CWT 10-11

CLEAN WATER

AN EVALUATION OF THE SIGNIFICANCE OF COMBINED SEWER OVERFLOWS IN THE HUDSON RIVER CONFERENCE AREA

JUNE 1969

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION • U. S. DEPARTMENT OF THE INTERIOR
HUDSON-DELAWARE BASINS OFFICE, EDISON, NEW JERSEY

AN EVALUATION OF THE SIGNIFICANCE OF COMBINED SEWER OVERFLOWS IN THE HUDSON RIVER ENFORCEMENT CONFERENCE AREA

U. S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
NORTHEAST REGION
HUDSON-DELAWARE BASINS OFFICE

June 1969

Excerpts from the Conference In the Matter of Pollution of the Interstate Waters of the Hudson River and its Tributaries - New York and New Jersey September 28, 29, and 30, 1965.

Item 13 - Conclusions and Recommendations

The magnitude of the pollution problem caused by discharges from combined sewer overflows is recognized. The Department of Health, Education, and Welfare, in cooperation with the States of New Jersey, New York, and the Interstate Sanitation Commission, will undertake a review of the problem and develop a program for action for consideration by the Federal Government, the States and the Interstate Sanitation Commission by December 31, 1968.

The construction of combined sewer systems in newly developed or redeveloped urban areas shall be prohibited, and existing combined sewers shall be eliminated wherever feasible.

Programs shall be established for surveillance of existing combined sewer systems and flow regulating structures to convey the maximum practicable amount of combined flows to and through treatment plants.

Acknowledgement

We wish to thank the States of New York and New Jersey and the Interstate Sanitation Commission for their assistance in gathering data contained in this report.

TABLE OF CONTENTS

TABLES

FIGURES

SUMMARY AND CONCLUSIONS

1. The waters of the Hudson River Enforcement Conference Area receive the discharge from 74 municipal sewerage systems, 43 of which have collection systems which are totally or partially combined.

2. After implementation of the conference recommendations, combined sewer overflows will contribute approximately 82% of the estimated BOD from municipal discharges, or 61,000,000 pounds per year.

3. Only 2.6%, or 1,600,000 pounds per year of the future combined sewer overflow load will discharge to bodies of water classified for water supply or bathing. Significant quantities of combined sewer overflow in the New York Metropolitan Area discharge immediately adjacent to waters used for bathing (salt water beaches of Staten Island, Coney Island and western Long Island Sound). Bacterial contamination of these recreational areas is of particular concern.

4. Studies are needed in the conference area to determine: a) the quantitative and qualitative characteristics of combined sewer overflow resulting from differing land use areas; and b) the effect of combined sewer overflow on the quality of the receiving water.

5. When the above studies are completed, consideration should be given for remedial action, if indicated, to eliminate combined sewer overflows in areas of highest proposed water use.

INTRODUCTION

Purpose and Scope

Overflows from combined sewer collection systems can create pollution problems. The extent of these problems in the Hudson River Conference area are not known. Studies have been carried out in other areas to evaluate the quality of combined sewer overflows, and to a lesser extent, their effect on the receiving water. The purposes of this study are to review briefly the work already done, assess the problem as it relates to the Hudson River Conference Area and offer suggestions to the conferees regarding a solution to the problem.

The Hudson River Enforcement Conference Area, as shown in Figure 1, is defined as the main stem of the Hudson River from the Federal Lock at Troy, New York to the Battery in New York City, the Upper Bay of New York Harbor, the East River from the Battery to Throgs Neck, the Harlem River, Kill Van Kull and Newark Bay.

Background

Because of the need for power, transportation and water supply, the vast majority of American cities developed along waterways. Even before the installation of public water supplies, diversion of stormwater was of concern in these communities. To this end open ditches and later closed piping systems were developed. All discharges were made directly into the nearest water course.

As public water supplies were developed it became necessary to collect and dispose of wastewater. The most convenient and economic solution was to utilize the existing storm sewers to carry the domestic wastewater. As municipalities became increasingly aware of the need to treat sanitary wastewater, the many short sewers discharging untreated wastewater to the nearest watercourses had to be intercepted and the collection system modified to deliver the wastewater to a single point - the treatment plant. Because it was considered hydraulically and economically impractical to deliver all wastewater and stormwater to a plant, intercepting sewers were constructed which diverted only the dry weather flow to the treatment plant. All flows in excess of this were diverted directly to a watercourse via diversion chambers. Design of the intercepting sewer was usually based on the acceptance of two to three times the average dry weather flow. It was not recognized until later that these diverted flows constituted a significant source of pollution.

Since the overflow is a mixture of sanitary wastewater and stormwater, such diversions result in the discharge of untreated wastes to the stream. Overflows also flush any organic matter which has accumulated in the collection system during dry weather-low flow periods. This phenomenon is one of the many factors responsible for substantial organic loading of streams during storms.

The latest unpublished FWPCA inventory of municipal sewage facilities in the United States lists more than 1300 jurisdictions which are served in whole or part by combined sewers. These systems, serving a total population of 54 million[(1)] represent 43% of the total sewered population.

There have been few studies conducted which provide information on the quality and quantity of overflow from either combined sewer or separate stormwater systems. These studies differ widely in their approach to the problem and presentation of the pertinent data. The results of several of these studies are summarized in Appendix A.

These limited studies show that the quality of both combined sewer overflows and stormwater runoff is highly variable and dependent on the particular characteristics of an individual drainage or catchment area. Data collected in one area are not generally applicable to other areas of

HUDSON RIVER CONFERENCE AREA

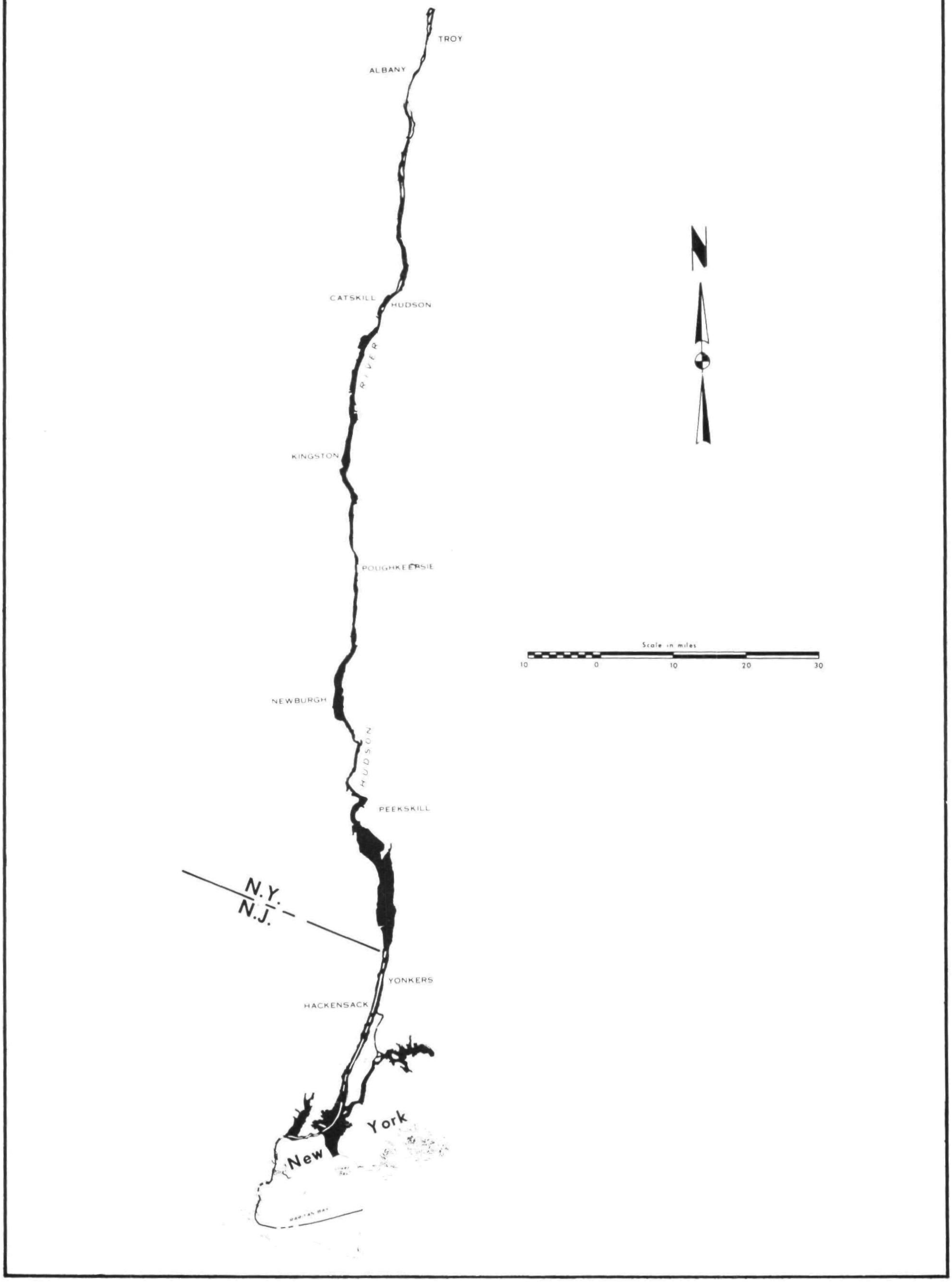

Figure 1

similar, let alone different, characteristics. Combined sewer overflow data have not been collected for systems within the study area. Therefore, an evaluation of the problem necessitates the use of data collected in other areas; namely, that contained in the literature.

METHODOLOGY

The procedure used to evaluate the significance of the pollutional load from combined sewer overflows in the Hudson River Conference Area involved developing estimates of:

1. The pollutional load resulting from combined sewer overflows.

2. The pollutional load from existing municipal systems.

3. The pollutional loads from municipal systems after implementation of the conference recommendations. One of these recommendations states, "All wastes prior to discharge into the waters covered by the conference (a) shall be treated to provide a minimum of 80 percent reduction of biochemical oxygen demand at all times. It is recognized that this will require a design for an average removal of 90 percent of biochemical oxygen demand".

These loadings were compared to assess the significance of combined sewer overflows. Urban runoff via separate collection systems and rural surface runoff were not included in this evaluation since they do not contribute to the combined sewer overflow problem as defined within the context of this report. Although some data are available on the magnitude of industrial waste discharges, they are not considered sufficiently accurate for inclusion in the waste load comparison.

For purposes of evaluating the data, the waters in the conference area were divided into eight sections which conform to those established by the water quality standards. The description of each section and its designated use under the Standards is summarized in Table 1. Figures 2A, 2B and 2C illustrate these sections.

The pollutional load from combined sewer overflows was estimated by using a procedure similar to the analysis suggested by Stanley.[2] This technique involves the computation of the average volume discharged from each combined sewer collection system and a calculation of the yearly average BOD load contained in the discharged volume. Calculation of the volume discharged was based upon the equation:

$$Q_o = CIA + Q_d - Q_p$$

Where:

Q_o = volume of combined sewer overflow per unit time

C = runoff coefficient

I = average intensity of rainfall

A = drainage area served by combined sewers

Q_d = volume of average municipal dry-weather flow per unit time

Q_p = capacity of waste treatment facility

The overflow BOD load was determined by using the equation:

$$L_o = Q_o \times \frac{T}{24} \times B_o$$

Where:

L_o = the BOD_5 load from combined sewer overflows

Q_o = volume of combined sewer overflow per unit time

T = time duration of storms which cause combined sewer overflow

B_o = average concentration of 5-day BOD

A detailed discussion of the computational procedure is presented in Appendix B.

The two most significant variables in this computation are the runoff coefficient, "C", and the BOD concentration, "B_o". Runoff coefficient values for each area were chosen primarily on the basis of population density. Two values of BOD concentration were used: 150 mg/l for the highly urbanized metropolitan area (Sections VI - VIII) and 40 mg/l for the less urbanized areas of the central and Upper Hudson River Valley (Sections I - V).

