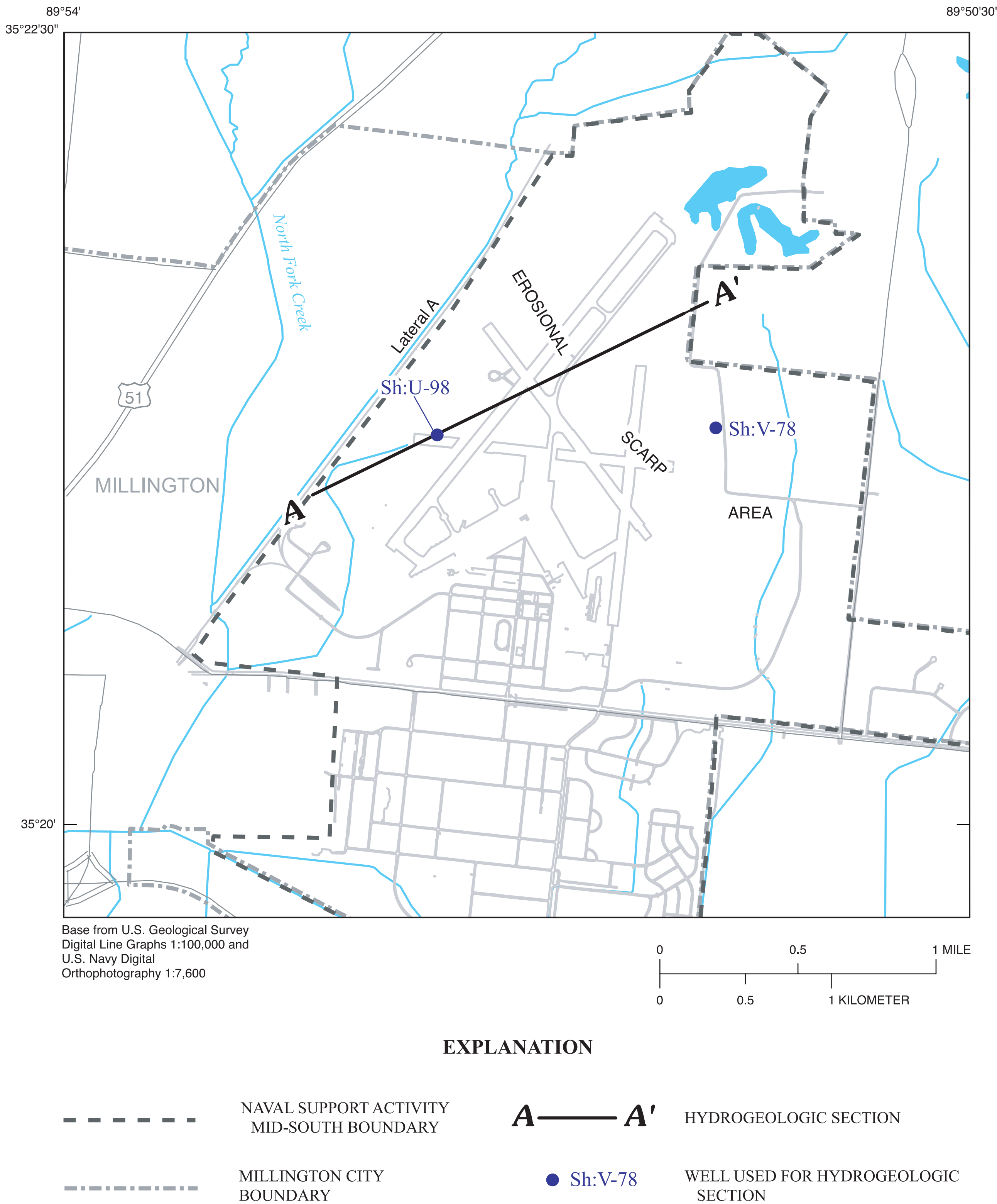


Figure 6a. Location of hydrogeologic section A-A' at Area of Concern (AOC) A, Naval Support Activity Mid-South, Millington, Tennessee.

