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Approximate potentiometric surface of the bedrock aquifer at Great Bay, southeastern New Hampshire, 2001

Base from U.S. Geological Survey
Dover West, 1956, photorevised 1993; Dover East, Maine-N.H., 1956, photorevised 1988;
Newmarket, 1956, photorevised 1973; Portsmouth, 1956, photorevised 1993; 1:24,000 scale.
State plane coordinate system, tics in feet, referenced to North American Datum of 1983

Approximate mean declination

SCALE 1:24,000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Potentiometric surface contours by J.R. Degnan and T.J. Mack, 2003

EXPLANATION

— 20 — Approximate potentiometric contour—Shows elevation of water level in open borehole. Contour interval 20 feet

Bedrock well and potentiometric-head elevation, in feet

12 ○ USGS historic ground-water site inventory

7.6 ● June 11-15, 2001 (Roseen, 2002)

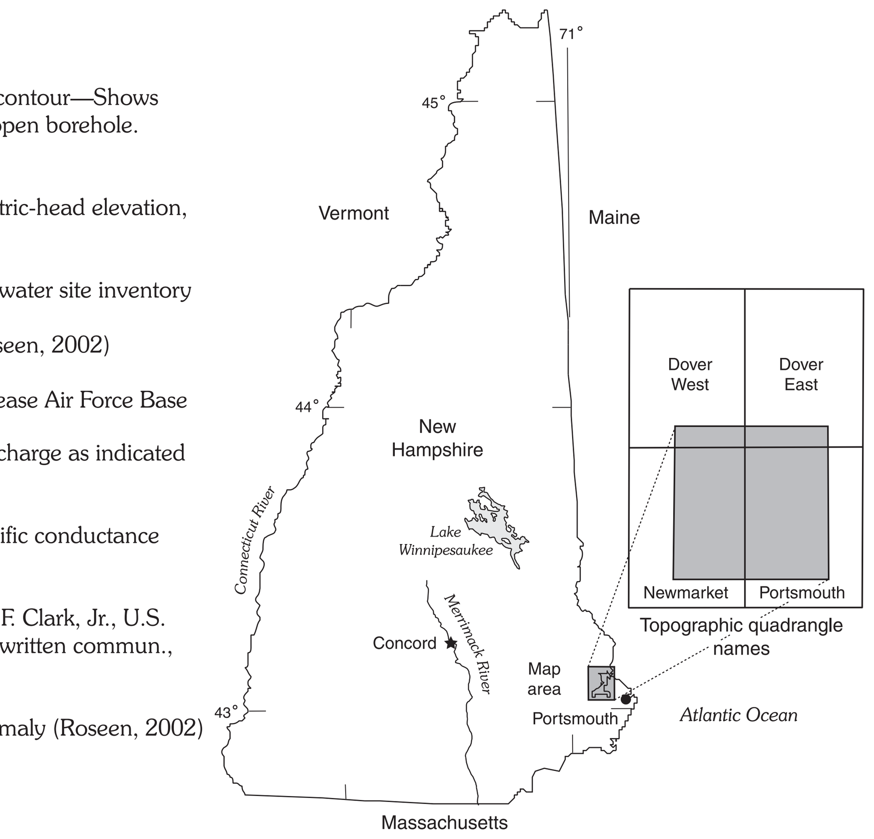
31.1 ● Spring 2001, former Pease Air Force Base

Location of ground-water discharge as indicated by:

▲ Temperature and specific conductance (Roseen, 2002)

△ Temperature (Stewart F. Clark, Jr., U.S. Geological Survey, written commun., 2002)

▲ Thermal infrared anomaly (Roseen, 2002)



Location of the study area in the Dover West, Dover East, Newmarket, and Portsmouth1:24,000-scale quadrangles in southeastern New Hampshire

ABSTRACT

Ground-water elevations (heads) in 265 wells were used to map the potentiometric-head surface in the fractured-bedrock aquifer adjacent to Great Bay, N.H. Remotely sensed data, spring-water temperatures and specific conductances, land-surface elevations, and simulated heads were also used to guide construction of the potentiometric surface. Heads in the bedrock aquifer locally varied more than 20 ft (feet) between adjacent wells as little as 200 ft apart. The depth to water below land surface was greater on the western and northwestern sides of the bay (about 20 ft) than on the southern and eastern sides (about 8 ft). Topography has a greater effect on heads than does temporal variation or measurement accuracy. Head gradients are steeper at the southern side of Great Bay, where the topographic relief is greatest, than at the northwestern and northeastern sides.