Present municipal waste discharge loads were obtained from published reports and documents or were computed using the population served, a factor of 0.17 pounds of BOD_5 per capita per day, and a percentage of BOD removal based on the existing waste treatment facilities (see Appendix B). Future municipal loads were computed based on present municipal waste loads treated to 90 percent BOD removal.

Table 1

Sections Established for the Evaluation of Combined Sewer Overflow

Section	Limits of Section	Water Quality Standards	Definition of Best Usage of Waters
I	Troy Locks to New Baltimore	NY - Class C	Fishing and any other usages except for bathing or as a source of water supply for drinking, culinary or food processing purposes.
II	New Baltimore to Esopus	NY - Class A	Source of water supply for drinking, culinary or food processing purposes and any other uses.
III	Esopus to Chelsea	NY - Class A	Source of water supply for drinking culinary or food processing purposes and any other uses.
IV	Chelsea to Bear Mountain Bridge	NY - Class B	Bathing and any other usages, except as a source of water supply for drinking, culinary or food processing purposes.
V	Bear Mountain Bridge to N. J. State Line	NY - Class SB	Bathing and any other usages except shellfishing for market purposes.
VI	NY-NJ State Line to The Narrows, including Upper New York Harbor	NY - Class I	Fishing and any other usages except bathing or shellfishing for market purposes.
		NJ - Class TW-2	Tidal surface waters having limited recreational value and ordinarily not acceptable for bathing but suitable for fish survival although perhaps not suitable for fish propagation. These waters shall not be an odor nuisance and shall not cause damage to pleasure craft having occasion to traverse the waters.
VII	The East River from the Battery to Throgs Neck, including the Harlem River	NY - Class II	All waters not primarily for recreational purposes, shellfish culture or the development of fish life.
VIII	Newark Bay and Kill Van Kull	NY - Class II	All waters not primarily for recreational purposes, shellfish culture or the development of fish life.
		NJ - Class TW-3	Tidal surface waters used primarily for navigation, not recreation. These waters although not expected to be used for fishing shall provide for fish survival. These waters shall not be an odor nuisance and shall not cause damage to pleasure craft traversing them.

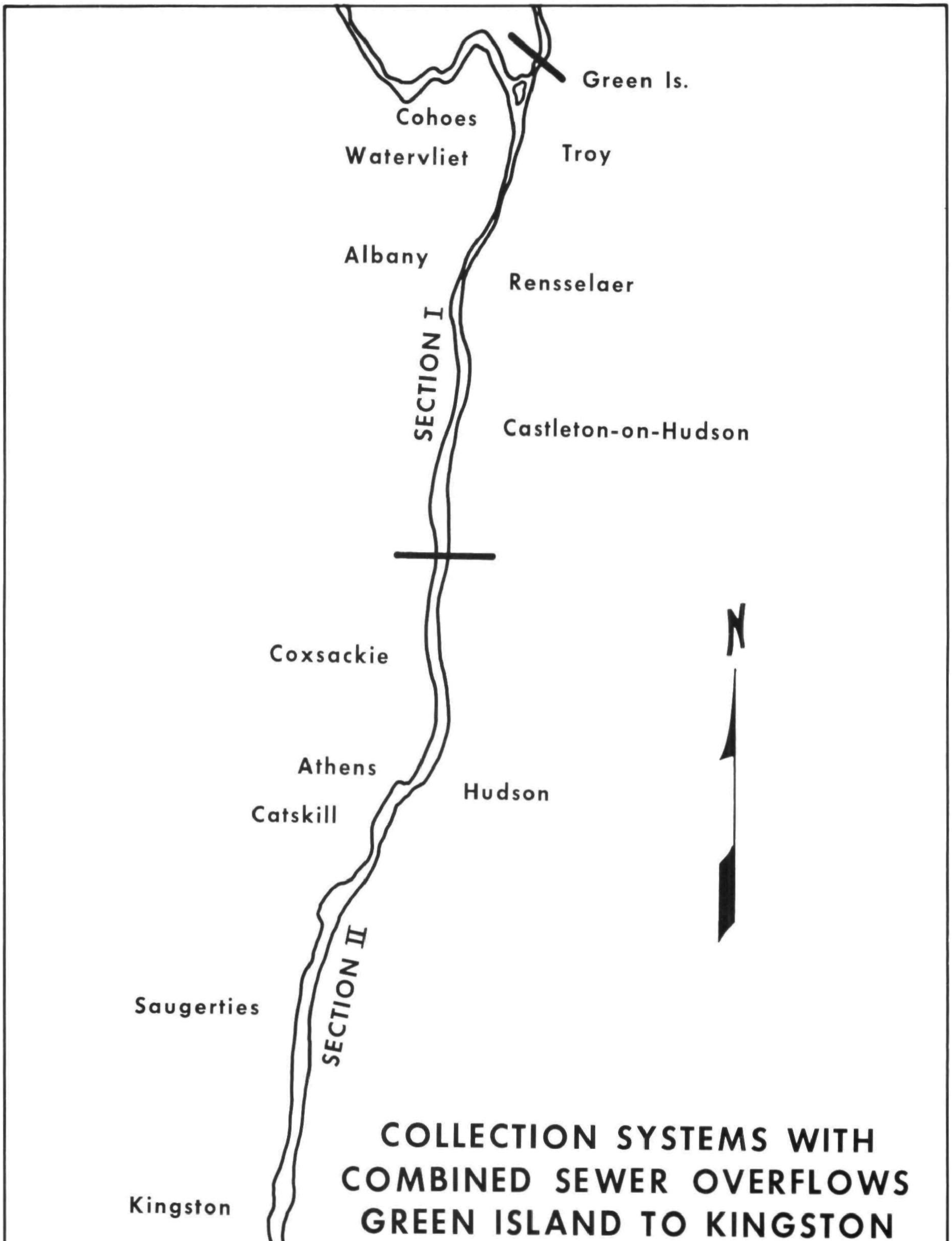
Green Is.
Cohoes
Watervliet
Troy
Albany
Rensselaer
SECTION I
Castleton-on-Hudson
N
Coxsackie
Athens
Hudson
Catskill
SECTION II
Saugerties
COLLECTION SYSTEMS WITH
COMBINED SEWER OVERFLOWS
GREEN ISLAND TO KINGSTON
HUDSON RIVER
Kingston

Figure 2A

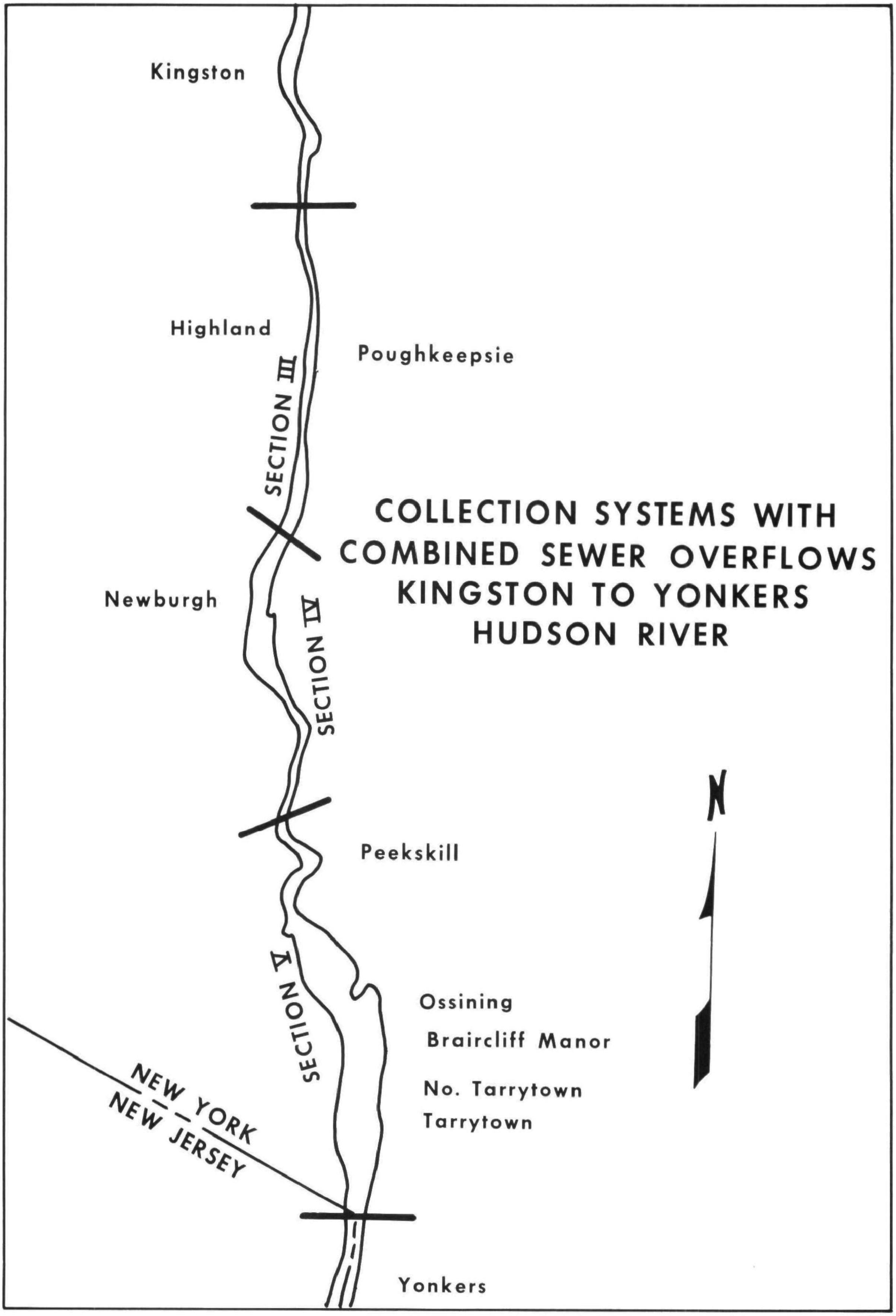
COLLECTION SYSTEMS WITH
COMBINED SEWER OVERFLOWS
KINGSTON TO YONKERS
HUDSON RIVER
Kingston
Highland
Poughkeepsie
SECTION III
Newburgh
SECTION IV
Peekskill
SECTION V
Ossining
Braircliff Manor
No. Tarrytown
Tarrytown
NEW YORK
NEW JERSEY
Yonkers
N

