RAISING PUTNAM LAKE DAM,

Greenwich, Conn.

By Sheldon E. Minor, Mem. Conn. Soc. C. E.

The Greenwich Water Company, which supplies water to the town of Greenwich and to the villages of Port Chester and Rye, New York, obtains its supply from three different sources:

Putnam Lake, an impounding reservoir on Horse Neck Brook, has a water shed of 1¾ square miles and a storage capacity of 570 million gallons.

Rockwood Lake, an impounding reservoir on the west branch of Brothers Brook, has a water shed of 1 square mile and a storage capacity of 460 million gallons.

By means of a diversion dam known as Brush's Dam, on Pipen Brook, a branch of the Mianus River, the water from a shed of $1\frac{7}{10}$ square miles is diverted into Rockwood Lake through a 20-inch cast iron main. The storage of the reservoir formed by Brush's Dam is only about 14 million gallons.

Putnam Lake is located about 4 miles directly north from the Borough of Greenwich and has a flow line elevation of 300 feet above mean low water of Greenwich Harbor.

Rockwood Lake is about ¼ of a mile northeast of Putnam Lake, has a flow line elevation of 326 feet and the water can be drawn directly into Putnam Lake through a 20-inch cast iron main laid through the ridge dividing the water sheds.

Brush's Lake is about 2 miles northeast of Rockwood Lake and has a flow line elevation of 362 feet. The connection with Rockwood is through a main of 20-inch cast iron pipe.

The Greenwich Water Co., formed about 1879 by four wealthy residents of Greenwich, primarily to obtain water for their own use and incidentally to supply any of their neighbors who might be persuaded to overlook their prejudices in favor of wells, has had the usual experience of water companies in growing communities and its history has been a continuous race between supply and demand, with demand often in the lead.

Putnam Lake was built in 1880 with a storage of 190 million gallons, and the owners believed that they had an unlimited supply for all time. In 1888 the dam was raised 5 feet and the storage increased to 280 million gallons.

Rockwood Lake was built in 1893 with a storage of 360 million gallons; the dam was raised 3 feet in 1906, increasing the storage

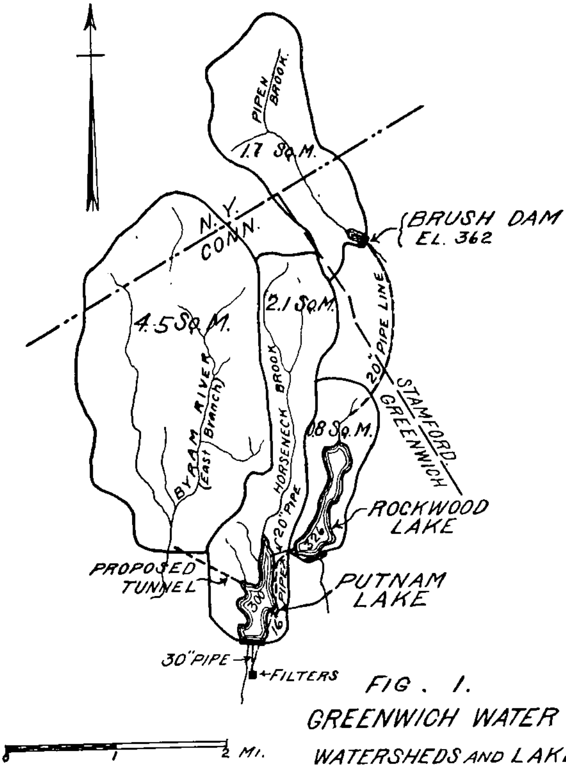


FIG. 1.
GREENWICH WATER CO.
WATERSHEDS AND LAKES.

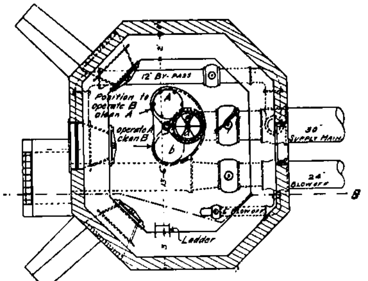
to 460 million gallons, and the dam at Brush's built to divert the waters of Pipen Brook into Rockwood Lake.

At this time it was evident that additional sources of supply must be developed and plans were made to raise Putnam Lake dam 9½ feet to elevation 300, increase the storage to 570 million gallons and divert into the lake the water from 4½ square miles of the water shed of the East Branch of the Byram River through a tunnel about 4000 feet long. This would give the company a storage of more than 1 billion gallons and a tributary water shed of about 9 square miles. Owing to delays connected with the right of way and riparian rights the tunnel has not been built, but it is hoped to have it completed during the coming year.

