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PASSAIC RIVER INVESTIGATION

Effects on Water Quality of Proposed Flood Control Reservoir

U. S. Public Health Service
Sanitary Engineering Division
Water & Sanitation Investigations
Cincinnati, Ohio
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By

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Prepared by the U. S. Public Health Service
at the request of and in co-operation with
the District Engineer, U. S. Engineer Office,
New York, N.Y.

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Introduction

This study of the possible benefits to pollution abatement of low-flow regulation by proposed flood control reservoirs on the Passaic River and its tributaries was authorized by the District Engineer, U. S. Engineer Office, New York, N.Y., on February 18, 1946. The largest and most important of these reservoirs is the one at Two Bridges near the junction of the Pompton River with the Passaic.

Considerable use has been made of data furnished through the U. S. Engineer Office by the Passaic Valley Water Commission, the Passaic Valley Sewerage Commission, and the U. S. Geological Survey. Reports of the New Jersey State Health Department on sanitary conditions in the watershed of the Passaic above Little Falls have also been very helpful. Although additional laboratory and sanitary survey data on the Passaic below Little Falls would be desirable, the expense of obtaining such information was not deemed justified for the purpose of this report.

Grateful acknowledgment is made of the assistance of personnel of the New York District Engineer Office and of those who furnished information used in connection with this report.

Conclusions

1. The Passaic River and its tributaries are sources of public water supply for a major part of the population of the Northeastern New Jersey Metropolitan Area including Newark, Jersey City, Paterson, and many smaller communities.

2. Although the Passaic Basin is densely populated and highly urbanized, the continued, vigorous efforts of the State Health Department and the various public water supply agencies using the streams have maintained the quality of the streams in satisfactory condition for use as raw water supplies for municipal water purification plants as far downstream as Little Falls.

3. Most of the sewage and industrial wastes from the communities along the Passaic below Little Falls is collected and treated by the Passaic Valley Sewerage Commission and discharged into New York Bay. It thus does not affect the Passaic River.

4. Residual pollution from this lower section, including sewage and industrial wastes not collected by the Passaic Valley Sewerage Commission and urban storm drainage, is sufficient to cause gross pollution of the tidal portion of the lower Passaic.

5. In view of the extremely low flows to which the Passaic River is subject and the intensive development of its lower reaches, the cost of abating this pollution by collection and treatment will be high.

6. Low-flow regulation by the proposed flood control reservoir on the Passaic at Two Bridges would permit considerable savings in the cost of pollution abatement. It would still be necessary to reduce the pollution load, however.

7. It is estimated that such flow regulation would have a value of at least $3.00 per c.f.s.-day of reliable increased flow during the season June-September. More intensive study of alternative methods of pollution abatement may well indicate that increased flows have even greater value.

Description

The Passaic River drains an area of some 950 square miles in densely populated northeastern New Jersey and southeastern New York. It discharges into Newark Bay. The main stream and several of its tributaries, notably the Rockaway, the Wanaque and the Pequannock, supply water to a large part of the population of northeastern New Jersey including Newark, Jersey City, Paterson and many smaller cities, with a total population of over 1,500,000. The lower 15 miles of the Passaic are tidal and have been improved for navigation with project depths ranging from 10 feet near the upper end to 30 feet near the mouth. The lower 26 miles of the river from Paterson to the mouth is densely urbanized and highly industrialized.

The principal tributary of the Passaic, the Pompton River, joins the Passaic at Two Bridges, 33 miles above the mouth of the main stream. A flood control reservoir is proposed which would impound the Passaic and the Pompton immediately above their confluence and would inundate a large amount of marsh and meadowland.

Water Supply

The Passaic and its tributaries furnish much of the water supply for the metropolitan area of northeastern New Jersey. There are four principal developments, as follows:

Supply	Source	Consumption, M.G.D.
Newark	Pequannock R.	57
Jersey City	Rockaway R.	52
Passaic Valley Water Commission	Passaic R.	10
North Jersey District Water Supply Commission	Wanaque R.	69

All of these supplies are interconnected to some extent. All are municipally owned, the Passaic Valley Commission by Paterson, Passaic and Clifton; and the North Jersey District supply by these three municipalities plus Newark, Kearny, Montclair, Bloomfield and Glen Ridge. Many other communities are served wholly or in part by these systems.