Figure 2B

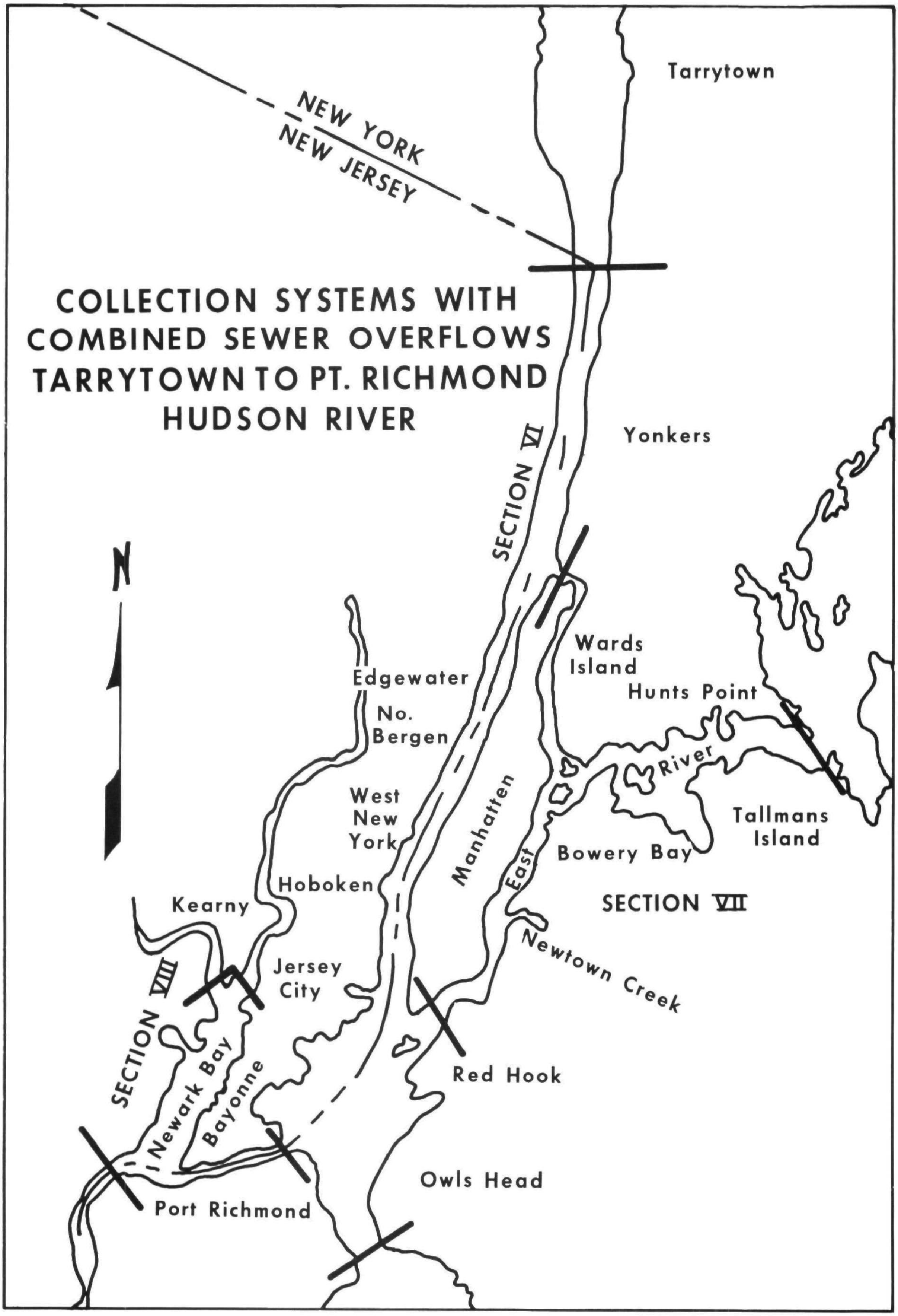
COLLECTION SYSTEMS WITH
COMBINED SEWER OVERFLOWS
TARRYTOWN TO PT. RICHMOND
HUDSON RIVER
NEW YORK
NEW JERSEY
Tarrytown
Yonkers
SECTION VI
N
Wards Island
Hunts Point
Edgewater
No. Bergen
West New York
River
Tallmans Island
Manhatten
East
Bowery Bay
Hoboken
Kearny
SECTION VII
Newtown Creek
Jersey City
SECTION VIII
Newark Bay
Bayonne
Red Hook
Owls Head
Port Richmond

Figure 2C

RESULTS

The significance of the pollutional load from combined sewer overflow can be evaluated by comparing them with municipal waste discharges. However, before making this comparison, several factors should be emphasized concerning the methodology employed, the distribution of the combined sewer overflow load and the validity of the estimated loads versus those which exist in the real environment.

1. The discharges from municipal systems and combined-sewer overflows are unevenly distributed throughout the conference area.

2. The degree of treatment given municipal discharges at present varies from no treatment (raw discharge) to secondary treatment. This significantly affects the magnitude of the municipal discharge load to a given section, but does not materially influence the load from combined sewer overflows.

3. In the calculations for this report, municipalities with combined sewers discharging untreated (raw) waste were not considered to contribute to the present combined sewer overflow load. After implementation of the conference recommendations, these systems would have combined sewer overflows which are then included in the waste load tabulation.

4. The occurrence of overflows from combined sewers is a random phenomenon dependent on rainfall. Computations for the overflow load were based on an average rainfall intensity for an average precipitation year. Actual overflow conditions, however, depend upon the type of storm, its intensity and duration. Short duration, high intensity storms impose significant transient loads upon a collection system and the receiving water. Long duration, low intensity storms, can also produce high loadings which are spread over greater time periods. The initial discharge from a given storm can contain a large portion of the total load because of flushing of solids accumulated in the collection

system during dry weather conditions.[3] [4]

5. It has been reported that as much as 95 percent of the untreated wastewater can be discharged directly to the receiving water via combined sewer overflow during periods of rainfall.[5]

6. It is recognized that untreated municipal discharges and combined sewer outflows contain significant quantities of suspended solids and bacteria. The large variability in the available data precluded a detailed evaluation of these parameters.

Present Combined Sewer Overflow Load

The combined sewer and municipal discharge loads to the conference area are summarized in Table 2. The location of the existing combined sewer collection systems are shown in Figures 2A, 2B and 2C. Within this area, there are 74 municipal collection systems, 43 of which have combined sewers. These combined systems serve an area of approximately 165,000 acres and a population of approximately 7.5 million people. The average annual load of 5-day BOD presently discharged to the waters of the conference area from these combined sewer overflows is estimated at 48 million pounds per year or approximately 11 percent of the 449 million pounds per year originating from existing municipal systems. Nearly all of this combined sewer overflow pollutional load is discharged to Sections VI, VII and VIII, which includes the highly urbanized New York Metropolitan Area. The municipal collection systems discharging to these sections serve a drainage area of 124,000 acres and a population slightly in excess of 7.0 million people.

In Sections I through V, Troy to the New York-New Jersey state lines, the average combined sewer overflow load is 8 percent of the annual 27 million pounds of BOD from municipal discharges. The largest concentration of these loads is in Section I, the Albany-Troy metropolitan area. Combined sewer

TABLE 2

Estimated BOD Load from Municipal Discharges and
Combined Sewer Overflows in the Hudson River Conference Area

Section	Number Municipal Sources	Number of Combined Sewer Systems	Present Waste Load: Municipal Discharge Lbs/yr.	Present Waste Load: Combined Sewer[1/] Overflow Lbs/yr.	Present Waste Load: Ratio of Combined Sewer Overflow to Municipal Discharge Percent	Future Waste Load: Municipal Discharge Lbs/yr.	Future Waste Load: Combined Sewer[1/] Overflow Lbs/yr.	Future Waste Load: Ratio of Combined Sewer Overflow to Municipal Discharge Percent
I	17	7	13,955,000	838,000	6	1,789,000	1,760,000	98
II	9	6	2,496,000	353,000	14	350,000	462,000	131
III	5	2	2,352,000	256,000	11	362,000	256,000	71
IV	8	1	3,331,000	--	-	406,000	259,000	64
V	15	7	4,531,000	631,000	14	757,000	631,000	83
Sub-Total	54	23	26,665,000	2,078,000	8	3,664,000	3,368,000	92
VI	10	10	316,909,000	9,608,000	3	37,487,000	18,898,000	50
VII	6	6	94,800,000	32,840,000	35	31,077,000	35,500,000	114
VIII	4	4	10,550,000	3,185,000	30	1,962,000	3,185,000	162
Sub-Total	20	20	422,259,000	45,633,000	11	70,526,000	57,583,000	82
Total	74	43	448,924,000	47,711,000	11	74,190,000	60,951,000	82

1/ Present combined sewer overflow load does not include the load from those combined systems discharging raw, untreated waste.

overflows in this section represent a very small portion of the total municipal load because, based upon the methodology used, four of the eight combined systems discharging without treatment were not considered to contribute to the present overflow load.

The combined sewer overflow load in Sections VI, VII and VIII was estimated to be 11 percent of the total municipal load. Wide discrepancies between the overflow and municipal discharge loads were found among the respective sections. In Section VI, combined sewer overflows contributed only 3 percent of the municipal load. This results from the large raw discharges from Manhattan with the assumption of no associated combined sewer overflow and the municipal discharge from the Passaic Valley Sewerage Commission, which discharges its combined sewer overflow to waters outside the conference area. In contrast, the combined sewer overflow load in Sections VII and VIII was approximately one-third the municipal load. In both these sections, the large metropolitan service areas are characterized by dense urban development with generally high runoff coefficients which increase combined sewer overflows, while there is a significant reduction of the municipal discharge load through treatment.

Future Combined Sewer Overflow Load

After implementation of the conference recommendations, the significance of the pollutional load from combined sewer overflows becomes more apparent. Overflow loads will then be greater than 80 percent of the municipal discharge load, or 61,000,000 versus 74,200,000 pounds of BOD per year. A significant change occurs in Sections I through V, where the load from combined systems will be 92 percent of the municipal load or 3,400,000 versus 3,700,000 pounds of BOD per year. In Sections VI through VIII, combined sewer overflows will be 82 percent of the municipal discharge load, or 57,600,000 versus 70,500,000 pounds of BOD per year.

Although data are not available to include industrial waste discharge loads in the overall comparison with combined sewer overflows, an estimate was made to determine in which sections it will have the most significant effect. Large industrial discharges are known to exist in the Albany-Troy area(Section I) and in the Tarrytown area (Section V). When these industrial waste loads are considered, combined sewer overflow would drop to about 1.7 and 2.2 percent of the present load and 19.5 and 11.5 percent of the future load, respectively, in Sections I and V. The ratio of combined sewer overflow to total discharge load for other sections of the study area do not materially change.

Although this report is concerned primarily with the BOD load contained in combined sewer overflows, there are other pollutional characteristics such as suspended solids and bacteria that add to the total problem.

Suspended Solids

Overflows from combined sewers contain suspended solids normally found in municipal sewage and accumulated solids that have settled in sewers and are flushed out during periods of storm flow. This material constitutes a portion of the BOD contained in combined sewer overflows. It increases the turbidity of the receiving water and may settle to form oxygen demanding benthic deposits. The suspended solids concentrations found in combined sewer overflows from previous studies are summarized in Appendix Table A-1. Applying an average concentration for suspended solids to the estimated volume of combined sewer overflow after implementation of the conference recommendations indicates that approximately 150 million pounds per year will be discharged to the water of the conference area.

Bacteria

Combined sewer overflows have been found to contain densities of coliform organisms in the order of magnitude of that present in raw sewage.[(6)]

Other studies have indicated that coliform densities increased by a factor of ten in the vicinity of combined sewer overflows, and persisted for periods of several days. It is reasonable to assume that similar conditions would occur in the conference area.

Effect on Water Uses

The conference recommendations specify in part that all wastes in the conference area "...require a design for an average removal of 90 percent of biochemical oxygen demand..." and "...effective disinfection of the effluents as required to protect water uses...". Combined sewer overflows will continue to introduce to the receiving water constituents that may temporarily violate the standards for the prescribed uses. Overflows contribute organic material which decrease dissolved oxygen, introduce floating, suspended and settleable material which reduce the aesthetic and recreational values of the water and increase bacterial densities which can constitute a danger to public health.

The future combined sewer overflow and municipal discharge loads in relation to the primary water uses as defined by the water quality standards are summarized in Table 3.

Of the 43 combined systems in the conference area, 16 will discharge overflows representing 2 percent of the total load, or 1,600,000 pounds of BOD per year, to waters classified for water supply and bathing. Overflows from 27 combined systems will discharge the remaining 59,000,000 pounds per year to water classified for fishing and navigation. A large portion of this latter discharge, however, affects bathing waters which are immediately adjacent to New York Harbor in the western end of Long Island Sound and the Lower Bay outside the Narrows. Water quality and dye studies conducted by the FWPCA in connection with the Conference on Pollution of Raritan Bay and

TABLE 3

Future Waste Loads as Discharged to Prescribed Water Use Areas

Primary Water Use	Section	Number Municipal Sources	Number Municipal Sources with Combined Systems	Future Waste Load	
				Municipal Discharge Lbs/yr.	Combined Overflow Sewer Lbs/yr.
Water Supply	II, III	14	8	712,000	718,000
Bathing	IV, V	23	8	1,163,000	890,000
Fishing	I, VI	27	17	39,276,000	20,658,000
Navigation	VII,VIII	10	10	33,039,000	38,685,000
Total		74	43	74,190,000	60,951,000

Adjacent Interstate Waters [7] showed that waste discharged to Upper Bay of New York Harbor affected the waters off Coney Island and Staten Island.

