# Total Maximum Daily Loads for Fecal Coliform for Jarrett Bay and Its Embayment, North Carolina

*[Waterbody ID 21-35-7-22-1, Waterbody ID 21-35-7-22-2, Waterbody ID 21-35-7-22-3, Waterbody ID 21-35-7-22-4, Waterbody ID 21-35-7-22-5, Waterbody ID 21-35-7-22-6, Waterbody ID 21-35-7-22-7a, Waterbody ID 21-35-7-22-7b, Waterbody ID 21-35-7-22a, Waterbody ID 21-35-7-22b, Waterbody ID 21-35-7-22c, Waterbody ID 21-35-7b]*

**Final Report**
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***White Oak River Basin***

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## List of Abbreviations

| | |
|---|---|
| BMP | Best Management Practice |
| CAFO | Confined Animal Feeding Operations |
| cfs | Cubic Feet per Second |
| CFR | Code of Federal Regulations |
| CWA | Clean Water Act |
| CWP | Center for Watershed Protection |
| DEH | Division of Environmental Health |
| DEM | Digital Elevation Model |
| EPA | Environmental Protection Agency |
| FA | Future Allocation |
| GIS | Geographic Information System |
| HSPF | Hydrological Simulation Program FORTRAN |
| HUC | Hydrologic Unit Code |
| LA | Load Allocation |
| LSPC | Loading Simulation Program in $C^{++}$ |
| MF | MF is an abbreviation for the membrane filter procedure for bacteriological analysis. |
| ml | Milliliter(s) |
| MLW | Mean Low Water |
| MOS | Margin of Safety |
| MPN | Most Probable Number |
| MRLC | Multi-Resolution Land Cover |
| NOAA | National Ocean and Atmospheric Administration |
| NCAC | NC Administration Code |
| NCDWQ | North Carolina Department of the Environment |
| NCDENR | North Carolina Department of Environment and Natural Resources |
| NSSP | National Shellfish Sanitation Program |
| SA | Class SA water body: suitable for commercial shellfishing and all other tidal saltwater use |
| SSO | Sanitary Sewer Overflows |
| $T^{-1}$ | Per Tidal Cycle |
| TMDL | Total Maximum Daily Load |
| TP | Tidal Prism model |
| USDA | U.S. Department of Agriculture |
| USGS | United States Geological Survey |
| WLA | Waste Load Allocation |
| WQIA | Water Quality Improvement Act |
| WQLS | Water Quality Limited Segment |
| WWTP | Waste Water Treatment Plant |

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# SUMMARY SHEET

**Total Maximum Daily Load (TMDL)**

**1. 303(d) Listed Waterbody Information**

**State:** North Carolina

**County:** Carteret

**Major River Basin:** White Oak River Basin

**Watershed:** Jarrett Bay and Its Embayment (HUC 03020106)

**Impaired Waterbody (2002 303(d) List):**

| Waterbdy Name – (ID) | Description | Water Quality Classification | Acres |
|---|---|---|---|
| Smyrna Creek - (21-35-7-22-1) | From source to Jarrett Bay | SA | 27 |
| Ditch Cove - (21-35-7-22-2) | From source to Jarrett Bay | SA ORW | 32.1 |
| Broad Creek - (21-35-7-22-3) | From source to Jarrett Bay | SA ORW | 36.6 |
| Great Creek – (21-35-7-22-4) | From source to Jarrett Bay | SA ORW | 71.9 |
| Howland Creek - (21-35-7-22-5) | From source to Jarrett Bay | SA ORW | 26.3 |
| Williston Creek - (21-35-7-22-6) | From source to Jarrett Bay | SA | 24.5 |
| Wade Creek - (21-35-7-22-7a) | From source to DEH closure line | SA | 24.6 |
| Wade Creek - (21-35-7-22-7b) | From DEH closure line to Jarrett Bay | SA | 116.9 |
| Jarrett Bay – (21-35-7-22a) | From head of bay to DEH conditionally approved open line | SA | 37.6 |
| Jarrett Bay - (21-35-7-22b) | From DEH conditionally approved open line to Core Sound | SA | 1111.1 |
| Jarrett Bay - (21-35-7-22c) | DEH closed area at embayment at mouth of Williston Creek | SA | 57.9 |
| Core Sound - (21-35-7b) | Conditionally approved open area at the mouth of Jarrett Bay | SA ORW | 81 |

**Constituent(s) of Concern:** Fecal Coliform Bacteria

**Designated Uses:** Biological integrity, propagation of aquatic life, and recreation.

**Applicable Tidal Salt Water Quality Standards for Class SA Waters:**

*"Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions."*

## 2. TMDL Development

### Development Tools (Analysis/Modeling):

The linked watershed and Tidal Prism modeling approach was used to estimate current fecal coliform load from watersheds and to simulate fecal coliform concentrations in the Bay. The long-term model results were used to establish allowable loads for each restricted shellfish harvesting area in Jarrett Bay. Since the real-time model simulation is used to establish TMDLs, it accounts for the seasonal variability and critical conditions, which thereby represents the hydrology, hydrodynamics, and water quality condition of each selected restricted shellfish harvesting area.

### Critical Conditions:

The 90$^{th}$ percentile concentration is the concentration exceeded only 10% of the time. Since the model simulation period spans 10 years, the critical condition is implicitly included in the value of the 90$^{th}$ percentile of model results. Given the length of the monitoring record and model simulation, the 90$^{th}$ percentile is utilized instead of the absolute maximum.

### Seasonal Variation:

Seasonal variation in hydrology, climatic conditions, and watershed activities are represented through the use of continuous simulation. Model simulations show that high fecal coliform concentrations occurred in January, March, and August for Wade Creek, while fecal coliform concentrations distribution is more evenly distributed over the year in Williston and Smyrna Creeks. The largest standard deviation corresponds to the highest concentration for each station. These high concentrations result in a high 90$^{th}$ percentile concentration. Given the length of the model simulation, the seasonal variability is directly included in the model simulation.

## 3. TMDL Allocation Summary

Model results show that 90$^{th}$ percentile requires highest reduction. The allocation is established based on 90$^{th}$ percentile load.

| Waterbody | Pollutant | Existing | WLA[1] | LA | MOS[2] | Reduction Required | TMDL |
|---|---|---|---|---|---|---|---|
| Williston Creek (21-35-7-22-6) | Fecal coliform (counts/day) | **$8.85\times10^{9}$** | 0.00 | **$2.07\times10^{9}$** | 10% | 74% | **$2.30\times10^{9}$** |
| Wade Creek (21-35-7-22-7a) and (21-35-7-22-7b) | Fecal coliform (counts/day) | **$4.67\times10^{10}$** | 0.00 | **$5.05\times10^{9}$** | 10% | 88% | **$5.61\times10^{9}$** |
| Smyrna Creek (21-35-7-22-1) | Fecal coliform (counts/day) | **$4.7\times10^{10}$** | 0.00 | **$3.81\times10^{9}$** | 10% | 91% | **$4.23\times10^{9}$** |

Notes: WLA = wasteload allocation, LA = load allocation, MOS = margin of safety
WLA = TMDL - LA - MOS;

1 Margin of safety (MOS) equivalent to 10 percent of the target concentration for fecal coliform.

**4. Contributing Municipalities TMDL Allocation Summary : N/A**

**5. Contributing NPDES Facilities TMDL Allocation Summary: N/A**

**6. Public Notice Information**

| | |
|---|---|
| **Summary:** | A draft of the TMDL was publicly noticed through various means. The TMDL was public noticed in the relevant counties through two local newspapers (Carteret County NEWS-TIMES on April 18, 2007 and New Bern Sun Journal on April 22, May 13, and May 14, 2007, Appendix H). The TMDL was also public noticed on April 18, 2007 through the North Carolina Water Resources Research Institute email list-serve (Appendix D). Finally, the TMDL was available on DWQ's website http://h2o.enr.state.nc.us/tmdl/ during the comment period. The public comment period lasted until May 18, 2007. Two written comments were received (Appendix F-1), one from NC Department of Transportation, and another from the Division Soil and Water Conservation(Area 6). DWQ's responses to those comments are provided in Appendix F-2. |
| **Did notification contain specific mention of TMDL Proposal?** | Yes |
| **Were comments received from the public?** | Yes |
| **Was a responsiveness summary prepared?** | Yes, see Appendix F-2 of the TMDL report |

**7. Public Notice Date: April 18, 2007**

**8. Submittal Date: July 13, 2007**

**9. Establishment Date:**

**10. EPA Lead on TMDL (EPA or blank):**

**11. DOT a Significant Contribution (Yes or Blank):**

**12. Endangered Species (yes or blank):**

**13. MS4s Contributions to Impairment (Yes or Blank):**

**14. TMDL Considers Point Source, Nonpoint Source, or both: Nonpoint Source**

## EXECUTIVE SUMMARY

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each state to identify and list waters, known as water quality limited segments (WQLSs), in which current required controls of a specified substance are inadequate to achieve water quality standards. For each WQLS, the State is to either establish a Total Maximum Daily Load (TMDL) of the specified substance that the waterbody can receive without violating water quality standards, or demonstrate that water quality standards are being met.

Jarrett Bay is located in the White Oak River Basin (NC Subbasin 30504 – HUC 03020106050020) in Carteret County, north of Morehead City along the North Carolina coast in the White Oak River Basin. The Bay is located within the shellfish area designated E-8 by the Division of Environmental Health (DEH). The main portion of Jarrett Bay is Conditionally Approved Open, while the tributaries Williston Creek, Wade Creek, and Smyrna Creek are prohibited from shellfish harvesting. Jarrett Bay, Williston Creek, Wade Creek, Smyrna Creek, Ditch Cove, Broad Creek, Great Creek, and Howland Creek are considered impaired on the 2002 North Carolina Integrated Report. Eleven segments in Jarrett Bay are listed as impaired by fecal coliform in specific restricted shellfish harvesting areas. The Jarrett Bay fecal coliform TMDL has been prioritized for TMDL development by the NCDWQ. This document addresses the fecal coliform impairment of these restricted shellfish harvesting areas within Jarrett Bay as listed in the following table.

| 305b_ID | Name | Description |
|---|---|---|
| 21-35-7-22-1 | Smyrna Creek | From source to Jarrett Bay |
| 21-35-7-22-2 | Ditch Cove | From source to Jarrett Bay |
| 21-35-7-22-3 | Broad Creek | From source to Jarrett Bay |
| 21-35-7-22-4 | Great Creek | From source to Jarrett Bay |
| 21-35-7-22-5 | Howland Creek | From source to Jarrett Bay |
| 21-35-7-22-6 | Williston Creek | From source to Jarrett Bay |
| 21-35-7-22-7a | Wade Creek | From source to DEH closure line |
| 21-35-7-22-7b | Wade Creek | From DEH closure line to Jarrett Bay |
| 21-35-7-22a | Jarrett Bay | From head of bay to DEH conditionally approved open line |
| 21-35-7-22b | Jarrett Bay | From DEH conditionally approved open line to Core Sound |
| 21-35-7-22c | Jarrett Bay | DEH closed area at embayment at mouth of Williston Creek |
| 21-35-7b | Core Sound | Conditionally approved open area at the mouth of Jarrett Bay |

This document proposes to establish TMDLs of fecal coliform for Williston Creek, Wade Creek, and Smyrna Creek and to re-categorize the remaining seven segments. These restricted shellfish harvesting areas are impaired by levels of bacteria exceeding North Carolina's water quality standards for fecal coliform, which has resulted in closure of the waterbodies to shellfish harvesting.

Fecal coliform is an indicator organism used in water quality monitoring in shellfish waters to indicate fresh sources of pollution from human waste. When the water quality standard for fecal coliform in shellfish waters is exceeded, waters are closed for shellfish harvesting to protect human health due to the potential risk from consuming raw molluscan shellfish from contaminated waters. The water quality goal of this TMDL is to reduce high fecal coliform concentrations to levels whereby the designated uses for these creeks will be met.

A variety of data at the watershed scale, including shoreline sanitary survey data, were used to identify potential fecal coliform contributions. The potential fecal coliform contributions were estimated using Geographic Information Systems (GIS) data coverage including land use, septic distribution, property, and stream data, concurrently with local agriculture census data. There are no permitted point source facilities in any of the shellfish areas addressed in this report. From these estimates, the major contributions of fecal coliform load are nonpoint sources, including wildlife, pets, failing septic systems, and minimal contribution from livestock.

The linked watershed and Tidal Prism modeling approach was used to estimate current fecal coliform load from watersheds and to simulate fecal coliform concentrations in the Bay. The long-term model results were used to establish allowable loads for each restricted shellfish harvesting area in Jarrett Bay. Since the real-time model simulation is used to establish TMDLs, it accounts for the seasonal variability and critical conditions, which thereby represents the hydrology, hydrodynamics, and water quality condition of each selected restricted shellfish harvesting area. The load is then allocated to sources (human, livestock, pets, and wildlife) by determining the proportional contribution of each source based on animal/source density per land use acre times the fecal coliform production.

One of the critical tasks for these TMDLs is to determine current loads from all potential sources in the watershed. The procedure needs to account for temporal variability caused by the seasonal variation and the wet-dry hydrological conditions. Long-term model simulation was conducted to simulate fecal coliform concentration in the waterbodies. The long-term daily mean load is estimated for each watershed based on the watershed model results. These results were then used to estimate the current load condition. The allowable loads for each restricted shellfish harvesting area were then computed using both the median water quality standard for shellfish harvesting of 14 Most Probable Number (MPN)/100ml and the $90^{th}$ percentile standard of 43 MPN/100ml. An explicitly Margin of Safety (MOS) of 10% was incorporated into the analysis to account for uncertainty. The TMDLs developed for the restricted shellfish harvesting areas of Jarrett Bay basin for fecal coliform load are as follows:

**Williston Creek:**
The fecal coliform TMDL = $2.30\times10^9$ counts per day

**Wade Creek:**
The fecal coliform TMDL = $5.61\times10^9$ counts per day

**Smyrna Creek:**
The fecal coliform TMDL = $4.23\times10^9$ counts per day

The goal of load allocation is to determine the estimated loads for each drainage area while ensuring that the water quality standard can be attained. For restricted shellfish harvesting areas in the Williston, Smyrna, and Wade Creeks, the 90th percentile criterion requires the greatest reduction. Therefore, the load reduction scenario is developed based on the 90th percentile water quality standard. The load reductions needed in the watershed of each restricted shellfish harvesting area to meet the shellfish criteria and the load allocations required to meet the TMDLs are 74%, 88%, and 91%, respectively for Williston Creek, Wade Creek, and Smyrna Creek.

Once the EPA has approved a TMDL, and it is known what measures must be taken to reduce pollution levels, implementation of best management practices (BMPs) is expected to take place. The North Carolina Department of Environment and Natural Resources (NCDENR) intends for the required reductions to be implemented in an iterative process that first addresses those sources with the largest impact on water quality, with consideration given to ease of implementation and cost.

Analysis of existing data provided by the NC DEH Shellfish Sanitation section for Howland Creek, Ditch Cove, Broad Creek, Great Creek, and Jarrett Bay does not indicate that there is an exceedance of the North Carolina Division of Water Quality (DWQ) Surface Water Standard for shellfish harvesting areas in Class SA waters. The purpose of the monitoring performed by the DEH Shellfish Sanitation program is to protect public health and therefore, to determine when waters are safe for shellfishing. For this reason, evaluation of the DEH Shellfish Sanitation water quality data will not always indicate an exceedance of the standard, and in these cases, development of TMDLs will not be appropriate. For DWQ's purposes, these waterbodies or assessment units (AUs) will be considered impaired based on DEH's closure policy, and they will be moved from Category 5 to Category 4CS in the DWQ's Integrated Report to the US EPA. It should be noted that the Jarrett Bay area has a conditional management plan where the bay is temporarily closed to shellfish harvest after 2.0 inches of rain or more in a 24-hour period. The area is not re-opened to shellfish harvest again until satisfactory water samples are obtained. In the future, data needed for TMDL development should include samples collected immediately after a rainfall event causing closure of waterbodies.

**Waterbodies Proposed for Re-categorization**

| Waterbody Name – (ID) | Description | Water Quality Classification | Acres |
|---|---|---|---|
| Ditch Cove - (21-35-7-22-2) | From source to Jarrett Bay | SA ORW | 32.1 |
| Broad Creek - (21-35-7-22-3) | From source to Jarrett Bay | SA ORW | 36.6 |
| Great Creek – (21-35-7-22-4) | From source to Jarrett Bay | SA ORW | 71.9 |
| Howland Creek - (21-35-7-22-5) | From source to Jarrett Bay | SA ORW | 26.3 |
| Jarrett Bay – (21-35-7-22a) | From head of bay to DEH conditionally approved open line | SA | 37.6 |
| Jarrett Bay - (21-35-7-22b) | From DEH conditionally approved open line to Core Sound | SA | 1111.1 |
| Jarrett Bay - (21-35-7-22c) | DEH closed area at embayment at mouth of Williston Creek | SA | 57.9 |

## 1.0 INTRODUCTION

Section 303(d)(1)(C) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each State to develop a Total Maximum Daily Load (TMDL) for each impaired water quality limited segment (WQLS) on the Section 303(d) list, taking into account seasonal variations and a protective margin of safety (MOS) to account for uncertainty. A TMDL reflects the total pollutant loading of the impairing substance a waterbody can receive and still meet water quality standards.

TMDLs are established to achieve and maintain water quality standards. A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include activities such as swimming, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

Jarrett Bay is located in the White Oak River Basin (NC Subbasin 30504 – HUC 03020106050020) in Carteret County, north of Morehead City along the North Carolina coast. The Bay is located within the shellfish growing area designed E-8 by the Division of Environmental Health (DEH). The main portion of Jarrett Bay is Conditionally Approved Open, while the tributaries Williston Creek, Wade Creek, and Smyrna Creek are prohibited due to excessive levels of fecal coliform bacteria. Jarrett Bay, Williston Creek, Wade Creek, Smyrna Creek and several other tributary creeks and coves are considered impaired on the 2002 North Carolina Integrated Report. Monitoring is ongoing in shellfish areas, and openings and closings occur routinely. This report provides an analysis of recent monitoring data and proposes to establish TMDLs of fecal coliform for the impaired shellfish harvesting areas within the Jarrett Bay Basin.

Fecal coliform bacteria are found in the intestinal tract of humans and other warm-blooded animals. Few fecal coliform bacteria are pathogenic; however, the presence of elevated levels of fecal coliform in shellfish waters indicates recent sources of pollution. Some common waterborne diseases associated with the consumption of raw clams and oysters harvested from polluted water include viral and bacterial gastroenteritis and hepatitis A. Fecal coliform may occur in surface waters from point and nonpoint sources.

### 1.1 TMDL Components

The 303(d) process requires that a TMDL be developed for each of the waters appearing in Category 5 of the Surface Water Integrated list. The objective of a TMDL is to estimate allowable pollutant loads and allocate to known sources so that actions may be taken to restore the water to its intended uses (USEPA, 1991). A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality criteria, in this case North Carolina's water quality criteria for shellfish waters. Currently, TMDLs are expressed as a "mass per unit time, toxicity, or other appropriate measure" (40 CFR 130.2(i)). It is also important to note that the TMDLs presented herein are not literal daily limits. These loads are based on an averaging period that is defined by the water quality criteria (i.e., 30 samples per station). The averaging period used for development of these TMDLs requires at least 30 samples and uses the most recent 5-year window of data. Generally, the primary components of a TMDL, as identified by EPA (1991, 1999) and the Federal Advisory Committee (USEPA, 1998) are as follows:

*Target Identification* or selection of pollutant(s) and end-point(s) for consideration. The pollutant and end-point are generally associated with measurable water quality related characteristics that indicate compliance with water quality standards. North Carolina indicates known pollutants on the 303(d) list.

*Source Assessment*. All sources that contribute to the impairment should be identified and loads quantified, where sufficient data exist.

*Reduction Target.* Estimation or level of pollutant reduction needed to achieve water quality goal. The level of pollution should be characterized for the waterbody, highlighting how current conditions deviate from the target end-point. Generally, this component is identified through water quality modeling.

*Allocation of Pollutant Loads*. Allocating pollutant control responsibility to the sources of impairment. The wasteload allocation portion of the TMDL accounts for the loads associated with existing and future point sources. Similarly, the load allocation portion of the TMDL accounts for the loads associated with existing and future non-point sources, stormwater, and natural background.

*Margin of Safety*. The margin of safety addresses uncertainties associated with pollutant loads, modeling techniques, and data collection. Per EPA (2000a), the margin of safety may be expressed explicitly as unallocated assimilative capacity or implicitly due to conservative assumptions.

*Seasonal Variation*. The TMDL should consider seasonal variation in the pollutant loads and end-point. Variability can arise due to stream flows, temperatures, and exceptional events (e.g., droughts, hurricanes).

*Critical Conditions*. Critical conditions indicate the combination of environmental factors that result in just meeting the water quality criterion and have an acceptably low frequency of occurrence.

Section 303(d) of the CWA and the Water Quality Planning and Management regulation (USEPA, 2000a) require EPA to review all TMDLs for approval or disapproval. Once EPA approves a TMDL, then the waterbody may be moved to Category 4a of the Integrated Report. Waterbodies remain in Category 4a until compliance with water quality standards is achieved. Where conditions are not appropriate for the development of a TMDL, management strategies may still result in the restoration of water quality.

TMDL is comprised of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background levels. The TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody, and in the scientific and technical understanding of water quality in natural systems. In addition, the TMDL may include a future allocation (FA) when necessary. Conceptually, this definition is denoted by the equation:

TMDL = WLAs + LAs + MOS + (FA, where applicable)

## 1.2 Documentation of Impairment

The North Carolina Division of Water Quality (DWQ) Surface Water and Wetlands classification for these restricted shellfish harvesting areas is Class SA Waters – Shellfish Harvesting Waters (15A NCAC 02B.0221 Tidal Salt Water Quality Standards for Class SA Waters). A Class SA water is a waterbody that is suitable for commercial shellfishing and all other tidal saltwater use (NCAD 2003).

Twelve segments of Jarrett Bay basin have been included on the 2002 North Carolina Integrated Report. These restricted shellfish harvesting areas located in the Jarrett Bay are identified as areas in this basin that do not meet their designated uses. Waters within this classification, according to 15A NCAC 02B.0021 (Tidal Salt Water Quality Standards for Class SA Waters), must meet the following water quality standard in order to meet their designated use: **"Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions."**

For this report, the monitoring data-averaging period was based on monitoring procedures for classifying SA water, i.e. fecal coliform concentration cannot exceed a median or a geometric mean of an MPN of 14 per 100 ml and the 90$^{th}$ percentile of an MPN of 43 per 100 ml, for six samples per year and 30 samples per station. The averaging period for the monitoring data required at least 30 samples and used all data within the most recent five-year period. For this report, the monitoring data-analysis period was based on the period 1998-2003. The water quality impairment was assessed using the geometric mean, median, and 90$^{th}$ percentile concentrations.

### *1.2.1. Re-categorization of Waterbodies*

The analysis of existing data provided by the NC DEH Shellfish Sanitation section for some of the impaired segments (or assessment units (AUs)) in the Jarrett Bay watershed does not indicate that there is an exceedance of the North Carolina Division of Water Quality (DWQ) Surface Water Standard for shellfish harvesting areas in Class SA waters. This water quality standard is not used to classify growing areas as prohibited, conditionally approved, or approved. NC DEH operates its monitoring program under guidelines outlined in the National Shellfish Sanitation Program's (NSSP's) *Guide for the Control of Molluscan Shellfish*. When a condition or event occurs that would elevate fecal coliform levels that impact the open status of waters, DEH closes those waters to protect public health. The purpose of the monitoring performed by the DEH

Shellfish Sanitation program is to protect public health and therefore, to determine when waters are safe for shellfishing. For this reason, evaluation of the DEH Shellfish Sanitation water quality data will not always indicate an exceedance of the standard, and in these cases, development of TMDLs will not be appropriate. For DWQ's purposes, these waterbodies, or AUs, will be considered impaired based on DEH's closure policy, and they will be moved from Category 5 to Category 4CS in the DWQ's Integrated Report to the US EPA, as explained below.

Shoreline surveys conducted by DEH Shellfish Sanitation in accordance with NSSP guidelines identify potential pollution sources that may intermittently impact water quality and not be detected by water samples collected periodically throughout the year. Examples of potential sources would include marinas, stormwater outfalls, and sanitary sewer pump stations. According to the NSSP *Guide for the Control of Molluscan Shellfish*, if, in the judgment of the state authority (DEH Shellfish Sanitation), pollution sources present an actual or potential public health hazard, those waters cannot be classified as "Approved".

Class SA waters that are not "Approved" based on DEH Shellfish Sanitation growing area classifications are considered "impaired" by DWQ, regardless of water quality data. Non-approved (impaired) growing areas that do not have a measured water quality standards violation will be reassigned in the 2008 Integrated Report to Category 4CS. Waterbodies in Category 4CS are Class SA shellfish harvesting waters that are impaired but do not currently require development of a TMDL due to the following circumstances:

- The waterbody is subject to administrative closure and there is no standards violation.
- Conditional areas where data from DEH Shellfish Sanitation do not indicate a standards violation and data were not collected to assess the water quality standard. (Data are collected for public health management of the growing area).
- The shoreline survey portion of the Sanitary Survey indicates potential pollution sources that could cause the adjacent waters to be unsafe for shellfish harvesting and are closed without required water sampling results.

If waterbodies in Category 4CS are later found to have water quality standards violations based on monitoring data, these waterbodies, or AUs, will be moved to Category 5 requiring development of a TMDL. In the future, data needed for TMDL development should include samples collected immediately after a rainfall event causing closure of waterbodies.

### 1.3 Watershed Description

Jarrett Bay is located in Carteret County, north of Morehead City along the North Carolina coast. Figure 1.3.1 shows the location of the Bay (NC Subbasin 30504 – HUC 03020106050020). The Bay is a western coastal embayment of Core Sound. The length of the Bay is approximately 7.65 km and the width of the Bay is about 1 km near the head of the Bay and 4 km near the mouth. The mean depth of the Bay is about 0.7 m (mean low water). The drainage area is about 9753.3 acres (39.47 $km^2$). The drainage basins of three creeks including Wade Creek, Williston Creek, and Smyrna Creek on the Western Shore of the Bay drain fresh water swamp areas which are adjacent to forest land and two large farms, Open Ground Farm and Smyrna Farm. The drainage areas are located in the low-lying areas characterized by poorly drained soil. The USGS sediment inventory data shows that the dominant soil type is hydrologic class D (U. S. Department of Agriculture (USDA), 1995), which is consistent with the location information. In most areas, the low elevations in the area along with a high water table do not provide adequate conditions for proper functioning of ground absorbing septic systems, especially in winter. The dominant tide in this region is the lunar semi-diurnal ($M_2$) tide with a mean tidal range of 0.48 m (based on the NOAA station at Harkers Island Bridge) with a tidal period of 12.42 hours (NOAA, 2004).

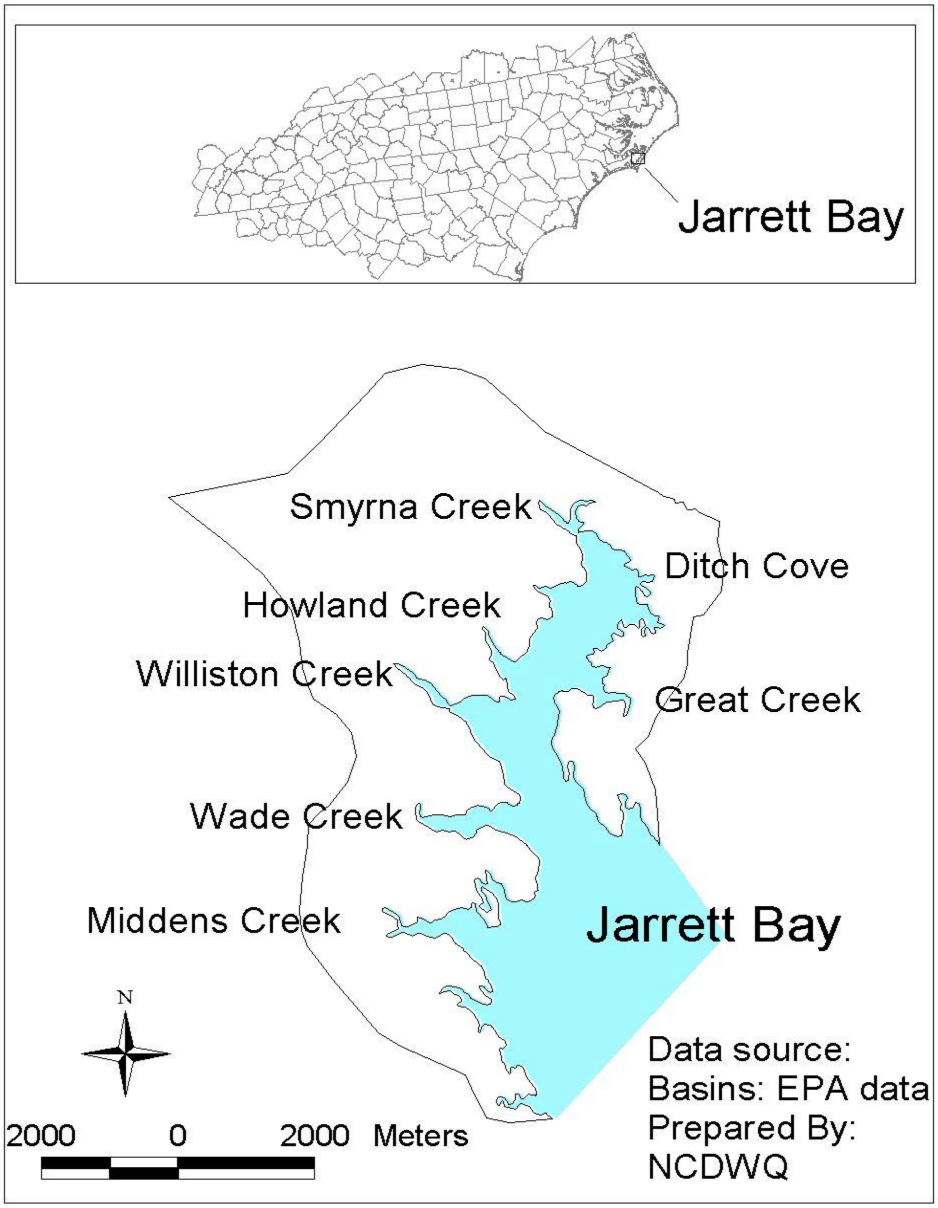


**Figure 1.3.1: Location Map of the Jarrett Bay Basin**

### *1.3.1* Land Use/Land Cover

The USGS Multi-resolution Land Characterization (MRLC) land use/land cover data shows that the watershed can be characterized as rural. The land use distribution is shown in Figure 1.3.2 and land use statistics are listed in Table 1.3.1, in which the land uses are grouped into four categories: wetland, forest, pasture, and urban land. Wetland and forest are dominant land uses in the watershed, which are approximately 62% and 22%, respectively. The urban land including low intensity residential, high intensity residential, and open urban land is less than 1%.

**Table 1.3.1: Land use distributions**

| Land use | Area ($km^2$) | Percent |
|---|---|---|
| Wetland | 24.34 | 61.76 |
| Crop | 6.05 | 15.32 |
| Forest | 8.73 | 22.10 |
| Urban | 0.32 | 0.82 |
| Total | 39.44 | 100 |

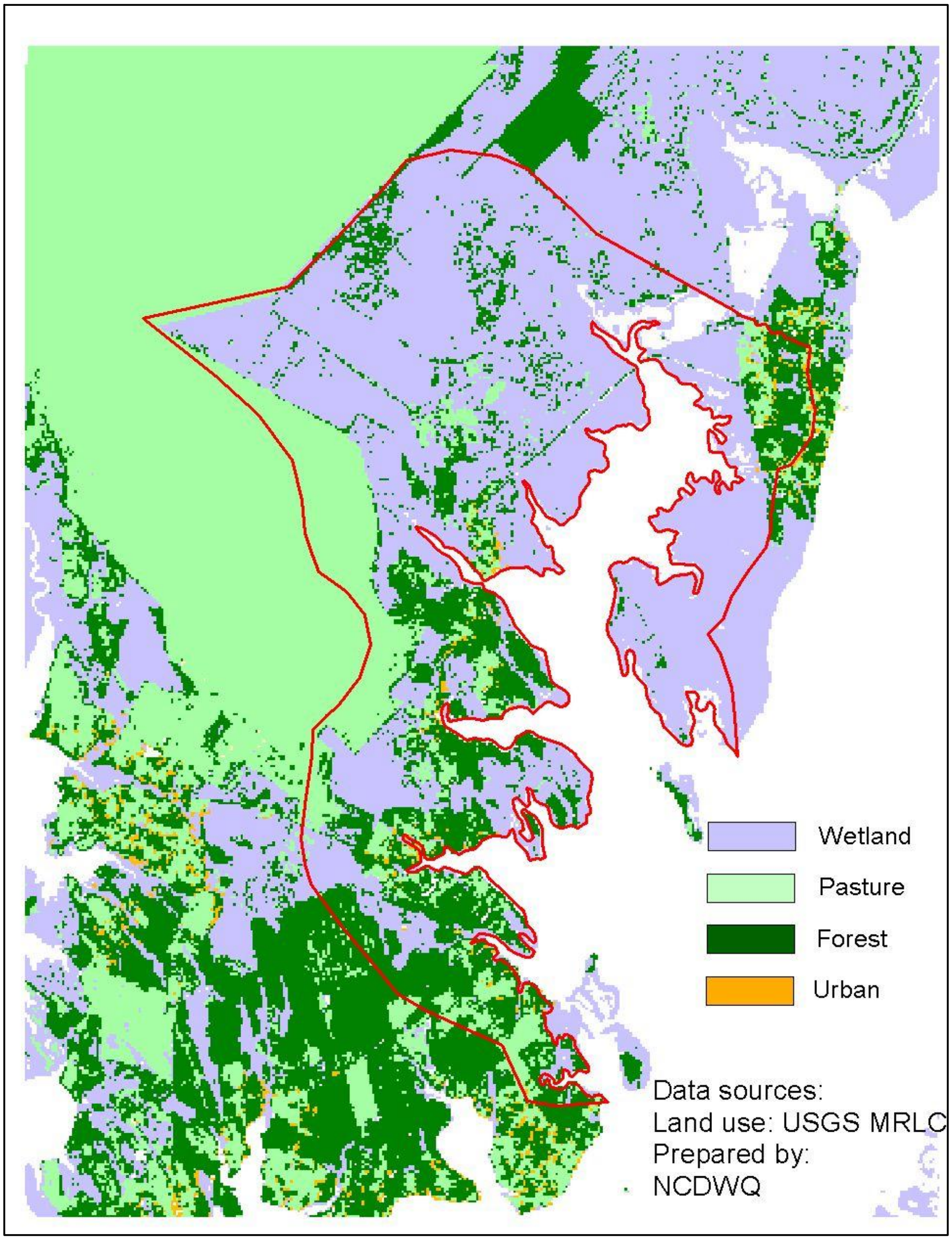


**Figure 1.3.2: Land use distributions**

## 1.4 Water Quality Characterization

The Shellfish Sanitation and Recreational Water Quality Branch of the Division of Environmental Health (NCDEH) is responsible for classifying shellfish harvesting waters to ensure oysters and clams are safe for human consumption. NCDENR adheres to the requirements of the National Shellfish Sanitation Program (NSSP), with oversight by the U.S. Food and Drug Administration. NCDEH conducts shoreline surveys and collects routine bacteria water quality samples in the shellfish-growing areas of North Carolina. The data are used to determine if the water quality criteria are being met. If the water quality criteria are exceeded, the shellfish areas are closed to harvest and the designated use is not being achieved.

NCDEH has monitored shellfish growing regions throughout North Carolina for the past few decades. Jarrett Bay is sampled using the systematic random sampling strategy as outlined in the National Shellfish Sanitation Program's Model Ordinance and guidance document. In addition to the routine bacteriological monitoring of the areas, conditional area samples are collected after rainfall events for some stations. Water quality stations in Jarrett Bay are mostly located in its coastal embayment and most data was collected at least six times a year from 1994 until the present. There are 9 fecal coliform monitoring stations inside the Bay. The locations of these stations are shown in Figure 1.4.1. The data collected from these observation stations are used for the water quality assessment for the TMDL study. The time series plots of these observations are shown in Appendix A. Based on field measurements, the fecal coliform concentrations exceed the water quality standards at four stations: 64, 50B and 50, and 48. These stations are located in Wade Creek, Williston Creek, and Smyrna Creek, respectively. Violations indicate that observed concentrations exceed the 90$^{th}$ percentile water quality standard. Based on analysis of available data, the water quality standards appear to be met at the remaining stations inside Jarrett Bay area. However, the data collected in these creeks is insufficient to determine conformance with the water quality criteria and TMDLs will not be appropriate for these waterbodies. These waterbodies will be reassigned in the 2008 Integrated Report to Category 4CS (See Section 1.2.1 for a detailed description of the reassignment criteria).

**Table 1.4.1: A Summary of Statistics of Observation Data**

| Station | Area | **Last 30 sample geometric mean** (MPN /100ml) | **Last 30 sample Median** (MPN /100ml) | **Last 30 sample 90%** (MPN/100ml) |
|---|---|---|---|---|
| 52 | Wade Creek | 5.89 | 4.5 | 30.6 |
| 64 | Wade Creek | 6.89 | 5.7 | 48.62 |
| 50B | Williston Creek | 6.27 | 2.0 | 65.18 |
| 50 | Williston Creek | 9.43 | 7.8 | 54.04 |
| 49 | Howland Creek | 4.97 | 4.0 | 25.59 |
| 48B | Great Creek | 2.92 | 2.0 | 8.21 |
| 48A | Ditch Cove | 3.65 | 2.0 | 17.70 |
| 48 | Smyrna Creek | 7.89 | 7.0 | 61.96 |
| 8A | Smyrna Creek | 5.76 | 4.5 | 29.84 |

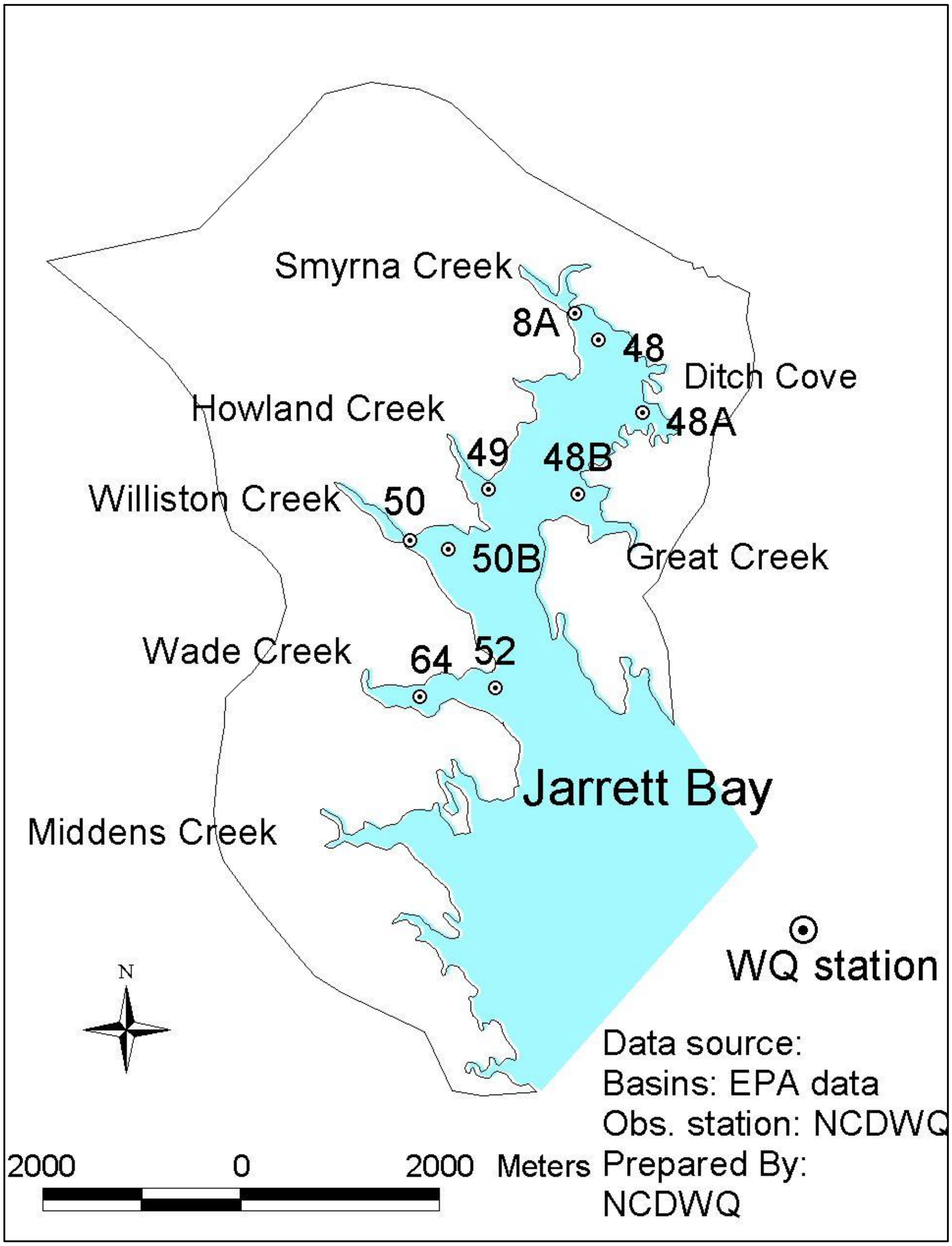


**Figure 1.4.1: Locations of fecal coliform observation stations**

# 2.0 SOURCE ASSESSMENT

## 2.1 Nonpoint Source Assessment

Nonpoint sources of fecal coliform bacteria do not have one discharge point but occur over the entire length of a stream or waterbody. There are many types of nonpoint sources in watersheds discharging to the restricted shellfish harvesting areas. The possible introductions of fecal coliform bacteria to the non-human sources are through the manure spreading process, direct deposition from livestock during the grazing season, and excretions from pets and wildlife. Fecal coliform inputs from livestock sources is minimal in the Jarrett Bay area. During rain events, surface runoff transports water and fecal coliform over the land surface and discharges to the restricted shellfish harvesting area. The deposition of non-human fecal coliform directly to the restricted shellfish area occurs when runoff occurs and when livestock or wildlife have direct access to the waterbody. Nonpoint source contributions to the bacterial levels from human activities generally arise from failing septic systems and their associated drain fields as well as through pollution from recreation vessel discharges. The transport of fecal coliform from land surface to the restricted shellfish harvesting area is dictated by the hydrology, soil type, land use, and topography of the watershed.

The complete distributions of these source loads for the drainage areas of Williston Creek, Wade Creek, and Smyrna Creek are listed in Table 1.5.1, along with counts/day for each loading. These values are direct inputs to the watershed from various sources and do not take decay into account. Details of the source estimate procedure and source distributions for drainage area of other Creeks can be found in Appendix C.

**Table 2.1.1: Distribution of Fecal Coliform Source Loads**

| Area | Fecal Coliform Source | Loading Counts/day | Loading Percent |
|---|---|---|---|
| **Williston Creek** | Livestock | 9.48E+08 | 0.1% |
| | Pets | 1.65E+11 | 25.1% |
| | Human | 8.87E+09 | 1.4% |
| | Wildlife | 4.80E+11 | 73.4% |
| | Total | 6.54E+11 | 100.0% |
| **Wade Creek** | Livestock | 2.20E+08 | 0.1% |
| | Pets | 1.53E+11 | 48.0% |
| | Human | 8.35E+09 | 2.6% |
| | Wildlife | 1.58E+11 | 49.4% |
| | Total | 3.19E+11 | 100.0% |
| **Smyrna Creek** | Livestock | 5.56E+08 | 0.1% |
| | Pets | 1.21E+11 | 22.0% |
| | Human | 6.54E+09 | 1.2% |
| | Wildlife | 4.22E+11 | 76.7% |
| | Total | 5.50E+11 | 100% |

## 2.2 Point Source Assessment

There are no permitted point source facilities discharging fecal coliform directly into any of the restricted shellfish harvesting areas, based on the point source permitting information.

# 3.0 TOTAL MAXIMUM DAILY LOADS AND LOAD ALLOCATION

This section documents detailed fecal coliform TMDL development and allocations for Williston Creek, Wade Creek, Smyrna Creek, Howland Creek, Ditch Cove, Broad Creek, Great Creek, and Jarrett Bay. In order to estimate existing load and allowable load for the Creeks, a watershed model was used to simulate fecal coliform loads from the watershed. Once the fecal coliform is discharged to the receiving water, it will be transported to the different areas in the Bay due to interaction of tide and freshwater discharge and decay. Therefore, the Tidal Prism model was used to simulate fecal coliform concentrations in the Bay. The required load reduction was determined based on five years of modeling results spanning from 1998 to 2003. The TMDL is presented as counts/day. The following sections present the detailed TMDL development and load allocations for the Jarrett Bay area. The first section describes watershed and Tidal Prism models used for the TMDL study and model set up. The second section presents the model calibration and verification procedures. The third and fourth sections address the critical period and seasonal variability. The fifth section discusses TMDL loading caps. The sixth section presents the load allocation and the seventh section presents the margin of safety. Finally, the variables of the equation are combined in a summary accounting of the TMDL.

## 3.1 Modeling Approach

Based on the considerations of both the influence of nonpoint sources and tidal induced transport in the Bay, analysis of the monitoring data, review of the literature, and past pathogens modeling applications, a linked watershed and Tidal Prism modeling approach was used to simulate fecal coliform loading on the watershed and fecal coliform concentration in the Bay. A description of the modeling approach is described in the following section.

### *3.1.1 Watershed Model Description*

The watershed model selected for simulating fecal coliform load on the watershed is the Loading Simulation Program in $C^{++}$ (LSPC). LSPC is a general watershed model developed by the U.S. Environmental Protection Agency (EPA) Region 3, with support from the West Virginia Department of Environmental Protection, and TetraTech, Inc. Continued development and refinement is supported by EPA Regions 3 and 4 (Henry et al., 2002; Shen et al., 2005). LSPC is a stand-alone, PC-based application with built-in GIS functionality. The dynamic watershed model simulates watershed hydrology and pollutant transport, as well as stream hydraulics and in-stream water quality. It is capable of dynamically simulating flow, sediments, metals, temperature, pH, as well as other conventional pollutants for pervious and impervious lands and waterbodies of varying order. The model is essentially a re-coded $C^{++}$ version of selected Hydrological Simulation Program FORTRAN (HSPF) (Bicknell et al., 1996) modules.

The numerical algorithms are identical to those in HSPF. The model has been successfully applied to TMDL studies for in-land watersheds and coastal basins (Henry et al., 2002; Shen et al., 2002; USEPA, 2001).

### *3.1.2 Tidal Prism Model*

The Tidal Prism model (TP) simulates the tidal transport in terms of the concept of tidal flushing (Ketchum, 1951). The tidal prism, or inter-tidal volume, is the amount of water entering and leaving a coastal basin during each tidal cycle. During flood tide, a large amount of water (i.e., the tidal prism) floods into the coastal basin. This amount of water mixes with the lower tidal water within the basin. A portion of pollutant inside the basin will be transported out of the basin during ebb tide as water is transported out of the basin. The Tidal Prism model can simulate pollutant transport in an embayment with multiple branches both temporally and spatially (Kuo and Neilson, 1988; Kuo et al., 1998). Because the Tidal Prism model is capable of simulating pollutants both spatially and temporally, it can be applied to a coastal basin with a high degree of branching. The input data required to run the model only includes tidal range, surface area, and depth of the water body. These data are readily available for most of the small coastal basins. Thus, the tidal prism for each modeling area can be estimated based on the volume of the basins and the tidal range in the area.

### *3.1.3 Model Setup*

Because the Jarrett Bay watershed is located in a low-lying coastal area, the topographic maps and USGS Digital Elevation Model (DEM) data do not have sufficient vertical resolution showing variation of surface elevation. No historical watershed delineation information is available either. Hence, the watershed delineation was conducted based on all available information including DEM, maps, and aerial photos. To provide a better linkage between LSPC and TP models, the Tidal Prism model segmentation was also used as a guideline for the watershed delineation. To represent watershed loadings and linkage between the watershed model and the Tidal Prism model, the watershed was divided into 26 subwatersheds. Figure 3.1.1 shows the watershed delineation. For modeling purposes, the land use data were grouped into 5 categories as listed in Appendix B. The USGS MRLC land use data were used to obtain land use in each subwatershed. The land use distribution for each subwatershed is also listed in Appendix B.

The Jarrett Bay embayment was segmented into 31 segments based on the Tidal Prism model theory (Kuo and Park, 1994), with 8 segments in the main channel and 23 in its tributaries. The segmentation is shown in Figures 3.1.1 and 3.1.2. The volume of each segment is obtained from NOAA survey data together with a local sounding map. The dominant tide in this region is the lunar semi-diurnal ($M_2$) tide with a tidal range of 0.48 m based on NOAA station at Harkers Island Bridge (NOAA, 2002). The surface area of each segment together with tidal range was used to compute the high tide water volume and tidal prisms. Using mean tidal range and mean volume, the model provides the daily mean results, but not the instantaneous condition, which is consistent with the standard. The geometry information of Tidal Prism model is listed in Appendix B. A linkage table was generated to distribute subwatershed loads to their corresponding Tidal Prism segments. Since the Tidal Prism model is on the scale of a tidal cycle (i.e., about 12.42 hours for the $M_2$ tide), the daily load was calculated from hourly loads generated from the watershed model. Then the load for each tidal cycle was calculated and fed to the segments. The simulation period of the Tidal Prism model is the same as that of the watershed model.

