

**LEVEL ONE WATER-QUALITY INVENTORY AND MONITORING**  
**BOOKER T. WASHINGTON NATIONAL MONUMENT (BOWA),**  
**VIRGINIA**

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## **INTRODUCTION**

The U.S. Geological Survey conducted a Level 1 Water-Quality Inventory and Monitoring (WAQIM) data-collection effort for Booker T. Washington National Monument (BOWA) from August 1998 through July 1999. The primary objective of the WAQIM program was to provide the National Park Service (NPS) and BOWA with at least a nominal inventory of its natural resources and that those data are available in a data-management system consistent with park management needs. Water-quality inventory data (physical, chemical, and biological) were collected from “key” water bodies within the boundaries of BOWA. The key water bodies are those waters within park boundaries that are essential to the central cultural, historical or natural resources management themes of the parks or provide habitats to threatened or endangered plants and animals. Data were collected during the fall, winter, spring, and summer over a range of hydrologic conditions. Because of the drought conditions that persisted during the study period, variations in flow between seasons were less pronounced than during normal hydrologic conditions.

Booker T. Washington National Monument (BOWA) comprises 224 acres located about 22 miles southeast of Roanoke, Virginia. The park commemorates the life and work of Booker T. Washington and includes most of the original 207-acre farm where Washington was born into slavery. The park contains two perennial streams, Gills Creek and Jack-O-Lantern Branch. The headwaters of Gills Creek are located outside of the monument boundaries, but Jack-O-Lantern Branch originates from the outflow of three perennial springs located within the park. A key unnamed tributary enters the park and joins Jack-O-Lantern Branch on its eastern boundary.

Potential threats to water-quality in the park include: (1) encroaching development; (2) logging in areas outside of the park boundaries; (3) agricultural activities (4) animal waste from farm animals maintained within the park for living history exhibits. Data-collection sites and the parameters analyzed were selected based on the spatial distribution of land-use activities inside and immediately outside of the park’s boundaries and the nature of the potential threats to park water-quality.

## **DESCRIPTION OF INVENTORY PROCESS**

### **Site Descriptions**

The water-quality inventory for BOWA included the periodic collection of physical, chemical, and microbiological data from two sites on Jack-O-Lantern Branch, one site on an unnamed tributary to Jack-O-Lantern Branch, and one site on Gills Creek, (fig. 1). These sites are: (1) Jack-O-Lantern Branch near Haleford Church near Scruggs, Va (0205706010), (2) Jack-O-Lantern Branch near Mouth near Scruggs, Va (0205706030), (3) Jack-O-Lantern Branch Tributary 1 near Scruggs, Va (0205706020), and (4) Gills

Creek above Jack-O-Lantern Branch near Scruggs, Va. (0205706010). Data-collection activities were conducted in August and December 1998 and in March, June, and July 1999. Jack-O-Lantern Branch near Haleford Church (0205706010) is located immediately downstream from the confluence of the three spring-fed tributaries that form Jack-O-Lantern Branch. The surrounding area is moderately wooded with a park trail passing nearby. Access is via Farm Trail Loop, approximately 0.3 miles from the Visitor Center. The station is less than 50 feet downstream from the three springs that form the stream. This site is also located immediately downstream from the on-site septic system and the containment areas for the park's domestic animals. Jack-O-Lantern Branch near Mouth near Scruggs, Va (0205706030) is located on the southeast boundary of BOWA 40 feet upstream from the confluence with Gills Creek. The surrounding area is heavily wooded. Access is via Jack-O-Lantern Branch Trail. Jack-O-Lantern Branch Tributary 1 near Scruggs, Va (0205706020) is located on the east boundary of BOWA approximately 15 feet upstream from the confluence with Jack-O-Lantern Branch. The surrounding area is heavily wooded. Access is via Jack-O-Lantern Branch Trail, approximately 0.5 miles from Visitor Center. Gills Creek above Jack-O-Lantern Branch near Scruggs, Va (02057060) is located on the southeast boundary of BOWA approximately 35 feet upstream from the confluence with Jack-O-Lantern Branch. The surrounding area is moderately wooded on the left bank and has pasture on the right bank. Access is via Jack-O-Lantern Branch Trail, approximately 0.8 miles from Visitor Center. Gills Creek is tributary to the Blackwater River.

