GROUND-WATER RECONNAISSANCE IN THE KITTERY-ELIOT-SOUTH BERWICK AREA, MAINE, AND THE DOVER-ROLLINSFORD-SOMERSWORTH AREA, NEW HAMPSHIRE

By

Claude M. Roberts

U. S. Geological Survey

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INTRODUCTION

Through Commander K. M. Clark of the Navy Department, Bureau of Yards and Docks, Office of the Superintending Civil Engineer, Area 1, Boston, Massachusetts, the Ground Water Division of the U. S. Geological Survey was requested to make a brief reconnaissance in the vicinity of Portsmouth, New Hampshire, to determine the possibilities of developing a ground-water supply for utilization at the Portsmouth Navy Yard.

On January 8, 1945, the writer conferred with Commander Clark at Boston. The Navy Department had assembled information on the present water supply and also on the development of ground-water supplies in the Portsmoith area, particularly for projects connected with defense work. Included in these papers was a copy of the findings and recommendations of W. S. Coulter, Senior Engineer, Defense Public Works Division of the Federal Works Agency. In 1941 M. L. Brashears, Jr., of the U. S. Geological Survey, made a reconnaissance survey in the vicinity of Portsmouth for that agency. His work covered an area south of that covered in the present investigation.

The average consumption of water at the Portsmouth Navy Yard is reported to be about 1,800,000 gallons a day. At present the water is purchased from the Kittery Water District, whose chief source of supply consists of Folly Pond and adjacent watercourses. The pond supply is augmented by a single well, which is capable of furnishing about 125 gallons per minute. In addition, water can be pumped during emergencies from Chases Pond, whose water rights are owned by the York Water District, by means of equipment installed by the Federal Works Agency. The locations of these sources of water are shown on the accompanying map (fig. 1).

It is expected that the average consumption at the Navy Yard may increase during the coming year and that peak demands of as much as 3,000,000 gallons a day may occur. The present system of the Kittery Water District is incapable of furnishing the additional water that may be required unless certain economies are effected in the distribution system and unless the average yields of its surface-water and ground-water sources are increased. The Navy Department desires to develop an independent supply from wells rather than place such an additional burden on the system of the Kittery Water District.

One other important matter was brought forth during preliminary discussions. The Portsmouth Navy Yard is situated on an island in the tidal portion of the Piscataqua River between Portsmouth, New Hampshire, and Kittery, Maine. The tidal flow in the vicinity of the Navy Yard is very strong, especially in the deep narrow channel that separates Portsmouth from Kittery. It is therefore important to avoid, if possible, crossing the river with pipe-lines from the Portsmouth side directly into the Navy Yard. For this reason the ground-water reconnaissance in the immediate vicinity of the Navy Yard was confined to the area north of the Piscataqua River. Further, there seemed to be little likelihood of obtaining a large supply of ground water south of the river near the Navy Yard, as much of the area already has been developed by the city of Portsmouth or has been proved relatively barren.

Two days, January 9 and 10, 1945, were spent in interviewing drillers and other informed persons relative to test and water-supply wells, springs, sand and gravel pits, clay deposits and other allied features in the general vicinity of the Navy Yard, particularly north and west of the Piscataqua River. From January 11 to January 15, 1945, field examinations and inquiries were made in parts of Kittery, Eliot, and South Berwick, Maine, and Dover, Rollinsford, and Somersworth, New Hampshire. Rock outcrops, sand and gravel exposures, and clay deposits were noted. In addition data were collected regarding well supplies of communities and farms, and on springs. Despite somewhat unfavorable conditions, due to snow cover and sub-zero weather, considerable field data were collected and many exposures of bedrock, sand and gravel, and clay, and many seeps and springs, were recorded.

GEOLOGY

The area covered is in the southwestern part of York County, in the southwestern corner of Maine, and in the eastern part of Strafford County, New Hampshire. The area is shown on the York, Dover, and Berwick sheets of the topographic atlas of the U. S. Geological Survey, parts of which are reproduced in figure 1.

