MISSISSIPPI DEQ APPROACH TO FECAL COLIFORM TMDLS

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INTRODUCTION

The development of total maximum daily loads (TMDLs) is required for waterbodies not meeting their designated use by Section 303(d) of the Clean Water Act and the implementing federal regulations at 40 C.F.R.§130.7. A TMDL is the total maximum daily load of a pollutant that a waterbody can receive and still meet it's designated use. Mississippi Department of Environmental Quality (MDEQ) has completed 96 Fecal Coliform TMDLs since 1999. These TMDLs have been prepared in accordance with the schedule contained within the federal consent decree between EPA Region Four and the Sierra Club dated December 22, 1998. These TMDLs were done on waterbodies on the Mississippi 1998 Section 303(d) List of Waterbodies. During the past few years, the MDEQ approach to Fecal Coliform TMDLs has undergone many changes and has been fine-tuned in many ways. The components that have been affected include source assessment, water quality monitoring, modeling approaches, and both hydraulic calibration and water quality calibration.

SOURCE ASSESSMENT

The fecal coliform TMDLs begin with a source assessment that includes both point and nonpoint sources.

<u>Point Source Assessment</u>

The first fecal coliform TMDLs done by MDEQ were completed for waterbodies in the Pascagoula River Basin in 1999. The point sources that discharged into these waterbodies were identified using an NPDES permit database that was developed for use by the permitting divisions at MDEQ. This database was lacking information such as latitudes and longitudes of discharge points and in some cases the name of the receiving waterbody. MDEQ has since implemented a new database to track all NPDES permitted facilities. All outfalls in the state are in the process of being located using GPS technology. This new database and specific location information will enable all the point sources in a watershed to be pinpointed exactly in a much more efficient and complete way.

Nonpoint sources that are considered are septic tank failures, agricultural animals, and wildlife contributions. MDEQ began it's nonpoint source assessment of the fecal coliform load by contacting local agriculture and wildlife agencies, reviewing census data, and by using a GIS based tool to review land use features, population densities, and agricultural animal populations. In 1999, information was gathered concerning agricultural animal practices for beef cattle, dairy cattle, hogs, broiler poultry, and layer poultry. This information came primarily from the Natural Resources Conservation Service (NRCS) and the Mississippi Agricultural and Forestry Experiment Station (MAFES). The types of information gathered included animal confinement times and manure application practices. Also, the Mississippi Department of Wildlife, Fisheries, and Parks was contacted concerning approximate wildlife densities in our study areas. The percentage of failing septic tanks for a particular watershed was estimated with help from the Mississippi State Department of Health.

The Watershed Characterization System (WCS) is a GIS based tool developed by Tetra Tech that MDEQ uses to determine agricultural animal populations, human populations, and landuse characteristics. The 1997 agricultural census is used to determine agricultural animal populations by county. This information is then used in conjunction with landuse information to determine the agricultural animal populations in a given watershed. Initially, all agricultural animals were assumed to be distributed evenly throughout a county. The 1990 U. S. Census was used to determine human populations in a given watershed and also how many of those people were connected to a septic tank or a public sewer. The landuse information being used by MDEQ was developed by the Mississippi Automated Resource Information System (MARIS). This landuse information is based on aerial photography taken between 1992 and 1993. A sample map showing the

MARIS landuse for the Upper Hatchie River in the North Independent Basin can be seen in figure 1.

Since the first generation of fecal coliform TMDLs done in 1999, MDEQ has been continually fine tuning the nonpoint source assessment portion of the TMDL. One of the major changes made has been to the approximate time a grazing cow spends loafing in a stream. Initially, it was assumed that a cow spent five percent of its grazing time loafing in a stream, and as a result, five percent of the manure produced was deposited directly to the stream. After discussions with the NRCS and other agencies, MDEQ reduced this to 0.025 percent of the grazing time spent in the stream in the winter months and 0.052 percent of the grazing time spent in the stream in the summer months. Also, MDEQ is currently revisiting all of its agricultural animal practices assumptions with a survey in an attempt to improve the quality of our TMDLs. Another change in our nonpoint source assessment has been with respect to wildlife. Initially an approximated deer density of 45 deer per square mile was used to represent the contribution of all wildlife in the watershed. MDEQ is beginning to focus on other wildlife contributors of fecal coliform such as waterfowl. The Mississippi State Department of Health has also been helpful in estimating septic tank failure rates on a regional basis.

