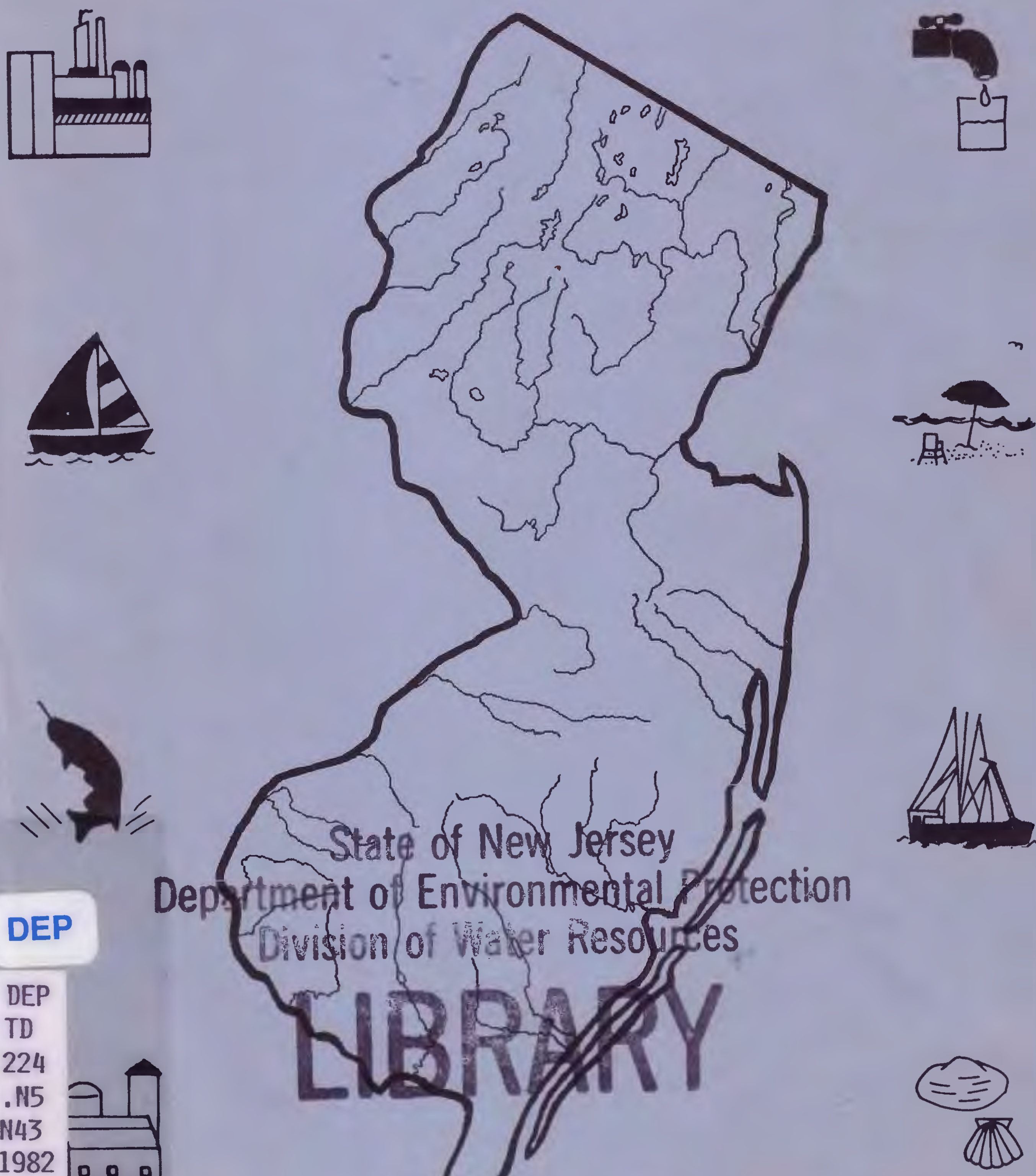
New Jersey 1982
State Water Quality Inventory Report

Executive Summary



New Jersey Department of Environmental Protection • Division of Water Resources

NEW JERSEY 1982 STATE WATER QUALITY INVENTORY REPORT

EXECUTIVE SUMMARY

A REPORT ON THE STATUS OF WATER QUALITY IN NEW JERSEY
PURSUANT TO THE NEW JERSEY WATER POLLUTION CONTROL
ACT AND SECTION 305(b) OF THE FEDERAL CLEAN WATER ACT

WATER RESOURCES REPORT 39-A

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June, 1983

ACKNOWLEDGMENTS AND CONTRIBUTIONS

This report was prepared under the direction of George Horzepa, Chief, Bureau of Planning and Standards, and the supervision of Barry Chalofsky, Supervising Planner.

Robert Scro, Patricia Garces, Barry Miller and Edward Frankel of the Bureau of Planning and Standards all assisted in or completed various sections of this report. Significant contributions were made to this report by the following persons and groups within the Division of Water Resources: Robert Hirst (conventional parameters section of the water quality assessments, Appendix 1) and the Data Management Unit (water quality data graphs in Appendix 1) of the Bureau of Monitoring and Data Management; Gail Carter, New Jersey Geological Survey, for Chapter IV - Ground Waters of New Jersey; Tom Vernam, Bureau of Shellfish Control for the Shellfish Harvesting section of Chapter III; Surya Shah, Bureau of Industrial Waste Management, for the discharge inventories in Appendix 1; the Division Drafting Unit; and the Word Processing Center. Acknowledgment is also given to the Office of Cancer and Toxic Substances Research, NJDEP, for producing the toxics parameters section in the water quality assessments of Appendix 1; and to the Interstate Sanitation Commission and Delaware River Basin Commission for their water quality status reports (presented in Appendix 1) on their jurisdictional waters.

Information useful in the preparation of this report was also supplied by the following offices and agencies: Enforcement Element, Construction Grants Administration, and Water Supply and Watershed Management Administration of the Division of Water Resources; Division of Fish, Game and Wildlife; Division of Waste Management (formerly Hazard Management); designated Water Quality Management agencies; and the many local, regional and county health agencies and officials.

The Office of Cancer and Toxic Substances Research is now named the Office of Science and Research. This name change is not reflected throughout the report, but is being noted here.

INTRODUCTION

The New Jersey 1982 State Water Quality Inventory Report was prepared pursuant to Section 305(b) of the Federal Clean Water Act, and represents the fifth in a series of State Water Quality Inventory Reports that began in 1975. This report is the first complete revision of a State Water Quality Inventory (305(b)) Report since 1977. To prepare the 305(b) Report, information was gathered from throughout the Department of Environmental Protection, and numerous local, county and regional agencies and organizations.

The 305(b) Report reviews surface water quality in the State from 1977 to 1981, using ambient monitoring data collected at 78 fixed stations. Included in these analyses are the results of the first five years of monitoring toxic and carcinogenic substances in the State's surface waters. The 305(b) Report also discusses: the ability of the State's waters to meet the swimmable and fishable goals of the Clean Water Act; the quality of waters used for potable supplies; trends in shellfish harvesting areas classifications; and recommendations for improving surface water quality. In order to facilitate management decisions for improving waterways, a rating system was developed which assigns an index to individual or grouped watersheds on the basis of water quality and water use. In addition, the 305(b) Report also contains a review of ground water quality and quantity, and their associated problems in New Jersey.

CONCLUSIONS

SURFACE WATERS

Results of the water quality data evaluated in the 305(b) Report are summarized in "Table 1 - New Jersey Surface Water Quality Trends 1977 to 1981." This table shows that surface water quality throughout the State has been relatively stable over the last 4 to 5 years. However, it should be noted that the coastal bays and estuaries improved significantly during this period, particularly with regard to bacterial quality. This has been evidenced by the upgrading of over 7000 acres of shellfish harvesting areas from restrictive categories to less restrictive or open categories. The elimination, regionalization and upgrading of antiquated or improperly operating municipal sewerage facilities in the 1970's appears to be the principal reason for this water quality improvement. Conversely, water quality degradation did occur in the Passaic, Raritan and Hackensack River basins during the mid-1980 to early 1981 drought. This drought resulted in significantly lower stream flows and consequently reduced pollutant assimilation capacity. This caused lower dissolved oxygen and elevated levels of nutrients, biochemical oxygen demand and un-ionized ammonia.

Stress to aquatic life in streams within these basins was evident.

Comparison of water quality data generated at the 78 fixed stations with State Water Quality Standards indicates that nutrient enrichment is a major problem in the State's waterways. Forty-five percent of all total phosphorus values exceeded criteria, accounting for the large number of lakes in the State that are considered eutrophic. For other water quality indices, 4% of the dissolved oxygen values fell below standards, while 3 and 2% of the un-ionized ammonia and total dissolved solids values, respectively, exceeded their standards. In addition, the majority of fecal coliform samples gathered during the period of review were greater than the 200 MPN/100 ml criterion.

The causes of water quality degradation are quite varied throughout the State. Each watershed has a different set of pollution sources affecting water quality which are often difficult to identify and to quantify their impacts. New Jersey has approximately 1600 permitted point source wastewater discharges (one-third are municipal/institutional and the remaining two-thirds are industrial), and many possible non-point sources of pollution. Even with the implementation of discharge permits and their resultant discharge limitations, there are facilities throughout the State that are not in compliance with their permit requirements or are providing inadequate treatment. As a result, the major cause of nutrients in surface waters generally appears to be point sources, while non-point sources are the likely contributor of the frequently high fecal coliform counts found.

The majority of New Jersey's inland surface waters do not meet minimum standards for swimming and are not expected to meet the national swimmable goal in the foreseeable future. Although there are some localized acceptable stream bathing beaches as confirmed by regular monitoring, only the Flat Brook, Paulins Kill, and Mullica River are considered entirely acceptable for swimming. New Jersey as a whole has approximately 700 bathing beaches, most of which are found along the Atlantic Coast, within the Pinelands region, and in the ridge and valley lakes and streams of the State's northwest. Achievement of the Clean Water Act's fish propagation and maintenance goal will occur throughout much of New Jersey. Occasional stress to fish life is likely a result of periodic low dissolved oxygen, high un-ionized ammonia, excessive metals, and other toxic or hazardous substances. Waters that are not expected to meet the 1983 fishable goal are those in the urbanized and industrialized regions of the State, including tributaries to the Delaware River in Mercer, Burlington and Camden Counties, portions of the Passaic and Hackensack basins, and the New Jersey-New York interstate waters.

Because of fish tissue contamination by toxic or hazardous substances certain waters in the State have been closed to fishing, or advisories issued recommending the intake of specific fish be limited. Cooper River, portions of Pennsauken Creek and Steward Lake are closed to all fishing because of chlordane contamination. New Jersey - New York interstate waters are contained in fishing advisories issued by both New Jersey and New York due to the presence of elevated PCB levels in striped bass, American eel, bluefish, white perch and white catfish (striped bass and American eels caught from these waters are prohibited from being sold).

A review of coastal bay and estuary studies by the NJ Division of Fish, Game and Wildlife in the mid to late 1970s has shown that many of the State's bays and estuaries experience low summertime dissolved oxygen concentrations, often under 4.0 mg/l. While these levels partially reflect background conditions, they also point to the limited ability these waters have for assimulating oxygen-demanding pollutants from point and non-point sources.

Toxics including volatile organics, pesticides, PCBs and heavy metals were analyzed for their presence in the water column, sediment and fish tissue. These substances seem to be fairly widespread at very low concentrations (depending on the substance and the medium sampled) throughout the State. Volatile organics were found in highest concentrations in waters adjacent to, or flowing through, industrialized urban and suburban centers. Metals, PCBs and pesticides were also found throughout the State in fish tissue in low levels, but appeared highest in catadromous and anadromous species. Most concentrations of these substances in fish tissue are not thought to be dangerous to the fish or to people consuming fish taken from State waters, with the exception of waters currently closed to all fishing or where advisories have been issued.

The stability of State water quality for the last five years should not be viewed in a pessimistic manner. Water quality degradation has been for the most part halted, largely due to higher treatment levels at municipal and industrial wastewater treatment facilities. However, if water quality in New Jersey is to improve beyond current "status quo" conditions, then water quality management agencies have to look beyond point source management to more technically complicated issues such as developing a more thorough understanding of the physical, chemical and biological nature of the State's water bodies; determining the specific pollution sources in a watershed and their affect on stream quality and biota; and identifying which control activities will be most effective from an environmental, technical and economical perspective.

WATER QUALITY AND WATER USE RATING SYSTEM

The water quality and water use rating system represents, quantitatively, an objective summation of: 1) the degree of water quality impairment; and 2) the value of the water uses in a watershed. It is anticipated that the rating system will assist management in the decision-making process with regard to directing available public resources for water quality management activities. Indexes are allocated to 29 segments (individual or grouped watersheds as evaluated in the 305(b) Report) in the State on the basis of certain water quality parameters which violate standards and on the occurrence of water uses identified within the segment. The water quality index considers dissolved oxygen, total phosphorus, total dissolved solids, un-ionized ammonia and toxics. The water use index incorporates information on surface diversions for potable supplies; fisheries resources, including stocking of trout and anadromous fish spawning runs; the number of bathing beaches; shellfish harvesting, including percentage of waters approved for harvesting and shellfisheries production; and agricultural use.

A summary of the water quality/water use rating system is found in Table 2. Segments are listed by major river basin and not by ratings assigned to it. This is to emphasize that the rating system is not designed to prioritize one watershed over another, but rather to guide water quality management activities in an informed and efficient manner.

GROUND WATERS

Ground water plays an important role in New Jersey for supplying potable, agricultural and industrial waters; and for contributing base flows to streams in the State. The 305(b) Report discusses the availability of ground water for these uses in three major physiographic provinces (Coastal Plain, Triassic Lowlands and Highlands), major quantity and quality problems in each province, and current and suggested management practices.

Natural ground water quality is generally very good throughout the State and most ground waters can be used for potable purposes without treatment. Common natural quality problems which do require treatment in some areas include high iron, dissolved solids, manganese; hardness; and variations in pH. The development of ground water resources is not usually limited by natural quality, but rather by contamination of the resource through man's activities. The two common methods of contamination include over pumpage and pollutant introduction.

Over pumpage has led to the intrusion of saltwater into formally fresh water formations along the coast, rendering the water unsuitable for use. Over pumpage has resulted in the lowering of ground water levels in many water-bearing formations throughout the State, although it is most severe in the Coastal Plain. Currently, an estimated 500 million gallons per day (mgd) are being pumped from Coastal Plain Aquifers, causing lowering water levels in areas of Middlesex, Monmouth, Burlington, Camden, Ocean, Atlantic, Cape May, Gloucester and Salem Counties. In addition, this problem may be affecting streams dependent upon ground water inflows.

Many of the above noted problems in the Coastal Plain are also occurring in the Triassic Lowlands and Highlands provinces of northern New Jersey where resource development has exceeded the recovery capacity of certain ground water systems. Basic information gathering activities (mapping, exploration, consumption and recharge rates, and impacts on water levels) are in the planning process, but lacking in many regions of central and northern New Jersey.

Ground water pollution is a serious and immediate problem when municipal or residental supplies are contaminated. The Department has closed 74 public supply wells since 1971. Ninety percent were closed because of contamination by organic and industrial chemicals. Many of these contamination events were due directly to point sources. Well closings are not primarily limited to a particular region of the State, but have occurred throughout. A monitoring study by the NJDEP Office of Science and Research found approximately 30 wells (out of 670) to be contaminated with more than one chemical group at levels above drinking water standards. Chemical groups included halogenated volatile organics, chlorinated pesticides and related compounds, and metals.

Many causes of ground water pollution exist. Three-hundred registered landfills are found in the State, along with 134 known abandoned landfills and illegal dump sites. Of these 434 sites, 134 are or are suspected of contaminating ground water based on information from the Hazardous Site Mitigation Administration. Roughly 7 billion gallons of landfill leachate is generated in New Jersey each year, much of which will enter ground water systems. Three-hundred and fifty-six waste disposal surface impoundments have been identified in the State, 65 percent being unlined. This may be leading to 6 billion gallons of leachate liquid entering ground waters each year. Accidental spills (2,512 petroleum and chemical spills in 1981 alone), leaking underground storage tanks and pipelines, on-site wastewater disposal systems, and other sources are contaminating ground water resources to a varying extent. Over the next several decades it is expected that of the 750 million gallons a day of ground water used for potable purposes, 40 to 50 million gallons a day will be lost because of pollution. Major investments in the 1980s will be required for additional water treatment, ground water resource development and protection, and aquifer restoration in New Jersey.

RECOMMENDATIONS FOR IMPROVING WATER QUALITY IN NEW JERSEY

SURFACE WATERS

New Jersey's surface waters, on the basis of ambient monitoring results, have generally not shown significant improvement in the last five years. Even with the successful efforts to prevent further water quality degradation in the face of increased industrial, residential and transportation corridor development; the State's waters are for the most part just as close to meeting the Clean Water Act's goals of swimmable and fishable as they were in 1977. The recommendations presented below are designed to facilitate thought and discussion concerning surface water quality improvement throughout the State.

Revamp water quality monitoring activities so they are designed for detecting specific water pollution sources. Water quality monitoring in New Jersey has historically and primarily been designed for long-term trend analysis. To maximize the effectiveness of pollution control activities, pollution sources and their impacts on water quality and biota must be identified.

It is recommended that the current long-term, fixed-station monitoring programs used by the DWR be operated on a minimal basis, and that intensive surveys be emphasized as the primary tool for monitoring water quality. The purpose of such monitoring would be to indentify specific pollution sources so that control activities can be targeted. Intensive or special monitoring surveys have recently begun to play a greater role in DWR monitoring programs. This trend should be extended to all waters of the State.

Greater identification and control of non-point sources. Non-point pollution contributes more of certain pollutants than point sources in many of New Jersey's watersheds. The frequently excessive fecal coliform counts indicates that this parameter continues to be a serious water quality problem in the State, despite advances in sewage treatment. Non-point sources, ranging from feedlot runoff to antiquated and leaking sewer lines, are prevalent in New Jersey and probably the sources of bacteria being detected. These sources must be effectively controlled if water quality is to be improved to where national clean water goals can be realized. Intensive monitoring will identify non-point sources and therefore, will enable the appropriate application of control measures.

One example of how intensive surveys have proved effective in indentifying non-point sources is the Bureau of Planning and Standards project in the Navesink River watershed. High fecal coliform counts in the upper Navesink estuary have resulted in the closure of shellfish growing areas. Intensive monitoring by the DWR found the predominant sources of bacteria to be upstream livestock (horse) farms along a major tributary, and suburban runoff. The DWR, the Soil Conservation Service, and the local conservation district, are currently exploring the feasibility of a watershed project designed to correct the agricultural runoff problem. The local health agencies are focusing on managing bacterial pollution from the suburban sector.

Achieving necessary effluent quality from point sources. Due to the large number of point sources in many of New Jersey's watersheds, wastewaters can often have profound impacts on stream water quality. This was exemplified in the Passaic River during the recent drought when as much as 75 percent of the river's flow at Little Falls was thought to be upstream point source effluent. In addition, streams in the State consistently having poor water quality, have the average, the greatest number of wastewater treatment plants that are not meeting their effluent requirements. If clean water goals are to be met in New Jersey, it is imperative that all point sources be in compliance with their discharge permit limitations. Poor discharge quality is often due to inadequate, antiquated or underdesigned treatment systems and poor or delinquent operation of facilities. Primary treatment plants are still found in the State, and many secondary treatment plants are discharging unsatisfactory treated wastewaters because of system overload or improper operation. These deficiencies need to be corrected at all municipal/domestic, industrial and other wastewater facilities.

Coordinated watershed management activities. Coordination of activities dealing with water pollution control and water resource management in a watershed should be improved so that duplication of effort is eliminated and greater efficiency results. This coordination should involve local, county, regional, state and federal agencies; with special consideration given to local and county health offices or departments. The County Environmental Health Act is currently serving as a tool for such coordination to take place. Cooperative monitoring agreements with many counties are now in progress, or are being developed.

Water pollution control efforts should also be coordinated so that specific water use goals are targeted. The public can best identify water quality improvement with restoration of water uses (such as bathing, greater fisheries and shellfisheries) which are available in the past, but are now not possible because of water quality degradation. Identification of water use goals will also assist in determining what control resources should be allocated and where.

GROUND WATERS

The increasing number of pollution incidents affecting New Jersey's ground waters each year has resulted in a greater frequency of public and private supply well closures. This, in addition to hydrologic problems such as lowering of aquifer water levels, increasing occurrences of saltwater intrusion into formally fresh water formations, and the loss of surface water flows due to the reversal of ground water inflows, clearly demonstrates that increased research and management is necessary to protect the State's ground water resources. The following recommendations outline activities which can be pursued to achieve such ground water goals.

Protection of ground water levels and availability. To prevent existing or future aquifer degradation an depletion in the Coastal Plain Region, the following are suggested: eliminate the practice of aquifer overdevelopment; uniformly distribute future well development; institute projects designed to reverse water level declines in problem areas; promote recharge of aquifers in outcrop areas; develop new supplies in problem localities; and supplement ground water supplies with surface water supplies (conjunctive use). In the Triassic Lowlands and Highlands Regions of the State the following are recommended: conduct hydrogeologic exploration and delineation of the available ground water resources; establish monitoring programs to gather vital ground water statistics; and institute management of the ground water resources of northern New Jersey on a regional basis.

Protection of ground water quality. Managing abandoned or technologically outdated landfill sites, and monitoring and regulating operating landfill sites is essential if unnecessary pollution of the State's ground waters is to be reduced. Proper landfill closure when necessary must include a relatively impervious cap, as well as leachage collection and treatment. New Jersey Pollutant Discharge Elimination System (NJPDES) permits should be issued for all existing and potential point sources contributing to ground water pollution. However, adequate ambient monitoring is needed so as to properly assign NJPDES permit limitations to ground water discharges.

Table 1- New Jersey Surface Water Quality Trends - 1977 to 1981

Stream	DO	Total P	NH_3	TDS	BOD	DO Sat.	Fecal Coli.	NO_3/NO_2	NH_3/NH_4^+	pH	1982 Overall Water Quality***
DELAWARE BASIN											
Wallkill River	D	S	S	S	S	D	S	S	S	S	Fair
Flat Brook	S	S	S	S	S	S	S	S	S	S	Excellent
Paulins Kill	S	S	S	S	S	I	S	S	S	S	Good
Pequest River	S	S	S	S	S	S	S	S	S	S	Good
Musconetcong River	S	S*	S	S	I	S	S	S	S	S	Good
Pohatcong Creek	S	D*	S	S	S	S	D	D	S	S	Good
Lopatcong Creek	S	D	S	S	S	S	D	D	S	S	Good
Delaware River Tribs.- Hunterdon County	D	S	S	D	S	S	S	S	S	S	Good
Assunpink Creek	I	I*	S	S	S	S	S	S	S	D	Fair
Crosswicks Creek	I	S*	S	S	I	S	S	S	S	S	Fair
Assiscunk Creek	I	S	S	S	I	S	S	S	S	S	Fair
Rancocas Creek - North Branch	S	I	S	S	I	I	S	S	S	S	Fair
Rancocas Creek - South Branch	S	I*	S	S	I	I	S	S	S	S	Fair
Pennsauken Creek	S	S*	S	S	S	S	S	S	S	S	Poor
Big Timber Creek	S	S*	S	S	S	S	S	S	S	S	Poor
Cooper River	S	S*	S	S	S	S	S	S	S	S	Poor
Mantau Creek	S	S*	S	S	S	S	D	S	S	S	Fair
Raccoon Creek	S	S*	S	S	S	S	S	S	S	S	Fair
Oldmans Creek	I	S	S	S	S	S	S	S	S	S	Fair
Salem River	S	S*	S	S	S	S	S	S	S	S	Poor
Cohansey River	S	D	S	S	S	S	D	S	S	S	Poor
Maurice River	I	I	S	S	S	S	S	S	S	S	Fair/Good

Legend

I = Improving
D = Declining
S = Stable/Unchanged
- = Insufficient data to determine trend
* = Exceeded State Water Quality Standard 50% or more of the time
** = Derived from 208 Areawide Quality Management Plans
*** = Classification may be based on water quality parameters other than the ten presented here.

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ATLANTIC COASTAL BASIN											
Tuckahoe River	S	S	D	S	S	S	S	S	D	D	Good
Great Egg Harbor	S	S	S	S	S	S	S	S	S	S	Fair
Mullica River	S	S	S	S	S	D	S	S	S	S	Excellent
Metedeconk River	I	I	S	S	S	S	S	S	S	S	Fair
Toms River	S	S	S	S	D	S	S	S	S	S	Fair
Manasquan River	S	S*	S	S	S	S	S	S	S	S	Fair
N.Atlantic Coastal-(Willow,Yellow,Jumping Br's)	S	S	S	S	S	S	S	S	S	S	Good
RARITAN BASIN											
North Branch Raritan River	S	S*	D	S	D	S	D	S	S	S	Good
South Branch Raritan River	S	S	D	S	S	S	S	S	S	S	Good
Millstone River	I	I*	S	S	I	S	S	S	S	S	Fair/Good
Lawrence Brook	S	D	S	S	S	S	I	S	S	S	Good
South River	S	S	S	S	S	S	S	S	S	S	Fair
Raritan River	I	D*	I	S	S	S	S	S	I	S	Poor/Fair
Elizabeth River	S	S	D	-	I	S	D	-	D	-	Poor
Rahway River	S	S	S	-	D	S	D	-	S	-	Poor/Fair

Legend

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PASSAIC/HACKENSACK BASIN											
Upper Passaic River	S	S*	S	S	S	S	I	S	S	S	Poor/Fair
Mid-Passaic River	S	S*	S	S	S	S	S	S	S	S	Poor
Mid-Passaic Tributaries											
Rockaway River	S	S*	S	S	S	S	I	S	S	S	Poor
Whippany River	S	S*	S	S	S	S	D	S	S	S	Poor/Fair
Ramapo River	S	S*	S	S	S	S	S	S	S	S	Fair
Pompton River	S	S*	S	-	D	-	D	S	S	-	Fair
Lower Passaic River	S	S*	S	S	S	S	S	S	S	S	Poor
Hackensack River	S	S	S	S	S	S	S	S	S	S	Poor

Legend

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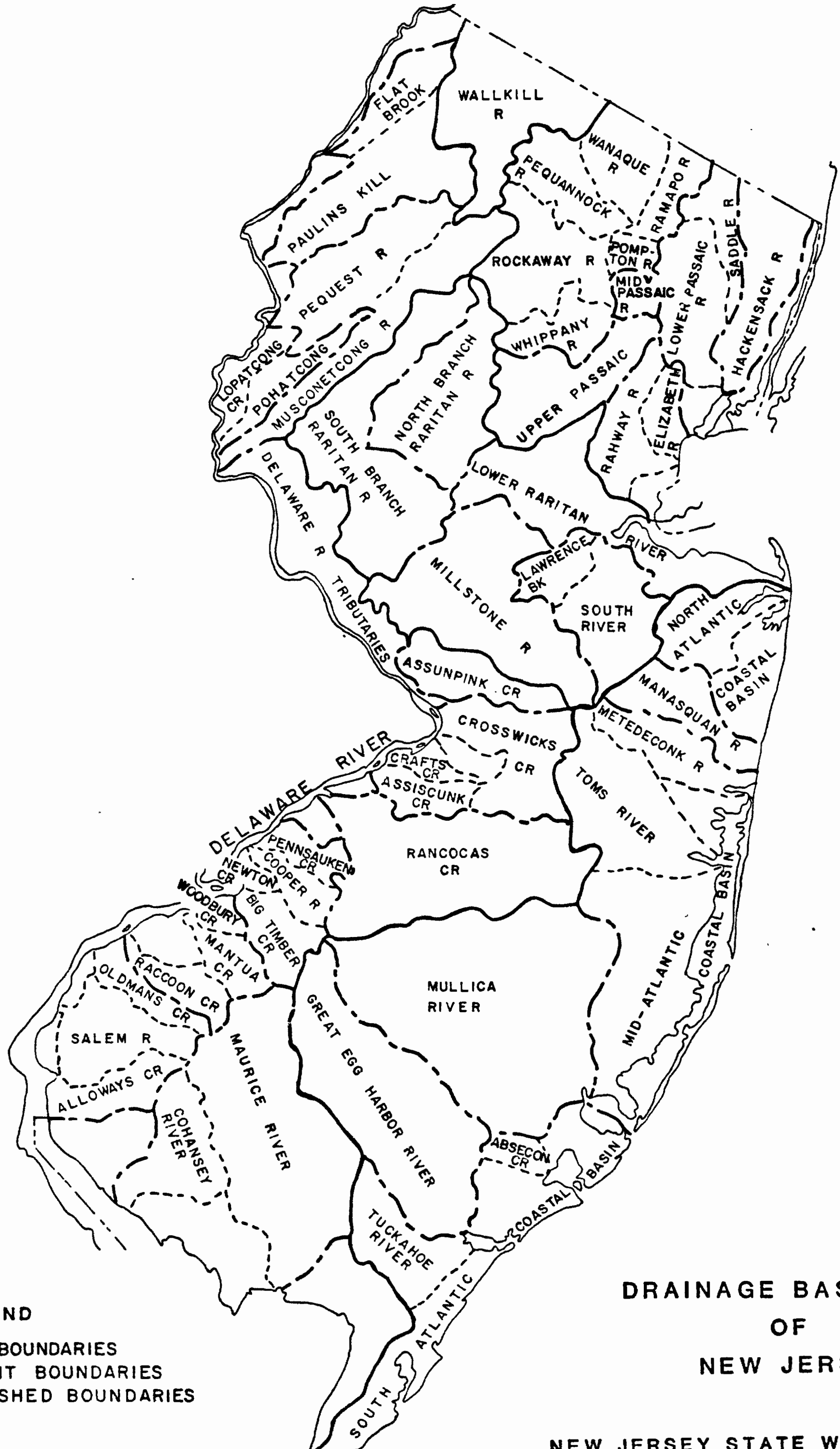
Table 2 Results of the Water Quality/Water Use Rating System

Segment	Water Quality Index	Water Use Index
Wallkill River	47	59
Delaware River Basin		
Flat Brook and Paulins Kill	20	34
Pequest and Musconetcong Rivers	66	124
Pohatcong and Lopatcong Creeks	39	8
Delaware River Tributaries Hunterdon/Mercer Counties	26	28
Assunpink Creek	74	30
Crosswick and Assiscunk Creeks	90	68
Rancocas Creek	70	69
Pennsauken Creek, Big Timber Creek, Cooper River	119	8
Woodbury, Mantua and Raccoon Creeks	84	51
Oldmans Creek, Salem River and Alloway Creek	94	36
Cohansey and Maurice Rivers	33	76
Atlantic Coastal Basin		
Southern Atlantic Coastal Basin	12	138
Great Egg Harbor River	73	27
Mullica River	39	86
Mid-Atlantic Coastal Basin	50	245
Manasquan River	134	15
North Atlantic Coastal Basin	47	106
Raritan River Basin		
North Branch Raritan River	69	16
South Branch Raritan River	85	101
Millstone River	58	88
Lawrence Brook and South River	63	21
Raritan River and Raritan Bay Drainage	103	85
Passaic River Basin/Northeast		
Elizabeth and Rahway Rivers	66	4
Upper Passaic River	40	10
Mid-Passaic River	146	20
Mid-Passaic River Tributaries (Whippany, Rockaway, Pequannock, Wanaque, Ramapo and Pompton Rivers)	98	137
Lower Passaic River	163	12
Hackensack River	64	45



LEGEND

——— BASIN BOUNDARIES
— — — SEGMENT BOUNDARIES
- - - - - - - WATERSHED BOUNDARIES

DRAINAGE BASIN MAP OF NEW JERSEY

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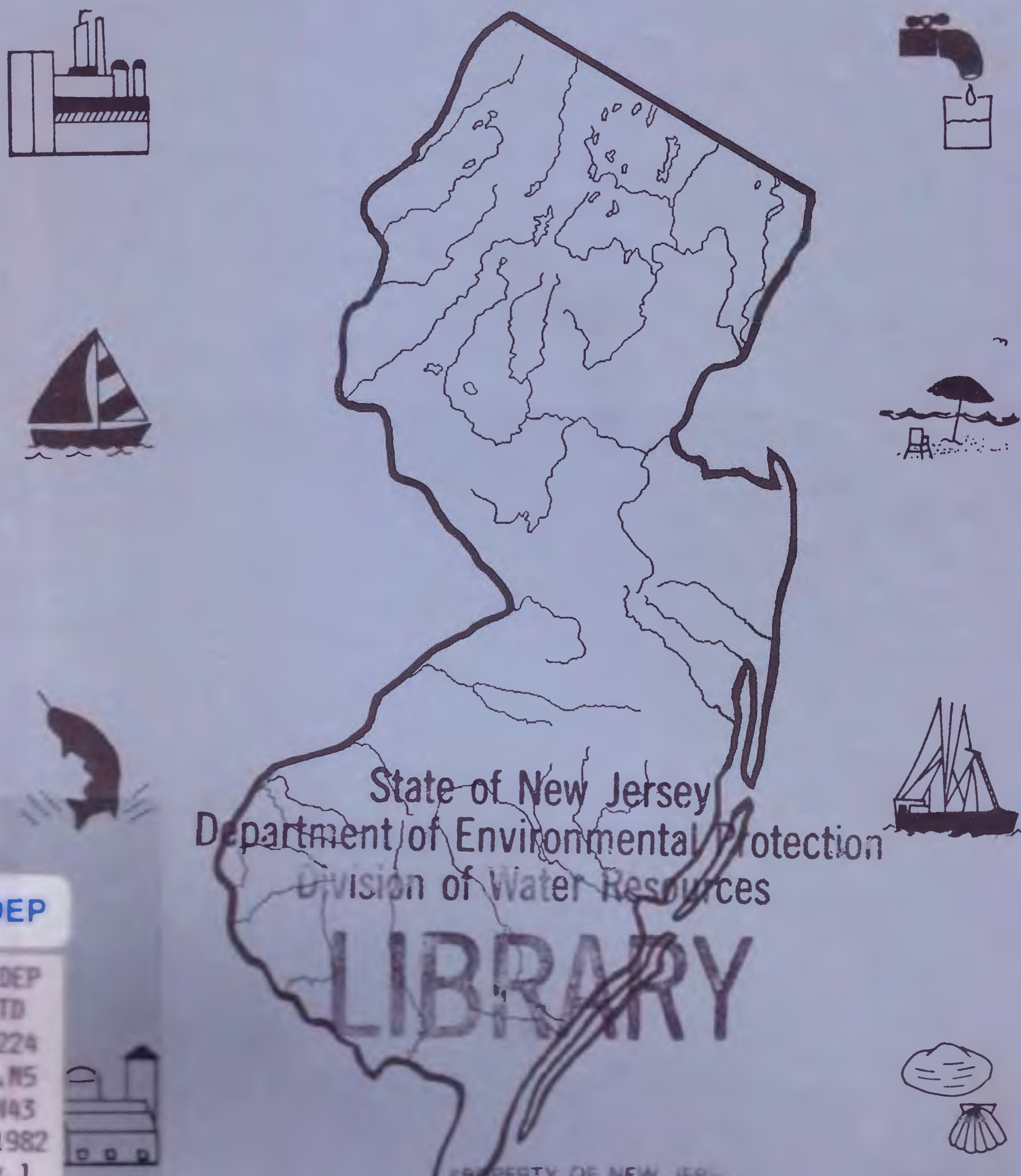

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I. INTRODUCTION

A. DESCRIPTION OF THE STATE WATER QUALITY INVENTORY REPORT

The last decade has seen a concerted public and private effort to improve the quality of the nation's waterways. This effort has incorporated the largest public works program in the nation's history, the funding and building of municipal sewage treatment facilities, to help accomplish the clean water goals outlined in federal and state legislation. This document is a review of how water quality has changed in the State as a result of these water pollution control efforts and outlines what is needed to ensure improvements in water quality.

The New Jersey 1982 State Water Quality Inventory (305(b)) Report represents the fifth State Water Quality Inventory Report completed by the New Jersey Department of Environmental Protection's (NJDEP) Division of Water Resources (DWR) since 1975. The report is prepared biannially pursuant to Section 305(b) of the federal Clean Water Act (P.L. 92-500 as amended by P.L. 95-217) and is a report to Congress designed to address the following:

-What is the current quality of waters in the State and does this quality represent improvement or decline?;

-What waters are meeting the swimmable and fish propagation/maintenance goals of the Clean Water Act, and are more waters meeting these goals today than 5 years ago?;

-What are the sources of water pollution in the State, what types of pollution are these sources contributing, and are the sources impacting designated water uses?; and

-What is generally needed for eliminating water quality problems in each watershed, are controls economically and technically feasible and will these controls be forthcoming in the near future.

This report also contains, for the first time, a discussion on the quality and quantity of ground waters and a rating system of surface waters based on water quality conditions and water uses. Ground water issues are not necessarily required to be addressed in the 305(b) report by the Clean Water Act, however they are important in relation to stream base flows and to the supply of water for potable, industrial and recreational use. The surface water rating system lists watersheds (or groups of watersheds) on the basis of water quality and amount of water uses. Water uses evaluated include potable water diversions, bathing beaches, fisheries resources and agricultural water use. This rating system is designed to summarize the information gathered for this report in a manner so that it can be used in the decision-making process for water quality management activities.

New Jersey's water quality is reviewed in Chapter III, Surface Water Quality Conditions, is divided into five sections: Summary of Surface Water Quality in New Jersey, Water Quality of Surface Water Drinking Supplies, Contact Recreational Activities, Shellfish Harvesting and Fisheries Resources. Summary of Surface Water Quality in New Jersey summarizes trends in water quality from 1977 to 1981 in individual watersheds or grouped watersheds, presents major conclusions regarding water quality from 1977 to 1981, and contains recommendations for improving the efficiency of water pollution control programs and our knowledge of water quality problems. The Water Quality of Surface Water Drinking Supplies section reviews the quality of surface waters used for drinking water and what can be done to protect public health with improved water quality. Contact Recreational Activities discusses the swimmability of the State's surface waters, why certain waters are not capable of supporting contact recreational activities and where the federal Clean Water Act's swimmable goal will or will not be met. The Shellfish Harvesting section is a description of trends in shellfish catch and areas available for shellfish harvesting. The ability of New Jersey's waters to support balanced fish, shellfish and wildlife populations and meet the fish propagation and maintenance goal of the Clean Water Act is reviewed in the Fisheries Resources section.

Chapter IV, Ground Waters of New Jersey, is a review of hydrogeologic conditions in the State, ground water quality, major pollution sources known and recommendations for the effective management of New Jersey's ground water resources. This Chapter was prepared by the New Jersey Geological Survey, DWR. It is anticipated that future 305(b) reports will contain updated reviews of ground water quality and quantity problems that are afflicting the State.

The second document for this report are the appendices. Appendix 1 is the Water Quality Inventory. This appendix reviews the State's water quality in 31 segments from the period 1977 to 1981. All but two (29)"segment analysis" were compiled by the DWR and contain four sections: Basin Description, Water Quality Assessment, Problem Assessment, and Goal Assessment and Recommendations. The Water Quality Assessment is divided into two subsections, one reviewing conventional water quality data and a second subsection evaluating toxic materials in the water column, sediments and fish tissue. The review of conventional parameters was performed by the Bureau of Monitoring and Data Management, DWR; while the toxic parameters subsection was written by the Office of Cancer and Toxic Substances Research (OCTSR), NJDEP. This watershed by watershed assessment of toxic substances is the first since the OCTSR began sampling in 1977. These 29 segment analyses also include a segment map, water quality data charts (conventional parameters) and a discharge inventory. The two remaining segment analyses were written by the Interstate Sanitation Commission (ISC) and the Delaware River Basin Commission on ISC jurisdictional waters and the Delaware River, respectively. The second appendix is a summation of ground water bearing formations in New Jersey and their characteristics. The third appendix is the 1982 - 1983 New

Jersey Construction Grants Administration (DWR) Project Priority System and List for use in distribution of state and federal grant monies for sewerage treatment facilities.

B. USES OF THE STATE WATER QUALITY INVENTORY REPORT

The State Water Quality Inventory or 305(b) Report serves two major functions. First, it is used to convey information on the quality of surface waters in the State and whether this quality represents improvement, no change or degradation. In addition, the report is prepared for submission to Congress and the USEPA for the purposes of evaluating the effectiveness of the federal Clean Water Act. The report is also used as a reporting document to the State's citizens on general water quality conditions and what is needed for improving these conditions. The 1982 report has been specifically designed to review how water quality in New Jersey has affected major water uses: potable water supplies, swimming locations, shellfisheries and fisheries resources. The loss or gain of a water use is probably the most common method whereby the general public can identify changes in water quality. The second important function of this report is that it can be the basis for determing whether and where particular water pollution control projects and resources are needed in the State. In addition, this report attempts to identify the major weaknesses and strengths of various water pollution control programs in the State, and makes recommendations for how some programs can be improved. Essentially, this report can be used as a manager's guide for where, why and what activities are needed to improve water quality in New Jersey.

The 305(b) report also contains a significant amount of information that makes it a valuable working document. This report not only reviews how surface water quality has changed in the last five years, but contains new information on the location of bathing beaches, the presence and extent of toxic substances in the State's surface waters, how water quality is affecting fish life, the quality and quantity of the State's ground waters, and the quality of surface waters used as drinking water supplies.

During this period of reduced public resources available for water pollution control it is imperative that monies be targeted to the waters where the greatest improvements in quality can be achieved with the most cost-effective methods. Continued work by both the public and private sectors is necessary if the clean water goals are to be attained.

II. NEW JERSEY SURFACE WATERS: A WATER QUALITY AND WATER USE RATING SYSTEM

A. INTRODUCTION

The protection and improvement of water quality is, in large part, dependent upon the expenditure of public funds for pollution control activities. Those agencies responsible for managing these programs must ensure that public monies are spent in the most effective manner, so that the greatest public benefit occurs with the least costs. It is of vital importance to both public and private concerns that government expenditures are directed to the areas of greatest need. This is particularily true for water pollution control projects today. Therefore, a system is needed which appraises watersheds in the State on the degree of water pollution and water use.

The rating system which has been developed for the New Jersey 1982 State Water Quality Inventory (305(b)) Report is discussed below. The system is designed to highlight watersheds from the standpoint of degraded water quality and existing water uses. It is anticipated that this rating system will ultimately serve to aid in making water quality management decisions that will assist in meeting the swimmable and fishable goals of the federal Clean Water Act, and protecting public health. This rating system provides an objective analysis of the 29 watersheds (or segments) reviewed for water quality in the 305(b) Report's Appendix 1 (not including the Delaware River and Interstate Sanitation Commission waters).*

This system represents, for the first time, a comparative assessment of watersheds based upon an evaluation of quantitative information collected from a number of federal, state and local agencies.

B. COMPONENTS OF THE SURFACE WATER RATING SYSTEM

The rating system consists of two interrelated components: a "Water Quality Index" and a "Water Use Index", equally weighted in importance. Each of these two indices is comprised of a number of parameters used to measure water quality and water uses in the 29 segments. The parameters chosen are readily quantifiable and reflect, in large part, much of the information necessary to objectively assess water quality and water uses in each watershed. However, certain information on water quality

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*The reasons for not including the Delaware River and Interstate Sanitation Commission (ISC) waters in the rating system were: differences in the water quality data collected and evaluated by the ISC and Delaware River Basin Commission; difficulties in assigning water use points because of their interstate nature; and the possibility that assigning ratings to these waters may interfere with cooperative pollution control efforts between participating state and interstate agencies.

and water uses considered to be important indicators were not available for incorporation into the present ranking system. Bacteriological data was not used in the rating system because statewide fecal coliform sampling was performed to gather information on a preliminary basis, and therefore, is not comparable to standards. The "Fisheries" data is exclusive of warm water species, since quantitative information was only available by watershed on trout stocking (cold water species) and anadromous fish spawning runs. The "Agricultural" water use information is based on the data collected by the U.S. Department of Agriculture for the State Erosion, Sedimentation and Animal Waste (SESAW) survey and includes only those watersheds with intensive agricultural activities. It is anticipated that many of these deficiencies can be corrected in subsequent rating systems as additional information gathering activities are performed.

The Water Quality Index includes five parameters: "Dissolved Oxygen", "Total Phosphorous", "Un-ionized Ammonia", "Total Dissolved Solids", and "Toxics". Aside from "Toxics", which for the majority of substances were evaluated by comparison with USEPA suggested criteria for surface waters, the four water quality indicators were chosen because of the large amount of collected data for each during the 1977 to 1981 sampling period reviewed in this report, and the presence of a criteria in the New Jersey Surface Water Quality Standards. Therefore, biological and chemical indicators of pollution for which no state standards have been set were not incorporated into the Water Quality Index (with the exception of toxics data). A brief discussion and rationale for the indicator parameters follows below:

Dissolved Oxygen (DO) - The oxygen freely available in the water column. The amount of DO in a waterbody will determine the type and quantity of aquatic life that can be supported. Generally, as DO decreases, the species diversity decreases. State minimum standards for DO range from 3.0 to 7.0 milligrams per liter depending on waterbody classification.

Total Phosphorous (Total P) - An essential nutrient in the aquatic environment. It is usually the limiting factor in the rate of inland freshwater plant growth. As total phosphorous increases the tendency toward eutrophication increases. State maximum standards for total phosphorous range from 0.05 to 0.7 milligrams per liter depending on a water's classification.

Un-ionized Ammonia (NH_3) - A by-product primarily of wastewater treatment plant effluent which is toxic to aquatic life. State maximum standards for un-ionized ammonia range from 0.02 to 0.05 milligram per liter depending on waterbody classification. The most stringent standard is found in trout production and trout maintenance waters.

Total Dissolved Solids (TDS) - The total amount of dissolved material, organic and inorganic, contained in water and wastewater. High concentrations of TDS may make treatment of drinking water difficult or cause stress to aquatic life. The state maximum standard for TDS range from 100 to 500 milligrams per liter, depending on a waterbody's classification.

Toxics - Chemical substances which have been shown to have acute or chronic toxicity to human and aquatic life.

In the Water Quality Index, with the exception of toxics, point values for each parameter are based directly on the percent violations of the State Surface Water Quality Standards recorded during the last five years (i.e., a maximum of 100 possible points can be awarded for each of these four parameters). Therefore, each monitoring station within a watershed can be awarded a maximum of 400 points for the "Violations Subscore". Since the number of monitoring stations per watershed varies, provision is made in the ranking methodology to account for this variability by computing the "Average Violations Subscore" for each watershed.

The data utilized to assess the presence of toxic pollutants in each watershed was derived from a separate statewide survey conducted by NJDEP's Office of Cancer and Toxic Substances Research. Their study focused on the concentration of toxic substances in the water column, bottom sediments, and fish tissue. Point scores for toxics in any of the three sampling media were based on the average levels found. The maximum "Toxics Subscore" is 100 points. This is based on the combination from a segment of a maximum 33.3 points for toxics in the water column, 33.3 points for toxics in sediments and 33.3 points for toxics in fish tissue. Each sampling medium was evaluated separately for the levels found, and an average score given. Scores for each medium were based on non-detectable (0 points per medium), low (11.1 points per medium), moderate (22.2 points per medium) and high or excessive (33.3 points per medium) levels. The point scores for each of the three media are added together to get the final "Toxics Subscore". Some watersheds or segments were sampled for toxics in only one or two medium, and therefore, their "Toxics Subscore" may not reflect actual conditions throughout the water column, sediments and fish tissue. The "Toxic Subscore" is then added to the "Average Violations Subscore" to give the overall "Water Quality Index" (maximum of 500 points).

The Water Use Index includes five indices: "Potable Supply", "Fisheries", "Bathing", "Shellfish", and "Agriculture". Each use is defined as:

Potable Supply - Based upon data compiled by the Division of Water Resources on surface water diversions (million gallons per day) for the last pre-drought year (1979).

Fisheries - Based upon data compiled by the Division of Fish, Game and Wildlife on number of fish stocked (average of last five years) and number of anadromous fish spawning runs confirmed.

Bathing - Based upon data provided by 80 percent of the health departments throughout the State in response to a questionnaire on bathing resources prepared by the Division of Water Resources.

Shellfish - Based upon percentage of "Approved" or "Seasonal" shellfish growing waters classified by the Division of Water Resources in each watershed, and, the pounds of meat harvested during 1980 as recorded by the National Marine Fisheries Service.

Agriculture - Taken from data compiled by the U.S. Department of Agriculture's SESAW survey, regarding surface water diversions for irrigation and livestock purposes.

Since the importance of the five water uses varies from one section of the State to the next, or even from one watershed to the next, it was determined that equitability and objectivity would be best served by assigning to each parameter the same maximum possible point value. Therefore, a maximum of 100 points was assigned to each of the five water use indices, resulting in a maximum possible "Water Use Score" of 500 points.

The point value awarded to a given water use in a watershed is based on the percentage derived from the ratio of a watershed's use to the highest use watershed. For example, the Mid-Passaic Tributaries segment has the greatest "Potable Supply" use of the 29 segments in the State, i.e., 251 mgd; therefore, it receives 100 points. The Assunpink Creek segment has a potable supply use of 31 mgd, which is 12 percent of 251 mgd, thus the Assunpink segment is awarded 12 points. Using this methodology to determine the Water Use Index enables each of the 29 segments to be assessed in relation to each other and to the State as a whole.

In addition, the "Fisheries" and "Agriculture" indices are each composed of two categories, thus requiring an additional step to be performed to equally divide the 100 point maximum parameter value, (resulting in a maximum of 50 points for each of the two categories within the parameter). The "Shellfish" parameter is also divided into two categories. One, pounds of meat, is based on the percentage of the highest watershed value as previously described, the other, percent of "Approved" or "Seasonal" waters, is based directly on percentages classified within each watershed. An additional step is performed to equally divide the 100 point maximum parameter value, resulting in a maximum of 50 points for each of the two categories within the use evaluated.

C. SURFACE WATER RATINGS AND THE DECISION - MAKING PROCESS

The surface water rating system developed for the 1982 305(b) Report, identifies watersheds which have the greatest water quality impairment in conjunction with the greatest water use for a variety of indices. This system is, essentially, an information source for waste quality managers which presents a quantitative and comparative assessment of water quality and water use conditions in the State. Ultimately, the surface water rating system will be used to assist the managers in the decision-making process for a variety of purposes, the foremost being the identification of a need for water pollution control activities.

The surface water rating system can also provide the manager with the level of detail required for a comparative assessment of water quality impairment at various locations within a watershed. This is possible by evaluating the site-specific water quality information from individual monitoring stations within the watershed. By using this approach, those stations exhibiting the poorest quality within an impaired (ie., high water quality index) watershed can be identified for further analysis by management, with a focus on sources of pollution, appropriate management practices to be implemented, benefits to be accrued, potential for mitigation of health hazards, size of affected population, and numerous other issues.

The following illustration on the use of this system serves as an example. The six segments with the highest combined Water Quality Index and Water Use Index are: Mid-Atlantic Coastal, Mid-Passaic tributaries, Lower Raritan, South Branch Raritan, Musconetcong and Pequest Rivers and Mid-Passaic River. Of these six, the Mid-Passaic, Lower Raritan, and Mid-Passaic tributaries and South Branch Raritan have the greatest water quality impairment between 1977 and 1981 with Water Quality Indexes of 146, 103, 98 and 85; respectively. Further examination of the Lower Passaic, Lower Raritan, Mid-Passaic tributaries and South Branch Raritan segments reveal that the Lower Raritan (Raritan River at Victory Bridge) and the Mid-Passaic tributaries (Whippany River at Pine Brook) have the highest Violations Subscore, with 163 and 132, respectively. Thus, from a total of 17 monitoring locations within the top six rated segments, the Raritan River at Victory Bridge (Lower Raritan segment), and the Whippany River at Pine Brook (Mid-Passaic tributaries segment) merit strong consideration for pollution control activities, based on the evaluation of water quality and water use information. Additional considerations, not accounted for in the rating system (i.e., water quality of Raritan Bay at Victory Bridge is influenced by tidal actions), can also be factored into the process. The same rationale can be used with the water use index. The Mid-Atlantic Coastal Basin has a fairly low Water Quality Index, yet it has a high Water Use Index. Therefore, protection of water quality is imperative for protection of water uses in this basin.

The quantitative information presented on water quality and water uses for each segment can be used in a variety of ways, depending on the type of pollution control activity to be used or the specific goals of a particular program. For example, soil and water conservation practices may be needed in those watersheds with the highest ratings for agricultural water use, and total phosphorus and un-ionized ammonia water quality violations. The presence of excessive nutrients in a watershed dominated by agricultural land uses can indicate high sedimentation and fertilizer application rates and/or the contamination of streams by livestock wastes. Similarly, for the protection of fisheries, where identified as a program priority by this Department, then water pollution clean-up efforts for purposes of the program should be initially proposed in watersheds with the highest fisheries use ratings and greatest dissolved oxygen and un-ionized ammonia violations subscores. The inherent flexibility of the rating system, therefore, affords water quality managers a myriad of selective alternatives upon which informed decisions can be based.

The surface water rating system concept developed for the 1982 305(b) Report is a foundation upon which informed management decisions and meaningful policy determinations can be formulated. In addition, this system can be the basis for future rating systems that will utilize a greater amount of water quality and water use information. Since the incorporation of subjective information has been minimized in determining watershed ratings, the defensibility of management decisions with respect to allocation of resources for pollution control is strengthened. It is of vital importance to both public and governmental concerns that State expenditures, particularly during times of economic stress, are reasonable and justifiable. This rating system can help meet these goals.

NEW JERSEY SURFACE WATER RATING SYSTEM

SEGMENT	MONITORING STATIONS STREAM/LOCATION	WATER QUALITY INDEX: % VIOLATIONS DO	TOTAL P	NH_3	TDS	VIOL. SUB-SCORE	TOXICS SUB-SCORE	WATER QUALITY INDEX	WATER USE INDEX: POTABLE SUPPLY	FISHERIES	BATHING	SHELL FISH	AGRI.	WATER USE INDEX	MAJOR POLLUTION SOURCE
Wallkill River	Wallkill R. at Franklin	3	13	8	0	24									1.NPS-Agr (Waste) 2.PS (Mun)
	Wallkill R. at Unionville	3	26	0	0	29									
	Papakating Ck. at Sussex	8	26	0	0	34									
	Black Ck. at Vernon	8	32	0	0	40									
	Avg. Violations Subscore					32									
	Segment Totals					32	15	47	0	3	40	0	16	59	
Flat Brook and Paulins Kill	Flatbrook at Flatbrookville	0	7	2	0	9									1.PS (Mun) 2.NPS-Agr (Waste, Nutr.)
	Paulinskill at Blairstown	0	9	0	0	9									
	Avg. Violations Subscore					9									
	Segment Totals					9	11	20	0	3	17	0	14	34	
Pequest and Musconetcong Rivers	Pequest R. at Belvidere	0	17	13	0	30									1.Septics 2.PS (Mun)
	Musconetcong R. at Lockwood	4	61	0	0	65									
	Musconetcong R. at Bloomsbury	0	48	2	0	50									
	Avg. Violations Subscore					48									
	Segment Totals					48	18	66	42	22	40	0	20	124	
Pohatcong and Lopatcong Creeks	Lopatcong Ck. at Phillipsburg	0	18	0	0	18									1.NPS-Agr (Waste,Sed) 2.Septics
	Pohatcong Ck. at Carpentersville	0	52	4	4	60									
	Avg. Violations Subscore					39									
	Segment Totals					39	0	39	0	7	0	0	1	8	

NEW JERSEY SURFACE WATER RATING SYSTEM

SEGMENT	MONITORING STATIONS STREAM/LOCATION	WATER QUALITY INDEX							WATER USE INDEX						
		% VIOLATIONS				VIOL. SUB-SCORE	TOXICS SUB-SCORE	WATER QUALITY INDEX	POTABLE SUPPLY	FISHERIES	BATHING	SHELL FISH	AGRI.	WATER USE INDEX	MAJOR POLLUTION SOURCE
		DO	TOTAL P	NH_3	TDS										
Delaware River Tributaries - Hunterdon/Mercer Counties	Hakihokake Ck. at Milford	0	13	8	0	21									1.Septics
	Lockatong Ck. at Raven Rock	0	20	0	0	20									
	Wickecheoke Ck. at Stockton	0	9	21	7	37									
	Avg. Violations Subscore					26									
	Segment Totals					26	0	6	0	12	1	0	15	28	
Assunpink Creek	Assunpink Ck. at Clarksville	0	15	0	0	15									1.NPS (Urb, Agr) 2.PS (Mun)
	Assunpink Ck. at Trenton	0	97	0	0	97									
	Avg. Violations Subscore					56									
	Segment Totals					56	18	74	12	6	1	0	11	30	
Crosswick's and Assiscunk Creeks	Crosswicks Ck. at Extonville	6	92	0	0	98									1.NPS-Agr (Waste, Nutr) 2.PS (Mun, Ind)
	Crosswicks Ck. at Groveville	3	92	0	0	95									
	Assiscunk Ck. at Burlington	3	40	0	0	43									
	Avg. Violations Subscore					79									
	Segment Totals					79	11	90	0	6	1	0	61	68	
Rancocas Creek	N.B. Rancocas at Pemberton	0	0	0	0	0									1.PS (Mun)
	N.B. Rancocas at Mt. Holly	0	51	0	0	51									
	S.B. Rancocas at Retreat	0	25	0	0	25									
	S.B. Rancocas at Hainesport	2	90	0	0	92									
	Avg. Violations Subscore					42									
	Segment Totals					42	28	70	0	7	31	0	31	69	

NEW JERSEY SURFACE WATER RATING SYSTEM

SEGMENT	MONITORING STATIONS STREAM/LOCATION	WATER QUALITY INDEX							WATER USE INDEX						MAJOR POLLUTION SOURCE
		% VIOLATIONS				VIOL. SUB-SCORE	TOXICS SUB-SCORE	WATER QUALITY INDEX	POTABLE SUPPLY	FISHERIES	BATHING	SHELL FISH	AGRI.	WATER USE INDEX	
		DO	TOTAL P	NH_3	TDS										
Pennsauken Creek, Big Timber Creek and Cooper River (including Newton Creek)	S.B. Pennsauken at Cherry Hill	6	100	15	0	121									1.PS (Mun, Ind.) 2.NPS (Pesticides)
	Cooper River at Lindenwold	0	4	0	0	4									
	Cooper R. at Haddonfield	11	100	22	0	153									
	S.B. Big Timber at Blackwood	3	83	0	0	86									
		Avg. Violations Subscore				86									
		Segment Totals				86	33	119	0	2	6	0	0	8	
Woodbury, Mantua and Raccoon Creeks	Mantua Ck. at Mantua	0	75	0	0	75									1.PS (Mun, Ind.) 2.NPS (Agr.)
	Raccoon Ck. at Swedesboro	0	50	0	0	50									
		Avg. Violations Subscore				63									
		Segment Totals				63	21	84	0	10	9	0	32	51	
Oldmans Creek, Salem River and Alloway Creek	Oldmans Ck. at Porches Mill	0	29	0	0	29									1.NPS (Agr.) 2.Septics
	Salem R. at Courses Landing	12	98	5	0	115									
		Avg. Violations Subscore				72									
		Segment Totals				72	22	94	0	14	3	0	19	36	
Cohansey and Maurice Rivers	Maurice R. at Norma	0	11	0	0	11									1.NPS (Agr) 2.Septics
	Cohansey R. at Seely	0	33	0	0	33									
		Avg. Violations Subscore				22									
		Segment Totals				22	11	33	0	31	22	0	23	76	

NEW JERSEY SURFACE WATER RATING SYSTEM

SEGMENT	MONITORING STATIONS STREAM/LOCATION	WATER QUALITY INDEX: % VIOLATIONS DO	TOTAL P	NH_3	TDS	VIOL. SUB-SCORE	TOXICS SUB-SCORE	WATER QUALITY INDEX	WATER USE INDEX: POTABLE SUPPLY	FISHERIES	BATHING	SHELL FISH	AGRI.	WATER USE INDEX	MAJOR POLLUTION SOURCE
Southern Atlantic Coastal Segment-Great Bay to Cape May Point	Tuckahoe R. at Head of River	0	8	0	0	8									1. NPS(Urb) 2. Septics
	Avg. Violations Subscore					8									
	Segment Totals					8	4	12	1	21	50	66	0	138	
Great Egg Harbor River	GEHR at Sicklerville	7	83	0	0	90									1. PS(Mun) 2. NPS(Agr)
	GEHR at Weymouth	0	12	0	0	12									
	Avg. Violations Subscore					51									
	Segment Totals					51	22	73	0	20	7	9	9	27	
Mullica River	Mullica R. at Pleasant Mills	67	0	0	0	57									1. PS(Mun) 2. Septics
	Oswego R. at Harrisville	21	0	0	0	21									
	E.B. Bass R. at New Gretna	0	6	0	0	6									
	Avg. Violations Subscore					28									
	Segment Totals					28	11	39	0	17	12	47	0	86	
Mid-Atlantic Coastal Basin - Great Bay to Manasquan Inlet	Toms R. at Rt. 547	0	0	0	0	0									1. NPS(Sub) 2. Septics
	Metedeconk R. at Rt. 547	5	33	0	0	38									
	Avg. Violations Subscore					19									
	Segment Totals					19	31	50	0	53	100	90	2	245	
Manasquan River	Manasquan R. at Georgia	0	84	0	0	84									1. PS (Mun,Ind) 2. Toxics
	Manasquan R. at Squankum	5	88	4	0	97									
	Avg. Violations Subscore					90									
	Segment Totals					90	44	134	0	10	1	0	4	15	

NEW JERSEY SURFACE WATER RATING SYSTEM

SEGMENT	MONITORING STATIONS STREAM/LOCATION	WATER QUALITY INDEX: % VIOLATIONS DO	TOTAL P	NH_3	TDS	VIOL. SUB-SCORE	TOXICS SUB-SCORE	WATER QUALITY INDEX	WATER USE INDEX: POTABLE SUPPLY	FISHERIES	BATHING	SHELL FISH	AGRI.	WATER USE INDEX	MAJOR POLLUTION SOURCE
North Atlantic Coastal Basin - Manasquan Inlet to Sandy Hook	Willow Bk. at Holmdel	0	42	0	0	42									1. NPS-Agr (Waste) 2. Septics
	Yellow Bk. at Colts Neck	0	16	0	0	16									
	Jumping Bk. at Neptune City	0	3	0	0	3									
	Avg. Violations Subscore					20									
	Segment Totals					20	27	47	12	22	29	35	8	106	
North Branch Raritan River	N.B. Raritan at Chester	7	93	0	0	100									1. NPS(Agr) 2. Septics
	N.B. Raritan at Burnt Mills	0	29	0	0	29									
	Lamington R. at Ironia	10	98	0	0	108									
	Lamington R. at Lamington	9	25	13	0	38									
	Avg. Violations Subscore					69									
	Segment Totals					69	0	69	0	9	2	0	5	16	
South Branch Raritan River	S.B. Raritan at Middle Valley	0	38	4	0	42									1. PS(Mun,Ind) 2. NPS
	S.B. Raritan at Stanton Station	0	20	9	10	39									
	S.B. Raritan at Three Bridges	0	38	0	3	41									
	Avg. Violations Subscore					41									
	Segment Totals					41	44	85	0	50	6	0	51	101	
Millstone River	Millstone R. at Applegarth	0	32	0	0	32									1. PS(Nutr) 2. NPS-Agr (Sed)
	Millstone R. at Blackwells Mill	3	97	0	0	100									
	Stony Bk. at Princeton	0	8	0	0	8									
	Avg. Violations Subscore					47									
	Segment Totals					47	11	58	30	7	2	0	49	88	

NEW JERSEY SURFACE WATER RATING SYSTEM

SEGMENT	MONITORING STATIONS STREAM/LOCATION	WATER QUALITY INDEX: % VIOLATIONS DO	TOTAL P	NH_3	TDS	VIOL. SUB-SCORE	TOXICS SUB-SCORE	WATER QUALITY INDEX	WATER USE INDEX: POTABLE SUPPLY	FISHERIES	BATHING	SHELL FISH	AGRI.	WATER USE INDEX	MAJOR POLLUTION SOURCE
Lawrence Brook and South River	Lawrence Bk. at Weston Mills	0	8	0	0	8									1. NPS-Agr (Sed.Nutr) 2. PS
	Matchaponix Bk. at Spotswood	0	23	0	0	23									
	South R. at Old Bridge	0	37	0	12	49									
	Avg. Violations Subscore					27									
	Segment Totals					27	36	63	4	8	3	0	6	21	
Raritan River Mainstem and Raritan Bay Drainage (Lower Raritan)	Raritan R. at S. Bound Bk.	2	98	24	0	124									1. PS(Mun,Ind)
	Raritan R. at Raritan	0	39	0	0	39									
	Raritan R. at Victory Bridge	18	-	9	-	27									
	Raritan R. at Manville	0	44	0	0	44									
	Avg. Violations Subscore					59									
	Segment Totals					59	44	103	74	1	10	0	0	85	
Elizabeth and Rahway Rivers	Elizabeth R. at Elizabeth	0	7	0	13	20									1. NPS(Urb, Sub)
	Rahway R. at Rahway	0	15	0	0	15									
	Rahway R. Robinson Branch	0	31	0	0	31									
	Avg. Violations Subscore					22									
	Segment Totals					22	44	66	2	2	0	0	0	4	
Upper Passaic River	Passaic R. at Millington	15	67	0	0	41									1. PS (Mun)
	Passaic R. at Chatham	6	87	4	7	26									
	Avg. Violations Subscore					34									
	Segment Totals					34	6	40	7	2	1	0	0	10	

NEW JERSEY SURFACE WATER RATING SYSTEM

SEGMENT	MONITORING STATIONS STREAM/LOCATION	WATER QUALITY INDEX							WATER USE INDEX						MAJOR POLLUTION SOURCE
		% VIOLATIONS				VIOL. SUB-SCORE	TOXICS SUB-SCORE	WATER QUALITY INDEX	POTABLE SUPPLY	FISHERIES	BATH-ING	SHELL FISH	AGRI.	WATER USE INDEX	
		DO	TOTAL P	NH_3	TDS										
Mid-Passaic River	Passaic R. at Two Bridges	48	85	21	0	154									1. PS(Mun) 2. NPS(Urb)
	Passaic R. at Little Falls	0	90	25	0	115									
		Avg. Violations Subscore				135									
		Segment Totals				135	11	146	20	0	0	0	0	20	
Mid-Passaic River Tributaries-Whippany, Rockaway, Pompton, Pequannock, Ramapo and Wanaque Rivers	Rockaway R. at Pine Bk.	3	79	0	0	82									1. PS 2. NPS(Sub)
	Whippany R. at Pine Bk.	24	100	8	0	132									
	Ramapo R. at Mahwah	3	58	0	0	61									
	Pompton R. at Packanack Lk.	0	67	0	0	67									
		Avg. Violations Subscore				86									
		Segment Totals				86	12	98	100	1	36	0	0	137	
Lower Passaic River	Passaic R. at Elmwood Park	3	95	4	0	102									1. PS(Mun,Ind) 2. NPS(Urb)
	Saddle R. at Lodi	3	100	26	0	129									
		Avg. Violations Subscore				116									
		Segment Totals				116	47	163	2	2	8	0	0	12	
Hackensack River	Hackensack R. at Rivervale	0	28	0	0	28									1. NPS(Sub) 2. PS
	Hackensack R. at New Milford	3	22	0	0	25									
		Avg. Violations Subscore				27									
		Segment Totals				27	37	64	36	7	2	0	0	45	

III. SURFACE WATER QUALITY CONDITIONS

A. SUMMARY OF SURFACE WATER QUALITY CONDITIONS IN NEW JERSEY

A synopsis of surface water quality conditions in New Jersey and the major recommendations developed from this report for the improvement of water quality in the State are presented in this section. Also discussed below is a review of how water quality has changed in New Jersey over the past 10 years based on conclusions in the first four State Water Quality Inventory Reports.

Results of Prior State Water Quality Inventory Reports

The first four State Water Quality Inventory Reports (1975, 1976, 1977 and 1980) prepared by the NJDEP showed that the continued degradation of waters in New Jersey was halted with the advent of higher treatment levels for municipal and industrial wastewaters, and the issuance of pollutant discharge permits in the mid-1970s. The discussion below is a review of the four prior report's major conclusions concerning water quality and the needed source controls.

The 1975 305(b) report found that with the exception of certain streams, (Raritan and Passaic Rivers, and the Delaware estuary), there was insufficient water quality data to make objective statistical analysis. In the Passaic River Basin water quality in the freshwater reaches was found to be degrading, as was the Raritan and Millstone Rivers near Manville. The Delaware River Basin from Trenton to Hope Creek was in poor condition. In the Atlantic Ocean frequent red tide blooms took place. Shellfish harvesting areas had experienced a ten percent reduction in the acreage available for harvesting since 1967 (however, 75 percent of the total amount was open). Primary and secondary contact recreation, water supply, propagation and maintenance of fish, and shellfish harvesting were available at various locations throughout the State in most watersheds (with the exception of shellfish harvesting which is specific to coastal waters). The 1975 report also stated, that in addition to point sources, non-point sources were significant in the developed rivers of the northeast section of the State, and in urban areas of Mercer, Burlington and Camden Counties. The report concluded that increased monitoring of surface and ground waters was needed, as well as approximately $12.2 billion for sewage treatment, stormwater control and abatement of combined sewer overflows.

The 1976 State Water Quality Inventory Report identified significant improvements in dissolved oxygen and fecal coliform in the State's waters. This change was evident in the freshwaters of the Passaic and Hackensack Rivers, and the Millstone River in the Raritan Basin, (these river systems though were still not considered to be healthy aquatic environments). In the Raritan River potentially toxic levels of ammonia reflected the poor water quality found. Poor water quality was also found in the Delaware River tributaries of Camden and Mercer Counties. The reduction in harvestable shellfish growing waters continued in New Jersey into 1976, as only 63 percent of the total were suitable for harvesting.

Little change in overall water quality throughout the State was noted in the 1977 305(b) report, with the exception of improved bacteria quality in the coastal bays and estuaries. This improved quality resulted in greater acreage available for shellfish harvesting. Dissolved oxygen levels in the urbanized northeast were depressed with little identifiable improvement. This was similar to conditions in the urbanized Camden and Burlington County regions. The 1977 305(b) report also noted that there was a lack of definitive monitoring data for several streams throughout the State. Non-point sources (septic systems, feedlot and other agricultural runoff, and urban runoff) were the main cause for fecal coliform levels found in many streams. The ability of the State's waters to meet swimmable and fishable goals was reviewed in this report. It stated that swimmability was assured for most of New Jersey's waters by 1983 with the exception of the urbanized streams. Fishability would also occur throughout except in urban Mercer and Camden Counties, and the northeast New Jersey region. The 1976 Needs Survey estimated that all wastewater treatment needs in the State would cost approximately $11 billion (8 billion for stormwater/runoff controls).

The 1980 State Water Quality Inventory Report contained the same conventional water quality information which was in the 1977 report. However, the results of limited toxic substances sampling, intensive lake surveys, and updates in shellfish harvesting areas classification were included in the report. The initial toxics sampling program of surface and ground waters in the northeast region of the State and Monmouth County found various substances at various levels throughout the study areas. Expansion of toxic substances sampling and specific water quality standards for toxic substances were among the recommendations generated from the initial sampling program. Gains in approved shellfish harvesting areas in years 1978 and 1980 were the first in over 11 years. This upgrading of shellfish growing areas was a result of water quality improvements from the regionalization of sewage treatment plants, advance to secondary treatment levels, and the conversion of bay discharges to ocean discharges. The first two years of the DWR Lakes Management Program identified nearly two-thirds of the lakes sampled to be eutrophic (or mesoeutrophic), with a variety of sources the reason for the trophic states.

Water Quality Trends

Trends in water quality for the major rivers and streams of New Jersey are presented in this section. These waters are grouped according to the major drainage basins of the State: Delaware, Atlantic Coastal, Raritan and the Passaic/Hackensack. Streams in the Walkill Basin, which is a minor drainage basin in northwest New Jersey and lower New York State, have been grouped with the Delaware Basin for purposes of this report. The boundaries for these areas and the watersheds within each, are delineated in Figure III-1.

In order to obtain detailed information on water quality for individual rivers and streams, specific indicator substances must be examined. The monitoring stations sampled by the Division of Water Resources, and included in the 1982 State Water Quality Inventory 305(b) Report, measure a variety of substances on a regular schedule. Ten water quality indicators were utilized in this assessment. They are Dissolved Oxygen, Total Phosphorus, Un-ionized Ammonia, Total Dissolved Solids, Biochemical Oxygen Demand, Percent Dissolved Oxygen Saturation, Fecal Coliform bacteria, Nitrate and Nitrite, Total Ammonia, and pH. Each of these indicators reflects one aspect of water quality, and, when combined, provides a good indication of water quality conditions in a given stream. The significance of each of these water quality parameters is described below:

Dissolved Oxygen (DO) - The oxygen freely available in water and necessary for aquatic life. The amount of DO in a waterbody will determine the type and quantity of aquatic life that can be supported. DO decreases as water temperature increases. The amount of DO is also influenced by water temperature, turbulence, presence of photosynthetic plants, algae, and oxygen depleting substances such as decaying organic matter. Over long periods a DO of less than 4.0 mg/l can be lethal to most fish.

Total Phosphorus (Total P) - An essential nutrient in the aquatic environment which is also a limiting factor in the rate of plant growth. As total phosphorus in a waterbody increases, the tendency toward eutrophication generally increases.

Un-ionized Ammonia (NH_3) - A by-product primarily of wastewater treatment plant effluent which is toxic to aquatic life. Its abundance is dependent on pH and temperature.

Total Dissolved Solids (TDS) - The total amount of dissolved material, organic and inorganic, contained in water and wastewater. High concentrations of TDS may render drinking water unsuitable for use unless treated beforehand or make treatment processes difficult.

Biochemical Oxygen Demand (BOD) - A measure of the amount of oxygen that organic material would consume in the process of decomposition (usually based on a five day test). BOD reflects the oxygen demand placed on a body of water.

Fecal Coliform - Waterborne bacteria which originate from the intestinal tract of warm blooded animals. Their sanitary

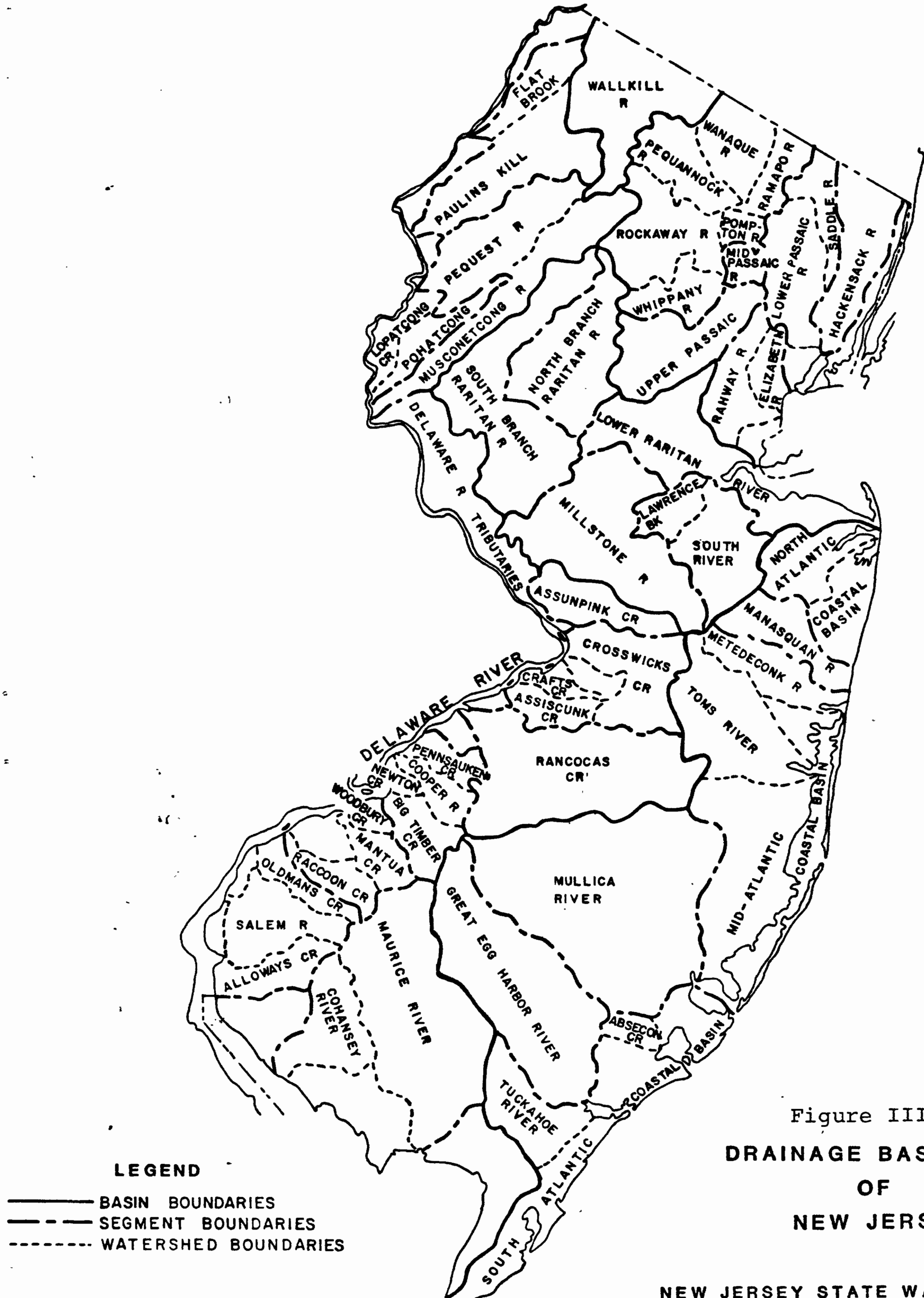

Figure III-1

DRAINAGE BASIN MAP OF NEW JERSEY

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significance as an indicator of fecal contamination lies in their ability to suggest the presence of microbial pathogens and the possible degree of health risk associated with the use of water for drinking (without treatment), swimming, or shellfishing.

Nitrate and Nitrite (NO_3/NO_2) - Essential nutrients present in the aquatic environment which are limiting factors in the rate of plant growth. As these nitrogenous compounds increase in the waterbody the tendency toward eutrophication increases. These nutrients are formed during the breakdown of organic materials, such as sewage.

Total Ammonia (NH_3 - NH_4+) - A measurement of the un-ionized (NH_3) and ionized (NH_4+) forms of ammonia in water. The ratio of NH_3 to NH_4+ is dependent on pH and temperature.

pH - A measure of hydrogen ion concentration. pH ranges from 0 to 14 with 0 the most acidic, 7 neutral, and 14 the most basic. The degree of dissociation of weak acids or bases is affected by changes in pH. Most rivers and streams have a natural pH value ranging from mildly acidic to mildly alkaline (approximately 7.0). Severe alterations in the natural pH conditions of a waterbody can adversely affect aquatic life, particularly through activation or release of toxic substances.

Table III-1 provides an overview of water quality trends for individual rivers and streams. The trends have been developed by averaging the conditions for individual monitoring sites on a given waterbody, and therefore, are based on water quality information gathered over the last five years. The information contained in Table III-1 notes the trends for each stream segment. Four possible entries are made for each of the ten water quality indicators at each stream location: I = Improving; D = Declining; S = Stable/Unchanged; and - = Insufficient data to determine trend (the phase "insufficient date to determine trend" reflects a lack of historical water quality data rather than current water quality data and, as such, meaningful long-term trends are not possible.

Overall Stream Water Quality

The overall water quality classification (poor, fair, good, or excellent) assigned to each stream segment is an average water quality assessment, and is given for the years 1977 and 1982 for comparitive purposes. In order to understand the status of New Jersey's waters relative to the goals of the federal Clean Water Act, water quality classifications are defined as follows:

Poor - Quality prevents fish propagation but would allow fish survival except for certain times of the year when fish kills may occur. Unsuitable for swimming and shellfish harvesting.

Fair - Fish propagation could occur for pollution tolerant species. Provides for fish survival except for instances when limited fish kills may occur. Generally unsuitable for swimming and shellfish harvesting.

Good - Fish propagation and maintenance of desirable species would occur. Suitable for swimming except for localized bacterial problems. Generally suitable for shellfish harvesting, except for localized restrictions.

Excellent - Essential absence of significant pollution problems. Fish propagation and maintenance of natural species would occur. Suitable for swimming except for localized bacterial problems. Suitable for shellfish harvesting.

These categories do not attempt to identify water purity from the standpoint of potable water use. Many waters in all categories are suitable for potable use after appropriate treatment processes are applied.

The classification of each stream segment into one of the four categories is based on available physical, chemical and biological data. Nevertheless, it should be recognized that the category assigned to a given stream segment may not apply to every mile of the segment, particularly the headwaters where water quality may be significantly better than the average water quality stated for the entire segment. With regard to fishlife, it must also be emphasized that there are many interrelated factors that determine whether or not a given species will be present in a stream. Even if the amount of DO is sufficient for fish survival and reproduction, the presence of one or more toxic substances, excess suspended solids, or other factors acting alone or in combination may limit fish populations in a stream.

The four categories represent a continuum of water quality ranging from levels below the goal of fishable and swimmable (poor) to levels achieving these goals (excellent). By applying these categories to waters of the State it is possible to identify progress being made toward attainment of the goals in the Clean Water Act.

Major Water Quality Issues - 1977 to 1981

The identification of trends in water quality data and the subsequent determination of overall stream water quality together represent an evaluation of pollution in the major rivers and streams of the State. The water quality indicators which have been reviewed above are affected by two factors: man's impact on the environment, and natural conditions. The former is, to a large extent, manageable; the latter may or may not be.

TABLE III-1 New Jersey Surface Water Quality Trends - 1977 to 1981

Stream	DO	Total P	NH_3	TDS	BOD	DO Sat.	Fecal Coli.	NO_3/NO_2	NH_3/NH_4+	pH	1982 Overall Water Quality***
DELAWARE BASIN											
Wallkill River	D	S	S	S	S	D	S	S	S	S	Fair
Flat Brook	S	S	S	S	S	S	S	S	S	S	Excellent
Paulins Kill	S	S	S	S	S	I	S	S	S	S	Good
Pequest River	S	S	S	S	S	S	S	S	S	S	Good
Musconetcong River	S	S*	S	S	I	S	S	S	S	S	Good
Pohatcong Creek	S	D*	S	S	S	S	D	D	S	S	Good
Lopatcong Creek	S	D	S	S	S	S	D	D	S	S	Good
Delaware River Tribs.- Hunterdon County	D	S	S	D	S	S	S	S	S	S	Good
Assunpink Creek	I	I*	S	S	S	S	S	S	S	D	Fair
Crosswicks Creek	I	S*	S	S	I	S	S	S	S	S	Fair
Assiscunk Creek	I	S	S	S	I	S	S	S	S	S	Fair
Rancocas Creek - North Branch	S	I	S	S	I	I	S	S	S	S	Fair
Rancocas Creek - South Branch	S	I*	S	S	I	I	S	S	S	S	Fair
Pennsauken Creek	S	S*	S	S	S	S	S	S	S	S	Poor
Big Timber Creek	S	S*	S	S	S	S	S	S	S	S	Poor
Cooper River	S	S*	S	S	S	S	S	S	S	S	Poor
Mantau Creek	S	S*	S	S	S	S	D	S	S	S	Fair
Raccoon Creek	S	S*	S	S	S	S	S	S	S	S	Fair
Oldmans Creek	I	S	S	S	S	S	S	S	S	S	Fair
Salem River	S	S*	S	S	S	S	S	S	S	S	Poor
Cohansey River	S	D	S	S	S	S	D	S	S	S	Poor
Maurice River	I	I	S	S	S	S	S	S	S	S	Fair/Good

Legend

I = Improving
D = Declining
S = Stable/Unchanged
- = Insufficient data to determine trend
* = Exceeded State Water Quality Standard 50% or more of the time
** = Derived from 208 Areawide Quality Management Plans
*** = Classification may be based on water quality parameters other than the ten presented here.

TABLE III-1 New Jersey Surface Water Quality Trends - 1977 to 1981

Stream	DO	Total P	NH_3	TDS	BOD	DO Sat.	Fecal Coli.	NO_3/NO_2	NH_3/NH_4^+	pH	1982 Overall Water Quality***
ATLANTIC COASTAL BASIN											
Tuckahoe River	S	S	D	S	S	S	S	S	D	D	Good
Great Egg Harbor	S	S	S	S	S	S	S	S	S	S	Fair
Mullica River	S	S	S	S	S	D	S	S	S	S	Excellent
Metedeconk River	I	I	S	S	S	S	S	S	S	S	Fair
Toms River	S	S	S	S	D	S	S	S	S	S	Fair
Manasquan River	S	S*	S	S	S	S	S	S	S	S	Fair
N.Atlantic Coastal-(Willow,Yellow,Jumping Br's)	S	S	S	S	S	S	S	S	S	S	Good
RARITAN BASIN											
North Branch Raritan River	S	S*	D	S	D	S	D	S	S	S	Good
South Branch Raritan River	S	S	D	S	S	S	S	S	S	S	Good
Millstone River	I	I*	S	S	I	S	S	S	S	S	Fair/Good
Lawrence Brook	S	D	S	S	S	S	I	S	S	S	Good
South River	S	S	S	S	S	S	S	S	S	S	Fair
Raritan River	I	D*	I	S	S	S	S	S	I	S	Poor/Fair
Elizabeth River	S	S	D	-	I	S	D	-	D	-	Poor
Rahway River	S	S	S	-	D	S	D	-	S	-	Poor/Fair

Legend

I = Improving
D = Declining
S = Stable/Unchanged
- = Insufficient data to determine trend
* = Exceeded State Water Quality Standard 50% or more of the time
** = Derived from 208 Areawide Water Quality Management Plans
*** = Classification may be based on water quality parameters other than the ten presented here.

TABLE III-1 New Jersey Surface Water Quality Trends - 1977 to 1981

Stream	DO	Total P	NH_3	TDS	BOD	DO Sat.	Fecal Coli.	NO_3/NO_2	NH_3/NH_4^+	pH	1982 Overall Water Quality***
PASSAIC/HACKENSACK BASIN											
Upper Passaic River	S	S*	S	S	S	S	I	S	S	S	Poor/Fair
Mid-Passaic River	S	S*	S	S	S	S	S	S	S	S	Poor
Mid-Passaic Tributaries											
Rockaway River	S	S*	S	S	S	S	I	S	S	S	Poor
Whippany River	S	S*	S	S	S	S	D	S	S	S	Poor/Fair
Ramapo River	S	S*	S	S	S	S	S	S	S	S	Fair
Pompton River	S	S*	S	-	D	-	D	S	S	-	Fair
Lower Passaic River	S	S*	S	S	S	S	S	S	S	S	Poor
Hackensack River	S	S	S	S	S	S	S	S	S	S	Poor

Legend

I = Improving
D = Declining
S = Stable/Unchanged
- = Insufficient data to determine trend
* = Exceeded State Water Quality Standard 50% or more of the time
** = Derived from 208 Areawide Water Quality Management Plans
*** = Classification may be based on water quality parameters other than the ten presented here.

Precipitation and temperature are the most important natural factors influencing water quality. For example, the amount of DO in a waterbody exhibits a natural seasonal variation. During the winter months colder stream waters can hold much more DO than the same waters during the warmer summer season. For this reason, fish kills normally occur during the summer months. Variation in precipitation will also affect water quality. If the amount of man-induced pollutants discharged into a stream remains constant while flows drop due to reduced rainfall, aquatic life will probably be more seriously affected because of an increase in the concentration of pollutants.

Point sources of water pollution, such as discernible discharges from sewage treatment plants or industries, can also degrade stream water quality. Indiscernible or non-point pollution sources, such as stormwater runoff from urban/suburban or agricultural areas, can also increase the total load of pollutants entering a stream. However, this usually occurs during rainfall events. Therefore, combined natural and man-made pollution create serious water quality problems.

To evaluate the impact of these problems and to keep abreast of current water quality conditions, the DWR conducts sampling programs to measure the concentration of many water pollutants. The sampling results are then compared to water quality standards to determine if the individual pollutant concentrations meet the prescribed standards. The DWR promulgated Water Quality Standards for some of the more important indicators of water quality in 1974, with subsequent revisions in 1981 (mainly to reflect recent literature and water quality information on toxic substances). The standards also vary according to type of surface water: freshwater, tidal water and coastal water; and ability of waters to attain different water uses. This allows normal background differences to be taken into account.

The current overall water quality of 44 major rivers and streams was compared to water quality conditions which existed at the time of the last two State Water Quality Inventory Reports (1977 and 1980). The quality of surface waters in the State has shown no significant improvement or decline over the last 4-5 years based on conventional data collected at the monitoring stations reviewed in the Surface Water Quality Inventory (Appendix 1). Comparison revealed that 38 waterbodies remained unchanged, 5 declined and 1 improved. Recent improvement in water quality has occurred over the last few years in the coastal bays and estuaries. This is evident in the reclassification of over 7000 acres of shellfish growing areas from restrictive classifications to classifications allowing harvesting of shellfish.

Overall, for all conventional data evaluated which can be compared to respective State Surface Water Quality Standards, 45 percent of the total phosphorus values exceeded standards, 4 percent of the dissolved oxygen, 3 percent of the un-ionized ammonia and 2 percent of total dissolved solids readings exceeded standards. In addition most of the fecal coliform concentrations were above 200 MPN/100 ml. (the level in State standards), but not enough samples were collected to compare to standards which requires a geometric average of five samples per 30 day period. The conventional data collected indicates that there is widespread fecal coliform contamination and excessive nutrients (total phosphorus) in the surface waters of the State.

The causes of water quality degradation are quite varied throughout the State. Each watershed has a different set of pollution sources affecting water quality which are often difficult to identify and to quantify their impacts. New Jersey has approximately 1600 permitted point source wastewater discharges (one-third are municipal/institutional and the remaining two-thirds are industrial), and many possible non-point sources of pollution. Even with the implementation of discharge permits and their resultant discharge limitations, there are facilities throughout the State that are not in compliance with their permit requirements or are providing inadequate treatment. As a result, the major cause of nutrients in surface waters generally appears to be point sources, while non-point sources are the likely contributor of the frequently high fecal coliform counts found.

The majority of New Jersey's inland surface waters do not meet minimum standards for swimming and are not expected to meet the national swimmable goal in the foreseeable future. Although there are some localized acceptable stream bathing beaches as confirmed by regular monitoring, only the Flat Brook, Paulins Kill, and Mullica River are considered entirely acceptable for swimming. New Jersey as a whole has approximately 700 bathing beaches, most of which are found along the Atlantic Coast, within the Pinelands region, and in the ridge and valley lakes and streams of the State's northwest. Achievement of the Clean Water Act's fish propagation and maintenance goal will occur throughout much of New Jersey. Occasional stress to fish life is likely a result of periodic low dissolved oxygen, high un-ionized ammonia, excessive metals, and other toxic or hazardous substances. Waters that are not expected to meet the 1983 fishable goal are those in the urbanized and industrialized regions of the State, including tributaries to the Delaware River in Mercer, Burlington and Camden Counties, portions of the Passaic and Hackensack basins, and the New Jersey-New York interstate waters.

Many streams in northern New Jersey experienced significantly reduced water quality in mid-1980 to early 1981 because of a severe lack of rainfall. This drought condition affected northern waters more than central and southern streams because southern streams receive much of their baseflows from ground waters, whereas northern streams are more dependent on rainfall for base flows. The water quality impacts of the drought were generally reflected by reduced dissolved oxygen readings and increased fecal coliform, biochemical oxygen demand, nutrients and un-ionized ammonia concentrations. By the end of the monitoring period evaluated in this report (mid-1981) waterways had generally recovered to pre-drought conditions. Stress to aquatic life probably occurred during the drought because of the reduced DO and increases in un-ionized ammonia concentrations.

The NJ Division of Fish, Game and Wildlife has identified in their studies of coastal bays and estuaries that very low DO levels (below 4.0 mg/l) often occurs in these waters during summer months, possibly causing stressful conditions to aquatic life. Because of these low DO levels the coastal bays and estuaries must be considered to be very sensitive to oxygen-demanding pollution loads.

Toxic chemical parameters (includes volatile organics, pesticides, PCB's and heavy metals) were sampled for their presence in the water column, sediments and fish tissue. These substances seem to be fairly widespread at very low concentrations (depending on the substance and the medium sampled) throughout the State. Volatile organics were found in highest concentrations in waters adjacent to, or flowing through, industrialized urban and suburban centers. Metals, PCBs and pesticides were found throughout the State in fish tissue, but appeared highest in certain catadromous and anadromous species.

Recommendations for Improving Water Quality in New Jersey

Water quality in New Jersey has improved in some streams and declined somewhat in others but has generally held steady in most areas and waterways. How then, can greater improvements in water quality take place across the State, while utilizing limited public resources? Although this may not be easy, listed below are a series of recommendations that are designed to gain more knowledge of New Jersey's water resources. With this knowledge it is anticipated that greater water quality improvements can take place with fewer resources.

Increased water quality monitoring activities that are designed to detect specific water pollution sources. Current water quality monitoring programs such as the Primary (Ambient) Water Quality Monitoring Network and the National Basic Water Monitoring Network utilize the collection of monthly or bimonthly samples from a fixed number of monitoring stations spaced throughout the State. The major purpose of these programs is to identify long-term water quality trends for use in the 305(b) report. However, these programs do not identify sources of water pollution, the effects of these sources on stream quality and biota, the assimilation or removal of pollution by the stream environment, and the effectiveness of specific water pollution control activities. If public resources are to be used in the most efficient manner then specific sources of pollution which can be controlled, must be properly identified and analyzed for impacts on the receiving waters and the aquatic ecosystem.

To accomplish these objectives, it is recommended that a long-term intensive survey monitoring program be implemented in the State. This program would replace the existing water monitoring programs being conducted by NJDEP and other agencies under contract, so that the majority of all sampling performed would be of the intensive or special survey type. Watersheds or segments of a watershed would be intensively sampled on a periodic basis, with the number of monitoring sites in the watershed dependent upon water quality, land uses, wastewater discharges and the amount of historical data.

An intensive survey program would have as its specific objectives the following: Determination of water quality trends; identification of pollution sources; quantification of pollution impacts on receiving waters; comparison of water quality data to flow conditions; modelling for wasteload allocation purposes; determination of assimilative capacity of the waterbody; and statistical analysis of the data gathered.

Each intensive survey would be tailored to the segment or watershed it is designed to study. The size of the segment sampled in each survey would depend upon the size of the stream in question, but would generally correspond to the segments reviewed in the Water Quality Inventory appendix. For example, the North Branch Raritan River would constitute one survey, as would Raccoon Creek. Major rivers (such as the Passaic River) or complex systems (coastal estuaries) could be studied in segments. All segments or watersheds in the State would be intensively sampled within a period of time that depended upon the availability of manpower and funds (possibly once every 3-5 years). But, each segment would be sampled consistently at the same time of the year or under the same conditions (low flows, during runoff events, warmweather, etc.). This would allow direct comparison between data collected in one year with data collected at a later date. The time of year (temperature) or stream conditions (flow) surveyed would depend on the presence of point sources, land uses and critical flows. For example, those streams considered to receive significant pollution loads from point sources would be sampled during low flows; and vice versa for streams receiving large non-point source loads. Sampling sites would be located upstream and downstream of suspected pollution sources and important tributaries. Compliance monitoring for permitted point sources (of both influent and effluent), and biological monitoring (for aquatic invertebrates and fishlife) should also take place during the intensive survey period.

Streams would be sampled for a limited, but variety of water quality indicators. Flows would always be calculated. Because of the large volume of samples collected from each survey, resource limitations will dictate that fewer parameters be evaluated. To supplement the intensive surveys, limited fixed-station monitoring should continue on a year-round basis. However, only one station per segment or watershed would be required since the purpose of the fixed-station monitoring would be to detect major short-term and seasonal water quality changes that would not be identified through the intensive surveys. It is suggested that the National Basic Water Monitoring Network (presently containing 32 stations) continue operating because of its appropriate size, and existing committments; but that the Primary or Ambient Water Quality Monitoring Network be discontinued.

Before each intensive survey is implemented, a thorough understanding of the segment or watershed is required. The following information must be gathered before the survey is performed: Past water quality conditions, known or suspected pollution sources, critical regions or conditions in the stream, background conditions, existing water uses and stream biota. Background water quality would be determined on the basis of existing (past) water quality data and the results of sampling in headwaters and other upstream waters during intensive surveys.

A major concern in using a statewide intensive survey monitoring program are the costs (manpower, equipment and laboratory services) involved; and the possible loss of monitoring funds from agencies currently under contract with the DWR for cooperative monitoring programs. Greater cooperation with other monitoring agencies can lessen many of these concerns. However, even if monitoring costs are greater because of this system, it is anticipated that pollution sources will be better identified and control activities more accurately targeted. This will, in the long-term, help to achieve clean water goals in a more efficient manner.

Greater identification of surface water uses and resources. Water pollution control activities should be geared towards achieving greater water use benefits, such as contact recreation activities and improved fisheries, (as is already being done in DEP's Clean Lakes Program). Water use goals will result in tangible benefits to the public and will assist in determining what water pollution control resources should be allocated and where. To help produce these results more knowledge on the use of surface waters in the State must be generated. Existing, past and potential use of surface waters for public and private potable water supplies, agricultural and industrial processes, bathing and other primary contact recreation activities, fishing intensity, fish and wildlife habitat, and aesthetics should be thoroughly inventoried across the State. Such use inventories should be updated on a schedule similar to water quality inventory revisions to allow comparison between water quality changes with water use changes.

Coordinated watershed management activities. All activities in a watershed dealing with water pollution control and water resource management should be coordinated so that duplication of effort is eliminated and maximum efficiency results. This coordination should involve local, county, regional, state, and federal agencies; with special consideration given to local and county health offices or departments, in light of responsibilities designated to those agencies under the New Jersey County Environmental Health Act of 1977 (P.L. 1977, c 443).

Specific activities that would benefit from a coordinated approach include water quality monitoring, water use identification, location and recognition of pollution sources, and generation of public support for water quality management activities.

Identification and control of non-point pollution sources. Water Data reviewed in this report indicates that water quality throughout the State has not worsened or improved significantly since 1977. Despite substantial point source control efforts during this five-year period, water quality problems continue to persist in the State. Non-point sources of pollution must be recognized as the cause for many of the water quality problems which still exist. This is underscored by the fact that non-point and point sources are found in all watersheds of the State, and that regulatory requirements have resulted in overall improvements in point source effluent quality.

As more and more point sources utilize higher treatment levels, it is recommended that greater emphasis be placed on the identification and control of non-point sources. Intensive surveys should help identify non-point sources and their impacts on receiving waters, while controls can be implemented through existing enabling legislation. Only with effective point and non-point source controls can clean water goals in New Jersey be met.

Achieving necessary effluent quality from point sources. Due to the large number of point sources in many of New Jersey's watersheds, wastewaters can often have profound impacts on stream water quality. This was exemplified in the Passaic River during the recent drought when as much as 75 percent of the river's flow at Little Falls was thought to be upstream point source effluent. In addition, streams in the State consistently having poor water quality, have the average, the greatest number of wastewater treatment plants that are not meeting their effluent requirements. If clean water goals are to be met in New Jersey, it is imperative that all point sources be in compliance with their discharge permit limitations. Poor discharge quality is often due to inadequate, antiquated or underdesigned treatment systems and poor or delinquent operation of facilities. Primary treatment plants are still found in the State and many secondary treatment plants are discharging unsatisfactory treated wastewaters because of system overload or improper operation. These deficiencies need to be corrected at all municipal/domestic, industrial and other wastewater facilities.

B. WATER QUALITY OF SURFACE DRINKING WATER SUPPLIES

Introduction

New Jersey's water supply needs are met by a diverse system of surface and ground waters which are harnessed, treated and distributed by both public and self-supplied private purveyors. However, approximately 75 percent of the water supplied to New Jersey residents is the responsibility of the twenty-five largest public purveyors.

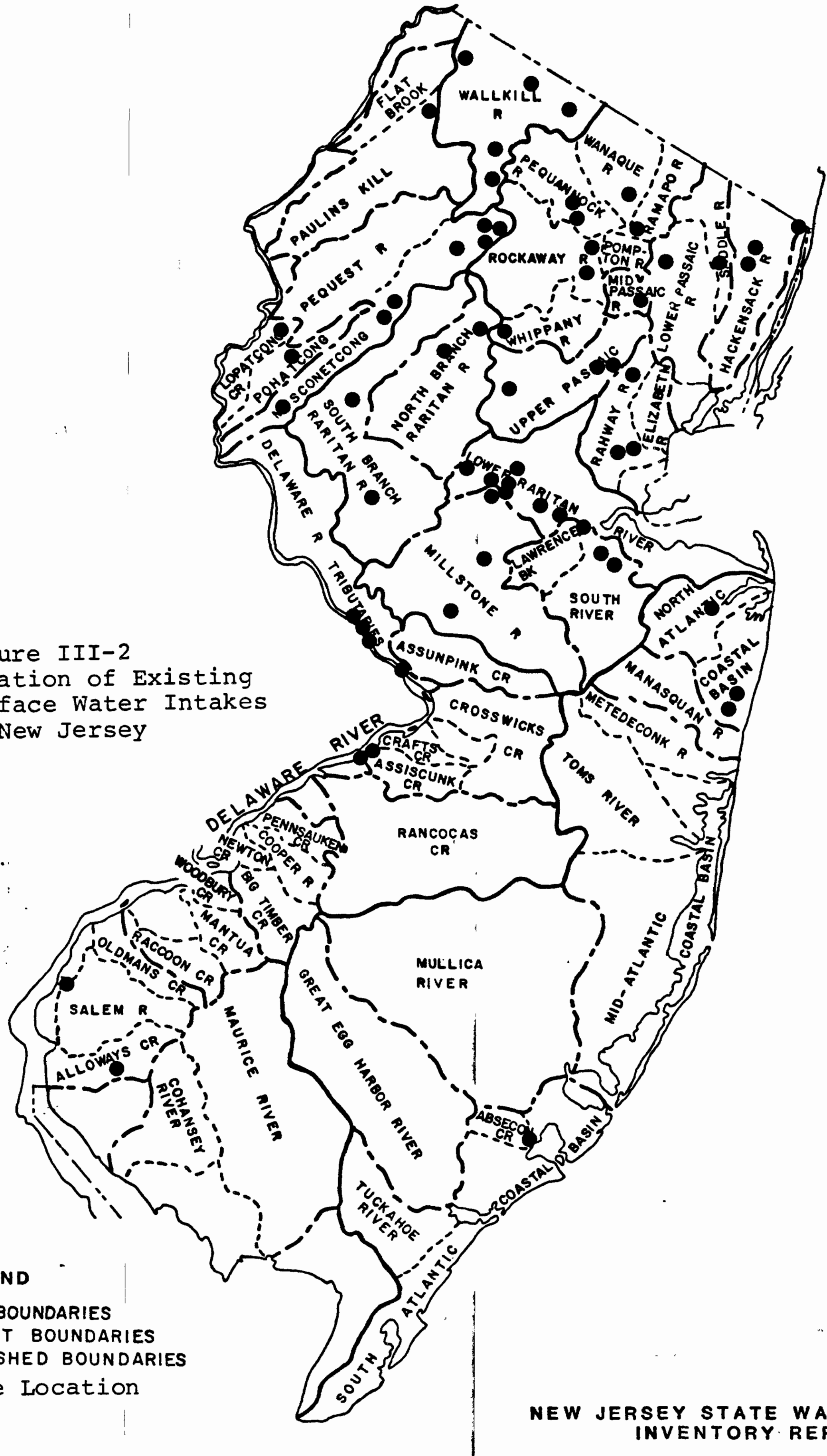
Sources of drinking water in the State may be found in reservoirs, rivers, well systems, purchased water from other purveyors or a combination of these. Figure III-2 presents the location of existing surface water intakes in the State. In general, the northern sector of the State relies predominantly on an interrelated system of surface water supplies. Sixty percent of water used by purveyors for potable supplies statewide are from surface water resources primarily supplying the most populous counties. The southern portion of the State is dependent for the most part on groundwater resources. Table III-2 illustrates that the southern counties of Atlantic (81.7 percent groundwater), Burlington (97.2 percent groundwater), Camden (100 percent groundwater), Cape May (100 percent groundwater) and Ocean (100 percent groundwater) rely heavily on the sensitive aquifer systems of the Atlantic Coastal Plain. Much of the State's growth is occuring in these coastal areas thereby increasing pressures on the quantity and quality of the groundwater (NJDEP, 1981a).

New Jersey is fortunate in that it is a water-rich state. Proper management of the quantity and quality of this water is necessary for it to be a useful and healthful resource. The State, in its interaction with water purveyors, has the major responsibility for assuring the adequacy and integrity of our water supplies.

The Department of Environmental Protection, Division of Water Resources is responsible for the long-range planning of water supply facilities, the issuance of well drilling, water allocation and water diversion permits and related record keeping duties. Water purveyors generally manage their own facilities, but do report reservoir levels to the State semi-monthly. State-owned water supply facilities are maintained and operated by the Water Supply Authority created by New Jersey law (N.J.S.A. 58:1B-1 et seq). The Water Supply Advisory Council advises the State on water supply planning and decision-making pursuant to the Water Supply Management Act (N.J.S.A. 58:1A-1 et seq). Together, the Water Supply Advisory Council and the State work with the Water Supply Authority and water purveyors to provide water supply facilities to meet present and growing demands.

Water quality is managed in New Jersey through several regulatory programs with varying perspectives. State Surface Water and

Figure III-2
Location of Existing Surface Water Intakes in New Jersey



LEGEND

- BASIN BOUNDARIES
- SEGMENT BOUNDARIES
- WATERSHED BOUNDARIES
- Intake Location

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TABLE III-2 Summary of 1975 Water Diversions by Purveyors Based Within the County

County	Groundwater Diversions (mgd)	Percent of Total	Surface Water Diversions (mgd)	Percent of Total	Total Diversions (mgd)
Atlantic	16.45	81.72	3.68	18.28	20.13
Bergen	27.91	23.33	91.71	76.67	119.62
Burlington	29.87	97.23	.85	2.77	30.72
Camden	71.55	100.00	0.00	0.00	71.55
Cape May	9.96	100.00	0.00	0.00	9.96
Cumberland	12.26	100.00	0.00	0.00	12.26
Essex	35.37	20.94	133.59a	79.06	168.96
Gloucester	14.44	100.00	0.00	0.00	14.44
Hudson	0.00	0.00	77.31b	100.00	77.31
Hunterdon	1.70	51.99	1.57	48.01	3.27
Mercer	5.11	14.02	31.35	85.98	36.46
Middlesex	25.99	42.69	34.89	57.31	60.88
Monmouth	24.56	48.36	26.23	51.64	50.79
Morris	28.78	87.88	3.97	12.12	32.75
Ocean	25.19	100.00	0.00	0.00	25.19
Passaic	5.28	6.55	75.38c	93.45	80.66
Salem	2.88	64.29	1.60	35.71	4.48
Somerset	1.46	44.65	1.81	55.35	3.27
Sussex	2.54	47.57	2.80	52.43	5.34
Union	28.62	23.42	93.56	76.58	122.18
Warren	2.50	73.96	.88	26.04	3.38
TOTAL	372.42	39.05	581.18	60.95	953.60

a Includes 50.0 MGD of North Jersey District Water Supply Commission (NJDWSC) diversion supplied to Newark and Montclair.
b Includes 12.0 MGD of NJDWSC diversion supplied to Kearny.
c Of the 137.38 MGD surface water diversions from purveyors (NJDWSC) in Passaic County, 50 MGD was allocated to Essex County (Newark and Montclair), and 12 MGD was allocated to Hudson County (Kearny).

Note: The figures above were submitted solely by public purveyors for inclusion in the Water Supply Master Plan, Task I - Data Bank, p. 16. Figures represent amount of water collected by purveyors based in the county, and therefore, does not necessarily represent the amount of water diverted from the county. Information on self-supplies users was not readily available.

Source: Havens et al, (1980).

Ground Water Quality Standards (N.J.A.C. 7:9-4.1 et seq and 7:9-5.1 et seq) establish certain specific criteria for the maintenance of high quality surface and ground waters and the restoration of degraded water quality. The NJDEP is working to assure compliance with these standards through better management of point and non-point sources of pollution.

These standards focus on designated uses of specific waters and quality criteria to continue these uses. Among the designated uses is "public potable water supply after such treatment as shall be required by law or regulation". These Surface Water Quality Standards contain criteria to protect the raw water quality for potable supplies. However, the raw water will still require treatment to assure safe drinking water (finished water). The New Jersey Safe Drinking Water Act (N.J.S.A. 58:12A-1 et seq) establishes that New Jersey will assure the provision of safe drinking water to consumers and is qualified for primary enforcement responsibility under the Federal Safe Drinking Water Act (P.L. 93-523, 42 USC 300 et seq.). State Safe Drinking Water Regulations were adopted in July, 1979 to achieve these purposes. Water suppliers are self-monitoring and are required to report monthly to the Department which supervises compliance with the regulations. State inspections assure the integrity of treatment processes, equipment and record-keeping.

Several treatment methodologies are employed by water purveyors throughout the State varying with the quality of the raw water available. All waters in the State require some degree of physical and chemical treatment to assure their suitability as a potable water supply. Conventional surface water treatment includes prechlorination, coagulation, sedimentation, rapid sand filtration, past chlorination and pH adjustment. A combination of treatment methods if properly adopted will convert a moderately polluted water supply into a safe drinking water. The success of these and alternative treatment processes is dependent on the incoming water quality and volume, economic feasibility, recognition of the limitations of each process and the degree of quality control exercized.

The State has been divided into six regions for planning purposes which generally follow watershed boundaries in the north and county boundaries further south (see Figure III-3). These regions are consistent with those reviewed in the State Water Supply Master (NJDEP, 1981a) and consists of the following:

Region 1 Northeastern New Jersey (Bergen, Hudson, Essex, Union, Somerset. Middlesex and parts of Passaic, Morris, Sussex, Hunterdon, Mercer and Monmouth Counties)

Region 2 Monmouth and Ocean Counties

Region 3 Atlantic and Cape May Counties

Region 4 Cumberland and Salem Counties

Region 5 Burlington, Camden and Gloucester Counties

Region 6 Northwestern New Jersey (Warren and parts of Passaic, Sussex, Morris, Hunterdon and Mercer Counties)

Present and future water supply needs and water quality issues are discussed throughout the remainder of this subchapter using this regional format. The section below outlines the present water needs and available potable supplies of each region. Associated water quality issues and current treatment methodologies are also discussed. The final section presents projected future demands and an indication of the water supply facilities required to meet these demands. Topics throughout these sections focus on surface waters. A more detailed discussion of groundwater may be found in Chapter IV.

Water Quality of Present Surface Water Supplies

The following section is a synopsis of present surface water intakes throughout the State. Where information was available on the raw water quality in close proximity to the intake it was included in the discussion. Presently all potable supplies meet the Safe Drinking Water Act Regulations, though some refurbishment of treatment plants is needed.

Region 1 (Northeastern New Jersey)

Northeastern New Jersey contains three major watersheds, the Hackensack, Passaic and Raritan River Basins, forming a complex water supply network to serve a significant portion of the State's population. Water supply demands in the region were 756 mgd in 1976, already beyond the existing supply available (NJDEP, 1981a). The region depends almost entirely on surface water resources (Havens et al, 1980).

Most of the water supply deficits in the region are located in the Passaic and Hackensack Basins, whereas a surplus of water exists in the Raritan Basin. The State-owned Round Valley-Spruce Run Reservoir System contains most of this surplus waters. Unfortunately, the current water supply infrastructure is inadequate to transport this surplus water to other purveyors in the region who are presently overdrafting their resources beyond safe yields.

Table III-3 provides a summary of projects water supply needs by region. In Region 1, the 1976 deficit of 55 mgd, combined with the increased demands projected for 1980 and 1990, show a 1980 deficit of 63 mgd increasing to 107 mgd by 1990. The recent drought dramatically illustrated this area's deficiency and

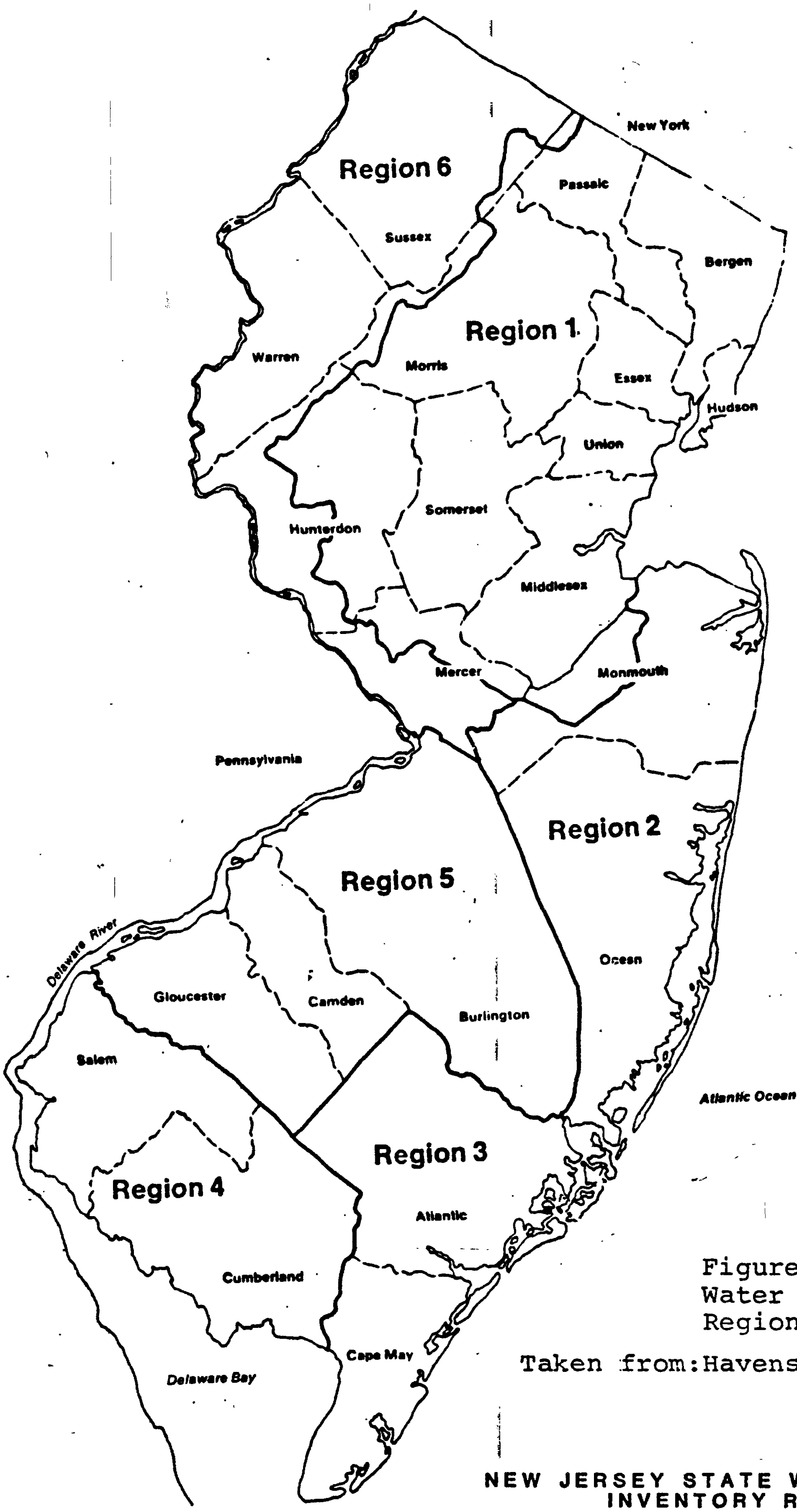

Figure III-3
Water Supply Planning
Regions

Taken from:Havens <u>et</u> <u>al</u>.(1980)

immediate need for the transfer of available surplus supplies to those purveyor systems operating with deficits, and until new water supply projects are completed.

A. Hackensack River Basin

Within the Hackensack River Basin, the Hackensack Water Company draws water from Oradell Reservoir and from the Hackensack River near the reservoir. Another intake draws water from Sparkill Brook which drains north to the Hudson River, located just northeast of the basin but still within the State's jurisdiction.

There is no water quality monitoring data in the vicinity of Sparkill Brook, however two monitoring stations are located near the other two intakes. One station is just downstream of these intakes on the Hackensack River at New Milford and the other is in River Vale 4.6 miles upstream from Oradell Dam. Sampling at this station indicates that water quality in the Hackensack River from the New York/New Jersey border to New Milford is generally good. A thorough description of water quality in the Hackensack basin can be found in the Water Quality Inventory Appendix. (The quality of the river declines further downstream where there are no surface water intakes.) Fecal coliform concentrations were frequently above the 200 MPN/100 ml standard as recorded at River Vale, but chlorination at Oradell Dam for potable water purposes by the Hackensack Water Company contributed to lower levels at New Milford. Total dissolved solids levels were within the criterion at River Vale, though data from New Milford was insufficient to make an assessment. The generally alkaline pH values noted at New Milford exhibited variability over the period, possibly due to the occasional addition of alum, chlorine and polymers to the river at the Oradell Dam for purposes of treatment.

The Hackensack River exhibited increasing total phosphorus concentrations over the period at New Milford, particularly during the 1980-81 drought period when levels exceeded 1.0 mg/l. Total ammonia concentrations rose slightly in the segment above Oradell Reservoir, but were at generally acceptable levels at both stations over the period.

Sampling for toxic parameters at and above Oradell Reservoir in addition to other locations indicated low levels of trihalomethanes and organic solvents. This type of toxic contamination is not uncommon in river basins such as the Hackensack, where industrial land use is prevalent. The inability of Publicly-Owned Treatment Works to adequately treat the large volume of industrial waste flow contributes to the poor quality of the river. Reduced flow of freshwater from upstream impoundments and tidal action blocks removal of the pollutants and the ability of the river to cleanse itself; thereby requiring treatment before the water can be used for potable water purposes. The Hackensack Water Company employs conventional surface water treatment.

Table III-3 Additional Water Supply Needs by Planning Region

Region	1976 Demand	Existing and Projected Additional Needs* 1976	1980	1990	2000	2010	2020
1	756	55	63	107	151	186	203
2	79	0	12	30	38	44	50
3	28	0	5	16	17	20	22
4	21	0	0	2	5	7	9
5	107	0	5	15	26	33	36
6	56	0	4	11	18	23	27
Total	1047	55	89	181	255	313	347

* These needs are based on projections made in 1976 and do not reflect implementation of projects designed to meet these needs.

SOURCE: NJDEP (1981a).

B. Passaic River Basin

The Passaic River Basin is comprised of four segments: the Upper Passaic, the Mid-Passaic, the Mid-Passaic Tributaries and the Lower Passaic. Each segment is discussed separately below.

The Passaic River originates in eastern Somerset County and southern Morris County. Generally, land in the headwaters contains scattered developments and towns. The Commonwealth Water Company employs conventional surface water treatment to process 17.8 mgd from the Passaic River and the Canoe Brook Reservoir in Essex County (Upper Passaic River Segment). The Canoe Brook Reservoir derives its supply from a blend of groundwater and river water.

There are no monitoring stations located on Canoe Brook, however, information on river quality is available from the station near Chatham. As reported in the segment analysis in Appendix 1-Y, monitoring data generated at Chatham indicated stable water quality conditions until 1980. The 1980-81 drought period sharply reduced flow in the river and elevated many parameters. Subsequent to the drought period, fecal coliform levels generally continued to exceed the 200 MPN/100 ml level. The most excessive coliform levels in this segment appeared to be isolated incidents largely due to municipal treatment plant malfunctions.

Total dissolved solids concentrations also increased in the downstream direction and periodically exceeded the 500 mg/l standard near Chatham during the summer of 1977 and 1978. Subsequent levels were in compliance with the standard.

Concentrations of total phosphorus were extremely high at Chatham where 90 percent of the measurements contravened the 0.10 mg/l phosphorus standard with values frequently exceeding 0.50 mg/l during the summer months.

No evidence of toxic contamination was detected in the vicinity of Commonwealth's intake.

The Mid-Passaic River Basin segment begins at the confluence of the Passaic River with the Whippany and Rockaway Rivers and includes lands downstream to Little Falls. The Passaic Valley Water Commission (PVWC) draws 52 mgd from the Passaic River at Little Falls for water supply. Monitoring station reports from Little Falls and Two Bridges indicate that conditions in the upstream segment were acceptable, but declined downstream between Livingston and Little Falls which exhibited poor water quality during the 1977-1981 period. The PVWC uses conventional surface water treatment processes which thus far has proven adequate though the raw water quality downstream is extremely poor.

Fecal coliform concentrations were excessive throughout the segment during the period. Concentrations of total dissolved solids were within the standard, ranging from 100 to 400 mg/l.

The pH at Two Bridges and Little Falls generally remained neutral throughout 1977-1980 with slightly alkaline values occuring at Little Falls towards 1981.

A four day study of toxic contaminants was conducted on the Passaic River during the recent drought (December, 1980), in the vicinity of the PVWC plant which provided composite results over the 96-hour sampling period. Two sites were chosen along the river; one at the PVWC intake point, and one downstream at Fairlawn Avenue. The other sites sampled include treated drinking water collected within the plant and one sampling site for delivered water. It should be noted that samples for volatile organic analysis were collected as grab samples at the beginning of each 24-hour sampling interval.

The results of the four day composite sampling effort indicate an increase in the number and concentrations of toxic contaminants detected in the Passaic River at the Fairlawn Avenue site in comparison to the upstream site at PVWC. The concentrations of individual compounds are low, but the number of compounds detected reflect the effect that numerous industrial point source discharges have on this section of the Passaic River. The pollutant concentrations measured during the four day study cannot be considered "typical" for the Passaic River because of the drought conditions which resulted in decreased river flow. These results can be viewed as one example of extreme conditions in the Passaic River. More sampling is needed to characterize other extreme conditions; the effects that storm conditions and urban runoff have on the Passaic River.

There are two major tributaries or sub-basins in the Mid-Passaic River Basin. The Whippany and Rockaway Rivers form the New River and one sub-basin. The Pompton River sub-basin consists of the Pequannock, Wanaque, Ramapo and Pompton Rivers. A total of 251.4 mgd are with drawn from these sub-basins for drinking water.

The Whippany River watershed is located in the southernmost portion of the New River sub-basin. One surface intake is located at the Clyde Potts Reservoir, serving as a potable water source for Morristown. It is located in the headwaters of the Whippany River. No data was available on the raw water quality in this area, though the finished water met all of the standards. Present treatment consists of chlorination and pH adjustment which has proven inadequate. Proposals for semi-conventional treatment are under consideration.

The Rockaway River watershed drains 133 square miles of primarily undeveloped land. The Boonton and Split Rock Reservoirs supply Jersey City's water, and the Taylortown Reservoir is used by the Town of Boonton. The only routine monitoring station in this area was on the Rockaway River at Boonton and was considered to be too far upstream of the reservoir to be representative of its quality. The Jersey City Water Department employs conventional surface water treatment as does the Town of Boonton.

The Pequannock River portion of the Pompton sub-basin serves as a major supplier of potable water. There are five reservoirs or lakes, (total surface area of 63.7 square miles), that are used for water storage by the City of Newark. The water company has the water rights for 50 mgd. In addition, the Butler Water Department utilizes Kakeout Reservoir in Butler for potable supplies. Butler Water Department effectively employs conventional surface water treatment with pressure filtration.

The Wanaque River, having its headwaters in New York State, flows southwest entering the Wanaque Reservoir and Lake Inez before joining the Pequannock River. As an important source of potable supply, the Wanaque Reservoir is operated by the North Jersey District Water Supply Commission (NJDWSC) which has water rights to withdraw 94.0 mgd. Again water quality monitoring data was unavailable for this area. The NJDWSC adequately treats its raw water using conventional methods.

The Ramapo River, also having its headwaters in New York State, flows in a northeast to southwest direction and enters the Pequannock River to form the Pompton River at Wayne Township. In the New Jersey portion of the basin, the NJDWSC draws water from the river for potable supply under emergency conditions. An intake at the Point View Reservoir, owned by PVWC, withdraws water only during high flows. In addition, PVWC uses the passing water downstream at an intake on the Pompton River and on the Passaic River at Little Falls.

Conditions in the Ramapo River near Mahwah were described as marginal water quality primarily due to elevated levels of fecal coliform, total phosphorous and biochemical oxygen demand. There was some water quality decline due to the exceptionally low flows experienced during the summer of 1980 drought period.

The presence of toxic substances was quite variable in the Mid-Passaic Tributaries. The Rockaway River was sampled at Route 46 in Pine Brook and found to have high levels of trihalomethanes. This may be attributed to a point source discharge along this segment of the river. The Whippany River at Pine Brook was sampled and found to be free of toxic contamination. Further upstream, at Cedar Knolls and Morristown, low levels of organic solvents were detected. At Parsippany-Troy Hills low levels of trihalomethanes were detected. The Ramapo River was sampled at Route 17 in Mahwah. Moderate levels of trihalomethanes and organic solvents were detected at this site. The Pompton River at Packanack Lake showed no evidence of toxic contamination. Further downstream at Two Bridges low levels of organic solvents were detected.

The Lower Passaic River Basin is freshwater from the dam on the river at Little Falls to Dundee Dam, and is tidal from Dundee Dam to Newark Bay. Two surface water intakes are located in Haledon and Paramus. The Haledon Water Department uses Molly Ann's Brook Reservoir where occasional water quality sampling was performed.

The conventional surface water treatment employed here is marginally adequate. The Hackensack Water Company, also using conventional surface water treatment, uses water from the Saddle River which is monitored at Lodi, downstream of the intake. Results of the monitoring indicate generally poor water quality throughout the period. As in the other segments of the Passaic River, the recent drought had a significant impact on its water quality. Fecal coliform levels in the Saddle River were generally excessive as were concentrations of total dissolved solids, though concentrations remained below the 500 mg/l standard. Toxic parameters were not sampled for in this area.

C. Raritan River Basin

The Raritan River Basin is comprised of the North Branch, the South Branch, the Millstone River, the Lawrence Brook, and South River, and the Lower Raritan River Segments.

The North Branch of the Raritan River, drains approximately 190 square miles before it joins the South Branch at Raritan to mark the beginning of the Raritan River's mainstem. The North Branch is used for potable supply in the Boro of Mendham via India Brook Reservoir. Water obtained here receives rapid sand direct filtration and chlorination which has proven adequate thus far. The Peapack-Gladstone Water Department also has a surface water intake in the North Branch watershed, though it is currently not in use.

Sampling for conventional and toxic contaminants has not been performed in the vicinity of the India Brook Reservoir, however monitoring in other portions of the watershed indicate overall good water quality.

The South Branch of the Raritan River, which originates in western Morris County, drains 147 square miles of primarily rural land uses. The watershed contains two large man-made reservoirs, Spruce Run and Round Valley, which are important sources of water supply in the basin . The reservoirs will also be significant sources of water for the central and northeastern portions of the State outside the basin as changes are made in the near future to the system's infrastructure.

Presently, the Boro of Flemington Water Department draws nearly 0.6 mgd from the South Branch for water supply. Monitoring at Stanton Station on the South Branch is conducted two to three miles upstream of the intake. Based on this sampling, the South Branch exhibited generally good water quality. Concentrations were all within the standards, with the exception of total dissolved solids which contravened the standard at Stanton Station during 1978. TDS concentrations otherwise were below the 200 mg/l standard throughout the segment.

The South Branch was sampled at the outlet of Budd Lake, in the headwaters of the watershed, and found to be free of toxic contamination.

The Millstone River watershed is located in central New Jersey and drains 271 square miles of primarily agricultural land having some extensive and recent suburban development. The Elizabethtown Water Company occasionally uses the Millstone River (near its confluence with the Raritan River) as one of its sources of potable water supply. Water from Carnegie Lake and the upper Millstone River is sometimes diverted into the Delaware and Raritan Canal, a source of potable water supply, when flow through upstream segments of the Canal is interrupted or inadequate. Conventional surface water treatment by Elizabethtown Water Company is enhanced by dechlorination of the finished water.

Also, a pumping station along the Millstone River just upstream from its confluence with the Raritan River allows the New Jersey Water Supply Authority to pump Millstone River water (or a mixture of Raritan River and Millstone River water) into the Delaware and Raritan Canal as needed. Carnegie Lake serves as a source of recharge to nearby potable water supply wellfields. Nearly 75.0 mgd are used in this watershed by the Elizabethtown Water Company and the Township of North Brunswick Water Department for water supply.

Water quality in the Millstone River was generally good in the upstream segment but declined to marginal conditions downstream from Carnegie Lake to the Raritan River confluence. This is based on water quality sampling in the Millstone River at Blackwells Mills and Applegarth, and in Stony Brook at Princeton. Stony Brook, which flows into Carnegie Lake at Princeton, exhibited generally good water quality throughout most of the segment. Fecal coliform concentrations in the Millstone River increased in the downstream direction and periodically were above 200 MPN/100 ml in both the Millstone River and Stony Brook. Concentrations for total dissolved solids were consistently below the standard. However, levels of total phosphorous increased in a downstream direction and were in excess of the standard. Increases also occurred during the low flows experienced in the summer of 1980. Tests for toxic parameters in this watershed showed the water to be free of toxic contamination.

The Lawrence Brook and South River watershed drain central Middlesex County, and eastern Middlesex and west-central Monmouth Counties, respectively to the Raritan River downstream of New Brunswick. Three surface water intakes are located in these watersheds. The New Brunswick Water Department withdraws water from the Lawrence Brook. Conventional surface water treatment employed by the New Brunswick Water Department has resulted in marginal quality finished water due to fair raw water quality and the age of the treatment plant. In the South River watershed, the Perth Amboy Water Department takes water through infiltration from Tennents Creek and the Sayreville Water Department uses an infiltration well field recharged by water pumped from the South River. In total, 9.5 mgd are used from these watersheds for potable water supplies. The intake at Tennents Creek is actually a set of shallow wells with treatment consisting of filtration and disinfection only. Treatment here is considered to produce marginally adequate results. The South River intake mixes surface and ground water. Treatment, like at Tennents Creek, consists of filtration with chlorination and is considered marginally adequate. However, in both Tennents Creek and South River, finished water supplies do meet minimum potable water standards.

Water quality information was not available for Tennents Creek. However, a station at the outlet of Farrington Lake (Westons Mill Pond) provided data representative of the quality near the intake on Lawrence Brook. There is a monitoring station at Old Bridge which is located upstream of the intake on the South River.

Generally good to marginal water quality conditions were exhibited in the Lawrence Brook, while the quality of the South River was demonstrated to be marginal. Concentrations of fecal coliform declined over the monitoring period in both watersheds.

Lawrence Brook displayed generally stable, neutral pH values at the Westons Mill Pond outlet. On the other hand, pH values in the South River watershed fluctuated between slightly acid and neutral levels, particularily in Matchaponix Brook where acid soil conditions in the headwaters area may have an impact on pH levels. Matchaponix and Lawrence Brooks exhibited consistently low concentrations of total dissolved solids throughout the period. The elevation of total dissolved solids in the South River in 1979-1980 was attributed to the upstream migration of the salt line during the low flow (drought) period.

Total phosphorus concentrations in Lawrence Brook at the outlet of Westons Mill Pond were generally acceptable for streams but frequently contravened the standard for lakes (0.05 mg/l). In the South River watershed a similar situation occurred at the Matchaponix Brook station, located approximately 0.5 miles upstream from eutrophic Duhernal Lake, which also receives a significant nutrient load from Manalapan Brook. Complete uptake of the phosphorus into Duhernal Lake was not apparent as levels downstream at Old Bridge often exceeded the criterion.

Matchaponix Brook in the South River watershed, was sampled in Spotswood and at Route 527 in Monmouth County and found to be free of toxic contamination.

Lawrence Brook at Weston Mills had high trihalomethane levels in one set of samples. Subsequent resampling did not confirm these levels, however, moderate levels of organic solvents were found. This is an indication of industrial land use within the watershed and reflects general water quality conditions.

The Lower Raritan River Basin is comprised of the drainage basin from the confluence of the North and South Branches to the Raritan Bay, including the Raritan Bay tributaries in eastern Middlesex and northern Monmouth Counties. Over 187 mgd are used for potable water supply in this watershed. The major purveyor in this area is the Elizabethtown Water Company drawing water from the Raritan River and the D & R Canal. The New Brunswick Water Department and the Middlesex Company utilize the D & R Canal for water supply.

The D & R Canal has no routine water quality monitoring stations. A station does exist on the Raritan River at Manville above the surface water intakes. The data reveals a general decline in water quality in the downstream direction. The non-tidal segment exhibited marginal water quality due to frequently high fecal coliform and moderate to high nutrient levels. No total dissolved solids problems were indicated from the levels measured at the freshwater stations. The pH values at each station fluctuated between neutral and slightly alkaline, particularly at Raritan.

The nontidal stretch of the Raritan River has been sampled at numerous locations for toxic contamination between 1978 and 1981. The sites chosen represent a variety of surrounding land uses ranging from undeveloped land at Duke's Island Park to the heavily developed suburban and industrial areas of Bound Brook. In addition to the nine sites discussed, all major tributaries to the Raritan have been sampled, as well as the effluents of sixteen industrial or sewage treatment plants which discharge to tributaries or the mainstem of the Raritan River.

The results of sampling the nine sites on the mainstem of the Raritan River indicate the presence of low concentrations of several volatile organic compounds in the water column. Sediment results show the presence of heavy metals reflecting concentrations common in the sediments of New Jersey surface waters. Very low concentrations of several persistant pesticides were also detected in sediment samples collected along the Raritan. In general, the water quality of the mainstem of the Raritan, with regard to toxics was comparable to other surface waters throughout the State which flow through developed areas.

The Elizabeth River and the Rahway River, draining 17 and 41 square miles in eastern New Jersey respectively flow southeasterly to the Arthur Kill. There are two surface water intakes diverting a total of 5.2 mgd in the Rahway River watershed, one on the river (Rahway Water Department) and the other on the West Branch (City of Orange Water Department). The Rahway Water Department uses conventional surface water treatment with flouridation and produces adequate finished water, though the river quality is marginal. In emergency situations, when the raw water quality is extremely poor, water is purchased from the Elizabethtown Water Company. The City of Orange Water Department has received only marginally adequate results using pretreatment with pressure filtration.

Monitoring station data indicated marginal water quality in the Rahway River. Fecal coliform concentrations at Rahway were excessive, though generally below 5,000 MPN/100 ml. The majority of the total dissolved solids data for the Rahway River station in Rahway was less than 300 mg/l. Overall, pH values were slightly alkaline. The Rahway River exhibited a slight decline to neutral levels in late 1980, but a return to slightly alkaline pH values ensured. Periodic contravention of the total phosphorus standard occurred in the Rahway River over the period, but concentrations were generally below 0.30 mg/l.

The Rahway River, sampled for toxics at Route 22, had low levels or organic solvents. These same contaminants were also found downstream at Route 27 at lower levels. This can be attributed to the volatility of these compounds along with dilution effects.

Region 2 (Monmouth and Ocean Counties)

Monmouth and Ocean Counties, comprising Region 2 (see Figure III-3), had a 1976 potable water demand of 79 mgd and a 1980 estimated demand of 92 mgd (NJDEP, 1981a). Demands are met in Monmouth County by generally equal quantities of surface and ground water. Ocean County relies primarily on groundwater (Havens et al, 1980).

The majority of the region's surpluses are groundwater resources located in Ocean and southern Monmouth Counties. These existing surpluses are committed to peaking conditions of the region. Monmouth and Ocean Counties are experiencing development pressures which will impact the quantity and quality of surface water supplies and groundwater systems. As such, salt water intrusion has resulted from serious overdrafting of groundwater resources in certain areas of water-bearing formations.

Three surface water intakes are located in Region 2. All three intakes are located in the North Atlantic Coastal Basin located in eastern Monmouth County. The basin encompasses three distinct watersheds; the Navesink River with one surface water intake at Swimming River Reservoir, the Shrewsbury River Basin having no surface water intakes, and the Shark River Basin with an intake on the river itself and another intake on Jumping Brook, a tributary. A total of 29.6 mgd are diverted by these three intakes. The Monmouth Consolidated Water Company processes this water adequately using conventional surface water treatment.

Water quality monitoring was performed on Willow Brook and Yellow Brook in the Navesink River watershed above Swimming River Reservoir and on Jumping Brook. Except for periodic elevations of fecal coliform and total phosphorous, Willow, Yellow and Jumping Brooks exhibited generally good water quality through the period 1977 to 1981. The only violations recorded at either of the stations were for excesses of total phosphorus above the standard. Phosphates, known to stimulate plant growth, have been at high enough levels in the waters of the Swimming River Reservoir to require treatment during the summer months by the Monmouth Consolidated Water Company.

Total dissolved solids levels were relatively consistent (below 100 mg/l) in Yellow and Jumping Brooks, but Willow Brook exhibited an increase over the period, although remaining well below the 500 mg/l standard. All three streams exhibited generally neutral pH values for the period.

Monitoring for toxic parameters indicated that moderate levels of organic solvents were found in every sample taken from Willow Brook. Low pesticide levels were also detected. Sampling of the water column at Yellow Brook exhibited low levels of pesticides and polynuclear aromatic hydrocarbons (PAH). In both brooks, additional sampling is warranted with particular attention to sediment analysis. The Jumping Brook was found to be free of toxic contaminants.

Region 3 (Atlantic and Cape May Counties)

Region 3, consisting of Atlantic and Cape May Counties, experiences increased demands on its water supply with seasonal population influxes primarily along the coastal areas. Surpluses are committed to the peak demand during the summer months. Demand from 1976 to 1980 was expected to increase by 5 mgd which is not considered large enough to require any new source development. However the impact of resort induced growth must be closely observed in the near future (NJDEP, 1981a).

Almost 81 percent of Atlantic County's and 100 percent of Cape May County's water demands are met by groundwater resources (Havens et al, 1980). One surface water intake exists in the region and is located on Doughty Pond (Atlantic City Reservoir) in Atlantic City. This surface water is mixed with well water by the Atlantic City Water Department. Raw water quality data was not available on this water supply, though monitoring of finished water indicates it is in compliance with the standards after conventional surface water treatment.

Atlantic and Cape May Counties overlie the Cohansey Sand Aquifer. Unconfined hydraulic conditions typify this aquifer, however, lowering of the water table has been documented in central Cape May County where the aquifer exhibits artesian conditions. Declines in the water level are expected to be limited to the central and southern portions of Cape May County. Additional information on groundwater quality in this region may be found in Chapter IV.

Region 4 (Cumberland and Salem Counties)

Sufficient water supplies exist in Cumberland and Salem Counties to meet all 1980 demands. The abundance of both developed and undeveloped groundwater supplies coupled with a moderate projected growth rate point to water supply stability in this region for the near future. Cumberland County is entirely dependent on groundwater for recorded potable supplies. In some portions of Salem County, surface water has proven to be a viable, though scarsely developed, resource (NJDEP, 1981a).

The Salem Water Department draws .90 mgd from Laurel Lake and uses conventional surface water treatment for their potable water. No raw water quality data was available.

All remaining potable water supplies are drawn from groundwater resources. More discussion on groundwater quality may be found in Chapter IV.

Regions 5 and 6 (Burlington, Camden and Gloucester Counties and Northwestern New Jersey)

Region 5 (Burlington, Camden and Gloucester Counties) and Region 6 (Northwestern New Jersey) includes most of New Jersey's portion of the Delaware River Basin (see Figure III-3). This interstate river basin poses a complex water management problem to the member states of New Jersey, New York, Pennsylvania and Delaware. The responsibility for coordination and management of the basin's water is fulfilled by these states through the Delaware River Basin Commission (DRBC) created in 1961. Water supply quantity and quality problems are numerous and varied for surface water, groundwater and their interface.

Although water supply demands have generally been met, the degradation of aquifer systems is especially critical in Region 5 which is, for the most part, entirely dependent on groundwater resources. The Potomac-Raritan-Magothy Aquifer provided 81 percent (146 mgd) of the region's total groundwater withdrawals in 1976 (NJDEP, 1981a). The aquifer, which is hydrologically linked to the river, at one time contributed water to its flow. Now the situation has reversed due to the lowering of the water table caused by extensive development of the ground water resource. The fair to poor quality of the river in this area is threatening the integrity of the groundwater as a potable source. Almost half of the water withdrawn from the ground is actually induced infiltration from the Delaware River. Saltwater intrusion into the aquifer is a critical problem and may be exacerbated by low flows during periods of below normal precipitation.

The DRBC noted that the quality of the Delaware River in the vicinity of Region 5 was fair to poor (Appendix 1.DD). A fair rating was assigned to the upper 25 miles of river adjacent to Burlington County due to frequent violations of one or more water quality standards throughout the year. Water quality is expected to improve in this segment as current treatment plant projects are completed. One surface water intake at Burlington City located in Region 5 is currently drawing water from the river, and employs conventional surface water treatment which has produced adequate finished water.

The next 29 river miles downstream were rated as poor due to discharges in the Camden-Philadelphia area. Water quality in the middle estuary is expected to remain as poor until upgraded plants come on-line. For more information on Delaware River quality refer to Appendix 1.DD.

Region 6, on the other hand, relies fairly evenly on both surface water and groundwater for potable supplies. Northwestern New Jersey had 1976 demands totalling 56 mgd with an expected increase to 60 mgd in 1980. As reported in the NJ Statewide Water Supply Master Plan, there are sufficient resources in Region 6, whether developed or readily accessible, to assimilate the increase (NJDEP, 1981a).

The Delaware River Tributaries Hunterdon/Mercer Counties Segment in the southernmost portion of Region 6 provides for surface water intakes for potable water usage. The Lambertville Water Company currently takes water from Swan Creek (Swan Creek Reservoirs East and West) and treats it with conventional surface water processes. Those tributaries to the Delaware River in this segment that have undergone study indicate that water quality problems in this area are a result of non-point source pollution. The nature of the soils and bedrock in this area are not conducive to the placement of septic systems which are a likely source of the high levels of fecal coliform and phosphorous found. These high concentrations are aggravated by periodic low flow conditions. The Delaware-Raritan Canal, which originates in this segment, is not used here, but is available to the Lambertville Water Company for use in emergency situations.

Additionally, water is diverted from the Delaware River by the Trenton Water Department to supply Trenton area residents. Conventional surface water treatment is used by the water department. Water quality in this portion of the river was rated as good by the DRBC. However, monitoring data from the Trenton station indicated that total phosphorous levels were consistently excessive throughout the testing period. Though within the standard, suspended solids levels were slightly excessive on a few occasions at Trenton.

The Pohatcong and Lopatcong Creeks Segment lie just north of the Delaware River Tributaries - Hunterdon/Mercer Counties Segment, and flow through southwestern Warren County to the Delaware River. In addition to groundwater withdrawals there are two surface water intakes in this segment. The Buckhorn Springs Water Company uses water from an impounded reservoir on Buckhorn Creek in the upper reaches of the Lopatcong Creek watershed.

Currently only chlorination is employed during treatment. The water company is under enforcement action to install conventional surface water treatment. The Roaring Rock Creek Reservoir provides water to the New Jersey Water Company in the upper reaches of the Pohatcong Creek watershed. The New Jersey Water Company only provides chlorination for the raw water since it is of generally good water quality. This intake is being phased out and the water company is looking for a groundwater source. The two intakes together average .80 mgd. Monitoring stations in this segment are located close to the confluence of the creeks with the Delaware River and thus provide little information on the raw water quality in the vicinity of the intakes. However, the downstream water quality was described as relatively good and a general assessment of the area in close proximity to these intakes indicates that only non-point sources of pollution from failing septic systems and agricultural land uses may exist.

The Pequest and Musconetcong Rivers Segment lie generally northeast of the Lopatcong and Pohatcong Creeks Segment and drain portions of Sussex, Warren, Hunterdon and Morris Counties to the Delaware River. Currently, over 106 mgd of surface water is consumed in this area through seven surface water intake systems. The trend in this area however is toward less reliance on surface water resources due to resident opposition to incoming development and the expense of surface water intake and treatment. It is expected that Sparta Mountain Water Company's drinking water sources from Lake Shawnee and Weldon Brook, and East Shores Inc. water intake on Lake Hopatcong will eventually be eliminated and service areas taken over by the Jefferson Township Water Company.

The present water supply system is an infiltration gallery on Lake Hopatcong. Chlorination and pressure filtration employed here is somewhat inadequate. Additionally, the Hopatcong Boro Water Department plans to take over the West Shore Water Company intake. This is a direct intake from the same lake. Chlorination and pressure filtration are applied, but have proven inadequate. Both of these water suppliers expect to eliminate these intakes in the next couple of years. The intakes are located in the upper portions of the Musconetcong River watershed where water quality is relatively good, though the specific status of raw water quality is unknown due to lack of monitoring stations. This is also the case with the two intakes in Hackettstown (also in the Musconetcong watershed). The Hackettstown MUA has full conventional surface water treatment with granulated activated carbon for filtration. Water quality monitoring on the Musconetcong near Bloomsbury and on Pine Hollow, the location of an intake by the Boro of Bloomsbury, indicates that the surface water is of overall good quality, but exhibits to varying degrees excessive levels of fecal coliform and total phosphorus. Treatment here is adequate to meet drinking water standards.

The Flat Brook and Paulins Kill Segment drain portions of Sussex and Warren Counties in a southwesterly direction to the Delaware

River. One surface water intake is located in Branchville on the Flat Brook which is categorized as one of New Jersey's highest quality streams. Sequestration and chlorination are the only forms of treatment applied now, though more treatment may become necessary.

In the northernmost portion of Region 6, the Wallkill River Segment drains 201 square miles of predominantly agricultural land to the north into New York State as part of the Hudson River drainage network. Five surface water intakes draw .54 mgd from surface waters in this segment. Two of the intakes in Vernon Township are used during the summer months only.

The Franklin Water Commission takes water from the Wallkill River (Franklin Pond). A monitoring station located at the outlet of Franklin Pond reports that surface water quality in the pond is marginal. Contraventions of the fecal coliform standard were frequent throughout the Wallkill segment, though were most severe at downstream stations. Total phosphorous data also clearly illustrates the marginal water quality of the segment. Several excessive values for total phosphorus were noted in the Wallkill River at Franklin, though frequent and excessive contraventions were recorded downstream at Unionville. Fortunately, the intake at Franklin Pond is upstream of the most degraded water in the basin and can be treated for use as a potable source. Weed and algal growth is a problem at Franklin Pond causing a taste and odor problem. Currently, ozonation is used as a means of disinfection and then conventional surface water treatment with post chlorination is applied.

Two other intakes in the segment are located on Lake Morris and Lake Rutherford. The Newton Water Department uses chlorination solely since the water quality in Lake Morris is exceptionally good. The Sussex Water Department draws water from Lake Rutherford and uses chlorination as the only means of treatment as the intake is located in a semi-protected watershed.

Projected Future Water Supply Demands and Facilities

To meet present deficits and growing demands for potable water the State of New Jersey has indicated a number of water supply and water quality problems which must be addressed immediately and some that require longer term investigations (NJDEP, 1981a). The NJ Statewide Water Supply Master Plan calls for certain actions including the initiation of interconnections, testing programs, development of drought and emergency response plans, implementation of conservation practices in all regions, and development of a potable source protection strategy to improve the management of available water supplies. Additionally, certain surface water supply development projects are recommended. These projects are discussed by region below.

Region 1 (Northeastern New Jersey)

As mentioned earlier, in Region 1 some purveyors are operating with surpluses while others are overdrafting their supplies beyond safe yields. As illustrated in Table III-3 the 1980 estimated deficit of 63 mgd and future projected deficits of 107 mgd for 1990 and 150 mgd for the year 2000 strongly indicates a need for development of additional and reliable water supplies.

The recent drought not only added to, but pointed out previously unknown problems in this region in several ways as reported in the NJ Statewide Water Supply Master Plan (NJDEP, 1981a):

- Unexpected severe deterioration of water quality in the Passaic River had significantly reduced its supply capabilities, pointing to a need for flow augmentation during droughts in the future.

- The Commonwealth Water Company encountered severe flow shortages in the Passaic River which were partially relieved by relaxing environmental flow restrictions. The shortage in this system proved to be substantially greater than the estimates originally predicted by earlier studies.

- The Elizabethtown Water Company's system is now being more strongly interconnected to the Newark Water Department's system, and will soon be able to transfer 30-35 mgd of Raritan River Basin water during drought periods.

- The Delaware and Raritan Canal, assumed by studies to have a dependable supply of 75 mgd, had its drought allocation from the Delaware River reduced by 13 mgd for a maximum supply of 62 mgd.

These circumstances, subsequent to the baseline reports prepared for the NJ Statewide Water Supply Master Plan, prompted DEP to reconsider their recommendations.

Nine permanent water supply projects have been recommended as possibilities for this region. They include:

(1) Additional storage reservoirs in the Passaic and Raritan River basins such as the Washington Valley, Dunkers Pond, Longwood Valley, Monksville and Six Mile Run sites;

(2) Wanaque South, a combined storage and pumping project to increase the yield of the Wanaque River System;

(3) The Elizabethtown-Newark Interconnection, and the Raritan - D & R Canal Interconnection;

(4) The Raritan - Passaic Pipeline;

(5) Confluence Reservoir, pump station and force main;

(6) Additional, other interconnections;

(7) Rehabilitation of existing water systems;

(8) Various other minor projects of local impact; and

(9) Improvement of D & R Canal capacity to 100 mgd (NJDEP, 1981a).

Preliminary evaluations by both the State's consultants and the DEP show the need for detailed feasibility studies on the additional storage reservoirs (NJDEP, 1981a).

The proposed Washington Valley Reservoir is located on the Whippany River in Morris Township, Morris County. It will have a storage of 1.2 billion gallons and a potable supply yield of 7 mgd. The drainage area is approximately 14.5 square miles. The Dunkers Pond project has a 2.7 square mile drainage area within the Pequannock River watershed and is located approximately three-quarters of a mile northeast of the junction of State Highway 23 and Canister Road in West Milford Township in Passaic County. Since the local drainage area is small, the reservoir, if enlarged to its maximum potential capacity of 11.0 BG, could not be filled by the natural runoff for water supply utilization and thereby, will need an external source of inflow.

The proposed Longwood Valley Reservoir would be located about 4 miles north of Route 15 on the west side of the Rockaway River in Jefferson Township. It has a drainage area of 23 square miles. The project, as conceived would be a joint potable water supply and power development project between Jersey City and Jersey Central Power and Light Company. A marked increase in costs over original estimates resulted in reevaluation of this project. Various alternatives were considered, including construction of lower reservoir for water supply only. The potential total storage of Longwood Valley reservoirs system including power storage is 7.92 BG out of which 5.3 is allocated to water supply.

The proposed Monksville Reservoir would be created by construction of a 2,000 foot long dam across the Wanaque River at Monksville. The lake created by this dam would cover 500 acres at an average depth of 43 feet, on the Green Acre tract upstream of the Wanaque Reservoir. The water to fill this reservoir would come from the 40 square mile Wanaque River watershed which includes Greenwood Lake. It is proposed that the Ramapo River be tapped for the additional 25.0 mgd to be pumped into the Wanaque Reservoir while the natural flow from the Wanaque River fills the Monksville Reservoir. The Monksville facility will be a part of the Wanaque South Project (see below). (NJDWSC already diverts 25 mgd to the Wanaque Reservoir from the Ramapo River. This would increase it to 50 mgd.)

Six Mile Run Reservoir, with a drainage area of 16 square miles and storage of 5.9 BG, is located about 5 miles west of New

Brunswick, Middlesex County, in the Millstone River watershed. The main purpose of this reservoir is to regulate water in the D & R Canal and to meet peak demands. The project as proposed will yield 38 mgd.

The Wanaque South Project is one of the key projects in Region 1 and represents comprehensive development of the region's resources so as to relieve the threat of future severe water crisis in northeastern New Jersey. This project jointly sponsored by the NJDWSC and the Hackensack Water Company will consist of: (a) a pumping station at the confluence of the Passaic and Pompton Rivers located in Lincoln Park with an intake provided to draw water from both rivers; (b) a 102" force main about 11 miles long laid from the pumping station to the Wanaque Reservoir so that pumped flows can be stored in the reservoir; (c) an interconnection with the existing Ramapo force main so that they can be operated in parallel with reductions in the power cost at the Ramapo pumping station; (d) a connection which would provide for diversion to the proposed Hackensack Water Company's pipeline and would pump flows to the Oradell Reservoir with a connection to the Ramapo force main; and (e) the present Ramapo pumping station at Pompton Lakes will house new pumps with increased pumping capacity. The project will provide 79 mgd of yield, which will be equally shared by Hackensack Water Company and the NJDWSC.

At present, all major supplies, with the exception of the Passaic Valley Water Commission, serving the northeastern New Jersey are significantly overdrafted. The present drought of the 1980's emphasizes the need for new water supply resource development and the Wanaque South Project is one of these essential projects.

The Raritan - Passaic Pipeline would potentially provide 40 mgd during time of drought to the Passaic River for supply and flow augmentation. The specific location of this pipeline has not been decided upon. In addition, studies are currently underway in NJDEP to determine the affects that the increased flow will have on pollutant waste load allocations to dischargers in the Passaic River Basin.

The Confluence Reservoir with a capacity of 800 million gallons, will be located at the confluence of the North and South Branches of the Raritan River. The reservoir would be connected by a force main and pumping station to the existing pipeline at White House Station. During periods of high flow in the Raritan River, the confluence pumping station, proposed to be located on the west side of the South Branch of the Raritan River near its confluence with Holland Brook, would pump water through the force main for storage in Round Valley Reservoir. This project would provide an additional yield of 60 mgd to present yields of the Spruce Run/Round Valley System. Because of upstream nutrient inputs the Confluence Reservoir may be highly susceptible to eutrophication. Studies are underway to determine what the impacts may be to both water quality and aquatic biota.

Improvements to the D & R Canal would include dredging the canal, removal of vegetation and the rehabilitation of control gates and structures. It is expected that capacity may be improved from less than 75 mgd to 100 mgd.

Detailed feasibility studies of these alternatives are necessary to insure proper water supply management.

Region 2 (Ocean and Monmouth Counties)

Demands for drinking water in Region 2 are expected to increase from 13 mgd in 1980 to 30 mgd by 1990. Groundwater supplies in some areas are currently threatened by overdrafting and saltwater intrusion. In light of these factors, the development of surface water supplies within the region was recommended. The Manasquan River Project consisting of two reservoirs is recommended to meet demands for potable water in the near future. The lower reservoir, expected to yield up to 10 mgd, is to be bypassed during low flows. The upper reservoir has a capacity of 5 BG and is located off-stream. It will receive flows from a diversion on the Manasquan River.

By 1985 when demands are expected to increase by 20 mgd, the reservoir project if completed should provide 35 mgd which would suffice the need for potable water up to the year 1995. The proposed Manasquan River Reservoir system will be composed of two impoundments, one at the Allaire Intake and the other at Oak Glen. The Allaire Intake, which will contain a side channel spillway, will be located adjacent to the main stem of the Manasquan River upstream of the Garden State Parkway in Wall Township. This facility will be designed to provide 8 mgd instream sustained flow and 10 mgd for public water supply. The Oak Glen Reservoir, an off-river storage site will be located at Oak Glen in Howell Township. It will provide 25 mgd of potable water supply with a storage capacity of 5 billion gallons. The surface area of this reservoir is 770 acres.

An issue of concern in the Manasquan River watershed is the impacts of leachate from Lone Pine and Bog Creek Landfill sites on surface and ground waters. Studies at the federal and State levels either are or soon will be undertaken to deal with the clean-up, containment and treatment aspects of the two sites. The results of these studies will be considered in the design of the reservoir system and its related treatment facilities.

Regions 3 and 4 (Atlantic, Cape May, Salem and Cumberland Counties)

No major surface water supply projects will be undertaken in these regions. However, groundwater monitoring and modeling efforts should be expanded since this area relies heavily on groundwater resources.

Region 5 (Burlington, Camden and Gloucester Counties)

As shown in Table III-3, water supply deficits are expected to be 5 mgd in 1980 and 15 mgd in 1990. This region relies on local groundwater supplies and these supplies could suffice for the projected needs. Serious concerns exist regarding contamination of this resource and the general salinity problem in this area. For these reasons, substitute supplies must be developed in the Camden area. As recommended in the NJ Statewide Water Supply Master Plan a feasibility analysis must be undertaken to examine the various alternative solutions including purchase of water from Philadelphia, use of water from well fields further east, and conjunctive use of ground and surface waters. A feasibility study will also be necessary to explore alternatives to provide augmentation in the Delaware River.

Region 6 (Northwestern New Jersey)

Projected needs in this region were 4 mgd in 1980 and 11 mgd by 1990. Diversions from the Musconetcong River, the Delaware River, and local surface and groundwater resources could provide sufficient supply for the region to meet 2020 demands without any new resource development. A low flow augmentation project is expected to be constructed in this area, (such as the Merrill Creek Project), to maintain surface water quality in the river.

Conclusions

The use of surface waters for potable supplies occurs primarily in the central and northern portions of New Jersey. As such, much of the State's major residential, commercial and industrial centers are dependent upon these water resources. Major surface water intakes or supplies are located on or in the watersheds of the Passaic River, Pequannock River, Rockaway River, Wanaque River, Hackensack River, South Branch Raritan River, Raritan River, Millstone River and the Delaware and Raritan Canal. Additional water supply projects are being planned by the State of New Jersey in these and other watersheds. To avert water supply shortages like the one which existed from the fall of 1980 to the winter of 1981 new supply sources and storage areas are needed. This is exemplified by the projected increases in water demands for northeastern New Jersey, even though it was affected most by the recent drought (see Table III-3).

The quality of those surface waters currently used for drinking supplies varies between each source and sometimes between intake on a source. General water quality conditions range from fair to poor in the Mid-Passaic River, where the Passaic Valley Water Commission (PVWC) draws 52 mgd, to the excellent quality waters of the Flat Brook at the Branchville intake. During the 1977-1981 period the greatest changes to surface water quality, as they relate to potable water intakes, occurred during the 1980-1981 drought. The drought caused extremely low flows in streams of the State dependent upon rainfall and runoff for flows (primarily the northern half of New Jersey) and nearly exhausted stored water in many of the supply reservoirs (Passaic and

Hackensack River basins). Water quality of streams worsened because of poor dilution of pollutants from wastewater discharges. At the height of the drought (early winter 1981) it has been estimated that up to 50 percent of the flows in the Passaic River at Little Falls was discharged wastewaters from municipal and industrial facilities. This resulted in reduced dissolved oxygen concentrations and elevated biochemical oxygen demand and nutrient levels. By mid-1981 drought conditions had subsided and pollutant concentrations lessened.

Despite the known variability of surface water quality where intakes exist, for the most part, only minimal information is available on the quality of waters upstream from the approximately 55 community surface water supply intakes in the State. This lack of available water quality information is due to a variety of reasons. First, there is a lack of surface water quality monitoring programs in the State that are designed to review conditions at the intake or in the watershed above it. Based on the NJ Safe Drinking Water Act, no monitoring of surface waters before treatment is required to be done by water purveyors, only of finished waters. Some monitoring is conducted by the larger water purveyors (such as Passaic Valley Water Commission and Monmouth Consolidated Water Company) of streams that feed their source(s), but the monitoring varies between water purveyor and is often dependent upon available laboratory space, personnel and monies. Other sampling programs like the NJDEP ambient monitoring program do not have sampling stations near all intakes; as it concentrates on the larger streams and rivers. Therefore, water quality data for streams above intakes located on tributaries to larger water bodies is non-existant in most cases. Requirements for increased monitoring of finished drinking water which originates from surface supplies has been proposed and acted upon in the New Jersey Legislature. This legislation would amend the NJ Safe Drinking Water Act. The final out come of the legislation at this time is not known, however.

The surface water quality data that is collected by water purveyors is not always readily available for use by other agencies. Only the PVWC's monitoring data is accessable through STORET computer services, (the STORET system is a computerized water quality data bank for the entire country and is used in New Jersey for centralized data storage and retrieval). Water quality data collected by the other purveyors with sampling programs in the State often must be hand copied or zeroxed which compounds the difficulty in obtaining the information.

Regardless of the quality of surface (raw) waters before they enter the treatment system of a water purveyor the finished water must meet specific quality requirements as stated in the NJ Safe Drinking Water Act. Purveyors are required to sample finished water for turbidity daily, bacteria (frequency varies depending on population; served), inorganics (includes arsenic, chromium, lead, cadmium, silver, mercury, flourine, selenuim, barium and nitrates) annually, and organics (includes various chlorinated hydrocarbons and chlorophenolys) triannually. Based on the results of this sampling by purveyors and by the NJDEP during routine inspections very few violations of the requirements have occurred. Only with some ground water supplies have pollutants been concentrated so as to prevent the potable use of water.

The treatment of water for drinking purposes varies throughout the State, and is dependent upon raw water quality and the availability of funds for newer and advanced treatment technologies. Usually the better the raw water quality the less amount of treatment required. Conventional treatment is employed by most purveyors.

New Jersey's surface waters will play a greater role in the future for meeting potable water demands, especially in the heavily populated Raritan, Passaic and Hackensack River Basins. However, the proposed water supply projects will have an impact on the water bodies involved. The impacts may be most severe when impoundments receive stream water which contains elevated levels of nutrients. These nutrients can lead to eutrophication of the reservoir, subsequent nuisance vegetative growth and the loss of in-stream fish populations.

Recommendations

The following recommendations are designed to improve the knowledge of potable surface waters, and to minimize the impacts of proposed water supply projects on surface water quality following the completion of the project.

Centralization of Water Quality Data Collected by Water Purveyors: The water purveyors which have been conducting surface water quality monitoring activities should centralize their data into the STORET computer system. The current and historical data generated by these purveyors may be useful in filling data gaps and providing knowledge for many programs in the State. In addition, better coordination between state, local and purveyor sampling programs may result and therefore, eliminate wasteful duplication of work.

Increased Monitoring of Watersheds Above Surface Water Intakes: While some watersheds above a surface water intake are intensively monitored, many have been only randomly or never sampled in the past. This lack of information may hide potential public health dangers, especially with regard to toxic and carcinogenic compounds and substances. Monitoring coordination between all agencies which conduct sampling in the region and the purveyor should be implemented so accurate water quality conditions can be defined.

C. CONTACT RECREATIONAL ACTIVITIES

Introduction

New Jersey has a wealth of surface water resources that are currently being used for primary contact recreational activities. Unfortunately though, many areas of the State do not have the capability to support the water contact recreational activities of swimming, diving and water skiing because water quality is not adequate to protect the public's health. This section is a review of water quality conditions in New Jersey with respect to contact recreation, an analysis of the problems causing degraded water quality, and what is needed to improve conditions in the State to allow for increased bathing opportunities. In addition, there is an assessment of which waters of the State are or will be meeting the swimmable goal of the federal Clean Water Act. This goal states that all surface waters of the nation should be of sufficient quality to allow for recreational activities in and on the water by July 1, 1983.

The New Jersey Department of Environmental Protection, (NJDEP), (1977) estimated that in the mid-1970's the State had over 114,000 linear feet of fresh water shoreline and 285,590 linear feet of salt water shoreline available for recreational bathing. This represents a very small portion of the State's total fresh water shoreline, (there are approximately 34 million linear feet of just freshwater rivers and streams, not including lakes, ponds and reservoirs), and nearly 45 percent of the State's total Atlantic Ocean shoreline. Table III-4 presents a breakdown by county of swimming beaches in the State. Cape May and Ocean Counties, located along the Atlantic Ocean coast, have the greatest amount of beaches in the State. NJDEP (1977) also noted that the State's swimming capacity (including indoor and outdoor pools) was nearing 2,398,000 people daily in 1976.

Swimming is considered the second most popular outdoor recreational activity in the State, being second only to bicycling (NJDEP, 1977). Demand was estimated at approximately 172 million activity days in 1976 and is projected to rise to 214 million activity days by 1995 (NJDEP, 1977). The Statewide Comprehensive Outdoor Recreation Plan (NJDEP, 1977) also found swimming capacity deficits totalling approximately 300,000 activity days at fresh water facilities in 1976, with the deficit scheduled to increase to 460,000 activity days by 1985. For salt water bathing facilities a deficit is expected by 1985 and 1995 in all four coastal counties. Deficits were greatest in the larger urban centers of the State (NJDEP, 1977).

There are a number of factors that influence the ability of a water body to support bathing and its associated industries. Foremost is the presence of water that is of sufficient quality to allow swimming even if some treatment is necessary (such as periodic chlorination). The existence of pathogenic organisms, as indicated by total and fecal coliforms, generally determines

Table III-4 Amount of Beaches by County and Water-Type

County	Freshwater Beaches (linear feet)	Salt water Beaches (linear feet)
Atlantic	2,600	61,870
Bergen	11,600	
Burlington	1,600	
Camden	5,760	
Cape May	1,600	87,149
Cumberland	1,700	
Essex	200	
Gloucester	6,580	
Hudson	-	
Hunterdon	7,460	
Mercer	315	
Middlesex	1,900	
Monmouth	10,775	66,500
Morris	14,984	
Ocean	15,065	70,068
Passaic	16,130	
Salem	1,605	
Somerset	700	
Sussex	5,555	
Union	-	
Warren	8,240	
Total	114,369	285,587

Source: NJ Statewide Comprehensive Outdoor Recreation Plan (NJDEP, 1977) if waters are of suitable quality to be used for bathing (see the Water Quality Criteria for Surface Water Contact Recreation section below). Other factors include physical charactistics of the site (water body depth, presence of nuisance vegetation, nature of the shore or bank, and swiftness of water current), proximity of the site to users, its accessability, and the availability of facilities or accessory commodities that are used during bathing activities. Davidson et al. stated that socio-economic factors (user age, lifestyle, etc.) are of more importance than location or proximity factors when deciding whether or not a swimming facility is used. Binkley and Haneman (1978) instead found proximity the most important factor for going to beaches in the Boston, Massachusetts area based on information from public questionaires. Actual selection of a specific site though, depended upon its cleanliness and the absence of litter.

Whatever the reasons for use of a site, bathing, especially in salt water, is a major industry in the State. In the regions of the State where bathing and other recreational water uses dominate local economical and social characteristis (such as along the Atlantic Coast, Delaware Bay, the larger northern lakes of Hopatcong, Greenwood and Spruce Run and Round Valley Reservoirs); the maintenance of good water quality is an important statewide priority.

Water Quality Criteria for Surface Water Contact Recreation

The suitability of water for contact recreational activities is generally determined by the presence of total and or fecal coliforms. The coliform group are bacteria that originate in the digestive systems of warm-blood animals and thus, when found in water, is indicative of fecal contamination.

Currently the State of New Jersey has a set of standards and guidelines that are used to evaluate surface water quality for bathing. The NJ Department of Health (DOH) issued in 1967 lake bathing guidelines for use in judging natural lake quality. These guidelines recommend no bathing in natural lakes when the arithematic average of the total coliforms most probable number (MPN) of two sets of samples taken at any particular time exceeds 2400 per 100 ml (NJDOH, 1967). It also suggests that a sanitary survey be conducted when levels are found that exceed this number.

The NJDEP has promulgated State Water Quality Standards (N.J.A.C. 7:9-4.1 et seq.) which defines quality standards by classification and designated uses for surface waters (NJDEP, 1981b). The State's surface waters are divided into three main classifications - fresh waters tidal, waters and coastal waters. All fresh have designated uses that include either swimming or primary contact recreation. Bacterial quality standards for fresh waters are:

"...fecal coliform shall not exceed a geometric average of 200 MPN/100 ml, nor should more than 10 percent of the total samples taken during any 30 day period exceed 400 MPN/100 ml" (NJDEP, 1981b).

The standards above do not apply to the freshwater tidal portions of the tributaries to the Delaware River between and including Rancocas and Big Timber Creeks (geometric average of 770 MPN/100 ml as a standard). The bacterial quality standard also recommends that a minimum of five samples per 30 day period be collected for accurate determination.

Only tidal and coastal waters classified as TW-1 and CW-1 are designated to be suitable for primary contact recreation (NJDEP, 1980). The bacterial quality standards for TW-1 waters relating to bathing is the same as for fresh waters presented above. CW-1 waters have a bacterial standard which states that "fecal coliform levels shall not exceed a geometric average of 50 MPN/100 ml" (NJDEP, 1981b).

Surface water monitoring for bacterial quality is conducted throughout the State by a variety of public and private agencies. However, only a very few monitoring programs collect bacteria samples at a sufficient frequency to compare to State standards and guidelines for bathing. Local and county health agencies for the most part do the monitoring of swimming sites found in the State. Routine water quality sampling of bathing beaches by health offices if performed throughout warm weather months (swimming season) generally on a weekly or bi-weekly basis. The Bureau of Planning & Standards, DWR, worked with the approximately 110 local health agencies to inventory all bathing waters in the State. The results of the inventory are found later in this section and in Chapter II.

The long-term U.S. Geological Survey, U.S. Environmental Protection Agency and NJDEP ambient water quality monitoring programs currently being used in New Jersey do not collect bacteria samples frequently enough so that a "swimmable" determination can be made (these monitoring programs are described in Appendix 1). The monitoring stations used to evaluate surface water quality through out the State in Appendix 1 ("Water Quality Inventory") are sampled 6-12 times per year. Therefore, when assessing if a stream is meeting the federal Clean Water Act goal of being swimmable, a procedure had to be developed which could make this determination with limited data. For freshwater of the State swimmable status was assigned to a watersheds if bathing beaches were known to exist throughout, or if fecal coliform data from the monitoring stations during warm weather months (May to September) were consistently low. If over 25 percent of the fecal coliforms sample were greater than 200 MPN/100 ml the waters are considered not swimmable; 0-25 percent of the samples over 200 MPN/100 ml was construed to mean the waters are marginally swimmable (or that swimming is possible at various times); and when all fecal coliform samples were under

200 MPN/100 ml then the waters are consistently swimmable. Note: This system for evaluating the swimmability of the State's waters is based on subjective methodology, and not indicative of all conditions at all times in a segment. Therefore, regardless of the swimmable classification assigned to a segment in this report, swimming is recommended only in those waters routinely monitored for bathing.

Contact Recreational Waters of New Jersey

During the development of this report it had become evident that no comprehensive inventory of bathing beaches in the State exists, with the exception of county totals (see Table III-4) in the Statewide Comprehensive Outdoor Recreation Plan. Since this information is general in nature it can not be readily applied to water quality data. What is needed is a watershed by watershed list of bathing areas and waters so that some comparison to water quality data can be made. To create such a list the Bureau of Planning and Standards sent a questionaire to all health agencies in the State requesting information on where beaches or bathing waters are located in their area of jurisdiction, the water body used for bathing, and the quality of the bathing area (this was determined by asking if it was always open, occasionally closed or permanently closed). The returned responses were approximately 80 percent of the surveys sent.

The results of the questionaire (summarized in Table III-5), plus an evaluation of water quality data is presented below to describe the presence of swimming locations in the State's watersheds, the impacts of water quality problems on bathing waters and where the swimmable goal of the federal Clean Water Act will or will not be met. It should be noted beaches are described and added together by the segments used in Appendix 1 and based on the health agency survey results. Irregularity was detected in what some health agencies considered to be a beach, especially along the coast. One health department considered the entire municipality's beach as one beach, while a second municipality or health agency considered its stretch of ocean shoreline as any number of beaches (each beach separated by a lifeguard station).

New Jersey as a whole has around 700 fresh and salt water bathing beaches, based upon responses to the health agency survey. These bathing areas are concentrated in three regions of the State: the bays and shores along the Atlantic Coast, the ridge and valley lakes of northern New Jersey, and the Pinelands in the southern portion of the State. Of the 669 beaches identified from the questionaires, 573 (85 percent) are always open and 48 (7 percent) are occasionally closed due to high coliform counts or excessive aquatic vegetation. It appears therefore, that once a beach is opened for bathing it will likely remain open until permanently closed (due to pollution or lack of demand).

Table III-5 Location, Number and Status of Bathing Beaches - 1982

Segment[1] (Basin)	Total Number of Beaches/ Bathing Areas	Number Always Open	Number Occasionally Closed	Number Permanently Closed	Number of Water Bodies Where Bathing Occurs, But Not Monitored
Wallkill River	60	51	7	1	1
Flat Brook and Paulins Kill	25	23	2		
Pequest and Muscontcong Rivers	61	58	1	1	1
Pohatcong and Lopatcong Creeks	0				
Delaware River Tributaries (Hunterdon County)	0				
Assunpink Creek	1	1			
Crosswicks and Assiscunk Creeks	2	2			
Rancocas Creek	47	38	2	1	6
Pennsauken Creek, Big Timber Creek and Cooper River	9	5	2	2	
Woodbury, Mantua and Raccoon Creeks	13	5	5	2	1
Oldmans, Salem and Alloways Creeks	5	3		2	
Cohansey and Maurice Rivers	33	19	5	3	6
South Atlantic Coastal Basin	76	70	4	1	1
Great Egg Harbor River	11	5	6		
Mullica River	18	18			

Table III-5 Location, Number and Status of Bathing Beaches - 1982 (Cont'd)

Segment[1] (Basin)	Total Number of Beaches/ Bathing Areas	Number Always Open	Number Occasionally Closed	Number Permanently Closed	Number of Water Bodies Where Bathing Occurs, But Not Monitored
Mid-Atlantic Coastal Basin	151	146	5		
Manasquan River	1			1	
North Atlantic Coastal Basin	44	41	3		
North Branch Raritan River	3	3			
South Branch Raritan River	9	6	3		
Millstone River	3	1		1	1
Lawrence Brook and South River	5	2		2	1
Lower Raritan River (and Raritan Bay drainage)	15	10	1		4
Elizabeth and Rahway Rivers	0				
Upper Passaic River	1	1			
Mid-Passaic River	0				
Mid-Passaic River Tributaries	54	50	2	1	1
Lower Passaic River	12	6		3	3
Hackensack River	3	2		1	
Other	7	7			
<u>Totals</u>	669	573	48	22	26

1 - Segment corresponds to the segments analyzed in Appendix 1 - Water Quality Inventory

The great majority of New Jersey's fresh surface waters will not meet the 1983 nation swimmable goal outlined in the federal Clean Water Act (see Table III-6). In fact only four segments in their entirety are expected to reach the goal: the Flat Brook and Paulins Kill watersheds, the Delaware River from the New York/New Jersey border to the confluence with Rancocas Creek (two segments) and the Mullica River watershed. Many of the waters in New Jersey will be swimmable in 1983 (including the ocean coasts and bays and northern lakes), but the entire watershed in which they are contained will not. For example many tributaries to the Atlantic Ocean (Metedeconk and Toms Rivers) in the Mid-Atlantic Coastal Basin do not meet the criteria for being swimmable, even though the beaches along the Atlantic Ocean do. In most freshwater streams throughout New Jersey, upper tributaries and headwaters will meet the swimmable goal, but the mainstem of the stream or river will not. Making a swimmable classification therefore, was often difficult and generalized.

Following below is a discussion of bathing waters present in the State and how current water quality is impacting the use of surface waters for bathing. The State is divided into four major river basins (Delaware River, Atlantic Coastal, Raritan River, Passaic and Hackensack Rivers for this discussion (see Figure III-1).

The Delaware River Basin (including the Wallkill Watershed)

The Delaware River Basin, along with the Wallkill River and its tributaries (which flows north to New York State eventually emptying into the Hudson River), stretches from the New York stateline southward to Cape May County at the southern tip of New Jersey. The Delaware River mainstem north of Trenton is a major, regional, recreational water resource. It is heavily used for canoeing, boating, fishing, swimming and rafting (tubing). Water-based recreation activities occurs in and on many of the Delaware River tributaries, but bathing is usually limited to the upper reaches of these tributaries. 263 bathing beaches were identified in this basin. Table III-6 summarizes which segments or watersheds are considered swimmable, with only two segments (Flat Brook and Paulin Kills, and the Delaware River from the New York border down to Trenton) swimmable throughout.

Most of the swimming beaches in the watershed of the northern Delaware River tributaries (Flat Brook, Paulins Kill, Pequest River, and Musconetcong River watersheds) and the Wallkill River basin are located on the many glacial lakes present. These lakes are generally well suited for use as swimming beaches because they are located in the upper portions of stream drainage areas and consequently pollution sources are limited. The greatest threat to these lakes is the residential development which has taken place around the lake shores. In most instances, the homes around the lakes utilize on-site disposal systems, and stormwater is diverted to the lake. These potential pollution sources are

Table III-6 Past and Present Status, and Feasbility of Meeting the 1983 Swimmable Goal in New Jersey

Segment (Basin)	Swimmable 1977[1]	Swimmable 1982	Swimmable 1983
Wallkill River	No	Yes*	Yes*
Flat Brook and Paulins Kill	Yes*	Yes	Yes
Pequest and Musconetcong Rivers	Yes*	Yes*	Yes*
Pohatcong and Lopatcong Creeks	Yes*	No	No
Delaware River Tributaries Hunterdon County	No	No	No
Assunpink Creek	No	Yes*	Yes*
Crosswicks and Assiscunk Creeks	Yes*	No	No
Rancocas Creek	No	Yes*	Yes*
Pennsauken Creek, Big Timber Creek and Cooper River	No	Yes*	Yes*
Woodbury, Mantua and Raccoon Creeks	No	Yes*	Yes*
Oldmans, Salem and Alloways Creeks	Yes*	Yes*	Yes*
Cohansey and Maurice Rivers	No	Yes*	Yes*
Delaware River			
NY/NJ Border to Trenton	Yes*	Yes	Yes
Trenton to Rancocas Creek	Yes*	No	Yes
Rancocas Creek to Woodbury (Estuary)	No	No	No
Delaware Bay	No	Yes*	Yes*

Table III-6 Past and Present Status, and Feasbility of Meeting the 1983 Swimmable Goal in New Jersey (Con't)

Segment (Basin)	Swimmable 1977[1]	Swimmable 1982	Swimmable 1983
South Atlantic Coastal Basin	Yes	Yes*	Yes*
Great Egg Harbor River	Yes*	Yes*	Yes*
Mullica River	Yes	Yes	Yes
Mid-Atlantic Coastal Basin	Yes*	Yes*	Yes*
Manasquan River	No	No	No
North Atlantic Coastal Basin	Yes*	Yes*	Yes*
North Branch Raritan River	No	Yes*	Yes*
South Branch Raritan River	No	Yes*	Yes*
Millstone River	No	No	No
Lawrence Brook and South River	No	No	No
Lower Raritan River including Raritan Bay	Yes*	Yes*	Yes*
Elizabeth and Rahway Rivers	No	No	No
Upper Passaic River	No	No	No
Mid-Passaic River	No	No	No

Table III-6 Past and Present Status, and Feasbility of Meeting the 1983 Swimmable Goal in New Jersey (Con't)

Segment (Basin)	Swimmable 1977[1]	Swimmable 1982	Swimmable 1983
Mid-Passaic River Tributaries:			
Whippany River	No	No	No
Rockaway River	Yes*	Yes*	Yes*
Pompton River	Yes*	No	No
Ramapo River	Yes*	Yes*	Yes*
Lower Passaic River	No	Yes*	Yes*
Hackensack River	No	No	No
Arthur Kill	No	No	No
Newark Bay	No	No	No
Hudson River	No	No	No

* - Portions only

1 - Source: 1977 305(b) Report

capable of supplying nutrients and bacteria to a lake. Major recreational lakes in the northern Delaware River and Wallkill drainage areas include Lake Mohawk (12 beaches) in the Wallkill watershed, Kittatinny (2 beaches) and Stony (Stokes State Forest) Lakes in the Flat Brook watershed; Culver Lake (2 beaches), Lake Owassa (4 beaches), Swartswood Lake (Swartswood Lake State Park), and Crandon Lakes (4 beaches) in the Paulins Kill watershed; Panther (3 beaches) and Forest (5 beaches) Lakes in the Pequest watershed; and Lake Hopatcong (over 30 beaches and Lake Hopatcong State Park) in the Musconetcong watershed. Lake Hopatcong is the largest natural lake in the State and supports a major regional recreational industry during the summer months.

Downstream of the lakes in these watersheds, water quality conditions generally declines such that bathing does not occur or is not recommended. However, beaches do exist on some streams. Lafayette and Stillwater municipal beaches are found on the Paulins Kill with the Stillwater beach occasionally closed due to periodic high coliform counts. One beach is found on Lake Musconetcong at Stanhope, while a second beach on this stream at Saxton Falls-Stephens State Park has been permanently closed. The Wallkill, Pequest and Musconetcong Rivers all receive excessive coliform bacteria loads from non-point sources (most likely from agricultural and residential stream runoff) and periodic point source malfunctions.

Delaware River tributaries in New Jersey below the Musconetcong River confluence do not offer the level of bathing found in the northern tributaries. Freshwater swimming activities and opportunities in the watersheds of tributaries below the Musconetcong and above Rancocas Creek are extremely limited. No bathing beaches were identified in Pohatcong and Lopatcong Creeks and the Delaware River Tributaries-Hunterdon/ Mercer Counties segments. Only one beach has been located in the Assunpink Creek watershed and two in the Crosswicks and Assiscunk Creeks Segment. The only Assunpink Creek swimming beach is located in the headwaters of a tributary in Hopewell Township. Crafts Creek, a tributary to the Delaware River in Burlington County contains one bathing beach at Liberty Lake. (Crafts Creek is included in the Crosswicks and Assiscunk Creeks Segment.) The second beach is at Prospertown Lake, headwaters to Crosswicks Creek, and is operated by the NJ Division of Parks, Forestry and Green Acres. Coliform bacteria concentrations in this region are generally excessive throughout and only the upstream areas of Assunpink Creek appear to be marginally suitable for recreational bathing. The Delaware River above Trenton is the major surface water recreational resource in this area of its basin. Water pollution sources include agricultural runoff (Pohatcong Creek, Lopatcong Creek, upper Assunpink Creek, Crosswicks Creek and Assiscunk Creek), septic systems (Pohatcong and Lopatcong Creeks, Hunterdon County tributaries to the Delaware River and Assiscunk Creek), and point sources (Assunpink and Crosswick Creeks).

The Rancocas Creek watershed has nearly 50 identified bathing beaches, roughly half on lakes and half at in-stream locations. Most are found in the upper watersheds of the South Branch Rancocas Creek as it flows through and out of the Pinelands region. Water quality in the headwaters of the Rancocas that originate in the Pinelands is very good. This is due to the large amount of lands in state parks and forests. Despite poorer water quality in the lower portions of the Rancocas, bathing facilities exist in many lakes that drain to the Creek. Bathing also occurs in unmonitored locations along the lower Rancocas. Point source discharges (mainly municipal) and stormwater runoff from developed areas contribute to degraded water quality conditions in the Rancocas.

Recreational bathing opportunities are scattered throughout the watersheds of tributaries to the lower Delaware River and Delaware Bay. Beaches are present in the Pennsauken and Big Timber Creeks watersheds, before these waterways flow through the heavily developed Camden region. Some lakes in this area require chlorination to maintain low bacteria counts in the water. Overall, water quality in these streams deteriorates from the headwaters downstream due to agricultural and suburban/urban runoff, and numerous point sources. As such, swimmable status is assigned to the Pennsauken Creek, Cooper River and Big Timber Creek watersheds in portions, but not throughout.

In the Woodbury, Mantua and Woodbury Creeks Segment the number of bathing beaches increases (13), but over one-half of those beaches identified are either closed occasionally or permanently. The Mantua Creek watershed contains the largest amount (10) with all beaches at lakes or abandoned sand and gravel pits. The largest number of bathing beaches in the lower Delaware River and Bay region are found in the Maurice and Cohansey River watersheds, (33). Most of these are located at lakes and sand and gravel pits, but some occur directly on the Maurice River (three are unmonitored sites in Vineland). The surface waters in the sand and gravel pits are in most cases actually ground water brought to the surface during excavation. The quality of this water is influenced by ground water conditions and rainfall with little overland surface water impacts.

Although ambient surface water monitoring in these watersheds show conditions generally not suitable for bathing, the lakes and ponds in this region evidently play a major role in recreation. Agricultural runoff, septic systems and sporadic sewage plant malfunctions are the main sources of bacteria in the Delaware River and Bay tributaries from Mantua Creek down to the Maurice River (including Salem, Oldmans and Alloways Creeks). It is likely that the headwaters of most of these streams are of sufficient quality to allow bathing, but the mainstem of the creeks and rivers are not; and therefore will not meet the 1983 swimmable goal.

As a whole, the Delaware River basin in New Jersey contains numerous freshwater bathing opportunities especially in the northern and southern areas. The Delaware River itself is heavily used north of Trenton and would undoubtably be a contact recreational resource south of Trenton if water quality was adequate to support such activities.

Atlantic Coastal Basin

The Atlantic Coastal Basin contains the greatest number of recreational beaches in the State, (301 have been identified). The coastal beaches of New Jersey are the basis for a major recreational and tourist industry which supplies the State with income, employment and recognition. In addition, with the development of the casino industry in Atlantic City the recreational value of New Jersey's coastal beaches will increase. Numerous freshwater beaches also occur in this basin, primarily in streams flowing through the Pinelands region (Great Egg Harbor and Mullica River watersheds).

NJDEP and local health agencies located along the coast have been conducting, since 1974, a Cooperative Coastal Monitoring Program (CCMP), which monitors coastal and bay waters (at sites every two miles from Sandy Hook to Cape May) bi-weekly for bacteria concentrations during the summer months. Results from this program have been very consistent during the summers of 1979, 1980 and 1981. Bacterial water quality in the bays, estuaries and ocean surf show generally low levels of fecal coliform with the exception of some localized problems. Beach closings along the coast are rare and usually associated with short-term and localized pollution problems. In fact, NJDEP has never had to order beach closures, except during localized pollution emergencies.

The CCMP has identified approximately 5 out of 135 miles of New Jersey coastal beaches which have periodically elevated fecal coliform counts. These include Sea Bright (North Atlantic Coastal Basin); and Brigantine City, Atlantic City, Wildwood area, Cape May City and Lower Township in the South Atlantic Coastal Basin.

Fecal coliform counts have been periodically elevated off Sea Bright, Monmouth County, and in the Shrewsbury River since 1980, but have caused no closures. Non-point sources (stormwater runoff) are suspected to be the origin of the bacteria. Further down the coast, Brigantine City has reported somewhat elevated and recurrent fecal bacteria counts since 1980 in bay waters. The source of the bacteria is thought to be a cross-connection between stormwater and sanitary sewer lines. Atlantic City has also experienced elevated coliforms on a periodic nature, since before 1979, in both bay and coastal waters. Septic, systems leaky sewer lines, and stormwater runoff are the likely causes. Water quality problems in the Wildwood area (including North

Wildwood, Wildwood City and Wildwood Crest) have been occuring since 1977 in ocean waters, but no beach closures have had to be issued. Sewage treatment problems for these municipalities, force main breaks and stormwater runoff are thought to be the sources of bacteria. In Cape May City fecal coliform problems have existed since 1976 when beach closings took place due to cross-connections emitting raw fecal material. The municipality has been performing sewer rehabilitations to rectify the problem. Lower Township's beaches have also been experiencing elevated fecal coliform counts since 1979. The closeness of the beach to Cape May City's STP discharge location has resulted in a recommendation by the CCMP that no swimming occur in appropriate areas of the township. Despite these few problems, the coastal waters of New Jersey contain good quality waters suitable for bathing.

Bathing beaches in the inland freshwaters of the Atlantic Coastal Basin are concentrated in the Great Egg Harbor River and Mullica River watersheds and in lakes in Cape May County. In the South Atlantic Coastal Basin (Cape May Point to Great Bay) beaches are present in 15 lakes and on the Tuckahoe River at two locations. The majority of the lakes are groundwater fed and are generally always open, while the stream fed lakes and the Tuckahoe sites are occasionally closed. Non-point sources (septic systems) are the likely contributors of bacteria. The Great Egg Harbor River watershed contains 11 identified beaches, nine of which are found on lakes (many are occasionally closed). The two beaches on the Great Egg Harbor River itself are not monitored, but swimming regularly occurs. The Mullica River watershed has 18 known bathing areas, most of which are in-stream. Five sites are located on lakes. High quality waters in this drainage area are due to very little development, the protection of most lands as part of State parks and forests, and the significant ground water inflow to the streams.

In the Mid-Atlantic Coastal Basin (Great Bay to Manasquan Inlet) numerous bathing beaches are present in Barnegat Bay on the mainland side; while occasionally beaches are found on the freshwater inland tributaries to Barnegat Bay and the Atlantic Ocean. Most of the these scattered inland beaches are located on lakes with many periodically closed due to high coliform counts. The Toms and Metedeconk Rivers receive moderate bathing demands in their tidal estuaries before joining Barnegat Bay. The Shark, Navesink and Shrewsbury River's in the North Atlantic Coastal Basin (Manasquan Inlet to Sandy Hook) contain a few bathing areas each. Most of these are occasionally closed. The Manasquan River watershed contained one lake site, but it has been permanently closed.

The sources of water pollution in the Atlantic Coastal Basin are varied from watershed to watershed. In the Southern Atlantic Coastal Basin elimination of older treatment plants and antiquated sewer lines should improve bacterial quality. The Great Egg Harbor River and Mullica River watersheds also experience scattered point source problems, while the lower Mullica River and Great Bay tributaries are experiencing increased development that could threaten existing good water quality because of increases in stormwater runoff. A combination of point and non-point sources affect the larger freshwater streams in the Mid and North Atlantic Coastal Basins. The regionalization and elimination of bay discharges to the ocean from Atlantic County north to Monmouth County has undoubtably reduced bacteria levels in the back bays and along the shore. The Manasquan River watershed contains numerous point and non-point sources problems which are causing poor water quality on the river.

The swimmable goal will be met in almost all coastal waters and some bay waters along the coast. However, with the exception of the Mullica watershed, inland freshwaters are generally not capable of supporting contact recreational activities and will not meet the swimmable goal. As swimming demand increases along the New Jersey shore, the bays, inland waters and tidal estuaries will probably play a larger role in meeting these demands. Efficient and coordinated water pollution control activities will make many of the currently unswimmable waters, capable of supporting primary contact recreation.

Raritan River Basin

The Raritan River Basin drains much of central New Jersey (see Figure III-1), but only 35 bathing beaches were identified. Despite the occurance of many lakes in this basin swimming is not the major activity in most of them. Swimming beaches are frequent only along the southern shores of Raritan Bay in northern Monmouth County. Bacterial concentrations in the fresh water streams and rivers are generally excessive which does not permit in-stream bathing. The Raritan River Basin is broken into five segments: the North Branch Raritan River, South Branch Raritan River, Millstone River, Lawrence Brook and South River, and the Lower Raritan River including Raritan Bay drainage.

The North Branch Raritan River contains three identified beaches, all in lakes that serve as headwaters. These lakes in Roxbury Township are always open. The lack of bathing sites in the remainder of the North Branch watershed is likely a result of poor water quality and or unsuitable sites. The North Branch receives bacterial pollution loads from non-point sources such as agricultural runoff and malfunctioning septic systems, and point sources. Waters of the North Branch will not meet the swimmable goal of the federal Clean Water Act with the exception of some headwater streams and lakes.

The South Branch Raritan River has three major recreational water bodies in its watershed. Spruce Run Reservoir, Round Valley Reservoir and Budd Lake are heavily used during the bathing season as a recreational resource. Budd Lake contains three beaches which are always open. Spruce Run and Round Valley Reservoirs are owned by the State of New Jersey and function primarily for supplying potable water. However, both are used for swimming, boating and fishing. Additional bathing sites are found in Roxbury Township (Ledgewood Pond) and along the South Branch in Hillsborough Township. The three sites in Hillsborough are not routinely monitored as bathing beaches; but data collected at these sites in 1981 often revealed high (greater than 1000/100 ml) fecal coliform concentrations. Ambient water quality data (see Appendix 1.T) show high bacteria levels throughout the South Branch and as a result, it will not meet the 1983 swimmable goal in its entirety. Septic systems and improperly discharging sewer lines and treatment plants are likely sources for the high bacterial levels found.

Bathing beaches on freshwater streams and ponds in the Lower Raritan River, Millstone River, and Lawrence Brook/South River Segments are fairly scattered. Three beaches were identified in the Millstone River watershed. However, only one is always opened while one is permanently closed and the third is not monitored as a bathing beach. The Millstone River and its tributaries are classified as not swimmable, due to fecal coliform loads from periodic raw sewage discharges to streams in the watershed (from sewer lines and treatment plants) and urban/agricultural stormwater runoff. In the Lawrence Brook watershed bathing does occur in abandoned sand mines. Two mines (in South Brunswick Township) are not monitored for bathing, while a third is used by East Brunswick Township as a community pool. Duhernal Lake in the South River watershed was recently closed for swimming because of extensive aquatic plant growth. This is a result of excessive nutrients in the water and reduction of lake depth from sedimentation. Lawrence Brook is considered not swimmable, as are most waters in the South River. Matchaponix Brook, a tributary to the South River was found to be marginally swimmable.

Fifteen beaches are located in the Lower Raritan River Segment. The majority of these are along the Raritan Bay coast in Monmouth County. Some of these beaches are occasionally closed because of excessive bacteria counts. Bathing takes place in two freshwater lakes in this area (Lakes Matawan and Lefferts). In addition there is lake bathing at Cheesequake State Park in Middlesex County. Four other lakes in the Lower Raritan River drainage region allow bathing to local residents or club members. As a whole though, the Lower Raritan River and its tributaries are not suitable to allow bathing. Significant point source discharges, combined sewer overflows and urban/suburban runoff all contribute pollution loads to these streams. In Raritan Bay, primary sewage treatment plants still discharge to the Bay in eastern Middlesex and northern Monmouth Counties.

The lack of bathing beaches in the Raritan River Basin, in part due to poor water quality conditions with respect to bacteria levels, is probably a result of low demand. Major recreational waters lie outside the basin, (Lake Hopatcong to the north, the Delaware River to the west and the ocean shores to the east), and accommodate much of the demands generated in this basin. If water quality was sufficient to allow bathing in the larger streams and lakes in the Raritan River Basin, then the recreational demand placed on resources outside the basin could possibly be lessened. Waters in the basin which would likely generate heavy swimming demands with improvements in water quality include the Millstone River and tributaries, Lawrence Brook, and the South River and tributaries.

Passaic and Hackensack River Basins

The Passaic and Hackensack Rivers flow through and drain the heavily developed northeastern region of New Jersey (see Figure III-1). Despite the origin of both rivers and their major tributaries in sparsely developed areas, the waters experience significant degradation in the downstream sections. All beaches identified are found in the watershed of tributaries to these rivers. 67 beaches occur in the Passaic River Basin and 3 in the Hackensack Basin (see Table III-5). Of these 67 beaches, 54 are found in the Mid-Passaic Tributaries Segment (includes the Whippany, Rockaway, Pequannock, Wanaque and Ramapo Rivers). One beach is located in the Upper Passaic River Segment and 12 are in the Lower Passaic River Segment (all are found in the upper tributaries to the Lower Passaic River). The 3 beaches in the Hackensack watershed are also found in the upper watershed just below the New York State line.

All open beaches in the Passaic and Hackensack Basins are located on lakes and ponds. Only one in-stream beach was identified (the Rockaway River in Boonton Township) and it is now permanently closed. The Pequannock, Wanaque and Rockaway River watersheds contains the greatest amount of bathing waters in this region of the State and most are always open. The beaches are owned by a combination of public and private agencies, (the private agencies are mostly camps and homeowner associations). Lakes with more than one bathing beach include White Meadow Lake (3 beaches) in the Rockaway River watershed, and Lake Stockholm (3 beaches) and Cliffwood Lake (2 beaches) in the Pequannock River watershed. The three beaches in the Lower Passaic River Segment are located on waters draining to HoHoKus Brook and the Saddle River (one beach is permanently closed).

Recreational opportunities in the streams and rivers of northeastern New Jersey are for the most part limited to secondary or non-contact recreational activities (boating, fishing and aesthetics). This is due primarily to poor water quality found in the Passaic and Hackensack Rivers and their tributaries. Significant point source discharge and stormwater runoff pollution loadings from urban (including antiquated sewer lines) and industrial areas are main causes of the water quality conditions presently found. In the upstream waters of the major tributaries to the Passaic and Hackensack Rivers improperly operating septic systems at homes around the many lakes is the greatest threat to the bathing areas currently being used. As a result of water quality conditions in the Passaic and Hackensack Rivers and their major tributaries (Whippany, Pequannock, Rockaway, Wanaque and Ramapo Rivers) they can not be considered swimmable in their entirety and will meet the Clean Water Act's swimmable goal only in headwater streams and lakes. To meet this on the Passaic and Hackensack Rivers mainstem, and, larger tributaries, certain goal vast public and private expeditures will be needed to eliminate the sources of bacteria and other pollutants currently being found. Surface water contact recreational demands generated in the urban areas are and will in the future continue to be met with waters outside this area or by artifical ponds and swimming pools. However, the potential for increased bathing opportunities exist on many of the smaller tributaries to the rivers in this region, if appropriate pollution control activities can be implemented.

Conclusions

A number of conclusions can be made relating to contact recreational activities in New Jersey's surface waters, and how water quality is affecting this valuable use of surface waters. The conclusions presented below are grouped into two categories: one reviews water quality in the State and how it impacts contact recreational activities; and the second looks at the contact recreational resource in the State.

The quality of most of New Jersey's freshwaters are not suitable for contact recreational activities based on the results of ambient surface water quality monitoring programs. The presence of fecal coliform bacteria in surface freshwaters, is widespread throughout the State and often in high concentrations (greater than 200 MPN/100 ml). This data shows only four entire segments or watersheds in the State to be swimmable: the Flat Brook, Paulins Kill and Mullica River watersheds and the Delaware River mainstem above Trenton. These watersheds are also the only segments in their entirety which will meet the 1983 swimmable goal of the federal Clean Water Act. In addition, the coastal waters of the Atlantic Ocean are swimmable with the exception of some small, localized beaches, particularily after heavy rainfall events. In the remainder of the State many bathing beaches occur, but are limited for the most part to the upper watersheds or headwaters. The State has bathing beaches concentrated in three regions: along the Atlantic Coast, in the northwestern portion of the State and in the Pinelands of southern New Jersey.

The statewide ambient water monitoring programs do not generate a sufficient amount of fecal coliform readings so that accurate swimmable determinations can be made. Since these monitoring programs only take 6-12 samples per year at each site definitative conclusions are not possible, unless fecal coliform readings are consistently very high. If an accurate swimmable conclusion is to be made weekly or bi-weekly samples are needed so that comparison to State Water Quality Standards are possible.

Comparison of water quality data in this 305(b) report with data presented in the 1977 305(b) report show changes in the swimmable classification of 13 segments. Eight segments identified as not swimmable in 1977 are now considered swimmable in a portion of their segment. These segments include the Wallkill River, Rancocas Creek, Pennsauken Creek, Big Timber Creek and Cooper River, Woodbury, Mantua and Raccoon Creeks, Cohansey and Maurice Rivers, Delaware Bay, South Branch Raritan River, North Branch Raritan River and the Lower Passaic River. The upgrading in classification of these segments is due primarily to the identification of bathing beaches in the segment and not necessarily improvements in water quality. A reduction in classification occurred in four segments or streams: Pohatcong and Lopatcong Creeks, Crosswicks and Assiscunks Creeks, the Delaware River from Trenton to Rancocas Creek, and the Pompton River (a Mid-Passaic River tributary). These reductions are based on excessive fecal coliform bacteria detected in the streams and a lack of bathing beaches identified from the health agency survey.

A diversity of known and suspected sources contribute bacteria to New Jersey's streams and lakes. Municipal sewage treatment plants, once considered the major source of bacteria in the nation's waterways, have improved their treatment efficiencies and disinfection rates in the last decade pursuant to federal and state laws. Bacteria loads from point sources discharges in now thought to be a minor portion of the total bacteria load as long as treatment plants are discharging within their permit requirements. Non-point sources, therefore, are suspected of being the main cause of excessive bacteria concentrations in the State's surface waters. These non-point sources include: on-site septic systems, antiquated and leaky sewer lines, combined sewer overflows, street runoff, agricultural runoff from livestock grazing and feedlot areas, concentrated waterfowl and wildlife populations, the illegal disposal of septage wastes, and the natural flushing of soil bacteria during storm events. Any one or combination of these sources may cause elevated bacteria counts in a water body.

The bathing waters and beaches of New Jersey are not subject to a routine statewide inventory (except in coastal waters). Therefore, to compare water quality trends with changes in bathing use intensity or locations is not possible. Initial inventories have been performed for the 1977 Statewide Comprehensive Outdoor Recreation Plan (SCORP) by the Office of Green Acres, NJDEP (NJDEP, 1977). However this inventory is not specific enough to allow comparison to water quality data. A recent update of the information used in the SCORP incorporates a different system of measuring beaches, so comparison of 1977 and 1982 data is also not possible. The health agency survey developed for and used in this report represents the first inventory that defines bathing areas by water body and watershed and its quality (in terms that it is always open, occasionally closed or permanently closed). However, improvements to this survey can be made. They include full return of all sent (or follow-up correspondence) and a standard quantitative definition for enumerating a beach.

Unfortunately the majority of New Jersey's swimmable waters are not near the State's population centers. Because of this, portions of the States population may not be able to utilize the bathing resources located at a distance from them. If water quality in the State's urban areas could be improved so that bathing is possible a significant recreational resource would be available. However, the expense to the public and private sectors for achieving this improvement would have to be carefully weighed against the possible benefits.

Recommendations

The recommendations presented below are designed to further identify the importance of surface water bathing in New Jersey, the ability of the State's water to support this activity and how water quality can be improved to handle more bathing in the future.

Inventory of bathing areas: A thorough biannial bathing areas inventory should be conducted corresponding with future 305(b) reports. Such an inventory should utilize the NJDEP, NJDOH, and regional and local health agencies. The results of this inventory will be compared to water quality trends identified in the 305(b) to gain an understanding if water quality is affecting the use of surface waters for bathing, and where it is occuring.

Increased water quality monitoring: There is a need for greater bacteria monitoring of the State's surface waters if they are to be accurately classified as swimmable, marginally swimmable or not swimmable. In addition, greater monitoring will assist in determining the origin or bacteria pollution entering waterways. Sampling should be performed at a frequency so that comparison to the State Water Quality Standards is possible. The sampling program should incorporate a matrix of state, regional and local agencies to do the field collection, laboratory analysis and data evaluation.

Greater non-point source controls: As point source control programs are fully implemented in New Jersey and bacteria discharge limitations are enforced, non-point sources will become the major contributor of coliform bacteria found in the state's waters. Therefore, if bacteria levels in surface waters are to be reduced and new swimming beaches opened, non-point source controls should be implemented where they are found to be effective.

<u>Uniform water quality standard</u>: It is recommended that one water quality standard (or guideline) be used in the State of New Jersey to evaluate the suitability of surface waters for primary contact recreation. The NJDOH should replace their guidelines for bathing water quality (a total coliform concentration of 2400 MPN/100 ml) with the fecal coliform values in the New Jersey State Water Quality Standards (NJDEP, 1981b). A uniform State standard will also cause water quality sampling and analysis to be consistent throughout the State.

<u>Analysis of bathing potential in urban areas</u>: There is a shortage of recreational bathing water in the large urban centers of the State. This problem is largely a result of stressed local economies which can not afford the construction and maintenance of a sufficient number of such facilities, and generally poor surface water quality that does not allow bathing to take place. Studies should be performed on selected water bodies in urban areas across the State that may have the potential to be used as a bathing beach. The study could utilize results of the New Jersey Lakes Management Program to select water bodies that may show significant water quality improvements (with an emphasis on bacteria quality) with minimal public expeditures, and which would serve to eliminate a recreational void for that area.

New Jersey's surface waters allow primary contact recreation on a limited basis due to excessive fecal coliform concentrations present in the water. The main cause of this bacteria pollution in the State appears to be non-point sources, which are often difficult and expensive to eliminate. Any reduction in bacteria contamination, and subsequent increases in available bathing beaches will depend on how effective non-point source controls can be implemented and existing point sources controls maintained.

D. SHELLFISH RESOURCES AND HARVESTING

Introduction

The shellfish industry in New Jersey is a significant national industry. New Jersey shellfish account for a major portion of the national market of clams, oysters and mussels. Currently the yearly dockside value of shellfish landed in New Jersey is $28,500,00. In addition to its monetary value, an estimated 270,000 mandays of effort were expended in the harvest of New Jersey shellfish in 1980. Over two-thirds of this time was spent by recreational fishermen. This activity originated from 30,420 licensed shellfishermen (1980) of which 92 percent harvested only for recreation, 4 percent were primarily recreational with a small portion of the catch sold, and the remaining 4 percent commerically shellfished.

The Bureau of Shellfish Control, Division of Water Resources, DEP, monitors the quality of estuarine and ocean waters for the suitability of shellfish harvesting. Their criteria for determining shellfish growing water status is based on the presence of total coliform bacteria. In the Division of Fish, Game and Wildlife, DEP, the Bureau of Shellfisheries manages the State's shellfish resources by reviewing the resource base, and operation relaying transplanting and licensing programs.

The State's shellfish resources are spread throughout its coastal and estuarine waters. Hard clams (Mercenaria mercenaria), the most valuable shellfish resource, is found and harvested most intensively in the central and southern estuarine waters (Little Egg Harbor, Barnegat Bay, Atlantic County bays and Cape May County bays). Soft clams (Mya arenaria), are primarily found in the two Raritan Bay tributaries the Navesink and Shrewsbury Rivers; and are associated with depuration. Oysters (Crassostrea virginica) are for the most part harvested from Delaware Bay.

The Bureau of Shellfish Control annually assigns harvest classifications to the State's shellfish growing waters. From January 1971 through January, 1979 18,660 estuarine acres were reclassified from approved to a more restrictive classification. Approximately 25 percent of these areas were reclassified Fully Condemned. The general decline in classification was attributed to increased recreational and development pressure in coastal areas and the declining effectiveness of older municipal wastewater treatment plants. In 1980 a net gain of over 5000 acres upgraded was recorded. During 1981 an additional net gain of approximately 2500 acres was established. The 1982 reclassifications resulted in a net loss of slightly over 200 acres. This recent, overall change in trends is attributed to the upgrading of wastewater treatment in many of the coastal areas and the evaluation of more condemned areas as potential seasonal areas.

Classifications totals for the ocean waters have fluctuated in recent years. Large numbers of acres are initially closed when each regional ocean discharge goes on line. After assessment of observed water quality some refinement (reduction) of classifications may occur.

The Bureau of Shellfish Control of the New Jersey Department of Environmental Protection has classified coastal waters into four categories of shellfish harvesting areas. These categories are as follows:

1) Approved - Waters meeting the sanitary standards for approved shellfish harvesting as recommended by the National Shellfish Sanitation Program. Waters not classified as condemned, special restricted, or seasonal shall be considered approved for the harvest of shellfish.

2) Special Restricted Area - Waters condemned for the harvest of oysters, clams and mussels. However, harvesting for further processing may be done under special permit from the State Department of Environmental Protection.

3) Seasonal - Waters which are condemned and opened for the harvest of oysters, clams and mussels each year but open by operation of regulations according to the schedule of 7:12-1.3(b) seasonal areas approved November 1 through April 30, condemned May 1 through October 31 and 1.3(c) seasonal areas approved January 1 through April 30, condemned May 1 through December 31 yearly.

4) Condemned - Water not meeting the established sanitary standards as recommended by the National Shellfish Sanitation Program of the Federal Food and Drug Administration. Applications for removal of shellfish to be used for human consumption from areas classified as condemned will be considered for resource recovery programs of promulgated by the Department of Environmental Protection.

Relay Program

The ability of shellfish to purify themselves of bacterial contamination when relayed to clean water was discovered early in the 1900's. New Jersey's Department of Environmental Protection presently operates a program which relays shellfish from its Special Restricted and Condemned growing areas into Approved growing areas for a minimum of thirty days. This enables shellfish to cleanse themselves of contaminating bacteria and/or viruses. Following the purification period, a sample of clams are analyzed for bacterial quality prior to being released for harvest and marketing. The cleansed shellfish now become a part of the economy and deprive illegal clamming operations of a source of shellfish, thus protecting consumer health.

The Relay Program was initially begun in the vicinity of Atlantic City. This area includes Lakes Bay, Absecon Bay and Scull Bay plus the vast complex of interwinding waterways. The program has been subsequently expanded to include the Manasquan and Shark Rivers and certain areas in Cape May County. The waters in these localities are classified as Special Restricted or Condemned for the harvesting of shellfish. Hard clams taken from these waters are relayed to beds in Great Bay or in some instances, to lots in Barnegat Bay.

An individual must comply with two requirements in order to participate in the program. These are that one must possess a valid commercial clamming license and a valid Relay Permit.

The program is under the supervision of the New Jersey Bureau of Shellfish Control, through the issuance of necessary permits. Day to day patrol is provided by the Division of Fish, Game and Wildlife, Bureau of Law Enforcement. All clams harvested on any one day by clammers involved in the program are bagged, tagged and transported under secured conditions to the Approved growing area. Transportation of clams by secured means insures the public that none of the clams will be marketed before being relayed. After arriving at the Approved growing waters, the clams are deposited on the privately leased grounds by the clammers. The Division of Fish, Game and Wildlife, Bureau of Law Enforcement patrols the area until the clammers are notified that the clams are safe to harvest and market. The Bureau of Shellfish Control and the Division of Fish, Game and Wildlife monitor the relayed waters to insure proper water conditions are being met. Clams are not relayed during the winter because it is known that lower water temperatures (minimum 50°F) inhibits the rate of cleansing action by the shellfish.

Recent upgradings of classification in Atlantic County altered the scope of the relay program. Areas which had been the nucleus of the program are now available for direct harvest. These waters (including Lakes Bay, Absecon Bay, Skull Bay and Reed Bay) were found to be experiencing a severe decline in its hard clam resource base. Evidently the pressures of an intense fisheries in these waters contributed to resource decline. This resource base decline appears as reduced total catch and increased effort per catch. As a result of the upgrades in the Atlantic County bays a decline in interest in the relay program has been seen. Two expansions of the statewide relay program are proposed which will generate new interest:

(1) A cold water relay program which will be active during the winter months, and

(2) the incorporation of areas in Monmouth County into the relay program.

Depuration Program

The State of New Jersey has licensed two plants for the depuration of soft shelled clams. This program, like the relay program, relys on the natural ability of shellfish to purge themselves of bacterial contamination when placed in a clean environment. The program involves harvesting soft shelled clams from areas classified as Special Restricted and a 48 hour depuration period. At the depuration plant, the shellfish are placed in a water environment closely controlled to provide optimal conditions for efficient purification. Salinity and water temperatures are controlled to maintain maximum pumping rates in the shellfish. The water in the depuration tanks is also disinfected to maintain high bacterial quality. Following the depuration process laboratory analyses are performed to verify that the shellfish meet market standards. The depurated shellfish are then released for marketing.

New Jersey's two depuration plants are located in Highlands, Monmouth County, the center of the soft clam resource. Primary harvest sites are the navesink and Shrewsbury Rivers. Specially designated non-power boats are used for harvesting under the direction of the Division of Fish, Game and Wildlife (Bureau of Law Enforcement). At the end of the daily harvest activities, shellfish are loaded aboard a "mother craft" for transportation to the depuration plant. All aspects of harvesting and transportation of these shellfish are closely monitored by the Division of fish, Game and Wildlife (Bureau of Law Enforcement) to insure complete compliance with program procedures. A third depuration plant is planned for in Highlands. This plant will perform depuration of hard clams.

Status of New Jersey's Shellfish Growing Waters

New Jersey has been divided into four major basins which are subject to shellfish regulations. These are Raritan River Basin, New Jersey North Coastal Basin, New Jersey South Coastal Basin, and Delaware River Basin Zones 5 and 6. The classification of shellfish growing waters are found in NJDEP (1982b).

Raritan River Basin

Only a small portion of the Raritan River need be examined, as most of this Basin consists of freshwater habitats. Considered here are Raritan Bay, Lower New York Bay, Sandy Hook Bay, Navesink River, Shrewsbury River and their tributaries. There are no waters in this basin classified Approved. Thirty five percent of the available acreage is classified Special Restricted. Since June 1978 only one reclassification have occurred (1982) in the Raritan River Basin. McClees Creek, a tributary of the Navesink River, has been downgraded from Special Restricted to Condemned (15 acres).

The Bureau of Planning and Standards, Division of Water Resources, recently conducted a study on the sources of bacteria in the Navesink estuary (NJDEP, 1982a). The Navesink River contains a soft clam resource in Condemned and Special Restricted classified waters. Based on intensive surveys and review of existing information, bacteria were found to be entering tributaries of the Navesink Swimming River, Pine Brook, and Hockhockson Brook from agricultural lands with livestock. As a result of this study, the U.S. Department of Agriculture's Soil Conservation Service is reviewing the possibility of implementing a soil erosion and animal waste control project in the Navesink watershed.

New Jersey North Coastal Basin

This basin consists of a large portion of the Atlantic Ocean coastal environment in New Jersey. Most of the acreage classified in this basin is in Barnegat Bay. Barnegat Bay comprises 65 percent of the total acreage available for shellfish harvesting in this basin (46,158 acres). The remainder of the basin is made up of a number of smaller bays, rivers, creeks and their tributaries. These include Shark River, Manasquan River, Little Egg Harbor, Cedar Run, Westecunk Creek, Tuckerton Creek, Big Thorofare and Big Creek.

Fully open shellfish harvesting acreage constitutes 72 percent as of (1981) of the total available acreage in this basin. These areas are generally located in Barnegat Bay and Little Egg Harbor. This leaves 15 percent (1981) of the total available acreage Condemned and 13 percent (1981) classified as Seasonally Approved. Under the Shellfish Relay Program, clams are removed from Condemned waters in the Manasquan and Shark Rivers and deposited in specified Approved waters in Barnegat Bay or Great Bay for purification. Reclassifications in the North Coastal Basin since 1979 include:

May 1979:

Upper Barnegat Bay (Mantoloking Area) - approximately 321 acres downgraded from Approved to Seasonally Approved.

Kettle Creek - Silver Bay - approximately 553 acres downgraded from Approved to Seasonally Approved.

Barnegat Bay (Lavallette Area) - approximately 859 acres downgraded from Approved to Seasonally Approved.

Barnegat Bay (Seaside Park Area) - approximately 2122 acres downgraded from Approved to Seasonally Approved.

May 1980:

Long Beach Island - approximately 361 acres upgraded from Condemned to Seasonally Approved, 38 acres upgraded from Condemned to Approved and 175 acres downgraded from Approved to Seasonally Approved.

May 1981:

Manahawkin Bay - Mill Creek - approximately 150 upgraded from Condemned to Seasonally Approved.

May 1982:

Upper Barnegat Bay (Swan Point Area) - 31 acres downgraded from seasonally Approved to Condemned.

Silver Bay - 395 acres downgraded from Seasonally Approved to Condemned.

New Jersey South Coastal Basin

The New Jersey South Coastal Basin, combined with the New Jersey North Coastal Basin, make up more than 90 percent of the Atlantic Ocean coastal zone in New Jersey. In comparison with the three other basins (Raritan River, New Jersey North Coastal Basin and Delaware River Zones 5 and 6) which support shellfish harvesting, this basin is the most productive. According to statistics reported in the annual summaries of New Jersey Landings reports, this basin has an annual shellfish harvest of at least double the combined totals of the other three basins. A portion of this productivity is associated with the relay program.

The New Jersey South Coastal Basin includes Great Bay, Mullica River, Reed Bay, Absecon Bay, Lakes Bay, Great Egg Harbor, Great Egg Harbor River, Ludlam Bay, Great Sound, Jenkins Sound, Grassey Sound, Richardson Sound and Cape May Harbor. The total area classified in the New Jersey South Coastal Basin encompasses 77,520 acres, of the total area classified, 49 percent of the acreage is designed as Approved, 34 percent is Condemned, 6 percent is classified as Special Restricted and 11 percent is Seasonally Approved (based on 1981 data). Reclassifications which have taken place in this basin since 1979 include:

May 1979:

Great Egg Harbor River - approximately 217 acres downgraded from Seasonally Approved to Condemned.

May 1980:

Reed Bay (Absecon Bay Area) - approximately 3,395 acres upgraded from Condemned to Seasonal.

Lakes Bay - approximately 996 acres upgraded from Condemned to Seasonal.

Scull Bay - approximately 586 acres upgraded from Condemned to Seasonal.

Steelman Bay - small undetermined area downgraded from Approved to Condemned.

Somers Cove - small undetermined area upgraded from Condemned to Approved.

Strathmere - small undetermined areas downgraded from Seasonally Approved to Condemned.

Townsends Inlet - small undetermined area downgraded from Approved to Condemned.

May 1981:

Landing Creek - Approximately 23 acres downgraded from Approved to Condemned.

Steelman Bay (Obes Thorofare) - approximately 75 acres upgraded from Condemned to Seasonally Approved.

Broad Creek (Reed Bay) - approximately 1383 acres upgraded from Seasonally Approved to Approved.

Scull Bay (Broad Thorofare) - approximately 810 acres upgraded from Seasonally Approved or Special Restricted to Approved.

Great Egg Harbor Bay - approximately 163 upgraded from Seasonally Approved to Approved.

May 1982:

Great Sound (Holmes Creek) - 80 acres upgraded from Condemned to Seasonally Approved.

Delaware River Basin - Zones 5 and 6

This basin has six areas which are subject to shellfish classification. Delaware Bay contains 97 percent of the total classified acreage in the basin and is the only area in the basin that contains waters classified as Approved for shellfish harvesting. The other five areas are classified either Condemned or Seasonally Approved. This includes Maurice River and Cove area, the Cohansey River area, the Back Creek area, the Cedar Creek area and the Nantuxent Creek area. Of the total acreage available for shellfish harvesting, 88 percent is classified Approved, 10 percent is Condemned and 2 percent is Seasonally Approved (1981 data). The reclassifications for this region since 1979 are as follows:

May 1979:

Mouth of Dennis Creek - Approximately 296 acres upgraded from Condemned to Approved.

East Point Area - approximately 622 acres downgraded from Approved to Seasonal.

Cohansey River - approximately 449 acres downgraded from Approved to Condemned.

May 1980:

Fishing Creek - approximately 100 acres upgraded from Condemned to Seasonal.

May 1981:

Cohansey Cove - approximately 75 acres downgraded from Approved to Condemned.

Delaware Bay is the major oyster producing area of the State. Although the bay and its tributaries still produce approximately 98 percent of the oysters harvested, their numbers have been severely reduced due to MSX (Minchinia nelsoni) disease and the presence of the oyster drill (Urosalpinx cinerea and Euplaura candata). Most oysters which are harvested in New Jersey originate in Delaware Bay seed beds and are transplanted to the Maurice River Cove for growing and harvesting. Roughly 28,000 acres in the Maurice River Cove are leased for planting oyster seeds.

Atlantic Ocean

None of the basins previously discussed included figures on the Atlantic Ocean. There are 280,708 acres of marine waters which are regulated by the Bureau of Shellfish Control. Of this total area 70 percent of the waters are classified as Approved while the remainder is classified as condemned (1981 data). The reclassi- fications in the Atlantic Ocean Since 1979 are as follows:

May 1979:

Inland Beach Area - approximately 718 acres downgraded from Approved to Condemned. Approximately 867 acres upgraded from Condemned to Approved.

Long Beach Inland Area - Approximately 7112 acres upgraded from Condemned to Approved.

Atlantic City Area - Approximately 6997 acres downgraded from Approved to Condemned.

May 1980:

Monmouth County Area - Approximately 8856 acres upgraded from Condemned to Approved.

May 1981:

Long Beach Island Area - Approximately 2822 acres upgraded from Condemned to Approved.

November 1981:

Ocean City Area - Approximately 2570 acres downgraded from Approved to Condemned.

May 1982:

Monmouth County Area - 2515 acres upgraded from Condemned to Approved.

Atlantic City Area - 205 acres upgraded from Condemned to Approved.

Peck Beach Area - 2570 acres downgraded from Approved to Condemned.

Summary of Shellfish Waters and Resources

It is important to be cautious when examining shellfish harvesting data for the past 11 years as seen in Table III-7 "Total N.J. Shellfish Catch". These figures represent the total amount of shellfish (clams, oysters and mussels) produced in New Jersey and not necessarily the total amount taken from New Jersey's territorial waters. Three major factors that can not be evaluated, but neverless affect these statistics must be considered: 1) catches from non-state harvest areas are included in these figures; 2) out-of-state fishermen use New Jersey's harvest areas and take their catches to other states for processing; and 3) shellfish harvested by sports fishermen. When these three factors are considered, one can readily see the difficulty involved when attempting to discuss past and future harvest trends. However, it appears that there has been a general decline in shellfish harvesting in the State.

Table III-9 indicates the net change in shellfish growing area acreage and the total shellfish growing area acreage by designated classifications. A general reversal of trends in reclassifications is seen when comparing the most recent six years of data with the preceding five years of data. The improved trend is attributed to the upgrading of wastewater

Table III-7 Yearly New Jersey Shellfish Catches

Year	Catch (in pounds)
1970	42,955,839
1971	32,067,077
1972	25,303,811
1973	24,896,494
1974	25,501,852
1975	38,325,940
1976	31,519,713
1977	39,302,494
1978	34,925,000
1979	45,281,000
1980	37,616,000

Table III-8 Composition of Shellfish Yearly Catches and Monetary Values 1979-1980

	1979		1980	
Species	Catch (pounds)	Values (dollars)	Catch	Value
Hard Clam	898,000	1,570,000	845,000	1,695,000
Soft Clam	1,190,000	208,000	336,000	375,000
Oyster	1,675,000	2,360,000	771,000	1,167,300
Surf Clam	12,325,000	6,300,000	9,597,700	4,791,000
Quahog	24,968,000	7,500,000	22,574,300	6,772,800
Scallops (ocean)	5,225,000	16,850,000	3,492,600	13,760,100
Totals	45,281,000	34,790,000	37,616,600	28,561,200

Table III-9 Ocean and Estuarine Shellfish Growing Area Acreages Reclassified

Year Adopted	Total Acres Downgraded	Total Acres Upgraded	Net Change
1982	3,011	2,800	- 211
1981	98	5,403	+ 5,305
1980	175	14,332	+14,157
1979	12,858	8,275	- 4,583
1978	583	1,129	+ 546
1977	42	1,599	+ 1,557
1976	2,353	2,135	- 218
1975	5,018	885	- 4,133
1974	5,462	146	- 5,316
1973	2,490	0	- 2,490
1972	2,951	5,511	+ 2,560

treatment in our coastal areas through regionalization and the fine tuning of existing classifications.

While the Bureau of Shellfish Control is encouraged by recent gains in classification, there is concern for the immediate future. The casino industry in Atlantic City has created extensive building pressure for commerical, residential and industrial facilities in coastal Atlantic County. The major concern regarding this construction is degraded stormwater runoff associated with developed areas. Water quality gains realized through regionalization of wastewater treatment could be negated through extensive new construction and its associated runoff. It is noted that the estuarine waters of Atlantic County which are jeopardized by this development, are among the most productive in the State. Stormwater controls are being required in many of the developments now under construction through the issuance of Coastal Area Facilities Review Act (CAFRA) permits. In addition, the largest projects are also implementing water quality sampling programs to determine whether water quality degradation is resulting from their development.

A coordinated management approach is a requirement if New Jersey's shellfish resource is to be maintained as a national industry. Besides overall water quality improvements in New Jersey's coastal waters, there is a need for protection of shellfish habitats (bay and estuary bottoms), continued protection of significant clam and oyster seed beds, monitoring of annual harvest amounts and shellfish growing rates, and sampling of shellfish tissue for chemical and metals contamination. Depuration and relay programs will also undoubtably play a greater role in the harvesting of New Jersey's shellfish resource in the future.

E. FISHERIES RESOURCES

Introduction

The variety of land forms, local climates and water resources found in New Jersey creates a great diversity of fishlife. This diversity ranges from the nursery grounds of commercially important marine fisheries along the Atlantic coast to clear, cool and fast running mountain streams with native trout in the State's highlands. In addition, new fish communities containing both native and exotic species have developed in many waterways of the State. These fish communities have generally different life-supporting requirements, but all require adequate water quality. This section of Chapter III is a review of the water quality needs for the various fish communities in the State and if existing water quality conditions are suitable for supporting healthy fishlife.

The ability of waters in the State to meet the "fishable" goal of the federal Clean Water Act is also discussed. The fishable goal is written in the Act as the "...level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish and wildlife...," and is to be achieved by July 1983. This section reviews the sources of water pollution that are impacting fisheries, and what is and should be done in the State to alleviate these problems.

New Jersey's fisheries resources can be roughly divided into three groups: coldwater fisheries, warmwater fisheries and marine fisheries. The cold and warmwater groups are found in the freshwaters of the State, while the marine fisheries inhabit brackish and salt waters found in estuaries, bays and coastal waters. Anadromous (species which live in ocean waters but spawn in fresh waters) and catadromous (spawn in ocean waters but live in fresh waters; the only catadromous fish indigenous to New Jersey is the American eel, *Anguilla nostrata*) fish are also present in many waters statewide.

The geographical provinces of the State (Figure III-4) are the approximate boundaries between the cold and warmwater fisheries. The northern half of New Jersey, containing the Ridge and Valley Highlands, and Piedmont provinces (simply called the Northern Uplands) are where the cold water fisheries predominately occur. However, the lakes in this region contain primarily warmwater fishes. In the Inner and Outer Coastal Plains warmwater and coldwater communities are interspersed, with warmwater fish communities predominating. Although there is variation within each province they can be characterized in rough terms. The Northern Uplands are typified by colder, faster moving streams and rivers containing rock and gravel bottoms. The Outer Coastal Plain has somewhat slower moving and warmer waters which are moderately to highly acidic, and have mostly mud and sandy

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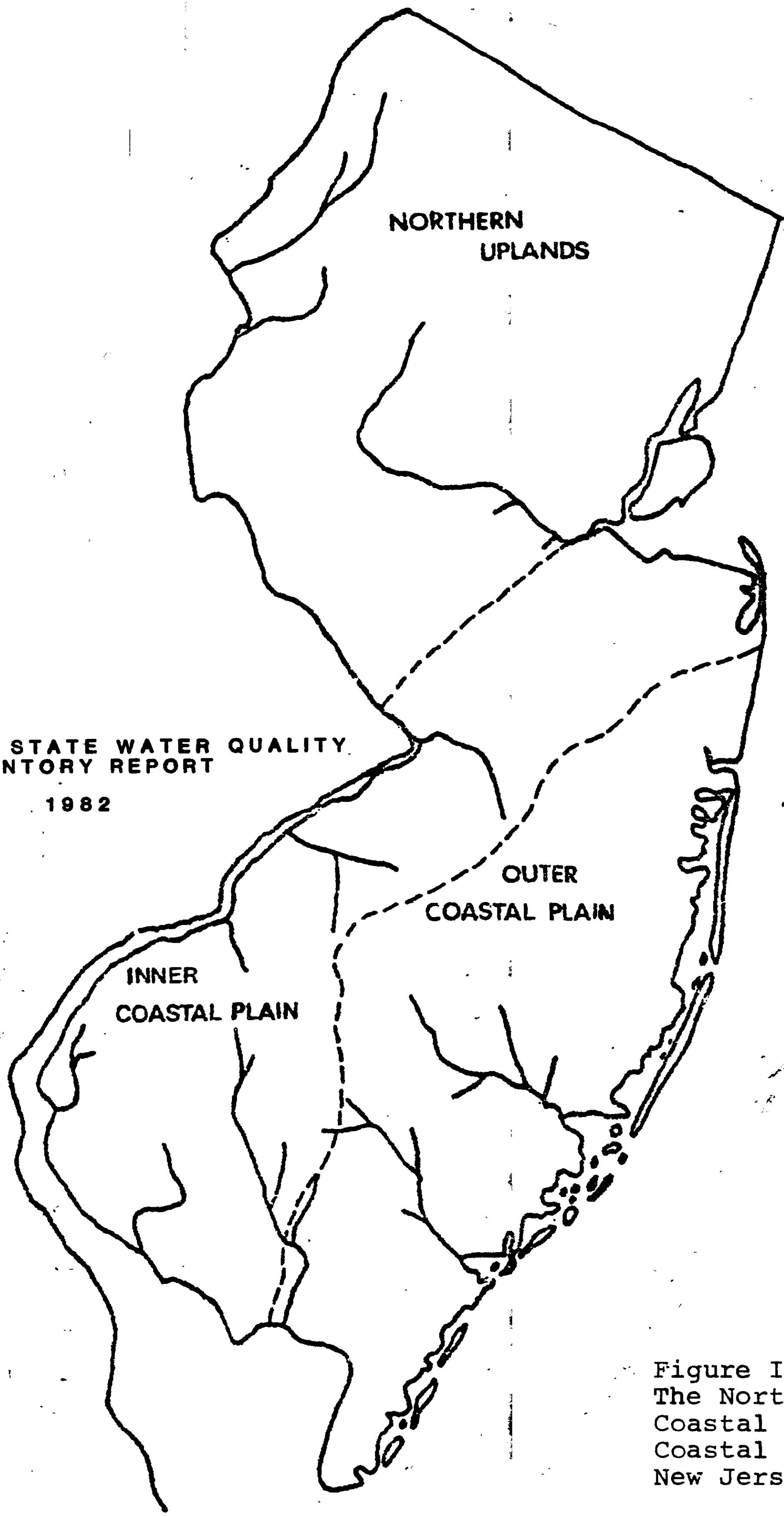

Figure III-4
The Northern Uplands, Inner Coastal Plain and Outer Coastal Plain Regions of New Jersey

Taken from: Weis <u>et al</u>. (1979)

bottoms. The Inner Coastal Plain often has waters which contain features of both the Northern Uplands and Outer Coastal Plain.

There is great overlap in where fish species will be found in the State. Generalizations regarding coldwater and warmwater fish communities are possible, however. The presence of indigenous trout species is indicative of a coldwater community. In New Jersey brook trout (Salvelinus fontinalis); rainbow trout (Salmo gairdneri), brown trout (Salmo trutta) and lake trout (Salvelinus namaycush) are found, although only brook trout is native to the State. The other three species have been introduced through stocking efforts, with lake trout currently found only in Round Valley Reservoir. Other fish commonly found with trout include blacknose dace (Rhinichthys atratulus), longnose dace (Rhinichthys cataractae), fallfish (Semotilus corporalis) and slimy scalpin (Cottus cognatus) (Hamilton and Minervini, 1982; and Weis et al, 1979).

Common warmwater fish found in New Jersey include chain pickerel (Esox niger), shiners (Notropis spp.), white catfish (Ictalurus catus), channel catfish (Ictalurus punctatus), yellow bullhead (Ictalurus natalis), black bullhead (Ictalurus melas), pirate perch (Aphredoderus sayanus), yellow perch (Perca flevescens) and sunfishes (Enneacanthus spp. and Lepomis spp.). There are also a large number of fish species that are found in both cold and warmwater environments. Among these are the pumpkin seed (Lepomis gibbosus), bluegill (Lepomis machrochirus), smallmouth bass (Micropterus dolomieue), largemouth bass (Micropterus salmoides), rockbass (Ambloplites ruprestris), white or common sucker (Catostomus commersoni) and the creek chub (Semotilus atromaculatus). Many of the above mentioned freshwater fishes also occur in the lakes of the State.

Many of the now important recreational fishes in the State were introduced from other regions of the country and the world. These include largemouth bass, brown trout, rainbow trout, and carp (Cyprinus carpio). Even some fishes which are indigenous to areas in the State (such as brook trout, chain pickerel and smallmouth bass) have been stocked and restocked throughout the State, so that their current ranges are not reflective of original ranges (Weis et al, 1979). Therefore, the waters of New Jersey contain many fish which were not originally found in them.

