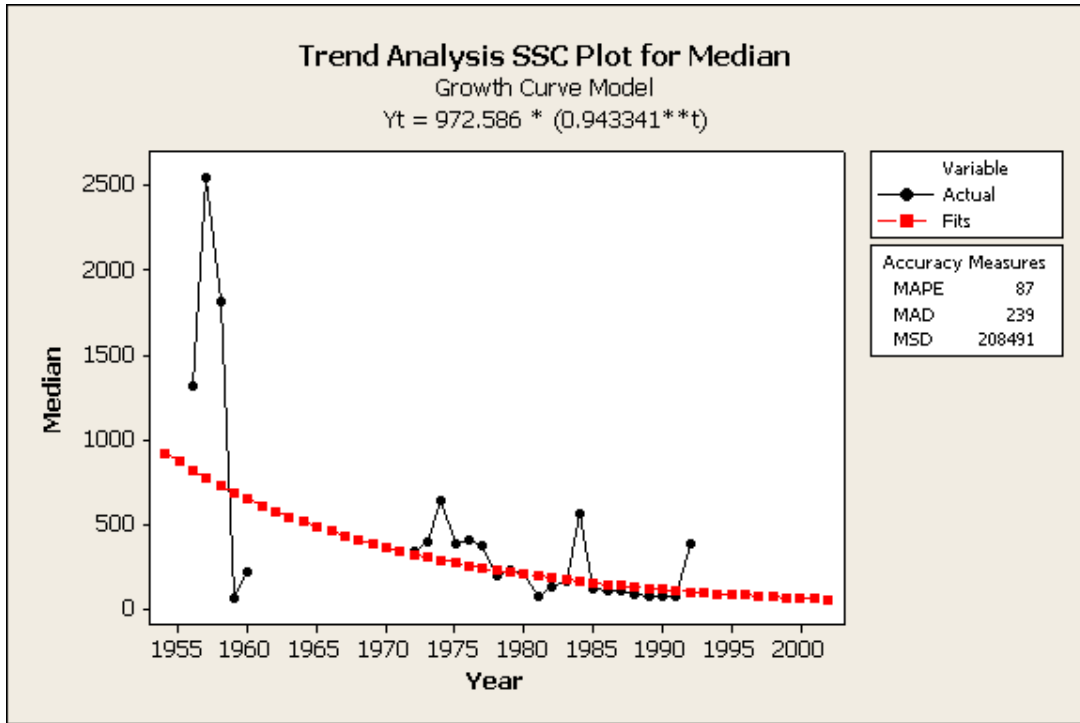
# INSUFFICIENT DATA



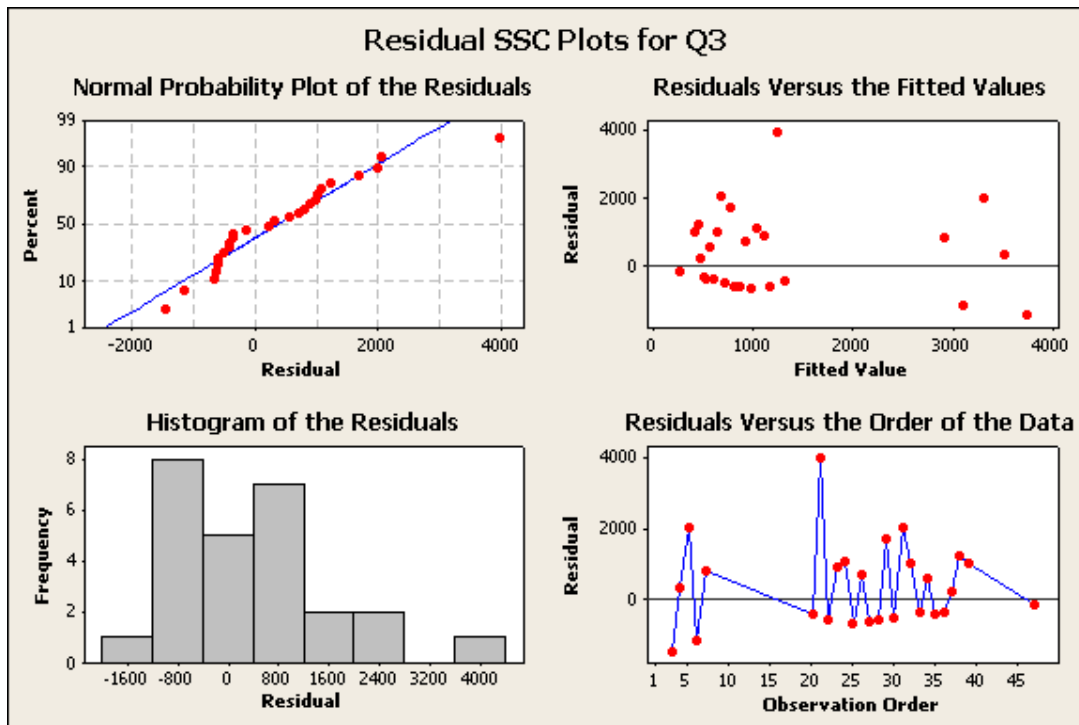
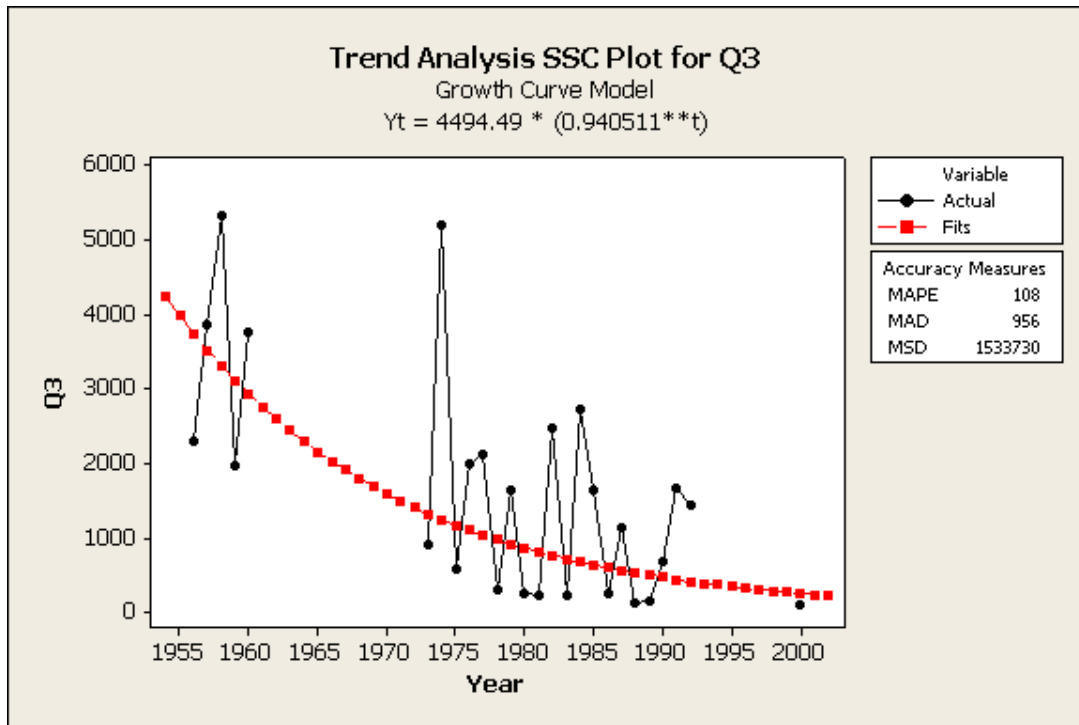
**Figure A-8.** Box Plot of TDS, SC, and Discharge Versus Decade for All Sites.



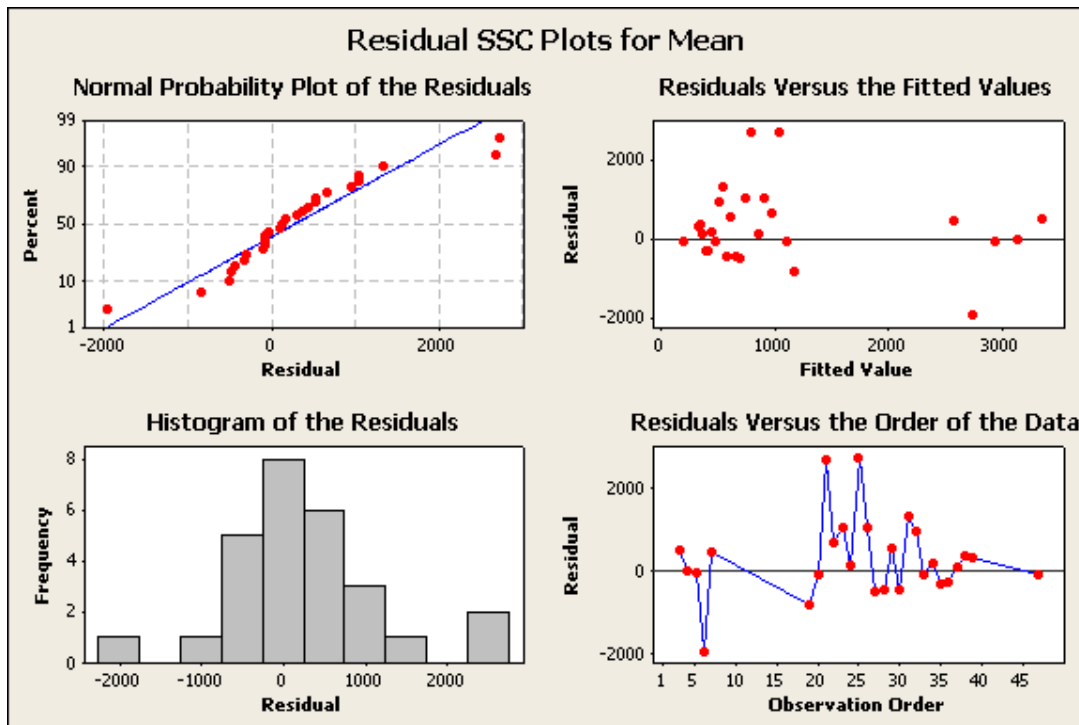
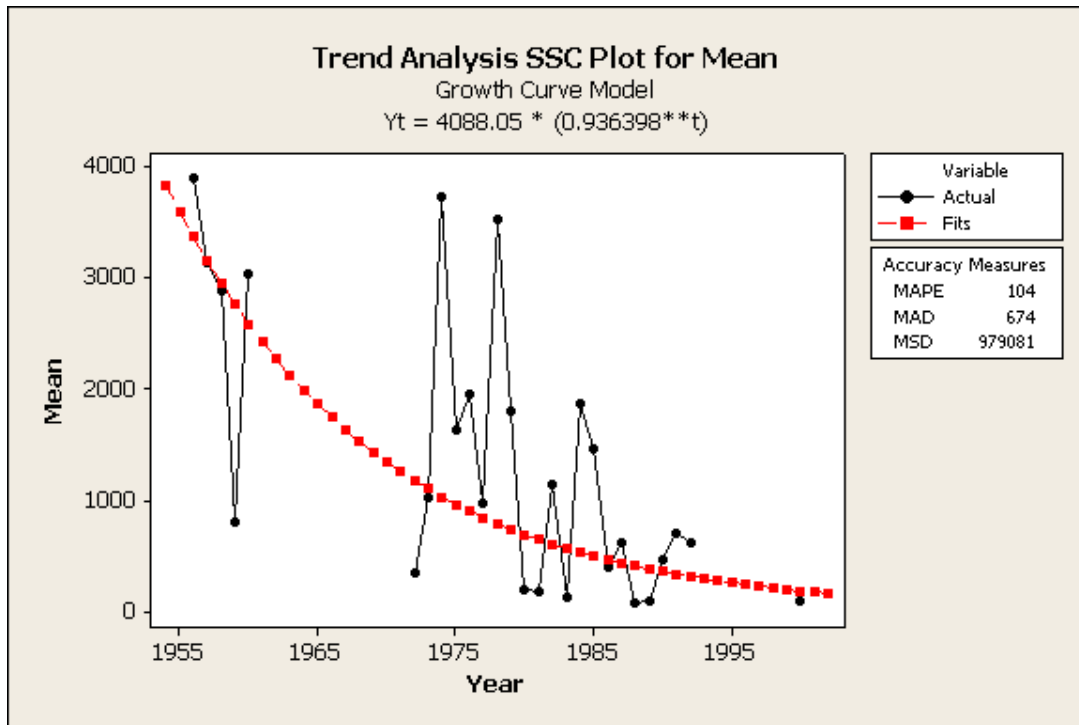
**Figure A-9.** Fitted Line for TDS Versus SC, SSC Versus Turbidity, SSC Versus Discharge, and Turbidity Versus Discharge for All Sites.



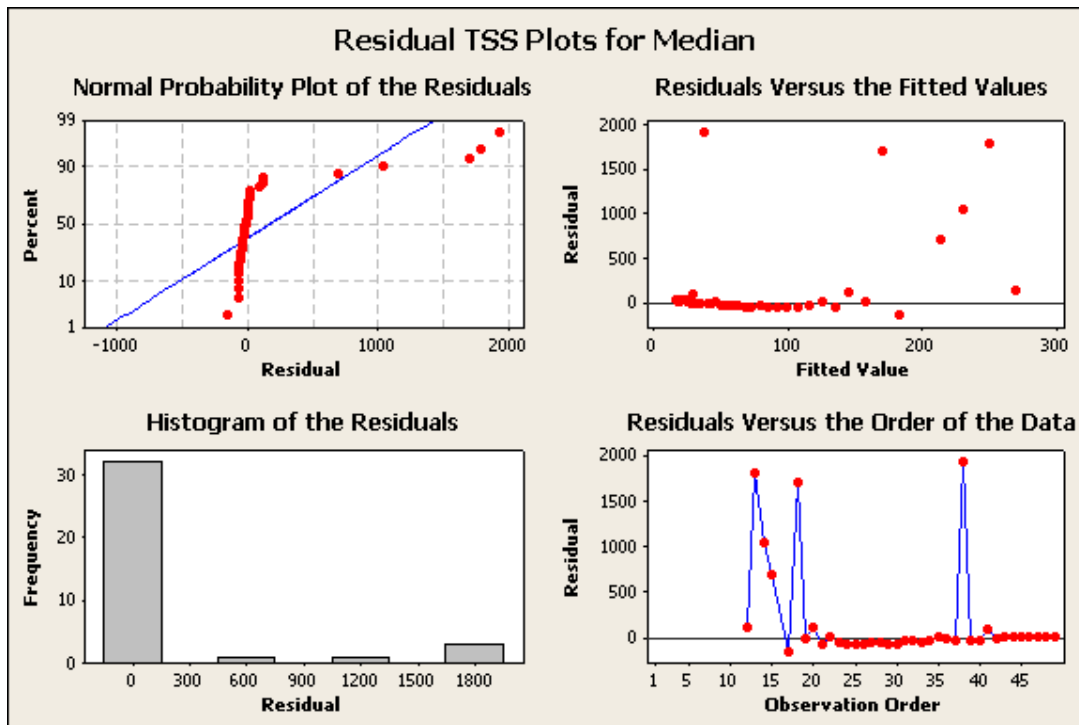
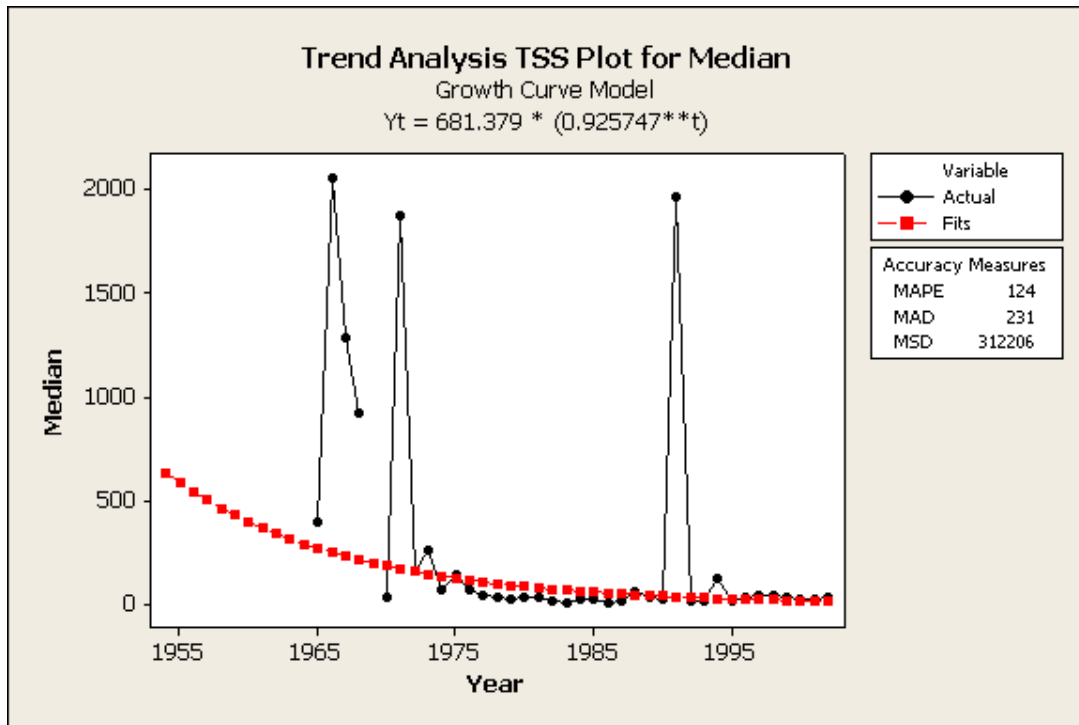
**Figure A-10.** Trend Analysis for Median Suspended Solids Concentration by Year for All Sites.



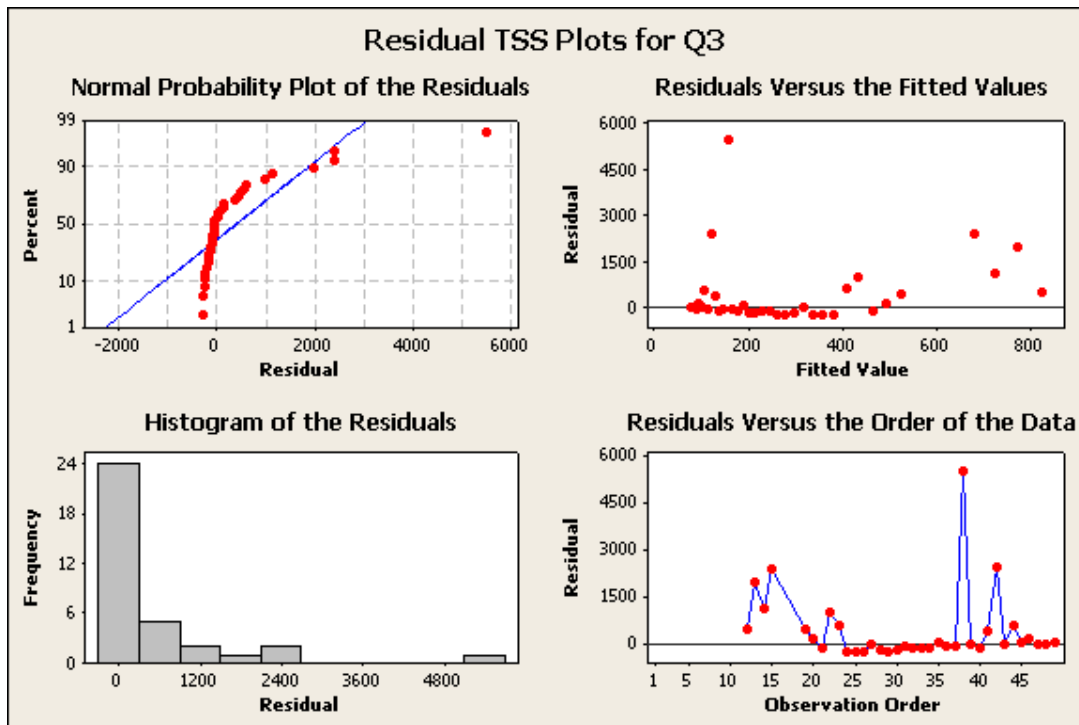
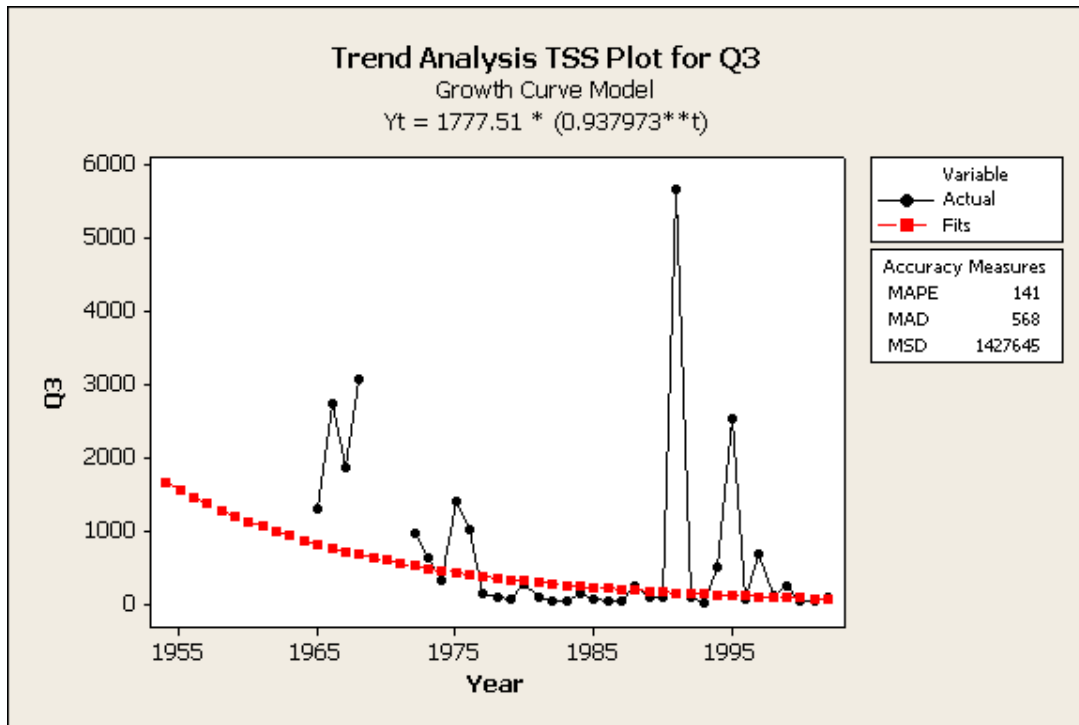
**Figure A-11.** Trend Analysis for 3<sup>rd</sup> Quartile Suspended Solids Concentration by Year for All Sites.



**Figure A-12.** Trend Analysis for Mean Suspended Solids Concentration by Year for All Sites.

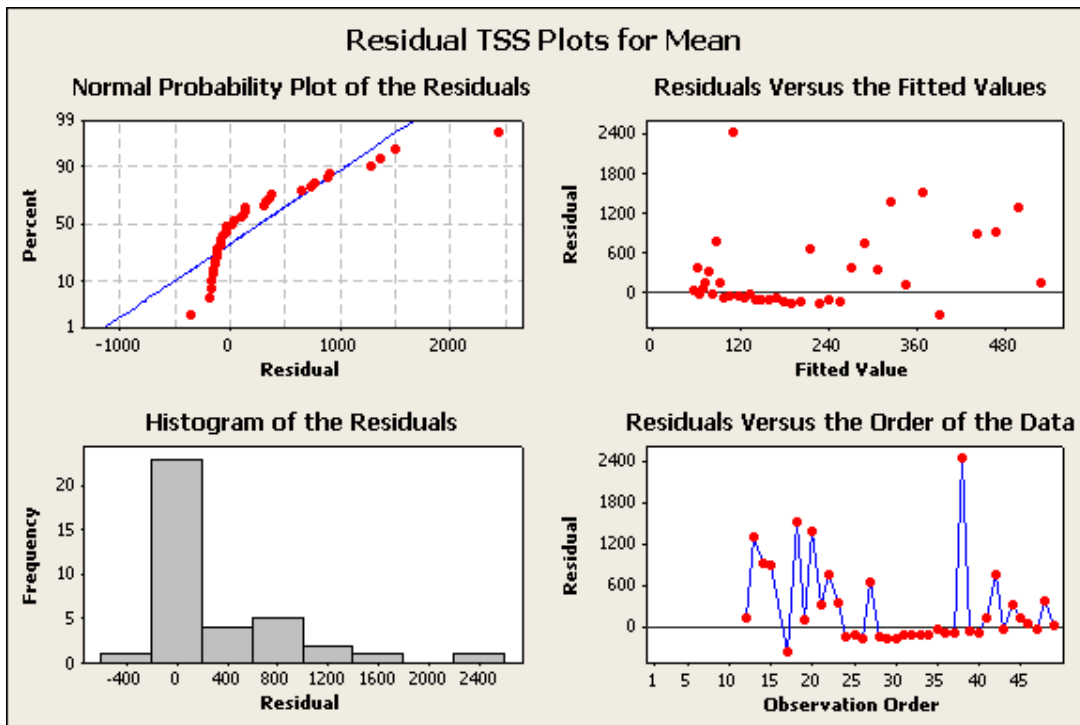
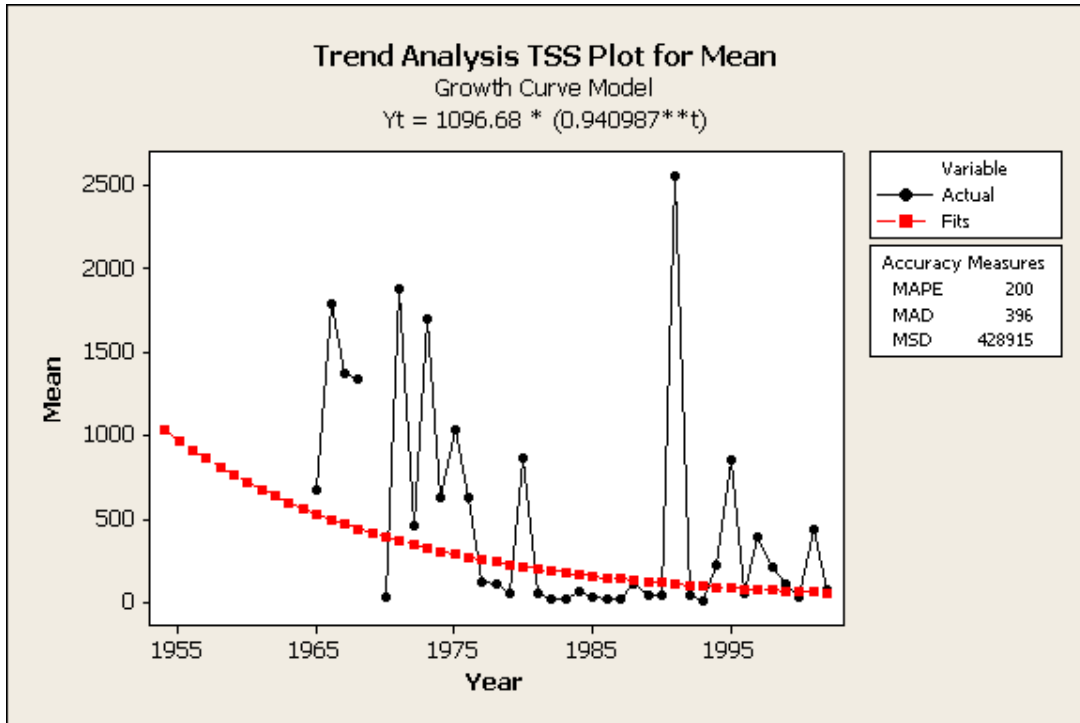


**Figure A-13.** Trend Analysis for Median Total Suspended Solids Concentration by Year for All Sites.

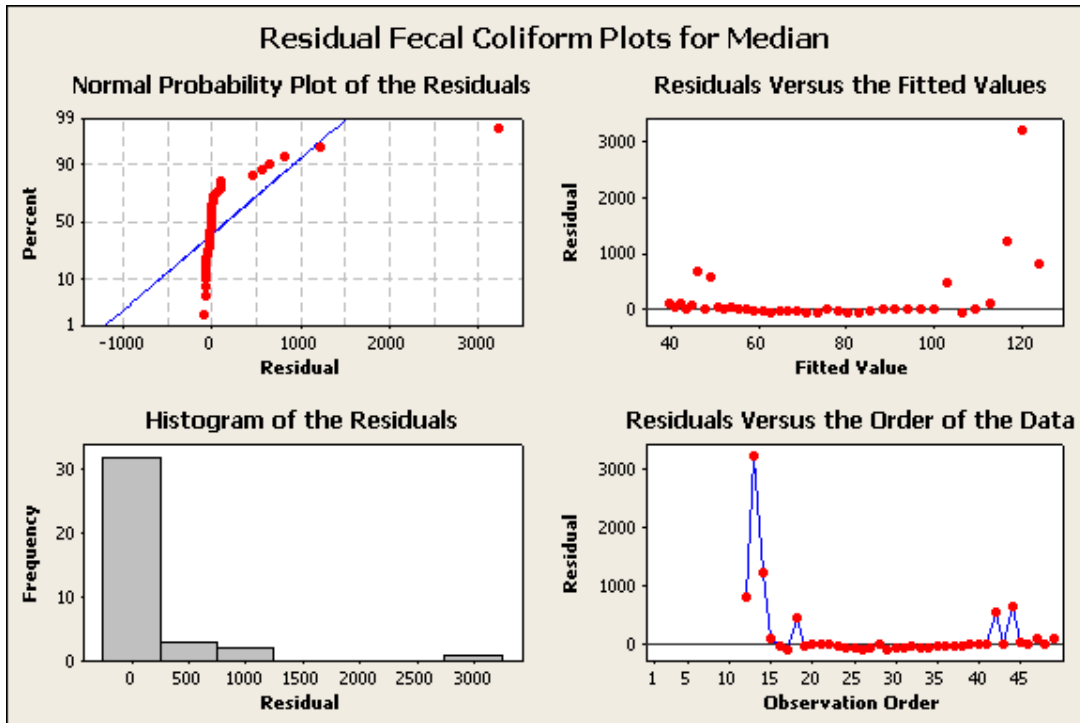
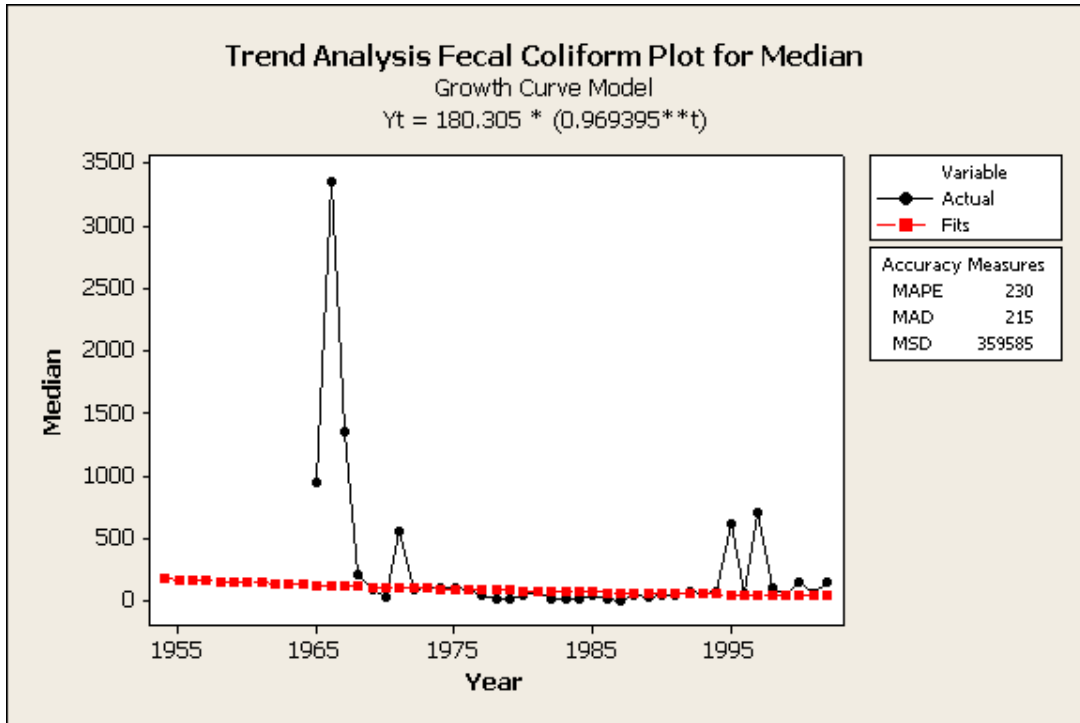


**Figure A-14.** Trend Analysis for 3<sup>rd</sup> Quartile Total Suspended Solids Concentration by Year for All Sites.

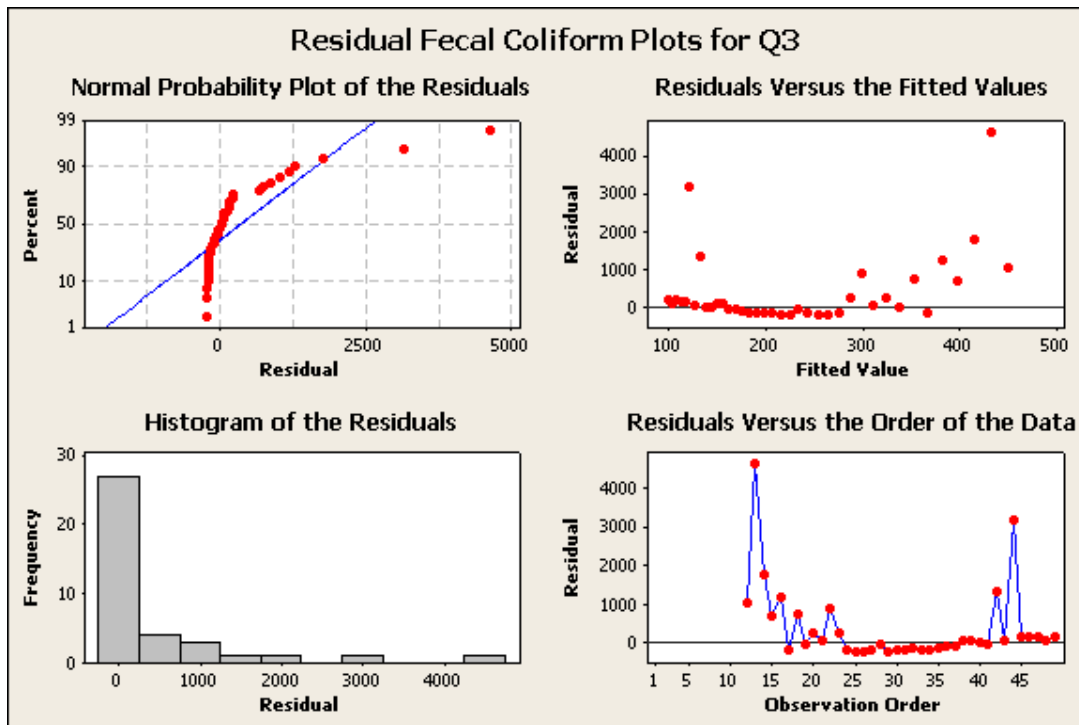
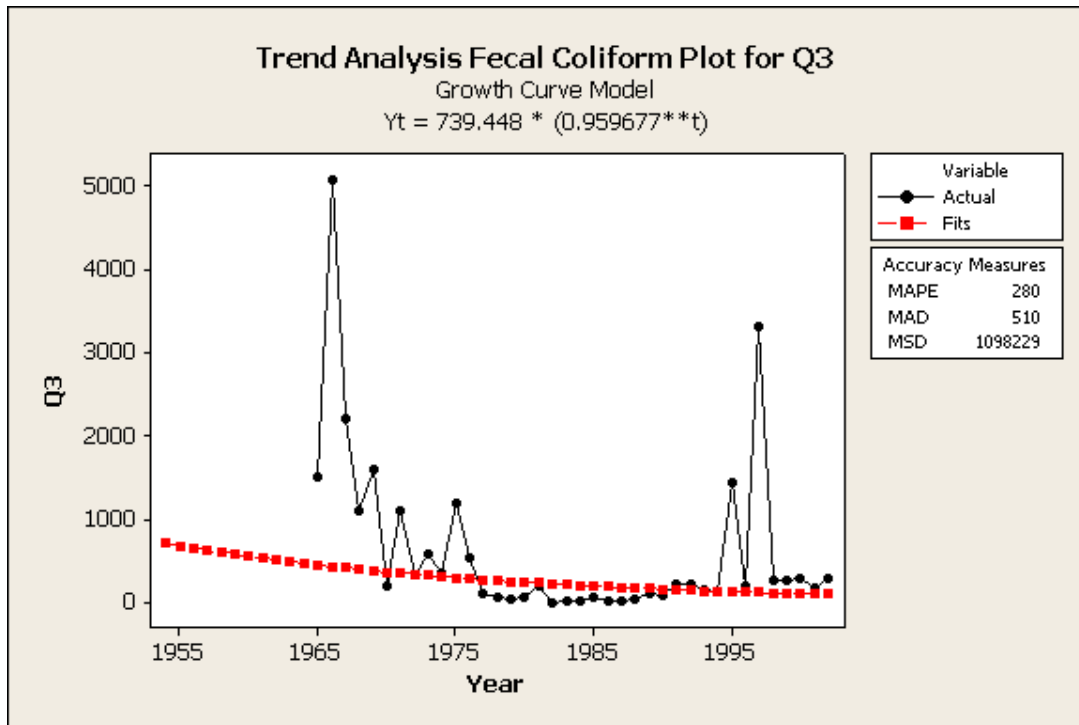




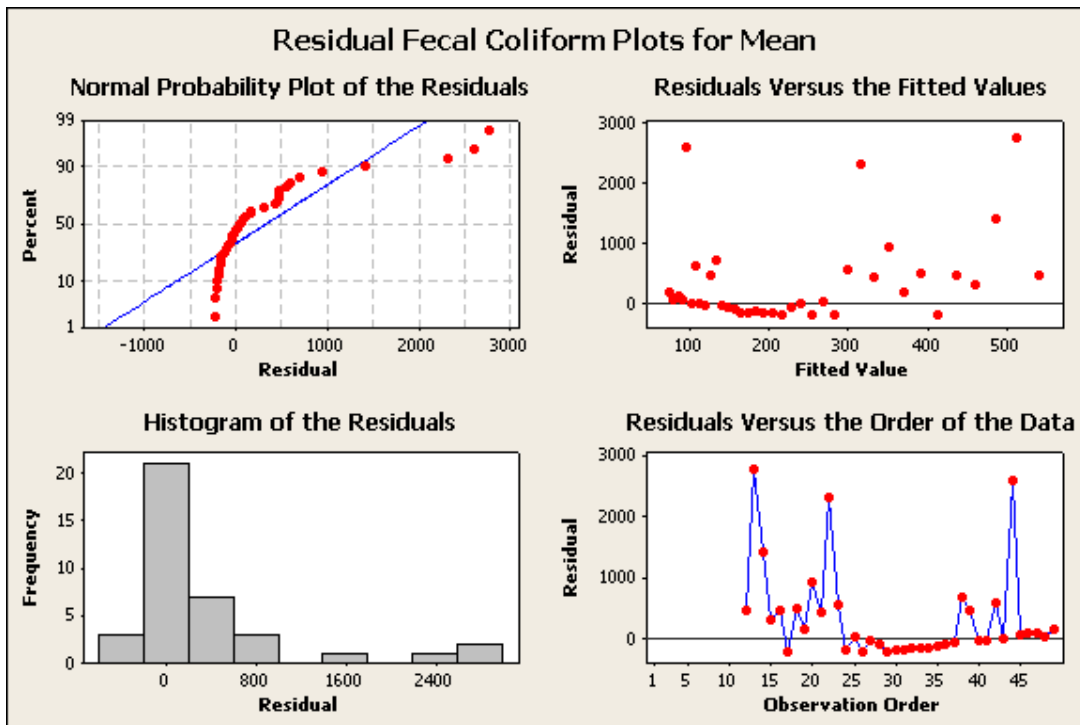
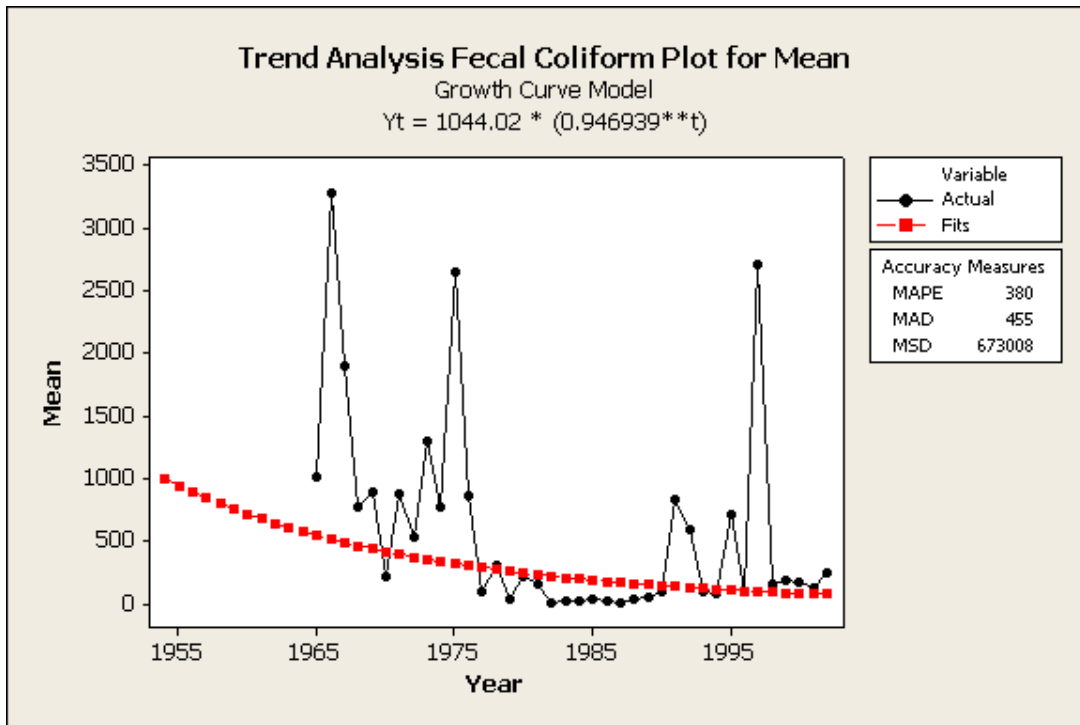
**Figure A-15.** Trend Analysis for Mean Total Suspended Solids Concentration by Year for All Sites.