MONITORING

Historically, fecal coliform data were collected either monthly or bi-monthly as part of the ambient monitoring program at MDEQ. The water quality standard for fecal coliform is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. The standard states that, for a contact recreation waterbody, the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than ten percent of the samples examined during any month exceed a colony count of 400 per 100 ml. With samples only being collected once a month or once every two months, it was not possible to identify waters that do not meet the state standards as they are written. Waters were identified as being impaired that had ten percent of the total samples violating the standard. The limited data also make water quality calibration difficult.

Recently, MDEQ increased the frequency of fecal coliform sampling. MDEQ contracted a monitoring project for the Yazoo Basin. All 303(d) listed waterbodies in the Yazoo Basin were identified and monitoring stations selected. Each listed segment had at least one monitoring station. Six samples were taken in a 30-day period for both the summer and winter seasons. This same procedure is currently being implemented. Fecal coliform samples will no longer be taken as part of the ambient monitoring program. This change in fecal coliform monitoring will enable to MDEQ to accurately identify waters that do not meet the state fecal coliform water quality standard. It will also allow for better water quality calibration of the watershed models.

MODELING APPROACHES

<u>BASINS and NPSM</u>

The primary modeling tool that MDEQ uses for the development of fecal coliform TMDLs is the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) and the Nonpoint Source Model (NPSM). BASINS is a multipurpose environmental analysis system for use in performing watershed and water quality based studies. GIS provides the integrating framework for BASINS and allows for the display and analysis of a wide variety of landscape information such as monitoring stations and stream network characteristics. The NPSM model simulates nonpoint source runoff from selected watersheds, point source discharges into stream reaches, as well as the transport and die off of the pollutant through the stream reaches. NPSM also simulates the hydraulic characteristics of the stream. A key reason for using NPSM as the modeling framework is its ability to integrate both point and nonpoint sources in the simulation, as well as its ability to assess instream water quality response.

<u>Mass Balance</u>

One change that MDEQ has made in its fecal coliform modeling efforts is the use of a mass balance approach to the TMDL for waterbodies that would not be adequately modeled by NPSM. These waterbodies include streams that have very small drainage areas or have a very low flow. Most often these are not Reach File Version 1 waterbodies, but are Reach File Version 3 waterbodies. Mass balance TMDLs are phase 1 TMDLs, meaning that further monitoring, source assessment, or modeling will be needed before a final TMDL is established. The TMDL is calculated by taking the water quality standard, typically 200 counts / 100 ml, and multiplying that by the average annual flow in the waterbody to get the counts of fecal coliform. A recent phase 1 fecal coliform TMDL that MDEQ has completed is for Cedar Creek in the Tombigbee Basin.

Special Projects

Another advancement in MDEQ's modeling effort has been special projects for St. Louis Bay and Biloxi Bay. For these TMDLs, the modeling work was contracted out to the Mississippi State University Department of Civil Engineering. Various water quality models were used including NPSM, EFDC, and WASP5. Two-dimensional models were used to simulate the fecal coliform concentrations in the bays. These models also represented the tidal influence on these waterbodies. The models were calibrated and verified based on extensive monitoring projects.

CALIBRATION

Hydraulic Calibration

For the NPSM models, hydraulic calibration was done with United States Geologic Survey (USGS) gages in the watersheds of the impaired waterbodies. Daily flow values from the gages were compared to average daily flow values generated by the model. Parameters in the model were modified to achieve the hydraulic calibration. The new values were used to create new parameter data sets.

The NPSM models for the waterbodies in the Pascagoula River Basin that were completed in 1999 were calibrated for hydrology by the Environmental Protection Agency (EPA) Region Four. MDEQ received these models from EPA with only the hydrology parameters already determined. MDEQ used it's own source assessment assumptions and TMDL scenario selection. In the beginning of MDEQ's fecal coliform TMDL undertaking, hydraulic caibration of the NPSM model would have required more training than time allowed for if the consent decree requirements were going to be met. The result of the 1999 Pascagoula River Basin TMDL undertaking was that MDEQ received some help from EPA Region Four, the TMDL staff received valuable on the job training, and the consent decree was met. A graph showing model output and USGS gage data for the Tallahala River in the Pascagoula River Basin can be seen in figure 2.

