UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D.C.

MEMORANDUM ON THE HYDROLOGY OF THE JOHNSON CREEK AREA, DOVER-MADBURY, NEW HAMPSHIRE

By Edward Bradley

Ground-water conditions in the Johnson Creek area (Dover-Madbury, N.H.) are described on pages 23-26 in "Preliminary report on the ground-water resources of part of the seacoast region of New Hampshire," by Edward Bradley, U.S. Geological Survey open-file report, 1955. A copy of those pages is attached as an appendix to this memorandum. The purpose of the present memorandum is to outline the hydrology of the Johnson Creek area as now understood, with particular reference to stream-discharge characteristics and their relation to geologic and ground-water conditions.

Summary of geologic and hydrologic features

The consolidated rocks, or bedrock formations, in the Johnson Creek area consist of igneous and metamorphic rocks of Devonian age. They crop out in isolated spots in the Johnson Creek area, but generally they are covered by unconsolidated deposits ranging in thickness from less than a foot to at least 135 feet. In general the consolidated rocks contain only small quantities of ground water, in joint cracks.

Open-file report. Not reviewed for conformance with standards and nomenclature of the Geological Survey.
March 1957

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The unconsolidated deposits of the Johnson Creek area consist of Pleistocene and Recent sediments of glacial, marine, and alluvial origin. Their distribution is shown on the accompanying map, which is a copy of plate 2 of the 1955 report with some recently collected data added to it. The subsurface relationships of the unconsolidated deposits in parts of the area are shown in plate 3 of the 1955 report. Logs of selected test holes and wells in the area are given below for easy reference. The word "refusal" in the logs of all the holes except Dover 1032 and Madbury 6 and 8 indicates that the samples were taken with an instrument that was driven to refusal, against or into resistant material.

Dover 1031

	Thickness (feet)	Depth (feet)
Marine and estuarine silt and clay:		
Topsoil	2	2
Clay	20	22
Undifferentiated:		
Sand, silty, with clay	113	135
Refusal		135

Dover 1032

	Thickness (feet)	Depth (feet)
Marine and estuarine silt and clay:		
Topsoil	3	3
Clay	21	24
Ice-contact deposits:		
Sand and gravel	18	42
Sand, fine, silty	35	77

Madbury 1

	Thickness (feet)	Depth (feet)
Ice-contact deposits:		
Sand and gravel	40	40
Refusal		40

Madbury 2

	Thickness (feet)	Depth (feet)
Ice-contact deposits:		
Sand, fine	20	20
Sand, coarse, and gravel	30	50
Sand, fine	5	55
Till:		
Hardpan	5	60
Refusal		60

Madbury 3

	Thickness (feet)	Depth (feet)
Ice-contact deposits:		
Clay 1/	5	5
Clay, sandy	5	10
Sand, coarse	20	30
Sand and gravel	16	46
Sand and gravel, gray	8	54
Refusal		54

Madbury 4

	Thickness (feet)	Depth (feet)
Ice-contact deposits:		
Clay 1/....................................	8	8
Gravel, fine, sandy.........................	35	43
Sand, coarse, and gravel....................	17	60
Refusal.....................................		60

Madbury 5

Marine and estuarine silt and clay:		
Topsoil.....................................	2	2
Clay, gray, with some sand..................	51	53
Clay, sandy, fine, gray.....................	5	58
Ice-contact deposits:		
Sand, coarse, brown, and gravel.............	4	62
Refusal.....................................		62

Madbury 6

Marine and estuarine silt and clay:		
Topsoil.....................................	2	2
Clay, gray..................................	26	28
Sand and clay...............................	14	42
Ice-contact deposits:		
Sand, gray..................................	16	58
Sand, coarse, brown, and gravel.............	32	90
Till:		
Hardpan.....................................	1	91

Madbury 8

Ice-contact deposits:		
Loam, sandy.................................	6	6
Bedrock:		
Rock..	123	123

1/ Although logged as "clay," the material at the sites of these test holes (Madbury 3 and 4) was found to be sand, and hence is classified with the ice-contact deposits, which consist of sand and gravel.

The Madbury well field, a source of water supply for the city of Portsmouth and the Portsmouth Air Force Base, is located in a kame (ice-contact) deposit of stratified sand and gravel, which crops out along the valley of Johnson Creek (see location of gravel-packed wells on attached map). This deposit consists of sand and gravel and is very permeable, but its extent is limited. Between wells 4 and 6 (see attached map), the deposits are overlain by marine and estuarine silt and clay, which are relatively impermeable. Ground water contained in sand and gravel beneath the clay at well 6 is under artesian pressure.

Johnson Creek, a perennial stream about 3-1/2 miles long, flows from the southern part of Dover through parts of Madbury and Durham to the tidewater section of the Oyster River. Johnson Creek flows across part of the outcrop area of the kame deposit, and the ground water in the kame is in unrestricted hydraulic continuity with the stream in this section. Water levels in observation wells adjacent to the creek indicated that the water table sloped toward the creek before pumping began in the Madbury well field. Thus, under natural conditions ground water from the Johnson Creek kame discharged into the stream.