The problem of obtaining adequate supplies of water for this metropolitan area is a continuing and complex one which has been studied for many years. Many proposals have been advanced and studied, and the controversies over various plans have been bitter. The area is still in need of additional water. It could be obtained from the proposed Two Bridges Reservoir if storage for that purpose were provided in the reservoir.

Sources of Pollution

Because of the extensive use of the Passaic and its tributaries as sources of water supply, the attention devoted to abating and preventing water pollution has been greater than usual and most of the wastes engering the streams above Little Falls (about mile 30) receive a high degree of treatment and disinfection. As a result, although the population density on the 761-square-mile drainage area above Little Falls is 263 per square mile, the quality of the water as indicated by standard chemical and bacteriological tests is fairly good. Industrial wastes entering the Whippany and Pequannock Rivers cause some difficulties, but progress has been made in reducing pollution from these sources.

The Passaic Valley Sewerage Commission includes most of the communities along the lower 25 miles of the Passaic. Its facilities intercept all sanitary sewage and most of the industrial wastes from the member municipalities and discharge the wastes after treatment into New York Bay. The population served by the Passaic Valley Sewerage Commission is about 1,035,000. The municipalities, East Paterson, Fairlaw and Hawthorne, with a total population of 26,500, are located along this same stretch of the river but are not included in the Passaic Valley Sewerage Commission.

The principal tributary of the lower Passaic, Saddle River, enters about 15-1/2 miles above the mouth. It drains a largely suburban area which includes some 40,000 population served by public water supplies but not by public sewer systems.

Storm drainage and interceptor overflow from combined sewers during storms add a certain amount of putrescible matter to the Passaic, and a limited amount of industrial wastes also finds its way to the stream in the lower 25 miles. It has not been possible during this study to make the detailed studies necessary to arrive at an accurate figure as to the magnitude of the waste load reaching the stream.

Hydrometric Data

The Passaic River has a comparatively high dry weather flow for a stream of its size, considering the large amount of water diverted for water supply. An analysis of the published flow record at Great Falls at Paterson shows the following:

Frequency	Mihimum Monthly Flow	Minimum Weekly Flow	Minimum Daily Flow
2 year	150	80	40
10 "	60	25	10
20 "	38	18	3

These figures indicate the small amount of dilution water available in the lower Passaic.

Laboratory Data

A limited amount of laboratory data is available on the upper Passaic and its tributaries as a result of surveys in 1942 and 1943 by the New Jersey State Health Department and in 1944 by Morris Knowles, Inc., consulting engineers to the Passaic Valley Water Commission. These data are primarily of value in connection with this report as an indication of the quality of the water which would be available at the Two Bridges Reservoir. Long-time records of water quality are available from the Little Falls plant of the Passaic Valley Water Commission.

The only available data on the lower Passaic are routine dissolved oxygen determinations made by the Passaic Valley Sewerage Commission at nine points on the river from Paterson to Newark Bay for the calendar year 1945 and the first four months of 1946. These data are presented in Table 1 and indicate that as far downstream as the head of navigation at the 8th Street Bridge in Passaic the river was in relatively good condition as regards dissolved oxygen during the above period. Between Station 1 above Great Falls and Station 2 at 33rd Street in Paterson the dissolved oxygen content increased. From there to Station 3 at Market Street in Paterson, there was a marked decline in D. O., presumably due to wastes not discharged to the system of the Passaic Valley Sewerage Commission. This was followed by a short stretch in which the dissolved oxygen again increased. In this stretch the water passed over the Dundee Dam where some oxygen was added and Saddle River entered, bringing some wastes and some added flow. No data are available on the quality of this stream. At Station 4, the 8th Street Bridge in Passaic, the stream entered a zone of degradation which varied in length depending upon temperature and stream flow conditions. During periods of low temperature, when stream flows were com-

paratively high, the greatest oxygen deficiency was found at Station 8, Jackson St., Newark. During warmer weather, when biochemical oxidation was more rapid and stream flow generally lower, the worst conditions were found at Station 7, Clay St., Newark.

