# *FINAL*

Total Maximum Daily Loads (TMDLs)

for Metals (Zinc), pH and Siltation in the
Village Creek Watershed

Village Creek AL/03160111-140_02

Alabama Department of Environmental Management
Water Quality Branch
Water Division

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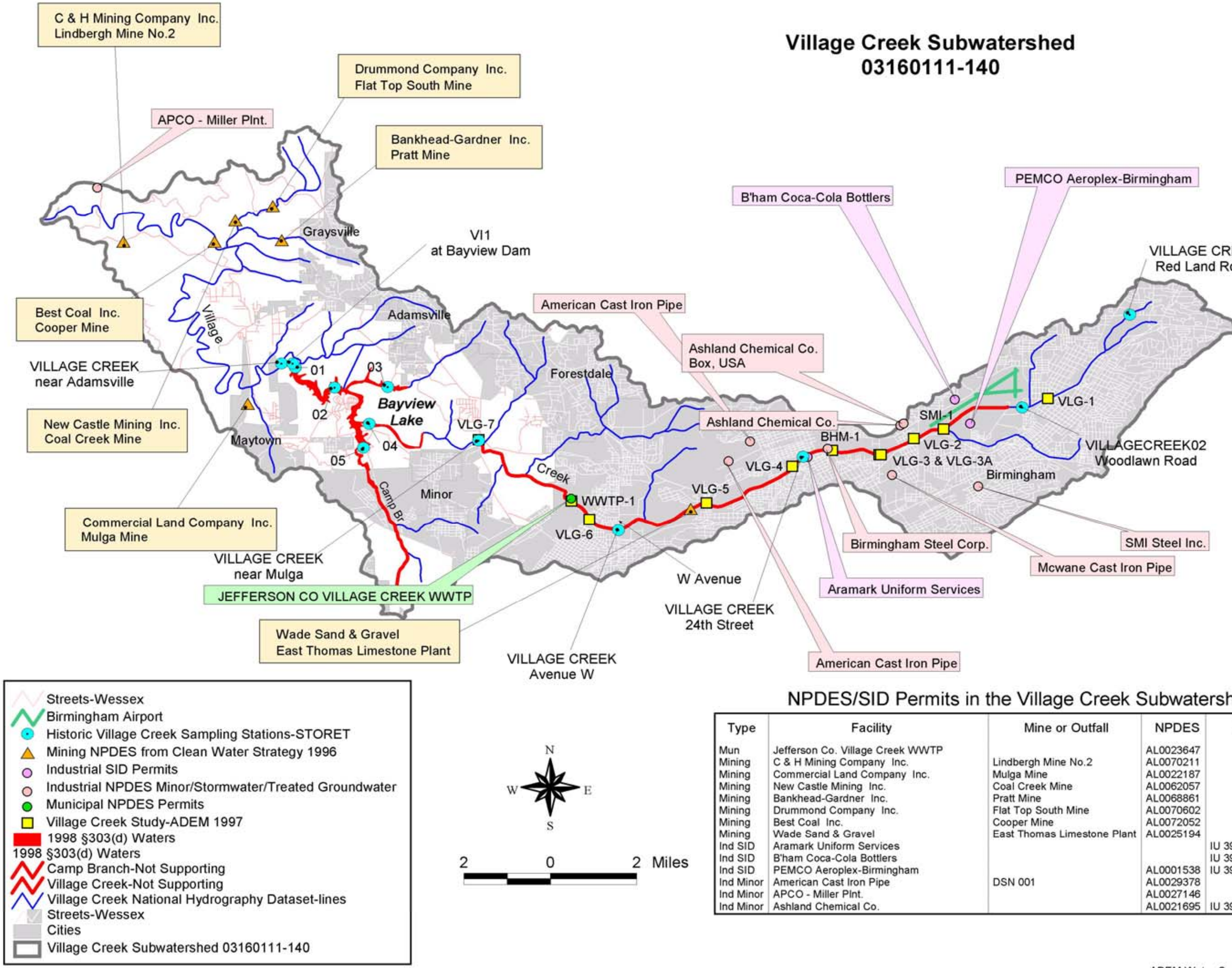


## NPDES/SID Permits in the Village Creek Subwatershed

| Type | Facility | Mine or Outfall | NPDES | SID |
|---|---|---|---|---|
| Mun | Jefferson Co. Village Creek WWTP | | AL0023647 | |
| Mining | C & H Mining Company Inc. | Lindbergh Mine No.2 | AL0070211 | |
| Mining | Commercial Land Company Inc. | Mulga Mine | AL0022187 | |
| Mining | New Castle Mining Inc. | Coal Creek Mine | AL0062057 | |
| Mining | Bankhead-Gardner Inc. | Pratt Mine | AL0068861 | |
| Mining | Drummond Company Inc. | Flat Top South Mine | AL0070602 | |
| Mining | Best Coal Inc. | Cooper Mine | AL0072052 | |
| Mining | Wade Sand & Gravel | East Thomas Limestone Plant | AL0025194 | |
| Ind SID | Aramark Uniform Services | | | IU 39 37 00335 |
| Ind SID | B'ham Coca-Cola Bottlers | | | IU 39 37 00316 |
| Ind SID | PEMCO Aeroplex-Birmingham | | AL0001538 | IU 39 37 00047 |
| Ind Minor | American Cast Iron Pipe | DSN 001 | AL0029378 | |
| Ind Minor | APCO - Miller Plnt. | | AL0027146 | |
| Ind Minor | Ashland Chemical Co. | | AL0021695 | IU 39 37 00132 |

ADEM Water Quality Section-mjr

Figure I Village Creek Watershed in the Black Warrior River Basin HUC AL/03160111-140

## List of Abbreviations

| | |
|---|---|
| ACIPCO | American Cast Iron Pipe Company |
| ADEM | Alabama Department of Environmental Management |
| AWW | Alabama Water Watch |
| BCF | Bioconcentration Factor |
| BETX | Benzene, Ethyl-benzene, Toluene, and Xylene |
| BMP | Best Management Practices |
| CAFO | Confined Animal Feeding Operation |
| CCC | Criteria Continuous Concentration |
| CFR | Code of Federal Regulations |
| CFS | Cubic Feet per Second |
| CPF | Cancer Potency Factor |
| CWA | Clean Water Act |
| CWP | Clean Water Partnership |
| DEM | Digital Elevation Model |
| DO | Dissolved Oxygen |
| EPA | Environmental Protection Agency |
| FCR | Fish Consumption Rate |
| FSA | Farm Services Agency |
| GIS | Geographic Information System |
| HBW | Human Body Weight |
| HUC | Hydrologic Unit Code |
| LA | Load Allocation |
| MGD | Million Gallons per Day |
| MOS | Margin of Safety |
| MRLC | Multi-Resolution Land Characteristic |
| MS4 | Municipal Separate Stormwater System |
| NED | National Elevation Database |
| NHD | National Hydrography Dataset |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | Nonpoint Source Pollution |
| NRCS | Natural Resources Conservation Service |
| OE | Organic Enrichment |
| OEO | Office of Education and Outreach |
| RF3 | Reach File 3 |
| RfD | Reference Dose |
| RL | Risk Level |
| RM | Rivermile |
| SIC | Source Industrial Code |
| STORET | STOrage RETrieval Database |
| SWMA | Storm Water Management Authority |
| TMDL | Total Maximum Daily Load |
| TSS | Total Suspended Solids |
| USDA | United States Department of Agriculture |
| USF&WS | United States Fish and Wildlife Service |

| | |
|---|---|
| USGS | United States Geological Survey |
| USLE | Universal Soil Loss Equation |
| $W/m^2$ | Watts per Meter Squared |
| WCR | Water Consumption Rate |
| WCS | Watershed Characterization System |
| WLA | Waste Load Allocation |
| WWTF | Wastewater Treatment Facility |
| WWTP | Wastewater Treatment Plant |

# 1.0 Executive Summary

The Village Creek watershed is located in the Black Warrior River basin in Jefferson County, Alabama. The watershed drains 94.5 square miles at its confluence with the Locust Fork (HUC AL/03160111). Urban activities dominate the upper most portion of the watershed. There are three segments identified on the State of Alabama's §303(d) list of impaired waters: an upper segment of Village Creek (HUC AL/03160111_140-02), Camp Branch (HUC AL/03160111_140-01), and Bayview Lake (HUC AL/03160111_140-03). Camp Branch and the listed portion of Village Creek drain to Bayview Lake, a 440-acre impoundment on the mainstem of Village Creek.

The headwater segment of Village Creek (HUC AL/03160111_140-02) has been included on the State of Alabama's §303(d) list of impaired waters since 1996. These impairments are attributed to abandoned subsurface mining, abandoned mill tailings, urban runoff/storm sewers, industrial and municipal activities. Village Creek was classified as Agricultural and Industrial Water Supply (A&I) at the time of the original listing. Since that time, the streams designated use has been upgraded to Limited Warmwater Fishery (LWF).

This report presents the results of Total Maximum Daily Load (TMDL) development for Village Creek (HUC AL/03160111_140-02). Based on the assessment of all available physical, chemical, and biological data, EPA approved delistings, in July 2003, for organic enrichment/dissolved oxygen (OE/DO), ammonia, and non-priority organics that are not causing use impairment of water quality for this stream segment (Table 1-1). Therefore, TMDLs will not be developed where *more recent or accurate data* demonstrate waterbodies are meeting water quality standards, which is just cause for delisting a waterbody according to Title 40 of the Code of Federal Regulations (CFR), Part 130.7(b)(6)(iv.). TMDLs were conducted where recently collected data confirmed impairment, as shown in Tables 1-2 through Table 1-4.

**Table 1-1 Assessment Decision for Pollutants in the Village Creek Watershed**

| Impaired Segment | Pollutant | Decision |
|---|---|---|
| Village Creek AL/03160111-140_02 | Ammonia | Delisting |
| | Non-Priority Organics (BETX) | Delisting |
| | OE/DO | Delisting |

**Table 1-2 pH TMDLs for the Village Creek Watershed HUC AL/03160111-140**

| Impaired Segment | Cause | WLA (Continuous Sources) | WLA (Stormwater Sources) | LA (Stormwater Sources) | MOS | TMDL |
|---|---|---|---|---|---|---|
| Village Creek AL/03160111-140_02 | pH | 6.0-8.5 s.u. | 6.0-8.5 s.u. (1) | 6.0-8.5 s.u. | N/A(2) | 6.0-8.5 s.u |

(1) As per EPA Office of Water's TMDL Policy Memo dated November 22, 2002, NPDES-regulated stormwater sources may be controlled using best management practices (BMPs). Where effluent limits are specified as BMPs, the permit should also specify the monitoring necessary to assess if the expected load reductions attributed to BMP implementation are achieved.
(2) A MOS was not considered necessary due to the TMDL being established equal to the pH water quality criterion.

**Table 1-3 Siltation TMDLs and Reductions Necessary to Meet the TMDL in the Village Creek Watershed HUC AL/03160111-140**

| Impaired Segment | Area[1] (acres) | Existing Loads | | | Allowable Loads | | | Reductions | | | TMDL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WLA[2] (Continuous Sources) | WLA (Stormwater Sources) [3] | LA | WLA[2] (Continuous Sources) | WLA (Stormwater Sources) [3] | LA | WLA[2] (Continuous Sources) | WLA (Stormwater Sources) [3] | LA | |
| Village Creek AL/03160111-140_02 | 21,440 | 16,571 lbs/day | 12.9 lb/acre/hr | 12.9 lb/acre/hr | 16,571 lbs/day | 8.3 lb/acre/hr | 8.3 lb/acre/hr | 0% | 35% | 35% | 178,000 lbs/hr |

(1) Drainage area to the USGS gage at Avenue W and not the downstream end of the impaired segment.
(2) The WLA equals the permitted TSS for process dischargers in Village Creek as shown in Table 5-3.
(3) NPDES regulated stormwater discharges include and may not be limited to construction activities, mining activities, and MS4 discharges.

**Table 1-4 Dissolved Zinc TMDL and Reductions Necessary to Meet the TMDL in the Village Creek Watershed HUC AL/03160111-140**

| Impaired Segment | Condition | Existing Loads (lb/day) | | Allowable Loads (lb/day) | | | Reductions | | TMDL as Dissolved Zinc (lb/day) |
|---|---|---|---|---|---|---|---|---|---|
| | | WLA Dissolved Zinc (Continuous Sources) | LA Dissolved Zinc | WLA Dissolved Zinc (Continuous Sources) | WLA Dissolved Zinc (Stormwater Sources)[1] | LA Dissolved Zinc | % WLA | % LA | |
| Village Creek AL/03160111-140_02 | Acute | 15 | 11 | 10 | 34% | 7 | (2) | 34% | 17 |

(1) The MS4 Allowable Load is expressed as a percent reduction equal to the LA reduction.
(2) Wasteload Reductions were calculated at the point of discharge. AL0003735 has 0% reduction, AL0001554 has 0% reduction, and AL0029378 has 83% reduction.

# 2.0 Basis for the §303(d) Listing

## *2.1 Introduction*

Section §303(d) of the Clean Water Act (CWA) as amended by the Water Quality Act of 1987 and EPA's Water Quality Planning and Management Regulations [Title 40 of the Code of Federal Regulations (CFR), Part 130] require states to identify waterbodies, which are not meeting water quality criteria applicable to their designated use classifications. The identified waters are prioritized based on severity of pollution with respect to designated use classifications. TMDLs for all pollutants resulting in violations of applicable water quality criteria are established for each identified waterbody. Such loads are established at levels necessary to implement the applicable water quality criteria with seasonal variations and margins of safety. The TMDL process establishes allowable loading of pollutants (or other quantifiable parameters for a waterbody) based on the relationship between pollution sources and instream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and to restore and maintain the quality of their water resources (EPA, 1991).

Village Creek was added to the §303(d) list based on data collected for the 1988 §305(b) Report to Congress. Site visits and data collected by ADEM between 1986 and 1991 identified impairments to this Village Creek segment of the Black Warrior River Basin. The 12.6 mile headwater segment of Village Creek has been listed as being impaired due to ammonia and OE/DO because of overflows and bypasses from the Village Creek wastewater treatment plant

(WWTP); metals and pH from abandoned mining activities, industrial spills, and urban runoff; and siltation from urban runoff and instream erosion. All of these water quality parameters are impacted by other, unknown sources. Table 2-1 describes the designated uses and causes as they appear on the 2000 §303(d) list. More recent water quality data has shown Village Creek is supporting its Limited Warmwater Fishery use classification for ammonia, non-priority organics (BETX), and OE/DO. In July 2003, EPA approved delistings for ammonia, non-priority organics (BETX) and organic enrichment/dissolved oxygen (OE/DO) (Table 1-1). Therefore, this TMDL will address the remaining pollutants, which are metal (zinc), siltation, and pH, that are causing impairment to Village Creek.

**Table 2-1 2000 §303(d) Impaired Segments in the Village Creek Watershed AL/03160111_140-02**

| Waterbody Name (ID) | Use Classification | Causes of Impairment | Sources of Impairment | Size (Miles) | Downstream/ Upstream Locations |
|---|---|---|---|---|---|
| Village Creek (03160111_140-02) | Limited Warmwater Fishery | Non-Priority Organics<br>Metals<br>Ammonia<br>pH<br>Siltation<br>OE/DO | Industrial<br>Municipal<br>Urban Runoff/Storm sewers<br>Surface Mining-abandoned<br>Subsurface Mining-abandoned<br>Mill Tailings-abandoned<br>Mine Tailings-abandoned | 12.6 | Jefferson Co. Rd. 65/ Woodlawn Bridge |

In 1989, in response to requirements of Section 319 of the Federal Water Pollution Control Act, Alabama published its Nonpoint Source Assessment Report. Because nonpoint source stream studies had not been completed in most states, including Alabama, prior to the implementation of the 319 Program, assessments were based on a combination of existing water quality data and an evaluation process.

The 1989 Nonpoint Source Assessment Report, which outlined the status of waterbodies thought to be threatened or impaired by nonpoint sources of pollution, was prepared using a cooperative approach to evaluate and identify waters of concern. This was accomplished by using a combination of efforts that included a questionnaire, a series of public meetings held throughout the state and anecdotal information derived from a combination of sources. ADEM, in cooperation with USDA, prepared a nonpoint source questionnaire that was submitted to a comprehensive list of agencies, organizations and groups identified as having an interest or involvement in water quality issues. Results of the questionnaire were then combined with information obtained from Soil & Water Conservation Districts and placed in a database developed to prioritize segments. Other information used to develop the Assessment Report included anecdotal information obtained through the public meeting process and through agency contacts as well as personal knowledge of water quality issues by ADEM staff.

The majority of waterbodies listed in the 1989 Assessment Report were identified based on evaluations rather than actual water quality monitoring data. These evaluations were based on knowledge of complaints, fish kills, discharge monitoring report violations, and best professional judgment determinations. It should be noted that ADEM's intent of the 1989 Assessment Report was not to deny or confirm that waters of the State failed to meet applicable water quality standards. Rather, inclusion of waterbodies in the 1989 Report constituted reference to impairment, threat, or special concern related to Nonpoint Source activities. Subsequently, ADEM could use the information to effectively monitor and address the aforementioned concerns. However, some segments incorporated into Alabama's 303(d) List from the 1989 Nonpoint Source Assessment Report may have been inadvertently included on the 303(d) list prior to full documentation of support status (ADEM, 2002).

This report was prepared using the most recent and available water quality monitoring data collected prior to 2002 when the TMDL was first proposed to determine the appropriate action to take regarding TMDL development. TMDLs are presented in this report where the subject segments are in violation with applicable water quality standards.

The TMDLs presented are consistent with a phased-approach; estimates are made of needed pollutant reductions, load reduction controls are implemented and water quality is monitored for plan effectiveness. Control actions may affect the loads of various pollutants. Flexibility is built into the plan so that load reduction targets and control actions can be reviewed and modified accordingly if monitoring indicates continuing water quality problems or improvement in water quality is occurring.

## *2.2 Problem Definition*

Village Creek (HUC AL03160111_140-02) originates in the vicinity of Roebuck, Jefferson County, Alabama and travels west through northern Birmingham until it reaches the impounded waters of Bayview Lake. The Village Creek watershed includes a broad spectrum of landuse activities. The upper segment of Village Creek drains a major metropolitan area and has typical urban stream characteristics such as poor habitat, degraded water quality, and stressed biological communities. The degraded condition of upper Village Creek is primarily due to the extensive industrial, commercial, and residential uses that dominate its watershed. The urbanized landscape creates dynamic flow events, reduced riparian zones, increased siltation, and other conditions that destroy habitat and impair water quality, thus making it difficult to sustain a healthy aquatic community.

The 12.6 mile headwater segment of Village Creek has been listed as being impaired due to ammonia and OE/DO because of overflows and bypasses from the Village Creek wastewater treatment plant (WWTP); metals and pH from abandoned mining activities, industrial spills, and urban runoff; and siltation from urban runoff and instream erosion. All of these water quality parameters are impacted by other, unknown sources. More recent water quality data has shown standards being met for ammonia, non-priority organics (BETX), and OE/DO and these parameters were presented in a delisting document approved by EPA in July 2003.

<u>Waterbody Impaired:</u> Village Creek; from Jefferson Co. Rd. 65 to Woodlawn Bridge

<u>Pollutant(s) of Concern:</u> Metals (Zinc), pH, and Siltation

<u>Water Use Classification:</u> Limited Warmwater Fishery (LWF)

Village Creek is classified as a Limited Warmwater Fishery. Usages of waters in this classification are described in ADEM Admin. Code R. 335-6-10-.09(6)(a), (b), (c), (d), and (e). The usages are described below:

> (a) The provisions of the Fish and Wildlife water use classification as Rule 335-6-10-.09(5) shall apply to the Limited Warmwater Fishery water use classification, except as noted below. Unless alternative criteria for a given parameter are provided in paragraph (e) below, the applicable Fish and Wildlife criteria at paragraph10-.09(5)(e) shall apply year round. At the time the Department proposes to assign the Limited Warmwater Fishery classification to a specific waterbody, the Department may apply criteria from other classifications within this chapter if necessary to protect a documented, legitimate existing use.
>
> (b) Best usage of waters (May through November):
> The waters will be suitable for agricultural irrigation, livestock watering, industrial cooling and process water supplies, and any other usage, except fishing, bathing, recreational activities, including water-contact sports, or as a source of water supply for drinking or food processing purposes.
>
> (c) Conditions related to best usage (May through November):
> 1. The waters will be suitable for agricultural irrigation, livestock watering, and industrial cooling waters. The waters will be usable after special treatment, as may be needed under each particular circumstance, for industrial process water supplies. The waters will also be suitable for other uses for which waters of lower quality will be satisfactory.
> 2. This category includes watercourses in which natural flow is intermittent, or under certain conditions non-existent, and which may receive treated wastes from existing municipalities and industries. In such instances, recognition is given to the lack of opportunity for mixture of the treated wastes with the receiving stream for purposes of compliance. It is also understood in considering waters for this classification that urban runoff or natural conditions may impact any waters so classified.
>
> (d) Conditions related to other usage: none recognized.
>
> (e) Specific criteria:
> 1. Dissolved oxygen (May through November): treated sewage, industrial wastes, or other wastes shall not cause the dissolved oxygen to be less than 3.0 mg/L. In the application of dissolved oxygen criteria referred to above, dissolved oxygen shall be measured at a depth of 5 feet in waters 10 feet or greater in depth; and for those waters less than 10 feet in depth, dissolved oxygen criteria will be applies at mid-depth.
> 2. Toxic substances and taste-, odor-, and color-producing substances attributable to treated sewage, industrial wastes, and other wastes: only such amounts as will not render the waters unsuitable for agricultural irrigation, livestock watering, industrial cooling, and industrial process water supply purposes; interfere with downstream water uses; or exhibit acute toxicity or chronic toxicity, as demonstrated by effluent toxicity testing or by application of numeric criteria given in Rule 335-6-10-.07, to fish and aquatic life, including shrimp and crabs in estuarine or salt waters or the propagation thereof.

The State has established a narrative criterion to maintain the biological integrity of waters of the State of Alabama where numerical criteria have not been established (ADEM 335-6-10-.06 (a) & (c)). Alabama's Water Quality Program does not include numerical water quality criteria for aquatic life protection due to sediment. However, ADEM uses its narrative criteria as shown in ADEM Rule 335-6-10-.06 to address impairments of this nature. ADEM and EPA guidance documents are used to establish numerical targets for the purposes of developing TMDLs.

# 3.0 Technical Basis for TMDL Development

## *3.1 Water Quality Target Identification*

Alabama has defined water quality criteria as a numeric concentration, equations based on acute and chronic doses or as a narrative statement representing a quality of water that meets the designated use. The TMDLs addressed in this report will include all of the aforementioned criteria.

### 3.1.1 Metals Criteria

According to ADEM's water quality criteria (Admin. Code 335-6-10-.07) the acute and chronic aquatic life criteria and human health (consumption of fish only) criteria are applicable for waterbodies classified as Limited Warmwater Fishery. The State acute criterion for metals is the one-hour maximum average concentration that can occur once in a three-year period. The chronic criterion for metals is the 4-day maximum average concentration that can occur once in a three-year period.

Criterion for metals is based on hardness dependent dissolve acute and chronic levels. The State of Alabama has established dissolved criteria calculated from calcium carbonate (CaCO3), or hardness, concentrations for a number of metals which include: arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. The equations for these metals are provided in Appendix B. Of these metals, only the mercury criteria is based on fish consumption. All available arsenic, chromium, mercury and nickel data sampled on Village Creek was compiled and analyzed for this TMDL. However, this data reported all less than method detection limits; therefore, no violations were reported for the arsenic, chromium, mercury, and nickel criteria. As a result, this TMDL will not discuss the metals arsenic, chromium, mercury, and nickel. Also, the metals for which the State has not set instream concentrations for aquatic life or fish consumption will not be considered in this TMDL. The metals that were considered for the Village Creek TMDL are listed in Table 3-1. The cadmium, copper, lead, and zinc metals data for Village Creek were not all reported as less than detection limits; therefore, were compared to the applicable metals criteria. Of the following metals: cadmium, copper, lead, and zinc, only zinc showed violations of its criteria; therefore, zinc is the basis for the Village Creek metals TMDL.

For the purpose of establishing effluent limitations for a Limited Warmwater Fishery, the one-day low flow that occurs once in 10-years (1Q10) shall be applied for the acute aquatic criteria. Analysis of both chronic and acute criteria show that the acute criterion is protective of chronic toxicity affects and will therefore be applied as the TMDL. It is reasonable to expect metals violations are typically short in duration, during wet weather events; therefore, the acute criteria is more protective.

Metals impairment is established if more than one measured sample is violating the States criteria, when a minimum of ten samples have been collected. All metals data, to include arsenic, chromium, mercury and nickel, which was available for Village Creek, was compiled and analyzed as part of the Village Creek Zinc TMDL. All metals for which the Department has established water quality criteria values, were considered during the TMDL development process. Evaluation of the available metals data found that none of the metals, except for zinc (Figure 3-1), exceeded their respective acute and chronic criterion values, or were reported at less than method detection limits. Therefore, it was concluded by the Department that these metals were not in violation of the applicable water quality criteria and showed to be fully supporting designated uses of Village Creek.

**Table 3-1 Metals Data on Village Creek Evaluated in the Report**

| Total Metals | # Obs | # Violations* | 2002 ADEM Detection Limit (mg/L) |
|---|---|---|---|
| Cadmium | 38 | 0 | 0.003 |
| Copper | 73 | 0 | 0.02 |
| Lead | 70 | 0 | 2 |
| Zinc | 105 | 2 | 0.03 |

*The number of violations was determined by the measured value being greater than the detection limit. Metals criteria is based on instream hardness and varies with each sample.

### 3.1.2 pH Criteria

The pH criteria for Limited Warmwater Fishery classified streams cannot be greater than 8.5 standard units nor less then 6.0 standard units.

### 3.1.3 Siltation Criteria

Biological assessment data is used in combination with other physical and chemical data or information to arrive at an overall use support determination for siltation. Use support determinations for the State of Alabama's §303(d) list are made with the following guidelines for interpretation of biological data:

- Fully Supporting - Macroinvertebrates determined to be Excellent (Unimpaired), Good (Slightly Impaired), and Fair (Moderately Impaired) rating if Chemical/Physical/Field Data indicates compliance.
- Partial Supporting - Macroinvertebrates determined to be Fair (Moderately Impaired) and Chemical/Physical/Field Data indicates impairment.
- Not Supporting - Macroinvertebrates determined to be Poor (Severely Impaired) and Chemical/Physical/Field Data indicates impairment.

Alabama's water quality standards do not include numerical water quality criteria for aquatic life protection due to sediment. Narrative criteria are considered to maintain the biological integrity of the waters of the State of Alabama. Therefore, it is necessary to develop numerical targets based upon this narrative criterion for Village Creek.

A sediment model to address the siltation TMDL for Village Creek, such as the sediment tool, is not appropriate in this case because the large contributor of degradation to the habitat in the stream is due to peak flows and the carrying (shaping) capacity of the stream. A technique is used that calculates and compares the specific stream power to that of a stable system. A stable system is defined as a cross-section that its width and thalweg depth remain relatively constant over a long period (i.e., 15-20 years). If the cross-section is remaining constant through time, the net sedimentation/deposition and erosion/scouring is zero. This idea was used to develop a target of stream power that could be used to assess if the impaired stream is stable or unstable and help determine the evolution of the stream channel. Specific stream power has been used in prior studies to predict channel stability, with most streams attaining relative stability less than 30 $W/m^2$ (Bledsoe *et al.*, 2002).

### 3.2 Data Availability and Analysis

A wide range of data and information were used to characterize the watershed and instream conditions. The categories of data used include physiographic data that describe the physical conditions of the watershed, environmental monitoring data that identify potential pollutant sources and their contribution, and instream water quality monitoring data.

Instream water quality data are necessary to evaluate impairment and characterize watershed loads. Figures 3-1 and 3-2 and Figures A-1 through A-3 illustrate the location of water quality stations, USGS flow stations, and the weather station utilized in the development of TMDLs presented in this report. Various data types and sources are listed in Table 3-2.

**Table 3-2 Data Utilized in TMDL Development**

| Data Category | Description | Source(s) |
|---|---|---|
| Watershed Physiographic Data | Landuse – 1992 MRLC | USGS |
| | National Elevation Data-30 x 30 meter grid | USEPA |
| | National Hydrography Database Reach Network | USGS |
| | Level IV Ecoregion Coverage | ADEM, USEPA and NRCS |
| Meteorological Data | Rainfall, Air Temperature, Solar Radiation, Wind Speed and Direction, Relative Humidity, and Cloud Cover at Birmingham International Airport | National Climatic Data Center |
| Environmental Monitoring Data | NPDES Permits | ADEM |
| | Discharge Monitoring Reports | ADEM |
| | 303(d) Listed Waters | ADEM |
| | Water Quality Monitoring Data | ADEM, USEPA, USGS, B'ham SWMA, AWW, and STORET |

There are several continuous flow gages in operation on the impaired segment of Village Creek. The USGS gaging stations and their corresponding period of record are listed in Table 3-3. Figure 3-1 shows the location of the USGS gaging stations in the impaired segment of Village Creek, upstream of Bayview Lake.

**Table 3-3 USGS Gaging Stations on Village Creek**

| USGS Station ID | Location | Drainage Area (sq.miles) | Period of Record |
|---|---|---|---|
| 02458600 | Village Creek near Docena-Minor Parkway. | 52.2 | 6/21/1996 - Present |
| 02458500 | Village Creek at Ave F | 35.7 | NA |
| 02458450 | Village Creek at Ave W | 33.5 | 7/01/1975 – Present |
| 02458375 | Unnamed Tributary to Village at Dixie Hub Center | NA | 1992 |
| 02458300 | Village Creek at 24th Street | 26 | 6/01/1988 - Present |
| 02458203 | Unnamed Tributary to Village at 10 Ave and L&N Railroad | NA | 1992 |
| 02458200 | Village Creek at Apalachee St | 15.6 | 10/01/1998 - Present |
| 02458180 | Tributary to Unnamed Tributary off Georgia Rd. | NA | 1992 |
| 02458148 | Village Creek at 86th Street | 4.1 | 10/01/1998 - Present |

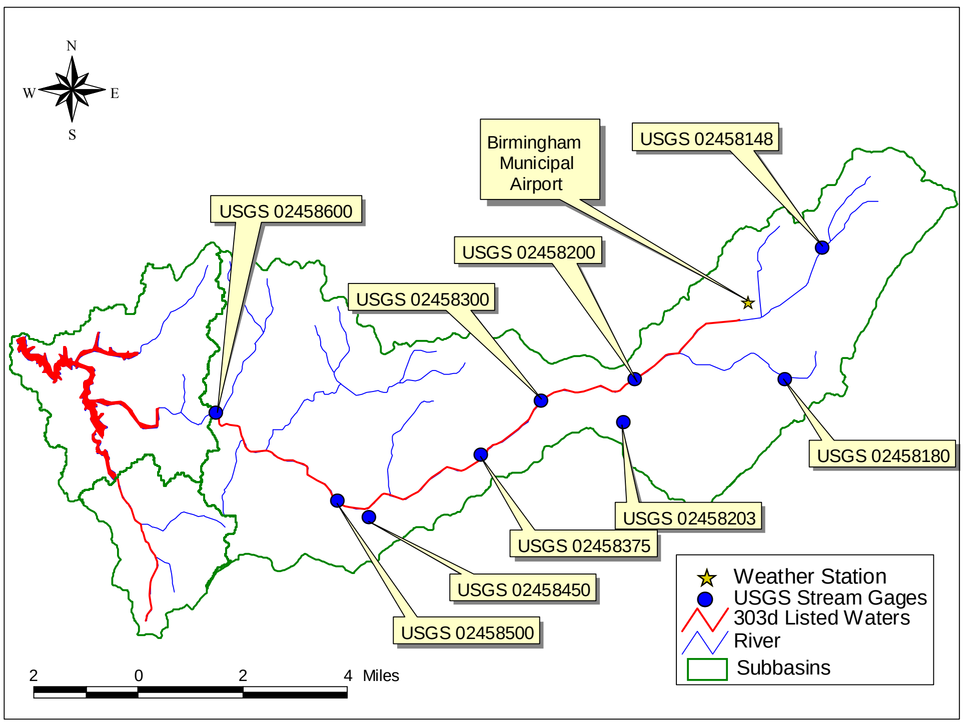


**Figure 3-1 USGS Stations in the Village Creek Watershed**

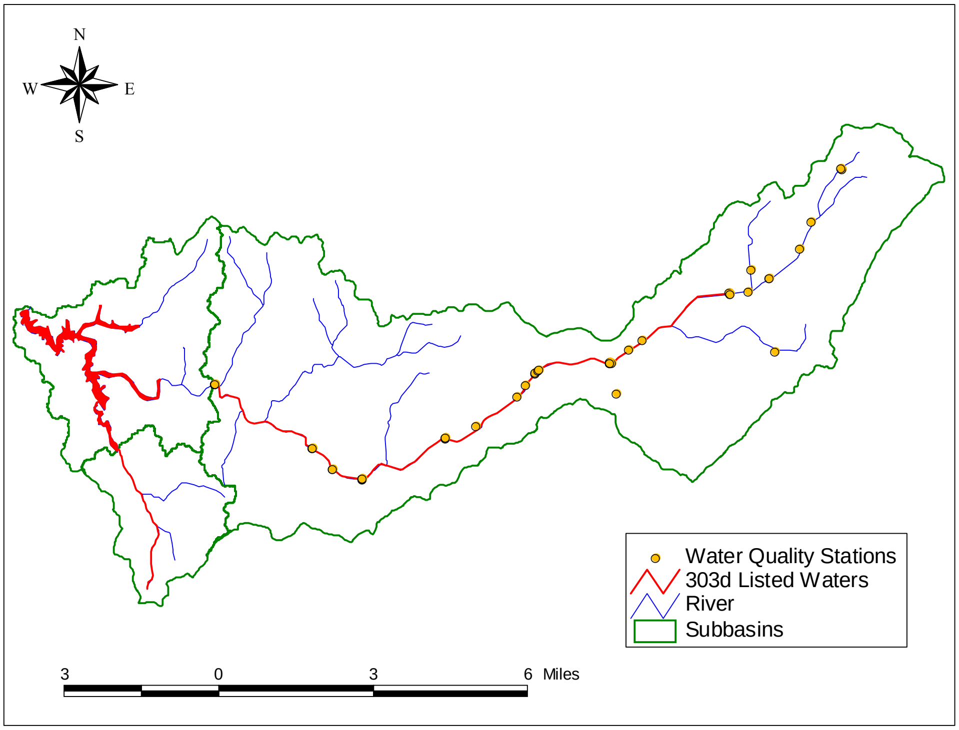


**Figure 3-2 Water Quality Stations on Village Creek Upstream of Bayview Lake (Stations are identified by Agency in Appendix A.)**

As part of ADEM's §303(d) Monitoring Program, water quality data were collected on Village Creek in 1997 and 2002. Several other agencies have collected water quality data for Village Creek since 1997 including the USGS, EPA, SWMA and Friends of Village Creek (USGS, 2002; EPA, 1999, SWMA, 2002; AWW, 2002). All available water quality data collected on Village Creek since 1997 was used to determine compliance with ADEM's water quality standards. TMDLs for metals (zinc), pH, and siltation are presented in this report where water quality data are in violation with applicable water quality standards.

### 3.2.1 Metals

As part of ADEM's §303(d) Monitoring Program, in 2002 dissolved and total metals were measured monthly at six stations on the impaired segment (ADEM, 2002). Total metals and TSS were collected by ADEM in 1997. SWMA also collected total metals and TSS during wet and dry conditions in 1999, 2000, and 2001 (SWMA, 2002). TSS was used to calculate the dissolved concentration from the total metals concentration. The dissolved concentration was calculated with the guidance of *EPA's The Metals Translator: Guidance for Calculating A Total Recoverable Permit Limit From A Dissolved Criterion*, June 1996. The guidance offers a list of default partition coefficients, $K_{pO}$ and α, which are used to calculate the dissolved concentration with TSS and a total concentration.

$$Dissolved = Metal * [1/[1 + K_{pO} * TSS^{\alpha} * TSS * 10^{-6}]] \text{ (EPA, 1996)}$$

Total metals collected by SWMA for wet and dry weather were analyzed to determine sources and critical conditions in the watershed. The wet and dry weather samples illustrate the impact of storm events on instream total metals concentrations, shown in Figures 3-3 and 3-4. The areas of high metals concentrations can be discerned by examination of these longitudinal plots. Metal concentrations peak near the USGS Station 02458450 at Ave W, River Mile 3.9, upstream of Minor Parkway/Jefferson County Rd. 65.