New Jersey's Division of Fish, Game and Wildlife (DFGW) and Division of Water Resources (DWR) have special resource protection and water quality criteria for waters of the State that have reproducing or year-round brook, rainbow and brown trout populations (trout production and trout maintenance waters). Trout production and maintenance waters have among the best water quality conditions in the State (see the Water Quality Criteria for Fisheries of New Jersey section below). These waters drain approximately 16 percent of the State's land area (see Figures III-5 and 6 and Table III-10). One half as these waters are

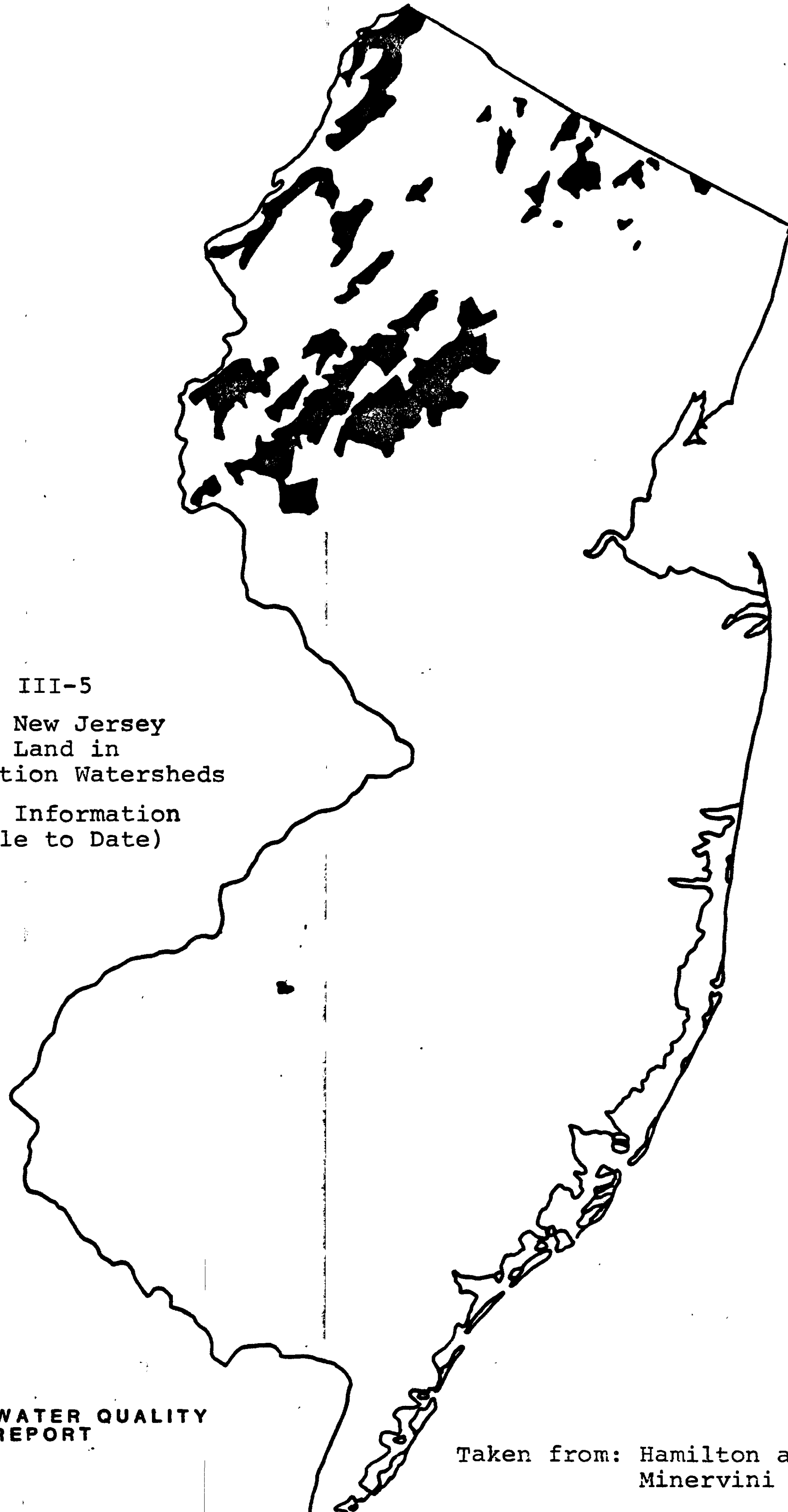

Figure III-5

Areas of New Jersey With Land in Trout Production Watersheds

(Based on Information Available to Date)

Taken from: Hamilton and Minervini (1982)

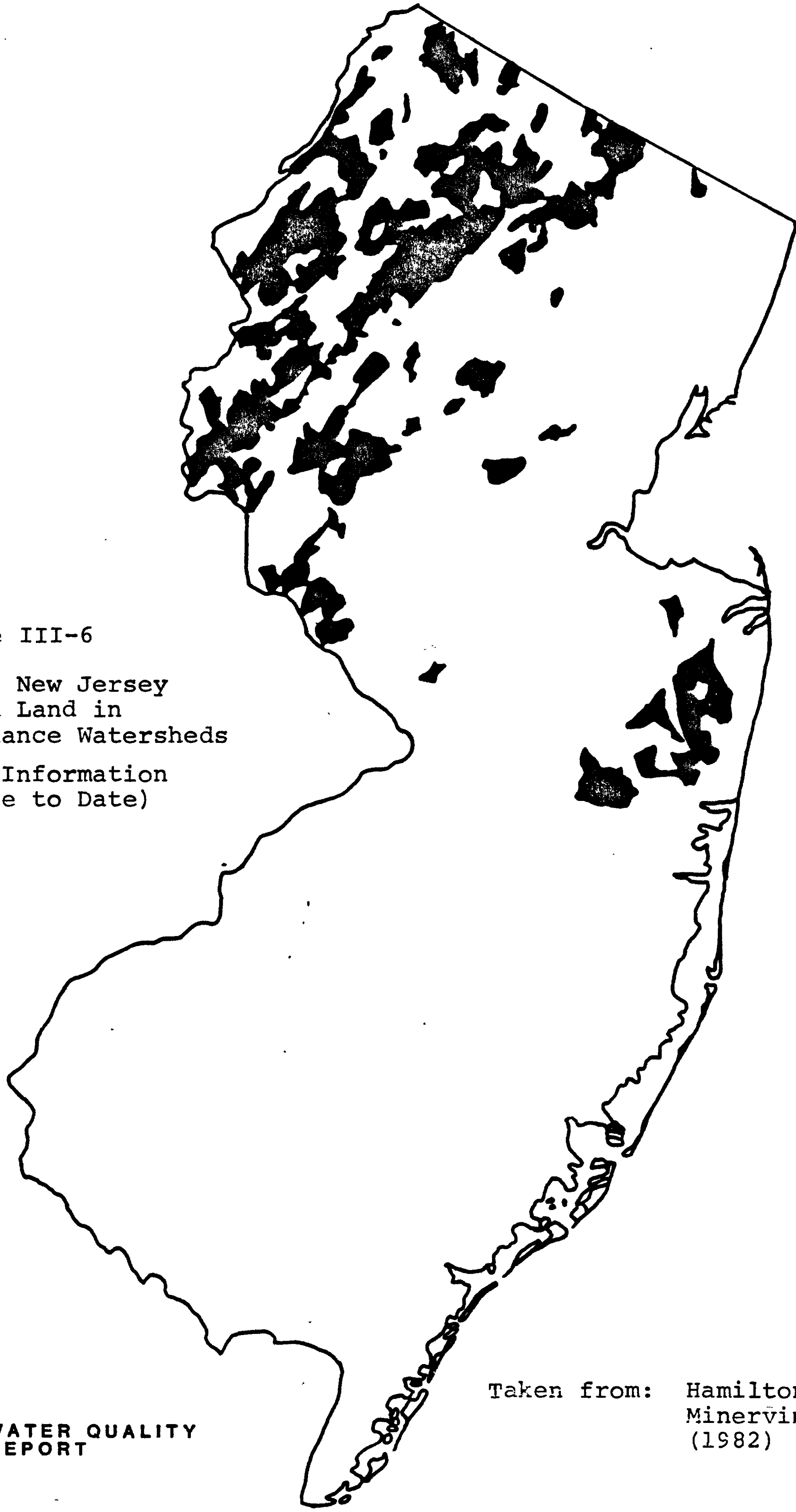

Figure III-6

Areas of New Jersey
With Land in
Trout Maintenance Watersheds

(Based on Information
Available to Date)

Taken from: Hamilton and Minervini (1982)

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located in Sussex, Warren and Hunterdon Counties (Hamilton and Minervini, 1982).

The DFGW constantly monitors the waters of the State to determine if trout production or trout maintenance is occurring. The classification of waters as trout production or trout maintenance is based on the following criteria: physical characteristics of the stream (shading, bottom material, shelter and flow or turbulence), summertime electrofishing results and water quality conditions. A thorough description of the classification process is outlined in the report by Hamilton and Minervini (1982).

The DFGW maintains an active trout stocking program to supplement reproducing trout populations so that angling demands can be met. In addition, the stocking allows trout to be a recreational resource in waters of the State that would not normally contain the fish (waters classified as nontrout). Table III-11 shows the amount of trout and other fish stocked by the DFGW from 1977 to 1981. All trout stocking is conducted in either trout production, trout maintenance or nontrout waters. Table III-12 indicates the amount of the State's waters that are stocked based on 1977 data. The DFGW has specific criteria for determining if a water is eligible to be stocked with trout. The criteria include, but are not limited to, waters are open to the public and have public access, the water must support the trout from mid-March to mid-May, the present fish community will not be adversely affected by the stocking, trout are expected to stay in the area stocked and the public has requested the fish to be stocked (Hamilton and Minervini, 1982).

The DFGW stocks largemouth bass, channel catfish and bluegill in addition to trout. These warmwater fish are primarily introduced to ponds and lakes. Other fish that have been introduced to specific lakes or reservoirs on a trial basis include the tiger muskellunge (Esox lucius x masquinongy) and striped bass (Morone saxitilis). The DFGW will be increasing its production and stocking of warmwater fisheries when the new Pequest Fish Hatchery becomes fully operational.

The freshwater fisheries of New Jersey supports a large recreational fishing industry. The sport is just as popular in the northern trout maintenance waters, as it is in urban ponds and southern creeks. Approximately 170,000 to 180,000 residents annually buy fishing licenses of which nearly two-thirds include a trout stamp. NJDEP (1977) estimates that more than 500,000 residents freshwater fish along the 6,400 miles of streams and rivers, and 50,000 acres of inland lakes and impoundments. Pyle (1981) approximated that of $50 to 75 million annually is spent on coldwater fishing and related activities alone. (Figures on the value of the State's warmwater fisheries are not readily available.) Fishing is considered the eleventh most popular recreational activity in the State (NJDEP, 1977). The value and demand of freshwater fishing is likely to increase in the near

Table III-10 Areas by Major Drainage Basin Classified Trout Production or Trout Maintenance in New Jersey (Square Miles)

MAJOR DRAINAGE BASIN	TROUT PRODUCTION WATERS	TROUT MAINTENANCE WATERS*		NONTROUT WATERS UPSTREAM FROM TROUT PRODUCTION WATERS**	NONTROUT WATERS UPSTREAM FROM TROUT MAINTENANCE WATERS
Atlantic Coastal		112.0			76.9
Delaware River	168.2	443.9	(14.2)	44.0	171.3
Passaic River	60.0	115.8	(2.1)	3.6	106.9
Raritan River	161.0	86.1	(8.3)	29.1	6.8
Wallkill River	3.2	69.4			14.2
Total	392.4	827.2	(24.6)	76.7	376.1

* The left-hand column under "Trout Maintenance Waters" refers to all trout maintenance waters. The right-hand column (values in parentheses) refers only to those trout maintenance waters that are upstream from trout production waters.

** This column includes, but is not limited to, cases in which there are trout maintenance waters between upstream nontrout waters and downstream trout production waters.

Source: Hamilton and Minervini, 1982.

future as more types and numbers of fish are stocked, and the number of residents and non-residents which fish increases.

New Jersey's marine fisheries are also an important commercial and recreational resource to residents and non-residents. NJDEP (n.d.) states that 1.5 million resident and 1.2 million non-resident recreational marine anglers, crabbers and clammers expend 37 million mandays of recreation per year. In addition, some $300 to $400 million per year are spent by these fishermen for equipment, bait, transportation, food and lodging. This industry is the basis for 485 marinas, 125 bait and tackle shops, more than 30,000 boat slips, 160 boat ramps and approximately 2,700 rental, charter and party boats (NJDEP, n.d.) Recreational pressures on the important marine game fishes are greater than commercial pressures. More pounds of game fish are caught recreationally than commercially.

The fishes that support these activities are, for the most part, migratory in nature, spending only a portion of their life in the coastal, bay and estuarine waters of New Jersey. The important game and commercial fish include striped bass, bluefish (Pomatomus saltatrix), weakfish (Cynoscion regalis), summer flounder or fluke (Paralichthys dentatus), mackeral (Scomber spp and Sarda sarda), and cod (Gadus morhua). Numerous other fish are caught but fishing pressures are greatest for those listed above. Major forage fish often associated with the game fishes above include bay anchovy (Anchoa mitchilli), menhaden (Brevoortia tyrannus), spot (Leiostomus xanthurus), Atlantic silverside (Menidia menidia) and fourspine stickleback (Apeltes quadracus). These forage fish are also generally the most numerous fish found in the bays and estuaries.

The State's 390,000 acres of bay waters, 263,000 acres of tidal wetlands and 120 miles of saltwater shoreline contain a great variety of marine life. The recreational and commercially important marine fishes experience great population fluctuations and are highly migratory up and down the Atlantic Coast. The factors which cause population fluctuations are not fully understood, but are thought to include the abundance of zooplankton (food for fish larvae), wind direction (onshore winds push fish larvae to nursery waters), water temperatures, salinities and fishing pressures. The striped bass population is currently in the low point of it population cycle, a phenomena which has not been correlated with any known factor. The summer flounder experienced reduced populations in the 1960s, but have since increased in numbers.

There is much diversity in the natural histories of the marine fishes found in New Jersey waters. For instance, striped bass and bluefish generally migrate north and south along the Atlantic Coast, while weakfish and summer flounder move between estuary, bay and near-shore waters, and deeper ocean waters. Striped bass migrate north from wintering and spawning grounds in the spring as water temperatures rise. Mid-Atlantic striped bass spawning

Table III-11 Amount of Fish Stocked by the NJ Division of Fish, Game and Wildlife 1977-1981.

FISH	YEAR 1978	1979	1980	1981
Trout (including rainbow, brook and brown)	614,810	623,278	581,275	568,560
Largemouth Bass	5,080	3,200	3,175	1,365
Channel Catfish	6,190	4,090	6,550	5,000
Bluegill	3,400	1,214	2,960	4,436
Tiger Muskellunge			4,770	4,318
Striped Bass			4,345	16,646

Source: NJDFGW Annual Reports from 1977-1978 to 1980-1981.

Table III-12 Amount of New Jersey's Freshwaters Stocked by the NJ Division of Fish, Game and Wildlife.

Water's	Streams		Lakes	
Classification	No. (%)[1]	Miles (%)[1]	No. (%)[1]	Miles (%)[1]
Trout Production	39 (50)	93.0 (44)	0	0
Trout Maintenance	52 (64)	260.0 (83)	11 (48)	9,426 (59)
Non-Trout	61 (12)	186.0 (9)	58 (10)	2,291 (8)
Totals:	152 (20)	539.0 (21)	69 (11)	11,717 (26)

(1) - Percent of the particular freshwater classification which is stocked.

Source: Pyle and Soldwedel, 1979.

takes place primarily in Chesapeake and Delaware Bays and their tributaries, and in the Hudson River, although it also occurs in scattered smaller estuaries associated with the Great Egg Harbor River, the Mullica River, the Raritan River and others. The greatest number of striped bass in New Jersey waters are found during the spring and late fall during migration, but large concentrations are also present in the rivers and near-coastal waters during the winter. The bluefish also migrate as water temperatures warm and by mid-summer are found off the shore. They travel in schools with the larger individuals traveling further offshore (50 to 70 miles) than the smaller ones. The bluefish which are found in near shore waters through the summer travel localling depending on the location of forage fish. Bluefish spawn in Atlantic coastal waters south of New Jersey. They move to bay and estuarine waters in the spring where they are found through the summer. The summer flounder or fluke spawn and winter in ocean waters. After ocean spawning in the fall, fluke larvae drift to coastal bays and estuaries that serve as nursery grounds. Fluke harvests are greatest during the early summer period.

The examples above show how variations in natural history are common among marine fishes. In contrast, freshwater fishes usually spend their entire life in a stretch of stream, river and lake, although the various fish species found do fill different niches in the lotic ecosystem. Anadromous fish are also common in New Jersey's fresh, brackish and salt waters. These fish include the striped bass and white perch but are mostly members of the Clupeid (herring) family and include the American shad (Alosa sapidissima), alewife (Alosa psuedoharengus), blueback herring (Alosa aestivalis) and hickory shad (Alosa mediocris). The American shad is both recreationally and commercially valuable. Pollution and instream obstructions have eliminated the shad in all but the Delaware River in New Jersey. The American shad was originally found in the Delaware River and every major creek in the State between Delaware Bay and Trenton, and in the Raritan River and the larger Atlantic Coastal drainage streams to the North.

Recently the American shad popultion in the Delaware River has been experiencing increases, and the DFGW has begun the stocking of American shad in the Raritan River basin in an effort to re-establish it there. Currently, the alewife utilizes approximately 108 streams for spawning runs in the State, the blueback herring 24, and the American shad one (Zich, 1978). These occur in 63 major drainages that are physically continuous with the marine environment (Zich, 1978). Alewife and blueback herring are important forage fish, with various commercial values.

Water Quality Requirements for New Jersey's Fishes

Sufficient water quality is more often than not a major reason why particular fish species are present in a waterbody. However, there are numerous other factors that influence the presence of fish. These basic life supporting requirements include sufficient living space, shelter, ample food and proper spawning and nursery conditions.

The NJDEP has developed State Surface Water Quality Standards which are designed to protect specific uses of the State's waters. Among these "designated uses" are that fresh, certain tidal and coastal waters "be suitable for the maintenance, migration and propagation of the natural and established biota", (NJDEP, 1981b). Tidal waters classified as Tidal Waters Two (TW-2) are to be suitable for the propagation and maintenance of fish populations, and the migration of anadromous fish; while Tidal Waters Three (TW-3) are to be suitable for the maintenance of fish populations and the migration of anadromous fish (NJDEP, 1981b). Therefore, the State Water Quality Standards have numerical values, toxcity test requirements and narrative criteria that are designed to protect the State's fishes. For the purposes of protecting the various freshwater fishlife in the State, freshwater standards are broken into those for nontrout waters (FW-Nontrout), trout maintenance waters (FW-Trout Maintenance) and trout production waters (FW-Trout Production).

The water quality standards which are designed for enhancing and maintaining conditions suitable to fish include pH, suspended solids, dissolved oxygen, temperature and heat dissipation areas, toxic or hazardous substances (generally determined by use of acute toxicity tests), un-ionized ammonia, total residual chlorine, and various pesticides and polychlorinated biphenyls (PCBs). Most of these standards are present in Appendix 1, or are available from the DWR upon request.

Dissolved oxygen (DO) is generally recognized as the most important water quality parameter for determining a water's suitability to fish. DO is required for fish to breathe and therefore, if not in sufficient quantities is lethal. Consistently low DO causes stress to fish and can prevent reproduction, feeding and movement. In New Jersey trout (rainbow, brown and brook) are considered some of the most sensitive fish to DO (as well as many other water quality indices). The lowest "safe" level for stream trout is 5.0 mg/l with 7 mg/l preferable (lake trout tolerate DO at levels as low as 4.0 mg/l). In contrast, the introduced carp can survive in water with no DO, utilizing atmospheric oxygen to breathe. Reduced DO (under 4.0 mg/l) is generally indicative of polluted waters or natural waters with large loads of oxygen-demanding organic materials and little reaeration. Abnormally low DO can also be caused by heavy phytoplankton densities in response to high nutrient concentrations, that are a result of nutrient loadings from pollution sources. DO in surface waters increases with lower temperatures and decreases with high temperatures.

Overall DO and temperature conditions often determines the fish community of a waterbody (coldwater or warmwater fisheries). The interaction of water temperatures can also influence the behavior of many fishes. Marine fishes migrate on the basis of warming or cooling of ocean and estuarine waters. Anadromous fish initiate their spawning runs when ocean waters warm. Feeding rates, egg and larvae development, and time of spawning are all influenced primarily by seasonal changes or ambient water temperatures. The temperature of water is for the most part influenced by air temperature and currents. However, other local and geographical influences on temperature include waterbody depth (deeper waters hold temperatures longer), water movement (agitated and faster moving waters exchange heat with the atmosphere, thereby reducing temperatures), amount of shading to the waterbody, and heat containing dischargers if present.

The amount of acidity or alkalinity (interpreted as pH) found in water also influences to the fish species found. Trout generally do best in neutral to slightly alkaline waters (pH of 7 to 8), while in the Pinelands the blackbanded and bluespotted sunfishes can survive the region's moderately acidic (pH 4 to 5) waters where few other fish can. Many fish, such as the chain pickerel, are adaptable to both moderately acidic and alkaline waters. pH levels can also influence the toxicity of many substances in water. Ammonia, a by-product of organic matter breakdown, is more toxic as water temperatures and pH rises, (this causes increasingly higher percentages of un-ionized ammonia which is toxic to aquatic life). Certain metals are released into solution when waters are acidic, but are bound to bottom materials when the water is alkaline.

The U.S. Food and Drug Administration has issued requirements that fish and shellfish must meet to be suitable for human consumption. These "action levels" are listed in Table III-13, and consist of long-lived pesticides, metals and PCB's. The NJDEP closes waters to fishing when contaminated fish and shellfish are found, and the potential exists that they will be consumed after harvest.

Water Quality And Its Impact On Fishes In New Jersey

The fish currently occupying many of New Jersey's waters are different than the native communities. These changes are attributable to modifications of fish habitats and the introduction of exotic species. Human activities often result in changes in surface water quality which can affect fish habitat. One of the earlier documented affects of water pollution on fishlife in New Jersey occurred in the mid-1800's when American shad, a pollution sensitive fish, stopped migrating into the Raritan River, and other heavily polluted and impounded streams draining to the Delaware River (Zich, 1978). The most important changes to native fish communities in New Jersey have taken place since the

Table III-13 U.S Food and Drug Administration Maximum Allowable Contaminant Concentration for Consumption of Fish Tissue.

Parameter	Commodity	Criteria (maximum concentrations in ppm)
Aldrin/dieldrin	Fish (raw and smoked)	.3
Chlordane	Fish	.3
DDT, TDE, DDE	Fish (raw, smoked, frozen, canned)	5.0
Endrin	Fish (raw, smoked, frozen, canned)	.3
Heptachlor and Heptachlor epoxide	Fish (raw, smoked, frozen, canned)	.3
Kepone	Fish (raw, smoked, frozen, canned)	.3
Mercury	Fish (fresh, frozen, processed)	1.0
Mirex	Fish	.1
PCBs	Fish	5.0
Toxaphene	Fish (raw, smoked, frozen, canned)	5.0

turn of this century. As the State become heavily industrialized and populated the introduction of polluted wastewaters into its waters greatly accelerated. Because of this pollution native fish species were eliminated and new or exotic fish species more tolerant to pollution were stocked so as to create a new recreational fisheries resource. Fish introduced include carp, goldfish and largemouth bass.

The impacts of current water quality conditions on the fishes in New Jersey is evident in the types of fish found throughout the State. This report has used Weis et al. (1979) to review the fish community structure of the State's watersheds. Weis et al. (1979) compiled DFGW electroshocking and netting data in addition to conducting their own field work in an effort to determine fish specie diversity. The work by Weis et al. (1979) was the only thorough, relatively current watershed by watershed assessment of the State's freshwater fisheries found. Table III-14 summarizes the information in Weis et al. (1979), and notes if anadromous fish spawn, and the presence of trout maintenance or trout production waters in a watershed.

Although fish diversity in a watershed gives an indication of the healthiness of a stream for fish, it does not show if the fish are frequently, occasionally or seldom under stress. To determine this, water quality data is evaluated for those indicators that are known to cause stress to fish. The occurrence of fish kills can also be used to determine water quality problems and their affects on fish life. Table III-15 shows the major fish kills in New Jersey since 1977. Below is an analysis by major river basin (Delaware, Raritan, Atlantic and Passaic/Hackensack; see Figure III-1), of the fish communities present in the State and how water quality data relates to that community.

Also discussed below is the ability of the State's watersheds to meet the federal Clean Water Act's goal of sufficient water quality to allow for the protection and propagation of fish, shellfish and wildlife. This "fishable" goal is to be met by July, 1983. A watershed's attainability of the goal is based on the fish species identified, water quality conditions utilizing ambient monitoring results, and the occurrence of fish kills. In 1982, 26 segments or watersheds are considered meeting the fishable goal (versus 24 in 1977), while 12 segments meet the goal in portions or only at various times throughout the year (versus 5 in 1977) (see Table III-16). Sixteen segments or watersheds in the State will not achieve fishable status in their entirety by July, 1983. Overall, eight segments showed improvement in their classification while four segments or watersheds showed decline. The basin by basin description reviews the ability of the State's waters to meet the fish propagation and maintenance requirements, what is causing stress in waters with poorer water quality, and what is needed to alleviate these problems.

Table III-14 Summary of New Jersey's Fish Resources (not including marine fishes).

Watershed	Number of Fish Species Identified[1]	Trout Production Waters	Trout Maintenance Waters	Anadromous Fish Spawning Runs[2]
Wallkill River	26	X	X	
Flat Brook	25	X	X	
Paulins/Kill	31	X	X	
Pequest River	30	X	X	
Musconetcong River	27	X	X	
Lopatcong Creek	12	X*	X	X
Pohatcong Creek	16	X	X	
Lockatong Creek	26		X	
Assunpink Creek	18		X	X
Crosswicks Creek	18			X
Assiscunk Creek	20			
Rancocas Creek	24			X
Pennsauken Creek	10			
Big Timber Creek	16	X*		
Mantua Creek	1			X
Raccoon Creek	21			X
Oldmans Creek	17			X
Salem Creek	9			X
Alloway Creek	1			X
Cohansey River	9			X
Maurice River	17			X
Great Egg Harbor River	12			X
Mullica River	13			X
Cedar Creek	10			X
Forked River	10			

Table III-14 Continued

Watershed	Number of Fish Species Identified[1]	Trout Production Waters	Trout Maintenance Waters	Anadromous Fish Spawning Runs[2]
Toms River	14		X	X
Metedeconk River	17		X	X
Manasquan River	15		X	X
Navesink River	18		X	X
North Branch Raritan River	31	X	X	
South Branch Raritan River	30	X	X	
Millstone River	24			X
Lawrence Brook	17			X
South River	14			X
Lower Raritan River	29		X	X
Rahway River	9			
Upper Passaic River	25		X	
Whippany River	20	X		
Rockaway River	24	X	X	
Pequannock River	28	X	X	
Wanaque River	26	X	X	
Ramapo River	21	X		
Saddle River	17	X	X	
Lower Passaic River	17			X
Hackensack River	12			X
Delaware River				
NY/NJ Border to Trenton	38			X
Trenton to Alloway Creek	30			X

* Classification pending revision to State Surface Water Quality Standards (NJDEP, 1981b)

1 From: Weis et al (1979)
2 From: Zich, (1978)

Delaware River Basin

The Delaware River Basin in New Jersey contains a great variety of fish resources, habitats, water quality conditions and fisheries (included in the discussion of the Delaware Basin is the Wallkill River watershed which drains north out of New Jersey to New York State). The northern Delaware Basin contains excellent trout production waters, while the southern drainage areas are known for good warmwater fishing. The Delaware River itself is used extensively for fishing as diverse fish communities exists in the river. American shad, although not abundant, migrate up the Delaware River during the spring and is considered a prized game fish.

The Wallkill River watershed contains classified trout maintenance waters, and has received approximately 8,300 stocked trout annually from 1977 to 1981. However, much of the watershed is considered nontrout. Water quality data shows periodically low dissolved oxygen at Unionville (nontrout) and Franklin (trout maintenance) on the Wallkill River, and in Papakating and Black Creeks (both nontrout) during summer months. There is some organic enrichment to these streams, but it is not a severe problem with regard to affecting fish. Agricultural runoff, swampy areas, municipal treatment plants and septic systems (through the introduction of organic material) are the main reasons for reduced dissolved oxygen levels.

The Flat Brook and Paulins Kill are among the two most heavily used trout fishing streams in the State. Excellent water quality and lack of habitat degradation are the reasons for the trout production and trout maintenance status afforded most of the Flat Brook watershed. Water quality is excellent in the Flat Brook and very good in the Paulins Kill. The Paulins Kill watershed is also predominantly trout production and trout maintenance waters with non-trout waters above Paulins Kill Lake. Point sources and natural conditions cause depressed DO values in the upper Paulins Kill, but the waterway improves its quality below Paulins Kill Lake. The Flat Brook and Paulins Kill are meeting and will meet the 1983 goal of fish propagation and maintenance.

Trout fishing is also a major recreation activity in the Pequest and Musconetcong Rivers. Both of these waterways contain trout production and trout maintenance waters, and are heavily stocked by trout by the NJDFGW (nearly 70,000 fish annually between the two watersheds). Water quality is good in both rivers with regard to DO and pH, despite periodic high un-ionized ammonia levels near the downstream end of both waterways. Lake fishing year-round is common on the lakes in these watersheds especially in Lakes Hopatcong and Musconetcong. Sources of pollutants in these watersheds include agricultural runoff, septic systems and improperly operating municipal treatment works. The land in the Pequest and Musconetcong watersheds will be subject to increasing development in the future. This development could could pose a threat to trout, other cold water fisheries and sensitive

Table III-15 Major Fishkills Occurring in New Jersey Since 1977.

DATE	WATER BODY	LOCATION	FISH LOSS	SUSPECTED CAUSE OF KILL
June 1977	Kikeout Reservoir	Butler	1,500	Cooper sulfate
March 1977	Atlantic Ocean	Atlantic City	Crabs, Clams Snail, Mussels (2000)	Low dissolved oxygen
March 1977	Peter Creek	Audubon Park	5,000	Low dissolved oxygen
February 1977	Coopermine Run	Edison	2,000	No. 2 fuel oil
October 1978	Victor Crowell Pk. Pond	Middlesex	1,500	Low dissolved oxygen
September 1978	Reisburg Lake	Hope	1,000	Unknown
September 1978	Raritan River	Middlesex	3,000	No. 2 fuel oil
August 1978	Hudson River	Bergen-Hudson Co.	15,000	Environmental stresses
June 1978	Hudson River	Alpine-North Bergen	8,000	Environmental stresses
March 1978	Lawrence Brook	East Brunswick	4,000	Low dissolved oxygen
October 1979	Matthew Branch	Woodbury	1,350	Phenoloc resin
August 1979	Commonwealth Water Reservoir	Linden	Thousands	Parasite infection
June 1979	Almonesson Lake	Deptford Twp.	1,900	Low dissolved oxygen
September 1980	West Creek	Cape May Co.	120,000	Unknown
June 1981	Delaware River	Gloucester City	1,000's	Low dissolved oxygen
September 1981	Ramapo River	Mahwah	1,000	Sewage
September 1981	Nelley's Pond	Delanco	1,000	Low dissolved oxygen

warmwater fisheries from the standpoint of habitat destructive, and increased pollution and sedimentation. High sedimentation rates are already thought to exist in the agricultural regions of these watersheds. However, both streams will meet the 1983 fishable goal.

Lopatcong and Pohatcong Creeks are smaller tributaries to the Delaware River between the Musconetcong and Pequest Rivers. The Pohatcong Creek watershed is classified trout production and trout maintenance in its entirety. Lopatcong Creek contains nontrout, trout maintenance and trout production waters (the trout production waters were identified in the summer of 1982 by the DFGW and as yet, have not been included in the State Water Qaulity Standards). Water quality is generally good in Pohatcong and Lopatcong Creeks, although there are bacteria and nutrient problems in both. Parameters impacting fishlife show upstressed conditions with the exception of recurring high pH readings in Pohatcong Creek. This may be due to agricultural activities in the watershed. Sedimentation and loss of stream shading is a threat to trout in both stream, while inadequately treated sewage severely affects Lopatcong Creek at Phillipsburg. Pohatcong and Lopatcong Creeks are currently expected to meet the fishable goal of the Clean Water Act, yet stress conditions for fishlife may occur due to the strongly alkaline pH readings on the Pohatcong and Pollution loads to Lopatcong Creek in the Phillipsburg area.

Numerous small tributaries to the Delaware River occur below the Musconetcong River and above Assunpink Creek (Trenton). Some of these tributaries are Lockatcong, Hakihokake, Wickecheoke and Alexauken Creeks. Trout maintenance and nontrout waters are found throughout these small watersheds in western Hunterdon and Mercer Counties. General water quality is good throughout these streams, although periodic problems do occur. High (alkaline) pH, elevated un-ionized ammonia and low flows are common conditions in the streams identified above that would appear to cause the most stressful conditions to fishlife. The sources of the high un-ionized ammonia, especially on Wichecheoke Creek, may be due to non-point sources and decaying vegetation. Achievement of the fishable goal is expected, however.

The Assunpink Creek watershed, as are the remaining watersheds in the Delaware River Basin discussed below, is primarily a warmwater stream. There is a short trout maintenance stretch in the middle Assunpink watershed. Water quality varies greatly on the Assunpink; from good conditions in the agricultural/suburban section upstream of Whitehead Mill Pond to poor in urban Trenton. Fish habitat destruction, significant pollution loads and large thermal (cooling water) discharges have altered the aquatic community in the lower Assunpink. It is for this reason that the Assunpink Creek watershed will meet the fishable goal only in waters upstream of Whitehead Mill Pond.

Crosswicks and Assiscunk Creeks are nontrout throughout and contain fairly diverse warmwater fish communities. Water quality

Table III-16 Past and Present Status, and Feasibility of Meeting the 1983 Fishable Goal in New Jersey

Segment (Basin)	Fishable 1977[1]	Fishable 1982	Fishable 1983[2]
Wallkill River	Yes	Yes	Yes
Flat Brook and Paulins Kill	Yes	Yes	Yes
Pequest and Musconetcong Rivers	Yes	Yes	Yes
Pohatcong and Lopatcong Creeks	Yes	Yes	Yes
Delaware River Tributaries-Hunterdon County	Yes	Yes	Yes
Assunpink Creek	Yes*	Yes*	No
Crosswicks and Assiscunk Creeks	Yes	Yes	Yes
Rancocas Creek	No	Yes*	No
Pennsauken Creek, Big Timber Creek and Cooper River	No	Yes*	No
Woodbury, Mantua and Raccoon Creeks	Yes	Yes*	No
Oldmans, Salem and Alloway Creeks	No	Yes	Yes
Cohansey and Maurice Rivers	Yes	Yes	Yes
Delaware River NY/NJ Border to Trenton	Yes	Yes	Yes
Trenton to Rancocas Creek	Yes	Yes	Yes
Rancocas Creek to Woodbury (Estuary)	No	No	No
Delaware Bay	Yes*	Yes*	No

Table III-16 Continued

Segment (Basin)	Fishable 1977[1]	Fishable 1982	Fishable 1983[2]
South Atlantic Coastal Basin	Yes	Yes	Yes
Great Egg Harbor River	Yes	Yes	Yes
Mullica River	Yes	Yes	Yes
Mid-Atlantic Coastal Basin	Yes	Yes	Yes
Manasquan River	Yes	Yes	Yes
North Atlantic Coastal Basin	Yes	Yes	Yes
North Branch Raritan River	Yes	Yes	Yes
South Branch Raritan River	Yes	Yes	Yes
Millstone River	Yes*	Yes	Yes
Lawrence Brook and South River	Yes*	Yes	Yes
Lower Raritan River and Raritan Bay	No	Yes*	No
Elizabeth and Rahway Rivers	Yes*	Yes*	No
Upper Passaic River	Yes	Yes	Yes
Mid-Passaic River	Yes	Yes*	No
Mid-Passaic River Tributaries:			
Whippany River	Yes	Yes*	No
Rockaway River	Yes	Yes*	No

Table III-16 Continued

Segment (Basin)	Fishable 1977[1]	Fishable 1982	Fishable 1983[2]
Pompton River	Yes	Yes	Yes
Ramapo River	Yes	Yes	Yes
Lower Passaic River	No	Yes*	No
Hackensack River	No	Yes*	No
Arthur Kill	No	No	No
Newark Bay	No	No	No
Hudson River	No	Yes*	No

* - Only portions or periods throughout the year will meet the goal due to stress conditions to fishlife.

1 - Source: 1977 305(b) Report.

2 - 1983 goal determination reviews segment as a whole; either the entire segment does or does not meet the 1983 goal of fish propagation and maintenance.

is for the most part conducive to this type of fisheries, although DO values occasionally contravene the 4.0 mg/l standard. Other water quality parameters do not indicate possible adversity to fishlife. As a result, these streams will meet the fish propagation/maintenance goal of the Clean Water Act.

The Rancocas Creek watershed has a wide range of water quality conditions, and therefore, fish communities. The creek has its headwaters in the forested Pinelands with naturally acidic soils and waters. The creek's tributaries then flow through suburban/agricultural lands before becoming a tidal estuary. Water quality degradation takes place primarily around the developed areas, Mount Holly, Pemberton and Medford Lakes, and is evident in reduced DO and elevated nutrients. Numerous lakes are present in the South Branch Rancocas watershed with many classified as eutrophic. Some chlordane contamination has been detected in fish from the tidal estuary but the frequency of contamination does not warrent closing these waters to fishing. Because of this contamination and reduced water quality downstream of Medford Lakes, Mount Holly and Pemberton, fishable status cannot be assigned to the entire Rancocas Creek watershed.

Fishlife in Pennsauken Creek and the Cooper River have very stressed environments where these waters flow through the urbanized Camden/Cherry Hill region. Very low DO, high amounts of organic material loading and disturbed habitat limits the fish present to only hardy species. Chlordane contamination has been identified in elevated levels throughout the Pennsauken Creek watershed and the Cooper River from Cooper River Lake downstream to the Delaware River. These high levels has forced these waters to be closed to all fishing activities. Stewart Lake in the Woodbury Creek drainage basin is also closed to fishing because of chlordane contamination in fish. Big Timber Creek also drains highly developed areas and has at times greatly reduced DO levels (especially in the downstream tidal sections). However, one headwater stream of Big Timber Creek, Masons Run, has been found to contain reproducing brook trout and is scheduled to be classified as trout production when State Water Quality Standards are revised. All of these watersheds (Pennsauken Creek, Cooper River, Woodbury Creek and Big Timber Creek) will not meet the goal of balanced fish propagation and maintenance throughout until significant loadings from municipal sewage treatment plants and stormwater runoff are alleviated, and chlordane contamination is reduced.

The southern Delaware River tributaries, Mantua Creek, Raccoon Creek, Oldmans Creek, Alloway Creek and the Salem River all are generally similar in water quality (fair to poor) and fishlife. The fish in the freshwaters of these streams are generally indicative of shallow, slow moving, weedy waterways. In the tidal estuarine reaches anadromous and other migrating ocean fish sporadically use these waters for feeding, spawning and as nursery grounds. Lakes in the upstream sections contain good warmwater fisheries (pickerel, largemouth bass and pumpkinseed).

At times low DO may cause distress to fishlife in these streams (especially the Salem River), but generally the streams can be considered fishable.

Water quality in the two southern-most Delaware tributaries, Cohansey and Maurice Rivers, varies from very good in the upper Maurice to poor in the lower Cohansey at Bridgeton. In general, the freshwater fish communities in these rivers are similar to those found in other lower Delaware tributaries. Lake fishing is also popular and considered good in the lakes within these watersheds. The Cohansey and Maurice Rivers also have large saltwater fish communities in their estuaries. The DFGW conducted a study of the Maurice River and Cove system in the mid-1970's (NJDEP, 1978). Their study found very low (at times less than 1.0 mg/l) summertime DO concentrations at points in the estuary. This has caused sporadic fishfills and is likely a result of natural biological oxygen demands in the estuary. Various metals and pesticides were found in finfish tissue samples, generally in low levels.

There is current concern for the striped bass population because of significant declines in its numbers over the last five years. Since Delaware Bay and its tributaries were formally some major spawning and nursery grounds for this fish, it is possible degraded water quality conditions may have influenced its population decline. Further study is needed, though, to determine the reason(s) for the decline.

Atlantic Coastal Basin

Fishes in the Atlantic Coastal Basin can be divided into fresh and salt water species. Fresh waters vary between the naturally acidic and unproductive waters of the Pinelands to the trout maintenance waters in northeastern Ocean and Monmouth Counties. The saltwater fisheries in New Jersey waters are an important economic and recreational resource for the entire middle Atlantic states region. The Atlantic Coastal Basin is discussed below in six segments (South, Mid-, and North Atlantic Coastal Segments, Great Egg Harbor River, Mullica River and Manasquan River) which corresponds to the segment analyses in Appendix 1, Water Quality Inventory.

In the South Atlantic Coastal Basin (Cape May Point to Great Bay) surface waters include numerous small tidal creeks, the Tuckahoe River, Absecon Creek, and bays, inlets and ocean waters along its oceanside. Freshwater fishing in this segment is limited to lakes, upstream portions of the Tuckahoe River, and the many small streams, before they enter the salt water marshes. Fishing in the freshwater lakes is best for warmwater species such as white catfish, bullheads and largemouth bass. The major water quality problem in these lakes is likely low DO during the summer and early fall. This low DO is a result of aquatic plant material decompositon and groundwater inflows to the lake which is naturally poor in DO. The marine fisheries of this area are heavily fished both commercially and recreationally. A study by NJDEP (1979) of the back bays of Atlantic County showed forage fishes (Atlantic menhaden, Atlantic silverside, bay anchory and nummichog) to be most prevalent, with sport fishes including bluefish, spot, weakfish, fluke and winter flounder. This study also found traces of DDT and its metabolities in 95 percent of the finfishes sampled, with levels highest in summer flounder and weakfish. The study concluded that the levels of DDT and chlordane found throughout the study area were in sufficient quantities to possibly have sub-lethal effects on estuarine organisms (NJDEP, 1979). In addition, mercury was found in high levels (near or above to FDA's .50 mg/l acceptable limit for human consumption) in yellow perch samples taken from Absecon Creek. The reason for the DDT, chlordane and mercury found is probably the past use of the substances as pesticides.

The major watersheds in the Mid and Southern Atlantic Coastal Basin are the Great Egg Harbor River and Mullica River. Water quality in the Great Egg Harbor River varies from fair in the upstream reaches to good below New Brooklyn Lake. Lake fishing is an important recreational activity in the watershed with good populations of largemouth bass, bluegill, catfish and pickerel; however, many of the lakes are eutrophic. Reduced DO and at times high un-ionized ammonia are water quality problems in the upper Great Egg Harbor watershed. Municipal treatment plants, runoff from increased development, and poor assimilative capacities of the waters are the reasons for the fair conditions. Water quality also declines again below Mays Landing, but impacts on fishlife are not thought to be significant. Despite these water quality problems the Great Egg Harbor River watershed will meet the fishable goal. The Mullica River watershed contains very good quality water that portrays to the naturally acidic and nutrient poor waters of the Pinelands region. The fishlife of the watershed is indicative of this region with most species tolerant of acidic waters. Because of the acidity of some waters fish communities are limited to only a few species (sunfishes of the <u>Enneacanthus</u> genus).

The waters of Mullica River containing the greatest fisheries resources and biological productivity are those in Great Bay and the tidal portions of the river. Great Bay is home to numerous fish species at various times of the year and supports a significant sport fisheries. Important fisheries include summer flounder, striped bass and weakfish. Great Bay is also nursery grounds to various fish populations. The high quality waters of Great Bay is a major reason for its importance to marine fish. However, increased development in the southern drainage areas to Great Bay may threaten this excellent water quality.

The Mid-Atlantic Coastal Basin (Great Bay to Manasquan Inlet) contains a wide range of fish resources in its waters. Freshwaters drain acidic Pinelands areas as well as trout maintenance streams in the headwaters of the Toms and Metedeconk

Rivers. Brackish and saltwaters support a diverse group of marine fisheries, especially in Barnegat and Little Egg Harbor Bays. Water quality monitoring also shows the variation exhibited by the fish communities, with quality generally adequate to support indigenous fish species. Greatest water quality problems are likely in the bays and tributaries to the bays where very low DO levels have occurred in the past (NJDEP, 1971). But with the regionalization of municipal sewage treatment plants and the transfer of discharges to the ocean, demands for DO have been lessened and the low readings in the past have been mostly eliminated. Recreational fishing for bluefish, weakfish, winter flounder and fluke are a major activity in the waters of Barnegat, Manahawken and Little Egg Harbor Bays. These waters are also nursery grounds for numerous fishes. Waters of the Mid-Atlantic Coastal Basin are considered fishable and will meet the goals of the federal Clean Water Act.

The Manasquan River drains portions of central and southern Monmouth Counties via Manasquan Inlet to the Atlantic Ocean. Its waters contain primarily warmwater fishes, but also has trout maintenance and tidal, brackish waters. The Manasquan itself is an important recreational freshwater fishing stream as exemplified in the number of trout annually stocked to the river and its tributaries. Water quality is considered marginal as a whole for the river with some segments exhibiting poor quality (upstream reaches and tributaries). Periodic low DO at Squankum in the Manasquan River reveals likely stress for trout in this trout maintenance section. Another water quality problem is the presence of Lone Pine Landfill, a known hazardous waste site, in Freehold Township. Leachate from the landfill is entering the headwaters of the Manasquan River. The transport of chemical contaminates from the leachate through the watershed is currently under study and may affect the ability of the river to support healthy fish populations. As of now, however, fishable status is assigned to the Manasquan River.

In the North Atlantic Coastal Basin (Manasquan Inlet to Sandy Hook) larger tributaries to the Atlantic Ocean and Raritan Bay include the Shark, Navesink and Shrewsbury Rivers. Like the Manasquan River, these streams have a mixture of trout maintenance and nontrout waters. In the estuaries of the Shark and Navesink/Shrewsbury Rivers many of the sport marine fishes already mentioned are caught recreationally. Water quality monitoring data is available on upstream tributaries of the Navesink and Shark Rivers, and show conditions adequate to support the fishlife occurring there. As such, fishable status is given to this segment.

The DFGW and Office of Cancer and Toxic Substances Research has, during their study of PCBs in finfish and shellfish tissue throughout the State, identified the substance to be at high levels in certain species from Atlantic Coastal waters. As a result of this study, a fishing advisory was issued by the NJDEP and NJ Department of Health in December, 1982, for some coastal and interstate waters. The advisory stated that the consumption of striped bass and bluefish (adults exceeding 24 inches or 6 pounds) taken from New Jersey's northern coastal area (coastal waters from Barnegat Bay northward) should be limited to no more than one meal per week. Bluefish and striped bass taken from these waters were found to have PCBs in concentrations greater than the 5.0 ppm US FDA action limit (see Table III-13).

The fishes present in the Atlantic Coastal Basin includes a wide range of both fresh and saltwater species. The freshwater fisheries serve generally local needs, while the marine fisheries resources are of major importance to the entire Mid-Atlantic region. The fish species found in the State's bay, estuaries and ocean water, in addition to being important links in the marine food chain, generate a significant amount of recreational and commercial activity. Many of these important marine fishes are also intolerant of polluted waters and will quickly disappear when water quality deteriorates. Special concern should also be given to the presence of PCBs in bluefish and striped bass, important recreational and commercial fishes.

Raritan River Basin

The Raritan River Basin contains some of the best coldwater trout fisheries in New Jersey. This is highlighted by the fact that approximately 40 percent of the State's trout production waters are located in this basin. In addition, trout is stocked by the DFGW throughout much of the basin; while warmwater fisheries support recreational fishing in the remainder of the basin's freshwater sections. The Raritan River is used by anadromous herring for spawning, and attempts are currently underway by the DFGW to reintroduce the American shad to this basin. The Raritan River basin will be discussed below by its major tributaries (South Branch, North Branch, Millstone River, South River, Lawrence Brook and the Raritan River mainstem).

The South Branch of the Raritan River and its tributaries are the most heavily used trout fishing streams in the State. Besides the presence of trout production and trout maintenance waters throughout most of the South Branch watershed, the DFGW annually stocks over 150,000 trout to its waters (the largest amount in the State). Smallmouth bass is found in many other streams within this watershed and excellent lake fishing is available at Round Valley Reservoir, Spruce Run Reservoir and Budd Lake. The South Branch Raritan River contains generally good quality waters with the exception of frequently high levels (exceeding standards) of un-ionized ammonia during summer months. These elevated concentrations may be the result of sewage treatment discharges and agricultural runoff. Tributaries to the South Branch Raritan River (Mulhockaway Creek, Spruce Run and Prescott Brook) have very good water quality, while the Neshanic River and Bushkill Creek occasionally had insufficient DO concentrations. The greatest threat to the fisheries in this watershed will probably be the increased development which can affect both water quality and fish habitat. A project between NJDEP's DFGW and DWR has identified how trout habitat can be protected through the implementation of comprehensive stream encroachment regulations. These regulations are currently in the draft phase.

The North Branch Raritan River also contains significant amounts of trout production waters, and trout stocked streams and lakes. The North Branch and its tributary the Lamington River have good water quality with marginal conditions locally due to moderate biochemical oxygen demand and elevated fecal coliform and nutrient concentrations. DO levels fell below the trout production standard in the North Branch at Chester, while un-ionized ammonia exceeded its trout maintenance standard in the Lamington River at Lamington. The reduced DO was probably from low flows in the summer and fall of 1980. The high un-ionized ammonia may be due to a variety of non-point sources. The North Branch will meet the fishable goal of the Clean Water Act.

Southern tributaries of the Raritan River (Millstone River, South River and Lawrence Brook) contains warmwater fish species throughout their drainage areas. Fishing opportunities in these watersheds include trout stocked waters, smallmouth bass in headwater streams and tributaries, and lake fishing in the many manmade lakes. Some of these lakes include Carnegie, Brainerd and Rosedale Lakes in the Millstone watershed; Farrington Lake, Westons Mill Pond and the Davisdon Mill Pond in the Lawrence Brook watershed; and Manalapan, Duhernal and Millhurst Mill Lakes within the South River watershed. Water quality in the Millstone River is good in the upstream sections and tributaries (Stony Brook), but declines in the sections below Carnegie Lake as it travels to the Raritan River. Low summertime DO is common in the downstream reaches of the Millstone and Stony Brook, and appears to be related to excessive organic loads to the streams. Enriched conditions in the Millstone at Blackwells Mills are also represented by macro-invertebrate samples showing only pollution tolerant organism present. Overall though, slight water quality improvements have occurred in the upper Millstone within the last five years.

Lawrence Brook and the South River (including the tributary Matchaponix Brook) exhibit good and marginal water quality, respectively. Water quality data is supportive of warmwater fishes. However, the main lakes in the watershed are eutrophic. This may cause stress for fishlife because of reduced DO during periods of plant die-off. Conditions are similar in the South River. In addition to freshwater fisheries, the tidal South River seasonally contains marine fish such as bluefish, striped bass and flounder. The Millstone River, Lawrence Brook and South River will all meet the 1983 goal of fish propagation and maintenance.

The Raritan River mainstem contains fresh, brackish and salt waters that range in quality from marginal (below the confluence of the North and South Branches) to poor (the river's mouth at Perth Amboy). The Raritan River was in the distant past a major spawning stream of American shad and striped bass. However, pollution and impoundments have eliminated the use of this river for spawning except for all but hardy anadromous fish species (alewife, blueback herring). Water quality declines in the downstream direction. Significant municipal and industrial point source discharges, urban and suburban runoff and scattered combined sewer overflows are the principle reasons for frequently very high (four times greater than standards) un-ionized ammonia, high total dissolved solids and periodic low DO. Because of these conditions there is likely some adversity to fishlife at various locations along the river. Despite this, fishes have shown population and diversity increases over the last five years largely a result of improved treatment at a major industrial discharge at Bound Brook. It is important that good quality water flow into Raritan Bay from the Raritan River because of the bay's use by numerous marine fisheries. Based on water quality data however, the Raritan River adds poor quality water which likely has impacts throughout the bay system.

The Raritan River downstream of New Brunswick and Raritan Bay are also contained in the PCB fishing advisory issued by the State in December, 1982. PCBs were found at such levels that the intake of striped bass, american eels, bluefish (adults exceeding 24 inches or 6 pounds), white perch and white catfish is advised to be no more often than once a week.

A wide range of water quality conditions, both naturally occurring and man-induced, are presently found in the Raritan River Basin. With these conditions, numerous fish communities exist in its waters, but some are probably under stress because of poor water quality. Habitat protection and point source controls should help improve the healthiness of fishes in this basin.

Passaic-Hackensack River Basins

The Passaic and Hackensack Rivers drain the heavily developed regions of northeastern New Jersey. As a result, the fish communities in these rivers change significantly from the upstream headwaters where trout production and maintenance waters exist to the lower mainstems that at times can barely support fishlife.

The Passaic River Basin is reviewed in four segments: the Upper Passaic River (headwaters to Livingston), the Mid-Passaic River (Livingston to Little Falls), Mid-Passaic River tributaries (includes the Whippany, Rockaway, Pequannock, Wanaque, Pompton and Ramapo Rivers) and the Lower Passaic River (Little Falls to Newark Bay). The Passaic River at its origins in Morris County contains trout maintenance waters, but the river is for the most part nontrout in its freshwater reaches. Following trout stocking, the Upper Passaic River is heavily used by trout fishermen. Water quality in the Upper Passaic is generally fair, but poor conditions occurred during the drought period of mid 1980 through early 1981. The periodic low DO, high un-ionized ammonia and nutrients became much more severe during the low flows of the drought. Total dissolved solids also exceeded the standard at times in the Upper Passaic River. The reason for reduced DO and high nutrient concentrations are the municipal treatment plant discharges. The organic loading from these plants at times exceeds the ability of the river to assimilate it.

Water quality worsens downstream in the Mid-Passaic River. Nutrients, DO and un-ionized ammonia are indicative of poor conditions, which worsened during the drought. Severe stress to fishlife probably took place in the river because of extreme low flows. Because of these conditions the Mid-Passaic can considered to be only marginally capable of fish propagation and maintenance. Significant point source loadings (municipal and industrial), upstream contributions and urban runoff are the reasons for the poor quality found.

The Mid-Passaic River tributaries, the New River (formed by the confluence of the Whippany and Rockaway Rivrs) and the Pompton River (formed by the Pequannock, Wanaque and Ramapo Rivers), contribute large flows and pollutant loadings to the Passaic River. These rivers all have some trout production and or trout maintenance waters in their headwaters, but experience degradation downstream. Numerous lakes, natural and man-made, are present throughout these watersheds with many serving as water supply reservoirs. The lakes and reservoirs provide excellent fishing (some lakes and reservoirs require permission of its owner to fish) for a variety of warmwater lake fisheries. Major lakes and impoundments draining to the Mid-Passaic River tributaries include Greenwood Lake, Wanaque Reservoir, Canistear Reservoir, Splitrock Reservoir, Pompton Lakes and Boonton Reservoir.

Water quality in the Whippany River is considered fair to poor as DO often fall below standards and un-ionized ammonia exceeded appropriate standards in the lower river. Excessive municipal point source discharges are the causes for the fair/poor water quality. The Rockaway River also has generally poor water quality, due to high bacteria, biochemical oxygen demand and nutrient concentrations. The Rockaway River, like all of the waters in the Passaic River Basin, experienced much lower DO during low flows from the drought. As a result the Whippany and Rockaway Rivers are classified as not meeting the 1983 fishable goal. Waters draining to the Pompton River (Pequannock, Wanaque and Ramapo Rivers) are of overall better quality than the Whippany and Rockaway Rivers. Both the Ramapo and Pompton Rivers have fair water quality with low DO the major factor affecting fishes. The Pequannock River is in mostly protected lands as part of the Newark Watershed and therefore, has little development in the upper half of its drainage. The Pequannock, Ramapo and Pompton Rivers are of fishable quality and will meet the 1983 fishable goal. Inadequate sewage treatment plants and septic systems are the main reasons for water quality conditions as they exist.

The Lower Passaic River experiences continued water quality degradation which was exacerbated during the drought period of 1980 to 1981. The sporadic low DO and high un-ionized ammonia in the Lower Passaic River, and it's tributary the Saddle River, help to give this segment poor quality overall. Although angling in the Lower Passaic and its tributaries is for the most part, limited to residents of the area, much of what is caught is consumed. The Lower Passaic is tidal downstream of Dundee Dam and contains various migratory marine fishes. But because of the poor water quality found the Lower Passaic River segment is classified as not meeting the fishable goal of the Clean Water Act.

The Hackensack River drains the northeastern corner of New Jersey to Newark Bay. The Hackensack watershed contains warmwater fish communities throughout its freshwater reach, and anadromous and marine fishes in the brackish, tidal portions. The lower Hackensack is noted for its large expanses of tidal marshes (known as the Hackensack Meadowlands) that contain a great variety of terrestrial and aquatic life. However, the community make-up found in the Meadowlands is largely pollution tolerant organisms, despite recent improvements in water quality and the diversity of organisms found (Mattson and Vallario, 1976). Water quality is generally good in the upper freshwaters of the Hackensack, but decline to poor in the estuary and lower freshwaters. Freshwaters experienced reduced flows in the drought period that resulted in significantly lower DO. This probably caused severe stress if not acute toxicity, to fishlife in the river at New Milford (DO dropped below 1.0 mg/l). In the tidal sections major water quality issues facing fishlife include reduced DO, elevated water temperatures (from power plant cooling water discharges) and metals contamination. Fish tissue from the lower Hackensack contained levels of cadmium, lead and nickel above the State mean. A sample from the forage fish mummichog contained the highest recorded levels in the State. It is because of these problems that the Hackensack watershed is fishable only in portions, and therefore, will not meet the goal throughout.

A severe water quality event occurred in Newark Bay during the summer of 1980 that resulted in anaerobic conditions. Inadequately treated sewage discharged from the Passaic Valley Sewerage Commissioners treatment plant, while construction on their facilities took place, combined with abnormally low base flows to cause massive fish kills in the Bay. By summer's end the problem had rectified itself. Poor inflow water quality and flushing rates, numerous organic-loading discharges and large amounts of cooling wastewaters continues, through, to cause poor water quality in Newark Bay.

The Elizabeth and Rahway Rivers flow into the Arthur Kill after draining portions of Essex, Union and Middlesex Counties. Both rivers contain tidal and freshwater sections. The Rahway River is stocked with trout and contains a number of lakes that are used for angling. However, both rivers flow through urban/-suburban lands that has degrading affects on water quality. The Elizabeth River is judged to be in poor quality throughout while the Rahway River is fair in the upstream sections and tributaries, and poor in the lower sections. Significant organic pollutant loads from discharges, combined sewer overflows and Arthur Kill waters are the main causes for the conditions found in the rivers. As a result, the Elizabeth and Rahway Rivers are fishable only in upstream sections and therefore, they will not meet in their entirety, the 1983 goal.

The fishing advisory issued for Raritan River and Bay, and Atlantic Coastal waters in December, 1982, also applies to tidal or other waters of northeastern, New Jersey. Because of the higher levels of PCBs found in northeastern waters, closures were also issued. The sale of striped bass and American eels taken from the Hudson River, Upper New York Bay, Newark Bay, Lower Passaic and Hackensack Rivers, the Arthur Kill and Kill Van Kull is prohibited. In addition, advisories for limiting the consumption of striped bass, American eels, bluefish, white perch and white catfish have been issued for the State's northeastern region. This region includes the Arthur Kill, Kill Van Kull, Newark Bay, the Passaic River to Dundee Dam, the Hackensack River up to Oradell Dam, Upper New York Bay and the Hudson River up to the New York-New Jersey border.

The generally poor water quality found throughout the Passaic and Hackensack River basins and in the boundary tidal waters (Newark Bay), Hudson River, Upper New York Bay, Kill Van Kull and Arthur Kill) are indicative of the intensively developed lands, abundant wastewater discharges and non-point source runoff. With the exception of headwaters and upstream reaches of the waterways in these basins, fishlife likely experiences severe physiological stress at various periods throughout the year (primarily during warmweather periods).

Improvement to these distressed waters will only be marginal in the near future, largely because of uncontrolled non-point sources, the condition of boundary waters, increased use of baseflows for water supply purposes (thus possibly reducing diluation ratios) and limited public and private expeditures for pollution control.

Conclusions

New Jersey's fresh, brackish and salt waters contain a wide diversity of fish populations, whose presence can generally be correlated with water quality conditions. These fisheries support significant and statewide recreational, activities and in the coastal waters, a commercial industry. The importance of the State's fishes: their ecological, economic and use values, can not be overlooked by those, who make decisions that affect the well-being of this resource.

The diversity of fish habitats and background water quality in New Jersey makes it extremely difficult to determine if present water quality is affecting the health (maintenance) and propagation of balanced fish communities. So many factors are involved that only rough and indirect answers to this question can usually be made (as has been done in this report). To begin with, if accurate fishable determinations are to be made, a thorough and current knowledge of the fish community present in a water body is required. Unfortunately though, the only compiled list of fish species by watershed is in Weis et al (1979) and much of the information used (primarily DFGW electrofishing and netting data) was collected over a twenty year period. This indicates that the information may be out-of-date for certain watersheds. With the proper knowledge of the fish community in a waterbody comparison to water quality and macroinvertebrate survey data (provided that the water quality requirements of the fishes present are known) can be made to get a general indication of the healthiness of the aquatic community. The amount of current water quality data and macroinvertebrate survey results available in New Jersey (generally two long-term monitoring stations per watershed), allows for only rough determination on the healthiness of fish in a stream. It is even more difficult to identify changes in a fish community's well-being when using only changes in water quality data.

Despite the difficulties described above, general conclusions can be made concerning the impacts of water quality on the State's fishes. The results of the Office of Cancer and Toxic Substances Research's first five years of fish tissue contamination data has shown that the occurrence of heavy metals, pesticide, and PCBs in fish tissue (includes marine, anadromous and freshwater species) is widespread at low levels throughout the State. The level of contamination generally corresponds with levels of sediment contamination, and is usually higher in waters that drain developed and industrialized lands with numerous point source discharges. The affects of this low level contamination must be looked at from the standpoint of what, if any, chronic impacts it is having on fish communities. Review of the ambient and conventional water quality data throughout the State indicates that periodic low DO and elevated ammonia (near or in violation of appropriate State Water Quality Standards) are found. DO and un-ionized ammonia can be lethal if in too low or too great concentrations, respectively. The greatest frequency at which levels of DO and un-ionized ammonia, although dependent on a number of factors, were in violation or approaching the standard were in waters with large organic pollutant loads. Depending on the water body, the source and cause of the organic loading varied between agricultural runoff, inadequate sewage treatment, excessive wastewater discharges and insufficient assimilative capacity of the stream. Reduced DO and elevated un-ionized ammonia concentrations were most severe in the Passaic, Hackensack and Raritan River Basins during the drought (low flow) period of mid 1980 to mid 1981.

The DFGW has conducted a series of resource inventories of coastal bays and estuaries from Barnegat Bay to the Maurice River. Water quality data collected during these studies shows that low DO concentrations (less than 4.0 mg/l) in the State's bays and estuaries are common during the summer. These DO levels have been responsible for fish kills, especially in the Maurice River Cove system. Apparently, the DO concentrations are a response to biological productivity (naturally occurring) and inputs of nutrients from man's activities. This indicates that bay and estuaries are quite sensitive to additional organic loadings from point and non-point sources. The importance of these water as spawning, nursery and feeding grounds for marine fishes highlights the need to maintain sufficient water quality conditions.

The State as a whole has shown some improvement in the ability of surface waters to meet the fishable goal of the federal Clean Water Act. Waters not considered capable of maintenance and propagation of fish in earlier 305(b) reports, but now thought to be meeting the goal throughout most of the watershed or segment include: Oldmans Creek, Salem Creek, Alloway Creek, Millstone River, Lawrence Brook and South River. Segments or watersheds that are now considered not fishable but which were in earlier State Water Quality Inventories include: Woodbury, Mantua and Raccoon Creeks; Mid-Passaic River; Whippany River and Rockaway River.

A major issue concerning the protection of the State's trout production and trout maintenance waters is physical habitat destruction. Trout are highly sensitive to changes in their habitat and with the continued development of lands draining to trout production and trout maintenance waters, such as in the North and South Branches of the Raritan River, special controls are needed to insure the protection of their habitat. Habitat protection is also important in the estuarine and bay waters along the Atlantic Coast and Delaware Bay.

Recommendations

The following recommendations are designed to improve knowledge of New Jersey's fishes resources; the quality of waters with regard to fishes; and the protection of the resource and its life-supporting requirements.

Increased Monitoring of Fishlife in the State's Waterways. The waters of New Jersey should be evaluated on a routine basis for fish population abundance and diversity. In addition, macro-invertebrate community structure should be identified. The monitoring of fishlife should be performed in relation to water quality studies so that correlations between water quality changes and fish communities change can be determined. Monitoring should also be conducted so that changes in a community as a result of specific pollution sources, can be identified.

Reduce Oxygen-Demanding Loads to Streams Affected with Low Dissolved Oxygen and Elevated Ammonia Concentrations. The occurrence of low DO and high un-ionized ammonia in streams is generally a result of excessive organic materials in a waterbody and insufficient reaeration. This situation is most critical in streams afflicted with seasonal low flows and in the coastal bays and estuaries. In those streams or water bodies where this takes place and is man-induced, source controls are needed so that in-stream conditions can be improved. Additional controls of organic material loadings to bays and estuaries, by point and non-point sources, should be properly regulated so that oxygen demands are not increased beyond natural conditions.

Continued Monitoring of Fish Tissue for Toxic Substances. Monitoring of fish tissue for the presence of substances known to cause acute and chronic toxicity to aquatic life and humans should continue. The impact of these substances on the stability of aquatic ecosystem must also be determined and if possible, sources of the substances identified.

Protection of Trout Habitat in Watersheds Containing Trout Protection and Trout Maintenance Waters. The presence of trout production and trout maintenance waters is generally indicative of high quality waters containing undisturbed habitats for coldwater fisheries. This is a valuable resource in the State, and measures are needed to ensure that these habitats are protected. The draft Stream Encroachment Regulations, issued in April 1982, pursuant to the Flood Hazard Area Control Act (N.J.S.A. 58;16-50 *et seq.*), contains special provisions for the protection of trout habitats (besides provisions for protection of warmwater fishery habitats throughout the State). These draft regulations should be implemented.

Additional Studies and Management of Marine Fisheries Present in New Jersey Waters. Research and management of marine fisheries that are found in New Jersey's coastal bay and estuarine waters has not kept pace with the utilization of the resource by recreational and commercial interests. Additional studies are needed to define how current water quality conditions, other environmental factors, and harvesting rates are affecting these fisheries so that proper management programs can be carried out. If such management or protection measures are not generated in the near future, then the marine fisheries resources may be severely strained as attempts are made to meet current and past landings. This may result in more long-term or permanent impacts on fisheries abundance.

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IV. GROUND WATERS OF NEW JERSEY

A. INTRODUCTION

B. HYDROGEOLOGIC CONDITIONS AND THEIR EFFECTS ON GROUND WATER QUANTITY

C. GROUND WATER QUALITY IN NEW JERSEY

D. GROUND WATER MANAGEMENT PRACTICES IN NEW JERSEY

E. RECOMMENDATIONS FOR IMPROVING GROUND WATER QUALITY AND QUANTITY IN NEW JERSEY

A. INTRODUCTION

One effect of the recent drought in New Jersey was a sudden increase in the general public's awareness of the importance of our water resources. With the imposition of water rationing, the public understood what water resource professionals have always known: water is the vital denominator in our lives, in both our personal lives and our economic existence. The following chapter of the 1982 New Jersey Water Quality Inventory (305(b)) Report briefly describes the importance of ground water to the State's water supplies, the resource's quality, factors affecting its quality and alternatives designed to alleviate ground water pollution.

For this report, the State has been divided into three major physiographic regions: the Coastal Plain, the Triassic Lowlands and the Highlands Region (Figure IV-1). Each of the three physiographic regions represents a distinctive geologic assemblage of rocks; each assemblage having unique hydraulic characteristics. For each of the three physiographic regions, the following four major, quantity dependent aspects of ground water are covered in the Hydrogeologic Conditions Dependent Upon Ground Water Quantity section of this chapter:

1. Regional hydrogeologic characteristics;
2. Regional ground water usage and availability;
3. Incidents of salt water intrusion; and,
4. The relationship of regional ground water diversion to surface stream flow.

In the section Ground Water Quality, the ambient ground water quality of each region is described. This is followed by the identification and evaluation of the major types of ground water pollution found in New Jersey. The sources of pollution discussed are:

1. Landfills;
2. Surface impoundments;
3. Accidental spills;
4. Underground storage tanks and pipelines;
5. Municipal sewer systems;
6. On-site waste water disposal systems; and,
7. Other pollution sources.

In the forth segment of this chapter, existing management practices are reviewed; including:

1. Ground water allocation practices;
2. Ground water quality protection programs; and,
3. Monitoring programs.

In the final section recommendations are given, which are designed to enhance the State's effective management of this important natural resource. Approximately sixty percent of New

Jersey's drinking water is derived from ground water resources. In the Coastal Plain Region, this figure rises to 90 percent. Ground water is the largest reserve of potable water available in New Jersey and our future depends upon the careful protection and management of this precious resource.

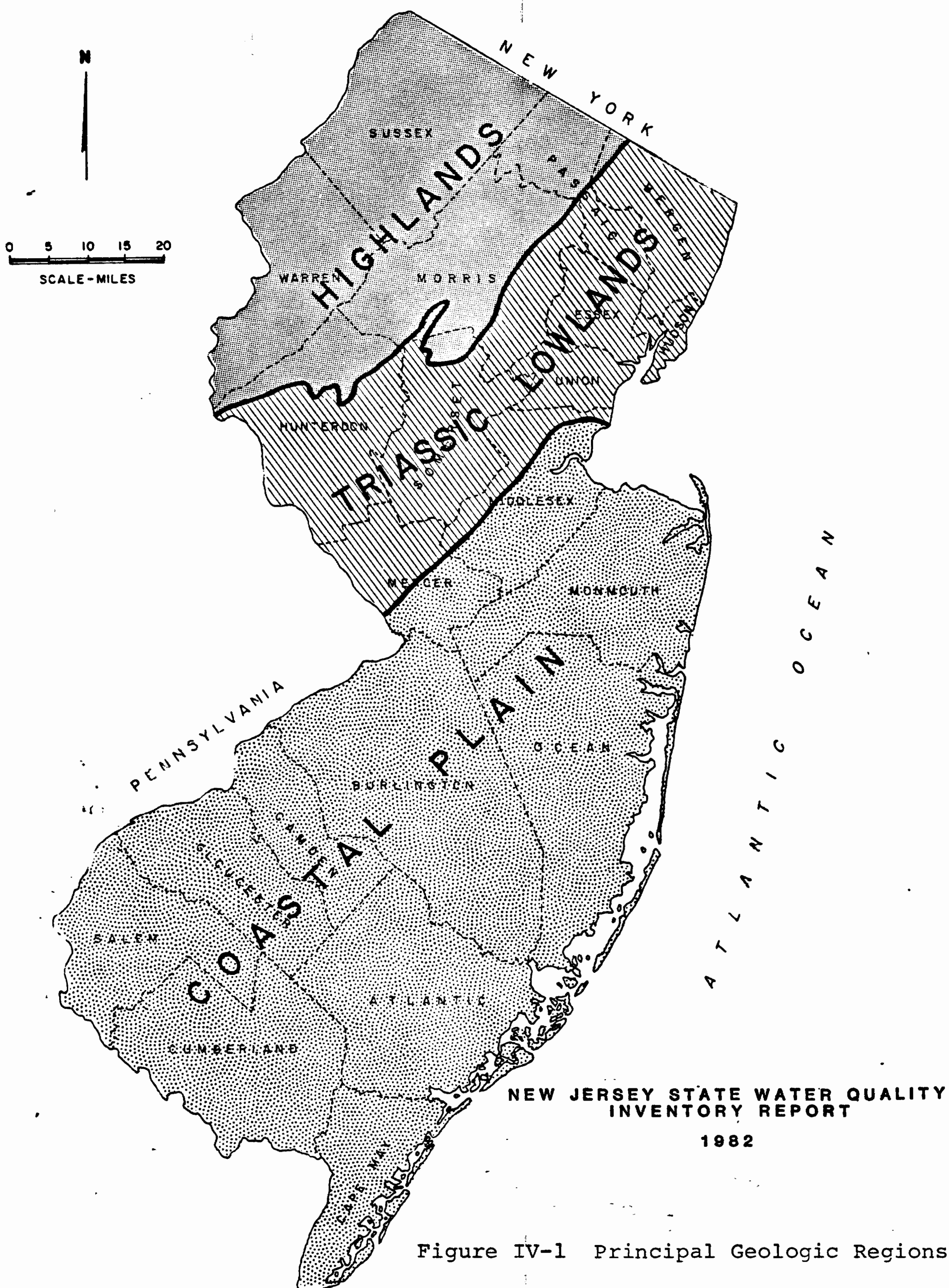


Figure IV-1 Principal Geologic Regions.

Taken from: Havens et al. (1980).

B. HYDROGEOLOGIC CONDITIONS AND THEIR EFFECTS ON GROUND WATER QUANTITY

The major factors controlling ground water quantity are described in this section for each of the three physiographic regions. The division of the State into three physiographic regions is based upon the distinctive and prevailing lithologies found in each region. This lithology generally determines the occurence and movement of ground water.

However, throughout this report it is essential to keep in mind the effect of man's activities on the ground water system. Vowinkel and Foster (1981) of the U.S. Geological Survey have summarized man's effect in this way:

> "Previous to development by wells, the ground water system was in a state of dynamic equilibrium. Withdrawal of ground water by wells is a stress superimposed on a previously balanced ground water system. The response of an aquifer to pumping stresses may result in an increase in recharge to the aquifer, a decrease in the natural discharge, a loss of storage within the aquifer, or a combination of these effects" (Vowinkel and Foster, 1981).

Changes of water quality can also result from pumping, especially where deleterious substances are released into the ground water system.

It is a well documented fact that the response of an aquifer under stress (overpumpage, pollutant introduction) often extends beyond the purely stratigraphic boundaries of the aquifer. Significant stresses can, and often do, effect adjacent formations or a large portion of the hydrogeolgic system in the stressed locality and may thereby induce poor quality water into the system where pollutants have been introduced into the recharge area.

Appendix 2 in the Appendices to this report contains a table entitled Geohydrologic/Stratigraphic Column of New Jersey - Showing Counties Where Formations Outcrop and Their Potential Ground Water Yield. This table presents information which is specific to the various geohydrologic formations of New Jersey and not discussed in this chapter.

The Coastal Plain Region

Hydrogeologic Description of the Coastal Plain Region

The Coastal Plain Physiographic Region is the largest of the three regions in New Jersey and covers the southern 4400 square miles of New Jersey's total 7836 square miles. Nine of New Jersey's twenty-one counties are completely in the Coastal Plain;

while two other counties are partially in the Coastal Plain (see Figure IV-1).

Generally, the geology of the Coastal Plain can be characterized as an overlying and overlapping sequence of southeasterly dipping and thickening sediments. This sequence of unconsolidated sediments, or wedge, lies uncomformably upon predominantly crystalline rock (Figure IV-2). The individual formations outcrop in a series of northeast-southwest trending belts, which roughly parallel the fall line (Figure IV-3). The fall line itself, separates the Coastal Plain Region from the Triassic Lowlands Regions. Sand, gravel, silt and clay are the dominant materials composing the unconsolidated Coastal Plain sediments.

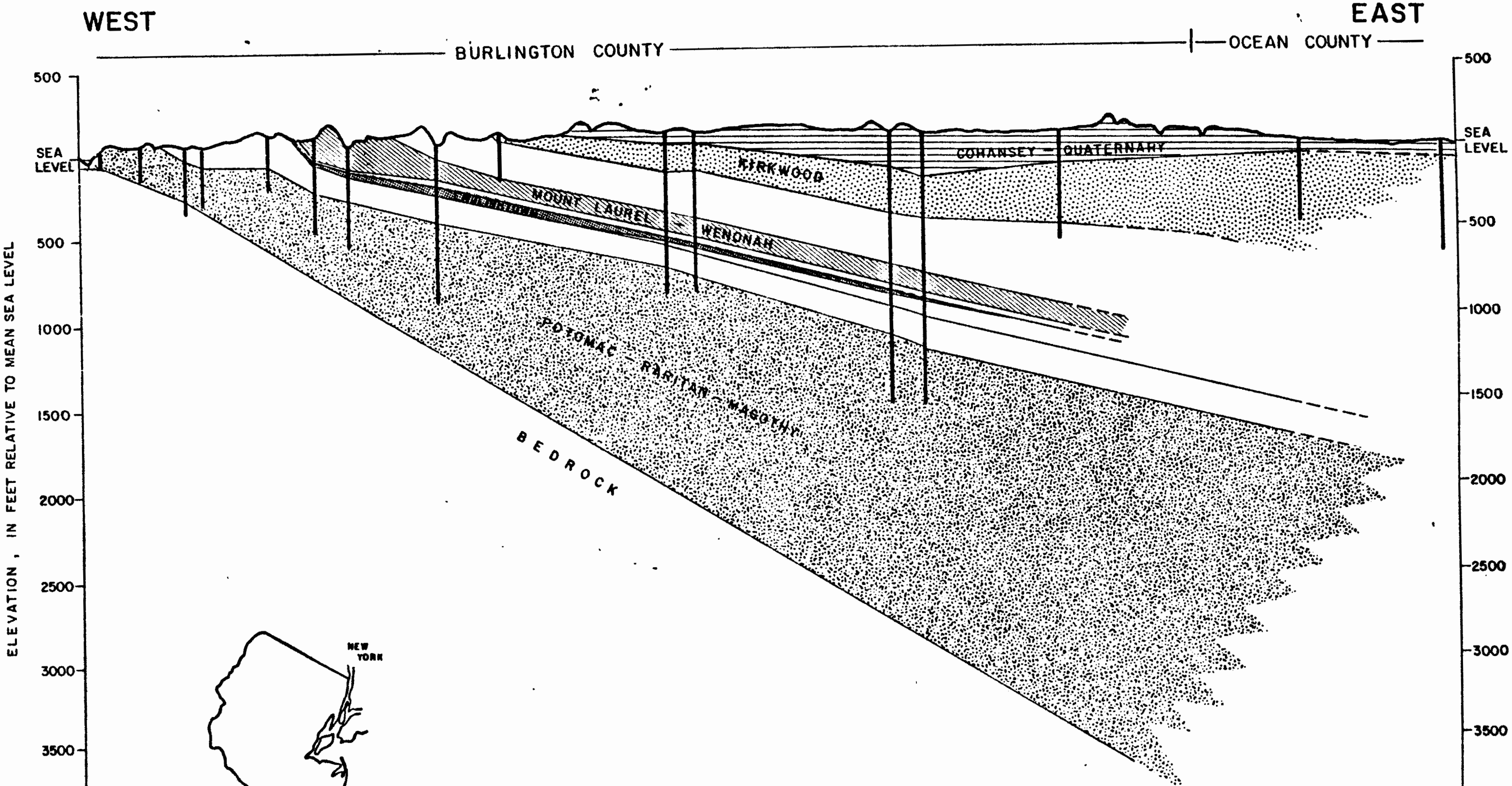
Ground water accounts for approximately 90 percent of the Coastal Plain Region's water supply. The five major aquifer systems existing in the Coastal Plain which are each capable of yielding large quantities of water on a regional basis are:

1. Potomac-Magothy-Raritan System;
2. Englishtown Formation;
3. Wehonah-Mt. Laurel System;
4. Kirkwood Formation;
5. The Cohansey Sand.

The Potomac-Raritan-Magothy Formation is the oldest, thickest and most extensive aquifer in the Coastal Plain Region. It is the most prolific Coastal Plain aquifer and is presently the most highly developed. On the order of a million gallons of water per day (1,000,000 gpd) or more can be produced from a properly constructed large diameter well in this aquifer.

The Englishtown Formation is quite thin in comparison with the Potomac-Raritan-Magothy Formation and has a limited aerial distribution. Most of the development in the Englishtown is along the coast in Monmouth and Ocean Counties. In addition, the lithology of this formation varies considerably. In the Southern Coastal Plain, unproductive clay and silt dominate the sediment. Generally, the Englishtown Formation is found to have a low transmissivity, which limits the formation's capacity to produce extensive amounts of water. An average range of five-hundred thousand gallons of water per day (500,000 gpd) can be produced from a properly constructed large diameter well in this aquifer in Monmouth and Ocean Counties.

The Mount Laurel Sand and Wenonah Formation, although two geologic formations, function hydraulically as a unit and therefore comprise one aquifer. The Mount Laurel-Wenonah Formation is rather thin; however, the thickness of the water producing facie is very consistent. Like the Englishtown Formation, the Mount Laurel-Wenonah Aquifer generally has a low transmissivity. However, the extensiveness of the aquifer permits broad-range development and greatly enhances its value as a water supply source.



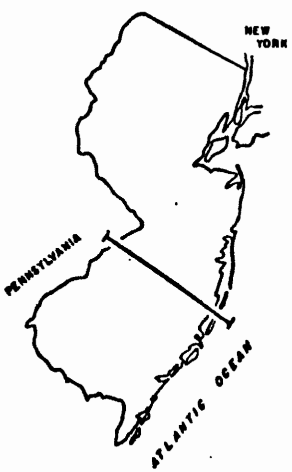


Figure IV-2 Generalized Cross Section of Coastal Plain Aquifers

Taken from: Havens <u>et al</u>. (1980).

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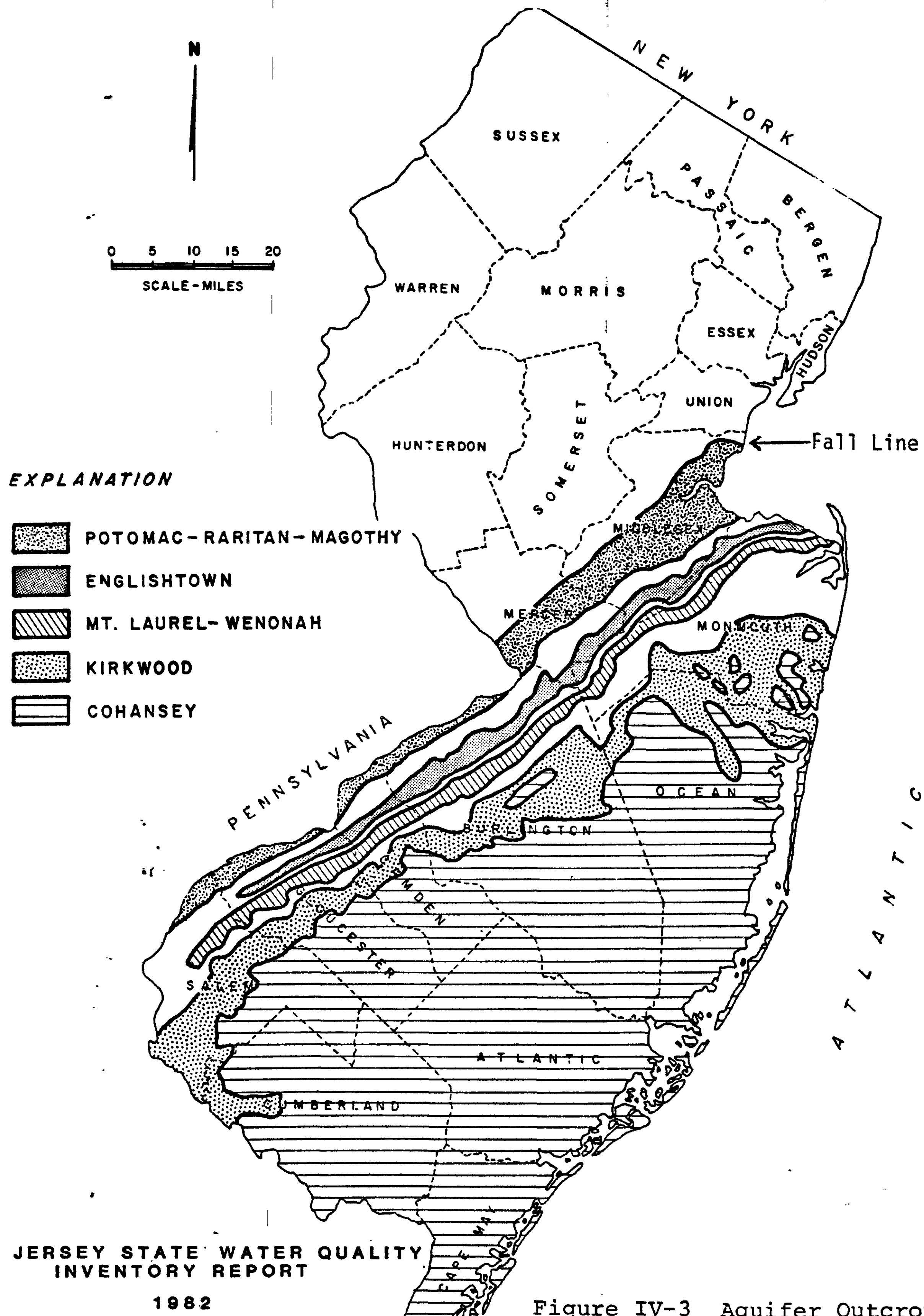

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Figure IV-3 Aquifer Outcrop Areas of the Coastal Plain.

Taken from: Havens et al. (1980)

The Kirkwood Formation thickens greatly in the down dip direction and is an extremely extensive aquifer, occurring in most areas of the Coastal Plain. The lithology and transmissivity of this aquifer is highly variable and this will restrict supply development in some localities. One million gallons of water per day (1,000,000 gpd) can be produced from most properly constructed large diameter wells in the Kirkwood Formation along the Southeastern part of the Coastal Plain.

The Cohansey Sand is the youngest of the major aquifers in the Coastal Plain and water supply areas are essentially restricted to the Pine Barrens Region. The Cohansey Sand has highly variable transmissivities (the rate water is transmitted through an aquifer) and may be a very prolific water producer where there is sufficient thickness. In the areas of high transmissivity, (as in the Southern Coastal Plain), 1,000,000 gpd can be expected from a properly contructed large diameter well.

Ground Water Usage and Availability in the Coastal Plain Region

The amount of ground water recharge to the entire Coastal Plain has been estimated as approximately 5 billion gpd (Havens et al., 1980). Currently, about 500 million gpd is being pumped from the Coastal Plain formations as estimated by Havens et al. (1980). Development of 10 percent of the total recharge may not seem excessive; however, in the Coastal Plain Region population and industrial development is highly concentrated in three areas: along the Delaware River, the Atlantic Coast and Raritan Bay. These three areas have very heavy water demands and all are experiencing severe water level declines. In addition, population and demographic forecasts for the current decade predict even greater demands in these highly developed areas. This is exemplified in Figures IV-4 and IV-5 taken from a study by the Delaware River Basin Commission (DRBC) (Camp, Dresser and McKee Inc., 1981). In select localities many high capacity wells, yielding one to two million gpd, have been constructed in the Potomac-Magothy-Raritan, the Kirkwood and the Cohansey Aquifers. However, lithologic variations within each of these aquifers prevents the development of high capacity wells throughout the region. One water supply option is the development of high capacity supply wells in presently untapped areas and piping the water to the areas of high demand.

In the evaluation of ground water availability, it is essential to consider the interrelationship of the entire Coastal Plain sequence of sediments which behave, in effect, as one enormous ground water reservoir. Overdevelopment in one aquifer may alter the movement, recharge, discharge and water levels in adjacent aquifers depending upon the permeability and hydraulic head differences of the aquicludes and aquifers. Overdevelopment of a locality can also result in salt water intrusion and water quality changes as well as water supply problems and stream flow depletion.

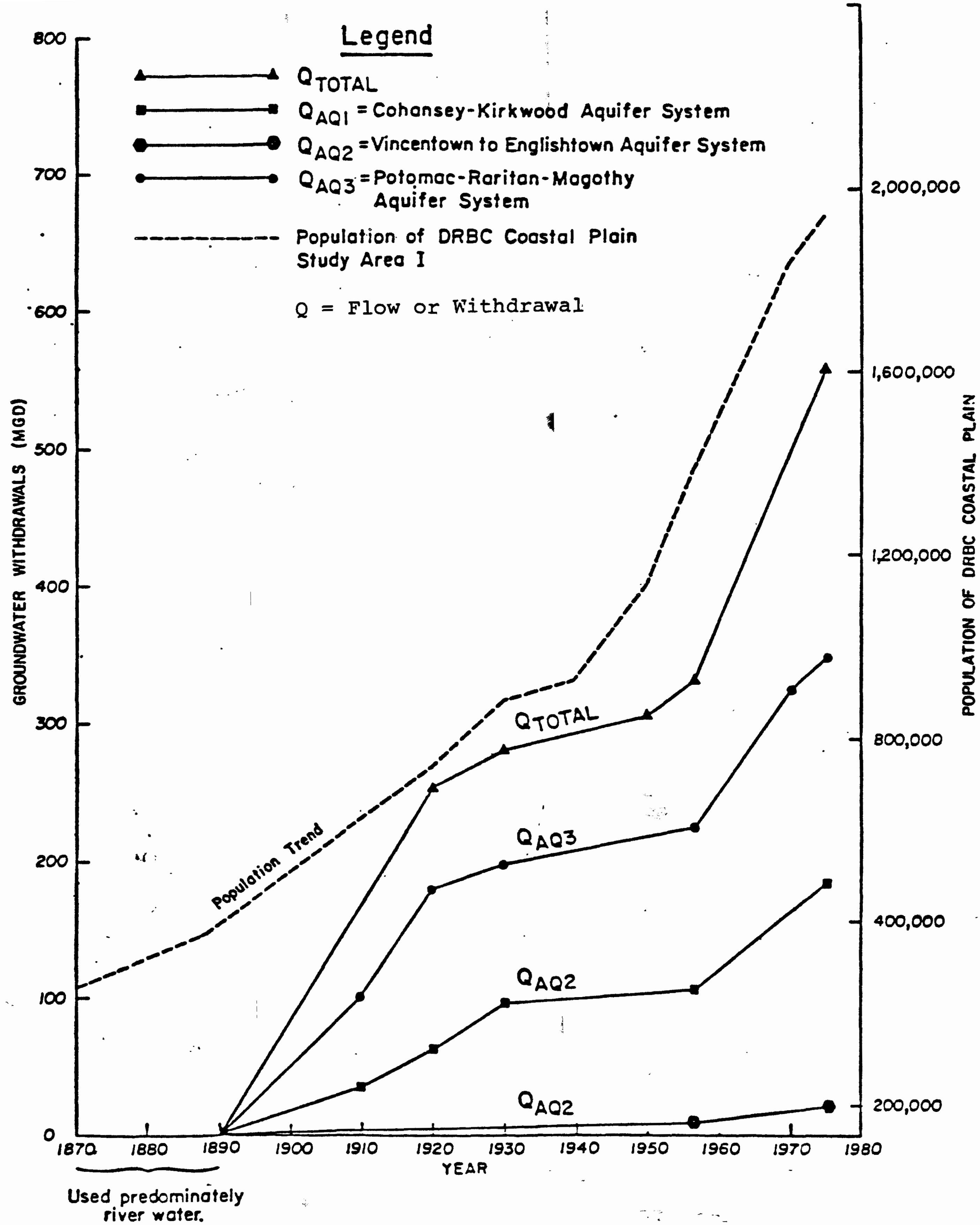
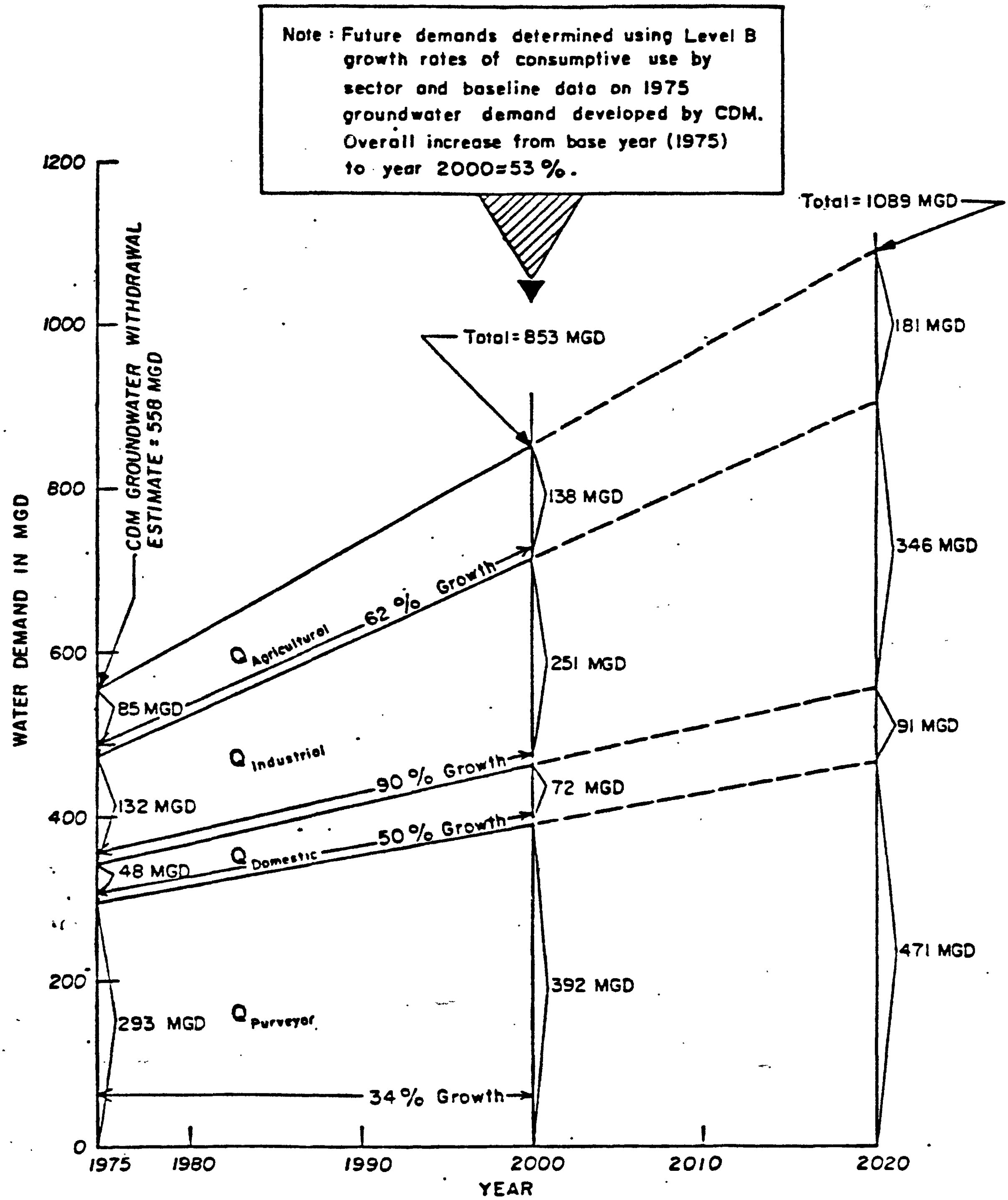


Figure IV-4 Actual Ground Water Withdrawals in the Coastal Plain Region (from 1890-1977)

Source: Camp, Dresser and McKee, Inc., (1981)



Q = Flow or Withdrawal

Figure IV-5 Future Water Demand Estimates in the Coastal Plain Region

Source: Camp, Dresser and McKee, Inc., (1981) The Potomac-Magothy-Raritan System is the most highly developed aquifer system in the Coastal Plain. Much of the heavy pumpage in this aquifer occurs within a few miles southeast of its outcrop area which extends along the southern Delaware River to the Raritan Bay area in Middlesex County.

Prior to heavy pumpage, water levels throughout much of the area were above mean sea level and ground water discharged from the aquifer to the surface flows. However, persistent municipal and industrial pumpage since the early 1900's has reversed this condition. Significant water level declines (over 100 feet) have been documented in Burlington, Camden, Middlesex and Monmouth Counties.

In Burlington, Camden, Gloucester and Salem Counties, the annually compounded growth of water withdrawal is two to three percent each year and water levels continue to drop (Havens et al., 1980). It is estimated that 47 percent of the water pumped from the Potomac-Magothy-Raritan System between Trenton and Salem, is actually induced infiltration from the Delaware River and another 31 percent is supplied by vertical leakage from overlying aquifers (Havens et al., 1980). Additional supplies can be produced from this prolific aquifer system; however, development should be distributed in the less developed portions of the system.

The Englishtown Formation is an extremely important source of potable water, meeting public supply needs, throughout the northern and western Coastal Plain. This aquifer is very heavily developed in southeastern Monmouth and northeastern Ocean Counties and a large cone of depression (water level drop) has developed along the coast in these two areas where water levels are over 200 feet below sea level.

The seasonal water demands in this coastal area, where the summer tourist season demand is typically two to four times the winter demand, aggravates the already serious water level declines. Given the current demographic predictions of development, water levels in the Englishtown Formation are expected to continue declining despite restrictions on new ground water diversions. This is due to the increased use of existing diversion rights.

The severe water level declines in the Englishtown Formation also have affected the overlying Mount Laurel-Wenonah Aquifer System. Water level declines documented in the Mount Laurel-Wenonah System in Monmouth and Ocean Counties can be largely attributed to pumpage in the Englishtown Formation. These effects will continue as long as the Englishtown Aquifer is significantly overstressed in coastal areas.

Additional ground water diversions in the Englishtown Formation should not occur along the coast in these affected localities. However, properly managed development near the outcrop areas in Burlington, Monmouth and Ocean Counties should not interfere with the existing coastal water supply problems.

The Mount Laurel-Wenonah Aquifer is the least developed of the five major Coastal Plain aquifers. As mentioned previously, the severest supply problem in this system is the large cone of depression in southeastern Monmouth County which generally corresponds to the area of greatest water level declines in the underlying Englishtown Formation. The decline or water levels in this area, which are more than 140 feet below mean sea level, are the result of vertical leakage into the Englishtown Formation.

The Mount Laurel-Wenonah Aquifer water levels are still declining and will continue to do so until pumpage in the Englishtown Formation is reduced. Although future development of the Mount Laurel-Wenonah should be limited in the southeastern portion of Monmouth County; development in the vicinity of the outcrop area in counties bordering the Delaware River presents a viable option in the utilization of this groundwater resource.

The Kirkwood Formation is the third most heavily developed aquifer in the Coastal Plain. Concentrated pumpage exists in this aquifer along the shore and barrier beach in Atlantic, Ocean and Cape May Counties. Although water level declines have stabilized in most of Atlantic and Cape May Counties, a large cone of depression exists in this aquifer between Atlantic and Cape May Counties. The area of continued water level declines centers around Atlantic City and extends into Cape May County. The water levels in this area are currently more than 70 feet below mean sea level. As with most of the Atlantic Coast area, the tourist trade is a dominant sector of the economy and summer pumpage is typically three to four times winter pumpage rates. Because of the casino-related development, progressively higher water demands and correspondingly lower water levels are anticipated. Also, the salt water/fresh water interface lies an undetermined distance off shore. Given continuation of the present conditions, salt water will eventually move into the Kirkwood wells on the barrier beach.

In addition to the Atlantic City area problem, pumpage is increasing in southern Ocean County in response to the unprecedented population growth experienced by this county during the past decade. Water level declines in the Kirkwood Aquifer are expected to continue along the coast in this county.

The Cohansey Sand Aquifer is heavily developed in Atlantic, Cape May, Cumberland and Ocean Counties. In these counties high demand occurs during the summer tourist and agricultural seasons; while winter domestic and industrial demand is low.

Water table, or unconfined conditions exist throughout most of the Cohansey Sand. However, water level declines have been documented in this aquifer in central Cape May County, where the aquifer is under semi-confined conditions. Because unconfined hydraulic conditions do not readily develop regional cones of depression, the Cape May County water level declines will likely be limited to the central and southern portions of the county. In most areas, this aquifer is in direct hydraulic connection with the overlying Pleistocene deposits which often act as additional recharge and storage zones for the Cohansey Sand.

Generally, except for the problem areas of excessive ground water pumpage mentioned in the preceeding section, a huge reservoir of potable water resources remains untapped in the Coastal Plain Region. High yield wells cannot be constructed everywhere in the Coastal Plain, but they can be constructed in many localities in three of the five regional aquifers. And, less prolific, but substantial water supplies can be developed locally in all of the Coastal Plain counties.

The critical concern in this region is not water availability, but demographic distribution. The main areas of currently untapped water supply (Figure IV-6) do not correspond with the areas of high population or industrial demand. Because, new well construction in the heavily developed problem areas will exacerbate existing situations of aquifer degradation and depletion, the following four strategies have been suggested to prevent future, localized water supply shortages (Camp, Dresser and McKee, 1981):

1. Halt the current practices of aquifer overdevelopment;

2. Uniformly distribute future well development;

3. Institute projects designed to reverse water level declines in problem areas;

4. Develop new supplies in problem localities; and

5. Supplement ground water supplies with surface water supplies.

In applying these to ground water development, five general objectives should be considered:

1. Reduction of regional drawdown in problem areas;

2. Preservation of ecologically sound base stream flows;

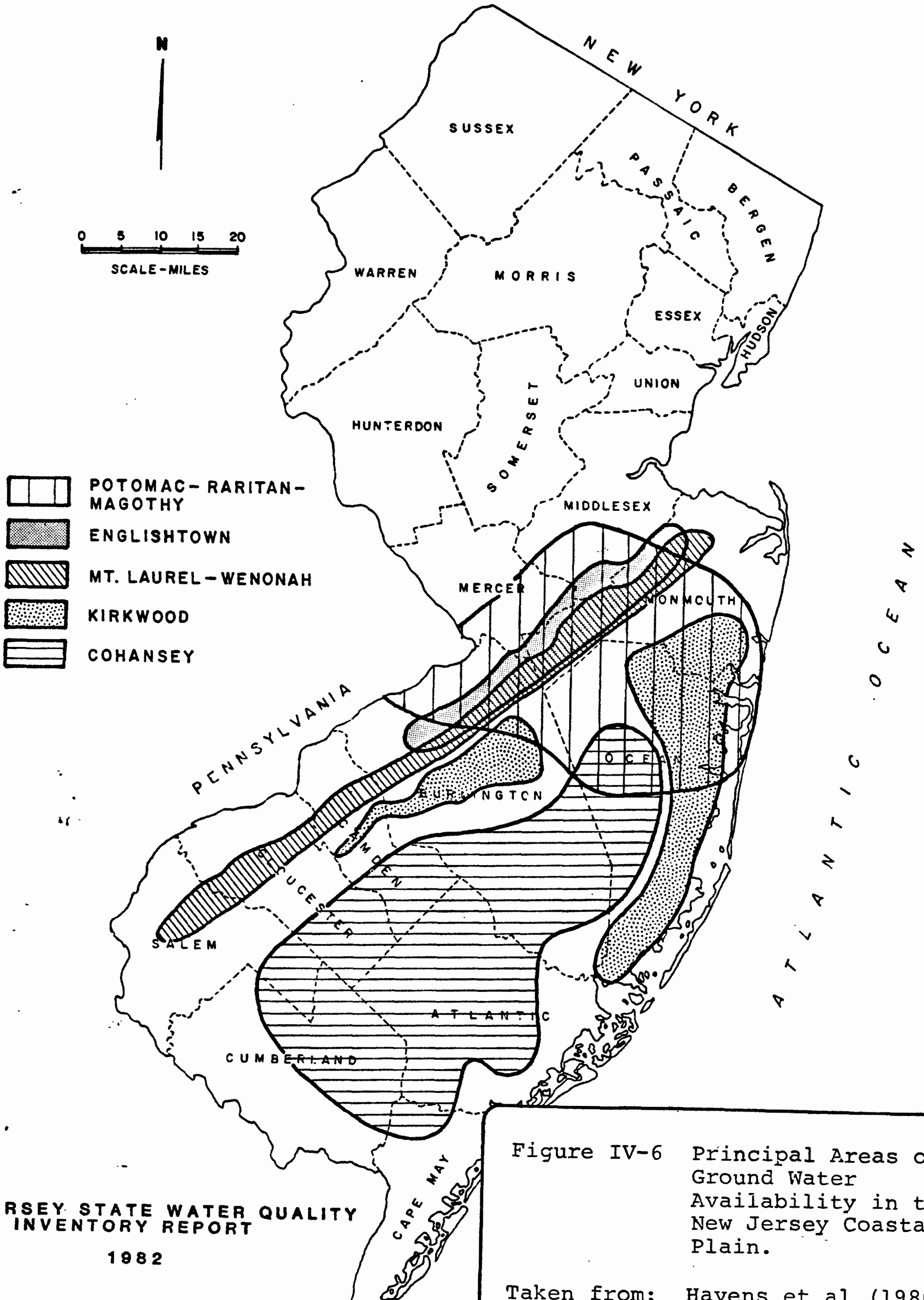
3. Preservation of existing wetlands;

4. Avoidance of accelerating or redirecting existing pollution plume flows; and

5. Production of adequate potable water supplies.

Salt Water Intrusion in the Coastal Plain Region

Saline water is present, to some degree, in all five of the major Coastal Plain Aquifers. However, salt water contamination of potable supplies is currently a serious concern in only two of



NEW JERSEY STATE WATER QUALITY INVENTORY REPORT

1982

Figure IV-6 Principal Areas of Ground Water Availability in the New Jersey Coastal Plain.

Taken from: Havens et al. (1980)

the regional aquifers: the Potomac-Raritan-Magothy System and the Cohansey Sand.

Water containing a chloride concentration higher than the potable water standard of 250 mg/l is described as unpotable. On the average, sea water contains 19,000 mg/l of chloride and 11,000 mg/l of sodium.

The presence of salt water in a New Jersey aquifer is usually due to one of the following three conditions, or a combination of these conditions:

1. Salt water has been trapped in the interstitial pores of an aquifer at the time of sedimentary deposition, this is termed as connate water;

2. Hydraulic stress has reversed existing aquifer conditions and caused former aquifer discharge zones to act as recharge zones. When a recharge zone is in contact with a body of salt water, this water will intrude into the aquifer. Man's activities, such as heavy pumping rates, or natural occurences, such as changes in sea level, can produce the necessary hydraulic stresses which cause these reversals. This is known as salt water encroachment; and

3. Chloride or sodium containing materials used on the surface (e.g., road salt) have released chloride or sodium ions into ground waters.

Under equilibrium conditions, a fresh water/salt water interface remains stable and stationary. Theoretically, a wedge of the denser salt water will underlie the discharging ground water and a transition zone of mixed water will exist between the two water zones (Figure IV-7). The fresh water head in coastal recharge/discharge areas is a major factor in determining the configuration of the interface. When the fresh water head in coastal areas is lowered, fresh water discharges will decrease. In response to such a decrease, the salt water wedge will move further inland. This type of movement is called salt water intrusion.

Another important factor controlling the configuration of the fresh water/salt water interface is the Ghyben-Herzberg Relationship. According to this relationship, sea water can be expected to occur at a depth that is approximately 40 times the height of fresh water above sea level. When the fresh water head is lowered around a well by pumping, the salt water in the wells vicinity responds by rising. This phenomena is known as upconing. Upconing can result in the mixing of fresh water with the transition zone and underlying salt waters.

Salt water contamination of potable ground water supplies has been documented in the following five localities:

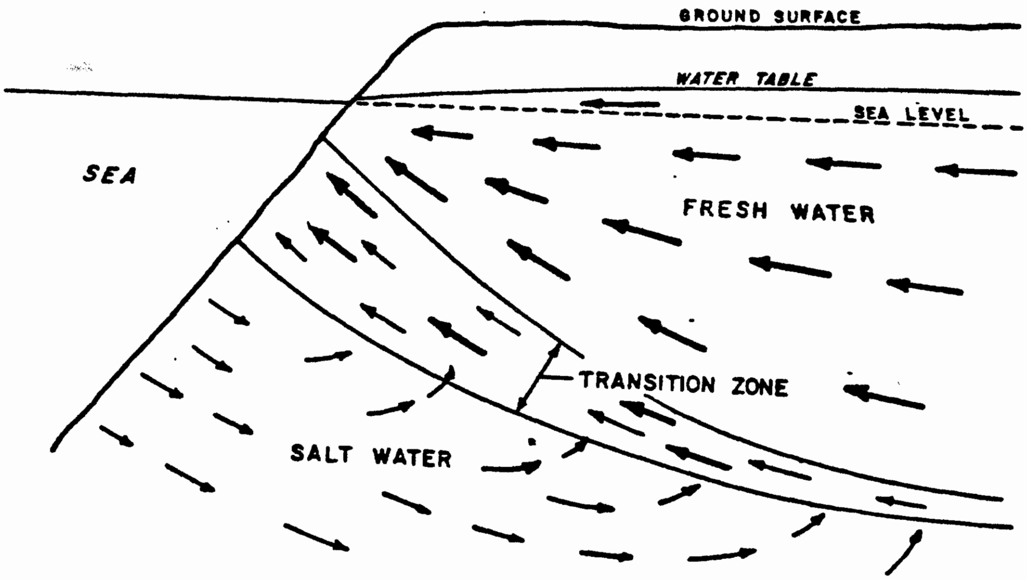


Figure IV-7 Schematic Vertical Cross Section Showing Fresh Water and Sea Water Circulation Within a Transition Zone.

Source: Havens et al. (1980).

Locality	County	Aquifer
Camden Area	Camden	Potomac-Raritan-Magothy
Sayreville	Middlesex	Potomac-Raritan-Magothy
Keyport - Union Beach	Monmouth	Potomac-Raritan-Magothy
Atlantic City	Atlantic	Cohansey Sand
Various Locations	Cape May	Holly Beach Zone, Estuarine Sands, Cohansey Sand Kirkwood Formation
Salem	Salem	Mt. Laurel-Wenonah

The Potomac-Raritan Magothy Aquifer contains brackish water in the lower aquifer over approximately one-half of the Coastal Plain Region. Only the upper aquifer levels are heavily developed south of the Camden area. However, locally high chloride levels have been observed in the upper aquifer levels. The saline water in the upper levels is due to intrusion of saline Delaware River estuary water and upconing of lower aquifer water into the upper fresh water zones.

It has been suggested by Camp, Dresser and McKee (1981) in their DRBC study that, "... the observed up dip movement of saltwater in the Potomac-Raritan-Magothy is a natural but delayed response to the post-Pleistocene rise in sea levels." Regardless of the cause, the salt water in the lower aquifer level is moving and the Camden area cone of depression will accelerate its movement both vertically and horizontally.

In the Sayreville area of Middlesex County, a unit in the Potomac-Raritan-Magothy System known as the Farrington Sand has been heavily developed since the early 1900's. Saline water from the Raritan River has contaminated several industrial supply wells and is moving towards well fields in this area. The dredging of the Washington Canal is partially responsible for this problem. The dredging processes removed clay units which separated the brackish river waters from the Farrington Sand, thereby providing direct access of river water to the aquifer.

Salt water encroachment has been documented in the Keyport-Union Beach area of Monmouth County in a Potomac-Raritan-Magothy unit called the Old Bridge Sand. This encroachment has been linked to heavy water use coupled with the aquifer's connection with Raritan Bay.

In the Atlantic City area the upper level of the Cohansey Sand has developed high chloride levels; although the lower level has remained potable. Investigations have shown that salt water was intruding into the upper levels of the Cohansey Sand from the nearby salt water marshes. Since the occurrence of high chloride levels, the deeper sand levels in the Cohansey have been developed in this area.

Local instances of salt water intrusion have been documented in the Estuarine Sands of the Cape May Formation, near Delaware Bay, at the southern most tip of the State. Although the local contamination problem will likely continue, progressive encroachment of the water bearing zones is not expected (Havens <u>et al</u>., 1980).

Saline water was present in the Cohansey Sand at the southern end of Cape May County when pumping first started. Since that time several localities have observed slow but continuous increases in chloride levels which correspond to seasonal pumping cycles. Chloride levels are expected to increase as long as the Cohansey Sand is pumped in these localities.

In summary, several local water supply pumping centers situated along the New Jersey coastline have induced salt water intrusion. The intrusions limit ground water availability in these localities. The persistence of chloride and sodium contamination should be considered in the evaluation of each local problem area. During and after the 1960's drought, a study of estuary salt water intrusion into the Potomac-Raritan-Magothy Aquifer in the Camden area was conducted. Camp, Dresser and McKee (1981) expressed the study's findings with the following conclusion:

> ". . . in 1978, even though chloride concentrations were lower than peak levels observed during the drought, concentrations still had not been reduced to pre-drought levels. Thus, once introduced into the aquifer system, chloride contamination is not readily removed and recovery periods of a decade or longer are probable even with no further addition of saline water."

The Relationship of Regional Ground Water to Surface Stream Flow

The water flowing in a stream is derived from two principal sources - precipitation runoff and/or ground water discharges. The stream reaches in the Coastal Plain Region represent the area where the water table intersects the ground surface. At this intersection, water either discharges from the ground into the stream or recharges the water table from the stream. Thus, a balance and correlation exists between stream flow and water table elevations. Where only ground water discharges to a stream, the resulting flow is called base flow. Base flow can be measured during periods of little or no precipitation runoff or melt.

Havens <u>et al</u>. (1980) estimated that base flow accounts for 67 to 89 percent of the streamflow in the Coastal Plain Region. Heavy development of the water table aquifer or of deeper aquifers which induce significant vertical leakage from the water table can reduce the volume of ground water discharging to a stream. Given enough pumping stress, hydraulic gradients can be reversed to cause surface water infiltration into a previously discharging aquifer, as is the case with the Potomac-Raritan-Magothy System and the Delaware River in the Camden area.

Any mechanism which lowers water table elevations can effect the balance between stream flow and ground water. The following two conditions, in addition to over-development of an aquifer, are concerns in New Jersey:

1. Intensive urbanization of the outcrop areas of an aquifer reduces the amount and quality of precipitation infiltrating into and recharging an aquifer, thereby reducing stream flow by reducing aquifer water levels, in addition to causing water quality degradation; and,

2. The consumptive use of ground water by municipal and industrial systems reduces existing aquifer water levels. Consumptive use of ground water is defined as water taken from an aquifer and returned, after use, to a surface water body or another aquifer or is lost to evaporation. This situation exists in many sewered areas with municipal waste treatment plants or areas with extensive storm drains, where used ground water or potential recharge is collected, treated and discharged to a surface water body.

Future development, urban development or ground water resource development, must account for its potential effect on water table elevations and stream baseflow, including the resulting effect on wetlands and surface supplies. Conjunctive use of ground and surface water resources can be extremely useful in planning future water development. Conjunctive use is the concept of supplementing ground water pumpage with surface supplies, or supplementing surface supplies with ground water. One example of conjunctive development is a situation where wells are distributed both along a stream and at a distant from streams. During periods of high stream flow ground water is pumped from wells along the stream, inducing surface water recharge into the aquifer. Conversely, during periods of low stream flow supplies can be pumped from the distant wells which are drawing water from aquifer storage. Another example of conjunctive use is direct supplementation of ground water supplies with surface water or vise versa.

A study conducted by the United States Geological Survey (Harbaugh, Luzier and Stellerine, 1980) demonstrates the potential benefits which could be obtained from conjunctive use of ground and surface water in the Camden area. Figure IV-8 depicts the water levels in the Potomac-Raritan-Magothy Aquifer if all water supply for the Camden area is supplied from pumpage. Figure IV-9 depicts the water levels if surface water supplies are used for seven months each year. And, Figure IV-10 depicts the water levels if surface water is used for seven months each year and the aquifer is recharged from surface water supplies at 90 percent of the projected water use rate. Comparison of these three figures clearly shows the potential of this management option for certain areas of the State.

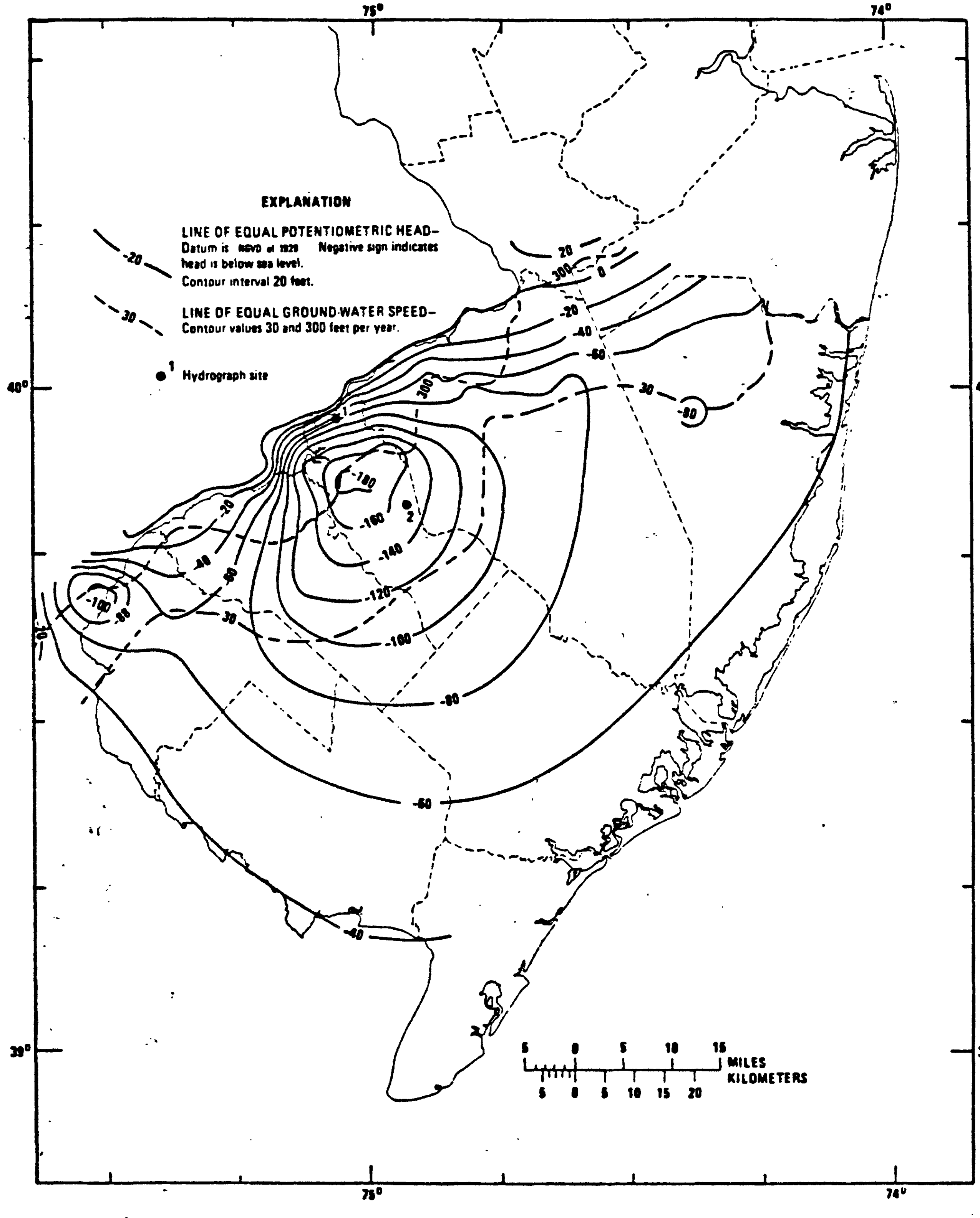


Figure IV-8 Computer Simulation of Potentiometric Heads in 1999 for the Potomac-Raritan-Magothy Aquifer System Without Conjunctive Use.

Taken from: Harbaugh et al. (1980).

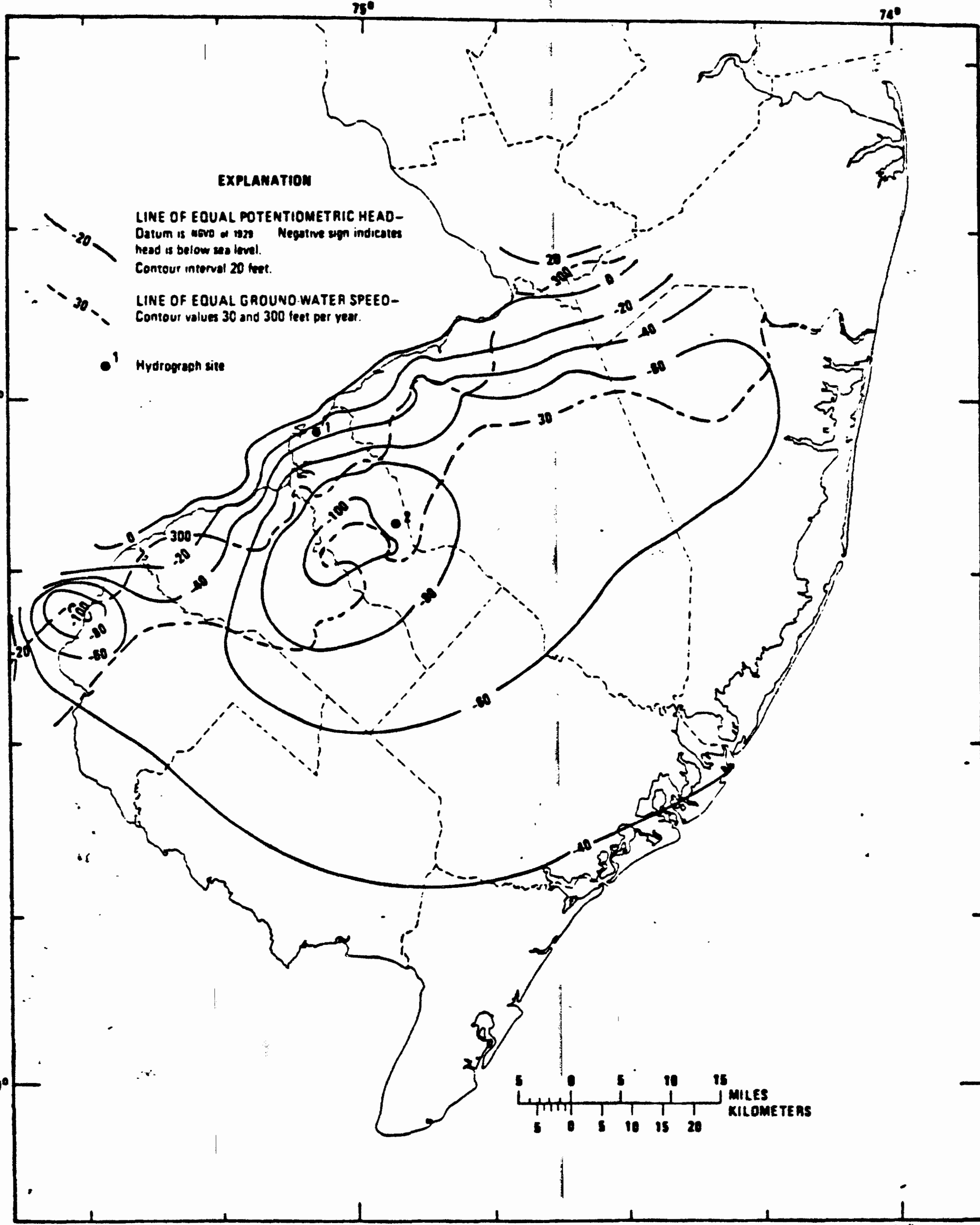


Figure IV-9 Computer Simulation of Potentiometric Heads in 1999 for the Potomac-Raritan-Magothy Aquifer System with Conjunctive Use, (Surface Water Supplies are Used for Seven Months).

Taken from: Harbaugh et al. (1980).

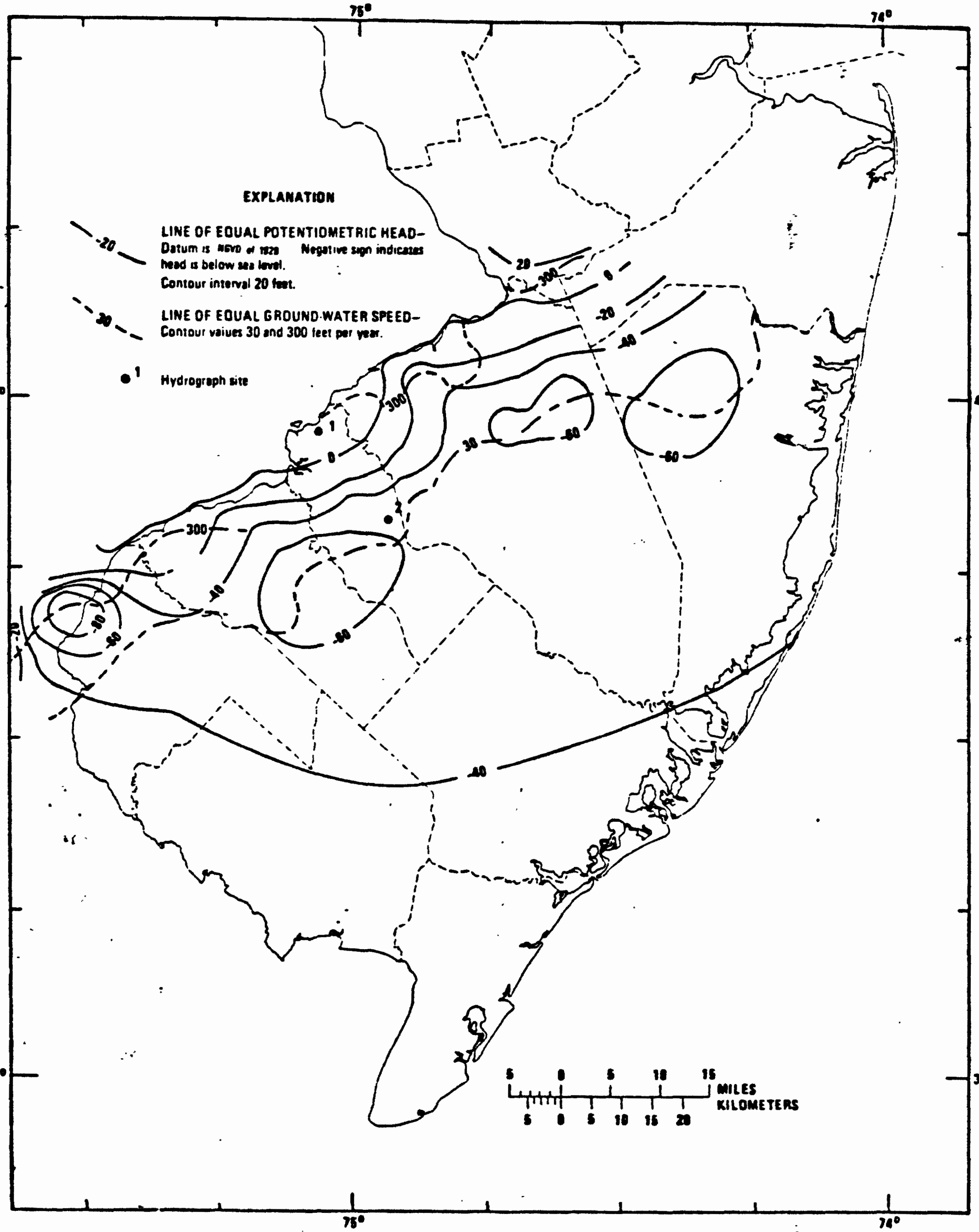


Figure IV-10 Computer Simulation of Potentiometric Heads in 1999 for the Potomac-Raritan-Magothy Aquifer System with Conjunctive Use, (Surface Water Supplies are Used for Seven Months and Aquifer is Recharged).

Taken from: Harbaugh et al. (1980).

The Triassic Lowlands Region

Hydrogeologic Description of the Triassic Lowlands Region

The Triassic Lowlands Region is a northeast-southwest trending belt of rocks which covers approximately one fourth of the State's area and is situated between the Coastal Plain and Highlands Regions (Figure IV-1). Three of New Jersey's twenty-one counties are completely in the Triassic Lowlands Region; while seven other counties are partially in the Region.

The geology of the Triassic Lowlands Region is composed of three basic rock types: sedimentary rocks, igneous rocks and unconsolidated glacial deposits. The region is dominated by a red shale called the Brunswick Formation and contains less abundant layers of sandstone, siltstone and conglomerate materials. Although the Brunswick Shale has very low primary permeability, intersecting fracture and joint systems pervade the formation. Generally, the upper, weathered portions of the formation are more fractured than the lower layers. It is through these intersecting fracture and joint systems that ground water storage and flow occurs. This is known as secondary permeability.

The hydrology of fracture and joint permeability is very complex, extremely erratic and often directional in nature. Much of the ground water supplies in this region are from deep wells in the Brunswick Formation at depths which range, generally, from less than 200 feet to 600 feet below land surface Havens et al. (1980) However, the Brunswick Formation's ability to sustain high capacity wells is not persistent throughout the region and the lowering of water levels which results from high yield pumpage is observed very rapidly and for great distances in surrounding wells. In many areas the Brunswick Formation is in hydraulic connection with the overlying glacial deposits. In these areas a direct relationship exists between the thickness and lithology of the glacial deposits and the production capacity of the Brunswick wells. Also, the glacial deposits act as a source of recharge and storage for the bedrock shales. An average of approximately 500,000 gpd of water per day (gpd) are produced from 35 large diameter wells examined in Essex County. However, the production of the individual wells ranges from 50,400 gpd to 1,180,800 gpd Havens et al. (1980).

The Palisades and Watchung Mountains, composed of diabase and basalt, respectively, are the principal igneous rocks associated with the sedimentary Triassic formations. These rocks are highly resistant and lack wide-spread fracturing. Because of the impermeable nature of igneous rocks, these are very poor water producers and are mainly tapped for domestic use where no other supplies are available.

Unconsolidated glacial sediments - generally till, clay and stratified drift - overlie the bedrock formations in many localities in the Triassic Lowlands Region. However the persistence, thickness and lithology of these deposits is extremely variable from locality to locality. Individual layers of the unconsolidated glacial deposits can radically change in composition and therefore, in ground water yield over distances of several hundred feet.

The stratified drift deposits are the primary water yielding layers of the unconsolidated glacial sediments. These layers are very prolific and are capable of yielding several hundred thousand gallons of water per day (Havens et al., 1980). In the areas where stratified drift occurs, water suppliers are heavily dependant upon these deposits. In certain localities, unconsolidated glacial material has been deposited in eroded rock channels. Thick and permeable deposits of this type, called buried valley-fill, can yield substantial amounts of water and may be the most important source of ground water in the region. Total pumpage from wells in Essex and Morris Counties tapping a system of buried valleys yield approximately 20 million gallons of water per day (Havens et al., 1980). Very high yielding wells may also be constructed where the stratified drift deposits are hydraulically connected to surface water bodies.

Ground Water Usage and Availability in the Triassic Lowlands Region

The Triassic Lowlands Region can be divided into two areas, based on the use and development of ground water resources:

Area 1 - The Brunswick Shale and the Stratified Drift Deposits are heavily developed in the highly urbanized and industrialized northeastern half of the Triassic Lowlands Region. This area includes Bergen, Essex, Hudson, Union, northwestern Middlesex, southern Passaic and eastern Morris Counties. Heavy pumpage, consumptive use, urbanization of recharge areas and contamination has locally stressed ground water usage and availability.

Area 2 - In the southwestern half of the Triassic Lowlands Region, ground water resources have not been extensively developed. This is mainly due to the rural nature and available surface water supplied in southern Hunterdon, northern Mercer, and most of Somerset Counties.

Area 1

Bergen County is underlain by the Brunswick Shale and other Newark Group rocks almost everywhere. The three exceptions are a small area in the northwestern corner of the county which is in the Highlands Region, the southwestern portion which is part of the Watchung Mountains and the eastern border which is bounded by the Palisades Sill. A large portion of the county is covered by unconsolidated glacial deposits and this is predominately stratified drift. Surface water generally supplies the eastern portion of Bergen County, while ground water supplies the western portion. A broad band of concentrated pumpage exists through the center of the county. The available ground water resources in the western and southern portions of Bergen County are highly developed and major pumpage increases in these areas would likely cause ground water level declines. However, the Valley-Fill and Stratified Drift Deposits can yield additional water supplies.

Essex County is underlain by the Brunswick Shale and other Newark Group rocks everywhere except the western boundary along the Watchung Mountains. Water-bearing zones in the Brunswick Formation in Essex County are generally at a depth of 300 to 400 feet (Havens et al., 1980). Although ground water accounts for less than one third of the total county water use, ground water supplies 80 percent of the public water supply (Havens et al., 1980). Most of this water is pumped from the Stratified Drift Deposits which occur in the western portions of Essex County. Severe water level declines have been documented in the unconsolidated glacial and sandstone aquifers in the Livingston-Florham Park-Millburn area and in the Triassic Rock Aquifers in the Newark area (Havens et al., 1980). Havens et al. (1980) has stated that the presently allocated ground water diversion rights exceed the estimated maximum potential yield.

Salt water has been intruding the Triassic bedrock aquifers of the Newark area for years. Heavy pumpage in this area, resulting in water level declines, has induced saline water from Newark Bay and the Passaic River.

Hudson County is underlain by the Palisades Sill which is an unproductive igneous rock called diabase. This rock condition limits the potential to develop ground water resources throughout most of the county, except for the Hackensack Meadowlands area which is covered with Stratified Drift. Tidal influences and heavy pumping has caused Hackensack River water to infiltrate the aquifers. This water is of very poor quality and often high in chlorides as well.

Union County is underlain by Triassic sedimentary rocks throughout except for a small area in the northwest where the Watchung Mountains exist. Unconsolidated glacial deposits occur in many areas, especially to the west and southwest and are extremely vital water resources locally. In Havens et al. (1980) it has been suggested that water level declines may be occurring, but the lack of a water level monitoring system cannot identify the problem if it does exist. According to Havens et al. (1980) calculations, present pumpage may exceed maximum safe yields. This condition has been attributed to the high degree of consumptive use and the estimated available recharge in the county.

The northern portion of Middlesex County is underlain almost entirely by the Triassic Brunswick Formation which is covered by glacial materials in many areas. Pumpage is mainly in the northeastern portion of the Triassic Lowlands in Middlesex County, an area which is heavily sewered. Very little information on water levels in the Triassic rock and glacial deposits is available for this area.

Although ground water resources play a small municipal and industrial role, supplying approximately 10 percent (Havens et al., 1980) of Passaic County's water supply; it is a vital domestic resource. Triassic sedimentary rock underlies southern Passaic County and provides a substantial amount of the pumped water supply, while Stratified Drift Deposits are important locally.

The eastern portion of Morris County, where population density is the highest, is underlain by Triassic sedimentary rock. Portions of this area are covered by glacial deposits. Ground water supplied from these systems accounts for most of the public supply; while most industrial needs are met by surface water supplies from the Passaic and Raritan River basins. Additional supplies may be available from unexplored stratified drift deposits. However, the eastern portion of Morris County is heavily sewered and in these areas the consumptive use of ground water may overstress the Triassic rock and unconsolidated glacial aquifers.

Area 2

Hunterdon County obtains most of its water supply from the Triassic sedimentary rocks which underlie the county, except for the northwestern area near the Musconetcong and Delaware Rivers. Approximately thirty-seven percent (Havens et al., 1980) of the county is underlain by Brunswick Shale. Many of the heavily populated areas of Hunterdon County derive their supplies from this important aquifer. Other Triassic sedimentary rocks occupy approximately twenty-six percent of the county (Havens et al., 1980) and are all low yield aquifers which are satisfactory for domestic purposes only. Important glacial aquifers in this county occur along the Delaware and Musconetcong Rivers where induced infiltration allows high yields. Very little stratified drift is found elsewhere in Hunterdon County.

The northern sixty percent of Mercer County is underlain by Triassic sedimentary rock (Havens et al., 1980), mantled by glacial deposits along the Delaware River. The areas of highest population density occupy the western half of Mercer County, and utilize surface water supplied by the Delaware River and its tributaries. Roughly, one fifth of the county's requirements are supplied by ground water withdrawals (Havens et al., 1980). Much of this water consumption is domestic and occurs in the northeastern segment of Mercer County. Two Triassic formations, the Brunswick and Stockton, are utilized for moderate yield water supplies where they occur. In some areas, the Stockton Formation is hydraulically connected to surface water bodies and large withdrawals are possible. Shallow zones of Stratified Drift Deposits exist along the Delaware River. Small to moderate yields are obtainable from these shallow deposits.

Somerset County is underlain by Triassic sedimentary rocks and is covered in several areas with stratified and valley-fill glacial deposits. Most of the water demand in this county is supplied by surface diversions from the Neshanic, Raritan, North Branch Raritan, and Millstone Rivers. Ground water resources are primarily developed for industrial and agricultural use in rural areas.

Brunswick Shale underlies about seventy-five percent of the county and yields very adequate supplies where it has been developed. Approximately twenty percent (Havens et al., 1980) is underlain by igneous rocks, which form the Sourland and Watchung Ridges. Ground water yields in the areas underlain by igneous rocks are spotty and variable, and generally only adequate for domestic supply.

No major supply problems currently exist in Somerset County. A high potential for additional development exists in areas underlain by the Brunswick Shale and overlain by extensive deposits of glacial drift.

The Relationship of Regional Ground Water to Surface Stream Flow

Adverse effects on streamflow from ground water pumpage is a serious concern in the heavily urbanized, northeastern half of the Triassic Lowlands Region. The impact on baseflow during low flow periods is evident along portions of the following four major river basins or subbasins:

1. the Ramapo River subbasin in Bergen County;
2. the Whippany River subbasin in Morris County;
3. the Rockaway River subbasin in Hunterdon County and;
4. along the Passaic River basin in Hudson and Bergen Counties.

The construction of regional sewer systems, paving of aquifer recharge areas, and use of storm drains are all responsible for the significant reduction in ground water availability in this area of the Triassic Lowlands.

Unconsolidated glacial deposits cover bedrock aquifers throughout many parts of the Triassic Lowlands Region. When adjacent to a river system, these glacial deposits are often found to be in direct hydraulic connection with the river, as well as with the underlying bedrock. Such situations are common in northern New Jersey. Pumpage from stratified drift deposits flanking a river or lake can reverse original discharge/recharge relationships and lower baseflow levels. This has been documented along the Ramapo River and the Rockaway River and is suspected along the Whippany and Passaic Rivers (Havens et al., 1980).

The Highlands Region

Hydrogeologic Description of the Highlands Region

The Highlands Region occupies the northern most one fourth of New Jersey. Two entire counties and portions of five other counties comprise this region.

Crystalline rock formations, primarily Precambrian gneisses and quartzites, and Paleozoic sedimentary rocks, underly the Highlands Region. Because these formations vary in their ability to resist erosion, this part of the region is characterized by a series of northeast to southwest trending valleys and ridges. The northeast to southwest trend corresponds to the strike of the Highland's formations.

The Precambrian gneisses are generally unproductive rock aquifers that store water only in their limited joint and fracture systems. The sandstone, shale, siltstone, limestone and conglomerate layers which comprise the Paleozoic sedimentary rocks are generally poor aquifers; although they can be productive locally. These rocks also store their available water resources in limited joint and fracture systems.

One major exception to the poor yielding Paleozoic sedimentary rocks is the Kittatinny Limestone. This formation, which underlies portions of Hunterdon, Sussex and Warren Counties, contains very prolific water bearing zones. In this formation, water may be stored in solution cavities where the rock material has dissolved away. Certain units of this formation are an important source of domestic water supply, as well as a municipal, industrial and agricultural water resource.

Unconsolidated glacial deposits cover many areas in the Highlands Region and are an important water source, especially in those areas where the deposits flank rivers. Large withdrawals are noted in stratified drift deposits which are in hydraulic connection with surface water bodies.

Ground Water Usage and Availability in the Highlands Region

The Highlands portion of the State is dominantly rural in nature which has kept the demand for the widespread development of ground water supplies to a minimum. The availability of surface water has also limited the need to develop the area's ground water resources.

The northwestern most tip of Bergen County is underlain by Precambrian gneisses. These rocks generally exhibit poor ground water yields. The northern third of Hunterdon County is also underlain by Precambrian gneiss and carbonate formations. The gneisses have formed ridges which are separated by valleys underlain by Paleozoic carbonates and some shales. High yielding wells in the Musconetcong and Delaware River areas may induce recharge into glacial stratified deposits. The Kittatinny limestone occurs in the northern part of the county and is capable of prolific yields where solution cavities exist.

Approximately seventy percent of Morris County of is underlain by Precambrian gneiss or Paleozoic sedimentary rock (Havens et al., 1980). Secondary permeability, in the form of faults and fractures, throughout much of the Precambrian gneiss allows moderate yields to be withdrawn in many areas of the county. The Paleozoic rocks are very poor aquifers, except for the three narrow belts of Kittatinny Limestone which cross the county from the northeast to the southwest. Solution cavities pervade this formation, making it an extremely prolific water source. About fifty percent of the ground water pumped in the county is derived from the stratified drift found in many areas (Havens et al., 1980). Although some areas of limited ground water availability are being stressed, other areas of high potential exist and should be explored.

The northwestern half of Passaic County is underlain by Precambrian gneisses with a fringe of Paleozoic sedimentary rocks which parallel the western border. Although the gneisses are generally poor aquifers, they are the major domestic water supply source in most of the Highlands Region of Passaic County. The Paleozoic sedimentary formations are generally quite poor aquifers. Small areas are mantled by stratified drift and valley-fill glacial deposits, which have not been explored for the most part. These deposits may locally yield substantial water supplies in the northern section of the county.

The northern-most five percent of Somerset County is underlain by Precambrian gneisses. In this area the gneiss is an extremely poor aquifer (Havens et al., 1980). However, unexplored glacial deposits in some areas may prove to be adequate sources of water.

A northeast-southwest trending belt which covers the eastern thirty-five percent of Sussex County is underlain by Precambrian gneiss and Franklin Limestone (Havens et al., 1980) In this area, domestic supply is dominantly from the gneisses, which provide an adequate and reliable yield. Locally, the Franklin Limestone contains sufficient solution cavities to provide abundant yields; however, generally this formation is not a prolific aquifer. The remaining sixty-five percent of Sussex County is underlain by Paleozoic formations. Two of these formations, the Kittatinny Limestone and the High Falls Formation, yield adequate water supplies; however, both formations are variable. A third formation, the Martinsburg Formation, underlies about thirty percent of Sussex County, (Havens et al., 1980). This formation is a poor aquifer and has limited water availability throughout much of its outcrop area. Glacial deposits occur in many areas of Sussex County, especially along the western border, and are an excellent water supply source. Where these deposits flank rivers, very large production potential exists. More than eighty percent (Havens et al., 1980) of municipal water supplies are derived from ground water or conjunctive use supplies.

The southern thirty percent of Warren County is underlain by a northeast-southwest trending belt of Precambrian gneisses and

Franklin Limestone which are generally very low yield sources of water. Heavy industrial and municipal demands in Phillipsburg and Belvidere Townships likely surpass aquifer recharge, but a great deal of the ground water yield is derived through induced infiltration from the Delaware River into the glacial stratified deposits. However, very little hydrogeologic or water use information has been collected, and a precise evaluation of the magnitude of the problem can not be made. The problem is probably being aggravated in the Phillipsburg Township area by extensive sewer systems. The remaining seventy percent of Warren County is underlain by Paleozoic formations (Havens et al., 1980). Thirty-six percent of the county is underlain by Kittatinny Limestone. In a few localities, fractures, joints and solution cavities do permeate certain units in the Kittatinny Formation and provide abundant water supplies. Another twenty-three percent of Warren County is underlain by the Martinsburg Formation, a very poor water source, but adequate to fill most domestic supply needs (Havens et al., 1980). However, many areas underlain by poor rock aquifers are rural in nature and available surface water has not been developed. Unconsolidated glacial deposits are scattered throughout Warren County and some areas of stratified drift and valley-fill deposits have yet to be explored. Those glacial deposits which have been developed are predominantly deposits adjoining surface water bodies near urban areas.

The Relationship of Regional Ground Water to Surface Stream Flow

The mechanisms which control the balance between baseflow and ground water in the Highlands Region are identical to those which control the balance in the Triassic Lowlands Region. As mentioned in that section of this chapter, Morris, Sussex and Warren Counties have developed stratified drift or valley-fill deposits directly associated with surface water bodies. In addition, exploration of glacial deposits may reveal similar situations in other areas and counties. No major problems exist in the Highlands Region which are associated with the development of aquifers in direct hydraulic connection to surface water systems.

Conclusions - The Triassic Lowlands And Highlands Regions

In summary, the Triassic sedimentary formations, Precambrian gneisses, and Paleozoic sedimentary formations only have been generally delineated in most areas of northern New Jersey. Mapping and exploration of the unconsolidated glacial deposits and bedrock aquifers are severely deficient in many locations, In addition, monitoring of consumption, recharge, and water levels is lacking.

Development of ground water resources in the northern portion of New Jersey has been controlled by local needs. This is due to the advanced age of most heavily urbanized pumping centers or to the site-by-site construction of wells in rural areas. The future growth of northern New Jersey, for industrial, agricultural and municipal requirements, makes it absolutely essential that the following recommendations be implemented:

1. Hydrogeologic exploration and delineation of the available water resources be conducted, including the mapping of unconsolidated and bedrock aquifers of northern New Jersey;

2. Ground water monitoring programs be expanded to gather vital water statistics in northern New Jersey; and

3. The information collected be used to manage the water resources of northern New Jersey on a regional basis.

C. GROUND WATER QUALITY IN NEW JERSEY

Ambient Ground Water Quality

Ambient ground water quality in New Jersey is generally very good; although some areas require treatment. The common ambient quality problems requiring treatment are high iron, high dissolved solids content, high manganese content, acidity, alkalinity, and hardness.

All of the Coastal Plain aquifers have localized problems with high iron. Low pH problems are common in the Potomac-Raritan-Magothy Formation and the Cohansey Sand. Salt water, naturally present in all of the Coastal Plain aquifers, may be the ambient factor most commonly limiting ground water resource development.

Ambient ground water quality in northern New Jersey is generally good. Ground water derived from the Triassic sedimentary rocks of the Triassic Lowlands is quite variable in ambient quality, but is generally suitable for use with little or no treatment. Common ground water quality problems in the Triassic rocks include: high dissolved solids content, high iron content, high manganese content, and hardness. The water derived from the Precambrian gneisses may be high in iron. The Paleozoic sedimentary rocks of the Highlands Region is generally of very good chemical quality; however, high sulfate is frequently reported in the Martinsburg Shale. Carbonate rock aquifers produce water of increased hardness and high dissolved solids. The ambient quality of water derived from the unconsolidated glacial deposits is generally determined by the underlying bedrock. In those areas where pumpage is from stratified drift deposits in hydraulic connection with surface waters, ambient quality may depend upon the quality of the surface water body.

The development of ground water resources is not limited by ambient water quality (except where salt water naturally exists); however, contamination of this resource by man's activities will locally limit available ground water supplies.

Ground Water Pollution

Pollution of New Jersey's ground water resources by man's activities has been documented in all the major aquifers and in all areas of the State. The combination of New Jersey's small size, high population and industrial density, plus our reliance on ground water resources has resulted in a tremendous number of localized contamination incidents, many of which have seriously affected local residents and their water supplies.

Although pollution of potential water resources is a serious management concern, the pollution of ground waters supplying municipal and/or residential wells is an immediate problem. When pollution affects municipal supplies, generally, only one or two wells of a well field are contaminated. These wells can be taken out of service and the money needed to develop new sources or to provide water treatment can usually be raised. However, developing new water sources or expanding treatment processes always results in higher user-charges. On a more severe scale, pollution of residential wells is often devastating to the individual home owner when public water systems are not available. An estimated 500,000 households in New Jersey rely on domestic wells.

The NJDEP Bureau of Potable Water has closed 74 public supply wells and 697 non-public supply wells (domestic and industrial wells serving less than 25 people) since the Bureau was formed in 1971. Of the 771 wells closed by the Bureau of Potable Water, over 90 percent were contaminated by organic and industrial chemicals, mainly volatile organic compounds.

In addition to the high level contamination found, which occurs in wells as a direct result of point source pollution discharges; low level contamination of ground water by chemicals which have been ubiquitously distributed in the environment is suspected. A study of ground water conducted by the NJDEP Office of Cancer and Toxic Substances Research examined 1118 samples from 670 wells in the State. Fifty chemicals from three major chemical groups - halogenated volatile organics, chlorinated pesticides and related compounds, and metals were tested for. Thirty-one wells were found to be seriously contaminated with one or more of the chemical groups. Twenty-eight wells showed halogenated volatile organic contamination greater than 10 parts per billion, twenty-nine wells exceed the potable water standards for metals, and thirty-one wells had pesticide concentrations exceeding drinking water standards (Tucker, 1981).

Tucker has hypothesized that, "low level concentrations of volatile organics may occur in wells subject to wide spread contamination by a variety of mechanisms including aerial transport and recharge from surface water" (Tucker, 1981). While metals and pesticides tend to be caught up in the materials of the aquifer, the halogenated volatile organic compounds tend to move easily with the ground water flow and persist in the subsurface environment. The widespread use and cancer causing potential of these substances combine to make them a serious threat to our ground water resources.

Many causes of ground water pollution exist. Identification and control of contamination problems which occurred in the past, before the impact of various activities were understood, is an immense and expensive task. In addition to managing abandoned or technologically outdated sites; monitoring and regulatory control of operating and new sites is essential if pollution of the ground waters is to be prevented.

The following sections of this report will briefly describe the seven major sources of ground water pollution (see Table IV-1).

Table IV-1 Classification of Sources and Causes of Ground Water Pollution.

WASTES		NON-WASTES	
CATEGORY I	CATEGORY II	CATEGORY III	CATEGORY IV
Systems, facilities or activities designed to discharge waste or waste waters (residuals) to the land and ground waters	Systems, facilities or activities which may discharge wastes or waste waters to the land and ground waters	Systems, facilities or activities which may discharge or cause a discharge of contaminants that are not wastes to the land and ground waters	Causes of ground water pollution which are not discharges
LAND APPLICATION OF WASTE WATER - spray irrigation, infiltration-percolation basins, overland flow	SURFACE IMPOUNDMENTS - waste holding ponds, lagoons and pits	BURIED PRODUCT STORAGE TANKS AND PIPELINES	SALT-WATER INTRUSION - sea water encroachment, upward coning of saline ground water
SUB-SURFACE SOIL ABSORPTION SYSTEMS - (septic systems)	LANDFILLS AND OTHER EXCAVATIONS - landfills for industrial wastes, sanitary landfills for municipal solid wastes, landfills for municipal water and waste water treatment plant sludges, other excavations (e.g., mass burial of livestock)	STOCKPILES - highway deicing salt stockpiles, ore stockpiles	RIVER INFILTRATION
WASTE DISPOSAL WELLS AND BRINE INJECTION WELLS	ANIMAL FEEDLOTS	APPLICATION OF HIGHWAY DEICING SALTS	IMPROPERLY CONSTRUCTED OR ABANDONED WELLS
DRAINAGE WELLS AND SUMPS	LEAKY SANITARY SEWER LINES	PRODUCT STORAGE PONDS	FARMING PRACTICES - (e.g., dry land farming)
RECHARGE WELLS.	ACID MINE DRAINAGE	AGRICULTURAL ACTIVITIES - fertilizers and pesticides, irrigation return flows	
	MINE SPOIL PILES AND TAILINGS	ACCIDENTAL SPILLS	

Source: Schiffman (1982).

Landfills

A substantial portion of the ground water contamination in New Jersey is associated with the land disposal of municipal and industrial wastes. Three hundred registered landfills exist in the State, (seven of which are lined), along with 134 known abandoned landfills and illegal dumpsites. The NJDEP Hazardous Site Mitigation Administration has identified 134 landfills and dumpsites in New Jersey which are contaminating or are suspected of contaminating ground water.

Because landfills have been located in all parts of New Jersey point source pollution discharges from these facilities are widespread occurrences. Most landfills were sited in the past, before their potential for polluting ground water was recognized. At that time, site locations were determined by low property values, proximity to the waste producers, and availability of soil cover. Typically, low property value meant abandoned sand pits, and marshes or other areas unsuitable for building because of high water table levels. Relative proximity to municipal or industrial waste producers reduced transportation costs. Often, the upper soil layers of the property were excavated, to bedrock, for use as a waste cover and to deepen the available fill space. Unfortunately, these are precisely the site characteristics and conditions which provide landfill leachate with a direct channel to the ground water table. These are also the characteristics and conditions which result in the greatest environmental and human impact. Table IV-2 presents the approximate amount of landfill leachate generated in each of the State's geologic provinces.

Landfill leachate is a highly mineralized chemical "soup" which is formed as water percolates through the filled wastes. Although the chemical composition of leachate varies with the nature, mixture and volume of the landfilled wastes, leachate typically contains chloride, iron, lead, copper, sodium, nitrate, numerous organic chemicals, exotic metals, pathogens and toxic substances, (Tables IV-3 and IV-4).

Precipitation, surface runoff, moisture contained in the waste, moisture derived from decomposition or reaction of the waste, or from ground water entering the fill through its sides or bottom provides the liquid base for landfill leachate. The typical location and construction of landfills will tend to increase the amount of ground water available for leachate generation. In Havens et al. (1980) it has been estimated that an average landfill in New Jersey generates approximately 18.7 million gallons of leachate per year. Given the 300 registered landfills and 134 known abandoned sites, roughly 7 billion gallons of leachate will be generated in New Jersey each year. Much of this leachate will enter our ground water systems.

Landfills continue to produce contaminating leachate long after operations cease, but proper closure, including a relatively

Table IV-2 Approximation of the Amount of Leachate Generated Within Each Geologic Province in New Jersey.

Geologic Province	Geologic Formation	Number of Landfills	Volume of Leachate Generated per Landfill (million gal./year)	Total Volume of Leachate Generated (billion gal./year)
Highlands		27	18.7	504
Triassic Lowlands	Sandstones, shales, etc.	58	18.7	1,083
Coastal Plain	Potomac/Magothy/Raritan	54	18.7	1,009
	Englishtown	6	18.7	112
	Mt. Laurel/Wenonah	7	18.7	130
	Kirkwood	14	18.7	261
	Cohansey	89	18.7	1,664

Source: Havens _et_ _al_. (1980).

Table IV-3 Summary of Leachate Characteristics From Municipal Solid Wastes (Constituents in ppm, except pH).

Constituent	Median Value	Ranges of All Values
Alkalinity ($CaCO_3$)	3,050	0 -20,850
Biochemical Oxygen Demand (5 days)	5,700	81 -33,360
Calcium (Ca)	438	60 - 7,200
Chemical Oxygen Demand (COD)	8,100	40 -89,520
Copper (Cu)	0.5	0 - 9.9
Chloride (Cl)	700	4.7 - 2,500
Hardness ($CaCO_3$)	2,750	0 -22,800
Iron, Total (Fe)	94	0 - 2,820
Lead (Pb)	0.75	< 0.1 - 2
Magnesium (Mg)	230	17 -15,600
Manganese (Mn)	0.22	0.06- 125
Nitrogen (NH_4)	218	0 - 1,106
Potassium (K)	371	28 - 3,770
Sodium (Na)	767	0 - 7,700
Sulfate (SO_4)	47	1 - 1,558
Total Dissolved Solids (TDS)	8,955	584 -44,900
Total Suspended Solids (TSS)	220	10 -26,500
Total Phosphate (PO_4)	10.1	0 - 130
Zinc (Zn)	3.5	0 - 370
pH	5.8	3.7 - 8.5

Source: Havens et al. (1980)

Table IV-4 Components of Industrial Waste.

	Metals Mining	Primary Metals	Pharmaceuticals	Batteries	Inorganic Chemicals	Organic Chemicals	Pesticides	Explosives	Paints	Petroleum Refining	Electroplating
Ammonium salts		X								X	
Antimony	X				X				X		
Arsenic	X	X	X		X					X	
Asbestos					X				X		
Barium									X		
Beryllium	X									X	
Biological waste			X								
Cadmium	X	X		X	X				X	X	X
Chlorinated hydrocarbons					X	X			X		X
Chromium		X	X	X	X				X	X	X
Cobalt									X	X	
Copper	X	X	X	X					X	X	X
Cyanide		X			X					X	X
Ethanol waste, aqueous			X								
Explosives (TNT)								X			
Flammable solvents						X			X		
Fluoride		X			X						
Halogenated solvents			X								
Lead solvents	X	X		X	X				X	X	X
Magnesium	X										
Manganese		X									
Mercury		X	X	X	X				X	X	
Molybdenum										X	
Nickel		X		X	X					X	
Oil		X								X	X
Organics, miscellaneous						X					
Pesticides (organophosphates)							X				
Phenol		X								X	X
Phosphorus					X						X
Radium	X										
Selenium	X	X	X							X	
Silver				X						X	X
Van adium										X	
Zinc	X	X	X	X	X				X	X	X

Source: Havens _et_ _al._ (1980).

impervious cap and leachate collection system may reduce leachate impact.

Surface Impoundments

Surface impoundments are defined as lined or unlined, natural or man-made depressions, or diked areas which are used for the holding, treatment, storage or percolation of waste waters or waters containing waste. Typically, industrial surface impoundments are called basins, pits, ponds or lagoons. Contamination of the ground water by this source is caused either by improper design, accidental breaching, failure of an impoundment, or the common belief that the impoundment will seal itself if it contains various sludges.

Three hundred and fifty-six surface impoundment sites have been identified in the State. Impoundments exist in every county; however, they are somewhat more concentrated in the heavily industrialized areas of the State, especially from Elizabeth to Trenton and along the Delaware River. A 1979 study conducted by the NJDEP Bureau of Ground Water Management (Hutchinson, D'Angelo and Sweigart, 1980) found that of the over 200 impoundment sites assessed for their potentially adverse impact on ground water, sixty-five percent of the impoundments are unlined and unmonitored. Slightly more than ten percent of the unlined and unmonitored sites were rated very high in their potential adverse impact upon the ground water. In addition, some leakage is expected from lined impoundments. Artificial linings commonly rupture and natural liners, such as clay, are not totally impermeable.

Active impoundments are now subject to environmental controls under New Jersey's permit programs; however, abandoned impoundments which still retain sludges from their original contents pose a great threat to the ground water system. The forty-six known abandoned surface impoundments and the unknown sites which have been covered by fill material, will continue to contribute additional volumes of leachate to the ground water system.

Based upon the estimate in Havens et al. (1980) that twenty million gallons of liquids leak each year from an average impoundment, approximately 6 billion gallons of liquid will enter New Jersey's ground water each year from the more than one thousand acres of existing impoundments.

The chemical composition of the liquids leaked from surface impoundments varies with its contents, but can generally be classified according to major Standardized Industry Code (SIC) category (Table IV-5). As can be seen in Table IV-5, the chemical composition of impoundment liquids percolating into the ground water system presents a serious and dangerous pollution problem.

Table IV-5 Industrial Waste Water Parameters Having or Indicating Significant Ground Water Contamination Potential.

<u>PAPER AND ALLIED PRODUCTS</u> (Pulp and Paper Industry)

Ammonia	Nutrients (nitrogen and phosphorus)	
Chemical Oxygen Demand	pH	
Color	Phenols	Total Dissolved Solids
Heavy Metals	Sulfite	Total Organic Carbon

<u>PETROLEUM AND COAL PRODUCTS</u> (Petroleum Refining Industry)

Ammonia	Iron	Sulfate
Chloride	Lead	Sulfite
Chromium	Mercaptans	Total Dissolved Solids
Chemical Oxygen Demand	Nitrogen	Total Organic Carbon
Color	Odor	Total Phosphorus
Copper	pH	Turbidity
Cyanide	Phenols	Zinc

<u>PRIMARY METALS</u> (Steel Industries)

Ammonia	Iron	Sulfate
Chloride	pH	Tin
Chromium	Phenols	Zinc
Cyanide		

<u>CHEMICALS AND ALLIED PRODUCTS</u> (Organic Chemicals Industry)

Chemical Oxygen Demand	pH	Total Nitrogen
Cyanide	Phenols	Total Organic Carbon
Heavy Metals	Total Dissolved Solids	Total Phosphorus

Source: Havens <u>et</u> <u>al</u>. (1980).

Accidental Spills

The NJDEP Division of Waste Management reported 2,512 petroleum and chemical spills in 1981 (Table IV-6). Examination of Table IV-6 shows that this number has increased each year since FY 1977 and that the magnitude of the problem has reached the order of millions of gallons and hundreds of thousands of pounds per year. Thus, a significant amount of contaminating materials is entering the water systems of the state from this pollution source.

The New Jersey Division of Waste Management (1981) prepared the following evaluation of the problem for this report:

> "The pollution of water by oil and chemical spills is pervasive throughout New Jersey. While this impact seems to fall on the surface water and ground water, the effects on the latter are probably more severe. This is due in large measure to the well-established response capability and technology available to (1) prevent entry of pollutants into surface waters, and (2) remove them after entry. In the case of ground water contamination, however, removal is much more difficult and expensive, and frequently technologically infeasible. Also, the sources of ground water pollution are generally more difficult to trace and eliminate.
>
> Sources of water pollution other than spills, can, of course, be enumerated. However, these are generally point sources, such as NJPDES permitted discharge points, or stationary abandoned sites. Once determined, they can be isolated and removed as a source. Spills, on the other hand, occur everywhere with increasing frequency (e.g., 980 reported in FY 77 and 2,512 in FY 81). While area sources such as rainwater runoff have a huge areal coverage, the pollutants involved are usually not as toxic, or in as high a concentration as those associated with spills. We believe that chemical incidents such as fires and spills represent the greatest danger to the water quality of New Jersey."

Ground water experts from the New Jersey Geological Survey are called in only on the most severe (less than 10 percent) of spill incidents. Despite the increased number of spill investigations involving hydrogeologists each year, the number of spills which can be adequately investigated is severely limited. Currently, about sixteen percent of the Survey's Ground Water Pollution Analysis Program workload is accidental spill related cases. The number of pollution incidents seriously hamper effective ground water clean-up from this pollution source.

Underground Storage Tanks And Pipelines

Underground storage tanks and buried pipelines are responsible for a substantial portion of the accidental spills reported above. Large storage tanks are concentrated in the industrial areas of New Jersey; however underground tanks are located

TABLE IV-6 Summary of Spill Response FY 1977 to 1981 Division of Waste Management (formally Division of Hazard Management)

	FY 77	FY 78	FY 79	FY 80	FY 81	Total
Number of Spills Reported	980	1,299	1,618	2,123	2,512	8,532
Number of Spills Quantity Unknown	227	609	585	927	902	3,250
Petroleum Spilled						
Gallons	-	1,959,917	758,106	7,650,996	707,341	11,076,360
Drums	-	-	-	497	918	1,415
Chemicals Spilled						
Gallons	-	218,240	266,769	220,221	524,280	1,229,510
Drums	-	-	-	8,987	13,707	22,694
Pounds	-	-	-	190,919	317,677	508,596
Total Spillage						
Gallons	1,340,207	2,753,955	1,024,875	7,871,217	1,231,621	14,221,875
Drums	-	-	-	9,484	14,625	24,109
Pounds	-	-	-	190,919	317,677	336,696
Total Covered On-Scene						
Gallons	901,274	2,389,561	524,134	7,580,270	503,049	11,898,288
Drums	-	-	-	8,723	12,508	21,231
Pounds	-	-	-	55,528	166,954	222,482

NOTE: A bar (-) indicates that data was not recorded in that format at that time. Totals may be higher than petroleum + chemical due to reporting changes during fiscal year.

Ascan be seen from the table, during the five-year period, a total of 14,221,875 gallons, 24,109 drums and 336,696 pounds of hazardous materials was known to have been released within New Jersey. However, of the total of 8,532 spills reported, quantities were indeterminate for 3,250 (38%).

throughout the State. The major petroleum transportation pipelines run parallel to the Delaware River to Trenton and northeast to Bayonne.

Major leaks from pipelines and large capacity tanks are serious problems; however, these incidents are easily detected due to the volume of material lost. The more pervasive problem is the literally thousands of smaller, long-term leaks which generally go undetected. In 1977, Simon estimated that approximately 8,500 gasoline service stations existed in New Jersey, each with an average on-site storage capacity of 10,000 gallons (Havens, et al., 1980).

Low volume leakage from gasoline station tanks, industrial storage tanks, and home fuel storage tanks is quite common after 15 to 20 years of service. Even though routine maintenance on smaller tanks is almost non-existent, where it does occur, evaporation and normal losses often mask the leakage. Therefore, these incidents go uninvestigated unless nearby wells are contaminated. Rupture, external corrosion, and structural failure of a tank, pipebody or joint can cause the loss of petroleum or chemical product.

Because tanks and pipelines are buried, lost material may have direct access to the ground water systems in the State. Often, the older structures were inadvertently placed directly in outcrop/recharge areas for some of New Jersey's most productive aquifers. Fifty percent of the large capacity storage facilities (Havens et al., 1980) are located over productive Triassic aquifers or the Potomac-Magothy-Raritan outcrop area (Table IV-7).

Municipal Sewer Systems

Another threat to New Jersey's shallow ground water resources is long term, low level, pervasive leakage from municipal sewer system pipelines. In the older urbanized areas of the State, especially in Bergen, Essex and Union Counties, original municipal sewer systems are contributing to aquifer degradation (Havens et al., 1980).

Defective pipes, corroded pipes, ruptured pipes, differential settling, and joint failure have all combined to result in the loss of thousands of gallons of sewage above the unavoidable leakage inherent in all systems. Commonly, 1,000 to 2,000 leak prone mortar sealed pipe joints per mile of pipeline exist in older systems (Havens et al., 1980). The significance and potential adverse effects from the older systems increases when industrial wastes are released into sewer systems.

Contamination from this source is not monitored or investigated unless wells are affected. Havens et al. (1980) recommends that all sewer systems over 40 years of age should be considered leak

Table IV-7 Major Storage Facilities and Geologic Provinces Within New Jersey.

Geologic Province	Formation	Petroleum Storage No.	Petroleum Storage Percent	Chemical or Chemical and Petroleum Storage No.	Chemical or Chemical and Petroleum Storage Percent
		Product Storage Type			
Highlands	-	3	3.5	1	2
Triassic Lowlands	Triassic formations	43	50.5	20	41.6
Coastal Plain	Potomac/Magothy/Raritan	21	24.7	19	39.5
	Englishtown	1	1.1	0	0
	Mt. Laurel/Wenonah	2	2.4	0	0
	Kirkwood	1	1.1	1	2
	Cohansey	9	10.5	2	4.1
	Non-aquifer formation	3	3.5	3	6.2
	Facilities not located on map	2	2.3	2	4.1
	TOTAL:	85	99.6	48	99.5

Note: All facilities have a minimum capacity of 400,000 gallons.

Source: Havens et al. (1980)

prone and investigated in order to detail their potential threat to ground water quality.

On-Site Wastewater Disposal Systems

On-site wastewater disposal systems, (e.g., septic tanks and cesspools) are designed to directly discharge large volumes of domestic wastewater into the ground. Properly designed and functioning systems theoretically should separate and retain the solids, while allowing the liquids to percolate into the ground for treatment.

The human and household wastes which generally enter these systems contain a host of potentially contaminating substances; however, the common pollution concerns are: nitrates, sulfates, bicarbonates, dissolved solids, synthetic detergents, water treatment chemicals and organic compounds. Generally, phosphates, bacteria, viruses and pathogens are removed by the system before they reach the ground water.

These systems exist in every county in New Jersey (Table IV-8). Bergen, Monmouth, Morris and Ocean Counties have 50,000 units or more (Havens et al., 1980). In any given area the total number and density of on-site wastewater disposal systems are factors that will determine whether ground water contamination from this source may become a local or regional problem.

Improper design of on-site wastewater disposal systems, poor siting, overloading, malfunction and poor maintenance are the typical causes of system failure. When systems are operating properly, on-site wastewater disposal systems provide recharge to the local aquifer and represent non-consumptive use of water resources. Hundreds of domestic water supplies have been contaminated from this pollution source; although most have functioned properly since installation.

Other Sources of Ground Water Pollution

Three other common sources of ground water pollution of concern in New Jersey are agricultural practices, highway deicing practices, and spray irrigation of wastewaters.

There are approximately one million acres (Havens et al., 1980) of open agricultural land in the State. The improper application, accidental spillage and casual disposal of fertilizers, pesticides, herbicides, soil conditioners and animal wastes pose threats to ground water resources. Although the volume of agricultural chemicals used in New Jersey is large; the potential impact upon potable water supply wells from this source is generally low because agricultural areas tend to be removed from areas of ground water pumpage and the high cost of agricultural chemicals dictates the use of best management practices. Most contamination cases from this source involve

Table IV-8 Comparison of Housing Units Served by Sewers to Housing Units Served by Septic Systems.

County	Total Housing Units (year-round)	Sewage Disposal: Public Sewer	Sewage Disposal: Septic Tank or Cesspool	Sewage Disposal: Other	Area (sq mi)	Density of Septic Systems (units/sq mi)
Atlantic	67,801	47,526	19,774	501	569	34.7
Bergen	283,575	234,545	48,589	441	234	207.6
Burlington	87,758	69,438	17,614	695	819	21.5
Camden	143,150	131,722	10,820	600	221	48.9
Cape May	28,335	17,305	10,830	239	267	40.5
Cumberland	38,932	22,020	15,853	1,030	500	31.7
Essex	311,566	308,321	2,717	519	130	20.9
Gloucester	51,075	32,652	17,865	566	329	54.3
Hudson	214,665	213,634	676	343	47	14.3
Hunterdon	22,116	5,096	16,653	403	423	39.3
Mercer	96,401	86,233	9,861	306	228	43.2
Middlesex	171,599	160,313	10,956	328	312	35.1
Monmouth	142,927	89,517	52,686	773	476	110.6
Morris	113,033	63,804	48,605	594	468	103.8
Ocean	80,460	33,040	46,973	435	642	73.1
Passaic	151,093	135,124	15,515	407	192	80.8
Salem	19,408	10,631	8,110	679	365	22.2
Somerset	58,149	40,201	17,618	330	307	57.3
Sussex	24,415	4,366	19,739	384	527	37.4
Union	174,328	173,246	958	113	103	9.3
Warren	24,553	12,243	11,829	437	362	32.6

Source: Havens <u>et al</u>. (1980).

individual farm water supplies. The problem of excessive fertilizer application is also common in many residential areas.

The use of sodium and calcium chloride provides state and local agencies with an efficient and low cost method for deicing roadways in the winter. Pollution from this source is a result of the brine solution, which is formed when rainwater or snowmelt runoff dissolves salt on roadways and in stockpiles, recharges the ground water or discharges to a surface water body.

The amount of salt used on any given roadway is determined by roadway conditions and operator training, and can range from several hundred pounds to tens of tons of salt per road-lane mile (Havens et al., 1980). Salt stockpiles exist throughout New Jersey, and the State's storage facilities can accommodate up to 80,000 tons (Havens et al., 1980). Where these stockpiles are left uncovered, considerable volumes of salt can be lost to the environment. Nearly all state-owned facilities now keep salt in buildings, however, non-state-owned saltpiles still exist.

Industrial, municipal and domestic wastewaters are treated by spray irrigation or land application in several localities in New Jersey. These systems are designed so that during percolation of wastewater through the soil, contaminants will be adsorbed onto soil particles or by plant cover. However, the effectiveness of this type of treatment system depends on the composition of the wastewater or waste, the soil, the hydrology of the site, proper application rates and the extent of wastewater pretreatment and stabilization. However, as long as continued ground water and surface water monitoring accompanies these facilities and the soil is not overloaded, such practices pose no serious threat to the ground water resources of the State. Where these facilities do function effectively, water recharges local aquifers and nutrients are utilized by vegetation. Where the systems are not functioning properly contaminants infiltrate into the shallow ground water system or leach into nearby streams and waterbodies.

Conclusions

It has been estimated that the millions of gallons and pounds of contaminants entering New Jersey's ground water from thousands of existing pollution sources will create a loss, over the next several decades, of 40 to 50 million gallons a day (mgd) of potable ground water supplies (Havens et al., 1980). This is a substantial portion of the estimated 750 mgd of ground water used in New Jersey (Schiffman, 1982).

Once contaminated, ground water is very difficult to clean up and numerous, costly technical problems are involved in aquifer restoration. Since 1975 the Pollution Analysis Program of the N.J. Geological Survey has investigated 164 accidental spill cases, 24 illegal dumping cases, 157 industrial pollution cases, 27 landfill pollution cases and 4 septic system pollution cases. Because all of the substantial pollution cases are investigated, there is an enormous workload, which at any given time averages to 30 or more cases per person. Meanwhile, the number of ground water pollution sites continues to grow and long term cases with extended clean up and protracted enforcement actions drain the limited available staff and funding resources.

Generally, however, ground water pollution is a limited and localized problem which extracts its greatest toll on the individual well owner or the local community who must cope with the financial burden of obtaining an alternate water supply sources. As Clark (1978) stated:

> "Municipal landfills or chemical/petroleum spills can result in polluted ground water over areas measured in square miles. Surrounding these areas of ground water pollution, however, are tens and hundreds of square miles of area where the ground water moving through the aquifer maintains its natural good quality. The ratio of good quality to contaminated water is such that ground water pollution can really only be considered a limited problem."

Still, given New Jersey's small size and high population and industrial densities, by allowing numerous localities to go without assistance in ground water pollution and water resource development, a barrier to economic revival and development can be created. Ground water resource development and protection, and aquifer restoration will require major investments in New Jersey in the 1980s. This includes adequate funding for programs dealing with permitting, monitoring and enforcement activities.

D. GROUND WATER MANAGEMENT PRACTICES IN NEW JERSEY

The following section briefly explains the various ground water management practices currently utilized in New Jersey.

Diversion permits, the first topic discussed regulates the quantity of ground water pumped from the State's aquifers. A legislative background of efforts to protect the ground water supply since 1907 is presented. Current practices involving the Water Allocation Office are discussed. This includes application and review procedures, to whom permits are issued, and the amounts allocated.

Next, the New Jersey Pollutant Discharge Elimination System (NJPDES), designed in part to help protect the quality of the State's ground water supplies, is briefly discussed. Although technically the discussion of NJPDES should come under the ground water monitoring programs section of this section, the effects of this program deserve discussion on their own merit. This section includes requirements for ground water dischargers, special regulations governing hazardous waste facilities, and on-site subsurface sewage disposal systems.

The third topic covered is ground water monitoring programs currently underway in the State. Included are brief descriptions of programs administered by many federal, state, and county agencies in New Jersey.

Water Allocation (Quantity Protection)

Legislative Background

The Water Supply Commission was created by the New Jersey Legislature in 1907 to control all public supplies, and in 1910 an amendment was passed to specifically include public supplies from ground water. Withdrawal of water was not regulated prior to 1907. In 1945, the Commission's name was changed to the Water Policy and Supply Council.

The "Ground Water Law" of 1947 granted the Council the power to designate areas as "protected for ground water supply" (New Jersey Annotated Statute 58:4A-1). This enabled the Council to regulate ground water withdrawals in areas found to be threatened. The entire State is now designated as a protected ground water area.

The Council was abolished in 1981 and its functions were delegated to the newly established Water Allocation Office, NJDEP.

When granting a permit, the Division may require recording of water level and water quality data from production wells and observation wells. The applicant is usually required to begin construction of the well within six months to one year after the permit is issued and to complete construction within two years. If the construction is not completed within this period and the applicant does not request an extension of time, he loses his right to the water. This usually occurs when the projected demand for water does not materialize, making additional wells or pumpage unnecessary.

Inspections

NJDEP officials inspect many newly installed wells for compliance with permit criteria and to establish deadlines for correcting any failures or omissions. Not all new wells are inspected, but when permit requirements (i.e. submission of chemical analysis or pumpage data) are not met, an inspection may be made and the well owner given a time limit to comply. Continued failure to comply may result in action by the Attorney General's Office, revocation of the diversion permit and/or the imposition of a fine.

Administration

Ground water withdrawals throughout the State are regulated by the Water Allocation Office. The primary purpose of the office's program is to manage existing water supplies within each basin to insure adequate supplies for present and future needs. The program is based upon uniform permit systems for drilling wells and allocating water diversions from surface and subsurface water sources. Both systems are supported by a fee schedule to defray the cost of program operations and a monitoring program to measure water usage. In addition, inspection programs have been instituted to insure that wells are properly constructed, to prevent aquifer contamination, to properly measure diversion, to verify safe yield and to insure that abandoned wells are properly sealed. A licensing and certification program insures that well drillers, pump installers and well sealers are properly qualified. The Water Allocation Office also calculates and bills purveyors for excess diversions as defined by law.

Diversion Permits - Application and Review Process

The Water Supply Management Act of 1981 requires that all existing permits be reissued; and all grandfather users be issued appropriate permits. A diversion permit must be obtained by anyone planning to withdraw ground water at a rate in excess of 100,000 gpd. A diversion permit is not required for a private well with a pump capacity of less than 70 gallons per minute (gpm); although a construction permit to drill the well must be secured from the NJDEP. Wells with pump capacities over 70 gpm are excluded from permit requirements, provided that daily pumpage can be documented to be within the 100,000 gpd limit. However, permits to divert ground water for public potable use must be acquired regardless of the daily withdrawal rate.

Upon receipt of a ground water diversion permit application, a hearing date is set and potential objectors are notified.

Potential objectors notified include public suppliers within a 5 mile radius and private well owners within a one-mile radius who have diversion permits. NJDEP geologists and other personnel may present data at the hearings to support or refute any objections to an application.

A withdrawal permit indicates the amount of water that may be withdrawn, the pump capacity, and the depth from which the water may be withdrawn. All withdrawals must be metered with monthly pumpage reported to the Division of Water Resources on a quarterly basis.

Current Water Allocations

There are more than 1,000 diversion permits granting rights to nearly one billion gpd of ground water. The Water Allocation Office projects that approximately 30,000 well permits will be issued in FY's 82-84. In addition, 1,050 water allo- cation permits will be issued over the same period.

Ground Water Quality Protection

The New Jersey Pollutant Discharge Elimination System

Effective in March, 1981, NJPDES regulations were promulgated pursuant to several legislative acts. It is the purpose of these regulations, with respect to ground water resources, to:

1. Restore, enhance, and maintain the chemical, physical, and biological integrity of the waters of the State;
2. Protect public health and safety;
3. Protect potable water supplies;
4. Enhance the domestic, municipal, recreational, industrial, agricultural and other uses of water; and
5. Prevent, control, and abate water pollution and to implement the New Jersey Water Pollution Control Act, N.J.S.A. 58:10A-1 et seq.

The NJ Water Pollution Control Act provides for the above through the NJPDES Permit Program. Permits are required for all facilities which impact ground water supplies around the State. This includes facilities which:

1. Discharge pollutants to ground waters;
2. Use land application of residuals;
3. Use land application of municipal and industrial wastewaters;

4. Discharge leachate into the ground water from facilities under the jurisdiction of the Solid Waste Management Act, (N.J.S.A. 13:1E-1 et seq.);

5. Store any liquid or solid pollutant, in a significant quantity, in a manner designed to keep if from entering the waters of the State (e.g., chemical and oil storage tanks); and

6. Discharge pollutants into wells.

Requirements For Discharges To Ground Water

All discharges of pollutants to the ground water or onto land which might flow or drain into State waters must be accompanied by a monitoring program. A new source shall not discharge to ground water prior to installing a ground water monitoring system which satisfies all NJPDES requirements and has been approved by the Department. It is essential that the monitoring program provide adequate data over a sufficient period of time to accurately represent conditions and variations of background ground water quality and the hydrologic characteristics of the site area. More importantly, it is imperative that the monitoring program be sufficient to ensure protection of ground water resources.

In the case of hazardous waste facilities, the program must consist of monitoring wells installed hydraulically upgradient from the limit of the waste management area. The samples collected from these wells must be representative of background water quality and must not be affected by the facility. In addition, there should be at least three wells installed downgradient at the limit of the waste management area. The purpose of such a monitoring program is to detect any significant impact of hazardous waste constituents on the ground water flowing beneath the facility.

Administrative/Scientific Data Systems

The NJPDES permit program utilizes the RAMIS system as an application tracking system. As an administrative data base, RAMIS maintains records for every NJPDES application processed by the Division of Water Resources. When an application is received by the Office of Permits Administration, a NJPDES number is assigned to the facility and the appropriate application tracking forms are completed with information from the application. Whenever a milestone (such as the date the facility was inspected, date of public notice, date permits is certified, etc.) occurs, the RAMIS file is updated. Once a permit is issued, the record is transferred from the application tracking file to the billing file.

The permit tracking system maintains records of compliance with the Solid Waste Administration and NJPDES requirements, including submission of quarterly reports of ground water quality monitoring at landfills throughout the State. The system produces violation summaries for facilities not in compliance through the compliance tracking system.

Periodically, all actual ground water chemical quality data is transferred, by the N.J. Geological Survey, to the EPA STORET system, which serves as a repository and scientific data base. This data, which is entered, maintained, reviewed and analyzed on a regular basis, by the Survey, results in water quality assessments and recommendations. The Survey develops and uses digital computer ground water models, statistical packages and graphical programing to assist in the assessment and evaluation of the available ground water compliance monitoring data.

Ground-Water Monitoring Programs

There are 15 government agencies engaged in some form of data collection related to ground water in New Jersey. They are briefly described below.

USEPA, Region II, Surveillance and Analyses Division

The major purpose of the EPA monitoring program is to characterize ground water contamination associated with hazardous waste sites. Monitoring is undertaken at select hazardous waste sites located throughout the State. Sites having the greatest priority are sampled regularly and the remaining sites are sampled at intervals determined by their potential hazard. The chemical parameters examined consist of the 129 priority pollutants shown in Table IV-9. The samples are analyzed at an EPA laboratory. The information generated by the EPA ground water monitoring program is stored in the STORET computer data base system, where it is readily accessible for tabulation or statistical calculations.

US Geological Survey, Water Resources Division (USGS/WRD), Trenton District Office

The USGS conducts two types of ground water monitoring programs: long-term basic data gathering programs and short-term special projects. All programs are conducted as joint, cooperative programs between the USGS and the Division of Water Resources, NJDEP. The two types of data gathering programs are designed to monitor and evaluate the quality and quantity aspects of the ground water supplies within the State. Short-term special projects are conducted in response to ground water contamination or supply problems discovered during analysis of data generated by the two existing long-term monitoring programs: the Salt Water Encroachment Monitoring Network and the Synoptic Water Level Monitoring Program.

The Salt Water Encroachment Monitoring Network consists of approximately 500 wells located in 9 coastal and estuarine counties of the New Jersey Coastal Plain. The program's purpose is to delineate and document salt water intrusion into New Jersey's aquifers. Two hundred of the wells are sampled annually for 16 physical parameters; including temperature, specific conductance, altitude, depth of well, water level, depth to sample interval, pump or flow period, instantaneous flow rate, pH and dissolved chloride.

The Synoptic Water Level Monitoring Program consists of a network of 175 wells distributed throughout the New Jersey Coastal Plain. The program's purpose is to document changes in the piezometric water levels of the major aquifers. Ninety six of the network well are measured manually on a semi-annual basis. Fifty-one of the network wells are equipped with water level recorders and are field-measured on a quarterly basis. Twenty-eight of the network wells are equipped with automatic water level recorders (analog or digital) and are measured on an hourly basis. All wells are tested for twenty-four parameters; altitude, water level, drawdown, specific capacity, etc.

Some of the short-term special projects have included:

1. Water Quality in the Potomac-Raritan-Magothy Aquifer System;

2. Synoptic Water Level Project;

3. Saltwater Intrusion into the Old Bridge Aquifer in the Keyport-Union Beach area of Monmouth County; and

4. Subsidence in the Atlantic City area of Atlantic County, New Jersey.

The information generated by the various USGS programs and projects is stored in the USGS in-house computer system or is transferred to the federal WATSTORE system. This information is periodically transferred into the EPA STORET system.

Delaware River Basin Commission (DRBC)

The DRBC monitoring program examines ground water quality and quantity at specific sites within the Delaware River drainage basin. The DRBC collects water level information on approximately 1,800 wells, usually on a monthly basis. The water level, latitude/longitude and the aquifer are then stored in DRBC files. Ambient ground water information is usually collected only for specific projects.

NJDEP, DWR, Bureau of Monitoring and Data Management

This bureau does not currently maintain a ground water monitoring program, but plans are under way to begin ground water monitoring to supplement the Bureau's cooperative surface water program with USGS. The bureau is also involved in promoting communication among agencies which do not have monitoring programs or are interested in existing programs. In addition, the Bureau of

Monitoring and Data Management has assisted sub-state agencies in creating their own monitoring programs.

NJDEP, DWR, Bureau of Potable Water

This bureau has a threefold raw ground water monitoring program: when requested they test for contamination of drinking water wells (tap water); test raw water from new ground water public supplies; and inspects all water supply company wells and municipal supply wells. The bureau collects approximately 300 to 500 ground water samples per year. Generally, these wells are sampled for pH, hardness, heavy metals and volatile organics. The data is stored in paper files in the bureau's office.

NJDEP, DWR, Bureau of Ground Water Discharge Permits

This section does not conduct a ground water monitoring program; however, now that New Jersey has adopted the New Jersey Pollutant Discharge Elimination System, the monitoring required by the permits is determined and reviewed by this section. In addition, this section is responsible for the Individual Subsurface Sewage Disposal Systems Regulations (Chapter 199) and will perform courtesy reviews for local government agencies, as well as review major subdivisions and alternate disposal systems as requested.

NJDEP, Division of Waste Management

The purpose of this Division's program is to monitor water quality around non-hazardous landfills and to report potential and actual ground water contamination to DEP's enforcement elements. Samples are collected at four to six landfills each month in response to complaints, to verify the analytical results from a private laboratory submitting a landfill compliance monitoring report, or to test for organic compounds.

The Division also conducts a permit program which requires all landfills to install wells and conduct compliance monitoring. Analytical results are reported to the N.J. Geological Survey quarterly and are entered into RAMIS and later into STORET by the DWR.

NJDEP, Office of Cancer and Toxic Substances Research

One purpose of this office's monitoring program is to examine the state's ground water for toxic chemicals. The data generated by this office, which is discussed in section C of this chapter, is in the process of being entered into the STORET computer system.

NJ Department of Transportation, Bureau of Quality Control

This bureau conducts specific ground water tests at DOT construction sites in compliance with existing construction regulations. Only those parameters likely to be present as a result of construction are monitored.

Other Ground Water Monitoring Programs

Agency	Purpose
NJDEP, DWR, Enforcement and Regulatory Services Element	Enforcement cases.
NJDEP, DWR Water Supply and Watershed Management Administration	Ground water quantity monitoring.
NJDEP, Division of Waste Mgt.	Monitor environmental hazards after spills.
NJDEP, DWR, N.J. Geological Survey	Research, resource assessment, data base and computer modeling development.

In addition to the above state and federal ground water monitoring programs, eight county agencies are planning or have instituted ambient ground water quality monitoring programs, primarily under the auspices of the County Environmental Health Act. These counties are listed below:

(1) Atlantic County Planning Division
(2) Burlington County Health Department
(3) Camden County Health Department
(4) Cumberland County Health Department
(5) County of Essex, Division of Planning
(6) Middlesex County Planning Board
(7) Ocean County Planning Board
(8) Sussex County
(9) Gloucester County

The Department is encouraging counties to develop and implement long-term ambient ground water monitoring programs. These county activities, along with the proposed DWR ambient ground water monitoring network, will comprise much of the long-term ground water quality monitoring to be done in the State. To eliminate ground water quality information gaps, the N.J. Geological Survey's Ground Water Resource Evaluation Program is attempting to coordinate all ground water quality data generated by the numerous agencies performing sampling activities into a centralized data pool.

E. RECOMMENDATIONS FOR IMPROVING GROUND WATER QUALITY AND QUANTITY IN NEW JERSEY

New Jersey is fortunate that it contains geologic formations that are for the most part rich in ground water supplies. In addition, the State's ground waters are generally very good in quality, with little or no treatment needed for potable usage. However, a number of quantity and quality problems are plaguing New Jersey's ground waters. The following recommendations, summarized from the preceeding text, are designed to outline activities which can be pursued to alleviate these problems.

Identification of ambient ground water quality conditions. Long-term ground water quality data is lacking for many regions of the State. As a result, ambient quality conditions are not thoroughly understood. This has led to imprecise resource evaluation, and made analysis of ground water pollution incidents difficult. Efforts by the DWR to create a joint USGS/DEP ambient ground water quality monitoring network, and by some counties to initiate their own ground water quality monitoring programs, will help to significantly reduce many information gaps. Despite this, an increase in ambient ground water quality monitoring is needed in the State so that ground water conditions are understood throughout.

Protection of ground water quality. Managing abandoned or technologically outdated landfill sites, and monitoring and regulating operating landfill sites is essential if unnecessary pollution of the State's ground waters is to be reduced. Proper landfill closure when necessary must include a relatively impervious cap, as well as leachate collection and treatment. New Jersey Pollutant Discharge Elimination System (NJPDES) permits should be issued for all existing and potential point sources contributing to ground water pollution. However, adequate ambient monitoring is needed so as to properly assign NJPDES permit limitations to ground water discharges. Other existing and potential pollution sources affecting ground quality which require certain management activities include surface impoundments, accidental spills, underground storage tanks and pipelines, municipal sewer systems and on-site wastewater disposal systems.

Protection of ground water levels and availability. To prevent existing or future aquifer degradation or depletion in the Coastal Plain Region, the following are suggested: eliminate the practice of aquifer overdevelopment; uniformly distribute future well development; institute projects designed to reverse water level declines in problem areas; promote recharge of aquifers in outcrop areas; develop new supplies in problem localities; and supplement ground water supplies with surface water supplies (conjunctive uses). In the Triassic Lowlands and Highlands Regions of the State the following are recommended: conduct hydrogeologic exploration and delineation of the available ground water resources; establish monitoring programs to gather vital ground water statistics; and institute management of the ground water resources of northern New Jersey on a regional basis.

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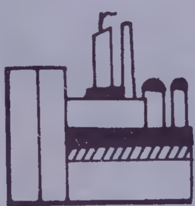
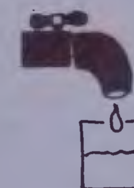
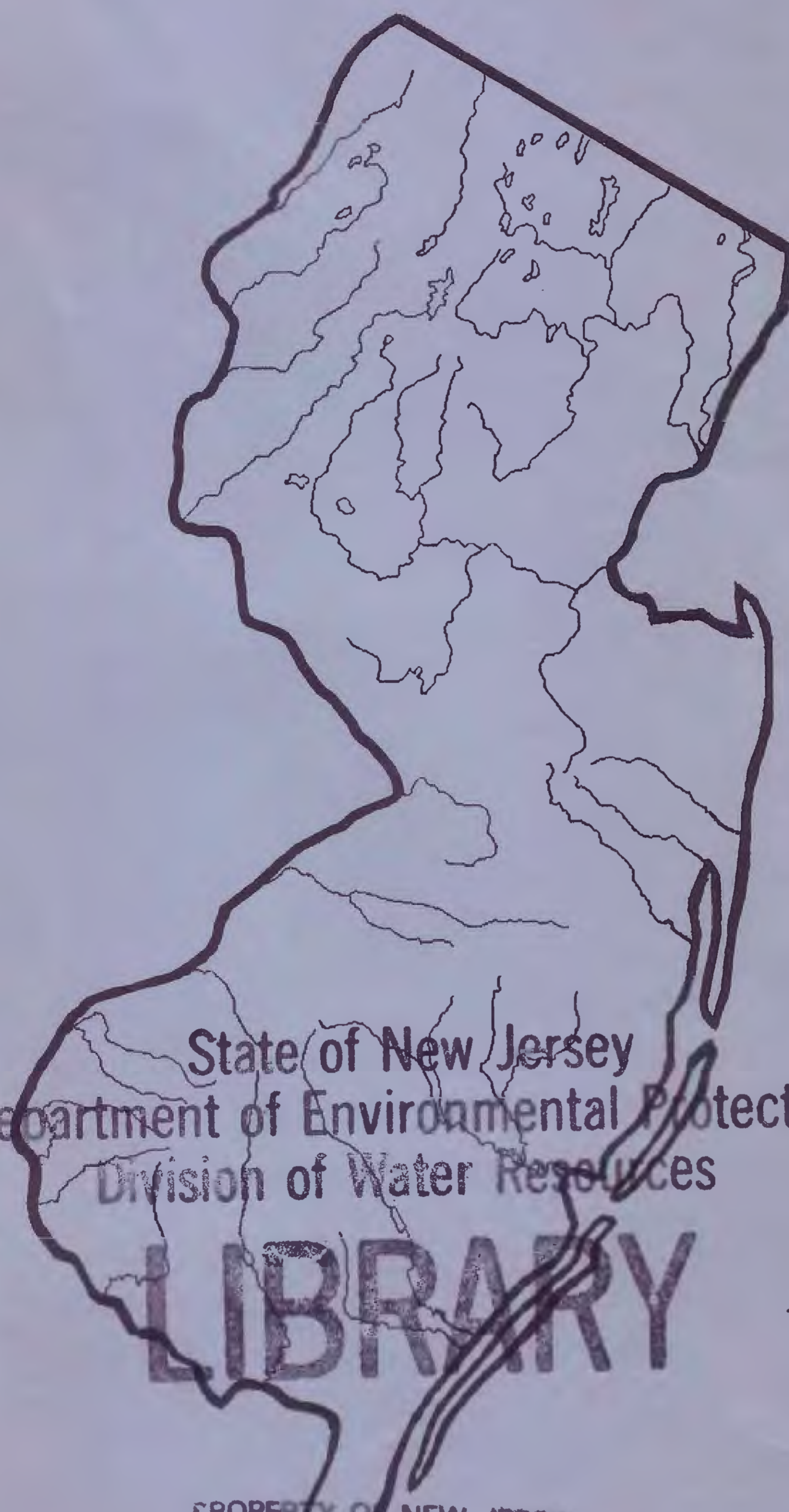
Appendix–Delaware River Basin




New Jersey Department of Environmental Protection ▪ Division of Water Resources

NEW JERSEY 1982 STATE WATER QUALITY INVENTORY REPORT

APPENDIX - DELAWARE RIVER BASIN

A REPORT ON THE STATUS OF WATER QUALITY IN NEW JERSEY PURSUANT TO THE NEW JERSEY WATER POLLUTION CONTROL ACT AND SECTION 305(b) OF THE FEDERAL CLEAN WATER ACT

WATER RESOURCES REPORT 39-C: 1.A

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June, 1983

APPENDIX 1 - WATER QUALITY INVENTORY

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APPENDIX 1-A

WATER QUALITY INVENTORY

DELAWARE RIVER BASIN

INTRODUCTION

This appendix contains a review of surface water quality in New Jersey's rivers, streams, coastal bays and lakes. This water quality review represents the biennial assessment of the State's waters as required by Section 305(b) of the federal Clean Water Act. For the 1982 305(b) report the State has been divided into 31 segments (Table 1-i) that are generally either single or grouped watersheds. The breakdown of the State into these segments is also similar to the segments used in prior New Jersey 305(b) reports, and therefore, allows comparison of water quality in a segment from one reporting period to the next. All segments were analyzed for water quality by the NJ Department of Environmental Protection with the exception of segments "DD" (Delaware River Basin) and "EE" (Interstate Sanitation Commission jurisdictional waters) which were prepared by the Delaware River Basin Commission and the Interstate Sanitation Commission, respectively.

The 29 NJDEP-prepared segment analyses contain four written sections, (Basin Description, Water Quality Assessment, Problem Assessment, and Goal Assessment and Recommendations), in addition to a segment map, water quality data charts and a wastewater discharge inventory. Numerous offices throughout NJDEP, and especially the Division of Water Resources, contributed information and or text to the segment analyses. In cooperation with the Bureau of Planning and Standards, DWR, the Bureau of Monitoring and Data Management, DWR, prepared the Water Quality Assessment - Conventional Parameters sub-section and the water quality data charts. Also in the DWR, the Bureau of Industrial Waste Management prepared the discharge inventories based on information in their New Jersey Pollutant Discharge Elimination System (NJPDES) computer files. The Office of Cancer and Toxic Substances Research (OCTSR), NJDEP, wrote the Toxic Parameters subsection for each Water Quality Assessment section. Their review of water column, sediment and fish tissue toxics sampling data represents the first such statewide watershed by watershed analysis since the program began in the mid-1970s. Following below is a description of the four sections that comprise the 29 NJDEP produced segment analyses.

Basin Description

The Basin Description characterizes each segment from a geographical and land use perspective in addition to noting what known surface water uses are present. Water uses identified included diversions of surface waters for potable supplies, agricultural irrigation and industrial processes; monitored swimming locations; fishing opportunities and resources; shellfish harvesting; and other specific uses that may be unique to a region of the State. The sources of information for this

TABLE 1-i SEGMENTS ANALYZED IN THE WATER QUALITY INVENTORY

A. Wallkill River
B. Flat Brook and Paulins Kill
C. Pequest and Musconetcong Rivers
D. Pohatcong and Lopatcong Creeks
E. Delaware River Tributaries - Hunterdon/Mercer Counties
F. Assunpink Creek
G. Crosswicks and Assiscunk Creeks
H. Rancocas Creek
I. Pennsauken Creek, Big Timber Creek and Cooper River
J. Woodbury, Mantua and Raccoon Creeks
K. Oldmans, Salem and Alloways Creek
L. Cohansey and Maurice Rivers
M. Southern Atlantic Coastal Basin - Cape May to Great Bay
N. Great Egg Harbor River
O. Mullica River
P. Mid-Atlantic Coastal Basin - Great Bay to Manasquan Inlet
Q. Manasquan River
R. North Atlantic Coastal Basin - Manasquan Inlet to Sandy Hook
S. North Branch Raritan River
T. South Branch Raritan River
U. Millstone River
V. Lawrence Brook and South River
W. Lower Raritan River Basin
X. Elizabeth and Rahway Rivers
Y. Upper Passaic River - Headwater to Livingston
Z. Mid-Passaic River - Livingston to Little Falls
AA. Mid-Passaic River Tributaries (Whippany, Rockaway, Pequannock, Wanaque, Ramapo and Pompton Rivers)
BB. Lower Passaic River - Little Falls to Newark Bay
CC. Hackensack River
DD. Status Report on the Delaware River
EE. Status Report on Interstate Sanitation Commission Waters

section included a number of different agencies in state, federal and local governments.

In the process of gathering water use data for the 29 segments of the State numerous information deficiencies were found to exist. Formost was the lack of statewide inventories dealing with monitored bathing beaches, and the presence of agricultural and industrial surface water diversions. Since bathing beaches are routinely monitored by local health departments under state guidelines and no statewide reporting requirements have been instituted there exists no regularily updated list of swimming areas found in the State. As a result of this data gap the Bureau of Planning and Standards mailed questionaires to all local health departments in the State requesting a list of bathing beaches and areas under their jurisdiction. The identification of surface water diversions for agricultural, industrial and other purposes is limited to where surface water diversion permits have been issued under the provisions of NJSA 58:1-36 by the State of New Jersey. Only diversions in excess of 70 gallons per minute (gpm) are required to obtain a permit. Therefore, numerous unreported diversions exist across the State which are pumping under 70 gpm. The information deficiencies described above exemplifies the difficulties uncovered while developing the Basin Description. These difficulties point to the need for a more coordinated water resource approach when identifing and understanding water quality problems, so that long-term direct use impacts can be measured.

Water Quality Assessment

The Water Quality Assessment section is a review of surface water quality data collected in a segment from 1977 to 1981. Water quality is analyzed for a group of standard indices (Table 1-ii) in the Conventional Parameters subsection, while known and suspected carcinogenic or toxic substances (Table 1-iii) identified in the segments water bodies are discussed in the Toxic Parameters subsection. In each Conventional Parameters subsection there is a brief review of overall water quality trends which have been found in that segment. This review of trends is a comparison of water quality conditions as described in the 1977 and 1980 305(b) reports against conditions as found today.

The ten conventional parameters reviewed were selected because of their values for indicating pollution, making swimmable and fishable determinations and for compatibility with data reviewed in prior 305(b) reports. These ten parameters were evaluated at 78 monitoring stations throughout the State.

The ambient monitoring stations reviewed in the Conventional Parameters subsection represents approximately one half of the total long-term monitoring stations present in the State. Those stations used were selected on the basis of their location in a

TABLE 1-ii PARAMETERS LIST AND CRITERIA FOR WATER QUALITY ASSESSMENTS - CONVENTIONAL PARAMETERS

Parameter	Criteria Source
1. Dissolved oxygen Concentrations and Saturation	N.J. Water Quality Standards
2. Biochemical oxygen demand (5 day)	N.J. Water Quality Standards Comparison to statewide ambient data
3. Fecal coliform	N.J. Water Quality Standards
4. Total dissolved solids	N.J. Water Quality Standards
5. pH	N.J. Water Quality Standards
6. Total phosphorus	N.J. Water Quality Standards
7. Nitrate + nitrite nitrogen	Quality Criteria for Water, 1976, USEPA National Interim Primary Drinking Water Regulations, 1976, USEPA
8. Total ammonia	Comparison to statewide ambient data
9. Un-ionized ammonia	N.J. Water Quality Standards

TABLE 1-iii TOXIC CHEMICALS ANALYZED IN THE WATER QUALITY ASSESSMENT - TOXIC PARAMETERS

Group 1 - Metals	Lower Analytical Limit ug/l (ppb)	EPA Standard for Drinking Water ug/l (ppb)
Arsenic	1	50
Beryllium	1	-
Cadmium	1	10
Chromium	1	50
Copper	1	1000[a]
Lead	1	50
Nickel	5	-
Selemium	2	10
Zinc	5	5000[a]
Group 2 - Pesticides and Related Compounds		
PCBs	0.06	-
Arochlor 1016	0.06	-
Arochlor 1242	0.06	-
Arochlor 1248	0.01	-
Arochlor 1254	0.01	-
α-BHC	0.01	-
β-BHC	0.01	-
Lindane (γ-BHC)	0.01	4
Heptachlor	0.01	0.1
Heptachlor epoxide	0.01	0.1
Aldrin	0.01	-
Dieldrin	0.01	-
Chlordane	0.01	-
Toxaphene	0.06	5
Methoxychlor	0.08	100
Mirex	0.02	-
Endrin	0.01	0.2
o,p-DDT	0.04	-
p,p'-DDT	0.04	-
o,p-DDE	0.01	-
p,p'-DDD	0.02	-

Group 3 - Low Molecular Weight Halogenated Organics b,c

Methylene chloride	90
Methyl chloride	6.0
Methyl bromide	1.0
Chloroform	0.8
Bromoform	1.0
Trichloroethylene	0.3
1,1,2,2-Tetrachloroethane	0.3
1,1,2-Trichloroethane	1.0
Dibromochloromethane	0.1
Trifluoromethane	0.5
Carbon tetrachloride	0.1
1,2-Dibromoethane	0.1
1,2-Dichloroethane	1.6
1,1,1-Trichloroethane	2.0
Vinyl chloride	0.5
Tetrachloroethylene	0.1
o-Dichlorobenzene	2.2
m-Dichlorobenzene	1.3
p-Dichlorobenzene	1.3
Trichlorobenzene	2.0
Diiodomethane	0.3
Dichlorobromoethane	0.5

a - secondary standards
b - Group 3 tested in water column only, not in sediments and fish tissue
c - Trihalomethanes: The EPA drinking water standard is 100 ppb for total trihalomethanes

watershed, the presence of other stations in the segment, the amount of data collected for each station, the ability of a monitoring station to reflect existing land use and known pollution sources, and the limitations in staffing and support services which prevented the review of all ambient monitoring stations statewide.

The DWR, through the Bureau of Monitoring and Data Management (BMDM) maintains and/or participates in several surface water quality monitoring programs throughout New Jersey. The most extensive program, the Primary Water Quality Monitoring Network, is a cooperative effort involving the BMDM and the United States Geological Survey's Water Resources Division in Trenton, N.J. The network, instituted in 1976, is composed of 135 stations from which samples are collected six times annually. In addition to the routine or conventional water column parameter schedule, a supplemental set of 75 samples is collected biannually from the water column for trace organic and metals analysis, and annually from the sediments at 50 stations. In 1982, the Primary Water Quality Monitoring Network was reduced to approximately 100 stations statewide.

EPA's National Basic Water Monitoring Program (BWMP) is comprised of thirty one stations in New Jersey. Samples are collected monthly at each station. Beginning in January, 1981, a revised parameter schedule was implemented with the approval of EPA Region II, as certain parameters were collected biannually rather than monthly. This change occurred at stations where there was no indication of consistently excessive concentrations of pollutants. These parameters include chemical oxygen demand, chloride, petroleum hydrocarbons, metals and dissolved minerals.

Biomonitoring was also conducted at each of the BWMP stations during the report period. Macroinvertebrate samples were acquired at each station using three Hester-Dendy samplers with the invertebrates later identified and enumerated in the laboratory. Diversity index, percent abundance and equitability of sample population were among the items evaluated. Five replicate periphyton samples were obtained at each station using clean glass slides mounted in a floating sampler, while chlorophyll a concentrations were measured using the acetone extraction method.

In addition, electrofishing and analysis of fish tissue samples for trace metals and pesticides were initiated in 1980 at most of the BWMP stations in New Jersey. The fish were identified and prepared in the BMDM's biological laboratory and then forwarded to the New Jersey Department of Health Laboratory for analysis.

Additional ambient surface water monitoring is conducted by the Ocean County Health Department, the Passaic Valley Water Commission, the Interstate Sanitation Commission, the Delaware River Basin Commission and other agencies throughout the State.

Their data was used in this report when applicable. In the future it is anticipated that many other counties will participate in expanded monitoring activities. Station selection in all monitoring networks were generally in accordance with the criteria cited in the EPA publication entitled Basic Water Monitoring Program (EPA 440/9-76-025, revised May, 1978).

The water quality data used to make each Conventional Parameter assessment is presented in the form of graphs (concentration versus time), and is found in the segment analyses following the text. The graphs show all raw data points collected for the ten parameters from 1977 to mid 1981. Conventional water quality data was compared against New Jersey Surface Water Quality Standards (N.J.A.C. 7:9-4.1 et seq) where applicable for dissolved oxygen concentration and saturation, biochemical oxygen demand (five day), total dissolved solids, pH, total phosphorus and un-ionized ammonia. Table 1-iv present the surface water classification and its appropriate water quality standards. A standard line is used on the water quality graphs for those parameters with standards for comparitive purposes. Although there is a state standard for fecal coliform (for most freshwater the criteria is a geometric average of 200/100 ml, or no more than 10 percent of the total samples taken during any 30 day period exceeding 400/100 ml), the frequency with which fecal coliform samples are collected in current statewide monitoring programs in regarded as not being of sufficient frequency to compare to existing standards.

The Toxic Parameters subsection was provided by the Office of Cancer and Toxic substances Research (OCTSR), NJDEP, specifically for this report. This subsection describes the preliminary results of water column, sediment and fish tissue sampling for toxic and carcinogenic substances in New Jersey's aquatic environment. The surface water monitoring for toxic pollutants began at OCTSR in 1977 when there was practically no background data concerning the occurrence of toxic pollutants in surface waters throughout New Jersey. In addition standardized sampling techniques and methods for analysis had not been defined for determining toxic contamination in water, sediment, and aquatic biota.

The approach taken to generate a data base for toxics in New Jersey's surface waters involved the collection of grab samples of water at various sites throughout the State in accordance with the State Water Quality Management Program surface water studies carried out by NJDEP and designated regional and county agencies. The water column samples were analyzed for all three groups of chemicals shown in the Table 1-iii. As the program progressed, the collection of sediments samples was incorporated at many sites to access the partitioning and accumulation of toxic pollutants in the sediments. Sites usually were sampled once per year, but sites which were found to be contaminated or suspected to receive toxic inputs were sampled at least twice. Sediments and fish tissue were tested for substances in groups 1 and 2 in

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARD (NJDEP, 1981)

	Classification				
Parameter	FW-Lower Mullica and Wading Rivers Central Pine Barrens	FW-Central Pine Barrens	FW-2 Trout Production	FW-2 Trout Maintenance	FW-2 Nontrout
pH (Standard Units)	4.5-6.0	3.5-5.5	6.5-8.5	6.5-8.5	6.5-8.5
5 day Biochemical oxygen demand (mg/l)	Maximum of 5.0 at any time.	Maximum of 5.0 at any time. None which would render the waters unsuitable for the designated uses.			
Dissolved oxygen	No less than 85% saturation at any time.	Not less than 85% saturation at any time.	Not less than 7.0 mg/l at any time.	24 hour average not less than 6.0 mg/l. Not less than 5.0 mg/l at any time.	i. 24 hour average not less than 5.0 mg/l, but not less than 4.0 mg/l at anytime, except as noted in paragraph ii. below. ii. Not less than 4.0 mg/l at any time in the freshwater tidal portions of tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive.
Bacterial quality (MPN/100 ml)	1. Except as noted in paragraph two below, fecal coliform levels shall not exceed a geometric average of 200/100 ml., nor should more than 10 per cent of the total samples taken during any 30-day period exceed 400/100 ml. 2. Fecal coliform levels shall not exceed a geometric average of 770/100 ml. in the freshwater tidal portion of tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive. 3. Samples shall be obtained at sufficient frequencies and at locations and during periods which will permit valid interpretation of laboratory analyses. Appropriate sanitary surveys shall be carried out as a supplement to such sampling and laboratory analyses. As a guideline and for the purpose of these regulations, a minimum of five samples taken over a 30-day period should be collected, however, the number of samples, frequencies and locations will be determined by the department in any particular case.				

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARDS (NJDEP, 1981)

Parameter	FW-Lower Mullica and Wading Rivers Central Pine Barrens	FW-Central Pine Barrens	Classification FW-2 Trout Production	FW-2 Trout Maintenance	FW-2 Nontrout
Total dissolved solids - filterable residue (mg/l)	Maximum of 100 at anytime	Maximum of 100 at anytime	1. Not to exceed 500 mg/l or 133 per cent of background whichever is less. Notwithstanding this criterion, the department, after notice and opportunity for hearing, may authorize increases exceeding these limits provided the discharge responsible for such increases can demonstrate to the satisfaction of the department that such increases will not significantly affect the growth and propagation of indigenous aquatic biota or other designated uses, including public water supplies. 2. Any authorization by the department of such increases shall be conditioned upon utilization of the maximum practicable control technology.		
Ammonia (un-ionized; Maximum concentration ug/l)	50.0	50.0	20.0	20.0	50.0
Phosphorus (mg/l)	Maximum of 0.7 at anytime; phosphorus as phosphate.		1. Lakes: Phosphorus as total P shall not exceed 0.05 in any reservoir, lake, pond, or in a tributary at the point where it enters such bodies of water, unless it can be demonstrated that total P is not a limiting factor considering the morphological, physical, chemical, and other characteristics of the water body. 2. Streams: Phosphorus as total P shall not exceed 0.1 in any stream, except at those locations in paragraph one above, where total P is determined to have a detrimental effect on stream use or to be the limiting factor considering the morphological, physical, chemical, and other characteristics of the water body.		

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARDS

Parameter	TW-1
pH (Standard Units)	6.5-8.5
Dissolved oxygen (mg/l)	24 hour average not less than 5.0. Not less than 4.0 at any time.
Bacterial quality (MPN/100 ml)	1. Approved shellfish harvesting waters: where shellfish harvesting is permitted, requirements established by the National Shellfish Sanitation Program as set forth in its current manual of operation shall apply. 2. All other waters: Fecal coliform levels shall not exceed a geometric average of 200/100 ml, nor should more than 10 per cent of the total samples taken during any 20-day period exceed 400/100 ml.
Total dissolved solids - Filterable residue (mg/l)	None which would render the water unsuitable for the designated uses.

KR:305B2:b

Table 1-iii. Methodology to accurately test for volatiles had not been developed at the time.

Throughout the Toxic Parameters subsections general statements of contaminant levels are identified. This is due to the lack of surface water quality standards for the majority of the substances. In general, when a parameter was found in the water column in concentrations greater than 100 ug/l it was considered in high levels. Moderate levels fell between 10 and 100 ug/l, while low levels meant under 10 ug/l. With regard to sediments and fish tissue analyses, contamination is generally related to the presence of PCBs (polychlorinated biphenols), chlordane, and DDT and its metabolite substances. Elevated levels of PCBs are considered above 3.0 ppm, low levels from 1.0 to 3.0 ppm and trace levels below 1.0 ppm. For chlordane elevated levels were .3 ppm or more, moderate levels are .1 to .3 ppm, with trace levels below .1 ppm. Total DDT was considered elevated when at 5.0 ppm or more, at low levels from 1.0 to 2.0 ppm, and at trace levels below 1.0 ppm. The elevated concentrations reflect the U.S. Food and Drug Administration action levels for fish tissue which is used for human consumption.

As preliminary results were being reviewed, various shortcomings in this sampling approach were identified, but the need for baseline data was imperative and the results generated have proved very useful in identifying areas where further and more intensive studies are needed. Several of the problems discovered during the surface water survey deserve mention in order that the data be viewed in proper perspective. One problem is the limitation of collecting grab water samples for toxic pollutant analysis. The presence of toxics is often variable due to many factors including intermittant discharges, toxic spills, illegal dumping etc.; grab samples provide only an instantaneous look at the water quality of a particular system. The OCTSR has found that composite samples (samples collected over time) provide a more representative picture of true water quality; however, collecting and analyzing composite samples is much more expensive than grab samples.

The natural variability of surface water samples has been another interesting finding of the OCTSR's survey. Toxic pollutants in surface waters are dynamic; compounds present in one stretch of stream will not necessarily be detected in another area. This has led to a need for greater understanding of the physical and chemical processes relating to the partitioning of chemical compounds into different environmental compartments. With the development of the data base, it is now possible to predict where different classes of compounds are most likely to be found, whether in water, sediment, or aquatic biota. The knowledge and experience gained from the survey has resulted in more cost-effective sampling programs designed to gain a maximum amount of information for each dollar spent for analysis.

The OCTSR wrote a brief description on the risks of chemical contaminants on human health. This report, entitled "Health Effects of Chemical Contaminants" is a working paper for the 305(b) report and is available upon request from the Bureau of Planning and Standards, DWR.

Problem Assessment Section

The Problem Assessment is an evaluation of the probable and known water pollution sources within each segment. An attempt was made to identify pollution sources as specifically as possible; but in most cases only wastewater discharges under Department enforcement and administrative actions, and identified by the DWR Enforcement and Regulatory Affairs Element were named as specific sources. Other information sources included the 12 Water Quality Management (WQM) Plans prepared in late 1970s, the 1980 State 305(b) Report, DWR Construction Grants Administration project descriptions, designated WQM Agency supplied information; as well as a variety of other sources. One source which contains alot of useful information on the origin of water pollution were the Lakes Management Program's intensive surveys conducted in 1978 and 1979. However, these surveys were performed on only a local basis and on selected lakes.

Unfortunately the statewide surface water monitoring programs described above are not designed to identify water pollution sources, but rather to determine long-term changes in overall water quality. This makes it difficult, if not impossible, to reliably identify sources of pollution and the impacts they may be having on stream quality. The inherent variabilities and limitations of periodic grab samples from a water body were also expressed above in the description of the OCTSR Program. Unless source specific intensive surveys above and below suspected pollution sources can be performed, then accurate determinations on the contribution of various wastewater facilities, storm drains and land uses to pollution loads can not be made. In the Problem Assessment, therefore, while pollution sources are identified, in most cases their impacts are not truely known.

Goal Assessment and Recommendations Section

The ability of surface waters within each of the 29 segments to meet the swimmable and fishable goals of the federal Clean Water Act is presented in this section. In addition, corrective actions to alleviate water pollution problems identified in the Water Quality Assessment and Problem Assessment sections are recommended.

The Clean Water Act states that surface waters of the nation must be swimmable and fishable (provide for the propagation and protection of a balanced population of shellfish, fish and wildlife) by July 1, 1983. Because this 305(b) report reflects

conditions as of late 1981 and that surface waters will not generally experience significant waters quality differences from late 1981 to mid 1983, the swimmable and fishable determinations made in this report can be interpretated as 1983 goal attainability.

Criteria were developed for this report in order to make the swimmable/fishable goal determination. The swimmable status was assigned to a segment if bathing beaches were known to exist throughout its waters, or if fecal coliform bacteria were of sufficient levels to allow bathing. Fecal coliform data were assessed at monitoring stations used in the segment analyses for the frequency of samples greater than 200/100 ml (surface water standard) during warm weather (May - September) periods. If over 25 percent of the samples were greater than 200 MPN/100 ml then the waters are considered not swimmable; 0-25 percent over 200 MPN/100 ml was construed to mean the waters are marginally swimmable; and when all fecal coliform samples were under 200 MPN/100 ml then the waters are swimmable. It should be noted that irregardless of the swimmable classification assigned to a segment, swimming is recommended only in those waters routinely monitored for bathing.

The fishable determination was based on a number of criteria. This included the presence of trout production or trout maintenance waters (as defined in the state water quality standards); water quality data for dissolved oxygen, pH and un-ionized ammonia which would indicate stressful or acute toxicity to fishlife; and the species of fish identified to exist in the segment by the report Establishment of a Statewide List of Bioassay Organisms Pursuant to the New Jersey Surface Water Quality Standards (Rutgers University, 1979). All waters of the State can be classified as fishable (fishing is allowed) with the exception of portions of the Pennsauken Creek, Cooper River and Woodbury Creek watersheds. Determining the ability of a watershed to support a balanced fish community is difficult since a great variety of factors are involved. What is needed, but is not available, is continuous monitoring of fish communities in the State's waters through various collection and identification programs.

Recommendations for the improvement of water quality within a segment were based generally on the pollution sources identified in the Problem Assessment and what actions are needed to alleviate these problems.

A. WALLKILL RIVER

Basin Description

The Wallkill River basin, including the major tributaries of Papakating Creek and Pochuck Creek, drains 203 square miles of the Valley and Ridge region of northwestern New Jersey. Flows from this basin are to the north into New York State as part of the Hudson River drainage network.

The Wallkill River basin is highly prone to flooding, especially in the headwaters. The lower Wallkill, Papakating and Pochuck become meandering waterways with broad flood plains containing swamps and agricultural lands. The 21 mile length of the Wallkill River as it enters New York near Unionville contains an average unadjusted flow of 217 cfs.

The Wallkill River basin is primarily agricultural in its broad valleys, and forested along ridge slopes and tops. The Sussex County Water Quality Management Plan (1979) states that 30 percent of the Wallkill watershed is agricultural, 50 percent forested, 14 percent urban/developed and six percent is devoted to other uses; the Papakating watershed is 44 percent agricultural, 27 percent forested, 27 percent devoted to special uses and 2 percent is urban; and the Pochuck watershed is 68 percent forested, 21 percent agricultural and 11 percent urban or other uses.

The Wallkill basin has maintained its rural character, with population centers limited to the towns of Hardyston, Sparta, Franklin and Vernon. Population growth between 1970 and 1980 occurred throughout the basin, with Vernon Township experiencing the greatest growth, a 150 percent increase.

Currently only two small areas of the Wallkill River basin have municipal sewerage facilities: portions of Sparta (.03 mgd) which discharges to the Wallkill River and Sussex Borough which discharges (.25 mgd) to Clove Brook, a tributary of Papakating Creek. Construction of a secondary treatment plant and related facilities to serve Franklin Borough, Hamburg Borough and Hardyston Township is currently underway. The future plant will discharge a design flow of 2.5 mgd to the Wallkill River. Twenty -three sanitary and seven industrial dischargers are located in this basin, with the .30 mgd sanitary discharge from the Playboy Club Hotel, Vernon Township, being the largest. The remainder of the Wallkill River basin is served by on-site septic systems.

The Wallkill River basin contains numerous lakes that provide recreational opportunities for bathing, boating and fishing. Lake Mohawk is a major recreation source for the region which allows swimming, motor and non-motor boating and serves as an important fishing location for the area. Franklin and Sussex

Boroughs also contain swimming and boating facilities, although Clove Acres Lake in Sussex has been closed due to high bacteria counts. The State of New Jersey owns and operates High Point State Park which is partially located in the Papakating watershed, Wawayanda State Park in the Pochuck watershed and the Hamburg Mountain Wildlife Management Area in the Wallkill watershed. Wawayanda Lake in Wawayanda State Park allows swimming, boating and fishing. The N.J. Division of Fish, Game and Wildlife stocks trout once or more yearly in the following streams: Clove Brook, Franklin Pond Creek, Greenwood Brook, Papakating Creek, West Branch Papakating Creek and Wawayanda Lake.

The Wallkill River and tributaries serve as a source of potable water for three municipalities. Franklin Borough intakes Wallkill River water at Franklin Pond, Sussex Borough uses Lake Rutherford (Papakating Creek) and Vernon Township takes water from a reservoir on the Pochuck River. In addition, a summer recreation club in Vernon Township uses water from Wallkill Lake for potable purposes. Agriculture in the basin consists predominantly of dairy cattle and poultry operations, with heavy concentrations of these activities in the Papakating and Wallkill watersheds. Acreage devoted to hay, corn and vegetable crops is also prevalent. Industrial activities, although not important in the basin, are heaviest in the Hardyston and Sparta areas.

N.J. Water Quality Standards give the Wallkill River basin a variety of water quality classifications. Waters flowing from state lands (High Point, Wawayanda, and Hamburg Mountain) are listed as FW-1. One tributary of Black Creek at McAfee is FW-2 Trout Production, with the majority of the remaining streams of the basin given FW-2 Trout Maintenance or FW-2 Nontrout status.

Water Quality Assessment

Conventional Parameters

Monitoring programs indicate that surface water quality within the Wallkill River basin is marginal with respect to certain water quality parameters. Dissolved oxygen concentrations and saturation levels were generally sufficient for the five year period at the two Wallkill River monitoring locations (upstream at Franklin; downstream near Unionville, N.Y.), with saturation values occurring primarily in the 70 to 110 percent range. Fewer supersaturated dissolved oxygen values were recorded for the same period in the Papakating (Papakating Creek at Sussex) and Pochuck (Black Creek near Vernon) watersheds. Although D.O. concentrations exceeded the minimum criterion of 4.0 mg/l at each of the two locations, saturation values occasionally declined to 50 percent or less during the summer months.

Biochemical oxygen demand (BOD_5) in the upstream segment of the Wallkill River was relatively consistent, and within the 1.0 to 3.0 mg/l range at Franklin but exhibited greater variability (1.0 to 7.0 mg/l) downstream at Unionville. Moderate fluctuations of BOD_5 concentrations (1.0 to 3.0 mg/l) were also noted during the monitoring period at the Black Creek station near Vernon. Higher values (up to 5.0 mg/l) were occasionally noted in Papakating Creek.

Fecal coliform data for the Wallkill basin clearly illustrates the marginal water quality. Contraventions of the fecal coliform 200 MPN/100 ml standard are frequent throughout the basin and are most severe at Unionville on the Wallkill River and at Sussex on Papakating Creek. In contrast to the relatively stable MPN values at Franklin and in Black Creek near Vernon, the variable values at Unionville were indicative of a fairly unstable situation. Papakating Creek at Sussex exhibited the highest fecal coliform values in the basin, exceeding 24,000 MPN/100 ml on at least three occasions in 1978-79.

Total dissolved solids concentrations in the Wallkill basin were below the criterion of 500 mg/l for the five year period (1977-81). The lowest and most consistent concentrations occurred in Papakating Creek (100-200 mg/l) while the highest values were found in Black Creek. The Wallkill River station at Unionville once again exhibited a wide range of concentrations (127-328 mg/l).

Moderately alkaline pH values were prevalent in each of the three streams monitored in the Wallkill basin, usually in the 7.5 to 8.5 range. Papakating Creek exhibited the widest variability of this parameter with values ranging from 6.6 to 8.9. The alkaline values are probably a combined result of biological and geological factors.

Total phosphorus data for the period once again enforces the marginal water quality found throughout the basin. Twenty-three percent of the total phosphorus values recorded at Unionville between 1977 and 1981 exceeded the state standard of 0.1 mg/l. Contravention rates were lower elsewhere in the basin, with only two and three excessive values noted in the Wallkill River at Franklin and Papakating Creek at Sussex, respectively.. Nitrate + nitrite concentrations were generally under 1.5 mg/l throughout the basin. The Wallkill River exhibited values consistently below 1.0 mg/l until late 1980 when a few concentrations in excess of 2.0 mg/l were noted at the Unionville station. This rise in nitrate + nitrite levels was followed by a decline to concentrations once again below 1.0 mg/l. Total and un-ionized ammonia concentrations were all below the criteria established for FW-2 Nontrout waters, the classification assigned at all stations except the Wallkill River at Franklin (trout maintenance). One value at Franklin in July, 1977 slightly exceeded the criterion of 20 ug/l for trout maintenance streams.

Samples for biological evaluation were collected at the Unionville station on the Wallkill River. The macroinvertebrate community contained a relatively high number of taxa (36) and a moderate population density (3648 individuals/square meter) in 1977. The dominant taxa were the midges Endochironomus (23%) and Pentaneura (12%), the mollusc Gyraulus (15%) and the freshwater shrimp Gammarus (8%). The mean periphyton chlorophyll a concentrations were consistently high (17.85 to 28.3 mg/m^2), suggesting moderate organic enrichment. The presence of eutrophic river forms such as Cocconeis placentula, the dominant periphyte present, supports the water quality assessment of marginally acceptable conditions.

Few water quality trends were noted in the Wallkill basin over the period of 1977-1981. The Wallkill River at Franklin exhibited a decline in dissolved oxygen concentrations and saturation levels after a mild increase in the 1973-1977 period, but was stable for all other parameters. Little or no change in water quality was apparent at the other locations in the basin or with data generated from 1973-1977.

Toxic Parameters

Two tributaries to the Wallkill River, Black Creek and Papakating Creek, were not found to be impacted with toxic chemicals. The Wallkill River itself, however, has experienced high levels of several volatile organic chemicals in the water column. In Franklin, high trihalomethane levels were found. These levels were also found in the Wallkill at Route 565. Along with the trihalomethanes, moderate levels of organic solvents were also found. At this time there has been no widespread tissue sampling program implemented. As site specific occurrences become known those locations will be considered for future samples.

Overall, the potential for toxic contamination to the aquatic organisms found within this region is considered to be limited to non-point agricultural runoff and the relatively few industrial and municipal discharges.

Problem Assessment

Despite the fact that the Wallkill River watershed is not a densely developed area, its streams do exhibit local pollution problems. While certain water quality parameters such as phosphorus are occasionally unsatisfactory, the high levels of fecal coliforms which have been found are of greatest concern. This problem was also recognized in the Sussex County WQM Plan, which stated that high fecal coliform levels constitute the most significant water quality problem in the Wallkill watershed. The Sussex County WQM Plan also found fecal coliform to fecal streptococci ratios that indicate the bacteria is mainly of non-human origin. A major source of the coliforms is probably farming activity, especially the common dairy and beef cattle operations within the watershed. Excessive coliform bacteria levels have been determined to be from the dairy cattle farms in the Clove Brook watershed, a tributary of the Wallkill. A plan has been developed and is now being implemented by the U.S. Soil Conservation Service in cooperation with the Sussex County Board of Chosen Freeholders and the Sussex County Soil Conservation District for reducing the non-point source bacteria loadings in the Clove Brook watershed area. This project will utilize erosion control and animal waste management practices. The waters of the Wallkill also receive bacteria from waterfowl which are present in heavy concentrations in early spring and fall.

In addition to contributions of bacteria by animal sources, there also appear to be loadings from human sources. Both the Sussex Borough Sewage Treatment plant and the Franklin Borough Sewage Treatment Plant are in need of upgrading and enlarging. The Sussex Borough facility frequently overloads and discharges raw sewage to the Wallkill River via Clove Brook. These problems should be remedied, however, when the Sussex County M.U.A. regional treatment facility is completed in late 1984. The Sparta Plaza Sewage Treatment Plant is presently under enforcement action, as the facility is also contributing significant pollutional loadings (BOD, suspended solids, nutrients and fecal coliform) to the Wallkill. The toxics program sampling results are an indication of the sewage treatment plant discharges in the area and further intensive sampling would be valuable to trace the distribution of these chemicals.

Septic tanks are a common means of sewage disposal in the watershed and when inproperly installed and/or maintained can also serve to eventually degrade surface waters. Among the areas identified as having septic tank problems are portions of Sparta Township and the Highland Lake/Barry Lake/Wawayanda Lake areas of Vernon Township. Franklin Pond is experiencing water quality problems, possibly from a combination of non-point agricultural and livestock sources, and is highly eutrophic.

There are presently two enforcement cases against dischargers which are degrading water quality in the basin. The Accurate Forming Corporation in Hamburg Borough is in non-compliance with its permit requirements, and is contributing volatile organics, cyanide and heavy metals. The Sparta Board of Education High School treatment plant (#2) is not meeting permit requirements for BOD and fecal coliform removal. That situation is presently being rectified, however, as corrections are presently underway.

Goal Assessment and Recommendations

Fecal coliform concentrations render the streams in the basin generally unsuitable for swimming, with the exception of marginally acceptable upstream segments of the Wallkill River that include the lakes serving as headwaters. The waters are fishable, although the chemical findings of dissolved oxygen, pH, and un-ionized ammonia concentrations have occasionally shown stressed conditions. The water supports a diverse fish population indicative of varied habitats and conditions. Twenty species have been identified in Pochuck and Papakating Creeks and twenty-two species have been found in the Wallkill. The fish community present in Papakating Creek is more suggestive of clear, cool running waters than those in Pochuck Creek and the Wallkill River.

Due to the importance of lakes for recreation in the basin, it is essential that they be protected against degradation. This can be accomplished by prohibiting wastewater discharges to lakes and their tributaries, by instituting proper domestic waste water disposal and treatment practices and by controlling stormwater pollution loads. The current animal waste control project in the Clove Brook watershed should be instrumental in reducing bacteria and nutrient levels in the brook, Papakating Creek and Clove Acres Lake. If the project accomplishes it intended goals, then Clove Acres Lake should once again be used for swimming and as a public water supply by the Borough of Sussex. Correction of problems at the Sussex Borough STP are warranted to improve conditions in Clove Brook and Papakating Creek downstream of Sussex. In the upper Wallkill River, improvements to the Franklin Borough STP and Sparta Plaza STP will result in improved water quality conditions in the river.

Throughout the Wallkill and Pochuck basins septic tank management districts are recommended, along with best management practices in the regions where agriculture is the main land use. Elimination of organic chemical contamination to the Wallkill from Accurate Forming Corporation's facility in Hamburg should also be a priority for corrective actions.

