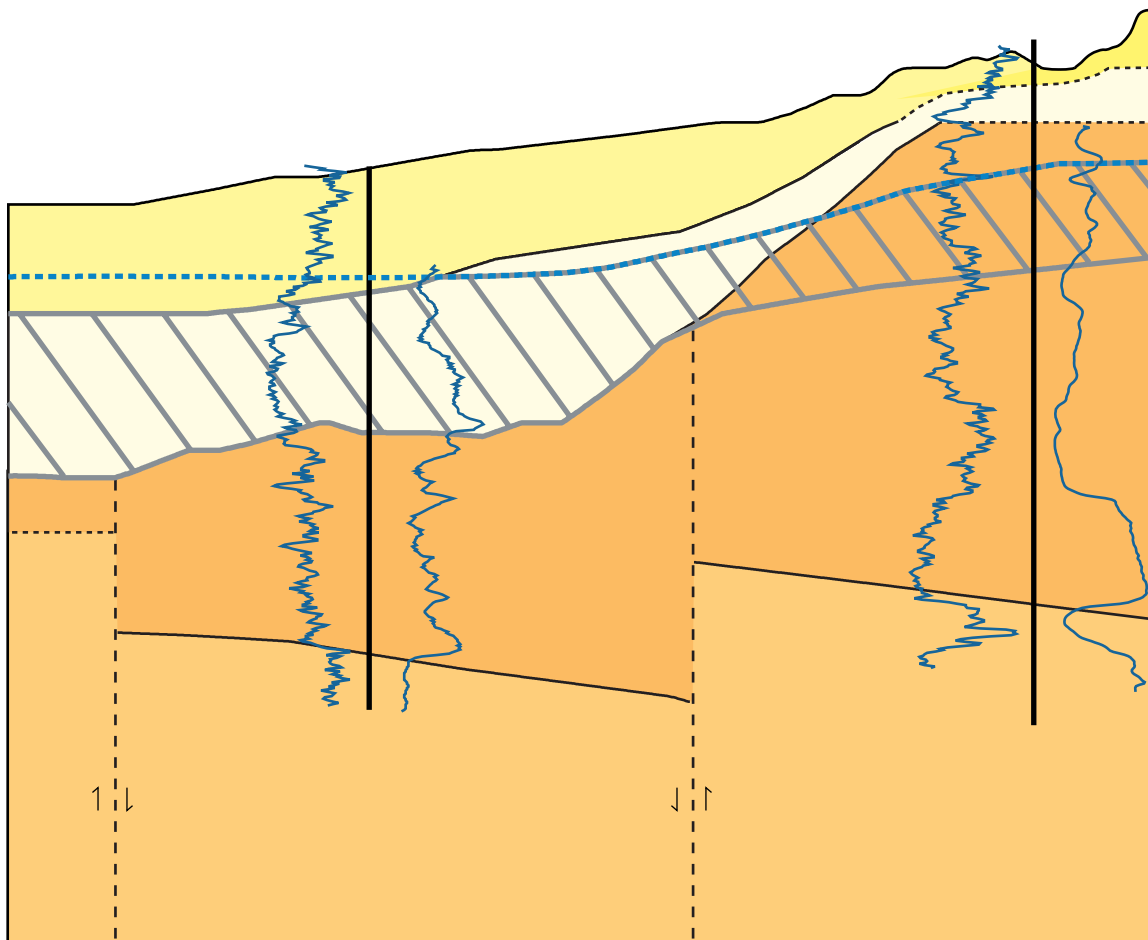


Prepared in cooperation with the  
Department of the Navy, Southern Division,  
Naval Facilities Engineering Command

## Hydrogeology and Ground-Water-Flow Simulation in the Former Airfield Area of Naval Support Activity Mid-South, Millington, Tennessee



Scientific Investigations Report 2004-5040

**Cover.** See figure 6b, page 13.

# **Hydrogeology and Ground-Water-Flow Simulation in the Former Airfield Area of Naval Support Activity Mid-South, Millington, Tennessee**

By Connor J. Haugh, John K. Carmichael, and David E. Ladd

Prepared in cooperation with the  
Department of the Navy, Southern Division, Naval Facilities Engineering Command

Scientific Investigations Report 2004-5040

**U.S. Department of the Interior  
U.S. Geological Survey**

**U.S. Department of the Interior**  
Gale A. Norton, Secretary

**U.S. Geological Survey**  
Charles G. Groat, Director

**U.S. Geological Survey, Reston, Virginia: 2004**

For sale by U.S. Geological Survey, Information Services  
Box 25286, Denver Federal Center  
Denver, CO 80225

For more information about the USGS and its products:  
Telephone: 1-888-ASK-USGS  
World Wide Web: <http://www.usgs.gov/>

Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this report is in the public domain, permission must be secured from the individual copyright owners to reproduce any copyrighted materials contained within this report.