This zone of degradation coincides with the navigable section of the stream. In this section, due to the much larger cross-sectional area, the velocity of flow is much lower than in the reaches above the head of navigation. The reaeration capacity of the stream is closely related to its velocity and consequently is much lower in the navigable section than it is upstream. Therefore the dissolved oxygen content falls upon reaching the navigable portion of the stream. The reduction in velocity has an additional detrimental effect by increasing the deposition of organic matter previously held in suspension. Decomposition of this material makes an additional demand on the oxygen resources of the stream.

During the period for which laboratory data are available on the lower Passaic, the stream flow was unusually high. The minimum monthly average flow at Paterson was 618 c.f.s., and during the summer months the lowest monthly mean flow at Paterson was 956 c.f.s. (June). Even with these comparatively high flows the dissolved oxygen fell as low as 2.0 p.p.m., less than 25 per cent of saturation.

Discussion

Present and prospective use of the lower Passaic does not demand a high standard of water quality. The standards adopted by the Interstate Sanitation Commission for Class "B" waters; that is, waters which are not expected to be used primarily for recreation, shellfish culture or development of fish life, appear to be desirable and practicable ones for the tidal portion of the Passaic. Although the river itself is outside the jurisdiction of the Interstate Sanitation Commission, Newark Bay into which the river discharges is within the area covered by the compact and its waters are classified as Class "B." The quality standards for such waters require a minimum dissolved oxygen content of 30 per cent of saturation. It is desirable that the Passaic River be of no worse quality than that required of Newark Bay.

From the laboratory data it is apparent that even with the abnormally high flows that prevailed during the summer of 1945, such a dissolved oxygen content cannot be maintained with the present waste load on the stream. On the other hand, the maintenance of the desired water quality with the low flows likely to occur during dry years would probably require not only the removal of all sewage and industrial wastes but also treatment of much of the urban storm drainage prior to its entrance into the river.

Under such conditions the most economical method of attaining the required water quality is probably by a combination of waste collection and treatment and low-flow control. Determination of precisely which combination of treatment and flow control would result in the lowest overall cost, would require the collection and analysis of much more data than are available at present.

The amount of flow regulation that would be of value is not less than 1000 c.f.s. If such a flow could be maintained during the summer months, satisfactory stream conditions could be maintained. However the cost of maintaining such a flow on so small a river would be too great to be practicable.

The most economical range of regulated summer flows will probably be from 300 to 500 c.f.s. Such flows could be maintained by storing spring runoff for later release with little or no carry-over storage from one year to the next. In considering flow regulation for pollution abatement, it is not necessary that the flow be absolutely dependable as would be required for a public water supply development. It is not usually economical to design pollution abatement works against minimum flows likely to occur less often than once in ten years. Storage regulation which would provide flows of equal dependability is sufficient for pollution abatement. Flows approximately 70 to 80 per cent of the flow of 10-year frequency should be provided during all years, however.

The problem of further reducing the pollution load in the lower Passaic is a complex and continuing one. Major sources of pollution have been eliminated and it is probable that further corrective measures will involve locating and eliminating individual residual pollution sources which are of minor consequence except in the aggregate. Such minor sources may be created from time to time and a continu-

ing corrective effort is required. The cost of correcting pollution from urban storm drainage, presumably with storm water holding tanks, can be quite high.

Because of the above considerations, the estimates of benefits to be derived from flow regulation, based on the cost of accomplishing similar results by alternative methods, have been based on cost experience elsewhere. Studies made in connection with the Ohio River Pollution Survey have provided much of the cost data used in making these estimates. These data reflected costs as of 1939. A 50 per cent increase in cost has been allowed to conform more nearly to present cost levels. On this basis, regulated summer flows of the order 300 to 500 c.f.s. will have a value of approximately $3.00 per c.f.s.-day increase over the unregulated minimum monthly flow of 60 c.f.s. These flows should be provided during the months June to September inclusive. Thus a reliable flow of 300 c.f.s. would have a value of $87,000 per year, and 400 c.f.s. would have an annual value of $122,000.

It is believed that these benefit estimates are conservatively low. It is not unlikely that a more detailed study of the problem would show that the costs of pollution abatement by collection and treatment of the wastes would be higher in this area than in those from which the basic data used were obtained, on account of the greater density of population and greater complexity of the problem generally.