Hardness concentrations are required to establish exceedances of the State metals criteria. First, an attempt was made to develop a correlation between hydrology and hardness concentrations to establish targets for TMDL development, but the relationship between flow and hardness is difficult to establish in a dynamic system. A relationship on Village Creek could not be correlated to show significance (Figure 3-5). Dissolved concentrations of cadmium, copper, lead and zinc were then plotted against the percent hardness exceedance curves for the State acute and chronic criteria (Figures D-2 through D-6). The probability of exceedance was calculated for hardness concentrations measured in Village Creek (Appendix D).

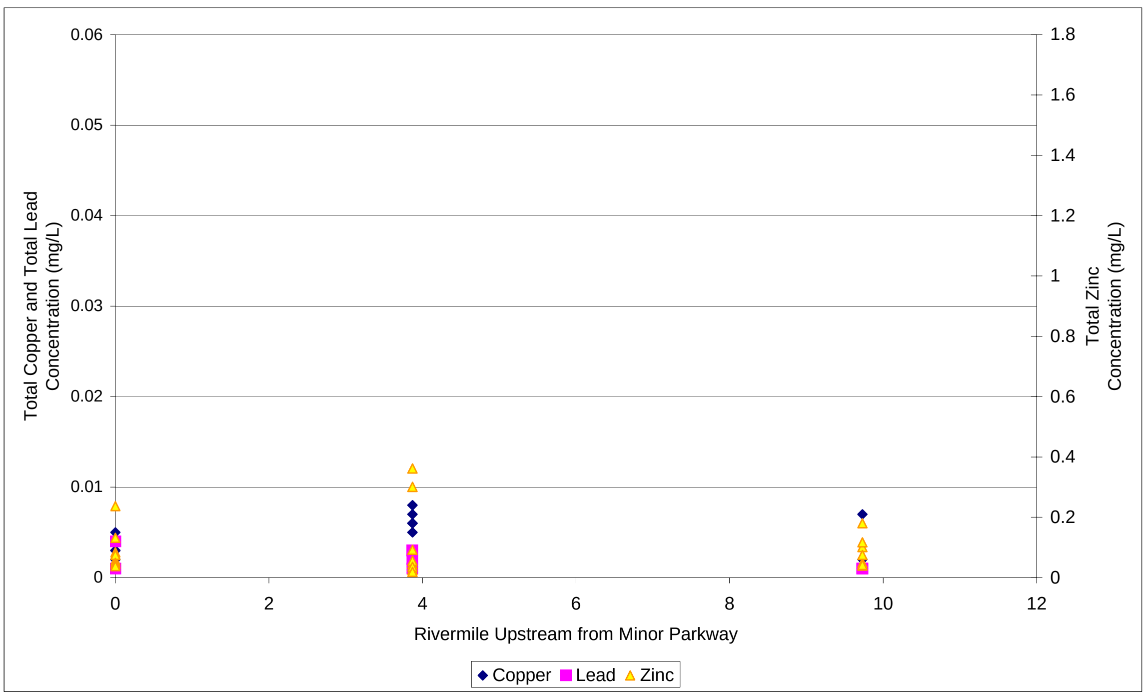


**Figure 3-3 Dry Weather Total Metal Concentrations in Village Creek (SWMA, 2002)**

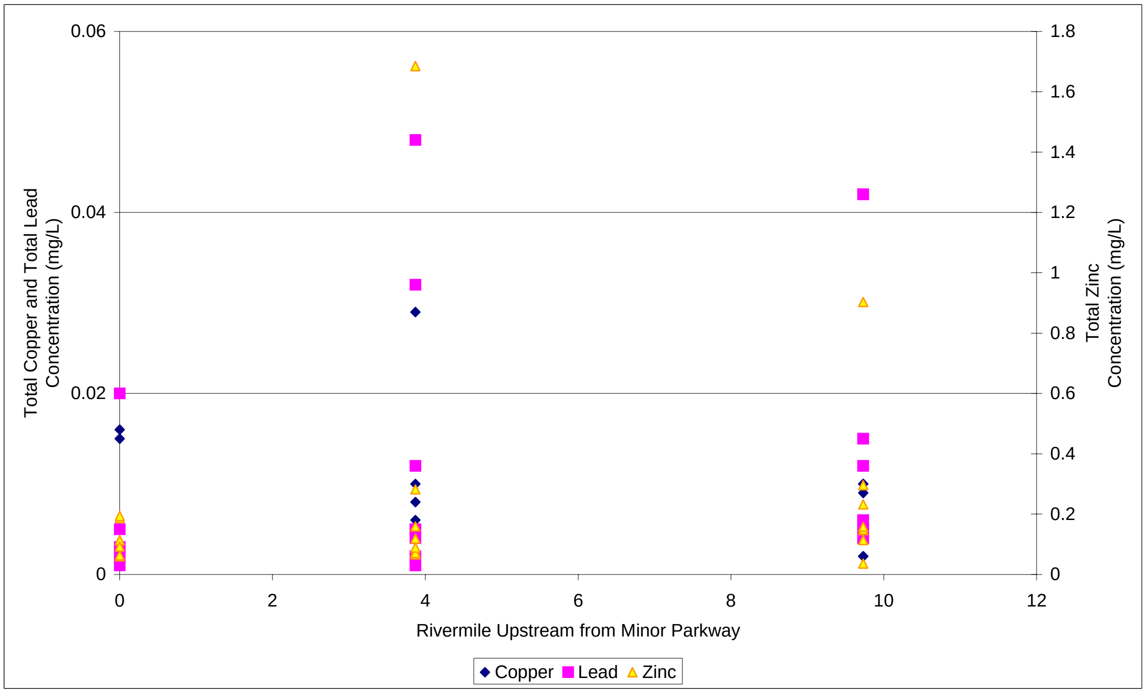


**Figure 3-4 Wet Weather Total Metal Concentrations in Village Creek (SWMA, 2002)**

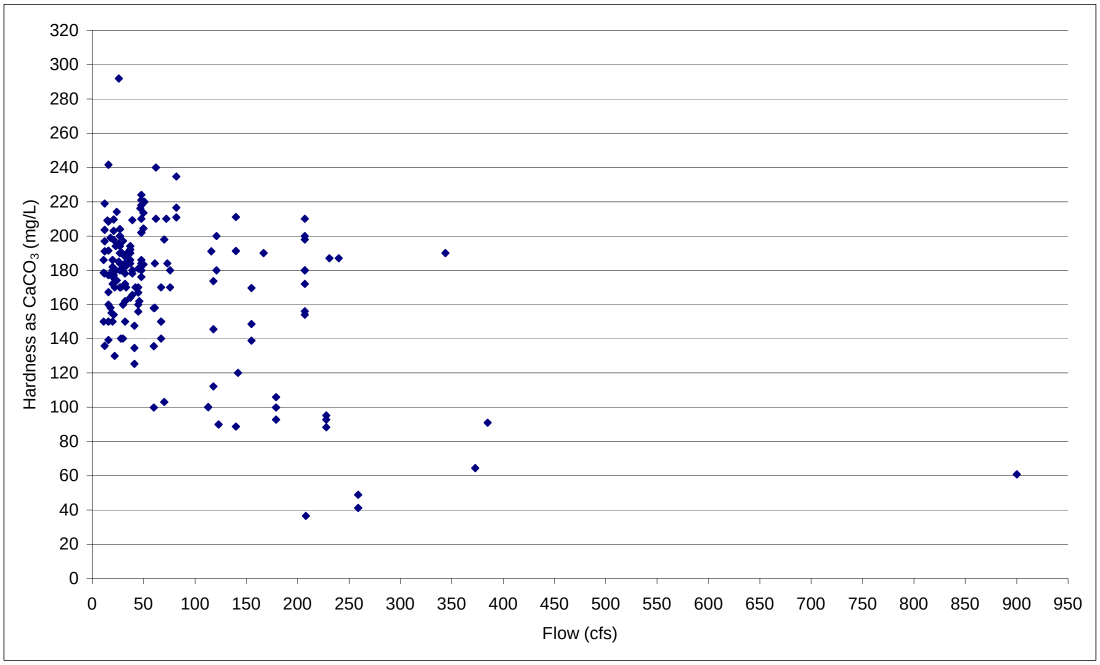


**Figure 3-5 Hardness Concentrations Related to Flow on the Impaired Segment of Village Creek**

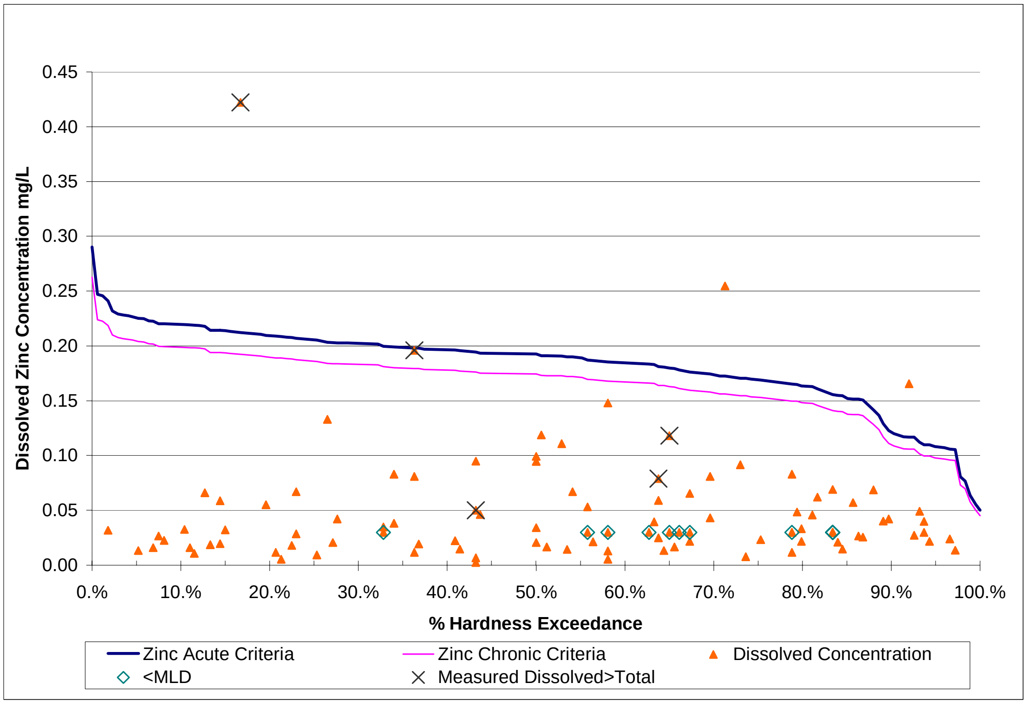


**Figure 3-6** **Zinc Measurements Collected 1997 – 2002 in the Impaired Segment of Village Creek; Zinc Criteria Based on the Percentage of Time Hardness is Exceeded**

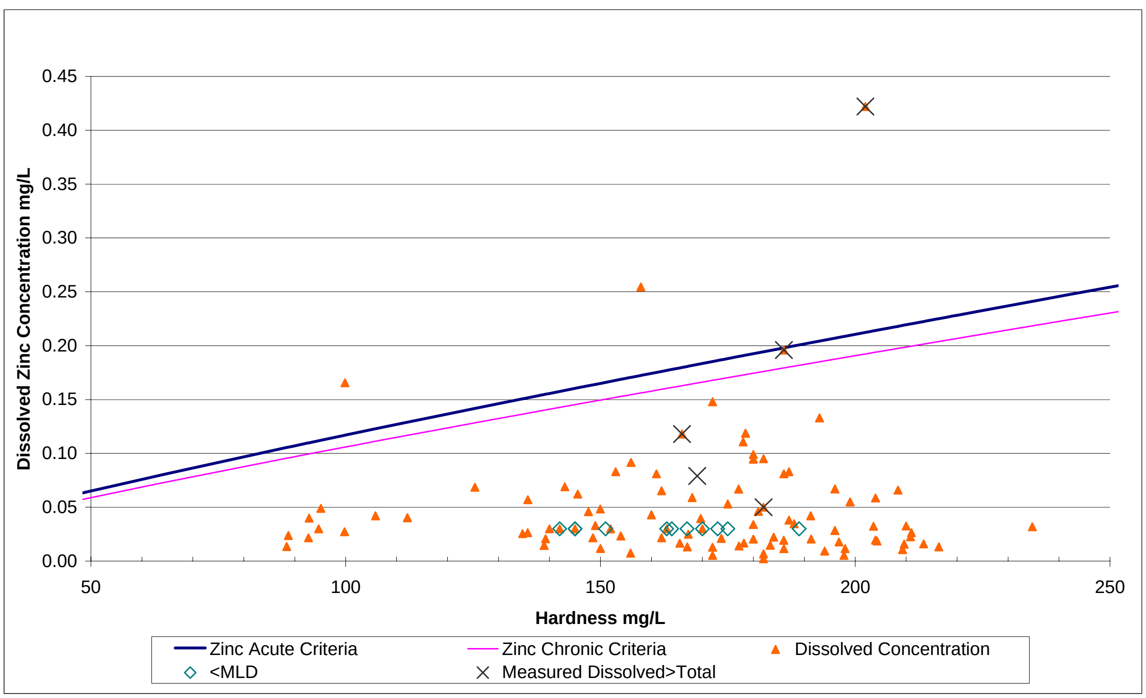


**Figure 3-7** **Zinc Measurements Collected 1997 – 2002 in the Impaired Segment of Village Creek; Zinc Criteria Based on Hardness**

After examining the available metals data for Village Creek, arsenic, cadmium, chromium, copper, mercury, nickel, and lead were found to be fully supporting the use classification of Limited Warmwater Fishery and zinc was the only metal exceeding the State criteria showing impairment to the segment. On September 29, 1999, during a rain event and permitted discharge, the concentration of zinc at Avenue W and Vanderbilt was above the State acute and chronic criteria. Two dissolved concentrations are well above the State criteria in Figures 3-6 and 3-7. These dissolved concentrations were calculated from total zinc concentrations collected by SWMA on September 29, 1999, during wet weather sampling. The validity of the two other sampled violations shown in Figures 3-6 and 3-7 is unknown because dissolved (filtered) concentrations were measured at higher concentrations than the measured total concentrations.

Many of the metals samples were measured below the constituent's detection limit. In Figures 3-6 and 3-7, points designated "<MDL" were measured below the detection limit. Some samples in the figures are expressed at concentrations less then the detection limit. This occurs for two reasons; the sample was measured to a lower detection limit or the dissolved concentration was calculated from a total sample that was measured above the detection limit. Measured dissolved (filtered sample) concentrations that exceeded measured total concentrations, distinguished in Figure 3-6, were not considered when the metals targets were established for Village Creek.

### 3.2.2 pH

Figure 3-8 illustrates 1997 and 2002 pH violations. High pH values may be attributed to naturally high background levels from limestone bedrock and soils, urban runoff, mining activities or algae production. The elevated concentrations at Vanderbilt (RM 9.73) and Tallapoosa (RM 10.5) suggest that urban sources may be contributing metals and other constituents impairing pH. Issues regarding pH will be addressed in the ongoing development of the nutrient criteria for state waters.

### 3.2.3 Siltation

An EPA water quality assessment of Village Creek in 1989 noted habitat limitations in the embayment to Bayview Lake due to excessive sediment deposition (EPA, 1989). In this study, the excessive sediment at the downstream portions of Village Creek and in the embayment have been attributed to instream erosion processes that occur due to an urbanization of the upper watershed. In 2002, ADEM performed macroinvertebrate sampling at three stations: VLGJ1, VLGJ2, and VLGJ4. All three stations received "poor" assessments confirming impairment to the segment.

Since the primary mechanism of siltation in Village Creek is due to urban hydrology, it is important to understand the hydrographs in the stream. Figure 3-9 shows a time series plot of the USGS daily average flow record from July 8, 1988, through September 30, 2001. Figure 3-10 displays the recent TSS measurements collected by ADEM and SWMA for Village Creek (1997-2000). The TSS measurements are plotted versus daily average flow data because simultaneous measurements of flow were not collected by either agency. There was one TSS measurement collected with an instantaneous flow measurement and, therefore, is not shown in Figure 3-10.

The measurements by the USGS on May 17, 1980, were 384 mg/L for TSS and a flow of 1,380 cfs. As shown in Figure 3-10, it is impossible to come up with one relationship of flow and TSS for Village Creek. The events are so dynamic that it would entail wet weather sampling through an entire hydrograph to make any defensible relation. Indeed, there is evidence by a few samples exhibiting high TSS concentration during high peak flow. The TSS data will be discussed in further detail in Appendix C. For the TMDL analysis and in the absence of TSS at peak flows, there was an attempt made to use the available data and derive a relationship between daily average and peak flow. The wet weather TSS data were then used to estimate sediment loads during runoff events.

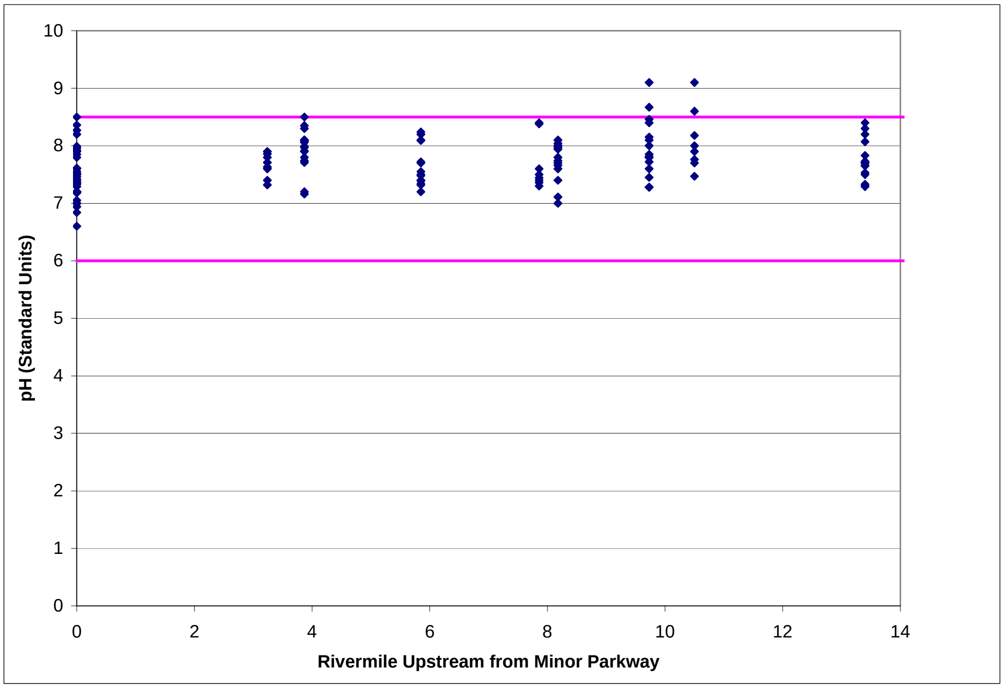


**Figure 3-8 pH Measured on Village Creek by ADEM (ADEM, 1997; ADEM, 2002)**

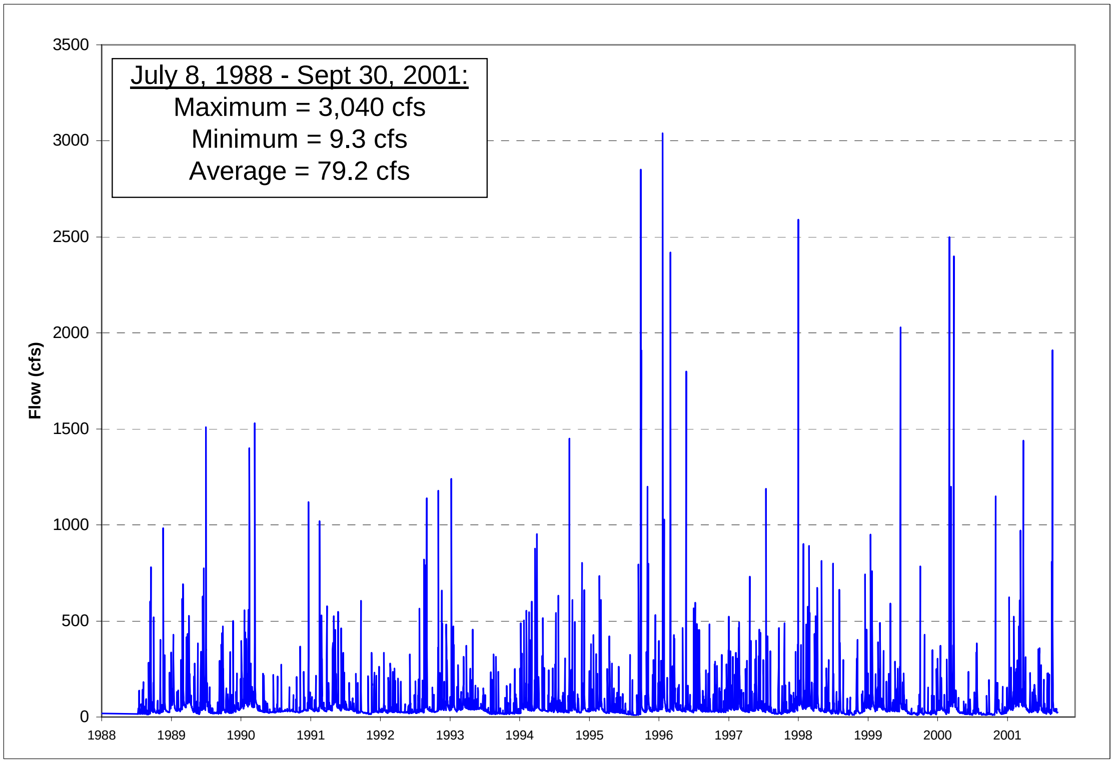


**Figure 3-9** **Daily Average Flow Measurements at USGS 02458450 – Village Creek at Avenue W at Ensley**

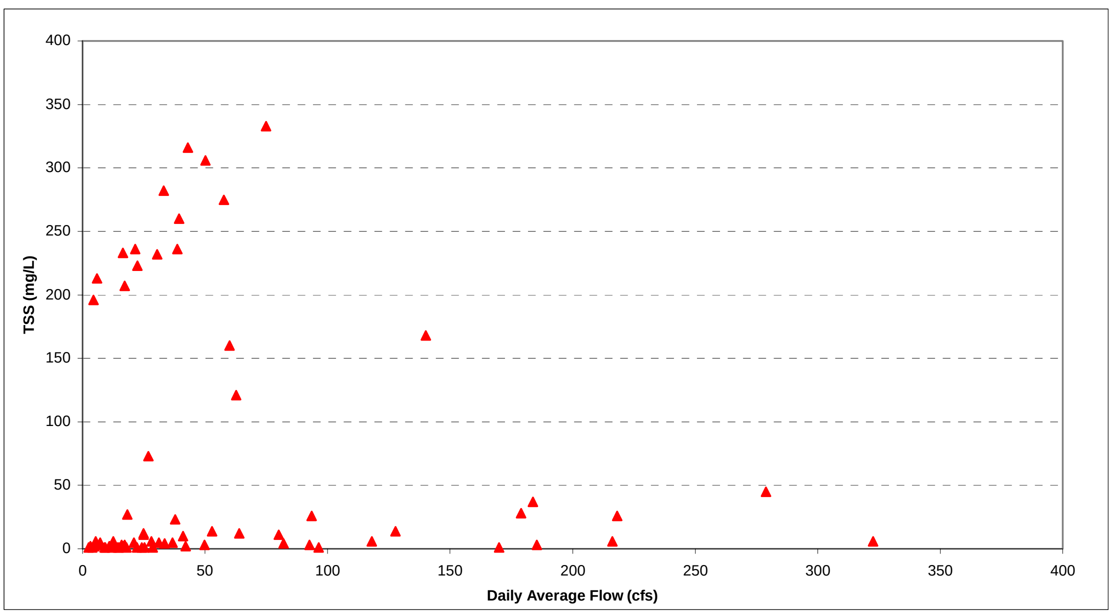


**Figure 3-10** **Daily Average Flow versus Suspended Sediment Concentration (1997 – 2000).**

### 3.2.4 Special Studies

Since 1988, the EPA has conducted two assessments of water quality on Village Creek. The first, in 1988, examined the habitat and water quality conditions of several urban streams in the Black Warrior River basin (EPA, 1989). This study concluded that habitat in Village Creek was severely limited by excessive sediment deposition in the embayment of Bayview Lake. This limitation was attributed to scouring of the streambed with high flows from urban runoff. During this period no violations of zinc, pH or DO were measured, but there was a noted increase in nutrient levels at Minor Parkway, downstream of the WWTP. Ten years later, the EPA conducted a study to develop a waste load allocation and determine if a change in use classification could be supported.

In 2000 and 2001, the USGS conducted an Investigation of Water Quality and Aquatic-Community Structure in Village Creek (USGS, 2002). Several water quality samples were collected, including *in-situ* data, nutrients, metals, pesticides, and herbicides. Nutrient levels were noted to increase in the downstream direction and metals toxicity for cadmium, copper, lead, and zinc exceeded chronic criteria (McPherson, 2002).

### *3.3 Source Assessment*

TMDL evaluations examine the known potential sources of pollutants in the watershed including point sources, nonpoint sources and background levels. For the purpose of these TMDLs, facilities permitted under the National Pollutant Discharge Elimination System (NPDES) Program are considered point sources. The source assessment was used as the basis of the TMDL allocations. Organic and nutrient loading, metals, and siltation within the Village Creek watershed include both point and nonpoint sources.

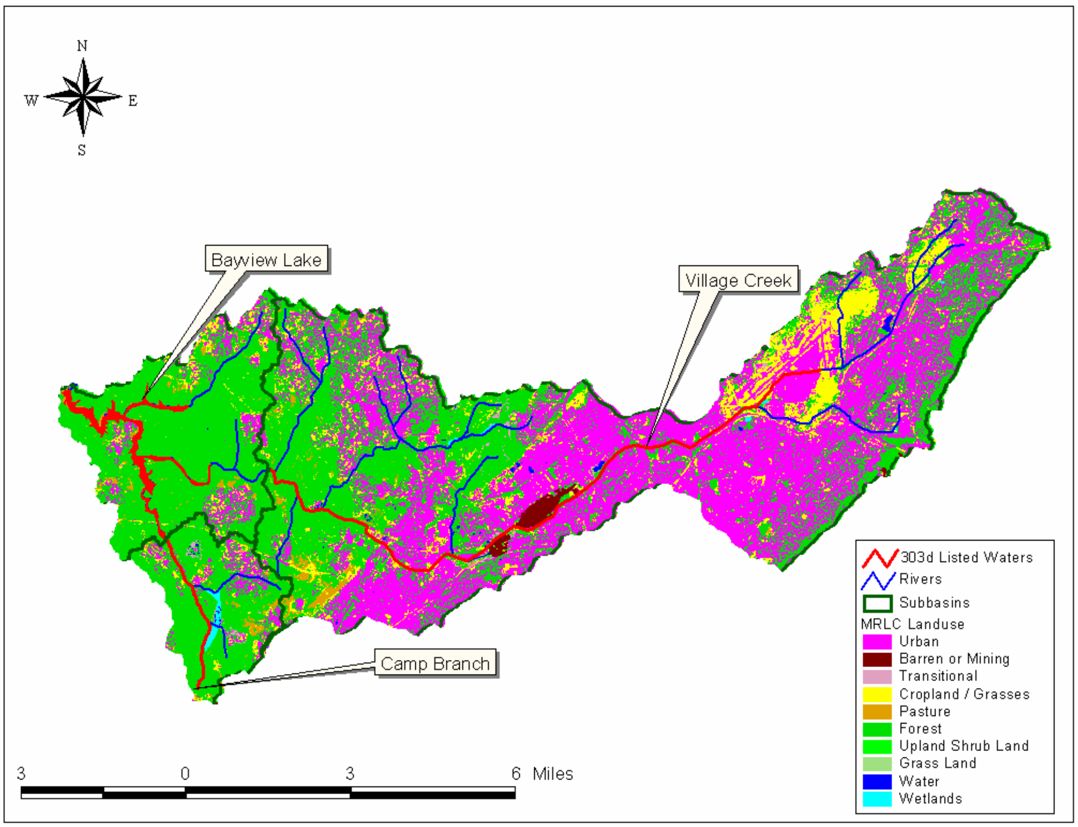


**Figure 3-11 Landuse Map of the Village Creek Watershed**

**Table 3-4 Landuse Characteristics within the Village Creek Watershed**

| Landuse Classification | Percent of Watershed |
|---|---|
| Open Water | <1% |
| Low Intensity Residential | 25% |
| High Intensity Residential | 9% |
| High Intensity Commercial/Industrial/Transportation | 16% |
| Quarries/Strip Mines/Gravel Pits | <1% |
| Transitional | <1% |
| Forest | 38% |
| Pasture/Crops/Other Grasses (Urban/recreational; e.g. parks, lawns) | 11% |
| Wetlands | <1% |

### 3.3.1 Nonpoint Sources

A landuse map of the Village Creek watershed, including Camp Branch and Bayview Lake, is presented in Figure 3-11. The predominant landuses within the watershed are forest and urban with respective percentages of the total watershed equal to 49 percent and 50 percent. Much of the urban area is commercial and industrial, including the Birmingham International Airport. Table 3-4 lists landuse percentages determined from the 1992 Multi-Resolution Land Characteristics (MRLC) map. Each landuse type has the potential to contribute to the organic loading in the watershed due to organic material on the land surface that potentially can be washed off into the receiving waters. Urban storm water runoff can be a significant source of sediment load, metals, priority organics (BETX) and pesticides.

The major sources of impairment in Village Creek are due to nonpoint sources from urban runoff. The large percentage of impervious area and limited stream buffer create dynamic flow events that destroy riparian habitat and impair water quality as noted in several studies (EPA, 1999; EPA, 1989; USGS, 2002; ADEM, 2001). Water reaches the stream very quickly in urban areas at high velocities. Figure 3-12 illustrates the hydrograph response of Village Creek to a 2-year, 24-hour storm; within hours Village Creek flows increase 6,000 cfs. The dramatic change to velocity increases instream scour. Instream scour in Village Creek generates a large amount of sediment that settles in the backwater area of Bayview Lake causing impairment to both segments. Metals, non-priority organics (BETX), and pesticides washed off residential areas, parking lots and roads during the first flush of rain events can also cause impairment to the stream.

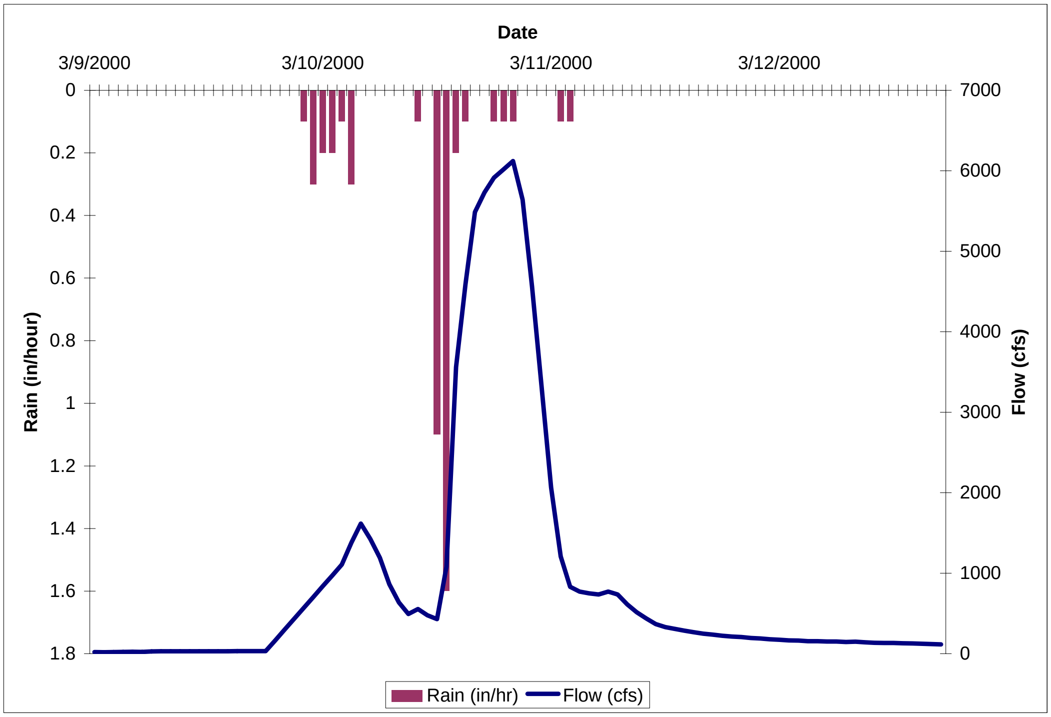


**Figure 3-12 Village Creek Hydrograph Response to the 2 year – 24-Hour Storm Event or 4 inches in 24hours, at Ave W.**

Past mining activities also create high background levels of metals and low pH in the watershed. Village Creek begins at the base of Red Mountain, an iron ore mine closed in 1974 (USGS, 2002). The historic impacts of mining are a significant factor to impaired water quality, though current mining activities are less than one percent of the total area within the watershed.

High concentrations of hardness also influence the toxicity of metals and pH. The concentrations of calcium carbonate ($CaCO_3$), measured by hardness in mg/L, are elevated in this region because of the presence of limestone. The Village Creek watershed is in the Southern Limestone/Dolomite Valleys and Low Rolling Hills (67f) and Shale Hills (68f) Level IV Ecoregions (Omernik, 1995). Figure 3-13 illustrates the watershed coverage for each Ecoregion.

-(67f.) The Southern Limestone/Dolomite Valleys and Low Rolling Hills form a heterogeneous region composed predominantly of limestone and cherty dolomite. Landforms are mostly undulating valleys and rounded ridges and hills, with many caves and springs. Soils vary in their productivity, and land cover includes oak-hickory and oak-pine forests, pasture, intensive agriculture, and urban and industrial. Along the Coosa River floodplain, biota more typical of coastal plain regions can be found due to the valley and riverine connection to Ecoregion 65.

-(68f.) The Shale Hills Ecoregion, sometimes called the Warrior Coal Field, has more shale and less sandstone than 68e. The soils generally have silt loam surfaces rather than sandy loams and have a silty clay or clayey subsoil. Although it has the lowest elevations in Ecoregion 68, the surface features are characterized by extensive hills and mostly strongly sloping topography. The shale, siltstone, and sandstone are relatively impermeable, and streams do not have the base flow found in more permeable adjacent areas, such as 65i or 67f. The region is mostly forested, but coal mining is a major industry, and the extensive open-pit mines have altered the landscape, soils, and streams.

