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THE PROPOSED NEW CROTON LAKE DAM AND THE NEW CROTON LAKE.

The New York Croton Aqueduct Commission, consisting of the Mayor, Comptroller, and Commissioner of Public Works, of the city of New York, and of four other commissioners, at a meeting held January 22, 1891, adopted a resolution for the preparation of plans for the construction of a dam upon the Croton River valley below the present Croton dam and at or near what is known as the Cornell site, a short distance above Quaker Bridge. The meaning of this resolution is that the construction of the famous Quaker Bridge dam is to be abandoned and a substitute therefor, situated some distance further up the stream, is to be built to provide additional storage capacity in the Croton River valley. The newly proposed dam is the outcome of a discussion in which different engineers took opposite views as to the future water supply of the city, and a compromise between the conflicting opinions is afforded by it.

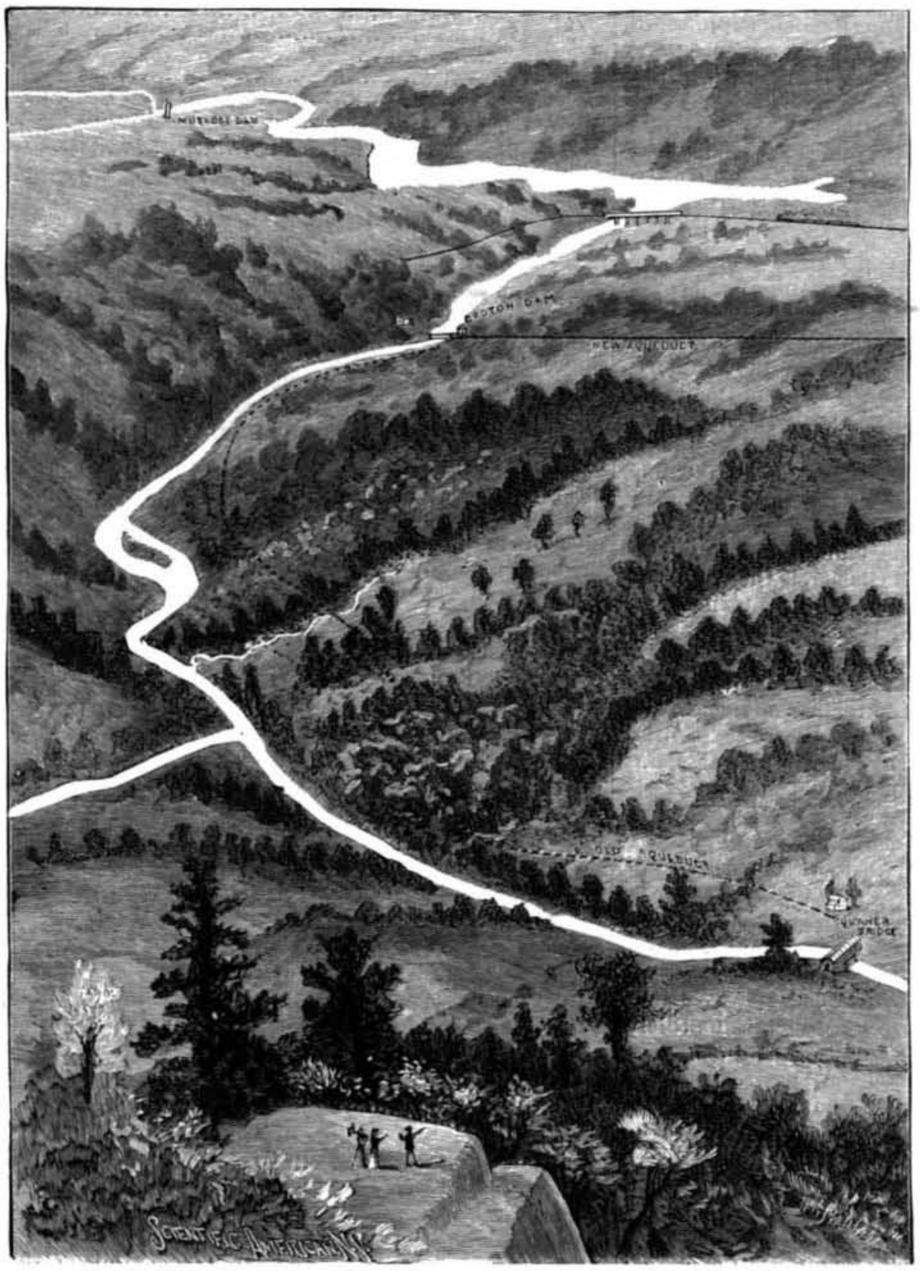
For immediate water supply the city of New York is dependent on the old Croton dam. This structure, 400 feet long and 50 feet high, was in its day considered quite an engineering achievement. It is composed partly of earthwork and partly of masonry. The earthwork portion has no masonry core. It has its foundation upon hard pan, and in its construction a considerable amount of wooden cribwork was employed. As an additional provision for water supply several reservoirs are completed and in process of construction upon the upper branches of the Croton River; but these are to have no connection with the aqueduct except by way of the present Croton Lake. Their purpose is simply to impound water that would otherwise run to waste over the apron of the Croton dam.