**Figure A-16.** Trend Analysis for Median Fecal Coliform Concentration by Year for All Sites.



**Figure A-17.** Trend Analysis for 3<sup>rd</sup> Quartile Fecal Coliform Concentration by Year for All Sites.



**Figure A-18.** Trend Analysis for Mean Fecal Coliform Concentration by Year for All Sites.

**Minitab Project Report  
 Chemical Analysis  
 Belle Fourche River Watershed  
 South Dakota  
 All Sites  
 by Dan Hoyer  
 9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	138	35.77	0.00	3.90	11.50	36.25	625.00
	2	104	155.5	0.2	7.8	30.0	93.5	2990.0
	3	193	500.8	1.8	23.5	108.0	350.0	9080.0
	4	154	390.7	0.7	21.8	75.0	373.1	8020.0
	5	181	1288	0	49	183	664	34900
	6	193	553.2	1.2	32.5	145.0	368.5	11000.0
	7	161	281.7	3.4	48.5	158.0	293.5	4860.0
	8	159	175.1	4.9	40.0	126.0	250.5	1240.0
	9	115	342	4	32	81	274	9450
	10	158	85.8	0.9	10.0	30.5	69.5	3760.0
	11	141	57.2	1.3	8.5	30.0	57.5	1230.0
	12	105	36.39	1.60	5.70	22.00	41.50	499.00
Turbidity	1	10	6.59	0.50	0.90	2.80	12.25	20.00
	2	7	27.6	0.5	0.7	4.3	10.0	170.0
	3	10	255	4	8	48	633	1000
	4	10	220	4	6	47	385	1100
	5	11	102.4	4.4	11.0	65.0	180.0	400.0
	6	10	158.6	4.7	11.4	61.5	222.5	820.0
	7	10	895	1	29	269	1450	4100
	8	12	138.2	9.7	23.3	34.5	77.5	940.0
	9	12	446	2	5	15	35	4800
	10	7	94.9	1.3	1.3	2.7	4.6	650.0
	11	10	8.56	0.70	1.30	6.30	15.25	26.00
	12	9	2.222	0.500	0.850	2.000	3.050	5.500
SC	1	241	3147.5	580.0	2490.0	3000.0	3825.0	6810.0
	2	190	2515.6	500.0	1877.5	2405.0	2800.0	6500.0
	3	270	2058.8	273.0	1375.0	2050.0	2512.5	8760.0
	4	265	1988.3	582.5	1490.0	1880.0	2325.0	9250.0
	5	256	1812.2	569.0	1205.0	1700.0	2100.0	5770.0
	6	263	1723.0	567.0	1450.0	1770.0	1950.0	4400.0
	7	281	1746.5	770.0	1615.0	1780.0	1910.0	2780.0
	8	228	1791.3	750.0	1670.0	1840.0	1950.0	2580.0
	9	202	1862.9	535.0	1720.0	1870.0	2040.0	2990.0
	10	291	2228.8	950.0	1950.0	2200.0	2430.0	4980.0
	11	260	2555.0	550.0	2122.5	2490.0	2800.0	5230.0
	12	190	2969.6	380.0	2420.0	2890.0	3335.0	5640.0
TSS	1	36	28.94	0.00	7.00	12.50	44.00	200.00
	2	24	61.7	3.0	7.0	17.0	71.8	620.0
	3	19	689	3	8	30	270	11000

	4	53	734	4	20	120	729	7618
	5	29	1205	6	22	68	1224	14977
	6	28	1274	15	112	483	1200	8080
	7	54	389	6	44	82	273	3920
	8	28	290	17	39	82	296	2250
	9	24	189.3	1.0	21.3	60.5	122.5	1313.0
	10	47	106.3	1.0	7.0	11.0	34.0	2300.0
	11	23	22.91	0.00	4.00	8.00	26.00	213.00
	12	17	26.6	4.0	5.8	11.0	26.0	202.0
Fecal Coliform	1	40	48.0	0.0	2.0	11.5	30.0	500.0
	2	27	54.6	1.0	7.0	14.0	43.0	480.0
	3	21	319	1	7	33	135	3000
	4	51	973	0	16	80	900	11000
	5	49	1548	7	41	130	1400	24000
	6	39	710	33	120	330	1100	6700
	7	93	775	4	47	170	620	14200
	8	45	433	9	36	110	445	4000
	9	37	1797	13	33	80	245	52400
	10	50	312	2	10	19	90	5400
	11	30	34.43	0.00	5.00	21.00	38.00	140.00
	12	22	13.77	0.00	2.00	7.00	13.00	83.00
TDS	1	99	2689.2	612.0	2112.0	2530.0	3270.0	5549.0
	2	95	2196.1	798.0	1658.0	2120.0	2580.0	5520.0
	3	87	1838.3	405.0	1180.0	1740.0	2430.0	4040.0
	4	124	1478.5	346.0	1045.0	1370.0	1897.5	4800.0
	5	125	1519.2	198.0	926.0	1400.0	1955.0	5320.0
	6	82	1372.7	626.0	1067.5	1460.0	1651.5	2312.0
	7	128	1439.3	330.0	1300.0	1455.0	1643.8	2480.0
	8	109	1502.6	732.0	1380.0	1530.0	1704.0	2046.0
	9	80	1536.9	380.0	1365.0	1555.0	1699.0	2702.0
	10	106	1914.2	784.0	1650.0	1925.0	2163.8	4400.0
	11	104	2145.4	1066.0	1690.0	2213.0	2414.5	3850.0
	12	70	2718.2	1770.0	2264.5	2755.5	3210.0	4020.0
SSC	1	20	206.2	7.0	57.3	129.0	258.0	1040.0
	2	16	422	4	31	216	509	2720
	3	46	2581	20	215	1180	3535	21500
	4	31	1714	12	58	433	2070	11000
	5	50	1390	17	107	241	1228	12750
	6	48	1682	17	108	226	2245	20200
	7	46	2430	30	63	171	1693	38300
	8	38	673	12	53	138	238	6220
	9	31	949	3	44	74	265	10900
	10	24	207.7	3.0	9.3	32.5	199.5	1580.0
	11	27	162.6	3.0	26.0	65.0	223.0	1280.0
	12	17	157.3	18.0	45.0	122.0	295.5	376.0

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1954	0	*	*	*	*	*	*
	1955	1	68.000	68.000	*	68.000	*	68.000

1956	15	216	34	41	127	171	1729
1957	18	128.7	50.0	52.8	110.5	162.8	375.0
1958	22	162.1	20.0	46.8	71.5	226.5	607.0
1959	13	67.1	10.0	28.3	56.0	106.5	190.0
1960	18	165.0	2.8	22.0	49.0	180.5	1530.0
1961	10	22.70	3.70	10.58	18.50	29.25	74.00
1962	10	1441	19	129	204	2193	8560
1965	0	*	*	*	*	*	*
1966	0	*	*	*	*	*	*
1967	0	*	*	*	*	*	*
1968	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	6	78.2	34.0	34.8	63.5	115.3	179.0
1974	26	135.9	8.0	30.5	69.5	224.5	564.0
1975	39	229.4	4.1	22.0	74.0	349.0	1600.0
1976	63	321	3	22	63	160	8440
1977	74	147.0	3.3	19.5	64.5	163.8	2950.0
1978	59	618	3	19	51	464	9080
1979	55	135.0	0.2	10.0	58.0	231.0	758.0
1980	47	69.9	1.0	6.2	31.0	68.0	362.0
1981	36	197.2	2.6	5.5	36.5	112.3	2170.0
1982	45	304	1	8	39	140	9360
1983	58	283.9	2.8	27.8	103.5	407.6	1530.0
1984	73	408	2	15	61	291	4120
1985	89	100.8	1.9	10.4	47.0	163.5	681.0
1986	72	648	3	18	96	411	9450
1987	64	339.9	2.4	19.0	143.5	339.3	4970.0
1988	96	145.8	1.5	20.5	82.5	225.0	989.5
1989	55	97.3	1.2	6.8	33.0	137.0	748.0
1990	54	98.9	1.5	7.9	34.0	81.3	1460.0
1991	51	92.6	0.0	4.4	28.0	111.0	1920.0
1992	55	93.1	0.3	7.0	25.0	40.0	1760.0
1993	65	737	0	30	131	503	14900
1994	59	246.6	1.7	15.0	64.0	215.0	2760.0
1995	62	1334	2	16	81	259	28400
1996	62	1633	4	46	228	878	34900
1997	48	538	3	34	101	566	4410
1998	46	536	2	26	159	286	11000
1999	51	635	3	49	258	625	7100
2000	44	250	2	13	74	252	5530
2001	44	137.3	2.4	14.0	37.5	195.5	720.0
2002	61	61.4	1.8	8.7	30.0	59.0	309.0
2003	36	216	2	10	42	129	4360
2004	0	*	*	*	*	*	*

Turbidity

1954	0	*	*	*	*	*	*
1955	0	*	*	*	*	*	*
1956	0	*	*	*	*	*	*
1957	0	*	*	*	*	*	*
1958	0	*	*	*	*	*	*
1959	0	*	*	*	*	*	*
1960	0	*	*	*	*	*	*
1961	0	*	*	*	*	*	*

1962	0	*	*	*	*	*	*
1965	0	*	*	*	*	*	*
1966	0	*	*	*	*	*	*
1967	0	*	*	*	*	*	*
1968	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	0	*	*	*	*	*	*
1975	0	*	*	*	*	*	*
1976	0	*	*	*	*	*	*
1977	0	*	*	*	*	*	*
1978	7	165	1	1	3	260	820
1979	8	180	1	2	23	178	1100
1980	14	139.0	0.6	2.6	5.0	127.8	820.0
1981	18	449	3	14	79	335	4100
1982	4	29.5	1.0	4.0	14.5	70.0	88.0
1983	7	41.8	0.5	1.3	11.0	66.0	180.0
1984	5	7.86	0.90	2.75	6.80	13.50	17.00
1985	5	8.78	0.70	2.50	8.50	15.20	21.00
1986	7	761	3	3	33	400	4800
1987	5	146	1	7	17	350	600
1988	6	13.07	0.80	1.10	4.70	32.75	35.00
1989	6	216	1	4	16	445	1000
1990	6	19.18	2.30	6.43	19.50	31.50	36.00
1991	5	30.60	15.00	15.00	26.00	48.50	65.00
1992	6	214	7	8	16	330	1200
1993	5	300	2	2	5	745	940
1994	4	207	1	3	47	569	730
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*
2004	0	*	*	*	*	*	*

SC

1954	9	2648	1970	2170	2530	2980	3960
1955	34	2582	1430	1960	2440	3068	5440
1956	30	2406.3	1240.0	2025.0	2470.0	2775.0	3330.0
1957	46	2622.0	1680.0	2142.5	2615.0	3100.0	4010.0
1958	35	2554	1270	1930	2360	3150	5770
1959	13	2698	1990	2120	2530	3105	4160
1960	17	2309	629	1765	2190	2550	4750
1961	10	2716	1350	2100	2725	3093	4580
1962	10	1902	1200	1553	2010	2190	2480
1965	7	2107.1	1920.0	1930.0	2020.0	2250.0	2510.0
1966	28	1677.1	960.0	1207.5	1685.0	2017.5	2530.0
1967	25	1501.6	627.0	1085.0	1460.0	1810.0	2520.0
1968	42	1815.8	801.0	1397.5	1760.0	2050.0	3400.0
1969	69	1897.9	689.0	1455.0	1875.0	2185.0	4200.0



1970	65	1998.4	818.0	1380.0	1820.0	2430.0	4340.0
1971	43	1779	583	1190	1700	2280	4350
1972	41	2041	888	1420	1820	2600	3935
1973	45	1749.5	894.0	1330.0	1740.0	1920.0	3900.0
1974	34	2092	1020	1525	1865	2528	5200
1975	50	2092	998	1550	1960	2630	4000
1976	57	2131.7	390.0	1670.0	1950.0	2635.0	3700.0
1977	71	2128	830	1560	1900	2700	4300
1978	89	1962.6	380.0	1500.0	1805.0	2680.0	3500.0
1979	94	2289.2	580.0	1670.0	1965.0	2800.0	6500.0
1980	87	2421.0	1180.0	1980.0	2350.0	2800.0	4500.0
1981	73	2148.6	750.0	1585.0	2100.0	2710.0	4600.0
1982	62	2327	795	1829	2200	2590	6000
1983	53	2186	873	1760	1900	2530	5500
1984	71	2238	755	1760	2130	2450	5600
1985	90	2371.8	700.0	1825.0	2140.0	2677.5	5600.0
1986	70	2138	535	1545	1940	2583	5000
1987	151	2343.5	880.0	1940.0	2320.0	2570.0	5600.0
1988	332	2290.1	550.0	1862.5	2000.0	2460.0	5430.0
1989	61	2403	700	1930	2290	2505	5600
1990	57	2104.7	835.0	1770.0	1990.0	2340.0	4330.0
1991	53	2388	919	1800	2003	2465	6810
1992	60	2403	995	1833	2150	2500	6300
1993	67	1725	567	958	1520	2140	5450
1994	126	2163.0	806.0	1738.8	2105.0	2455.0	5430.0
1995	65	2375	569	1615	1960	2660	9250
1996	64	1805	409	1288	1855	2148	4940
1997	52	1905	496	1480	1775	2185	5230
1998	54	1946	950	1398	1655	2090	6070
1999	58	1953	1060	1440	1730	2018	5640
2000	53	2141	1140	1590	1910	2210	5740
2001	57	2016	1000	1435	1840	2270	5860
2002	87	2434	1620	1850	2110	2490	6570
2003	54	1972	273	1610	1800	2255	6190
2004	16	2374	1620	1700	2085	2483	5910

TSS

1954	0	*	*	*	*	*	*
1955	0	*	*	*	*	*	*
1956	0	*	*	*	*	*	*
1957	0	*	*	*	*	*	*
1958	0	*	*	*	*	*	*
1959	0	*	*	*	*	*	*
1960	0	*	*	*	*	*	*
1961	0	*	*	*	*	*	*
1962	0	*	*	*	*	*	*
1965	0	*	*	*	*	*	*
1966	0	*	*	*	*	*	*
1967	3	673	320	320	398	1300	1300
1968	4	1786	147	572	2048	2738	2900
1969	6	1376	90	608	1282	1864	3510
1970	3	1332	7	7	918	3072	3072
1971	0	*	*	*	*	*	*
1972	1	36.000	36.000	*	36.000	*	36.000
1973	1	1874.0	1874.0	*	1874.0	*	1874.0
1974	6	461	3	23	156	976	1685
1975	12	1702	0	105	264	633	14977

1976	16	632	0	39	74	325	7183
1977	26	1035	1	56	139	1412	7618
1978	25	631	6	14	70	1018	5160
1979	28	115.6	1.0	6.0	45.0	138.8	805.0
1980	29	113.6	1.0	7.0	32.0	87.0	1100.0
1981	15	52.4	3.0	7.0	27.0	65.0	274.0
1982	13	865	6	13	30	287	8080
1983	4	50.0	4.0	8.0	38.0	104.0	120.0
1984	4	21.5	4.0	5.3	12.0	47.3	58.0
1985	5	20.6	4.0	4.5	11.0	41.5	65.0
1986	4	61.8	7.0	8.8	27.5	149.0	185.0
1987	4	36.5	3.0	4.3	26.0	79.3	91.0
1988	5	22.6	1.0	4.0	11.0	47.0	65.0
1989	4	23.75	9.00	9.75	18.00	43.50	50.00
1990	4	106.3	15.0	15.3	60.5	243.0	289.0
1991	3	41.3	11.0	11.0	30.0	83.0	83.0
1992	4	40.3	10.0	12.5	23.5	84.8	104.0
1993	4	2548	5	6	1964	5675	6260
1994	4	42.5	3.0	4.0	16.5	107.0	134.0
1995	4	14.00	4.00	6.00	13.00	23.00	26.00
1996	4	224	26	30	125	518	620
1997	4	854	2	6	18	2540	3380
1998	6	51.7	12.0	19.5	35.5	78.8	150.0
1999	23	395	5	12	44	692	3530
2000	22	209.2	7.0	12.3	41.0	114.0	2030.0
2001	19	105.5	5.0	15.0	36.0	240.0	320.0
2002	16	35.13	6.00	8.00	25.50	54.25	110.00
2003	29	435	6	10	28	56	11000
2004	18	71.7	6.0	9.5	32.5	91.5	600.0

Fecal Coliform	1954	0	*	*	*	*	*	*
	1955	0	*	*	*	*	*	*
	1956	0	*	*	*	*	*	*
	1957	0	*	*	*	*	*	*
	1958	0	*	*	*	*	*	*
	1959	0	*	*	*	*	*	*
	1960	0	*	*	*	*	*	*
	1961	0	*	*	*	*	*	*
	1962	0	*	*	*	*	*	*
	1965	0	*	*	*	*	*	*
	1966	0	*	*	*	*	*	*
	1967	3	1010	590	590	940	1500	1500
	1968	4	3285	1000	1425	3350	5080	5440
	1969	12	1900	300	1100	1350	2200	5100
	1970	11	772	9	17	210	1100	2700
	1971	13	892	2	17	88	1600	5000
	1972	16	210	0	11	28	208	2200
	1973	15	877	14	180	560	1100	3000
	1974	16	533	6	10	90	330	2700
	1975	36	1293	3	39	95	575	24000
	1976	38	770	2	26	103	363	11000
	1977	29	2648	3	20	100	1200	52400
	1978	34	857	3	17	80	540	7000
	1979	32	91.0	0.0	5.5	40.0	111.5	530.0
	1980	32	301	0	1	16	55	8000
	1981	15	38.6	1.0	2.0	10.0	40.0	340.0

1982	19	218.9	10.0	30.0	38.0	60.0	1150.0
1983	8	156.3	2.0	8.0	76.0	190.0	700.0
1984	8	4.875	2.000	2.250	5.000	7.500	8.000
1985	9	17.44	6.00	9.50	10.00	28.00	32.00
1986	6	18.67	10.00	10.00	16.00	30.00	30.00
1987	7	32.86	10.00	10.00	40.00	60.00	60.00
1988	7	10.86	2.00	10.00	10.00	12.00	20.00
1989	6	4.67	2.00	2.00	2.00	10.00	10.00
1990	6	38.67	2.00	27.50	38.50	51.25	73.00
1991	10	54.6	6.0	20.8	34.5	102.5	130.0
1992	10	92.4	10.0	18.0	44.0	95.0	520.0
1993	12	832	4	7	43	230	9100
1994	11	596	2	7	70	220	3315
1995	7	86.9	18.0	30.0	58.0	150.0	220.0
1996	4	85.5	40.0	46.3	76.0	134.3	150.0
1997	4	713	22	74	615	1450	1600
1998	4	98.3	47.0	47.3	58.0	189.5	230.0
1999	8	2703	60	155	710	3300	14200
2000	9	153.9	50.0	75.0	100.0	270.0	340.0
2001	9	184.2	18.0	39.5	46.0	275.0	870.0
2002	8	173.1	15.0	30.0	145.0	290.0	500.0
2003	13	125.5	4.0	12.0	60.0	185.0	570.0
2004	13	239.8	30.0	87.0	150.0	285.0	1300.0

TDS

1954	9	2438	1730	1955	2320	2795	3760
1955	34	2334	1140	1708	2170	2843	5170
1956	30	2155.9	966.0	1707.5	2240.0	2487.5	3170.0
1957	46	2382.0	1320.0	1867.5	2370.0	2842.5	3830.0
1958	34	2261	971	1645	2030	2800	5320
1959	5	2338	1660	1700	2300	2995	3210
1960	17	2093	432	1475	1930	2325	4820
1961	10	2523	1090	1803	2520	2973	4630
1962	10	1604	924	1100	1725	1935	2240
1965	7	1742.9	1540.0	1560.0	1680.0	1900.0	2130.0
1966	28	1359.1	736.0	983.0	1325.0	1647.5	2200.0
1967	28	1243.9	422.0	839.0	1130.0	1487.5	2320.0
1968	42	1589	560	1073	1540	1845	3260
1969	61	1591.0	484.0	1170.0	1610.0	1832.5	3270.0
1970	60	1688.6	582.0	1080.0	1555.0	2075.0	3650.0
1971	32	1423	432	869	1250	1950	4410
1972	23	1692	644	1160	1610	2210	3640
1973	19	1303	642	934	1250	1460	3200
1974	9	2133	916	1518	2175	2560	3530
1975	24	1853	780	1356	1585	2268	3720
1976	27	2077	700	1490	1837	2759	3450
1977	41	1929	628	1410	1610	2364	4268
1978	44	1707	247	1099	1412	2487	3306
1979	38	2213	1206	1468	1585	2442	5549
1980	36	2300	1390	1810	2250	2680	3790
1981	30	2195	788	1697	2229	2507	4320
1982	30	1799	626	1479	1747	2015	4690
1983	43	1476.1	571.0	1195.0	1460.0	1654.0	3370.0
1984	21	1786	198	1476	1824	2225	3310
1985	26	1836	346	1494	1740	2347	3760
1986	36	1776	380	1321	1645	2522	3250
1987	36	1734.4	803.0	1370.5	1682.0	2111.8	2750.0

1988	39	2213	1100	1590	1827	2290	4940
1989	22	1947	310	1581	1826	2229	3790
1990	18	1761	1066	1452	1762	2007	2710
1991	16	1816	1128	1543	1684	1909	3650
1992	18	1759.9	886.0	1550.8	1755.0	2005.0	2450.0
1993	17	1389	330	978	1384	1731	2470
1994	22	1499	730	1078	1472	1781	2610
1995	12	2063	1389	1625	1979	2382	3126
1996	12	1432	830	1038	1427	1885	1954
1997	12	1504	835	1266	1583	1780	2218
1998	12	1414.3	1020.0	1100.0	1448.0	1707.3	1769.0
1999	19	1339.8	584.0	1096.0	1270.0	1623.0	2143.0
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	18	1583.3	1100.0	1300.0	1550.0	1825.0	2600.0
2004	36	1740.6	760.0	1400.0	1700.0	1975.0	3000.0

SSC

1954	0	*	*	*	*	*	*
1955	0	*	*	*	*	*	*
1956	11	3879	338	941	1310	2290	22800
1957	10	3121	950	1235	2550	3850	9800
1958	14	2878	12	136	1815	5310	9290
1959	8	807	4	7	56	1959	3610
1960	15	3033	12	68	217	3750	20200
1961	0	*	*	*	*	*	*
1962	0	*	*	*	*	*	*
1965	0	*	*	*	*	*	*
1966	0	*	*	*	*	*	*
1967	0	*	*	*	*	*	*
1968	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	2	341.0	297.0	*	341.0	*	385.0
1975	12	1023	144	297	396	903	4480
1976	10	3725	202	354	637	5208	21500
1977	13	1627	213	251	386	585	11000
1978	9	1955	30	205	410	1990	11800
1979	12	972	114	212	373	2128	2980
1980	12	3513	44	134	193	308	38300
1981	10	1790	107	173	224	1635	10800
1982	6	194.2	83.0	149.8	208.0	237.0	267.0
1983	24	179.7	9.0	22.0	75.0	224.0	844.0
1984	33	1143	26	59	127	2465	6470
1985	29	130.3	3.0	8.0	158.0	216.0	257.0
1986	32	1866	15	44	557	2720	10900
1987	31	1453	7	45	115	1630	12750
1988	44	397	3	54	111	237	4715
1989	6	616	32	61	110	1138	2780
1990	6	87.0	39.0	60.8	82.5	121.0	133.0
1991	6	96.5	53.0	53.0	73.0	149.8	191.0
1992	6	467	28	39	69	690	2510
1993	5	702	46	50	74	1667	2370

1994	4	622	54	62	382	1423	1670
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	24	93.6	17.0	38.3	57.0	107.3	448.5
2003	0	*	*	*	*	*	*
2004	0	*	*	*	*	*	*

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Decade	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1950	69	145.9	10.0	50.0	79.0	172.5	1728.5
	1960	38	463	3	19	49	184	8560
	1970	322	273.1	0.2	20.0	61.0	230.3	9080.0
	1980	635	263.1	0.9	13.0	61.0	228.0	9450.0
	1990	553	623	0	16	68	273	34900
	2000	185	154.4	1.6	11.5	39.0	160.5	5530.0
Turbidity	1950	0	*	*	*	*	*	*
	1960	0	*	*	*	*	*	*
	1970	15	173.1	0.5	1.4	21.0	210.0	1100.0
	1980	77	233.2	0.5	4.0	13.0	88.0	4800.0
	1990	26	149.2	1.4	7.6	17.5	46.3	1200.0
	2000	0	*	*	*	*	*	*
SC	1950	167	2568.3	1240.0	2030.0	2500.0	2980.0	5770.0
	1960	208	1884.2	627.0	1450.0	1850.0	2215.0	4750.0
	1970	589	2049.2	380.0	1520.0	1820.0	2560.0	6500.0
	1980	1050	2295.6	535.0	1840.0	2140.0	2570.0	6000.0
	1990	656	2082.5	409.0	1560.0	1920.0	2330.0	9250.0
	2000	267	2189.5	273.0	1730.0	1960.0	2390.0	6570.0
TSS	1950	0	*	*	*	*	*	*
	1960	13	1340	90	359	1300	2048	3510
	1970	118	721	0	26	81	561	14977
	1980	87	187.6	1.0	8.0	22.0	65.0	8080.0
	1990	60	414	2	12	27	135	6260
	2000	104	203	5	10	32	78	11000
Fecal Coliform	1950	0	*	*	*	*	*	*
	1960	19	2051	300	1000	1500	2700	5440
	1970	240	958	0	20	89	530	52400
	1980	117	139.0	0.0	6.0	12.0	39.0	8000.0
	1990	76	580	2	22	63	190	14200
	2000	52	176.5	4.0	46.0	100.0	240.0	1300.0
TDS	1950	158	2304.5	966.0	1740.0	2255.0	2772.5	5320.0
	1960	203	1604.7	422.0	1120.0	1560.0	1900.0	4820.0
	1970	317	1793.5	247.0	1230.0	1530.0	2263.0	5549.0
	1980	319	1902.4	198.0	1470.0	1796.0	2282.0	4940.0

	1990	158	1591.3	330.0	1239.0	1593.5	1874.0	3650.0
	2000	54	1688.1	760.0	1300.0	1700.0	1900.0	3000.0
SSC	1950	43	2805	4	218	1580	3610	22800
	1960	15	3033	12	68	217	3750	20200
	1970	58	1735	30	263	386	1000	21500
	1980	227	1026	3	49	139	433	38300
	1990	27	367	28	54	75	136	2510
	2000	24	93.6	17.0	38.3	57.0	107.3	448.5

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Station	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	460130	0	*	*	*	*	*	*
	460681	0	*	*	*	*	*	*
	460683	0	*	*	*	*	*	*
	6428500	381	153.0	0.3	21.0	47.0	106.0	6320.0
	6436000	305	192.6	1.0	4.4	8.5	18.5	11300.0
	6436760	253	126.2	0.3	3.3	13.0	52.5	6420.0
	6437000	462	471.1	1.8	57.8	174.0	308.0	17500.0
	6438000	401	721	0	50	139	333	34900
Turbidity	460130	0	*	*	*	*	*	*
	460681	0	*	*	*	*	*	*
	460683	0	*	*	*	*	*	*
	6428500	13	187.8	3.0	5.5	90.0	375.0	650.0
	6436000	0	*	*	*	*	*	*
	6436760	0	*	*	*	*	*	*
	6437000	0	*	*	*	*	*	*
	6438000	105	209.5	0.5	3.4	13.0	68.0	4800.0
SC	460130	0	*	*	*	*	*	*
	460681	0	*	*	*	*	*	*
	460683	0	*	*	*	*	*	*
	6428500	532	1698.1	273.0	1310.0	1690.0	2070.0	3500.0
	6436000	272	1877.4	515.0	1550.0	1890.0	2240.0	3670.0
	6436760	248	3156	500	1880	2610	4400	9250
	6437000	1346	2218.0	380.0	1790.0	2090.0	2600.0	5770.0
	6438000	539	2238.7	390.0	1740.0	2070.0	2660.0	6500.0
TSS	460130	7	146.0	8.0	10.0	49.0	130.0	690.0
	460681	23	354	6	10	28	74	6005
	460683	22	126.2	6.0	13.0	50.0	98.3	828.0
	6428500	12	106.4	3.0	10.3	55.0	132.0	516.0
	6436000	0	*	*	*	*	*	*
	6436760	0	*	*	*	*	*	*
	6437000	193	541	0	12	42	280	14977
	6438000	125	378	1	12	39	112	11000
Fecal Coliform	460130	14	599	60	150	305	518	3800
	460681	27	286	3	50	87	220	2480
	460683	30	308	5	29	70	178	3315
	6428500	24	337	2	30	128	290	2700
	6436000	0	*	*	*	*	*	*

	6436760	0	*	*	*	*	*	*
	6437000	270	647	0	10	40	308	24000
	6438000	139	936	0	13	70	320	52400
TDS	460130	20	1592.9	760.0	1282.0	1650.0	1875.0	2400.0
	460681	89	1460.5	310.0	1172.0	1511.0	1695.5	2334.0
	460683	89	1841.3	198.0	1626.0	1856.0	2189.0	5549.0
	6428500	189	1302.3	422.0	902.0	1230.0	1660.0	2470.0
	6436000	8	1236	620	738	1160	1810	1940
	6436760	8	2340	380	1483	1760	3953	4800
	6437000	460	1977.0	330.0	1470.3	1837.5	2437.5	5320.0
	6438000	346	2017.2	405.0	1440.0	1752.5	2422.5	5520.0
SSC	460130	0	*	*	*	*	*	*
	460681	0	*	*	*	*	*	*
	460683	0	*	*	*	*	*	*
	6428500	2	364	218	*	364	*	510
	6436000	23	686	18	60	152	844	4710
	6436760	5	1608	25	40	1730	3115	3510
	6437000	161	1517	3	46	169	1605	22800
	6438000	203	1197	3	68	190	501	38300

## Kruskal-Wallis Test: Discharge versus Month

1802 cases were used  
1639 cases contained missing values

Kruskal-Wallis Test on Discharge

Month	N	Median	Ave Rank	Z
1	138	11.50	461.4	-10.34
2	104	30.00	710.4	-3.86
3	193	108.00	1020.3	3.36
4	154	75.00	981.1	1.99
5	181	183.00	1155.9	6.93
6	193	145.00	1093.7	5.43
7	161	158.00	1113.9	5.43
8	159	126.00	1062.9	4.10
9	115	81.00	1013.3	2.38
10	158	30.50	686.1	-5.45
11	141	30.00	630.1	-6.45
12	105	22.00	538.4	-7.37
Overall	1802		901.5	

H = 360.01 DF = 11 P = 0.000  
H = 360.02 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: TSS versus Month

382 cases were used  
3059 cases contained missing values

Kruskal-Wallis Test on TSS

Month	N	Median	Ave Rank	Z
1	36	12.500	117.5	-4.23
2	24	17.000	140.6	-2.33
3	19	30.000	180.9	-0.43
4	53	120.000	237.7	3.28
5	29	68.000	232.0	2.06
6	28	483.000	302.6	5.53
7	54	81.500	247.3	4.01
8	28	82.000	243.0	2.56
9	24	60.500	206.0	0.66
10	47	11.000	115.1	-5.07
11	23	8.000	88.1	-4.63
12	17	11.000	104.6	-3.32
Overall	382		191.5	

H = 136.48 DF = 11 P = 0.000  
H = 136.51 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: SSC versus Month

394 cases were used  
3047 cases contained missing values

Kruskal-Wallis Test on SSC

Month	N	Median	Ave Rank	Z
1	20	129.00	156.4	-1.66
2	16	215.50	180.5	-0.61
3	46	1180.00	276.6	5.01
4	31	433.00	223.8	1.34
5	50	241.00	224.5	1.79
6	48	226.00	227.7	1.96
7	46	171.00	209.3	0.75
8	38	138.00	174.8	-1.29
9	31	74.00	159.5	-1.94
10	24	32.50	109.9	-3.89
11	27	65.00	130.1	-3.19
12	17	122.00	154.0	-1.61
Overall	394		197.5	

H = 64.60 DF = 11 P = 0.000  
H = 64.60 DF = 11 P = 0.000 (adjusted for ties)



## Kruskal-Wallis Test: Turbidity versus Month

118 cases were used  
3323 cases contained missing values

Kruskal-Wallis Test on Turbidity

Month	N	Median	Ave Rank	Z
1	10	2.800	31.5	-2.71
2	7	4.300	34.2	-2.02
3	10	48.000	75.1	1.51
4	10	46.750	70.6	1.07
5	11	65.000	75.1	1.59
6	10	61.500	78.2	1.81
7	10	269.000	89.6	2.91
8	12	34.500	80.5	2.25
9	12	15.000	62.0	0.27
10	7	2.700	34.0	-2.03
11	10	6.300	38.8	-2.00
12	9	2.000	18.7	-3.72
Overall	118		59.5	

H = 51.66 DF = 11 P = 0.000  
H = 51.67 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: SC versus Month

2937 cases were used  
504 cases contained missing values

Kruskal-Wallis Test on SC

Month	N	Median	Ave Rank	Z
1	241	3000	2332.7	16.50
2	190	2405	1832.9	6.12
3	270	2050	1362.0	-2.17
4	265	1880	1252.2	-4.36
5	256	1700	1016.9	-8.93
6	263	1770	950.8	-10.39
7	281	1780	967.4	-10.43
8	228	1840	1042.5	-7.91
9	202	1870	1168.2	-5.22
10	291	2200	1680.5	4.48
11	260	2490	1986.1	10.30
12	190	2890	2332.4	14.51
Overall	2937		1469.0	

H = 970.77 DF = 11 P = 0.000  
H = 970.80 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: TDS versus Month

1209 cases were used  
2232 cases contained missing values

Kruskal-Wallis Test on TDS

Month	N	Median	Ave Rank	Z
1	99	2530	937.8	9.90
2	95	2120	777.2	5.01
3	87	1740	610.4	0.15
4	124	1370	433.6	-5.77
5	125	1400	438.9	-5.62
6	82	1460	378.4	-6.09
7	128	1455	411.9	-6.62
8	109	1530	461.2	-4.51
9	80	1555	476.6	-3.40
10	106	1925	710.3	3.25
11	104	2213	808.7	6.22
12	70	2756	1021.2	10.28
Overall	1209		605.0	

H = 418.77 DF = 11 P = 0.000  
H = 418.77 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: Fecal Coliform versus Month

504 cases were used  
2937 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
1	40	11.500	128.5	-5.61
2	27	14.000	145.5	-3.92
3	21	33.000	203.2	-1.59
4	51	80.000	272.1	1.01
5	49	130.000	324.0	3.62
6	39	330.000	373.1	5.38
7	93	170.000	316.8	4.71
8	45	110.000	299.7	2.28
9	37	80.000	285.5	1.43
10	50	19.000	194.2	-2.98
11	30	21.000	150.1	-3.97
12	22	7.000	86.3	-5.47
Overall	504		252.5	

H = 161.71 DF = 11 P = 0.000  
H = 161.77 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: Discharge versus Year

1802 cases were used

1639 cases contained missing values

Kruskal-Wallis Test on Discharge

Year	N	Median	Ave Rank	Z
1955	1	68.00	966.0	0.12
1956	15	127.00	1082.0	1.35
1957	18	110.50	1084.1	1.50
1958	22	71.50	1070.7	1.53
1959	13	56.00	823.6	-0.54
1960	18	49.00	870.6	-0.25
1961	10	18.50	488.2	-2.52
1962	10	204.00	1309.5	2.49
1973	6	63.50	926.3	0.12
1974	26	69.50	978.5	0.76
1975	39	74.00	990.3	1.08
1976	63	63.00	917.4	0.25
1977	74	64.50	870.0	-0.53
1978	59	51.00	967.3	0.99
1979	55	58.00	838.8	-0.91
1980	47	31.00	682.3	-2.93
1981	36	36.50	734.2	-1.95
1982	45	39.00	761.5	-1.83
1983	58	103.50	1051.6	2.23
1984	73	61.00	896.4	-0.09
1985	89	47.00	797.0	-1.94
1986	72	95.50	1030.9	2.15
1987	64	143.50	1036.1	2.11
1988	96	82.50	947.6	0.89
1989	55	33.00	720.7	-2.62
1990	54	34.00	689.2	-3.04
1991	51	28.00	625.1	-3.85
1992	55	25.00	558.2	-4.97
1993	65	131.00	1065.1	2.58
1994	59	64.00	915.4	0.21
1995	62	81.00	966.8	1.01
1996	62	228.00	1198.8	4.58
1997	48	100.50	1104.2	2.74
1998	46	158.50	1041.0	1.84
1999	51	258.00	1200.2	4.16
2000	44	73.50	902.6	0.01
2001	44	37.50	851.9	-0.64
2002	61	30.00	648.8	-3.86
2003	36	41.50	761.8	-1.63
Overall	1802		901.5	

H = 182.62 DF = 38 P = 0.000

H = 182.62 DF = 38 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: TSS versus Year

382 cases were used

3059 cases contained missing values

Kruskal-Wallis Test on TSS

Year	N	Median	Ave Rank	Z
1967	3	398.00	326.2	2.12
1968	4	2047.50	343.3	2.76
1969	6	1281.50	336.5	3.24
1970	3	918.00	255.0	1.00
1972	1	36.00	179.0	-0.11
1973	1	1874.00	361.0	1.54
1974	6	156.00	225.8	0.77
1975	12	264.00	277.5	2.74
1976	16	74.00	233.7	1.56
1977	26	138.50	264.7	3.50
1978	25	70.00	218.2	1.25
1979	28	45.00	167.6	-1.19
1980	29	32.00	158.5	-1.68
1981	15	27.00	154.0	-1.34
1982	13	30.00	198.5	0.23
1983	4	38.00	162.8	-0.52
1984	4	12.00	108.8	-1.51
1985	5	11.00	100.0	-1.87
1986	4	27.50	160.5	-0.56
1987	4	26.00	133.0	-1.07
1988	5	11.00	107.7	-1.71
1989	4	18.00	132.5	-1.07
1990	4	60.50	201.8	0.19
1991	3	30.00	168.5	-0.36
1992	4	23.50	159.6	-0.58
1993	4	1964.00	211.4	0.36
1994	4	16.50	123.0	-1.25
1995	4	13.00	95.0	-1.76
1996	4	125.00	240.4	0.89
1997	4	17.50	157.9	-0.61
1998	6	35.50	182.6	-0.20
1999	23	44.00	207.4	0.71
2000	22	41.00	188.3	-0.14
2001	19	36.00	186.3	-0.21
2002	16	25.50	145.1	-1.72
2003	29	28.00	159.9	-1.60
2004	18	32.50	163.5	-1.10
Overall	382		191.5	

H = 79.23 DF = 36 P = 0.000

H = 79.24 DF = 36 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: SSC versus Year