As MDEQ continued doing NPSM models for waterbodies throughout the state, more hydraulic calibration of models was needed. With help from EPA Region Four, basinwide hydraulic calibration parameter data sets were created. That is, a hydraulic calibration was performed on the Tombigbee Basin, for instance. This hydraulic calibration was then used for models of any waterbody within the Tombigbee Basin. This technique allowed MDEQ to continue to meet its consent decree obligations while not spending more time than was needed calibrating individual NPSM models.

For the 2002 Yazoo River Basin fecal coliform TMDL undertaking, initial hydraulic calibration was done by Tetra Tech for the hills, the delta, and the transitional regions of the basin. These hydraulic calibration parameter data sets are now being fine-tuned on a waterbody basis. Each NPSM model that is created for a waterbody in the Yazoo River Basin initially uses the hydraulic calibration parameters for the region in which it is located. These parameters are then modified to calibrate each waterbody model, as opposed to just the basin region. A graph showing model output and USGS gage flow for the Little Tallahatchie River in the Yazoo River Basin can be seen in figure 3.

Water Quality Calibration

Initially, water quality calibration was not considered to be possible for the NPSM models. This was due in large part to the very limited amount of water quality data that was available. The source assessment that MDEQ carries out results in a fecal coliform loading rate for the different landuse types that are present in the NPSM model and a continuous discharge of fecal coliform due to agricultural animals, failing septic tanks, and NPDES permitted dischargers. For the first generation of TMDLs that MDEQ developed, the model output from these assumptions was not compared to the water quality data. This was due to the differences in the data and the model output. The fecal coliform data that MDEQ has from its ambient monitoring program is an instantaneous concentration of fecal coliform. It was taken as a grab sample. The output from the model is a daily average of a fecal coliform concentration. A direct comparison cannot be made.

Recently, MDEQ began using the limited water quality data available to do a very basic water quality calibration of the NPSM models. The data are not compared directly to the model output. However, when the monitoring data, the model output, and rainfall data are all reviewed together, some basic calibration can occur. This information is analyzed to see if the model output responds to rain events in a similar manner to the monitoring data. How the model behaves during dry weather can be compared to the monitoring data for dry periods. Also, whether the model output and the monitoring data are of similar magnitude during different weather events can also be determined. A graphical representation of this analysis can be seen in figure 4. The fecal coliform loading rates for the different landuse types or the assumed constant fecal coliform discharge can be modified based on this analysis of the monitoring data, model output, and rainfall data.

CONCLUSION

While MDEQ has always been proud of its TMDL program, we recognize that vast improvements have been made in the past three years, especially with fecal coliform TMDLs. The fecal coliform TMDLs being produced today are of a much higher quality, with more realistic source assessments, increased monitoring, more appropriate modeling, and better model calibration.