The absolute dependence of the city upon the original dam is thus made clear. If any accident were to happen to it, the supply of water would be at once cut off. The washing away of the South Fork dam, with the ensuing destruction of Johnstown, and the carrying away of many other dams before and since that memorable disaster, have occasioned some fears to be entertained for the safety of the Croton dam. It has stood intact for fifty years, and in all that time the water has never passed over the earthwork crest. Yet if this should occur, the dam would quickly be destroyed.

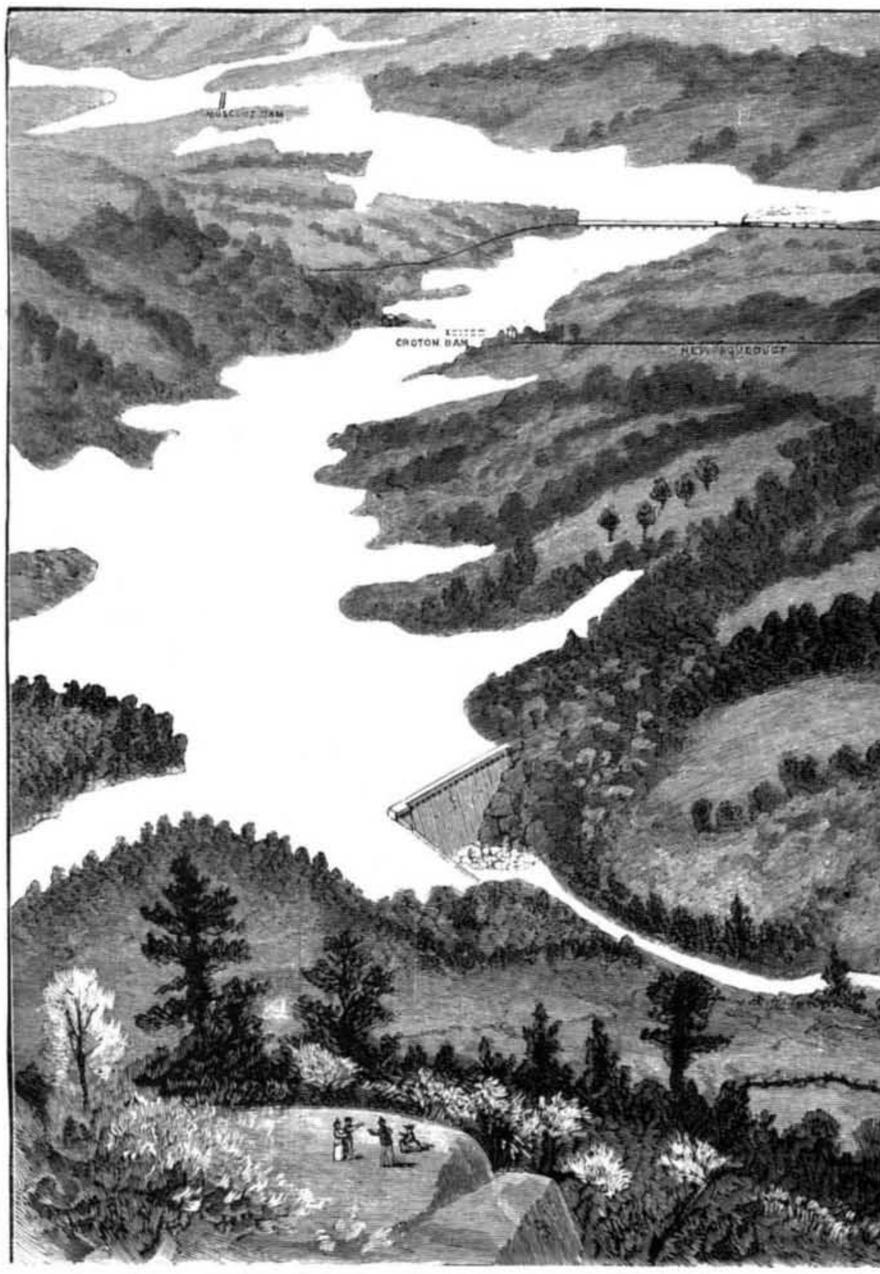
Estimates astothe rain fall that would be required to overtop the crest of the earthwork make it probable that a rainfall of nine inches, or even much less, under certain conditions, in twenty-four hours, would place the security of the dam in doubt. If the earthwork portion was washed away, it is probable that a part of the masonry would also succumb; but even if this did not happen, a gap one hundred and twenty-five feet long would be left, through which the flow of the river would pass, and New York would be without water until that gap could be filled. How long it would take to reconstruct this portion of the dam cannot be exactly stated. It is certain that it