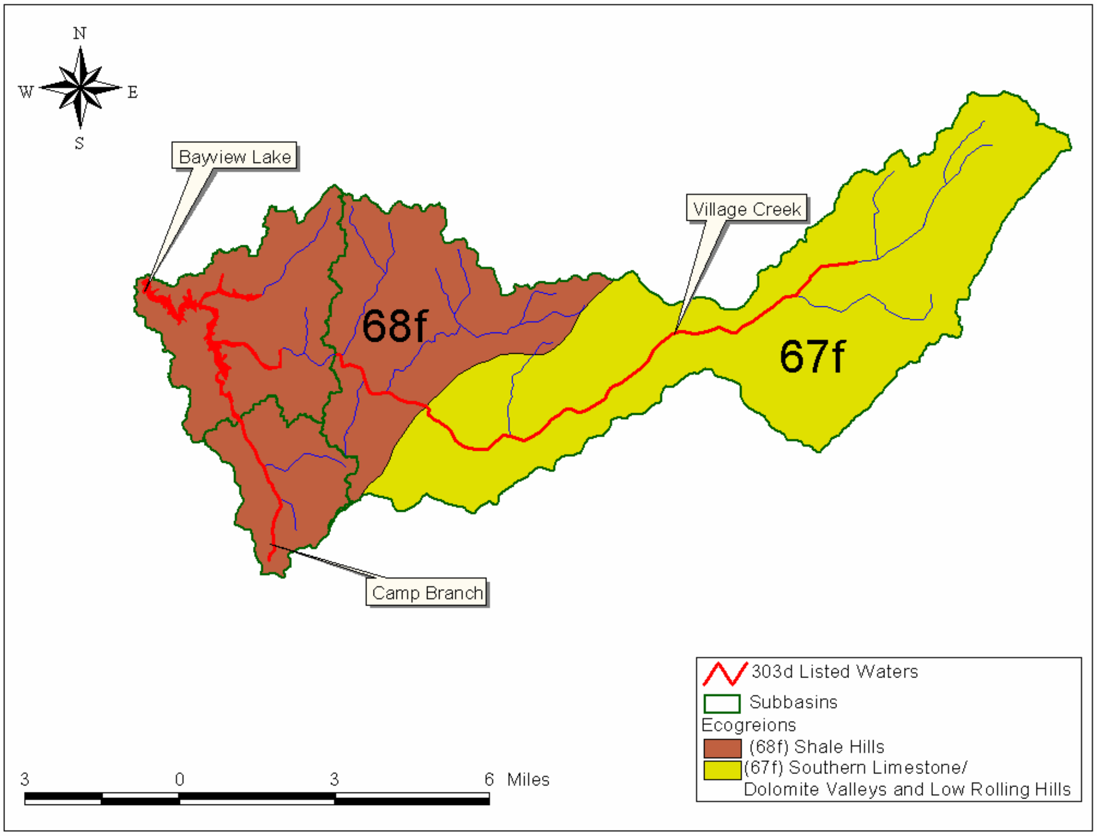


**Figure 3-13 Ecoregions in the Village Creek Watershed**

### 3.3.2 Point Sources

ADEM maintains a database of current NPDES permits and GIS files that locate each permitted outfall. This database includes municipal, semi-public/private, industrial, mining, industrial storm water and concentrated animal feeding operations (CAFO) permits.

There are several point sources in the watershed, but only seven facilities discharge process wastewater to the impaired segment of Village Creek or its tributaries. Of those discharging directly to Village Creek, the Jefferson County Village Creek WWTP is the most significant, permitted at a design flow of 60 MGD. Other facilities discharge infrequently with flows less than 2 MGD. Table 3-5 identifies the facilities discharging process wastewater to the impaired segment of Village Creek and its tributaries.

**Table 3-5 Process Wastewater NPDES Permitted Discharges to Village Creek**

| Facility | NPDES Permit | Flow | CBOD5 | DO | NH3 | pH | Zinc | TSS | TKN | Fecal Coliform |
|---|---|---|---|---|---|---|---|---|---|---|
| Jefferson County WWTP | AL0023647 | **X** | **X** | **X** | **X** | **X** | | **X** | **X** | **X** |
| Nucor Steel | AL0003735 | | | | | **X** | **X** | **X** | | |
| American Cast Iron Pipe Co. | AL0029378 | | | | | **X** | **X** | **X** | | |
| Ashland Chemical | AL0021695 | | | | | **X** | | | | |
| SMI Steel | AL001554 | | | | | **X** | **X** | **X** | | |
| Honeywell International | AL0002097 | | **X** | | **X** | **X** | | **X** | | |
| McWane Industries* | AL0001791 | **X** | | | | **X** | **X** | **X** | | |

**X** = Denotes NPDES permit limit
*Discharges to Avondale Creek, an intermittent tributary to Village Creek

Nationwide, poorly treated municipal sewage are a major source of organic compounds that decay and create additional organic loading. Throughout the last decade, the Village Creek WWTP has bypassed treatment during excessive rain events (ADEM, 2002). These discharges are a large contributor to nutrients in Village Creek and Bayview Lake. In 1995, a lawsuit was settled with the issuance of a consent decree against Jefferson County, Alabama, for violation of the Clean Water Act. The county is currently implementing a sewer improvement plan for plant upgrades, expansions, and sewer line replacement by 2007. Figure 3-14 depicts the 28 diverted sewer flows that occurred in 1999 and the corresponding measured daily flow in the stream. Details of the consent decree are described in Section 6.1.2.

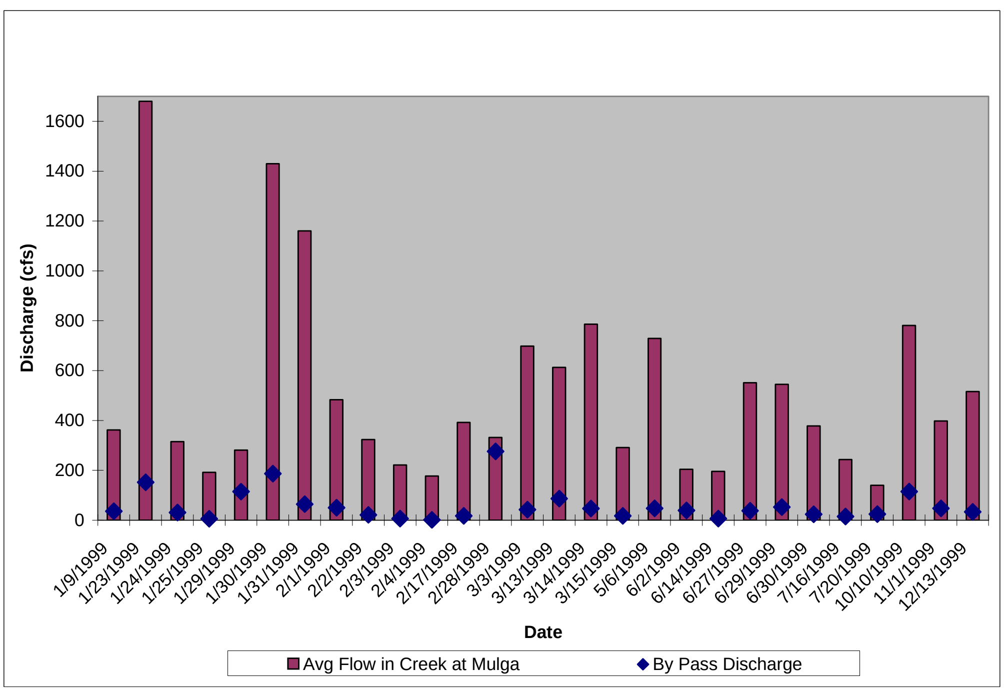


**Figure 3-14 Jefferson County Village Creek WWTP Sewer By Pass Flows during 1999**

From examination of 1999-2001 Discharge Monitoring Reports (DMRs), the Jefferson County Village Creek WWTP effluent has very low levels of $CBOD_5$ (monthly average < 2.0 mg/L) and NH3 (monthly average < 0.5 mg/L); however, the nutrient concentrations are significant. The 1999 ADEM effluent sampling data measured Total Phosphorus from 0.5 to 3.0 mg/L and Total Nitrogen from 5.0 to 30.0 mg/L during 1999, as shown in Figure 3-15. The 1999 EPA study on Village Creek discussed the change in the algal dynamics downstream of the effluent. Standing crops of periphytic algae are noted upstream of Bayview Lake and downstream of the Jefferson County effluent that alter the diurnal dissolved oxygen swing. Although the stream is in compliance to the dissolved oxygen criteria by meeting the 3.0 mg/L, there are significant levels of nutrients entering Bayview Lake to sustain dense algal mats in the growing season months (May – October).

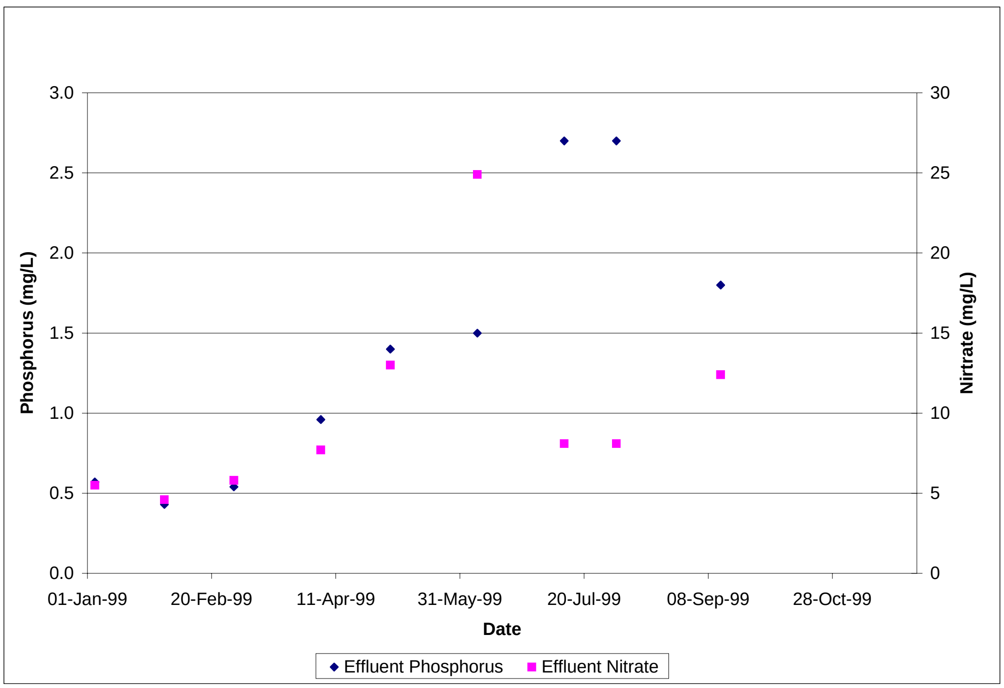


**Figure 3-15 Jefferson County Village Creek WWTP Nutrient Concentrations During 1999**

Other spills from permitted discharges in Village Creek are attributed to out dated treatment equipment. Pemco Aeroplex, an industrial State Indirect Discharge (SID), reported a number of violations for total chromium from 1997 through 1999 because of failure of biological treatment (ADEM, 2002). American Cast Iron Pipe Company (ACIPCO) reported exceedances of zinc in 1999 and new treatment methods were proposed to stop the violations. Untreated discharges prior to 1977 are also cause for impairment to Bayview Lake (ADEM, 1989).

Four of the seven facilities in Table 3-4 are permitted to discharge zinc to Village Creek or its tributaries. Nucor, ACIPCO and SMI Steel are permitted to discharge zinc directly to Village Creek and McWane Industries is permitted to discharge zinc to Avondale Creek a tributary to Village Creek.

Nucor (NPDES Permit #AL0003735) is permitted to discharge a total zinc daily maximum load of 0.206 lbs/day. SMI Steel (NPDES Permit #AL0001554) is permitted to discharge a maximum daily load of 2.06 lbs/day total zinc or a concentration of 0.065 mg/L of total recoverable zinc with monitoring by-weekly. ACIPCO (NPDES Permit #AL0029378) is permitted to discharge a maximum daily load of 5.50 lbs/day total zinc or a concentration of 6.53 mg/L of total recoverable zinc. All of these facilities are required to monitoring twice per month. The permit limits for ACIPCO were found to be a significant source of zinc to Village Creek. As defined in Permit #AL0029378, the average monthly discharge is calculated as the sum of all "daily discharges" measured during a calendar month divided by the number of "daily discharges". Therefore, maximum daily loads can be discharged for more than 10 days per month to achieve the monthly average loads.

The current permit for McWane Industries was issued on October 1, 1993, and has been administratively continued from the expiration date of September 30, 1998. McWane Industries are currently permitted to discharge to Avondale Creek, a tributary to the impaired segment of Village Creek. Avondale Creek is an intermittent stream, with a 7Q10 flow of zero; therefore, McWane Industries discharge to Avondale Creek will be required to have end-of-pipe limits. Under their current permit, AL0001791, monitoring of daily maximum total zinc is required and daily maximum total recoverable zinc cannot exceed 0.85 mg/L.

There are several stormwater NPDES permits in the watershed including a MS4 permit. Other stormwater permits have been issued to the Jefferson County WWTP (AL0023647), various construction sites, and mining facilities in the watershed. Table 3-6 lists that facilities permitted to discharge TSS and pH. They are also required to monitor outfall flow bi-monthly. The stormwater NPDES permits to Village Creek and its tributaries do not include zinc.

**Table 3-6 Stormwater NPDES Permitted Discharges to Village Creek**

| Discharger | NPDES Permit | 5-yr Avg Flow (MGD) | Permitted TSS (mg/L) | pH |
|---|---|---|---|---|
| MS4 | ALS000001 | - | - | - |
| Jefferson Co. WWTP | AL0023647 | Report | Report | Report |
| Wade Sand & Gravel Co. | AL0025194 | Monitor | - | 6-9 s.u. |

# 4.0 Model Development

Establishing the relationship between instream water quality and source loading is an important component of TMDL development. It allows the determination of the relative contribution of sources to total pollutant loading and the evaluation of potential changes to water quality resulting from implementation of various management options. This relationship can be developed using a variety of techniques ranging from qualitative assumptions based on scientific principles to numerical computer modeling. In this section, the techniques developed to simulate loadings are presented.

A mass balance and hardness exceedance curve were used for metals in Village Creek, see Section 4.1.2 and Appendix D; and for the siltation TMDL, instream scour was quantified by calculating Stream Power as described in Section 4.1.1 and Appendix C. The following presents general descriptions of each of these methods.

## *4.1 Sediment Modeling*

### 4.1.1 Stream Power

The goal of the approach to address the siltation TMDL for Village Creek is to restore and protect the habitat and biological community present in the stream. A sediment model, such as the sediment tool, is not appropriate in this case because the large contributor of degradation to the habitat in the stream is due to peak flows and the carrying (shaping) capacity of the stream. A technique is used that calculates and compares the specific stream power to that of a stable system. A stable system is defined as a cross-section that its width and thalweg depth remain relatively constant over a long period (i.e., 15-20 years). If the cross-section is remaining constant through time, the net sedimentation/deposition and erosion/scouring is zero. This idea was used to develop a target of stream power that could be used to assess if the impaired stream is stable or unstable and help determine the evolution of the stream channel. Specific stream power has been used in prior studies to predict channel stability, with most streams attaining relative stability less than 30 $W/m^2$ (Bledsoe *et al.*, 2002).

The stream power approach identifies a relationship between sediment loads and instream flows and links the peak flows to stream stability through an aggregate parameter of specific stream power. The stability requirements of the stream are directly related to the habitat and biological community in the stream. If sedimentation is reduced through reducing peak hydrographs, it will allow for a benthic habitat that will provide greater protection for aquatic life. A further discussion of the stream power approach is presented in Appendix C.

### 4.1.2 Mass Balance and Metals Hardness Curve

A loading curve was initially applied to determine where metals violations occur relative to hardness in stream. This approach utilizes existing hardness to calculate violations and to establish existing conditions for the TMDL. The following reasons, which are specific to the Village Creek watershed, can support the use of this approach:

- Existing USGS flow gages throughout the impaired segment of Village Creek (Figure 3-1).
- Intensive sampling in 1997, 2000, 2001, and 2002 by the ADEM, USGS and other organizations for metals and hardness concentrations.
- Local datasets and information to characterize the watershed and determine potential sources of metals.
- The known sources are not all influenced by predictable hydrological or meteorological events.

After applying the hardness exceedance curve to determine violations, a mass balance was used to determine the TMDL. The source assessment information in Section 3.3 was used to help identify the leading contributors to the impairments and justify the required reductions. Further discussion of the hardness exceedance curve methodology can be found in Appendix D.

# 5.0 Development of Total Maximum Daily Load

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 Alabama's water quality criteria for aquatic life. TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measures. TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background levels. In addition, 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. Conceptually, this definition is denoted by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

This section presents the TMDLs developed for Village Creek (HUC AL/03160111-140_02).

## *5.1 Numeric Targets For TMDLs*

EPA regulations define loading, or assimilative capacity, as the greatest amount of loading that a waterbody can receive without violating water quality standards (40 CFR Part 130.2(f)). As stated in Section 3.1, the numeric criteria and targets vary for each pollutant.

### 5.1.1 Linking Metals Targets and Pollutant Sources

For the Village Creek zinc TMDL, an acute target was established from State criteria. The range of hardness from water quality data showed upstream (Vanderbilt) values from 89 to 216 mg/L, and downstream (Ave. W) values from 93 to 241 mg/L. Typically the low values of hardness occur during wet weather periods and are not reflective of low flow, dry weather conditions. The tenth percentile of all hardness concentrations collected in Village Creek was 100 mg/L. This concentration also represents the measured hardness concentration during the violation of zinc at Vanderbilt on September 29, 1999. This hardness concentration also represents the concentration used by the Department to establish NPDES permitted values.

The metals target is referenced to the concentration of dissolved metals in the water column. Metals effluent permit limits are expressed as total recoverable concentrations and loads. The dissolved criteria was found to be equal to the total recoverable concentration using the EPA's guidance for metals translators by using a TSS of 5 mg/L and a hardness of 100 mg/L as discussed previously. Therefore, the load and wasteload allocation of this TMDL will be expressed as a dissolved load and a total recoverable load, respectively.

### 5.1.2 Linking pH Targets and Pollutant Sources

No load was targeted for pH because the water quality criterion is not based on a concentration. Instead, the pH criteria for Limited Warmwater Fishery will be equal to the TMDL, between 6.0 standard units and 8.5 standard units for Village Creek.

### 5.1.3 Linking Sediment Targets and Pollutant Sources

Alabama's water quality criteria do not include numerical water quality criterion for aquatic life protection due to sediment. Instead, the State of Alabama's water quality criteria document (ADEM Admin. Code R. 335-6-10-06-(a)&(c)) provides a narrative criteria that establishes that biological integrity within the stream segment must be maintained.

In Village Creek, the siltation TMDL target was specific to stream power as discussed in detail in Appendix C. The peak hydrograph, with an average recurrence interval of 1.5 years, $Q_{1.5}$, was calculated based on measured peak flows and reduced to meet a stability requirement of 25 W/m$^2$, including a margin of safety. The proposed peak hydrograph would allow the stream to reach an equilibrium so that instream sedimentation would be reduced and ultimately provide a sustainable habitat.

## *5.2 Existing Conditions*

### 5.2.1 Metals in Village Creek

Exceedances of the State criteria for zinc were isolated from other samples to establish a feasible TMDL target. The zinc violations quantify the influence of a high flow event combined with a point source discharge. Though a statistical correlation cannot be made between hardness and flow in Village Creek, it is generally assumed that as instream flows increase, instream hardness decreases. As hardness decreases the toxicity of metals increases.

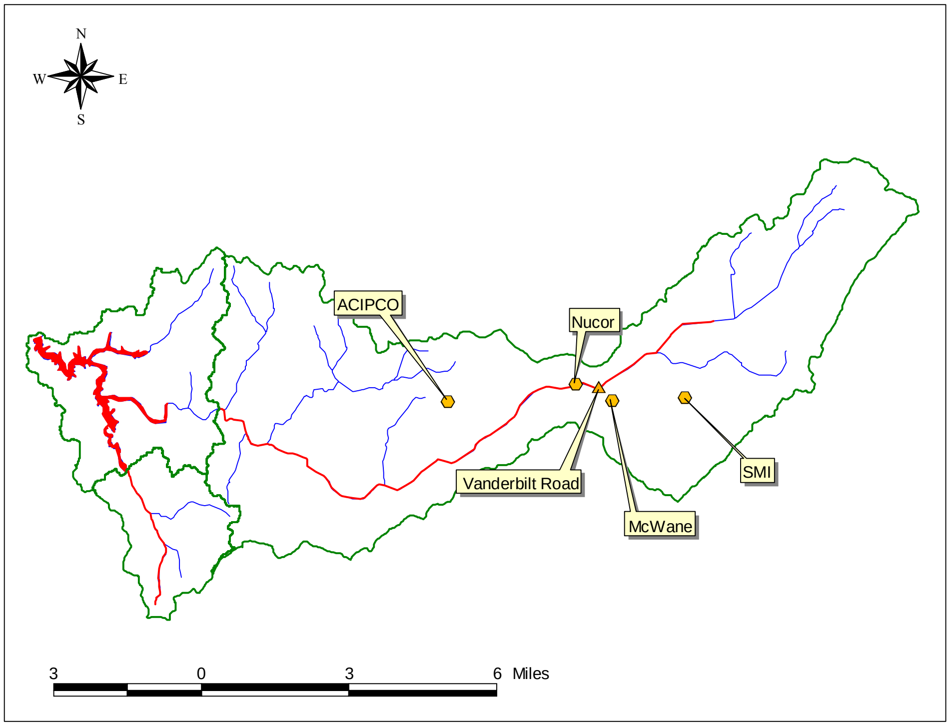


**Figure 5-1 Existing Sources of Zinc to Village Creek** (Vanderbilt Road represents the location of the nonpoint source violation and McWane discharges to a tributary of Village Creek)

The dissolved zinc concentrations (0.166 mg/L at Vanderbilt and 0.255 mg/L at Ave. W) that exceeded the State's acute criteria on September 29, 1999 provided the wet weather conditions that were targeted for TMDL development. On this day hardness concentrations were low, instream flows were high and a point source discharged 7.12 pounds of zinc into the impaired segment.

The conditions during the exceedance measured at Vanderbilt, were utilized to establish the existing load allocation. The State's acute criteria was calculated using the comparable hardness to that measured on the day of the exceedance (99.86 measured, 100 utilized). Percent reductions to the load allocation were calculated for the acute criteria.

**Table 5-1 Existing Sources of Zinc to Village Creek**

| | Instream at Vanderbilt Road | | | SMI | | | Nucor Steel | | | ACIPCO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Measured Daily Average Flow (mgd) | Total Drainage Area (mi sq) | Measured Dissolved Zinc (lb/day) | Q (mgd)* | Total Drainage Area (mi sq) | Existing Total Recoverable Zinc (lb/day) | Q (mgd)* | Total Drainage Area (mi sq) | Existing Total Zinc (lb/day) | Q (mgd)* | Total Drainage Area (mi sq) | Existing Total Recoverable Zinc (lb/day) |
| Acute Conditions | 9.1 | 21.20 | 10.54 | 0.294 | 16.32 | 0.16 | 0.1 | 22.18 | 0.619 | 0.58 | 27.93 | 14.74 |

Table 5-1 presents the existing sources of zinc to Village Creek and Figure 5-1 presents the location of facilities. Allowable wasteloads were calculated considering the allowable dissolved acute criteria (0.1172 mg/L). Existing conditions were calculated with current permitted daily maximum total recoverable concentrations converted to dissolved concentrations, average five-year effluent flows and 1Q10 instream flows based on the drainage area to the discharge. Reductions to existing zinc discharges were calculated from allowable effluent loads. A 83 percent reduction of total recoverable zinc will be required to meet the allowable wasteload load at ACIPCO. This criterion is based on a total recoverable concentration of zinc calculated using with the *EPA's Metals Translator Guidance* (EPA, 1996), where the total recoverable zinc is 0.978 of the dissolved zinc criteria.

### 5.2.2 pH

The pH data collected in Village Creek between 1997 and 2002 slightly exceeds the States criteria of 8.5 standard units (Figure 3-8). Of the 479 samples taken by different agencies at various stations and dates on Village Creek, there were 49 pH violations that exceeded the States criteria of 8.5 standard units. The highest reported pH value, 9.1 s.u., was recorded by ADEM on June 10, 1997 at two stations, VLG2 and VLG3. No samples were reported lower than the States criteria of 6.0 standard units. A summary table depicting the number of observations and violations occurring at each station may be found in Appendix A. Violations of the pH standard are not seen in the headwaters or lower reaches of the watershed but tend to occur in the middle reaches as depicted in Figure 5-2.

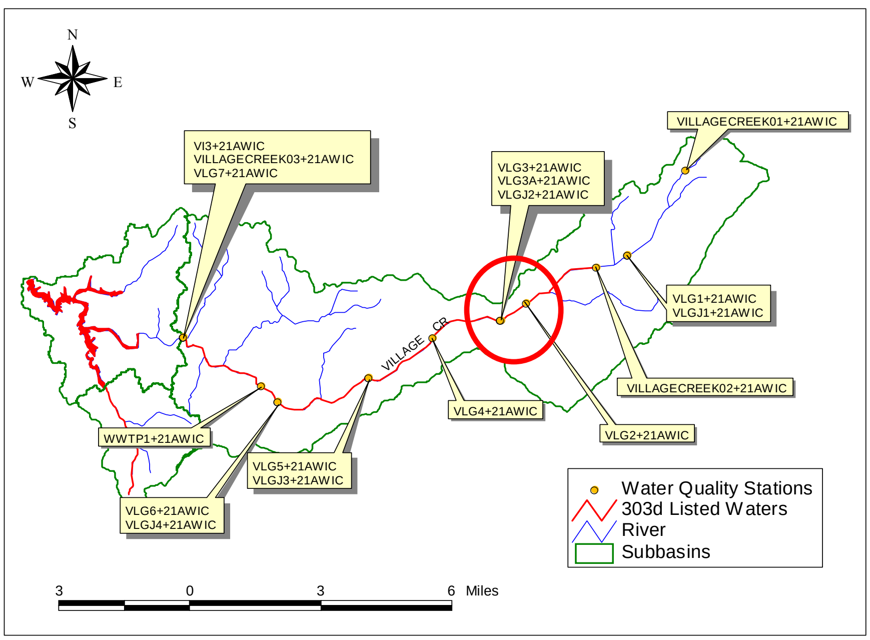


**Figure 5-2 Location of pH Violations in Village Creek**

### 5.2.3 Siltation

The existing siltation conditions in Village Creek is a degraded habitat based on excessive sedimentation originating instream due to urban runoff (Table 5-2). The TMDL target is representative of a recurring phenomenon of flashy hydrology that typically has a higher energy than the stream can handle. By targeting a low return interval (1.5 years), it is more protective of the storms that occur frequently; therefore, providing the greatest mechanism for instream erosion. The proposed TMDL condition is to decrease the timing of the peak of the hydrograph by catching and retaining the runoff during storm events. The volume of runoff would not change, but the peak flow magnitude and timing would be modified to stabilize the stream.

**Table 5-2 Village Creek Existing Sediment Conditions at Avenue W**

| Watershed | Flow (cfs) | Suspended Sediment Load (tons/hr) | Area (sq. miles) | Suspended Sediment Load (tons/sq. mile/hr) | Suspended Sediment Load (lbs/sq. mile/hr) | Suspended Sediment Load (lbs/acre/hr) |
|---|---|---|---|---|---|---|
| Village Creek | 3120 | 138.4 | 33.5 | 4.13 | 8,262 | 12.9 |

In addition to several stormwater permits for TSS, six process wastewater facilities are permitted to discharge TSS to Village Creek, which are listed in Table 5-3. The industrial facilities are permitted for daily maximum and monthly average loads and the municipal facility is permitted for a monthly and weekly average load. The TSS existing wasteload allocation was based on the monthly average load to be consistent with the industrial and municipal permits.

**Table 5-3 Village Creek Process Wastewater Permitted TSS**

| Facility | NPDES Permit | Monthly Average TSS (ppd) |
|---|---|---|
| Jefferson County WWTP | AL0023647 | 15012 |
| Nucor | AL0003735 | 448 |
| American Cast Iron Pipe Co. | AL0029378 | 668 |
| SMI Steel | AL001554 | 423 |
| Honeywell International | AL0002097 | 20.4 |
| McWane Industries | AL0001791 | 5,936 (ppy) |

## 5.3 Critical Conditions

### 5.3.1 Metals

For the metals calculations, critical conditions were established for acute conditions to be protective of chronic toxicity affects. Loads were determined using flow conditions for establishing effluent limits; the minimum 1-day low flow that occurs once in 10-years (1Q10). A hardness value of 100 mg/L was used in the establishment of the acute criteria.

### 5.3.2 pH

Critical conditions for pH exist during high flows and the growing season. During high flows hardness concentrations are low, decreasing the pH. During periods of algae production, pH is elevated, as seen in Village Creek. Targeting a range of values incorporates both critical conditions.

### 5.3.3 Siltation

The critical condition for the siltation TMDL on Village Creek is the 1.5-year recurrence interval peak flow. This flow is the effective discharge that performs most of the channel shaping activities in an urban setting. The critical condition was determined to be 3,120 cfs by analyzing available USGS flow and peak hourly flow records.

## 5.4 Margin of Safety (MOS)

There are two methods for incorporating a MOS in the analysis: a) by implicitly incorporating the MOS using conservative model assumptions to develop allocations; or b) by explicitly specifying a portion of the TMDLs as the MOS and using the remainder for allocations.

### 5.4.1 Metals

An implicit MOS for the zinc TMDL includes the conservative assumptions used in selecting the critical conditions and the establishment of the criteria. The acute criteria targets the low range hardness concentrations, 100 mg/L.

### 5.4.2 pH

The allocations used in this TMDL ensure that loads from any point source(s) meet the pH target of 6.0 to 8.5 s.u. before entering the stream. It is ADEM's position that water quality standards in Village Creek will be met if pH from both point and nonpoint source activities are consistent with the allocations in this TMDL. Therefore, an additional consideration of a margin of safety for Village Creek was determined to be unnecessary.

### 5.4.3 Siltation

An explicit MOS was incorporated in the Village Creek siltation TMDL. The stability target of the stream was based on the specific stream power approach. The literature values indicate that 30 $W/m^2$ is an appropriate target and that any stream power less than that would indicate a stable stream. The explicit MOS was determined to be 17 percent by expressing the target as 25 $W/m^2$, rather than 30 $W/m^2$, to provide for a conservative approach.

## 5.5 Seasonal Variation

### 5.5.1 Metals

The zinc TMDL on Village Creek addresses seasonal variation by examining acute and chronic conditions and critical conditions of hardness. By plotting the metal loads on the percent exceedance of hardness curve, and understanding the hydrology during measured exceedances the choice for TMDL allocations protect against the most critical flow conditions using acute criterion.

### 5.5.2 pH

Based on several years of pH data for Village Creek a seasonal fluctuation was not observed. Violations of the criteria, 6.0 to 8.5 s.u., are measured throughout the year. Therefore, a seasonal variation was not necessary.

### 5.5.3 Siltation

Sediment loading is expected to fluctuate according to the amount and distribution of rainfall. For the stream power approach on Village Creek, the seasonal variation was handled through the examination of the historical flow record at the USGS gage at Avenue W. All of the peak flows were determined from the flow record and a statistical approach of the 1.5-year recurrence interval was derived from literature. Also, a relationship between TSS and flow did not exist because the peak hourly data were not available for the entire record. The sediment erosion processes that exist in Village Creek occur solely when the flows are large enough to exert more energy on the banks and bed than the stream can handle. The large flows occur only during or subsequent to rain events. Therefore, even though the flow record was examined, the dry weather, low flow periods were not used in the TMDL approach.

## 5.6 Wasteload Allocations

There are seven facilities in the listed segment of the Village Creek watershed with NPDES permits to discharge process wastewater. Four of these NPDES regulated facilities discharge zinc to Village Creek and its tributaries and six are permitted to discharge TSS. Permits must be reviewed by ADEM for compliance with the TMDLs presented in this report. Urban runoff is included under the MS4 Phase I permit for the City of Birmingham. Based on EPA's recommendations, the LA is given the same unit load as the WLA for stormwater sources.

### 5.6.1 Metals

The allowable dissolved zinc concentration is 0.1172 mg/L to meet the acute criteria. The allowable loading for point sources is calculated from the aforementioned concentration, effluent 5-year average flow and the 1Q10 instream flow at the point of discharge. Table 5-4 defines the effluent flow rates, allowable loads, and concentrations. Calculations are presented in Appendix E.

**Table 5-4 Allowable Zinc Wasteloads to Village Creek**

| | SMI | | Nucor Steel | | ACIPCO | |
|---|---|---|---|---|---|---|
| | Total Recoverable Allowable Concentration (mg/L) | Total Recoverable Allowable load (lb/day) | Total Recoverable Allowable Concentration mg/L | Total Recoverable Allowable load lb/day | Total Recoverable Allowable Concentration mg/L | Total Recoverable Allowable load lb/day |
| Acute Conditions | 2.33 | 5.72 | 2.45 | 2.05 | 0.51 | 2.49 |

### 5.6.2 pH

Since pH is not a load, but rather a measure of acidity and/or alkalinity of a given solution, this TMDL uses an *other appropriate measure* (40 CFR §130.2(i)) rather than an actual mass-per-unit time measure. For this TMDL, the State's numeric pH criterion of 6.0-8.5 s.u. is used as the TMDL target (*other appropriate measure*). Thus, the pH wasteload allocation (WLA) for this TMDL requires that effluent pH levels in current and future point sources shall be no less than 6.0 s.u. and no greater than 8.5 s.u. However, in accordance with EPA Office of Water's policy memorandum dated November 22, 2002, NPDES-regulated stormwater sources may be controlled using best management practices (BMPs).

### 5.6.3 Siltation

The existing TSS loads for the continuous WLA, or process wastewater facilities, were found to be insignificant loads to the watershed; therefore, the continuous wasteload allocation for siltation will be equal to the existing load. Stormwater discharges for siltation will be equal to the LA.

## *5.7 Load Allocations*

### 5.7.1 Metals

The load allocation for the metals TMDL on Village Creek is based on the acute criteria for dissolved zinc. The concentration of dissolved zinc from nonpoint sources shall not exceed an average of 0.1172 mg/L in one-hour. This concentration was calculated using the State criteria evaluated at 100 mg/L of hardness. The allowable load was calculated from the flow conditions at Vanderbilt Road where upstream point source contributions have been removed. The Vanderbilt Road was used to represent contributions from nonpoint sources in the watershed. The nonpoint source is urban runoff and will be addressed through implementation. Calculations are presented in Appendix E.

**Table 5-5 Allowable Zinc Loads to Village Creek**

| | Instream at Vanderbilt Road | |
|---|---|---|
| | Dissolved Allowable Concentration mg/L | Dissolved Allowable load lb/day |
| Acute Conditions | 0.1172 | 7 |

### 5.7.2 pH

The load allocation for pH is based the State's criteria of 6.0 to 8.5 standard units.

### 5.7.3 Siltation

Reductions to siltation in the watershed will be addressed through modifying the existing urban hydrology. Again, urban runoff is included under the MS4 Phase I permit for the City of Birmingham. The LA is given the same unit load as the WLA for stormwater sources.

## *5.8 TMDL Results*

### 5.8.1 Metals

Based upon the critical conditions established above, along with the criteria established for acute effects, scenarios were run to establish the TMDL as shown in Table 5-6.

**Table 5-6 Allocations of Zinc in Village Creek**

| Impaired Segment | Condition | Existing Loads (lb/day) | | Allowable Loads (lb/day) | | | Reductions | | Dissolved Zinc TMDL (lb/day) |
|---|---|---|---|---|---|---|---|---|---|
| | | WLA Dissolved Zinc (Continuous Sources) | LA Dissolved Zinc | WLA Dissolved Zinc (Continuous Sources)(1) | WLA Dissolved Zinc (Stormwater Sources) | LA Dissolved Zinc | % WLA | % LA | |
| Village Creek AL/03160111-140_02 | Acute | 15 | 11 | 10 | 34% | 7 | (2) | 34% | 17 |

(1) The MS4 Allowable Load is expressed as a percent reduction equal to the LA reduction.
(2) Wasteload Reductions were calculated at the point of discharge. AL0003735 has 0% reduction, AL0001554 has 0% reduction, and AL0029378 has 83% reduction.

The zinc TMDL for Village Creek requires reductions from the existing load and wasteload to meet the water quality criteria. A 34 percent reduction to the zinc load and an even greater reduction to the wasteload are required to meet the TMDL.