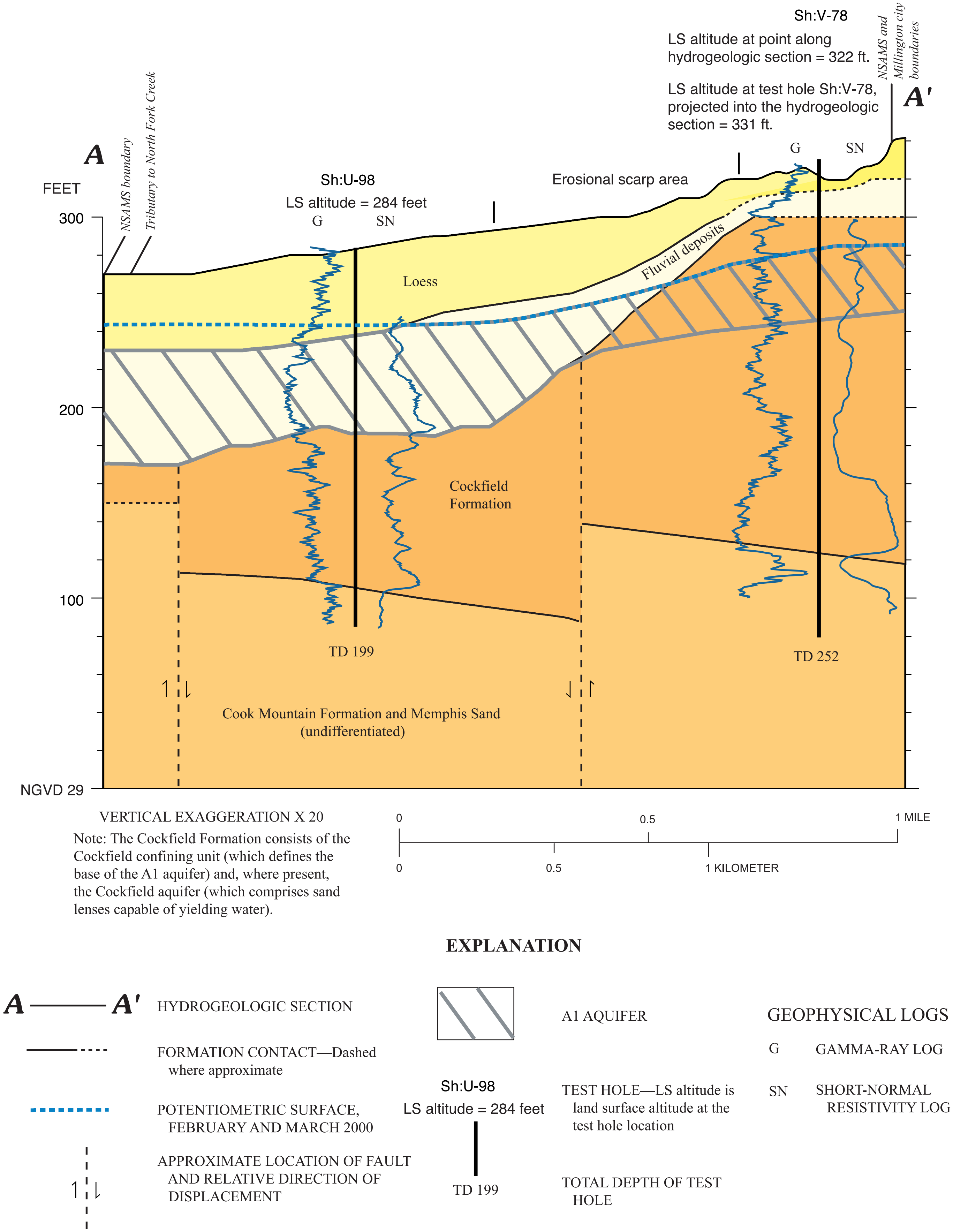
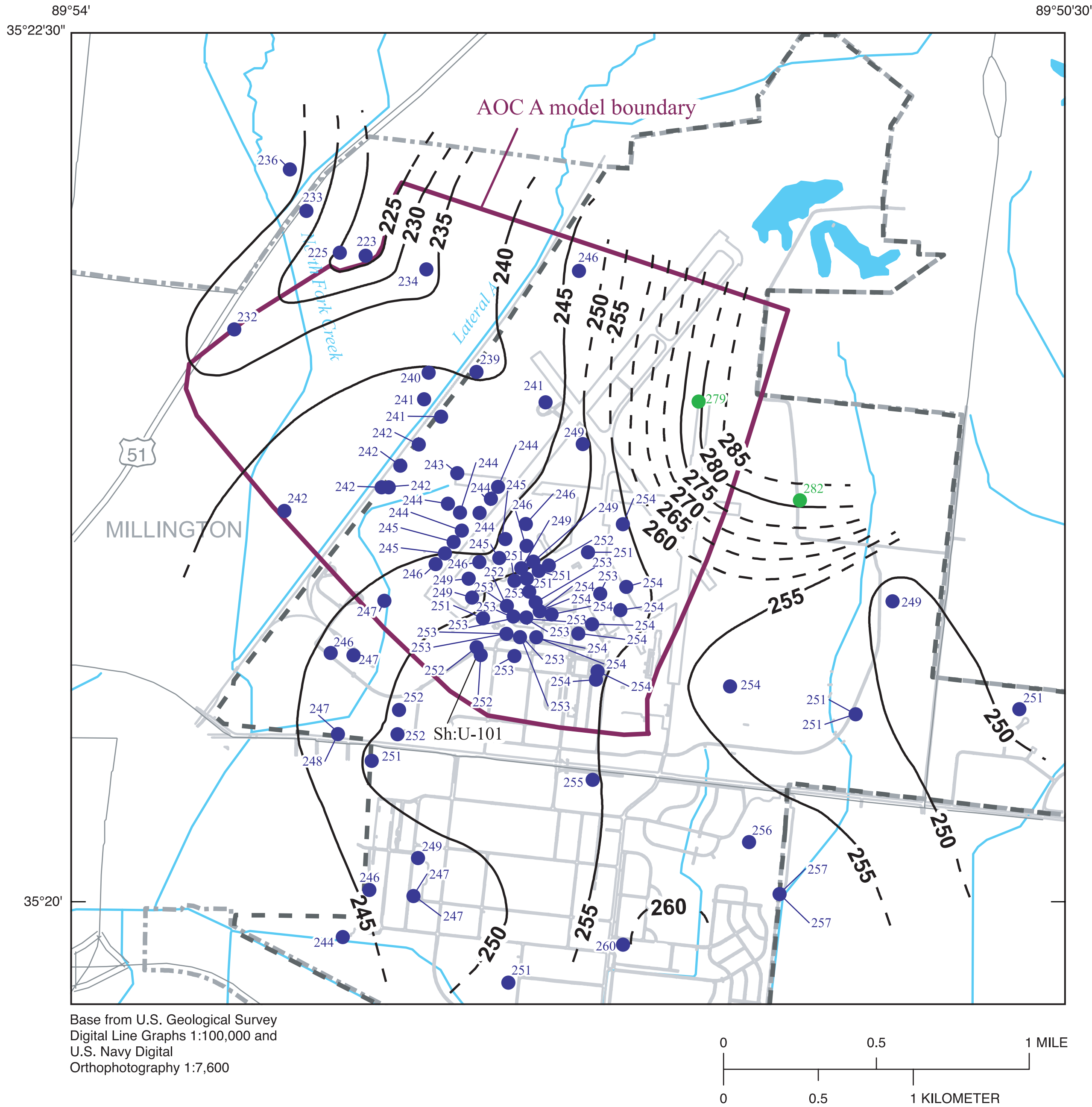