WALLKILL RIVER STATION LIST

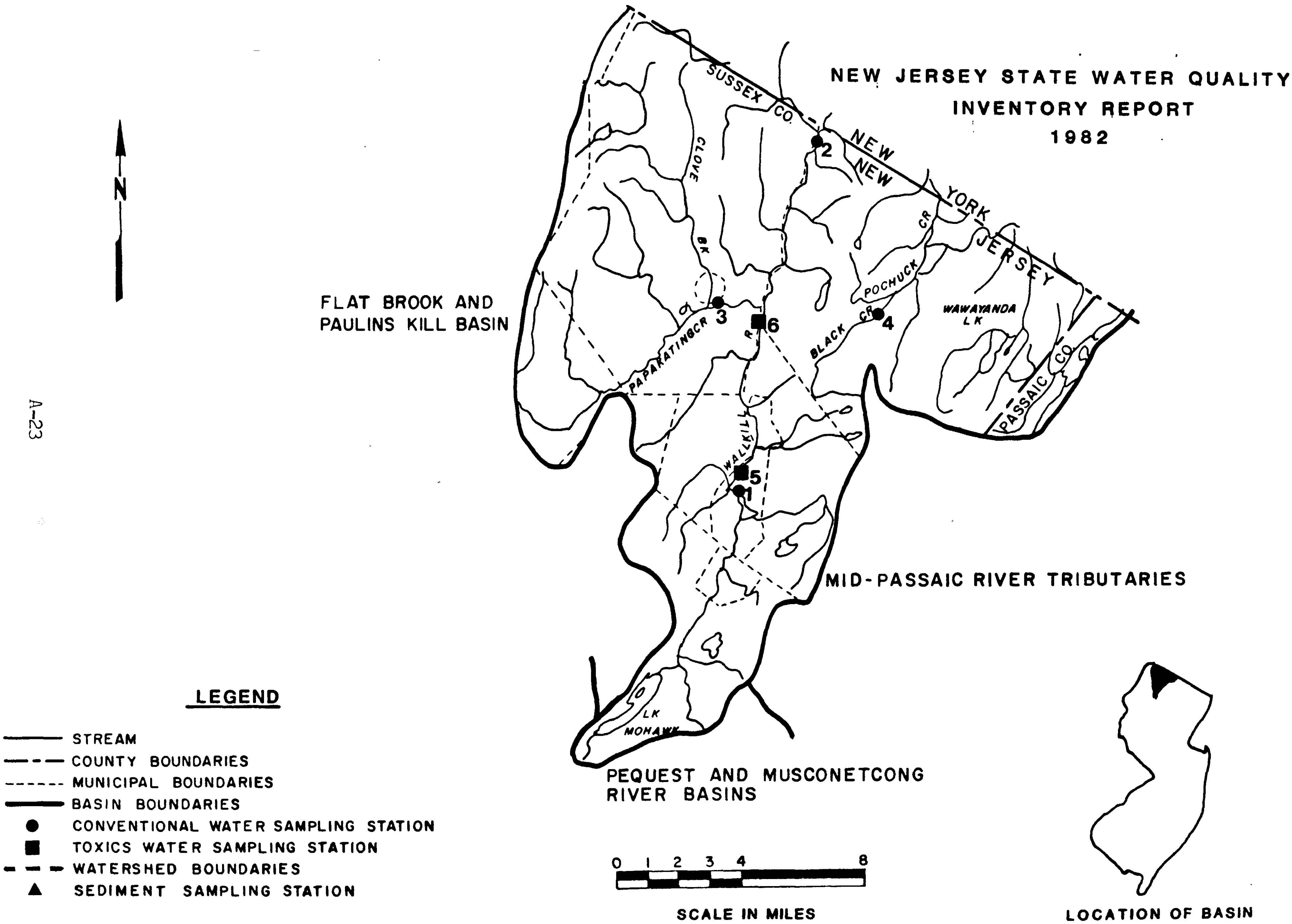
A. Ambient Monitoring Stations

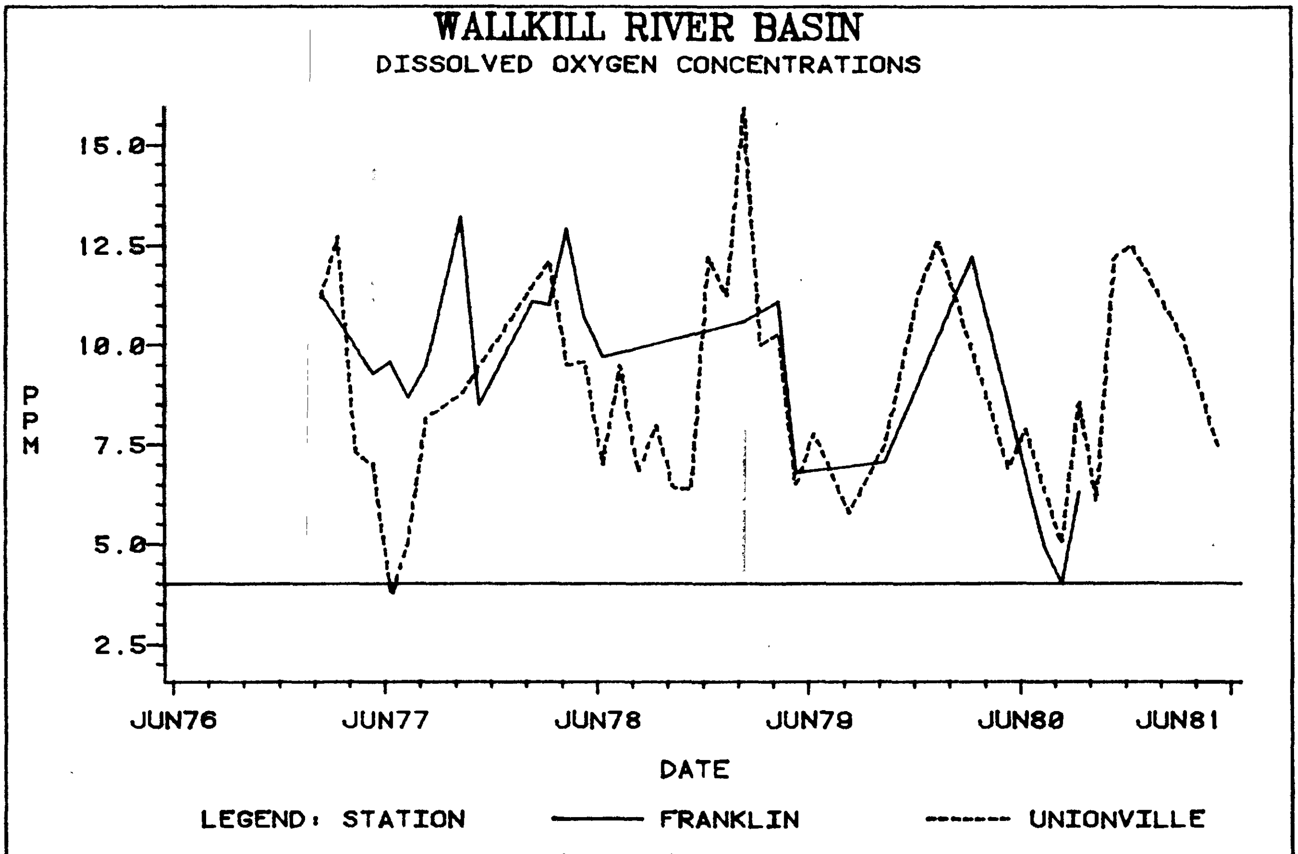
STORET Number	Station Description	Map Number
01367700	Wallkill River at Franklin, Sussex County Latitude 41°06'43" Longitude 74°35'21" FW-2 Trout Maintenance USGS/DEP Network Upstream side of dam at outlet of Franklin Pond, 0.8 mile upstream from Wildcat Brook.	1
01368000	Wallkill River near Unionville, New York Latitude 41°15'36" Longitude 74°32'56" FW-2 Nontrout Basic Water Monitoring Program Downstream side of bridge on Bossetts Bridge Road, 2.0 miles south of the New York-New Jersey State line and 3.0 miles south of Unionville, New York.	2
01367910	Papakating Creek at Sussex, Sussex County Latitude 41°12'02" Longitude 74°35'59" FW-2 Non-trout USGS/DEP Network Downstream side of abandoned railroad bridge, 0.7 mile downstream from Clove Brook, approximately 0.1 mile upstream from Route 23.	3
01368950	Black Creek near Vernon, Sussex County Latitude 41°13'21" Longitude 74°28'33" FW-2 Non-trout USGS/DEP Network Upstream side of bridge on Maple Grange Road, 0.6 mile upstream of confluence with Wawayanda Creek and 1.7 miles northeast of Vernon.	4

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Wallkill River at Franklin	Water column	5
Wallkill River at Route 565	Water column	6

WALLKILL RIVER BASIN





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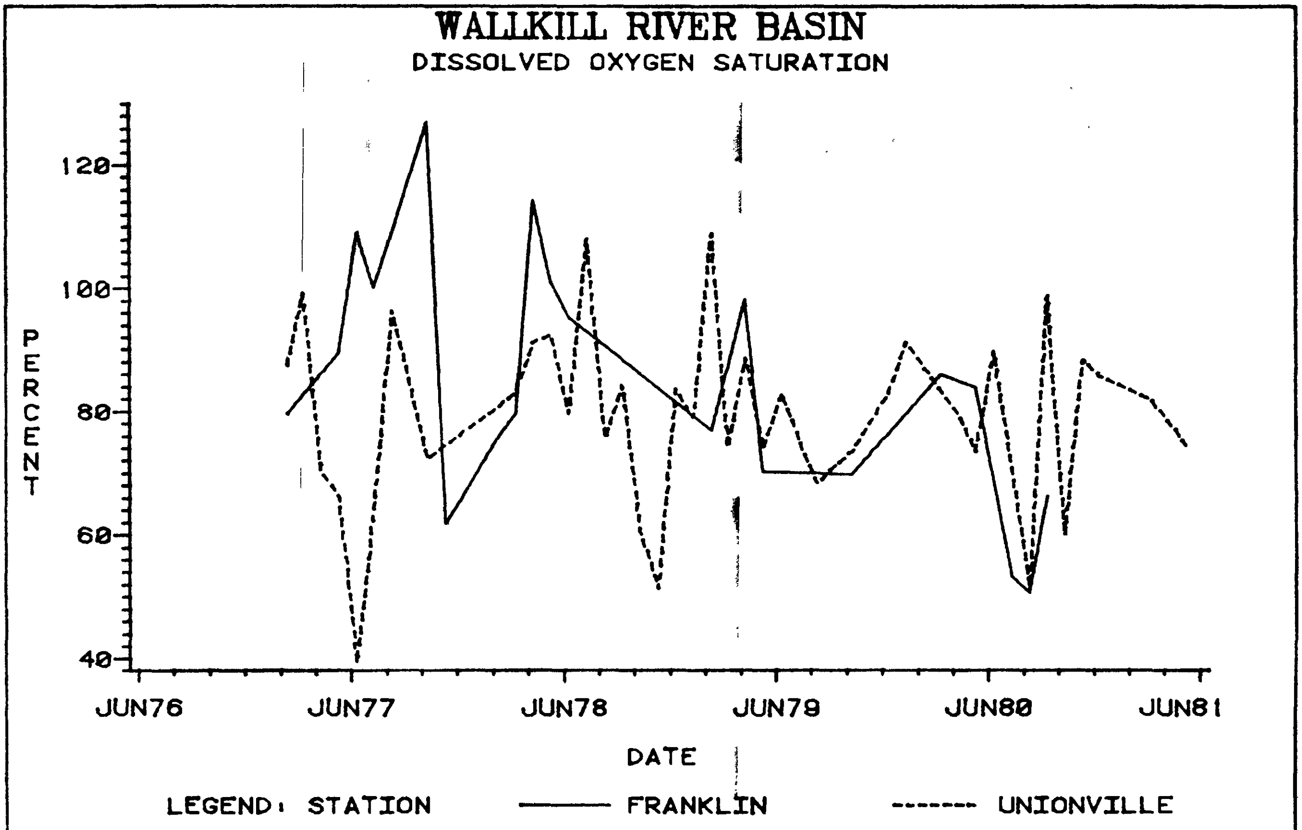

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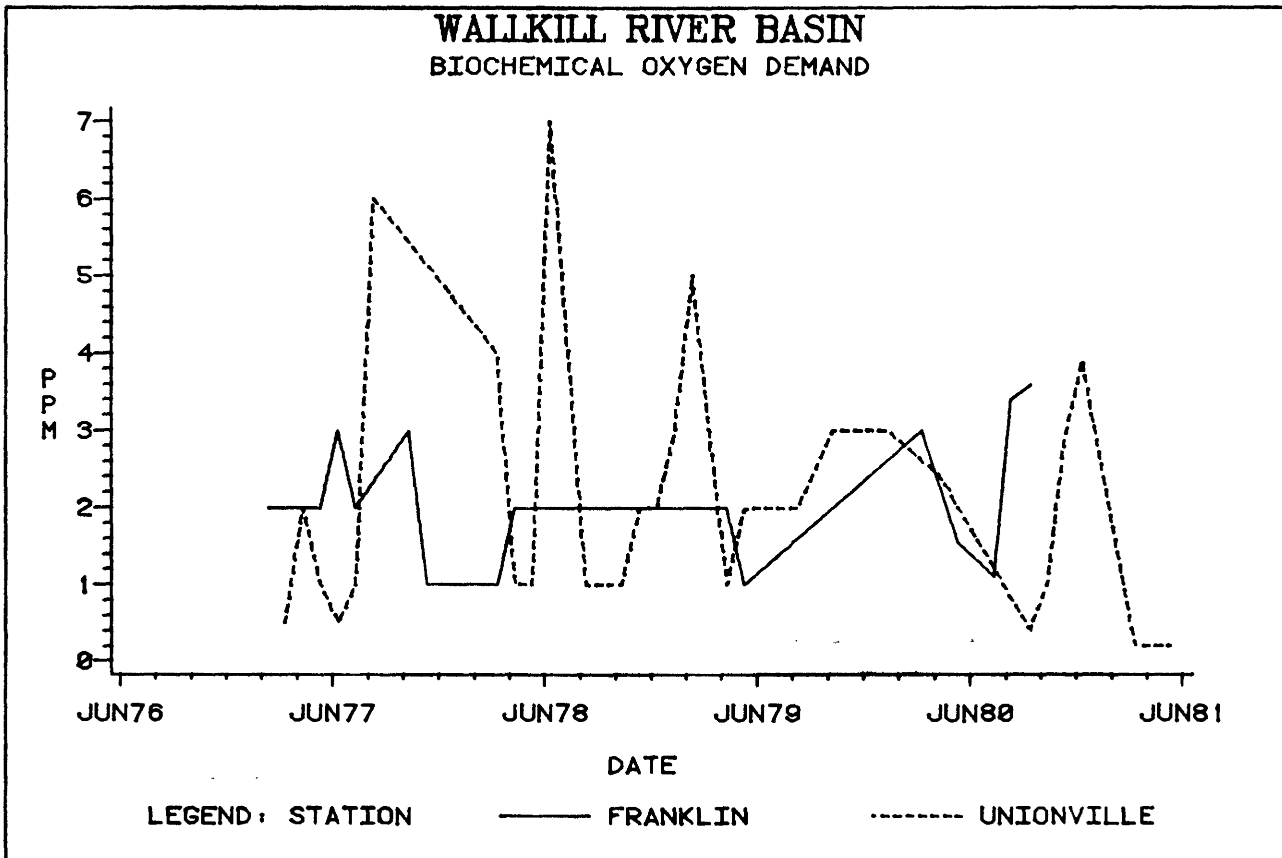

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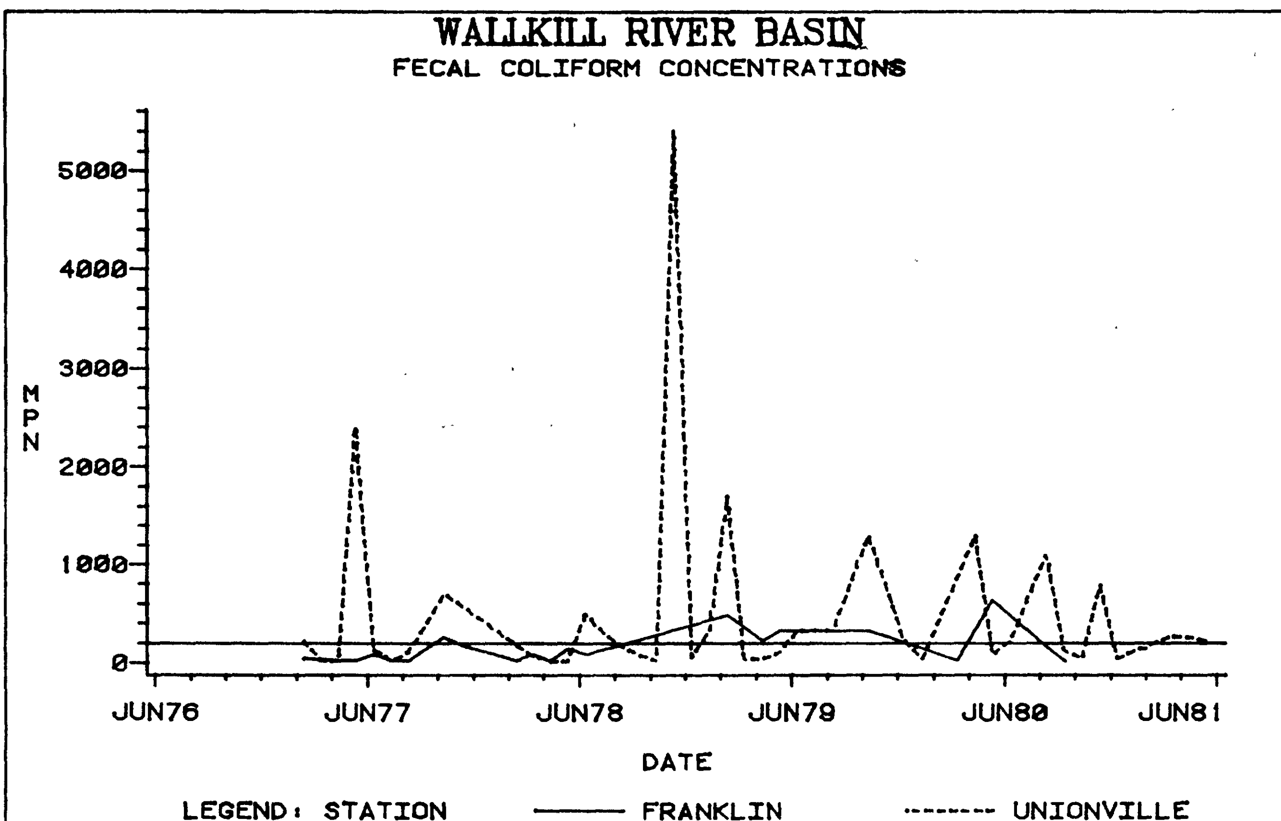

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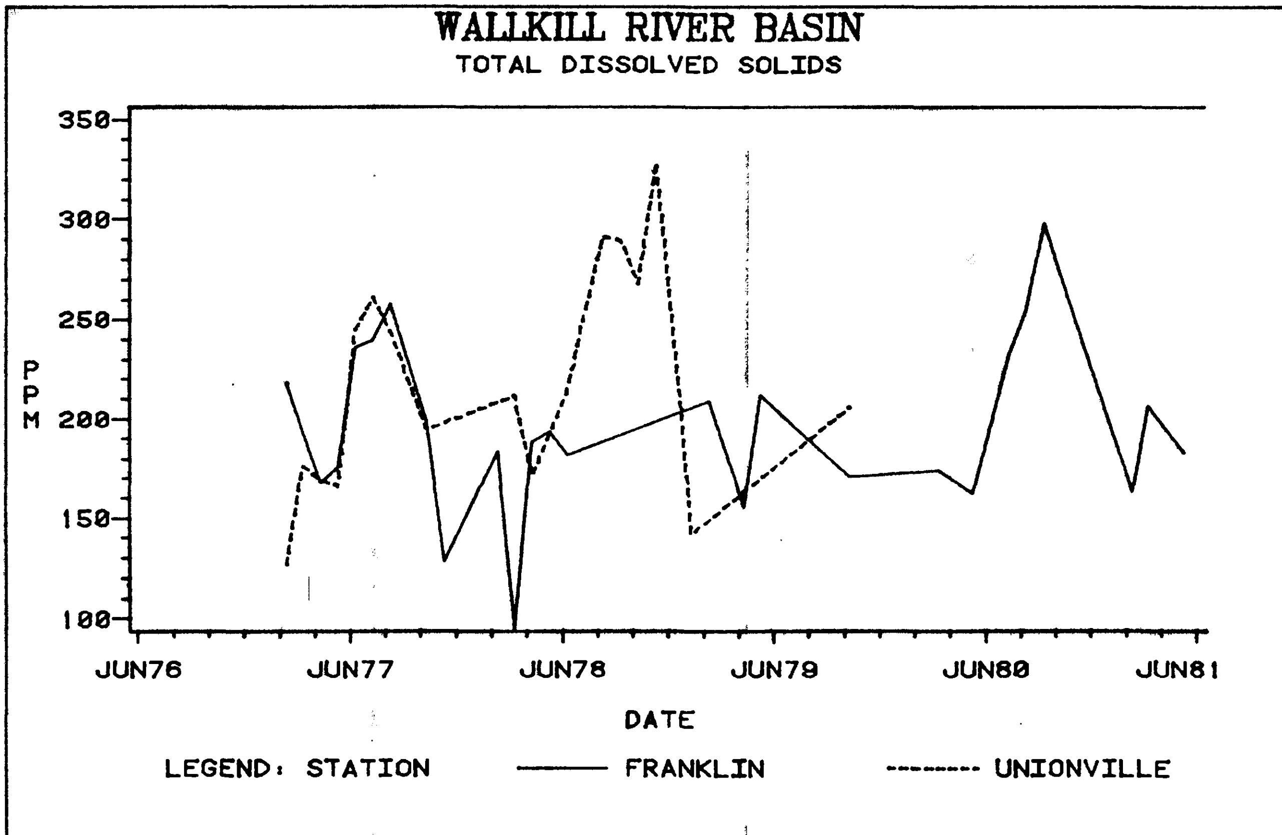

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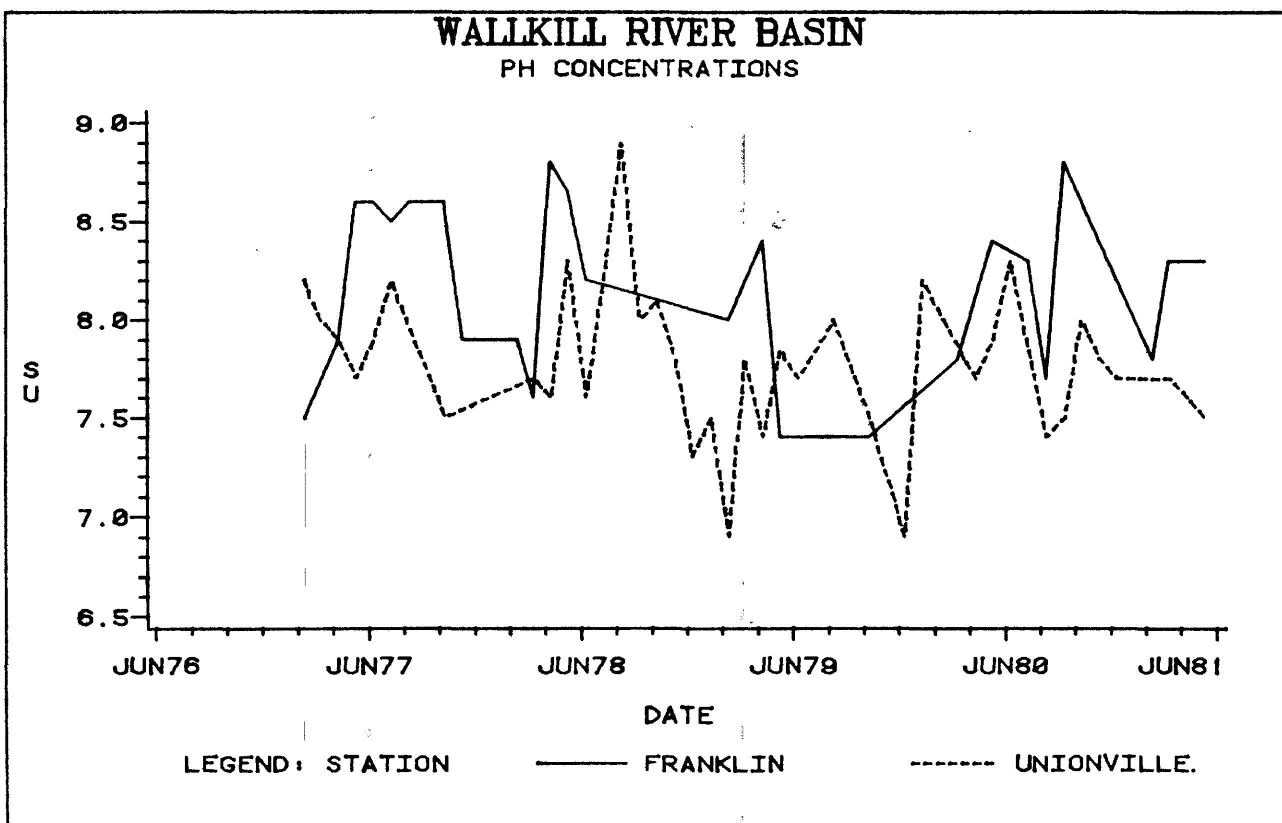

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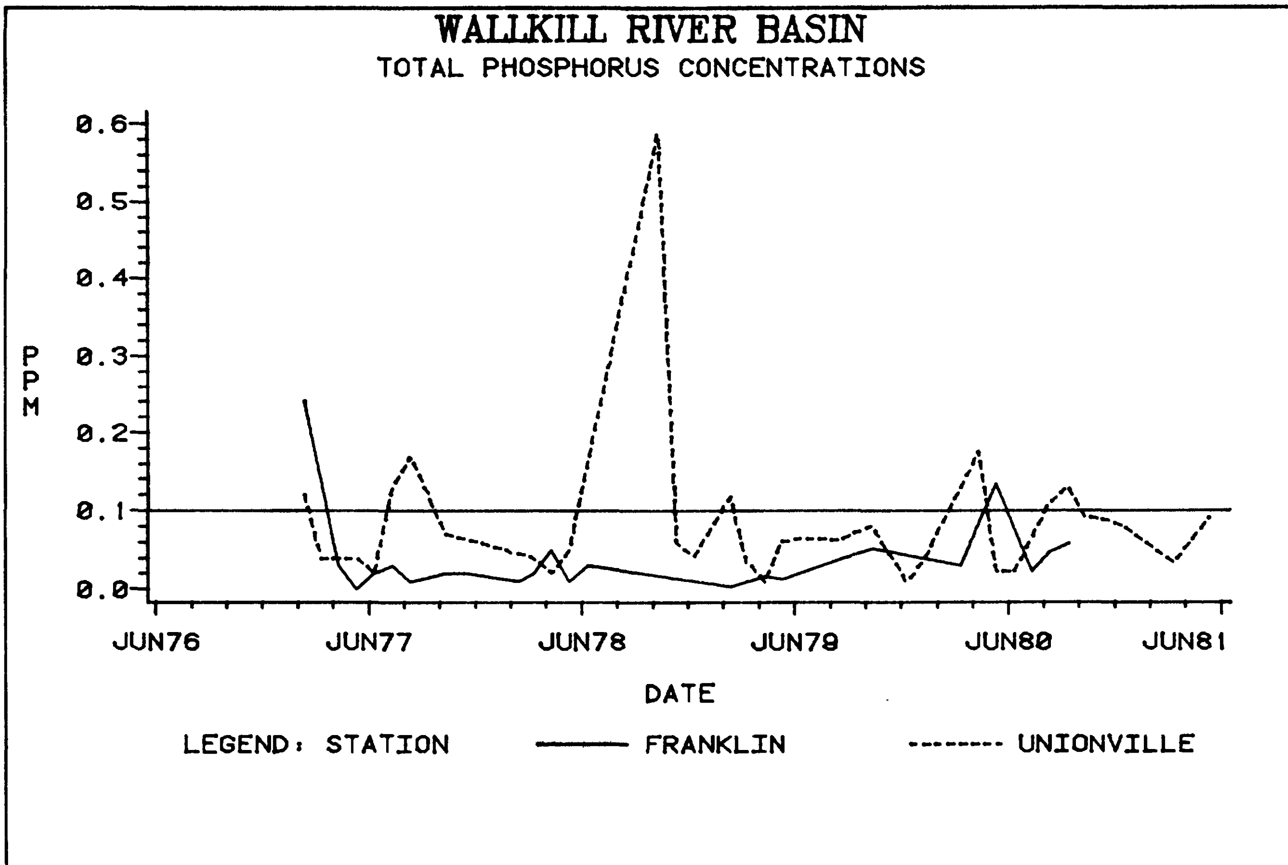

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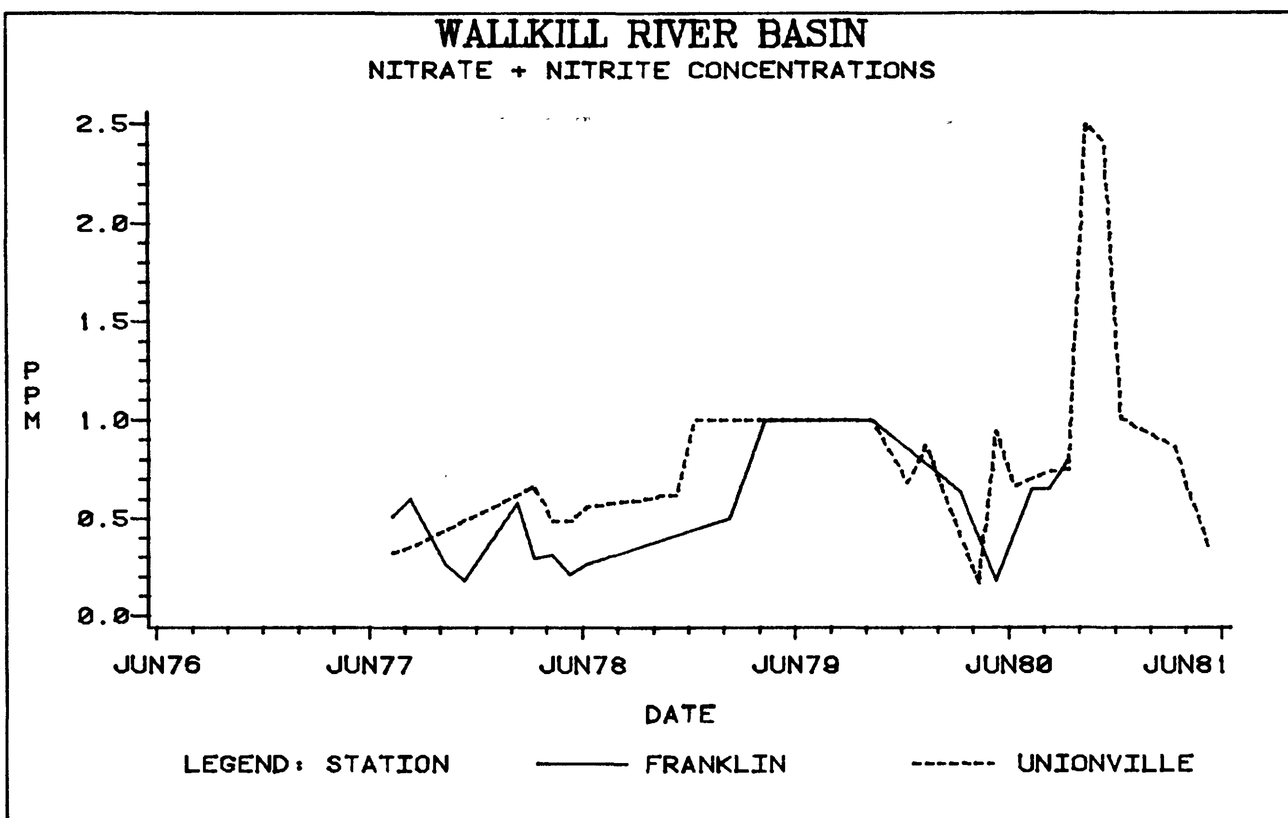

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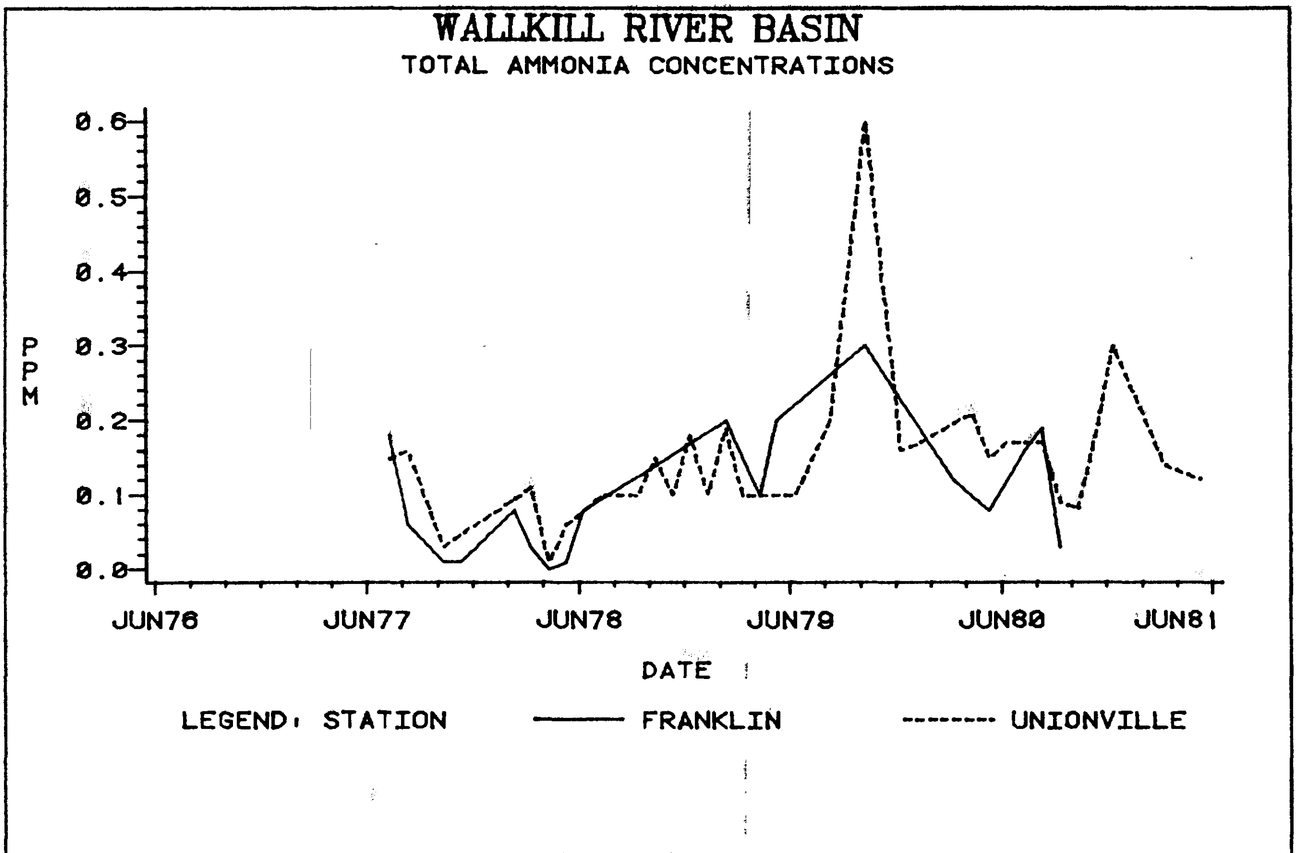

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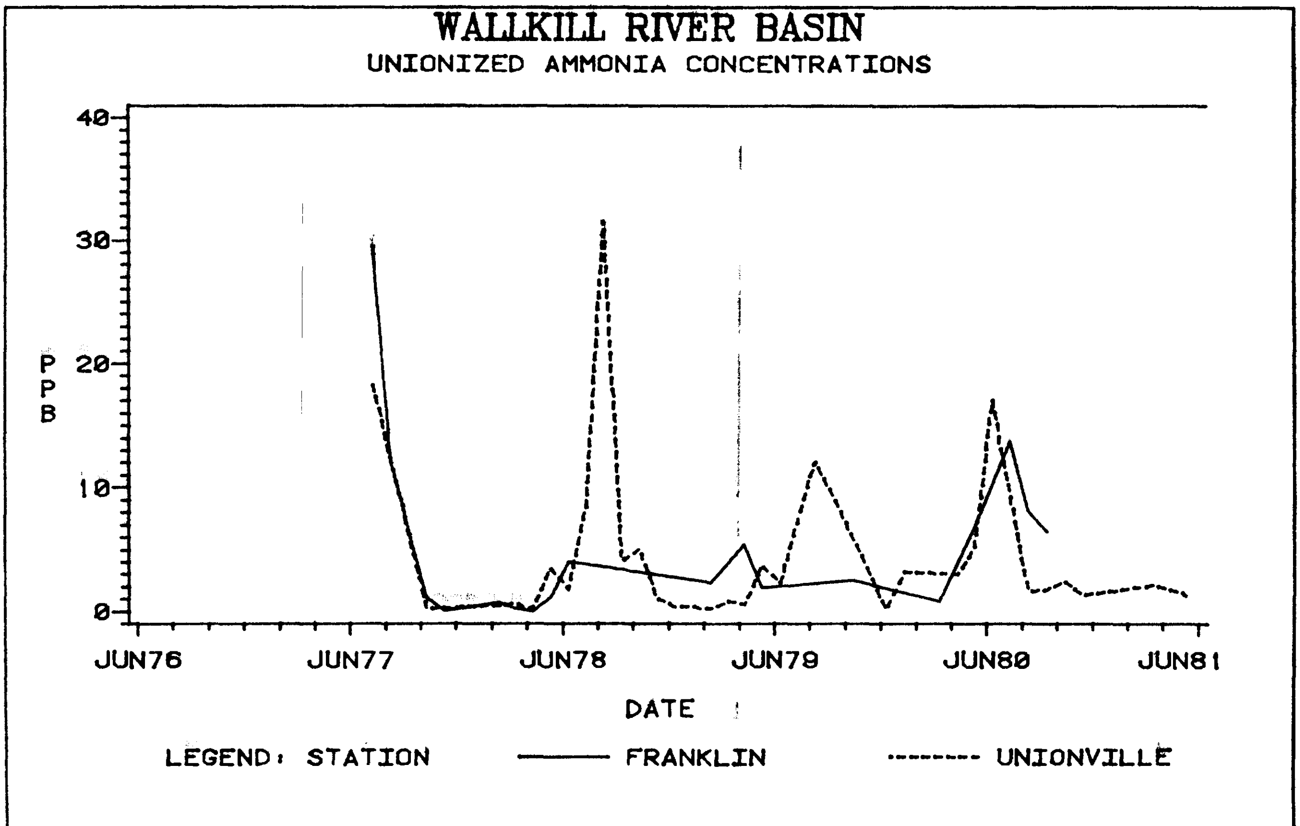
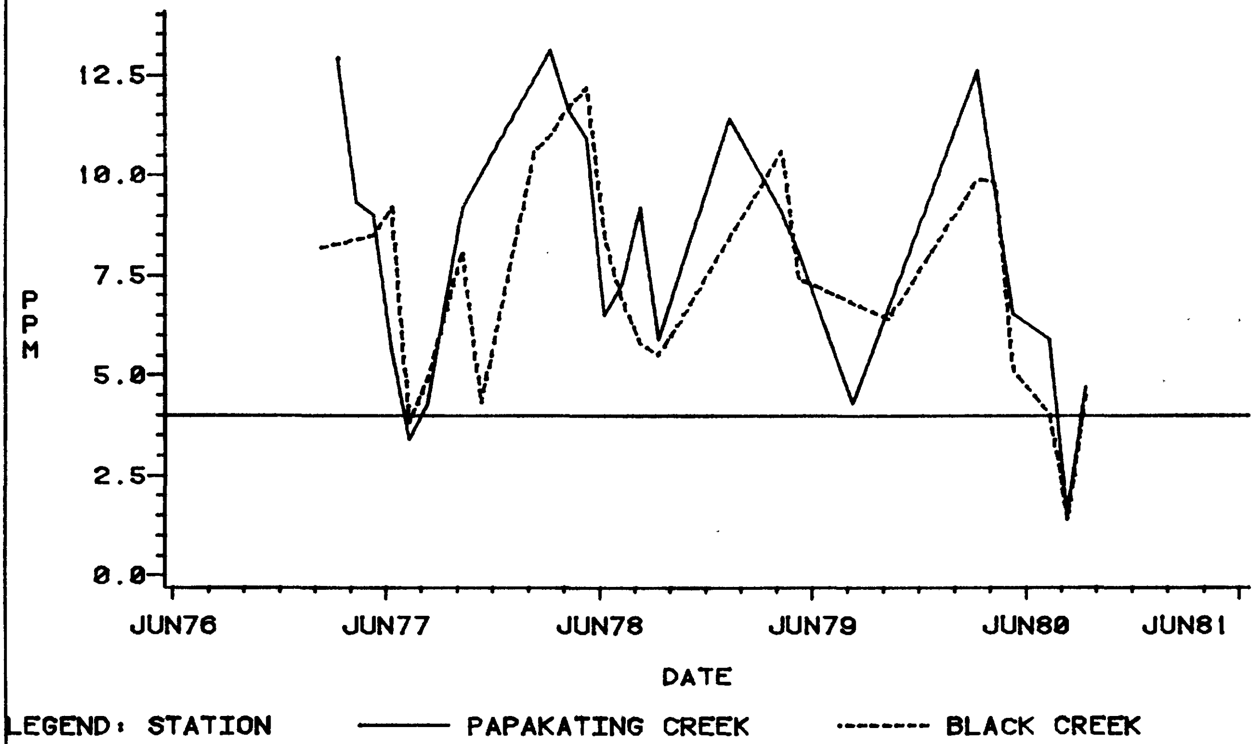


Figure: A1 -10

WALLKILL RIVER BASIN
DISSOLVED OXYGEN CONCENTRATIONS



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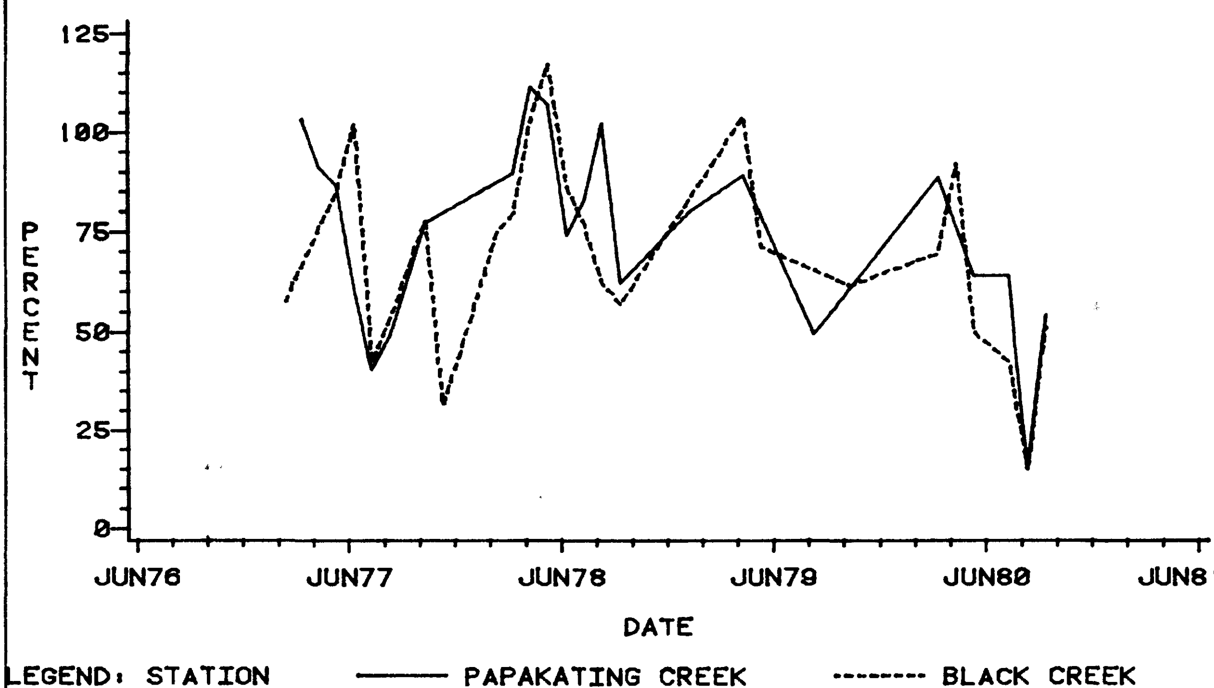

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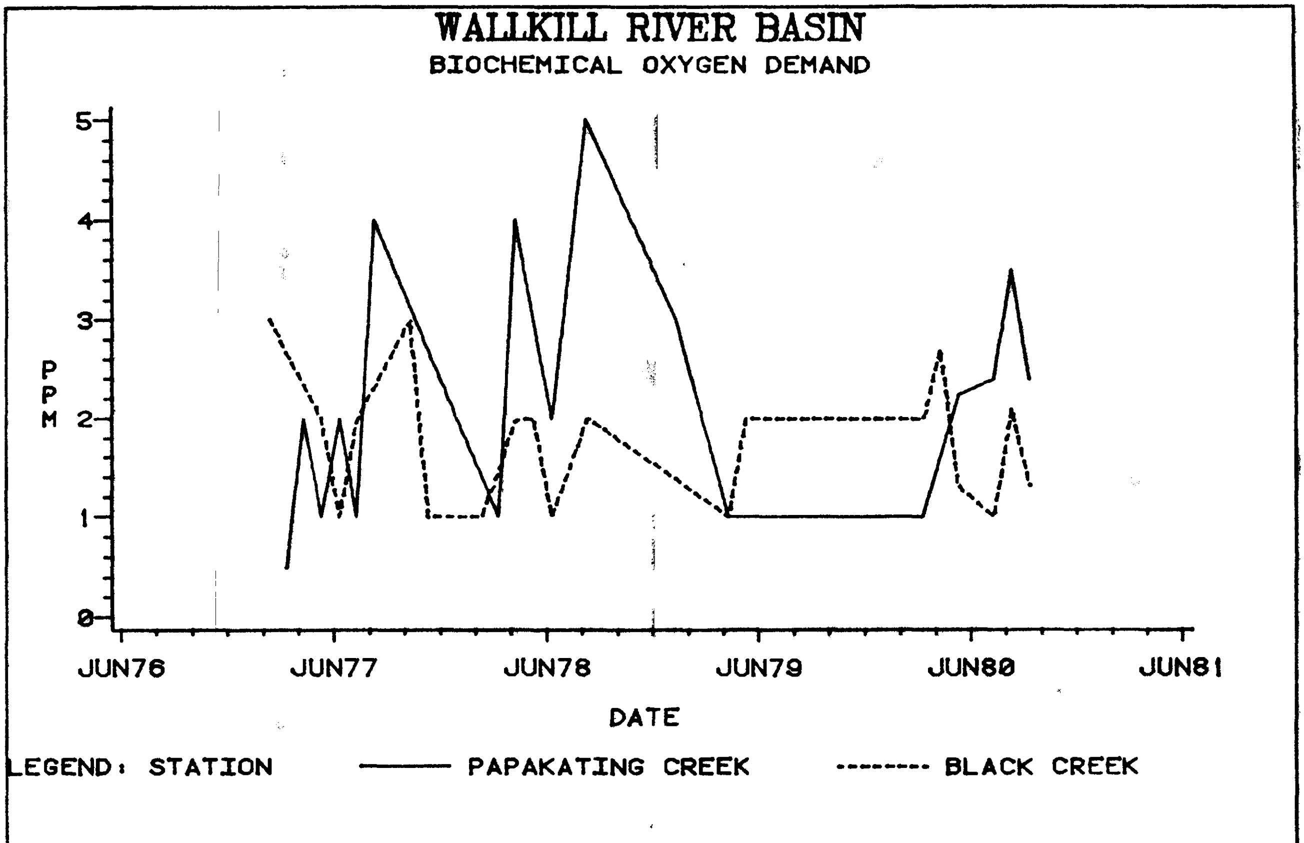

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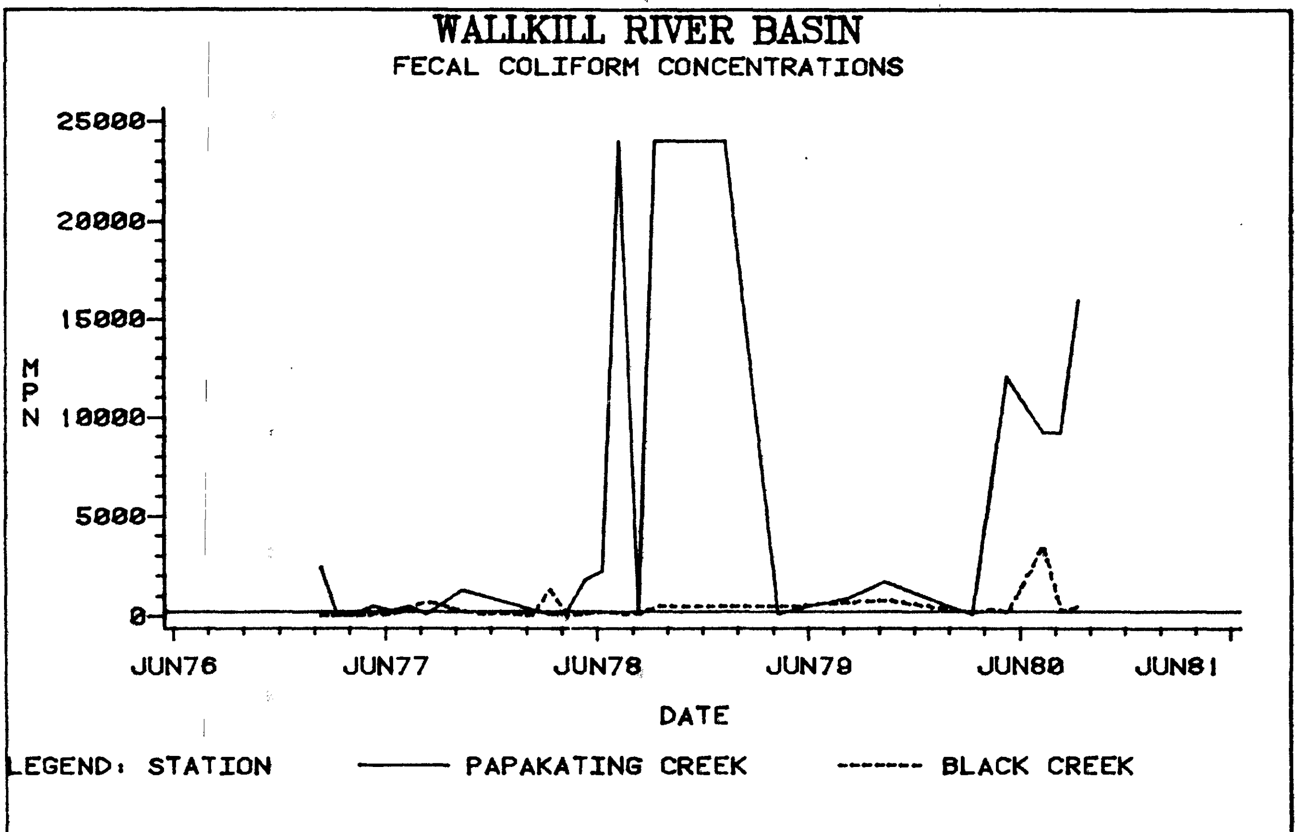

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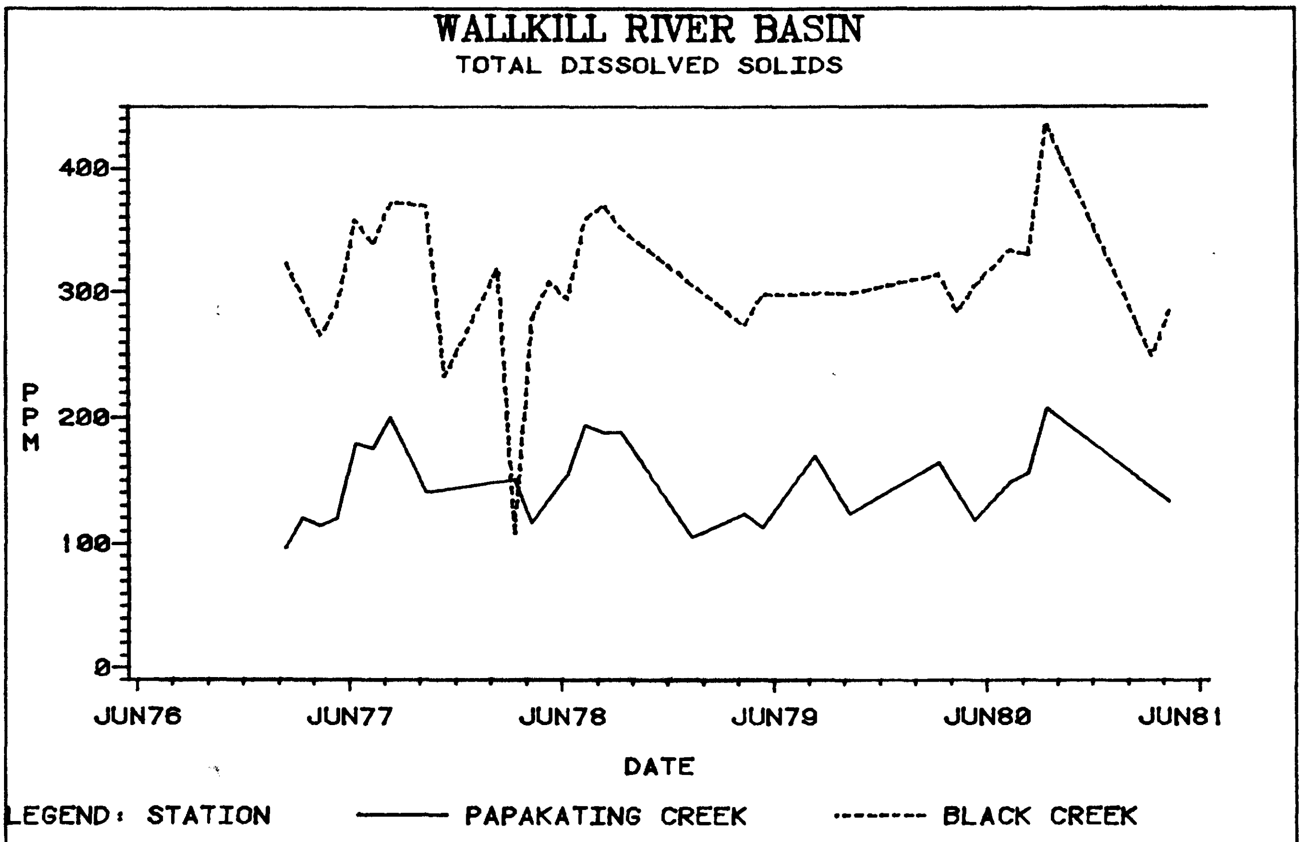

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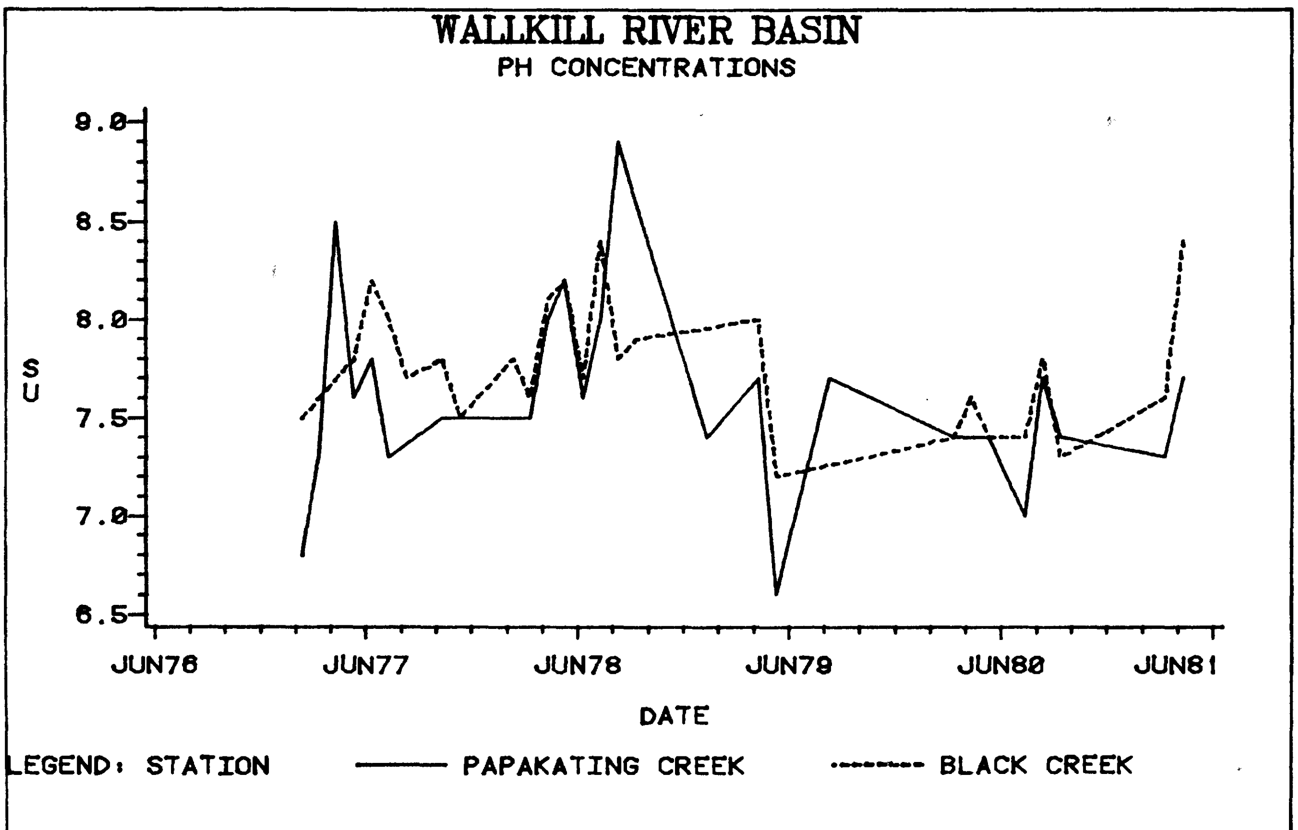

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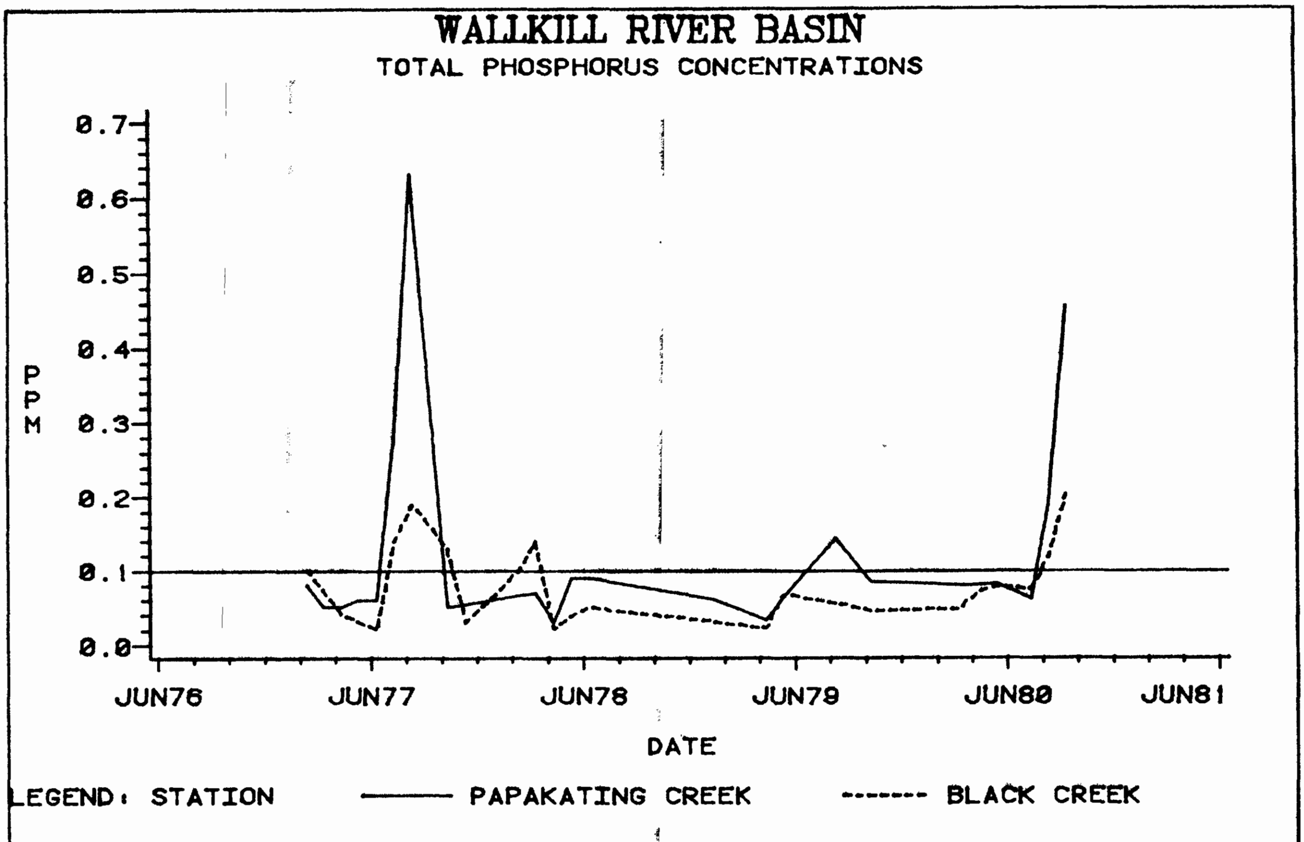

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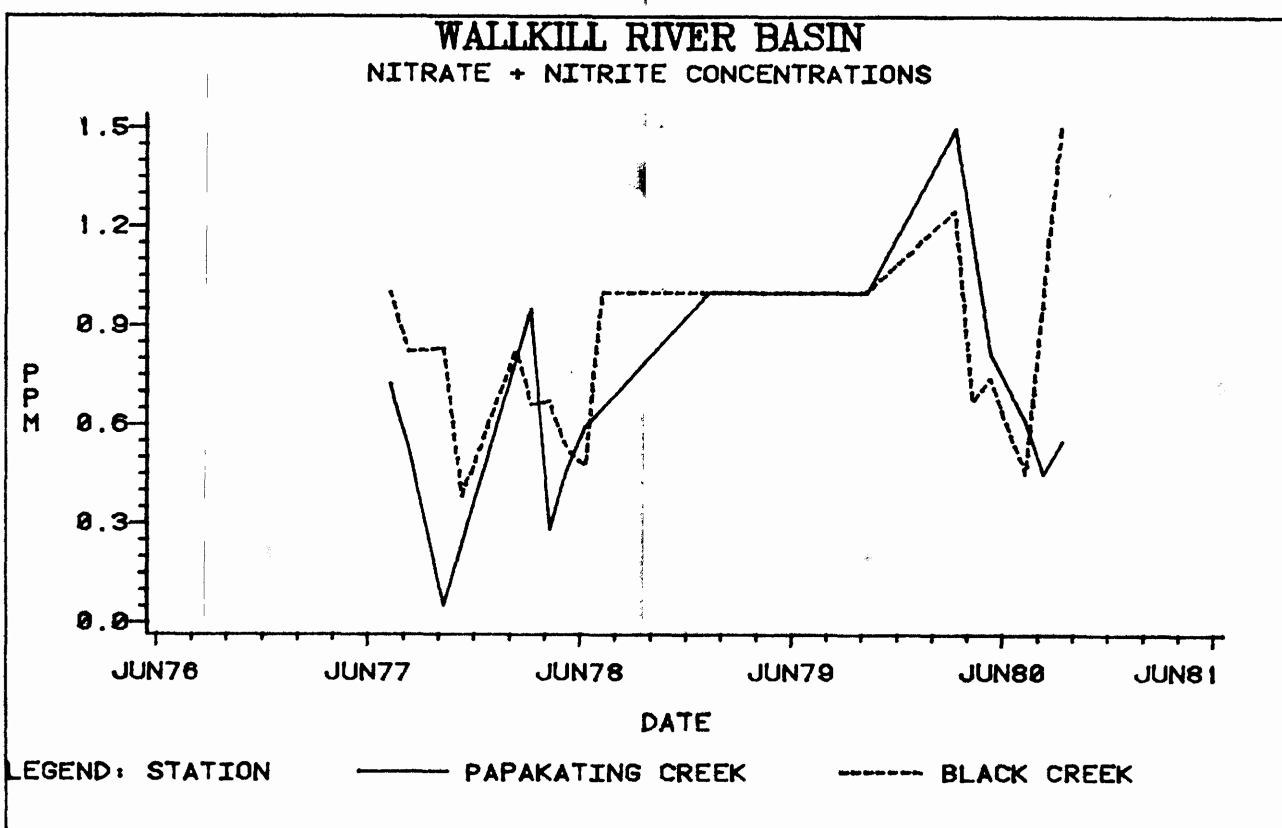

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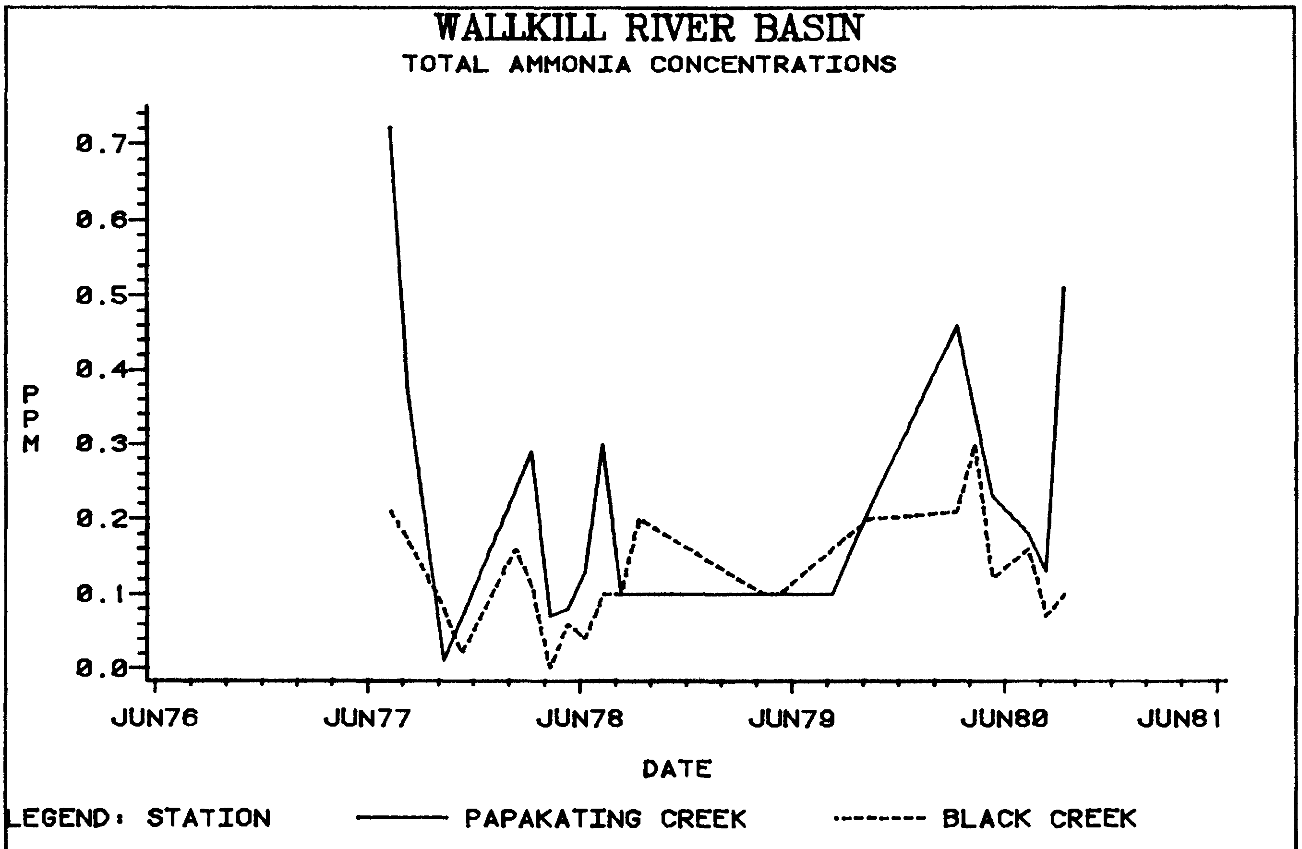

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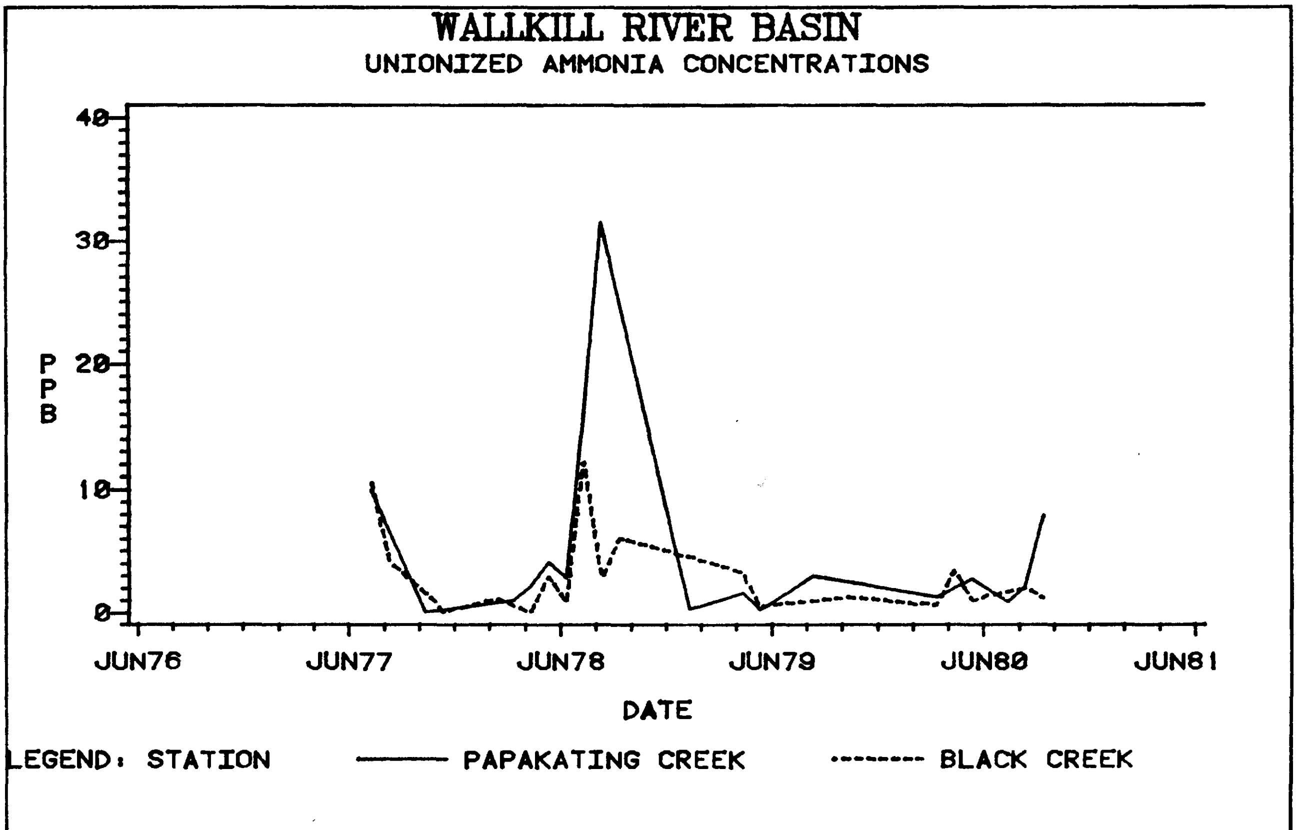


Figure: A2 -10

DISCHARGE INVENTORY - - - WALLKILL RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE SAN/PRO	AVG. FLOW MGD
SUSSEX BOROUGH	0021857	SUSSEX BOROUGH	WALLKILL R.	SANITARY	.19
FRANKLIN BOARD OF PUBLIC WORKS	0031038	FRANKLIN	WALLKILL RIVER		.025
FRANKLIN DPW	0029220	FRANKLIN	WALLKILL RIVER	SAN/SIG INDUS	
LIMESTONE PROD CORP.	0035564	FRANKLIN	WALLKILL RIVER		
FRANKLIN SHOPPING CENTERS INC	0026999	FRANKLIN BORO	WALLKILL RIVER	SANITARY	
BOROUGH OF FRANKLIN BD PUB WKS	0022055	FRANKLIN BOROUGH	WALLKILL RIVER	SANITARY	.197
ACCURATE FORMING CORP.	0002275	HAMBURG	WALLKILL RIVER	PROCESS WASTE	
AMES RUBBER CORP	0000141	HAMBURG BORO	WALLKILL RIVER	COOLING WATER	.107
PLASTOID CORP	0006661	HARDY STON TWP	WALLKILL RIVER		.02
PLASTOID CORPORATION	0020885	HARDY STON TWP	WALLKILL RIVER	COOLING WATER	
WALLKILL SEWER COMPANY	0027367	HARDYSTON TWP.	WALLKILL RIVER	SANITARY	
NEW JERSEY ZINC CO.	0004596	OGDENSBURG BORO	WALLKILL RIVER		.221
TRI-CN'TY WATER CONDITION CO.	0033472	SPARTA	WALLKILL RIVER	SANITARY	
REGENCY AT SUSSEX	0029041	WANTAGE	TRIBUTARY TO WALKILL RIVER		
MEM COMPANY INC	0028215	NORTHVALE N.J.	TRIBUTARY OF SPARKILL		.032
GREAT GORGE SKI AREA	0021814	VERNON TWP	TRIB TO BLACK CREEK	SANITARY	
POPE JOHN REGIONAL SCHOOL XXII	0027049	SPARTA TWP	TRIB OF WALKILL RIVER	SANITARY	
SPARTA BD OF ED ALPINE SCHOOL	0027065	SPARTA TWP	TRIB OF WALKILL RIVER	SANITARY	
SPARTA BD OF ED HIGH SCHOOL #	0027073	SPARTA TWP	TRIB OF WALKILL RIVER	SANITARY	
SPARTA BD OF ED HIGH SCHOOL #	0027081	SPARTA TWP	TRIB OF WALKILL RIVER	SANITARY	
SPARTA TOWNSHIP	0027057	SPARTA TWP	TRIB OF WALKILL RIVER	SANITARY	
HARDEN FUEL OIL CO.	0026115	HAMBURG	SWAMPY AREA TO DITCH	SANITARY	
EXXON STATION #5432	0034967	NORTHVALE	SPARKILL RIVER		
HIGH POINT REGIONAL HS	0031585	SUSSEX	PAPAKATING CREEK	SANITARY	.01
VERNON TWP SCHOOL BOARD	0023841	VERNON TWP	BLACK CR.	SANITARY	
STONEHILL CORPORATION	0032841	VERNON	BLACK CREEK	SANITARY	
PLAYBOY CLUB HOTEL	0023949	VERNON TWP	BLACK CREEK	SANITARY	.304
VERNON VALLEY SKI AREA	0023027	VERNON TWP	BLACK CREEK	SANITARY	
DEER TRAIL PARK VILLAGE	0035335	HARDYSTON TWP	FAWN LAKE		

B. FLAT BROOK AND PAULINS KILL

Basin Description

The Flat Brook and Paulins Kill drain portions of Sussex and Warren Counties in a southwesterly direction to the Delaware River. The Flat Brook, formed by the confluence of the Little Flat Brook and Big Flat Brook, drains 65 square miles of Sussex County. The Paulins Kill watershed is significantly larger draining a total of 172 square miles (110 in Sussex County and 62 in Warren County); and includes the major tributaries of Blair Creek, Yards Creek, Morses Brook, Culver Brook and Trout Brook. Paulins Kill Lake is the largest impoundment on the Paulins Kill. The lake is approximately 3 miles long, but has a surface area of .4 square miles. Flows for the Flat Brook average 109 cfs at Flatbrookville 1.5 miles upstream of the confluence with the Delaware River; compared to an average flow of 194 cfs in the Paulins Kill at Blairstown (126 square miles drainage area).

The Flat Brook is considered to have some of New Jersey's best quality surface waters and is a valuable recreation resource for trout fishing and other activities that require clean water. The Flat Brook watershed is primarily undeveloped, mountainous forest land in Montague, Sandyston, and Walpack Townships. State parks (High Point), forests (Stokes) and wildlife management areas (Hainesville, Flat Brook-Roy and Walpack) along with the federal Delaware Water Gap National Recreational Area are all or partially within the Flat Brook watershed. Numerous small ponds and lakes facilitate the watershed's fisheries resources. Trout are stocked yearly or more often in the Beer's Kill, Big Flat Brook, Little Flat Brook, Parker Brook, Stony Brook and Lake, and Tuttles Corner Brook by the NJ Division of Fish, Game and Wildlife (DFGW). DFGW has also identified many of the above streams as containing reproducing brown and brook trout populations.

Because the Flat Brook watershed is largely park lands, the population is under 2,000 with very little growth expected for the future. Actual population decreased in the period from 1970-1980. One institutional sewerage facility discharges in this watershed (the Annandale-Stokes Unit Youth Correctional Institute).

The Paulins Kill watershed, in contrast to the Flat Brook, contains a variety of land uses. The Upper Delaware Water Quality Management Plan (1979) noted that 59 percent of the Paulins Kill watershed is forested (primarily along steep slopes and ridge tops), 34 percent is agricultural, 4 percent is developed and 3 percent is contained in the numerous water bodies found in the watershed. Development is heaviest in Newton and Blairstown, along lakes and the major roads, especially Route 15. The Paulins Kill watershed has a high growth potential, as some municipalities experienced a 50-100 percent population increase (Blairstown, Hardwick, Hampton and Stillwater Townships) between 1970-1980. Although the entire watershed is included within two wastewater facilities planning areas, (Paulins Kill Basin Study Area in Sussex County and the Paulins Kill Sewerage Authority in Warren County), only Newton and some surrounding areas are sewered. The Town of Newton discharges approximately 1 mgd to Moore's Brook, a tributary of the Paulins Kill. There are a total of 11 dischargers in the watershed, 7 of which are sanitary and 4 that are industrial. The largest discharge in the watershed is the Limestone Products of America (5-6 mgd).

Agricultural activities predominate in the watershed, with beef and dairy cattle, horse, sheep, swine and poultry operations common. Crop production also occurs throughout the watershed. A flood and sediment control project for the Paulins Kill was completed in the early 1970's by local Soil Conservation Districts and municipalities, and the federal Soil Conservation Service. Three impoundments were constructed in the headwaters above Newton for flood control purposes and also serve as incidental recreation areas. One surface water intake in the Paulins Kill watershed is used by the Branchville Water Department and is located at the Dry Brook Reservoir.

Recreational usage is another important value of the Paulins Kill and tributaries. Contact recreation occurs in Columbia, Blairstown and Stillwater (Swartswood Lake). Other swimming beaches are found throughout the watershed. Boating, both motorized and non-motorized, is also common. Fishing is the major activity on the Paulins Kill and in its watershed. Certain stream segments contain reproducing rainbow, brown and brook trout populations. In addition, the DFGW stocks trout in the following streams within the Paulins Kill watershed: Alm's House Brook, Culver's Lake Brook, Dry Brook, Little Swartswood Lake, Swartswood Lake, Neldon Brook, Blair Creek and Lake, Yards Creek, Pond Brook, Jacksonbury Creek and Sparta Junction Brook.

Both the Flat Brook and Paulins Kill watersheds have a variety of water quality classifications according to the NJ State Water Quality Standards. The Flat Brook and tributaries are either FW-1, FW-2 Trout Production, FW-2 Trout Maintenance or FW-2 Nontrout. The Paulins Kill and tributaries are classified FW-2 Trout Production, FW-2 Trout Maintenance and FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

Flat Brook is categorized as one of New Jersey's highest quality streams. Data collected on the Flat Brook at Flatbrookville over the five year period from 1977-1981 generally supports this claim, with a few exceptions in fecal coliform and nutrient concentrations.

Dissolved oxygen concentrations at Flatbrookville were sufficient for the stream segment classified as trout maintenance, with only one recorded value below 7.0 mg/l. Similarly, D.O. saturation levels were generally above 65 percent. The dissolved oxygen data was generally accompanied by low biochemical oxygen demand concentrations. However, isolated values of 5.0 mg/l were recorded.

Fecal coliform levels at Flatbrookville were elevated only twice during the period. Over 95 percent of the values were less than 200 MPN/100 ml.

Total dissolved solids concentrations, recorded for 1977 and 1978 only, were generally under 150 mg/l. Alkaline conditions were prevalent in the Flat Brook as pH levels averaged 7.5 to 8.0 with the high and low values being 8.7 and 7.1 respectively.

Nutrient data suggests only a periodically enriched condition at Flatbrookville. Total phosphorus concentrations exceeded the 0.1 mg/l standard on only three occasions, but were otherwise 0.05 mg/l or less. Similarly, nitrate + nitrite, total ammonia and un-ionized ammonia concentrations were at very low levels with all un-ionized ammonia levels within the criteria. The pattern of low nutrient levels with occasional sharp, short-term increases along with the fecal coliform data, suggests the occurrence of contamination in the Flat Brook during rainfall events.

The water quality in the Paulins Kill at Blairstown seems to be affected by factors similar to those outlined above for the Flat Brook. The data illustrates normally high quality water with occasional concentrations approaching or exceeding applicable criteria.

Seasonal declines in dissolved oxygen concentrations remained above the minimum criterion of 5.0 mg/l for trout maintenance streams. Dissolved oxygen saturation levels were also sufficient as values were predominantly in excess of 65 percent. These dissolved oxygen levels were accompanied by biochemical oxygen demand concentrations of 4.0 mg/l or less.

Fecal coliform concentrations in the Paulins Kill at Blairstown were frequently in excess of the 200 MPN/100 ml level. Those periodic high counts were more frequent and severe than those noted in the Flat Brook.

Total dissolved solids concentrations were within acceptable limits in the Paulins Kill, although 50 to 75 percent higher than in Flat Brook. Alkaline conditions were prevalent in the Paulins Kill as mean pH values were approximately 8.0 at Blairstown.

Total phosphorus concentrations were generally within acceptable limits. The contraventions (one in both 1977 and 1979) were much less severe than those which occurred in the Flat Brook. Nitrate + nitrite data was consistently less than 1.0 mg/l for the period, but total and un-ionized ammonia concentrations once again exhibited periodic fluctuations.

Biological samples were collected in the Flat Brook at Flatbrookville in 1977, 1978 and 1979. Macroinvertebrate samples exhibited large numbers of taxa indicative of healthy communities. These dominant taxa were the midge Tanytarsus and the caddisfly, Cheumatopsyche. Periphyton chlorophyll a mean values (8.9 to 21.3 mg/m^2) were indicative of an enriched condition as Cocconeis was the dominant or subdominant genus all three years.

Overall, one water quality trend was noted in the Paulins Kill at Blairstown; dissolved oxygen saturation levels increased from seasonal lows of less than 60 percent during the summer of 1977 to low values of 70 percent or more throughout the remainder of the period. No clear trends were apparent for other parameters in the Paulins Kill or in the Flat Brook.

Toxic Parameters

In one sample taken from the Paulins Kill at Columbia, high levels of a trihalomethane compound were found. These levels were not found in two successive samples from this site. There has currently been no information collected on the Flat Brook. To date no extensive tissue sampling regime for toxic contamination has been conducted within either of these basins. Considerations for future sampling will be made with respect to site specific toxic perturbances and/or establishment of base line data for both basins.

Problem Assessment

The waters of the Flat Brook watershed are of high or excellent quality, while generally good quality characterizes the waters of the Paulins Kill. The excellent quality of the Flat Brook can be attributed to the predominantly undeveloped nature of the watershed. It should be noted, however, that the watershed is not completely without problems. The Annandale-Stokes Unit Youth Correctional Institution in Montague Township is experiencing operating problems and, therefore, is discharging pollutants in violation of its permit limitations. The facility discharges to a marsh through which Big Flat Brook flows. It is believed that after significant precipitation, a pollutional load is flushed into Big Flat Brook; possibly contributing to periodic short-term increases in fecal coliform levels, as detected in the monitoring downstream at Flatbrookville.

The headwaters of Little Flat Brook are experiencing nutrient pollution problems believed to be of agricultural and livestock origin. Hainesville (Secret) Pond in particular, which is located in the Hainesville Wildlife Management Area, is highly eutrophic.

While water quality in the Paulins Kill is generally good, it is adversely affected by inadequate sewage plant discharges, agricultural and livestock runoff and other sources such as septic system malfunctions. It was stated in the Sussex Water Quality Management Plan that water quality in the river below Newton is degraded because of high carbonaceous and nitrogenous BOD loadings associated with discharges from the Newton sewage treatment plant. Another factor thought to be affecting water quality in the basin is Hamm's Landfill in Lafayette Township. It is believed that the marsh adjacent to the landfill collects pollutants which "flush" into the Paulins Kill after significant rainfall. Agricultural activities, primarily livestock operations, appear to be the cause of water quality problems in the lower portion of the Paulins Kill watershed.

Goal Assessment and Recommendations

The waters of the Flat Brook, being of high quality, meet the goal of swimmable waters. The waters of the Paulins Kill, however, are of only marginally swimmable quality due to the frequency in which fecal coliform bacteria levels were found to contravene the 200 MPN/100 ml level. The waters of both watersheds are fishable and support diverse populations of fish species, including native trout. Twenty-five species of fish have reportedly been found in the Flat Brook, many of which require clean, cool running waters. The Paulins Kill watershed has a great diversity of fish life, numbering 31 species. The fish life, from carp to native brook trout, represent a wide range of conditions. Overall though, both watersheds contain some of the best lake and running waters for fishing in the State.

Reductions in the periodic high fecal coliform counts in the Flat Brook should occur as the Annandale-Stokes Unit Youth Correctional Institution eliminates its operational problems. Agricultural best management practices will reduce nutrient loadings to the numerous ponds and lakes in the Flat Brook watershed. Emphasis for implementing these practices should be placed on waters draining into eutrophic Hainesville Lake.

Major water quality improvements to the Paulins Kill can take place when the Town of Newton STP is enlarged and upgraded. Approximately 85% of the total nutrient loading to the Paulins Kill from point sources originates from this plant. Higher phosphorus removal rates at the plant will assist in reducing the eutrophication process in Paulins Kill Lake. Septic tank management and agricultural runoff controls will benefit the lower reaches of the Paulins Kill. Severe septic tank problems are in need of correction in Blairstown Township.

FLAT BROOK AND PAULINS KILL STATION LIST

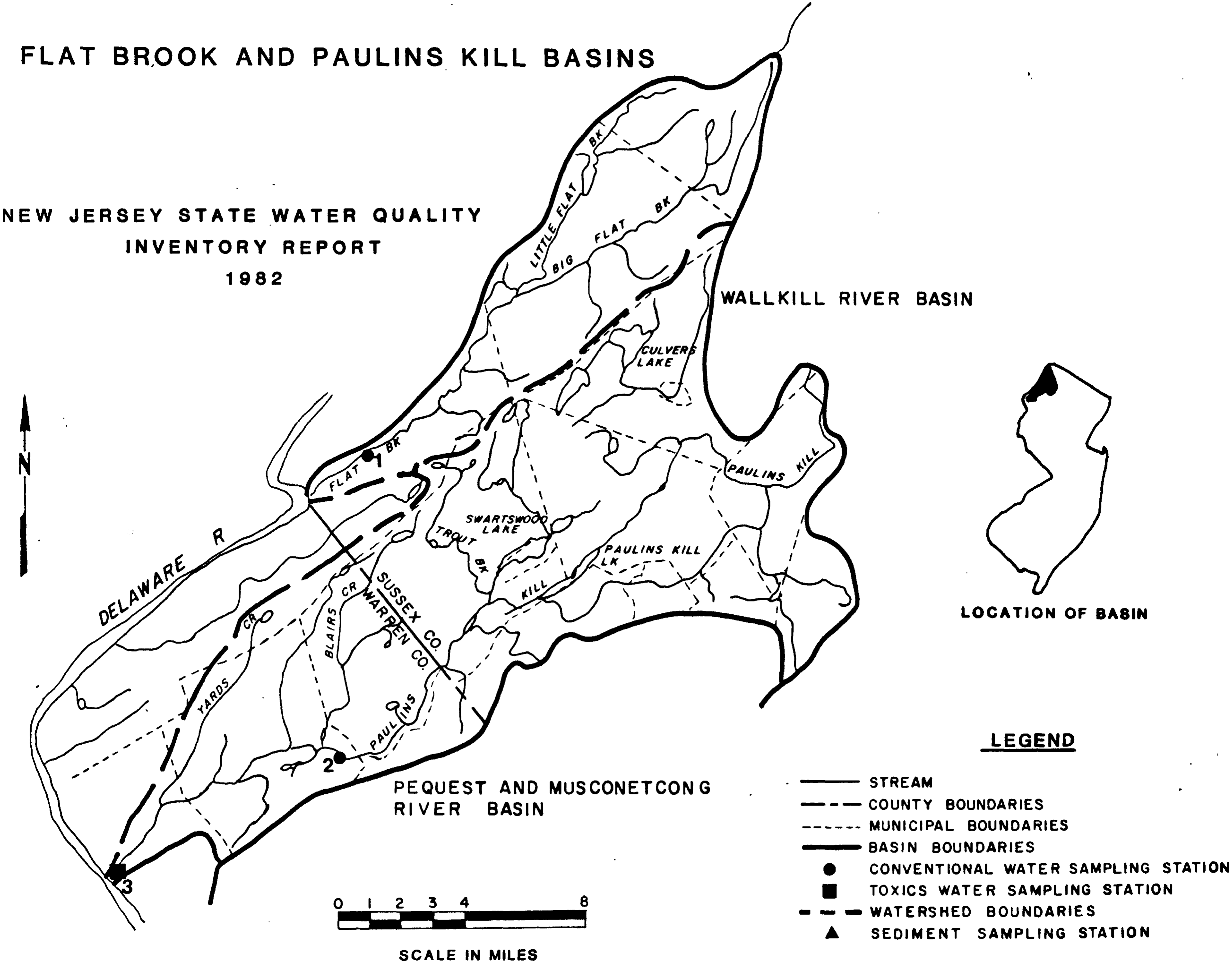
A. Ambient Monitoring Stations

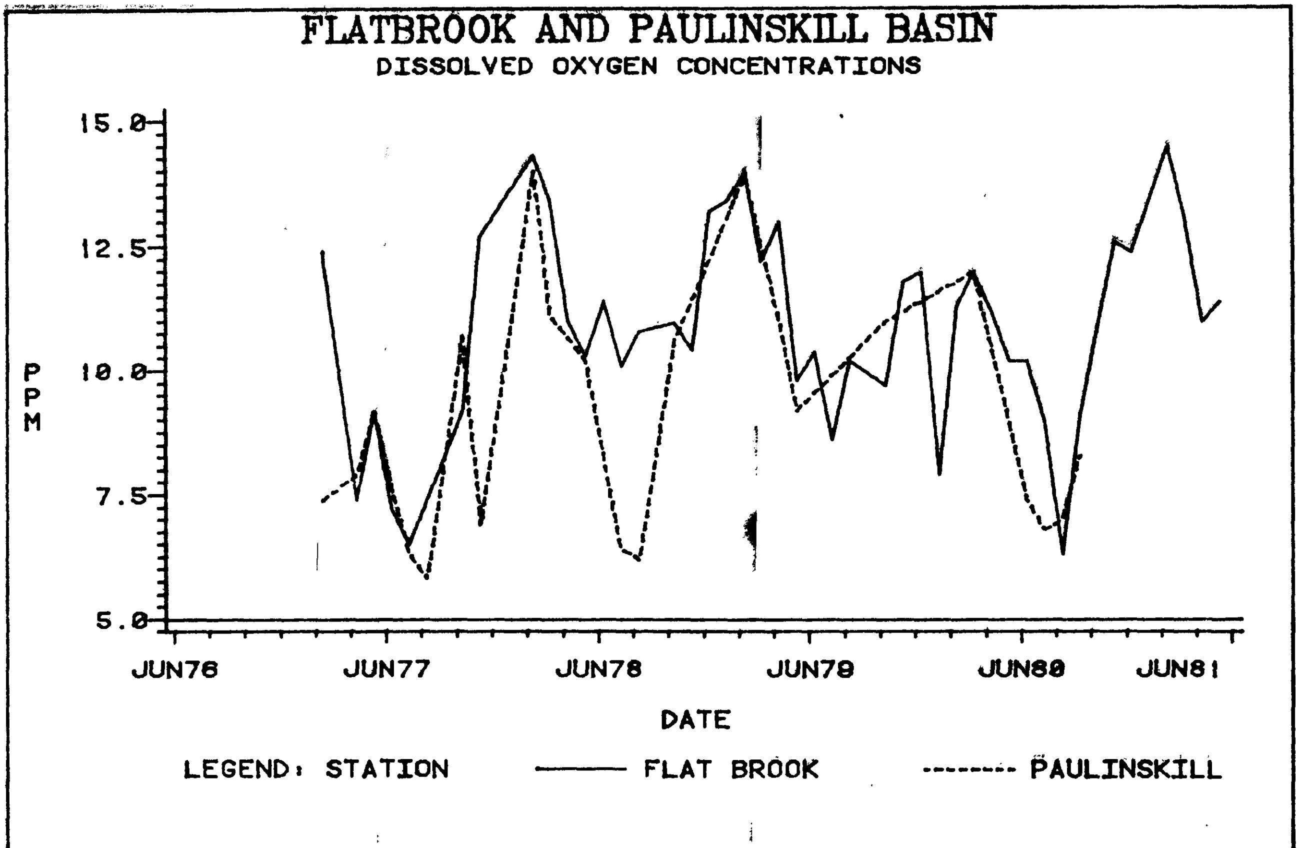
STORET Number	Station Description	Map Number
01440000	Flat Brook at Flatbrookville, Sussex County Latitude 41°06'24" Longitude 74°57'19" FW-2 Trout Maintenance Basic Water Monitoring Program Upstream side of weir, 1.0 mile upstream from Flatbrookville and 1.5 mile upstream from mouth at Delaware River.	1
01443500	Paulins Kill at Blairstown, Warren County Latitude 40°58'44" Longitude 74°57'15" FW-2 Trout Maintenance USGS/DEP Network	2

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Flat Brook at Columbia	Water column	3

FLAT BROOK AND PAULINS KILL BASINS





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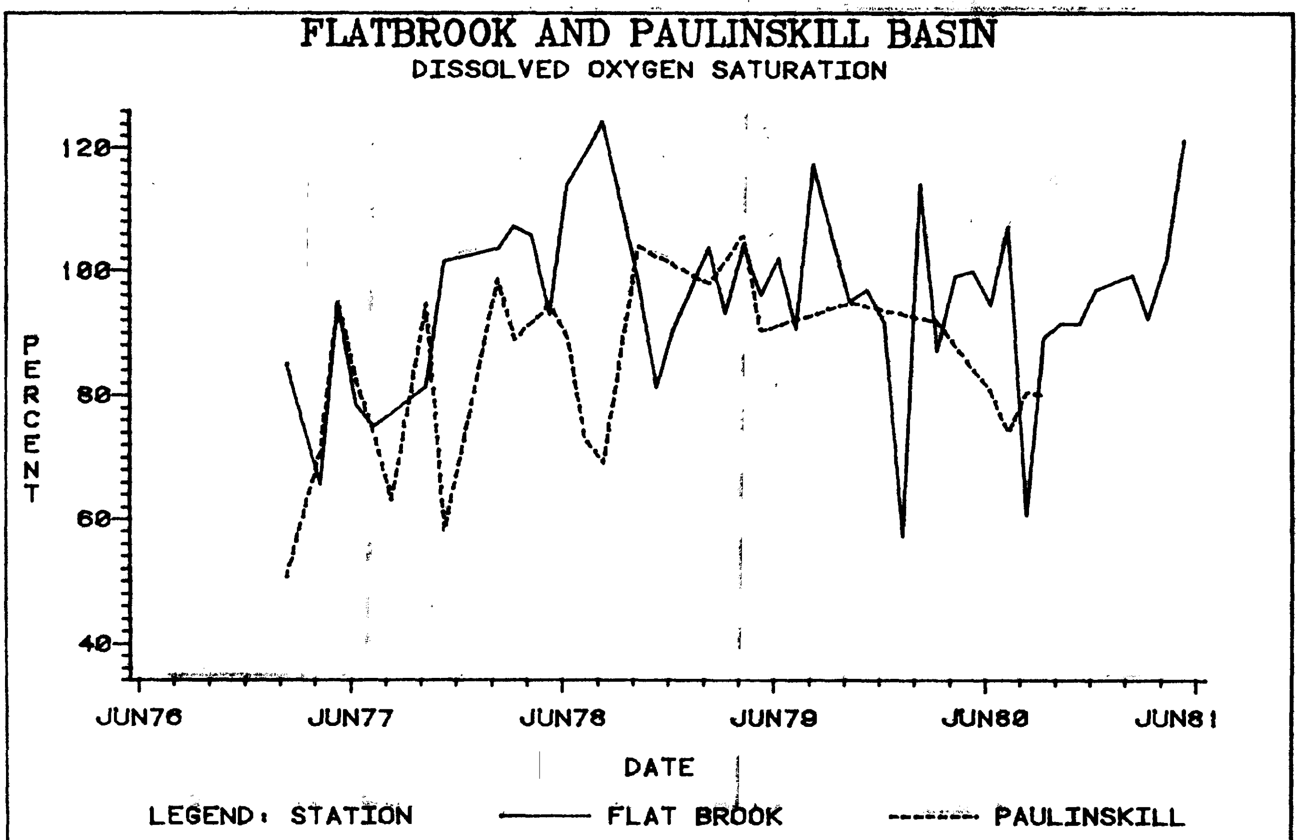

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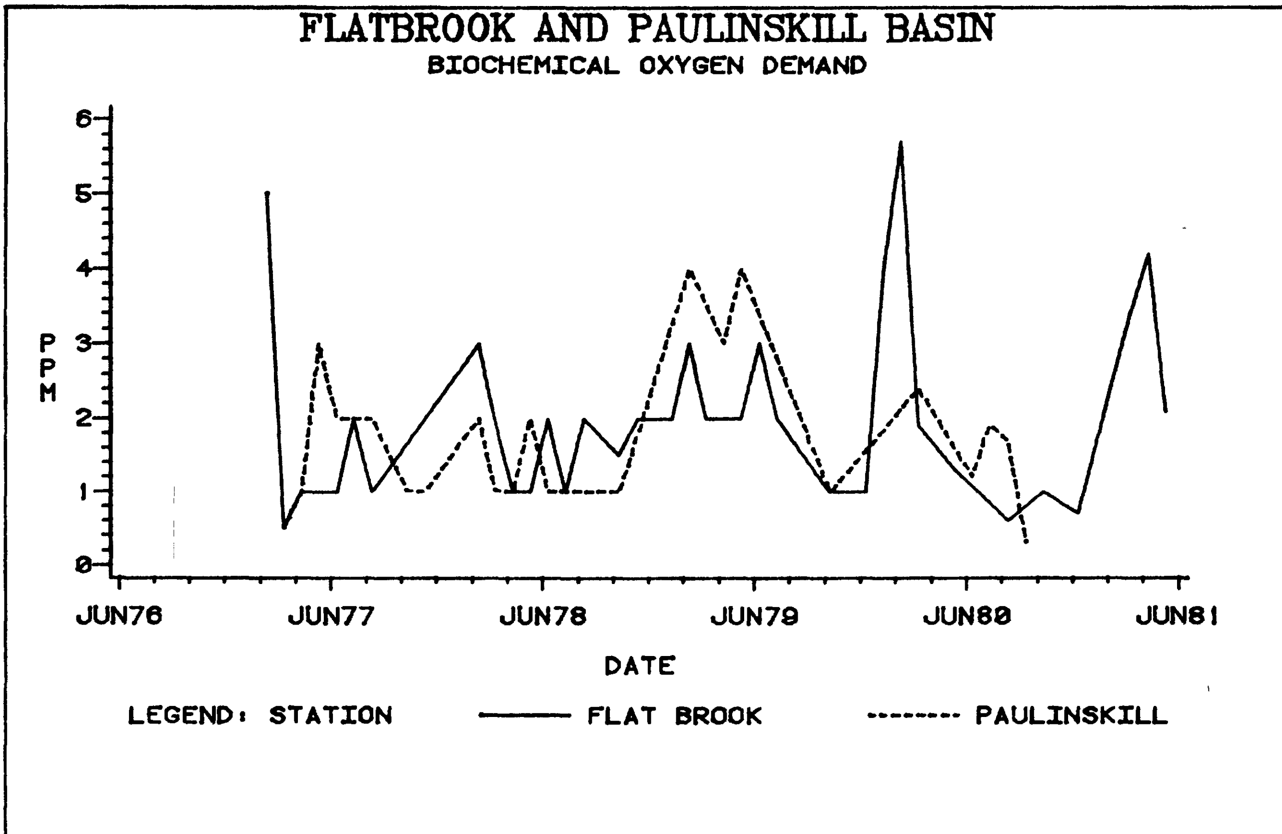

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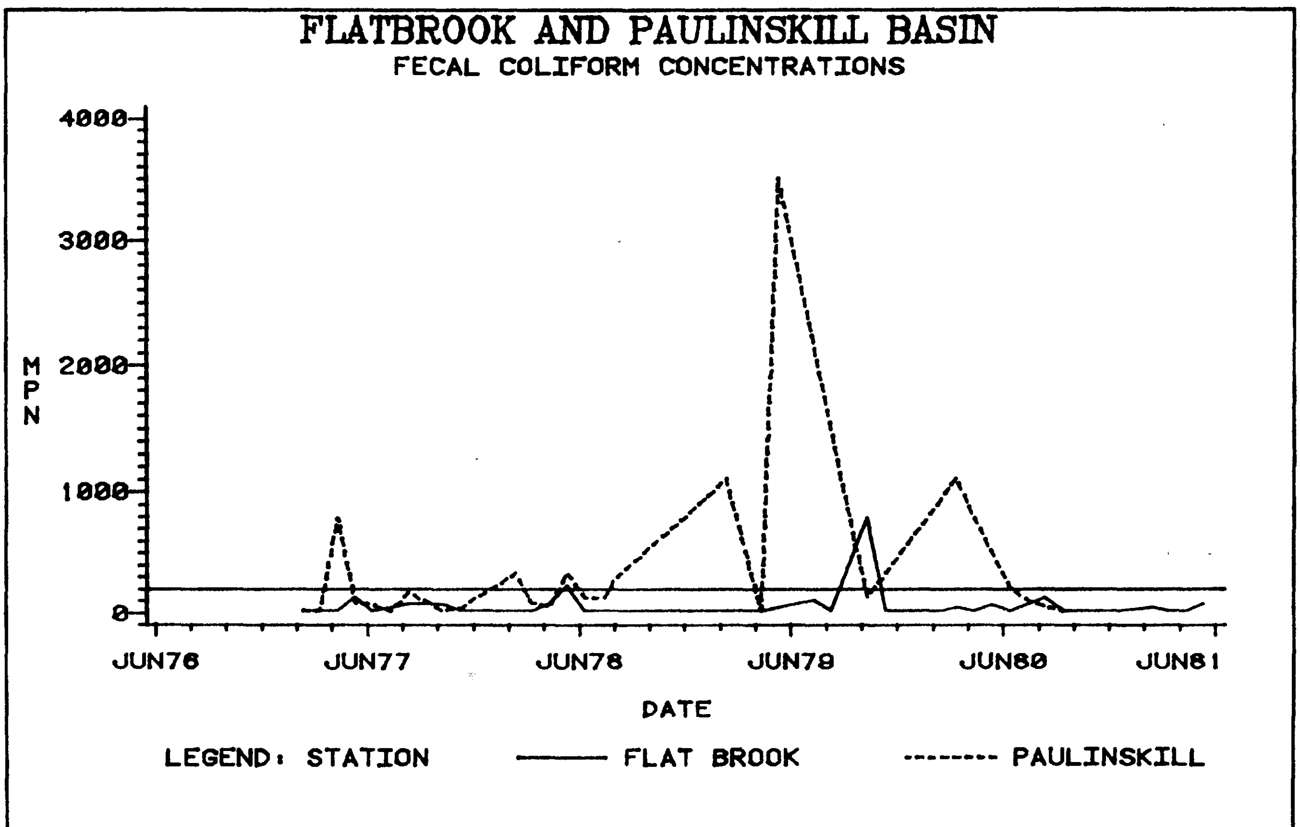

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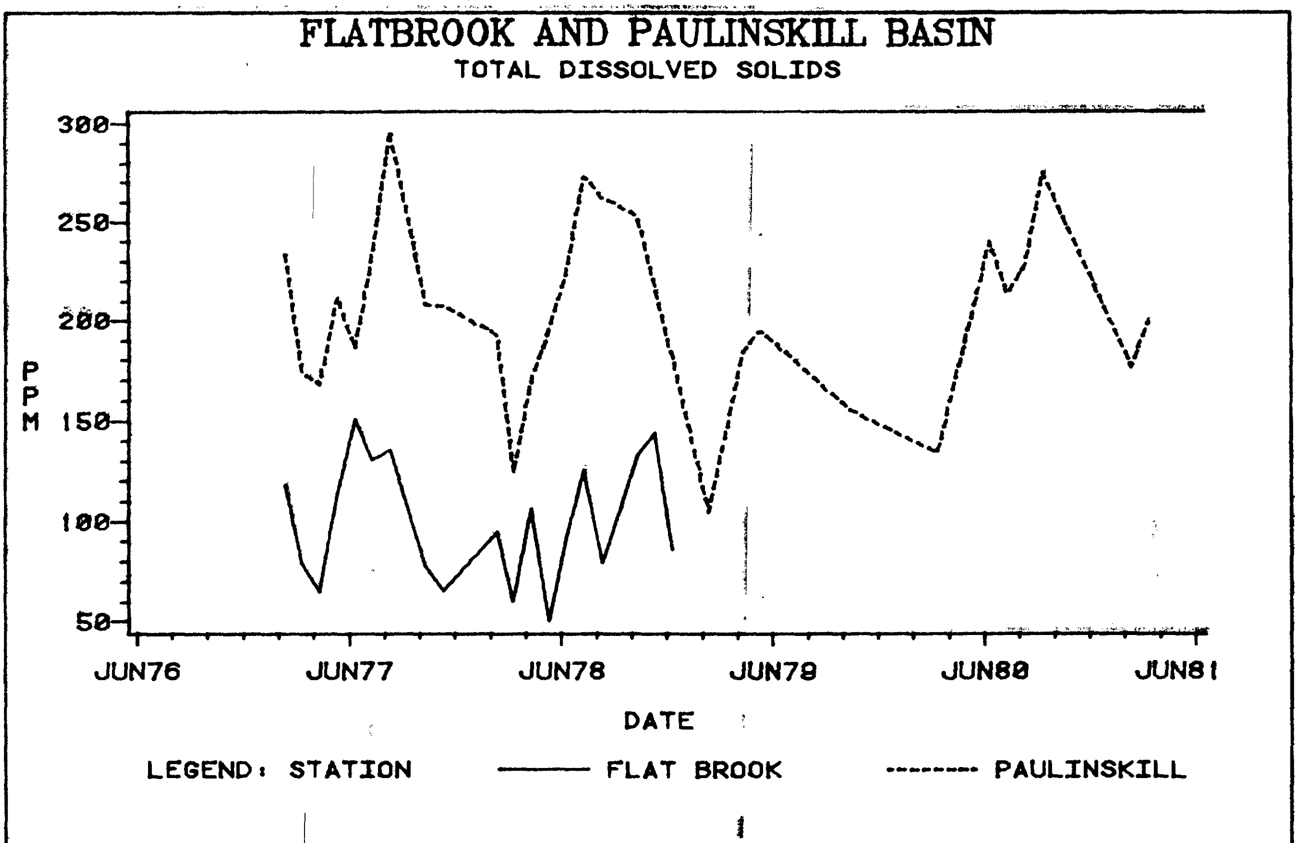

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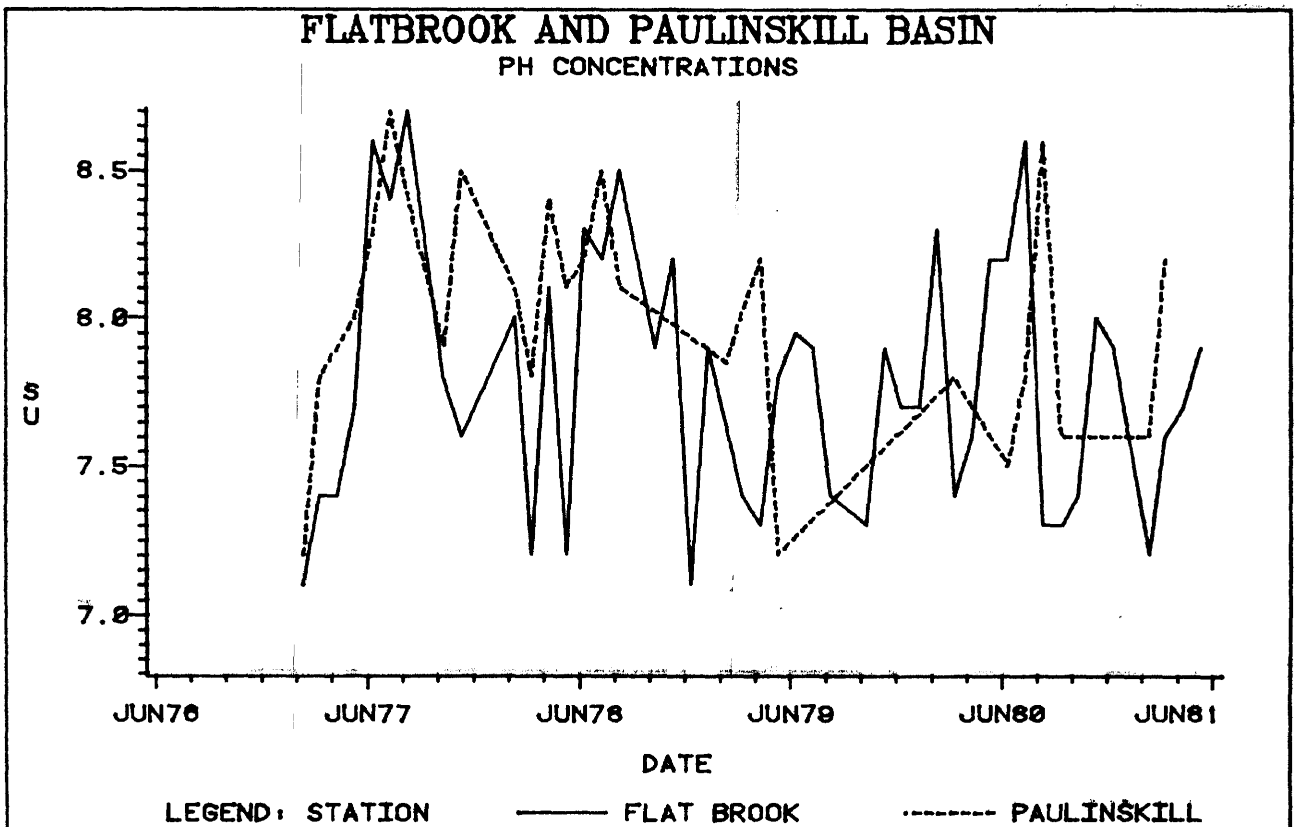

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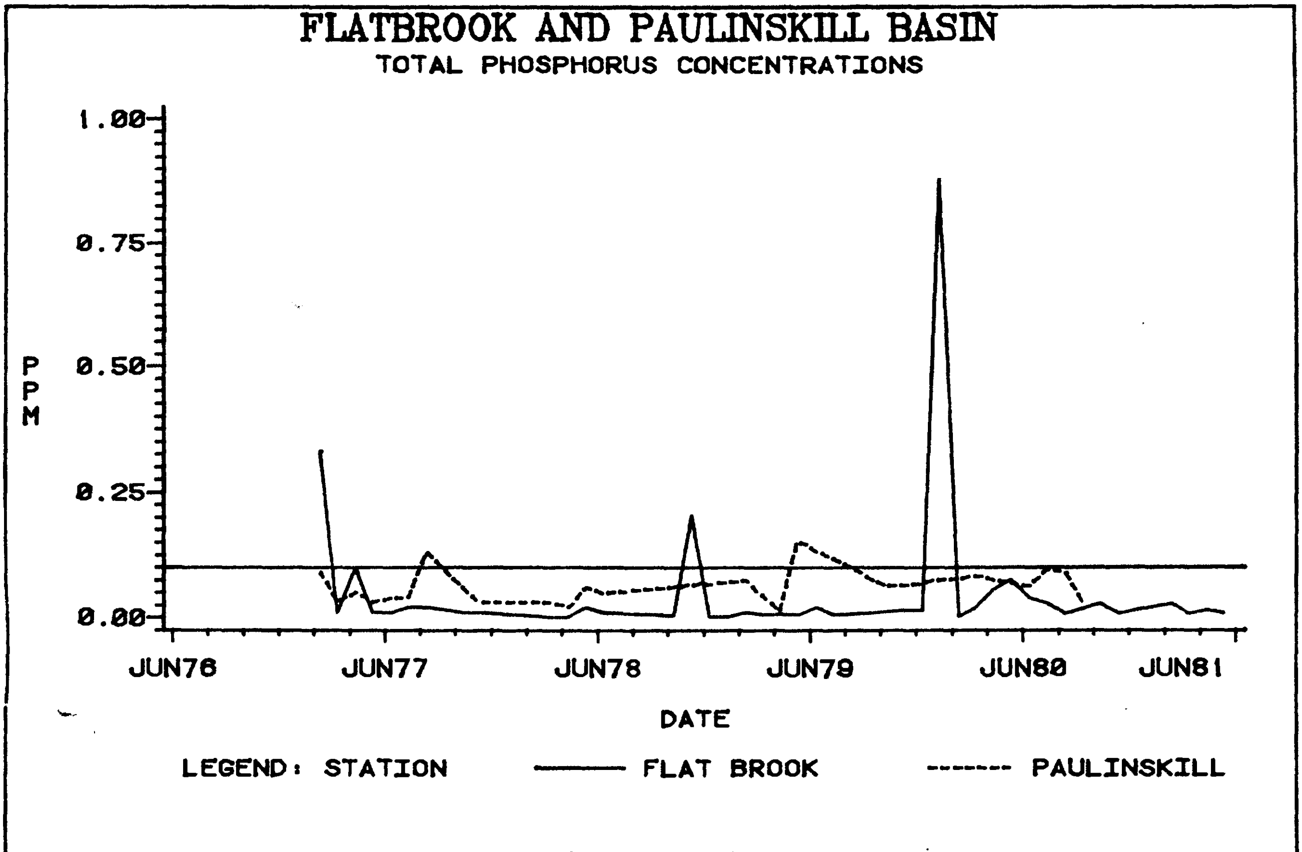

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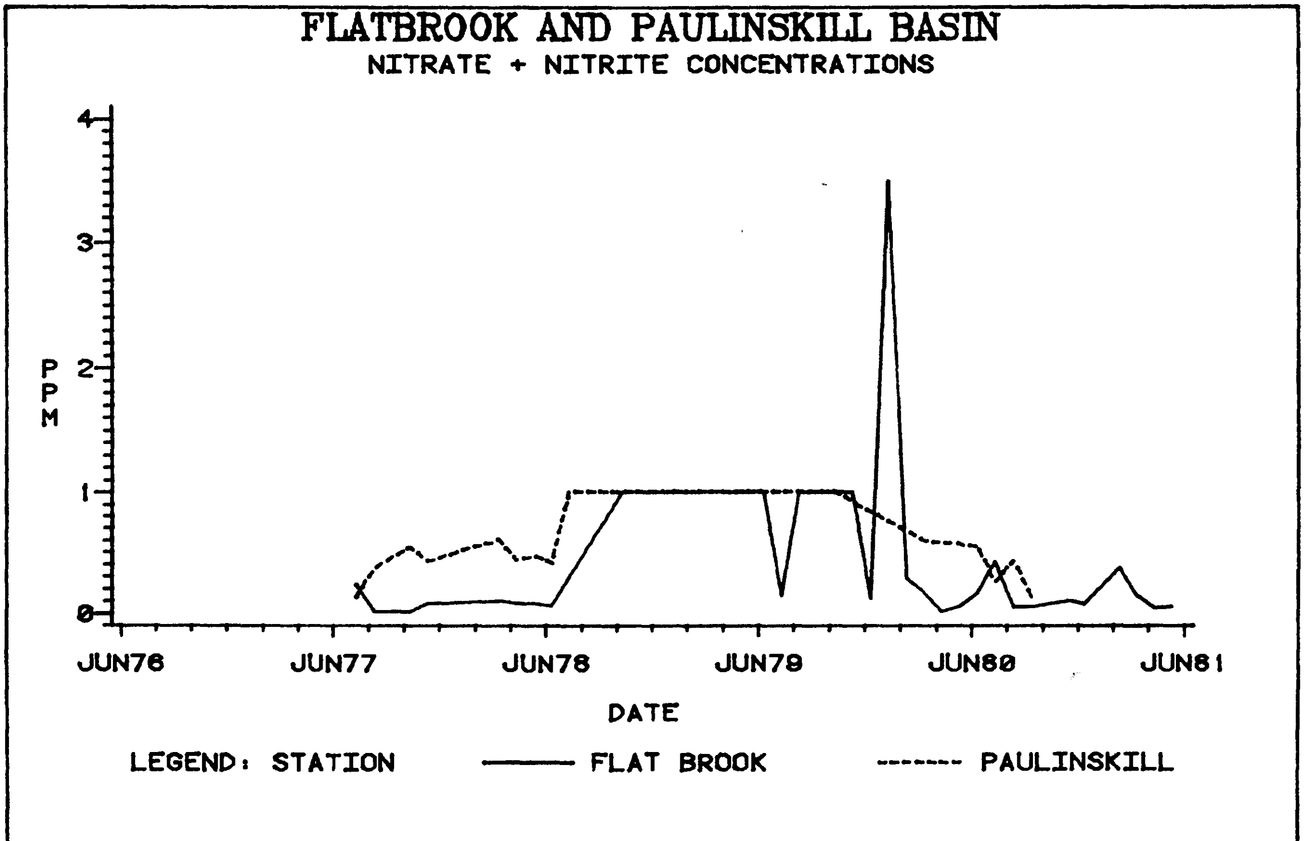

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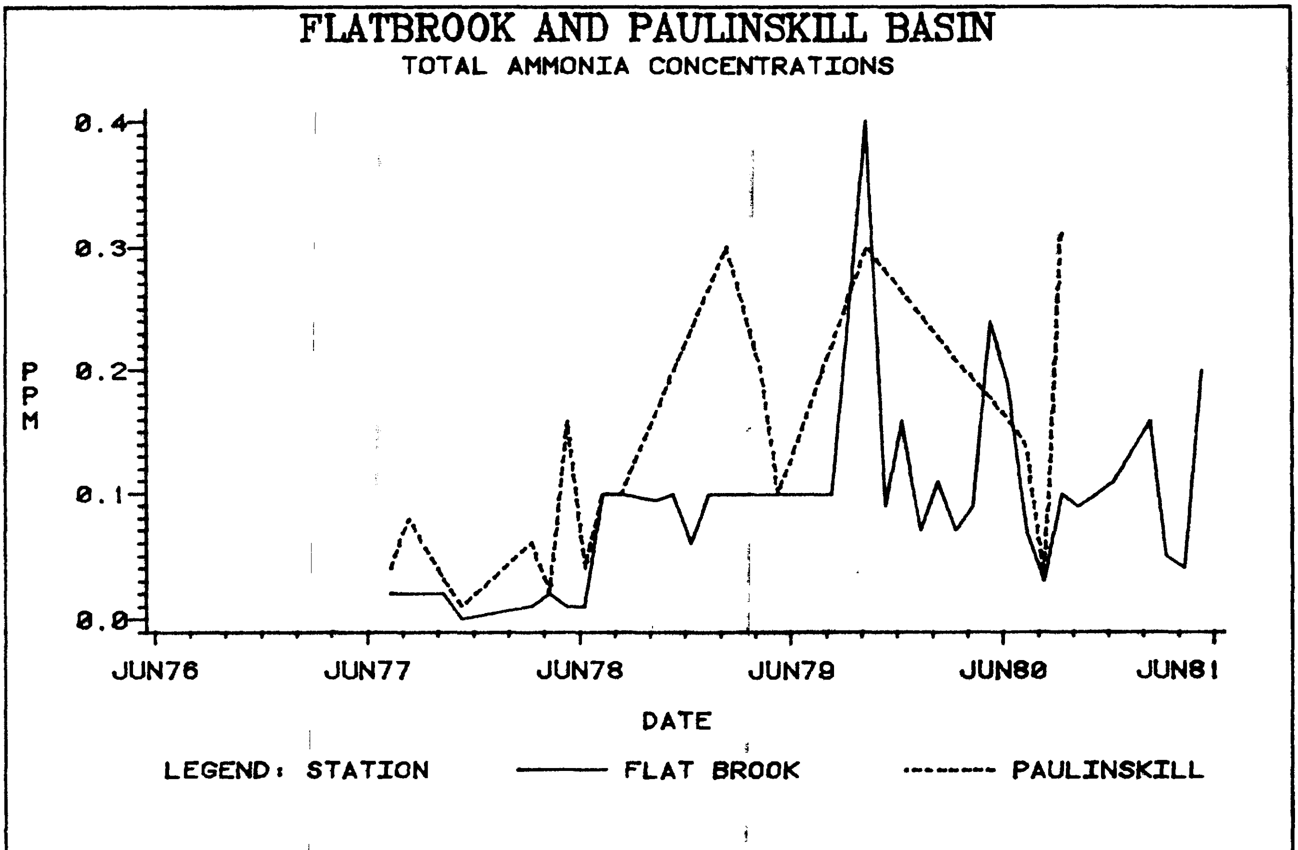

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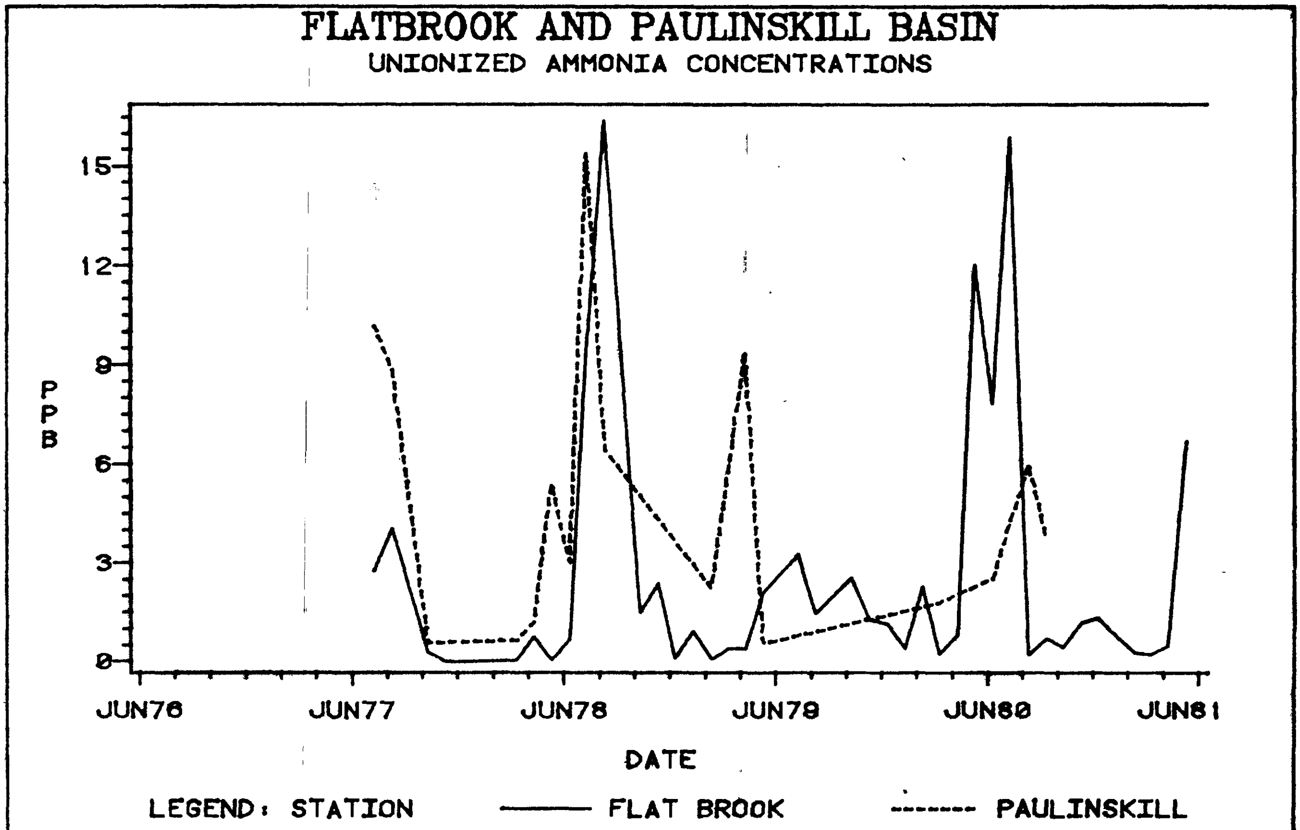


Figure: B -10

DISCHARGE INVENTORY - - - FLATBROOK AND PAULINS KILL BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
BLAIR ACADEMY	0022101	BLAIRSTOWN BOROUGH	BLAIR CREEK	SANITARY	.01
HART & ILIFF FUEL OIL CO., INC	0028819	NEWTON	HYPER HUMUS SWAMP TO PAULINSKI		
JERSEY CENTRAL POWER & LIGHT	0005525	BLAIRSTOWN BOROUGH	YARDS CREEK		
TOWN OF NEWTON	0020184	NEWTON	MOORE'S BROOK	SANITARY	.835
SUSSEX CO HEALTH CENTER	0022063	FRANKFORD TWP	PAULINS KILL	SANITARY	.02
KITTATINNY REGIONAL BD OF ED	0028894	HAMPTON TWP	PAULINS KILL	SANITARY	.01
SCHERING CORPORATION	0005711	LAFAYETTE	PAULINS KILL		.01
KENNEDY CONSTRUCTION CO INC	0024163	RAMSEY	PAULINS KILL	SANITARY	
LIMESTONE PRODUCTS OF AMERICA	0004791	LAFAYETTE	PAULINSKILL TR		5.85
SUSSEX CO DEPT OF CIVIL DEF.	0026701	FRANKFORD TWP	PAULINSKILL TRIBUTARY	SANITARY	
NORTH WARREN REG. H.S.	0031046	BLAIRSTOWN	PAVLINS KILL	SANITARY	
ANNANDALE STOKES UNIT YOUTH CO	0029874	MONTAGUE TWP	FLAT BROOK	SANITARY	.005

C. PEQUEST AND MUSCONETCONG RIVERS

Basin Description

The Pequest and Musconetcong Rivers constitute two major watersheds in northwestern New Jersey; draining portions of Sussex, Warren, Hunterdon and Morris Counties to the Delaware River. The Pequest River originates at Stickle Pond in southern Sussex County and flows for 32 miles southwesterly through Warren County, draining 158 square miles. Major tributaries include Trout Brook, Beaver Brook, Furnace Brook and Bear Creek. The Musconetcong River begins at the outlet of Lake Hopatcong, Sussex County, and flows for 42 miles through Warren, Hunterdon and Morris Counties before its confluence with the Delaware River at Riegelsville. The Musconetcong has a drainage basin size of 156 square miles. There are seven impoundments on the Musconetong mainstem downstream of Lake Musconetcong. The average flows (to 1980) for the Pequest River at Pequest (drainage area of 108 square miles) are 154 cfs; and 234 cfs for the Musconetcong River at Bloomsbury (143 square mile drainage area).

The Pequest River watershed is predominantly forested (58 percent). Agricultural uses comprise the majority of the remaining lands (37 percent) according to the Upper Delaware Water Quality Management Plan (1979). Agricultural activities are primarily dairy cattle operations with the exception of intensive truck crop and sod farming in the Great Meadows muck area. Only a small area of the watershed is developed. This area is primarily located in and around Belvidere, Warren County. However, development potential for the Pequest watershed remains high, primarily due to the completion of Interstate 80. Population growth between 1970 and 1980 was greatest in the northern half of the watershed, with Green Township, Sussex County, experiencing nearly a 100 percent increase. Currently, the only municipal sewers in the Pequest watershed are in Belvidere. The Pequest River Sewerage Authority is currently constructing sewers for all of Belvidere, and portions of White and Oxford Townships. Eight dischargers, 3 municipal/ institutional and 5 industrial, are located in the watershed.

The Pequest River has primary value as a recreation resource. Fishing, canoeing and hunting activities are common in and along the river and its tributaries. Jenny Jump State Forest is an upland recreational resource in the central Pequest watershed while the Pequest and Whittingham Wildlife Management Areas (WMA) contain both upland and lowland resources. The Pequest WMA also contains the new state fish hatchery completed in December, 1981. The Pequest WMA is considered one of the best freshwater fisheries locations in the state. The Pequest and tributaries are known to contain reproducing brook and brown trout populations. In addition, the NJ Division of Fish, Game and Wildlife stocks trout in the following streams or lakes within the Pequest watershed: Sussex County - Pequest River, Andover Junction Brook, Hunts Lake Brook, Illiff Lake, Kymer's Brook, Tarblill Brook and Yellow Frame Brook; Warren County - Barker's Mill Brook, Bear Creek, Beaver Brook, Pequest River, Dark Moon Brook, Furnace Brook, Honey Run, Johnsonburg Creek, Mountain Lake, Muddy Run, Oxford Furnace lake, Silver Lake and Trout Brook.

Municipal and private bathing and boating facilities exist on many of the 6 lakes present in the Pequest watershed. A project sponsored by Oxford Township, the local Soil Conservation District and the federal Soil Conservation Service on Furnace Brook included development of a lake (Oxford Furnace Lake) which is used for fishing, bathing and boating, in addition to its flood control functions.

The Musconetcong River watershed, in contrast to the Pequest River watershed, has areas of significant development, especially in the headwater areas of Lake Hopatcong and Lake Musconetcong in Sussex County. Although the remaining sections of the watershed are still primarily undeveloped (forested and agricultural), potential for development is quite high. The upper watershed, containing Lake Hopatcong (the largest lake in the state) and Lake Musconetcong, once had primarily a summer population because of recreational activities in and around the lakes, but within the last 10-15 years the region's population has grown and become year-round. The 1980 population for the upper Musconetcong watershed in Sussex County has been on the order of 75 percent higher than 1970 levels. Growth was greatest in Hopatcong Borough and Byram Township. The increases in population for this area largely represent residential and commercial expansion of the New York City Suburban Complex. Development is scattered throughout the remainder of the watershed with Hackettstown and Washington Borough serving as population centers.

Much of the Musconetcong River watershed is within a wastewater facilities planning area, although, only minor portions are currently sewered. Sanitary sewers exist in Hackettstown and surrounding areas, and portions of Mt. Olive, Stanhope and Roxbury (which has a 1 mgd treatment plant discharging to Wills Brook, a tributary of the Musconetcong River). The highly developed region of the upper Musconetcong River watershed is still for the most part utilizing on-site septic systems. There are currently 27 dischargers to the Musconetcong and its tributaries, the largest being Riegel Paper Company in Pohatcong Township, discharging approximately 19 mgd of industrial cooling water.

The Musconetcong River is one of the most important tributaries to the Delaware River in New Jersey because of the value it has for a variety of uses. Currently surface water in the Musconetcong River watershed is used for potable water supplies by Bloomsbury (from Pine Hollow), Sparta Mountain Water Company (Lake Shawnee and Weldon Brook), East Shores (Lake Hopatcong), Hackettstown (Lower Mine Hill and Burd Reservoirs), Roxbury Township and the Andover Borough Water Department. The NJ Water Supply Master Plan has considered the Musconetcong River (north of Hackettstown) as a site for a reservoir which would have a number of functions that include: stream flow regulation for the Musconetcong River, flow augmentation for the Delaware River during low flow periods and, as necessary, local water supply. Recently, however, geologic studies have found the bedrock to be unsuitable to support a reservoir. In addition to serving water supply needs, the Musconetcong River furnishes water for industrial facilities along its length.

The Musconetcong River watershed contains numerous recreational opportunities for fishing, boating, bathing and hunting. The NJ Wild and Scenic Rivers Program has given the Musconetcong River the third highest ranking of all the state's rivers due to its high recreational value. Bathing is present in Lake Hopatcong, Lake Musconetcong and Lake George as well as in various municipalities throughout the watershed. State recreational park lands in the Musconetcong River watershed include Hopatcong, Allamuchy and Stephen's State Parks, and the Hackettstown State Fish Hatchery. The lakes of the upper Musconetcong River watershed are major fishing and boating areas for northern New Jersey. In addition to having large reproducing game fish populations in these lakes, reproducing brook trout population are found in many of the Musconetcong River's tributaries. The Division of Fish, Game and Wildlife stocks trout in the following water bodies within the Musconetcong River watershed: Lakes Musconetcong and Hopatcong, Musconetcong River, Cranberry Lake, Dragon Brook, Lubber's Run and Trout Brook.

The NJ Water Quality Standards have classified both the Pequest River and tributaries, and the Musconetcong River and tributaries at various locations FW-1, FW-2 Trout Production, FW-2 Trout Maintenance and FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

The surface waters of the Pequest and Musconetcong Rivers are of overall good quality based on data collected from 1977 to 1981; but exhibit to varying degrees excessive levels of fecal coliform and total phosphorus.

Dissolved oxygen concentrations and saturation levels ranged from sufficient to supersaturated year-round at the Pequest River station at Belvidere. Biochemical oxygen demand was fairly consistent as values were usually in the range of 1.0 to 3.0 mg/l, well below what can be considered problem levels. Conversely, 45 percent of the fecal coliform values recorded for the period exceeded the 200 MPN/100 ml level for any single observation.

Total dissolved solids (TDS) concentrations were within the criterion for the entire period from 1977 to 1981 as values varied from 180 to 300 mg/l. Nearly all pH observations at Belvidere for the period were above 8, indicative of alkaline conditions.

Total phosphorus concentrations, which did not exceed 0.20 mg/l from 1977 to 1981, indicate the presence of only mild organic enrichment in the Pequest River. The 0.1 mg/l phosphorus standard was contravened just three times during this period (summer months in 1978 and 1979). Levels of nitrate + nitrite and total ammonia in the Pequest River were below 1.5 mg/l and 1.0 mg/l respectively, at all times; one slight contravention of the un-ionized ammonia standard for trout maintenance waters was noted during a two month period in 1978. No other extended periods of elevated levels were identified from 1977-1981.

Biological samples were collected from the Pequest River several miles upstream of Belvidere at the town of Pequest. The data indicates water quality conditions similar to those downstream at Belvidere. The moderately high number of individuals (3940/ square meter) and relatively large number of taxa (35) found in 1977 were indicative of generally healthy conditions. However, diversity indices and community structure both suggest some degree of nutrient enrichment. The oligochaete Nais communis was most abundant, comprising 40 percent of the total number of individuals recovered. Snails, midge larvae, and the stonefly Taeniopteryx were also common. Mayflies and caddisflies, however, were scarce.

The Musconetcong River exhibited water quality conditions similar to those present in the Pequest River at Belvidere, based on samples collected at Lockwood (Sussex County) and Bloomsbury (Warren County). Dissolved oxygen concentrations and saturation values were generally sufficient or supersaturated at both Lockwood and Bloomsbury throughout the period. Biochemical oxygen demand concentrations were also similar at both the upstream (Lockwood) and downstream (Bloomsbury) stations, ranging from near zero to 4.0 mg/l. Fecal coliform concentrations were frequently above the 200 MPN/100 ml level at each station, (50 and 65 percent of all observations at Lockwood and Bloomsbury, respectively). Bacteria counts at Bloomsbury were as high as 16,000 MPN/100 ml on two occasions.

TDS levels were well within the established criterion at each of the two Musconetcong River stations. TDS concentrations downstream at Bloomsbury were slightly higher than those at Lockwood. All values were consistently below 250 mg/l. Alkaline conditions were evident at both stations with pH values averaging approximately 8.0; however, relatively wide pH variations were exhibited at the two sites. This alkaline condition is characteristic of surface water in this geological region.

Total phosphorus data for the Musconetcong River exhibits a large percentage (nearly 50 percent) of values in the upstream segment in excess of the 0.10 mg/l standard, with four notable peaks between 0.30 and 0.50 mg/l. The phosphorus values at Bloomsbury also indicated a moderately enriched condition, although the values were frequently lower than those concentrations upstream at Lockwood. Nitrate + nitrite values were generally below 1.5 mg/l at Lockwood, but increased downstream (1.0-2.5 mg/l) at Bloomsbury. Total ammonia values declined between Lockwood and Bloomsbury. One slight contravention (21.3 ug/l) of the un-ionized ammonia standard was recorded during the period at Bloomsbury.

Samples for biological assessment were collected at the Bloomsbury station. The dominant macroinvertebrate taxa recovered were the midges Tanytarsus (50 percent) and Cricotopus (6 percent) and the hydropsychidae caddisflies (19 percent). While the number of taxa (40) was the highest of any station monitored in 1977, the elevated number of individuals (6638/square meter) is indicative of nutrient enrichment. Siltation was also suspected as being a significant factor limiting some organisms. Periphyton data corroborates the presence of some nutrient enrichment, the autotrophic index being somewhat elevated.

An intensive stream survey was conducted on the upstream segment of the Musconetcong River (Lake Musconetcong to Saxton Lake) during June and July, 1980. The survey report concluded that water quality in this segment must be classified as moderate due to occasional violations of FW-2 standards for dissolved oxygen and phosphorus. High nutrient concentrations, favorable flow and substrate characteristics resulted in excessive primary productivity in this segment, especially in Waterloo and Saxton Lakes. Problems with fluctuating dissolved oxygen levels resulted from this productivity. The biological characteristics of this segment exhibit some improvement in the downstream direction past the confluence with Wills Brook, the receiving waters for the Musconetcong Sewage Treatment Plant discharge.

No significant trends were apparent for the five year period in either the Pequest or Musconetcong Rivers. A slight overall decline in BOD_5 concentrations was suggested in the upstream segment of the Musconetcong River, however fecal coliform and total phosphorus levels have remained generally excessive in both rivers from the mid-1970s to the present.

Toxic Parameters

In one of three samples taken from the Pequest River moderate trihalomethane levels were detected. The Musconetcong River showed no evidence of toxic contamination throughout the period of study. Some additional monitoring would be valuable down-stream of the major sanitary discharges.

A limited number of fish tissue samples were collected in 1980 along the Pequest River at Townsbury, Warren County. These samples included various species indigenous to this reach, including both open water and bottom feeding members. Analyses for PCB Arochlor 1254 and several organochlorine pesticides (chlordane, BHC, DDT and metabolities) revealed no elevated levels. Results of sediment analyses from the same location produced non-detectable levels of these compounds. Additional sampling for toxic contamination of aquatic organisms from these basins will be considered on a site by site basis, or in response to a known contamination event.

Problem Assessment

The Pequest and Musconetong Rivers are of overall good water quality although both rivers do have fecal coliform and occasional phosphorus problems. In addition, both watersheds are thought to be affected by soil erosion rates that are among the highest in the state based on a 1979 working paper for the NJDEP Water Quality Management Program.

Since the population centers, such as Belvidere, Hackettstown and the areas around Lake Hopatcong and Lake Musconetcong, are scattered throughout these watersheds, water quality is highly influenced by non-point sources and septic systems. Septic system problems occur in the Lake Hopatcong area as well as in the municipalities of Jefferson, Mount Arlington, Roxbury, and Byram in the Musconetcong watershed; and Mountain Lake, Hope and Oxford in the Pequest watershed. Septic system problems can be especially troublesome in some of these areas, because the terrain underlying these areas consists of fractured rock which is not favorable for sewage disposal with the current septic system density.

Other non-point sources contributing to water quality problems are leaking fuel oil tanks in the Hopatcong area and storm sewer discharges to the Musconetcong River mainstem, tributaries and lakes. It can be concluded then, that many of the problems affecting parts of these watersheds may be considered to be somewhat periodic in nature (influenced by rainfall and ground water levels) and difficult to solve.

The accumulation of nutrients and organic matter in Waterloo and Saxton Lakes has resulted in eutrophic conditions in the lakes and periodic enrichment in the Musconetcong River downstream of the lakes. One source of nutrients in the lakes, and possibly the major contributor, is the Musconetcong Sewerage Authority's discharge to Wills Brook. Through an intensive survey the discharge has been shown to have deleterious effects on Wills

Brook and the Musconetcong River because of its large organic loadings. Improvements to the treatment system should result in higher discharge quality and improved stream conditions. Further downstream on the Musconetcong in Holland Township, the Warren Glen facility of Riegel Paper Company is under administrative order to maximize and improve its wastewater treatment. In addition, the Diamond Hill Estates Sewage Company in Mansfield Township, which discharges to Hances Creek, is under enforcement action for violations of BOD and suspended solids criteria.

In the Pequest River watershed two industrial dischargers are under enforcement action. The Oxford Textile Finishing Company in Oxford Borough is contributing excessive BOD, COD and phenol levels. That facility, however, is in the process of upgrading its treatment to consistently achieve their NJPDES effluent limitations. The Southland Chemical Company in Independence Township is also in violation of its permit limitations, as it is contributing unacceptable levels of BOD, COD and suspended solids. Their wastewater facilities are scheduled for upgrading with carbon absorption units and sludge drying beds which will help mitigate effluent violations. Agricultural runoff from both dairy and crop farms is likely a major nutrient and bacteria source in the upper Pequest River watershed.

Goal Assessment and Recommendations

Based on the concentration of fecal coliform bacteria detected, these streams do not meet the goal of swimmable waters (this determination is based on stream quality and does not necessarily represent the many lakes present). The waters in the Pequest and Musconetcong Rivers do, however, contain diverse fish communities despite a pH which is strongly alkaline. Thirty species were reported present in the Pequest River watershed and twenty-seven in the Musconetcong River watershed. Native brook trout are found in both watersheds, as the Musconetcong River and tributaries are classified almost in their entirety either trout production or trout maintenance.

The Pequest and Musconetcong River watersheds need agricultural best management practices implemented to assist in the reduction of sedimentation, fecal coliform and total phosphorus pollutant levels. The other important nonpoint source contributor in these watersheds are septic systems. Wastewater facilities planning activities currently underway and projected will address septic system problems. It is also imperative that wastewater facilities planning activities currently underway and projected will address septic system problems. It is imperative that wastewater facilities planning take place in the municipalities listed in the "Problem Assessment" as having on-site problems, especially in the Lakes Hopatcong and Musconetcong areas. The protection of these lakes should be a priority because of their significant statewide value.

When the Musconetcong Sewerage Authority's discharge to Wills Brook is improved through upgrading (advanced treatment) and enlarging, then water quality will improve in Saxton and Waterloo Lakes, Wills Brook and subsequently the Musconetcong River. Dredging is recommended for Saxton and Waterloo Lakes because of nutrients present in the sediments. The Riegal Paper Company in Holland Township should be pursued to conform to discharge limitations. This facility has been noted in earlier 305(b) reports as having harmful effects on the lower Musconetcong River.

PEQUEST AND MUSCONETCONG RIVERS STATION LIST

A. Ambient Monitoring Stations

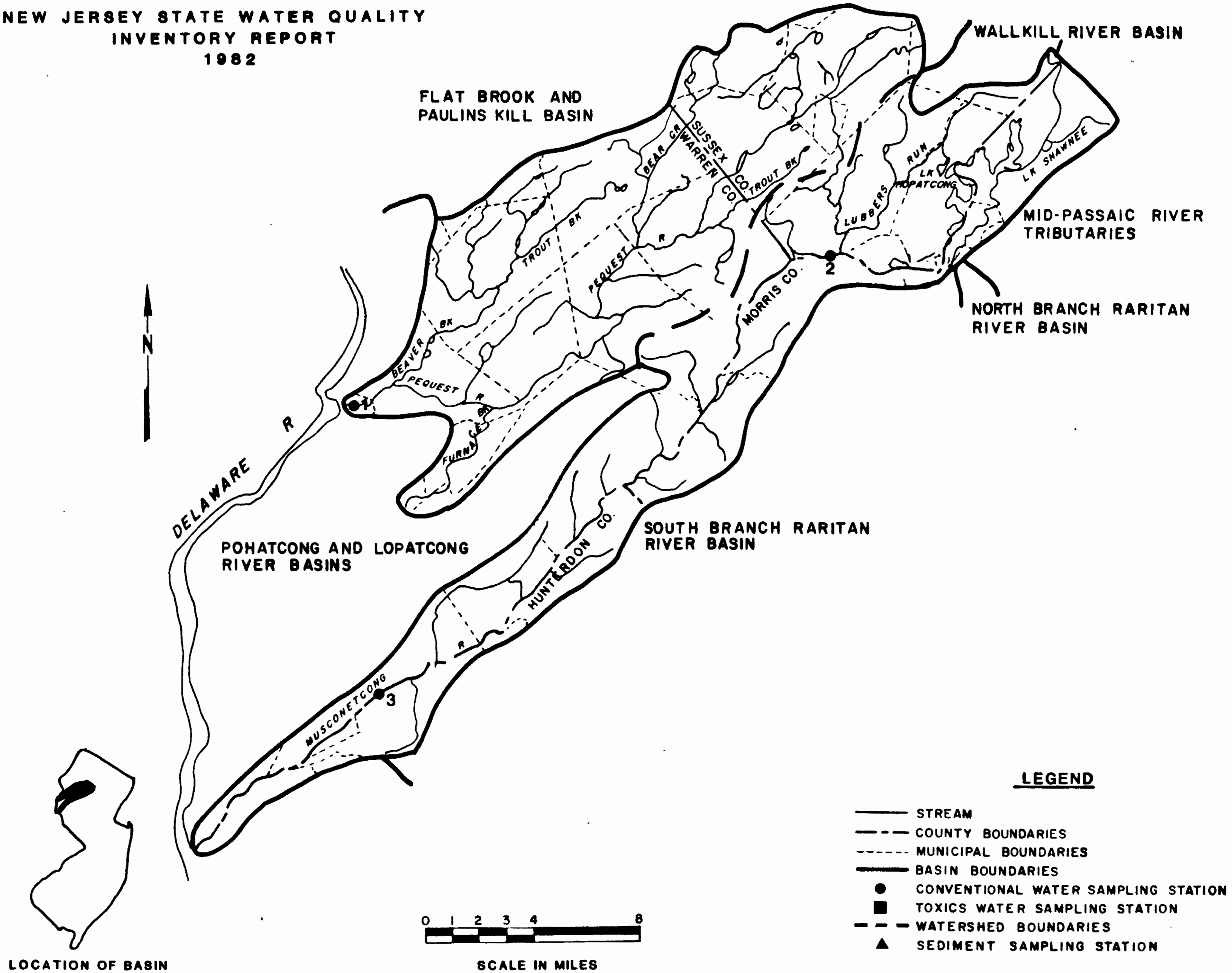
STORET number	Station Description	Map Number
01446400	Pequest River at Belvidere, Warren County Latitude 40°49'45" Longitude 75°04'44" FW-2 Trout Maintenance USGS/DEP Network Downstream side of Greenwich Street bridge, 0.3 miles upstream from mouth at Delaware River.	1
01455801	Musconetcong River at Lockwood, Sussex County Latitude 40°55'10" Longitude 74°44'07" FW-2 Trout Maintenance USGS/DEP Network Intensive Survey, 1980 At bridge in Lockwood, 0.4 miles south of Jefferson Lake and 0.9 miles downstream from Lubbers Run.	2
01457000	Musconetcong River near Bloomsbury, Warren County Latitude 40°40'20" Longitude 75°03'40" FW-2 Trout Maintenance Basic Water Monitoring Program Upstream side of weir, 1.5 miles upstream from Bloomsbury and 9.5 miles upstream from mouth at Delaware River at Riegelsville.	3

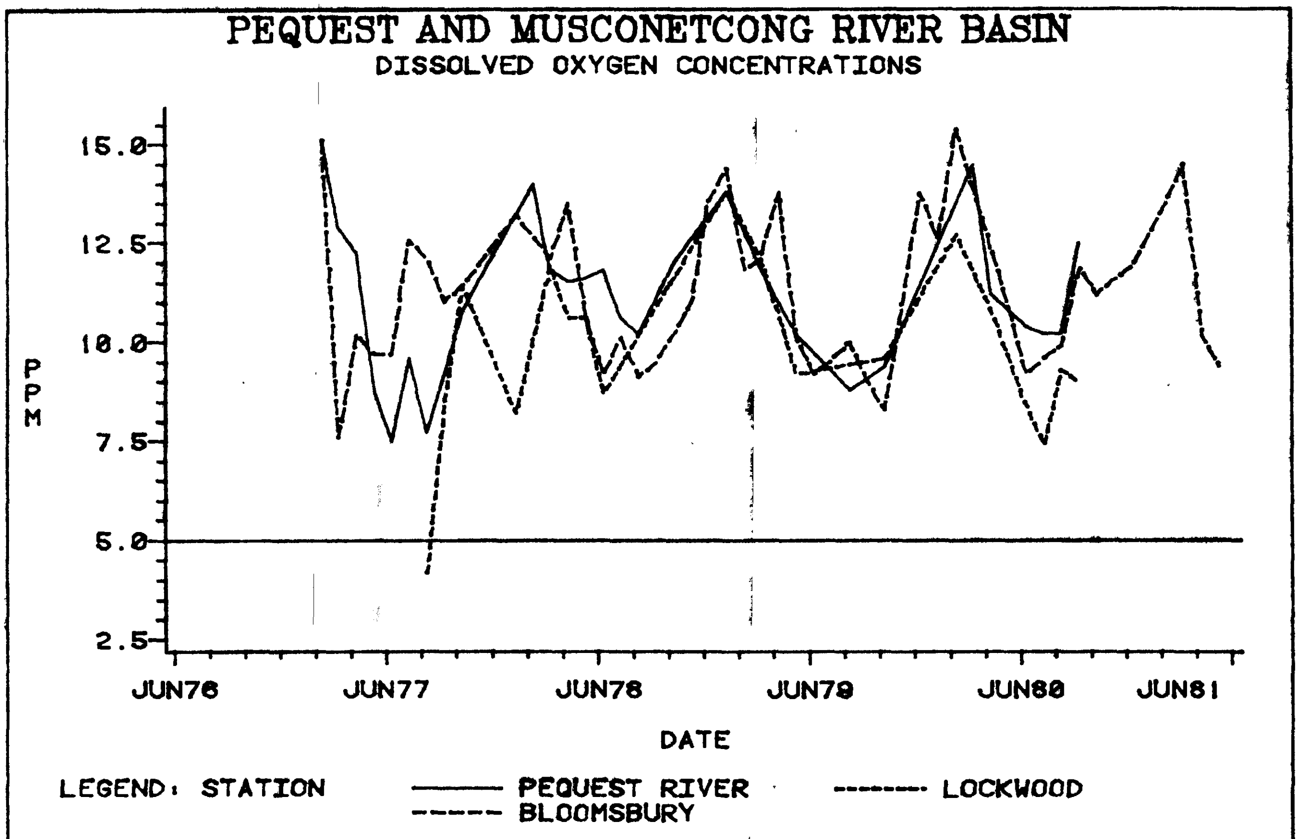
B. Toxics Monitoring Stations

Station Locations	Sampling Regime	Map Number
Pequest River at Townsbury	Fish tissue	-

PEQUEST AND MUSCONETCONG RIVER BASINS

NEW JERSEY STATE WATER QUALITY INVENTORY REPORT 1982





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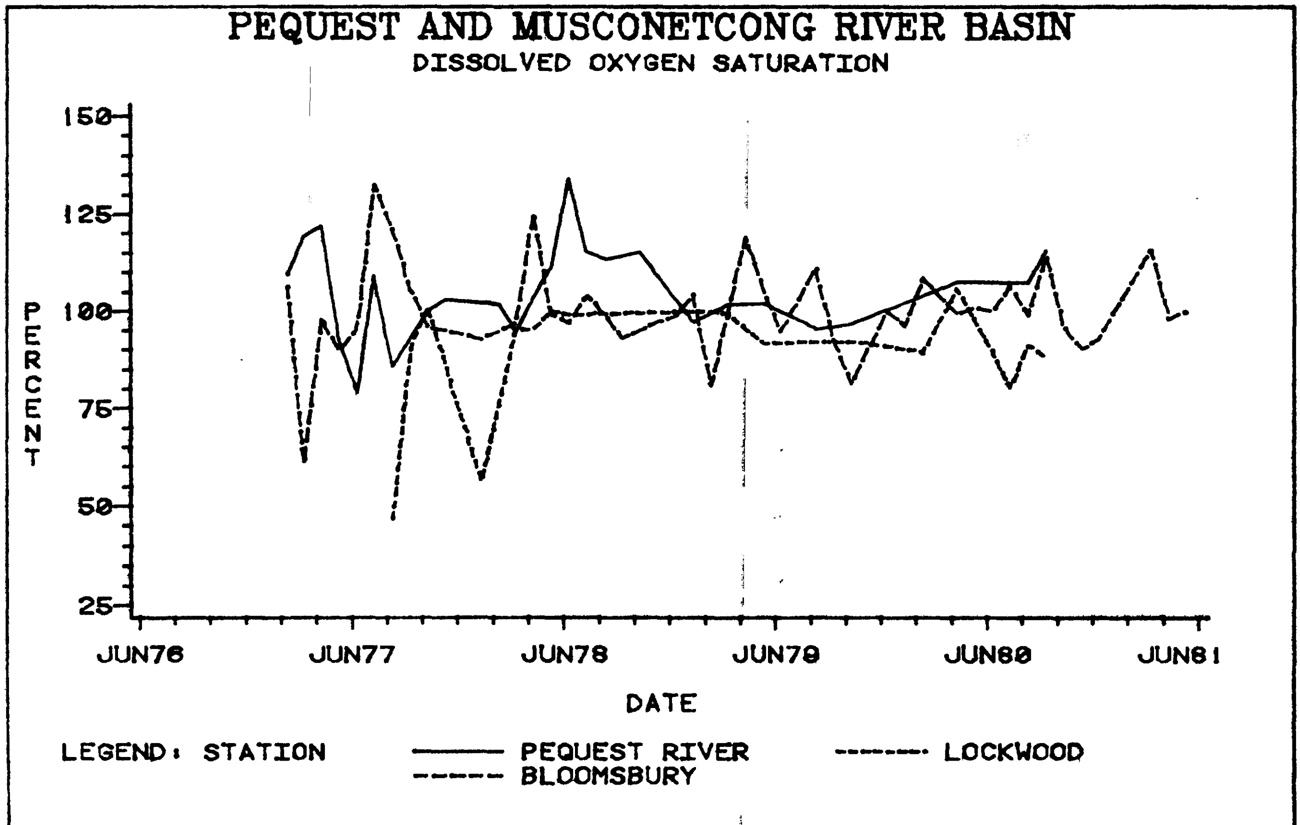

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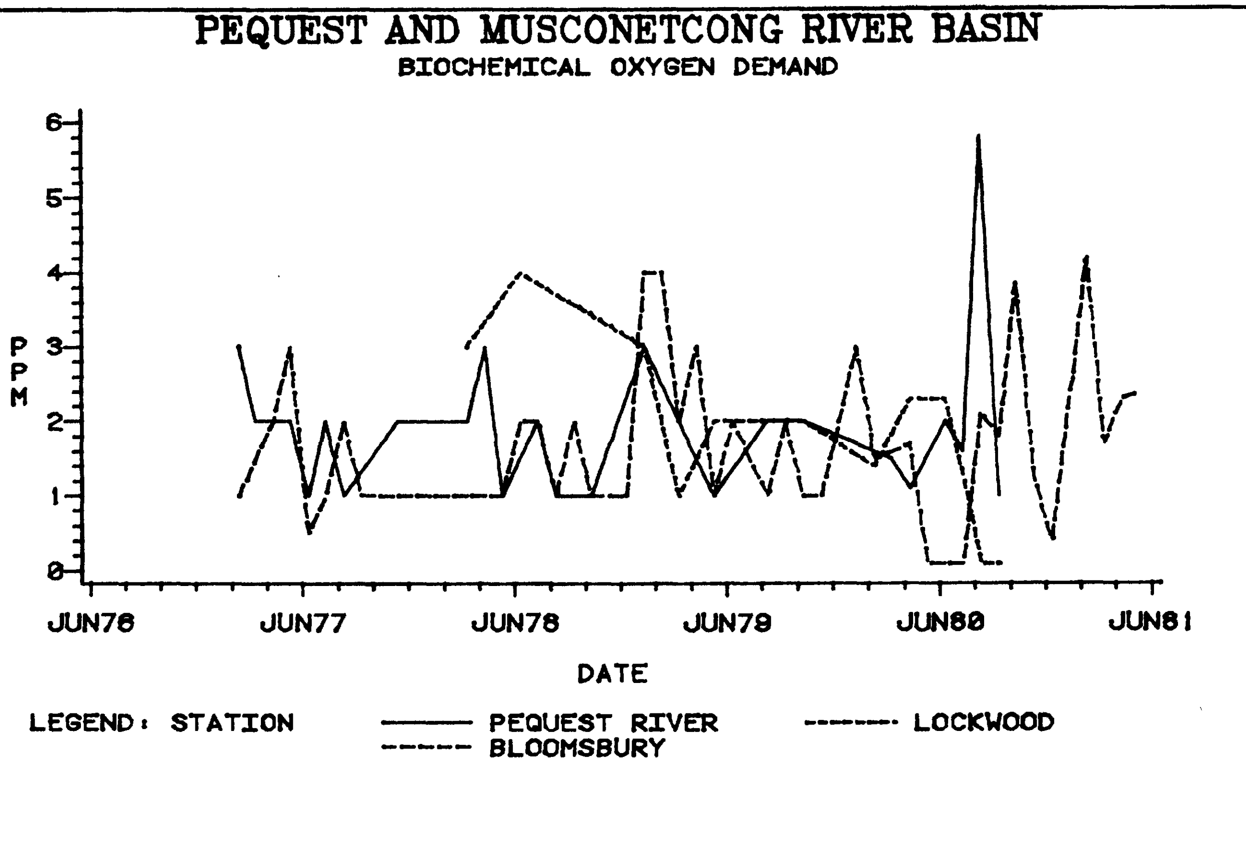

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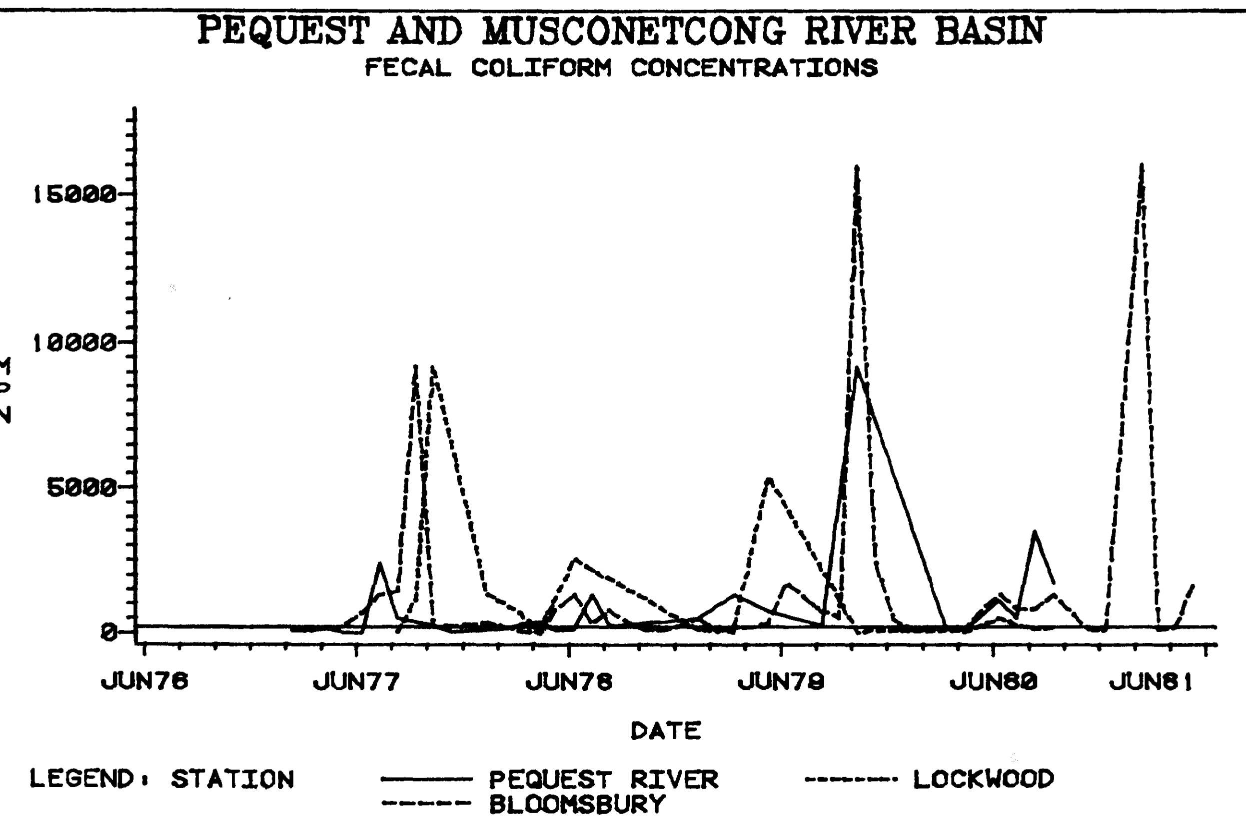

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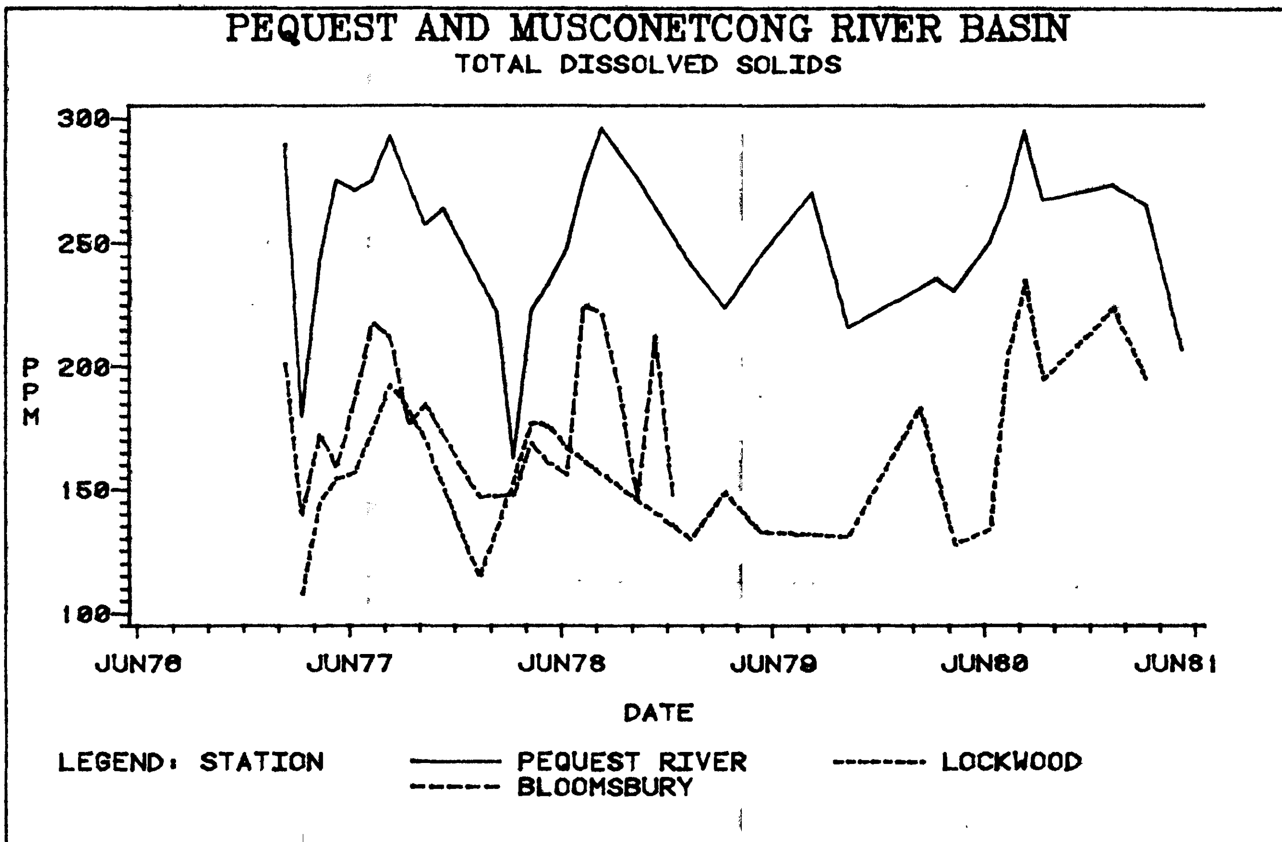

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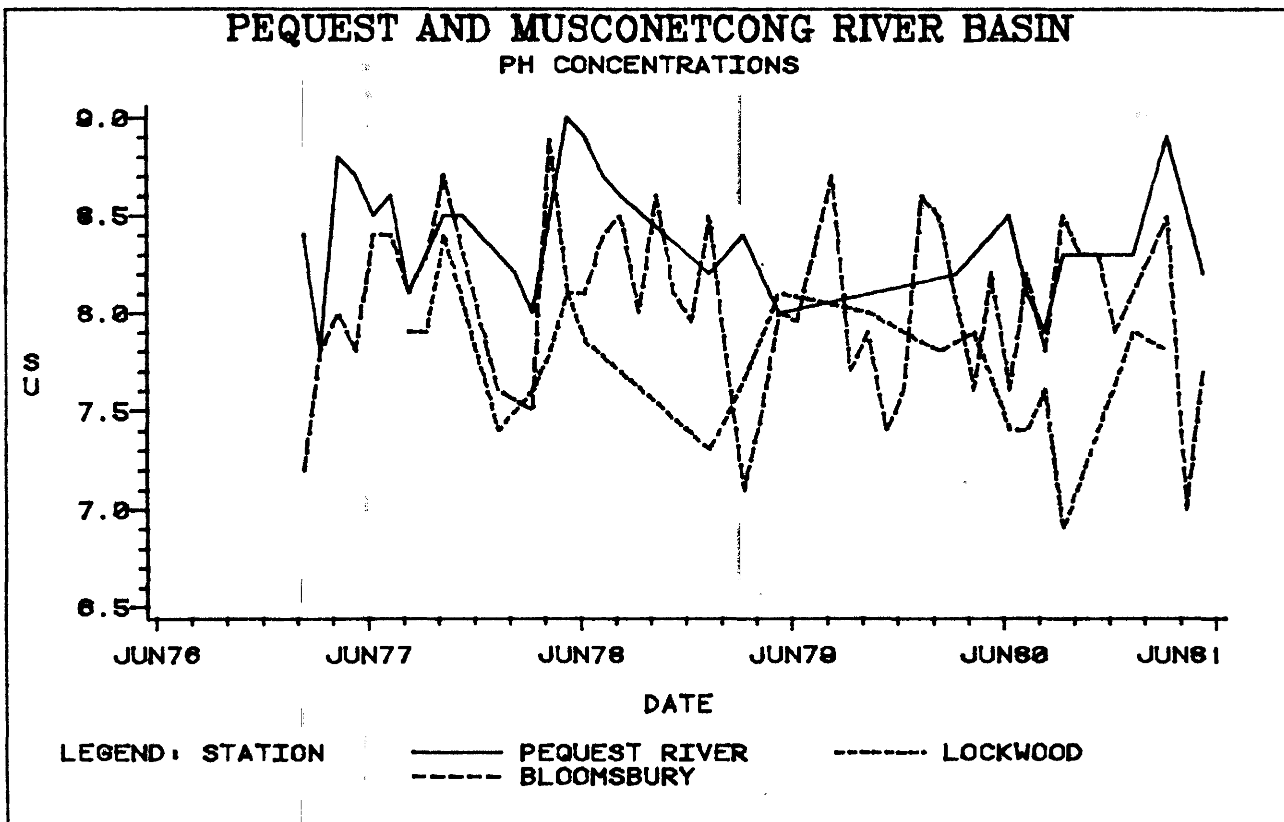

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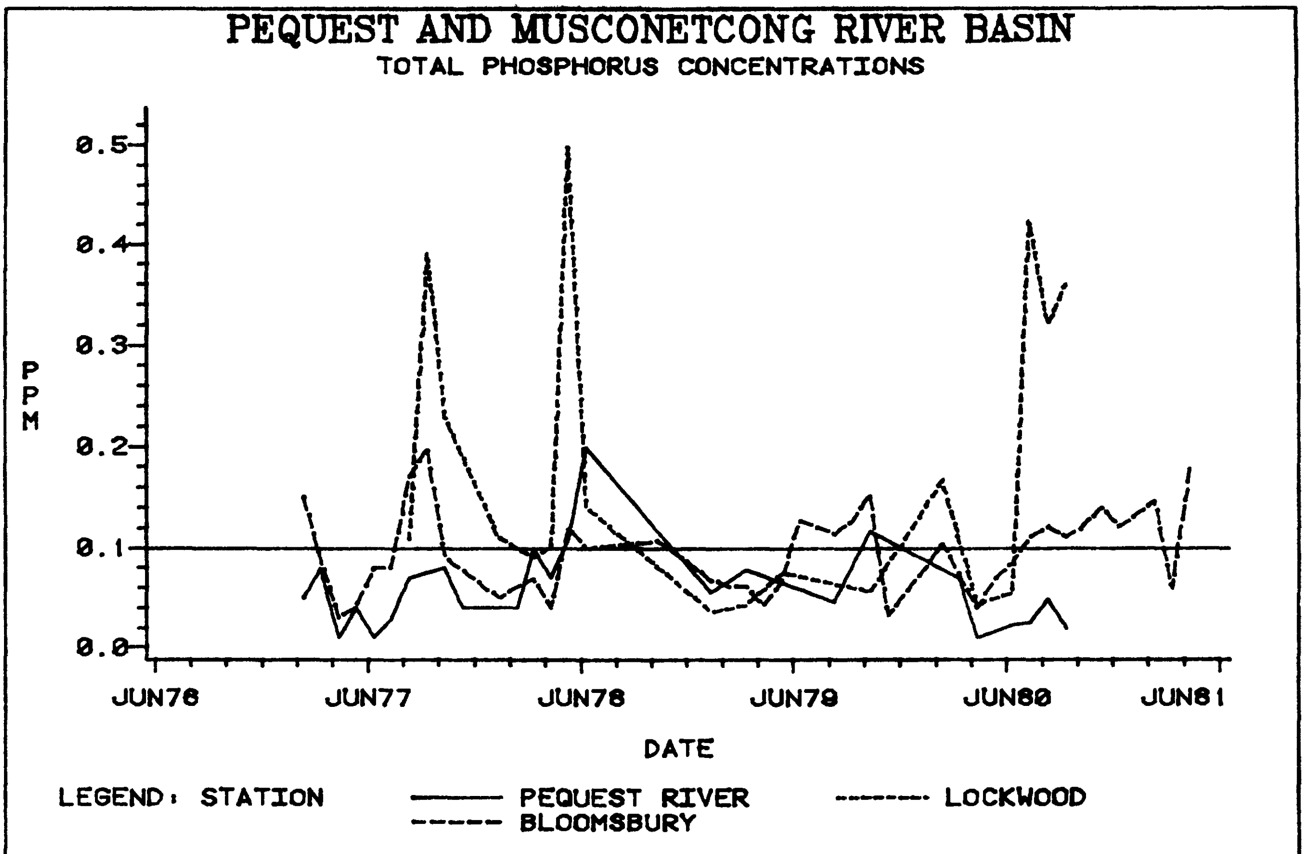

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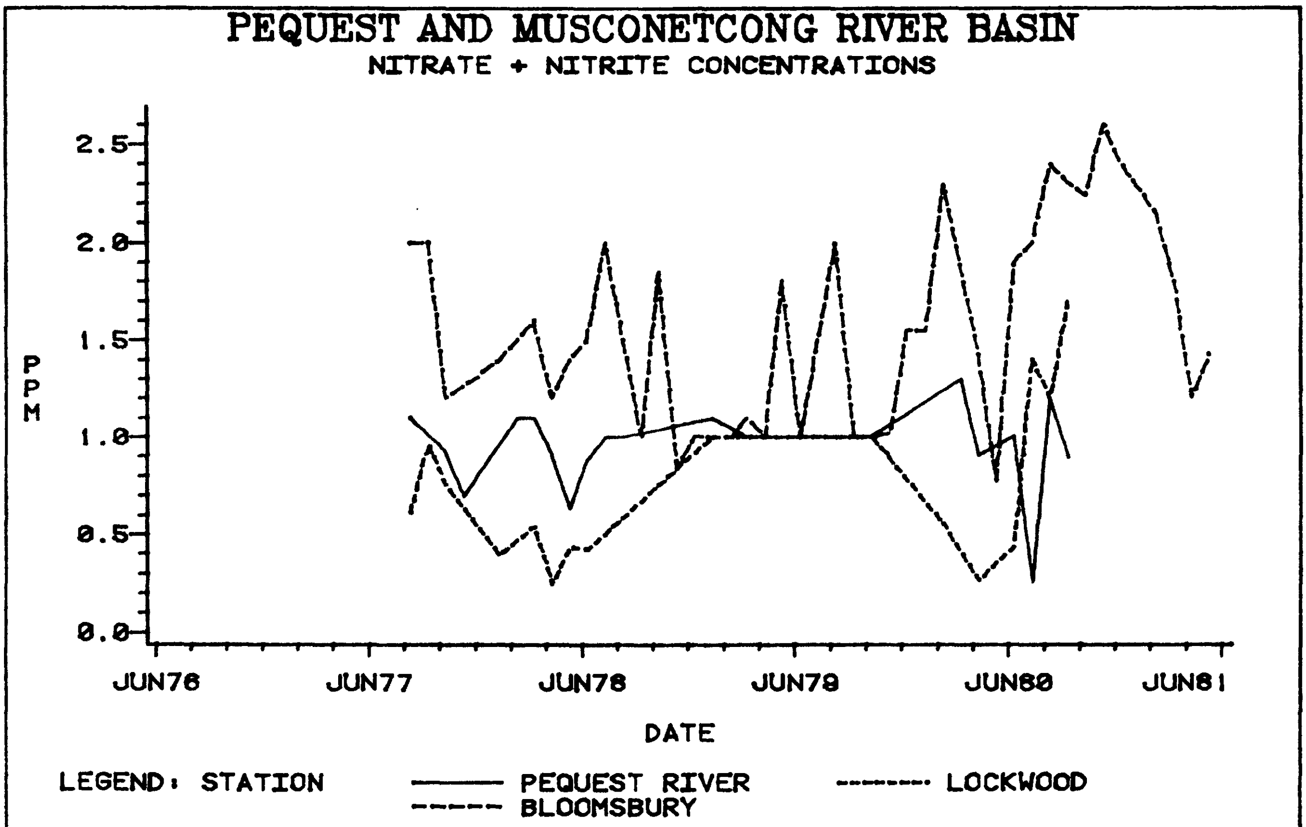

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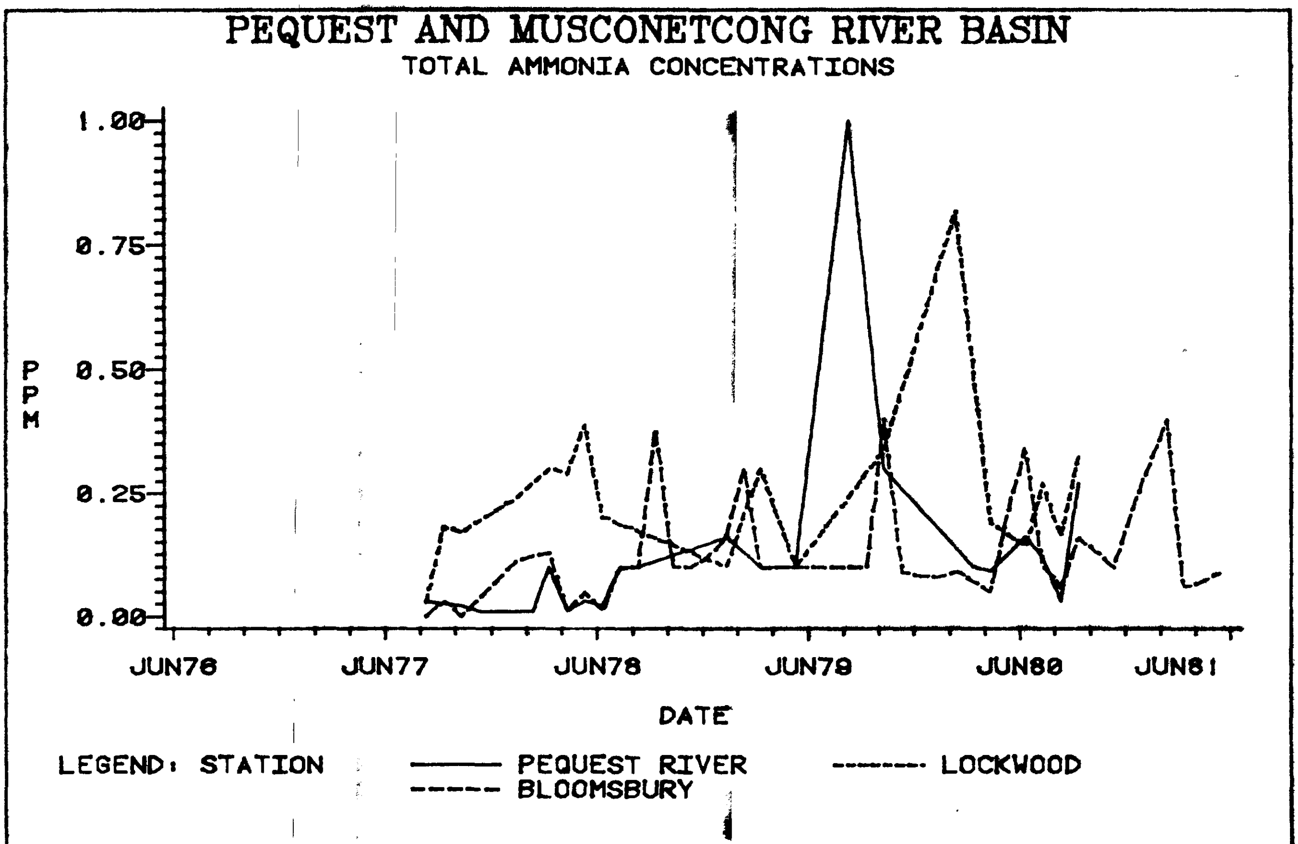

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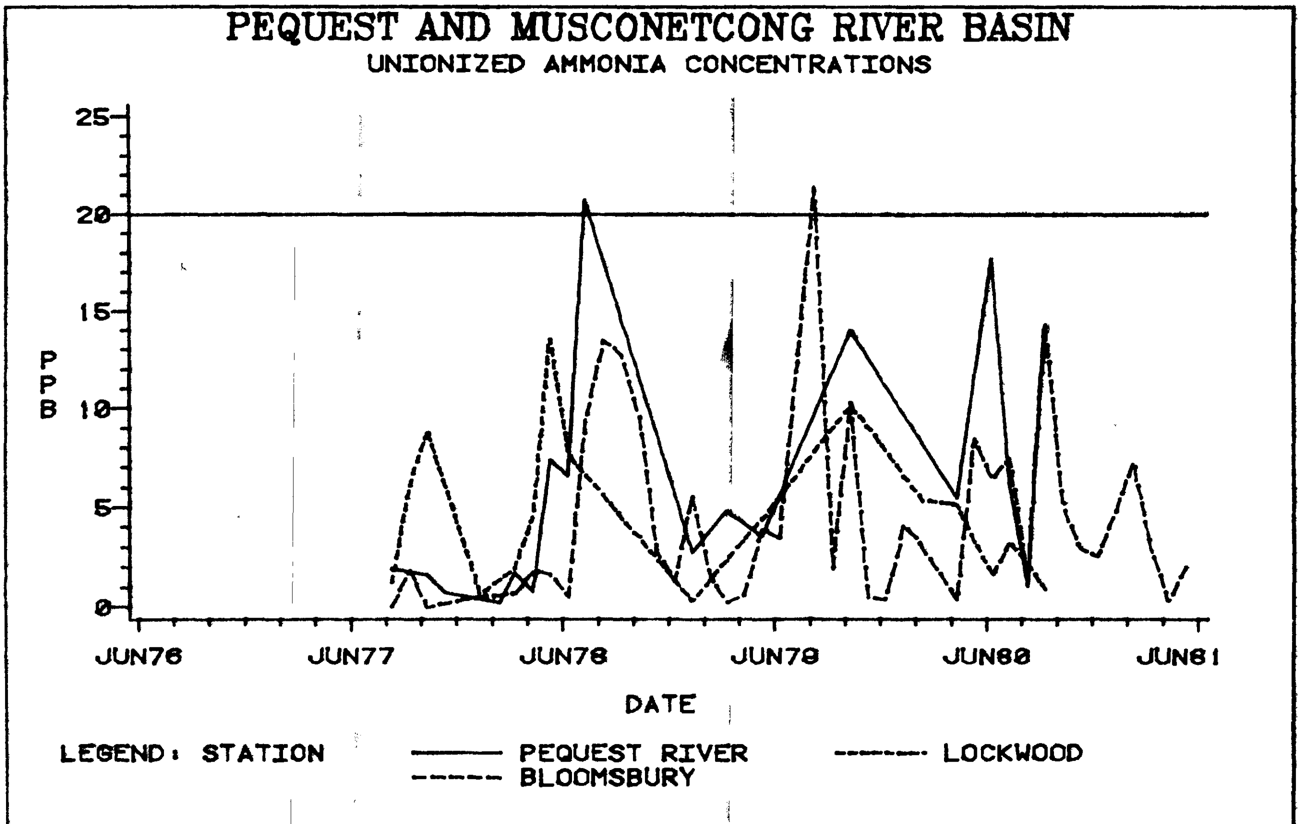


Figure: C -10

DISCHARGE INVENTORY - - - PEQUEST AND MUSCONETCONG RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
AMERACE-ESNA CORP.	0004812	WASH TWP-MORRIS CTY	SCHOOLEYS MTN B		.12
USR OPTONIX, INC	0032247	WASHINGTON TWP	MUSCENTCONC RIVER	COOLING WATER	
M&M/MARS.	0004928	HACKETTSTOWN /T/	MUSCONETCONG R	PROCESS WASTE	
RIEGEL PAPER CO	0004430	POHATCONG TWP	MUSCONETCONG R	PROCESS WASTE	.45
US MINERAL PRODUCTS	0004600	STANHOPE	MUSCONETCONG R	COOLING WATER	19.30
ASBURY GRAPHITE MILLS INC	0031208	ASBURY	MUSCONETCONG RIVER	PROCESS WASTE	.02
BOROUGH OF BLOOMSBURY WAT. DEP	0025569	BLOOMSBURY	MUSCONETCONG RIVER	WATER TREATMENT	
UNION OIL TRUCK PARK	0023094	BLOOMSBURY TWP	MUSCONETCONG RIVER	SANITARY	
HACKETTSTOWN MUA	0021369	HACKETTSTOWN	MUSCONETCONG RIVER	SANITARY	1.26
NJ DIV FISH, GAME, & WILDLIFE	0033154	HACKETTSTOWN	MUSCONETCONG RIVER		.88
NJ DIV FISH, GAME, & WILDLIFE	0033162	HACKETTSTOWN	MUSCONETCONG RIVER		
NJ DIV FISH, GAME, & WILDLIFE	0033154	HACKETTSTOWN	MUSCONETCONG RIVER		.50
NJ DIV OF FISH, GAME, & SHELLF	0033171	HACKETTSTOWN	MUSCONETCONG RIVER		
ROELACK INC-T/A TIMB. HOMES	0028509	HAMPTON BORO	MUSCONETCONG RIVER	SANITARY	.16
COOKE DIV REICHHOLD CHEM INC	0028657	MANSFIELD TWP	MUSCONETCONG RIVER	PROCESS WASTE	.16
MUSCONETCONG SEWERAGE AUTH.	0027821	MOUNT OLIVE TWP	MUSCONETCONG RIVER	SANITARY	.91
JEFFERSON TWP BD OF ED	0021156	JEFFERSON TWP	LAKE HOPATCONG	SANITARY	.03
JEFFERSON TWP BD OF ED	0021105	JEFFERSON TWP	LAKE HOPATCONG	SANITARY	.03
HACKETTOWN OIL CO	0035033	HACKETTOWN	HATCHERY BROOK		
OXFORD TEXTILE FINISHING CO	0004901	OXFORD TWP	FURNACE BROOK	PROCESS WASTE	.55
OXWALL TOOL CO. LTD.	0004847	OXFORD TWP	FURNACE BROOK	PROCESS & SANIT	
ANDOVER INDUSTRIES INC	0035726	ANDOVER	PEQUEST R		
PEQUEST SEWER CO	0020605	ALLAMUCHY TWP	PEQUEST RIVER	SANITARY	.23
PEQUEST WATER CO	0029033	ALLAMUCHY TWP	PEQUEST RIVER	PROCESS WASTE	.02
SOUTHLAND CORP	0005291	INDEPENDENCE TWP	PEQUEST RIVER	PROCESS WASTE	.33
NJ DIV DEPT/ TRES DIV.OF BLDG	0033189	LIBERTY	PEQUEST RIVER		
WATSON'S QUALITY TURKEY PROD	0035467	WASHINGTON TWP	BELLS LAKE BRANCH		
MT ARLINGTON SANITATION CORP	0026212	MT ARLINGTON BORO	DELAWARE BASIN	SANITARY	
BYRAM TOWNSHIP BD OF ED	0022632	BYRAM TWP	EAST BROOK	SANITARY	
RIEGEL PAPER CO.	0004421	HOLLAND TWP	MUSCONETCONG R	PROCESS WASTE	
RIEGEL PAPER CO.	0004448	HOLLAND TWP	MUSCONETCONG R	PROCESS & COOL.	
ADVANCED ENVIR TECHNOLOGY CORP	0034975	MOUNT OLIVE	WILLIS BROOK		
OXFORD AREA WASTEWTR TREAT FAC	0035483	OXFORD	PEQUEST RIVER		
DIAMOND HILL ESTATES SEWAGE CO	0028592	MANSFIELD TWP	HANSEN CREEK	SANITARY	.10

D. POHATCONG AND LOPATCONG CREEKS

Basin Description

Pohatcong and Lopatcong Creeks flow entirely through southwestern Warren County, draining 57 and 14 square miles respectively. Pohatcong Creek begins in Independence Township and joins the Delaware River south of Phillipsburg, 28 miles from its origin. Lopatcong Creek originates in Harmony Township and flows for only 10 miles before its confluence with the Delaware River at Phillipsburg. Major tributaries to Pohatcong Creek include Brass Castle Creek, Merrill Creek and Shabbecong Creek.

Pohatcong and Lopatcong Creeks drain predominately agricultural lands. Extensive crop lands and pastures support corn, hay, dairy cattle, beef cattle and chicken farming. Population centers for these watersheds consists of Phillipsburg adjacent to Lopatcong Creek, and Washington and Alpha Boroughs within the Pohatcong watershed. Population growth from 1970 to 1980 occurred throughout both watersheds, though generally the increase was under 20 percent. Only two small areas of the Pohatcong and Lopatcong combined watersheds are served by municipal sewers; portions of Washington Borough and Township, (a.61 mgd discharge to Shabbecong Creek by the Washington Borough Treatment Plant), and Phillipsburg and surrounding areas of Pohatcong Township and Alpha Borough, (the Phillipsburg Treatment Plant discharges 2-2.5 mgd to Lopatcong Creek). Wastewater facilities planning activities for both the Lopatcong and Pohatcong basins is performed by either the Lopatcong Creek Sewerage Authority or Pohatcong Sewerage Authority. Four wastewater dischargers (three of which are municipal-institutional) exist in the Pohatcong and Lopatcong watershed. The largest discharge is the Phillipsburg Sewerage Treatment Plant.

Identifiable water use activities for both Pohatcong Creek and Lopatcong Creek appear to be limited because of the stream's sizes. The New Jersey Water Company of Washington Borough utilizes water for potable purposes from Roaring Rock Brook Reservoir, a tributary of Brass Castle Creek. A joint water supply stream augmentation and energy production project is scheduled to be constructed on Merrill Creek. The 17 billion gallon storage reservoir in Harmony Township will have a 42-113 mgd yield when fully completed. Fishing is common throughout both the Pohatcong and Lopatcong watersheds. Reproducing brook and brown trout populations have been identified throughout Pohatcong Creek's drainage basin. In addition, the New Jersey Division of Fish, Game and Wildlife stocks trout in Lopatcong Creek, Pohatcong Creek, Merrill Creek and Roaring Rock Brook.

New Jersey Water Quality Standards have classified Pohatcong Creek and tributaries either FW-2 Trout Production or FW-2 Trout

Maintenance. Lopatcong Creek has been classified FW-2 Trout Maintenance and FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

Water quality monitoring of Pohatcong Creek at Carpentersville and Lopatcong Creek at Phillipsburg shows generally good water quality at those two locations. Total phosphorus and fecal coliform concentrations, however, were often found to be excessive.

Dissolved oxygen concentrations and saturation levels for both streams were sufficient for trout maintenance status. Pohatcong Creek exhibited some improvement at Carpentersville from 1977 to 1978 as dissolved oxygen saturations increased from less than 70 percent to an annual level generally in excess of 90 percent. This increase may be due to elevated nutrient levels, particularly total phosphorus, which resulted in an increase in biological productivity. Dissolved oxygen saturation levels were consistently above 85 percent in Lopatcong Creek at Phillipsburg. Biochemical oxygen demand in Lopatcong and Pohatcong Creeks was generally acceptable with only one elevated concentration exhibited simultaneously in each stream in early 1979. Neither stream exhibited a definitive trend for biochemical oxygen demand.

As stated above, fecal coliform concentrations were generally excessive in both Lopatcong and Pohatcong Creeks. The contravention rate over 200 MPN/100 ml was 64 percent and 100 percent at the Phillipsburg and Carpentersville stations, respectively. Pohatcong Creek exhibited apparent severe fluctuations in fecal coliform levels over the period, while a clearly defined trend for the Lopatcong Creek station could not be determined due to the small quantity of data collected over the two year period from 1979-1980.

Total dissolved solids concentrations were well within the criterion at both stations. While TDS concentrations were generally below 200 mg/l in Pohatcong Creek; Lopatcong Creek exhibited an overall increase from 1979 to 1981 (100 mg/l to over 250 mg/l). Both streams were slightly alkaline as pH values generally ranged between 7.5 and 8.5.

Elevated nutrient concentrations were frequent at each station, with total phosphorus levels often exceeding the 0.10 mg/l standard. Approximately 50 percent of the values contravened the standard in Pohatcong Creek at the Carpentersville station. Lopatcong Creek exhibited an overall decline in total phosphorus concentrations from 1979 to 1980. Nitrate + nitrite concentrations, however, exhibited a general increase over the same period in Lopatcong Creek, with levels increasing from approximately 1.5 mg/l to over 4.0 mg/l. Concentrations for nitrate + nitrite were generally under 3 mg/l at the Carpentersville station on Pohatcong Creek. Total and un-ionized ammonia concentrations were at acceptable levels at both stations throughout the period with a slight overall decline in total and un-ionized ammonia values in Lopatcong Creek at Phillipsburg since 1979.

Biomonitoring activities were not conducted on either stream during the period 1977 through 1981.

Comparison of water quality data in this report with conclusions made in earlier 305(b) reports shows that similar problems continue to exist. Fecal coliform counts and nutrients remain at problematic levels, with nutrients experiencing a moderate increase since the mid-1970s.

Toxic Parameters

To this date, no surface water samples have been collected from these watersheds.

The relatively good water quality, as established in the section above is indicative of the lack of development within the respective watersheds. Since this region is mainly agricultural or forested with limited residential or industrial development, the incidence of extensive toxic contamination appears to be minimal. Presently there is no data on toxic contamination of aquatic organisms available for these basins. As expansion of this data occurs, site specific sampling within these watersheds may provide useful information.

Problem Assessment

The water in these primarily agricultural basins is generally of good quality. However, there are some problems with fecal coliform and nutrient levels, especially phosphorus.

The sources of water pollution in these watersheds are mostly of non-point origin. The Upper Delaware WQM Plan identified septic tanks and livestock wastes as the sources of bacterial contamination, and overfertilization on farm lands as the reason for excessive nutrients in the streams. These conclusions are still warranted at this time. Within the Pohatcong Creek watershed, septic tank problems are known to exist in Greenwich Township.

Another non-point source of pollution is the high sedimentation loading thought to be occurring in both watersheds. The extensive use of land for crop agriculture together with existing moderate to steep slopes contribute to the soil losses. The Pohatcong watershed was identified as having the greatest soil loss rate in the State (13.3 tons per acre per year), based on work conducted in 1979 for the State Water Quality Management Program.
Two point sources present have water quality impacts. The Washington Borough Treatment Plant causes some immediate degradation

to Pohatcong Creek, but the stream is able to assimilate the wastes. The Phillipsburg STP is known to cause severe quality problems to Lopatcong Creek downstream of the sampling station, just prior to the creek's confluence with the Delaware River. The plants' treatment efficiencies need to be improved, excessive inflows managed and industrial contributions properly pretreated.

Goal Assessment and Recommendations

Both these streams do not meet the goal of swimmable water quality due to the continually high levels of fecal coliform bacteria found. However, the waters are of good fishable quality. Both streams support a moderately diverse community of fish species, with sixteen species reportedly present in the Pohatcong and twelve species identified in the Lopatcong. Native trout are present in Pohatcong Creek. The Pohatcong watershed is of sufficient quality to be classified as either trout maintenance or trout production throughout.

The existing water quality can be improved with effective agricultural best management practices implemented on the many farms that are adjacent to the streams in this segment. Sedimentation can be controlled with proper tillage procedures; excessive nutrients reduced with animal waste control and minimal fertilizer applications; and fecal coliform levels decreased with animal waste management. Improvements to on-site disposal are needed in areas with septic problems, especially in Greenwich Township.

Wastewater facilities planning activities are called for in the lower Lopatcong watershed. Improvements are necessary at the Phillipsburg STP; where industrial pretreatment ordinances are needed to protect the quality of the inflow to the Phillipsburg plant.

POHATCONG AND LOPATCONG CREEKS STATION LIST

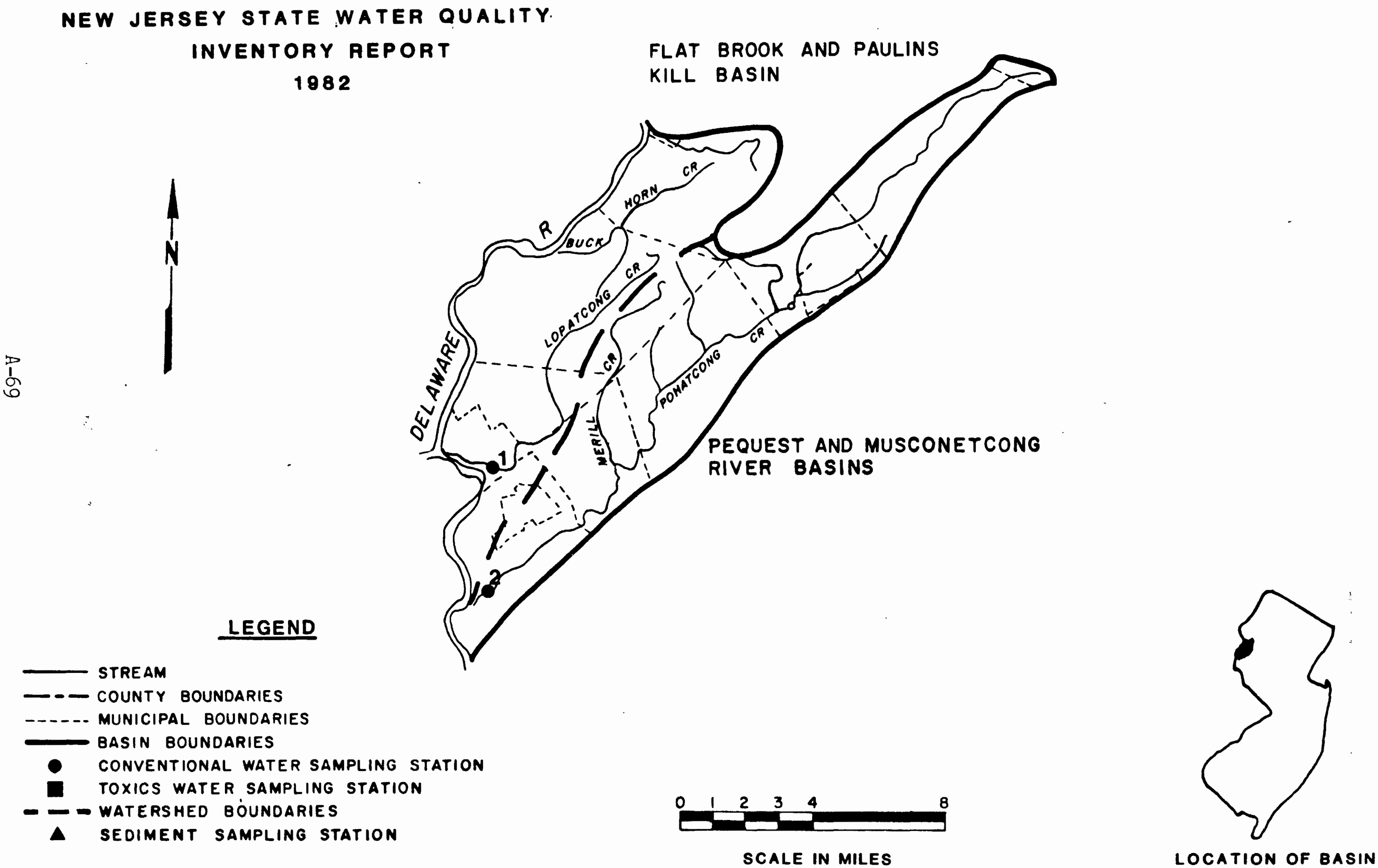
A. Ambient Monitoring Stations

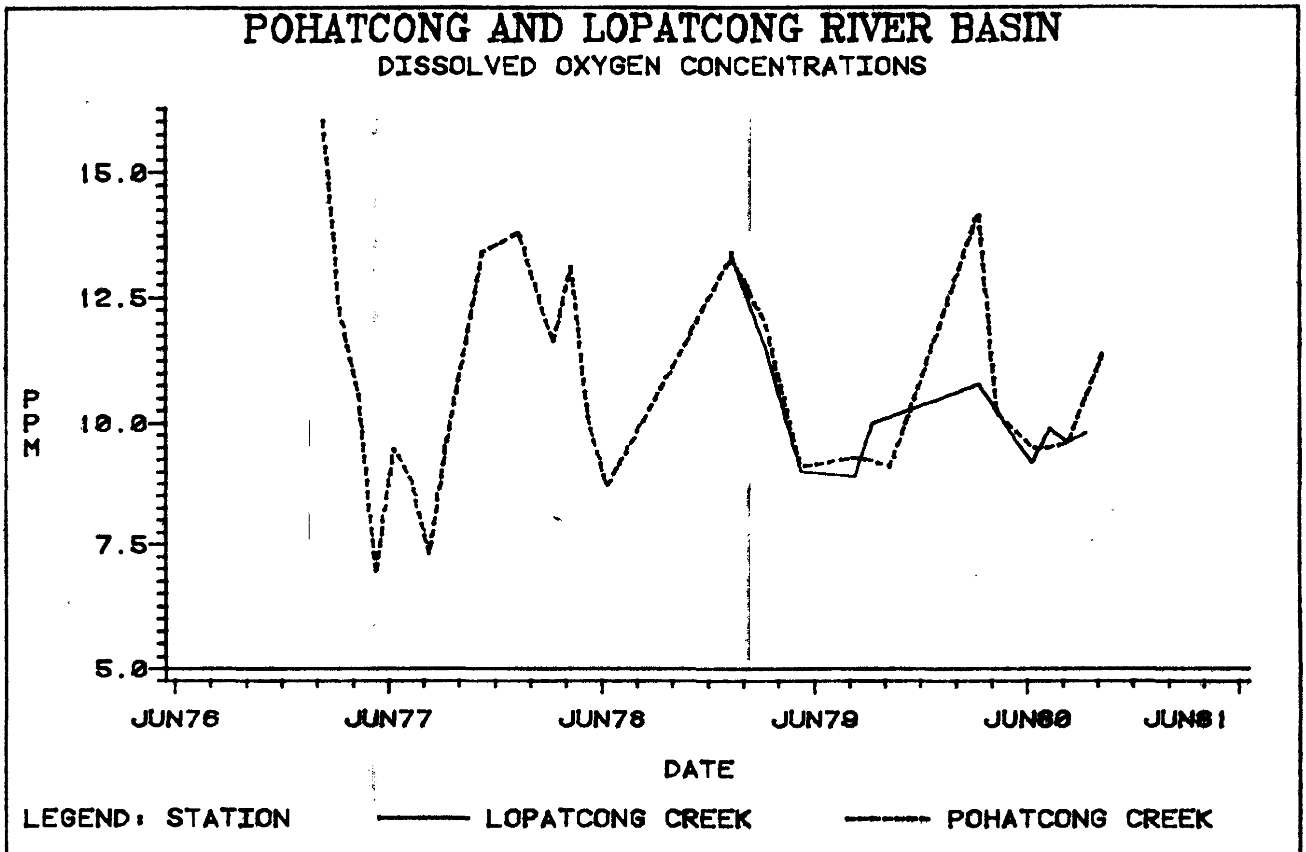
STORET Number	Station Description	Map Number
01455100	Lopatcong Creek at Phillipsburg, Warren County Latitude 40°40'38" Longitude 75°10'13" FW-2 Nontrout USGS/DEP Network At bridge on Lock Street in Phillipsburg, 0.9 mile upstream from mouth at Delaware River.	1
01455300	Pohatcong Creek at Carpentersville, Warren County Latitude 40°37'30" Longitude 75°11'10" FW-2 Trout Maintenance USGS/DEP Network At bridge on Carpentersville Reigelsville Road, 2,000 feet upstream from mouth at Delaware River.	2

B. Toxic Monitoring Stations

None present

POHATCONG AND LOPATCONG CREEK BASINS





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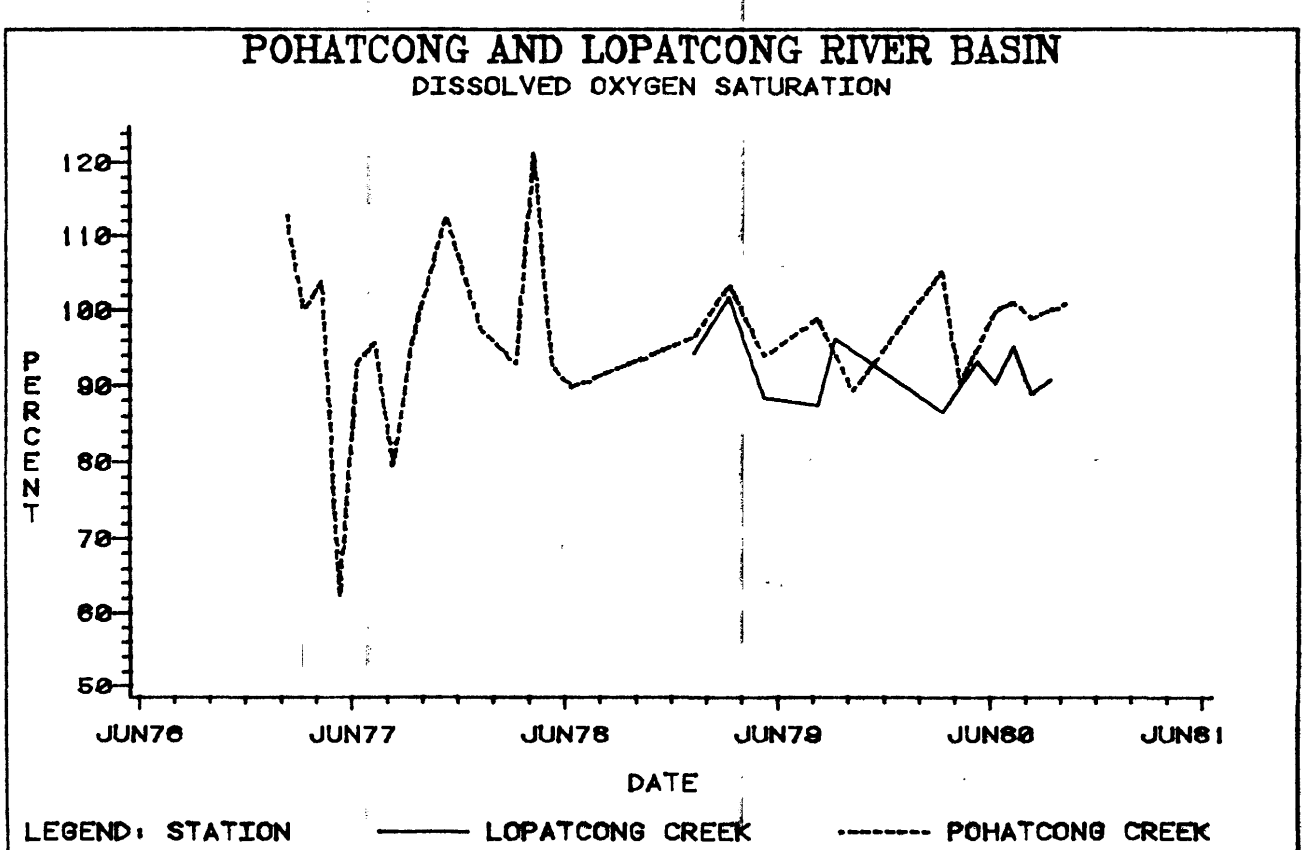

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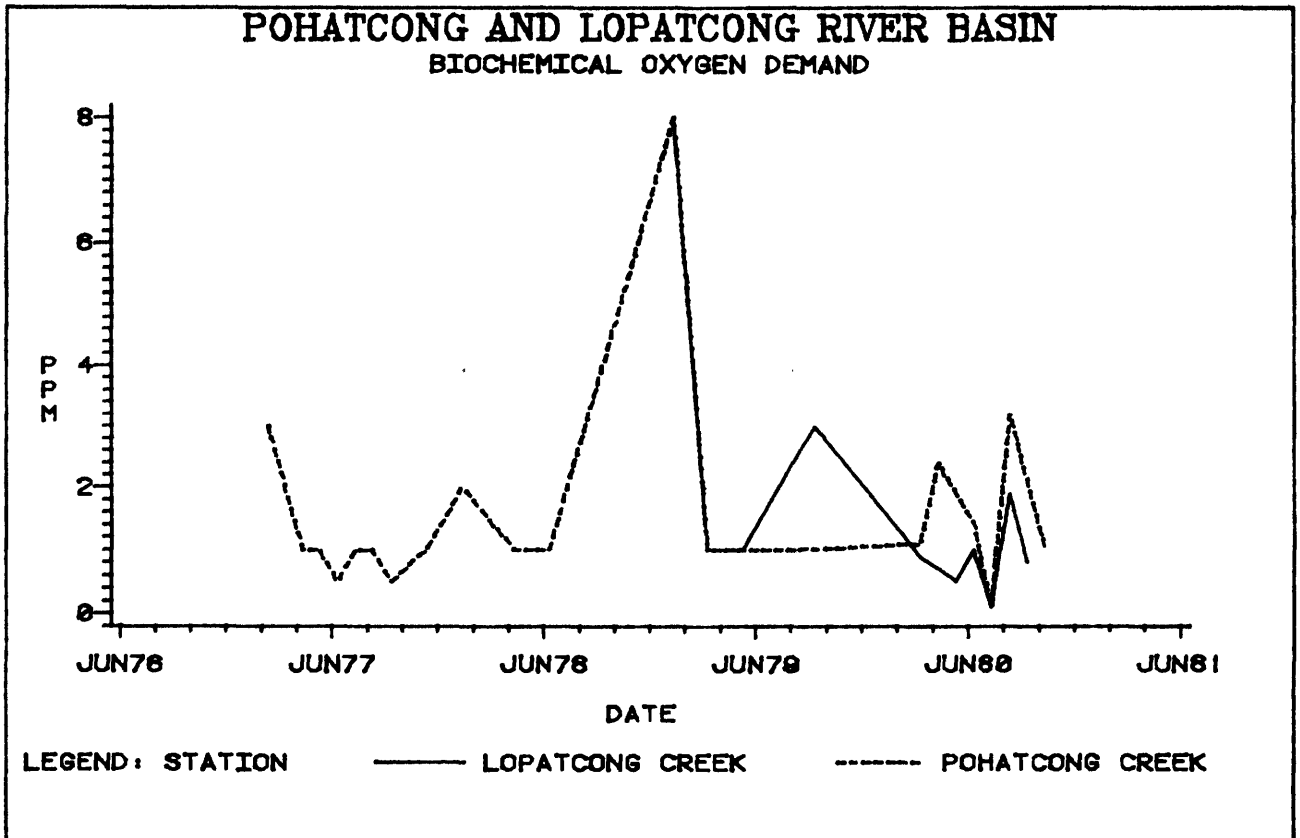

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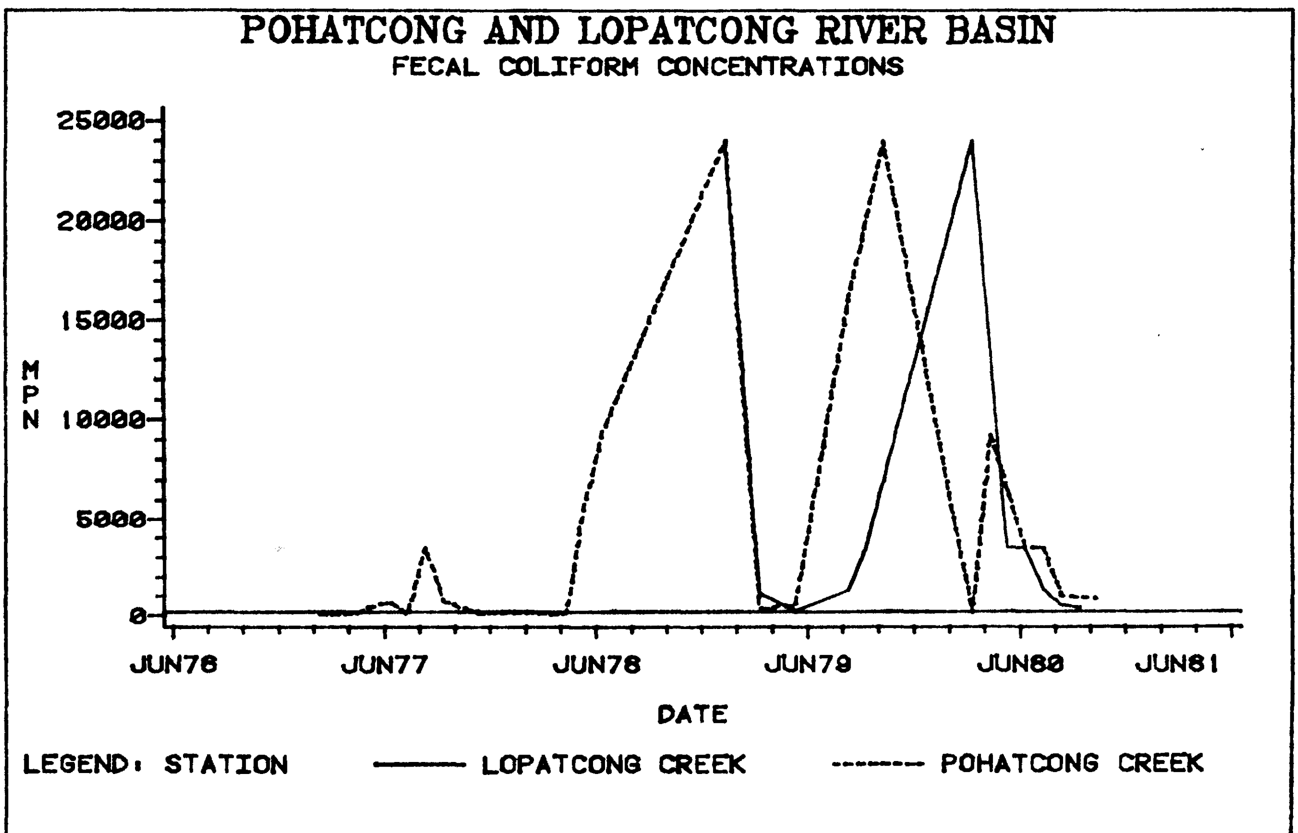

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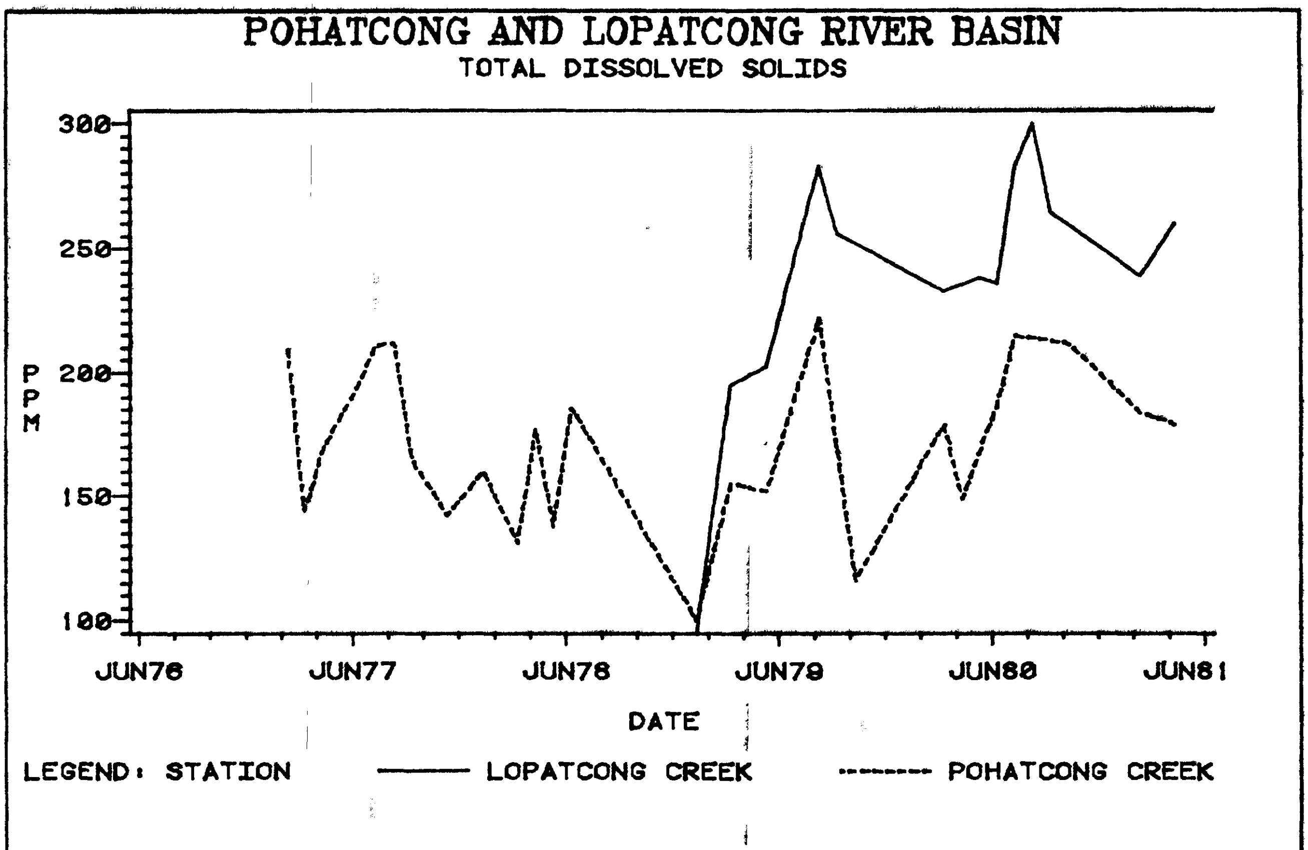

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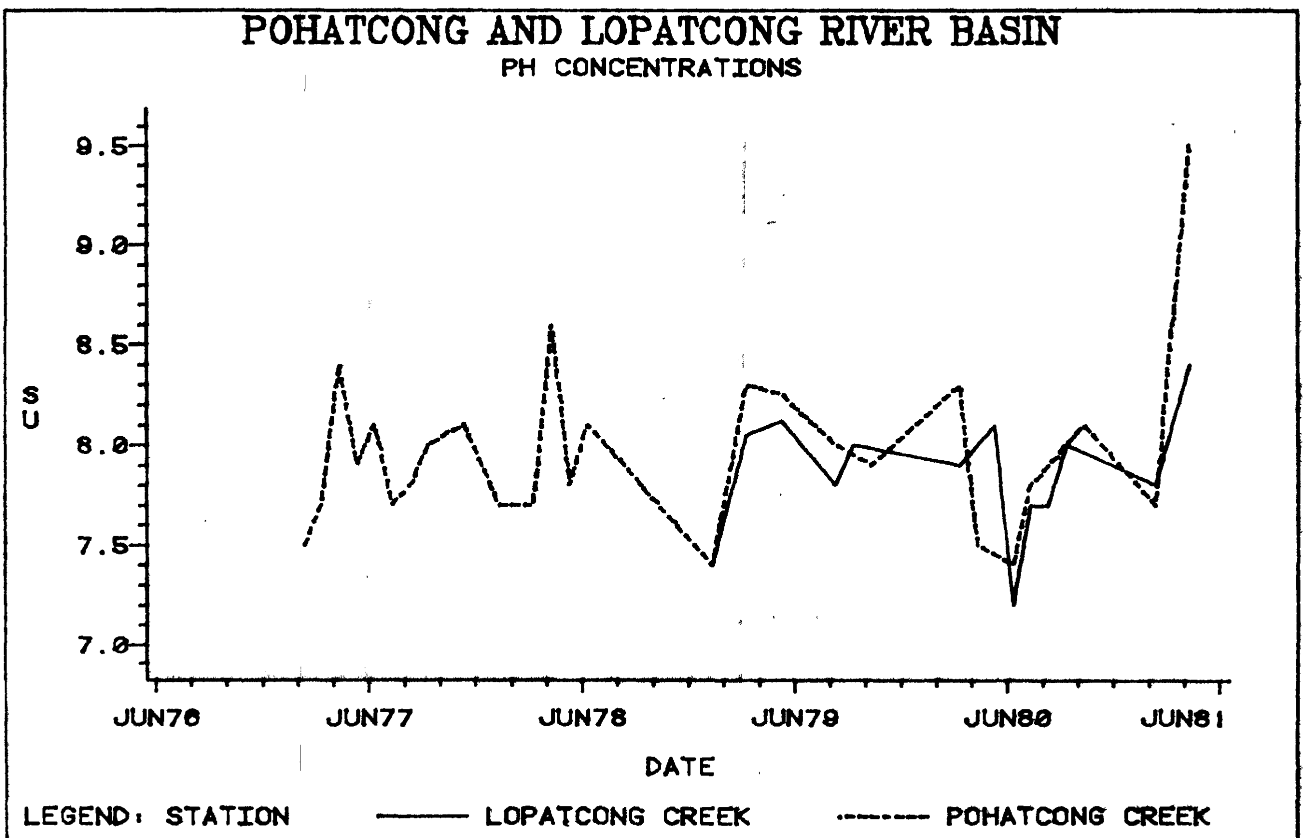

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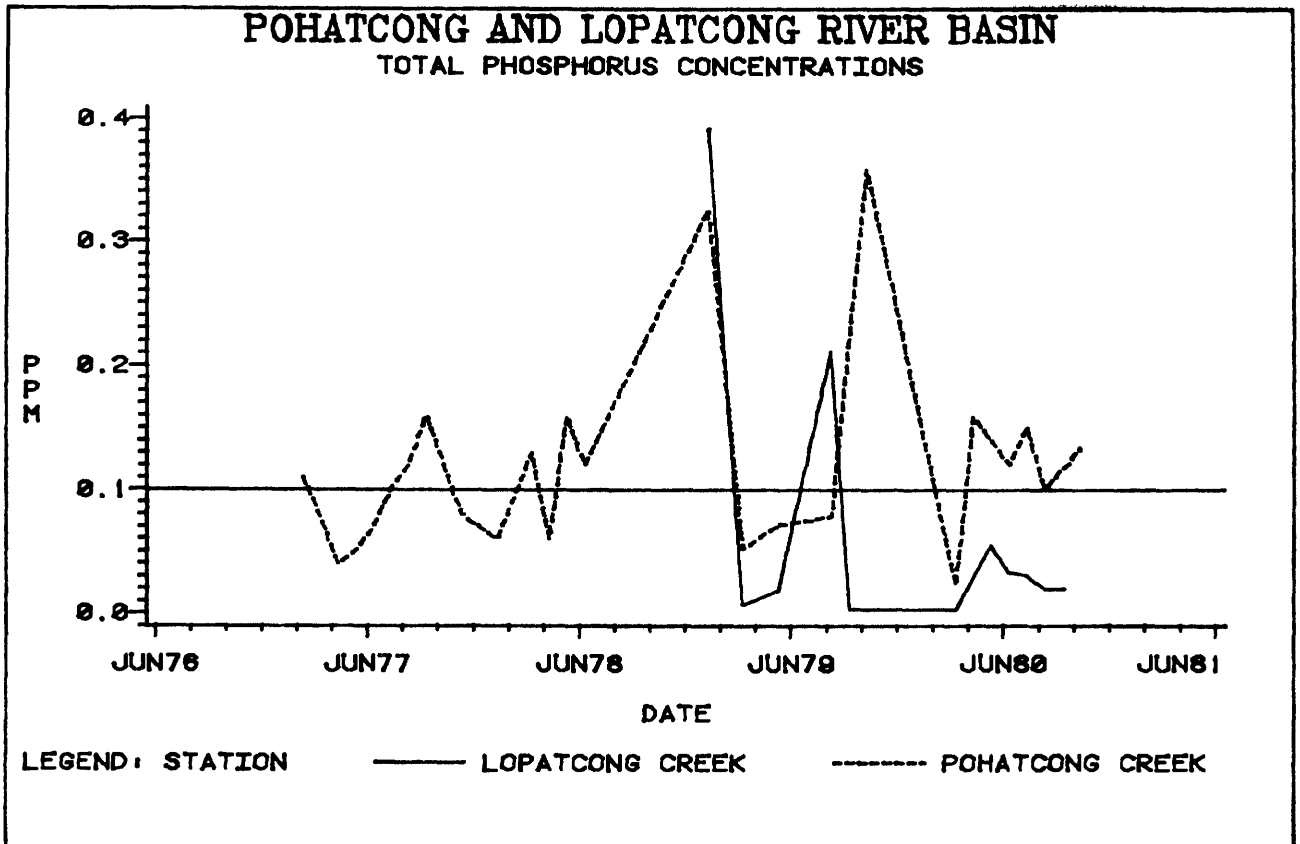

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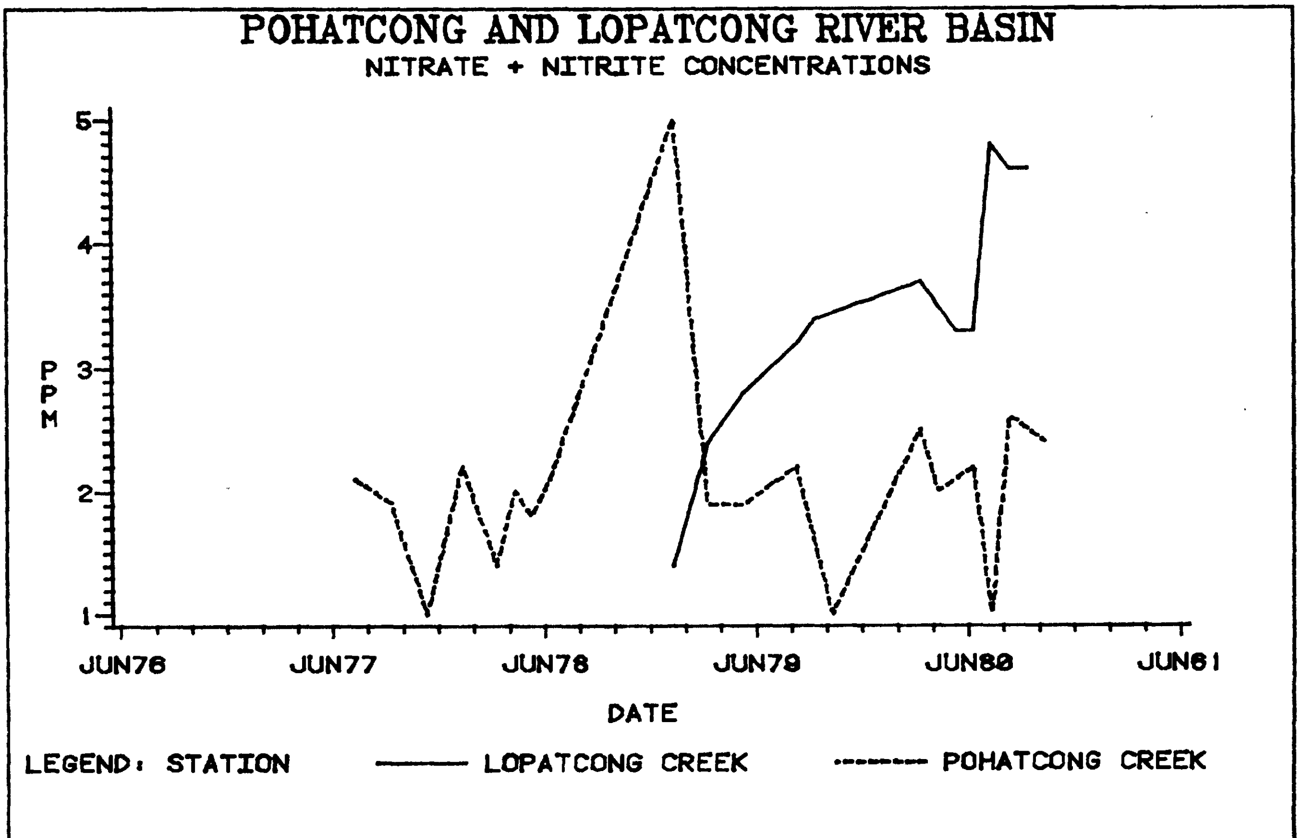

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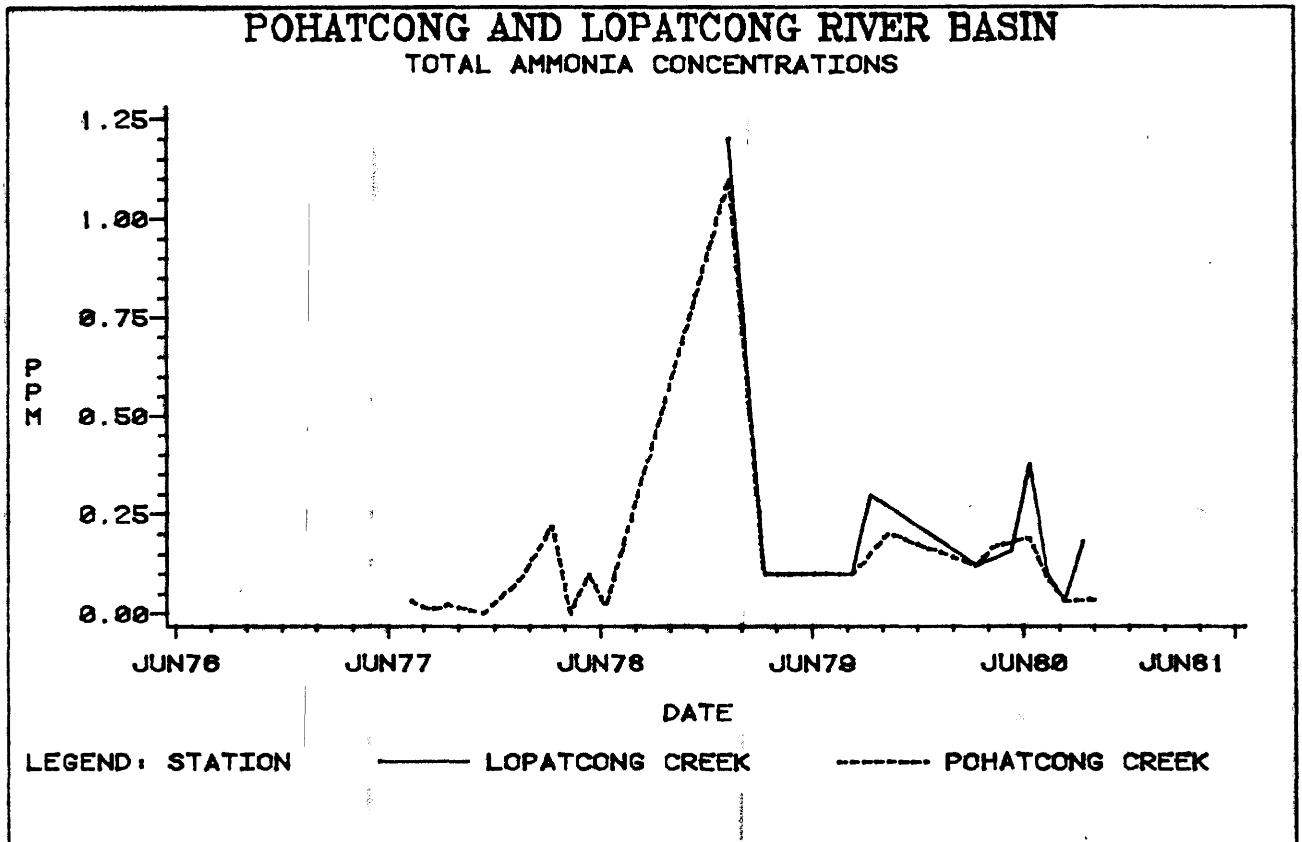

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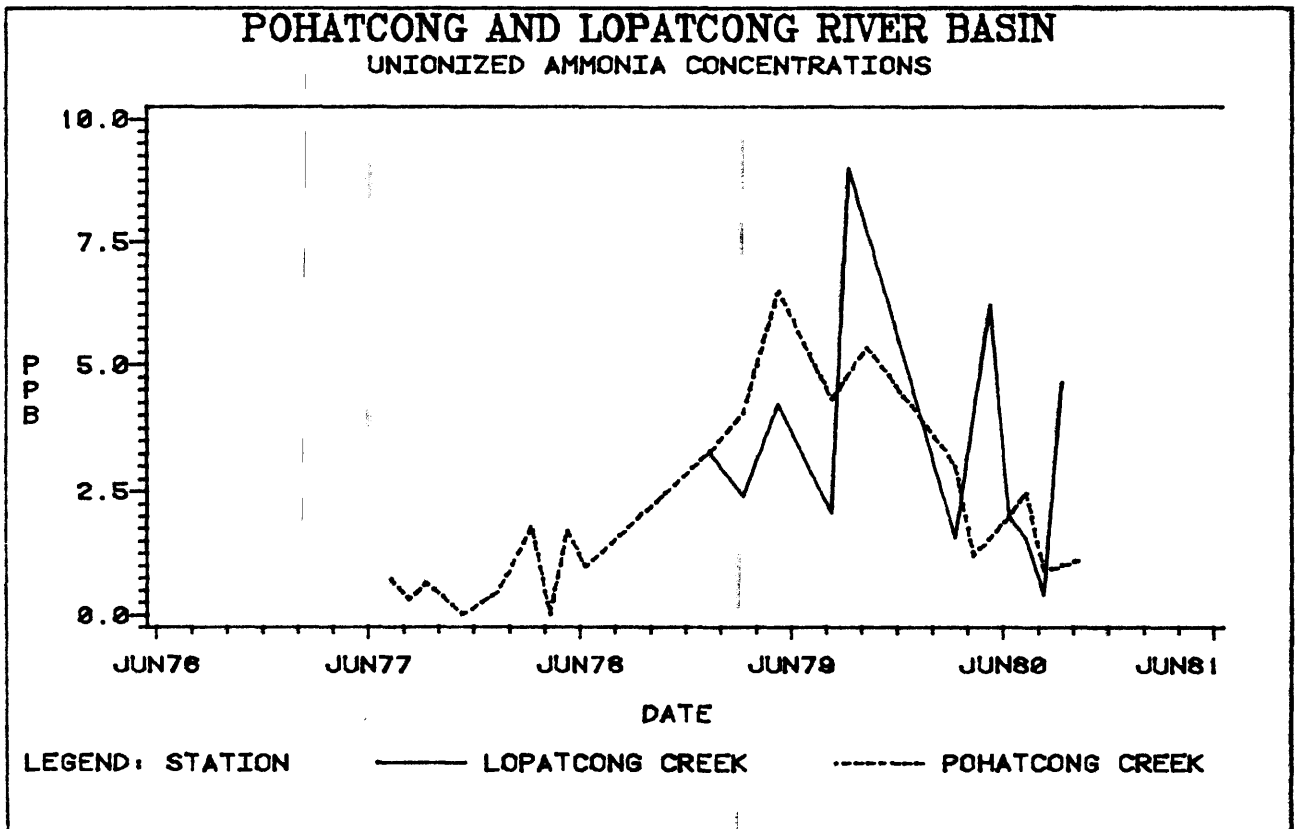

Figure: D -10

DISCHARGE INVENTORY - - - POHATCONG AND LOPATCONG RIVER BASINS

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD	
WARREN COUNTY TECHNICAL SCHOOL	0020711	FRANKLIN TWP	POHATCONG CR.	SANITARY		
WASHINGTON BOROUGH	0021113	WASHINGTON TWP	HEBECCNG CREEK TO POHATONG CRE	SAN/SIG INDUS	.39	
INGERSOLL-RAND CO	0004049	PHILLIPSBURG	LOPATCONG CREEK	COOLING WATER	.06	
TOWN OF PHILLIPSBURG	0024716	PHILLIPSBURG	LOPATCONG CR.			2.2

E. DELAWARE RIVER TRIBUTARIES - HUNTERDON/MERCER COUNTIES

Basin Description

This segment consists of tributaries to the Delaware River south of the Musconetcong River and north of Assunpink Creek. The tributaries to this 45 mile length of the Delaware River include Hakihokake, Harihokake, Nishisakowick, Copper, Lockatong, Wickecheoke, Alexauken and Swan Creeks in Hunterdon County; and Moores, Fiddlers and Jacobs Creeks in Mercer County. The tributaries, all less than 15 miles in length, drain western Hunterdon and northwestern Mercer Counties. Drainage basin size range from approximately 2 square miles for Swan Creek to Wickecheoke Creek's 27 square miles. Total drainage area for this region is roughly 200 square miles. The Delaware and Raritan (D&R) Canal originates in this segment and transverses through the segment along the Delaware River from Delaware Township (Hunterdon County) southward. Lockatong and Wickecheoke Creeks, considered tributaries of the Delaware River, actually discharge to the D&R Canal. During high flow periods, however, much of the flow from these creeks travels across the Canal and flows over a spillway into the Delaware River.

Land uses in these small watersheds are primarily agricultural and forests with scattered villages. Farming devoted to corn and hay crops, as well as beef and dairy cattle, horses and swine predominate in the northern three-quarters of this segment. Residential and commercial development is limited to Mercer County and the Lambertville area of Hunterdon County. The natural beauty of this area of New Jersey, however, makes it a desirable region for growth. Population increases between 1970 and 1980 were slight.

Most of this segment relies on septic systems for disposal of domestic wastewaters. However, four small areas utilize municipal sewers (Milford Borough, Frenchtown, Sergeantsville, portions of Lambertville and Stockton, and Ewing in Mercer County). Facilities planning work is being conducted for Holland Township and Milford, the Lambertville area, and in Mercer County by the Ewing-Lawrence Sewerage Authority. Nine facilities discharge wastewaters to streams in this segment (does not include discharges directly to the Delaware River).

Lambertville, via the Lambertville Water Company, takes water from Swan Creek (Swan Creek Reservoirs East and West) for potable supplies. With scattered industries located throughout this segment there is some industrial usage of waters (Wickecheoke Creek). Recreational activities occur along the water bodies within this segment. The D&R Canal Park provides for hiking and fishing along its entire length, as does Washington Crossing State Park in Mercer County. Trout fishing is a common recreational activity in this segment. The N.J. Division of

Fish, Game and Wildlife stocks trout in Alexandria Brook, Alexander Creek, Everittstown Brook, Hakihokake Creek, Little York Brook, Lockatong Creek, Milford Brook, Mt. Pleasant Brook, Spring Mills Brook and Wickecheoke Creek in Hunterdon County; and Belle Mountain Park Pond in Mercer County. Also, reproducing brown trout populations have been located in Little York Brook, Spring Mills Brook and Milford Brook.

Streams in this segment have been classified by the N.J. Water Quality Standards as either FW-1 (waters in Washington Crossing State Park), FW-2 Trout Production, FW-2 Trout Maintenance or FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

The water quality data collected at Hakihokake Creek at Milford, Lockatong Creek at Raven Rock and Wickecheoke Creek at Stockton generally indicates good conditions in the Delaware River tributaries; although seasonal low flow periods appear to cause occasional adverse impacts on conditions in the streams. Elevated fecal coliform concentrations indicate possible problems, particularly in Hakihokake and Wickecheoke Creeks. Although approximately 67 percent of the fecal coliform values from Lockatong Creek contravened the 200 MPN/100 ml level, they were much less severe than the higher values in Hakihokake and Wickecheoke Creeks.

Dissolved oxygen concentrations and saturation values exhibited a slight decline at all three stations in 1980 after three years of normal seasonal variations. This trend was accompanied by a rise in biochemical oxygen demand concentrations at the Milford and Raven Rock stations (Hakihokake and Lockatong Creeks, respectively).

While total dissolved solids concentrations were at consistent levels (generally 100-200 mg/l) in Hakihokake and Lockatong Creeks; Wickecheoke Creek exhibited a sharp increase in 1977 to greater than 500 mg/l, followed by a gradual decline over a three year period to a level well within the criterion. This water quality improvement was a result of a discharge abatement agreement between DEP and a discharger upstream of the Stockton station. Slightly alkaline pH values were exhibited in each of the three streams.

Periodic contraventions of the total phosphorus standard were recorded in Hakihokake, Lockatong, and Wickecheoke Creeks, but only Hakihokake Creek at Milford exhibited a slight upward trend. Nitrate + nitrite and total ammonia levels were under 4.5 mg/l and 1.00 mg/l respectively during the period in all three

West Amwell. Although the densities of septic systems found is not high, the soils and bedrock in this area are generally not suitable for their placement. The septic systems are the likely source of fecal coliform and phosphorus present in the streams. The streams in this segment also experience low flow conditions, which can exacerbate the effects the septic systems may have on water quality. Decaying vegetative matter in the streams may also contribute to the excessive nutrients occasionally found.

Goal Assessment and Recommendations

Due to the frequency with which the fecal coliform values contravened the 200 MPN/100 ml level in these waterways, they do not meet the goal of swimmable waters. Although the waters are often strongly alkaline and do occasionally experience contraventions of the un-ionized ammonia standard, these waters are fishable. Lockatong Creek has been found to support a diverse community of fish (twenty-six different species) which represent various water quality conditions and habitats. Much of this segment is classified as trout maintenance, supporting the overall good water quality found. The most stressful conditions for fish in these streams occurs during low flow periods.

Much of this segment is in undesignated areas, meaning that no wastewater facilities planning activities are underway. It is recommended, however, that such activities be initiated to study on-site systems management. Where agricultural activities are present, their impacts on the waters in this segment should be evaluated further, especially with regard to sedimentation rates.

Goal Assessment and Recommendations

Due to the frequency with which the fecal coliform values contravened the 200 MPN/100 ml level in these waterways, they do not meet the goal of swimmable waters. Although the waters are often strongly alkaline and do occasionally experience contraventions of the un-ionized ammonia standard, these waters are fishable. Lockatong Creek has been found to support a diverse community of fish (twenty-six different species) which represent various water quality conditions and habitats. Much of this segment is classified as trout maintenance, supporting the overall good water quality found. The most stressful conditions for fish in these streams occurs during low flow periods.