### **Description of Data Collection**

Data-collection activities were conducted in August and December 1998 and in March, June, and July 1999 (table 1). Data-collection and analysis were conducted according to standard USGS protocols (U.S. Geological Survey, 1997, 1998, 1999; Rantz and others, 1982). Stream water-quality samples were collected as point samples or cross-sectional depth-integrated samples, depending on streamflow conditions. Discharge, water temperature, pH, specific conductivity, dissolved oxygen, and alkalinity were measured at every site on every visit. Water samples were collected and analyzed for nutrients and bacteria at every site on every visit. Samples were collected and analyzed for major element and trace element analysis on one visit. Also, during each data-collection trip, quality control/quality assurance (QA/QC) samples were collected and analyzed to insure data quality. Field blanks and duplicate samples were routinely employed for all analytical methods.

Table 1. Data-collection schedule

| Parameter        | Data-collection period |               |            |                |
|------------------|------------------------|---------------|------------|----------------|
|                  | August 1998            | December 1998 | March 1999 | June/July 1999 |
| Field parameters | X                      | X             | X          | X              |
| Fecal bacteria   | X                      | X             | X          | X              |
| Nutrients        | X                      | X             | X          | X              |
| Major Ions       | X                      |               |            |                |
| Trace elements   |                        |               |            | X              |