### 5.8.2 pH

Since pH is not a load, but rather a measure of acidity and/or alkalinity of a given solution, this TMDL uses an *other appropriate measure* (40 CFR §130.2(i)) rather than an actual mass-per-unit time measure. For this TMDL, the State's numeric pH criterion of 6.0-8.5 s.u. is used as the TMDL target (*other appropriate measure*). Thus, the pH wasteload allocation (WLA) for this TMDL requires that effluent pH levels in current and future point sources shall be no less than 6.0 s.u. and no greater than 8.5 s.u. However, in accordance with EPA Office of Water's policy memorandum dated November 22, 2002, NPDES-regulated stormwater sources may be controlled using best management practices (BMPs).

**Table 5-7 pH TMDL for the Village Creek Watershed HUC AL/03160111-140**

| Impaired Segment | Cause | WLA (Continuous Sources) | WLA (Stormwater Sources) | LA (Stormwater Sources | MOS | TMDL |
|---|---|---|---|---|---|---|
| Village Creek AL/03160111-140_02 | pH | 6.0-8.5 s.u. | 6.0-8.5 s.u. (1) | 6.0-8.5 s.u. | N/A(2) | 6.0-8.5 s.u |

(1) As per EPA Office of Water's TMDL Policy Memo dated November 22, 2002, NPDES-regulated stormwater sources may be controlled using best management practices (BMPs). Where effluent limits are specified as BMPs, the permit should also specify the monitoring necessary to assess if the expected load reductions attributed to BMP implementation are achieved.
(2) A MOS was not considered necessary due to the TMDL being established equal to the pH water quality criterion.

### 5.8.3 Siltation

The siltation TMDL for Village Creek is a 35 percent reduction to the existing sediment load to meet the narrative water quality criteria of aquatic life protection due to sediment (Table 5-8). The long-term goal is to achieve a stable stream that allows extended periods of time for a healthy substrate and benthic community to develop that does not get washed out during each major rain event or, on the other hand, has excessive sediment deposition from upstream scouring sources. The allocations presented in Table 5-8 are consistent with this goal, where the stormwater sources and load allocations are presented as hourly loads. Since the methodology used in TMDL development is based on peak flow events the allocations were established to be protective of these critical conditions. Waste load allocations in the TMDL are in units per day since these are continuous discharges. The difference in units was established to be protective of the critical conditions in the impaired segment. The implementation of the reduction will occur through the reduction of the peak flow during a runoff event.

**Table 5-8 Siltation TMDL in the Village Creek Watershed HUC AL/03160111-140**

| Impaired Segment | Area(1) (acres) | Existing Loads | | | Allowable Loads | | | Reductions | | | TMDL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WLA(2) (Continuous Sources) | WLA (Stormwater Sources) (3) | LA | WLA(2) (Continuous Sources) | WLA (Stormwater Sources) (3) | LA | WLA(2) (Continuous Continuous) | WLA (Stormwater Sources) (3) | LA | |
| Village Creek AL/03160111-140_02 | 21,440 | 16,571 lbs/day | 12.9 lb/acre/hr | 12.9 lb/acre/hr | 16,571 lbs/day | 8.3 lb/acre/hr | 8.3 lb/acre/hr | 0% | 35% | 35% | 178,000 lbs/hr |

(1) Drainage area to the USGS gage at Avenue W and not the downstream end of the impaired segment.
(2) The WLA equals the permitted TSS for process dischargers in Village Creek as shown in Table 5-3.
(3) NPDES regulated stormwater discharges include and may not be limited to construction activities, mining activities, and MS4 discharges.

# 6.0 TMDL Implementation

## *6.1 Point Sources*

### 6.1.1 NPDES Zinc Loading

Compliance with the zinc TMDL for Village Creek will require a modification of the existing NPDES Permit # AL0029378, American Cast Iron Pipe Company. NPDES effluent limitations for zinc will be developed using the total recoverable concentration.

### 6.1.2 Jefferson County Village Creek WWTP - Consent Decree

The Environmental Protection Agency in conjunction with some environmental interest groups filed a lawsuit against Jefferson County, Alabama, on December 6, 1994, alleging that the county was in violation of the Clean Water Act. The lawsuit was settled in 1995 with the issuance of a consent decree, which was entered into the court in 1996. Under terms of the consent decree, Jefferson County agreed to:

- Eliminate further bypasses and unpermitted discharges of untreated wastewater containing raw sewage to the Black Warrior and Cahaba River Basins,
- Eliminate sewer system overflows,
- Achieve full compliance with its NPDES permits, and
- Fully comply with the Clean Water Act.

The sewer collection system and its operations were studied and analyzed to determine the necessary corrective measures. The Waste Treatment System Capital Improvement Plan (WTSCIP) was developed to document the sewer rehabilitation and replacement projects.

A water quality-monitoring plan was developed that included weekly upstream and downstream sampling of all county wastewater treatment plants and automatic overflow points. Monitoring stations were selected to provide adequate coverage of all major streams influenced by discharges from the wastewater treatment plants. Jefferson County is required to document quarterly updates and submit them to the EPA and the Public Document Repository. The updates describe the current status of the remedial actions, progress made since the last quarterly report, and the projected work for the next quarter. The report also includes the number of sewer impact connection permits and the number of fixtures permitted in each collection system.

Fines for bypasses, overflows, and violation of NPDES permits will be issued after the evaluation period, or other specified time period, stated in the consent decree. In order to avoid a fine, the county must show data or other engineering documents prior to end of the evaluation period, or other specified time period stated in the consent decree, that show that the violations were due to weather conditions.

The county is currently implementing a sewer improvement plan and will spend $3 billion from 1995 through 2007 for plant upgrades, expansions, and sewer line replacement. Prior to the lawsuit, the county owned approximately 25 percent (primarily trunk lines) of the collection system within its system boundaries. Twenty-one municipalities owned their own sewer lines.

As a result of the consent decree, the county acquired the municipalities' sewer lines in 1998. This acquisition gave the county more control over the system and its quality (ACIPCO, 2002).

## 6.2 Nonpoint Source Approach

The listed segments within the Village Creek watershed are primarily impaired by nonpoint sources. For 303(d) listed waters impaired solely or primarily by nonpoint source (NPS) pollutants, necessary reductions will be sought during TMDL implementation using a phased approach. Voluntary incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired water. Cooperation and active participation by the general public and various industrial, business, and environmental groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. Therefore, TMDL implementation activities will be coordinated through interaction with local entities in conjunction with Clean Water Partnership efforts.

The primary TMDL implementation mechanism used will employ concurrent education and outreach, training, technology transfer and technical assistance with incentive-based pollutant management measures. The ADEM Office of Education and Outreach (OEO) will assist in the implementation of TMDLs in cooperation with public and private stakeholders. Planning and oversight will be provided by or coordinated with the Alabama Department of Environmental Management's (ADEM) Section 319 nonpoint source grant program in conjunction with other local, state and federal resource management and protection programs and authorities. The CWA Section 319 grant program may provide limited funding to specifically ascertain NPS pollution sources and causes, identify and coordinate management programs and resources, present education and outreach opportunities, promote pollution prevention, and implement needed management measures to restore impaired waters.

Depending on the pollutant of concern, resources for corrective actions may be provided, as applicable, by the Alabama Cooperative Extension System (education and outreach); the USDA-Natural Resources Conservation Service (NRCS) (technical assistance) and Farm Services Agency (FSA) (federal cost-share funding); and the Alabama Soil and Water Conservation Committee (state agricultural cost share funding and management measure implementation assistance) through local Soil and Water Conservation Districts, or Resource Conservation and Development Councils (funding, project implementation, and coordination). Additional assistance from such agencies as the Alabama Department of Public Health (septic systems), Alabama Department of Agriculture and Industries (pesticides), and the Alabama Department of Industrial Relations and Department of Interior - Office of Surface Mining (abandoned minelands), Natural Heritage Program and US Fish and Wildlife Service (threatened and endangered species), may also provide practical TMDL implementation delivery systems, programs, and information. Landuse and urban sprawl issues will be addressed through the Nonpoint Source for Municipal Officials (NEMO) education and outreach program. Memorandums of Agreements (MOAs) may be used as a tool to formally define roles and responsibilities.

Additional public/private assistance is available through the Alabama Clean Water Partnership (CWP) Program. The CWP program uses a local citizen-based environmental protection approach to coordinate efforts to restore and protect the state's resources in accordance with the goals of the Clean Water Act. Interaction with the state or river basin specific CWP will facilitate TMDL implementation by providing improved and timely communication and information exchange between community-based groups, units of government, industry, special interest groups, and individuals. The CWP can assist local entities to plan, develop, and coordinate restoration strategies that holistically meet multiple needs, eliminate duplication of efforts and allow for effective and efficient use of available resources to restore the impaired waterbody or watershed.

Other mechanisms that are available and may be used during implementation of these TMDLs include local regulations or ordinances related to zoning, landuse, or storm water runoff controls. Local governments can provide funding assistance through general revenues, bond issuance, special taxes, utility fees and impact fees. If applicable, reductions from point sources will be addressed by the NPDES permit program. The Alabama Water Pollution Control Act empowers ADEM to monitor water quality, issue permits, conduct inspections and pursue enforcement of discharge activities and conditions that threaten water quality. In addition to traditional "end-of-pipe" discharges, the ADEM NPDES permit program addresses animal feeding operations and land application of animal wastes. For certain water quality improvement projects, the State Clean Water Revolving Fund (SRF) can provide low interest loans to local governments.

Long-term physical, chemical, and biological improvements in water quality will be used to measure TMDL implementation success. As may be indicated by further evaluation of stream water quality, the effectiveness of implemented management measures may necessitate revisions of these TMDLs. The ADEM will continue to monitor water quality according to the rotational river basin monitoring schedule as allowed by resources. In addition, assessments may include local citizen-volunteer monitoring through the Alabama Water Watch Program and/or data collected by agencies, universities or other entities using standardized monitoring and assessment methodologies. Core management measures will include, but not be limited to water quality improvements and designated use support, preserving and enhancing public health, enhancing ecosystems, pollution prevention and load reductions, implementation of NPS controls, and public awareness and attitude/behavior changes.

## 6.3 Endangered and Threatened Species in Village Creek

The Federal Register indicates the federally listed threatened flattened musk turtle (*Sternotherus depressus*) historically occurred in Village Creek. This particular listing was updated on January 4, 1994, and currently is present on the Federal Register list. The Fish and Wildlife Service reported in a letter to ADEM on November 16, 2000, in regards to the Jefferson County Village Creek WWTP permit expansion, that their records indicated the flattened musk turtle historically occurred and may still occur in Village Creek (USF&WS, 2000). The turtles feed and spend virtually all of their time at the stream bottom and therefore are in constant contact with bottom sediments. The reduction in sediment and metal loads to Village Creek described in this TMDL report will improve the benthic conditions that should support good biology for the turtle species.

## 7.0 Follow-up Monitoring

ADEM has adopted a basin approach to water quality management; an approach that divides Alabama's fourteen major river basins into five groups. Each year, the ADEM water quality resources are concentrated in one of the basin groups. One goal is to continue to monitor §303(d) listed waters. This monitoring will occur in each basin according to the schedule listed below.

**Table 7-1 Major Basin Rotation Monitoring Schedule for Alabama**

| River Basin Group | Scheduled Year |
|---|---|
| Choctawhatchee, Chipola, Perdido-Escambia and Chattahoochee | 2004 |
| Tallapoosa, Alabama and Coosa | 2005 |
| Escatawpa, Upper Tombigbee, Lower Tombigbee and Mobile | 2006 |
| Cahaba and Black Warrior | 2007 |
| Tennessee | 2008 |

Monitoring will help further characterize water quality conditions resulting from the implementation of best management practices in the watershed.

## 8.0 Public Participation

As part of the public participation process, these TMDLs were placed on public notice and made available for review and comment. The public notice was prepared and published in the four major daily newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who have requested to be on ADEM's postal and electronic mailing distributions. In addition, the public notice and subject TMDLs was made available on ADEM's Website: www.adem.state.al.us. The public can also request paper or electronic copies of the TMDLs by contacting Mr. Chris Johnson at 334-271-7827 or clj@adem.state.al.us. The public was given an opportunity to review the TMDLs and submit comments to the Department in writing. At the end of the public review period, all written comments received during the public notice period became part of the administrative record. ADEM considered all comments received by the public prior to finalization of these TMDLs and subsequent submission to EPA Region 4 for final review and approval.

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# Appendix A Data Used In TMDL Development

### Table A-1 Sampling Stations

| Year | STUDY | Station | AGENCY | Stream Section | Road Crossing | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| 1980 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1980 | USGS | 02460500+112WRD | USGS | Village Creek near Adamsville, Al. | | 33.6056 | -87.0069 |
| 1980 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1981 | USGS | 02460500+112WRD | USGS | Village Creek near Adamsville, Al. | | 33.6056 | -87.0069 |
| 1981 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1982 | USGS | 02460500+112WRD | USGS | Village Creek near Adamsville, Al. | | 33.6056 | -87.0069 |
| 1982 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1983 | USGS | 02460500+112WRD | USGS | Village Creek near Adamsville, Al. | | 33.6056 | -87.0069 |
| 1983 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1984 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1985 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1986 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1987 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1988 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1988 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1988 | | BAYVIEWLAKE06+ 21AWIC | ADEM | Village Creek DS of Bayview Lake at | FAS-12 W. of Mulga | 33.5538 | -86.9626 |
| 1988 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| 1988 | | VILLAGECREEK01+ 21AWIC | ADEM | Village Creek | | 33.5908 | -86.7164 |
| 1988 | | VILLAGECREEK02+ 21AWIC | ADEM | Village Creek | | 33.5592 | -86.7492 |
| | | | | | | | |
| 1989 | | 010359E+1114PEST | | 24.8 Miles Up Village Creek | | 33.5528 | -86.9333 |
| 1989 | | 010359F+1114PEST | | 28.03 Miles Up Village Creek | | 33.5278 | -86.8958 |

| Year | STUDY | Station | AGENCY | Stream Section | Road Crossing | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| 1989 | | 010359G+1114PEST | | 33 Miles Up Village Creek | | 33.5444 | -86.8222 |
| 1989 | | 010359H+1114PEST | | 37.42 Miles Up Village Creek | | 33.5653 | -86.7444 |
| 1989 | | 010359I+1114PEST | | 39.6 Miles Up Village Creek | | 33.5903 | -86.7125 |
| 1989 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1989 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1989 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| 1989 | EPA | VIC01+EPA | EPA | Village Creek | Ensley Rd.-Rt65 | 33.5482 | -86.926 |
| 1989 | EPA | VIC02+EPA | EPA | Village Creek | | 33.515 | -86.8783 |
| 1989 | EPA | VIC03+EPA | EPA | Village Creek | | 33.5378 | -86.8133 |
| 1989 | EPA | VIC04+EPA | EPA | Village Creek | Airport HWY | 33.5596 | -86.7495 |
| 1989 | EPA | VIC05+EPA | EPA | Village Creek | 86th St. | 33.577 | -86.7193 |
| | | | | | | | |
| 1990 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1990 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1990 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1991 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1991 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1991 | | BAYVIEWLAKE06+ 21AWIC | ADEM | Village Creek DS of Bayview Lake at | FAS-12 W. of Mulga | 33.5538 | -86.9626 |
| 1991 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1992 | USGS | 02458180+112WRD | USGS | Unnamed Trib to Village Cr | Georgia Rd | 33.5419 | -86.7361 |
| 1992 | USGS | 02458203+112WRD | USGS | Unnamed Trib to Village Cr | 10 Ave & L&N Rr | 33.5344 | -86.7908 |
| 1992 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1992 | USGS | 02458375+112WRD | USGS | Unnamed Trib to Village Cr | Dixie Hub Ctr | 33.5292 | -86.8392 |
| 1992 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1993 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1993 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1994 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1994 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| 1994 | | VLG1+21AWIC | ADEM | Village Creek near East Lake | 75th St. | 33.5625 | -86.7356 |
| | | | | | | | |
| 1995 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1995 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |

| Year | STUDY | Station | AGENCY | Stream Section | Road Crossing | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| 1995 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1996 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1996 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1996 | Volunteer Monitoring | 10009001+AWW | AWW | Village Creek | Coosa St. bridge, North bank | 33.5465 | -86.7851 |
| 1996 | Volunteer Monitoring | 10009002+AWW | AWW | Village Creek | 18th St. bridge, North bank | 33.5363 | -86.8243 |
| 1996 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| | | | | | | | |
| 1997 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1997 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1997 | USGS | 02458600+112WRD | USGS | VILLAGE CREEK NEAR DOCENA AL | | 33.5481 | -86.9258 |
| 1997 | Volunteer Monitoring | 10009001+AWW | AWW | Village Creek | Coosa St. bridge, North bank | 33.5465 | -86.7851 |
| 1997 | Volunteer Monitoring | 10009002+AWW | AWW | Village Creek | 18th St. bridge, North bank | 33.5363 | -86.8243 |
| 1997 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| 1997 | | VILLAGECREEK02+21AWIC | ADEM | Village Creek | | 33.5592 | -86.7492 |
| 1997 | 303(d) Monitoring Program | VLG1+21AWIC | ADEM | Village Creek near East Lake | 76th St. | 33.5625 | -86.7356 |
| 1997 | 303(d) Monitoring Program | VLG2+21AWIC | ADEM | Village Creek | Tallapoosa St | 33.5488 | -86.7804 |
| 1997 | 303(d) Monitoring Program | VLG3+21AWIC | ADEM | Village Creek | Vanderbilt Rd | 33.5432 | -86.792 |
| 1997 | 303(d) Monitoring Program | VLG3A+21AWIC | ADEM | Unnamed Tributary | US I-65 near quarry | 33.5432 | -86.7914 |
| 1997 | 303(d) Monitoring Program | VLG4+21AWIC | ADEM | Village Creek | US I-65 near quarry | 33.5393 | -86.8212 |
| 1997 | 303(d) Monitoring Program | VLG5+21AWIC | ADEM | Village Creek | RR US Arkadelphia Rd | 33.5268 | -86.8498 |
| 1997 | 303(d) Monitoring Program | VLG6+21AWIC | ADEM | Village Creek | Avenue F | 33.5211 | -86.889 |
| 1997 | 303(d) Monitoring Program | VLG7+21AWIC | ADEM | Village Creek | Jeff Co Rd 65 | 33.5483 | -86.9261 |

| Year | STUDY | Station | AGENCY | Stream Section | Road Crossing | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| 1997 | 303(d) Monitoring Program | WWTP1+21AWIC | ADEM | Village Creek WWTP | | 33.5275 | -86.895 |
| | | | | | | | |
| 1998 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1998 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1998 | USGS | 02458600+112WRD | USGS | VILLAGE CREEK NEAR DOCENA AL | | 33.5481 | -86.9258 |
| 1998 | Volunteer Monitoring | 10009001+AWW | AWW | Village Creek | Coosa St. bridge, North bank | 33.5465 | -86.7851 |
| 1998 | Volunteer Monitoring | 10009002+AWW | AWW | Village Creek | 18th St. bridge, North bank | 33.5363 | -86.8243 |
| 1998 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| 1998 | TREND STATION | VI3+21AWIC | ADEM | Village Creek | Jefferson Co Rd 65 | 33.548 | -86.9257 |
| 1998 | | VILLAGECREEK03+21AWIC | ADEM | Village Creek | | 33.5481 | -86.9256 |
| | | | | | | | |
| 1999 | USGS | 02458300+112WRD | USGS | Village Creek | 24th St. | 33.5425 | -86.8175 |
| 1999 | USGS | 02458450+112WRD | USGS | Village Creek | Avenue W | 33.5175 | -86.8792 |
| 1999 | USGS | 02458600+112WRD | USGS | VILLAGE CREEK NEAR DOCENA AL | | 33.5481 | -86.9258 |
| 1999 | Volunteer Monitoring | 10013002+AWW | AWW | Village Creek | Vanderbuilt Rd. | 33.5431 | -86.792 |
| 1999 | Volunteer Monitoring | 10013003+AWW | AWW | Village Creek | 65th Street | 33.5595 | -86.7429 |
| 1999 | Volunteer Monitoring | 10013005+AWW | AWW | Village Creek | Air Cargo Rd. | 33.5593 | -86.7493 |
| 1999 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| 1999 | TREND STATION | VI3+21AWIC | ADEM | Village Creek | Jefferson Co Rd 65 | 33.548 | -86.9257 |
| 1999 | EPA | VIC1+EPA | EPA | Village Creek | RR bridge crossing US78 | 33.5267 | -86.8499 |
| 1999 | SWMA | VIC1_DRY+SWMA | SWMA | Village Creek | Vanderbilt | 33.5433 | -86.7919 |
| 1999 | SWMA | VIC1_WET+SWMA | SWMA | Village Creek | Vanderbilt | 33.5433 | -86.7919 |
| 1999 | SWMA | VIC2_DRY+SWMA | SWMA | Village Creek | Avenue W | 33.5178 | -86.8792 |
| 1999 | SWMA | VIC2_WET+SWMA | SWMA | Village Creek | Avenue W | 33.5178 | -86.8792 |
| 1999 | 1999 VILLAGE CREEK WATER QUALITY STUDY | VIC3+EPA | EPA | Village Creek | Avenue W | 33.5178 | -86.8792 |
| 1999 | SWMA | VIC3_DRY+SWMA | SWMA | Village Creek @ Adamsville, AL | Minor Parkway | 33.5483 | -86.9261 |
| 1999 | SWMA | VIC3_WET+SWMA | SWMA | Village Creek @ Adamsville, AL | Minor Parkway | 33.5483 | -86.9261 |

| Year | STUDY | Station | AGENCY | Stream Section | Road Crossing | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| 1999 | 2006 VILLAGE CREEK WATER QUALITY STUDY | VIC4+EPA | EPA | Village Creek US of WWTP discharge | | 33.5273 | -86.8957 |
| 1999 | 2007 VILLAGE CREEK WATER QUALITY STUDY | VIC5+EPA | EPA | Village Creek at Docena Rd | HWY 65 | 33.5482 | -86.9261 |
| 1999 | 2008 VILLAGE CREEK WATER QUALITY STUDY | VIC6+EPA | EPA | Village Creek | Mulga Rd. | 33.5462 | -86.9508 |
| 1999 | 2009 VILLAGE CREEK WATER QUALITY STUDY | VICWWTP+EPA | EPA | Village Creek at WWTP effluent discharge | | 33.5289 | -86.8965 |
| | | | | | | | |
| 2000 | TREND STATION | VI1+21AWIC | ADEM | Village Ck at Bayview Res Dam | | 33.5742 | -86.9867 |
| 2000 | TREND STATION | VI3+21AWIC | ADEM | Village Creek | Jefferson Co Rd 65 | 33.548 | -86.9257 |
| 2000 | SWMA | VIC1_DRY+SWMA | SWMA | Village Creek | Vanderbilt | 33.5433 | -86.7919 |
| 2000 | SWMA | VIC1_WET+SWMA | SWMA | Village Creek | Vanderbilt | 33.5433 | -86.7919 |
| 2000 | SWMA | VIC2_DRY+SWMA | SWMA | Village Creek | Avenue W | 33.5178 | -86.8792 |
| 2000 | SWMA | VIC2_WET+SWMA | SWMA | Village Creek | Avenue W | 33.5178 | -86.8792 |
| 2000 | SWMA | VIC3_DRY+SWMA | SWMA | Village Creek @ Adamsville, AL | Minor Parkway | 33.5483 | -86.9261 |
| 2000 | SWMA | VIC3_WET+SWMA | SWMA | Village Creek @ Adamsville, AL | Minor Parkway | 33.5483 | -86.9261 |
| 2000 | USGS | VIL1+112WRD | USGS | Village Creek at East Lake in Birmingham | | 33.57 | -86.7242 |
| 2000 | USGS | VIL2+112WRD | USGS | Village Creek | 24th St | 33.5425 | -86.8175 |
| 2000 | USGS | VIL3+112WRD | USGS | Village Creek | Avenue W | 33.5178 | -86.8792 |
| 2000 | USGS | VIL4+112WRD | USGS | Village Creek near Docena | | 33.5481 | -86.9258 |
| | | | | | | | |
| 2001 | SWMA | VIC1_DRY+SWMA | SWMA | Village Creek | Vanderbilt | 33.5433 | -86.7919 |
| 2001 | SWMA | VIC1_WET+SWMA | SWMA | Village Creek | Vanderbilt | 33.5433 | -86.7919 |
| 2001 | SWMA | VIC2_DRY+SWMA | SWMA | Village Creek | Avenue W | 33.5178 | -86.8792 |
| 2001 | SWMA | VIC2_WET+SWMA | SWMA | Village Creek | Avenue W | 33.5178 | -86.8792 |
| 2001 | SWMA | VIC3_DRY+SWMA | SWMA | Village Creek @ Adamsville, AL | Minor Parkway | 33.5483 | -86.9261 |
| 2001 | SWMA | VIC3_WET+SWMA | SWMA | Village Creek @ Adamsville, AL | Minor Parkway | 33.5483 | -86.9261 |

| Year | STUDY | Station | AGENCY | Stream Section | Road Crossing | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| 2001 | USGS | VIL1+112WRD | USGS | Village Creek at East Lake in Birmingham | | 33.57 | -86.7242 |
| 2001 | USGS | VIL2+112WRD | USGS | Village Creek | 25th St | 33.5425 | -86.8175 |
| 2001 | USGS | VIL3+112WRD | USGS | Village Creek | Avenue W | 33.5178 | -86.8792 |
| | | | | | | | |
| 2002 | TREND STATION | VI3+21AWIC | ADEM | Village Creek | Jefferson Co Rd 65 | 33.548 | -86.9257 |
| 2002 | 303(d) Monitoring Program | VLGJ-1 | ADEM | Village Creek | 75th Street North | 33.5625 | -86.7356 |
| 2002 | 303(d) Monitoring Program | VLGJ-2 | ADEM | Village Creek | Vanderbilt Rd | 33.5433 | -86.7919 |
| 2002 | 303(d) Monitoring Program | VLGJ-3 | ADEM | Village Creek | RR Bridge U/S of Arkedelphia Rd "US Hwy 78 | 33.5268 | -86.8498 |
| 2002 | 303(d) Monitoring Program | VLGJ-4 | ADEM | Village Creek | Avenue F in Ensley | 33.5211 | -86.889 |

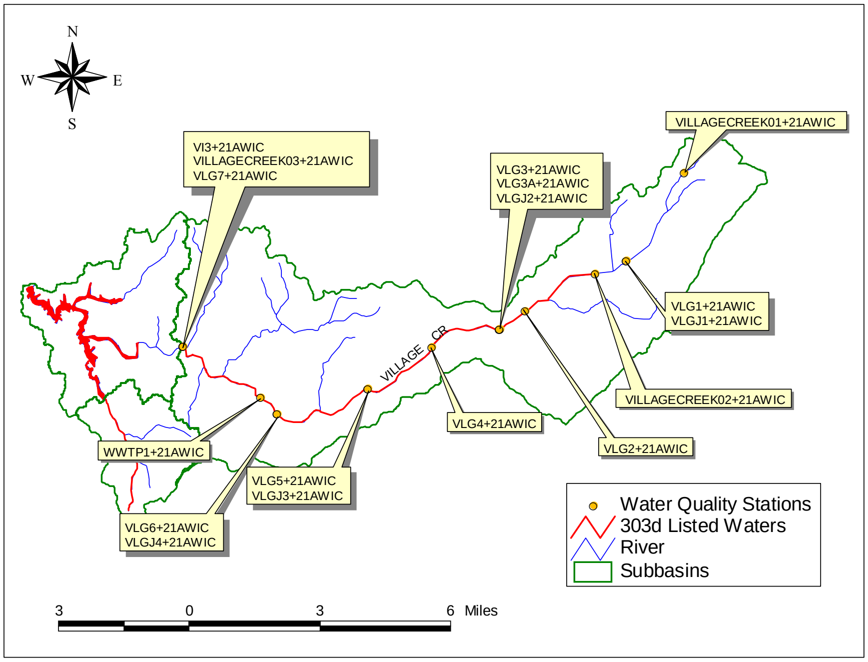



**Figure A-1 ADEM Station Locations on Village Creek**

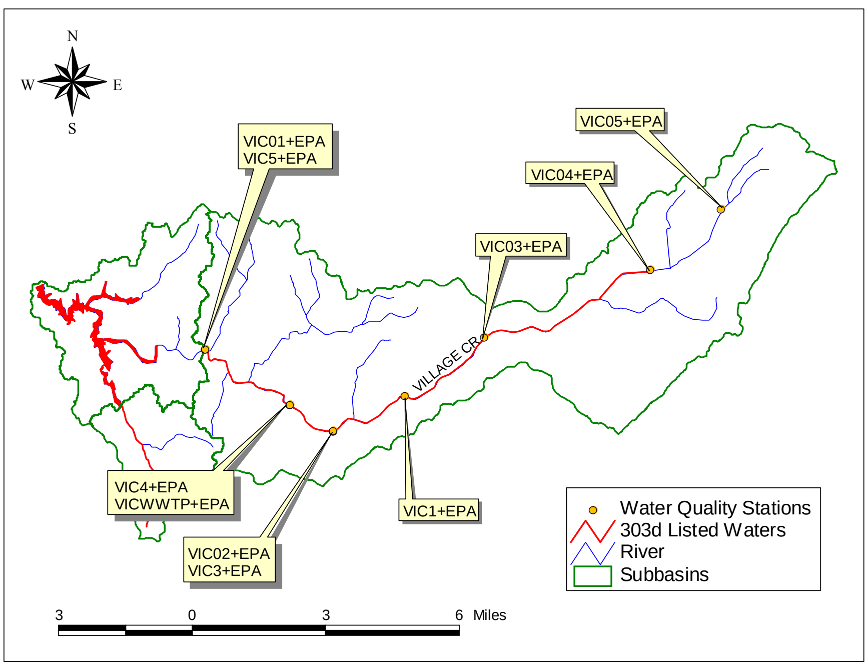



**Figure A-2 EPA Station Locations on Village Creek**

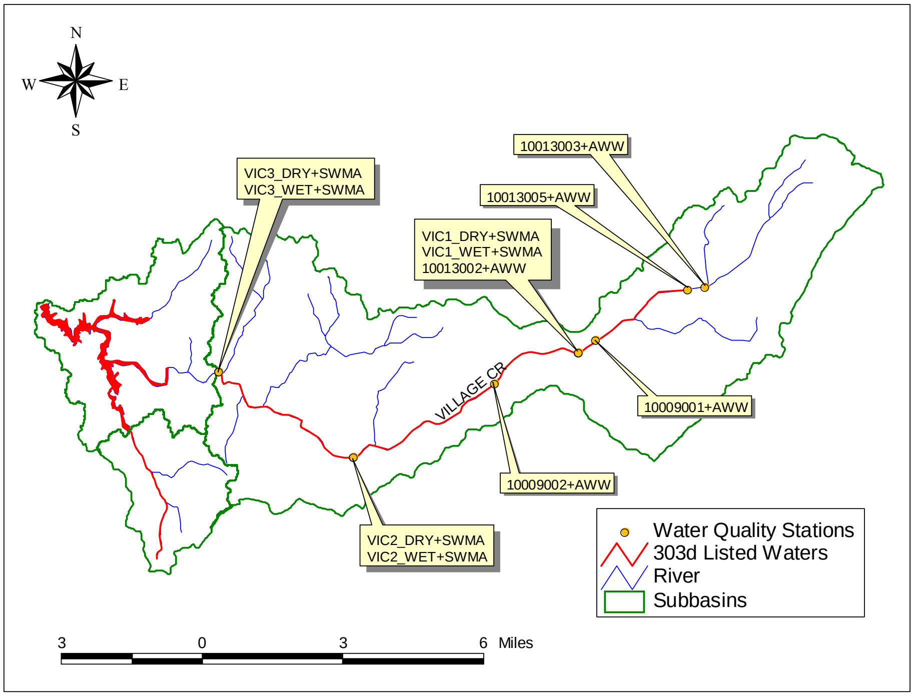



**Figure A-3 SWMA and Volunteer Monitoring Station Locations on Village Creek**

**Table A-2 Village Creek Hardness and the Percentage of Time a Value is Exceeded, based on the data used in this TMDL.**

| Station ID | Date Time | Hardness (mg/L) | % Exceedance |
|---|---|---|---|
| 10009001+AWW | 11/1/1996 13:35 | 190 | 32% |
| 10009001+AWW | 12/9/1996 13:45 | 170 | 63% |
| 10009001+AWW | 1/14/1997 13:45 | 170 | 63% |
| 10009001+AWW | 2/14/1997 13:30 | 150 | 79% |
| 10009001+AWW | 3/14/1997 14:30 | 120 | 89% |
| 10009001+AWW | 4/14/1997 13:30 | 150 | 79% |
| 10009001+AWW | 5/15/1997 13:45 | 140 | 83% |
| 10009001+AWW | 6/16/1997 14:00 | 100 | 91% |
| 10009001+AWW | 7/14/1997 13:45 | 140 | 83% |
| 10009001+AWW | 8/15/1997 14:00 | 140 | 83% |
| 10009001+AWW | 9/17/1997 14:00 | 150 | 79% |
| 10009001+AWW | 10/16/1997 14:30 | 130 | 87% |
| 10009001+AWW | 11/20/1997 13:30 | 180 | 50% |
| 10009001+AWW | 12/19/1997 14:00 | 180 | 50% |
| 10009001+AWW | 1/20/1998 14:00 | 170 | 63% |
| 10009001+AWW | 2/16/1998 13:45 | 90 | 96% |
| 10009001+AWW | 3/16/1998 13:45 | 160 | 70% |
| 10009001+AWW | 4/20/1998 14:00 | 180 | 50% |
| 10009002+AWW | 11/4/1996 13:15 | 190 | 32% |
| 10009002+AWW | 12/10/1996 15:00 | 190 | 32% |
| 10009002+AWW | 1/15/1997 14:00 | 190 | 32% |
| 10009002+AWW | 2/14/1997 15:00 | 170 | 63% |
| 10009002+AWW | 3/17/1997 15:00 | 180 | 50% |
| 10009002+AWW | 4/15/1997 15:00 | 160 | 70% |
| 10009002+AWW | 5/15/1997 15:00 | 160 | 70% |
| 10009002+AWW | 6/16/1997 15:15 | 100 | 91% |
| 10009002+AWW | 7/14/1997 14:45 | 170 | 63% |
| 10009002+AWW | 8/15/1997 14:45 | 150 | 79% |
| 10009002+AWW | 9/17/1997 15:00 | 150 | 79% |
| 10009002+AWW | 10/16/1997 15:45 | 170 | 63% |
| 10009002+AWW | 11/20/1997 15:45 | 180 | 50% |
| 10009002+AWW | 12/19/1997 15:00 | 190 | 32% |
| 10009002+AWW | 1/20/1998 15:00 | 180 | 50% |
| 10009002+AWW | 2/16/1998 15:00 | 90 | 96% |
| 10009002+AWW | 3/16/1998 15:00 | 170 | 63% |
| 10009002+AWW | 4/20/1998 15:30 | 200 | 19% |
| 10013002+AWW | 1/12/1999 12:30 | 220 | 4% |
| 10013002+AWW | 2/15/1999 14:30 | 170 | 63% |
| 10013003+AWW | 1/25/1999 13:00 | 210 | 10% |
| 10013003+AWW | 3/17/1999 11:30 | 240 | 1% |
| 10013005+AWW | 3/17/1999 13:00 | 210 | 10% |
| VIC1_DRY+SWMA | 9/23/1999 0:00 | 186 | 37% |
| VIC1_DRY+SWMA | 12/29/1999 0:00 | 208 | 13% |
| VIC1_DRY+SWMA | 3/23/2000 0:00 | 216 | 5% |
| VIC1_DRY+SWMA | 7/7/2000 0:00 | 204 | 15% |
| VIC1_DRY+SWMA | 9/21/2000 0:00 | 167 | 64% |
| VIC1_DRY+SWMA | 1/4/2001 0:00 | 210 | 11% |
| VIC1_DRY+SWMA | 4/18/2001 0:00 | 204 | 13% |
| VIC1_DRY+SWMA | 7/11/2001 0:00 | 181 | 44% |
| VIC1_WET+SWMA | 9/29/1999 0:00 | 100 | 92% |
| VIC1_WET+SWMA | 2/14/2000 0:00 | 146 | 82% |

