Showing bed of Hudson inside the dam after water was drained off.

NEW MUNICIPAL PIERS A TRIUMPH OF ENGINEERING

Giant Cofferdam Built to Hold Back Hudson for 800 Feet While Construction Is in Progress

GREAT interest was excited among engineers a year ago by the announcement that in constructing the new 1,050 foot piers between Forty-fourth and Forty-sixth streets the Dock Department planned to hold the Hudson River at bay for a shore length of nearly 800 feet by means of a dam of exceptional size. The project has now been carried out. The cofferdam has been built and the enclosed basin has been drained of its 55,000,000 gallons of water. The structure is unique in its effectiveness, as well as in its dimensions, for it is fulfilling its mission with a measure of thoroughness not before accomplished in any similar undertaking.

The piers to be built now include the whole of the first and one-half of the second of the 1,050 foot group of piers that will form berthing spaces for the biggest of transatlantic liners. It was found when the riverward limits were fixed by the United States army engineers that for the slips enough water could be obtained near the shore only by extensive excavating of underlying rock.

Experience had proved work of this sort to be extremely costly and at best it meant that jagged surfaces would be left projecting upward. With ocean liners costing millions of dollars and so heavy that their least contact with rocky projections would rip their steel skins Dock Commissioner Smith wisely decided to eliminate that peril and at the same time to cheapen the cost of the quarrying operations.

Accordingly, after careful study of what was done by the United States Government in the case of the refloating of the wreck of the old battleship Maine and the Black Rock harbor improvement in the Niagara River Engineer Charles W. Staniford of the Dock Department decided to have recourse to a steel spined cofferdam patterned after the examples set by the Government undertakings. But even so he had to contend with a far more serious problem than that presented at Havana or at Black Rock.

In the case of the Maine the hulk was surrounded by an elliptical cofferdam made up of a series of circular units of steel sheet pilings with their cavities loaded with mud. The very form of this enveloping wall made it possible to shore the various elements by heavy beams canted against them from within the space to be drained and also at certain points to tie the cofferdam units by braces spanning the minor axis of the ellipse from side to side. With all of these precautions it was found necessary radically to modify the design of the cofferdam during its building, entailing a total outlay of $785,774 instead of the original estimate of $300,000.

In the case of the Black Rock cofferdam the constructors had to contend with water of moderate depth, while at Havana the bottom lay thirty-seven feet below the surface of the water. In New York the task was to provide against a head of sixty-eight feet and the enormous hydrostatic pressure that would be exerted against the bulkhead by the river when the supporting water within the enclosure was withdrawn. It was necessary not only to hold the river at bay above the Hudson's bed but also to arrest leakage through the underlying silt and sand.

At the Black Rock harbor site three fifteen inch pumps were kept continually going in order to neutralize the leakage, and at Havana ceaseless pumping was also required to prevent the water from flooding the enclosed area after its draining. To-day the New York cofferdam space is dry; the leakage is substantially nothing.

The achievement was not due to chance; it was the result of careful planning. Engineer Staniford could not count upon the self-supporting factor of an elliptical cofferdam. He had to provide for substantially a straight bulwark against the Hudson, and, with water nearly twice as deep as that at Havana, he had to make sure that his work should be strong enough to resist the river's frontal and subterranean attack.

Therefore the Black Rock and Havana projects were only suggestively valuable, showing how interlocking sheet pilings of steel could be used better than those of wood, and Mr. Staniford soon realized that he would have to steady his steel core with ramparts or slanting supports of riprap or broken stone front and back in addition to filling in the semi-elliptical units forming the backbone of the dam.

When it was decided to include a half pier on the line of Forty-fourth street an extension shoreward several hundred feet was involved and this presented a new difficulty. Because the rock had to be cut out clean at the southwest corner it was impossible to cover that area with supporting riprap. For a while the situation was puzzling. But Mr. Staniford overcame the difficulty by substituting two great circular units of steel piling, each fifty-five feet in diameter, for the smaller semi-elliptical pockets sixteen feet wide and twenty-four feet in length.

When filled with rock these big units, without sustaining riprap, became absolutely rigid and watertight. It will now be possible to cut out the rock for the dock berthing space right up to the very foot of these enormous cofferdam units. In passing, it might be mentioned that the material for the riprap and the other rock used on this cofferdam has been taken from subway excavations by the contractors, Holbrook, Cabot & Rollins, who are engaged upon these two city improvements.