Figure 6b. Hydrogeologic section A-A' showing the A1 aquifer and related features at Area of Concern (AOC) A, Naval Support Activity Mid-South, Millington, Tennessee.



EXPLANATION

NAVAL SUPPORT ACTIVITY MID-SOUTH BOUNDARY

MILLINGTON CITY BOUNDARY

245 POTENTIOMETRIC CONTOUR—Shows altitude, in feet, at which water level would have stood in tightly cased wells. Dashed where approximate. Contour interval 5 feet. Datum is NGVD 29

260 WELL SCREENED IN THE ALLUVIUM OR FLUVIAL DEPOSITS—Number is altitude of water level, in feet. Datum is NGVD 29

282 WELL SCREENED IN THE COCKFIELD FORMATION—Number is altitude of water level, in feet. Datum is NGVD 29

Figure 7. 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 (AOC) A model boundary, Naval Support Activity Mid-South, Millington, Tennessee.

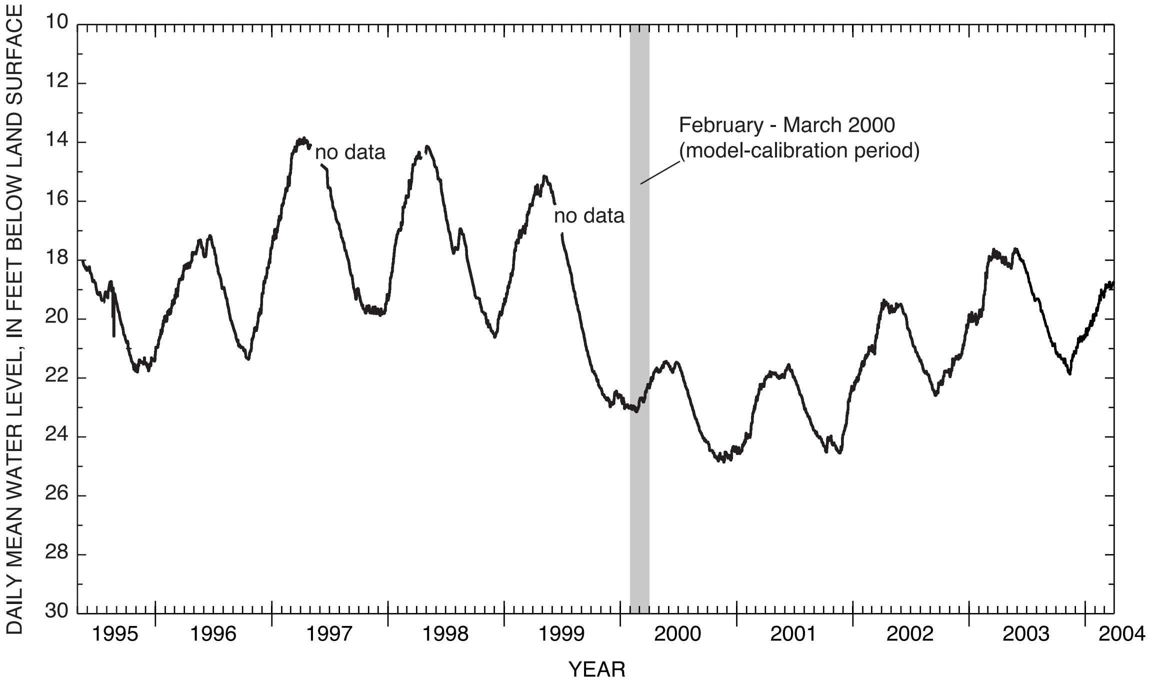


Figure 8. Hydrograph showing water levels recorded in well Sh:U-101 at Naval Support Activity Mid-South, May 1995 through March 2004.