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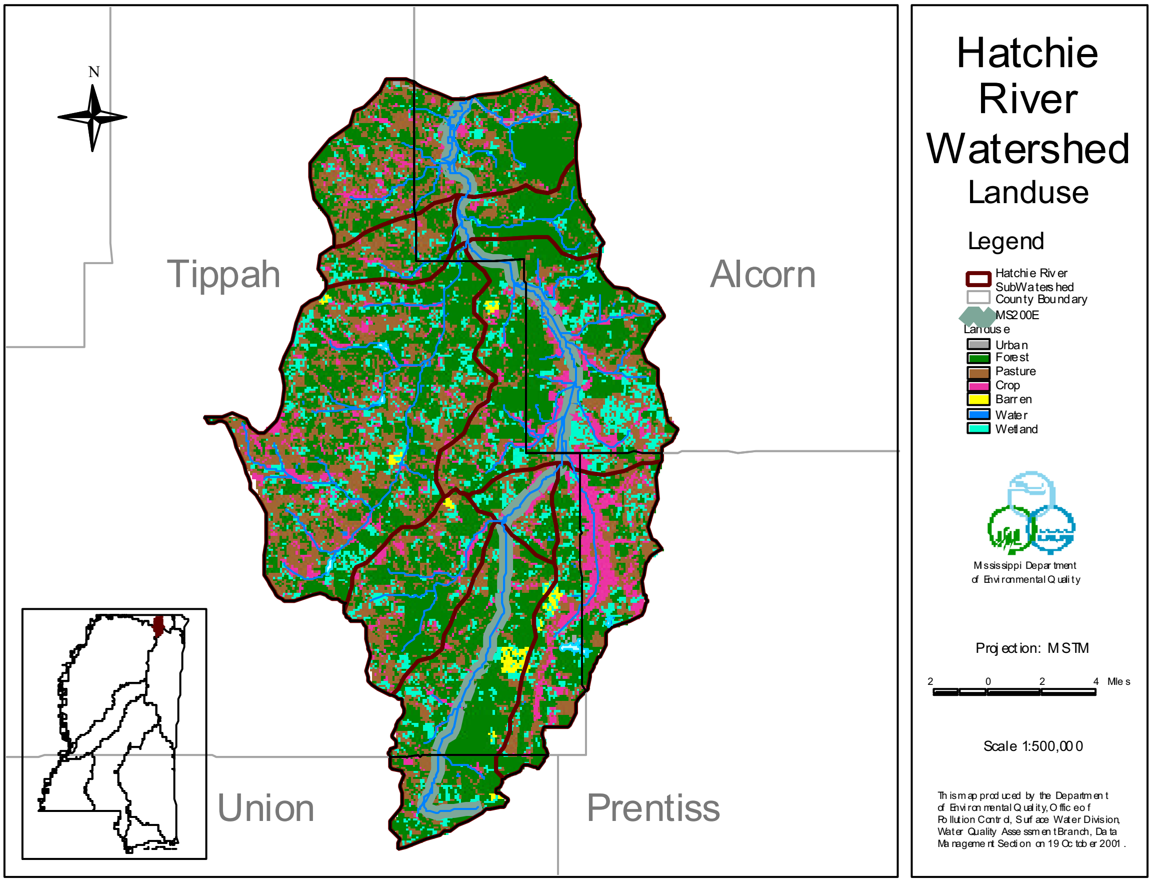