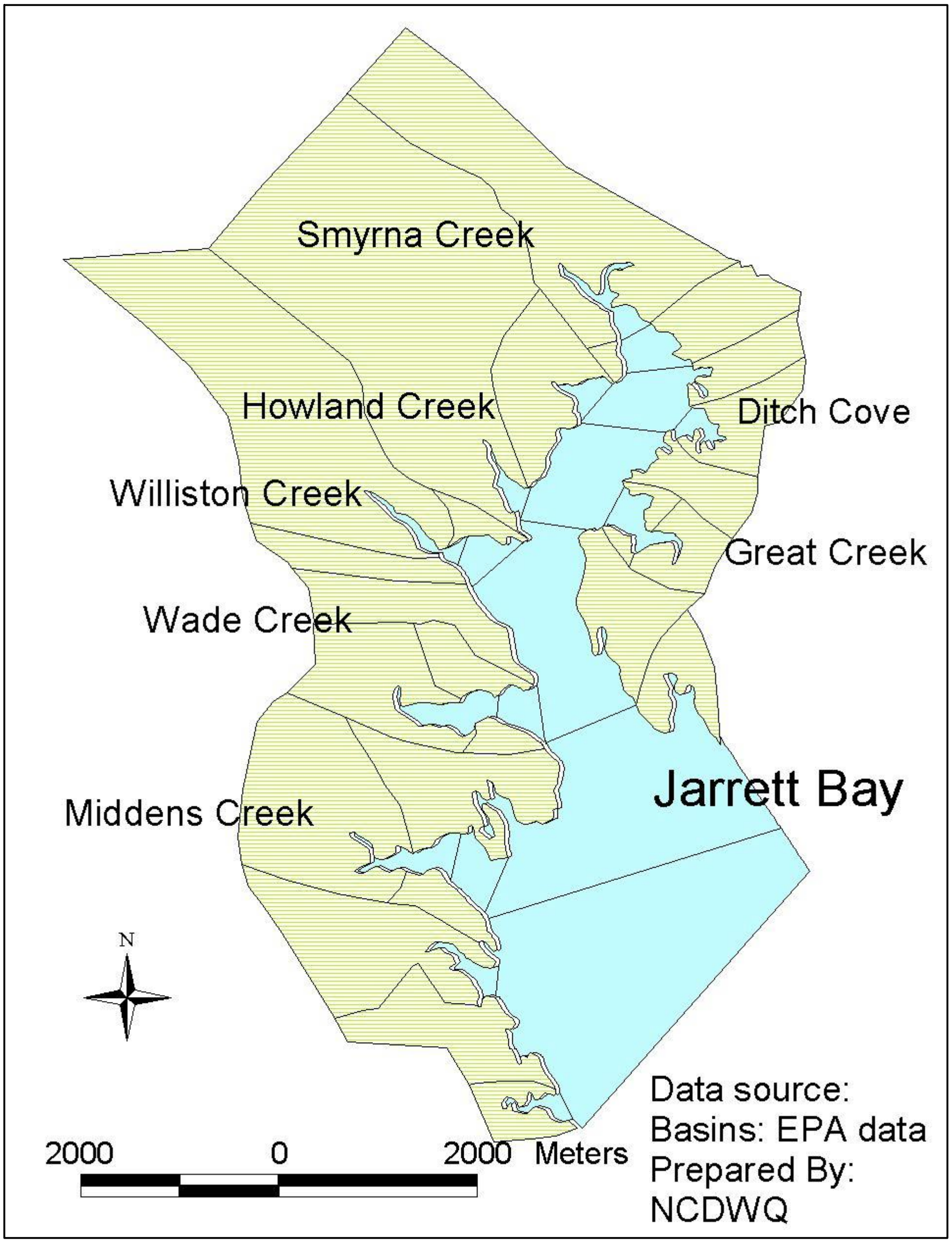


**Figure 3.1.1: Watershed delineation and Tidal Prism model segmentation**

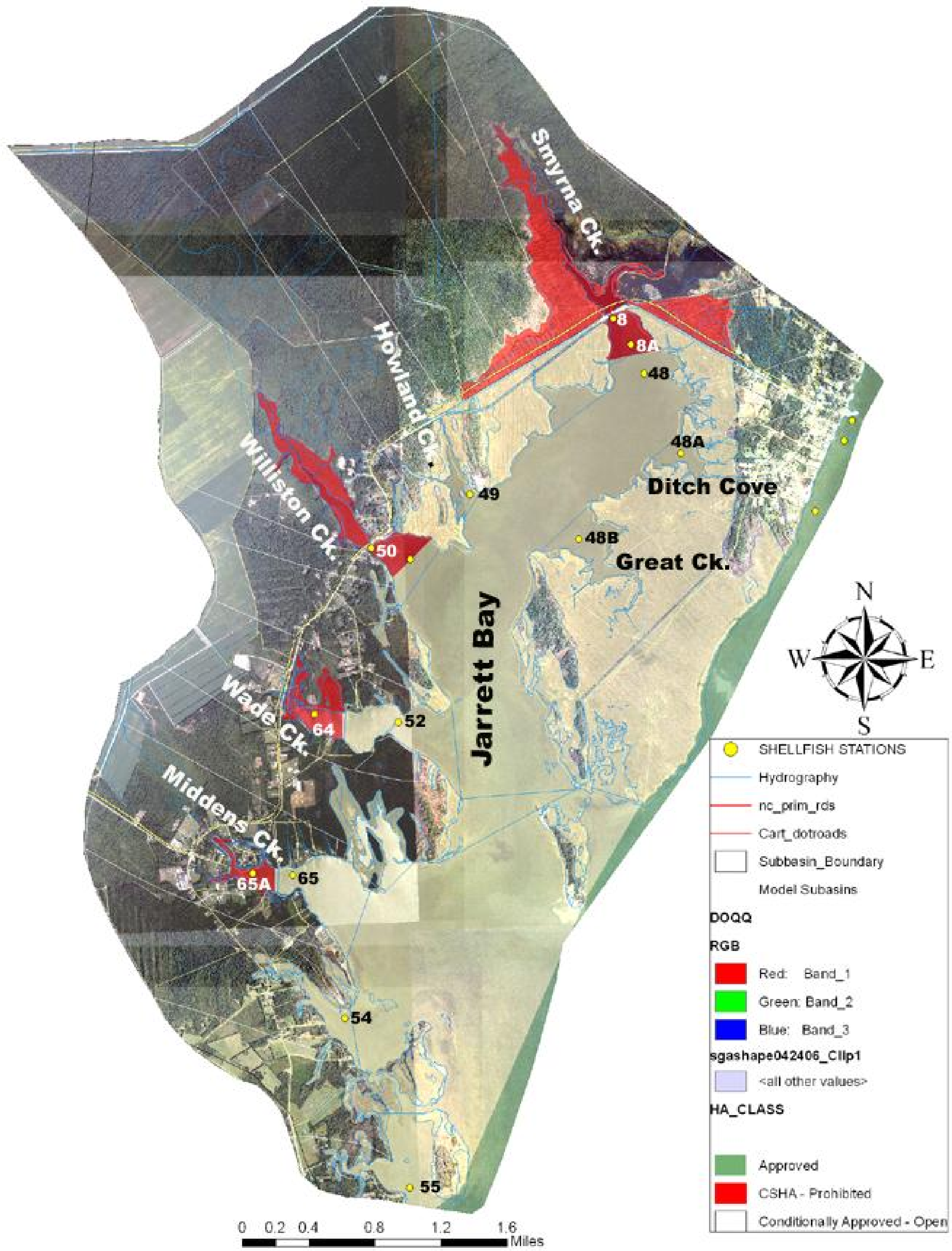


**Figure 3.1.2: Jarrett Bay watershed boundary and model subbbasins**

## 3.2 Model Calibration and Verification

Both watershed and Tidal Prism models are calibrated and verified based on observation data. Detailed description of the model calibration and verification is presented in the following sections.

### *3.2.1 Meteorological data*

Meteorological data are a critical component of the watershed model. Appropriate representation of precipitation, potential evapotranspiration, cloud cover, temperature, and dewpoint are acquired in an effort to develop the most representative dataset for the Jarrett Bay watershed. In general, hourly precipitation data are recommended for nonpoint source modeling due to the storm sensitive processes. The meteorological data used in this study is the hourly data obtained from the NOAA weather station at Morehead City 2 WNW, NC, which provides the best available long-term data set in the area.

### *3.2.2 Watershed model calibration*

The hydrology of the LSPC model was calibrated and verified for water years from 1989 to 1990. Because there is no long-term USGS gauge station in the drainage basin, the hydrology calibration was conducted by using a reference watershed calibration approach. The model hydrology parameters are calibrated based on the nearest USGS gauge station in the upper part of the New River basin (USGS Gauge 02093000), which is approximately 90 km west from Jarrett Bay. The hydrology calibration involved adjustment of the model parameters used to represent the hydrologic cycle until acceptable agreement was achieved between simulated flows and historic stream flow data measured at the gage for the same period of time. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge. The water years 1989 to 1990 were used for the model calibration. The calibrated parameters are in the same range as those parameters used in the Eastern Shore, a low-lying region of Virginia. These calibrated hydrological parameters were used for the Jarrett Bay watershed. An example of model simulation of daily flow in 1990 is shown in Figure 3.2.1. The model was further verified by comparing the model simulation against the data at USGS gauge station from water years 1991 to 1998. An example of model verification in year 1998 is shown in Figure 3.2.2. A 10-year accumulative flow simulation results is shown in Figure 3.2.3. The results show that the long-term water budget is balanced and the hydrology simulation is satisfactory.

In modeling the fecal coliform processes, LSPC uses the same algorithm in HSPF that is based on the 'build-up and wash-off' approach with user-prescribed monthly build-up and wash-off rates for the fecal coliform sources for different land use categories (Shen et al., 2005). In this study, the 26 subwatersheds were grouped into 8 groups based on estimated fecal coliform accumulation rates. Subwatersheds in the same group will use the same parameter set that has similar accumulation rate for each land use category. The accumulation rate of fecal coliform for each group was estimated partly based on the field survey data (e.g., numbers of septic systems, manure application, livestock, poultries and wildlife). The wildlife contributions were applied to forest, wetland, and pasture. The livestock contributions were applied to pasture and cropland. Livestock account only 0.1% of the fecal colifrom load in the watershed. The contribution of pets and urban runoff were applied to residential lands. However, exact wildlife numbers are usually difficult to obtain, and thus an empirical estimation based on wildlife density and their habitat was used to estimate the rates. These parameters were further calibrated during the Tidal Prism model calibration process as necessary. Fecal coliform production rates of different kinds of sources were based on the empirical numbers in previous studies and literature (see Appendix C). Detailed source estimation is presented in Appendix C. In this study, the fecal coliform storage limit was set to be 9 times the accumulation rate, which represents a decay rate of 0.1 day$^{-1}$ (USEPA, 1985). Because there are no direct fecal coliform measurements available in the watershed, the model calibration is based on the simulation of fecal coliform concentration in the Bay using the linked watershed and Tidal Prism modeling approach.

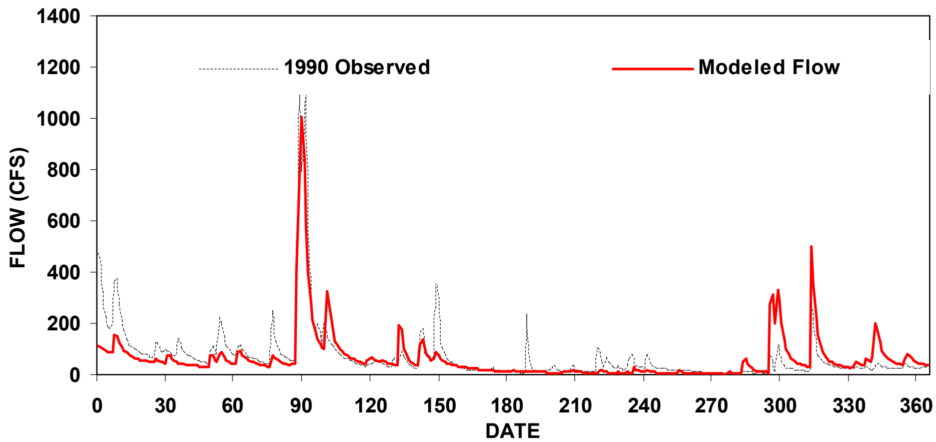


**Figure 3.2.1: Example of hydrology model calibration (1990)**

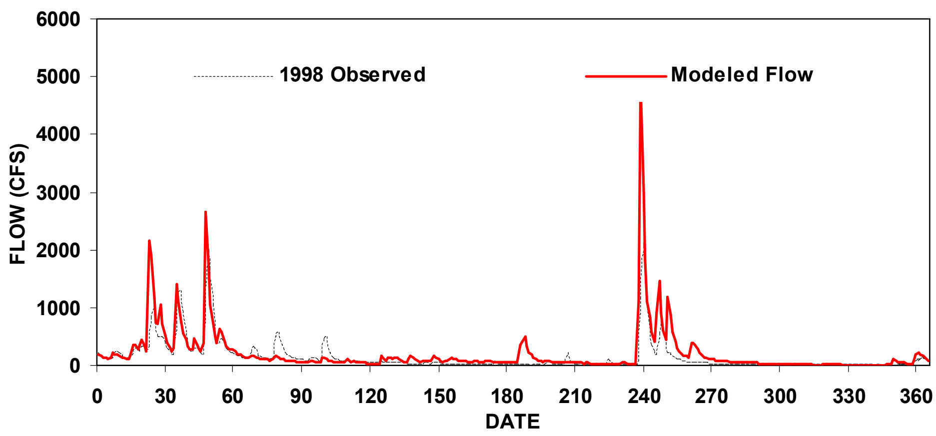


**Figure 3.2.2: Example of hydrology model verification (1998)**

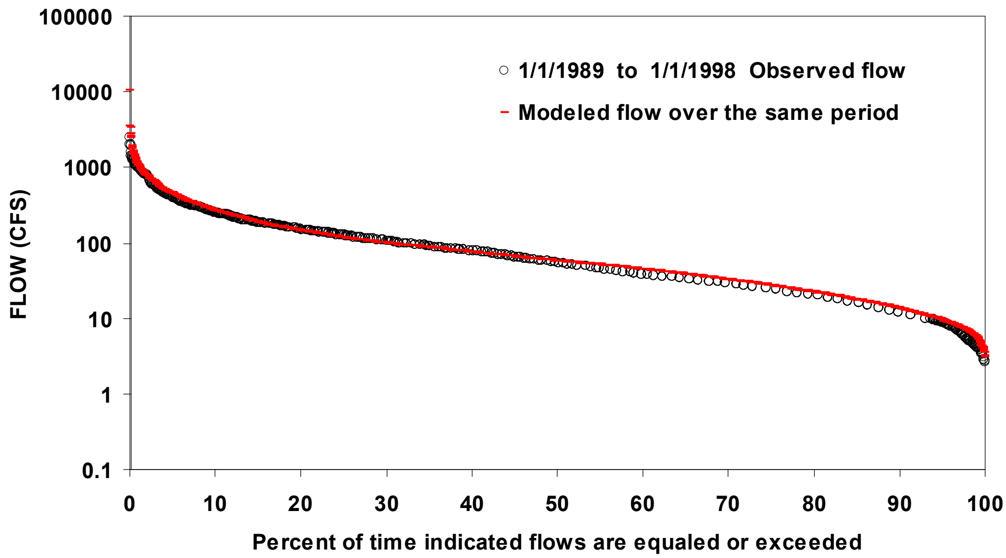


**Figure 3.2.3: Comparison of long-term model results and USGS flow data**

### *3.2.3 Tidal Prism model calibration*

The Tidal Prism (TP) model calibration was conducted based on the comparison of model simulated fecal coliform in the Bay and observations. The only parameters that need to be calibrated are return ratio and fecal coliform decay rate in the TP model. The return ratio of 0.3 was used in the TP model. The return ratio is the fraction of water leaving the embayment during the ebb tide that will be transported back to the embayment during the next flood tide. The return ratio ranges from 0 –1. Past studies of the Tidal Prism model have demonstrated that the calculated salinity is relatively insensitive to the value of return ratio between 0.1 to 0.5 and the value of 0.3 works well for small creeks in Virginia (Kuo, et al., 1998). The first order decay is used in the model to represent the fecal coliform die-off due to temperature, salinity, and solar radiation, and loss due to settling and other factors. A system with a higher decay rate has a higher assimilative capacity than the system with lower decay rate. The value of the decay rate varies from 0.7 to 3.0 per day in salt water (Mancini, 1978; Thomann and Mueller, 1987). A decay rate of 0.7 per day was used as a conservative estimate in the TMDL calculation.

Figure 3.3.4, Figure 3.3.5, and Figure 3.3.6 show the 10-year simulation results for Wade Creek, Williston Creek, and Smyrna Creek, respectively. The model verifications at other stations are shown in Appendix D. The 10-year model simulations show that the model captured seasonal variability and peak fecal coliform concentrations. It is understandable that the model may fail to simulate some isolated events due to the high variability of the nature of fecal coliform, which has a quick response to an isolated event. The measurements show the lowest concentration is always 1.7 MPN/100ml. This is probably due to the methods used for determining the fecal coliform counts. The high concentration is more critical for determining the capacity. Judging from long-term simulation results, the overall model performance is satisfactory.

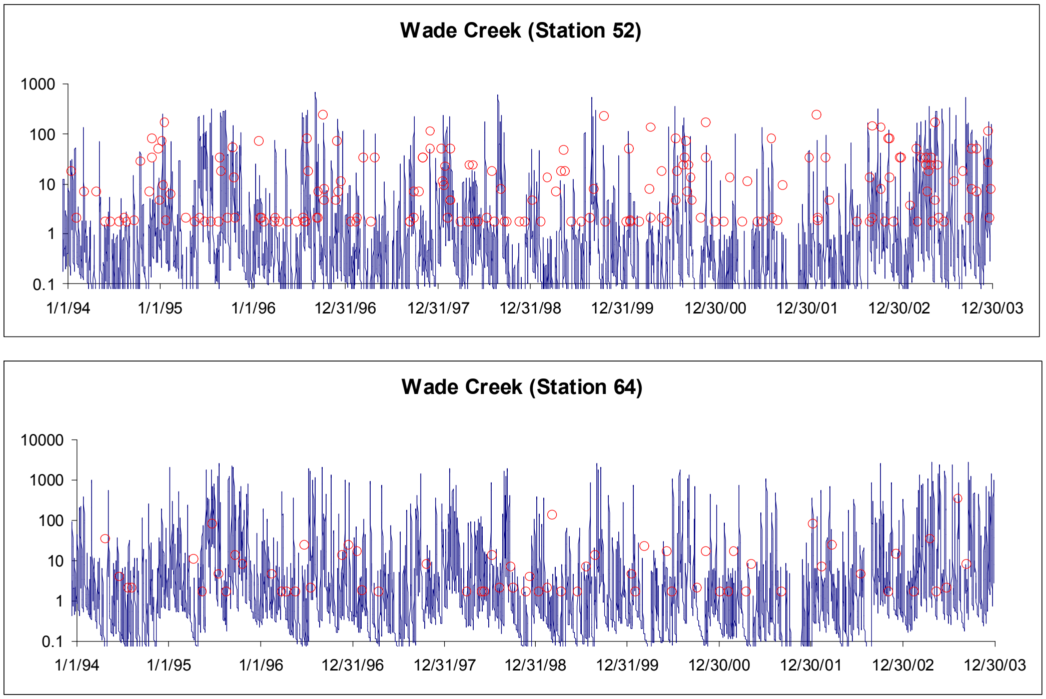


**Figure 3.3.4: Comparisons of model simulation of fecal coliform and observations (Wade Creek)**

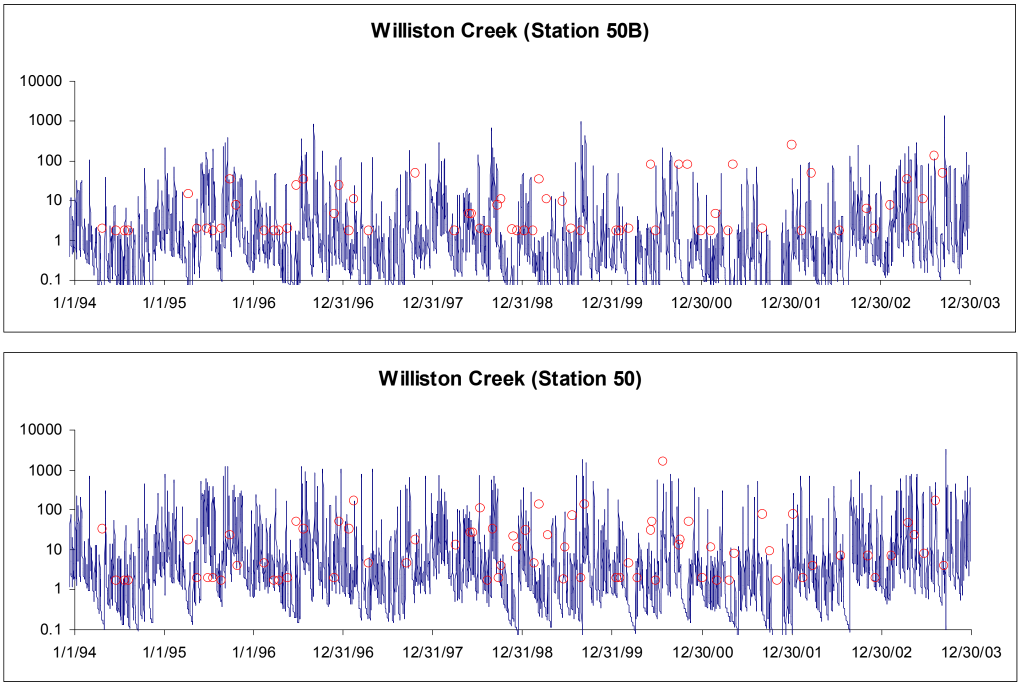


**Figure 3.3.5: Comparisons of model simulation of fecal coliform and observations (Williston Creek)**

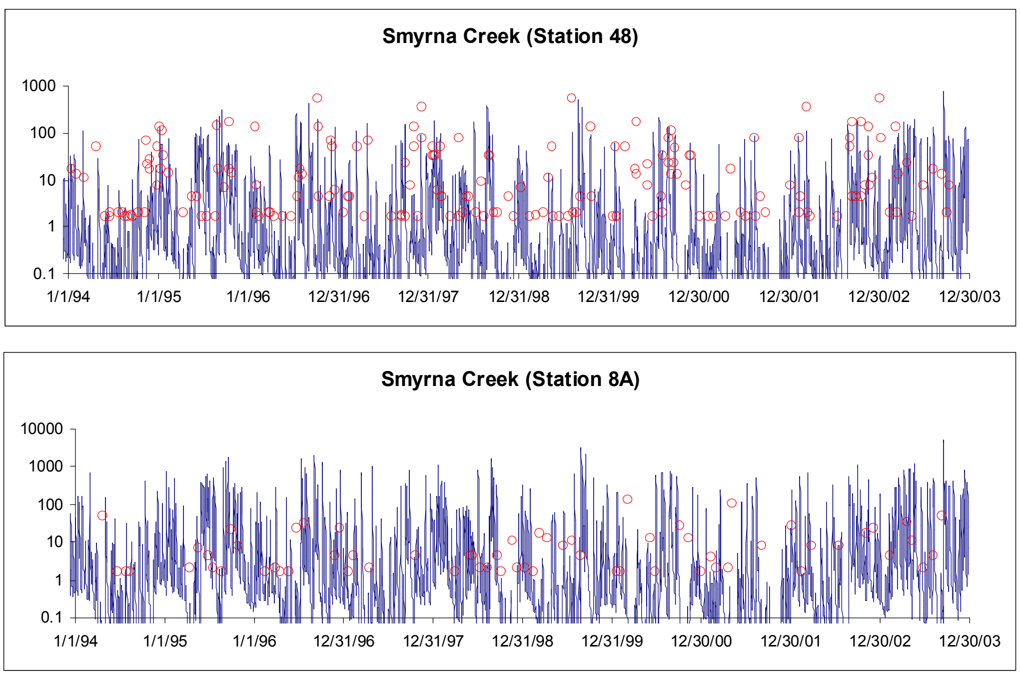


**Figure 3.3.6: Comparisons of model simulation of fecal coliform and observations (Smyrna Creek)**

#### *3.2.4 TMDL Calculation*

The existing load (or current condition) for each impaired creek is estimated as the sum of all the loads from subwatersheds discharging into the creek. The loading is expressed as counts per day. The TMDL calculation is based on the water quality criteria, i.e., median and 90$^{th}$ percentiles. For a Tidal Prism model segment indicating impairment due to excessive fecal coliform loading from the watershed, the loading from its drainage area is reduced until the simulated fecal coliform concentration satisfies the water quality criteria during the five-year model simulation. The running 30-month median and 90$^{th}$ percentile were calculated for each Tidal Prism segment so that both water quality standards are met through the model simulation period. The final loading input to the Tidal Prism model segment was computed as the TMDL for its corresponding subwatersheds. The load reduction is computed based on the difference of current condition and TMDL loads. For those Tidal Prism model segments not showing violation, no load reduction was conducted. The existing loading for each drainage basin of the Creek is listed in Table 3.2.1. For impaired creeks, the TMDLs and estimated reduction are provided. The time series plots of median and 90$^{th}$ percentile for each tidal segment under existing condition and after reduction are presented in Appendix E.

**Table 3.2.1: Existing Load and Allowable Load By Watershed**

<table>
<tr><th>Creek Name</th><th>Existing Load (Count/day)</th><th>Allowable Load (Count/day)</th><th>Reduction</th><th>Notes</th></tr>
<tr><td>Broad Creek</td><td>4.33E+08</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><td>Ditch Cove</td><td>5.91E+08</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><td>Great Creek</td><td>3.39E+08</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><td>Howland Creek</td><td>8.11E+08</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><td>Smyrna Creek</td><td>4.70E+10</td><td>4.23E+09</td><td>91%</td><td></td></tr>
<tr><td>Wade Creek (a)</td><td rowspan="2">4.67E+10</td><td rowspan="2">5.61E+09</td><td rowspan="2">88%</td><td rowspan="2">Existing loads and allocation of these 2 areas are combined due to tidal mixing</td></tr>
<tr><td>Wade Creek (b)</td></tr>
<tr><td>Williston Creek</td><td>8.85E+09</td><td>2.30E+09</td><td>74%</td><td></td></tr>
<tr><td>Jarrett Bay</td><td>1.38E+10</td><td>N/A</td><td>N/A</td><td>Existing loads of 3 listed areas in the Jarrett Bay are combined due to tidal mixing</td></tr>
<tr><td>Core Sound</td><td>N/A</td><td>N/A</td><td>N/A</td><td>The drainage area of Jarrett Bay is not the only source of Core Sound.</td></tr>
</table>

For the remaining areas, plots of median and 90$^{th}$ percentile for each tidal segment are also presented in Appendix E. The analysis of available data and the current 5-year model simulation for Howland Creek, Ditch Cove, Great Creek, Jarrett bay, and Broad Creek does not indicate that there is an exceedance of the North Carolina Division of Water Quality (DWQ) Surface Water Standard for shellfish harvesting areas. Therefore, load reduction is not necessary to achieve water quality standard, and estimation of TMDLs for these areas is not appropriate. These waterbodies, or AUs, will be considered impaired based on DEH's closure policy, and they will be moved from Category 5 to Category 4CS in the DWQ's Integrated Report (see Section 1.2.1 for detailed description of the re-categorization criteria).

### 3.3 Critical Condition

The EPA Code of Federal Regulations (40 CFR 130.7 (c)(1)) requires TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the waterbody is protected during times when it is most vulnerable. The critical condition accounts for the hydrologic variation in the watershed over many sampling years whereas the critical period is the condition under which a waterbody is the most likely to violate the water quality standard(s).

The $90^{th}$ percentile concentration is the concentration exceeded only 10% of the time. Since the model simulation period spans 10 years, the critical condition is implicitly included in the value of the $90^{th}$ percentile of model results. Given the length of the monitoring record and model simulation, the $90^{th}$ percentile is utilized instead of the absolute maximum.

### 3.4 Seasonality

Fecal coliform distributions often show high seasonal variability, which is required to be considered in calculation TMDLs. The seasonal fecal coliform distributions for each station in Williston and Wade Creeks are presented in Figure 3.4.1 and Figure 3.4.2, respectively. The results show that high fecal coliform concentrations occurred in January, March, and August for Wade Creek, while fecal coliform concentrations are more evenly distributed over the year in Williston Creek. The largest standard deviation corresponds to the highest concentration for each station. These high concentrations result in a high $90^{th}$ percentile concentration. Given the length of the model simulation, the seasonal variability is directly included in the model simulation.

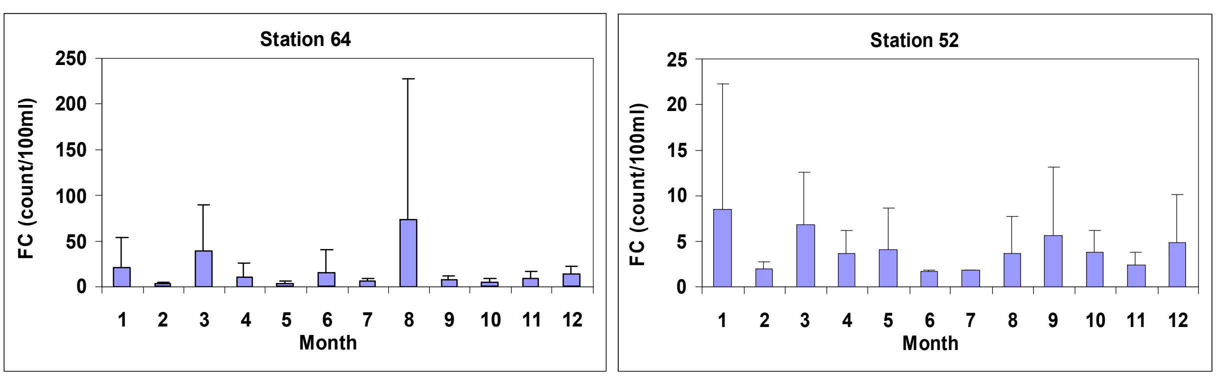


**Figure 3.4.1: Seasonal distribution of fecal coliform in Wade Creek**

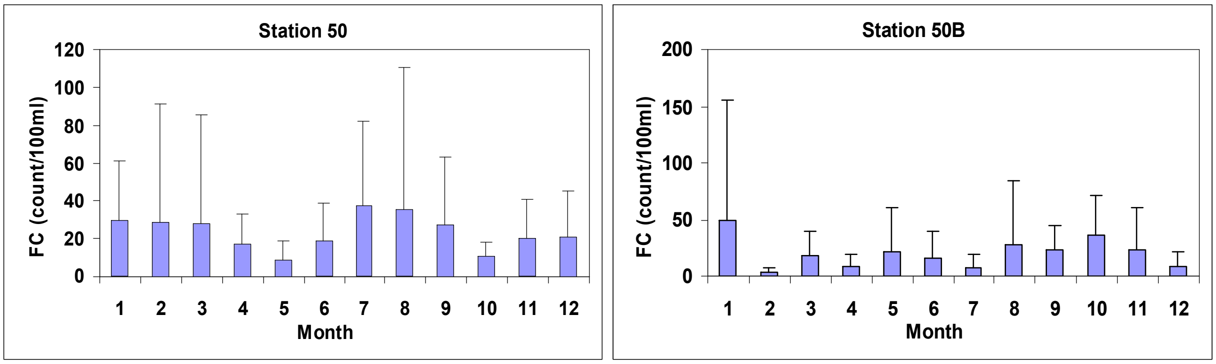


**Figure 3.4.2: Seasonal distribution of fecal coliform in Williston Creek**

## 3.5 TMDL Loading Cap

This section presents the TMDL for the median and 90th percentile conditions for Williston, Smyrna, and Wade Creeks. The TMDLs for shellfish harvesting areas calculated based 1998-2003 model results are as follows:

**Williston Creek**

The fecal coliform TMDL = $2.30\times10^9$ counts per day

**Wade Creek**

The fecal coliform TMDL = $5.61\times10^9$ counts per day

**Smyrna Creek**

The fecal coliform TMDL = $4.23\times10^9$ counts per day

The greater reduction required when comparing the median and the 90th percentile results was used for the load allocation. These loads are based on an averaging period that is defined by the water quality criteria (i.e., at least 30 samples). The averaging period for the development of these TMDLs used all data within the most recent five-year period.

## 3.6 Segments Proposed for Re-categorization

Analysis of existing data provided by the NC DEH Shellfish Sanitation section for Howland Creek, Ditch Cove, Broad Creek, Great Creek, and Jarrett Bay does not indicate that there is an exceedance of the North Carolina Division of Water Quality (DWQ) Surface Water Standard for shellfish harvesting areas in Class SA waters. The purpose of the monitoring performed by the DEH Shellfish Sanitation program is to protect public health and therefore, to determine when waters are safe for shellfishing. For this reason, evaluation of the DEH Shellfish Sanitation water quality data will not always indicate an exceedance of the standard, and in these cases, development of TMDLs will not be appropriate. Load reduction is not necessary to achieve water quality standards in these watersheds based on the existing monitoring data and modeling results. For DWQ's purposes, these waterbodies, or AUs, will be considered impaired based on DEH's closure policy, and they will be moved from Category 5 to Category 4CS in the DWQ's Integrated Report to the US EPA (see Section 1.2.1 for detailed description of the re-categorization criteria). It should be noted that the Jarrett Bay area has a conditional management plan where the bay is temporarily closed to shellfish harvest after 2.0 inches of rain or more in a 24-hour period. The area is not re-opened to shellfish harvest again until satisfactory water samples are obtained. If these waterbodies are later found to have water quality standards violations based on monitoring data, these waterbodies, or AUs, will be moved to Category 5 requiring development of a TMDL. In the future, data needed for TMDL development should include samples collected immediately after a rainfall event causing closure of waterbodies.

**Table 3.6.1 Waterbodies Proposed for Re-categorization**

| Waterbody Name – (ID) | Description | Water Quality Classification | Acres |
|---|---|---|---|
| Ditch Cove - (21-35-7-22-2) | From source to Jarrett Bay | SA ORW | 32.1 |
| Broad Creek - (21-35-7-22-3) | From source to Jarrett Bay | SA ORW | 36.6 |
| Great Creek – (21-35-7-22-4) | From source to Jarrett Bay | SA ORW | 71.9 |
| Howland Creek - (21-35-7-22-5) | From source to Jarrett Bay | SA ORW | 26.3 |
| Jarrett Bay – (21-35-7-22a) | From head of bay to DEH conditionally approved open line | SA | 37.6 |
| Jarrett Bay - (21-35-7-22b) | From DEH conditionally approved open line to Core Sound | SA | 1111.1 |
| Jarrett Bay - (21-35-7-22c) | DEH closed area at embayment at mouth of Williston Creek | SA | 57.9 |

## 3.7 Load Allocation

Based on the model results, the 90$^{th}$ percentile criterion requires the greatest reduction for restricted shellfish harvesting areas in the Williston Creek, Wade Creek, and Smyrna Creek. The load reductions needed in the watershed of each restricted shellfish harvesting area to meet the shellfish criteria and the load allocations required to meet the TMDLs are 74%, 88%, and 91%, respectively for Williston Creek, Wade Creek, and Smyrna Creek. The reduction established based on the 90th percentile criterion ensures that the water body will meet water quality standards 90% of the time. Management strategies to meet the proposed reduction will be implemented on a daily basis, to achieve the control of fecal loads for all but the most extreme 10% of events (i.e. ensure that 90% of the concentrations are at or below the 90th percentile criterion). These extreme events are often caused due to hydrologic variability, storm water management, change of land use practices, and change of wildlife activities during the previous ten-year period. Source reductions can be assigned by first managing controllable sources (human, livestock, and pets) and then determining if the TMDL could be achieved. If the total required reduction was not achieved, then the wildlife source can be considered to be reduced.

### 3.8 Margin of Safety

A Margin of Safety (MOS) is required as part of a TMDL in recognition of many uncertainties in the understanding and simulation of water quality in natural systems. For example, knowledge is incomplete regarding the exact nature and magnitude of pollutant loads from various sources and the specific impacts of those pollutants on the chemical and biological quality of complex, natural water bodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection.

For TMDL development, the MOS needs to be incorporated to account for uncertainty due to model parameter selection. Based on previous model sensitivity analysis, it was determined that the most sensitive parameter is the decay rate. The value of the decay rate varies from 0.7 to 3.0 per day in salt water (Mancini, 1978; Thomann and Mueller, 1987, EPA 1985). A decay rate of 0.7 per day was used. As a conservative estimate in the TMDL calculation, an explicit MOS of 10% is used.

### 3.9 Summary of Total Maximum Daily Loads

Since there are no permitted point sources in the watershed, all allocations are to nonpoint sources. The TMDLs calculated based on 5 years (1998-2003) of data are summarized as follows:

**Table 3.9.1 The Fecal Coliform TMDL (counts per day)**

| Area | TMDL | = | LA | + | WLA | + | FA | + | MOS |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| **Williston Creek** | **$2.30\times10^9$** | **=** | **$2.07\times10^9$** | **+** | **N/A** | **+** | **N/A** | **+** | **10%** |
| | | | | | | | | | |
| **Wade Creek** | **$5.61\times10^9$** | **=** | **$5.05\times10^9$** | **+** | **N/A** | **+** | **N/A** | **+** | **10%** |
| | | | | | | | | | |
| **Smyrna Creek** | **$4.23\times10^9$** | **=** | **$3.81\times10^9$** | **+** | **N/A** | **+** | **N/A** | **+** | **10%** |

Where:

TMDL = Total Maximum Daily Load
LA = Load Allocation (Nonpoint Source)
WLA = Waste Load Allocation (Point Source)
FA = Future Allocation
MOS = Margin of Safety

## 4.0 TMDL IMPLEMENTATION PLAN

The TMDL analysis was performed using the best data available to specify the fecal coliform reductions necessary to achieve water quality criteria. The intent of meeting the criteria is to support the designated use classifications in the watershed. An implementation plan is not included in this TMDL. The involvement of local governments and agencies will be needed in order to develop an implementation plan. Potential funding sources for implementation include Section 319 funds, and 205(j) funds.

The appropriate measures to reduce pollution levels in the impaired segments include, where appropriate, the use of better treatment technology or installation of best management practices (BMPs). In general, NCDENR recommends for the required reductions to be implemented in an iterative process that first addresses those sources with the largest impact on water quality, with consideration given to ease of implementation and cost. The iterative implementation of BMPs in the watershed has several benefits: tracking of water quality improvements following BMP implementation through follow-up stream monitoring; providing a mechanism for developing public support through periodic updates on BMP implementation; and helping to ensure that the most cost-effective practices are implemented first.

Department of Environmental Health has a conditional area management plan in place for Jarrett bay area. The Jarrett Bay area will be immediately recommended closed to shellfishing after 2.0 inches of rain within 24 hours. After the rainfall has ended and sufficient time has elapsed to allow shellfish to cleanse, the temporarily closed area will be sampled. If the results indicate fecal coliform levels to be acceptable, recommendations will be made to Division of Marine Fisheries to reopen the area.

The preliminary source assessment suggests that pets and wild animals may be the major source of fecal coliform loading to Jarrett Bay. Therefore, reductions for fecal coliform should first be sought through installation and maintenance of BMPs to tackle loads from the primary sources. It is expected that in some waters for which TMDLs will be developed, the bacteria source analysis will indicate that after controls are in place for all anthropogenic sources, the waterbody does not meet water quality standards. However, neither the State of North Carolina nor EPA is proposing the elimination of wildlife to allow for the attainment of water quality standards. This is considered to be an impracticable and undesirable action. While managing the overpopulation of wildlife remains an option for State and local stakeholders, the reduction of wildlife or changing a natural background condition is not the intended goal of a TMDL.

## 5.0 STREAM MONITORING

The Shellfish Sanitation Section of DEH will continue to monitor shellfish waters and classify harvesting areas and close them if levels of fecal coliform indicate that harvesting shellfish from those waters could cause a public health risk. Those waters meeting shellfish water quality standards may be reclassified as open to harvesting and can serve to track the effectiveness of TMDL implementation and water quality improvements. Additional monitoring will also include bacteria source tracking that will be used to confirm the source estimates presented in this document. In the future, data needed for TMDL development should include samples collected immediately after a rainfall event causing closure of waterbodies.

## 6.0 FUTURE EFFORTS

Potential mechanisms for reduction of fecal coliform include implementation of appropriate BMPs, local regulations or ordinances related to zoning, land use, or storm water runoff controls. Local governments can provide funding assistance through general revenues, bond issuance, special taxes, utility fees, and impact fees. Additional mechanisms may employ concurrent education and outreach, training, technology transfer, and technical assistance with incentive-based pollutant management measures. The state and local governments will take the primary lead in the TMDL implementation. Bacteria source tracking can be used to confirm the source estimates presented in this document and target major fecal coliform sources for reduction. DWQ will work with NCDEH Shellfish Sanitation section to prioritize shellfish areas and to collect additional data immediately after a rainfall event causing closure of waterbodies.

## 7.0 PUBLIC PARTICIPATION

A draft of the TMDL was publicly noticed through various means. The TMDL was public noticed in the relevant counties through two local newspapers (Carteret County NEWS-TIMES on April 18, 2007 and New Bern Sun Journal on April 22, May 13, and May 14, 2007, Appendix H). The TMDL was also public noticed on April 18, 2007 through the North Carolina Water Resources Research Institute email list-serve (Appendix D). Finally, the TMDL was available on DWQ's website http://h2o.enr.state.nc.us/tmdl/ during the comment period. The public comment period lasted until May 18, 2007. Two written comments were received (Appendix F-1), one from NC Department of Transportation, and another from the Division Soil and Water Conservation(Area 6). DWQ's responses to those comments are provided in Appendix F-2.

## 8.0 FURTHER INFORMATION

Further information concerning North Carolina's TMDL program can be found on the Internet at the Division of Water Quality website**:**
http://h2o.enr.state.nc.us/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the DWQ Modeling/TMDL Unit:

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Kathy Stecker
e-mail: kathy.stecker@ncmail.net

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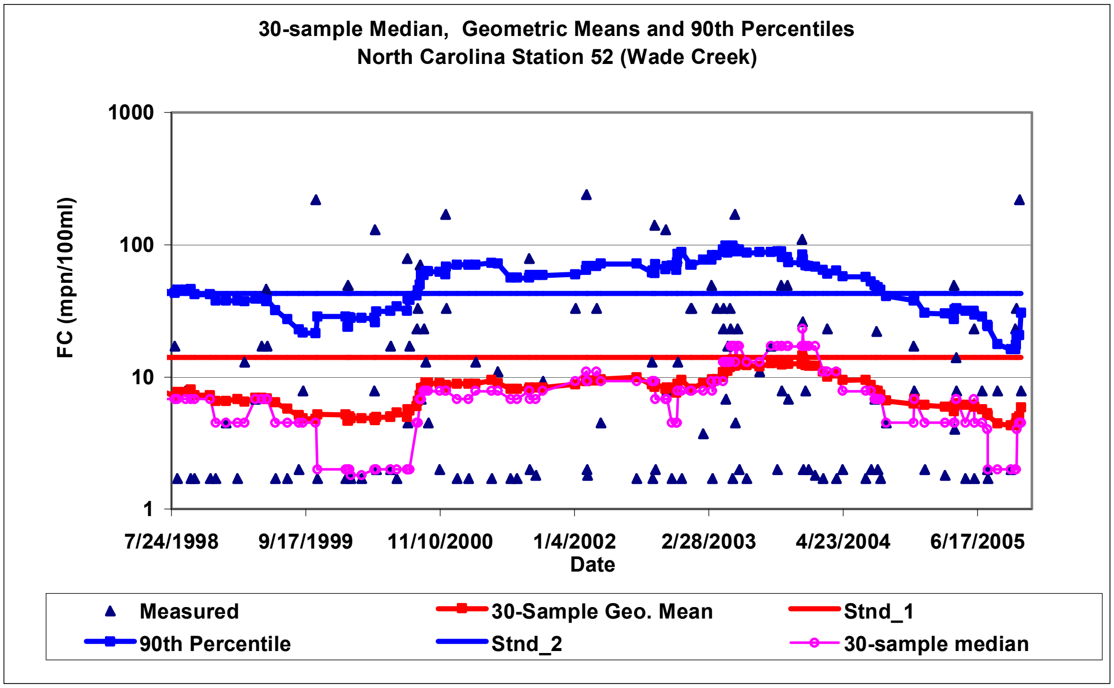
## Appendix A. Observation Time Series Plots and Water Quality Data

Fecal coliform observation data from 1998 to 2005 are analyzed. The time series together with geometric mean and 90$^{th}$ percentile are plotted in Figure A-1 to Figure A-6.