The general physical character of the region is that of a coastal lowland flanked on the upland side by dissected rock terraces or platforms. Within the coastal lowland there are several lower rock terraces and the remnant of one of the upland terraces, Mt. Agamenticus. The rock-floored coastal lowland consists of many narrow ridges separated by open valleys, and rises from below the level of the sea to an altitude of somewhat more than 300 feet. The Pleistocene glaciation has left a mantle of glacial deposits of many kinds over much of the region. Marine deposits consisting chiefly of clay were laid down in many places in the area during both glacial and recent times.

The drainage pattern of the region has been modified by the deposition of glacial and marine material. The principal streams in the area are shown in figure 1. Slight deflections of the south to east-southeast courses of these rivers have been caused by the unequal and irregular deposition of the glacial and marine material.

The rock floor is composed of a group of metamorphosed sedimentary rocks and several types of metamorphosed igneous rocks. The Kittery quartzite and Eliot slate are sedimentary rocks of Carboniferous age that have been deformed and intruded by volcanics. The igneous rocks are chiefly the Biddeford granite and the Exeter diorite, both post-Carboniferous intrusive masses. Other rocks occur within the area but are of minor importance. All these rocks are hard and crystalline in character and are jointed and fractured. The unconsolidated overburden is mainly glacial drift. Drift laid on top of the rock by the glacial ice is till, a mixture of boulders, gravel, sand, and clay, and is usually very solid. Where the drift has been modified by over-riding ice after its deposition, the deposits are different in character, depending on the conditions of deposition. The modified drift consists of ground moraine, outwash plains, kame hills and kettle holes, and deposits of till. At places, depressions on the surface of the drift have been filled in with marine clays. There is a narrow strip of marine clay and sand of recent origin along the present shoreline.

FIELD WORK

Five days, January 11 to January 15, 1945, were spent in the field, during which time observations and notes were made of the distribution and character of the rock and overburden and the extent to which ground water is utilized. As the ground was covered with snow at this time, many exposures could not be examined.

Within the boundaries of Kittery rock exposures are numerous and not far apart. The overburden is relatively thin, clayey in composition, and in places quite bouldery. However, in the western and northwestern parts of Kittery there are several small areas of thicker overburden composed of clay, boulders, and sand and gravel. At one of these locations, Cutts Road (A on fig. 1), the overburden has been utilized for a ground-water supply by the Kittery Water District, as mentioned previously. A gravel-packed well was installed in November 1942. The well yields about 125 gallons per minute from 17 feet of clean sand and gravel, which is overlain by 21 feet of fine sand and clay and underlain by 12 feet of mixed sand, gravel and clay. Bedrock is at a depth of 50 feet. The information supplied by the driller indicates that the static water level was just below the ground level and that the pumping level was 13.5 feet below the ground level on November 16, 1942, when the well was tested. The well delivered 128 gallons per minute during the test but, according to the driller, with increased pump speed 150 gallons per minute could be obtained. The Kittery Water District has put down test wells in other small areas of overburden in the vicinity of Kittery. One such area, Cider Hill (B on fig. 1), along the York River, was test-drilled in December 1941. No other information on this test work is available at the present time.

Relatively thick overburden is indicated by exposures of sand and gravel in an old pit about three-quarts of a mile east of the Kittery-Eliot boundary on State Highway 103 (C on fig. 1). Stratified sands and layers of well-assorted gravel appear in the present face of this pit, which is about 25 feet deep. It is not known whether these sands and gravels extend north to the vicinity of Bartlett Hill. South of the pit is a sloping terrace of sandy clay.

Nearly all the wells in the town of Kittery are "ledge wells"; that is, they penetrate water-bearing fractures below the present bedrock surface. The yield of wells of this type is small, the maximum production in most cases being not more than 5 gallons per minute. The ground water is reported to be hard but of good sanitary quality. Several people reported having heard of wells that produced sulphurous water, but these statements were not verified.