Methods of Correction (1) (5) (4)

Several alternatives are available for the elimination and/or treatment of the overflow from combined sewers. For the purpose of discussion, these methods have been divided into the following categories:

1. Separation of sewers
2. Storage and return to the system for treatment
3. Treatment at the point of overflow
4. Miscellaneous

Separation of Sewers

Complete Separation

New construction of waste collection systems favors a separation of stormwater and sanitary waste. One recommendation of the conferees in the Hudson River Enforcement Conference, September 1965, was "the construction of combined sewer systems in newly developed or redeveloped urban areas shall be prohibited". This recommendation has been effected for new construction throughout the conference area. The conferees also recommended elimination of combined sewers wherever feasible.

Complete separation of an existing combined system can be an enormous structural and economic undertaking. In many instances, the task is further complicated by the presence of underground utility lines (gas, electric, telephone, steam, etc.) and subways, and the traffic rerouting associated with open-cut excavations.

The American Public Works Association(1) has estimated that the cost of complete separation of sewers on a national basis will exceed $49 billion. These studies indicate average per acre costs of $13,000 and $19,000 and average per capita costs of $1125 and $700 for the Middle Atlantic and New England areas, respectively. It is reasonable to expect that costs for complete separation in the New York Metropolitan Area would be significantly higher than these estimates. Weighing these factors with the need for funds for other aspects of the pollution control program, complete separation does not appear feasible in the conference area.

Partial Separation

In lieu of complete separation, collection of either street runoff, roof drains, air conditioner flow or foundation drains for diversion to a separate collection system can represent an alternative which would partially alleviate the problem of combined sewer overflows. Partial separation has been calculated to reduce the total volume of runoff by 30-60 percent. The cost can be from 10-50 percent of that required for complete separation.[4]

Storage and Return to the System for Treatment

Methods for the storage of combined sewer overflow include: (1) utilization of excess capacity of the combined sewer, (2) underground storage facilities such as tunnels, (3) surface structures such as holding basins, ponds or lagoons, and (4) inflatable underwater holding tanks. The stored wastewater would be returned to the system for treatment during low flow periods. Each of these methods has merit depending on the physical characteristics of the area, geological structure and proximity to a water body. Among the storm and combined sewer grants and projects that have been awarded by the FWPCA (see Appendix C), Minneapolis, Minn. is investigating in-sewer storage, Chicago, Ill. is constructing a tunnel for storage and several areas are studying inflatable tanks. Surface ponds and lagoons are feasible only where sufficient land is available near the point of overflow, i.e., in rural areas or close proximity to tidal or flood plain flatlands. When studies of these storage concepts are completed, the results will provide guidelines for recommending alternative solutions for other areas.

All methods which provide storage of combined sewer overflow will effect some degree of treatment by the removal of grit and other settleable solids. The need for collection and removal of this accumulated matter will increase operation and maintenance costs.

Treatment at the Point of Overflow

Various types and degrees of treatment may be effected at the point of overflow. Selection of the type of treatment should be dependent on the projected use of the receiving water. Treatment methods which can be used include disinfection, screening, settling or any combination of the three. Disinfection alone can significantly reduce the bacterial concentrations to levels required by the standards but will have little effect upon the solids and BOD concentrations present in the overflow. Chlorination, when applied at the proper dosage, will require effective contact time in terms of residence or flow time in the sewer or holding basin. High solids concentrations tend to reduce the bacteriocidal effects of the disinfectants resulting in the need for larger and costlier dosages. It has been estimated that the chlorine needed to disinfect a mixture of stormwater and sanitary sewage would be 20 percent greater than for sanitary wastes alone.[8]

Screening or microstraining at points of discharge can effectively reduce suspended solids and associated BOD, and the solids can then be returned to the intercepting sewer for transport to the treatment plant. This method is presently being investigated in the Philadelphia, Pa. area (see Appendix C).

The City of New York, with the aid of an FWPCA construction grant, has completed design and initiated construction of its first prototype "Auxiliary Water Pollution Control Plant" (see Appendix C). This study is supported by an FWPCA demonstration grant. The facility is designed to settle and disinfect overflows and return the impounded water and settled solids to the water pollution control plant. This project, located at Spring Creek in Jamaica Bay, also includes a study of the effect on water quality from the effluent.

Miscellaneous Methods

By the addition of polyelectrolytes to combined sewers, their capacity to carry greater volumes is increased. These polymers reduce friction and increase the hydraulic capacity by a factor greater than two. This method is presently being investigated with the aid of an FWPCA grant (see Appendix C).

Most combined sewers in the Hudson River Conference Area were built over 50 years ago. Interstate, state and local water pollution control agencies are concerned that population densities have increased such that the collection systems are overloaded, causing raw sewage to be by-passed to the receiving stream via structures intended to divert stormwater flow only. Many of these diversion structures are presently under-designed or mechanically inoperable without continuous maintenance. Improved diversion chambers with anti-fouling mechanisms or devices automatically controlled in conjunction with flood routing of storm induced flows would result in improved sewer efficiency and a reduction in the number and frequency of combined sewer overflow. An FWPCA grant has been given the City of New York to construct and evaluate a new diversion structure design which is intended to eliminate dry weather discharge and increase interceptor efficiency during storm flows (see Appendix C).

Constant changes in zoning with resultant increases in population densities, and change in land use patterns and surface characteristics can impose conditions for which sewers were not designed. Through proper regional planning it may be possible to control land use and maximize the capabilities of a collection system to reduce combined sewer overflows.

Infiltration is a major problem in many collection systems, both old and new, and the increased flow often results in overflows even without rainfall. Rigid specifications should be adopted and enforced regarding methods of joining pipe sections, including more stringent construction inspection and testing. The evaluation of infiltration problems in old collection systems should be encouraged together with the establishment of logical long-range programs to correct dificiencies and replace or repair sewer lines as required. For existing sewers, recent innovations for television inspection and in-place sealing have become available.

Discussion

A conservative approach was taken in developing the data discussed in this report. For example, values for the runoff coefficient "C" were reduced because an annual average rainfall intensity was utilized in computing combined sewer overflow volumes. The use of a lower runoff coefficient was substantiated by comparison with runoff coefficients computed from actual rainfall-runoff data collected by the Federal Water Pollution Control Administration, Delaware Estuary Comprehensive Study. Lower values of BOD in combined sewer overflows were applied to the less urbanized communities as opposed to the large, densely populated Metropolitan areas.

Many factors complicate the solution of the combined sewer overflow problem. The foremost of these is the necessity of channeling presently available funds into areas of more immediate need, namely the construction of municipal waste treatment facilities. Also, the construction of combined sewer overflow treatment facilities will not completely eliminate the problem because, at this time, it appears that technical and economic problems preclude the design of a system which provides complete treatment of overflows from all storms. Systems can be designed, however, to provide minimum treatment for most overflows.

Another factor affecting the solution to the problem is the existence of combined sewer collection systems which have been designed and constructed many years ago. Hydraulic loads to intercepting sewers and diversion structures in these systems often exceed design capacity. This results in more frequent overflows during storm periods and in some cases the diversion of raw sewage during dry weather periods. Many of the existing diversion structures are mechanical devices which foul readily and function inefficiently. Before a massive construction program of combined sewer overflow treatment facilities is initiated, a program of maintenance and/or modernization of the diversion structures should be undertaken.

There is a lack of sufficient quantitative information on the characteristics of combined sewer overflows, particularly in the Hudson River Conference Area. It is known that land use and developmental characteristics of a given community or municipality greatly affect the quality and quantity of combined sewer overflows. Most previous studies have been conducted in larger cities which have high runoff characteristics, high population densities and areas of commercial and/or industrial activities. Very few studies have been conducted in less urbanized, lower population density areas such as those located in the middle Hudson River Valley. Few studies have been conducted which show the effect of combined sewer overflows on the receiving water body. Studies such as those presently being carried out by the City of New York in Jamaica Bay for the "Spring Creek Auxilliary Water Pollution Control Program" will add significantly to knowledge regarding these effects. Additional comprehensive studies should be conducted in other water bodies (i.e. fresh water and salt water) classified for different water uses (i.e. water supply, bathing, fishing and shellfishing) which receive combined sewer overflows. The effect of various land use characteristics should be integrated into such a program wherever possible.

The method to treat combined sewer overflow is dependent on many factors such as economics, a feasible treatment process and the availability of space within close proximity of the overflow point. In the rural middle and Upper Hudson Valley, land might be available for the construction of treatment facilities at the point of overflow. In the urbanized New York Metropolitan area surrounding New York Harbor, where space is at a premium and land costs are high, a combination of methods such as increased utilization of in-sewer storage through automated overflow regulators, inflatable storage in the receiving water with return to the system for treatment or some method of treatment at the point of overflow might prove feasible. The City of New York is awaiting an evaluation of its Spring Creek-Jamaica Bay prototype installation before recommending a course of action for future auxilliary projects.

To receive the maximum benefit from a combined sewer overflow abatement program, remedial action should first be undertaken in high priority water use areas. These include Sections II, III, IV, and V in the Hudson River and the Sections in the New York Metropolitan Area which affect the recreational waters immediately adjacent to the conference area. The health hazard resulting from the discharge of bacteria in the overflows may be of prime concern with regard to the established water uses. The program may then be extended to areas of less critical water uses, or to sections where the water quality standards may be upgraded in the future.

Bibliography (References)

1. Federal Water Pollution Control Administration, U. S. Department of Interior, "Problems of Combined Sewer Facilities and Overflows, (1967), WP-20-11.

2. Stanley, R. H., "How to Analyze Combined Sewage-Storm Water Collection Systems", Water and Wastes Engineering, 3, 3, 58 (March 1966) and 3, 4, 48 (April 1966).

3. Federal Water Pollution Control Administration, U. S. Department of Interior, Delaware Estuary Study, Chapter 4, Section F, Storm Water Overflow, to be published July 1969.

4. Dunbar, D. D., Henry, J. G. F., "Pollution Control Measures for Stormwaters and Combined Sewer Overflows", Journal of the Water Pollution Control Federation, 38, 1, 9 (January 1966).

5. U. S. Department of Health, Education and Welfare, Public Health Service, "Pollutional Effects of Stormwater and Overflows from Combined Sewer Systems", Public Health Service Publication No. 1246, (November 1964).

6. Burm, R. J., "The Bacteriological Effect of Combined Sewer Overflows on the Detroit River", Journal of the Water Pollution Control Federation, 39, 3, 410 (March 1967).

7. U. S. Department of the Interior, Federal Water Pollution Control Administration, Northeast Region, Raritan Bay Project, Edison, N. J., "Report for the Conference on Pollution of Raritan Bay and Adjacent Interstate Waters", Third Session, May 1967.

8. Camp, T. R., "Chlorination of Mixed Sewage and Stormwater", Journal San. Eng. Div., Proc. Amer. Soc. Civil Engr., 87, SA 1, 1 (1961).

9. Chanin, G., "Summary of Storm Water Studies at the East Bay Municipal Utility District's Wastewater Treatment Plant" Oakland, California, (Undated memorandum).

10. Riis-Carstensen, E., "Improving the Efficiency of Existing Interceptors", Journal of the Water Pollution Control Federation, 27, 10, 1115 (October 1955).

11. Burm, R. J., and Vaughan, R. D., "Bacteriological Comparison between Combined and Separate Sewer Discharges in Southeastern Michigan", Journal of the Water Pollution Control Federation, 38, 3, 400 (March 1966).

12. Burm, R. J., Krawczyk, D. F., and Harlow, G. L., "Chemical and Physical Comparison of Combined and Separate Sewer Discharges", Journal of the Water Pollution Control Federation, 40, 1, 112 (January 1968).

13. U. S. Department of Health, Education and Welfare, Public Health Service, Division of Water Supply and Pollution Control, Great Lakes - Illinois River Basins Project, "Report on the Illinois River System - Water Quality Conditions", Part I Text; Chicago, Illinois, (1963).

14. Weibel, S. R., Anderson, R. J., and Woodward, R. L., "Urban Land Runoff as a Factor of Stream Pollution", Journal of the Water Pollution Control Federation, 36, 7, 914 (July 1964).