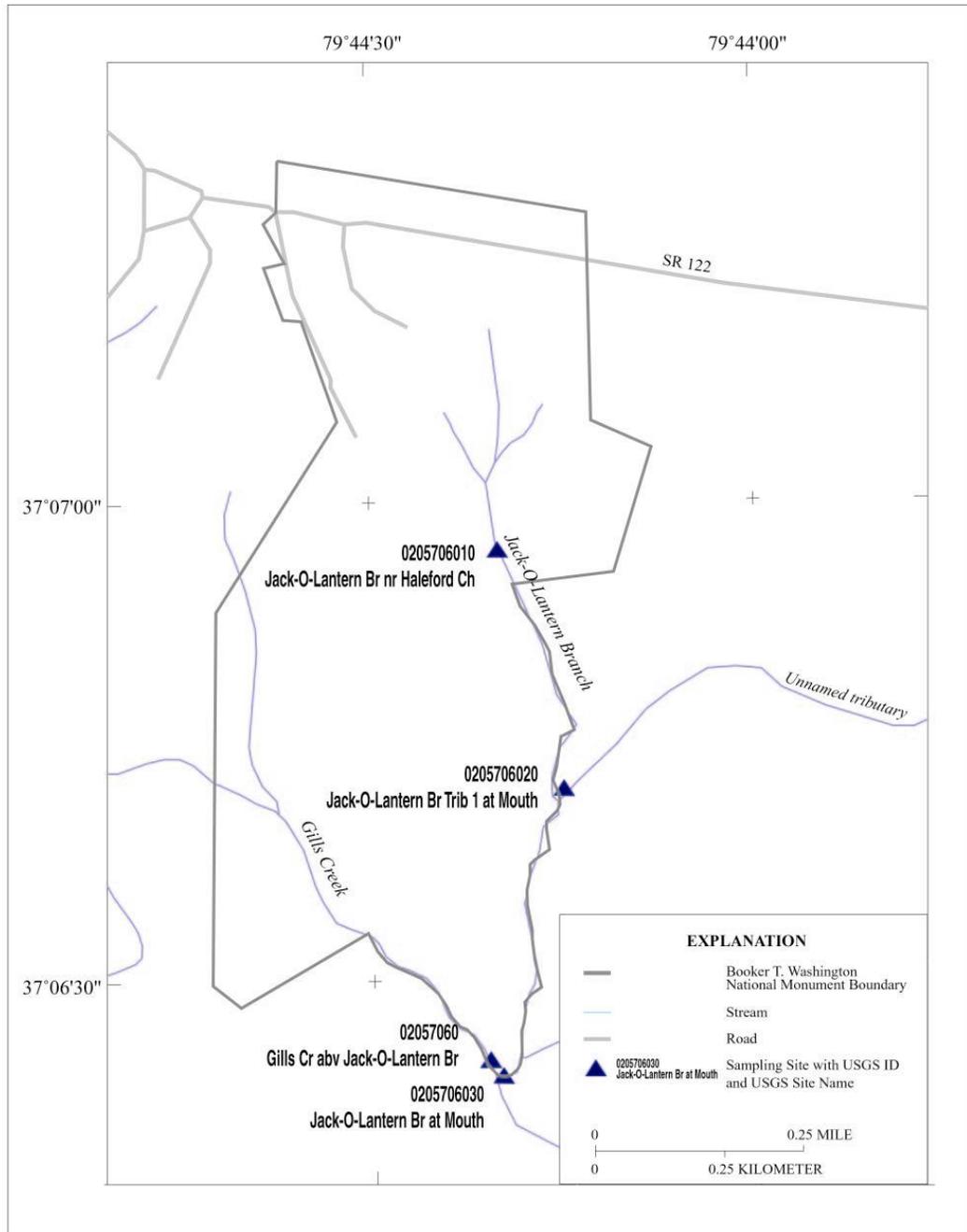


Figure 1. Map of study area and data-collection sites.

## **PRINCIPAL INVESTIGATORS**

The principal investigators of the WAQIM program included staff of the U.S. Geological Survey (USGS), Water Resources Division (WRD) district office in Richmond, Virginia. Michael E. Lewis, Supervisory Hydrologist, supervised all work. J. Michael Gearheart, Hydrologic Technician, implemented all fieldwork. All water-quality samples collected as part of the inventory, with the exception of bacteriological samples, were submitted for analysis to the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado. Bacteriological samples were processed by field personnel at each site and analyzed in the Richmond, Virginia office of the USGS.

## **WATER-QUALITY RESULTS**

Tables 2-6 provide all physical, microbiological, and chemical data collected as part of the BOWA WAQIM project. All data are also provided in a Microsoft Excel spreadsheet (WQDATA.XLS). In addition to the water-quality data spreadsheet, three additional supporting documents are included on the attached 3.5-inch diskette: (1) PARAMETER.DOC; (2) STATION.XLS; AND (3) README.DOC. "PARAMETER.DOC" is a Microsoft Word file that explicitly defines each water-quality parameter included in the following tables and in the water-quality data spreadsheet. "STATION.XLS" is a Microsoft Excel file that contains specific location data for each site where water-quality data was collected. "README.DOC" is a Microsoft Word file that contains basic information related to the project such as contact information for those who conducted the work and analyzed the samples.

Table 2. Field parameter data

[ft<sup>3</sup>/s, cubic feet per second; °C, degrees Celsius;  $\mu$  S/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter; mg/L as CaCO<sub>3</sub>, milligrams per liter as calcium carbonate; <, less than; --, no data]