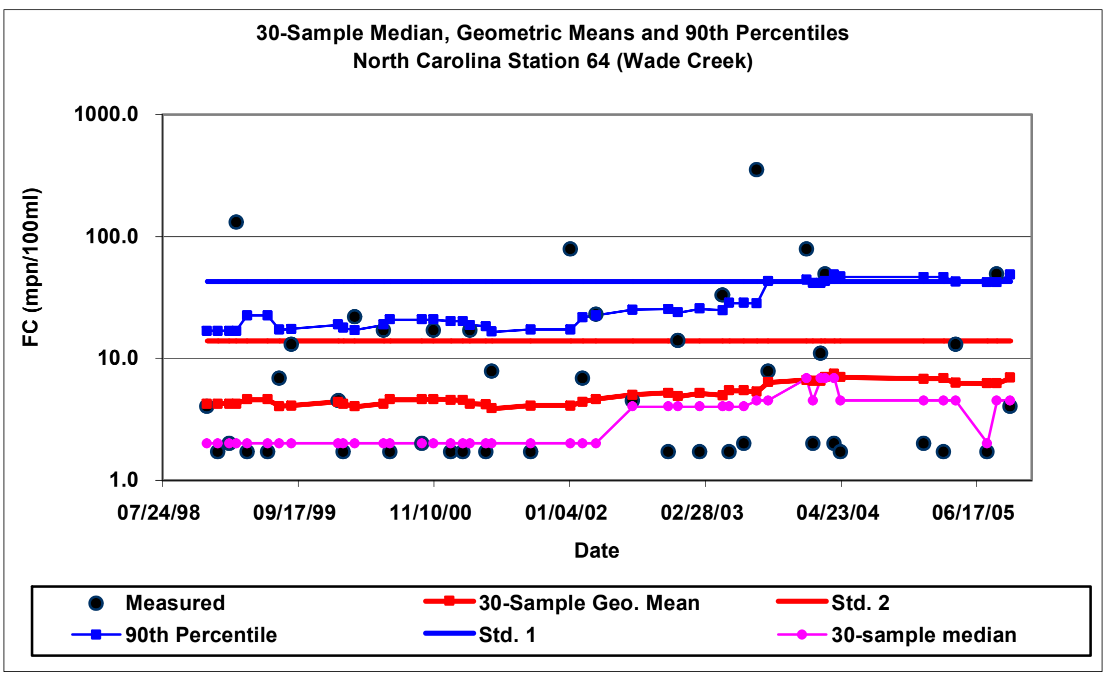
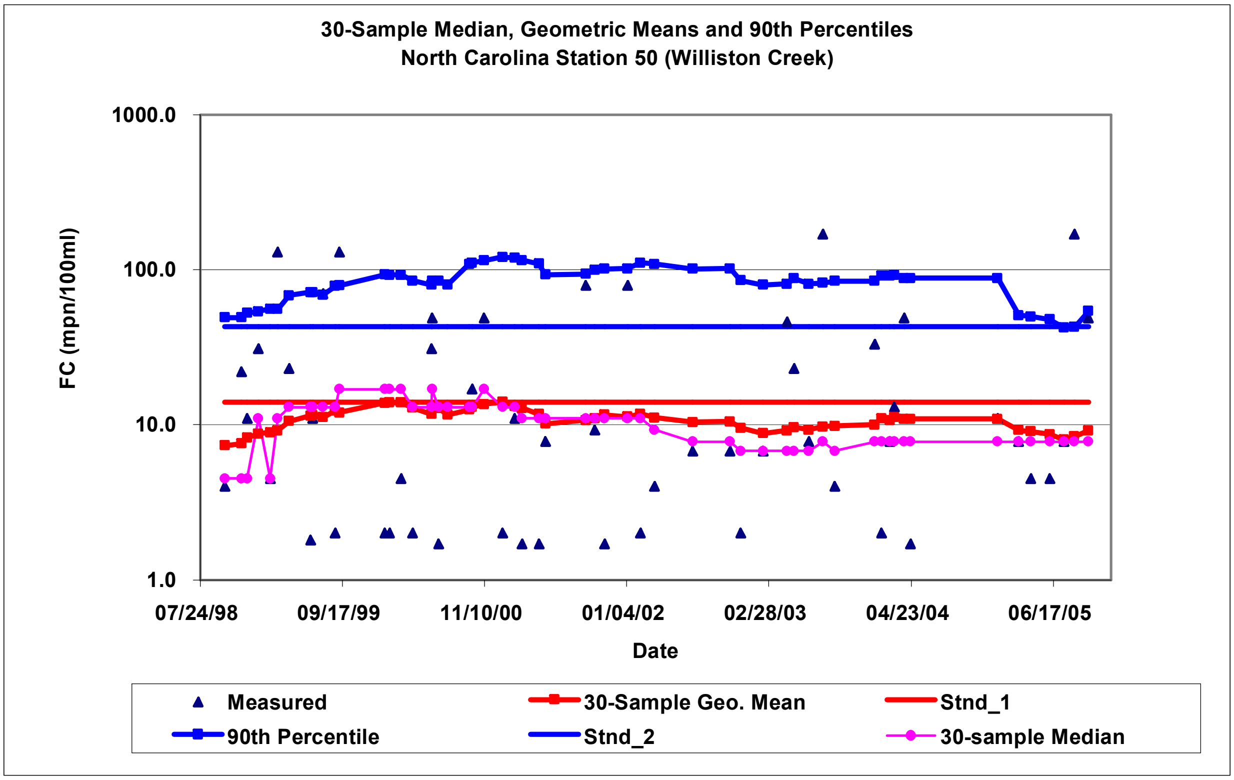




**Figure A-1: Time series plots of fecal coliform observations in Wade Creek Stations**



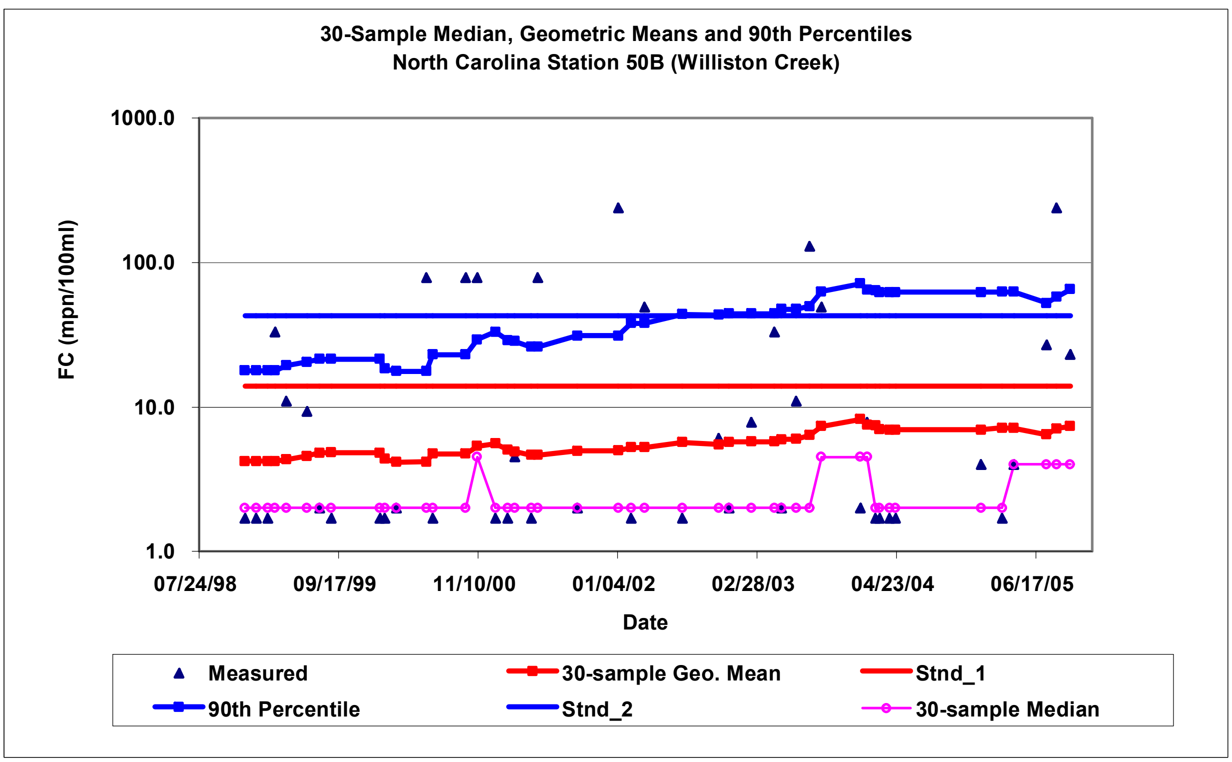
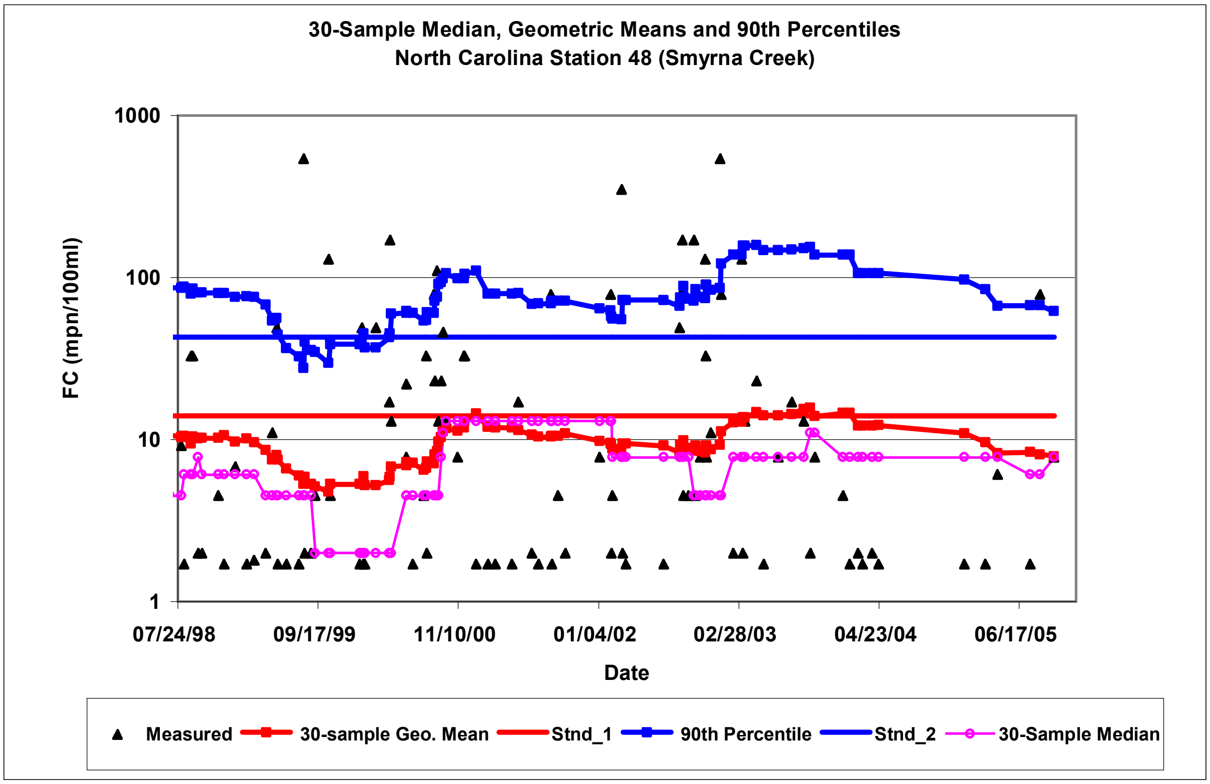




**Figure A-2: Time series plots of fecal coliform observations in Williston Creek Stations**



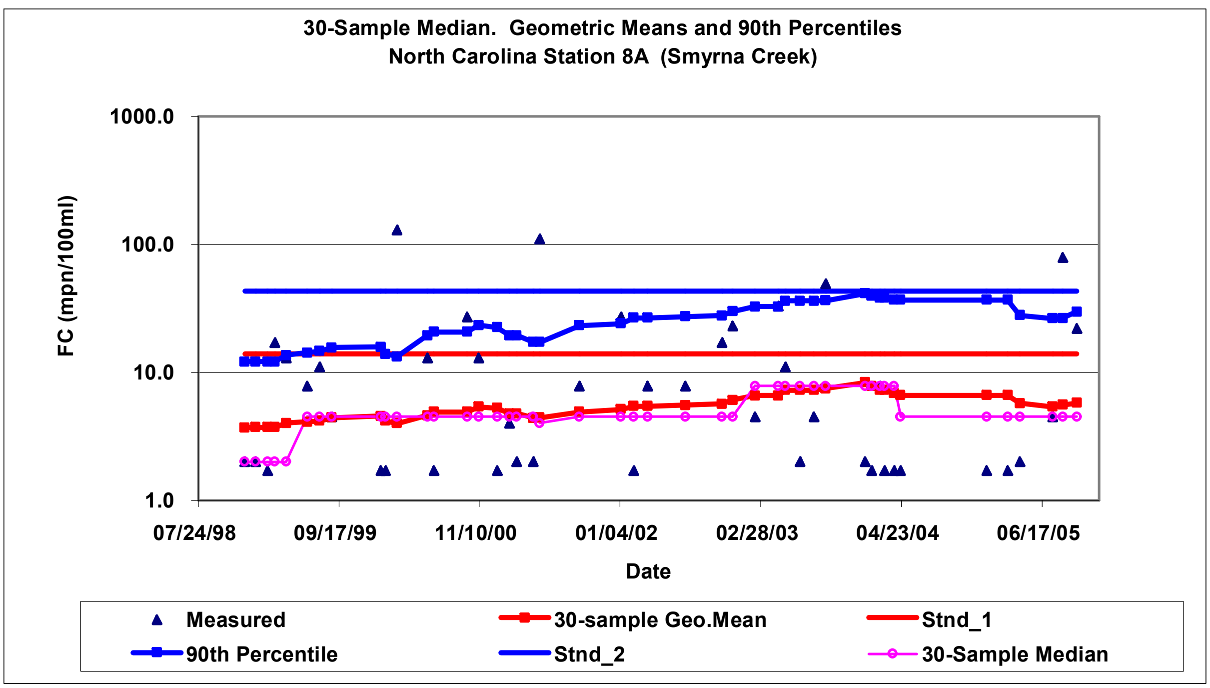




**Figure A-3: Time series plots of fecal coliform observations in Smyrna Creek Stations**

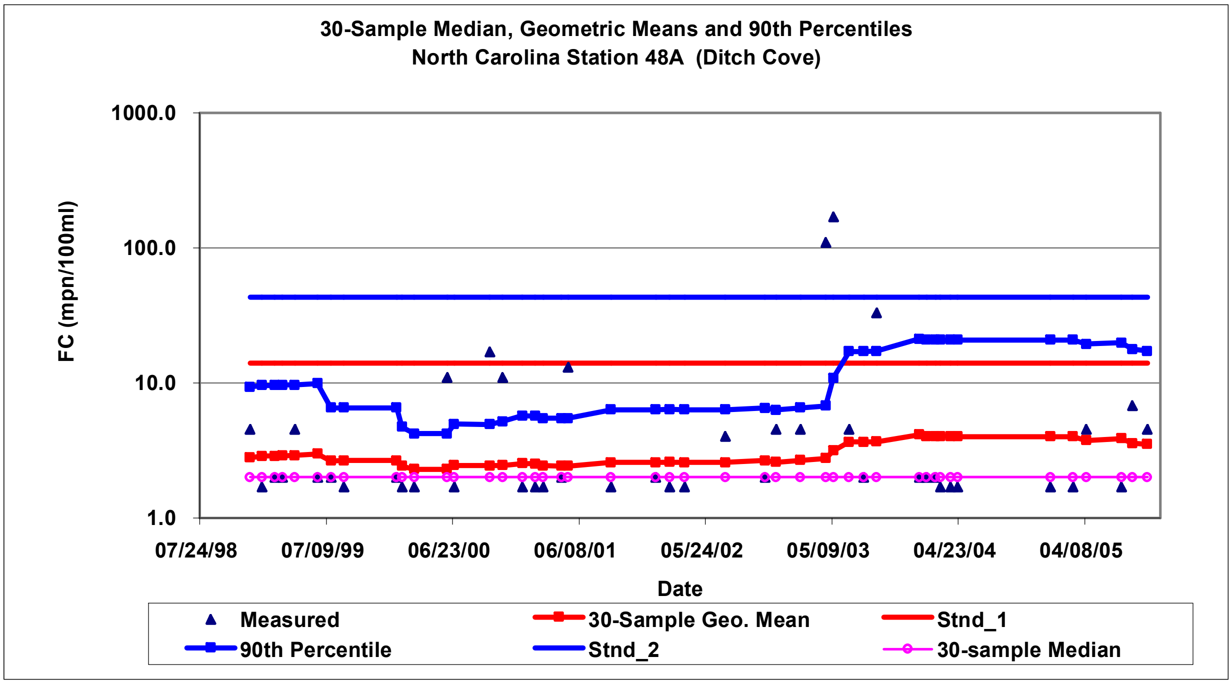



**Figure A-4: Time series plot of fecal coliform observations in Ditch Cove Station**

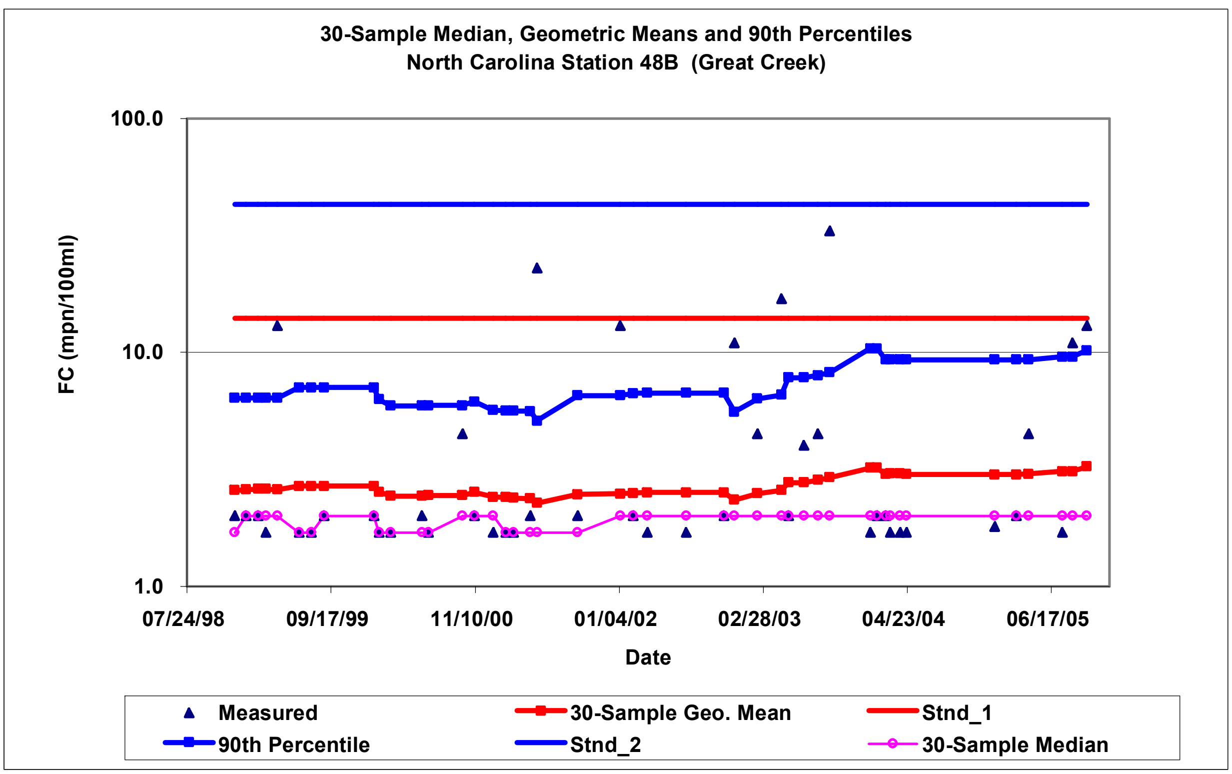



**Figure A-5: Time series plot of fecal coliform observations in Great Creek Station**

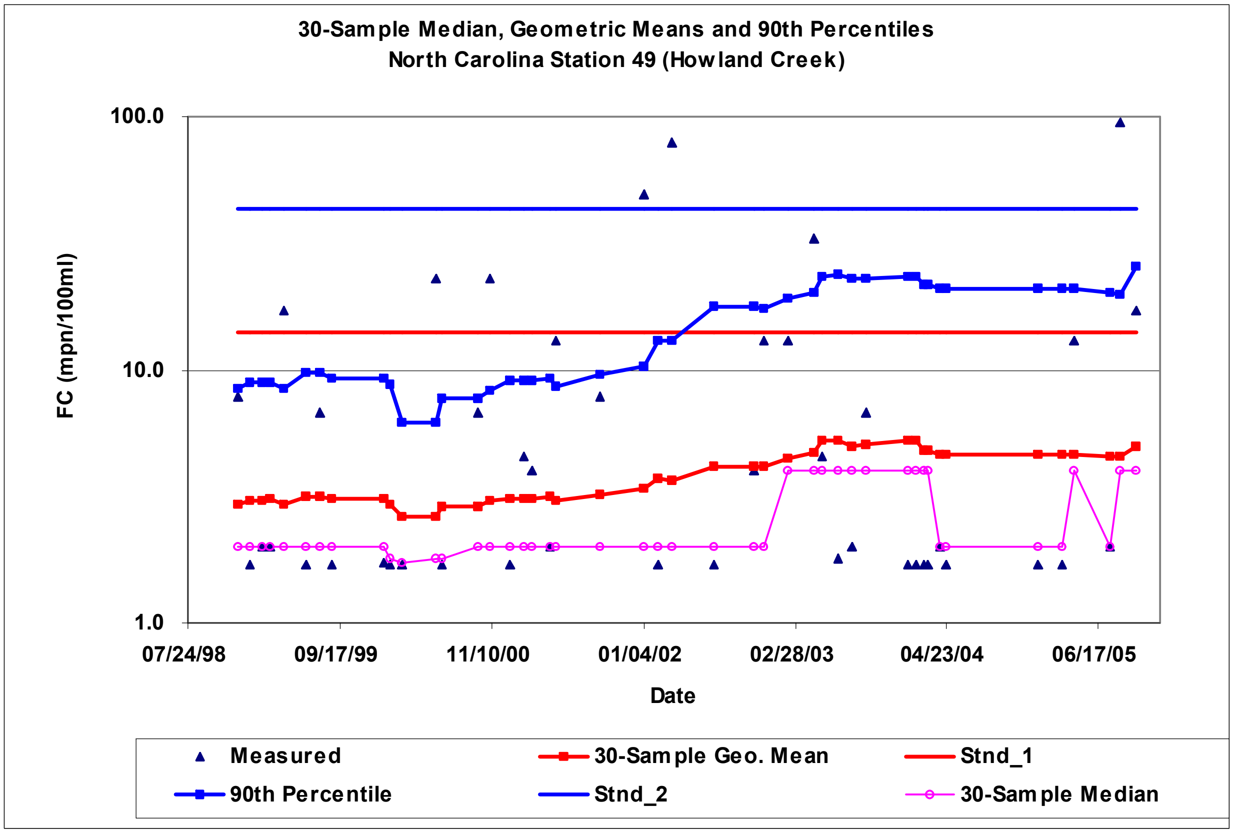



**Figure A-6: Time series plot of fecal coliform observations in Howland Creek Station**

| *Sanitary Survey data* | | | | | |
|---|---|---|---|---|---|
| DATE | STATION | | TIDE | SALINITY | FC |
| 4/25/1994 | 8 | A | 1/2 FLD | 32 | 49.0 |
| 6/21/1994 | 8 | A | 1/2 EBB | 33 | 1.7 |
| 7/26/1994 | 8 | A | 1ST FLD | 40 | 1.7 |
| 8/11/1994 | 8 | A | 1ST FLD | 37 | 1.7 |
| 4/12/1995 | 8 | A | 1ST EBB | 30 | 2.0 |
| 5/17/1995 | 8 | A | 1/2 FLD | 34 | 6.8 |
| 6/27/1995 | 8 | A | 1/2 FLD | 33 | 4.5 |
| 7/20/1995 | 8 | A | 3/4 EBB | 36 | 2.0 |
| 8/22/1995 | 8 | A | 1ST EBB | 34 | 1.7 |
| 9/26/1995 | 8 | A | 3/4 FLD | 26 | 22.0 |
| 10/25/1995 | 8 | A | 2/3 FLD | 21 | 7.8 |
| 2/15/1996 | 8 | A | 3/4 EBB | 17 | 1.7 |
| 3/25/1996 | 8 | A | LST.FLD | 19 | 2.0 |
| 4/15/1996 | 8 | A | 1/4 EBB | 22 | 1.7 |
| 5/20/1996 | 8 | A | 1/2 FLD | 27 | 1.7 |
| 6/24/1996 | 8 | A | 1ST FLD | 34 | 23.0 |
| 7/23/1996 | 8 | A | 1st FLD | 14 | 31.0 |
| 11/25/1996 | 8 | A | 2/3 FLD | 21 | 4.5 |
| 12/16/1996 | 8 | A | 1/4 EBB | 17 | 23.0 |
| 1/23/1997 | 8 | A | 1/2 FLD | 22 | 1.7 |
| 2/12/1997 | 8 | A | 1/2 FLD | 20 | 4.5 |
| 4/15/1997 | 8 | A | 2/3 EBB | 28 | 2.0 |
| 10/22/1997 | 8 | A | 3/4 EBB | 31 | 4.5 |
| 4/1/1998 | 8 | A | 1ST FLD | 15 | 1.7 |
| 6/1/1998 | 8 | A | 1/4 FLD | 22 | 4.5 |
| 6/11/1998 | 8 | A | 1/4 FLD | 22 | 4.5 |
| 7/13/1998 | 8 | A | 1ST FLD | 28 | 2.0 |
| 8/12/1998 | 8 | A | 1ST FLD | 26 | 2.0 |
| 9/23/1998 | 8 | A | LST.FLD | 24 | 4.5 |
| 10/5/1998 | 8 | A | LST.FLD | 26 | 1.7 |
| 11/23/1998 | 8 | A | 1ST FLD | 26 | 11.0 |
| 12/10/1998 | 8 | A | | 26 | 2.0 |
| 1/12/1999 | 8 | A | 1/2 EBB | 15 | 2.0 |
| 2/16/1999 | 8 | A | LSTFLD | 22 | 1.7 |
| 3/10/1999 | 8 | A | 3/4EBB | 25 | 17.0 |
| 4/13/1999 | 8 | A | 1STEBB | 28 | 13.0 |
| 6/15/1999 | 8 | A | 1/3FLD | 32 | 7.8 |
| 7/22/1999 | 8 | A | 3/4EBB | 32 | 11.0 |
| 8/27/1999 | 8 | A | ¼ FLD | 30 | 4.5 |
| 1/20/2000 | 8 | A | LST.FLD | 28 | 1.7 |
| 2/4/2000 | 8 | A | 1/3FLD | 22 | 1.7 |
| 3/9/2000 | 8 | A | 1/4FLD | 22 | 130.0 |
| 6/8/2000 | 8 | A | 3/4 EBB | 24 | 13.0 |
| 6/27/2000 | 8 | A | 3/4 EBB | 29 | 1.7 |
| 10/4/2000 | 8 | A | LST.EBB | 21 | 27.0 |
| 11/8/2000 | 8 | A | 3/4 EBB | 24 | 13.0 |

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| 2/7/2001 | 8 | A | ¼ EBB | 22 | 4.0 |
| 5/9/2001 | 8 | A | ½ FLD | 30 | 110.0 |
| 9/5/2001 | 8 | A | ½ FLD | 29 | 7.8 |
| 1/7/2002 | 8 | A | 3/4 EBB | 30 | 27.0 |
| 2/14/2002 | 8 | A | 1/2 FLD | 28 | 1.7 |
| 3/27/2002 | 8 | A | 1/4 EBB | 19 | 7.8 |
| 7/18/2002 | 8 | A | 3/4 EBB | 34 | 7.8 |
| 11/5/2002 | 8 | A | LST FLD | 22 | 17.0 |
| 12/6/2002 | 8 | A | LST FLD | 22 | 23.0 |
| 2/11/2003 | 8 | A | LST EBB | 24 | 4.5 |
| 4/22/2003 | 8 | A | 1/2 EBB | 13 | 33.0 |
| 5/13/2003 | 8 | A | 1/2 EBB | 14 | 11.0 |
| 6/26/2003 | 8 | A | 1/4 EBB | 24 | 2.0 |
| 8/6/2003 | 8 | A | LST EBB | 25 | 4.5 |
| 9/10/2003 | 8 | A | 1ST EBB | 28 | 49.0 |
| 1/6/2004 | 8 | A | 1/4 EBB | 18 | 2.0 |
| 1/26/2004 | 8 | A | 3/4 FLD | 22 | 1.7 |
| 2/20/2004 | 8 | A | 1/2 FLD | 12 | 7.8 |
| 3/4/2004 | 8 | A | 3/4 FLD | 14 | 1.7 |
| 4/2/2004 | 8 | A | 1ST EBB | 20 | 1.7 |
| 4/21/2004 | 8 | A | 1/4 FLD | 24 | 1.7 |
| 1/3/2005 | 8 | A | LST. FLD | 20 | 1.7 |
| 3/7/2005 | 8 | A | 1/2 EBB | 18 | 1.7 |
| 4/12/2005 | 8 | A | 1/4 FLD | 18 | 2.0 |
| 7/19/2005 | 8 | A | 1st FLD | 26 | 4.5 |
| 8/18/2005 | 8 | A | 1/2 FLD | 27 | 79.0 |
| 9/29/2005 | 8 | A | 1/4 EBB | 18 | 22.0 |
| 3/27/2002 | 8 | | 1/4 EBB | 15 | 23.0 |
| 7/18/2002 | 8 | | 3/4 EBB | 34 | 7.8 |
| 11/5/2002 | 8 | | LST FLD | 22 | 4.5 |
| 12/6/2002 | 8 | | LST FLD | 22 | 49.0 |
| 2/11/2003 | 8 | | LST EBB | 18 | 31.0 |
| 4/22/2003 | 8 | | 1/2 EBB | 11 | 79.0 |
| 5/13/2003 | 8 | | 1/2 EBB | 12 | 17.0 |
| 6/26/2003 | 8 | | 1/4 EBB | 22 | 23.0 |
| 8/6/2003 | 8 | | LST EBB | 22 | 170.0 |
| 9/10/2003 | 8 | | 1ST EBB | 30 | 46.0 |
| 1/6/2004 | 8 | | 1/4 EBB | 16 | 33.0 |
| 1/26/2004 | 8 | | 3/4 FLD | 20 | 4.5 |
| 2/20/2004 | 8 | | 1/2 FLD | 14 | 13.0 |
| 3/4/2004 | 8 | | 3/4 FLD | 12 | 3.7 |
| 4/2/2004 | 8 | | 1ST EBB | 20 | 4.5 |
| 4/21/2004 | 8 | | 1/4 FLD | 24 | 1.7 |
| 1/3/2005 | 8 | | LST. FLD | 20 | 2.0 |
| 3/7/2005 | 8 | | 1/2 EBB | 16 | 1.7 |
| 4/12/2005 | 8 | | 1/4 FLD | 18 | 11.0 |
| 7/19/2005 | 8 | | 1st FLD | 26 | 4.5 |
| 9/29/2005 | 8 | | 1/4 EBB | 18 | 33.0 |

| *Sanitary Survey data* | | | | | |
|---|---|---|---|---|---|
| **DATE** | **STATION** | | **TIDE** | **SALINITY** | **FC** |
| 6/21/1994 | 48 | A | 1/2 EBB | 33 | 2.0 |
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| 8/11/1994 | 48 | A | 1ST FLD | 37 | 1.7 |
| 4/12/1995 | 48 | A | 1ST EBB | 30 | 1.7 |
| 5/17/1995 | 48 | A | 1/2 FLD | 35 | 1.8 |
| 6/27/1995 | 48 | A | 1/2 FLD | 32 | 79.0 |
| 7/20/1995 | 48 | A | 3/4 EBB | 37 | 1.7 |
| 8/22/1995 | 48 | A | 1ST EBB | 34 | 1.7 |
| 9/26/1995 | 48 | A | 3/4 FLD | 26 | 33.0 |
| 10/25/1995 | 48 | A | 2/3 FLD | 19 | 7.8 |
| 2/15/1996 | 48 | A | 3/4 EBB | 18 | 1.7 |
| 3/25/1996 | 48 | A | LST.FLD | 26 | 1.7 |
| 4/15/1996 | 48 | A | 1/4 EBB | 21 | 2.0 |
| 5/20/1996 | 48 | A | 1/2 FLD | 31 | 13.0 |
| 6/24/1996 | 48 | A | 1ST FLD | 35 | 4.5 |
| 7/23/1996 | 48 | A | 1st FLD | 21 | 2.0 |
| 11/25/1996 | 48 | A | 2/3 FLD | 22 | 4.5 |
| 12/16/1996 | 48 | A | 1/4 EBB | 20 | 2.0 |
| 1/23/1997 | 48 | A | 1/2 FLD | 22 | 2.0 |
| 2/12/1997 | 48 | A | 1/2 FLD | 20 | 2.0 |
| 4/15/1997 | 48 | A | 2/3 EBB | 29 | 1.7 |
| 10/22/1997 | 48 | A | 3/4 EBB | 31 | 1.7 |
| 4/1/1998 | 48 | A | 1ST FLD | 16 | 2.0 |
| 6/1/1998 | 48 | A | 1/4 FLD | 22 | 1.7 |
| 6/11/1998 | 48 | A | 1/4 FLD | 22 | 1.7 |
| 7/13/1998 | 48 | A | 1ST FLD | 28 | 4.5 |
| 8/12/1998 | 48 | A | 1ST FLD | 25 | 1.7 |
| 9/23/1998 | 48 | A | LST.FLD | 25 | 1.7 |
| 10/5/1998 | 48 | A | LST.FLD | 26 | 2.0 |
| 11/23/1998 | 48 | A | 1ST FLD | 24 | 2.0 |
| 12/10/1998 | 48 | A | | 26 | 4.5 |
| 1/12/1999 | 48 | A | 1/2 EBB | 16 | 1.7 |
| 2/16/1999 | 48 | A | LSTFLD | 24 | 2.0 |
| 3/10/1999 | 48 | A | 3/4EBB | 26 | 2.0 |
| 4/13/1999 | 48 | A | 1STEBB | 28 | 4.5 |
| 6/15/1999 | 48 | A | 1/3FLD | 32 | 2.0 |
| 7/22/1999 | 48 | A | 3/4EBB | 33 | 2.0 |
| 8/27/1999 | 48 | A | ¼ FLD | 30 | 1.7 |
| 1/20/2000 | 48 | A | LST.FLD | 28 | 2.0 |
| 2/4/2000 | 48 | A | 1/3FLD | 21 | 1.7 |
| 3/9/2000 | 48 | A | 1/4FLD | 24 | 1.7 |
| 6/8/2000 | 48 | A | 3/4 EBB | 24 | 11.0 |
| 6/27/2000 | 48 | A | 3/4 EBB | 30 | 1.7 |
| 10/4/2000 | 48 | A | LST.EBB | 21 | 17.0 |

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|---|---|---|---|---|---|
| 11/8/2000 | 48 | A | 3/4 EBB | 24 | 11.0 |
| 1/2/2001 | 48 | A | L.LST.EBB | 20 | 1.7 |
| 3/1/2001 | 48 | A | 1ST FLD. | 24 | 1.7 |
| 1/7/2002 | 48 | A | 3/4 EBB | 30 | 2.0 |
| 2/14/2002 | 48 | A | 1/2 FLD | 28 | 1.7 |
| 3/27/2002 | 48 | A | 1/4 EBB | 21 | 1.7 |
| 7/18/2002 | 48 | A | 3/4 EBB | 34 | 4.0 |
| 11/5/2002 | 48 | A | LST FLD | 23 | 2.0 |
| 12/6/2002 | 48 | A | LST FLD | 23 | 4.5 |
| 2/11/2003 | 48 | A | LST EBB | 23 | 4.5 |
| 4/22/2003 | 48 | A | 1/2 EBB | 14 | 110.0 |
| 5/13/2003 | 48 | A | 1/2 EBB | 14 | 170.0 |
| 6/26/2003 | 48 | A | 1/4 EBB | 24 | 4.5 |
| 8/6/2003 | 48 | A | LST EBB | 25 | 2.0 |
| 9/10/2003 | 48 | A | 1ST EBB | 30 | 33.0 |
| 1/6/2004 | 48 | A | 1/4 EBB | 20 | 2.0 |
| 1/26/2004 | 48 | A | 3/4 FLD | 20 | 2.0 |
| 2/20/2004 | 48 | A | 1/2 FLD | 14 | 2.0 |
| 3/4/2004 | 48 | A | 3/4 FLD | 14 | 1.7 |
| 4/2/2004 | 48 | A | 1ST EBB | 20 | 1.7 |
| 4/21/2004 | 48 | A | 1/4 FLD | 26 | 1.7 |
| 1/3/2005 | 48 | A | LST. FLD | 20 | 1.7 |
| 3/7/2005 | 48 | A | 1/2 EBB | 18 | 1.7 |
| 4/12/2005 | 48 | A | 1/4 FLD | 18 | 4.5 |
| 7/19/2005 | 48 | A | 1st FLD | 28 | 1.7 |
| 8/18/2005 | 48 | A | 1/2 FLD | 30 | 6.8 |
| 9/29/2005 | 48 | A | 1/4 EBB | 18 | 4.5 |

| ***Sanitary Survey data*** | | | | | |
|---|---|---|---|---|---|
| **DATE** | **STATION** | | **TIDE** | **SALINITY** | **FC** |
| 6/21/1994 | 48 | | 1/2 EBB | 34 | 2.0 |
| 7/26/1994 | 48 | | 1ST FLD | 39 | 2.0 |
| 8/11/1994 | 48 | | 1ST FLD | 37 | 2.0 |
| 4/12/1995 | 48 | | 1ST EBB | 29 | 2.0 |
| 5/17/1995 | 48 | | 1/2 FLD | 35 | 4.5 |
| 6/27/1995 | 48 | | 1/2 FLD | 32 | 1.7 |
| 7/20/1995 | 48 | | 3/4 EBB | 37 | 1.7 |
| 8/22/1995 | 48 | | 1ST EBB | 35 | 1.7 |
| 9/26/1995 | 48 | | 3/4 FLD | 26 | 6.8 |
| 10/25/1995 | 48 | | 2/3 FLD | 19 | 14.0 |
| 2/15/1996 | 48 | | 3/4 EBB | 20 | 1.7 |
| 3/25/1996 | 48 | | LST.FLD | 24 | 2.0 |
| 4/15/1996 | 48 | | 1/4 EBB | 24 | 1.7 |
| 5/20/1996 | 48 | | 1/2 FLD | 30 | 1.7 |
| 6/24/1996 | 48 | | 1ST FLD | 35 | 1.7 |
| 7/23/1996 | 48 | | 1st FLD | 14 | 11.0 |
| 11/25/1996 | 48 | | 2/3 FLD | 21 | 4.5 |

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|---|---|---|---|---|---|
| 12/16/1996 | 48 | | 1/4 EBB | 20 | 6.1 |
| 1/23/1997 | 48 | | 1/2 FLD | 22 | 2.0 |
| 2/12/1997 | 48 | | 1/2 FLD | 20 | 4.5 |
| 4/15/1997 | 48 | | 2/3 EBB | 28 | 1.7 |
| 10/22/1997 | 48 | | 3/4 EBB | 31 | 7.8 |
| 4/1/1998 | 48 | | 1ST FLD | 16 | 1.7 |
| 6/1/1998 | 48 | | 1/4 FLD | 22 | 4.5 |
| 6/11/1998 | 48 | | 1/4 FLD | 22 | 4.5 |
| 7/13/1998 | 48 | | 1ST FLD | 28 | 2.0 |
| 8/12/1998 | 48 | | 1ST FLD | 26 | 1.7 |
| 9/23/1998 | 48 | | LST.FLD | 24 | 2.0 |
| 10/5/1998 | 48 | | LST.FLD | 26 | 2.0 |
| 11/23/1998 | 48 | | 1ST FLD | 26 | 4.5 |
| 12/10/1998 | 48 | | | 26 | 1.7 |
| 1/12/1999 | 48 | | 1/2 EBB | 16 | 6.8 |
| 2/16/1999 | 48 | | LSTFLD | 24 | 1.7 |
| 3/10/1999 | 48 | | 3/4EBB | 26 | 1.8 |
| 4/13/1999 | 48 | | 1STEBB | 28 | 2.0 |
| 6/15/1999 | 48 | | 1/3FLD | 32 | 1.7 |
| 7/22/1999 | 48 | | 3/4EBB | 33 | 1.7 |
| 8/27/1999 | 48 | | ¼ FLD | 31 | 2.0 |
| 1/20/2000 | 48 | | LST.FLD | 30 | 1.7 |
| 2/4/2000 | 48 | | 1/3FLD | 20 | 1.7 |
| 3/9/2000 | 48 | | 1/4FLD | 22 | 49.0 |
| 6/8/2000 | 48 | | 3/4 EBB | 24 | 7.8 |
| 6/27/2000 | 48 | | 3/4 EBB | 30 | 1.7 |
| 10/4/2000 | 48 | | LST.EBB | 22 | 13.0 |
| 11/8/2000 | 48 | | 3/4 EBB | 24 | 7.8 |
| 1/2/2001 | 48 | | L.LST.EBB | 20 | 1.7 |
| 2/7/2001 | 48 | | ¼ EBB | 24 | 1.7 |
| 3/1/2001 | 48 | | 1ST FLD. | 23 | 1.7 |
| 4/20/2001 | 48 | | 1ST EBB | 26 | 1.7 |
| 5/9/2001 | 48 | | ½ FLD | 30 | 17.0 |
| 9/5/2001 | 48 | | ½ FLD | 29 | 4.5 |
| 1/7/2002 | 48 | | 3/4 EBB | 29 | 7.8 |
| 2/14/2002 | 48 | | 1/2 FLD | 26 | 4.5 |
| 3/27/2002 | 48 | | 1/4 EBB | 22 | 1.7 |
| 7/18/2002 | 48 | | 3/4 EBB | 34 | 1.7 |
| 11/5/2002 | 48 | | LST FLD | 22 | 7.8 |
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| 2/11/2003 | 48 | | LST EBB | 23 | 2.0 |
| 4/22/2003 | 48 | | 1/2 EBB | 13 | 23.0 |
| 5/13/2003 | 48 | | 1/2 EBB | 12 | 1.7 |
| 6/26/2003 | 48 | | 1/4 EBB | 22 | 7.8 |
| 8/6/2003 | 48 | | LST EBB | 26 | 17.0 |
| 9/10/2003 | 48 | | 1ST EBB | 31 | 13.0 |
| 1/6/2004 | 48 | | 1/4 EBB | 18 | 4.5 |
| 1/26/2004 | 48 | | 3/4 FLD | 22 | 1.7 |

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|---|---|---|---|---|---|
| 2/20/2004 | 48 | | 1/2 FLD | 16 | 2.0 |
| 3/4/2004 | 48 | | 3/4 FLD | 14 | 1.7 |
| 4/2/2004 | 48 | | 1ST EBB | 20 | 2.0 |
| 4/21/2004 | 48 | | 1/4 FLD | 24 | 1.7 |
| 1/3/2005 | 48 | | LST. FLD | 21 | 1.7 |
| 3/7/2005 | 48 | | 1/2 EBB | 17 | 1.7 |
| 4/12/2005 | 48 | | 1/4 FLD | 20 | 6.1 |
| 7/19/2005 | 48 | | 1st FLD | 30 | 1.7 |
| 8/18/2005 | 48 | | 1/2 FLD | 27 | 79.0 |
| 9/29/2005 | 48 | | 1/4 EBB | 18 | 7.8 |

**Conditional Monitoring Data**

| DATE | STATION | FC | | DATE | STATION | FC |
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| 1/18/1994 | 48 | 17 | | 12/29/1994 | 48 | 7.8 |
| 2/3/1994 | 48 | 13 | | 1/12/1995 | 48 | 17 |
| 3/6/1994 | 48 | 11 | | 1/18/1995 | 48 | 110 |
| 5/31/1994 | 48 | 1.7 | | 1/23/1995 | 48 | 33 |
| 6/21/1994 | 48 | 1.7 | | 2/13/1995 | 48 | 14 |
| 8/22/1994 | 48 | 1.7 | | 6/9/1995 | 48 | 4.5 |
| 8/29/1994 | 48 | 1.7 | | 8/28/1995 | 48 | 140 |
| 9/14/1994 | 48 | 1.8 | | 8/30/1995 | 48 | 17 |
| 9/20/1994 | 48 | 1.7 | | 10/16/1995 | 48 | 170 |
| 10/17/1994 | 48 | 2 | | 10/18/1995 | 48 | 17 |
| 11/9/1994 | 48 | 2 | | 1/29/1996 | 48 | 130 |
| 11/14/1994 | 48 | 68 | | 2/2/1996 | 48 | 2 |
| 11/21/1994 | 48 | 21 | | 2/6/1996 | 48 | 7.8 |
| 11/30/1994 | 48 | 17 | | 4/2/1996 | 48 | 2 |
| 12/1/1994 | 48 | 27 | | 7/19/1996 | 48 | 4.5 |
| 12/27/1994 | 48 | 49 | | 7/31/1996 | 48 | 17 |
| 8/7/1996 | 48 | 13 | | 4/24/2000 | 48 | 13 |
| 10/9/1996 | 48 | 540 | | 6/8/2000 | 48 | 22 |
| 10/11/1996 | 48 | 130 | | 8/6/2000 | 48 | 33 |
| 10/14/1996 | 48 | 4.5 | | 8/8/2000 | 48 | 2 |
| 12/5/1996 | 48 | 49 | | 8/29/2000 | 48 | 79 |
| 3/17/1997 | 48 | 49 | | 9/1/2000 | 48 | 23 |
| 4/30/1997 | 48 | 70 | | 9/8/2000 | 48 | 110 |
| 8/4/1997 | 48 | 1.7 | | 9/11/2000 | 48 | 13 |
| 9/14/1997 | 48 | 1.8 | | 9/20/2000 | 48 | 23 |
| 9/17/1997 | 48 | 1.7 | | 9/26/2000 | 48 | 46 |
| 9/30/1997 | 48 | 23 | | 11/27/2000 | 48 | 33 |
| 10/2/1997 | 48 | 1.7 | | 11/29/2000 | 48 | 33 |
| 11/3/1997 | 48 | 49 | | 6/18/2001 | 48 | 2 |
| 11/5/1997 | 48 | 130 | | 7/8/2001 | 48 | 1.7 |
| 11/17/1997 | 48 | 1.7 | | 8/15/2001 | 48 | 79 |
| 12/2/1997 | 48 | 350 | | 8/17/2001 | 48 | 1.7 |
| 12/4/1997 | 48 | 79 | | 9/27/2001 | 48 | 2 |
| 1/19/1998 | 48 | 33 | | 2/10/2002 | 48 | 79 |

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|---|---|---|---|---|---|---|
| 1/21/1998 | 48 | 49 | | 2/12/2002 | 48 | 2 |
| 1/26/1998 | 48 | 33 | | 3/14/2002 | 48 | 350 |
| 1/30/1998 | 48 | 33 | | 3/17/2002 | 48 | 2 |
| 2/9/1998 | 48 | 6.1 | | 9/4/2002 | 48 | 49 |
| 2/19/1998 | 48 | 49 | | 9/6/2002 | 48 | 79 |
| 2/22/1998 | 48 | 4.5 | | 9/12/2002 | 48 | 170 |
| 2/23/1998 | 48 | 4.5 | | 9/15/2002 | 48 | 4.5 |
| 5/4/1998 | 48 | 1.7 | | 9/30/2002 | 48 | 4.5 |
| 5/6/1998 | 48 | 79 | | 10/17/2002 | 48 | 170 |
| 5/21/1998 | 48 | 2 | | 10/21/2002 | 48 | 4.5 |
| 8/4/1998 | 48 | 9.2 | | 11/19/2002 | 48 | 130 |
| 9/2/1998 | 48 | 33 | | 11/21/2002 | 48 | 33 |
| 9/7/1998 | 48 | 33 | | 11/24/2002 | 48 | 7.8 |
| 5/3/1999 | 48 | 11 | | 1/3/2003 | 48 | 540 |
| 5/17/1999 | 48 | 49 | | 1/6/2003 | 48 | 79 |
| 5/20/1999 | 48 | 1.7 | | 3/9/2003 | 48 | 130 |
| 8/5/1999 | 48 | 540 | | 3/12/2003 | 48 | 2 |
| 8/8/1999 | 48 | 2 | | 3/19/2003 | 48 | 13 |
| 9/9/1999 | 48 | 4.5 | | 9/30/2003 | 48 | 2 |
| 10/19/1999 | 48 | 130 | | 10/14/2003 | 48 | 7.8 |
| 10/24/1999 | 48 | 4.5 | | | | |
| 1/27/2000 | 48 | 49 | | | | |
| 1/31/2000 | 48 | 1.7 | | | | |
| 4/18/2000 | 48 | 17 | | | | |
| 4/20/2000 | 48 | 170 | | | | |

***Sanitary Survey data***

| DATE | STATION | | TIDE | SALINITY | FC |
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| 4/25/1994 | 48 | B | 1/2 FLD | 33 | 17.0 |
| 6/21/1994 | 48 | B | 1/2 EBB | 34 | 1.7 |
| 7/26/1994 | 48 | B | 1ST FLD | 38 | 1.7 |
| 8/11/1994 | 48 | B | 1ST FLD | 37 | 2.0 |
| 4/12/1995 | 48 | B | 1ST EBB | 30 | 2.0 |
| 5/17/1995 | 48 | B | 1/2 FLD | 35 | 4.5 |
| 6/27/1995 | 48 | B | 1/2 FLD | 32 | 1.7 |
| 7/20/1995 | 48 | B | 3/4 EBB | 37 | 1.7 |
| 8/22/1995 | 48 | B | 1ST EBB | 32 | 2.0 |
| 9/26/1995 | 48 | B | 3/4 FLD | 26 | 11.0 |
| 10/25/1995 | 48 | B | 2/3 FLD | 21 | 6.1 |
| 2/15/1996 | 48 | B | 3/4 EBB | 17 | 1.7 |
| 3/25/1996 | 48 | B | LST.FLD | 30 | 1.7 |
| 4/15/1996 | 48 | B | 1/4 EBB | 22 | 1.7 |
| 5/20/1996 | 48 | B | 1/2 FLD | 31 | 1.7 |
| 6/24/1996 | 48 | B | 1ST FLD | 34 | 7.8 |
| 7/23/1996 | 48 | B | 1st FLD | 22 | 2.0 |
| 11/25/1996 | 48 | B | 2/3 FLD | 21 | 2.0 |
| 12/16/1996 | 48 | B | 1/4 EBB | 22 | 2.0 |
| 1/23/1997 | 48 | B | 1/2 FLD | 21 | 7.8 |

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| 2/12/1997 | 48 | B | 1/2 FLD | 21 | 1.7 |
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| 4/1/1998 | 48 | B | 1ST FLD | 14 | 1.7 |
| 6/1/1998 | 48 | B | 1/4 FLD | 23 | 1.7 |
| 6/11/1998 | 48 | B | 1/4 FLD | 23 | 1.7 |
| 7/13/1998 | 48 | B | 1ST FLD | 28 | 17.0 |
| 8/12/1998 | 48 | B | 1ST FLD | 25 | 1.7 |
| 9/23/1998 | 48 | B | LST.FLD | 25 | 1.7 |
| 10/5/1998 | 48 | B | LST.FLD | 27 | 1.7 |
| 11/23/1998 | 48 | B | 1ST FLD | 24 | 2.0 |
| 12/10/1998 | 48 | B | | 26 | 2.0 |
| 1/12/1999 | 48 | B | 1/2 EBB | 16 | 2.0 |
| 2/16/1999 | 48 | B | LSTFLD | 24 | 2.0 |
| 3/10/1999 | 48 | B | 3/4EBB | 26 | 1.7 |
| 4/13/1999 | 48 | B | 1STEBB | 30 | 13.0 |
| 6/15/1999 | 48 | B | 1/3FLD | 34 | 1.7 |
| 7/22/1999 | 48 | B | 3/4EBB | 34 | 1.7 |
| 8/27/1999 | 48 | B | ¼ FLD | 32 | 2.0 |
| 1/20/2000 | 48 | B | LST.FLD | 30 | 2.0 |
| 2/4/2000 | 48 | B | 1/3FLD | 22 | 1.7 |
| 3/9/2000 | 48 | B | 1/4FLD | 24 | 1.7 |
| 6/8/2000 | 48 | B | 3/4 EBB | 24 | 2.0 |
| 6/27/2000 | 48 | B | 3/4 EBB | 30 | 1.7 |
| 10/4/2000 | 48 | B | LST.EBB | 22 | 4.5 |
| 11/8/2000 | 48 | B | 3/4 EBB | 24 | 2.0 |
| 1/2/2001 | 48 | B | L.LST.EBB | 20 | 1.7 |
| 2/7/2001 | 48 | B | ¼ EBB | 24 | 1.7 |
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| 4/20/2001 | 48 | B | 1ST EBB | 26 | 2.0 |
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| 9/5/2001 | 48 | B | ½ FLD | 28 | 2.0 |
| 1/7/2002 | 48 | B | 3/4 EBB | 30 | 13.0 |
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| 3/27/2002 | 48 | B | 1/4 EBB | 22 | 1.7 |
| 7/18/2002 | 48 | B | 3/4 EBB | 34 | 1.7 |
| 11/5/2002 | 48 | B | LST FLD | 22 | 2.0 |
| 12/6/2002 | 48 | B | LST FLD | 23 | 11.0 |
| 2/11/2003 | 48 | B | LST EBB | 24 | 4.5 |
| 4/22/2003 | 48 | B | 1/2 EBB | 15 | 17.0 |
| 5/13/2003 | 48 | B | 1/2 EBB | 14 | 2.0 |
| 6/26/2003 | 48 | B | 1/4 EBB | 24 | 4.0 |
| 8/6/2003 | 48 | B | LST EBB | 27 | 4.5 |
| 9/10/2003 | 48 | B | 1ST EBB | 30 | 33.0 |
| 1/6/2004 | 48 | B | 1/4 EBB | 19 | 1.7 |
| 1/26/2004 | 48 | B | 3/4 FLD | 22 | 2.0 |
| 2/20/2004 | 48 | B | 1/2 FLD | 14 | 2.0 |
| 3/4/2004 | 48 | B | 3/4 FLD | 14 | 1.7 |

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| 4/2/2004 | 48 | B | 1ST EBB | 20 | 1.7 |
| 4/21/2004 | 48 | B | 1/4 FLD | 26 | 1.7 |
| 1/3/2005 | 48 | B | LST. FLD | 20 | 1.8 |
| 3/7/2005 | 48 | B | 1/2 EBB | 18 | 2.0 |
| 4/12/2005 | 48 | B | 1/4 FLD | 20 | 4.5 |
| 7/19/2005 | 48 | B | 1st FLD | 28 | 1.7 |
| 8/18/2005 | 48 | B | 1/2 FLD | 31 | 11.0 |
| 9/29/2005 | 48 | B | 1/4 EBB | 20 | 13.0 |

***Sanitary Survey data***

| DATE | STATION | | TIDE | SALINITY | FC |
|---|---|---|---|---|---|
| 4/25/1994 | 52 | | 1/2 FLD | 34 | 6.8 |
| 6/21/1994 | 52 | | 1/2 EBB | 35 | 1.7 |
| 7/26/1994 | 52 | | 1ST FLD | 38 | 1.7 |
| 8/11/1994 | 52 | | 1ST FLD | 36 | 2.0 |
| 4/12/1995 | 52 | | 1ST EBB | 30 | 2.0 |
| 5/17/1995 | 52 | | 1/2 FLD | 37 | 1.7 |
| 6/27/1995 | 52 | | 1/2 FLD | 34 | 1.7 |
| 8/22/1995 | 52 | | 1ST EBB | 32 | 1.7 |
| 9/26/1995 | 52 | | 3/4 FLD | 24 | 2.0 |
| 10/25/1995 | 52 | | 2/3 FLD | 21 | 2.0 |
| 2/15/1996 | 52 | | 3/4 EBB | 22 | 1.7 |
| 3/25/1996 | 52 | | LST.FLD | 29 | 1.7 |
| 4/15/1996 | 52 | | 1/4 EBB | 25 | 1.7 |
| 5/20/1996 | 52 | | 1/2 FLD | 32 | 1.7 |
| 6/24/1996 | 52 | | 1ST FLD | 34 | 1.7 |
| 7/23/1996 | 52 | | 1st FLD | 27 | 1.7 |
| 11/25/1996 | 52 | | 2/3 FLD | 21 | 4.5 |
| 12/16/1996 | 52 | | 1/4 EBB | 22 | 11.0 |
| 1/23/1997 | 52 | | 1/2 FLD | 23 | 1.7 |
| 2/12/1997 | 52 | | 1/2 FLD | 19 | 1.7 |
| 4/15/1997 | 52 | | 2/3 EBB | 30 | 1.7 |
| 10/22/1997 | 52 | | 3/4 EBB | 32 | 6.8 |
| 4/1/1998 | 52 | | 1ST FLD | 16 | 1.7 |
| 6/1/1998 | 52 | | 1/4 FLD | 25 | 1.7 |
| 6/11/1998 | 52 | | 1/4 FLD | 25 | 1.7 |
| 7/13/1998 | 52 | | 1ST FLD | 30 | 2.0 |
| 8/12/1998 | 52 | | 1ST FLD | 24 | 1.7 |
| 9/23/1998 | 52 | | LST.FLD | 26 | 1.7 |
| 10/5/1998 | 52 | | LST.FLD | 28 | 1.7 |
| 11/23/1998 | 52 | | 1ST FLD | 24 | 1.7 |
| 12/10/1998 | 52 | | | 28 | 1.7 |
| 1/12/1999 | 52 | | 1/2 EBB | 19 | 4.5 |
| 2/16/1999 | 52 | | LSTFLD | 24 | 1.7 |
| 3/10/1999 | 52 | | 3/4EBB | 28 | 13.0 |
| 4/13/1999 | 52 | | 1STEBB | 31 | 6.8 |
| 6/15/1999 | 52 | | 1/3FLD | 34 | 1.7 |