15. American Public Works Association, "Interpretive Data, Combined Sewer Overflows", Appendix B, Questionnaire, 1967.

16. Benjes, H. H., Haney, P. D., Schmidt, O. J. and Yorabeck, R. R., "Storm-Water Overflows from Combined Sewers", Journal of the Water Pollution Control Federation, 33, 12, 1252, (December 1961).

17. Benzie, W. J. and Courchaine, R. J., "Discharges from Separate Storm Sewers and Combined Sewers", Journal of the Water Pollution Control Federation, 38, 3, 410 (March 1966).

18. Camp, T. R., "The Problem of Separation in Planning Sewer Systems", Journal of the Water Pollution Control Federation, 38, 12, 1959 (December 1966).

19. Chow, V. T., "Handbook of Applied Hydrology", McGraw-Hill Book Company, 1964, p14-8.

20. City of New York, Department of Public Works, Bureau of Water Pollution Control, "A Presentation on the New York City Water Pollution Program", September 1967.

21. Evans, L. S. III, Geldreich, E. E., Weibel, S. R., and Robeck, G. G., "Treatment of Urban Stormwater Runoff", Journal of the Water Pollution Control Federation, 40, 5, R162 (May 1968).

22. Federal Water Pollution Control Administration, U. S. Department of the Interior, "Inventory of Municipal Waste Facilities", (1968, unpublished).

23. Geldreich, E. E., Best, L. C., Kenner, B. A., and Van Donsel, D. J. "The Bacteriological Aspects of Stormwater Pollution", Journal of the Water Pollution Control Federation, 40, 11, 1861 (November 1968).

24. Hess, S. G., and Manning, F. G., "A Rational Determination of Storm Overflows from Intercepting Sewers", Journal of the Water Pollution Control Federation, 22, 2, 145 (February 1950).

25. Johnson, C. Frank, "Equipment, Methods, and Results from Washington, D. C., Combined Sewer Overflow Studies." Journal of the Water Pollution Control Federation, 33, 7, 721, (July 1961).

26. Moorehead, George J., "Overflows from Combined Sewers in Washington, D. C." Journal of the Water Pollution Control Federation, 33, 7, 711, (July 1961).

27. New York State Department of Health, "Existing Polluter Printout", April 1968.

28. Palmer, C. L., "Feasibility of Combined Sewer Systems", Journal of the Water Pollution Control Federation, 35, 2, 162 (February 1963).

29. Palmer, C. L., "The Pollutional Effects of Storm Water Overflows from Combined Sewers", Journal of the Water Pollution Control Federation, 22, 2, 154 (February 1950).

30. Romer, H., and Klashman, L. M., "The Influence of Combined Sewers on Pollution Control", Public Works, March, April, 1962.

31. Weather Bureau, U. S. Department of Commerce, "Hourly Precipitation Data", New York, (1961).

APPENDIX A

PREVIOUS STUDIES

Studies of Combined Sewer Systems

East Bay Metropolitan Utility District, Oakland, Calif. (5) (9)

Of the six cities connected to the wastewater treatment plant, only Oakland retains combined sewers which generate overflows through diversion structures. These structures permit stormwater-diluted wastewater to pass through outfalls to San Francisco Bay. In spite of the essentially separate collection system, wastewater flows in the interceptors increase substantially during storms. Because the treatment plant will not accommodate the increased flow, it is necessary to bypass the plant during storms.

Extensive sampling of the various features of the system indicated that substantial pollutional loads as measured by organic and inorganic standards are carried by the combined sewer overflows. In addition, the effect of overflows on the receiving streams was also examined. The effect was clearly shown by the increase in BOD concentration from an average of 6.8 mg/l above to 25 mg/l below the overflow discharge and the increase in coliform levels from an average of about 2,000/100 ml to 40,500/100 ml.

Buffalo, N. Y. (5) (10)

In Buffalo, a number of methods were investigated with the objective of reducing pollution from combined sewer overflows. A special term "Ch", or characteristic factor, was introduced as a method of compensating for variables in population density and runoff coefficient. The results of the study indicated that it was not possible to calculate a favorable balancing of diversion factors for an actual combined sewer system.

Detroit, Michigan (11) (12)

This investigation involved a sampling program of the outfalls of combined sewers in the Detroit area. The Detroit-Connors Creek combined sewer system, located in the northwest portion of the city, serves about 25 percent of the city population in an area of approximately 22,000 acres. Total coliform concentrations were found to approach those in raw wastewater.

Philadelphia, Pennsylvania (3)

An investigation was conducted to evaluate the significance of combined sewer overflows in the Delaware Estuary at Philadelphia. An automatic instrumentation system was developed to record combined-sewer overflows and determine the quality of these overflows at six outfalls in Philadelphia. Data from two of the outfalls were generated continuously for a period of two years. A network of 21 rain gages was installed at strategic locations in the city.

It was found that on the average, combined-sewer overflows contributed approximately 6 percent of the total carbonaceous oxygen demanding material to the Delaware Estuary. Since the investigation was conducted during an extended drought period, this was considered a conservative estimate.

Illinois River System (5) (13)

A 9-month study was carried out in Chicago, Illinois in an area of about 8.6 square miles served by the Roscoe Street sewer. During the study period 31 storms occurred. The total BOD load discharged to the stream was computed at 278,000 lbs. These figures were used to estimate the total BOD overflow load to the canal system. Flow data from three major plants were used for the computation and on this basis the average total BOD overflow load was calculated to be 46,900 lbs/day.

Detroit River (6)

The Detroit River was studied to determine the effects of combined sewer overflows on stream coliform densities. The effects of the discharges from combined sewers were evident for several days after the actual overflows had ceased. The duration of adverse effects on the river was directly proportional to the intensity of the storm. After a moderate rain, the relative increase in coliform density was greater than a thousandfold within a few miles of the discharge points. Patterns of fecal coliform and fecal streptococcus densities were similar to those of the total coliforms, but to a lower order of magnitude. Total coliform densities exceeded 100,000/100 ml in a large volume of the receiving water after a moderate rain, and exceeded 1,000,000/100 ml after a severe storm.

Jamaica Bay

In 1968, the Federal Water Pollution Control Administration, with the cooperation of the City of New York, conducted a bacteriological survey in Jamaica Bay to evaluate the significance of seasonal versus year round chlorination of treatment plant effluents. Results indicated a reduction in the steady state coliform levels to approximately 3,000/100 ml near the point of discharge after the start of chlorination. During periods of combined sewer overflow, coliform levels increased by at least a factor of ten and persisted for a period of approximately three days.

Summary

As a result of these studies, there is little doubt that combined sewer overflows are important sources of water pollution.

Table A-1 is a compilation of data gathered from these investigations regarding the quality of overflow discharges.

Studies of Separate Stormwater Systems

Cincinnati, Ohio (14)

This study, conducted over a one-year period (July 1962 - September 1963), investigated the pollutional characteristics of urban land runoff. The study covered a 27 acre residential and light industrial section of the city served by separate sewers. The study area consisted primarily of single family homes, apartments and commercial buildings. The population density was nine persons per acre. The results indicated that the BOD from surface runoff is about equal to that expected from the effluent of a secondary sewage treatment plant, but suspended solids concentrations are equivalent to those found in raw domestic sewage.

Detroit, Michigan (11) (12)

A study was conducted which included the sampling of the Ann Arbor - Allen Creek stormwater drain serving approximately 3,800 acres. This area included residential, commercial and light industrial sections as well as some undeveloped area. Results indicated that:

1. BOD in separate stormwater discharges was generally about one-fifth of that observed in combined sewer overflows.

2. Total coliform densities were approximately one-tenth of those in combined sewer overflows.

Washington, D. C. (5)

A study was conducted to obtain data on street runoff. Limited sampling at catch basins during storm periods indicated that the average BOD concentrations in the stormwater runoff from this urbanized area was 126 mg/l. The average concentration of suspended solids was found to be 2,100 mg/l.

East Bay Metropolitan Utility District, Oakland, Calif. (5) (9)

Sampling during storm periods at 21 sampling stations located throughout the East Bay Metropolitan Area indicate that these flows contained substantial pollutional loads. The results, as reported, showed that BOD concentrations ranged from 3 to over 700 mg/l with an average concentration of 87 mg/l. Coliform densities (MPN/100 ml) ranged from 4 to 70,000 and averaged 11,800. The average concentration of suspended solids was 613 mg/l with a range of 16 to 4,400 mg/l.

Los Angeles Flood Control District (5)

A study, by the Water Conservation Division of the Los Angeles Flood Control District, determined the quality of stormwater for the purpose of investigating the feasibility of replenishment of groundwater supplies. Average BOD concentrations during the storm seasons of 1932-34, 1957-58 and 1962-63 were 6.9 mg/l, 8.2 mg/l and 16.1 mg/l, respectively. The results also indicated that in the early period of storms BOD concentrations were about 70 mg/l and decreased to around 10-20 mg/l as the storm continued.

Table A-2 is a summary of the results of studies conducted on stormwater runoff collection systems.

TABLE A-1

Quality Characteristics of
Combined Sewer Overflows for Various Studies

Combined-Sewer Overflow Study Areas	Average Total Coliform per 100 ml	Average Susp. Solids (mg/1)	Average 5-Day BOD (mg/1
Oakland, California			
East Bay Met. Utility Dist.			
Interceptor Flows	293,000	128	180
Plant Bypassed Flows	1,408,000	253	133
Detroit Michigan			
Corner Street Sewer System	37,000,000	274	153
Buffalo, New York			
Bird Ave. Sewer	--	544	100
Baily Ave. Sewer	--	436	121
Philadelphia, Pa.			
WIN - H St. & Ramona	--	330	145
SUS - Wildey & Susquehanna Ave.	--	484	152
BING - Garland & Bingham St.	--	373	192
CHRIS - Water & Christian St.	--	573	243

TABLE A-2

Quality Characteristics of
Stormwater Runoff Collection Systems

Stormwater Collection System Study Areas	Average Total Coliform MPN/100 ml	Average Suspended Solids (mg/l)	Average 5-Day BOD (mg/l)
Cincinnati, Ohio	--	208	21
Ann Arbor - Allen Creek (Detroit, Michigan)	--	2,080	28
Washington, D.C.	--	2,100	126
East Bay Met. Utility Dist.	11,800	613	87
Los Angeles Flood Control Dist. (1962-63)	--	2,909	16

APPENDIX B

DISCUSSION OF METHODOLOGY

APPENDIX B

Discussion of Methodology

A summary of data and results of discharge load computations for all municipal waste systems which significantly affect the waters of the Hudson River Conference Area is presented in Table B-1. Discharge loads were computed on the basis of present conditions and estimates prepared which represent conditions after implementation of the conference recommendations. Assumptions used are described as footnotes in the Table.

The data used in computing the combined sewer overflow loads and the results of these computations are summarized in Table B-2. The basic equations employed were:

$$Q_o = CIA + Q_d - Q_p \qquad 1)$$

$$L_o = Q_o \times \frac{T}{24} \times B_o \qquad 2)$$

The methodology used in developing the entries in Table B-2 follow.

Column (1) - Combined Sewer Systems, (2) - Estimated Population Served, (3) - Area Served, (4) - Population Density, (5) - Treatment Plant Capacity, (6) - Average Dry Weather Flow

All collection systems served by combined sewers are listed, including raw discharges. Data were obtained from FWPCA Municipal Waste Inventory, 1968,[22] New York State Existing Polluter Printout,[27] a New York City Publication,[20] FWPCA Report WP-20-11[15] and correspondence with the States of New York and New Jersey and the Interstate Sanitation Commission. For certain selected communities with large tracts of undeveloped marginal lands, the area served was derived by measurement from USGS quadrangle topographic maps. When actual data were not available, dry weather flow was computed on the basis of the population served and a per capita flow of 100 gallons per day.

Column (7) - Average Runoff Coefficient

The runoff coefficient for a given area depends upon both natural topography and patterns of land development. Runoff coefficients used for this report are based upon those published by Chow,[19] which were originally formulated as the basis for (1) calculating runoff for storms of high intensity and (2) calculating runoff at peak flow conditions.