If and when it is determined that inclusion of provision of storage for low-flow regulation in the Two Bridges Reservoir is justified, it is recommended that the problem be reviewed in detail and that additional laboratory data be collected in order to determine more exactly the most desirable regulated flow and possible monthly variations that may be justified in this regulated flow.

Table 1 - Passaic River - Dissolved Oxygen Results, Paterson to Mouth, Jan.,1945 - April,1946*

Date	Sta.1,mile 25.4 McBride Ave. Paterson			Sta.2,mile 20.9 33rd St. Paterson			Sta.3,mile 18.9 Market St. Paterson			Sta.4,mile 16.0 8th St. Passaic			Sta.5,mile 11.6 Rutherford Ave. Rutherford			Sta.6,mile 8.4 Rutgers St. Belleville			Sta.7,mile 5.8 Clay St. Newark			Sta.8,mile 4.2 Jackson St. Newark			Sta.9,mile 0.7 Mouth at Newark Bay			Flow at Paterson c.f.s.
	T°F	Diss.Oxy. ppm	Diss.Oxy. %	T°F	Diss.Oxy. ppm	Diss.Oxy. %	T°F	Diss.Oxy. ppm	Diss.Oxy. %	T°F	Diss.Oxy. ppm	Diss.Oxy. %	T°F	Diss.Oxy. ppm	Diss.Oxy. %	T°F	Diss.Oxy. ppm	Diss.Oxy. %	T°F	Diss.Oxy. ppm	Diss.Oxy. %	T°F	Diss.Oxy. ppm	Diss.Oxy. %	T°F	Diss.Oxy. ppm	Diss.Oxy. %	
1945																													
Jan.	32	13.4	91.6	32	13.7	93.7	32	-----	----	32	13.0	88.9	32	12.9	88.3	32	12.8	87.5	32	10.95	75.0	32	10.55	72.3	32	12.75	87.3	1005
Feb.	32	-----	----	32.7	12.8	88.6	32	-----	----	32.5	13.4	92.2	32.5	12.3	84.9	32.5	11.2	77.2	32.7	9.75	67.4	33.5	8.85	61.8	33.5	11.3	79.1	882
March	45	11.0	90.6	----	-----	----	45.6	10.5	87.3	45.4	11.7	97.1	44.6	10.8	88.5	44.4	10.8	88.5	44.6	10.4	85.3	45.2	10.1	83.6	46.5	9.4	79.4	3057
April	59	8.7	85.7	59.5	9.25	91.9	59.5	8.9	88.4	59.7	9.6	95.4	59.0	8.25	81.1	59.0	6.95	68.5	59.2	5.7	56.1	59.5	5.2	51.6	57.4	6.6	64.1	1299
May	60.6	8.3	83.4	60.6	8.95	89.8	60.6	8.5	85.1	60.6	9.2	92.1	61.0	8.1	81.5	61.2	7.25	73.5	61.8	7.05	71.9	61.8	6.7	68.3	58.0	7.15	69.9	2474
June	73.2	7.4	85.4	73.7	8.2	94.7	72.5	7.0	79.9	72.7	7.65	87.5	72.0	4.3	48.9	72.0	3.05	34.8	71.7	2.0	22.8	71.7	2.0	22.4	75.5	2.3	27.0	956
July	75.2	7.5	88.2	76.2	7.75	91.6	76.0	6.95	82.4	76.5	6.5	77.5	76.0	4.5	53.3	76.0	2.65	31.5	76.5	2.3	27.0	76.5	2.4	28.2	76.2	3.15	37.4	3124
Aug.	73.2	6.5	76.4	73.0	7.7	88.7	73.2	6.45	74.2	73.2	7.75	89.4	73.7	4.9	57.0	73.5	5.25	60.8	73.5	4.35	50.1	72.7	5.2	59.3	75.2	2.9	34.1	1617
Sept.	70.7	7.35	82.6	71.0	8.3	93.2	71.2	7.3	82.5	74.0	8.3	96.5	71.7	6.2	70.1	70.7	4.65	52.0	71.0	3.55	40.1	72.0	3.9	44.3	72.7	3.9	44.8	1362
Oct.	55.2	9.0	84.8	57.0	9.6	92.4	56.7	8.9	85.2	58.0	9.7	94.6	57.7	7.0	68.1	57.0	5.0	48.4	58.7	4.0	39.1	60.0	3.9	38.6	60.0	5.7	56.9	641
Nov.	49.0	9.45	82.6	49.6	10.3	90.1	49.6	9.8	85.7	50.2	10.4	91.7	50.2	8.85	78.1	50.0	7.95	70.2	50.2	6.75	59.8	50.8	6.1	54.3	47.5	7.9	67.7	1395
Dec.	33.2	13.05	94.3	33.5	12.45	87.2	33.2	13.05	94.5	33.5	13.9	97.3	33.5	13.3	93.2	33.5	13.3	93.1	34.0	12.45	87.8	34.0	12.3	86.9	32.0	13.5	92.3	2506
1946																													
Jan.	34.2	12.9	91.3	34.4	13.7	96.9	34.4	13.4	95.3	34.4	13.8	97.8	34.4	13.3	94.5	34.7	12.8	91.4	35.0	11.85	84.9	35.4	11.8	84.9	35.0	13.1	93.9	2107
Feb.	36.7	10.8	79.3	35.7	12.45	90.0	36.0	12.0	87.3	36.2	12.85	93.8	35.7	11.7	84.9	36.2	11.5	83.5	35.7	10.1	73.1	37.0	9.2	68.0	34.0	10.55	74.3	618
March	49.2	10.35	90.5	49.2	10.7	97.9	49.2	10.95	95.8	49.5	11.0	96.9	49.0	10.45	91.3	47.6	10.2	87.1	50.0	9.45	83.4	48.5	8.95	77.6	46.0	9.05	75.7	1663
April	55.0	9.1	85.7	55.7	11.1	94.8	55.7	9.8	92.2	56.2	10.2	97.1	55.2	8.15	76.6	54.0	7.0	64.9	53.7	6.45	59.6	54.2	6.75	62.6	54.6	8.2	76.4	773