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| 7/22/1999 | 52 | | 3/4EBB | 35 | 1.7 |
| 8/27/1999 | 52 | | ¼ FLD | 32 | 2.0 |
| 1/20/2000 | 52 | | LST.FLD | 30 | 1.7 |
| 2/4/2000 | 52 | | 1/3FLD | 23 | 1.7 |
| 3/9/2000 | 52 | | 1/4FLD | 26 | 1.7 |
| 6/8/2000 | 52 | | LST.EBB | 24 | 2.0 |
| 6/27/2000 | 52 | | 3/4 EBB | 32 | 1.7 |
| 10/4/2000 | 52 | | 1ST FLD | 22 | 4.5 |
| 11/8/2000 | 52 | | 3/4 EBB | 24 | 2.0 |
| 1/2/2001 | 52 | | L.LST.EBB | 22 | 1.7 |
| 2/7/2001 | 52 | | ¼ EBB | 26 | 1.7 |
| 3/1/2001 | 52 | | 1ST FLD. | 24 | 13.0 |
| 4/20/2001 | 52 | | 1ST EBB | 29 | 1.7 |
| 5/9/2001 | 52 | | ½ FLD | 31 | 11.0 |
| 9/5/2001 | 52 | | ½ FLD | 29 | 1.8 |
| 1/7/2002 | 52 | | LST EBB | 30 | 33.0 |
| 2/14/2002 | 52 | | 1/2 FLD | 28 | 1.8 |
| 3/27/2002 | 52 | | 1/4 EBB | 24 | 4.5 |
| 12/6/2002 | 52 | | LST FLD | 27 | 1.7 |
| 2/11/2003 | 52 | | LST EBB | 24 | 3.7 |
| 4/22/2003 | 52 | | 1/2 EBB | 15 | 6.8 |
| 5/13/2003 | 52 | | 1/2 EBB | 22 | 1.7 |
| 6/26/2003 | 52 | | 1/4 EBB | 28 | 1.7 |
| 8/6/2003 | 52 | | LST EBB | 29 | 11.0 |
| 9/10/2003 | 52 | | 1ST EBB | 28 | 17.0 |
| 1/6/2004 | 52 | | 1/4 EBB | 20 | 2.0 |
| 1/26/2004 | 52 | | 3/4 FLD | 22 | 1.8 |
| 2/20/2004 | 52 | | 2/3 FLD | 14 | 1.7 |
| 3/4/2004 | 52 | | 3/4 FLD | 14 | 23.0 |
| 4/2/2004 | 52 | | 1ST EBB | 20 | 1.7 |
| 4/21/2004 | 52 | | 1/4 FLD | 28 | 2.0 |
| 1/3/2005 | 52 | | SLACK | 20 | 2.0 |
| 3/7/2005 | 52 | | 1/2 EBB | 18 | 1.8 |
| 4/12/2005 | 52 | | 1/4 FLD | 20 | 7.8 |
| 7/19/2005 | 52 | | 1st FLD | 32 | 1.7 |
| 8/18/2005 | 52 | | 1/2 FLD | 31 | 7.8 |
| 9/29/2005 | 52 | | 1/4 EBB | 18 | 2.0 |

| *Conditional Monitoring Data* | | | | | | |
|---|---|---|---|---|---|---|
| **DATE** | **STATION** | **FC** | | **DATE** | **STATION** | **FC** |
| 1/18/1994 | 52 | 17 | | 10/16/1995 | 52 | 52 |
| 2/3/1994 | 52 | 2 | | 10/18/1995 | 52 | 13 |
| 3/6/1994 | 52 | 6.8 | | 1/29/1996 | 52 | 70 |
| 5/31/1994 | 52 | 1.7 | | 2/2/1996 | 52 | 2 |
| 8/22/1994 | 52 | 1.7 | | 10/11/1996 | 52 | 4.5 |
| 9/20/1994 | 52 | 1.8 | | 10/14/1996 | 52 | 7.8 |
| 10/17/1994 | 52 | 27 | | 12/2/1996 | 52 | 70 |

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|---|---|---|---|---|---|---|
| 11/21/1994 | 52 | 6.8 | | 12/5/1996 | 52 | 6.8 |
| 11/30/1994 | 52 | 79 | | 2/18/1997 | 52 | 2 |
| 12/1/1994 | 52 | 33 | | 3/17/1997 | 52 | 33 |
| 12/27/1994 | 52 | 49 | | 4/30/1997 | 52 | 33 |
| 12/29/1994 | 52 | 4.5 | | 9/14/1997 | 52 | 1.7 |
| 1/9/1995 | 52 | 70 | | 9/17/1997 | 52 | 1.7 |
| 1/12/1995 | 52 | 9.3 | | 9/30/1997 | 52 | 6.8 |
| 1/18/1995 | 52 | 170 | | 10/2/1997 | 52 | 2 |
| 1/23/1995 | 52 | 1.8 | | 11/3/1997 | 52 | 33 |
| 2/13/1995 | 52 | 6.1 | | 11/5/1997 | 52 | 33 |
| 6/9/1995 | 52 | 2 | | 12/2/1997 | 52 | 110 |
| 8/28/1995 | 52 | 33 | | 12/4/1997 | 52 | 49 |
| 8/30/1995 | 52 | 17 | | 1/19/1998 | 52 | 49 |
| | | | | 1/21/1998 | 52 | 11 |
| 1/26/1998 | 52 | 9.3 | | 10/17/2002 | 52 | 130 |
| 1/30/1998 | 52 | 22 | | 10/21/2002 | 52 | 7.8 |
| 2/9/1998 | 52 | 2 | | 11/19/2002 | 52 | 79 |
| 2/19/1998 | 52 | 49 | | 11/21/2002 | 52 | 79 |
| 2/22/1998 | 52 | 4.5 | | 11/24/2002 | 52 | 13 |
| 2/23/1998 | 52 | 4.5 | | 1/3/2003 | 52 | 33 |
| 5/4/1998 | 52 | 1.7 | | 1/6/2003 | 52 | 33 |
| 5/21/1998 | 52 | 23 | | 3/9/2003 | 52 | 49 |
| 8/4/1998 | 52 | 17 | | 3/25/2003 | 52 | 33 |
| 9/7/1998 | 52 | 7.8 | | 4/14/2003 | 52 | 23 |
| 5/3/1999 | 52 | 17 | | 4/15/2003 | 52 | 33 |
| 5/17/1999 | 52 | 46 | | 4/28/2003 | 52 | 17 |
| 5/20/1999 | 52 | 17 | | 5/5/2003 | 52 | 33 |
| 9/9/1999 | 52 | 7.8 | | 5/7/2003 | 52 | 23 |
| 10/19/1999 | 52 | 220 | | 5/20/2003 | 52 | 170 |
| 10/24/1999 | 52 | 1.7 | | 5/22/2003 | 52 | 4.5 |
| 1/27/2000 | 52 | 49 | | 5/29/2003 | 52 | 23 |
| 1/31/2000 | 52 | 1.8 | | 6/3/2003 | 52 | 2 |
| 4/18/2000 | 52 | 7.8 | | 9/30/2003 | 52 | 2 |
| 4/20/2000 | 52 | 130 | | 10/12/2003 | 52 | 49 |
| 4/24/2000 | 52 | 2 | | 10/14/2003 | 52 | 7.8 |
| 6/8/2000 | 52 | 17 | | 10/31/2003 | 52 | 49 |
| 7/30/2000 | 52 | 79 | | 12/16/2003 | 52 | 110 |
| 8/1/2000 | 52 | 4.5 | | 12/18/2003 | 52 | 26 |
| 8/6/2000 | 52 | 17 | | 12/20/2003 | 52 | 2 |
| 8/29/2000 | 52 | 23 | | 12/27/2003 | 52 | 7.8 |
| 9/1/2000 | 52 | 33 | | 7/2/2004 | 52 | 1.7 |
| 9/8/2000 | 52 | 70 | | 7/19/2004 | 52 | 2 |
| 9/11/2000 | 52 | 6.8 | | 7/31/2004 | 52 | 6.8 |
| 9/20/2000 | 52 | 23 | | 8/5/2004 | 52 | 22 |
| 9/26/2000 | 52 | 13 | | 8/9/2004 | 52 | 2 |
| 11/27/2000 | 52 | 170 | | 8/18/2004 | 52 | 1.7 |
| 11/29/2000 | 52 | 33 | | 9/4/2004 | 52 | 4.5 |
| 6/18/2001 | 52 | 1.7 | | 11/29/2004 | 52 | 17 |

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|---|---|---|---|---|---|---|
| 7/8/2001 | 52 | 1.7 | | 12/1/2004 | 52 | 7.8 |
| 8/15/2001 | 52 | 79 | | 4/4/2005 | 52 | 49 |
| 8/17/2001 | 52 | 2 | | 4/6/2005 | 52 | 4 |
| 9/27/2001 | 52 | 9.3 | | 4/11/2005 | 52 | 14 |
| 2/10/2002 | 52 | 240 | | 5/10/2005 | 52 | 1.7 |
| 2/12/2002 | 52 | 2 | | 6/6/2005 | 52 | 23 |
| 3/14/2002 | 52 | 33 | | 6/7/2005 | 52 | 1.7 |
| 9/4/2002 | 52 | 13 | | 7/1/2005 | 52 | 7.8 |
| 9/6/2002 | 52 | 1.7 | | 10/13/2005 | 52 | 23 |
| 9/12/2002 | 52 | 140 | | 10/16/2005 | 52 | 33 |
| 9/15/2002 | 52 | 2 | | 10/18/2005 | 52 | 4.5 |
| 10/26/2005 | 52 | 220 | | | | |
| 10/31/2005 | 52 | 7.8 | | | | |

| ***Sanitary Survey data*** | | | | | |
|---|---|---|---|---|---|
| **DATE** | **STATION** | | **TIDE** | **SALINITY** | **FC** |
| 4/25/1994 | 50 | | 1/2 FLD | 32 | 33.0 |
| 6/21/1994 | 50 | | 1/2 EBB | 35 | 1.7 |
| 7/26/1994 | 50 | | 1ST FLD | 39 | 1.7 |
| 8/11/1994 | 50 | | 1ST FLD | 37 | 1.7 |
| 4/12/1995 | 50 | | 1ST EBB | 28 | 17.0 |
| 5/17/1995 | 50 | | 1/2 FLD | 36 | 2.0 |
| 6/27/1995 | 50 | | 1/2 FLD | 33 | 2.0 |
| 7/20/1995 | 50 | | 3/4 EBB | 36 | 2.0 |
| 8/22/1995 | 50 | | 1ST EBB | 33 | 1.7 |
| 9/26/1995 | 50 | | 3/4 FLD | 25 | 23.0 |
| 10/25/1995 | 50 | | 2/3 FLD | 21 | 4.0 |
| 2/15/1996 | 50 | | 3/4 EBB | 18 | 4.5 |
| 3/25/1996 | 50 | | LST.FLD | 26 | 1.7 |
| 4/15/1996 | 50 | | 1/4 EBB | 22 | 1.7 |
| 5/20/1996 | 50 | | 1/2 FLD | 31 | 2.0 |
| 6/24/1996 | 50 | | 1ST FLD | 33 | 49.0 |
| 7/23/1996 | 50 | | 1st FLD | 22 | 33.0 |
| 11/25/1996 | 50 | | 2/3 FLD | 21 | 2.0 |
| 12/16/1996 | 50 | | 1/4 EBB | 21 | 49.0 |
| 1/23/1997 | 50 | | 1/2 FLD | 22 | 33.0 |
| 2/12/1997 | 50 | | 1/2 FLD | 17 | 170.0 |
| 4/15/1997 | 50 | | 2/3 EBB | 30 | 4.5 |
| 10/22/1997 | 50 | | 3/4 EBB | 31 | 17.0 |
| 4/1/1998 | 50 | | 1ST FLD | 15 | 13.0 |
| 6/1/1998 | 50 | | 1/4 FLD | 25 | 27.0 |
| 6/11/1998 | 50 | | 1/4 FLD | 25 | 27.0 |
| 7/13/1998 | 50 | | 1ST FLD | 24 | 110.0 |
| 8/12/1998 | 50 | | 1ST FLD | 24 | 1.7 |
| 9/23/1998 | 50 | | LST.FLD | 26 | 2.0 |
| 10/5/1998 | 50 | | LST.FLD | 27 | 4.0 |
| 11/23/1998 | 50 | | 1ST FLD | 24 | 22.0 |

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| 12/10/1998 | 50 | | | 27 | 11.0 |
| 1/12/1999 | 50 | | 1/2 EBB | 18 | 31.0 |
| 2/16/1999 | 50 | | LSTFLD | 24 | 4.5 |
| 3/10/1999 | 50 | | 3/4EBB | 26 | 130.0 |
| 4/13/1999 | 50 | | 1STEBB | 30 | 23.0 |
| 6/15/1999 | 50 | | 1/3FLD | 34 | 1.8 |
| 7/22/1999 | 50 | | 3/4EBB | 34 | 70.0 |
| 8/27/1999 | 50 | | ¼ FLD | 30 | 2.0 |
| 1/20/2000 | 50 | | LST.FLD | 30 | 2.0 |
| 2/4/2000 | 50 | | 1/3FLD | 22 | 2.0 |
| 3/9/2000 | 50 | | 1/4FLD | 24 | 4.5 |
| 6/8/2000 | 50 | | LST.EBB | 24 | 49.0 |
| 6/27/2000 | 50 | | 3/4 EBB | 30 | 1.7 |
| 10/4/2000 | 50 | | LST.EBB | 21 | 17.0 |
| 11/8/2000 | 50 | | 3/4 EBB | 24 | 49.0 |
| 1/2/2001 | 50 | | L.LST.EBB | 22 | 2.0 |
| 2/7/2001 | 50 | | ¼ EBB | 22 | 11.0 |
| 3/1/2001 | 50 | | 1ST FLD. | 24 | 1.7 |
| 4/20/2001 | 50 | | 1ST EBB | 28 | 1.7 |
| 5/9/2001 | 50 | | ½ FLD | 31 | 7.8 |
| 9/5/2001 | 50 | | ½ FLD | 25 | 79.0 |
| 1/7/2002 | 50 | | 3/4 EBB | 30 | 79.0 |
| 2/14/2002 | 50 | | 1/2 FLD | 29 | 2.0 |
| 3/27/2002 | 50 | | 1/4 EBB | 18 | 4.0 |
| 7/18/2002 | 50 | | 3/4 EBB | 34 | 6.8 |
| 11/5/2002 | 50 | | LST FLD | 24 | 6.8 |
| 12/6/2002 | 50 | | LST FLD | 26 | 2.0 |
| 2/11/2003 | 50 | | LST EBB | 24 | 6.8 |
| 4/22/2003 | 50 | | 1/2 EBB | 11 | 46.0 |
| 5/13/2003 | 50 | | 1/2 EBB | 20 | 23.0 |
| 6/26/2003 | 50 | | 1/4 EBB | 24 | 7.8 |
| 8/6/2003 | 50 | | LST EBB | 24 | 170.0 |
| 9/10/2003 | 50 | | 1ST EBB | 30 | 4.0 |
| 1/6/2004 | 50 | | 1/4 EBB | 18 | 33.0 |
| 1/26/2004 | 50 | | 3/4 FLD | 22 | 2.0 |
| 2/20/2004 | 50 | | 1/2 FLD | 14 | 7.8 |
| 3/4/2004 | 50 | | 3/4 FLD | 12 | 13.0 |
| 4/2/2004 | 50 | | 1ST EBB | 20 | 49.0 |
| 4/21/2004 | 50 | | 1/4 FLD | 28 | 1.7 |
| 1/3/2005 | 50 | | LST. FLD | 20 | 11.0 |
| 3/7/2005 | 50 | | 1/2 EBB | 18 | 7.8 |
| 4/12/2005 | 50 | | 1/4 FLD | 20 | 4.5 |
| 7/19/2005 | 50 | | 1st FLD | 30 | 7.8 |
| 8/18/2005 | 50 | | 1/2 FLD | 29 | 170.0 |
| 9/29/2005 | 50 | | 1/4 EBB | 16 | 49.0 |

| *Conditional Monitoring Data* | | |
|---|---|---|
| DATE | STATION | FC |
| 9/17/1997 | 50 | 4.5 |
| 9/2/1998 | 50 | 33 |
| 6/22/1999 | 50 | 11 |
| 9/8/1999 | 50 | 130 |
| 4/12/2000 | 50 | 2 |
| 6/6/2000 | 50 | 31 |
| 7/24/2000 | 50 | 1601 |
| 9/26/2000 | 50 | 13 |
| 10/1/2001 | 50 | 9.3 |
| 10/31/2001 | 50 | 1.7 |
| 6/6/2005 | 50 | 4.5 |
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| *Sanitary Survey data* | | | | | |
|---|---|---|---|---|---|
| **DATE** | **STATION** | | **TIDE** | **SALINITY** | **FC** |
| 4/25/1994 | 50 | B | 1/2 FLD | 33 | 2.0 |
| 6/21/1994 | 50 | B | 1/2 EBB | 36 | 1.7 |
| 7/26/1994 | 50 | B | 1ST FLD | 38 | 1.7 |
| 8/11/1994 | 50 | B | 1ST FLD | 37 | 1.7 |
| 4/12/1995 | 50 | B | 1ST EBB | 29 | 14.0 |
| 5/17/1995 | 50 | B | 1/2 FLD | 34 | 2.0 |
| 6/27/1995 | 50 | B | 1/2 FLD | 32 | 2.0 |
| 7/20/1995 | 50 | B | 3/4 EBB | 37 | 1.7 |
| 8/22/1995 | 50 | B | 1ST EBB | 32 | 2.0 |
| 9/26/1995 | 50 | B | 3/4 FLD | 25 | 33.0 |
| 10/25/1995 | 50 | B | 2/3 FLD | 21 | 7.8 |
| 2/15/1996 | 50 | B | 3/4 EBB | 21 | 1.7 |
| 3/25/1996 | 50 | B | LST.FLD | 26 | 1.7 |
| 4/15/1996 | 50 | B | 1/4 EBB | 24 | 1.7 |
| 5/20/1996 | 50 | B | 1/2 FLD | 31 | 2.0 |
| 6/24/1996 | 50 | B | 1ST FLD | 34 | 23.0 |
| 7/23/1996 | 50 | B | 1st FLD | 26 | 33.0 |
| 11/25/1996 | 50 | B | 2/3 FLD | 21 | 4.5 |
| 12/16/1996 | 50 | B | 1/4 EBB | 22 | 23.0 |
| 1/23/1997 | 50 | B | 1/2 FLD | 22 | 1.7 |
| 2/12/1997 | 50 | B | 1/2 FLD | 19 | 11.0 |
| 4/15/1997 | 50 | B | 2/3 EBB | 30 | 1.7 |
| 10/22/1997 | 50 | B | 3/4 EBB | 30 | 49.0 |
| 4/1/1998 | 50 | B | 1ST FLD | 16 | 1.7 |
| 6/1/1998 | 50 | B | 1/4 FLD | 24 | 4.5 |
| 6/11/1998 | 50 | B | 1/4 FLD | 24 | 4.5 |
| 7/13/1998 | 50 | B | 1ST FLD | 29 | 2.0 |
| 8/12/1998 | 50 | B | 1ST FLD | 24 | 1.7 |
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| 10/5/1998 | 50 | B | LST.FLD | 26 | 11.0 |

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|---|---|---|---|---|---|
| 11/23/1998 | 50 | B | 1ST FLD | 24 | 1.8 |
| 12/10/1998 | 50 | B | | 28 | 1.7 |
| 1/12/1999 | 50 | B | 1/2 EBB | 19 | 1.7 |
| 2/16/1999 | 50 | B | LSTFLD | 24 | 1.7 |
| 3/10/1999 | 50 | B | 3/4EBB | 27 | 33.0 |
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| 6/15/1999 | 50 | B | 1/3FLD | 34 | 9.3 |
| 7/22/1999 | 50 | B | 3/4EBB | 34 | 2.0 |
| 8/27/1999 | 50 | B | ¼ FLD | 32 | 1.7 |
| 1/20/2000 | 50 | B | LST.FLD | 30 | 1.7 |
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| 3/9/2000 | 50 | B | 1/4FLD | 24 | 2.0 |
| 6/8/2000 | 50 | B | LST.EBB | 24 | 79.0 |
| 6/27/2000 | 50 | B | 3/4 EBB | 30 | 1.7 |
| 10/4/2000 | 50 | B | LST.EBB | 20 | 79.0 |
| 11/8/2000 | 50 | B | 3/4 EBB | 24 | 79.0 |
| 1/2/2001 | 50 | B | L.LST.EBB | 22 | 1.7 |
| 2/7/2001 | 50 | B | ¼ EBB | 24 | 1.7 |
| 3/1/2001 | 50 | B | 1ST FLD. | 24 | 4.5 |
| 4/20/2001 | 50 | B | 1ST EBB | 28 | 1.7 |
| 5/9/2001 | 50 | B | ½ FLD | 31 | 79.0 |
| 9/5/2001 | 50 | B | ½ FLD | 24 | 2.0 |
| 1/7/2002 | 50 | B | 3/4 EBB | 29 | 240.0 |
| 2/14/2002 | 50 | B | 1/2 FLD | 28 | 1.7 |
| 3/27/2002 | 50 | B | 1/4 EBB | 22 | 49.0 |
| 7/18/2002 | 50 | B | 3/4 EBB | 34 | 1.7 |
| 11/5/2002 | 50 | B | LST FLD | 24 | 6.1 |
| 12/6/2002 | 50 | B | LST FLD | 26 | 2.0 |
| 2/11/2003 | 50 | B | LST EBB | 24 | 7.8 |
| 4/22/2003 | 50 | B | 1/2 EBB | 12 | 33.0 |
| 5/13/2003 | 50 | B | 1/2 EBB | 22 | 2.0 |
| 6/26/2003 | 50 | B | 1/4 EBB | 24 | 11.0 |
| 8/6/2003 | 50 | B | LST EBB | 25 | 130.0 |
| 9/10/2003 | 50 | B | 1ST EBB | 30 | 49.0 |
| 1/6/2004 | 50 | B | 1/4 EBB | 20 | 2.0 |
| 1/26/2004 | 50 | B | 3/4 FLD | 22 | 7.8 |
| 2/20/2004 | 50 | B | 1/2 FLD | 14 | 1.7 |
| 3/4/2004 | 50 | B | 3/4 FLD | 12 | 1.7 |
| 4/2/2004 | 50 | B | 1ST EBB | 20 | 1.7 |
| 4/21/2004 | 50 | B | 1/4 FLD | 26 | 1.7 |
| 1/3/2005 | 50 | B | LST. FLD | 20 | 4.0 |
| 3/7/2005 | 50 | B | 1/2 EBB | 18 | 1.7 |
| 4/12/2005 | 50 | B | 1/4 FLD | 20 | 4.0 |
| 7/19/2005 | 50 | B | 1st FLD | 30 | 27.0 |
| 8/18/2005 | 50 | B | 1/2 FLD | 31 | 240.0 |
| 9/29/2005 | 50 | B | 1/4 EBB | 18 | 23.0 |

| Sanitary Survey data | | | | | |
|---|---|---|---|---|---|
| DATE | STATION | | TIDE | SALINITY | FC |
| 6/21/1994 | 64 | | 1/2 EBB | 34 | 4.0 |
| 7/26/1994 | 64 | | 1ST FLD | 38 | 2.0 |
| 8/11/1994 | 64 | | 1ST FLD | 37 | 2.0 |
| 4/12/1995 | 64 | | 1ST EBB | 30 | 11.0 |
| 5/17/1995 | 64 | | 1/2 FLD | 36 | 1.7 |
| 6/27/1995 | 64 | | 1/2 FLD | 32 | 79.0 |
| 7/20/1995 | 64 | | 3/4 EBB | 37 | 4.5 |
| 8/22/1995 | 64 | | 1ST EBB | 34 | 1.7 |
| 9/26/1995 | 64 | | 3/4 FLD | 26 | 13.0 |
| 10/25/1995 | 64 | | 2/3 FLD | 23 | 7.8 |
| 2/15/1996 | 64 | | 3/4 EBB | 20 | 4.5 |
| 3/25/1996 | 64 | | LST.FLD | 27 | 1.7 |
| 4/15/1996 | 64 | | 1/4 EBB | 26 | 1.7 |
| 5/20/1996 | 64 | | 1/2 FLD | 31 | 1.7 |
| 6/24/1996 | 64 | | 1ST FLD | 34 | 23.0 |
| 7/23/1996 | 64 | | 1st FLD | 30 | 2.0 |
| 11/25/1996 | 64 | | 2/3 FLD | 21 | 13.0 |
| 12/16/1996 | 64 | | 1/4 EBB | 23 | 23.0 |
| 1/23/1997 | 64 | | 1/2 FLD | 22 | 17.0 |
| 2/12/1997 | 64 | | 1/2 FLD | 20 | 1.8 |
| 4/15/1997 | 64 | | 2/3 EBB | 31 | 1.7 |
| 10/22/1997 | 64 | | 3/4 EBB | 32 | 7.8 |
| 4/1/1998 | 64 | | 1ST FLD | 15 | 1.7 |
| 6/1/1998 | 64 | | 1/4 FLD | 26 | 1.7 |
| 6/11/1998 | 64 | | 1/4 FLD | 26 | 1.7 |
| 7/13/1998 | 64 | | 1ST FLD | 28 | 13.0 |
| 8/12/1998 | 64 | | 1ST FLD | 22 | 2.0 |
| 9/23/1998 | 64 | | LST.FLD | 26 | 6.8 |
| 10/5/1998 | 64 | | LST.FLD | 26 | 2.0 |
| 11/23/1998 | 64 | | 1ST FLD | 24 | 1.7 |
| 12/10/1998 | 64 | | | 28 | 4.0 |
| 1/12/1999 | 64 | | 1/2 EBB | 18 | 1.7 |
| 2/16/1999 | 64 | | LSTFLD | 24 | 2.0 |
| 3/10/1999 | 64 | | 3/4EBB | 26 | 130.0 |
| 4/13/1999 | 64 | | 1STEBB | 30 | 1.7 |
| 6/15/1999 | 64 | | 1/3FLD | 34 | 1.7 |
| 7/22/1999 | 64 | | 3/4EBB | 34 | 6.8 |
| 8/27/1999 | 64 | | ¼ FLD | 32 | 13.0 |
| 1/20/2000 | 64 | | LST.FLD | 30 | 4.5 |
| 2/4/2000 | 64 | | 1/3FLD | 22 | 1.7 |
| 3/9/2000 | 64 | | 1/4FLD | 26 | 22.0 |
| 6/8/2000 | 64 | | LST.EBB | 24 | 17.0 |
| 6/27/2000 | 64 | | 3/4 EBB | 32 | 1.7 |
| 10/4/2000 | 64 | | 1ST FLD | 22 | 2.0 |
| 11/8/2000 | 64 | | 3/4 EBB | 24 | 17.0 |
| 1/2/2001 | 64 | | L.LST.EBB | 24 | 1.7 |

| | | | | | |
|---|---|---|---|---|---|
| 2/7/2001 | 64 | | ¼ EBB | 26 | 1.7 |
| 3/1/2001 | 64 | | 1ST FLD. | 24 | 17.0 |
| 4/20/2001 | 64 | | 1ST EBB | 30 | 1.7 |
| 5/9/2001 | 64 | | ½ FLD | 31 | 7.8 |
| 9/5/2001 | 64 | | ½ FLD | 30 | 1.7 |
| 1/7/2002 | 64 | | LST EBB | 30 | 79.0 |
| 2/14/2002 | 64 | | 1/2 FLD | 28 | 6.8 |
| 3/27/2002 | 64 | | 1/4 EBB | 22 | 23.0 |
| 7/18/2002 | 64 | | 3/4 EBB | 34 | 4.5 |
| 11/5/2002 | 64 | | LST FLD | 24 | 1.7 |
| 12/6/2002 | 64 | | LST FLD | 26 | 14.0 |
| 2/11/2003 | 64 | | LST EBB | 24 | 1.7 |
| 4/22/2003 | 64 | | 1/2 EBB | 14 | 33.0 |
| 5/13/2003 | 64 | | 1/2 EBB | 22 | 1.7 |
| 6/26/2003 | 64 | | 1/4 EBB | 26 | 2.0 |
| 8/6/2003 | 64 | | LST EBB | 24 | 350.0 |
| 9/10/2003 | 64 | | 1ST EBB | 30 | 7.8 |
| 1/6/2004 | 64 | | 1/4 EBB | 18 | 79.0 |
| 1/26/2004 | 64 | | 3/4 FLD | 21 | 2.0 |
| 2/20/2004 | 64 | | 1/2 FLD | 14 | 11.0 |
| 3/4/2004 | 64 | | 3/4 FLD | 14 | 49.0 |
| 4/2/2004 | 64 | | 1ST EBB | 20 | 2.0 |
| 4/21/2004 | 64 | | 1/4 FLD | 28 | 1.7 |
| 1/3/2005 | 64 | | SLACK | 21 | 2.0 |
| 3/7/2005 | 64 | | 1/2 EBB | 18 | 1.7 |
| 4/12/2005 | 64 | | 1/4 FLD | 20 | 13.0 |
| 7/19/2005 | 64 | | 1st FLD | 32 | 1.7 |
| 8/18/2005 | 64 | | 1/2 FLD | 30 | 49.0 |
| 9/29/2005 | 64 | | 1/4 EBB | 16 | 4.0 |

| **Sanitary Survey data** | | | | | |
|---|---|---|---|---|---|
| **DATE** | **STATION** | | **TIDE** | **SALINITY** | **FC** |
| 6/21/1994 | 49 | | 1/2 EBB | 34 | 1.7 |
| 7/26/1994 | 49 | | 1ST FLD | 39 | 1.7 |
| 8/11/1994 | 49 | | 1ST FLD | 37 | 1.7 |
| 4/12/1995 | 49 | | 1ST EBB | 29 | 7.8 |
| 5/17/1995 | 49 | | 1/2 FLD | 35 | 1.7 |
| 6/27/1995 | 49 | | 1/2 FLD | 33 | 2.0 |
| 7/20/1995 | 49 | | 3/4 EBB | 37 | 11.0 |
| 8/22/1995 | 49 | | 1ST EBB | 33 | 2.0 |
| 9/26/1995 | 49 | | 3/4 FLD | 26 | 6.8 |
| 10/25/1995 | 49 | | 2/3 FLD | 22 | 49.0 |
| 2/15/1996 | 49 | | 3/4 EBB | 20 | 1.7 |
| 3/25/1996 | 49 | | LST.FLD | 23 | 1.7 |
| 4/15/1996 | 49 | | 1/4 EBB | 24 | 1.7 |
| 5/20/1996 | 49 | | 1/2 FLD | 31 | 1.7 |
| 6/24/1996 | 49 | | 1ST FLD | 33 | 11.0 |

| | | | | | |
|---|---|---|---|---|---|
| 7/23/1996 | 49 | | 1st FLD | 20 | 1.7 |
| 11/25/1996 | 49 | | 2/3 FLD | 21 | 4.5 |
| 12/16/1996 | 49 | | 1/4 EBB | 21 | 2.0 |
| 1/23/1997 | 49 | | 1/2 FLD | 22 | 7.8 |
| 2/12/1997 | 49 | | 1/2 FLD | 20 | 1.8 |
| 4/15/1997 | 49 | | 2/3 EBB | 30 | 1.7 |
| 10/22/1997 | 49 | | 3/4 EBB | 31 | 4.0 |
| 4/1/1998 | 49 | | 1ST FLD | 16 | 2.0 |
| 6/1/1998 | 49 | | 1/4 FLD | 22 | 1.7 |
| 6/11/1998 | 49 | | 1/4 FLD | 22 | 1.7 |
| 7/13/1998 | 49 | | 1ST FLD | 28 | 4.5 |
| 8/12/1998 | 49 | | 1ST FLD | 24 | 1.7 |
| 9/23/1998 | 49 | | LST.FLD | 26 | 2.0 |
| 10/5/1998 | 49 | | LST.FLD | 28 | 1.7 |
| 11/23/1998 | 49 | | 1ST FLD | 24 | 4.0 |
| 12/10/1998 | 49 | | | 28 | 7.8 |
| 1/12/1999 | 49 | | 1/2 EBB | 18 | 1.7 |
| 2/16/1999 | 49 | | LSTFLD | 24 | 2.0 |
| 3/10/1999 | 49 | | 3/4EBB | 28 | 2.0 |
| 4/13/1999 | 49 | | 1STEBB | 30 | 17.0 |
| 6/15/1999 | 49 | | 1/3FLD | 34 | 1.7 |
| 7/22/1999 | 49 | | 3/4EBB | 34 | 6.8 |
| 8/27/1999 | 49 | | ¼ FLD | 30 | 1.7 |
| 1/20/2000 | 49 | | LST.FLD | 30 | 1.7 |
| 2/4/2000 | 49 | | 1/3FLD | 22 | 1.7 |
| 3/9/2000 | 49 | | 1/4FLD | 24 | 1.7 |
| 6/8/2000 | 49 | | 3/4 EBB | 24 | 23.0 |
| 6/27/2000 | 49 | | 3/4 EBB | 31 | 1.7 |
| 10/4/2000 | 49 | | LST.EBB | 22 | 6.8 |
| 11/8/2000 | 49 | | 3/4 EBB | 24 | 23.0 |
| 1/2/2001 | 49 | | L.LST.EBB | 20 | 1.7 |
| 2/7/2001 | 49 | | ¼ EBB | 26 | 4.5 |
| 3/1/2001 | 49 | | 1ST FLD. | 24 | 4.0 |
| 4/20/2001 | 49 | | 1ST EBB | 26 | 2.0 |
| 5/9/2001 | 49 | | ½ FLD | 31 | 13.0 |
| 9/5/2001 | 49 | | ½ FLD | 30 | 7.8 |
| 1/7/2002 | 49 | | 3/4 EBB | 30 | 49.0 |
| 2/14/2002 | 49 | | 1/2 FLD | 28 | 1.7 |
| 3/27/2002 | 49 | | 1/4 EBB | 23 | 79.0 |
| 7/18/2002 | 49 | | 3/4 EBB | 34 | 1.7 |
| 11/5/2002 | 49 | | LST FLD | 24 | 4.0 |
| 12/6/2002 | 49 | | LST FLD | 25 | 13.0 |
| 2/11/2003 | 49 | | LST EBB | 22 | 13.0 |
| 4/22/2003 | 49 | | 1/2 EBB | 11 | 33.0 |
| 5/13/2003 | 49 | | 1/2 EBB | 16 | 4.5 |
| 6/26/2003 | 49 | | 1/4 EBB | 26 | 1.8 |
| 8/6/2003 | 49 | | LST EBB | 28 | 2.0 |
| 9/10/2003 | 49 | | 1ST EBB | 30 | 6.8 |

| | | | | | |
|---|---|---|---|---|---|
| 1/6/2004 | 49 | | 1/4 EBB | 18 | 1.7 |
| 1/26/2004 | 49 | | 3/4 FLD | 22 | 1.7 |
| 2/20/2004 | 49 | | 1/2 FLD | 16 | 1.7 |
| 3/4/2004 | 49 | | 3/4 FLD | 14 | 1.7 |
| 4/2/2004 | 49 | | 1ST EBB | 20 | 2.0 |
| 4/21/2004 | 49 | | 1/4 FLD | 26 | 1.7 |
| 1/3/2005 | 49 | | LST. FLD | 20 | 1.7 |
| 3/7/2005 | 49 | | 1/2 EBB | 18 | 1.7 |
| 4/12/2005 | 49 | | 1/4 FLD | 21 | 13.0 |
| 7/19/2005 | 49 | | 1st FLD | 30 | 2.0 |
| 8/18/2005 | 49 | | 1/2 FLD | 29 | 95.0 |
| 9/29/2005 | 49 | | 1/4 EBB | 18 | 17.0 |

## Appendix B. Watershed Delineation and Tidal Prism Model Segmentation

The USGS Multi-Resolution Land Cover (MRLC) data was used to obtain land use for each subwatershed. There are 23 land use categories in the MRLC data. For modeling purposes, the land use categories were further grouped into eight categories. The land use categories are listed in Table B-1. The model group is used for the watershed model. The pervious and impervious land uses were estimated based on the perviousness, which are listed in Table B-1 in Pervious/impervious column. The number represents the percent of pervious in that land use category.

**Table B-1: MRLC land use categories and modeling land use categories**

| Model Grouping | Land Use Code | MRLC Category | Pervious / impervious |
|---|---|---|---|
| Water | 11 | Open Water | N/A |
| Barren | 31 | Bare Rock/Sand/Clay | 1.0 |
| Barren | 32 | Quarries/Strip Mines/Gravel Pits | 1.0 |
| Barren | 33 | Transitional Barren | 1.0 |
| Barren | 84 | Bare Soil | 1.0 |
| Cropland | 82 | Row Crops | 1.0 |
| Cropland | 83 | Small Grains | 1.0 |
| Forest | 41 | Deciduous Forest | 1.0 |
| Forest | 42 | Evergreen Forest | 1.0 |
| Forest | 43 | Mixed Forest | 1.0 |
| Forest | 51 | Deciduous Shrub land | 1.0 |
| Forest | 52 | Evergreen Shrub land | 1.0 |
| Forest | 53 | Mixed Shrub land | 1.0 |
| Forest | 61 | Non-Natural Woody (Orchards/Groves/etc) | 1.0 |
| Pasture | 71 | Grasslands/Herbaceous (Natural/Semi Natural Herbaceous) | 1.0 |
| Pasture | 81 | Pasture/Hay | 1.0 |
| Pasture | 85 | Other Grasses/(Urban Grasses) | 1.0 |
| Urban Pervious | 21 | Low Intensity Residential | 0.88 |
| Urban Pervious | 22 | High Intensity residential | 0.35 |
| Urban Pervious | 23 | High Intensity Commercial/Industrial/Transportation | 0.15 |
| Wetlands | 91 | Woody Wetlands | 1 |
| Wetlands | 92 | Emergent Herbaceous Wetlands | 1.0 |
| Other | 99 | No data/to be processed | 1.0 |
| Urban Impervious | 21 | Low Intensity Residential | 0.12 |
| Urban Impervious | 22 | High Intensity residential | 0.65 |
| Urban Impervious | 23 | High Intensity Commercial/Industrial/Transportation | 0.85 |

Figure B-1 shows the watershed delineation. The land use data for each subwatershed is listed in Table B-2. The Tidal Prism model segmentation is shown in Figure B-2. The geometry information used for Tidal Prism model is listed in Table B-3.

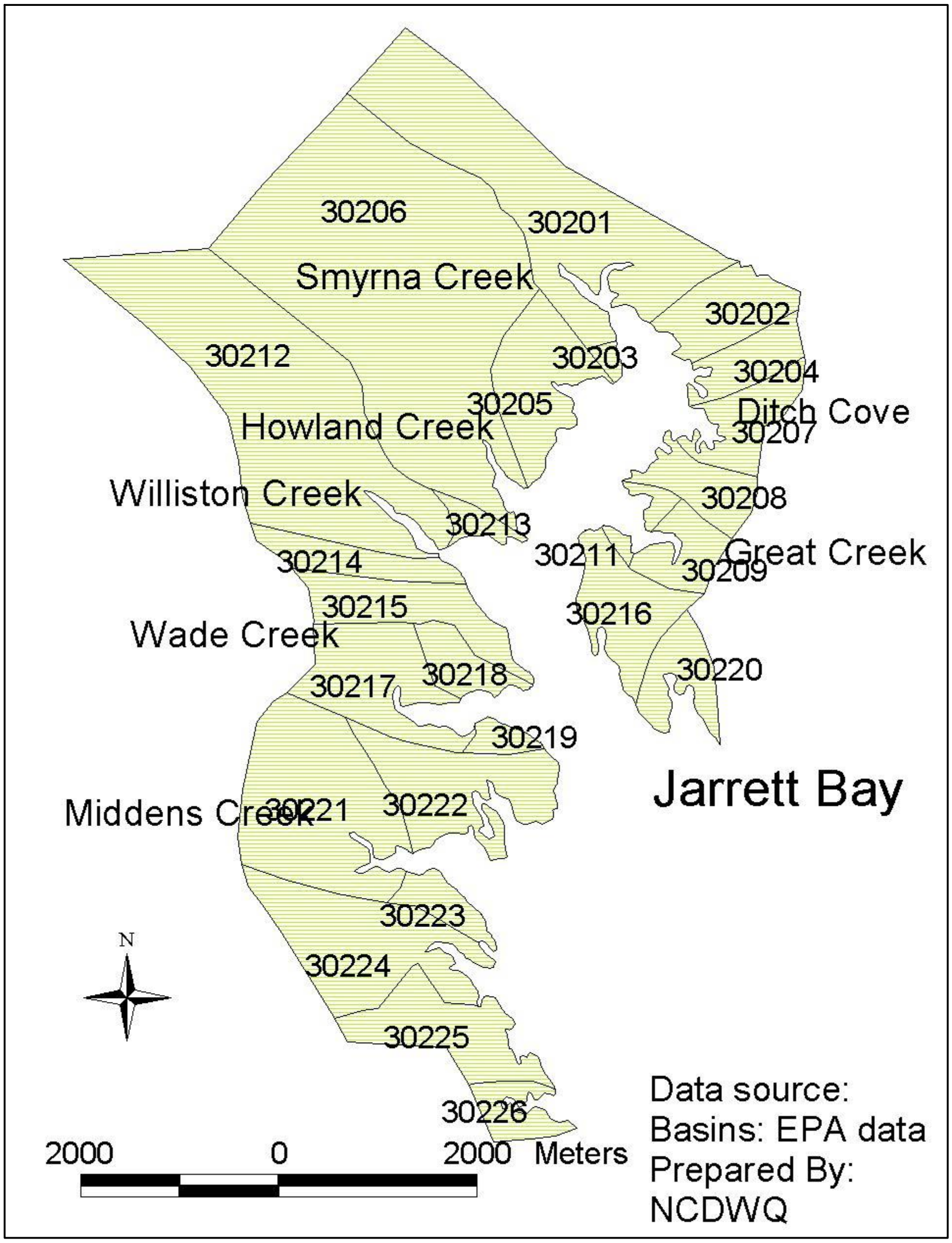



**Figure B-1: A map of watershed delineation**

**Table B-2: Land Use by Subwatershed**

| Land Use | SWS | Area (ac) | SWS | Area (ac) | SWS | Area (ac) |
|---|---|---|---|---|---|---|
| Barren | 30201 | 0.0 | 30210 | 0.0 | 30219 | 0.0 |
| Cropland | 30201 | 3.8 | 30210 | 0.0 | 30219 | 0.0 |
| Forest | 30201 | 92.3 | 30210 | 0.0 | 30219 | 19.8 |
| Pasture | 30201 | 1.1 | 30210 | 0.0 | 30219 | 0.2 |
| Urban Pervious | 30201 | 0.0 | 30210 | 0.0 | 30219 | 0.0 |
| Wetlands | 30201 | 842.4 | 30210 | 29.1 | 30219 | 31.6 |
| Other | 30201 | 0.0 | 30210 | 0.0 | 30219 | 0.0 |
| Urban Impervious | 30201 | 0.0 | 30210 | 0.0 | 30219 | 0.0 |
| Barren | 30202 | 0.0 | 30211 | 0.0 | 30220 | 0.0 |
| Cropland | 30202 | 33.8 | 30211 | 0.0 | 30220 | 0.0 |
| Forest | 30202 | 56.3 | 30211 | 0.0 | 30220 | 1.8 |
| Pasture | 30202 | 13.1 | 30211 | 0.0 | 30220 | 0.0 |
| Urban Pervious | 30202 | 7.2 | 30211 | 0.0 | 30220 | 0.0 |
| Wetlands | 30202 | 113.0 | 30211 | 14.5 | 30220 | 140.6 |
| Other | 30202 | 0.0 | 30211 | 0.0 | 30220 | 0.0 |
| Urban Impervious | 30202 | 2.1 | 30211 | 0.0 | 30220 | 0.0 |
| Barren | 30203 | 0.0 | 30212 | 0.2 | 30221 | 0.4 |
| Cropland | 30203 | 0.0 | 30212 | 445.2 | 30221 | 120.5 |
| Forest | 30203 | 0.0 | 30212 | 109.0 | 30221 | 198.6 |
| Pasture | 30203 | 0.0 | 30212 | 52.5 | 30221 | 67.6 |
| Urban Pervious | 30203 | 0.0 | 30212 | 2.1 | 30221 | 9.7 |
| Wetlands | 30203 | 20.2 | 30212 | 762.8 | 30221 | 319.6 |
| Other | 30203 | 0.0 | 30212 | 0.0 | 30221 | 0.0 |
| Urban Impervious | 30203 | 0.0 | 30212 | 1.9 | 30221 | 2.8 |
| Barren | 30204 | 0.0 | 30213 | 0.0 | 30222 | 0.2 |
| Cropland | 30204 | 10.2 | 30213 | 0.7 | 30222 | 6.9 |
| Forest | 30204 | 61.4 | 30213 | 3.8 | 30222 | 144.1 |
| Pasture | 30204 | 12.9 | 30213 | 4.2 | 30222 | 26.7 |
| Urban Pervious | 30204 | 6.2 | 30213 | 2.4 | 30222 | 1.8 |
| Wetlands | 30204 | 49.1 | 30213 | 41.4 | 30222 | 222.4 |
| Other | 30204 | 0.0 | 30213 | 0.0 | 30222 | 0.0 |
| Urban Impervious | 30204 | 1.6 | 30213 | 1.6 | 30222 | 0.4 |
| Barren | 30205 | 0.0 | 30214 | 0.0 | 30223 | 0.0 |
| Cropland | 30205 | 1.8 | 30214 | 53.6 | 30223 | 3.1 |
| Forest | 30205 | 18.0 | 30214 | 72.1 | 30223 | 50.3 |
| Pasture | 30205 | 1.1 | 30214 | 4.0 | 30223 | 19.6 |
| Urban Pervious | 30205 | 0.0 | 30214 | 0.8 | 30223 | 0.0 |
| Wetlands | 30205 | 306.9 | 30214 | 34.2 | 30223 | 16.0 |
| Other | 30205 | 0.0 | 30214 | 0.0 | 30223 | 0.0 |
| Urban Impervious | 30205 | 0.0 | 30214 | 0.1 | 30223 | 0.0 |
| Barren | 30206 | 0.0 | 30215 | 0.0 | 30224 | 0.4 |
| Cropland | 30206 | 18.2 | 30215 | 59.8 | 30224 | 3.6 |
| Forest | 30206 | 348.5 | 30215 | 136.8 | 30224 | 332.9 |
| Pasture | 30206 | 66.7 | 30215 | 22.5 | 30224 | 35.4 |

| Land Use | SWS | Area (ac) | SWS | Area (ac) | SWS | Area (ac) |
|---|---|---|---|---|---|---|
| Urban Pervious | 30206 | 1.7 | 30215 | 3.0 | 30224 | 3.1 |
| Wetlands | 30206 | 1678.6 | 30215 | 51.4 | 30224 | 145.0 |
| Other | 30206 | 0.0 | 30215 | 0.0 | 30224 | 0.0 |
| Urban Impervious | 30206 | 0.8 | 30215 | 0.8 | 30224 | 1.5 |
| Barren | 30207 | 0.0 | 30216 | 0.0 | 30225 | 0.0 |
| Cropland | 30207 | 0.9 | 30216 | 0.0 | 30225 | 35.6 |
| Forest | 30207 | 63.4 | 30216 | 12.2 | 30225 | 159.2 |
| Pasture | 30207 | 16.5 | 30216 | 0.0 | 30225 | 103.9 |
| Urban Pervious | 30207 | 3.4 | 30216 | 0.0 | 30225 | 3.0 |
| Wetlands | 30207 | 89.6 | 30216 | 258.2 | 30225 | 17.6 |
| Other | 30207 | 0.0 | 30216 | 0.0 | 30225 | 0.0 |
| Urban Impervious | 30207 | 1.2 | 30216 | 0.0 | 30225 | 0.6 |
| Barren | 30208 | 0.0 | 30217 | 0.0 | 30226 | 0.2 |
| Cropland | 30208 | 0.0 | 30217 | 93.0 | 30226 | 13.3 |
| Forest | 30208 | 2.2 | 30217 | 119.6 | 30226 | 60.0 |
| Pasture | 30208 | 0.0 | 30217 | 24.0 | 30226 | 18.2 |
| Urban Pervious | 30208 | 0.0 | 30217 | 7.2 | 30226 | 2.2 |
| Wetlands | 30208 | 160.6 | 30217 | 119.0 | 30226 | 14.5 |
| Other | 30208 | 0.0 | 30217 | 0.0 | 30226 | 0.0 |
| Urban Impervious | 30208 | 0.0 | 30217 | 1.9 | 30226 | 0.3 |
| Barren | 30209 | 0.0 | 30218 | 0.0 | | |
| Cropland | 30209 | 0.0 | 30218 | 11.3 | | |
| Forest | 30209 | 0.0 | 30218 | 62.9 | | |
| Pasture | 30209 | 0.0 | 30218 | 22.7 | | |
| Urban Pervious | 30209 | 0.0 | 30218 | 2.3 | | |
| Wetlands | 30209 | 148.3 | 30218 | 24.9 | | |
| Other | 30209 | 0.0 | 30218 | 0.0 | | |
| Urban Impervious | 30209 | 0.0 | 30218 | 0.3 | | |