However, the coefficient of runoff to be used to calculate average flow conditions is less than the coefficient for determining peak runoff during any storm. For the purposes of this investigation, the runoff coefficients as published in Chow[19] were reduced by one-third. This reduction was substantiated by comparing computed runoff coefficients from prototype data collected by the FWPCA, Delaware Estuary Comprehensive Study, with the values listed in Chow. The computed values were found to be approximately one-third less than those published.

Exceptions to the above rationale were made for Manhattan and portions of the Bronx, Queens and Brooklyn. These areas, which are unique in terms of population density and land use characteristics, are served by the Wards Island, Newtown Creek, Red Hook and Manhattan collection systems. The runoff coefficients for these areas were not reduced as described above. The coefficients used were the mean of the ranges given by Chow[19] for areas characterized as (1) Business: Downtown Areas and (2) Residential: Apartment Dwellings.

Column (8) - Average Storm Intensity

Rainfall data for the study area were obtained from the Environmental Science Service Administration, Weather Bureau for stations located at Albany-City, Poughkeepsie-1 N and New York-Central Park. Data for 1961, an average precipitation year, were used in the computations.

All rainfall falling on a given area does not produce combined sewer overflow. To determine the minimum intensity which would produce overflow in each of the systems, the following expression was used:

$$Q_o = Q_s + Q_d - Q_p \qquad 3)$$

Q_o = combined sewer overflow

Q_s = stormwater flow

Q_d = average dry weather flow

Q_p = treatment plant capacity

At the time just before overflow begins, $Q_o = 0$ and $Q_s = CIA$. Substituting in equation 3) and solving for I,

$$I_{Min} = \frac{Q_p - Q_d}{CA} \qquad 4)$$

Example calculation - Bayonne, N. J.

A = 1260 acres

Q_p = 20 MGD

Q_d = 8 MGD

C = 40%

$$I_{Min} = \frac{20.0\ MGD - 8.0\ MGD}{.40 \times 1260\ acres} \times .645\ MGD/CFS$$

I_{Min} = 0.035 in/hr

Of the combined systems in the conference area, only five could accept rainfall intensities above the minimum (.01 in/hr) recorded by the Weather Bureau without causing an overflow. These five systems were the Owls Head and Newtown Creek sections of New York City, and Jersey City, Bayonne and Kearny, N. J.

The average intensity of rainfall for each collection system was computed by using the weighted average of all storms with intensities above the minimum required to produce overflow. The general equation used was:

$$I_{avg.} = \frac{I_i \times n_i}{n_i} \qquad 5)$$

where:

$I_{avg.}$ = average rainfall intensity (in/hr)

I_i = unit storm intensity (in/hr)

n_i = number of occurrences of unit storm intensity

Example calculation - Bayonne, N. J.

$$I_{avg.} = \frac{6.322}{83} = 0.076 \text{ in/hr}$$

Column (9) - Combined Sewer Overflow

The combined sewer overflow volume was calculated by using the data from columns (3), (5), (6), (7) and (8) and equation (1),

$$Q_o = CIA + Q_d - Q_p$$

For the systems which are presently discharging raw wastes, it was assumed that the future treatment plant capacity would be equal to the average dry weather flow (Column (6)). Therefore, the future overflow volume for these systems would be equal to Q_o = CIA.

Example calculation - Bayonne, N. J.

C = 40%

1 = 0.076 in/hr

A = 1260 acres

Q_d = 8.0 MGD

Q_p = 20.0 MGD

Q_o = 0.40 x 0.076 in/hr x 1260 acres x 0.645 MGD/CFS

+ 8.0 MGD - 20.0 MGD

Q_o = 12.7 MGD

Columns (10) and (11) - Combined Sewer BOD Load, Present and Future

The estimated BOD load was computed using equation (2),

$$L_o = Q_o \times \frac{T}{24} \times B_o$$

Two levels of BOD concentration were applied to combined sewer overflows in the study area. A concentration of 150 mg/l was applied to overflows in the New York Metropolitan area. This is approximately the mean of the data reported in the literature, with particular emphasis on data collected in large urban areas similar to those which exist in metropolitan New York, (i.e., Philadelphia, Detroit, etc.). A concentration of 40 mg/l was used for the less urbanized areas, namely those systems in Sections I through V, and for Edgewater, N. J., Kearny, N. J. and Port Richmond, Staten Island, N. Y. This value was the average of data obtained by computing the resultant BOD concentration for a mixture of raw sewage and stormwater runoff for several communities in the study area. As stated previously, collection systems presently discharging untreated wastes were not credited with combined sewer overflow loads, and were omitted from the listing of present loads, Column (10). After construction of treatment facilities, these systems would have overflow loads, and were therefore included in the future load tabulation, Column (11).

Example calculation - Bayonne, N. J.

Q_o = 12.7 MGD

T = 513 hrs/yr

B_o = 150 mg/l

$$L_o = 12.7 \text{ MGD} \times \frac{513 \text{ hrs/yr}}{24 \text{ hrs/day}} \times 150 \text{ mg/l} \times 8.35 \frac{\text{lbs/MG}}{\text{mg/l}}$$

L_o = 340,000 lbs/yr

TABLE B-1

Estimated Load from Municipal Discharges Hudson River Conference Area

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
						Municipal Discharge BOD Load		
Municipal Sewerage System	Type of System [a/]	Estimated Population Served	Type of Treatment	Treatment Plant Capacity (MGD)	Average Dry-Weather Flow (MGD) [b/]	Present (Lbs/day) [c/]	Present (Lbs/yr)	Future (Lbs/yr) [d/]
			Section I - Troy to New Baltimore					
Pleasantdale	S	840	None	--	0.08	143	52,000	5,000
Troy	C	67 673	None	--	6 80	11,500	4,200,000	420,000
East Greenbush	S	5,200	Primary	75	0 52	575	210,000	32,000
Castleton-On-Hudson	C	1.752	None	--	0.18	298	110,000	11,000
Rensselaer	C	10,506	None	--	1 05	1,786.02	652,000	65,000
Latham S. D. Colonie	S	7,000	Primary	77	0.70	774	283,000	43,000
Delmar & Elsmere S. D. Bethlehem	S	11,900	Primary	1 60	1 20	1,320	480,000	74,000
Maplewood S. D. Colonie	S	2,500	Primary	2 50	0.25	276	101,000	16,000
Albany-Schenectedy S. D.	S	9,000	Primary	1.50	0.90	995	363,000	56,000
Cohoes	C	19,950	None	--	2 00	3,392	1,238,000	124,000
Green Island	B	3,533	None	--	0.35	601	219,000	22,000
Watervliet	C	14,000	Primary	2 00	1.40	1,552	566,000	87,000
Menands	S	2.304	None		0.24	392	143,000	14,000
Albany	C	126,000	Primary	30.00	12 60	13,923	5,082,000	782,000
West Albany	S	600	None	--	0.06	102	37,000	4,000
Colonie Latham	S	3.000	Primary	.77	0.30	332	121,000	19,000
Ravena	S	2,424	Primary	.21	0.24	268	98,000	15,000
Sub-Total		288,182					13.955,000	1,789,000

TABLE B-1 (cont'd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
						Municipal Discharge BOD Load		
Municipal Sewerage System	Type of System [a/]	Estimated Population Served	Type of Treatment	Treatment Plant Capacity (MGD)	Average [b/] Dry-Weather Flow (MGD)	Present [c/] (Lbs/day)	Present (Lbs/yr)	Future [d/] (Lbs/yr)
			Section II - New Baltimore to Esopus					
Greenport S. D.	S	1,500	Primary	0.15	0.15	166	61.000	9,000
Hudson	C	11,270	Primary	3 70	1 10	1,246	455,000	70,000
Coxsackie	C	2,849	None	--	0 30	484	177,000	18,000
Athens	C	1,754	None	--	0 20	298	109,000	11,000
Catskill	C	5,825	None	--	0 60	990	361,000	36,000
Whittier S. D.	S	250	Primary	0 10	02	28	10,000	2,000
Saugerties	B	3.250	Primary	0 80	0 50	359	131,000	20,000
Kingston	C	28,817	Primary	5.00	3.50	3,184	1,162,000	179,000
Tivoli	S	750	Primary	0.10	08	83	30,000	5,000
Sub-Total		56,265					2,496,000	350,000
			Section III - Esopus to Chelsea					
Highland S. D. Lloyd	C	5,000	Primary	0 50	0 20	553	202,000	31,000
Millbrook	S	1,823	Primary	0.15	0.18	201	73,000	11,000
Poughkeepsie	B	40,000	Primary	10.00	4 00	4,420	1,613 000	248,000
Arlington S. D. Poughkeepsie	S	8,000	Primary	1.00	0.80	884	323,000	50,000
Wappinger Falls	S	3,500	Primary	75	0.35	387	141,000	22,000
Sub-Total		58,323					2,352,000	362,000

TABLE B-1 (cont'd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
						Municipal Discharge BOD Load [d]		
Municipal Sewerage System	Type of System [a]	Estimated Population Served	Type of Treatment	Treatment Plant Capacity (MGD)	Average [b] Dry-Weather Flow (MGD)	Present [c] (Lbs/day)	Present (Lbs/yr)	Future (Lbs/yr)
Section IV - Chelsea to Bear Mountain Bridge								
Beacon	S	17,500	Primary	4.10	1.75	1,933	706,000	109,000
Newburgh	C	30,000	None	--	3 00	5,100	1,862,000	186,000
Cornwall	S	2,000	Primary	.240	0.20	221	81,000	12,000
New Windsor	S	6,250	Primary	625	.625	691	252,000	39,000
Cornwall S. D. #1	S	2,500	Primary	240	0.25	276	101,000	16,000
Highland Falls - North	S	4,469	Primary	1.00	.45	494	180,000	28,000
Cold Springs	S	2,083	None	--	0 20	354	129,000	13,000
Highland Falls - South	S	500	Primary	.1	.05	55	20,000	3,000
Sub-Total		65,302					3,331,000	406,000
Section V - Bear Mountain Bridge to New Jersey State Line								
West Haverstraw	S	6,500	Primary	.30	0.65	718	262,000	40,000
Haverstraw	S	6,000	Primary	1.00	0.60	663	242,000	37,000
Upper Nyack	S	900	Primary	0.11	0.09	99	36,000	6,000
Nyack	S	5,300	Primary	.80	0.53	586	214,000	33,000
South Nyack	S	3,200	Primary	30	0.32	354	129,000	20,000
Orangetown S. D. #2	S	34,000	Primary	8 50	5.00	3,757	1,371,000	211,000
Peekskill	B	18,000	Intermediate	3.00	1.80	910	335,000	112,000
Croton-On-Hudson	S	3,920	Primary	0.75	0.40	433	158,000	24,000
Ossining-Water St. STP	B	14,000	Primary	2.00	1.40	1,547	565,000	87,000
Briarcliff Manor #1	B	125	Primary	.044	0.01	14	5.000	1,000
N. Tarrytown	B	9,100	Primary	1.70	0.90	1,006	367,000	56,000
Tarrytown	B	10,000	Primary	1.50	1.00	1,105	403,000	62,000
Irvington	S	4,000	Primary	1.00	0.40	442	161,000	25,000
Ossining-Liberty St. STP	B	2,000	Primary	1.40	.20	221	81,000	12,000
Briarcliff Manor #2	B	5,000	Primary	0.45	0.50	553	202,000	31,000
Sub-Total		122,045					4,531,000	757,000