Figure 1: MARIS landuse for the Upper Hatchie River Watershed

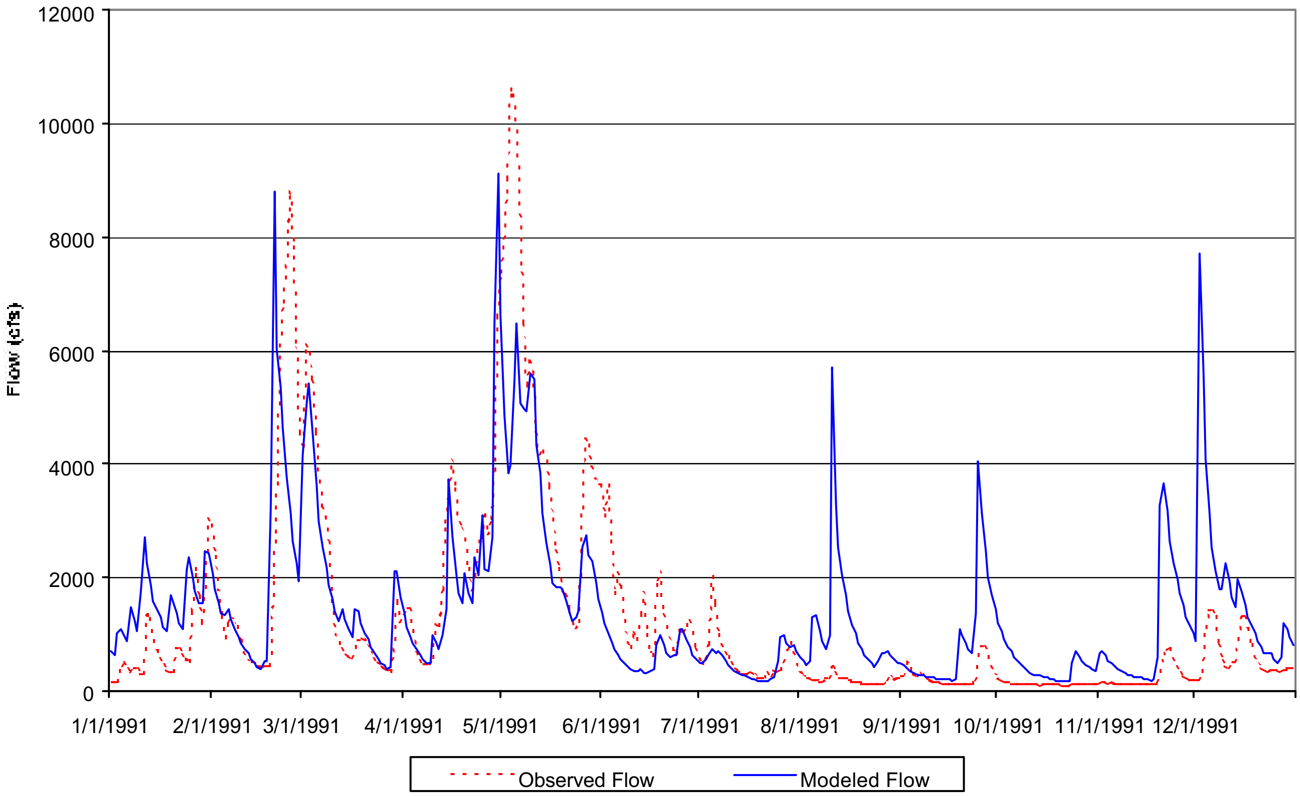

Figure 2: Hydrodynamic Calibration for the Tallahala River in the Pascagoula River Basin

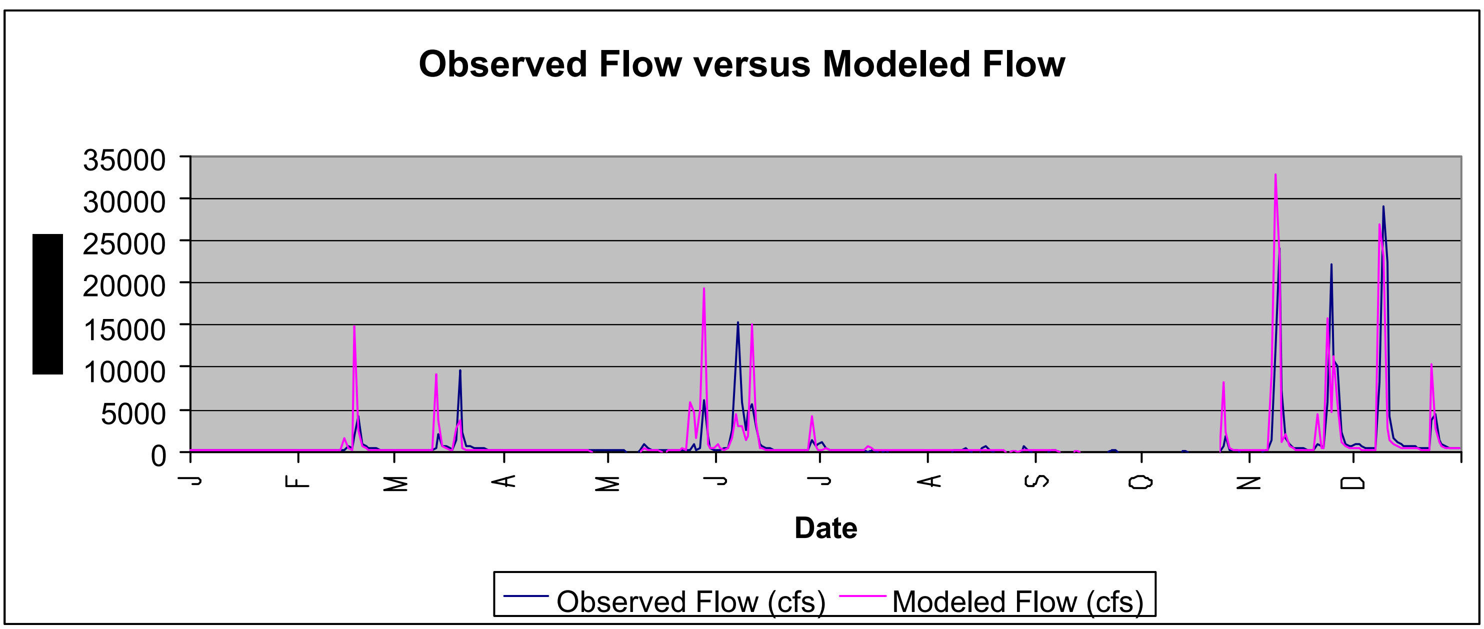

Figure 3: Hydrodynamic Calibration for the Little Tallahatchie River in the Yazoo River Basin