(*Continued on page* 389.)

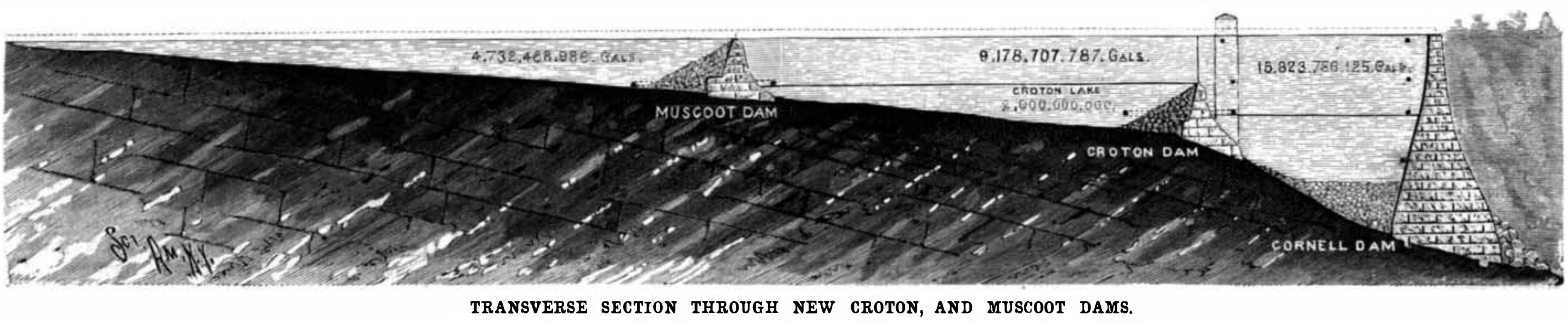
CAPACITY OF LAKES COMPARED.



PRESENT APPEARANCE OF CROTON RIVER AND LAKE.



LAKE FORMED BY PROPOSED DAM NEAR THE CORNELL SITE.