TABLE B-1 (cont'd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
						Municipal Discharge BOD Load d/		
Municipal Sewerage System	Type of System a/	Estimated Population Served	Type of Treatment	Treatment Plant Capacity (MGD)	Average Dry-Weather Flow (MGD) b/	Present c/ (Lbs/day)	Present (Lbs/yr)	Future (Lbs/yr)
			Section VI - New Jersey State Line to The Narrows					
Edgewater	C	11.700	Primary	4 40	2.30	1,700	620,000	73,000
Hoboken	C	97,000	Primary	20 80	15 30	10,700	3,900.000	602,000
West New York	C	52.600	Primary	10 00	5 50	5.830	2,130,000	326,000
Jersey City-East Side	C	160.000	Primary	46 00	29 10	17,700	6,460 000	993,000
North Bergen	C	15,000	Primary	3 30	2 00	1 650	604.000	93,000
Passaic Valley Sewerage Commission	B	1.200.000	Primary	240	242 00	563.000	205,495,000	22,800,000
Yonkers	B	500.000	Primary	63 00	62.00	55.200	20.200,000	3,100,000
Manhattan	C	811 400	None	--	113 50	125,000	45,600,000	4,560,000
Red Hook	C	235,000	None	--	32 20	35,400	12,900,000	1,290,000
Owls Head	C	800 000	--	160 00	92.00	52,000	19,000,000	3,650,000
Sub-Total		3.882.700					316.909,000	37,487,000
			Section VII - East River					
Wards Island	C	1.250 000	--	220 00	210.00	57.000	20,800,000	9,617,000
Hunts Point	C	703,000	--	150 00	120 00	33.500	12,200.000	4,526,000
Bowery Bay	C	637,000	--	120 00	100 00	52.000	18.950.000	6,351,000
Newtown Creek	C	763.600	--	310 00	110 00	51,000	18.600.000	6,205,000
Tallman's Island	C	390.000	--	60 00	42 00	21,500	7,850.000	2,738,000
Manhattan	C	291,400	None	--	41 00	45.000	16.400.000	1,640,000
Sub-Total		4,035.000					94.800.000	31,077,000
			Section VIII - Newark Bay and Kill Van Kull					
Bayonne	C	74,000	Primary	20 00	8.00	8,200	2,990,000	459,000
Jersey City-West Side	C	110,000	Primary	36.00	15 70	12,200	4,450,000	683,000
Kearny	C	32,100	Primary	4 00	3.20	3,540	1,290,000	199,000
Port Richmond	B	131,000		10.00	10.00	5,000	1,825,000	621,000
Sub-Total		347,100					10,555,000	1,962,000
Total		8,854,917					448.929,000	74,190,000

TABLE B-1 (cont'd.)

a/ S = Separate sewer collection system
C = Combined sewer collection system
B = Separate and combined sewer collection system

b/ Actual flow if available. Where not available, computed using the estimated population served and a per capita flow of 100 gallons per day.

c/ Where plant data were not available, waste load was computed based upon the population served and a factor of 0.17 pounds of BOD per capita per day. Treatment plants were credited with 35 percent BOD removal for primary treatment and 70 percent removal for intermediate treatment.

d/ Calculated on the assumption that implementation of the conference recommendations require all wastes receive an average of 90 percent removal of BOD.

TABLE B-2

Estimated Load from Combined Sewer Overflows Hudson River Conference Area

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
									Combined Sewer BOD Load	
Combined Sewer Systems	Estimated Population Served	Area Served (acres)	Population Density (Persons/acre)	Treatment Plant Capacity (MGD)	Average Dry-Weather Flow (MGD)	Runoff Coefficient (Percent)	Average Storm Intensity (in/hr)	Combined Sewer Overflow (MGD)	Present (Lbs/yr)	Future (Lbs/yr)
Section I - Troy to New Baltimore										
Albany	126,000	8,544	14.7	30 00	12.60	35	0.056	90 60	768,000	768,000
Watervliet	14,000	705	19 9	2.00	1.40	35	0.056	8.30	70,000	70,000
Castleton-On-Hudson	1,752	384	4.6	--	0.18	25	0 056	3 50	--	29,000
Rensselaer	10,506	1,790	5.9	--	1.05	25	0.056	16 20	--	137,000
Troy	67,673	6,450	10 5	--	6.80	35	0.056	81.60	--	691,000
Green Island	3,533	510	6 9	--	0.35	25	0.056	4.60	--	39,000
Cohoes	19,950	2,430	8.2	--	2 00	35	0 056	30 70	--	260,000
Sub-Total	243,414	20,813							838,000	1,994,000
Section II - New Baltimore to Esopus										
Hudson	11,200	1,000	11.2	3 70	1.10	30	0.056	8.3	70,000	70,000
Kingston	28,817	2,540	11.3	5.00	3 50	25	0.048	18 2	189,000	189,000
Saugerties	3,250	1,000	3 2	0.80	0.50	30	0.048	9 0	94,000	94,000
Catskill	5,825	500	11.6	--	0 60	30	0.056	5.4	--	46,000
Athens	1,754	333	5.3	--	0.20	20	0 056	2.4	--	20,000
Coxsackie	2,849	711	4.0	--	0 30	20	0.056	5.1	--	43,000
Sub-Total	53,695	6,084							353,000	462,000
Section III - Esopus to Chelsea										
Highland	5,000	792	6.3	0.50	0.20	20	0 048	4.6	48,000	48,000
Poughkeepsie	40,000	2,400	16 7	10.00	4.00	35	0.048	20.0	208,000	208,000
Sub-Total	45,000	3,192							256,000	256,000

TABLE B-2 (cont'd.)

(1) Combined Sewer Systems	(2) Estimated Population Served	(3) Area Served (acres)	(4) Population Density (Persons/acre)	(5) Treatment Plant Capacity (MGD)	(6) Average Dry-Weather Flow (MGD)	(7) Runoff Coefficient (Percent)	(8) Storm Intensity (in/hr)	(9) Sewer Overflow (MGD)	(10) Combined Sewer BOD Load Present (Lbs/yr)	(11) Combined Sewer BOD Load Future (Lbs/yr)
Section IV - Chelsea to Bear Mountain Bridge										
Newburgh	30,000	2,300	13.0	--	3.00	35	0.048	24.9	--	259,000
Sub-Total	30,000	2,300							--	259,000
Section V - Bear Mountain Bridge to New Jersey State Line										
Peekskill	18,000	2,880	6.3	3.00	1 80	25	0.051	22.5	218,000	218,000
Ossining	14,000	1,920	7.3	2 00	1.40	25	0.051	14.0	136,000	136,000
Briarcliff Manor	125	540	23	0 044	0.01	20	0 051	3.5	34,000	34,000
N. Tarrytown	9,100	1,410	6.5	1 70	0.90	25	0 051	10.8	105,000	105,000
Tarrytown	10,000	1,790	5.6	1 50	1.00	25	0.051	14.2	138,000	138,000
Sub-Total	51,225	8,540							631,000	631,000
Section VI - New Jersey State Line to The Narrows										
Hoboken, West New York, Union City & Weehawken	149,600	2,680	55.8	30.80	20.80	40	0.051	25.3	921,000	921,000
Edgewater	11,700	890	13.1	4 40	2.30	35	0 051	8.2	79,000	79,000
Yonkers	500,000	2,700	185.2	63.00	62.00	40	0.051	34.5	1,255,000	1,255,000
Manhattan	811,400	7,402	109.6	--	113.50	80	0.051	195.0	--	7,100,000
Red Hook	235,000	3,054	76.9	--	32.20	60	0.051	60.3	--	2,190,000
Owls Head	800,000	12,947	61.8	160.00	92.00	45	0.063	169.0	5,640,000	5,640,000
No. Bergen	15,000	550	27.3	3.30	2.00	35	0.051	5.0	182,000	182,000
Jersey City	160,000	3,880	41.2	46.00	29.10	40	0.063	46.1	1,531,000	1,531,000
Sub-Total	2,682,700	34,103							9,608,000	18,898,000

TABLE B-2 (cont'd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
									Combined Sewer BOD Load	
Combined Sewer Systems	Estimated Population Served	Area Served (acres)	Population Density (Persons/acre)	Treatment Plant Capacity (MGD)	Average Dry-Weather Flow (MGD)	Runoff Coefficient (Percent)	Storm Intensity (in/hr)	Sewer Overflow (MGD)	Present (Lbs/yr)	Future (Lbs/yr)
					Section VII - East River					
Wards Island	1,250,000	12,056	103.7	220.00	210.00	60	0.051	228.0	8,300,000	8,300,000
Hunts Point	703,000	16,664	42.2	150.00	120.00	40	0.051	189.0	6,870,000	6,870,000
Bowery Bay	637,000	15,203	41.9	120.00	100.00	40	0.051	180.0	6,550,000	6,550,000
Newtown Creek	763,600	11,394	67.0	310.00	110.00	60	0.103	255.0	4,720,000	4,720,000
Tallman's Island	390,000	16,860	23.1	60.00	42.00	35	0.051	176.0	6,400,000	6,400,000
Manhattan	291,400	2,775	10.5	--	41.00	80	0.051	73.0	--	2,660,000
Sub-Total	4,035,000	74,952							32,840,000	35,500,000
				Section VIII - Newark Bay and Kill Van Kull						
Bayonne	74,000	1,260	58.7	20.00	8.00	40	0.076	12.7	340,000	340,000
Jersey City	110,000	4,470	24.6	36.00	15.70	40	0.063	52.3	1,745,000	1,745,000
Port Richmond	131,000	7,740	16.9	10.00	10.00	35	0.051	89.0	863,000	863,000
Kearny	32,100	1,692	19.0	4.00	3.20	40	0.063	26.7	237,000	237,000
Sub-Total	347,100	15,162							3,185,000	3,185,000
Total	7,488,134	165,146							47,711,000	61.185.000

APPENDIX C

LIST OF FWPCA GRANTS AND CONTRACTS FOR THE INVESTIGATION OF STORM AND COMBINED SEWER OVERFLOWS

A listing of Federal Water Pollution Control Administration sponsored grants and contracts for the investigation of combined sewer overflows and stormwater runoff is provided in Tables C-1 and C-2. These grants and contracts are designed to assist projects which will develop or demonstrate a new or improved method of controlling the discharge into any waters of untreated or inadequately treated wastes from sewers which carry stormwater or both stormwater and sewage.

TABLE C-1

WATER POLLUTION CONTROL

STORM AND COMBINED SEWER GRANTS

FISCAL YEAR 1968

AWARDED UNDER SECTION 6(a)1 OF THE FEDERAL WATER POLLUTION CONTROL ACT, AS AMENDED

LOCATION/GRANTEE	PROJECT TITLE	GRANT NO.	ESTIMATED TOTAL PROJECT COST	FWPCA GRANT
CALIFORNIA				
City and County of San Francisco San Francisco	Treatment of Combined Sewer Overflows by the Dissolved Air Flotation Process	WPRD-258-01	1,463,000	921,000
IDAHO				
City of Meridian Meridian	Reduction of Ground Water Infiltration into Sewers by Zone Pumping	29-IDA-2	25,000	18,375*
ILLINOIS				
City of Chicago Chicago	Lawrence Avenue Overflow Sewer System	31-ILL-6	14,389,600	1,500,000*
City of Shelbyville Shelbyville	Systems Approach to Combined Sewer Storm Water Overflow Pollution Abatement	24-ILL-4	2,640,760	440,000*
Springfield Sanitary District Springfield	Evaluation of a Stabilization Pond for Treatment of Combined Sewer Overflows	3-ILL-1	199,140	86,570*

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/GRANTEE	PROJECT TITLE	GRANT NO.	ESTIMATED TOTAL PROJECT COST	FWPCA GRANT
<u>INDIANA</u>				
East Chicago Sanitary District East Chicago	East Chicago Treatment Lagoon	11-IND-1	3,116,533	1,044,120*
<u>LOUISIANA</u>				
Sewerage and Water Board New Orleans	Chlorination and Hypochlorination of Polluted Storm Water Pumpage	14-LA-1	1,429,000	1,034,250*
<u>MASSACHUSETTS</u>				
Merrimack College North Andover	Controlling Pollution from Combined Sewer Overflows and Storm Water by Electrode Potential	WPD-217-01-68	45,413	21,563
Metropolitan District Commission Boston	The Construction of a Storm Detention and Chlorination Station	7-MASS-1	4,345,650	1,000,000*
<u>MICHIGAN</u>				
City of Detroit Board of Water Commissioners Detroit	System Monitoring and Remote Control	4-MICH-1	2,113,000	1.000,000*
City of Mt. Clemens Mt. Clemens	A Combined Sewerage Collection and Treatment Facility	37-MICH-2	667,500	500,250
The Regents of the University of Michigan Detroit	Rainfall - Runoff Relations on Urban (and Rural) Areas	WP-00834-04	20,085 (1968-69)	18,986