| Station ID | Date Time | Hardness (mg/L) | % Exceedance |
|---|---|---|---|
| VIC1_WET+SWMA | 4/14/2000 0:00 | 89 | 97% |
| VIC1_WET+SWMA | 6/29/2000 0:00 | 125 | 88% |
| VIC1_WET+SWMA | 11/7/2000 0:00 | 106 | 90% |
| VIC1_WET+SWMA | 1/8/2001 0:00 | 170 | 63% |
| VIC1_WET+SWMA | 6/15/2001 0:00 | 209 | 12% |
| VIC1_WET+SWMA | 8/7/2001 0:00 | 95 | 93% |
| VIC2_DRY+SWMA | 9/23/1999 0:00 | 178 | 51% |
| VIC2_DRY+SWMA | 12/29/1999 0:00 | 241 | 1% |
| VIC2_DRY+SWMA | 3/23/2000 0:00 | 235 | 2% |
| VIC2_DRY+SWMA | 7/7/2000 0:00 | 197 | 23% |
| VIC2_DRY+SWMA | 9/21/2000 0:00 | 191 | 27% |
| VIC2_DRY+SWMA | 1/4/2001 0:00 | 198 | 21% |
| VIC2_DRY+SWMA | 4/18/2001 0:00 | 213 | 7% |
| VIC2_DRY+SWMA | 7/11/2001 0:00 | 156 | 74% |
| VIC2_WET+SWMA | 9/29/1999 0:00 | 158 | 71% |
| VIC2_WET+SWMA | 2/14/2000 0:00 | 174 | 56% |
| VIC2_WET+SWMA | 4/14/2000 0:00 | 191 | 28% |
| VIC2_WET+SWMA | 6/29/2000 0:00 | 148 | 81% |
| VIC2_WET+SWMA | 11/7/2000 0:00 | 100 | 93% |
| VIC2_WET+SWMA | 1/8/2001 0:00 | 149 | 80% |
| VIC2_WET+SWMA | 6/15/2001 0:00 | 178 | 51% |
| VIC2_WET+SWMA | 8/7/2001 0:00 | 93 | 94% |
| VIC3_DRY+SWMA | 9/23/1999 0:00 | 150 | 79% |
| VIC3_DRY+SWMA | 12/29/1999 0:00 | 177 | 54% |
| VIC3_DRY+SWMA | 3/23/2000 0:00 | 211 | 8% |
| VIC3_DRY+SWMA | 7/7/2000 0:00 | 136 | 86% |
| VIC3_DRY+SWMA | 9/21/2000 0:00 | 139 | 84% |
| VIC3_DRY+SWMA | 1/4/2001 0:00 | 177 | 54% |
| VIC3_DRY+SWMA | 4/18/2001 0:00 | 183 | 41% |
| VIC3_DRY+SWMA | 7/11/2001 0:00 | 167 | 64% |
| VIC3_WET+SWMA | 9/29/1999 0:00 | 136 | 86% |
| VIC3_WET+SWMA | 2/14/2000 0:00 | 112 | 89% |
| VIC3_WET+SWMA | 4/14/2000 0:00 | 211 | 8% |
| VIC3_WET+SWMA | 6/29/2000 0:00 | 135 | 87% |
| VIC3_WET+SWMA | 11/7/2000 0:00 | 93 | 94% |
| VIC3_WET+SWMA | 1/8/2001 0:00 | 139 | 85% |
| VIC3_WET+SWMA | 6/15/2001 0:00 | 166 | 66% |
| VIC3_WET+SWMA | 8/7/2001 0:00 | 88 | 97% |
| VIL1+112WRD | 3/1/2000 16:25 | 197 | 22% |
| VIL1+112WRD | 4/1/2000 11:39 | 184 | 41% |
| VIL1+112WRD | 5/17/2000 9:10 | 194 | 25% |
| VIL1+112WRD | 6/30/2000 10:20 | 203 | 16% |
| VIL1+112WRD | 8/1/2000 15:00 | 184 | 41% |
| VIL1+112WRD | 8/30/2000 13:45 | 191 | 29% |
| VIL1+112WRD | 10/4/2000 13:00 | 199 | 20% |
| VIL1+112WRD | 11/8/2000 20:00 | 37 | 100% |
| VIL1+112WRD | 12/14/2000 13:15 | 198 | 21% |
| VIL1+112WRD | 1/24/2001 9:05 | 202 | 17% |
| VIL1+112WRD | 1/29/2001 19:00 | 41 | 100% |
| VIL1+112WRD | 3/19/2001 12:30 | 187 | 34% |
| VIL1+112WRD | 5/9/2001 13:05 | 187 | 34% |
| VIL2+112WRD | 8/1/2000 8:10 | 158 | 71% |
| VIL2+112WRD | 8/30/2000 8:30 | 219 | 4% |
| VIL2+112WRD | 10/4/2000 8:10 | 158 | 71% |

| Station ID | Date Time | Hardness (mg/L) | % Exceedance |
|---|---|---|---|
| VIL2+112WRD | 11/14/2000 8:20 | 292 | 0% |
| VIL2+112WRD | 12/14/2000 8:30 | 103 | 90% |
| VIL2+112WRD | 1/24/2001 15:00 | 221 | 3% |
| VIL2+112WRD | 1/29/2001 21:00 | 49 | 99% |
| VIL3+112WRD | 3/2/2000 10:10 | 214 | 6% |
| VIL3+112WRD | 3/30/2000 11:15 | 65 | 98% |
| VIL3+112WRD | 6/30/2000 16:30 | 154 | 75% |
| VIL3+112WRD | 8/2/2000 14:40 | 91 | 95% |
| VIL3+112WRD | 8/29/2000 8:30 | 178 | 53% |
| VIL3+112WRD | 10/3/2000 13:15 | 160 | 70% |
| VIL3+112WRD | 11/14/2000 14:30 | 185 | 37% |
| VIL3+112WRD | 12/12/2000 13:00 | 209 | 12% |
| VIL3+112WRD | 1/23/2001 14:45 | 216 | 6% |
| VIL3+112WRD | 2/14/2001 9:10 | 191 | 29% |
| VIL4+112WRD | 3/2/2000 16:00 | 174 | 56% |
| VIL4+112WRD | 4/2/2000 12:30 | 61 | 98% |
| VIL4+112WRD | 7/1/2000 14:15 | 155 | 74% |
| VLG1+21AWIC | 5/22/1997 9:30 | 172 | 58% |
| VLG1+21AWIC | 6/11/1997 9:44 | 186 | 36% |
| VLG1+21AWIC | 6/12/1997 9:33 | 186 | 36% |
| VLG1+21AWIC | 7/9/1997 9:45 | 198 | 21% |
| VLG1+21AWIC | 8/12/1997 9:30 | 200 | 19% |
| VLG1+21AWIC | 9/9/1997 10:45 | 182 | 43% |
| VLG2+21AWIC | 5/22/1997 10:15 | 182 | 43% |
| VLG2+21AWIC | 6/11/1997 9:29 | 176 | 55% |
| VLG2+21AWIC | 6/12/1997 9:17 | 184 | 41% |
| VLG2+21AWIC | 7/9/1997 10:25 | 200 | 19% |
| VLG2+21AWIC | 8/12/1997 10:00 | 184 | 41% |
| VLG2+21AWIC | 9/9/1997 10:15 | 176 | 55% |
| VLG3+21AWIC | 5/22/1997 11:00 | 184 | 41% |
| VLG3+21AWIC | 6/11/1997 9:10 | 180 | 50% |
| VLG3+21AWIC | 6/12/1997 8:56 | 194 | 25% |
| VLG3+21AWIC | 7/9/1997 10:55 | 210 | 10% |
| VLG3+21AWIC | 8/12/1997 10:30 | 194 | 25% |
| VLG3+21AWIC | 9/9/1997 9:30 | 186 | 36% |
| VLG3A+21AWIC | 5/22/1997 11:30 | 182 | 43% |
| VLG3A+21AWIC | 6/11/1997 9:08 | 202 | 17% |
| VLG3A+21AWIC | 6/12/1997 8:54 | 194 | 25% |
| VLG3A+21AWIC | 7/9/1997 11:20 | 180 | 50% |
| VLG3A+21AWIC | 8/12/1997 10:45 | 180 | 50% |
| VLG3A+21AWIC | 9/9/1997 9:35 | 186 | 36% |
| VLG4+21AWIC | 5/21/1997 12:00 | 162 | 67% |
| VLG4+21AWIC | 6/11/1997 8:44 | 210 | 10% |
| VLG4+21AWIC | 6/12/1997 8:37 | 192 | 27% |
| VLG4+21AWIC | 7/9/1997 8:25 | 172 | 58% |
| VLG4+21AWIC | 8/12/1997 12:10 | 200 | 19% |
| VLG4+21AWIC | 9/9/1997 8:50 | 178 | 53% |
| VLG5+21AWIC | 5/22/1997 9:15 | 178 | 53% |
| VLG5+21AWIC | 6/11/1997 8:09 | 218 | 5% |
| VLG5+21AWIC | 6/12/1997 8:21 | 192 | 27% |
| VLG5+21AWIC | 7/9/1997 9:25 | 156 | 73% |
| VLG5+21AWIC | 8/12/1997 13:10 | 204 | 14% |
| VLG5+21AWIC | 9/9/1997 9:15 | 180 | 50% |
| VLG6+21AWIC | 5/22/1997 10:20 | 188 | 33% |

| Station ID | Date Time | Hardness (mg/L) | % Exceedance |
|---|---|---|---|
| VLG6+21AWIC | 6/11/1997 7:24 | 224 | 2% |
| VLG6+21AWIC | 6/12/1997 7:40 | 190 | 32% |
| VLG6+21AWIC | 7/9/1997 9:45 | 180 | 50% |
| VLG6+21AWIC | 8/12/1997 13:45 | 204 | 14% |
| VLG6+21AWIC | 9/9/1997 9:40 | 172 | 58% |
| VLG7+21AWIC | 5/22/1997 11:10 | 162 | 67% |
| VLG7+21AWIC | 6/11/1997 6:54 | 184 | 41% |
| VLG7+21AWIC | 6/12/1997 7:12 | 164 | 66% |
| VLG7+21AWIC | 7/9/1997 10:20 | 154 | 75% |
| VLG7+21AWIC | 8/12/1997 14:20 | 196 | 23% |
| VLG7+21AWIC | 9/9/1997 10:10 | 150 | 79% |
| WWTP1+21AWIC | 6/11/1997 10:00 | 166 | 65% |
| WWTP1+21AWIC | 6/12/1997 10:00 | 156 | 73% |
| WWTP1+21AWIC | 7/10/1997 10:00 | 156 | 73% |
| WWTP1+21AWIC | 8/12/1997 12:25 | 148 | 81% |
| WWTP1+21AWIC | 9/9/1997 9:45 | 136 | 85% |

**Table A-3 Village Creek pH**

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| 10009001+AWW | AWW | 11/1/1996 13:35 | 8 |
| 10009001+AWW | AWW | 12/9/1996 13:45 | 8.5 |
| 10009001+AWW | AWW | 1/14/1997 13:45 | 8.5 |
| 10009001+AWW | AWW | 2/14/1997 13:30 | 8.5 |
| 10009001+AWW | AWW | 3/14/1997 14:30 | 8.5 |
| 10009001+AWW | AWW | 4/14/1997 13:30 | 9 |
| 10009001+AWW | AWW | 5/15/1997 13:45 | 9.5 |
| 10009001+AWW | AWW | 6/16/1997 14:00 | 8 |
| 10009001+AWW | AWW | 7/14/1997 13:45 | 9 |
| 10009001+AWW | AWW | 8/15/1997 14:00 | 8 |
| 10009001+AWW | AWW | 9/17/1997 14:00 | 8.5 |
| 10009001+AWW | AWW | 10/16/1997 14:30 | 8.5 |
| 10009001+AWW | AWW | 11/20/1997 13:30 | 8.5 |
| 10009001+AWW | AWW | 12/19/1997 14:00 | 8.5 |
| 10009001+AWW | AWW | 1/20/1998 14:00 | 8.5 |
| 10009001+AWW | AWW | 2/16/1998 13:45 | 8 |
| 10009001+AWW | AWW | 3/16/1998 13:45 | 9 |
| 10009001+AWW | AWW | 4/20/1998 14:00 | 8 |
| 10009002+AWW | AWW | 11/4/1996 13:15 | 8 |
| 10009002+AWW | AWW | 12/10/1996 15:00 | 8.5 |
| 10009002+AWW | AWW | 1/15/1997 14:00 | 8.5 |
| 10009002+AWW | AWW | 2/14/1997 15:00 | 8.5 |
| 10009002+AWW | AWW | 3/17/1997 15:00 | 8 |
| 10009002+AWW | AWW | 4/15/1997 15:00 | 8 |
| 10009002+AWW | AWW | 5/15/1997 15:00 | 8.5 |
| 10009002+AWW | AWW | 6/16/1997 15:15 | 8 |
| 10009002+AWW | AWW | 7/14/1997 14:45 | 8 |
| 10009002+AWW | AWW | 8/15/1997 14:45 | 8 |
| 10009002+AWW | AWW | 9/17/1997 15:00 | 8.5 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| 10009002+AWW | AWW | 10/16/1997 15:45 | 8.5 |
| 10009002+AWW | AWW | 11/20/1997 15:45 | 8.5 |
| 10009002+AWW | AWW | 12/19/1997 15:00 | 8.5 |
| 10009002+AWW | AWW | 1/20/1998 15:00 | 8 |
| 10009002+AWW | AWW | 2/16/1998 15:00 | 7.5 |
| 10009002+AWW | AWW | 3/16/1998 15:00 | 9 |
| 10009002+AWW | AWW | 4/20/1998 15:30 | 8.5 |
| 10013002+AWW | AWW | 1/12/1999 12:30 | 8.5 |
| 10013002+AWW | AWW | 2/15/1999 14:30 | 9 |
| 10013003+AWW | AWW | 1/25/1999 13:00 | 8 |
| 10013003+AWW | AWW | 3/17/1999 11:30 | 8.5 |
| 10013005+AWW | AWW | 3/17/1999 13:00 | 8 |
| VI3+21AWIC | ADEM | 1/9/2002 0:00 | 6.6 |
| VI3+21AWIC | ADEM | 2/12/2002 0:00 | 7.61 |
| VI3+21AWIC | ADEM | 3/20/2002 0:00 | 7.18 |
| VI3+21AWIC | ADEM | 5/8/2002 0:00 | 7.5 |
| VI3+21AWIC | ADEM | 6/19/2002 0:00 | 7.8 |
| VI3+21AWIC | ADEM | 7/9/2002 0:00 | 7.19 |
| VI3+21AWIC | ADEM | 7/15/2002 0:00 | 7.85 |
| VI3+21AWIC | ADEM | 9/17/2002 0:00 | 7.2 |
| VI3+21AWIC | ADEM | 10/13/1998 11:00 | 6.94 |
| VI3+21AWIC | ADEM | 6/2/1999 10:30 | 7.46 |
| VI3+21AWIC | ADEM | 8/5/1999 9:40 | 7.55 |
| VI3+21AWIC | ADEM | 10/12/1999 11:15 | 7.33 |
| VI3+21AWIC | ADEM | 6/6/2000 10:10 | 7 |
| VI3+21AWIC | ADEM | 8/8/2000 10:30 | 7.2 |
| VIC1_DRY+SWMA | SWMA | 9/23/1999 0:00 | 8.1 |
| VIC1_DRY+SWMA | SWMA | 12/29/1999 0:00 | 8.1 |
| VIC1_DRY+SWMA | SWMA | 3/23/2000 0:00 | 8.2 |
| VIC1_DRY+SWMA | SWMA | 7/7/2000 0:00 | 8.1 |
| VIC1_DRY+SWMA | SWMA | 9/21/2000 0:00 | 8.2 |
| VIC1_DRY+SWMA | SWMA | 1/4/2001 0:00 | 8.6 |
| VIC1_DRY+SWMA | SWMA | 4/18/2001 0:00 | 8.3 |
| VIC1_DRY+SWMA | SWMA | 7/11/2001 0:00 | 8.3 |
| VIC1_WET+SWMA | SWMA | 9/29/1999 0:00 | 8.4 |
| VIC1_WET+SWMA | SWMA | 2/14/2000 0:00 | 7.9 |
| VIC1_WET+SWMA | SWMA | 4/14/2000 0:00 | 7.9 |
| VIC1_WET+SWMA | SWMA | 6/29/2000 0:00 | 8 |
| VIC1_WET+SWMA | SWMA | 11/7/2000 0:00 | 8.6 |
| VIC1_WET+SWMA | SWMA | 1/8/2001 0:00 | 8.3 |
| VIC1_WET+SWMA | SWMA | 6/15/2001 0:00 | 8.6 |
| VIC1_WET+SWMA | SWMA | 8/7/2001 0:00 | 7.9 |
| VIC1+EPA | SWMA | 8/22/1999 0:00 | 9 |
| VIC2_DRY+SWMA | SWMA | 9/23/1999 0:00 | 8.2 |
| VIC2_DRY+SWMA | SWMA | 12/29/1999 0:00 | 8.2 |
| VIC2_DRY+SWMA | SWMA | 3/23/2000 0:00 | 7.9 |
| VIC2_DRY+SWMA | SWMA | 7/7/2000 0:00 | 8.3 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VIC2_DRY+SWMA | SWMA | 9/21/2000 0:00 | 8.3 |
| VIC2_DRY+SWMA | SWMA | 1/4/2001 0:00 | 8.1 |
| VIC2_DRY+SWMA | SWMA | 4/18/2001 0:00 | 8 |
| VIC2_DRY+SWMA | SWMA | 7/11/2001 0:00 | 8.1 |
| VIC2_WET+SWMA | SWMA | 9/29/1999 0:00 | 7.7 |
| VIC2_WET+SWMA | SWMA | 2/14/2000 0:00 | 8 |
| VIC2_WET+SWMA | SWMA | 4/14/2000 0:00 | 7.9 |
| VIC2_WET+SWMA | SWMA | 6/29/2000 0:00 | 7.8 |
| VIC2_WET+SWMA | SWMA | 11/7/2000 0:00 | 7.8 |
| VIC2_WET+SWMA | SWMA | 1/8/2001 0:00 | 7.9 |
| VIC2_WET+SWMA | SWMA | 6/15/2001 0:00 | 8 |
| VIC2_WET+SWMA | SWMA | 8/7/2001 0:00 | 7.8 |
| VIC3_DRY+SWMA | SWMA | 9/23/1999 0:00 | 7.6 |
| VIC3_DRY+SWMA | SWMA | 12/29/1999 0:00 | 7.6 |
| VIC3_DRY+SWMA | SWMA | 3/23/2000 0:00 | 7.4 |
| VIC3_DRY+SWMA | SWMA | 7/7/2000 0:00 | 7.5 |
| VIC3_DRY+SWMA | SWMA | 9/21/2000 0:00 | 7.5 |
| VIC3_DRY+SWMA | SWMA | 1/4/2001 0:00 | 7.4 |
| VIC3_DRY+SWMA | SWMA | 4/18/2001 0:00 | 7.6 |
| VIC3_DRY+SWMA | SWMA | 7/11/2001 0:00 | 7.7 |
| VIC3_WET+SWMA | SWMA | 9/29/1999 0:00 | 7.7 |
| VIC3_WET+SWMA | SWMA | 2/14/2000 0:00 | 7.4 |
| VIC3_WET+SWMA | SWMA | 4/14/2000 0:00 | 7.6 |
| VIC3_WET+SWMA | SWMA | 6/29/2000 0:00 | 7.5 |
| VIC3_WET+SWMA | SWMA | 11/7/2000 0:00 | 7.5 |
| VIC3_WET+SWMA | SWMA | 1/8/2001 0:00 | 7.7 |
| VIC3_WET+SWMA | SWMA | 6/15/2001 0:00 | 7.5 |
| VIC3_WET+SWMA | SWMA | 8/7/2001 0:00 | 7.6 |
| VIC3+EPA | EPA | 8/22/1999 0:00 | 9 |
| VIC3+EPA | EPA | 9/20/1999 9:00 | 7.74 |
| VIC3+EPA | EPA | 9/20/1999 9:30 | 7.81 |
| VIC3+EPA | EPA | 9/20/1999 10:00 | 7.9 |
| VIC3+EPA | EPA | 9/20/1999 10:30 | 7.97 |
| VIC3+EPA | EPA | 9/20/1999 11:00 | 7.99 |
| VIC3+EPA | EPA | 9/20/1999 11:30 | 8 |
| VIC3+EPA | EPA | 9/20/1999 12:00 | 8.05 |
| VIC3+EPA | EPA | 9/20/1999 12:30 | 8.24 |
| VIC3+EPA | EPA | 9/20/1999 13:00 | 8.42 |
| VIC3+EPA | EPA | 9/20/1999 13:30 | 8.48 |
| VIC3+EPA | EPA | 9/20/1999 14:00 | 8.56 |
| VIC3+EPA | EPA | 9/20/1999 14:30 | 8.64 |
| VIC3+EPA | EPA | 9/20/1999 15:00 | 8.7 |
| VIC3+EPA | EPA | 9/20/1999 15:30 | 8.73 |
| VIC3+EPA | EPA | 9/20/1999 16:00 | 8.76 |
| VIC3+EPA | EPA | 9/20/1999 16:30 | 8.78 |
| VIC3+EPA | EPA | 9/20/1999 17:00 | 8.79 |
| VIC3+EPA | EPA | 9/20/1999 17:30 | 8.78 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VIC3+EPA | EPA | 9/20/1999 18:00 | 8.75 |
| VIC3+EPA | EPA | 9/20/1999 18:30 | 8.72 |
| VIC3+EPA | EPA | 9/20/1999 19:00 | 8.68 |
| VIC3+EPA | EPA | 9/20/1999 19:30 | 8.65 |
| VIC3+EPA | EPA | 9/20/1999 20:00 | 8.62 |
| VIC3+EPA | EPA | 9/20/1999 20:30 | 8.6 |
| VIC3+EPA | EPA | 9/20/1999 21:00 | 8.57 |
| VIC3+EPA | EPA | 9/20/1999 21:30 | 8.54 |
| VIC3+EPA | EPA | 9/20/1999 22:00 | 8.51 |
| VIC3+EPA | EPA | 9/20/1999 22:30 | 8.46 |
| VIC3+EPA | EPA | 9/20/1999 23:00 | 8.41 |
| VIC3+EPA | EPA | 9/20/1999 23:30 | 8.35 |
| VIC3+EPA | EPA | 9/21/1999 0:00 | 8.29 |
| VIC3+EPA | EPA | 9/21/1999 0:30 | 8.23 |
| VIC3+EPA | EPA | 9/21/1999 1:00 | 8.17 |
| VIC3+EPA | EPA | 9/21/1999 1:30 | 8.12 |
| VIC3+EPA | EPA | 9/21/1999 2:00 | 8.06 |
| VIC3+EPA | EPA | 9/21/1999 2:30 | 7.97 |
| VIC3+EPA | EPA | 9/21/1999 3:00 | 7.92 |
| VIC3+EPA | EPA | 9/21/1999 3:30 | 7.85 |
| VIC3+EPA | EPA | 9/21/1999 4:00 | 7.78 |
| VIC3+EPA | EPA | 9/21/1999 4:30 | 7.71 |
| VIC3+EPA | EPA | 9/21/1999 5:00 | 7.66 |
| VIC3+EPA | EPA | 9/21/1999 5:30 | 7.62 |
| VIC3+EPA | EPA | 9/21/1999 6:00 | 7.64 |
| VIC3+EPA | EPA | 9/21/1999 6:30 | 7.76 |
| VIC3+EPA | EPA | 9/21/1999 7:00 | 7.95 |
| VIC3+EPA | EPA | 9/21/1999 7:30 | 8.03 |
| VIC3+EPA | EPA | 9/21/1999 8:00 | 7.99 |
| VIC3+EPA | EPA | 9/21/1999 8:30 | 7.92 |
| VIC3+EPA | EPA | 9/21/1999 9:00 | 7.87 |
| VIC3+EPA | EPA | 9/21/1999 9:30 | 7.82 |
| VIC3+EPA | EPA | 9/21/1999 10:00 | 7.8 |
| VIC3+EPA | EPA | 9/21/1999 10:30 | 7.78 |
| VIC3+EPA | EPA | 9/21/1999 11:00 | 7.79 |
| VIC3+EPA | EPA | 9/21/1999 11:30 | 7.83 |
| VIC3+EPA | EPA | 9/21/1999 12:00 | 7.86 |
| VIC3+EPA | EPA | 9/21/1999 12:30 | 7.94 |
| VIC3+EPA | EPA | 9/21/1999 13:00 | 8.05 |
| VIC3+EPA | EPA | 9/21/1999 13:30 | 8.15 |
| VIC3+EPA | EPA | 9/21/1999 14:00 | 8.21 |
| VIC3+EPA | EPA | 9/21/1999 14:30 | 8.25 |
| VIC3+EPA | EPA | 9/21/1999 15:00 | 8.3 |
| VIC3+EPA | EPA | 9/21/1999 15:30 | 8.33 |
| VIC3+EPA | EPA | 9/21/1999 16:00 | 8.35 |
| VIC3+EPA | EPA | 9/21/1999 16:30 | 8.36 |
| VIC3+EPA | EPA | 9/21/1999 17:00 | 8.4 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VIC3+EPA | EPA | 9/21/1999 17:30 | 8.38 |
| VIC3+EPA | EPA | 9/21/1999 18:00 | 8.38 |
| VIC3+EPA | EPA | 9/21/1999 18:30 | 8.34 |
| VIC3+EPA | EPA | 9/21/1999 19:00 | 8.29 |
| VIC3+EPA | EPA | 9/21/1999 19:30 | 8.25 |
| VIC3+EPA | EPA | 9/21/1999 20:00 | 8.2 |
| VIC3+EPA | EPA | 9/21/1999 21:00 | 8.12 |
| VIC3+EPA | EPA | 9/21/1999 21:30 | 8.07 |
| VIC3+EPA | EPA | 9/21/1999 22:00 | 8.02 |
| VIC3+EPA | EPA | 9/21/1999 22:30 | 7.97 |
| VIC3+EPA | EPA | 9/21/1999 23:00 | 7.92 |
| VIC3+EPA | EPA | 9/21/1999 23:00 | 8.16 |
| VIC3+EPA | EPA | 9/21/1999 23:30 | 7.88 |
| VIC3+EPA | EPA | 9/22/1999 0:00 | 7.84 |
| VIC3+EPA | EPA | 9/22/1999 0:30 | 7.81 |
| VIC3+EPA | EPA | 9/22/1999 1:00 | 7.78 |
| VIC3+EPA | EPA | 9/22/1999 1:30 | 7.76 |
| VIC3+EPA | EPA | 9/22/1999 2:00 | 7.73 |
| VIC3+EPA | EPA | 9/22/1999 2:30 | 7.72 |
| VIC3+EPA | EPA | 9/22/1999 3:00 | 7.7 |
| VIC3+EPA | EPA | 9/22/1999 3:30 | 7.68 |
| VIC3+EPA | EPA | 9/22/1999 4:00 | 7.67 |
| VIC3+EPA | EPA | 9/22/1999 4:30 | 7.66 |
| VIC3+EPA | EPA | 9/22/1999 5:00 | 7.64 |
| VIC3+EPA | EPA | 9/22/1999 5:30 | 7.64 |
| VIC3+EPA | EPA | 9/22/1999 6:00 | 7.63 |
| VIC3+EPA | EPA | 9/22/1999 6:30 | 7.62 |
| VIC3+EPA | EPA | 9/22/1999 7:00 | 7.62 |
| VIC3+EPA | EPA | 9/22/1999 7:30 | 7.63 |
| VIC3+EPA | EPA | 9/22/1999 8:00 | 7.65 |
| VIC3+EPA | EPA | 9/22/1999 8:30 | 7.67 |
| VIC3+EPA | EPA | 9/22/1999 9:00 | 7.69 |
| VIC3+EPA | EPA | 9/22/1999 9:30 | 7.73 |
| VIC4+EPA | EPA | 9/20/1999 9:30 | 8.61 |
| VIC4+EPA | EPA | 9/20/1999 10:30 | 8.29 |
| VIC4+EPA | EPA | 9/20/1999 11:00 | 8.41 |
| VIC4+EPA | EPA | 9/20/1999 11:30 | 8.52 |
| VIC4+EPA | EPA | 9/20/1999 12:00 | 8.59 |
| VIC4+EPA | EPA | 9/20/1999 12:30 | 8.66 |
| VIC4+EPA | EPA | 9/20/1999 13:00 | 8.71 |
| VIC4+EPA | EPA | 9/20/1999 13:30 | 8.75 |
| VIC4+EPA | EPA | 9/20/1999 14:00 | 8.81 |
| VIC4+EPA | EPA | 9/20/1999 14:30 | 8.87 |
| VIC4+EPA | EPA | 9/20/1999 15:00 | 8.9 |
| VIC4+EPA | EPA | 9/20/1999 15:30 | 8.91 |
| VIC4+EPA | EPA | 9/20/1999 16:00 | 8.9 |
| VIC4+EPA | EPA | 9/20/1999 16:30 | 8.9 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VIC4+EPA | EPA | 9/20/1999 17:00 | 8.89 |
| VIC4+EPA | EPA | 9/20/1999 17:30 | 8.85 |
| VIC4+EPA | EPA | 9/20/1999 18:00 | 8.78 |
| VIC4+EPA | EPA | 9/20/1999 18:30 | 8.72 |
| VIC4+EPA | EPA | 9/20/1999 19:00 | 8.65 |
| VIC4+EPA | EPA | 9/20/1999 20:00 | 8.56 |
| VIC4+EPA | EPA | 9/20/1999 20:30 | 8.45 |
| VIC4+EPA | EPA | 9/20/1999 21:00 | 8.35 |
| VIC4+EPA | EPA | 9/20/1999 21:30 | 8.29 |
| VIC4+EPA | EPA | 9/20/1999 22:00 | 8.34 |
| VIC4+EPA | EPA | 9/20/1999 22:30 | 8.29 |
| VIC4+EPA | EPA | 9/20/1999 23:00 | 8.25 |
| VIC4+EPA | EPA | 9/20/1999 23:30 | 8.21 |
| VIC4+EPA | EPA | 9/21/1999 0:00 | 8.17 |
| VIC4+EPA | EPA | 9/21/1999 0:30 | 8.15 |
| VIC4+EPA | EPA | 9/21/1999 1:00 | 8.11 |
| VIC4+EPA | EPA | 9/21/1999 1:30 | 7.99 |
| VIC4+EPA | EPA | 9/21/1999 2:00 | 7.84 |
| VIC4+EPA | EPA | 9/21/1999 2:30 | 7.84 |
| VIC4+EPA | EPA | 9/21/1999 3:00 | 7.85 |
| VIC4+EPA | EPA | 9/21/1999 3:30 | 7.88 |
| VIC4+EPA | EPA | 9/21/1999 4:00 | 7.9 |
| VIC4+EPA | EPA | 9/21/1999 4:30 | 7.87 |
| VIC4+EPA | EPA | 9/21/1999 5:00 | 7.87 |
| VIC4+EPA | EPA | 9/21/1999 5:30 | 7.85 |
| VIC4+EPA | EPA | 9/21/1999 6:00 | 7.82 |
| VIC4+EPA | EPA | 9/21/1999 6:30 | 7.78 |
| VIC4+EPA | EPA | 9/21/1999 7:00 | 7.75 |
| VIC4+EPA | EPA | 9/21/1999 7:30 | 7.73 |
| VIC4+EPA | EPA | 9/21/1999 8:00 | 7.74 |
| VIC4+EPA | EPA | 9/21/1999 8:30 | 7.8 |
| VIC4+EPA | EPA | 9/21/1999 9:00 | 7.89 |
| VIC4+EPA | EPA | 9/21/1999 9:30 | 7.95 |
| VIC4+EPA | EPA | 9/21/1999 10:00 | 7.97 |
| VIC4+EPA | EPA | 9/21/1999 10:30 | 7.97 |
| VIC4+EPA | EPA | 9/21/1999 11:00 | 7.97 |
| VIC4+EPA | EPA | 9/21/1999 11:30 | 7.98 |
| VIC4+EPA | EPA | 9/21/1999 12:00 | 8 |
| VIC4+EPA | EPA | 9/21/1999 12:30 | 8.06 |
| VIC4+EPA | EPA | 9/21/1999 13:00 | 8.15 |
| VIC4+EPA | EPA | 9/21/1999 13:30 | 8.25 |
| VIC4+EPA | EPA | 9/21/1999 14:00 | 8.32 |
| VIC4+EPA | EPA | 9/21/1999 14:30 | 8.39 |
| VIC4+EPA | EPA | 9/21/1999 15:00 | 8.46 |
| VIC4+EPA | EPA | 9/21/1999 15:30 | 8.49 |
| VIC4+EPA | EPA | 9/21/1999 16:00 | 8.57 |
| VIC4+EPA | EPA | 9/21/1999 16:30 | 8.6 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VIC4+EPA | EPA | 9/21/1999 17:00 | 8.6 |
| VIC4+EPA | EPA | 9/21/1999 17:30 | 8.58 |
| VIC4+EPA | EPA | 9/21/1999 18:00 | 8.53 |
| VIC4+EPA | EPA | 9/21/1999 18:30 | 8.46 |
| VIC4+EPA | EPA | 9/21/1999 19:00 | 8.41 |
| VIC4+EPA | EPA | 9/21/1999 19:30 | 8.34 |
| VIC4+EPA | EPA | 9/21/1999 20:00 | 8.28 |
| VIC4+EPA | EPA | 9/21/1999 20:30 | 8.21 |
| VIC4+EPA | EPA | 9/21/1999 21:00 | 8.15 |
| VIC4+EPA | EPA | 9/21/1999 21:30 | 8.1 |
| VIC4+EPA | EPA | 9/21/1999 22:00 | 8.06 |
| VIC4+EPA | EPA | 9/21/1999 22:30 | 8.03 |
| VIC4+EPA | EPA | 9/21/1999 23:00 | 8 |
| VIC4+EPA | EPA | 9/21/1999 23:30 | 7.98 |
| VIC4+EPA | EPA | 9/22/1999 0:00 | 7.96 |
| VIC4+EPA | EPA | 9/22/1999 0:30 | 7.93 |
| VIC4+EPA | EPA | 9/22/1999 1:00 | 7.92 |
| VIC4+EPA | EPA | 9/22/1999 1:30 | 7.91 |
| VIC4+EPA | EPA | 9/22/1999 2:00 | 7.89 |
| VIC4+EPA | EPA | 9/22/1999 2:30 | 7.87 |
| VIC4+EPA | EPA | 9/22/1999 3:00 | 7.86 |
| VIC4+EPA | EPA | 9/22/1999 3:30 | 7.85 |
| VIC4+EPA | EPA | 9/22/1999 4:00 | 7.83 |
| VIC4+EPA | EPA | 9/22/1999 4:30 | 7.83 |
| VIC4+EPA | EPA | 9/22/1999 5:00 | 7.83 |
| VIC4+EPA | EPA | 9/22/1999 5:30 | 7.82 |
| VIC4+EPA | EPA | 9/22/1999 6:00 | 7.81 |
| VIC4+EPA | EPA | 9/22/1999 6:30 | 7.82 |
| VIC4+EPA | EPA | 9/22/1999 7:00 | 7.81 |
| VIC4+EPA | EPA | 9/22/1999 7:30 | 7.81 |
| VIC4+EPA | EPA | 9/22/1999 8:00 | 7.82 |
| VIC4+EPA | EPA | 9/22/1999 8:30 | 7.83 |
| VIC4+EPA | EPA | 9/22/1999 9:00 | 7.81 |
| VIC4+EPA | EPA | 9/22/1999 9:30 | 7.8 |
| VIC4+EPA | EPA | 9/22/1999 10:00 | 7.81 |
| VIC4+EPA | EPA | 9/22/1999 10:30 | 7.8 |
| VIC4+EPA | EPA | 9/22/1999 11:00 | 7.8 |
| VIC4+EPA | EPA | 9/22/1999 11:30 | 7.8 |
| VIC4+EPA | EPA | 9/22/1999 12:00 | 7.8 |
| VIC5+EPA | EPA | 9/20/1999 12:30 | 7.17 |
| VIC5+EPA | EPA | 9/20/1999 13:00 | 7.21 |
| VIC5+EPA | EPA | 9/20/1999 13:30 | 7.25 |
| VIC5+EPA | EPA | 9/20/1999 14:00 | 7.29 |
| VIC5+EPA | EPA | 9/20/1999 14:30 | 7.35 |
| VIC5+EPA | EPA | 9/20/1999 15:00 | 7.38 |
| VIC5+EPA | EPA | 9/20/1999 15:30 | 7.38 |
| VIC5+EPA | EPA | 9/20/1999 16:00 | 7.38 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VIC5+EPA | EPA | 9/20/1999 16:30 | 7.36 |
| VIC5+EPA | EPA | 9/20/1999 17:00 | 7.34 |
| VIC5+EPA | EPA | 9/20/1999 17:30 | 7.33 |
| VIC5+EPA | EPA | 9/20/1999 18:00 | 7.32 |
| VIC5+EPA | EPA | 9/20/1999 18:30 | 7.3 |
| VIC5+EPA | EPA | 9/20/1999 19:00 | 7.28 |
| VIC5+EPA | EPA | 9/20/1999 19:30 | 7.27 |
| VIC5+EPA | EPA | 9/20/1999 20:00 | 7.25 |
| VIC5+EPA | EPA | 9/20/1999 20:30 | 7.24 |
| VIC5+EPA | EPA | 9/20/1999 21:00 | 7.23 |
| VIC5+EPA | EPA | 9/20/1999 21:30 | 7.22 |
| VIC5+EPA | EPA | 9/20/1999 22:00 | 7.2 |
| VIC5+EPA | EPA | 9/20/1999 22:30 | 7.19 |
| VIC5+EPA | EPA | 9/20/1999 23:00 | 7.17 |
| VIC5+EPA | EPA | 9/20/1999 23:30 | 7.15 |
| VIC5+EPA | EPA | 9/21/1999 0:00 | 6.97 |
| VIC5+EPA | EPA | 9/21/1999 0:00 | 7.14 |
| VIC5+EPA | EPA | 9/21/1999 0:30 | 6.99 |
| VIC5+EPA | EPA | 9/21/1999 0:30 | 7.12 |
| VIC5+EPA | EPA | 9/21/1999 1:00 | 7.01 |
| VIC5+EPA | EPA | 9/21/1999 1:00 | 7.1 |
| VIC5+EPA | EPA | 9/21/1999 1:30 | 7.05 |
| VIC5+EPA | EPA | 9/21/1999 1:30 | 7.09 |
| VIC5+EPA | EPA | 9/21/1999 2:00 | 7.07 |
| VIC5+EPA | EPA | 9/21/1999 2:30 | 7.06 |
| VIC5+EPA | EPA | 9/21/1999 2:30 | 7.1 |
| VIC5+EPA | EPA | 9/21/1999 3:00 | 7.04 |
| VIC5+EPA | EPA | 9/21/1999 3:00 | 7.13 |
| VIC5+EPA | EPA | 9/21/1999 3:30 | 7.03 |
| VIC5+EPA | EPA | 9/21/1999 3:30 | 7.16 |
| VIC5+EPA | EPA | 9/21/1999 4:00 | 7.03 |
| VIC5+EPA | EPA | 9/21/1999 4:00 | 7.17 |
| VIC5+EPA | EPA | 9/21/1999 4:30 | 7.02 |
| VIC5+EPA | EPA | 9/21/1999 4:30 | 7.17 |
| VIC5+EPA | EPA | 9/21/1999 5:00 | 7.02 |
| VIC5+EPA | EPA | 9/21/1999 5:00 | 7.17 |
| VIC5+EPA | EPA | 9/21/1999 5:30 | 7.01 |
| VIC5+EPA | EPA | 9/21/1999 5:30 | 7.17 |
| VIC5+EPA | EPA | 9/21/1999 6:00 | 7.01 |
| VIC5+EPA | EPA | 9/21/1999 6:00 | 7.15 |
| VIC5+EPA | EPA | 9/21/1999 6:30 | 7.01 |
| VIC5+EPA | EPA | 9/21/1999 6:30 | 7.15 |
| VIC5+EPA | EPA | 9/21/1999 7:00 | 7.01 |
| VIC5+EPA | EPA | 9/21/1999 7:00 | 7.15 |
| VIC5+EPA | EPA | 9/21/1999 7:30 | 7.01 |
| VIC5+EPA | EPA | 9/21/1999 7:30 | 7.14 |
| VIC5+EPA | EPA | 9/21/1999 8:00 | 6.99 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VIC5+EPA | EPA | 9/21/1999 8:00 | 7.14 |
| VIC5+EPA | EPA | 9/21/1999 8:30 | 6.98 |
| VIC5+EPA | EPA | 9/21/1999 8:30 | 7.13 |
| VIC5+EPA | EPA | 9/21/1999 9:00 | 6.96 |
| VIC5+EPA | EPA | 9/21/1999 9:00 | 7.12 |
| VIC5+EPA | EPA | 9/21/1999 9:30 | 6.96 |
| VIC5+EPA | EPA | 9/21/1999 9:30 | 7.11 |
| VIC5+EPA | EPA | 9/21/1999 20:00 | 7.11 |
| VIC5+EPA | EPA | 9/21/1999 20:30 | 7.1 |
| VIC5+EPA | EPA | 9/21/1999 21:00 | 7.1 |
| VIC5+EPA | EPA | 9/21/1999 21:30 | 7.09 |
| VIC5+EPA | EPA | 9/21/1999 22:00 | 7.09 |
| VIC5+EPA | EPA | 9/21/1999 22:30 | 7.08 |
| VIC5+EPA | EPA | 9/21/1999 23:00 | 7.07 |
| VIC5+EPA | EPA | 9/21/1999 23:30 | 7.07 |
| VIC5+EPA | EPA | 9/22/1999 0:00 | 7.06 |
| VIC5+EPA | EPA | 9/22/1999 0:30 | 7.05 |
| VIC5+EPA | EPA | 9/22/1999 1:00 | 7.05 |
| VIC5+EPA | EPA | 9/22/1999 1:30 | 7.04 |
| VIC5+EPA | EPA | 9/22/1999 2:00 | 7.04 |
| VIC5+EPA | EPA | 9/22/1999 2:30 | 7.03 |
| VIC5+EPA | EPA | 9/22/1999 3:00 | 7.03 |
| VIC5+EPA | EPA | 9/22/1999 3:30 | 7.03 |
| VIC5+EPA | EPA | 9/22/1999 4:00 | 7.02 |
| VIC5+EPA | EPA | 9/22/1999 4:30 | 7.01 |
| VIC5+EPA | EPA | 9/22/1999 5:00 | 7.01 |
| VIC5+EPA | EPA | 9/22/1999 5:30 | 7 |
| VIC5+EPA | EPA | 9/22/1999 6:00 | 7 |
| VIC5+EPA | EPA | 9/22/1999 6:30 | 6.99 |
| VIC5+EPA | EPA | 9/22/1999 7:00 | 6.98 |
| VIC5+EPA | EPA | 9/22/1999 7:30 | 6.98 |
| VIC5+EPA | EPA | 9/22/1999 8:00 | 6.98 |
| VIC5+EPA | EPA | 9/22/1999 8:30 | 6.99 |
| VIC5+EPA | EPA | 9/22/1999 9:00 | 6.99 |
| VIL1+112WRD | USGS | 3/1/2000 16:25 | 7.9 |
| VIL1+112WRD | USGS | 4/1/2000 11:39 | 7.7 |
| VIL1+112WRD | USGS | 5/17/2000 9:10 | 7.9 |
| VIL1+112WRD | USGS | 6/30/2000 10:20 | 7.7 |
| VIL1+112WRD | USGS | 8/1/2000 15:00 | 8.1 |
| VIL1+112WRD | USGS | 8/30/2000 13:45 | 8.1 |
| VIL1+112WRD | USGS | 10/4/2000 13:00 | 8 |
| VIL1+112WRD | USGS | 11/8/2000 20:00 | 7.4 |
| VIL1+112WRD | USGS | 12/14/2000 13:15 | 8 |
| VIL1+112WRD | USGS | 1/24/2001 9:05 | 8.1 |
| VIL1+112WRD | USGS | 1/29/2001 19:00 | 6.9 |
| VIL1+112WRD | USGS | 3/19/2001 12:30 | 7.8 |
| VIL1+112WRD | USGS | 5/9/2001 13:05 | 8 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VIL2+112WRD | USGS | 8/1/2000 8:10 | 7.8 |
| VIL2+112WRD | USGS | 8/30/2000 8:30 | 8 |
| VIL2+112WRD | USGS | 10/4/2000 8:10 | 8 |
| VIL2+112WRD | USGS | 11/14/2000 8:20 | 7.7 |
| VIL2+112WRD | USGS | 12/14/2000 8:30 | 7.4 |
| VIL2+112WRD | USGS | 1/24/2001 15:00 | 8.1 |
| VIL2+112WRD | USGS | 1/29/2001 21:00 | 7 |
| VIL3+112WRD | USGS | 3/2/2000 10:10 | 8.1 |
| VIL3+112WRD | USGS | 3/30/2000 11:15 | 7.2 |
| VIL3+112WRD | USGS | 6/30/2000 16:30 | 8.5 |
| VIL3+112WRD | USGS | 8/2/2000 14:40 | 8.1 |
| VIL3+112WRD | USGS | 8/29/2000 8:30 | 8.1 |
| VIL3+112WRD | USGS | 10/3/2000 13:15 | 8.3 |
| VIL3+112WRD | USGS | 11/14/2000 14:30 | 7.8 |
| VIL3+112WRD | USGS | 12/12/2000 13:00 | 8.1 |
| VIL3+112WRD | USGS | 1/23/2001 14:45 | 8.1 |
| VIL3+112WRD | USGS | 2/14/2001 9:10 | 7.9 |
| VIL4+112WRD | USGS | 3/2/2000 16:00 | 7.2 |
| VIL4+112WRD | USGS | 4/2/2000 12:30 | 7.2 |
| VIL4+112WRD | USGS | 7/1/2000 14:15 | 7.35 |
| VILLAGECREEK02+21AWIC | ADEM | 8/13/1997 10:10 | 7.68 |
| VILLAGECREEK02+21AWIC | ADEM | 11/18/1997 12:00 | 6.96 |
| VILLAGECREEK03+21AWIC | ADEM | 8/18/1998 10:25 | 7.67 |
| VILLAGECREEK03+21AWIC | ADEM | 10/13/1998 11:00 | 6.94 |
| VLG1+21AWIC | ADEM | 5/22/1997 9:30 | 7.65 |
| VLG1+21AWIC | ADEM | 6/10/1997 14:44 | 8.3 |
| VLG1+21AWIC | ADEM | 6/11/1997 9:44 | 7.7 |
| VLG1+21AWIC | ADEM | 6/11/1997 14:44 | 7.7 |
| VLG1+21AWIC | ADEM | 6/12/1997 9:33 | 7.7 |
| VLG1+21AWIC | ADEM | 7/9/1997 9:45 | 7.66 |
| VLG1+21AWIC | ADEM | 8/12/1997 9:30 | 7.71 |
| VLG1+21AWIC | ADEM | 9/9/1997 10:45 | 7.53 |
| VLG2+21AWIC | ADEM | 5/22/1997 10:15 | 8.18 |
| VLG2+21AWIC | ADEM | 6/10/1997 14:29 | 9.1 |
| VLG2+21AWIC | ADEM | 6/11/1997 9:29 | 7.7 |
| VLG2+21AWIC | ADEM | 6/11/1997 14:29 | 8.6 |
| VLG2+21AWIC | ADEM | 6/12/1997 9:17 | 8 |
| VLG2+21AWIC | ADEM | 7/9/1997 10:25 | 7.76 |
| VLG2+21AWIC | ADEM | 8/12/1997 10:00 | 7.9 |
| VLG2+21AWIC | ADEM | 9/9/1997 10:15 | 7.47 |
| VLG3+21AWIC | ADEM | 5/22/1997 11:00 | 8.1 |
| VLG3+21AWIC | ADEM | 6/10/1997 14:16 | 9.1 |
| VLG3+21AWIC | ADEM | 6/11/1997 9:10 | 7.8 |
| VLG3+21AWIC | ADEM | 6/11/1997 14:20 | 8.4 |
| VLG3+21AWIC | ADEM | 6/12/1997 8:56 | 7.6 |
| VLG3+21AWIC | ADEM | 7/9/1997 10:55 | 7.81 |
| VLG3+21AWIC | ADEM | 8/12/1997 10:30 | 7.8 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VLG3+21AWIC | ADEM | 9/9/1997 9:30 | 7.28 |
| VLG4+21AWIC | ADEM | 5/21/1997 12:00 | 7.36 |
| VLG4+21AWIC | ADEM | 6/10/1997 13:58 | 8.4 |
| VLG4+21AWIC | ADEM | 6/11/1997 8:44 | 7.6 |
| VLG4+21AWIC | ADEM | 6/11/1997 14:00 | 7.4 |
| VLG4+21AWIC | ADEM | 6/12/1997 8:37 | 7.5 |
| VLG4+21AWIC | ADEM | 7/9/1997 8:25 | 7.3 |
| VLG4+21AWIC | ADEM | 8/12/1997 12:10 | 8.38 |
| VLG4+21AWIC | ADEM | 9/9/1997 8:50 | 7.44 |
| VLG5+21AWIC | ADEM | 5/22/1997 9:15 | 7.39 |
| VLG5+21AWIC | ADEM | 6/10/1997 13:40 | 8.2 |
| VLG5+21AWIC | ADEM | 6/11/1997 8:09 | 7.5 |
| VLG5+21AWIC | ADEM | 6/11/1997 13:44 | 7.7 |
| VLG5+21AWIC | ADEM | 6/12/1997 8:21 | 7.4 |
| VLG5+21AWIC | ADEM | 7/9/1997 9:25 | 7.48 |
| VLG5+21AWIC | ADEM | 8/12/1997 13:10 | 7.2 |
| VLG5+21AWIC | ADEM | 9/9/1997 9:15 | 7.32 |
| VLG6+21AWIC | ADEM | 5/22/1997 10:20 | 7.63 |
| VLG6+21AWIC | ADEM | 6/10/1997 13:23 | 7.9 |
| VLG6+21AWIC | ADEM | 6/11/1997 7:24 | 7.8 |
| VLG6+21AWIC | ADEM | 6/11/1997 13:17 | 7.4 |
| VLG6+21AWIC | ADEM | 6/12/1997 7:40 | 7.6 |
| VLG6+21AWIC | ADEM | 7/9/1997 9:45 | 7.32 |
| VLG6+21AWIC | ADEM | 8/12/1997 13:45 | 7.86 |
| VLG6+21AWIC | ADEM | 9/9/1997 9:40 | 7.71 |
| VLG7+21AWIC | ADEM | 5/22/1997 11:10 | 7.29 |
| VLG7+21AWIC | ADEM | 6/10/1997 13:03 | 7.5 |
| VLG7+21AWIC | ADEM | 6/11/1997 6:54 | 7.2 |
| VLG7+21AWIC | ADEM | 6/11/1997 13:03 | 7.4 |
| VLG7+21AWIC | ADEM | 6/12/1997 7:12 | 7 |
| VLG7+21AWIC | ADEM | 7/9/1997 10:20 | 7.05 |
| VLG7+21AWIC | ADEM | 8/12/1997 14:20 | 7.9 |
| VLG7+21AWIC | ADEM | 9/9/1997 10:10 | 7.37 |
| VLGJ-1 | ADEM | 1/9/2002 0:00 | 7.5 |
| VLGJ-1 | ADEM | 2/12/2002 0:00 | 8.4 |
| VLGJ-1 | ADEM | 3/20/2002 0:00 | 7.29 |
| VLGJ-1 | ADEM | 5/8/2002 0:00 | 8.07 |
| VLGJ-1 | ADEM | 5/22/2002 0:00 | 8.2 |
| VLGJ-1 | ADEM | 6/19/2002 0:00 | 7.3 |
| VLGJ-1 | ADEM | 7/9/2002 0:00 | 7.33 |
| VLGJ-1 | ADEM | 7/15/2002 0:00 | 7.73 |
| VLGJ-1 | ADEM | 9/17/2002 0:00 | 7.83 |
| VLGJ-2 | ADEM | 1/9/2002 0:00 | 7.8 |
| VLGJ-2 | ADEM | 2/12/2002 0:00 | 8.67 |
| VLGJ-2 | ADEM | 3/20/2002 0:00 | 7.28 |
| VLGJ-2 | ADEM | 5/8/2002 0:00 | 8.46 |
| VLGJ-2 | ADEM | 5/22/2002 0:00 | 8 |