| Date  | Time  | Discharge<br>(ft <sup>3</sup> /s) | Water<br>temperature<br>(°C) | pH<br>(units) | Specific<br>conductance<br>( $\mu$ S/cm) | Dissolved<br>oxygen<br>(mg/L) | Alkalinity<br>(mg/L as<br>CaCO <sub>3</sub> ) |
|---|-------|-----------------------------------|------------------------------|---------------|--|-------------------------------|---|
| <b>Jack-O-Lantern Branch near Haleford Church near Scruggs, VA (0205706010)</b> |       |                                   |                              |               |  |                               |   |
| Aug 25, 1998  | 12:45 | 0.07                              | 19.1                         | 7.2           | 89                                       | --                            | 30  |
| Dec 01, 1998  | 09:00 | 0.04                              | 10.1                         | 7.2           | 77                                       | 9.8                           | 25  |
| Mar 03, 1999  | 08:00 | 0.08                              | 7.8                          | 7.4           | 76                                       | 10.5                          | 24  |
| Jul 01, 1999  | 08:45 | 0.06                              | 17.9                         | 7.1           | 84                                       | 7.9                           | 24.7  |
| <b>Jack-O-Lantern Branch Tributary 1 near Scruggs, VA (0205706020)</b>          |       |                                   |                              |               |  |                               |   |
| Aug 25, 1998  | 16:00 | 0.12                              | 22.0                         | 7.6           | 70                                       | 7.3                           | 30  |
| Dec 01, 1998  | 11:30 | 0.10                              | 9.6                          | 7.3           | 68                                       | 10.7                          | 29  |
| Mar 03, 1999  | 10:00 | 0.25                              | 6.8                          | 7.5           | 66                                       | 11.4                          | 26  |
| Jul 01, 1999  | 10:40 | 0.138                             | 20.8                         | 7.3           | 72                                       | 7.6                           | 28.2  |
| <b>Jack-O-Lantern Branch at Mouth near Scruggs, VA (0205706030)</b>             |       |                                   |                              |               |  |                               |   |
| Aug 26, 1998  | 09:00 | 0.39                              | 20.1                         | 7.4           | 75                                       | 8.4                           | 33  |
| Dec 01, 1998  | 13:45 | 0.35                              | 10.9                         | 7.6           | 73                                       | 9.6                           | 29  |
| Mar 03, 1999  | 11:45 | 0.56                              | 7.9                          | 7.4           | 71                                       | 11.4                          | 25  |
| Jul 01, 1999  | 13:05 | 0.246                             | 21.4                         | 7.2           | 74                                       | 7.2                           | 27.3  |
| <b>Gills Creek above Jack-O-Lantern Branch near Scruggs, VA (02057060)</b>      |       |                                   |                              |               |  |                               |   |
| Aug 26, 1998  | 11:15 | 9.5                               | 23.5                         | 7.5           | 74                                       | 7.4                           | 27  |
| Dec 02, 1998  | 09:30 | 11                                | 5.3                          | 7.2           | 64                                       | 11.9                          | 22  |
| Mar 03, 1999  | 14:10 | 14                                | 8.6                          | 7.6           | 61                                       | 11.7                          | 21  |
| Jun 30, 1999  | 12:30 | 3.89                              | 23.5                         | 7.2           | 74                                       | 7.2                           | 24.5  |

Table 3. Bacteria data.

[col/100 ml; colonies per 100 milliliters; e, estimated value; >, greater than; K, non-ideal colony count]

| Date  | Time  | Total coliform<br>(col/100 ml) | Fecal coliform<br>(col/100 ml) | Fecal streptococcus<br>(col/100 ml) |
|---|-------|--------------------------------|--------------------------------|-------------------------------------|
| <b>Jack-O-Lantern Branch near Haleford Church near Scruggs, VA (0205706010)</b> |       |                                |                                |                                     |
| Aug 25, 1998  | 12:45 | >290                           | 1100K                          | 920                                 |
| Dec 01, 1998  | 09:00 | 180                            | 130K                           | 390                                 |
| Mar 03, 1999  | 08:00 | 260                            | 29K                            | 51K                                 |
| Jul 01, 1999  | 08:45 | >8,000                         | >6,000                         | >10,000                             |
| <b>Jack-O-Lantern Branch Tributary 1 near Scruggs, VA (0205706020)</b>          |       |                                |                                |                                     |
| Aug 25, 1998  | 16:00 | 350                            | 270                            | 1,500                               |
| Dec 01, 1998  | 11:30 | 360                            | 27K                            | 310                                 |
| Mar 03, 1999  | 10:00 | 160                            | 31K                            | 11K                                 |
| Jul 01, 1999  | 10:40 | 5,200                          | 3,400                          | 5,900                               |
| <b>Jack-O-Lantern Branch at Mouth near Scruggs, VA (0205706030)</b>             |       |                                |                                |                                     |
| Aug 26, 1998  | 09:00 | 2,420K                         | 570K                           | >1,220                              |
| Dec 01, 1998  | 13:45 | 270                            | 30K                            | 42K                                 |
| Mar 03, 1999  | 11:45 | 390                            | 220                            | 34K                                 |
| Jul 01, 1999  | 13:05 | 15,000K                        | 7,100K                         | 4,000                               |
| <b>Gills Creek above Jack-O-Lantern Branch near Scruggs, VA (02057060)</b>      |       |                                |                                |                                     |
| Aug 26, 1998  | 11:15 | 720                            | 540                            | 220                                 |
| Dec 02, 1998  | 09:30 | 520K                           | 280                            | 390                                 |
| Mar 03, 1999  | 14:10 | 410K                           | 330K                           | >840                                |
| Jun 30, 1999  | 12:30 | 190                            | 69K                            | 173                                 |