394 cases were used  
3047 cases contained missing values

Kruskal-Wallis Test on SSC

Year	N	Median	Ave Rank	Z
1956	11	1310.00	319.0	3.59
1957	10	2550.00	336.1	3.90
1958	14	1815.00	276.4	2.64
1959	8	56.00	134.7	-1.58
1960	15	217.00	218.3	0.72
1974	2	341.00	256.0	0.73
1975	12	395.50	273.5	2.35
1976	10	636.50	297.3	2.81
1977	13	386.00	271.4	2.38
1978	9	410.00	256.5	1.57
1979	12	373.00	258.1	1.87
1980	12	193.00	212.8	0.47
1981	10	223.50	243.5	1.29
1982	6	208.00	202.1	0.10
1983	24	75.00	134.5	-2.80
1984	33	127.00	194.8	-0.14
1985	29	158.00	139.0	-2.88
1986	32	556.50	211.2	0.71
1987	31	115.00	183.8	-0.70
1988	44	110.50	158.0	-2.44
1989	6	110.00	181.7	-0.34
1990	6	82.50	122.8	-1.62
1991	6	73.00	129.2	-1.48
1992	6	69.00	131.8	-1.43
1993	5	74.00	182.1	-0.30
1994	4	382.00	204.5	0.12
2002	24	57.00	108.8	-3.94
Overall	394		197.5	

H = 106.44 DF = 26 P = 0.000  
H = 106.44 DF = 26 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: Turbidity versus Year

118 cases were used  
3323 cases contained missing values

Kruskal-Wallis Test on Turbidity

Year	N	Median	Ave Rank	Z
1978	7	2.900	51.6	-0.63

1979	8	23.000	59.6	0.01
1980	14	4.950	48.6	-1.26
1981	18	79.000	78.7	2.59
1982	4	14.500	55.8	-0.22
1983	7	11.000	51.4	-0.65
1984	5	6.800	40.8	-1.25
1985	5	8.500	41.2	-1.22
1986	7	33.000	66.6	0.57
1987	5	17.000	67.2	0.51
1988	6	4.700	40.7	-1.38
1989	6	15.500	63.0	0.26
1990	6	19.500	57.7	-0.13
1991	5	26.000	70.7	0.75
1992	6	15.500	68.3	0.64
1993	5	4.700	58.8	-0.05
1994	4	47.350	66.3	0.40
Overall	118		59.5	

H = 14.38 DF = 16 P = 0.571

H = 14.38 DF = 16 P = 0.570 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: SC versus Year

2937 cases were used

504 cases contained missing values

Kruskal-Wallis Test on SC

Year	N	Median	Ave Rank	Z
1954	9	2530	2164.2	2.46
1955	34	2440	1907.3	3.03
1956	30	2470	1926.4	2.97
1957	46	2615	2125.1	5.29
1958	35	2360	1841.3	2.61
1959	13	2530	2182.8	3.04
1960	17	2190	1601.9	0.65
1961	10	2725	2096.0	2.34
1962	10	2010	1248.7	-0.82
1965	7	2020	1614.4	0.45
1966	28	1685	906.2	-3.53
1967	25	1460	689.4	-4.62
1968	42	1760	1077.1	-3.02
1969	69	1875	1180.4	-2.86
1970	65	1820	1250.6	-2.10
1971	43	1700	977.1	-3.83
1972	41	1820	1324.9	-1.10
1973	45	1740	928.3	-4.31
1974	34	1865	1333.4	-0.94
1975	50	1960	1379.7	-0.75
1976	57	1950	1452.1	-0.15
1977	71	1900	1386.9	-0.83

1978	89	1805	1278.9	-2.15
1979	94	1965	1513.8	0.52
1980	87	2350	1851.3	4.27
1981	73	2100	1511.9	0.44
1982	62	2200	1672.1	1.91
1983	53	1900	1444.0	-0.22
1984	71	2130	1542.0	0.73
1985	90	2140	1682.4	2.42
1986	70	1940	1423.9	-0.45
1987	151	2320	1759.1	4.32
1988	332	2000	1625.4	3.57
1989	61	2290	1740.3	2.52
1990	57	1990	1453.4	-0.14
1991	53	2003	1553.0	0.73
1992	60	2150	1660.7	1.77
1993	67	1520	922.1	-5.34
1994	126	2105	1534.0	0.88
1995	65	1960	1484.2	0.15
1996	64	1855	1093.6	-3.58
1997	52	1775	1121.0	-2.99
1998	54	1655	1069.4	-3.50
1999	58	1730	1071.4	-3.61
2000	53	1910	1332.5	-1.18
2001	57	1840	1212.2	-2.31
2002	87	2110	1719.7	2.80
2003	54	1800	1227.6	-2.11
2004	16	2085	1604.7	0.64
Overall	2937		1469.0	

H = 330.02 DF = 48 P = 0.000

H = 330.03 DF = 48 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TDS versus Year

1209 cases were used

2232 cases contained missing values

Kruskal-Wallis Test on TDS

Year	N	Median	Ave Rank	Z
1954	9	2320	934.1	2.84
1955	34	2170	813.8	3.54
1956	30	2240	820.1	3.42
1957	46	2370	899.4	5.83
1958	34	2030	771.2	2.82
1959	5	2300	880.2	1.77
1960	17	1930	689.8	1.01
1961	10	2520	891.6	2.61
1962	10	1725	532.7	-0.66
1965	7	1680	622.5	0.13
1966	28	1325	367.4	-3.64
1967	28	1130	308.1	-4.55
1968	42	1540	497.1	-2.04

1969	61	1610	501.5	-2.38
1970	60	1555	526.0	-1.80
1971	32	1250	388.9	-3.55
1972	23	1610	538.4	-0.92
1973	19	1250	309.9	-3.71
1974	9	2175	764.7	1.38
1975	24	1585	611.7	0.10
1976	27	1837	719.1	1.72
1977	41	1610	619.9	0.28
1978	44	1412	540.8	-1.24
1979	38	1585	673.6	1.23
1980	36	2250	863.5	4.51
1981	30	2229	822.6	3.46
1982	30	1747	616.7	0.19
1983	43	1460	428.3	-3.38
1984	21	1824	638.0	0.44
1985	26	1740	644.4	0.58
1986	36	1645	598.4	-0.12
1987	36	1682	593.6	-0.20
1988	39	1827	724.0	2.16
1989	22	1826	686.0	1.10
1990	18	1762	612.9	0.10
1991	16	1684	622.6	0.20
1992	18	1755	636.1	0.38
1993	17	1384	400.6	-2.43
1994	22	1472	448.8	-2.12
1995	12	1979	769.9	1.64
1996	12	1427	419.3	-1.85
1997	12	1583	462.8	-1.42
1998	12	1448	393.5	-2.11
1999	19	1270	355.2	-3.14
2003	18	1550	493.1	-1.37
2004	36	1700	600.7	-0.08
Overall	1209		605.0	

H = 246.57 DF = 45 P = 0.000

H = 246.57 DF = 45 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: Discharge versus Decade

1802 cases were used

1639 cases contained missing values

Kruskal-Wallis Test on Discharge

Decade	N	Median	Ave Rank	Z
1950	69	79.00	1028.6	2.07
1960	38	49.00	885.5	-0.19
1970	322	61.00	916.2	0.56
1980	635	61.00	883.9	-1.06
1990	553	68.00	939.3	2.05
2000	185	39.00	779.5	-3.37
Overall	1802		901.5	



H = 18.22 DF = 5 P = 0.003  
H = 18.22 DF = 5 P = 0.003 (adjusted for ties)

### **Kruskal-Wallis Test: TSS versus Decade**

382 cases were used  
3059 cases contained missing values

Kruskal-Wallis Test on TSS

Decade	N	Median	Ave Rank	Z
1960	13	1300.00	336.2	4.81
1970	118	80.50	226.8	4.17
1980	87	22.00	153.0	-3.70
1990	60	27.00	185.5	-0.46
2000	104	31.50	169.1	-2.43
Overall	382		191.5	

H = 49.38 DF = 4 P = 0.000  
H = 49.39 DF = 4 P = 0.000 (adjusted for ties)

### **Kruskal-Wallis Test: SSC versus Decade**

394 cases were used  
3047 cases contained missing values

Kruskal-Wallis Test on SSC

Decade	N	Median	Ave Rank	Z
1950	43	1580.00	274.8	4.72
1960	15	217.00	218.3	0.72
1970	58	386.00	270.7	5.30
1980	227	139.00	177.9	-3.98
1990	27	75.00	149.3	-2.28
2000	24	57.00	108.8	-3.94
Overall	394		197.5	

H = 70.41 DF = 5 P = 0.000  
H = 70.42 DF = 5 P = 0.000 (adjusted for ties)

### **Kruskal-Wallis Test: Turbidity versus Decade**

118 cases were used  
3323 cases contained missing values

Kruskal-Wallis Test on Turbidity

Decade	N	Median	Ave Rank	Z
1970	15	21.00	55.9	-0.44
1980	77	13.00	58.6	-0.38
1990	26	17.50	64.2	0.79
Overall	118		59.5	

H = 0.70 DF = 2 P = 0.705

H = 0.70 DF = 2 P = 0.705 (adjusted for ties)

### Kruskal-Wallis Test: SC versus Decade

2937 cases were used

504 cases contained missing values

Kruskal-Wallis Test on SC

Decade	N	Median	Ave Rank	Z
1950	167	2500	1992.2	8.21
1960	208	1850	1160.0	-5.45
1970	589	1820	1309.1	-5.12
1980	1050	2140	1641.5	8.23
1990	656	1920	1317.8	-5.18
2000	267	1960	1428.1	-0.83
Overall	2937		1469.0	

H = 177.06 DF = 5 P = 0.000

H = 177.07 DF = 5 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TDS versus Decade

1209 cases were used

2232 cases contained missing values

Kruskal-Wallis Test on TDS

Decade	N	Median	Ave Rank	Z
1950	158	2255	839.7	9.06
1960	203	1560	496.1	-4.87
1970	317	1530	561.7	-2.57
1980	319	1796	655.4	3.01
1990	158	1594	509.0	-3.71
2000	54	1700	564.8	-0.86
Overall	1209		605.0	

H = 115.34 DF = 5 P = 0.000

H = 115.34 DF = 5 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TSS versus Station

382 cases were used  
3059 cases contained missing values

Kruskal-Wallis Test on TSS

Station	N	Median	Ave Rank	Z
460130	7	49.00	193.7	0.05
460681	23	28.00	166.1	-1.14
460683	22	50.00	187.8	-0.16
6428500	12	55.00	186.0	-0.18
6437000	193	42.00	197.1	1.00
6438000	125	39.00	188.6	-0.36
Overall	382		191.5	

H = 1.85 DF = 5 P = 0.869  
H = 1.85 DF = 5 P = 0.869 (adjusted for ties)

### Kruskal-Wallis Test: SSC versus Station

394 cases were used  
3047 cases contained missing values

Kruskal-Wallis Test on SSC

Station	N	Median	Ave Rank	Z
6428500	2	364.0	246.8	0.61
6436000	23	152.0	189.6	-0.34
6436760	5	1730.0	228.9	0.62
6437000	161	169.0	196.9	-0.08
6438000	203	190.0	197.6	0.01
Overall	394		197.5	

H = 0.87 DF = 4 P = 0.929  
H = 0.87 DF = 4 P = 0.929 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: Turbidity versus Station

118 cases were used  
3323 cases contained missing values

Kruskal-Wallis Test on Turbidity

Station	N	Median	Ave Rank	Z
6428500	13	90.00	72.3	1.44
6438000	105	13.00	57.9	-1.44

Overall 118 59.5

H = 2.06 DF = 1 P = 0.151

H = 2.06 DF = 1 P = 0.151 (adjusted for ties)

### Kruskal-Wallis Test: SC versus Station

2937 cases were used

504 cases contained missing values

Kruskal-Wallis Test on SC

Station	N	Median	Ave Rank	Z
6428500	532	1690	956.1	-15.42
6436000	272	1890	1217.0	-5.15
6436760	248	2610	1979.3	9.90
6437000	1346	2090	1593.5	7.32
6438000	539	2070	1556.8	2.66
Overall	2937		1469.0	

H = 343.26 DF = 4 P = 0.000

H = 343.27 DF = 4 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TDS versus Station

1209 cases were used

2232 cases contained missing values

Kruskal-Wallis Test on TDS

Station	N	Median	Ave Rank	Z
460130	20	1650	518.0	-1.12
460681	89	1511	435.8	-4.75
460683	89	1856	665.1	1.69
6428500	189	1230	346.3	-11.09
6436000	8	1160	324.1	-2.28
6436760	8	1760	704.8	0.81
6437000	460	1838	687.1	6.40
6438000	346	1753	674.5	4.38
Overall	1209		605.0	

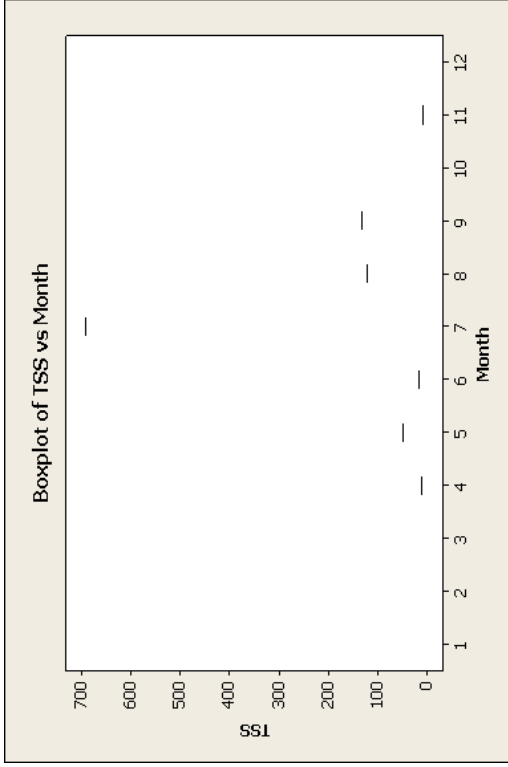
H = 173.46 DF = 7 P = 0.000

H = 173.46 DF = 7 P = 0.000 (adjusted for ties)

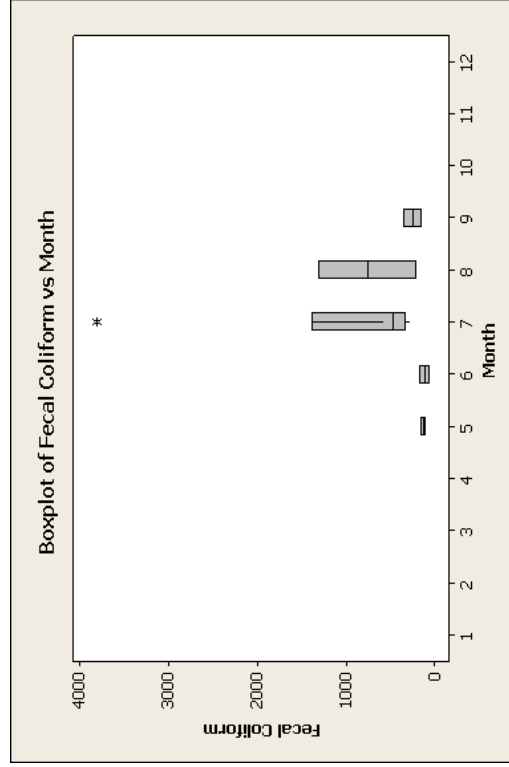
**APPENDIX B**

**HISTORICAL DATA–  
MAP AND STATISTICAL ANALYSIS OF  
FLOW AND CHEMISTRY FOR  
STORET ID 460130  
BELLE FOURCHE RIVER IN  
BELLE FOURCHE, SOUTH DAKOTA**

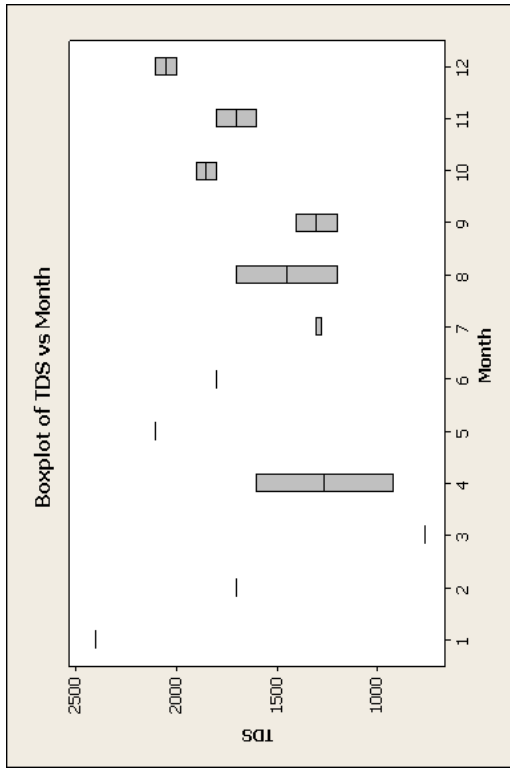
## INSUFFICIENT DATA



## INSUFFICIENT DATA



**Figure B-1.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for Storet ID 460130.



# INSUFFICIENT DATA

# INSUFFICIENT DATA

**Figure B-2.** Box Plot of TDS, SC, and Discharge Versus Month for Storet ID 460130.

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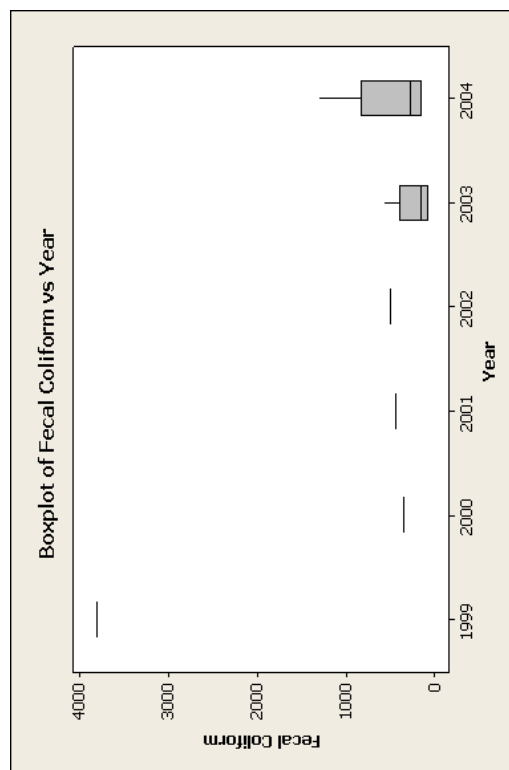
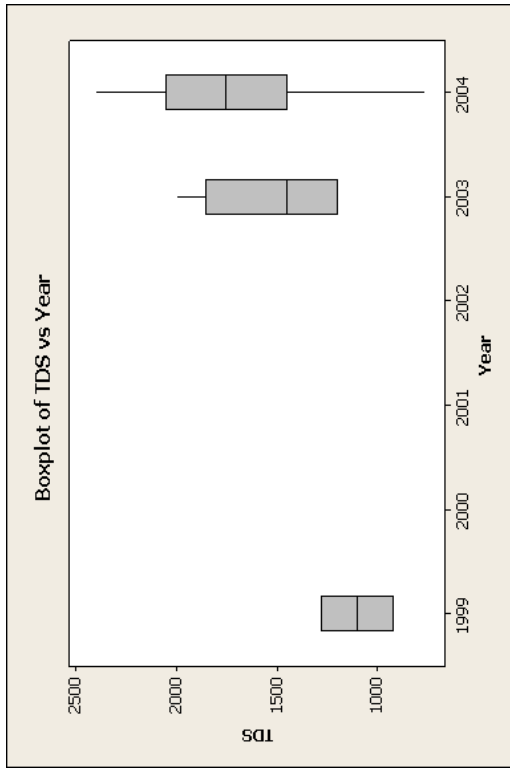


Figure B-3. Box Plot of SSC, TSS, Turbidity, and Fecal Colliform Versus Year for Storet ID 460130.





## INSUFFICIENT DATA

## INSUFFICIENT DATA

**Figure B-4.** Box Plot of TDS, SC, and Discharge Versus Year for Storet ID 460130.

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INSUFFICIENT DATA

**Figure B-5.** Fitted Line for TDS Versus SC, SSC Versus Turbidity, SSC Versus Discharge, and Turbidity Versus Discharge for Storet ID 460130.

**Minitab Project Report**  
**Chemical Analysis**  
**Belle Fourche River Watershed**  
**South Dakota Storet ID 460130**  
**by Dan Hoyer**  
**9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
Turbidity	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
SC	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
TSS	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	1	10.000	10.000	*	10.000	*	10.000

	5	1	49.000	49.000	*	49.000	*	49.000
	6	1	15.000	15.000	*	15.000	*	15.000
	7	1	690.00	690.00	*	690.00	*	690.00
	8	1	120.00	120.00	*	120.00	*	120.00
	9	1	130.00	130.00	*	130.00	*	130.00
	10	0	*	*	*	*	*	*
	11	1	8.0000	8.0000	*	8.0000	*	8.0000
	12	0	*	*	*	*	*	*
Fecal Coliform	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	2	125.0	100.0	*	125.0	*	150.0
	6	2	110.0	60.0	*	110.0	*	160.0
	7	6	987	270	323	470	1378	3800
	8	2	755	210	*	755	*	1300
	9	2	245.0	150.0	*	245.0	*	340.0
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
TDS	1	1	2400.0	2400.0	*	2400.0	*	2400.0
	2	1	1700.0	1700.0	*	1700.0	*	1700.0
	3	1	760.00	760.00	*	760.00	*	760.00
	4	2	1261	922	*	1261	*	1600
	5	1	2100.0	2100.0	*	2100.0	*	2100.0
	6	1	1800.0	1800.0	*	1800.0	*	1800.0
	7	3	1292.0	1276.0	1276.0	1300.0	1300.0	1300.0
	8	2	1450	1200	*	1450	*	1700
	9	2	1300	1200	*	1300	*	1400
	10	2	1850.0	1800.0	*	1850.0	*	1900.0
	11	2	1700	1600	*	1700	*	1800
	12	2	2050.0	2000.0	*	2050.0	*	2100.0

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
	2004	0	*	*	*	*	*	*
Turbidity	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
	2004	0	*	*	*	*	*	*
SC	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*

	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
	2004	0	*	*	*	*	*	*
TSS	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	7	146.0	8.0	10.0	49.0	130.0	690.0
	2004	0	*	*	*	*	*	*
Fecal Coliform	1999	1	3800.0	3800.0	*	3800.0	*	3800.0
	2000	1	340.00	340.00	*	340.00	*	340.00
	2001	1	440.00	440.00	*	440.00	*	440.00
	2002	1	500.00	500.00	*	500.00	*	500.00
	2003	5	218.0	60.0	80.0	150.0	390.0	570.0
	2004	5	444	150	155	270	820	1300
TDS	1999	2	1099	922	*	1099	*	1276
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	6	1517	1200	1200	1450	1850	2000
	2004	12	1713	760	1450	1750	2050	2400

### Kruskal-Wallis Test: TSS versus Month

7 cases were used  
30 cases contained missing values

Kruskal-Wallis Test on TSS

Month	N	Median	Ave Rank	Z
4	1	10.000	2.0	-1.00
5	1	49.000	4.0	0.00
6	1	15.000	3.0	-0.50
7	1	690.000	7.0	1.50
8	1	120.000	5.0	0.50
9	1	130.000	6.0	1.00
11	1	8.000	1.0	-1.50
Overall	7		4.0	

H = 6.00 DF = 6 P = 0.423

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: TDS versus Month

20 cases were used  
17 cases contained missing values

Kruskal-Wallis Test on TDS

Month	N	Median	Ave Rank	Z
1	1	2400.0	20.0	1.65
2	1	1700.0	11.5	0.17
3	1	760.0	1.0	-1.65
4	2	1261.0	5.8	-1.20
5	1	2100.0	18.5	1.39
6	1	1800.0	14.0	0.61
7	3	1300.0	6.0	-1.43
8	2	1450.0	7.5	-0.76
9	2	1300.0	5.8	-1.20
10	2	1850.0	15.0	1.13
11	2	1700.0	11.8	0.31
12	2	2050.0	17.8	1.83
Overall	20		10.5	

H = 16.44 DF = 11 P = 0.125  
H = 16.55 DF = 11 P = 0.122 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: Fecal Coliform versus Month

14 cases were used  
23 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
5	2	125.0	2.8	-1.73
6	2	110.0	3.0	-1.64
7	6	470.0	10.4	2.26
8	2	755.0	9.5	0.73
9	2	245.0	6.0	-0.55
Overall	14		7.5	

H = 8.52 DF = 4 P = 0.074  
H = 8.56 DF = 4 P = 0.073 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: TDS versus Year

20 cases were used  
17 cases contained missing values

Kruskal-Wallis Test on TDS

Year	N	Median	Ave Rank	Z
1999	2	1099	3.5	-1.76
2003	6	1450	9.0	-0.74
2004	12	1750	12.4	1.77
Overall	20		10.5	

H = 4.45 DF = 2 P = 0.108  
H = 4.48 DF = 2 P = 0.107 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: Fecal Coliform versus Month

14 cases were used  
23 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
5	2	125.0	2.8	-1.73
6	2	110.0	3.0	-1.64
7	6	470.0	10.4	2.26
8	2	755.0	9.5	0.73
9	2	245.0	6.0	-0.55
Overall	14		7.5	

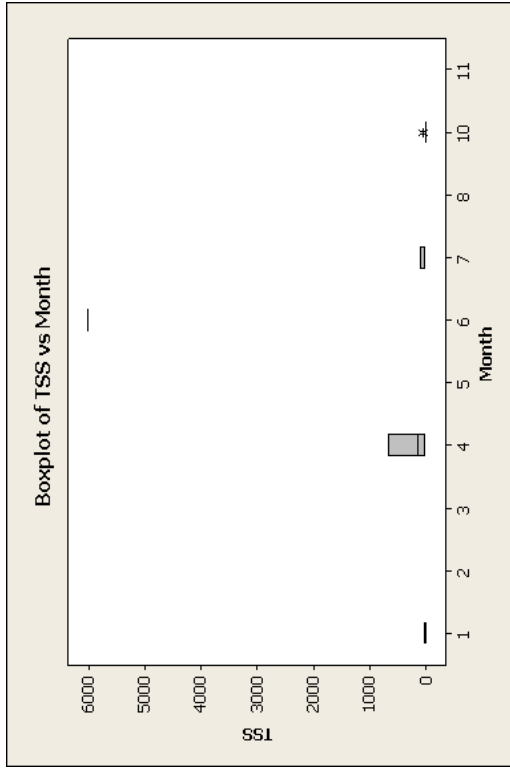
H = 8.52 DF = 4 P = 0.074  
H = 8.56 DF = 4 P = 0.073 (adjusted for ties)

**APPENDIX C**

**HISTORICAL DATA–  
MAP AND STATISTICAL ANALYSIS OF  
FLOW AND CHEMISTRY FOR  
STORET ID 461681  
BELLE FOURCHE RIVER  
NEAR VALE, SOUTH DAKOTA**



## INSUFFICIENT DATA



## INSUFFICIENT DATA

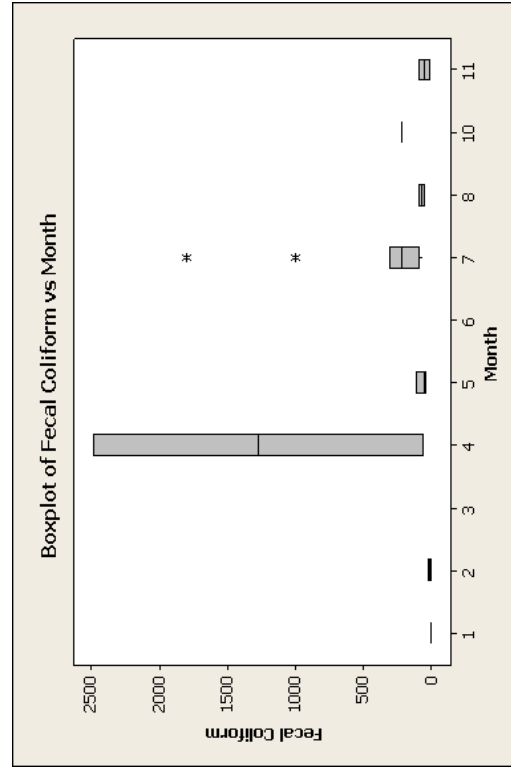
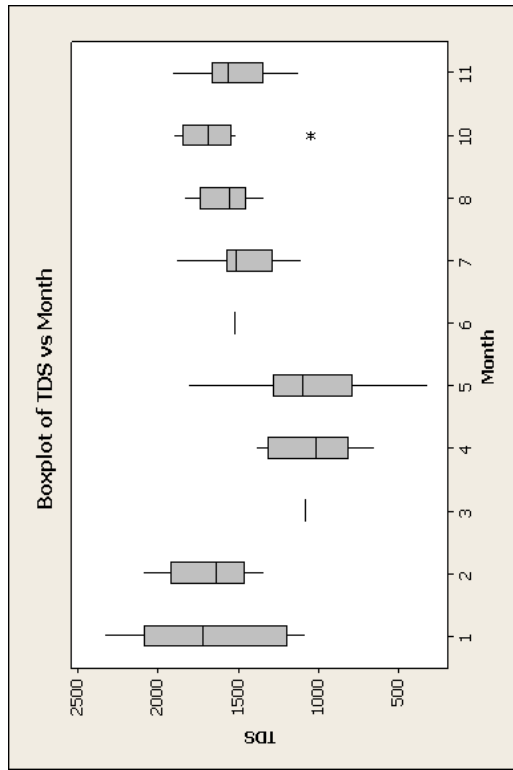


Figure C-1. Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for Storet ID 460681.



## INSUFFICIENT DATA

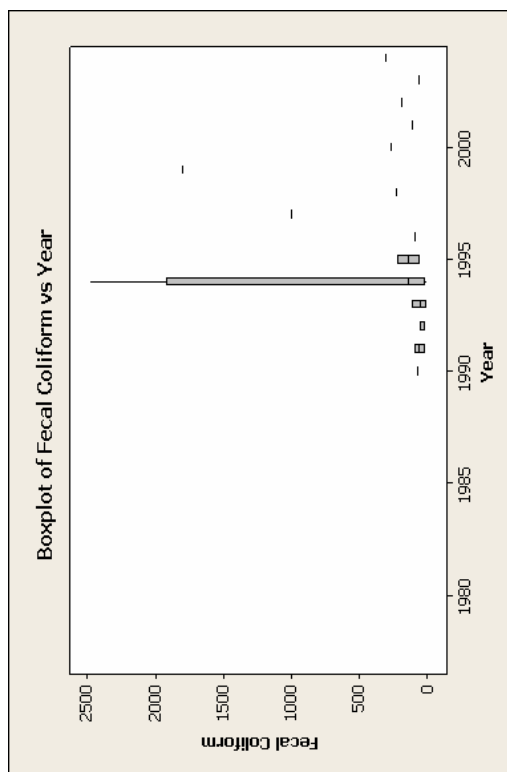
## INSUFFICIENT DATA

**Figure C-2.** Box Plot of TDS, SC, and Discharge Versus Month for Storet ID 460681.

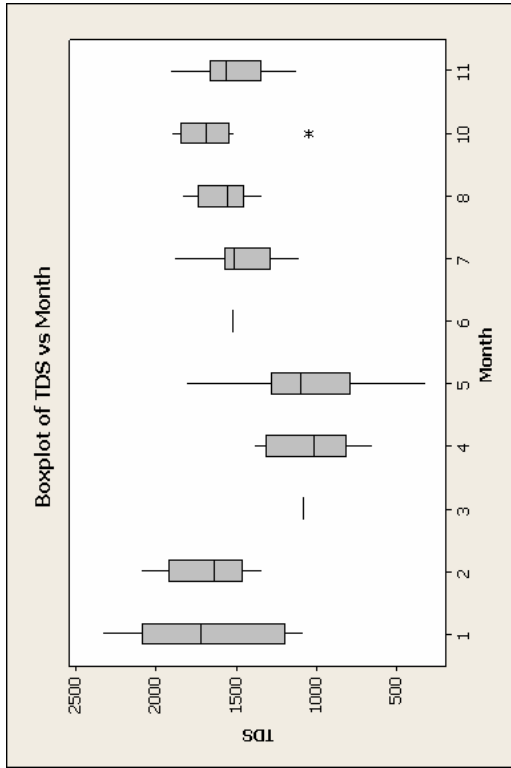
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**Figure C-3.** Box Plot of SSC, TSS, Turbidity, and Fecal Colliform Versus Year for Storet ID 460681.



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# INSUFFICIENT DATA

**Figure C-4.** Box Plot of TDS, SC, and Discharge Versus Year for Storet ID 460681.

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**Figure C-5.** Fitted Line for TDS Versus SC, SSC Versus Turbidity, SSC Versus Discharge, and Turbidity Versus Discharge for Storet ID 460681.

**Minitab Project Report  
 Chemical Analysis  
 Belle Fourche River Watershed  
 South Dakota Storet ID 460681  
 by Dan Hoyer  
 9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	Turbidity	1	0	*	*	*	*	*
2		0	*	*	*	*	*	*
3		0	*	*	*	*	*	*
4		0	*	*	*	*	*	*
5		0	*	*	*	*	*	*
6		0	*	*	*	*	*	*
7		0	*	*	*	*	*	*
8		0	*	*	*	*	*	*
10		0	*	*	*	*	*	*
11		0	*	*	*	*	*	*
SC		1	0	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	TSS	1	4	18.25	6.00	7.00	11.50	36.25
2		0	*	*	*	*	*	*
3		0	*	*	*	*	*	*
4		6	278	16	27	133	670	692
5		0	*	*	*	*	*	*
6		1	6005.0	6005.0	*	6005.0	*	6005.0
7		5	58.2	24.0	26.0	36.0	101.5	129.0
8		0	*	*	*	*	*	*
10		7	14.86	6.00	6.00	8.00	11.00	55.00
11		0	*	*	*	*	*	*

Fecal Coliform	1	1	3.0000	3.0000	*	3.0000	*	3.0000
	2	2	10.50	4.00	*	10.50	*	17.00
	3	0	*	*	*	*	*	*
	4	2	1269	58	*	1269	*	2480
	5	3	67.3	42.0	42.0	50.0	110.0	110.0
	6	0	*	*	*	*	*	*
	7	11	392	55	87	220	300	1800
	8	3	69.3	50.0	50.0	70.0	88.0	88.0
	10	1	220.00	220.00	*	220.00	*	220.00
	11	4	51.3	12.0	14.0	46.5	93.3	100.0
	TDS	1	9	1695	1076	1195	1717	2085
2		13	1686.8	1337.0	1458.5	1631.0	1918.0	2090.0
3		1	1074.0	1074.0	*	1074.0	*	1074.0
4		8	1039.4	648.0	814.5	1010.5	1309.8	1389.0
5		13	1049	310	784	1091	1274	1812
6		1	1519.0	1519.0	*	1519.0	*	1519.0
7		9	1461.6	1100.0	1282.0	1511.0	1566.5	1887.0
8		13	1584.5	1332.0	1453.5	1554.0	1738.5	1834.0
10		9	1640.6	1045.0	1541.0	1683.0	1844.0	1900.0
11		13	1518.8	1121.0	1342.5	1558.0	1663.0	1910.0

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*	
1998	0	*	*	*	*	*	*	
1999	0	*	*	*	*	*	*	
2000	0	*	*	*	*	*	*	
2001	0	*	*	*	*	*	*	
2002	0	*	*	*	*	*	*	
2003	0	*	*	*	*	*	*	
2004	0	*	*	*	*	*	*	

Turbidity	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
	2004	0	*	*	*	*	*	*

SC	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*



	2003	0	*	*	*	*	*	*
	2004	0	*	*	*	*	*	*
TSS	1977	1	6005.0	6005.0	*	6005.0	*	6005.0
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	1	55.000	55.000	*	55.000	*	55.000
	1999	4	219	11	19	87	551	692
	2000	4	190	10	11	44	515	662
	2001	4	69.5	6.0	6.0	21.0	181.5	230.0
	2002	3	22.33	8.00	8.00	24.00	35.00	35.00
	2003	4	15.00	6.00	7.00	13.00	25.00	28.00
	2004	2	19.0	8.0	*	19.0	*	30.0
Fecal Coliform	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	1	73.000	73.000	*	73.000	*	73.000
	1991	4	57.3	17.0	23.3	56.0	92.5	100.0
	1992	3	40.0	20.0	20.0	50.0	50.0	50.0
	1993	4	53.5	4.0	6.0	50.0	104.5	110.0
	1994	4	690	3	16	138	1915	2480
	1995	2	139.0	58.0	*	139.0	*	220.0
	1996	1	87.000	87.000	*	87.000	*	87.000
	1997	1	1000.0	1000.0	*	1000.0	*	1000.0
	1998	1	230.00	230.00	*	230.00	*	230.00
	1999	1	1800.0	1800.0	*	1800.0	*	1800.0
	2000	1	260.00	260.00	*	260.00	*	260.00

	2001	1	110.00	110.00	*	110.00	*	110.00
	2002	1	190.00	190.00	*	190.00	*	190.00
	2003	1	60.000	60.000	*	60.000	*	60.000
	2004	1	300.00	300.00	*	300.00	*	300.00
TDS	1977	2	1601.0	1519.0	*	1601.0	*	1683.0
	1978	4	1476	1074	1122	1387	1920	2057
	1979	3	1692	1313	1313	1652	2112	2112
	1980	2	1921	1778	*	1921	*	2064
	1981	3	1769	1544	1544	1674	2090	2090
	1982	3	1317	1091	1091	1186	1674	1674
	1983	3	1319	571	571	1442	1944	1944
	1984	4	1291	672	837	1445	1591	1602
	1985	4	1715.5	1554.0	1588.5	1748.0	1810.0	1812.0
	1986	4	1498	960	1088	1561	1845	1910
	1987	4	1538	1158	1241	1550	1822	1892
	1988	4	1450	1104	1162	1447	1741	1802
	1989	4	1260	310	599	1548	1634	1635
	1990	4	1455	1121	1188	1432	1744	1834
	1991	4	1471	1128	1221	1541	1650	1673
	1992	4	1411	997	1109	1475	1651	1699
	1993	4	1210	896	958	1265	1408	1416
	1994	4	1444	807	987	1551	1795	1869
	1995	4	1757	1389	1420	1652	2199	2334
	1996	4	1475	1001	1030	1503	1893	1895
	1997	4	1345	837	946	1438	1652	1667
	1998	4	1308	1020	1026	1247	1650	1717
	1999	3	1078	648	648	1076	1511	1511
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	2	1400	1100	*	1400	*	1700
	2004	4	1550	1300	1300	1500	1850	1900

## Kruskal-Wallis Test: TSS versus Month

23 cases were used

83 cases contained missing values

Kruskal-Wallis Test on TSS

Month	N	Median	Ave Rank	Z
1	4	11.500	8.4	-1.18
4	6	132.500	16.7	1.96
6	1	6005.000	23.0	1.66
7	5	36.000	15.0	1.12
10	7	8.000	6.4	-2.64
Overall	23		12.0	

H = 12.44 DF = 4 P = 0.014

H = 12.47 DF = 4 P = 0.014 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: TDS versus Month

89 cases were used  
17 cases contained missing values

Kruskal-Wallis Test on TDS

Month	N	Median	Ave Rank	Z
1	9	1717	59.7	1.80
2	13	1631	59.9	2.25
3	1	1074	13.0	-1.25
4	8	1011	15.2	-3.42
5	13	1091	20.2	-3.74
6	1	1519	47.0	0.08
7	9	1511	41.9	-0.37
8	13	1554	52.4	1.12
10	9	1683	60.3	1.87
11	13	1558	49.4	0.67
Overall	89		45.0	

H = 36.13 DF = 9 P = 0.000  
H = 36.13 DF = 9 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: Fecal Coliform versus Month

27 cases were used  
79 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
1	1	3.000	1.0	-1.67
2	2	10.500	3.0	-2.04
4	2	1269.000	18.5	0.83
5	3	50.000	10.3	-0.85
7	11	220.000	19.2	2.81
8	3	70.000	11.5	-0.58
10	1	220.000	20.5	0.83
11	4	46.500	9.3	-1.30
Overall	27		14.0	

H = 14.90 DF = 7 P = 0.037  
H = 14.91 DF = 7 P = 0.037 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: TDS versus Year

89 cases were used  
 17 cases contained missing values

Kruskal-Wallis Test on TDS

Year	N	Median	Ave Rank	Z
1977	2	1601	56.5	0.64
1978	4	1387	41.5	-0.28
1979	3	1652	59.0	0.95
1980	2	1921	79.0	1.88
1981	3	1674	66.8	1.49
1982	3	1186	34.2	-0.74
1983	3	1442	40.3	-0.32
1984	4	1445	35.0	-0.79
1985	4	1748	67.0	1.74
1986	4	1561	47.5	0.20
1987	4	1550	50.0	0.40
1988	4	1447	43.0	-0.16
1989	4	1548	39.0	-0.48
1990	4	1432	42.3	-0.22
1991	4	1541	44.8	-0.02
1992	4	1475	39.0	-0.48
1993	4	1265	23.3	-1.72
1994	4	1551	46.0	0.08
1995	4	1652	59.9	1.18
1996	4	1503	47.0	0.16
1997	4	1438	37.3	-0.61
1998	4	1247	32.8	-0.97
1999	3	1076	20.8	-1.65
2003	2	1400	42.8	-0.12
2004	4	1500	51.1	0.49
Overall	89		45.0	

H = 20.08 DF = 24 P = 0.692  
 H = 20.09 DF = 24 P = 0.692 (adjusted for ties)

\* NOTE \* One or more small samples

**Kruskal-Wallis Test: Fecal Coliform versus Month**

27 cases were used  
 79 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
1	1	3.000	1.0	-1.67
2	2	10.500	3.0	-2.04
4	2	1269.000	18.5	0.83
5	3	50.000	10.3	-0.85
7	11	220.000	19.2	2.81
8	3	70.000	11.5	-0.58

10	1	220.000	20.5	0.83
11	4	46.500	9.3	-1.30
Overall	27		14.0	

H = 14.90 DF = 7 P = 0.037

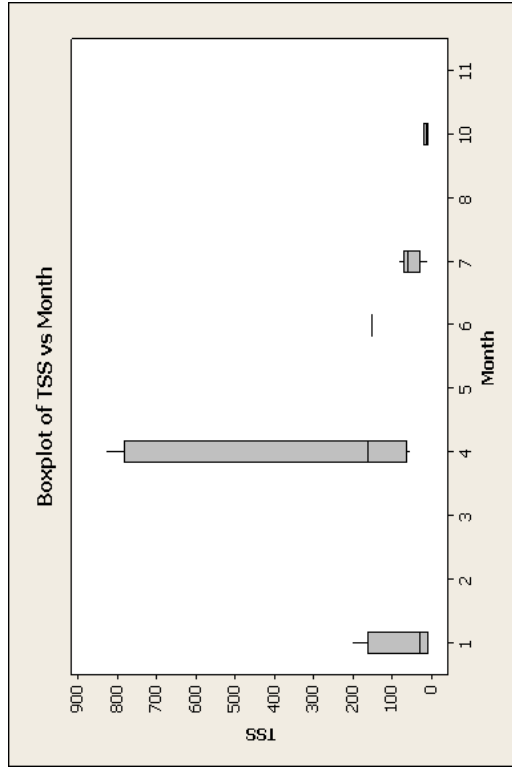
H = 14.91 DF = 7 P = 0.037 (adjusted for ties)

\* NOTE \* One or more small samples

**APPENDIX D**

**HISTORICAL DATA–  
MAP AND STATISTICAL ANALYSIS OF  
FLOW AND CHEMISTRY FOR  
STORET ID 461683  
BELLE FOURCHE RIVER  
NEAR VALE, SOUTH DAKOTA**

## INSUFFICIENT DATA



## INSUFFICIENT DATA

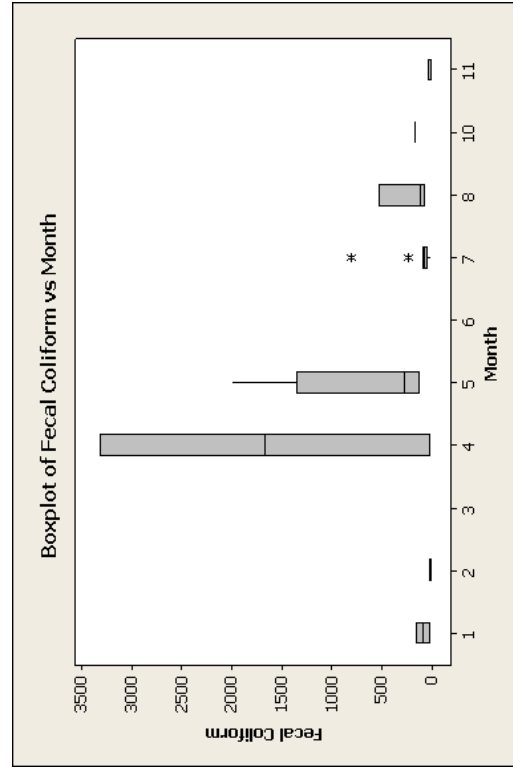
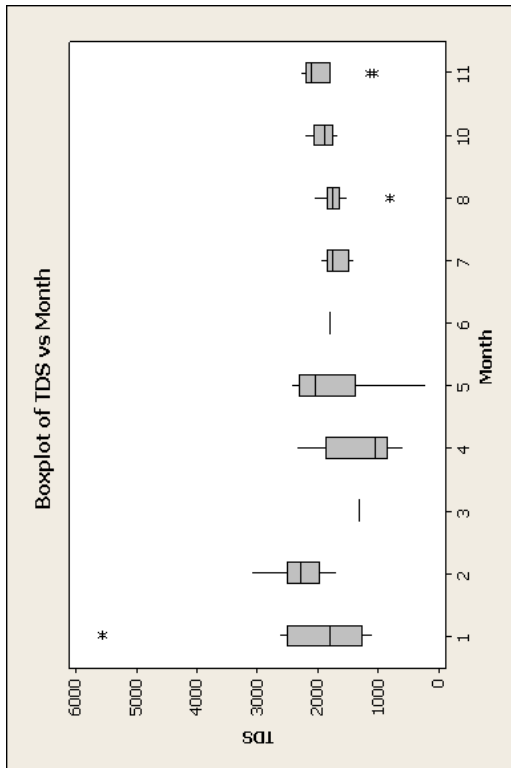


Figure D-1. Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for Storet ID 460683.