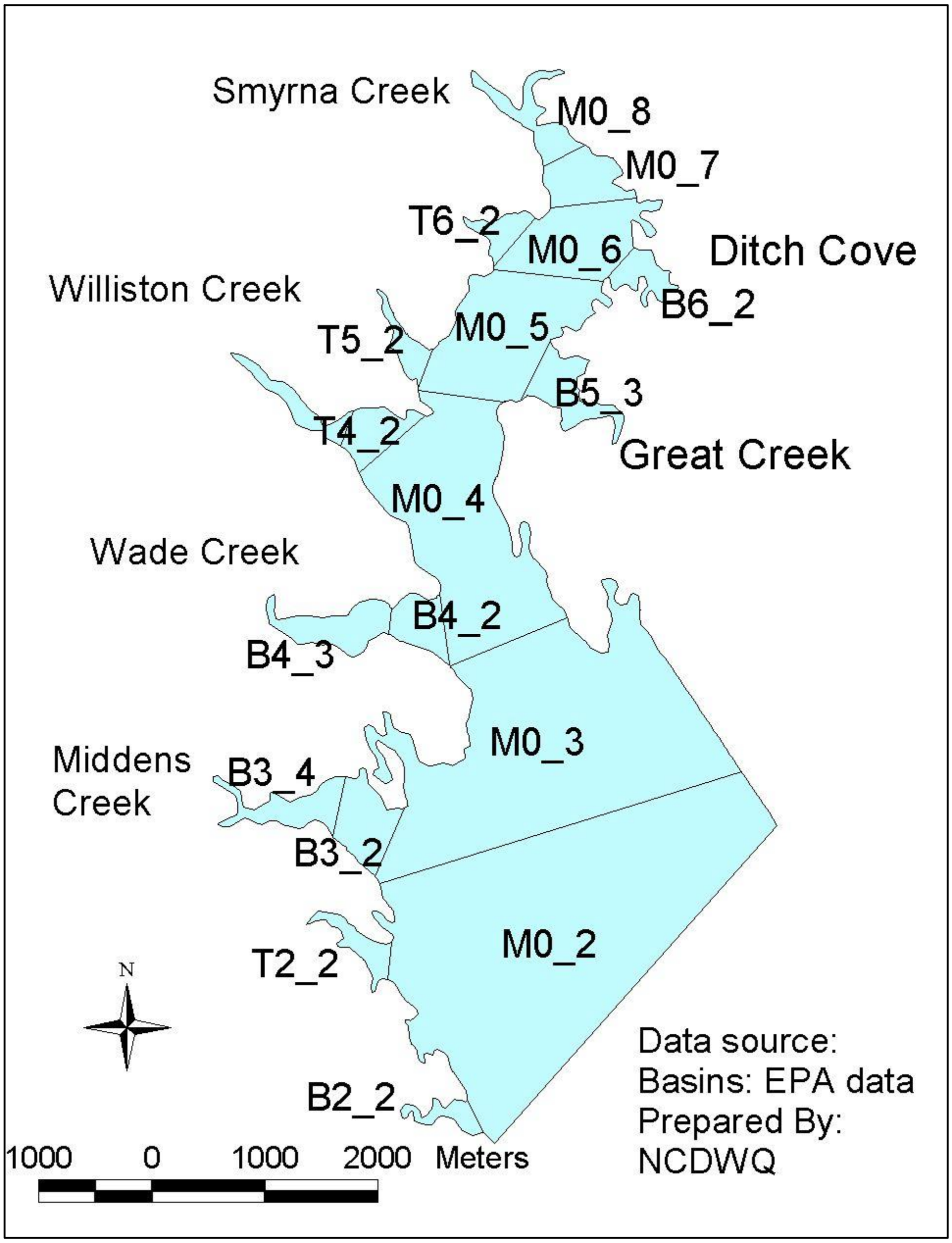



**Figure B-2: A map of Tidal Prism model segmentation**

**Table B-3: Geometry information used for Tidal Prism model**

| Segment | Distance from mouth (km) | High Water Volume ($m^3 \times 10^6$) | Tidal Prism ($m^3 \times 10^6$) | Depth (m) | Creek |
|---|---|---|---|---|---|
| M0_1 | 0.00 | 0.00 | 7.91 | 0.00 | Jarrett Bay |
| M0_2 | 1.56 | 7.92 | 5.15 | 0.94 | Jarrett Bay |
| M0_3 | 3.26 | 5.15 | 2.91 | 0.71 | Jarrett Bay |
| M0_4 | 5.74 | 2.91 | 1.32 | 0.58 | Jarrett Bay |
| M0_5 | 7.12 | 1.38 | 0.56 | 0.51 | Jarrett Bay |
| M0_6 | 7.66 | 0.62 | 0.25 | 0.52 | Jarrett Bay |
| M0_7 | 8.15 | 0.25 | 0.12 | 0.40 | Jarrett Bay |
| M0_8 | 8.64 | 0.12 | 0.04 | 0.22 | Smyrna |
| M0_9 | 9.17 | 0.04 | 0.00 | 0.08 | Jarrett Bay |
| B2_1 | 0.00 | 0.00 | 0.05 | 0.00 | Jarrett Bay |
| B2_2 | 0.55 | 0.06 | 0.00 | 0.08 | Jarrett Bay |
| T2_1 | 0.00 | 0.00 | 0.07 | 0.00 | Jarrett Bay |
| T2_2 | 0.74 | 0.08 | 0.00 | 0.06 | Jarrett Bay |
| B3_1 | 0.00 | 0.00 | 0.27 | 0.00 | Jarrett Bay |
| B3_2 | 0.56 | 0.27 | 0.13 | 0.41 | Middens |
| B3_3 | 1.07 | 0.13 | 0.04 | 0.26 | Middens |
| B3_4 | 1.45 | 0.05 | 0.00 | 0.11 | Middens |
| B4_1 | 0.00 | 0.00 | 0.24 | 0.00 | Jarrett Bay |
| B4_2 | 0.81 | 0.24 | 0.09 | 0.30 | Wade |
| B4_3 | 1.58 | 0.11 | 0.00 | 0.09 | Wade |
| T4_1 | 0.00 | 0.00 | 0.14 | 0.00 | Jarrett Bay |
| T4_2 | 0.47 | 0.14 | 0.06 | 0.33 | Williston |
| T4_3 | 1.47 | 0.07 | 0.00 | 0.10 | Williston |
| B5_1 | 0.00 | 0.00 | 0.13 | 0.00 | Jarrett Bay |
| B5_2 | 0.47 | 0.13 | 0.04 | 0.19 | Great |
| B5_3 | 0.92 | 0.04 | 0.00 | 0.02 | Great |
| T5_1 | 0.00 | 0.00 | 0.06 | 0.00 | Jarrett Bay |
| T5_2 | 0.08 | 0.07 | 0.00 | 0.07 | Williston |
| B6_1 | 0.00 | 0.00 | 0.07 | 0.00 | Jarrett Bay |
| B6_2 | 0.45 | 0.08 | 0.00 | 0.07 | Ditch Cove |
| T6_1 | 0.00 | 0.00 | 0.06 | 0.00 | Jarrett Bay |
| T6_2 | 0.08 | 0.09 | 0.00 | 0.22 | Jarrett Bay |

**Table B-4: Mapping table between subwatersheds and creeks**

| Creek | Subwatershed | | | |
|---|---|---|---|---|
| Smyrna | 30201 | | | |
| Williston | 30212 | 30213 | 30214 | |
| Wade Creek | 30217 | 30218 | 30219 | |
| Great Creek | 30208 | 30211 | 30209 | |
| Ditch Creek | 30207 | | | |
| Howland | 30206 | | | |
| Middens Creek | 30221 | 30222 | 30223 | |
| Jarrett Bay | 30203 | 30205 | 30202 | 30204 |
| | 30208 | 30211 | 30216 | 30220 |
| | 30215 | 30224 | 30225 | 30226 |

## Appendix C. Source Assessment

### Nonpoint Source Assessment

Nonpoint sources of fecal coliform bacteria do not have one discharge point but occur over the entire length of a stream or waterbody. There are many types of nonpoint sources in watersheds discharging to the restricted shellfish harvesting areas. The possible introductions of fecal coliform bacteria to the land surface are through the manure spreading process, direct deposition from livestock during the grazing season, and excretions from pets and wildlife. As the runoff occurs during rain events, surface runoff transports water and fecal coliform over the land surface and discharges to the restricted shellfish harvesting area. The deposition of non-human fecal coliform directly to the restricted shellfish area occurs when livestock or wildlife have direct access to the waterbody. Nonpoint source contributions to the bacterial levels from human activities generally arise from failing septic systems and their associated drain fields as well as through pollution from recreation vessel discharges. The transport of fecal coliform from land surface to the restricted shellfish harvesting area is dictated by the hydrology, soil type, land use, and topography of the watershed.

In order to determine the sources of fecal coliform contribution and reduction needed to achieve water quality criteria, and to allocate fecal coliform load among these sources, it is necessary to identify all existing sources. The nonpoint source assessment was conducted using available data collected in the watershed. Multiple data sources were used to determine the potential sources of the fecal coliform load from the watershed. The data used for source assessment are:

1. Land use data of USGS Multi-Resolution Land Cover
2. County Agriculture Cense data (USDA)
3. Shoreline sanitary survey data (NRDWQ)
4. Shoreline survey conducted by Duke University
5. GIS 2000 Census of Human population
6. Pet survey results (Duke University, 2004)
7. Fecal coliform monitoring data
8. USGS digital elevation model (MDE) data
9. Stream GIS coverage (EPA, 1994)
10. Septic survey data (Duke University 2004)
11. Wildlife population

A shoreline survey was conducted on July 6, 2001 by NCDWQ. The drainage areas of three creeks on the list including Wade Creek, Williston Creek, and Smyrna Creek, were also surveyed. Each of these creeks drain freshwater swamp areas which are adjacent to forest land and two large farms, Open Ground Farm and Smyrna Farm. A survey was conducted in Williston, Davis, and Smyrna watershed in 2004 by Duke University.

In the Jarrett Bay, wildlife contributions, both mammalian and avian, are natural conditions and may represent a background level of bacterial loading. Livestock contributions, such as those from mammalian and avian livestock, mainly result from surface runoff. Pet contributions usually occur through runoff from streets and land. Since there are no direct point source discharges to the embayment and there is a lack of information available for the discharge from boats, it is assumed that human loading results from failures in septic waste treatment systems. The major nonpoint source contributions assessed for restricted shellfish areas in the Jarrett Bay basin are summarized in Table C-1. The potential nonpoint sources were grouped into four categories: wildlife; human; pets; and livestock It should be noted that livestock are not a major source of fecal coliform in this area. Due to insufficient data sources, the source assessment method does not account for boat discharge, resuspension from bottom sediment, and the potential for regrowth of fecal coliform in the embayment.

**Table C-1: Summary of Nonpoint Sources**

| Category | Source |
|---|---|
| Wildlife | Beaver, deer, goose, duck, muskrat, raccoon and wild turkey |
| Human | Septic |
| Pets | Dog |
| Livestock | Cattle, sheep, chicken, and horse |

## A. Human Contributions

Human loading can result from failures in septic waste treatment systems or through pollution from recreational vessel discharges in the identified restricted shellfish harvesting areas. It is assumed that the failing of a septic system is a direct load contribution from humans. The estimation of human contribution is based on human population, properties, the number of septic systems in the watershed, and an estimated septic system failure rate.

The human population and the number of households were estimated from the GIS 2000 Census data of Carteret County that includes the Jarrett Bay basin. Since the subwatersheds throughout the Jarrett Bay are sub-areas of the Census Block, the GIS tool was used to estimate the population from the 2000 Census data. The percentages of the residential area of subwatershed relative to the total residential area of the 2000 Census, including low and high intensity residential areas, were calculated. This percentage was applied to the total county census population and total census number of households to proportion the population within the area of the subwatersheds. A survey was conducted in Williston, Davis, and Smyrna watershed in 2004. The total households surveyed were 134, of which about 80% of the households returned the survey. The septic systems were counted during the survey. The results are shown in Table C-2. Since the survey was conducted only in portion of the area, the census data were used to estimate the population and household. The mean ratios of septic and dog to the household obtained from survey results were used to estimate the number of dog and septic in the area.

**Table C-2: Proportional Population, Households, and Septic Systems in the Jarrett Bay**

| | Census | | | | | Survey | |
|---|---|---|---|---|---|---|---|
| **Creek** | **Population** | **Household** | **Pet** | **Septic** | **Household** | **Pet** | **Septic** |
| Broad | 0 | 0 | 0 | 0 | | | |
| Ditch | 51 | 22 | 17 | 21 | | | |
| Great Creek | 0 | 0 | 0 | 0 | 43 | 19 | 21 |
| Howland | 27 | 11 | 9 | 11 | | | |
| Smyrna | 102 | 43 | 35 | 41 | | | |
| Wade | 129 | 55 | 44 | 52 | | | |
| Williston | 138 | 59 | 47 | 56 | 49 | 35 | 62 |

Since there is no public sewer system in the Jarrett Bay watershed, the failing of septic is the main contribution of fecal coliform sources from human. It is assumed that the human contribution is attributed to septic systems (although recreational vessels might be a source, we have not attempted to quantify that source). The human contribution to the restricted shellfish harvesting areas was calculated using the number of septic systems, the average number of people per septic system, and the failure rate of the septic systems. The estimated fecal coliform loading from humans is calculated as follows:

Load = $P\ S\ F_r\ C\ Q\ C_V$

Where
P = number of people per septic system
S = number of septic systems in the restricted area
$F_r$ = failure rate of septic systems
C = fecal coliform concentration of wastewater
Q = daily discharge of wastewater per person
$C_V$ = unit conversion factor (37.854)

The number of people using each septic system is estimated by the ratio of the population to the number of septic systems. According to shoreline sanitary survey data in the Jarrett Bay and other areas in North Carolina, the failing rate is between 10% and 15%. Therefore, the rate of 12% was used for the total number of failing septic systems for the watersheds. It was assumed that wastewater for each person was 70 gallons per day. In general, a fecal coliform concentration of $1\times10^5$ to $5\times10^5$ most probable number (MPN)/100ml is often used (EPA 2002). The measurement concentration shows that the concentration can be as high as $9.2\times10^5$ near a failing septic site. A concentration of $2\times10^5$ (MPN)/100ml was used in this study. An average of 2.5 people per household were used in the calculation. The estimated load due to failures of septic systems is about 2-3%.

### B. Pet Contributions

Pet contributions usually occur through runoff from either an urban or a low-density residential area. Dogs are the only domestic pets assumed to contribute fecal coliform. Dog license information can be obtained from the county; however, these data will not include feral or unlicensed pets. This is likely to cause an underestimation of the total population. Therefore, the dog populations for restricted shellfish harvesting areas in the Jarrett Bay watershed was estimated based on the number of households (see Table C-2) and ratio of dog to household obtained from the survey. According to the survey in the Jarrett Bay, it is assumed that most people walk their dogs and some people clean up the dog waste. Therefore, an estimated total load available for wash-off is 70%. The fecal coliform contribution from the dog population was estimated using a production rate of $5\times10^9$ counts/dog/day (EPA, 2000). Using information from Table C-2, estimated fecal coliform loading from dogs is calculated as follows:

$$LOADING_{dog} = P\ R_1\ R_2\ R_3\ PR_{dog}$$

where:
P = number of households in specified restricted area
$R_1$ = ratio of dogs per household in this region
$R_2$ = percentage of owners that walk their dogs
$R_3$ = percentage of walked dogs contributing fecal matter
$PR_{dog}$ = average fecal coliform production rate for dogs

### C. Wildlife Contributions

According to the survey results, there are more than 35 wildlife species existent in the watershed. The most abundant wildlife species include goose, duck, muskrat, raccoon, deer, and wild turkey. Fecal coliform from wildlife can be from excretion on land that is subject to runoff or direct deposition into the stream. Migration birds are abundant in the area. Based on the data collected from Cedar Island National Wildlife Refuge, the bird density ranges from 0.01 to 0.25 per acre in different years. The average density is 0.07 per acre. The mean density is in the same rage as the bird density in Maryland, which is about 0.06 per acre. Wildlife populations within the watershed were estimated based on a combination of information from the Maryland DNR Wildlife and Heritage Service and from habitat information listed in Virginia bacteria TMDL report (VA DEQ, 2002) As listed in Table C-3.

**Table C-3: Wildlife Habitat and Densities**

| Wildlife | Population Density | Habitat Requirements |
|---|---|---|
| Deer[2] | 0.047 animals/acre | Entire watershed |
| Birds | 0.10 animals/acre | Entire watershed |
| Duck[2] | 0.039 animals/acre | Entire watershed |
| Muskrat[1] | 2.75 animals/acre | Within 66 feet of streams and ponds |
| Raccoon[1] | 0.07 animals/acre | Within 600 feet of streams and ponds |
| Wild Turkey[1] | 0.01 animals/acre | Entire watershed excluding farmsteads and urban |

[1] VA DEQ (2002); [2]MD DNR (2003)

The habitat areas for each species were determined using ArcView GIS based on EPA basins land use and reach coverage in the watershed. The GIS tool was applied to the land use coverage to create a habitat area according to Table C-3. For the deer, bird, and duck estimates, the entire watershed was used because the density estimates were developed using watershed area as the ratio estimator. Wildlife populations were obtained by applying assumed wildlife densities to these extracted areas. The populations of the wildlife were obtained by applying density factors to estimated habitat areas. The fecal coliform contributions were estimated based on the estimated number of wildlife and fecal coliform production rates, which are listed in Table C-4. To obtain the total wildlife contribution, population density is multiplied by the applicable acreage or stream mile and that product is multiplied by fecal coliform production rates for each animal.

**Table C-4: Wildlife Fecal Coliform Production Rates**

| Source | Fecal Coliform Production (counts/animal/day) |
|---|---|
| Deer[1] | 5.00E+08 |
| Bird[2] | 2.43E+09 |
| Duck[1] | 2.43E+09 |
| Muskrat[3] | 3.40E+07 |
| Raccoon[3] | 1.00E+09 |
| Wild turkey[4] | 9.30E+07 |

[1]USEPA (2000); ); [2]Use duck rate (USEPA, 2000);
[3]Kator and Rhodes (1996); [4]ASAE (1998)

## D. Livestock Contributions

The fecal coliform contribution from livestock is through the manure spreading processes and direct deposition during grazing. This contribution was estimated based on survey. The fecal coliform load was estimated based on the total number of livestock and the fecal coliform production rates.

Fecal coliform production rates used to estimate loading are listed in Table C-5. The estimated fecal coliform produced by animals was divided into manure spreading and direct deposition, depending on the percent of time they were confined. The percent of time livestock was confined is listed in Table C-6. The estimated percentage of manure available for wash-off is about 40% (US EPA 2004). Therefore, fecal coliform decay is also considered in the estimation of fecal coliform production. The percent of fecal coliform available for wash-off from manure spreading in the field is also listed in Table C-6. For Williston and Wade Creeks, there are no domestic animal farms. According to the survey, there are only a couple ducks in the watershed. The sources from livestock are very limited.

**Table C-5: Livestock Fecal Coliform Production Rates**

| Source | Fecal Coliform Production (counts/animal/day) |
|---|---|
| Dairy | 1.01E+11 |
| Beef | 1.20E+10 |
| Horses | 4.20E+08 |
| Sheep | 1.20E+10 |
| Broilers | 1.36E+08 |
| Turkeys | 9.30E+07 |
| Chickens | 1.36E+08 |
| Layers | 1.36E+08 |
| Hogs | 1.08E+10 |

**Table C-6: Percent of Time Livestock is Confined**

| Livestock | Percent of time confined |
|---|---|
| Dairy | 80.0% |
| Beef | 20.0% |
| Horses | 50.0% |
| Sheep | 50.0% |
| Broilers | 85.0% |
| Turkeys | 85.0% |
| Chickens | 85.0% |
| Layers | 85.0% |
| Hogs | 100.0% |

**E. Nonpoint Source Summary**

The complete distributions of these source loads are listed in Tables C-7 and C-8, along with counts/day for each loading.

**Table C-7: Estimated Distribution of Fecal Coliform Source Loads in the Watersheds**

| Creek | Pet | Septic | Wildlife | Livestock | Total |
|---|---|---|---|---|---|
| Broad | 0.00E+00 | 0.00E+00 | 1.21E+11 | 0.00E+00 | 1.21E+11 |
| Ditch | 6.06E+10 | 3.27E+09 | 6.29E+10 | 0.00E+00 | 1.27E+11 |
| Great Creek | 0.00E+00 | 0.00E+00 | 7.12E+10 | 0.00E+00 | 7.12E+10 |
| Howland | 3.17E+10 | 1.71E+09 | 7.77E+11 | 0.00E+00 | 8.10E+11 |
| Smyrna | 1.21E+11 | 6.54E+09 | 4.22E+11 | 0.00E+00 | 5.50E+11 |
| Wade | 1.53E+11 | 8.25E+09 | 1.58E+11 | 2.20E+08 | 3.19E+11 |
| Williston | 1.65E+11 | 8.87E+09 | 4.80E+11 | 6.72E+08 | 6.54E+11 |

**Table C-8: Estimated Percent Distribution of Fecal Coliform Source Loads in the Watersheds**

| Creek | Pet | Septic | Wildlife | Livestock | Total |
|---|---|---|---|---|---|
| Broad | 0.0% | 0.0% | 100.0% | 0.0% | 100.0% |
| Ditch | 47.8% | 2.6% | 49.6% | 0.0% | 100.0% |
| Great Creek | 0.0% | 0.0% | 100.0% | 0.0% | 100.0% |
| Howland | 3.9% | 0.2% | 95.9% | 0.0% | 100.0% |
| Smyrna | 22.0% | 1.2% | 76.8% | 0.0% | 100.0% |
| Wade | 48.0% | 2.6% | 49.4% | 0.1% | 100.0% |
| Williston | 25.1% | 1.4% | 73.4% | 0.1% | 100.0% |

## Appendix D. Model Validation

The model data comparisons at each observation stations are shown in Figure D1-D3.

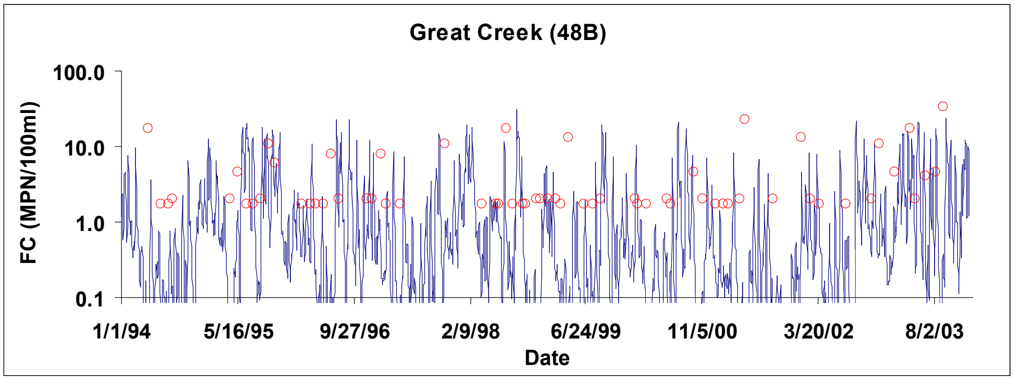



**Figure D-1: Great Creek - model simulation of fecal coliform versus observations**

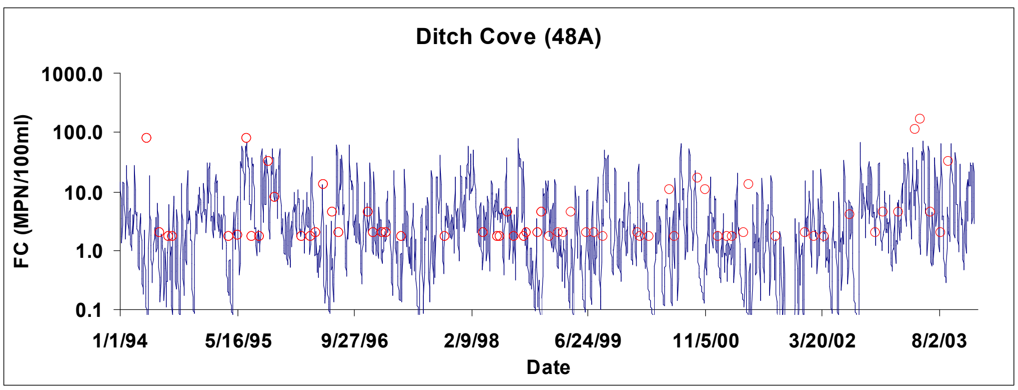



**Figure D-2: Ditch Cove - model simulation of fecal coliform versus observations**

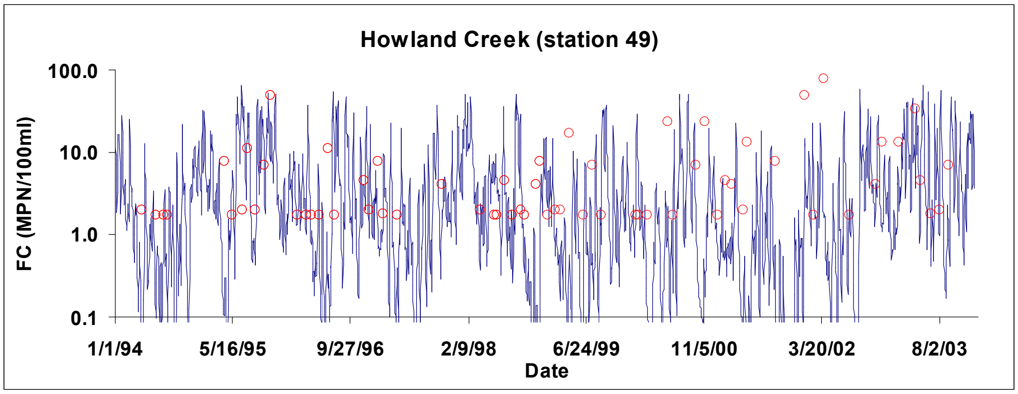



**Figure D-3: Howland Creek - model simulation of fecal coliform versus observations**

## Appendix E. Model Results of Median and 90th Percentile

The 30-month median and 90th percentile were computed for Tidal Prism model segments. The time series plots of existing condition are load reduction presented in Figure E1.0 to Figure E6.1 for Williston Creek and Wade Creek, and Smyrna Creek.

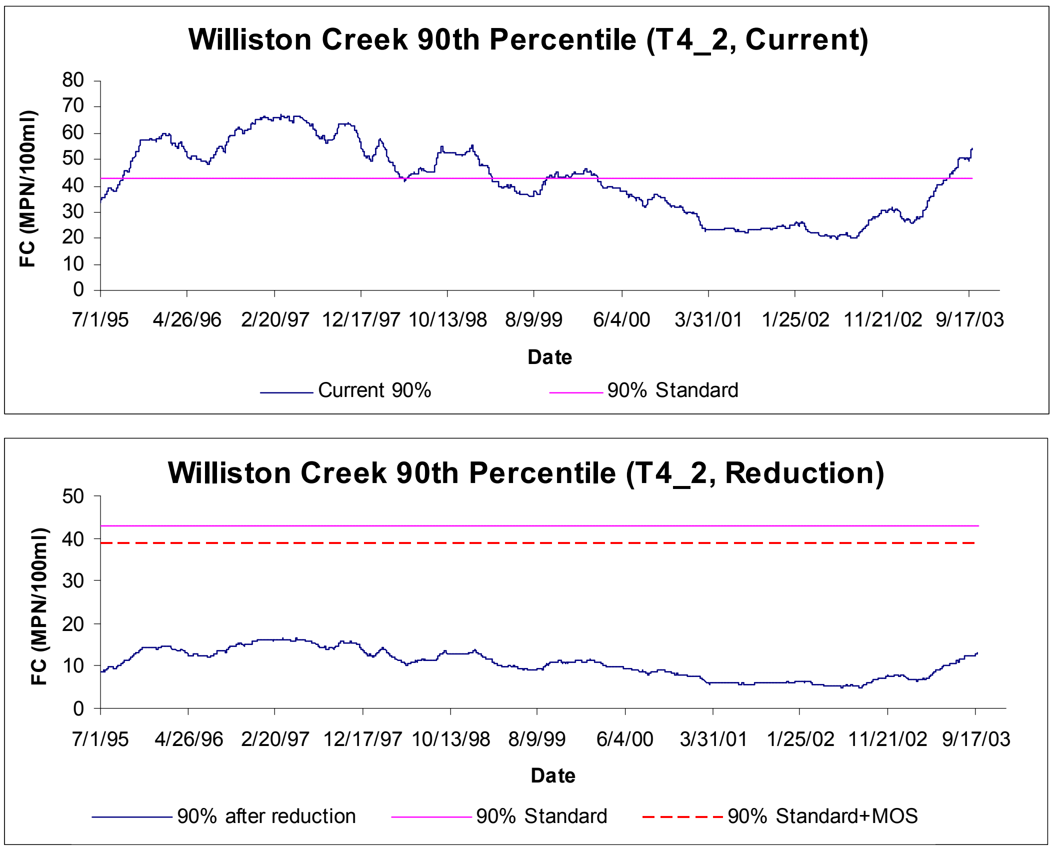



**Figure E1.0 Plot of 30-month 90th percentiles for Williston Creek (T4_2)**

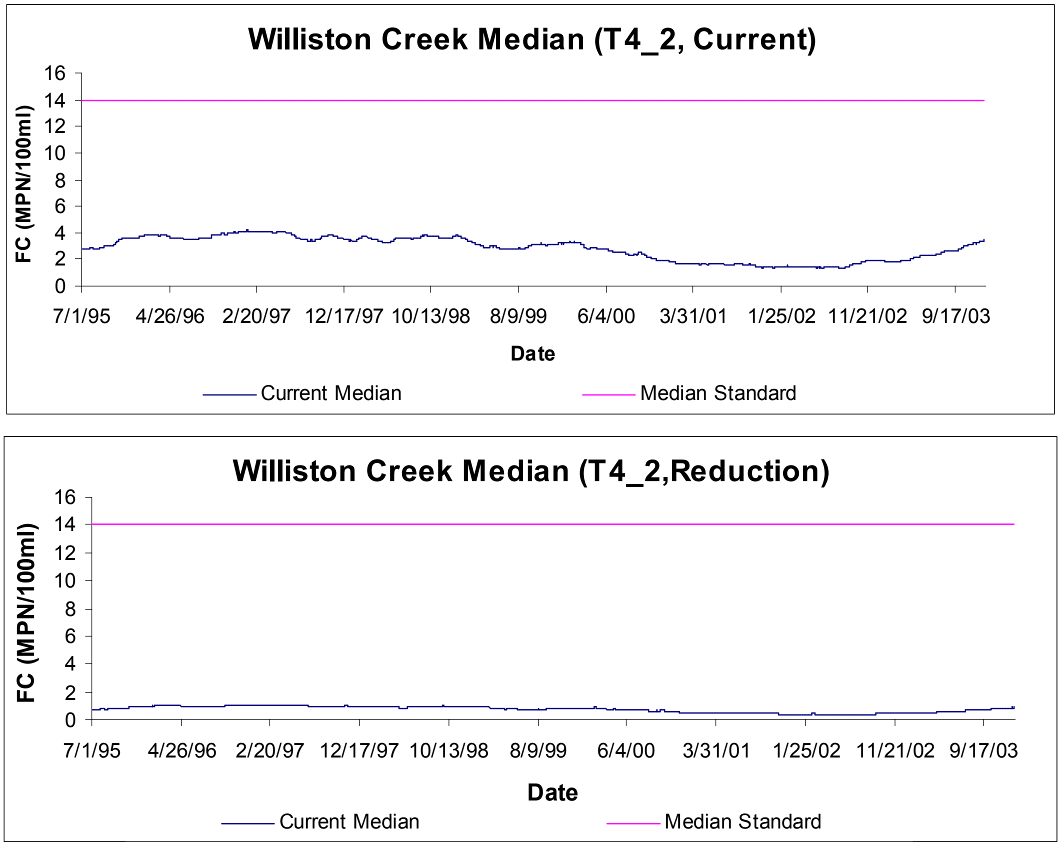



**Figure E1.1 Plot of 30-month median for Williston Creek (T4_2)**

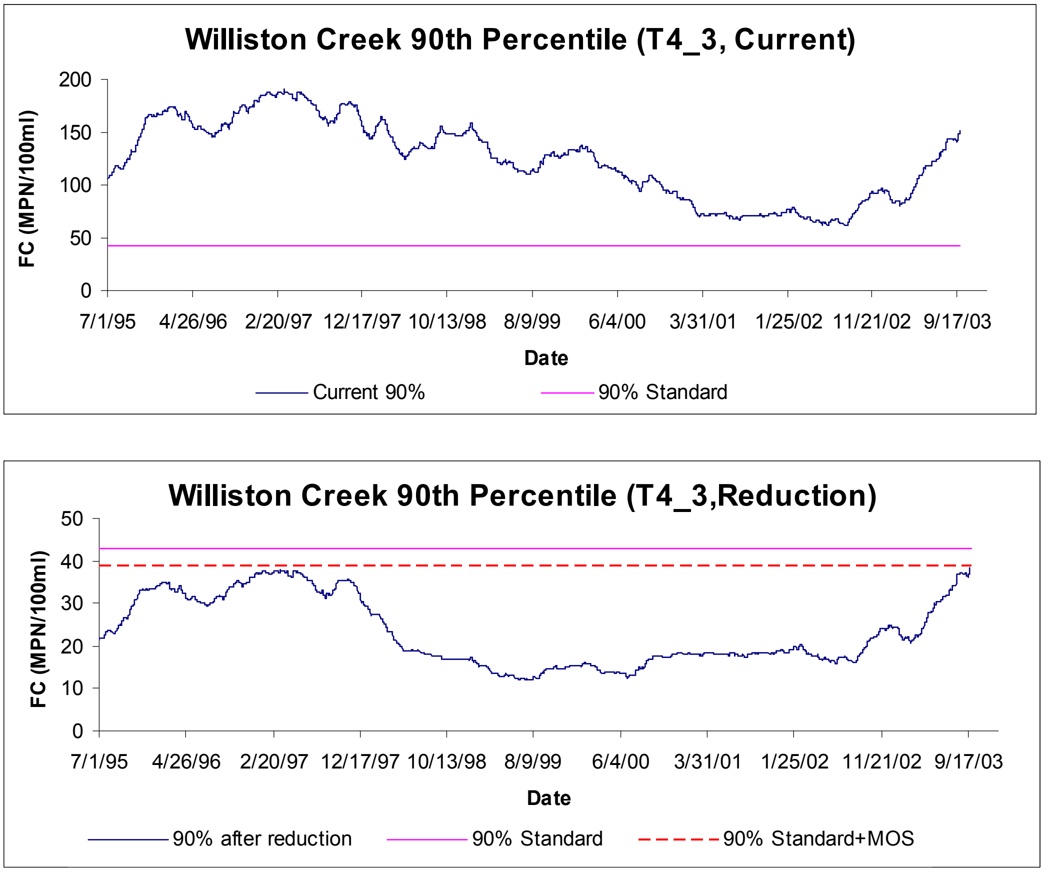



**Figure E2.0 Plot of current 30-month 90th percentiles for Williston Creek (T4_3)**

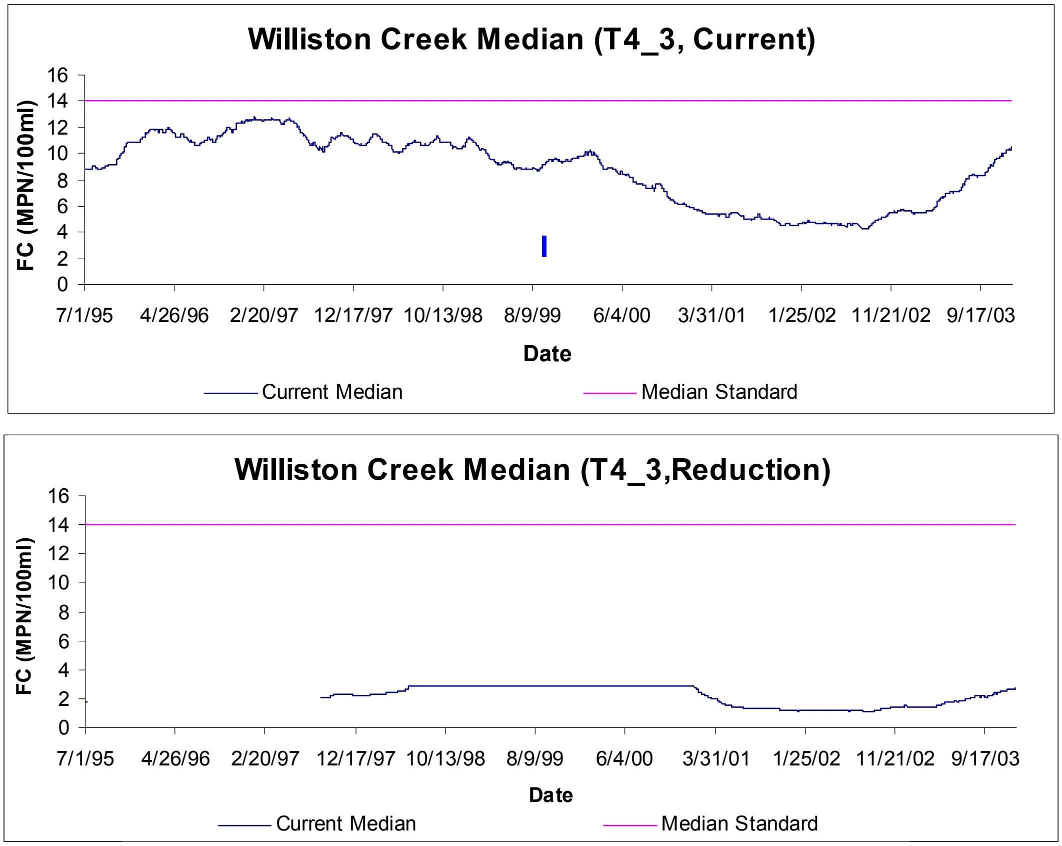



**Figure E2.1 Plot of current 30-month 90th median for Williston Creek (T4_3)**

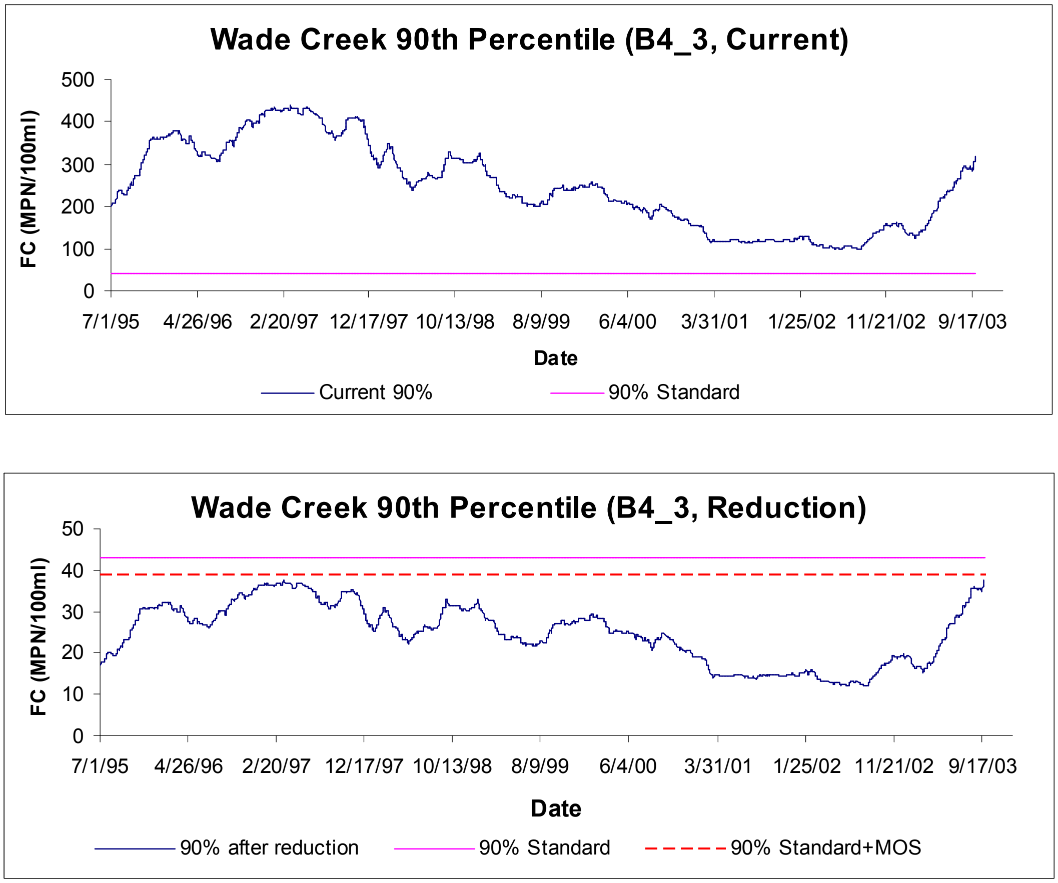



**Figure E3.0 Plot of 30-month 90th percentiles for Wade Creek (B4_3)**

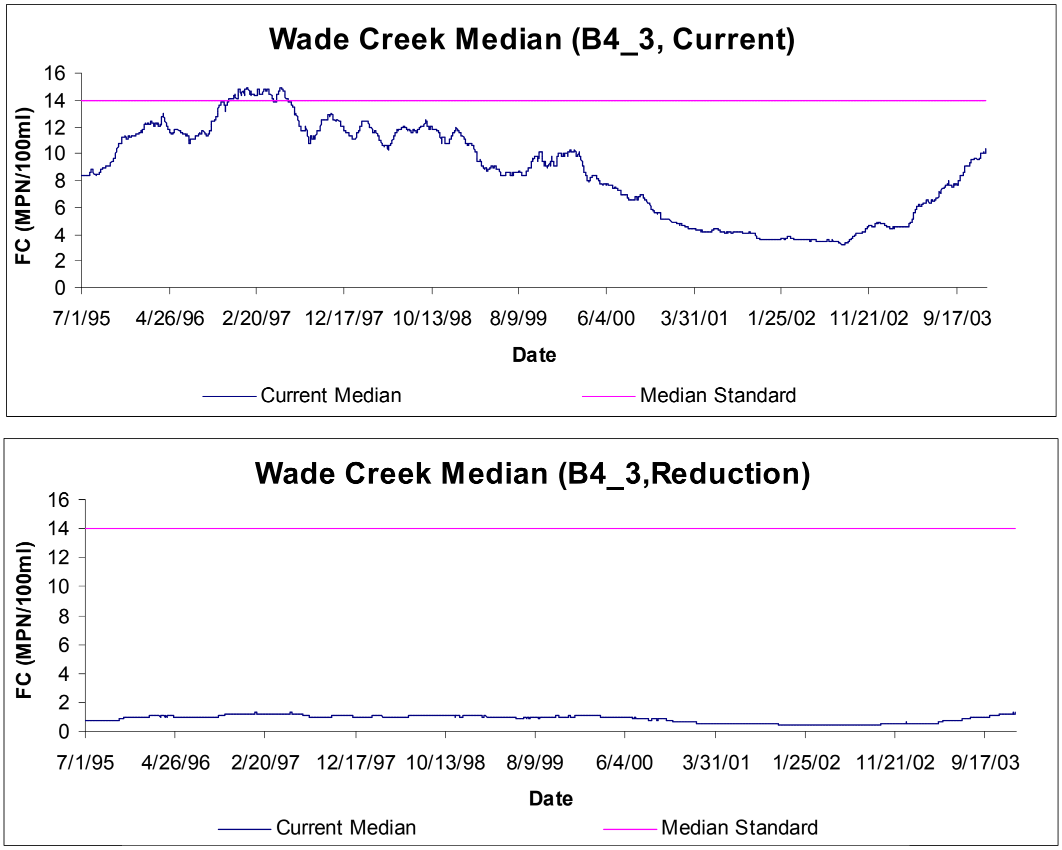
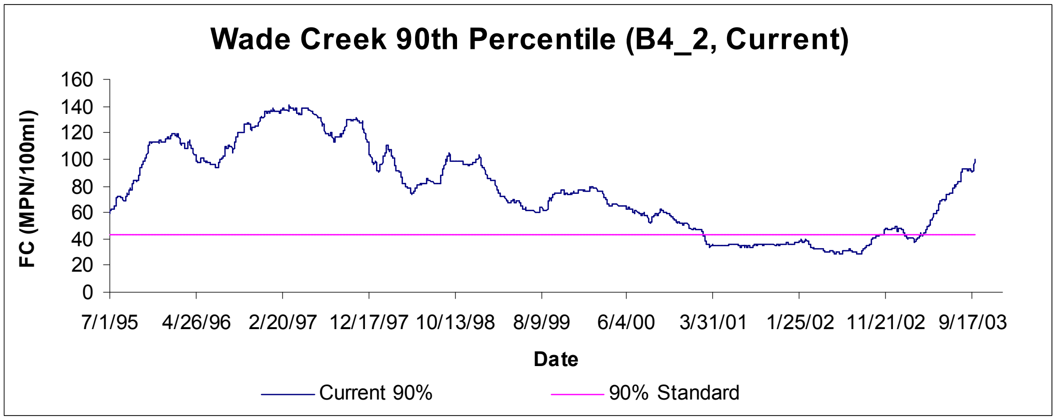



**Figure E3.1. Plot of 30-month medians for Wade Creek (B4_3)**



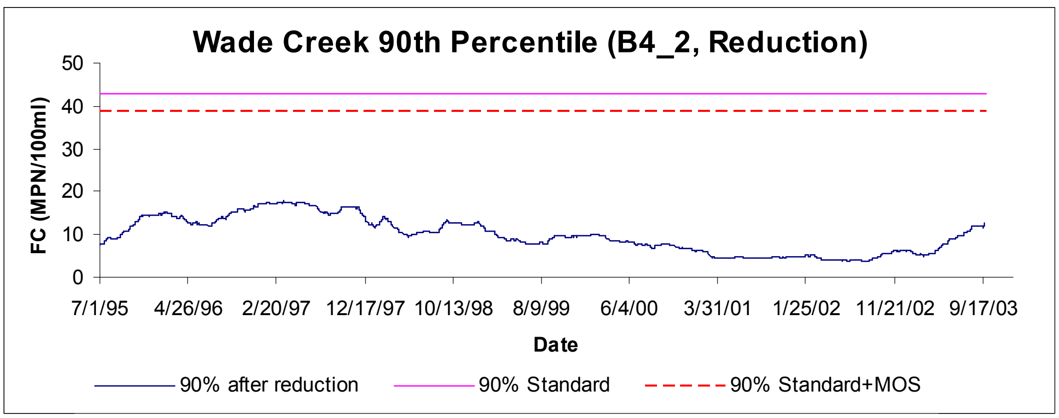
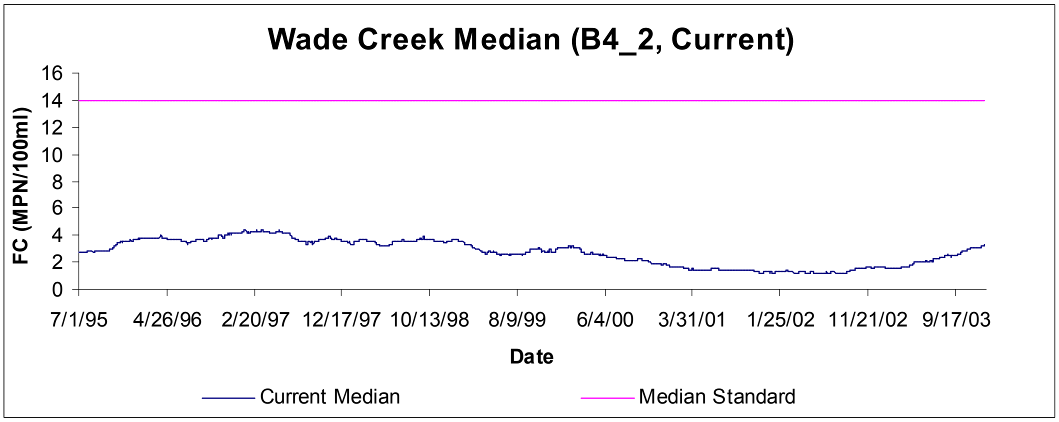




**Figure E4.0 Plot of 30-month 90th percentiles for Wade Creek (B4_2)**



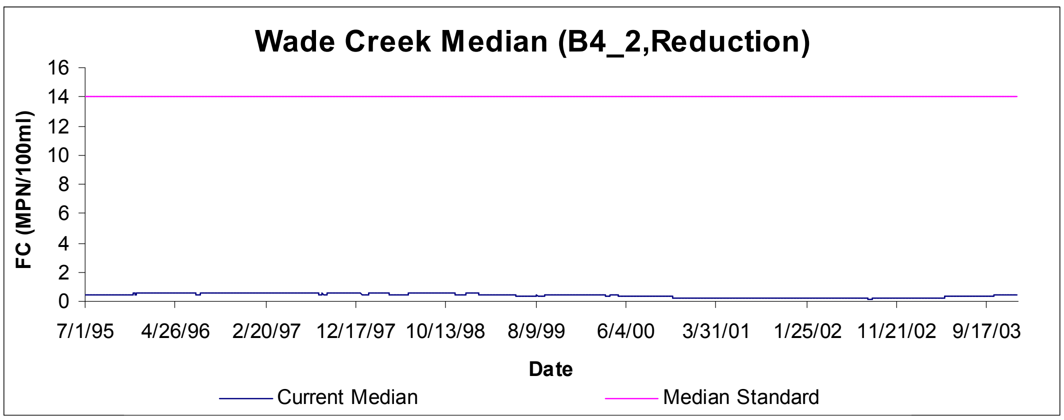
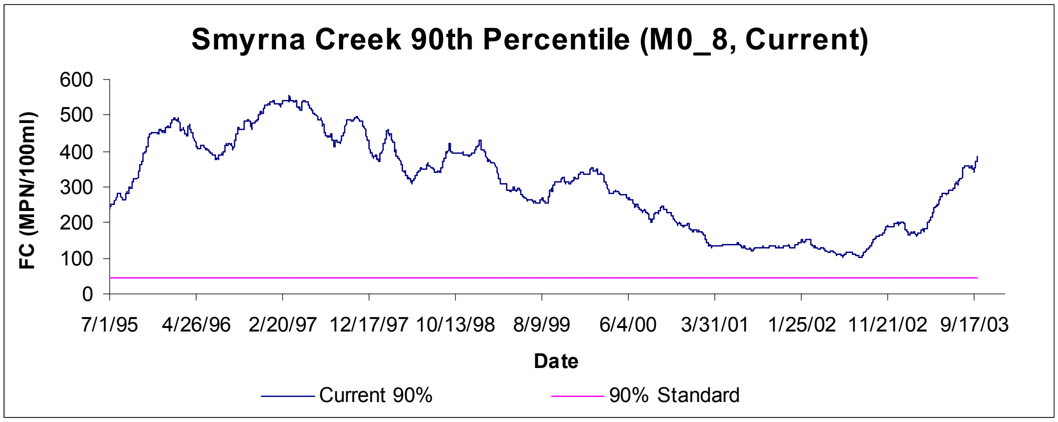




