SELECTION OF EQUIPMENT FOR CLOVE PUMPING STATION, STATEN ISLAND SYSTEM[1]

By William Flannery[2]

The Clove Pumping Station is located on Victory Boulevard and Ontario Avenue about three quarters of a mile south of the Silver Lake Reservoir in the Borough of Richmond. It serves a district at the northerly end of Staten Island, comprising a high pressure area of some 7 square miles and an intermediate pressure zone of more than 4 miles in extent. Within the limits of this territory, the elevation of which places it beyond the reach of service from the main reservoir at Silver Lake, are several of the most desirable and more highly developed residential neighborhoods of the borough.

The original steam driven station, which was located adjacent to the present one was built in 1886 and operated by a private company in conjunction with the development of driven wells up to 1902, at which time it was taken over by the city.

In 1923, it was decided, rather than replace or enlarge the wells, the yield from which had been steadily falling off, to convert the station into a booster connecting the suction to the Catskill service, which was available at 30 pounds per square inch.

Shortly thereafter, it was agreed that repairs or replacements either of the frame structures that housed the station equipment, or of the equipment itself which was composed mainly of units that had already given their best service at some other station before being transferred to Clove, would not be practicable.

The new station, which was to occupy a site adjacent to the old one, would be called upon to provide the following service, drawing its supply from a 24-inch main in which water from Silver Lake Reservoir at 30 to 35 pounds per square inch was available.

THE HIGH PRESSURE ZONE

A quantity of water, averaging 3.5 to 4 m.g.d., was needed at a pressure of approximately 135 pounds pressure per square inch,

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ranging in delivery rates throughout the day from 2.5 to 5 m.g.d. The variation in the draft is of particular moment since the standpipe on the high pressure system cannot be expected to carry the service unaided for more than an hour at the 3 m.g.d. rate.

THE INTERMEDIATE ZONE

An average of 350,000 g.p.d. was needed at a pressure of 55 pounds per square inch. The capacity of the intermediate district reservoir being 2.5 m.g. renders the time and date of pumping to replenish it subject, to a great degree, to the choice and convenience of the operating force.

In comparing the different types of equipment from which a selection was to be made it was assumed that the station would have three pumping units for the high service and one for the intermediate. Each of the pumps would have a capacity of 3 m.g.d. One of the high service pumps was to be considered as a spare. No reserve pumping unit was provided for the intermediate service since this could be taken care of in emergency by bleeding from the high.

Four types of drive were considered, viz., electric, motors, steam turbines, gas engines and Diesel oil engines. The comparative costs of several types are shown in table 1.

The figures in table 1, which were computed in 1923 before it had been determined to abandon the wells and convert the station to a booster, were based upon a driven well installation having a total head of 313 feet on the high service and 134 feet on the intermediate. It was assumed that the station would deliver six millions on the high and three millions on the intermediate for 365 days in the year.

The high operating cost for the electric driven station was due to the inability of the department at that time to procure a better rate than 5 cents per kilowatt hour from the light and power company serving the borough.

In August, 1925, bids were taken on a Diesel driven station of four pumping units designed for booster service. Before the award was made, however, the Staten Island Edison Corporation which had taken over the properties and franchise of the Richmond Light and Power Company, and was engaged in a vigorous campaign for additional power load, offered to serve the City with current on the basis of $75.00 per year per horsepower of demand. This rate has worked out in practice to an average of 1.27 cents per kilowatt hour. It is interesting to note that, if we substitute this rate for the 5 cent rate

in the figures previously made for the electric station, it alters the costs to read as follows:

Total operating cost	$71,314
Cost per million foot gallons	0.085693
Cost per million gallons	$21.72

TABLE 1

Comparative costs of motive power

TYPE OF EQUIPMENT	MOTOR DRIVEN	STEAM TURBINES	GAS ENGINES	OIL ENGINES
Ground and buildings	$40,580	$93,916	$110,845	$71,670
Equipment	34,549	128,087	138,460	132,465
Total first cost	75,129	222,003	249,305	204,135
Fixed charges (15 percent of first cost)	11,269	33,300	37,395	30,620
Fuel or current	187,000	36,200	19,500	28,600
Labor	9,264	24,318	24,318	16,792
Lubricants	525	600	1,697	1,932
Miscellaneous	880	2,300	2,300	1,590
Maintenance and repairs, 2.5 per-cent	1,878	5,550	6,233	5,103
Operating charges	199,547	68,968	54,048	54,017
Total operating costs: viz., operating charges plus fixed charges	210,816	102,268	91,443	84,637
Million foot gallons	832,200	832,200	832,200	832,200
Million gallons	3,285	3,285	3,285	3,285
Cost per million foot gallons	$0.25332	$0.122888	$0.109881	$0.101702
Cost per million gallons, dollars	64.18	31.13	27.84	25.76

Round figures, in dollars

	ELECTRIC	STEAM	PRODUCER GAS	OIL
Total investment	75,000	222,000	249,000	204,000
Total annual cost, fixed and operating charges	211,000	102,000	91,000	85,000
Cost per million gallons	64	31	28	26

With this rate in view the plans for both buildings and equipment were redrawn and work on a contract for an electric driven station was started in May, 1927. The station went into service in August, 1928.

The equipment as at present installed and operating is as follows.

Three high service centrifugal motor driven units designed for a total lift of 254 feet: The pumps are of the 2-stage type of 3 m.g.d. capacity each, direct connected to a 200 h.p., 440 volt, 60 cycle, 3 phase, slip ring motor. The normal full load speed of each motor is 1165 r.p.m.

One intermediate service pump designed for 70 feet lift and 3 m.g.d. capacity, driven by a 60 H.P. motor of type similar to the above: This pumping unit is made up of two separate pumps mounted on the same shaft, operating in parallel and designed to permit their being later run in series in the event that it is decided later to substitute a zone of some higher pressure to replace the present intermediate one.

One 4 m.g.d. centrifugal pump operating at 490 r.p.m. designed for a total lift of 254 feet and driven by a 300 H.P. marine type gasoline engine: The gasoline driven reserve unit has been installed to provide pumping facilities in case of failure of electric service.

The question of continuity of service was considered of first importance in the design of the station. With this end in view the Edison Company has installed duplicate sets of three transformers to serve the station. The current reaches these at 6600 volts from the Livingston power station through three main feeders. Two of these come direct from the main station at Livingston, while the third is connected to the Atlantic substation where, through a breakdown connection, reserve current from the Public Service Corporation, N. J., is available.

The Staten Island Edison Company's orders, in the event of a breakdown, call for first preference in service to be given to the main line electric transportation and municipal water supply.

The pumpage at the station during the first five months of 1929 has averaged 2.626 m.g.d. on the high service and 0.362 m.g.d. on the intermediate service. The kilowatt hours consumed during this period have averaged 104,160 per month, the average monthly cost for current being $1,324.53.

In connection with the question of continuity of service it is interesting to note that, while there have been several interruptions during thunder storms, there has been no time when the station was shut down for this cause for more than seven minutes.