Figure 1 shows the relative location of reservoirs. As a rule water is drawn from Putnam Lake direct to the filter plant located about ¼ of a mile below the dam, but in case of emergency it can be drawn direct from Rockwood Lake through a 16-inch main, laid from the 20-inch main connecting the two lakes, along the east shore of Putnam Lake and connecting with supply mains just below the dam. The inlet pipes through the dam into the gate house were so located and so small that they could not at times furnish the amount of water required and it was decided that it would be better to build a new house than to make the necessary additions and alterations to the old one.

The new gate house is located on the inside toe of the dam, is hexagonal in shape, built entirely of concrete and has maximum inside dimensions of 11 feet by 13 feet 6 inches. Equipment comprises a 24 inch blow-off pipe, 30 inch supply pipe with 12 inch by-pass, 3 inlet openings at different levels, each opening 24 inches by 36 inches, 2 cylinder screens and the fixtures necessary for operating valves and screens.

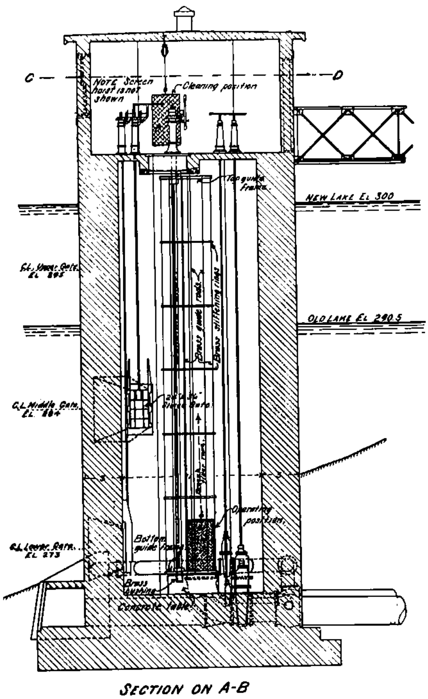
During the summer months the demand for water required the use of supply mains from both lakes and construction was not begun until October of 1909, when the amount of water necessary could be supplied by the emergency main from Rockwood Lake. Putnam Lake was emptied and the gate house foundations put in without a coffer dam. While the expense of the dam was saved, it was not clear gain, as cold weather came before the work could be finished and extra precautions were necessary to avoid frozen concrete and frozen material for refilling the cut made through the dam for laying the new waste and supply mains. Concrete was mixed 1:2½:5 for foundation and 1:2:4 for walls, operating floor and roof. Foundation, floor and roof were reinforced with twisted steel rods. Walls were not reinforced, and were 3 feet thick from foundation to operating floor and 1 foot thick from floor to roof. The arrangement of screens is different from that usually adopted and has proved so satisfactory in operation that a description may be of interest to those con-



SECTION ON C-D
WITH FLOOR OF GATE HOUSE REMOVED.
FIG. 2.

0 5 10 15 FT

PUTNAM GATE HOUSE.



SECTION ON A-B
FIG. 3.

0 5 10 15 FT

PUTNAM GATE HOUSE.

nected with water supply engineering and management. The supply main is brought through the floor of the gate house by a quarter bend so laid that the opening is parallel to and about 1 foot above the floor. Surrounding the pipe is a concrete table with top just below top of supply pipe. A 3-inch steel shaft suspended from a stand on the operating floor extends down into a socket 5 inches deep in the concrete table. A ¾-inch cast iron plate, faced on the bottom with a ¼-inch brass plate, is attached to the shaft so as to just clear the mouth of the supply main. The plate has two circular openings of same diameter as the supply main. Attached to plate are duplicate guide frames extending to under side of operating floor. Each guide frame consists of 6 vertical brass bars 1 inch square and held together by 1½-inch by ¾-inch brass rings spaced 5 feet apart. The screens are cylinders four feet long, 2 feet in diameter and made of brass wire cloth on a brass frame. Screen wires are No. 14 Stubs gauge and laid 3 to the inch. Screens are counter weighted and raised and lowered by ropes leading from hoists on floor of operating floor over pulleys hung in the roof. Screens are changed by turning the shaft and the opening in supply main is at all times covered by a screen or the plate supporting the screen guides. Figures 2 and 3 show sections of gate house and method of operation of screens.