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DELAWARE RIVER TRIBUTARIES
(HUNTERDON/MERCER COUNTIES) STATION LIST

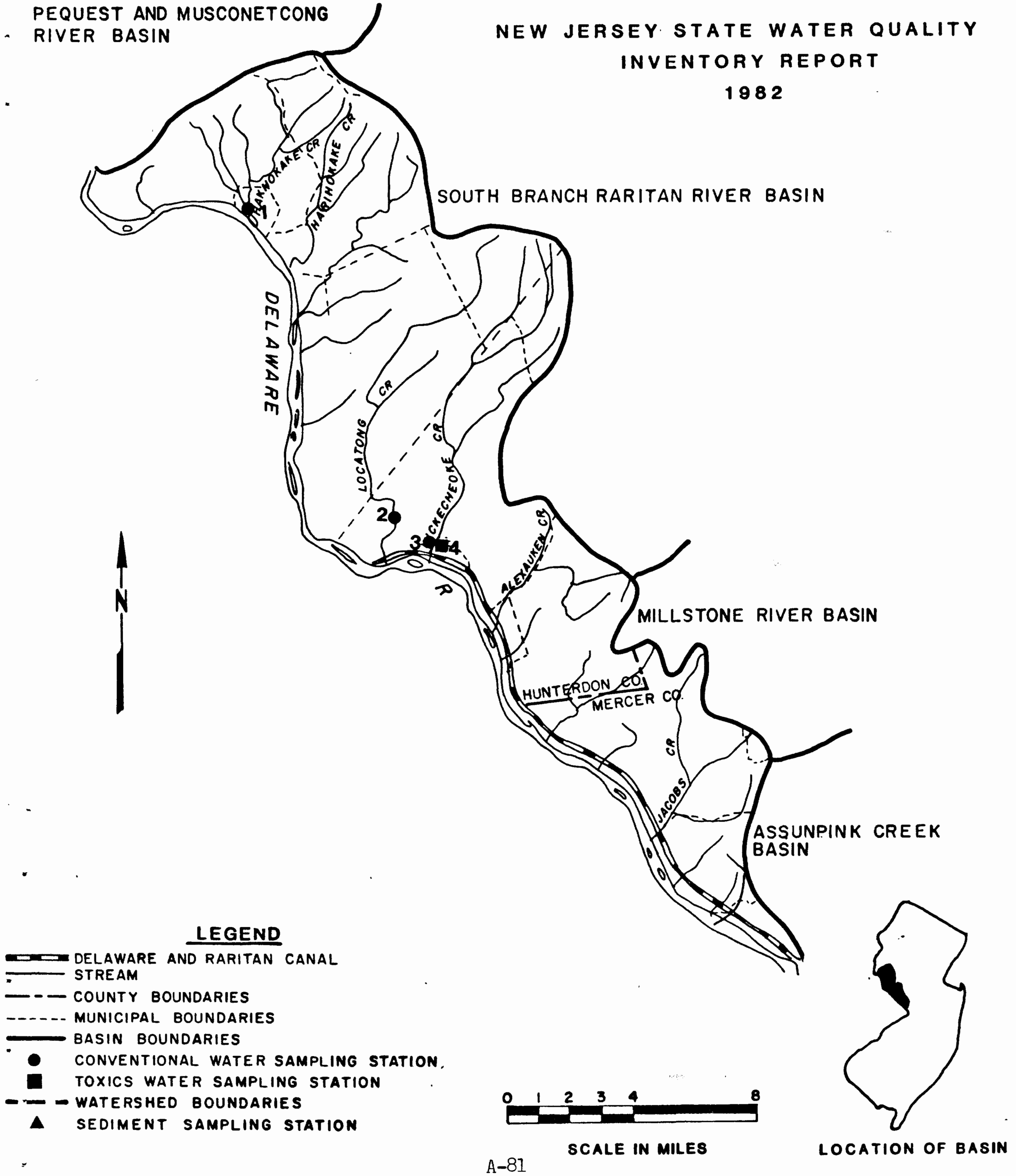
A. Ambient Monitoring Stations

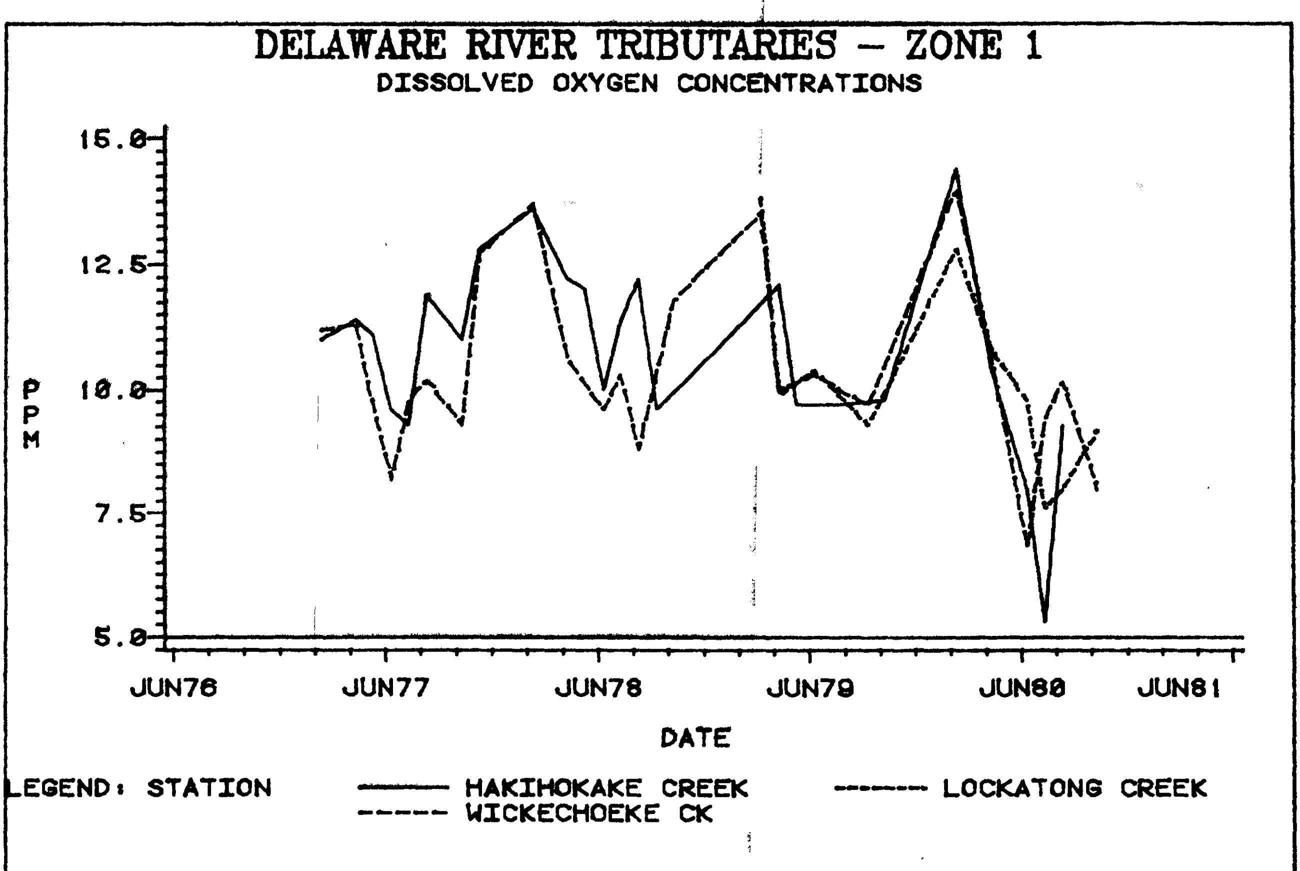
STORET Number	Station Description	Map Number
01458100	Hakihokake Creek at Milford, Hunterdon County Latitude 40°34'06" Longitude 75°05'44" FW-2 Trout Maintenance USGS/DEP Network At bridge on Bridge Street, 4,000 feet upstream from mouth at Delaware River.	1
01460880	Lockatong Creek at Raven Rock, Hunterdon County Latitude 40°24'58" Longitude 75°01'05" FW-2 Trout Maintenance USGS/DEP Network At bridge on Raven Rock-Rosemont Road, 0.7 mile upstream from mouth at Delaware River.	2
01461300	Wickecheoke Creek at Stockton, Hunterdon County Latitude 40°24'41" Longitude 74°59'13" FW-2 Trout Maintenance USGS/DEP Network At Route 29 bridge, 900 feet upstream from mouth at Delaware River.	3

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Wickecheoke Creek at Stockton	Water column	4

DELAWARE RIVER TRIBUTARIES - ZONE 1 (HUNTERDON/MERCER COUNTIES)





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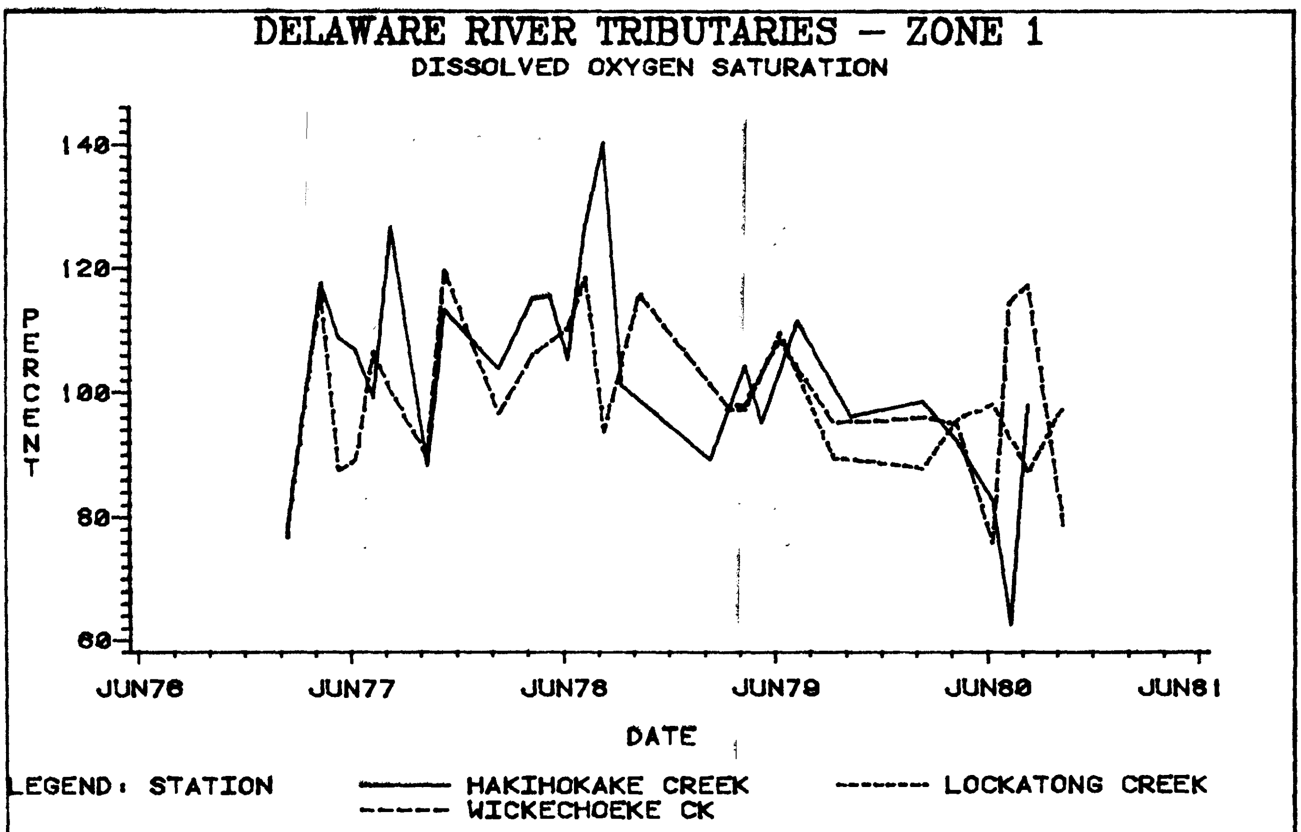

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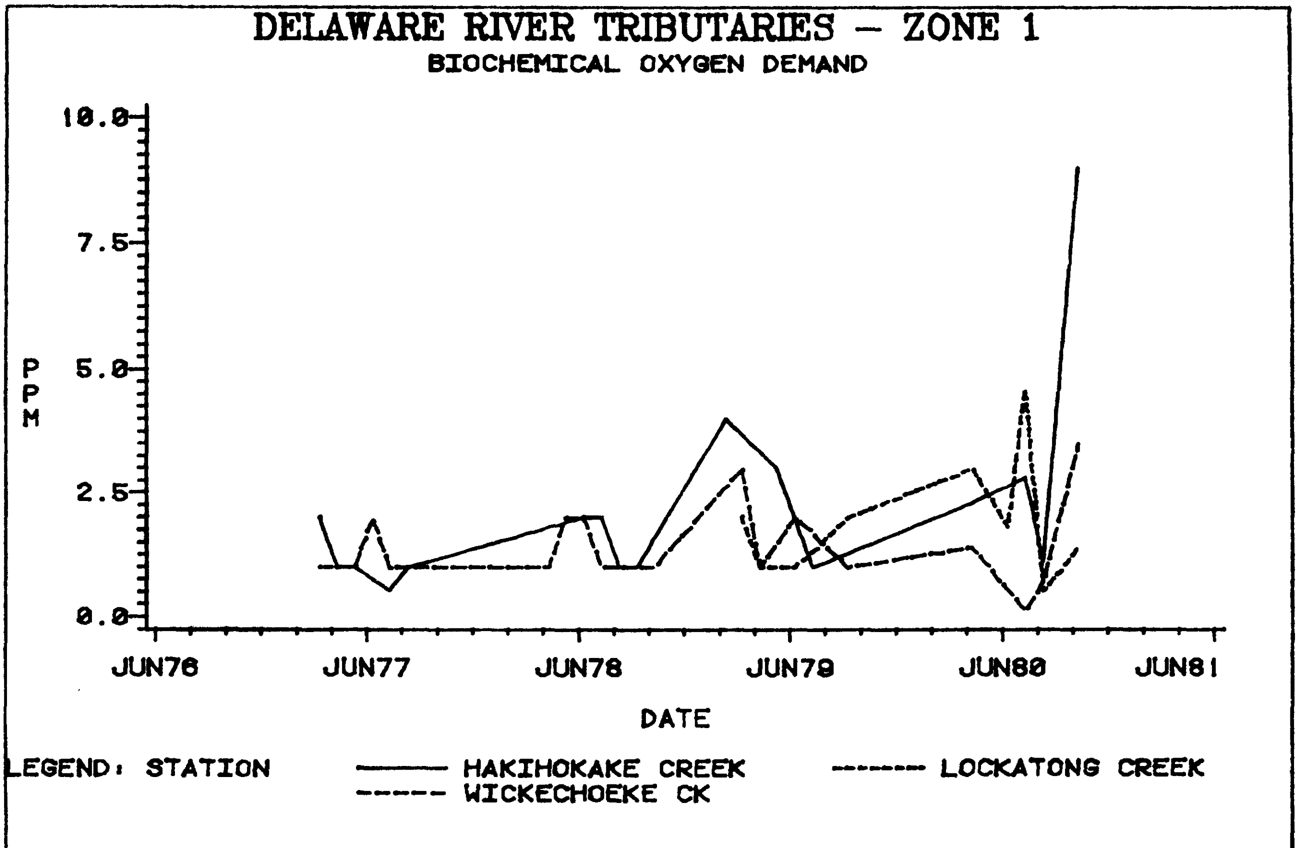

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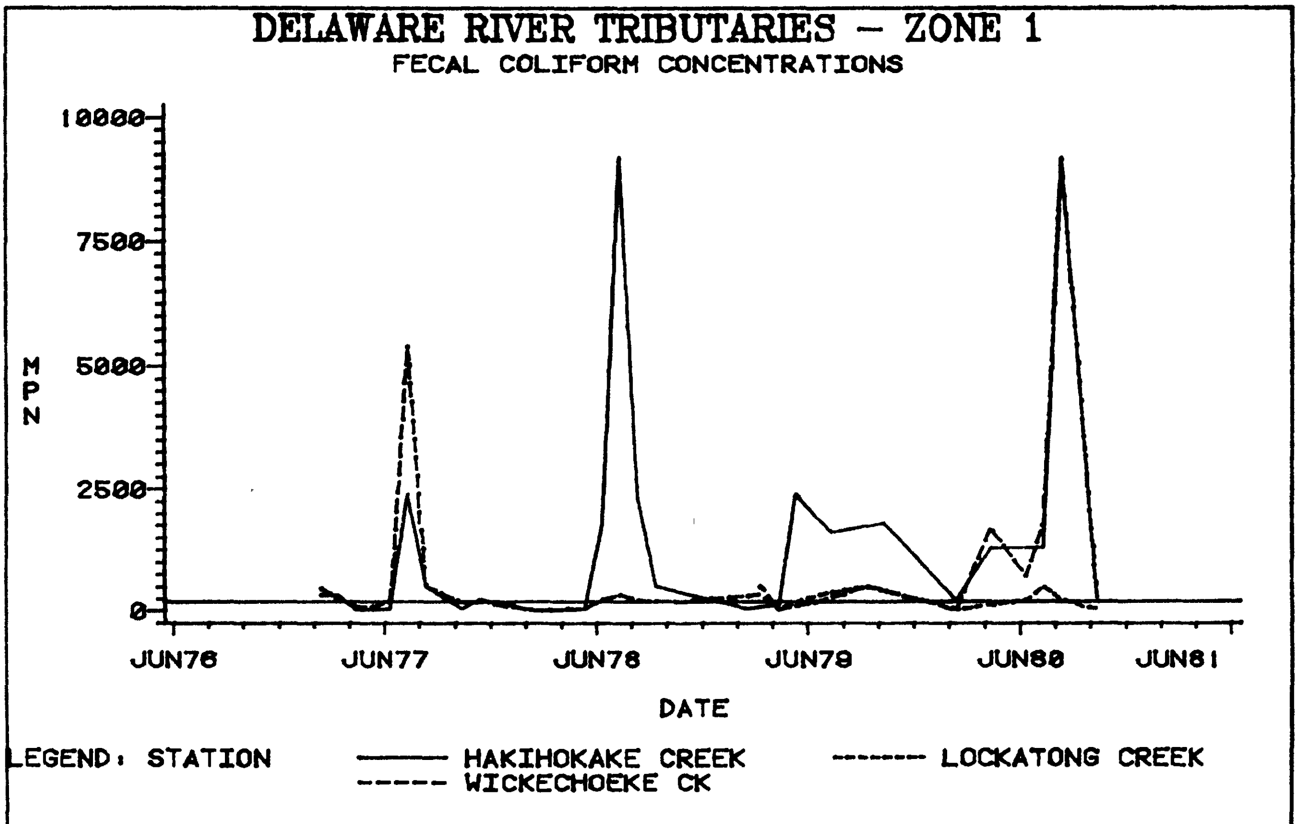

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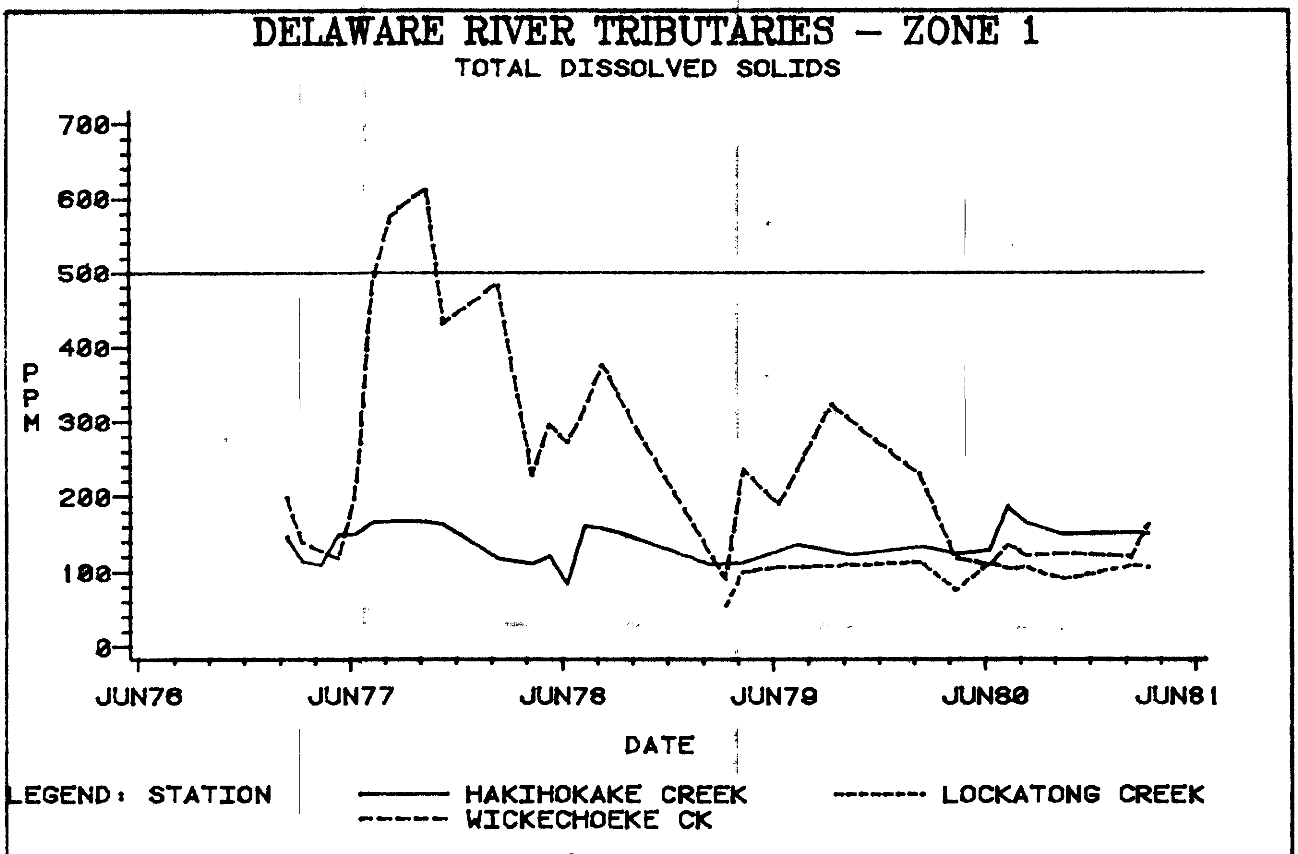

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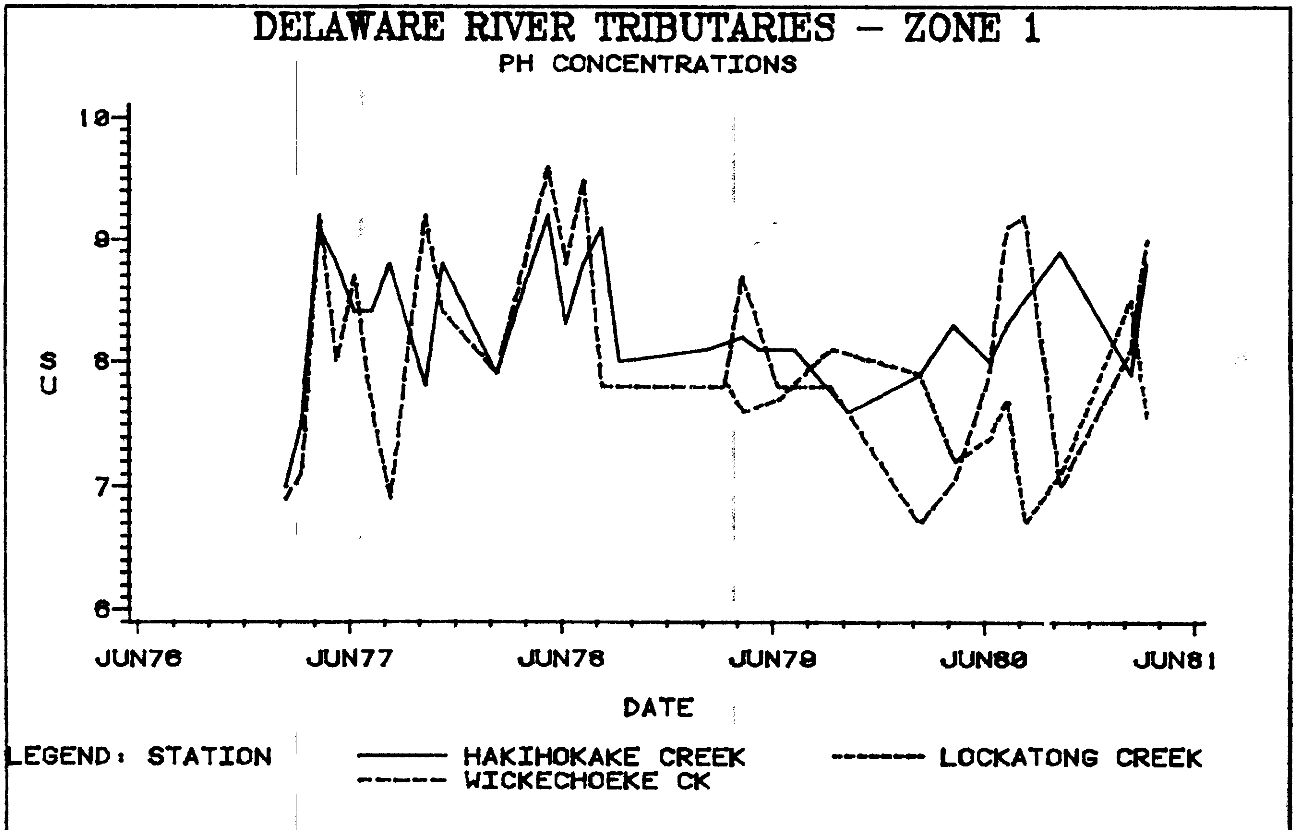

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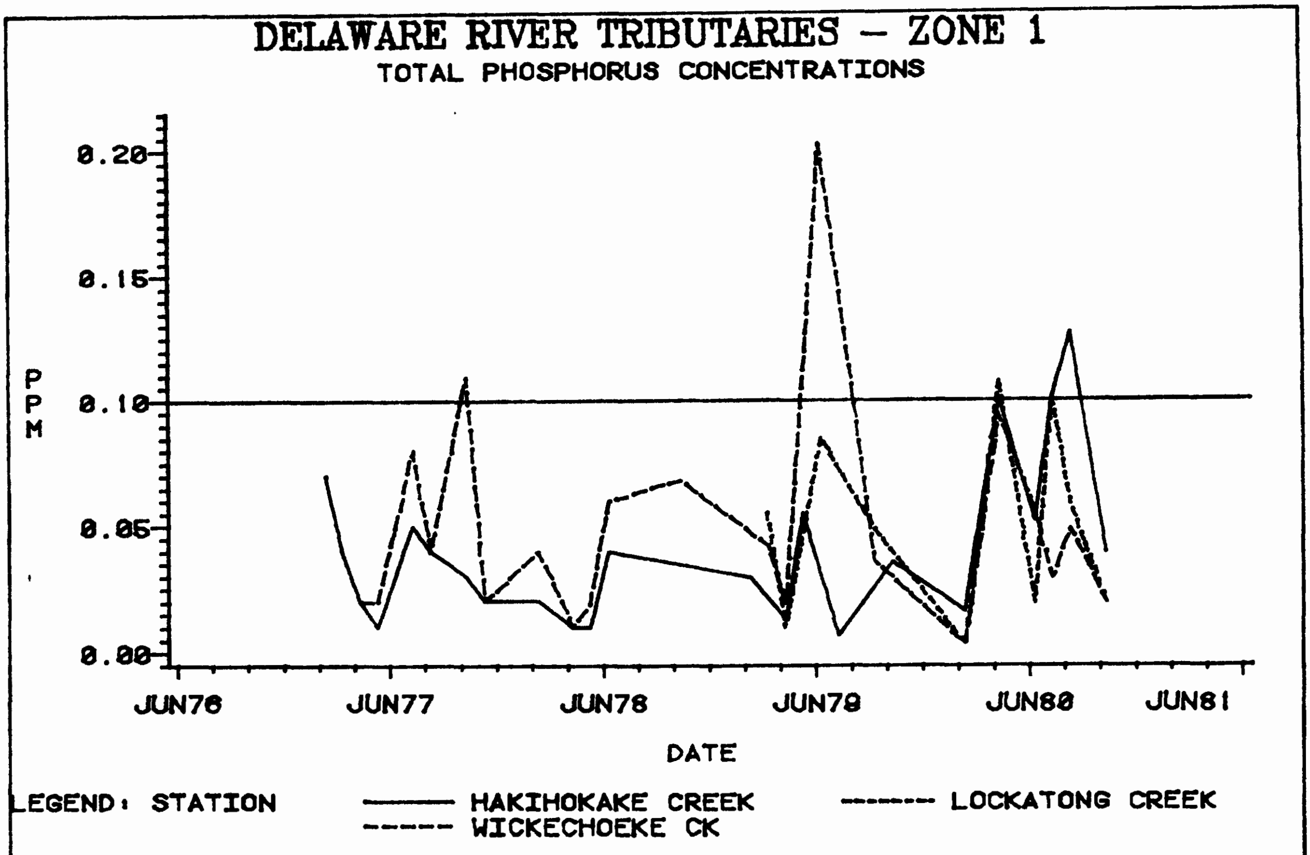

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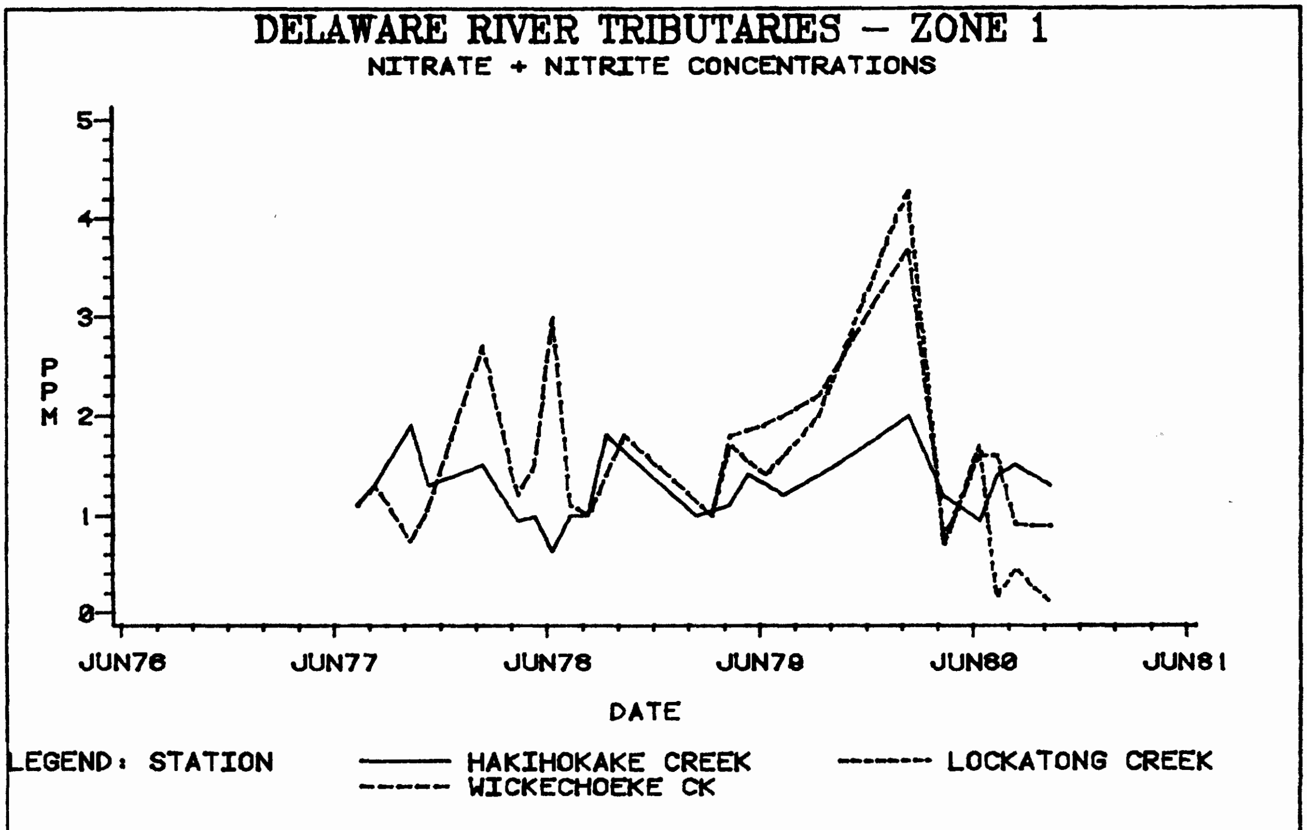


Figure: E –8

DELAWARE RIVER TRIBUTARIES – ZONE 1
TOTAL AMMONIA CONCENTRATIONS

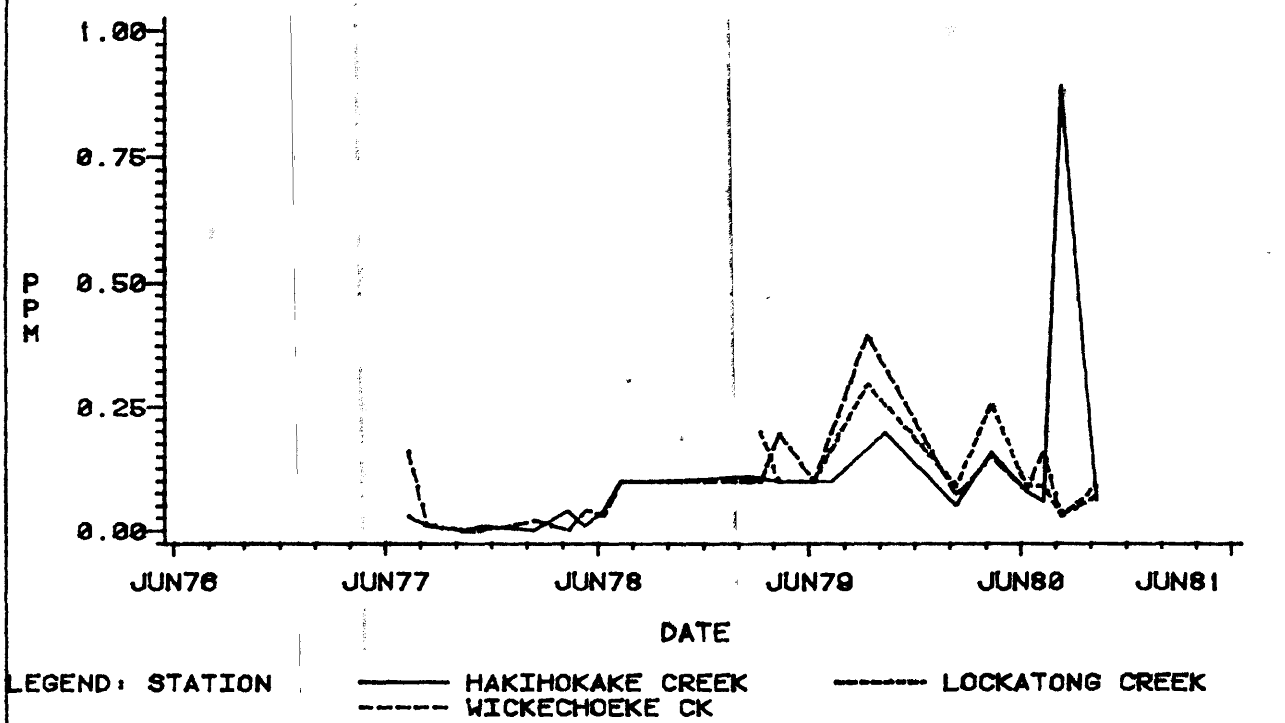


Figure: E -9

DELAWARE RIVER TRIBUTARIES – ZONE 1
UNIONIZED AMMONIA CONCENTRATIONS

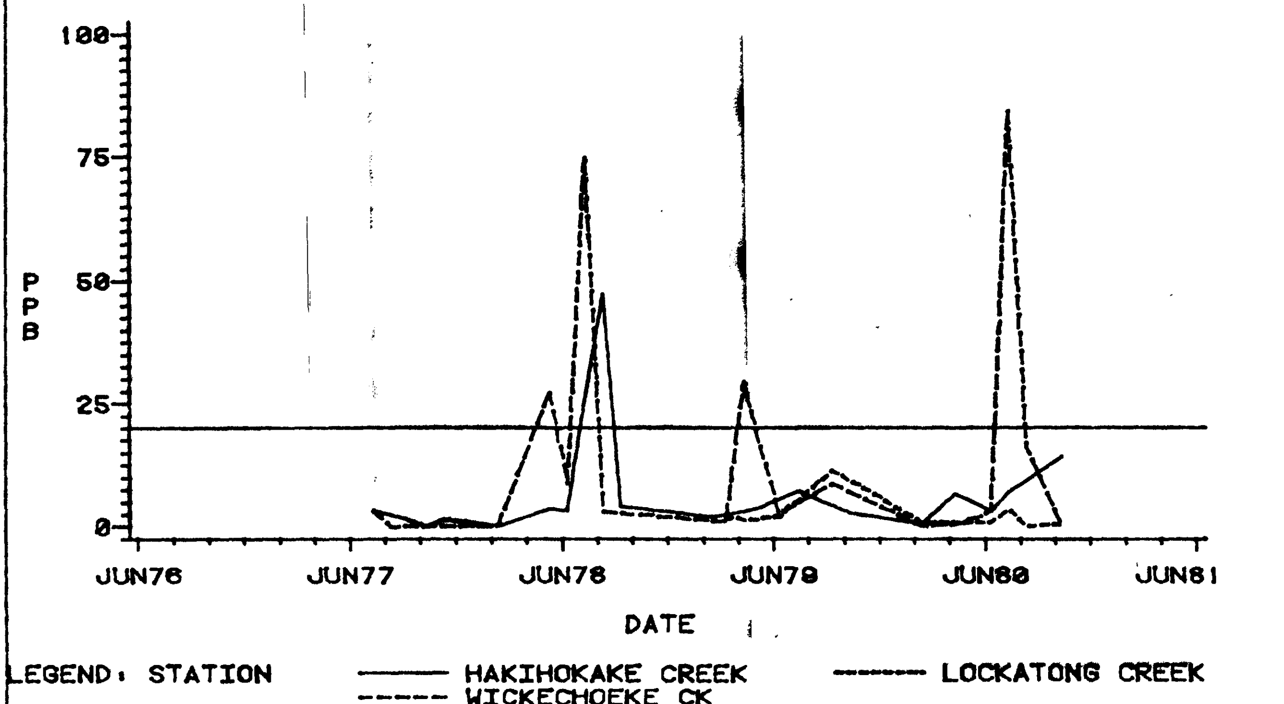


Figure: E -10

DISCHARGE INVENTORY - - - DELAWARE RIVER TRIBUTARIES - ZONE 1

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
MAGNESIUM ELEKTRON INC	0027537	KINGWOOD TWP	WICKECHOEKE CREEK	PROCESS & COOL.	.14
HOPEWELL VALLEY REG BD OF ED	0021776	HOPEWELL TWP	TRIBUTARY OF DELAWARE RIVER	SANITARY	
KINGWOOD TWP BD OF ED	0023311	KINGWOOD TWP	KRIAL POND	SANITARY	
MERCER COUNTY AIRPORT S T P	0023779	EWING TWP	JACOB CR.	SANITARY	.04
ROLLER BEARING CO OF AMERICA	0034321	EWING TWP	GOLD RUN CREEK		
HOMASOTE CO.	0004031	EWING TWP	GOLD RUN	PROCESS WASTE	.13
COUNTY OF MERCER	0027715	HOPEWELL TWP	FIDLER CREEK	SANITARY	.03
GULF OIL COMPANY US	0026042	TRENTON	WATSONS CREEK A TRIBUTARY		
MILFORD SEWER UTILITY	0021890	MILFORD	QUEQUACOMISSACONG CREEK	SANITARY	.25
ALEXANDRIA TWP BRD OF EDUCATION	0027553	ALEXANDRIA TWP	TRIBUTARY OF DELAWARE RIVER	SANITARY	

F. ASSUNPINK CREEK

Basin Description

Assunpink Creek and its tributaries drain a 91 square mile region of central New Jersey to the Delaware River. Originating in Millstone Township, Monmouth County, the Assunpink flows westerly for approximately 25 miles through central Mercer County, discharging an average unadjusted flow of approximately 130 cfs to the Delaware at Trenton. The basin can be characterized as containing gently rolling terrain with broad stream channels historically prone to flooding. Major tributaries include Shabacunk Creek and Miry Run.

The Assunpink drainage basin contains a wide variety of land uses. The Mercer County Water Quality Management Plan (1977) states that 32 percent of the basin is urban/suburban, with the remaining 68 percent agricultural/undeveloped. The eastern half of the basin is primarily agricultural land; with grain, vegetable and sod farming activities predominating. Although suburban development is spreading eastward, only the western third of the basin can be classified as strictly urban and suburban. Heavily developed areas include Trenton and surrounding townships. Population growth in the basin from 1970 to 1980 was generally under five percent, despite high growth potential in the eastern half of the basin.

Sanitary sewerage facilities are provided in the basin by the Borough of Roosevelt, Monmouth County and the Ewing-Lawrence Sewerage Authority (SA), Trenton SA (flows discharged to the Delaware River), and Hamilton Township Municipal Utilities Authority (sewage flows generated in the Assunpink Basin are transferred out of the basin for treatment and discharge by the Hamilton Township MUA). The Ewing-Lawrence treatment facility is the largest in the basin, discharging approximately 9 mgd on the average. This facility is currently undergoing upgrading and enlarging. Wastewater discharges in the watershed total 28; specifically, 21 industrial and 7 municipal/institutional.

Water uses in the Assunpink watershed are based heavily on the existing and on-going flood control programs being sponsored by the NJDEP, Soil Conservation Districts (Mercer and Freehold), Hamilton Township and the Counties of Mercer and Monmouth. These flood control projects, utilizing dams and stream channelization, have created numerous lakes throughout the basin that are used for secondary contact recreational activities such as fishing, boating, picnicking and aesthetics. Fish and wildlife propagation is another major benefit of the flood control program, which is expected to be completed in the early 1980's. The Assunpink Fish and Wildlife Management Area, owned and maintained by the NJDEP, is located in the upstream region of the watershed and was used by nearly 60,000 vistors in 1976 for fishing, hunting, nature education and hiking. Construction of a county recreation area in Mercer County is near completion with various water-based recreational activities planned. Trout is stocked by the NJ Division of Fish, Game and Wildlife four times yearly in the segment of the Assunpink from Route 130 bridge (Washington Township) to Carnegie Road (Hamilton Township). Assunpink Creek and tributaries also serve as a source of irrigation water for farming activities in the upstream areas of Monmouth and Mercer Counties, and industrial water (primarily cooling) downstream in Trenton.

NJ Water Quality Standards classify waters in the Assunpink watershed primarily FW-2 Nontrout with the exception of a small, two mile stretch of the central Assunpink assigned FW-2 Trout Maintenance status.

Water Quality Assessment

Conventional Parameters

The Assunpink Creek exhibits a marked decline in water quality from its rural headwaters in Monmouth County to the urban downstream segment through the City of Trenton. Water quality sampling results from the two monitoring stations on the Assunpink Creek, Clarksville in the upper Assunpink and Trenton in the urban region near the confluence with the Delaware River, indicate that the greatest degree of water quality deterioration occurs in the final two or three mile segment before the confluence with the Delaware River. Dissolved oxygen concentrations along the upstream segment ranged from sufficient to supersaturated, while D.O. levels along the downstream urban segment often fell below 6.0 mg/l during the period 1977 to 1981. D.O. saturated levels also frequently fell below 70 percent at Trenton. Except for one event during July, 1979, biochemical oxygen demand was usually higher at Trenton than at Clarksville.

Fecal coliform levels were generally acceptable in the upper region of Assunpink Creek, with only a few readings above 200 MPN/100 ml, but were frequently excessive in the urban segment where 63 percent of the values measured from 1977 to 1981 were greater than 200 MPN/100 ml. One extreme value (160,000 MPN/100 ml), which occurred in October, 1978 at the Trenton station, far surpassed any other values obtained during the period.

The pH values of both the rural and urban segments of Assunpink Creek fluctuated from slightly acidic to slightly alkaline, with the highest alkaline values occuring downstream. The lowest pH values were found in the upstream region.

Ammonia and un-ionized ammonia levels in the upstream region of Assunpink Creek, with the exception of September, 1979 values, remained relatively constant. Un-ionized ammonia was always well below water quality criteria. Nitrite + nitrate data, although sporadic, was generally under 2.0 mg/l at all times. Ammonia and un-ionized ammonia levels in the downstream urban reach did not show the relative consistency of concentrations exhibited further upstream at Clarksville. However, no contravention of standards were observed during the period for un-ionized ammonia.

Total phosphorus standards were contravened on a few occasions during the period in the rural reaches, but were consistently excessive throughout the period at Trenton. On three occasions, the phosphorus values were nearly ten times the standard of 0.1 mg/l. Suspended solids levels were slightly excessive on a few occasions at Trenton, but were all within the standard.

Biological data collected at Trenton in 1977 and 1979 reiterate the poor water quality in the urban region of Assunpink Creek. The macroinvertebrate community reflected stress conditions, with samples being comprised predominantly of individuals from two species of oligochaete worms (Nais josinae and Dero obtusa). In 1977 and 1979 oligochaetes represented 90 and 61 percent of the total number of individuals recovered, respectively. Mean periphyton chlorophyll a values showed extreme variations during the period from 1977 (30.7 mg/m^2) to 1979 (0.9 mg/m^2). The 1977 level suggested a highly enriched condition at Trenton. The abundant periphyton genera in 1977 and 1978 were Schizomeris and Eunotia.

Water quality in the Assunpink watershed is generally similar to conditions described in earlier 305(b) reports. From 1973 to 1981 there has been some increase in acidity (lower pH) and dissolved oxygen at Trenton and reduced total phosphorus in the creek at Clarksville.

Toxic Parameters

Samples taken from the Assunpink Creek at Monmouth Place had moderate levels of an organic solvent. In addition to this site, samples were taken from the Assunpink at Trenton and Carson's Mills. In each case there was no toxic contamination detected. The Assunpink at Trenton, however, is severely impacted from urban runoff according to conventional quality analyses, and should therefore be studied more intensely with regard to toxic contamination.

As part of a 1979 pesticide survey, fish samples were collected along the Assunpink Creek at Quakerbridge Road. Several species of fish including the American eel, Anguilla rostrata, and white sucker, Catostomos commersoni, were analyzed for chlordane content. Results of these examinations produced only trace levels of this contaminant in edible portions of fish tissue. Sediment analyses from the same locations indicated non-detectable levels for various organochlorine pesticides and PCB Arochlor 1254.

Further sampling would be necessary to determine if a pattern of pesticide and PCB content in aquatic organisms exists in the more urban and suburban areas of this basin.

Problem Assessment

Water quality in the upper Assunpink watershed is generally good, although there is concern for periodic high fecal coliform and total phosphorus concentrations. The origin of these pollution problems appears to be on-site systems (fecal coliform) and runoff from agricultural lands (nutrients). In addition, the Roosevelt Borough STP, which discharges to the Assunpink in its headwaters area, is not meeting the secondary treatment levels assigned to it for BOD_5 and suspended solids. Nutrients from these sources may have their most severe impacts in the many impoundments found on the Assunpink and tributaries. According to the Mercer County WQM Plan there are two small, closed landfills in Hamilton and Lawrence Townships which may be contributing pollution to Assunpink Creek.

The lower Assunpink contains poor quality because of exceedingly high levels of fecal coliform, nutrients and oxygen demanding substances, and at various times low dissolved oxygen. The causes for this include the numerous and significant point sources present and the urban runoff that drains into the creek and its tributaries. A regional treatment plant discharges nearly 9 mgd on the average to the Assunpink as it enters Trenton. The plant is currently undergoing modification and enlarging so that it can meet advanced treatment requirements (scheduled for completion in mid-1982). Downstream on the Assunpink an industrial facility intakes a significant portion of the creek's low flows for industrial cooling purposes. This cooling water is then discharged back into the stream under jurisdiction of a NJPDES permit. Any increase in stream temperature that may result from this discharge will also cause depletion in dissolved oxygen concentrations.

Urban runoff from Trenton and surrounding localities also has a large impact on water quality in the Assunpink. This runoff traditionally carries high concentrations of bacteria, nutrients, oxygen demanding substances, metals and hydrocarbons into receiving streams. In the lower reaches of Assunpink Creek much of the combined sewer overflows have recently been diverted to the Trenton City STP for storage and treatment. This has eliminated the potential for raw sewage to enter the Assunpink during most storms.

The watershed's impoundments are constantly being subjected to excessive nutrients from their upstream sources. The lower watershed, especially Whitehead Pond, has problems with undesirable algal growth and emergent aquatic weeds.

Goal Assessment and Recommendations

The waters of the Assunpink watershed are considered to be marginally swimmable in the upper portions and not swimmable downstream from the Clarksville area. It is doubtful that the lower Assunpink and tributaries can be improved to swimmable status because of the significant point and non-point source impacts to the creek. Fishable status for the creek and its tributaries can be assigned for the segment from the dam at Whitehead Pond upstream. The 18 fish species identified in the watershed were generally indicative of shallow waters with sandy bottoms and vegetation. For a small section of the Assunpink, water quality and conditions are such that it can be classified as trout maintenance. Downstream of Whitehead Pond Dam, point sources (primarily industrial cooling water) and stormwater runoff make the Assunpink primarily unsuitable to maintain a balanced fish community.

Improvements to water quality in the upper watershed can be made if the Roosevelt Borough treatment plant is upgraded and treatment efficiency maintained, septic problems eliminated, and agricultural best management practices instituted on the vegetable, grain and sod farms present. Improvements to the Assunpink below Whitehead Pond will result only with costly runoff control practices, reduction of the significant nutrient loadings from current discharges and if the present facility utilizing the creek for cooling water finds an alternate source of cooling water. Dredging and lake management practices are recommended for Whitehead Pond.

ASSUNPINK CREEK STATION LIST

A. Ambient Monitoring Stations

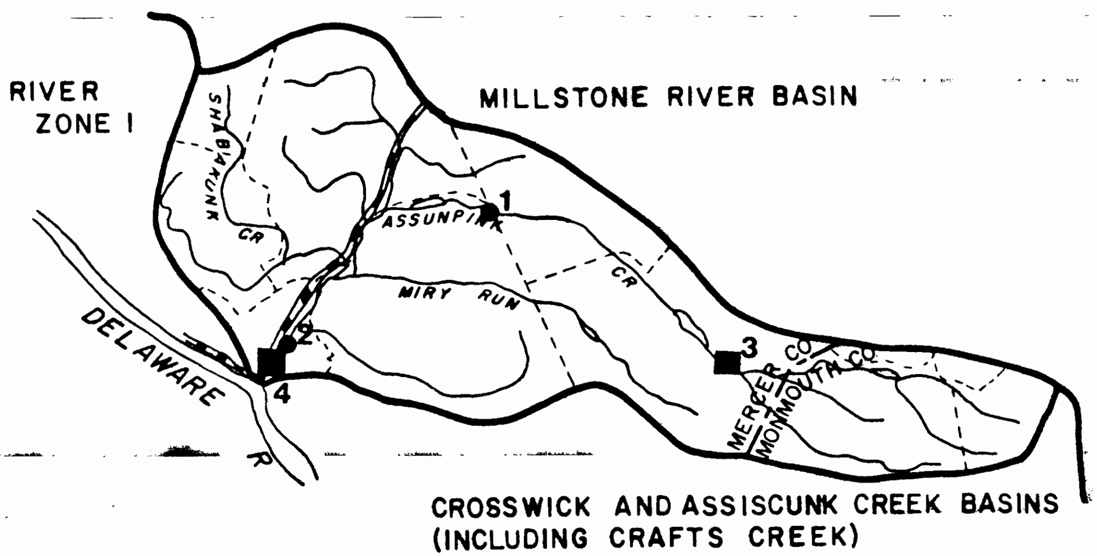
STORET Number	Station Description	Map Number
01463620	Assunpink Creek near Clarksville, Mercer County Latitude 40°16'11" Longitude 74°40'20" 200 feet upstream from bridge on Quakerbridge Road, 1.9 miles (3.1 km) south of Clarksville, and 7.6 miles (12.2 km) upstream of confluence with Delaware River.	1
01464000	Assunpink Creek at Trenton, Mercer County Latitude 40°13'27" Longitude 74°44'58" Upstream side of Monmouth Street bridge 1.5 mile (2.4 km) upstream of confluence with Delaware River.	2

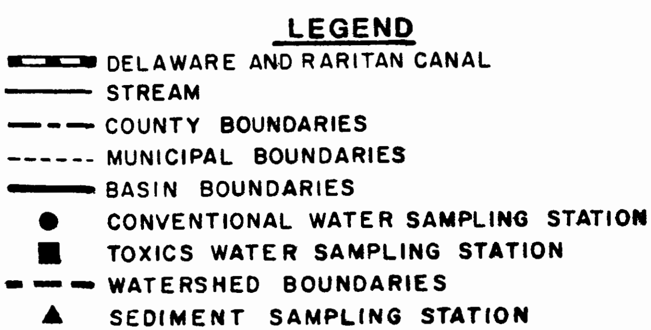
B. Toxics Monitoring Stations

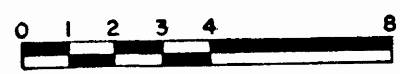
Station Location	Sampling Regime	Map Number
Assunpink Creek at Carsons Mill	Water column	3
Assunpink Creek at Trenton	Water column	4

ASSUNPINK CREEK BASIN

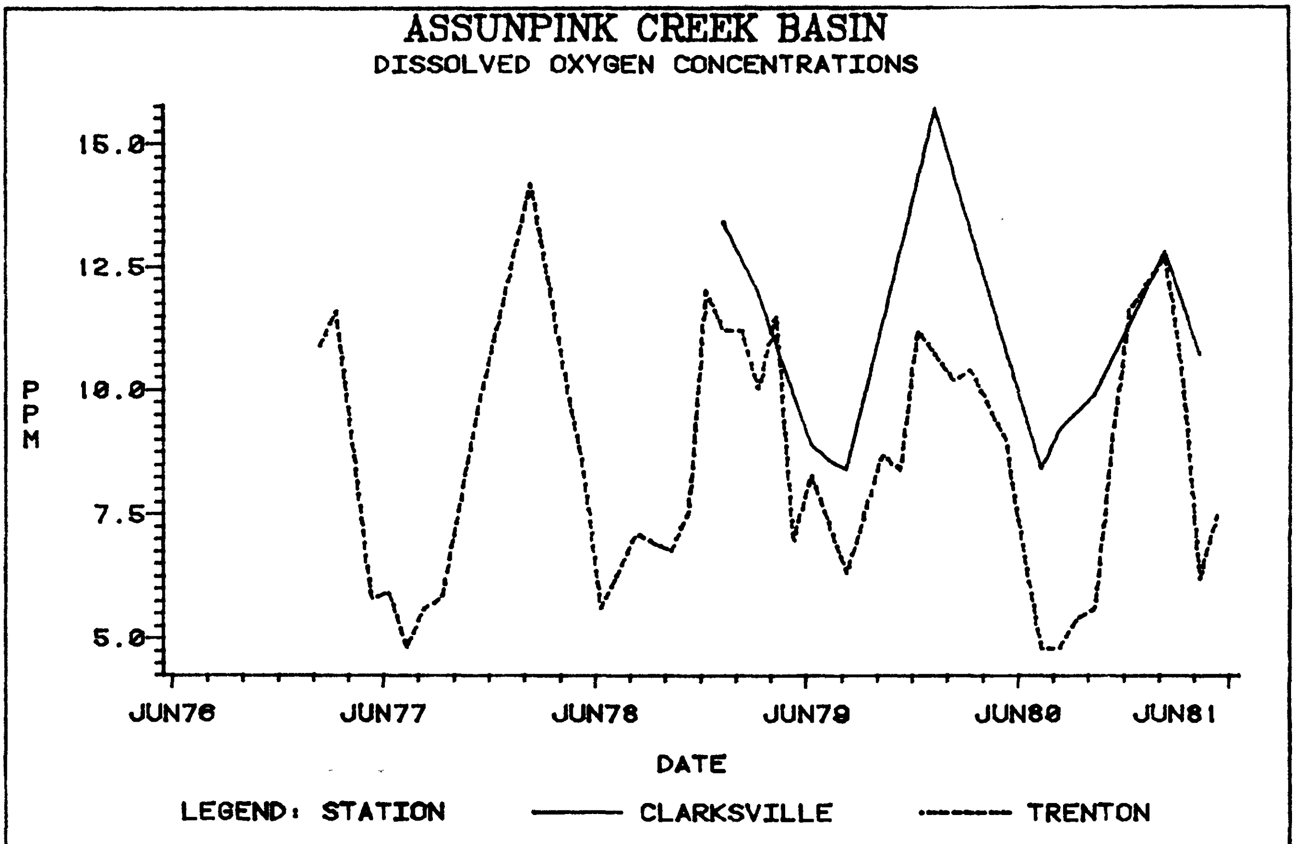
NEW JERSEY STATE WATER QUALITY
INVENTORY REPORT
1982







LOCATION OF BASIN



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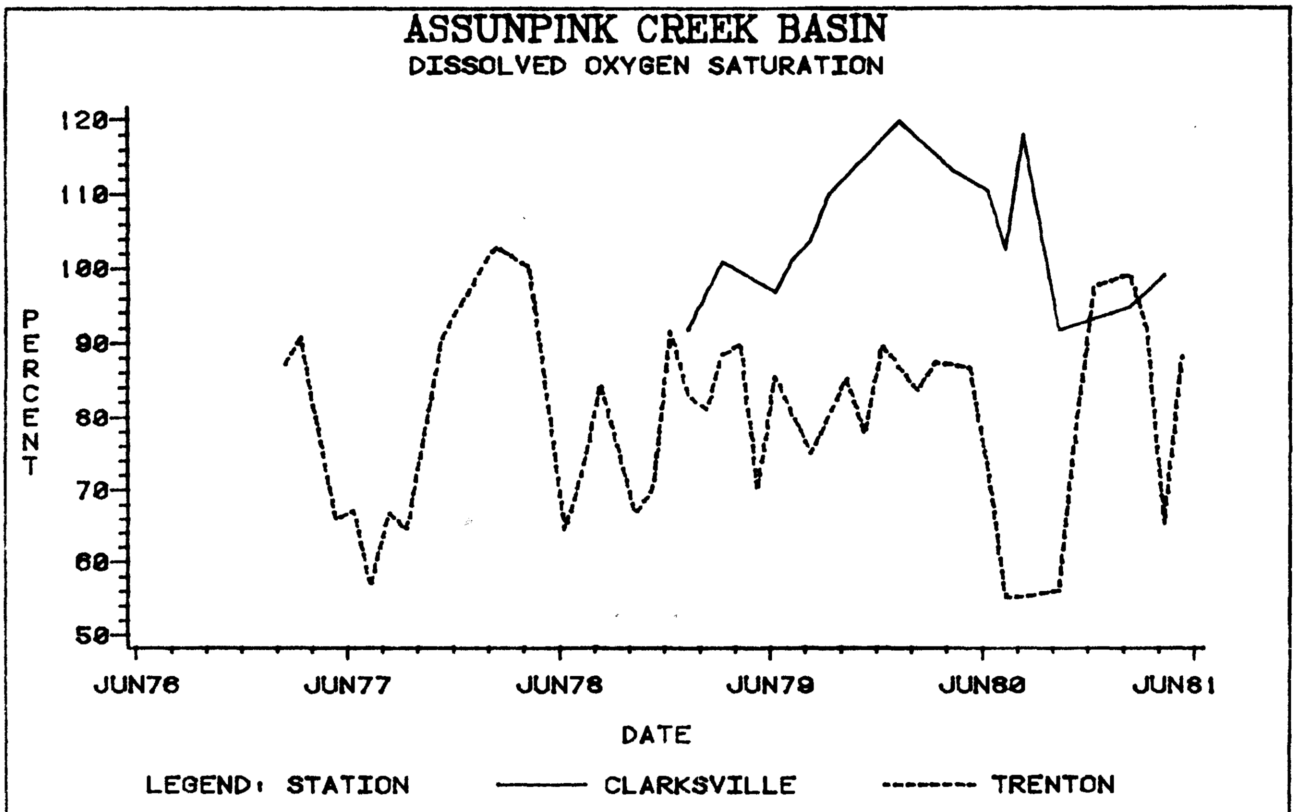

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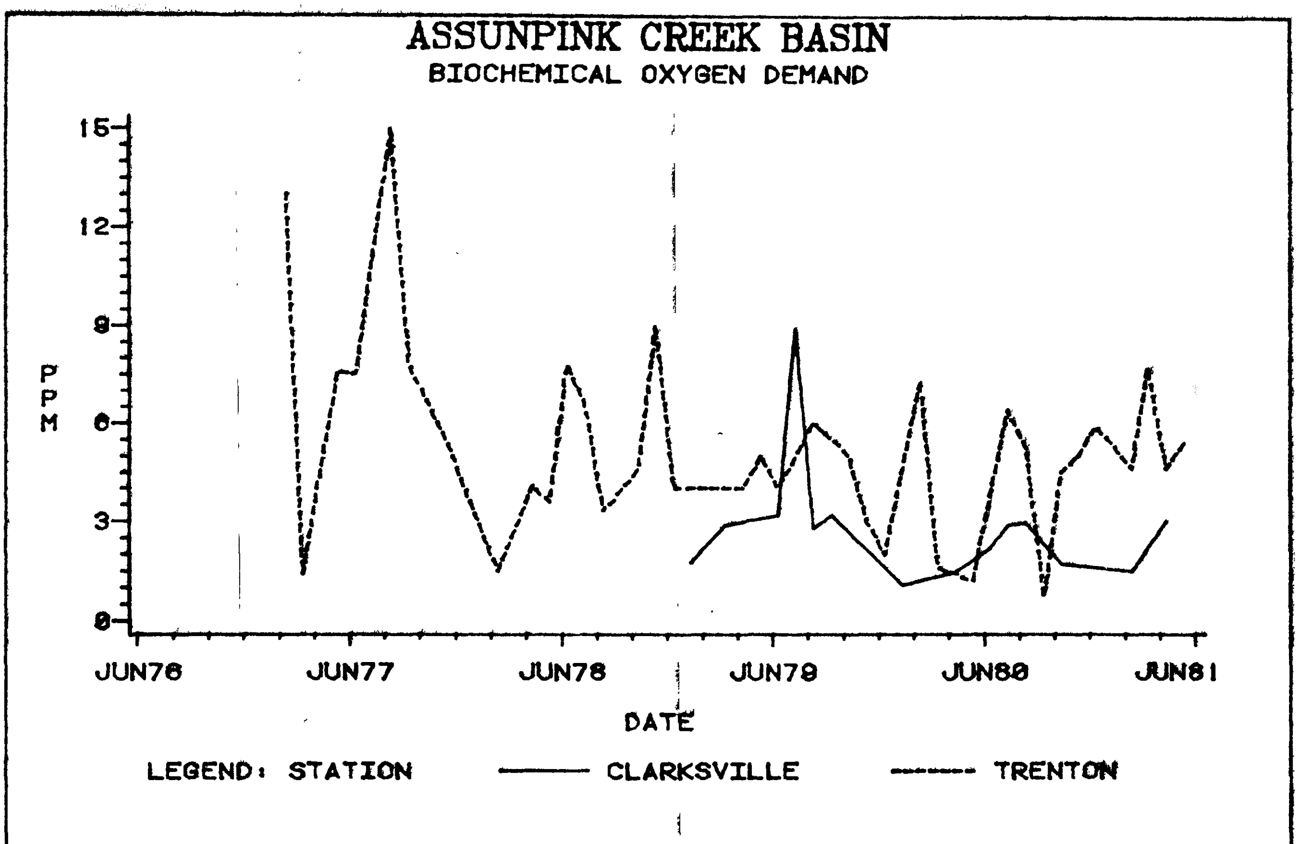

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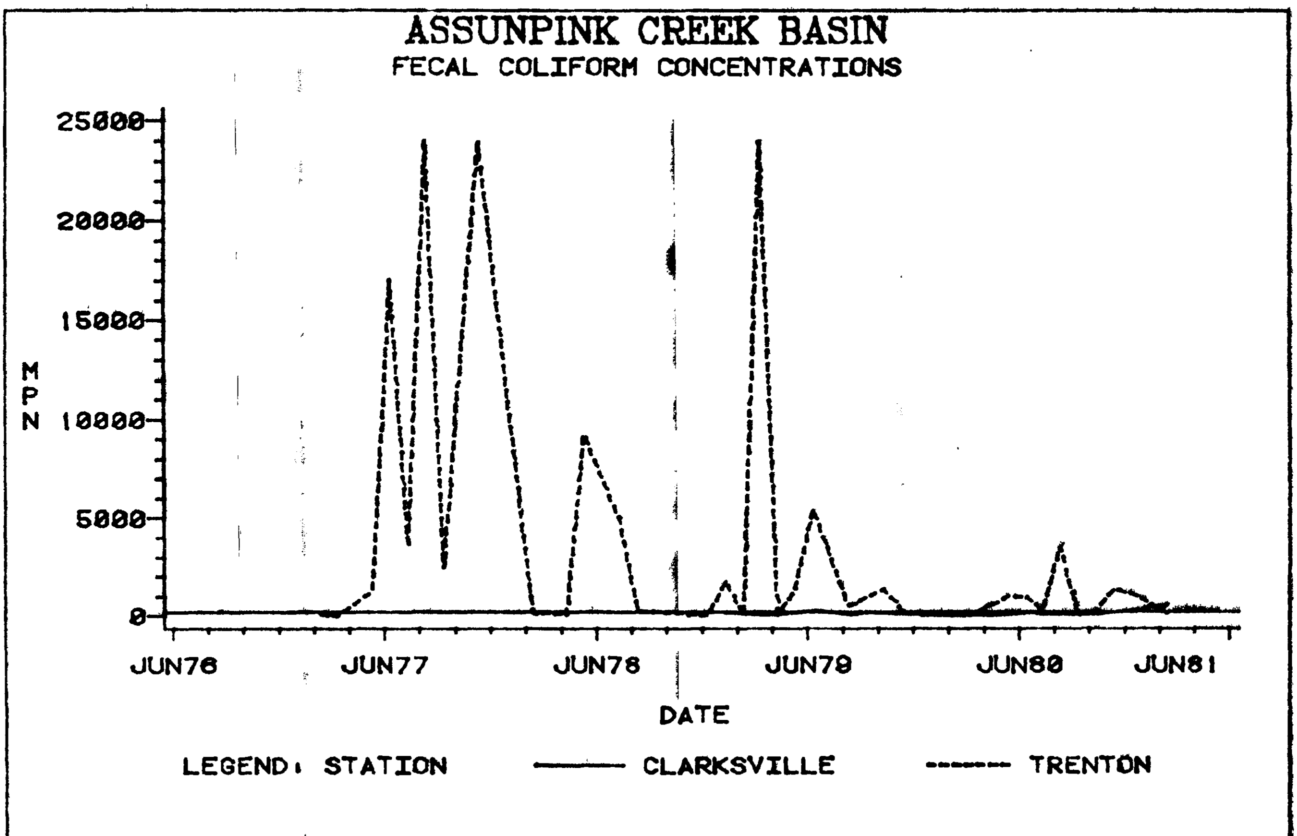

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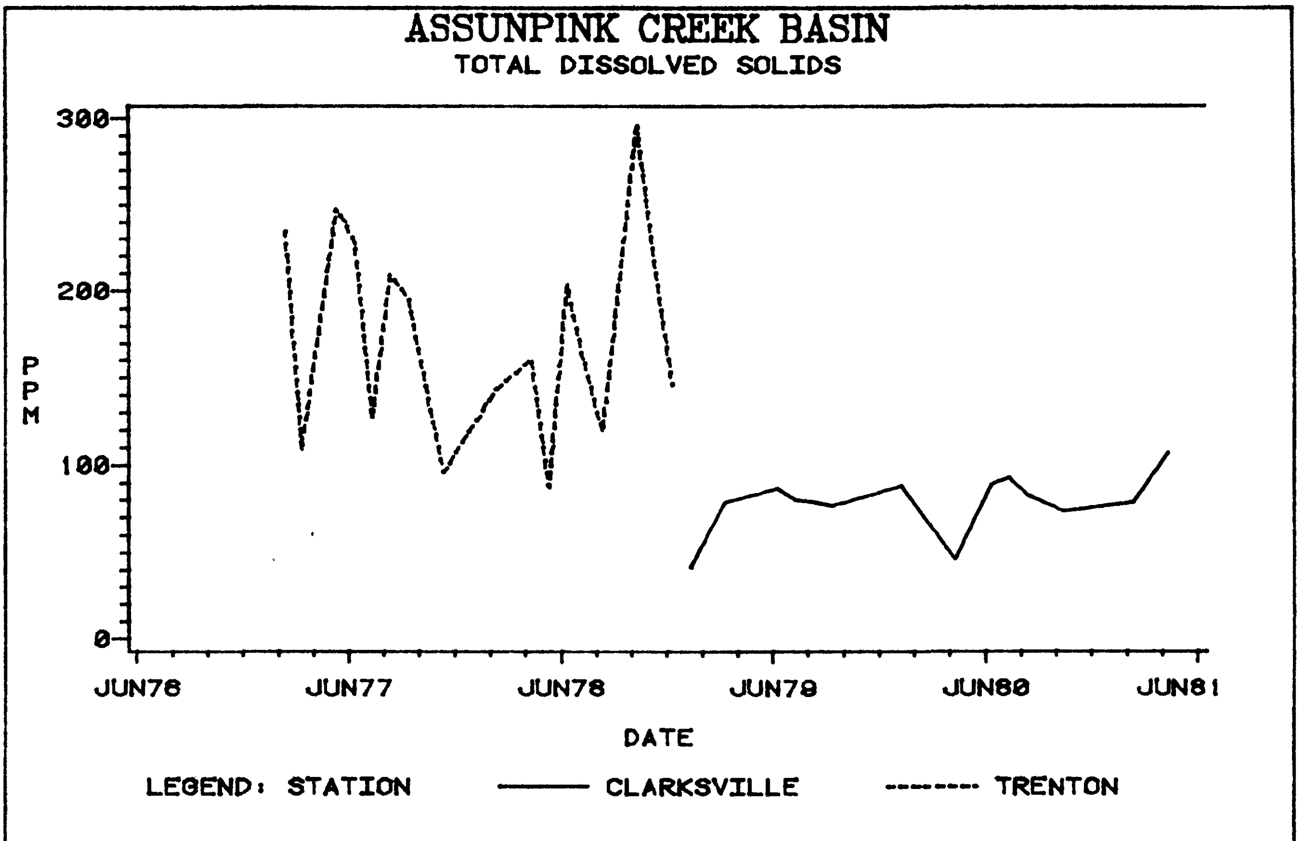

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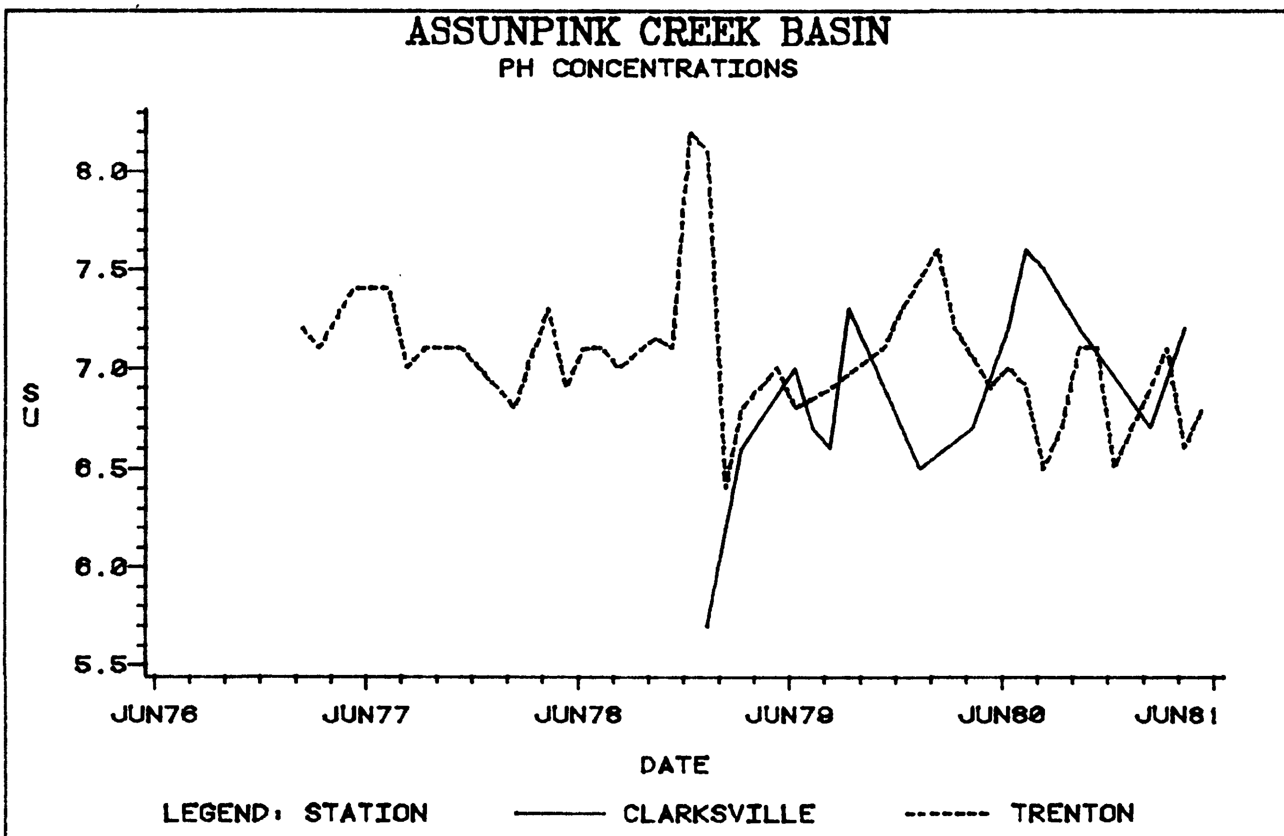

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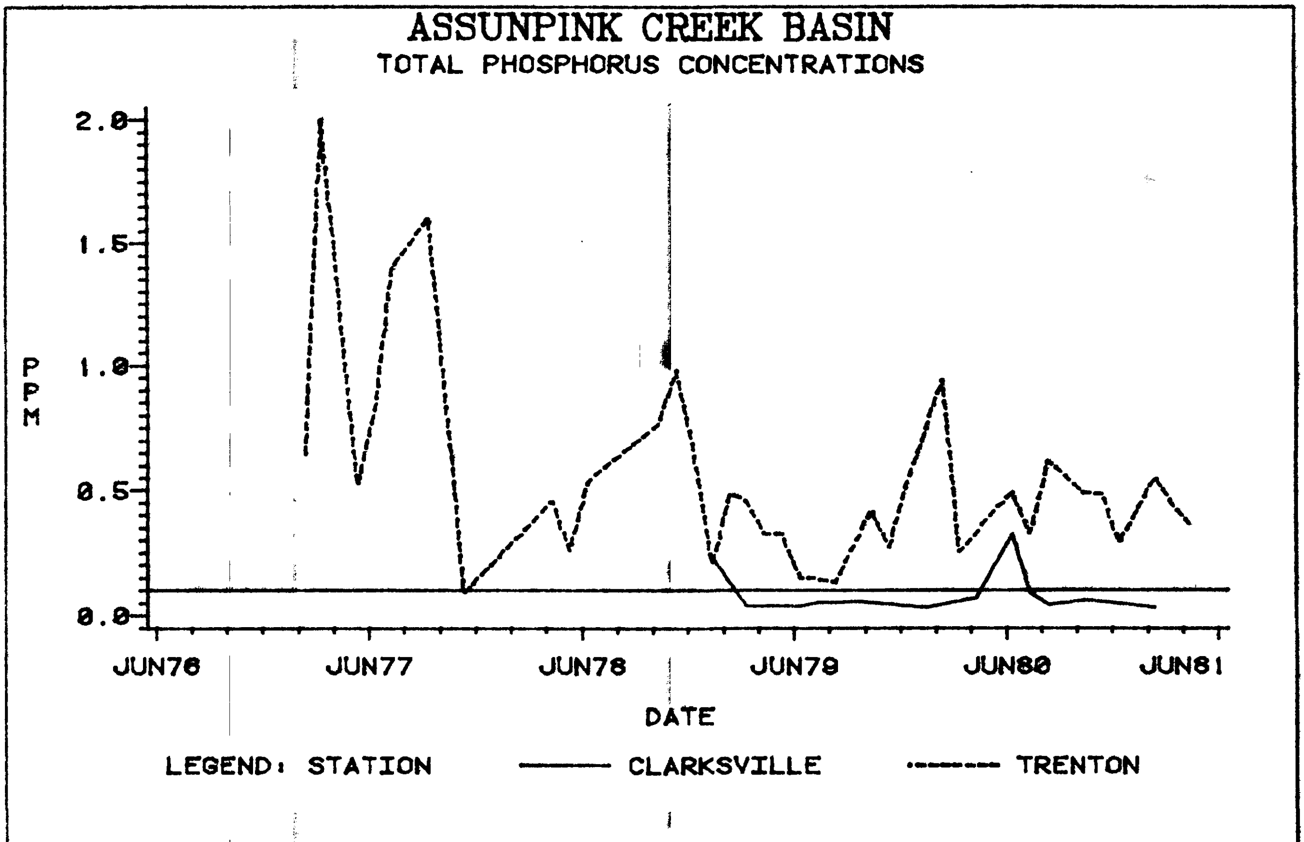

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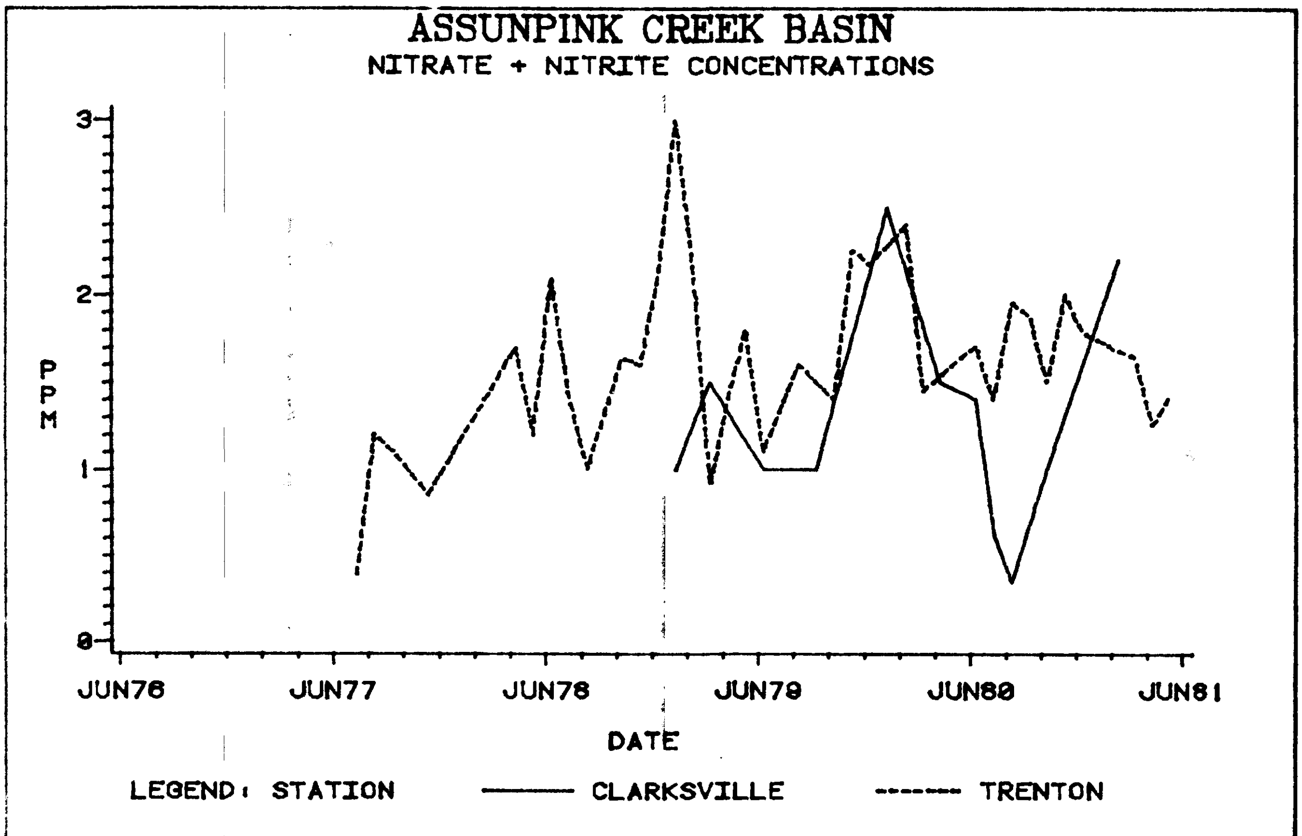

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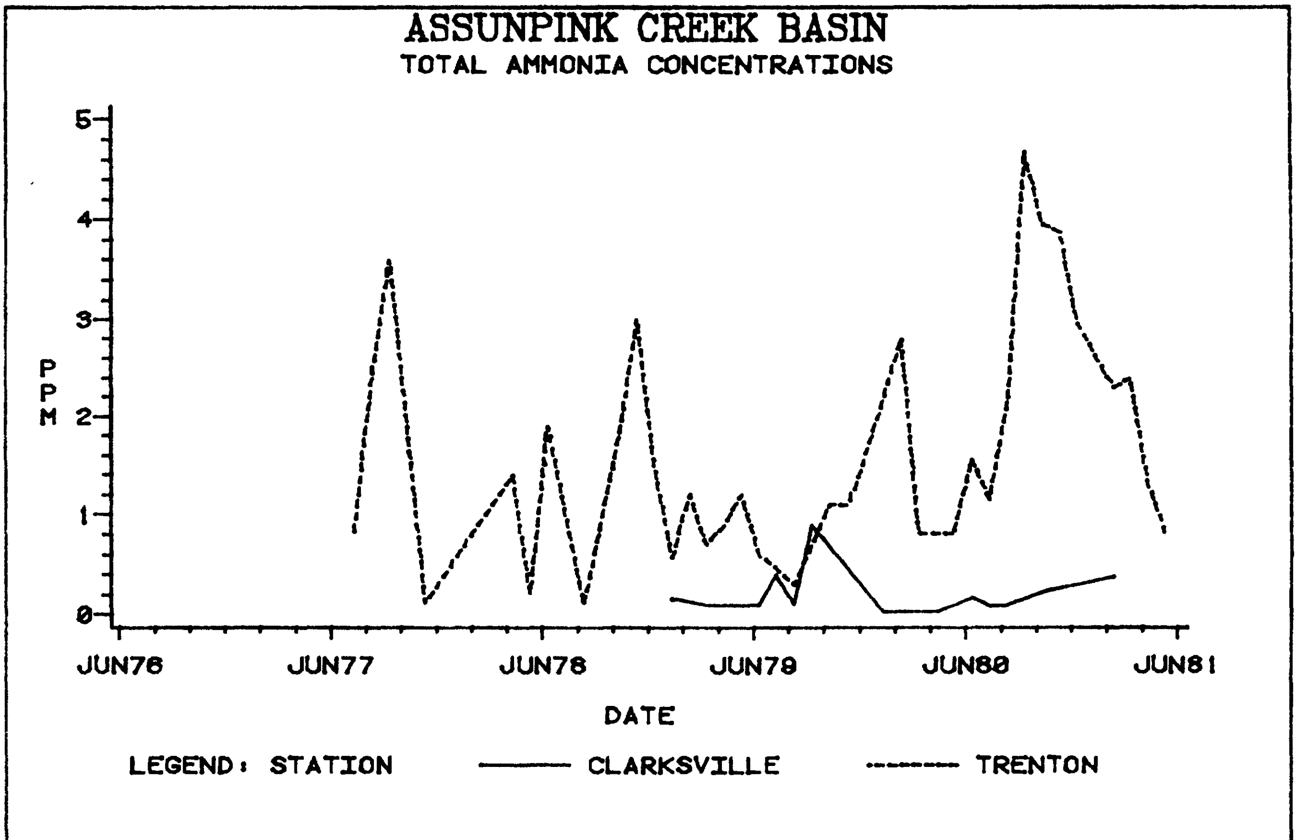

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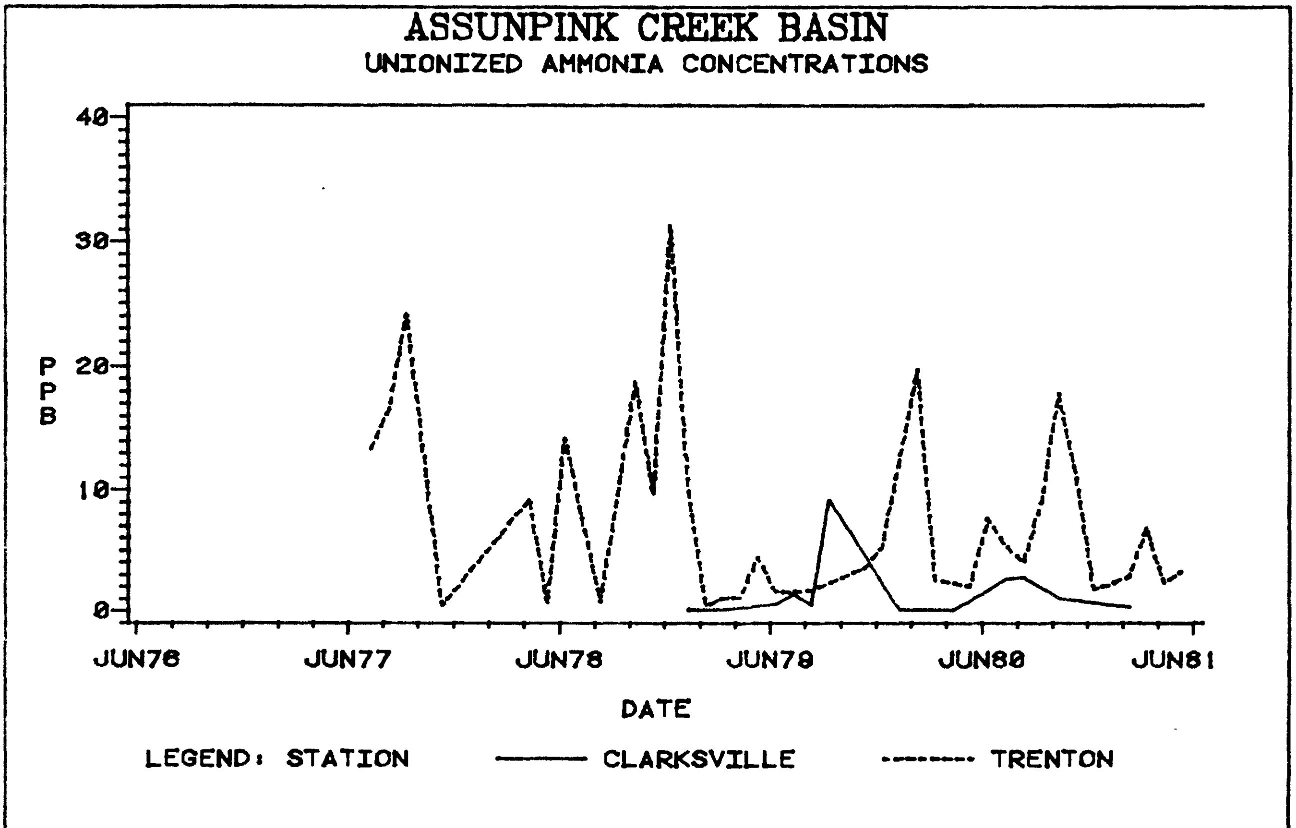


Figure: F -10

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
TOWNSHIP OF WEST WINDSOR	0022551	WEST WINDSOR TWP	BRIDEGROOM RUN	SANITARY	
CONGOLEUM IND. INC.	0004537	HAMILTON /TWP/	MIRY RUN	COOLING WATER	.30
SHARON ARMS APARTMENTS	0031461	WASHINGTON TWP	MIRY RUN	SANITARY	
MORRIS WHEELER & CO INC	0034100	TRENTON	STORM SEWER TO SHABAKUNK CREEK	COOLING WATER	
ARCTIC PRODUCTS CO INC	0032824	TRENTON	SHABAKUNK RIVER	PROCESS & COOL.	
WESTINGHOUSE ELECTRIC CORP	0034274	EWING TOWNSHIP	SHABAKUNK CREEK	PROCESS WASTE	
NASSAU CHEMICAL CORP	0032786	TRENTON	SHABAKUNK CREEK	COOLING WATER	.01
TRENTON STATE COLLEGE	0032981	TRENTON	SHABAKUNK CREEK		.01
AMERICAN CYANAMID CO	0005541	WEST WINDSOR TWP	ASSUMPINK CR	COOLING WATER	
TRANSAMERICA DELAVAL INC	0032891	HAMILTON TWP	ASSUMPINK CREEK	COOLING WATER	
AMERICAN BILTRITE INC	0031895	TRENTON	ASSUMPINK CREEK	COOLING WATER	.16
GENERAL ELECTRIC CO	0032832	TRENTON	ASSUMPINK CREEK	COOLING WATER	
EWING-LAWRENCE S.A.	0024759	LAWRENCE TWP	ASSUNPINK CR.	SANITARY	8.8
STOKES MOLDED PROD.	0032875		ASSUNPINK CREEK		
DE LAVAL TURBINE INC	0004677	HAMILTON TWP	ASSUNPINK CREEK		
GOODALL RUBBER CO	0004626	HAMILTON TWP	ASSUNPINK CREEK	COOLING WATER	.23
SATURN CHEMICAL INC	0027600	LAWRENCE TWP	ASSUNPINK CREEK	COOLING WATER	
HYDROCARBON RESEARCH INC	0032913	LAWRENCEVILLE	ASSUNPINK CREEK		.18
BOROUGH OF ROOSEVELT	0022918	ROOSEVELT	ASSUNPINK CREEK	SANITARY	
NATIONAL SPONGE CUSHION CO.	0032999	TRENTON	ASSUNPINK CREEK		
WENCZEL TILE CO	0033278	TRENTON	ASSUNPINK CREEK		
YOUNGS RUBBER CORPORATION	0031429	TRENTON	ASSUNPINK CREEK	COOLING WATER	
BOROUGH OF ROOSEVELT	0032476	ROOSEVELT	ASSUNPINK CREEK	SANITARY	.20
DIAMOND SHAMROCK CO.	0004502	LAWRENCE TWP	SAND RUN CREEK	COOLING WATER	.28
STERLING DRUG INC	0032255	TRENTON	POND RUN		
MERCER MOBILE HOMES	0026395	WASHINGTON TWP	EDGEWOOD CREEK	SANITARY	.02
FEDERATED METALS CORPORATION	0020664	TRENTON	DELAWARE BASIN		
E R SQUIBB & SON INC	0027618	PRINCETON TWP	SHIPTAUKEN CREEK	COOLING WATER	

G. CROSSWICKS AND ASSISCUNK CREEKS

Basin Description

Crosswicks Creek and Assiscunk Creek are tributaries to the Delaware River in south-central New Jersey, draining 146 and approximately 50 square miles, respectively. Crosswicks Creek originates in northwestern Ocean County, with the watershed located in portions of northeastern Burlington County, northwestern Ocean County, western Monmouth County and southern Mercer County. Major tributaries to Crosswicks Creek include Jumping Brook, North Run, Lahaway Creek, Doctors Creek and Back Edges Brook. Crosswicks Creek, which is tidal from the Delaware River to Crosswicks Mill Dam, has an average flow of 136 cfs at Extonville (83.6 square mile drainage area). Assiscunk Creek originates and flows through central Burlington County for approximately 6 miles before its confluence with the Delaware River at Burlington City. Barker's Brook joins Assiscunk Creek in Springfield Township and serves as its major tributary.

The Crosswicks Creek watershed incorporates a variety of land uses with agriculture comprising the majority (55%) of the basin according to the Mercer County Water Quality Management Plan (1977). Forested (29%) and developed (16%) areas make up the remainder of the watershed. Land uses are predominately forest and agriculture upstream in Ocean and Burlington Counties, becoming intensively farmed in Monmouth County. Urban/suburban development occurs basically in the Yardville (Mercer County) - Bordentown (Burlington County) region. Agricultural activities in the Crosswicks Creek watershed are varied and include farming for potatoes, corn, hay, soybeans, wheat, beef cattle, chickens and nursery plant stock. Residential and commercial growth is occurring in the area of Chesterfield and Hamilton Townships; but population increases for this area (and the watershed in general) from 1970 to 1980 was minor in some areas and non-existent in others.

Municipal sewage facilities are present in various sections of the Crosswicks Creek watershed. The Allentown Sewerage Treatment Plant (STP) in Monmouth County provides service for Allentown and immediately adjacent areas, (has a .24 mgd discharge to Doctors Creek); the Hamilton Township plant treats sewage from most of the township, (including portions of the township in the Assunpink Creek watershed), and discharges 8.3 mgd to Crosswicks Creek near the Delaware River; the Wrightstown MUA treats sewage from Wrightstown and discharges .11 mgd to North Run; and Bordentown Township serves portions of the township with a .47 mgd facility discharging to Crosswicks Creek. The Hamilton Township treatment plant was recently upgraded to a design capacity of 16 mgd with secondary treatment, which has eliminated the Yardville/Groveville STP discharge. There are a total of 18 dischargers to Crosswicks Creek and tributaries, the largest being the Hamilton Township treatment plant. 201 facilities planning areas cover the entire watershed with the exception of portions of Upper Freehold Township, Monmouth County.

Crosswicks Creek and tributaries (most notably Doctors Creek) are an important source of irrigation water for farms in the watershed. Approximately 20 farms in the Crosswicks watershed have state water diversion permits for surface water intakes. Other existing water uses are primarily recreational. Imlaystown Lake and Allentown Lake in Monmouth County and Oakford Lake in Ocean County allow both boating and fishing activities. The Prospertown Lake Wildlife Management Area permits non-motorized boating, fishing and bathing. In addition, Prospertown Lake is the only water body in the Crosswicks Creek watershed stocked with trout by the NJ Division of Fish, Game and Wildlife. Other scattered lakes are found in the watershed.

The Assiscunk Creek watershed is predominately agricultural with development occurring in and around Burlington City. Industrial facilities are located in Burlington City along the Delaware River and tidal portions of Assiscunk Creek. There was little or no population growth in the watershed from 1970 to 1980. Development pressure is greatest in the southern portions of the watershed due to increased growth of the Mt. Holly area. Five point sources have been identified in the Assiscunk Creek basin, 3 industrial and 2 municipal/institutional. Only a small area of the Assiscunk Creek basin is sewered, the City of Burlington and sections of adjacent Burlington Township. Burlington Township's LaGorce treatment plant discharges approximately .2 mgd, to Assiscunk Creek. Only about 60 percent of the Assiscunk Creek watershed is located within an existing 201 facilities planning area, as all of Springfield Township is undesignated.

Access for fishing, which occurs primarily in the tidal sections of Assiscunk Creek, includes beaches, bulkheads and docks in Burlington City. Burlington Township is in the process of developing a 235 acre park on Assiscunk Creek just upstream from Burlington City. No other surface water activities or uses were identified in the Assiscunk Creek basin.

Crosswicks Creek and tributaries have been given the following classifications in the NJ Water Quality Standards: FW-1 for headwaters of Lahaway Creek located within the boundaries of Colliers Mill Wildlife Management Area; and FW-2 Nontrout for the remainder of the watershed. Assiscunk Creek and tributaries are classified entirely as FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

Excessive fecal coliform and total phosphorus concentrations are causative factors for marginal water quality in the Crosswicks and Assiscunk Creeks watersheds, particularly in the increasingly urbanized downstream sections. This conclusion is based upon water quality sampling in Crosswicks Creek at Extonville and Groveville, and in Assiscunk Creek near Burlington City.

Crosswicks Creek exhibited generally sufficient dissolved oxygen concentrations for the period in well-defined annual cycles at both stations. Dissolved oxygen saturation levels were also adequate at each location, accompanied by moderate biochemical oxygen demand levels. Similar dissolved oxygen data and seasonal variations were exhibited at the Assiscunk Creek station. Biochemical oxygen demand in Assiscunk Creek, however, was slightly lower than at either station on Crosswicks Creek, as concentrations were consistently below 3.0 mg/l throughout the five year period.

Fecal coliform concentrations were a severe problem on the downstream segment of Crosswicks Creek as nearly 50 percent of the samples collected from 1977 to 1981 exceeded 1,000 MPN/100 ml (60 percent exceeded 200 MPN/100 ml). A less severe problem existed at the upstream station (Extonville), where the majority of contravening results were less than 1,000 MPN/100 ml, but 52 percent were still above 200 MPN/100 ml. The downstream segment of Assiscunk Creek also exhibited a serious fecal coliform problem as just over 40 percent of the data exceeded the 1,000 MPN/100 ml concentration and 71 percent exceeded 200 MPN/100ml. A pattern of alternating low and excessively high fecal coliform concentrations was exhibited at each station on Crosswicks and Assiscunk Creeks, possibly illustrating the effects of non-point contributions to stream flow.

Total dissolved solids concentrations were well below the standard of 500 mg/l and exhibited minor fluctuations throughout the period in both streams. Crosswicks Creek exhibited a very slight decline of pH values from 1977 to 1979, followed by a slight increase in 1980-81. Assiscunk Creek pH values remained generally neutral over the entire period.

Total phosphorus concentrations exhibited notable increases during the summer months in Crosswicks and Assiscunk Creeks. More than 90 percent of the data for total phosphorus at Extonville and Groveville exceeded the 0.10 mg/l standard for streams. Total phosphorus concentrations in Assiscunk Creek contravened the standard only during the summer months. In contrast, nitrate + nitrite values showed no well defined seasonal variations and generally ranged between 0.5 - 1.5 mg/l at all three stations. Total and un-ionized ammonia concentrations also exhibited no definitive trend, as un-ionized ammonia concentrations were generally well within the applicable criteria.

Biomonitoring activities were not conducted on either stream in this segment during 1977-1981.

Water quality conditions in these two watersheds have shown no significant improvements from earlier 305(b) reports. However, there have been increases in dissolved oxygen levels for both streams, as the DO standard is now only periodically violated. In addition, BOD_5 concentrations are somewhat lower than what was reported in the mid-1970s.

Toxic Parameters

Crosswicks Creek was sampled in Groveville and New Egypt. In both cases the results were free of toxic contamination. The Assiscunk Creek was sampled at Neck Road in Burlington. This site was also found to be free of toxic contamination. This basin should be studied further near sewage treatment plants to assess the impacts of the discharges on the waterways.

Sediment and fish tissue samples were collected in 1980 along Crosswicks Creek at Bordentown. Samples included several bottom feeding species, carp, Cyprinus carpio, and white catfish, Ictalurus catus; a forage species golden shiner, Notemigonus crysoleucas, and white perch, Morone americana. Tissue samples revealed levels which ranged from below detection to trace amounts of several pesticides and PCB Arochlor 1254. Sediment analyses provided no detectable amounts of these same parameters.

Levels of these specific parameters did not exceed the established or proposed action or tolerance levels developed by the Food and Drug Administration (FDA) for pesticides and PCB residues in fish tissue utilized for human consumption. These levels are also consistent with similar values found in fish tissue for other suburban development areas around the state.

Expansion of the data base through additional sampling will identify background contaminant levels for comparative analyses.

Problem Assessment

The water quality problems identified in the Crosswicks and Assiscunk watersheds appear to be due to both point and non-point sources. The excessive concentrations of fecal coliform and nutrients (primarily total phosphorus), and periodic low dissolved oxygen levels, are most severe in the downstream sections of both watersheds. The upper Crosswicks Creek receives municipal/institutional effluent from Fort Dix as well as from a number of smaller discharges which together exceed the assimilative capacity of the stream for nutrients. Extensive farming activities throughout the Crosswicks watershed must also be a source of nutrients, while fecal coliform originates from poor quality discharges, on-site disposal systems and the scattered livestock operations present. Doctors Creek drains agricultural lands that are known to contribute nutrients. One point source on Doctors Creek (Yardville-Groveville STP) has been eliminated due to regionalization.

The portions of Crosswicks watershed in Ocean County have been sampled and evaluated by the Ocean County Health Department. This watershed had the poorest quality waters of all streams in the county from 1977 to mid-1978.

The lower Crosswicks Creek flows through a large freshwater tidal marsh before it enters the Delaware River. Although sampling has not been conducted throughout the marsh, stress conditions due to low dissolved oxygen concentrations must occur because of the point sources that contribute to the creek upstream of the marsh. In addition, runoff from the developed Bordentown area must also contribute oxygen demanding loads to the creek.

Allentown and Imlaystown Lakes on Doctors Creek have undergone intensive surveys by DWR's Lake Management Program. Both were classified as eutrophic, with Allentown considered accelerated eutrophic. The lakes receive excessive nutrients and sediments from agricultural runoff in the watershed. Allentown Lake is likely to be restored in the near future. This will be accomplished through dredging and agricultural runoff controls in the watershed.

Assiscunk Creek quality is influenced by the same factors that affect Crosswicks Creek. There are point source contributions to the creek, but agricultural runoff and failing on-site systems appear to have the greatest impact on the Assiscunk.

Goal Assessment and Recommendations

Both the Crosswicks Creek and Assiscunk Creek watersheds can be classified as not swimmable because of excessive fecal coliform levels throughout (Doctors Creek was noted in earlier 305(b) reports as being swimmable but there has been no additional water quality data collected which can be used to support this classification). The waters can be considered, however, as fishable; although low dissolved oxygen concentration periodically may cause stressful conditions for fish life. The 18 fish species found in Crosswicks Creek and 20 in the Assiscunk are indicative of shallow, slow moving and weedy water bodies. Both are spawning waters for yellow perch, while Crosswicks Creek and tributaries support blueback herring and alewife spawning grounds.

Various water quality management activities are needed for improved conditions in these streams. In the upper Crosswicks, either improvements at the treatment plants used by Fort Dix and McGuire Air Force Base or the possibility of transfer of flows to the Northern Burlington County Regional Sewerage Authority (NBCRSA) should be instituted. In addition, studies are needed in the southern area of the NBCRSA to determine the best alternative for treating sewage generated in the study area.

Agricultural best management practices are required in the Doctors Creek watershed above Allentown, especially if lake restoration occurs in Allentown Lake. Downstream on Crosswicks Creek, the Bordentown City and Mile Hollow STPs are at capacity or overloaded and are under sewer extension bans. Correction of this problem and the poor quality effluent from Bordentown City are needed. Reduction of oxygen demanding substances and nutrients is especially critical in the lower watershed because of the large fresh tidal marsh present and the low dissolved oxygen levels periodically found. Also, increased water quality studies should be performed in this marsh.

In the Assiscunk watershed, correction of on-site system problems is the greatest need. Agricultural pollution should be evaluated in more detail to determine the specific sources.

CROSSWICKS AND ASSISCUNK CREEKS STATION LIST

A. Ambient Monitoring Stations

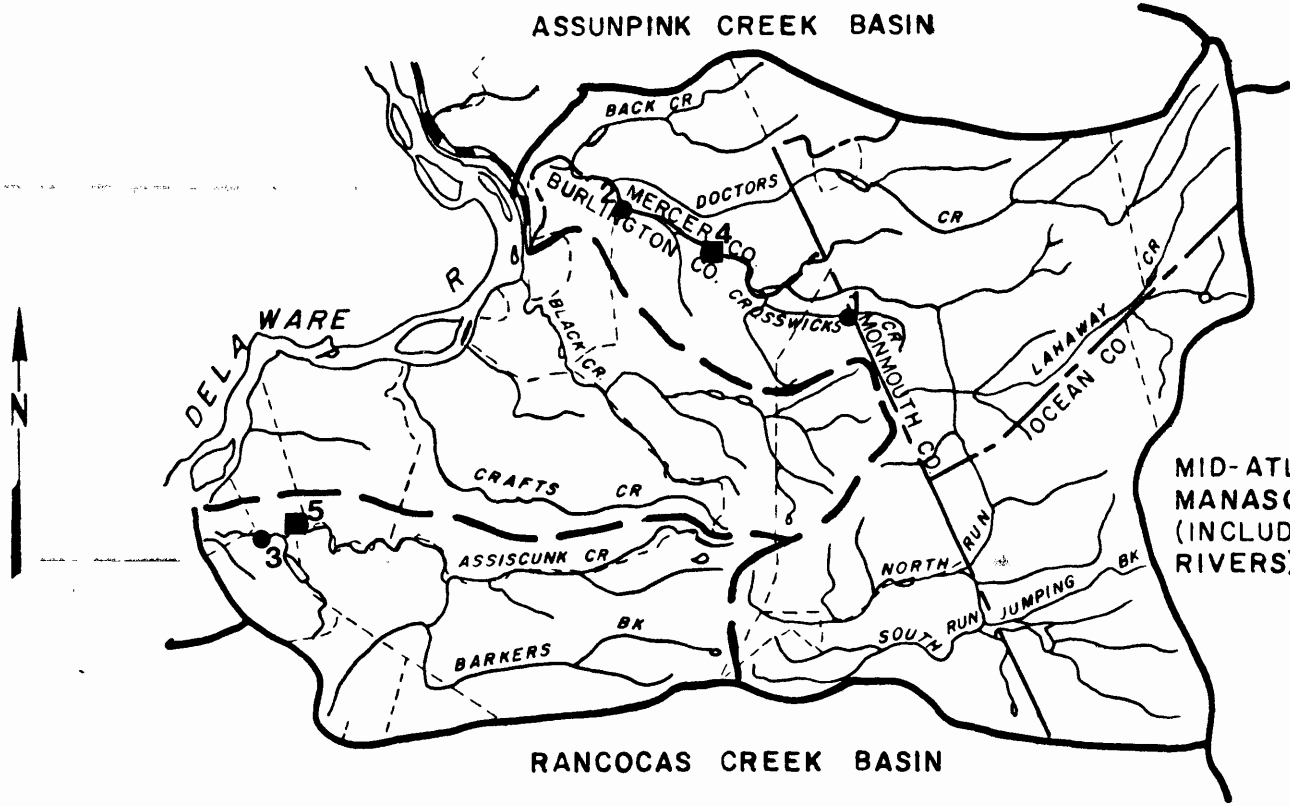
STORET Number	Station Description	Map Number
01464500	Crosswicks Creek at Extonville, Mercer County Latitude 40°08'15" Longitude 74°36'02" FW-2 Nontrout USGS/DEP Network Upstream side of bridge on Extonville Road, 0.7 mile downstream from Mercer-Monmouth County line.	1
01464505	Crosswicks Creek at Groveville, Mercer County Latitude 40°10'26" Longitude 74°40'48" FW-2 Nontrout USGS/DEP Network At bridge on U.S. Route 130, 0.3 mile upstream from Doctors Creek and 0.6 mile southwest of Yardville.	2
01464590	Assiscunk Creek near Burlington, Burlington County Latitude 40°04'19" Longitude 74°47'57" FW-2 Nontrout USGS/DEP Network At bridge on Old York Road, 4.2 miles upstream from mouth at Delaware River.	3

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Crosswicks Creek at Groveville	Water column	4
Assiscunk Creek at Burlington	Water column	5

CROSSWICK AND ASSISCUNK CREEK BASINS
(INCLUDING CRAFTS CREEK)

NEW JERSEY STATE WATER QUALITY INVENTORY REPORT 1982



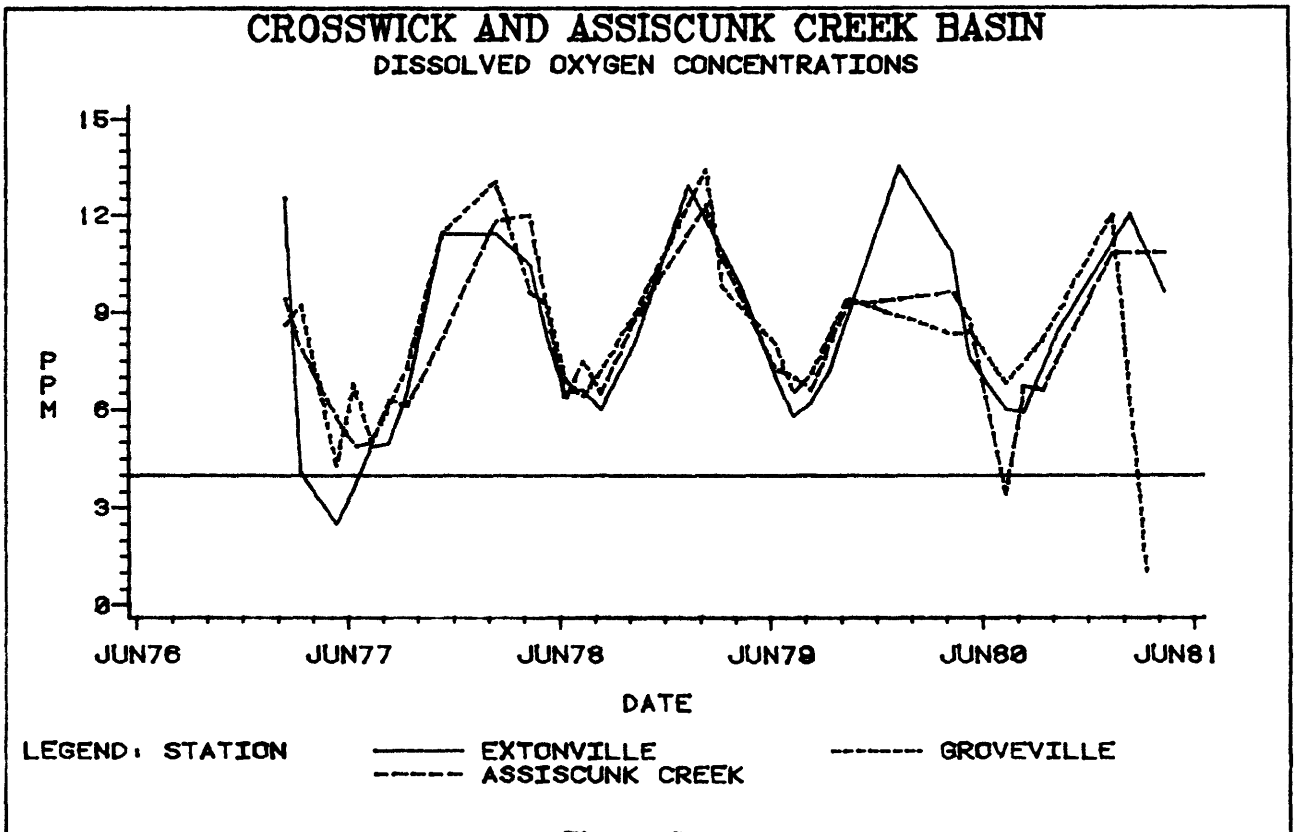
LEGEND

- DELAWARE AND RARITAN CANAL
- STREAM
- COUNTY BOUNDARIES
- MUNICIPAL BOUNDARIES
- BASIN BOUNDARIES
- ● CONVENTIONAL WATER SAMPLING STATION
- ■ TOXICS WATER SAMPLING STATION
- WATERSHED BOUNDARIES
- ▲ SEDIMENT SAMPLING STATION

0 1 2 3 4 8

SCALE IN MILES

LOCATION OF BASIN



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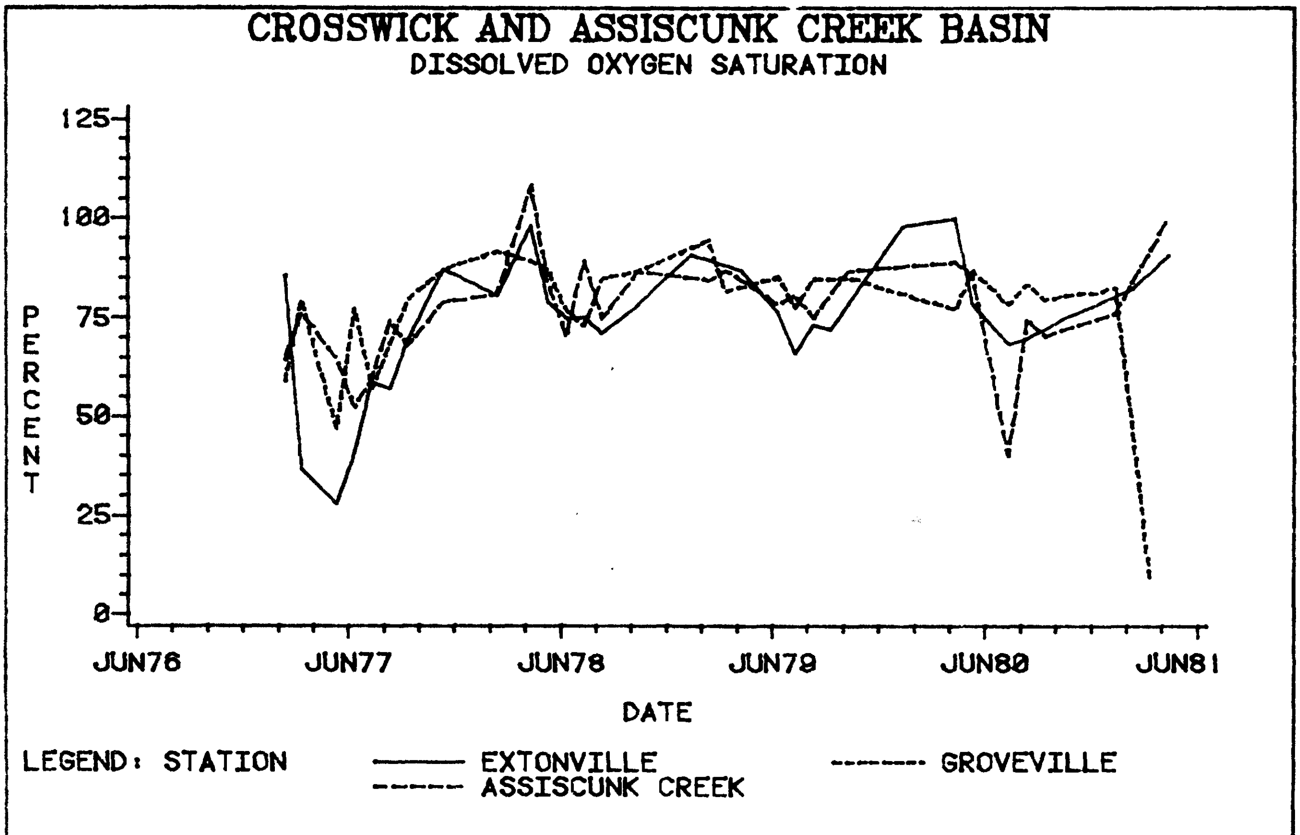

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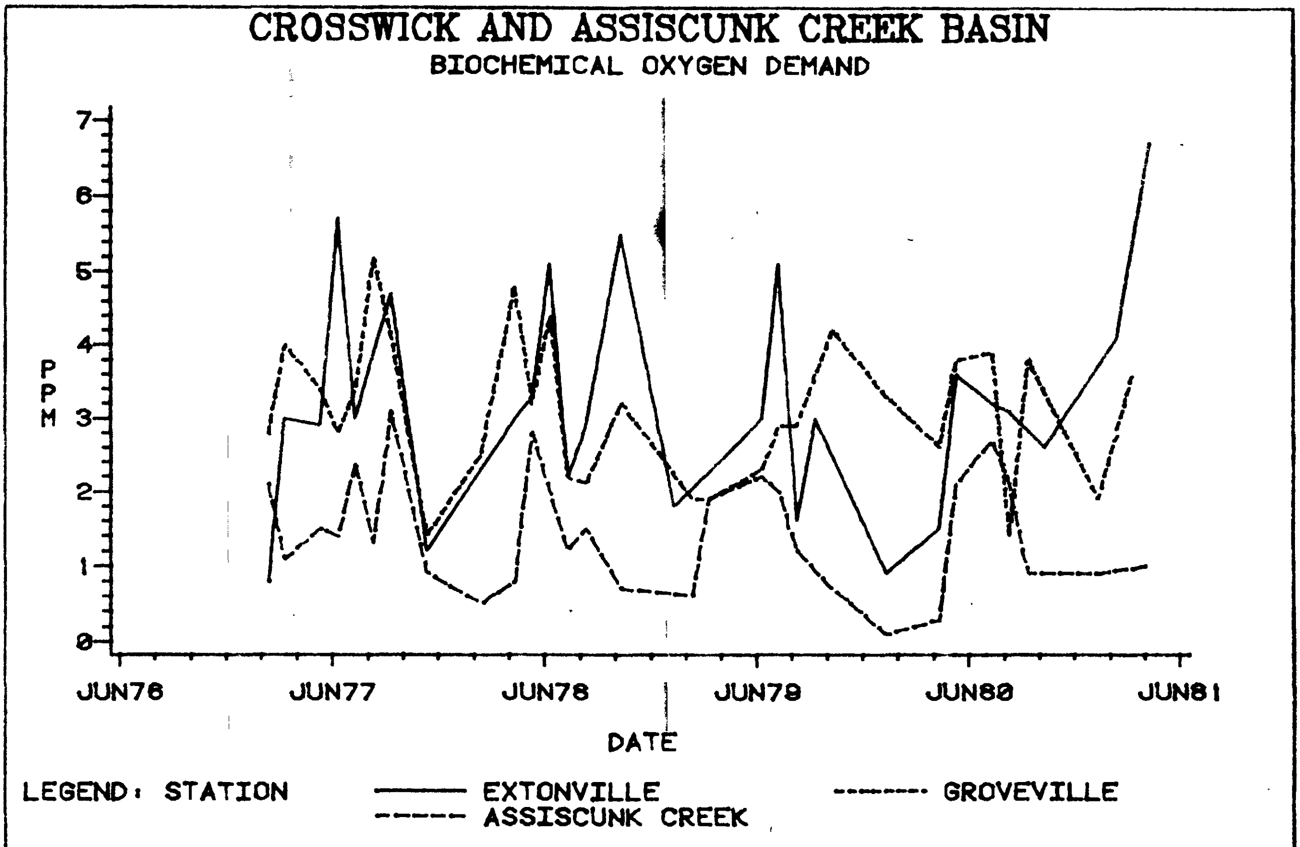

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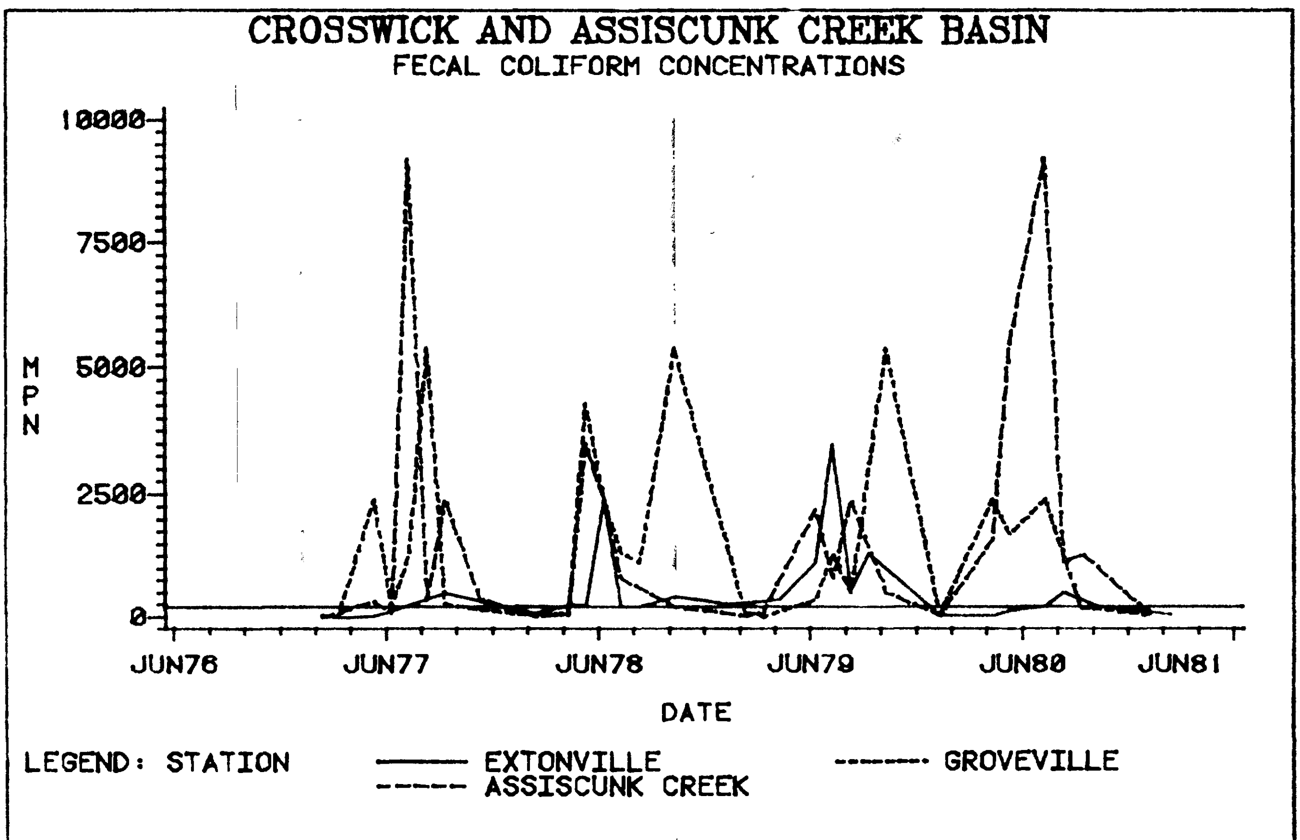

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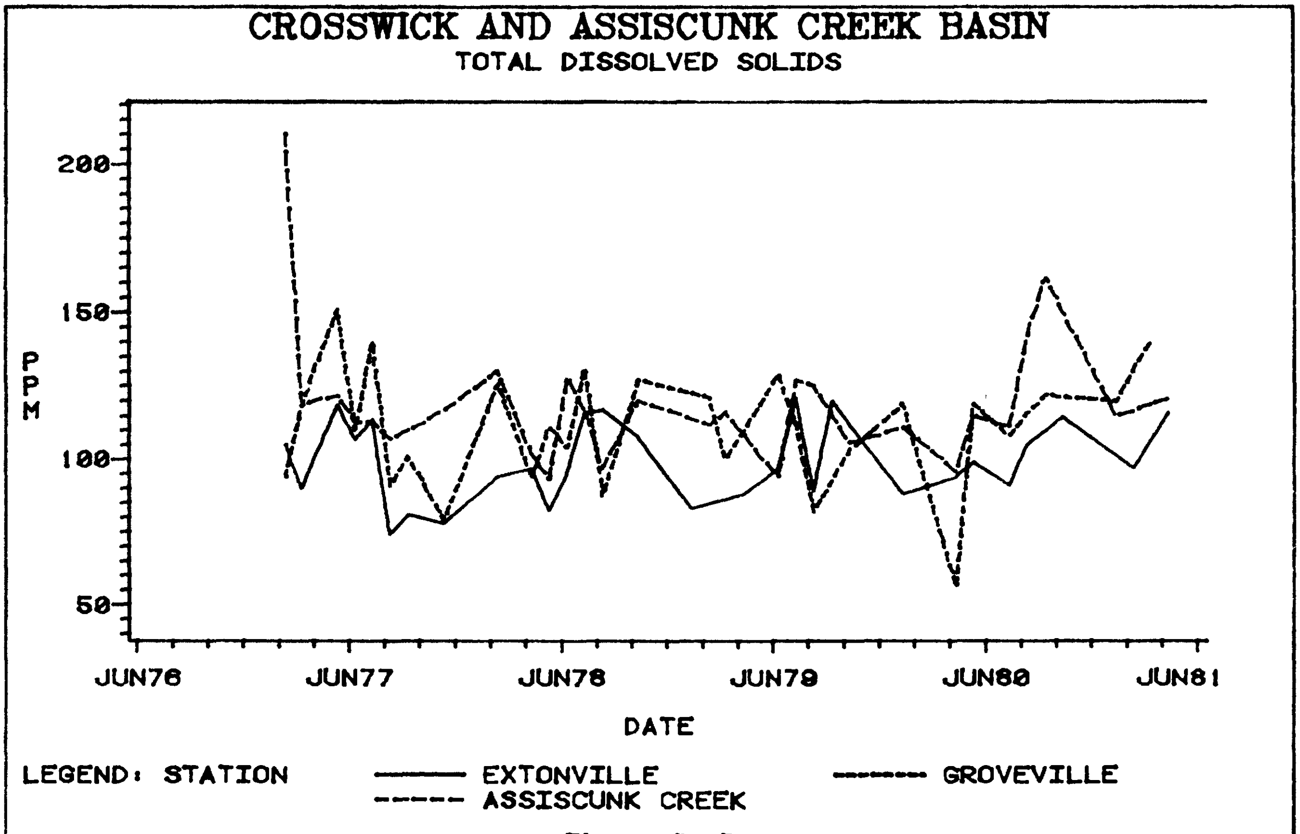

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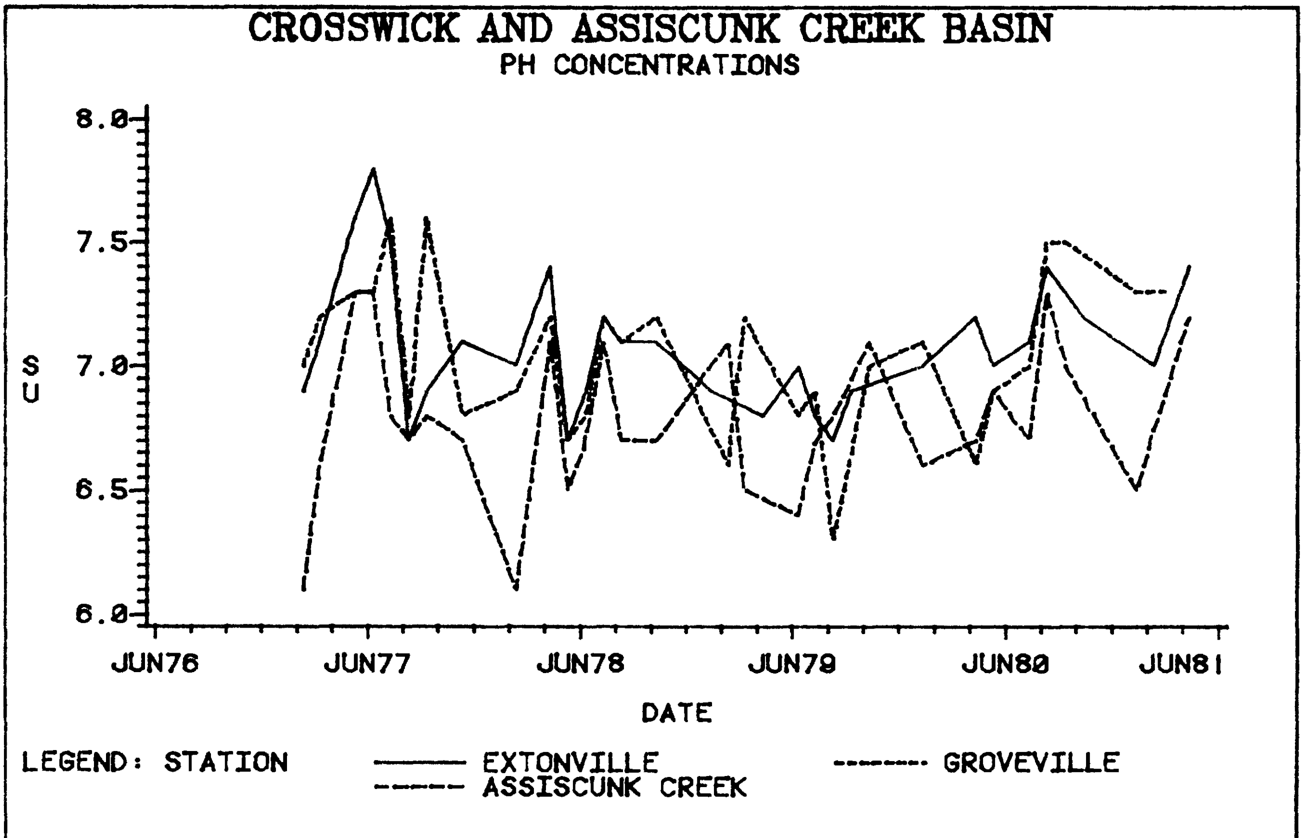

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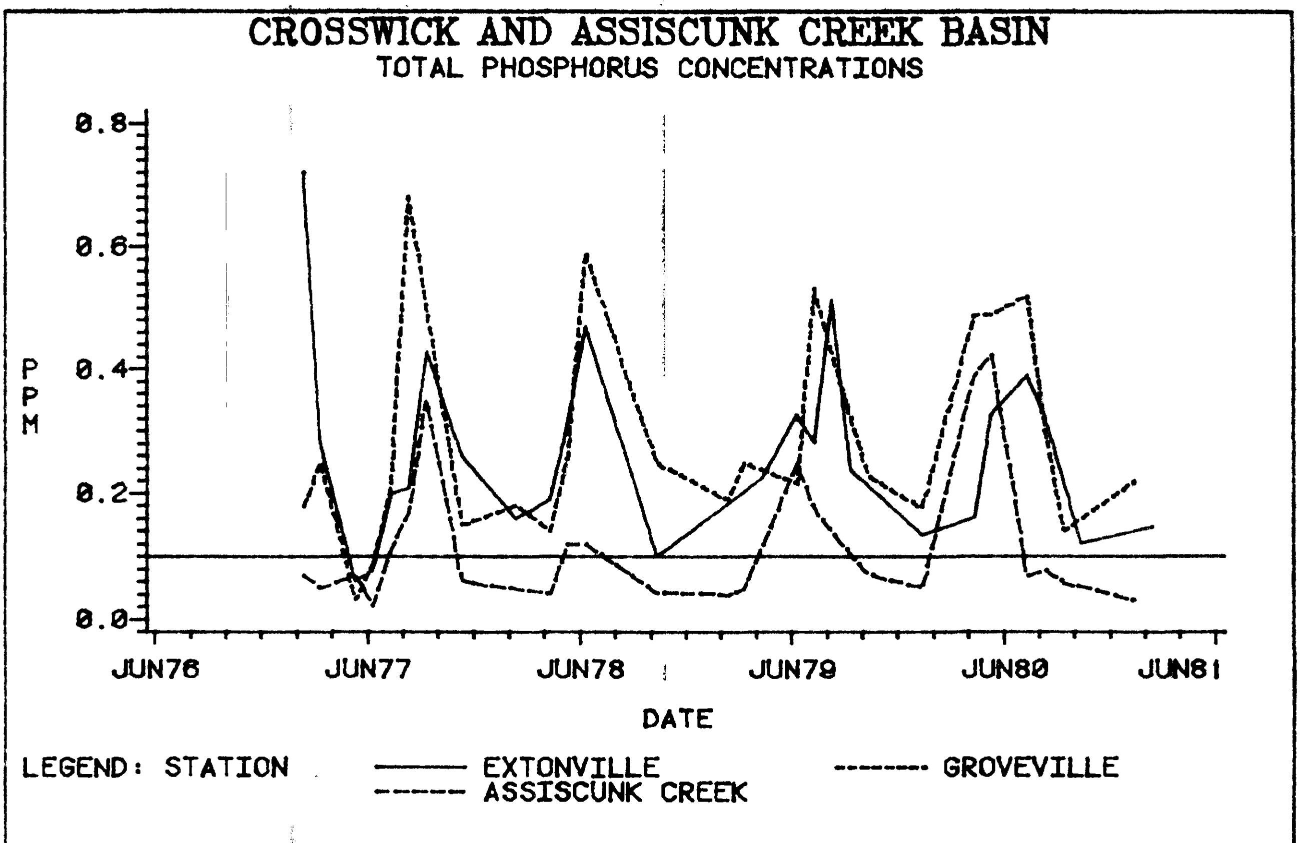

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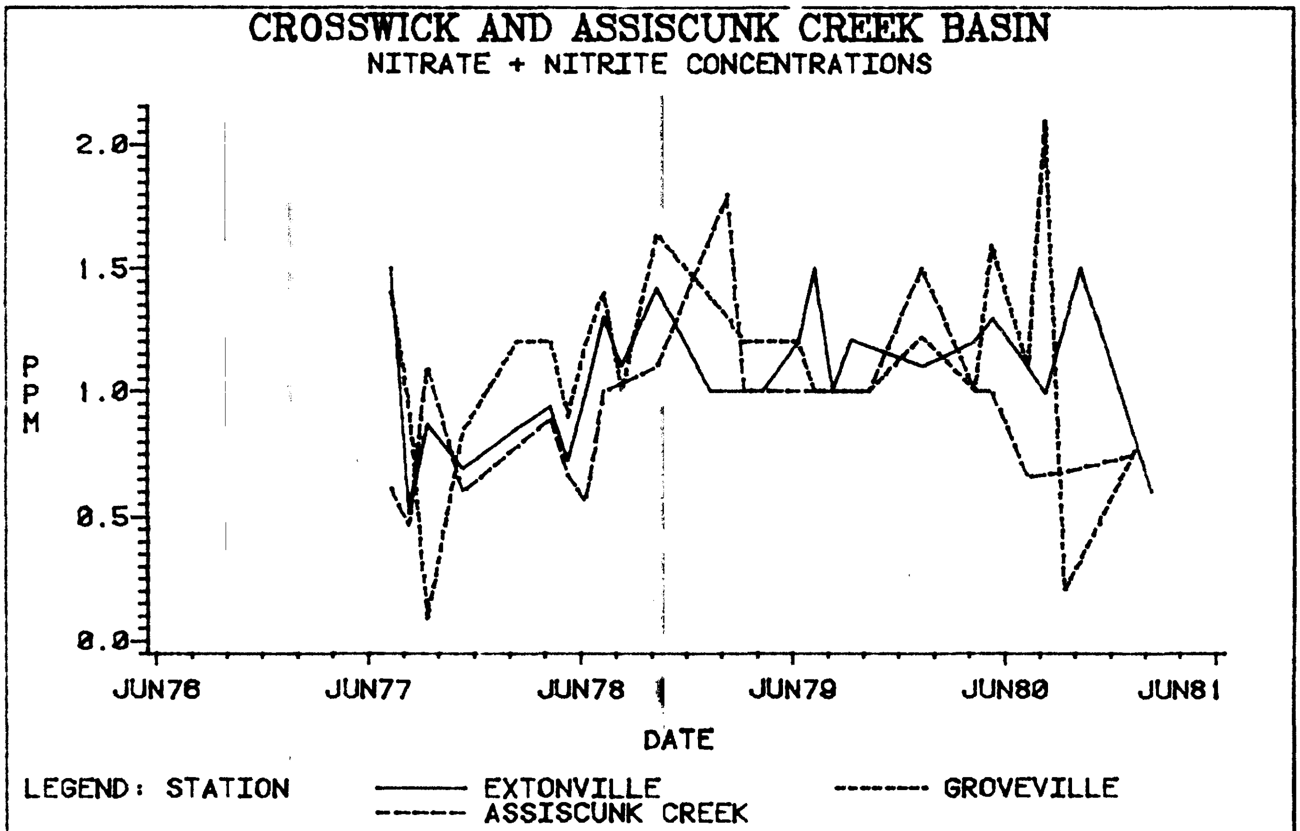

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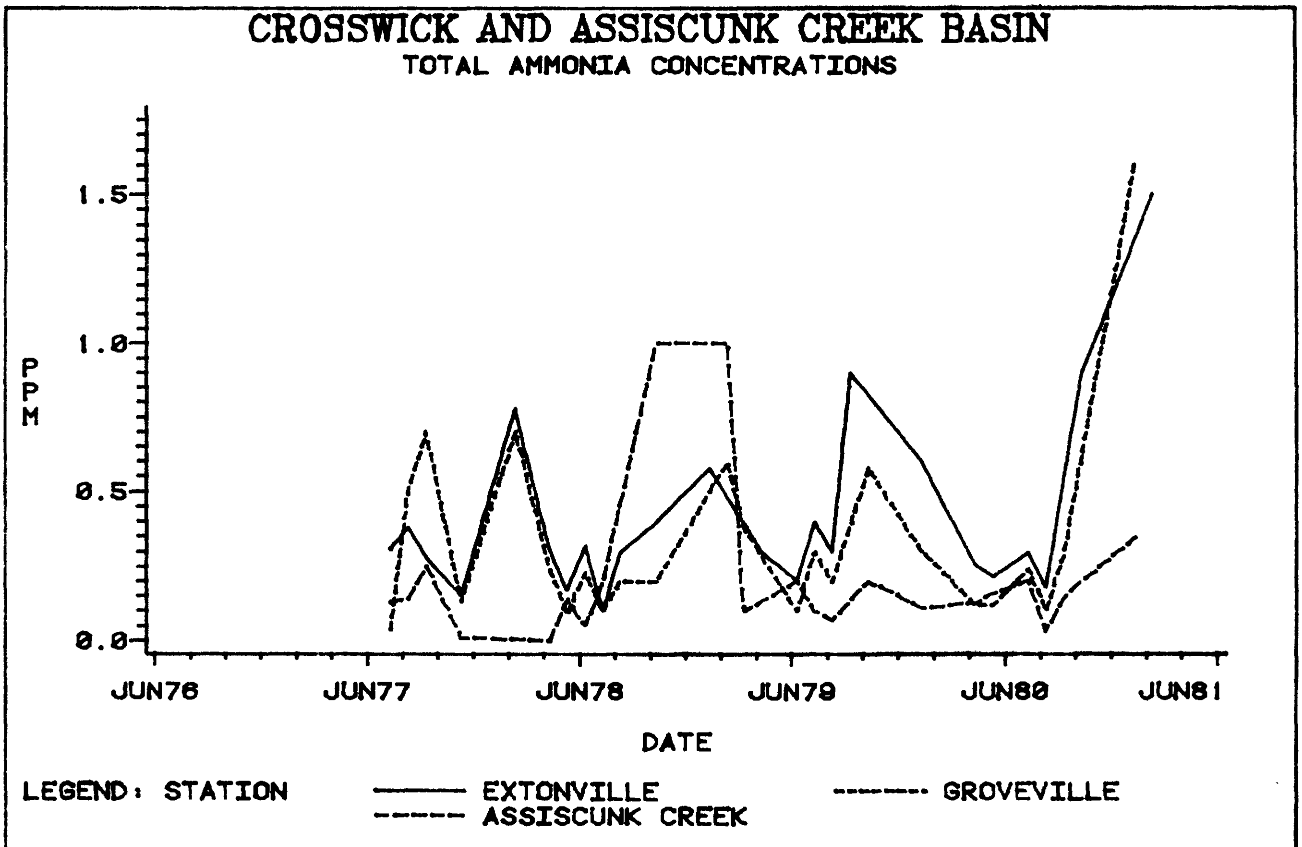

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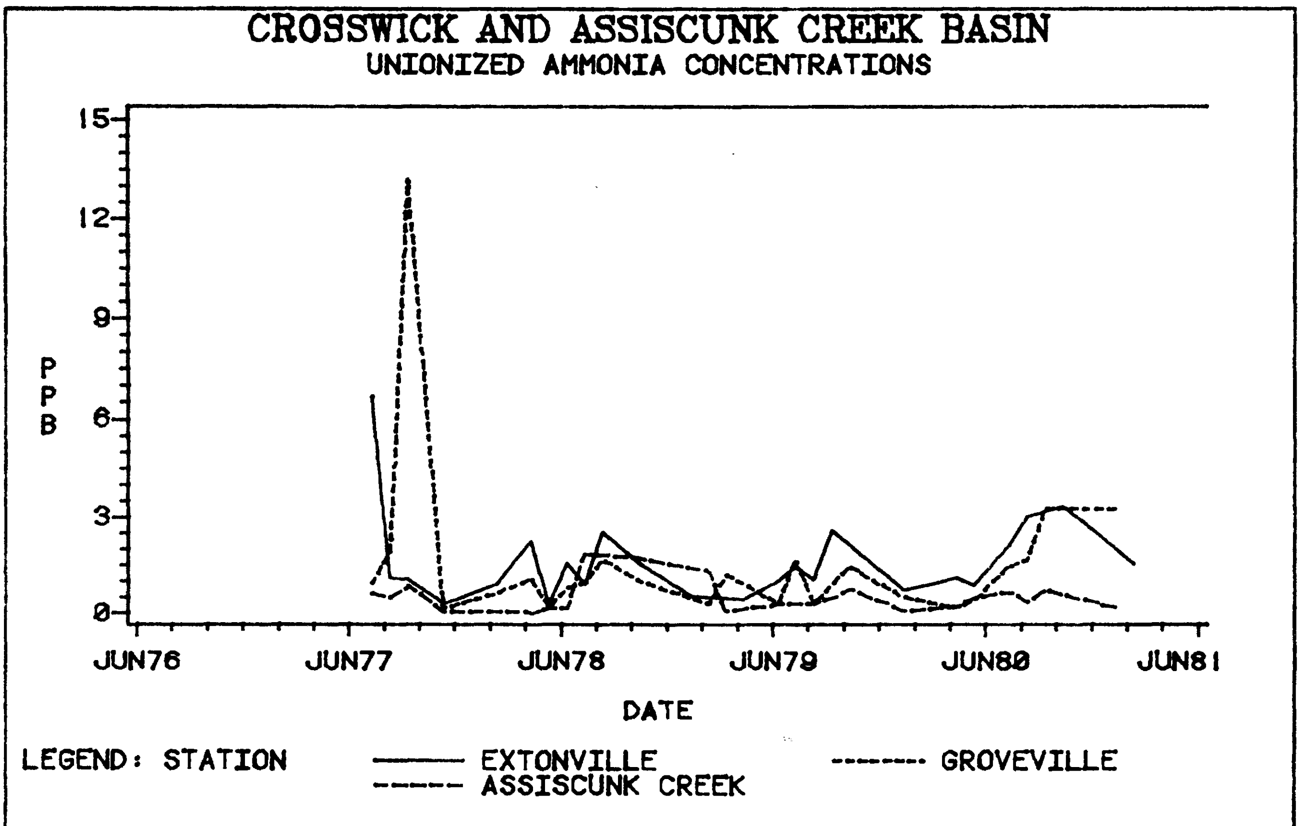


Figure: G -10

DISCHARGE INVENTORY - - - CROSSWICK AND ASSISCUNK CREEK BASINS

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
INTERSTATE STORAGE & PIPELINE	0033677	BURLINGTON	DITCH TO ASSISCUNK CREEK		
BURLINGTON TWP LA GORCE SQUARE	0021695	BURLINGTON /TWP/	ASSISCUNK CR.	SANITARY	.16
FLORENCE LAND RECONTOURING CO	0029289	MANSFIELD TWP	ASSISCUNK CREEK		
KAUFFMAN & MINTEER INC	0032310	JOBSTOWN	ASSISCUNK RIVER		
SPRINGFIELD TWP BD OF ED	0021571	SPRINGFIELD TWP	BARKERS CREEK	SANITARY	
CITY OF BORDENTOWN DPW	0024678	BORDENTOWN /C/	BLACKS CR.		1.25
LAUREL RUN S T P	0024139	BORDENTOWN TWP	BACON RUN	SANITARY	.10
NORTHERN BURLINGTON BD OF ED	0022381	MANSFIELD TWP	BACON RUN	SANITARY	
OCEAN SPRAY CRANBERRIES INC	0004294	BORDENTOWN /C/	THORNTON CREEK	COOLING WATER	.04
SPARTAN VILLAGE MOBILE HOME PK	0027596	WRIGHTSTOWN	NORTH RUN		
BOROUGH OF ALLENTOWN STP	0020206	ALLENTOWN	DOCTORS CREEK	SANITARY	
STAUFFER CHEMICAL CO.	0004472	HAMILTON TWP	DOCTORS CREEK	COOLING WATER	.61
NEW JERSEY TURNPIKE AUTHORITY	0020737	HAMILTON /TWP/	CROSSWICK'S CR.	SANITARY	
FORT DIX	0004855	FORT DIX	CROSSWICKS CR		2.1
MILE HOLLOW S T P	0024121	BORDENTOWN TWP	CROSSWICKS CR.	SANITARY	.41
WRIGHTSTOWN MUA	0022985	WRIGHTSTOWN	CROSSWICKS CR.	SANITARY	.11
ANCHOR THREAD CO.	0004821	HAMILTON TWP	CROSSWICKS CREE	PROCESS WASTE	.35
BOROUGH OF ALLENTOWN WATER PL.	0030848	ALLENTOWN	DOCTORS CREEK		.02
CITY OF BORDENTON WATER PLANT	0028649	BORDENTOWN CITY	CROSSWICKS CREEK		.02
STATE OF NJ-BORDENTOWN Y'TH CT	0026719	CHESTERFIELD TWP	CROSSWICKS CREEK	SANITARY	.30
HAMILTON TOWNSHIP	0026310	HAMILTON /TWP/	CROSSWICKS CREEK	SANITARY	.50
HAMILTON TOWNSHIP	0026301	HAMILTON /TWP/	CROSSWICKS CREEK	SANITARY	8.3
CALIFORNIA VILLA M H P	0027511	NEW HANOVER	CROSSWICKS CREEK	SANITARY	.02
PRIHODICO BROS INC	0027464	NORTH HANOVER TWP	CROSSWICKS CREEK	SANITARY	.00
HOOKER CHEMICAL CORP	0004235	BURLINGTON /TWP/	TR DELAWARE RIV	COOLING WATER	.33
BURLINGTON TWP MAIN STP	0021709	BURLINGTON /TWP/	TANNER'S RUN	SANITARY	.93
TENNECO CHEMICALS INC	0004391	BURLINGTON /TWP/	MARTERS DITCH	COOLING WATER	3.94
YATES INDUSTRIES INC.	0004332	BORDENTOWN TWP	MILE HOLLOW BK	PROCESS WASTE	.25
MCGUIRE AIR FORCE BASE	0022578	WRIGHTSTOWN	SOUTH RUN	SANITARY	1.6
PLUMSTEAD TWP SCHOOL DIST.	0021407	PLUMSTED TWP	CROSSWICKS CREEK	SANITARY	

H. RANCOCAS CREEK

Basin Description

The Rancocas Creek watershed is the largest in south-central New Jersey which drains to the Delaware River, encompassing a total of 360 square miles. Rancocas Creek is formed by the confluence of the North and South Branches of the Rancocas just upstream of the NJ Turnpike crossing. The North Branch begins in western Ocean County draining 167 square miles along its 25 mile length. Major tributaries to the North Branch include Mt. Misery Brook, Greenwood Branch and McDonald Branch. The South Branch drains 144 square miles after its origin in central Burlington and eastern Camden Counties. While the North Branch flows in a primarily western direction, the South Branch flows more northwesterly. Stop the Jade Run, Southwest Branch Rancocas, Haynes Creek and Friendship Creek are major tributaries to the South Branch. The mainstem Rancocas Creek flows westerly for 8 miles, draining 35 square miles, before it joins the Delaware River at Delanco and Riverside. Tidal influence extends the entire length of the mainstem to the dam at Mount Holly on the North Branch, Vincentown on the South Branch and Kirby Mills on the Southwest Branch.

The Rancocas watershed contains a wide variety of land use types. According to the Tri-County Water Quality Management Plan (1977) 54 percent of the basin is forested, 26 percent is agricultural and 20 percent is urban/suburban development. The upstream segments drain forests indigenous to the Pinelands region of New Jersey. The Pinelands contain expanses of pine and oak forests intermixed with swamps, bogs and meandering streams, all underlain with acidic sandy soils of the Outer Coastal Plain. This environment can be found in the eastern half of the watershed. Agriculture, although found throughout, is heaviest in central portions of the Rancocas basin. Farming for blueberries, cranberries and acid soil tolerant crops are the most common. Development, generally scattered east of Mount Holly, is heaviest west of the town. Population centers within the watershed include Pemberton Township, Medford Township, Medford Lakes, Evesham Township, Mount Holly and Willingboro. The areas of greatest population growth from 1970 to 1980 were Pemberton and Medford Townships. The eastern half of the basin, outside the boundaries of the Pinelands Protection Area, will likely be subject to increased growth in the near future.

Twenty-four dischargers have been identified in the Rancocas Creek watershed, the majority of these treating sanitary sewage. The largest treatment facility is the Willingboro MUA plant, discharging on the average nearly 4 mgd to Rancocas Creek. A new regional treatment plant has been completed in Pemberton Township serving Pemberton Borough and Township. Currently, sanitary sewers are present in the western third of the watershed: Mount

Holly, Medford Lakes and Pemberton Borough in their entirety and portions of Pemberton, Evesham, Medford, Southampton, Lumberton and Westhampton Townships. Existing and projected collection systems are sited primarily along streams and lowland areas. The entire Rancocas watershed is within an existing 201 facilities planning area.

Rancocas Creek and tributaries have scattered and varied uses. Fort Dix and associated facilities utilize surface waters from the South Branch for both consumptive and non-consumptive purposes, as does an industrial facility on the mainstem. Surface waters are also used for irrigation purposes in some areas of the watershed. Recreational usage appears to be important throughout. Canoeing is popular in the North and South Branches, while power boating occurs on the tidal mainstem. Fishing is also prevalent throughout. Although trout is stocked by the NJ Division of Fish, Game and Wildlife (DFGW) in only two water bodies in the basin (Crystal Lake in Willingboro and Woolman's Lake in Mount Holly), numerous ponds and lakes provide fishing opportunities. Eight ponds have been identified by the DFGW which contain fishable populations of catfish, pickerel and largemouth bass (they include Crystal Lake, Deep Hollow Pond, Medford Park Pond, Mirrow Lake, Pakim Pond, Smithville Lake, Whitesbog and Woolman's Lake). In addition there are numerous private, semi-public and municipal parks that have boating (motor and non-motor), canoeing, fishing, and some bathing.

Significant sections of the Rancocas Creek watershed, especially in headwaters areas, are in state parks, forests and wildlife management areas (WMA). Lebanon State Forest and Pasadena WMA are found in the eastern section of the watershed, while Rancocas State Park and Medford WMA are located in the central and western watershed. In addition, parts of the Pinelands National Reserve's "Protection Area" are located in the upper Rancocas basin. The Protection Area, which limits the impacts of development through extensive planning activities, was designed to protect the Pineland's unique natural and cultural resources and extends eastward from near Medford, Vincentown and Pemberton.

NJ Water Quality Standards have designated waters in the Rancocas Creek basin the following classifications: FW-Central Pine Barrens, FW-1 (waters within state parks, forests and WMAs) and FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

Water quality in the Rancocas Creek drainage area is characterized by a decline from generally good conditions in the upstream segments and tributaries of the North and South Branches to poor conditions in the mainstem in western Burlington County. The mainstem Rancocas Creek experiences excessive fecal coliform and total phosphorus concentrations and seasonal contraventions of dissolved oxygen requirements. These conclusions are based on samples collected in the North Branch at Pemberton and Mt. Holly, and in the South Branch at Retreat and Hainesport.

Dissolved oxygen concentrations were sufficient in the North Branch Rancocas Creek at both Pemberton (upstream) and Mount Holly (downstream). A well defined seasonal trend having winter maximum and summer minimum values was evident throughout the period. Dissolved oxygen saturation levels were satisfactory as values were generally in the 70 to 100 percent range. The Mount Holly station usually exhibited slightly higher daytime D.O. values than the Pemberton location, possibly due to higher primary productivity. A similar downstream trend was indicated between Retreat and Hainesport on the South Branch Rancocas Creek. Dissolved oxygen concentrations were also generally sufficient for the period, with the data suggesting a slight overall improvement in D.O. saturation at the Retreat station. Low to moderate biochemical oxygen demands (generally 4.0 mg/l or less) were recorded at all stations during the period, with the downstream stations at Mount Holly and Hainesport generally registering higher values than the upstream stations.

Fecal coliform concentrations in the North Branch at Pemberton, although occasionally contravening the 200 MPN/100 ml level, were low enough to indicate the general absence of any serious problems. The same situation was exhibited at Retreat on the South Branch Rancocas Creek.

Total dissolved solids levels were generally below 100 mg/l throughout the basin for the period 1977-1982. The trend of increasing concentrations in the downstream direction was also true for total dissolved solids, with the lowest values (generally below 60 mg/l) occurring in the upstream segments. There were no clearly defined trends over the period for TDS. As a rule, the basin's waters are slightly acidic. Upstream pH ranged from 4 to 6, increasing to the 5 to 8 range at the downstream stations in Mount Holly and Hainesport.

As with most of the other parameters, nutrient levels also tended to increase as one goes downstream. Total phosphorus concentrations were consistently below the criterion at Pemberton (North Branch), but occasionally exceeded 0.10 mg/l at Retreat (South Branch). On the other hand, the rates of contravention at the downstream stations were 50 and 85 percent at Mount Holly and Hainesport, respectively. Nitrate + nitrite concentrations were below 1.5 mg/l at all stations in the Rancocas Creek basin, however, there was a notable increase at all locations in 1978, with a subsequent decrease to earlier levels in 1980. The South Branch station at Hainesport exhibited a slight overall increase in nitrate + nitrite concentrations during the period. Very low total ammonia (generally below 1.0 mg/l) and un-ionized ammonia (below 2.0 ug/l) were the norm at all stations throughout most of the period.

Biomonitoring findings support the moderately polluted water quality conditions described above for the Mount Holly and Hainesport stations. The biological communities at both stations appeared relatively healthy, in spite of being under moderate stresses. The periphyton chlorophyll a levels were high two out of three years at the South Branch station, indicative of enriched conditions; North Branch chlorophyll a level were low in 1977 and 1978, with no samples being recovered in 1979. However, the macroinvertebrate data indicates that the South Branch has the more balanced community. Over the three year period at the North Branch Station, 50 to 70 percent of the community consisted of chironomids (midges). Trichopterans (caddisflies) made up another 20 percent of the sample population in 1978 and 1979. In contrast, at the South Branch station, mollusks (snails) were the only taxonomic group to ever comprise over 30 percent of the individuals in any one year (39 percent in 1979). The other major taxonomic groups at the South Branch station were chironomids, oligochaetes (worms), coleopterans (beetles), and polychaetes (worms).

Comparison of the water quality data above with that presented in earlier 305(b) reports indicate water quality improvements are occurring in the Rancocas basin. Although the overall trend of poorer quality downstream and in the South and Southwest Branches remains there appears to be increases in dissolved oxygen saturation and decreases in total phosphorus and BOD_5. This is especially true in the Mount Holly/Hainesport area.

Toxic Parameters

One sample was collected near a landfill on the North Branch of the Rancocas at Mount Holly. Low levels of polychlorinated biphenyls (PCBs) were found at this site. These compounds will not persist in the water column and eventually partition onto sediment. The North Branch of the Rancocas was also sampled at Mount Holly near Route 206. Here moderate levels of an organic solvent were found in the first year of the study. Subsequent sampling in the second and third years did not confirm this problem. The North Branch was also sampled at the intersection of Route 537 and Pine Street in Mount Holly and at Pemberton. At both sites there was no evidence of toxic contamination.

Water quality data on the South Branch of the Rancocas Creek at Hainesport indicates no problem with regard to toxic contamination in the water column.

In 1979 as part of an overall investigation into a chlordane contamination survey (see Pennsauken Creek), a limited number of fish tissue samples were collected along the Rancocas Creek at Delran. These samples were analyzed for several organochlorine pesticides and PCB Arochlor 1254. Several species of catfish, Ictalurus sp., and the forage fish, gizzard shad, Dorosoma cepedianum, were found to contain elevated levels of chlordane and its isomer metabolities. These results met or exceeded the U.S. Food and Drug Administration allowable levels for chlordane in fish tissue used for human consumption. Sediment analyses showed trace level contamination of organochlorine pesticides and PCB Arochlor 1254. Tissue analysis for PCB Arochlor 1254 revealed results ranging from non-detectable to low level contamination. This site is under further study by the Office of Cancer and Toxic Substances Research.

Samples of fish tissue taken from the Rancocas Creek at Birmingham (Southampton Township) in 1980 revealed only trace levels of either organochlorine pesticides or PCB Arochlor 1254. A sediment analysis from this same location resulted in non-detectable levels for all parameters tested.

Fish obtained from Parkers Creek, a tributary to the Rancocas Creek at Centerton (Mount Laurel Township) produced low levels of chlordane in one composite sample of American eel, Anguilla rostrata. Other species sampled produced only trace levels of chlordane.

Problem Assessment

Water quality degradation in the Rancocas basin is caused by various sources, but point sources appear to be the dominant pollutant source in most segments of the creek. Numerous fecal coliform, periodic low dissolved oxygen (as well as supersaturated DO levels) and high total phosphorus concentrations are the generalized problems that afflict the Rancocas basin. The upper reaches of the North Branch experience pollution because of agricultural runoff and septic systems, according to the Tri-County Water Quality Management Plan (1977). Water quality, however, as measured in the North Branch at Pemberton, is generally good. Degradation occurs below the monitoring station because of the Pemberton Borough treatment plant and the Sunbury Village Sewer Company plant, both of which are operating inefficiently and are under enforcement action to connect to the Pemberton Township MUA (PTMUA) treatment plant. The PTMUA plant is the only facility along the North Branch which employs phosphorus removal. The Country Lakes area of Pemberton Township is experiencing septic system problems due to high water tables. Studies have been proposed to connect this area to the PTMUA plant. Further water quality degradation occurs to the North Branch as it flows through Mount Holly. This is due to urban stormwater runoff and nutrient loading from the Mount Holly Sewerage Authority's discharge.

In the South and Southwest Branches of the Rancocas water quality problems are more severe than in the North Branch, especially with regard to dissolved oxygen levels. Although conditions are good in the South Branch at Retreat, water quality worsens by the time it reaches Hainesport. Septic system malfunctions are occurring in the Pine Grove area of Evesham Township and are having an impact on the Southwest Branch, in addition to being a health hazard. Development in the Medford Lakes region has caused water quality to worsen. An intensive survey conducted by the Division of Water Resources in 1979 on the South and Southwest Branches indicated that municipal discharges were responsible for the high fecal coliform and nutrient levels found.

Water quality on the mainstem was not measured, but problems are known to exist because of nutrient contributions from the North and South Branches, significant municipal point source discharges to the mainstem and the influences from tidal action. An intensive survey has been proposed for the main segment of the Rancocas to determine the need for advanced nutrient removal, but has not yet been conducted. The Willingboro MUA treatment plant discharges effluent that is frequently in violation of its NJPDES permit. Substantial rehabilitation may be needed to improve operating efficiency of this plant. Urban stormwater runoff may also contribute to problems on the mainstem.

Goal Assessment and Recommendations

Waters of the Rancocas are not swimmable with the possible exception of the headwaters that originate in state forest and game lands. Fecal coliform counts are generally higher in the watershed during summer months, further reinforcing the non-swimmable status of the Rancocas. Although the waters can be classified as fishable, periodic stress conditions for aquatic life likely exists on the Southwest Branch, downstream of Medford Lakes in the South Branch, downstream of Pemberton Borough in the North Branch, and in the tidal mainstem. Fish life in the Rancocas watershed includes 24 identified species that require clean water, as well as have a tolerence to pollution.

Correction of water quality problems has begun in this watershed, as evident in the reduction of total phosphorus and BOD_5 levels from what was observed in the mid-1970s. This can be attributed to additional phosphorus removal requirements instituted at the Pemberton Township and Medford Lake treatment plants. Elimination of the Pemberton Borough and Sunbury Village plants, and failing septic systems are needed to improve conditions in the North Branch. An industrial facility in the North Branch which is discharging very large amounts of total dissolved solids must also be corrected. In the South Branch, correction of malfunctioning septic systems and an effective regional sewerage plan is needed for Evesham Township.

Despite the lack of studies in the tidal mainstem, advanced nutrient removal requirements will probably be instituted at the municipal point sources present in the Rancocas watershed. This will not only assist in alleviating high nutrient levels and low dissolved oxygen conditions in the tidal mainstem, but will also help protect the many small lakes in the upper reaches of the watershed. Vast recreational opportunities exist in these lakes if existing pollution problems are eliminated and lake management techniques are practiced.

RANCOCAS CREEK STATION LIST

A. Ambient Monitoring Stations

STORET Number	Station Description	Map Number
01467000	North Branch Rancocas Creek at Pemberton, Burlington County Latitude 39°58'10" Longitude 74°41'05" FW-2 Nontrout USGS/DEP Network Downstream side of bridge on Hanover Street, 12 miles upstream from confluence with South Branch.	1
01467006	North Branch Rancocas Creek at Mount Holly Burlington County Latitude 30°59'22" Longitude 74°47'06" FW-2 Nontrout Basic Water Monitoring Program At wooden footbridge, 500 feet upstream of Pine Street bridge.	2
01465835	South Branch Rancocas Creek at Retreat, Burlington County Latitude 39°55'23" Longitude 74°43'05" FW-Central Pine Barrens USGS/DEP Network At bridge in Retreat, 40 feet upstream of Friendship Creek and 1.2 mile southwest of Buddtown.	4
01465915	South Branch Rancocas Creek at Hainesport, Burlington County Latitude 30°58'44" Longitude 74°49'28" Basic Water Monitoring Program At bridge on Route 38, 2.0 miles west of Mount Holly.	3

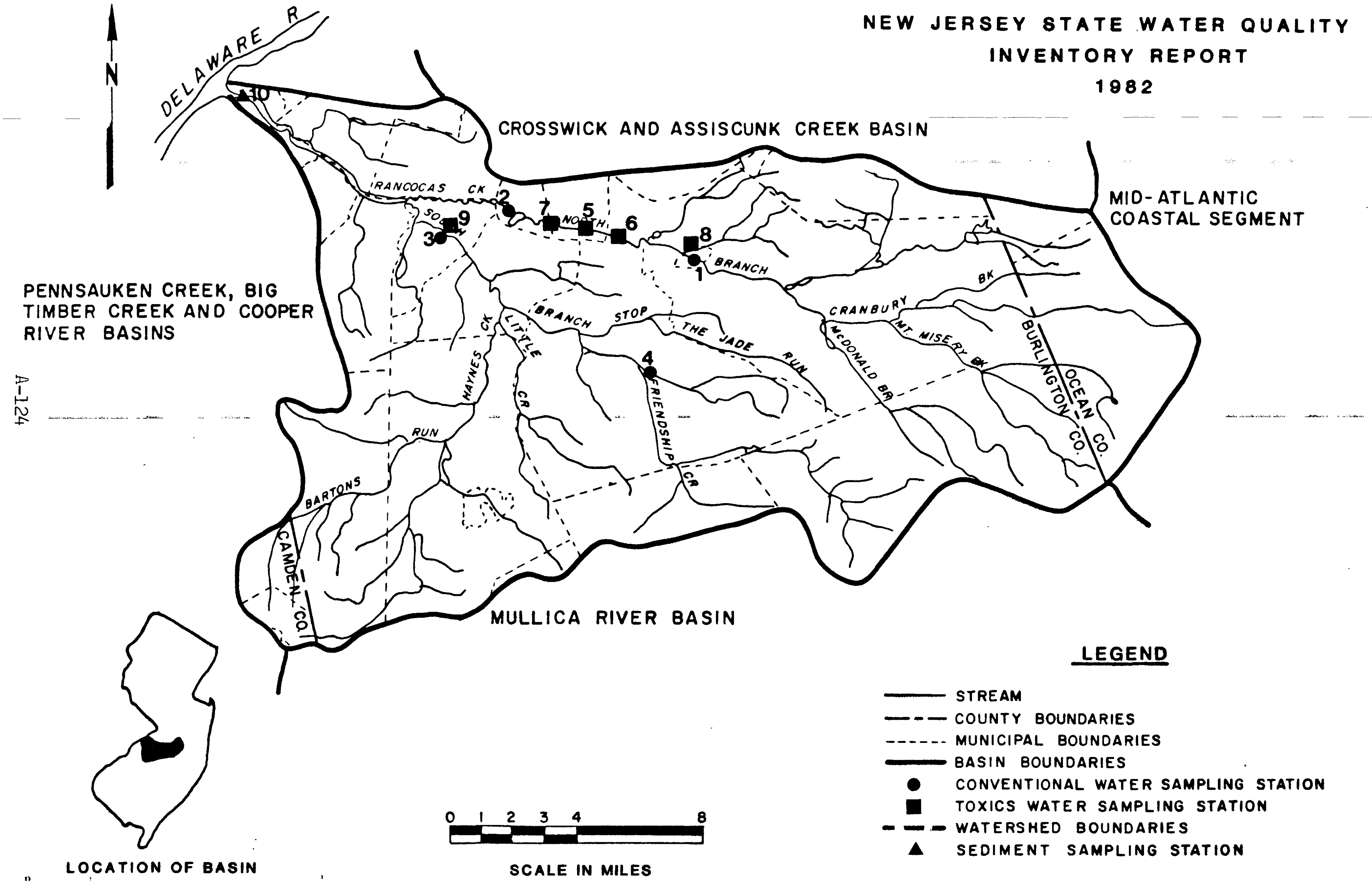
B. Toxics Monitoring Stations

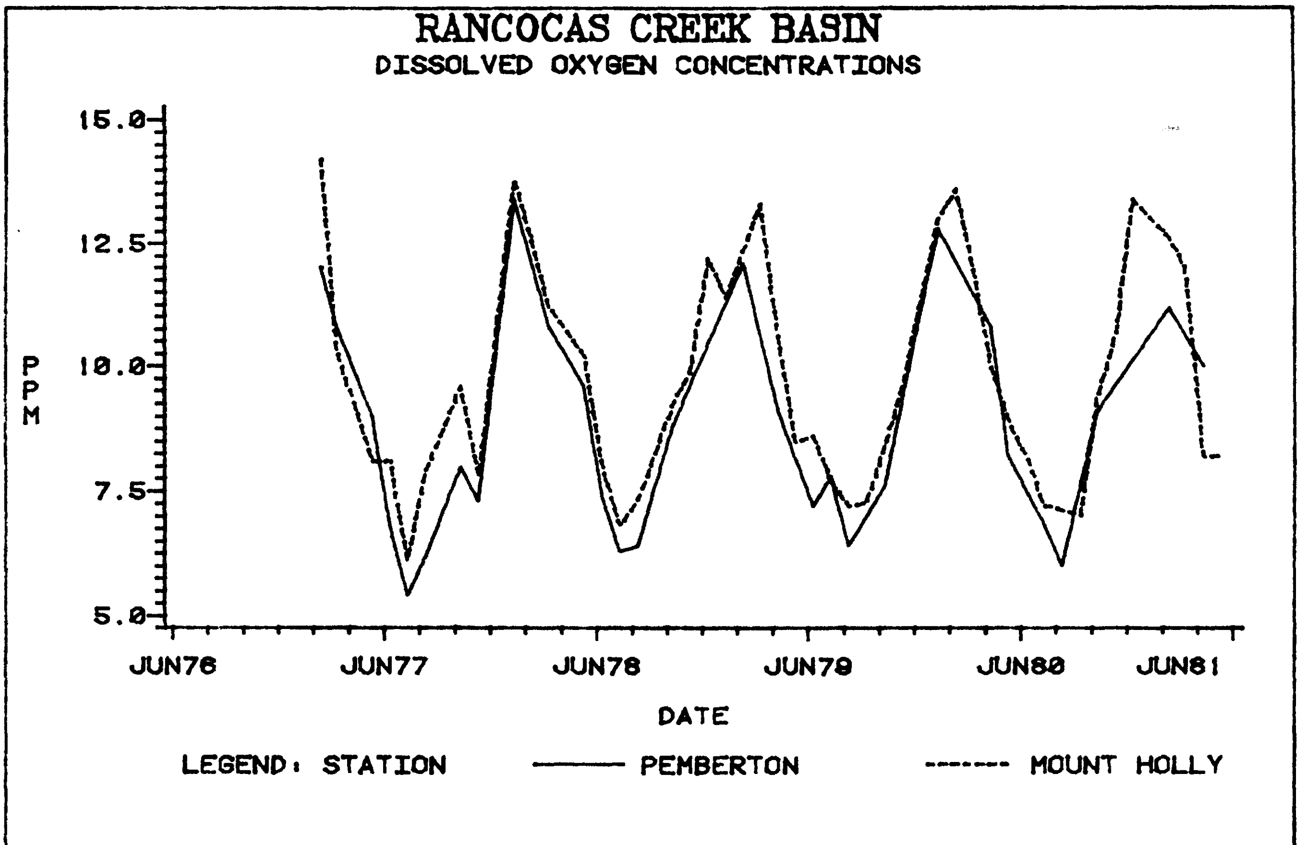
Station Location	Sampling Regime	Map Number
North Branch Rancocas Creek near L&D Landfill	Water column	5
North Branch Rancocas Creek at Mount Holly	Water column	6

North Branch Rancocas Creek at Route 537 and Pine Street	Water column	7
North Branch Rancocas Creek at Pemberton	Water column	8
South Branch Rancocas Creek at Hainesport	Water column	9
Rancocas Creek at Delran	Sediments	10

RANCOCAS CREEK BASIN

NEW JERSEY STATE WATER QUALITY INVENTORY REPORT 1982





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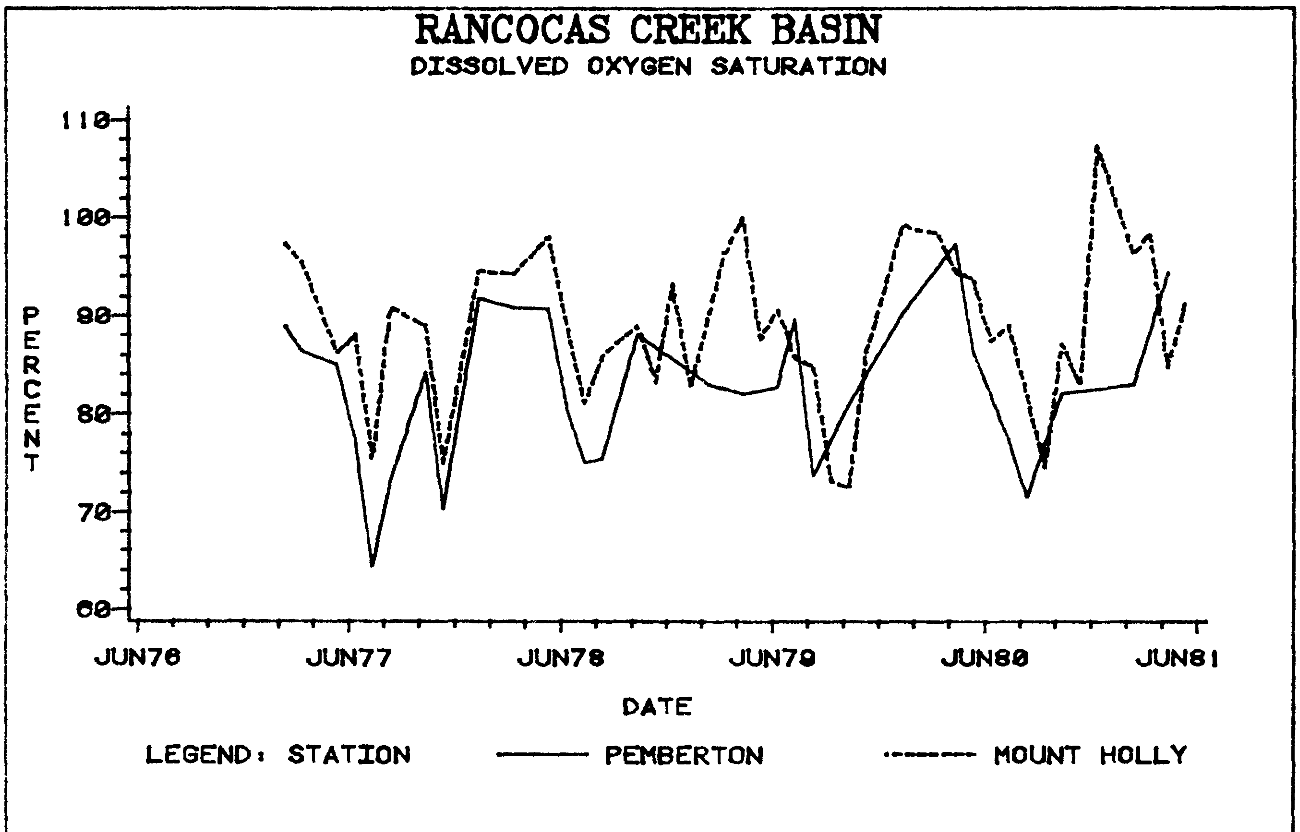

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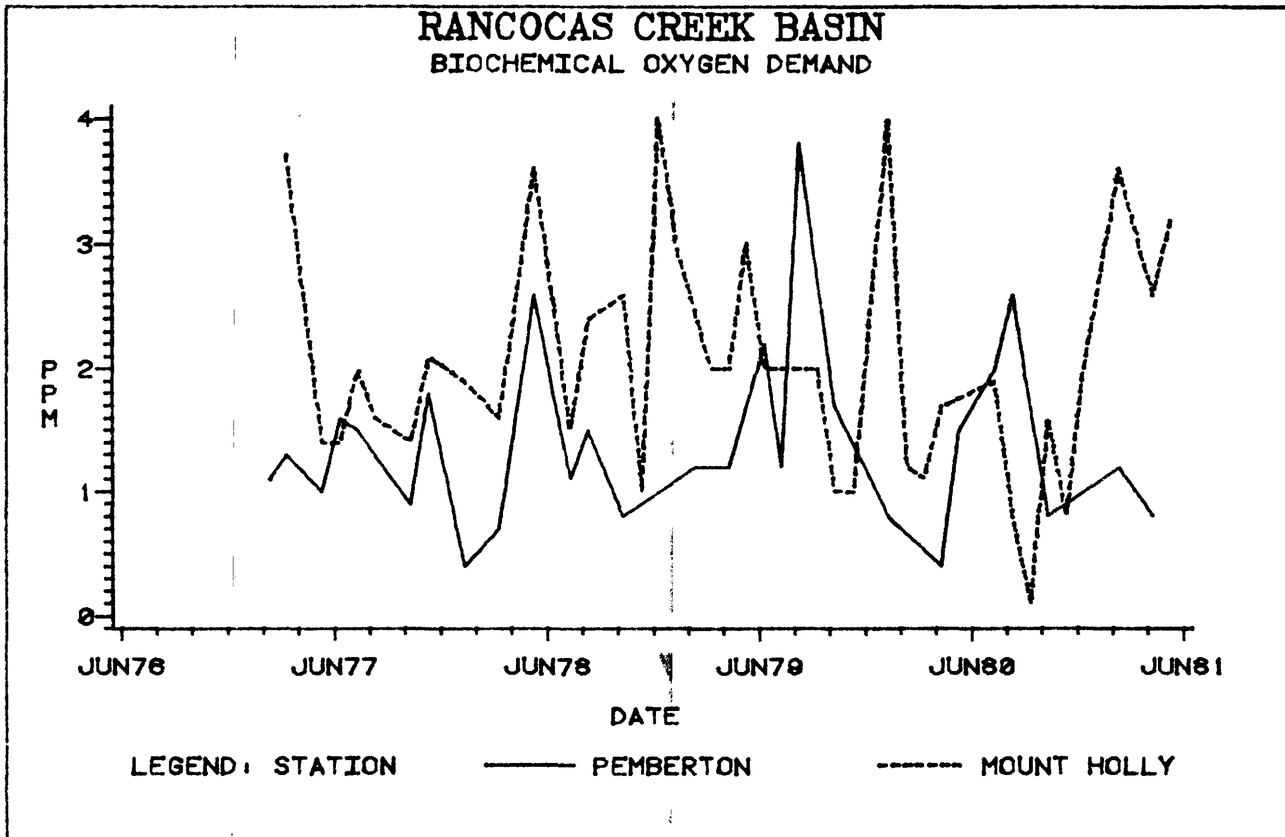

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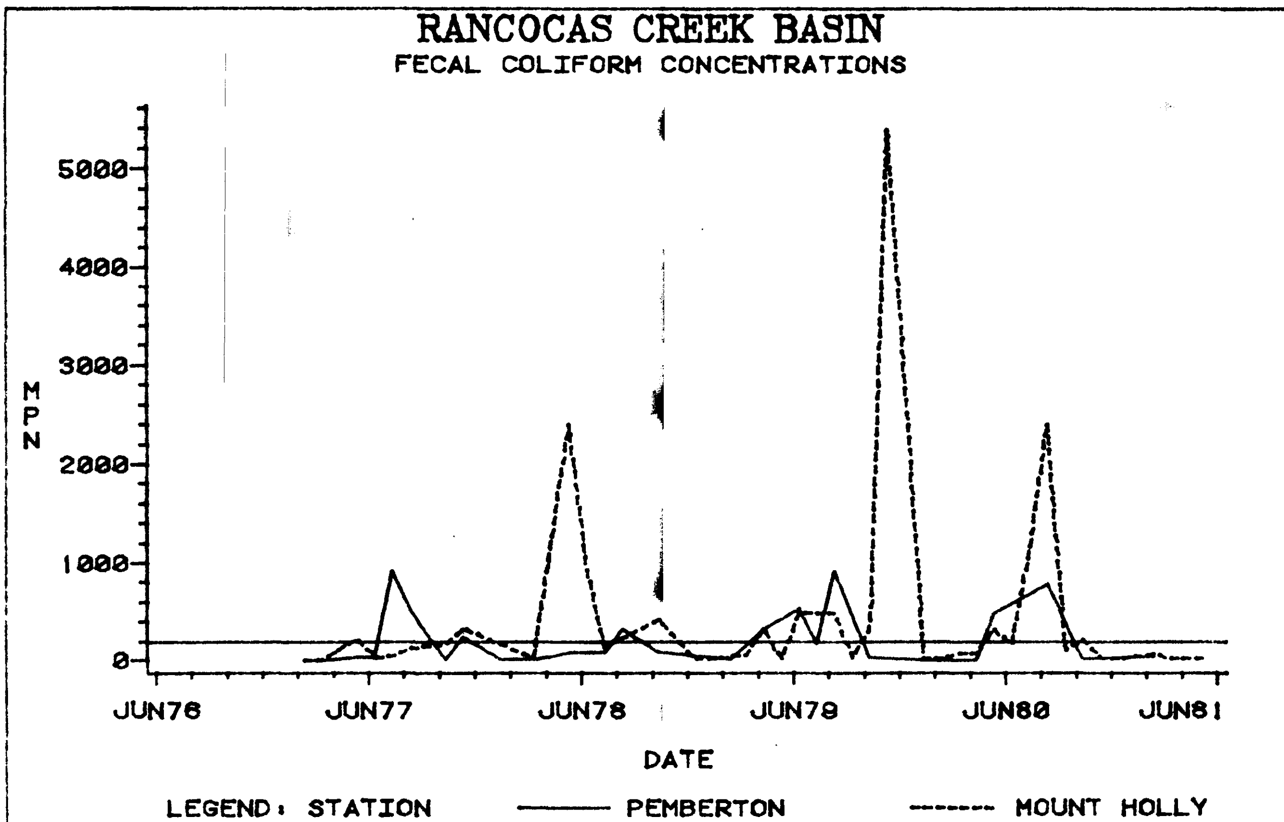

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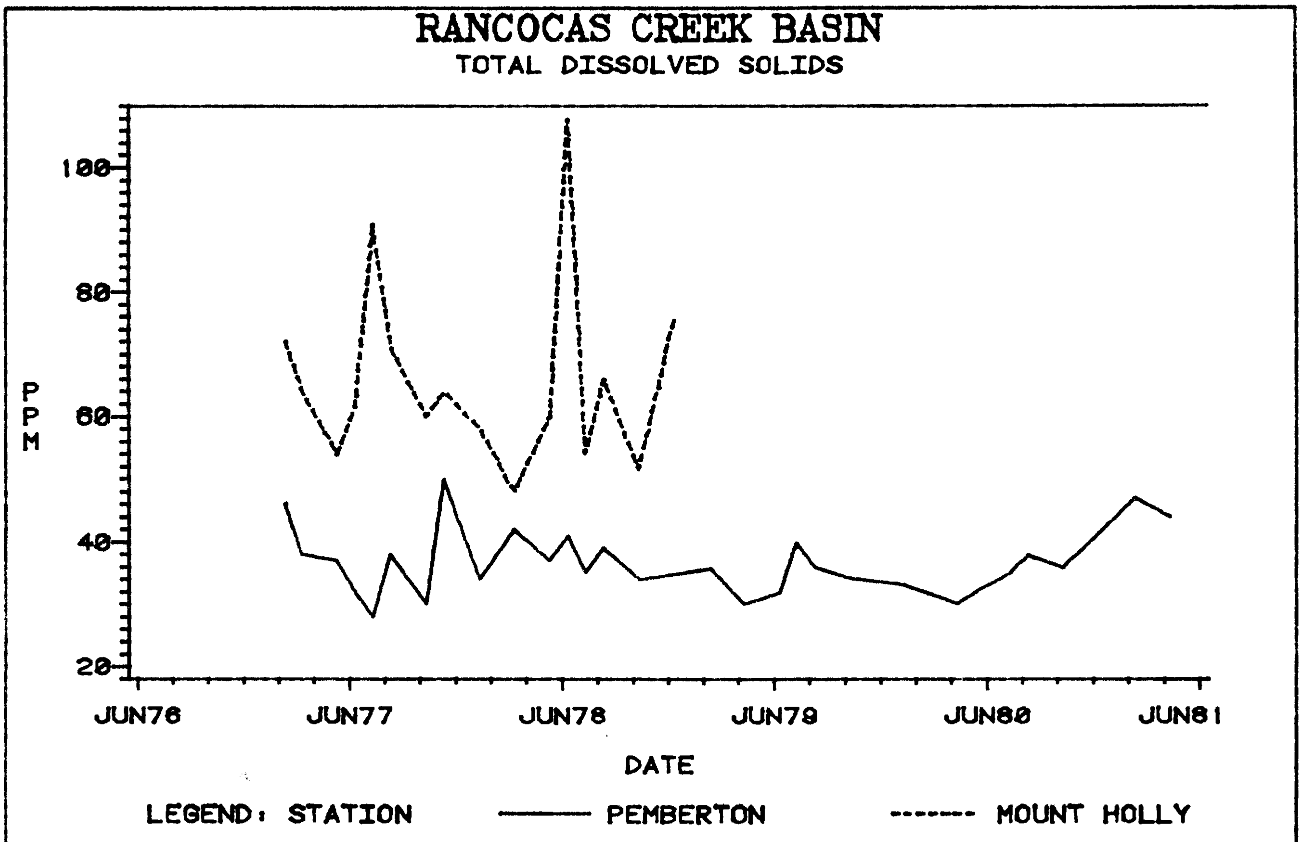

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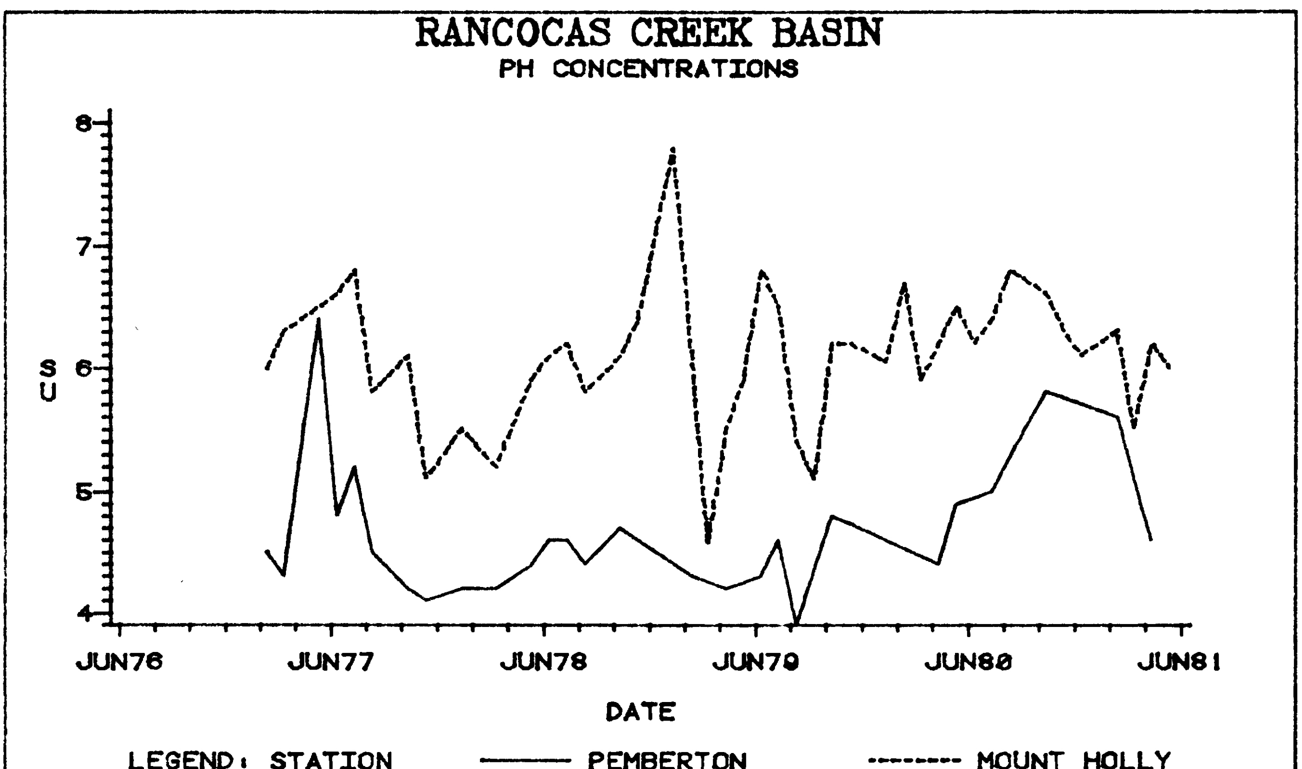

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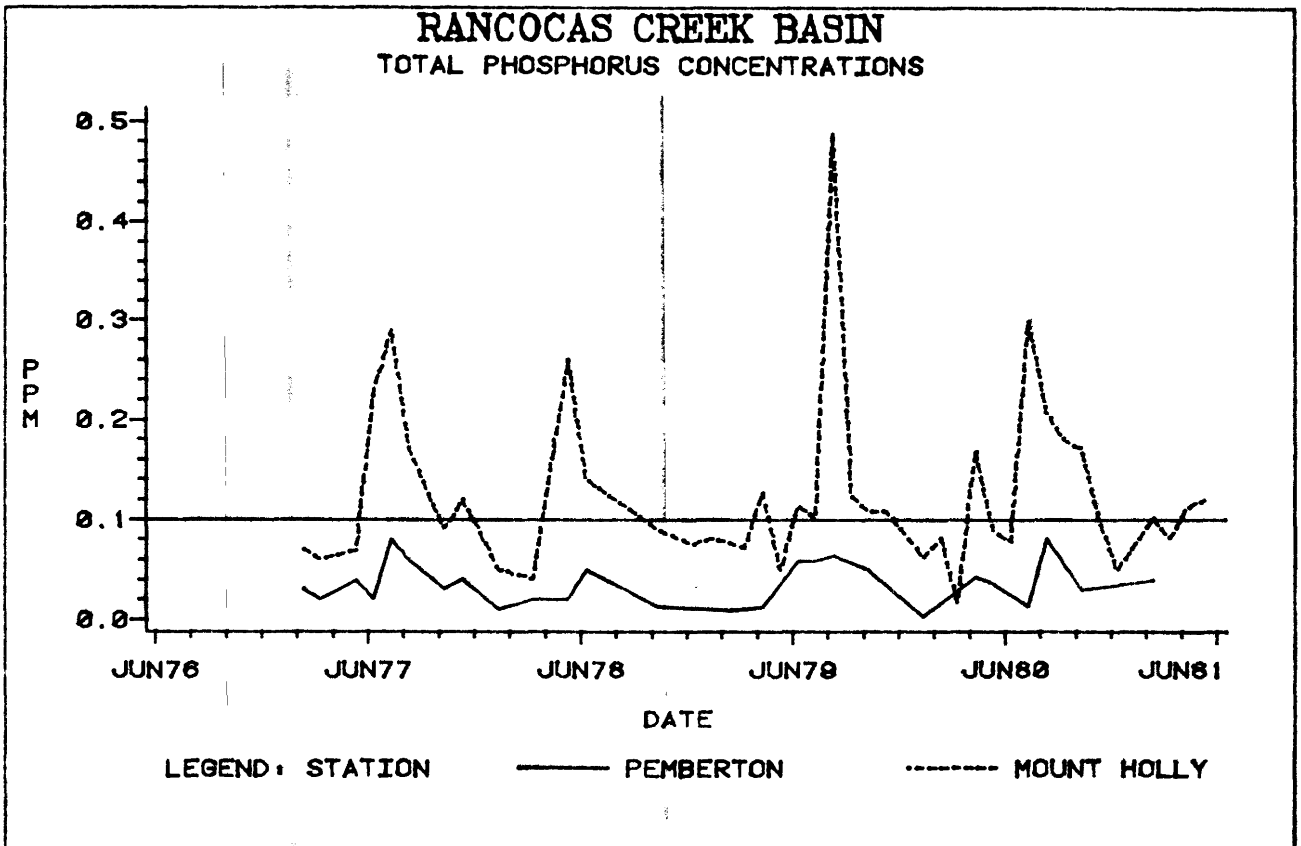

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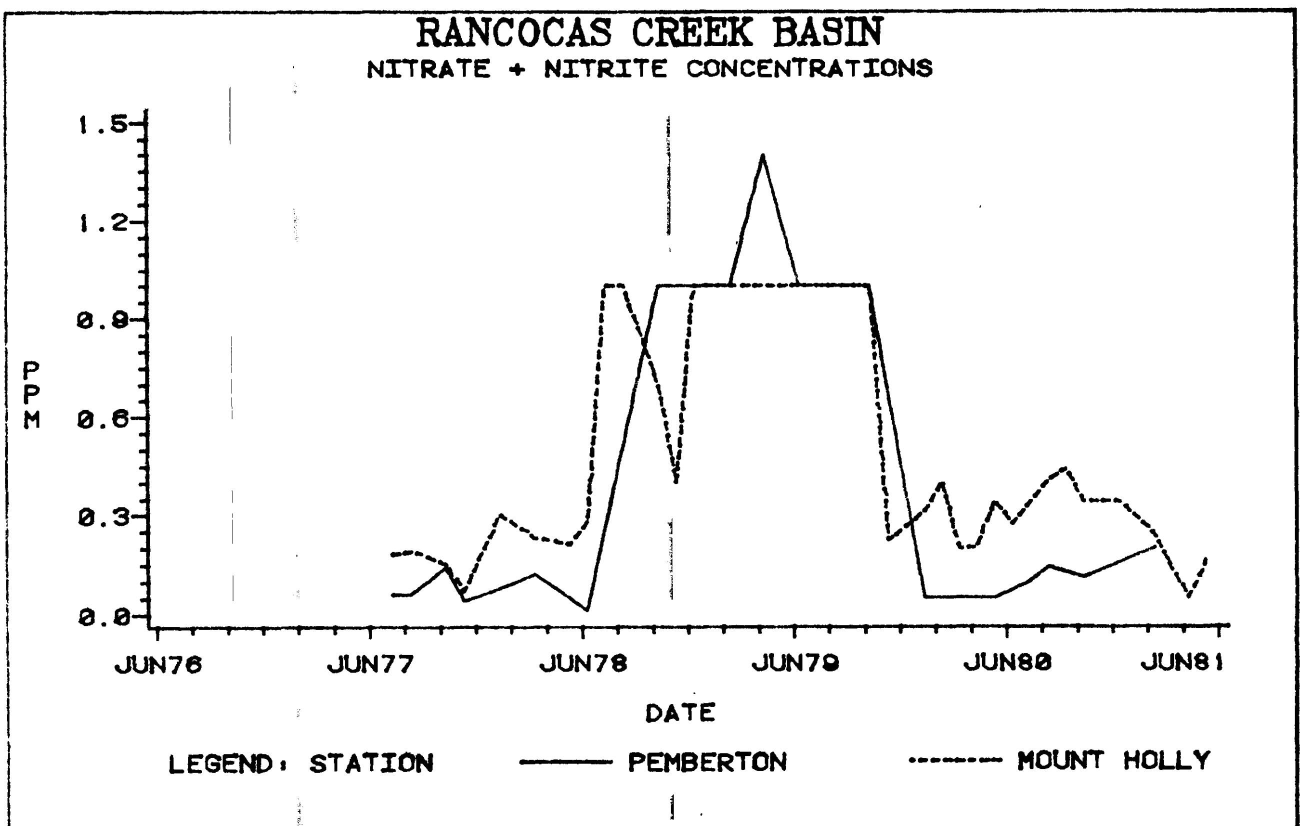

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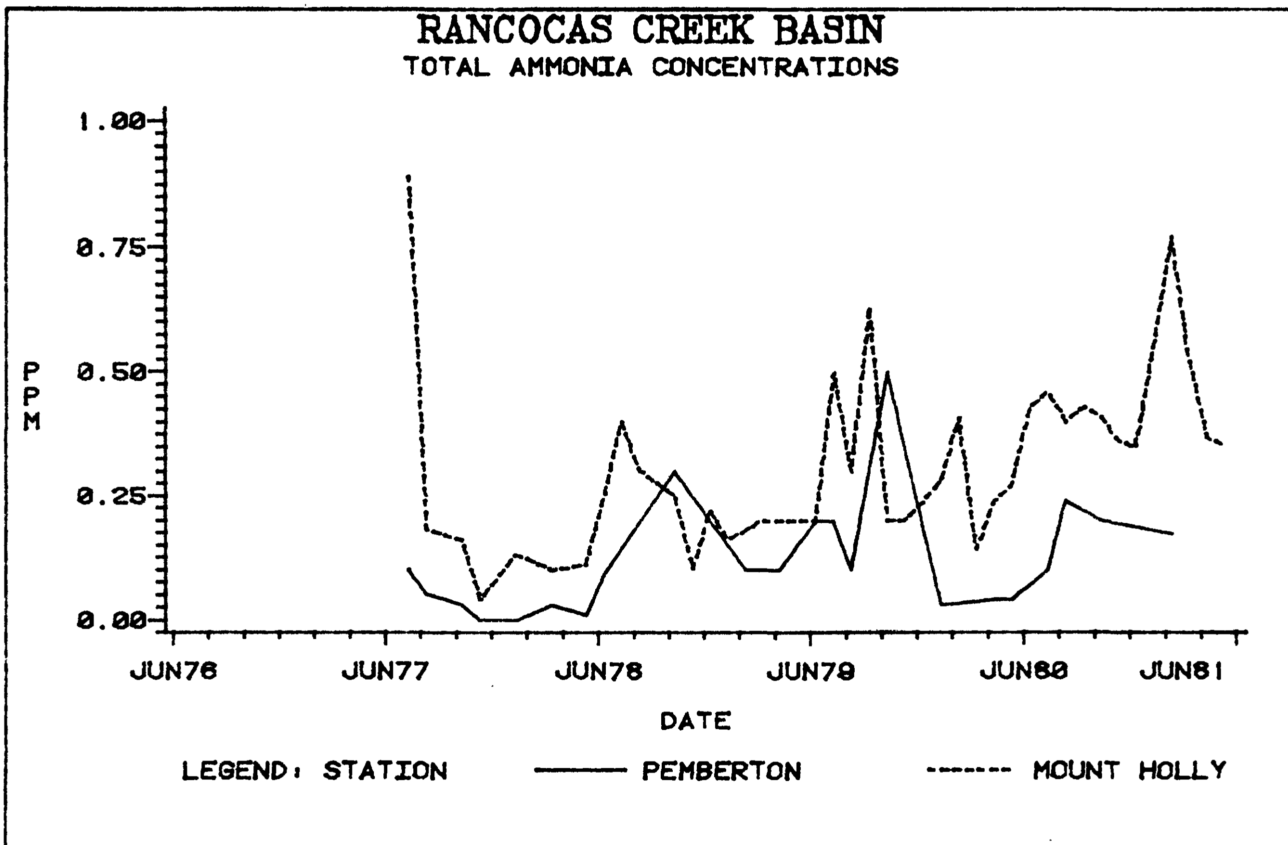

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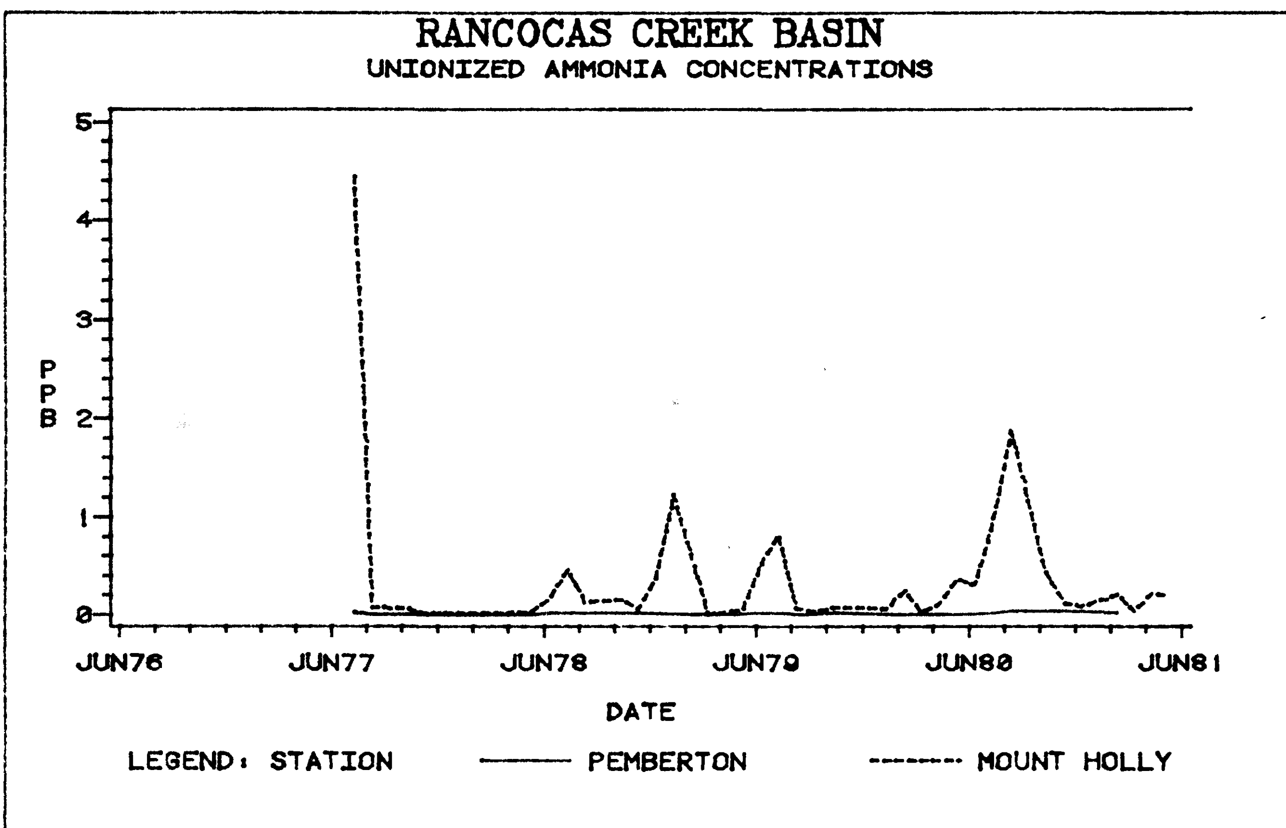

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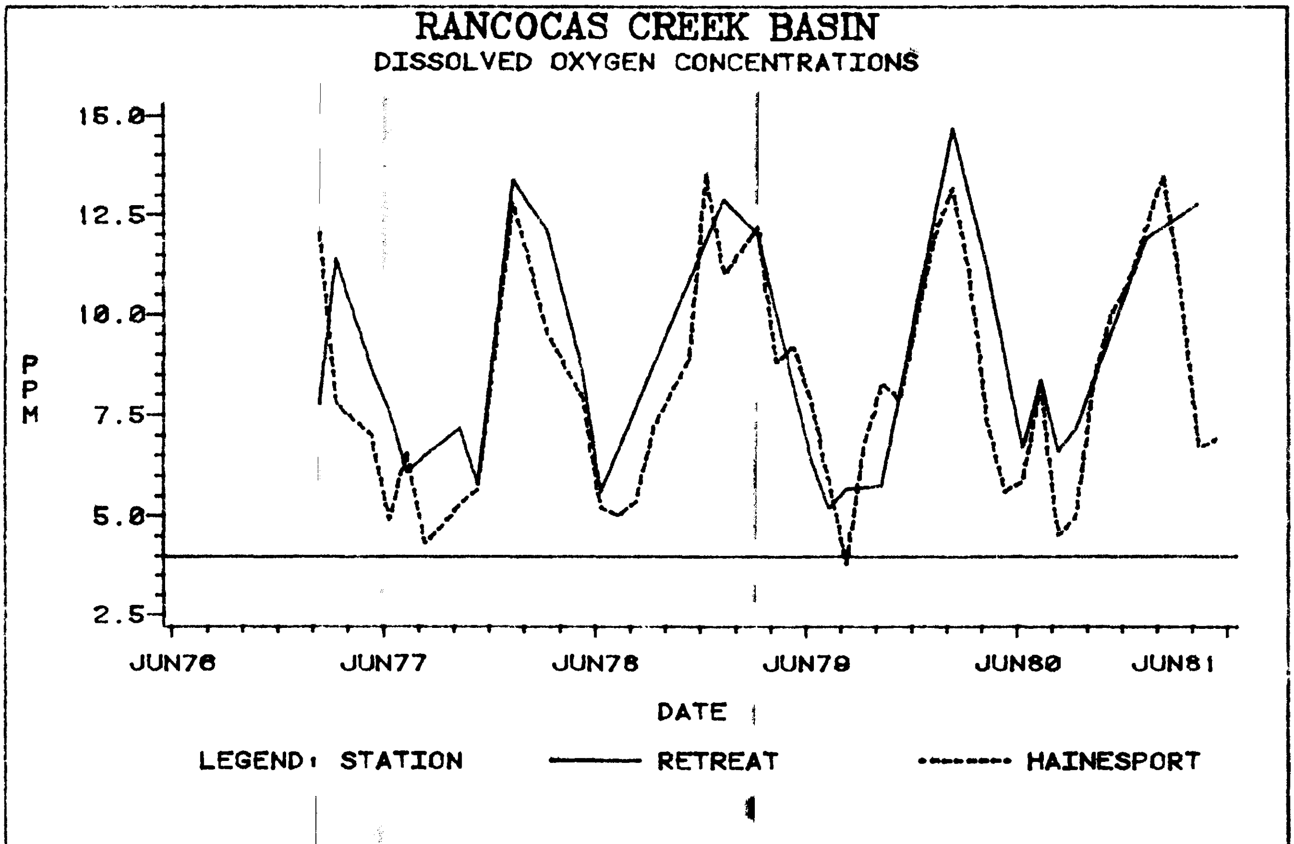

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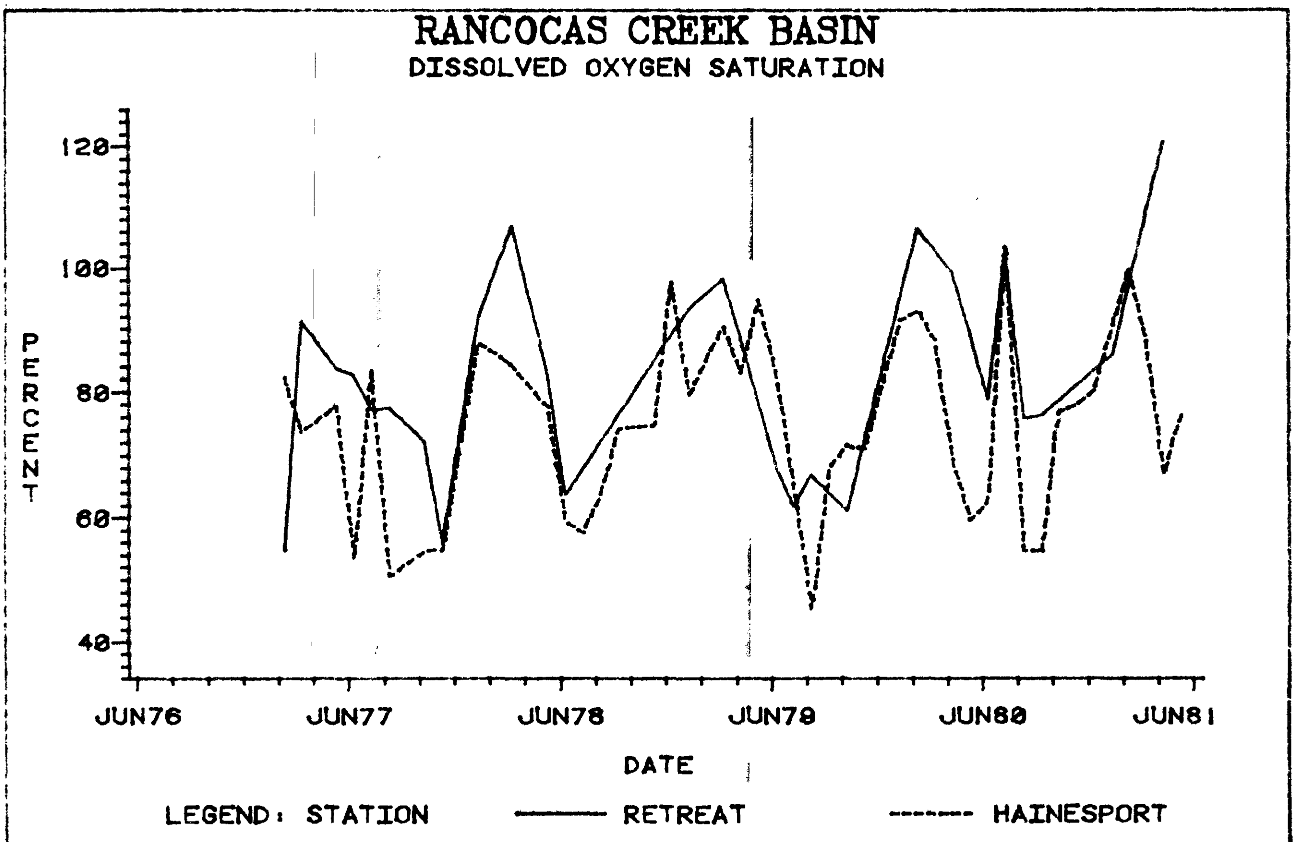

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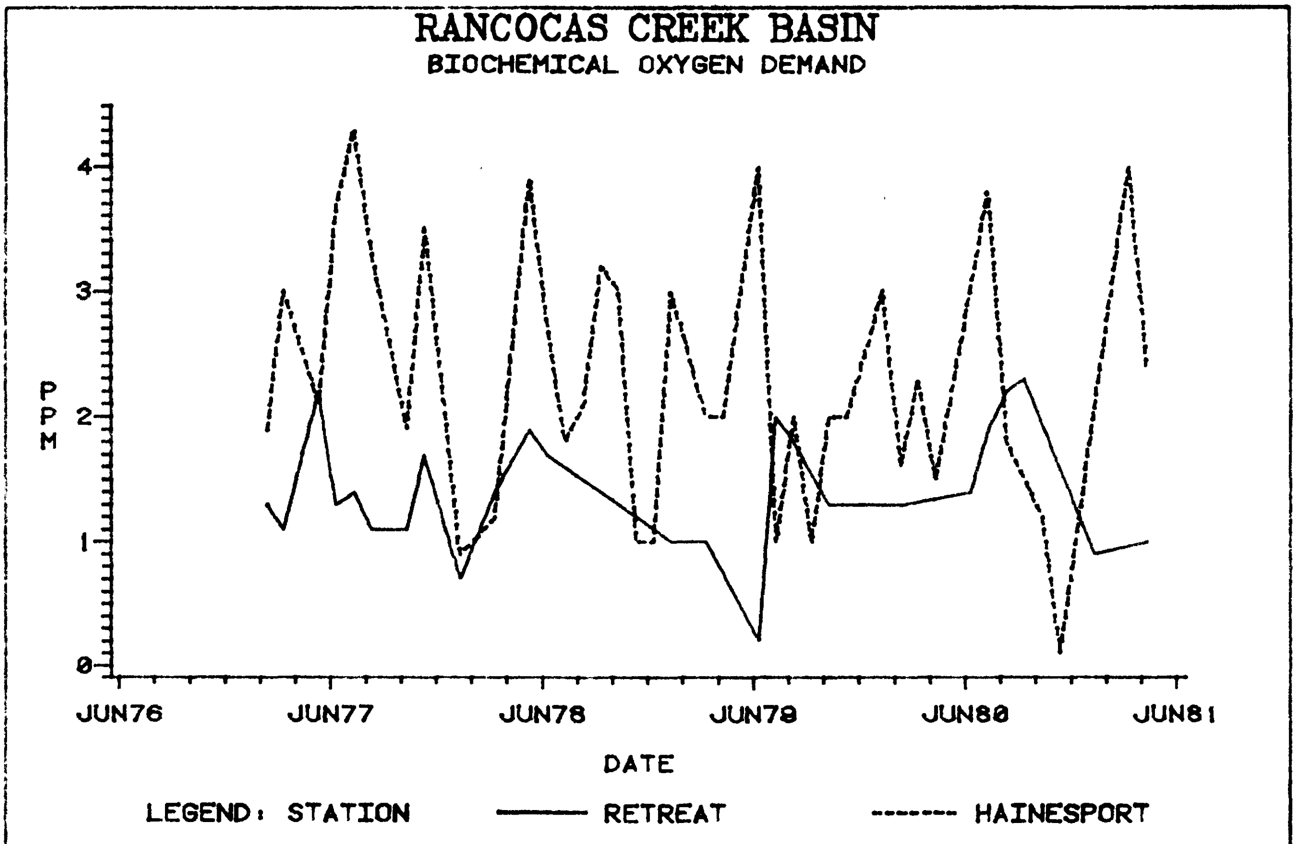

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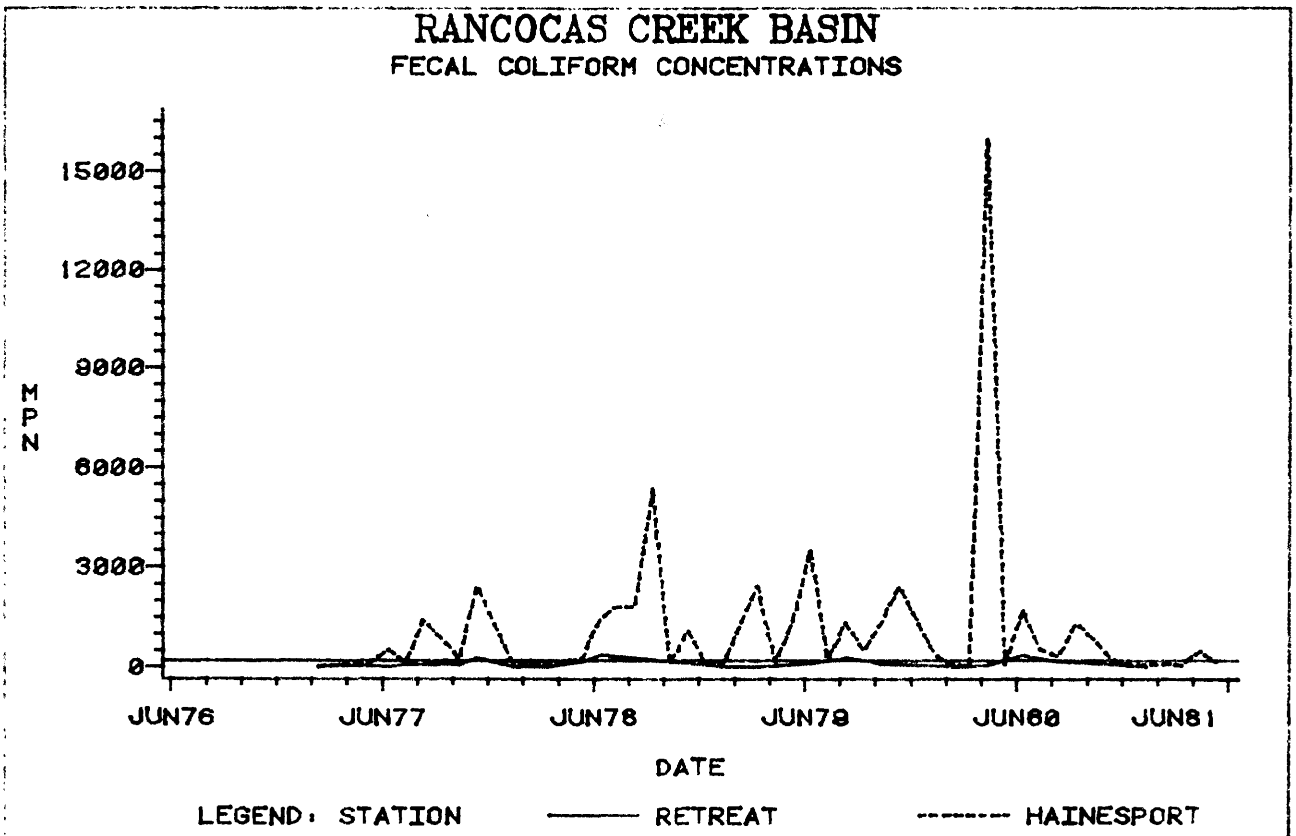

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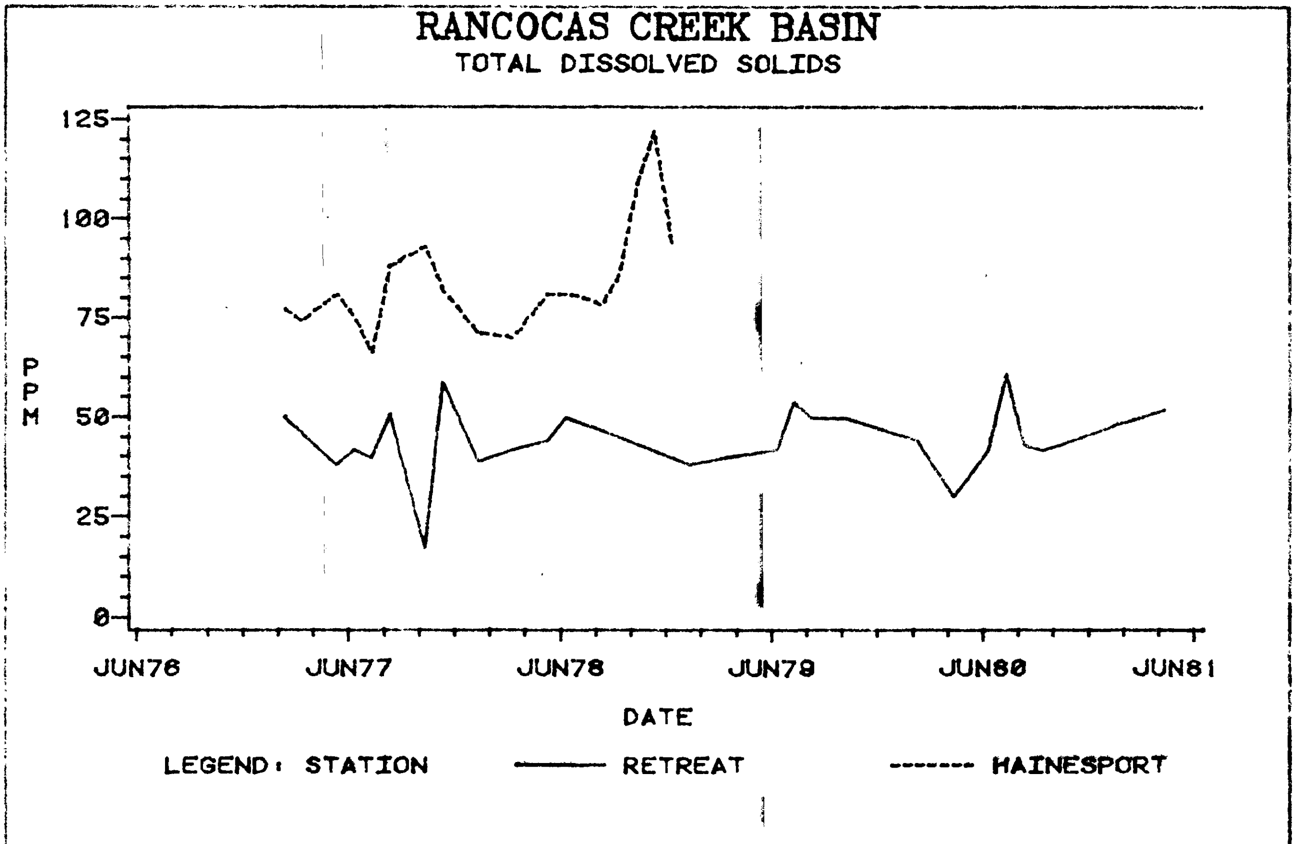

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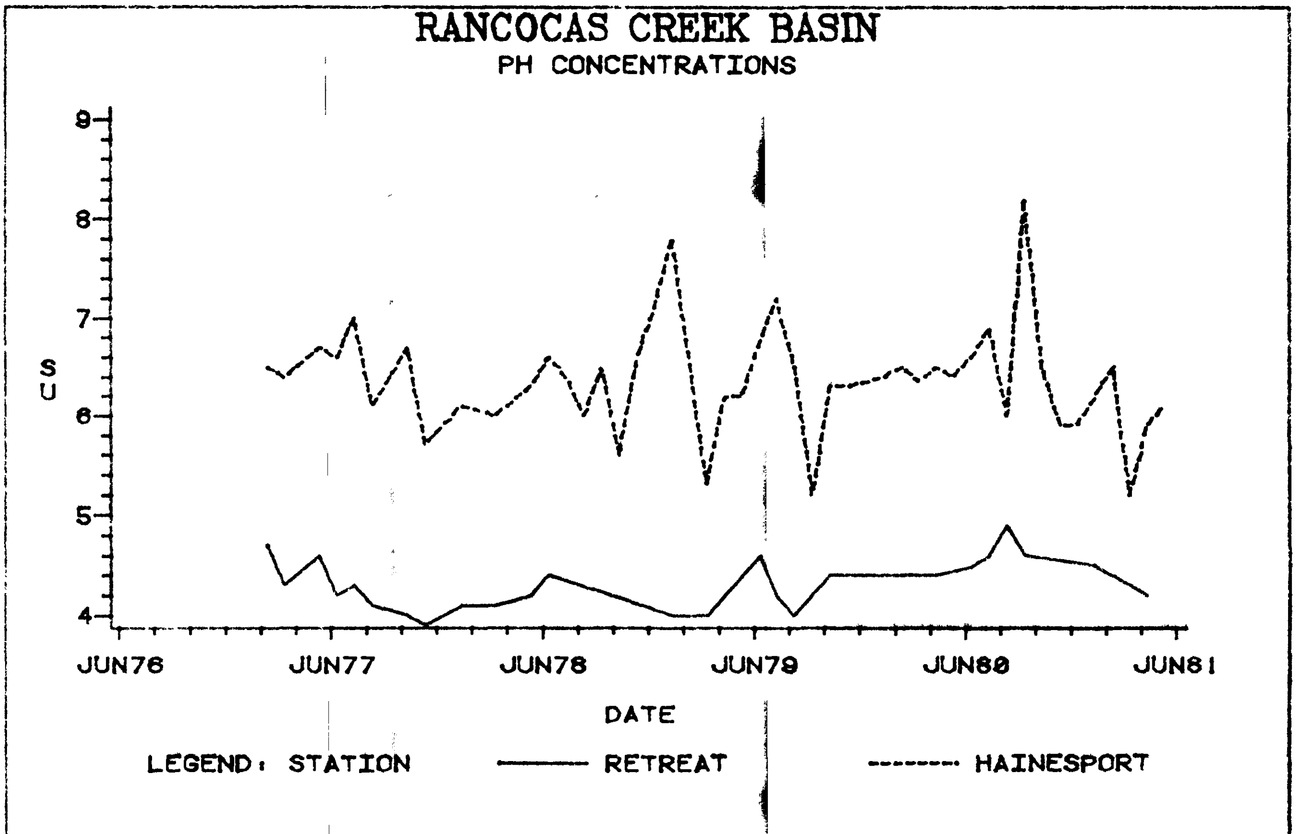

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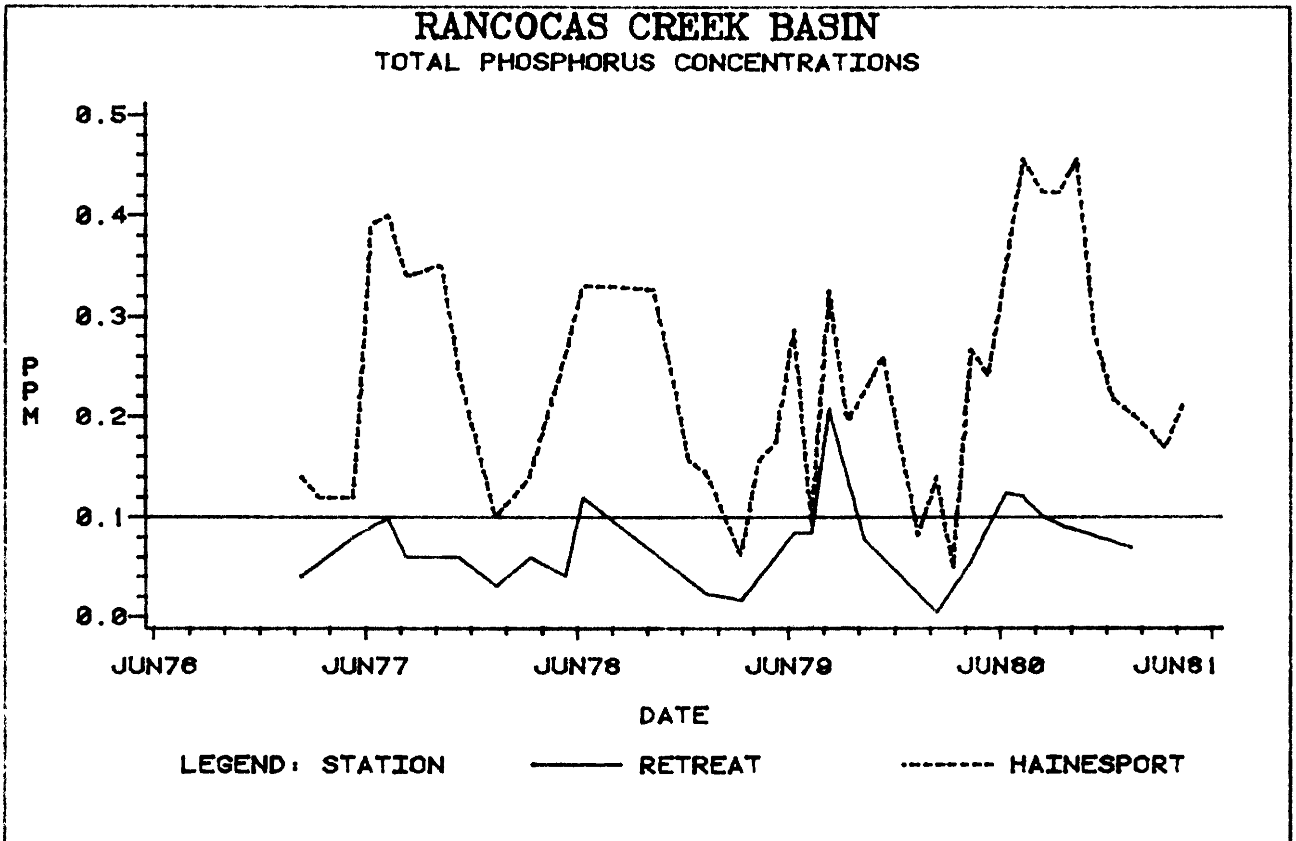

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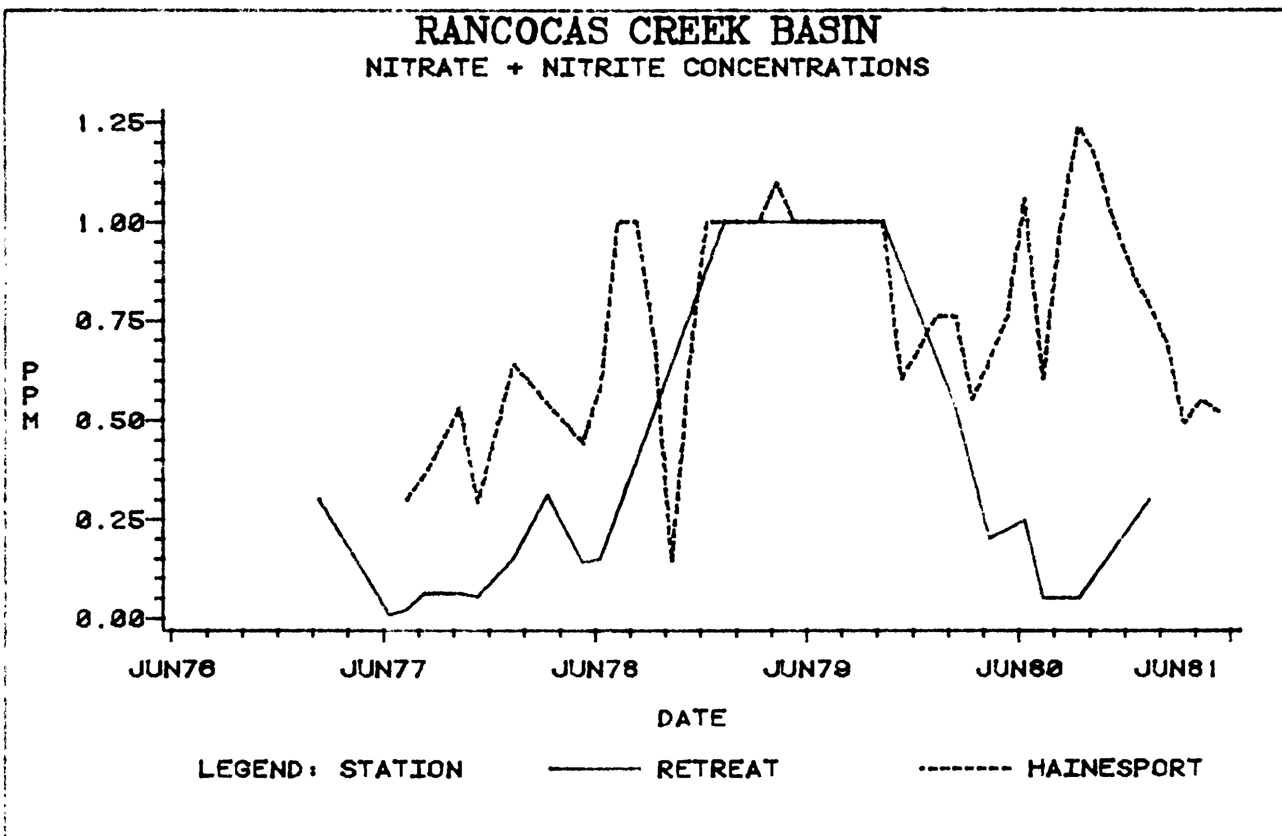

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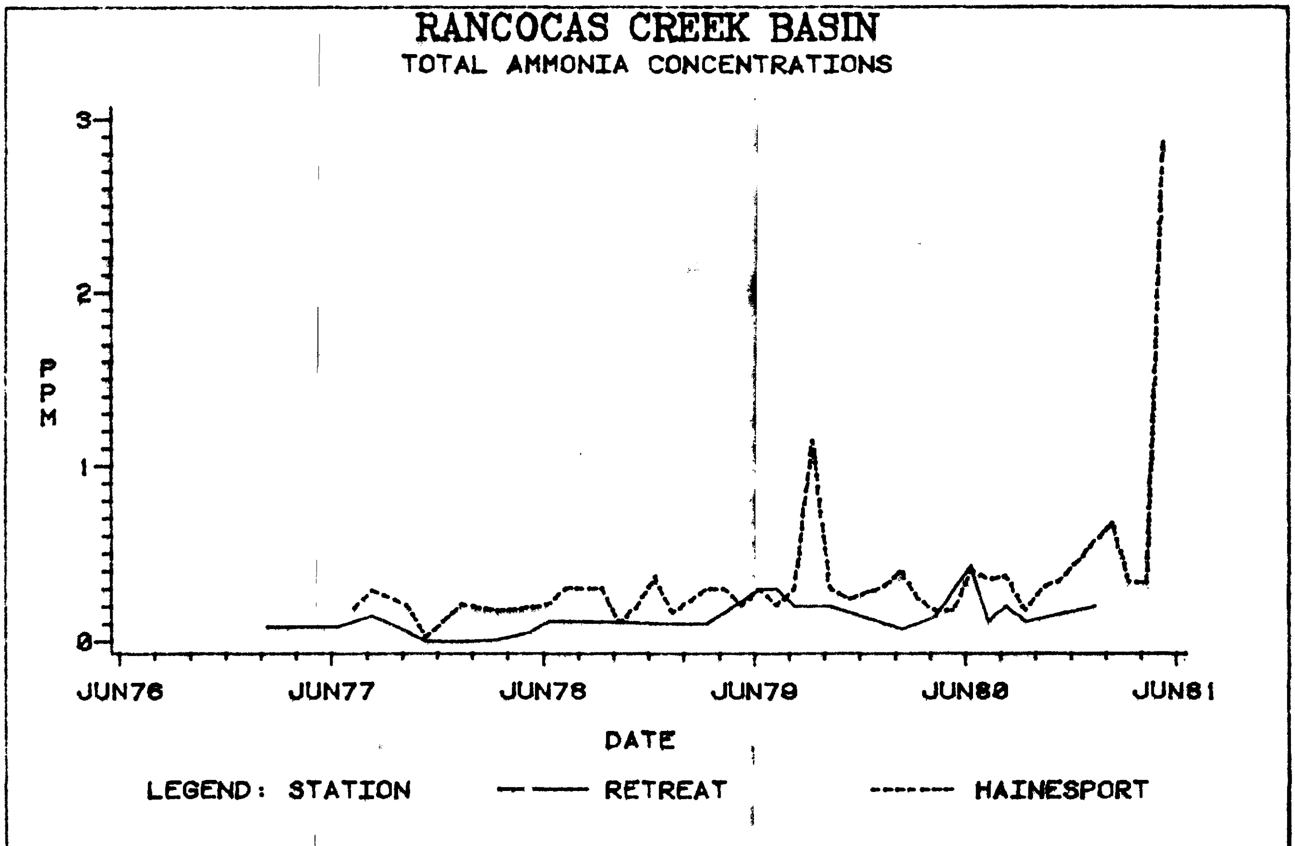

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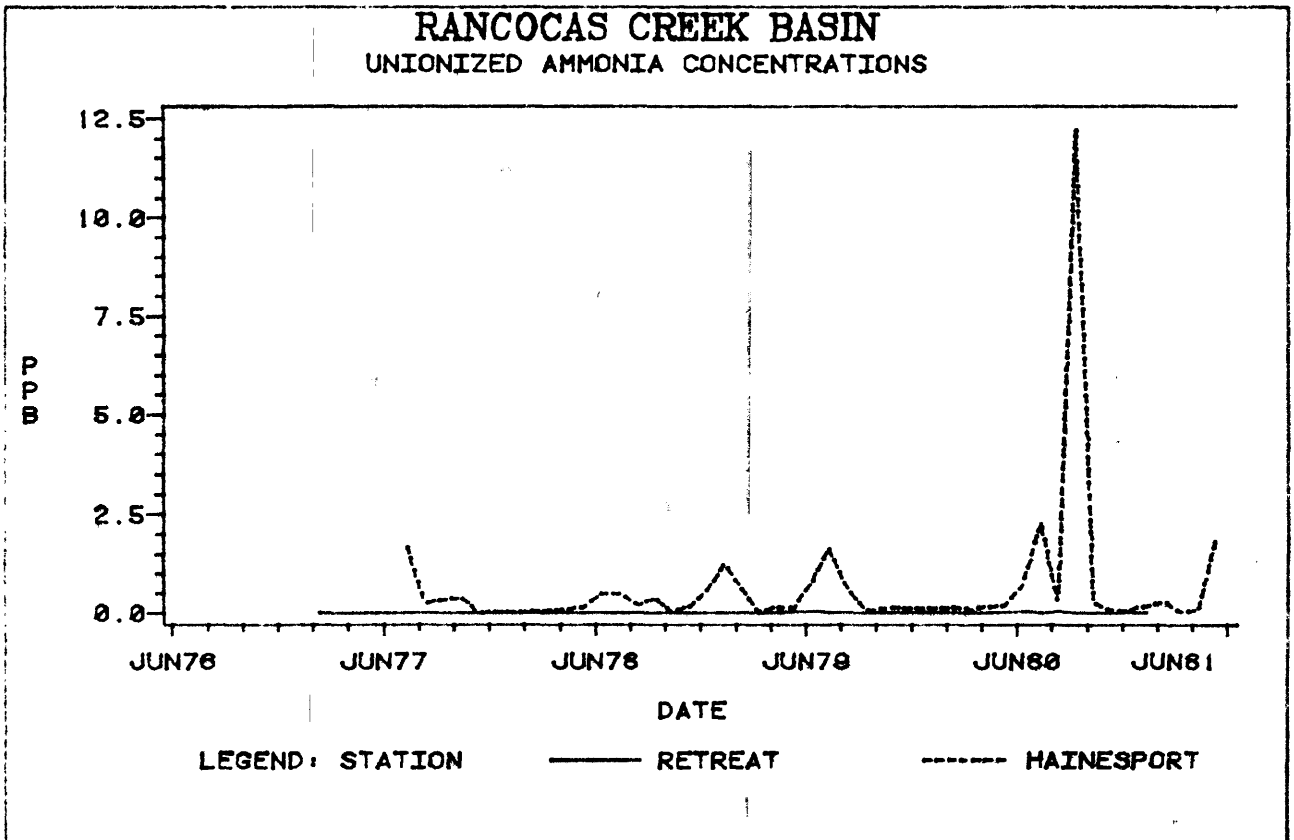

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DISCHARGE INVENTORY - - - RANCOCAS CREEK BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
NEW JEPSEY TURNPIKE AUTHORITY	0020745	MOUNT LAUREL TWP	PARKERS CREEK	SANITARY	
MOUNT LAUREL MUA	0025178	MOUNT LAUREL TWP	RANCOCAS CR.	SANITARY	.75
PEMBERTON TOWNSHIP MUA	0024821	PEMBERTON TWP	RANCOCAS CR.	SANITARY	1.10
DELRAN SEWERAGE AUTHORITY	0023507	DELRAN TWP	RANCOCAS CREEK	SANITARY	1.10
ELIZABETHTOWN WATER CO	0004731	MOUNT HOLLY	RANCOCAS CREEK		.08
MOUNT HOLLY SEWERAGE AUTHORITY	0024015	MOUNT HOLLY	RANCOCAS CREEK	SANITARY	1.6
MOUNT LAUREL MUA	0023990	MT LAUREL TWP	RANCOCAS CREEK	SANITARY	.04
LANDFILL AND DEVELOPMENT CO.,	0033502	MT. HOLLY	RANCOCAS CREEK		
BOROUGH OF PEMBERTON	0021733	PEMBERTON TWP	RANCOCAS CREEK	SAN/SIG INDUS	.09
RIVERSIDE SEWERAGE AUTHORITY	0022519	RIVERSIDE TWP	RANCOCAS CREEK	SANITARY	.09
MOBILE ESTATES OF SOUTHAMPTON,	0028665	SOUTHAMPTON TWP	RANCOCAS CREEK	SANITARY	
WILLINGBORO MUA STP	0023361	WILLINGBORO TWP	RANCOCAS CREEK	SANITARY	3.85
NEW LISBON STATE SCHOOL	0021768	WOODLAND TOWNSHIP	RANCOCAS CREEK	SANITARY	.25
STOKES OF VINCENTOWN	0033367	VINCENTOWN	RANCOCAS RIVER		.09
PEMBERTON TWP BD OF ED-HS	0022438	PEMBERTON TWP	NO BR RANCOCAS CREEK	SANITARY	
SUNBURY VILLAGE SEWER COMPANY	0027383	PEMBERTON TWP	NO BR RANCOCAS CREEK	SANITARY	.12
SYBRON CHEMICAL DIV	0005509	PEMBERTON TWP	NO BR RANCOCAS CREEK	PROCESS & COOL.	.87
PEMBERTON TOWNSHIP BD OF ED	0031011	BROWNS MILLS	N B RANCOCAS	SANITARY	
MEDFORD TOWNSHIP	0026832	MEDFORD TWP	SW BR RANCOCAS CREEK	SANITARY	1.13
SOUTHAMPTON SEWERAGE CO	0023736	SOUTHAMPTON TWP	SO BR RANCOCAS CREEK	SANITARY	.20
MOORESTOWN TWP	0029548	MOORESTOWN	KENDALL'S RUN-RANCOCAS CREEK	PROCESS WASTE	.02
MEDFORD LAKES	0021326	MEDFORD LAKES BOROUG	ATNA RUN	SANITARY	.46
WILLINGBORO MUA WATER PLANT	0030741	WILLINGBORO	MILL CREEK	WATER TREATMENT	.08
EVESHAM MUA	0024031	EVESHAM /TWP/	RANCOCAS CREEK	SANITARY	1.00

I. PENNSAUKEN CREEK, BIG TIMBER CREEK AND COOPER RIVER

Basin Description

Pennsauken Creek, Big Timber Creek and Cooper River are all tributaries to the Delaware River which drain the highly developed western Camden County area. The Pennsauken Creek watershed drains 33 square miles of southwestern Burlington County and northern Camden County. There are two major branches of Pennsauken Creek; the North Branch which is in Burlington County and the South Branch that serves as the boundary between Burlington and Camden Counties before joining the North Branch at Cinnaminson and Pennsauken. Pennsauken Creek is tidal along its 3 mile mainstem and in the first few miles of the North and South Branches. The Cooper River watershed, with the exception of a very small area in Burlington County, is located in northwestern Camden County and discharges to the Delaware River at Camden directly opposite Philadelphia. The Cooper River is formed by the confluence of the North and South Branches and drains a total of 40 square miles. Several small lakes regulate the streams in the upper Cooper River watershed, while the Cooper River in its lower portion is characterized by wide tidal flats. Big Timber Creek, the third watershed in this segment analysis, forms the boundary between Camden and Gloucester Counties draining 63 square miles. Big Timber Creek also has, as major tributaries, North and South Branches that originate in central Camden and northern Gloucester Counties, respectively.