Table 4. Nutrient data

[mg/L, milligrams per liter; N, nitrogen; P, phosphorous; &lt;, less than; e, estimated value; --, no data]

| Date  | Time  | Nitrogen,<br>nitrite,<br>dissolved<br>(mg/L as N) | Nitrogen,<br>nitrate +<br>nitrite,<br>dissolved<br>(mg/L as N) | Nitrogen,<br>ammonia,<br>dissolved<br>(mg/L as N) | Nitrogen,<br>ammonia +<br>organic,<br>total<br>(mg/L as N) | Nitrogen,<br>ammonia +<br>organic,<br>dissolved<br>(mg/L as N) |
|---|-------|---|--|---|--|--|
| <b>Jack-O-Lantern Branch near Haleford Church near Scruggs, VA (0205706010)</b> |       |   |  |   |  |  |
| Aug 25, 1998  | 12:45 | 0.011   | 0.538  | 0.095   | <0.10  | <0.10  |
| Dec 01, 1998  | 09:00 | <0.01   | 0.46   | <0.02   | 0.3  | <0.1   |
| Mar 03, 1999  | 08:00 | <0.01   | 0.64   | <0.02   | 0.06e  | <0.1   |
| Jul 01, 1999  | 08:45 | 0.02  | 0.60   | 0.03  | 0.7  | 0.3  |
| <b>Jack-O-Lantern Branch Tributary 1 near Scruggs, VA (0205706020)</b>          |       |   |  |   |  |  |
| Aug 25, 1998  | 16:00 | 0.01  | 0.118  | 0.071   | 0.10   | <0.1   |
| Dec 01, 1998  | 11:30 | <0.01   | <0.05  | <0.02   | <0.1   | <0.1   |
| Mar 03, 1999  | 10:00 | <0.01   | 0.05   | <0.02   | 0.06e  | 0.05e  |
| Jul 01, 1999  | 10:40 | 0.01  | 0.10   | <0.02   | 0.2  | 0.1  |
| <b>Jack-O-Lantern Branch at Mouth near Scruggs, VA (0205706030)</b>             |       |   |  |   |  |  |
| Aug 26, 1998  | 09:00 | 0.010   | 0.176  | 0.094   | <0.10  | <0.10  |
| Dec 01, 1998  | 13:45 | <0.01   | <0.05  | <0.02   | <0.1   | <0.1   |
| Mar 03, 1999  | 11:45 | <0.01   | 0.10   | 0.03  | 0.09e  | 0.08e  |
| Jul 01, 1999  | 13:05 | 0.01  | 0.19   | <0.02   | 0.4  | 0.1  |
| <b>Gills Creek above Jack-O-Lantern Branch near Scruggs, VA (02057060)</b>      |       |   |  |   |  |  |
| Aug 26, 1998  | 11:15 | 0.016   | 0.320  | 0.103   | 0.19   | 0.14   |
| Dec 02, 1998  | 09:30 | <0.01   | <0.05  | <0.02   | 0.1  | 0.1  |
| Mar 03, 1999  | 14:10 | <0.01   | 0.14   | 0.03  | 0.1  | 0.10e  |
| Jun 30, 1999  | 12:30 | 0.06  | 0.54   | 0.08  | 0.4  | 0.4  |

Table 4. Nutrient data--Continued.

[mg/L, milligrams per liter; N, nitrogen; P, phosphorous; &lt; less than; --, no data]