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/GRANTEE	PROJECT TITLE	GRANT NO.	ESTIMATED TOTAL PROJECT COST	FWPCA GRANT
MINNESOTA				
Minneapolis-St. Paul Sanitary District St. Paul	Dispatching System for Control of Combined Sewer Losses	1-MINN-1	1,741,500	870,750*
City of South St. Paul South St. Paul	Demonstration Project for Temporary Detention of Storm and Combined Sewage in Natural Underground Formations	WPRD-249-01	380,000	385,000
City of South St. Paul South St. Paul	Efficiency and Economy of Polymeric Sewage Clarification	WPRD-111-01	845,159	450,000*
NEW HAMPSHIRE				
City of Somersworth Somersworth	Somersworth Combined Sewage Overflow Treatment Project	30-NH-1	931,800	559,080
NEW JERSEY				
Borough of New Providence New Providence	Utilization of High Rate Trickling Filters for Treatment of Combined Sewer Overflows	34-NJ-1	637,500	474,000
NEW YORK				
City of New York New York	Evaluation of Spring Creek Auxiliary Pollution Control Project	36-NY-2	1,126,000	843,750
City of New York New York	Wards Island Water Pollution Control Plant Ponsar Flow Regulating Siphon	25-NY-1	223,000	167,250*

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/GRANTEE	PROJECT TITLE	GRANT NO.	ESTIMATED TOTAL PROJECT COST	FWPCA GRANT
OHIO				
City of Cleveland Cleveland	A Program for Demonstrating Combined Sewer Overflow Control Techniques for Water Quality Improvement and Beach Protection	WPRD-234-01	1,030,000	325,162
City of Columbus Columbus	Modification of Whittier Street Storm Stand-by Tanks	27-OHIO-1	1,231,519	300,000*
Montgomery County Board of County Commissioners Kettering	The Determination of Ground Water Infiltration and the Effects of Internal Chemical Sealing of Sanitary Sewers	WPRD-211-01-68	137,000	96,570
TEXAS				
City of Dallas Dallas	Stormwater Treatment Facilities	WPRD-35-TEX-1	1,105,000	828,750
WASHINGTON				
Municipality of Metropolitan Seattle Seattle	Duwamish River-Elliot Bay Storm Water Contol System	13-WASH-1	3,891,900	1,400,000*
WASHINGTON, D. C.				
National Association of Counties - Research Foundation Washington, D. C.	Community Action Guide for Erosion and Sedimentation Control	15030 DTL	56,543	41,343

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/GRANTEE	PROJECT TITLE	GRANT NO.	ESTIMATED TOTAL PROJECT COST	FWPCA GRANT
WISCONSIN				
City of Chippewa Falls Chippewa Falls	Utilization of a Storage Pond with Treatment for Combined Sewer Overflows	22-WIS-2	773,983	289,685*
City of Milwaukee Milwaukee	Humboldt Avenue Overflow Detention and Chlorination Facility	10-WIS-1	2,118,118	1,468,589*

* Active in FY 1968 - Supported by funds awarded in previous years.

TABLE C-2

WATER POLLUTION CONTROL

STORM AND COMBINED SEWER CONTRACTS

FISCAL YEAR 1968

AWARDED UNDER SECTION 6(a)1 OF THE FEDERAL WATER POLLUTION CONTROL ACT, AS AMENDED

LOCATION/CONTRACTOR	PROJECT TITLE	CONTRACT NO.	AMOUNT
CALIFORNIA			
Acoustica Associates Los Angeles	Demonstrate Feasibility of Use of Ultrasonic Filtration in Treating Overflows from Combined and/or Storm Sewers	14-12-23	$ 75,693*
Aerojet-General Corp. El Monte	A Method for Assessing the Extent of Pollution from Storm Water Run-off in an Urban Area	14-12-197	402,594
Aerojet-General Corp. El Monte	Role of Solids in Combined Sewage Pollution	14-12-180	92,605
American Process Equipment Corp. Los Angeles	Fabrication and Evaluation of a Ultrasonic System for Treating Sewage	14-12-195	248,500
FMC Corporation Santa Clara	Feasibility of a Periodic Flushing System for Combined Sewer Cleansing	14-12-19	31,093*
FMC Corporation Santa Clara	Feasibility of a Periodic Flushing System for Combined Sewer Cleansing	14-12-19	1,278
FMC Corporation Santa Clara	Evaluation of a Periodic Flushing System for Combined Sewer Cleansing	14-12-466	323,600
Metcalf & Eddy, Inc. Engineers Palo Alto	Engineering Investigation of the East Bay Municipal Utility District of the San Francisco Bay Area (Oakland)	14-12-407	141,300

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/CONTRACTOR	PROJECT TITLE	CONTRACT NO.	AMOUNT
CALIFORNIA (Cont'd.)			
Metcalf & Eddy, Inc. Palo Alto	Triumvirate, Storm Water Pollution Control Management	14-12-502 (11024 DOC)	$253,800
Water Resources Engineers, Inc. Walnut Creek	Triumvirate, Storm Water Pollution Control Management	14-12-501 (11024 EBI)	114,860
DISTRICT OF COLUMBIA			
Economic Systems Corp., AYCO Washington	Develop the Relation between Land-Use Practices and Influence of Pollution in Urban Storm Water	14-12-187	114,300
Underwater Storage Inc. Washington	Demonstrate Underwater Facility to Provide Temporary Storage of Storm Overflows from a Combined Sewer	14-12-42	97,714*
Underwater Storage Inc. and Silver Schwartz Ltd. Washington	Pilot Demonstration Underwater Storage Facility for Storm Water Overflow	14-12-139	573,067
FLORIDA			
University of Florida Department of Environmental Engineering Gainesville	Triumvirate, Storm Water Pollution Control Management	14-12-503 (11024 EBJ)	144,990
GEORGIA			
Black, Crow & Eidsness Atlanta	An Engineering Investigation of Combined Sewer Problems of Atlanta, Georgia	14-12-458	263,826

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/CONTRACTOR	PROJECT TITLE	CONTRACT NO.	AMOUNT
ILLINOIS			
American Public Works Association Chicago	Analysis of Regulator Facilities, Their Application and Maintenance Practices	14-12-456	$ 65,000
American Public Works Association-Research Foundation Chicago	Causes, Extent and Control of Infiltration		
American Public Works Association Chicago	Study Methods for Reducing Water Pollution from Storm Sewer and Combination Discharges through Defined Public Work Practices	WA-66-23	104,000*
American Public Works Association Chicago	The Problems of Combined Sewer Facilities and Overflows in United States Communities	14-12-65	250,000
MARYLAND			
Bowles Engineering Corp. Silver Spring	Fluidic Interceptor Study	14-12-486 (11020 DGZ)	58,891
Hercules Incorporated Cumberland	A Feasibility Study of Utilizing a Self-Cleaning, Self-Adjusting Spiralloy Filter	14-12-39	108,293
Hittman Associates Baltimore	System Study, Design and Evaluation of Local Storage, Treatment and Reuse of Water	14-12-20	197,724
MASSACHUSETTS			
Ionics Incorporated Watertown	Feasibility of High Current Density Hypochlorite Generation	14-12-490 (11023 DAA)	74,646

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/CONTRACTOR	PROJECT TITLE	CONTRACT NO.	AMOUNT
MICHIGAN			
Dow Chemical Company Midland	Demonstrate the Use of Polymeric Flocculants for Improved Efficiency in the Treatment of Combined Sewer Overflows at the Milk River Pumping Station	14-12-9	$700,000*
Dow Chemical Company Midland	Rock Creek Clarification Project (Washington, D. C.)	14-12-170	52,604
NEBRASKA			
Henningson, Durham, & Richardson Omaha	An Engineering Investigation of Storm and Combined Sewer Problems	14-12-402	301,200
NEW JERSEY			
American Standard Incorporated New Brunswick	Develop a Suspended Solids Monitor	14-12-494	121,946
NEW YORK			
American Society of Civil Engineers New York	Feasibility and Development of New Methods of Separating Sanitary Sewage from Combined Sewerage Systems	14-12-29	343,210
OHIO			
Burgess & Nipple, Limited Consulting Engineers Columbus	Develop the Relation Between Land-Use Practices and Increase of Pollution in Urban Stormwater	14-12-401	136,665
Havens and Emerson Consulting Engineers	Feasibility Study and a Preliminary Design of a Full-Scale Stabilization Retention Basin to be Installed in Lake Erie and to Serve the Demonstration Area Within the Easterly Sewer District	14-12-27	87,616*

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/CONTRACTOR	PROJECT TITLE	CONTRACT NO.	AMOUNT
OHIO (Cont'd.)			
Karl R. Rohrer Associates Akron	Design; Construction, and Operation of a Facility to Demonstrate Offshore Underwater Temporary Storage of Storm Overflow from a Combined Sewer	14-12-143	$498,248
Rand Development Corporation Cleveland	Design, Construction, Operation and Evaluation of a Rapid-Flow Combustile Filter for Treatment of Combined Sewer Overflow	WA-67-2	300,000*
OKLAHOMA			
Rhodes Corporation Oklahoma City	Demonstration Project of a Prototype Treatment Plant Designed to Treat Wastes Found at a Combined Sewer Overflow	14-12-11	256,448*
Rhodes Corporation Oklahoma City	Demonstration Project of a Prototype Treatment Plant Designed to Treat Wastes Found at a Combined Sewer Overflow	14-12-11	61,285
OREGON			
Cornell, Howland, Hayes and Merrifield Corvallis	Primary Treatment of Storm Water Overflow from Combined Sewers by High Rate Fine Mesh Screens	14-12-128	139,331
PENNSYLVANIA			
Glenfield and Kennedy Inc. King of Prussia	Microstraining Pilot Tests	14-12-136	186,086

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/CONTRACTOR	PROJECT TITLE	CONTRACT NO.	AMOUNT
PENNSYLVANIA (Cont'd.)			
R. F. Weston West Chester	Develop and Demonstrate a Method for Assessing the Extent of Pollution from Storm Water Run-off in an Urban Area	14-12-403	$223,514
The Franklin Institute Philadelphia	Selected Abstracts of Storm Water Discharges and Combined Sewer Overflows	14-12-467	8,946
RHODE ISLAND			
Fram Corporation Providence	Feasibility Investigation of a Self-Cleaning Strainer and a Self-Cleaning Filter	14-12-17	32,733
TEXAS			
Western Company Richardson	Methods to Reduce Water Pollution Caused by Storm Water Sewer Loading by Using Fluid Flow Friction Reducers	14-12-34	300,178*
Western Company Richardson	Methods to Reduce Water Pollution Caused by Storm Water Sewer Loading by Using Fluid Flow Friction Reducers	14-12-34	76,000
Western Company Richardson	Development and Demonstration of Materials to Reduce or Eliminate Water Infiltration Into Sewerage	14-12-146	96,702
VIRGINIA			
Hayes, Seay, Mattern and Mattern Roanoke	Engineering Investigation of Combined Sewer Overflow Problem	14-12-200	104,191
Melpar, Incorporated Falls Church	Construction of a Facility to Demonstrate Off-Shore Underwater, Temporary Storage of Storm Overflow from a Combined Sewer	14-12-133	411,305

* Active in FY 1968 - Supported by funds awarded in previous years.

LOCATION/CONTRACTOR	PROJECT TITLE	CONTRACT NO.	AMOUNT
WISCONSIN			
Allis-Chalmers Milwaukee	Design, Construction, Operation and Evaluation of a Demonstration Waste Treatment Device Termed the Rotating Biological Contractor	14-12-24	$388,526
Rex Chainbelt, Inc. Milwaukee	Demonstration of the Applicability of Screening and Chemical Oxidation of Storm and Combined Sewage	14-12-40	197,989