The three watersheds all experience similar land use patterns as development increases downstream. Land use in the Pennsauken Creek watershed is predominately suburban with 47 percent of the basin developed, 23 percent farmland and the remaining 30 percent forested (Tri-County Water Quality Management Plan, 1977). Farming exists in the upstream areas, particularly along the North Branch; while the South Branch is located in mostly developed areas mixed with farmland. Housing developments and large commercial centers dominate the watershed from Maple Shade downstream. Industrial activity is common in sections of the basin near the Delaware River. Recent development has been greatest in the eastern half of the Pennsauken Creek watershed, particularly in Mount Laurel Township. Population growth in the watershed from 1970 to 1980 was quite small due to the heavy development which existed prior to 1970. Fourteen dischargers are located in the Pennsauken Creek watershed, the largest being a Cherry Hill Township treatment plant. Most of the watershed is currently utilizing sanitary sewers, with only portions of Mount Laurel Township using on-site disposal systems. Facilities planning (201) activities are underway for all sections of the Pennsauken Creek watershed. Water uses appear to be limited. Fishing has been banned by the local county health departments and the New Jersey Division of Fish, Game and Wildlife (DFGW) on Pennsauken Creek, the North and South Branches and Strawbridge

Lake since 1977 due to chlordane contamination identified in fish tissue. This ban remains in effect.

The Cooper River watershed is heavily developed along the mainstem and in portions adjacent to the North and South Branches. The upper segments of the North and South Branches of the Cooper River in Gibbsboro and Voorhees contain farmland and wooded vacant lands. Voorhees and adjacent Lindenwold have however, experienced significant residential and commercial growth since 1970. Population levels increased 100 percent in Voorhees between 1970 and 1980, and 50 percent in Lindenwold during the same period. The highly suburbanized region of Cherry Hill, Haddonfield and Haddon have experienced little or no growth in the last decade; while urbanized Camden City has lost a significant number of residents (nearly 20,000) in the 1970-1980 period. Much of the Cooper River and tributaries have wooded areas on both banks which make the streams attractive in this developed region. Twenty-three discharges have been identified in the Cooper River basin. Most of these are municipal/institutional discharges. The largest discharger is the Lindenwold MUA treatment plant (2.4 mgd to the South Branch). The City of Camden discharges approximately 30 mgd to the Delaware River. The entire Cooper River basin is sewered with the exception of the eastern portion of Cherry Hill and Voorhees Townships, and much of Gibbsboro. The Camden County MUA is responsible for 201 facilities planning for the entire Cooper River basin.

The Cooper River watershed provides many recreational opportunities. Numerous lakes in the upper watershed provide sources for boating and fishing. Linden Lake, Hopkins Lake and Evans Lake have excellent catfish, carp and sunfish populations for fishing. Hopkins Lake and Square Circle Lake are also stocked with trout by the NJ DFGW. Cooper River Lake Park, along the Cooper River in Cherry Hill and Collingswood is used intensively as a source of recreation for the residents of the area. However, Cooper River Lake and the portions of Cooper River downstream from Cooper River Lake are closed for fishing due to the presence of chlordane in fish tissue.

The Big Timber Creek watershed is primarily suburbanized. However, there are areas of extensive forests in the headwaters, as well as urban cities downstream of the North Branch and South Branch confluence. The North Branch drains the suburban municipalities of Clementon, Lindenwold and Stratford.

The South Branch currently contains more open wooded and farm lands than the North Branch, but it is also experiencing greater residential and commercial growth than the other regions of the watershed. Gloucester Township in Camden County and Washington Township in Gloucester County had population increases from 1970 to 1980 of 59 and 57 percent, respectively. Development and population in the downstream segments of the Big Timber Creek basin, which includes Runnemede, Bellmawr and Deptford has stabilized with no increases from 1970 to 1980. As with the Cooper River and Pennsauken Creek watersheds, industrial facilities are prevalent near and along the Delaware River.

Much of the Big Timber Creek watershed is served by sanitary sewers. Camden County municipalities in the watershed generally have their own treatment facilities, discharging at various locations on the North and South Branches. Only portions of Gloucester and Pine Hill in Camden County are not sewered. In the future, as the Camden County regional treatment plant is completed, all the currently operating municipal plants will be eliminated and flows will go to the Camden County facility in Camden City (projected to discharge 60 mgd to the Delaware River). The sections of the Big Timber Creek basin in Gloucester County are also primarily sewered with the exception of areas in Deptford and Washington Townships. All sewage flows generated in the watershed are transferred out of the basin to the Gloucester County regional treatment plant at Paulsboro, which was recently upgraded and enlarged. Two 201 facilities planning areas (Camden County MUA and Gloucester County MUA) cover the entire Big Timber Creek watershed. Eighteen dischargers are located in the watershed, the largest being a discharge to Big Timber Creek by Gloucester Township.

Water uses in the Big Timber Creek watershed appear to be limited to non-contact recreation. Many lakes and ponds (such as Blackwood Lake, Grenlock Lake, Hirsch Pond and Nashs Lake) provide good fishing locations for largemouth bass, catfish, carp and sunfish. In addition, the Rowands Pond Wildlife Management Area in Camden County provides fishing opportunities and is stocked with trout by the NJ Division of Fish, Game and Wildlife. Big Lebanon Run to Grenlock Lake on the South Branch is also stocked with trout. Mason's Run, a tributary to the North Branch of Big Timber Creek, contains reproducing brook trout populations. Almonesson Lake in Deptford Township, once a bathing lake, has been closed because of fecal coliform bacteria contamination.

All waters in the Pennsauken Creek, Cooper River and Big Timber Creek watersheds have been classified by the NJ Water Quality Standards as FW-2 Nontrout, with the exception of Mason's Run which is considered FW-2 Trout Production.

Water Quality Assessment

Conventional Parameters

Water quality sampling from the South Branch of Pennsauken Creek at Cherry Hill, the Cooper River at Lindenwold and Haddonfield, and the South Branch of Big Timber Creek at Blackwood were used for this water quality assessment. High five-day biochemical oxygen demand, fecal coliform, and nutrient concentrations are the major factors for generally poor water quality conditions in the heavily developed drainage areas of Pennsauken Creek, Cooper River and Big Timber Creek. Dissolved oxygen levels were, for the most part, within the minimum standard of 4.0 mg/l at the Cherry Hill and Blackwood stations, even during summer months. Pennsauken Creek biochemical oxygen demand levels were frequently high, occasionally exceeding 10 mg/l at the Cherry Hill station. South Branch Big Timber Creek exhibited BOD_5 concentrations generally from 1.0 to 4.0 mg/l for the period. The Cooper River at Lindenwold (at the outlet of Linden Lake) was sufficiently aerated year-round. Five-day biochemical oxygen demand levels, under 4.0 mg/l at Lindenwold, increased in the downstream direction to frequently greater than 10 mg/l at Haddonfield. Since the excessive BOD_5 levels had little impact on daytime oxygen depletions, (particularly at Cherry Hill and Haddonfield), the elevated daytime dissolved oxygen levels were probably due to excessive algal production in the streams.

Extreme fecal coliform concentrations also indicated severe problems at Cherry Hill and Haddonfield (South Branch Pennsauken Creek and Cooper River, respectively). Values in excess of 160,000 MPN/100 ml were recorded at the Cherry Hill station in 1979 and 1980. High values were also exhibited in Big Timber Creek throughout the period. Fecal coliform levels at the Cooper River station below Linden Lake, frequently in excess of 200 MPN/100 ml until mid-1979, declined sharply and were below 200 MPN/100 ml for the remainder of the period.

Total dissolved solids concentrations were in compliance with the criterion at all stations throughout the period, with values below 100 mg/l being recorded at Blackwood (South Branch Big Timber Creek) and Lindenwold (Cooper River). Relatively neutral pH concentrations were recorded throughout the period in Pennsauken and Big Timber Creeks and in the downstream segment of the Cooper River. However, slightly acidic values were occasionally exhibited in the upstream segment of the Cooper River.

The Lindenwold station on the Cooper River exhibited generally acceptable nutrient concentrations for the period, but quite high levels were persistent downstream at Haddonfield, where approximately 70 percent of the total phosphorus values for the period exceeded 1.0 mg/l. Occasionally, severe levels of total phosphorus were also recorded from the South Branch Pennsauken Creek while concentrations in the South Branch Big Timber Creek were generally between 0.1 and 0.5 mg/l. A slight overall increase in nitrate + nitrite concentrations occurred during the period in Pennsauken and Big Timber Creeks. The Cooper River exhibited a general increase in nitrate + nitrite levels in the downstream direction, but remained under 1.5 mg/l. Total and un-ionized ammonia concentrations remained within the criteria in Big Timber Creek and Cooper River (Lindenwold). However, there were frequent elevations of total and un-ionized ammonia in the Cooper River at

Haddonfield, occasionally at very serious levels, further supporting the presence of an organic pollution problem.

Biological data was collected at the Haddonfield station and clearly reflects the impact of enrichment in the lower segments of the Cooper River. The Cooper River was one of the most degraded stations surveyed in the state. In 1977 and 1978 approximately 85 percent of the samples consisted of oligochaete worms, a single species Dero obtus accounting for 75 percent of the macroinvertebrate community. In 1979, chironomids (midges) dominated the samples, primarily the genus Polypedilum.

In reviewing the water quality assessment above with the assessments from earlier 305(b) reports, there appears to have been very little change in water quality in these streams. Conditions have remained the same in the South Branch of the Pennsauken Creek, as well as in the Cooper River at Haddonfield. There seems to be a slight improvement in the Cooper River at Lindenwold, but this may be due to the presence of Linden Lake above the sampling station and not a reduction in pollution loads. Water quality in Big Timber Creek shows lower levels of pollutants, but direct comparison cannot be made because much of the data used in prior reports were taken further downstream than Blackwood, the station analyzed here.

Toxic Parameters

A sampling program was established by the Office of Cancer and Toxic Substances Research to determine the extent of chlordane contamination found in aquatic organisms sampled from this region. The initial investigation took place in response to a pesticide contamination event. Sampling revealed elevated chlordane levels in fish throughout the entire watershed. Continued sampling in 1979 uncovered elevated levels in fish from various river sections and subsequently other river systems of this region. This widespread contamination includes Pennsauken Creek (North and South Branches), Cooper River, Newton Creek, Strawbridge Lake and Woodbury Creek. Other incidences of elevated chlordane have been found in Rancocas Creek as well. The result of this is a ban on fishing encompassing the most significant areas of contamination.

Low levels of DDT and metabolites were also found in fish tissue samples taken from Newton Creek, Newton Lake and Big Timber Creek at Grenloch Lake.

Determination of the possible sources of the contamination is continuing in an effort to understand the overall effects of this surface water perturbation on the socio-economic framework within this basin. A fishing resource utilization project will be in progress in the near future.

Problem Assessment

The water quality in these watersheds is among the worst in the State. The very high levels of BOD_5, nutrients and fecal coliform are the result of both significant point and non-point source loadings, urbanized drainage basins, and stream flows and conditions that cannot assimilate the pollution loads. In addition, widespread pesticide contamination of the aquatic life in these streams has been identified.

Pennsauken Creek experiences large amounts of municipal discharges that exceed the capacity of the stream to assimilate the wastes. In the North Branch watershed, three municipal treatment plants are in violation of their NJPDES permits. This includes the Ramblewood plant (Mount Laurel Township MUA), Moorestown STP and the Maple Shade Number 2 STP. The last two plants are also under sewer extension bans. A source of the chlordane found in the watershed has been identified as a garden supply store which was destroyed by a fire in 1978. The store contained small amounts of pesticide and fertilizers that washed into the North Branch via storm drains. This also resulted in a fish kill in the creek. Strawbridge Lake, on the North Branch, was investigated through an intensive survey in 1979 by the Lakes Management Program. The lake can be classified as eutrophic; consisting of excessive nutrients and plant growth, and unbalanced phytoplankton communities. Stormwater/non-point sources and treatment plant loadings were the main causes of the nutrients and bacteria found.

On the South Branch Pennsauken Creek, the Maple Shade Number 1 plant is not meeting treatment requirements and is under a sewer ban. This is the major problem on the South Branch which can be corrected, although there are a number of other treatment plant discharges which are currently meeting the effluent limitations. The mainstem Pennsauken Creek receives further municipal wastewater discharges with the Cherry Hill main plant being the largest discharge. This segment is also tidal and, therefore, receives pollution from the Delaware River. The combination of upstream pollution loads with tidal influences, additional dischargers, stormwater runoff and Delaware River pollution, make the mainstem Pennsauken Creek a very stressed waterway.

The problems identified above in the Pennsauken watershed are also occurring in the Cooper River watershed. The Cooper River and its tributaries receive a major amount of municipal and industrial wastewater that overwhelms the stream's ability to cleanse itself. At least 10 municipal discharges to the Cooper River will be eliminated, many of which are under sewer extension bans, when the District I Camden County MUA regional facility is completed. The Cooper River also receives combined sewer overflows in the Camden area, as well as large urban and suburban stormwater runoff contributions. An intensive survey on Kirkwood Lake, in the upper reaches of the Cooper River watershed, shows it to be highly eutrophic. It is influenced by upstream municipal discharges.

Big Timber Creek is also severely degraded because of very large pollution loads from municipal and industrial point sources, combined sewer overflows, urban and suburban storm runoff, and polluted Delaware River water brought into the creek by tidal action. Like the Cooper River, almost all municipal discharges to Big Timber Creek and its tributaries will be eliminated when the Camden County MUA District I plant is built.

The chlordane contamination problem in this area, probably the result of various non-point sources, should be investigated further to determine its origin.

Goal Assessment and Recommendations

The Pennsauken Creek, Big Timber Creek and Cooper River watersheds are all suffering from extremely high fecal coliform counts and, therefore, can be considered not swimmable. Because of the extensive urban/suburban development in these watersheds, and the associated stormwater runoff, restoration of swimmable status is unlikely even if point sources are eliminated. The streams in this segment contain most of the waters in the state which are closed to fishing (including the Pennsauken Creek watershed and the Cooper River from Cooper River Lake downstream to its confluence with the Delaware River). These waters are closed to fishing because of identified chlordane contamination in fish. Fish life seems to be in better condition in Big Timber Creek, as 16 species have been identified. The fish species are generally pollution tolerant, and several are anadromous.

Improvement to water quality in all three watersheds will take place with modification and or regionalization of municipal/institutional treatment plants. In the Pennsauken watershed the two Maple Shade plants need to be upgraded and enlarged. The same is true for the Moorestown plant. In addition, the proposed elimination of the Ramblewood STP in Mount Laurel Township is supported. On the Pennsauken mainstem, the regionalization of District II, Camden County MUA, will lessen nutrient loadings into the tidal reaches. The construction of the Camden County MUA District I regional treatment plant at Camden will have the greatest effect on water quality in the region. Not only will it involve the elimination of 38 municipal/institutional discharges to the Cooper, Big Timber and Newton Creek watersheds, but will provide secondary treatment for 75 mgd prior to discharge to the Delaware River. This will result in greatly reduced pollution loadings to the Cooper River, Big Timber and Newton Creek, and elimination of Camden City's primary discharge to the Delaware. This project will also reduce pollution in the tidal reaches of the area's many Delaware tributaries. Other corrective actions planned for in the Camden area include the elimination of combined sewer overflows to the Cooper River and Big Timber Creek. Significant water quality improvements will result in the Cooper

River and Big Timber Creek when the entire Camden County project is completed.

Further studies are needed in this region to determine what the sources of chlordane are. To eliminate the chlordane contamination, extensive stormwater controls and sediment dredging may be necessary.

PENNSAUKEN CREEK, COOPER RIVER AND BIG TIMBER CREEK STATION LIST

A. Ambient Monitoring Stations

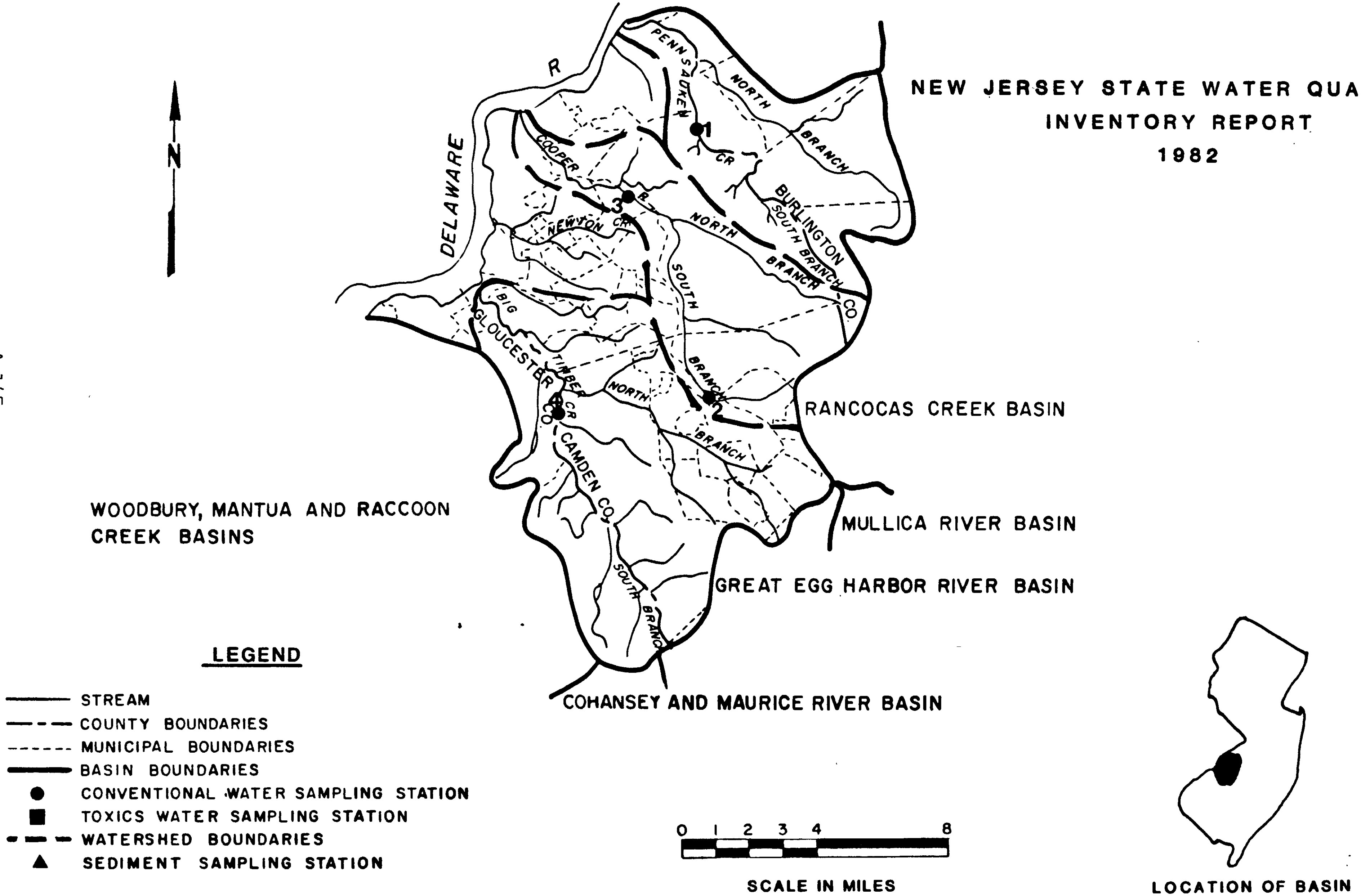
STORET Number	Station Description	Map Number
01467081	South Branch Pennsauken Creek at Cherry Hill, Camden County Latitude 39°56'30" Longitude 75°00'05" FW-2 Nontrout USGS/DEP Network At bridge on Mill Road, 1.1 miles south of Maple Shade and 3.8 miles upstream from confluence with the North Branch.	1
01467120	Cooper River at Lindenwold, Camden County Latitude 30°49'43" Longitude 74°58'55" FW-2 Nontrout USGS/DEP Network At bridge on Norcross Road, 50 feet downstream from outlet of Linden Lake.	2
01467150	Cooper River at Haddonfield, Camden County Latitude 30°54'11" Longitude 75°01'19" FW-2 Nontrout Basic Water Monitoring Program At footbridge in Pennypacker Park, 100 feet downstream from dam at outlet of Wallworth Lake and 7.7 miles upstream from mouth.	3
01467329	South Branch Big Timber Creek at Blackwood, Gloucester County Latitude 39°48'05" Longitude 75°04'27" FW-2 Nontrout USGS/DEP Network At bridge on Blackwood-Clemonton Road, 1,000 feet upstream from Bull Run.	4

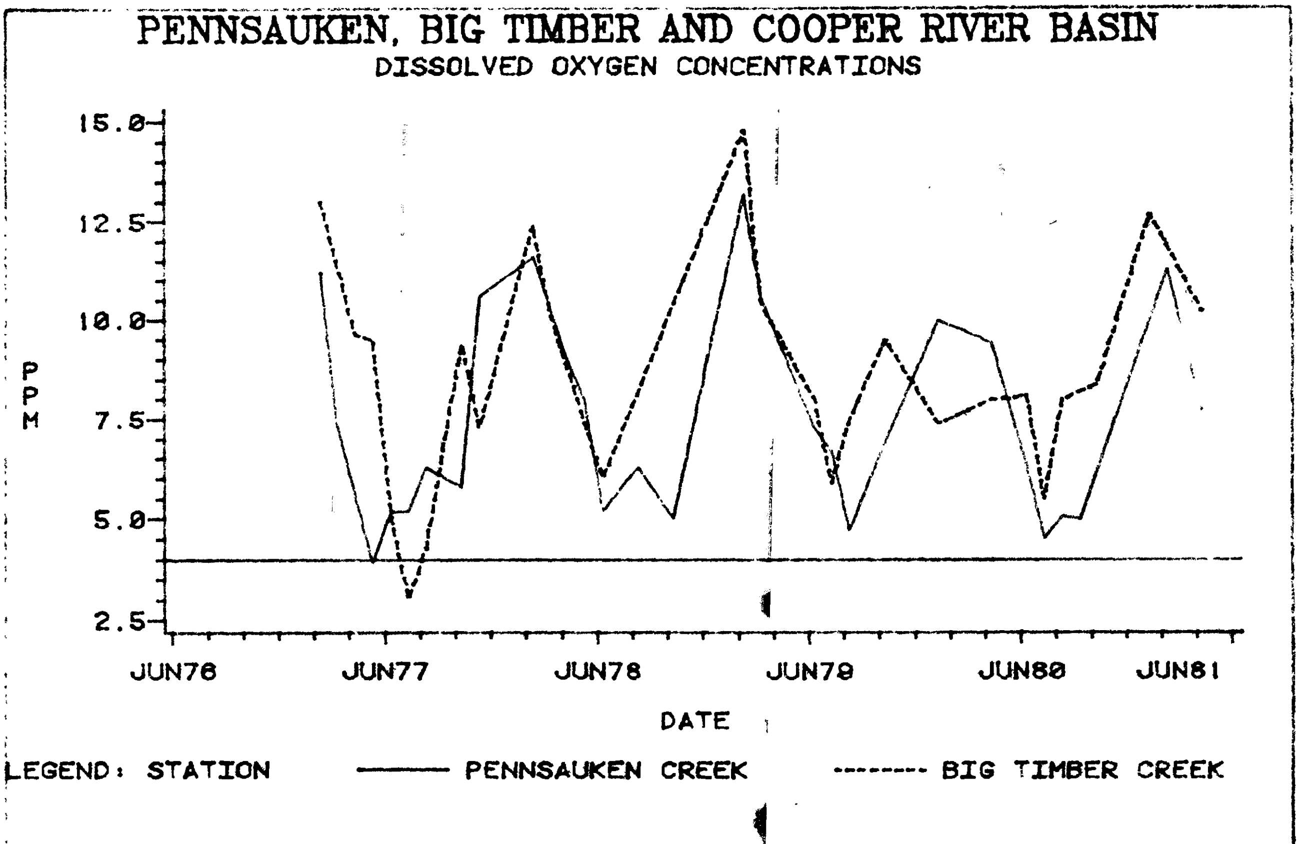
B. Toxics Monitoring Stations

Station Locations	Sampling Regime	Map Number
Intensive Survey of Cooper River and Pennsauken Creek	Fish tissue	-

PENNSAUKEN CREEK, BIG TIMBER CREEK AND COOPER RIVER BASINS (INCLUDING NEWTON CREEK)

NEW JERSEY STATE WATER QUAL INVENTORY REPORT
1982





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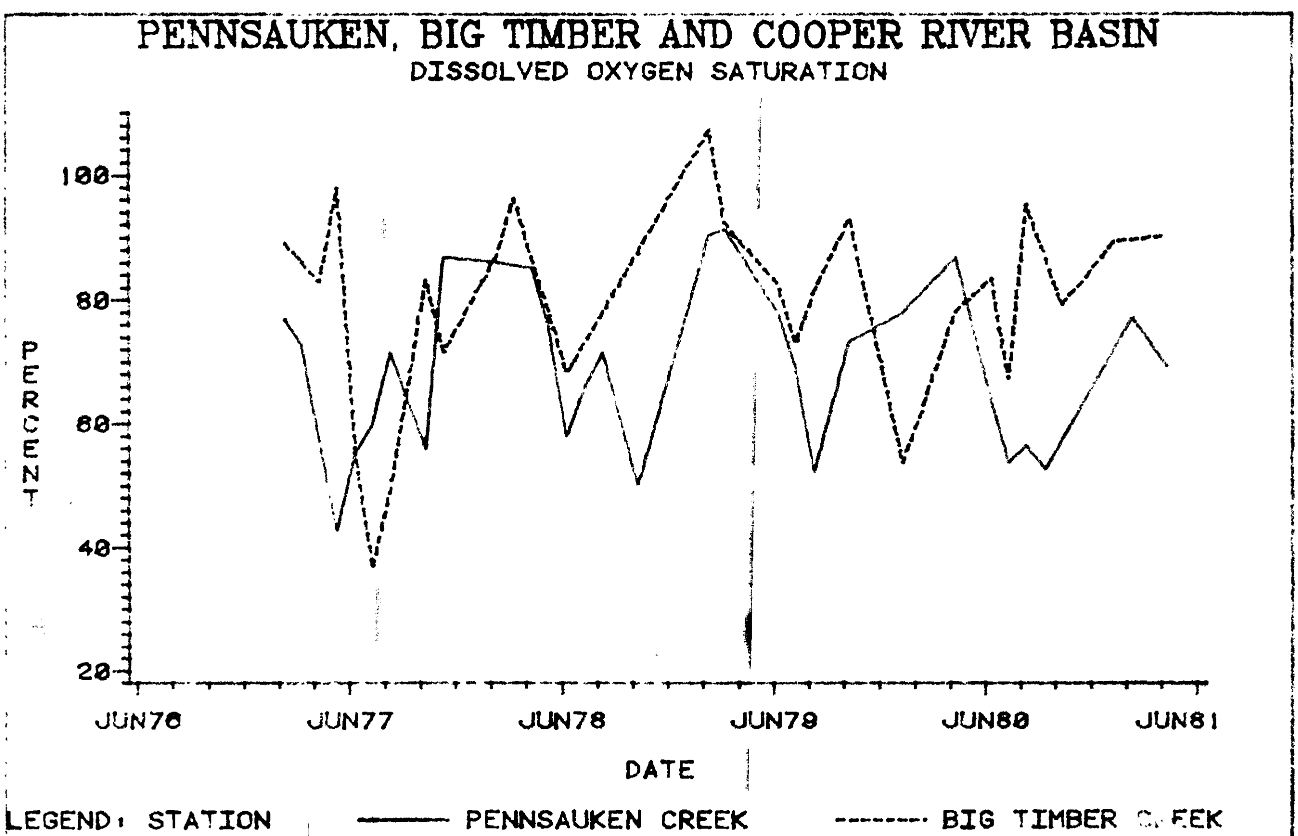

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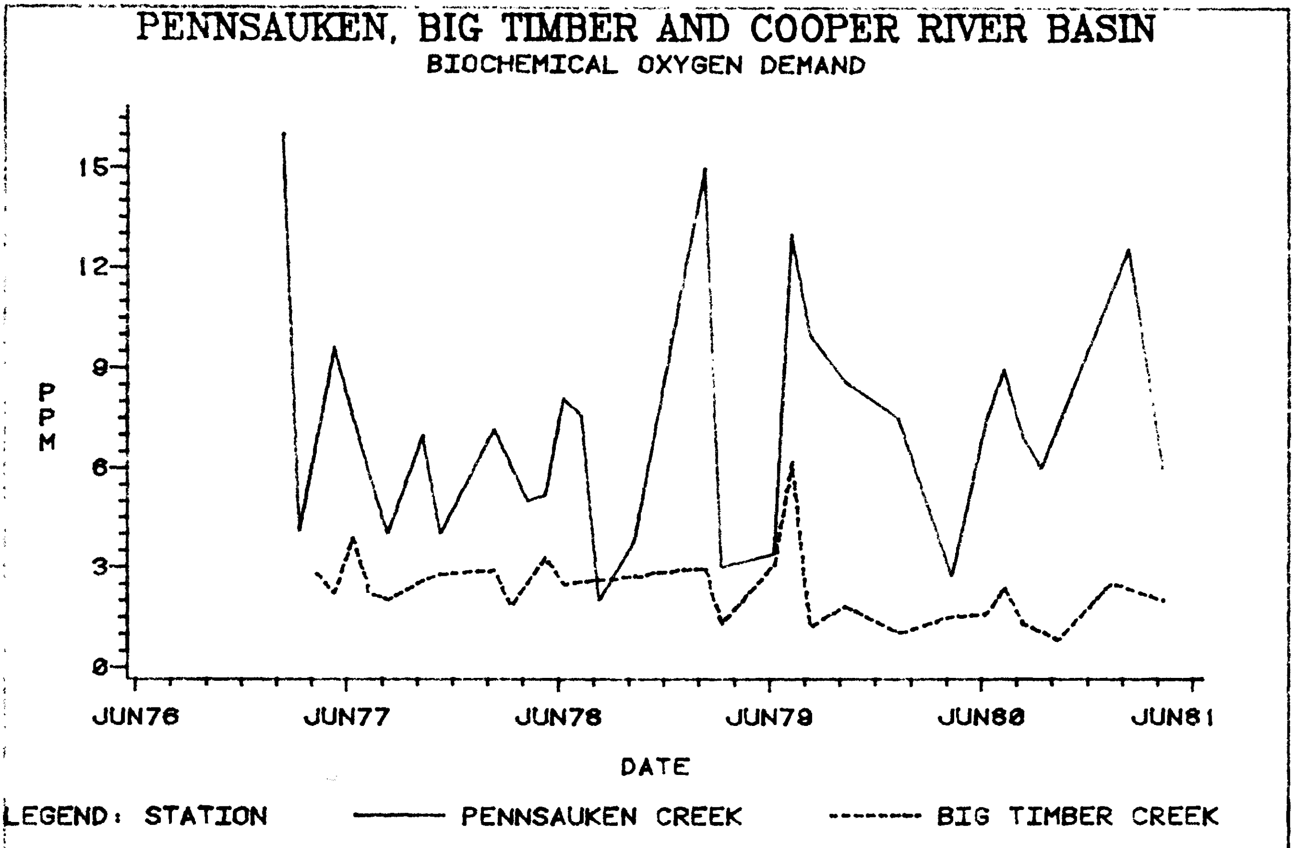

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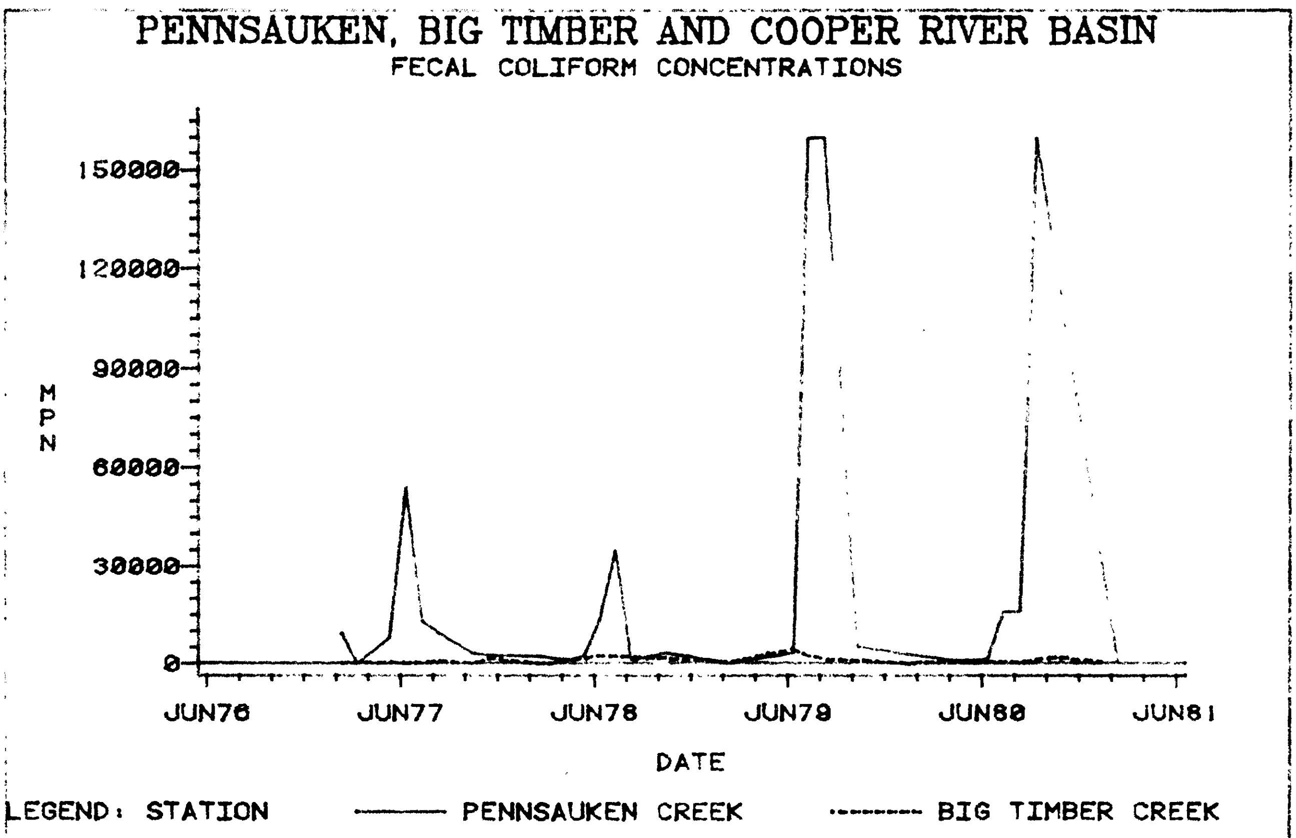

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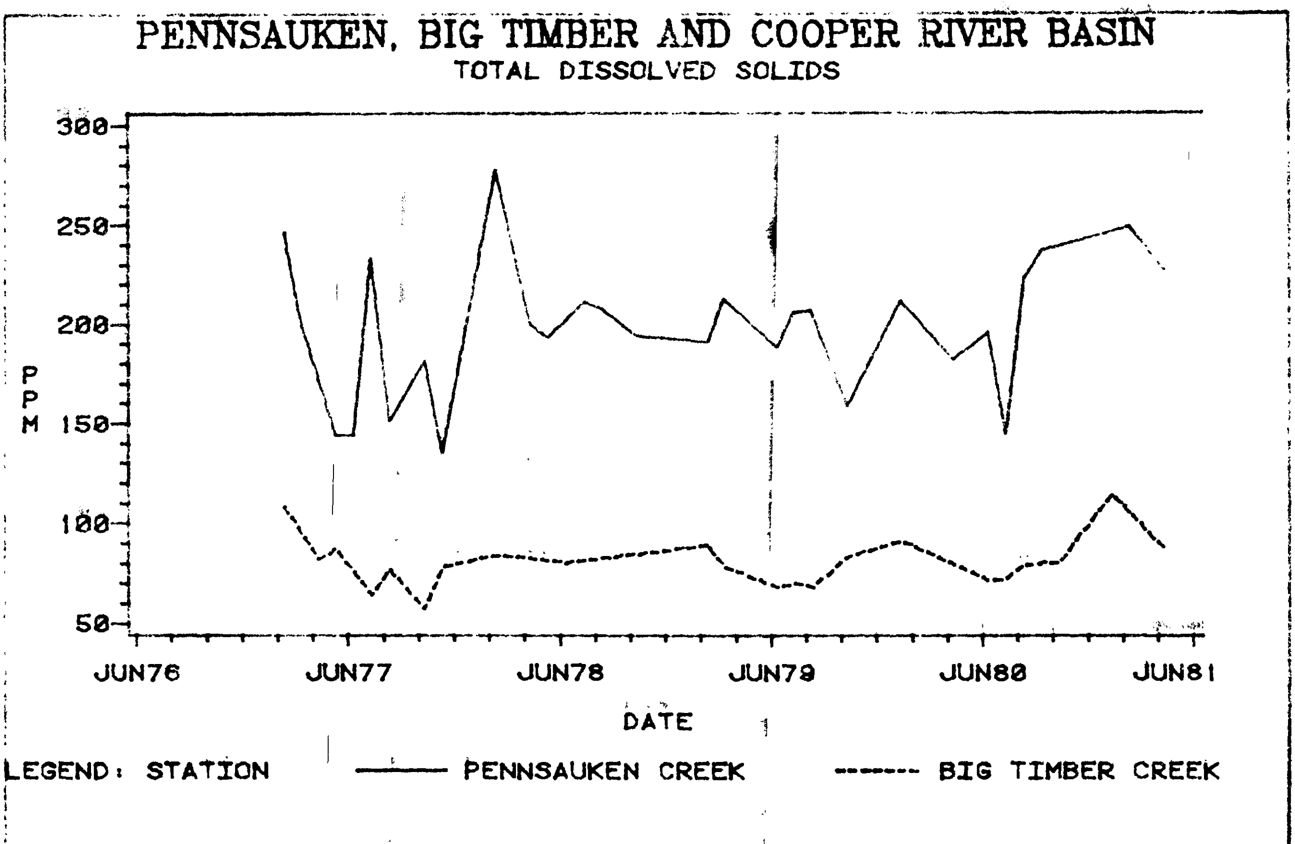

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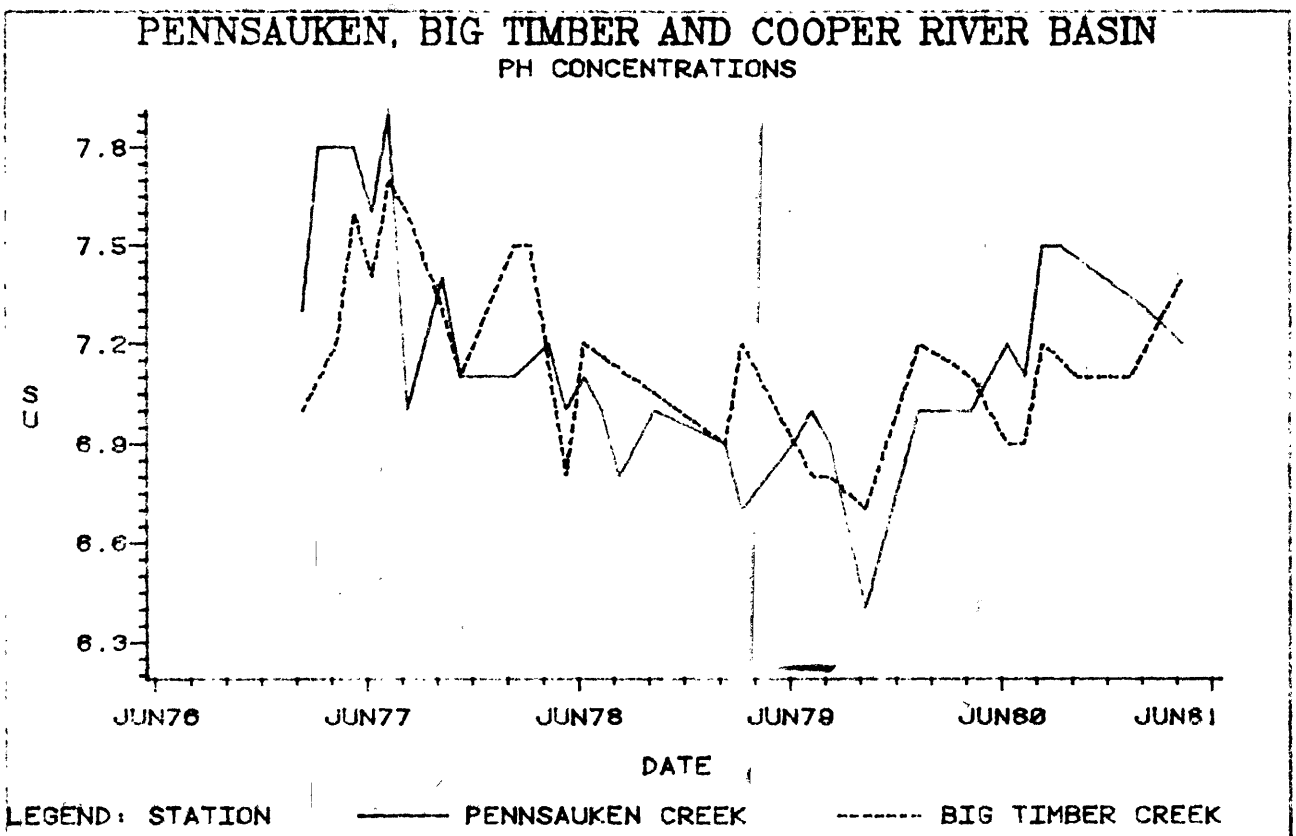

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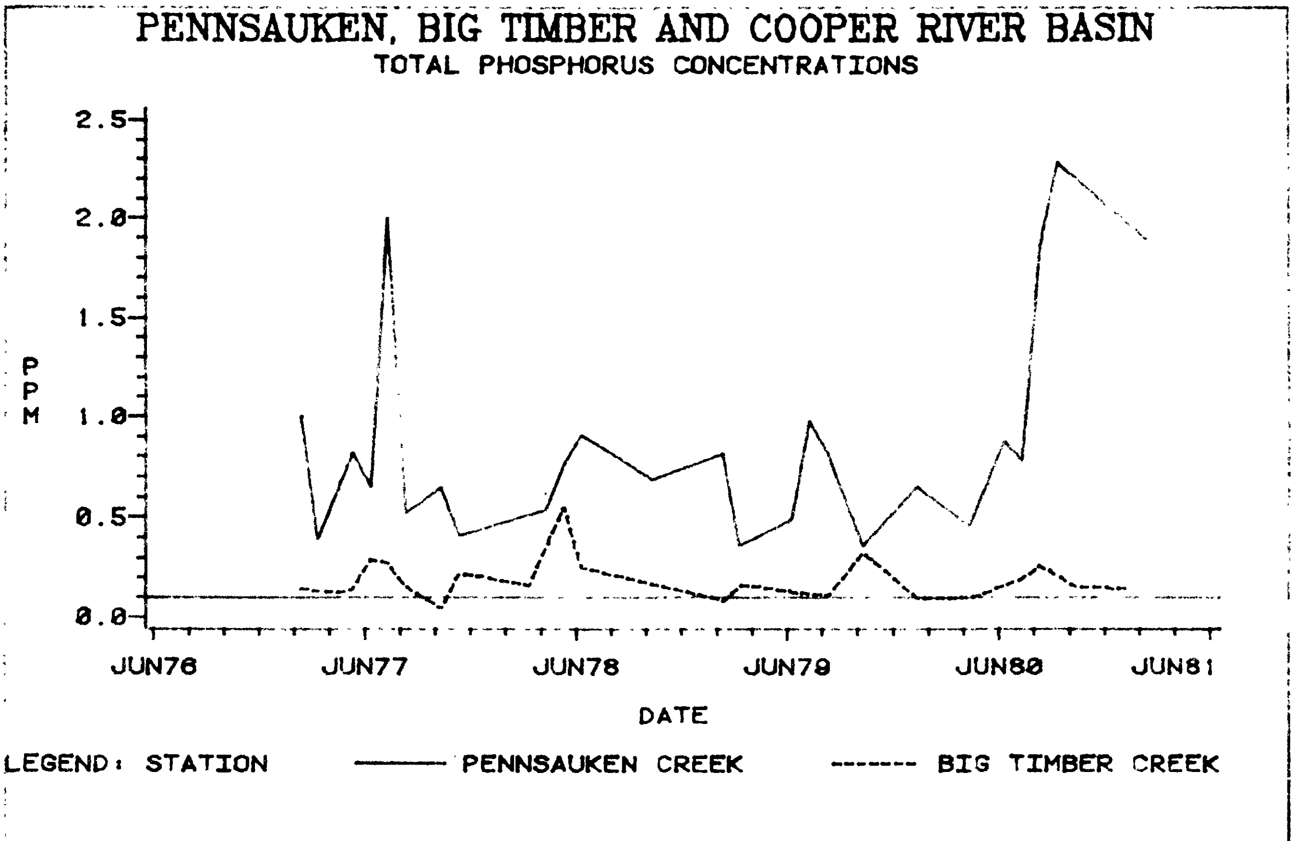

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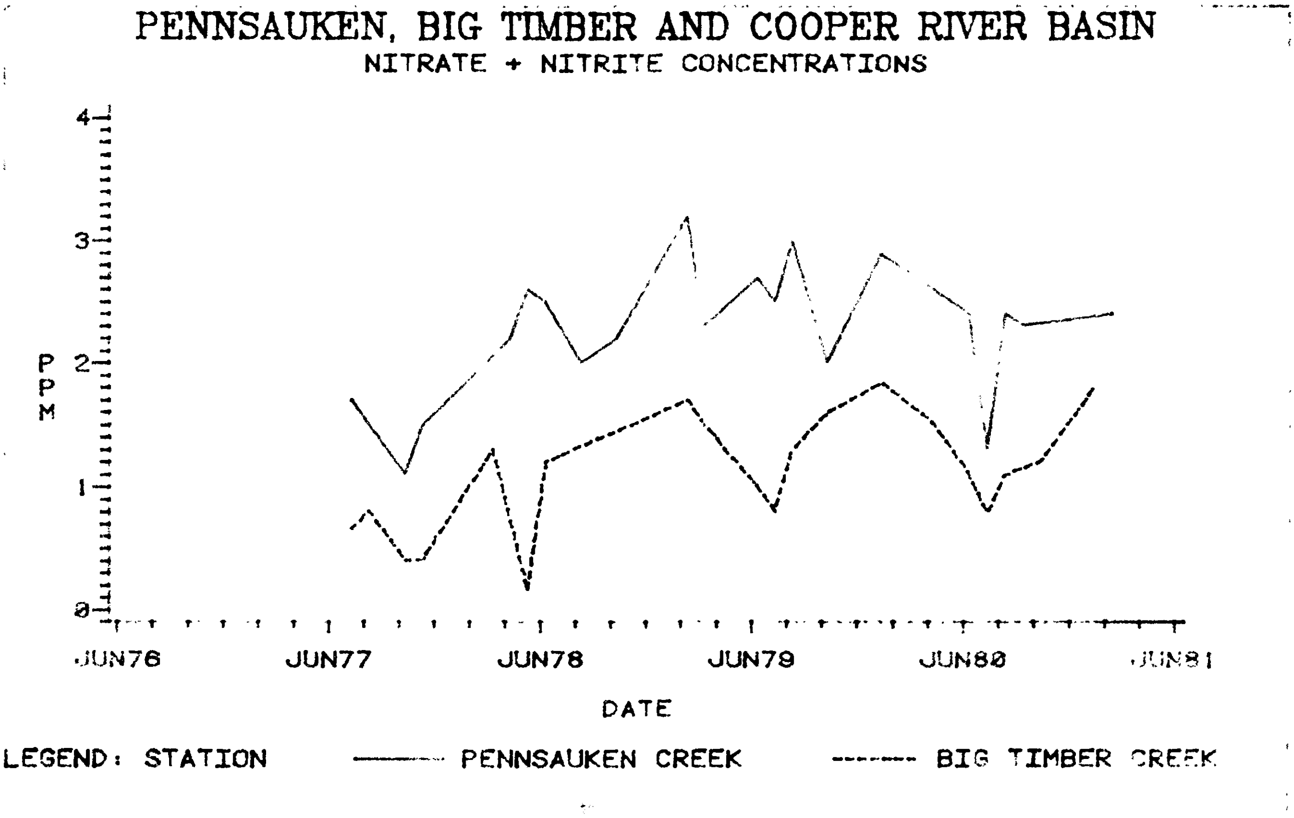

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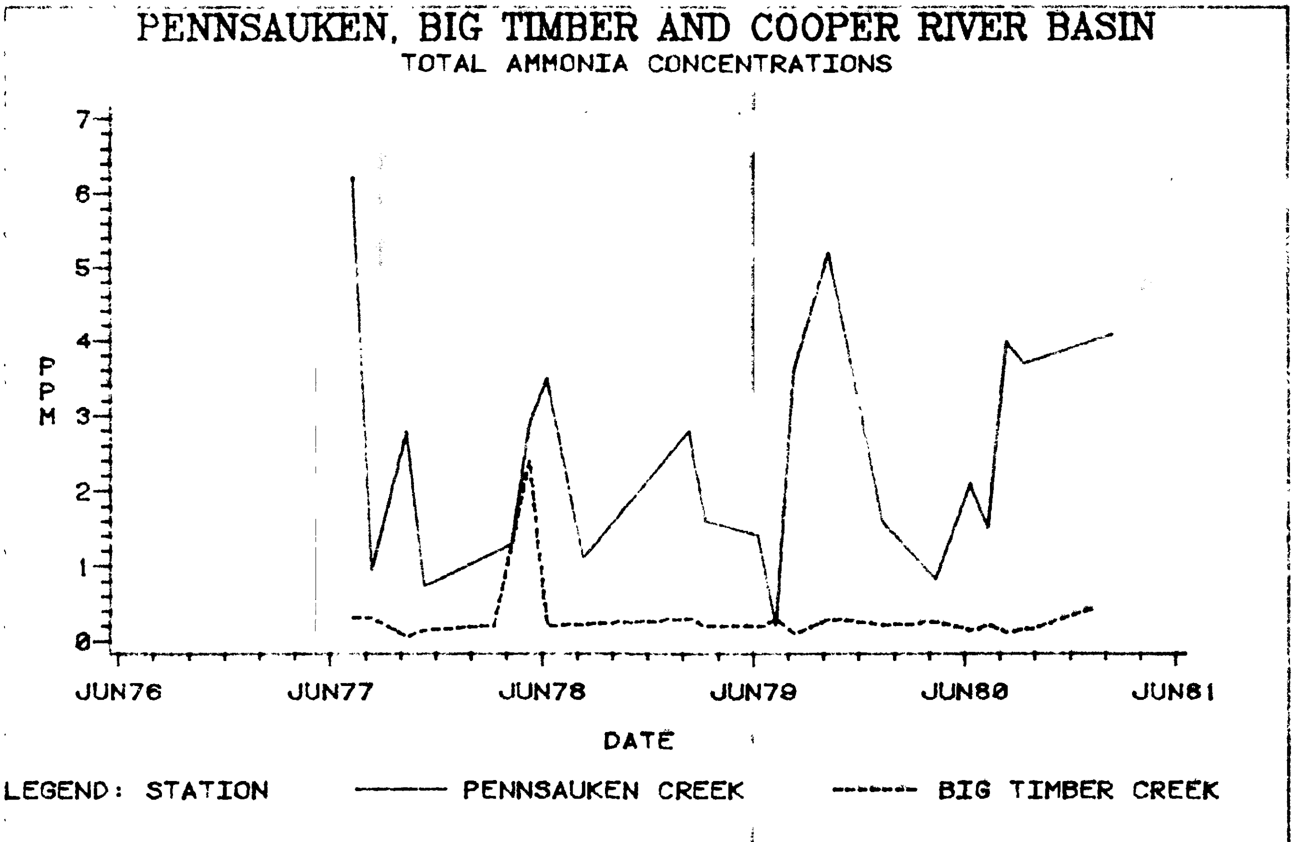

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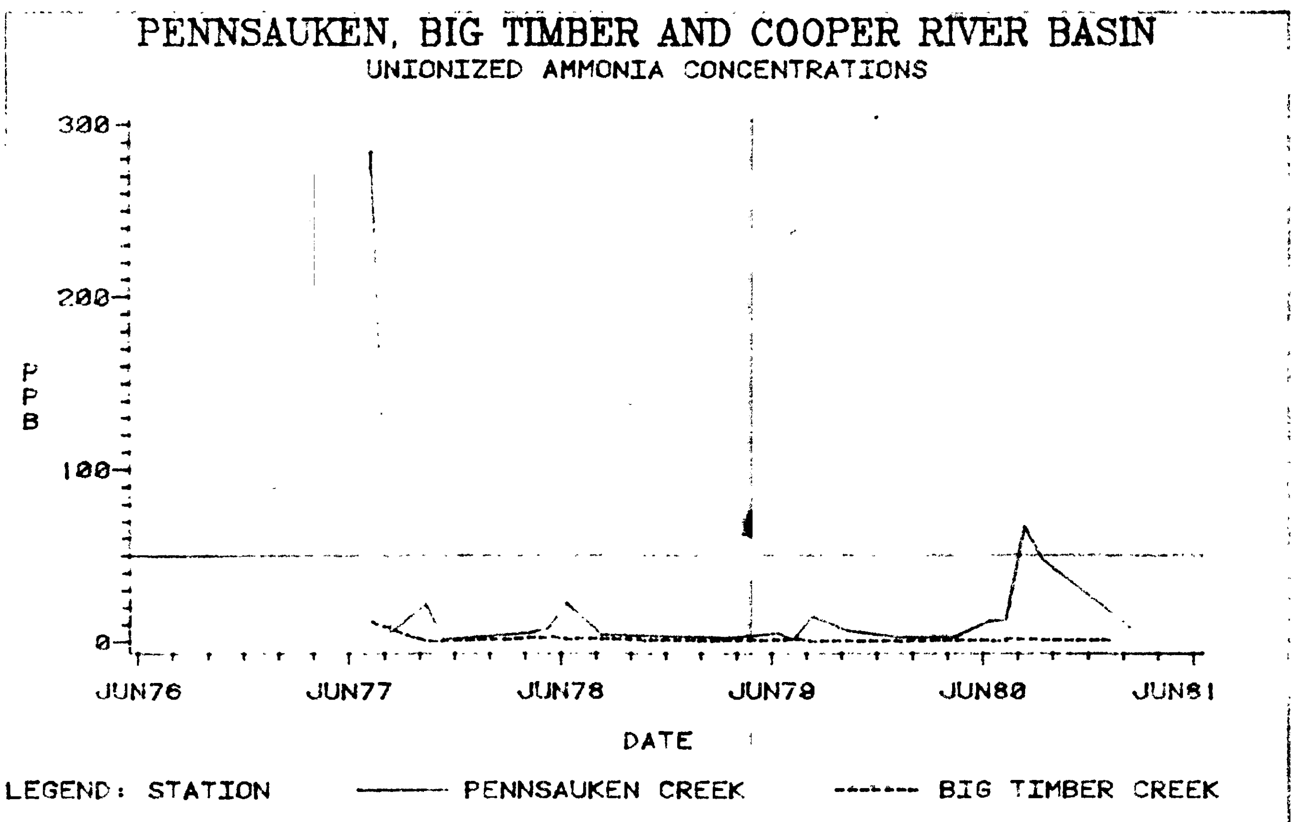

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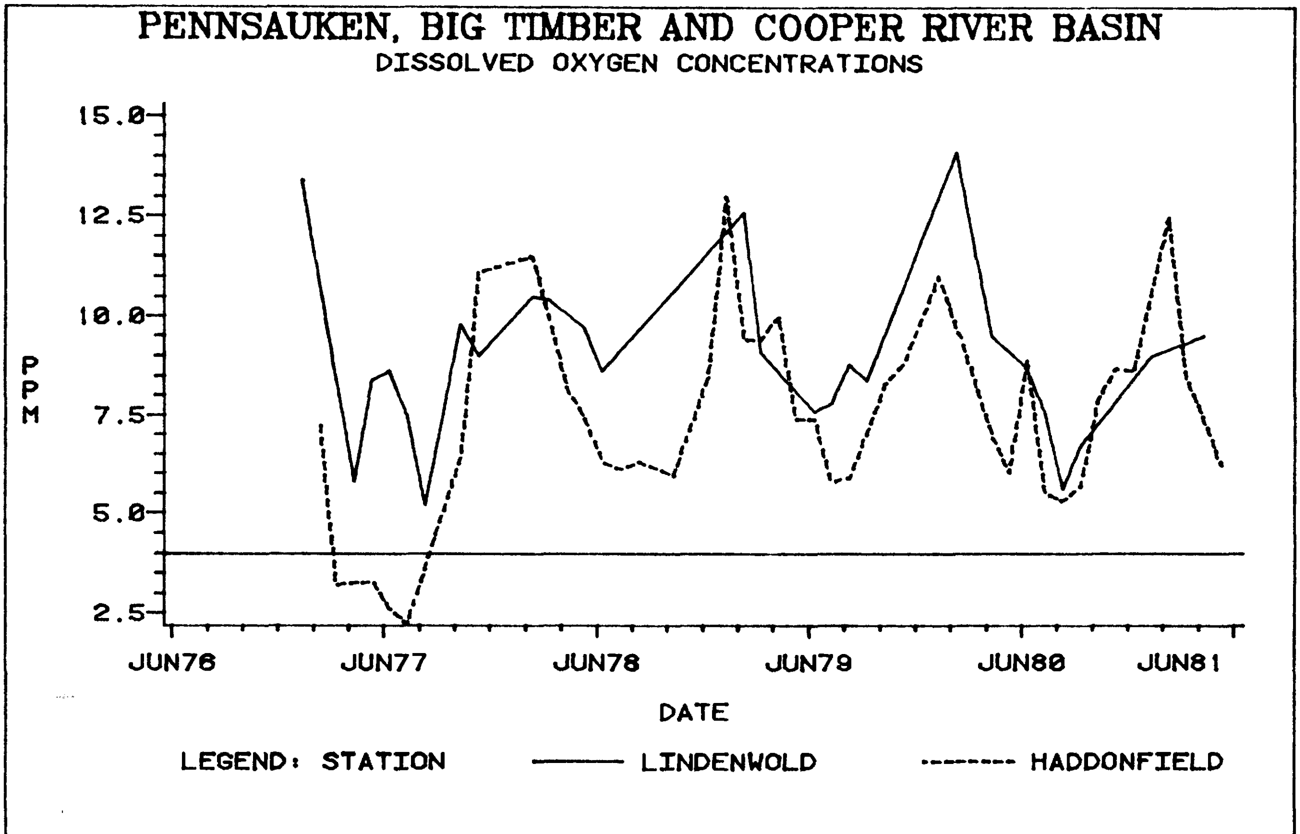

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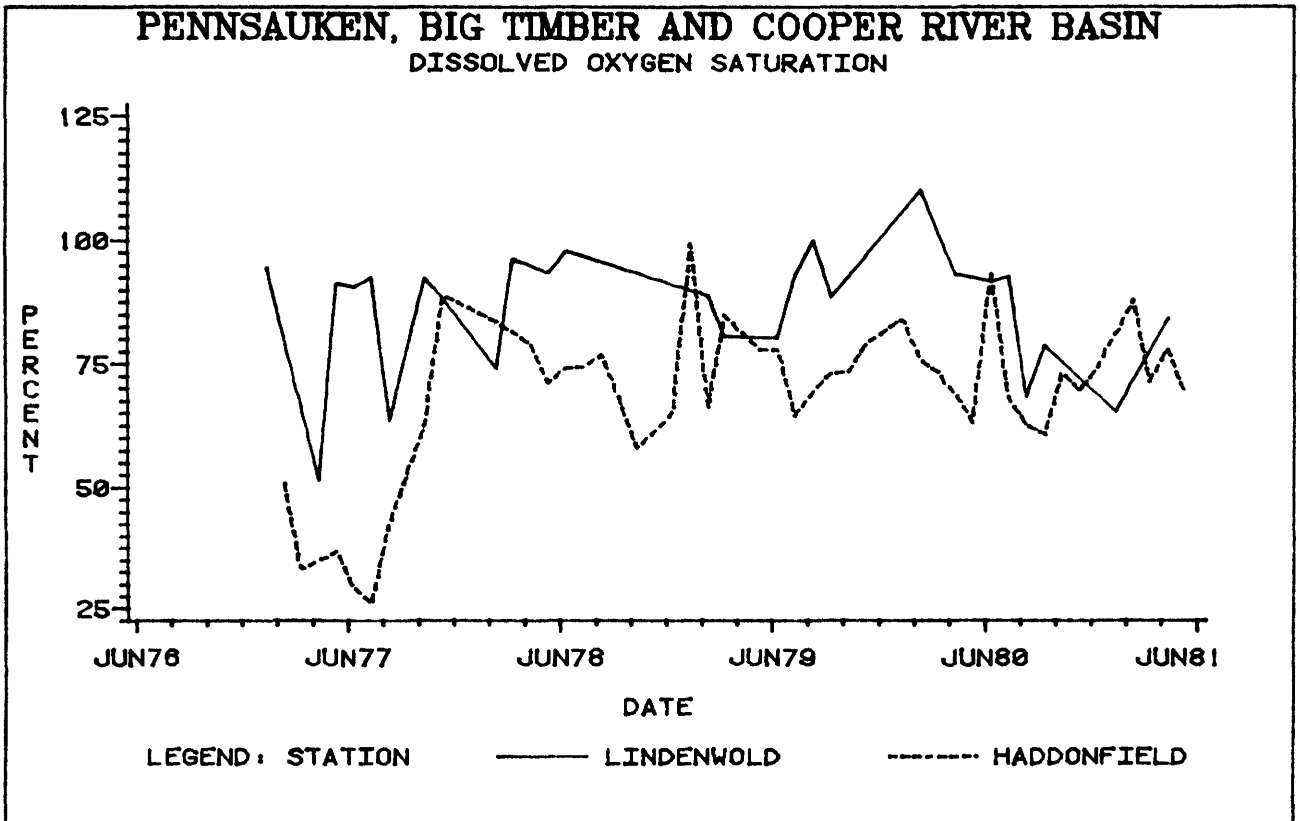

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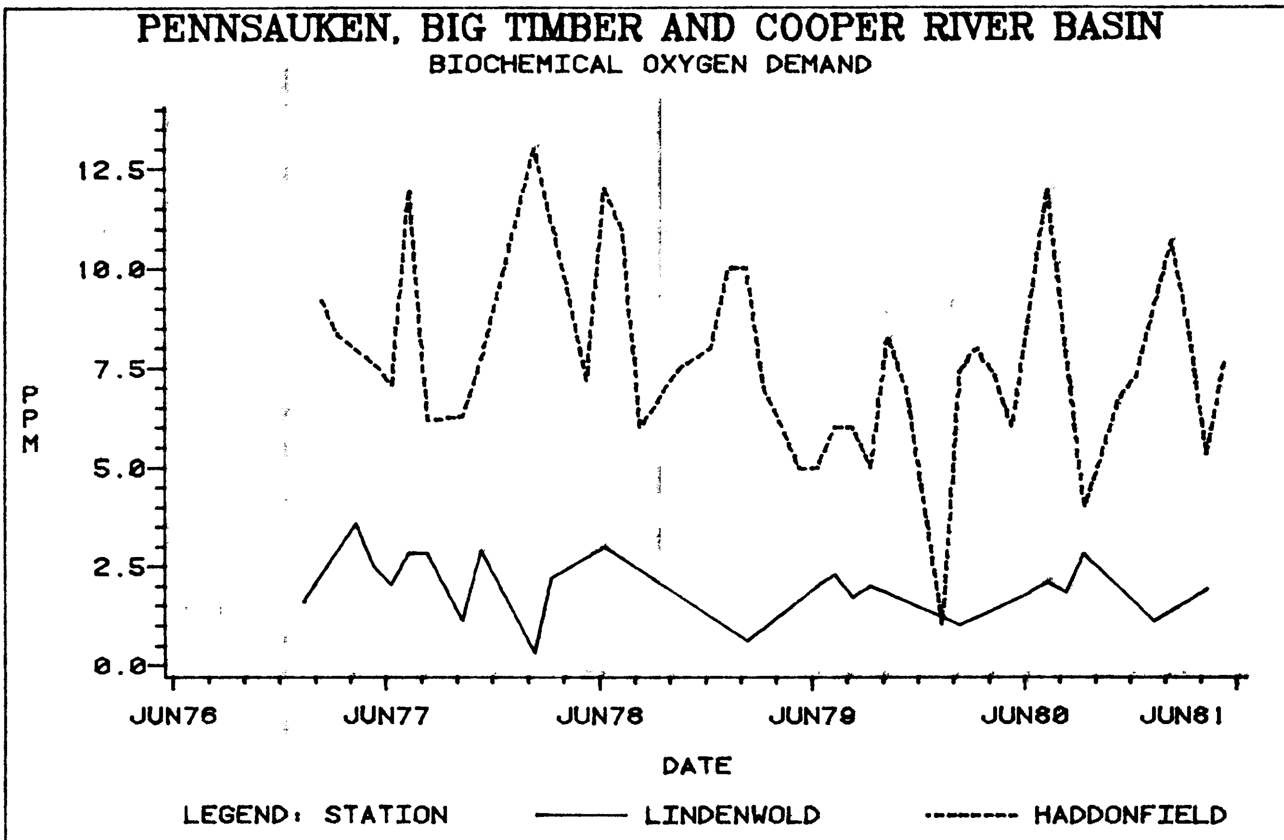

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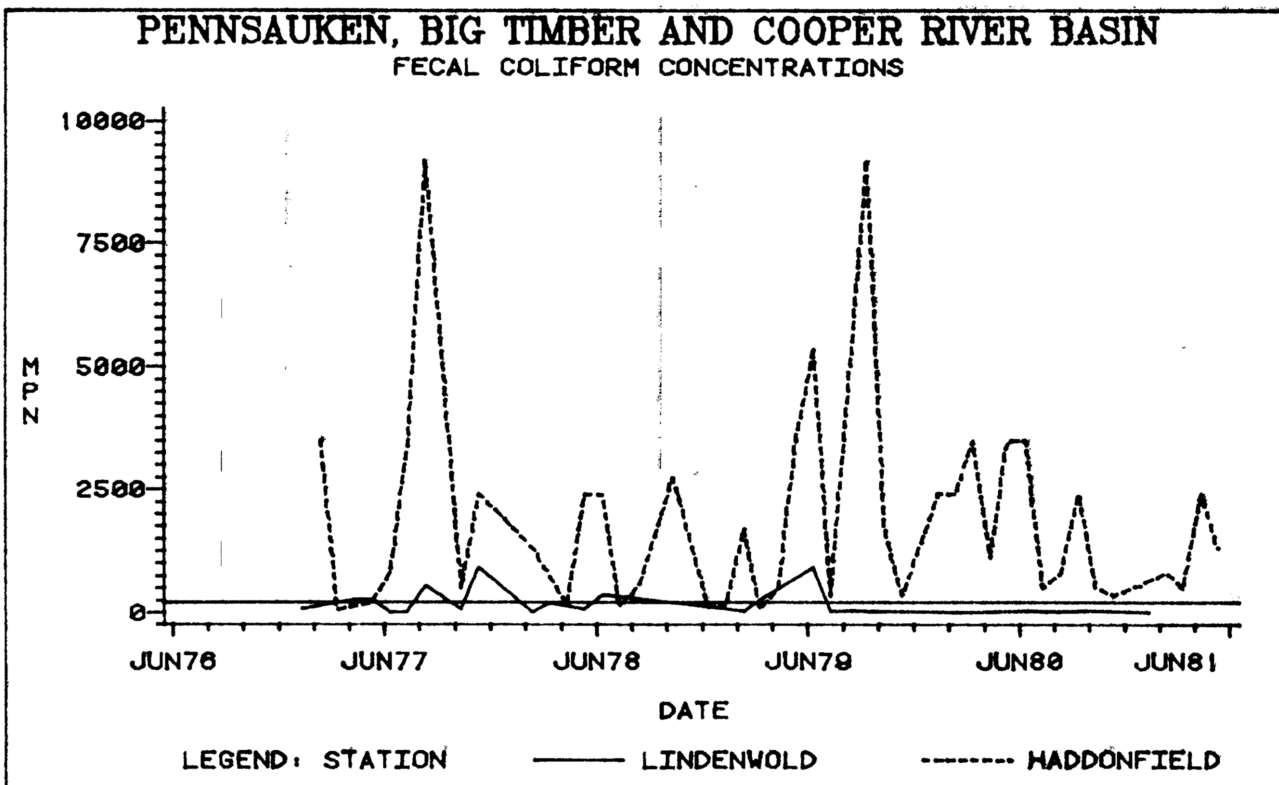

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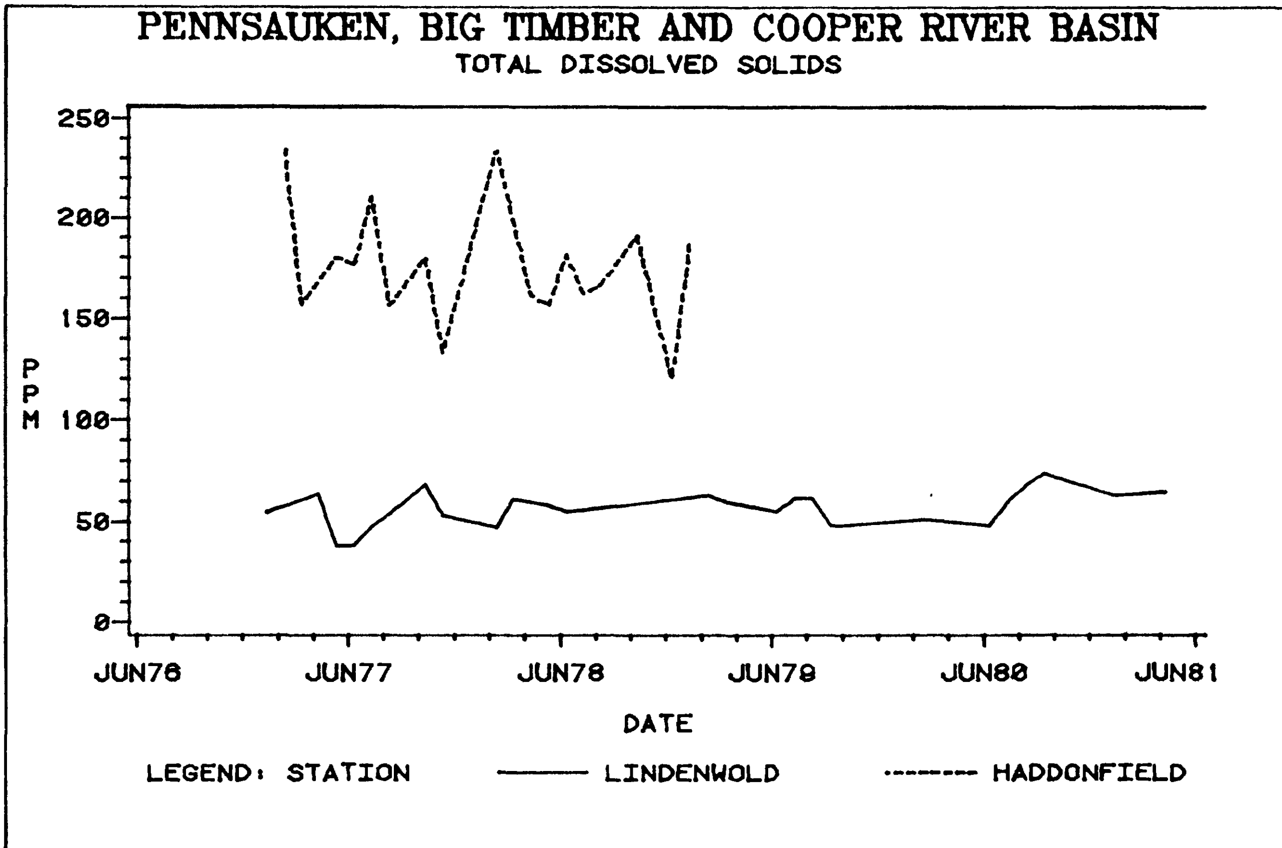

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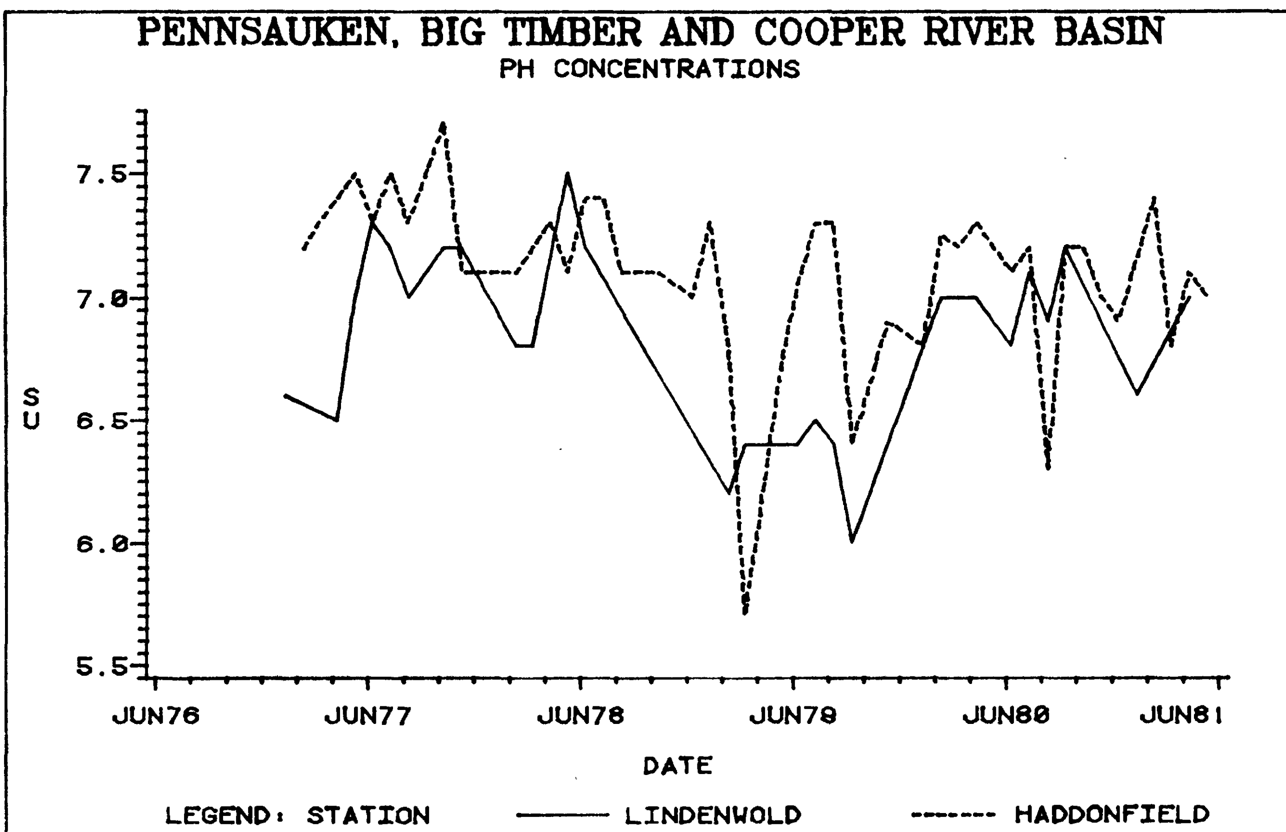

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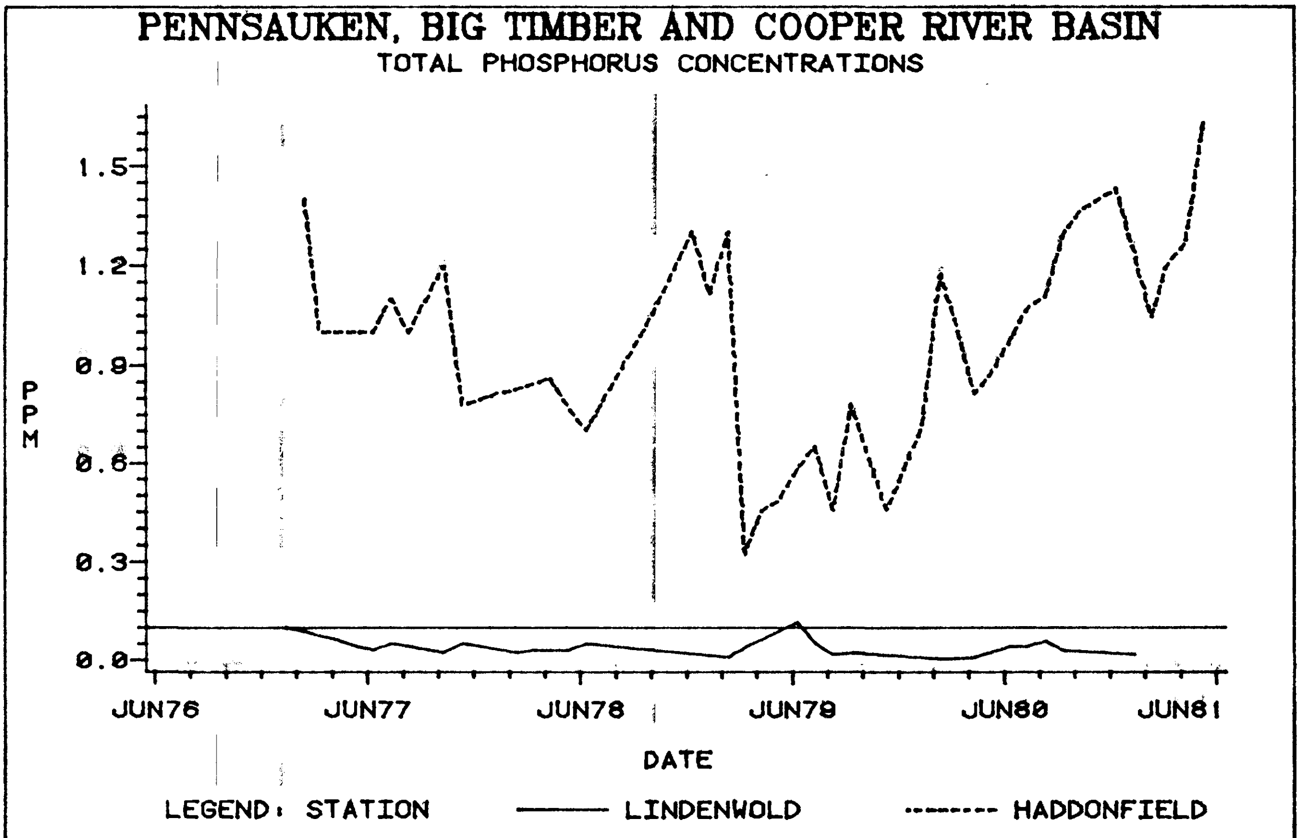

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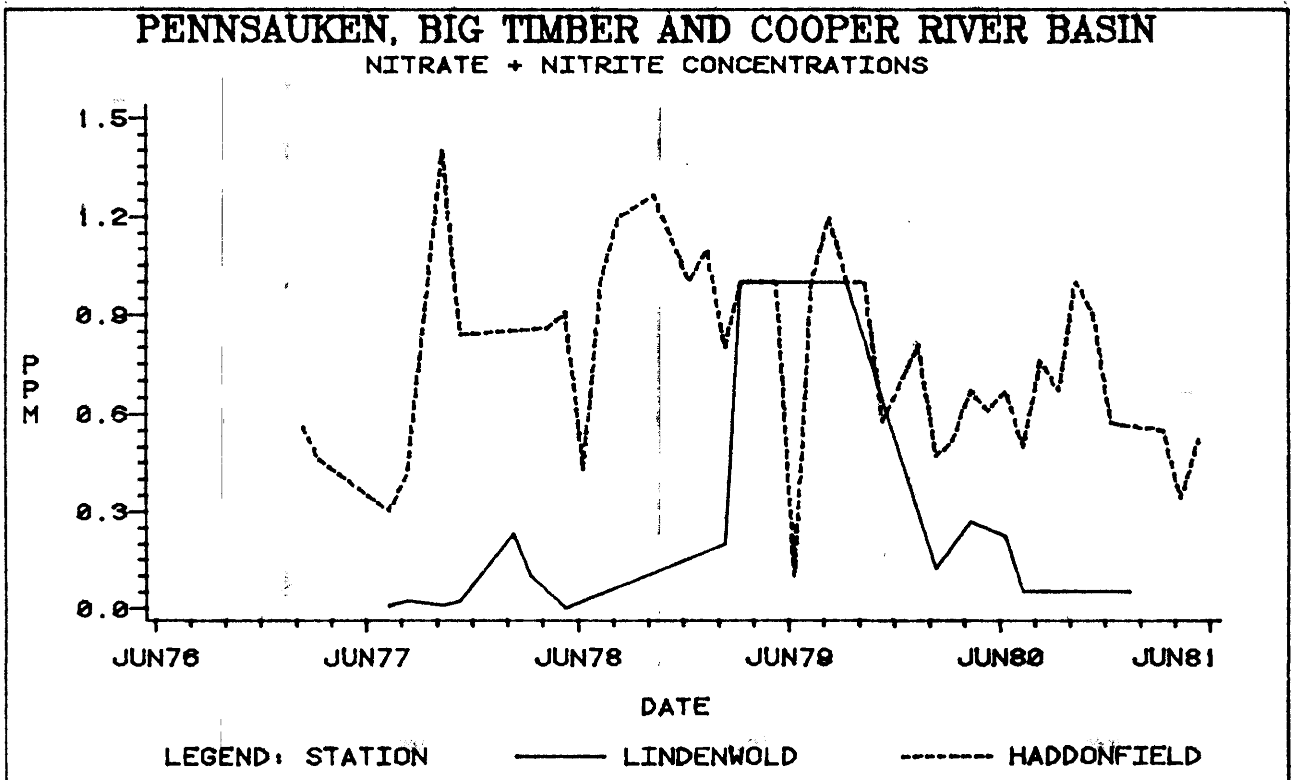

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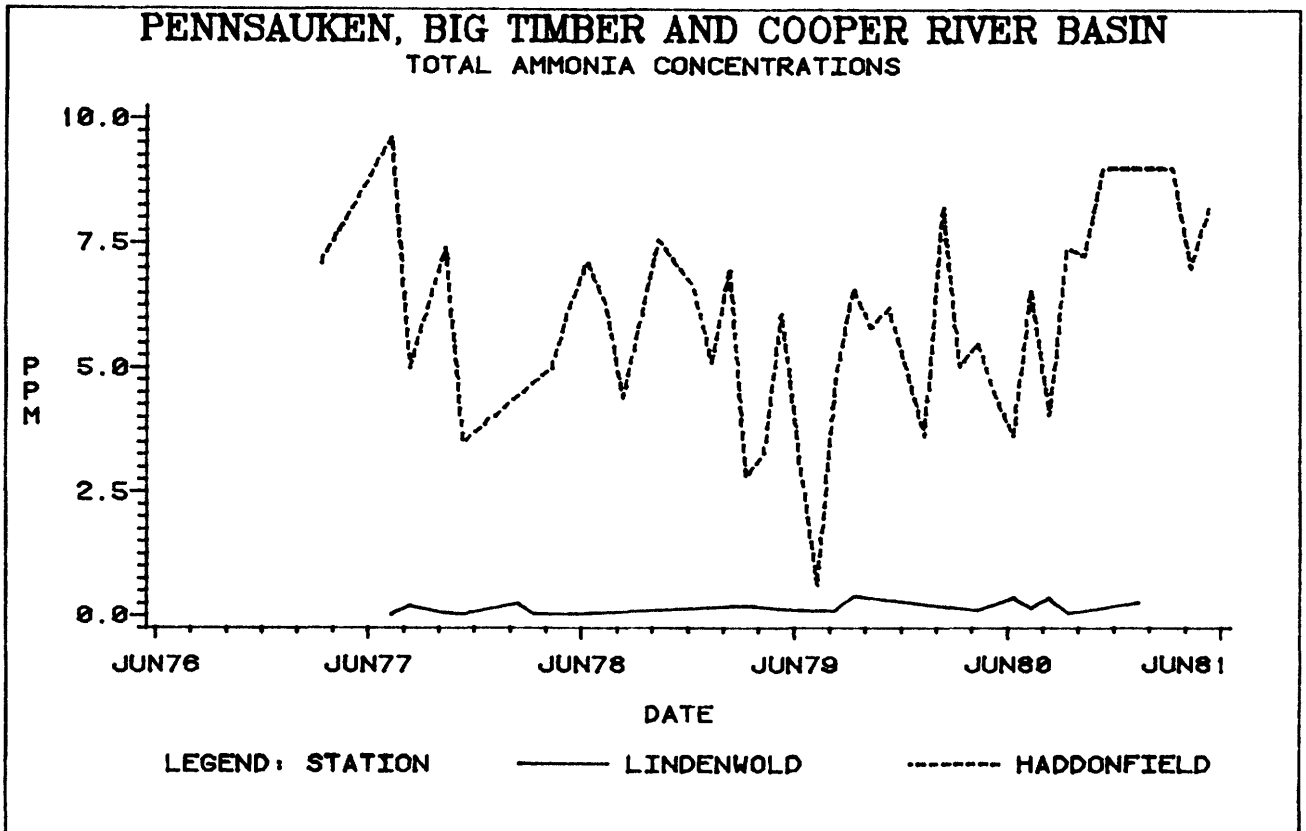

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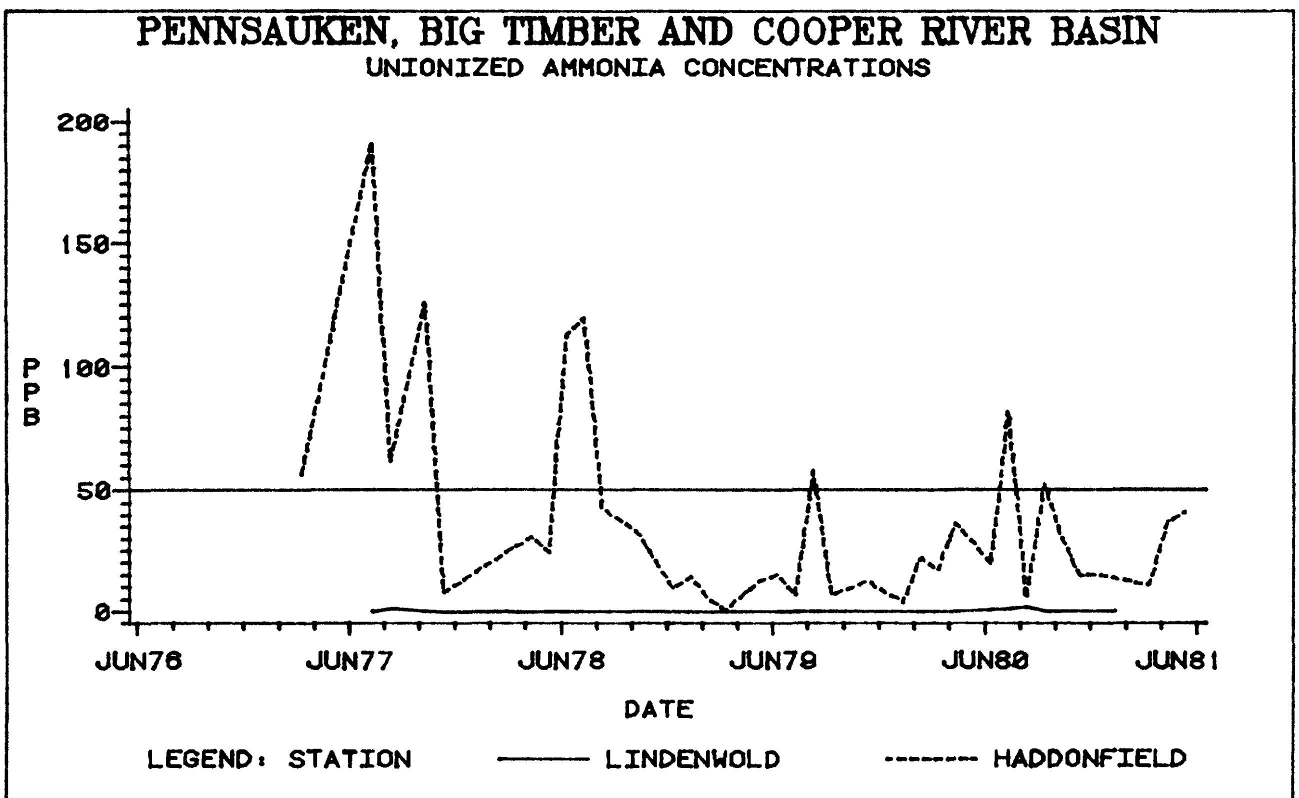

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DISCHARGE INVENTORY - - - PENNSAUKEN CREEK, BIG TIMBER CREEK AND COOPER RIVER BASINS

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
MERCHANTVILLE-PENNSAUKEN	0032085	PENNSAUKEN TWP	CHANDLER'S RUN		
TOWNSHIP OF HADDON-COLES MILL	0024830	HADDON /TWP/	COOPER CR.	SANITARY	1.46
HUSSMAN REFRIGERATOR CO	0003999	CHERRY HILL /TWP/	COOPER CREEK	COOLING WATER	
LEISURE ARMS	0034282	HANCOCKS BRIDGE	COOPER CREEK	SANITARY	
CHERRY HILL TOWNSHIP	0025062	CHERRY HILL /TWP/	COOPER R.	SANITARY	1.48
CHERRY HILL TOWNSHIP	0025054	CHERRY HILL /TWP/	COOPER R.	SANITARY	.92
CHERRY HILL TOWNSHIP	0025046	CHERRY HILL /TWP/	COOPER R.	SAN/SIG INDUS	1.11
CHERRY HILL TOWNSHIP	0025101	CHERRY HILL /TWP/	COOPER R.	SAN/SIG INDUS	.74
CHERRY HILL TOWNSHIP	0025097	CHERRY HILL /TWP/	COOPER R.	SANITARY	.19
BOROUGH OF HADDONFIELD	0024503	HADDONFIELD	COOPER R.	SANITARY	1.46
BOROUGH OF SOMERDALE	0021652	SOMERDALE	COOPER R.	SANITARY	.50
CAMPBELL SOUP CO RESEARCH LAB	0005053	CAMDEN	COOPER RIVER	PROCESS WASTE	
MERIT OIL CORP	0029157	CAMDEN	COOPER RIVER	SANITARY	
BOROUGH OF LAWNSIDE	0020621	LAWNSIDE	COOPER RIVER	SANITARY	.22
NATIONAL FREIGHT INC	0027341	LAWNSIDE	COOPER RIVER		
NEW JERSEY TRANSIT	0027359	LINDENWOLD	COOPER RIVER	PROCESS WASTE	
LINDENWOLD BOROUGH MUA	0026409	LINDENWOLD	COOPER RIVER SO BRANCH	SANITARY	2.4
GIBBSBORO SEWERAGE CORP	0026361	GIBBSBORO	HILLIARDS CREEK	SANITARY	.08
BORO OF COLLINGSWOOD WATER PL.	0029564	COLLINGSWOOD	MAIN BRANCH OF COOPER RIVER	WATER TREATMENT	.04
SOUTHAMPTON TWP BD OF ED	0022268	SOUTHAMPTON TWP	SOUTH BRANCH OF COOPER CREEK	SANITARY	
VOORHEES TOWNSHIP	0022403	VOORHEES TWP	SOUTH BRANCH OF COOPER CREEK	SANITARY	.80
NEW JERSEY TURNPIKE AUTHORITY	0020753	CHERRY HILL /TWP/	TINDALE'S RUN	SANITARY	.02
CHERRY HILL TOWNSHIP	0025119	CHERRY HILL TWP	TRIBUTARY TO COOPER RIVER	SANITARY	.16
MAPLE SHADE TWP STP 1	0028738	MAPLE SHADE TWP	SOUTH BRANCH OF PENNSAUKEN CRE	SAN/SIG INDUS	1.05
MAPLE SHADE TWP STP 2	0028746	MAPLE SHADE TWP	NORTH BRANCH OF PENNSAUKEN CRE	SAN/SIG INDUS	.79
MAGIC MARKER CORPORATION	0033138	CHERRY HILL	NORTH BRANCH PENNSAUKEN CREEK	COOLING & SANIT	
CHERRY HILL TOWNSHIP	0025089	CHERRY HILL /TWP/	PENNSAUKEN CR.	SANITARY	2.54
CHERRY HILL TOWNSHIP	0025127	CHERRY HILL /TWP/	PENNSAUKEN CR.	SANITARY	.12
MOORESTOWN TWP STP	0024996	MOORESTOWN TWP	PENNSAUKEN CR.	SANITARY	2.17
MOUNT LAUREL MUA	0023981	MOUNT LAUREL TWP	PENNSAUKEN CR.	SANITARY	.25
CHERRY HILL TOWNSHIP	0025071	CHERRY HILL /TWP/	PENNSAUKEN CREEK	SANITARY	1.04
MAPLE SHADE WATER PLANT NO2	0031879	MAPLE SHADE	PENNSAUKEN CREEK		.53
CADILLAC PET FOODS INC	0031216	PENNSAUKEN	PENNSAUKEN CREEK	BOILER BLOWDOWN	.00
MERCHANTVILLE-PENNSAUKEN	0032093	TWP PENNSAUKEN	PENNSAUKEN CREEK		
MAPLE SHADE WATER DEPT.	0025577	MAPLE SHADE TWP	PENNSAUKEN CREEK (NORTH BRANCH		1.22
ARMAK COMPANY	0004588	MAPLE SHADE /TWP/	PENNSAUKEN CRK	PROCESS WASTE	.02
MORRIS-DELAIR WAT. TR. PLANT	0031984	DELAIR	PENNSAUKEN CREEK		
OWENS-CORNING FIBERGLAS CORP	0004316	BARRINGTON BORO	OTTER BR CREEK	PROCESS & COOL.	.04
MAGNOLIA SEWERAGE AUTH	0021431	MAGNOLIA	OTTER BR CREEK	SANITARY	.40
STRATFORD SEWERAGE AUTHORITY	0022624	STRATFORD	NORTH BRANCH OF BIG TIMBER CRE	SANITARY	.88
GLOUCESTER TOWNSHIP MUA	0028959	GLOUCESTER TWP	NORTH BRANCH BIG TIMBER CREEK		
DEPTFORD PLATING CO INC	0032492	DEPTFORD	BIG TIMBER CREEK		
H G ENDERLEIN CO	0032433	GRENLOCH	BIG TIMBER CREEK		.01
B'D OF FREEHOLDERS	0024627	GLOUCESTER TWP	BIG TIMBER CR.	SANITARY	.01
CAMDEN C'NTY BD. OF FREEHOLDER	0029840	GLOUCHESTER TWP	SOUTH BRANCH BIG TIMBER CREEK	SANITARY	
GLOUCESTER TOWNSHIP MUA	0026484	GLOUCESTER TWP	SIGNEY RUN	SANITARY	.15
MOUNT EPHRAIM BD OF COMM	0023817	MOUNT EPHRAIM	LITTLE TIMBER CR.	SANITARY	.7
RUNNEMEDE SEWERAGE AUTHORITY	0026859	RUNNEMEDE	BEAVER BROOK BR	SANITARY	.84
CHEWS LANDING FISCALIN W W T P	0032191	BLACKWOOD	BIG TIMBER CREEK		
BOROUGH OF BROOKLAWN	0022748	BROOKLAWN BORO	BIG TIMBER CREEK	SANITARY	.25
CLEMENTON SEWERAGE AUTHORITY	0020320	CLEMENTON BORO	BIG TIMBER CREEK	SANITARY	1.1
GLOUCESTER CITY SEW. AUTH.	0026620	GLOUCESTER CITY	BIG TIMBER CREEK	SANITARY	1.5

DISCHARGE INVENTORY - - - PENNSAUKEN CREEK, BIG TIMBER CREEK AND COOPER RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
GLOUCESTER TOWNSHIP MUA	0026468	GLOUCESTER TWP	BIG TIMBER CREEK NO BRANCH	SANITARY	2.5
GLOUCESTER TOWNSHIP MUA	0026476	GLOUCESTER TWP	BIG TIMBER CREEK SO BRANCH	SANITARY	.73
BOROUGH OF WOODLYNNE	0022012	WOOD-LYNNE	N BR OF NEWTOWN CREEK	SANITARY	.20
TOWNSHIP OF HADDON	0021440	HADDON /TWP/	NEWTON CR.	SANITARY	.15
CITY OF CAMDEN	0035271	CAMDEN	NEWTON CREEK		
A L HYDE CO	0032336	GRENLOCH	BIG TIMBER CREEK	COOLING WATER	
BORO OF COLLINGSWOOD WAT.PLANT	0032000	COLLINGSWOOD	NEWTON CREEK		
BOROUGH OF COLLINGSWOOD	0025526	COLLINGSWOOD	NEWTON CREEK	SANITARY	1.54
BOROUGH OF AUDUBON NJ	0022446	AUDUBON BORO	NEWTON CREEK SO BR	SANITARY	1.00
GLOUCESTER CITY WATER WORKS	0025593	GLOUCESTER CITY	NEWTON CREEK SOUTH BRANCH	WATER TREATMENT	.07
BELLMAWR SEWERAGE AUTHORITY	0026743	BELLMAWR BORO	BIG TIMBER CREEK	SANITARY	2.00
EVESHAM MUA	0024040	EVESHAM /TWP/	LANDING CREEK	SANITARY	.82

J. WOODBURY, MANTUA AND RACCOON CREEKS

Basin Description

Woodbury, Mantua and Raccoon Creeks all lie in western Gloucester County draining 13, 60 and 40 square miles, respectively. Woodbury Creek originates in Deptford Township and flows for 4.5 miles before it joins the Delaware River at National Park. Woodbury Creek and its major tributaries, Hessian Run and Matthews Branch, are influenced by tidal action for most of their lengths. Mantua Creek is characterized by wide tidal marshes and sandy flats in the lower portion of the watershed. Mantua Creek originates in Glassboro and flows northwesterly for 17 miles. Major tributaries to Mantua Creek include Chestnut Run, Monongahela Brook and Edwards Run. The third stream in this segment, Raccoon Creek, is approximately 20 miles long after originating in Elk Township. The major tributary to Raccoon Creek is the South Branch Raccoon Creek and joins the mainstem at Harrison. There are a number of small impoundments in the upstream areas of the Raccoon Creek watershed.

The Woodbury Creek watershed contains a mix of urban/suburban developed areas with agricultural and forested lands. The major population center is Woodbury, with National Park also primarily developed. Although population has not increased significantly in the Woodbury Creek basin, there are scattered developments throughout. Agricultural and forested land are more common in the upstream region of Woodbury Creek and along Matthews Branch. Most of the Woodbury Creek watershed is already sewered with most municipal flows transferred to the Gloucester County Utilities Authority (GCUA) regional treatment plant at Paulsboro. Portions of East Greenwich Township are served by the East Greenwich Sewerage Corporation, (discharges to Nehonsey Creek), and the GCUA (West Deptford treatment plant). Four dischargers are known to exist in this watershed. Steward Lake and adjacent water bodies in Woodbury are used for recreational activities and this appears to be the main water use of this watershed. However, fishing in Steward Lake has been banned because of chlordane contamination.

The Mantua Creek drainage area, like Woodbury Creek, has a mixture of land uses. The Tri-County Water Quality Management Plan (1977) determined that 28 percent is suburban, 32 percent agricultural and 40 percent forested. Development in the basin increases in a downstream direction. Development and population are greatest in the Pitman and Glassboro area, sections of Mantua Township and in Paulsboro. There was little or no population increase in the Mantua Creek watershed during the 1970 to 1980 period. Agricultural activities occur throughout the basin with production of vegetables most common. In the upstream half of the watershed there are numerous small ponds that help serve as sources of irrigation water. Newer developments are found in

Mantua Township, while in the lower segment, near the Delaware River, large gas and oil tank farms are common. Stream channels, with the exception of those in the tidal segment of the creek, are generally wooded.

Only about one-half of the Mantua Creek watershed is presently sewered. This includes Pitman, Glassboro, northwestern Mantua Township, Wenonah, portions of East Greenwich Township, Paulsboro and sections of West Deptford Township. All flows in the basin go to the recently upgraded and enlarged GCUA regional treatment plant which discharges 16 mgd to the Delaware River at Paulsboro. Eight dischargers are found in the watershed. Water uses of Mantua Creek and tributaries are basically farm irrigation and recreational. Water diversions occur in Washington Township where numerous irrigation ponds are present. Alcyon Lake in Pitman contains fishable sunfish, carp, pickerel and catfish populations.

Raccoon Creek and tributaries drain primarily agricultural-rural lands, especially in the eastern two-thirds of the watershed. Development is sparse, only occurring in the Swedesboro and Mullica Hill (Harrison Township) areas. Agricultural activities concentrate on fruit, orchard and cash crop production. Tidal marshes are present along and adjacent to Raccoon Creek's confluence with the Delaware River. Stream channels are for the most part wooded. There are numerous small impoundments in the upstream half of the basin which serve as sources of irrigation water. Only three areas of the Raccoon Creek watershed are sewered - portions of Logan Township, and Swedesboro and Mullica Hill in their entirety. These three areas are currently utilizing local treatment facilities. Six facilities discharge to Raccoon Creek and tributaries: three municipal and three industrial.

Recreational usage of Raccoon Creek is the heaviest of the three streams in this segment. Raccoon Creek from Ewan Lake dam to Harrisonville-Gibbstown Road, Mullica Hill Pond and Swedesboro Lake are stocked with trout by the N.J. Division of Fish, Game and Wildlife. Swedesboro Lake and Mullica Hill Pond also have excellent largemouth bass, pickerel, catfish, carp and sunfish populations. In addition, Swedesboro Lake contains bathing facilities.

Water Quality Assessment

Conventional Parameters

Measurements of water quality in Mantua Creek at Mantua and Raccoon Creek near Swedesboro were used for this segment's assessments. Water quality in these watersheds was shown to be marginal due to high fecal coliform and total phosphorus concentrations, and in Mantua Creek, raised biochemical oxygen demand. This is particularly true in the downstream regions. Seasonal fluctuations of dissolved oxygen concentrations and saturation resulted in marginally acceptable daytime saturation levels during the summer months at the downstream station on Mantua Creek. These low summer D.O. readings were also associated with elevated BOD levels. On the other hand, Raccoon Creek near Swedesboro exhibited less seasonal variation and generally acceptable dissolved oxygen and biochemical oxygen demand levels throughout the period.

The Mantua Creek station at Mantua showed more severe fecal coliform fluctuation than those at the downstream station in Raccoon Creek. No clear improvement was exhibited at either station as the contravention, rate was above 200 MPN/100 ml 89 and 69 percent at Mantua and Swedesboro, respectively.

Total dissolved solids and pH concentrations were all within the criteria throughout the period in each stream. A very slight decline and rise in pH values was exhibited in both streams from 1977 to 1981, but remained generally neutral.

Total phosphorus concentrations exceeded the 0.10 mg/l standard more than 60 percent of the time at both stations during the period reviewed. Mantua Creek exhibited on overall decline in total phosphorus while some increases were evident in Raccoon Creek. Nitrate + nitrite levels were generally acceptable throughout the period. Although occasional high total and un-ionized ammonia concentrations were noted, un-ionized ammonia levels remained within the criteria.

There were no fixed-station biomonitoring stations located in these basins during the period.

Water quality data in Mantua and Raccoon Creeks has not shown any improvement in overall conditions. Pollution problems identified in earlier 305(b) reports remain today and at similar levels. In fact, fecal coliform levels have increased in Mantua Creek at Mantua.

Toxic Parameters

Sampling on Mantua Creek at Mantua has been conducted each year of the toxics study. The results indicated the presence of a few extremely volatile organic compounds. The analytical methodology employed in the early portion of the survey did not give accurate information on these compounds, therefore, plans to return to this area to resample and perform more specific analysis to follow up have been made.

Raccoon Creek was sampled near Mullica Hill in three successive years. In each case there was no evidence of toxic contamination.

As part of an investigation into widespread chlordane contamination (see Pennsauken Creek), tissue samples of aquatic organisms were collected from Steward Lake and Woodbury Creek. These samples included various bottom dwelling species indigenous to this region. Results obtained were in excess of the 0.3 ppm U.S. Food and Drug Administration action level for chlordane in fish tissue. Consequently, a ban of fishing was imposed in Steward Lake which still remains in effect.

Several samples of fin fish collected from Mantua Creek at Mount Royal revealed trace levels of DDT and DDE metabolites in edible portions of tissue. All results were below the established action level for these compounds.

Analyses of fish tissue taken along Raccoon Creek at Swedesboro, adjacent to the Rollins Recovery Facility, and at the Route 130 crossing in Bridgeport found low concentrations of the organochlorine pesticides and PCB Arochlor 1254. Several samples of the catadromous American eel, Anguilla rostrata, were shown to contain PCB levels in the 1.0 to 3.0 ppm range (low levels). One sample of the anadromous striped bass, Morone saxtilius, contained elevated chlordane at the 0.3 ppm level. Overall, samples of resident species revealed only trace amounts of the parameters examined.

Fish collected from Alcyon Lake adjacent to a landfill in Pitman produced no significant levels of organochlorine pesticides and PCB Arochlor 1254 in resident species. One tissue analysis of American eel showed low levels of chlordane and elevated levels of DDT metabolities.

Problem Assessment

The water quality in Mantua and Raccoon Creeks, which can be classified as being marginal, is affected by both point and non-point sources. Water quality data is lacking for Woodbury Creek, but in Raccoon and Mantua Creeks high fecal coliform and total phosphorus concentrations with seasonal low dissolved oxygen levels occur.

The four discharges present in the Woodbury Creek watershed are either industrial process or cooling waters, or runoff. All municipal sewage generated within the watershed is treated out of basin at the GCUA regional plant. Because of development and the presence of industrial facilities in the watershed, non-point sources appear to be a major cause of water quality degradation in Woodbury Creek. An intensive survey was conducted in Woodbury (Steward) Lake by the Lakes Management Program in 1979. Results show the lake is eutrophic because of nutrient inputs from stormwater. Chlordane contamination is also present in the lake, which has resulted in a ban on fishing.

In the Mantua Creek watershed industrial discharges dominate the point sources. However, the water quality conditions present are more indicative of sewage or organic loadings. Septic system problems have been identified in Mantua and West Deptford Township and in Glassboro. Non-point sources are likely causes for conditions as they exist. Stormwater runoff from suburban and agricultural areas are the prime non-point source contributors. In upper reaches of the Mantua watershed, Bethel Lake was the target of an intensive survey in 1979. It was determined to be somewhat eutrophic primarily because of agricultural non-point source loadings. Downstream, water quality conditions are further aggravated by incoming Delaware River water which is brought into the creek by tides. Infiltration/inflow (I/I) problems are thought to be occurring in some sewer lines going to the GCUA treatment plant. This may also contribute bacteria and nutrients to the streams in the area.

The water quality of Raccoon Creek, as presented above, is primarily a result of agricultural runoff and on-site disposal systems. One municipal discharge above the Swedesboro sampling station is discharging effluent within its permit limitations. However, water quality is thought to worsen downstream. At Swedesboro, the borough's treatment plant does not meet suspended solids removal requirements and receives relatively high strength wastewaters from a local canning industry. In the tidal estuary, a large chemical neutralizing and processing facility discharges to Raccoon Creek. Water quality conditions in the tidal estuary are probably naturally stressed in summer because of low dissolved oxygen concentrations resulting from poor reaeration. The addition of oxygen demanding substances to this reach of Raccoon Creek likely has significant impacts on the stream's ability to cleanse itself.

Goal Assessment and Recommendations

Both Mantua and Raccoon Creeks are not of swimmable quality because of high fecal coliform levels. Such a determination cannot be made for Woodbury Creek because of a lack of water quality data. However, reviewing land use patterns and the presence of point source discharges, making the assumption that Woodbury Creek is not swimmable is realistic. The three streams can be considered fishable with the exception of Steward (Woodbury) Lake which is closed to fishing because of chlordane contamination. Caution should also be used for classifying the waters draining into Steward (Woodbury) Lake as fishable because of the contamination. Both Mantua and Raccoon Creeks are used for spawning by the anadromous herring (Cluepeidae) family; Raccoon Creek is thought to have an overall greater diversity in its fish community. Most fish species found are indicative of warm, slow moving waters with extensive vegetation and sandy or smooth bottoms. There may be periodic summertime low D.O., causing stresses in these streams, particularly in the tidal areas.

Water quality in Mantua Creek should show improvement with the implementation of best management practices on agricultural lands in the upper watershed and correction of septic problems throughout. The seriousness of the inflow/infiltration problem with existing sewage collection and interceptor pipes should be studied further and areas with high I/I corrected. Stormwater runoff controls in the lower Mantua watershed may assist in the reduction of nutrient, metal and bacteria loadings to the tidal creek. Upgrading and enlargement of the Swedesboro STP so that effluent quality can be improved will reduce nutrient levels in the lower Raccoon Creek watershed. Pretreatment of the significant industrial contributions will assist the Swedesboro plant in meeting its permit limitations. In the upper watershed, agricultural runoff controls will have the greatest impacts for improving water quality.

Pollution loads in the tidal stretches of both creeks can be reduced when the treatment process at the GCUA regional STP is upgraded and improved. Restoration of the lakes in these watersheds for contact recreation can only be accomplished with costly stormwater controls, aeration measures and dredging where appropriate. Special studies to determine the extent of chlordane contamination in the Steward (Woodbury) Lake watershed should be performed. Additional water quality studies are also needed in Woodbury Creek and in the tidal sections of Raccoon and Mantua Creeks.

WOODBURY, MANTUA AND RACCOON CREEKS STATION LIST

A. Ambient Monitoring Stations

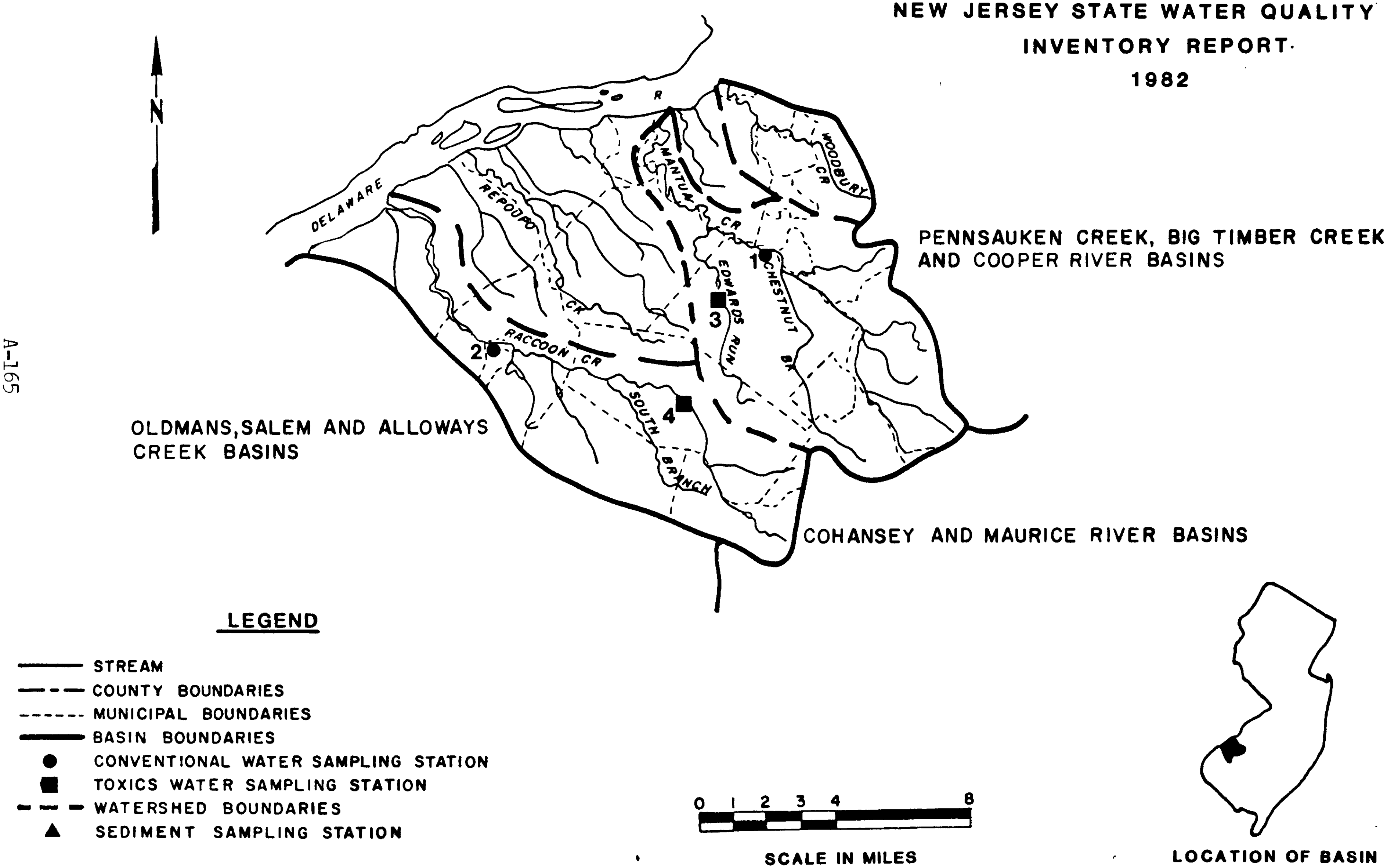
STORET Number	Station Description	Map Number
01475045	Mantua Creek at Mantua, Gloucester County Latitude 30°47'42" Longitude 75°10'21" FW-2 Nontrout USGS/DEP Network At bridge on Route 45, 0.9 miles downstream from Chestnut Branch.	1
01477120	Raccoon Creek near Swedesboro, Gloucester County Latitude 30°44'28" Longitude 75°15'33" FW-2 Nontrout USGS/DEP Network At bridge on Harrisonville - Gibbstown Road, 2.8 miles east of Swedesboro.	2

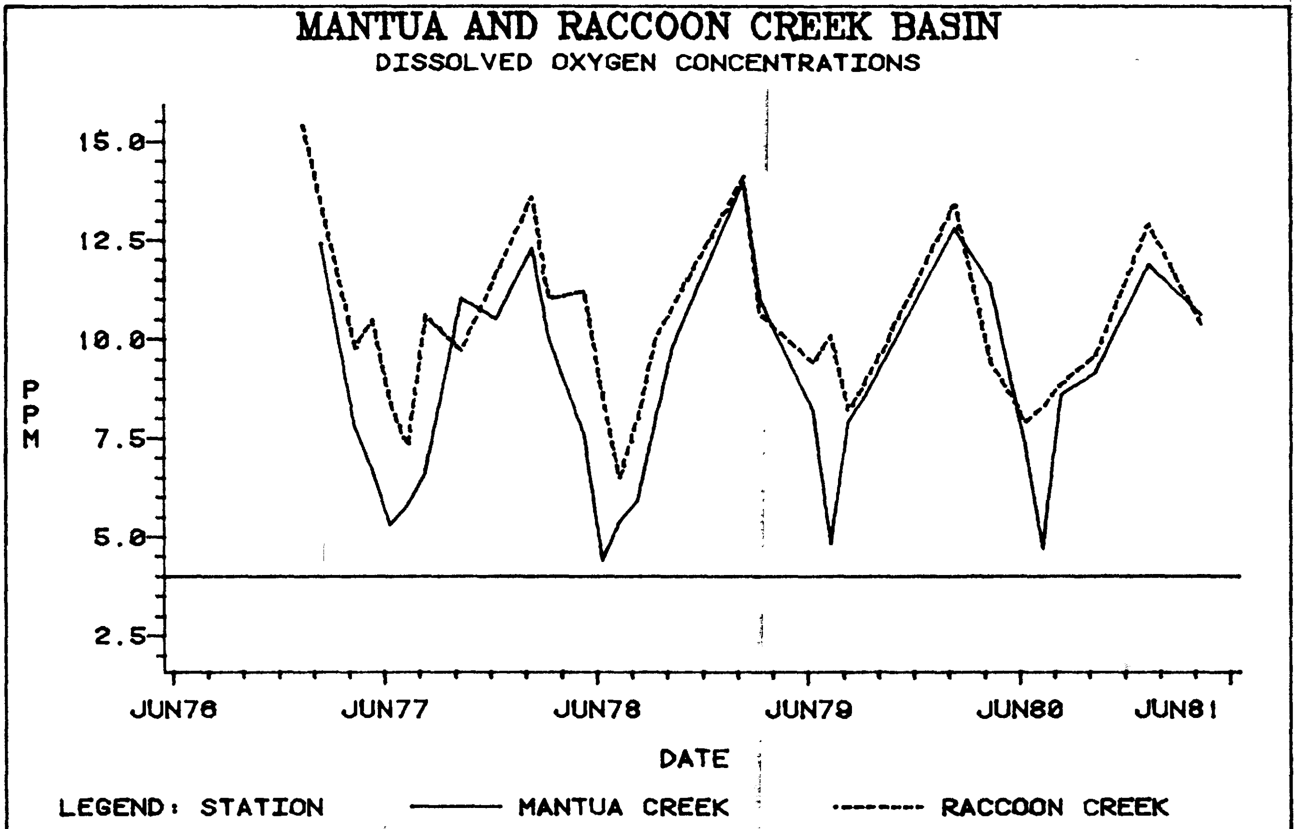
B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Mantua Creek at Mantua	Water column	3
Raccoon Creek at Mullica Hill	Water column	4

WOODBURY, MANTUA AND RACCOON CREEK BASINS

NEW JERSEY STATE WATER QUALITY
INVENTORY REPORT
1982





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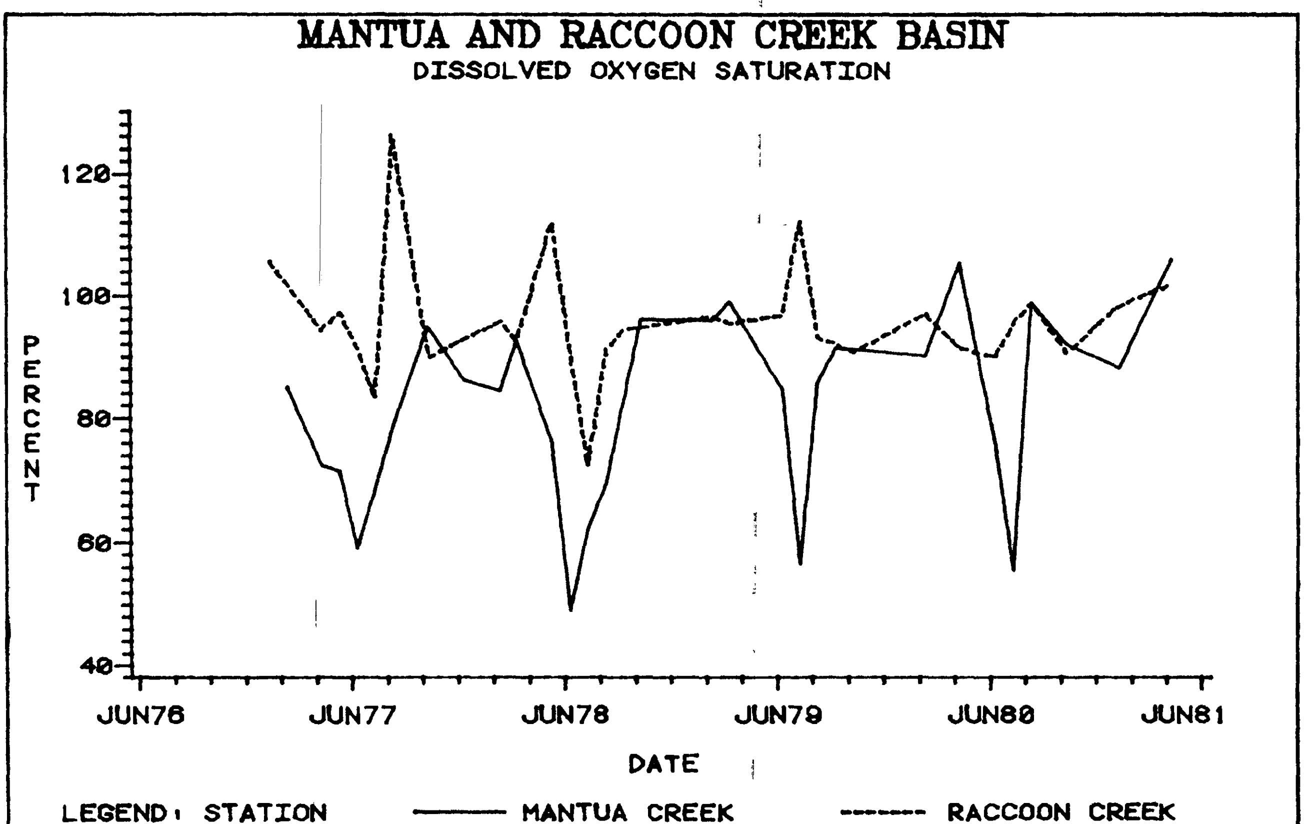

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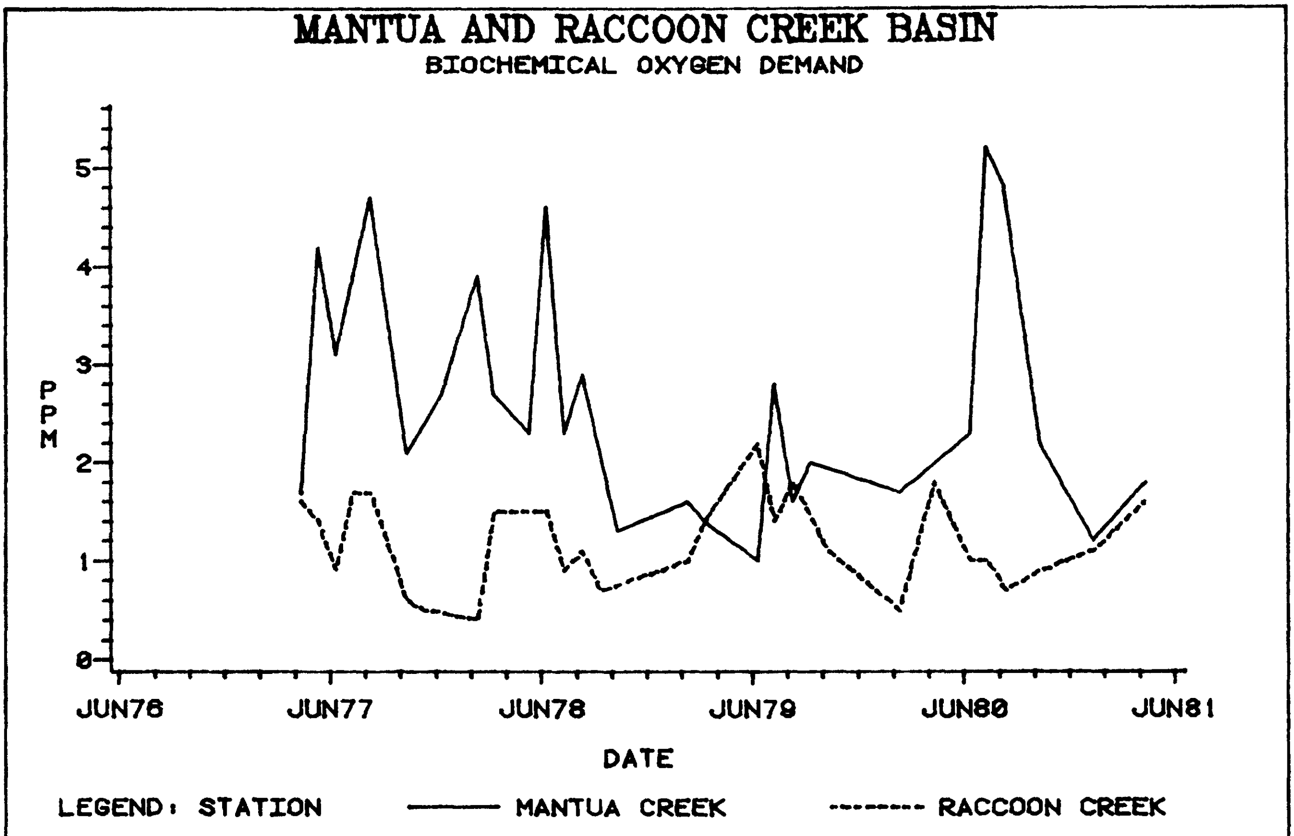

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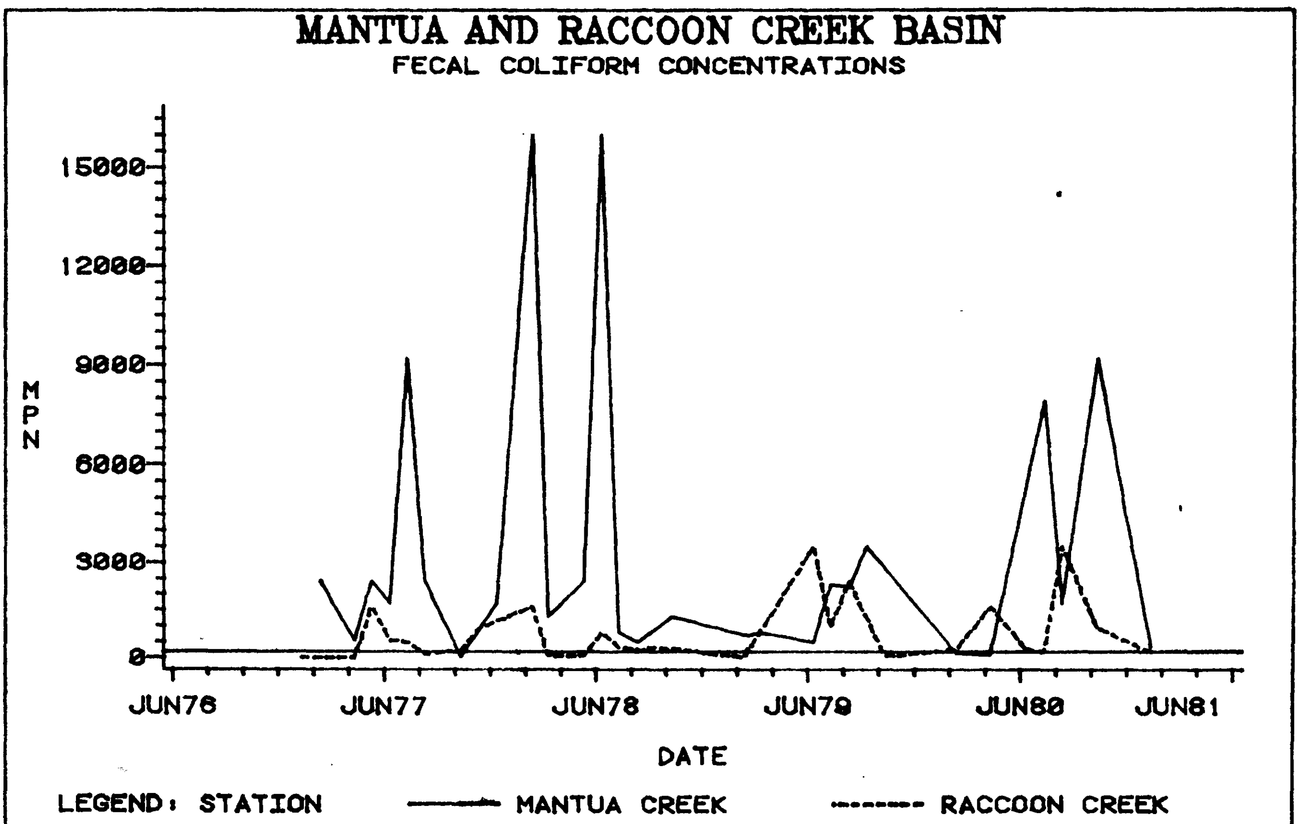

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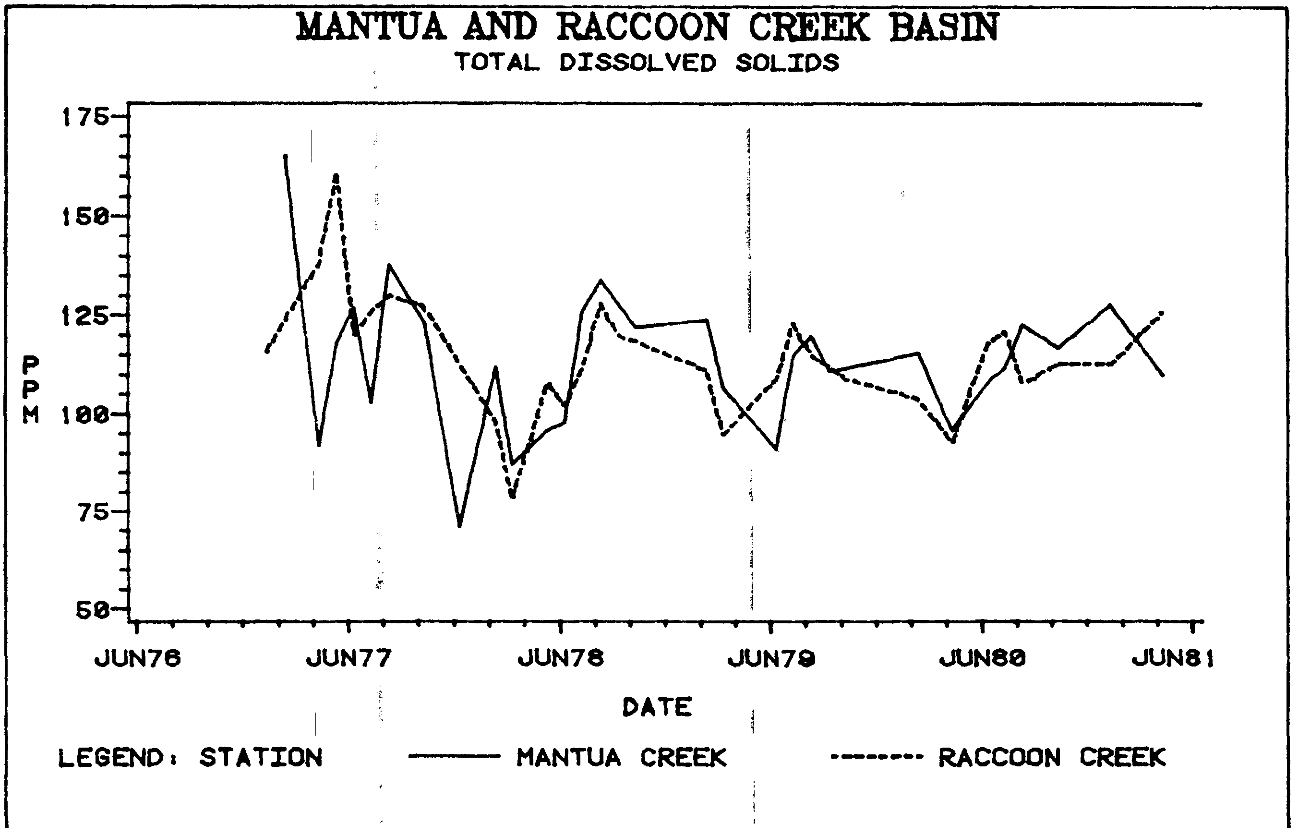

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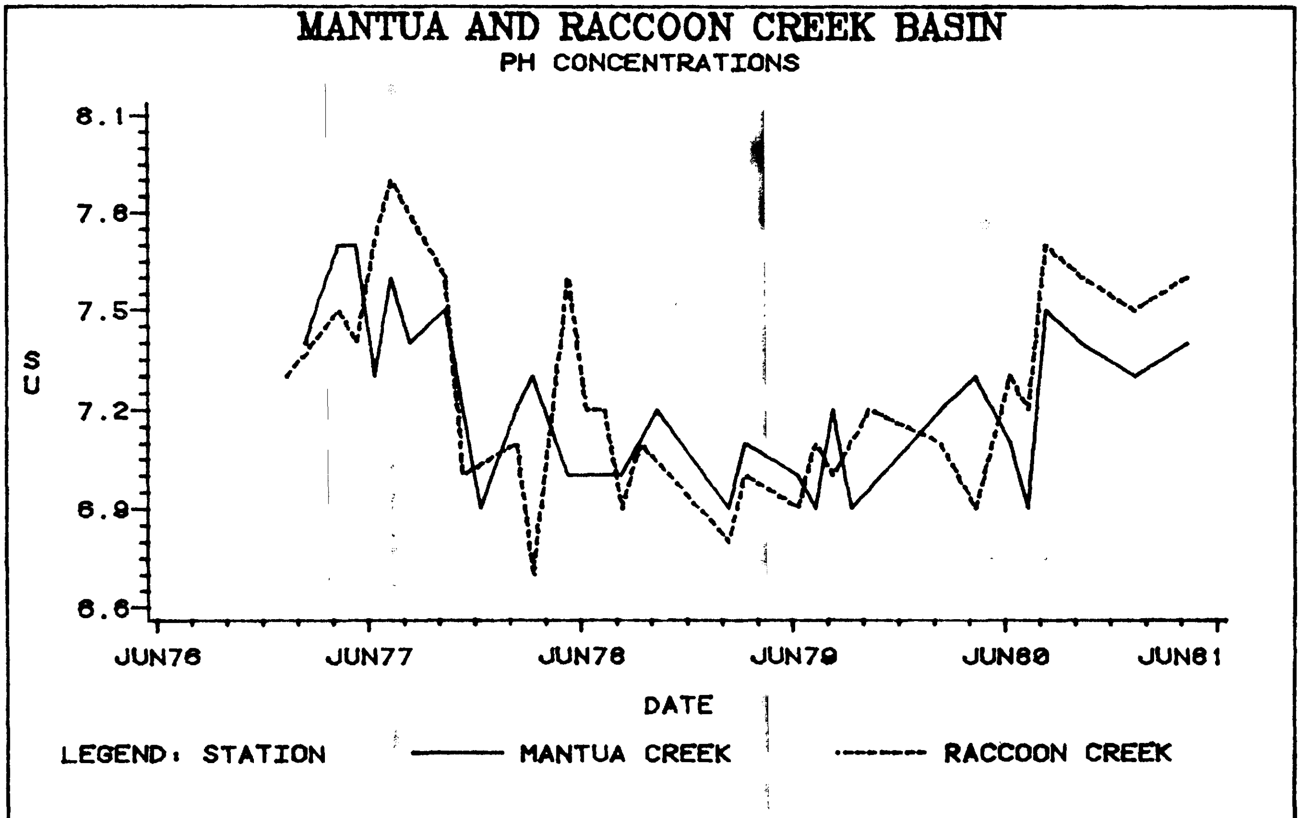

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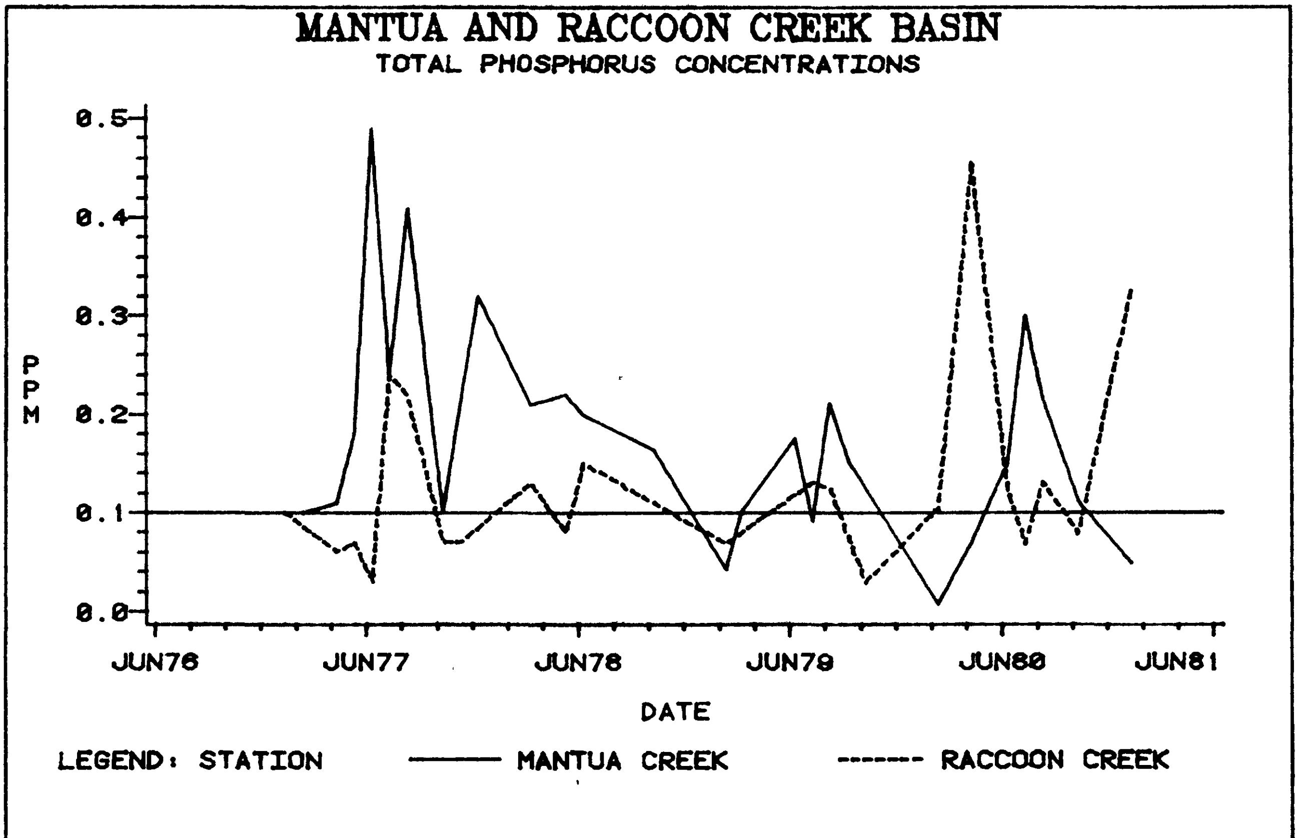

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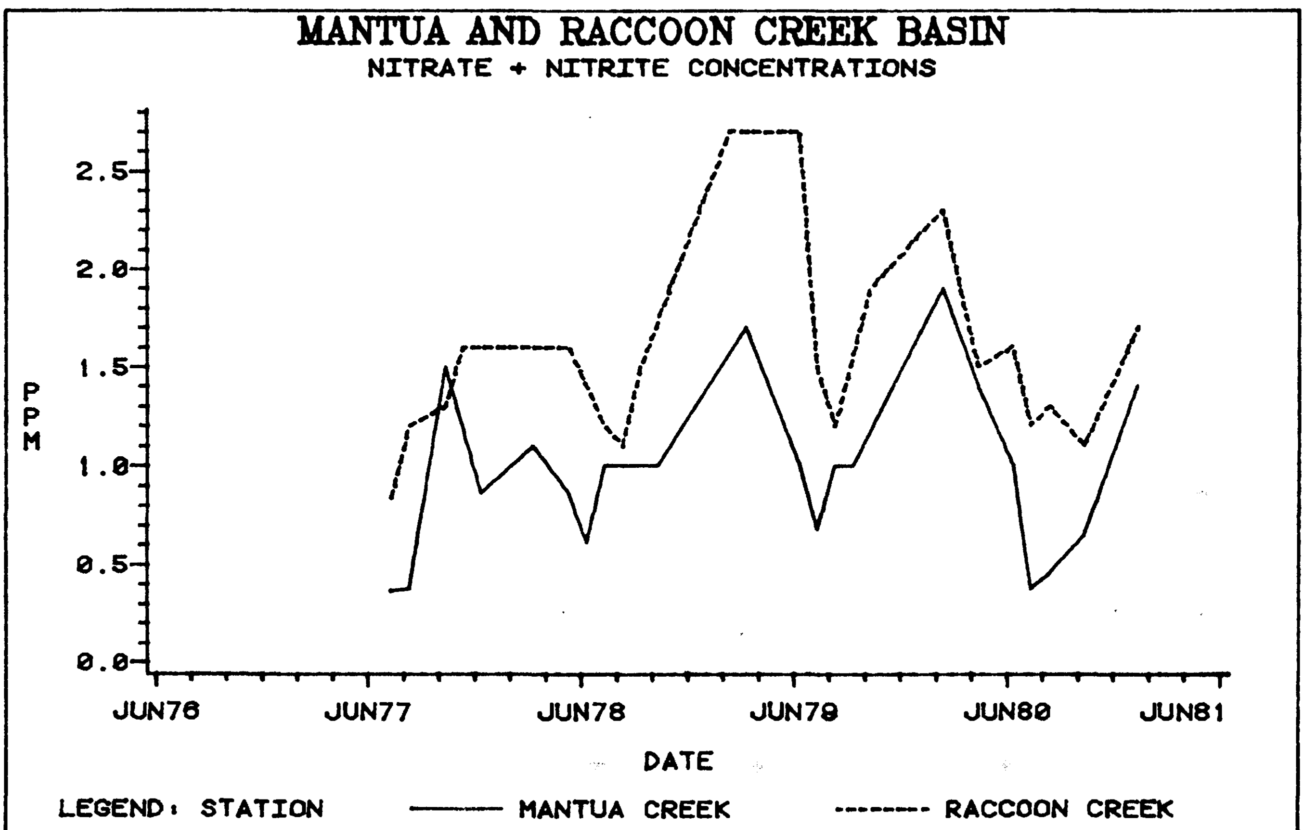

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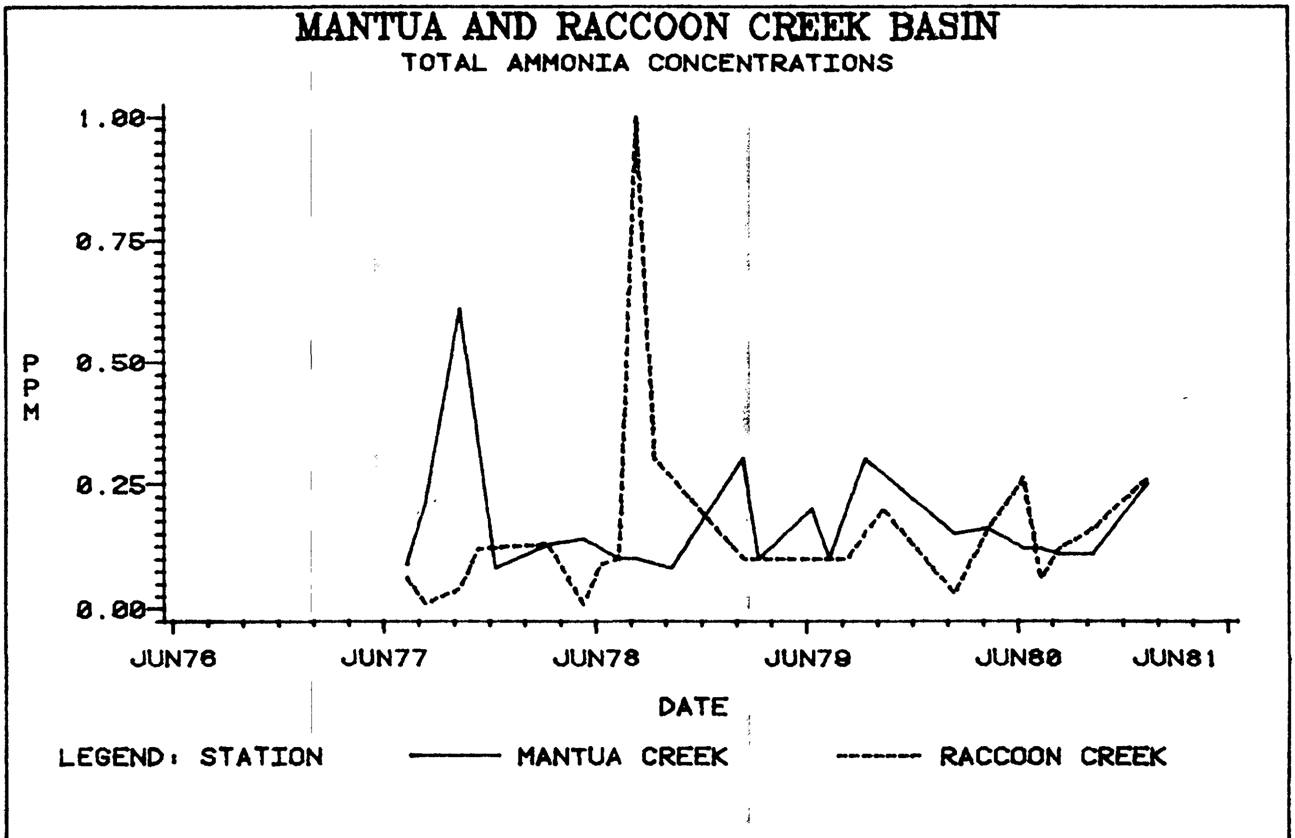

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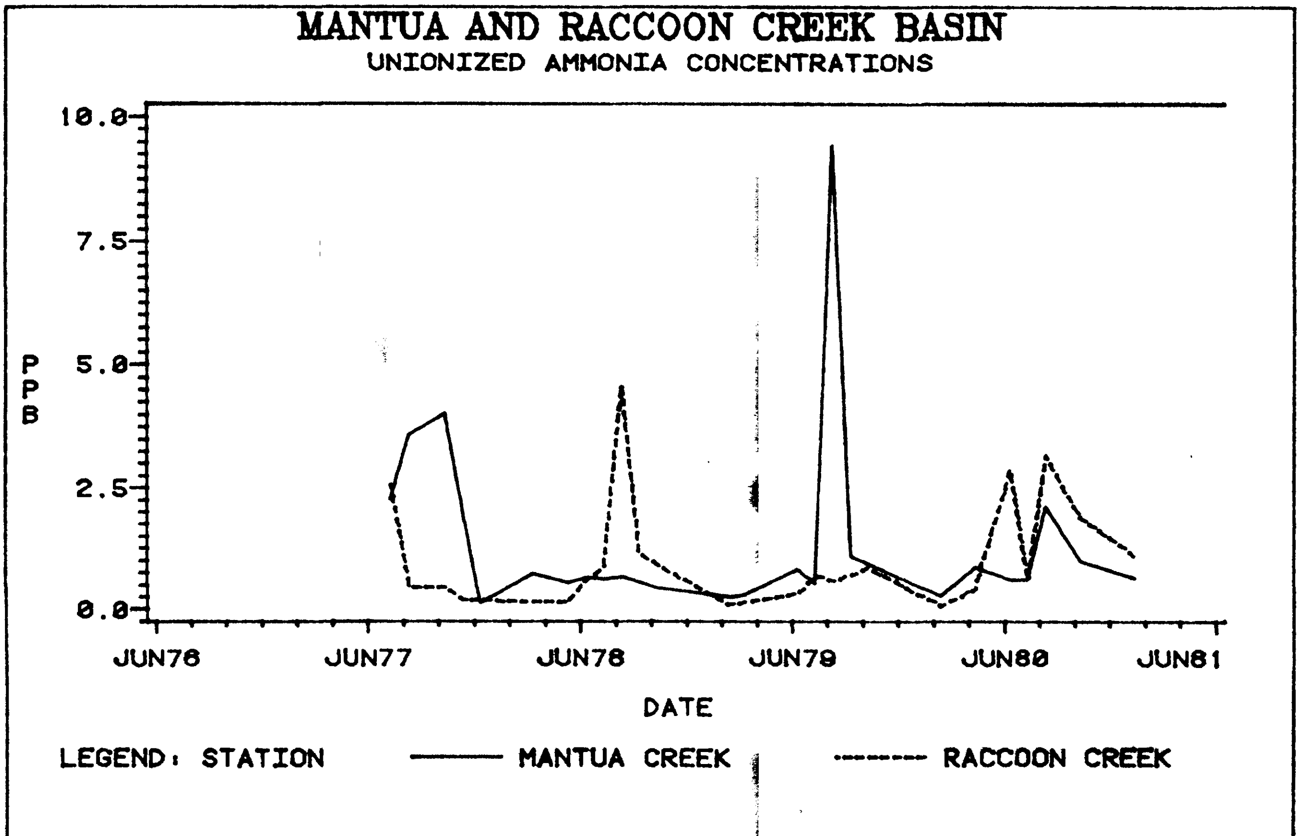

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DISCHARGE INVENTORY - - - WOODBURY MANTUA AND RACCOON CREEK BASINS

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
MATLACK INC.	0028398	SWEDESBORO, N.J.	RACOON CREEK		
TOWNSHIP OF HARRISON	0020532	HARRISON TWP	RACCOON CR.	SANITARY	.13
DELAWARE RIVER PORT AUTHORITY	0026379	CAMDEN	RACCOON CREEK	COOLING WATER	
ROLLINS-ENVIRONMENTAL SERVICES	0005240	LOGAN TWP	RACCOON CREEK	PROCESS WASTE	.8
BOROUGH OF SWEDESBORO	0022021	SWEDESBORO	RACCOON CREEK	SANITARY	.20
PURELAND WATER COMPANY	0023299	LOGAN TWP	TRIB TO RACOON CREEK		
CBS RECORDS	0004413	PITMAN	TR CHESTNUT BR	PROCESS & COOL.	.20
INVERSAND COMPANY-SEWELL	0004146	MANTUA TWP	MANTUA CREEK		.35
BOROUGH OF PAULSBORO	0026191	PAULSBORO	MANTUA CREEK	SANITARY	.01
AMERICAN TRANSIT CORPORATION	0032531	PITMAN	MANTUA CREEK	PROCESS WASTE	12.00
ICI AMERICAS INC	0033588	WOODBURY	MANTUA CREEK	COOLING WATER	
GREENWICH TOWNSHIP	0030333	GIBBSTOWN	WIGGINS POND	SANITARY	
SHELL CHEMICAL CO	0035831	WOODBURY	MANTU		
POLYREZ CO INC	0004871	WOODBURY /C/	MATTHEWS BRANCH	COOLING WATER	.45
SOHIO PIPE LINE CO.	0028801	W. DEPTFORD	UNNAMED DITCH-WOODBURY CREEK-D	RUNOFF OIL & GR	
GULF OIL CO US	0026026	WOODBURY /C/	WOODBURY RIVER		
NATIONAL PARK WATER DEPARTMENT	0025844	NATIONAL PARK	WOODBURY CREEK		.02

K. OLDMANS CREEK, SALEM RIVER AND ALLOWAY CREEK

Basin Description

The Oldmans Creek, Salem River and Alloway Creek watersheds are all located within Salem County, except for the northeastern half of the Oldmans Creek watershed which is located in Gloucester County. The streams are all located within the Coastal Plain physiographic province and flow to the Delaware River. The largest of the three is the Salem River which drains an area of 114 square miles.

The Salem River originates near Pole Tavern (Upper Pittsgrove Township) and flows westward towards Deepwater, after which it flows southward to the Delaware River. Approximately 40 percent of the Salem River basin is devoted to cropland with the remainder being woodland, tidal and freshwater marshes, urban and pasture. Among the diverse products produced are truck and processing vegetable crops, corn, soybeans, hay, potatoes and nursery crops. There is also a significant number of dairy operations located in the upper portions of the watershed.

Water from the Salem River and its tributaries is used for crop irrigation, fishing and swimming, although these activities have been restricted to some of the ponds along the river due to unsatisfactory water quality elsewhere. Downstream, where the river flows into the Salem Canal at Deepwater, it is used as a potable water supply for the E.I. DuPont de Nemours Company. Salem City also obtains potable water from the Salem River.

The Oldmans Creek and Alloway Creek basins contain wide tidal marshes in the vicinity of their confluence with the Delaware River. They are also characterized by such land cover types as agriculture (65-70 percent), forest, and suburban areas. The Oldmans Creek watershed is experiencing increasing residential development and industrial growth, while developed areas within the Alloway Creek basin generally consists of small towns. There are eleven point source dischargers to the Salem River with the City of Salem sewage treatment plant (average flow 1.20 mgd) being the largest.

The 1980 estimated population for Salem County was 64,579 which represents a moderate increase from the 1970 total of 60,346. The population of the Alloway Creek basin utilize septic tanks, while population centers in the Salem River basin are served by the Penns Grove Sewerage Authority, Pennsville Sewerage Authority, Salem City, Carney's Point Sewerage Authority, and Woodstown Sewerage Authority. A portion of Logan Township (Gloucester County) is sewered; the wastewater is transferred to a plant in the Raccoon Creek watershed.

Recreational waters in the three watersheds include: Woodstown Memorial Lake (near Woodstown), Fox Mill Lake (near Pole Tavern), and Harrisonville Lake (near the Salem/Gloucester County boundary). Harrisonville Lake is stocked with trout.

Oldmans Creek, Salem River and Alloway Creek are classified as FW-2 Nontrout, except for the tidal portions which are classified as TW-1.

Water Quality Assessment

Convention Parameters

Water quality was generally marginal in Oldmans Creek and poor in the Salem River based on sampling at Porches Mill (Oldmans Creek) and Courses Landing (Salem River), respectively. No stations are present on Alloway Creek. Dissolved oxygen concentrations and saturation levels were sufficient through the period in Oldmans Creek, but dropped below the minimum criteria during the summer months in Salem River. Some improvement in dissolved oxygen concentrations was exhibited in the Salem River after 1979 as summer values remained above 4.0 mg/l. Biochemical oxygen demand in Salem River exhibited seasonal variation with high levels generally occurring during the summer months. Low to moderate BOD_5 levels (0.5 to 3.0 mg/l) were recorded in Oldmans Creek.

Thirty-nine percent of the fecal coliform data collected from Oldmans Creek contravened 200 MPN/100 ml. In comparison, a 70 percent rate for contravening this level was recorded over the same period in the Salem River. Fecal coliform counts were as high as 24,000 MPN/100 ml in the Salem River. No trends for fecal coliform concentrations for the period were evident at either station.

Total dissolved solids levels were slightly higher in Salem River than in Oldmans Creek. But were well within the criterion as values were basically in the 100 to 200 mg/l range. The pH was generally within the 6.5 to 8.5 criterion range.

Nearly 100 percent of the total phosphorus data for the Salem River station at Courses Landing exceeded the 0.10 mg/l standard. Oldmans Creek exhibited occasional contraventions of the total phosphorus standard. Nitrate + nitrite values, however, exhibited a similar pattern of seasonal variation in each stream, with values from .6 mg/l to 3.7 mg/l being recorded. Higher levels were found consistently during the winter months. Total ammonia levels in the Salem River were under 1.0 mg/l for all values and appeared to decline over the period. However, un-ionized ammonia concentrations exceeded the 50 ug/l standard on two occasions. Un-ionized ammonia concentrations in Oldmans Creek were well within the criteria for the period, while total ammonia did not exceed .5 mg/l during the period of record.

Biological data collected from the Salem River at Courses Landing confirms the presence of stressed conditions. Periphyton chlorphyll a concentrations were consistently elevated indicating very enriched conditions. The macroinvertebrate data also indicates very stressed conditions. In 1977, oligochaete worms represented 90 percent of the organisms sampled. The dominant taxonomic group shifted to the chironomids in 1978 and 1979, comprising 89 and 78 percent of the population, respectively. In 1978, midges of the tolerant genus Glypotendipes alone represented 84 percent of the individuals recovered.

Overall, water quality conditions have not shown improvement in Oldmans Creek or the Salem River. Some increases in dissolved oxygen have occurred in Oldmans Creek, but nutrients and fecal coliform levels are similar to what has been reported in earlier 305(b) reports.

Toxic Parameters

The Salem River was sampled at two locations, near Route 46 and at the Route 49 bridge near Salem City. These results showed no evidence of toxic contamination. More intensive studies of these drainage basins are planned with particular attention to the Salem River and Oldmans Creek.

In 1979, a limited number of fish tissue samples were collected from Alloway Creek near Hancocks Bridge, Lower Alloways Creek Township. Elevated levels of PCB Arochlor 1254 were not detected in either brown bullhead, *Ictalurus nebulosus*, or American eel, *Anguilla rostrata*. The DDE in *Anguilla* was elevated but not in excess of the 5.0 ppm action level for fish tissue. Sediment analyses at this location revealed non-detectable results for the organochlorinated pesticides and PCB Arochlor 1254. At this time there has been no widespread sampling regime for toxics in aquatic organisms from these basins.

Problem Assessment

As is indicated above, these streams are of marginal to poor quality. Nutrients and fecal coliform problems occur in Oldmans Creek while the Salem River experiences low dissolved oxygen and high biochemical oxygen demand, nutrients, fecal coliform and un-ionized ammonia concentrations. Although not monitored routinely, according to the Lower Delaware WQM Plan, Alloway Creek contains fecal coliform problems. Despite the presence of both point and non-point sources of pollution in these watersheds, these stream's ability to assimilate organic pollutants are naturally low due to their slow flows, meandering characteristics and the occurrence of vegetative growth.

Oldmans Creek quality is influenced by non-point sources present in the watershed. The principle contributors appear to be agricultural runoff from livestock and septic systems. No point sources discharge to Oldmans Creek. Similar water quality problems are thought to exist on Alloway Creek. Known septic system problem areas exist in Alloway, Quinton and Lower Alloways Creek Townships within the Alloway watershed. Like Oldmans Creek, there are no point source discharges in the Alloway Creek watershed.

The Salem River watershed contains a number of dischargers, with the largest one located downstream near the City of Salem. Therefore, the poor water quality conditions detected at Courses Landing are due to small dischargers in Pilesgrove Township and non-point sources. The major contributor of non-point pollution is most likely the abundant dairy farm operations in the Upper Salem River. An intensive survey on Memorial Lake in 1979 by the Lakes Management Program showed the Lake to be eutrophic. Excess nutrients and sediments flowing into the lake from the Salem River were likely from agricultural areas and suburban developments.

Goal Assessment and Recommendations

Based on the sampling results, both these streams do not yet meet the goal of swimmable water quality. They are fishable, although the Salem River occasionally contravened the standards for dissolved oxygen and un-ionized ammonia concentrations, which indicate stress conditions for aquatic organisms. Of the two water bodies, Oldmans Creek supports a more diverse fish population. Seventeen species have been reported from Oldmans Creek, while only nine were identified in the Salem River. Both streams appear to favor fish that prefer slow moving waters with abundant weed growth.

Increased monitoring activities are needed in this area of the State, especially in the Alloway Creek watershed. Control of the main pollution sources in this segment can be accomplished with animal waste management practices in livestock operations, and the proper installation and maintenance of on-site disposal systems. Salem County's Department of Health has recently become a facilities planning agency, and received federal and state funds to study on-site system management for the majority of the county. With this action improvements to water quality should be forthcoming.

Point source controls in the Salem River watershed should begin with improvements to the Woodstown STP so it can consistently achieve secondary treatment and studies to determine if advanced treatment levels are required by the municipal/institutional dischargers. Treatment plant upgrading is also needed in the lower Salem River area (Mannington, Salem City and Elsinboro) because the Salem City STP is operating at primary level. Improvements to the estuary and marshes of the Salem River would result from such action.

OLDMANS CREEK, SALEM RIVER, AND ALLOWAY CREEK STATION LIST

A. Ambient Monitoring Stations

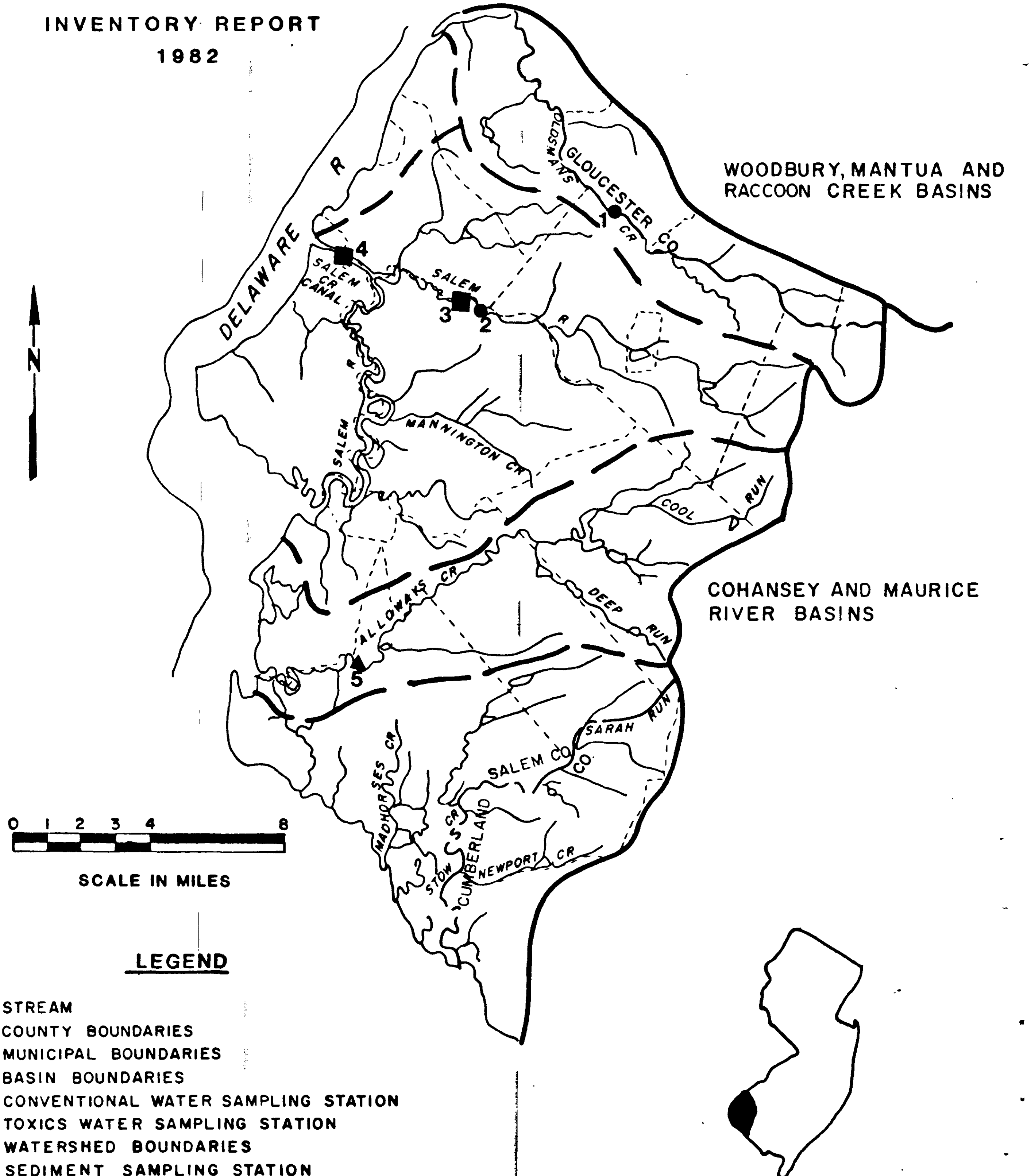
STORET Number	Station Description	Map Number
01477510	Oldmans Creek at Porches Mill, Salem County Latitude 30°41'57" Longitude 75°20'01" FW-2 Nontrout USGS/DEP Network At bridge on Kings Highway, 2.1 miles southeast of Auburn.	1
01482527	Salem River at Courses Landing, Salem County Latitude 30°39'38" Longitude 75°24'34" FW-2 Nontrout Basic Water Monitoring Program At bridge on Pointers-Auburn Road, 4.0 miles southwest of Auburn and 1.0 mile southwest of intersection with U.S Route 40.	2

B. Toxics Monitoring Station

Station Location	Sampling Regime	Map Number
Salem River at Route 46	Water column	3
Salem River at Route 49	Water column	4
Alloway Creek at Hancocks Bridge	Sediments	5

OLDSMAN, SALEM, AND ALLOWAYS CREEK BASINS

NEW JERSEY STATE WATER QUALITY
INVENTORY REPORT
1982

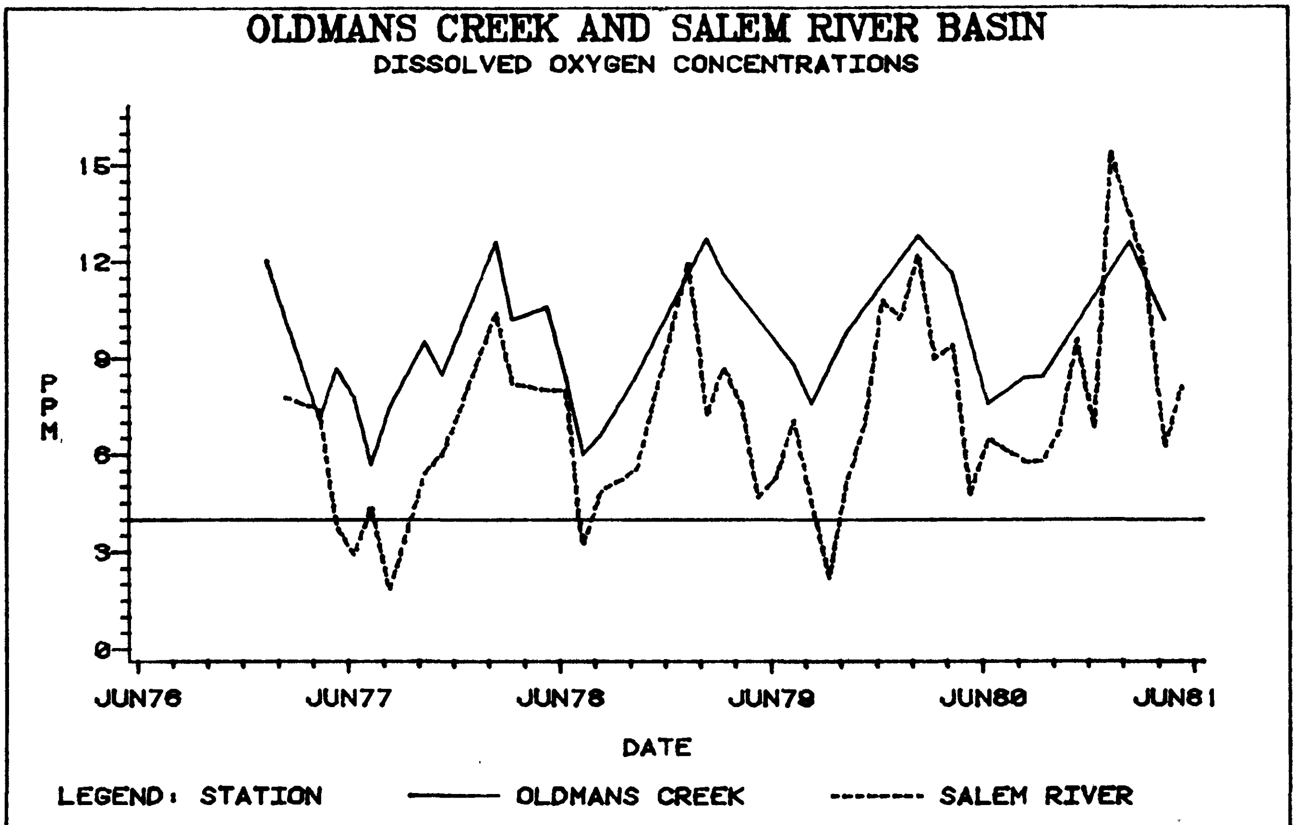


SCALE IN MILES

LEGEND

- STREAM
- COUNTY BOUNDARIES
- MUNICIPAL BOUNDARIES
- BASIN BOUNDARIES
- ● CONVENTIONAL WATER SAMPLING STATION
- ■ TOXICS WATER SAMPLING STATION
- WATERSHED BOUNDARIES
- ▲ SEDIMENT SAMPLING STATION

LOCATION OF BASIN



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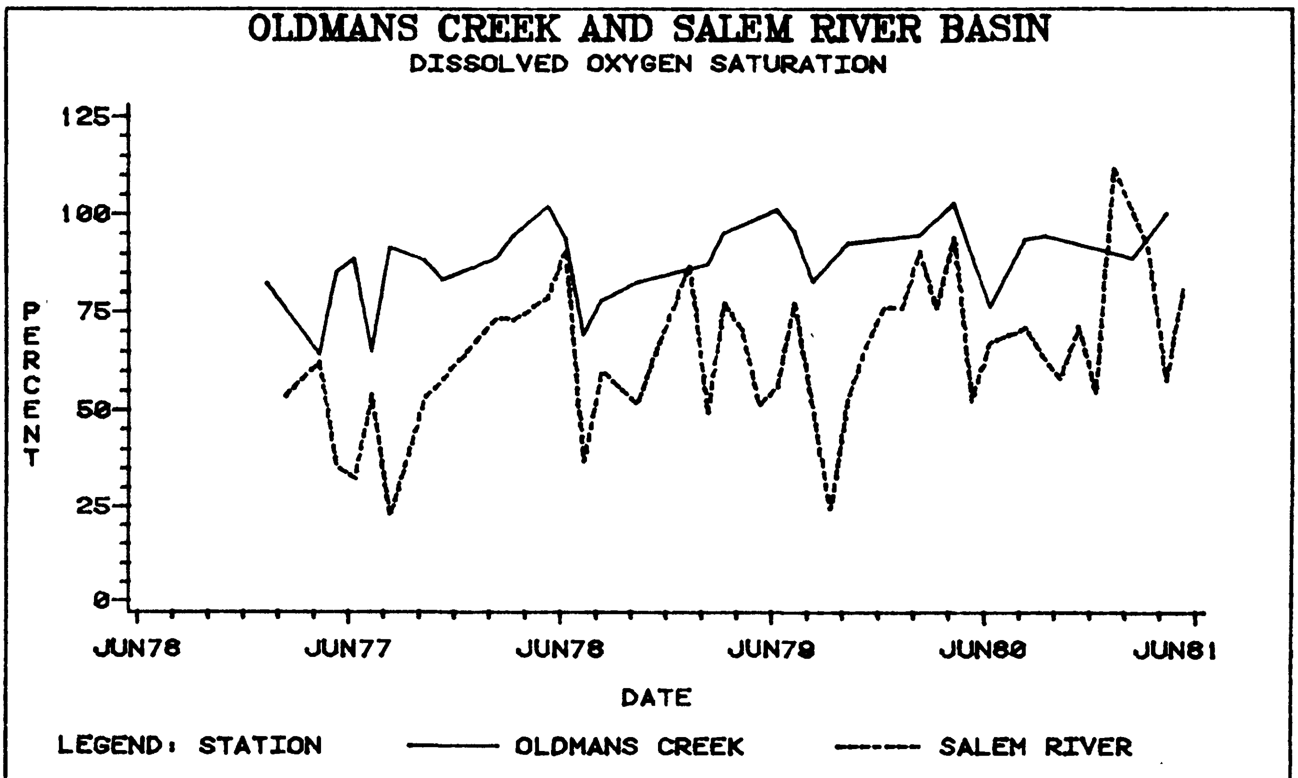

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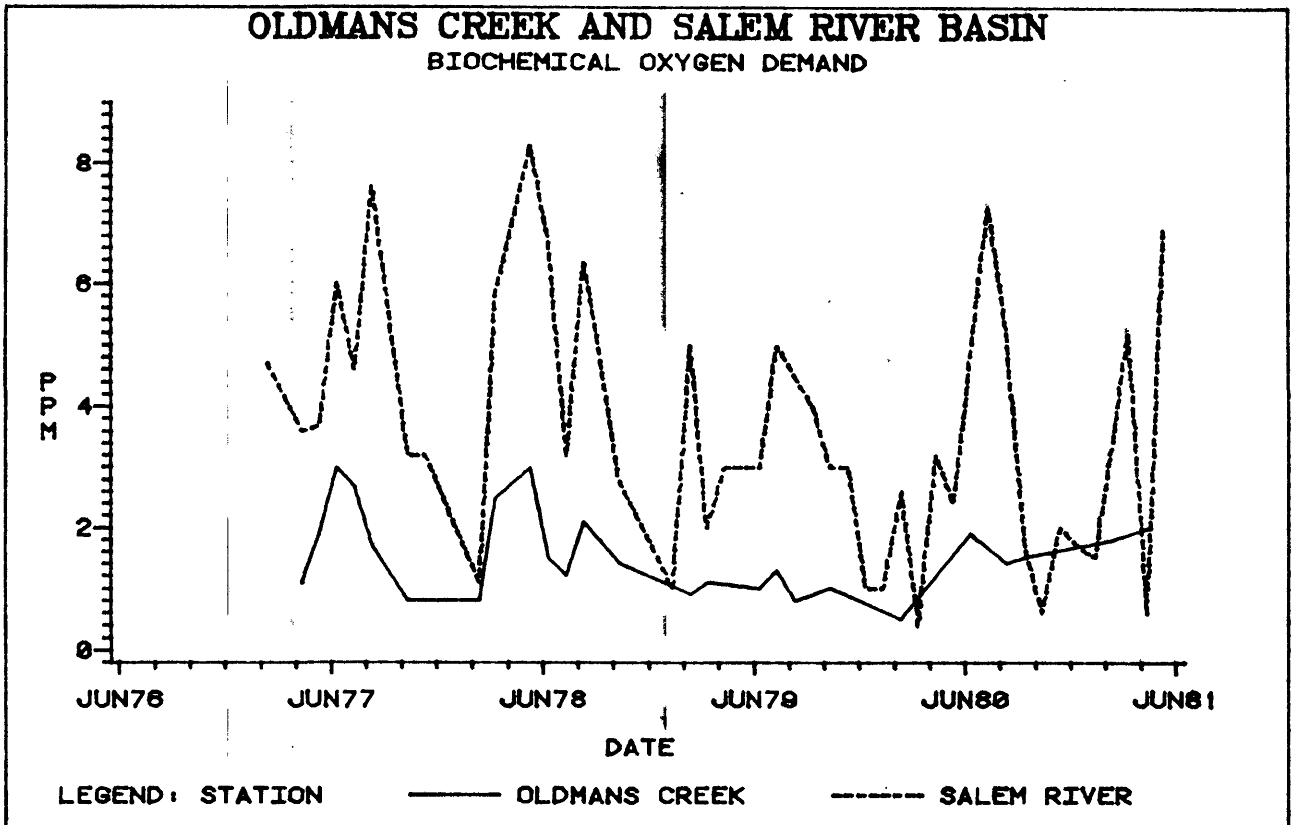

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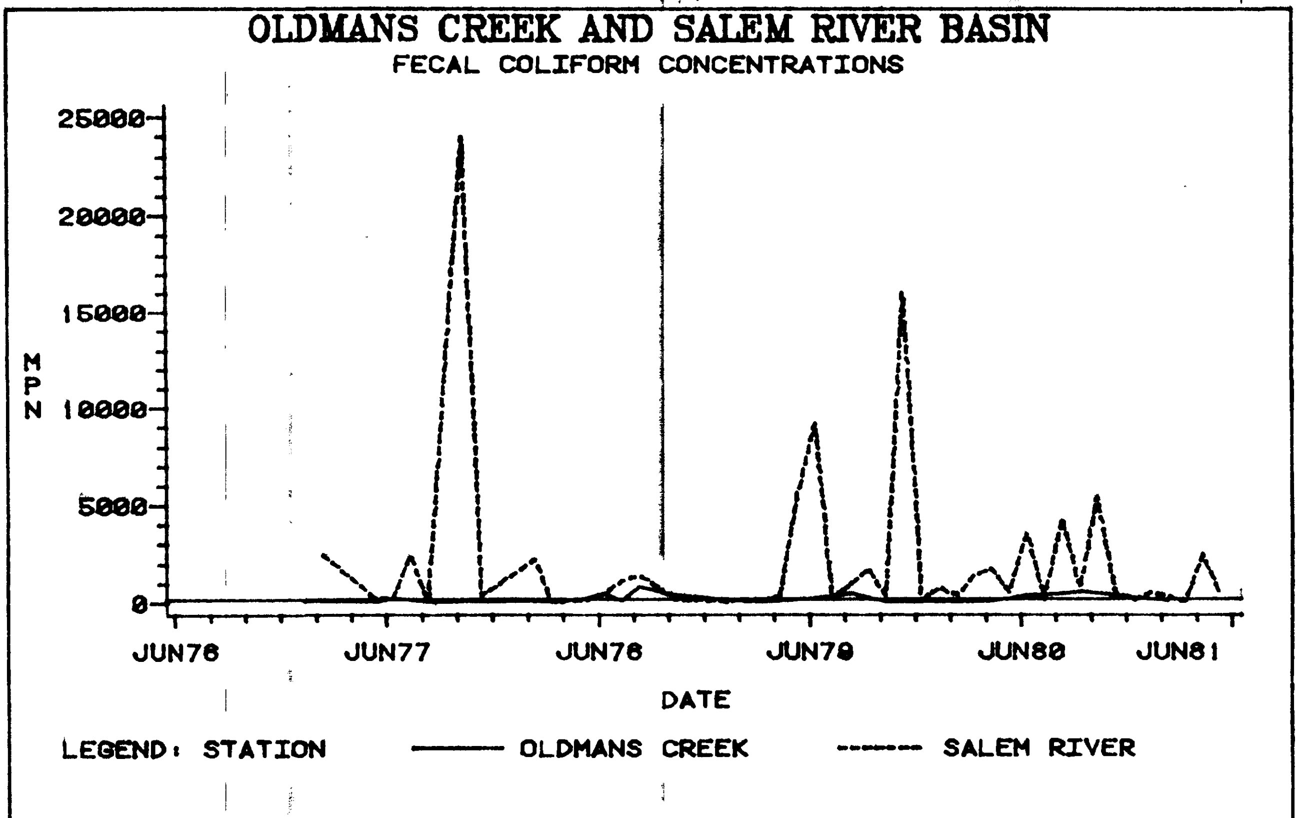

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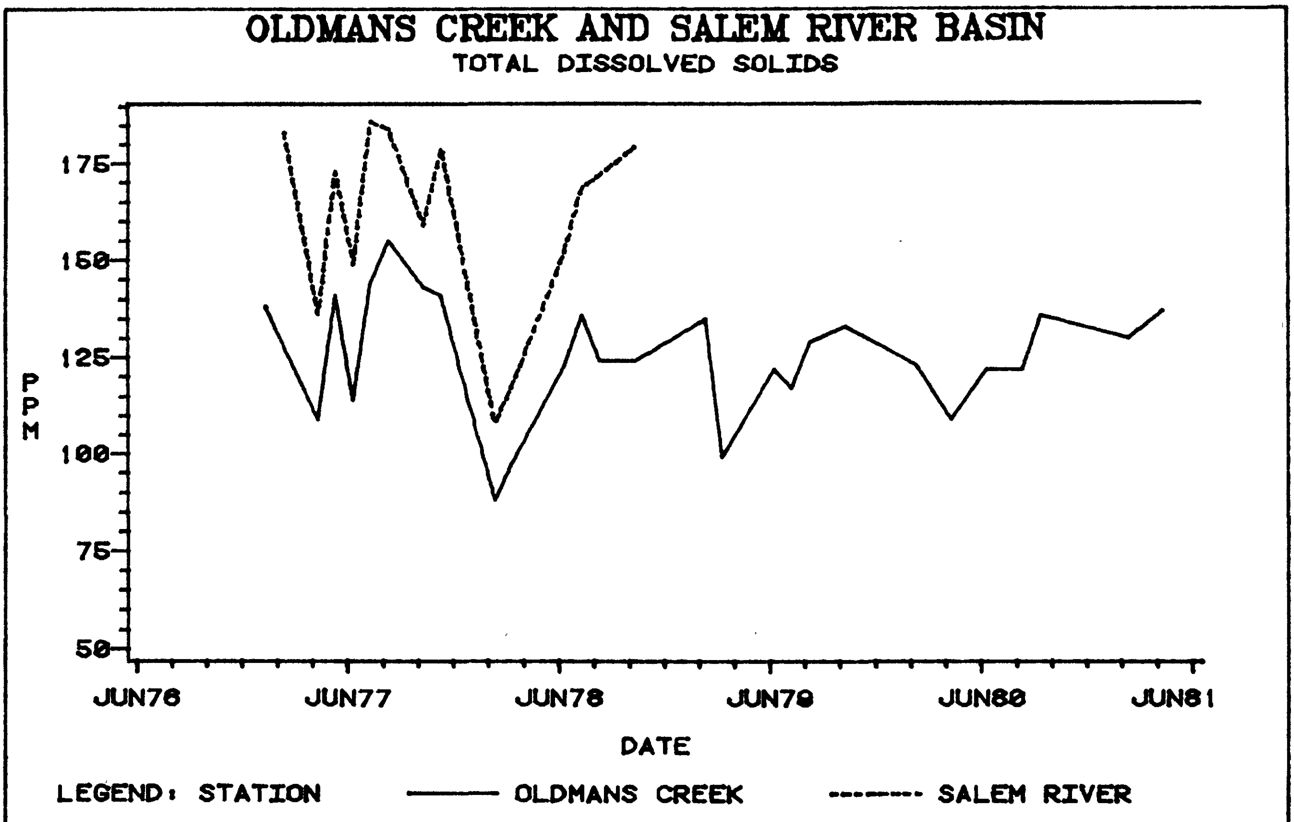

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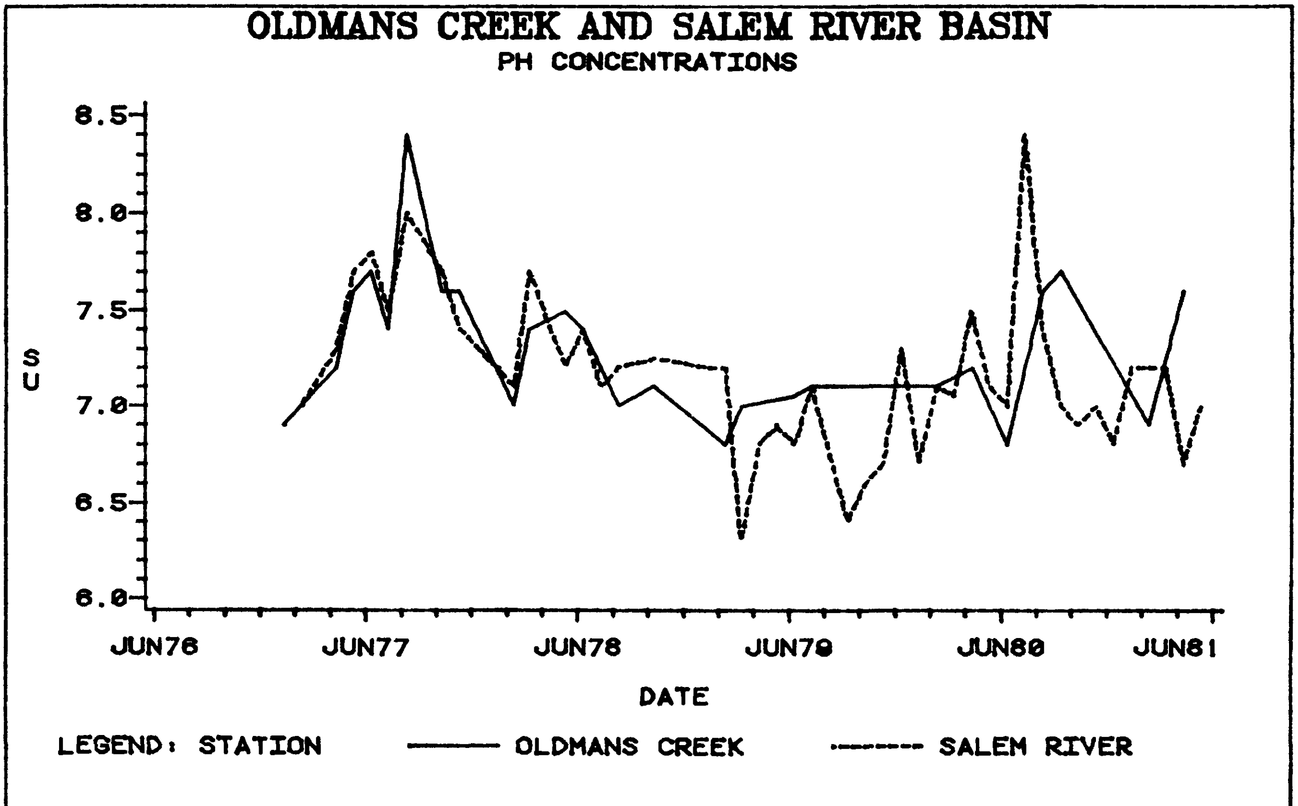

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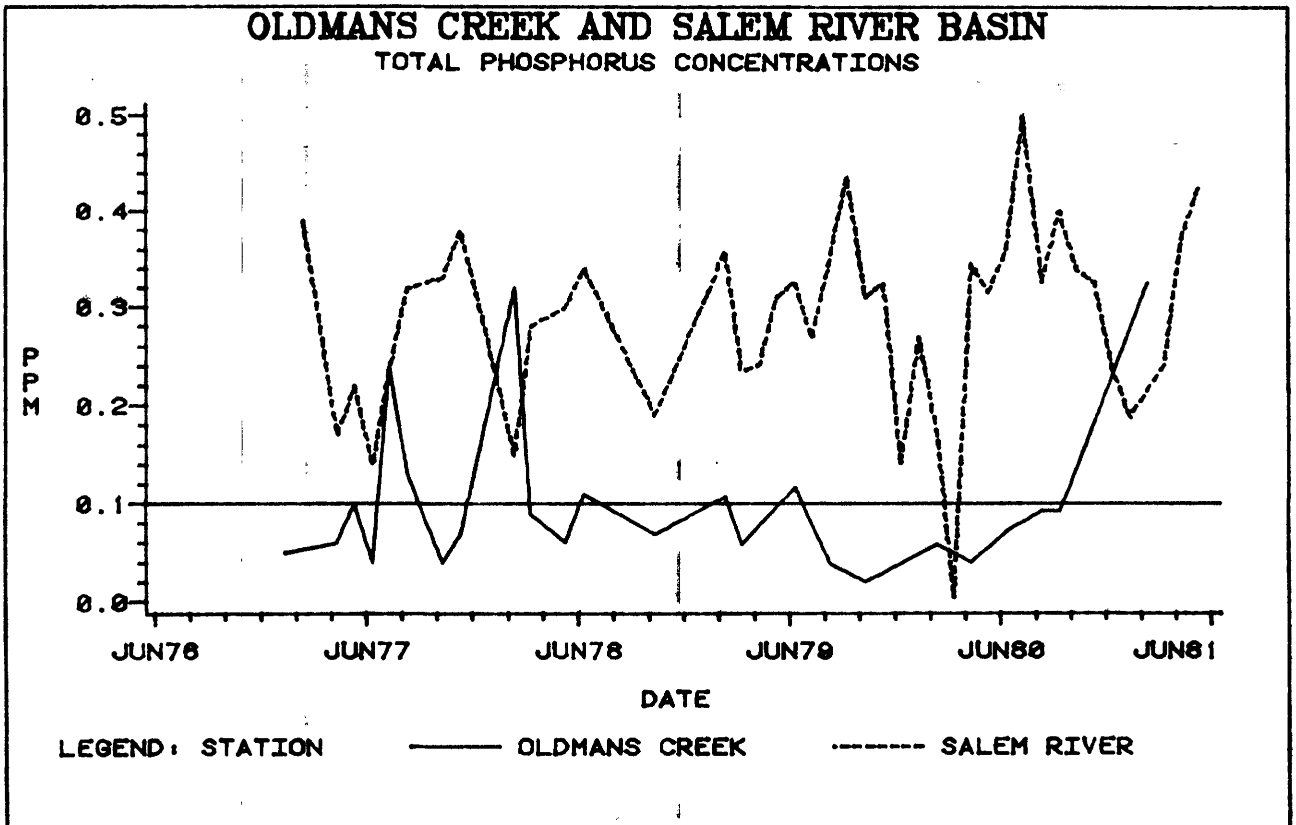

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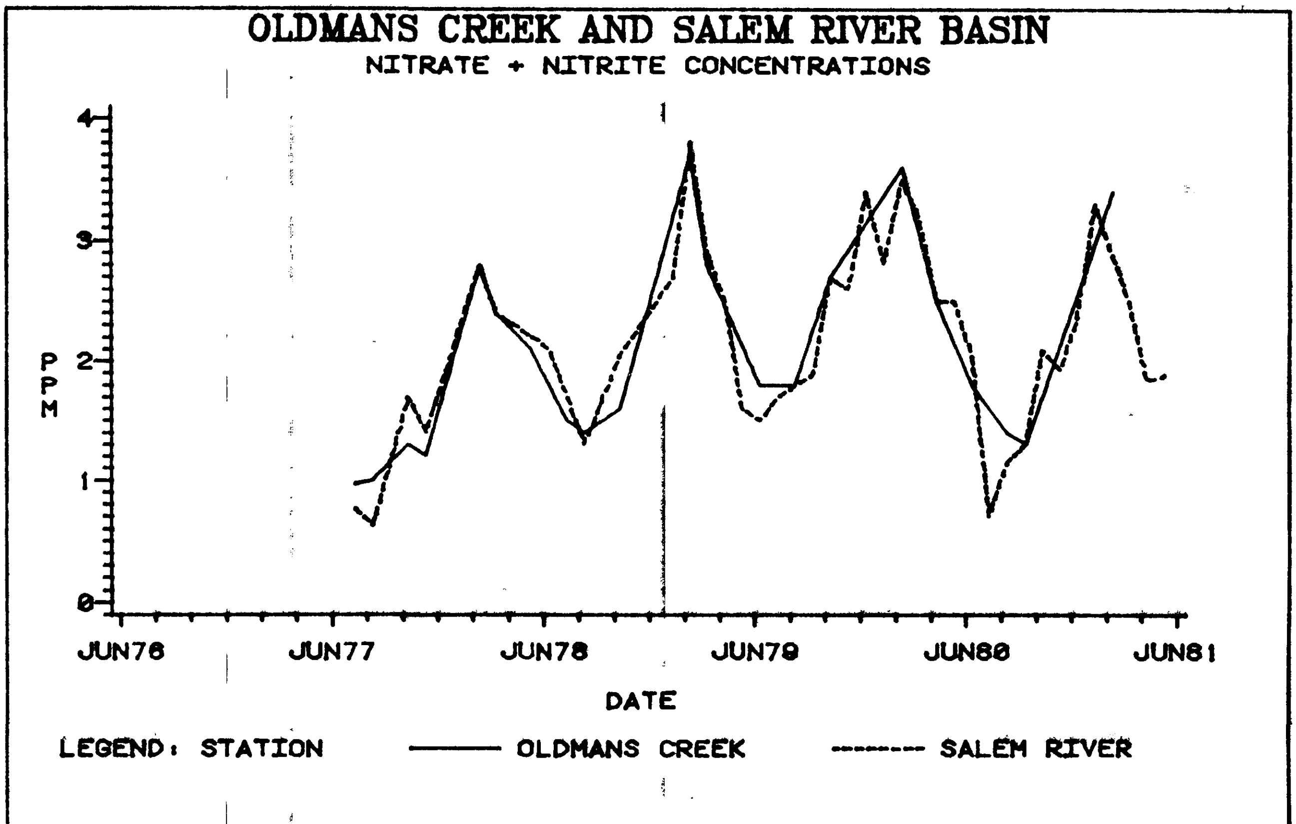

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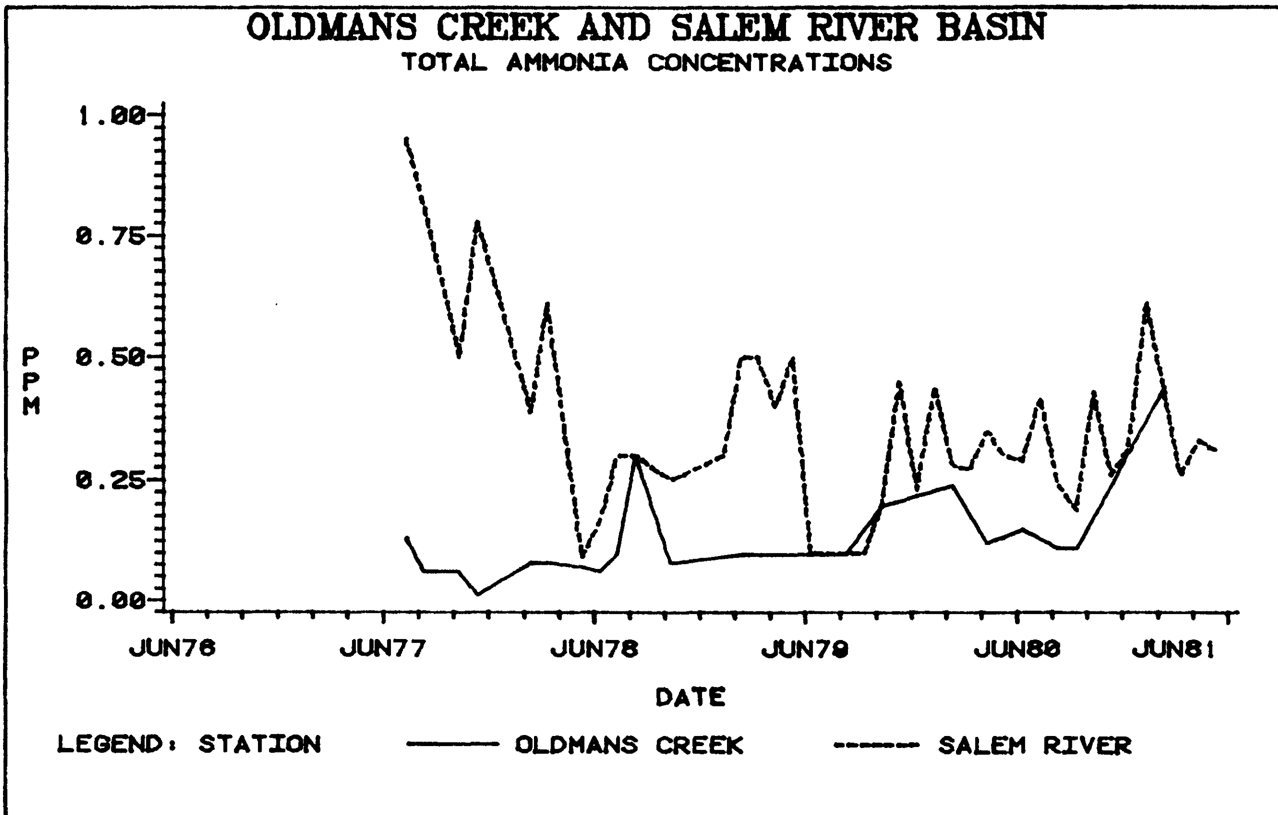

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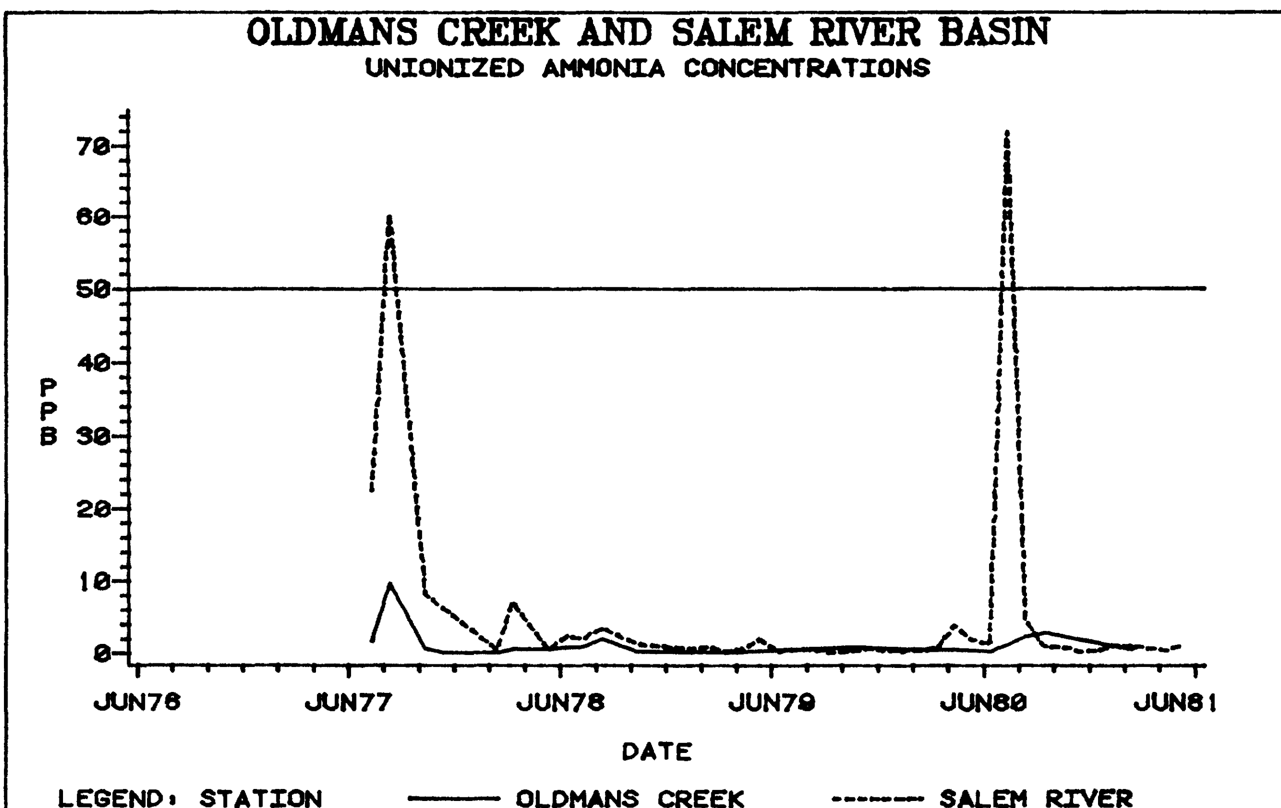

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DISCHARGE INVENTORY - - - OLDSMANS, SALEM AND ALLOWAYS CREEK BASINS

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
ANCHOR HOCKING CORP PLANT 6	0005151	SALEM	SALEM CREEK	PROCESS & COOL.	.16
CITY OF SALEM	0024856	SALEM	SALEM R.	SANITARY	1.10
RICHMAN ICE CREAM CO	0004308	PILESGROVE TWP	SALEM RIVER	COOLING WATER	.06
MANNING MILLS INC	0005614	SALEM	PLEDGER CREEK	PROCESS & COOL.	.09
SALEM COUNTY VOC. TECH. SCHOOL	0028797	WOODSTOWN	MAJOR RUN CREEK	SANITARY	
CITY OF SALEM W.T.P.	0035742	SALEM	KEASBEY CREEK		
B.F. GOODRICH CO.	0004286	OLDMANS TWP	DITCH OLDMANS T	PROCESS & COOL.	.38
BUDD CHEMICAL CO	0033570	CARNEYS POINT	TRIBUTARY DELAWARE RIVER	COOLING WATER	
GANES CHEMICALS INC	0035394	PENNSVILLE	MILES CREEK		
WOODBINE STATE SCHOOL	0021172	WOODBINE BORO	DENNIS CREEK	SANITARY	
NEW JERSEY TURNPIKE AUTHORITY	0020761	OLDMANS TWP	PLAYTON LAKE	SANITARY	.06
WOODSTOWN SEWERAGE AUTHORITY	0022250	WOODSTOWN	ROCK BROOK	SANITARY	.24

L. COHANSEY AND MAURICE RIVERS

Basin Description

The Cohansey and Maurice Rivers originate in eastern Salem County and southeast Gloucester County, respectively, draining a total of 491 square miles of predominantly forested land. Both meander in a southerly direction through Cumberland County, emptying into Delaware Bay. Major tributaries in the Maurice River watershed are Scotland Run, Muddy Run, Manantico Creek, Manumuskin River and Muskie Creek. The average flow for the Maurice River recorded at the Norma gauging station (113 square mile drainage area) is 169 cfs. The Cohansey River is tidal downstream of the dam at Sunset Lake, while the Maurice River is tidal downstream of the dam at Union Lake.

Both watersheds are heavily forested, with agriculture being the dominant land use. Several non-tidal tributaries are utilized for irrigation purposes in various agricultural sectors of both watersheds. Agriculture in the Cohansey River watershed consists primarily of beef and dairy operations, with crop acreage devoted primarily to corn, soybeans, hay and barley. Agriculture in the Maurice River watershed consists mainly of beef, dairy and swine operations, while crop acreage is devoted primarily to corn, hay, soybeans, tomatoes and barley.

Population growth between 1970 and 1980 occurred throughout the basin, with development in the Cohansey River watershed proceeding at a greater rate than the rest of the State. The largest urban centers in the Maurice River watershed are Vineland and Millville and in the Cohansey River watershed, Bridgeton.

Two treatment plants owned by the Cumberland County Sewerage Authority (CCSA) represent the only significant point source dischargers in the Cohansey River watershed: one located at Bridgeton City on the Cohansey River (average flow of 3.0 mgd), the other in Upper Deerfield Township on Foster Run, a tributary to the Cohansey River (0.3 mgd). In the Maurice River watershed, the Vineland City STP (0.75 mgd) and Landis STP (3.5 mgd) utilize only primary treatment and ground discharge in the upstream areas. In addition, a 2.2 mgd municipal facility is located in Millville. The major industrial treatment plant, Wheaton Glass Co., discharges 3.0 mgd into Petticoat Creek. In the lower portion of the Maurice River (Port Norris area) are ten clam and oyster shucking industries, with effluent flows that vary from 1000 to 50,000 gallons per day per facility. The Vineland Chemical Co. is also a significant point source discharger in the Maurice River watershed. Thirty-two dischargers have been identified in the Maurice and Cohansey River basins; all but seven are located in the Maurice watershed. The Cohansey and Maurice watersheds lie within the boundaries of four facility planning areas. Potable water supplies in these watersheds are derived primarily from ground water sources.

Twelve major lakes lie within the Cohansey River watershed, the preponderance of which are privately owned and devoted to recreational activities (primarily bathing, motor and non-motor boating and shoreline fishing). The largest of these, Sunset Lake (43 acres), has been classified as eutrophic (Tri-County Water Quality Management Plan, 1977). The City of Bridgeton is in the process of a multi-million dollar improvement of their City Park along the Cohansey River and Sunset and Mary Elmer Lakes. Twenty major lakes lie within the Maurice River watershed, five of which are public and are devoted primarily to recreational activities such as bathing, motor and non-motor boating and fishing. The largest of these, Union Lake (920 acres), is the most significant standing body of water in southern New Jersey and has also been classified as eutrophic (Lower Delaware Water Quality Management Plan, 1979). One hundred percent of the shellfish harvesting areas in the Cohansey and Maurice watersheds are condemned for direct harvest and marketing. A limited hard clam and oyster resource exists in this coastal zone.

The State of New Jersey owns and operates two wildlife management areas in the Cohansey River watershed, i.e., Charles Pond and Dix, and five in the Maurice River watershed, i.e., Heislerville, Union Lake, Edward G. Bevan, Peaslee and Manantico Ponds, as well as Parvin State Park which allows bathing, motor and non-motor boating and fishing activities. The N.J. Division of Fish, Game and Wildlife stocks trout once or more yearly in the following waters: Cohansey River, Maurice River, Cumberland Pond, Sunset Lake, Giampietro Park Lake and Mary Elmer Lake.

New Jersey Water Quality Standards give the Cohansey and Maurice River watersheds a variety of water quality classifications. Headwaters downstream to the dams at Sunset and Union lakes are classified as FW-2 Nontrout; waters downstream of both dams are classified as TW-1; the majority of the remaining streams are either FW-2 Nontrout, TW-1 or FW-1 (streams within state parks and wildlife management areas).

Water Quality Assessment

Conventional Parameters

The Cohansey River's water quality declines as one goes downstream; marginal conditions exist at Seeley upstream, while poor conditions occur in both Sunset Lake and the lower segment at Bridgeton. Generally, very good water quality is exhibited in the upstream segment of the Maurice River, but marginal conditions exist below Union Lake and Millville.

Dissolved oxygen concentration data for the period at Seely (Cohansey River) and Norma (Maurice River) exhibited seasonal fluctuations with little apparent correlation to the generally moderate biochemical oxygen demand concentrations. Supersaturated daytime dissolved oxygen levels were exhibited in Sunset Lake and the downstream segment of the Cohansey River. This is due to excessive primary productivity supported by elevated levels of nitrate and total phosphorus.

The frequent contraventions of fecal coliform over the 200 MPN/100 ml level on the Cohansey River at Seeley indicated a greater problem than in the vicinity of Norma on the Maurice River. The highest fecal coliform concentrations (up to 2500 MPN/100 ml) on the Cohansey River were recorded during 1979 and 1980.

Total dissolved solids levels in both streams were well below the 500 mg/l standard. The Maurice River at Norma exhibited TDS values below 90 mg/l throughout the period, while the Cohansey River at Seeley exhibited higher concentrations. Values for pH concentrations were also slightly higher at Seeley than at Norma. The pH levels increased below Sunset Lake in the Cohansey River. The upstream segment of the Maurice River was naturally acidic, with the lowest pH levels occurring during low flow periods in the summer or fall months. The pattern of increasing pH values in the downstream direction which applied to the Cohansey River also occurs in the Maurice River.

Nutrient concentrations were generally higher in the Cohansey River than in the Maurice River. This was especially true for nitrate + nitrite concentrations which probably supported some nuisance aquatic vegetation in the downstream segment of the Cohansey River. Conversely, nitrate + nitrite concentrations at Norma were 50 percent lower than at Seeley. Total phosphorus standard contraventions in the Maurice River were also fewer and less severe compared to the Cohansey River. Un-ionized ammonia concentrations were well within the criteria in each river, with the Cohansey River once again exhibiting slightly higher levels for each parameter.

Biological data collected at Maurice River in Millville, just below Union Lake in 1978 and 1979 confirms the declining water quality in the downstream segments. The mean periphyton chlorophll <u>a</u> concentration was greater than 20 mg/m^2, indicative of enriched conditions. The macroinvertebrate data also reflects a somewhat stressed community. In 1978, the community was dominated by midges (40%), caddisflies (23%), and oligochaete worms (17%). Midges completely dominated the macroinvertebrate community in 1979, with a single species of the genus <u>Calopsectra</u> comprising 74 percent of the individuals in the samples.

Water quality in the Cohansey River at Seeley has shown somewhat of a decline over conditions reported in earlier 305(b) reports. Fecal coliform levels have seemed to increase recently, as has total phosphorus. The Maurice River at Norma is of somewhat better quality now than when reported in prior 305(b) reports. Dissolved oxygen and total phosphorus levels have increased and decreased, respectively.

Toxic Parameters

Samples of aquatic organisms taken from the Maurice River at the Delaware Bay and Mauricetown produced only trace levels of PCB Arochlor 1254 in all but one sample of white perch, Morone americana. This one result, while elevated did not exceed the established action level for PCBs in fish tissue. Heavy metal concentrations in a wide variety of aquatic organisms sampled from the Delaware Bay location produced trace levels of mercury and arsenic, low levels of zinc and copper, and a single incidence of nickel detected in mummichog, Fundulus heteroclitus, blue claw crab, Callinectes sapidus, and spot, Leiostomus xanehurus. These levels were not elevated and are considered to be within the range typically found in aquatic organisms from similar waterways.

Problem Assessment

The Cohansey and Maurice Rivers are impacted from a combination of point and non-point sources, and both have generally poor capacities for assimilating oxygen demanding substances. This is evident in the decline of water quality as one goes downstream in both watersheds. In addition to the identified water quality problems in the upper watersheds, the NJ Division of Fish, Game and Wildlife has found very low summertime dissolved oxygen concentrations (at times under 1.0 mg/l) in the Maurice and Cohansey estuaries. These low DO levels have been responsible for periodic fish kills and are probably the result of upstream nutrient loadings and high biological productivity in the tidal reaches and estuaries of both streams.

The marginal water quality found in the Cohansey River at Seeley is likely due to agricultural runoff and improperly operating septic systems. These sources were identified in a 1979 intensive survey by the Lakes Management Program as the reason for eutrophication in Sunset Lake and the mesoeutrophic state of Mary Elmer Lake. Septic system problems are known to occur in Upper Deerfield Township. Other areas of the Township are served by the CCSA Seabrook Farms treatment plant which discharges to Fosters Run. It is expected that this plant will be phased out with flows transfered to the main CCSA plant at Bridgeton. The Seabrook Farms plant has had difficulty in meeting the NJPDES permit limitations assigned to it. Further downstream the Cohansey receives additional point source loadings from the Bridgeton CCSA plant and industrial facilities, as well as from suburban runoff.

The good water quality exhibited by the Maurice River at Norma is due to the lack of significant point sources and intensive development in the watershed above the station. The watershed is not without problems however. The Vineland Chemical Company has contaminated the Maurice River, Blackwater Branch and Union Lake with arsenic that originates from the company's site. In response to the contamination, the Department of Environmental Protection has enforcement actions pending against the company. Just downstream of the Norma station, the City of Vineland and the Landis Sewerage Authority ground recharge approximately 4 mgd of primary treated effluent. It is thought that the effluent has been percolating to nearby streams and is causing reduced dissolved oxygen, and excess suspended solids and nutrients in the streams. The two dischargers have received Administrative Orders to upgrade their treatment facilities. The Millville Sewer Authority discharges nearly 3 mgd to the Maurice below Union Lake in the tidal section of the river.

Non-point sources impacting the Maurice and its tributaries appear to be primarily malfunctioning on-site disposal systems and agricultural runoff. Septic systems are known problems in the following municipalities: Elk Township, Clayton Borough, Franklin Township, Maurice River Township and Commercial Township. A combination of pollutants from septic systems and agricultural runoff is thought to be the causes of the mesoeutrophic state of Rainbow Lake in Pittsgrove Township. This lake on Muddy Run was the subject of a 1978 intensive survey by the Lakes Management Program.

Goal Assessment and Recommendations

The Cohansey and Maurice Rivers cannot be classified as swimmable based on fecal coliform levels at the monitoring station for each river. The Maurice River upstream of Norma may be of swimmable quality, but no water quality data has been collected upstream of this location. Both rivers are of fishable quality, although seasonal stresses affect aquatic life, as has been exhibited in the estuaries of both rivers. The very low dissolved oxygen concentrations measured in the summer may have profound impacts on the fish populations using the estuaries as nursery grounds. The Maurice and Cohansey Rivers support fish life indicative of shallow, slow moving waters. Both have a large salt water fish community in their estuaries. Fifteen and nine fish species have been identified in the Maurice and Cohansey watersheds, respectively.

One important recommendation for these watersheds is that water quality monitoring activities be increased, especially in the lower tidal sections. Understanding the extent and causes of very low summertime dissolved oxygen levels in the estuaries should be a priority.

Salem County's Department of Health has recently become a wastewater facilities planning agency for those areas of the county not sewered. An effective septic system management program will help to improve water quality in both basins. Such a management program is also recommended for Cumberland County. Agricultural best management practices should be implemented throughout with emphasis on controlling runoff from livestock operations and sedimentation.

In the Cohansey watershed the Seabrook Farms STP should be upgraded or eliminated. This should assist in water quality improvements in the upper watershed. In addition, areas adjacent to the service area of the Seabrook Farms plant with septic problems (Upper Deerfield Township) should be studied for wastewater management. Lands draining to Sunset and Mary Elmer Lakes are in need of agricultural runoff controls. The intensive survey concluded that very little in-lake restoration would be necessary if nutrient inputs can be controlled and reduced.

Problems needing corrective actions in the Maurice River drainage area include the upgrading to secondary treatment of the Landis SA/Vineland Township ground discharge, lake management practices (possibly including dredging, chemical control of algae weed and nutrients and lake drawdown) in Rainbow Lake, and elimination of the arsenic problem originating from Vineland Chemical Company.