But the Dock Department has had its worries since the initial draining of the cofferdam space began. On the north side of the enclosure, where there was an approach to fairly solid ground, pockets of piling were not deemed necessary. Instead a single line of the interlocking steel units was driven, and this was tied to old wooden cribbing that supported an existing dock.

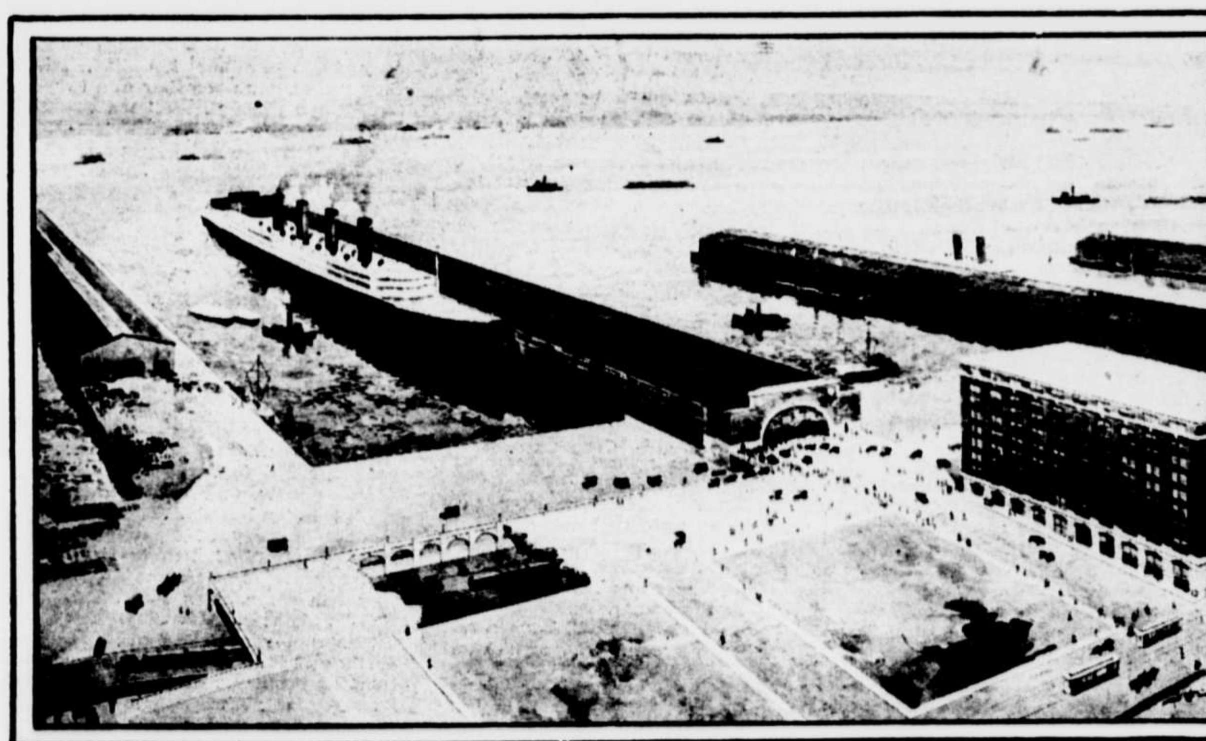
This bulwark failed to keep out the water when the dammed space was partly drained, and a serious leak developed there. The question was how to stop the invasion. It was first suggested to pump a fluid cement or grouting into the interstices, but the element of expense precluded this. An ingenious way was found to halt the incoming water, and this at a moderate outlay.

To begin with a timber pile a foot in diameter was driven into the filled in space back of the old crib, and then withdrawn, leaving a hole. This cavity was next filled with layers c, earth, sawdust and manure and forced down into the subsurface and plugged by the superposed pile that acted as an additional stopper. In this fashion an impervious wall was formed all along the north side flanking the single line of steel pilings, and the only breach in the entire cofferdam was thus effectually sealed before it could do any harm.

With this work done the unwatering was resumed, and now the bared area is dry and ready for the rock drills which will shortly take up their task of quarrying out broad and smooth niches in Manhattan's rocky foundation, so that the great liners of the years to come will find ready for them ample and safe berthing spaces. As a preliminary to this excavation work a battery of big air compressors has been installed, and by means of pipes that will be led around the cofferdam and down into the enclosed space motive air can be had at every desired point.