| Station_ID | Agency | Date_Time | pH (SU) |
|---|---|---|---|
| VLGJ-2 | ADEM | 6/19/2002 0:00 | 7.72 |
| VLGJ-2 | ADEM | 7/9/2002 0:00 | 7.45 |
| VLGJ-2 | ADEM | 7/15/2002 0:00 | 8.15 |
| VLGJ-2 | ADEM | 9/17/2002 0:00 | 7.85 |
| VLGJ-3 | ADEM | 1/9/2002 0:00 | 7.4 |
| VLGJ-3 | ADEM | 2/12/2002 0:00 | 8.24 |
| VLGJ-3 | ADEM | 3/20/2002 0:00 | 7.34 |
| VLGJ-3 | ADEM | 5/8/2002 0:00 | 8.2 |
| VLGJ-3 | ADEM | 6/19/2002 0:00 | 8.1 |
| VLGJ-3 | ADEM | 7/9/2002 0:00 | 7.55 |
| VLGJ-3 | ADEM | 7/15/2002 0:00 | 8.09 |
| VLGJ-3 | ADEM | 9/17/2002 0:00 | 7.72 |
| VLGJ-4 | ADEM | 1/9/2002 0:00 | 7.36 |
| VLGJ-4 | ADEM | 2/12/2002 0:00 | 8.27 |
| VLGJ-4 | ADEM | 3/20/2002 0:00 | 7.52 |
| VLGJ-4 | ADEM | 5/8/2002 0:00 | 8.36 |
| VLGJ-4 | ADEM | 5/22/2002 0:00 | 8.5 |
| VLGJ-4 | ADEM | 6/19/2002 0:00 | 8.2 |
| VLGJ-4 | ADEM | 7/9/2002 0:00 | 7.6 |
| VLGJ-4 | ADEM | 7/15/2002 0:00 | 7.96 |
| VLGJ-4 | ADEM | 9/17/2002 0:00 | 7.99 |

**Table A-4 Summary of pH Violations on Village Creek**

| Station ID | # obs | # violations | % impaired |
|---|---|---|---|
| VI3+21AWIC | 14 | 0 | 0.0% |
| VIC1_DRY+SWMA | 8 | 1 | 12.5% |
| VIC1_WET+SWMA | 8 | 2 | 25.0% |
| VIC1+EPA | 1 | 1 | 100.0% |
| VIC2_DRY+SWMA | 8 | 0 | 0.0% |
| VIC2_WET+SWMA | 8 | 0 | 0.0% |
| VIC3_DRY+SWMA | 8 | 0 | 0.0% |
| VIC3_WET+SWMA | 8 | 0 | 0.0% |
| VIC3+EPA | 99 | 18 | 18.2% |
| VIC4+EPA | 100 | 23 | 23.0% |
| VIC5+EPA | 89 | 0 | 0.0% |
| VIL1+112WRD | 13 | 0 | 0.0% |
| VIL2+112WRD | 7 | 0 | 0.0% |
| VIL3+112WRD | 10 | 0 | 0.0% |
| VIL4+112WRD | 3 | 0 | 0.0% |
| VILLAGECREEK02+21AWIC | 2 | 0 | 0.0% |
| VILLAGECREEK03+21AWIC | 2 | 0 | 0.0% |
| VLG1+21AWIC | 8 | 0 | 0.0% |
| VLG2+21AWIC | 8 | 2 | 25.0% |
| VLG3+21AWIC | 8 | 1 | 12.5% |
| VLG4+21AWIC | 8 | 0 | 0.0% |
| VLG5+21AWIC | 8 | 0 | 0.0% |
| VLG6+21AWIC | 8 | 0 | 0.0% |
| VLG7+21AWIC | 8 | 0 | 0.0% |
| VLGJ-1 | 9 | 0 | 0.0% |
| VLGJ-2 | 9 | 1 | 11.1% |
| VLGJ-3 | 8 | 0 | 0.0% |
| VLGJ-4 | 9 | 0 | 0.0% |

**Table A-5 Village Creek Metals Collected by SWMA Prior to 2002**

| Sample Date | TYPE | Site # | Hardness (mg/l as $CaCO_3$) | Cadmium, Total (mg/l) | ADEM Criteria Cadmium Freshwater Acute levels (mg/l) | Copper, Total (mg/l) | ADEM Criteria Copper Freshwater Acute levels (mg/l) | Lead, Total (mg/l) | ADEM Criteria Lead Freshwater Acute levels (mg/l) | Zinc - Total (mg/l) | ADEM Criteria Zinc Freshwater Acute levels (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/23/1999 | DRY | VIC 1 | 185.976 | ND | 0.008 | ND | 0.032 | 0.001 | 0.179 | 0.049 | 0.198 |
| 12/29/1999 | DRY | VIC 1 | 208.398 | ND | 0.009 | ND | 0.035 | ND | 0.207 | 0.180 | 0.218 |
| 3/23/2000 | DRY | VIC 1 | 216.405 | ND | 0.009 | ND | 0.037 | ND | 0.217 | 0.040 | 0.225 |
| 7/7/2000 | DRY | VIC 1 | 203.585 | ND | 0.009 | 0.007 | 0.035 | ND | 0.201 | 0.101 | 0.214 |
| 9/23/1999 | DRY | VIC 2 | 178.460 | ND | 0.008 | 0.008 | 0.031 | 0.003 | 0.170 | 0.301 | 0.191 |
| 12/29/1999 | DRY | VIC 2 | 241.485 | ND | 0.011 | 0.007 | 0.041 | 0.003 | 0.250 | 0.362 | 0.247 |
| 3/23/2000 | DRY | VIC 2 | 234.753 | ND | 0.010 | 0.006 | 0.040 | 0.001 | 0.241 | 0.092 | 0.241 |
| 7/7/2000 | DRY | VIC 2 | 196.810 | ND | 0.008 | 0.002 | 0.034 | ND | 0.193 | 0.045 | 0.208 |
| 9/23/1999 | DRY | VIC 3 | 149.974 | ND | 0.006 | 0.002 | 0.026 | 0.004 | 0.136 | 0.132 | 0.165 |
| 12/29/1999 | DRY | VIC 3 | 177.116 | ND | 0.007 | 0.005 | 0.030 | ND | 0.168 | 0.237 | 0.190 |
| 3/23/2000 | DRY | VIC 3 | 210.843 | ND | 0.009 | ND | 0.036 | ND | 0.210 | 0.084 | 0.220 |
| 7/7/2000 | DRY | VIC 3 | 135.752 | ND | 0.006 | 0.002 | 0.024 | ND | 0.120 | 0.057 | 0.152 |
| 9/21/2000 | DRY | VIC 1 | 167.243 | ND | 0.007 | 0.002 | 0.029 | 0.001 | 0.157 | 0.075 | 0.181 |
| 1/4/2001 | DRY | VIC 1 | 209.610 | ND | 0.009 | ND | 0.036 | ND | 0.209 | 0.040 | 0.219 |
| 4/18/2001 | DRY | VIC 1 | 204.296 | ND | 0.009 | ND | 0.035 | ND | 0.202 | 0.042 | 0.214 |
| 7/11/2001 | DRY | VIC 1 | 180.987 | ND | 0.008 | ND | 0.031 | ND | 0.173 | 0.117 | 0.193 |
| 9/21/2000 | DRY | VIC 2 | 191.347 | ND | 0.008 | 0.005 | 0.033 | ND | 0.186 | 0.056 | 0.203 |
| 1/4/2001 | DRY | VIC 2 | 197.791 | ND | 0.008 | 0.006 | 0.034 | 0.002 | 0.194 | 0.026 | 0.209 |
| 4/18/2001 | DRY | VIC 2 | 213.435 | ND | 0.009 | 0.003 | 0.036 | ND | 0.213 | 0.036 | 0.222 |
| 7/11/2001 | DRY | VIC 2 | 155.911 | ND | 0.006 | ND | 0.027 | ND | 0.143 | 0.019 | 0.170 |
| 9/21/2000 | DRY | VIC 3 | 139.225 | ND | 0.006 | 0.004 | 0.024 | 0.001 | 0.124 | 0.075 | 0.155 |
| 1/4/2001 | DRY | VIC 3 | 177.184 | ND | 0.007 | 0.002 | 0.030 | ND | 0.168 | 0.049 | 0.190 |
| 4/18/2001 | DRY | VIC 3 | 183.339 | ND | 0.008 | 0.003 | 0.031 | ND | 0.176 | 0.046 | 0.196 |
| 7/11/2001 | DRY | VIC 3 | 167.047 | ND | 0.007 | 0.003 | 0.029 | ND | 0.156 | 0.038 | 0.181 |
| 9/29/1999 | WET | VIC 1 | 99.860 | 0.002 | 0.004 | 0.010 | 0.018 | 0.042 | 0.081 | 0.903 | 0.117 |
| 2/14/2000 | WET | VIC 1 | 145.538 | ND | 0.006 | 0.009 | 0.025 | ND | 0.131 | 0.232 | 0.161 |
| 4/14/2000 | WET | VIC 1 | 88.747 | ND | 0.003 | 0.010 | 0.016 | 0.015 | 0.070 | 0.147 | 0.106 |
| 6/29/2000 | WET | VIC 1 | 125.360 | ND | 0.005 | 0.006 | 0.022 | 0.006 | 0.108 | 0.296 | 0.142 |
| 9/29/1999 | WET | VIC 2 | 157.932 | 0.007 | 0.007 | 0.029 | 0.027 | 0.048 | 0.145 | 1.685 | 0.172 |
| 2/14/2000 | WET | VIC 2 | 173.718 | ND | 0.007 | 0.010 | 0.030 | 0.001 | 0.164 | 0.066 | 0.187 |
| 4/14/2000 | WET | VIC 2 | 191.264 | ND | 0.008 | 0.032 | 0.033 | 0.032 | 0.186 | 0.282 | 0.203 |
| 6/29/2000 | WET | VIC 2 | 147.650 | ND | 0.006 | 0.006 | 0.026 | ND | 0.134 | 0.159 | 0.163 |
| 9/29/1999 | WET | VIC 3 | 135.723 | ND | 0.006 | 0.003 | 0.024 | 0.002 | 0.120 | 0.113 | 0.152 |
| 2/14/2000 | WET | VIC 3 | 112.119 | ND | 0.004 | 0.016 | 0.020 | 0.005 | 0.094 | 0.187 | 0.129 |
| 4/14/2000 | WET | VIC 3 | 211.033 | ND | 0.009 | 0.003 | 0.036 | 0.001 | 0.210 | 0.113 | 0.220 |
| 6/29/2000 | WET | VIC 3 | 134.720 | ND | 0.005 | ND | 0.023 | ND | 0.119 | 0.092 | 0.151 |
| 11/7/2000 | WET | VIC 1 | 105.855 | ND | 0.004 | ND | 0.019 | 0.005 | 0.087 | 0.149 | 0.123 |
| 1/8/2001 | WET | VIC 1 | 169.684 | ND | 0.007 | ND | 0.029 | ND | 0.159 | 0.114 | 0.183 |
| 6/15/2001 | WET | VIC 1 | 209.277 | ND | 0.009 | 0.002 | 0.036 | 0.012 | 0.208 | 0.036 | 0.219 |
| 8/7/2001 | WET | VIC 1 | 95.118 | ND | 0.004 | 0.002 | 0.017 | 0.004 | 0.076 | 0.158 | 0.112 |
| 11/7/2000 | WET | VIC 2 | 99.770 | ND | 0.004 | 0.008 | 0.018 | 0.012 | 0.081 | 0.119 | 0.117 |
| 1/8/2001 | WET | VIC 2 | 148.525 | ND | 0.006 | 0.002 | 0.026 | 0.002 | 0.135 | 0.075 | 0.164 |

| Sample Date | TYPE | Site # | Hardness (mg/l as $CaCO_3$) | Cadmium, Total (mg/l) | ADEM Criteria Cadmium Freshwater Acute levels (mg/l) | Copper, Total (mg/l) | ADEM Criteria Copper Freshwater Acute levels (mg/l) | Lead, Total (mg/l) | ADEM Criteria Lead Freshwater Acute levels (mg/l) | Zinc - Total (mg/l) | ADEM Criteria Zinc Freshwater Acute levels (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6/15/2001 | WET | VIC 2 | 178.143 | ND | 0.008 | ND | 0.031 | 0.005 | 0.170 | 0.071 | 0.191 |
| 8/7/2001 | WET | VIC 2 | 92.691 | ND | 0.004 | 0.005 | 0.017 | 0.004 | 0.074 | 0.089 | 0.110 |
| 11/7/2000 | WET | VIC 3 | 92.824 | ND | 0.004 | 0.015 | 0.017 | 0.020 | 0.074 | 0.194 | 0.110 |
| 1/8/2001 | WET | VIC 3 | 138.947 | ND | 0.006 | ND | 0.024 | 0.003 | 0.124 | 0.062 | 0.155 |
| 6/15/2001 | WET | VIC 3 | 165.575 | ND | 0.007 | 0.003 | 0.029 | ND | 0.155 | 0.060 | 0.179 |
| 8/7/2001 | WET | VIC 3 | 88.431 | ND | 0.003 | ND | 0.016 | 0.003 | 0.070 | 0.063 | 0.105 |

Note: ND is non-detect

**Table A-6 Village Creek Metals Collected by USGS and ADEM Prior to 2002**

| Station ID | Date Time | Hardness (mg/L) | Cadmium (mg/L) | ADEM Criteria Cadmium Freshwater Acute levels (mg/l) | Copper (mg/L) | ADEM Criteria Copper Freshwater Acute levels (mg/l) | Lead (mg/L) | ADEM Criteria Lead Freshwater Acute levels (mg/l) | Zinc (mg/L) | ADEM Criteria Zinc Freshwater Acute levels (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|
| VIL1+112WRD | 3/1/2000 16:25 | 197 | ND | 0.008 | ND | 0.034 | ND | 0.193 | ND | 0.208 |
| VIL1+112WRD | 6/30/2000 10:20 | 203 | ND | 0.009 | ND | 0.035 | ND | 0.200 | ND | 0.213 |
| VIL1+112WRD | 8/30/2000 13:45 | 191 | ND | 0.008 | ND | 0.033 | ND | 0.185 | ND | 0.202 |
| VIL1+112WRD | 11/8/2000 20:00 | 36.6 | 0.00014 | 0.001 | 0.005 | 0.007 | 0.013 | 0.023 | 0.045 | 0.050 |
| VIL1+112WRD | 1/24/2001 9:05 | 202 | ND | 0.009 | ND | 0.034 | ND | 0.199 | ND | 0.212 |
| VIL1+112WRD | 1/29/2001 19:00 | 41.3 | 0.0002 | 0.001 | 0.007 | 0.008 | 0.017 | 0.026 | 0.075 | 0.055 |
| VIL2+112WRD | 8/30/2000 8:30 | 219 | | | 0.003 | 0.037 | 0.002 | 0.221 | 0.244 | 0.227 |
| VIL2+112WRD | 11/14/2000 8:20 | 292 | 0.002 | 0.013 | 0.005 | 0.049 | 0.004 | 0.318 | 0.155 | 0.290 |
| VIL2+112WRD | 1/24/2001 15:00 | 221 | 0.0002 | 0.010 | 0.002 | 0.037 | 0.001 | 0.223 | 0.018 | 0.229 |
| VIL2+112WRD | 1/29/2001 21:00 | 48.9 | 0.005 | 0.002 | 0.030 | 0.009 | 0.058 | 0.033 | 0.670 | 0.064 |
| VIL3+112WRD | 3/2/2000 10:10 | 214 | 0.001 | 0.009 | 0.011 | 0.036 | 0.004 | 0.214 | 0.316 | 0.223 |
| VIL3+112WRD | 6/30/2000 16:30 | 154 | 0.0003 | 0.006 | 0.010 | 0.027 | 0.004 | 0.141 | 0.089 | 0.169 |
| VIL3+112WRD | 8/29/2000 8:30 | 178 | | | 0.007 | 0.031 | 0.001 | 0.169 | 0.016 | 0.191 |
| VIL3+112WRD | 11/14/2000 14:30 | 185 | 0.0001 | 0.008 | 0.007 | 0.032 | 0.001 | 0.178 | 0.028 | 0.197 |
| VIL3+112WRD | 1/23/2001 14:45 | 216 | 0.0001 | 0.009 | 0.006 | 0.037 | 0.001 | 0.217 | 0.031 | 0.225 |
| VIL4+112WRD | 3/2/2000 16:00 | 174 | 0.0002 | 0.007 | 0.004 | 0.030 | 0.001 | 0.165 | 0.161 | 0.187 |
| VIL4+112WRD | 7/1/2000 14:15 | 155 | 0.0004 | 0.006 | 0.009 | 0.027 | 0.008 | 0.142 | 0.149 | 0.170 |
| VLG1+21AWIC | 5/22/1997 9:30 | 172 | ND | 0.007 | ND | 0.030 | ND | 0.162 | 0.012 | 0.185 |
| VLG1+21AWIC | 7/9/1997 9:45 | 198 | ND | 0.008 | ND | 0.034 | 0.005 | 0.194 | 0.026 | 0.209 |
| VLG1+21AWIC | 8/12/1997 9:30 | 200 | ND | 0.009 | ND | 0.034 | ND | 0.197 | ND | 0.211 |
| VLG1+21AWIC | 9/9/1997 10:45 | 182 | ND | 0.008 | ND | 0.031 | ND | 0.174 | 0.005 | 0.194 |
| VLG2+21AWIC | 5/22/1997 10:15 | 182 | ND | 0.008 | ND | 0.031 | ND | 0.174 | 0.015 | 0.194 |
| VLG3+21AWIC | 5/22/1997 11:00 | 184 | ND | 0.008 | ND | 0.031 | ND | 0.177 | 0.050 | 0.196 |
| VLG3+21AWIC | 7/9/1997 10:55 | 210 | ND | 0.009 | ND | 0.036 | 0.006 | 0.209 | 0.089 | 0.219 |
| VLG3+21AWIC | 8/12/1997 10:30 | 194 | ND | 0.008 | ND | 0.033 | ND | 0.189 | 0.021 | 0.205 |
| VLG3+21AWIC | 9/9/1997 9:30 | 186 | ND | 0.008 | ND | 0.032 | ND | 0.179 | 0.026 | 0.198 |
| VLG4+21AWIC | 5/21/1997 12:00 | 162 | ND | 0.007 | ND | 0.028 | ND | 0.150 | 0.272 | 0.176 |
| VLG5+21AWIC | 5/22/1997 9:15 | 178 | ND | 0.008 | 0.012 | 0.031 | 0.008 | 0.169 | 0.249 | 0.191 |
| VLG5+21AWIC | 7/9/1997 9:25 | 156 | ND | 0.006 | ND | 0.027 | 0.006 | 0.143 | 0.250 | 0.171 |
| VLG5+21AWIC | 8/12/1997 13:10 | 204 | ND | 0.009 | 0.005 | 0.035 | ND | 0.202 | 0.132 | 0.214 |
| VLG5+21AWIC | 9/9/1997 9:15 | 180 | ND | 0.008 | ND | 0.031 | 0.005 | 0.172 | 0.213 | 0.193 |
| VLG6+21AWIC | 5/22/1997 10:20 | 188 | ND | 0.008 | 0.007 | 0.032 | ND | 0.182 | 0.100 | 0.200 |
| VLG6+21AWIC | 7/9/1997 9:45 | 180 | ND | 0.008 | 0.006 | 0.031 | 0.008 | 0.172 | 0.064 | 0.193 |
| VLG6+21AWIC | 8/12/1997 13:45 | 204 | ND | 0.009 | ND | 0.035 | 0.005 | 0.202 | 0.061 | 0.214 |
| VLG6+21AWIC | 9/9/1997 9:40 | 172 | ND | 0.007 | ND | 0.030 | ND | 0.162 | 0.039 | 0.185 |
| VLG7+21AWIC | 5/22/1997 11:10 | 162 | ND | 0.007 | 0.005 | 0.028 | ND | 0.150 | 0.059 | 0.176 |
| VLG7+21AWIC | 7/9/1997 10:20 | 154 | ND | 0.006 | ND | 0.027 | 0.005 | 0.141 | 0.073 | 0.169 |
| VLG7+21AWIC | 8/12/1997 14:20 | 196 | ND | 0.008 | ND | 0.033 | ND | 0.192 | 0.072 | 0.207 |
| VLG7+21AWIC | 9/9/1997 10:10 | 150 | ND | 0.006 | ND | 0.026 | ND | 0.136 | 0.035 | 0.165 |
| WWTP1+21AWIC | 6/11/1997 10:00 | 166 | ND | 0.007 | 0.005 | 0.029 | ND | 0.155 | 0.061 | 0.180 |
| WWTP1+21AWIC | 6/12/1997 10:00 | 156 | ND | 0.006 | 0.005 | 0.027 | ND | 0.143 | 0.063 | 0.171 |

| **Station ID** | **Date Time** | **Hardness (mg/L)** | **Cadmium (mg/L)** | **ADEM Criteria** Cadmium Freshwater Acute levels **(mg/l)** | **Copper (mg/L)** | **ADEM Criteria** Copper Freshwater Acute levels **(mg/l)** | **Lead (mg/L)** | **ADEM Criteria** Lead Freshwater Acute levels **(mg/l)** | **Zinc (mg/L)** | **ADEM Criteria** Zinc Freshwater Acute levels **(mg/l)** |
|---|---|---|---|---|---|---|---|---|---|---|
| WWTP1+21AWIC | 7/10/1997 10:00 | 156 | ND | 0.006 | ND | 0.027 | ND | 0.143 | 0.082 | 0.171 |
| WWTP1+21AWIC | 8/12/1997 12:25 | 148 | ND | 0.006 | 0.007 | 0.026 | 0.015 | 0.134 | 0.080 | 0.163 |
| WWTP1+21AWIC | 9/9/1997 9:45 | 136 | ND | 0.006 | ND | 0.024 | ND | 0.120 | 0.050 | 0.152 |