| Date  | Time  | Phosphorus,<br>total<br>(mg/L as P) | Phosphorus,<br>dissolved<br>(mg/L as P) | Orthophosphate,<br>dissolved<br>(mg/L as P) |
|---|-------|-------------------------------------|---|---|
| <b>Jack-O-Lantern Branch near Haleford Church near Scruggs, VA<br/>(0205706010)</b> |       |                                     |   |   |
| Aug 25, 1998  | 12:45 | 0.012                               | <0.010                                  | 0.019                                       |
| Dec 01, 1998  | 09:00 | 0.06                                | <0.05                                   | 0.01  |
| Mar 03, 1999  | 08:00 | 0.019                               | 0.004                                   | <0.01                                       |
| Jul 01, 1999  | 08:45 | 0.14                                | 0.02                                    | 0.02  |
| <b>Jack-O-Lantern Branch Tributary 1 near Scruggs, VA (0205706020)</b>              |       |                                     |   |   |
| Aug 25, 1998  | 16:00 | 0.019                               | <0.01                                   | 0.015                                       |
| Dec 01, 1998  | 11:30 | <0.05                               | <0.05                                   | <0.01                                       |
| Mar 03, 1999  | 10:00 | 0.011                               | <0.004                                  | <0.01                                       |
| Jul 01, 1999  | 10:40 | 0.03                                | 0.007                                   | 0.02  |
| <b>Jack-O-Lantern Branch at Mouth near Scruggs, VA (0205706030)</b>                 |       |                                     |   |   |
| Aug 26, 1998  | 09:00 | <0.010                              | <0.010                                  | 0.015                                       |
| Dec 01, 1998  | 13:45 | <0.05                               | <0.05                                   | 0.01  |
| Mar 03, 1999  | 11:45 | 0.008                               | <0.004                                  | <0.01                                       |
| Jul 01, 1999  | 13:05 | 0.11                                | 0.005                                   | 0.01  |
| <b>Gills Creek above Jack-O-Lantern Branch near Scruggs, VA (02057060)</b>          |       |                                     |   |   |
| Aug 26, 1998  | 11:15 | 0.048                               | 0.013                                   | 0.016                                       |
| Dec 02, 1998  | 09:30 | <0.05                               | <0.05                                   | 0.01  |
| Mar 03, 1999  | 14:10 | 0.029                               | 0.011                                   | 0.02  |
| Jun 30, 1999  | 12:30 | 0.096                               | 0.051                                   | 0.05  |

Table 5. Major-element data.  
 [mg/l, milligrams per liter, <, less than; --, no data]

| Date  | Time  | Calcium,<br>dissolved<br>(mg/L as Ca) | Magnesium,<br>dissolved<br>(mg/L as Mg) | Sodium,<br>dissolved<br>(mg/L as Na) | Potassium,<br>dissolved<br>(mg/L as K) | Alkalinity<br>(mg/L as CaCO <sub>3</sub> ) | Sulfate,<br>dissolved<br>(mg/L as SO <sub>4</sub> ) |
|---|-------|---------------------------------------|---|--------------------------------------|--|--|---|
| <b>Jack-O-Lantern Branch near Haleford Church near Scruggs, VA (0205706010)</b> |       |                                       |   |                                      |  |  |   |
| Aug 25, 1998  | 12:45 | 5.3                                   | 3.7                                     | 3.4                                  | 1.2                                    | 30   | 1.9   |
| Dec 01, 1998  | 09:00 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| Mar 03, 1999  | 08:00 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| Jul 01, 1999  | 08:45 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| <b>Jack-O-Lantern Branch Tributary 1 near Scruggs, VA (0205706020)</b>          |       |                                       |   |                                      |  |  |   |
| Aug 25, 1998  | 16:00 | 4.8                                   | 3.0                                     | 3.9                                  | 1.5                                    | 30   | 1.5   |
| Dec 01, 1998  | 11:30 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| Mar 03, 1999  | 10:00 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| Jul 01, 1999  | 10:40 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| <b>Jack-O-Lantern Branch at Mouth near Scruggs, VA (0205706030)</b>             |       |                                       |   |                                      |  |  |   |
| Aug 26, 1998  | 09:00 | 5.1                                   | 3.4                                     | 3.7                                  | 1.6                                    | 33   | 1.8   |
| Dec 01, 1998  | 13:45 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| Mar 03, 1999  | 11:45 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| Jul 01, 1999  | 13:05 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| <b>Gills Creek above Jack-O-Lantern Branch near Scruggs, VA (02057060)</b>      |       |                                       |   |                                      |  |  |   |
| Aug 26, 1998  | 11:15 | 5.8                                   | 2.3                                     | 3.3                                  | 2.2                                    | 27   | 1.3   |
| Dec 02, 1998  | 09:30 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| Mar 03, 1999  | 14:10 | --                                    | --                                      | --                                   | --                                     | --   | --  |
| Jun 30, 1999  | 12:30 | --                                    | --                                      | --                                   | --                                     | --   | --  |