*Suggested citation:*

Haugh, C.J., Carmichael, J.K., and Ladd, D.E., 2004, Hydrogeology and ground-water-flow simulation in the former airfield area of Naval Support Activity Mid-South, Millington, Tennessee: U.S. Geological Survey Scientific Investigations Report 2004-5040, 31 p.

# Contents

|  |    |
|--|----|
| Abstract .....                         | 1  |
| Introduction .....                     | 1  |
| Purpose and scope .....                | 4  |
| Previous investigations .....          | 4  |
| Hydrogeology .....                     | 4  |
| Structure .....                        | 8  |
| Shallow aquifer .....                  | 8  |
| Simulation of ground-water flow .....  | 11 |
| Conceptual model .....                 | 11 |
| Model assumptions .....                | 11 |
| Model boundaries .....                 | 15 |
| Model construction .....               | 15 |
| Model calibration .....                | 20 |
| Sensitivity analysis .....             | 27 |
| Model limitations .....                | 27 |
| Advective flow particle tracking ..... | 28 |
| Summary and conclusions .....          | 30 |
| Selected references .....              | 31 |

## Figures

|   |    |
|---|----|
| 1-6a. Maps showing:   |    |
| 1. Location of Naval Support Activity Mid-South, Millington, Tennessee .....  | 2  |
| 2. Naval Support Activity Mid-South, the Northside and Southside, and property transferred to the city of Millington .....  | 3  |
| 3. Locations of study area, Area of Concern A, and interpreted plumes of trichloroethene in the alluvial-fluvial deposits aquifer beneath the former airfield area part of the Naval Support Activity Mid-South Northside, Millington, Tennessee .....                                | 5  |
| 4. Altitude of the base of the loess or silt and clay in the upper alluvium at Area of Concern A, Naval Support Activity Mid-South, Millington, Tennessee .....   | 9  |
| 5. Altitude of the base of sand and gravel in the lower alluvium or fluvial deposits at Area of Concern A, Naval Support Activity Mid-South, Millington, Tennessee .....  | 10 |
| 6a. Location of hydrogeologic section A-A' at Area of Concern A, Naval Support Activity Mid-South, Millington, Tennessee .....  | 12 |
| 6b. Hydrogeologic section A-A' showing the A1 aquifer and related features at Area of Concern A, Naval Support Activity Mid-South, Millington, Tennessee .....  | 13 |
| 7. Map showing altitude of the potentiometric surface of the A1 aquifer, February and March 2000; location of well Sh:U-101 for which continuous water-level data were collected; and Area of Concern A model boundary, Naval Support Activity Mid-South, Millington, Tennessee ..... | 14 |
| 8. Hydrograph showing water levels recorded in well Sh:U-101 at Naval Support Activity Mid-South, May 1995 through March 2004 .....   | 15 |

|       |   |    |
|-------|---|----|
| 9-17. | Maps showing:   |    |
| 9.    | Altitude of the top of the A1 aquifer at Area of Concern A, Naval Support Activity Mid-South, Millington, Tennessee .....   | 16 |
| 10.   | Altitude of the base of the A1 aquifer at Area of Concern A, Naval Support Activity Mid-South, Millington, Tennessee .....  | 17 |
| 11.   | Model grid cell types for the Area of Concern A flow model, Naval Support Activity Mid-South, Millington, Tennessee .....   | 18 |
| 12.   | Thickness of the modeled A1 aquifer, Naval Support Activity Mid-South, Millington, Tennessee .....  | 19 |
| 13.   | Hydraulic conductivity zones for the Area of Concern A flow model, Naval Support Activity Mid-South, Millington, Tennessee .....  | 21 |
| 14.   | Simulated steady-state water levels for layers 1, 2, and 3 of the Area of Concern A flow model, Naval Support Activity Mid-South, Millington, Tennessee .....                   | 23 |
| 15.   | Calibrated transmissivities for layer 1 of the Area of Concern A flow model, Naval Support Activity Mid-South, Millington, Tennessee .....                                      | 24 |
| 16.   | Calibrated transmissivities for layer 2 of the Area of Concern A flow model, Naval Support Activity Mid-South, Millington, Tennessee .....                                      | 25 |
| 17.   | Calibrated transmissivities for layer 3 of the Area of Concern A flow model, Naval Support Activity Mid-South, Millington, Tennessee .....                                      | 26 |
| 18.   | Graph showing composite scaled sensitivities for Area of Concern A flow model parameters, Naval Support Activity Mid-South, Millington, Tennessee .....                         | 27 |
| 19.   | Map showing advective flow path lines from the “grassy” area and “north edge of apron” area at Area of Concern A, Naval Support Activity Mid-South, Millington, Tennessee ..... | 29 |