Before raising the dam it was necessary to stop a considerable leakage that came through the side walls of the spillway, which was faced with ashlar masonry and located in the dam about 75 feet from the westerly end. This was accomplished by excavating, while the lake was dry, a trench to rock for the full length of the spillway and for 10 feet on each side and backing up the old rubble masonry core wall with a concrete wall from 2 to 2½ feet thick. No leakage showed when the lake filled. The dam was of earth with a rubble masonry core wall, and at elevation 290.5 was 560 feet long, 25 feet high, 15 feet wide on top, inside slope 2 feet horizontal to 1 foot vertical, and outside slope 1½ feet horizontal to 1 foot vertical. As raised to elevation 300 it is 640 feet long, 34½ feet high, 30 feet wide on top, inner slope 1¼ feet horizontal for upper 15 feet and 2 feet horizontal to 1 foot vertical for the balance, outer slope 2 feet horizontal to 1 foot vertical. As the outer slope was finished a filling largely of stones was placed along the toe for a width of 30 feet and to

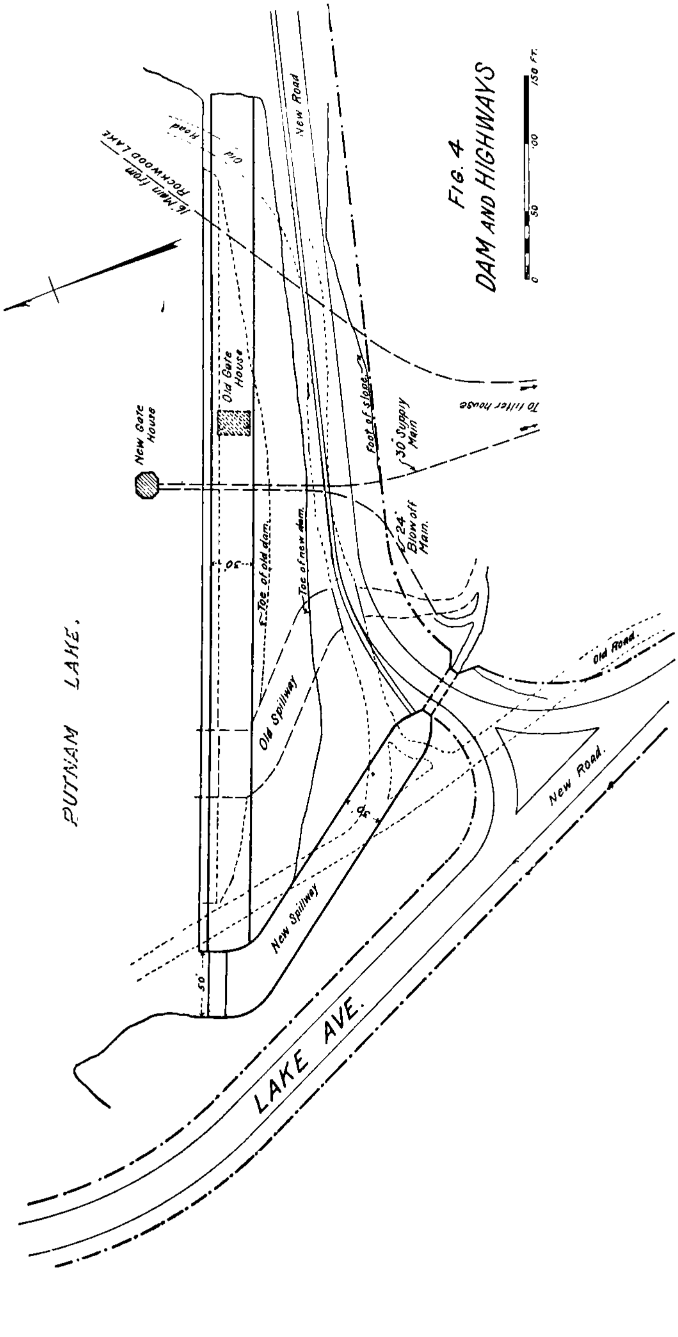


FIG. 4
DAM AND HIGHWAYS

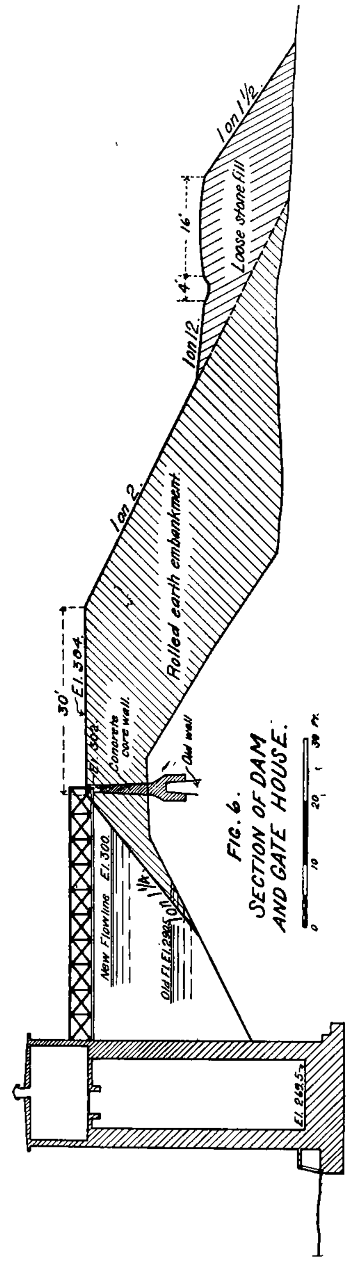


FIG. 6.
SECTION OF DAM AND GATE HOUSE.

elevation 286, forming a berm on which is located the public highway.

The area to be covered by the new embankment was stripped to hard bottom of all vegetable matter, loam and soft material. New material was spread in 4-inch layers, cleared of all stones exceeding 2 inches in diameter, dampened when necessary and thoroughly rolled. A weighted grooved roller drawn by horses was first used, but the work was not satisfactory and the contractor substituted a 10 ton steam roller with much better results.

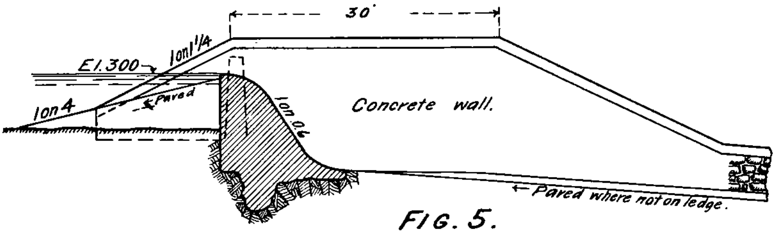


FIG. 5.
SECTION AT SPILLWAY.

Places inaccessible to the roller were thoroughly tamped with iron tampers. The core wall was carried up to the new grade with concrete mixed 1 : 2½ : 5 and tied to the old wall with concrete wings lapping down in inverted U form for 3 feet on each side. The old spillway was abandoned and a new one built at the extreme west end of the dam. The new spillway has a concrete rollway and wing walls and discharges into a channel which joins the brook about 200 feet below the dam. On the inner slope the old