# INSUFFICIENT DATA



# INSUFFICIENT DATA

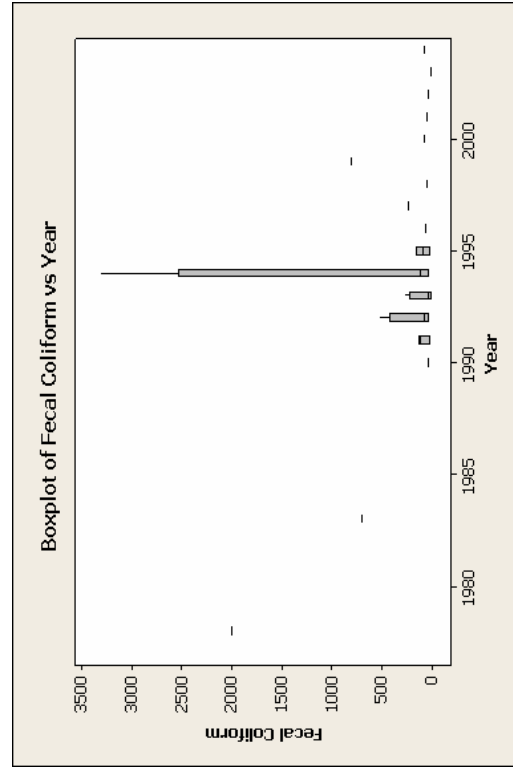
**Figure D-2.** Box Plot of TDS, SC, and Discharge Versus Month for SD WQM Site 460683.



INSUFFICIENT DATA

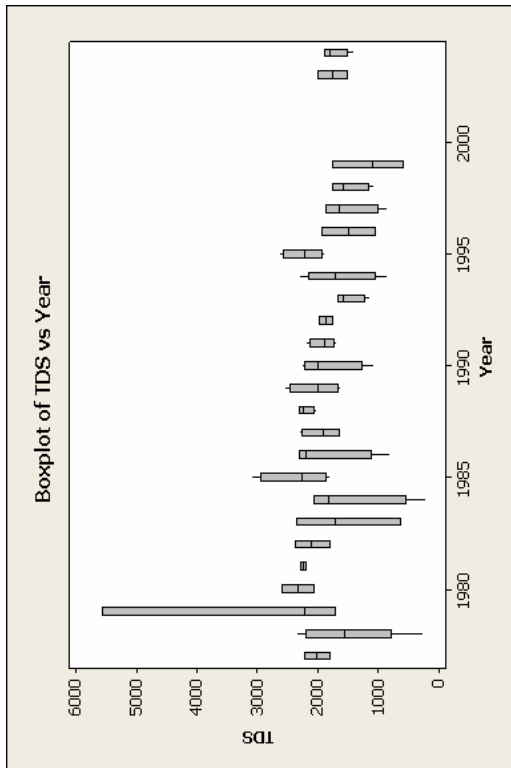
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INSUFFICIENT DATA



**Figure D-3.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Year for Storet ID 460683.

# INSUFFICIENT DATA



# INSUFFICIENT DATA

**Figure D-4.** Box Plot of TDS, SC, and Discharge Versus Year for Storet ID 460683.

INSUFFICIENT DATA

INSUFFICIENT DATA

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INSUFFICIENT DATA

**Figure D-5.** Fitted Line for TDS Versus SC, SSC Versus Turbidity, SSC Versus Discharge, and Turbidity Versus Discharge for Storet ID 460683.

**Minitab Project Report**  
**Chemical Analysis**  
**Belle Fourche River Watershed**  
**South Dakota Storet ID 460683**  
**by Dan Hoyer**  
**9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	Turbidity	1	0	*	*	*	*	*
2		0	*	*	*	*	*	*
3		0	*	*	*	*	*	*
4		0	*	*	*	*	*	*
5		0	*	*	*	*	*	*
6		0	*	*	*	*	*	*
7		0	*	*	*	*	*	*
8		0	*	*	*	*	*	*
10		0	*	*	*	*	*	*
11		0	*	*	*	*	*	*
SC		1	0	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	TSS	1	4	66.3	7.0	8.8	29.0	161.0
2		0	*	*	*	*	*	*
3		0	*	*	*	*	*	*
4		6	338	50	61	160	782	828
5		0	*	*	*	*	*	*
6		1	150.00	150.00	*	150.00	*	150.00
7		5	50.4	6.0	28.0	57.0	69.5	81.0
8		0	*	*	*	*	*	*
10		6	13.50	7.00	8.50	12.50	19.00	22.00
11		0	*	*	*	*	*	*

Fecal Coliform	1	2	85.0	20.0	*	85.0	*	150.0
	2	2	16.00	8.00	*	16.00	*	24.00
	3	0	*	*	*	*	*	*
	4	2	1667	18	*	1667	*	3315
	5	5	642	110	120	270	1350	2000
	6	0	*	*	*	*	*	*
	7	11	138.9	12.0	46.0	70.0	82.0	800.0
	8	3	233	68	68	110	520	520
	10	1	160.00	160.00	*	160.00	*	160.00
	11	4	25.25	5.00	9.25	29.00	37.50	38.00
	TDS	1	9	2225	1080	1274	1800	2494
2		12	2266	1679	1972	2277	2494	3100
3		1	1299.0	1299.0	*	1299.0	*	1299.0
4		8	1286	584	839	1042	1849	2341
5		14	1704	198	1370	2034	2288	2422
6		1	1802.0	1802.0	*	1802.0	*	1802.0
7		9	1671.3	1400.0	1474.0	1744.0	1847.0	1954.0
8		13	1693.4	794.0	1639.0	1745.0	1833.5	2046.0
10		9	1910.6	1662.0	1739.0	1878.0	2045.5	2213.0
11		13	1936	1066	1797	2108	2194	2268

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*	
1998	0	*	*	*	*	*	*	
1999	0	*	*	*	*	*	*	
2000	0	*	*	*	*	*	*	
2001	0	*	*	*	*	*	*	
2002	0	*	*	*	*	*	*	
2003	0	*	*	*	*	*	*	
2004	0	*	*	*	*	*	*	

Turbidity	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
	2004	0	*	*	*	*	*	*

SC	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*

	2003	0	*	*	*	*	*	*
	2004	0	*	*	*	*	*	*
TSS	1977	1	150.00	150.00	*	150.00	*	150.00
	1978	1	200.00	200.00	*	200.00	*	200.00
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	1	22.000	22.000	*	22.000	*	22.000
	1999	4	206	6	7	27	586	766
	2000	4	235	14	15	50	641	828
	2001	3	101.7	15.0	15.0	50.0	240.0	240.0
	2002	2	68.5	58.0	*	68.5	*	79.0
	2003	4	34.0	7.0	7.0	32.0	63.0	65.0
	2004	2	30.0	10.0	*	30.0	*	50.0
Fecal Coliform	1977	0	*	*	*	*	*	*
	1978	1	2000.0	2000.0	*	2000.0	*	2000.0
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	1	700.00	700.00	*	700.00	*	700.00
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	1	36.000	36.000	*	36.000	*	36.000
	1991	3	87.3	22.0	22.0	110.0	130.0	130.0
	1992	4	173	24	28	74	418	520
	1993	4	87.8	5.0	5.8	38.0	219.5	270.0
	1994	4	891	20	33	115	2526	3315
	1995	3	83.3	18.0	18.0	82.0	150.0	150.0
	1996	1	65.000	65.000	*	65.000	*	65.000
	1997	1	230.00	230.00	*	230.00	*	230.00
	1998	1	47.000	47.000	*	47.000	*	47.000
	1999	1	800.00	800.00	*	800.00	*	800.00
	2000	1	70.000	70.000	*	70.000	*	70.000

	2001	1	46.000	46.000	*	46.000	*	46.000
	2002	1	30.000	30.000	*	30.000	*	30.000
	2003	1	12.000	12.000	*	12.000	*	12.000
	2004	1	76.000	76.000	*	76.000	*	76.000
TDS	1977	2	2008	1802	*	2008	*	2213
	1978	5	1491	247	773	1550	2181	2351
	1979	3	3151	1695	1695	2208	5549	5549
	1980	2	2313	2046	*	2313	*	2580
	1981	2	2229.0	2180.0	*	2229.0	*	2278.0
	1982	3	2094	1802	1802	2108	2372	2372
	1983	3	1559	621	621	1704	2352	2352
	1984	4	1471	198	547	1805	2062	2078
	1985	4	2344	1788	1858	2244	2931	3100
	1986	4	1869	794	1119	2182	2306	2318
	1987	4	1938	1632	1645	1911	2257	2296
	1988	4	2200.8	2002.0	2058.3	2242.0	2302.0	2317.0
	1989	4	2034	1620	1668	1988	2447	2541
	1990	4	1822	1066	1264	1986	2217	2250
	1991	4	1913	1687	1723	1883	2133	2198
	1992	4	1854.5	1745.0	1750.0	1850.5	1963.0	1972.0
	1993	4	1486	1129	1222	1568	1668	1679
	1994	4	1638	850	1053	1707	2155	2289
	1995	4	2234	1877	1928	2211	2562	2636
	1996	4	1484	1024	1038	1479	1935	1954
	1997	4	1494	835	989	1634	1859	1873
	1998	4	1489	1060	1157	1563	1746	1769
	1999	3	1141	584	584	1096	1744	1744
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	2	1750	1500	*	1750	*	2000
	2004	4	1725	1400	1500	1800	1875	1900

### Kruskal-Wallis Test: TSS versus Month

22 cases were used

85 cases contained missing values

Kruskal-Wallis Test on TSS

Month	N	Median	Ave Rank	Z
1	4	29.00	9.4	-0.72
4	6	159.50	17.6	2.69
6	1	150.00	18.0	1.02
7	5	57.00	11.3	-0.08
10	6	12.50	5.9	-2.47
Overall	22		11.5	

H = 11.14 DF = 4 P = 0.025

H = 11.15 DF = 4 P = 0.025 (adjusted for ties)

\* NOTE \* One or more small samples



### Kruskal-Wallis Test: TDS versus Month

89 cases were used  
18 cases contained missing values

Kruskal-Wallis Test on TDS

Month	N	Median	Ave Rank	Z
1	9	1800	49.7	0.58
2	12	2277	68.5	3.39
3	1	1299	14.0	-1.21
4	8	1042	24.0	-2.41
5	14	2034	46.5	0.24
6	1	1802	40.5	-0.18
7	9	1744	30.8	-1.74
8	13	1745	34.1	-1.64
10	9	1878	47.2	0.27
11	13	2108	53.3	1.25
Overall	89		45.0	

H = 23.47 DF = 9 P = 0.005  
H = 23.47 DF = 9 P = 0.005 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: Fecal Coliform versus Month

30 cases were used  
77 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
1	2	85.00	13.5	-0.33
2	2	16.00	4.5	-1.83
4	2	1666.50	17.0	0.25
5	5	270.00	24.3	2.45
7	11	70.00	15.0	-0.24
8	3	110.00	19.8	0.90
10	1	160.00	23.0	0.87
11	4	29.00	6.5	-2.20
Overall	30		15.5	

H = 13.95 DF = 7 P = 0.052  
H = 13.96 DF = 7 P = 0.052 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: TDS versus Year

89 cases were used  
18 cases contained missing values

Kruskal-Wallis Test on TDS

Year	N	Median	Ave Rank	Z
1977	2	2008	55.3	0.57
1978	5	1550	34.6	-0.93
1979	3	2208	62.7	1.20
1980	2	2313	72.0	1.49
1981	2	2229	71.0	1.44
1982	3	2108	62.2	1.17
1983	3	1704	39.0	-0.41
1984	4	1805	34.8	-0.81
1985	4	2244	67.0	1.74
1986	4	2182	55.0	0.79
1987	4	1911	48.3	0.26
1988	4	2242	69.3	1.92
1989	4	1988	53.8	0.69
1990	4	1986	47.8	0.22
1991	4	1883	47.9	0.23
1992	4	1851	42.9	-0.17
1993	4	1568	20.8	-1.92
1994	4	1707	35.5	-0.75
1995	4	2211	68.8	1.88
1996	4	1479	29.8	-1.21
1997	4	1634	28.0	-1.35
1998	4	1563	21.8	-1.84
1999	3	1096	15.7	-2.00
2003	2	1750	36.0	-0.50
2004	4	1800	35.3	-0.77
Overall	89		45.0	

H = 35.01 DF = 24 P = 0.068  
H = 35.01 DF = 24 P = 0.068 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: Fecal Coliform versus Month

30 cases were used  
77 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
1	2	85.00	13.5	-0.33
2	2	16.00	4.5	-1.83
4	2	1666.50	17.0	0.25

5	5	270.00	24.3	2.45
7	11	70.00	15.0	-0.24
8	3	110.00	19.8	0.90
10	1	160.00	23.0	0.87
11	4	29.00	6.5	-2.20
Overall	30		15.5	

H = 13.95 DF = 7 P = 0.052

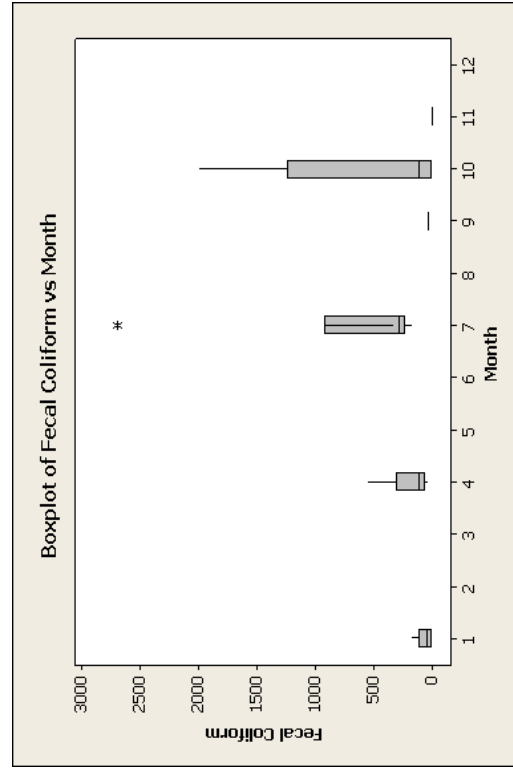
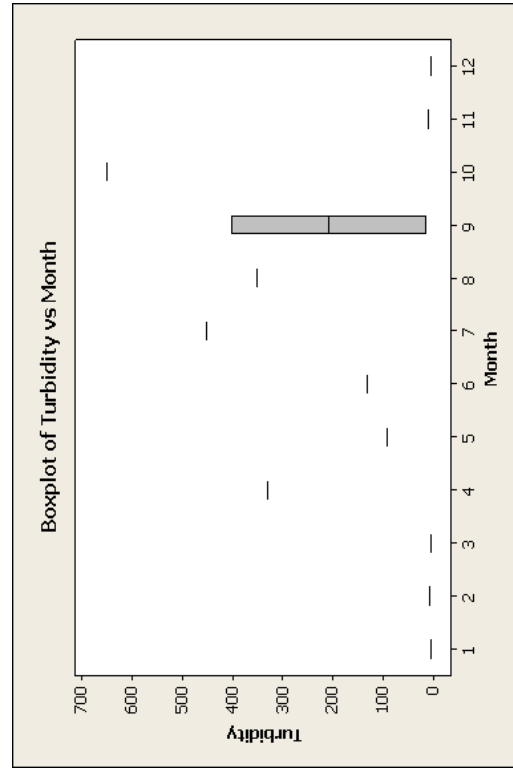
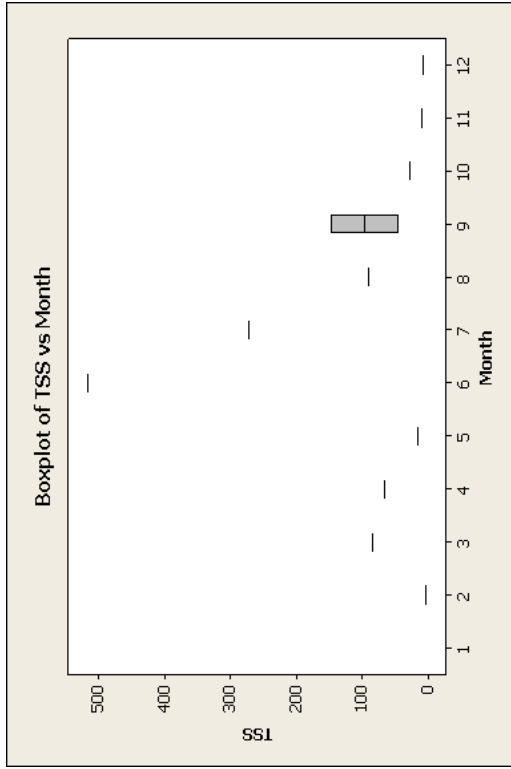
H = 13.96 DF = 7 P = 0.052 (adjusted for ties)

\* NOTE \* One or more small samples

**APPENDIX E**

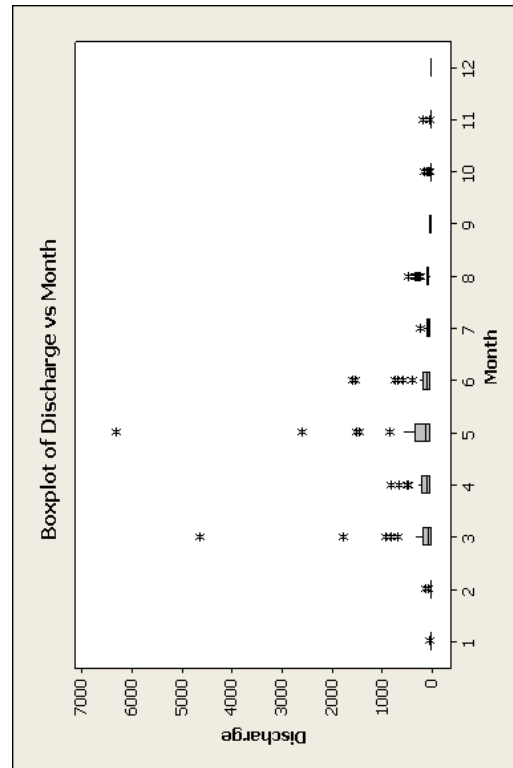
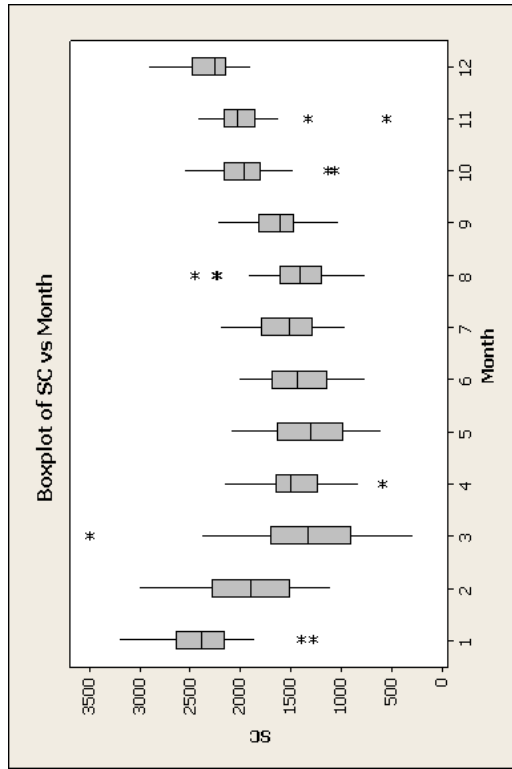
**HISTORICAL DATA-  
MAP AND STATISTICAL ANALYSIS OF  
FLOW AND CHEMISTRY FOR  
USGS SITE 6428500  
BELLE FOURCH RIVER AT THE  
SOUTH DAKOTA/WYOMING STATE LINE**

# INSUFFICIENT DATA



**Figure E-1.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for USGS Site 6428500.

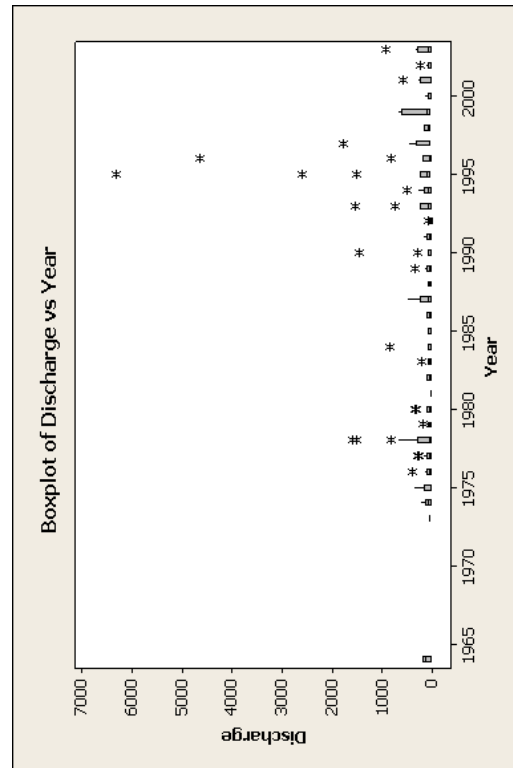
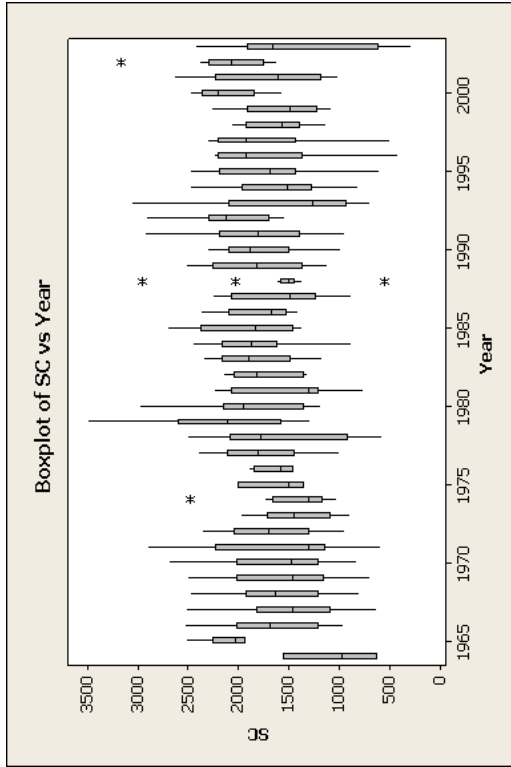
# INSUFFICIENT DATA



**Figure E-2.** Box Plot of TDS, SC, and Discharge Versus Month for USGS Site 6428500.

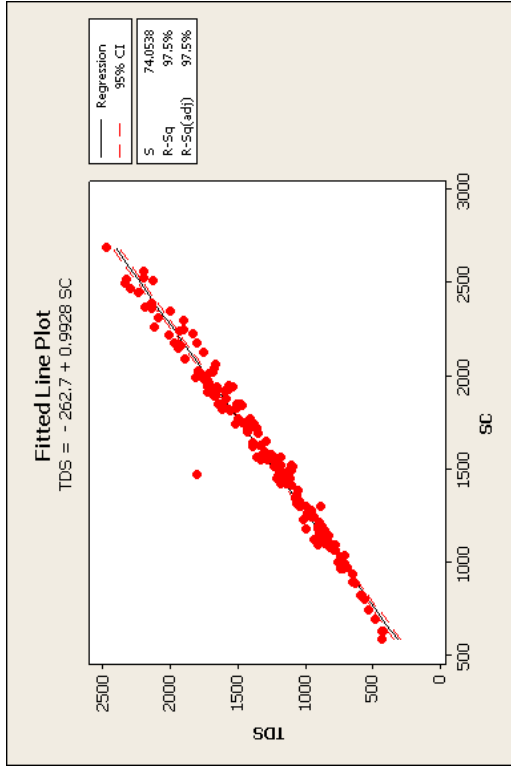


# INSUFFICIENT DATA



**Figure E-4.** Box Plot of TDS, SC, and Discharge Versus Year for USGS Site 6428500.





INSUFFICIENT DATA

INSUFFICIENT DATA

INSUFFICIENT DATA

**Figure E-5.** Fitted Line for TDS Versus SC, SSC Versus Turbidity, SSC Versus Discharge, and Turbidity Versus Discharge for USGS Site 6428500.

**Minitab Project Report  
 Chemical Analysis  
 Belle Fourche River Watershed  
 USGS Site 6428500  
 by Dan Hoyer  
 9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	30	16.58	0.30	7.20	14.00	18.00	60.00
	2	19	28.77	5.70	15.00	20.00	33.00	117.00
	3	39	304	8	22	76	183	4640
	4	36	166.5	12.0	53.3	111.5	206.8	820.0
	5	39	493	22	58	136	334	6320
	6	38	262.8	24.0	51.0	93.0	168.3	1600.0
	7	33	83.92	9.30	50.50	82.00	107.00	238.00
	8	35	115.7	9.3	68.0	82.0	113.0	474.0
	9	20	41.20	20.00	24.25	34.50	59.00	82.00
	10	34	30.46	6.30	13.75	24.00	30.50	151.00
	11	32	31.38	8.00	20.25	25.50	33.00	184.00
	12	26	18.65	2.20	13.75	19.00	23.25	35.00
Turbidity	1	1	3.0000	3.0000	*	3.0000	*	3.0000
	2	1	7.0000	7.0000	*	7.0000	*	7.0000
	3	1	4.0000	4.0000	*	4.0000	*	4.0000
	4	1	330.00	330.00	*	330.00	*	330.00
	5	1	90.0000	90.0000	*	90.0000	*	90.0000
	6	1	130.00	130.00	*	130.00	*	130.00
	7	1	450.00	450.00	*	450.00	*	450.00
	8	1	350.00	350.00	*	350.00	*	350.00
	9	2	208	15	*	208	*	400
	10	1	650.00	650.00	*	650.00	*	650.00
	11	1	9.0000	9.0000	*	9.0000	*	9.0000
	12	1	3.0000	3.0000	*	3.0000	*	3.0000
SC	1	43	2391.0	1270.0	2160.0	2390.0	2630.0	3200.0
	2	32	1939.4	1100.0	1512.5	1890.0	2275.0	3000.0
	3	57	1353.5	273.0	895.0	1320.0	1695.0	3500.0
	4	48	1468.4	582.5	1232.5	1495.0	1642.5	2160.0
	5	48	1325.4	595.0	974.5	1295.0	1630.0	2090.0
	6	45	1401.6	750.0	1140.0	1430.0	1685.0	2010.0
	7	52	1522.6	960.0	1285.0	1510.0	1792.5	2200.0
	8	42	1458.8	750.0	1190.0	1405.0	1597.5	2450.0
	9	36	1628.1	1020.0	1472.5	1600.0	1820.0	2230.0
	10	46	1941.3	1060.0	1802.5	1960.0	2155.0	2550.0
	11	47	1978.8	550.0	1850.0	2030.0	2160.0	2420.0
	12	36	2300.3	1900.0	2150.0	2255.0	2470.0	2910.0
TSS	1	0	*	*	*	*	*	*
	2	1	3.0000	3.0000	*	3.0000	*	3.0000
	3	1	84.0000	84.0000	*	84.0000	*	84.0000
	4	1	65.0000	65.0000	*	65.0000	*	65.0000

	5	1	14.000	14.000	*	14.000	*	14.000
	6	1	516.00	516.00	*	516.00	*	516.00
	7	1	272.00	272.00	*	272.00	*	272.00
	8	1	90.000	90.000	*	90.000	*	90.000
	9	2	95.5	45.0	*	95.5	*	146.0
	10	1	27.000	27.000	*	27.000	*	27.000
	11	1	9.0000	9.0000	*	9.0000	*	9.0000
	12	1	6.0000	6.0000	*	6.0000	*	6.0000
Fecal Coliform	1	5	60.2	5.0	14.0	43.0	115.0	180.0
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	6	187.0	31.0	64.8	117.5	305.0	560.0
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	6	670	170	238	280	923	2700
	8	0	*	*	*	*	*	*
	9	1	30.000	30.000	*	30.000	*	30.000
	10	5	521	6	9	110	1240	2000
	11	1	2.0000	2.0000	*	2.0000	*	2.0000
	12	0	*	*	*	*	*	*
TDS	1	14	1972.1	1050.0	1870.0	2005.0	2200.0	2470.0
	2	16	1447	908	1085	1375	1708	2240
	3	17	920.2	422.0	638.0	938.0	1185.0	1390.0
	4	17	1031.9	432.0	720.0	1110.0	1255.0	1520.0
	5	17	933.9	432.0	728.0	858.0	1165.0	1510.0
	6	14	1016.6	642.0	859.0	973.5	1207.5	1360.0
	7	18	1038.2	686.0	763.0	967.0	1315.0	1550.0
	8	13	952.3	774.0	844.0	900.0	1110.0	1180.0
	9	16	1193.0	738.0	944.5	1175.0	1410.0	1610.0
	10	14	1531.7	784.0	1457.5	1570.0	1712.5	1800.0
	11	18	1688.3	1380.0	1605.0	1675.0	1760.0	2120.0
	12	15	2006.7	1770.0	1810.0	1950.0	2140.0	2320.0
SSC	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	1	510.00	510.00	*	510.00	*	510.00
	5	0	*	*	*	*	*	*
	6	1	218.00	218.00	*	218.00	*	218.00
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1960	3	117.0	26.0	26.0	134.0	191.0	191.0
	1965	0	*	*	*	*	*	*
	1966	0	*	*	*	*	*	*

1967	0	*	*	*	*	*	*
1968	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	3	40.67	34.00	34.00	35.00	53.00	53.00
1974	12	79.5	8.0	26.8	73.5	118.0	229.0
1975	13	93.2	8.0	19.5	26.0	160.5	360.0
1976	22	72.3	12.0	21.5	50.0	93.3	399.0
1977	27	78.8	14.0	20.0	36.0	110.0	294.0
1978	22	321	18	23	60	300	1600
1979	19	56.4	10.0	17.0	40.0	73.0	188.0
1980	13	86.4	4.8	15.7	42.0	102.5	343.0
1981	2	11.00	9.00	*	11.00	*	13.00
1982	6	55.3	20.0	21.5	54.0	90.0	93.0
1983	7	61.9	13.0	23.0	35.0	71.0	213.0
1984	16	91.9	13.0	21.8	31.0	72.8	840.0
1985	15	38.51	3.80	14.00	28.00	73.00	82.00
1986	12	57.8	11.0	23.3	46.0	88.3	124.0
1987	10	150.6	17.0	18.0	85.0	231.8	502.0
1988	14	55.64	2.00	14.00	59.00	83.50	112.00
1989	12	78.6	2.9	11.0	45.0	107.0	334.0
1990	12	176	8	14	34	85	1460
1991	11	57.9	0.6	12.0	38.0	104.0	171.0
1992	11	23.71	2.20	6.30	14.00	36.00	82.00
1993	14	253	0	32	86	242	1540
1994	14	119.6	16.0	20.0	77.0	150.8	509.0
1995	16	735	15	39	110	242	6320
1996	12	512	23	27	54	188	4640
1997	10	286	32	35	60	311	1780
1998	8	94.1	38.0	43.3	63.5	162.3	184.0
1999	10	242.3	28.0	40.3	96.0	598.8	688.0
2000	8	44.7	9.3	10.3	25.5	71.3	159.0
2001	9	140.0	10.0	15.0	31.0	227.5	574.0
2002	10	58.2	4.7	13.8	28.5	72.3	243.0
2003	8	195	10	22	68	280	923

Turbidity

1960	0	*	*	*	*	*	*
1965	0	*	*	*	*	*	*
1966	0	*	*	*	*	*	*
1967	0	*	*	*	*	*	*
1968	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	0	*	*	*	*	*	*
1975	0	*	*	*	*	*	*
1976	0	*	*	*	*	*	*
1977	0	*	*	*	*	*	*
1978	0	*	*	*	*	*	*
1979	0	*	*	*	*	*	*
1980	4	266	3	5	205	588	650
1981	9	153.2	3.0	5.5	90.0	340.0	450.0

1982	0	*	*	*	*	*	*
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*
1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	0	*	*	*	*	*	*
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	0	*	*	*	*	*	*
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*

SC

1960	3	1047	629	629	963	1550	1550
1965	7	2107.1	1920.0	1930.0	2020.0	2250.0	2510.0
1966	28	1677.1	960.0	1207.5	1685.0	2017.5	2530.0
1967	25	1501.6	627.0	1085.0	1460.0	1810.0	2520.0
1968	32	1612.3	801.0	1205.0	1635.0	1920.0	2470.0
1969	30	1558.8	689.0	1152.5	1460.0	2007.5	2500.0
1970	27	1580.3	818.0	1210.0	1470.0	2010.0	2690.0
1971	12	1599	583	1145	1300	2231	2900
1972	12	1675	938	1303	1693	2034	2360
1973	12	1433	894	1084	1448	1715	1970
1974	9	1464	1020	1160	1300	1650	2470
1975	3	1617	1350	1350	1500	2000	2000
1976	4	1625	1450	1463	1575	1838	1900
1977	8	1773	1000	1445	1800	2100	2400
1978	20	1602	570	918	1775	2075	2500
1979	23	2167	1280	1580	2110	2600	3500
1980	22	1898	1180	1355	1950	2148	2985
1981	19	1545	750	1200	1300	2070	2240
1982	6	1742	1310	1355	1815	2035	2140
1983	5	1834	1160	1480	1900	2155	2350
1984	12	1845	870	1613	1865	2163	2450
1985	12	1903	1370	1458	1825	2373	2700
1986	12	1788.3	1410.0	1522.5	1665.0	2087.5	2370.0
1987	10	1602	880	1235	1490	2073	2250
1988	14	1569	550	1450	1495	1580	2950
1989	12	1812	1110	1370	1810	2255	2510
1990	12	1755	985	1495	1880	2095	2300
1991	11	1800	947	1390	1800	2190	2920
1992	11	2114	1540	1700	2120	2290	2910
1993	14	1490	684	923	1255	2093	3060
1994	14	1587	806	1268	1515	1963	2480
1995	14	1708	595	1435	1685	2185	2470
1996	12	1743	409	1365	1925	2193	2240

	1997	10	1759	496	1425	1920	2200	2300
	1998	9	1607	1130	1385	1560	1915	2070
	1999	10	1560	1070	1213	1480	1903	2270
	2000	9	2108	1560	1840	2200	2355	2470
	2001	10	1712	1010	1180	1600	2225	2630
	2002	9	2093	1620	1750	2060	2290	3170
	2003	8	1422	273	614	1655	1905	2420
TSS	1960	0	*	*	*	*	*	*
	1965	0	*	*	*	*	*	*
	1966	0	*	*	*	*	*	*
	1967	0	*	*	*	*	*	*
	1968	0	*	*	*	*	*	*
	1969	0	*	*	*	*	*	*
	1970	0	*	*	*	*	*	*
	1971	0	*	*	*	*	*	*
	1972	0	*	*	*	*	*	*
	1973	0	*	*	*	*	*	*
	1974	0	*	*	*	*	*	*
	1975	0	*	*	*	*	*	*
	1976	0	*	*	*	*	*	*
	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	4	21.75	6.00	6.75	18.00	40.50	45.00
	1980	8	148.8	3.0	26.8	87.0	240.5	516.0
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
Fecal Coliform	1960	0	*	*	*	*	*	*
	1965	0	*	*	*	*	*	*
	1966	0	*	*	*	*	*	*
	1967	0	*	*	*	*	*	*
	1968	0	*	*	*	*	*	*
	1969	0	*	*	*	*	*	*
	1970	1	11.000	11.000	*	11.000	*	11.000

1971	4	600	23	36	188	1575	2000
1972	4	85.8	2.0	9.3	40.5	207.5	260.0
1973	4	277.5	110.0	127.5	220.0	485.0	560.0
1974	3	950	6	6	145	2700	2700
1975	4	236	43	55	210	443	480
1976	4	106.3	5.0	11.3	100.0	207.5	220.0
1977	0	*	*	*	*	*	*
1978	0	*	*	*	*	*	*
1979	0	*	*	*	*	*	*
1980	0	*	*	*	*	*	*
1981	0	*	*	*	*	*	*
1982	0	*	*	*	*	*	*
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*
1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	0	*	*	*	*	*	*
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	0	*	*	*	*	*	*
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*