Within the boundaries of Eliot rock exposures are less numerous than in Kittery and areas of overburden more numerous and extensive, particularly between the Piscataqua River and the Boston & Maine Railroad line. A number of fairly large hills such as Bolt Hill, Sunset Hill, and the hills south of Eliot between School No. 2 and School No. 4 are composed of glacial deposits (D on fig. 1). Bolt Hill, on top of which is located the water tank of the Kittery Water District, is composed of sand and gravel. Records of the foundations for the tank, which are not available in this office might shed some light on the character and depth of the overburden. North of this hill the marshy land and gentle slopes seem to indicate that rock

is near the surface or is overlain by clayey till. Ground conditions did not permit closer inspection of the area. South and west of Bolt Hill the overburden is clayey and thin in most places. Rock is exposed at few places along the main road. There are some dug wells in this area that have not been used since the mains of the Kittery Water District were laid.

The east clope of Sunset Hill is quite boulders, and on the west slope there is an excellent exposure of poorly-sorted sand and gravel in an old pit. A small spring-fed brook was observed a little to the north of this pit. In the vicinity of School No. 2 there is a narrow, elongated hill with flat sloping fields to the west and east and a marsh to the southeast. No exposures of the overburden which comprises this hill were seen because of a heavy snow covering over the land surface. However, it was learned from the owners of several farms in this vicinity that exposures of sand and gravel can be seen when the ground is bare. A spring that feeds Stacy Creek, on the south side of this hill, was observed and other springs are known to exist. Wells on nearby farms penetrate bedrock, but no knowledge of the depth to rock or nature of the overburden was available from the owners of the wells. The elongated hills to the east are similar in character, and the narrow throughs that separate them are marshy and fed by short creeks that emanate from springs on the sides of the hills. Clay banks were found at several places along the east bank of the Piscataqua River just above the level of the river.

Between Eliot and South Berwick Junction (E on fig. 1) the area of overburden narrows and rock exposures are found at Gould Corner, where the railroad line cuts through the rock at several places. East of the railroad the overburden is thin and clayey, but to the west it becomes sandy and much thicker and many springs issue from the overburden where it grades into clay along the banks of the Piscataqua River. There are dug wells, "ledge wells," and springs on the farms in this area. None have large yields.

Information on several driven and dug wells in South Berwick was obtained from drillers. This information and an inspection of the terrain indicates that small pockets of glacial drift, from which limited supplies of ground water are obtained, exist between the closely-spaced rock outcrops.

On the New Hampshire side of the Salmon Falls River in northern Rollinsford, rock crops out in many places and encloses small depressions in which glacial overburden has been deposited. Drillers report clay, sand and sandy clay, but very little gravel.

Observations made in a sand pit on the north side of Portland Road about midway between Dover ans South Berwick (F on fig. 1), show a thin layer of clay at the surface, underlain by several feet of clayey sand, below which are sands mixed with pebbles and some gravel at the bottom. A well drilled nearby passed through similar overburden and entered rock at a depth of about 110 feet below the land surface. Dug wells supply water to some of the homes in this area, but wells drilled into bedrock are more reliable. There are many good springs in the southern part of the town of Rollinsford,

particularly between Portland Road and the Salmon Falls River. Several springs on the small neck of land between Fresh Creek and the Salmon Falls River (G on fig. 1) were reported to yield from 25,000 to 55,000 gallons daily. The northernmost springs are reported never to fail, but along the south end of the point the smaller springs disappear during dry periods. The overburden is sandy in most places at the surface and is covered by heavy woods. Exposures along the river banks were poor due to slumping and snow cover, but indicate sandy materials with some clay and occasional lenses or beds of coarse sand and gravel underlain by a hard bouldery clay.