Note: ND is non-detect

**Table A-7 Cadmium and Cooper Collected on Village Creek during ADEMs 303(d) Monitoring Program (ADEM, 2002)**

| Station_ID | Date | Hardness (mg/l) | | Cd (mg/l) | Cd Criteria | | Cd-dis (mg/l) | | Cu (mg/l) | Cu Criteria | | Cu-dis (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI3 | 1/9/2002 | 166 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.029 | LDL | 0.02 |
| VI3 | 2/12/2002 | 168 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.029 | LDL | 0.02 |
| VI3 | 3/20/2002 | 175 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.030 | LDL | 0.02 |
| VI3 | 5/8/2002 | 160 | LDL | 0.003 | 0.007 | | 0.004 | LDL | 0.02 | 0.028 | LDL | 0.02 |
| VI3 | 6/19/2002 | 140 | LDL | 0.003 | 0.006 | LDL | 0.003 | LDL | 0.02 | 0.024 | LDL | 0.02 |
| VI3 | 7/9/2002 | 152 | LDL | 0.003 | 0.006 | | 0.003 | LDL | 0.02 | 0.026 | LDL | 0.02 |
| VI3 | 7/15/2002 | 163 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.028 | LDL | 0.02 |
| VLGJ-1 | 1/9/2002 | 169 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.029 | LDL | 0.02 |
| VLGJ-1 | 2/12/2002 | 173 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.030 | LDL | 0.02 |
| VLGJ-1 | 3/20/2002 | 151 | LDL | 0.003 | 0.006 | LDL | 0.003 | LDL | 0.02 | 0.026 | LDL | 0.02 |
| VLGJ-1 | 5/8/2002 | 189 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.032 | LDL | 0.02 |
| VLGJ-1 | 6/19/2002 | 167 | | 0.007 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.029 | LDL | 0.02 |
| VLGJ-1 | 7/9/2002 | 145 | LDL | 0.003 | 0.006 | | 0.005 | LDL | 0.02 | 0.025 | LDL | 0.02 |
| VLGJ-1 | 7/15/2002 | 164 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.028 | LDL | 0.02 |
| VLGJ-2 | 1/9/2002 | 180 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.031 | LDL | 0.02 |
| VLGJ-2 | 2/12/2002 | 182 | LDL | 0.003 | 0.008 | | 0.003 | LDL | 0.02 | 0.031 | LDL | 0.02 |
| VLGJ-2 | 3/20/2002 | 94.7 | LDL | 0.003 | 0.004 | LDL | 0.003 | LDL | 0.02 | 0.017 | LDL | 0.02 |
| VLGJ-2 | 5/8/2002 | 186 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.032 | LDL | 0.02 |
| VLGJ-2 | 6/19/2002 | 172 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.030 | LDL | 0.02 |
| VLGJ-2 | 7/9/2002 | 153 | LDL | 0.003 | 0.006 | LDL | 0.003 | LDL | 0.02 | 0.026 | LDL | 0.02 |
| VLGJ-2 | 7/15/2002 | 182 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.031 | LDL | 0.02 |
| VLGJ-3 | 1/9/2002 | 202 | LDL | 0.003 | 0.009 | LDL | 0.003 | LDL | 0.02 | 0.034 | LDL | 0.02 |
| VLGJ-3 | 2/12/2002 | 193 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.033 | LDL | 0.02 |
| VLGJ-3 | 3/20/2002 | 143 | LDL | 0.003 | 0.006 | | 0.003 | LDL | 0.02 | 0.025 | LDL | 0.02 |
| VLGJ-3 | 5/8/2002 | 199 | LDL | 0.003 | 0.009 | LDL | 0.003 | LDL | 0.02 | 0.034 | LDL | 0.02 |
| VLGJ-3 | 6/19/2002 | 161 | LDL | 0.003 | 0.007 | LDL | 0.003 | LDL | 0.02 | 0.028 | LDL | 0.02 |
| VLGJ-3 | 7/9/2002 | 149 | | 0.004 | 0.006 | LDL | 0.003 | LDL | 0.02 | 0.026 | LDL | 0.02 |
| VLGJ-3 | 7/15/2002 | 180 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.031 | LDL | 0.02 |
| VLGJ-4 | 1/9/2002 | 186 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.032 | LDL | 0.02 |
| VLGJ-4 | 2/12/2002 | 187 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.032 | LDL | 0.02 |
| VLGJ-4 | 3/20/2002 | 196 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.033 | LDL | 0.02 |
| VLGJ-4 | 5/8/2002 | 187 | LDL | 0.003 | 0.008 | LDL | 0.003 | LDL | 0.02 | 0.032 | LDL | 0.02 |
| VLGJ-4 | 6/19/2002 | 145 | LDL | 0.003 | 0.006 | LDL | 0.003 | LDL | 0.02 | 0.025 | LDL | 0.02 |
| VLGJ-4 | 7/9/2002 | 142 | LDL | 0.003 | 0.006 | | 0.007 | LDL | 0.02 | 0.025 | LDL | 0.02 |
| VLGJ-4 | 7/15/2002 | 170 | | 0.003 | 0.007 | LL | 0.003 | LDL | 0.02 | 0.029 | LDL | 0.02 |

Note: LDL is less than detection limits

**Table A-8 Lead and Zinc Collected on Village Creek during ADEMs 303(d) Monitoring Program (ADEM, 2002)**

| Station_ID | Date | Hardness (mg/l) | | Pb (ug/l) | Pb Criteria | | Pb-dis (ug/l) | | Zn (mg/l) | Zn Criteria | | Zn-dis (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI3 | 1/9/2002 | 166 | LDL | 2 | 0.155 | LDL | 2 | | 0.087 | 0.180 | | 0.118 |
| VI3 | 2/12/2002 | 168 | LDL | 2 | 0.157 | LDL | 2 | | 0.068 | 0.182 | | 0.059 |
| VI3 | 3/20/2002 | 175 | | 9.74 | 0.166 | LDL | 2 | | 0.083 | 0.188 | | 0.053 |
| VI3 | 5/8/2002 | 160 | LDL | 2 | 0.148 | LDL | 2 | | 0.05 | 0.174 | | 0.043 |
| VI3 | 6/19/2002 | 140 | LDL | 2 | 0.125 | LDL | 2 | | 0.032 | 0.156 | | 0.03 |
| VI3 | 7/9/2002 | 152 | LDL | 2 | 0.139 | LDL | 2 | LDL | 0.03 | 0.167 | | 0.03 |
| VI3 | 7/15/2002 | 163 | | 2.27 | 0.151 | LDL | 2 | LDL | 0.03 | 0.177 | LDL | 0.03 |
| VLGJ-1 | 1/9/2002 | 169 | LDL | 2 | 0.159 | LDL | 2 | LDL | 0.03 | 0.183 | | 0.079 |
| VLGJ-1 | 2/12/2002 | 173 | LDL | 2 | 0.163 | LDL | 2 | LDL | 0.03 | 0.186 | LDL | 0.03 |
| VLGJ-1 | 3/20/2002 | 151 | LDL | 2 | 0.137 | LDL | 2 | LDL | 0.03 | 0.166 | LDL | 0.03 |
| VLGJ-1 | 5/8/2002 | 189 | LDL | 2 | 0.183 | LDL | 2 | LDL | 0.03 | 0.201 | LDL | 0.03 |
| VLGJ-1 | 6/19/2002 | 167 | LDL | 2 | 0.156 | LDL | 2 | LDL | 0.03 | 0.181 | LDL | 0.03 |
| VLGJ-1 | 7/9/2002 | 145 | LDL | 2 | 0.131 | LDL | 2 | LDL | 0.03 | 0.160 | LDL | 0.03 |
| VLGJ-1 | 7/15/2002 | 164 | LDL | 2 | 0.153 | LDL | 2 | LDL | 0.03 | 0.178 | LDL | 0.03 |
| VLGJ-2 | 1/9/2002 | 180 | LDL | 2 | 0.172 | LDL | 2 | | 0.153 | 0.193 | | 0.099 |
| VLGJ-2 | 2/12/2002 | 182 | LDL | 2 | 0.174 | LDL | 2 | | 0.049 | 0.194 | | 0.05 |
| VLGJ-2 | 3/20/2002 | 94.7 | | 9.87 | 0.076 | LDL | 2 | | 0.078 | 0.112 | | 0.03 |
| VLGJ-2 | 5/8/2002 | 186 | LDL | 2 | 0.179 | LDL | 2 | | 0.151 | 0.198 | | 0.081 |
| VLGJ-2 | 6/19/2002 | 172 | LDL | 2 | 0.162 | LDL | 2 | | 0.213 | 0.185 | | 0.148 |
| VLGJ-2 | 7/9/2002 | 153 | LDL | 2 | 0.140 | LDL | 2 | | 0.116 | 0.168 | | 0.083 |
| VLGJ-2 | 7/15/2002 | 182 | | 2.15 | 0.174 | LDL | 2 | | 0.121 | 0.194 | | 0.095 |
| VLGJ-3 | 1/9/2002 | 202 | | 2.28 | 0.199 | LDL | 2 | | 0.268 | 0.212 | | 0.422 |
| VLGJ-3 | 2/12/2002 | 193 | | 2.35 | 0.188 | LDL | 2 | | 0.137 | 0.204 | | 0.133 |
| VLGJ-3 | 3/20/2002 | 143 | | 16.8 | 0.128 | LDL | 2 | | 0.159 | 0.158 | | 0.069 |
| VLGJ-3 | 5/8/2002 | 199 | LDL | 2 | 0.195 | LDL | 2 | | 0.081 | 0.210 | | 0.055 |
| VLGJ-3 | 6/19/2002 | 161 | LDL | 2 | 0.149 | LDL | 2 | | 0.116 | 0.175 | | 0.081 |
| VLGJ-3 | 7/9/2002 | 149 | LDL | 2 | 0.135 | LDL | 2 | | 0.065 | 0.164 | | 0.033 |
| VLGJ-3 | 7/15/2002 | 180 | LDL | 2 | 0.172 | LDL | 2 | | 0.039 | 0.193 | | 0.034 |
| VLGJ-4 | 1/9/2002 | 186 | LDL | 2 | 0.179 | LDL | 2 | | 0.13 | 0.198 | | 0.196 |
| VLGJ-4 | 2/12/2002 | 187 | LDL | 2 | 0.180 | LDL | 2 | | 0.116 | 0.199 | | 0.083 |
| VLGJ-4 | 3/20/2002 | 196 | LDL | 2 | 0.192 | LDL | 2 | | 0.171 | 0.207 | | 0.067 |
| VLGJ-4 | 5/8/2002 | 187 | | 2.13 | 0.180 | | 2 | | 0.044 | 0.199 | | 0.038 |
| VLGJ-4 | 6/19/2002 | 145 | LDL | 2 | 0.131 | LDL | 2 | | 0.038 | 0.160 | LDL | 0.03 |
| VLGJ-4 | 7/9/2002 | 142 | LDL | 2 | 0.127 | LDL | 2 | LDL | 0.03 | 0.158 | LDL | 0.03 |
| VLGJ-4 | 7/15/2002 | 170 | LDL | 2 | 0.160 | LDL | 2 | LDL | 0.03 | 0.183 | LDL | 0.03 |

Note: LDL is less than detection limits

# Appendix B Equations for Calculating Specific Metals Criteria

1. Cadmium

(i) freshwater acute aquatic life:

conc. (µg/l) = $e^{(1.128[\ln(\text{hardness in mg/l as } CaCO_3)]-3.828)}$ **(Eq. 1)**

(ii) freshwater chronic aquatic life:

conc. (µg/l) = $e^{(0.7852[\ln(\text{hardness in mg/l as } CaCO_3)]-3.490)}$ **(Eq. 2)**

2. Chromium (trivalent)

(i) freshwater acute aquatic life:

conc. (µg/l) = $e^{(0.8190[\ln(\text{hardness in mg/l as } CaCO_3)]+3.688)}$ **(Eq. 3)**

(ii) freshwater chronic aquatic life:

conc. (µg/l) = $e^{(0.8190[\ln(\text{hardness in mg/l as } CaCO_3)]+1.561)}$ **(Eq. 4)**

3. Copper

(i) freshwater acute aquatic life:

conc. (µg/l) = $e^{(0.9422[\ln(\text{hardness in mg/l as } CaCO_3)]-1.464)}$ **(Eq. 5)**

(ii) freshwater chronic aquatic life:

conc. (µg/l) = $e^{(0.8545[\ln(\text{hardness in mg/l as } CaCO_3)]-1.465)}$ **(Eq. 6)**

4. Lead

(i) freshwater acute aquatic life:

conc. (µg/l) = $e^{(1.273[\ln(\text{hardness in mg/l as } CaCO_3)]-1.460)}$ **(Eq. 7)**

(ii) freshwater chronic aquatic life:

conc. (µg/l) = $e^{(1.273[\ln(\text{hardness in mg/l as } CaCO_3)]-4.705)}$ **(Eq. 8)**

5. Nickel

(i) freshwater acute aquatic life:

conc. (µg/l) = $e^{(0.8460[\ln(\text{hardness in mg/l as } CaCO_3)]+3.3612)}$ **(Eq. 9)**

(ii) freshwater chronic aquatic life:

conc. (µg/l) = $e^{(0.8460[\ln(\text{hardness in mg/l as } CaCO_3)]+1.1645)}$ **(Eq. 10)**

6. Pentachlorophenol

(i) freshwater acute aquatic life:

conc. (µg/l) = $e^{[1.005(pH)-4.830]}$ **(Eq. 11)**

(ii) freshwater chronic aquatic life:

conc. (µg/l) = $e^{[1.005(pH)-5.290]}$ **(Eq. 12)**

7. Silver

(i) freshwater acute aquatic life:

conc. (µg/l) = $e^{(1.72[\ln(\text{hardness in mg/l as } CaCO_3)]-6.52)}$ **(Eq. 13)**

8. Zinc

(i) freshwater acute aquatic life:

conc. (µg/l) = $e^{(0.8473[\ln(\text{hardness in mg/l as } CaCO_3)]+0.8604)}$ **(Eq. 14)**

(ii) freshwater chronic aquatic life:

conc. (µg/l) = $e^{(0.8473[\ln(\text{hardness in mg/l as } CaCO_3)]+0.7614)}$ **(Eq. 15)**

For pollutants classified by the U.S. Environmental Protection Agency as non-carcinogens, the criteria shall be given by the following equation.

(ii) Consumption of fish only:

conc. (mg/L)= (HBW x RfD)/(FCR x BCF) **(Eq. 17)**

where: HBW = human body weight, set at 70 kg
RfD = reference dose, in mg/(kg-day)
FCR = fish consumption rate, set at 0.030 kg/day
BCF = bioconcentration factor, in 1/kg
WCR = water consumption rate, set at 2 1/day

For pollutants classified by the U.S. Environmental Protection Agency as carcinogens, the criteria shall be given by the following.

(ii) Consumption of fish only:

conc. (mg/L)= (HBW x RL)/(CPF x FCR x BCF) **(Eq. 19)**

where: HBW = human body weight, set at 70 kg
RL = risk level, set at 1 x $10^{-5}$
CPF = cancer potency factor, in (kg-day)/mg
FCR = fish consumption rate, set at 0.030 kg/day
BCF = bioconcentration factor, in 1/kg
WCR = water consumption rate, set at 2 1/day

# Appendix C Stream Power Methodology

The siltation TMDL approach described herein was developed to account for the dominant process of sedimentation in an urban stream, as evident in Village Creek. The urbanization of the metropolitan area of Birmingham in the upper watershed of Village Creek produces large, abrupt hydrographs in the creek that cause bank degradation and instability due to high velocities in the channel. Village Creek is typical of urban streams in this respect with characteristics such as poor habitat, degraded water quality, and stressed biological communities (ADEM, 2001). The technical approach was developed with the overlying goals to be achieved:

Technically defensible approach,

Major sources of sediment and their spatial location identified,

Available monitoring and additional monitoring needs identified,

Allows implementation to start in a focused manner by identifying percent reductions needed for major sources, and

TMDL only to identify how much sediment needs to be reduced to WQS over time, it does not determine how the goals will be implemented (EPA discussions, 2002).

Previous TMDL approaches in EPA Region 4 have utilized the Watershed Characterization System's Sediment Tool to simulate land-based sources of sediment, namely tillage practices in agricultural areas, active and abandoned mining facilities, and unimproved roads adjacent to streams. This is the approach is considered to be the Level I approach to address excessive sediment contributors in the watershed. The Sediment Tool uses the Universal Soil Loss equation to calculate the source erosion potential and adds a delivery mechanism of the sediment load reaching the stream based on distance and relief of the source to the stream. The Sediment Tool was not appropriate in this analysis because the major source of the sediment originates instream and the tool does not account form instream sediment processes.

EPA Region 4 is currently developing a Level II approach to sediment TMDLs where instream sedimentation is predominant. Given that a major source of sediment in the region's stream is from eroding channel banks, instream sediment loads will be simulated using other more complex, process-based models like CONCEPTS developed by the National Sediment Laboratory in Oxford, Mississippi. The James Creek siltation TMDL in Mississippi is being developed in this manner along with an extensive field data collection to calibrate the channel evolution model. Where there is not sufficient data to develop channel evolution models, an intermediate approach is suggested in this document. The approach identifies a relationship between sediment loads and instream flows and ties the peak flows to stream stability through an aggregate parameter of specific stream power. The stability requirements of the stream are directly related to the habitat and biological community in the stream. If sedimentation is reduced through reducing peak hydrographs, it will allow for a benthic habitat that will provide greater protection for aquatic life.

Based on an examination of the source assessment listed in Section 3.3 of the TMDL document and communication with EPA Region 4, an approach was developed for Village Creek. The steps for developing the instream sediment TMDL were performed as follows:

Downloaded the historical peak and daily average flow data from http://waterdata.usgs.gov/al for USGS gage 02458450 - Village Creek at Avenue W at Ensley.

Requested hourly data at the same site for 1999-2001 to examine recent stormwater runoff events.

Plotted peak versus daily average flows to develop a relationship and examine the flashy nature of the basin's hydrology.

Requested and ran the HEC-RAS model for Village Creek that was developed by the USACE Mobile District.

Plotted the cross-section at USGS gage to determine bankfull depth and width.

Developed the $Q_{1.5}$ flow from peak flow data and a Log-Pearson Type III curve fit.

Calculated stream power with $Q_{1.5}$, energy slope, and bank width.

Ran HEC-RAS model to evaluate existing conditions of depth and water surface width under the $Q_{1.5}$.

Compared existing stream power to that of stable stream ranges.

Gathered all total suspended solids data on Village Creek and determined an associated peak discharge from the hourly time series flow data or by the relationship developed in (3).

Developed a relationship between suspended sediment loads and peak discharge.

Decreased the peak flow critical condition ($Q_{1.5}$) and calculated a stream power with the decreased peak flow.

Used sediment load relationship in (9) to calculate the existing and revised flow conditions.

The flow record was developed from data collected at USGS 02458450 – Village Creek at Avenue W at Ensley, Alabama. It is located approximately 2 miles upstream of the Jefferson County Village Creek WWTP as shown in Figure 3-1 of the TMDL document. At this location, the drainage area is 33.5 $mi^2$ and the elevation is 505.16 above sea level (NGVD 29) and is located in the Locust Fork 8-digit HUC (03160111) in the Village Creek basin (03160111140). Most of the watershed is urban upstream of the gage as shown in Figure 3-11 of the TMDL document. At the USGS gage at Avenue W, the bankfull depth is approximately 15 feet and the bank width is 110 feet. Figure C-1 shows a picture of Village Creek at Avenue W.

A HEC-RAS model was developed by the United States Army Corps of Engineers Mobile District simulate existing conditions and to forecast flood conditions along Village Creek for the City of Birmingham. The model was then utilized to run a series of flows and simulate the associated cross-sectional area, wetted perimeter, and water depth. The HEC-RAS model contained cross-sectional information recently collected by the USACE for development of the model. Figure C-2 shows the cross-section represented in the model for Village Creek at Avenue W. In the next few months the USACE plan to use the model to determine the future conditions with respect to various landuse changes and detention structures.

The daily average and peak hourly flows collected at Avenue W are plotted in Figure C-3. The flow record begins on July 1, 1975 and continues through current. There is a significant gap in the longterm record from September 30, 1979 to July 8, 1988. The minimum daily average flow of 9.2 cfs occurred on November 2, 2000 and a maximum of 3,400 cfs occurred on April 13, 1979. For the TMDL analysis, flow data from 1988 through current were used.

The peak discharge data were also collected and plotted in Figure C-4 along with the daily average that occurred over the day the peak flow occurred. In this analysis, the peak flow is more important for sediment transport in Village Creek. By comparing the peak flow to the daily average, a few items are clear:

Peak discharges are increasing from the 1980s to current,

The difference in peak and average daily flow is significant (3-4 times), and

The hydrology is very flashy with steep hydrographs.

In many parts of the United States, the effective discharge is approximately equal to the peak flow that occurs on average, about every 1.5 years (Andrews, 1980; Andrews and Nankervis, 1995). The $Q_{1.5}$ flow is defined as the discharge that occurs, on average every 1.5 years, that is the "effective discharge" and a flow rate that represents longterm sediment conditions. The $Q_{1.5}$ is the flow that shapes the channel and performs the most geomorphic work on the stream cross-section (i.e., the most sediment transport) (Simon, 2002). This would be analogous to the bankfull flow in a stable stream. The peak flows were gathered from 2 sources: USGS reported peak flows (> 3,500 cfs at this site) and the hourly flow data from 1999-2002. The USGS peak flows reported are all flows that the water level exceeds the banks. At Avenue W, this occurs at approximately 3,500 cfs. By plotting all peak flow data and then developing a curve fit of the data by a Log Pearson Type III, a recurrence interval can be picked off the graph. The $Q_{1.5}$ was determined by entering Figure C-4 at the 1.5 percent less than mark on the x-axis and reading a flow off of the curve fit. As shown in Figure C-4, it was determined to be 3,120 cfs.


**Figure C-1 Village Creek at Avenue W at Ensley Looking Upstream**

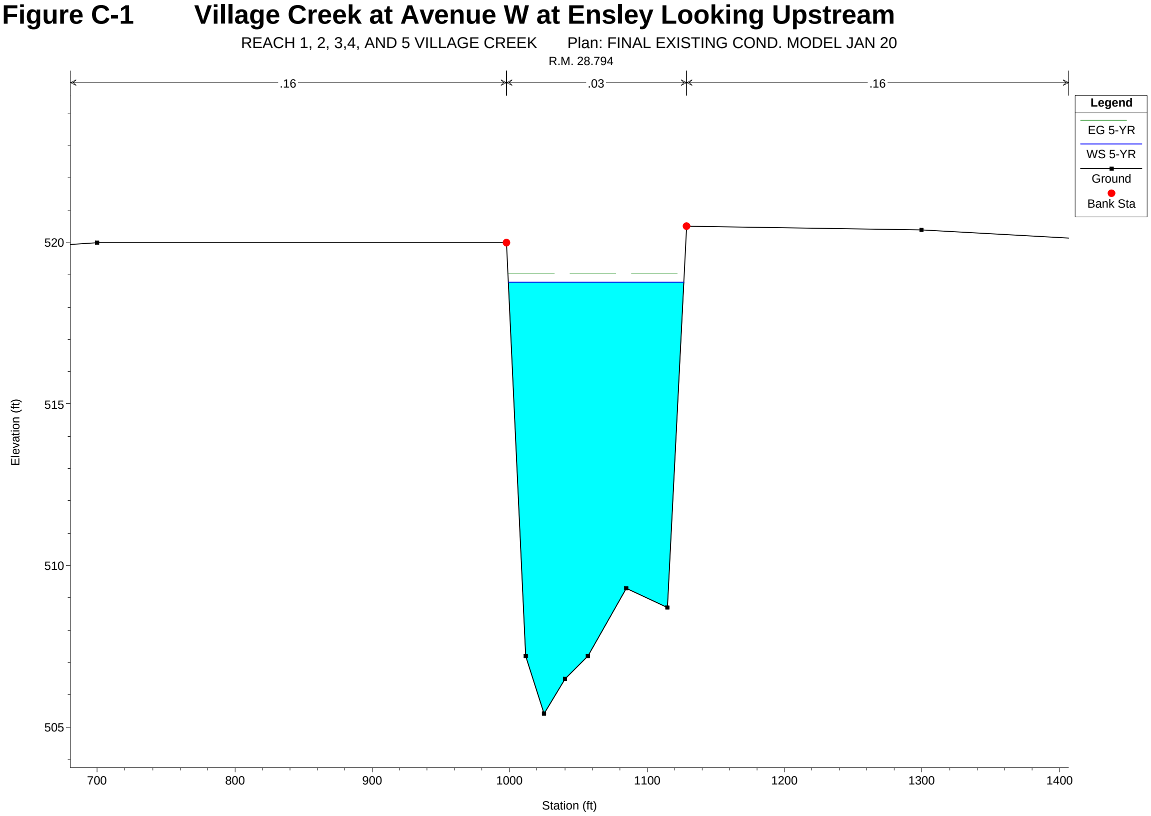



**Figure C-2 HEC-RAS Model Cross-Section on Village Creek at Avenue W**

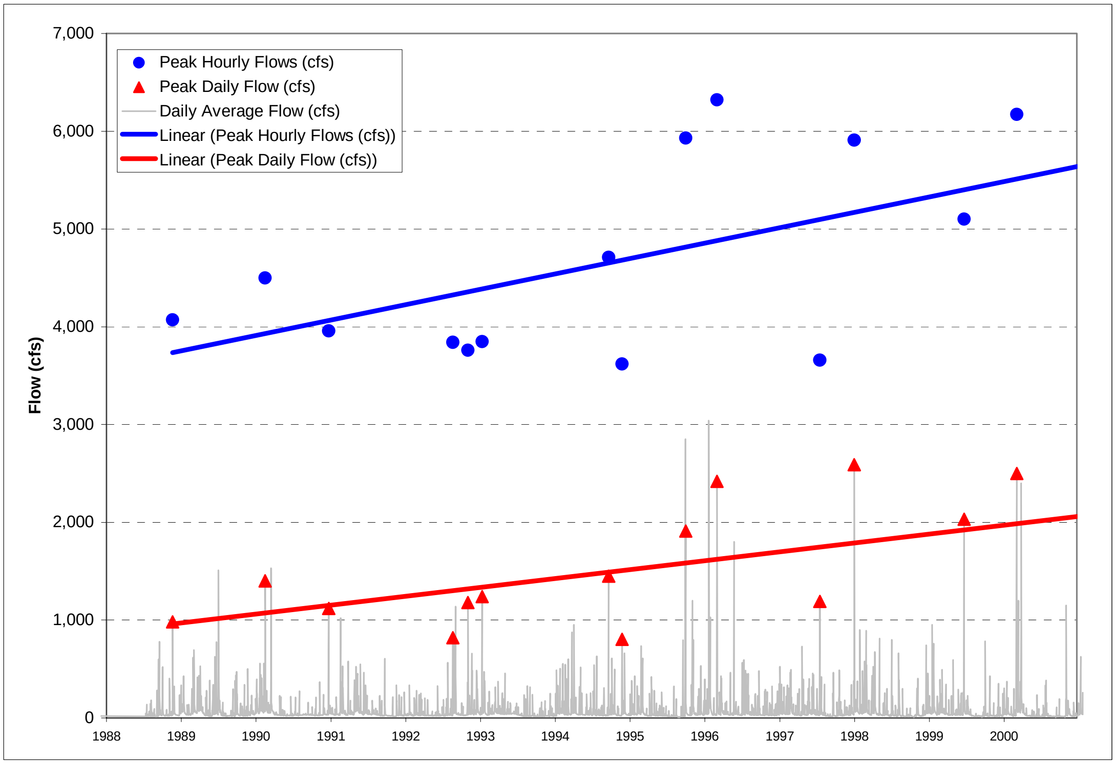



**Figure C-3 Peak and Daily Average Flows at Avenue W**

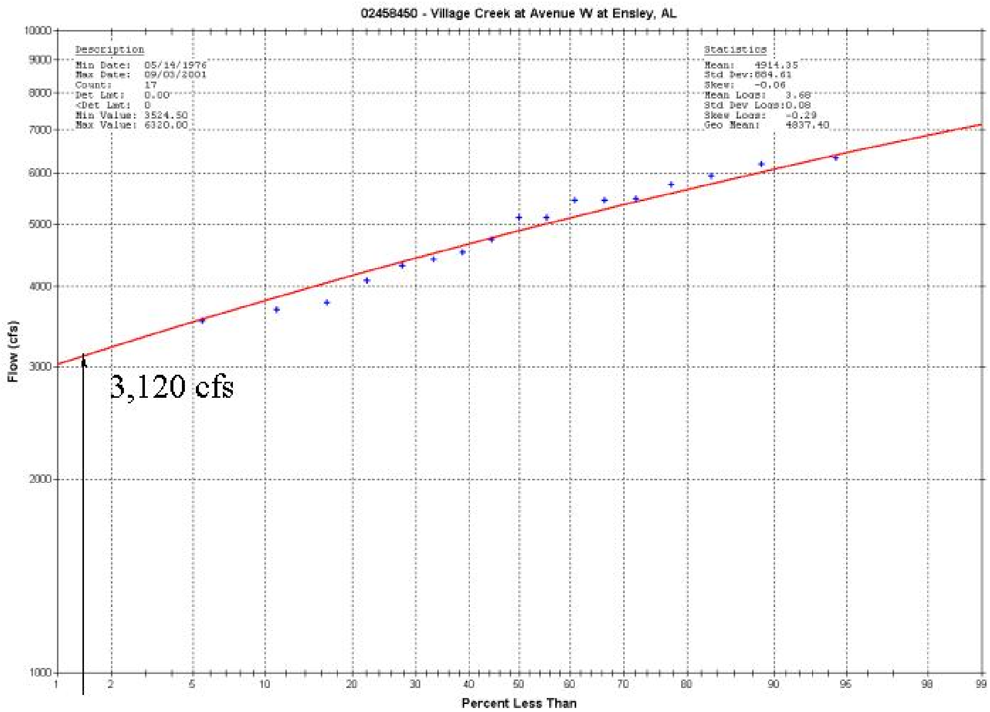



**Figure C-4 Log-Pearson Type III Flow Analysis for Peak Flow Data at Avenue W**

The TMDL is calculated based on the critical conditions of the impairment. Instead of choosing an episodic event for the critical conditions, it was determined that a more frequent peak flow that causes channel erosion and scouring should be chosen. Therefore, the $Q_{1.5}$ was determined to represent the critical conditions for the sediment transport in Village Creek. This TMDL was developed based on the critical condition flow to reduce the peak hydrograph of the $Q_{1.5}$ and reduce the sedimentation in the stream and deposition in the lower part of Village Creek.

The specific stream power was computed as the product of the specific weight of water, the two-year recurrence interval discharge, and the energy slope, divided by the channel width. Units of specific discharge are in Watts per square meter (14.56 W/m2 = 1 ft-lb/sec/ft2). Data collected in the Yazoo River Basin, Mississippi showed various stages of the incised channel evolution. This reference and data were used to determine a stability criterion for Village Creek. The trends in energy slope, TSS, and stream power are clear as shown in Figure C-5. Specific stream power appears to be an excellent predictor of channel stability, with most streams attaining relative stability at specific stream power less than 30 W/m2 (Bledsoe et al., 2002) as shown in the bottom graph in Figure C-5. The equation for specific stream power is:

$$Specific\ \ Stream\ \ Power\ \left(W/m^2\right) = \frac{14.56 \times \delta w \times S_{EGL} \times Q_{1.5}}{B}$$

where: $\delta_w$ = specific weight of water = 62.4 lb / $ft^3$

$S_{EGL}$ = longitudinal slope of energy grade line (ft / ft)

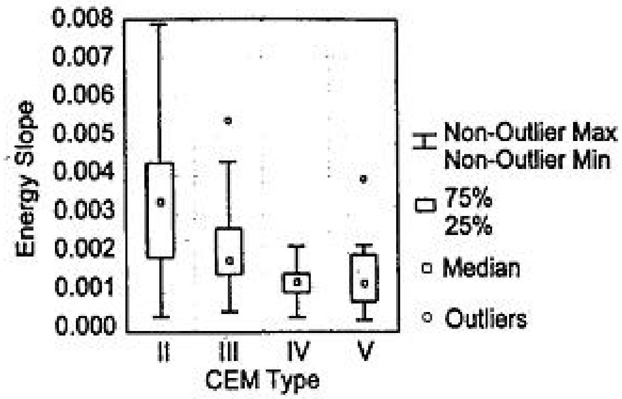
$Q_{1.5}$ = 1.5 year recurrence interval of peak flows (cfs)

B = bankfull width (ft)

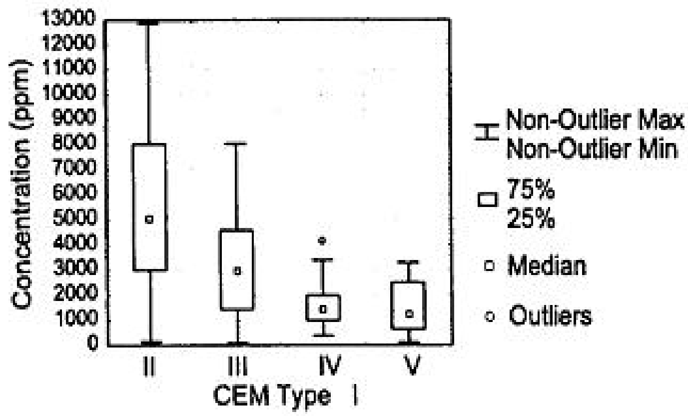
**Table C-1 Calculation of Stream Power for Existing (left) and TMDL (right) Conditions**

| | Existing | Units | TMDL | Units |
|---|---|---|---|---|
| specific weight of water, $\delta_w$ = | 62.4 | lb / $ft^3$ | 62.4 | lb / $ft^3$ |
| 1.5-year Recurrence Interval for Peak Discharge, $Q_{1.5}$ = | 3,120 | $ft^3$ / s | 2,115 | $ft^3$ / s |
| Slope of Energy Grade Line, $S_{EGL}$ = | 0.001432 | ft / ft | 0.001432 | ft / ft |
| Bank Width, $B_w$ = | 110.00 | ft | 110.00 | ft |
| Specific Stream Power = | 2.53 | lb / ft-s | 1.72 | lb / ft-s |
| | 36.90 | W / $m^2$ | 25.02 | W / $m^2$ |

The reduction in the peak hydrograph applies to the flow at the 1.5-year recurrence interval. The stream power was calculated at 3,120 cfs and then at a reduced flow to meet the 30 W/$m^2$. The other parameters were assumed to be constant. Therefore, the volume of water that would reach the stream during a storm event would remain constant but the peak flow would be reduced and the hydrograph flattened. As shown in Table C-1, the stream power target was 25 rather than 30 W/$m^2$ to allow greater protection and for a margin of safety.