The engineers of the Dock Department estimated that the cost of the temporary dam and the rock excavation should not exceed $497,500. Eleven contractors submited bids, and these ranged from $487,812.90 to $708,128.52. The lowest bidder got the job.

Of course the rock underlying the piers will not be removed, but will serve, in part, as the foundation for the two storied structures that will rise above the water level. But in order to carry this superposed structure, pillars of cement will reach upward from the basic rock and the sides



Drawing showing how the improvement will look when completed. It shows a 1,050 foot pier at the foot of Forty-fourth street. Elevated street over New York Central tracks gives access to upper deck of pier.

mprovement to Give Ample Berthing Space for Biggest Transatlantic Liners North of 44th Street

of the piers will be massive monoliths of cement.

As the pier reaches further riverward beyond the limits of the existing cofferdam, it will be impossible to build from the ledge upward, and the major stretch of the support for the piers will be of timber and rest upon many thousands of piles that cannot reach to solid bottom. Perhaps this seems like a very venturesome bit of business. As matters stand it is out of the question to get timber piling more than 90 feet long, and solid bottom at the outer end of the whole pier will be 150 feet or more below tide level. How, then, can a foundation be secured which will be stable and capable of sustaining a building two stories high, besides the additional load of passengers, their baggage and thousands of tons of freight?

The engineers have found that it is really not necessary to carry the foundation of piles down to solid ground. They have proved that the semi-fluid silt and mud can be made to bear the weight required without fear of subsidence. It has taken them some months to satisfy themselves on this score.

Two tests have been made, each with a group of sixteen piles, capped and loaded with a dead weight of 240 tons of great blocks of concrete. In the first test the piles showed too much settlement after an interval of six months. The second group has met all requirements and the sustaining power has been obtained by "lagging" each of the sixteen piles. Lagging, in this case, means that wooden pieces 30 feet long and of rectangular cross section, 5 by 6 inches, were securely strapped against the lower end of the 90 foot timbers, four of these in each case. In this fashion the piles were made web footed, so to speak.

As part of the river front improvement the New York Central Railroad will elevate its tracks so that its cars can be switched right into the second story of the new piers and a sunken double track will place the doors of these cars level with the freight platform or floor. This will not only relieve present traffic congestion on the street but will also greatly facilitate the rapid delivery of goods. The new piers are to be remarkable in other ways because it is the aim of Commissioner Smith to provide the most efficient and up to date facilities for getting freight from the dock to the ships and vice versa.

A great deal of criticism has been aimed at New York harbor. It has been said that it lacks modern methods of loading and discharging vessels. A little over two years ago Mr. Staniford and the First Deputy Commissioner made a report to the head of the department and Mr. Staniford visited Europe in order to study methods there.

According to this report, New York has reason for felicitation rather than fault finding. It is the aim here to develop the municipal docks with some regard to unity of equipment, expense of upkeep and a return upon the investment. The total straight water front in the port of New York has a stretch of 748 miles, 193 of these being on the New Jersey side. The city of New York has developed fifty-three miles of wharfage room, including 232 city owned piers. This state of affairs has called for a certain measure of conservatism because the city is renting to all nations, and within some limits these people must be free to follow their own practices if they so choose. But let the experts of the Dock Department explain the problem themselves.