**Figure E4.1. Plot of 30-month medians for Wade Creek (B4_2)**



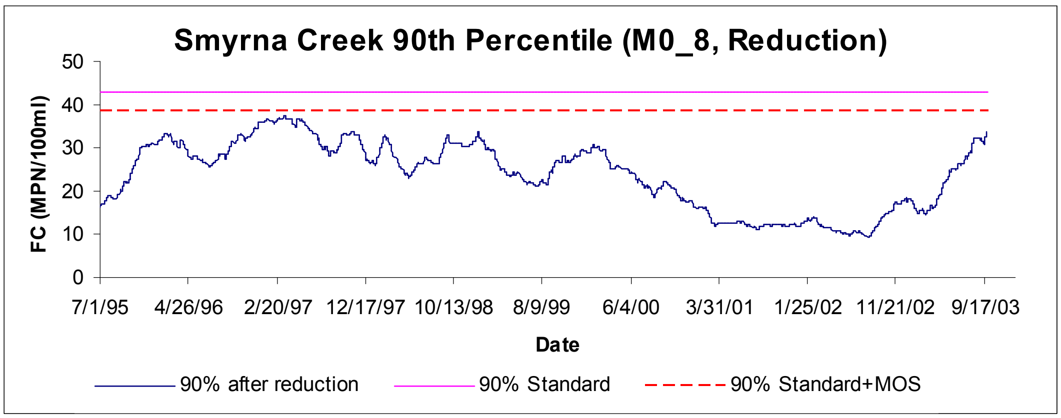
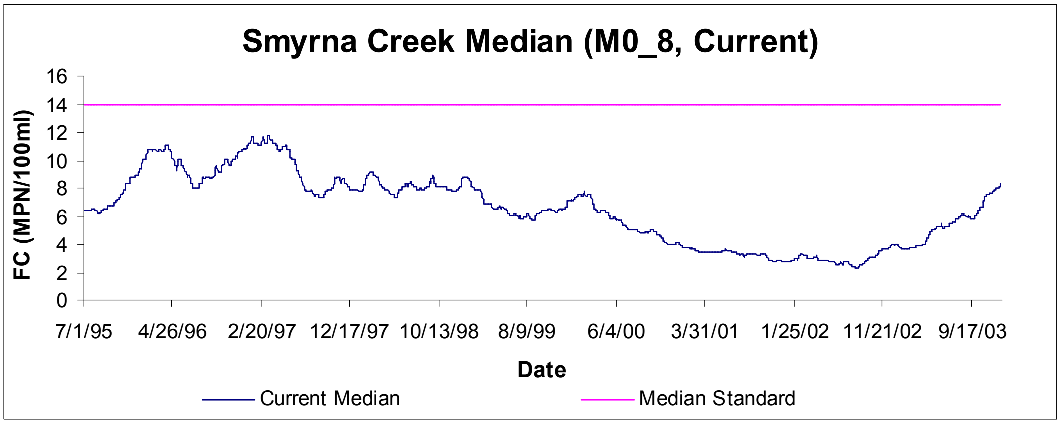




**Figure E5.0 Plot of 30-month 90th percentiles for Smyrna Creek (M0_8)**



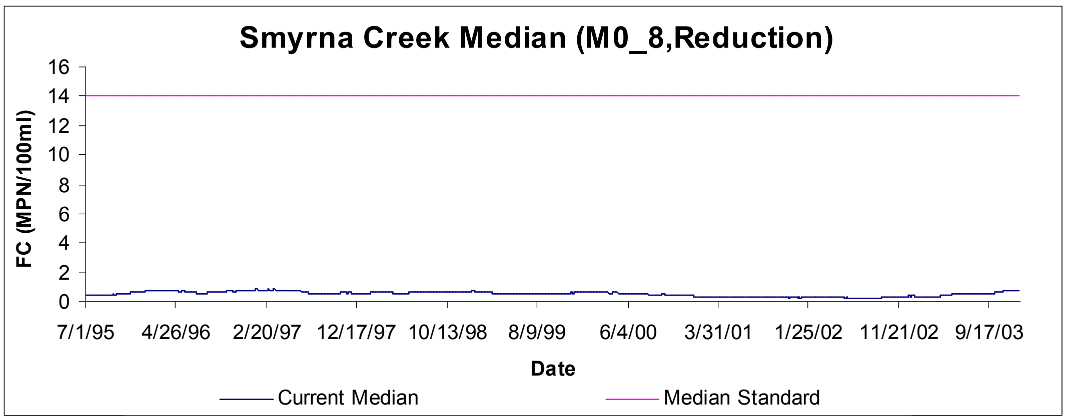




**Figure E5.1 Plot of 30-month median for Smyrna Creek (M0_8)**

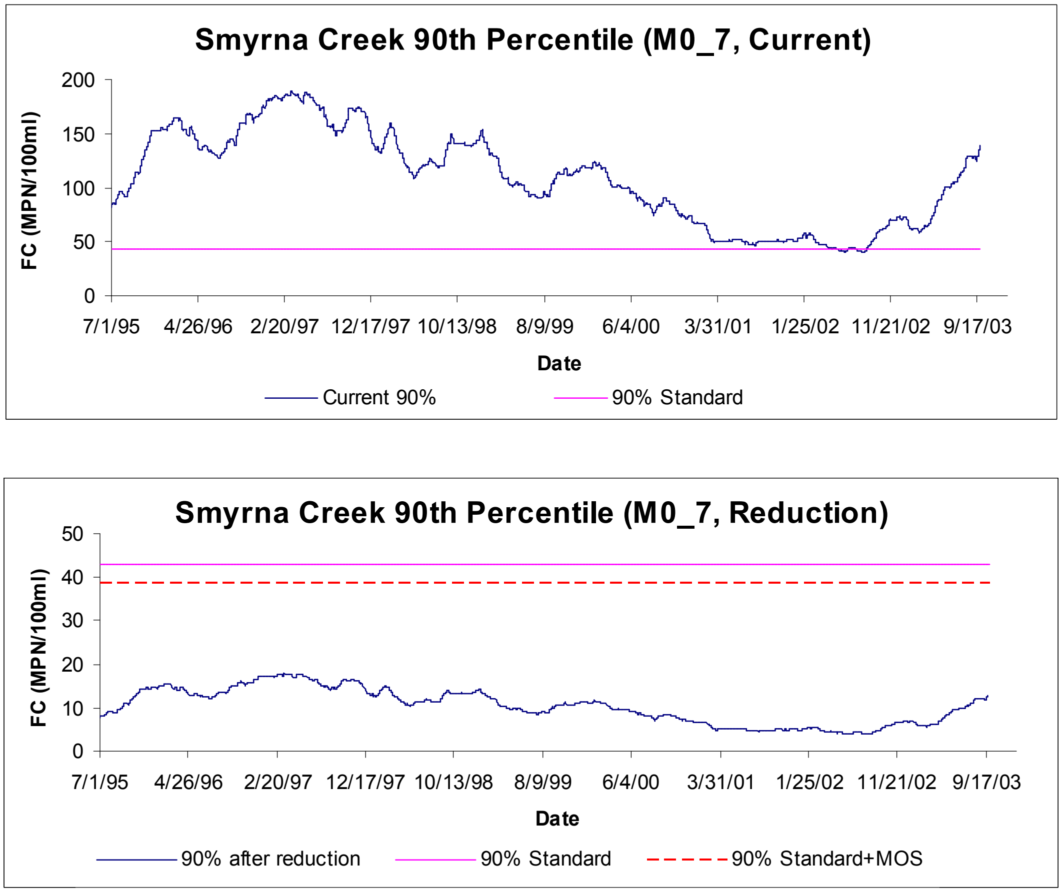
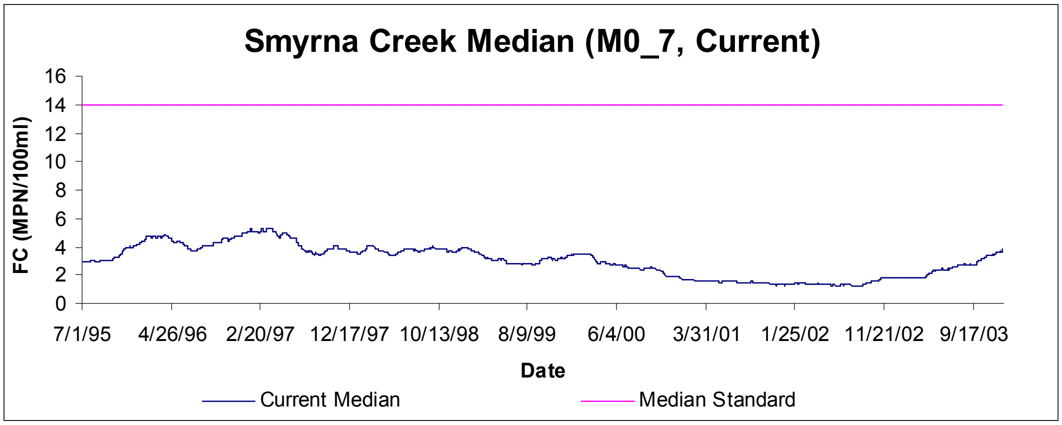



**Figure E6.0 Plot of 30-month 90th percentiles for Smyrna Creek (M0_7)**



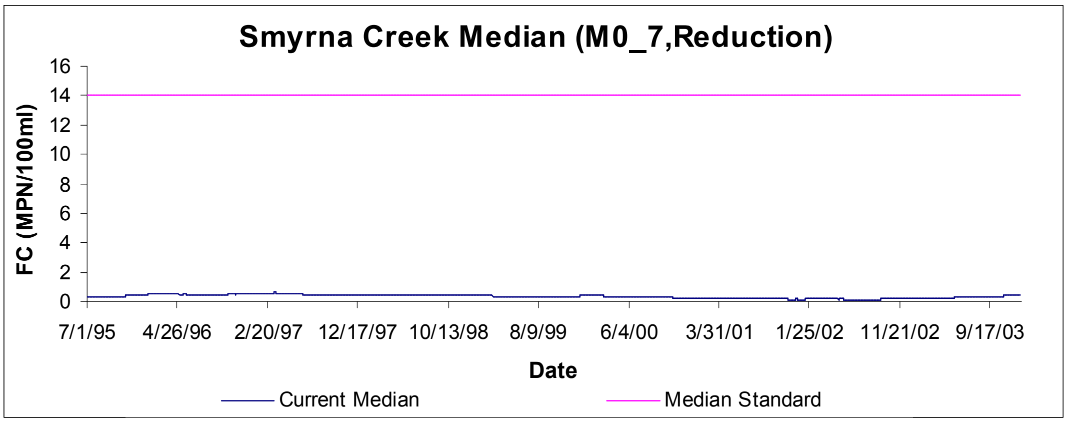




**Figure E6.1 Plot of 30-month median for Smyrna Creek (M0_7)**

For remaining stations, no direct loads reduction from their associated watersheds is needed. The Tidal Prism model simulation results are the same before and after reduction of loads. The current model results are plotted for these areas as follows:

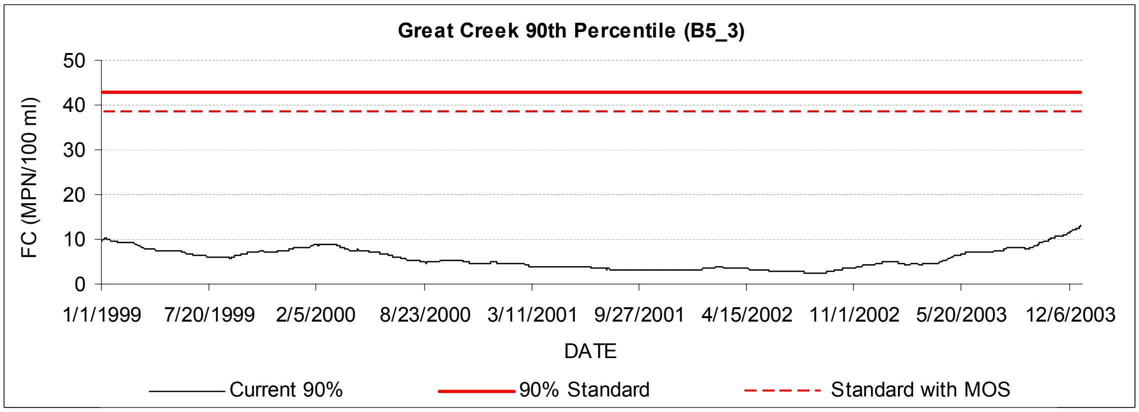



**Figure E7.0 Plot of 30-month 90th percentiles for Great Creek**

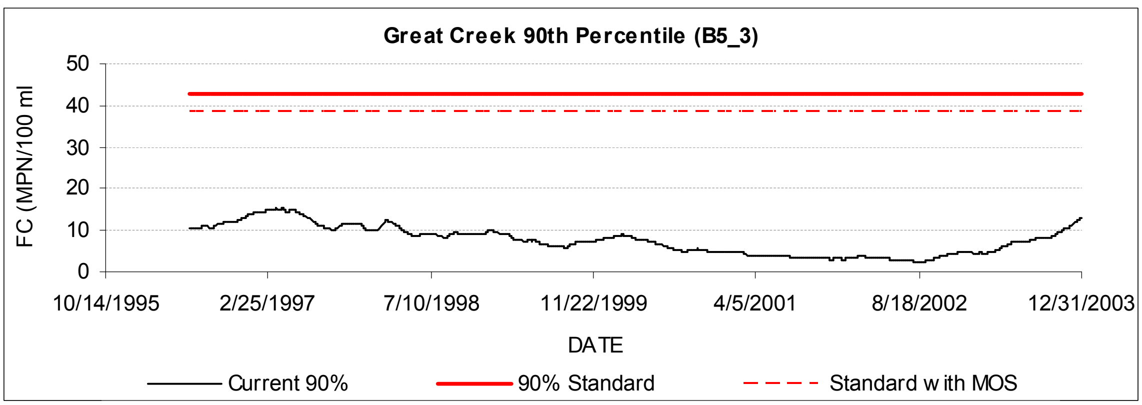



**Figure E7.1. Plot of 30-month 90th percentiles for Great Creek**

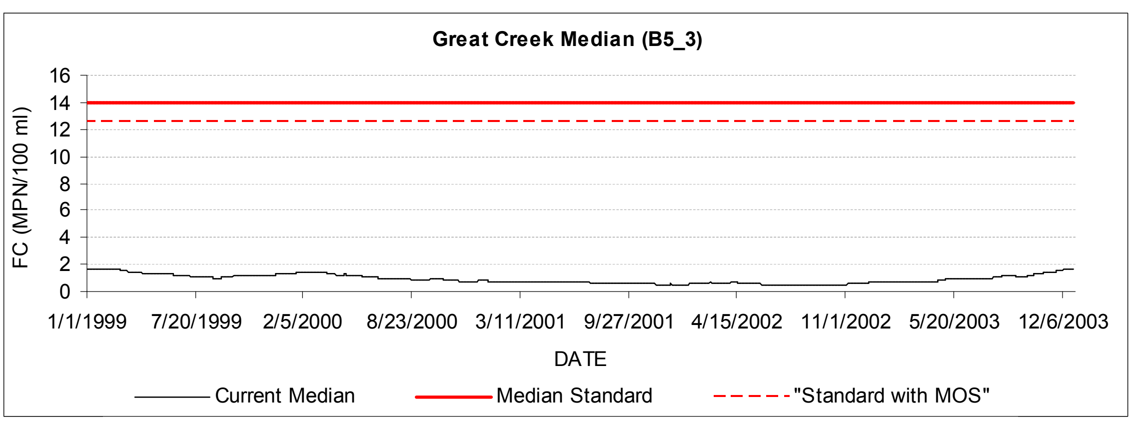



**Figure E8. Plot of 30-month medians for Great Creek**

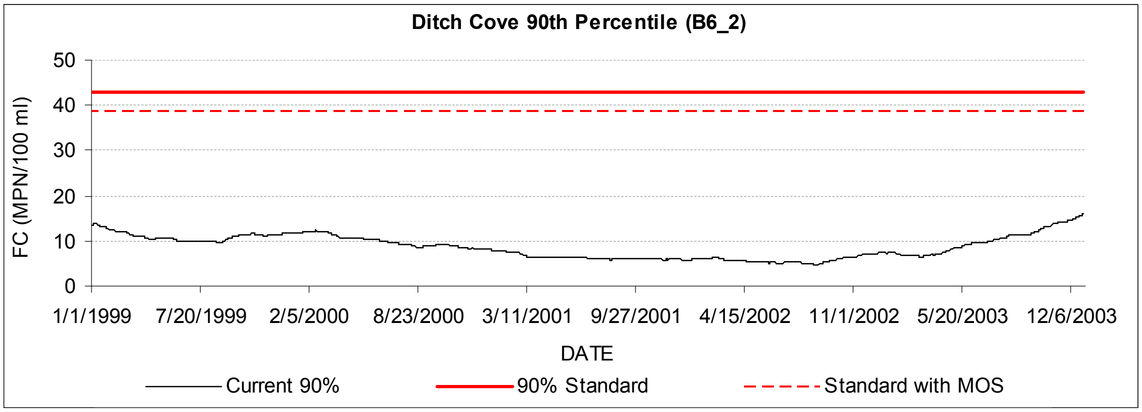



**Figure E9. Plot of 30-month 90th percentiles for Ditch Cove**

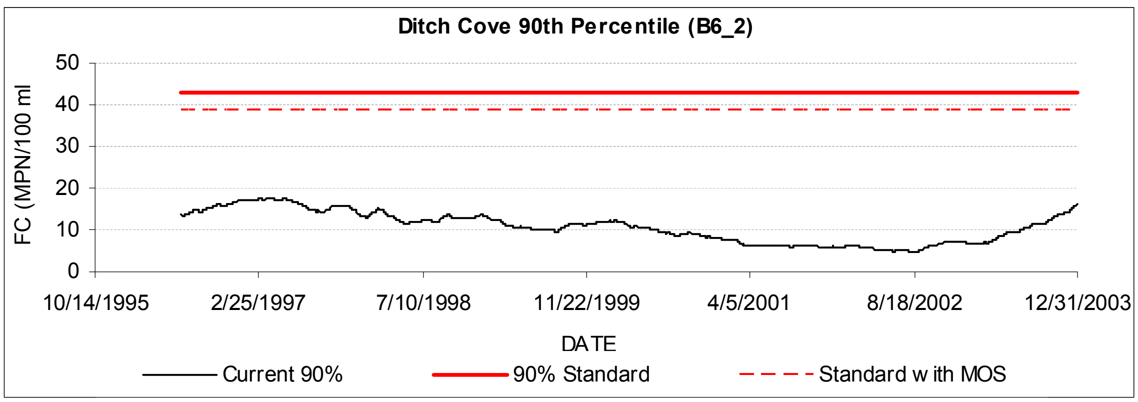



**Figure E9.1. Plot of 30-month 90th percentiles for Ditch Cove**

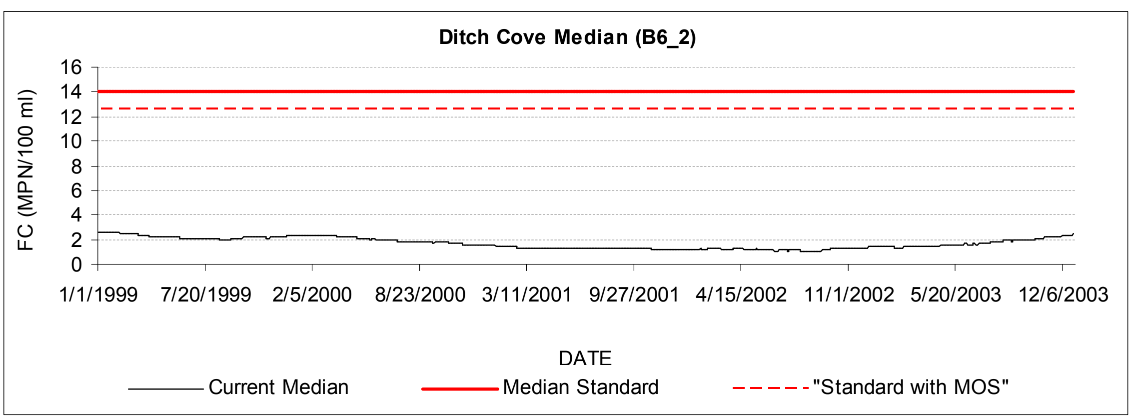



**Figure E10. Plot of 30-month medians for Ditch Creek**

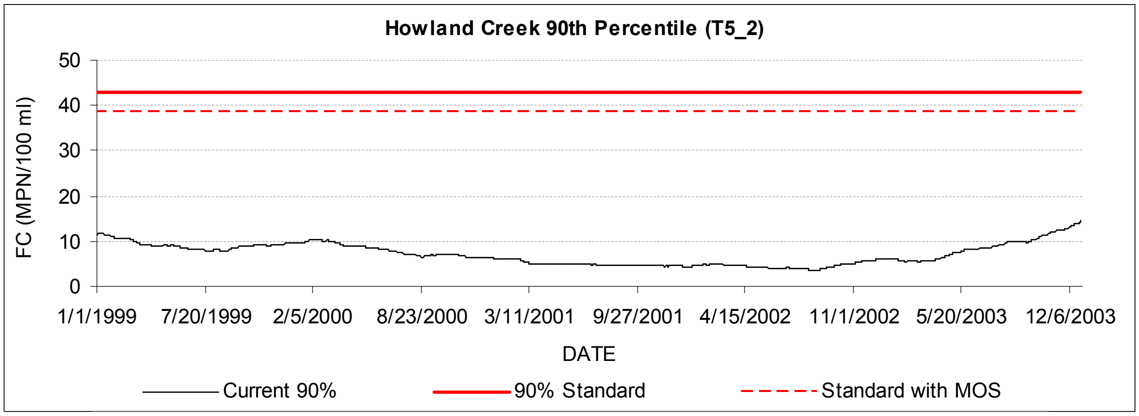



**Figure E11. Plot of 30-month 90th percentiles for Howland Creek**

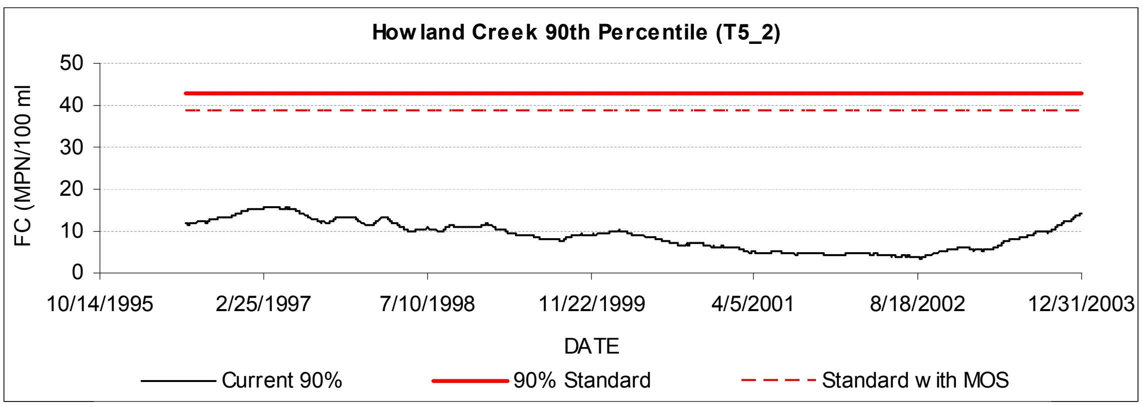



**Figure E11.1. Plot of 30-month 90th percentiles for Howland Creek**

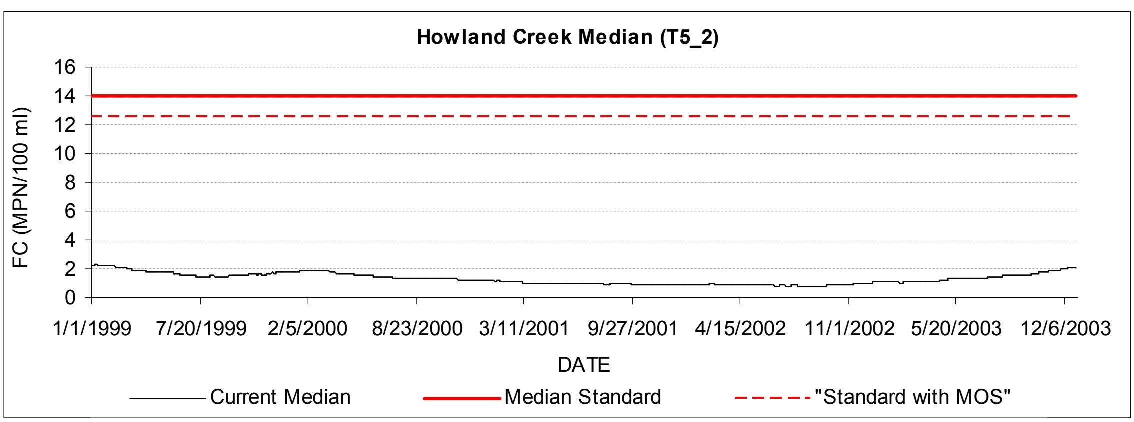



**Figure E12. Plot of 30-month medians for Howland Creek**

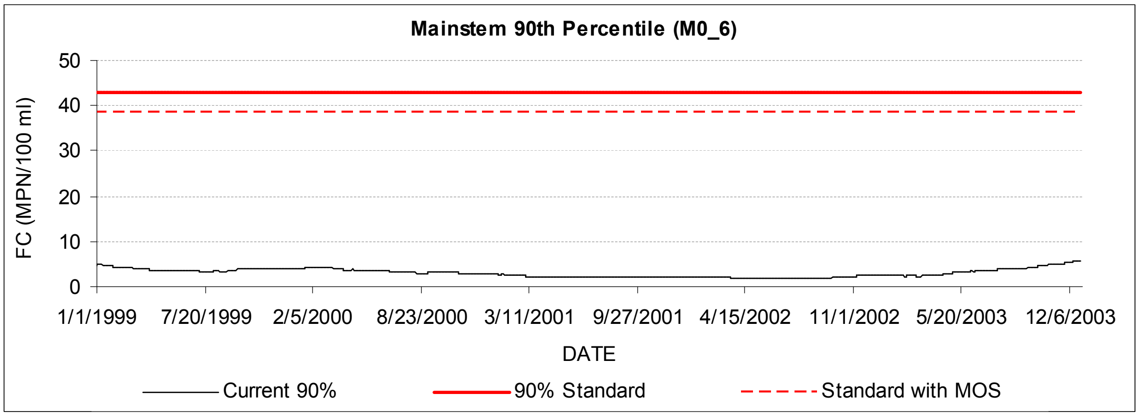



**Figure E13. Plot of 30-month 90th percentiles for Mainstem**

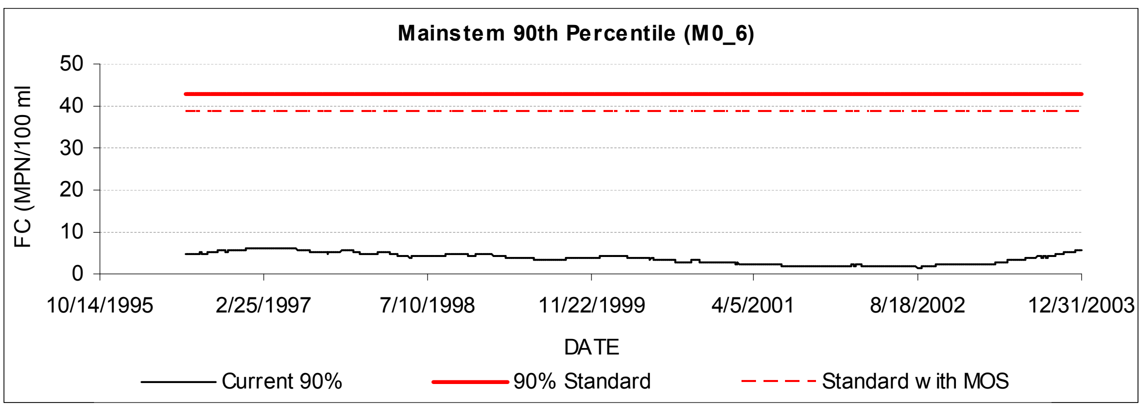



**Figure E13.1. Plot of 30-month 90th percentiles for Mainstem**

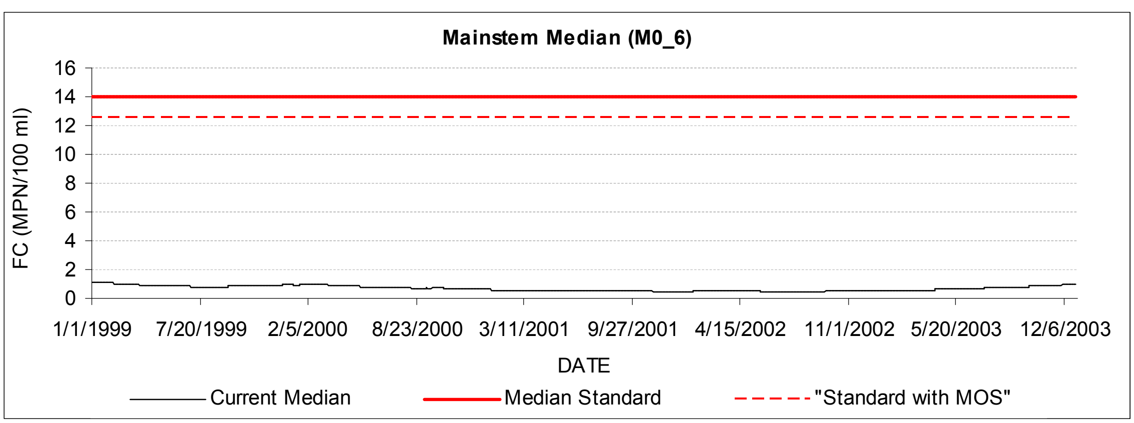



**Figure E14. Plot of 30-month medians for Mainstem**

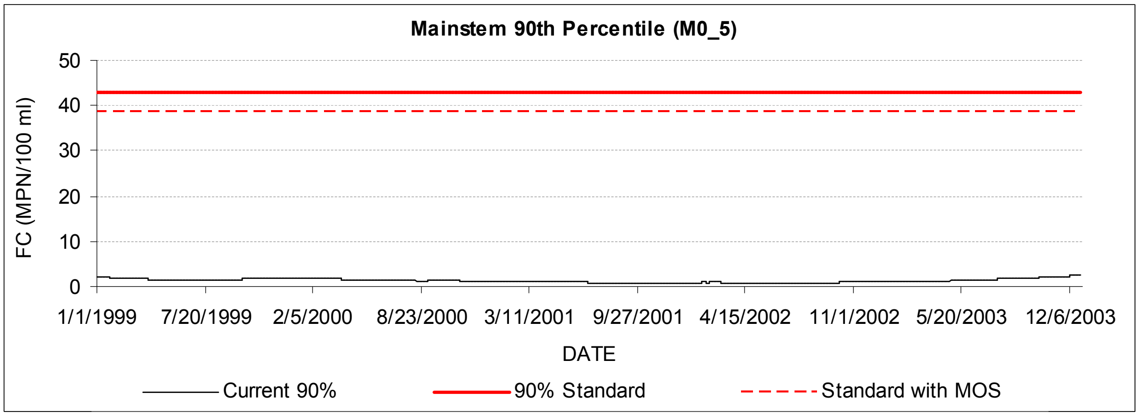



**Figure E14. Plot of 30-month 90th percentiles for Mainstem**

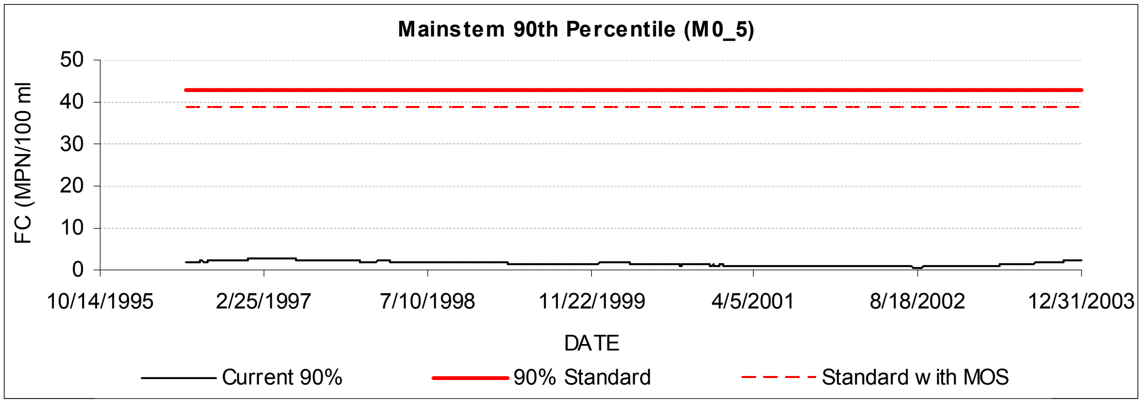



**Figure E14.1. Plot of 30-month 90th percentiles for Mainstem**

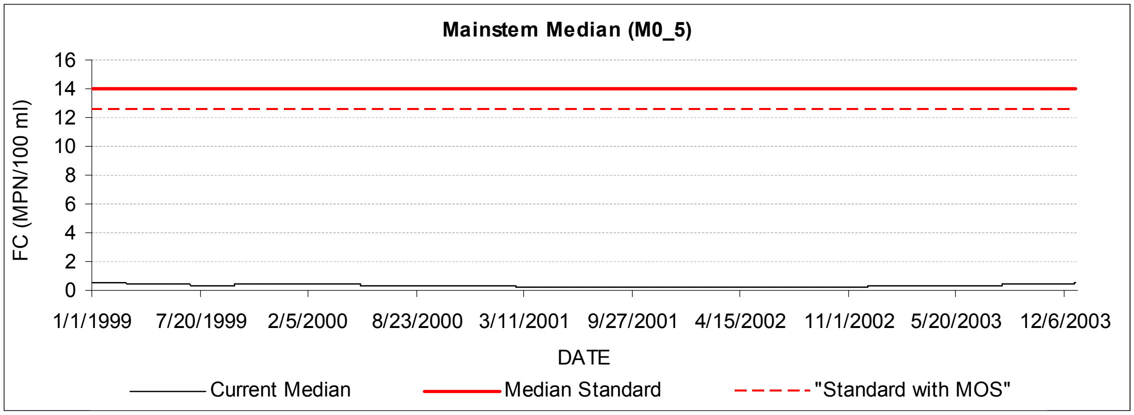



**Figure E15. Plot of 30-month medians for Mainstem**

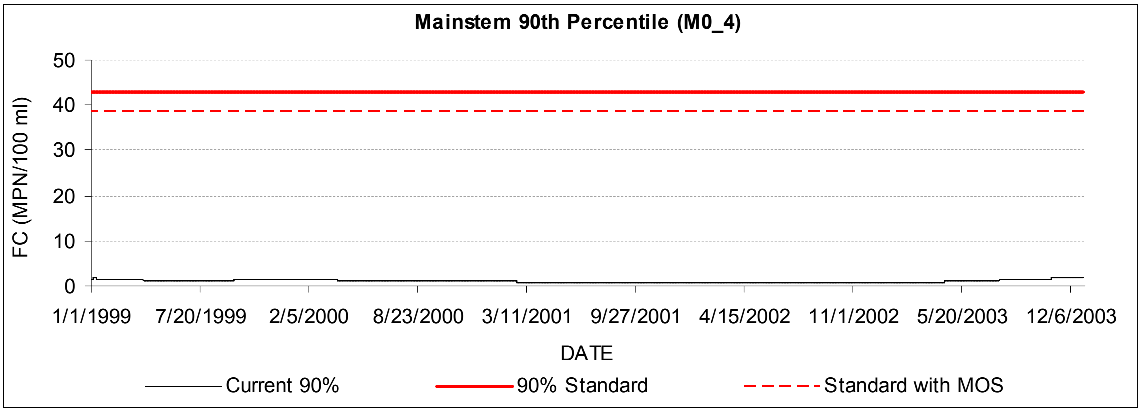



**Figure E16. Plot of 30-month 90th percentiles for Mainstem**

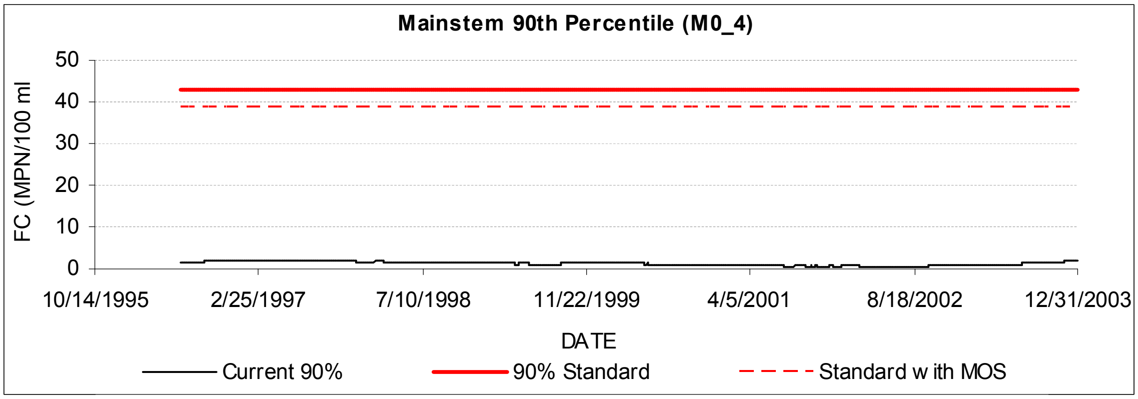



**Figure E17.1. Plot of 30-month 90th percentiles for Mainstem**

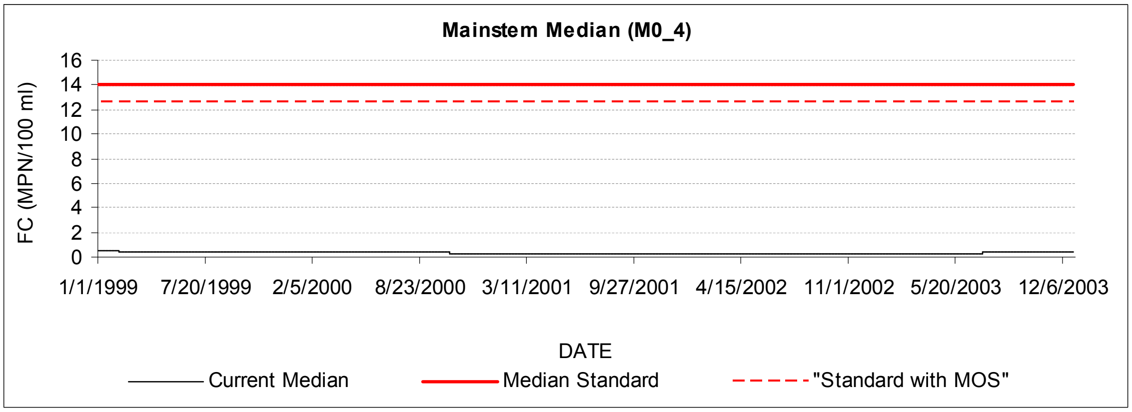



**Figure E18. Plot of 30-month medians for Mainstem**

## Appendix G-1. DWQ Response to Public Comment on the Public Review Draft of the Jarrett Bay and its Embayment Fecal Coliform TMDL

### I. Comments from the Division of Soil & Water Conservation (Area 6)

Kristina Fischer , Area 6 Coordinator, Division of Soil & Water Conservation
127 Cardinal Dr. Ext.
Wilmington, NC 28405
910.796.7236 (office) 910.512.5820 (mobile) 910.350.2004 (fax)

May 05, 20007

Good Afternoon, Adugna,

I spent some time looking through the Draft TMDL for Fecal Coliform for Jarrett Bay and Its Embayment. I think this is an interesting document and you have done a good job pulling all of the information together. That being said, there were a few comments in there that concerned me, and I wanted to share those with you.

First, the Executive Summary (p. xi) lists the fecal coliform sources as "nonpoint sources, including livestock, wildlife, pets, and failing septic systems". Later in the document (p. 10), when the distribution of fecal coliform source loads are broken down into the 3 areas, and percentages are attributed to the individual sources, livestock only accounts for 0.1% of the loading in each of the three creeks - Williston, Wade, and Smyrna. The majority of the source (greater than 95% in all 3 creeks), is attributed to pets and wildlife.

My concern is this; with livestock contributing such a minimal percentage to the impairment, I do not understand why this is listed as the first nonpoint source in the executive summary. I think it could be argued that the references to livestock as a "source" could be removed from the document all together since they only account for 0.1% of the impairment in each creek. Although I understand the need to include it, where references to livestock are made, the fact that these inputs are extremely minimal should be mentioned (2 times on p. xi, p.10, p. 14, p. 22).

I serve as a Regional Coordinator for the Division of Soil & Water Conservation, and Carteret Soil & Water Conservation District is one of the 12 Districts that I support. This group works hard to provide technical and financial assistance to local farmers in an effort to install best management practices on their land that improve water quality. Discussions with the staff in the local office have indicated that they are not aware of livestock in this area, and we are curious to see where these animals are located.

The process of spreading manure on fields is also mentioned as a potential input (p. 10); I am not certain if either Open Grounds or Smyrna Farms uses either of these techniques, but contact with these facilities should be made to determine if this is the case. Since these are two major land uses in the watershed, they certainly do have the potential to influence water quality, but perhaps not fecal coliform counts if manure in not used as fertilizer.

I will be interested to see what strategies are proposed to reduce the fecal inputs to the Bay. I understand with wildlife as such a large contributor, this will be a difficult problem to solve. Please do not hesitate to contact me with any questions, or if I can be of assistance as you move forward with this effort.

Thank you for the consideration of my comments.

Sincerely,

## II. Comments from the North Carolina Department of Transportation

RECE
MAY 1 8 2007
DIV. OF WATER QUALITY
DIRECTOR'S OFFICE

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY
GOVERNOR

LYNDO TIPPETT
SECRETARY

May 17, 2007

Adugna Kebede
Water Quality Planning Branch
NC Division of Water Quality
1617 Mail Service Center
Raleigh, NC 276991617

Re: Public Review Draft of Jarrett Bay fecal coliform TMDL
Carteret County

Dear Mr. Kebede,

The NC Department of Transportation appreciates the opportunity to comment on the public review draft of the fecal coliform TMDL for Jarrett Bay and its embayments. We offer the following comments for your consideration:

- Limited technical information is presented in the TMDL report with respect to the LSPC watershed model and the Tidal Prism estuary response model. Since Jarrett Bay is the first fecal coliform TMDL for SA (shellfish) waters to be published in NC, it is especially important that the modeling work be well documented and available to the public. Please provide all model input files/parameters as either appendices to the TMDL report or as separate modeling reports.

- For the benefit of those entities interested in implementing measures to control fecal coliform loads, it would be helpful to include a map which illustrates the watershed boundary and land marks identifiable in the field. Most of the maps presented in the report do not contain sufficient detail to locate the watershed boundary in the field. A very useful addition to the report would be an aerial photograph overlaid with the watershed boundary and a scale bar.

- Table 1.3.1 outlines that Urban land uses are estimated to comprise 0.82% of the watershed area. In Table B-1 the word "*Transportation*" was used as a descriptor for the Urban land use classification used in the TMDL model. From the NCDOT's perspective the word *transportation* can include many different types of facilities including ferry operations, rail, aviation, pedestrian and bicycle paths, as well as roads. Since the urban land use is insignificant in this watershed, we are not necessarily recommending any changes to this report regarding the term *transportation*. However, if additional TMDLs are developed using similar land use categories, we would appreciate DWQ clarifying specifically what the term *transportation* is intended to represent. If in future TMDLs the term *transportation* is specifically intended to represent NCDOT facilities, then this should be clearly stated in the report.

MAILING ADDRESS:
NC DEPARTMENT OF TRANSPORTATION
HYDRAULICS UNIT
1590 MAIL SERVICE CENTER
RALEIGH NC 27699-1590

TELEPHONE: 919-250-4100
FAX: 919-250-4108

WEBSITE: WWW.DOH.DOT.STATE.NC.US

LOCATION:
CENTURY CENTER COMPLEX
BUILDING B
1020 BIRCH RIDGE DRIVE
RALEIGH NC

- The NCDOT acknowledges that there are unique technical challenges associated with developing pathogen TMDLs for SA waters. Likewise, complexities in analyzing two dimensional flow for Tidal Prism determinations are significant. We recognize that a significant amount of effort went into the development of the Jarrett Bay TMDLs. We are also aware that there remains a large number of fecal coliform TMDLs which need to be developed for the coastal area of NC. It is important that these future TMDLs be of high quality from a technical perspective in order to advance the goal of restoring NC's shellfishing waters. As always, my staff is available to discuss any issues or questions DWQ may have regarding NCDOT facilities located in watersheds draining to 303(d) listed waters.

Sincerely,

D.R. Henderson

D.R. Henderson, PE
State Hydraulics Engineer

cc: Neil Lassiter, Division 2
Gregory Thorpe, PDEA
Matt Lauffer, Hydraulics Unit
Ken Pace, Roadside Environmental Unit

## Appendix F-2. DWQ Response to Public Comment on the Public Review Draft of the Jarrett Bay and its Embayment Fecal Coliform TMDL

### Introduction

The North Carolina Division of Water Quality (DWQ) has conducted a public review of the proposed Total Maximum Daily Loads of Fecal Coliform in Jarrett Bay and its embayment in the White Oak river basin. The public comment period was open from April 16, 2005 through May 18, 2007. The DWQ received two sets of comments during the comment period.

Below is a list of commenters, their affiliation, and the date comments were submitted.

| Author | Affiliation | Date |
|---|---|---|
| Kristina Fischer | Division of Soil & Water Conservation, Area 6 | May 05, 2007 |
| D.R Henderson | North Carolina Department of Transportation | May 18, 2007 |

Summaries of the comments provided and DWQ's response are presented as follows:

**Response to Comments on the Fecal Coliform TMDL for Jarrett Bay and Its Embayment**

### I. Summary of Comments from the Division of Soil & Water Conservation (Area 6) and DWQ's response

This section of the TMDL summarizes the issues raised in the comment letters and provides DWQ's response to those issues.

**Issue 1:** The commenter acknowledges that a good job was done in pulling all of the information together. The commenter expresses concern that while the proposed TMDL reports livestock to account only 0.1% of the loading in each of the three watersheds (Williston, Wade, and Smyrna Creeks), livestock are listed as one of the "sources" of fecal coliform in the document (page xi, p. 10, p. 14, and p. 22). The commentator understands the need to include livestock as a source, but the fact that these inputs are extremely minimal should be mentioned.

**Response**: DWQ recognizes that fecal coliform load from livestock is not significant in theses watersheds. The TMDL reports that livestock account for only 0.1% of the loading in each of the three watersheds. Where references to livestock are made (page xi, p. 10, p. 14, and p. 22), the final TMDL document is revised to reflect the fact that inputs from livestock sources are not significant.

**Issue 2:** The commenter indicated that discussions with the staff in the local Soil and Water Conservation office have indicated that they are not aware of livestock in this area, and are curious to see where these animals are located.

**Response:** The loading calculations from various sources is based on County Agriculture Census data (USDA) and Sanitary Survey conducted by the Division of Environmental health, and on site specific watershed survey conducted by Duke University in the Jarrett Bay and Nelson Bay areas. Appendix C lists the data sources used for source assessment.

**Issue 3:** The commenter indicated that the process of spreading manure on fields is mentioned as a potential input (p. 10); and is not certain if either Open Grounds or Smyrna Farms uses this technique, but contact with these facilities should be made to determine if this is the case. Since these are two major land uses in the watershed, they certainly do have the potential to influence water quality, but perhaps not fecal coliform counts if manure is not used as fertilizer.

**Response**: The Nonpoint Sources Assessment section (2.1) in the TMDL document summarizes the possible mechanisms of introduction of fecal coliform bacteria to an area including manure-spreading process. It only describes the various mechanisms of fecal coliform loading and is not specific to the Jarrett Bay watershed. Appendix C lists the data sources used for source assessment and presents a detailed source assessment for the Jarrett Bay area. The source assessment for Jarrett Bay area indicates that fecal coliform load from livestock sources is very limited and manure spreading is not included as a major input.

**Issue 3:** The commenter expressed interest to see what strategies are proposed to reduce the fecal inputs to the Bay and willingness to provide assistance as we move forward with this effort to solve a difficult problem.

**Response:** DWQ appreciates the interest of the local Soil and Water Conservation office and looks forward to working with local interest groups as we move forward to restore and improve water quality.

## II. Summary of Comments from the North Carolina Department of Transportation and DWQ's response

**Issue 1.** Limited technical information is presented in the TMDL report with respect to the LSPC watershed model and the Tidal Prism estuary response model. Since Jarrett Bay is the first fecal coliform TMDL for SA (shellfish) waters to be published in NC, it is especially important that the modeling work be well documented and available to the public. Please provide all model input files/parameters as either appendices to the TMDL report or as separate modeling reports.

**Response:** The TMDL report presented the summary of the linked LSPC and Tidal Prism modeling framework. The final TMDL document is revised to include the model input files/parameters. The model input files/parameters are provided in Appendix H.

**Issue 2:** For the benefit of those entities interested in implementing measures to control fecal coliform loads, it would be helpful to include a map which illustrates the watershed boundary and land marks identifiable in the field. Most of the maps presented in the report do not contain sufficient detail to locate the watershed boundary in the field. A very useful addition to the report would be an aerial photograph overlaid with the watershed boundary and a scale bar.

**Response:** A watershed map with an aerial photograph overlaid with the watershed boundary is included in the final TMDL report. Figure 3.1.2 (Page 14) is added to the report.

**Issue 3:** Table 3.1.1 outlines the urban land uses are estimated to comprise 0.82% of the watershed area. In table B-1 the word "Transportation" was used as a descriptor for urban land use classification used in the TMDL model. From the NCDOT's perspective the word transportation can include many different types of facilities including ferry operations, rail, aviation, pedestrian and bicycle paths, as well as roads. Since the urban land use is insignificant in this watershed, we are not necessarily recommending any changes to this report regarding the term transportation. However, if additional TMDLs are developed using similar land use categories, we would appreciate DWQ clarifying specifically what the term transportation is intended to represent. If in future TMDLs the term transportation is specifically intended to represent NCDOT facilities, then this should be clearly stated in the report.

**Response:** We appreciate the description of the term "Transportation" provided by the NCDOT. For Jarrett Bay TMDLs the term "transportation" is mainly used to represent roads. Future TMDLs will clearly state what the term transportation represents in the urban land use classification and state if it is specifically intended to represent NCDOT facilities.