(a) Energy Slope




(b) Concentration

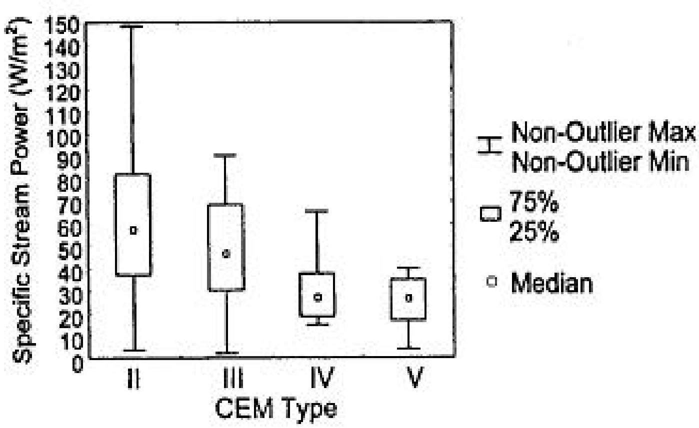



**Figure C-5 Channel Evolution Characteristics for Streams in Yazoo Basin**
(Bledsoe *et al*., 2002)

Suspended sediment (TSS) data were gathered and were compared to the daily flow record. The daily flows and rainfall data were used to discern wet versus dry weather sampling event. The wet weather events were separated and a peak flow was determined for each wet weather event. The peak flow was determined by the reported USGS peak measurement, from the hourly flow data in 1999-2002, or from an average relationship between measured peak and daily average flows.

A suspended sediment transport rating curve can be developed by plotting the suspended sediment load (TSS x peak flow) versus the peak flow on a log-log plot (Simon, 1989). A relationship can be developed by a trend line, which is power fit equation, as shown in Figure C-6. The power fit equation can be used to calculate the suspended sediment load at any give peak flow. The measured value at the right side of the plot in Figure C-6 was measured at 1,380 cfs (daily average), 3,192 cfs (calculated peak hourly), and a measured TSS concentration of 384 mg/L.

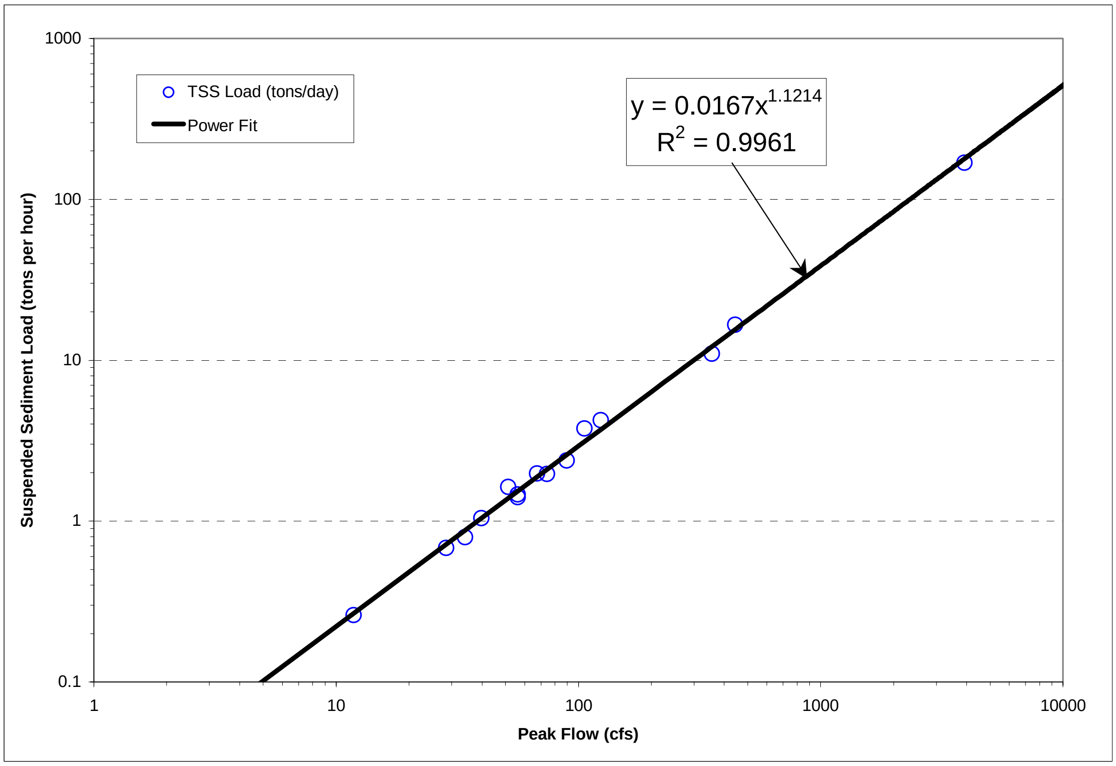



**Figure C-6 Suspended Sediment versus Peak Flow Relationship at Avenue W**

For the TMDL, the load vs peak discharge curve was used to develop a sediment load. The units are in tons (or lbs) per hour because the duration of the channel shaping flow ($Q_{1.5}$) is short. Therefore, the calculation of the load on a daily time frame would overestimate the total load.

Table C-2 shows the results of the TMDL calculation. The existing $Q_{1.5}$ and the proposed $Q_{1.5}$ are shown in separate sides of Table C-2. The suspended sediment loads are calculated using the power fit equation in Figure C-6. As shown in the table, 138.39 tons/hour is the existing condition and 89.48 is the proposed load to meet the stability requirements of the stream. Therefore, the TMDL reduction is 35% to meet the state's narrative water quality standard.

**Table C-2 TMDL Summary for Village Creek Siltation**

| Existing Load | | TMDL | | | |
|---|---|---|---|---|---|
| 3,120 | cfs | 2,115 | cfs | | |
| 138.39 | tons / hour | 89.48 | tons / hour | | |
| 33.5 | sq mi | 33.5 | sq mi | | |
| 4.13 | tons / sq mi / hr | 2.67 | tons / sq mi / hr | | |
| 8,262 | lbs / sq mi / hr | 5,342 | lbs / sq mi / hr | | |
| 12.9 | lbs / acres / hr | 8.3 | lbs / acres / hr | 35% | = Percent Reduction |

Using stream power as a stability target, as described in this section, is a defensible technique for developing a TMDL endpoint. This approach is useful when site-specific data to establish stream stability are not present. On the other hand, having site-specific measurements of stream stability would be more appropriate. Another method of establishing a TMDL endpoint would be to choose a reference stream that does not have a biological impairment, the stream channel is stable, and the watershed contains urban landuses. The most likely candidate would be a watershed that has been built out and the urban growth has been minimal over the past 10-20 years. Or, an urban watershed that has BMPs that are appropriately installed and functioning properly to reduce urban peak hydrographs.

# Appendix D Hardness Exceedance Curve Methodology

The hardness exceedance curve methodology was used to determine metals violations. These methods required the following information:

Existing hardness measurements,

Existing dissolved metals concentrations or total metals concentrations and TSS,

USGS flow measurements, and

Dissolved metals criteria.

The data must be analyzed in two parts to understand the critical conditions to target. The TMDL is simply a critical condition flow multiplied by the instream criterion, where critical condition hardness, measured in mg/L as $CaCO_3$, is utilized.

First, measured total metals concentrations were converted to dissolved concentrations using the methods described in *The Metals Translator: Guidance for Calculating A Total Recoverable Permit Limit From A Dissolved Criterion*, EPA, 1996. The guidance offers a list of default partition coefficients, $K_{pO}$ and α. These coefficients can be used to calculate the dissolved concentration with TSS and a total concentration.

$$Dissolved = Metal * [1/[1 + K_{pO} * TSS^{\alpha} * TSS * 10^{-6}]] \text{ (EPA, 1996)}$$

Table D-1 lists the default partition coefficients used in data analysis for this report.

**Table D-1 Calculation of Default Partition Coefficients (EPA, 1996)**

| Metal | Streams | |
|---|---|---|
| | $K_{pO}$ | α |
| Cu | 1.04E+06 | -0.7436 |
| Zn | 1.25E+06 | -0.7038 |
| Pb | 2.80E+06 | -0.8 |
| Cd | 4.00E+06 | -1.1307 |

The Figures on the following page show loading curves for dissolved acute and chronic criteria that would be applicable to the Limited Warmwater Fishery designated use on Village Creek for the metals of concern; cadmium, copper, lead, and zinc. Criteria outlined in the State of Alabama's Rules and Regulations for Water Quality Control specific criteria for toxic substances, ADEM 335-6-10-.07 (1)(a), are described for dissolved concentrations. In this analysis, the flow was provided from the USGS flow gages for Village Creek. All available hardness data collected on Village Creek since 1997 was ranked as an exceedance probability. The exceedance probability indicates the percentage of time that the hardness is exceeded. The hardness exceedance curves define conditions of hardness where exceedances of metals criteria occur, see Figures D-2 through D-6.

A correlation between hardness and flow could not be established from data collected in Village Creek, see Figure D-1. Thus, the criterion was used to isolate violations and violations were associated with flow conditions.

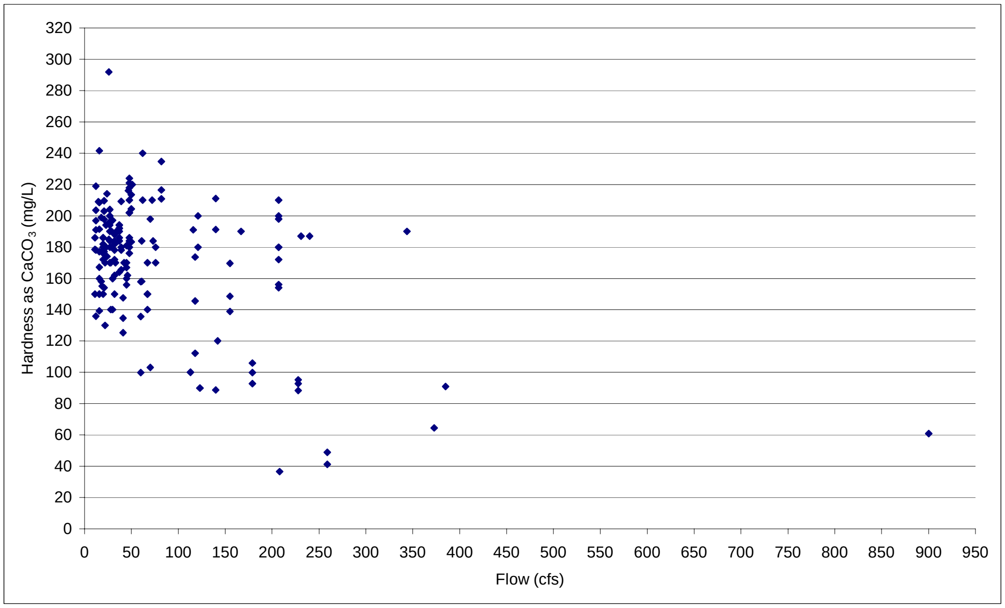



**Figure D-1 Hardness versus Flow Measured in Village Creek**

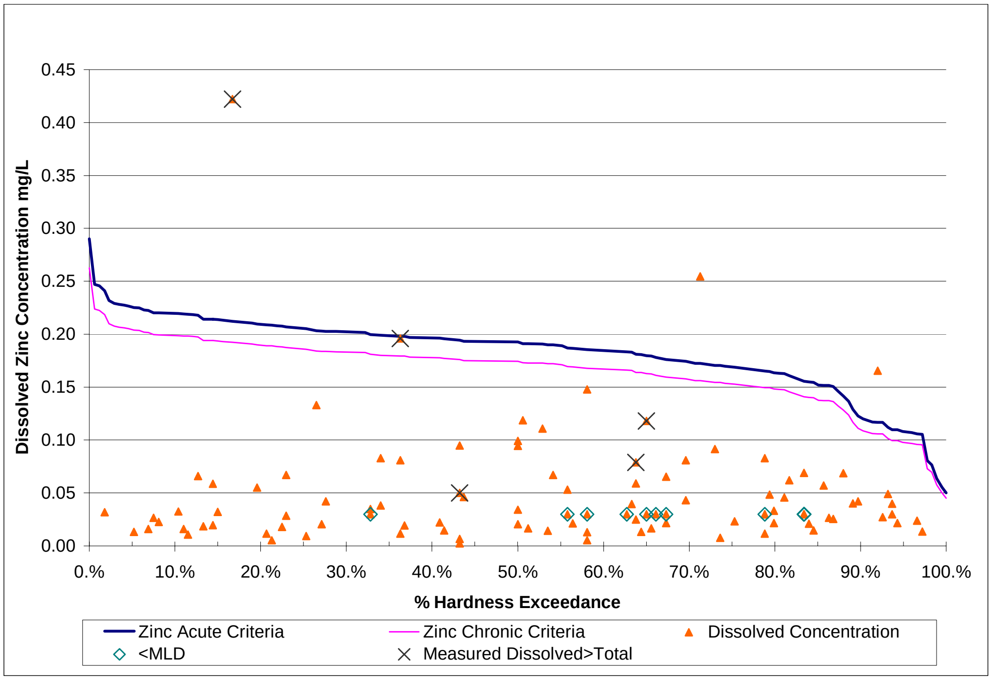



**Figure D-2 Zinc Criteria Evaluated at Various Hardness Conditions in the Impaired Segment of Village Creek**

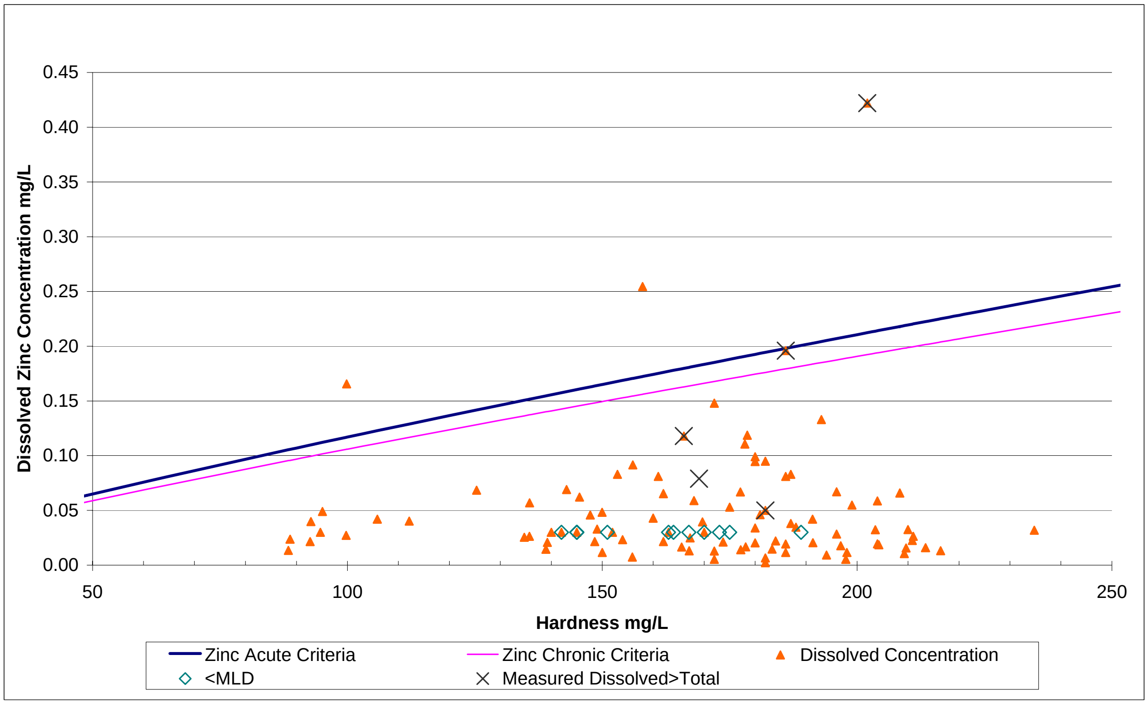



**Figure D-3 Zinc Criteria Based on Hardness Concentrations; Zinc Measurements Collected 1997 – 2002 in the Impaired Segment of Village Creek**

Figure D-2 illustrates four exceedances of the State's zinc criteria, also plotted in Figure D-3. The measured dissolved concentration was greater than the measured total concentration of two of these violations. The "true" value of these data is unknown and therefore these violations were not used to establish a target for the zinc TMDL in Village Creek. The two remaining violations of the dissolved State acute criteria were calculated from a measured total concentration using the *EPA's Metals Translator* (EPA, 1996).

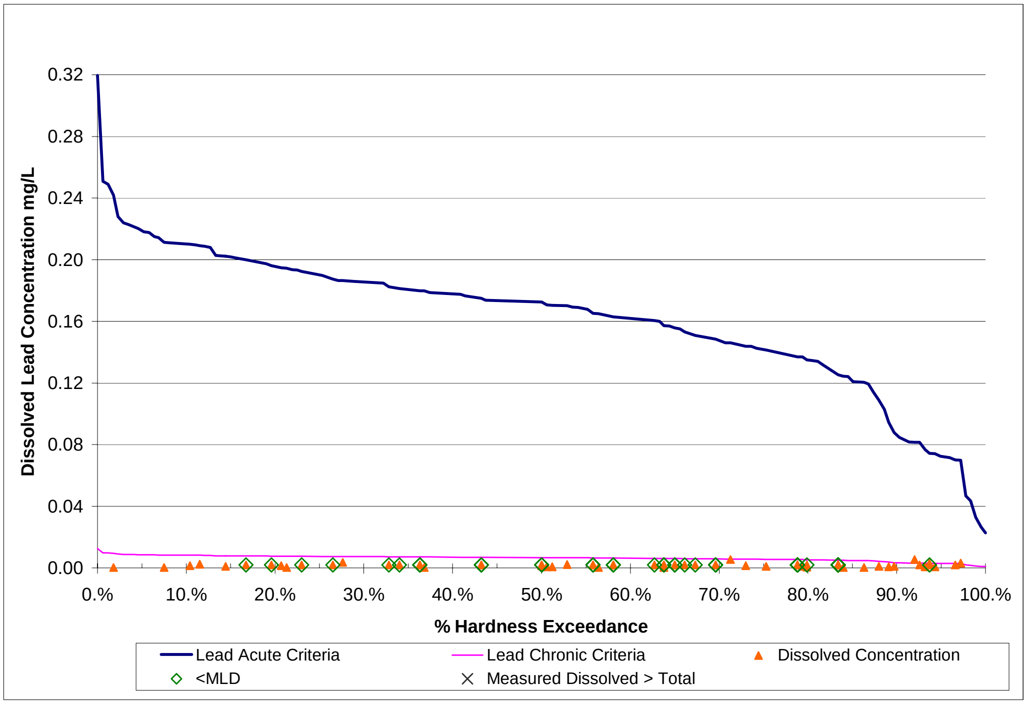



**Figure D-4** **Lead Criteria Evaluated at Various Hardness Conditions in the Impaired Segment of Village Creek**

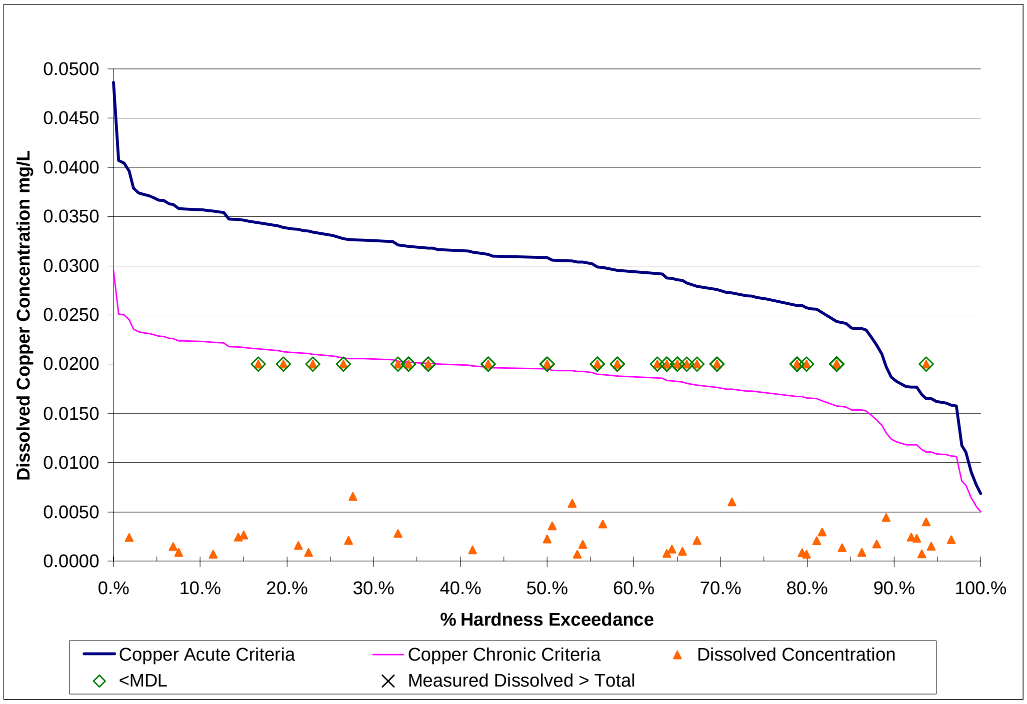



**Figure D-5** **Copper Criteria Evaluated at Various Hardness Conditions in the Impaired Segment of Village Creek**

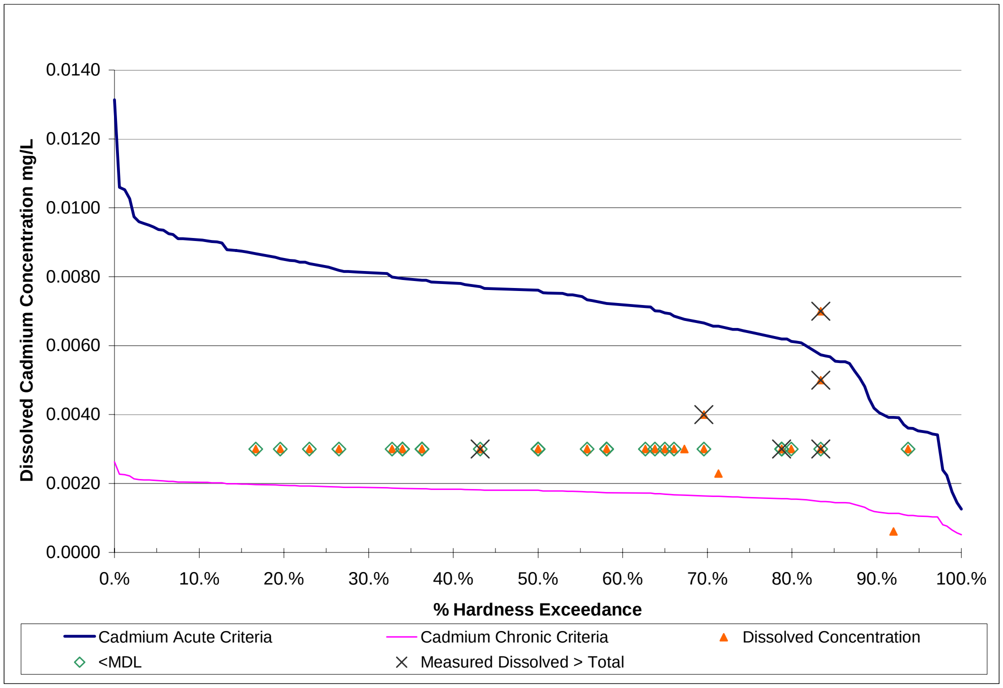



**Figure D-6 Cadmium Criteria Evaluated at Various Hardness Conditions in the Impaired Segment of Village Creek**

A closer look at chronic concentrations of dissolved lead in Figure D-4 shows two concentrations of 0.006mg/L. These points are equal to and exceeding the chronic criteria. The chronic criterion is the four-day maximum average concentration that can occur once in a three-year period. The dissolved concentration was calculated from a total concentration collected during wet weather sampling on September 29, 1999. The lead concentrations of 0.006 mg/L are instantaneous occurrences and do not represent chronic conditions. These concentrations were not considered impairments to the segment because they are wet weather samples and are not in violation of the acute criteria. The acute criterion for metals is the one-hour maximum average concentration that can occur once in a three-year period.

Calculated concentrations of dissolved copper in Figure D-5 were much less than the State chronic criteria. Values measured less than detection limits, 0.02mg/L, and exceeding the chronic criteria were measured dissolved concentrations of copper collected in 2002 as a part of ADEM's §303(d) Monitoring Program. This data collection also measured cadmium with a minimum detection limit exceeding the State chronic criteria, 0.003mg/L, Figure D-6.

In Figure D-6, one cadmium sample is illustrated below the chronic criteria and a second exceeding the criteria. In the development of these hardness exceedance curves, if a total concentration was less than the detection limit and the dissolved concentration had to be calculated, the samples were not plotted. More cadmium samples were collected in the watershed at total concentrations measured less then their detection limit. The single exceedance of the chronic cadmium concentration was again measured on September 29, 1999 during wet weather sampling. As indicated by concentrations collected during dry weather, this elevated concentration will not persist over a four-day period.

The next step is to examine the flow conditions of exceedances. This was done by plotting the data exceeding metals criteria against the exceedance of flows at Avenue W (USGS Station 02458450) that occur when the sample was collected, see Figure D-7.

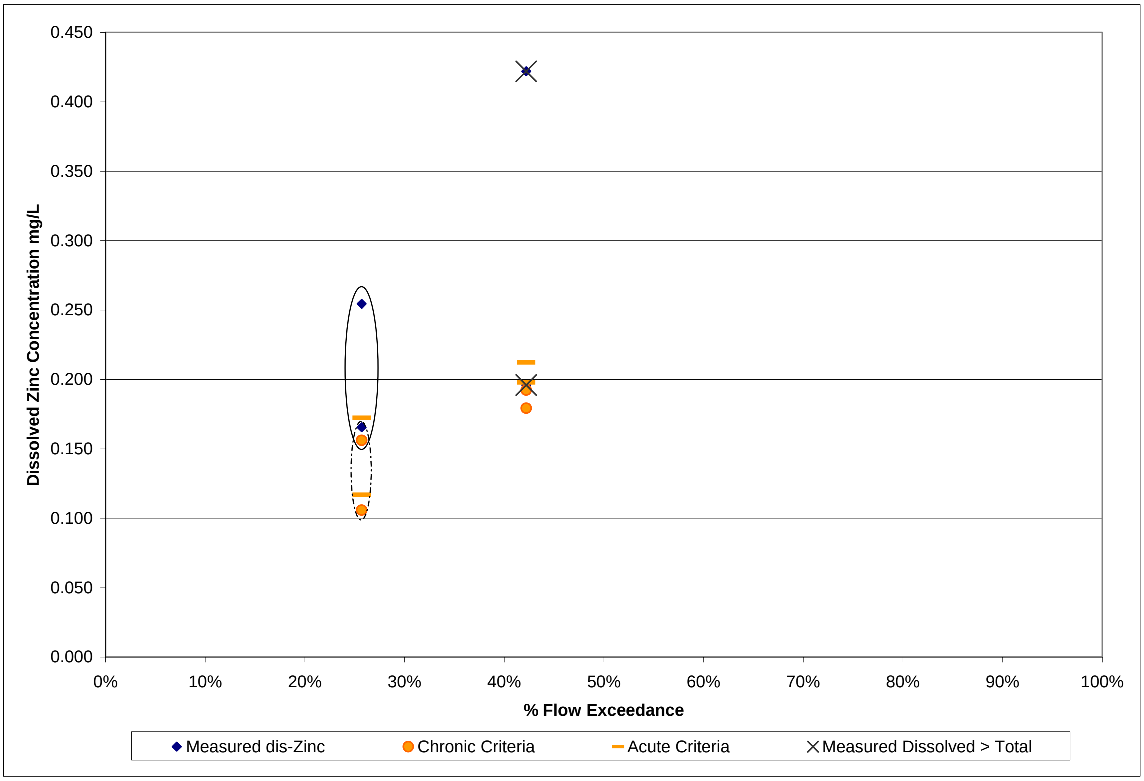



**Figure D-7 Flow Conditions at Ave. W during Violations of the Zinc Criteria in Village Creek**

The methods in this data analysis provide a useful technique in examining events by isolating random events to show the distribution of hardness, the corresponding hydrological event and other contributors, such as point sources or illicit discharges. These factors are important to understand in the development of a TMDL. Figure D-7 illustrates the zinc violations on Village Creek that exceed the State acute and chronic criteria. These violations were targeted for TMDL development.

Violating dissolved concentrations were calculated from total zinc concentrations collected by SWMA on September 29, 1999 during wet weather sampling. A data review of conditions during these violations reveals a permitted discharge from ACIPCO of zinc. The violations were measured at a station upstream (Vanderbilt) and downstream (Avenue W) of the discharger. Existing allocations can be made to nonpoint source loads and point source wasteload by understanding these violations.

The zinc violations plotted in Figure D-7 quantify the influence of a high flow event combined with a point source discharge. Though a statistical correlation cannot be made between hardness and hydrology in Village Creek, it is generally assumed that as instream flows increase, instream hardness decreases. As hardness decreases the toxicity of metals increases.

A hardness value of 100 mg/L, which reflects the low values measured during the targeted time period and the tenth percentile of all the data, was used in the calculation of the instream criteria. Plugging this value into the equations, acute and chronic criteria of 0.117 mg/L and 0.106 mg/L were established. Since original development of these TMDLs the State criteria have been updated and the current acute criteria is 0.1172 mg/L. The State acute criterion for metals is the one-hour maximum average concentration that can occur once in a three-year period. The chronic criterion for metals is the 4-day maximum average concentration that can occur once in a three-year period.

Dissolved zinc concentrations for the wasteload were calculated from the permitted maximum daily total recoverable zinc concentration, 5.5 lbs/day at ACIPCO and 0.065 mg/L at SMI Steel and total zinc of 0.206 lbs/day at Nucor. The existing wasteloads were calculated with the five-year average daily discharge, permitted zinc loads, instream 1Q10 flows minus a background zinc load equal to 0.029 mg/L of zinc. The ACIPCO, SMI, and Nucor five-year average daily discharges are 0.58 MGD, 0.294 MGD, and 0.1 MGD, respectively.

The conditions during the exceedance measured at Vanderbilt, were utilized to establish the existing load allocation during acute conditions. A total zinc concentration of 0.903 mg/L, TSS of 73 mg/L and hardness of 99.86 mg/L where measured on September 29, 1999 at Vanderbilt where the daily average flow was 60 cfs. Total zinc was translated to dissolved zinc (0.116 mg/L) using *EPA's Metals Translator Guidance* (EPA, 1996) and set as the existing loading. The State's acute criteria were calculated using the comparable hardness to that measured on the day of the exceedance (99.86 measured, 100 utilized). Percent reductions to the load allocation were calculated for the acute criteria, 0.1172 mg/L.

# Appendix E Zinc TMDL Calculations

**Table E-1 Point Source TMDL Calculations**

| Permitted Discharges | Q (mgd)* | TR Zinc (mg/L) | Permitted Total Recoverable effluent load lb/day | effluent load lb/day CONVERTED to dissolved | Total Drainage Area (mi sq) | Incremental Drainage Area (mi sq) | Total Instream Flow (MGD) | Incremental Instream Flow (MGD) | Criteria (mg/L) | Dissolved Allowable Concentration mg/L (with 0.029mg/L Background) | Dissolved Allowable load lb/day | % Reductions | Total Recoverable Zinc Allowable Concentration mg/L (with 0.029mg/L Background) | Total Recoverable Zinc Allowable load lb/day |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SMI | | | | | (est) | | | | | | | | | |
| **acute** | 0.294 | 0.065 | **0.16** | 0.156 | 16.32 | 16.32 | 7.21 | 7.21 | 0.1172 | 2.28 | 5.59 | **0%** | 2.33 | 5.72 |
| NuCorp Steel | | | | | (est) | | | | | | | | | |
| **acute** | 0.1 | | **0.619** | 0.605 | 22.18 | 5.86 | 9.79 | 2.59 | 0.1172 | 2.40 | 2.00 | **0%** | 2.45 | 2.05 |
| ACIPCO | | | | | (est) | | | | | | | | | |
| **acute** | 0.58 | 3.046 | **14.74** | 14.419 | 27.93 | 5.75 | 12.33 | 2.54 | 0.1172 | 0.50 | 2.44 | **83%** | 0.51 | 2.49 |

* 5yr flow calculated when the permit was created
from memo use acute to ensure water quality standards
Loads Presented are Based on Max Daily Permitted Value

**Table E-2 Point Source TMDL Calculations**

| | | | | |
|---|---|---|---|---|
| **SMI - Daily Max. In-stream Dissolved Zinc (ppd)** | = → | $[(Q_{instream} + Q_{SMI})(mgd) *WQ\ criteria\ (mg/l)-Q_{instream}*C_{background}]*8.345$ | **5.59** | **ppd** |
| **Nucor - Daily Max. In-stream Dissolved Zinc (ppd)** | = → | $[(Q_{incremental} + Q_{Nucor})(mgd) *WQ\ criteria\ (mg/l)-Q_{instream}*C_{background}]*8.345$ | **2.00** | **ppd** |
| **ACIPCO - Daily Max. In-stream Dissolved Zinc (ppd)** | = → | $[(Q_{incremental} + Q_{ACIPCO})(mgd) *WQ\ criteria\ (mg/l)-Q_{instream}*C_{background}]*8.345$ | **2.44** | **ppd** |
| **SMI - Daily Max. In-stream Dissolved Zinc (mg/L)** | = → | $[Load\ (ppd)*1/(Q_{SMI})(mgd)]/8.345$ | **2.28** | **mg/L** |
| **Nucor - Daily Max. In-stream Dissolved Zinc (mg/L)** | = → | $[Load\ (ppd)*1/(Q_{Nucor})(mgd)]/8.345$ | **2.40** | **mg/L** |
| **ACIPCO – Daily Max. In-stream Dissolved Zinc (mg/L)** | = → | $[Load\ (ppd)*1/(Q_{ACIPCO})(mgd)]/8.345$ | **0.50** | **mg/L** |

**Table E-3 Nonpoint Source TMDL Calculation**

| | Area (sq mi) | Flow at Sample (MGD) | Existing Dissolved Zinc mg/L | Background Concentration mg/L | Dissolved Allowable Concentration mg/L | Dissolved Existing load lb/day | Dissolved Allowable load lb/day | % Reductions |
|---|---|---|---|---|---|---|---|---|
| **Vanderbilt** | | | | | | | | |
| Instream 1Q10 | 21.2 | 9.07 | 0.166 | 0.022 | 0.1172 | 10.54 | 6.97 | 34% |