Table 5. Major-element data—Continued.  
 [mg/l, milligrams per liter, <, less than; --no data]

| Date  | Time  | Chloride,<br>dissolved<br>(mg/l as Cl) | Fluoride,<br>dissolved<br>(mg/L as F) | Silica,<br>dissolved<br>(mg/L as SiO <sub>2</sub> ) |
|---|-------|--|---------------------------------------|---|
| <b>Jack-O-Lantern Branch near Haleford Church near Scruggs, VA (0205706010)</b> |       |  |                                       |   |
| Aug 25, 1998  | 12:45 | 4.2                                    | <0.10                                 | 27  |
| Dec 01, 1998  | 09:00 | --                                     | --                                    | --  |
| Mar 03, 1999  | 08:00 | --                                     | --                                    | --  |
| Jul 01, 1999  | 08:45 | --                                     | --                                    | --  |
| <b>Jack-O-Lantern Branch Tributary 1 near Scruggs, VA (0205706020)</b>          |       |  |                                       |   |
| Aug 25, 1998  | 16:00 | 1.9                                    | <0.10                                 | 30  |
| Dec 01, 1998  | 11:30 | --                                     | --                                    | --  |
| Mar 03, 1999  | 10:00 | --                                     | --                                    | --  |
| Jul 01, 1999  | 10:40 | --                                     | --                                    | --  |
| <b>Jack-O-Lantern Branch at Mouth near Scruggs, VA (0205706030)</b>             |       |  |                                       |   |
| Aug 26, 1998  | 09:00 | 2.4                                    | <0.10                                 | 29  |
| Dec 01, 1998  | 13:45 | --                                     | --                                    | --  |
| Mar 03, 1999  | 11:45 | --                                     | --                                    | --  |
| Jul 01, 1999  | 13:05 | --                                     | --                                    | --  |
| <b>Gills Creek above Jack-O-Lantern Branch near Scruggs, VA (02057060)</b>      |       |  |                                       |   |
| Aug 26, 1998  | 11:15 | 2.8                                    | <0.10                                 | 16  |
| Dec 02, 1998  | 09:30 | --                                     | --                                    | --  |
| Mar 03, 1999  | 14:10 | --                                     | --                                    | --  |
| Jun 30, 1999  | 12:30 | --                                     | --                                    | --  |

Table 6.Trace-element data.

[  $\mu$  g/L, micrograms per liter; <, less than; --, no data]

| Date  | Time  | Aluminum,<br>total<br>( $\mu$ g/L<br>as Al) | Arsenic,<br>total<br>( $\mu$ g/L<br>as As) | Barium,<br>total<br>( $\mu$ g/L<br>as Ba) | Beryllium,<br>total<br>( $\mu$ g/L<br>as Ba) | Cadmium,<br>total<br>( $\mu$ g/L<br>as Cd) | Chromium,<br>total<br>( $\mu$ g/L<br>as Cr) | Cobalt,<br>total<br>( $\mu$ g/L<br>as Co) | Copper,<br>total<br>( $\mu$ g/L<br>as Cu) | Iron,<br>total<br>( $\mu$ g/L<br>as Fe) |
|---|-------|---|--|---|--|--|---|---|---|---|
| <b>Jack-O-Lantern Branch near Haleford Church near Scruggs, VA (0205706010)</b> |       |   |  |   |  |  |   |   |   |   |
| Aug 25, 1998  | 12:45 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Dec 01, 1998  | 09:00 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Mar 03, 1999  | 08:00 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Jul 01, 1999  | 08:45 | 1,360                                       | <1   | 67.7                                      | <4   | <1   | 8.3   | 3   | 27  | 2,570                                   |
| <b>Jack-O-Lantern Branch Tributary 1 near Scruggs, VA (0205706020)</b>          |       |   |  |   |  |  |   |   |   |   |
| Aug 25, 1998  | 16:00 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Dec 01, 1998  | 11:30 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Mar 03, 1999  | 10:00 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Jul 01, 1999  | 10:40 | 198   | <1   | 40.1                                      | <4   | <1   | 1.2   | <1  | 2   | 698                                     |
| <b>Jack-O-Lantern Branch at Mouth near Scruggs, VA (0205706030)</b>             |       |   |  |   |  |  |   |   |   |   |
| Aug 26, 1998  | 09:00 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Dec 01, 1998  | 13:45 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Mar 03, 1999  | 11:45 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Jul 01, 1999  | 13:05 | 1,270                                       | <1   | 57.2                                      | <4   | <1   | 5.2   | 3   | 4   | 3,020                                   |
| <b>Gills Creek above Jack-O-Lantern Branch near Scruggs, VA (02057060)</b>      |       |   |  |   |  |  |   |   |   |   |
| Aug 26, 1998  | 11:15 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Dec 02, 1998  | 09:30 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Mar 03, 1999  | 14:10 | --  | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Jun 30, 1999  | 12:30 | 187   | <1   | 22.2                                      | <4   | <1   | <1.0  | <1  | 4   | 754                                     |