2. The top boundary of the A1 aquifer model is assumed to be the bottom of the loess in the area southwest of the scarp where artesian conditions predominantly exist and the water table in the scarp area and to its northeast where water levels are below the base of the loess.
3. The bottom boundary of the A1 aquifer model is assumed to be the base of the alluvial-fluvial deposits aquifer southwest of the scarp and the base of the upper part of the Cockfield aquifer northeast of the scarp. This boundary, which corresponds to the top of the Cockfield confining unit throughout the model area, is assumed to be a no-flow boundary.
4. The hydraulic properties of the hydrogeologic units are homogeneous within a block of the finite-difference grid.
5. The hydraulic properties are isotropic within a layer.
6. Flow within a layer is horizontal; flow between layers is vertical.

Model Boundaries

The lateral boundaries of the AOC A model correspond to a local ground-water divide, ground-water flow-path lines, and a potentiometric contour (fig. 7). The east-southeastern boundary corresponds to a local ground-water divide and is simulated as a no-flow boundary. The north-northeastern and south-southwestern boundaries correspond to ground-water flow-path lines as defined by the February and March 2000 potentiometric surface of the A1 aquifer and are simulated as no-flow boundaries. The northwestern boundary corresponds to the 225-foot potentiometric contour of February and March 2000 and is simulated as a constant-head boundary. The upper boundary of the model ranges between altitudes of 220 and 285 feet above NGVD 29 and corresponds to the base of the loess southwest of the scarp where artesian conditions exist and to the water table northeast of the scarp where water levels are below the base of the loess (fig. 9). A recharge flux simulating leakage from the loess was applied to the upper boundary. The bottom boundary of the A1 aquifer is the top of the Cockfield confining unit throughout the model area which corresponds to the base of the alluvial-fluvial deposits aquifer southwest of the scarp and to the base of the upper part of the Cockfield aquifer northeast of the scarp (fig. 10). This boundary ranges between altitudes of 160 and 250 ft and is simulated as a no-flow boundary.

Model Construction

The AOC A model grid is approximately a 1.8- by 1.9-mi rectangle consisting of 100- by 100-ft grid cells (fig. 11). The grid is composed of 92 columns and 103 rows. About 2.2 mi^2 of the 3.4-mi^2 model grid is active. Vertically, the total thickness of the A1 aquifer (fig. 12) was divided into three equal layers to model vertical variations in aquifer texture and resulting hydraulic conductivity.

Model parameters, as discussed by Harbaugh and others (2000), were defined for recharge and hydraulic-conductivity zones (table 2). Recharge to the model is from downward leakage from the overlying loess and is constant throughout the area.

Hydraulic-conductivity zones for the AOC A flow model were determined on the basis of geology and well hydraulic-test