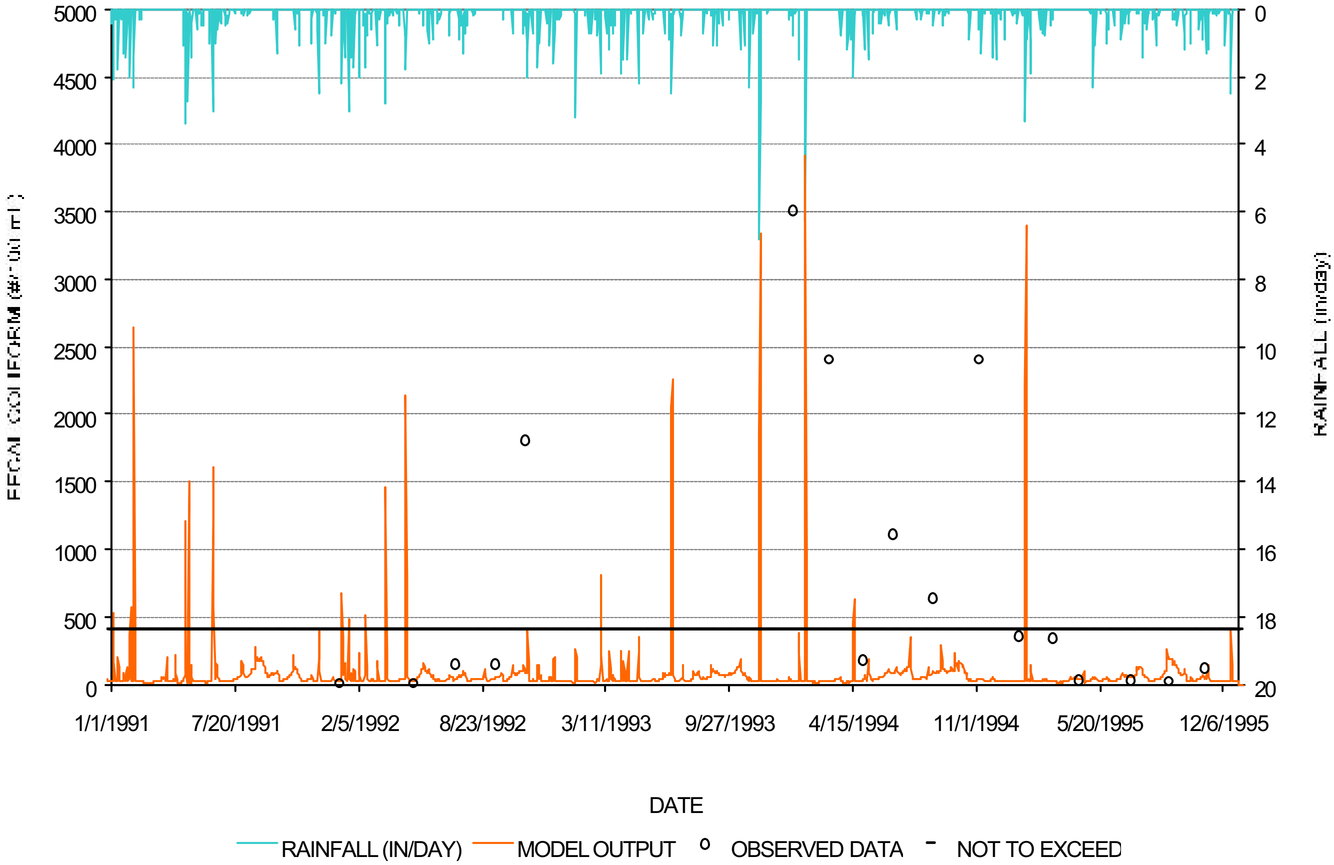

Figure 4: Water Quality Analysis for the Pearl River in Marion County in the Pearl River Basin

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