**Issue 4:** The NCDOT acknowledges that there are unique challenges associated with developing pathogen TMDLs for SA waters. Likewise, complexities in analyzing two dimensional flow for Tidal Prism determinations are significant. We recognize that a significant amount of effort went into the development of Jarrett Bay TMDLs. We are also aware that there remains a large number of fecal coliform TMDLs which need to be developed for the coastal area of NC. It is important that these future TMDLs be of high quality from a technical perspective in order to advance the goal of restoring NC's shellfishing waters.

**Response:** DWQ strives to use the best available resources in a cost effective manner when developing TMDLs. We acknowledge that there are unique challenges associated with developing pathogen TMDLs for SA waters. The Linked LSPC watershed and Tidal Prism modeling approach used for the Jarrett Bay TMDL, has been successfully applied to small coastal basins with high degree of branching in Virginia in the past. We acknowledge that more complex models (2-D and 3-D) have the advantages for simulating complex hydrodynamics in high resolution, but very fine model grids are needed to apply these models in coastal embayments, which is expensive in terms of computation for long-term simulation. The Tidal Prism Water Quality Model (TPWQM) is more cost effective for simulating water quality constituents than complex models because it requires less input data and it also has sufficient resolution to represent small coastal embayments and branches. But we recognize that, like any other modeling system, the linked model has several limitations. As with all modeling approaches there is uncertainty associated with this modeling approach. DWQ understands DOT's concerns and will do its best to produce high quality TMDLs from a technical perspective and in a cost effective manner.

DWQ appreciates DOT's comments and look forwarding to working with NCDOT as we move forward to restore and improve water quality in North Carolina.

# Appendix G. Public Notification of Fecal Coliform Total Maximum Daily Load for Jarrett Bay and Its Embayement

Michael F. Easley, Governor

William G. Ross Jr., Secretary
North Carolina Department of Environment and Natural Resources

Alan W. Klimek, P.E. Director
Division of Water Quality

Now Available Upon Request

**Fecal Coliform**
**Total Maximum Daily Load for**
**Jarrett Bay and Its Embayement**
Public Review Draft – April 2007

Is now available upon request from the North Carolina Division of Water Quality. This TMDL study was prepared as a requirement of the Federal Water Pollution Control Act, Section 303(d). The study identifies the sources of the pollutants, determines allowable loads to surface waters, and suggests pollutant allocations.

**TO OBTAIN A FREE COPY OF THE TMDL REPORTS:**

Please contact Ms. Linda Chavis (919) 733-5083, extension 558 or write to:
Adugna Kebede
Water Quality Planning Branch
NC Division of Water Quality
1617 Mail Service Center
Raleigh, NC 27699-1617

The draft TMDL is also located on the following website: http://h2o.enr.state.nc.us/tmdl. Interested parties are invited to comment on the draft TMDL study by May 18, 2007. Comments concerning the report should be directed to the Division of Water Quality at the above address.

North Carolina Division of Water Quality 1617 Mail Service Center Raleigh, NC 27699-1617 Phone (919) 733-7015 Customer Service
Internet: www.ncwaterquality.org Location: 512 N. Salisbury St. Raleigh, NC 27604 Fax (919) 733-2496 1-877-623-6748

**Public Notification of Fecal Coliform Total Maximum Daily Load for Jarrett Bay and Its Embayement – Affidavit of Publication (Carteret County NEWS-TIMES)**

CARTERET COUNTY,
NORTH CAROLINA

## AFFIDAVIT OF PUBLICATION

Before the undersigned, a notary public of said County and State, duly commissioned, qualified, and authorized by law to administer oaths, personally appeared Patti J. Lyerly who being first duly sworn, deposes and says that he (she) is Clerk

(Owner, partner, publisher or other officer or employee authorized to make this affidavit)

of THE CARTERET PUBLISHING CO., INC., engaged in the publication of a newspaper known as CARTERET COUNTY NEWS-TIMES, published, issued, and entered as second class mail in the Town of Morehead City, in said County and State; that he (she) is authorized to make this affidavit and sworn statement; that the notice or other legal advertisement, a true copy of which is attached hereto, was published in CARTERET COUNTY NEWS-TIMES on the following

dates: 04/18/2007

and that the said newspaper in which such notice, paper, document, or legal advertisement was published was, at the time of each and every such publication, a newspaper meeting all of the requirements and qualifications of Section 1-597 of the General Statutes of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statutes of North Carolina.

This 18th day of April, 2007

Patti J. Lyerly
(Signature of person making affidavit)

Sworn and subscribed to before me, this:
18th day of April, 2007

PAID

Rosa E. Garner
Notary Public

My commission expires July 16, 2011

Public Notice
State of North Carolina
Division of Water Quality

Availability of
the Fecal Coliform
Total Maximum Daily Load
(TMDL)
for Jarrett Bay and
Its Embayment

Copies of the TMDL may be obtained by calling Linda Chavis at (919)733-5083 ext. 558 or on the internet at http://h2o.enr.state.nc.us/tmdl Written comments regarding this TMDL will be accepted until May 18, 2007. Please mail comments to NCDWQ-Planning Branch, attn: Adugna Kebede. 1617 Mail Service Center, Raleigh NC 27699.
A18

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13548443

# Public Notification of Fecal Coliform Total Maximum Daily Load for Jarrett Bay and Its Embayement – Affidavit of Publication (New Bern Sun Journal)

32102922
15174288
Page 1 of 1

**Affidavit of Publication**
**New Bern Sun Journal**
**New Bern, NC**

Personally appeared before me, a Notary Public of the County of Onslow State of North Carolina, on this the 14th day of May, 2007

Kevin Blaylock

of The Sun Journal, who being duly sworn, states that the advertisement entitled **PUBLIC NOTICE STATE OF NORTH CAROLINA DIVISION OF WATER QUALITY Availability of the Fecal Coliform Total Maximum Daily Load (TMDL) for Jarrett Bay and Its Embayment Copies of the TMDL may be obtained by calling Linda Chavis at (919) 733 5083 ext. 558** a true copy of which is printed herewith, appeared in The Sun Journal, a newspaper published in the City of New Bern, NC, County of Craven, State of North Carolina, 1 day a week for Three weeks on the following dates:

April 22, 2007
May 13, 2007
May 14, 2007

NORTH CAROLINA
CRAVEN COUNTY

PUBLIC NOTICE
STATE OF NORTH
CAROLINA
DIVISION OF WATER QUALITY

Availability of the Fecal Coliform

Total Maximum Daily Load (TMDL) for Jarrett Bay and Its Embayment

Copies of the TMDL may be obtained by calling Linda Chavis at (919) 7335083 ext. 558 or on the internet at http://h2o.enr.state.nc.us/tmdl Written comments regarding this TMDL will be accepted until May 18, 2007. Please mail comments to NCDWQ-Planning Branch, attn: Adugna Kebede. 1617 Mail Service Center, Raleigh NC27699.

April 18, 2007

Subscribed and sworn to this 14th day of May, 2007

x Karla Jo Venters
**Notary Public**

**Message # 10 --- PUBLIC REVIEW: Draft Fecal Coliform TMDL for Jarrett Bay and Its Embayment --- "Kelly Porter" <kaporter@gw.fis.ncsu.edu>**

From wrri-news-owner@lists.ncsu.edu Fri Apr 20 18:09:30 2007
Received: from uni13mr.unity.ncsu.edu (uni13mr.unity.ncsu.edu [152.1.224.171])
by uni00ml.unity.ncsu.edu (8.13.7/8.13.3/N.20050331.02) with ESMTP id l3KM8QgX025075
for ; Fri, 20 Apr 2007 18:08:26 -0400
Received: from NCSTATEGW.fis.ncsu.edu (ncstategw.fis.ncsu.edu [152.1.243.38])
by uni13mr.unity.ncsu.edu (8.13.7/8.13.8/Nv5.2006.1109) with ESMTP id l3KM8Q2M020443
for ; Fri, 20 Apr 2007 18:08:26 -0400 (EDT)
Received: from NCSTATE-MTA by NCSTATEGW.fis.ncsu.edu
with Novell_GroupWise; Fri, 20 Apr 2007 18:08:26 -0400
Message-Id: <46290193.423B.0001.0@gw.fis.ncsu.edu>
X-Mailer: Novell GroupWise Internet Agent 7.0.1
Date: Fri, 20 Apr 2007 18:08:19 -0400
From: "Kelly Porter"
To:
Subject: PUBLIC REVIEW: Draft Fecal Coliform TMDL for Jarrett Bay and Its Embayment
Mime-Version: 1.0
Content-Type: multipart/alternative; boundary="=__PartFDDA9FC3.0__="
X-PMX-Version: 5.3.1.294258, Antispam-Engine: 2.5.0.283055, Antispam-Data: 2007.4.20.145636
X-Spam-Status: No, Hits=7%
X-Spam-Level: IIIIIII
X-Archive-Number: 200704/10
X-Sequence-Number: 1481

This is a MIME message. If you are reading this text, you may want to
consider changing to a mail reader or gateway that understands how to
properly handle MIME multipart messages.

--=__PartFDDA9FC3.0__=
Content-Type: text/plain; charset=UTF-8
Content-Transfer-Encoding: 8bit

NC Division of Water Quality
Now Available Upon Request
Fecal Coliform Total Maximum Daily Load for Jarrett Bay and Its Embayement Public Review Draft â€“ April 2007

This is now available upon request from the North Carolina Division of Water Quality. This TMDL study was prepared as a requirement of the Federal Water Pollution Control Act, Section 303(d). The study identifies the sources of the pollutants, determines allowable loads to surface waters, and suggests pollutant allocations.
TO OBTAIN A FREE COPY OF THE TMDL REPORTS:

Please contact Ms. Linda Chavis (919) 7335083, extension 558 or write to:
Adugna Kebede
Water Quality Planning Branch
NC Division of Water Quality
1617 Mail Service Center
Raleigh, NC 276991617
The draft TMDL is also located on the following website:
http://h2o.enr.state.nc.us/tmdl. Interested parties are invited to comment on the draft TMDL study by May 18, 2007. Comments concerning the report should be directed to the Division of Water Quality at the above address.

## Appendix H. Model inputs

### Geo.inp

```
C Hydrodynamic & Geometry Input
C
C
  0.700000
    8    9   JarretBay
    2    2  Name   2
    2    2  Name   2t
    4    3  Name   3
    3    4  Name   4
    3    4  Name   4t
    3    5  Name   5
    2    5  Name   5t
    2    6  Name   6
    2    6  Name   6t
    0

$$$ geometry and hydrodynamic input $$$
```

$$$ geometry and hydrodynamic input $$$

CH S# DIST VH P AL HA

(km) (10^6 m^3) (m)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| M | 0 | 1 | 0 | 0 | 7.913 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| M | 0 | 2 | 1.56 | 7.915 | 5.151 | 0.3 | 0.94 | 1 | 0.00E+00 | 0.00E+00 |
| M | 0 | 3 | 3.26 | 5.151 | 2.911 | 0.3 | 0.71 | 2 | 0.00E+00 | 0.00E+00 |
| M | 0 | 4 | 5.74 | 2.912 | 1.319 | 0.3 | 0.58 | 3 | 0.00E+00 | 0.00E+00 |
| M | 0 | 5 | 7.115 | 1.377 | 0.556 | 0.3 | 0.51 | 4 | 0.00E+00 | 0.00E+00 |
| M | 0 | 6 | 7.66 | 0.619 | 0.254 | 0.3 | 0.52 | 5 | 0.00E+00 | 0.00E+00 |
| M | 0 | 7 | 8.145 | 0.254 | 0.115 | 0.3 | 0.4 | 6 | 0.00E+00 | 0.00E+00 |
| M | 0 | 8 | 9 | 0.157 | 0 | 0.3 | 0.18 | 7 | 0.00E+00 | 0.00E+00 |
| B | 2 | 1 | 0 | 0 | 0.049 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 2 | 2 | 0.55 | 0.058 | 0 | 0.3 | 0.08 | 8 | 0.00E+00 | 0.00E+00 |
| B | 2 | 1 | 0 | 0 | 0.07 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 2 | 2 | 0.74 | 0.08 | 0 | 0.3 | 0.06 | 9 | 0.00E+00 | 0.00E+00 |
| B | 3 | 1 | 0 | 0 | 0.274 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 3 | 2 | 0.564 | 0.274 | 0.126 | 0.4 | 0.41 | 10 | 0.00E+00 | 0.00E+00 |
| B | 3 | 3 | 1.074 | 0.126 | 0.044 | 0.4 | 0.26 | 11 | 0.00E+00 | 0.00E+00 |
| B | 3 | 4 | 1.445 | 0.054 | 0 | 0.2 | 0.11 | 12 | 0.00E+00 | 0.00E+00 |
| B | 4 | 1 | 0 | 0 | 0.244 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 4 | 2 | 0.806 | 0.244 | 0.094 | 0.3 | 0.3 | 13 | 0.00E+00 | 0.00E+00 |
| B | 4 | 3 | 1.581 | 0.11 | 0 | 0.3 | 0.09 | 14 | 0.00E+00 | 0.00E+00 |
| B | 4 | 1 | 0 | 0 | 0.141 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 4 | 2 | 0.47 | 0.141 | 0.057 | 0.3 | 0.33 | 15 | 0.00E+00 | 0.00E+00 |
| B | 4 | 3 | 1.47 | 0.069 | 0 | 0.3 | 0.1 | 16 | 0.00E+00 | 0.00E+00 |
| B | 5 | 1 | 0 | 0 | 0.125 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 5 | 2 | 0.474 | 0.125 | 0.035 | 0.3 | 0.19 | 17 | 0.00E+00 | 0.00E+00 |
| B | 5 | 3 | 0.916 | 0.037 | 0 | 0.3 | 0.02 | 18 | 0.00E+00 | 0.00E+00 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| B | 5 | 1 | 0 | 0 | 0.058 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 5 | 2 | 0.083 | 0.066 | 0 | 0.3 | 0.07 | 19 | 0.00E+00 | 0.00E+00 |
| B | 6 | 1 | 0 | 0 | 0.068 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 6 | 2 | 0.45 | 0.077 | 0 | 0.3 | 0.07 | 20 | 0.00E+00 | 0.00E+00 |
| B | 6 | 1 | 0 | 0 | 0.061 | 0.3 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| B | 6 | 2 | 0.083 | 0.089 | 0 | 0.3 | 0.22 | 21 | 0.00E+00 | 0.00E+00 |
| S | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 8 | 0.00E+00 | 0.00E+00 |
| S | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 9 | 0.00E+00 | 0.00E+00 |
| S | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 10 | 0.00E+00 | 0.00E+00 |
| S | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 11 | 0.00E+00 | 0.00E+00 |
| S | 3 | 4 | 0 | 0 | 0 | 0 | 0 | 12 | 0.00E+00 | 0.00E+00 |
| S | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 13 | 0.00E+00 | 0.00E+00 |
| S | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 14 | 0.00E+00 | 0.00E+00 |
| S | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 15 | 0.00E+00 | 0.00E+00 |
| S | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 16 | 0.00E+00 | 0.00E+00 |
| S | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 17 | 0.00E+00 | 0.00E+00 |
| S | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 18 | 0.00E+00 | 0.00E+00 |
| S | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 19 | 0.00E+00 | 0.00E+00 |
| S | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 20 | 0.00E+00 | 0.00E+00 |
| S | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0.00E+00 | 0.00E+00 |
| S | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 21 | 0.00E+00 | 0.00E+00 |

**Jarrett_fecal.inp**

```
c-------------------------------------------------------------------------------------
-------
c LSPC -- Loading Simulation Program, C++
c Version 1.0
c
c Designed and maintained by:
c     Tetra Tech, Inc.
c     10306 Eaton Place, Suite 340
c     Fairfax, VA 22030
c     (703) 385-6000
c
c This code was last modified by Jian Shen & Jian Ouyang on 3/10/2002
c For questions, pleas send to shenji@tetratech-ffx.com
c
c this input file was last modified on  2005-2-18
c
c-------------------------------------------------------------------------------------
-------
c0   general control
c
c    pwafgt   if = 1 run pwater
c    sedfg    if = 1 run sediment
c    pqalfg   if = 1 run general quality
c    tempfg   if = 1 run temperature module
c    phfg     if = 1 run pH module
c    dofg     if = 1 run dissolved oxygen module
c
c  pwatfg sedfg pqalfg tempfg phfg dofg
1     0     1     0     0     0     0     1
c-------------------------------------------------------------------------------------
-------
c10  number of weather stations
c
c    nwst     number of weather stations
c
c   nwst
1
c-------------------------------------------------------------------------------------
-------
c20  weather station name and path (file path specified in card 30)
c
c    weastid   weather station id
c    weaname   weather station name (notation)
c    weafname  weather station file name
c
c  weastid   weaname        weafname
10    Jarrettbay.inp    Jarrettbay.inp
c-------------------------------------------------------------------------------------
-------
c30  output file path     input (weather) file path  (each must be a continuous
string)
c:\mdas\model\output\   c:\mdas\model\weather\
c-------------------------------------------------------------------------------------
-------
c40  general watershed controls
c
```

```
c    nsws      number of subwatersheds
c    ngroup    number of groups to assign parameters
c    nlnadp    maximum number of land use (pervious land)
c    optlevel  if = 1 general output (daily)
c              if = 2 general output (hourly)
c              if = 3 output more parameters
c              if = 10 debug output
c
c   nsws     ngroup    nlandp  optlevel
26    8     8     1
c-----------------------------------------------------------------------------------
-------
c50  model simulation time period
c
c    mstart   model start day.
c    mend     model end day.
c    delt     time step in hours (Use 1)
c
c    mstart        mend            delt
1/1/1993    1/1/2004    1.000000
c-----------------------------------------------------------------------------------
-------
c60  group information
c
c    iord      relational db index
c    gswsname  sws name
c    gparid    group parameter id
c    nwst      number of weather stations assigned to the watershed  (<=5)
c    for i = 1 up to 5
c       wsti = station id
c        wti  = weighting to calculate input
```

c

| c iord | gswsname | gparid | nwst | wst1 | wt1 | wst2 | wt2 | wst3 | wt3 | wst4 | wt4 | wst5 | wt5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 30201 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30202 | 8 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30203 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30204 | 8 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30205 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30206 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30207 | 8 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30208 | 7 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30209 | 7 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30210 | 7 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30211 | 7 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30212 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30213 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30214 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30215 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30216 | 7 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30217 | 4 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30218 | 4 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30219 | 4 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30220 | 7 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 30221 | 5 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30222 | 5 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30223 | 5 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30224 | 6 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30225 | 6 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 30226 | 6 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

```
c70  modeled land use names
c
c    luid     landuse id
c    pluname  landuse name
c
c luidp  pluname
1     Barren
2     Cropland
3     Forest
4     Pasture
6     UrbanPervious
7     Wetlands
8     Other
21    UrbanImpervious
c---------------------------------------------------------------------------------------
-------
c90  land use information
c
c    luid     land use id
c    luname   land use name
c    piid     1 imperivous land (subsurface processes disabled)
c             2 pervious  land (subsurface processes activated)
c    swsname  watershed
c    area     area (acres)
c    slsur    slope of overland flow plane (none)
c    lsur     length of overland flow plane (feet)
c
c  luid  luname             piid    swsname   area      slsur    lsur
    1              Barren     2      30201    0.00       0.05000   300.00
    2            Cropland     2      30201    3.78       0.05000   300.00
    3              Forest     2      30201   92.29       0.05000   300.00
    4             Pasture     2      30201    1.11       0.05000   300.00
    6       UrbanPervious     2      30201    0.00       0.05000   300.00
    7            Wetlands     2      30201  842.43       0.05000   300.00
    8               Other     2      30201    0.00       0.05000   300.00
   21     UrbanImpervious     1      30201    0.00       0.05000   300.00
    1              Barren     2      30202    0.00       0.05000   300.00
    2            Cropland     2      30202   33.80       0.05000   300.00
    3              Forest     2      30202   56.27       0.05000   300.00
    4             Pasture     2      30202   13.12       0.05000   300.00
    6       UrbanPervious     2      30202    7.25       0.05000   300.00
    7            Wetlands     2      30202  112.98       0.05000   300.00
    8               Other     2      30202    0.00       0.05000   300.00
   21     UrbanImpervious     1      30202    2.09       0.05000   300.00
    1              Barren     2      30203    0.00       0.05000   300.00
    2            Cropland     2      30203    0.00       0.05000   300.00
    3              Forest     2      30203    0.00       0.05000   300.00
    4             Pasture     2      30203    0.00       0.05000   300.00
    6       UrbanPervious     2      30203    0.00       0.05000   300.00
    7            Wetlands     2      30203   20.24       0.05000   300.00
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | Other | 2 | 30203 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30203 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30204 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30204 | 10.23 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30204 | 61.38 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30204 | 12.90 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30204 | 6.17 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30204 | 49.15 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30204 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30204 | 1.61 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30205 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30205 | 1.78 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30205 | 18.01 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30205 | 1.11 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30205 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30205 | 306.90 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30205 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30205 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30206 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30206 | 18.24 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30206 | 348.49 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30206 | 66.72 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30206 | 1.67 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30206 | 1678.63 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30206 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30206 | 0.78 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30207 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30207 | 0.89 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30207 | 63.38 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30207 | 16.46 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30207 | 3.43 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30207 | 89.62 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30207 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30207 | 1.24 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30208 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30208 | 0.00 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30208 | 2.22 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30208 | 0.00 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30208 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30208 | 160.57 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30208 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30208 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30209 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30209 | 0.00 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30209 | 0.00 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30209 | 0.00 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30209 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30209 | 148.34 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30209 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30209 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30210 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30210 | 0.00 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30210 | 0.00 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30210 | 0.00 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30210 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30210 | 29.13 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30210 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30210 | 0.00 | 0.05000 | 300.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Barren | 2 | 30211 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30211 | 0.00 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30211 | 0.00 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30211 | 0.00 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30211 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30211 | 14.46 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30211 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30211 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30212 | 0.22 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30212 | 445.23 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30212 | 108.97 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30212 | 52.48 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30212 | 2.06 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30212 | 762.81 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30212 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30212 | 1.94 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30213 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30213 | 0.67 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30213 | 3.78 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30213 | 4.23 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30213 | 2.39 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30213 | 41.37 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30213 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30213 | 1.62 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30214 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30214 | 53.60 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30214 | 72.06 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30214 | 4.00 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30214 | 0.78 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30214 | 34.25 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30214 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30214 | 0.11 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30215 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30215 | 59.82 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30215 | 136.77 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30215 | 22.46 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30215 | 3.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30215 | 51.37 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30215 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30215 | 0.78 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30216 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30216 | 0.00 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30216 | 12.23 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30216 | 0.00 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30216 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30216 | 258.20 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30216 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30216 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30217 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30217 | 92.96 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30217 | 119.65 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30217 | 24.02 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30217 | 7.21 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30217 | 118.98 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30217 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30217 | 1.91 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30218 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30218 | 11.34 | 0.05000 | 300.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | Forest | 2 | 30218 | 62.94 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30218 | 22.68 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30218 | 2.35 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30218 | 24.91 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30218 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30218 | 0.32 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30219 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30219 | 0.00 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30219 | 19.79 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30219 | 0.22 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30219 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30219 | 31.58 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30219 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30219 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30220 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30220 | 0.00 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30220 | 1.78 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30220 | 0.00 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30220 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30220 | 140.55 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30220 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30220 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30221 | 0.44 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30221 | 120.54 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30221 | 198.60 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30221 | 67.61 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30221 | 9.66 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30221 | 319.58 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30221 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30221 | 2.79 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30222 | 0.22 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30222 | 6.89 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30222 | 144.11 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30222 | 26.69 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30222 | 1.79 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30222 | 222.39 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30222 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30222 | 0.43 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30223 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30223 | 3.11 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30223 | 50.26 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30223 | 19.57 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30223 | 0.00 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30223 | 16.01 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30223 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30223 | 0.00 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30224 | 0.44 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30224 | 3.56 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30224 | 332.92 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30224 | 35.36 | 0.05000 | 300.00 |
| 6 | UrbanPervious | 2 | 30224 | 3.14 | 0.05000 | 300.00 |
| 7 | Wetlands | 2 | 30224 | 145.00 | 0.05000 | 300.00 |
| 8 | Other | 2 | 30224 | 0.00 | 0.05000 | 300.00 |
| 21 | UrbanImpervious | 1 | 30224 | 1.53 | 0.05000 | 300.00 |
| 1 | Barren | 2 | 30225 | 0.00 | 0.05000 | 300.00 |
| 2 | Cropland | 2 | 30225 | 35.58 | 0.05000 | 300.00 |
| 3 | Forest | 2 | 30225 | 159.23 | 0.05000 | 300.00 |
| 4 | Pasture | 2 | 30225 | 103.86 | 0.05000 | 300.00 |

```
    6      UrbanPervious     2      30225    2.97        0.05000   300.00
    7           Wetlands     2      30225   17.57        0.05000   300.00
    8              Other     2      30225    0.00        0.05000   300.00
   21    UrbanImpervious     1      30225    0.59        0.05000   300.00
    1             Barren     2      30226    0.22        0.05000   300.00
    2           Cropland     2      30226   13.34        0.05000   300.00
    3             Forest     2      30226   60.05        0.05000   300.00
    4            Pasture     2      30226   18.24        0.05000   300.00
    6      UrbanPervious     2      30226    2.15        0.05000   300.00
    7           Wetlands     2      30226   14.46        0.05000   300.00
    8              Other     2      30226    0.00        0.05000   300.00
   21    UrbanImpervious     1      30226    0.29        0.05000   300.00

c----------------------------------------------------------------------------------
-------
c100 pwat-parm1
c    pervious and impervious land hydrology control
c
c    (value of 0 = use constant pwat-parm4; 1 = use corresponding monthly variable
card)
c
c    vcsfg    interception storage capacity                            (card 150)
c    vuzfg    upper zone nominal storage                               (card 160)
c    vnnfg    manning's n for the overland flow plane       (card 170)
c    vifwfg   interflow inflow parameter                               (card 180)
c    vircfg   interflow recession constant                             (card 190)
c    vlefg    lower zone evapotranspiration (e-t) parameter (card 200)
c
c   vcscfg  vuzfg  vnnfg  vifwfg  vircfg  vlefg
1     1     1     0     0     1
c----------------------------------------------------------------------------------
-------
c110 pwat-parm2
c
c    gid     parameter group id
c    lid     landuse id
c    lzsn    lower zone nominal soil moisture storage (inches)
c    infilt  index to the infiltration capacity of the soil (in/hr)
c    kvary   variable groundwater recession (1/inches)
c    agwrc   base groundwater recession (none)
c
c   gid  lid    lzsn      infilt      kvary      agwrc
1     1     8.000000    0.040000    0.000000    0.950000
1     2     8.000000    0.080000    0.000000    0.950000
1     3     8.000000    0.050000    0.000000    0.950000
1     4     8.000000    0.060000    0.000000    0.950000
1     6     8.000000    0.050000    0.000000    0.950000
1     7     8.000000    0.050000    0.000000    0.940000
1     8     8.000000    0.030000    0.000000    0.960000
1     21    8.000000    0.000000    0.000000    0.989000
2     1     8.000000    0.040000    0.000000    0.950000
2     2     8.000000    0.080000    0.000000    0.950000
2     3     8.000000    0.050000    0.000000    0.950000
2     4     8.000000    0.060000    0.000000    0.950000
2     6     8.000000    0.050000    0.000000    0.950000
2     7     8.000000    0.050000    0.000000    0.940000
2     8     8.000000    0.030000    0.000000    0.960000
2     21    8.000000    0.000000    0.000000    0.989000
```

```
3     1     8.000000    0.040000    0.000000    0.950000
3     2     8.000000    0.080000    0.000000    0.950000
3     3     8.000000    0.050000    0.000000    0.950000
3     4     8.000000    0.060000    0.000000    0.950000
3     6     8.000000    0.050000    0.000000    0.950000
3     7     8.000000    0.050000    0.000000    0.940000
3     8     8.000000    0.030000    0.000000    0.960000
3     21    8.000000    0.000000    0.000000    0.989000
4     1     8.000000    0.040000    0.000000    0.950000
4     2     8.000000    0.080000    0.000000    0.950000
4     3     8.000000    0.050000    0.000000    0.950000
4     4     8.000000    0.060000    0.000000    0.950000
4     6     8.000000    0.050000    0.000000    0.950000
4     7     8.000000    0.050000    0.000000    0.940000
4     8     8.000000    0.030000    0.000000    0.960000
4     21    8.000000    0.000000    0.000000    0.989000
5     1     8.000000    0.040000    0.000000    0.950000
5     2     8.000000    0.080000    0.000000    0.950000
5     3     8.000000    0.050000    0.000000    0.950000
5     4     8.000000    0.060000    0.000000    0.950000
5     6     8.000000    0.050000    0.000000    0.950000
5     7     8.000000    0.050000    0.000000    0.940000
5     8     8.000000    0.030000    0.000000    0.960000
5     21    8.000000    0.000000    0.000000    0.989000
6     1     8.000000    0.040000    0.000000    0.950000
6     2     8.000000    0.080000    0.000000    0.950000
6     3     8.000000    0.050000    0.000000    0.950000
6     4     8.000000    0.060000    0.000000    0.950000
6     6     8.000000    0.050000    0.000000    0.950000
6     7     8.000000    0.050000    0.000000    0.940000
6     8     8.000000    0.030000    0.000000    0.960000
6     21    8.000000    0.000000    0.000000    0.989000
7     1     8.000000    0.040000    0.000000    0.950000
7     2     8.000000    0.080000    0.000000    0.950000
7     3     8.000000    0.050000    0.000000    0.950000
7     4     8.000000    0.060000    0.000000    0.950000
7     6     8.000000    0.050000    0.000000    0.950000
7     7     8.000000    0.050000    0.000000    0.940000
7     8     8.000000    0.030000    0.000000    0.960000
7     21    8.000000    0.000000    0.000000    0.989000
8     1     8.000000    0.040000    0.000000    0.950000
8     2     8.000000    0.080000    0.000000    0.950000
8     3     8.000000    0.050000    0.000000    0.950000
8     4     8.000000    0.060000    0.000000    0.950000
8     6     8.000000    0.050000    0.000000    0.950000
8     7     8.000000    0.050000    0.000000    0.940000
8     8     8.000000    0.030000    0.000000    0.960000
8     21    8.000000    0.000000    0.000000    0.989000
c------------------------------------------------------------------------------
-------
c120 pwat-parm3
c
c    gid     parameter group id
c    lid     landuse id
c    petmax  air temperature below which e-t will is reduced (deg F)
c    petmin  air temperature below which e-t is set to zero (deg F)
c    infexp  exponent in the infiltration equation (none)
```

```
c    INFILD  ratio between the maximum and mean infiltration capacities over the
PLS (none)
c    deepfr  fraction of groundwater inflow that will enter deep groundwater (none)
c    basetp  fraction of remaining potential e-t that can be satisfied from
baseflow (none)
c    agwetp  fraction of remaining potential e-t that can be satisfied from active
groundwater (none)
```

| c | gid | lid | petmax | petmin | infexp | infild | deepfr | basetp | agwetp |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 1 | 2 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 1 | 3 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 1 | 4 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 1 | 6 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 1 | 7 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0.5 |
| | 1 | 8 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 1 | 21 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 2 | 1 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 2 | 2 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 2 | 3 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 2 | 4 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 2 | 6 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 2 | 7 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0.5 |
| | 2 | 8 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 2 | 21 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 3 | 1 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 3 | 2 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 3 | 3 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 3 | 4 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 3 | 6 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 3 | 7 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0.5 |
| | 3 | 8 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 3 | 21 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 4 | 1 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 4 | 2 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 4 | 3 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 4 | 4 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 4 | 6 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 4 | 7 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0.5 |
| | 4 | 8 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 4 | 21 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 5 | 1 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 5 | 2 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 5 | 3 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 5 | 4 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 5 | 6 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 5 | 7 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0.5 |
| | 5 | 8 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| | 5 | 21 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 1 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 6 | 2 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 6 | 3 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 6 | 4 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 6 | 6 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 6 | 7 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0.5 |
| 6 | 8 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 6 | 21 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 7 | 1 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 7 | 2 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 7 | 3 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 7 | 4 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 7 | 6 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 7 | 7 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0.5 |
| 7 | 8 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 7 | 21 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 8 | 1 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 8 | 2 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 8 | 3 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 8 | 4 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 8 | 6 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 8 | 7 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0.5 |
| 8 | 8 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |
| 8 | 21 | 40 | 35 | 2 | 2 | 0.4 | 0 | 0 |

```
c130 pwat-parm4
c
c    gid     parameter group id
c    lid     landuse id
c    cepsc   interception storage capacity (inches)
c    uzsn    upper zone nominal storage (inches)
c    nsur    Manning's n for the assumed overland flow plane (none)
c    intfw   interflow inflow parameter (none)
c    irc     interflow recession parameter (none)
c    lzetp   lower zone e-t parameter (none)
c
```

| c | gid | lid | cepsc | uzsn | nsur | intfw | irc | lzetp |
|---|---|---|---|---|---|---|---|---|
| | 1 | 1 | 0.065 | 0.35 | 0.17 | 4 | 0.6 | 0.1 |
| | 1 | 2 | 0.1 | 0.35 | 0.1 | 7 | 0.6 | 0.2 |
| | 1 | 3 | 0.12 | 0.9 | 0.35 | 4 | 0.6 | 0.6 |
| | 1 | 4 | 0.065 | 0.7 | 0.1 | 5 | 0.6 | 0.1 |
| | 1 | 6 | 0.028 | 0.35 | 0.06 | 4 | 0.6 | 0.1 |
| | 1 | 7 | 0.038 | 0.7 | 0.2 | 3 | 0.6 | 0.6 |
| | 1 | 8 | 0.098 | 0.25 | 0.2 | 3 | 0.6 | 0.1 |
| | 1 | 21 | 0.036 | 0.25 | 0.2 | 1 | 0.6 | 0.1 |
| | 2 | 1 | 0.065 | 0.35 | 0.17 | 4 | 0.6 | 0.1 |
| | 2 | 2 | 0.1 | 0.35 | 0.1 | 7 | 0.6 | 0.2 |
| | 2 | 3 | 0.12 | 0.9 | 0.35 | 4 | 0.6 | 0.6 |
| | 2 | 4 | 0.065 | 0.7 | 0.1 | 5 | 0.6 | 0.1 |
| | 2 | 6 | 0.028 | 0.35 | 0.06 | 4 | 0.6 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 7 | 0.038 | 0.7 | 0.2 | 3 | 0.6 | 0.6 |
| 2 | 8 | 0.098 | 0.25 | 0.2 | 3 | 0.6 | 0.1 |
| 2 | 21 | 0.036 | 0.25 | 0.2 | 1 | 0.6 | 0.1 |
| 3 | 1 | 0.065 | 0.35 | 0.17 | 4 | 0.6 | 0.1 |
| 3 | 2 | 0.1 | 0.35 | 0.1 | 7 | 0.6 | 0.2 |
| 3 | 3 | 0.12 | 0.9 | 0.35 | 4 | 0.6 | 0.6 |
| 3 | 4 | 0.065 | 0.7 | 0.1 | 5 | 0.6 | 0.1 |
| 3 | 6 | 0.028 | 0.35 | 0.06 | 4 | 0.6 | 0.1 |
| 3 | 7 | 0.038 | 0.7 | 0.2 | 3 | 0.6 | 0.6 |
| 3 | 8 | 0.098 | 0.25 | 0.2 | 3 | 0.6 | 0.1 |
| 3 | 21 | 0.036 | 0.25 | 0.2 | 1 | 0.6 | 0.1 |
| 4 | 1 | 0.065 | 0.35 | 0.17 | 4 | 0.6 | 0.1 |
| 4 | 2 | 0.1 | 0.35 | 0.1 | 7 | 0.6 | 0.2 |
| 4 | 3 | 0.12 | 0.9 | 0.35 | 4 | 0.6 | 0.6 |
| 4 | 4 | 0.065 | 0.7 | 0.1 | 5 | 0.6 | 0.1 |
| 4 | 6 | 0.028 | 0.35 | 0.06 | 4 | 0.6 | 0.1 |
| 4 | 7 | 0.038 | 0.7 | 0.2 | 3 | 0.6 | 0.6 |
| 4 | 8 | 0.098 | 0.25 | 0.2 | 3 | 0.6 | 0.1 |
| 4 | 21 | 0.036 | 0.25 | 0.2 | 1 | 0.6 | 0.1 |
| 5 | 1 | 0.065 | 0.35 | 0.17 | 4 | 0.6 | 0.1 |
| 5 | 2 | 0.1 | 0.35 | 0.1 | 7 | 0.6 | 0.2 |
| 5 | 3 | 0.12 | 0.9 | 0.35 | 4 | 0.6 | 0.6 |
| 5 | 4 | 0.065 | 0.7 | 0.1 | 5 | 0.6 | 0.1 |
| 5 | 6 | 0.028 | 0.35 | 0.06 | 4 | 0.6 | 0.1 |
| 5 | 7 | 0.038 | 0.7 | 0.2 | 3 | 0.6 | 0.6 |
| 5 | 8 | 0.098 | 0.25 | 0.2 | 3 | 0.6 | 0.1 |
| 5 | 21 | 0.036 | 0.25 | 0.2 | 1 | 0.6 | 0.1 |
| 6 | 1 | 0.065 | 0.35 | 0.17 | 4 | 0.6 | 0.1 |
| 6 | 2 | 0.1 | 0.35 | 0.1 | 7 | 0.6 | 0.2 |
| 6 | 3 | 0.12 | 0.9 | 0.35 | 4 | 0.6 | 0.6 |
| 6 | 4 | 0.065 | 0.7 | 0.1 | 5 | 0.6 | 0.1 |
| 6 | 6 | 0.028 | 0.35 | 0.06 | 4 | 0.6 | 0.1 |
| 6 | 7 | 0.038 | 0.7 | 0.2 | 3 | 0.6 | 0.6 |
| 6 | 8 | 0.098 | 0.25 | 0.2 | 3 | 0.6 | 0.1 |
| 6 | 21 | 0.036 | 0.25 | 0.2 | 1 | 0.6 | 0.1 |
| 7 | 1 | 0.065 | 0.35 | 0.17 | 4 | 0.6 | 0.1 |
| 7 | 2 | 0.1 | 0.35 | 0.1 | 7 | 0.6 | 0.2 |
| 7 | 3 | 0.12 | 0.9 | 0.35 | 4 | 0.6 | 0.6 |
| 7 | 4 | 0.065 | 0.7 | 0.1 | 5 | 0.6 | 0.1 |
| 7 | 6 | 0.028 | 0.35 | 0.06 | 4 | 0.6 | 0.1 |
| 7 | 7 | 0.038 | 0.7 | 0.2 | 3 | 0.6 | 0.6 |
| 7 | 8 | 0.098 | 0.25 | 0.2 | 3 | 0.6 | 0.1 |
| 7 | 21 | 0.036 | 0.25 | 0.2 | 1 | 0.6 | 0.1 |
| 8 | 1 | 0.065 | 0.35 | 0.17 | 4 | 0.6 | 0.1 |
| 8 | 2 | 0.1 | 0.35 | 0.1 | 7 | 0.6 | 0.2 |
| 8 | 3 | 0.12 | 0.9 | 0.35 | 4 | 0.6 | 0.6 |
| 8 | 4 | 0.065 | 0.7 | 0.1 | 5 | 0.6 | 0.1 |
| 8 | 6 | 0.028 | 0.35 | 0.06 | 4 | 0.6 | 0.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 7 | 0.038 | 0.7 | 0.2 | 3 | 0.6 | 0.6 |
| 8 | 8 | 0.098 | 0.25 | 0.2 | 3 | 0.6 | 0.1 |
| 8 | 21 | 0.036 | 0.25 | 0.2 | 1 | 0.6 | 0.1 |

```
c-----------------------------------------------------------------------------------
c140 pwat-state1
c    initial conditions for the simulation
c
c    gid     parameter group id
c    lid     landuse id
c    ceps    initial interception storage.
c    surs    initial surface (overland flow) storage.
c    uzs     initial upper zone storage.
c    ifws    initial interflow storage.
c    lzs     initial lower zone storage.
c    agws    initial active groundwater storage.
c    gwvs    initial index to groundwater slope.
```

| c gid | lid | ceps | surs | uzs | ifws | lzs | agws | gwvs |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 1 | 2 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 1 | 3 | 0 | 0 | 0.8 | 0 | 6.55 | 0.87 | 0 |
| 1 | 4 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 1 | 6 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 1 | 7 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 1 | 8 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 1 | 21 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 2 | 1 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 2 | 2 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 2 | 3 | 0 | 0 | 0.8 | 0 | 6.55 | 0.87 | 0 |
| 2 | 4 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 2 | 6 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 2 | 7 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 2 | 8 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 2 | 21 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 3 | 1 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 3 | 2 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 3 | 3 | 0 | 0 | 0.8 | 0 | 6.55 | 0.87 | 0 |
| 3 | 4 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 3 | 6 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 3 | 7 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 3 | 8 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 3 | 21 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 4 | 1 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 4 | 2 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 4 | 3 | 0 | 0 | 0.8 | 0 | 6.55 | 0.87 | 0 |
| 4 | 4 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 4 | 6 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 4 | 7 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 4 | 8 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 4 | 21 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 5 | 1 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 2 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 5 | 3 | 0 | 0 | 0.8 | 0 | 6.55 | 0.87 | 0 |
| 5 | 4 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 5 | 6 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 5 | 7 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 5 | 8 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 5 | 21 | 0.01 | 0.01 | 0.1 | 0.01 | 3.5 | 2.01 | 0.01 |
| 6 | 1 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 6 | 2 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 6 | 3 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 6 | 4 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 6 | 6 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 6 | 7 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 6 | 8 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 6 | 21 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 7 | 1 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 7 | 2 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 7 | 3 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 7 | 4 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 7 | 6 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 7 | 7 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 7 | 8 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 7 | 21 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 8 | 1 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 8 | 2 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 8 | 3 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 8 | 4 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 8 | 6 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 8 | 7 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 8 | 8 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |
| 8 | 21 | 0.01 | 0.01 | 0.1 | 0.01 | 0.5 | 0.01 | 0.01 |

```
c--------------------------------------------------------------------------------
c150 mon-interception storage (cepscm)
c    only required if vcsfg=1 in pwat-parm1 (see card 100)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec interception storage capacity at start of each month (inches)
c
```

| c | gid | lid | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.036 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 |
| 1 | 2 | 0.065 | 0.065 | 0.058 | 0.058 | 0.058 | 0.065 | 0.125 | 0.148 | 0.14 | 0.11 | 0.095 | 0.08 |
| 1 | 3 | 0.065 | 0.065 | 0.065 | 0.105 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.105 | 0.065 | 0.065 |
| 1 | 4 | 0.068 | 0.065 | 0.07 | 0.083 | 0.1 | 0.103 | 0.103 | 0.1 | 0.1 | 0.082 | 0.077 | 0.072 |
| 1 | 6 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 1 | 7 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 1 | 8 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 1 | 21 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 | 0.093 |
| 2 | 1 | 0.036 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2 | 0.065 | 0.065 | 0.058 | 0.058 | 0.058 | 0.065 | 0.125 | 0.148 | 0.14 | 0.11 | 0.095 | 0.08 |
| 2 | 3 | 0.065 | 0.065 | 0.065 | 0.105 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.105 | 0.065 | 0.065 |
| 2 | 4 | 0.068 | 0.065 | 0.07 | 0.083 | 0.1 | 0.103 | 0.103 | 0.1 | 0.1 | 0.082 | 0.077 | 0.072 |
| 2 | 6 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 2 | 7 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 2 | 8 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 2 | 21 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 | 0.093 |
| 3 | 1 | 0.036 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 |
| 3 | 2 | 0.065 | 0.065 | 0.058 | 0.058 | 0.058 | 0.065 | 0.125 | 0.148 | 0.14 | 0.11 | 0.095 | 0.08 |
| 3 | 3 | 0.065 | 0.065 | 0.065 | 0.105 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.105 | 0.065 | 0.065 |
| 3 | 4 | 0.068 | 0.065 | 0.07 | 0.083 | 0.1 | 0.103 | 0.103 | 0.1 | 0.1 | 0.082 | 0.077 | 0.072 |
| 3 | 6 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 3 | 7 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 3 | 8 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 3 | 21 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 | 0.093 |
| 4 | 1 | 0.036 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 |
| 4 | 2 | 0.065 | 0.065 | 0.058 | 0.058 | 0.058 | 0.065 | 0.125 | 0.148 | 0.14 | 0.11 | 0.095 | 0.08 |
| 4 | 3 | 0.065 | 0.065 | 0.065 | 0.105 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.105 | 0.065 | 0.065 |
| 4 | 4 | 0.068 | 0.065 | 0.07 | 0.083 | 0.1 | 0.103 | 0.103 | 0.1 | 0.1 | 0.082 | 0.077 | 0.072 |
| 4 | 6 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 4 | 7 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 4 | 8 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 4 | 21 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 | 0.093 |
| 5 | 1 | 0.036 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 |
| 5 | 2 | 0.065 | 0.065 | 0.058 | 0.058 | 0.058 | 0.065 | 0.125 | 0.148 | 0.14 | 0.11 | 0.095 | 0.08 |
| 5 | 3 | 0.065 | 0.065 | 0.065 | 0.105 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.105 | 0.065 | 0.065 |
| 5 | 4 | 0.068 | 0.065 | 0.07 | 0.083 | 0.1 | 0.103 | 0.103 | 0.1 | 0.1 | 0.082 | 0.077 | 0.072 |
| 5 | 6 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 5 | 7 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 5 | 8 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 5 | 21 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 | 0.093 |
| 6 | 1 | 0.036 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 |
| 6 | 2 | 0.065 | 0.065 | 0.058 | 0.058 | 0.058 | 0.065 | 0.125 | 0.148 | 0.14 | 0.11 | 0.095 | 0.08 |
| 6 | 3 | 0.065 | 0.065 | 0.065 | 0.105 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.105 | 0.065 | 0.065 |
| 6 | 4 | 0.068 | 0.065 | 0.07 | 0.083 | 0.1 | 0.103 | 0.103 | 0.1 | 0.1 | 0.082 | 0.077 | 0.072 |
| 6 | 6 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 6 | 7 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 6 | 8 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 6 | 21 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 | 0.093 |
| 7 | 1 | 0.036 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 |
| 7 | 2 | 0.065 | 0.065 | 0.058 | 0.058 | 0.058 | 0.065 | 0.125 | 0.148 | 0.14 | 0.11 | 0.095 | 0.08 |
| 7 | 3 | 0.065 | 0.065 | 0.065 | 0.105 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.105 | 0.065 | 0.065 |
| 7 | 4 | 0.068 | 0.065 | 0.07 | 0.083 | 0.1 | 0.103 | 0.103 | 0.1 | 0.1 | 0.082 | 0.077 | 0.072 |
| 7 | 6 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 7 | 7 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 7 | 8 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 7 | 21 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 | 0.093 |
| 8 | 1 | 0.036 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 2 | 0.065 | 0.065 | 0.058 | 0.058 | 0.058 | 0.065 | 0.125 | 0.148 | 0.14 | 0.11 | 0.095 | 0.08 |
| 8 | 3 | 0.065 | 0.065 | 0.065 | 0.105 | 0.165 | 0.165 | 0.165 | 0.165 | 0.165 | 0.105 | 0.065 | 0.065 |
| 8 | 4 | 0.068 | 0.065 | 0.07 | 0.083 | 0.1 | 0.103 | 0.103 | 0.1 | 0.1 | 0.082 | 0.077 | 0.072 |
| 8 | 6 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 8 | 7 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 8 | 8 | 0.098 | 0.098 | 0.098 | 0.098 | 0.101 | 0.101 | 0.101 | 0.101 | 0.101 | 0.098 | 0.098 | 0.098 |
| 8 | 21 | 0.036 | 0.036 | 0.049 | 0.049 | 0.049 | 0.066 | 0.066 | 0.066 | 0.049 | 0.049 | 0.049 | 0.093 |

```
c160 mon-upper zone nominal storage (uzsnm)
c    only required if vuzfg=1 in pwat-parm1 (see card 100)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec upper zone nominal storage at start of each month (inches)
c
```

| c gid | lid | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 1 | 2 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 1 | 3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 1 | 4 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 1 | 6 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 1 | 7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 1 | 8 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 1 | 21 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 2 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 2 | 2 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 2 | 3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 2 | 4 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 2 | 6 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 2 | 7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 2 | 8 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 2 | 21 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 3 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 3 | 2 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 3 | 3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 3 | 4 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 3 | 6 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 3 | 7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 3 | 8 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 3 | 21 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 4 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 4 | 2 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 4 | 3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 4 | 4 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 4 | 6 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 4 | 7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 4 | 8 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 4 | 21 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 5 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 5 | 2 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 5 | 4 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 5 | 6 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 5 | 7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 5 | 8 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 5 | 21 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 6 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 6 | 2 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 6 | 3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 6 | 4 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 6 | 6 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 6 | 7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 6 | 8 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 6 | 21 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 7 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 7 | 2 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 7 | 3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 7 | 4 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 7 | 6 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 7 | 7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 7 | 8 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 7 | 21 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 8 | 1 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 8 | 2 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 8 | 3 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| 8 | 4 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 8 | 6 | 0.35 | 0.35 | 0.35 | 0.35 | 0.33 | 0.3 | 0.3 | 0.3 | 0.3 | 0.35 | 0.35 | 0.35 |
| 8 | 7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| 8 | 8 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| 8 | 21 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |

```
c--------------------------------------------------------------------------------------
c170 mon-Manning's roughness coefficient (nsurm)
c    only required if vnnfg=1 in pwat-parm1 (see card 100)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec Manning's roughness coefficient at start of each month (none)
c
```

| c gid | lid | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov | dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.17 | 0.165 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.2 | 0.2 | 0.12 | 0.12 | 0.12 |
| 1 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 1 | 3 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| 1 | 4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 1 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 1 | 7 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 1 | 8 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 1 | 21 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 2 | 1 | 0.17 | 0.165 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.2 | 0.2 | 0.12 | 0.12 | 0.12 |
| 2 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| 2 | 4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 2 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 2 | 7 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 2 | 8 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 2 | 21 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 3 | 1 | 0.17 | 0.165 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.2 | 0.2 | 0.12 | 0.12 | 0.12 |
| 3 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 3 | 3 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| 3 | 4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 3 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 3 | 7 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 3 | 8 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 3 | 21 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 4 | 1 | 0.17 | 0.165 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.2 | 0.2 | 0.12 | 0.12 | 0.12 |
| 4 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 4 | 3 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| 4 | 4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 4 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 4 | 7 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 4 | 8 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 4 | 21 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 5 | 1 | 0.17 | 0.165 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.2 | 0.2 | 0.12 | 0.12 | 0.12 |
| 5 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 5 | 3 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| 5 | 4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 5 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 5 | 7 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 5 | 8 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 5 | 21 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 6 | 1 | 0.17 | 0.165 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.2 | 0.2 | 0.12 | 0.12 | 0.12 |
| 6 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 6 | 3 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| 6 | 4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 6 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 6 | 7 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 6 | 8 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 6 | 21 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 7 | 1 | 0.17 | 0.165 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.2 | 0.2 | 0.12 | 0.12 | 0.12 |
| 7 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 7 | 3 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| 7 | 4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 7 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 7 | 7 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 7 | 8 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 7 | 21 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 8 | 1 | 0.17 | 0.165 | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.2 | 0.2 | 0.12 | 0.12 | 0.12 |
| 8 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 3 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| 8 | 4 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 8 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 8 | 7 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 8 | 8 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |
| 8 | 21 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.2 |