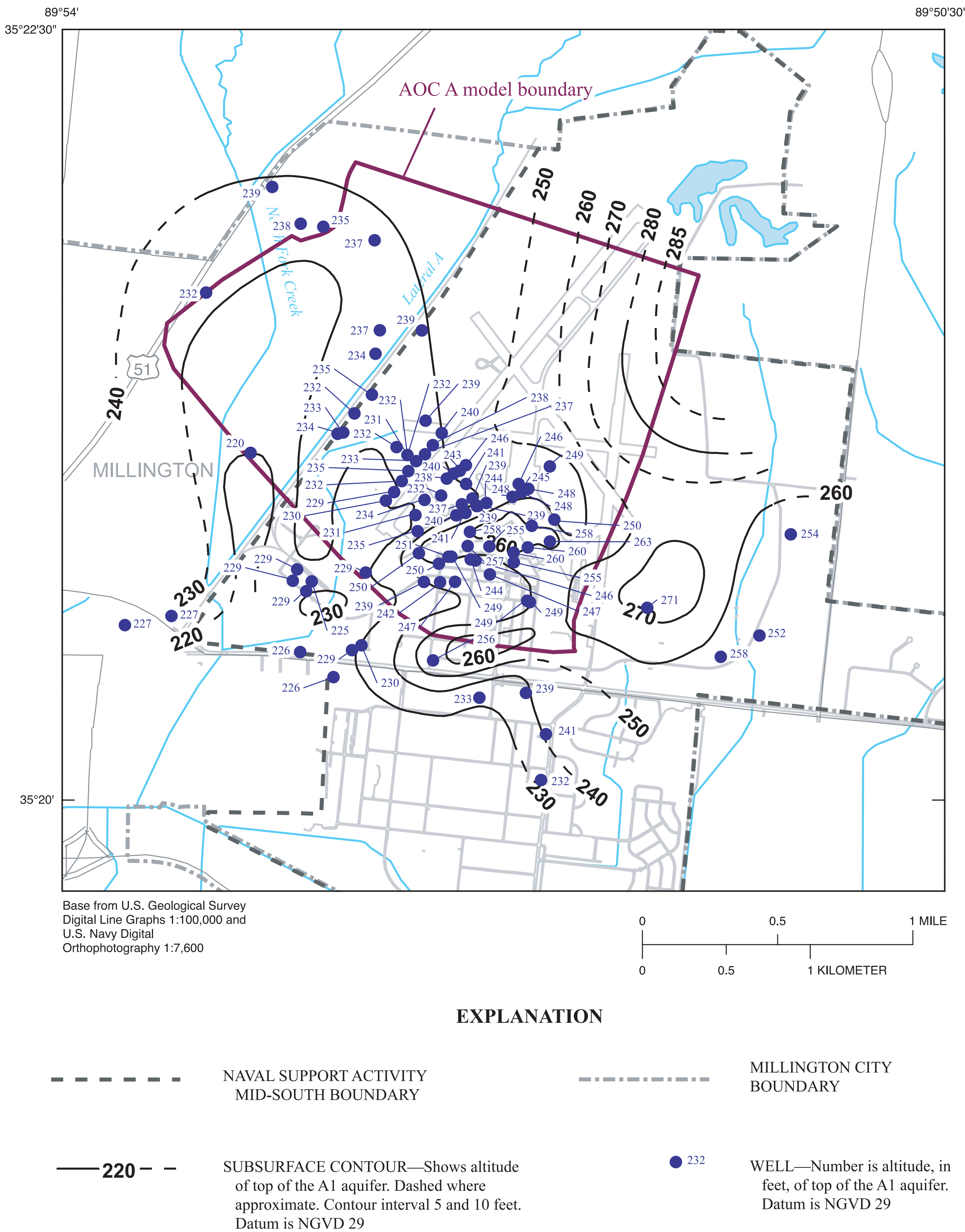
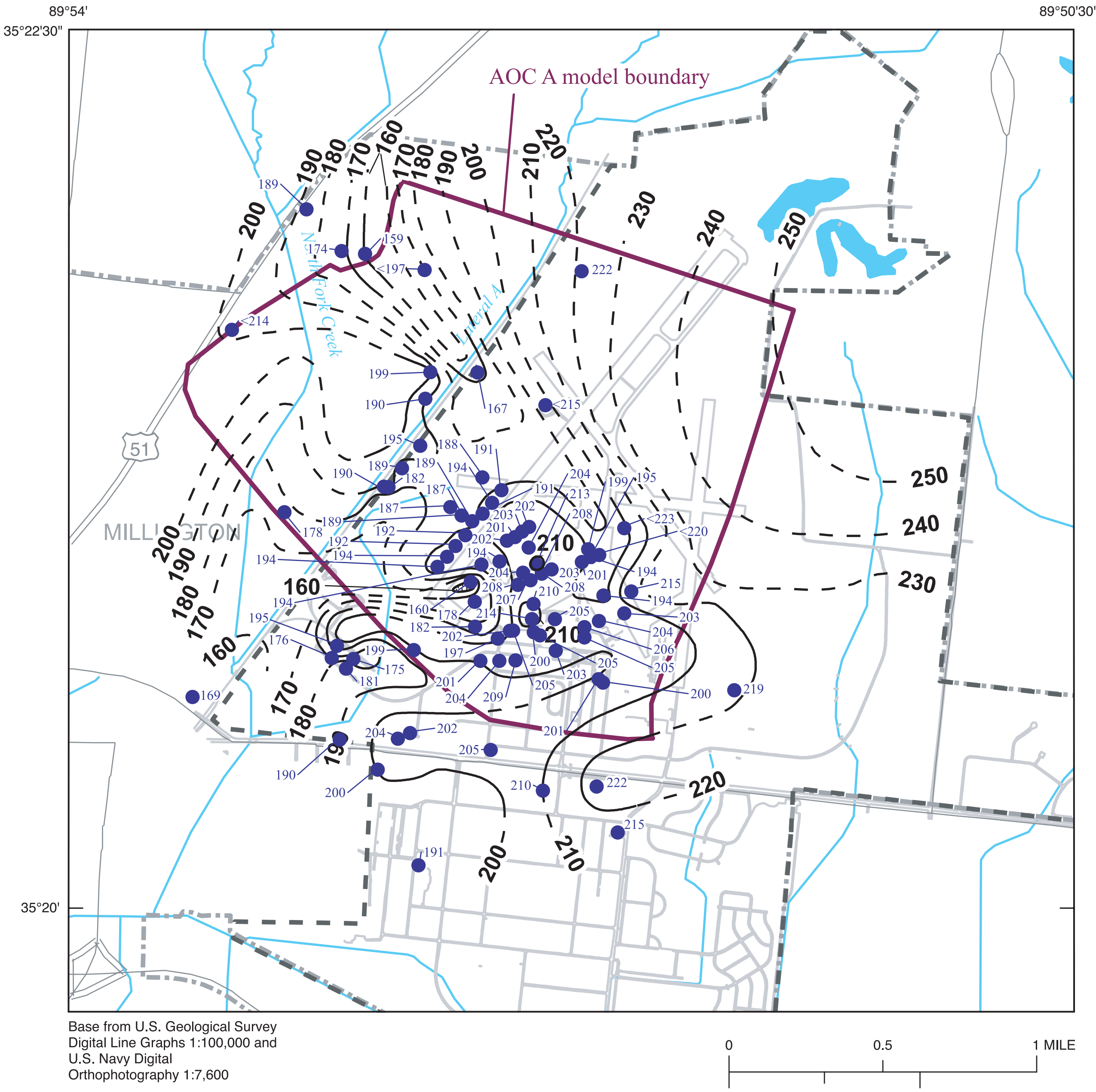