Data and comments supplementing 1955 preliminary open-file report

Four gravel-packed wells comprising the Madbury well field were constructed in the Johnson Creek area in 1954 and 1955. Data on these wells were not available for inclusion in the 1955 preliminary report but will be included in a final report on the ground-water resources of the seacoast region of New Hampshire (manuscript in preparation). These gravel-packed wells are shown on the accompanying map as wells 1, 2, 4, and 6 in Madbury. City of Portsmouth officials use the following numbers for these wells:

No. in this report	City of Portsmouth No.
Madbury no. 1	Madbury well field no. 1
" " 2	" " " " 2
" " 4	" " " " 3
" " 6	" " " " 4

Pumping in the Madbury well field for public supply began in February 1956. The following table shows the average daily yield of all of the wells for the first 5 months of pumping:

March	2.36 mgd (million gallons per day)
April	1.70
May	1.62
June	1.44
July	.91

By the end of July 1956 much of the ground water in storage in the Johnson Creek kame had been pumped out. The drawdown in the well field reversed the natural water-table gradient toward the stream, and the surface of wells 1, 2, and 4 was discontinued during the summer of 1956. The present yield of the Madbury well field, about 0.8 mgd, is all from well 6.

Discharge measurements, in cubic feet per second, of Johnson Creek made at gaging sites I and II (see attached map) are given in the following table:

Date	Discharge in cfs	Gaging site
June 6, 1955	1.72	I
May 31, 1956	1.20	I
May 31, 1956	1.29	II

Stream-stage readings were made at both sites I and II at about weekly intervals from May 1956 through October 1956. At site I the streambed was observed to be dry on July 2; some flow was noted on July 9. From July 20 to Sept. 27 no flow was observed at site I. Some flow was observed at site I on October 8, October 26, November 30, and December 27. The station was dry on October 10 and November 8. The discharge at site II dropped somewhat during June and July.

It is estimated that the flow of Johnson Creek at site II was less than 1 cfs during most of August and September. Flow in the streambed disappeared at a point between wells 4 and 6 near the contact between the sand and gravel deposits of the kame and the marine and estuarine silt and clay.

Static water levels in observation wells on the north and south sides of Pudding Hill (see attached map) have not been affected by the pumping in the Madbury well field. This fact indicates that essentially no hydraulic continuity exists between the kame deposits along Johnson Creek and sand and gravel deposits along Johnson Creek and sand and gravel deposits of Pudding Hill. Thus essentially all the ground water available from the Madbury well field comes from the flow of Johnson Creek and from the precipitation that falls on the limited outcrop area of the kame. During periods of little or no rainfall, the yield of the Madbury well field - currently the yield from well 6 - is maintained from the flow of Johnson Creek.

Upstream from a point between wells 4 and 6, the valley of Johnson Creek is underlain by relatively impermeable marine and estuarine silt and clay. A dam and surface-water reservoir constructed in this area might prevent streamflow from recharging the kame. If the streamflow that passes well 6 is cut off or reduced, the yield of well 6 will be reduced. Generally an impounded surface-water body may be expected to increase ground-water storage in adjacent deposits upstream from a dam site. However, in a case such as this, where materials of low permeability surround the surface-water body, the increased ground-water storage could not be pumped feasibly.

Appendix

The kame along Johnson Creek is a small body of ice-contact deposits that has been trenched by Johnson Creek. Its top is about 100 feet above sea level, and about 70 feet above the bed of the creek. As indicated in section A-A' (pl. 3) it is limited in northwest-southeast extent by hills or ridges of bedrock. Similarly, its seems to be separated from other water-bearing deposits on all sides except up Johnson Creek valley. In this direction the sand and gravel extends at least as far as well M6 and may extend far enough north to be hydraulically interconnected with the deposits beneath Pudding Hill. The intervening material is relatively fine grained (see test hole D1031), and therefore, even if the deposits are interconnected, the movement of water is restricted.