TRANSVERSE SECTION THROUGH NEW CROTON, AND MUSCOOT DAMS.

EXTENSION OF WATER SUPPLY SYSTEM FOR NEW YORK.

THE PROPOSED NEW CROTON LAKE DAM AND THE NEW CROTON LAKE.

(Continued from first page.)

would be a work of time—rather of weeks or of months than of a few days.

If the Quaker Bridge dam were built, the present Croton dam would be submerged beneath 34 feet of water, and would cease to be an element in the water supply of the city. Mr. A. Fteley, chief engineer of the Croton Aqueduct Commission, recognizing the possibility of failure of the Croton dam, and the requirement of additional storage, proposed the construction of a dam about one mile below the site of the present Croton dam. This structure, owing to the contour of the country and the nature of the subsoil, would be far less expensive than the Quaker Bridge dam. It would retain a much smaller quantity of water, and would but slightly increase the present watershed. But by making its crest correspond in level with the crest of the proposed Quaker Bridge dam, the present watershed would be far more thoroughly utilized, and Mr. Fteley calculated that such a dam would provide for the wants of the city for thirty years to come, and that the saving in cost over the Quaker Bridge dam would, with the associated saving in interest charges, represent enough money to build the larger structure if even then it should be required, thus giving the city two dams instead of one for the same cost.

After much discussion and the rendering of different reports, the compromise structure situated in the vicinity of the Cornell site was determined upon. As a matter of interest the following data may be examined, showing the relations of the abandoned Quaker Bridge project and of the proposed Cornell site dam:

of the rest, giving an aggregate of thirty thousand millions of gallons available for the city.

Tracing the lines of the Croton River and its tributaries, the two most remote reservoirs of the old supply are the "Boyd's Corners" and "Middle Branch," respectively. These represent a watershed of 43·76 square miles. The new dam on the Cornell site will represent a watershed of 332·52 square miles. In area this is 22·28 square miles in excess of the watershed tributary to the present Croton dam. But the advantage due to its greater height in rendering possible a fuller utilization of this great area is the point strongest in the favor of the new dam.

The selection of the Cornell site in preference to the Quaker Bridge site is due to a full examination of the country. An extensive series of drill holes, aggregating 14,005 lineal feet in length, together with test pits and trenches, have been made to determine the location of the country rock. At the Cornell site the rock is 123 feet below the surface, an advantage of nearly 40 feet over the Quaker Bridge site. The side hills from the point of view of imperviousness seem superior to those at Quaker Bridge. The dam may be made partly of earthwork, and its construction is recommended on that basis. The watershed is only one and one-half square miles less than at Quaker Bridge.

Concrete Walls and Piers.

Mr. T. Martin says that some substances, such as pozzuolana—a volcanic production found chiefly in Italy—have, in consequence apparently of silicate of alumina being predominant in their composition, the property of giving hydraulic qualities to the rich or non-hydraulic limes. It is of these that the concrete is made which has long been used for marine works on

Location.	Extreme Height above River Bed.	Extreme Depth below River Bed.	Extreme Total Height.	Length of Dam between Flow Lines.	Capacity in Gallons.	Estimated Cost.			Probable Time of Construction.	Watershed above Dam.
						Dam Proper.	Railroads, Roads, Bridges, and Clearing.	Muscoot Dam, as Previously Estimated.		
	Feet.	Feet.	Feet.	Feet.					Years.	Sq. Miles.
Quaker Bridge......	180	91	271	1,402	34,000,000,000	$4,087,000	$1,075,000	$300,000	6	377·8
Cornell's..	159	70	229	1,736	30,000,000,000	3,650,000	1,075,000	300,000	5	376·3

Should either dam be built, the proposed Muscoot dam must be built also, in order to preserve as far as possible a uniform level in the limits of the town of Crotona.

In this connection it should be noted that the dam proposed by Mr. Fteley, to be constructed about a mile below the present Croton dam, would have cost, if partially made of earthwork, but $1,750,000, and would have provided for a storage of 16,000 millions of gallons.