COHANSEY AND MAURICE RIVERS STATION LIST

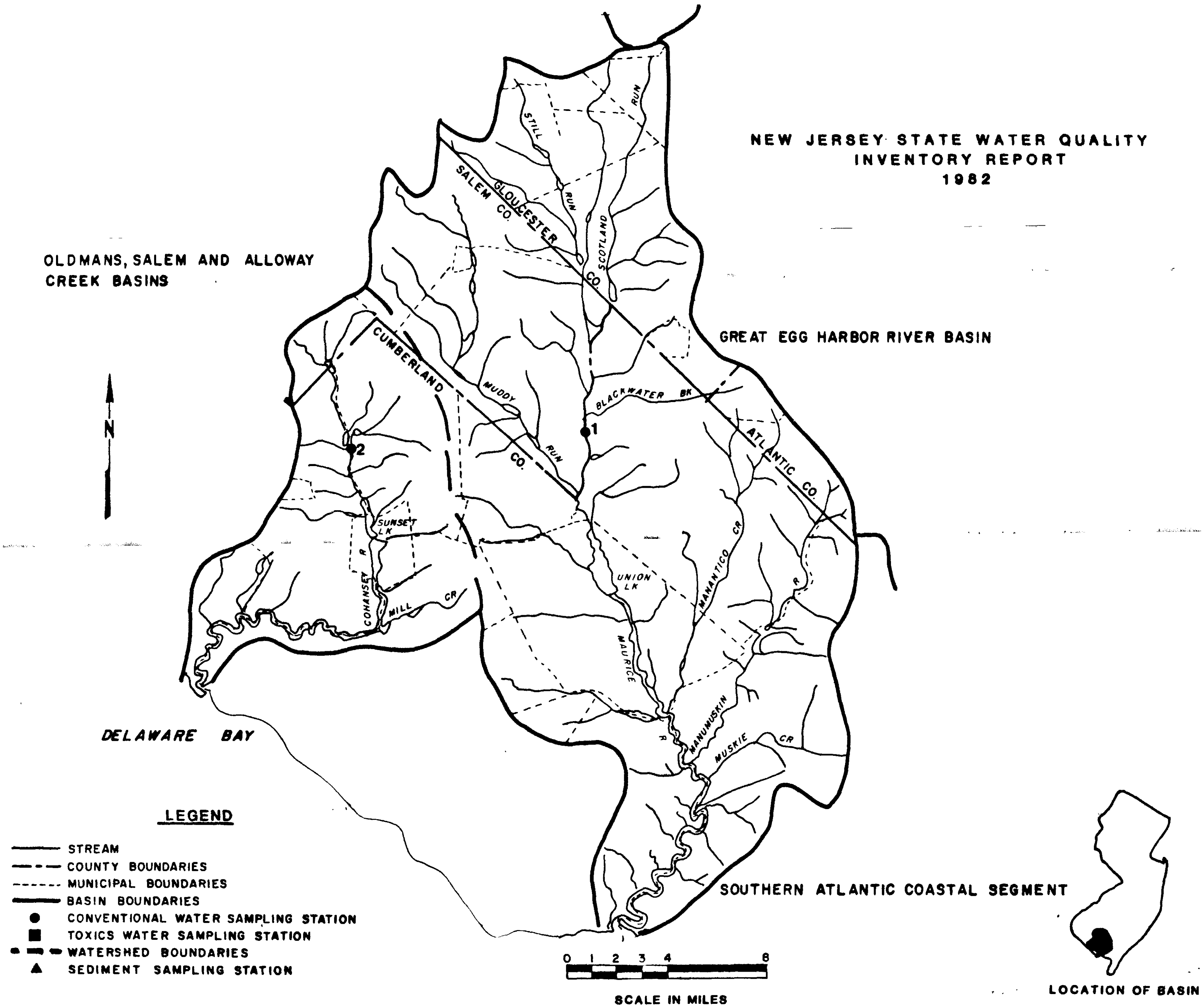
A. Ambient Monitoring Stations

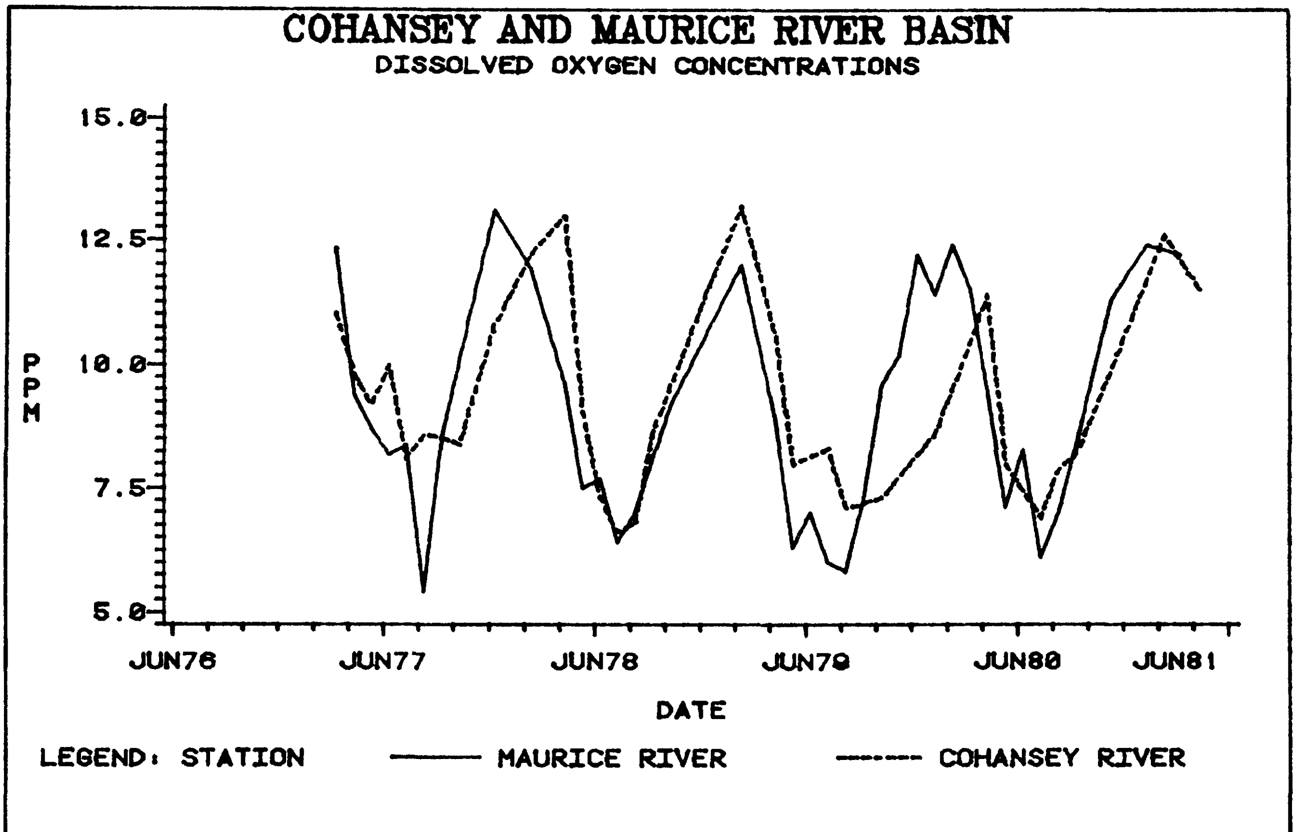
STORET Number	Station Description	Map Number
01411500	Maurice River at Norma, Salem County Latitude 39°29'42" Longitude 75°04'38" FW-2 Nontrout USGS/DEP Network National Stream Quality Accounting Network At bridge on Almond Road, 0.8 mile down-stream from Blackwater Branch.	1
01412800	Cohansey River at Seeley, Cumberland County Latitude 39°28'21" Longitude 75°15'21" FW-2 Nontrout USGS/DEP Network At bridge on Silver Lake Road, 4.1 miles north of Bridgeton and 22.5 miles upstream from mouth.	2

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Maurice River at Mauricetown and Delaware Bay	Fish tissue	-

COHANSEY AND MAURICE RIVER BASINS





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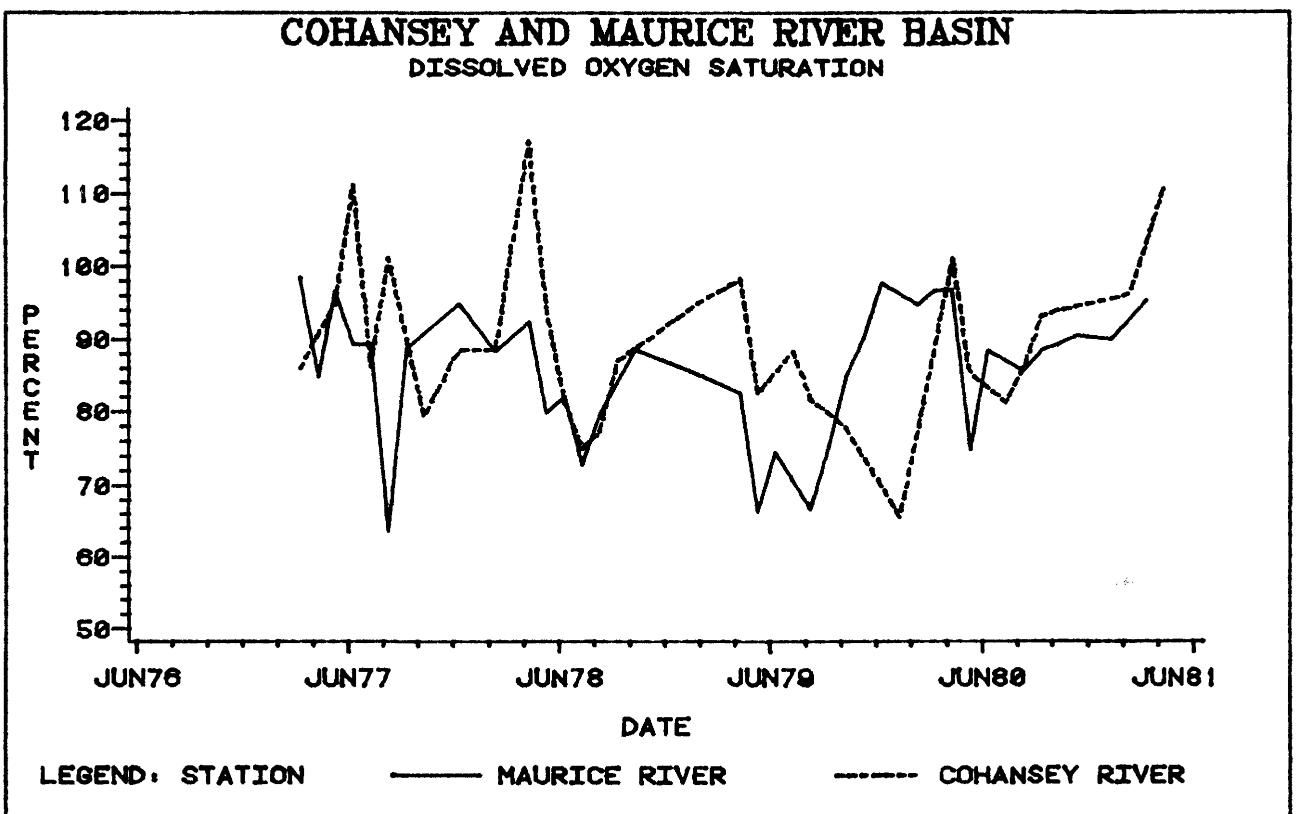

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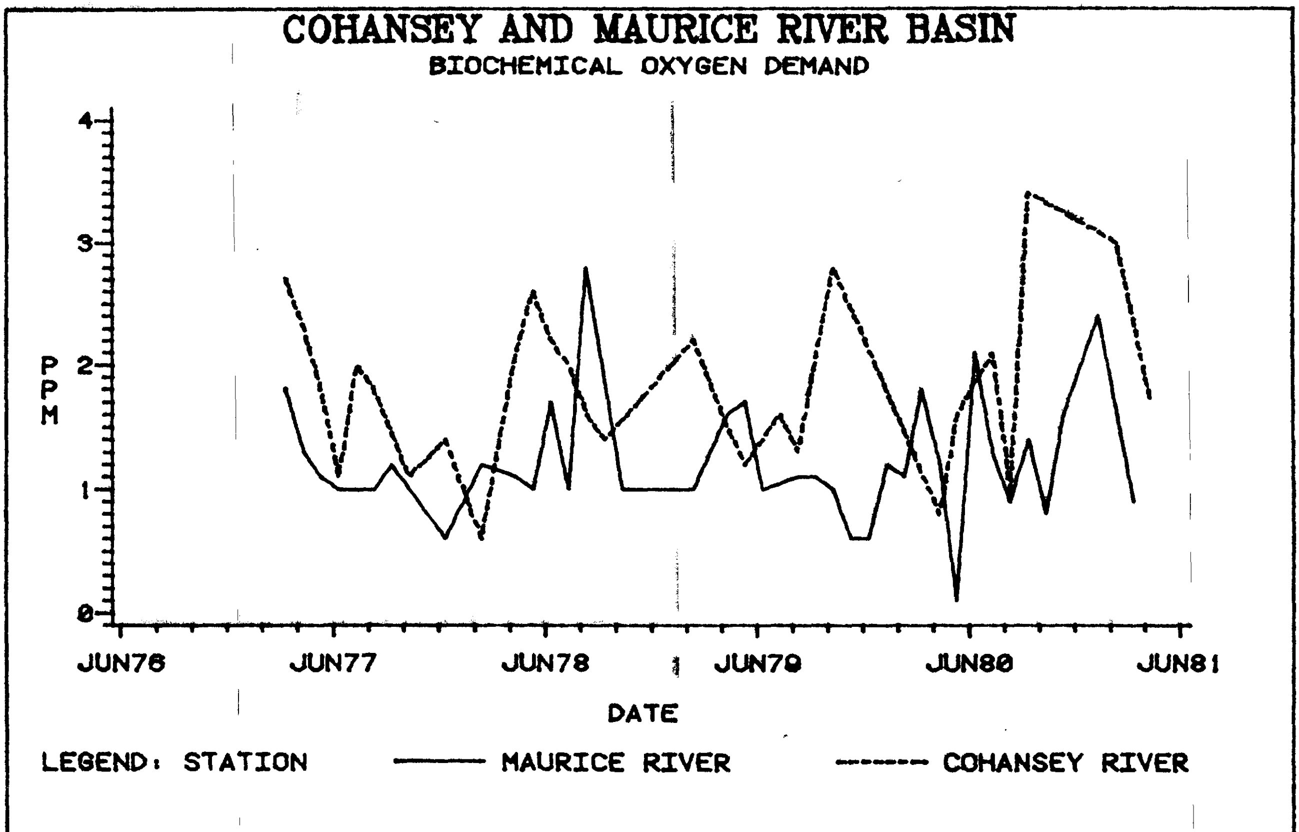

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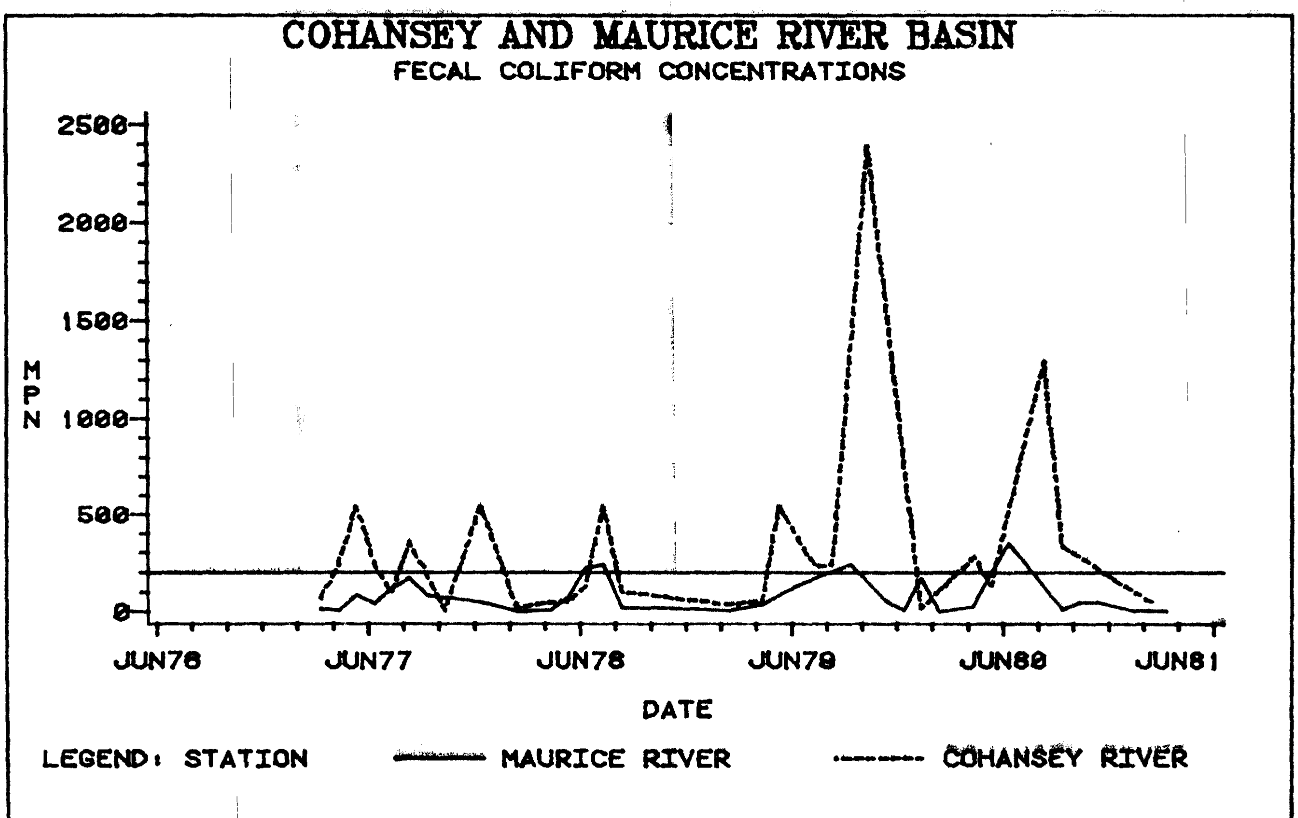

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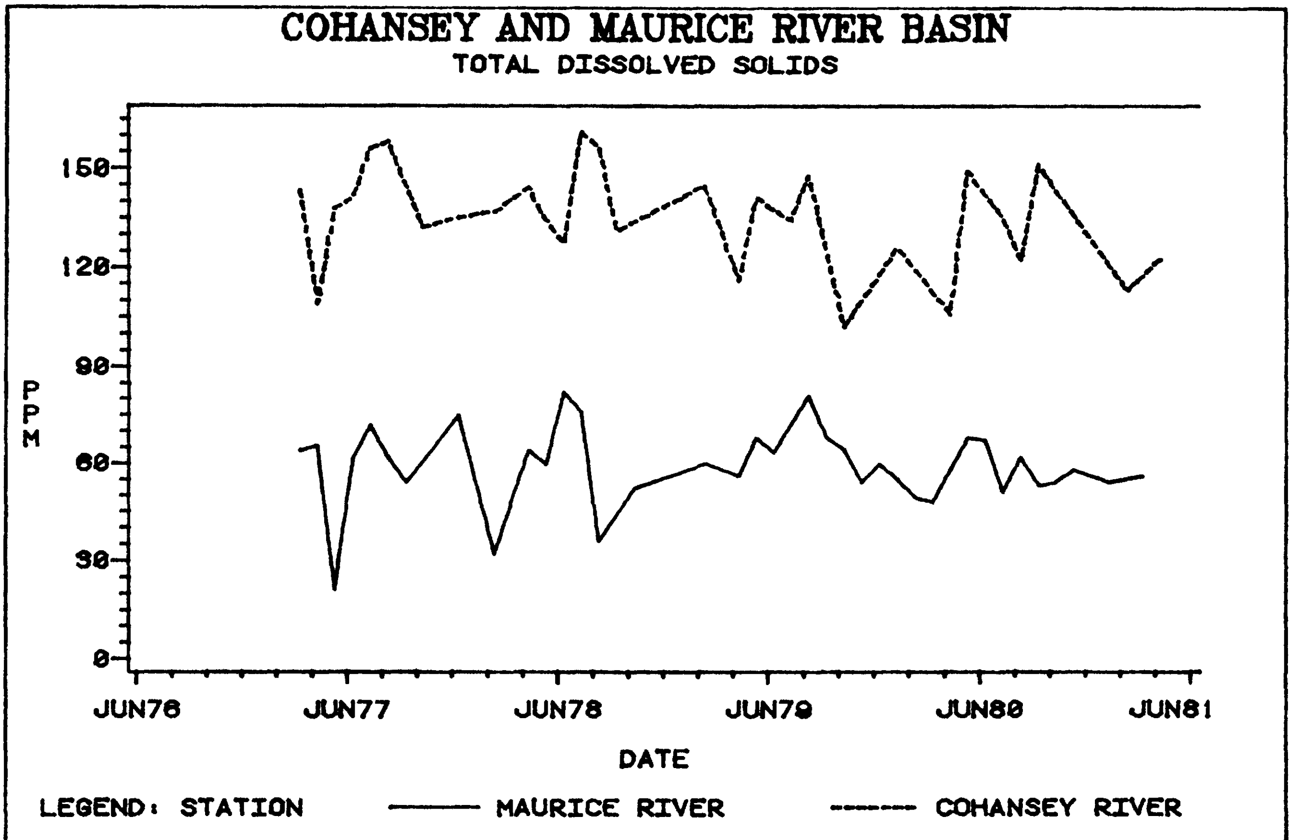

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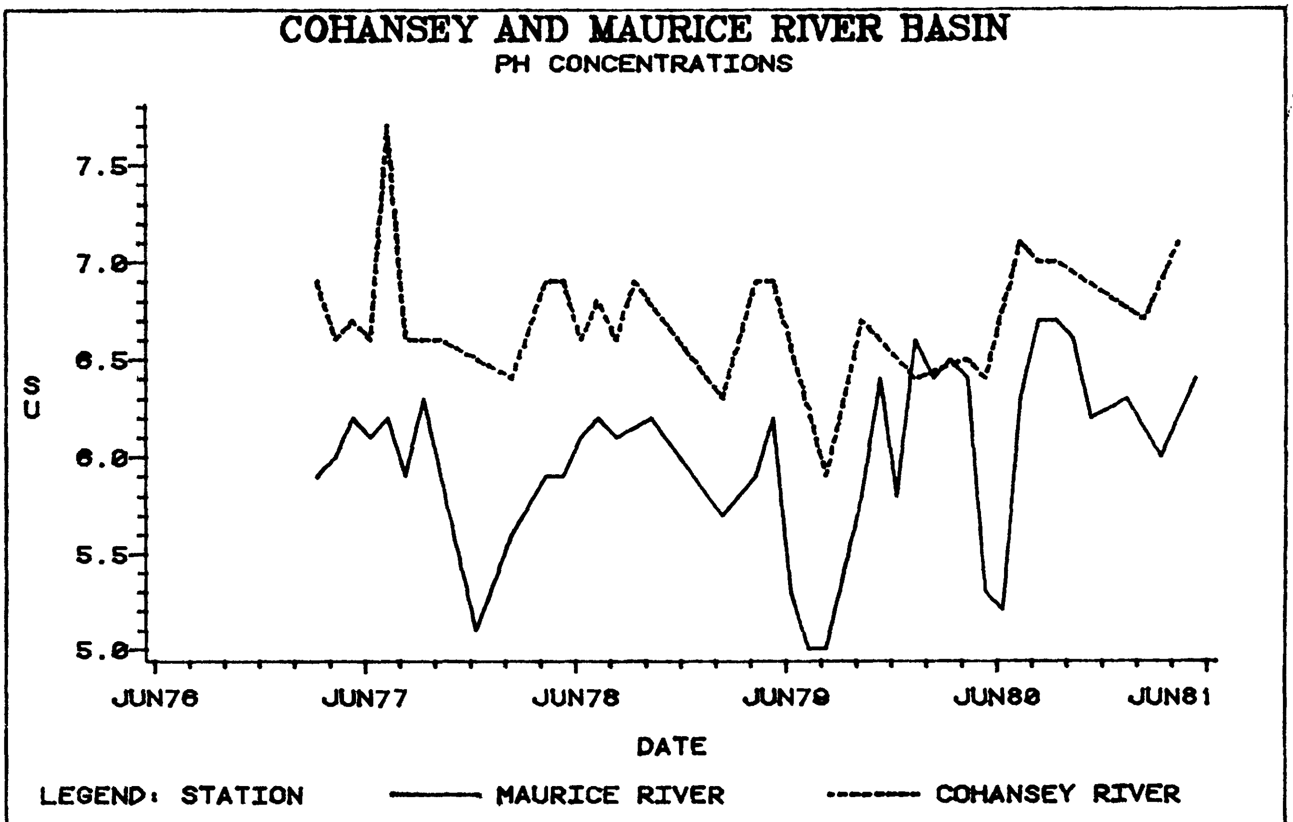

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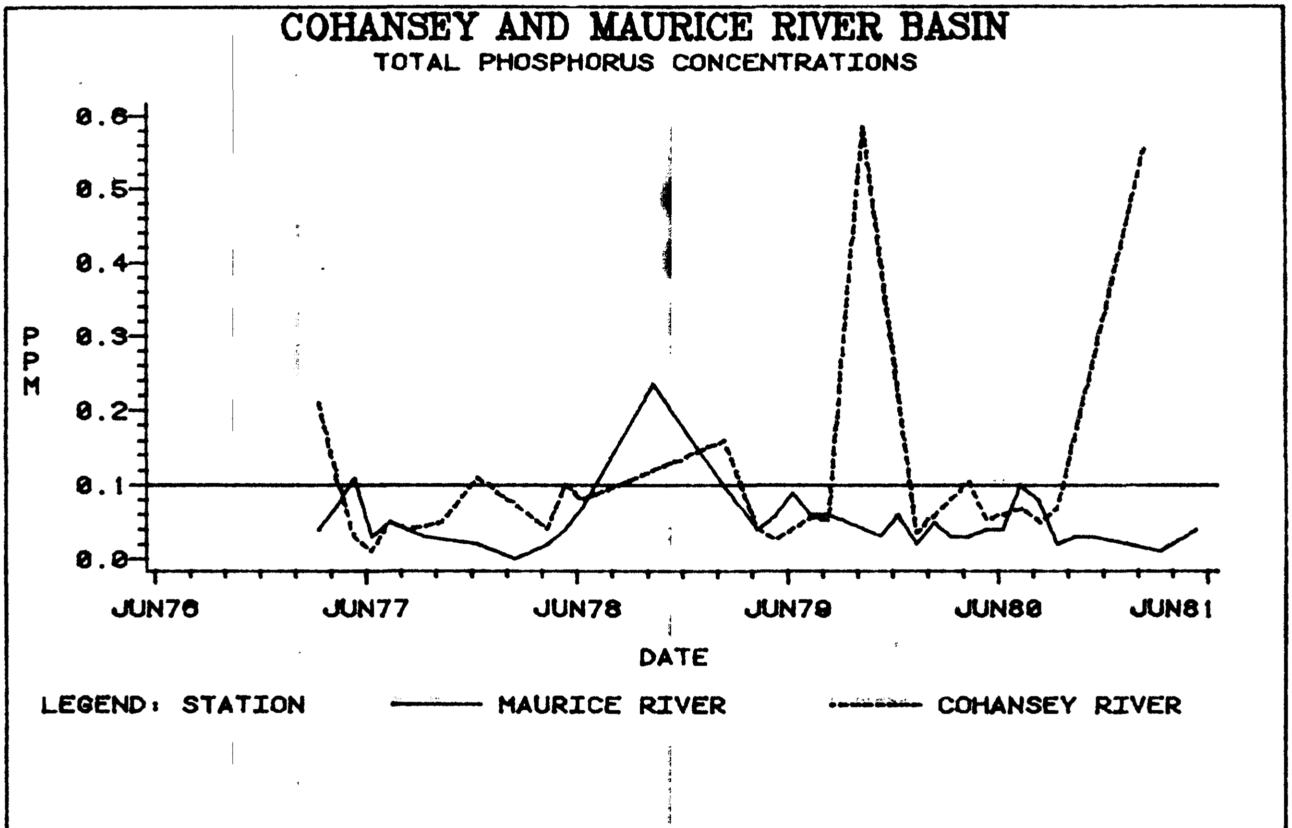

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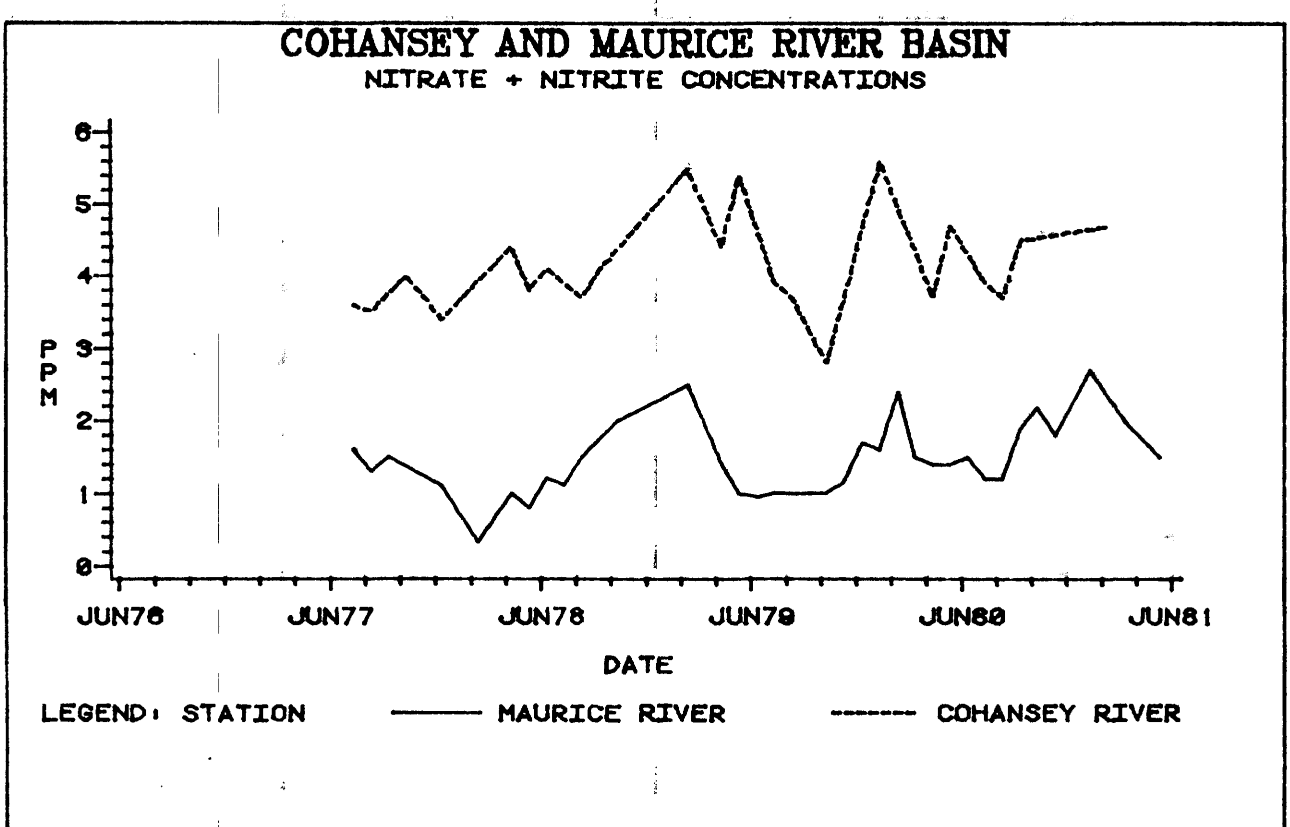

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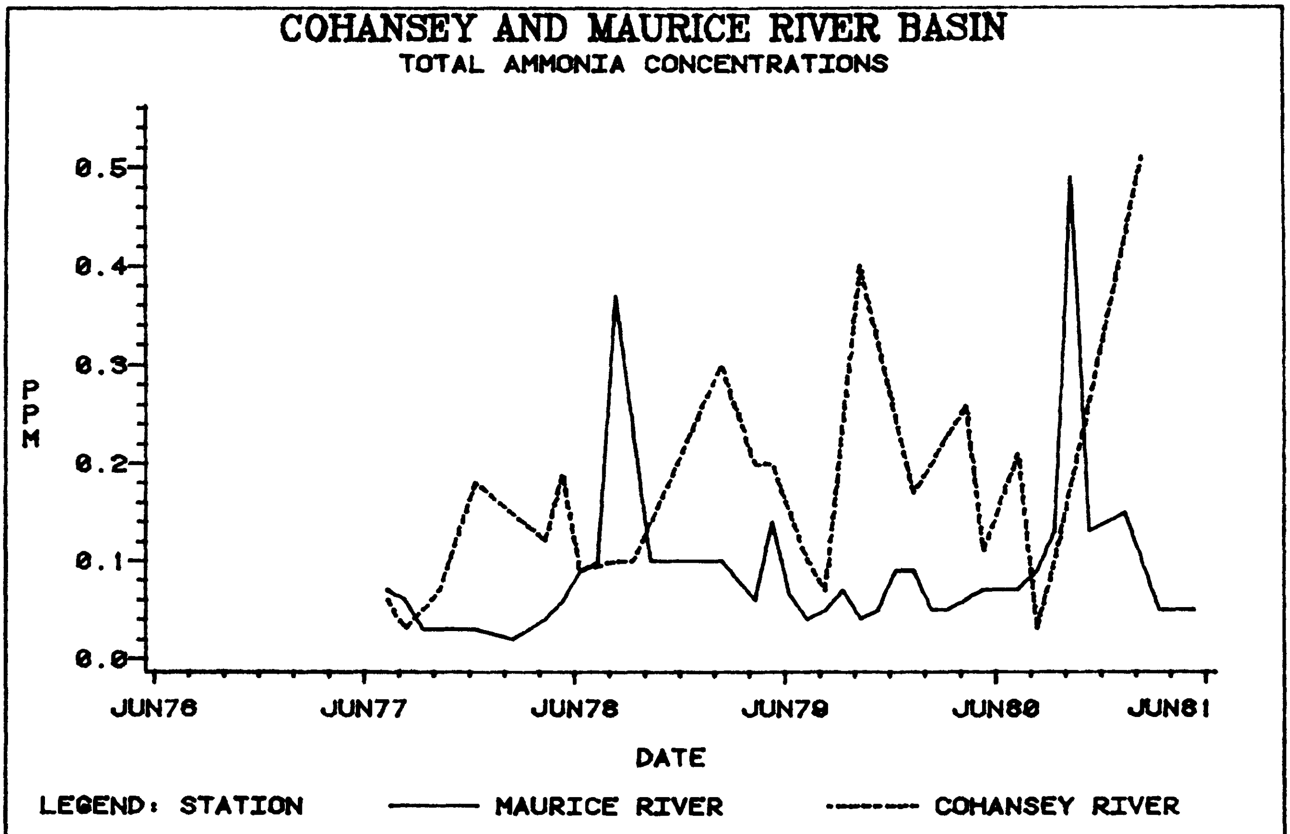

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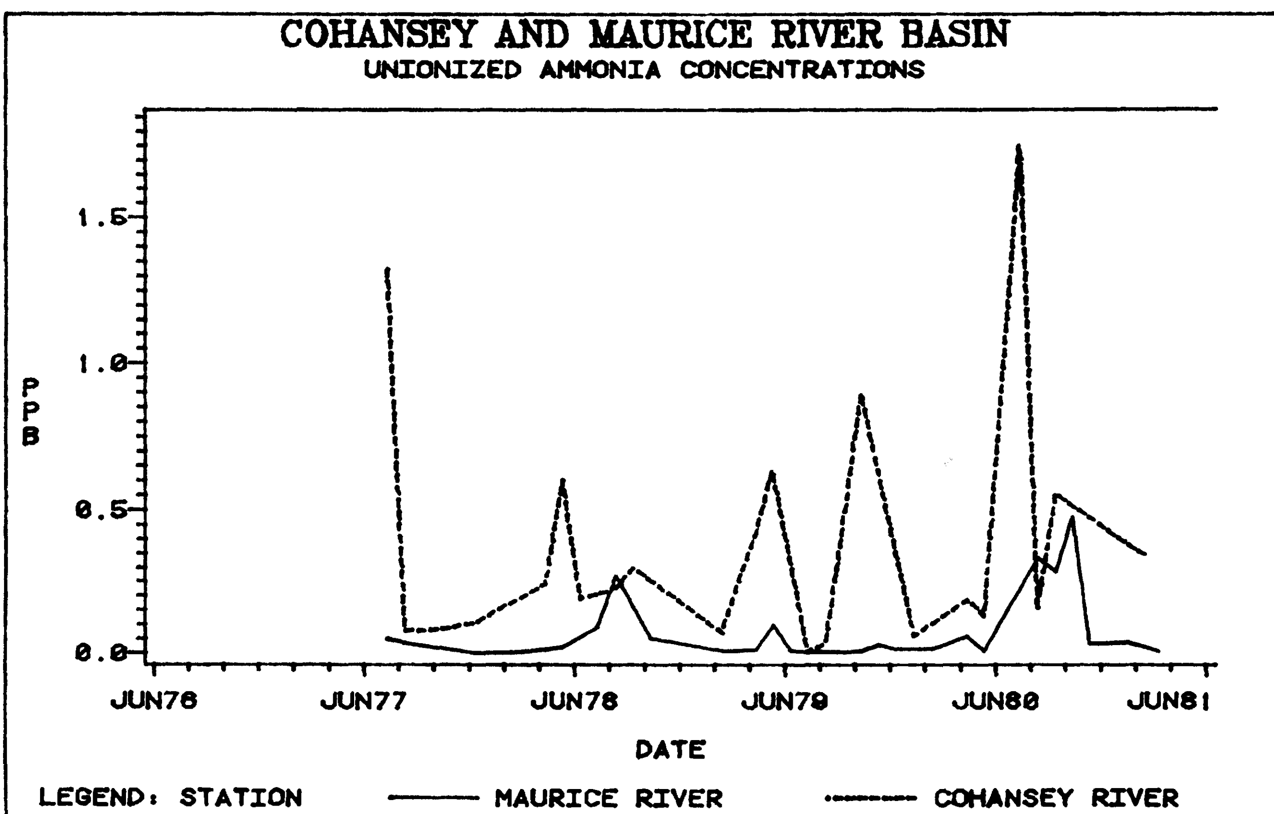


Figure: L -10

DISCHARGE INVENTORY - - - COHANCEY AND MAURICE RIVER BASINS

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
CUMBERLAND COUNTY UTILITIES	0024651	BRIDGETON /C/	COHANSEY R.	SAN/SIG INDUS	3.00
OWENS-ILLINOIS INC	0005321	BRIDGETON /C/	COHANSEY RIVER	PROCESS WASTE	.83
PETRUNIS REALTY CO	0025992	BRIDGETON /C/	COHANSEY RIVER		
SUNNY SLOPE FARMS OF NJ	0030554	CUMBERLAND COUNTY	COHANSEY RIVER	PROCESS WASTE	.01
BRIDGETON DYEING & FINISHING	0004839	BRIDGETON /C/	MILL CREEK TRIB	PROCESS & COOL.	.15
SEABROOK BROTHERS	0033006	SEABROOK	SOUTH BRANCH FOSTER RUN	COOLING WATER	
PIONEER METAL FINISHING INC.	0025658	FRANKLINVILLE.	SCOTLAND RUN	COOLING WATER	
KERR GLASS MFG. CO.	0005398	MILLVILLE	PETTICOAT CREEK	SANITARY	
WHEATON INDUSTRIES	0004171	MILLVILLE	PETTICOAT STRM	COOLING WATER	2.50
O-I SCHOTT PROCESS SYSTEMS INC	0005304	VINELAND	PARVINS BR	COOLING WATER	
OWENS-ILLINOIS CORP.	0005339	MAURICE RIVER TWP	MUSKIE RIVER		2.45
WEST COMPANY	0023744	MILLVILLE	WHEATON PROP POND		.75
PROGRESSO QUALITY FOODS	0004880	VINELAND	TRIBUTARY TO PARVIN BRANCH	PROCESS & COOL.	.09
LANDIS SEWERAGE AUTHORITY.	0025364	VINELAND	TRIB OF MAURICE RIVER	SAN/SIG INDUS	3.60
ICP COCOA INC	0032352	GLASSBORO	STILL RUN	COOLING WATER	
OWENS-ILLINOIS GLASS CONT DIV	0005312	GLASSBORO	STILL RUN	PROCESS & COOL.	.73
RON SON MUSHROOM PRODUCTS INC	0032361	GLASSBORO	STILL RUN	COOLING WATER	
CAPT. SIG'S SEA FOOD INC.	0004766	COMMERCIAL TWP	MAURICE RIVER	PROCESS WASTE	
JERSEY'S BEST INC	0030546	COMMERCIAL TWP	MAURICE RIVER	PROCESS WASTE	.02
PORT NORRIS OYSTER CO INC	0026051	COMMERCIAL TWP	MAURICE RIVER	PROCESS & SANIT	
BIVALVE PACKING CO INC	0029696	COMMERCIAL TWP.	MAURICE RIVER	FOOD PROCESSING	
JEFFRIES OYSTER FARM	0029530	COMMERCIAL TWP.	MAURICE RIVER	PROCESS WASTE	
CITY OF MILLVILLE SEWER UTH.	0029467	MILLVILLE	MAURICE RIVER	SAN/SIG INDUS	2.70
SHIELD ALLOY CORP	0004103	NEWFIELD	MAURICE RIVER	PROCESS & COOL.	.45
GEORGE O MCCONNELL CO	0029581	PORT NORRIS	MAURICE RIVER	PROCESS WASTE	
REED & REED	0029670	PORT NORRIS	MAURICE RIVER	PROCESS WASTE	
CITY OF VINELAND ELEC. UTILITY	0032182	VINELAND	MAURISE RIVER		
NEW JERSEY SILICA SAND CO	0004618	MILLVILLE	MANUMUSKIN R	PROCESS WASTE	1.70
OWENS-ILLINOIS INC.	0004499	VINELAND	DITCH TO MAURICE RIVER	COOLING & SANIT	.80
UNIMIN CORPORATION	0004405	MILLVILLE	DIVIDING CREEK	PROCESS WASTE	3.00
CUMBERLAND COUNTY UTILITIES	0024147	UPPER DEERFIELD TWP	FOREST RUN	SANITARY	.21
PENNSYLVANIA GLASS SAND CORP	0004251	MILLVILLE	MILL CREEK	PROCESS WASTE	2.02

CLEANING UP THE DELAWARE RIVER

A Status and Progress Report
Prepared under the Auspices of Section 305(b) of the
Federal Clean Water Act

Delaware River Basin Commission
West Trenton, N. J.
March 1982

Summary

The water quality of the Delaware River including the tidal Estuary and Bay was assessed. Eighty-one percent of the Delaware River length was found to be currently meeting the 1983 federal 'swimmable' water quality goal. This figure is anticipated to increase to 85% by 1983. Eighty-nine percent of the Delaware River length currently meets the federal 1983 'fishable' water quality goal. The 15% of the river that is not anticipated to meet both the 'swimmable' and 'fishable' water quality goals by 1983 is the middle Delaware River Estuary.

Great strides have been made in abating the pollution of the Delaware River, Estuary and Bay since 1940. The first generation water pollution control effort represented by the INCODEL cooperative program brought significant improvements in water quality by 1960. The second generation effort represented by the post-1962 programs of DRBC, the four Basin states and the federal government has resulted in significant additional improvements in water quality. The most recent trends are higher dissolved oxygen concentrations and lower fecal coliform levels in the reach of the Estuary below Philadelphia, Pennsylvania. Much of this latter improvement is attributed to the completion of upgrading of the Philadelphia Southwest water pollution control plant. Many problems remain. Toxic pollution, non-point pollution and increased wastewater treatment will be the subject of increasing attention as the Basin's water pollution control program moves forward to the twenty-first century.

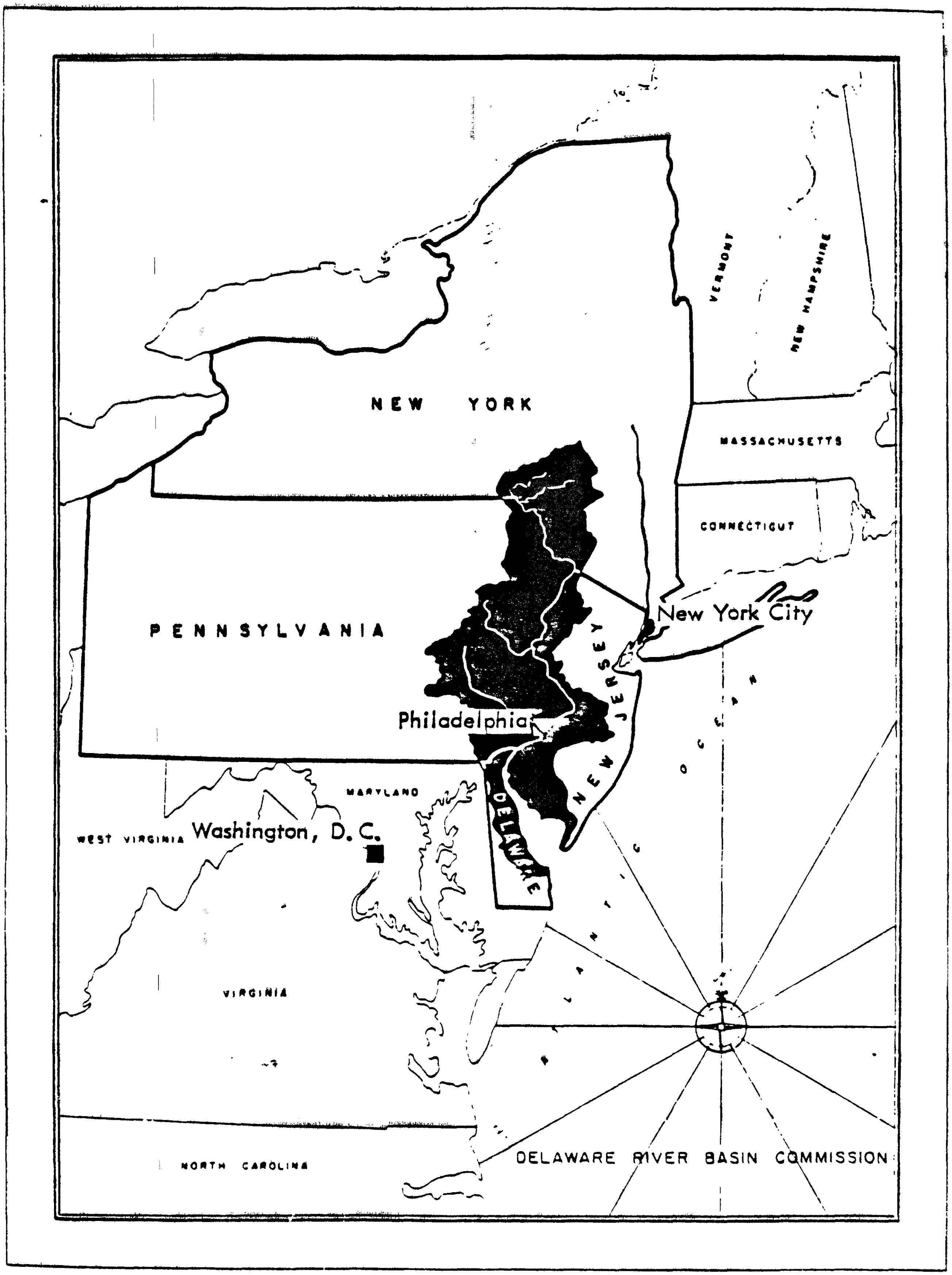


Figure 1. Location of Delaware River Basin.

Introduction

The Federal Clean Water Act (Section 305(b)) requires a biennial assessment of the water quality of the nation's rivers, streams and lakes. Reports containing the needed information are prepared under Section 305(b) by state agencies and interstate commissions with water pollution control responsibilities. The U. S. Environmental Protection Agency, on the basis of these reports, prepares a national report for the U. S. Congress. From the report, Congress determines how the Federal Act is working, whether new legislation is required and what additional resources, if any, are needed. The 305(b) reports of the states and interstate commissions serve a similar function at the regional, state and local level.

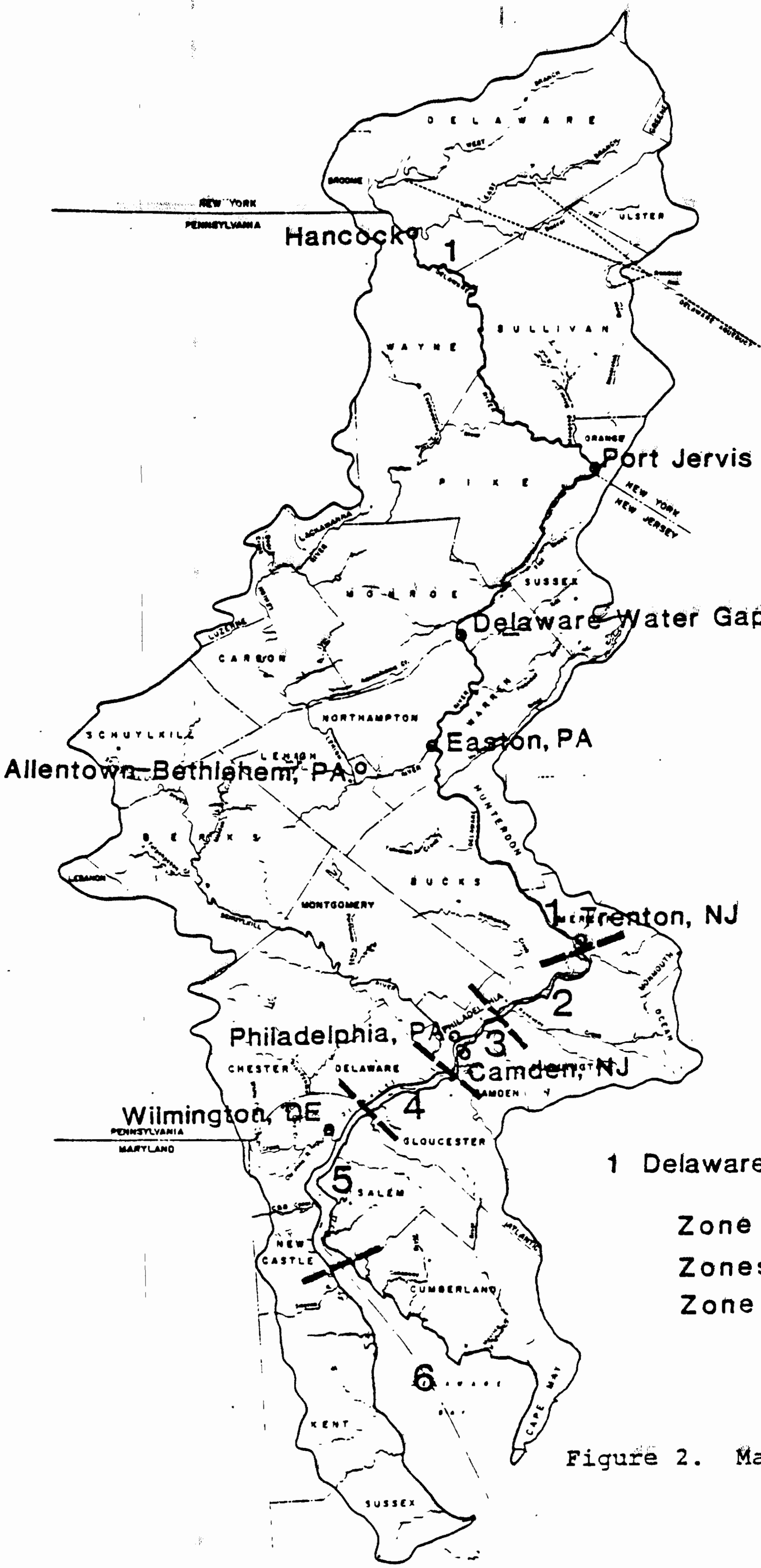
This 305(b) report marks the twentieth anniversary of the Delaware River Basin Commission (DRBC). The DRBC inherited and greatly expanded a water pollution control program that was initiated over forty years ago by the Interstate Commission on the Delaware Basin (INCODEL). Both programs received substantial support and cooperation from the four Basin states, the Federal Government and others. This report presents progress to date including a historical review of the cleanup of the Delaware River, once one of the most polluted rivers in the nation.

This report begins with a description of the Delaware River followed by a discussion of water pollution control progress over the last forty years. Data are presented that show vast improvements to Estuary water quality since the creation of DRBC and the implementation of a wasteload allocation program. The discussion is followed by an assessment of the current water quality of the entire river and the attainment of the 1983 federal 'fishable' and 'swimmable' goals. A discussion of current water quality concerns requiring ongoing actions completes the report. Information concerning tributaries of the Delaware River can be found in the Delaware, New Jersey, New York and Pennsylvania state 305(b) reports.

Description of the Delaware River

The Delaware River is formed by the confluence of its East and West Branches near Hancock, New York, on the Pennsylvania-New York state border (Figure 2). For its first 76 miles the Delaware River flows southeast across the Appalachian Plateau, represented in the Delaware River Basin by the Pocono and Catskill Mountains. In this reach the Delaware drops half the elevation to sea level. The reach is characterized by rapids and pools contained in a steep-sided, narrow valley. This section of the Delaware River has been designated the Upper Delaware Scenic and Recreation River under the National Wild and Scenic Rivers legislation.

At Port Jervis the Delaware River turns southwest and flows through the Minisink Valley to the Delaware Water Gap. This 44 mile reach of river is almost wholly contained within the Delaware Water Gap National Recreation Area. The stretch has been designated the Middle Delaware Scenic and Recreational River under federal legislation. Scenic rivers require high quality water and stringent protection from degradation.



1 Delaware River Interstate Zones

Zone 1	-non-tidal
Zones 2-5	-estuary
Zone 6	-bay

Figure 2. Map of Delaware River

At the Delaware Water Gap, the River cuts through the Appalachian Ridge and flows 77 miles to Trenton, New Jersey. Enroute the Delaware River passes through the Easton-Phillipsburg area. Here the Lehigh River flows into the Delaware River from the highly urbanized and industrialized lower Lehigh Valley. A significant amount of agriculture, small urban centers, industry and other cultural influences are found between the Delaware Water Gap and Trenton.

The Delaware River becomes tidal at Trenton, New Jersey. The first 86 miles of tidal river is the Delaware River Estuary which flows by Trenton, New Jersey; Philadelphia, Pennsylvania; Camden, New Jersey; and Wilmington, Delaware. This major urban-industrial area has a tremendous impact on water quality. In this area the Delaware River Estuary flows along the boundary between the Piedmont Plateau and the Atlantic Coastal Plain. Acquifers in the Coastal Plain are recharged from the Estuary making water quality a particular concern.

The Delaware Bay begins officially 48 miles from the ocean. This area is heavily farmed with many small towns catering to the fishing and resort industry.

Including its tidal portion the Delaware River drains one percent of the United States and is the 33rd largest U. S. river. Although a small river, over ten percent of the U. S. population is served by the Delaware River water resources.

Water Pollution Control Efforts Before 1962

Historically the Delaware River has been noted for its water pollution. As early as 1767 an English visitor to Philadelphia is supposed to have remarked what a "mess" the Delaware River had become. In 1799 the first water quality survey of the River in and around Philadelphia was conducted. The survey noted contamination entering the River from ships, wharves, public sewers and tidal wetlands that were also receiving pollution.

In the succeeding years the water quality problems worsened, and probably peaked during World War II. During warm weather dock workers and sailors often were overcome with nausea from the stench of the River. Ships using the River suffered corrosion damage to their hulls and paint from the polluted water. Aircraft pilots landing in Philadelphia for the first time were cautioned not to be alarmed when they smelled the Delaware River - at five thousand feet. Gases from the River caused metal corrosion on the assembly line at a secret radar plant during World War II. All sorts of solids and other material floated on the River. In 1941 President Roosevelt ordered an investigation to determine if pollution of the Delaware River was hampering defense buildup.

The source of all the pollution was raw sewage, (350 million gallons each day from Philadelphia, plus millions more from Trenton, Camden, Wilmington and other communities), along with untreated industrial wastewater of all kinds. Over two hundred industries within the City of

Philadelphia alone discharged 90,000 tons per year[7] solid and semi-solid wastes into the River directly or through city sewers. During warm weather dissolved oxygen levels were zero for wide reaches of the river. The River would run black and emit hydrogen sulfide, a particularly noxious smelling gas. At the worst section dissolved oxygen averaged 8 percent of saturation in the River (clean water would be around 95 percent) during the warmer months.

Sanitary surveys conducted in 1929 and 1937 found significant water quality problems in the non-tidal Delaware River as well.[6] Untreated municipal and industrial wastes were causing substantial pollution below Port Jervis, the Delaware Water Gap (from the Stroudsburgs) and Easton, Pennsylvania. These areas of pollution extended for many miles downstream. During high flow periods black waters from the Lehigh River-Easton area would reach as far downstream as the Trenton water supply intake which would be forced to close down.

In response the Interstate Commission on the Delaware River Basin (INCODEL), through its member states, launched a Basinwide water pollution control program in the late 1930's. The program was delayed by World war II, but resumed soon after. The abatement program was considered successfully completed by the end of the 1950's. During that time the number of Basin communities with "adequate" sewage collection and treatment facilities rose from 63 (20%) to 236 (75%). More importantly, all the major cities had constructed and brought on-line wastewater treatment facilities. Concurrent success was achieved in abating industrial pollution.

The first generation water pollution control efforts, largely completed by 1960, resulted in secondary treatment levels at most treatment plants above Philadelphia. Primary treatment was considered adequate in the Estuary below Philadelphia. While most areas built the required facilities, some facilities from the first-generation effort were not completed until the 1960's or 70's.

Water Quality Improvements Since 1962

The second-generation water pollution control effort was initiated in the 1960's with the U. S. Public Health Service's Delaware Estuary Comprehensive Study (DECS). The U. S. Public Health Service (later the Federal Water Pollution Control Administration) developed a mathematical model of Estuary water quality. This model was suitable for evaluating various alternative abatement programs and thus was a decision-making tool. Meanwhile in 1961 the Delaware River Basin Commission was created. The DRBC is an interstate-federal Compact Commission with broad water resources responsibilities including water pollution control. Based on the DECS model the Commission adopted new, higher water quality standards and then in 1968 issued wasteload allocations to approximately 90 waste dischargers to the Estuary. These required treatment levels more stringent than secondary treatment as defined by the U. S. EPA under the Federal Clean Water Act. Concurrent with the initiation of the wasteload allocations program was increased State, federal, and

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[7] See References

public interest in more stringent water pollution control. Nationally this interest culminated in the passage of the 1972 Amendments to the Federal Water Pollution Control Act. This Act provided the funding and enforcement to implement abatement programs like that established for the Estuary program.

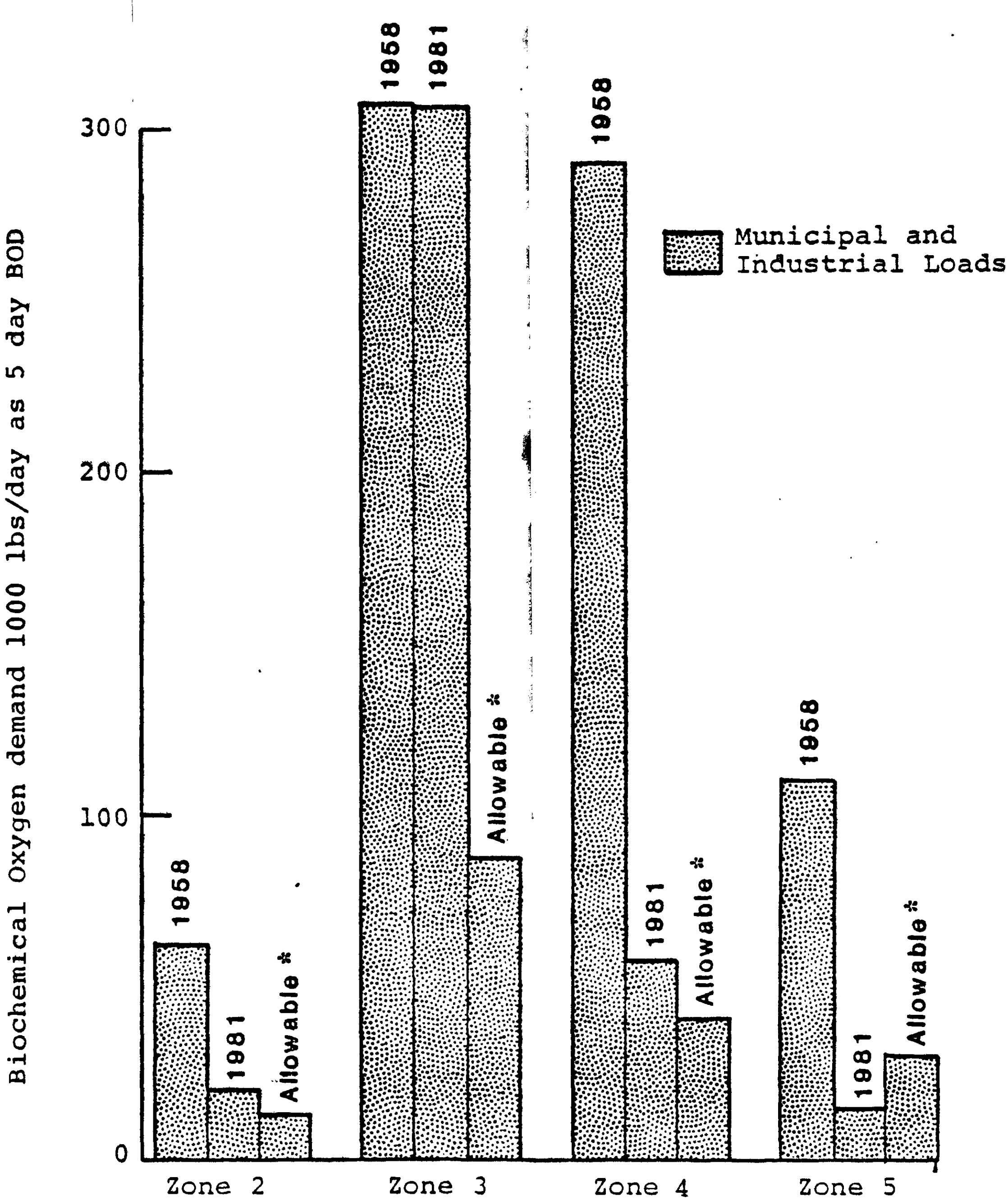
The results of the last forty years' abatement effort are reflected by today's water quality. In the non-tidal Delaware River the substantial pollution caused by Port Jervis, the Stroudsburgs and the lower Lehigh Valley has been largely cleaned up. In the tidal River vast improvement was seen between the Estuary of the 1930's and the Estuary of the late 1950's. The River was no longer septic and the smell was gone, as were the floating waste materials.

The objective of the DRBC wasteload allocation program and the corollary programs of Pennsylvania, New Jersey, Delaware, and the federal government has been to upgrade the somewhat improved water quality of 1960 to more acceptable levels. The progress of these programs on the Estuary is demonstrated in Figure 3. This figure compares the 1958, 1981 and allocated pollutant loadings to each of the Estuary water quality zones. Estuary-wide, pollution loadings (as BOD_5) have been reduced from 773,000 lbs/day in 1958[9/] to 399,000 lbs. per day in 1981, a 52% decrease. In reality the improvement is even higher since many of the large municipal treatment plants now serve outlying areas that formerly polluted neighborhood streams. The cleanup of tributaries is, of course, also beneficial to the quality of the Delaware.

Figure 4 breaks down the pollutant loading data into municipal and industrial components. In every zone except Zone 3 total industrial loadings meet the total allowable loadings. The progress of municipal upgrading has also been significant in every zone except Zone 3. In Zone 5 and elsewhere for industrial loads, the 1981 loads are less than the allocated load. This is due to treatment plant efficiencies being better than required and/or due to cuts in industrial production. The completion of upgrading of the Philadelphia Northeast and Southeast plants and plants for Camden, Trenton and elsewhere will dramatically decrease the indicated 1981 loads during the next several years. The recent progress being made as major dischargers come on-line is shown in Figure 5. While substantial progress has been achieved since 1979, in 1982 some slippage is shown. This occurred due to one of the larger Estuary treatment plants experiencing operating difficulties that has caused it to exceed its wasteload allocation.

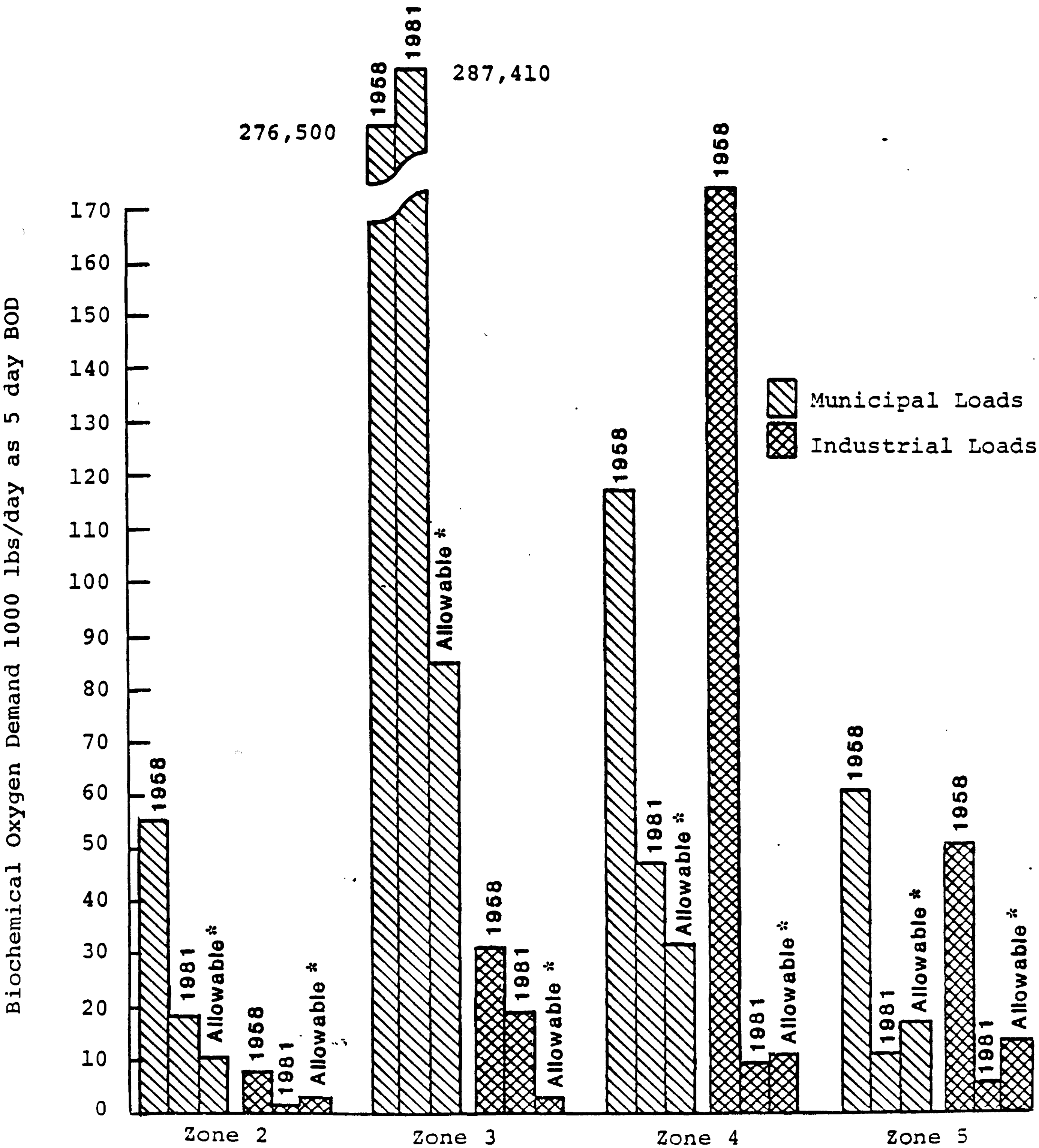
The value of upgrading wastewater treatment is shown in changes in water quality. Figures 6 through 10 demonstrate that in the last twenty years substantial water quality improvements have been achieved. The analyses compare the averages of observed data for the 1957-1961 period with the averages for the 1977-1981 period. In each time period the water samples were obtained in the same manner. The use of five year averages dampens out external vagaries such as flow differences, rainfall, temperature, etc.

Figure 3. Comparison of 1958, 1981 and Allowable Pollutant Loadings to Each Delaware Estuary Zone



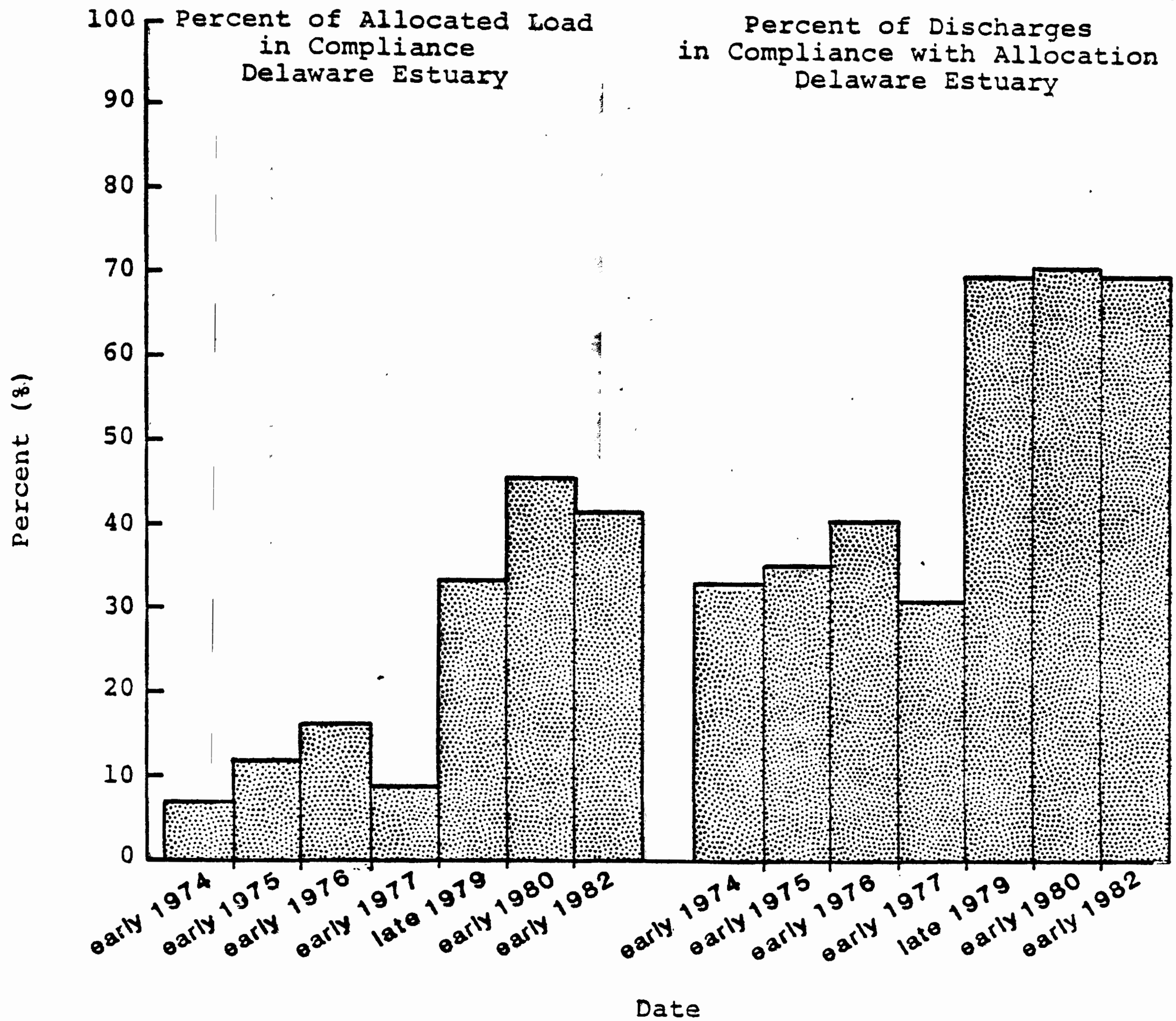
* DRBC allocations converted to BOD_5 equivalents

Figure 4. Comparison of 1958, 1981 and Allowable* Municipal and Industrial Pollutant Loadings by Delaware Estuary Zone



* DRBC allocations converted to BOD_5 equivalents

Figure 5. Summary of Discharger Compliance - 1974 to 1982



Dissolved oxygen data, presented in Figure 6, indicate improvement in over seventy miles of Estuary. The change in the mean values is over one mg/l at every location and is about 2 mg/l below River Mile 88. The improvement is attributed to reduction in pollution loading. Figure 7 compares biochemical oxygen demand (BOD) values observed in the Estuary for the two five year periods. Biochemical oxygen demand represents the demand for oxygen by the bacteria that break down the organic wastes in the water. In the area where the pollutant loadings have been reduced the most (from around River Mile 100 downstream to River Mile 65), an improvement of up to 2.5 mg/l in the mean values is observed. The difference observed between the maximum values of each five year time period also highlights the reduction in load which has occurred throughout the Estuary.

pH can be an important measure of some types of industrial pollution. pH is a method of expressing the intensity of acid or alkaline solutions as an expression of hydrogen-ion activity. Low pH values represent acid solutions with a pH of 7 being neutral. Since pH is based on a logarithmic scale small changes in pH are larger than apparent. A comparison of arithmetic means of pH observed at each location for both five year periods is presented in Figure 8. Below River Mile 90 the improvement in pH is quite apparent. This reach of River is also the reach where great reductions in industrial loads have occurred (see Figure 4). Figure 9 shows the relationship of maximum and minimum pH values and the adopted pH standards. The comparison indicates that in 1957-61 the lower limit pH standard was apt to be violated at many Estuary locations, particularly at River Mile 80 and downstream. As the 1977-81 data shows, abatement of industrial wastes has reduced this potential.

Acids are widely used in industrial processes. Disposal of high concentrations of acid into rivers cause pH values to drop significantly below natural levels by reducing the alkalinity and buffering capacity of water bodies. Acidity and pH are interrelated parameters since all acids contain the hydrogen ion measured by the pH test. Delaware Estuary acidity measurements for the 1957-1961 period and the 1977-1981 period are summarized and compared in Figure 10. The mean acidity observations of the latter time period are much less than the earlier period for every sampling locations. The greatest reductions are observed below River Mile 70. The reduction in the amount of acid discharged from industrial sources has had a desirable effect on pH and acidity.

Recent Trends

Trends in water quality for the last five years were analyzed by two methods. The first method was the direct comparison of the annual or seasonal means of the observed data for each year in the five year period (1977-81). The second method, used only for the Estuary and Bay locations, was the use of the linear regression technique to determine the rise or fall of a hypothetical line (least-squares line) drawn through the individual data points. Judgment was employed in each case to determine whether an observed change over time was significant.

Figure 6. Comparison of Mean Dissolved Oxygen Values 1957-61 vs 1977-81 June through October

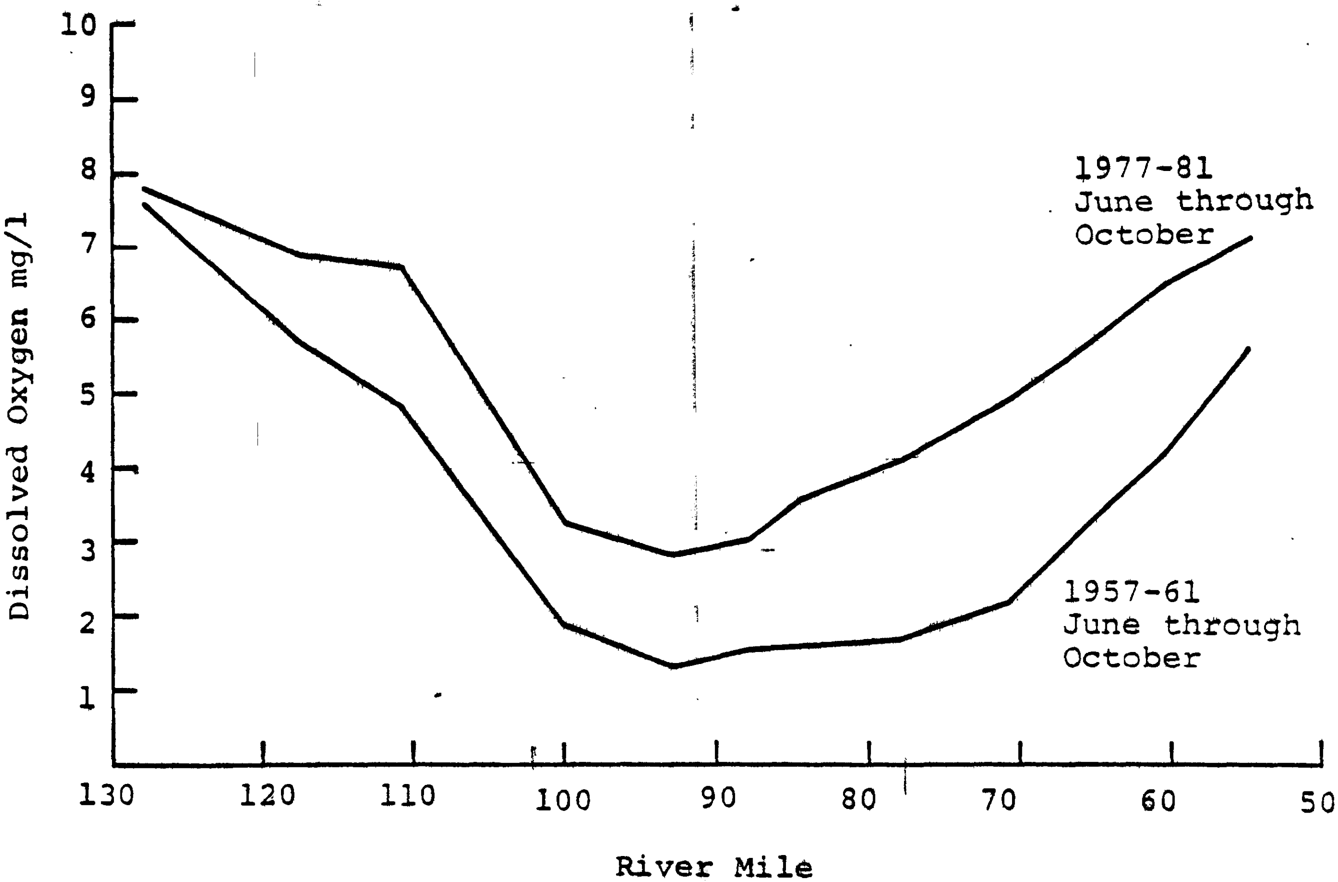


Figure 7. Comparison of Mean and Maximum BOD_5 Values 1957-61 vs 1977-81 June through October

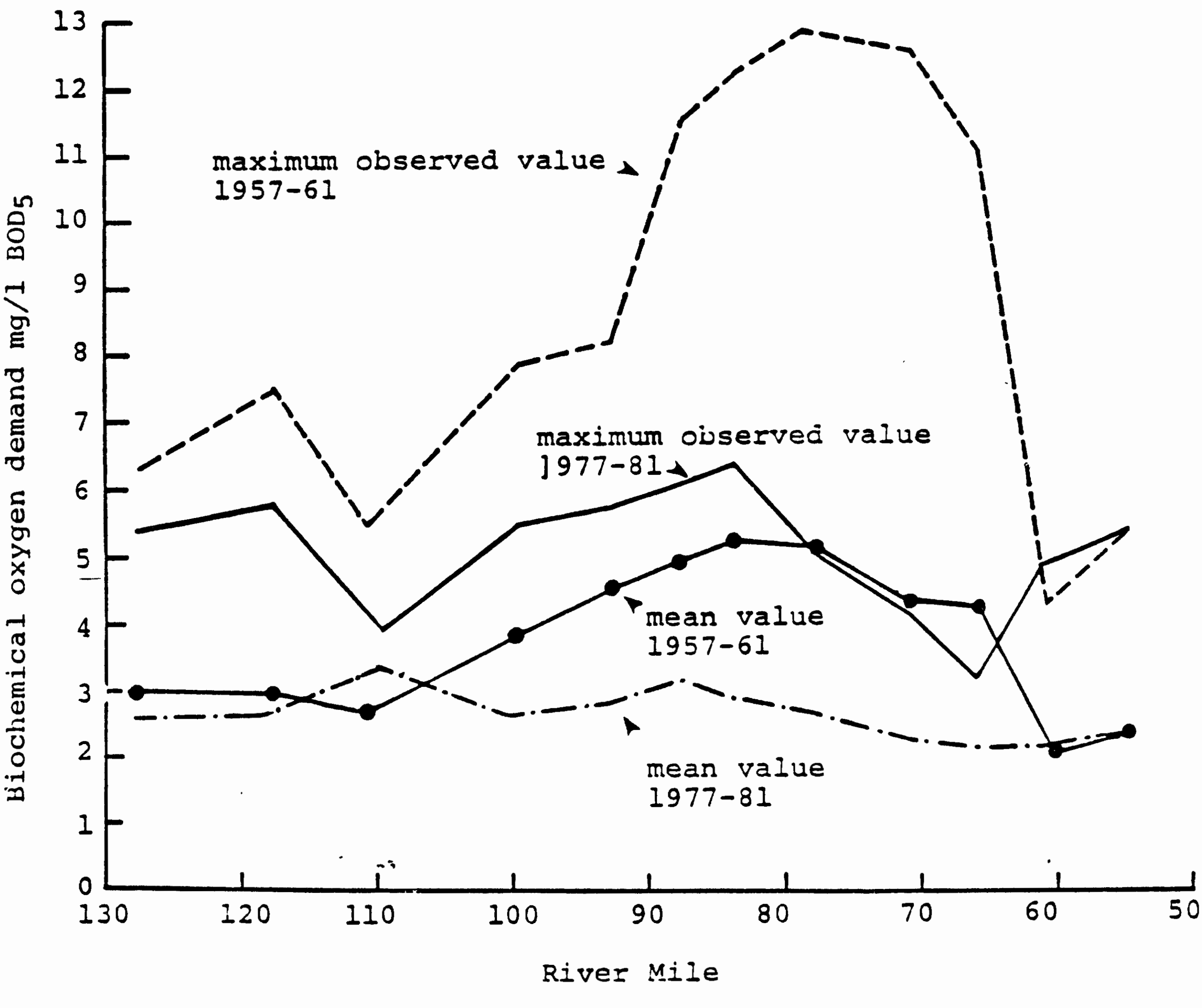


Figure 8. Comparison of Mean pH Values 1957-61 vs 1977-81

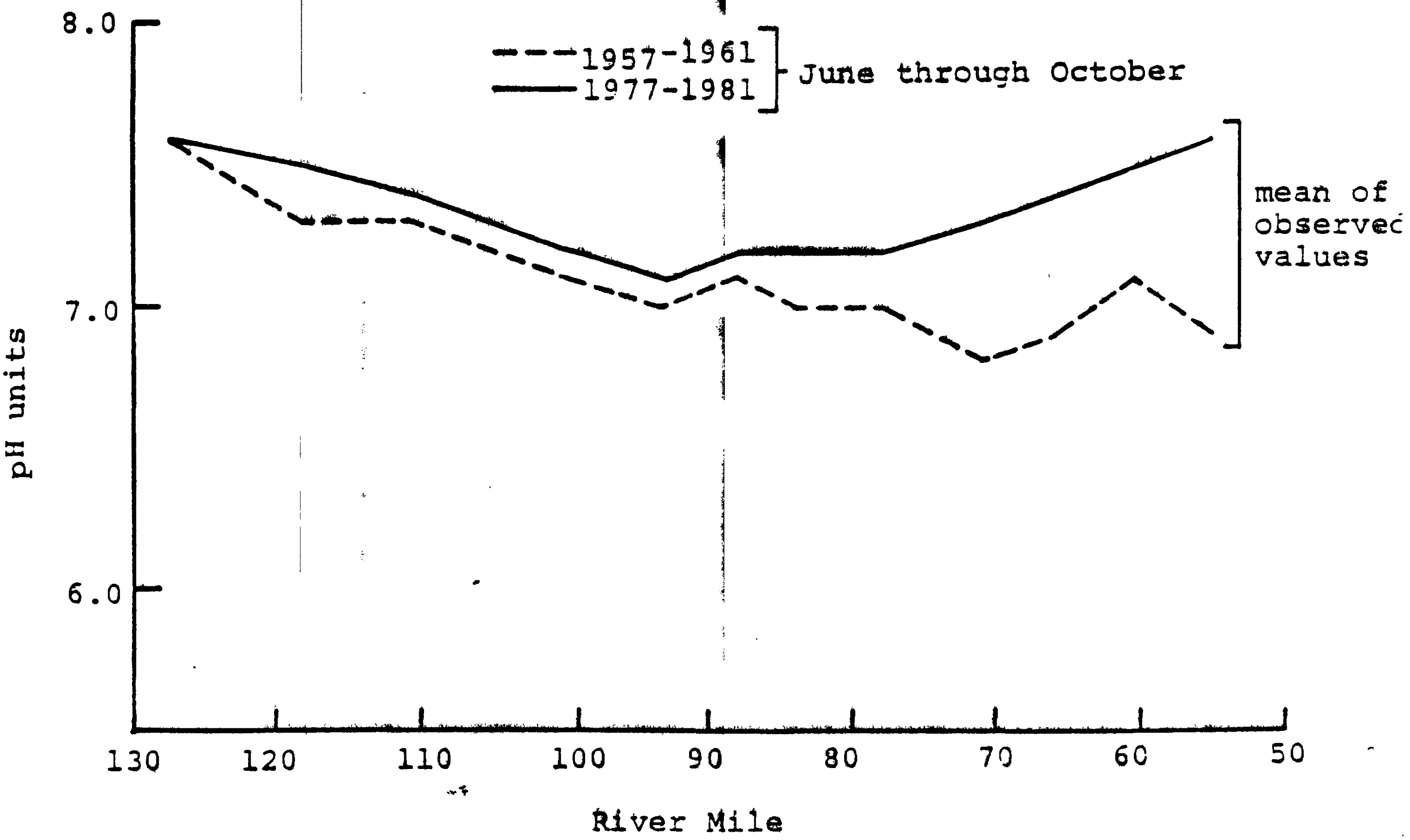


Figure 9. Comparison of Maximum and Minimum pH Values 1957-61 vs 1977-81

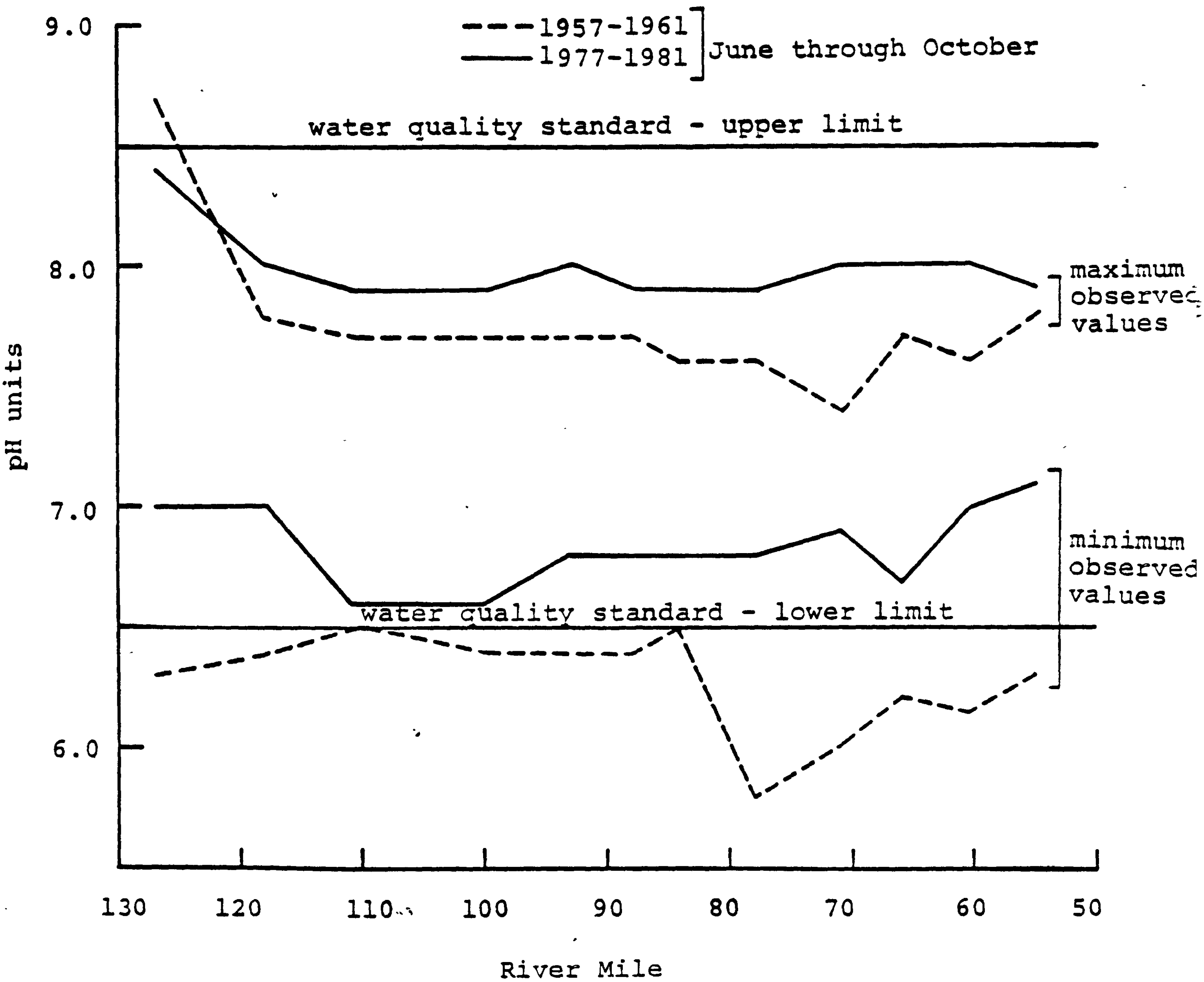
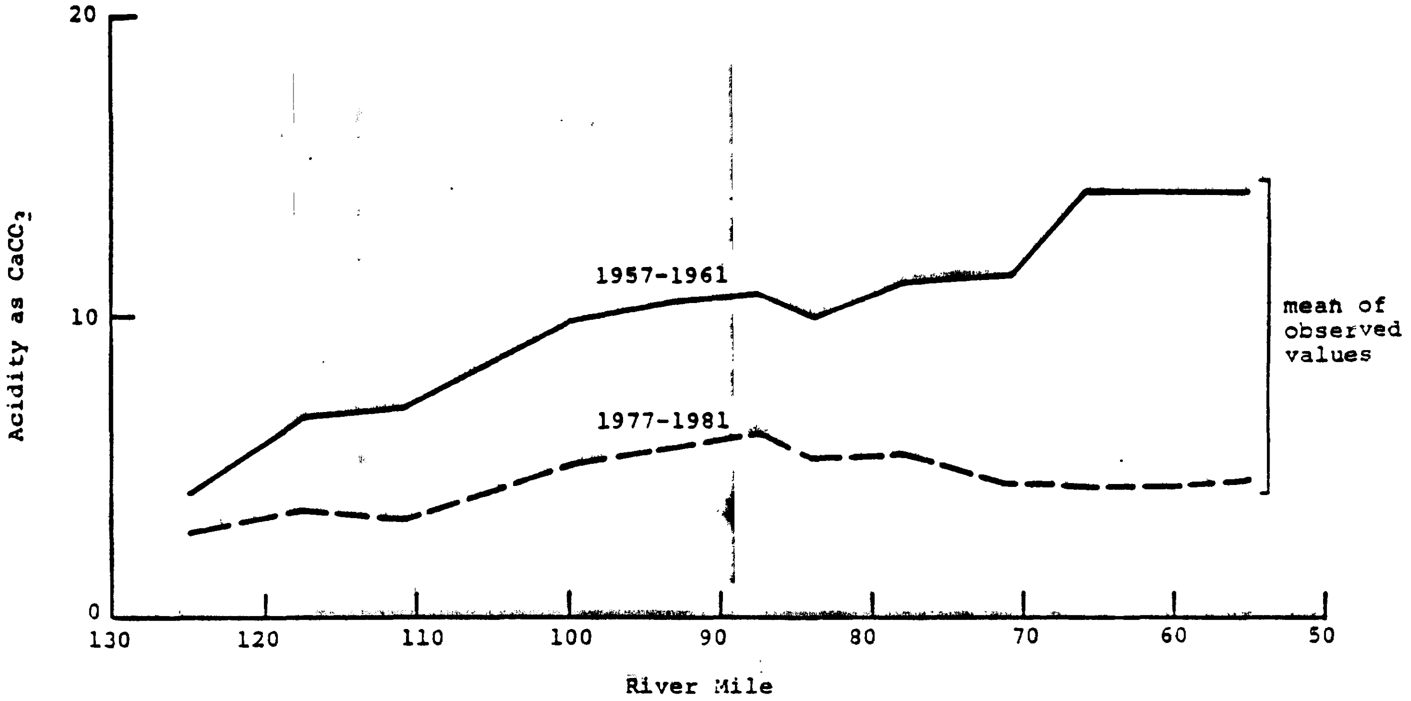


Figure 10. Comparison of Mean Acidity Values 1957-61 vs 1977-81 June through October



The analysis of trends in the non-tidal river above Trenton, New Jersey, is difficult because sampling is infrequent. One sample might represent 16% or 20% of the total data for the year and, thus, the data averages are easily influenced by unique conditions and random factors such as high temperatures or a major rain storm. In the Delaware Estuary and upper Bay sampling is more frequent. However, this reach of river is tidal and water quality is thus highly influenced by the variability of freshwater inflow. The determination of water quality trends from one year to the next in the Estuary requires that meteorological and hydrological variability be accounted for, especially at the transition areas from clean to polluted, or from polluted to clean water quality. These areas are of special interest in water quality management. In many instances meteorological and hydrological variations mask the more gradual trends in water quality.

Based on the limited data the non-tidal Delaware River above Trenton, New Jersey has generally stable water quality. In 1979 high fecal coliform concentrations below Easton, Pennsylvania were a major concern. The source of the bacteria, the Easton wastewater treatment plant, has corrected its problem. Data for 1980 is significant since it represents conditions during lower than normal flow conditions. That water quality did not change significantly during this time is an indication of the satisfactory condition of this reach of river.

The major trend in water quality improvement in the Estuary appears to be dissolved oxygen. This improvement was noted in 1980 when the City of Philadelphia's upgraded Southwest Water Pollution Control Plant came on line. In 1980, however, low freshwater inflow due to drought conditions allowed less polluted water to penetrate further upstream. Because of the drought influences at that time it was difficult to ascertain whether or not the improvement in dissolved oxygen was due to this upgrading. Data for the Summer of 1981 below River mile 88 (Paulsboro, N.J.) verify the conclusion that improvement has occurred, since freshwater inflow into the Estuary during the summer of 1981 was higher than 1980. Over the five year period non-drought related increases in dissolved oxygen concentrations appear elsewhere as well. Based upon interpretation of the regression analyses, these increases appear to be most significant in the Estuary below New Castle, Delaware.

Other changes of interest noted in the Estuary in the recent five year period are lowered phosphate, organic nitrogen and chlorophyll 'a' values and increased alkalinity concentrations. Some of these parameter changes at various locations may be drought-related. When stream flow/rainfall patterns return to normal it will be possible to verify trends, if any, for these parameters.

Fecal coliform bacteria concentrations are an important parameter of sanitary water quality which may be expected to change with upgraded wastewater treatment. In 1980 lowered fecal coliform values were noted downstream from the Philadelphia Southwest treatment plant which had just been upgraded. This reduction was attributed to the improvement in treatment even though disinfection was not yet in effect at the plant. In March 1981 disinfection of the effluent was initiated. Estuary data for 1981, therefore, show further reductions in fecal coliform bacteria. The decrease in 1981 largely rules out the likelihood that the recent changes in river fecal coliform levels are drought-related.

Water quality observations in the Delaware Bay are limited to the upper reaches. No trends indicating changes in water quality in the Bay have been observed in recent years.

Current Water Quality

There are two aspects of water pollution control programs. The first is the cleanup of past abuses and the attainment of water quality standards. The second is the prevention of water quality degradation, particularly in high quality waters such as designated scenic and recreational waters and fish spawning areas. Current water quality is the bench mark that tells how far pollution abatement programs have progressed, the benefits accrued to date, and new problems which may require remedial actions.

Water quality of the Delaware River is routinely monitored at various locations by agencies of the four Basin states, the City of Philadelphia, and the U. S. Geological Survey. In addition special studies or periodic sampling are also conducted by these agencies and the U. S. Environmental Protection Agency, the National Park Service, the Delaware River Basin Commission, universities and others.

Table 1 presents a general assessment of Delaware River water quality based on 1980 and 1981 data, in terms of excellent, good, fair, or poor. These terms are defined as follows:

Excellent - no significant pollution problems. Water quality standards are violated very infrequently or not at all. Use of River reach for effluent disposal is minimal or non-existent.

Good - Minor or localized pollution problems. Water quality standards are not violated in most samples or in major sections of the river reach. [Bacteria would be typical localized problem.] Wastewater dischargers to the River reach generally meet applicable effluent requirements.

Fair - Frequent violations of one or more water quality standards on an annual or seasonal basis. Fish life limited to pollution-tolerant species or fish kills noted periodically. Bacteria levels sufficiently high to prevent safe swimming.

Poor - Regular violations of various water quality standards. Water quality unsuitable for fish survival at least part of the year. Very high bacterial levels present.

TABLE 1

Status of Delaware River Estuary and Bay Water Quality

		No. of Miles	General Water Quality	Meets Swimmable Goal 1981	Will Meet Swimmable Goal 1983	Meets Fishable Goal 1981	Will Meet Fishable Goal 1983
A.	Upper Delaware Scenic River	76	Excellent	yes	yes	yes	yes
B.	Middle Delaware Scenic River	44	Excellent	yes	yes	yes	yes
C.	Delaware Water Gap Easton, Pa.	27	Good	yes	yes	yes	yes
D.	Easton, Pa. to Trenton, N.J.	50	Good	yes	yes	yes	yes
E.	Delaware Estuary Upper Zone 2	16	Fair	no	yes 1/	yes	yes
F.	Delaware Estuary Lower Zone 2	9	Fair	no	no 2/	yes	yes
G.	Delaware Estuary Zone 3	13	Poor	no	no 2/	no	no 2/
H.	Delaware Estuary Zone 4	16	Poor	no	no 2/	no	no 2/
I.	Delaware Estuary Upper Zone 5	9	Fair	no	no 2/	no	no 2/
J.	Delaware Estuary Lower Zone 5	22	Good	yes	yes	yes	yes
K.	Delaware Bay Zone 6	48	Excellent	yes	yes	yes	yes

1/ Assumes goal will be met with completion of upgrading of wastewater treatment plants now nearing completion.

2/ Attainment of adopted state and DRBC standards, approved by U. S. EPA, will not result in swimmable or fishable water quality, based on definitions cited herein.

The "fishable and swimmable" goals of the Federal Clean Water Act PL 95-217) require water quality adequate for "the protection and propagation of fish, shellfish and wildlife" and "recreation in and on the water" by 1983. Table 1 also presents an assessment of each reach of the Delaware River as to whether it currently meets the 1983 goals and estimates whether the goals will be met in 1983.

Precise definitions do not exist for either the fishable or the swimmable goal. The DRBC appointed an ad-hoc task force of fishery experts in 1978 (Task Force, 1979) to define fishable water quality and associated dissolved oxygen requirements for the Delaware Estuary. Propagation of fish rather than just survival was defined by the Task Force to be a key ingredient of any fishable water. In addition dissolved oxygen concentrations of at least 4 or 5 mg/l were also recommended. Swimmable water quality has historically been determined by fecal coliform bacterial levels. The DRBC standards for fecal coliform bacteria in Zone 1 and Zone 2 above the Burlington-Bristol Bridge were used as criteria along with subjective considerations concerning the potential for toxic and other pollution to assess the attainment of the swimmable goal. The DRBC criteria calls for bacteria levels to be less than 200 per 100 ml. for a sufficient number of samples. The current water quality standards for Zones 3, 4 and upper Zone 5 will not achieve fishable or swimmable water quality based on the previously mentioned definitions.

The overall water quality picture of the Delaware River Estuary and Bay that emerges from the analyses is summarized on Table 2. Over 80 percent of the Delaware is considered to represent good to excellent water quality that supports fish life, water-based recreation and other river uses. In the next several years it is likely that current upgrading projects will be completed in Zones 2 and 5. When that occurs about 90 percent of the Delaware may be classified as good or excellent. Poor water quality will remain in the middle Estuary, Zones 3 and 4, until Philadelphia and Camden bring upgraded plants on-line.

Water quality data obtained from monitoring programs in 1981 are presented The patterns of the data are similar to those reported in past DRBC 305(b) report. In spite of recent improvements violations of dissolved oxygen and fecal coliform standards are apparent in the Delaware Estuary.

Ongoing and Future Water Pollution Control Activities

Very significant water quality improvement has been observed in the last forty years along much of the Delaware River and its tributaries. In spite of improvements problems or concerns will continue. Some of these problems persist; others are new problems that have recently been identified such as non-point sources, urban runoff and toxics. Still others are not yet problems but are concerns. Table 3 lists some of the current problems or concerns that exist along the Delaware River. This list indicates that water pollution control requires an ongoing effort.

Table 2

Summary of Delaware River, Estuary and Bay Water Quality

Water Quality Category	Miles	% of Total
Excellent	168	50
Good	99	30
Fair	35	11
Poor	29	9
Fishable-1981	293	89
Fishable-1983	293	89
Swimmable-1981	267	81
Swimmable-1983	283	85

(Total miles, Delaware River, Estuary and Bay: 331)

Table 3*

Current Water Quality Problems or Concerns by Location or Zone

River Segment

Upper Delaware Scenic River

- \+ Hancock, N.Y. Raw sewage discharges, currently being corrected
- \+ Lordville - Possible environmental stress indicated by 1981 DRBC survey, reason unknown
- \+ Narrowsburg - landfill along river is possible concern
- \+ General - impacts of increasing recreational use are uncertain, upper reach impacted by reservoir releases

Middle Delaware Scenic River

- \+ Smithfield beach - high bacterial levels, infrequent, but of concern
- \+ General - impacts of increasing recreational use is uncertain

Delaware Water Gap to Easton, Pa.

- \+ No problems indicated. Data limited. Studies suggest some influence from artificial sources

Easton to Trenton, New Jersey

- \+ Occasional high fecal coliform values are a seasonally local problem
- \+ Phytoplankton found to be seasonally high in lower reach
- \+ Organic materials delivered to head of Estuary from this reach of river have possible deteterious impacts on Estuary water quality
- \+ Summer dissolved oxygen occasionally low at some locations

Delaware Estuary Zone 2 (Trenton to Philadelphia)

- \+ Occasional low dissolved oxygen values at Bristol, Pennsylvania
- \+ High fecal coliform values are a seasonal problem
- \+ Zone subject to industrial spills, urban runoff, combined sewer overflows and non-point pollution

Delaware Estuary Zones 3, 4 and upper Zone 5 (Philadelphia to Wilmington, Del

- \+ Chronic violations of fecal coliform and dissolved oxygen standards
- \+ Zone 5 subject to industrial and shipping spills, combined sewer overflows, urban/industrial runoff, non-point sources and massive amounts of treated and inadequately treated effluent
- \+ Potential for toxic materials is high
- \+ Bottom sediments exert oxygen demand

Delaware Estuary Zone 5 (lower)

- \+ Occasional low dissolved oxygen, high fecal coliform
- \+ Zone subject to industrial and shipping spills, combined sewer overflows and non-point pollution sources

Delaware Bay

- \+ Occasional low dissolved oxygen values

*This list is not all-inclusive

Delaware Estuary Study

Further action that may be necessary to abate water pollution in the Delaware River Estuary has been the subject of intensive study since 1974. Through funding and technical assistance from the U. S. Environmental Protection Agency a new mathematical model of the Estuary has been developed. The model is a management tool that allows various alternative pollution control strategies to be tested. The new model, unlike the older DECS model, has both dry weather and wet-weather components. The wet weather component allows planners to determine effects and to evaluate control strategies for urban runoff, combined sewer overflow and non-point sources that might be applied in lieu of increasing treatment requirements at wastewater treatment plants. The DRBC is currently using the model to determine the need for additional pollution control in the Estuary and interim solutions that may satisfy the Federal fishable and swimmable goals. The study is being conducted with participation from the States of New Jersey, Pennsylvania, and Delaware, and the U. S. Environmental Protection Agency. The preliminary outputs from the study are due in 1982. These will include tentative new point source requirements, based upon total maximum daily loads, costs, and non-point source strategies. Public hearings will be held, new regulations or standards adopted and studies initiated as required. DRBC will implement the final study results in 1983 after Estuary-wide inputs from all affected parties.

Zone 2 Study

An adjunct to the DRBC Estuary program is the proposed Zone 2 study. Zone 2 has a limited assimilative capacity yet receives large organic loadings from the non-tidal Delaware River and its drainage area. These loads affect the water quality of Zone 2 and have further impacts in the Estuary below the Zone. Located in Zone 2 are major public water supply intakes in the Delaware River. These require protection from pollution including spills and other sources emanating from upstream. DRBC has proposed a cooperative study among various state and federal agencies and seeking funds for the study.

Non-Point Sources

Non-point sources are various diffuse sources of pollutants which seep or are flushed into surface waters. Agricultural runoff, urban-suburban runoff, malfunctioning septic tanks and landfills/garbage dumps were the most commonly cited non-point source problems in water quality management plans developed in the Delaware River Basin under Section 208 of the Federal Clean Water Act. Because of the diffuse nature of non-point sources, it is difficult to assess the extent of non-point source abatement needs in the Delaware River Basin. An additional problem is the inadequate knowledge concerning the effectiveness of potential abatement programs and the costs involved. Non-point source control is a major component of the ongoing water pollution control effort.

Toxic Substances

More data are becoming available on the presence of toxic substances due to more sophisticated equipment that can detect extremely low concentrations of such materials. While many of such substances have been detected, they are generally not present at unacceptable levels. Toxic substances are monitored in larger public water supplies, as well as in the effluents of large wastewater treatment plants. Analyses are also made of fish and shellfish flesh.

Samples taken monthly at Philadelphia's Torresdale water treatment plant during 1981 were analyzed for 41 toxic substances. None were detected in the intake and only chloroform and dichlorobromethane were consistently found in the finished water. Concentrations of chloroform ranged from 18 to 99 micrograms/liter while dichlorobromethane ranged from 5.5 to 16 micrograms/liter. Found once were carbon tetrachloride (6.6 micrograms/liter) and dibromochloromethane (6.1 micrograms/liter). These levels do not exceed acceptable limits where established.

Monthly samples of effluent from Philadelphia's three wastewater treatment plants were analyzed for the same parameters. At the Northeast plant, nine substances were found at least once. Benzene and toluene were found in every sample; trichloroethylene, dichloroethane, cresols and phenol were found in most samples. At the Southeast plant chloroform was found in almost half the samples and tetrachloroethylene was found in most samples. At the Southwest plant six substances were found at least once. Toluene was found in all samples; chloroform, trichloroethylene, and cresols were found in most samples; and phenol and tetrachloroethylene once each

Analyses for eleven heavy metals were also performed on samples from Philadelphia's three wastewater treatment plant effluents. All but selenium were present in one or more samples. None, however, exceeded the DRBC effluent guidelines.

In 1979, fish and shellfish tissue monitoring was begun at key points along the Delaware River. In the lower Estuary and Bay seven sets of fish or shellfish specimens were collected and analyzed for 26 toxic substances. Ten of the 26 substances were found to be present but none exceeded recognized safe limits where established.

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3. ______________________________, Primary Productivity of the Non-tidal Delaware River, July and August, 1980, Report No. 2 Upper Delaware Summer Limnological Program, West Trenton, N.J. June 1981.

4. ______________________________, Water Quality of the Delaware River, 1980 West Trenton, N.J., June 1981.

5. ______________________________, Water Quality of the Upper Delaware Scenic and Recreational River: 1981 Special Survey; Report No. 3 Upper Delaware River Summer Limnological Program, West Trenton, N.J., September 1981.

6. Interstate Commission on the Delaware River Basin, The Delaware River Basin Physical Facts, Philadelphia, Pa., Circa 1940.

7. ____, Water Pollution Abatement in the Delaware River Basin, (A Symposium held on October 24, 1941) Statements by Dr. Abel Wolman pp. 27-29, Philadelphia, Pa., undated.

8. ____, A Progress Report Regarding Water Quality Parameters Obtained from Monitoring Stations on the Delaware River at Riegelsville, Martins Creek and Montague, Philadelphia, Pa., January 1962.

9. ____, Preliminary Report, Water Quality Survey, Delaware River Estuary, Philadelphia, Pa. April 1962.

10. ____, Second Progress Report on the Results of Water Quality Monitoring at Riegelsville, Martins Creek and Montague, Philadelphia, Pa. December 1962.

11. Task Force to Evaluate Dissolved Oxygen Requirements of Indigenous Estuary Fish, Dissolved Oxygen Requirements of A "Fishable" Delaware River Estuary Report to the Delaware River Basin Commission, March 1979.

Data Sources by Collecting Agency and Location

Data Sources by Collecting Agency and Location Used in the Preparation of this Report

River Reach

Hancock, NY to Port Jervis, NY:

NYDEC routine monitoring: Port Jervis
PaDER routine monitoring: Lordville and Lackawaxen
DRBC special studies: Hancock, Lordville, Kellams, Callicoon, Cochecton, Narrowsburg, Barryville, Lackawaxen, Pond Eddy, Millrift (PA), Port Jervis

Port Jervis, NY to Trenton, NJ:

NJDEP routine monitoring: Montague, Belvidere, Easton (PA), Riegelsville, Frenchtown, Lumberville (PA), Lambertville, Washington Crossing and Trenton, NJ.

NPS summer beach sampling: Milford Beach and Smithfield Beach

DRBC special studies: Dingmans Ferry, Bushkill, Smithfield, Sandts Eddy, Lumberville, Yardley

Delaware Estuary:

Del/DNREC: Fieldsboro, Bristol, Torresdale, Ben Franklin Bridge, Navy Yard, Paulsboro, Eddystone, Marcus Hook, Oldmans Point, Cherry Island, New Castle, Pea Patch Island, Reedy Island, Appoquinimink

Delaware Bay:

Del/DNREC: Smyrna, Ship John Light, Mahon River

Agency Code

Del/DNREC - Delaware Department of Natural Resources and Environmental Control

DRBC - Delaware River Basin Commission

NJDEP - New Jersey Department of Environmental Protection

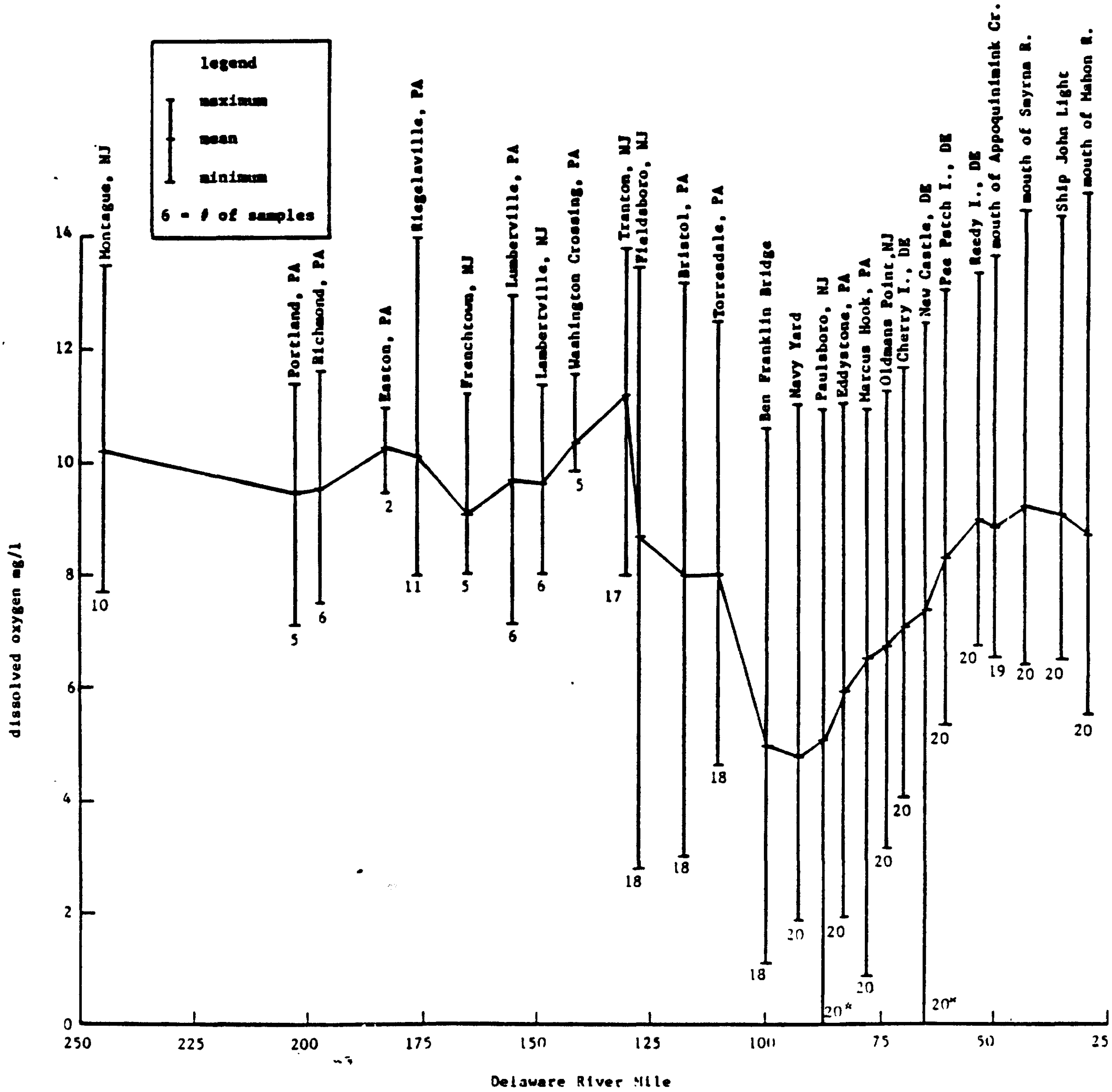
NYDEC - New York Department of Environmental Conservation

PaDER - Pennsylvania Department of Environmental Resources

NPS - National Park Service: Delaware Water Gap National Recreation Area

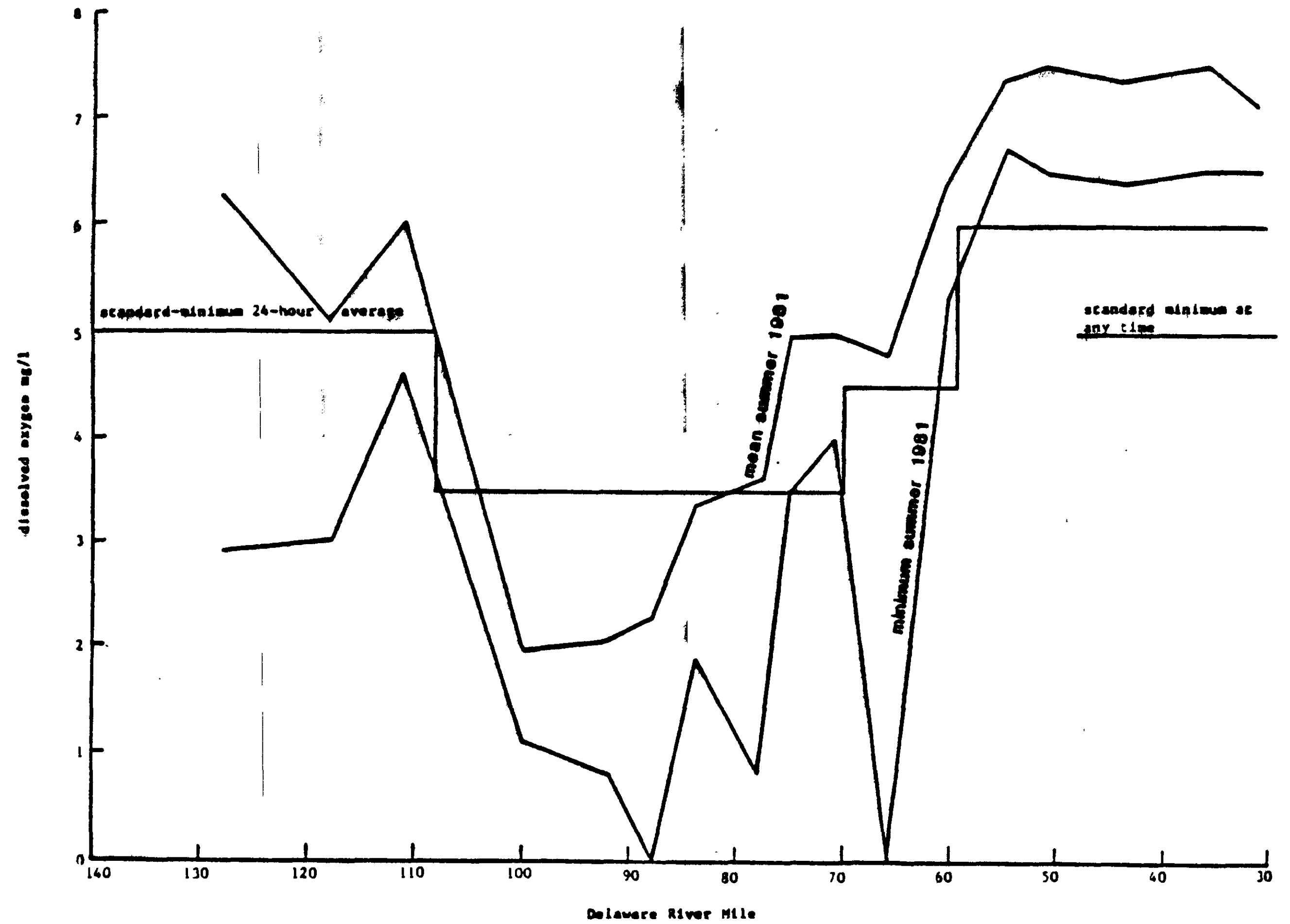
1981 Water Quality Data Profiles

1981 DISSOLVED OXYGEN

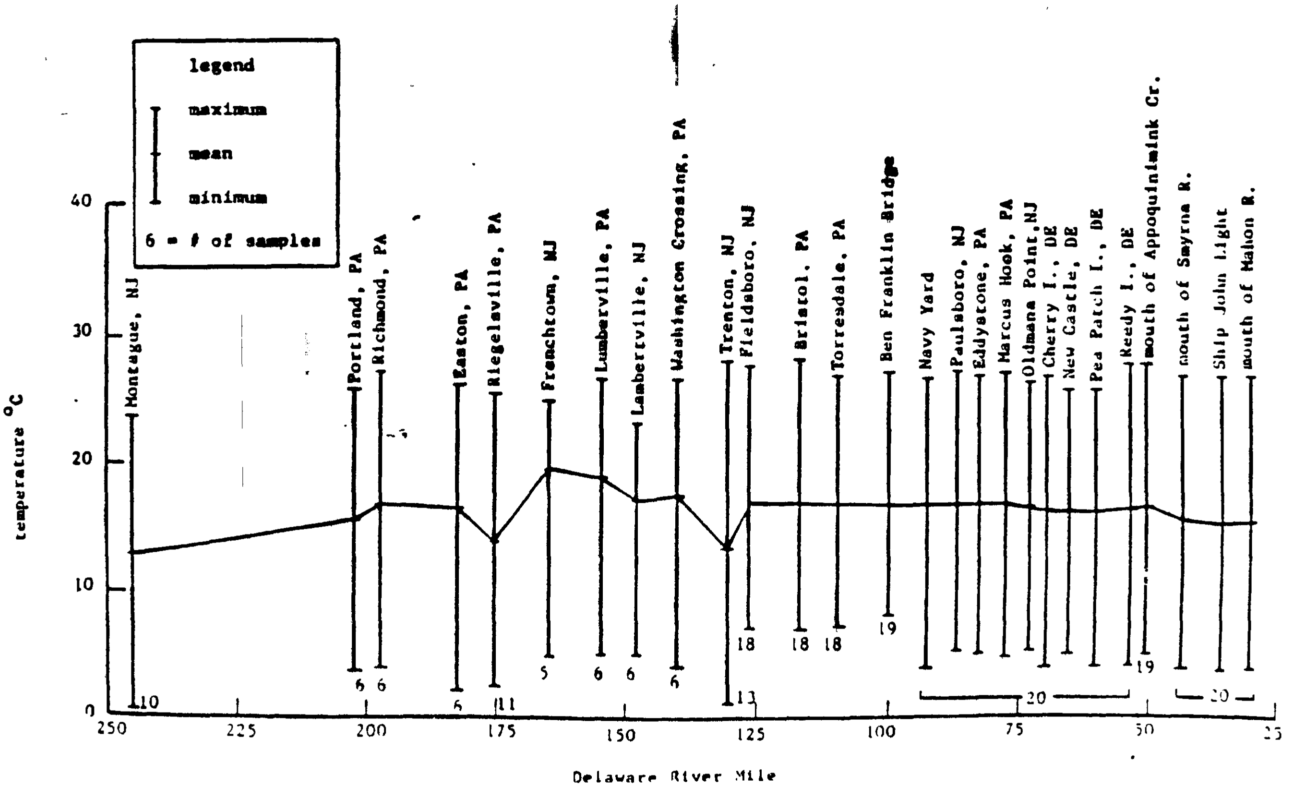


* value of zero observed in one sample

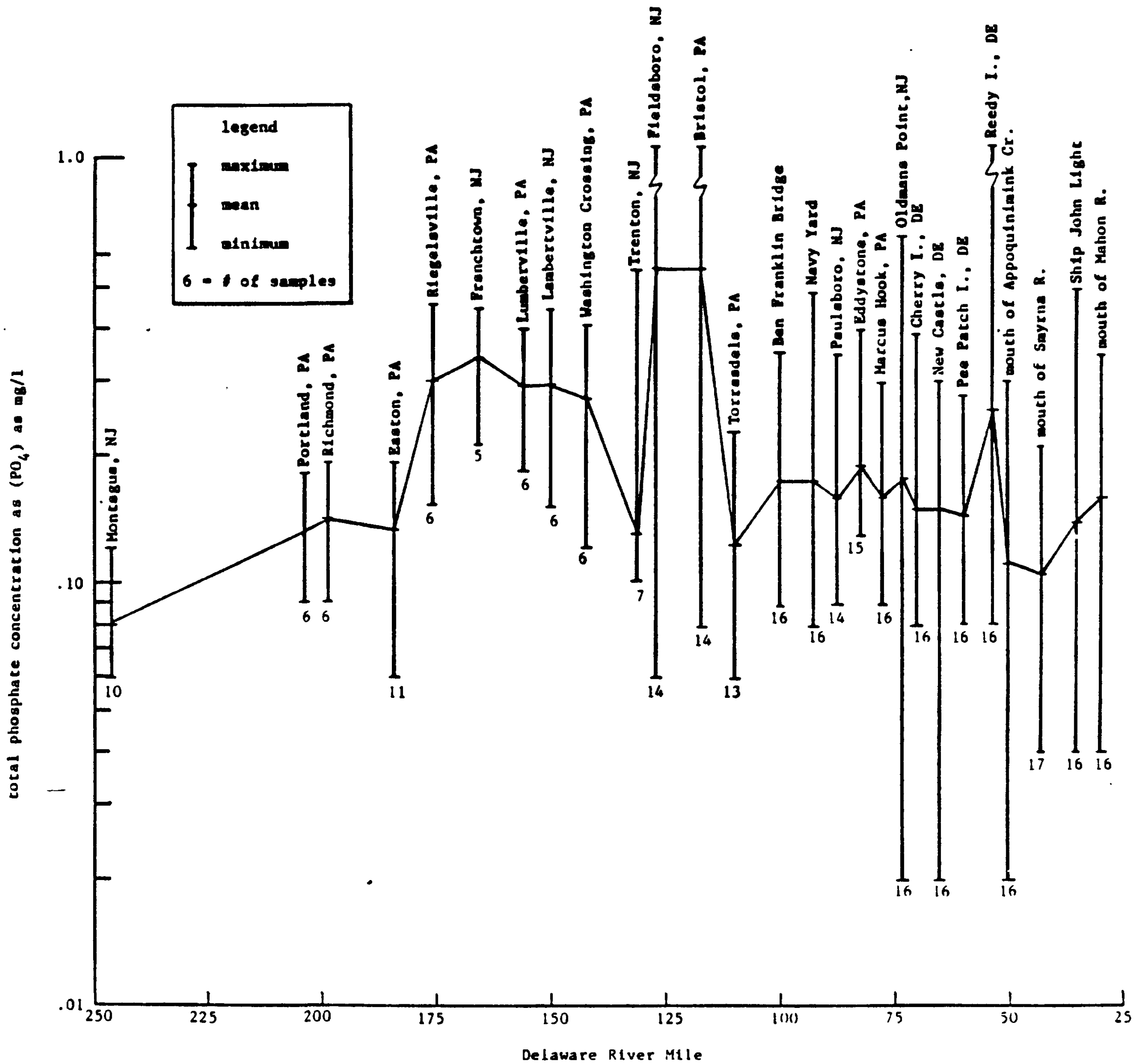
1981 MINIMUM AND MEAN DELAWARE RIVER ESTUARY AND BAY SUMMER DISSOLVED OXYGEN CONCENTRATIONS

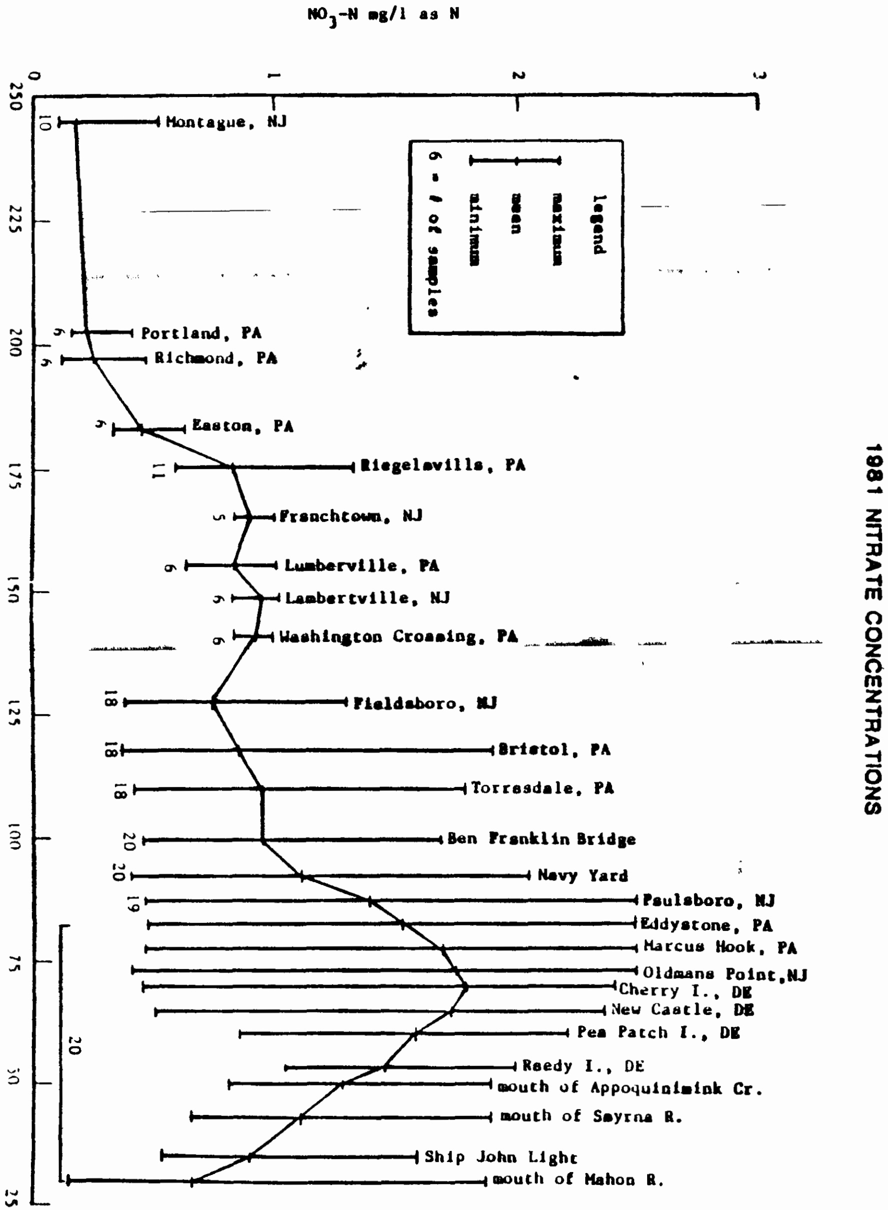


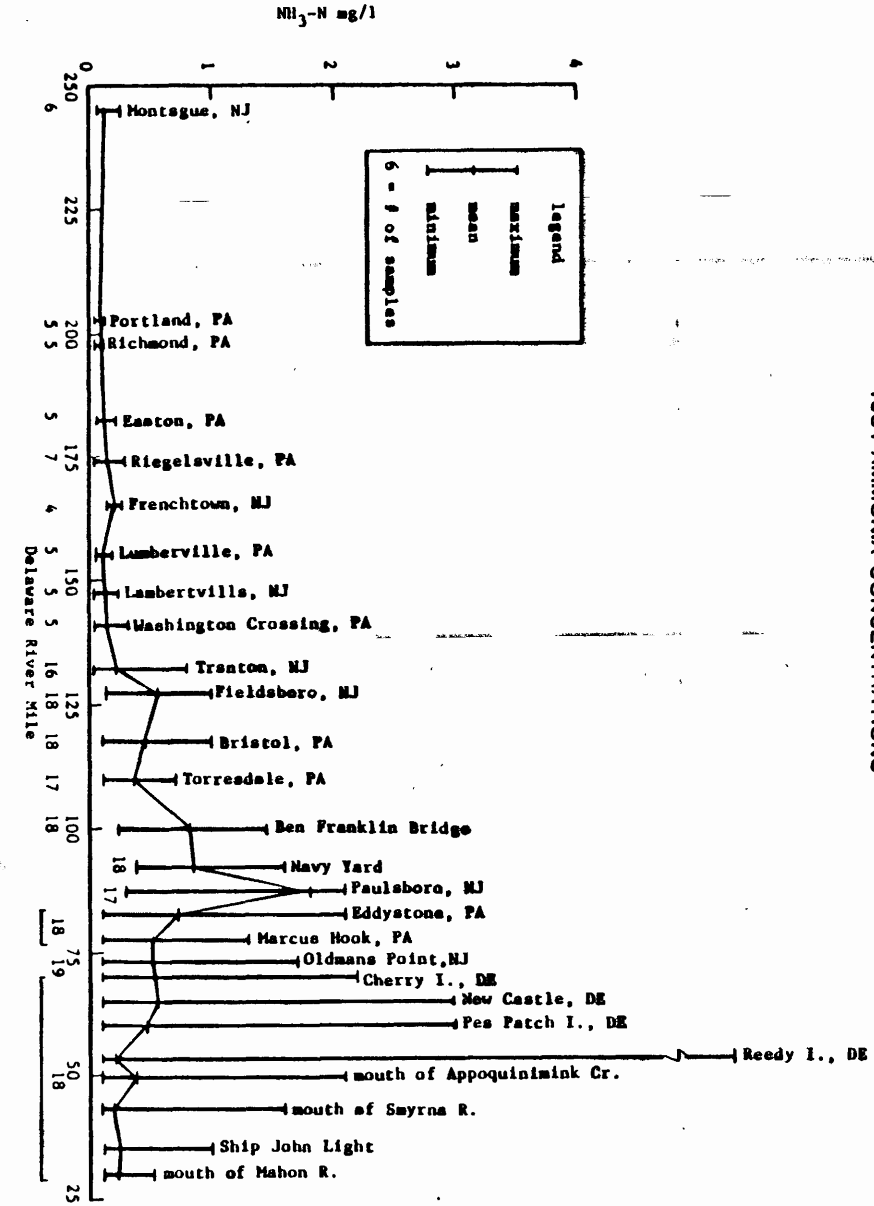
1981 WATER TEMPERATURE



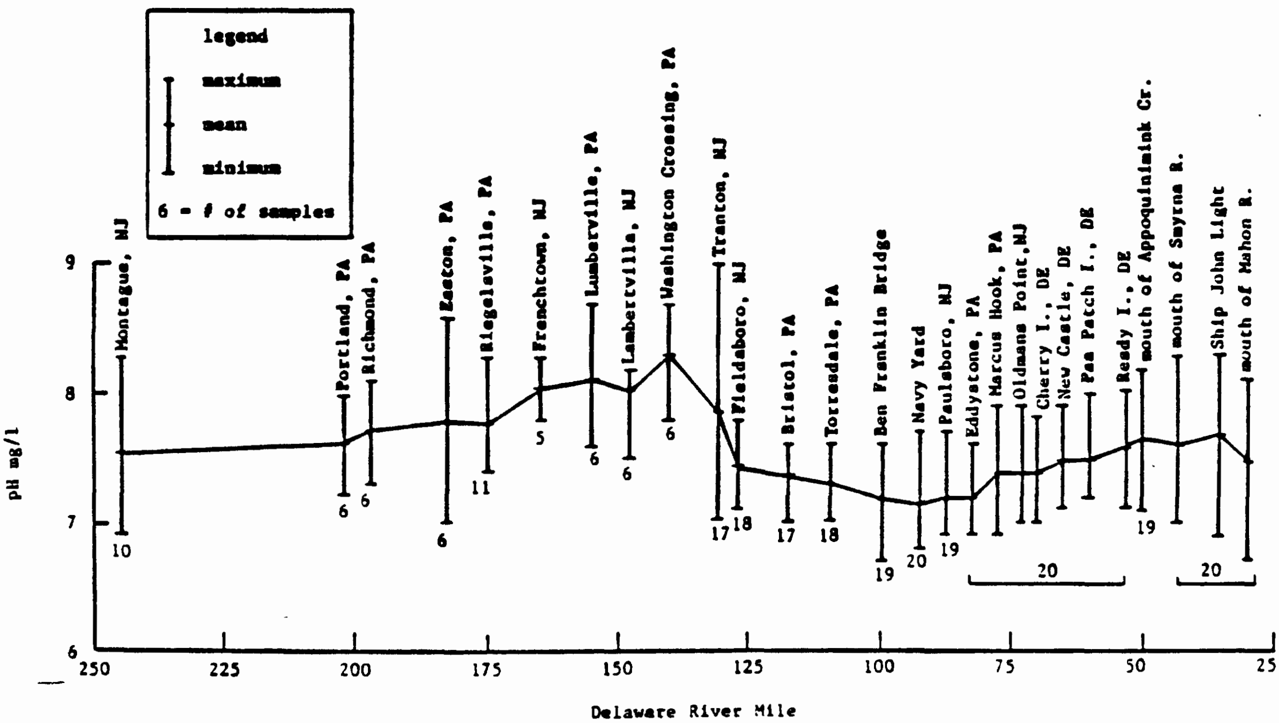
1981 PHOSPHATE CONCENTRATIONS



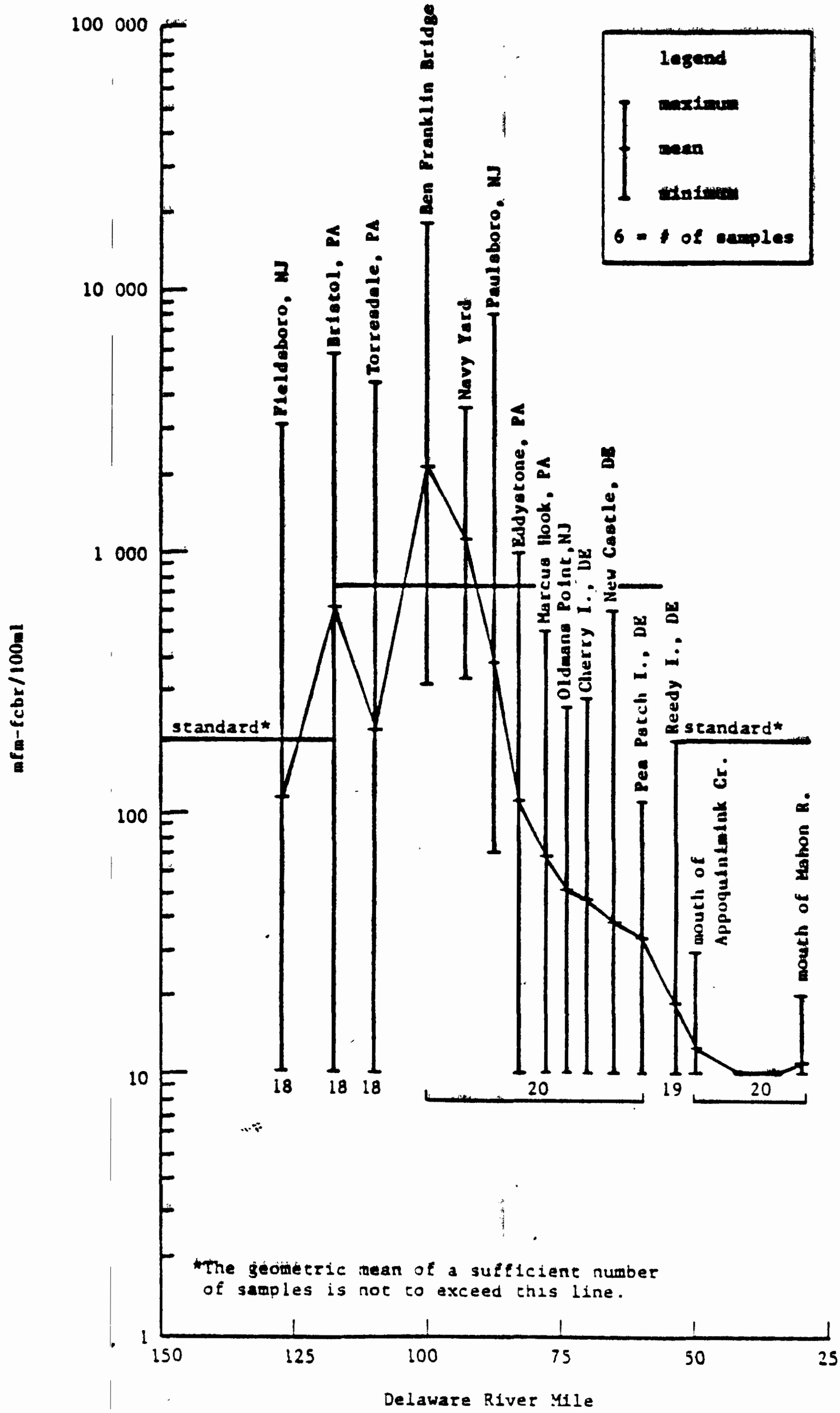

1981 NITRATE CONCENTRATIONS
NO3-N mg/l as N
0
1
2
3
Delaware River Mile
250
225
200
175
150
125
100
75
50
25
legend
maximum
mean
minimum
6 = # of samples
Montague, NJ
Portland, PA
Richmond, PA
Easton, PA
Riegelsville, PA
Frenchtown, NJ
Lumberville, PA
Lambertville, NJ
Washington Crossing, PA
Fieldsboro, NJ
Bristol, PA
Torresdale, PA
Ben Franklin Bridge
Navy Yard
Paulsboro, NJ
Eddystone, PA
Marcus Hook, PA
Oldmans Point,NJ
Cherry I., DE
New Castle, DE
Pea Patch I., DE
Reedy I., DE
mouth of Appoquinimink Cr.
mouth of Smyrna R.
Ship John Light
mouth of Mahon R.
10
6
6
6
11
5
6
6
6
18
18
18
20
20
19
20


1981 AMMONIA CONCENTRATIONS
NH3-N mg/l
0
1
2
3
4
Delaware River Mile
250
225
200
175
150
125
100
75
50
25
legend
maximum
mean
minimum
6 = # of samples
Montague, NJ
Portland, PA
Richmond, PA
Easton, PA
Riegelsville, PA
Frenchtown, NJ
Lumberville, PA
Lambertville, NJ
Washington Crossing, PA
Trenton, NJ
Fieldsboro, NJ
Bristol, PA
Torresdale, PA
Ben Franklin Bridge
Navy Yard
Paulsboro, NJ
Eddystone, PA
Marcus Hook, PA
Oldmans Point,NJ
Cherry I., DE
New Castle, DE
Pea Patch I., DE
Reedy I., DE
mouth of Appoquinimink Cr.
mouth of Smyrna R.
Ship John Light
mouth of Mahon R.
6
5
5
5
7
4
5
5
5
16
18
18
17
18
18
17
18
19
18

1981 pH VALUES

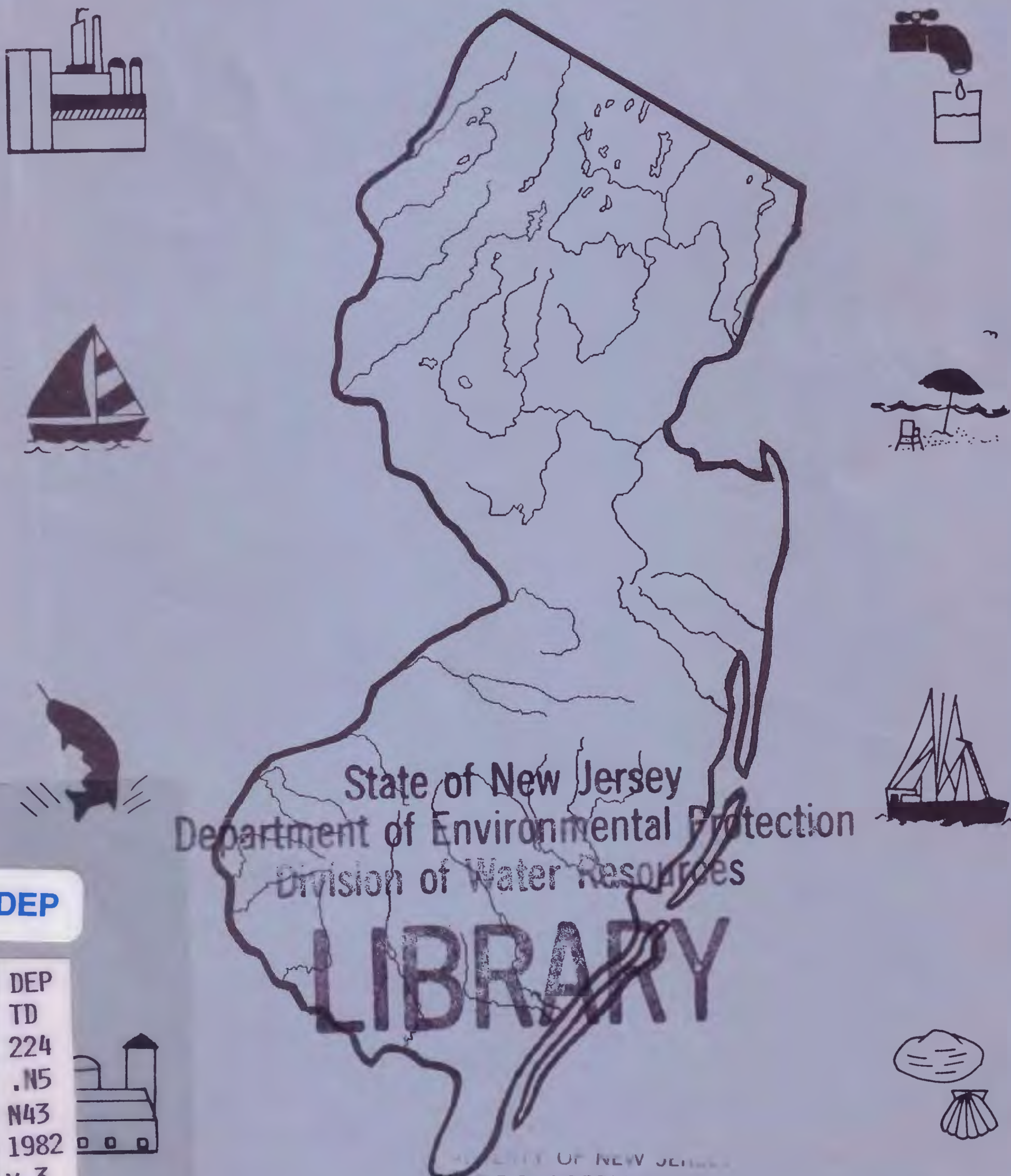


SUMMARY OF 1981 FECAL COLIFORM - ESTUARY AND BAY



New Jersey 1982
State Water Quality Inventory Report

Appendix–Atlantic Coastal Basin



New Jersey Department of Environmental Protection ▪ Division of Water Resources

NEW JERSEY 1982 STATE WATER QUALITY INVENTORY REPORT

APPENDIX - ATLANTIC COASTAL BASIN

A REPORT ON THE STATUS OF WATER QUALITY IN NEW JERSEY PURSUANT TO THE NEW JERSEY WATER POLLUTION CONTROL ACT AND SECTION 305(b) OF THE FEDERAL CLEAN WATER ACT

WATER RESOURCES REPORT 39-C: 1.B

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Thomas H. Kean, Governor
Robert E. Hughey, Commissioner
John W. Gaston, Jr., P.E., Director

June, 1983

APPENDIX 1 - WATER QUALITY INVENTORY

TABLE OF CONTENTS

APPENDIX 1-B

WATER QUALITY INVENTORY

ATLANTIC COASTAL BASIN

INTRODUCTION

This appendix contains a review of surface water quality in New Jersey's rivers, streams, coastal bays and lakes. This water quality review represents the biennial assessment of the State's waters as required by Section 305(b) of the federal Clean Water Act. For the 1982 305(b) report the State has been divided into 31 segments (Table 1-i) that are generally either single or grouped watersheds. The breakdown of the State into these segments is also similar to the segments used in prior New Jersey 305(b) reports, and therefore, allows comparison of water quality in a segment from one reporting period to the next. All segments were analyzed for water quality by the NJ Department of Environmental Protection with the exception of segments "DD" (Delaware River Basin) and "EE" (Interstate Sanitation Commission jurisdictional waters) which were prepared by the Delaware River Basin Commission and the Interstate Sanitation Commission, respectively.

The 29 NJDEP-prepared segment analyses contain four written sections, (Basin Description, Water Quality Assessment, Problem Assessment, and Goal Assessment and Recommendations), in addition to a segment map, water quality data charts and a wastewater discharge inventory. Numerous offices throughout NJDEP, and especially the Division of Water Resources, contributed information and or text to the segment analyses. In cooperation with the Bureau of Planning and Standards, DWR, the Bureau of Monitoring and Data Management, DWR, prepared the Water Quality Assessment - Conventional Parameters sub-section and the water quality data charts. Also in the DWR, the Bureau of Industrial Waste Management prepared the discharge inventories based on information in their New Jersey Pollutant Discharge Elimination System (NJPDES) computer files. The Office of Cancer and Toxic Substances Research (OCTSR), NJDEP, wrote the Toxic Parameters subsection for each Water Quality Assessment section. Their review of water column, sediment and fish tissue toxics sampling data represents the first such statewide watershed by watershed analysis since the program began in the mid-1970s. Following below is a description of the four sections that comprise the 29 NJDEP produced segment analyses.

Basin Description

The Basin Description characterizes each segment from a geographical and land use perspective in addition to noting what known surface water uses are present. Water uses identified included diversions of surface waters for potable supplies, agricultural irrigation and industrial processes; monitored swimming locations; fishing opportunities and resources; shellfish harvesting; and other specific uses that may be unique to a region of the State. The sources of information for this

TABLE 1-i SEGMENTS ANALYZED IN THE WATER QUALITY INVENTORY

A. Wallkill River
B. Flat Brook and Paulins Kill
C. Pequest and Musconetcong Rivers
D. Pohatcong and Lopatcong Creeks
E. Delaware River Tributaries - Hunterdon/Mercer Counties
F. Assunpink Creek
G. Crosswicks and Assiscunk Creeks
H. Rancocas Creek
I. Pennsauken Creek, Big Timber Creek and Cooper River
J. Woodbury, Mantua and Raccoon Creeks
K. Oldmans, Salem and Alloways Creek
L. Cohansey and Maurice Rivers
M. Southern Atlantic Coastal Basin - Cape May to Great Bay
N. Great Egg Harbor River
O. Mullica River
P. Mid-Atlantic Coastal Basin - Great Bay to Manasquan Inlet
Q. Manasquan River
R. North Atlantic Coastal Basin - Manasquan Inlet to Sandy Hook
S. North Branch Raritan River
T. South Branch Raritan River
U. Millstone River
V. Lawrence Brook and South River
W. Lower Raritan River Basin
X. Elizabeth and Rahway Rivers
Y. Upper Passaic River - Headwater to Livingston
Z. Mid-Passaic River - Livingston to Little Falls
AA. Mid-Passaic River Tributaries (Whippany, Rockaway, Pequannock, Wanaque, Ramapo and Pompton Rivers)
BB. Lower Passaic River - Little Falls to Newark Bay
CC. Hackensack River
DD. Status Report on the Delaware River
EE. Status Report on Interstate Sanitation Commission Waters

section included a number of different agencies in state, federal and local governments.

In the process of gathering water use data for the 29 segments of the State numerous information deficiencies were found to exist. Formost was the lack of statewide inventories dealing with monitored bathing beaches, and the presence of agricultural and industrial surface water diversions. Since bathing beaches are routinely monitored by local health departments under state guidelines and no statewide reporting requirements have been instituted there exists no regularily updated list of swimming areas found in the State. As a result of this data gap the Bureau of Planning and Standards mailed questionaires to all local health departments in the State requesting a list of bathing beaches and areas under their jurisdiction. The identification of surface water diversions for agricultural, industrial and other purposes is limited to where surface water diversion permits have been issued under the provisions of NJSA 58:1-36 by the State of New Jersey. Only diversions in excess of 70 gallons per minute (gpm) are required to obtain a permit. Therefore, numerous unreported diversions exist across the State which are pumping under 70 gpm. The information deficiencies described above exemplifies the difficulties uncovered while developing the Basin Description. These difficulties point to the need for a more coordinated water resource approach when identifing and understanding water quality problems, so that long-term direct use impacts can be measured.

Water Quality Assessment

The Water Quality Assessment section is a review of surface water quality data collected in a segment from 1977 to 1981. Water quality is analyzed for a group of standard indices (Table 1-ii) in the Conventional Parameters subsection, while known and suspected carcinogenic or toxic substances (Table 1-iii) identified in the segments water bodies are discussed in the Toxic Parameters subsection. In each Conventional Parameters subsection there is a brief review of overall water quality trends which have been found in that segment. This review of trends is a comparison of water quality conditions as described in the 1977 and 1980 305(b) reports against conditions as found today.

The ten conventional parameters reviewed were selected because of their values for indicating pollution, making swimmable and fishable determinations and for compatibility with data reviewed in prior 305(b) reports. These ten parameters were evaluated at 78 monitoring stations throughout the State.

The ambient monitoring stations reviewed in the Conventional Parameters subsection represents approximately one half of the total long-term monitoring stations present in the State. Those stations used were selected on the basis of their location in a

TABLE 1-ii PARAMETERS LIST AND CRITERIA FOR WATER QUALITY ASSESSMENTS - CONVENTIONAL PARAMETERS

Parameter		Criteria Source
1.	Dissolved oxygen Concentrations and Saturation	N.J. Water Quality Standards
2.	Biochemical oxygen demand (5 day)	N.J. Water Quality Standards Comparison to statewide ambient data
3.	Fecal coliform	N.J. Water Quality Standards
4.	Total dissolved solids	N.J. Water Quality Standards
5.	pH	N.J. Water Quality Standards
6.	Total phosphorus	N.J. Water Quality Standards
7.	Nitrate + nitrite nitrogen	Quality Criteria for Water, 1976, USEPA National Interim Primary Drinking Water Regulations, 1976, USEPA
8.	Total ammonia	Comparison to statewide ambient data
9.	Un-ionized ammonia	N.J. Water Quality Standards

TABLE 1-iii TOXIC CHEMICALS ANALYZED IN THE WATER QUALITY ASSESSMENT - TOXIC PARAMETERS

Group 1 - Metals	Lower Analytical Limit ug/l (ppb)	EPA Standard for Drinking Water ug/l (ppb)
Arsenic	1	50
Beryllium	1	-
Cadmium	1	10
Chromium	1	50
Copper	1	1000[a]
Lead	1	50
Nickel	5	-
Selemium	2	10
Zinc	5	5000[a]
Group 2 - Pesticides and Related Compounds		
PCBs	0.06	-
Arochlor 1016	0.06	-
Arochlor 1242	0.06	-
Arochlor 1248	0.01	-
Arochlor 1254	0.01	-
α-BHC	0.01	-
β-BHC	0.01	-
Lindane (γ-BHC)	0.01	4
Heptachlor	0.01	0.1
Heptachlor epoxide	0.01	0.1
Aldrin	0.01	-
Dieldrin	0.01	-
Chlordane	0.01	-
Toxaphene	0.06	5
Methoxychlor	0.08	100
Mirex	0.02	-
Endrin	0.01	0.2
o,p-DDT	0.04	-
p,p'-DDT	0.04	-
o,p-DDE	0.01	-
p,p'-DDD	0.02	-

Group 3 - Low Molecular Weight Halogenated Organics b,c

Methylene chloride	90
Methyl chloride	6.0
Methyl bromide	1.0
Chloroform	0.8
Bromoform	1.0
Trichloroethylene	0.3
1,1,2,2-Tetrachloroethane	0.3
1,1,2-Trichloroethane	1.0
Dibromochloromethane	0.1
Trifluoromethane	0.5
Carbon tetrachloride	0.1
1,2-Dibromoethane	0.1
1,2-Dichloroethane	1.6
1,1,1-Trichloroethane	2.0
Vinyl chloride	0.5
Tetrachloroethylene	0.1
o-Dichlorobenzene	2.2
m-Dichlorobenzene	1.3
p-Dichlorobenzene	1.3
Trichlorobenzene	2.0
Diiodomethane	0.3
Dichlorobromoethane	0.5

a - secondary standards
b - Group 3 tested in water column only, not in sediments and fish tissue
c - Trihalomethanes: The EPA drinking water standard is 100 ppb for total trihalomethanes

watershed, the presence of other stations in the segment, the amount of data collected for each station, the ability of a monitoring station to reflect existing land use and known pollution sources, and the limitations in staffing and support services which prevented the review of all ambient monitoring stations statewide.

The DWR, through the Bureau of Monitoring and Data Management (BMDM) maintains and/or participates in several surface water quality monitoring programs throughout New Jersey. The most extensive program, the Primary Water Quality Monitoring Network, is a cooperative effort involving the BMDM and the United States Geological Survey's Water Resources Division in Trenton, N.J. The network, instituted in 1976, is composed of 135 stations from which samples are collected six times annually. In addition to the routine or conventional water column parameter schedule, a supplemental set of 75 samples is collected biannually from the water column for trace organic and metals analysis, and annually from the sediments at 50 stations. In 1982, the Primary Water Quality Monitoring Network was reduced to approximately 100 stations statewide.

EPA's National Basic Water Monitoring Program (BWMP) is comprised of thirty one stations in New Jersey. Samples are collected monthly at each station. Beginning in January, 1981, a revised parameter schedule was implemented with the approval of EPA Region II, as certain parameters were collected biannually rather than monthly. This change occurred at stations where there was no indication of consistently excessive concentrations of pollutants. These parameters include chemical oxygen demand, chloride, petroleum hydrocarbons, metals and dissolved minerals.

Biomonitoring was also conducted at each of the BWMP stations during the report period. Macroinvertebrate samples were acquired at each station using three Hester-Dendy samplers with the invertebrates later identified and enumerated in the laboratory. Diversity index, percent abundance and equitability of sample population were among the items evaluated. Five replicate periphyton samples were obtained at each station using clean glass slides mounted in a floating sampler, while chlorophyll a concentrations were measured using the acetone extraction method.

In addition, electrofishing and analysis of fish tissue samples for trace metals and pesticides were initiated in 1980 at most of the BWMP stations in New Jersey. The fish were identified and prepared in the BMDM's biological laboratory and then forwarded to the New Jersey Department of Health Laboratory for analysis.

Additional ambient surface water monitoring is conducted by the Ocean County Health Department, the Passaic Valley Water Commission, the Interstate Sanitation Commission, the Delaware River Basin Commission and other agencies throughout the State.

Their data was used in this report when applicable. In the future it is anticipated that many other counties will participate in expanded monitoring activities. Station selection in all monitoring networks were generally in accordance with the criteria cited in the EPA publication entitled Basic Water Monitoring Program (EPA 440/9-76-025, revised May, 1978).

The water quality data used to make each Conventional Parameter assessment is presented in the form of graphs (concentration versus time), and is found in the segment analyses following the text. The graphs show all raw data points collected for the ten parameters from 1977 to mid 1981. Conventional water quality data was compared against New Jersey Surface Water Quality Standards (N.J.A.C. 7:9-4.1 et seq) where applicable for dissolved oxygen concentration and saturation, biochemical oxygen demand (five day), total dissolved solids, pH, total phosphorus and un-ionized ammonia. Table 1-iv present the surface water classification and its appropriate water quality standards. A standard line is used on the water quality graphs for those parameters with standards for comparitive purposes. Although there is a state standard for fecal coliform (for most freshwater the criteria is a geometric average of 200/100 ml, or no more than 10 percent of the total samples taken during any 30 day period exceeding 400/100 ml), the frequency with which fecal coliform samples are collected in current statewide monitoring programs in regarded as not being of sufficient frequency to compare to existing standards.

The Toxic Parameters subsection was provided by the Office of Cancer and Toxic substances Research (OCTSR), NJDEP, specifically for this report. This subsection describes the preliminary results of water column, sediment and fish tissue sampling for toxic and carcinogenic substances in New Jersey's aquatic environment. The surface water monitoring for toxic pollutants began at OCTSR in 1977 when there was practically no background data concerning the occurrence of toxic pollutants in surface waters throughout New Jersey. In addition standardized sampling techniques and methods for analysis had not been defined for determining toxic contamination in water, sediment, and aquatic biota.

The approach taken to generate a data base for toxics in New Jersey's surface waters involved the collection of grab samples of water at various sites throughout the State in accordance with the State Water Quality Management Program surface water studies carried out by NJDEP and designated regional and county agencies. The water column samples were analyzed for all three groups of chemicals shown in the Table 1-iii. As the program progressed, the collection of sediments samples was incorporated at many sites to access the partitioning and accumulation of toxic pollutants in the sediments. Sites usually were sampled once per year, but sites which were found to be contaminated or suspected to receive toxic inputs were sampled at least twice. Sediments and fish tissue were tested for substances in groups 1 and 2 in

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARD (NJDEP, 1981)

	Classification				
Parameter	FW-Lower Mullica and Wading Rivers Central Pine Barrens	FW-Central Pine Barrens	FW-2 Trout Production	FW-2 Trout Maintenance	FW-2 Nontrout
pH (Standard Units)	4.5-6.0	3.5-5.5	6.5-8.5	6.5-8.5	6.5-8.5
5 day Biochemical oxygen demand (mg/l)	Maximum of 5.0 at any time.	Maximum of 5.0 at any time. None which would render the waters unsuitable for the designated uses.			
Dissolved oxygen	No less than 85% saturation at any time.	Not less than 85% saturation at any time.	Not less than 7.0 mg/l at any time.	24 hour average not less than 6.0 mg/l. Not less than 5.0 mg/l at any time.	i. 24 hour average not less than 5.0 mg/l, but not less than 4.0 mg/l at anytime, except as noted in paragraph ii. below. ii. Not less than 4.0 mg/l at any time in the freshwater tidal portions of tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive.
Bacterial quality (MPN/100 ml)	1. Except as noted in paragraph two below, fecal coliform levels shall not exceed a geometric average of 200/100 ml., nor should more than 10 per cent of the total samples taken during any 30-day period exceed 400/100 ml. 2. Fecal coliform levels shall not exceed a geometric average of 770/100 ml. in the freshwater tidal portion of tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive. 3. Samples shall be obtained at sufficient frequencies and at locations and during periods which will permit valid interpretation of laboratory analyses. Appropriate sanitary surveys shall be carried out as a supplement to such sampling and laboratory analyses. As a guideline and for the purpose of these regulations, a minimum of five samples taken over a 30-day period should be collected, however, the number of samples, frequencies and locations will be determined by the department in any particular case.				

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARDS (NJDEP, 1981)

	Classification				
Parameter	FW-Lower Mullica and Wading Rivers Central Pine Barrens	FW-Central Pine Barrens	FW-2 Trout Production	FW-2 Trout Maintenance	FW-2 Nontrout
Total dissolved solids - filterable residue (mg/1)	Maximum of 100 at anytime	Maximum of 100 at anytime	1. Not to exceed 500 mg/1 or 133 per cent of background whichever is less. Notwithstanding this criterion, the department, after notice and opportunity for hearing, may authorize increases exceeding these limits provided the discharge responsible for such increases can demonstrate to the satisfaction of the department that such increases will not significantly affect the growth and propagation of indigenous aquatic biota or other designated uses, including public water supplies. 2. Any authorization by the department of such increases shall be conditioned upon utilization of the maximum practicable control technology.		
Ammonia (un-ionized; Maximum concentration ug/1)	50.0	50.0	20.0	20.0	50.0
Phosphorus (mg/1)	Maximum of 0.7 at anytime; phosphorus as phosphate.		1. Lakes: Phosphorus as total P shall not exceed 0.05 in any reservoir, lake, pond, or in a tributary at the point where it enters such bodies of water, unless it can be demonstrated that total P is not a limiting factor considering the morphological, physical, chemical, and other characteristics of the water body. 2. Streams: Phosphorus as total P shall not exceed 0.1 in any stream, except at those locations in paragraph one above, where total P is determined to have a detrimental effect on stream use or to be the limiting factor considering the morphological, physical, chemical, and other characteristics of the water body.		

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARDS

Parameter	TW-1
pH (Standard Units)	6.5-8.5
Dissolved oxygen (mg/l)	24 hour average not less than 5.0. Not less than 4.0 at any time.
Bacterial quality (MPN/100 ml)	1. Approved shellfish harvesting waters: where shellfish harvesting is permitted, requirements established by the National Shellfish Sanitation Program as set forth in its current manual of operation shall apply. 2. All other waters: Fecal coliform levels shall not exceed a geometric average of 200/100 ml, nor should more than 10 per cent of the total samples taken during any 20-day period exceed 400/100 ml.
Total dissolved solids - Filterable residue (mg/l)	None which would render the water unsuitable for the designated uses.

KR:305B2:b

Table 1-iii. Methodology to accurately test for volatiles had not been developed at the time.

Throughout the Toxic Parameters subsections general statements of contaminant levels are identified. This is due to the lack of surface water quality standards for the majority of the substances. In general, when a parameter was found in the water column in concentrations greater than 100 ug/l it was considered in high levels. Moderate levels fell between 10 and 100 ug/l, while low levels meant under 10 ug/l. With regard to sediments and fish tissue analyses, contamination is generally related to the presence of PCBs (polychlorinated biphenols), chlordane, and DDT and its metabolite substances. Elevated levels of PCBs are considered above 3.0 ppm, low levels from 1.0 to 3.0 ppm and trace levels below 1.0 ppm. For chlordane elevated levels were .3 ppm or more, moderate levels are .1 to .3 ppm, with trace levels below .1 ppm. Total DDT was considered elevated when at 5.0 ppm or more, at low levels from 1.0 to 2.0 ppm, and at trace levels below 1.0 ppm. The elevated concentrations reflect the U.S. Food and Drug Administration action levels for fish tissue which is used for human consumption.

As preliminary results were being reviewed, various shortcomings in this sampling approach were identified, but the need for baseline data was imperative and the results generated have proved very useful in identifying areas where further and more intensive studies are needed. Several of the problems discovered during the surface water survey deserve mention in order that the data be viewed in proper perspective. One problem is the limitation of collecting grab water samples for toxic pollutant analysis. The presence of toxics is often variable due to many factors including intermittant discharges, toxic spills, illegal dumping etc.; grab samples provide only an instantaneous look at the water quality of a particular system. The OCTSR has found that composite samples (samples collected over time) provide a more representative picture of true water quality; however, collecting and analyzing composite samples is much more expensive than grab samples.

The natural variability of surface water samples has been another interesting finding of the OCTSR's survey. Toxic pollutants in surface waters are dynamic; compounds present in one stretch of stream will not necessarily be detected in another area. This has led to a need for greater understanding of the physical and chemical processes relating to the partitioning of chemical compounds into different environmental compartments. With the development of the data base, it is now possible to predict where different classes of compounds are most likely to be found, whether in water, sediment, or aquatic biota. The knowledge and experience gained from the survey has resulted in more cost-effective sampling programs designed to gain a maximum amount of information for each dollar spent for analysis.

The OCTSR wrote a brief description on the risks of chemical contaminants on human health. This report, entitled "Health Effects of Chemical Contaminants" is a working paper for the 305(b) report and is available upon request from the Bureau of Planning and Standards, DWR.

Problem Assessment Section

The Problem Assessment is an evaluation of the probable and known water pollution sources within each segment. An attempt was made to identify pollution sources as specifically as possible; but in most cases only wastewater discharges under Department enforcement and administrative actions, and identified by the DWR Enforcement and Regulatory Affairs Element were named as specific sources. Other information sources included the 12 Water Quality Management (WQM) Plans prepared in late 1970s, the 1980 State 305(b) Report, DWR Construction Grants Administration project descriptions, designated WQM Agency supplied information; as well as a variety of other sources. One source which contains alot of useful information on the origin of water pollution were the Lakes Management Program's intensive surveys conducted in 1978 and 1979. However, these surveys were performed on only a local basis and on selected lakes.

Unfortunately the statewide surface water monitoring programs described above are not designed to identify water pollution sources, but rather to determine long-term changes in overall water quality. This makes it difficult, if not impossible, to reliably identify sources of pollution and the impacts they may be having on stream quality. The inherent variabilities and limitations of periodic grab samples from a water body were also expressed above in the description of the OCTSR Program. Unless source specific intensive surveys above and below suspected pollution sources can be performed, then accurate determinations on the contribution of various wastewater facilities, storm drains and land uses to pollution loads can not be made. In the Problem Assessment, therefore, while pollution sources are identified, in most cases their impacts are not truely known.

Goal Assessment and Recommendations Section

The ability of surface waters within each of the 29 segments to meet the swimmable and fishable goals of the federal Clean Water Act is presented in this section. In addition, corrective actions to allieviate water pollution problems identified in the Water Quality Assessment and Problem Assessment sections are recommended.

The Clean Water Act states that surface waters of the nation must be swimmable and fishable (provide for the propagation and protection of a balanced population of shellfish, fish and wildlife) by July 1, 1983. Because this 305(b) report reflects

conditions as of late 1981 and that surface waters will not generally experience significant waters quality differences from late 1981 to mid 1983, the swimmable and fishable determinations made in this report can be interpretated as 1983 goal attainability.

Criteria were developed for this report in order to make the swimmable/fishable goal determination. The swimmable status was assigned to a segment if bathing beaches were known to exist throughout its waters, or if fecal coliform bacteria were of sufficient levels to allow bathing. Fecal coliform data were assessed at monitoring stations used in the segment analyses for the frequency of samples greater than 200/100 ml (surface water standard) during warm weather (May - September) periods. If over 25 percent of the samples were greater than 200 MPN/100 ml then the waters are considered not swimmable; 0-25 percent over 200 MPN/100 ml was construed to mean the waters are marginally swimmable; and when all fecal coliform samples were under 200 MPN/100 ml then the waters are swimmable. It should be noted that irregardless of the swimmable classification assigned to a segment, swimming is recommended only in those waters routinely monitored for bathing.

The fishable determination was based on a number of criteria. This included the presence of trout production or trout maintenance waters (as defined in the state water quality standards); water quality data for dissolved oxygen, pH and un-ionized ammonia which would indicate stressful or acute toxicity to fishlife; and the species of fish identified to exist in the segment by the report Establishment of a Statewide List of Bioassay Organisms Pursuant to the New Jersey Surface Water Quality Standards (Rutgers University, 1979). All waters of the State can be classified as fishable (fishing is allowed) with the exception of portions of the Pennsauken Creek, Cooper River and Woodbury Creek watersheds. Determining the ability of a watershed to support a balanced fish community is difficult since a great variety of factors are involved. What is needed, but is not available, is continuous monitoring of fish communities in the State's waters through various collection and identification programs.

Recommendations for the improvement of water quality within a segment were based generally on the pollution sources identified in the Problem Assessment and what actions are needed to alleviate these problems.

M. SOUTHERN ATLANTIC COASTAL BASIN (CAPE MAY POINT TO GREAT BAY)

Basin Description

The Southern Atlantic Coastal Basin comprises the coastal, estuarine and inland fresh waters of Atlantic and Cape May Counties that drain to the Atlantic Ocean (excluding the Great Egg Harbor River basin). The fresh water streams originate in the sparsely populated interior and meander slowly through the topographically flat coastal plain in a southeasterly direction entering salt marshes and estuarine bays along the coast. These bays are separated from the Atlantic Ocean by barrier beach islands, but are connected via several inlets. Cedar and hardwood swamps are characteristic of inland lowlands, which are common in this area. Major tributaries in the Southern Atlantic Coastal Basin are Absecon Creek in Atlantic County, and the Tuckahoe River in Cape May County. The average flow, recorded on the Tuckahoe River at Head of River (drainage area of 30.8 square miles) is 47 cfs.

Population and development is generally concentrated on the barrier islands and eastern shore of the bays. The multimillion dollar resort industry, which now includes legalized casino gambling (Atlantic City) is primarily responsible for current intense development activity. Some agricultural activity takes place in the segment. Population growth between 1970 and 1980 occurred throughout the basin, with Cape May County experiencing the third largest population increase in the state. The largest urban centers are Atlantic City, Pleasantville City, Somers Point and Ventnor City in Atlantic County; and Lower Township, Middle Township and Ocean City in Cape May County. Significant population increases occur throughout the basin in the summer months, a response to the abundant water-based recreational opportunities of this coastal region. Bathing and fishing beaches in the Southern Atlantic Coastal segment are of significant recreational and commercial value, with public beaches located in Atlantic City, Margate, Ventnor, Absecon and Longport in Atlantic County; and Avalon, Wildwood, Middle Township, Ocean City, Stone Harbor, Upper Township, Cape May and North Wildwood in Cape May County.

The Atlantic County Regional Sewerage Authority's Coastal Region, one of three wastewater treatment service areas designated in Atlantic County, consists of a major regional system of interceptor sewers, force mains, pumping stations and a wastewater treatment plant in Atlantic City (design capacity of 40 mgd), which discharges to the Atlantic Ocean. This system has resulted in the elimination of eight package plants discharging to the back bays. In the Cape May County portion of the segment, Ocean City has replaced two package plants that discharge to the back bays with a wastewater treatment facility that discharges 5.5 mgd to the Atlantic Ocean. Cape May County has two additional regional service areas in its wastewater treatment facilities plan that discharge a total of 15 mgd to the back bays. A total of nine sanitary and nine industrial dischargers are located in the South Atlantic Coastal Segment.

The Southern Atlantic Coastal Basin is almost totally dependent on ground water for its potable water supply. Ground water is also the primary source of water for industrial and agricultural uses and supplies much of the base flows to freshwater rivers and streams.

The Southern Atlantic Coastal segment contains eleven private and two public lakes and impoundments of significant size, which provide recreational opportunities for bathing, boating and fishing. In Atlantic County, Birch Grove Park Pond provides excellent shore fishing for largemouth bass, pickerel, sunfish and catfish. Three Corbin City impoundments, totaling more than 630 acres, permit shore fishing and boating, and provide excellent angling for pickerel and catfish. In Cape May County, Dennisville Lake provides excellent shore fishing for largemouth bass, pickerel, catfish, yellow perch and sunfish, as well as boating facilities.

Fifty-eight percent of the shellfish harvesting areas from Great Bay to Cape May Point are classified as "approved" or "seasonal" for direct harvest and marketing, with the remaining 42 percent "condemned".

The Lester G. MacNamara Wildlife Management Area (WMA), largest of three tracts owned and operated by the N.J. Division of Fish, Game and Wildlife in this segment, contains 12,438 acres in Atlantic and Cape May Counties. The Absecon and Marmora WMAs, consisting of a total of 7,788 acres, are located in coastal wetlands. A diversity of water-based activities are available, including fresh and salt water fishing, boating and waterfowl hunting. The Brigantine National Wildlife Refuge contains 20,290 acres of fresh and brackish wetlands and forested uplands in Atlantic County, and provides a natural habitat and breeding ground for a wide variety of birds and waterfowl. The N.J. Division of Fish, Game and Wildlife stocks trout in the following waters: Atlantic County - Birch Grove Park Pond; Cape May County - Cape May County Lake #2 and Dennisville Lake.

New Jersey Water Quality Standards give the Southern Atlantic Coastal Basin a number of water quality classifications. Waters of the Lester MacNamara WMA from their origin downstream to where the influence of impounding occurs are classified as FW-1; Absecon Creek and tributaries upstream from Atlantic City Reservoir Dam, and the majority of mainland surface waters, are classified FW-2 Nontrout. The remainder of the waters are TW-1 CW-1 and CW-2.

Water Quality Assessment

Conventional Parameters

Generally good water quality is exhibited in the Tuckahoe River at Head of River, Cape May County, the only ambient monitoring station in this basin. Dissolved oxygen and biochemical oxygen demand concentrations were at acceptable levels annually. Seasonal (summer) declines in dissolved oxygen concentrations and saturation levels at the Head of River station were attributable in part to simultaneous increases in BOD_5 concentrations.

Fecal coliform concentrations in the Tuckahoe River exhibited occasionally moderate contraventions of the 200 MPN/100 ml level, but were not indicative of a major problem. Low total dissolved solids (below 50 mg/l) and pH (4.0 to 6.0) data for the period were characteristic of unstressed streams originating in the Pinelands vicinity. No significant trends were exhibited for either parameter over the five year period.

Nutrient concentrations through the period at Head of River were for the most part at low concentrations, especially the nitrogen parameters. The total phosphorus standard (0.10 mg/l) was contravened on two occasions during the period, but otherwise remained below 0.05 mg/l. Values for nitrate + nitrite were generally below 1.0 mg/l and concentrations of total and un-ionized ammonia were less than 0.60 and 0.05 mg/l, respectively.

No biological samples were collected from the Tuckahoe River during the period.

Comparison of the water quality data for the Tuckahoe River above with earlier 305(b) reports shows that water quality conditions have remained generally the same over the last five years. Although levels are low, total and un-ionized ammonia concentrations have shown small increases over the last two years. Some decrease in acidity has also appeared.

Toxic Parameters

To date freshwaters in this basin have not been sampled for toxic substances. A limited number of tissue samples were collected from several locations within this region. Various aquatic organisms taken from Absecon Creek and Nacote Creek were found to contain less than detectable levels of PCB Arochlor 1254. Tissue samples taken from the St. Georges Thorofare at Brigantine varied from less than detectable to trace levels of PCB Arochlor 1254. Species sampled include bluefish, *Pomatomus saltatrix*, and weakfish, *Cynoscion regalis*, which represent two of the major commercial and recreational species occurring in New Jersey coastal waterways.

Problem Assessment

The water in the Tuckahoe River at Head of River is of generally good quality because of the lack of development and point sources. The periodic high levels of fecal coliform and total phosphorus are likely from background sources and on-site disposal systems. Unfortunately, long-term monitoring data is severely lacking in most of the remaining areas of the Southern Atlantic Coastal Basin. Limited information does exist in the coastal estuaries from Division of Fish, Game and Wildlife (DFGW) studies, and in the results of the Cooperative Coastal Monitoring Program conducted every summer. In addition, the Cape May County and the Atlantic County Water Quality Management Plans discuss water quality in this region.

The DFGW conducted a study of the back bay ecosystem in Atlantic County from 1977 to 1979. The study evaluated fish species diversity and abundance, water and sediment quality, fish and shellfish tissue contamination, and use intensity. Water quality studies found dissolved oxygen to be frequently under 5.0 mg/l from May through September, which are "marginal" conditions for supporting fish populations. The low DO levels and high bacteria concentrations (which have closed shellfish harvesting waters) found in the bays should improve as the coastal communities of Atlantic County are all joined to the Atlantic County Sewerage Authority's Coastal Plant. This process in nearly complete. Fish tissue sampling showed traces of DDT and metabolities present in 95 percent of the finfish samples, with levels highest in fish which migrate. The most severe problem identified in the DFGW study was the presence of mercury in fish samples from Absecon Creek. The four fish samples from this waterway contained mercury at levels near or above the .5 ppm FDA acceptable level. No source(s) of the mercury was found in the sampling.

The Coastal Cooperative Monitoring Program during 1980 and 1981 has identified a number of problem areas in the South Atlantic Coastal Basin with elevated fecal coliform levels. Atlantic City, Brigantine City and Ventor City have periodic high fecal coliform counts in their adjacent coastal waters. Sources of the bacteria are nonpoint in origin, (most likely a broken sewer line or cross connection between storm and sewer lines), stormwater runoff and malfunctioning septic tanks (affecting back bays). The North Wildwood/Wildwood City area has had high bacteria counts, possibly as a result of wastewater dischargers, stormwater runoff and a force main across the back bay which has had numerous breaks in the past three years. This force main is thought to be adversely affecting the back bays. Cape May City has experienced elevated fecal coliform counts from sanitary sewers during rainfall events; this problem is currently being corrected. In Lower Township, certain beaches have been closed due to the proximity of the beach with the township's treatment plant discharge.

In Cape May County numerous problems continue to exist because of the inadequate sewage treatment facilities. Regional or upgraded existing plants are needed in two coastal beach areas. The Seven Mile Beach - Middle Township study area still has four primary plant discharging to bays and the ocean. One regional treatment facility has been designed for this area. In the Wildwood/Lower Region of the Cape May County MUA's service area, three primary plants are discharging to the back bay. A regional treatment facility has also been proposed to serve this region. In addition, septic tank problems have been identified in West Cape May Borough, Middle Township (Avalon Manor) and Lower Township (Cox Hall Creek area).

The Atlantic County WQM Plan stated Absecon Creek was of overall high quality; but the potential for pollution to the creek from landfills exists. A water quality report for the NJ Pinelands Commission (Commission's Technical Memorandum SW IV-1) stated that the Tuckahoe River at Estell Manor was of good quality.

Goal Assessment and Recommendations

The waters of this segment show great variability with regard to swimmable status. The Tuckahoe River at Head of River can be considered not swimmable because of the fecal coliform levels detected. However, the ocean beaches along the coast of Atlantic and Cape May Counties are for the most part swimmable. Specific knowledge on the swimmable status of the many small coastal tributaries is lacking. The Southern Atlantic Coastal Basin is an area rich in aquatic life. The DFGW study identified that Atlantic County's estuaries are nursery grounds for a number of forage and sport fisheries. The same should hold true for Cape May's coastal estuaries and bays. Although the coastal waters may have a significant shellfish resource, at least half of the shellfish waters are "condemned" for harvesting because of excessive bacteria concentrations. Other waters are classified as "seasonal" approved or "special restricted". The major concerns for making the fishable determination in this basin are the high mercury concentrations found in Absecon Creek finfish, and the widespread presence of DDT, which the DFGW stated may have sublethal effects on estuarine organisms. Further studies are needed to adequately assess the severity of these problems and the sources of contamination.

The protection of water quality in the estuaries, bays and near-shore ocean waters of this basin should be a statewide priority. The economy of this area is heavily dependent on good water quality, and as a result of legalized gambling in Atlantic City, these waters will face even greater demands placed on their use. Water quality management activities that are needed in this area consist mainly of eliminating the primary treatment plants still operating and replacing them with upgraded or regional facilities, and correcting sanitary sewer lines which are leaking sewage to waterways, or receive significant stormwater contributions. Areas with septic system problems need to be corrected with the proper wastewater treatment facilities. Finally, greater water quality monitoring activities should be performed in this basin. The lack of long-term and year-round monitoring stations prevents specific conclusions from being made.

SOUTHERN ATLANTIC COASTAL BASIN STATION LIST

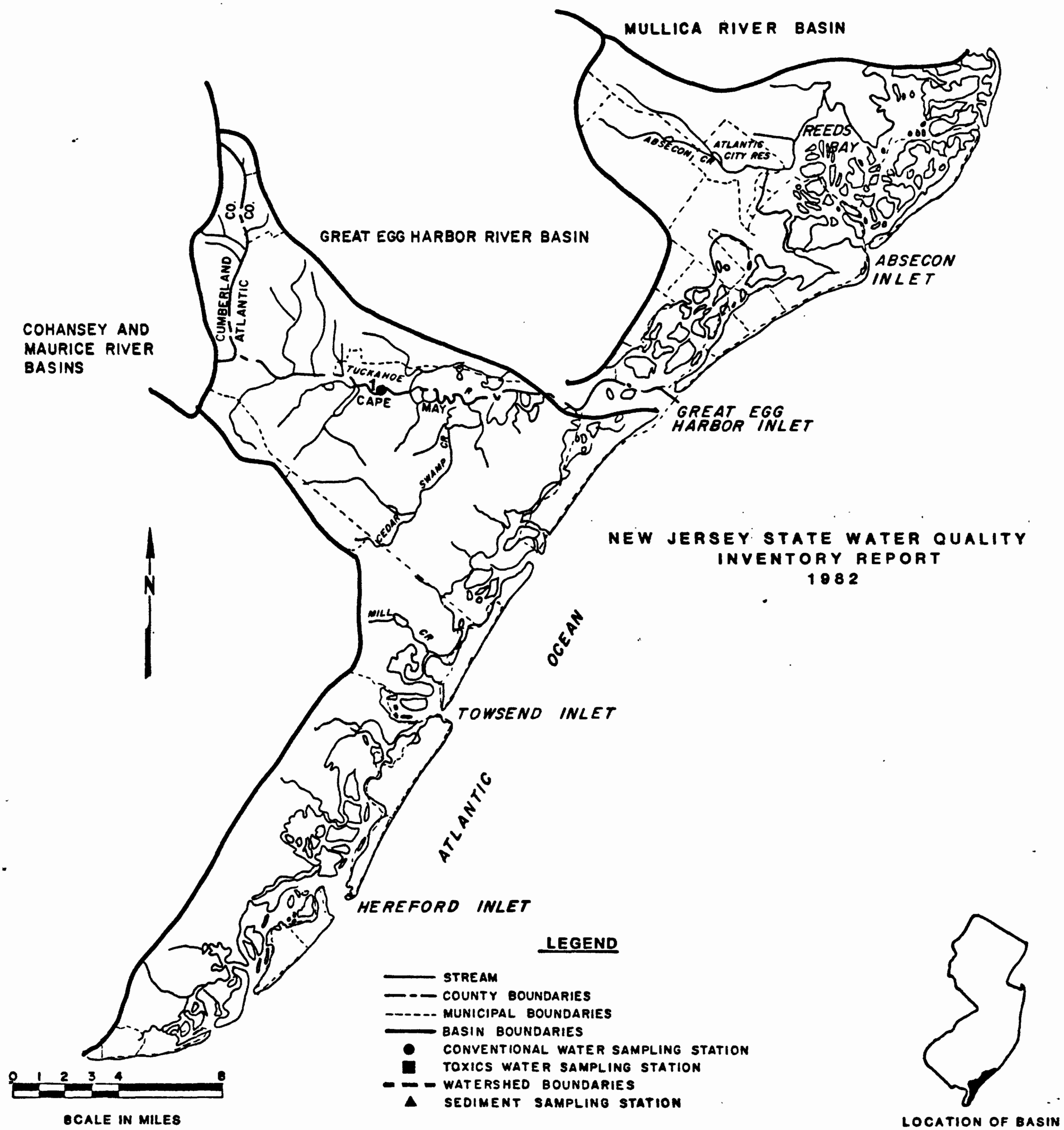
A. Ambient Monitoring Station

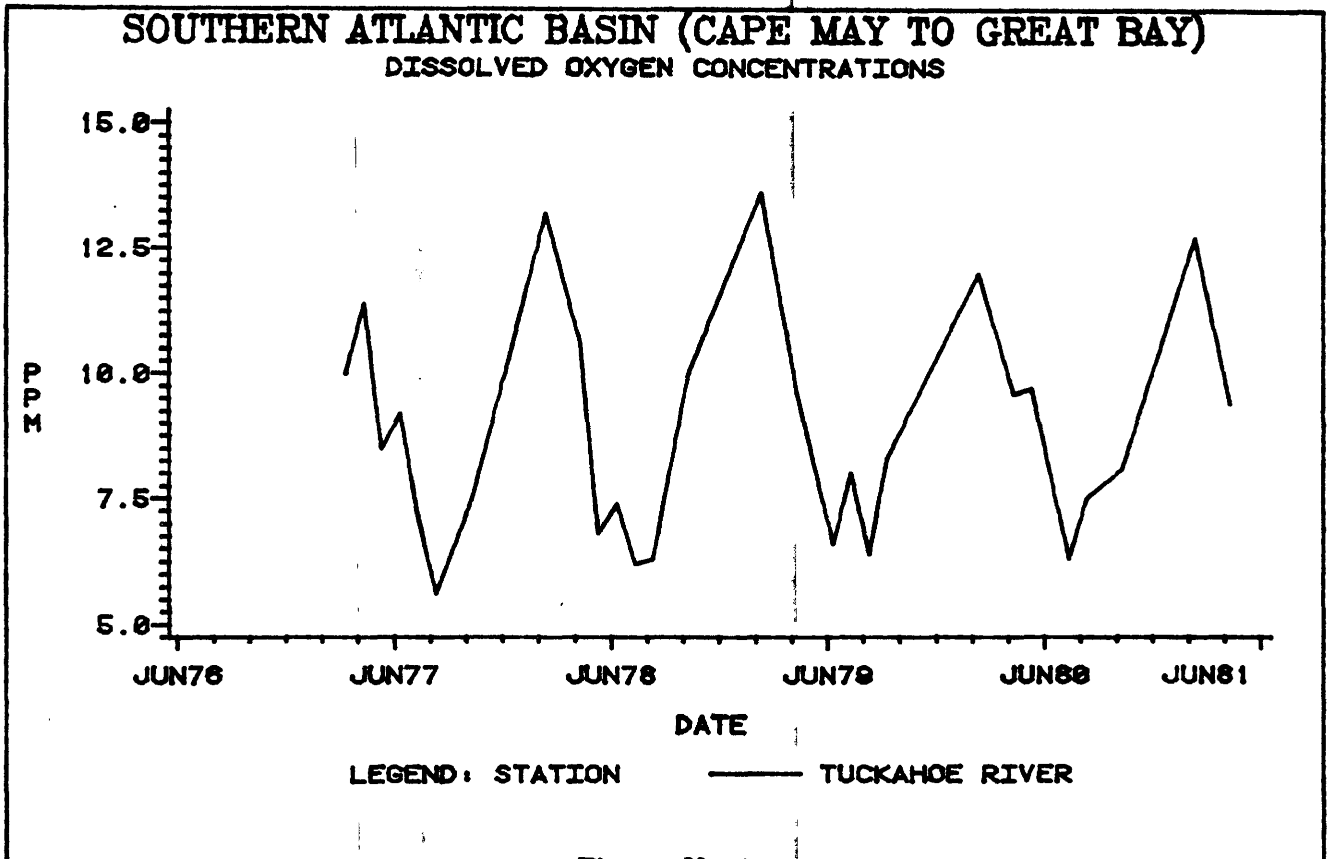
STORET Number	Station Description	Map Number
01411300	Tuckahoe River at Head of River, Cape May County Latitude 30°18'25" Longitude 74°49'15" FW-2 Nontrout USGS/DEP Network At Route 49 bridge, 3.7 miles west of Tuckahoe.	1

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Absecon Creek	Fish tissue	-
Nacote Creek	Fish tissue	-

SOUTHERN ATLANTIC COASTAL SEGMENT–GREAT BAY TO CAPE MAY POINT





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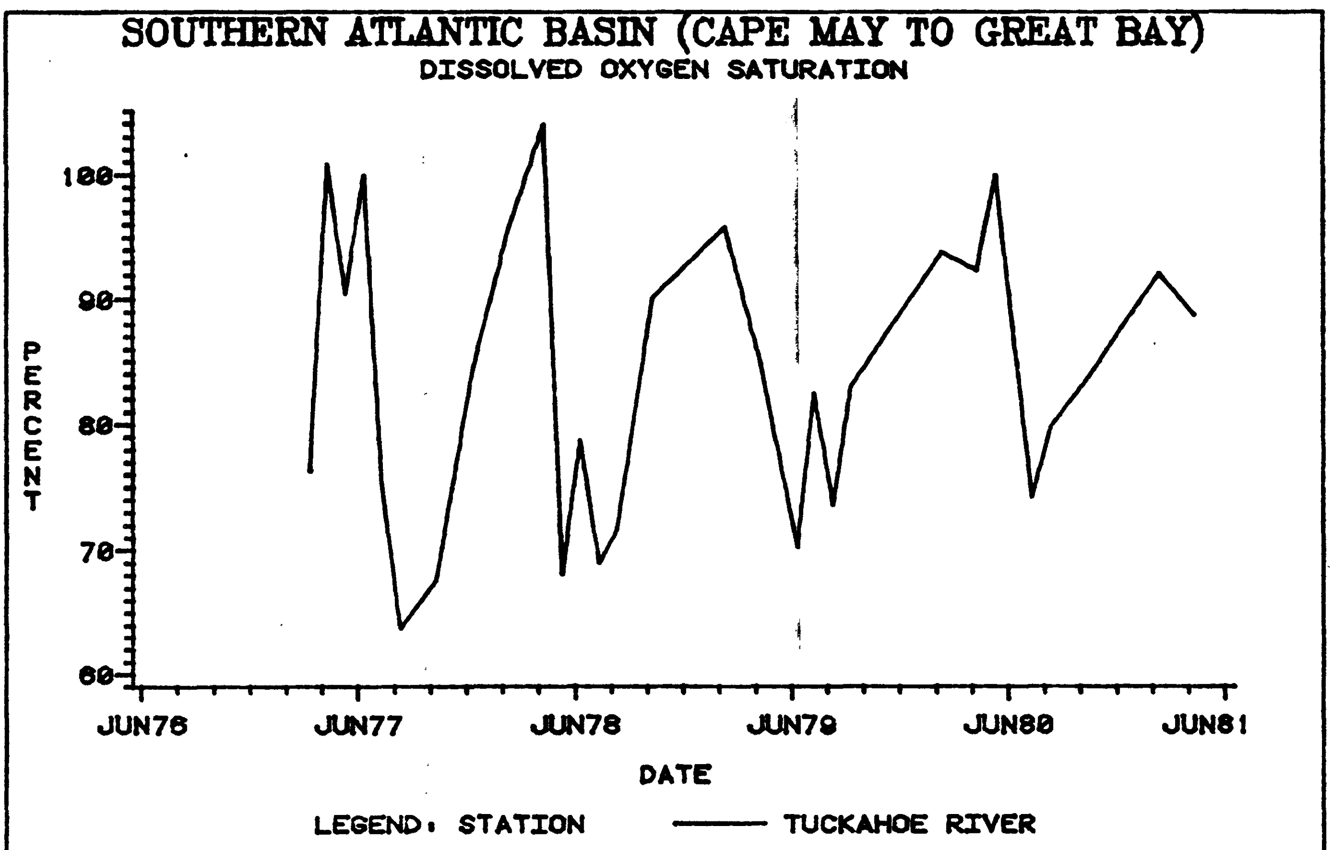

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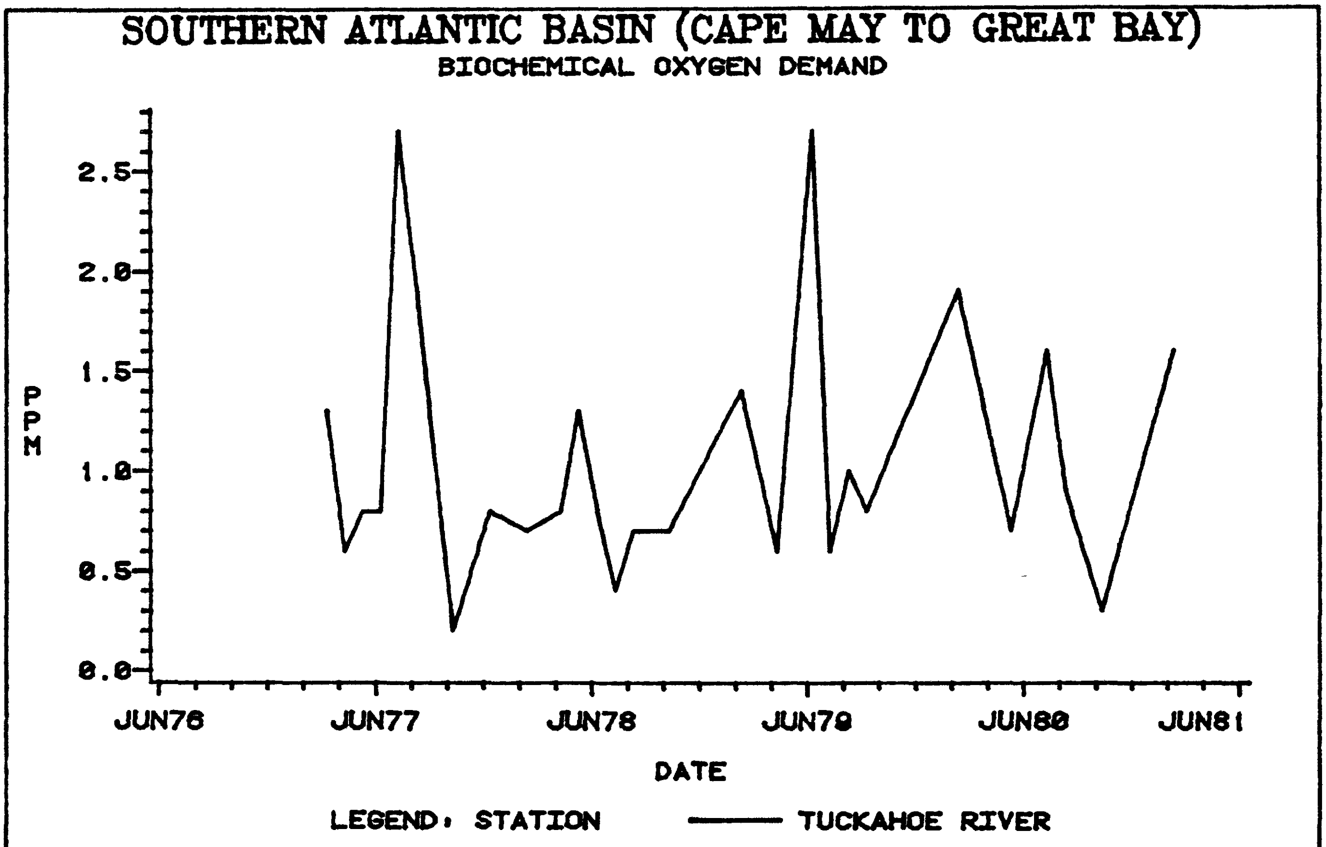

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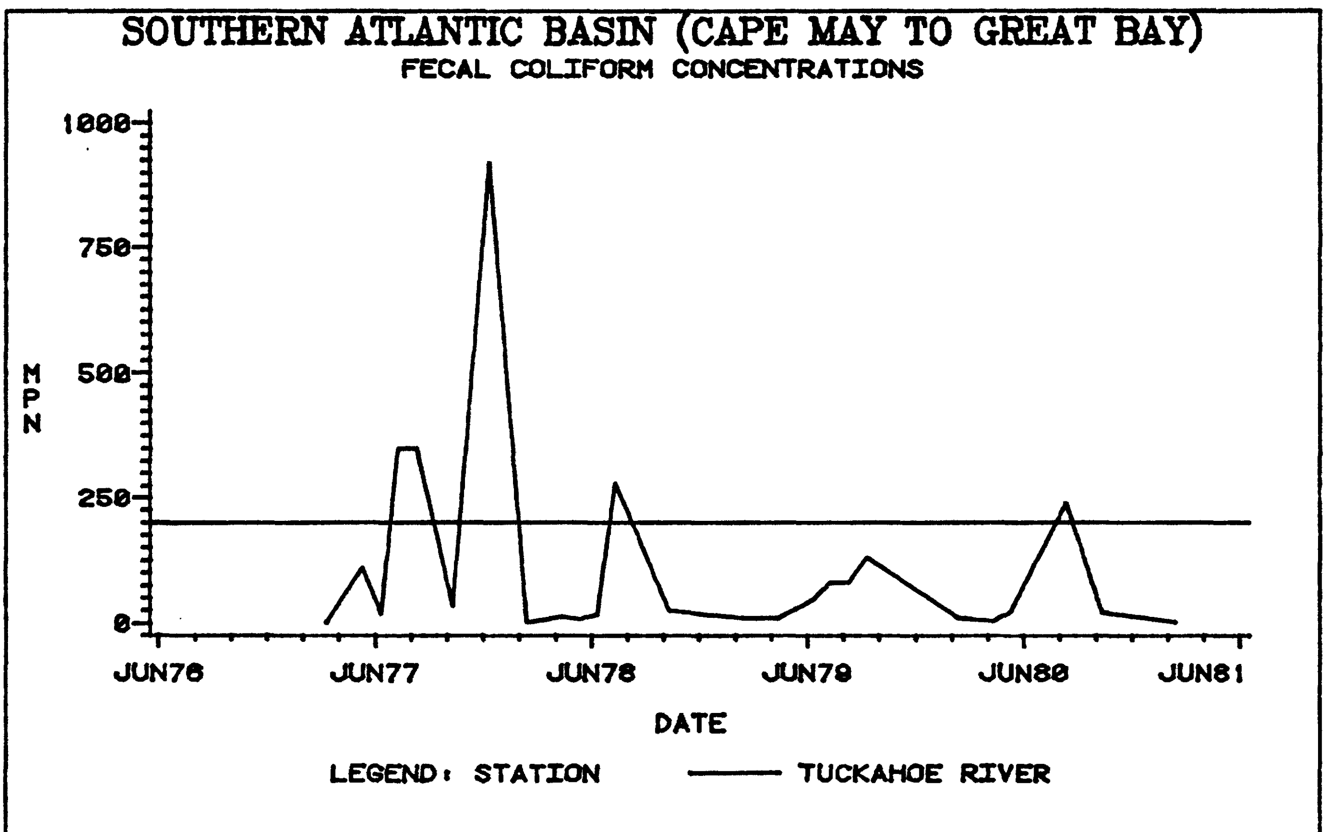

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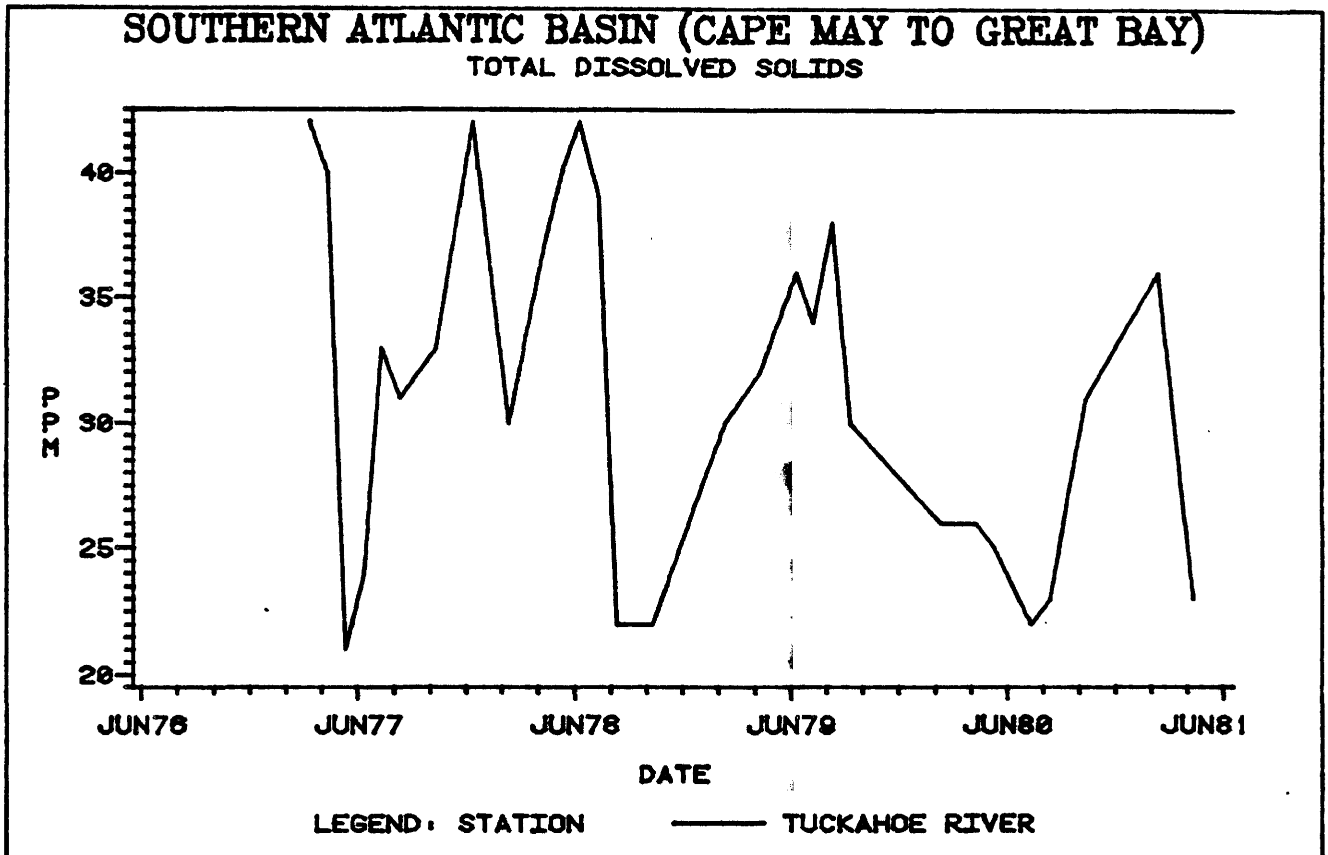

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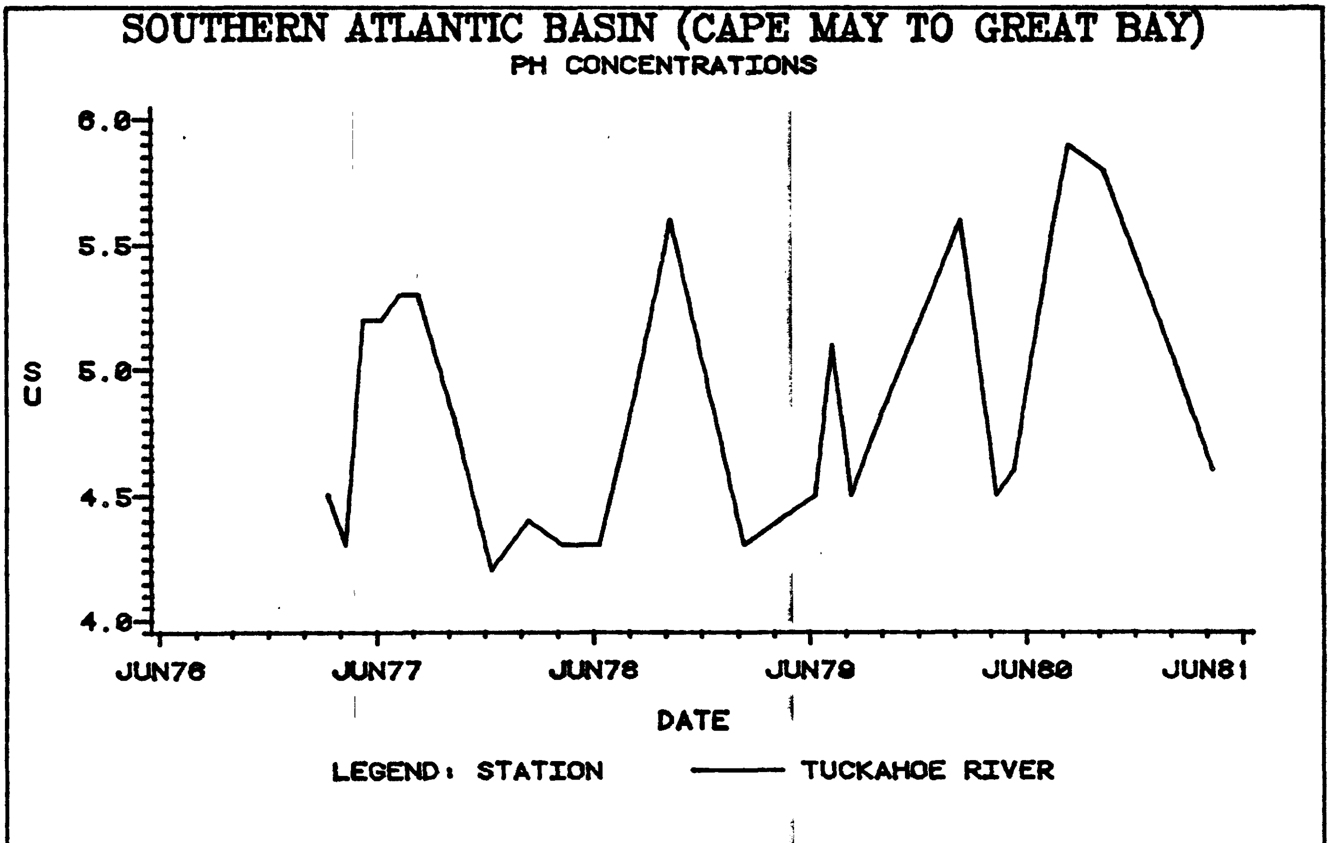


Figure: M -6

SOUTHERN ATLANTIC BASIN (CAPE MAY TO GREAT BAY)

TOTAL PHOSPHORUS CONCENTRATIONS

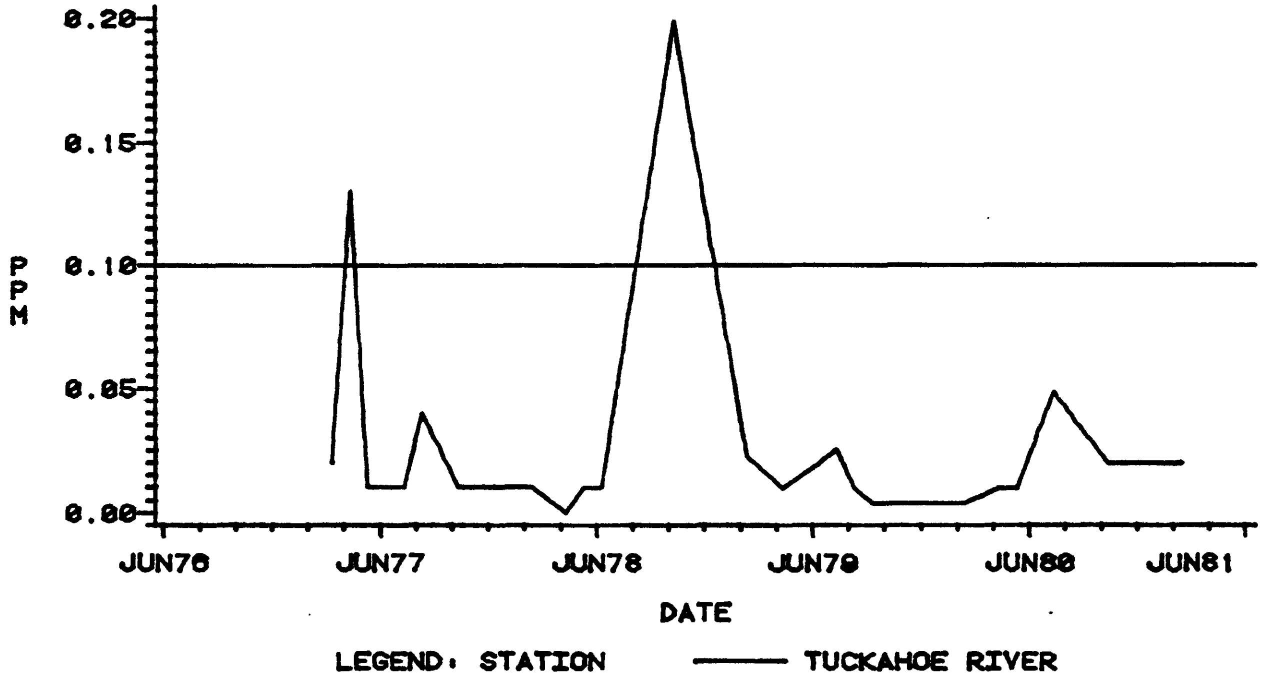
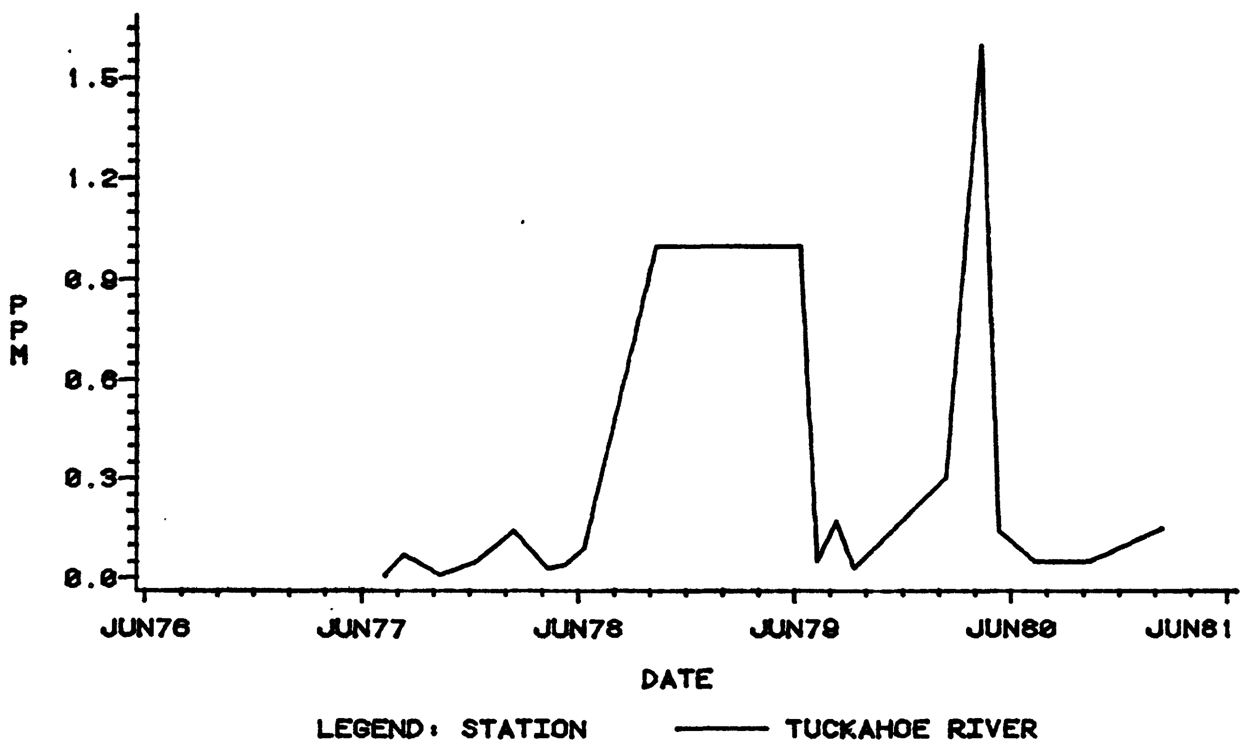


Figure: M -7

SOUTHERN ATLANTIC BASIN (CAPE MAY TO GREAT BAY)

NITRATE + NITRITE CONCENTRATIONS



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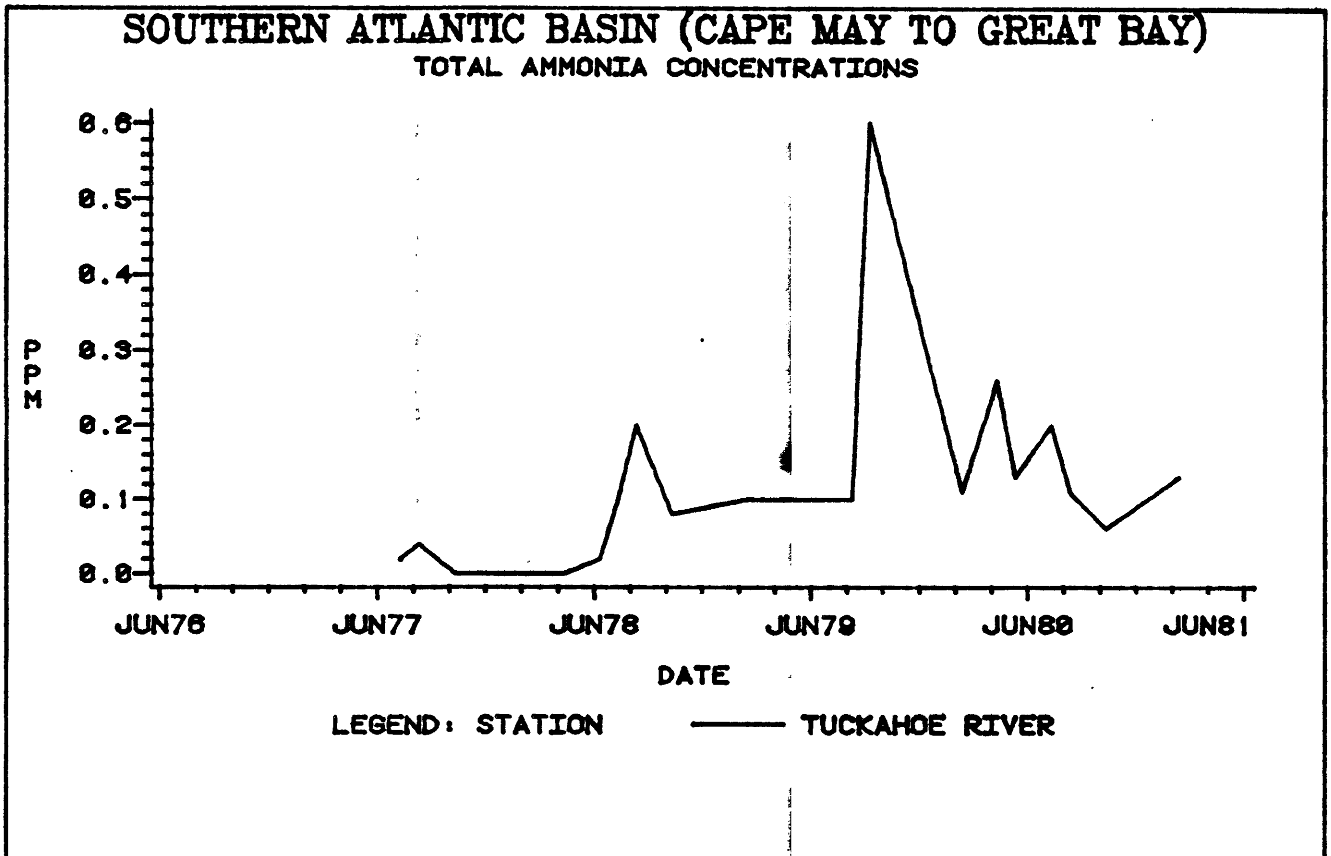

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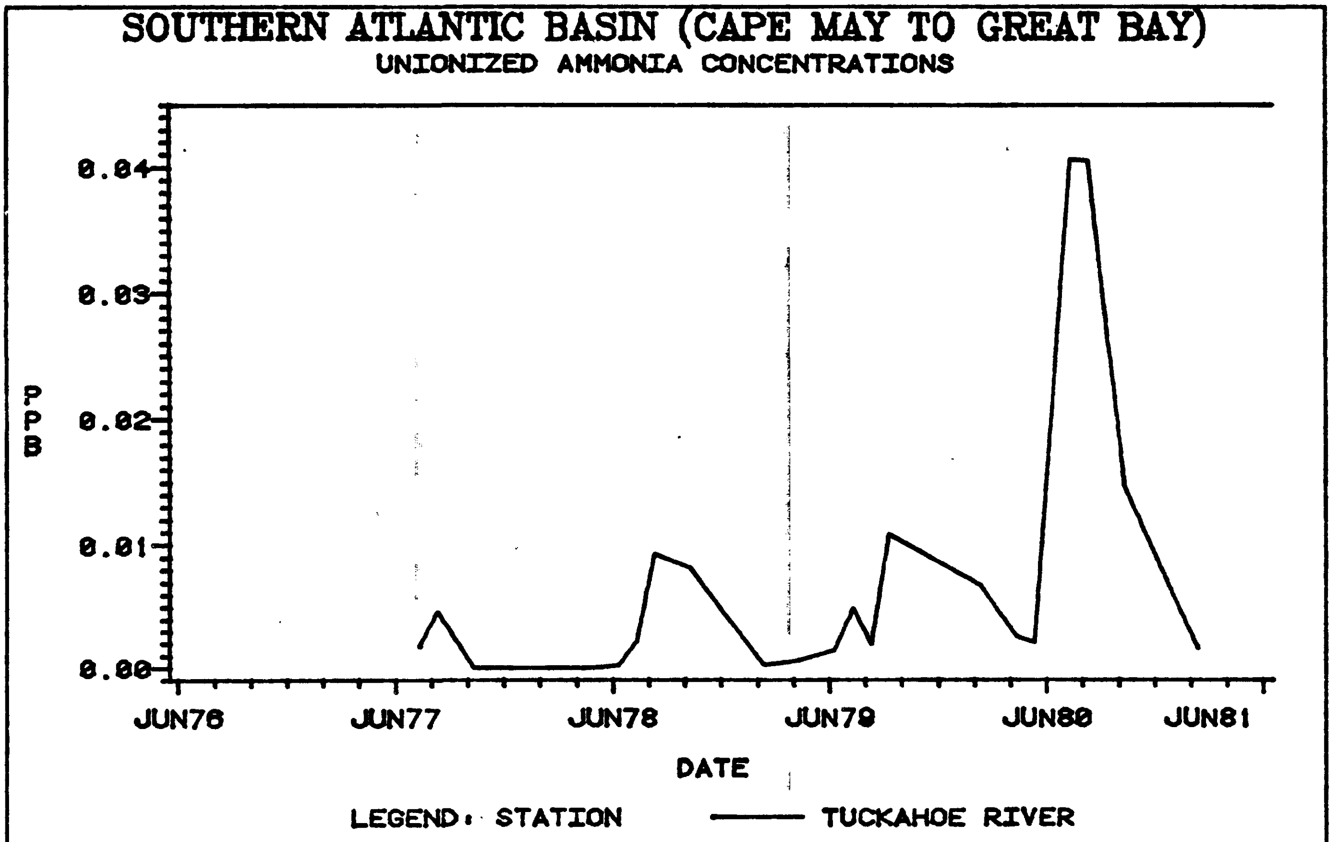


Figure: M -10

DISCHARGE INVENTORY - - - SOUTHERN ATLANTIC COASTAL SEGMENT-GREAT BAY TO CAPE MAY POINT

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
HILTON NEW JERSEY CORP	0035521	MORGATE	ABSECON INLET		.00
ATLANTIC COUNTY S.A.	0024473	ATLANTIC CITY	ATLANTIC OCEAN	SANITARY	19.50
CITY OF CAPE MAY	0033910	CAPE MAY	ATLANTIC OCEAN		
CAPE MAY COUNTY MUA	0035343	OCEAN CITY	ATLANTIC OCEAN		
BRIGANTINE EXPERIMENTAL LAB	0027588	BRIGANTINE CITY	BONITA TIDEWAY		.01
MIDDLE MOTOR COURT INC	0027499	MIDDLE TWP	BROOK BY GARDEN PKWY TO BEY	SANITARY	
CAPE MAY LEWES FERRY	0034304	CAPE MAY	CAPE MAY CANAL	PROCESS WASTE	.01
DELAWARE RIVER & BAY AUTH.	0029297	LOWER TWP	CAPE MAY CANAL	SANITARY	
TRANQUILITY PARK NORTH DEV.CO.	0035475	TOWNSHIP OF LOWER	CAPE MAY CANAL		
MILES PETROLEUM INC	0020125	ATLANTIC CITY	CLAM CREEK	RUNOFF OIL & GR	
BRIGANTINE HOMES ASSOCIATION	0033049	BRIGANTINE	CLAM CREEK		
CITY OF CAPE MAY	0033529	CAPE MAY	DEVILS REACH		
BOROUGH OF AVALON	0021385	AVALON BORO	FEEDER TO INGRAMS THRUFARE	SANITARY	1.24
BOROUGH OF STONE HARBOR	0026581	STONE HARBOR BORO	GREAT CHANNEL	SANITARY	.33
CITY OF NORTH WILDWOOD	0023515	NORTH WILDWOOD CITY	HEREFORD INLET	SANITARY	1.35
W R GROSSER SUBDIVISION	0033341	LONGBEACH TWP	LITTLE EGG HARBOR BAY		
NJ HIGHWAY AUTHORITY	0021121	DENNIS TWP	LUDLAMS BROOK	SANITARY	
N J HIGHWAY AUTH GARDEN STATE	0027189	GALLOWAY TWP	MATTILY RUN	SANITARY	.02
CITY OF WILDWOOD BD OF COMM.	0022811	WILDWOOD /CITY	POST CREEK ALSO K A SUNSET LAK	SANITARY	1.96
BOROUGH OF WILDWOOD CREST N J	0027171	WILDWOOD CREST BORO	RICHARDSON CHANNEL	SANITARY	1.01
CITY OF SEA ISLE CITY	0023680	SEA ISLE CITY	SCRAGGY CREEK	SANITARY	.58
BORDEN INC-SNOW FOOD PROD.	0004961	LOWER TWP	UPPER THOROFARE	SANITARY	.12
MIDDLE TOWNSHIP S.A.	0028037	MIDDLE TWP	CROOKED CREEK	SANITARY	.08
CAPE MAY CO BD. OF FREEHOLDERS	0026786	MIDDLE TWP.	HOLMES CREEK T W 1	SANITARY	.06
GARDEN LAKE CORP	0027197	MIDDLE TWP.	GRESSE CREEK	SANITARY	
SHAWCREST MOBILE HOME PARK	0024538	LOWER TWP	THREE REACH R.	SANITARY	.03
FEDERAL OIL CO. OF NJ	0026123	MIDDLE TWP	NOT KNOWN		

N. GREAT EGG HARBOR RIVER

Basin Description

The Great Egg Harbor River originates in the agricultural and suburban areas of eastern Gloucester and Camden Counties. Flows continue southeasterly through forest and agricultural areas, suburban, light industrial and commercial development, and tidal marshes in Atlantic County into Great Egg Harbor draining a total of 304 square miles. Major tributaries are Hospitality Branch, Deep Run, South River, Watering Race, Babcock Creek and Stephens Creek. The Great Egg Harbor River is tidal downstream of the dam at Mays Landing. This river drains much of the Pinelands area of New Jersey, a unique ecosystem based on acid waters and sandy, sterile soils.

In the Gloucester and Camden Counties portions of the watershed land use is classified as 67 percent forest, 22 percent agricultural and 11 percent developed. In Atlantic County land use is predominantly undeveloped forests and agriculture, although development is occurring. In the Great Egg Harbor River basin agriculture consists primarily of swine operations, with crop acreage devoted mainly to tomatoes, peppers and asparagus.

Population growth between 1970 and 1980 occurred throughout the basin, with Egg Harbor (95 percent increase) and Winslow Townships (80 percent increase) experiencing the greatest growth. The largest urban centers in the segment are Monroe, Winslow and Egg Harbor Townships, Mays Landing and Berlin. Eight municipal and 11 industrial point sources have been identified in the Great Egg Harbor River basin, with discharges ranging from .01 to 1.20 mgd. The largest of these is the Atlantic City Electric Co. which discharges a total of 1.20 mgd of processing and cooling water from three electric plants into the Great Egg Harbor. The majority of the basin is served by septic systems. Three waste-water treatment facilities are located in this segment. The Mays Landing Water Pollution Control Facility (0.625 mgd) is the largest, and is owned by the Hamilton Township MUA. It provides sewage treatment for Mays Landing, Harding Lakes, Cloverleaf Lakes and Belconville in Weymouth Township. Potable water supplies in the Great Egg Harbor River basin are derived primarily from ground water sources.

Twenty-five major lakes are located in the Great Egg Harbor River basin, with all but New Brooklyn Lake, in Camden County, privately owned. The largest, Pancoost Mill Pond (50 acres) in Buena Vista, is primarily used for angling (particularly for catfish and pickerel). This lake has been classified as eutrophic by the New Jersey Department of Environmental Protection. Cedar Lake and Stephens Lake are also used primarily for shore fishing. Many of the remaining lakes in the basin allow bathing and boating activities.

100 percent of the shellfish harvesting areas in the Great Egg Harbor River basin are "condemned" for direct harvest and marketing. A limited hard clam and oyster resource exists in this coastal zone.

The New Jersey Division of Fish, Game and Wildlife owns and operates the Winslow Wildlife Management Area (WMA) located in Camden and Gloucester Counties. This tract of approximately 5940 acres contains two ponds which offer excellent fishing for large-mouth bass and bluegill. Limited waterfowl hunting is available for wood duck, black duck and mallard. The Lester G. MacNamaro WMA is partially located in this basin and offers a diversity of water-based activities, including fresh and saltwater fishing, boating and waterfowl hunting. Virtually the entire Great Egg Harbor River basin falls within the Pinelands National Reserve, which provides for the preservation, protection and enhancement of the Pinelands environment.

New Jersey Water Quality Standards give the Great Egg River basin the following water quality classifications: streams within the Winslow and Lester G. MacNamara WMAs are FW-1; tidal waters downstream from the head of tide to surf waters are TW-1; all remaining waters of the basin are FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

In addition to routine monitoring data collected at Sicklerville and Weymouth, data generated by intensive surveys in the headwaters, estuary, and in New Brooklyn Lake have been used in assessing the water quality in the Great Egg Harbor River.

Occasionally insufficient dissolved oxygen levels, moderate biochemical oxygen demand, and elevated total phosphorus, nitrate + nitrite and fecal coliform levels illustrate the generally marginal conditions in the segment of the Great Egg Harbor River above New Brooklyn Lake. Downstream below the lake, water quality conditions improve as dissolved oxygen levels increase and nutrient and five-day biochemical oxygen demand levels decline. Conditions again deteriorate in the tidal segment below Mays Landing. Ground water is a major contributor to surface flows in the Great Egg Harbor River, and therefore, complicates efforts to make water quality assessments.

The Sicklerville station, located approximately 2.0 miles upstream of New Brooklyn Lake, exhibited declining daytime dissolved oxygen concentrations and saturation levels over the period. The seasonally low D.O. levels during the latter half of the period were accompanied by a somewhat elevated biochemical oxygen demand. Dissolved oxygen concentrations were above standards and BOD_5 levels were generally below 2 mg/l throughout the period at Weymouth, but again deteriorated below Mays Landing in the tidal segment.

Fecal coliform concentrations generally declined moving downstream from the headwaters to Weymouth. The levels at Sicklerville occasionally exceeded the 200 MPN/100 ml, with one extreme value (1700 MPN/100 ml) being recorded in 1979. No trends over the period were apparent at either Sicklerville or Weymouth.

Total dissolved solids concentrations were also higher at Sicklerville than at Weymouth, but were well below the 500 mg/l criterion. Elevated TDS values below Mays Landing were primarily due to tidal influence. A slight decline in pH between Sicklerville and Weymouth was apparent. Conversely, pH appeared to increase over time at Sicklerville with near neutral values being recorded in 1980-81.

Nutrient levels were uniformly excessive in the upstream segment. Nearly all total phosphorus values at Sicklerville were in excess of the standard, with concentrations over 1.0 mg/l being measured in 1980-81. The Weymouth station, on the other hand, exhibited levels generally within the criterion over the period. This was probably due to assimilation of a large portion of the phosphorus in the New Brooklyn Lake area. A general increase in nitrate + nitrite levels was also seen at Sicklerville. Total ammonia levels, although generally higher at Sicklerville, were below 1.0 mg/l at both stations. A slight increase in un-ionized ammonia levels was also noted at Sicklerville although levels remained well below the criterion.

The biological data acquired during 1976 reflected the poor water quality conditions in the segment upstream from New Brooklyn Lake. The macroinvertebrate community in the headwaters near Berlin was representative of a population typical of slow moving water and subject to moderate quantities of organic pollutants. The Berlin Borough sewage treatment plant, however, had a devastating effect on the macroinvertebrate community in the immediate area of its discharge. Recovery of the community was observed at the Sicklerville station, approximately five miles downstream of the sewage treatment plant discharge. The presence or organic, oxygen demanding pollutants was again suggested from the biological data collected further downstream at Blue Anchor. Community diversity was quite low, with 92 percent of the population being comprised of the generally more pollutant tolerant midges. The macroinvertebrate community recovered at Weymouth, indicating a return to low nutrient and acidic waters. This was reflected in the low total number or organisms recovered and the presence of pollution-intolerant stoneflies.

Generally, current water quality in the Great Egg Harbor River is similar to conditions reported in prior editions of the State

305(b) report. No significant improvements nor degradation of quality have been identified.

Toxic Parameters

The Great Egg Harbor River near Sicklerville was found to be free of toxic contamination during the three years of our study. This was also true of the river further downstream in Atlantic County near River Road. Further sampling is planned to assess the impacts of the power plant at Beesleys Point on Great Egg Harbor Bay.

Concentrations of PCB Arochlor 1254 in fish tissue samples collected near Beesleys Point varied from nondetectable to trace levels, with a single sample elevated above the existing action level. This sample of American eel, Anguillia rostrata, also displayed elevated DDE and trace DDD, DDT levels.

Heavy metal concentrations in various aquatic organisms taken from this location and at Powells Creek produced trace levels of mercury and arsenic. Low levels of zinc and copper were also noted.

Occasional incidences of cadmium and nickel were found in several resident species including blue claw crabs, Callinictes sapidus.

Because this watershed is located within a relatively pristine region, and an isolated fossil fuel power plant is the only industrial point source, further sampling will be conducted. This is may provide information on point source contamination in relationship to bioaccumulation by aquatic organisms.

Problem Assessment

In the Water Quality Assessment section above, the Great Egg Harbor River has marginal water quality in the upper watershed (headwaters to New Brooklyn Lake); but the river improves to good quality downstream of the lake. Parameters of concern in the upper watershed include low dissolved oxygen, and excessive oxygen demanding substances, nutrients, increased pH and fecal coliform bacteria. In the tidal reaches of the watershed, water quality again worsens as reflected in the closure of the river to shellfish harvesting because of elevated bacteria levels.

The headwaters of the Great Egg Harbor River receive point and non-point source loading which results in severely degraded water quality. The Berlin Borough treatment plant discharges to the very upper reaches of the river, and although the plant meets its NJPDES permit limitations, the stream cannot assimilate the organic loading. The low buffering capacity of surface waters in the Pinelands area makes organic pollutant assimilation difficult. The streams in this region are all sensitive to changes in pH, because the natural waters and aquatic communities represent low pH conditions. Septic systems, suburban runoff and agricultural runoff are thought to assist in the degradation of the upper Great Egg Harbor River. An intensive survey on New Brooklyn Lake in 1979 by the Lakes Management Program showed the lake to be eutrophic. Sources of nutrients and sediment were the Berlin Borough STP (nutrients), and residential and agricultural runoff (nutrients and sediment).

The improvement in water quality below New Brooklyn Lake can be mainly attributed to the lake's ability to trap nutrients and act as a "sink". However, residential and commercial development is occurring downstream of the lake along the river and its tributaries in Winslow Township. This area was the subject of a study by the U.S. Geological Survey on the effects of suburbanization on water resources in the region. With regard to water quality, the greatest impacts were from Winslow Township's treatment plant which recharges its wastewaters to the ground. Their study found increased nutrients and phosphorus in Fourmile Branch (Great Egg Harbor River tributary) below the recharge site. Water quality impacts to the Great Egg Harbor River were only "slight".

Below New Brooklyn Lake on-site disposal systems are known to be a problem in Franklin and Monroe Townships in Gloucester County; and Folsom Borough, Buena Vista Township, Hamilton Township and Egg Harbor Township in Atlantic County. However, water quality improves in the river down to Mays Landing because of the rural, undeveloped nature of the watershed in Atlantic County. The Hamilton Township MUA treatment plant discharges approximately .60 mgd to Babcock Creek and occasionally it does not meet NJPDES assigned BOD and suspended solids removal rates. This problem may contribute to the reduced water quality in the tidal river below Mays Landing.

The Pinelands Commission has reviewed water quality in the Great Egg Harbor River watershed, (N.J. Pinelands Commission Technical Memorandum S.W. IV-1). This study noted that waters of the river below Mays Landing are in a "natural condition" due to its predominantly undeveloped state. Domestic sewage systems, an industrial discharge and three landfills were noted as potential pollution sources. These sources and the Hamilton Township plant are the likely reasons why the shellfish waters are "condemned" for harvesting.

Goal Assessment and Recommendations

The Great Egg Harbor River at the two ambient monitoring stations (Sicklerville and Weymouth) reviewed are not of swimmable quality. However, swimmable quality likely exists in the tributaries originating and flowing through undeveloped or abandoned forest lands. The waters of the Great Egg Harbor River are thought to contain, for the most part, balanced fish communities indicative of the Pinelands region. The nineteen fish species identified favor slow moving coastal plain streams and swamps, and are generally tolerant of acidic waters. The tidal estuarine waters of this river contain shellfish and both forage and sport finfishes. The estuaries are nursery grounds for many of these finfishes. The organic pollution present in the upper watershed has caused increases in stream pH, in addition to reduced dissolved oxygen. Because the water is naturally acidic, changes in pH reflecting reduced acidity has profound impacts on the aquatic animal and plant life in these streams. Protecting this low pH is essential for maintaining indigenous communities.

The upper watershed is in greatest need of improvement. Advanced treatment and removal rates, or alternative wastewater disposal practices are suggested for the Berlin Borough treatment plant. A needs assessment for wastewater disposal in Berlin Township is currently being conducted, with the results of that survey determining what changes will be made to the Borough treatment plant and the Winslow Township ground recharge facility. Whatever alternative is decided upon for effective wastewater treatment and disposal, concern for preserving the low pH in these headwater streams is essential, if natural aquatic communities are to be maintained. The impacts of suburban runoff will also be of increasing interest as development in eastern Camden County continues.

In New Brooklyn Lake, the intensive survey recommended that dredging would likely be necessary to improve recreational potential. Reduction in nutrient loadings through removal or improvement of the Berlin Borough STP, along with non-point source controls is also needed.

Water quality in the lower Great Egg Harbor watershed should show improvement with regional sewage treatment, and elimination of the existing Hamilton Township treatment plant. This can be accomplished by transferring wastewater flows to the Atlantic County Coastal STP which is currently operating under capacity.