TDS

1960	3	832	432	432	734	1330	1330
1965	7	1742.9	1540.0	1560.0	1680.0	1900.0	2130.0
1966	28	1359.1	736.0	983.0	1325.0	1647.5	2200.0
1967	25	1227	422	803	1120	1450	2320
1968	32	1357.1	560.0	919.0	1390.0	1705.0	2290.0
1969	29	1277.1	484.0	856.0	1190.0	1730.0	2330.0
1970	26	1300.5	582.0	895.0	1180.0	1695.0	2470.0
1971	11	1220	432	900	1010	1550	2200
1972	12	1408	646	1006	1485	1668	2140
1973	10	1067	642	730	992	1343	1720
1974	0	*	*	*	*	*	*
1975	0	*	*	*	*	*	*
1976	0	*	*	*	*	*	*
1977	0	*	*	*	*	*	*
1978	0	*	*	*	*	*	*
1979	0	*	*	*	*	*	*
1980	0	*	*	*	*	*	*
1981	0	*	*	*	*	*	*
1982	0	*	*	*	*	*	*
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*

1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	4	1315	1100	1100	1180	1665	1800
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	2	1095.0	1090.0	*	1095.0	*	1100.0
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*

SSC

1960	2	364	218	*	364	*	510
1965	0	*	*	*	*	*	*
1966	0	*	*	*	*	*	*
1967	0	*	*	*	*	*	*
1968	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	0	*	*	*	*	*	*
1975	0	*	*	*	*	*	*
1976	0	*	*	*	*	*	*
1977	0	*	*	*	*	*	*
1978	0	*	*	*	*	*	*
1979	0	*	*	*	*	*	*
1980	0	*	*	*	*	*	*
1981	0	*	*	*	*	*	*
1982	0	*	*	*	*	*	*
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*
1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	0	*	*	*	*	*	*
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	0	*	*	*	*	*	*
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*



2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Station	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	6428500	381	153.0	0.3	21.0	47.0	106.0	6320.0
Turbidity	6428500	13	187.8	3.0	5.5	90.0	375.0	650.0
SC	6428500	532	1698.1	273.0	1310.0	1690.0	2070.0	3500.0
TSS	6428500	12	106.4	3.0	10.3	55.0	132.0	516.0
Fecal Coliform	6428500	24	337	2	30	128	290	2700
TDS	6428500	189	1302.3	422.0	902.0	1230.0	1660.0	2470.0
SSC	6428500	2	364	218	*	364	*	510

### Kruskal-Wallis Test: Discharge versus Month

381 cases were used  
223 cases contained missing values

Kruskal-Wallis Test on Discharge

Month	N	Median	Ave Rank	Z
1	30	14.00	60.2	-6.78
2	19	20.00	105.8	-3.46
3	39	76.00	225.6	2.07
4	36	111.50	260.3	3.97
5	39	136.00	281.9	5.44
6	38	93.00	266.5	4.45
7	33	82.00	236.3	2.47
8	35	82.00	250.8	3.37
9	20	34.50	165.7	-1.05
10	34	24.00	111.7	-4.40
11	32	25.50	122.9	-3.66
12	26	19.00	78.8	-5.38
Overall	381		191.0	

H = 190.03 DF = 11 P = 0.000  
H = 190.06 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TSS versus Month

12 cases were used  
592 cases contained missing values

Kruskal-Wallis Test on TSS

Month	N	Median	Ave Rank	Z
2	1	3.000	1.0	-1.59

3	1	84.000	8.0	0.43
4	1	65.000	7.0	0.14
5	1	14.000	4.0	-0.72
6	1	516.000	12.0	1.59
7	1	272.000	11.0	1.30
8	1	90.000	9.0	0.72
9	2	95.500	8.0	0.64
10	1	27.000	5.0	-0.43
11	1	9.000	3.0	-1.01
12	1	6.000	2.0	-1.30
Overall	12		6.5	

H = 10.38 DF = 10 P = 0.407

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: SSC versus Month

2 cases were used  
602 cases contained missing values

Kruskal-Wallis Test on SSC

Month	N	Median	Ave Rank	Z
4	1	510.0	2.0	1.00
6	1	218.0	1.0	-1.00
Overall	2		1.5	

H = 1.00 DF = 1 P = 0.317

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: Turbidity versus Month

13 cases were used  
591 cases contained missing values

Kruskal-Wallis Test on Turbidity

Month	N	Median	Ave Rank	Z
1	1	3.000	1.5	-1.47
2	1	7.000	4.0	-0.80
3	1	4.000	3.0	-1.07
4	1	330.000	9.0	0.53
5	1	90.000	7.0	0.00
6	1	130.000	8.0	0.27
7	1	450.000	12.0	1.34
8	1	350.000	10.0	0.80
9	2	207.500	8.5	0.59

10	1	650.000	13.0	1.60
11	1	9.000	5.0	-0.53
12	1	3.000	1.5	-1.47
Overall	13		7.0	

H = 11.14 DF = 11 P = 0.431  
H = 11.17 DF = 11 P = 0.429 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: SC versus Month

532 cases were used  
72 cases contained missing values

Kruskal-Wallis Test on SC

Month	N	Median	Ave Rank	Z
1	43	2390	454.9	8.38
2	32	1890	333.4	2.54
3	57	1320	168.3	-5.10
4	48	1495	196.0	-3.33
5	48	1295	153.2	-5.35
6	45	1430	170.9	-4.36
7	52	1510	209.5	-2.82
8	42	1405	185.7	-3.55
9	36	1600	245.6	-0.84
10	46	1960	352.2	3.95
11	47	2030	369.3	4.80
12	36	2255	456.0	7.66
Overall	532		266.5	

H = 256.97 DF = 11 P = 0.000  
H = 256.98 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TDS versus Month

189 cases were used  
415 cases contained missing values

Kruskal-Wallis Test on TDS

Month	N	Median	Ave Rank	Z
1	14	2005.0	163.9	4.90
2	16	1375.0	113.6	1.42
3	17	938.0	52.4	-3.36
4	17	1110.0	65.6	-2.32
5	17	858.0	50.6	-3.51
6	14	973.5	61.5	-2.38
7	18	967.0	63.8	-2.54

8	13	900.0	51.3	-2.98
9	16	1175.0	84.3	-0.81
10	14	1570.0	126.6	2.25
11	18	1675.0	145.0	4.08
12	15	1950.0	171.1	5.62
Overall	189		95.0	

H = 119.18 DF = 11 P = 0.000

H = 119.19 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: Fecal Coliform versus Month

24 cases were used

580 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
1	5	43.000	7.8	-1.67
4	6	117.500	13.2	0.27
7	6	280.000	18.7	2.47
9	1	30.000	6.0	-0.94
10	5	110.000	12.6	0.04
11	1	2.000	1.0	-1.66
Overall	24		12.5	

H = 10.32 DF = 5 P = 0.067

H = 10.32 DF = 5 P = 0.067 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: Discharge versus Year

381 cases were used

223 cases contained missing values

Kruskal-Wallis Test on Discharge

Year	N	Median	Ave Rank	Z
1960	3	134.00	254.7	1.01
1973	3	35.00	177.8	-0.21
1974	12	73.50	206.9	0.51
1975	13	26.00	185.6	-0.18
1976	22	50.00	188.9	-0.09
1977	27	36.00	187.3	-0.18
1978	22	59.50	212.1	0.93
1979	19	40.00	166.6	-0.99
1980	13	42.00	176.4	-0.49
1981	2	11.00	29.5	-2.08
1982	6	54.00	186.1	-0.11

1983	7	35.00	171.4	-0.48
1984	16	31.00	169.9	-0.78
1985	15	28.00	135.8	-1.98
1986	12	46.00	187.8	-0.10
1987	10	85.00	217.2	0.76
1988	14	59.00	180.2	-0.37
1989	12	45.00	174.7	-0.52
1990	12	33.50	169.9	-0.68
1991	11	38.00	158.5	-0.99
1992	11	14.00	87.2	-3.17
1993	14	85.50	246.4	1.92
1994	14	77.00	220.8	1.03
1995	16	109.50	253.9	2.33
1996	12	54.00	226.5	1.14
1997	10	60.00	244.7	1.56
1998	8	63.50	245.3	1.41
1999	10	96.00	260.7	2.03
2000	8	25.50	131.3	-1.55
2001	9	31.00	190.5	-0.01
2002	10	28.50	150.9	-1.17
2003	8	67.50	214.1	0.60
Overall	381		191.0	

H = 47.75 DF = 31 P = 0.028

H = 47.76 DF = 31 P = 0.028 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: TSS versus Year

12 cases were used

592 cases contained missing values

Kruskal-Wallis Test on TSS

Year	N	Median	Ave Rank	Z
1979	4	18.00	4.0	-1.70
1980	8	87.00	7.8	1.70
Overall	12		6.5	

H = 2.88 DF = 1 P = 0.089

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: Turbidity versus Year

13 cases were used

591 cases contained missing values

Kruskal-Wallis Test on Turbidity

Year	N	Median	Ave Rank	Z
1980	4	204.50	7.6	0.39
1981	9	90.00	6.7	-0.39
Overall	13		7.0	

H = 0.15 DF = 1 P = 0.700  
H = 0.15 DF = 1 P = 0.699 (adjusted for ties)

\* NOTE \* One or more small samples

**Kruskal-Wallis Test: SC versus Year**

532 cases were used  
72 cases contained missing values

Kruskal-Wallis Test on SC

Year	N	Median	Ave Rank	Z
1960	3	963.0	89.7	-2.00
1965	7	2020.0	407.1	2.44
1966	28	1685.0	261.7	-0.17
1967	25	1460.0	206.4	-2.00
1968	32	1635.0	240.6	-0.98
1969	30	1460.0	226.7	-1.46
1970	27	1470.0	227.4	-1.36
1971	12	1300.0	224.7	-0.95
1972	12	1692.5	261.7	-0.11
1973	12	1447.5	183.8	-1.89
1974	9	1300.0	185.3	-1.60
1975	3	1500.0	240.3	-0.30
1976	4	1575.0	241.6	-0.32
1977	8	1800.0	294.1	0.51
1978	20	1775.0	249.7	-0.50
1979	23	2110.0	374.5	3.44
1980	22	1950.0	318.3	1.61
1981	19	1300.0	219.8	-1.35
1982	6	1815.0	283.1	0.27
1983	5	1900.0	312.1	0.67
1984	12	1865.0	318.1	1.18
1985	12	1825.0	324.4	1.32
1986	12	1665.0	296.1	0.68
1987	10	1490.0	240.7	-0.54
1988	14	1495.0	220.2	-1.14
1989	12	1810.0	303.3	0.84
1990	12	1880.0	291.5	0.57
1991	11	1800.0	289.7	0.51
1992	11	2120.0	383.4	2.55
1993	14	1255.0	201.9	-1.59
1994	14	1515.0	232.4	-0.84
1995	14	1685.0	277.2	0.26

1996	12	1925.0	302.0	0.81
1997	10	1920.0	305.5	0.81
1998	9	1560.0	238.4	-0.55
1999	10	1480.0	220.0	-0.97
2000	9	2200.0	404.6	2.72
2001	10	1600.0	266.8	0.01
2002	9	2060.0	375.5	2.15
2003	8	1655.0	221.4	-0.84
Overall	532		266.5	

H = 72.89 DF = 39 P = 0.001

H = 72.90 DF = 39 P = 0.001 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: TDS versus Year

189 cases were used

415 cases contained missing values

Kruskal-Wallis Test on TDS

Year	N	Median	Ave Rank	Z
1960	3	734.0	42.8	-1.66
1965	7	1680.0	148.6	2.64
1966	28	1325.0	103.6	0.91
1967	25	1120.0	83.8	-1.10
1968	32	1390.0	102.5	0.85
1969	29	1190.0	90.8	-0.45
1970	26	1180.0	93.9	-0.11
1971	11	1010.0	83.6	-0.71
1972	12	1485.0	108.2	0.86
1973	10	992.0	67.4	-1.64
1988	4	1180.0	100.4	0.20
1994	2	1095.0	71.0	-0.62
Overall	189		95.0	

H = 16.12 DF = 11 P = 0.137

H = 16.12 DF = 11 P = 0.137 (adjusted for ties)

\* NOTE \* One or more small samples

**APPENDIX F**

**HISTORICAL DATA–  
MAP AND STATISTICAL ANALYSIS OF  
FLOW AND CHEMISTRY FOR  
USGS SITE 6436000  
BELLE FOURCHE RIVER  
NEAR FRUITDALE, SOUTH DAKOTA**



INSUFFICIENT DATA

INSUFFICIENT DATA

INSUFFICIENT DATA

INSUFFICIENT DATA

**Figure F-1.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for USGS Site 6436000.

# INSUFFICIENT DATA

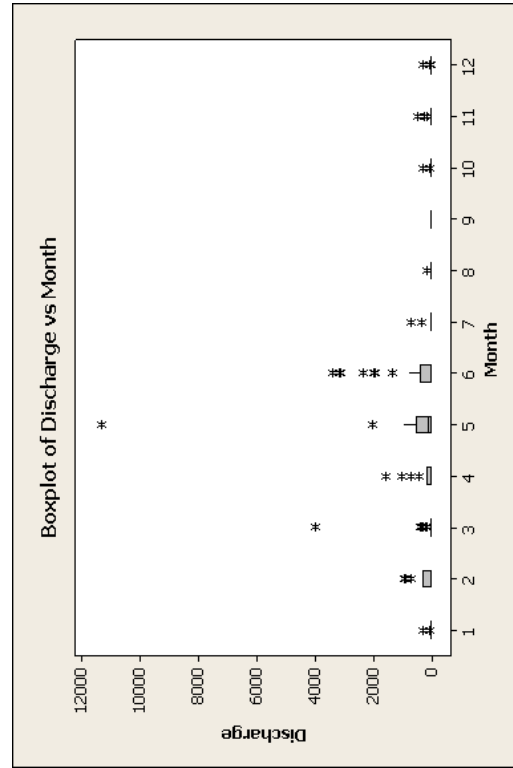
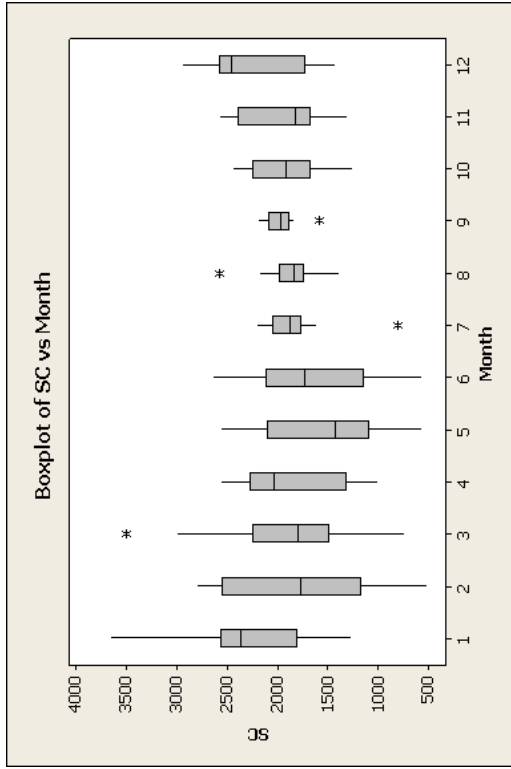


Figure F-2. Box Plot of TDS, SC, and Discharge Versus Month for USGS Site 6436000.



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**Figure F-4.** Box Plot of TDS, SC, and Discharge Versus Year for USGS Site 6436000.

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**Figure F-5.** Fitted Line for TDS Versus SC, SSC Versus Turbidity, SSC Versus Discharge, and Turbidity Versus Discharge for USGS Site 6436000.

**Minitab Project Report  
 Chemical Analysis  
 Belle Fourche River Watershed  
 USGS Site 6436000  
 by Dan Hoyer  
 9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	25	19.8	2.7	3.5	4.0	9.1	298.0
	2	18	186.3	2.6	3.4	6.4	273.0	939.0
	3	30	180	3	4	6	14	3960
	4	24	199.5	2.6	3.2	5.2	156.0	1540.0
	5	36	593	1	5	112	509	11300
	6	38	512	1	5	11	361	3390
	7	23	54.8	3.4	8.8	12.0	17.0	692.0
	8	27	17.72	4.90	7.80	13.00	17.00	142.00
	9	14	11.21	4.40	8.18	9.60	14.25	23.00
	10	27	20.4	3.8	5.2	7.4	13.0	281.0
	11	25	41.9	3.7	4.7	7.3	11.5	460.0
	12	18	23.6	3.5	4.0	5.2	8.0	258.0
Turbidity	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
SC	1	24	2251	1270	1808	2365	2568	3670
	2	16	1759	515	1168	1775	2550	2800
	3	27	1847	731	1490	1800	2250	3500
	4	22	1864	1000	1323	2030	2278	2570
	5	30	1582	569	1100	1420	2108	2570
	6	32	1659.6	567.0	1147.5	1735.0	2120.0	2640.0
	7	22	1860.9	799.0	1775.0	1870.0	2052.5	2210.0
	8	24	1861.3	1390.0	1745.0	1840.0	1982.5	2580.0
	9	14	1975.7	1580.0	1890.0	1970.0	2090.0	2200.0
	10	25	1950.8	1250.0	1675.0	1920.0	2245.0	2450.0
	11	22	1982.7	1300.0	1675.0	1825.0	2397.5	2580.0
	12	14	2241	1430	1730	2455	2578	2950
TSS	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*

	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
Fecal Coliform	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
TDS	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	1	1060.0	1060.0	*	1060.0	*	1060.0
	5	3	716.7	620.0	620.0	710.0	820.0	820.0
	6	1	1260.0	1260.0	*	1260.0	*	1260.0
	7	1	1880.0	1880.0	*	1880.0	*	1880.0
	8	1	1600.0	1600.0	*	1600.0	*	1600.0
	9	1	1940.0	1940.0	*	1940.0	*	1940.0
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
SSC	1	1	127.00	127.00	*	127.00	*	127.00
	2	1	27.000	27.000	*	27.000	*	27.000
	3	1	97.000	97.000	*	97.000	*	97.000
	4	2	176.0	93.0	*	176.0	*	259.0
	5	8	887	27	160	771	1323	2640
	6	4	1871	55	61	1360	4193	4710
	7	2	107.0	60.0	*	107.0	*	154.0
	8	1	129.00	129.00	*	129.00	*	129.00
	9	1	47.000	47.000	*	47.000	*	47.000
	10	0	*	*	*	*	*	*
	11	1	179.00	179.00	*	179.00	*	179.00
	12	1	18.000	18.000	*	18.000	*	18.000

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1975	3	4.500	4.100	4.100	4.600	4.800	4.800
	1976	12	49.0	3.1	4.5	6.3	11.2	309.0
	1977	12	5.008	3.300	3.525	5.050	6.050	7.800

1978	13	307	3	4	10	16	2000
1979	12	25.1	2.9	4.1	5.0	11.5	231.0
1980	10	4.010	1.000	3.325	3.750	5.675	6.200
1981	8	4.863	2.900	3.450	4.250	5.750	9.300
1982	11	62.9	2.6	5.0	7.3	11.0	316.0
1983	11	252	4	4	14	543	868
1984	16	482	3	4	10	305	3160
1985	12	4.933	2.100	2.925	4.100	7.475	9.800
1986	11	6.227	2.800	4.300	5.300	8.600	10.000
1987	9	142.0	3.5	4.1	7.4	273.5	697.0
1988	10	7.35	2.70	3.10	5.15	13.00	17.00
1989	10	4.110	1.200	2.875	3.850	4.925	7.800
1990	11	14.02	2.30	3.00	4.40	8.10	104.00
1991	10	6.24	1.90	4.13	5.30	8.18	13.00
1992	11	8.85	3.80	6.30	7.70	12.00	16.00
1993	13	485	8	9	46	595	3390
1994	11	126.7	5.0	7.2	12.0	79.0	962.0
1995	10	1334	3	5	12	507	11300
1996	13	623	11	14	62	899	3960
1997	9	219	15	19	28	510	776
1998	9	136.3	13.0	14.0	30.0	252.5	460.0
1999	11	558	18	24	298	803	2340
2000	10	102.8	12.0	12.8	57.5	163.3	354.0
2001	9	110.2	9.8	11.0	14.0	107.0	704.0
2002	11	10.80	3.70	8.10	10.00	14.00	19.00
2003	7	9.56	3.30	5.50	8.40	17.00	17.00

Turbidity

1975	0	*	*	*	*	*	*
1976	0	*	*	*	*	*	*
1977	0	*	*	*	*	*	*
1978	0	*	*	*	*	*	*
1979	0	*	*	*	*	*	*
1980	0	*	*	*	*	*	*
1981	0	*	*	*	*	*	*
1982	0	*	*	*	*	*	*
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*
1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	0	*	*	*	*	*	*
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	0	*	*	*	*	*	*
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*



SC	1975	0	*	*	*	*	*	*
	1976	0	*	*	*	*	*	*
	1977	2	2535.0	2520.0	*	2535.0	*	2550.0
	1978	12	2223	1050	1830	2280	2883	3000
	1979	12	2337	1360	1833	2160	2740	3670
	1980	10	2349.0	2050.0	2175.0	2275.0	2590.0	2700.0
	1981	8	1930.0	1550.0	1610.0	2010.0	2170.0	2270.0
	1982	9	2031	960	1520	2200	2485	2580
	1983	9	1974	873	1480	2200	2530	2570
	1984	12	1948	755	1670	2125	2368	2600
	1985	12	2285.0	1810.0	2032.5	2285.0	2445.0	2800.0
	1986	11	2171.8	1520.0	2020.0	2280.0	2390.0	2550.0
	1987	9	1909	1110	1185	2140	2360	2500
	1988	10	2072.0	1800.0	1890.0	2030.0	2225.0	2550.0
	1989	10	2309.0	1960.0	2105.0	2395.0	2477.5	2640.0
	1990	11	2022	835	1770	2100	2460	2550
	1991	10	1998.0	1660.0	1790.0	1970.0	2225.0	2420.0
	1992	11	1940.0	1760.0	1830.0	1840.0	2010.0	2250.0
	1993	12	1304	567	809	1405	1565	2130
	1994	11	1717	1100	1460	1700	1860	2450
	1995	11	1764	569	1460	1880	2140	2570
	1996	13	1451	515	981	1430	1915	2180
	1997	9	1495.6	1090.0	1290.0	1560.0	1650.0	1860.0
	1998	10	1536	1220	1293	1430	1728	2120
	1999	10	1358.0	1060.0	1225.0	1295.0	1617.5	1650.0
	2000	11	1460.9	1140.0	1260.0	1490.0	1760.0	1760.0
	2001	9	1530.0	1000.0	1370.0	1500.0	1745.0	1850.0
	2002	11	1877.3	1650.0	1790.0	1870.0	2020.0	2130.0
	2003	7	1565	874	1050	1780	1830	2030

TSS	1975	0	*	*	*	*	*	*
	1976	0	*	*	*	*	*	*
	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*

	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
Fecal Coliform	1975	0	*	*	*	*	*	*
	1976	0	*	*	*	*	*	*
	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
TDS	1975	0	*	*	*	*	*	*
	1976	0	*	*	*	*	*	*
	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	8	1236	620	738	1160	1810	1940
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*

	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
SSC	1975	0	*	*	*	*	*	*
	1976	0	*	*	*	*	*	*
	1977	0	*	*	*	*	*	*
	1978	0	*	*	*	*	*	*
	1979	0	*	*	*	*	*	*
	1980	0	*	*	*	*	*	*
	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	10	253.5	18.0	53.0	153.0	368.6	844.0
	1984	13	1018	27	70	127	2005	4710
	1985	0	*	*	*	*	*	*
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Station	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	6436000	305	192.6	1.0	4.4	8.5	18.5	11300.0
Turbidity	6436000	0	*	*	*	*	*	*
SC	6436000	272	1877.4	515.0	1550.0	1890.0	2240.0	3670.0
TSS	6436000	0	*	*	*	*	*	*
Fecal Coliform	6436000	0	*	*	*	*	*	*
TDS	6436000	8	1236	620	738	1160	1810	1940
SSC	6436000	23	686	18	60	152	844	4710

## Kruskal-Wallis Test: Discharge versus Month

305 cases were used

5 cases contained missing values

Kruskal-Wallis Test on Discharge

Month	N	Median	Ave Rank	Z
1	25	4.000	91.8	-3.62
2	18	6.400	141.7	-0.56
3	30	6.050	123.9	-1.90
4	24	5.200	135.9	-0.99
5	36	111.500	187.0	2.46
6	38	11.000	176.7	1.77
7	23	12.000	183.8	1.74
8	27	13.000	187.7	2.14
9	14	9.600	171.4	0.80
10	27	7.400	149.2	-0.24
11	25	7.300	143.0	-0.59
12	18	5.150	116.4	-1.82
Overall	305		153.0	

H = 35.70 DF = 11 P = 0.000

H = 35.70 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: SSC versus Month

23 cases were used

287 cases contained missing values

Kruskal-Wallis Test on SSC

Month	N	Median	Ave Rank	Z
1	1	127.00	10.0	-0.30
2	1	27.00	2.5	-1.43
3	1	97.00	9.0	-0.45
4	2	176.00	12.0	0.00
5	8	770.75	15.6	1.87
6	4	1359.50	14.1	0.69
7	2	107.00	9.5	-0.55
8	1	129.00	11.0	-0.15
9	1	47.00	4.0	-1.21
11	1	179.00	14.0	0.30
12	1	18.00	1.0	-1.66
Overall	23		12.0	

H = 9.32 DF = 10 P = 0.502

H = 9.33 DF = 10 P = 0.501 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: SC versus Month

272 cases were used  
38 cases contained missing values

Kruskal-Wallis Test on SC

Month	N	Median	Ave Rank	Z
1	24	2365	188.8	3.41
2	16	1775	124.1	-0.65
3	27	1800	126.6	-0.69
4	22	2030	137.0	0.03
5	30	1420	97.2	-2.90
6	32	1735	109.2	-2.09
7	22	1870	132.1	-0.27
8	24	1840	127.7	-0.57
9	14	1970	153.3	0.82
10	25	1920	147.6	0.74
11	22	1825	149.9	0.83
12	14	2455	190.4	2.63
Overall	272		136.5	

H = 31.46 DF = 11 P = 0.001  
H = 31.46 DF = 11 P = 0.001 (adjusted for ties)

## Kruskal-Wallis Test: TDS versus Month

8 cases were used  
302 cases contained missing values

Kruskal-Wallis Test on TDS

Month	N	Median	Ave Rank	Z
4	1	1060.0	4.0	-0.22
5	3	710.0	2.0	-2.24
6	1	1260.0	5.0	0.22
7	1	1880.0	7.0	1.09
8	1	1600.0	6.0	0.65
9	1	1940.0	8.0	1.53
Overall	8		4.5	

H = 6.67 DF = 5 P = 0.247

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: Discharge versus Year

305 cases were used

5 cases contained missing values

### Kruskal-Wallis Test on Discharge

Year	N	Median	Ave Rank	Z
1975	3	4.600	78.5	-1.47
1976	12	6.250	133.8	-0.77
1977	12	5.050	83.5	-2.79
1978	13	10.000	144.0	-0.37
1979	12	4.950	117.1	-1.44
1980	10	3.750	58.6	-3.44
1981	8	4.250	74.8	-2.54
1982	11	7.300	141.9	-0.42
1983	11	14.000	191.9	1.49
1984	16	10.300	162.6	0.45
1985	12	4.100	73.6	-3.18
1986	11	5.300	106.4	-1.79
1987	9	7.400	153.6	0.02
1988	10	5.150	104.2	-1.78
1989	10	3.850	57.7	-3.47
1990	11	4.400	91.5	-2.35
1991	10	5.300	104.3	-1.78
1992	11	7.700	147.3	-0.22
1993	13	46.000	226.7	3.08
1994	11	12.000	192.5	1.51
1995	10	12.300	177.5	0.89
1996	13	62.000	243.7	3.79
1997	9	28.000	248.8	3.31
1998	9	30.000	235.7	2.85
1999	11	298.000	266.5	4.35
2000	10	57.500	230.0	2.81
2001	9	14.000	212.9	2.07
2002	11	10.000	166.0	0.50
2003	7	8.400	145.9	-0.22
Overall	305		153.0	

H = 143.15 DF = 28 P = 0.000

H = 143.17 DF = 28 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: SSC versus Year

23 cases were used

287 cases contained missing values

Kruskal-Wallis Test on SSC

Year	N	Median	Ave Rank	Z
1983	10	153.0	11.1	-0.56
1984	13	127.0	12.7	0.56
Overall	23		12.0	

H = 0.31 DF = 1 P = 0.577  
 H = 0.31 DF = 1 P = 0.577 (adjusted for ties)

**Kruskal-Wallis Test: SC versus Year**

272 cases were used  
 38 cases contained missing values

Kruskal-Wallis Test on SC

Year	N	Median	Ave Rank	Z
1977	2	2535	246.3	1.98
1978	12	2280	181.9	2.05
1979	12	2160	184.9	2.18
1980	10	2275	218.3	3.35
1981	8	2010	142.8	0.23
1982	9	2200	167.2	1.19
1983	9	2200	157.2	0.80
1984	12	2125	156.8	0.92
1985	12	2285	204.8	3.07
1986	11	2280	187.5	2.20
1987	9	2140	148.0	0.45
1988	10	2030	167.8	1.28
1989	10	2395	211.9	3.09
1990	11	2100	163.6	1.17
1991	10	1970	155.1	0.76
1992	11	1840	144.4	0.34
1993	12	1405	55.3	-3.66
1994	11	1700	105.5	-1.33
1995	11	1880	129.3	-0.31
1996	13	1430	79.0	-2.70
1997	9	1560	67.4	-2.68
1998	10	1430	76.8	-2.45
1999	10	1295	48.9	-3.59
2000	11	1490	61.0	-3.25
2001	9	1500	72.4	-2.49
2002	11	1870	131.4	-0.22
2003	7	1780	87.9	-1.66
Overall	272		136.5	

H = 118.14 DF = 26 P = 0.000  
 H = 118.16 DF = 26 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

**APPENDIX G**

**HISTORICAL DATA–  
MAP AND STATISTICAL ANALYSIS OF  
FLOW AND CHEMISTRY FOR  
USGS SITE 6436760  
HORSE CREEK  
ABOVE VALE, SOUTH DAKOTA**



INSUFFICIENT DATA

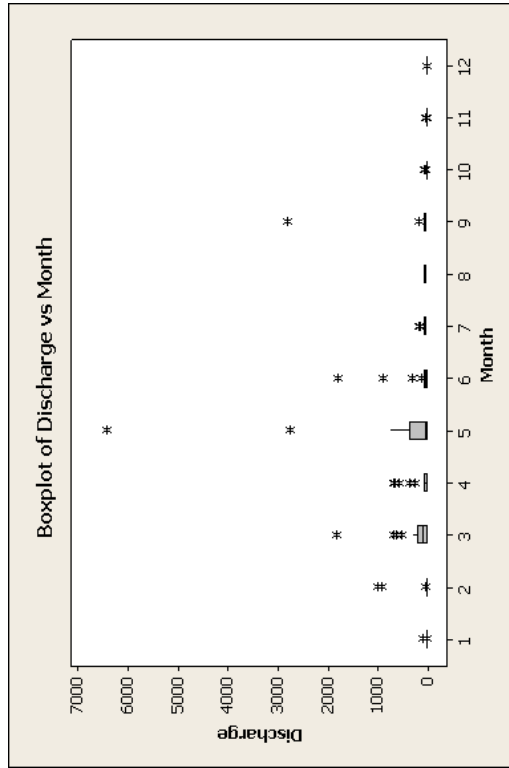
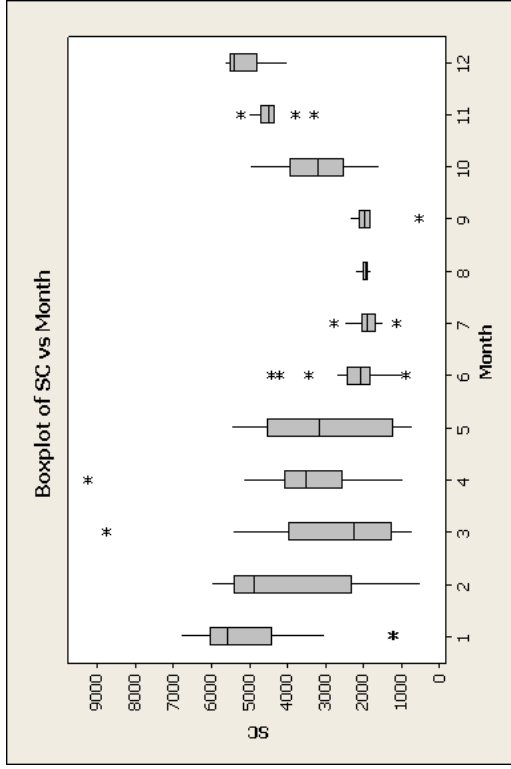
INSUFFICIENT DATA

INSUFFICIENT DATA

INSUFFICIENT DATA

**Figure G-1.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for USGS Site 6436760.

# INSUFFICIENT DATA



**Figure G-2.** Box Plot of TDS, SC, and Discharge Versus Month for USGS Site 6436760.

INSUFFICIENT DATA

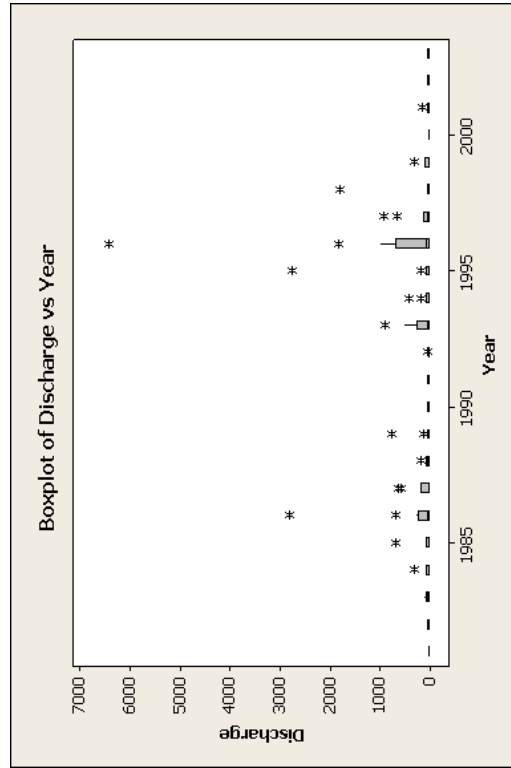
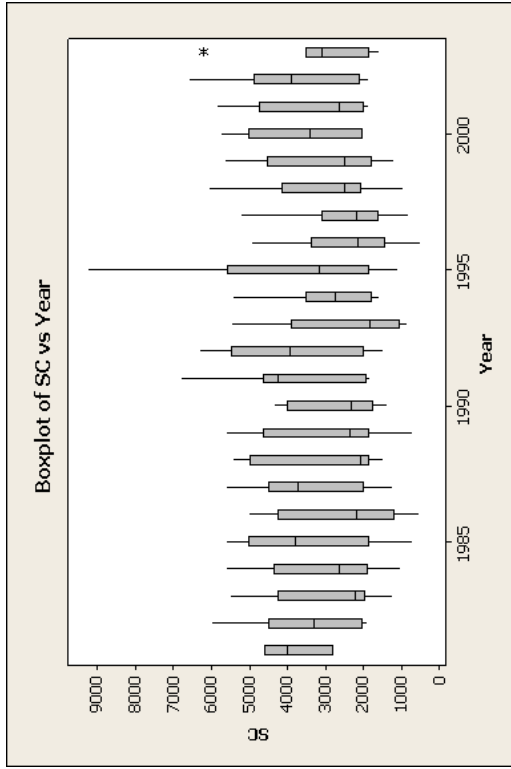
INSUFFICIENT DATA

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INSUFFICIENT DATA

**Figure G-3.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Year for USGS Site 6436760.

# INSUFFICIENT DATA



**Figure G-4.** Box Plot of TDS, SC, and Discharge Versus Year for USGS Site 6436760.



**Minitab Project Report  
 Chemical Analysis  
 Belle Fourche River Watershed  
 USGS Site 6436760  
 by Dan Hoyer  
 9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	20	7.64	0.40	1.93	2.65	4.20	93.00
	2	17	119.3	1.5	2.0	5.2	14.5	995.0
	3	32	195.7	1.8	6.8	106.0	198.0	1830.0
	4	22	119.0	0.7	2.2	7.1	73.3	667.0
	5	17	643	0	3	42	361	6420
	6	29	133.5	3.5	14.5	32.0	57.0	1790.0
	7	20	55.52	8.30	33.50	47.00	67.00	165.00
	8	19	46.37	26.00	33.00	48.00	60.00	66.00
	9	17	216	13	30	52	71	2797
	10	25	9.45	0.90	3.15	4.20	11.00	66.00
	11	22	6.02	1.30	3.05	3.35	4.10	34.00
	12	13	2.823	1.600	2.200	2.700	3.200	5.200
Turbidity	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
SC	1	20	5002	1190	4423	5555	6018	6810
	2	16	3967	500	2298	4870	5388	6000
	3	30	2703	700	1270	2255	3970	8760
	4	21	3513	950	2560	3510	4070	9250
	5	17	2990	700	1220	3140	4520	5470
	6	29	2195	874	1820	2070	2410	4400
	7	21	1898.1	1120.0	1685.0	1880.0	2015.0	2780.0
	8	19	1947.9	1790.0	1880.0	1920.0	2010.0	2200.0
	9	16	1902.8	535.0	1835.0	1955.0	2115.0	2350.0
	10	25	3244	1590	2515	3180	3920	4980
	11	21	4489.5	3290.0	4350.0	4480.0	4690.0	5230.0
	12	13	5172	4000	4815	5380	5500	5640
TSS	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*

	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
Fecal Coliform	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
TDS	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	2	3705	2610	*	3705	*	4800
	5	0	*	*	*	*	*	*
	6	1	1690.0	1690.0	*	1690.0	*	1690.0
	7	0	*	*	*	*	*	*
	8	2	1690	1550	*	1690	*	1830
	9	2	920	380	*	920	*	1460
	10	1	4400.0	4400.0	*	4400.0	*	4400.0
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
SSC	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	2	2620	1730	*	2620	*	3510
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	1	25.000	25.000	*	25.000	*	25.000
	9	1	2720.0	2720.0	*	2720.0	*	2720.0
	10	0	*	*	*	*	*	*
	11	1	55.000	55.000	*	55.000	*	55.000
	12	0	*	*	*	*	*	*

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1981	3	3.167	2.600	2.600	3.300	3.600	3.600
	1982	10	19.61	0.90	2.88	9.70	41.25	62.00
	1983	9	43.1	2.8	5.4	34.0	77.0	124.0

1984	12	51.2	3.3	4.6	13.5	66.3	310.0
1985	14	69.0	1.9	3.3	5.6	57.5	681.0
1986	16	283	3	9	48	228	2797
1987	14	125.4	2.4	4.0	20.0	174.5	615.0
1988	12	41.1	1.5	2.4	27.4	66.0	165.0
1989	11	90.7	2.1	2.5	14.0	42.0	748.0
1990	10	19.27	1.50	1.78	10.20	32.50	67.00
1991	10	10.76	0.40	1.40	3.05	29.00	33.00
1992	11	8.17	0.30	0.90	1.60	13.00	35.00
1993	13	172.2	1.3	3.2	46.0	251.5	883.0
1994	13	60.8	1.7	3.5	7.7	57.0	411.0
1995	13	241	2	4	12	54	2740
1996	13	788	4	17	76	680	6420
1997	11	171.5	3.4	4.3	41.0	117.0	928.0
1998	10	194	2	6	16	31	1790
1999	10	64.4	3.2	3.8	25.0	84.0	310.0
2000	8	14.39	2.20	2.93	5.90	26.00	49.00
2001	9	29.3	2.4	2.8	17.0	32.5	144.0
2002	14	14.34	1.80	2.00	3.20	30.75	66.00
2003	7	20.81	1.60	2.00	11.00	44.00	46.00

Turbidity	
1981	0 * * *
1982	0 * * *
1983	0 * * *
1984	0 * * *
1985	0 * * *
1986	0 * * *
1987	0 * * *
1988	0 * * *
1989	0 * * *
1990	0 * * *
1991	0 * * *
1992	0 * * *
1993	0 * * *
1994	0 * * *
1995	0 * * *
1996	0 * * *
1997	0 * * *
1998	0 * * *
1999	0 * * *
2000	0 * * *
2001	0 * * *
2002	0 * * *
2003	0 * * *

SC	
1981	3 3800 2800 2800 4000 4600 4600
1982	10 3426 1880 2028 3280 4488 6000
1983	9 2872 1220 1960 2200 4250 5500
1984	12 3022 1000 1893 2645 4350 5600
1985	14 3344 700 1870 3790 5000 5600
1986	14 2574 535 1178 2165 4250 5000
1987	11 3375 1240 2000 3700 4500 5600
1988	10 3132 1470 1840 2075 4980 5430
1989	11 3182 700 1860 2350 4630 5600
1990	10 2672 1360 1755 2295 4008 4330
1991	10 3745 1830 1940 4235 4628 6810