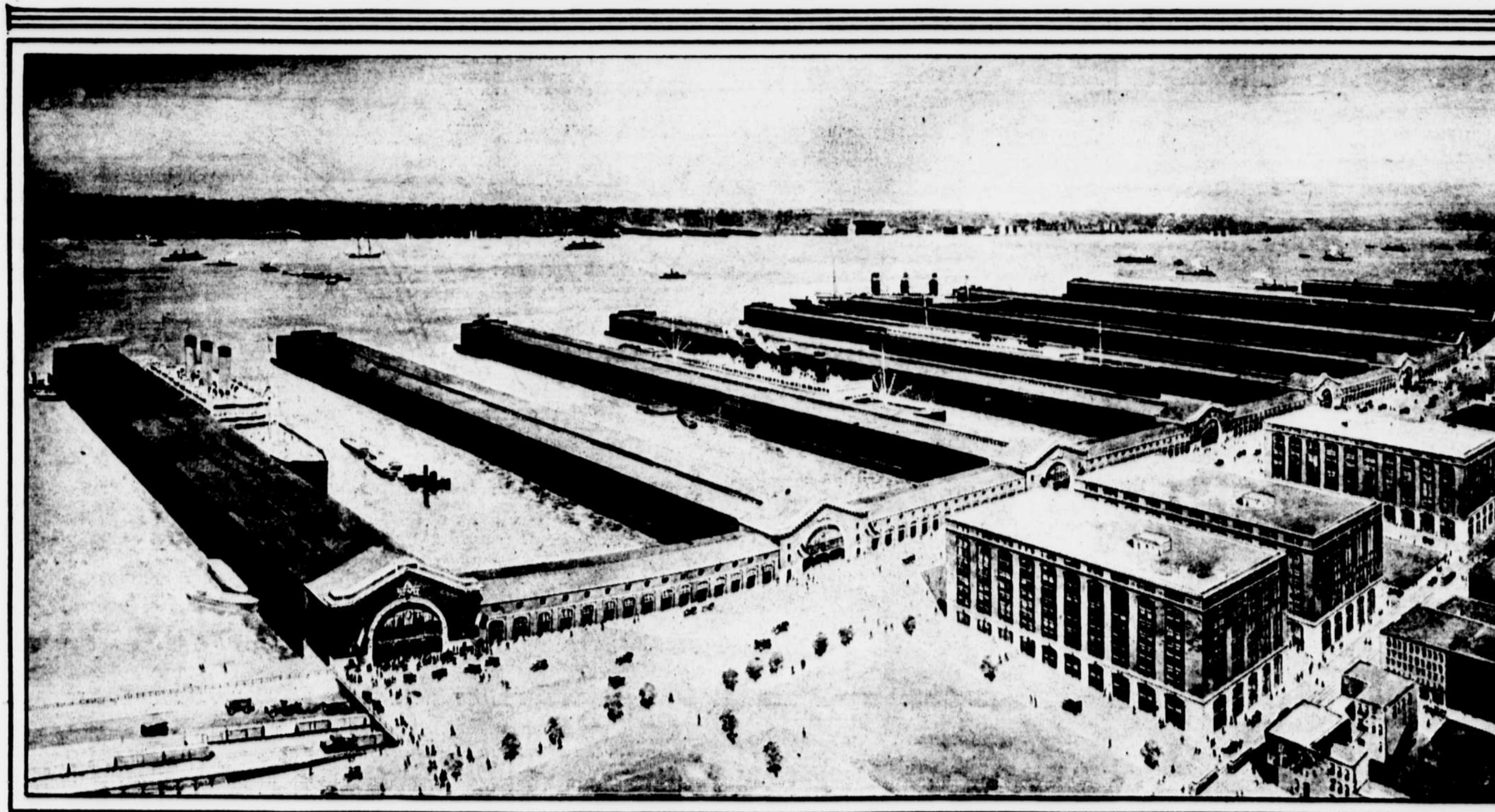
"European engineers have pointed with pride to their great travelling cranes and derricks, rolling towers, &c., installed along the quays and pier sides at their ports. A notable case being the Kuhwaerder dock at Hamburg, where 134 great travelling cranes frown upon the harbor's shipping like the great guns of a fortress.

"European engineers have also criticised American methods of handling freight. To what extent this criticism is justified by the facts is a question upon which shipping men differ, and many authorities lean to the opinion that the American methods are no more expensive than those in vogue in Europe, when consideration is given to the cost, maintenance and depreciation of plant, difference in the rate of pay of labor, the number of working hours of the dock ... and the difference in railroad ... stock.

"Many authorities state that ... is handled as rapidly in America ... Europe, if not more rapidly, particularly when sorting is required, ... is nearly always the case with American freight, be it transatlantic ... wise, railroad or general.

"For the handling of commodities in bulk, New York harbor is ... better equipped than European ... great installations of the most ... and effective types of machinery ... handling coal, grain, &c., in bulk ... be found in the various railroad terminals, at the power plants of electric lighting companies and manufacturing establishments. It is interesting to note further that the catalogues of American manufactured machinery show illustrations of ... American hoists and conveying machinery which have been installed ... them in European countries.

"Foreign engineers who have ... cised us in the beginning ... through ignorance, have been surprised and unstinted in their ... when they saw for themselves the excellence of the methods employed. It is a notable fact that foreign ... do not adopt the methods ... home ports but well-nigh ... make use of the various dock facilities which have proved ... fitness and economical worth ... tion these things merely that the public may know how far we are going ahead and how thoroughly we are going to equip and design our ... to meet the most exacting demands of service for years to come."



Proposed new piers, looking north from Forty-sixth street, showing Twelfth avenue removed inland to give greater pier length.