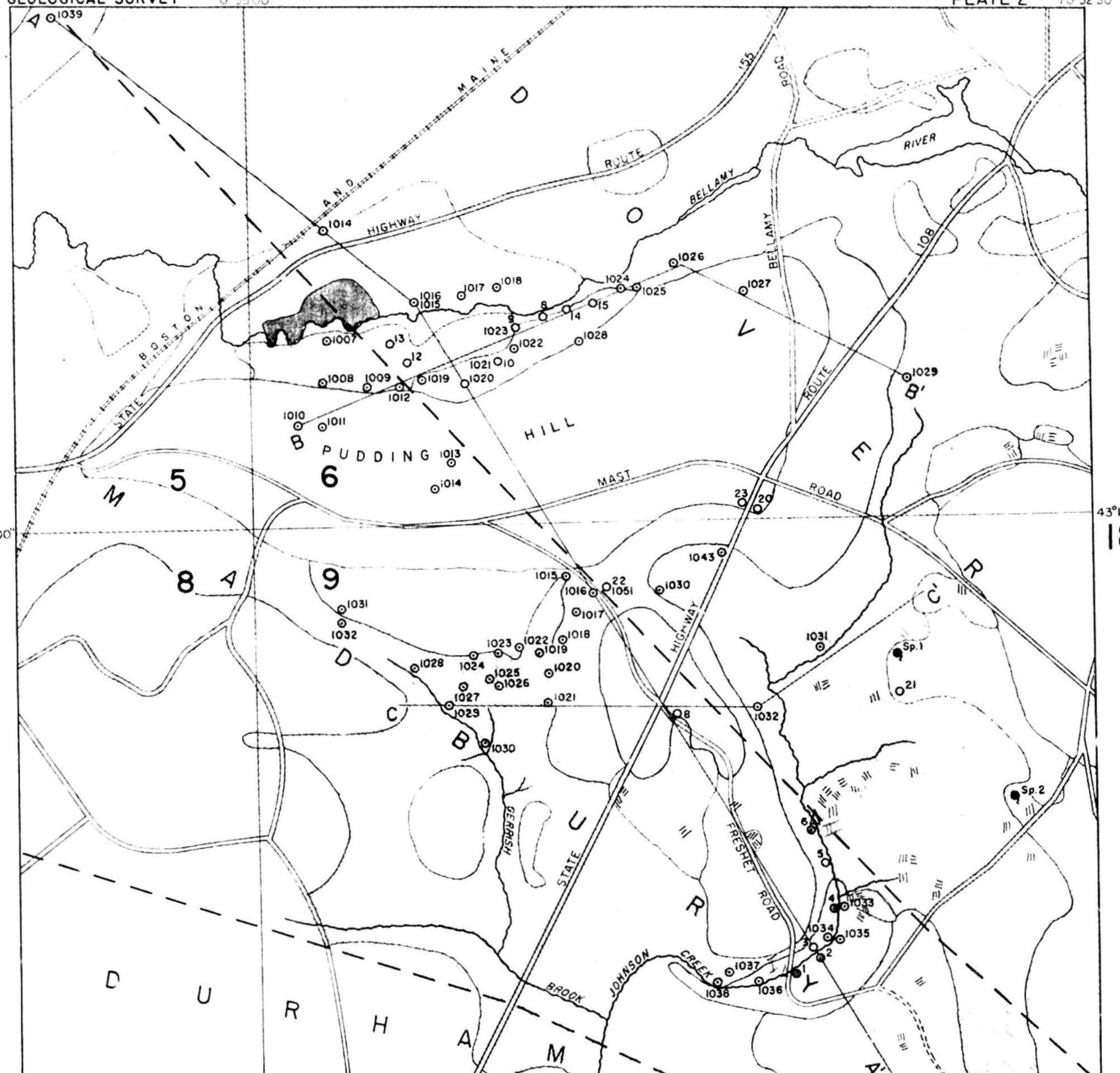
Ground water in the deposit along Johnson Creek is unconfined except where it underlies the marine and estuarine silt and clay. There the water is confined. These fine-grained deposits transmit water relatively slowly, and hence limit the possibilities for replenishment.

Under present conditions water enters the deposits chiefly by infiltration of rain and melted snow on the exposed surface of the deposits. This is a relatively small area, and the total quantity of water thus available deposits is small. Depending upon the extent and hydraulic interconnections of the deposits, some replenishment may occur from the ice-contact deposits near State Highway 108 and Freshet Road and from the deposits of Pudding Hill.

In the reach of Johnson Creek above well M4, the marine and estuarine silt and clay might transmit some water downward under favorable hydraulic gradient. However, in the reach approximately between M4 and test hole M1038 (pl. 3), the overlying marine and estuarine wilt and clay have been breached, and the water in the kame is in unrestricted hydraulic continuity with Johnson Creek.
Whereas under present conditions the ground water probably discharges into the creek, if the water table near the stream were lowered the flow of water would be reversed. Thus, except for the possibility of lateral movement of water from Pudding Hill, the amount of water available in the Johnson Creek area would nearly equal the flow of Johnson Creek. The stream discharge ordinarily is only a few cubic feet per second, and may be very small at the end of prolonged droughts.

U.S GEOLOGICAL SURVEY

PLATE 2



Base compiled from Whitman and Howard, Engineers. Plan showing well-site locations, Portsmouth airport water-supply investigation, June 1952.

Scale 1000 500 0 2640 5280 Feet

Geology by E. Bradley, 1955.

DETAILED MAP OF PUDDING HILL - JOHNSON CREEK AREA, NEW HAMPSHIRE

FOR EXPLANATION OF GEOLOGIC SYMBOLS SEE PLATE 1

O[21] Well Sp.2 Spring ⊙[1020] Test Hole

Ⅲ≡ Bedrock outcrop
● Gravel packed well
△ Gaging site

DRAFTING BY R.C.R.