1992	11	3809	1480	2000	3910	5470	6300
1993	13	2429	827	1040	1820	3875	5450
1994	13	2881	1580	1785	2720	3490	5430
1995	13	4014	1080	1865	3170	5565	9250
1996	13	2440	500	1450	2140	3360	4940
1997	11	2600	815	1610	2170	3090	5230
1998	11	3032	957	2080	2480	4150	6070
1999	11	3114	1190	1780	2480	4520	5640
2000	8	3561	1980	2045	3410	5018	5740
2001	9	3300	1840	2010	2620	4715	5860
2002	14	3841	1860	2085	3905	4875	6570
2003	7	3080	1560	1850	3080	3510	6190

TSS

1981	0	*	*	*	*	*	*
1982	0	*	*	*	*	*	*
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*
1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	0	*	*	*	*	*	*
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	0	*	*	*	*	*	*
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*

Fecal Coliform

1981	0	*	*	*	*	*	*
1982	0	*	*	*	*	*	*
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*
1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	0	*	*	*	*	*	*
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	0	*	*	*	*	*	*
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*

	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
TDS	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	2	965	380	*	965	*	1550
	1987	0	*	*	*	*	*	*
	1988	4	3180	1690	1725	3115	4700	4800
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	2	2035	1460	*	2035	*	2610
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*
SSC	1981	0	*	*	*	*	*	*
	1982	0	*	*	*	*	*	*
	1983	0	*	*	*	*	*	*
	1984	0	*	*	*	*	*	*
	1985	0	*	*	*	*	*	*
	1986	3	933	25	25	55	2720	2720
	1987	2	2620	1730	*	2620	*	3510
	1988	0	*	*	*	*	*	*
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	0	*	*	*	*	*	*
	2000	0	*	*	*	*	*	*
	2001	0	*	*	*	*	*	*
	2002	0	*	*	*	*	*	*
	2003	0	*	*	*	*	*	*

## Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Station	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	6436760	253	126.2	0.3	3.3	13.0	52.5	6420.0
Turbidity	6436760	0	*	*	*	*	*	*
SC	6436760	248	3156	500	1880	2610	4400	9250
TSS	6436760	0	*	*	*	*	*	*
Fecal Coliform	6436760	0	*	*	*	*	*	*
TDS	6436760	8	2340	380	1483	1760	3953	4800
SSC	6436760	5	1608	25	40	1730	3115	3510

## Kruskal-Wallis Test: Discharge versus Month

253 cases were used

2 cases contained missing values

Kruskal-Wallis Test on Discharge

Month	N	Median	Ave Rank	Z
1	20	2.650	57.5	-4.43
2	17	5.200	91.2	-2.09
3	32	106.000	166.9	3.30
4	22	7.050	111.2	-1.06
5	17	42.000	143.3	0.95
6	29	32.000	161.8	2.72
7	20	47.000	178.3	3.27
8	19	48.000	177.6	3.13
9	17	52.000	183.0	3.27
10	25	4.200	88.4	-2.78
11	22	3.350	73.3	-3.60
12	13	2.700	49.2	-3.94
Overall	253		127.0	

H = 102.45 DF = 11 P = 0.000

H = 102.46 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: SC versus Month

248 cases were used

7 cases contained missing values

Kruskal-Wallis Test on SC

Month	N	Median	Ave Rank	Z
1	20	5555	200.2	4.92
2	16	4870	161.8	2.15
3	30	2255	98.2	-2.14
4	21	3510	137.1	0.84
5	17	3140	112.8	-0.70
6	29	2070	84.7	-3.18

7	21	1880	64.4	-4.01
8	19	1920	71.3	-3.36
9	16	1955	71.9	-3.03
10	25	3180	138.4	1.02
11	21	4480	188.7	4.29
12	13	5380	215.8	4.71
Overall	248		124.5	

H = 113.29 DF = 11 P = 0.000

H = 113.29 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: Discharge versus Year

253 cases were used

2 cases contained missing values

Kruskal-Wallis Test on Discharge

Year	N	Median	Ave Rank	Z
1981	3	3.300	62.2	-1.54
1982	10	9.700	110.6	-0.72
1983	9	34.000	148.1	0.88
1984	12	13.500	143.7	0.81
1985	14	5.550	122.3	-0.25
1986	16	48.000	172.8	2.58
1987	14	20.000	148.0	1.11
1988	12	27.400	118.9	-0.39
1989	11	14.000	123.2	-0.18
1990	10	10.200	102.1	-1.10
1991	10	3.050	69.9	-2.52
1992	11	1.600	56.7	-3.26
1993	13	46.000	155.1	1.42
1994	13	7.700	128.1	0.05
1995	13	12.000	136.9	0.50
1996	13	76.000	190.1	3.19
1997	11	41.000	157.4	1.41
1998	10	15.500	127.8	0.03
1999	10	25.000	147.0	0.88
2000	8	5.900	102.4	-0.97
2001	9	17.000	113.3	-0.57
2002	14	3.200	82.0	-2.37
2003	7	11.000	101.4	-0.94
Overall	253		127.0	

H = 51.10 DF = 22 P = 0.000

H = 51.11 DF = 22 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: SC versus Year

248 cases were used

7 cases contained missing values

Kruskal-Wallis Test on SC

Year	N	Median	Ave Rank	Z
1981	3	4000	163.2	0.94
1982	10	3280	141.8	0.78
1983	9	2200	117.0	-0.32
1984	12	2645	120.5	-0.20
1985	14	3790	132.7	0.44
1986	14	2165	95.5	-1.56
1987	11	3700	137.7	0.62
1988	10	2075	121.2	-0.15
1989	11	2350	129.3	0.23
1990	10	2295	101.1	-1.06
1991	10	4235	149.3	1.12
1992	11	3910	154.2	1.41
1993	13	1820	84.3	-2.08
1994	13	2720	110.8	-0.70
1995	13	3170	141.1	0.86
1996	13	2140	98.7	-1.33
1997	11	2170	99.9	-1.17
1998	11	2480	123.5	-0.05
1999	11	2480	122.5	-0.10
2000	8	3410	151.1	1.07
2001	9	2620	136.5	0.51
2002	14	3905	157.2	1.75
2003	7	3080	118.7	-0.22
Overall	248		124.5	

H = 21.21 DF = 22 P = 0.508

H = 21.21 DF = 22 P = 0.508 (adjusted for ties)

\* NOTE \* One or more small samples

Date	SS	Turb.	Q
5/27/2004	1,285	1,226	64.4
6/2/2004	203	140	17
7/6/2004	860	523	115
7/8/2004	320	176	56
8/6/2004	58	31	21.7
8/20/2004	80	40	51.3
9/7/2004	41	23	53
9/28/2004	96	10	7.2
11/5/2004	15	5.3	1.8

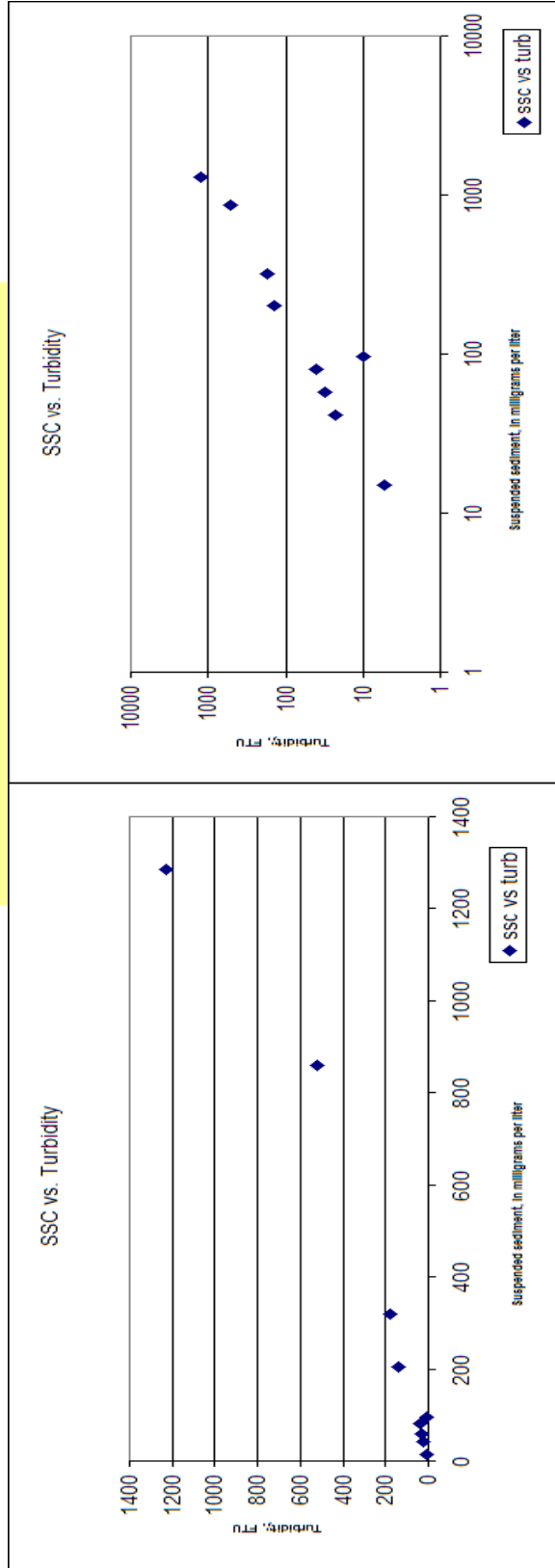
**Linear Regression**

SSC=1.0745\*Turb + 69.0892  
 P-value 0.000001  
 Multiple R-squared 0.9517

**Linear Regression of Logs**

Log(SSC)=.7599\*Log(Turb)+.761  
 P-value 0.000087  
 Multiple R-squared 0.9027

Note: Regression of logarithms provides a better fit for higher turbidity values/suspended sediment concentrations



**Figure G-6.** Horse Creek Water Quality Regression Analysis.

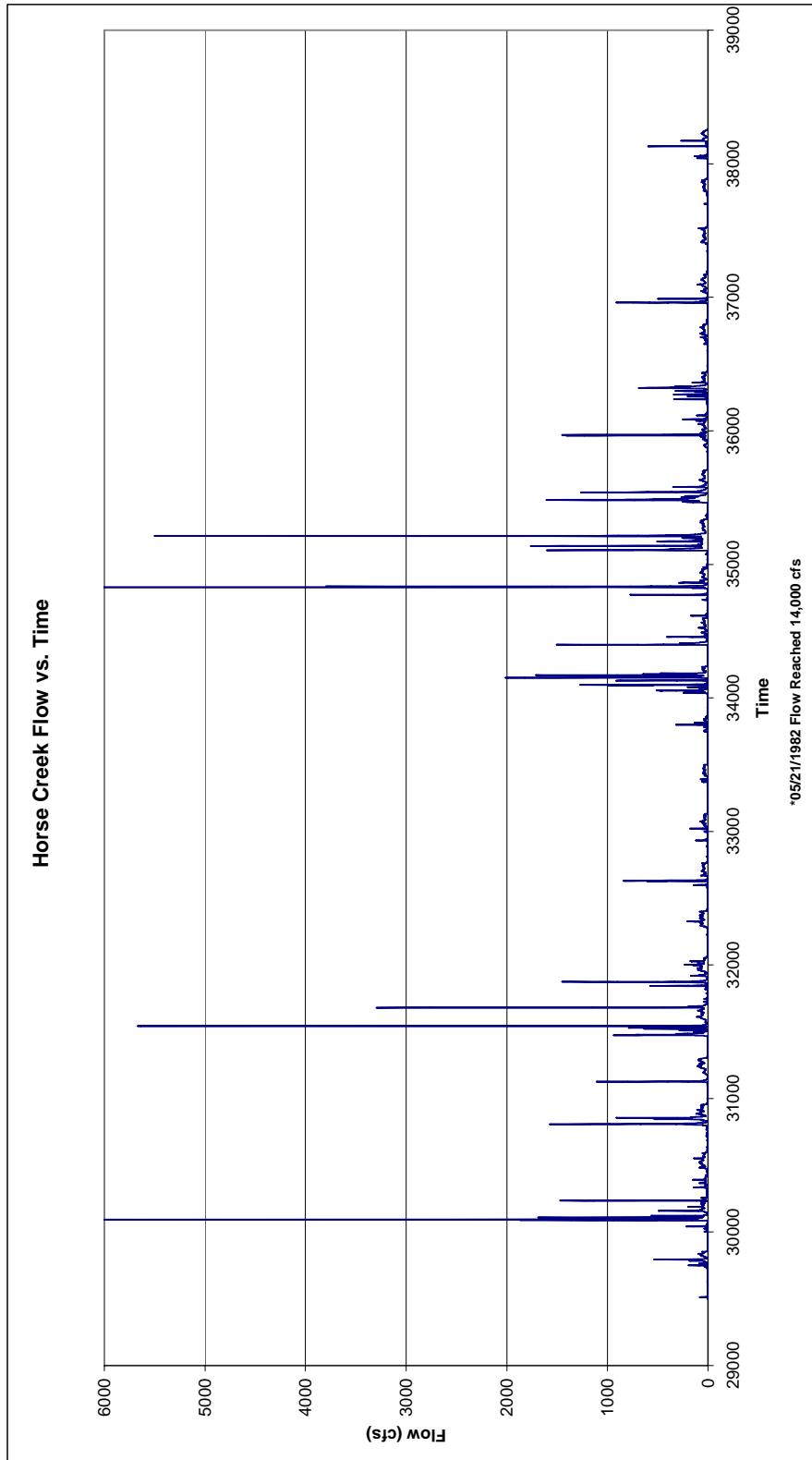


Figure G-7. Horse Creek Flow Versus Time.

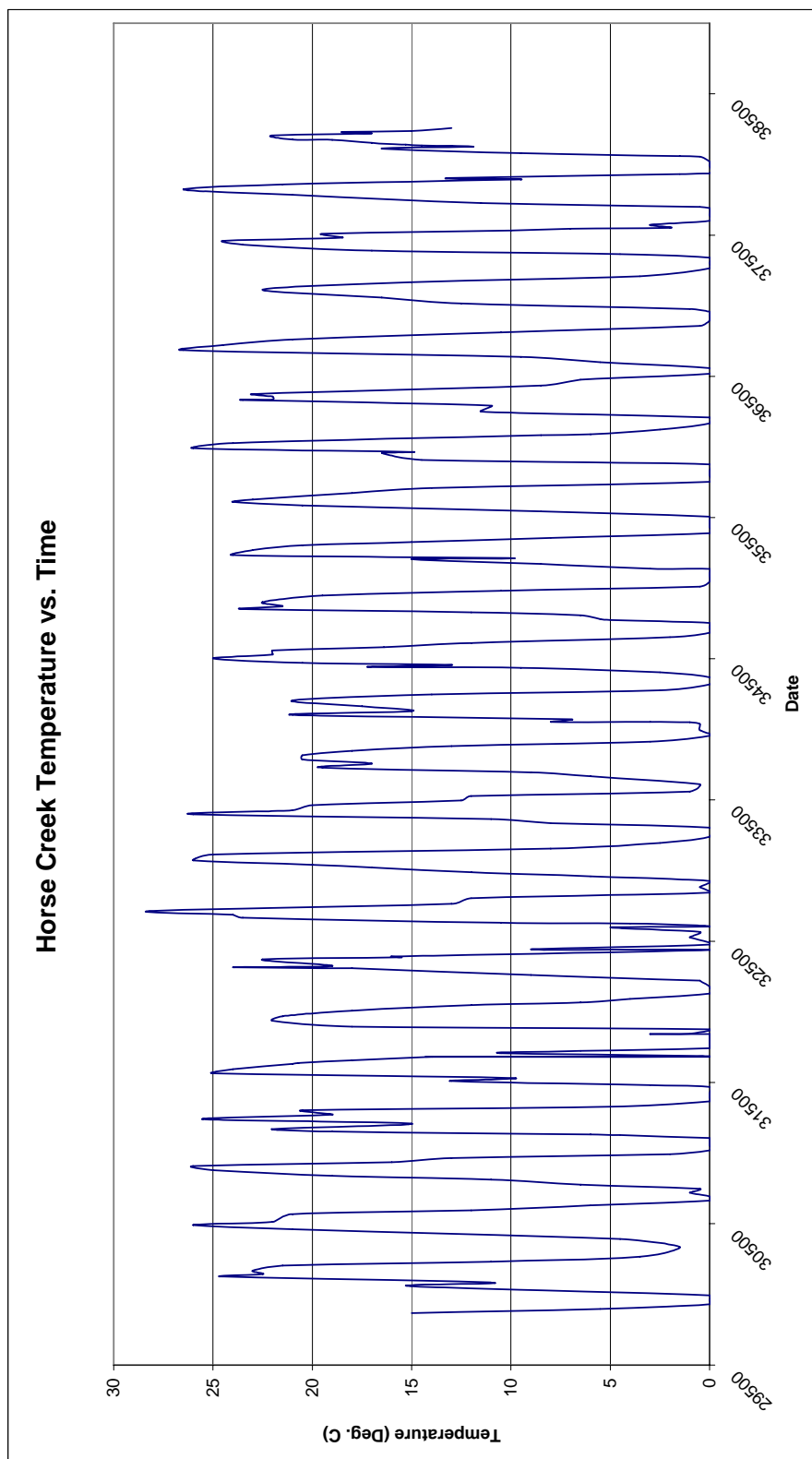
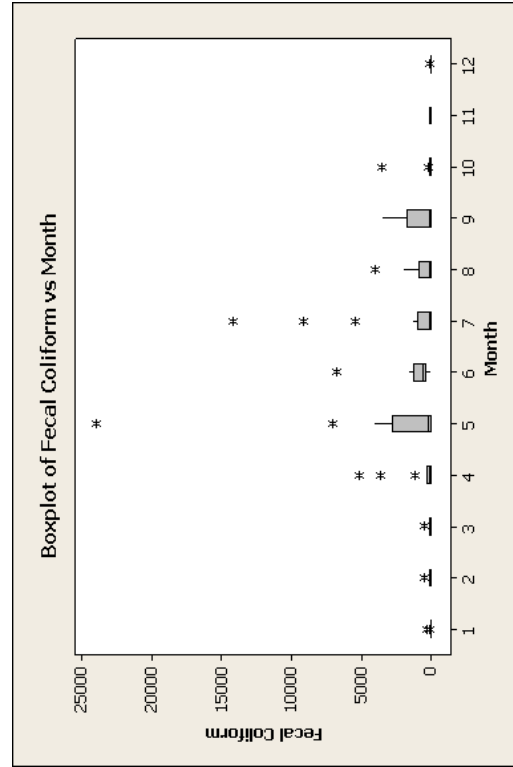
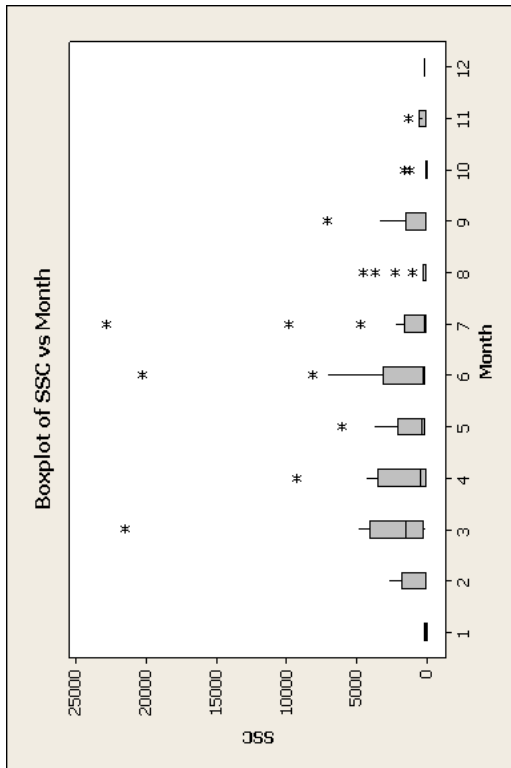
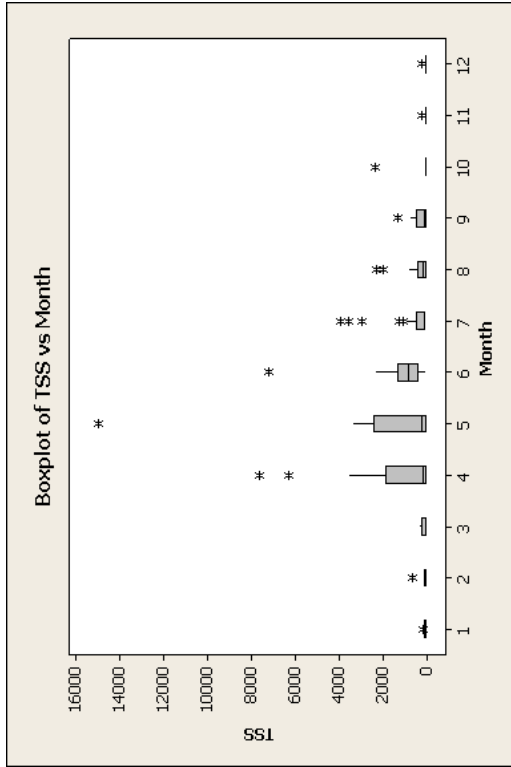


Figure G-8. Horse Creek Temperature Versus Time.



## **APPENDIX H**

### **HISTORICAL DATA– MAP AND STATISTICAL ANALYSIS OF FLOW AND CHEMISTRY FOR USGS SITE 6437000 BELLE FOURCHE RIVER NEAR STURGIS, SOUTH DAKOTA**



## INSUFFICIENT DATA

**Figure H-1.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for USGS Site 6437000.

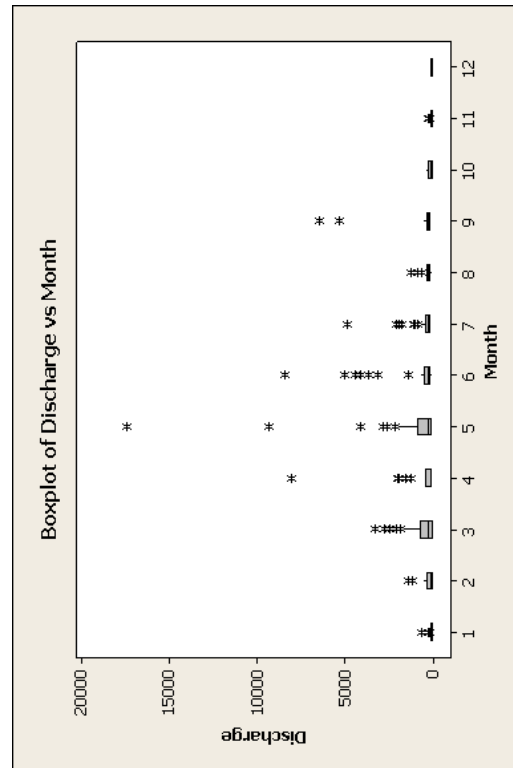
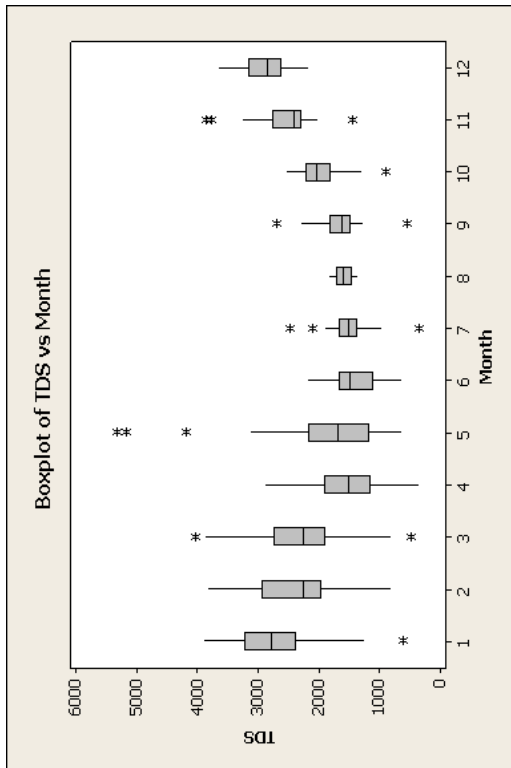
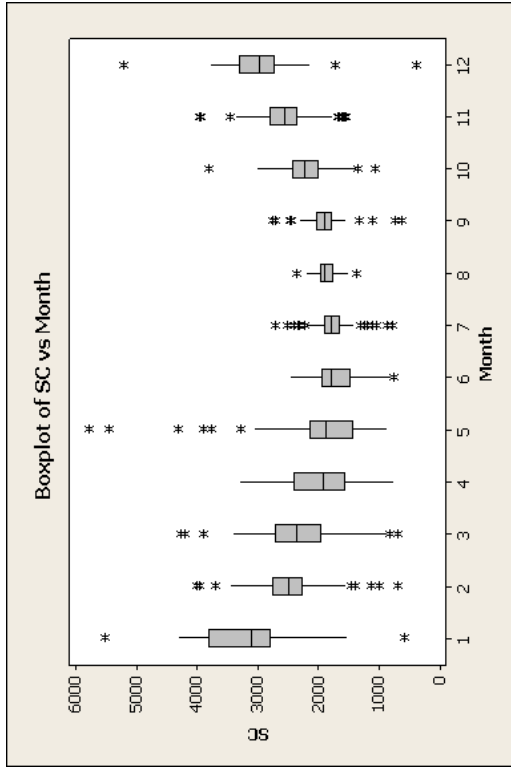
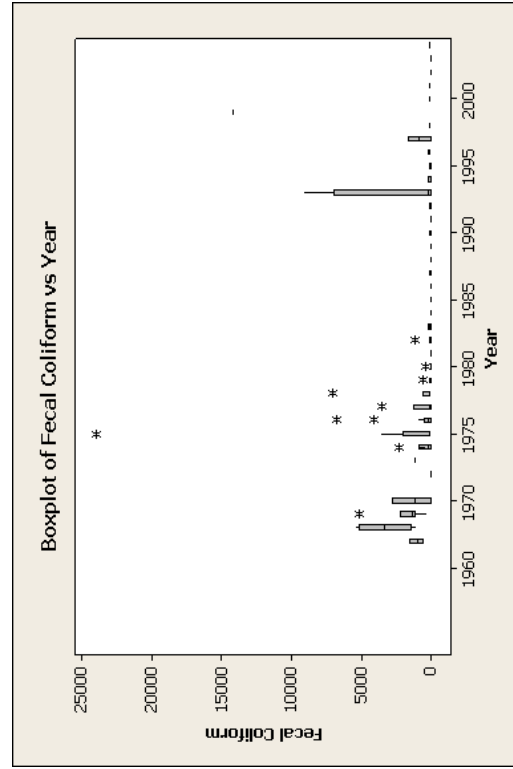
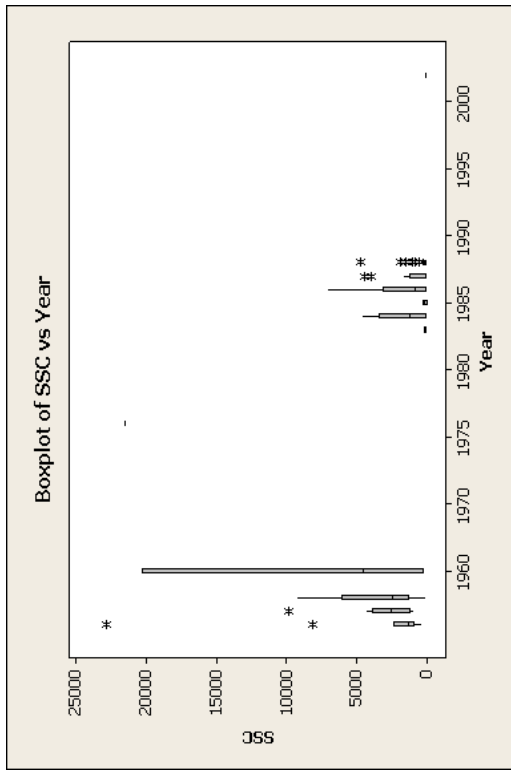
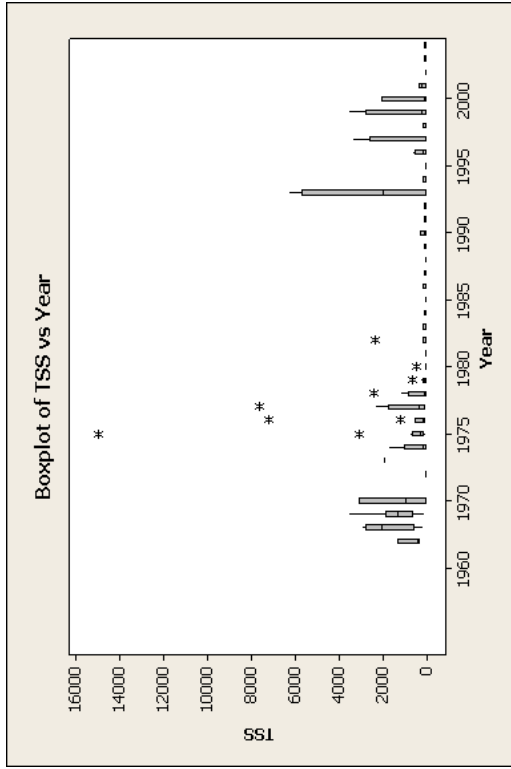
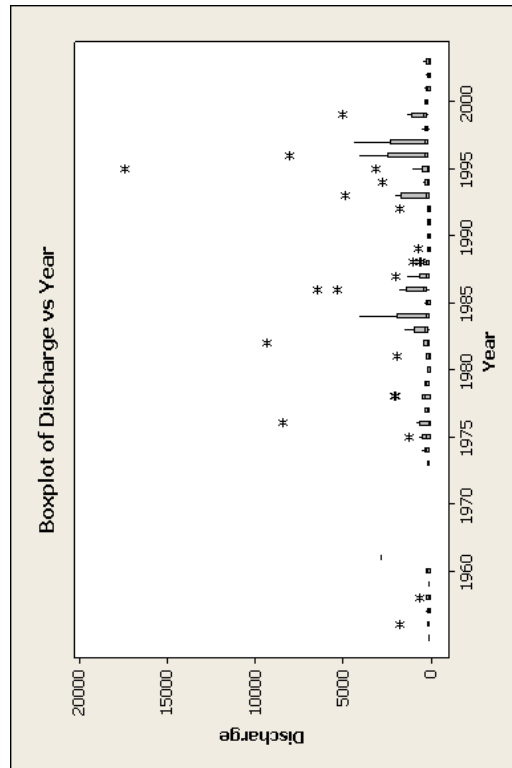
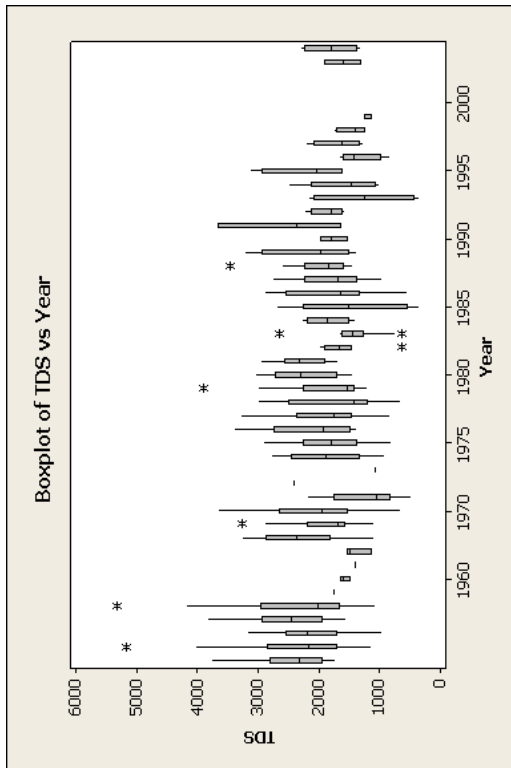
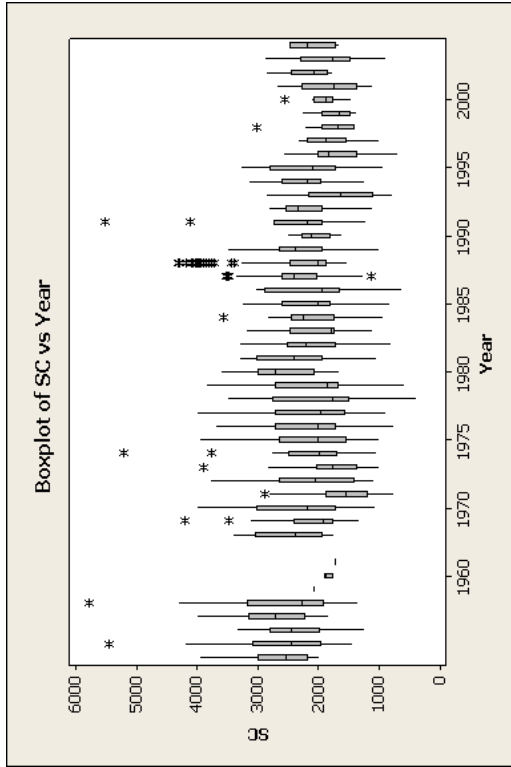


Figure H-2. Box Plot of TDS, SC, and Discharge Versus Month for USGS Site 6437000.

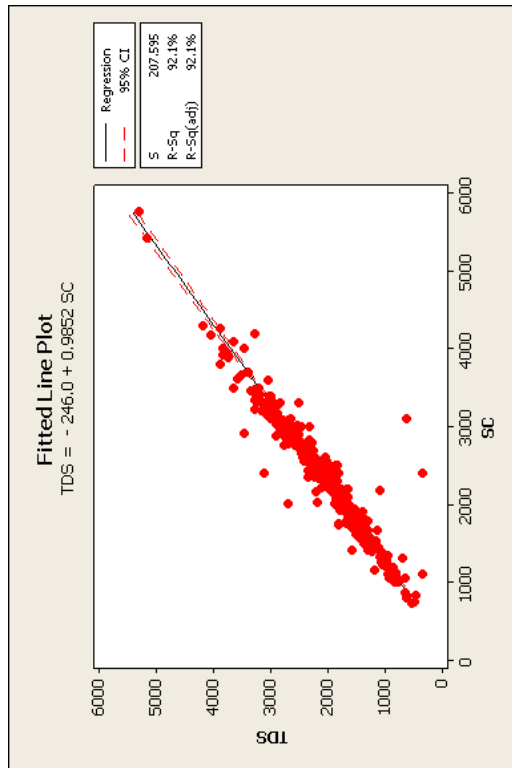


# INSUFFICIENT DATA

Figure H-3. Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Year for USGS Site 6437000.



**Figure H-4.** Box Plot of TDS, SC, and Discharge Versus Year for USGS Site 6437000.



INSUFFICIENT DATA

INSUFFICIENT DATA

INSUFFICIENT DATA

**Figure H-5.** Fitted Line for TDS Versus SC, SSC Versus Turbidity, SSC Versus Discharge, and Turbidity Versus Discharge for USGS Site 6437000.