The necessity for the new dam is not only due to the possible insecurity of the present structure. An immense quantity of water goes to waste over the Croton dam, owing to the area of the watershed tributary to it. During the dry season of 1890 a rain storm occurred after much water had been drawn from the storage basins. Yet the single rain fall was enough to produce a heavy waste, which, at a rate of over 600 millions of gallons per day, flowed over the Croton dam. The same shower produced but little increase in the upper reservoir. In other words, we are really losing the advantage of much of the best portions of the Croton River watershed. The area lying between the upper storage basins and the Croton dam is very insufficiently utilized.

The present Croton Lake is a long, narrow body of water, suggesting in its appearance a wide river. The Cornell dam will change all this and will create a wide and long lake of great size. The large illustration shows the condition of things at this time contrasted with the features to be established by the creation of the proposed new storage basin. In place of the present Croton Lake, with its capacity of about 2,000 millions of gallons, and of the insignificant stream from its overflow, an immense wide sheet of water appears extending far back into the country, submerging Croton dam and part of the line of the old aqueduct and extending a long distance back of the Muscoot dam site. The sectional drawing shows the relative heights and capacities of the elements of the proposed new system. The vertical measurements, it will be understood, are necessarily greatly exaggerated in this cut, its object being to present to the eye the whole situation at a glance. The relative capacities of the present and of the proposed Croton Lake are about as 1 to 15, as shown on the small cut.

Referring again to the sectional drawing, it will be seen that in place of the limited storage, about two thousand millions of gallons, of the old Croton Lake, an available storage of some twenty-four thousand millions of gallons is provided below Muscoot dam. A large body of water must always remain at the lower levels below the outlets which will be unavailable. The by-pass of Muscoot dam will, in case of necessity, enable its body of impounded water to be made a part

the shores of the Mediterranean, and, indeed, the piers at some of the Italian ports have been constructed almost entirely of hydraulic concrete. The author had lately an opportunity of examining at Genoa the extension of one of the moles of the harbor, the inner side of which has a vertical wall. The latter was in process of being constructed under water entirely of pozzuolana concrete, simply thrown into the sea from baskets carried on men's heads, a boarding confining it to the shape of the wall. In a short period it set quite hard, so as to enable the upper part of the wall, which is of stone, to be built upon it. The outer side of the mole, which had been previously made, was formed by stones deposited "a pierre perdue." Though the depth of the quay wall was not great, this shows the confidence which the Italian engineers have in concrete applied under water in a soft state. The piers of the new basin constructed by the Austrian government at Pola, in Istria, are also formed, in a similar manner, of concrete confined between rows of timber piling.

But perhaps the most striking application on a large scale of pozzuolana concrete is in the great mole which protects the port of Algiers. To form the mole, blocks of beton of immense size, so as to be immovable by the force of the sea, were employed. Some of these were formed *in situ*, by pouring the concrete into large timber cases without bottoms, sunk in the sea in the line of the mole. Other blocks of a smaller size, though upward of 30 tons in weight, were made on shore, being moulded in strong wooden boxes. After the beton had set, the boxes were removed, and the blocks were launched into the sea to find their own level. The beton for the blocks *in situ* was composed of one part of rich lime in paste, two parts of pozzuolana, and four parts of broken stone; that for the blocks made on shore was formed of one part of lime in paste, one part of pozzuolana, one part of sand, and three parts of broken stone. These blocks set sufficiently hard in twenty-four hours to resist the shocks of heavy seas, and the mole now stands firmly, instead of being, as it was when formed of loose blocks of stone in the time of the Moors, nearly destroyed every winter.