Figure 9. Altitude of the top of the A1 aquifer at Area of Concern (AOC) A, Naval Support Activity Mid-South, Millington, Tennessee.



EXPLANATION

NAVAL SUPPORT ACTIVITY MID-SOUTH BOUNDARY

MILLINGTON CITY BOUNDARY

220 — SUBSURFACE CONTOUR—Shows altitude of base of A1 aquifer. Dashed where approximate. Hachures indicate depression. Contour interval 10 feet. Datum is NGVD 29

215 WELL—Number is altitude, in feet, of base of A1 aquifer. Datum is NGVD 29

Figure 10. Altitude of the base of the A1 aquifer at Area of Concern (AOC) A, Naval Support Activity Mid-South, Millington, Tennessee.

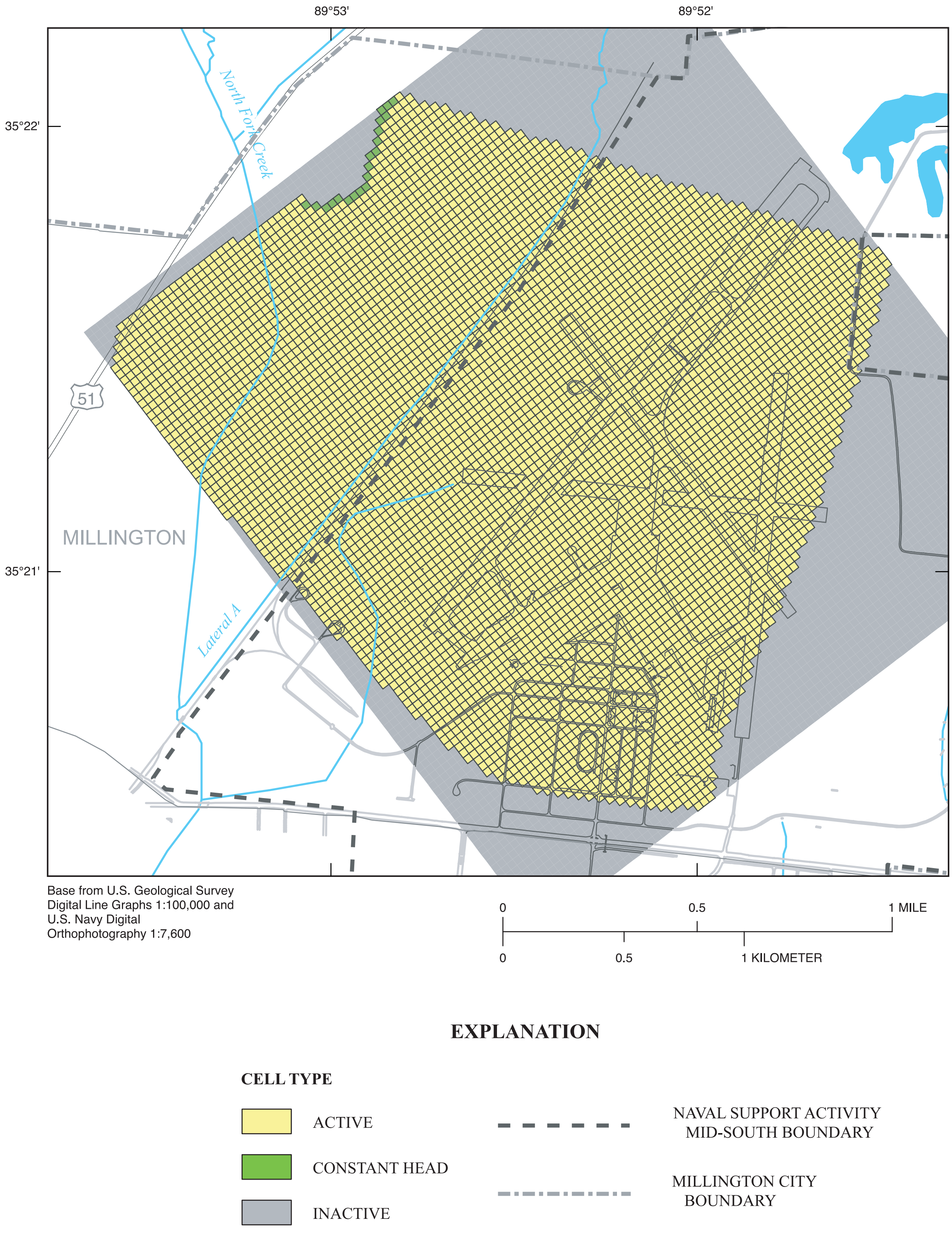


Figure 11. Model grid cell types for the Area of Concern (AOC) A flow model, Naval Support Activity Mid-South, Millington, Tennessee.

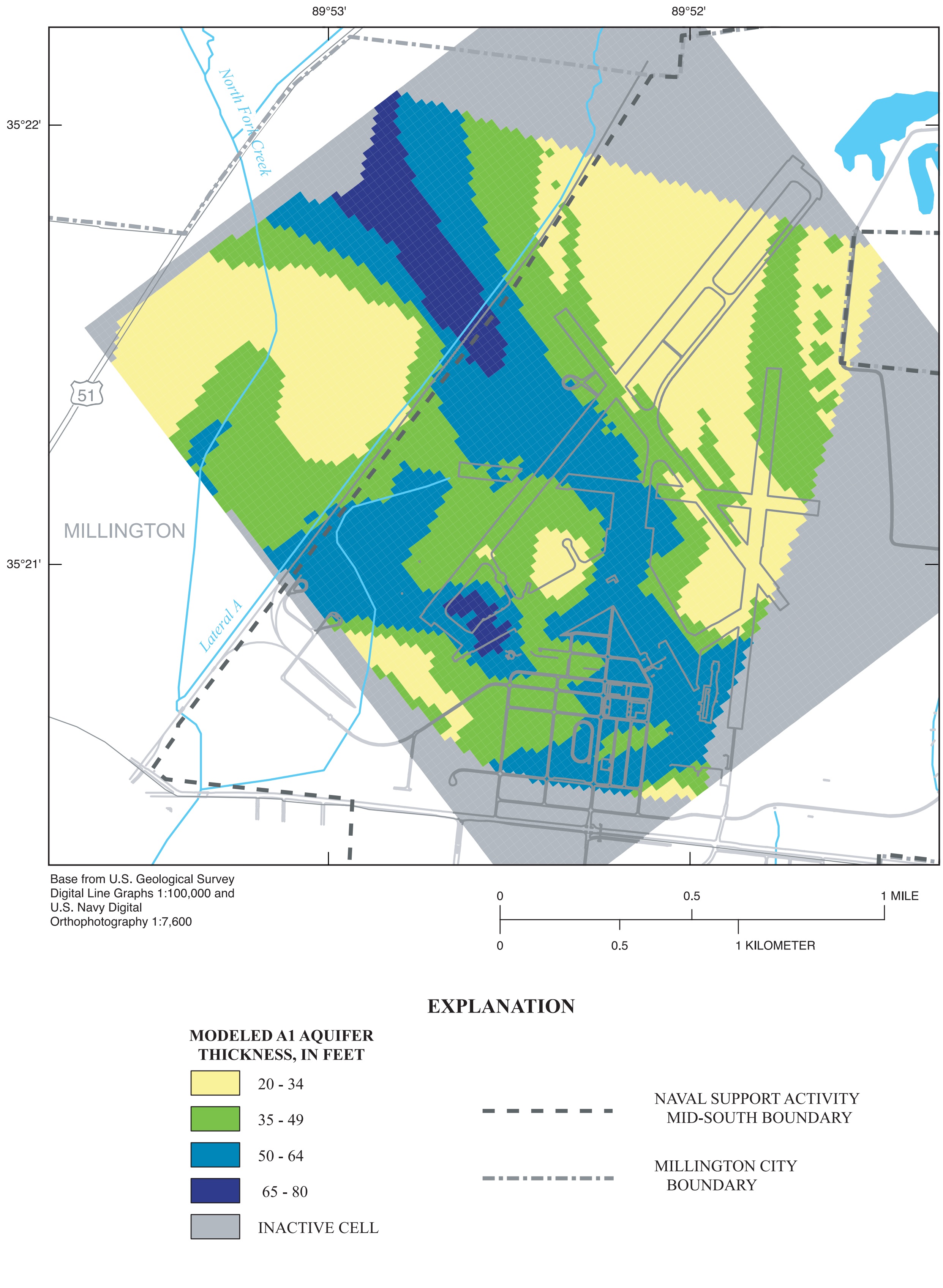


Figure 12. Thickness of the modeled A1 aquifer, Naval Support Activity Mid-South, Millington, Tennessee.