Table 6. Trace-element data—Continued.

[  $\mu$  g/L, micrograms per liter; <, less than; e, estimated value; --, no data]

| Date  | Time  | Lead,<br>total<br>( $\mu$ g/L<br>as Pb) | Lithium,<br>total<br>( $\mu$ g/L<br>as Li) | Manganese<br>total<br>( $\mu$ g/L<br>as Mn) | Mercury,<br>total<br>( $\mu$ g/L<br>as Hg) | Molyb-<br>denum,<br>total<br>( $\mu$ g/L<br>as Mo) | Nickel,<br>total<br>( $\mu$ g/L<br>as Ni) | Selenium,<br>total<br>( $\mu$ g/L<br>as Se) | Silver,<br>total<br>( $\mu$ g/L<br>as Ag) | Zinc,<br>total<br>( $\mu$ g/L<br>as Zn) |
|---|-------|---|--|---|--|--|---|---|---|---|
| <b>Jack-O-Lantern Branch near Haleford Church near Scruggs, VA (0205706010)</b> |       |   |  |   |  |  |   |   |   |   |
| Aug 25, 1998  | 12:45 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Dec 01, 1998  | 09:00 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Mar 03, 1999  | 08:00 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Jul 01, 1999  | 08:45 | 3                                       | <12  | 120   | <0.01                                      | <1.0   | 3   | <1.0  | <1.0                                      | 31.2e                                   |
| <b>Jack-O-Lantern Branch Tributary 1 near Scruggs, VA (0205706020)</b>          |       |   |  |   |  |  |   |   |   |   |
| Aug 25, 1998  | 16:00 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Dec 01, 1998  | 11:30 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Mar 03, 1999  | 10:00 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Jul 01, 1999  | 10:40 | <1                                      | <12  | 17.8  | <0.01                                      | <1.0   | <1  | <1.0  | <1.0                                      | <40                                     |
| <b>Jack-O-Lantern Branch at Mouth near Scruggs, VA (0205706030)</b>             |       |   |  |   |  |  |   |   |   |   |
| Aug 26, 1998  | 09:00 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Dec 01, 1998  | 13:45 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Mar 03, 1999  | 11:45 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Jul 01, 1999  | 13:05 | 3                                       | <12  | 167   | <0.01                                      | <1.0   | 2   | <1.0  | <1.0                                      | 20.8e                                   |
| <b>Gills Creek above Jack-O-Lantern Branch near Scruggs, VA (02057060)</b>      |       |   |  |   |  |  |   |   |   |   |
| Aug 26, 1998  | 11:15 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Dec 02, 1998  | 09:30 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Mar 03, 1999  | 14:10 | --                                      | --   | --  | --   | --   | --  | --  | --  | --                                      |
| Jun 30, 1999  | 12:30 | <1                                      | <12  | 54.6  | <0.01                                      | <1.0   | <1  | <1.0  | <1.0                                      | <40                                     |

## SELECTED REFERENCES

U.S. Geological Survey, 1997, 1998, 1999, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow--v. 1, Measurement of stage and discharge, *with a section on* Discharge - Current-meter method: U.S. Geological Survey Water-Supply Paper 2175, p. 80-183.