GREAT EGG HARBOR RIVER STATION LIST

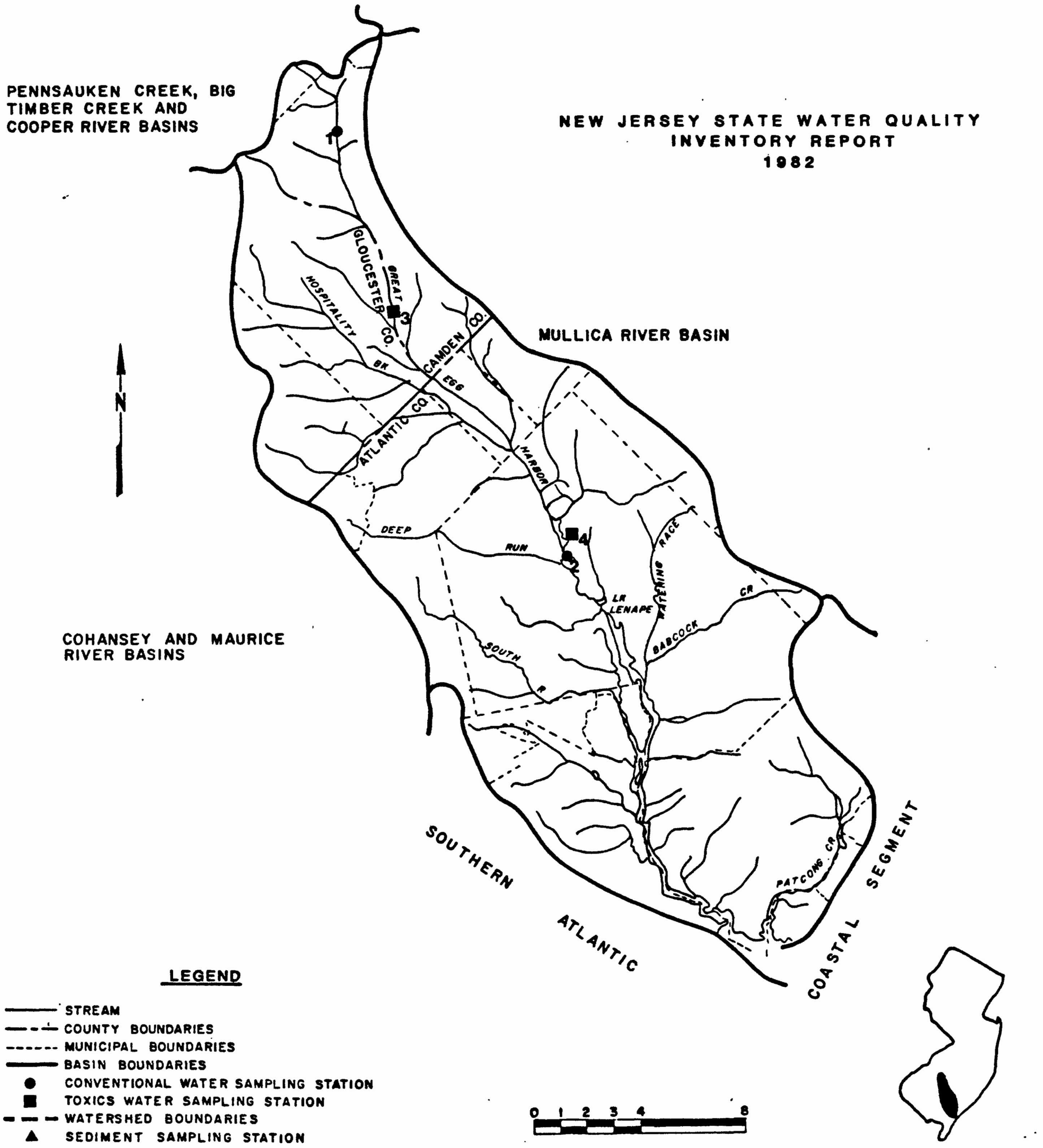
A. Ambient Monitoring Stations

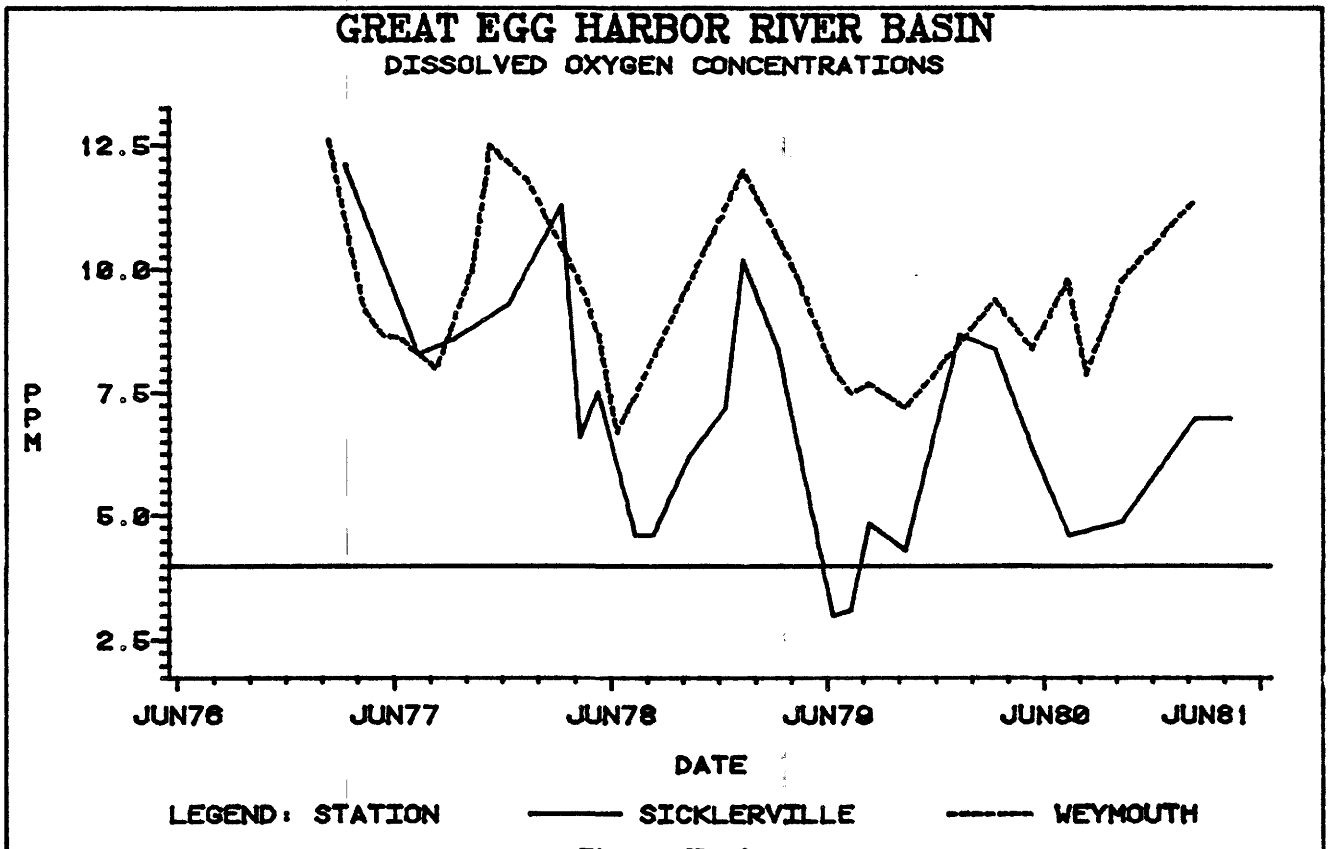
STORET Number	Station Description	Map Number
01410784	Great Egg Harbor River at Sicklerville, Camden County Latitude 39°44'02" Longitude 74°57'05" FW-2 Nontrout USGS/DEP Network Intensive Survey, 1981	1
01411110	Great Egg Harbor River at Weymouth, Atlantic County Latitude 39°30'50" Longitude 74°36'47" FW2 Nontrout USGS/DEP Network At bridge on U.S. Route 322, 0.5 miles upstream from Deep Run and 20.9 miles upstream from mouth.	2

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Great Egg Harbor River at Sicklerville	Water Column	3
Great Egg Harbor River at River Road, Atlantic County	Water Column	4

GREAT EGG HARBOR RIVER BASIN





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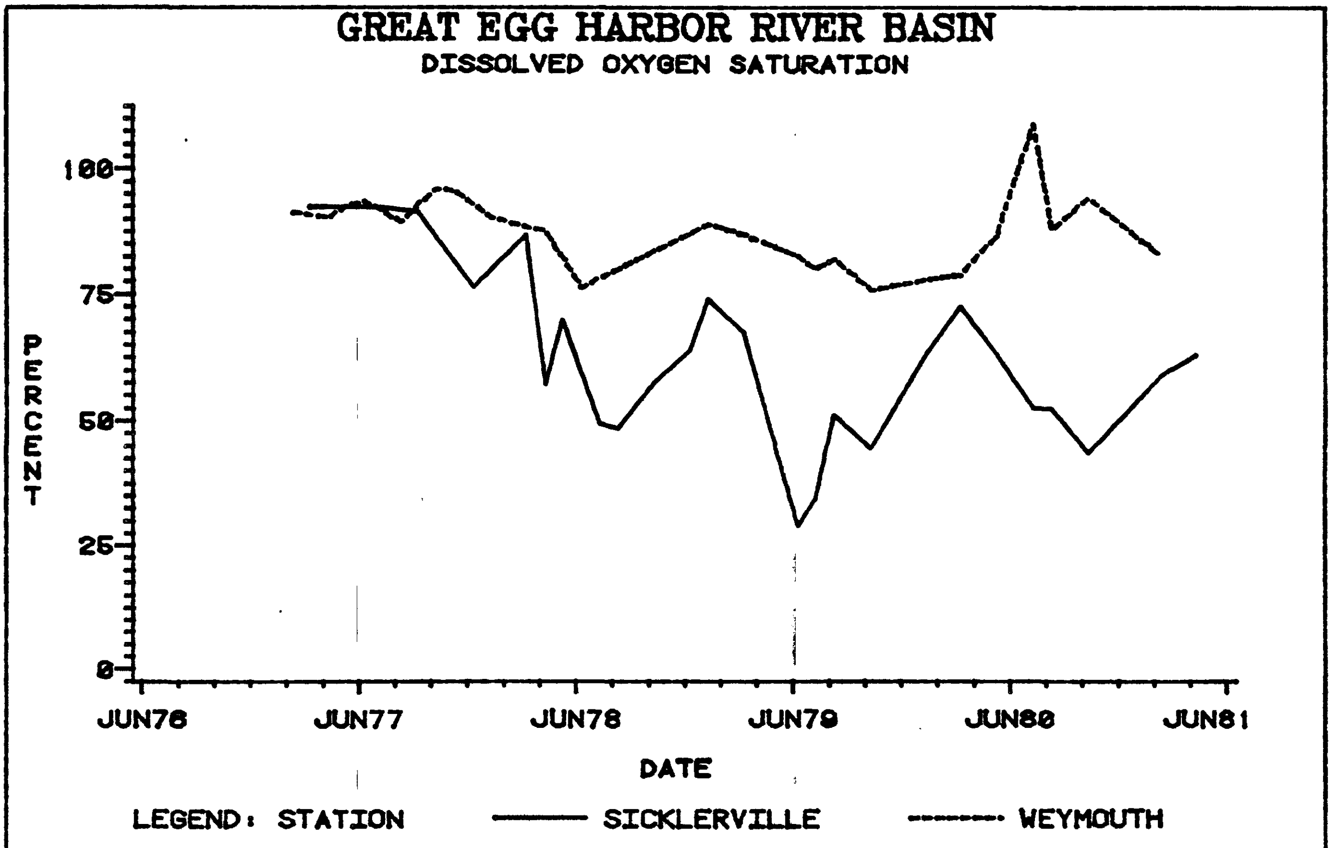

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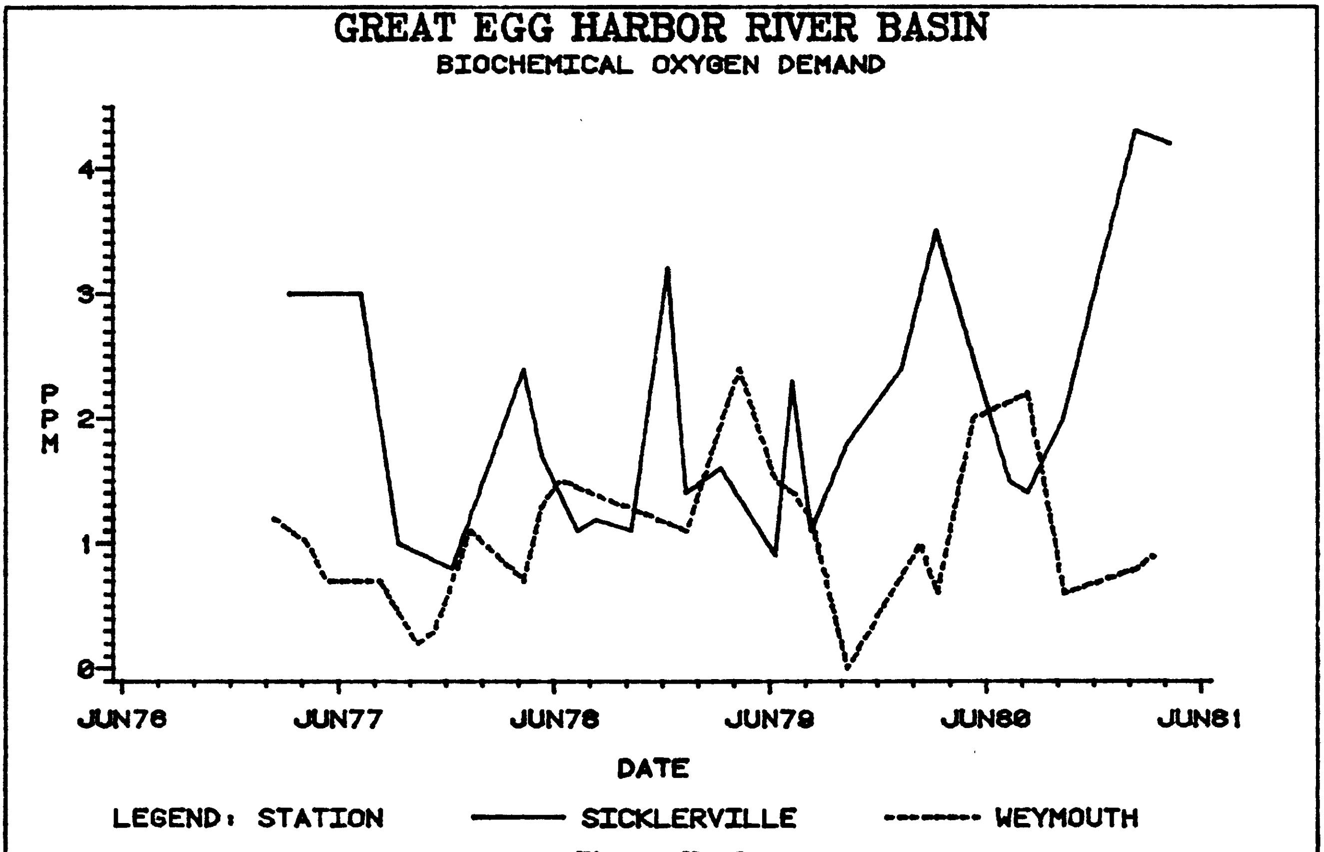

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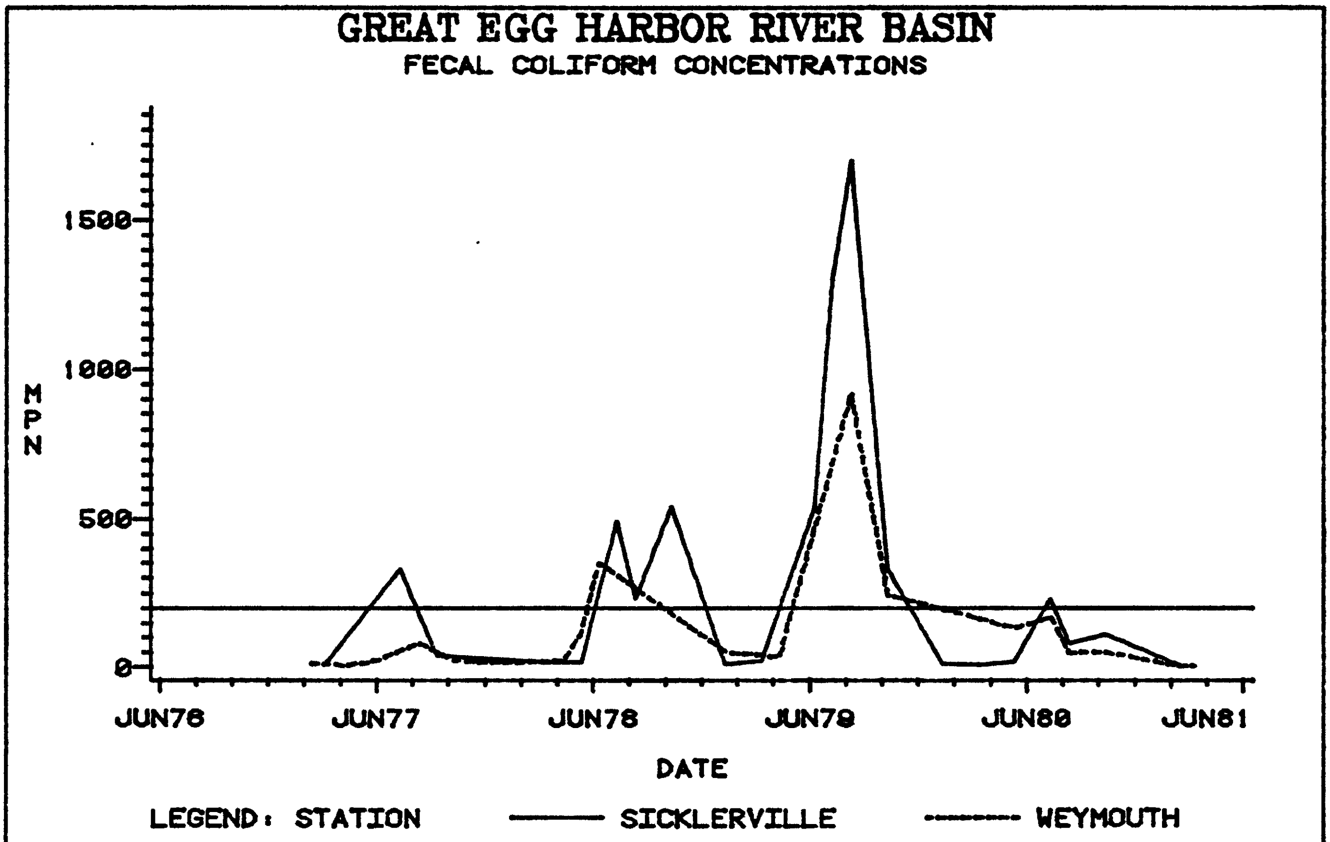

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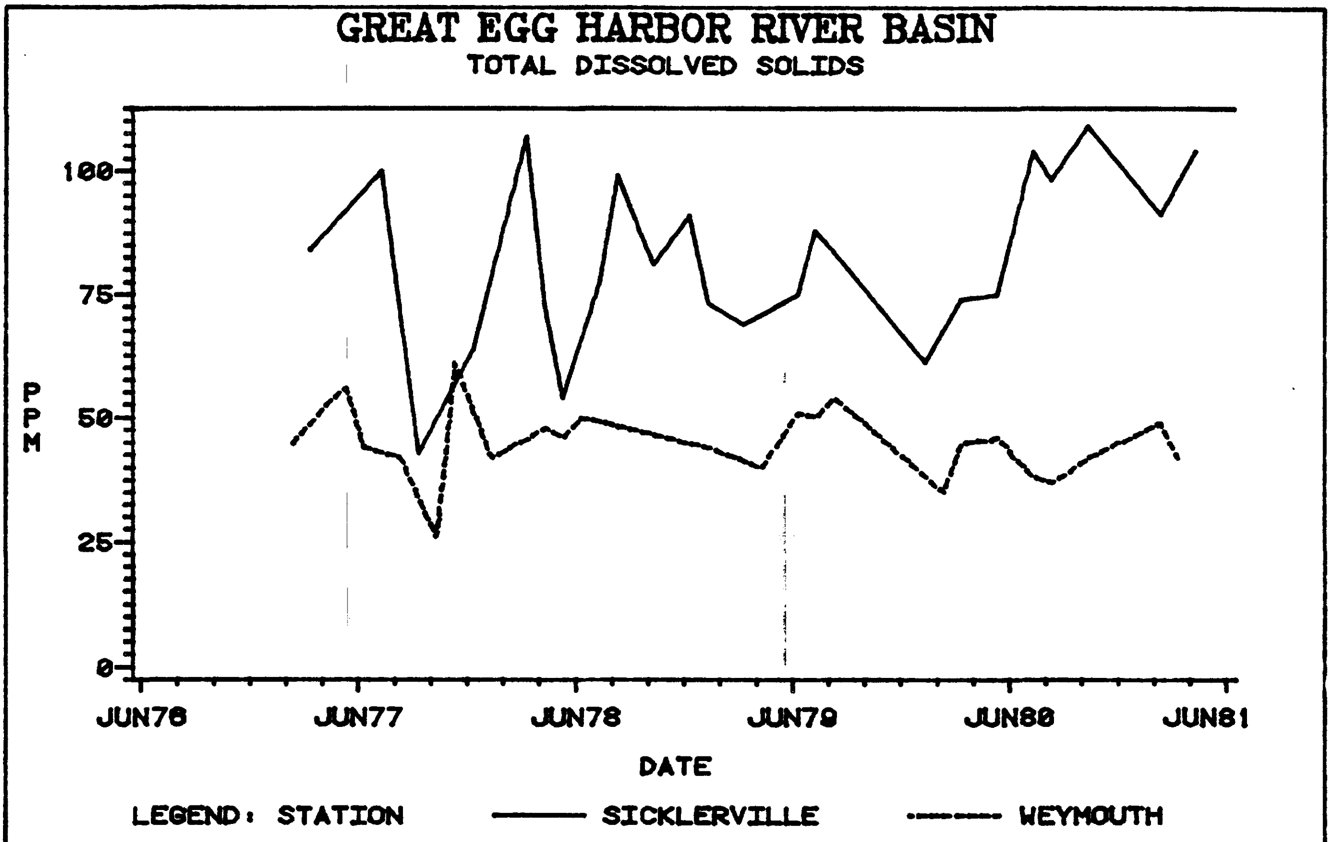

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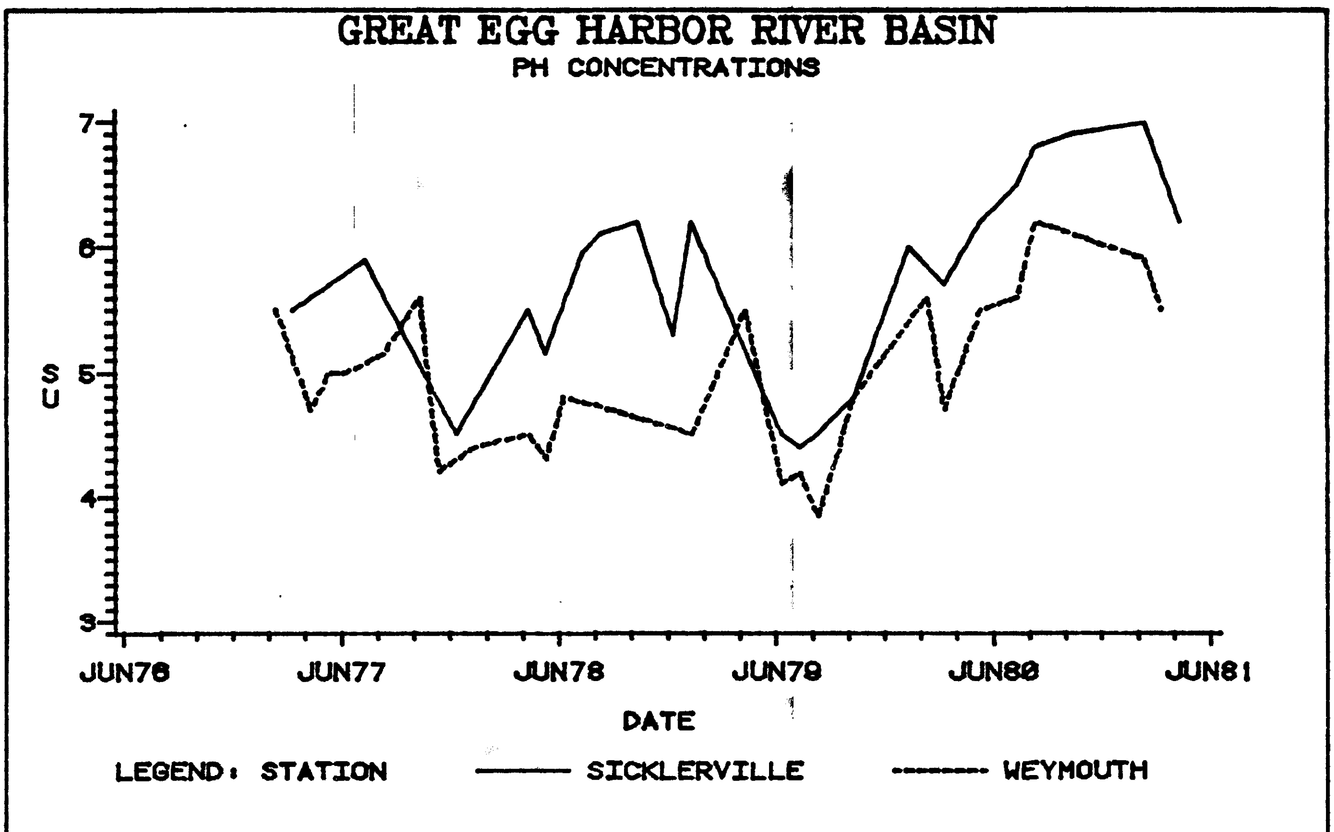

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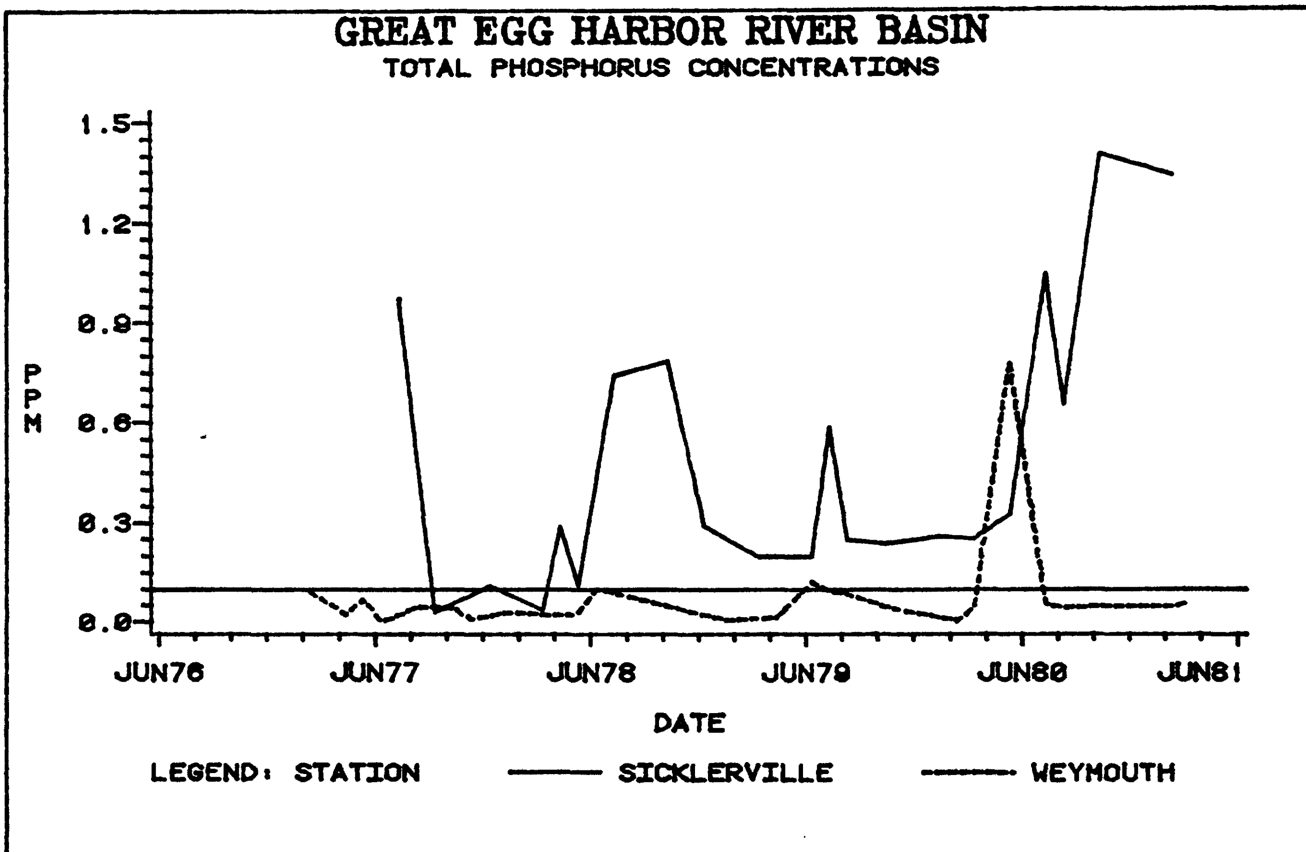

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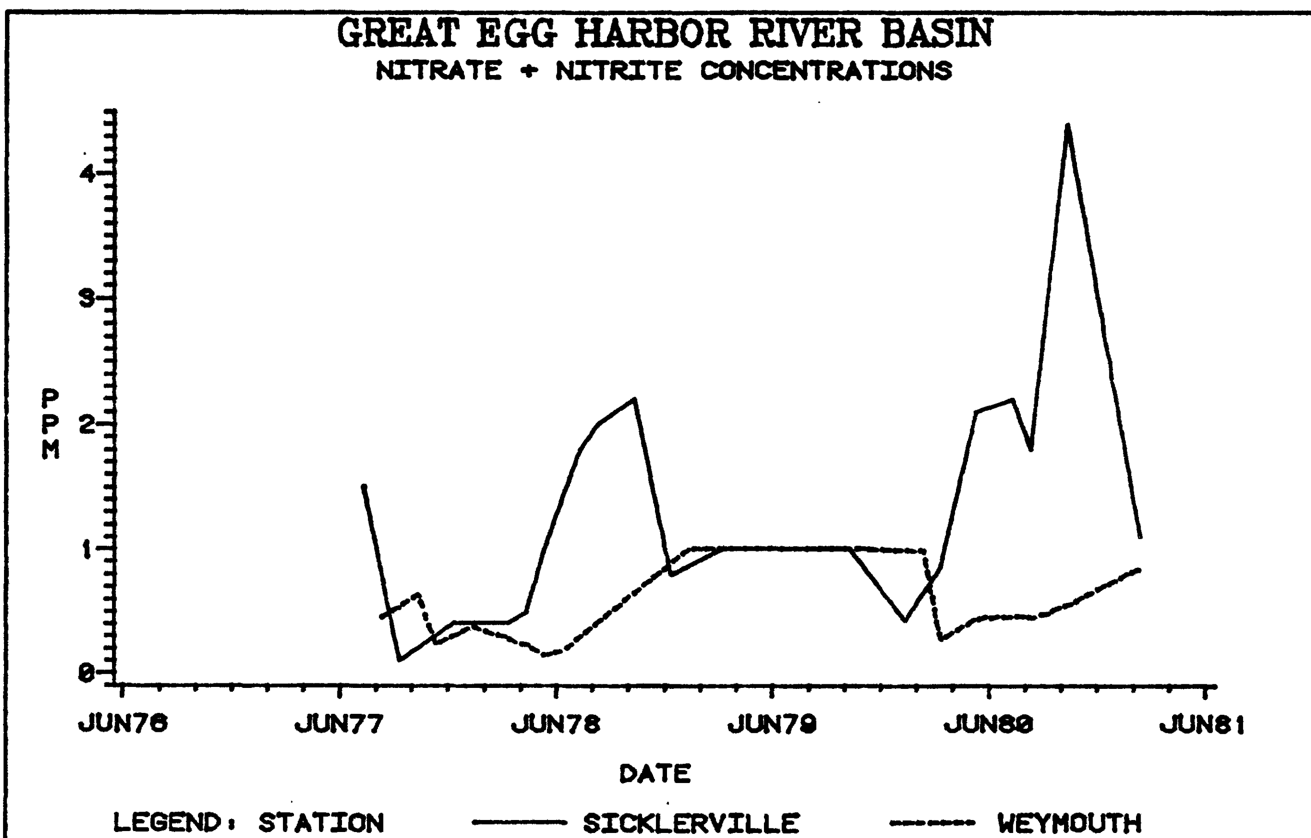

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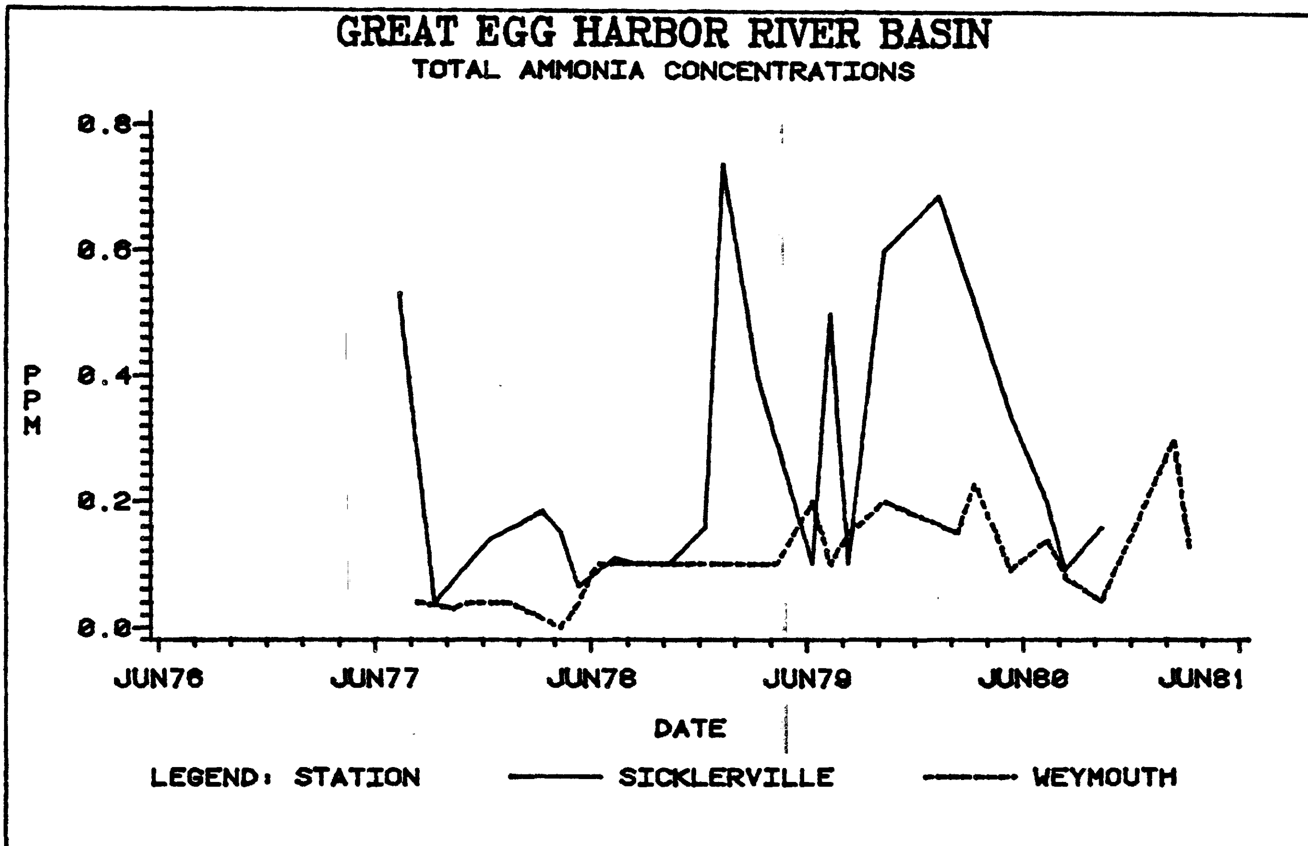

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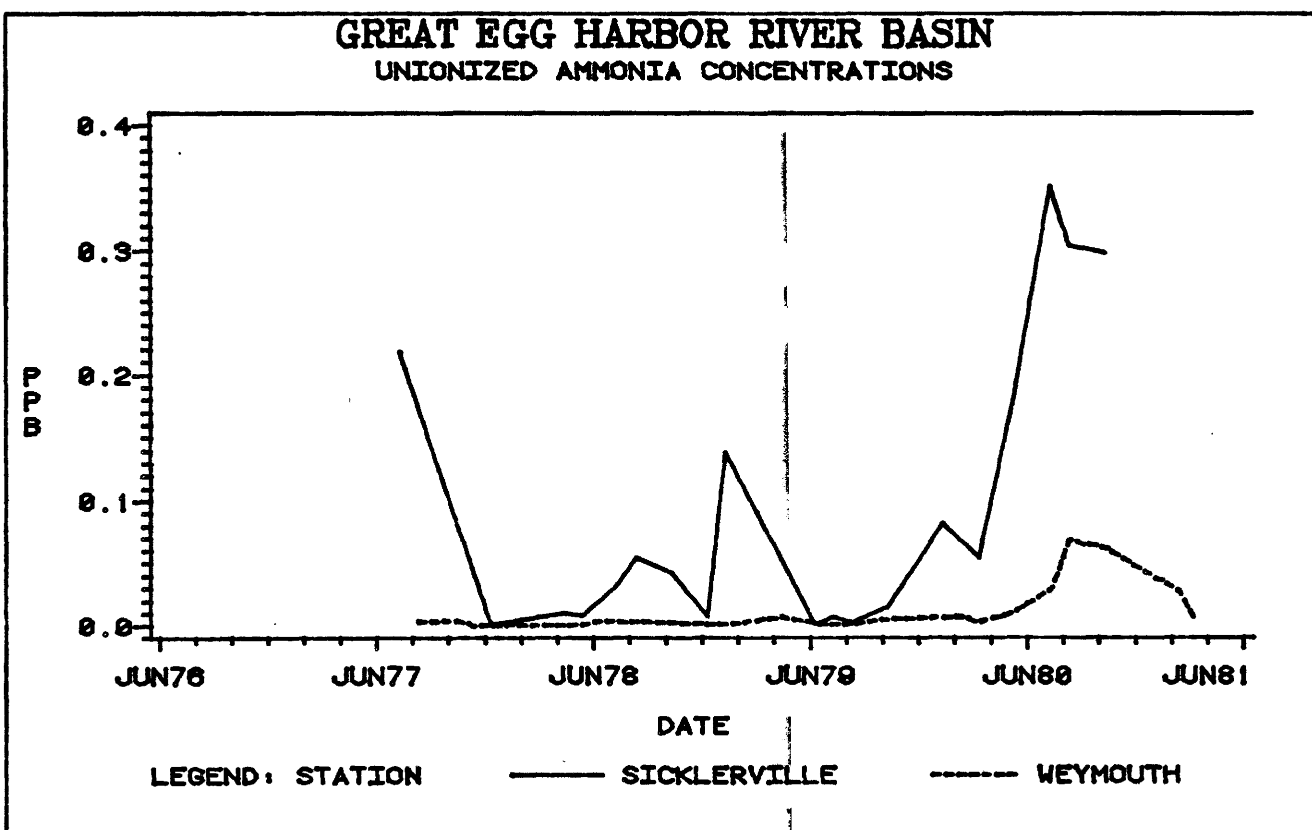


Figure: N -10

DISCHARGE INVENTORY - - - GREAT EGG HARBOR RIVER BASIN

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
ATLANTIC CITY RACING ASSOC.	0021211	HAMILTON TWP.	BABCOCK CREEK	SANITARY	
HAMILTON TWP MUA	0021393	HAMILTON TWP.	BABCOCK STR.	SANITARY	.56
EASTERN BREWING CORPORATION	0028223	HAMMONTON TOWN	CEDAR BRANCH STREAM	COOLING WATER	
BOARD OF ED-CNTY OF CAMDEN	0031615	SICKLERVILLE	EGG HARBOR		
GLOUCESTER TOWNSHIP MUA	0026492	GLOUCESTER TWP	GRAVELY RUN	SANITARY	.11
FAA TECHNICAL CENTER	0020800	EGG HARBOR TWP	GRAVELLY RUN BRANCH OF GREAT E	SANITARY	.16
ATLANTIC CITY ELEC.	0005444	UPPER TWP.	GREAT EGG HARBO	PROCESS WASTE	.21
ATLANTIC CITY ELEC.	0005461	UPPER TWP.	GREAT EGG HARBO	COOLING WATER	1.20
ATLANTIC CITY ELEC.	0005461	UPPER TWP.	GREAT EGG HARBO	PROCESS WASTE	
NEW JERSEY WATER COMPANY	0023281	OCEAN CITY	GREAT EGG HARBOR BAY	SANITARY	2.00
NEW JERSEY WATER COMPANY	0027286	OCEAN CITY	GREAT EGG HARBOR BAY	SANITARY	1.24
NEW JERSEY EXPRESSWAY AUTH.	0026531	ELLWOOD-WEYMOUT	MAKEPEACE STREAM	SANITARY	
NEW JERSEY EXPRESSWAY AUTH.	0026522	HAMMONTON TOWN	MAKEPEACE STREAM	SANITARY	
PICKLE PRODUCE INC	0035416	BUENA	MARSH AREA		
SCHOLLER BROTHERS INC	0032441	ELWOOD	TRIBUTARY MAKEPEACE STREAM	COOLING WATER	
BUENA BOROUGH MUA	0021717	BUENA BORO	TRIBUTORY TO THE GREAT EGG HAR	SAN/SIG INDUS	.30
GARDEN STATE WATER CO.	0001198	HAMILTON /TWP/	CULVERT POND RU		.01
SCOTT PAPER CO.	0004324	BUENA BORO	DEEP RUN	PROCESS & COOL.	.07
MONROE MUA	0031259	WILLIAMSTOWN	HARBOR RIVER		
BOROUGH OF BERLIN	0026972	BERLIN BORO	EGG HARBOR RIVER	SAN/SIG INDUS	.55

O. MULLICA RIVER

Basin Description

The Mullica River basin drains 561 square miles of predominantly forested land in the Pine Barrens region of southeastern New Jersey. The basin is divided into two major watersheds: the larger draining to the Mullica River (length 35 miles), the smaller draining to the Wading River (length 22 miles). Downstream of its confluence with the Wading River, the Mullica empties into Great Bay, which flows into the Atlantic Ocean through New Inlet. Major tributaries are Wading River, Batsto River, Mochescatauxin Brook, Nescochaque Creek, Atsion Creek, Landing Creek, and Hammonton Creek, in the Mullica watershed; and Bass River, Oswego River, Shoal Brook, Governors Hills Brook and Tulapehauken Creek in the Wading River watershed. The Mullica River mainstem, Batsto River and Oswego River are included in New Jersey's Wild and Scenic Rivers System. Most streams in the basin are shallow, slow moving and naturally acidic, with flows relatively constant throughout the year because of the substantial groundwater contribution. The Mullica River is tidal downstream of Charcoal Landing.

Land use in the Mullica River basin is predominantly undeveloped state park and forests, which together comprise 84 percent of the land, while less than 5 percent is developed. The upland areas drain primarily pine-oak forests. Agriculture in the upland portion of the basin consists primarily of horse and swine farms, with crop acreage devoted to apples, peaches, tomatoes, blueberries and sweet potatoes. The lowland areas are dominated by cedar and hardwood swamps that also serve, once cleared and dammed, as excellent cranberry growing areas. Agriculture in the lowlands of the basin consists primarily of horse and swine farms, with crop acreage devoted to cranberry and blueberry production. The New Jersey cranberry industry, which ranked third nationally in 1975, is dependent on the acid waters characteristic of the basin.

Population growth between 1970 and 1980 occurred throughout the Mullica River basin, with the greatest increases recorded in Tabernacle Township (200 percent) and Waterford Township (96 percent). The largest developed centers in the basin are Winslow, Galloway, Hammonton, Tabernacle and Woodland. Galloway Township, in Atlantic County, is currently experiencing major suburban development mainly due to the labor force and recreational pressures of the Atlantic City casino industry. It is estimated that a population increase of twenty to thirty thousand will occur within the next decade in the area adjacent to the lower Mullica River and Great Bay.

Nine wastewater treatment facilities are located in the Mullica River basin; the largest, in the Town of Hammonton, discharges

.75 mgd to Hammonton Creek, followed by the City of Egg Harbor which discharges .49 mgd to Union Creek. Six industrial point sources are also located within the basin and discharge processing and cooling water to tributaries of the Mullica River. The basin is served predominantly by septic systems. The Mullica River watershed falls within four facilities planning areas designated by the NJ Department of Environmental Protection. Potable water supplies are derived primarily from groundwater sources. Fourteen major lakes are located in the Mullica River basin. The majority of lakes are privately owned and are used for recreational activities such as bathing, motor and non-motor boating and fishing. Nescochaque, Paradise and Lily Lakes have been classified as eutrophic by the NJ Department of Environmental Protection (DEP). The largest lake, in Hammonton Town (125 acres), provides good shore fishing for largemouth bass, pickerel, catfish, yellow perch, carp and sunfish. Great Bay is utilized by the NJDEP's shellfish relay program. This involves the transplanting of hard clams and seed oysters taken from "condemned or special restricted" areas to the Bay's "approved" waters. 90 percent of the shellfish harvesting areas in the Mullica River Basin are "approved" or "special restricted" for direct harvest and marketing, whereas 10 percent are "condemned". A limited hard clam and oyster resource exists in this coastal zone.

The Mullica River watershed drains a significant portion of the Pinelands region of southern New Jersey. The Pinelands are primarily pine and oak forests that are situated on relatively sterile, acidic sandy soils. These soils, as part of the Outer Coastal Pain, are a major factor for the region's unique terrestrial and aquatic environments. In addition, the geologic formations in the Outer Coastal Plain are known to contain vast amounts of very high quality groundwaters. The Pinelands, managed through extensive planning activities by the Pinelands Commission, has been designated the Pinelands National Reserve and Pinelands Protection Area by the federal and state governments, respectively.

The State of New Jersey owns and operates two wildlife management areas (WMA) in the basin. The Swan Bay WMA contains 1,078 acres, principally salt marsh, which provides excellent striped bass and white perch fishing, as well as waterfowl hunting for teal, black duck, mallard and geese. The Port Republic WMA contains 755 acres, three-quarters of which are salt marsh, and also provides excellent fishing for striped bass and white perch, as well as waterfowl hunting for black duck and teal. Wharton State Forest, the largest state forest in New Jersey, contains 99,672 acres in Burlington and Camden Counties. Water-based activities such as bathing, fishing and boating are available. Bass River State Forest contains 3,640 acres, principally in Atlantic County, and provides bathing, fishing and boating opportunities. Penn State Forest contains 1,346 acres in Burlington County and provides opportunities for bathing, boating and canoeing. The NJ Division of Fish, Game and Wildlife stocks brook trout in Hammonton Lake.

The NJ Water Quality Standards give the Mullica River Basin a variety of water quality classifications, including FW-Central Pine Barrens; FW-Central Pine Barrens-Lower Mullica and Wading Rivers; FW-1; FW-2 Nontrout and TW-1.

Water Quality Assessment

Conventional Parameters

The assessment of water quality conditions in the Mullica River basin is based upon sampling at Pleasant Mills (Mullica River), Harrisville (Oswego River) and New Gretna (East Branch Bass River). With the exception of dissolved oxygen saturation levels which frequently contravened the Central Pine Barrens criterion (85 percent minimum), water quality in the Mullica River basin was generally very good. Daytime dissolved oxygen saturation values for the most part remained above 70 percent in the Mullica and Oswego Rivers, but declined to less than 70 percent in the East Branch Bass River during low flow periods in the summer months. This decline was accompanied by moderate five-day biochemical oxygen demand levels (2-3 mg/l). BOD_5 concentrations at Pleasant Mills (Mullica River) and Harrisville (Oswego River) were generally less than 2 mg/l for the period.

Fecal coliform concentrations were also generally under the 200 MPN/100 ml level at the Mullica and Oswego River stations. However, the East Branch Bass River exhibited occasional extreme values during summer low flow conditions. Total dissolved solids levels in this central Pine Barrens drainage area were characteristically low (less than the 100 mg/l criterion) and stable over the period. The basin also exhibited characteristically low pH values (generally less than 5.5) with the Mullica River station showing a slight increase to about 6.0 after 1979.

Nutrient concentrations were at acceptable levels throughout the basin for the period. Nitrate + nitrite levels fluctuated considerably at all three stations, with levels varying between 0.1 and 1.0 mg/l. A slight overall increase in total ammonia concentrations, particularly during low flow periods in summer and fall, was evident in the three streams. However, only the Mullica River at Pleasant Mills exhibited a nominal increase in un-ionized ammonia levels over the period.

Biological data has been collected from the tidal segment of the Mullica River at Green Bank. The condition of the macroinvertebrate community varied considerably over the three year monitoring period. In 1977, the amphipod Gammarus fasciatus alone comprised over 99 percent of the community and was found at a very high density (about 5000/sq.ft.). In 1978 and 1979, the faunal density dropped to 200 and 300 per sq. ft., respectively.

Chironomids and trichopterans comprising approximately 40 and 60 percent of the community, respectively, were found with single genera still comprising 20 to 55 percent of the community.

Water quality in the Mullica River basin is indicative of the Pinelands region. Overall, conditions reported above are similar to water quality described in previous 305(b) reports, with the exception of decreases in quality in the East Branch Bass River near New Gretna (due to higher fecal coliform counts and lower dissolved oxygen saturation). Moderate improvement has been noted in the Mullica River at Pleasant Mills because of reduced fecal coliform concentrations.

Toxic Parameters

The Mullica River has been sampled at Pleasant Mills and at Route 206 in Burlington County for toxics in the water column. At both sites all samples were free of toxic contamination. At this point there is no data on the Oswego River or the East Branch of the Bass River.

Heavy metal concentrations in various aquatic organisms taken from the Mullica River near the Garden State Parkway revealed trace levels of mercury in several species. Levels of zinc, copper and arsenic are consistent with samples collected from a variety of waterways through New Jersey. Occasional incidences of cadmium, and nickel were noted in eastern oyster, *Crassostrea virginica*, white perch, *Morone americana*, and black drum, *Pogonias cromis*. The levels noted were not above any set criteria for fish tissue contamination.

Problem Assessment

Water quality in the Mullica River basin is for the most part very good to excellent, with scattered streams experiencing poorer water quality. The Mullica watershed does, however, contain some of the best natural quality waters in the State. Natural influences such as very low pH (a result of acidic soils), poor buffering capacity and significant ground water contribution to stream flow together with its generally undeveloped nature (most of the watershed is within state parks and forests), makes the waters in the Mullica basin a unique national resource. Because of the acidic soils and waters found in the Pinelands region, specialized plant and animal communities also exist.

The water quality problems which have been identified include frequent dissolved oxygen saturations below the Central Pine Barrens standard and occasional high levels of fecal coliform bacteria. As a result of the high bacteria counts found, most of the Mullica River tributaries upstream of Great Bay are classified as "condemned" or "special restricted" for shellfish harvesting. In addition, the discovery of mercury in fish tissue sampled from this region is unexpected and of concern. This may reflect the use of mercurial pesticides in upstream areas of the watershed.

The greatest water quality impacts in the Mullica watershed are likely to be from municipal point source discharges and septic systems. The Town of Hammonton's sewage treatment plant discharges approximately .8 mgd to Hammonton Creek. The discharge has profound impacts on Hammonton Creek, as the stream cannot assimilate the discharge. The poorest quality waters in the Mullica basin are probably found in this creek. Upstream of Hammonton's STP discharge lies Hammonton Lake, which was studied in 1979 by the Lakes Management Program. The lake has been classified as mesoeutrophic with the presence of extensive macrophyte growth. Sources of the nutrients causing excessive vegetative growth are non-point in origin, and include septic systems, residential runoff and possibly domestic sewer pipeline leakage.

In a lower tributary to the Mullica River, the Egg Harbor City treatment facility discharges to Union Creek, a branch of Landing Creek. The plant is currently overloaded and discharges inadequately treated wastewaters. Degraded water quality occurs in Landing Creek because of this discharge. The impacts on the Mullica River, however, are not known.

The upper Mullica watershed contains areas with septic system problems. These problems are known to occur in Winslow Township, Chesilhurst Borough and Waterford Township. Also in Winslow Township is Ancora State Hospital's ground discharge, which is known to cause reduced water quality conditions in Blue Anchor Branch.

On-site disposal systems are a serious problem in lower Bass River Township, near the Mullica River. Septic tank overflows have created a health hazard in this area, and may be the main cause for closed shellfish harvesting waters in the lower Mullica.

A major concern for preserving water quality in the Mullica River, and adjacent Great Bay and tidal waterways, is the large scale residential and commercial developments presently underway in Galloway Township. This development is largely from demands placed upon the region by casino gambling in Atlantic City. Since most of these developments drain into Brigantine National Wildlife Refuge and Great Bay (areas of high quality waters), storm water management practices are being required. Sewage generated is transferred to the Atlantic County SA's Coastal Plant for ocean discharge. However, developments such as these may have long-term effects on the surface and ground waters of this region.

Goal Assessment and Recommendations

The waters of the Mullica River are generally swimmable. This is substantiated by the fecal coliform values found in the Mullica at Pleasant Mills and the Oswego River at Harrisville. Because of periodic high fecal coliform counts in the East Branch Bass River at New Gretna, these waters should be considered marginally swimmable. Fishable status can also be assigned to the waters in this basin, although occasionally low dissolved oxygen saturations may cause stress to certain fish species. Thirteen fish species have been identified in the water of the Mullica River. Those found are generally indicative of slow moving streams with silty bottoms and aquatic vegetation. The lower tidal reaches of the Mullica, especially Great Bay, is used by many important forage and sport saltwater fishes as nursery and feeding grounds. Great Bay is also an important clam and oyster harvesting area, in addition to being a source of clean water for transplanted oysters and clams from more polluted waters across the state. Protection of the very high quality waters in Great Bay is essential for maintaining its use as a major clam and oyster harvesting area.

Improvement to water in those streams which are degraded can occur in most cases with point source controls. In Hammonton Creek elimination of the town's surface water discharge should result in significant improvements to the creek. However, because of the intimate relationship between ground and surface waters in this region, ground discharges may not be totally adequate. Hammonton is currently studying various alternatives for wastewater treatment in a construction grants project. Whatever alternative is agreed upon, dischargers to either surface or ground waters will be required to meet advanced nutrient and oxygen demanding substances removal requirements. Maintenance of low pH conditions downstream of any discharge is also advised. Egg Harbor City and its service area in adjacent portions of Galloway Township (South Egg Harbor) will have sewage flows transferred to the Atlantic County Coastal Plant. This will eliminate the City's discharge.

Non-point source controls for residential runoff will assist in reducing the nutrient and bacteria loadings to Hammonton Lake. In addition, dredging and winter drawdown of the lake should increase its recreational potential. Elimination of non-point sources through the correction of malfunctioning or improperly draining on-site disposal systems is recommended for the following municipalities: Camden County - Winslow Township, Waterford Township and Chesilhurst Borough; Atlantic County - Bass River Township, Washington Township and Galloway Township. The recent creation of the Southern Burlington County Septage Management Study Group should help in solving septic tank problems within its study area (Shamong, Tabernacle, Washington, Bass River and Woodland Townships).

Effective stormwater monitoring is needed in the developing areas of Galloway Township to insure that the lower Mullica watershed, especially Great Bay and the Brigantine National Wildlife Refuge, are not being adversely affected. Special surveys are recommended for determining the extent of mercury contamination in the watershed, the possible effects on aquatic life, and its source(s).

MULLICA RIVER STATION LIST

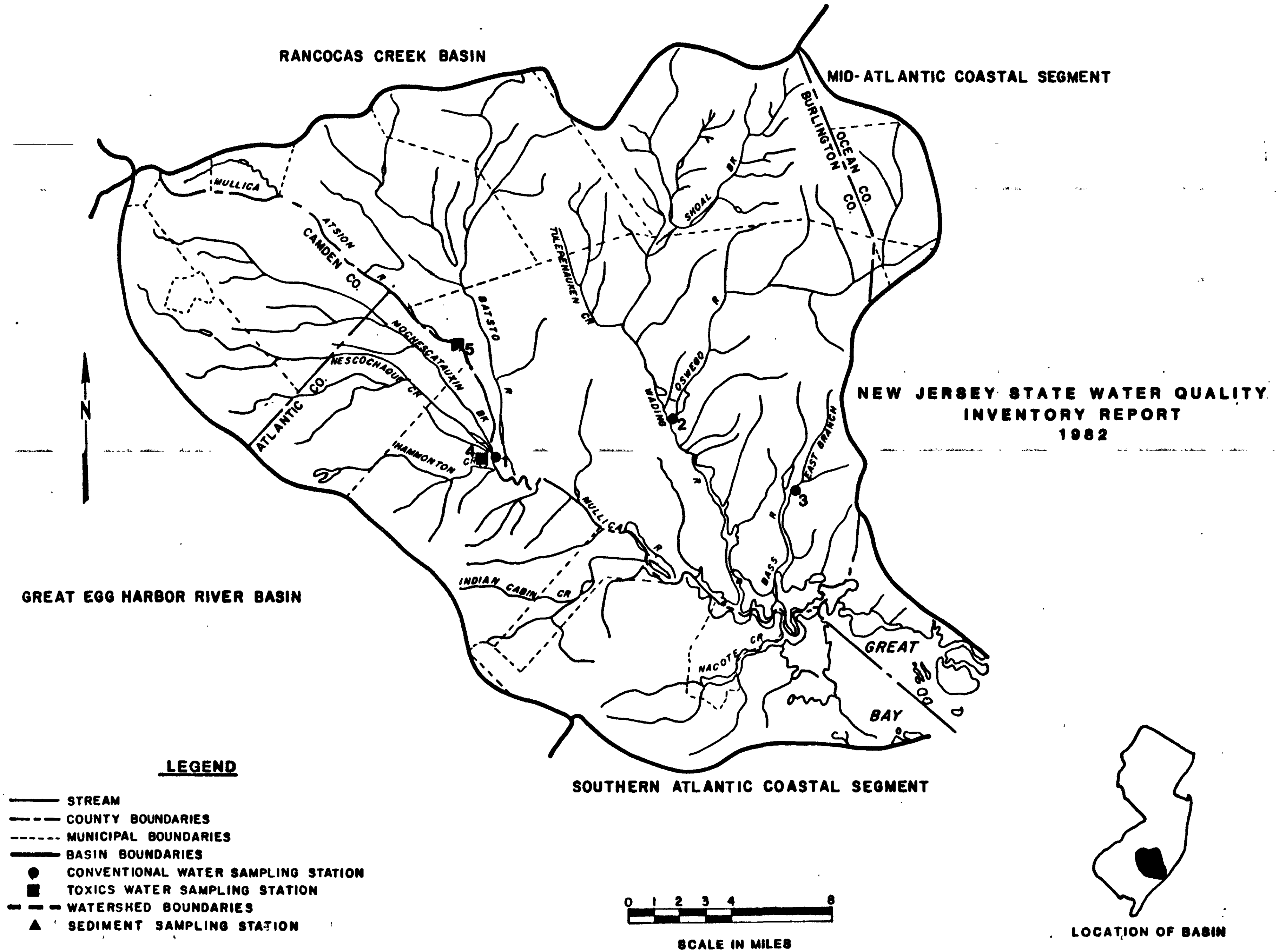
A. Ambient Monitoring Stations

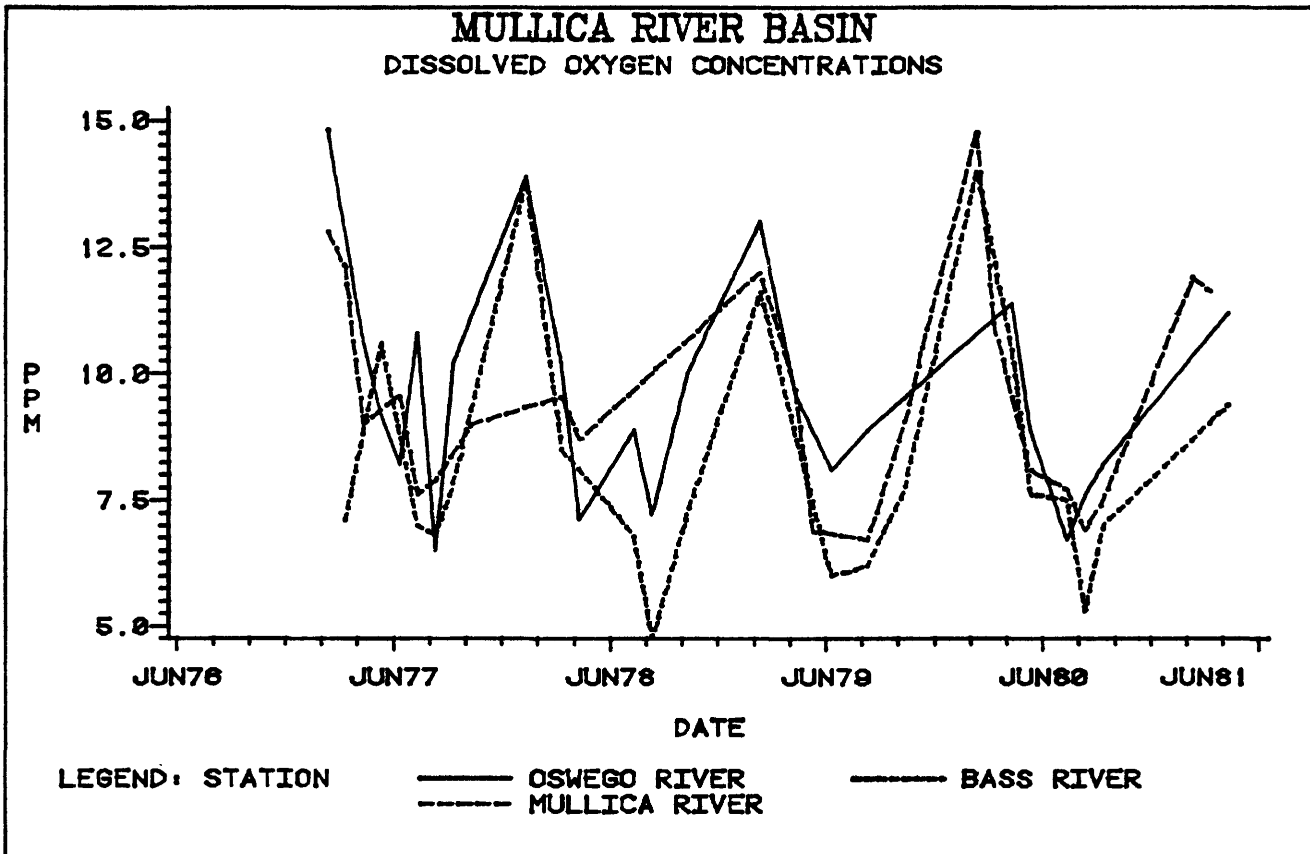
STORET Number	Station Description	Map Number
39382507/ 4393500	Mullica River at Pleasant Mills, Burlington County Latitude 39°38'25" Longitude 74°39'35" FW-Central Pine Barrens USGS/DEP Network Pine Barrens Survey, 1977 At Route 542 bridge, 0.6 miles southwest of Batsto	1
01410000	Oswego River at Harrisville, Burlington County Latitude 39°39'47" Longitude 74°31'26" FW-Central Pine Barrens USGS/DEP Network Pine Barrens Survey, 1977 Upstream side of weir, 50 feet downstream from Route 679 bridge and 0.5 miles upstream from confluence with West Branch Wading River.	2
01410150	East Branch Bass River near New Gretna, Burlington County Latitude 39°37'23" Longitude 74°26'30" FW-Central Pine Barrens USGS/DEP Network Pine Barrens Survey, 1977 At footbridge 100 feet upstream of Stage Road bridge and 2.2 miles north of New Gretna.	3

B. Toxics Monitoring Station

Station Location	Sampling Regime	Map Number
Mullica River at Pleasant Mills	Water column	4
Mullica River at Route 206	Water column	5

MULLICA RIVER BASIN





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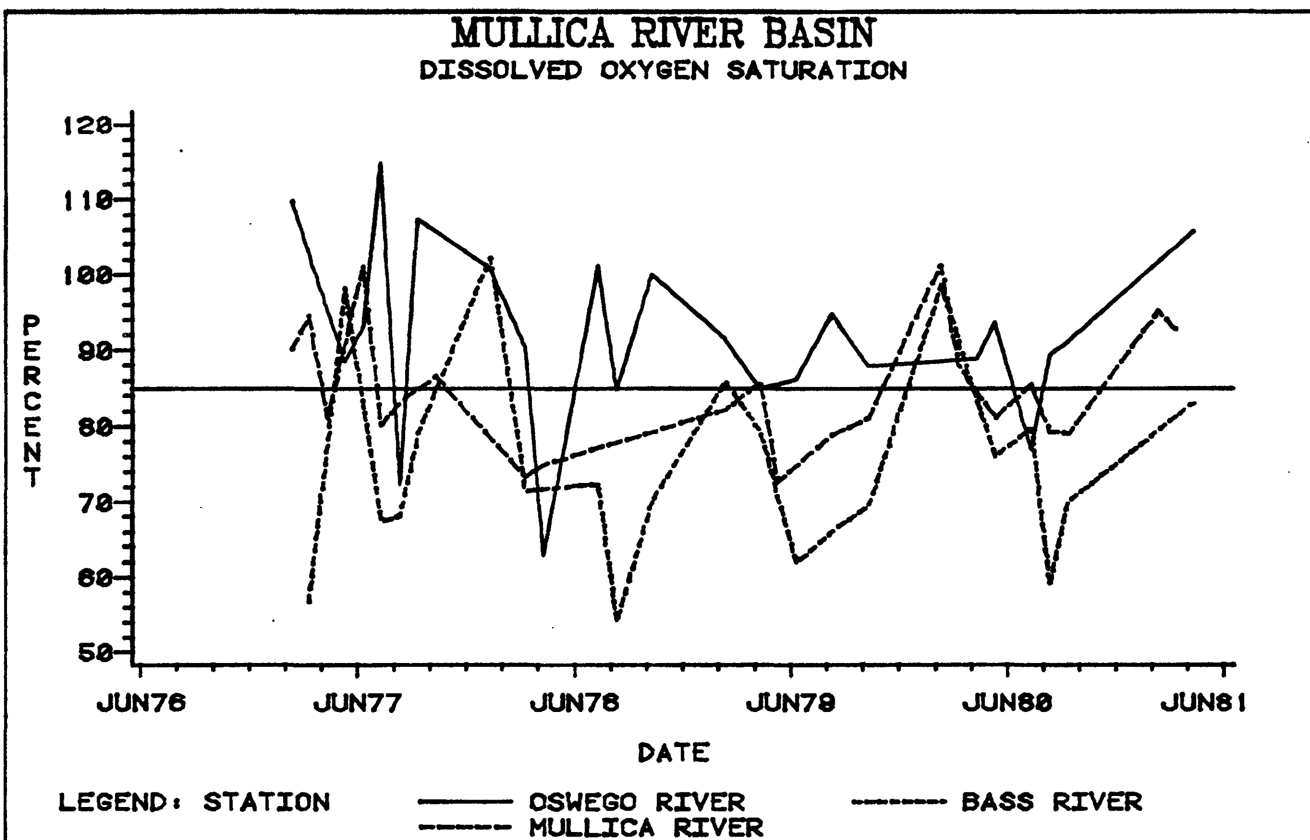

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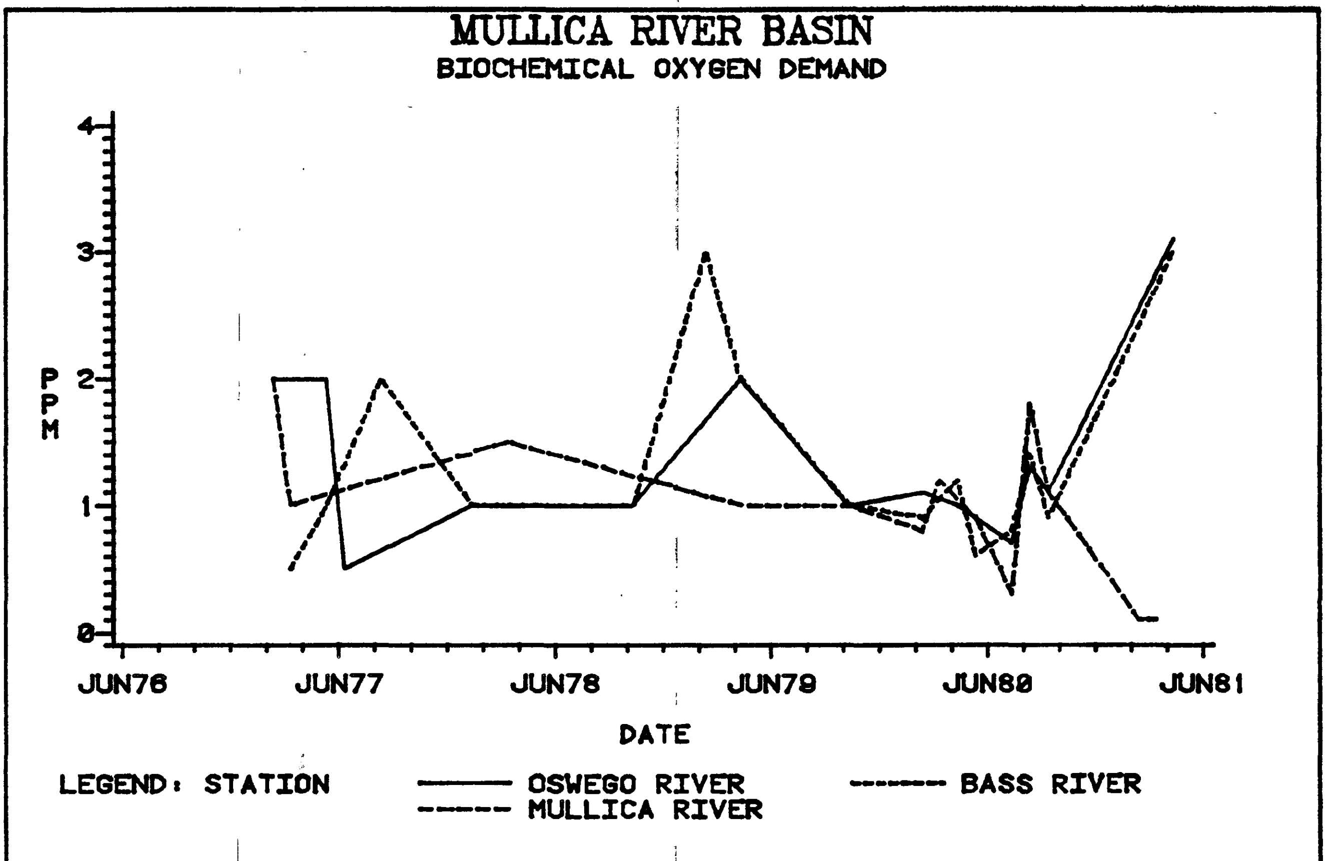

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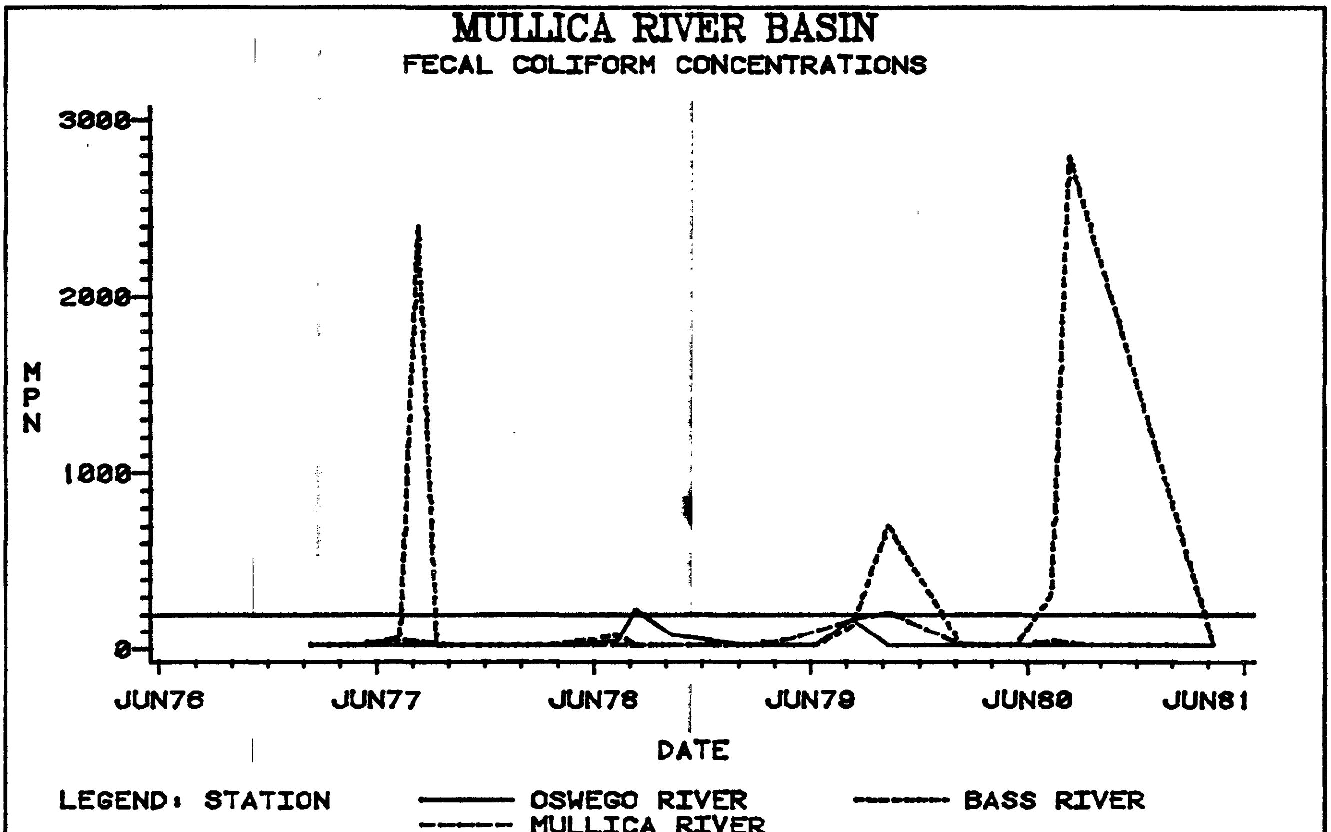

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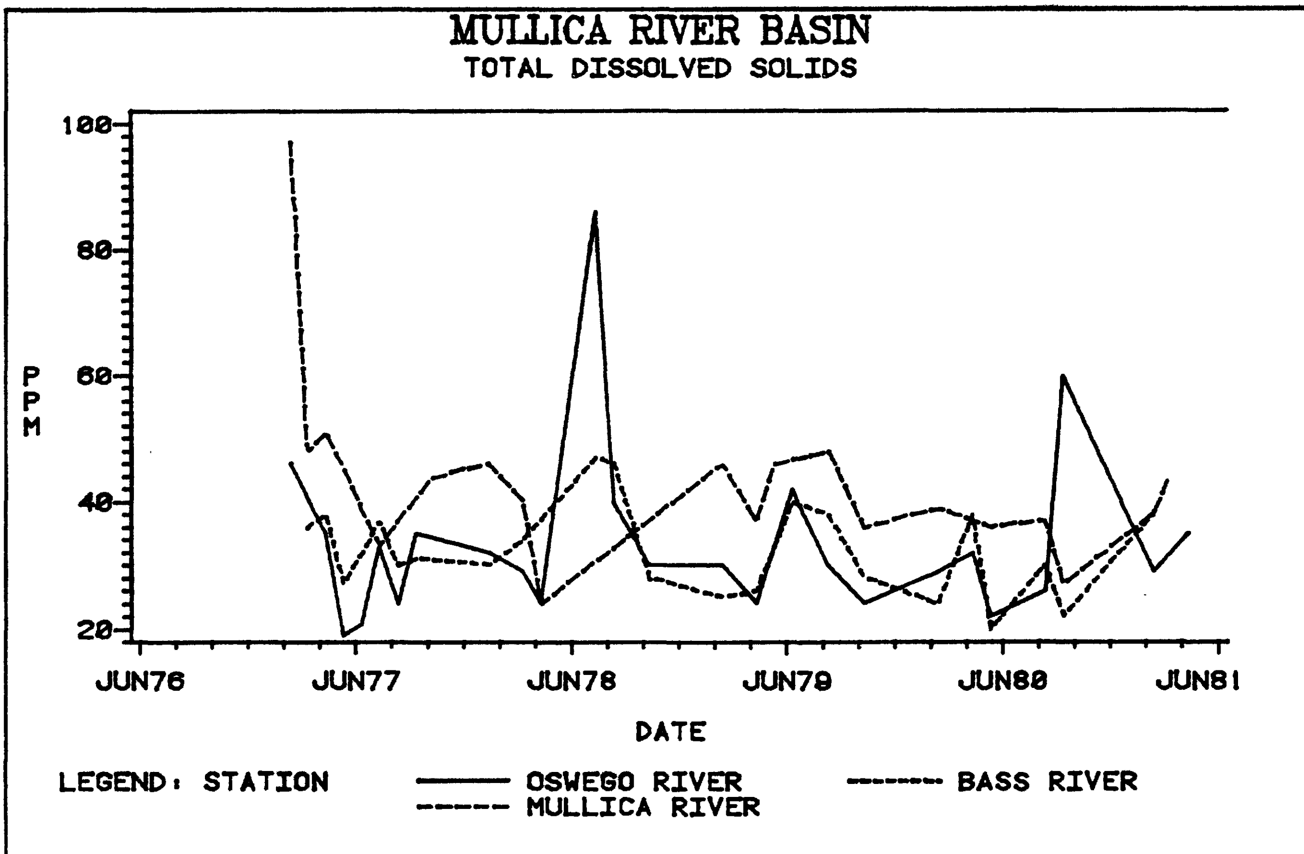

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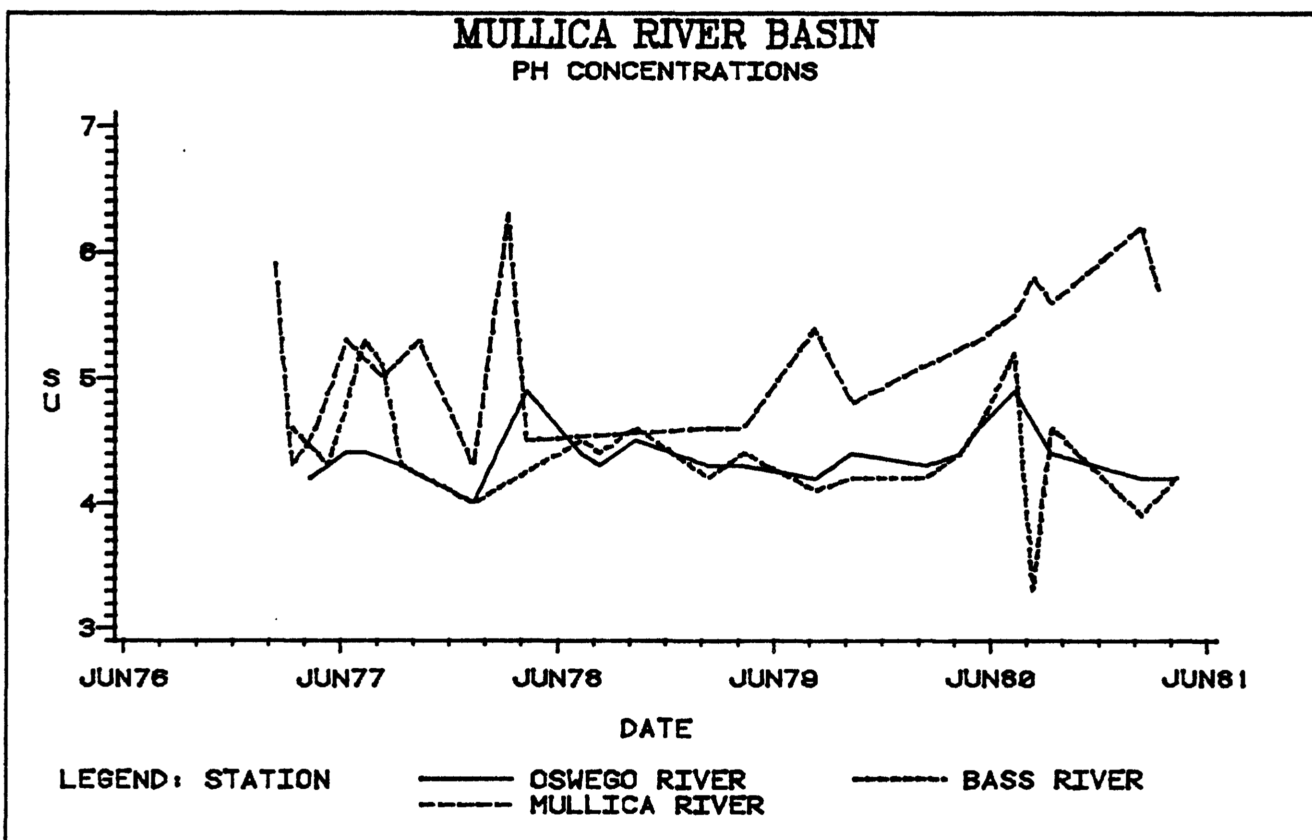

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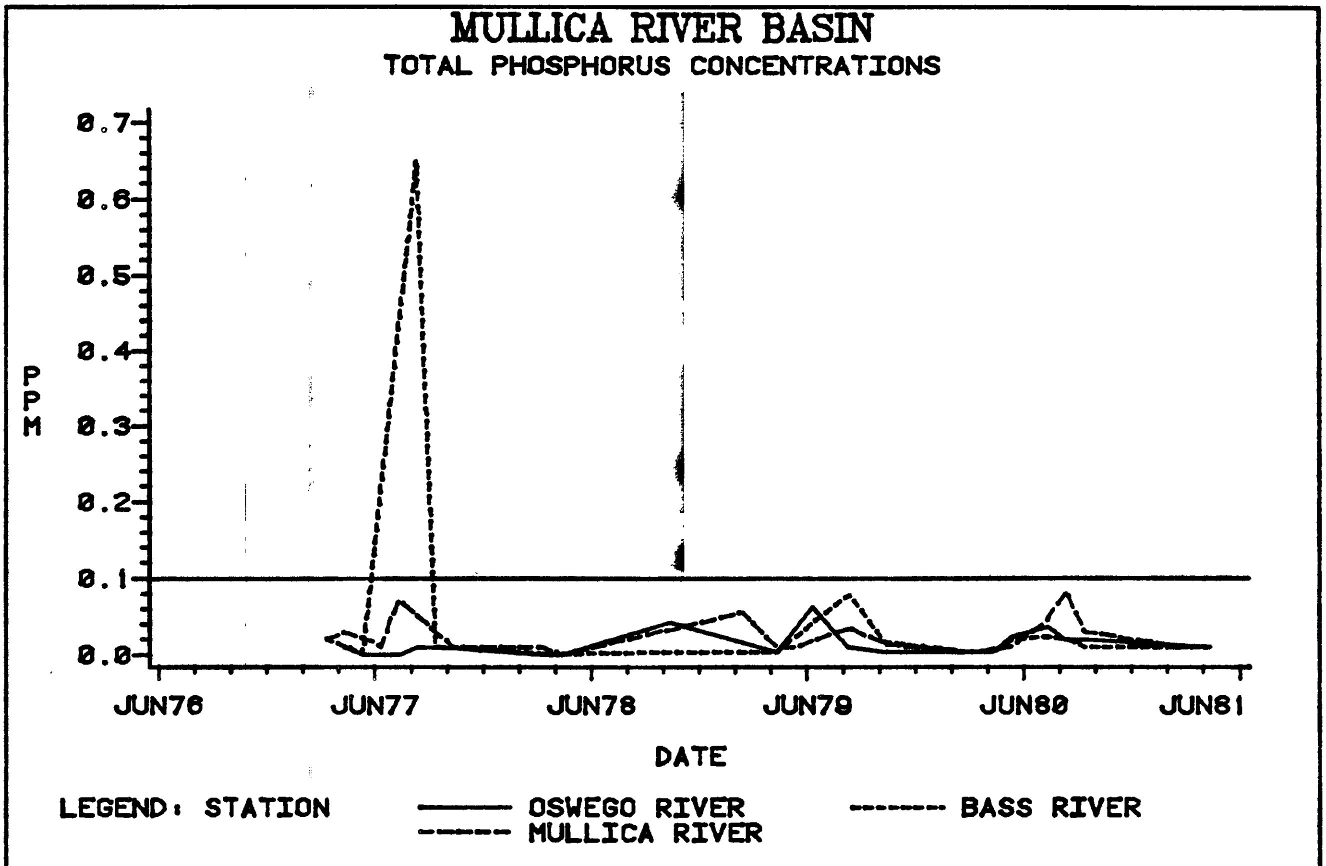

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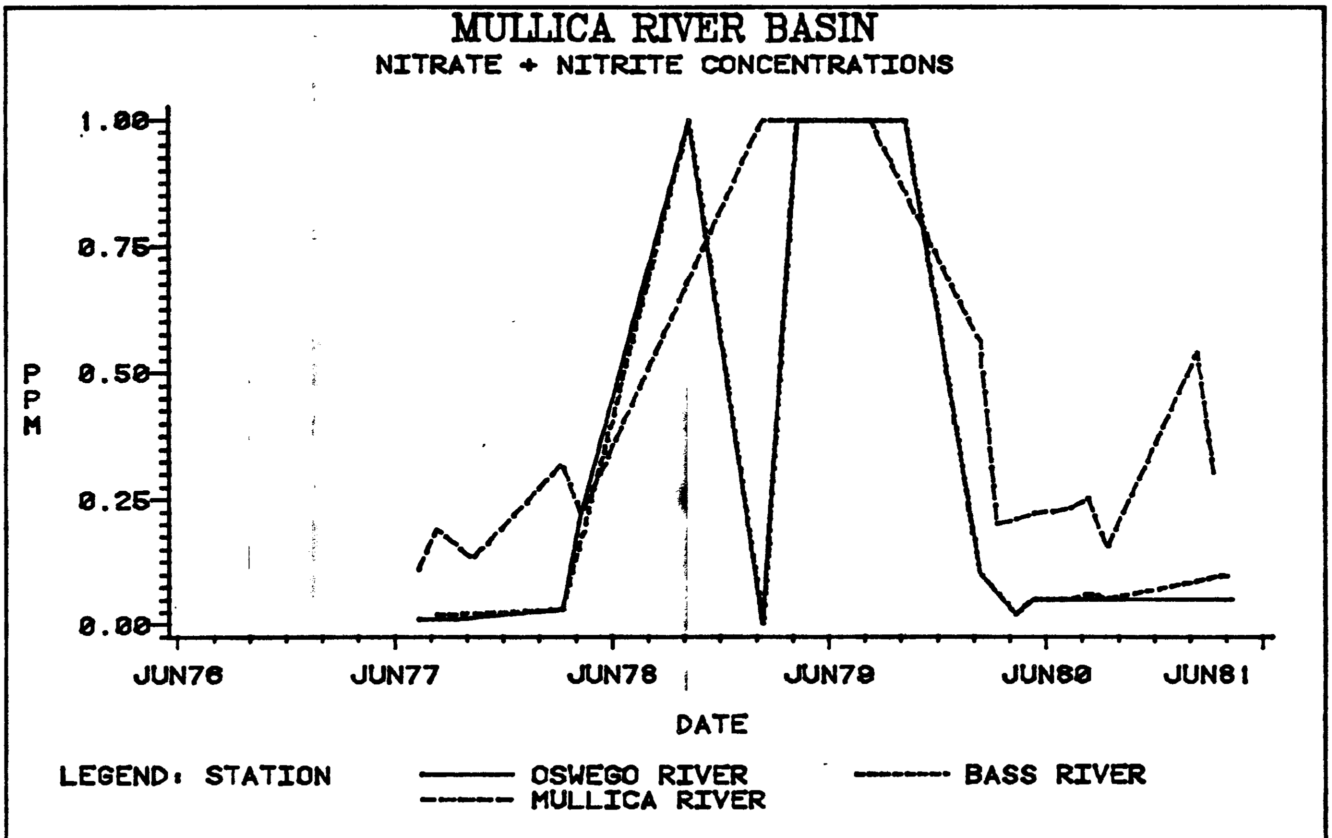

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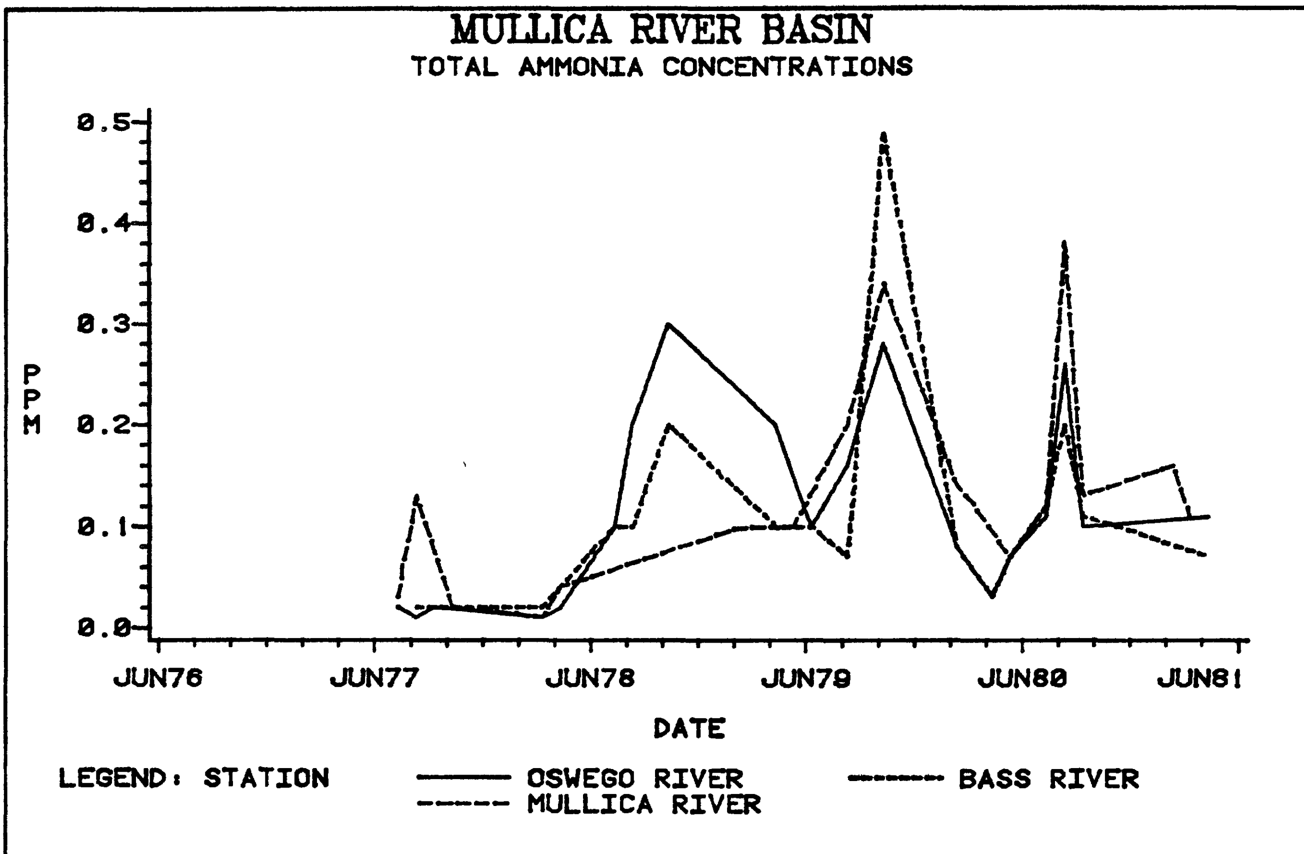

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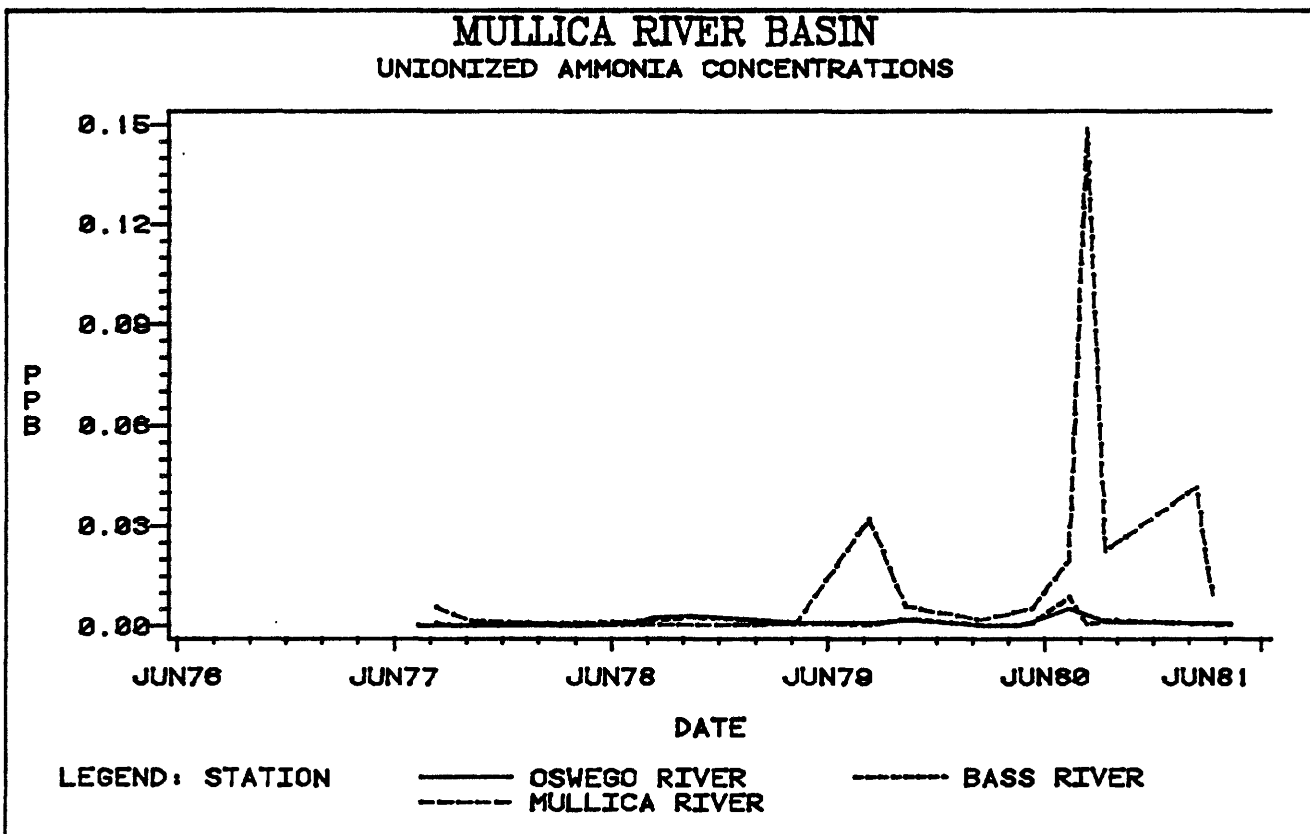


Figure: 0 -10

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
JEREX PLASTICS INC	0030066	CHESILHURST	CHESILHURST POND		
TOWN OF HAMMONTON	0025160	HAMMONTON TOWN	HAMMONTON CR.	SANITARY	.75
PACEMAKER CORP	0005428	WASHINGTON TWP	MULLICA RIVER	COOLING WATER	
ANCORA PSYCHIATRIC HOSPITAL	0021962	WINSLOW TWP.	NESCOHAQUE CR.	SANITARY	.00
PRESSWELL RECORDS MFG CO.	0031275	ANCORA	NESCOHAQUE CREEK	COOLING WATER	.06
WHITEHALL LABORATORIES	0024210	HAMMONTON TOWN	POND LAKE TO MULLICA RIVER	COOLING WATER	
BRADDOCK FROSTED FOODS	0004081	WINSLOW TWP	TR MULLICA RIV	PROCESS & COOL.	.25
CITY OF EGG HARBOR	0024589	EGG HARBOR CITY /C/	UNION CREEK	SANITARY	.49
LENOX CHINA INC	0005177	GALLOWAY TWP	JACK PUDDING BR	SANITARY	.20

P. MID-ATLANTIC COASTAL BASIN (GREAT BAY TO MANASQUAN INLET)

Basin Description

The Mid-Atlantic Coastal basin encompasses three discrete watersheds (the Metedeconk and Toms Rivers, and Cedar Creek) and southern Ocean County drainage. The basin drains central and eastern Ocean County (638 square miles) and the southern fringe of Freehold, Howell and Wall Townships (36 square miles) in Monmouth County. The Toms and Metedeconk Rivers are the major surface water corridors of the basin. The headwaters of the Toms River lie in the relatively undeveloped western section of Ocean and Monmouth Counties. The river flows southeasterly into Barnegat Bay, entering the bay eleven miles north of Barnegat Inlet. The average flow recorded at the town of Toms River (drainage area of 124 square miles) is 217 cfs. The downstream areas are densely populated, with residential and commercial development throughout. Surface waters are utilized for a diversity of activities, including agriculture, industrial, recreational and commercial shellfishing, sport fishing, bathing and boating. Toms River is tidal upstream to the dam at the town of Toms River. The headwaters of the Metedeconk River originate along the border of Ocean and Monmouth Counties. The topography of the watershed is flat, with upstream agricultural and residential areas containing several lakes fed by slow moving streams. The river flows through heavy residential development in downstream areas prior to entering northern Barnegat Bay. The waters of Barnegat Bay empty via inlets between barrier islands into the Atlantic Ocean. The bay experiences only limited tidal exchange with the ocean.

The Mid-Atlantic Coastal basin is predominantly forested (57 percent), with agriculture comprising 12 percent of the total land use, and residential development accounting for 10 percent. Ocean County has traditionally been rural in character. The county's economy has in the past been based on resort/tourist activities located in the ocean beach and bay front communities. While the resort/tourist characteristics are now complemented by the rapidly expanded year-round population, the basin continues to attract thousands of seasonal residents. On a summer weekend the county's population is estimated to exceed 650,000 persons.

The two principal types of agriculture, farming and raising livestock, are found in the basin. Plumsted and Jackson Townships are the primary producers, with livestock production limited to horse and poultry operations and crop acreage devoted to corn, soybeans and hay. Cranberry, blueberry and Christmas tree farming are also evident in the basin.

Population growth between 1970 and 1980 occurred throughout the basin. Census figures indicate that Ocean County is the fastest growing county in New Jersey, with a population increase of more than 135,000 persons, or 65 percent during the decade 1970 to 1980. The largest urban centers are Dover, Lakewood, Manchester and Jackson.

Thirty point sources are found in the Mid-Atlantic basin: 15 industrial, 15 municipal/institutional. The Ocean County Utilities Authority's northern, central, Ortley Beach and southern treatment facilities have recently gone on line with a total discharge of 26.8 mgd to the Atlantic Ocean. This has resulted in the elimination of twenty-two treatment plants, the majority of which had discharged to tributaries feeding Barnegat Bay. The Oyster Creek Nuclear Generating Station in Lacey Township is the largest point source in the basin, discharging over 17 mgd of process wastewater and cooling water to Oyster Creek. The Mid-Atlantic basin lies within three facilities planning areas, all part of the Ocean County Sewerage Authority, as designated by the N.J. Department of Environmental Protection. At present, groundwater provides all of the potable water supply for the basin.

More than fifty lakes, both natural and man-made, are located in the Mid-Atlantic basin. The majority of lakes are publically owned and provide shore fishing, with good angling quality for pickerel, catfish and sunfish. The largest lakes are Lake Shenandoah (101 acres) and Turn Mill Pond (100 acres). The broad, shallow back bays serve as a prime recreational resource, attracting thousands of tourists during the summer season for boating, fishing and bathing activities. The principal bays include Barnegat Bay, Manahawkin Bay and Little Egg Harbor Bay.

Eighty percent of the shellfish harvesting areas in the Mid-Atlantic Coastal segment are "approved" for direct harvest and marketing, while 20 percent of the waters are "condemned". A limited hard clam resource exists in this coastal zone. Barnegat Bay is used by the N.J. Department of Environmental Protection's shellfish relay program to provide approved waters for transportation of hard clams taken from "condemned" or "special restricted" areas.

The State of New Jersey owns and operates eight wildlife management areas (WMA) in Ocean County. The largest tract, Colliers Mills (12,962 acres), is located in Jackson and Plumsted Townships, and provides waterfowl hunting for mallard, black duck, wood duck and teal, as well as fishing for bass, pickerel and perch. The seven other WMAs include Butterfly Pond, Greenwood Forest, Whiting, Pasadena, Stafford Forge, Great Bay Boulevard and Manchester; the combined area is approximately 19,000 acres. Together they provide waterfowl hunting, fishing, crabbing, shellfishing and bathing. Five state parks and forests are located in Ocean County and include portions of Lebanon State Forest, Island Beach State Park, Double Trouble State Park. They provide bathing, fishing and boating activities. The New Jersey Division of Fish, Game and Wildlife stocks trout in the following waters: Toms River and Metedeconk River (North and South

Branches). Cedar Creek is a popular canoeing stream because of its Pinelands scenery and year-round flows. Much of the Mid-Atlantic Coastal basin has vegetation characteristic of the Pinelands and is included as part of the Pinelands Protection Area and National Reserve.

New Jersey Water Quality Standards give the Mid-Atlantic Coastal basin the following water quality classifications: FW-Central Pine Barrens, FW-1, FW-2 Trout Maintenance, FW-2 Nontrout, TW-1, CW-1 and CW-2.

Water Quality Assessment

Conventional Parameters

Stream water quality in the Mid-Atlantic drainage area varied over the 1977 to 1981 period from generally good conditions in rural undeveloped areas to marginal conditions in urbanized areas. The Metedeconk and Toms Rivers monitoring stations, near Lakewood and Whitesville, respectively, exhibited marginal conditions with frequently elevated biochemical oxygen demand levels and fecal coliform concentrations. Limited bay and estuary data revealed localized problem areas, but conditions appeared to improve over the period.

Relatively normal seasonal cycles were exhibited for dissolved oxygen from 1977 to 1981 at the Toms and Metedeconk Rivers stations, with all data remaining above the minimum standard of 4.0 mg/l. Biochemical oxygen demand was generally moderate to high through the period at each station with concentrations occasionally exceeding 7.5 mg/l.

Fecal coliform concentrations were frequently excessive in the Toms and Metedeconk Rivers, particularly during the summer months. The Ocean County Health Department reported that their ambient monitoring fecal coliform data indicated persistent problems in several recreational lakes in the county, including Pohatcong, Manchester, Deer Head, Pine and Shenandoah Lakes and Lake Barnegat. In contrast, the County Health Department and Bureau of Shellfish Control, DWR, reported that, based on coastal bacteria data, coliform count have declined sufficiently in the last five years to allow the reopening of over 5,000 acres of shellfish beds for harvesting.

Total dissolved solids concentrations at the Whitesville (Toms River) and Lakewood (North Branch Metedeconk River) stations were well below the maximum criterion of 500 mg/l through the period. The pH values were slightly acidic in both rivers with the North Branch Metedeconk River generally exhibiting values above 5.5 and Toms River frequently below 5.5.

Nutrient levels were normally acceptable at both stations by 1980. A decline in total phosphorus concentrations was exhibited in the North Branch Metedeconk River at Lakewood, while the Toms River at Whitesville data was consistently below the 0.10 mg/l standard. Nitrate + nitrite concentrations, generally lower in Toms River than in the North Branch Metedeconk, were also low for the period.

Biological data for the Mid-Atlantic Coastal basin was not collected during the period.

Review of water quality data for the Toms River and North Branch Metedeconk River in the 1977 and 1980 305(b) reports shows that conditions have generally remained the same during the last 5-7 years. In the Toms River there has been mild increases in BOD_5 while the North Branch Metedeconk has experienced moderate increases in dissolved oxygen and reductions in total phosphorus concentrations. The coastal waters have experienced reductions in bacteria loads in the last five years, which has resulted in the opening of over 5,000 acres of beds for shellfish harvesting.

The Ocean County WQM Program with assistance from the County Board of Health conducted an extensive surface water monitoring program from January, 1977 through to March 31, 1978. Their study found general patterns with regard to pollution in the county's streams. The poorest water quality was in the northern (Metedeconk and Manasquan basins) and western (Crosswicks Creek) portions of the County. The best quality waters were in the central and southeast parts of county (Oyster Creek, Forked River and Mill Creek). A thorough evaluation of their sampling results is available from the Ocean County WQM Program in Toms River.

Toxic Parameters

The Toms River was sampled at two locations, near Route 9 and near Route 527. In both cases high trihalomethane levels were found. This is probably a result of the point source discharges in the area. Subsequent resampling at these sites did not confirm these levels as a persistent problem.

The North Branch of the Metedeconk River at Route 547 was shown to be free of toxic contamination in all samples. In addition, water analyses of the South Branch Metedeconk was also free of toxic contamination.

Samples of aquatic organisms were taken during the period of 1975-1980 at the Toms River section of Barnegat Bay. Sampling locations included Beechwood, the confluence with Barnegat Bay, Goodluck Point, Holly Park, and at the Route 37 Bridge. Concentrations of PCB Arochlor 1254 varied throughout this region. Generally these levels did not exceed the PCB action level established by the FDA for fish tissue. Sediment samples taken at the Beechwood location produced only trace levels of organochlorine pesticides and less than detectable levels of PCB Arochlor 1254.

Heavy metal data for fish tissue from this section did not produce elevated levels of either mercury, arsenic, copper or zinc. Elevated concentrations of lead and/or cadmium did appear occasionally within various species although the incidence of occurrence was minimal.

This pattern also appears in aquatic organisms sampled in the Forked River section as well and throughout other estuarine locations.

Fish samples collected in 1977 from the Metedeconk River at Sandy Point, Haystack Branch and Forge Pond produced only trace levels of PCB 1254 and organochlorine pesticides. Sediment samples of the Haystack Branch and Forge Pond produced less than detectable levels for PCB 1254, and only trace levels of the organochlorine pesticides.

Problem Assessment

The Toms and North Branch Metedeconk Rivers were reviewed above for water quality and found to have good quality in the upstream regions, and poorer quality downstream. Excessive biochemical oxygen demand and fecal coliform were commonly found, especially in warm weather periods. In the coastal and tidal waters of this basin the quality is generally sufficient to allow bathing and shellfish harvesting (this is particularly true for most of Barnegat Bay and the ocean beaches). However, bacterial levels are such that in most of the tidal tributaries of Ocean County shellfish harvesting is "condemned" or "seasonal".

Most of the water quality problems found in this basin are the result of the extensive development that has occurred in the county during the last 10-15 years, the presence of on-site disposal systems too closely placed, antiquated package treatment plants and surface waters that are too sensitive to handle the pollution loads.

The Metedeconk River receives pollution from a combination of point and non-point sources. The North Branch is affected by inadequately treated wastewaters from the Cricket Restaurant in Howell Township, septic systems, stormwater runoff and possibly leachate from the Waste Disposal, Inc. landfill in lower Howell Township. This landfill is considered a serious threat to surface and ground waters because toxic materials (namely volatile organics) are known to have been dumped at the site. A number of other small point sources also discharge to the North Branch. In the South Branch Metedeconk watershed, the Harmony STP (Jackson Township) is currently operating above its capacity, and is providing inadequate secondary treatment.

Downstream in the Metedeconk, where it enters northern Barnegat Bay, the waters are "condemned" for shellfish harvesting. Stormwater runoff and leaking sewage lines are the likely sources of the bacteria.

The Toms River is affected by septic systems and several large ground discharge facilities. Crestwood Village, a retirement village in Manchester Township, has been unable to meet its effluent requirements for ground discharge. Impacts from this discharge on Davenport Branch is suspected. Septic systems are known to be problems in other areas of Manchester Township and in Pine Beach Borough along the tidal estuary. Existing septic systems, stormwater runoff and leaky sewers are probably responsible for the closed shellfish areas in the lower Toms River. Jackson Township, South Toms River, Berkeley Township, Stafford Township and Eagleswood Township are also known to contain on-site disposal systems which are malfunctioning.

Contact recreation in some of Ocean County's many lakes is threatened with persistent fecal coliform loads. The Ocean County Board of Health found excessive bacteria in Deer Head Lake, Lake Barnegat, Pine Lake and Shenandoah Lake during summer months. The Board of Health has attributed the problem to waterfowl using the lake and beach areas. Manahawkin Lake in Stafford Township was evaluated in an intensive survey by the Lakes Management Program in 1979. The lake was found to be mesotrophic with extensive macrophyte growths characteristic of eutrophic water bodies. Although nutrients and bacteria were not excessive, surrounding residential areas are the suspected source.

Along the coastal and tidal areas of this basin, clear trends with regard to bacteria contamination can be detected when reviewing the "Approved Areas Charts - Shellfish Growing Water Classification", distributed by the NJDEP. Bacteria levels are acceptable throughout most of Barnegat Bay but levels increase (therefore, causing the closure of shellfish waters) in tidal tributaries to the bay, along the bay where development has occurred and in the ocean surf waters. This is due to stormwater runoff from developed and upstream lands. Bathing water quality, however, is generally acceptable.

Although fish tissue taken from Barneget Bay and the inland tributaries did not show excessive concentrations of toxic substances, striped bass and bluefish tissues collected from offshore waters of the Atlantic Ocean did contain abnormally high levels of PCBs. As a result of this, the State DEP and Department of Health have issued in December, 1980 an advisory on the consumption of these fishes. Use of striped bass and bluefish taken from Atlantic Coastal waters from Barnegat Inlet northward is recommended to be no more than 1 meal per week.

Goal Assessment and Recommendations

Monitoring of the North Branch Metedeconk River near Lakewood and the Toms River at Whitesville reveals that these waters are not of swimmable quality. However, monitored bathing beaches are present throughout this basin (in lakes, bays and ocean beaches), such that much of the basin can be classified as swimmable. The water in this basin can be considered of fishable quality, although low pH in the inland waters limits the ability of these waters to support a varied fish community. Fish diversity totals 17 species in the Metedeconk River watershed, 14 species in the Toms River and 10 species each in Forked River and Cedar Creek. The Oyster Creek Nuclear Generating Station has periodic and profound impacts on the fish in Oyster Creek downstream of the discharge from the generating station. The plant discharges cooling water into a cooling channel at temperatures above ambient water temperatures. In winter months fish become acclimated to the warmer waters, so that when the plant shuts down far any prolonged period, fish kills result from the rapid drop in stream temperatures. The tidal and coastal waters are important spawning, nursery and feeding grounds for many forage and sport fisheries. Shellfish growing and harvesting is also an important function of the coastal waters in this basin.

The regionalization of practically all sewage flows in Ocean County by the County's Regional Sewage Authority has resulted in improved water quality in the coastal bays and ocean waters. Continued regionalization of existing discharges (namely Crestwood Village's ground discharge and the Harmony STP in Jackson) and areas with malfunctioning or inadequate on-site disposal systems (see municipalities listed above as having on-site problems) should help in improving many inland waters also. Improvement in coastal water quality around developed lands which are already sewered, however, is unlikely unless extensive stormwater control practices are implemented. Protection of water quality around landfills, particularly the Waste Disposal, Inc. site in Howell Township, is needed. The close connection between ground and surface waters necessitates protection of both water regimes around ground water pollution sites.

The low buffering capacity of the inland streams in this basin require advanced wastewater treatment measures and/or alternative disposal methods. In addition the sensitive character of the coastal bays in this region (because of poor tidal exchange) also necessitates advanced treatment methods. Increased long-term monitoring is suggested for the bay waters in this basin, possibly utilizing local and county agencies to conduct the monitoring.

MID-ATLANTIC COASTAL BASIN STATION LIST

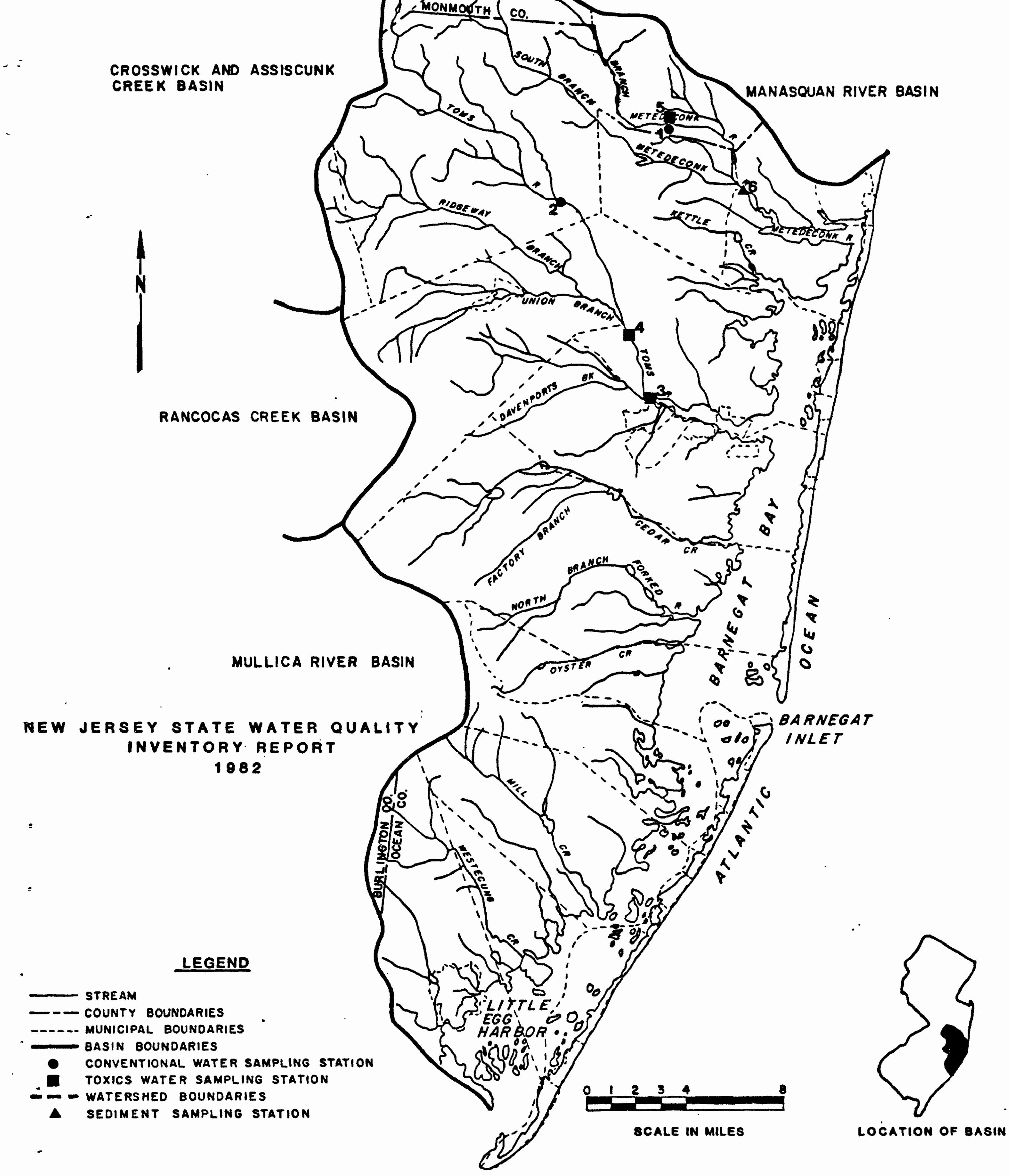
A. Ambient Monitoring Stations

STORET Number	Station Description	Map Number
OCN-004 (01408100)	North Branch Metedeconk River at Squankum-Lakewood Road near Lakewood FW-2 Nontrout Latitude 40°06'42" Longitude 74°11'58" Ocean County Department of Health Network	1
OCN-029	Toms River at Lakehurst-Whitesville Road at Whitesville FW-2 Nontrout Latitude 40°04'04" Longitude 74°16'29" Ocean County Department of Health Network	2

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Toms River at Route 9	Water column	3
Toms River at Route 527	Water column	4
North Branch Metedeconk River at Route 547	Water column	5
Forge Pond at Lakewood	Sediments	6

MID-ATLANTIC COASTAL SEGMENT—MANASQUAN INLET TO GREAT BAY, (INCLUDING TOMS AND METEDECONK RIVERS)



MID-ATLANTIC BASIN (GREAT BAY TO MANASQUAN INLET)

DISSOLVED OXYGEN CONCENTRATIONS

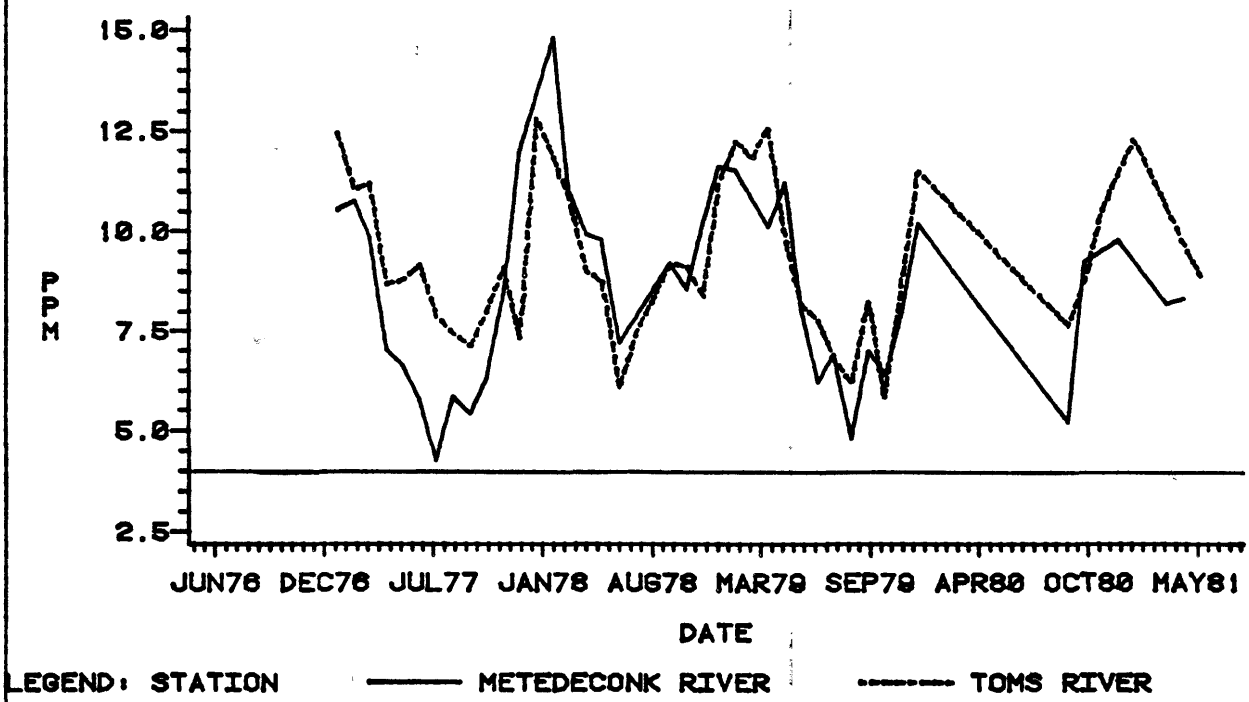


FIGURE – P – 1

MID-ATLANTIC BASIN (GREAT BAY TO MANASQUAN INLET)

DISSOLVED OXYGEN PERCENT SATURATION

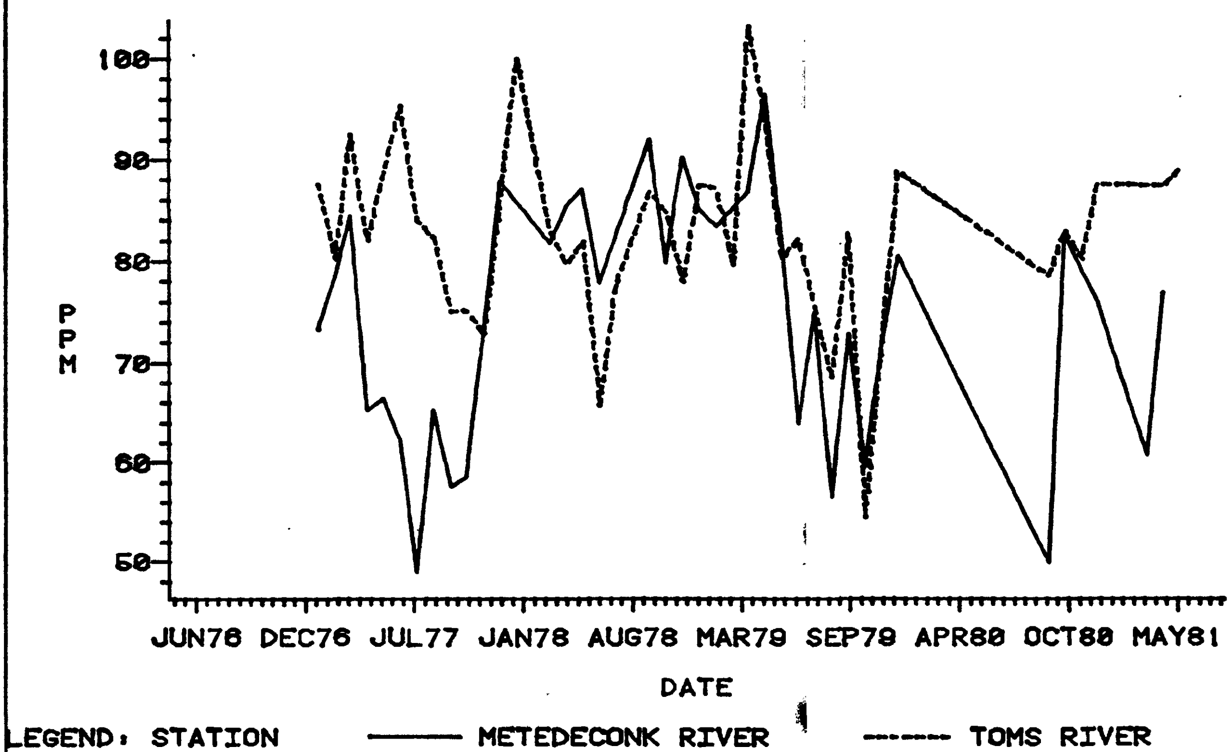
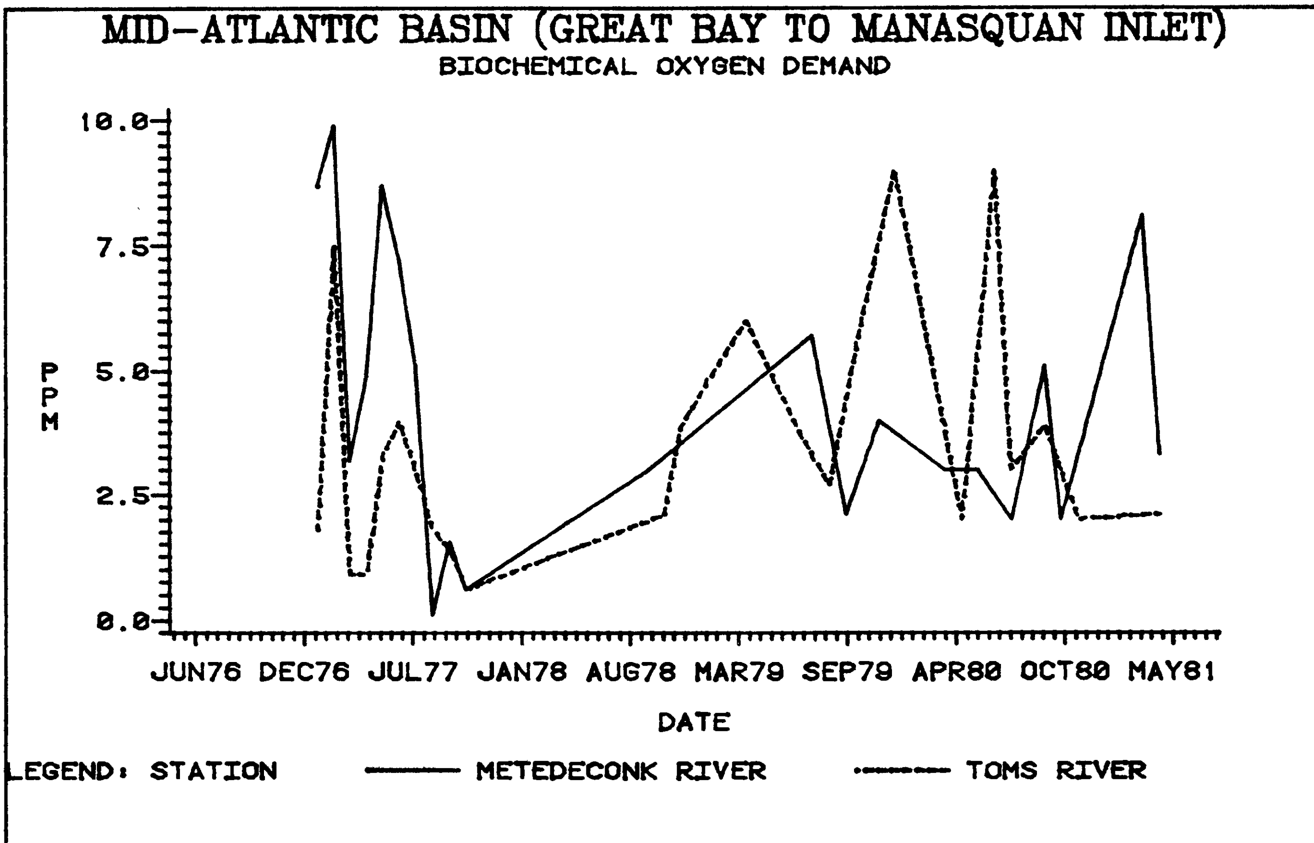


FIGURE – P – 2



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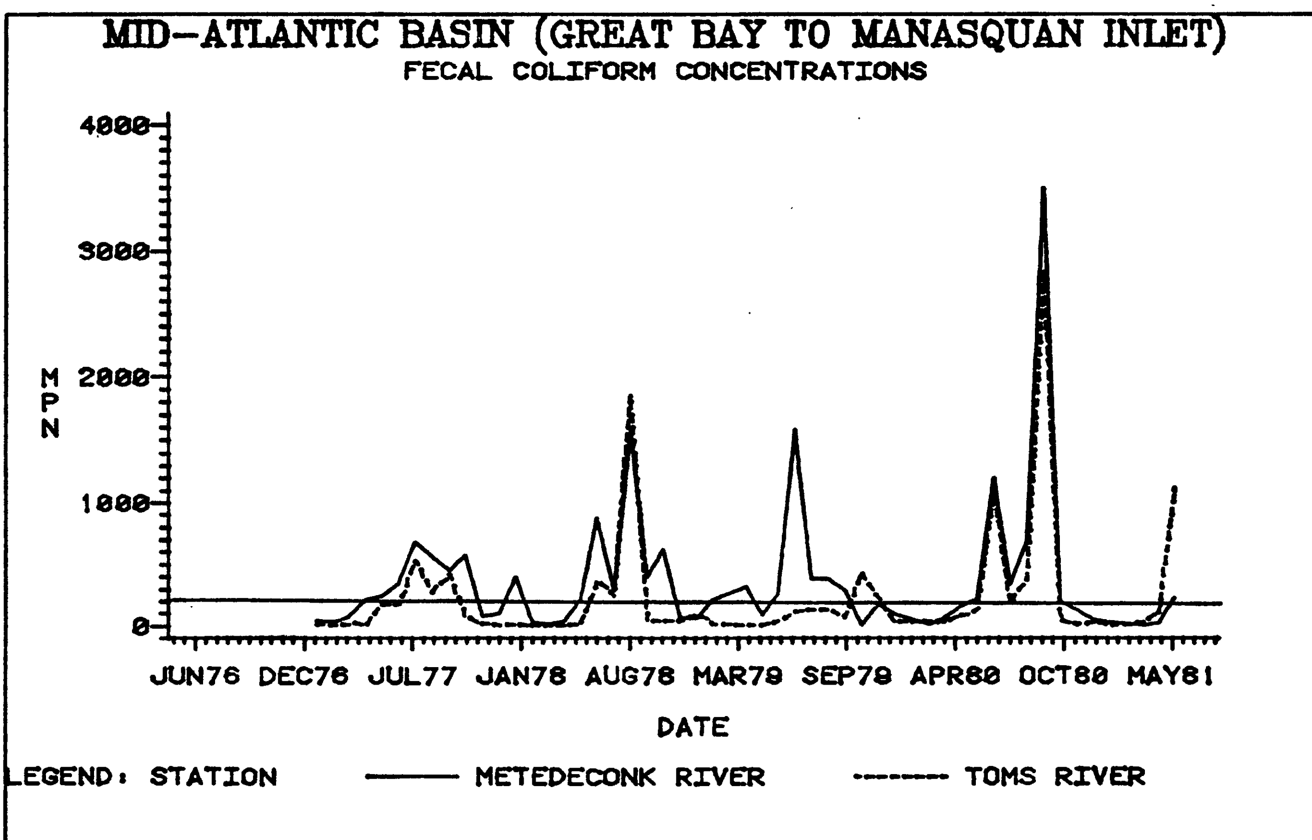


FIGURE – P – 4

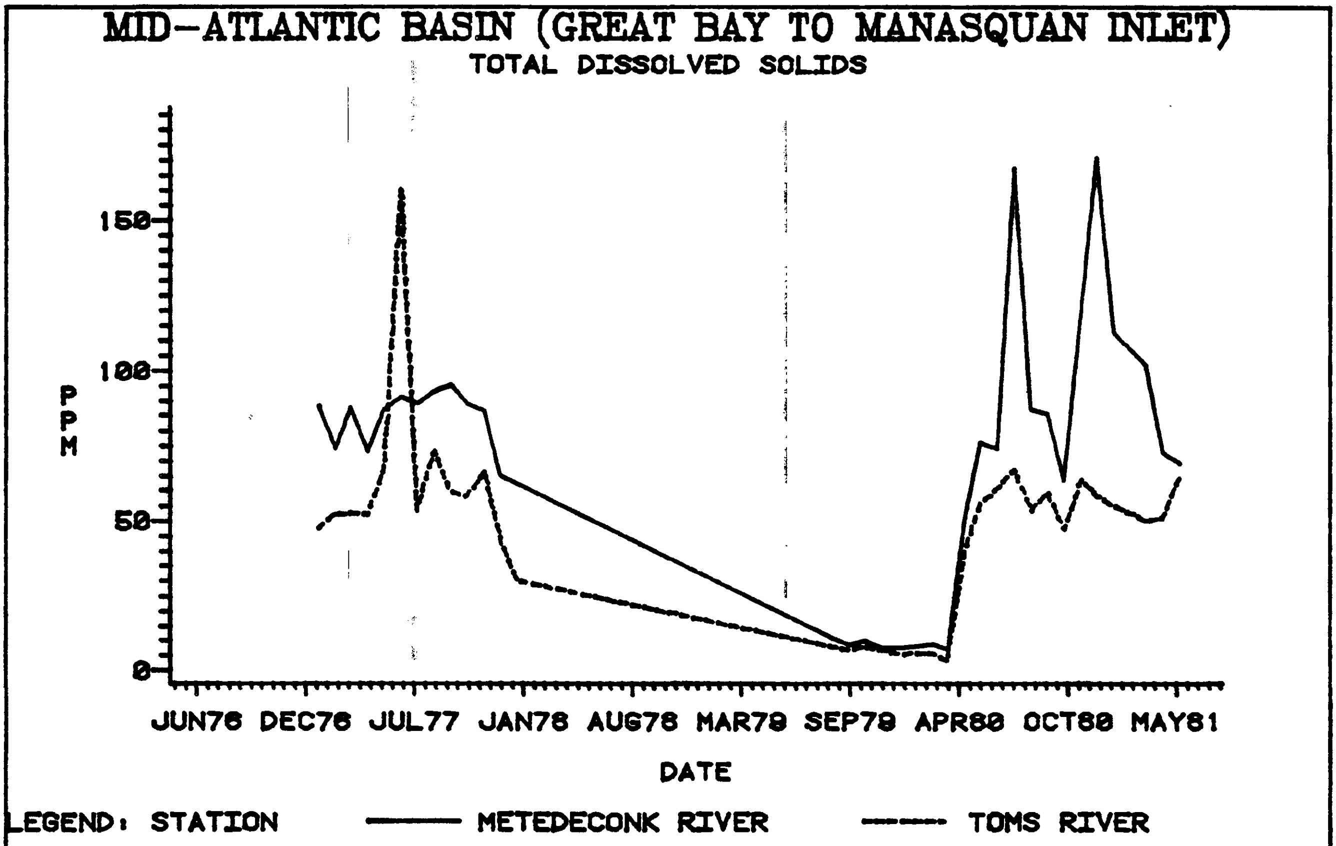


FIGURE - P - 5

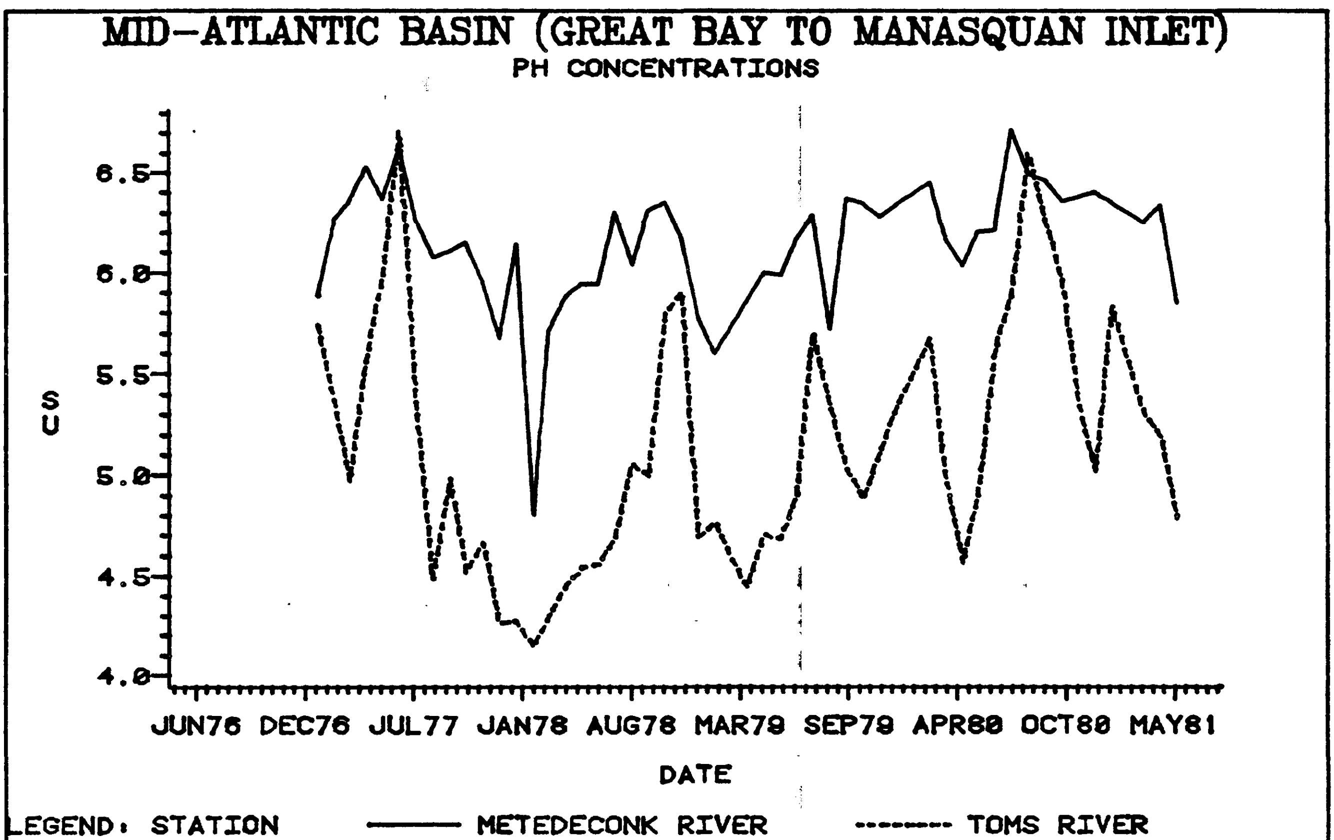


FIGURE - P - 6

MID-ATLANTIC BASIN (GREAT BAY TO MANASQUAN INLET)

TOTAL PHOSPHORUS CONCENTRATIONS

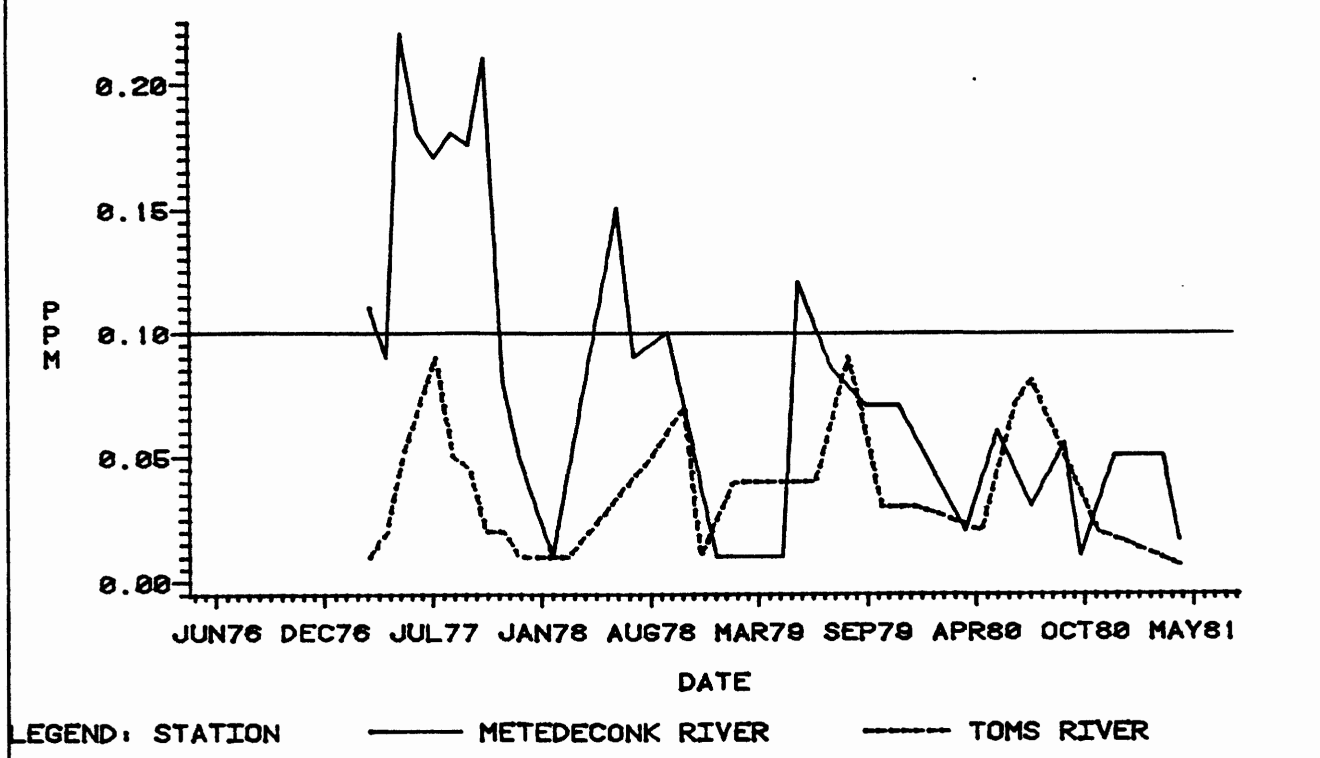


FIGURE - P - 7

MID-ATLANTIC BASIN (GREAT BAY TO MANASQUAN INLET)

NITRATE + NITRITE CONCENTRATIONS

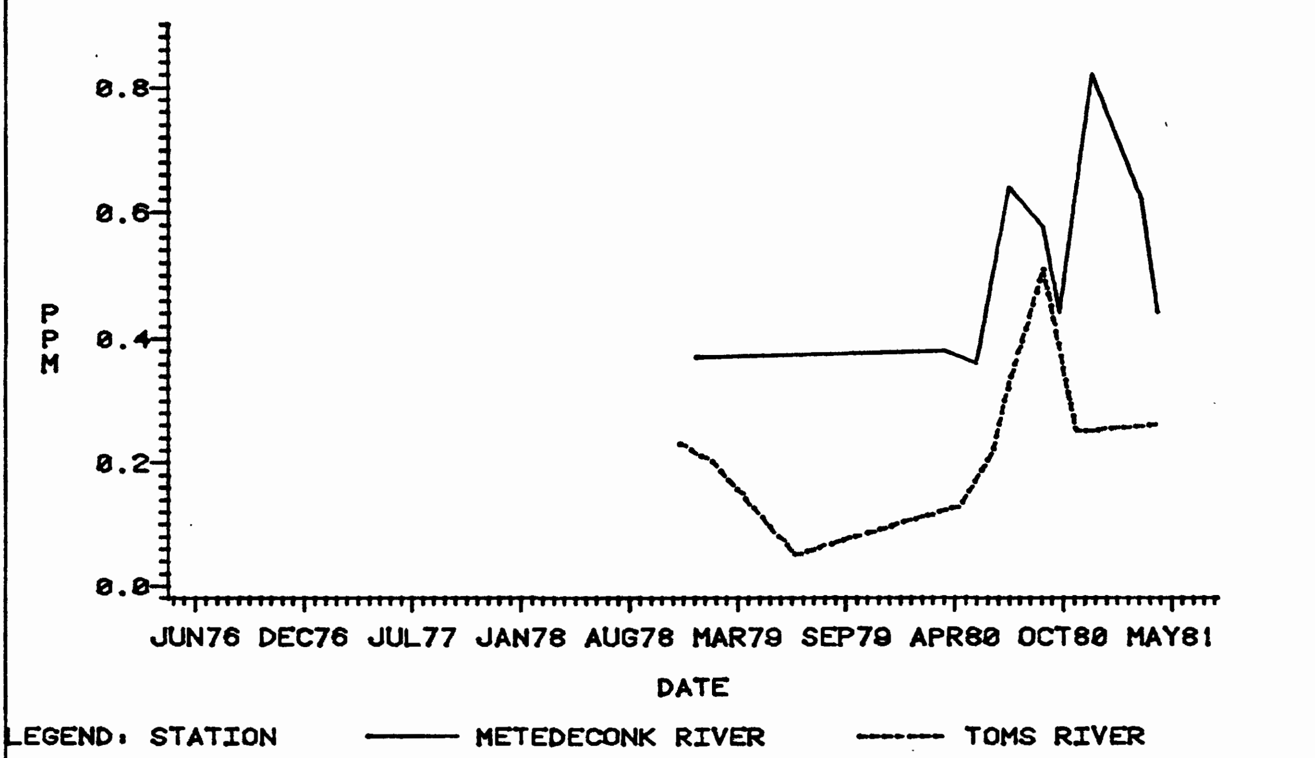


FIGURE - P - 8

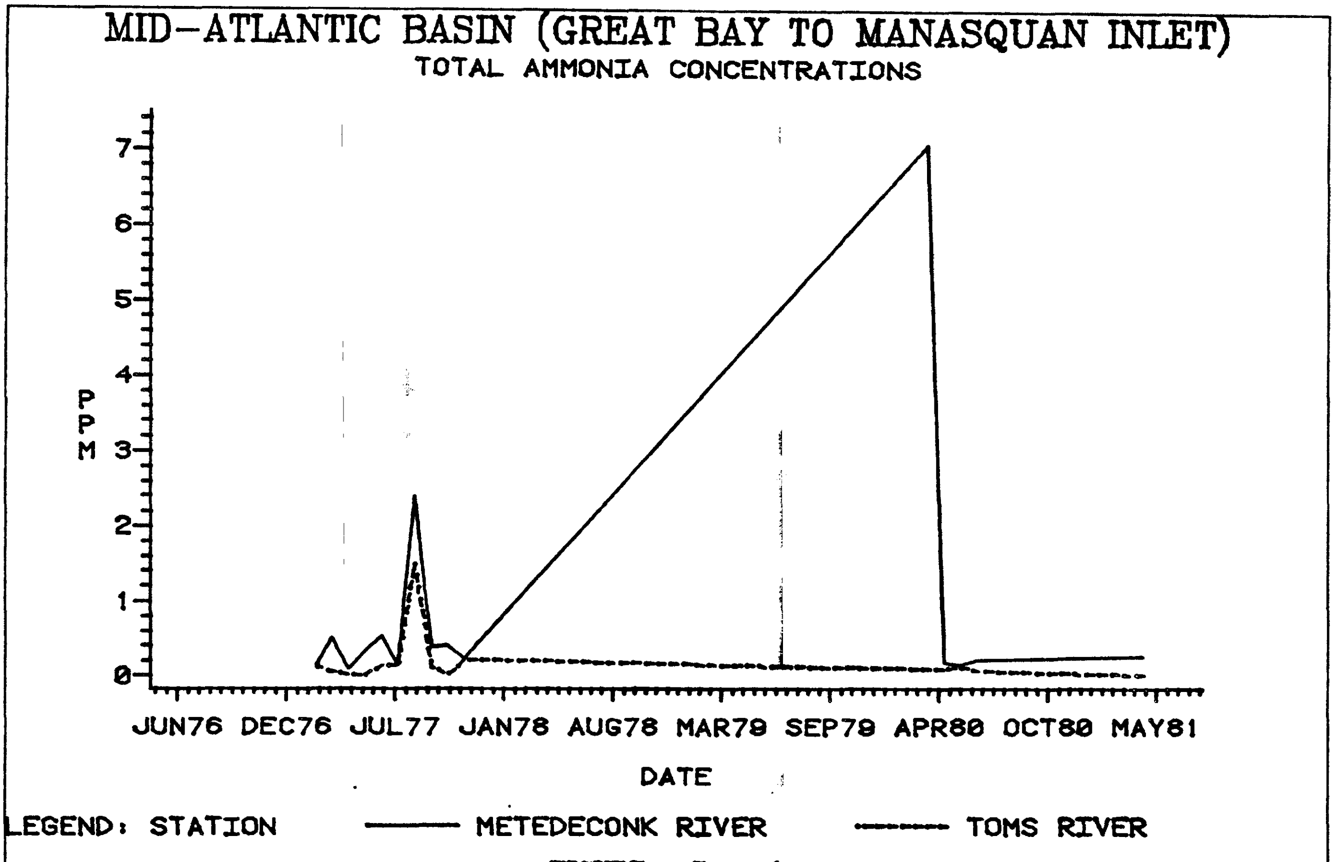


FIGURE – P – 9

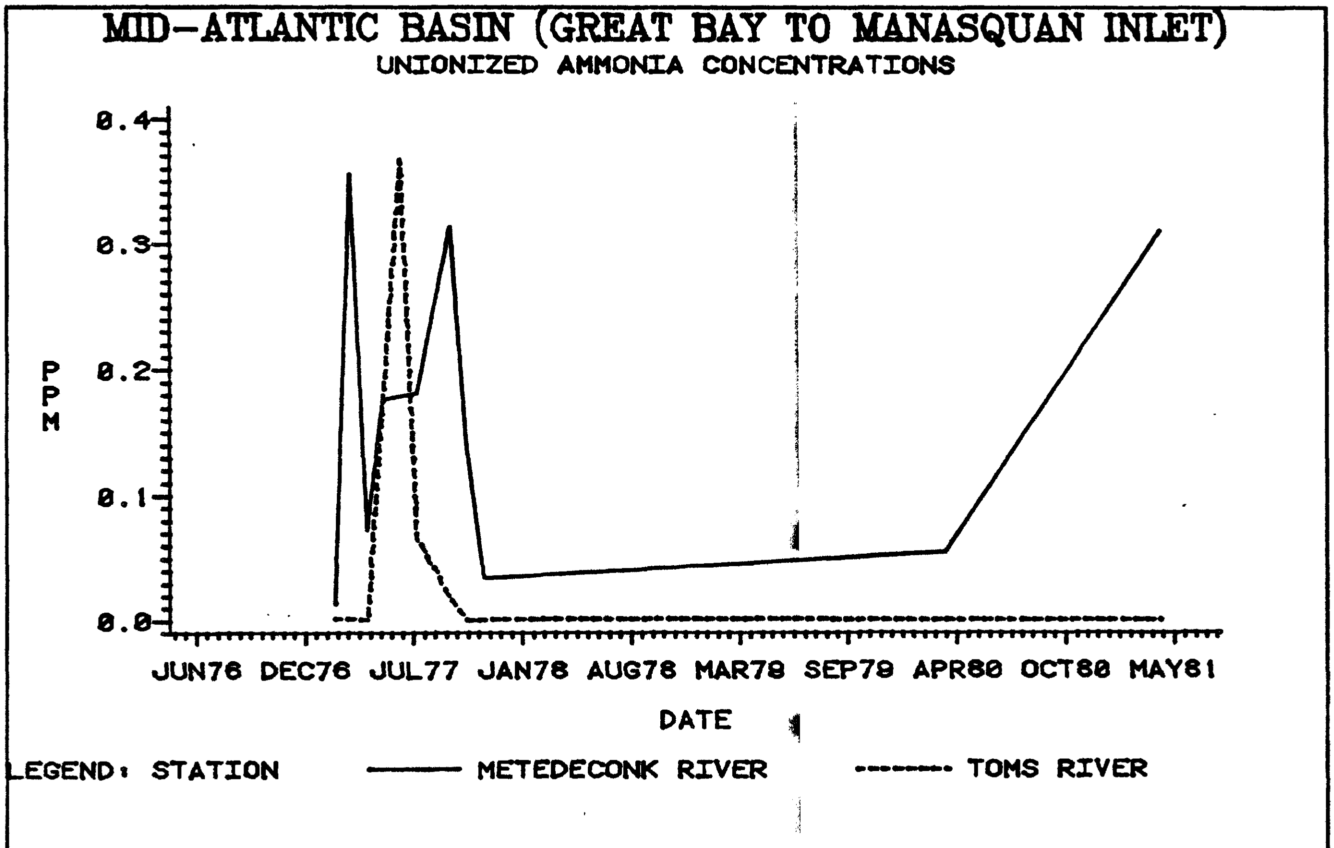


FIGURE – P – 10

DISCHARGE INVENTORY - - - MID-ATLANTIC COASTAL SEGMENT - MANASQUAN INLET TO GREAT BAY

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
WINDING BROOK MOBILE HOME PARK	0026956	HOWELL TWP.	HAYSTACK BROOK	PROCESS WASTE	.02
CLAYTON SAND COMPANY	0005169	LAKEWOOD	LONG BROOK	PROCESS WASTE	
INTERSTATE IND PARK	0032701	JACKSON	METEDECONK RIVER		
JACKSON TWP MUN UTILITIES AUTH	0035041	JACKSON	METEDECONK RIVER		
POINT BAY FUEL INC.	0034371	LAKEWOOD	METEDECONK RIVER		
JACKSON TWP BD OF ED	0029513	JACKSON TWP	NORTH BRANCH OF TOMS RIVER	SANITARY	.08
TOMS RIVER WATER CO.	0005649	DOVER TWP	TOMS RIVER	WATER TREATMENT	.04
OAK TREE MOBILE HOME PARK	0031267	JACKSON	TOMS RIVER	SANITARY	
LAKEHURST NAVAL AIR ENGR COMM.	0004642	LAKEHURST	TOMS RIVER BR	COOLING & SANIT	.32
FOUNTAINHEAD PARK INC	0035653	JACKSON TWP	TRIB METEDECONK R		
JACKSON TOWNSHIP MUA	0020583	JACKSON /TWP/	TRIB N BRANCH METEDECONK RIVER	SANITARY	.11
TOMS RIVER WATER CO	0005657	DOVER TWP	BAY LEA BROOK		.02
ASARCO INCORPORATED	0005746	DOVER TWP	CEDAR BAYOU	PROCESS WASTE	3.59
OCEAN COUNTY SEWERAGE AUTH.	0029408	BERKELEY TWP	ATLANTIC OCEAN	SAN/SIG INDUS	2.63
OCEAN COUNTY SEWERAGE AUTH.	0028142	BRICK TWP	ATLANTIC OCEAN	SANITARY	11.53
OCEAN COUNTY UTILITIES AUTH	0024775	DOVER TWP	ATLANTIC OCEAN	SANITARY	6.01
BOROUGH OF POINT PLEASANT	0034622	POINT PLEASANT BEACH	ATLANTIC OCEAN		
OCEAN COUNTY UTILITIES AUTH	0026018	STAFFORD TWP	ATLANTIC OCEAN	SANITARY	4.30
TOMS RIVER CHEMICAL CORP	0004120	DOVER TWP	ATLANTIC OCEAN & TOMS RIVER	PROCESS & COOL.	
IS. BEACH ST. PARK W.T.P.	0025780	BERKELEY TWP	BARNEGAT BAY		
BEACON PARK SUBDIVISION	0033782	HARVEY CEDARS	BARNEGAT BAY		
POINT PLEASANT BOROUGH	0031542	POINT PLEASANT	BARNEGAT BAY	WATER TREATMENT	.02
SHIP BOTTOM WATER DEPT	0032450	SHIP BOTTOM	BARNEGAT BAY		
NJ HIGHWAY AUTHORITY	0021130	LACEY TWP.	CEDAR CREEK	SANITARY	
STATE OF NJ DEP	0026808	LACEY TWP.	FORKED RIVER	SANITARY	.03
JERSEY CENTRAL POWER & LIGHT	0005550	LACEY /TWP/	OYSTER CREEK	PROCESS WASTE	4.70
JERSEY CENTRAL POWER & LIGHT	0031097	LACEY TWP.	OYSTER CREEK	PROCESS WASTE	12.14
JERSEY CENTRAL POWER & LIGHT	0030937	LACEY TWP.	OYSTER CREEK	PROCESS WASTE	
STOP & SHOP COMPANIES INC	0028274	LAURELTON	FORGE POND	COOLING WATER	
BOROUGH OF SEASIDE HEIGHTS	0023370	SEASIDE HEIGHTS BORO	MANALAPAN BROOK	SANITARY	1.15

Q. MANASQUAN RIVER

Basin Description

The Manasquan River drains approximately 81 square miles in Monmouth County, with an average flow as recorded at Squankum (drainage area of 43.4 square miles) of 76 cfs. The headwaters of the Manasquan River originate in agricultural/rural Freehold Township. The Manasquan River flows in a southeasterly direction through Howell and Wall Townships. The river flows through agricultural, residential and light industrial development to the densely populated areas of the Jersey shore. Along the border of Monmouth and Ocean Counties the Manasquan empties into the Atlantic Ocean via the Manasquan Inlet. The Manasquan River is connected in its lower tidal reach to northern Barnegat Bay through the Point Pleasant Canal, the northern inlet of the intracoastal waterway. The Manasquan River supports intensive boating and fishing in the downstream tidal portion and has developed into a major sport fishing and commercial clamming center. Major tributaries to the Manasquan River include Debois Creek, Marsh Bog Creek and Mingamahone Creek. The streams of the Manasquan River watershed receive much of their base flow from groundwater contributions especially in summer months. The sandy soils of this region allow for rapid percolation of precipitation which then becomes groundwater. The Manasquan River is tidal downstream from a point two miles east of the Garden State Parkway.

Forty one percent of the basin is utilized as crop and pasture land. Agriculture in the basin consists primarily of beef cattle, horse, poultry and swine operations, with crop acreage devoted primarily to barley, soybeans and tree/shrub farming. Significant surface water diversions from the Manasquan River (30 mgd) and Debois Creek (5 mgd) are permitted for sod farm irrigation.

Population growth between 1970 and 1980 occurred throughout the watershed. The largest urban centers are located in Howell, Freehold and Wall Townships and Freehold Borough.

Nineteen point sources are found in the Manasquan River basin; nine are municipal, nine industrial and one landfill. The largest industrial discharger in the basin is the Nestle Company (.6 mgd) in Freehold Borough which releases cooling water and filter backwash to Debois Creek. The Manasquan River Regional Sewerage Authority, which consists of five member communities (Howell Township, Farmingdale, Freehold Borough, Freehold Township and Wall Township), is currently installing an interceptor sewer system which will tie into the Ocean County Utilities Authority's northern treatment plant. The Manasquan River basin lies within the boundaries of two facilities planning areas designated by the New Jersey Department of Environmental

Protection. Potable water supplies in the basin are derived entirely from groundwater sources. The New Jersey Statewide Water Supply Master Plan has proposed the construction of two reservoirs in the basin which would ultimately provide 35 mgd for regional potable water supplies.

A number of small lakes and ponds lie within the Manasquan River basin. These lakes generally provide boating, shore fishing and ice skating activities.

All potential shellfish harvesting areas in the Manasquan River estuary are "condemned" for direct harvest and marketing. To utilize the limited hard clam resource that exists in this coastal zone, the local shellfish industry has been participating in the NJDEP's Shellfish Relay Program. Hard clams are transplanted from the "condemned" waters of Manasquan River to the "approved" waters of Barnegat Bay and Great Bay.

The State of New Jersey owns and operates two wildlife management areas (WMA) in the Manasquan River basin. The Manasquan River WMA comprises 726 acres and provides good quality fishing for trout, eels, catfish, white perch and bluegills. The Turkey Swamp WMA is partially located in the basin and provides for limited waterfowl hunting. Allaire State Park, consisting of approximately 3,000 acres, is also located in the basin. The New Jersey Division of Fish, Game and Wildlife stocks trout in the following waters: Manasquan River, Mingamohone Brook and Mac's Pond. The Manasquan River is included in New Jersey's Wild and Scenic Rivers Study Priority List.

New Jersey Water Quality Standards give the Manasquan River and tributaries a variety of water quality classifications including FW-1, FW-2 Trout Maintenance, FW-2 Nontrout and TW-1.

Water Quality Assessment

Conventional Parameters

Impacts of point and non-point pollution sources on water quality in the Manasquan drainage area has been the objective of numerous intensive surveys, in addition to routine ambient water quality monitoring. Water quality was marginal at best, with localized segments exhibiting poor conditions, particularly the upstream reaches of the Manasquan River and Debois Creek.

The Georgia station on the Manasquan River often exhibited marginally acceptable dissolved oxygen saturation levels during the summer months. Daytime, summer dissolved oxygen concentrations occasionally contravened the 6.0 mg/l minimum level, required for trout maintenance streams. The marginal dissolved oxygen levels exhibited seasonal fluctuations and were often associated with excessive five-day biochemical oxygen demand levels (1.0 to 11.0 mg/l) at both Georgia and Squankum.

Fecal coliform concentrations were higher than the 200 MPN/100 ml level at the rates of 61 and 81 percent at Georgia and Squankum, respectively; with some values at each station exceeding 5,000 MPN/100 ml. No improvement was apparent over the period at either station.

Total dissolved solids in the non-tidal segment were at acceptable levels through the period at the Georgia station. Total dissolved solids data at Squankum was insufficient to support an assessment. The pH at each station on the Manasquan River normally ranged from slightly acid to neutral over the period.

The Manasquan River exhibited moderate to high organic enrichment through the period as evidenced by usually excessive total phosphorus concentrations and elevated levels of other nutrients. Over 75 percent of the phosphorus data collected at both Georgia and Squankum contravened the 0.1 mg/l standard. In addition, nitrate + nitrite levels were occasionally greater than 1.5 mg/l at each station. Total ammonia concentrations were generally higher at the upstream station (Georgia), where levels often exceeded 2.0 mg/l. While un-ionized ammonia data collected at the Georgia and Squankum stations were generally within the standard through the period, three contraventions of the standard were noted at Squankum between 1978 to 1981.

Special surveys conducted on Debois Creek during the period revealed serious water quality problems, exhibited in part by excessive nutrient levels. Total ammonia concentrations measured in February, 1981, at Three Brooks Road and Strickland Road were 9.46 mg/l and 5.59 mg/l respectively. Total kjeldahl nitrogen levels exceeded 10 mg/l and total phosphate concentrations ranged from 2.0 to 5.0 mg/l.

An intensive survey conducted in the Manasquan estuary in 1979 concluded that nutrient loading from the upper watershed was degrading the upper region of the estuary.

Bacterial quality in the estuary was generally substandard, while elevated nitrate nitrogen concentrations, apparently the limiting nutrient, fostered extensive algal blooms in the upper estuary. Consequently nitrate nitrogen levels were generally less than 0.01 mg/l further downstream.

Biological samples were collected at Squankum in 1977 and 1978. Periphyton chlorophyll a concentrations were at low to intermediate levels, suggesting conditions of low to moderate organic enrichment. However, the macroinvertebrate data indicated a stressed community; it was dominated by oligochaete worms which are generally considered tolerant of organic pollution. In 1977 and 1978, at least 50 percent of the individuals were of one genera of oligochaetes, Paranais, and Limnodrilus, respectively.

A heavy silt loading in the river would also lower the macroinvertebrate diversity and favor the silt tolerant oligochaetes.

In reviewing water quality data from earlier 305(b) reports there have been no detectable trends showing either improvements or worsening of water quality. Excessive nutrients, BOD_5 and fecal coliform with seasonally low DO have been long-term problems in the Manasquan River near Georgia and at Squankum.

Toxic Parameters

Tissue samples collected in 1975 from the tidal Manasquan River at Treasure Island produced trace levels of PCB 1254. Further upstream, 1978 samples of fish taken from the same river at Georgia Road, Freehold Township revealed only trace levels of both organochlorine pesticides and PCB 1254. Sediment analyses of this same site in 1981 showed below detectable amounts for all parameters tested. The headwaters of the Manasquan River serves as the location for Lone Pine landfill, currently a closed site, but one which received a variety chemical wastes and waste sludges in the past.

The data that the Office of Cancer and Toxic Substances Research (OCTSR) has collected from the Manasquan River has centered on the effect of toxic contamination leaching from the landfill into the river. The landfill is surrounded by stream channels and accompanying swamps on three sides; therefore, any contaminants leaching from the landfill have the potential to enter the surface water.

The following assessment is based on data collected by OCTSR on several dates from 1977-1981 and on data from a joint survey of the Manasquan River conducted by EPA and the Division of Water Resources, February, 1981.

Samples collected from the landfill leachate and the headwaters of the Manasquan River have revealed the presence of several volatile organic compounds. The concentrations of the volatiles are quite high in the leachate, but are reduced downstream at Burke Road due to aeration and subsequent volatilization in the stream channel. The possibility for volatile compounds to be transported a considerable distance in the Manasquan River is evidenced by data collected in 1981 where eigth volatile compounds were detected approximately two miles downstream of the landfill. There are no other known point source discharges entering the Manasquan along the two mile stretch sampled. This data was produced using a gas chromatographic scan procedure which has limited capability to quantify contaminant concentrations. Therefore, the data must be intepreted in general terms, but is still useful in depicting the persistence of volatile compounds in the Manasquan River.

The most comprehensive sediment data available for toxic pollutants from the Manasquan River was collected in February, 1981 by EPA and the Division of Water Resources. A total of twelve sites were sampled in the nontidal portion of the river. Results from the sampling revealed the presence of a wide range of persistant organic contaminants in the sediments along the entire length of the stream. Compounds identified included several phthalate esters and polynuclear aromatic hydrocarbons. The concentrations of these compounds are not extremely high, but are above the background levels expected in South Jersey surface waters.

Problem Assessment

Water quality in this basin was described in the "Water Quality Assessment" section as ranging from marginal to poor. Parameters cited as being of concern included dissolved oxygen, biochemical oxygen demand, fecal coliform, total phosphorus and un-ionized ammonia. In addition, toxic contamination is a major issue in the watershed.

The initial Monmouth County WQM Plan had included a water sampling and water quality analysis component. That plan studied historical data as well as data from its own sampling. Based on that information, the plan found that dissolved oxygen, biochemical oxygen demand, phosphate, ammonia-nitrogen, total phosphorus, nitrate, and fecal coliform levels were unsatisfactory, at times, in portions of the Manasquan River basin. While this data predates the period of record for this report, the plan's conclusions regarding probable sources are of interest since that project had found similar water quality conditions. The WQM Plan concluded that the low levels of volatile organic compounds detected were contributed by point sources and a landfill. Contraventions of the water quality standards or EPA recommended criteria for standard parameters were generally attributed to point sources. Fecal coliform contamination, however, was believed to originate mainly from non-point sources although point sources were believed to possibly contribute, especially during a lapse of disinfection at one or more major dischargers.

An additional factor which may be impacting water quality in the basin is the abundance of septic tanks. The WQM Plan noted that Monmouth County placed in the top thirty of all counties nationwide, based on the number of on-site systems present. Among the municipalities having septic tank problems are Farmingdale, Wall, Manasquan and Freehold Township.

Debois Creek, a major tributary of the upper Manasquan River, contains degraded water quality according to the Monmouth County WQM Plan. The stream and tributaries receives treated wastewaters from 4 industrial and 2 municipal/domestic facilities and urban runoff from Freehold Borough. The combined flows of these sources are too great for Debois Creek to assimilate.

It is apparent that Lone Pine landfill is having an effect on the headwaters of the Manasquan River both from the addition of organic nutrients and toxic pollutants. However, the magnitude of the toxic effects and the extent of the toxicant transport have not been assessed. One of the most important questions which must be answered concerning the Manasquan River is how far downstream pollutants are carried, either dissolved in the water column or transported via adsorption onto sediments. If one examines the physical characteristics of the Manasquan River, it appears as a typical stream of the New Jersey coastal plain. The gradient of the stream is relatively flat resulting in slow current velocity; the flow can be characterized as constant with little turbulence and the stream has primarily a sandy substrate. These physical characteristics may partially explain the occurrence of the toxic contaminants in the Manasquan River.

Near Lone Pine landfill the stream velocity is very slow and the flow is quite constant, which probably explains the detection of volatile organic compounds well downstream of the landfill. However, the maximum distance that volatile compounds emanating from the landfill travel downstream in the Manasquan River is undetermined. The distribution of contaminants in the sediments may also be related to physical characteristics in the Manasquan River. Recent research has shown an inverse relationship between sediment grain size and sediment adsorptive characteristics for trapping pollutants. Due to the sandy sediments in portions of the Manasquan River, the existing sediment data might not provide an accurate record of past pollutant loading. Sandy substrates are also unstable and large amounts of sediments may move downstream in the Manasquan River during storm events when stream velocities increase.

The potential toxicity to human health of the compounds detected in the Manasquan River varies widely including several known carcinogens (vinyl chloride, benzo-a-pyrene, chloroform). Other compounds detected are classified as suspected carcinogens (bis-2-ethylhexyl phthalate) or mutagens (several of the polynuclear aromatic hydrocarbons). The presence of phthaletes in the sediment samples must be interpreted with caution; phthaletes are ubiquitous due to their common use as plasticizers and can easily contaminate samples in the laboratory.

The concentrations detected for any one compound are not alarmingly high; however, the number and types of different compounds detected are much higher than would be expected in a rural and agricultural watershed based on the toxic database developed at OCTSR. The data indicates a potential problem of toxic contaminants entering the Manasquan River and being transported to the site of the proposed reservoir.

Goal Assessment and Recommendations

The waters of the Manasquan River at Squankum and Georgia are not of swimmable quality. The very high counts of fecal coliform in the river are indicative of poor water quality. With regard to fishable status, the upper watershed is of good quality but offers stress conditions for trout species because of periodic low summer dissolved oxygen concentrations. Downstream at Squankum the same problem exists in addition to the toxics contamination identified by the OCTSR. Fifteen fish species were identified to occur in the Manasquan watershed. These species are generally indicative of slow moving, smooth bottom coastal streams.

The major water quality issue concerning the Manasquan River watershed is what impacts Lone Pine Landfill is having on surface waters downstream in the watershed and on the proposed Manasquan Reservoir System. Studies on the fate of sediment transport in the Manasquan River are currently underway in NJDEP and should be completed in the fall of 1982. The results of this study and other studies conducted on toxic substances transport in the watershed should be considered in the design of the reservoir system and its related treatment facilities.

Correction of malfunctioning septic systems in the watershed is needed, especially in portions of Wall Township and other areas adjacent to the Manasquan estuary. This may help in lowering bacteria levels and improve water quality for the harvesting of shellfish. Improvement to water quality in Debois Creek should take place once the Freehold Borough STP is eliminated and flows transferred to the Ocean County Utilities Authority's northern facility.

MANASQUAN RIVER STATION LIST

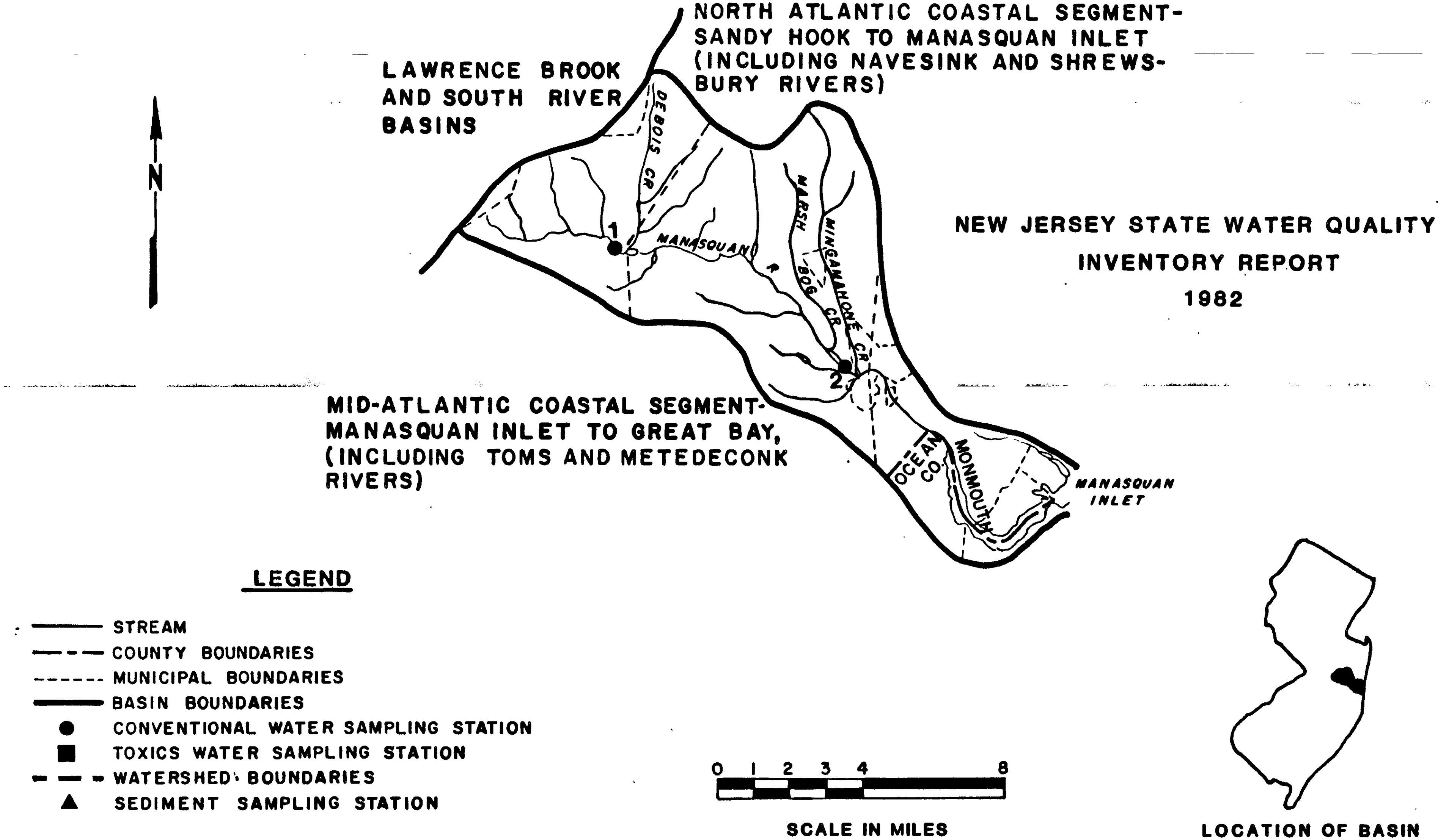
A. Ambient Monitoring Stations

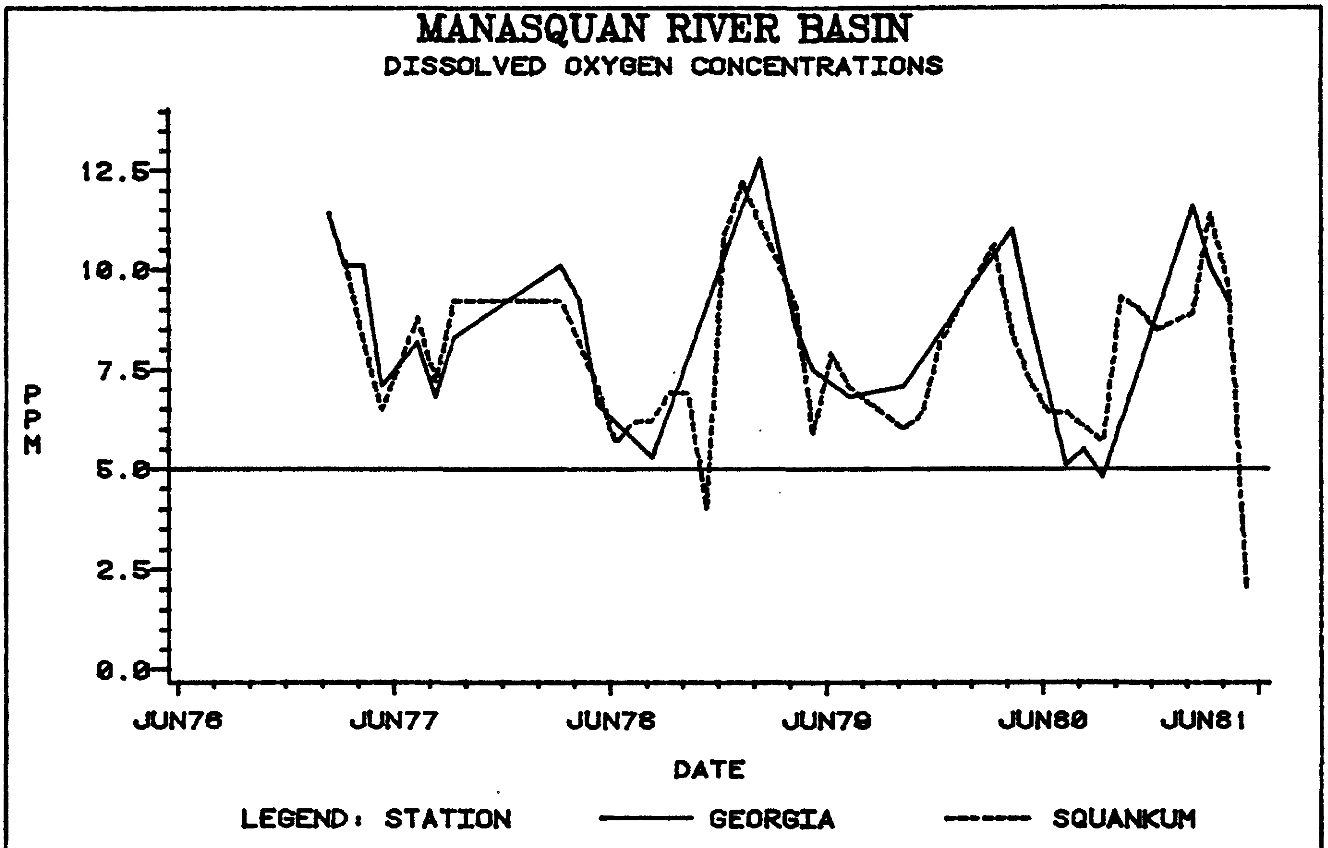
STORET Number	Station Description	Map Number
01407830	Manasquan River near Georgia, Monmouth County Latitude 40°12'36" Longitude 74°16'41" FW-2 Nontrout USGS/DEP Network At bridge on Jackson Mill Road, 0.5 miles upstream from Debois Creek and 1.6 miles north of Georgia.	1
01408000	Manasquan River at Squankum, Monmouth County Latitude 40°09'47" Longitude 74°09'21" FW-2 Trout Maintenance Basic Water Monitoring Program Intensive Survey, 1979 Ocean County Health Department Upstream side of weir, 20 feet downstream from bridge on Route 547 and 0.4 miles downstream from Marsh Bog Brook.	2

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Intensive survey in freshwater sections of Manasquan River	Water column	-

MANASQUAN RIVER BASIN





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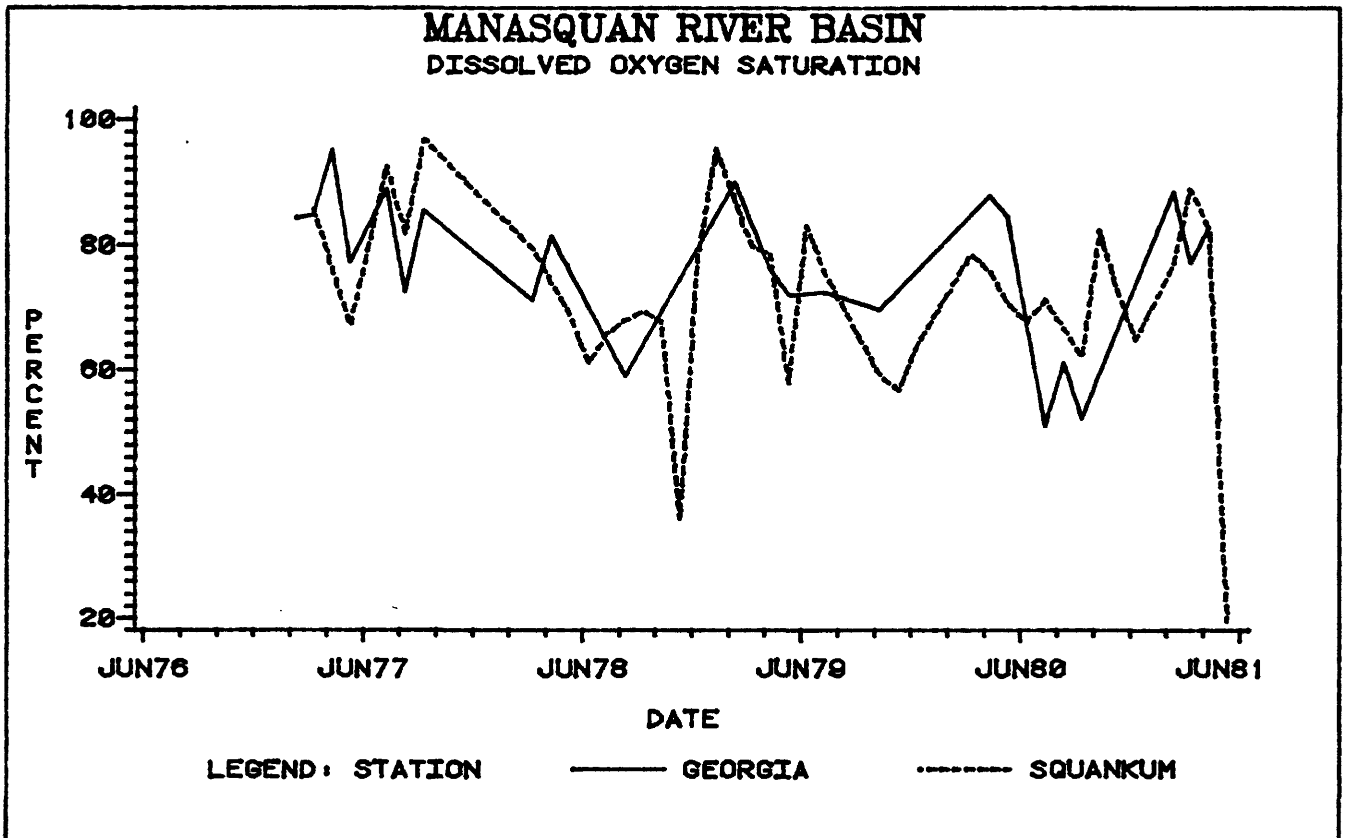

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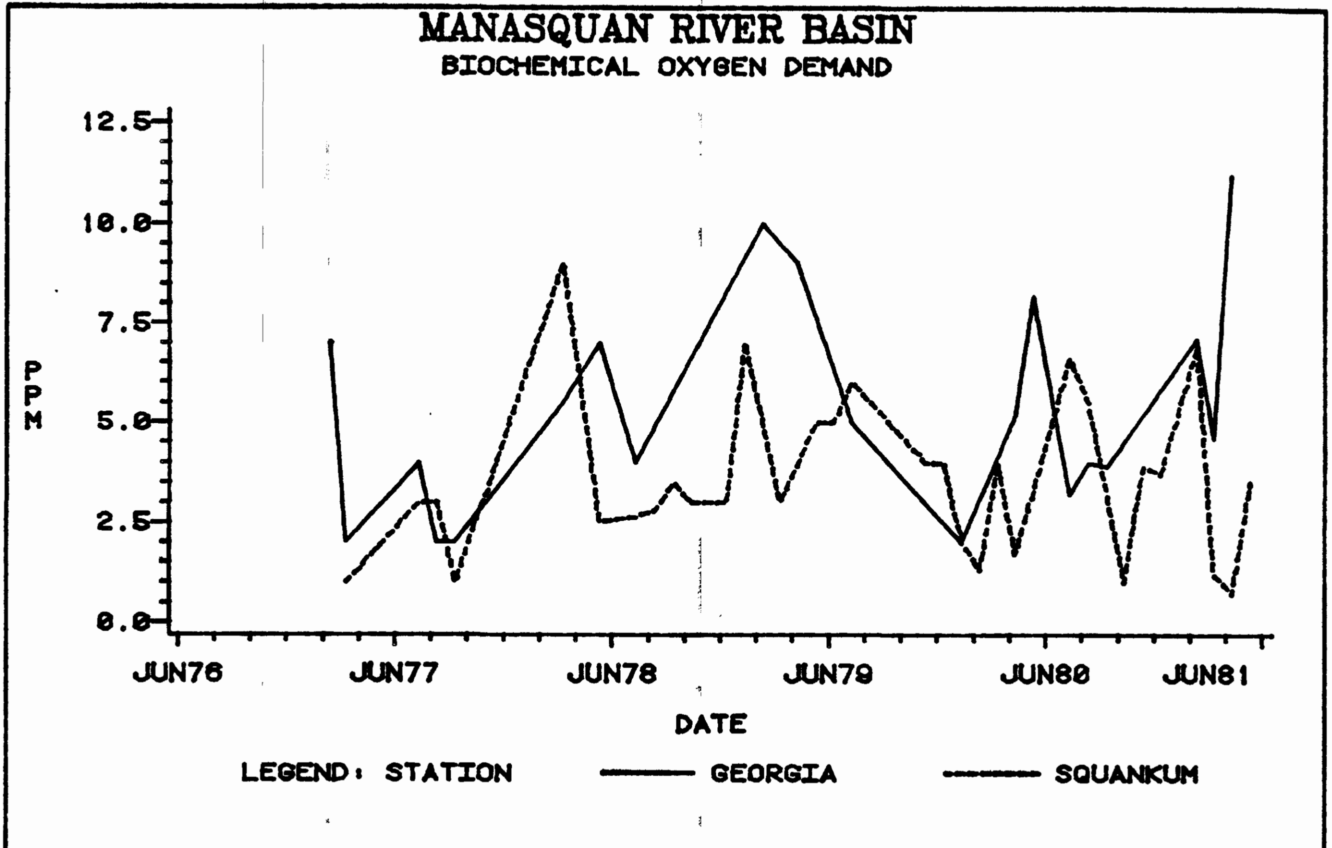

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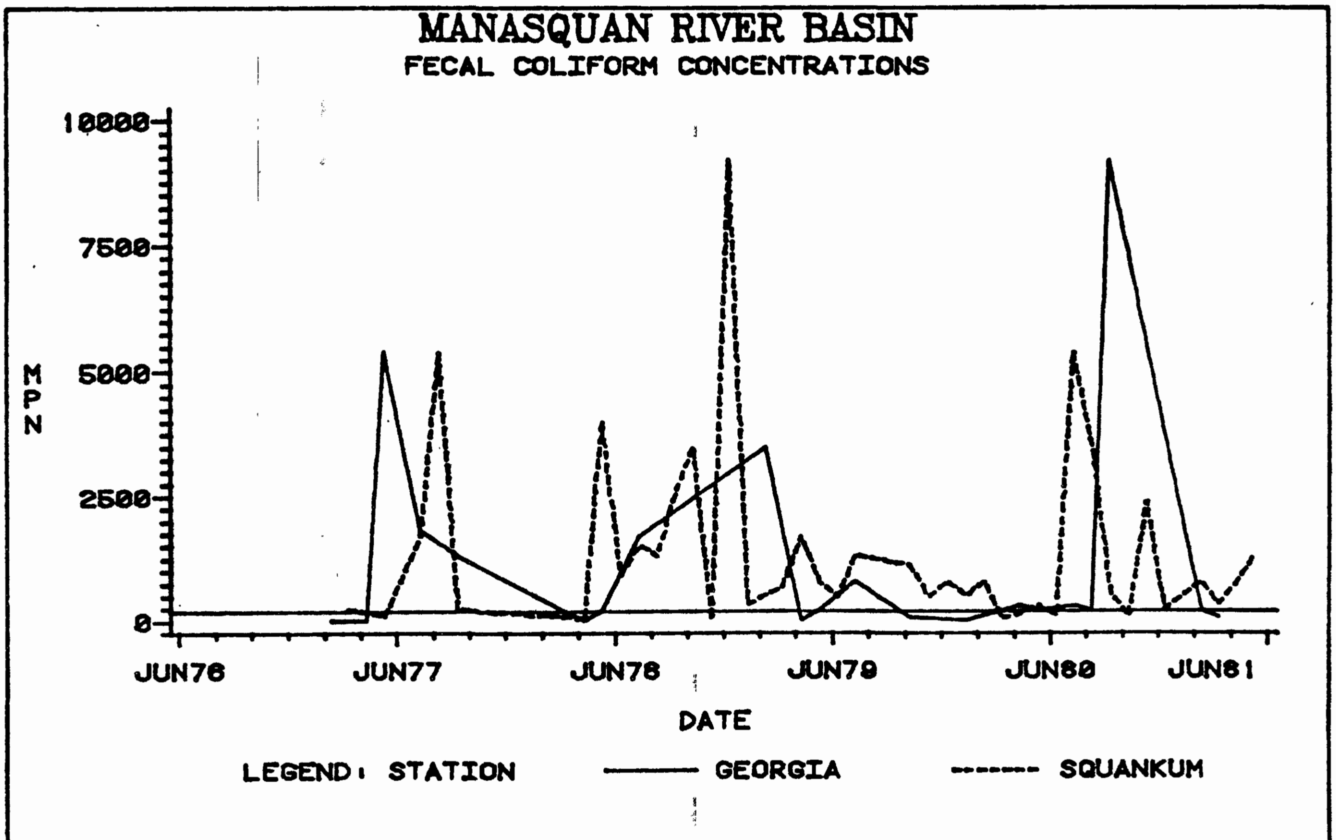

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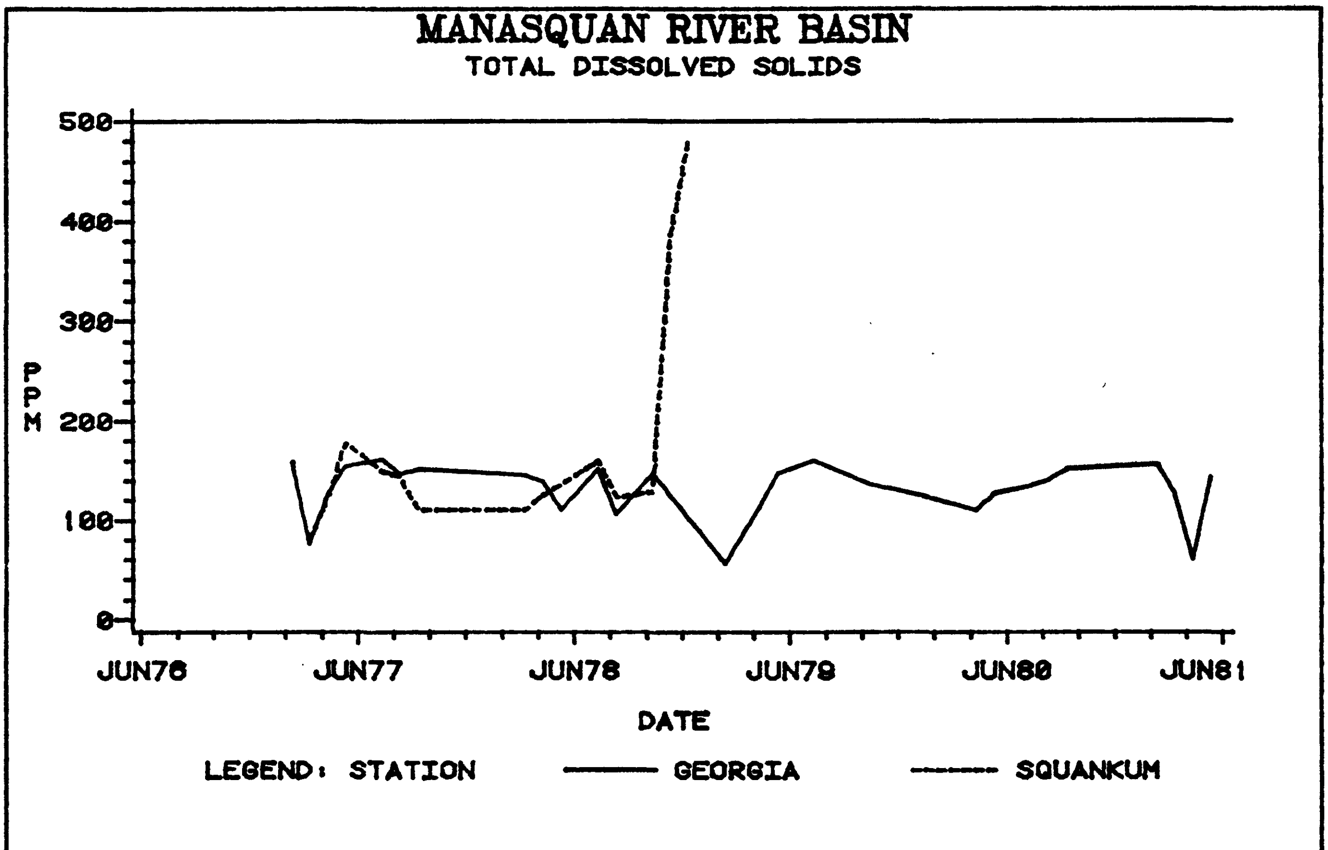

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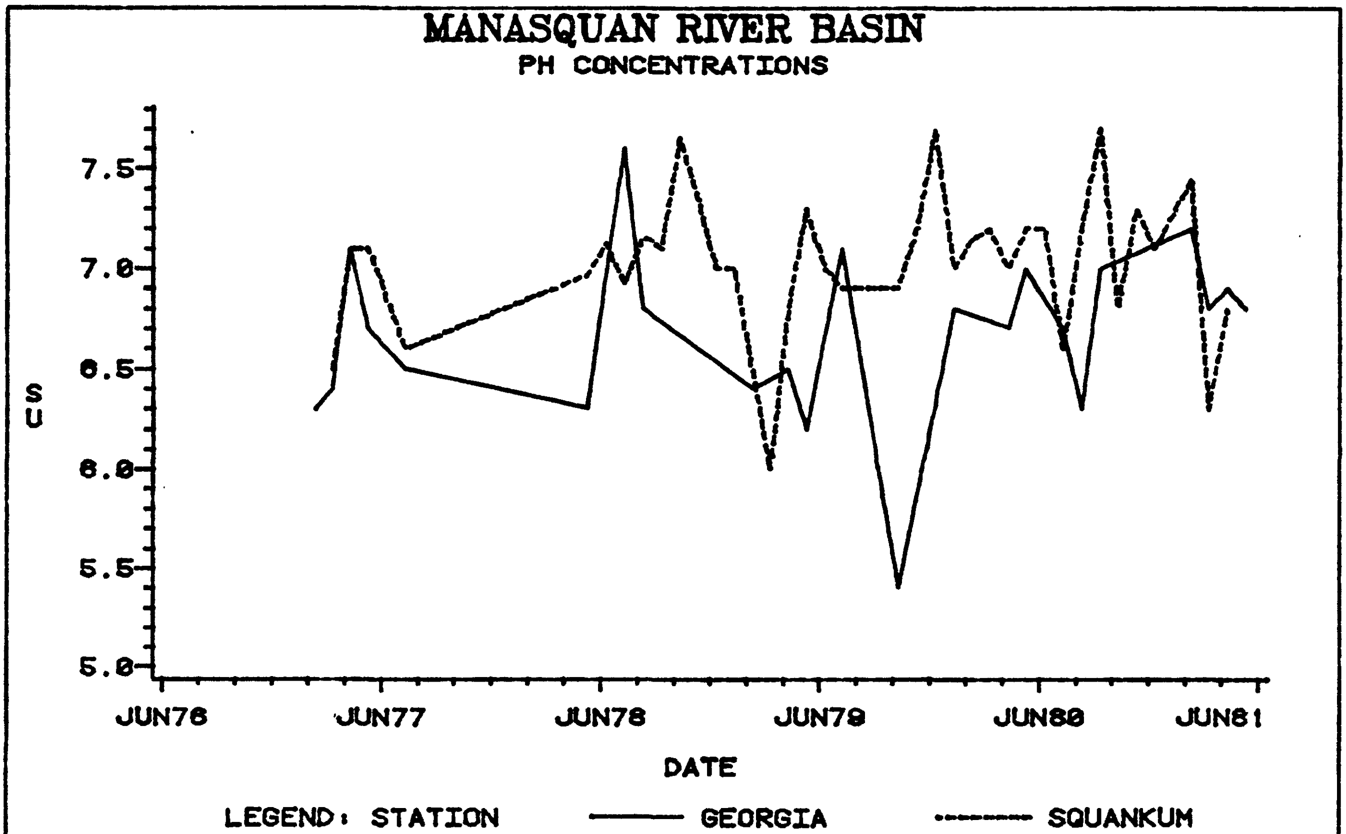

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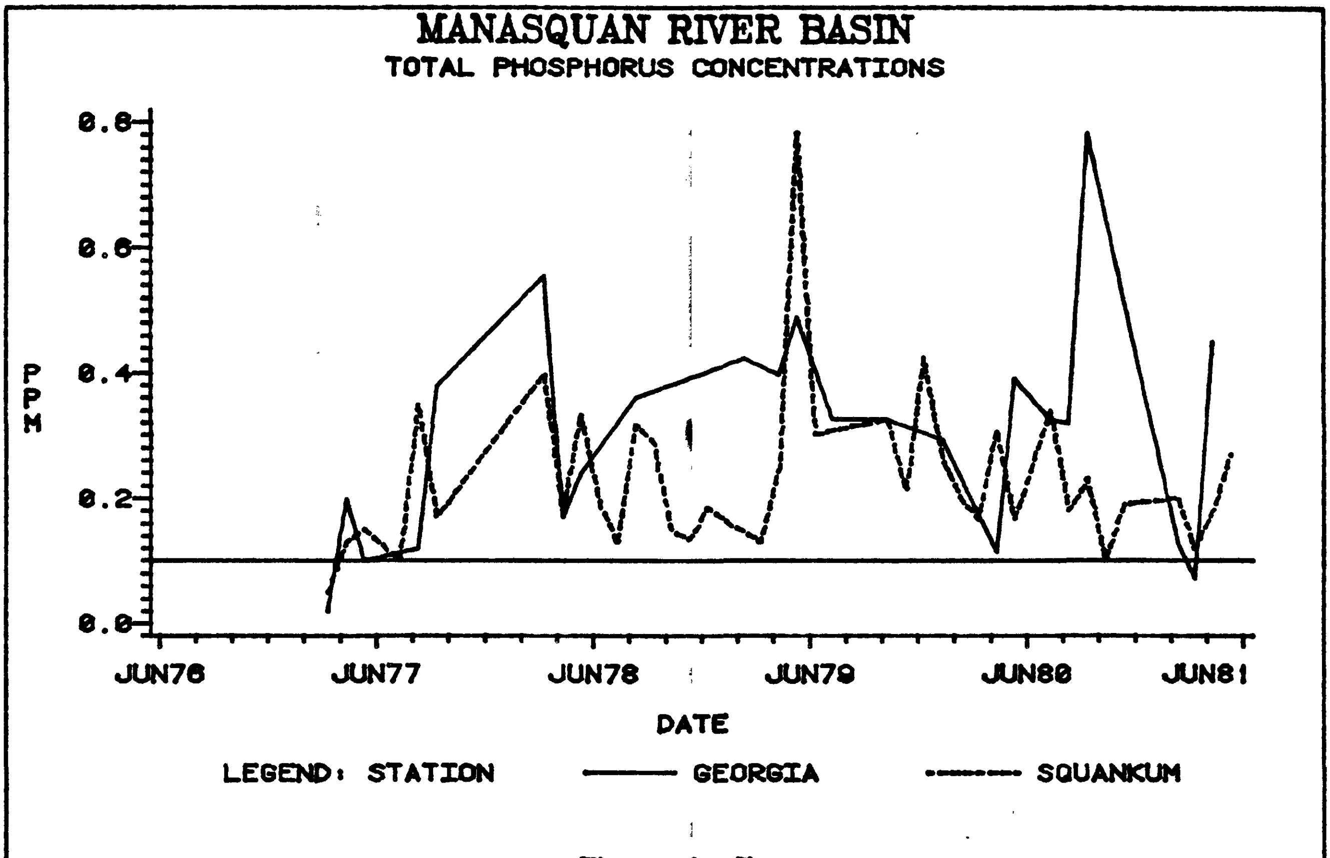

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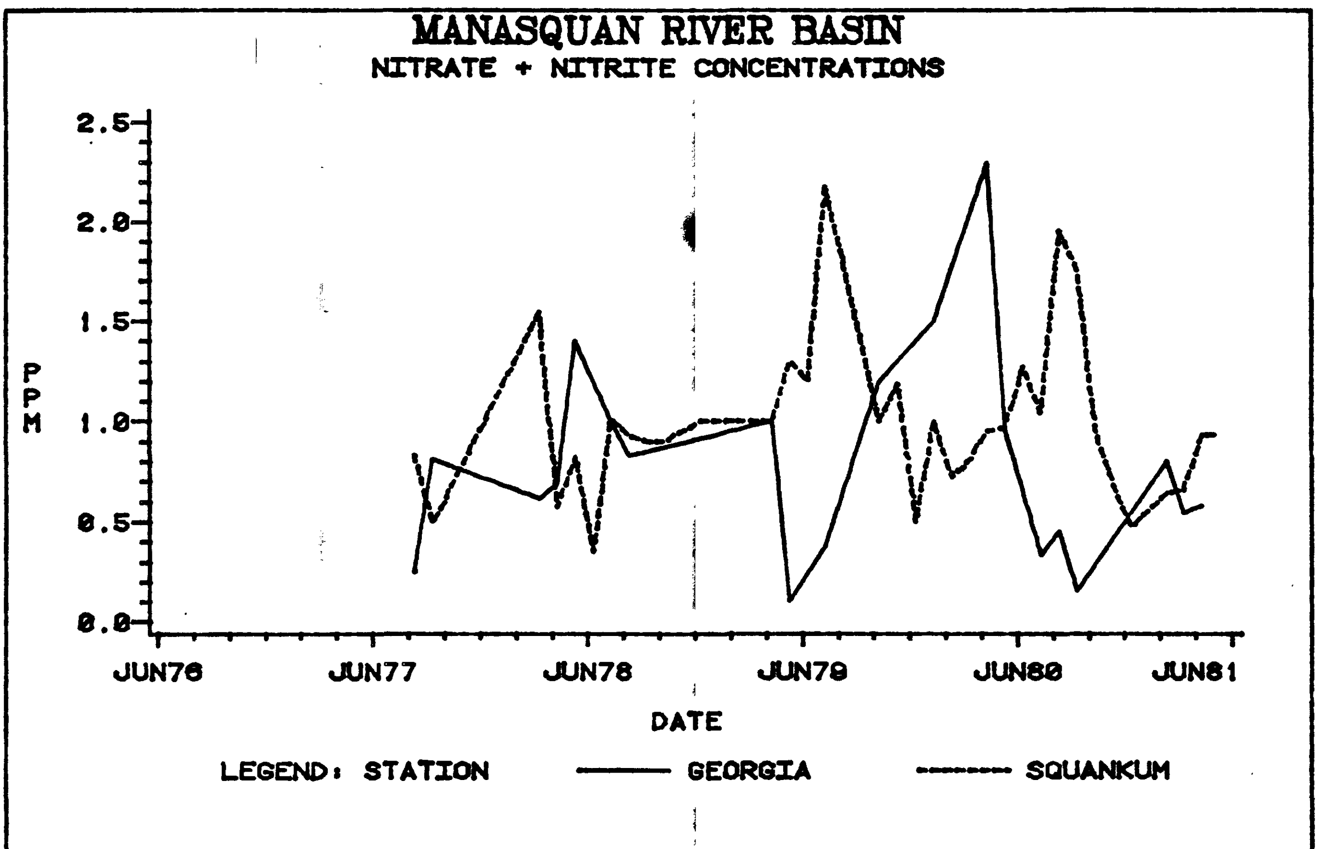

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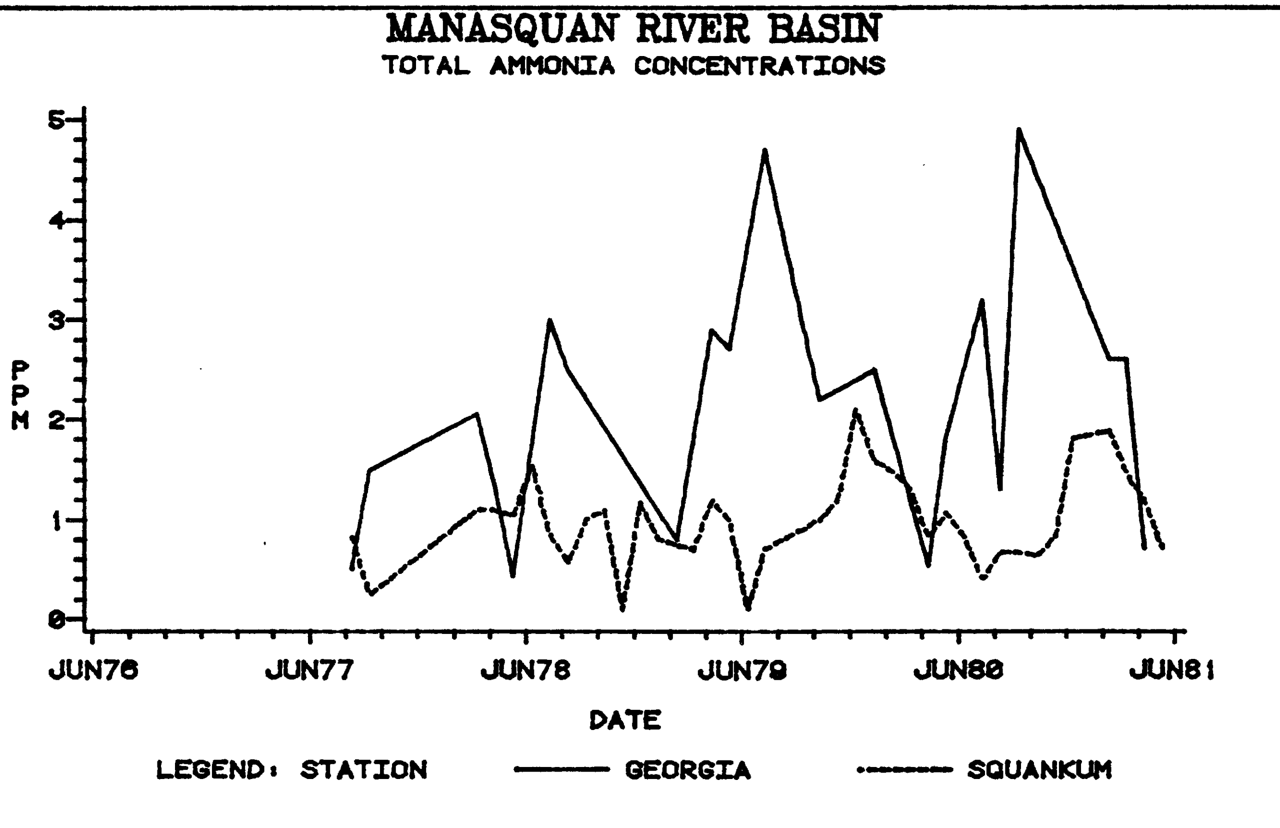

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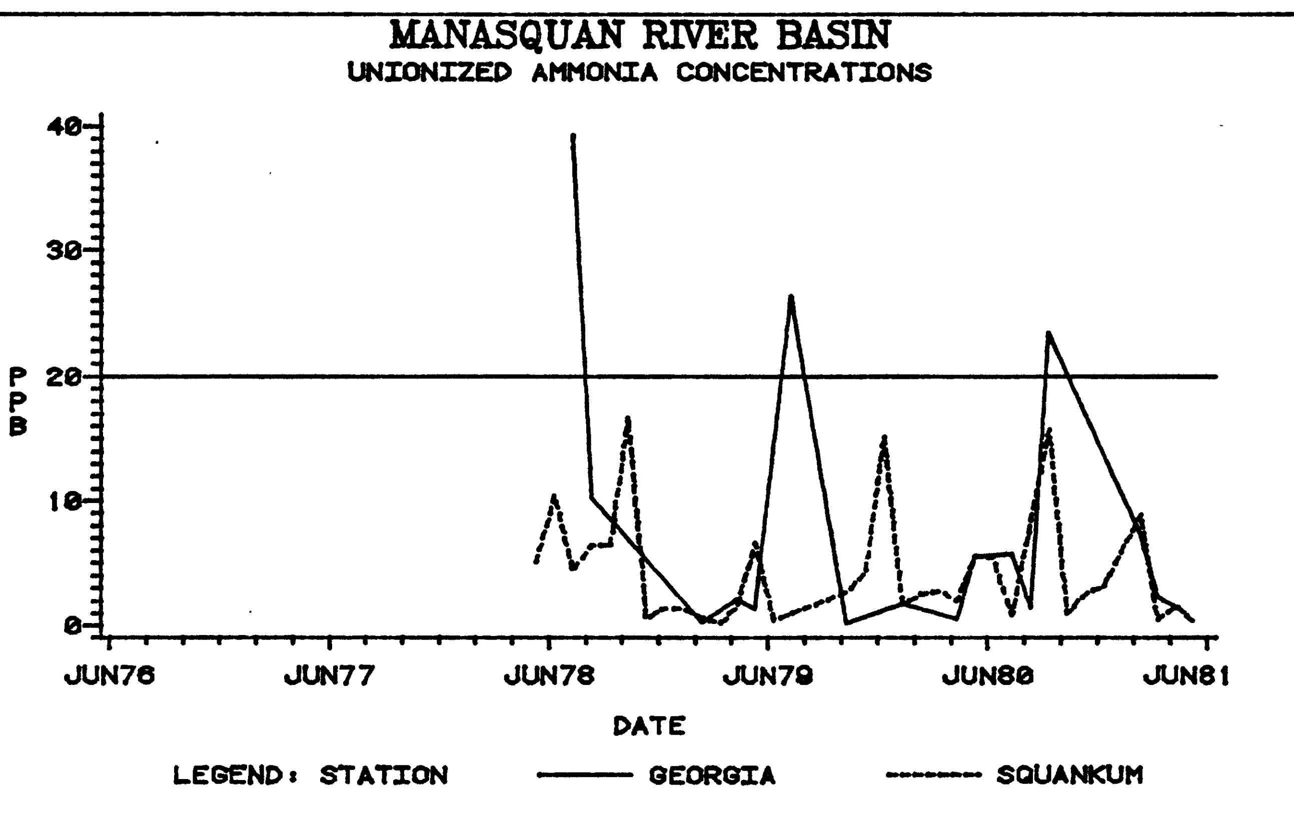


Figure: Q -10

DISCHARGE INVENTORY - - - MANASQUAN RIVER BASIN

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
ARTHUR BRISBANE CHILD TREAT.CT	0022977	WALL TWP	BRANCH OF MANASQUAN RIVER	SANITARY	
UNION CARBIDE CORP HOME&AUTOMO	0029661	FREEHOLD BORO	BURKE'S CREEK	COOLING WATER	.01
NESTLE CO. INC.	0005606	FREEHOLD BORO	DEBOIS CREEK	COOLING WATER	.60
BROCKWAY GLASS CO.INC.	0002933	FREEHOLD TWP.	DEBOIS CREEK	COOLING WATER	.35
BOROUGH OF FREEHOLD	0026565	FREEHOLD BORO	DUBOIS CREEK	SAN/SIG INDUS	1.60
.04S COMPANY	0025887	FREEHOLD TWP.	DUBOIS CREEK		.40
HARWOOD COMPANY	0032956	FARMINGDALE	MANASQUAN CREEK	COOLING WATER	
WYNNEWOOD SEW. UTILITY CO.	0021008	FREEHOLD TWP.	MANASQUAN R.	SANITARY	.25
FREEHOLD REGIONAL BD. OF ED.	0021644	HOWELL TWP	MANASQUAN R.	SANITARY	
ADELPHIA SEWER CO	0020133	HOWELL TWP.	MANASQUAN R.	SANITARY	.07
CERRO COMMUNICATION PRODUCTS	0031917	FREEHOLD	MANASQUAN RIVER	COOLING WATER	
LONE PINE CORP	0031925	FREEHOLD	MANASQUAN RIVER		
PEERLESS TUBE COMPANY	0004910	FREEHOLD /TWP	MANASQUAN RIVER	PROCESS WASTE	
FREEHOLD SEWER CO	0027766	FREEHOLD TWP.	MANASQUAN RIVER	SANITARY	.80
TOWNSHIP OF FREEHOLD	0027120	FREEHOLD TWP.	MANASQUAN RIVER	SANITARY	.03
FARMINGDALE GARDEN APTS.	0026638	FARMINGDALE BORO	MARSH BOG BROOK	SANITARY	
FOSTER CANNING CO INC	0026336	FARMINGDALE BORO	MARSH BOG BROOK	COOLING WATER	.04
I ROKEACH & SONS INC	0026417	FARMINGDALE BORO	MARSH BOG BROOK	COOLING WATER	.19
FREQUENCY ENGINEERING LABS	0028622	FARMINGDALE BORO	MINGAMAHONE CREEK	PROCESS & COOL.	
SILVERMEDE MOBILE HOME PARK	0028240	FREEHOLD TWP	PASAQUANACQUA BROOK	SANITARY	.02
MINN. MINING & MFG. CO.	0004359	FREEHOLD /TWP	PASSAQUANAQUA C	COOLING WATER	.22
NEW JERSEY DOT	0022373	BAY HEAD BORO	TWILIGHT LAKE		
BEL RAY COMPANY INC	0034177	WALL	NONE LISTED		

R. NORTH ATLANTIC COASTAL BASIN (SANDY HOOK TO MANASQUAN INLET)

Basin Description

The North Atlantic Coastal basin encompasses three distinct watersheds, i.e., the Navesink River (drainage of 95 square miles), the Shrewsbury River (drainage of 27 square miles) and the Shark River (drainage of 23 square miles). Headwaters streams of the Navesink River include Yellow Brook, Big Brook and Mine Brook in Colts Neck Township, and Willow Brook in Marlboro, Holmdel and Colts Neck Townships. These tributaries flow into the Swimming River Reservoir, which feeds the Swimming River; Pine Brook, and its major tributary, Hockhockson Brook, then joins the Swimming River. Flows continue in a northeasterly direction to join the Navesink River near Red Bank Borough and Middletown Township. The Navesink River then drains into the Shrewsbury River, which empties into Sandy Hook Bay between Sandy Hook and Highlands. The headwaters of the Shrewsbury River originate in Eatontown and Tinton Falls. The major tributaries are Parkers Creek and Oceanport Creek, which flow in a northeasterly direction, meeting between Little Silver and Oceanport, where they join the Shrewsbury River. The Shrewsbury flows northeast to join the Navesink River near Rumson. The two rivers then drain into Sandy Hook Bay. The headwaters of the Shark River originate in southeastern Monmouth County and flow eastward to join the Shark River, which enters the Atlantic Ocean through the Shark River Inlet. The headwaters of the Navesink, Shrewsbury and Shark Rivers generally flow through sparsely developed rural/agricultural lands, whereas the mainstem of the rivers traverse densely populated areas as they approach the Jersey shore. The average adjusted flow to 1980 for the Navesink River, recorded at Swimming River near Red Bank (drainage of 48.5 square miles) is 81.1 cfs.

Land use in the Navesink River watershed is comprised primarily of forested land (33 percent), agricultural land (29 percent); residential, industrial and commercial development (22 percent), and wetlands and water (15 percent). In the Shark River watershed 37 percent of the total acreage is forested, 33 percent is agricultural and 19 percent is developed. Land use in the Shrewsbury River watershed consists predominantly of residential, industrial and commercial development. Agriculture in the North Atlantic Coastal basin consists primarily of horse, beef cattle, swine and poultry farming, with crop acreage devoted primarily to soybeans, tomatoes and tree/shrub farming.

Population growth between 1970 and 1980 occurred throughout the basin, with Ocean Township experiencing the greatest increase (25 percent). The largest suburban centers are Middletown, Long Branch, Neptune, Ocean, Wall, Asbury Park, Holmdel and Red Bank.

There are a total of sixteen municipal and nineteen industrial point sources located in the North Atlantic Coastal basin. The largest treatment facility in the basin, Bayshore Regional Sewerage Authority, dischargers 8.61 mgd to the Atlantic Ocean via the Monmouth County Bayshore Outfall. The South Monmouth Regional Sewerage Authority, which serves Wall Township and adjacent shore communities discharges 3.23 mgd to the Atlantic Ocean near Spring Lake Heights. This has resulted in the elimination of five treatment plants previously discharging to the Atlantic Ocean. The Neptune Township Sewerage Authority discharges 3.71 mgd to the Atlantic Ocean near Bradley Beach. This has also resulted in the elimination of five plants previously discharging to the Atlantic Ocean. Additional, new treatment facilities in this region include Middletown Township (5 mgd), Northeast Monmouth Regional S.A. (8 mgd), Long Branch (5 mgd) and Township of Ocean S.A. (4 mgd). The North Atlantic Coastal Basin lies within six facilities planning areas designated by the NJ Department of Environmental Protection. The Swimming River Reservoir, owned and operated by the Monmouth Consolidated Water Company, is the largest existing potable water source in the basin. Additional surface water source of potable supply are from Shark River (Glendola Reservoir) and Jumping Brook, also owned and maintained by the Monmouth Consolidated Water Company.

Fifteen major lakes are located in the North Atlantic Coastal basin. The largest lake in the basin, Deal Lake (158 acres) provides boating facilities and good angling quality for largemouth bass, pickerel, white perch, carp, crappie and sunfish. The remaining lakes in the basin generally afford good shorefishing opportunities for a variety of freshwater species. Shore fishing and bathing activities are present along the entire Monmouth County coast. The shore also brings thousands of summer residents and visitors to the coastal communities. The Navesink and Shrewsbury Rivers are also heavily used for salt water fishing. All the shellfish harvesting areas in the North Atlantic basin are classified either "condemned" or "special restricted" for direct harvesting and marketing. The Navesink and Shrewsbury Rivers comprise virtually the entire soft clam shellfishery in New Jersey. Two soft clam depuration plants, regulated by the NJ Department of Health, are located in Atlantic Highlands and require 48-72 hour processing to enable clams to purge themselves of bacteria and pathogens. An additional hard clam depuration plant is currently under construction. In the Shark River watershed a relay program provides for hard clams, taken from "condemned" or "special restricted" waters, to be transplanted in the approved waters of Barnegat Bay.

The U.S. Department of Interior owns and operates Gateway National Recreation Area (i.e. Sandy Hook National Park) in Highlands Borough, which consists of 1800 acres providing water-based activities such as fishing, bathing, surfing and boating. The NJ Division of Fish, Game and Wildlife stocks trout in eleven water bodies throughout the basin (these include Big Brook, Garvey's Pond, Mohawk Pond, Hockhockson Brook, Holmdel Park Pond, Pine

Brook, Ramanessan Brook, Shadow Lake, Shark River, Willow Brook and Yellow Brook).

NJ Water Quality Standards give the North Atlantic Coastal basin a variety of water quality classifications, including FW-2 Trout Maintenance, FW-2 Nontrout, TW-1, CW-1 and CW-2.

Water Quality Assessment

Conventional Parameters

Water quality monitoring was performed on Willow Brook and Yellow Brook in the Navesink River watershed above Swimming River Reservoir, and in Jumping Brook, a tributary to Shark River. Except for periodic elevations of fecal coliform and total phosphorus, Willow, Yellow and Jumping Brooks exhibited generally good water quality through the period 1977 to 1981.

Daytime dissolved oxygen concentrations were generally sufficient at the three stations. Dissolved oxygen saturation levels were also for the most part acceptable for the period. Generally low to moderate levels of biochemical oxygen demand were recorded throughout the non-tidal segments in the basin. Only one elevated value of 4.0 mg/l was recorded in Willow Brook, but resulted in no measurable impacts on dissolved oxygen concentrations. All three streams exhibited periodic fecal coliform counts above 200 MPN/100 ml. Jumping Brook exhibited excessive fecal coliform concentrations (2,000 + MPN/100 ml) in August, 1977, but levels were lower over the remainder of the period.

Total dissolved solids levels were relatively consistent (below 100 mg/l) in Yellow and Jumping Brooks, but Willow Brook exhibited an increase over the period, although remaining well below the 500 mg/l standard. All three streams exhibited generally neutral pH values for the period.

As stated earlier, total phosphorus levels occasionally contravened the 0.10 mg/l standard in all three streams. The Colts Neck and Neptune City stations on Yellow and Jumping Brooks exhibited slight overall increases in total phosphorus concentrations for the period. Periodic rises in nitrate + nitrite occurred in the basin, but were at all times less than 2.0 mg/l. Total and un-ionized ammonia concentrations were at generally low levels throughout the period.

No biological monitoring was conducted in the North Atlantic Coastal basin area during the period.

This segment was not reviewed in earlier 305(b) reports, therefore, comparsion of data between collection periods is not possible. However, the water quality in Willow and Yellow Brooks as discussed above is similar to what was identified in the Monmouth County Water Quality Management Plan (1979).

Toxic Parameters

Willow Brook was sampled at four locations in Monmouth County, at Route 34, Routes 34 and 520, South Street and at Willow Brook Road. In every sample there were moderate levels of organic solvents. At the South Street and Willow Brook Road sites low pesticide levels were also detected. Additional sampling is warranted in this area with particular attention to the sediments.

The Yellow Brook was sampled at Montrose Road and Creamery Road. These sites also contained contaminants. Low levels of pesticides and polynuclear aromatic hydrocarbons (PAHs) were detected in the water column. These PAHs are particularly disturbing due to their potent carcinogenicity. Ongoing, further sampling in this area is needed including sediment analysis.

The Jumping Brook was sampled near Corlies Road in Neptune City and found to be free of toxic contamination.

Aquatic organisms collected in 1978-1979 along the Navesink River at Fair Haven and the Shrewsbury River at Sea Bright revealed only trace levels of zinc and copper, and sporadic incidences of cadmium and lead. Species sampled included representatives of various levels including bluefish, Pomatomus saltative, winter flounder, Pseudopheuronectes americanus, and ribbed mussel, Modiolus demissue. Contaminant levels and distribution within the population is consistent with results derived from samples of various other waterways where major migrational and seasonally flucuating fish communities predominate the aquatic systems. Resident species did not reflect a pattern of uptake indicative of point source contamination or seasonal trends.

Problem Assessment

The Water Quality Assessment section stated that water quality in this segment is generally good, except for some problems with fecal coliform and total phosphorus.

The Monmouth County WQM Plan had evaluated the probable impacts of various pollution sources. The plan stated that the waterways of the segment were affected, to varying degrees, by non-point sources. Some of the tributaries are the sites of point sources, and so it is difficult to evaluate the relative impact of non-point sources; while the Yellow Brook tributary, which was described as having no major point sources, is affected greatly by non-point sources. Among the types of non-point sources thought to be influencing water quality in the segment are livestock and other agricultural sources, stormwater runoff, landfills and septic tanks. Non-point loadings also appear to be the main causes of the meso-eutrophic state of Deal Lake, based on an intensive survey by the NJ Lakes Management Program in 1979. Deal Lake drains directly to the Atlantic Ocean north of Asbury Park and catches stormwater from residential areas, golf courses and two landfills, in addition to wastewaters from an industrial facility.

Summer monitoring of ocean beaches shows periodic higher bacteria levels in the Sea Bright area, but not high enough to cause closures. A great concern in this segment is the bacterial contamination of shellfish harvesting areas. In 1961, there had been an outbreak of viral hepatitis which was traced to the ingestion of shellfish taken from the Raritan Bay Complex, which includes the Navesink and Shrewsbury Rivers. As a result, the DEP intensified its monitoring of shellfish harvesting areas. In 1980, an intensive survey was conducted in the lower Navesink watershed to specifically identify the cause of bacterial contamination. Most of the samples indicated contamination by animal wastes from agricultural operations.

The Atlantic Coastal waters adjacent to this basin are included in the advisory recommending the intake of striped bass and bluefish taken from these waters be limited to no more than one meal per week because of high levels of PCBs in the tissue of these fishes.

Goal Assessment and Recommendations

Willow Brook, Yellow Brook and Jumping Brook all do not meet the goal of swimmable water quality due to the frequency with which samples exceeded 200 MPN/100 ml. The waters are of fishable water quality, however, despite frequent low pH values which may cause stress for some fish populations. The Navesink River reportedly has a fish community of eighteen species, including trout; six species have been found in the Shark River.

Due to the contamination of shellfish harvesting areas by animal wastes, it is recommended that agricultural facilities implement best management practices specified in the Statewide WQM Plans.

In addition, stormwater runoff controls in suburban and urban areas are probably needed to assist in reducing bacteria contamination of shellfish harvesting areas. Deal Lake would also benefit if stormwater controls (such as detention basins) are implemented in its watershed, along with dredging activities. Septic system problems are known to occur in Middletown, Marlboro and Holmdel Townships in the Swimming/Navesink River watershed, and therefore should be corrected. Protection of water quality in the coastal waters where bathing is the major activity should continue to be a statewide priority.

Year-round and longterm sampling stations are needed in the coastal estuaries; and expansion of the toxics sampling program is recommended due to the presence of various substances in earlier samples.

NORTHERN ATLANTIC COASTAL BASIN STATION LIST

A. Ambient Monitoring Stations

STORET Number	Station Description	Map Number
01407253	Willow Brook near Holmdel, Monmouth County Latitude 40°19'47" Longitude 74°10'26" FW-2 Nontrout USGS/DEP Network At bridge on Willow Brook Road, 0.6 miles upstream of Big Brook, 1.2 mile southeast of Holmdel, and upstream of Swimming River Reservoir.	1
01407400	Yellow Brook at Colts Neck, Monmouth County Latitude 40°17'47" Longitude 74°10'16" FW-2 Nontrout USGS/DEP Network At bridge on Creamery Road in Colts Neck, 0.3 miles upstream from Mine Brook.	2
01407760	Jumping Brook near Neptune City, Monmouth County Latitude 40°12'13" Longitude 74°03'58" FW-2 Nontrout USGS/DEP Network At bridge on Corlies Avenue, 0.85 miles upstream from confluence with Shark River.	3

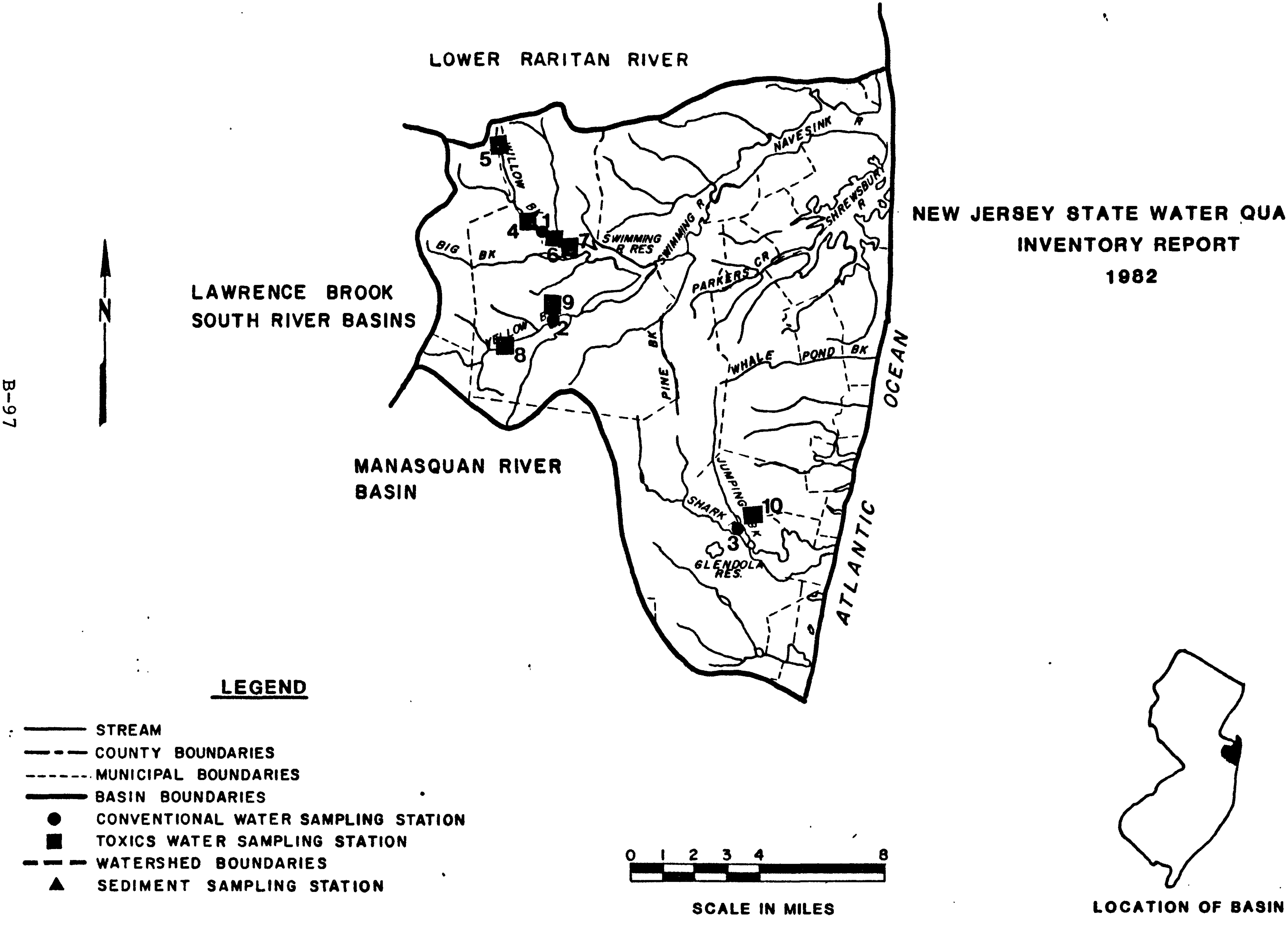
B. Toxics Monitoring Stations

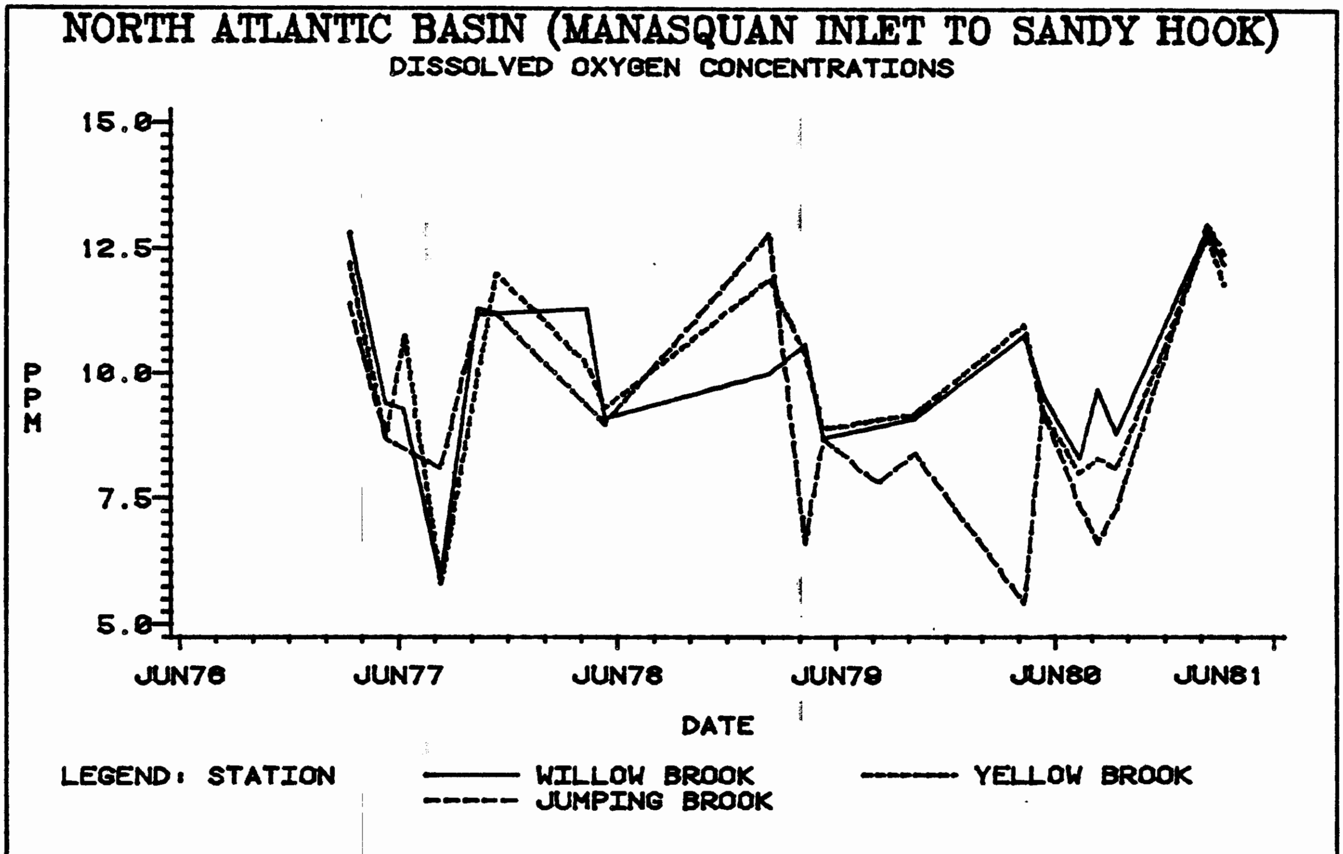
Station Location	Sampling Regime	Map Number
Willow Brook at Route 34	Water column	4
Willow Brook at Routes 34 and 520	Water column	5
Willow Brook at South Street	Water column	6

Willow Brook at Willow Brook Road	Water column	7
Yellow Brook at Montrose Road	Water column	8
Yellow Brook at Creamery Road	Water column	9
Jumping Brook at Corlies Road	Water column	10

NORTH ATLANTIC COASTAL SEGMENT–SANDY HOOK TO MANASQUAN INLET (INCLUDING NAVESINK AND SHREWSBURY RIVERS)

NEW JERSEY STATE WATER QUALITY INVENTORY REPORT
1982





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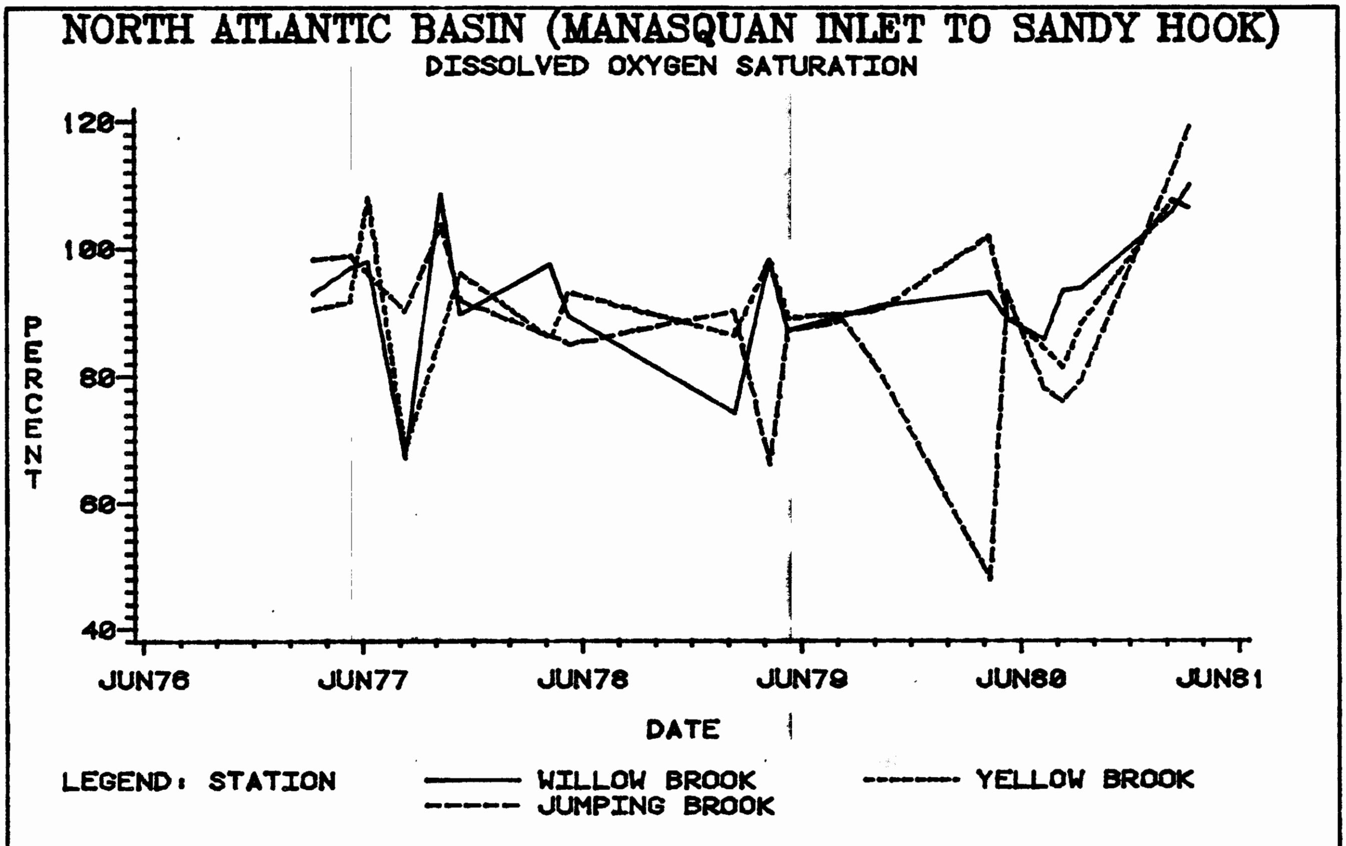

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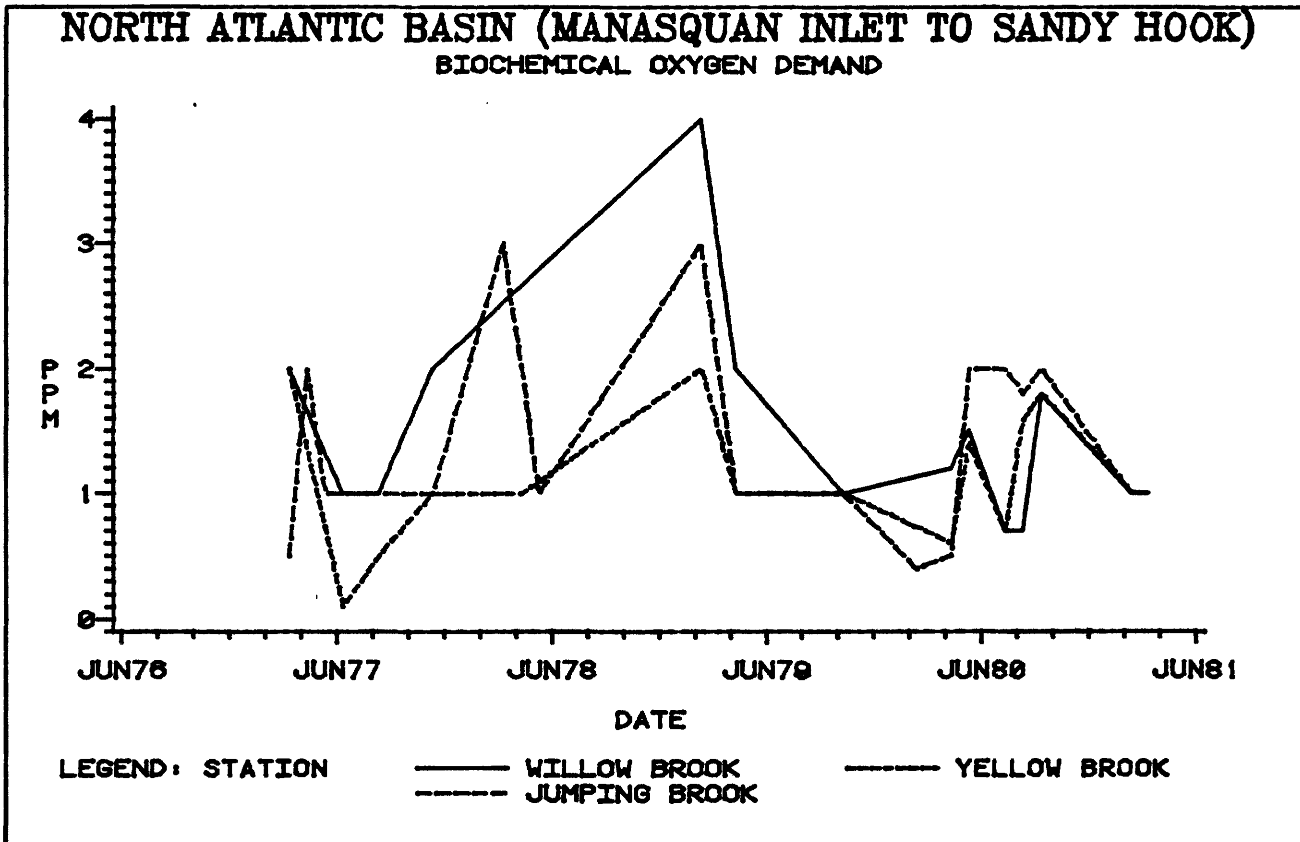

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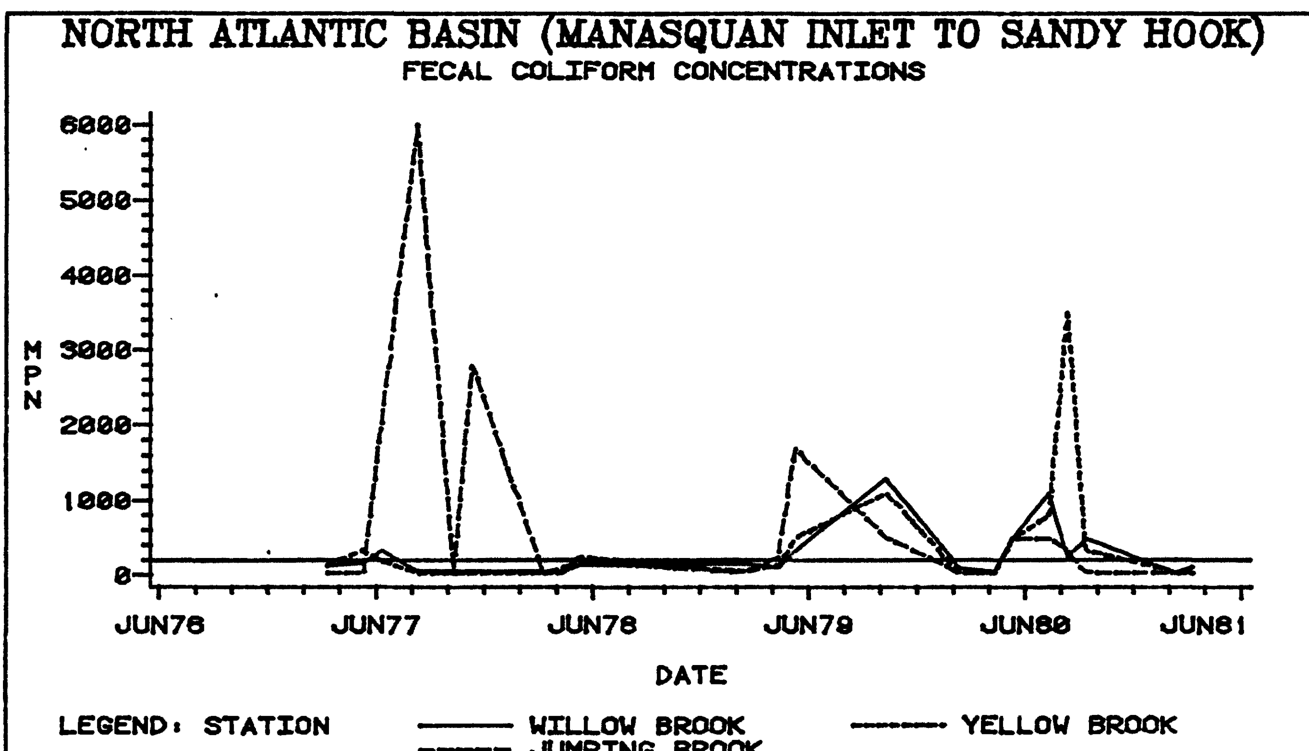

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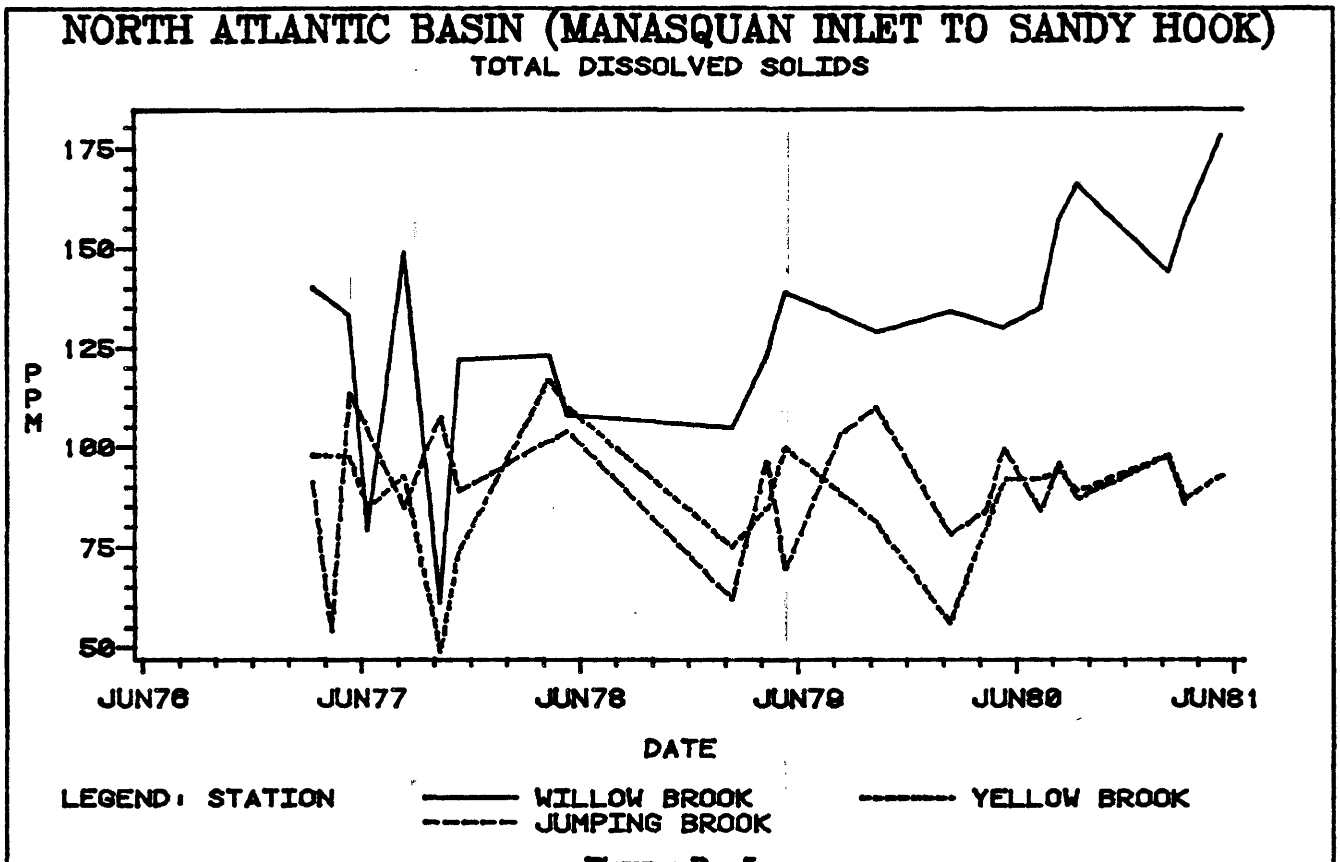

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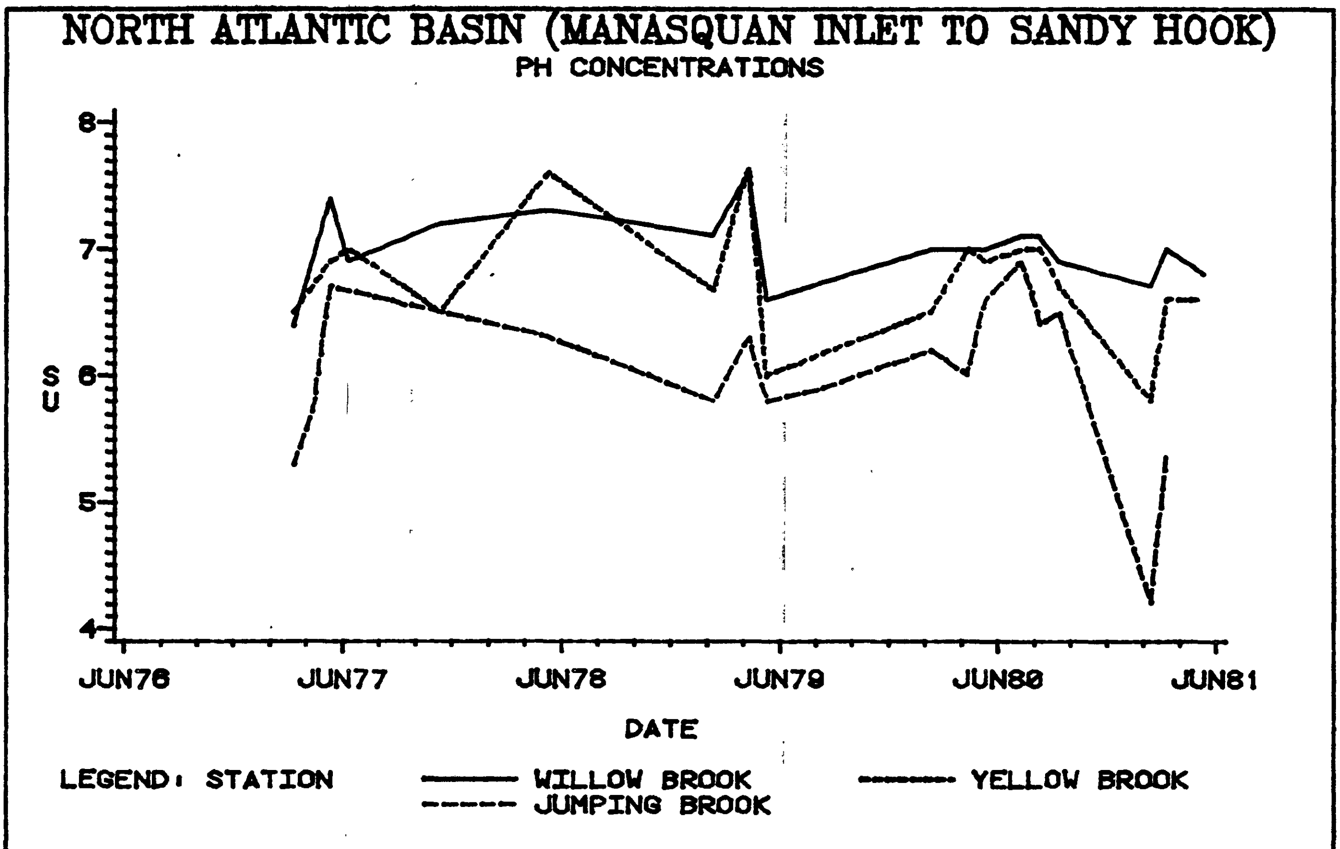

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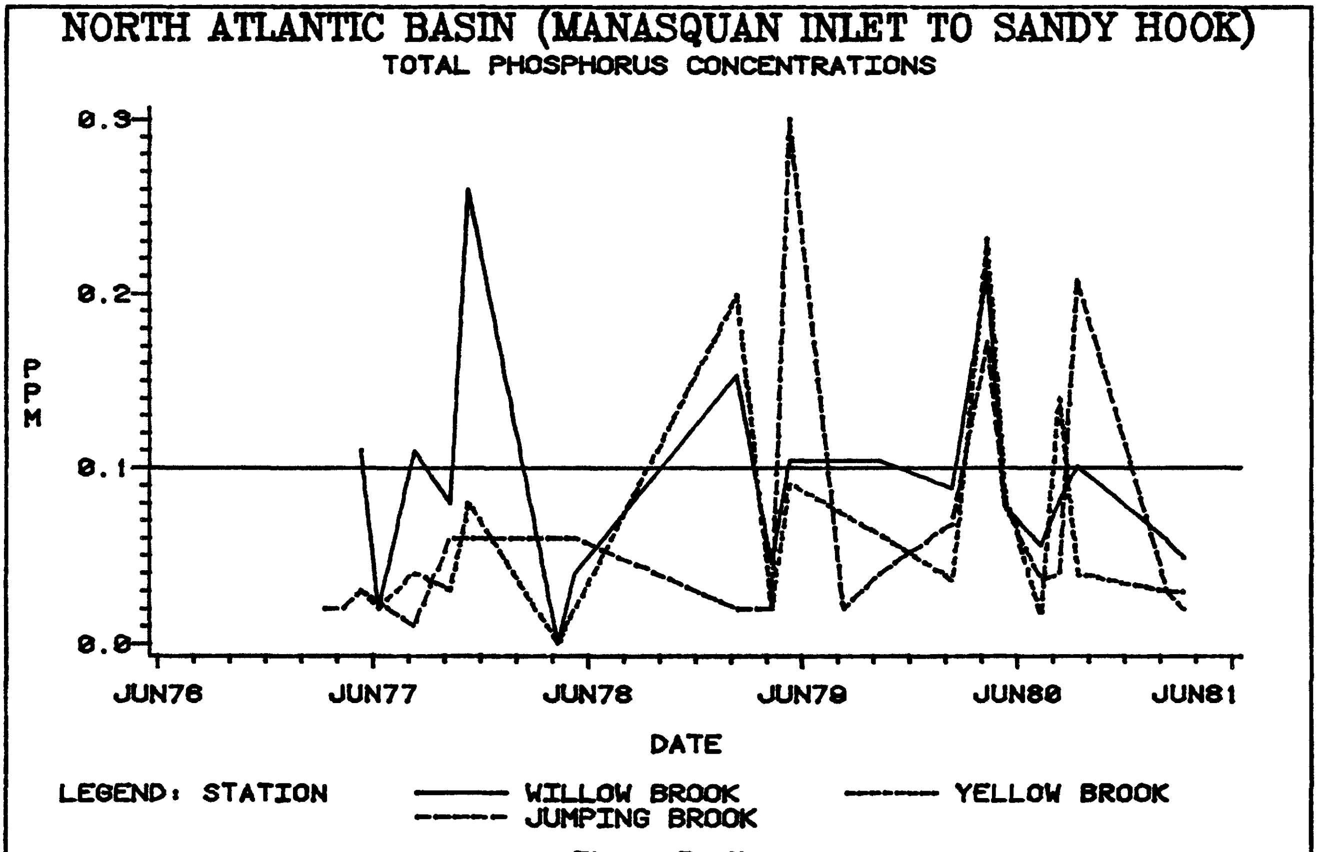

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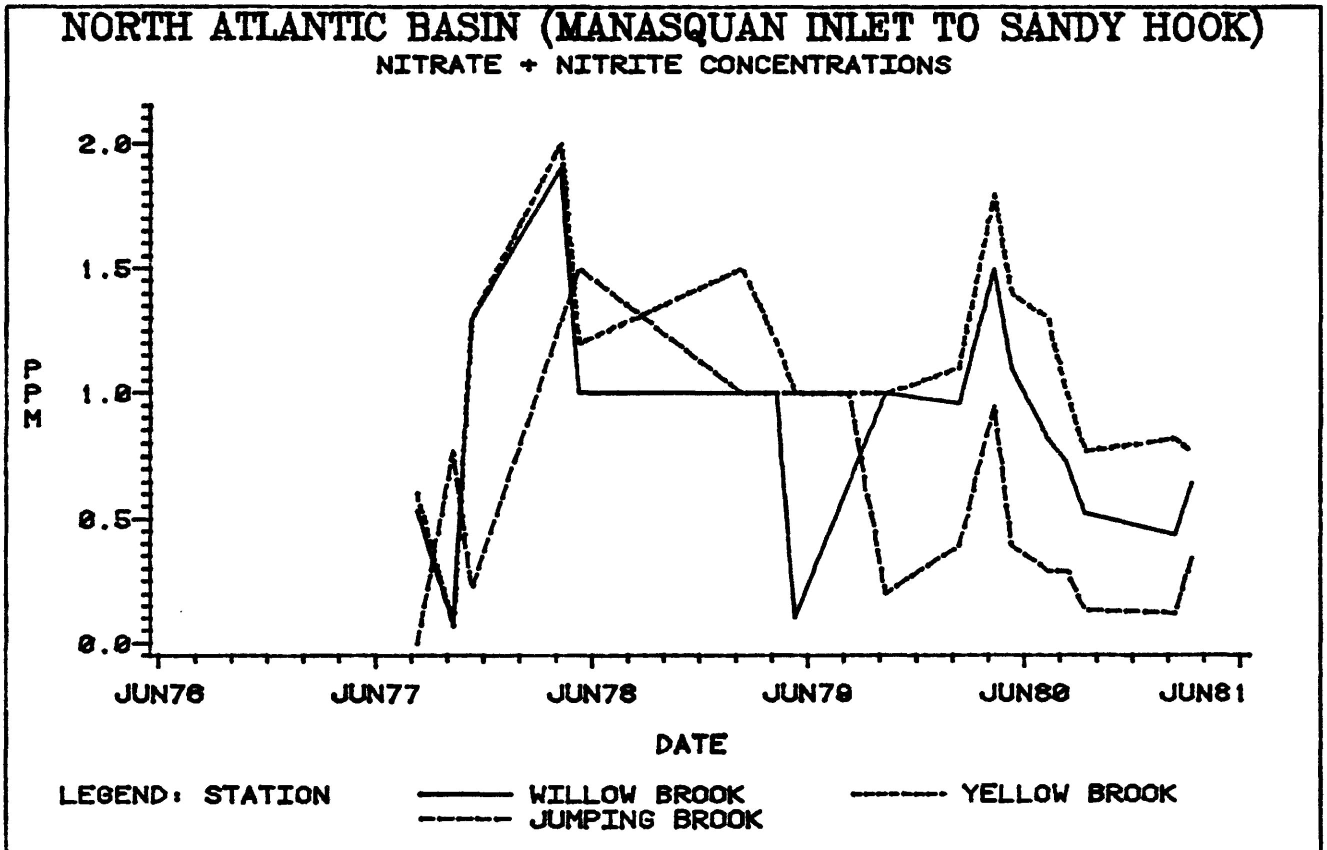

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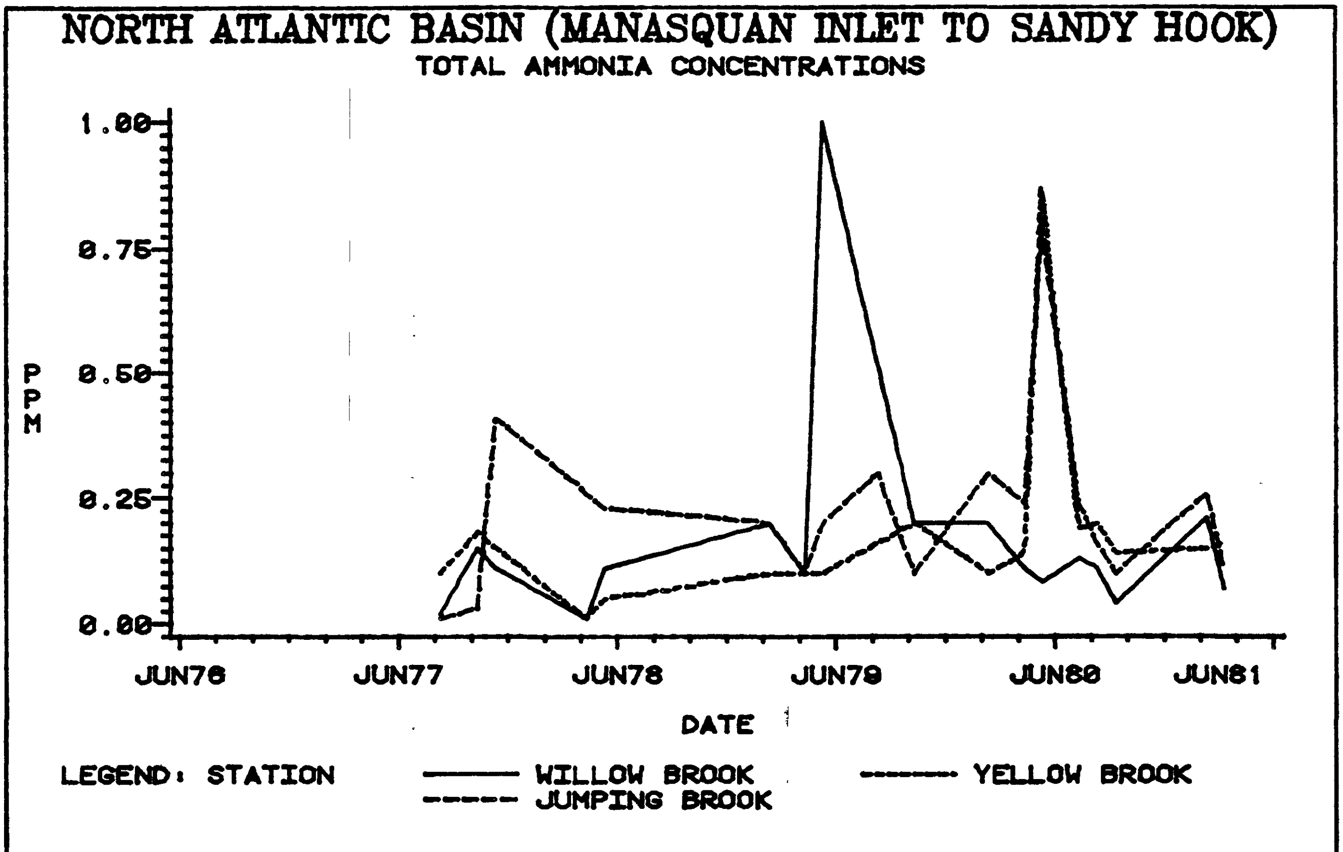

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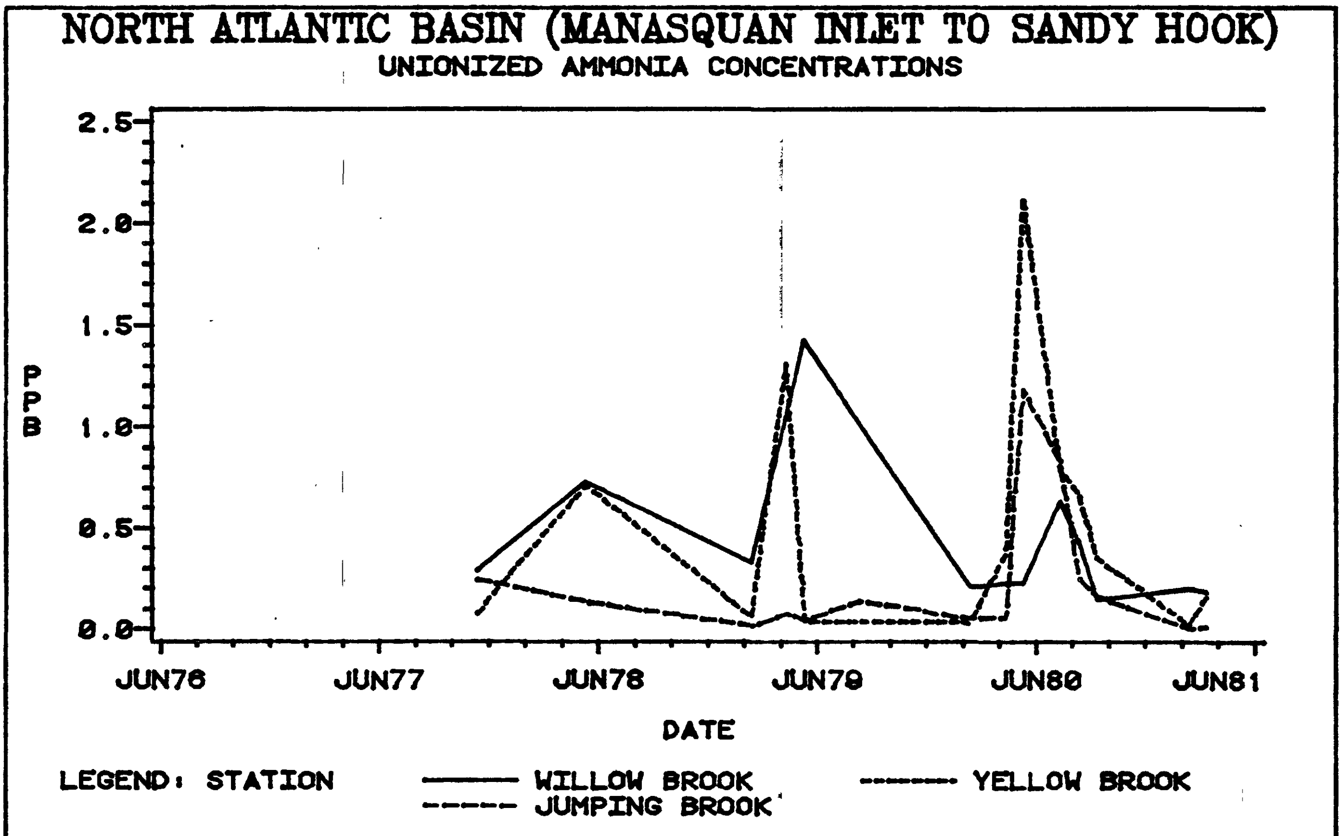


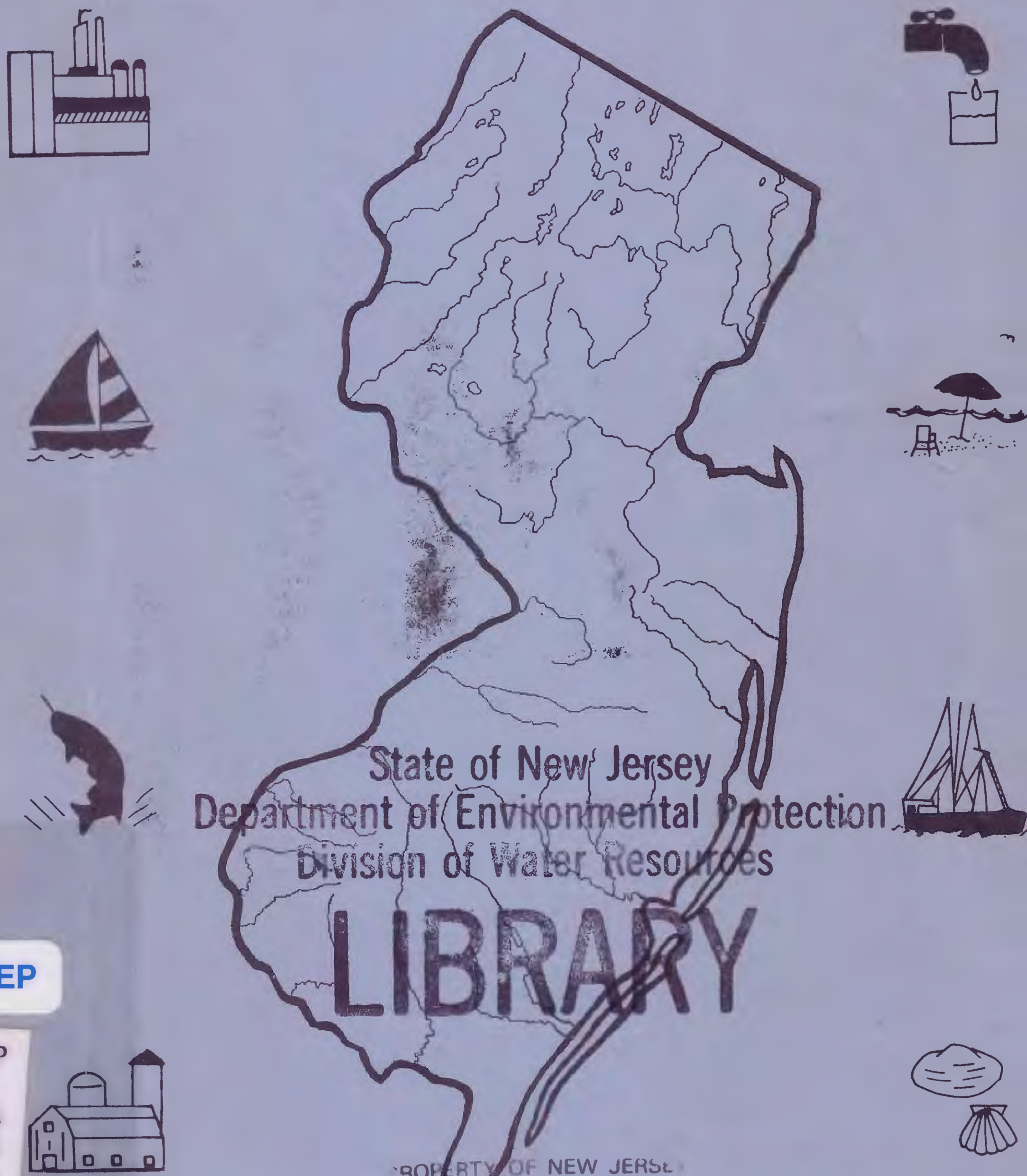
Figure: R -10

DISCHARGE INVENTORY - - - NORTH ATLANTIC COASTAL SEGMENT - SANDY HOOK TO MANASQUAN INLET

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
MARLBORO PSYCHIATRIC HOSPITAL	0022586	MARLBORO TWP	BIG BROOK	SANITARY	.20
HOLMDEL NURSING & CONV. HOME	0027529	HOLMDEL TWP	BRANCH WILLOW BROOK	SANITARY	
BENDIX CORP ELEC POWER DIV	0002623	EATONTOWN BORO	HUSKEY BROOK	PROCESS WASTE	.08
TURNING POINT RESTAURANT	0031674	HOLMDEL	NAVESINK RIVER	SANITARY	
CHRISTIAN BROTHERS ACADEMY	0026433	LINCROFT	NAVESINK RIVER	SANITARY	
BELL TELEPHONE LABS	0000485	HOLMDEL TWP	RAMANESSIN BK		.07
BELL TELEPHONE LABS	0000477	HOLMDEL TWP	RAMANESSIN BK		.07
HOLMDEL TWP BOARD OF EDUCATION	0027031	HOLMDEL	RAMANENSSIN BROOK	SANITARY	
BOROUGH OF HIGHLANDS	0026204	HIGHLANDS BORO	SHREWSBURY RIVER	SANITARY	.46
NAD EARLE COLTS NECK	0023540	COLTS NECK TWP	TRIB TO YELLOW BROOK	SANITARY	.08
ELECTRONIC ASSOCIATES INC	0002135	W. LONG BRANCH BORO	TURTLE MILL BK	COOLING WATER	
METALLURGICAL INTL INC	0002321	NEW SHREWSBURY BORO	WAMPUM BROOK	COOLING WATER	.30
MID-MONMOUTH INDUSTRIAL PARK	0026590	NEW SHREWSBURY BORO	WAMPUM CREEK		
PRUDENTIAL PROPERTY & CASUALTY	0035718	HOLMDEL	WILLOW BROOK		
PENNWALT CORP.	0001481	HOLMDEL TWP	WILLOW BROOK	COOLING WATER	.07
EMIL A SCHROTH INC	0034771	HOWELL TWP	YELLOW BROOK		
COLTS NECK INN	0031771	COLTS NECK	MINE BROOK	SANITARY	
MOLECU WIRE CORPORATION	0034258	WALL TOWNSHIP	SHARK RIVER	COOLING WATER	
SHORE GAS OIL CO	0021849	OCEAN TWP.-MON CO.	TAKANNASSEE LAKE	RUNOFF OIL & GR	
NJ HIGHWAY AUTHORITY	0021148	WALL TWP	TRIBUTARY TO SHARK RIVER	SANITARY	
TOWNSHIP OF MIDDLETOWN S.A.	0025356	MIDDLETOWN TWP	ATL OCEAN VIA MON CO BAYS OUTF	SANITARY	4.85
CITY OF ASBURY PARK	0025241	ASBURY PARK CITY	ATLANTIC OCEAN	SANITARY	2.92
BOROUGH OF DEAL	0023191	DEAL BORO	ATLANTIC OCEAN	SANITARY	.52
CITY OF LONG BRANCH	0030899	LONG BRANCH	ATLANTIC OCEAN		
LONG BRANCH SEWERAGE AUTHORITY	0024783	LONG BRANCH CITY	ATLANTIC OCEAN	SAN/SIG INDUS	4.65
MONMOUTH CO. BAYSHORE OUTFALL	0024694	MIDDLETOWN TWP	ATLANTIC OCEAN	SANITARY	12.23
NORTHEAST MONMOUTH CTY REG S.A	0026735	MONMOUTH BEACH BORO	ATLANTIC OCEAN	SANITARY	6.48
TOWNSHIP OF NEPTUNE STP	0024872	NEPTUNE /TWP/	ATLANTIC OCEAN	SANITARY	3.71
TOWNSHIP OF OCEAN S.A.	0024520	OCEAN TWP.-MON CO.	ATLANTIC OCEAN	SANITARY	3.62
LAPIN PRODUCTS INC	0003891	OCEAN TWP.-MON CO.	ATLANTIC OCEAN	COOLING WATER	.09
BAYSHORE REGIONAL S.A.	0024708	UNION BCH BORO	ATLANTIC OCEAN	SANITARY	8.61
SOUTH MONMOUTH REGIONAL S.A.	0024562	WALL TWP	ATLANTIC OCEAN	SANITARY	3.23
FOUR PONDS CENTER ASSOCIATES	0035441	MIDDLETOWN TWP	JUMPING BROOK		
NEW JERSEY GRAVEL & SAND CO	0032239	WALL TOWNSHIP	WRECK POND BROOK		.07
LAIRD & COMPANY	0035823	SCOBEYVILLE	YELLOW BROOK		

New Jersey 1982
State Water Quality Inventory Report

Appendix–Raritan River Basin



State of New Jersey
Department of Environmental Protection
Division of Water Resources

New Jersey Department of Environmental Protection • Division of Water Resources

NEW JERSEY 1982 STATE WATER QUALITY INVENTORY REPORT

APPENDIX - RARITAN RIVER BASIN

A REPORT ON THE STATUS OF WATER QUALITY IN NEW JERSEY
PURSUANT TO THE NEW JERSEY WATER POLLUTION CONTROL
ACT AND SECTION 305(b) OF THE FEDERAL CLEAN WATER ACT

WATER RESOURCES REPORT 39-C: 1.C

Principal Author: Keith Robinson

New Jersey Department of Environmental Protection
Division of Water Resources
Bureau of Planning and Standards
1474 Prospect Street
Trenton, N.J.