* Laboratory data furnished by Passaic Valley Sewerage Commission. Flow data from U. S. Geological Survey.

State of New Jersey
DEPARTMENT OF HEALTH
J. LYNN MAHAFFEY, M.D., DIRECTOR
TRENTON 7

IN REPLY REFER TO 6E431/4

April 25, 1947

Mr. H. W. Streeter
Sanitary Engineer Director
Officer in Charge
U. S. Public Health Service
Water and Sanitation Investigations
East Third and Kilgour Streets
Cincinnati 2, Ohio

Dear Sir:

This is to acknowledge the receipt of and to thank you for your letter dated April 7, 1947, together with a copy of a draft of a report recently completed by your office on the Passaic River.

The aforesaid report has been examined by the interested engineers of this Department, and based upon that examination, the following comments are offered. The comments are numbered to correspond with your enumeration of "Conclusions".

1. We concur
2. We concur
3. We concur (See also comment below)
4. See comment below
5. See comment below
6. It is assumed that this conclusion relates to the area controlled by the Passaic Valley Sewerage Commission; therefore, see comment below
7. No comment

With reference to conclusions Nos. 3 to 6 inclusive, please be advised that the Passaic River, from the Great Falls at Paterson to the mouth of the river is controlled, in so far as pollution is concerned, by the Passaic Valley Sewerage Commission. The State Department of Health has no jurisdiction over stream pollution, the construction of sewer lines, or the construction of sewage treatment plants along the aforesaid lower part of the Passaic River and the tributaries entering in that district, including the Saddle River, to which you refer on page 4 of your report.

It is appreciated, in consideration of the last paragraph of your report

that the proposed Two Bridges reservoir has not been planned in sufficient detail to supply all the information desired before a final report can be compiled. When this information is available, this Department will be interested in knowing the extent of the areas to be flooded, including existing sewage and industrial waste treatment plants which may be affected.

I trust that these comments are in accord with your request. Your cooperation in submitting the report for study and comment is appreciated.

Very truly yours,

J. Lynn Mahaffey, M. D.
Director of Health

By: H. P. Croft
Chief Engineer

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