Table 2. Recharge and hydraulic conductivity parameters defined in the Area of Concern A flow model, Naval Support Activity Mid-South

Model parameter	Description
RECH	Recharge rate to the A1 aquifer from leakage from the overlying loess
HK_Average	Hydraulic conductivity in layer 3 for the model area outside the scarp area and southeast of the main runway. The A1 aquifer in this area consists of the alluvial-fluvial deposits aquifer. Hydraulic conductivity of layers 2 and 1 in this area is calculated by multiplying the parameter HK_Average by 0.5 and 0.25, respectively.
HK_High	Hydraulic conductivity in layer 3 for the area outside the scarp area and northwest of the main runway. The A1 aquifer in this area consists of the alluvial-fluvial deposits aquifer. Hydraulic conductivity of layers 2 and 1 in this area is calculated by multiplying the parameter HK_High by 0.5 and 0.25, respectively.
HK_ScarpA	Hydraulic conductivity in layers 1, 2, and 3 for the scarp area. The A1 aquifer in this area consists of the upper part of the Cockfield aquifer.
HK_ScarpB	Hydraulic conductivity in layers 1, 2, and 3 for a transition area near the edge of the scarp. The A1 aquifer in this area consists of both the alluvial-fluvial deposits aquifer and the upper part of the Cockfield aquifer.
VANI	Ratio of the horizontal to vertical hydraulic conductivity

data including aquifer tests, slug tests, and borehole-flowmeter measurements, as well as on supplemental data from pumping rates, drawdown, and water-level recovery during well sampling. Each of the layers contains four hydraulic-conductivity zones (fig. 13). The highest conductivity zone (HK_High) is in the northwestern part of the model area where slug tests and the multiple-well aquifer test conducted by EnSafe, Inc., (written commun., 2000), indicate the highest horizontal hydraulic conductivities for the alluvial-fluvial deposits aquifer at AOC A. Based on 12 measured values, hydraulic conductivities in this zone range from 45 to 68 ft/d with a median value of 61 ft/d. The lowest conductivity zones (HK_ScarpA and HK_ScarpB) are located in the scarp area in the eastern part of the model area. In the HK_ScarpA zone, the aquifer consists of the upper part of the Cockfield aquifer. In the HK_ScarpB zone, the aquifer consists of both the alluvial-fluvial deposits aquifer and the upper part of the Cockfield aquifer. Based on 14 measured values, horizontal hydraulic conductivities in the upper part of the Cockfield Formation range from 0.5 to 3 ft/d with a median value of 1.0 ft/d (Robinson and others, 1997). The other conductivity zone (HK_Average) is located in the center and southern part of the model area where slug tests and a multiple-well aquifer test indicate hydraulic conductivities to be about an order of magnitude lower than the HK_High zone. Based on 10 measured values, horizontal hydraulic conductivities in this zone range from 5 to 40 ft/d (excluding one outlier of 150 ft/d) with a median value of 13 ft/d (Robinson and others, 1997).

Each model layer contains four hydraulic-conductivity zones. The layers are set up such that hydraulic conductivity increases with depth by a factor of two between layers in zones HK_High and HK_Average. Hydraulic conductivity is constant in all layers in zones HK_ScarpA and HK_ScarpB (table 3).

Transmissivity for each cell was calculated by the model using hydraulic-conductivity and layer or saturated thickness data, both of which vary areally. The model layers were assumed to be hydraulically well connected and not separated by confining material. The vertical hydraulic conductivity was modeled as a constant ratio of the horizontal hydraulic-conductivity value.

Model Calibration

The process of adjusting the input variables to produce the best match between simulated and observed water levels and flows is known as calibration. The model developed for this study was calibrated to steady-state conditions as defined by the potentiometric-surface map of the A1 aquifer for February and March 2000 (fig. 7). Because no ground water discharges to surface features within the modeled area, ground-water discharge fluxes could not be used to aid in model calibration. The recharge flux into the model (leakage from the overlying loess) is difficult to measure in the field, so no independent measurements of this flux are available. Therefore, data to calibrate the model are limited to matching observed water levels and measured hydraulic-conductivity values. To provide additional information to help calibrate the model, an advective-flow observation was added (Anderman and Hill, 1997; Hill and others, 2000). An advective-flow observation requires specifying two observation points, the advective travel time between the points, and the aquifer porosity. The starting and ending points for the advective-flow observation were at the southeastern end of the main TCE plume and the northwestern edge of the former Northside property boundary where the TCE plume crosses this boundary (fig. 3). An advective travel time of 40 years was estimated based on ground-water velocities of between 30 and 140 ft/yr determined for two different zones by Ensafe, Inc. (written commun., 2000). This travel time is consistent with the estimated site disposal history. An aquifer effective porosity of 25 percent was assumed (Robinson and others, 1997).

The AOC A model was calibrated using a combination of automated and manual methods to minimize the difference