**Minitab Project Report  
 Chemical Analysis  
 Belle Fourche River Watershed  
 USGS Site 6437000  
 by Dan Hoyer  
 9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	31	70.1	1.8	22.0	34.0	58.0	625.0
	2	26	213.6	18.0	32.8	69.0	281.3	1400.0
	3	50	558	25	50	230	720	3300
	4	37	517	25	55	90	378	8020
	5	48	1128	35	70	228	884	17500
	6	50	819	47	162	237	462	8440
	7	51	522	86	199	248	400	4860
	8	45	296.2	20.0	182.5	240.0	328.5	1240.0
	9	35	554	56	135	245	337	6460
	10	40	131.7	27.0	47.3	77.0	241.3	358.0
	11	30	73.93	11.00	45.75	59.00	74.50	233.00
	12	19	50.11	24.00	29.00	41.00	66.00	110.00
Turbidity	1	0	*	*	*	*	*	*
	2	0	*	*	*	*	*	*
	3	0	*	*	*	*	*	*
	4	0	*	*	*	*	*	*
	5	0	*	*	*	*	*	*
	6	0	*	*	*	*	*	*
	7	0	*	*	*	*	*	*
	8	0	*	*	*	*	*	*
	9	0	*	*	*	*	*	*
	10	0	*	*	*	*	*	*
	11	0	*	*	*	*	*	*
	12	0	*	*	*	*	*	*
SC	1	115	3200.6	580.0	2800.0	3100.0	3800.0	5510.0
	2	92	2491.6	690.0	2262.5	2485.0	2750.0	4010.0
	3	108	2279.8	680.0	1957.5	2350.0	2695.0	4260.0
	4	124	1977.3	743.0	1565.0	1915.0	2400.0	3300.0
	5	110	1931.8	860.0	1437.5	1865.0	2127.5	5770.0
	6	107	1687.5	750.0	1470.0	1790.0	1925.0	2460.0
	7	134	1772.7	770.0	1660.0	1785.0	1880.0	2710.0
	8	99	1854.0	1360.0	1760.0	1880.0	1960.0	2350.0
	9	92	1896.7	621.0	1780.0	1890.0	2025.0	2750.0
	10	150	2186.7	1060.0	1990.0	2210.0	2420.0	3800.0
	11	128	2525.8	1540.0	2350.0	2560.0	2785.0	3960.0
	12	87	2951.7	380.0	2730.0	2960.0	3300.0	5200.0
TSS	1	23	26.83	0.00	7.00	14.00	45.00	105.00
	2	13	86.2	6.0	9.0	18.0	97.0	620.0
	3	8	90.4	3.0	8.0	25.5	209.5	315.0
	4	27	1075	7	15	154	1845	7618

	5	15	1841	7	25	210	2380	14977
	6	12	1382	27	353	829	1311	7183
	7	29	556	27	44	83	419	3920
	8	15	440	17	26	148	398	2250
	9	9	277	1	27	79	440	1313
	10	23	118.4	1.0	4.0	9.0	42.0	2300.0
	11	12	34.5	0.0	3.0	8.5	40.5	213.0
	12	7	46.2	4.0	9.5	23.0	37.0	202.0
Fecal Coliform	1	26	35.7	0.0	2.0	8.5	22.5	300.0
	2	14	91.1	1.0	7.0	40.0	57.0	480.0
	3	15	81.2	1.0	7.0	33.0	43.0	460.0
	4	31	725	0	10	60	300	5100
	5	23	2463	7	33	220	2700	24000
	6	21	1031	33	330	600	1200	6700
	7	43	969	4	32	80	930	14200
	8	21	575	9	29	110	845	4000
	9	16	712	20	34	86	1684	3500
	10	32	141	2	10	18	40	3500
	11	14	45.5	2.0	5.0	23.0	100.0	140.0
	12	14	18.71	0.00	2.00	10.00	20.00	83.00
TDS	1	41	2746.3	612.0	2385.0	2780.0	3220.0	3893.0
	2	33	2335	798	1960	2260	2935	3830
	3	36	2296	462	1898	2260	2741	4040
	4	54	1565.6	346.0	1150.5	1507.5	1910.0	2880.0
	5	45	1839	630	1183	1690	2155	5320
	6	34	1390.8	626.0	1115.0	1479.0	1650.0	2180.0
	7	55	1507.1	330.0	1374.0	1496.0	1650.0	2480.0
	8	33	1580.6	1350.0	1467.0	1590.0	1694.0	1830.0
	9	27	1657.9	535.0	1477.0	1620.0	1819.0	2702.0
	10	45	1989.2	893.0	1822.0	2030.0	2215.0	2535.0
	11	32	2559.7	1434.0	2290.0	2413.0	2750.5	3850.0
	12	25	2851.9	2170.0	2635.0	2840.0	3161.0	3650.0
SSC	1	3	46.3	7.0	7.0	10.0	122.0	122.0
	2	5	723	27	35	49	1747	2720
	3	19	2986	20	238	1480	4070	21500
	4	12	1826	12	28	389	3458	9290
	5	21	1171	17	115	320	2035	6000
	6	24	2402	17	108	223	3123	20200
	7	24	1988	30	54	182	1578	22800
	8	19	678	12	46	88	224	4540
	9	13	1075	3	22	74	1435	7100
	10	12	246	3	5	15	51	1580
	11	6	278	4	16	65	496	1280
	12	3	120.33	108.00	108.00	122.00	131.00	131.00

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1954	0	*	*	*	*	*	*
	1955	1	68.000	68.000	*	68.000	*	68.000
	1956	12	254	37	67	143	173	1729



1957	10	122.1	50.0	50.8	116.0	162.8	297.0
1958	11	165.7	20.0	50.0	79.0	234.0	607.0
1959	1	109.00	109.00	*	109.00	*	109.00
1960	3	151.2	47.0	47.0	177.0	229.5	229.5
1962	1	2830.0	2830.0	*	2830.0	*	2830.0
1967	0	*	*	*	*	*	*
1968	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	3	115.7	74.0	74.0	94.0	179.0	179.0
1974	11	222.0	8.1	58.0	223.0	336.0	564.0
1975	11	330	22	29	240	460	1230
1976	14	847	35	41	96	590	8440
1977	12	179.4	20.0	53.3	158.0	294.5	414.0
1978	12	496	30	35	293	441	2090
1979	11	192.9	1.8	64.0	222.0	330.0	396.0
1980	12	76.3	18.0	26.0	37.5	145.8	242.0
1981	12	249	26	37	53	256	1880
1982	11	1028	4	66	184	405	9360
1983	14	558	29	142	336	942	1530
1984	16	954	14	59	258	1895	4120
1985	36	157.9	27.0	50.8	129.0	245.5	400.0
1986	22	1086	52	222	370	1418	6460
1987	18	463	42	80	238	618	1960
1988	42	227.6	22.0	75.8	214.0	253.8	989.5
1989	10	161.2	32.0	34.5	113.5	194.3	665.0
1990	10	99.0	27.0	50.0	94.5	149.5	192.0
1991	10	82.3	6.0	30.5	58.5	149.8	171.0
1992	12	209	26	29	55	132	1760
1993	13	914	34	94	214	1675	4860
1994	12	409	34	104	186	289	2760
1995	14	1666	31	86	174	505	17500
1996	11	1523	70	137	301	2420	8020
1997	10	1146	62	137	319	2280	4410
1998	10	248.0	51.0	142.5	225.5	336.5	553.0
1999	12	870	68	243	360	1086	5020
2000	9	243.7	60.0	186.5	249.0	301.0	417.0
2001	9	161.4	34.0	44.5	143.0	241.0	395.0
2002	16	115.5	25.0	41.3	58.5	201.5	309.0
2003	8	144.8	25.0	26.8	91.5	227.3	470.0
2004	0	*	*	*	*	*	*

Turbidity

1954	0	*	*	*	*	*	*
1955	0	*	*	*	*	*	*
1956	0	*	*	*	*	*	*
1957	0	*	*	*	*	*	*
1958	0	*	*	*	*	*	*
1959	0	*	*	*	*	*	*
1960	0	*	*	*	*	*	*
1962	0	*	*	*	*	*	*
1967	0	*	*	*	*	*	*
1968	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*

1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	0	*	*	*	*	*	*
1975	0	*	*	*	*	*	*
1976	0	*	*	*	*	*	*
1977	0	*	*	*	*	*	*
1978	0	*	*	*	*	*	*
1979	0	*	*	*	*	*	*
1980	0	*	*	*	*	*	*
1981	0	*	*	*	*	*	*
1982	0	*	*	*	*	*	*
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*
1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	0	*	*	*	*	*	*
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	0	*	*	*	*	*	*
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*
2004	0	*	*	*	*	*	*

SC

1954	9	2648	1970	2170	2530	2980	3960
1955	34	2582	1430	1960	2440	3068	5440
1956	27	2381	1240	1980	2430	2790	3330
1957	38	2703.4	1830.0	2222.5	2695.0	3137.5	4010.0
1958	24	2616	1340	1908	2265	3165	5770
1959	1	2060.0	2060.0	*	2060.0	*	2060.0
1960	3	1846.7	1770.0	1770.0	1870.0	1900.0	1900.0
1962	1	1720.0	1720.0	*	1720.0	*	1720.0
1967	0	*	*	*	*	*	*
1968	10	2467	1740	1945	2370	3040	3400
1969	33	2110	1320	1760	1920	2400	4200
1970	27	2250	1050	1720	2170	3010	4010
1971	19	1670	743	1190	1540	1860	2880
1972	19	2133	1080	1410	2040	2640	3780
1973	23	1856	1000	1360	1770	2020	3900
1974	22	2208	1044	1700	1988	2475	5200
1975	35	2087	998	1550	2000	2630	3950
1976	37	2219	750	1705	2000	2695	3700
1977	36	2135	875	1560	1960	2700	4000
1978	34	1996	380	1500	1760	2750	3500
1979	34	2169	580	1665	1855	2700	3840

1980	32	2597.8	1640.0	2067.5	2700.0	2985.0	3600.0
1981	27	2379	1030	1940	2400	3000	3300
1982	25	2100	795	1720	2200	2500	3300
1983	17	2055	1100	1735	1790	2470	3190
1984	23	2098	932	1730	2250	2440	3570
1985	41	2173.3	823.0	1810.0	1990.0	2595.0	3250.0
1986	23	2076	621	1650	1930	2880	3030
1987	109	2386.9	1130.0	2020.0	2390.0	2600.0	3510.0
1988	280	2277.0	1520.0	1870.0	2000.0	2460.0	4310.0
1989	16	2371	995	1933	2380	2635	3500
1990	14	2062.1	1600.0	1807.5	2120.0	2257.5	2500.0
1991	13	2560	1220	1942	2180	2725	5510
1992	17	2183	1110	1930	2320	2525	2810
1993	17	1677	770	1105	1620	2145	2860
1994	80	2227.6	1230.0	1952.5	2180.0	2585.0	3150.0
1995	18	2193	930	1723	2090	2793	3270
1996	14	1723	690	1360	1835	2003	2570
1997	14	1837	994	1548	1875	2168	2340
1998	15	1775	1380	1400	1670	1940	3010
1999	15	1734.7	1360.0	1470.0	1660.0	1940.0	2270.0
2000	13	1893.8	1460.0	1750.0	1870.0	2065.0	2540.0
2001	15	1827	1110	1360	1740	2270	2690
2002	26	2168.5	1760.0	1847.5	2070.0	2440.0	2850.0
2003	12	1843	878	1465	1760	2288	2880
2004	4	2115	1660	1723	2170	2453	2460

TSS

1954	0	*	*	*	*	*	*
1955	0	*	*	*	*	*	*
1956	0	*	*	*	*	*	*
1957	0	*	*	*	*	*	*
1958	0	*	*	*	*	*	*
1959	0	*	*	*	*	*	*
1960	0	*	*	*	*	*	*
1962	0	*	*	*	*	*	*
1967	3	673	320	320	398	1300	1300
1968	4	1786	147	572	2048	2738	2900
1969	6	1376	90	608	1282	1864	3510
1970	3	1332	7	7	918	3072	3072
1971	0	*	*	*	*	*	*
1972	1	36.000	36.000	*	36.000	*	36.000
1973	1	1874.0	1874.0	*	1874.0	*	1874.0
1974	6	461	3	23	156	976	1685
1975	12	1702	0	105	264	633	14977
1976	12	831	0	50	145	475	7183
1977	12	1202	1	49	302	1738	7618
1978	12	444	10	14	58	813	2380
1979	12	115.8	4.0	7.3	47.5	161.0	600.0
1980	11	58.4	1.0	3.0	19.0	39.0	410.0
1981	8	24.50	3.00	7.00	20.00	42.00	65.00
1982	7	372	7	17	30	154	2300
1983	4	50.0	4.0	8.0	38.0	104.0	120.0
1984	4	21.5	4.0	5.3	12.0	47.3	58.0
1985	5	20.6	4.0	4.5	11.0	41.5	65.0
1986	4	61.8	7.0	8.8	27.5	149.0	185.0
1987	4	36.5	3.0	4.3	26.0	79.3	91.0
1988	4	12.00	1.00	2.50	9.00	24.50	29.00

1989	4	23.75	9.00	9.75	18.00	43.50	50.00
1990	4	106.3	15.0	15.3	60.5	243.0	289.0
1991	3	41.3	11.0	11.0	30.0	83.0	83.0
1992	4	40.3	10.0	12.5	23.5	84.8	104.0
1993	4	2548	5	6	1964	5675	6260
1994	4	42.5	3.0	4.0	16.5	107.0	134.0
1995	4	14.00	4.00	6.00	13.00	23.00	26.00
1996	4	224	26	30	125	518	620
1997	4	854	2	6	18	2540	3380
1998	4	58.3	12.0	16.0	35.5	123.3	150.0
1999	4	993	5	8	218	2752	3530
2000	3	696	8	8	51	2030	2030
2001	2	176	31	*	176	*	320
2002	4	12.25	6.00	6.25	8.00	22.50	27.00
2003	3	37.0	8.0	8.0	48.0	55.0	55.0
2004	3	38.3	7.0	7.0	12.0	96.0	96.0

Fecal Coliform	1954	0	*	*	*	*	*	*
	1955	0	*	*	*	*	*	*
	1956	0	*	*	*	*	*	*
	1957	0	*	*	*	*	*	*
	1958	0	*	*	*	*	*	*
	1959	0	*	*	*	*	*	*
	1960	0	*	*	*	*	*	*
	1962	0	*	*	*	*	*	*
	1967	3	1010	590	590	940	1500	1500
	1968	4	3285	1000	1425	3350	5080	5440
	1969	12	1900	300	1100	1350	2200	5100
	1970	6	1273	20	20	1100	2700	2700
	1971	0	*	*	*	*	*	*
	1972	2	23.000	23.000	*	23.000	*	23.000
	1973	2	1100.0	1100.0	*	1100.0	*	1100.0
	1974	10	564	10	33	140	823	2300
	1975	20	2032	3	39	83	2000	24000
	1976	22	692	10	30	136	460	6700
	1977	20	625	17	20	79	1200	3500
	1978	23	795	3	43	83	540	7000
	1979	22	95.6	0.0	5.0	40.0	120.0	530.0
	1980	22	53.3	0.0	1.0	9.0	33.0	400.0
	1981	12	15.25	1.00	1.25	8.00	33.00	40.00
	1982	13	196	10	24	36	50	1100
	1983	7	78.6	2.0	8.0	76.0	190.0	190.0
	1984	6	5.33	2.00	2.00	6.00	8.00	8.00
	1985	8	18.50	6.00	10.00	17.00	30.00	32.00
	1986	6	18.67	10.00	10.00	16.00	30.00	30.00
	1987	7	32.86	10.00	10.00	40.00	60.00	60.00
	1988	6	9.33	2.00	8.00	10.00	12.00	12.00
	1989	6	4.67	2.00	2.00	2.00	10.00	10.00
	1990	4	30.75	2.00	10.75	38.50	43.00	44.00
	1991	3	18.33	6.00	6.00	22.00	27.00	27.00
	1992	3	37.3	10.0	10.0	12.0	90.0	90.0
	1993	4	2356	7	10	159	6900	9100
	1994	3	76.3	2.0	2.0	7.0	220.0	220.0
	1995	2	40.0	30.0	*	40.0	*	50.0
	1996	2	95.0	40.0	*	95.0	*	150.0
	1997	2	811	22	*	811	*	1600

1998	2	58.0	48.0	*	58.0	*	68.0
1999	1	14200	14200	*	14200	*	14200
2000	1	80.000	80.000	*	80.000	*	80.000
2001	1	46.000	46.000	*	46.000	*	46.000
2002	1	30.000	30.000	*	30.000	*	30.000
2003	1	4.0000	4.0000	*	4.0000	*	4.0000
2004	1	100.00	100.00	*	100.00	*	100.00

TDS

1954	9	2438	1730	1955	2320	2795	3760
1955	34	2334	1140	1708	2170	2843	5170
1956	27	2131	966	1700	2190	2540	3170
1957	38	2468.9	1550.0	1945.0	2455.0	2935.0	3830.0
1958	24	2353	1060	1655	2005	2950	5320
1959	1	1740.0	1740.0	*	1740.0	*	1740.0
1960	3	1566.7	1480.0	1480.0	1590.0	1630.0	1630.0
1962	1	1400.0	1400.0	*	1400.0	*	1400.0
1967	3	1383	1130	1130	1490	1530	1530
1968	10	2333	1084	1808	2355	2868	3260
1969	31	1890	1080	1580	1670	2180	3270
1970	26	2049	649	1518	1950	2645	3650
1971	9	1238	475	826	1050	1755	2190
1972	1	2416.0	2416.0	*	2416.0	*	2416.0
1973	1	1074.0	1074.0	*	1074.0	*	1074.0
1974	6	1875	916	1324	1876	2455	2771
1975	12	1796	793	1384	1796	2254	2902
1976	12	2096	1372	1481	1915	2739	3397
1977	12	1911	832	1455	1742	2369	3284
1978	12	1769	642	1204	1408	2497	2998
1979	12	1938	1206	1415	1519	2244	3893
1980	11	2248	1446	1708	2300	2714	3038
1981	8	2284	1678	1890	2316	2563	2950
1982	14	1564	626	1469	1659	1890	1990
1983	17	1475	630	1260	1442	1610	2654
1984	8	1851	1390	1501	1867	2188	2282
1985	13	1461	346	537	1510	2250	2690
1986	19	1842	535	1324	1640	2530	2900
1987	18	1794	966	1372	1685	2230	2750
1988	14	1987	1431	1591	1829	2230	3470
1989	8	2135	1380	1513	1970	2923	3220
1990	4	1761	1501	1535	1790	1960	1965
1991	3	2555	1647	1647	2369	3650	3650
1992	4	1845	1566	1608	1797	2130	2220
1993	4	1242	330	420	1236	2069	2165
1994	6	1587	996	1074	1462	2129	2493
1995	4	2199	1614	1625	2027	2944	3126
1996	4	1336	830	978	1427	1604	1660
1997	4	1673	1264	1338	1606	2076	2218
1998	4	1447	1220	1237	1405	1698	1757
1999	3	1168.0	1122.0	1122.0	1140.0	1242.0	1242.0
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	2	1600	1300	*	1600	*	1900
2004	4	1800	1300	1375	1800	2225	2300

Year	Station	Discharge	Turbidity	SC	TSS	Fecal Coliform	TDS	SSC
1954	0	*	*	*	*	*	*	*
1955	0	*	*	*	*	*	*	*
1956	11	3879	338	941	1310	2290	22800	
1957	10	3121	950	1235	2550	3850	9800	
1958	11	3624	12	1330	2440	6000	9290	
1959	0	*	*	*	*	*	*	*
1960	3	8319	217	217	4540	20200	20200	
1962	0	*	*	*	*	*	*	*
1967	0	*	*	*	*	*	*	*
1968	0	*	*	*	*	*	*	*
1969	0	*	*	*	*	*	*	*
1970	0	*	*	*	*	*	*	*
1971	0	*	*	*	*	*	*	*
1972	0	*	*	*	*	*	*	*
1973	0	*	*	*	*	*	*	*
1974	0	*	*	*	*	*	*	*
1975	0	*	*	*	*	*	*	*
1976	1	21500	21500	*	21500	*	21500	
1977	0	*	*	*	*	*	*	*
1978	0	*	*	*	*	*	*	*
1979	0	*	*	*	*	*	*	*
1980	0	*	*	*	*	*	*	*
1981	0	*	*	*	*	*	*	*
1982	0	*	*	*	*	*	*	*
1983	4	55.0	17.0	17.8	40.5	106.8	122.0	
1984	10	1708	26	49	1206	3398	4650	
1985	24	130.7	3.0	6.3	163.5	217.0	245.0	
1986	21	1590	15	45	774	3055	7100	
1987	17	901	7	23	49	1157	4460	
1988	35	401	10	54	115	252	4715	
1989	0	*	*	*	*	*	*	*
1990	0	*	*	*	*	*	*	*
1991	0	*	*	*	*	*	*	*
1992	0	*	*	*	*	*	*	*
1993	0	*	*	*	*	*	*	*
1994	0	*	*	*	*	*	*	*
1995	0	*	*	*	*	*	*	*
1996	0	*	*	*	*	*	*	*
1997	0	*	*	*	*	*	*	*
1998	0	*	*	*	*	*	*	*
1999	0	*	*	*	*	*	*	*
2000	0	*	*	*	*	*	*	*
2001	0	*	*	*	*	*	*	*
2002	14	59.04	17.00	32.25	44.00	91.13	132.00	
2003	0	*	*	*	*	*	*	*
2004	0	*	*	*	*	*	*	*

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC**

Variable	Station	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	6437000	462	471.1	1.8	57.8	174.0	308.0	17500.0
Turbidity	6437000	0	*	*	*	*	*	*
SC	6437000	1346	2218.0	380.0	1790.0	2090.0	2600.0	5770.0
TSS	6437000	193	541	0	12	42	280	14977

Fecal Coliform	6437000	270	647	0	10	40	308	24000
TDS	6437000	460	1977.0	330.0	1470.3	1837.5	2437.5	5320.0
SSC	6437000	161	1517	3	46	169	1605	22800

### Kruskal-Wallis Test: Discharge versus Month

462 cases were used

954 cases contained missing values

Kruskal-Wallis Test on Discharge

Month	N	Median	Ave Rank	Z
1	31	34.00	84.3	-6.36
2	26	69.00	167.9	-2.50
3	50	230.00	250.0	1.04
4	37	90.00	210.2	-1.01
5	48	227.50	274.6	2.36
6	50	237.00	299.5	3.81
7	51	248.00	316.1	4.80
8	45	240.00	294.9	3.36
9	35	245.00	279.4	2.21
10	40	77.00	177.0	-2.70
11	30	59.00	123.2	-4.59
12	19	41.00	83.8	-4.92
Overall	462		231.5	

H = 148.22 DF = 11 P = 0.000

H = 148.22 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TSS versus Month

193 cases were used

1223 cases contained missing values

Kruskal-Wallis Test on TSS

Month	N	Median	Ave Rank	Z
1	23	14.000	59.5	-3.43
2	13	18.000	78.7	-1.22
3	8	25.500	80.6	-0.85
4	27	154.000	117.3	2.04
5	15	210.000	125.3	2.04
6	12	828.500	158.2	3.92
7	29	83.000	125.4	2.97
8	15	148.000	120.6	1.70
9	9	79.000	108.9	0.66
10	23	9.000	51.5	-4.16
11	12	8.500	52.1	-2.88
12	7	23.000	71.6	-1.22
Overall	193		97.0	

H = 69.28 DF = 11 P = 0.000  
H = 69.29 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: SSC versus Month

161 cases were used  
1255 cases contained missing values

Kruskal-Wallis Test on SSC

Month	N	Median	Ave Rank	Z
1	3	10.00	29.3	-1.94
2	5	49.00	68.4	-0.61
3	19	1480.00	110.9	2.97
4	12	389.00	87.1	0.47
5	21	320.00	94.1	1.38
6	24	223.00	96.2	1.73
7	24	181.50	84.7	0.42
8	19	88.00	70.6	-1.03
9	13	74.00	68.3	-1.03
10	12	15.00	32.3	-3.77
11	6	65.25	53.6	-1.47
12	3	122.00	68.2	-0.48
Overall	161		81.0	

H = 33.74 DF = 11 P = 0.000  
H = 33.74 DF = 11 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: SC versus Month

1346 cases were used  
70 cases contained missing values

Kruskal-Wallis Test on SC

Month	N	Median	Ave Rank	Z
1	115	3100	1151.1	13.78
2	92	2485	881.3	5.31
3	108	2350	751.6	2.18
4	124	1915	539.6	-4.03
5	110	1865	475.2	-5.58
6	107	1790	332.3	-9.46
7	134	1785	362.6	-9.76
8	99	1880	433.2	-6.39
9	92	1890	482.1	-4.89
10	150	2210	709.5	1.20
11	128	2560	918.7	7.50



12	87	2960	1118.6	11.04
Overall	1346		673.5	

H = 642.25 DF = 11 P = 0.000  
H = 642.28 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TDS versus Month

460 cases were used  
956 cases contained missing values

Kruskal-Wallis Test on TDS

Month	N	Median	Ave Rank	Z
1	41	2780	370.0	7.04
2	33	2260	304.1	3.30
3	36	2260	294.8	3.03
4	54	1508	154.2	-4.49
5	45	1690	188.2	-2.25
6	34	1479	115.3	-5.25
7	55	1496	132.3	-5.84
8	33	1590	151.8	-3.53
9	27	1620	174.7	-2.25
10	45	2030	253.3	1.21
11	32	2413	350.8	5.31
12	25	2840	394.6	6.35
Overall	460		230.5	

H = 223.54 DF = 11 P = 0.000  
H = 223.55 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: Fecal Coliform versus Month

270 cases were used  
1146 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
1	26	8.500	68.4	-4.61
2	14	40.000	108.9	-1.31
3	15	33.000	102.9	-1.66
4	31	60.000	139.5	0.30
5	23	220.000	180.0	2.85
6	21	600.000	213.3	4.75
7	43	80.000	163.7	2.59
8	21	110.000	163.7	1.72
9	16	85.500	170.8	1.86
10	32	18.000	101.4	-2.63
11	14	23.000	102.0	-1.65

12	14	10.000	65.1	-3.47
Overall	270		135.5	

H = 83.51 DF = 11 P = 0.000  
H = 83.59 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: Discharge versus Year

462 cases were used  
954 cases contained missing values

#### Kruskal-Wallis Test on Discharge

Year	N	Median	Ave Rank	Z
1955	1	68.00	143.5	-0.66
1956	12	142.50	196.3	-0.92
1957	10	116.00	175.8	-1.33
1958	11	79.00	192.7	-0.98
1959	1	109.00	182.0	-0.37
1960	3	177.00	198.2	-0.43
1962	1	2830.00	448.0	1.62
1973	3	94.00	187.2	-0.58
1974	11	223.00	228.9	-0.07
1975	11	240.00	240.1	0.22
1976	14	96.00	230.5	-0.03
1977	12	158.00	213.0	-0.49
1978	12	292.50	243.8	0.32
1979	11	222.00	226.1	-0.13
1980	12	37.50	101.1	-3.43
1981	12	52.50	162.2	-1.82
1982	11	184.00	239.4	0.20
1983	14	336.00	301.6	2.00
1984	16	257.50	265.2	1.03
1985	36	129.00	201.1	-1.42
1986	22	369.50	336.8	3.79
1987	18	237.50	276.6	1.46
1988	42	214.00	248.8	0.88
1989	10	113.50	175.1	-1.35
1990	10	94.50	151.1	-1.93
1991	10	58.50	122.6	-2.61
1992	12	55.00	131.0	-2.64
1993	13	214.00	277.3	1.26
1994	12	186.00	249.6	0.48
1995	14	174.00	253.3	0.62
1996	11	301.00	328.2	2.43
1997	10	319.00	328.9	2.33
1998	10	225.50	271.8	0.97
1999	12	360.00	342.8	2.93
2000	9	249.00	287.4	1.27
2001	9	143.00	199.9	-0.72
2002	16	58.50	155.9	-2.31
2003	8	91.50	160.4	-1.52
Overall	462		231.5	

H = 96.35 DF = 37 P = 0.000  
H = 96.35 DF = 37 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: TSS versus Year

193 cases were used  
1223 cases contained missing values

Kruskal-Wallis Test on TSS

Year	N	Median	Ave Rank	Z
1967	3	398.000	157.5	1.89
1968	4	2047.500	167.3	2.54
1969	6	1281.500	164.5	3.01
1970	3	918.000	126.3	0.92
1972	1	36.000	89.0	-0.14
1973	1	1874.000	176.0	1.42
1974	6	156.000	111.4	0.64
1975	12	264.000	134.7	2.41
1976	12	145.000	124.9	1.79
1977	12	301.500	129.2	2.06
1978	12	58.000	109.3	0.78
1979	12	47.500	90.6	-0.41
1980	11	19.000	64.3	-2.00
1981	8	20.000	60.6	-1.88
1982	7	30.000	96.0	-0.05
1983	4	38.000	80.0	-0.62
1984	4	12.000	54.9	-1.52
1985	5	11.000	50.9	-1.87
1986	4	27.500	78.9	-0.66
1987	4	26.000	66.5	-1.10
1988	4	9.000	39.5	-2.08
1989	4	18.000	65.9	-1.13
1990	4	60.500	97.4	0.01
1991	3	30.000	82.3	-0.46
1992	4	23.500	78.1	-0.68
1993	4	1964.000	108.4	0.41
1994	4	16.500	60.8	-1.31
1995	4	13.000	48.5	-1.75
1996	4	125.000	117.0	0.72
1997	4	17.500	79.4	-0.64
1998	4	35.500	90.3	-0.24
1999	4	218.000	106.5	0.34
2000	3	51.000	106.2	0.29
2001	2	175.500	116.3	0.49
2002	4	8.000	41.4	-2.01
2003	3	48.000	81.5	-0.48
2004	3	12.000	67.3	-0.93
Overall	193		97.0	

H = 67.34 DF = 36 P = 0.001  
H = 67.36 DF = 36 P = 0.001 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: SSC versus Year

161 cases were used  
1255 cases contained missing values

Kruskal-Wallis Test on SSC

Year	N	Median	Ave Rank	Z
1956	11	1310.00	123.0	3.10
1957	10	2550.00	130.3	3.45
1958	11	2440.00	123.2	3.11
1960	3	4540.00	131.7	1.90
1976	1	21500.00	160.0	1.70
1983	4	40.50	38.4	-1.85
1984	10	1206.00	91.7	0.75
1985	24	163.50	58.3	-2.59
1986	21	774.00	88.9	0.83
1987	17	49.00	65.8	-1.42
1988	35	115.00	69.6	-1.64
2002	14	44.00	41.9	-3.28
Overall	161		81.0	

H = 59.48 DF = 11 P = 0.000  
H = 59.48 DF = 11 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: SC versus Year

1346 cases were used  
70 cases contained missing values

Kruskal-Wallis Test on SC

Year	N	Median	Ave Rank	Z
1954	9	2530	955.2	2.18
1955	34	2440	836.5	2.48
1956	27	2430	814.7	1.91
1957	38	2695	981.8	4.96
1958	24	2265	800.6	1.62
1959	1	2060	655.5	-0.05
1960	3	1870	414.5	-1.16
1962	1	1720	262.0	-1.06
1968	10	2370	833.5	1.31
1969	33	1920	581.9	-1.37

1970	27	2170	661.6	-0.16
1971	19	1540	337.6	-3.79
1972	19	2040	616.2	-0.65
1973	23	1770	429.5	-3.04
1974	22	1988	610.3	-0.77
1975	35	2000	585.2	-1.36
1976	37	2000	651.6	-0.35
1977	36	1960	606.1	-1.05
1978	34	1760	556.3	-1.78
1979	34	1855	586.3	-1.33
1980	32	2700	923.6	3.68
1981	27	2400	818.3	1.96
1982	25	2200	643.3	-0.39
1983	17	1790	540.2	-1.42
1984	23	2250	613.7	-0.74
1985	41	1990	678.3	0.08
1986	23	1930	618.3	-0.69
1987	109	2390	813.2	3.91
1988	280	2000	693.2	0.95
1989	16	2380	796.8	1.28
1990	14	2120	603.3	-0.68
1991	13	2180	788.8	1.07
1992	17	2320	708.0	0.37
1993	17	1620	391.0	-3.02
1994	80	2180	722.0	1.15
1995	18	2090	690.5	0.19
1996	14	1835	415.2	-2.50
1997	14	1875	442.0	-2.24
1998	15	1670	356.9	-3.17
1999	15	1660	334.2	-3.40
2000	13	1870	464.3	-1.95
2001	15	1740	431.0	-2.43
2002	26	2070	686.0	0.17
2003	12	1760	446.9	-2.03
2004	4	2170	639.9	-0.17
Overall	1346		673.5	

H = 173.63 DF = 44 P = 0.000

H = 173.64 DF = 44 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: TDS versus Year

460 cases were used

956 cases contained missing values

Kruskal-Wallis Test on TDS

Year	N	Median	Ave Rank	Z
1954	9	2320	325.8	2.17
1955	34	2170	282.0	2.35
1956	27	2190	273.3	1.72

1957	38	2455	328.4	4.74
1958	24	2005	271.1	1.54
1959	1	1740	208.5	-0.17
1960	3	1590	147.5	-1.08
1962	1	1400	88.0	-1.07
1967	3	1490	101.7	-1.68
1968	10	2355	305.3	1.80
1969	31	1670	216.2	-0.62
1970	26	1950	240.1	0.38
1971	9	1050	97.2	-3.04
1972	1	2416	344.0	0.85
1973	1	1074	38.0	-1.45
1974	6	1876	215.9	-0.27
1975	12	1796	198.6	-0.84
1976	12	1915	246.3	0.42
1977	12	1742	219.5	-0.29
1978	12	1408	185.6	-1.18
1979	12	1519	203.9	-0.70
1980	11	2300	294.3	1.61
1981	8	2316	310.7	1.72
1982	14	1659	164.6	-1.88
1983	17	1442	125.2	-3.33
1984	8	1867	218.2	-0.26
1985	13	1510	153.9	-2.11
1986	19	1640	207.4	-0.77
1987	18	1685	202.0	-0.93
1988	14	1829	240.5	0.29
1989	8	1970	257.3	0.58
1990	4	1790	200.9	-0.45
1991	3	2369	319.8	1.17
1992	4	1797	223.4	-0.11
1993	4	1236	131.0	-1.50
1994	6	1462	150.3	-1.49
1995	4	2027	278.1	0.72
1996	4	1427	97.8	-2.01
1997	4	1606	171.1	-0.90
1998	4	1405	117.1	-1.71
1999	3	1140	48.2	-2.38
2003	2	1600	153.3	-0.82
2004	4	1800	202.3	-0.43
Overall	460		230.5	

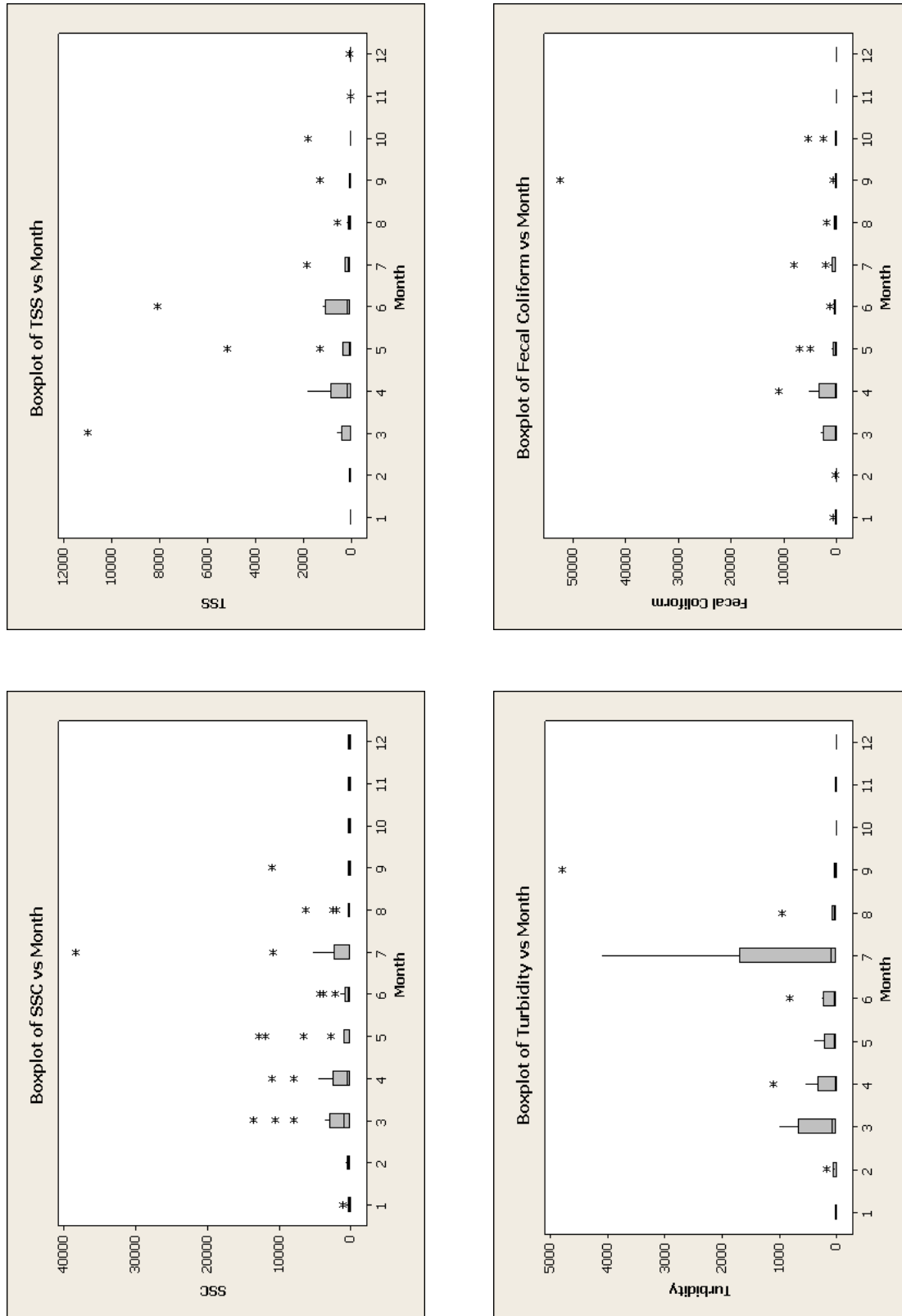
H = 105.39 DF = 42 P = 0.000

H = 105.39 DF = 42 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

**APPENDIX I**

**HISTORICAL DATA–  
MAP AND STATISTICAL ANALYSIS OF  
FLOW AND CHEMISTRY FOR  
USGS SITE 6438000  
BELLE FOURCHE RIVER  
NEAR ELM SPRINGS, SOUTH DAKOTA**



**Figure I-1.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Month for USGS Site 6438000.



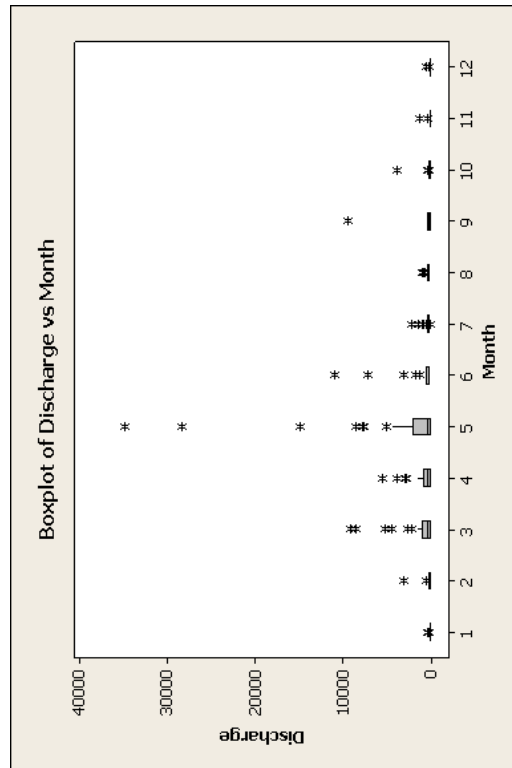
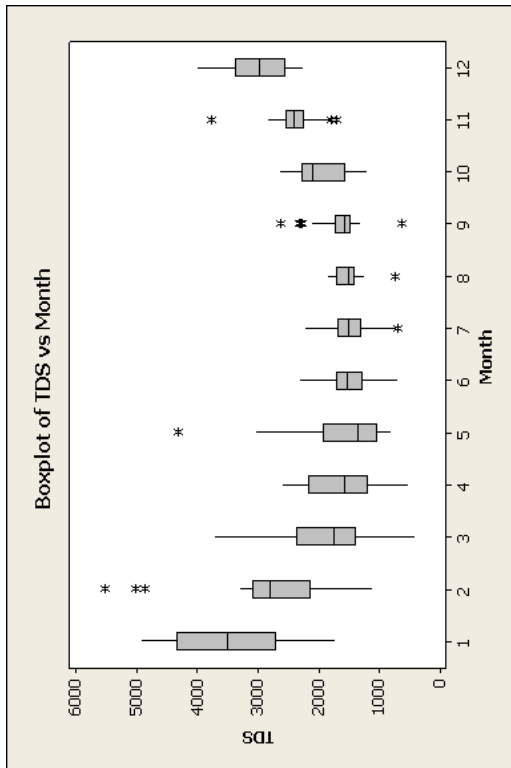
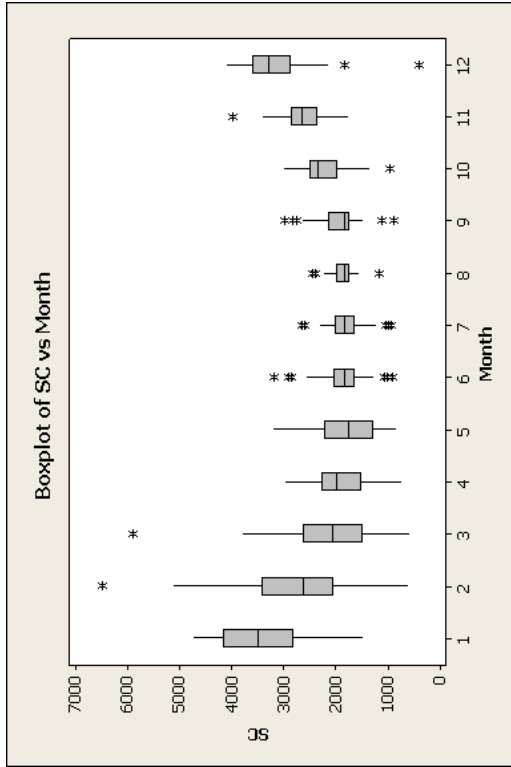
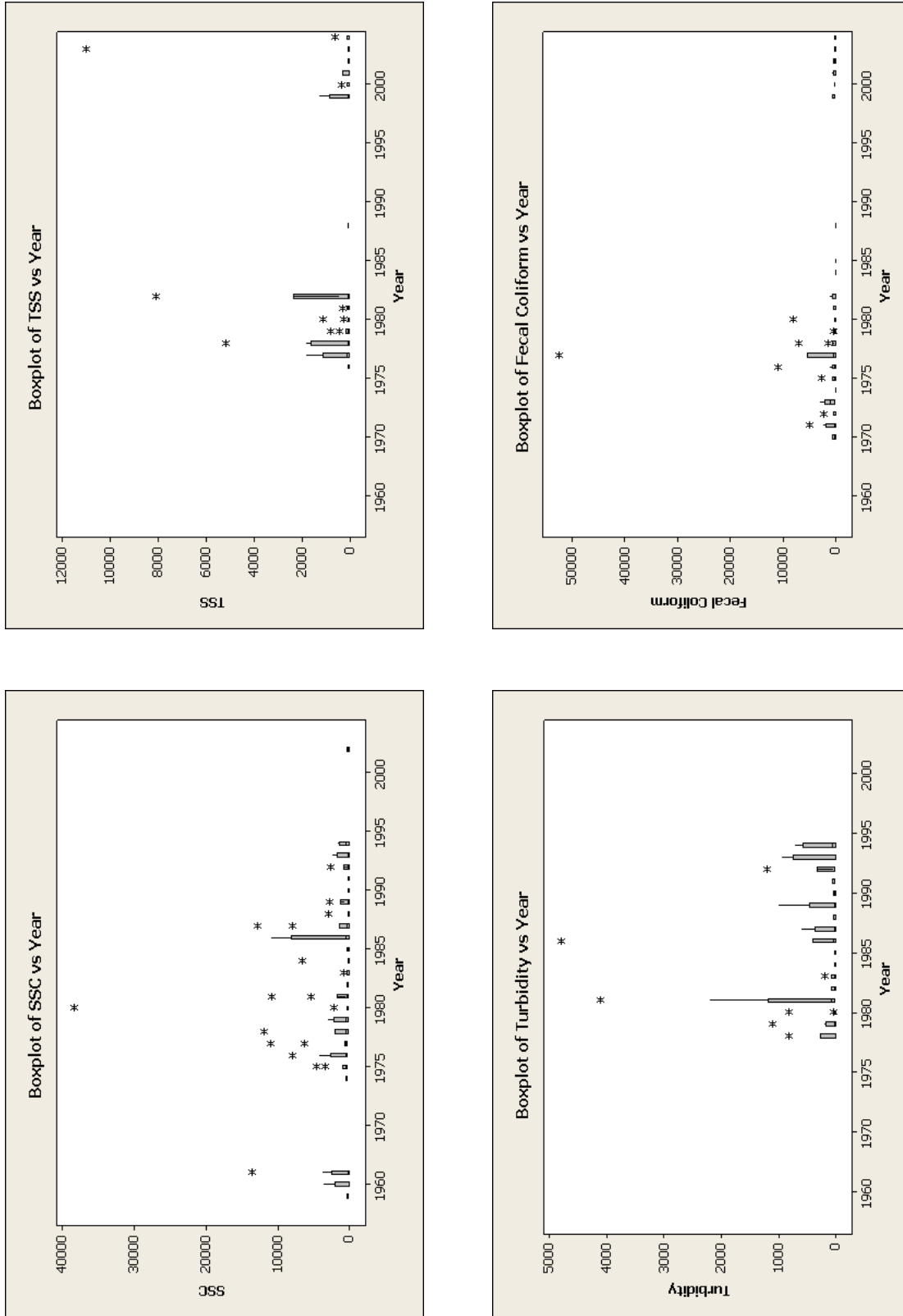
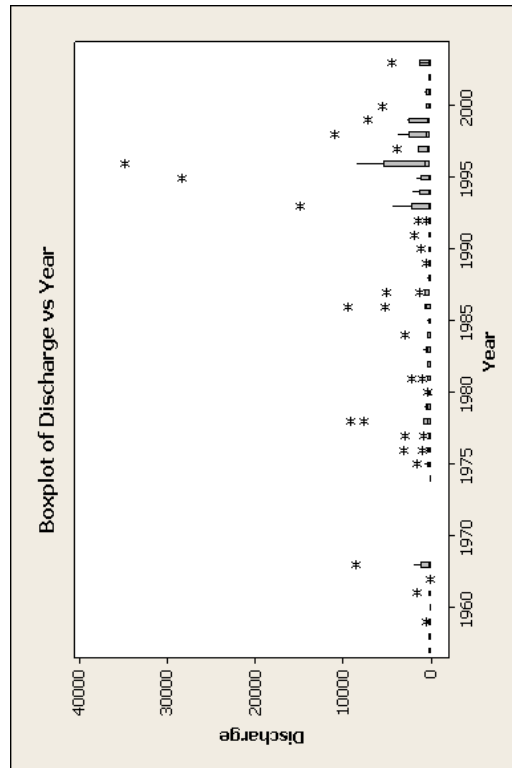
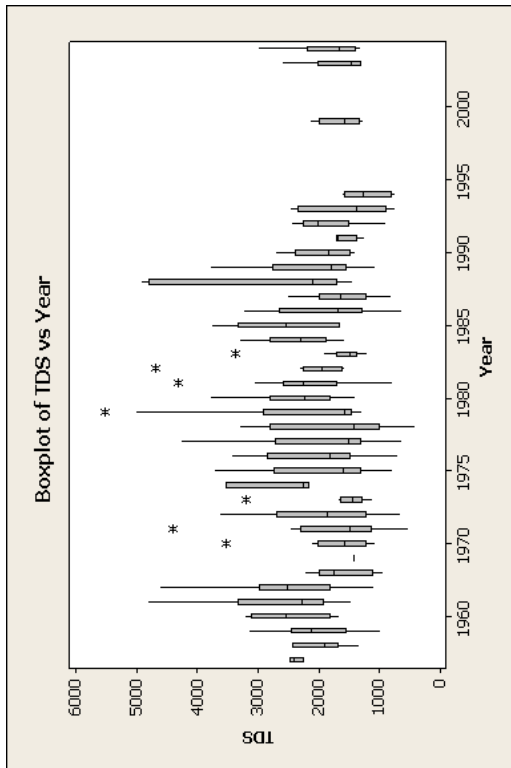
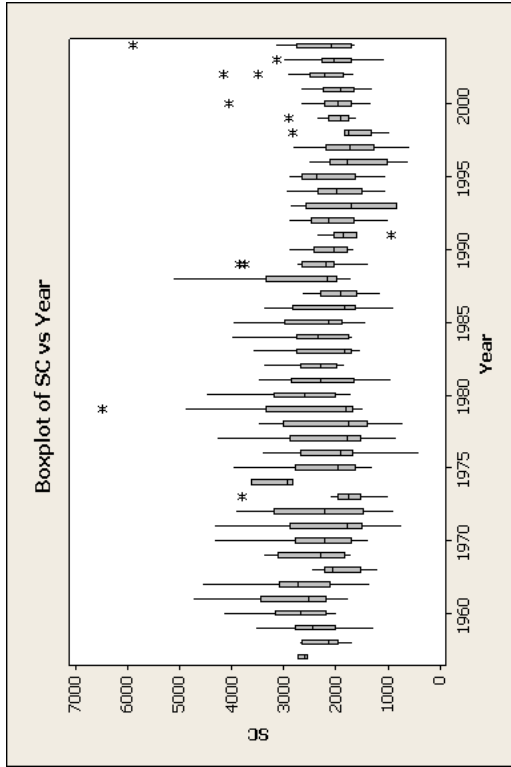


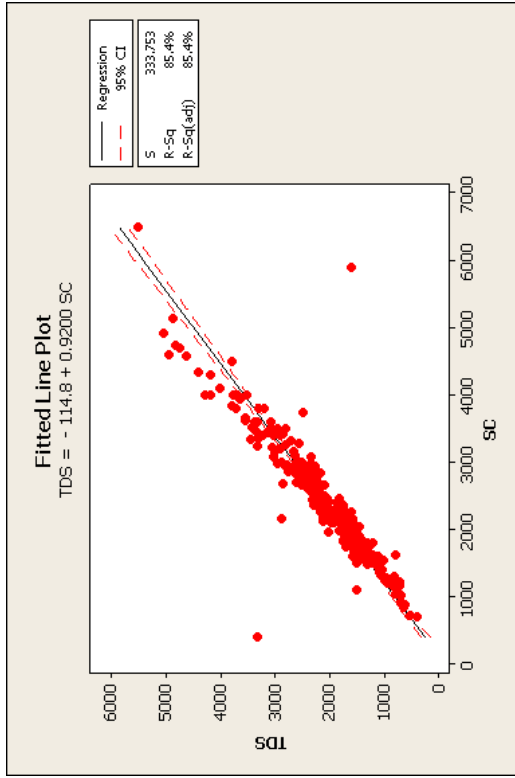
Figure I-2. Box Plot of TDS, SC, and Discharge Versus Month for USGS Site 6438000.