## Tables

|    |  |    |
|----|--|----|
| 1. | Post-Wilcox Group geologic units underlying Naval Support Activity Mid-South, Millington, Tennessee, and their hydrologic significance .....                         | 6  |
| 2. | Recharge and hydraulic conductivity parameters defined in the Area of Concern A flow model, Naval Support Activity Mid-South .....                                   | 20 |
| 3. | Relation between hydraulic conductivity parameters and hydraulic conductivity by layers for the Area of Concern A flow model, Naval Support Activity Mid-South ..... | 22 |
| 4. | Calibrated hydraulic conductivities of the Area of Concern A flow model, Naval Support Activity Mid-South .....  | 22 |
| 5. | Correlation coefficients between estimated parameters of the Area of Concern A flow model, Naval Support Activity Mid-South .....                                    | 27 |
| 6. | Estimated parameter values using alternate advective travel times, Area of Concern A flow model, Naval Support Activity Mid-South .....                              | 28 |

## Conversion Factors, Datums, Well-Numbering Information, and Acronyms

| Multiply  | By      | To obtain  |
|---|---------|--|
| inch (in.)  | 25.4    | millimeter (mm)  |
| foot (ft)   | 0.3048  | meter (m)  |
| mile (mi)   | 1.609   | kilometer (km)   |
| acre  | 4,047   | square meter (m <sup>2</sup> )   |
| acre  | 0.4047  | hectare (ha)   |
| square foot (ft <sup>2</sup> )  | 0.0929  | square meter (m <sup>2</sup> )   |
| square mile (mi <sup>2</sup> )  | 259.0   | hectare (ha)   |
| square mile (mi <sup>2</sup> )  | 2.590   | square kilometer (km <sup>2</sup> )  |
| foot per day (ft/d)   | 0.3048  | meter per day (m/d)  |
| foot per year (ft/yr)   | 0.3048  | meter per year (m/yr)  |
| cubic foot per second (ft <sup>3</sup> /s)                                    | 0.02832 | cubic meter per second (m <sup>3</sup> /s)   |
| cubic foot per second per square mile [(ft <sup>3</sup> /s)/mi <sup>2</sup> ] | 0.01093 | cubic meter per second per square kilometer [(m <sup>3</sup> /s)/km <sup>2</sup> ] |
| gallon per minute (gal/min)   | 0.06308 | liter per second (L/s)   |
| million gallons per day (Mgal/d)  | 0.04381 | cubic meters per second (m <sup>3</sup> /s)  |
| inch per year (in/yr)   | 25.4    | millimeter per year (mm/yr)  |
| gallon per minute per foot [(gal/min)/ft]                                     | 0.2070  | liter per second per meter [(L/s)/m]   |
| foot squared per day (ft <sup>2</sup> /d)                                     | 0.09290 | meter squared per day (m <sup>2</sup> /d)  |

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows:

$$^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$$

**Transmissivity:** In this report transmissivity is expressed as foot squared per day (ft<sup>2</sup>/d)—The standard unit for transmissivity (T) is cubic foot per day per square foot times foot of aquifer thickness “[ft<sup>3</sup>/d]/ft<sup>2</sup>ft” or cubic meter per day per square meter times meter of aquifer thickness “[m<sup>3</sup>/d]/m<sup>2</sup>m.” These mathematical expressions reduce to foot squared per day “(ft<sup>2</sup>/d)” or meter squared per day “(m<sup>2</sup>/d).”

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD27).

**Well-numbering system:** The U.S. Geological Survey assigns each well in this report a local Tennessee well number. The local well number in Tennessee consists of three parts: (1) an abbreviation of the name of the county in which the well is located; (2) a letter designating the 7 1/2-minute topographic quadrangle on which the well is plotted; and (3) a number generally indicating the numerical order in which the well was inventoried. The symbol Sh:U-98, for example, indicates that the well is located in Shelby County on the “U” quadrangle and is identified as well 98 in the numerical sequence. Quadrangles are lettered from left to right, beginning in the southwest corner of the county.

**Acronyms**

|       |  |
|-------|--|
| AOC   | Area of Concern                          |
| BRAC  | Base Closure and Realignment             |
| DCE   | Dichloroethene                           |
| IRP   | Installation Restoration Program         |
| NAS   | Naval Air Station                        |
| NATTC | Naval Aviation Technical Training Center |
| NSA   | Naval Support Activity                   |
| PCE   | Tetrachloroethene                        |
| RCRA  | Resource Conservation and Recovery Act   |
| RFI   | RCRA Facility Investigation              |
| RMSE  | Root mean square error                   |
| TCE   | Trichloroethene                          |
| USGS  | U.S. Geological Survey                   |