```
c-------------------------------------------------------------------------------------
c180 mon-interflow inflow parameter (intfwm)
c    only required if vifwfg=1 in pwat-parm1 (see card 100)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec interflow inflow parameter at start of each month (none)
c
c  gid  lid   jan    feb    mar    apr    may    jun    jul    aug    sep    oct    nov    dec
c---------------------------------------------------------------------------------------
----
c190 mon-interflow recession constant (ircm)
c    only required if vircfg=1 in pwat-parm1 (see card 100)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec interflow recession constant at start of each month (none)
c
c  gid  lid   jan    feb    mar    apr    may    jun    jul    aug    sep    oct    nov    dec
c---------------------------------------------------------------------------------------
--
c200 mon-lower zone evapotranspiration parameter (lzetpm)
c    only required if vlefg=1 in pwat-parm1 (see card 100)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec lower zone evapotranspiration parameter at start of each month (none)
c
```

| c gid | lid | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 1 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 1 | 3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 1 | 4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 |
| 1 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 1 | 7 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 1 | 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 1 | 21 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 2 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 2 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 2 | 3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 2 | 4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 |
| 2 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 2 | 7 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 2 | 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 2 | 21 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 3 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 3 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 3 | 4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 |
| 3 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 3 | 7 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 3 | 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 3 | 21 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 4 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 4 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 4 | 3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 4 | 4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 |
| 4 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 4 | 7 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 4 | 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 4 | 21 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 5 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 5 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 5 | 3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 5 | 4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 |
| 5 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 5 | 7 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 5 | 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 5 | 21 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 6 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 6 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 6 | 3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 6 | 4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 |
| 6 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 6 | 7 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 6 | 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 6 | 21 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 7 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 7 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 7 | 3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 7 | 4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 |
| 7 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 7 | 7 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 7 | 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 7 | 21 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 8 | 1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 8 | 2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.25 | 0.6 | 0.6 | 0.6 | 0.45 | 0.25 | 0.15 | 0.1 |
| 8 | 3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 8 | 4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 | 0.2 |
| 8 | 6 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 8 | 7 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 8 | 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 8 | 21 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

```
c-------------------------------------------------------------------------------------
c250 general quality constituent control
```

```
c
c    qualid  general quality id
c    qname   name of qual (must be a continuous string)
c    qunit   units for quality constituent output (mg/l) or (ug/l)
c    qsdfg   if = 2 sediment associated in pervious/impervious land
c    vpfwfg  if = 1 washoff potency factor may vary throughout the year (not yet
supported)
c    vpfsfg  if = 1 scour potency factor may vary throughout the year (not yet
supported)
c    qsofg   if = 1 then constituent is a QUALOF; assumed to be directly associated
with overland flow
c    ini.cond.   initial instream concentration at start of simulation by group
c    decay       general first-order instream loss rate of qual by group (1/day)
c
c   qualid  qname       qunit   qsdfg vpfwfg  vpfsfg  qsofg  ini.Cond. Decay
1     13    FECAL       (MPN) 0     0     0     0     1.000000    0.110000
2     13    FECAL       (MPN) 0     0     0     0     1.000000    0.110000
3     13    FECAL       (MPN) 0     0     0     0     1.000000    0.110000
4     13    FECAL       (MPN) 0     0     0     0     1.000000    0.110000
5     13    FECAL       (MPN) 0     0     0     0     1.000000    0.110000
6     13    FECAL       (MPN) 0     0     0     0     1.000000    0.110000
7     13    FECAL       (MPN) 0     0     0     0     1.000000    0.110000
8     13    FECAL       (MPN) 0     0     0     0     1.000000    0.110000
c-------------------------------------------------------------------------------
-------------------------
C255 subsurface quality control
c
c    (value of 0 = use constant qual-input; 1 = use corresponding monthly variable
card)
c
c    vqofg    if = 1 the accumulation rate and limiting storage of QUALOF varies
monthly   (cards 270, 280)
c    qifwfg   if = 1 the constituent is a QUALIF (interflow associated).
c    viqcfg   if = 1 the concentration of this constituent in interflow outflow
varies monthly   (card 290)= 1 read table 290
c    qagwfg   if = 1 the constituent is a QUALGW (groundwater associated).
c    vaqcfg   if = 1 the concentration of this constituent in groundwater outflow
varies monthly (card 300)
c    adfxfg   if = 1 atmosperic deposition
c
c     vqofg  qifwfg  viqcfg  qagwfg vaqcfg   adfxfg
1     1     0     1     0     0
c-------------------------------------------------------------------------------
-------------------------
C260  qual-input
c    storage on surface and nonseasonal parameters
c
c    gid     parameter group id
c    lid     landuse id
c    qualid  general quality id
c    sqo     initial storage of QUALOF on surface
c    potfw   washoff potency factor (when sediment associated qsdfg > 0, card 250)
c    potfs   scour potency pactor (when sediment associated qsdfg > 0, card 250)
c    acqop   accumulation rate of QUALOF on surface
c    sqolim  maximum storage of QUALOF on surface
c    wsqop   rate of surface runoff that removes 90% of stored QUALOF per hour
c    ioqc    concentration of constituent in interflow outflow
c    aoqc    concentration of constituent in groundwater outflow
```

C

| sqo | potfw | potfs | acqop | sqolim | wsqop | ioqc | aoqc | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| gid | lid | qualid | (lbs/ac) | (lbs/ton) | (lbs/ton) | (lbs/ac/day) | (lbs/ac) | (in/hr) | (mg/l) | (mg/l) |
| 1 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 2 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 3 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 4 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 6 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 7 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 8 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 21 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.3 | 300 | 300 | |
| 1 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 1.2 | 50 | 30 | |
| 2 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 1.2 | 50 | 30 | |
| 3 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 1.2 | 50 | 30 | |
| 4 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 1.2 | 50 | 30 | |
| 6 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 1.2 | 50 | 30 | |
| 7 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 1.2 | 50 | 30 | |
| 8 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 1.2 | 50 | 30 | |
| 21 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.5 | 50 | 30 | |
| 1 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 2 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 3 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 4 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 6 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 7 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 8 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 21 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.3 | 300 | 300 | |
| 1 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 500 | 800 | |
| 2 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 500 | 800 | |
| 3 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 500 | 800 | |
| 4 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 500 | 800 | |
| 6 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 500 | 800 | |
| 7 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 500 | 800 | |
| 8 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 500 | 800 | |
| 21 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.3 | 500 | 800 | |
| 1 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.8 | 300 | 300 | |
| 2 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.8 | 300 | 300 | |
| 3 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.8 | 300 | 300 | |
| 4 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.8 | 300 | 300 | |
| 6 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.8 | 300 | 300 | |
| 7 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.8 | 300 | 300 | |
| 8 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.8 | 300 | 30 | |
| 21 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.3 | 300 | 300 | |
| 1 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 2 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 3 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 4 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |
| 6 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 8 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 21 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.3 | 300 | 300 |
| 1 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 2 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 3 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 4 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 6 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 7 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 8 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 21 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.3 | 300 | 300 |
| 1 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 2 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 3 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 4 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 6 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 7 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 8 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.6 | 300 | 300 |
| 21 | 13 | 0.12 | 0.5 | 0.2 | 0 | 0 | 0.3 | 300 | 300 |

```
c270 mon-accumulation rate (monaccum)
c    only required if vqofg =1 (see card 255)
c
c    gid     parameter group id
c    lid     landuse id
c    qualid  general quality id
c    jan-dec accumulation rate at start of each month (lb/acre/day)
```

| c | gid | lid | qualid | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.E+00 | 1.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 1.E+00 | 2.E+00 | 1.E+01 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 |
| 1.E+00 | 3.E+00 | 1.E+01 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 |
| 1.E+00 | 4.E+00 | 1.E+01 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 |
| 1.E+00 | 6.E+00 | 1.E+01 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 |
| 1.E+00 | 7.E+00 | 1.E+01 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 |
| 1.E+00 | 8.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 1.E+00 | 2.E+01 | 1.E+01 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 |
| 2.E+00 | 1.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 2.E+00 | 2.E+00 | 1.E+01 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 |
| 2.E+00 | 3.E+00 | 1.E+01 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 |
| 2.E+00 | 4.E+00 | 1.E+01 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 |
| 2.E+00 | 6.E+00 | 1.E+01 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 |
| 2.E+00 | 7.E+00 | 1.E+01 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 | 1.E+08 |
| 2.E+00 | 8.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 2.E+00 | 2.E+01 | 1.E+01 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 |
| 3.E+00 | 1.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 3.E+00 | 2.E+00 | 1.E+01 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 |
| 3.E+00 | 3.E+00 | 1.E+01 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 |
| 3.E+00 | 4.E+00 | 1.E+01 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.E+00 | 6.E+00 | 1.E+01 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 |
| 3.E+00 | 7.E+00 | 1.E+01 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 |
| 3.E+00 | 8.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 3.E+00 | 2.E+01 | 1.E+01 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 |
| 4.E+00 | 1.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 4.E+00 | 2.E+00 | 1.E+01 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 |
| 4.E+00 | 3.E+00 | 1.E+01 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 | 5.E+08 |
| 4.E+00 | 4.E+00 | 1.E+01 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 | 8.E+05 |
| 4.E+00 | 6.E+00 | 1.E+01 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 |
| 4.E+00 | 7.E+00 | 1.E+01 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 |
| 4.E+00 | 8.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 4.E+00 | 2.E+01 | 1.E+01 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 | 6.E+09 |
| 5.E+00 | 1.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 5.E+00 | 2.E+00 | 1.E+01 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 | 1.E+06 |
| 5.E+00 | 3.E+00 | 1.E+01 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 |
| 5.E+00 | 4.E+00 | 1.E+01 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 | 3.E+05 |
| 5.E+00 | 6.E+00 | 1.E+01 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 | 7.E+09 |
| 5.E+00 | 7.E+00 | 1.E+01 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 | 8.E+07 |
| 5.E+00 | 8.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 5.E+00 | 2.E+01 | 1.E+01 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 | 2.E+09 |
| 6.E+00 | 1.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 6.E+00 | 2.E+00 | 1.E+01 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 | 3.E+06 |
| 6.E+00 | 3.E+00 | 1.E+01 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 | 4.E+08 |
| 6.E+00 | 4.E+00 | 1.E+01 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 | 6.E+05 |
| 6.E+00 | 6.E+00 | 1.E+01 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 |
| 6.E+00 | 7.E+00 | 1.E+01 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 |
| 6.E+00 | 8.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 6.E+00 | 2.E+01 | 1.E+01 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 |
| 7.E+00 | 1.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 7.E+00 | 2.E+00 | 1.E+01 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 | 2.E+06 |
| 7.E+00 | 3.E+00 | 1.E+01 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 | 6.E+08 |
| 7.E+00 | 4.E+00 | 1.E+01 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 | 4.E+05 |
| 7.E+00 | 6.E+00 | 1.E+01 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 | 4.E+10 |
| 7.E+00 | 7.E+00 | 1.E+01 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 |
| 7.E+00 | 8.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 7.E+00 | 2.E+01 | 1.E+01 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 | 9.E+09 |
| 8.E+00 | 1.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 8.E+00 | 2.E+00 | 1.E+01 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 | 9.E+05 |
| 8.E+00 | 3.E+00 | 1.E+01 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 | 3.E+08 |
| 8.E+00 | 4.E+00 | 1.E+01 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 | 2.E+05 |
| 8.E+00 | 6.E+00 | 1.E+01 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 | 2.E+10 |
| 8.E+00 | 7.E+00 | 1.E+01 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 | 2.E+08 |
| 8.E+00 | 8.E+00 | 1.E+01 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 | 0.E+00 |
| 8.E+00 | 2.E+01 | 1.E+01 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 | 5.E+09 |

```
c280 mon-storage limit of quality constituent (monsqolim)
c    only required if vqofg = 1 (see card 255)
c
c    gid     parameter group id
c    lid     landuse id
```

```
c     qualid  general quality id
c     jan-dec maximum storage at start of each month (lb/acre)
```

| c | gid | lid | qualid | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| | 1 | 2 | 13 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 |
| | 1 | 3 | 13 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 |
| | 1 | 4 | 13 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 |
| | 1 | 6 | 13 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 |
| | 1 | 7 | 13 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 |
| | 1 | 8 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| | 1 | 21 | 13 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 |
| | 2 | 1 | 13 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 |
| | 2 | 2 | 13 | 1E+07 | 1E+07 | 1E+07 | 1E+07 | 1E+07 | 1E+07 | 1E+07 | 1E+07 | 1E+07 | 1E+07 | 1E+07 | 1E+07 |
| | 2 | 3 | 13 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 |
| | 2 | 4 | 13 | 3E+06 | 3E+06 | 3E+06 | 3E+06 | 3E+06 | 3E+06 | 3E+06 | 3E+06 | 3E+06 | 3E+06 | 3E+06 | 3E+06 |
| | 2 | 6 | 13 | 8E+10 | 8E+10 | 8E+10 | 8E+10 | 8E+10 | 8E+10 | 8E+10 | 8E+10 | 8E+10 | 8E+10 | 8E+10 | 8E+10 |
| | 2 | 7 | 13 | 9E+08 | 9E+08 | 9E+08 | 9E+08 | 9E+08 | 9E+08 | 9E+08 | 9E+08 | 9E+08 | 9E+08 | 9E+08 | 9E+08 |
| | 2 | 8 | 13 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 |
| | 2 | 21 | 13 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 |
| | 3 | 1 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| | 3 | 2 | 13 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 |
| | 3 | 3 | 13 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 |
| | 3 | 4 | 13 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 |
| | 3 | 6 | 13 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 |
| | 3 | 7 | 13 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 |
| | 3 | 8 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| | 3 | 21 | 13 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 |
| | 4 | 1 | 13 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 |
| | 4 | 2 | 13 | 3E+07 | 3E+07 | 3E+07 | 3E+07 | 3E+07 | 3E+07 | 3E+07 | 3E+07 | 3E+07 | 3E+07 | 3E+07 | 3E+07 |
| | 4 | 3 | 13 | 4E+09 | 4E+09 | 4E+09 | 4E+09 | 4E+09 | 4E+09 | 4E+09 | 4E+09 | 4E+09 | 4E+09 | 4E+09 | 4E+09 |
| | 4 | 4 | 13 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 |
| | 4 | 6 | 13 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 |
| | 4 | 7 | 13 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 |
| | 4 | 8 | 13 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 | 1080 |
| | 4 | 21 | 13 | 5E+10 | 5E+10 | 5E+10 | 5E+10 | 5E+10 | 5E+10 | 5E+10 | 5E+10 | 5E+10 | 5E+10 | 5E+10 | 5E+10 |
| | 5 | 1 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| | 5 | 2 | 13 | 9E+06 | 9E+06 | 9E+06 | 9E+06 | 9E+06 | 9E+06 | 9E+06 | 9E+06 | 9E+06 | 9E+06 | 9E+06 | 9E+06 |
| | 5 | 3 | 13 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 |
| | 5 | 4 | 13 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 |
| | 5 | 6 | 13 | 7E+10 | 7E+10 | 7E+10 | 7E+10 | 7E+10 | 7E+10 | 7E+10 | 7E+10 | 7E+10 | 7E+10 | 7E+10 | 7E+10 |
| | 5 | 7 | 13 | 7E+08 | 7E+08 | 7E+08 | 7E+08 | 7E+08 | 7E+08 | 7E+08 | 7E+08 | 7E+08 | 7E+08 | 7E+08 | 7E+08 |
| | 5 | 8 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| | 5 | 21 | 13 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 | 2E+10 |
| | 6 | 1 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| | 6 | 2 | 13 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 |
| | 6 | 3 | 13 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 |
| | 6 | 4 | 13 | 6E+06 | 6E+06 | 6E+06 | 6E+06 | 6E+06 | 6E+06 | 6E+06 | 6E+06 | 6E+06 | 6E+06 | 6E+06 | 6E+06 |
| | 6 | 6 | 13 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 7 | 13 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 | 2E+09 |
| 6 | 8 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| 6 | 21 | 13 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 |
| 7 | 1 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| 7 | 2 | 13 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 | 2E+07 |
| 7 | 3 | 13 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 | 5E+09 |
| 7 | 4 | 13 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 | 4E+06 |
| 7 | 6 | 13 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 | 3E+11 |
| 7 | 7 | 13 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 |
| 7 | 8 | 13 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| 7 | 21 | 13 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 | 9E+10 |
| 8 | 1 | 13 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 |
| 8 | 2 | 13 | 8E+06 | 8E+06 | 8E+06 | 8E+06 | 8E+06 | 8E+06 | 8E+06 | 8E+06 | 8E+06 | 8E+06 | 8E+06 | 8E+06 |
| 8 | 3 | 13 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 | 3E+09 |
| 8 | 4 | 13 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 | 2E+06 |
| 8 | 6 | 13 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 | 2E+11 |
| 8 | 7 | 13 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 | 1E+09 |
| 8 | 8 | 13 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 | 450 |
| 8 | 21 | 13 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 | 4E+10 |

```
c290 mon-interflow concentration (moninterconc)
c    only required if viqcfg = 1 (see card 255)
c
c    gid     parameter group id
c    lid     landuse id
c    qualid  general quality id
c    jan-dec concentration of constituent in interflow at start of each month
(mg/l)
c
c  gid lid qualid  jan   feb   mar   apr   may   jun   jul   aug   sep   oct   nov
dec
c-------------------------------------------------------------------------------------
-----
c300 mon-groundwater concentration (mongrndconc)
c    only required if vaqcfg = 1 (see card 255)
c
c    gid     parameter group id
c    lid     landuse id
c    qualid  general quality id
c    jan-dec concentration of constituent in groundwater at start of each month
(mg/l)
c
c  gid lid qualid  jan   feb   mar   apr   may   jun   jul   aug   sep   oct   nov
dec
c-------------------------------------------------------------------------------------
----------
c400 general channel information
c
c    nch     number of stream channels (corresponds with number of subwatersheds)
c    npt     number of point sources (if > 0 then read card 430, constant point
source)
c    af      transport scheme weighting factor for flow
c    ks      transport scheme weighting factor for pollutants
c
```

```
c nch    npt    af    ks
26    0     0.000000    0.500000
c-----------------------------------------------------------------------------------
----------
c410 reach geometry information
c
c    rid     reach id (relational db index number)
c    rname   reach name (same as subwatershed name)
c    length  reach length (miles)
c    depth   bank full depth (feet)
c    width   bankfull width (feet)
c    slope   longitudinal channel slope
c    Mann    Manning's roughness coefficient for channel bottom
c    r1      ratio of bottom width to bank full width (bottom width = r1 * width)
c    r2      side slope of flood plane
c    w1      flood plane width factor (width of flood plane =w1*Width)
```

| c | rid | rname | length | depth | width | slope | mann | r1 | r2 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 30201 | 1.5 | 5.5362 | 58.125 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 2 | 30202 | 1.5 | 3.5625 | 32.276 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 3 | 30203 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 4 | 30204 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 5 | 30205 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 6 | 30206 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 7 | 30207 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 8 | 30208 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 9 | 30209 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 10 | 30210 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 11 | 30211 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 12 | 30212 | 1.5 | 4.9342 | 49.862 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 13 | 30213 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 14 | 30214 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 15 | 30215 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 16 | 30216 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 17 | 30217 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 18 | 30218 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 19 | 30219 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 20 | 30220 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 21 | 30221 | 1.5 | 4.9342 | 49.862 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 22 | 30222 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 23 | 30223 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 24 | 30224 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 25 | 30225 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |
| 26 | 30226 | 1.5 | 6.5789 | 49.342 | 0.0001 | 0.02 | 0.2 | 0.5 | 1 |

```
c-------------------------------------------------------------------------------------
c420 channel routing network
c
c    rid     reach id (relational db index number)
c    rname   reach name (same as subwatershed name)
c    uright  upstream right channel
c    uleft   upstream left channel
c    down    downstream channel
```

```
c    control output control switch for the corresponding rid
c            0 = will not write general output
c            1 = will write general output
c            4 = will write four-day running averge output
c
```

| c rid | rname | uright | uleft | down | |
|---|---|---|---|---|---|
| 1 | 30201 | 0 | 0 | 0 | 1 |
| 2 | 30202 | 0 | 0 | 0 | 1 |
| 3 | 30203 | 0 | 0 | 0 | 1 |
| 4 | 30204 | 0 | 0 | 0 | 1 |
| 5 | 30205 | 0 | 0 | 0 | 1 |
| 6 | 30206 | 0 | 0 | 0 | 1 |
| 7 | 30207 | 0 | 0 | 0 | 1 |
| 8 | 30208 | 0 | 0 | 0 | 1 |
| 9 | 30209 | 0 | 0 | 0 | 1 |
| 10 | 30210 | 0 | 0 | 0 | 1 |
| 11 | 30211 | 0 | 0 | 0 | 1 |
| 12 | 30212 | 0 | 0 | 0 | 1 |
| 13 | 30213 | 0 | 0 | 0 | 1 |
| 14 | 30214 | 0 | 0 | 0 | 1 |
| 15 | 30215 | 0 | 0 | 0 | 1 |
| 16 | 30216 | 0 | 0 | 0 | 1 |
| 17 | 30217 | 0 | 0 | 0 | 1 |
| 18 | 30218 | 0 | 0 | 0 | 1 |
| 19 | 30219 | 0 | 0 | 0 | 1 |
| 20 | 30220 | 0 | 0 | 0 | 1 |
| 21 | 30221 | 0 | 0 | 0 | 1 |
| 22 | 30222 | 0 | 0 | 0 | 1 |
| 23 | 30223 | 0 | 0 | 0 | 1 |
| 24 | 30224 | 0 | 0 | 0 | 1 |
| 25 | 30225 | 0 | 0 | 0 | 1 |
| 26 | 30226 | 0 | 0 | 0 | 1 |

c---------------------------------------------------------------------------------------------

```
c-----------------------------------------------------------------------------------
----------
c430 constant point source (lb/hour)
c    rid      reach id (relational db index number)
c    rname    reach name (same as subwatershed name)
c    ptmfg    time series flag > 0 indicates location of data in file point.inp
c    flow     constant flow in cfs
c    for each modeled general quality constituent (currently supports up to 10)
c           CONn is the constant loading of constituent n in lb/hr
c
c rid  rname  ptmfg  flow   CON1  CON2   CON3  CON4   CON5  CON6    CON7   CON8
CON9  CON10
c-----------------------------------------------------------------------------------
----------
c450 sediment parameter group 1      (read if sedfg =1)
c
c    gid     parameter group id
```

```
c    lid     landuse id
c    krer    coefficient in the soil detachment equation
c    jrer    exponent in the soil detachment equation
c    affox   fraction by which detached sediment storage decreases each day as a
result of
c            soil compaction.
c    cover   fraction of land surface which is shielded from rainfall erosion
c    nvsi    rate at which sediment enters detached storage from the atmosphere
c            negative value may be used to simulate removal by human activity or
wind
c    kser    coefficient in the detached sediment washoff equation
c    jser    exponent in the detached sediment washoff equation
c    kger    coefficient in the matrix soil scour equation, which simulates gully
erosion
c    jger    exponent in the matrix soil scour equation, which simulates gully
erosion
c    accsdp  rate at which solids accumulate on the land surface (used in
impervious land)
c    remsdp  fraction of solids storage which is removed each day when there is no
runoff,
c            for example, because of street sweeping (used in impervious land)
c
c  gid  lid  krer   jrer  affix  cover    nvsi  kser   jser  kger  jger   accsdp
remsdp
c-----------------------------------------------------------------------------------
----------
c451 sediment parameter group 2    (read if sedfg =1)
c
c    gid     parameter group id
c    lid     landuse id
c    clay    percent of clay
c    silt    percent of silt
c    sand    percent of sand
c            clay + silt + sand = 1
c
c gid  lid    clay    silt    sand
c-----------------------------------------------------------------------------------
----------
c460 Soil Temerature   (read if tempfg =1)
c
c    gid     parameter group id
c    lid     landuse id
c    aslt    surface layer temperature when the air temperature 0 degrees C
c            (it is the intercept of the surface layer temperature regression
equation)
c    bslt    slope of the surface layer temperature regression equation
c    ultp1   smoothing factor in the upper layer temperature calculation
c    ultp2   mean difference between upper layer soil temperature and air
temperature
c    lgtp1   smoothing factor from the upper layer soil temperature for calculating
c           lower layer/groundwater soil temperature
c    lgtp2   mean departure from the upper layer soil temperature for calculating
c           lower layer/groundwater soil temperature
c    asmo    if = 1 using smoothing method for upper and lower layers
c            if = 0 use regression mathod (ultp1 * ultp2 = intercept of regression
equation)
c
c gid  lid   aslt     bslt     ultp1     ultp2     lgtp1     lgtp2   asmo
```

```
c-------------------------------------------------------------------------------------
----------
c470 Temerature    (read if tempfg =1)
c
c    rid     reach id (relational db index number)
c    rname   reach name (same as subwatershed name)
c    elev    the mean RCHRES elevation
c    eldat   difference in elevation between the RCHRES and the air temperature
gage
c            (positive if RCHRES is higher than the gage).
c    cfsaex  correction factor for solar radiation; fraction of RCHRES surface
exposed to radiation
c    katrad  longwave radiation coefficient
c    kcond   conduction-convection heat transport coefficient
c    kevap   evaporation coefficient
c
c rid  rname    elev     eldat     cfsaex    katrad     kcond     kevap
c-------------------------------------------------------------------------------------
----------
c480 pH-gas control   (read if phfg =1)
c
c    midofg  if = 1 monthly very DO concentration in interflow
c    mico2fg if = 1 monthly very CO2 concentration in interflow
c    mgdofg  if = 1 monthly very DO concentration in ground water
c    mgco2fg if = 1 monthly very CO2 concentration in ground water
c
c    midofg     mico2fg      mgdofg      mgco2fg
c-------------------------------------------------------------------------------------
----------
c490   DO-CO2 Control constant values (read if dofg =1)
c
c    idoxp   concentration of dissolved oxygen in interflow outflow (mg/l)
c    ico2p   concentration of dissolved CO2 in interflow outflow (mg/l)
c    adoxp   concentration of dissolved oxygen in active groundwater outflow (mg/l)
c    aco2p   concentration of dissolved CO2 in active groundwater outflow (mg/l)
c
c   gid  lid   idoxp    ico2p     adoxp    aco2xp
c-------------------------------------------------------------------------------------
----------
c500 mon-DO (interflow)  mg C/l
c    only required if dofg = 1 and midofg = 1 (see card 480)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec interflow dissolved oxygen concentration at start of each month (mg/l)
c
c  gid  lid   jan   feb   mar   apr   may   jun   jul   aug   sep   oct   nov   dec
c-------------------------------------------------------------------------------------
--
c510 mon-DO (groundwater)
c    only required if dofg = 1 and mgdofg = 1 (see card 480)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec groundwater dissolved oxygen concentration at start of each month
(mg/l)
c
c  gid  lid   jan   feb   mar   apr   may   jun   jul   aug   sep   oct   nov   dec
```

```
c------------------------------------------------------------------------------------
--
c520 mon-CO2 (interflow)  mg C/l
c    only required if dofg = 1 and mico2fg = 1 (see card 480)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec interflow carbon dioxide concentration at start of each month (mg/l)
c
c  gid  lid   jan   feb   mar   apr   may   jun   jul   aug   sep   oct   nov   dec
c------------------------------------------------------------------------------------
----------
c530 mon-CO2 (groundwater)
c    only required if dofg = 1 and mico2fg = 1 (see card 480)
c
c    gid     parameter group id
c    lid     landuse id
c    jan-dec groundwater carbon dioxide concentration at start of each month (mg/l)
c
c  gid  lid   jan   feb   mar   apr   may   jun   jul   aug   sep   oct   nov   dec
c------------------------------------------------------------------------------------
----------
c540 clay  parameters group 1
c    cohesive suspended sediment source/sink parameters repeat data line
c    for each size class  one line of data required even if istran(7)=0
c
c    gid      parameter group id
c    sedo     initial sediment conc in fluid phase (mg/liter=gm/m^3)
c    sedbo    initial sediment per unit area or bottom surface (gm/sq meter)
c    poro     porosity
c    wsedo    constant or reference sediment settling velocity
c             in formula wsed=wsedo*( (sed/sedsn)^sexp )
c    sedn     normalizing sediment conc (cohesive sed transport) (gm/m^3)
c    sexp     exponential (cohesive sed transport)
c    taud     boundary stress below which deposition takes place according
c             to (taud-tau)/taud (m^2/s^2)
c    wrspo    ref resuspension rate (cohesive sed trans only) in formula
c             wrsp=wrsp0*( ((tau-taur)/taun)^tex ) (gm/m^2-sec)
c    taur     boundary stress above which resuspension occurs (m^2/s^2)
c    taun     normalizing stress (equal to taur for cohesive sed trans)
c    tex      exponential (coh sed)
c
c      20.0  1.E4  0.6  1.E-4  1.0   0.   2.E-3  0.005  1.E-3   1.E-3  1.
c
```

c

| c | gid | sedo | sedbo | poro | wsedo | sedn | sexp | taud | wrspo | taur | taun | tex |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 20 | 1 | 0.6 | 0.00005 | 50 | 1 | 0.0001 | 0.002 | 0.001 | 0.004 | 1 |
| | 2 | 20 | 1 | 0.6 | 0.00005 | 50 | 1 | 0.0001 | 0.002 | 0.001 | 0.004 | 1 |
| | 3 | 20 | 1 | 0.6 | 0.00005 | 50 | 1 | 0.0001 | 0.002 | 0.001 | 0.004 | 1 |
| | 4 | 20 | 1 | 0.6 | 0.00005 | 50 | 1 | 0.0001 | 0.002 | 0.001 | 0.004 | 1 |
| | 5 | 20 | 1 | 0.6 | 0.00005 | 50 | 1 | 0.0001 | 0.002 | 0.001 | 0.004 | 1 |
| | 6 | 20 | 1 | 0.6 | 0.00005 | 50 | 1 | 0.0001 | 0.002 | 0.001 | 0.004 | 1 |
| | 7 | 20 | 1 | 0.6 | 0.00005 | 50 | 1 | 0.0001 | 0.002 | 0.001 | 0.004 | 1 |
| | 8 | 20 | 1 | 0.6 | 0.00005 | 50 | 1 | 0.0001 | 0.002 | 0.001 | 0.004 | 1 |

c------------------------------------------------------------------------------------------

c550 silt parameters group 1

```
c       (see     c540        for        variable     definitions)
c
c       gid      sedo        sedbo   poro        wsedo  sedn     sexp    taud     wrspo   taur     taun     tex
      1      20           1       0.6      0.0005       1       0   0.001   0.002   0.002   0.004       1
      2      20           1       0.6      0.0005       1       0   0.001   0.002   0.002   0.004       1
      3      20           1       0.6      0.0005       1       0   0.001   0.002   0.002   0.004       1
      4      20           1       0.6      0.0005       1       0   0.001   0.002   0.002   0.004       1
      5      20           1       0.6      0.0005       1       0   0.001   0.002   0.002   0.004       1
      6      20           1       0.6      0.0005       1       0   0.001   0.002   0.002   0.004       1
      7      20           1       0.6      0.0005       1       0   0.001   0.002   0.002   0.004       1
      8      20           1       0.6      0.0005       1       0   0.001   0.002   0.002   0.004       1
c-----------------------------------------------------------------------------------------
c600 clay parameters group 2
c    toxic   contaminant sediment interaction parameters
c
c    qualid  general quality id
c    qname   name of qual (must be a continuous string)
c    toxparw: water column part coeff between
c             each toxic in water and associated sediment phases (liters/mg)
c    toxparb: sediment bed tox con part coeff between
c             each toxic in water and associated sediment phases (liters/mg)
c    toxintw:   init water colunm tot toxic variable concentration (ugm/litr)
c    toxintb:   init sed bed toxic conc  (ugm/litr)
c    toxres:    sediment resupension (m/yr) (only used in simple model)
c    toxdep:    particulate setting velocity (m/day)
c               (only used in simple model)
c    toxdiff:     difusion coeff between water and bed (m/yr).
c    toxvol:    bulk volitization

c       qualid  qname      toxparw  toxparb     toxintw toxintb  toxres   toxdep  toxdiff   toxvol
      1 FECAL       0.0002   0.0002       0.005      0.1    0.002     0.02       0       0
c-----------------------------------------------------------------------------------------
c610    silt     parameters group            2
c       (see     c600        for        variable     definitions)
c
c       qualid  qname      toxparw  toxparb     toxintw toxintb  toxres   toxdep  toxdiff   toxvol
      1 FECAL       0.0002   0.0002           0      0.1    0.002     0.02       0       0
c-----------------------------------------------------------------------------------------
c620 TMDL general settings
c
c    ncsws   number of watershed control locations
c    ncpoint number of point source control locations
c
c    ncsws  ncpoint
26    0
c---------------------------------------------------------------------------------------
----------
c630 TMDL pollutant specific control
c    sws            subwatershed name
c    qualid         general quality id
c    qname          name of qual (must be a continuous string)
c    reduction(%)  percent reduction of pollutant from sources, based on cards 640
and/or 650
```

```
c    threshold     water quality standard for calculating modeled exceedences (mg/l
or ug/l)
c
c   sws   qualid      qname   Reduction(%)      threshold
1     1            FECAL      0.000000    0.000000
c--------------------------------------------------------------------------------
----------
c640 TMDL watershed control specification
c
c    rid         reach id (relational db index number)
c    rname       reach name (same as subwatershed name)
c    bwatershed  if = 1 then reduce loads according to wfact and card 630
c    blanduse    if = 1 then reduce loads according to cards 630 and 650
c                if = 2 then use distributed controls card 670
c    bppt        if = 1 then use point source controls (card 660)
c    wfact       watershed weighting factor for performing reductions if bwatershed
= 1
c
c rid  rname  bwatershed  blanduse  bppt  wfact
1               30213   0     2     0     1.000000
2               30215   0     2     0     1.000000
3               30218   0     2     0     1.000000
4               30217   0     2     0     1.000000
5               30219   0     2     0     1.000000
6               30226   0     2     0     1.000000
7               30225   0     2     0     1.000000
8               30220   0     2     0     1.000000
9               30216   0     2     0     1.000000
10              30210   0     2     0     1.000000
11              30211   0     2     0     1.000000
12              30209   0     2     0     1.000000
13              30208   0     2     0     1.000000
14              30207   0     2     0     1.000000
15              30204   0     2     0     1.000000
16              30203   0     2     0     1.000000
17              30214   0     2     0     1.000000
18              30212   0     2     0     1.000000
19              30202   0     2     0     1.000000
20              30206   0     2     0     1.000000
21              30205   0     2     0     1.000000
22              30201   0     2     0     1.000000
23              30223   0     2     0     1.000000
24              30224   0     2     0     1.000000
25              30221   0     2     0     1.000000
26              30222   0     2     0     1.000000
c--------------------------------------------------------------------------------
----------
c650 TMDL landuse-based control
c
c    sws       subwatershed name
c    luid      landuse id
c    pluname   landuse name
c    control   if = 0 then no reduction of quality constituent from corresponding
land
c              if = 1 then apply reductions of quality constituent based on card
630
c    ratio     may be used with card 630 to reduce one land more than another
c              (only applies to lands where control = 1)
```

```
c
c sws  luid   pluname      control  ratio
1     1            Barren   0     1.000000
1     2          Cropland   0     1.000000
1     3            Forest   0     1.000000
1     4           Pasture   0     1.000000
1     6      UrbanPervious   0     1.000000
1     7          Wetlands   0     1.000000
1     8             Other   0     1.000000
1     21    UrbanImpervious   0     1.000000
c-------------------------------------------------------------------------------------------
c660 TMDL point sources control
c
c    rid            reach id (relational db index number)
c    rname          reach name (same as subwatershed name)
c    FCONL          flow control factor (fraction multiplier)
c    LFAC1-LFAC10  load control factors for each quality constituent (fraction
multipliers)
c
c rid rname   FCONL  LFAC1   LFAC2  LFAC3 LFAC4  LFAC5 LFAC6  LFAC7  LFAC8  LFAC9
LFAC10
c-------------------------------------------------------------------------------------------
c670 TMDL fully distributed controls (used if blanduse = 2 on card 640)
c
c    sws            subwatershed id
c    pluname        land use name
c    pname          pollutant name
c    reduction(%)  percent reduction of pollutant from corresponding landuse and
subwatershed
c
c sws  pluname   pname    reduction(%)
30201 Barren      FECAL    0.00
30201 Cropland    FECAL    0.00
30201 Forest      FECAL    0.00
30201 Pasture     FECAL    0.00
30201 UrbanPervious     FECAL    0.00
30201 Wetlands    FECAL    0.00
30201 Other FECAL    0.00
30201 UrbanImp    FECAL    0.00
30202 Barren      FECAL    0.00
30202 Cropland    FECAL    0.00
30202 Forest      FECAL    0.00
30202 Pasture     FECAL    0.00
30202 UrbanPervious     FECAL    0.00
30202 Wetlands    FECAL    0.00
30202 Other FECAL    0.00
30202 UrbanImp    FECAL    0.00
30203 Barren      FECAL    0.00
30203 Cropland    FECAL    0.00
30203 Forest      FECAL    0.00
30203 Pasture     FECAL    0.00
30203 UrbanPervious     FECAL    0.00
30203 Wetlands    FECAL    0.00
30203 Other FECAL    0.00
30203 UrbanImp    FECAL    0.00
30204 Barren      FECAL    0.00
```

```
30204 Cropland    FECAL    0.00
30204 Forest      FECAL    0.00
30204 Pasture     FECAL    0.00
30204 UrbanPervious     FECAL    0.00
30204 Wetlands    FECAL    0.00
30204 Other FECAL    0.00
30204 UrbanImp    FECAL    0.00
30205 Barren      FECAL    0.00
30205 Cropland    FECAL    0.00
30205 Forest      FECAL    0.00
30205 Pasture     FECAL    0.00
30205 UrbanPervious     FECAL    0.00
30205 Wetlands    FECAL    0.00
30205 Other FECAL    0.00
30205 UrbanImp    FECAL    0.00
30206 Barren      FECAL    0.00
30206 Cropland    FECAL    0.00
30206 Forest      FECAL    0.00
30206 Pasture     FECAL    0.00
30206 UrbanPervious     FECAL    0.00
30206 Wetlands    FECAL    0.00
30206 Other FECAL    0.00
30206 UrbanImp    FECAL    0.00
30207 Barren      FECAL    0.00
30207 Cropland    FECAL    0.00
30207 Forest      FECAL    0.00
30207 Pasture     FECAL    0.00
30207 UrbanPervious     FECAL    0.00
30207 Wetlands    FECAL    0.00
30207 Other FECAL    0.00
30207 UrbanImp    FECAL    0.00
30208 Barren      FECAL    0.00
30208 Cropland    FECAL    0.00
30208 Forest      FECAL    0.00
30208 Pasture     FECAL    0.00
30208 UrbanPervious     FECAL    0.00
30208 Wetlands    FECAL    0.00
30208 Other FECAL    0.00
30208 UrbanImp    FECAL    0.00
30209 Barren      FECAL    0.00
30209 Cropland    FECAL    0.00
30209 Forest      FECAL    0.00
30209 Pasture     FECAL    0.00
30209 UrbanPervious     FECAL    0.00
30209 Wetlands    FECAL    0.00
30209 Other FECAL    0.00
30209 UrbanImp    FECAL    0.00
30210 Barren      FECAL    0.00
30210 Cropland    FECAL    0.00
30210 Forest      FECAL    0.00
30210 Pasture     FECAL    0.00
30210 UrbanPervious     FECAL    0.00
30210 Wetlands    FECAL    0.00
30210 Other FECAL    0.00
30210 UrbanImp    FECAL    0.00
30211 Barren      FECAL    0.00
30211 Cropland    FECAL    0.00
30211 Forest      FECAL    0.00
```

```
30211 Pasture     FECAL    0.00
30211 UrbanPervious     FECAL    0.00
30211 Wetlands    FECAL    0.00
30211 Other FECAL    0.00
30211 UrbanImp    FECAL    0.00
30212 Barren      FECAL    0.00
30212 Cropland    FECAL    0.00
30212 Forest      FECAL    0.00
30212 Pasture     FECAL    0.00
30212 UrbanPervious     FECAL    0.00
30212 Wetlands    FECAL    0.00
30212 Other FECAL    0.00
30212 UrbanImp    FECAL    0.00
30213 Barren      FECAL    0.00
30213 Cropland    FECAL    0.00
30213 Forest      FECAL    0.00
30213 Pasture     FECAL    0.00
30213 UrbanPervious     FECAL    0.00
30213 Wetlands    FECAL    0.00
30213 Other FECAL    0.00
30213 UrbanImp    FECAL    0.00
30214 Barren      FECAL    0.00
30214 Cropland    FECAL    0.00
30214 Forest      FECAL    0.00
30214 Pasture     FECAL    0.00
30214 UrbanPervious     FECAL    0.00
30214 Wetlands    FECAL    0.00
30214 Other FECAL    0.00
30214 UrbanImp    FECAL    0.00
30215 Barren      FECAL    0.00
30215 Cropland    FECAL    0.00
30215 Forest      FECAL    0.00
30215 Pasture     FECAL    0.00
30215 UrbanPervious     FECAL    0.00
30215 Wetlands    FECAL    0.00
30215 Other FECAL    0.00
30215 UrbanImp    FECAL    0.00
30216 Barren      FECAL    0.00
30216 Cropland    FECAL    0.00
30216 Forest      FECAL    0.00
30216 Pasture     FECAL    0.00
30216 UrbanPervious     FECAL    0.00
30216 Wetlands    FECAL    0.00
30216 Other FECAL    0.00
30216 UrbanImp    FECAL    0.00
30217 Barren      FECAL    0.00
30217 Cropland    FECAL    0.00
30217 Forest      FECAL    0.00
30217 Pasture     FECAL    0.00
30217 UrbanPervious     FECAL    0.00
30217 Wetlands    FECAL    0.00
30217 Other FECAL    0.00
30217 UrbanImp    FECAL    0.00
30218 Barren      FECAL    0.00
30218 Cropland    FECAL    0.00
30218 Forest      FECAL    0.00
30218 Pasture     FECAL    0.00
30218 UrbanPervious     FECAL    0.00
```

```
30218 Wetlands    FECAL    0.00
30218 Other FECAL    0.00
30218 UrbanImp    FECAL    0.00
30219 Barren      FECAL    0.00
30219 Cropland    FECAL    0.00
30219 Forest      FECAL    0.00
30219 Pasture     FECAL    0.00
30219 UrbanPervious     FECAL    0.00
30219 Wetlands    FECAL    0.00
30219 Other FECAL    0.00
30219 UrbanImp    FECAL    0.00
30220 Barren      FECAL    0.00
30220 Cropland    FECAL    0.00
30220 Forest      FECAL    0.00
30220 Pasture     FECAL    0.00
30220 UrbanPervious     FECAL    0.00
30220 Wetlands    FECAL    0.00
30220 Other FECAL    0.00
30220 UrbanImp    FECAL    0.00
30221 Barren      FECAL    0.00
30221 Cropland    FECAL    0.00
30221 Forest      FECAL    0.00
30221 Pasture     FECAL    0.00
30221 UrbanPervious     FECAL    0.00
30221 Wetlands    FECAL    0.00
30221 Other FECAL    0.00
30221 UrbanImp    FECAL    0.00
30222 Barren      FECAL    0.00
30222 Cropland    FECAL    0.00
30222 Forest      FECAL    0.00
30222 Pasture     FECAL    0.00
30222 UrbanPervious     FECAL    0.00
30222 Wetlands    FECAL    0.00
30222 Other FECAL    0.00
30222 UrbanImp    FECAL    0.00
30223 Barren      FECAL    0.00
30223 Cropland    FECAL    0.00
30223 Forest      FECAL    0.00
30223 Pasture     FECAL    0.00
30223 UrbanPervious     FECAL    0.00
30223 Wetlands    FECAL    0.00
30223 Other FECAL    0.00
30223 UrbanImp    FECAL    0.00
30224 Barren      FECAL    0.00
30224 Cropland    FECAL    0.00
30224 Forest      FECAL    0.00
30224 Pasture     FECAL    0.00
30224 UrbanPervious     FECAL    0.00
30224 Wetlands    FECAL    0.00
30224 Other FECAL    0.00
30224 UrbanImp    FECAL    0.00
30225 Barren      FECAL    0.00
30225 Cropland    FECAL    0.00
30225 Forest      FECAL    0.00
30225 Pasture     FECAL    0.00
30225 UrbanPervious     FECAL    0.00
30225 Wetlands    FECAL    0.00
30225 Other FECAL    0.00
```

```
30225 UrbanImp    FECAL    0.00
30226 Barren      FECAL    0.00
30226 Cropland    FECAL    0.00
30226 Forest      FECAL    0.00
30226 Pasture     FECAL    0.00
30226 UrbanPervious     FECAL    0.00
30226 Wetlands    FECAL    0.00
30226 Other FECAL    0.00
30226 UrbanImp    FECAL    0.00
c-------------------------------------------------------------------------------------------
c800 Tidal Prism Model Link File
c  TPCELL = number of tidal prism model segment
31
c-------------------------------------------------------------------------------------------
c801 Tidal Prism Model Link File
c TPCELL =tidal prism model segment
c Npt = number of watershed output files
c S1-S5 = sub-watershed name
c T1-T5 = sub-watershed type (0= output from land; 1= from reach
c DIS   = Distance from mouth (km)
c VH =high tidal volume *1e-6
c P  =tidal prism volume *1e-6
c R  =return ratio
c HA =mean depth (m)
c PT =point source (cfs)
c TPload point source loads (count/hr)
```

| ID | TPCELL | Area | Npt | S1 | S2 | S3 | S4 | S5 | T1 | T2 | T3 | T4 | T5 | DIS | VH | P | R | HA | PT | Ptload (#/hr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | M0_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.913 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 50 | M0_2 | JarretBay | 1 | 30225 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.56 | 7.915 | 5.151 | 0.3 | 0.94 | 0.E+00 | 0.E+00 |
| 51 | M0_3 | JarretBay | 2 | 30220 | 30222 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.26 | 5.151 | 2.911 | 0.3 | 0.71 | 0.E+00 | 0.E+00 |
| 52 | M0_4 | JarretBay | 2 | 30215 | 30216 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.74 | 2.912 | 1.319 | 0.3 | 0.58 | 0.E+00 | 0.E+00 |
| 53 | M0_5 | JarretBay | 2 | 30205 | 30208 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.115 | 1.377 | 0.556 | 0.3 | 0.51 | 0.E+00 | 0.E+00 |
| 54 | M0_6 | JarretBay | 1 | 30204 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.66 | 0.619 | 0.254 | 0.3 | 0.52 | 0.E+00 | 0.E+00 |
| 55 | M0_7 | JarretBay | 2 | 30202 | 30203 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 8.145 | 0.254 | 0.115 | 0.3 | 0.4 | 0.E+00 | 0.E+00 |
| 56 | M0_8 | JarretBay | 1 | 30201 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 9 | 0.157 | 0 | 0.3 | 0.18 | 0.E+00 | 0.E+00 |
| 58 | B2_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.049 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 59 | B2_2 | JarretBay | 1 | 30226 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.55 | 0.058 | 0 | 0.3 | 0.08 | 0.E+00 | 0.E+00 |
| 60 | T2_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.07 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 61 | T2_2 | JarretBay | 1 | 30224 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.74 | 0.08 | 0 | 0.3 | 0.06 | 0.E+00 | 0.E+00 |
| 62 | B3_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.274 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 63 | B3_2 | JarretBay | 2 | 30222 | 30223 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.564 | 0.274 | 0.126 | 0.4 | 0.41 | 0.E+00 | 0.E+00 |
| 64 | B3_3 | JarretBay | 2 | 30222 | 30223 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.074 | 0.126 | 0.044 | 0.4 | 0.26 | 0.E+00 | 0.E+00 |
| 65 | B3_4 | JarretBay | 1 | 30221 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1.445 | 0.054 | 0 | 0.2 | 0.11 | 0.E+00 | 0.E+00 |
| 66 | B4_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.244 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 67 | B4_2 | JarretBay | 2 | 30218 | 30219 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.806 | 0.244 | 0.094 | 0.3 | 0.3 | 0.E+00 | 0.E+00 |
| 68 | B4_3 | JarretBay | 1 | 30217 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.581 | 0.11 | 0 | 0.3 | 0.09 | 0.E+00 | 0.E+00 |
| 69 | T4_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.141 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 70 | T4_2 | JarretBay | 2 | 30213 | 30214 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.47 | 0.141 | 0.057 | 0.3 | 0.33 | 0.E+00 | 0.E+00 |
| 71 | T4_3 | JarretBay | 1 | 30212 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1.47 | 0.069 | 0 | 0.3 | 0.1 | 0.E+00 | 0.E+00 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 72 | B5_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.125 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 73 | B5_2 | JarretBay | 2 | 30210 | 30211 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.474 | 0.125 | 0.035 | 0.3 | 0.19 | 0.E+00 | 0.E+00 |
| 74 | B5_3 | JarretBay | 1 | 30209 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.916 | 0.037 | 0 | 0.3 | 0.02 | 0.E+00 | 0.E+00 |
| 75 | T5_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.058 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 76 | T5_2 | JarretBay | 1 | 30206 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.083 | 0.066 | 0 | 0.3 | 0.07 | 0.E+00 | 0.E+00 |
| 77 | B6_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.068 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 78 | B6_2 | JarretBay | 1 | 30207 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.45 | 0.077 | 0 | 0.3 | 0.07 | 0.E+00 | 0.E+00 |
| 79 | T6_1 | JarretBay | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.061 | 0.3 | 0 | 0.E+00 | 0.E+00 |
| 80 | T6_2 | JarretBay | 1 | 30205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.083 | 0.089 | 0 | 0.3 | 0.22 | 0.E+00 | 0.E+00 |