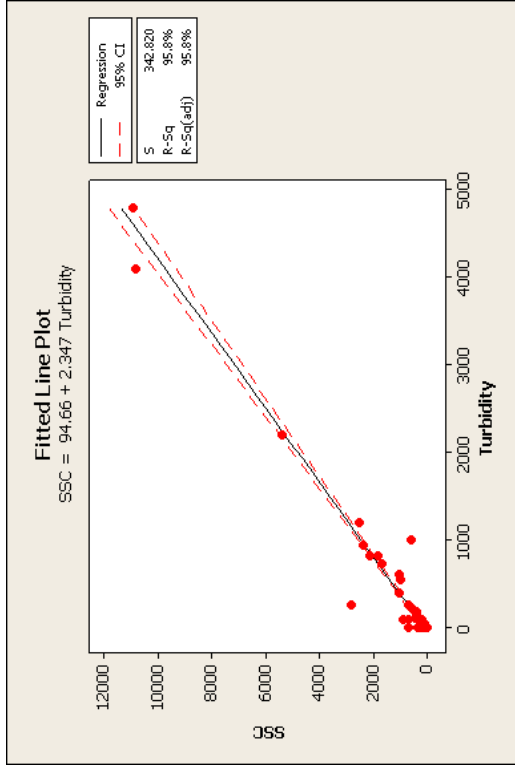
**Figure I-3.** Box Plot of SSC, TSS, Turbidity, and Fecal Coliform Versus Year for USGS Site 6438000.



**Figure I-4. Box Plot of TDS, SC, and Discharge Versus Year for USGS Site 6438000.**



INSUFFICIENT DATA



INSUFFICIENT DATA

**Figure I-5.** Fitted Line for TDS Versus SC, SSC Versus Turbidity, and Turbidity Versus Discharge for USGS Site 6438000.

**Minitab Project Report  
 Chemical Analysis  
 Belle Fourche River Watershed  
 USGS Site 6438000  
 by Dan Hoyer  
 9/05/05**

**Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC**

Variable	Month	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1	32	50.5	0.0	9.8	22.5	65.8	265.0
	2	24	195	0	23	40	128	2990
	3	42	1077	14	72	261	871	9080
	4	35	790	17	55	349	759	5530
	5	41	3107	12	64	261	1950	34900
	6	38	856	30	115	237	456	11000
	7	34	399.8	6.3	216.0	262.0	346.8	2170.0
	8	33	276.0	22.0	158.5	230.0	337.5	897.0
	9	29	529	10	101	225	325	9450
	10	32	202	24	48	67	115	3760
	11	32	114.5	14.0	39.0	55.5	93.0	1230.0
	12	29	66.3	2.8	25.0	46.0	66.5	499.0
Turbidity	1	9	6.99	0.50	0.80	2.60	13.50	20.00
	2	6	31.1	0.5	0.7	2.6	50.0	170.0
	3	9	282	4	12	66	665	1000
	4	9	207	4	6	9	325	1100
	5	10	103.6	4.4	10.2	45.0	200.0	400.0
	6	9	161.8	4.7	10.7	35.0	235.0	820.0
	7	9	944	1	26	88	1700	4100
	8	11	119.0	9.7	21.0	32.0	70.0	940.0
	9	10	493	2	4	14	31	4800
	10	6	2.433	1.300	1.300	2.050	3.625	4.600
	11	9	8.51	0.70	1.20	5.50	15.50	26.00
	12	8	2.125	0.500	0.825	1.950	2.900	5.500
SC	1	39	3426	1460	2820	3490	4170	4750
	2	34	2796	596	2068	2615	3425	6500
	3	48	2116	570	1493	2050	2635	5910
	4	50	1929.3	722.5	1530.0	1995.0	2255.0	2980.0
	5	51	1755.3	818.0	1280.0	1760.0	2220.0	3224.0
	6	50	1854.8	900.0	1655.0	1830.0	2030.0	3200.0
	7	52	1793.1	920.0	1642.5	1820.0	2007.5	2650.0
	8	44	1861.6	1160.0	1742.5	1840.0	1975.0	2450.0
	9	44	1933.8	880.0	1750.0	1840.0	2127.5	2990.0
	10	45	2253.6	950.0	1995.0	2350.0	2510.0	3000.0
	11	42	2621.4	1760.0	2372.5	2650.0	2845.0	4000.0
	12	40	3150	390	2890	3305	3600	4110
TSS	1	5	17.4	5.5	5.8	7.0	34.3	60.0
	2	10	35.7	3.5	4.0	14.5	57.3	135.0
	3	10	1228	4	7	29	390	11000
	4	12	508	4	16	175	828	1837

	5	12	606	6	20	53	332	5160
	6	12	1035	57	69	149	1049	8080
	7	13	260	20	73	110	253	1860
	8	11	117.4	38.0	39.0	52.0	113.0	559.0
	9	12	144	8	11	34	92	1279
	10	10	206	10	17	32	43	1810
	11	9	10.67	1.00	6.50	7.00	13.50	32.00
	12	9	13.72	4.00	5.25	7.00	15.50	53.00
Fecal Coliform	1	6	86.7	1.0	1.0	2.5	134.8	500.0
	2	9	16.33	1.00	4.50	10.00	17.00	70.00
	3	6	913	1	6	135	2400	3000
	4	10	2015	0	27	84	3300	11000
	5	16	973	12	39	190	605	7000
	6	16	365	43	113	165	406	1200
	7	16	915	10	81	200	835	8000
	8	16	313	10	31	175	360	1900
	9	18	3032	13	33	60	228	52400
	10	11	735	3	10	17	140	5400
	11	7	12.57	0.00	2.00	9.00	24.00	30.00
	12	8	5.13	0.00	0.75	5.50	9.25	10.00
TDS	1	25	3534	1720	2710	3516	4339	4940
	2	20	2881	1100	2140	2795	3077	5520
	3	31	1887	405	1390	1740	2360	3724
	4	32	1614	512	1189	1571	2160	2610
	5	32	1548	799	1045	1350	1930	4320
	6	29	1481.8	679.0	1282.5	1528.0	1694.5	2312.0
	7	33	1475.7	687.0	1295.0	1499.0	1690.0	2240.0
	8	32	1523.4	732.0	1417.0	1510.0	1703.0	1856.0
	9	32	1647.6	615.0	1472.5	1566.5	1734.5	2620.0
	10	26	1995.5	1200.0	1580.5	2105.0	2270.0	2650.0
	11	26	2404.2	1710.0	2245.0	2395.0	2542.5	3760.0
	12	28	3027.6	2260.0	2570.0	2985.5	3365.8	4020.0
SSC	1	16	241.1	13.0	62.3	136.0	336.0	1040.0
	2	10	311.1	4.0	129.0	322.0	503.8	685.0
	3	24	2361	71	200	940	2858	13600
	4	16	1897	26	70	484	2476	11000
	5	21	1801	23	68	202	965	12750
	6	19	809	21	120	255	820	4290
	7	20	3192	48	89	191	2315	38300
	8	17	737	44	72	174	269	6220
	9	16	793	25	52	76	250	10900
	10	12	169.8	7.0	30.5	136.5	297.5	498.0
	11	19	130.9	3.0	26.0	65.0	223.0	386.0
	12	13	176.5	24.0	45.0	157.0	297.5	376.0

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Year	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	1956	3	67.0	34.0	34.0	40.0	127.0	127.0
	1957	8	136.9	52.0	53.3	93.0	211.8	375.0
	1958	11	158.5	35.0	46.0	56.0	224.0	510.0

1959	12	63.6	10.0	27.4	51.0	94.0	190.0
1960	12	180	3	15	41	136	1530
1961	10	22.70	3.70	10.58	18.50	29.25	74.00
1962	9	1287	19	104	182	1113	8560
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	3	46.0	22.0	22.0	56.0	60.0	60.0
1975	12	341	6	56	247	369	1600
1976	15	412	29	60	153	360	3050
1977	23	284	14	67	145	221	2950
1978	12	1623	25	43	377	729	9080
1979	13	302.5	0.2	52.0	328.0	416.5	758.0
1980	12	100.6	10.0	22.3	46.5	138.5	362.0
1981	11	367	24	36	66	294	2170
1982	7	161.9	5.4	65.0	74.0	364.0	384.0
1983	17	297.8	35.0	75.5	269.0	434.8	875.8
1984	13	365	2	60	84	327	2850
1985	12	140.3	14.0	30.3	77.5	234.8	443.0
1986	11	1591	62	99	414	593	9450
1987	13	683	33	145	228	563	4970
1988	18	171.9	4.2	32.8	194.0	243.3	540.0
1989	12	146.6	9.7	56.3	121.5	201.0	518.0
1990	11	171.4	27.0	40.0	72.0	124.0	1070.0
1991	10	309	0	81	127	224	1920
1992	10	217	25	27	36	177	1410
1993	12	1993	10	53	234	2174	14900
1994	9	642	38	59	215	1226	2100
1995	9	3463	28	68	160	1020	28400
1996	13	4618	78	231	681	5385	34900
1997	8	959	80	112	332	1458	3890
1998	9	2030	67	230	499	2495	11000
1999	8	1591	81	134	366	2473	7100
2000	9	811	14	74	253	448	5530
2001	8	259.1	40.0	66.0	205.5	428.0	720.0
2002	10	99.5	9.8	37.3	54.0	195.3	258.0
2003	6	811	39	55	122	1212	4360
2004	0	*	*	*	*	*	*

Turbidity

1956	0	*	*	*	*	*	*
1957	0	*	*	*	*	*	*
1958	0	*	*	*	*	*	*
1959	0	*	*	*	*	*	*
1960	0	*	*	*	*	*	*
1961	0	*	*	*	*	*	*
1962	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	0	*	*	*	*	*	*
1975	0	*	*	*	*	*	*
1976	0	*	*	*	*	*	*

1977	0	*	*	*	*	*	*
1978	7	165	1	1	3	260	820
1979	8	180	1	2	23	178	1100
1980	10	88.5	0.6	1.2	4.2	14.8	820.0
1981	9	745	9	16	70	1185	4100
1982	4	29.5	1.0	4.0	14.5	70.0	88.0
1983	7	41.8	0.5	1.3	11.0	66.0	180.0
1984	5	7.86	0.90	2.75	6.80	13.50	17.00
1985	5	8.78	0.70	2.50	8.50	15.20	21.00
1986	7	761	3	3	33	400	4800
1987	5	146	1	7	17	350	600
1988	6	13.07	0.80	1.10	4.70	32.75	35.00
1989	6	216	1	4	16	445	1000
1990	6	19.18	2.30	6.43	19.50	31.50	36.00
1991	5	30.60	15.00	15.00	26.00	48.50	65.00
1992	6	214	7	8	16	330	1200
1993	5	300	2	2	5	745	940
1994	4	207	1	3	47	569	730
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	0	*	*	*	*	*	*
2004	0	*	*	*	*	*	*

SC

1956	3	2630.0	2540.0	2540.0	2610.0	2740.0	2740.0
1957	8	2235	1680	1955	2140	2665	2700
1958	11	2418	1270	2010	2450	2780	3560
1959	12	2752	1990	2190	2690	3163	4160
1960	11	2779	1760	2190	2520	3460	4750
1961	10	2716	1350	2100	2725	3093	4580
1962	9	1922	1200	1515	2060	2220	2480
1969	6	2429	1690	1829	2300	3103	3410
1970	11	2406	1380	1700	2220	2790	4340
1971	12	2131	723	1488	1788	2880	4350
1972	10	2306	888	1463	2218	3186	3935
1973	10	1886	990	1521	1763	1950	3805
1974	3	3130	2840	2840	2930	3620	3620
1975	12	2227	1280	1635	1965	2788	4000
1976	16	2056	390	1668	1895	2673	3420
1977	25	2199	830	1530	1790	2889	4300
1978	23	2091	700	1400	1750	3000	3500
1979	25	2542	1460	1678	1800	3340	6500
1980	23	2706	1710	2010	2600	3200	4500
1981	16	2276	936	1661	2305	2845	3500
1982	12	2397	1825	1973	2305	2688	3400
1983	13	2163	1515	1710	1820	2755	3600
1984	12	2408	1670	1760	2340	2760	4020
1985	11	2480	1420	1890	2140	2990	4000
1986	10	2055	880	1620	1830	2840	3400
1987	12	1948	1140	1595	1910	2298	2650
1988	18	2708	1700	1993	2165	3350	5140



1989	12	2403	1370	2028	2180	2650	3850
1990	10	2107	1640	1773	2030	2433	2920
1991	9	1784	919	1595	1850	2040	2360
1992	10	2061	995	1645	2145	2463	2910
1993	11	1727	818	831	1710	2570	2880
1994	8	1971	1040	1503	1990	2343	2970
1995	9	2154	1040	1620	2380	2665	2910
1996	12	1659	596	1018	1785	2103	2520
1997	8	1711	570	1253	1735	2203	2830
1998	9	1697	950	1325	1750	1830	2820
1999	12	1983	1610	1748	1900	2145	2920
2000	12	2110	1320	1693	1960	2215	4070
2001	14	1922	1280	1643	1920	2229	2690
2002	27	2301	1660	1850	2220	2490	4170
2003	20	2024	1050	1703	2025	2265	3140
2004	12	2460	1620	1700	2085	2753	5910

TSS

1956	0	*	*	*	*	*	*
1957	0	*	*	*	*	*	*
1958	0	*	*	*	*	*	*
1959	0	*	*	*	*	*	*
1960	0	*	*	*	*	*	*
1961	0	*	*	*	*	*	*
1962	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	0	*	*	*	*	*	*
1975	0	*	*	*	*	*	*
1976	4	36.3	7.0	13.8	42.5	52.5	53.0
1977	12	527	7	38	122	1099	1837
1978	12	853	6	10	50	1633	5160
1979	12	146.6	1.0	4.4	57.5	165.8	805.0
1980	10	146	4	4	17	87	1100
1981	7	84.3	4.0	13.0	50.0	110.0	274.0
1982	6	1441	6	8	67	2335	8080
1983	0	*	*	*	*	*	*
1984	0	*	*	*	*	*	*
1985	0	*	*	*	*	*	*
1986	0	*	*	*	*	*	*
1987	0	*	*	*	*	*	*
1988	1	65.000	65.000	*	65.000	*	65.000
1989	0	*	*	*	*	*	*
1990	0	*	*	*	*	*	*
1991	0	*	*	*	*	*	*
1992	0	*	*	*	*	*	*
1993	0	*	*	*	*	*	*
1994	0	*	*	*	*	*	*
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	11	310	11	13	47	836	1300
2000	11	73.9	7.0	10.0	39.0	92.0	320.0

	2001	10	107.1	5.0	15.0	42.0	277.5	310.0
	2002	7	44.1	7.0	8.0	35.0	82.0	110.0
	2003	11	1026	7	11	31	50	11000
	2004	11	98.0	6.0	10.0	42.0	99.0	600.0
Fecal Coliform	1956	0	*	*	*	*	*	*
	1957	0	*	*	*	*	*	*
	1958	0	*	*	*	*	*	*
	1959	0	*	*	*	*	*	*
	1960	0	*	*	*	*	*	*
	1961	0	*	*	*	*	*	*
	1962	0	*	*	*	*	*	*
	1969	0	*	*	*	*	*	*
	1970	4	212	9	11	114	510	610
	1971	9	1022	2	8	88	1775	5000
	1972	10	298	0	8	30	313	2200
	1973	9	1093	14	233	900	2000	3000
	1974	3	12.33	7.00	7.00	10.00	20.00	20.00
	1975	12	413	3	23	170	488	2600
	1976	12	1136	2	6	70	630	11000
	1977	9	7144	3	47	280	5400	52400
	1978	10	886	7	12	30	503	7000
	1979	10	80.9	0.0	5.3	56.5	110.5	370.0
	1980	10	846	0	1	25	155	8000
	1981	3	132	13	13	43	340	340
	1982	6	268	10	30	55	513	1150
	1983	0	*	*	*	*	*	*
	1984	2	3.500	3.000	*	3.500	*	4.000
	1985	1	9.0000	9.0000	*	9.0000	*	9.0000
	1986	0	*	*	*	*	*	*
	1987	0	*	*	*	*	*	*
	1988	1	20.000	20.000	*	20.000	*	20.000
	1989	0	*	*	*	*	*	*
	1990	0	*	*	*	*	*	*
	1991	0	*	*	*	*	*	*
	1992	0	*	*	*	*	*	*
	1993	0	*	*	*	*	*	*
	1994	0	*	*	*	*	*	*
	1995	0	*	*	*	*	*	*
	1996	0	*	*	*	*	*	*
	1997	0	*	*	*	*	*	*
	1998	0	*	*	*	*	*	*
	1999	4	255	60	80	170	515	620
	2000	5	127.0	50.0	67.5	100.0	200.0	280.0
	2001	5	203	18	26	46	460	870
	2002	4	158.8	15.0	36.3	150.0	290.0	320.0
	2003	5	93.2	10.0	11.0	34.0	205.0	250.0
	2004	5	84.4	30.0	37.0	98.0	125.0	150.0
TDS	1956	3	2380.0	2260.0	2260.0	2410.0	2470.0	2470.0
	1957	8	1969	1320	1675	1895	2435	2460
	1958	10	2039	971	1548	2110	2453	3160
	1959	4	2488	1660	1820	2540	3103	3210
	1960	11	2581	1470	1930	2280	3340	4820
	1961	10	2523	1090	1803	2520	2973	4630
	1962	9	1627	924	1100	1740	1980	2240

1969	1	1410.0	1410.0	*	1410.0	*	1410.0
1970	8	1778	1070	1215	1570	2015	3530
1971	12	1747	512	1140	1475	2288	4410
1972	10	1960	644	1207	1855	2695	3640
1973	8	1628	1110	1293	1445	1633	3200
1974	3	2650	2160	2160	2260	3530	3530
1975	12	1911	780	1308	1585	2730	3720
1976	15	2062	700	1490	1810	2850	3450
1977	25	1958	628	1306	1499	2712	4268
1978	23	1761	405	1000	1416	2810	3306
1979	20	2314	1290	1468	1560	2904	5520
1980	21	2363	1390	1810	2240	2800	3790
1981	17	2223	788	1695	2248	2571	4320
1982	10	2183	1564	1623	1940	2260	4690
1983	12	1656	1195	1383	1485	1693	3370
1984	5	2328	1570	1870	2290	2805	3310
1985	5	2502	1650	1665	2540	3320	3760
1986	7	1932	615	1290	1690	2650	3250
1987	10	1624	803	1223	1640	1988	2520
1988	9	2881	1440	1698	2100	4810	4940
1989	6	2097	1070	1550	1795	2763	3790
1990	6	1925	1390	1480	1830	2388	2710
1991	5	1570.0	1230.0	1380.0	1680.0	1705.0	1710.0
1992	6	1873	886	1497	2010	2248	2450
1993	5	1572	732	896	1380	2345	2470
1994	4	1215	730	808	1260	1578	1610
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	8	1637	1265	1325	1562	1996	2143
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	0	*	*	*	*	*	*
2003	6	1650	1300	1300	1450	2000	2600
2004	12	1817	1300	1400	1650	2175	3000

SSC

1956	0	*	*	*	*	*	*
1957	0	*	*	*	*	*	*
1958	3	140.3	99.0	99.0	104.0	218.0	218.0
1959	8	807	4	7	56	1959	3610
1960	10	1981	12	58	94	2408	13600
1961	0	*	*	*	*	*	*
1962	0	*	*	*	*	*	*
1969	0	*	*	*	*	*	*
1970	0	*	*	*	*	*	*
1971	0	*	*	*	*	*	*
1972	0	*	*	*	*	*	*
1973	0	*	*	*	*	*	*
1974	2	341.0	297.0	*	341.0	*	385.0
1975	12	1023	144	297	396	903	4480
1976	9	1750	202	332	501	2638	7960
1977	13	1627	213	251	386	585	11000
1978	9	1955	30	205	410	1990	11800
1979	12	972	114	212	373	2128	2980
1980	12	3513	44	134	193	308	38300

1981	10	1790	107	173	224	1635	10800
1982	6	194.2	83.0	149.8	208.0	237.0	267.0
1983	10	155.8	9.0	20.8	48.0	275.3	675.0
1984	10	740	32	55	124	167	6470
1985	5	128.8	26.0	26.0	145.0	223.5	257.0
1986	8	2939	24	37	501	8125	10900
1987	12	2040	10	50	259	1355	12750
1988	9	382	3	29	61	148	2870
1989	6	616	32	61	110	1138	2780
1990	6	87.0	39.0	60.8	82.5	121.0	133.0
1991	6	96.5	53.0	53.0	73.0	149.8	191.0
1992	6	467	28	39	69	690	2510
1993	5	702	46	50	74	1667	2370
1994	4	622	54	62	382	1423	1670
1995	0	*	*	*	*	*	*
1996	0	*	*	*	*	*	*
1997	0	*	*	*	*	*	*
1998	0	*	*	*	*	*	*
1999	0	*	*	*	*	*	*
2000	0	*	*	*	*	*	*
2001	0	*	*	*	*	*	*
2002	10	141.9	23.0	44.4	71.0	225.8	448.5
2003	0	*	*	*	*	*	*
2004	0	*	*	*	*	*	*

### Descriptive Statistics: Discharge, Turbidity, SC, TSS, Fecal Coliform, TDS, SSC

Variable	Station	N	Mean	Minimum	Q1	Median	Q3	Maximum
Discharge	6438000	401	721	0	50	139	333	34900
Turbidity	6438000	105	209.5	0.5	3.4	13.0	68.0	4800.0
SC	6438000	539	2238.7	390.0	1740.0	2070.0	2660.0	6500.0
TSS	6438000	125	378	1	12	39	112	11000
Fecal Coliform	6438000	139	936	0	13	70	320	52400
TDS	6438000	346	2017.2	405.0	1440.0	1752.5	2422.5	5520.0
SSC	6438000	203	1197	3	68	190	501	38300

### Kruskal-Wallis Test: Discharge versus Month

401 cases were used  
205 cases contained missing values

Kruskal-Wallis Test on Discharge

Month	N	Median	Ave Rank	Z
1	32	22.50	79.3	-6.19
2	24	40.00	116.2	-3.70
3	42	260.50	249.4	2.86
4	35	349.00	239.3	2.05
5	41	261.00	255.7	3.19
6	38	237.00	259.8	3.29
7	34	262.00	270.6	3.66

8	33	230.00	252.9	2.68
9	29	225.00	226.2	1.22
10	32	67.00	148.8	-2.66
11	32	55.50	132.4	-3.49
12	29	46.00	102.2	-4.76
Overall	401		201.0	

H = 137.18 DF = 11 P = 0.000

H = 137.18 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TSS versus Month

125 cases were used

481 cases contained missing values

Kruskal-Wallis Test on TSS

Month	N	Median	Ave Rank	Z
1	5	7.000	27.7	-2.22
2	10	14.500	42.3	-1.89
3	10	28.500	62.0	-0.10
4	12	175.000	75.8	1.29
5	12	53.000	72.2	0.93
6	12	148.500	98.0	3.52
7	13	110.000	87.5	2.58
8	11	52.000	78.6	1.50
9	12	33.500	59.9	-0.31
10	10	32.000	56.9	-0.56
11	9	7.000	23.9	-3.36
12	9	7.000	26.2	-3.17
Overall	125		63.0	

H = 49.67 DF = 11 P = 0.000

H = 49.68 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: SSC versus Month

203 cases were used

403 cases contained missing values

Kruskal-Wallis Test on SSC

Month	N	Median	Ave Rank	Z
1	16	136.00	89.2	-0.91
2	10	322.00	109.1	0.39
3	24	939.50	146.2	3.92
4	16	483.50	122.1	1.42
5	21	202.00	105.8	0.31
6	19	255.00	114.2	0.95
7	20	191.00	115.4	1.07

8	17	174.00	97.4	-0.33
9	16	76.00	73.7	-2.01
10	12	136.50	74.4	-1.68
11	19	65.00	64.6	-2.92
12	13	157.00	82.5	-1.24
Overall	203		102.0	

H = 33.89 DF = 11 P = 0.000

H = 33.89 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: Turbidity versus Month

105 cases were used

501 cases contained missing values

Kruskal-Wallis Test on Turbidity

Month	N	Median	Ave Rank	Z
1	9	2.600	29.7	-2.40
2	6	2.550	30.3	-1.88
3	9	66.000	72.3	1.99
4	9	8.500	61.2	0.85
5	10	45.000	67.2	1.55
6	9	35.000	69.7	1.72
7	9	88.000	79.4	2.72
8	11	32.000	72.0	2.19
9	10	14.000	53.2	0.02
10	6	2.050	20.8	-2.66
11	9	5.500	34.8	-1.87
12	8	1.950	17.3	-3.45
Overall	105		53.0	

H = 49.77 DF = 11 P = 0.000

H = 49.78 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: SC versus Month

539 cases were used

67 cases contained missing values

Kruskal-Wallis Test on SC

Month	N	Median	Ave Rank	Z
1	39	3490	448.5	7.43
2	34	2615	355.1	3.29
3	48	2050	248.7	-0.99
4	50	1995	215.2	-2.61
5	51	1760	173.4	-4.66
6	50	1830	190.2	-3.80
7	52	1820	179.1	-4.43

8	44	1840	191.2	-3.50
9	44	1840	212.9	-2.54
10	45	2350	305.0	1.58
11	42	2650	384.0	4.94
12	40	3305	449.2	7.56
Overall	539		270.0	

H = 213.87 DF = 11 P = 0.000

H = 213.88 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: TDS versus Month

346 cases were used

260 cases contained missing values

Kruskal-Wallis Test on TDS

Month	N	Median	Ave Rank	Z
1	25	3516	307.2	6.94
2	20	2795	262.0	4.08
3	31	1740	164.6	-0.52
4	32	1571	131.0	-2.52
5	32	1350	107.0	-3.95
6	29	1528	108.4	-3.66
7	33	1499	106.7	-4.04
8	32	1510	115.0	-3.47
9	32	1567	135.2	-2.28
10	26	2105	189.2	0.83
11	26	2395	248.5	3.97
12	28	2986	298.0	6.87
Overall	346		173.5	

H = 181.77 DF = 11 P = 0.000

H = 181.78 DF = 11 P = 0.000 (adjusted for ties)

### Kruskal-Wallis Test: Fecal Coliform versus Month

139 cases were used

467 cases contained missing values

Kruskal-Wallis Test on Fecal Coliform

Month	N	Median	Ave Rank	Z
1	6	2.500	30.5	-2.46
2	9	10.000	30.2	-3.06
3	6	135.000	76.3	0.39
4	10	84.000	81.6	0.94
5	16	190.000	88.0	1.90
6	16	165.000	94.7	2.61
7	16	200.000	92.1	2.33

8	16	175.000	81.9	1.26
9	18	60.000	73.8	0.43
10	11	17.000	58.8	-0.96
11	7	9.000	27.1	-2.89
12	8	5.500	16.2	-3.89
Overall	139		70.0	

H = 54.22 DF = 11 P = 0.000  
H = 54.24 DF = 11 P = 0.000 (adjusted for ties)

## Kruskal-Wallis Test: Discharge versus Year

401 cases were used  
205 cases contained missing values

### Kruskal-Wallis Test on Discharge

Year	N	Median	Ave Rank	Z
1956	3	40.00	112.7	-1.33
1957	8	93.00	179.8	-0.52
1958	11	56.00	170.1	-0.90
1959	12	51.00	106.9	-2.86
1960	12	41.25	110.7	-2.74
1961	10	18.50	42.1	-4.39
1962	9	182.00	231.0	0.79
1974	3	56.00	92.2	-1.63
1975	12	246.50	215.5	0.44
1976	15	153.00	212.3	0.38
1977	23	145.00	194.7	-0.27
1978	12	377.40	237.6	1.11
1979	13	328.00	235.5	1.09
1980	12	46.50	127.1	-2.24
1981	11	66.00	182.5	-0.54
1982	7	74.00	184.7	-0.38
1983	17	269.00	241.6	1.47
1984	13	84.00	196.7	-0.14
1985	12	77.50	162.2	-1.18
1986	11	414.00	285.4	2.45
1987	13	228.00	253.9	1.67
1988	18	194.00	181.1	-0.75
1989	12	121.50	175.4	-0.78
1990	11	72.00	156.6	-1.29
1991	10	126.50	192.9	-0.23
1992	10	35.50	135.0	-1.82
1993	12	233.50	234.3	1.01
1994	9	215.00	248.5	1.24
1995	9	160.00	229.4	0.74
1996	13	681.00	317.5	3.68
1997	8	331.50	284.7	2.06
1998	9	499.00	308.9	2.83
1999	8	366.00	295.3	2.32
2000	9	253.00	237.6	0.96
2001	8	205.50	223.6	0.56



2002	10	54.00	139.5	-1.70
2003	6	121.50	197.8	-0.07
Overall	401		201.0	

H = 103.55 DF = 36 P = 0.000  
H = 103.55 DF = 36 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: TSS versus Year

125 cases were used  
481 cases contained missing values

Kruskal-Wallis Test on TSS

Year	N	Median	Ave Rank	Z
1976	4	42.50	54.4	-0.48
1977	12	122.00	86.0	2.31
1978	12	50.00	68.8	0.58
1979	12	57.50	56.0	-0.70
1980	10	17.00	46.2	-1.53
1981	7	50.00	64.2	0.09
1982	6	66.50	67.7	0.32
1988	1	65.00	78.0	0.42
1999	11	47.00	72.3	0.89
2000	11	39.00	58.7	-0.41
2001	10	42.00	62.7	-0.03
2002	7	35.00	55.4	-0.57
2003	11	31.00	54.9	-0.78
2004	11	42.00	61.3	-0.16
Overall	125		63.0	

H = 10.00 DF = 13 P = 0.694  
H = 10.01 DF = 13 P = 0.693 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: SSC versus Year

203 cases were used  
403 cases contained missing values

Kruskal-Wallis Test on SSC

Year	N	Median	Ave Rank	Z
1958	3	104.00	84.7	-0.51
1959	8	56.00	68.7	-1.64
1960	10	94.00	91.7	-0.57
1974	2	341.00	137.5	0.86

1975	12	395.50	147.2	2.75
1976	9	501.00	153.7	2.70
1977	13	386.00	144.2	2.68
1978	9	410.00	135.8	1.76
1979	12	373.00	137.0	2.13
1980	12	193.00	108.4	0.39
1981	10	223.50	125.2	1.28
1982	6	208.00	102.7	0.03
1983	10	48.00	58.7	-2.39
1984	10	123.50	77.3	-1.37
1985	5	145.00	68.8	-1.28
1986	8	500.50	109.0	0.34
1987	12	259.25	104.9	0.17
1988	9	61.00	61.7	-2.10
1989	6	110.00	93.7	-0.35
1990	6	82.50	58.8	-1.83
1991	6	73.00	61.7	-1.71
1992	6	69.00	64.3	-1.59
1993	5	74.00	93.7	-0.32
1994	4	382.00	108.5	0.22
2002	10	71.00	68.9	-1.83
Overall	203		102.0	

H = 58.77 DF = 24 P = 0.000

H = 58.77 DF = 24 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: Turbidity versus Year

105 cases were used

501 cases contained missing values

### Kruskal-Wallis Test on Turbidity

Year	N	Median	Ave Rank	Z
1978	7	2.900	47.8	-0.47
1979	8	23.000	54.7	0.16
1980	10	4.200	36.3	-1.83
1981	9	70.000	77.0	2.47
1982	4	14.500	51.5	-0.10
1983	7	11.000	47.4	-0.51
1984	5	6.800	37.4	-1.17
1985	5	8.500	37.6	-1.16
1986	7	33.000	61.0	0.72
1987	5	17.000	61.2	0.62
1988	6	4.700	37.8	-1.26
1989	6	15.500	57.2	0.35
1990	6	19.500	53.2	0.01
1991	5	26.000	64.9	0.90
1992	6	15.500	61.9	0.74
1993	5	4.700	53.2	0.02
1994	4	47.350	60.3	0.49

Overall 105 53.0

H = 15.63 DF = 16 P = 0.479

H = 15.64 DF = 16 P = 0.479 (adjusted for ties)

\* NOTE \* One or more small samples

## Kruskal-Wallis Test: SC versus Year

539 cases were used

67 cases contained missing values

Kruskal-Wallis Test on SC

Year	N	Median	Ave Rank	Z
1956	3	2610	398.0	1.43
1957	8	2140	297.7	0.51
1958	11	2450	320.9	1.09
1959	12	2690	394.5	2.80
1960	11	2520	372.1	2.20
1961	10	2725	368.6	2.02
1962	9	2060	218.1	-1.01
1969	6	2300	319.5	0.78
1970	11	2220	292.8	0.49
1971	12	1788	223.7	-1.04
1972	10	2218	273.5	0.07
1973	10	1763	175.8	-1.93
1974	3	2930	465.8	2.18
1975	12	1965	254.7	-0.34
1976	16	1895	246.2	-0.62
1977	25	1790	237.7	-1.06
1978	23	1750	233.6	-1.15
1979	25	1800	268.4	-0.05
1980	23	2600	366.3	3.03
1981	16	2305	296.5	0.69
1982	12	2305	333.4	1.43
1983	13	1820	248.3	-0.51
1984	12	2340	310.9	0.92
1985	11	2140	322.9	1.14
1986	10	1830	230.6	-0.81
1987	12	1910	219.2	-1.14
1988	18	2165	339.4	1.92
1989	12	2180	317.0	1.06
1990	10	2030	259.2	-0.22
1991	9	1850	180.0	-1.75
1992	10	2145	262.6	-0.15
1993	11	1710	181.8	-1.90
1994	8	1990	232.2	-0.69
1995	9	2380	278.8	0.17
1996	12	1785	166.3	-2.33
1997	8	1735	168.9	-1.85
1998	9	1750	149.9	-2.33
1999	12	1900	222.3	-1.07

2000	12	1960	242.3	-0.62
2001	14	1920	210.4	-1.45
2002	27	2220	302.9	1.13
2003	20	2025	236.2	-0.99
2004	12	2085	280.3	0.23
Overall	539		270.0	

H = 81.07 DF = 42 P = 0.000  
H = 81.07 DF = 42 P = 0.000 (adjusted for ties)

\* NOTE \* One or more small samples

### Kruskal-Wallis Test: TDS versus Year

346 cases were used  
260 cases contained missing values

Kruskal-Wallis Test on TDS

Year	N	Median	Ave Rank	Z
1956	3	2410	252.5	1.37
1957	8	1895	189.9	0.47
1958	10	2110	191.4	0.57
1959	4	2540	246.9	1.48
1960	11	2280	235.6	2.09
1961	10	2520	236.2	2.01
1962	9	1740	136.7	-1.12
1969	1	1410	80.0	-0.94
1970	8	1570	141.8	-0.91
1971	12	1475	130.3	-1.52
1972	10	1855	167.7	-0.19
1973	8	1445	111.5	-1.77
1974	3	2260	258.2	1.47
1975	12	1585	157.4	-0.57
1976	15	1810	183.9	0.41
1977	25	1499	154.5	-0.99
1978	23	1416	143.5	-1.49
1979	20	1560	179.8	0.29
1980	21	2240	227.9	2.57
1981	17	2248	211.1	1.59
1982	10	1940	197.3	0.76
1983	12	1485	122.8	-1.79
1984	5	2290	228.4	1.24
1985	5	2540	238.5	1.46
1986	7	1690	166.6	-0.19
1987	10	1640	130.8	-1.37
1988	9	2100	233.6	1.83
1989	6	1795	190.3	0.42
1990	6	1830	176.2	0.07
1991	5	1680	125.1	-1.09
1992	6	2010	176.3	0.07
1993	5	1380	120.9	-1.18
1994	4	1260	68.3	-2.12

1999	8	1562	128.8	-1.28
2003	6	1450	126.8	-1.15
2004	12	1650	154.8	-0.66
Overall	346		173.5	

H = 58.11 DF = 35 P = 0.008

H = 58.12 DF = 35 P = 0.008 (adjusted for ties)

\* NOTE \* One or more small samples