The French engineers have shown great boldness and skill in the application of beton. as exemplified in the Pont de l'Alma over the Seine, the arches of which, as well as the piers, are formed of rubble concrete, in the new graving dock at Toulon, before alluded to, and in the formation or protection of breakwaters by enormous artificial blocks of beton, as carried out at Marseilles, Cherbourg, La Ciotat, Cette, Vendres, Cassis and Algiers. A short time ago, when the author inspected the mole or breakwater which incloses the harbor of Marseilles, he found the huge rectangular concrete blocks, weighing upward of 20 tons each, by which its seaward side is protected on the "pierre perdue" principle, perfectly entire and sharp in their outline, though they have been exposed for many years to the action of the sea. Any one standing upon that mole, and witnessing in a gale the heavy seas breaking with tremendous force on these concrete masses and recoiling harmlessly, could have no doubt as to the efficiency of concrete as a constructive material.

Hydraulic concrete, to be effective, requires care and attention in its manipulation, and in the regulation of the proper proportions of its materials. Any failures must have arisen from inattention to these or similar points, as there is ample experience to show that, when properly made, every confidence may be placed in its strength and durability. Even where stone is abundant, this material may be often employed with economy and advantage, but where stone cannot be obtained, the importance of being able to form an effective substitute out of materials of so little value, and so widely distributed, can hardly be overrated.

Lime Sulphate.

This substance is one of the most annoying and injurious of all those held in solution by water used for making steam. Some waters, especially those from limestone districts, contain it in such large quantities that its use in boilers becomes a real source of danger. The peculiarity about this substance is that the colder the water, the more of it will be held in solution, and this is not the case with a great number of substances which are soluble in water, for the higher the temperature, the more will be dissolved and held in suspension by the water. Water of ordinary temperature may hold as high as 7 per cent of lime sulphate in solution, but when the temperature of the water is raised to the boiling point, a portion of it is precipitated, leaving about 0·5 of 1 per cent still in solution. Then as the temperature of the water is raised, still more of the substance is precipitated, and this continues until a gauge pressure of 41 pounds has been reached, which gives a temperature of about 290 degrees. At this point all the sulphate of lime has been precipitated. Many other scale-forming substances act in a similar manner.

This shows quite plainly that any temperature that can be produced by the use of exhaust steam would not be sufficient to cause the precipitation of all the substances which might be contained in the water. But the highest temperature that can practically be obtained from the use of exhaust steam would be about 250 degrees; and this is far above the average practice, as to obtain this temperature a back pressure of about 14 pounds would be required, so it will be seen that the water still contains a sufficient amount of sulphate of lime and other matter to cause a perceptible amount of scale to form in the boiler. Most of the substances which go to form boiler scale follow a similar law in this respect, so that nearly all of them are precipitated from solution when the temperature reaches that point due the pressure of steam commonly carried, but in some cases even that is not sufficiently high to cause the total precipitation of all such matter, but the conversion of water into steam leaves these salts free, and as the water can hold no more in solution, they are precipitated in the form of granules or dust and kept in circulation in the water until they find an eddy and become deposited in some part of the boiler, or as the boiling ceases, the water still retaining its temperature, the sediment settles on the top of the tubes and on the boiler plates, from which place only a portion of it is dislodged when the boiling again takes place. Some of these substances when alone form a hard crystalline scale, while others are deposited as loose matter, and still other substances when they are deposited together combine and form a different kind of scale. As the greater proportion of these scale-forming substances are precipitated when the water is at a very high temperature, it would seem quite natural that they might be removed or prevented from entering the boiler by the use of a live steam heater. This it is asserted is the case where such devices are in use.—*G. H. West, in Stationary Engineer.*

A NOVEL plan for extinguishing a church debt has been hit upon in Melbourne. The church committee —or vestry, as the case may be—divide the total debt among themselves and each man insures his life for the amount that falls to his share. The policies are transferred to the church, and the annual payments on them are made out of the collections. Then, of course, as the members of committee "drop off," the sums insured on their lives drop in, and later, when the last committeeman is dead, the last installment of the church debt will be paid. The plan has the merit—if merit it be—of throwing the whole of the responsibility for the continuance of the indebtedness upon Providence.

SULPHATE or chloride of zinc dissolved in water is a good disinfectant.