riprap was removed to a level 4 feet below the old flow line. The new riprap 18 inches thick and carefully placed started at that level and was carried up on a slope of 1¼ horizontal to 1 foot vertical. No flatter slope could be used on account of the position of the core wall. Enquiry will be made as to why the dam was not widened on the inside sufficiently to allow the usual 2 or 2½ to 1 slope. This could not be done with water in the lake, and if water had not been in the lake at that time it would have been advisable for the officials of the company to reside at a considerable distance from Greenwich. Another way would have been to build practically a new dam, with a new core wall built up from the foot of the old dam and using the old dam entirely on the inside slope of the new work. This would have involved a large increase in cost both for construction and land damages.

The lake did not fill until December 1911 and has been covered with ice, so there has been little opportunity to note the effect of the wave action developed on a water surface about 1 mile long. It may be necessary to grout the riprap with concrete.

The gate house was designed by Mr. C. A. Ferry of Mr. A. B. Hill's office, and the entire work was carried out under the direction of Mr. Hill as consulting engineer.

DISCUSSION.

MR. MCKENZIE: One question occurred to me with reference to the capacity of those two reservoirs. The capacity of the reservoirs was so enormous in proportion to the shed that I wanted to be sure what you said the capacity of the shed was.

MR. HILL: The total contributing water shed is 4.7 square miles. The total storage 1,000,000,000 gallons.

MR. MCKENZIE: Wouldn't you think that that was a rather unusual capacity for that proportion of shed?

MR. HILL: Yes, but that is all the supply they had, and the reservoirs were somewhat exceptionally large in order to provide for the saving of the water. No water has gone to waste there in two or three years.

MR. MCKENZIE: I noticed that the proportion was very large.

MR. HILL: The reservoir did not fill the year before this. It was very dry the latter part of the season. Both reservoirs are very nearly full now.

MR. MCKENZIE: Have you some blue prints there?

THE PRESIDENT: Yes, we have some blue prints here if anyone wishes to look at them.