The City of Dover obtains its water supply from wells situated south of Willand Pond (H on fig. 1), which at one time was the source of supply for the city. The small depressions in the vicinity show exposures of sand and gravel. In 1941 a 12-inch gravel-packed well was added to those already in operation. The well is 85 feet deep and is reported to yield 1,000 gallons per minute from gravel. The specific capacity of the well is reported to be about 170 gallons per minute per foot of drawdown.

The City of Somersworth, north of Dover, has installed two gravel-packed wells which have a combined yield of 400,000 gallons daily. The wells are situated in the northern part of the city along the boundary between Rochester and Somersworth (I on fig. 1). The wells are 18 inches in diameter and about 70 feet deep, and pass through fine sand and clay into water-bearing sand and gravel lying on the bedrock, which is at a depth of 70 feet. The water-bearing formation is not very thick, as indicated by the length of

screens used, 2 feet and 5 feet, respectively. Each well is equipped with a turbine pump having a capacity of 450 gallons per minute. The drawdown in both wells is about 16 feet, from a static water level of about 8 feet below the surface.

West of Dover the glacial overburden is extensive and exposures of rock are few. Along the western boundary of Dover, south of the Cocheco River, hills, such as The Hoppers and Fancy Hill, are composed of sand and gravel and flanked by broad, gently-sloping sand plains. No information on wells and springs in this area was collected.

Dover Neck, which lies between Bellamy River and the Cocheco and Piscataqua Rivers (J on fig. 1), is composed mainly of morainal deposits. Rock crops out only at the north end of this neck in the narrow, deep gorge of the Cocheco River. The morainal deposits are quite thick, perhaps nearly 100 feet thick in places. Sand and gravel pits on both sides of the State Highway in the middle of the neck show a thin clayey surface deposit beneath which lie stratified sand and gravel with some clayey sands. A dense hard clay or hardpan underlies the sandymaterial and evidently rests on the bedrock surface. Most of the wells on the neck penetrate bedrock, but a few old shallow wells penetrate the upper portion of the sands just below the topsoil. Clay banks along the water's edge mark the presence of the lower hard clay. No springs were observed on the slopes, but these could possibly exist and not have been seen because of the snow cover. However, well drillers are of the opinion that the sand and gravel deposits on Dover Neck will not yield much ground water.

SUMMARY AND CONCLUSIONS

In Kittery and Eliot the area is studded with rock exposures that are close together. The overburden is relatively thin and in most places clayey at the surface. The isolated deposits of sand and gravel in these areas are small in extent and accordingly it is believed that only limited quantities of ground water can be developed from any one deposit. Although the required supply of ground water probably cannot be withdrawn from any one of the isolated deposits of sand and gravel, it is possible that the required supply could be obtained by developing several of them.

A part of eastern Rollinsford is underlain by relatively thick deposits of sand and gravel, which are the source of numerous large springs. Although these deposits will yield considerable quantities of ground water, it is believed that they cannot produce the entire supply that will be required by the Navy Yard.

Dover Neck does not seem to lend itself to any extensive ground-water development. Although the sandy overburden is thick in places, its areal extent is relatively small and much of the surface is clayey. Further, the neck is nearly surrounded by tidal water, which is a possible source of salt water and other contaminating agents.

In the region covered by the reconnaissance, the most favorable area lies west and north of Dover. Extensive deposits of highly permeable glacial outwash sand and gravel occur in this area. Wells that tap this material yield as much as 1,000 gallons per minute. For a number of years the public water supply for several of the cities in the area has been withdrawn from the glacial outwash.

The purpose of the reconnaissance was to determine briefly the ground-water possibilities in the region north and west of the Navy Yard. In view of the request for a prompt statement on the general possibilities, the area was covered hurriedly, under difficult field conditions, and therefore exact quantitative estimates of the available ground-water supplies cannot be given. A more intensive investigation, supplemented by a program of test drilling, should be made before a decision is made as to a site or sites for development of a ground-water supply sufficient to meet the needs of the Navy Department.