INTRODUCTION

Great Bay, a 9.1-square-mile estuary near Portsmouth, N.H., is part of the National Estuarine Research Reserve System designated by the National Oceanic and Atmospheric Administration (NOAA). The U.S. Geological Survey (USGS), in cooperation with the Civil Engineering Department at the University of New Hampshire (UNH) and the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), is assessing ground-water flow to the bay (Brannaka and others, 2002) to locate potential discharge sites, flow paths, and source areas of nutrients and other ground-water contaminants. The approximation of the potentiometric-head surface in the bedrock aquifer presented in this report characterizes regional ground-water flow to Great Bay.

Study Area

The regional ground-water-flow system consists of a till- or marine-sediment-covered crystalline bedrock aquifer. Till, an unsorted mixture of sand, silt, and gravel, and marine sediments consisting of fine-grained sand, silt, and clay, are generally less than 20 ft thick. Coarse-grained sand and gravel aquifers are generally small and discontinuous with the exception of a large ice-contact deposit beneath the former Pease Air Force Base, in Newington, N.H. Crystalline bedrock consists of three main units (Lyons and others, 1997): the Kittery Formation, a metasandstone on the western side of the bay; the Eliot Formation, a phyllite along the eastern and southern sides of the bay; and the Exeter Diorite, inland west of the bay. Most bedrock wells are domestic wells cased from the land surface to a depth of at least 10 ft into bedrock. Below the casing, the wells generally consist of an open borehole drilled from tens to hundreds of feet into the bedrock.

Acknowledgments

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APPROACH AND METHODS

A generalized (20-ft contour) potentiometric-head surface was constructed by contouring bedrock ground-water elevations (heads) measured at 165 wells between June 11 to June 15, 2001. The June 2001 head survey was augmented with heads measured from 86 bedrock wells at the former Pease Air Force Base in the spring of 2001. Historical records from 14 bedrock well completion reports in the USGS's ground-water-site inventory database and additional qualitative data also were used to construct the head surface.

The vertical accuracy of the June 2001 heads and those measured at the former Pease Air Force Base is within 0.1 ft or less, because measurements were made from surveyed top-of-casing elevations. The accuracy of the historical data is +/- one-half the topographic-map contour interval, or about 10 ft. Annual and seasonal variations in heads were generally about 3 ft or less during 2001 and 2002 at the former Pease Air Force Base. Tidal effects, measured in some bedrock wells in the study area (Montgomery Watson Herzog, Inc., 2002), were about 0.5 ft. Water-level-measurement error, which is generally less than 1 ft, was not a factor in constructing the potentiometric surface. Domestic-well owners in the study area were requested to not use their wells heavily during the June 2001 head survey to minimize the temporal effects of pumpage. Residual drawdowns were estimated to be less than a few feet, but heads that appeared to be affected were removed from the database.

Qualitative data were used to indicate areas where the potentiometric surface in the bedrock aquifer may be above the surface of the bay. Zones of ground-water discharge, interpreted from analysis of thermal infrared anomalies (Roseen and others, 2001; Roseen, 2002), and freshwater springs near bedrock outcrops (Degnan and Clark, 2002) with summer water temperatures less than surface-water temperatures (Roseen, 2002; and Stewart Clark, Jr., U.S. Geological Survey, written commun., 1999), were used to approximate the location of the 0-ft head contour. In areas where head data were particularly limited or unavailable, head contours were approximated from simulated heads (Mack and others, 2002) and digital-elevation-model data. In some areas, contours are above the land-surface elevations shown on the topographic map. These contours were modified where they were considered to be unrealistic, but were retained where they were considered to be reasonable and to contribute to a hydrologically sound representation of the regional potentiometric surface of the bedrock aquifer in the study area.

POTENTIOMETRIC SURFACE

Regional heads are depicted by a generalized potentiometric head surface because of inherent variations caused by the following: (1) heads were measured in open bedrock boreholes and do not reflect head variations that may be present at individual fractures in a borehole; (2) heads in the bedrock wells show large differences (greater than 20 ft) over short distances (as little as 200 ft); and (3) temporal effects, which include tidal, seasonal, and annual variations, as well as residual drawdowns from domestic well use, are not accounted for. Topographic relief in the study area ranges from 0 to nearly 300 ft and is probably the primary factor affecting the potentiometric surface.

Based on limited data, the average depth to water was about 20 ft on the northwestern and western sides of the bay and 8 ft on the southern and eastern sides. The configuration of the potentiometric surface generally follows the land-surface topography. Head gradients are steeper along the southern side of Great Bay, where the topographic relief is more pronounced, than at the northeastern and northwestern sides.

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