Thomas H. Kean, Governor
Robert E. Hughey, Commissioner
John W. Gaston, Jr., P.E., Director

June, 1983

APPENDIX 1 - WATER QUALITY INVENTORY

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APPENDIX 1-C

WATER QUALITY INVENTORY

RARITAN RIVER BASIN

INTRODUCTION

This appendix contains a review of surface water quality in New Jersey's rivers, streams, coastal bays and lakes. This water quality review represents the biennial assessment of the State's waters as required by Section 305(b) of the federal Clean Water Act. For the 1982 305(b) report the State has been divided into 31 segments (Table 1-i) that are generally either single or grouped watersheds. The breakdown of the State into these segments is also similar to the segments used in prior New Jersey 305(b) reports, and therefore, allows comparison of water quality in a segment from one reporting period to the next. All segments were analyzed for water quality by the NJ Department of Environmental Protection with the exception of segments "DD" (Delaware River Basin) and "EE" (Interstate Sanitation Commission jurisdictional waters) which were prepared by the Delaware River Basin Commission and the Interstate Sanitation Commission, respectively.

The 29 NJDEP-prepared segment analyses contain four written sections, (Basin Description, Water Quality Assessment, Problem Assessment, and Goal Assessment and Recommendations), in addition to a segment map, water quality data charts and a wastewater discharge inventory. Numerous offices throughout NJDEP, and especially the Division of Water Resources, contributed information and or text to the segment analyses. In cooperation with the Bureau of Planning and Standards, DWR, the Bureau of Monitoring and Data Management, DWR, prepared the Water Quality Assessment - Conventional Parameters sub-section and the water quality data charts. Also in the DWR, the Bureau of Industrial Waste Management prepared the discharge inventories based on information in their New Jersey Pollutant Discharge Elimination System (NJPDES) computer files. The Office of Cancer and Toxic Substances Research (OCTSR), NJDEP, wrote the Toxic Parameters subsection for each Water Quality Assessment section. Their review of water column, sediment and fish tissue toxics sampling data represents the first such statewide watershed by watershed analysis since the program began in the mid-1970s. Following below is a description of the four sections that comprise the 29 NJDEP produced segment analyses.

Basin Description

The Basin Description characterizes each segment from a geographical and land use perspective in addition to noting what known surface water uses are present. Water uses identified included diversions of surface waters for potable supplies, agricultural irrigation and industrial processes; monitored swimming locations; fishing opportunities and resources; shellfish harvesting; and other specific uses that may be unique to a region of the State. The sources of information for this

TABLE 1-i SEGMENTS ANALYZED IN THE WATER QUALITY INVENTORY

A. Wallkill River
B. Flat Brook and Paulins Kill
C. Pequest and Musconetcong Rivers
D. Pohatcong and Lopatcong Creeks
E. Delaware River Tributaries - Hunterdon/Mercer Counties
F. Assunpink Creek
G. Crosswicks and Assiscunk Creeks
H. Rancocas Creek
I. Pennsauken Creek, Big Timber Creek and Cooper River
J. Woodbury, Mantua and Raccoon Creeks
K. Oldmans, Salem and Alloways Creek
L. Cohansey and Maurice Rivers
M. Southern Atlantic Coastal Basin - Cape May to Great Bay
N. Great Egg Harbor River
O. Mullica River
P. Mid-Atlantic Coastal Basin - Great Bay to Manasquan Inlet
Q. Manasquan River
R. North Atlantic Coastal Basin - Manasquan Inlet to Sandy Hook
S. North Branch Raritan River
T. South Branch Raritan River
U. Millstone River
V. Lawrence Brook and South River
W. Lower Raritan River Basin
X. Elizabeth and Rahway Rivers
Y. Upper Passaic River - Headwater to Livingston
Z. Mid-Passaic River - Livingston to Little Falls
AA. Mid-Passaic River Tributaries (Whippany, Rockaway, Pequannock, Wanaque, Ramapo and Pompton Rivers)
BB. Lower Passaic River - Little Falls to Newark Bay
CC. Hackensack River
DD. Status Report on the Delaware River
EE. Status Report on Interstate Sanitation Commission Waters

section included a number of different agencies in state, federal and local governments.

In the process of gathering water use data for the 29 segments of the State numerous information deficiencies were found to exist. Formost was the lack of statewide inventories dealing with monitored bathing beaches, and the presence of agricultural and industrial surface water diversions. Since bathing beaches are routinely monitored by local health departments under state guidelines and no statewide reporting requirements have been instituted there exists no regularily updated list of swimming areas found in the State. As a result of this data gap the Bureau of Planning and Standards mailed questionaires to all local health departments in the State requesting a list of bathing beaches and areas under their jurisdiction. The identification of surface water diversions for agricultural, industrial and other purposes is limited to where surface water diversion permits have been issued under the provisions of NJSA 58:1-36 by the State of New Jersey. Only diversions in excess of 70 gallons per minute (gpm) are required to obtain a permit. Therefore, numerous unreported diversions exist across the State which are pumping under 70 gpm. The information deficiencies described above exemplifies the difficulties uncovered while developing the Basin Description. These difficulties point to the need for a more coordinated water resource approach when identifing and understanding water quality problems, so that long-term direct use impacts can be measured.

Water Quality Assessment

The Water Quality Assessment section is a review of surface water quality data collected in a segment from 1977 to 1981. Water quality is analyzed for a group of standard indices (Table 1-ii) in the Conventional Parameters subsection, while known and suspected carcinogenic or toxic substances (Table 1-iii) identified in the segments water bodies are discussed in the Toxic Parameters subsection. In each Conventional Parameters subsection there is a brief review of overall water quality trends which have been found in that segment. This review of trends is a comparison of water quality conditions as described in the 1977 and 1980 305(b) reports against conditions as found today.

The ten conventional parameters reviewed were selected because of their values for indicating pollution, making swimmable and fishable determinations and for compatibility with data reviewed in prior 305(b) reports. These ten parameters were evaluated at 78 monitoring stations throughout the State.

The ambient monitoring stations reviewed in the Conventional Parameters subsection represents approximately one half of the total long-term monitoring stations present in the State. Those stations used were selected on the basis of their location in a

TABLE 1-ii PARAMETERS LIST AND CRITERIA FOR WATER QUALITY ASSESSMENTS - CONVENTIONAL PARAMETERS

Parameter	Criteria Source
1. Dissolved oxygen Concentrations and Saturation	N.J. Water Quality Standards
2. Biochemical oxygen demand (5 day)	N.J. Water Quality Standards Comparison to statewide ambient data
3. Fecal coliform	N.J. Water Quality Standards
4. Total dissolved solids	N.J. Water Quality Standards
5. pH	N.J. Water Quality Standards
6. Total phosphorus	N.J. Water Quality Standards
7. Nitrate + nitrite nitrogen	Quality Criteria for Water, 1976, USEPA National Interim Primary Drinking Water Regulations, 1976, USEPA
8. Total ammonia	Comparison to statewide ambient data
9. Un-ionized ammonia	N.J. Water Quality Standards

TABLE 1-iii TOXIC CHEMICALS ANALYZED IN THE WATER QUALITY ASSESSMENT - TOXIC PARAMETERS

Group 1 - Metals	Lower Analytical Limit ug/l (ppb)	EPA Standard for Drinking Water ug/l (ppb)
Arsenic	1	50
Beryllium	1	-
Cadmium	1	10
Chromium	1	50
Copper	1	1000[a]
Lead	1	50
Nickel	5	-
Selemium	2	10
Zinc	5	5000[a]
Group 2 - Pesticides and Related Compounds		
PCBs	0.06	-
Arochlor 1016	0.06	-
Arochlor 1242	0.06	-
Arochlor 1248	0.01	-
Arochlor 1254	0.01	-
α-BHC	0.01	-
β-BHC	0.01	-
Lindane (γ-BHC)	0.01	4
Heptachlor	0.01	0.1
Heptachlor epoxide	0.01	0.1
Aldrin	0.01	-
Dieldrin	0.01	-
Chlordane	0.01	-
Toxaphene	0.06	5
Methoxychlor	0.08	100
Mirex	0.02	-
Endrin	0.01	0.2
o,p-DDT	0.04	-
p,p'-DDT	0.04	-
o,p-DDE	0.01	-
p,p'-DDD	0.02	-

Group 3 - Low Molecular Weight Halogenated Organics b,c

Methylene chloride	90
Methyl chloride	6.0
Methyl bromide	1.0
Chloroform	0.8
Bromoform	1.0
Trichloroethylene	0.3
1,1,2,2-Tetrachloroethane	0.3
1,1,2-Trichloroethane	1.0
Dibromochloromethane	0.1
Trifluoromethane	0.5
Carbon tetrachloride	0.1
1,2-Dibromoethane	0.1
1,2-Dichloroethane	1.6
1,1,1-Trichloroethane	2.0
Vinyl chloride	0.5
Tetrachloroethylene	0.1
o-Dichlorobenzene	2.2
m-Dichlorobenzene	1.3
p-Dichlorobenzene	1.3
Trichlorobenzene	2.0
Diiodomethane	0.3
Dichlorobromoethane	0.5

a - secondary standards
b - Group 3 tested in water column only, not in sediments and fish tissue
c - Trihalomethanes: The EPA drinking water standard is 100 ppb for total trihalomethanes

watershed, the presence of other stations in the segment, the amount of data collected for each station, the ability of a monitoring station to reflect existing land use and known pollution sources, and the limitations in staffing and support services which prevented the review of all ambient monitoring stations statewide.

The DWR, through the Bureau of Monitoring and Data Management (BMDM) maintains and/or participates in several surface water quality monitoring programs throughout New Jersey. The most extensive program, the Primary Water Quality Monitoring Network, is a cooperative effort involving the BMDM and the United States Geological Survey's Water Resources Division in Trenton, N.J. The network, instituted in 1976, is composed of 135 stations from which samples are collected six times annually. In addition to the routine or conventional water column parameter schedule, a supplemental set of 75 samples is collected biannually from the water column for trace organic and metals analysis, and annually from the sediments at 50 stations. In 1982, the Primary Water Quality Monitoring Network was reduced to approximately 100 stations statewide.

EPA's National Basic Water Monitoring Program (BWMP) is comprised of thirty one stations in New Jersey. Samples are collected monthly at each station. Beginning in January, 1981, a revised parameter schedule was implemented with the approval of EPA Region II, as certain parameters were collected biannually rather than monthly. This change occurred at stations where there was no indication of consistently excessive concentrations of pollutants. These parameters include chemical oxygen demand, chloride, petroleum hydrocarbons, metals and dissolved minerals.

Biomonitoring was also conducted at each of the BWMP stations during the report period. Macroinvertebrate samples were acquired at each station using three Hester-Dendy samplers with the invertebrates later identified and enumerated in the laboratory. Diversity index, percent abundance and equitability of sample population were among the items evaluated. Five replicate periphyton samples were obtained at each station using clean glass slides mounted in a floating sampler, while chlorophyll a concentrations were measured using the acetone extraction method.

In addition, electrofishing and analysis of fish tissue samples for trace metals and pesticides were initiated in 1980 at most of the BWMP stations in New Jersey. The fish were identified and prepared in the BMDM's biological laboratory and then forwarded to the New Jersey Department of Health Laboratory for analysis.

Additional ambient surface water monitoring is conducted by the Ocean County Health Department, the Passaic Valley Water Commission, the Interstate Sanitation Commission, the Delaware River Basin Commission and other agencies throughout the State.

Their data was used in this report when applicable. In the future it is anticipated that many other counties will participate in expanded monitoring activities. Station selection in all monitoring networks were generally in accordance with the criteria cited in the EPA publication entitled Basic Water Monitoring Program (EPA 440/9-76-025, revised May, 1978).

The water quality data used to make each Conventional Parameter assessment is presented in the form of graphs (concentration versus time), and is found in the segment analyses following the text. The graphs show all raw data points collected for the ten parameters from 1977 to mid 1981. Conventional water quality data was compared against New Jersey Surface Water Quality Standards (N.J.A.C. 7:9-4.1 *et seq*) where applicable for dissolved oxygen concentration and saturation, biochemical oxygen demand (five day), total dissolved solids, pH, total phosphorus and un-ionized ammonia. Table 1-iv present the surface water classification and its appropriate water quality standards. A standard line is used on the water quality graphs for those parameters with standards for comparitive purposes. Although there is a state standard for fecal coliform (for most freshwater the criteria is a geometric average of 200/100 ml, or no more than 10 percent of the total samples taken during any 30 day period exceeding 400/100 ml), the frequency with which fecal coliform samples are collected in current statewide monitoring programs in regarded as not being of sufficient frequency to compare to existing standards.

The Toxic Parameters subsection was provided by the Office of Cancer and Toxic substances Research (OCTSR), NJDEP, specifically for this report. This subsection describes the preliminary results of water column, sediment and fish tissue sampling for toxic and carcinogenic substances in New Jersey's aquatic environment. The surface water monitoring for toxic pollutants began at OCTSR in 1977 when there was practically no background data concerning the occurrence of toxic pollutants in surface waters throughout New Jersey. In addition standardized sampling techniques and methods for analysis had not been defined for determining toxic contamination in water, sediment, and aquatic biota.

The approach taken to generate a data base for toxics in New Jersey's surface waters involved the collection of grab samples of water at various sites throughout the State in accordance with the State Water Quality Management Program surface water studies carried out by NJDEP and designated regional and county agencies. The water column samples were analyzed for all three groups of chemicals shown in the Table 1-iii. As the program progressed, the collection of sediments samples was incorporated at many sites to access the partitioning and accumulation of toxic pollutants in the sediments. Sites usually were sampled once per year, but sites which were found to be contaminated or suspected to receive toxic inputs were sampled at least twice. Sediments and fish tissue were tested for substances in groups 1 and 2 in

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARD (NJDEP, 1981)

	Classification				
Parameter	FW-Lower Mullica and Wading Rivers Central Pine Barrens	FW-Central Pine Barrens	FW-2 Trout Production	FW-2 Trout Maintenance	FW-2 Nontrout
pH (Standard Units)	4.5-6.0	3.5-5.5	6.5-8.5	6.5-8.5	6.5-8.5
5 day Biochemical oxygen demand (mg/1)	Maximum of 5.0 at any time.	Maximum of 5.0 at any time. None which would render the waters unsuitable for the designated uses.			
Dissolved oxygen	No less than 85% saturation at any time.	Not less than 85% saturation at any time.	Not less than 7.0 mg/1 at any time.	24 hour average not less than 6.0 mg/1. Not less than 5.0 mg/1 at any time.	i. 24 hour average not less than 5.0 mg/1, but not less than 4.0 mg/1 at anytime, except as noted in paragraph ii. below. ii. Not less than 4.0 mg/1 at any time in the freshwater tidal portions of tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive.
Bacterial quality (MPN/100 ml)	1. Except as noted in paragraph two below, fecal coliform levels shall not exceed a geometric average of 200/100 ml., nor should more than 10 per cent of the total samples taken during any 30-day period exceed 400/100 ml. 2. Fecal coliform levels shall not exceed a geometric average of 770/100 ml. in the freshwater tidal portion of tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive. 3. Samples shall be obtained at sufficient frequencies and at locations and during periods which will permit valid interpretation of laboratory analyses. Appropriate sanitary surveys shall be carried out as a supplement to such sampling and laboratory analyses. As a guideline and for the purpose of these regulations, a minimum of five samples taken over a 30-day period should be collected, however, the number of samples, frequencies and locations will be determined by the department in any particular case.				

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARDS (NJDEP, 1981)

			Classification		
Parameter	FW-Lower Mullica and Wading Rivers Central Pine Barrens	FW-Central Pine Barrens	FW-2 Trout Production	FW-2 Trout Maintenance	FW-2 Nontrout
Total dissolved solids - filterable residue (mg/l)	Maximum of 100 at anytime	Maximum of 100 at anytime	1. Not to exceed 500 mg/l or 133 per cent of background whichever is less. Notwithstanding this criterion, the department, after notice and opportunity for hearing, may authorize increases exceeding these limits provided the discharge responsible for such increases can demonstrate to the satisfaction of the department that such increases will not significantly affect the growth and propagation of indigenous aquatic biota or other designated uses, including public water supplies. 2. Any authorization by the department of such increases shall be conditioned upon utilization of the maximum practicable control technology.		
Ammonia (un-ionized; Maximum concentration ug/l)	50.0	50.0	20.0	20.0	50.0
Phosphorus (mg/l)	Maximum of 0.7 at anytime; phosphorus as phosphate.		1. Lakes: Phosphorus as total P shall not exceed 0.05 in any reservoir, lake, pond, or in a tributary at the point where it enters such bodies of water, unless it can be demonstrated that total P is not a limiting factor considering the morphological, physical, chemical, and other characteristics of the water body. 2. Streams: Phosphorus as total P shall not exceed 0.1 in any stream, except at those locations in paragraph one above, where total P is determined to have a detrimental effect on stream use or to be the limiting factor considering the morphological, physical, chemical, and other characteristics of the water body.		

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARDS

Parameter	TW-1
pH (Standard Units)	6.5-8.5
Dissolved oxygen (mg/l)	24 hour average not less than 5.0. Not less than 4.0 at any time.
Bacterial quality (MPN/100 ml)	1. Approved shellfish harvesting waters: where shellfish harvesting is permitted, requirements established by the National Shellfish Sanitation Program as set forth in its current manual of operation shall apply. 2. All other waters: Fecal coliform levels shall not exceed a geometric average of 200/100 ml, nor should more than 10 per cent of the total samples taken during any 20-day period exceed 400/100 ml.
Total dissolved solids - Filterable residue (mg/l)	None which would render the water unsuitable for the designated uses.

KR:305B2:b

Table 1-iii. Methodology to accurately test for volatiles had not been developed at the time.

Throughout the Toxic Parameters subsections general statements of contaminant levels are identified. This is due to the lack of surface water quality standards for the majority of the substances. In general, when a parameter was found in the water column in concentrations greater than 100 ug/l it was considered in high levels. Moderate levels fell between 10 and 100 ug/l, while low levels meant under 10 ug/l. With regard to sediments and fish tissue analyses, contamination is generally related to the presence of PCBs (polychlorinated biphenols), chlordane, and DDT and its metabolite substances. Elevated levels of PCBs are considered above 3.0 ppm, low levels from 1.0 to 3.0 ppm and trace levels below 1.0 ppm. For chlordane elevated levels were .3 ppm or more, moderate levels are .1 to .3 ppm, with trace levels below .1 ppm. Total DDT was considered elevated when at 5.0 ppm or more, at low levels from 1.0 to 2.0 ppm, and at trace levels below 1.0 ppm. The elevated concentrations reflect the U.S. Food and Drug Administration action levels for fish tissue which is used for human consumption.

As preliminary results were being reviewed, various shortcomings in this sampling approach were identified, but the need for baseline data was imperative and the results generated have proved very useful in identifying areas where further and more intensive studies are needed. Several of the problems discovered during the surface water survey deserve mention in order that the data be viewed in proper perspective. One problem is the limitation of collecting grab water samples for toxic pollutant analysis. The presence of toxics is often variable due to many factors including intermittant discharges, toxic spills, illegal dumping etc.; grab samples provide only an instantaneous look at the water quality of a particular system. The OCTSR has found that composite samples (samples collected over time) provide a more representative picture of true water quality; however, collecting and analyzing composite samples is much more expensive than grab samples.

The natural variability of surface water samples has been another interesting finding of the OCTSR's survey. Toxic pollutants in surface waters are dynamic; compounds present in one stretch of stream will not necessarily be detected in another area. This has led to a need for greater understanding of the physical and chemical processes relating to the partitioning of chemical compounds into different environmental compartments. With the development of the data base, it is now possible to predict where different classes of compounds are most likely to be found, whether in water, sediment, or aquatic biota. The knowledge and experience gained from the survey has resulted in more cost-effective sampling programs designed to gain a maximum amount of information for each dollar spent for analysis.

The OCTSR wrote a brief description on the risks of chemical contaminants on human health. This report, entitled "Health Effects of Chemical Contaminants" is a working paper for the 305(b) report and is available upon request from the Bureau of Planning and Standards, DWR.

Problem Assessment Section

The Problem Assessment is an evaluation of the probable and known water pollution sources within each segment. An attempt was made to identify pollution sources as specifically as possible; but in most cases only wastewater discharges under Department enforcement and administrative actions, and identified by the DWR Enforcement and Regulatory Affairs Element were named as specific sources. Other information sources included the 12 Water Quality Management (WQM) Plans prepared in late 1970s, the 1980 State 305(b) Report, DWR Construction Grants Administration project descriptions, designated WQM Agency supplied information; as well as a variety of other sources. One source which contains alot of useful information on the origin of water pollution were the Lakes Management Program's intensive surveys conducted in 1978 and 1979. However, these surveys were performed on only a local basis and on selected lakes.

Unfortunately the statewide surface water monitoring programs described above are not designed to identify water pollution sources, but rather to determine long-term changes in overall water quality. This makes it difficult, if not impossible, to reliably identify sources of pollution and the impacts they may be having on stream quality. The inherent variabilities and limitations of periodic grab samples from a water body were also expressed above in the description of the OCTSR Program. Unless source specific intensive surveys above and below suspected pollution sources can be performed, then accurate determinations on the contribution of various wastewater facilities, storm drains and land uses to pollution loads can not be made. In the Problem Assessment, therefore, while pollution sources are identified, in most cases their impacts are not truely known.

Goal Assessment and Recommendations Section

The ability of surface waters within each of the 29 segments to meet the swimmable and fishable goals of the federal Clean Water Act is presented in this section. In addition, corrective actions to allieviate water pollution problems identified in the Water Quality Assessment and Problem Assessment sections are recommended.

The Clean Water Act states that surface waters of the nation must be swimmable and fishable (provide for the propagation and protection of a balanced population of shellfish, fish and wildlife) by July 1, 1983. Because this 305(b) report reflects

conditions as of late 1981 and that surface waters will not generally experience significant waters quality differences from late 1981 to mid 1983, the swimmable and fishable determinations made in this report can be interpretated as 1983 goal attainability.

Criteria were developed for this report in order to make the swimmable/fishable goal determination. The swimmable status was assigned to a segment if bathing beaches were known to exist throughout its waters, or if fecal coliform bacteria were of sufficient levels to allow bathing. Fecal coliform data were assessed at monitoring stations used in the segment analyses for the frequency of samples greater than 200/100 ml (surface water standard) during warm weather (May - September) periods. If over 25 percent of the samples were greater than 200 MPN/100 ml then the waters are considered not swimmable; 0-25 percent over 200 MPN/100 ml was construed to mean the waters are marginally swimmable; and when all fecal coliform samples were under 200 MPN/100 ml then the waters are swimmable. It should be noted that irregardless of the swimmable classification assigned to a segment, swimming is recommended only in those waters routinely monitored for bathing.

The fishable determination was based on a number of criteria. This included the presence of trout production or trout maintenance waters (as defined in the state water quality standards); water quality data for dissolved oxygen, pH and un-ionized ammonia which would indicate stressful or acute toxicity to fishlife; and the species of fish identified to exist in the segment by the report Establishment of a Statewide List of Bioassay Organisms Pursuant to the New Jersey Surface Water Quality Standards (Rutgers University, 1979). All waters of the State can be classified as fishable (fishing is allowed) with the exception of portions of the Pennsauken Creek, Cooper River and Woodbury Creek watersheds. Determining the ability of a watershed to support a balanced fish community is difficult since a great variety of factors are involved. What is needed, but is not available, is continuous monitoring of fish communities in the State's waters through various collection and identification programs.

Recommendations for the improvement of water quality within a segment were based generally on the pollution sources identified in the Problem Assessment and what actions are needed to alleviate these problems.

S. NORTH BRANCH RARITAN RIVER

Basin Description

The North Branch Raritan River is one of three large tributaries (the other two are the South Branch and Millstone Rivers) which form the Raritan River, the major drainage basin in central New Jersey. From its beginnings in west-central Morris County the North Branch, via the larger tributaries of Peapack Brook, Lamington River and Rockaway Creek, drains approximately 190 square miles before it joins the South Branch Raritan River at Raritan to mark the origin of the Raritan River mainstem. The Black River begins in Roxbury Township, the northern-most boundary of the North Branch watershed, and forms the Lamington River with Tanners Brook in Chester Township. The Lamington River drains 100 square miles with Rockaway Creek in Hunterdon and Somerset Counties before joining the North Branch near Burnt Mills. The average flow until 1980 for the North Branch at Raritan, one mile north of the confluence with the South Branch, was 305 cfs. The North Branch Raritan River watershed contains many ponds, lakes and reservoirs which are both naturally occurring and man-made. Round Valley Reservoir in Clinton Township, which was constructed in the 1960s by the State of New Jersey as a public water supply and recreation area, lies in the South Branch Raritan River watershed but discharges water by pipeline into the South Branch Rockaway Creek, a tributary of the North Branch.

Land in the North Branch watershed is primarily rural and wooded, with development occurring mainly along major road corridors (NJ Routes 24 and 206 and Highways 22 and 287) and in the southeastern section of the basin. Agricultural operations and present throughout the North Branch watershed, but are heaviest in the Hunterdon municipalities of Readington and Tewksbury. Cropland for barley, hay, corn and nursery stock occurs, as does pasture land for beef and dairy cattle, swine and chickens. Development has been intensified in the North Branch watershed by the building of several large corporate offices along Routes 206, 22 and 287. Additional light industrial facilities are now under construction or are planned for the future. This development has resulted in the growth of housing and commercial centers. Population centers are Chester, Raritan, Branchburg and Bernardsville. Population growth for the period 1970 to 1980 was greatest in Tewksbury Township (25 percent) in Hunterdon County and Roxbury and (20 percent) and Chester (25 percent) Townships in Morris County.

On-site (septic) systems are employed in most areas of the North Branch Raritan River watershed. Sanitary sewers are provided in only the town centers of Bernardsville, Mendham, Peapack-Gladstone, Far Hills and Bedminster. There are also a number of small package treatment plants that serve businesses and localized housing developments. Public sewer planning activities take place in portions of the North Branch watershed, but much of central Morris County and eastern Hunterdon County remain as undesignated areas. Twenty-seven dischargers are present in the basin, the majority treating sanitary wastewaters.

The North Branch Raritan River, along with the other major streams in the Raritan River basin, have a number of uses. Present and future potable water supplies and cold and warm water fisheries resources are important resources in the watershed. Currently, three municipalities, Mendham Borough, Bedminster Township and the Borough of Peapack-Gladstone, have surface water intakes in the North Branch watershed (the Borough of Peapack-Gladstone, however, does not use surface waters at present). In addition, a reservoir at the confluence of the North and South Branches has been termed feasible in the NJ State Water Supply Master Plan (1981). The Confluence Reservoir will be used to meet regional water needs in the future. In addition, waters from the North Branch (with augmentation of flows from Round Valley Reservoir), are expected to be transferred to the Passaic River so that flows and water needs can be met in that basin. Based on state water diversion permits, waters in the North Branch, Burnett Brook and the Lamington River are used for irrigation and industrial purposes.

The North Branch Raritan River and its tributaries are heavily used as a recreational resource. Hacklebarney State Park in Morris County has the Lamington River flowing through it and is intensively used for fishing, picnicking and hiking. The Black River Wildlife Management Area is situated along a six mile stretch of the Black River north of Chester Borough. Hunting, fishing and other recreational opportunities exist here. County and municipal parks are present adjacent to many of the small lakes in the watershed. These lakes generally have excellent largemouth bass, catfish and sunfish populations for fishing. The NJ Division of Fish, Game and Wildlife stocks trout in the following streams in the North Branch watershed: India Brook, Burnett Brook, Peapack Brook, Black River, Trout Brook, Rhinehart Brook, Harrison Brook, Lamington River, North and South Branches Rockaway Creek and the North Branch Raritan River. In addition, many streams also have reproducing brook, brown and rainbow trout populations.

Waters in the North Branch Raritan River basin have been classified by the NJ Water Quality Standards as FW-2 Trout Production, FW-2 Trout Maintenance and FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

Water quality in both the North Branch Raritan River and Lamington River are reviewed in this assessment and are based on samples collected through both the USGS/DEP network and intensive surveys (at headwater locations). The North Branch was sampled near Chester and at Burnt Mills and the Lamington River near Ironia and at Lamington.

The North Branch Raritan River exhibited generally good water quality with localized marginal conditions in both the upstream segment and below the confluence with the Lamington River. Water quality problems in these areas were characterized by moderate biochemical oxygen demand and elevated fecal coliform and nutrient levels.

The North Branch Raritan at Chester is classified as a trout production stream. Dissolved oxygen concentrations were generally sufficient throughout the period, although seasonally lower values were occasionally below the minimum requirement of 7.0 mg/l. Dissolved oxygen was generally at or above the 100 percent saturation level over the period. Biochemical oxygen demand, at low to moderate levels through most of the period, increased to over 3.0 mg/l during 1980, possibly due, in part, to low flow conditions. The upstream station near Chester also exhibited biochemical oxygen demand elevation during this same period. This increase also resulted in a sharp decline in dissolved oxygen concentrations in the upstream segment.

Fecal coliform concentrations generally increased over the period at both the Chester and Burnt Mills stations, particularly during 1980, although fewer than 50 percent of the values exceeded the 200 MPN/100 ml level.

Total dissolved solids concentrations were generally less than 200 mg/l over the period. The pH values in the North Branch were generally above 7.0 su at Chester while the downstream segment periodically exhibited values in excess of 8.0 su.

Total phosphorus concentrations at Chester exceeded the 0.10 mg/l stream standard throughout the period, while generally acceptable levels were recorded downstream at Burnt Mills, above the confluence with the Lamington River. Somewhat excessive levels were again recorded downstream below the North Branch-Lamington confluence. Nitrate + nitrite concentrations were marginal in the upstream segment, but were less than 1.0 mg/l overall at Burnt Mills; these levels increased below the confluence with the Lamington River. Total and un-ionized ammonia concentrations were periodically elevated, but all un-ionized ammonia readings were below the criteria levels. The Burnt Mills station exhibited a slight overall increase in un-ionized ammonia over the period.

Summer dissolved oxygen concentrations and saturation levels declined gradually over the period at both the Ironia and Lamington stations on the Lamington River. The upstream segment near Ironia contravened the minimum dissolved oxygen standard for non-trout streams (4.0 mg/l) in summer, 1980, but concentrations remained sufficient for trout maintenance downstream at Lamington. A general increase in biochemical oxygen demand provides some basis for the declining D.O. levels at Ironia, but BOD remained low to moderate at Lamington.

As in the North Branch Raritan River, approximately 50 percent of the fecal coliform data collected at both stations on the Lamington River exceeded 200 MPN/100 ml.

Total dissolved solids levels declined in the downstream direction from Ironia to Lamington, but pH values were generally higher at Lamington, as pH values exceeded 8.0 su during the summer months.

Excessive total phosphorus concentrations persisted near Ironia over the period with an extreme value in excess of 2.0 mg/l recorded in late 1980. The Ironia station also exhibited elevated nitrate + nitrite levels, but generally acceptable total and un-ionized ammonia concentrations. Total phosphorus levels declined downstream at Lamington, where only 25 percent of the values recorded over the period exceeded the criterion. Nitrate + nitrite and total ammonia concentrations also declined in the downstream segment, but un-ionized ammonia levels periodically exceeded the criterion, exhibiting a general increase from Ironia to Lamington.

Biological data collected from the North Branch Raritan River station near Raritan indicated the presence of a generally healthy community. Periphyton chlorophyll a values were low and the macroinvertebrate fauna was relatively well balanced. Despite moderate to high nutrient levels in the segment below the Lamington River confluence, turbidity and siltation in the North Branch may be important factors limiting primary production and, subsequently, grazing species.

The upper Lamington River intensive survey concluded that despite some water quality deterioration in the segment, the macroinvertebrate community reflects the presence of only slight or periodic impacts by oxygen-demanding wastes with minimal modification of the macroinvertebrate community.

The water quality description above is generally similar to what is discussed in earlier 305(b) reports (better water quality downstream in both the North Branch Raritan and Lamington Rivers). However, the following minor trends have been noted: the North Branch Raritan near Chester has increasing fecal coliform and BOD concentrations, higher fecal coliform and un-ionized ammonia in the North Branch at Burnt Mills, and higher BOD in the Lamington River.

Toxic Parameters

The North Branch of the Raritan River was sampled at Rt. 202 in Morris County and at Route 567 Somerset County. At both sites there was no evidence of toxic contamination. No surface water data on the Lamington River has been collected. This region of the Raritan River maintains generally good water quality throughout its length.

Additional sampling for toxics in this basin will be conducted in response to a known contamination occurrence, point source discharge, or to establish base line data.

Problem Assessment

Water quality in this segment is generally good although there are areas of only marginal quality. Parameters indicated as being of concern in portions of the North Branch are BOD, fecal coliforms, total phosphorus and nitrate + nitrite. In the Lamington River, there have been some problems with concentrations of dissolved oxygen, fecal coliforms, total phosphorus, and un-ionized ammonia. The low dissolved oxygen levels detected in the North Branch Raritan at Chester in the summer of 1980 were likely from low flows as a result of the drought.

Due to the generally rural land uses of the watershed, there are visible contributions of non-point source pollution, although there are also some significant point sources. The Upper Raritan Water Quality Management Plan, for example, had estimated that non-point source contributions in the watershed ranged from 37 to 82 percent of the total phosphorus loading, 66 to 91 percent for total nitrogen, 91 to 96 percent for total organic carbon, 56 to 80 percent for total dissolved solids, and 80 to 96 percent for total suspended solids.

Pollution is also partly the result of septic tanks in the area. Randolph Township and Chester Borough are municipalities which have on-site disposal problems. The WQM Plan had also noted fecal streptococci problems, indicative of animal sources.

Point sources of special concern include the Borough of Mendham Sewage Treatment Plant which is a source of ammonia and suspended solids; the Township of Bedminster Sewage Treatment Plant which is contributing phosphate and nitrate; and the Chester Diner which is contributing to BOD and fecal coliform problems. Each of these sources is presently under enforcement action.

Goal Assessment and Recommendations

The North Branch and the Lamington both do not meet the goal of swimmable water quality at the monitoring stations reviewed here. Despite periodic problems with dissolved oxygen and nutrient levels, these rivers are of fishable water quality. The North Branch supports a diverse community of fish, with thirty-one species (including native trout) reportedly occurring there.

Development in this watershed will place increasing demands for maintaining water quality, especially in headwaters. In order to protect stream quality, it is recommended that there be an education program to alert residents of the need to provide proper maintenance for septic tanks. In addition, best management practices for mitigating agricultural non-point source pollution should be implemented. Water quality in the basin will face additional pollution loads from the development which is occurring in many parts of the region. Current municipal treatment plants still need to be upgraded to provide for advanced removal so that the good water quality in the basin can be protected. Increased monitoring for toxic contaminants is also recommended.

NORTH BRANCH RARITAN RIVER STATION LIST

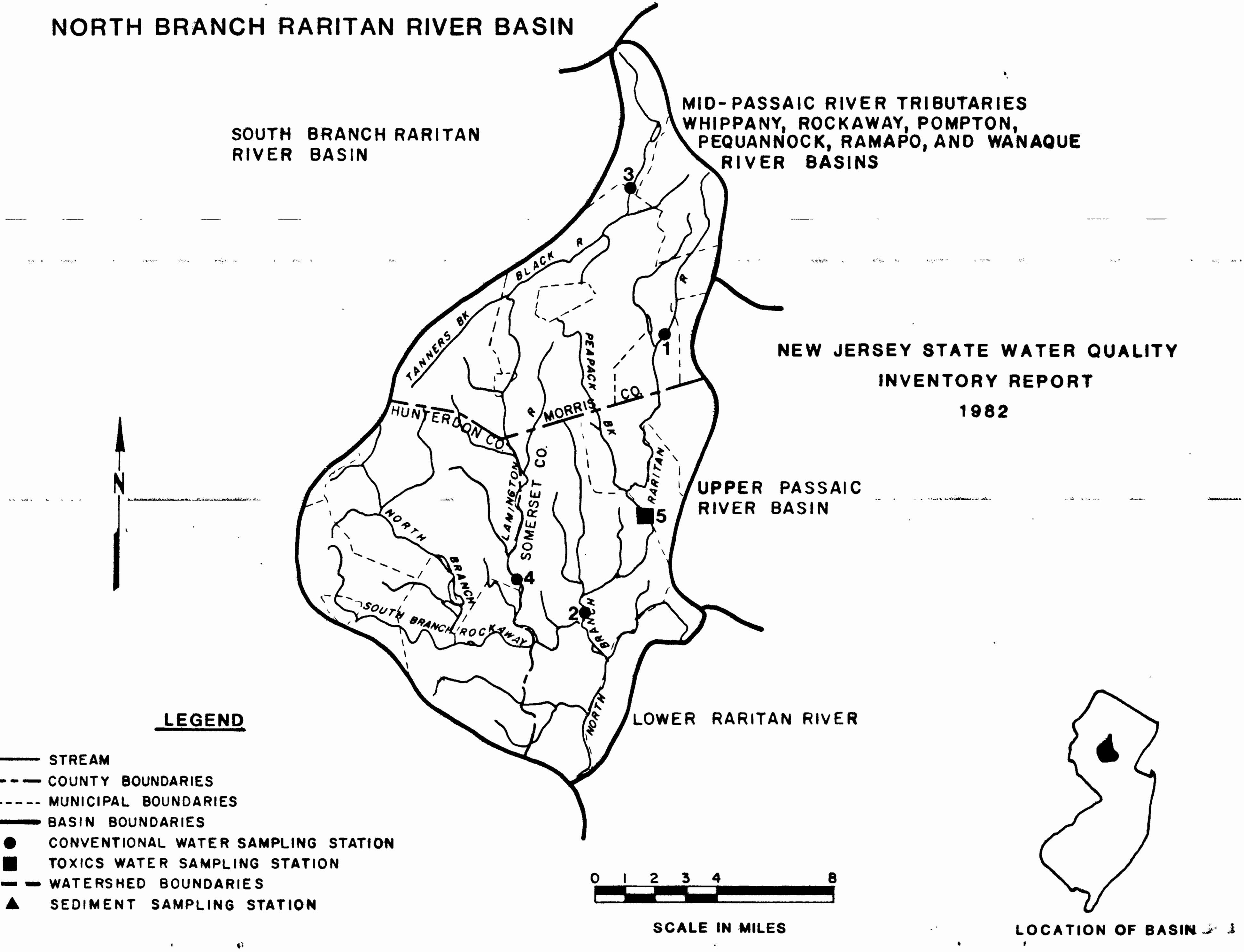
A. Ambient Monitoring Stations

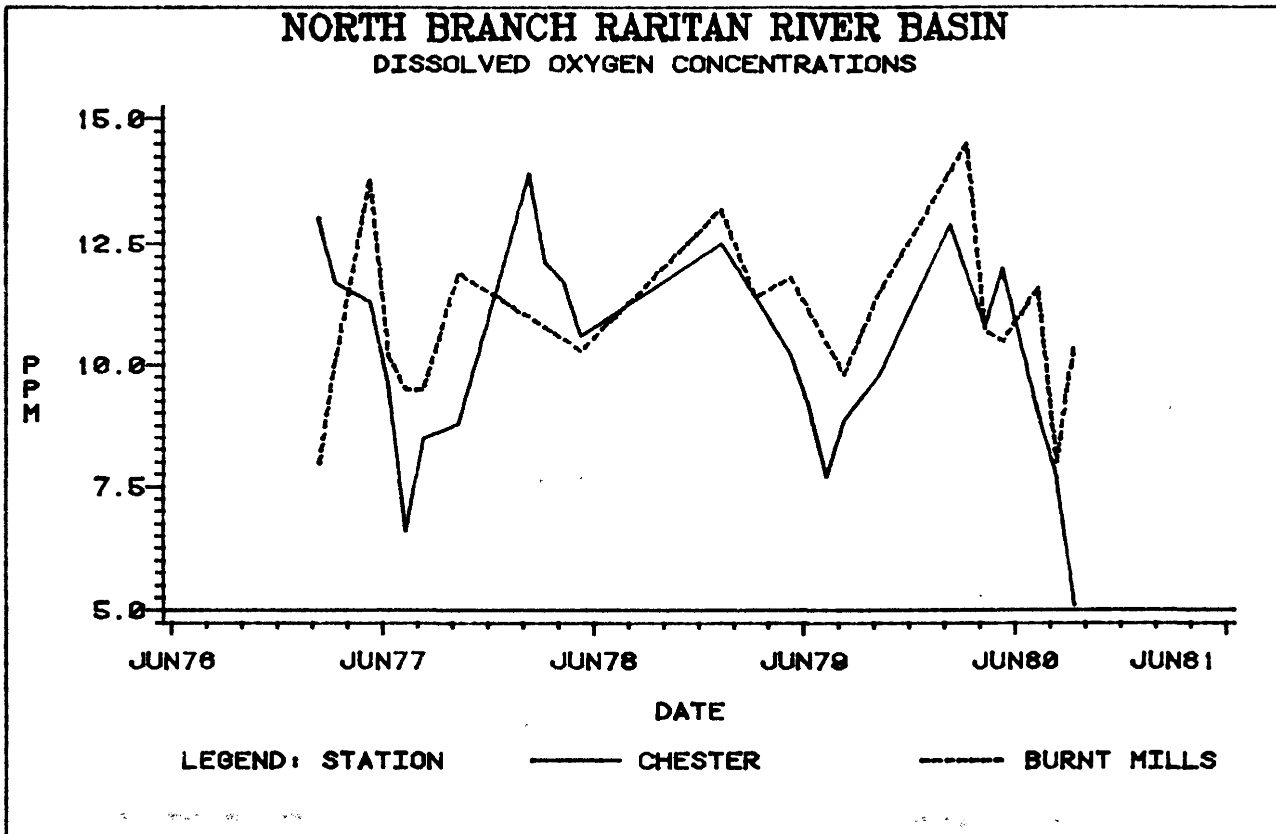
STORET Number	Station Description	Map Number
01398260	North Branch Raritan River near Chester, Morris County Latitude 40°46'16" Longitude 74°37'34" FW-2 Trout Production USGS/DEP Network Intensive Survey, 1979 At bridge on Route 24, 0.8 miles upstream from Burnett Brook and 3.8 miles east of Chester.	1
01399120	North Branch Raritan River at Burnt Mills, Somerset County Latitude 40°38'09" Longitude 74°40'56" FW-2 Nontrout USGS/DEP Network At Burnt Mills Road bridge, 0.1 mile upstream from Lamington River and 4.0 miles southwest of Far Hills.	2
01399200	Lamington River near Ironia, Morris County Latitude 40°50'07" Longitude 74°38'40" FW-2 Nontrout USGS/DEP Network Intensive Survey, 1980 At bridge on Ironia Road, 1.0 mile below Succasunna Brook and 1.3 miles northwest of Ironia.	3
01399545	Lamington River at Lamington, Somerset County Latitude 40°39'38" Longitude 74°43'46" FW-2 Trout Maintenance USGS/DEP Network At Route 523 bridge in Lamington, 0.4 miles downstream from Cold Brook.	4

B. Toxic Monitoring Stations

Station Location	Sampling Regime	Map Number
North Branch Raritan River at Route 206	Water column	5

NORTH BRANCH RARITAN RIVER BASIN





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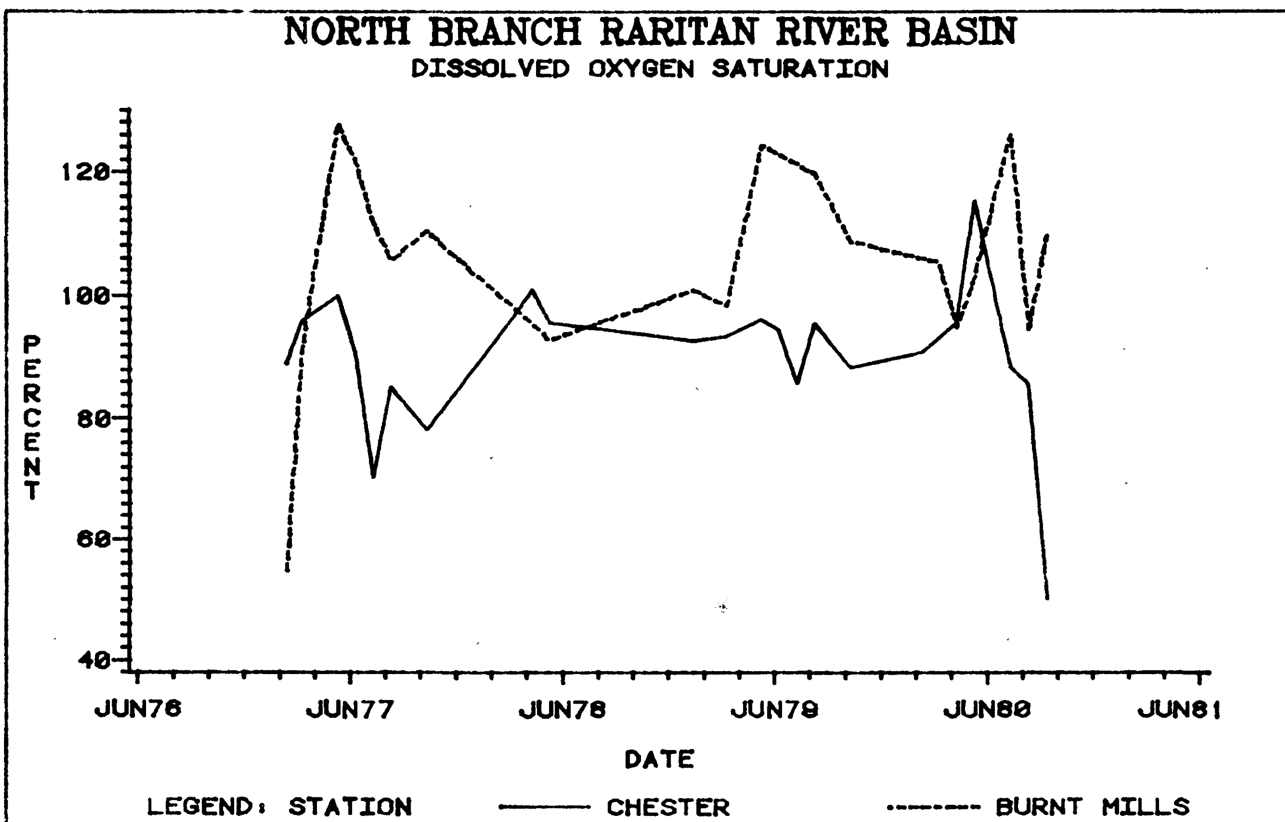

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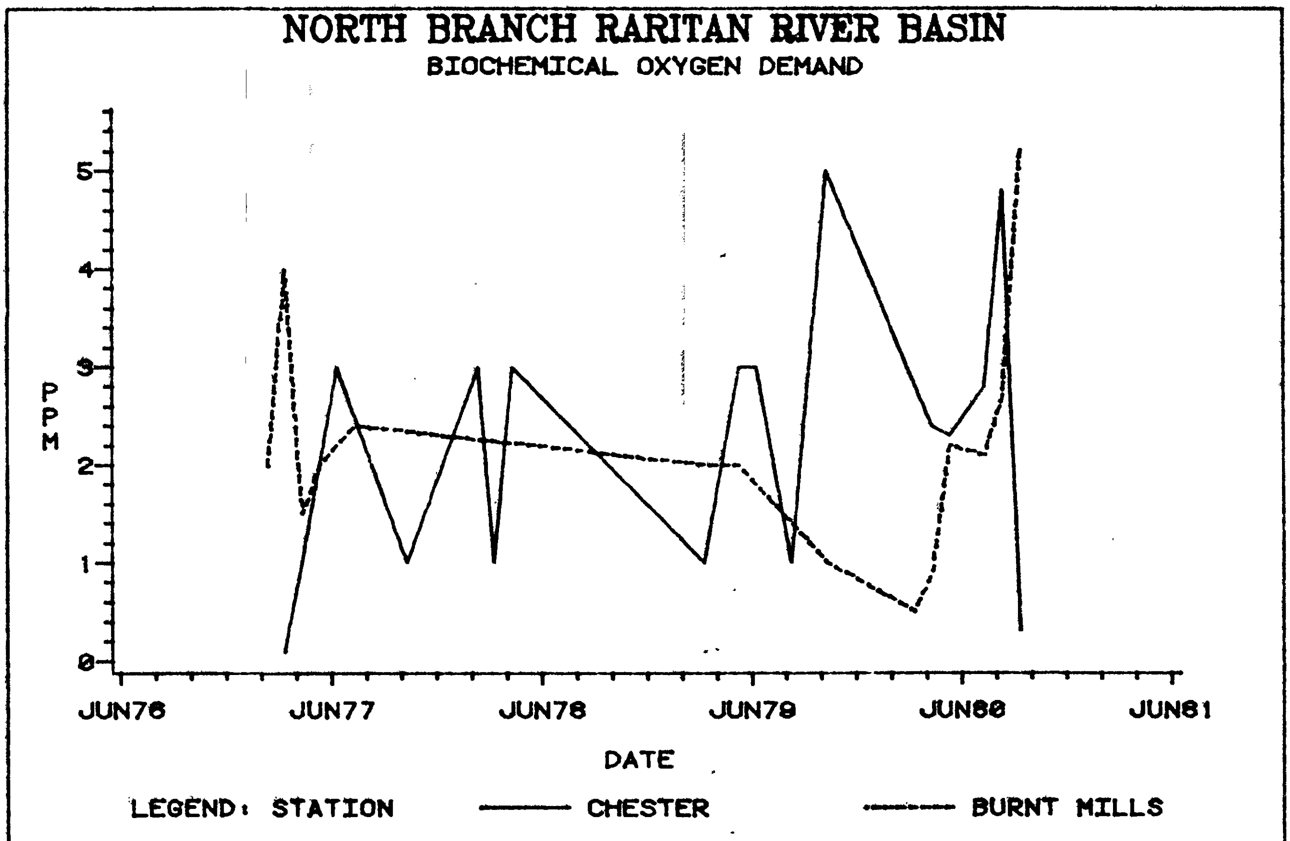

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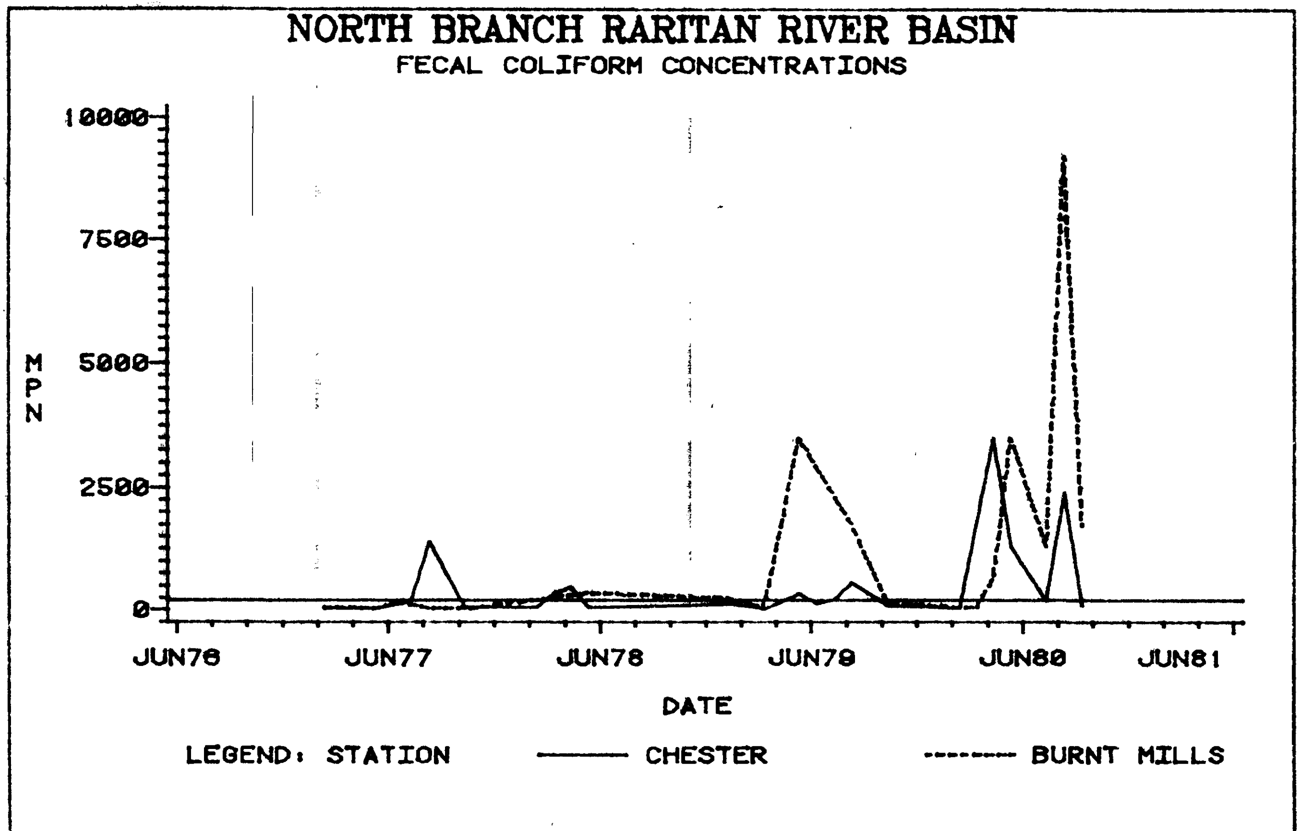

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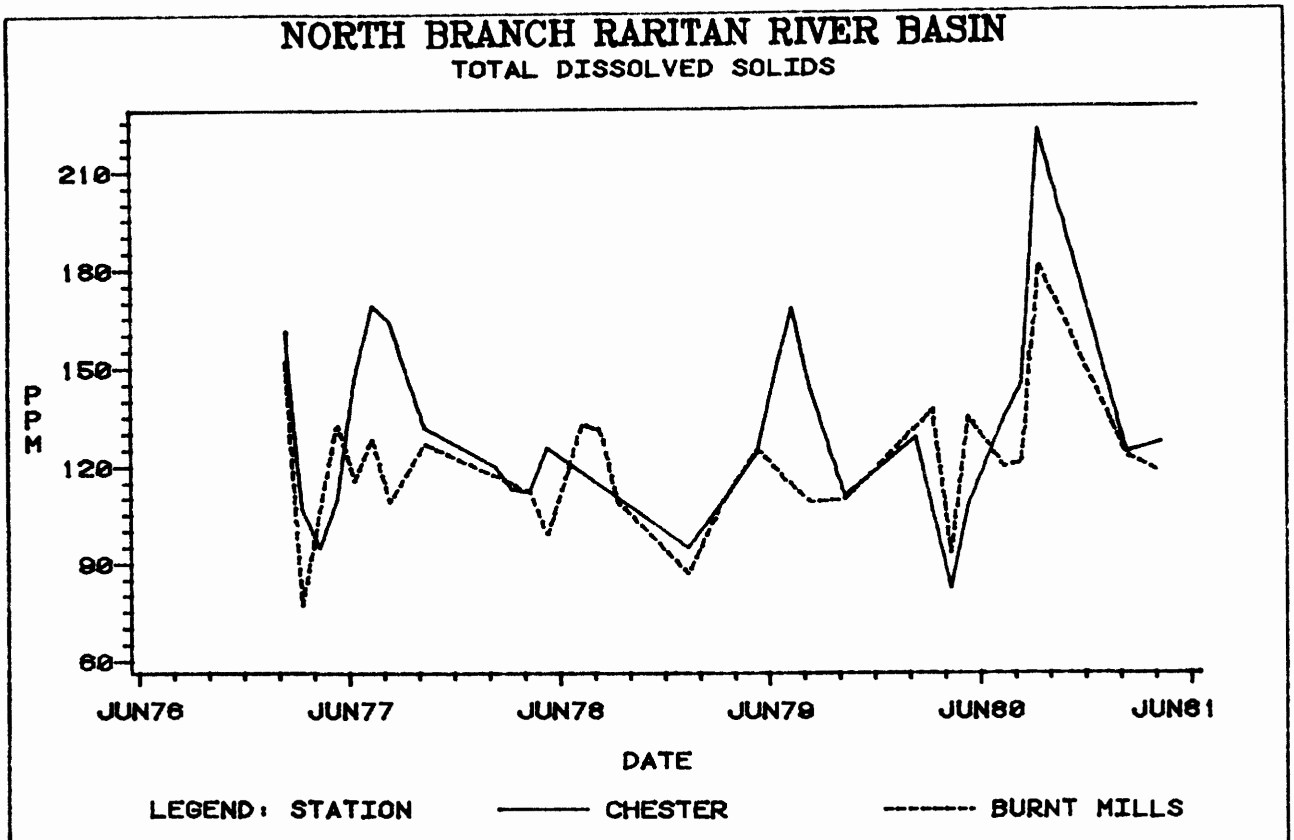

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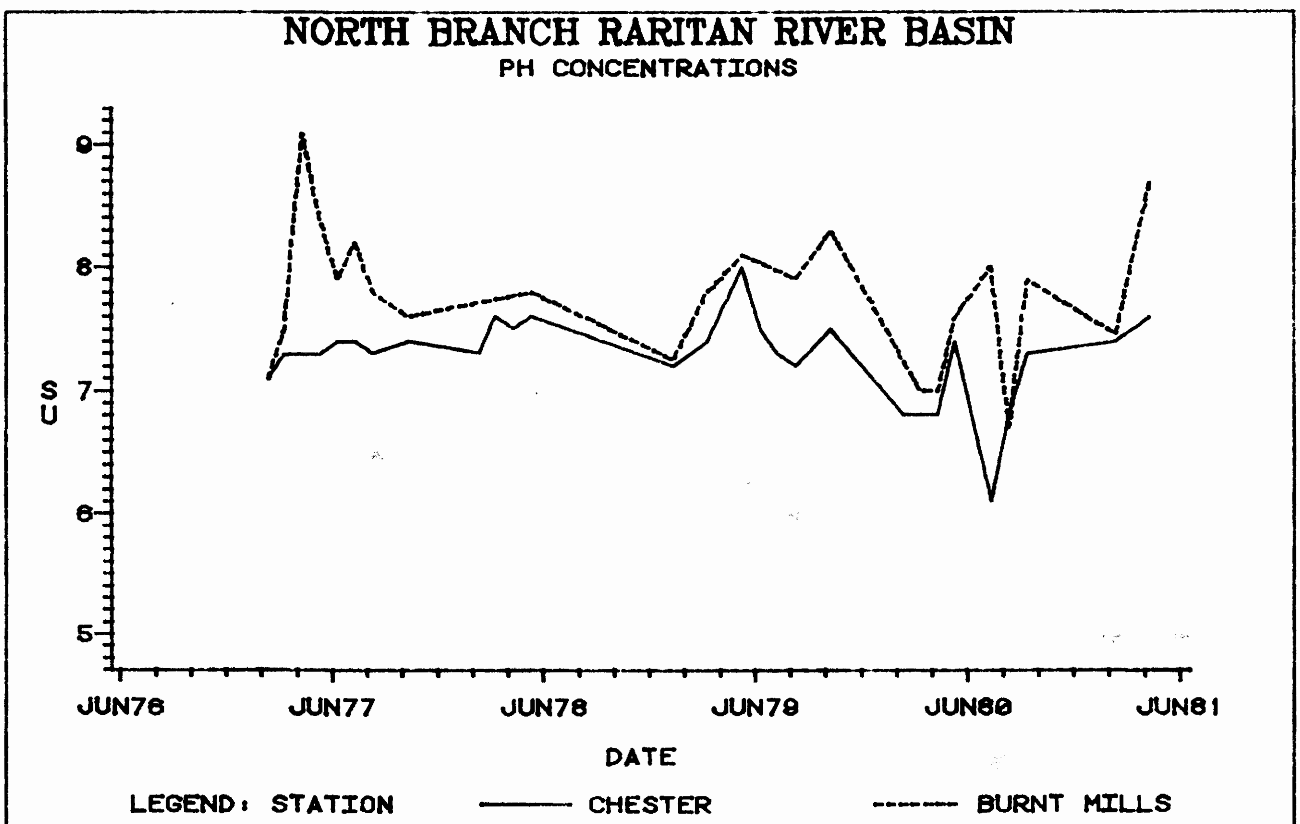

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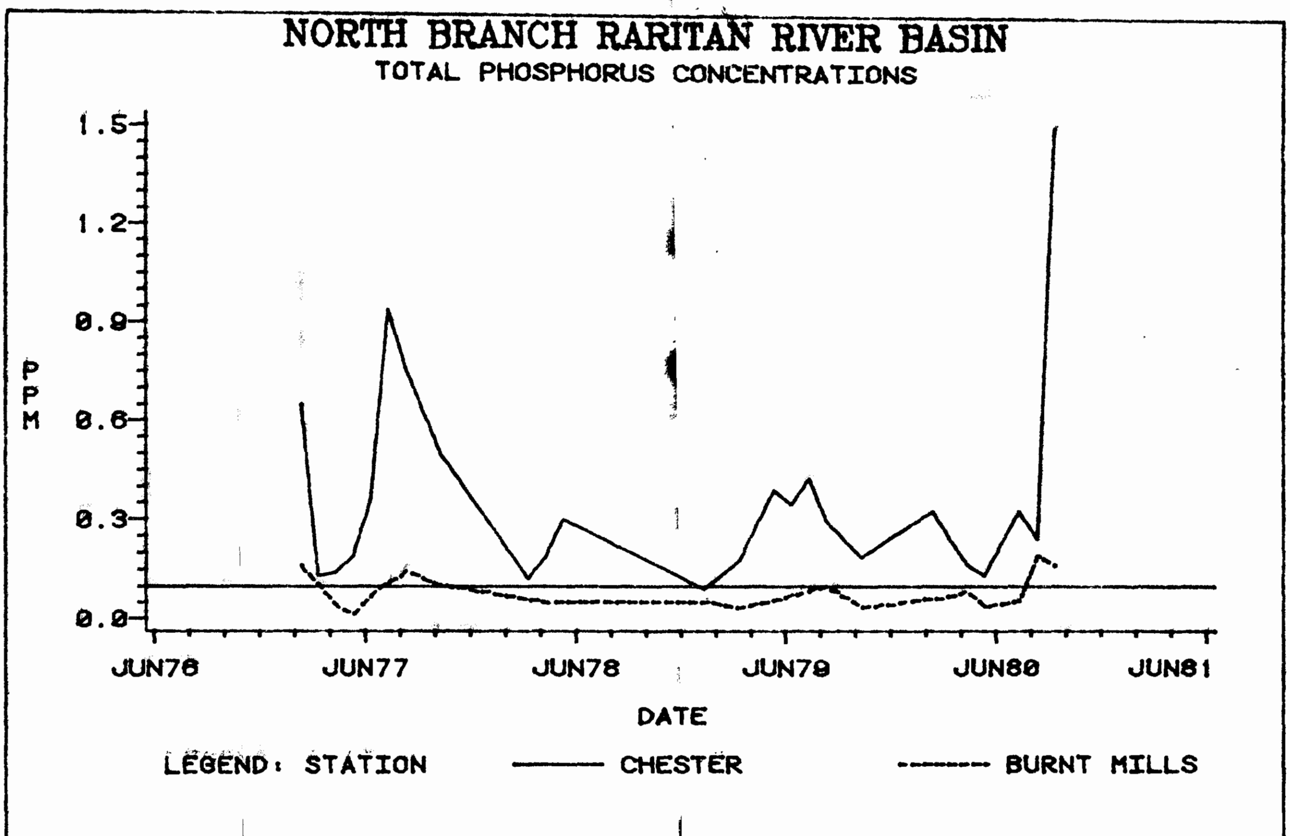
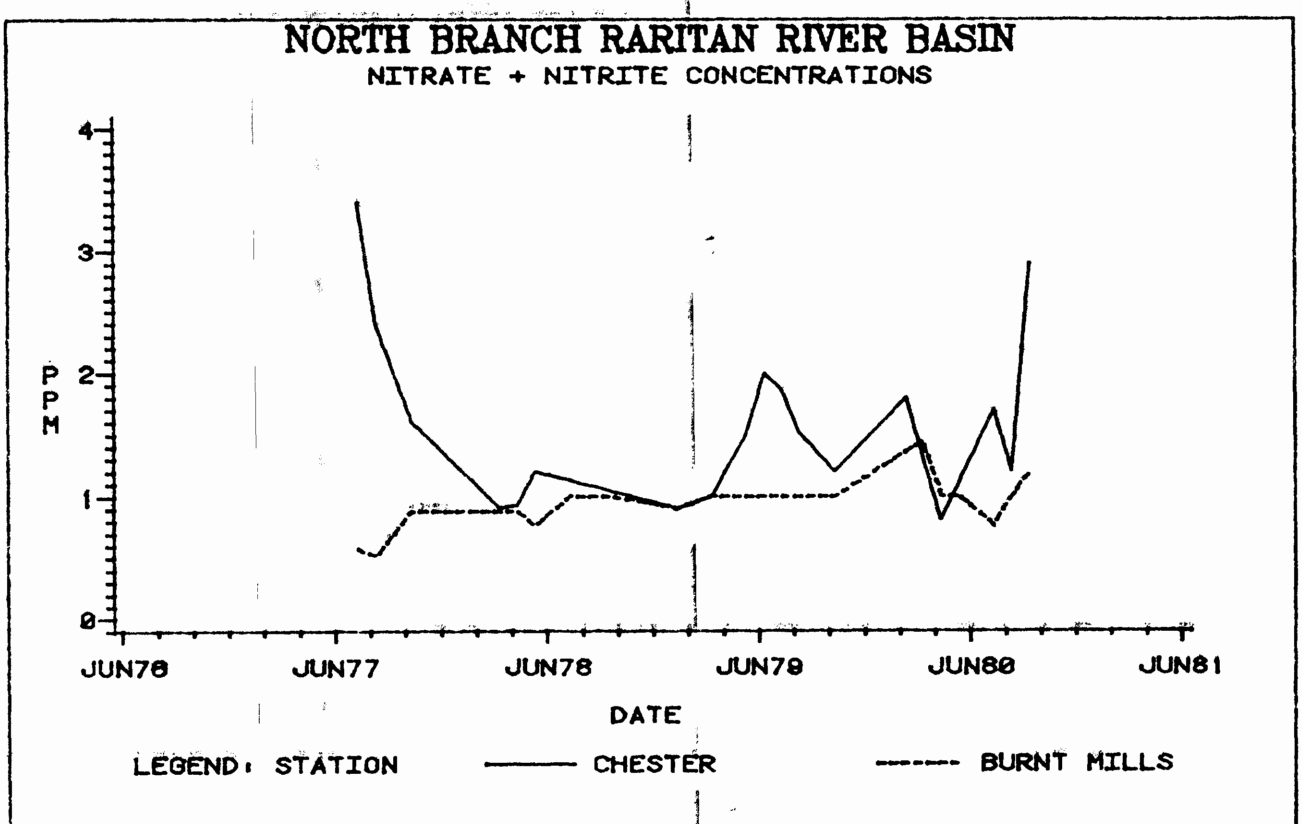


Figure: S1 -7



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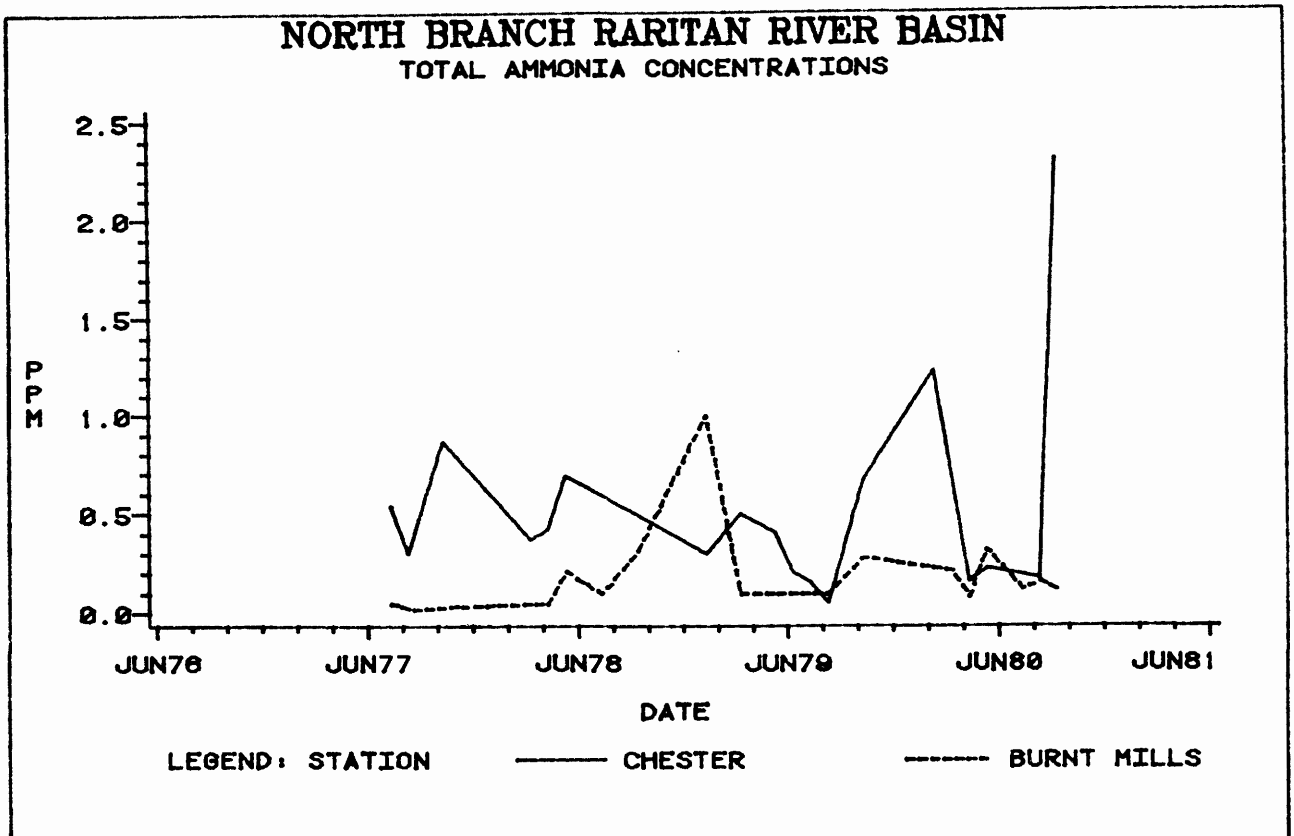

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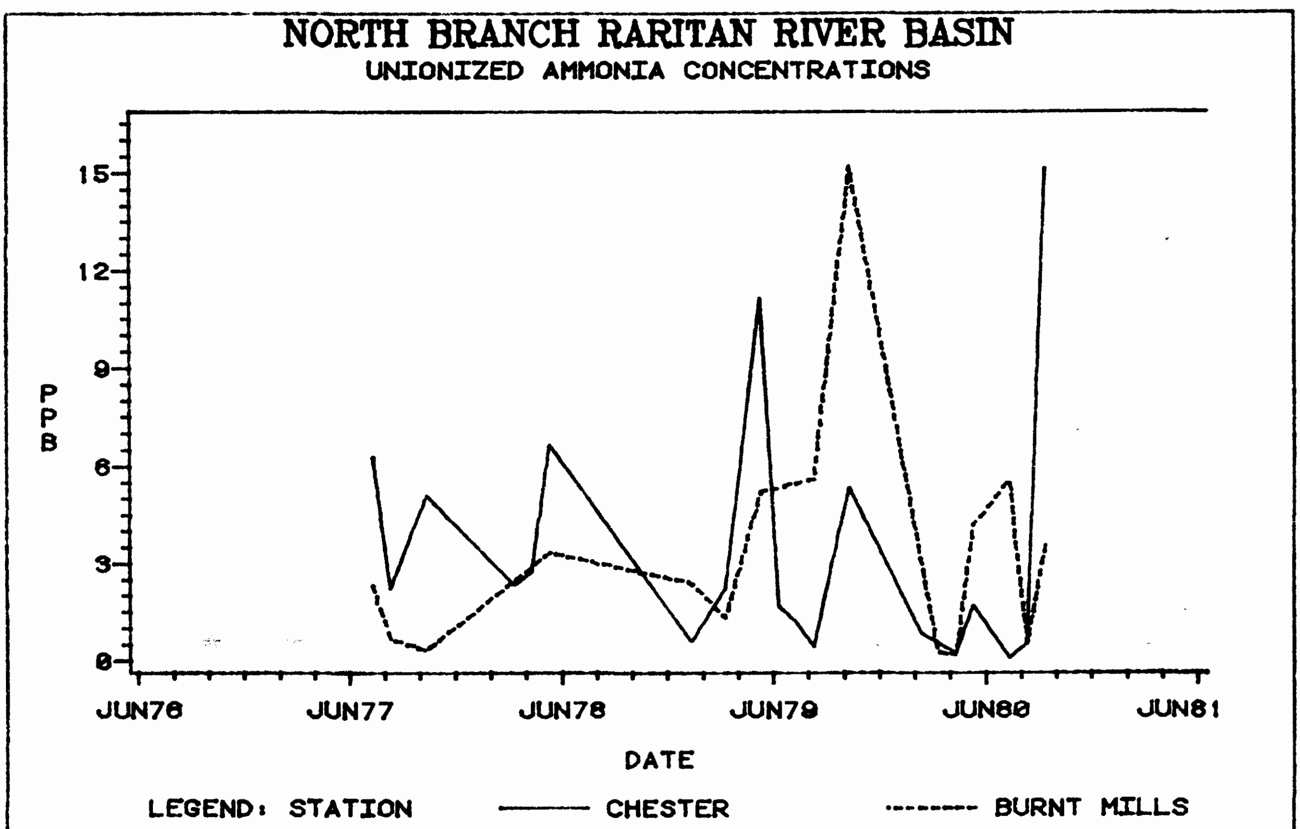

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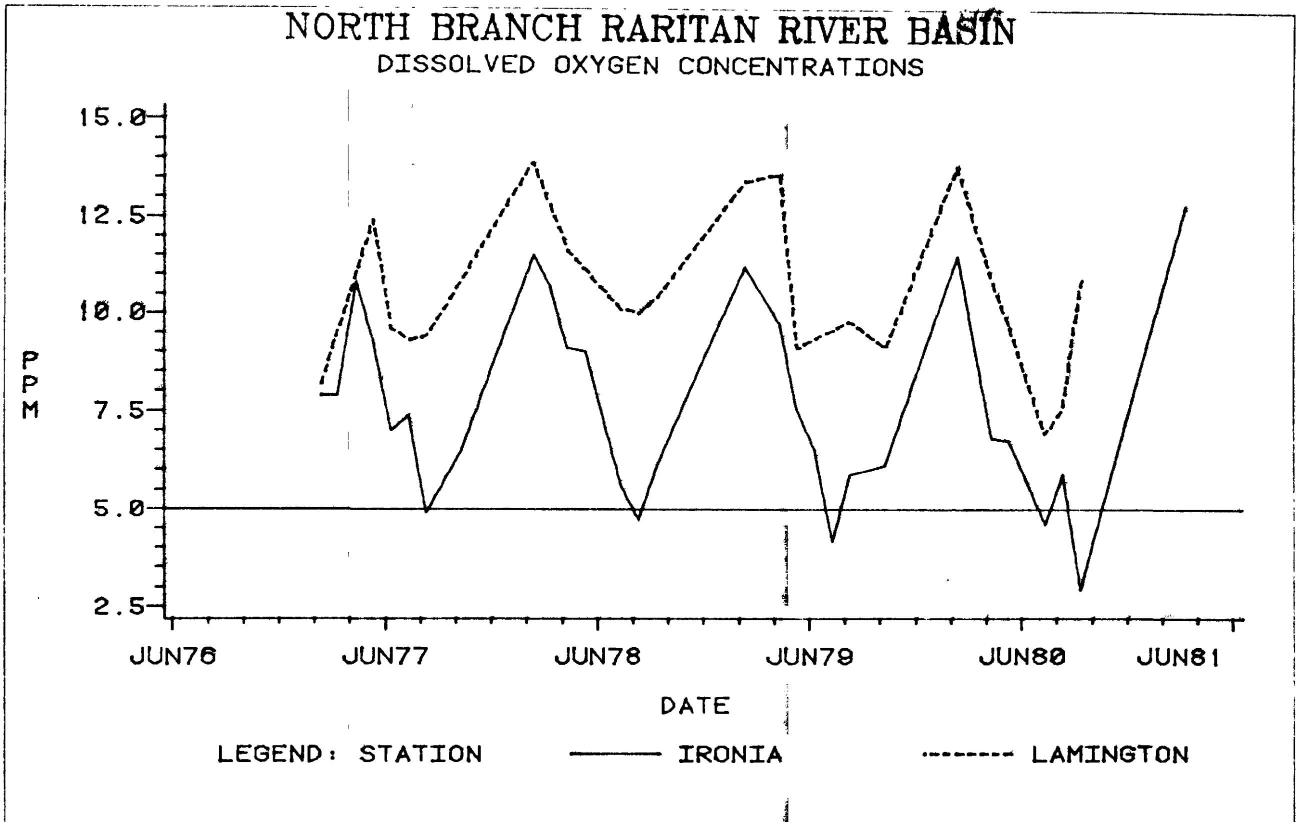

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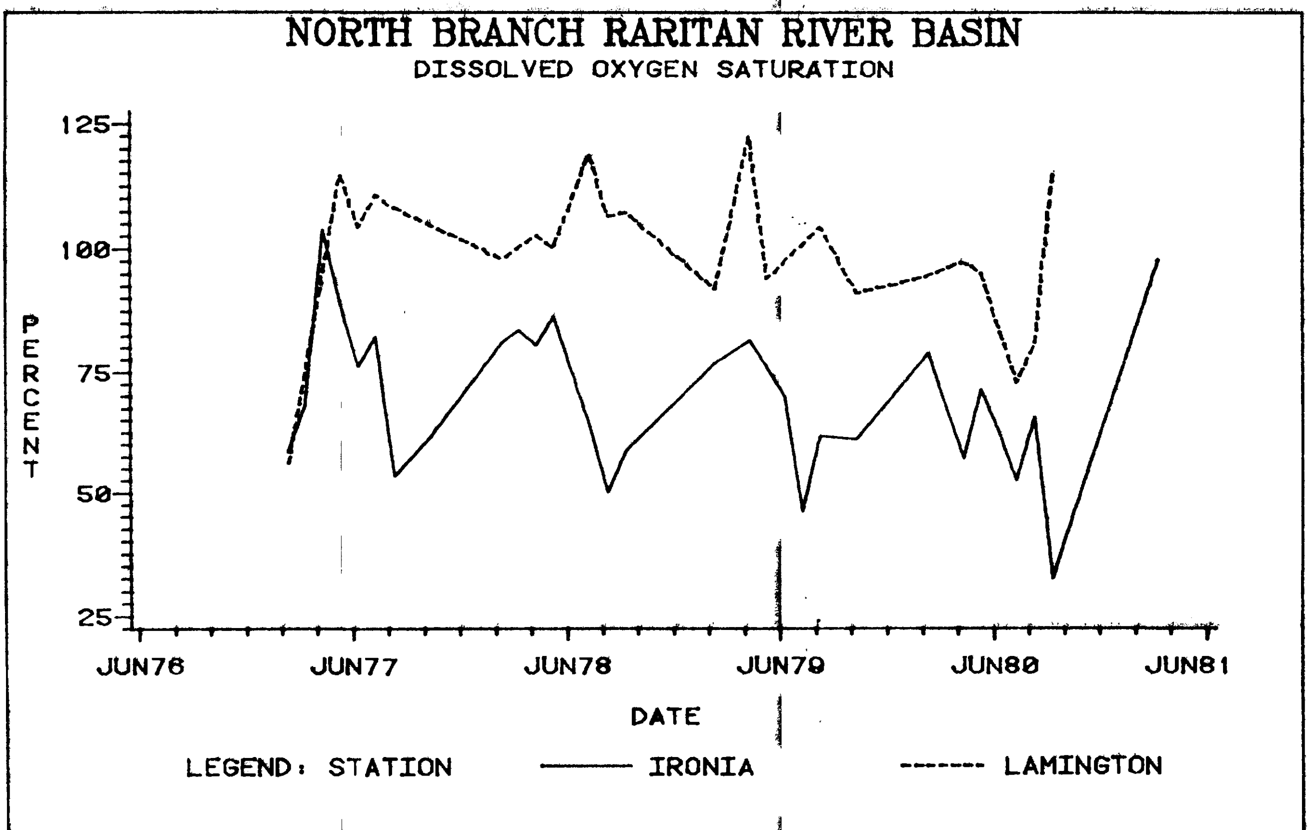

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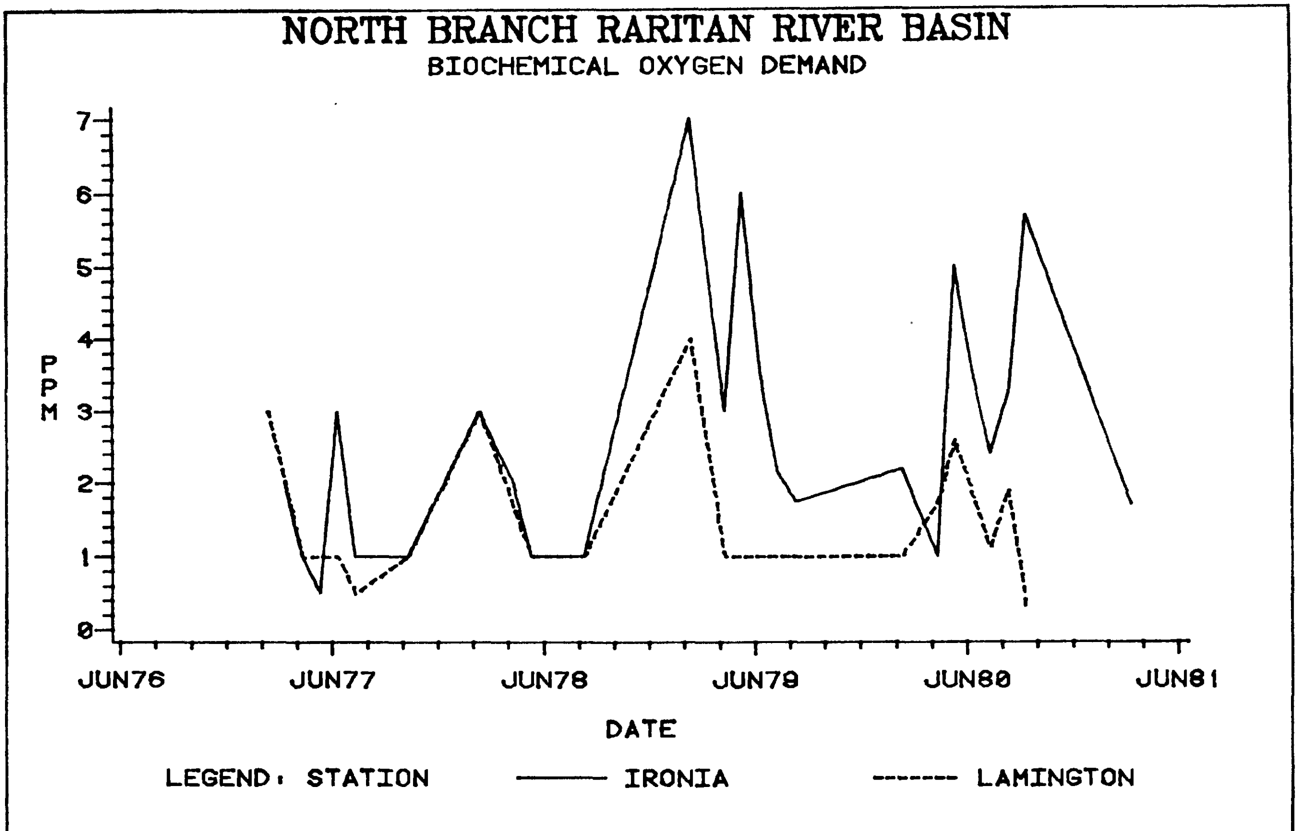

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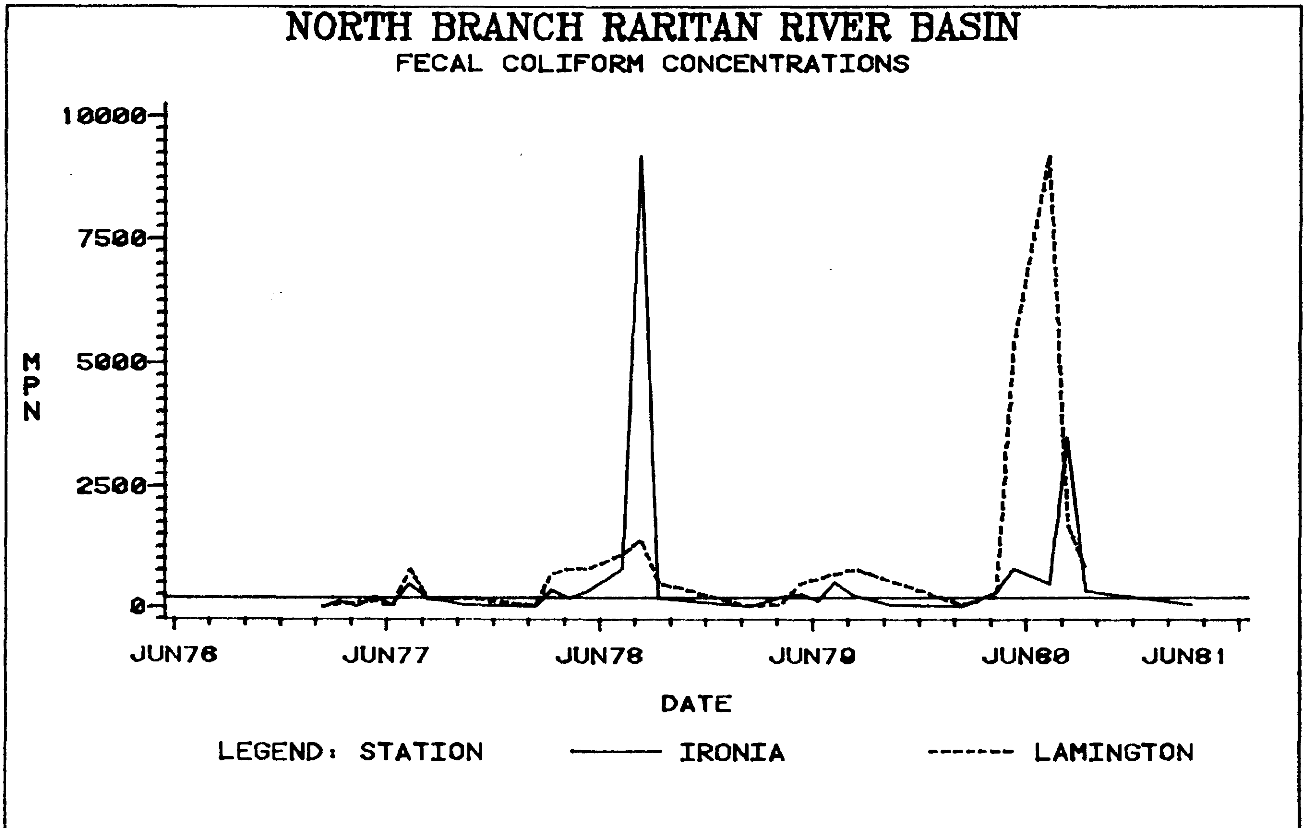

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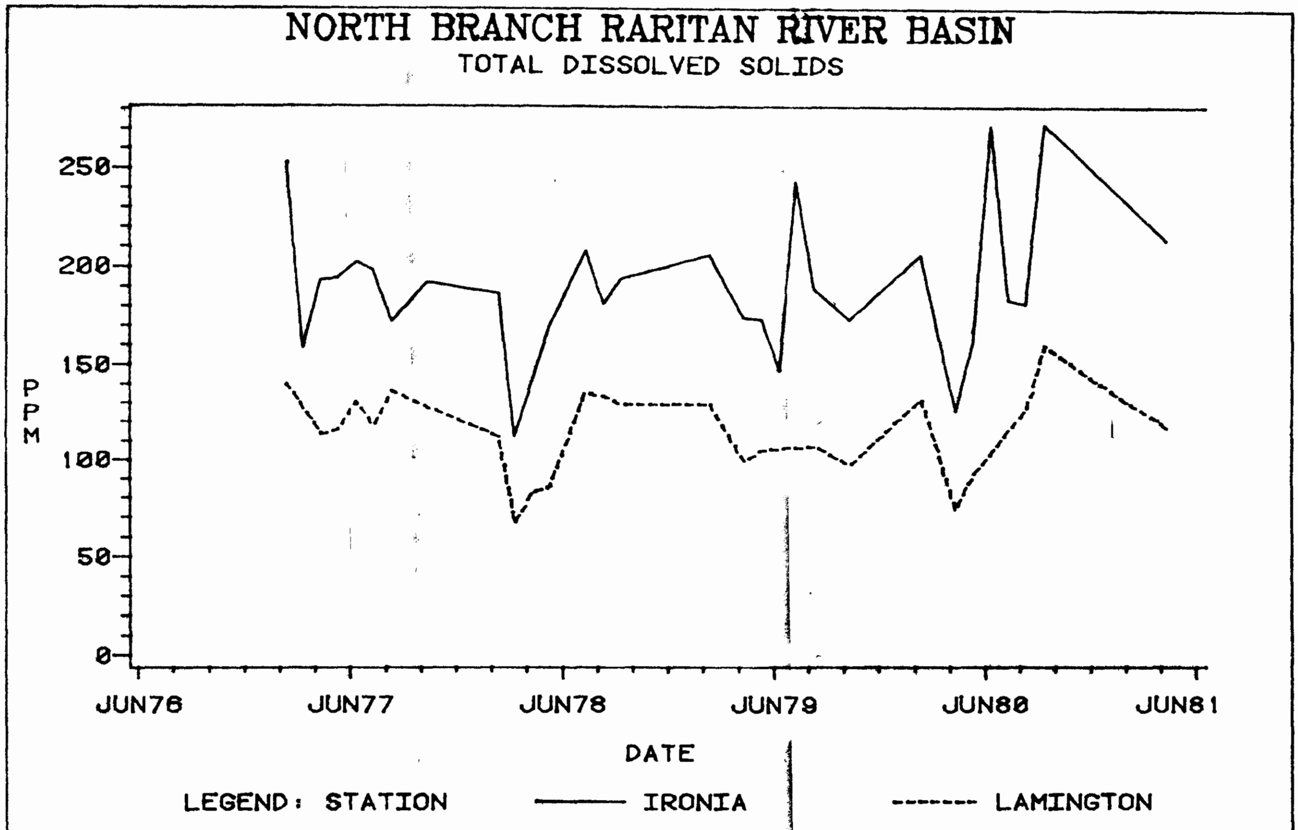

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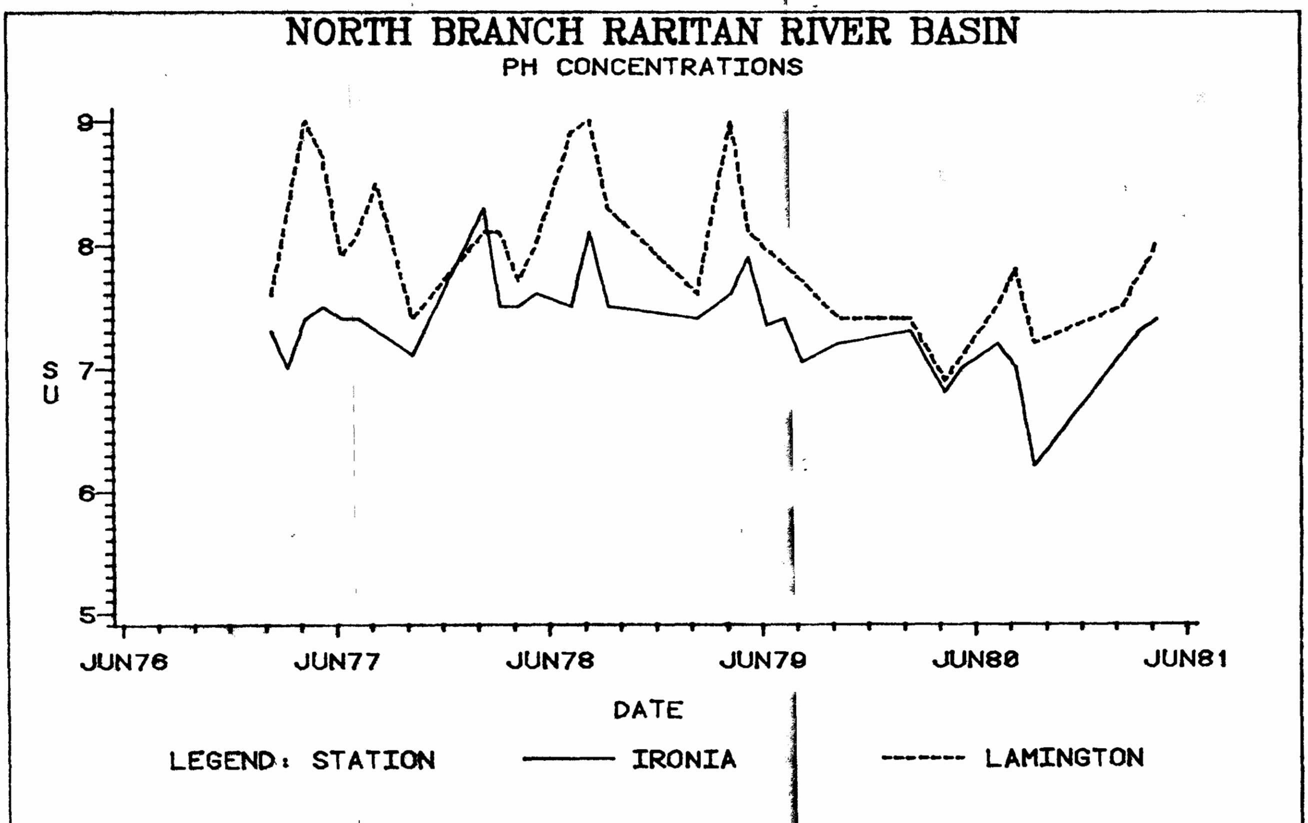

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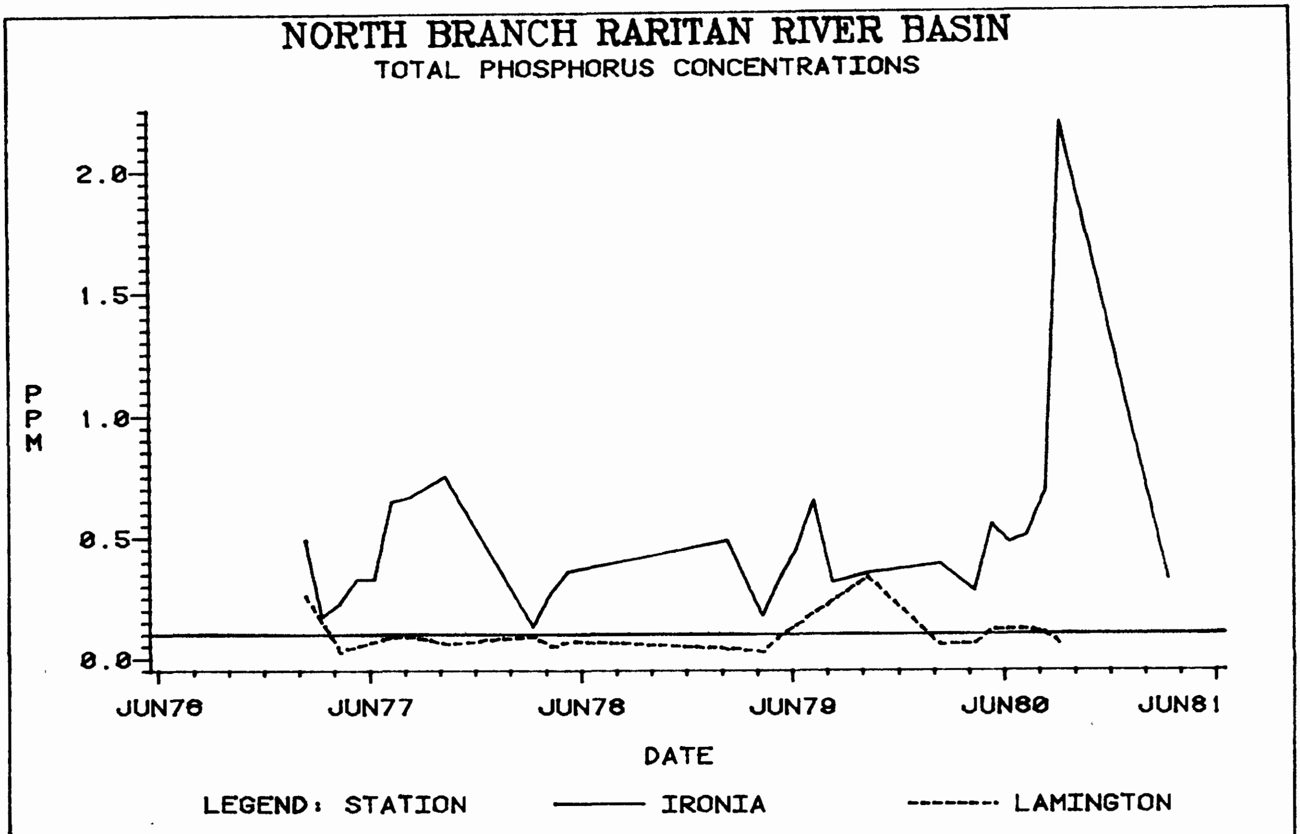

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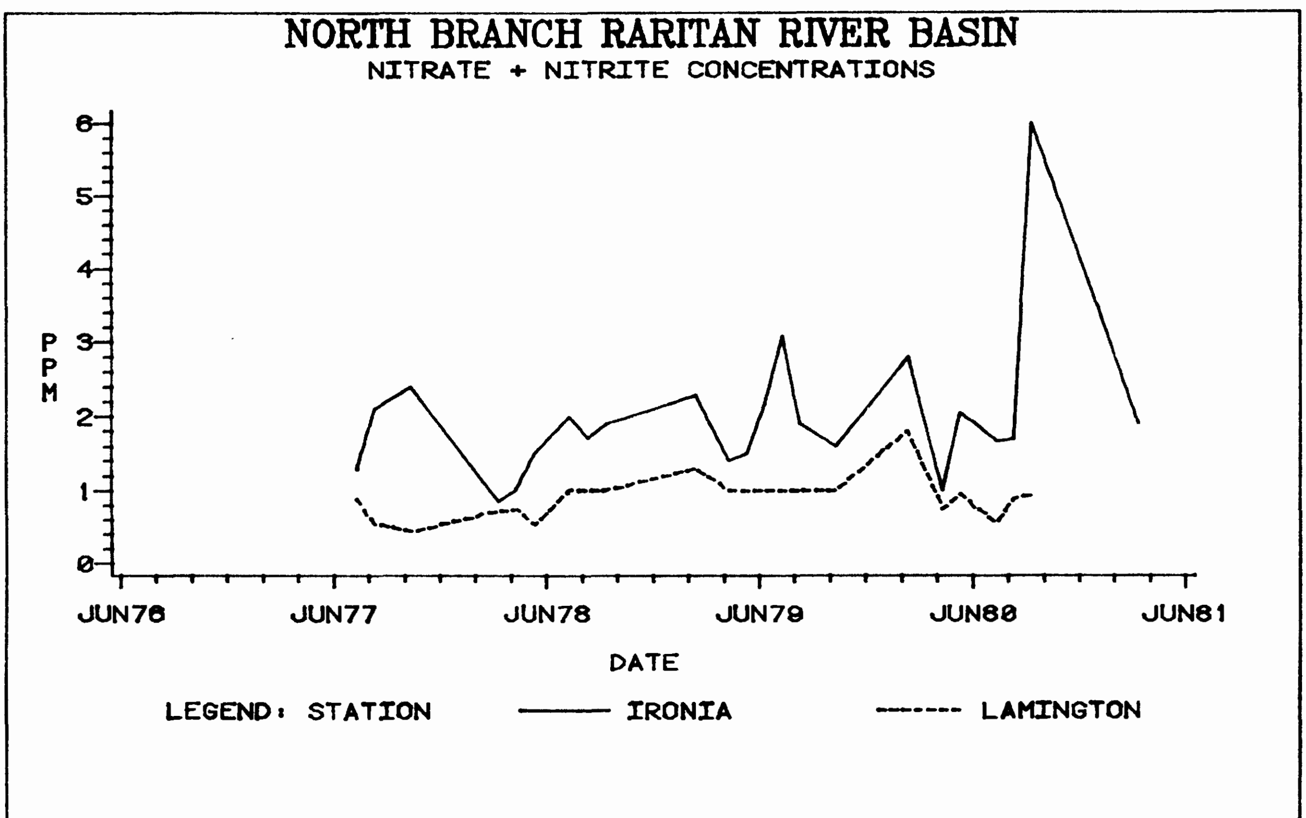

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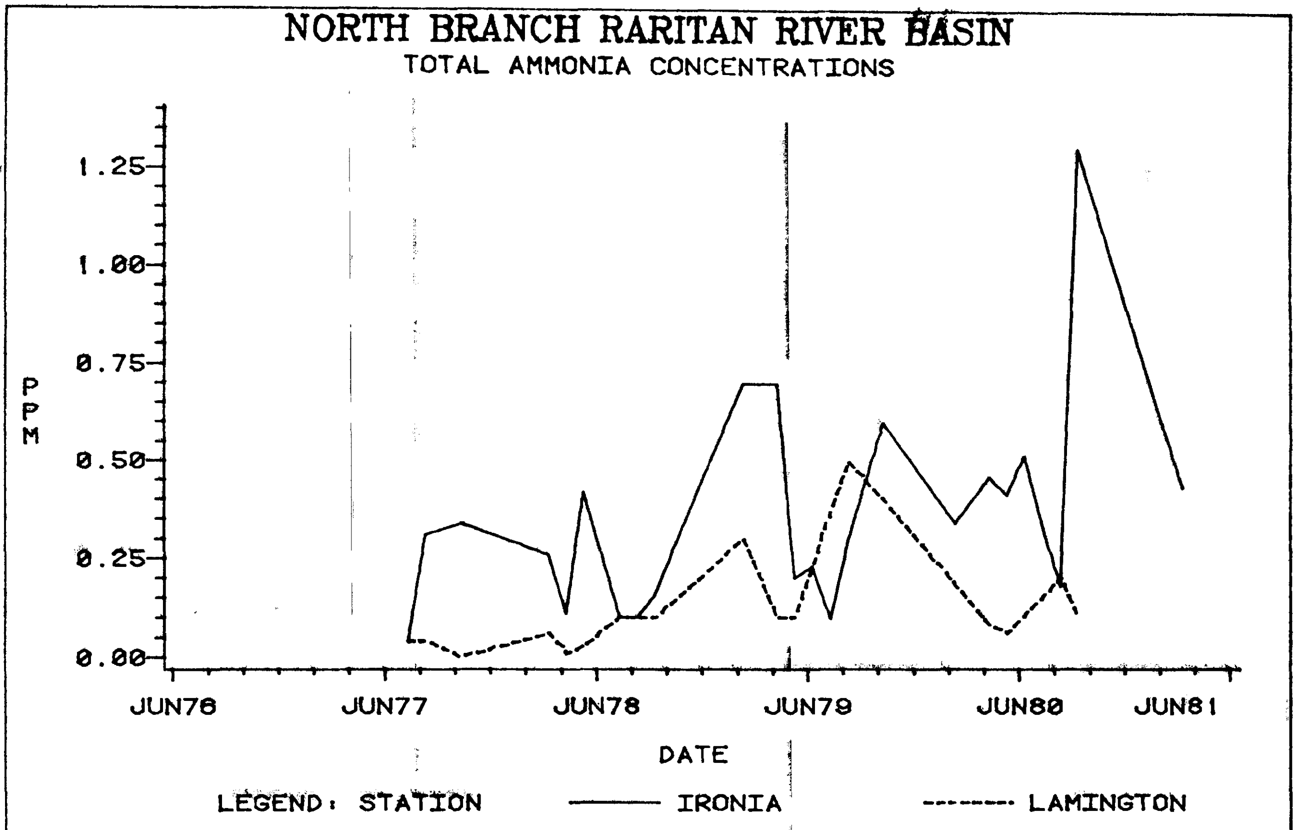

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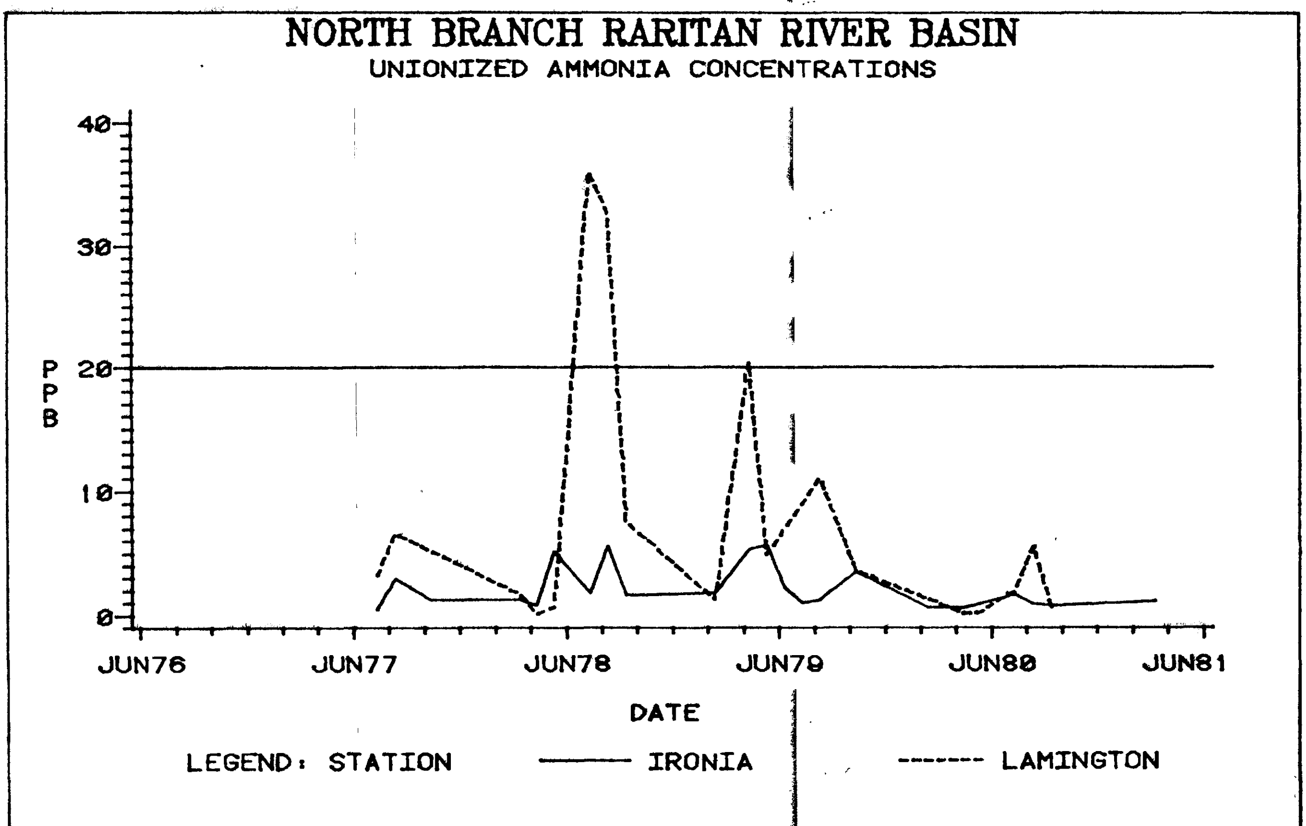


Figure: S2 -10

06/25/82
DISCHARGE INVENTORY - - - NORTH BRANCH RARITAN RIVER BASIN

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
SIMMONS PRECISION PROD DIV CO-	0002330	CHESTER	BLACK RIVER	PROCESS & SANIT	.05
COUNTY CONCRETE CORP	0002861	ROXBURY TWP	BLACK RIVER		3.50
HERCULES INC	0000876	ROXBURY TWP	BLACK RIVER	PROCESS & COOL.	1.50
TOWNSHIP OF ROXBURY-AJAX TERR.	0022675	ROXBURY TWP	BLACK RIVER	SANITARY	.90
BOROUGH OF MENDHAM	0021334	MENDHAM /BORO/	INDIA BROOK	SANITARY	
VALLEY ROAD SEWERAGE CO.	0022781	TEWKSBURY TWP	LAMINGTON R.	SANITARY	
JOHN K COWPERTHWAITE	0027227	BEDMINSTER TWP	LAMINGTON RIVER	SANITARY	
REYNWOOD CORP	0021865	BEDMINSTER TWP	LAMINGTON RIVER	SANITARY	.01
195 BROADWAY CORP.	0022993	MENDHAM /BORO/	MC VICARS BROOK	SANITARY	.01
ENERGY PRODUCTS GROUP	0003638	BRANCHBURG TWP	NO BR RARITAN	PROCESS & COOL.	.01
BELL TELEPHONE LABS	0000434	CHESTER BORO	NO BR RARITAN R		.01
NEW JERSEY DOT-RT 78 REST AREA	0032298	BEDMINSTER TWP	NORTH BRANCH RARITAN RIVER	SANITARY	
BOROUGH OF PEAPACK-GLADSTONE	0021881	PEAPACK-GLADSTONE BO	PEAPACK BR.	SANITARY	.08
KOMLINE SANDERSON ENGINEERING	0032671	PEAPACK	PEAPACK BROOK		
TECHNICAL INFORMATION SYSTEMS	0003158	BRANCHBURG /TWP/	TR CHAMBERS BK	PROCESS WASTE	.24
CLINTON TOWNSHIP BD OF ED	0023175	CLINTON TWP	SOUTH BRANCH OF ROCKAWAY CREEK	SANITARY	.00
TOWNSHIP OF BRANCHBURG	0020338	BRANCHBURG TWP	TRIB TO N BRANCH RARITAN RIVER	SANITARY	
TOWNSHIP OF BRANCHBURG	0020362	BRANCHBURG /TWP/	TRIBUTARY TO CHAMBERS BROOK TO	SANITARY	
JOHN MANVILLE PROPERTIES CORP	0033995	BEDMINSTER	RARITAN RIVER		
CHESTER SHOPPING CENTER	0026824	CHESTER BORO	RARITAN RIVER	SANITARY	
NEW JERSEY DOT-MAINTENANCE FAC	0029807	PLUCKEMIN	RARITAN RIVER	SANITARY	
TOWNSHIP OF BEDMINSTER	0028495	BEDMINSTER TWP	RARITAN RIVER NO BR	SANITARY	
BOROUGH OF BERNARDSVILLE	0026387	BERNARDSVILLE BORO	MINE BROOK	SANITARY	.29
LEBANON CHEESE CO	0034843	LEBANON	ROCKAWAY CREEK		
CURLING FARMS INC	0031488	WHITEHOUSE STATION	ROCKAWAY CREEK	COOLING WATER	.01
COVENTRY ASSOCIATES	0028673	READINGTON TWP	ROCKAWAY CREEK-RARITAN RIVER	SANITARY	.01
DELITE FOODS	0027804	CLINTON TWP	S BRANCH OF ROCKAWAY CR	PROCESS WASTE	
OLDWICK MATERIALS INC	0002917	TEWKSBURY TWP	ROCKAWAY CREEK	PROCESS WASTE	.02

T. SOUTH BRANCH RARITAN RIVER

Basin Description

The South Branch Raritan River originates in western Morris County with Drakes Brook and Budd Lake serving as headwaters for the river. The South Branch then flows southerly through central Hunterdon and western Somerset Counties, draining a total area of 279 square miles before it joins the North Branch at Raritan to form the Raritan River mainstem. Larger tributaries to the North Branch include Spruce Run Creek, Cakepoulin Creek and Neshanic River. The South Branch watershed contains two large man-made reservoirs - Spruce Run and Round Valley, which were constructed in the 1960s by the State of New Jersey for water supply and recreational purposes. Flows in the South Branch are measured at Stanton (147 square mile drainage area) and averaged to 1980, 243 cfs.

The South Branch watershed is primarily rural with agriculture the main land use. Development is limited to scattered towns and along major roads through the watershed, but is increasing as new corporate and industrial centers move into the area. Cropland (primarily for corn and hay) is greatest in Readington, Clinton, Raritan and East Amwell in Hunterdon County; Washington in Morris County; and Branchburg in Somerset County. Pasture and livestock raising (includes beef and dairy cattle, horses, swine and chickens) is heaviest in Readington, Union, Lebanon, Franklin and Bethlehem in Hunterdon County; Washington and Mt. Olive in Morris County; and the portions of Somerset County in the South Branch basin. Population centers in this watershed include High Bridge, Clinton and Flemington, although newer development has created scattered population centers in the rural townships. Population growth on the order of 20 percent has occurred throughout the South Branch watershed for the period 1970 to 1980. The largest increases have been noted in Mt. Olive and Washington Townships (approximately 75 percent) in Morris County, and Hillsborough Township (60 percent) in Somerset County.

Municipal sewers are provided in only the towns of Flemington, Clinton and High Bridge. The remainder of the basin, with the exception of individual developments and institutions, utilizes septic systems. 201 wastewater facilities planning, however, is underway in most of the South Branch basin. Only portions of Readington and Clinton Townships remain undesignated. Twenty-eight discharges have been identified in the South Branch watershed, with the majority of them treating sanitary wastewaters.

The South Branch Raritan River and tributaries have a number of water uses with the two reservoirs Round Valley and Spruce Run illustrating the watershed's importance for supplying potable waters. These two reservoirs will play an even greater role in providing water to central and northeastern sections of New

Jersey as inter-basin transfers and cross connections are built. The State Water Supply Master Plan (1981) estimates that the safe yield from the Spruce Run-Round Valley system is 160 mgd. Two other surface water intakes at Flemington (by the Borough Water Department) and the state sanitarium at Lebanon currently exist. Waters from the South Branch and tributaries are also used for irrigation (both farm and non-farm) and industrial purposes.

There are a number of state parks and wildlife management areas (WMA), along with county, municipal and private recreation areas in the watershed. Spruce Run and Round Valley State Parks have swimming beaches, boating and fishing facilities, and are intensively used as a recreation area. Ken Lockwood Gorge, Capooling Creek and Clinton WMAs provide a fishing and hunting (except Capooling Creek) location for residents from throughout the state. County swimming beaches also are present in Washington Township (Lake George) and other areas, and commercial beaches occur in Hunterdon County. Budd Lake in Morris County has public bathing beaches and good fishable populations of largemouth bass, catfish, pickerel, perch and sunfish. The NJ Division of Fish, Game and Wildlife stocks trout in the following streams in the South Branch watershed: Morris County - Budd Lake, ABC Pond, Ledgewood Brook, Flanders Brook and Drakes Brook; Hunterdon County - Tetertown Brook, Spruce Run Creek, Spruce Run Reservoir, Mulhockaway Creek, Beaver Brook, Sydney Brook, Capooling Creek, Round Valley Reservoir, Prescott Brook, Back Brook and the Neshanic River; and practically the entire South Branch Raritan River from the outlet at Budd Lake to the confluence with the North Branch. In addition to stocked trout, a number of streams in the South Branch watershed have reproducing brook, brown and rainbow trout populations.

NJ Water Quality Standards have given waters in the South Branch Raritan River basin one of the following classifications: FW-2 Trout Production, FW-2 Trout Maintenance and FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

The South Branch Raritan River, based on sampling at Middle Valley (Morris County), Stanton Station and Three Bridges (Hunterdon County), exhibited generally good water quality with some elevated fecal coliform and nutrient levels. Mulhockaway Creek, Spruce Run and Prescott Brook displayed very good water quality over the period, but occasionally insufficient dissolved oxygen levels and elevated nutrient concentrations were found in Bushkill Creek and the Neshanic River.

Dissolved oxygen levels were generally sufficient through the period in the South Branch. Although seasonal rises and declines of dissolved oxygen occurred at all stations over the period, adequate aeration and moderate primary productivity provided substance in maintaining near saturated or supersaturated conditions year-round. Biochemical oxygen demand at the Middle Valley, Stanton Station and Three Bridges stations was low to moderate and did not adversely impact dissolved oxygen concentrations.

Excessive fecal coliform concentrations occurred most often at the Middle Valley and Three Bridges stations on the South Branch where the number of samples over 200 MPN/100 ml (for all samples collected over the period) approached 50 percent.

The total dissolved solids standard was contravened during 1978 at Stanton Station and Three Bridges, but concentrations were otherwise below 200 mg/l throughout the segment. Overall, the pH values for the South Branch were slightly alkaline (7-9 su), due in part, to the geology of the region.

Total phosphorus concentrations were generally within the applicable standard with periodic contraventions occurring at similar frequency at all stations along the South Branch. Nitrate + nitrite nitrogen levels were generally at or above 1.0 mg/l with some measurements exceeding 2.0 mg/l recorded at all stations. Total ammonia levels were generally acceptable through the period, but un-ionized ammonia concentrations periodically contravened the trout maintenance standard during the summer months at Stanton Station and Three Bridges.

Biological data collected at Stanton Station indicated that the South Branch Raritan River supports a generally healthy community. Periphyton chlorophyll a values were low to intermediate and the macroinvertebrate fauna was well balanced.

Overall, water quality in the South Branch Raritan River has shown little change from what was described in earlier 305(b) reports. There was one notable rise in total dissolved solids at Stanton and Three Bridges which may be due to a rainfall event, plus periodic, summer-time values of un-ionized ammonia above respective state surface water quality standards.

Toxic Parameters

The South Branch of the Raritan River was sampled at the outlet of Budd Lake and found to be free of toxic contamination. The impacts of sewage treatment plant effluents was noted at South Branch and High Bridge where sampling showed high trihalomethane levels. More intensive surveys of reaches near these effluents are necessary to obtain additional information.

Tissue and sediment samples collected in 1980 along the South Branch Raritan River at Neshanic revealed non-detectable to trace amounts of organochlorine pesticides and PCB Arochlor 1254. Species resident to the South Branch (i.e. largemouth bass, Micropterus salmoides and golden shiner, Notemigonus crysoleucas) exhibited lower levels than the migratory species. American eel, Anguillia rostrata, showed high levels of chlordane, DDT and metabolites and PCB Arochlor 1254

Problem Assessment

The water quality of this segment is generally good to very good. Problems which were detected in the segment included fecal coliforms, nutrients, occasional low dissolved oxygen levels and in the lower South Branch periodic high un-ionized ammonia concentrations.

As is commonly the situation in New Jersey waterways, both point and non-point sources contribute pollution loads. The Upper Raritan Water Quality Management Plan noted that non-point sources are especially significant in the South Branch below its confluence with the Neshanic River; point sources are significant in Bushkill Brook. Septic tank disposal has caused problems in Mount Olive Township, the Village of Three Bridges and Annandale. The possibility of soil erosion problems exists in the South Branch basin. Another non-point source is an inoperative landfill in Roxbury Township which is contributing leachate to the headwaters of the South Branch. The periodic high TDS and nutrient values are indicative of runoff influences.

Toxics sampling revealed high levels of trihalomethanes in the river at South Branch and High Bridge. That contamination is believed to be from sewage treatment plants. Other point sources of concern are the Clover Hill Sewage Treatment Plant in Mount Olive, which is contributing to fecal coliform and suspended solids problems and Lentine Aggregates in Glen Gardner which, during periods of heavy rainfall, exceeds its permit limitations for total suspended solids. In addition, the Tenneco Chemical Company in Raritan Township discharges its pretreated wastewaters into the Raritan Township MUA system. Since its pretreatment system consisting of unlined ponds is situated adjacent to Bushkill Creek, contamination of the ground water and creek is possible. An enforcement action is presently underway in seeking an acceptable solution to the problem.

Considering the land use practices and watershed qualities of this basin, it is expected that the contamination of the aquatic community with regard to toxics would be limited to site-specific cases, agricultural land use and illegal discharges. Further sampling of this section should take these sources into consideration.

Goal Assessment and Recommendations

The South Branch of the Raritan River does not meet the goal of swimmable water quality at the stations monitored. At each sampling station, fecal coliform concentrations frequently exceeded 200 MPN/100 ml. The waters are of fishable water quality, although the standard for un-ionized ammonia was occasionally contravened. Stress, therefore, probably occurs in the fish communities at these locations. A diverse community of thirty fish species, including native trout, are reportedly present in the South Branch Raritan River.

In addition Spruce Run and Round Valley Reservoirs have excellent introduced sport fisheries communities. Round Valley is considered to be in an optimal trophic state whose quality should continue to be monitored and protected.

In order to protect water quality, it is recommended that there be an education program to alert residents of the need to provide proper maintenance for their septic systems. It is also recommended that agricultural best management practices be implemented.

Point source controls are needed at the Clover Hill STP, Lentine Aggregates and Tenneco Chemical Company. There is also a problem with antiquated sewer lines in Flemington. The sewers discharge raw sewage to waterways during storm events. This problem should be corrected to eliminate the health hazard potential and to improve water quality. Bushkill Creek and the Neshanic River are streams of special concern in this basin because of known water quality problems. Increased monitoring of these streams is recommended to further define the sources of pollution.

In the upper reaches of the watershed, further studies are needed to define sources of pollution going into Budd Lake from surrounding septic systems and the impacts of local treatment plants on headwater streams (Drakes Brook). Also, good water quality for the entire South and North Branches must be maintained because of the importance of the waters for supplying potable needs (current and future) and maintaining large trout fisheries.

SOUTH BRANCH RARITAN RIVER STATION LIST

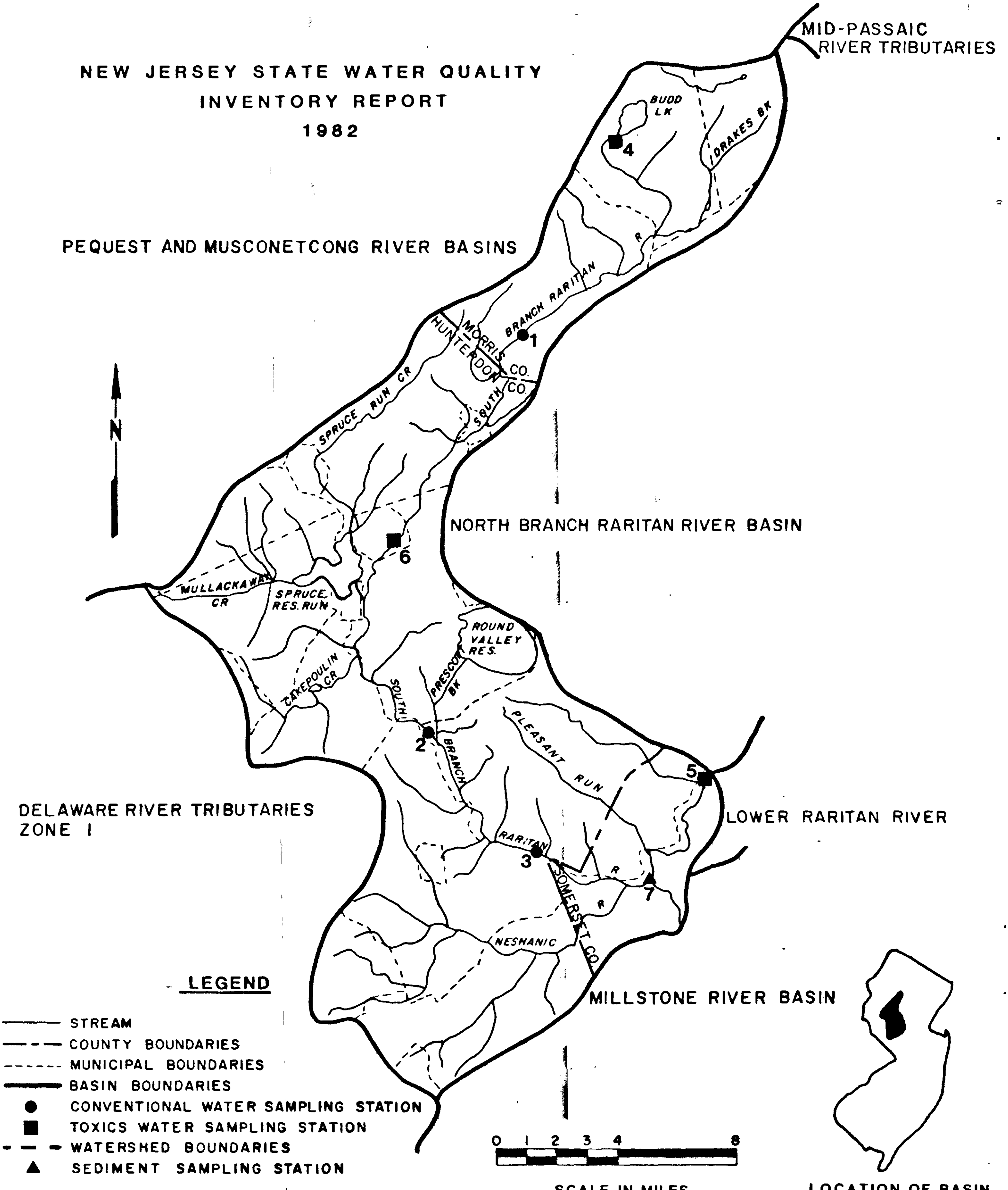
A. Ambient Monitoring Stations

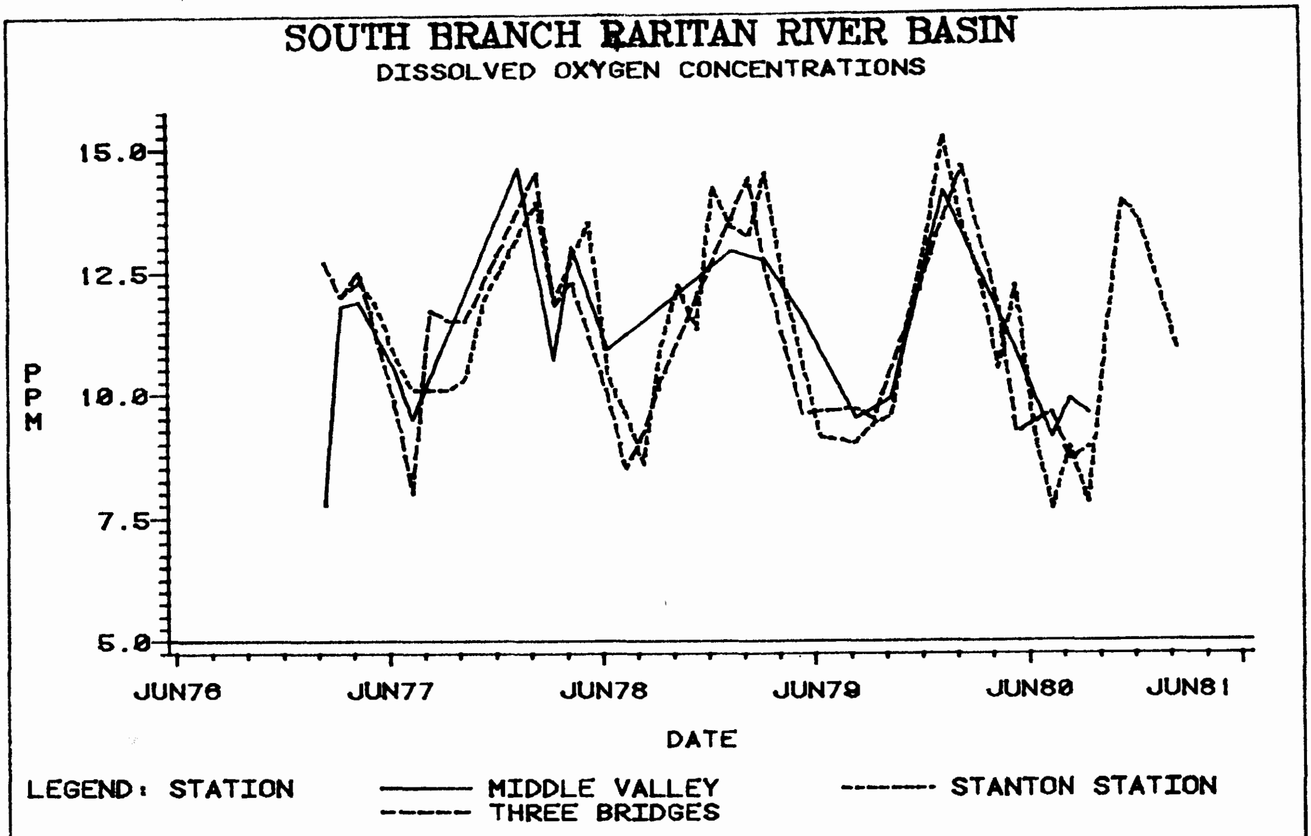
STORET Number	Station Description	Map Number
01366280	South Branch Raritan River at Middle Valley, Morris County Latitude 40°45'40" Longitude 74°49'18" FW-2 Trout Maintenance USGS/DEP Network At bridge on Middle Valley Road in Middle Valley, 200 feet northwest of Route 513 and 6.9 miles downstream from Drakes Brook.	1
01397000	South Branch Raritan River at Stanton Station, Hunterdon County Latitude 40°34'21" Longitude 74°52'10" FW-2 Trout Maintenance Basic Water Monitoring Program At bridge in Stanton Station, 0.5 miles west of Route 31 and 0.4 miles upstream from Prescott Brook.	2
01397400	South Branch Raritan River at Three Bridges, Hunterdon County Latitude 40°31'01" Longitude 74°48'12" FW-2 Nontrout USGS/DEP Network At Main Street bridge in Three Bridges, 1.3 miles downstream of Bushkill Creek.	3

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
South Branch Raritan River at outlet of Budd Lake	Water column	4
South Branch Raritan River at South Branch	Water column	5
South Branch Raritan River at High Bridge	Water column	6
South Branch Raritan River at Neshanic	Sediments	7

SOUTH BRANCH RARITAN RIVER BASIN





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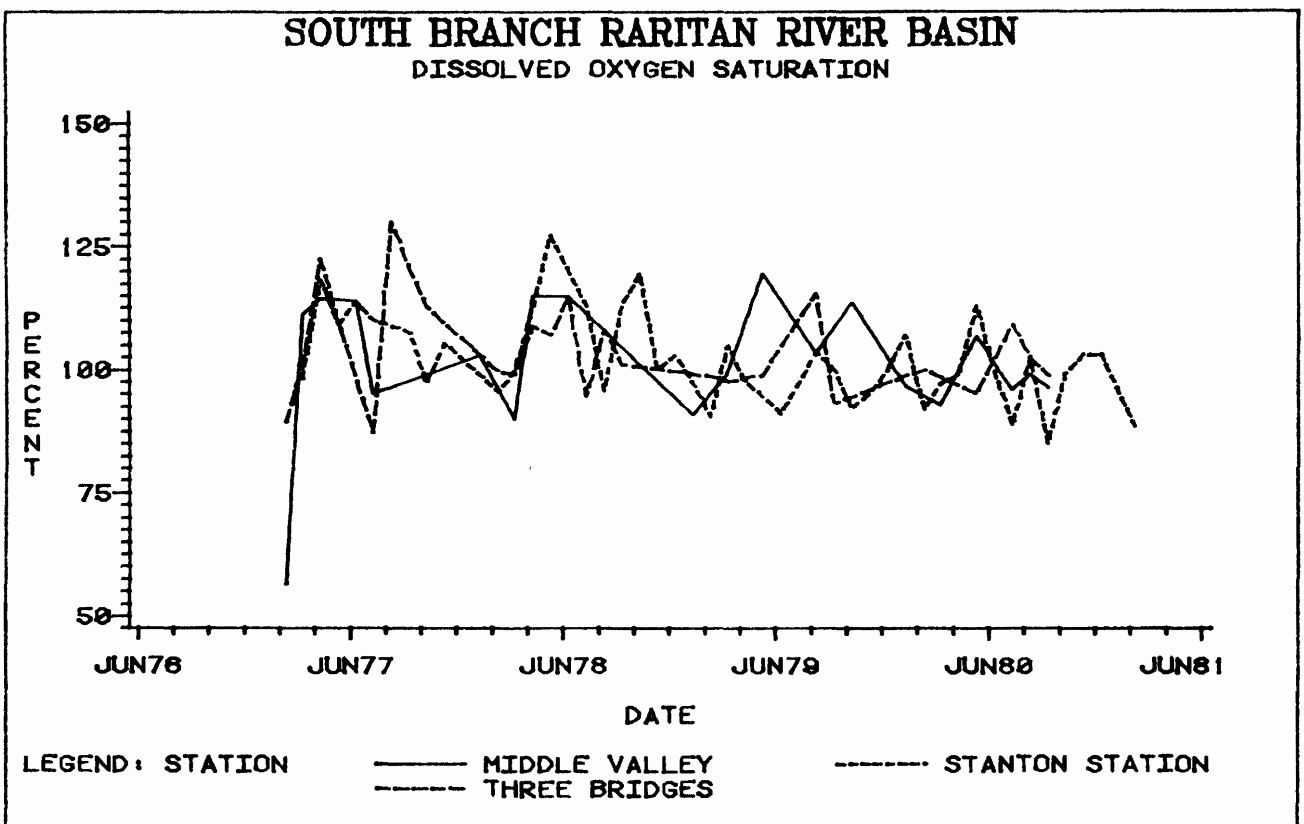

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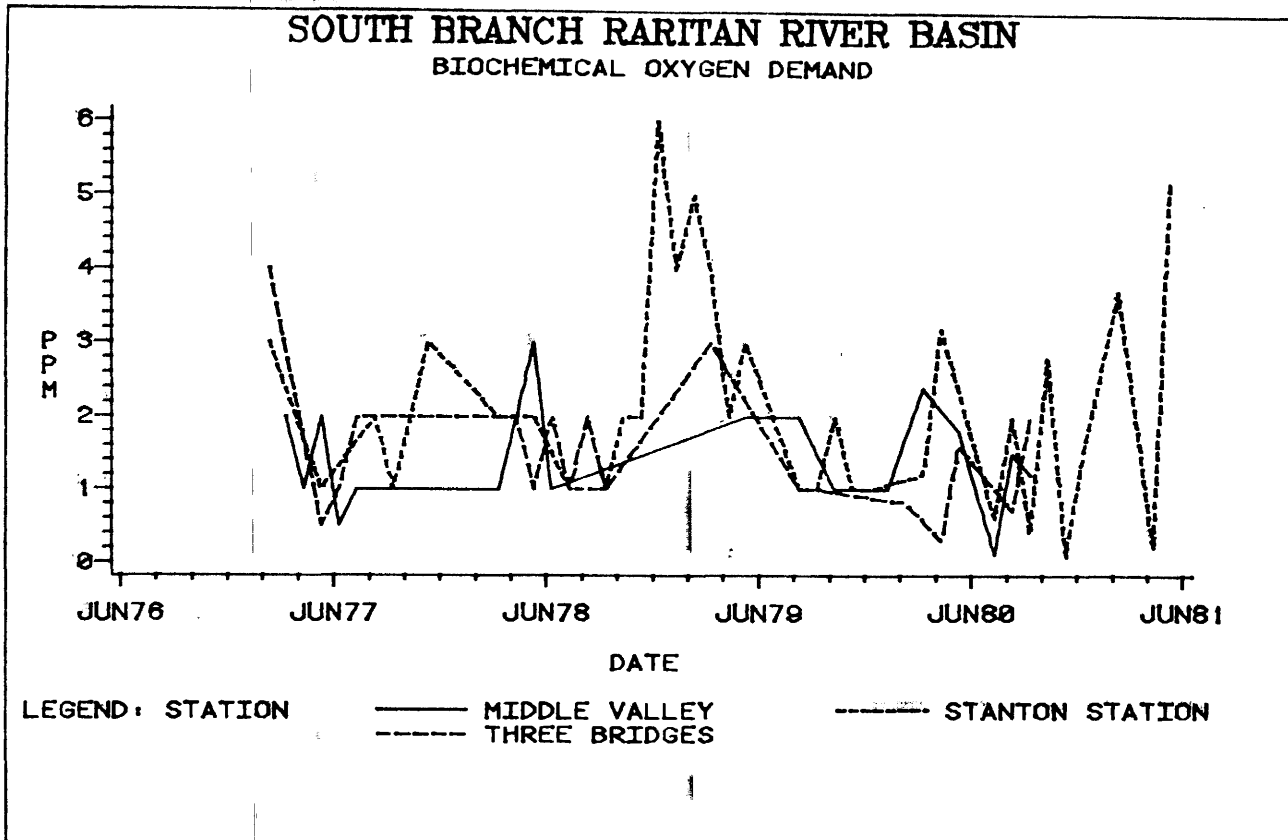

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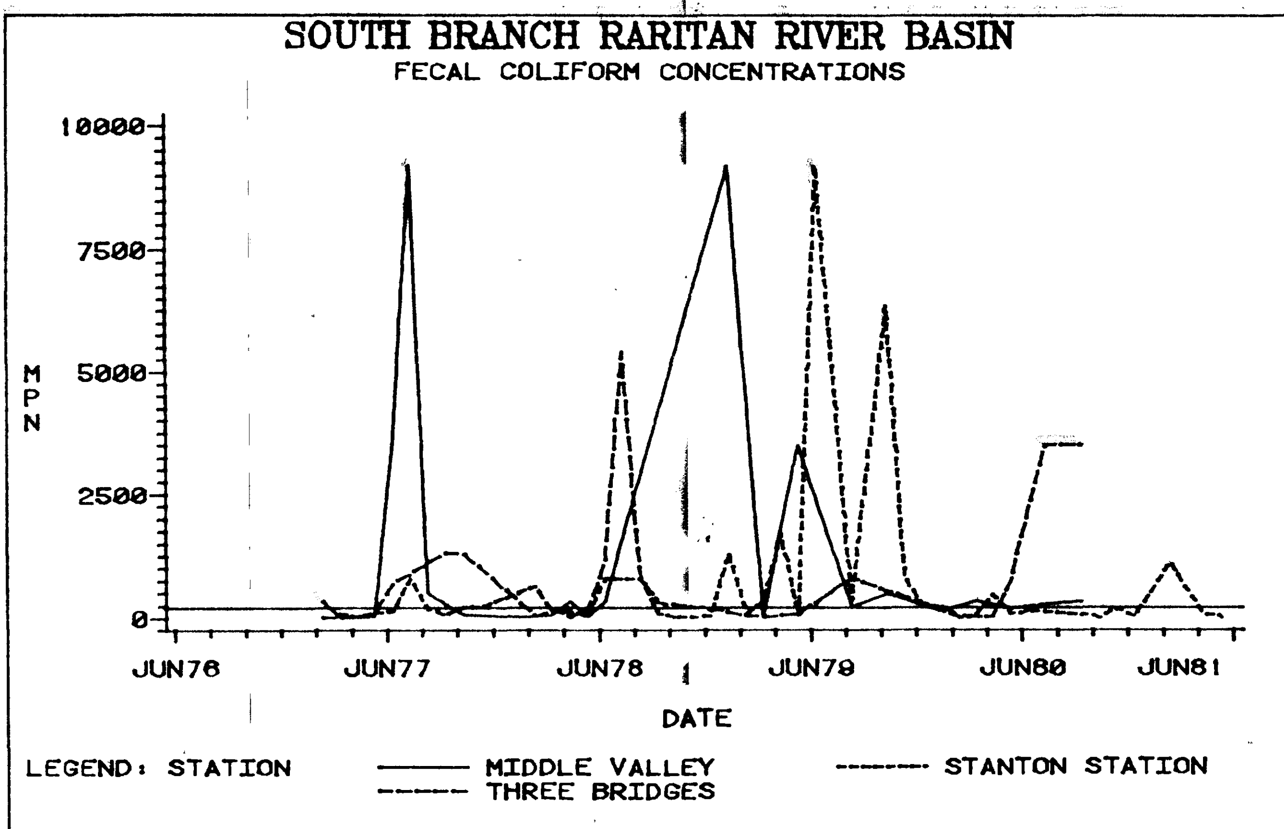

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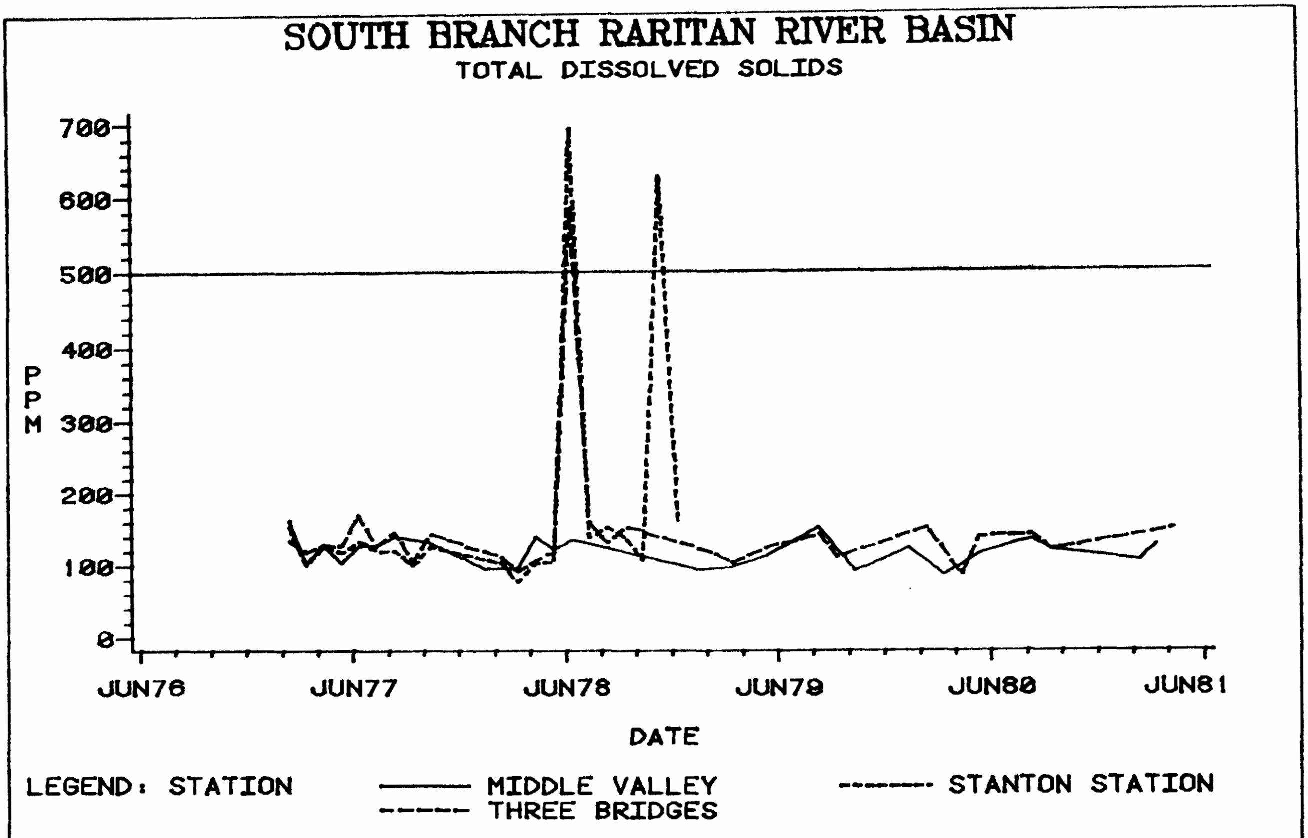

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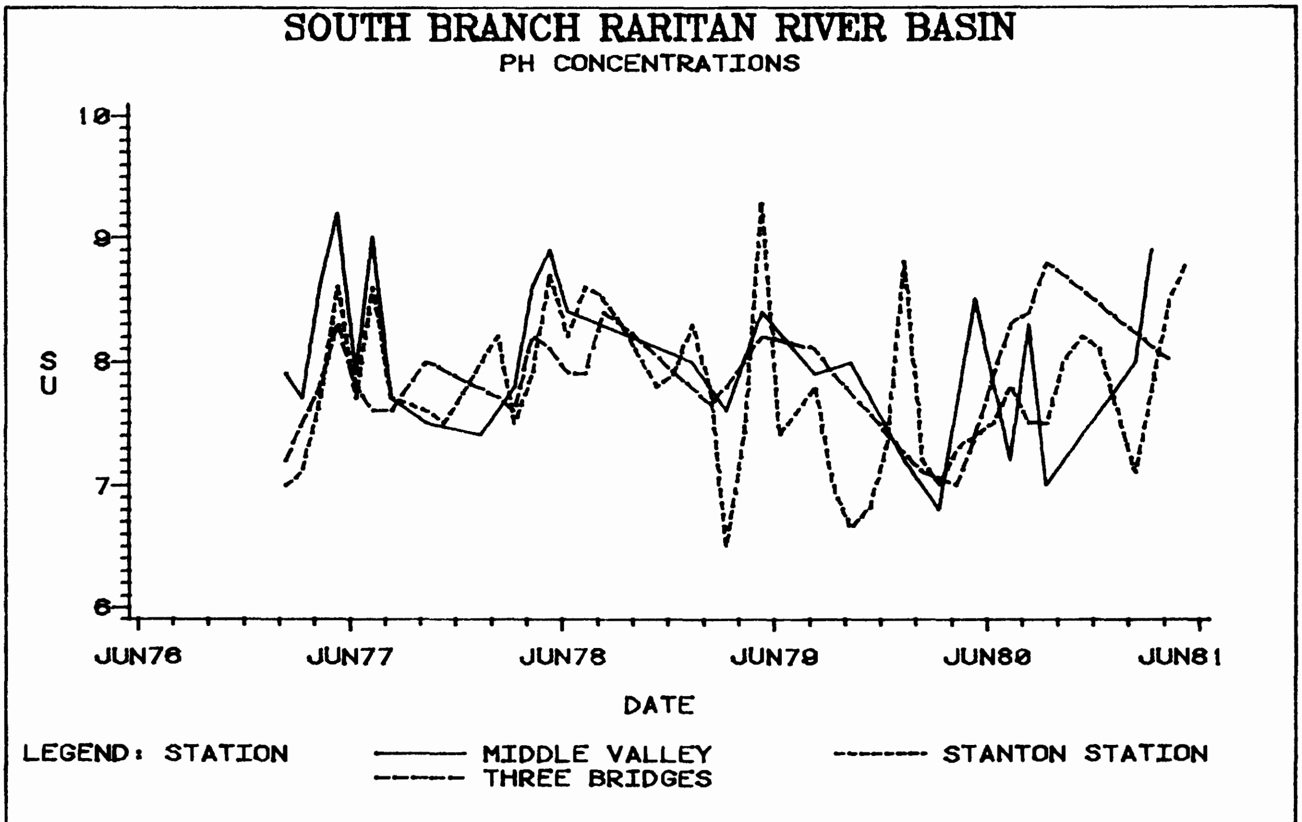

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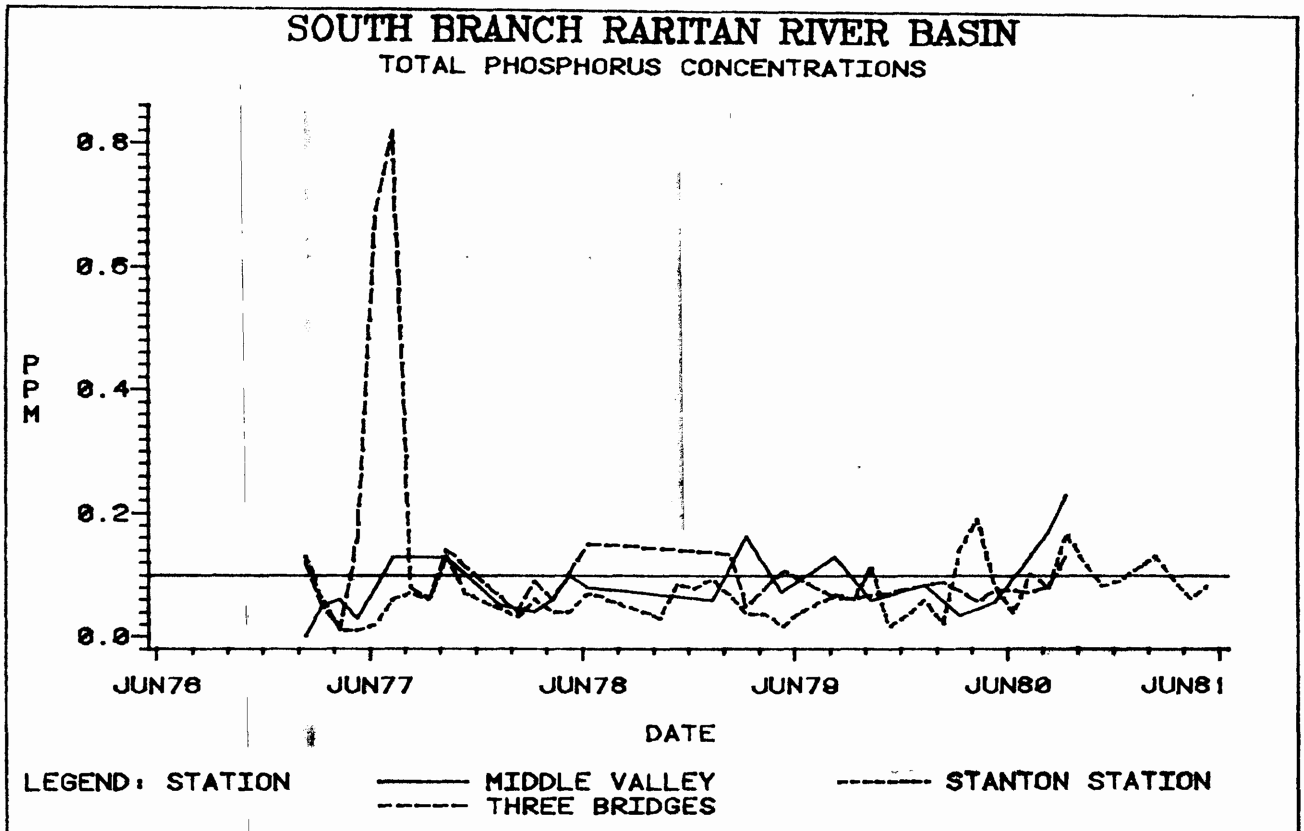

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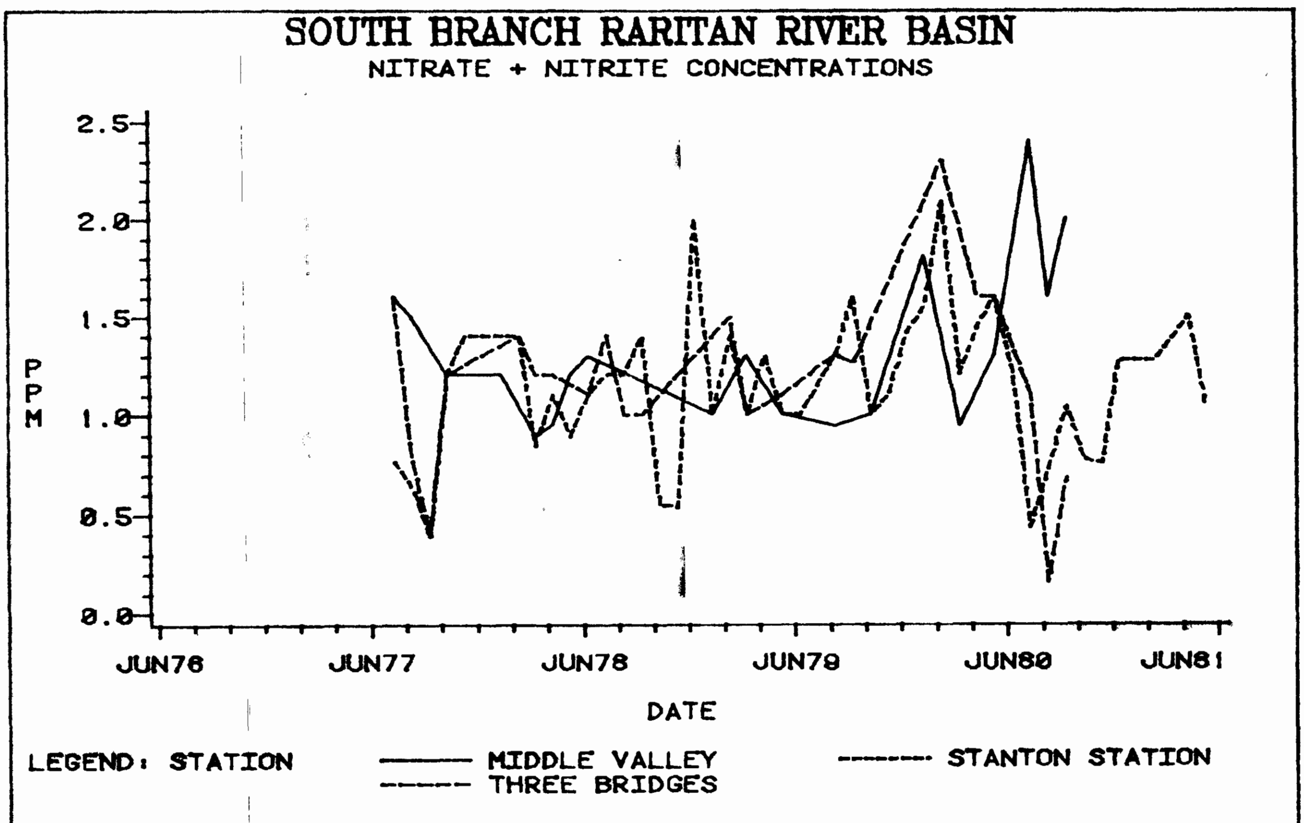

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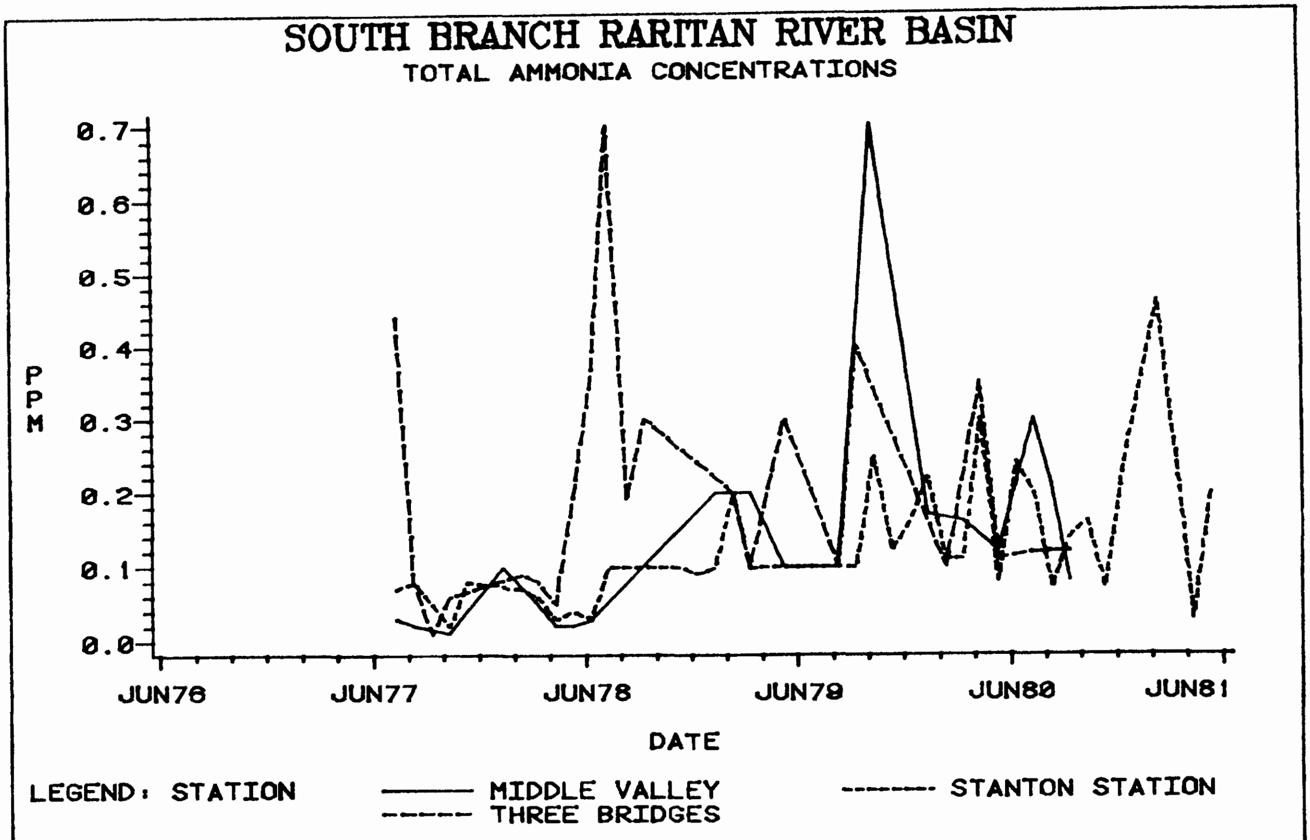

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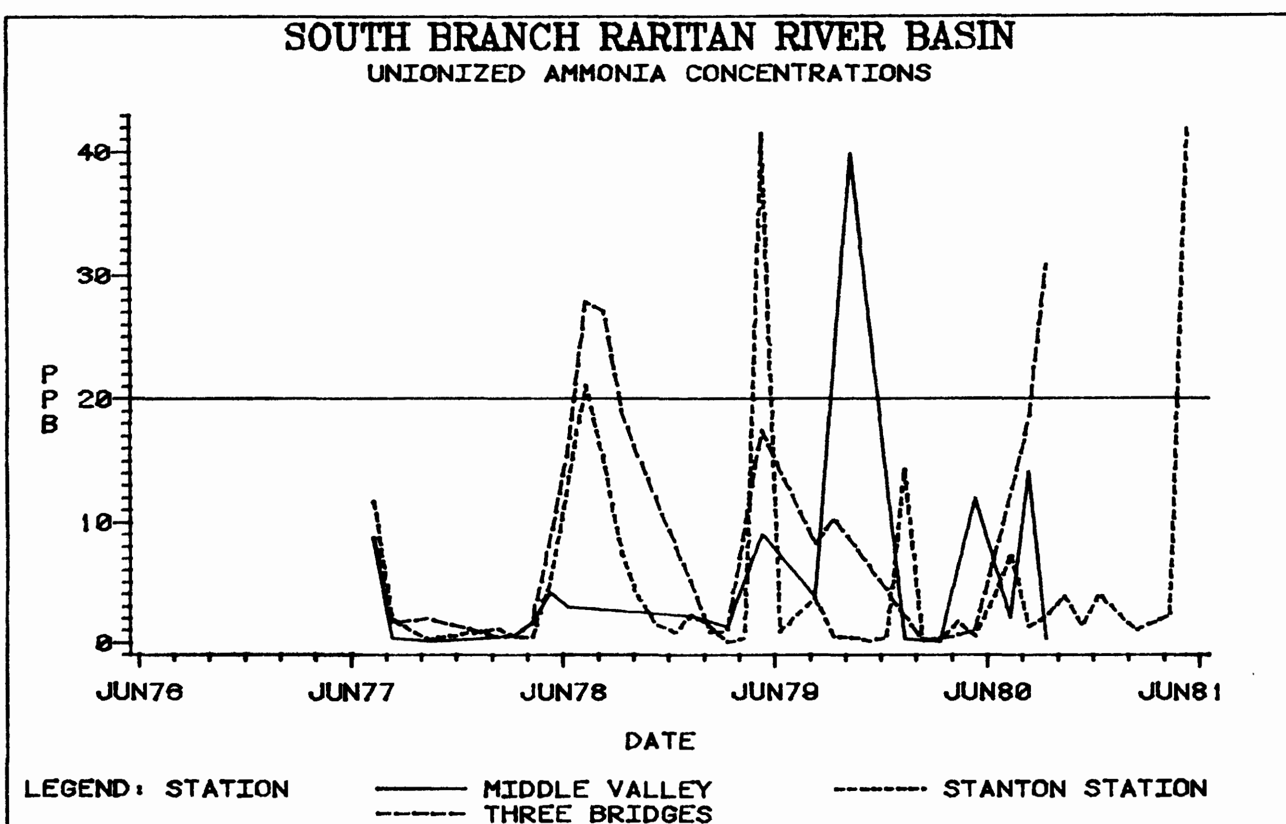


Figure: T -10

ISCHARGE INVENTORY - - - SOUTH BRANCH RARITAN RIVER BASIN

ISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
ETHYL CORP.	0003298	RARITAN TWP	BR RARITAN RIV	COOLING WATER	.30
FLEMINGTON BOROUGH COUNCIL	0028436	FLEMINGTON BORO	BUSHKILL CREEK	SANITARY	.30
TENNECO CHEMICALS CORP	0001660	RARITAN TWP	BUSHKILL CREEK	COOLING WATER	.70
U.S. BRONZE POWDERS CORP.	0003336	RARITAN TWP.	BUSHKILL CREEK		
ALEXANDRIA TWP BD OF ED	0035670	ALEXANDRIA TWP	CAKEPAULIN CR		
NORTH HUNTERDON HIGH SCHOOL	0028363	CLINTON TWP	CRAMER CREEK TO S. BRANCH RARI	SANITARY	.02
MT OLIVE TOWNSHIP	0021954	MT. OLIVE TWP.	DRAKES BR.	SANITARY	.42
ROXBURY MOTEL ASSOCIATES INC.	0028304	ROXBURY TWP	DRAKES BROOK	SANITARY	
WELSH FARMS INC	0001236	WASHINGTON TWP.	ELECTRIC BROOK	PROCESS WASTE	.13
E.R. SQUIBB & SON	0003905	HILLSBOROUGH TWP	ERIE BASIN		
READINGTON TOWNSHIP BD OF ED	0026697	READINGTON TWP	HOLLAND BROOK	SANITARY	
UNION TOWNSHIP BD OF ED	0024091	UNION TOWNSHIP	MULHOCAWAY CR.	SANITARY	
DIAMOND AEROSOL CORP	0034894	GLEN GARDNER	RUN CREEK		
RARITAN TOWNSHIP MUA	0022047	RARITAN TWP	SOUTH BRANCH OF THE RARITAN RI	SANITARY	1.20
TOWNSHIP OF BRANCHBURG	0020354	BRANCHBURG /TWP/	SOUTH BRANCH RARITAN RIVER	SAN/SIG INDUS	
YOUTH CORRECTIONAL INSTITUTION	0028487	CLINTON TWP.	SOUTH BRANCH RARITAN RIVER	SANITARY	.10
TOWN OF CLINTON	0020389	CLINTON/TOWN	SOUTH BRANCH RARITAN RIVER	SANITARY	.70
WILSON PROD CO-DIV OF DART IND	0032662	NESHANIC	SOUTH BRANCH RARITAN RIVER	COOLING WATER	
YOUTH CORRECTIONAL INSTITUTION	0029874	SUSSEX	SOUTH BRANCH RARITAN RIVER.	SANITARY	
WASHINGTON TWP MUA	0023493	WASHINGTON TWP.	SO.BR.RARITAN	SANITARY	.25
TOWNSHIP OF ROXBURY-SKYVIEW ST	0022683	ROXBURY TWP	TRIBUTARY DRAKES BROOK	SANITARY	
DAIRY QUEEN OF BUDD LAKE	0035122	BUDD LAKE	RARITAN RIVER	COOLING WATER	
EQUITY SHOPPING PLAZA	0035220	BUDD LAKE	RARITAN RIVER		
MEENAN OIL CO INC	0028754	CLINTON	RARITAN RIVER		
EXXON RESEARCH FACILITIES	0035084	CLINTON TWP	RARITAN RIVER		
EXXON COMPANY USA	0000892	RARITAN TWP	SECOND NESHANIC	RUNOFF OIL & GR	.00
LENTINE AGGREGATES	0026450	GLEN GARDENER BORO	SPRUCE RUN CREEK	PROCESS WASTE	
GLEN GARDNER CTR. FOR GERIATRI	0022144	LEBANON TWP	NAVESINK RIVER	SANITARY	

U. MILLSTONE RIVER

Basin Description

The Millstone River basin is located in central New Jersey, and comprises an area of 271 square miles. The basin includes portions of five counties: Hunterdon, Somerset, Middlesex, Mercer and Monmouth. The Millstone River has its origin in Millstone Township in Monmouth County and flows to the Raritan River, of which its is a tributary. From Carnegie Lake (Princeton) northward the Millstone travels adjacent to the Delaware and Raritan Canal. The Millstone and its major tributary, the Stony Brook, are slow-moving, narrow rivers which are characterized by having low base flows. Average flow to 1980 for the Millstone River at Blackwells Mills (drainage area of 258 square miles) is 378 cfs. The Millstone River basin is generally broken into three subwatersheds: lower Millstone, Stony Brook and upper Millstone. The upper Millstone is considered to be that part of the watershed upstream of Lake Carnegie. The Stony Brook and the lower Millstone subwatersheds lie on the Piedmont physiographic province, which is characterized by low rolling plains. The upper Millstone subwatershed lies on the Coastal Plain physiographic province and is typified by relatively flat topography.

The upper Millstone River basin area is primarily agricultural, although there has been extensive and recent suburban development in the area of East and West Windsor in Mercer County and Plainsboro in Middlesex County. Population increased 240 percent in Plainsboro and almost 100 percent in East Windsor between 1970 and 1980. Other population centers in the upper Millstone basin include Hightstown, Cranbury, and Princeton Junction. The lower Millstone basin is predominantly rural, with suburban centers along major roads. Among the municipalities within this drainage area are Franklin Township, Hillsborough Township and Manville in Somerset County, portions of North and South Brunswicks in Middlesex County and Princeton Boro in Mercer County. It is expected that most areas in the Millstone watershed will experience additional growth in the near future. There are seventy-two wastewater dischargers in the Millstone River basin.

The population centers having sewer collection service are: Princeton Borough, Princeton Township, Manville, Hillsborough, Rocky Hill, South Brunswick, Hightstown, East Windsor, West Windsor and Pennington. The major sewage treatment plants in the basin include: the Stony Brook Regional Sewerage Authority, Hightstown Borough plant, East Windsor MUA and the Montgomery Township Millstone River plant. The Stony Brook Regional treatment plant was recently upgraded and enlarged which resulted in the elimination of two treatment plants and a raw sewage bypass in Princeton.

The Millstone River and tributaries are designated FW-2 Nontrout by the NJ Water Quality Standards, although such water bodies as Stony Brook, Rock Brook, and Rosedale Lake are stocked with trout. The Millstone is canoeable, and offers such recreational opportunities as fishing, hiking and nature study. The Millstone and its tributaries are also especially valuable for water supply, in addition to being used for farm irrigation, golf course irrigation, and industrial processes. The NJ State Water Supply Master Plan has considered a reservoir on Six Mile Run in Somerset and Middlesex Counties as a viable alternative for meeting future water supplies in the region.

The Elizabethtown Water Company occasionally uses the Millstone River (near its confluence with the Raritan River) as one of its sources of potable water supply. Water from Carnegie Lake and the upper Millstone River is sometimes diverted into the Delaware and Raritan Canal, a source of potable water supply, when flow through upstream segments of the Canal is interrupted or inadequate. Also, a pumping station along the Millstone River just upstream from its confluence with the Raritan River allows the New Jersey Water Supply Authority to pump Millstone River water (or a mixture of Raritan River and Millstone River water) into the Delaware and Raritan Canal in such circumstances. Carnegie Lake serves as a source of recharge to nearby potable water supply wellfields.

Water Quality Assessment

Conventional Parameters

Water quality in the Millstone River was generally good in the upstream segment but declined to marginal conditions downstream from Carnegie Lake to the Raritan River confluence. This is based on water quality sampling in the Millstone River at Blackwells Mills and Applegarth, and in Stony Brook at Princeton. Stony Brook, which flows into Carnegie Lake at Princeton, exhibited generally good water quality throughout most of the segment.

Dissolved oxygen levels in the Millstone River were for the most part acceptable at Applegarth, but were marginal downstream at Blackwells Mills during the summer months. Stony Brook also displayed marginally acceptable dissolved oxygen concentrations at the Princeton station. Biochemical oxygen demand increased concurrently with declining dissolved oxygen concentrations at Blackwells Mills. However, BOD_5 levels were generally low in the upstream segment of the Millstone River at Applegarth and in Stony Brook at Princeton.

Fecal coliform concentrations in the Millstone River increased in the downstream direction and periodically were above 200 MPN/100 ml in both the Millstone River and Stony Brook. The highest fecal coliform levels for the period were recorded at Blackwells

Mills, where concentrations exceeded 2,000 MPN/100 ml on several occasions, while the upstream station at Applegarth infrequently exhibited levels over 1,000 MPN/100 ml. Stony Brook exhibited the fewest contraventions of 200 MPN/100 ml during the period.

Total dissolved solids concentrations were consistently below 100 mg/l over the period at Applegarth and were slightly higher downstream at Blackwells Mills and in Stony Brook at Princeton. The standard was not contravened at any of the stations during the period. The pH values increased from slightly acid levels at Applegarth to neutral levels at Blackwells Mills. Stony Brook exhibited pH values similar to those at Blackwells Mills.

Total phosphorus concentrations in the Millstone increased from Applegarth to Blackwells Mills with 24 to 100 percent, respectively, of the values from these stations in excess of the standard. The total phosphorus standard was contravened only once in Stony Brook, but the increase was consequential and occurred during low flow conditions in the summer of 1980. Total phosphorus levels also increased for similar reasons in 1980 at Applegarth and Blackwells Mills. Nitrate + nitrite concentrations at Blackwells Mills often exceeded 2.0 mg/l and increased up to 5.0 mg/l in 1980. However, levels were generally less than 1.50 mg/l through the period at Applegarth and Princeton. Stony Brook exhibited an overall decline in nitrate + nitrite levels over the period. Total and un-ionized ammonia concentrations were at uniformly low to moderate levels throughout the period. The Millstone River exhibited a short-term elevation of total ammonia to 1.30 mg/l at Applegarth in early 1981, but this was not indicative of a long-term problem.

The biological data for the Millstone River at Blackwells Mills suggest the presence of a stressed community. Although the macroinvertebrate samples yielded high number of individuals, they were comprised almost entirely of a few taxa, namely several chironmids (midges) and one trichopteran (caddisfly). One genera of midges in particular, <u>Glyptotendipes</u>, which is often characterized as tolerant to organic pollution, comprised over 50 percent of the samples in 1977 and 1978. The periphyton data suggested enriched conditions with mean chlorophyll <u>a</u> concentrations as high as 52.6 g/m^2.

From the mid-1970s to the present there have been noticable improvements of water quality in the Millstone River at Applegarth and in Stony Brook at Princeton. The Millstone River at Applegarth appears to receive less oxygen demanding wastes as evidenced in generally higher DO and lower BOD_5 concentrations. Total phosphorus continues to show moderate reductions (first noted in the 1977 305(b) report) at both of these monitoring stations. Stony Brook also has shown reduced BOD and pH levels (this lower pH is more indicative of background or natural conditions for this region).

Toxic Parameters

The Millstone River was sampled at Princeton, Penns Neck, Applegarth, Blackwells Mills and Manville. In each case, results showed the water to be free of toxic contamination. This is not indicative of the general water quality, and further sampling should be performed to investigate this system in greater detail.

Tissue samples collected in 1978 along the Millstone River at Manville produced trace levels of organochlorine pesticides and PCB Arochlor 1254 in black crappie, Pomoxis nigromaculatis; largemouth bass, Micropteus salmoides; Walleye, Stizostedion vetreum; and White sucker, Catostomus commersoni. A sample of American eel, Angullia rostrata, exhibited elevated levels of chlordane, DDT and metabolities, and PCB Arochlor 1254. These levels are consistent with values found in samples collected from similar waterways. An extensive tissue sampling regime for this basin has not been performed to date. Sampling considerations are currently being reviewed and should be implemented in the future.

Problem Assessment

Water quality in this segment varies from marginal in the downstream portion, to good in the upstream portion. Water quality problems include nutrient, fecal coliform and occasional low dissolved oxygen levels. The Upper Raritan Water Quality Management Plan (1979) noted nutrient and sediment problems in the watershed. The Lower Raritan/Middlesex County WQM Plan also discussed water quality in the Millstone, and stated that low dissolved oxygen levels are the major problem in the watershed.

The Upper Raritan WQM Plan, in evaluating sources of contamination, stated that nutrient loadings in the study area are associated with point sources while sediment loadings are associated with non-point sources. The plan also indicated that of the watersheds in the study area, the Millstone and its Bedens Brook tributary were believed to have the greatest non-point problems. For the purposes of evaluation, the watershed was divided into several portions. The portion with the highest ranking based on sedimentation rates was the lower Millstone (including Stony Brook). It is number three on the list and has an estimated annual soil loss of 10.0 tons per acre. Other portions of the Millstone on the list have an estimated annual soil loss ranging from 7.0 to 9.9 tons per acre. Pesticide and fertilizer contamination of the waterways also occurs because of the sedimentation problems. However, in the Stony Brook watershed a number of dams were constructed by the federal Soil Conservation Service to assist in reducing nutrient and sediment problems in the stream.

Point sources which are impacting water quality and are under enforcement action, include: Compo Industries, which is discharging various organic chemicals to the Millstone; the Valley Road Sewerage Authority (River Road treatment plant), which periodically releases raw sewage to the Millstone; and Phillips Concrete, which is a source of suspended solids.

Other problems in the watershed include severe inflow/infiltration within the Princeton Sewer Operating Committee sanitary sewer system that may cause public health hazards and raw sewage loadings to Carnegie Lake and the Millstone River. In the upper Millstone watershed, upgrading the Hightstown Borough and East Windsor MUA treatment plants will assist in reducing nutrient and oxygen demanding loads to the Millstone River and Rocky Brook. There is also the possibility of water contamination in the headwater streams of the Millstone River in Middlesex County from landfills located in South Brunswick Township. Septic system problems are known to occur in southern Franklin Township and Cranbury.

An intensive survey of Etra Lake on Rocky Brook by the NJ Lakes Management Program in 1979 revealed the lake to be upper mesotrophic, with some signs of eutrophication. The causes of this condition are agricultural and urban runoff.

Goal Assessment and Recommendations

Due to the frequent concentrations of fecal coliform bacteria in excess of 200 MPN/100 ml at the monitoring stations, the Millstone River and Stony Brook do no yet meet the goal of swimmable water quality. The waters are of fishable quality. However periodic low dissolved oxygen and high un-ionized ammonia at Blackwells Mills may cause stress to fish. The Millstone River supports a moderately diverse fish population of twenty-four different species that are indicative of warm waters with aquatic weed growth.

In order to abate the high rate of soil loss, it is recommended that agricultural best management practices implemented throughout the watershed. Elimination of nutrients going into Carnegie Lake is encouraged because of its high potential for recreational usage. Upgrading of the East Windsor Township MUA and Hightstown Boro STP may be necessary to assist in removing nutrient loads. Other point source controls should concentrate on those discharges listed in the "Problem Assessment".

The improvements in Stony Brook water quality are due to the implementation of best management practices on agricultural lands and the construction of the sediment control structures. Etra Lake will need dredging and best management practices on adjacent farmlands.

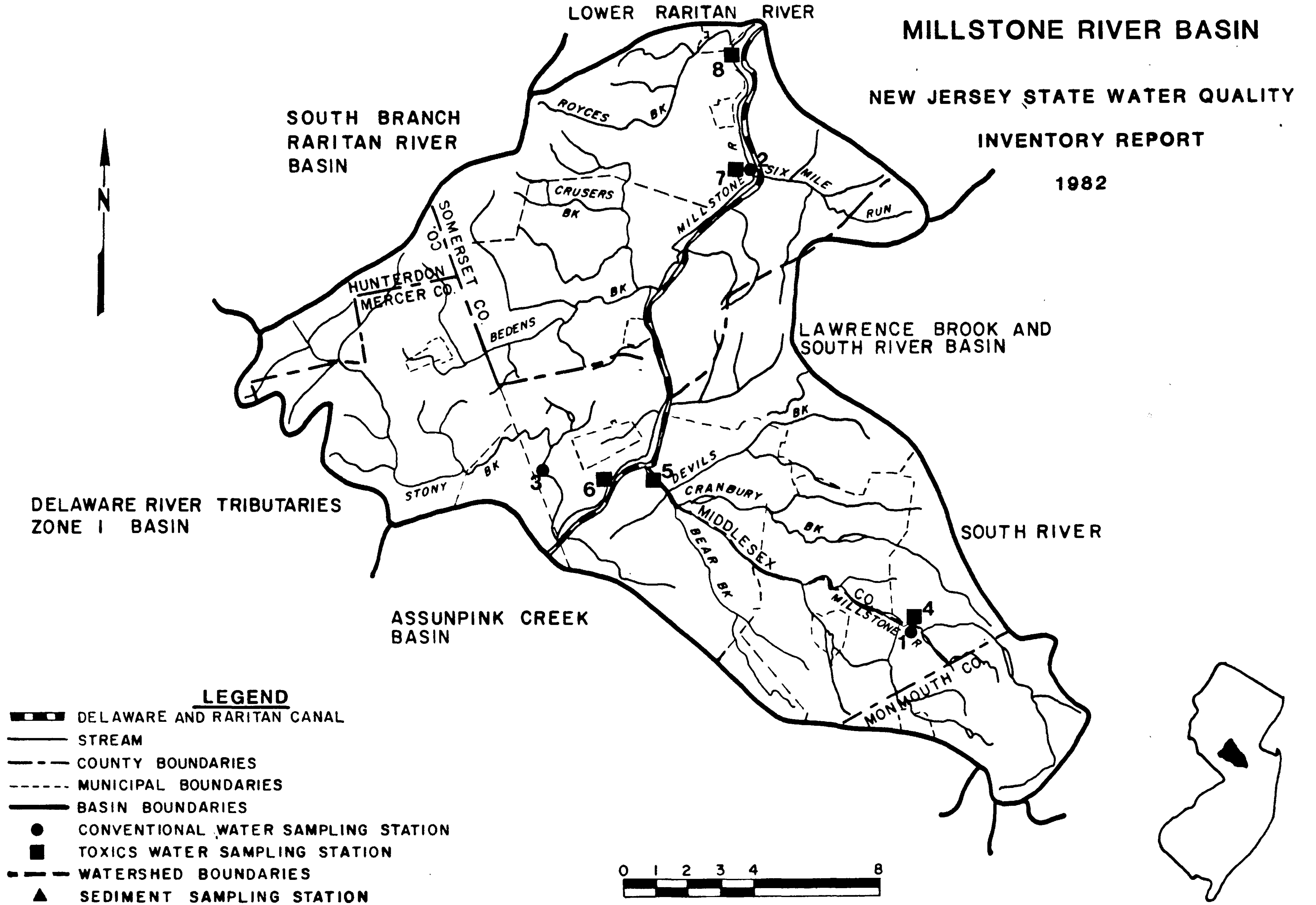
MILLSTONE RIVER STATION LIST

A. Ambient Monitoring Stations

STORET Number	Station Description	Map Number
01400560	Millstone River at Applegarth, Middlesex County Latitude 40°16'28" Longitude 74°28'22" FW2 Nontrout USGS/DEP Network At Prospect Plains - Applegarth Road Bridge in Applegarth, 2.7 miles east of Hightstown.	1
01402000	Millstone River at Blackwells Mills, Somerset County Latitude 40°28'30" Longitude 74°34'34" FW-2 Nontrout Basic Water Monitoring Program At bridge adjacent to River Road (Route 533) in Blackwells Mills, 0.3 miles downstream from Six Mile Run.	2
01401000	Stony Brook at Princeton, Mercer County Latitude 40°19'59" Longitude 74°40'56" FW-2 Nontrout USGS/DEP Network At U.S. Route 206 bridge, 1.6 miles southwest of Princeton and 4.0 miles upstream from Carnegie Lake.	3

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Millstone River at Applegarth	Water column	4
Millstone River at Penns Neck	Water column	5
Millstone River at Blackwells Mills	Water column	6
Millstone River at Manville	Water column	7
Stony Brook at Princeton	Water column	8



MILLSTONE RIVER BASIN
NEW JERSEY STATE WATER QUALITY
INVENTORY REPORT
1982
LOWER RARITAN RIVER
SOUTH BRANCH RARITAN RIVER BASIN
LAWRENCE BROOK AND SOUTH RIVER BASIN
SOUTH RIVER
DELAWARE RIVER TRIBUTARIES ZONE I BASIN
ASSUNPINK CREEK BASIN
N
ROYCES BK
CRUSERS BK
SIX MILE RUN
MILLSTONE R
SOMERSET CO.
HUNTERDON CO.
MERCER CO.
BEDENS BK
STONY BK
DEVILS BK
CRANBURY BK
MIDDLESEX CO
BEAR BK
MILLSTONE R
MONMOUTH CO.
1
2
3
4
5
6
7
8
LEGEND
DELAWARE AND RARITAN CANAL
STREAM
COUNTY BOUNDARIES
MUNICIPAL BOUNDARIES
BASIN BOUNDARIES
CONVENTIONAL WATER SAMPLING STATION
TOXICS WATER SAMPLING STATION
WATERSHED BOUNDARIES
SEDIMENT SAMPLING STATION
0 1 2 3 4 8
SCALE IN MILES
LOCATION OF BASIN

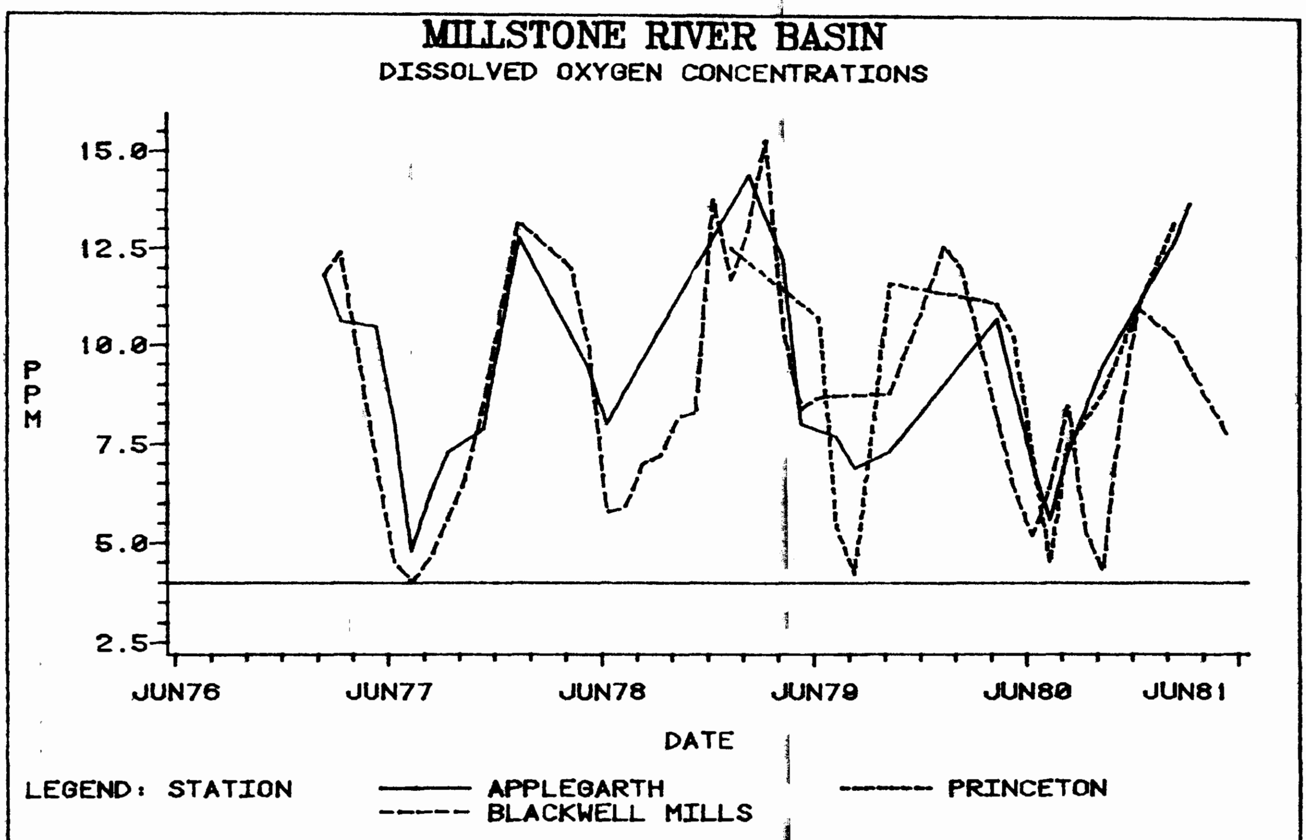
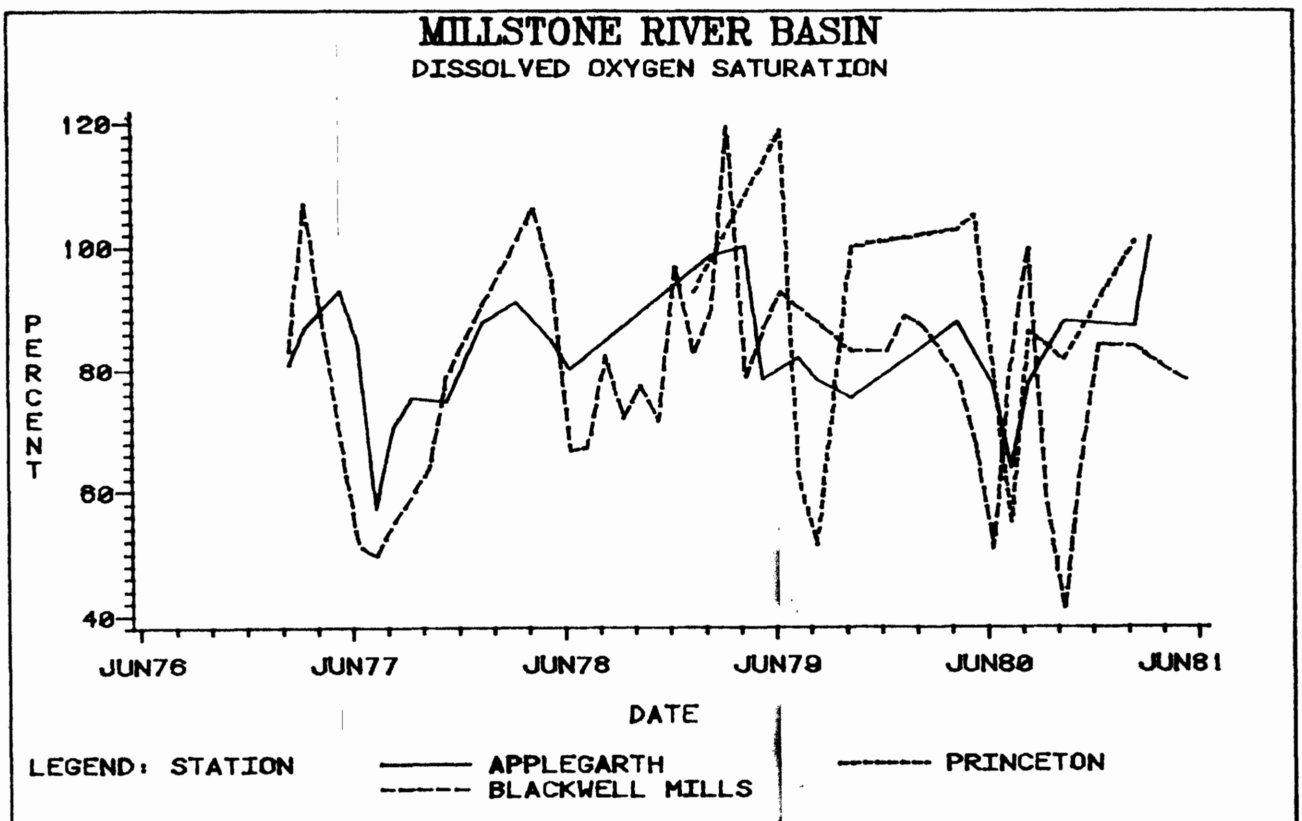


Figure: U -1



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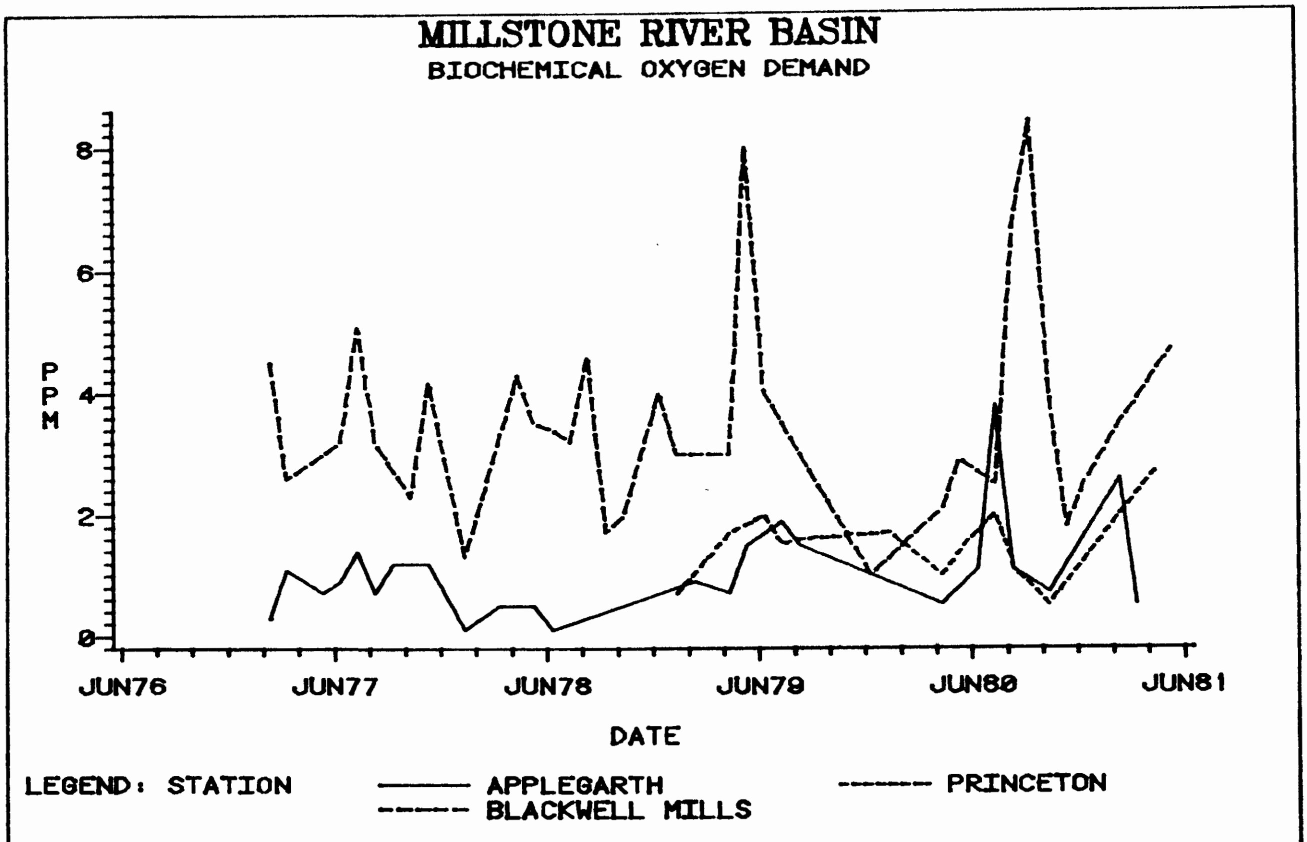

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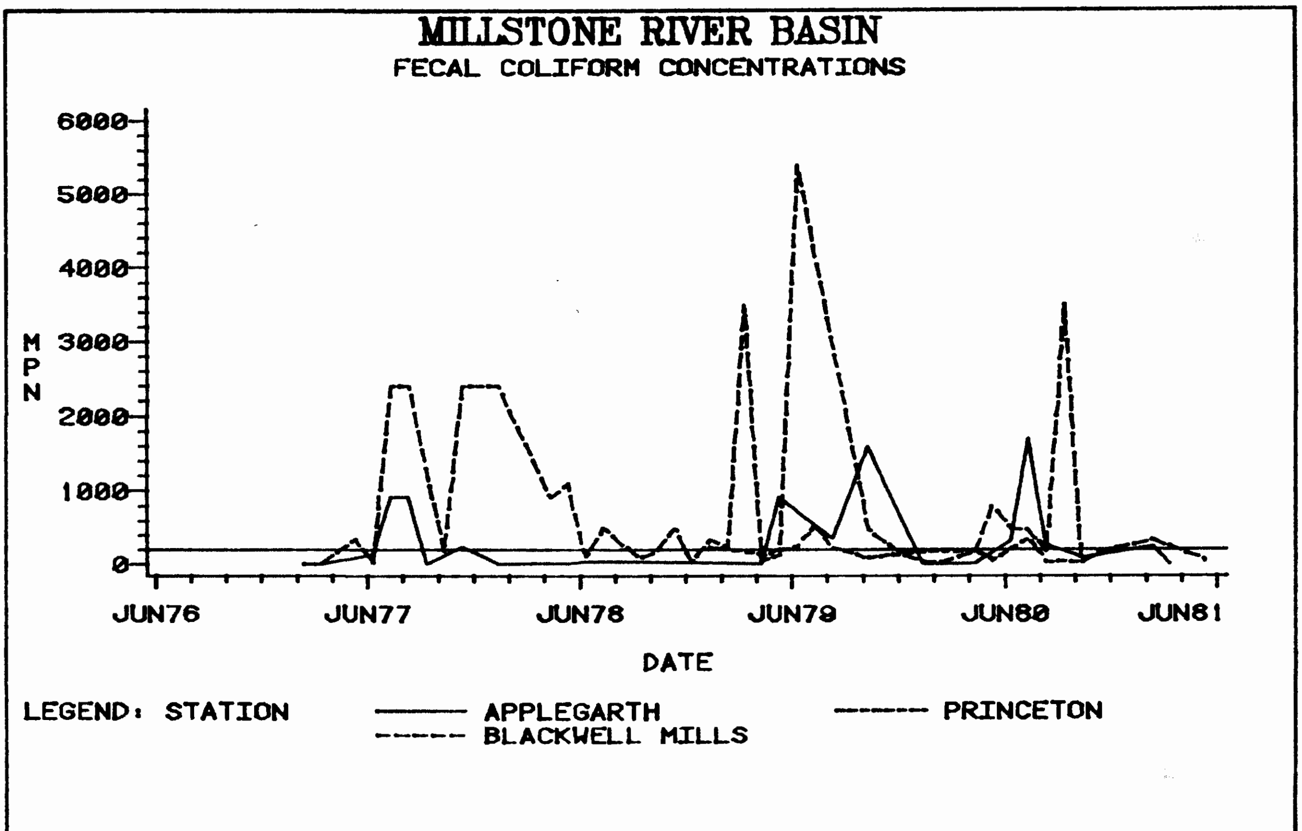

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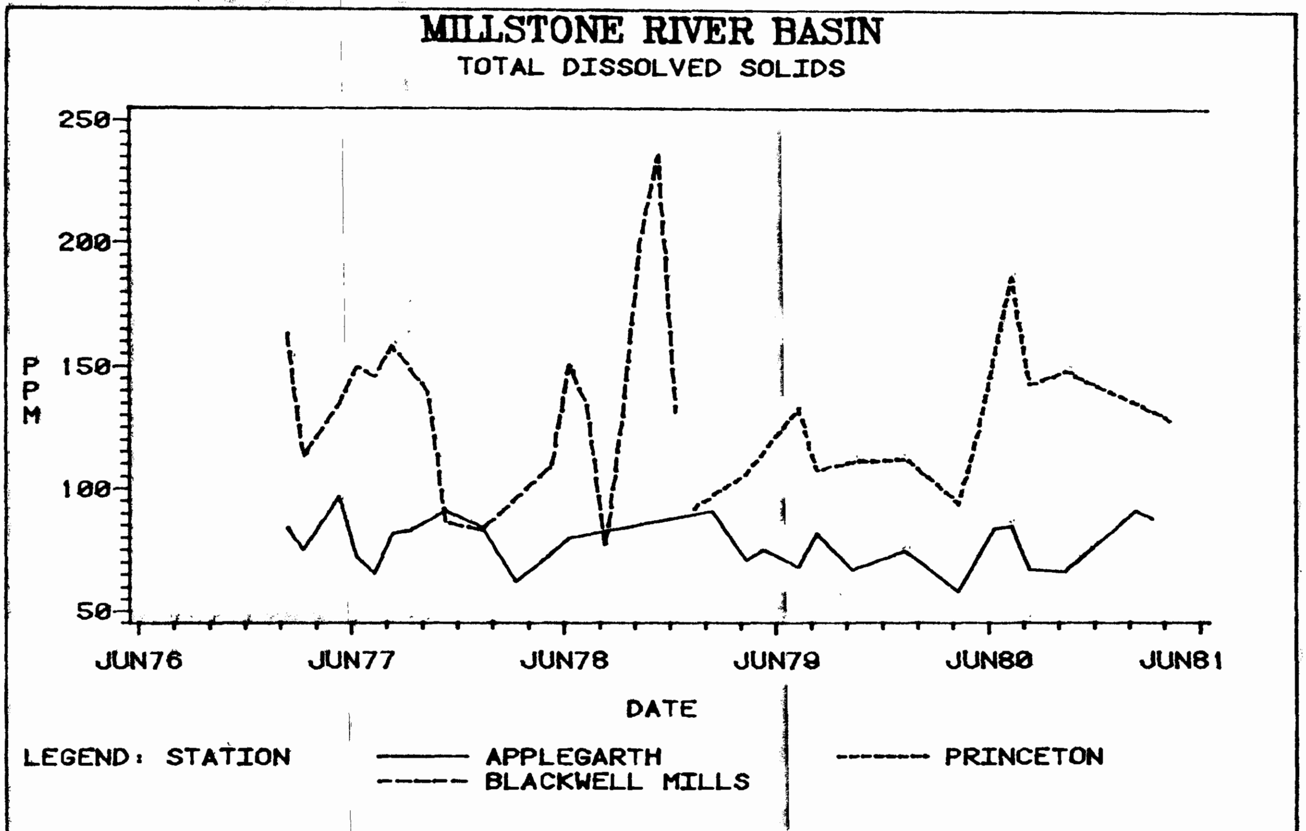

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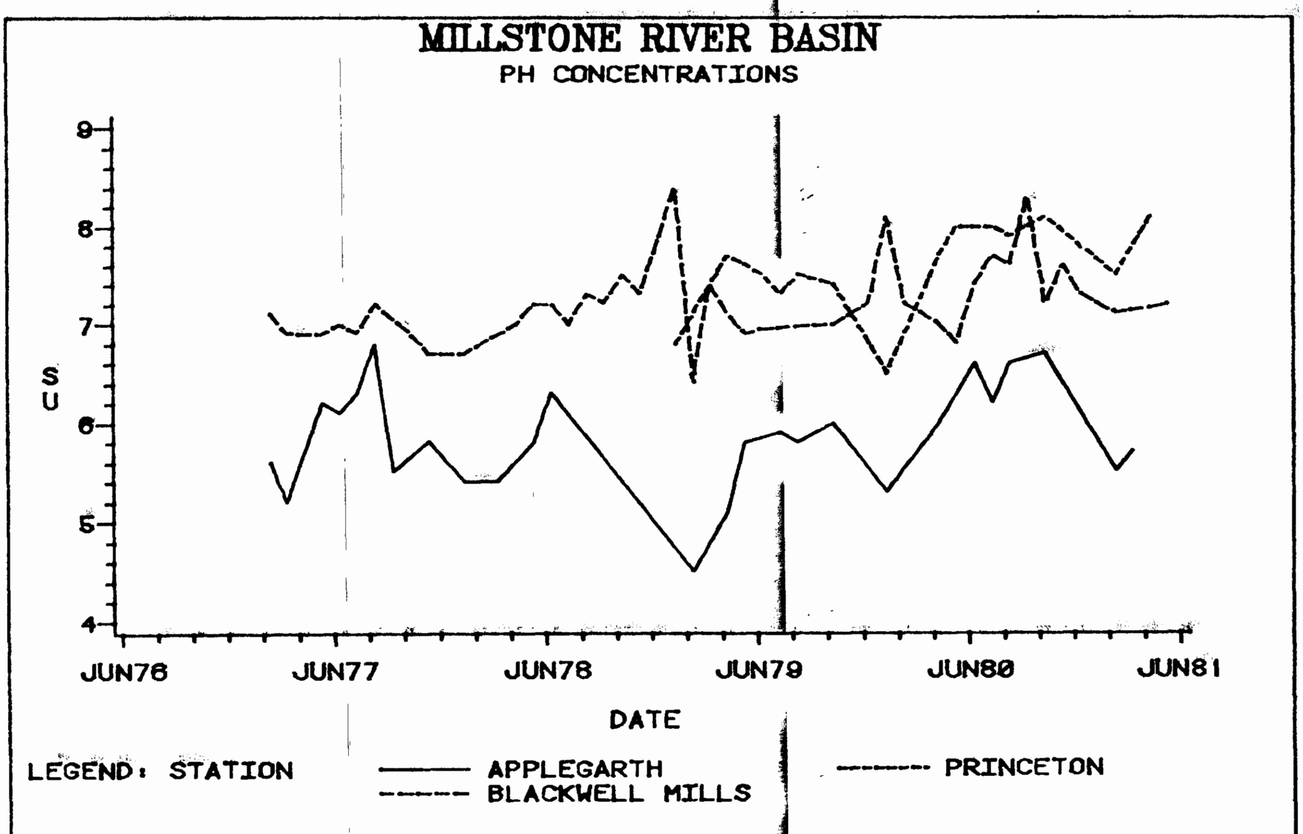

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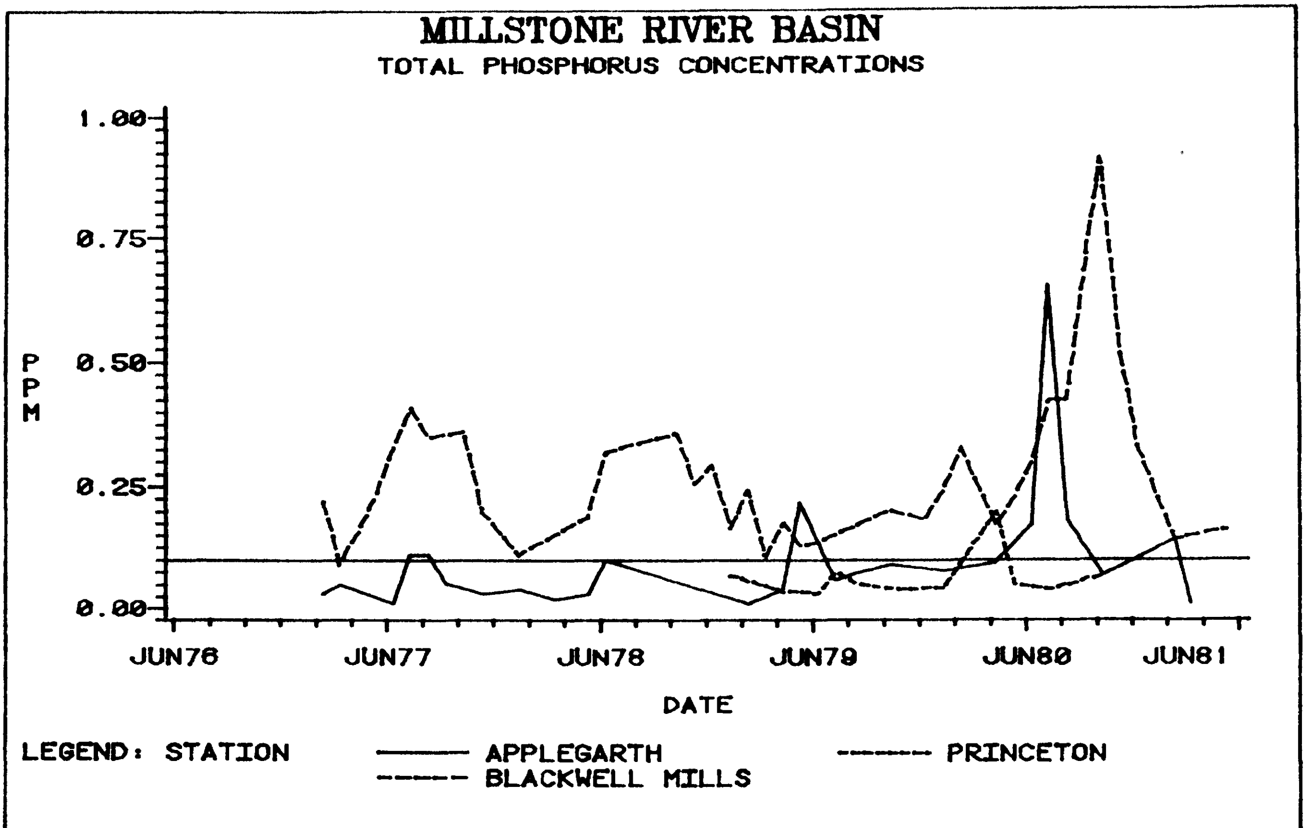

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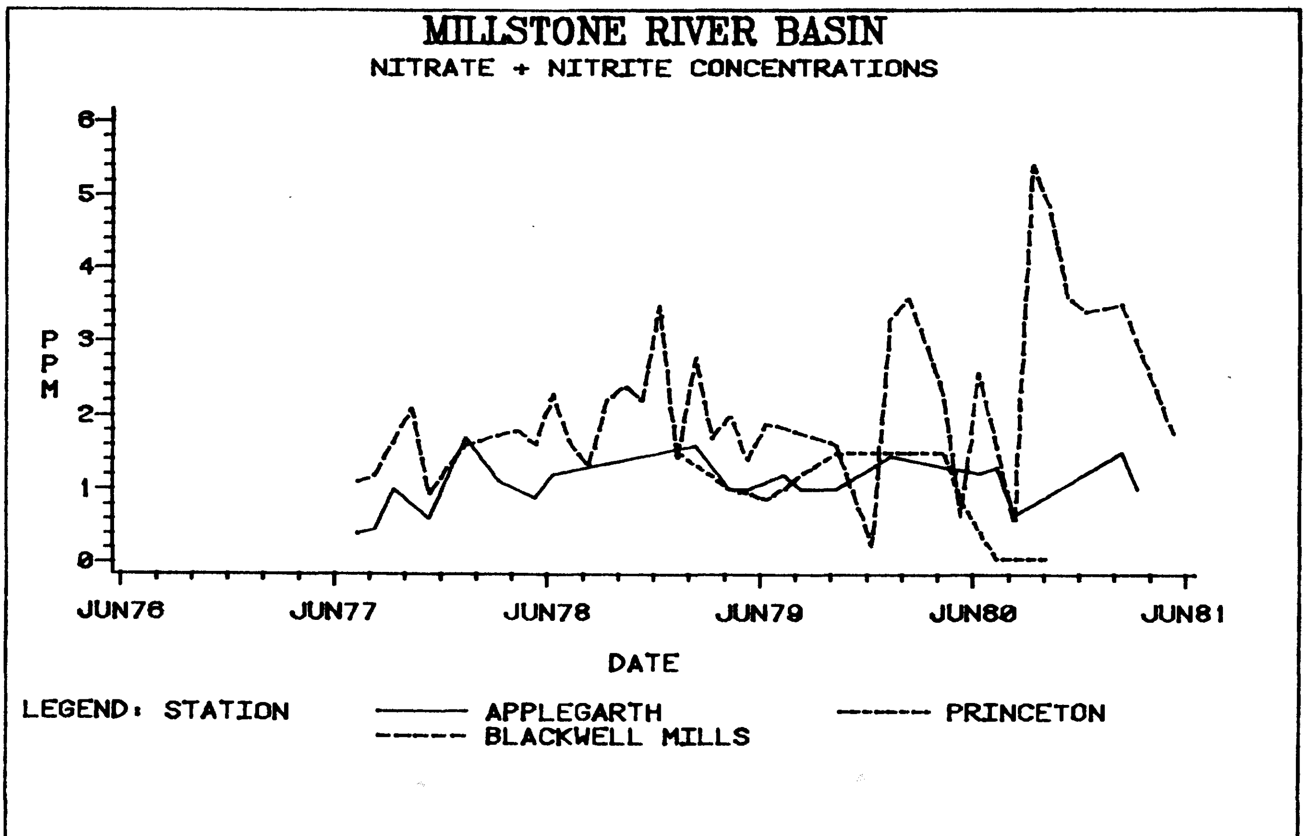


Figure: U -8

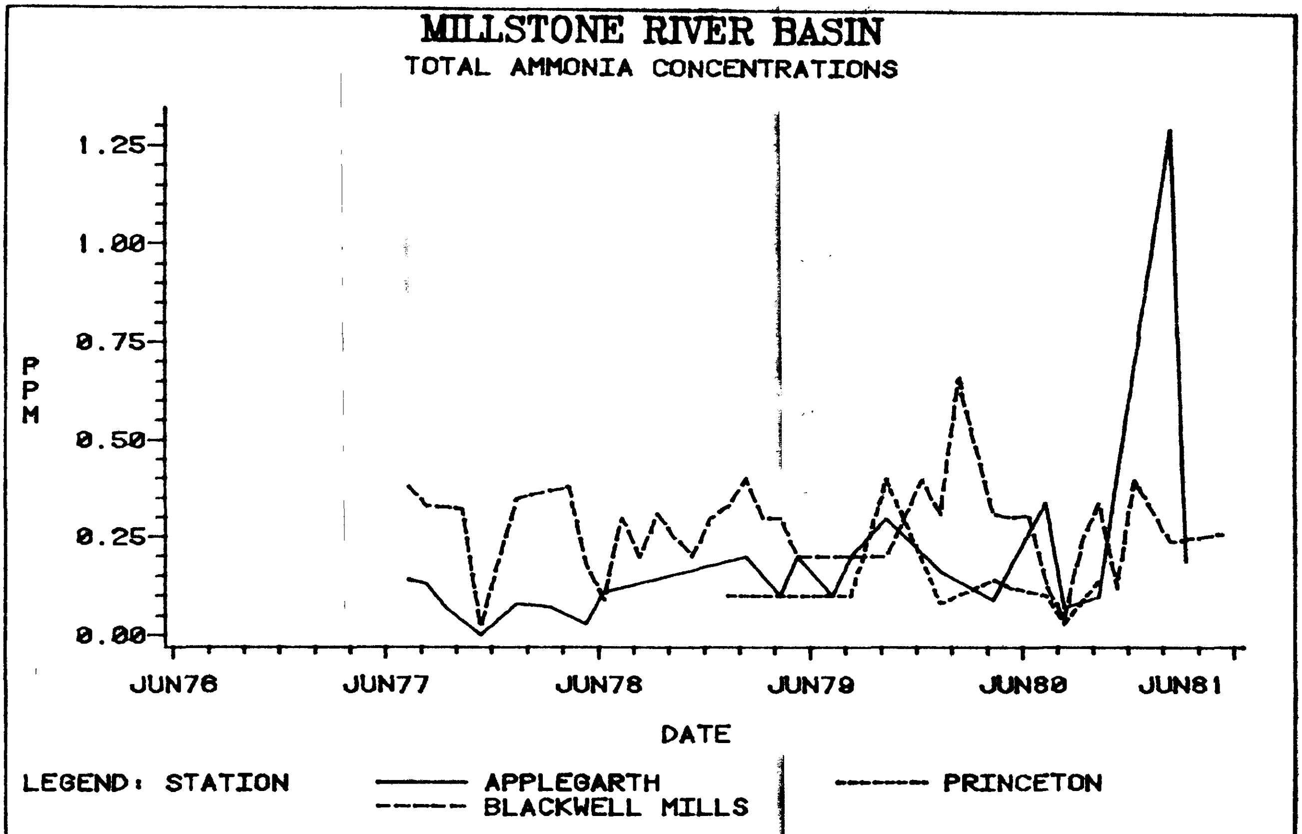


Figure: U -9

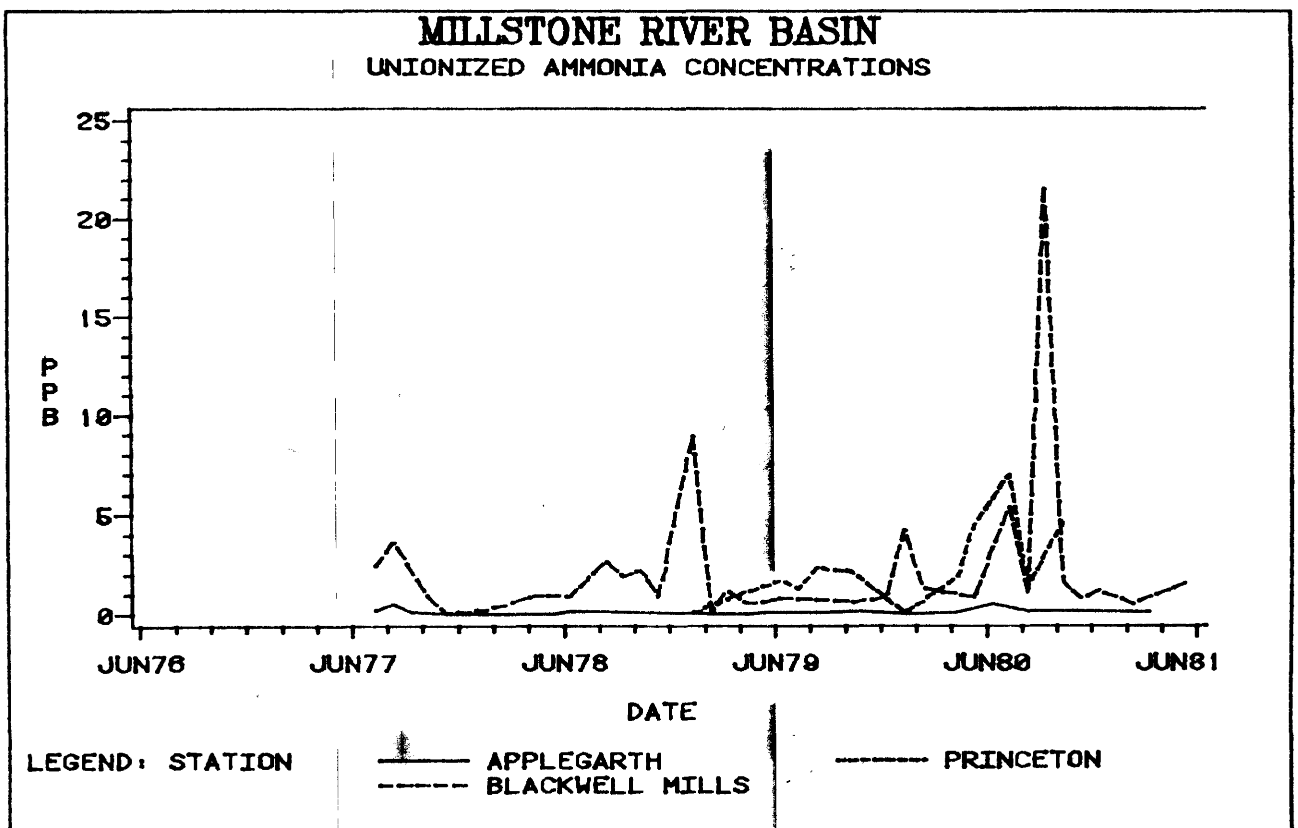


Figure: U -10

DISCHARGE INVENTORY - - - MILLSTONE RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
AMTRAK-ADAMS MAINT/WAY BASE	0033499	NO. BRUNSWICK TWP	MAE BROOK		
TRAP ROCK IND INC-PENNINGTON	0032263	KINGSTON	BALDWINS CREEK		
STONY BROOK REGIONAL SEW AUTH	0035301	PRINCETON	BEDEN BROOK		
COCA-COLA FOODS DIV	0004561	HIGHTSTOWN BORO	BIG BEAR BROOK	COOLING WATER	.03
GENERAL SERVICES ADM.	0020656	HILLSBOROUGH TWP	BRANCH CRUISERS BR.	SANITARY	.03
NEW JERSEY TURNPIKE AUTHORITY	0020729	CRANBURY TWP	CEDAR BROOK	SANITARY	.05
EXXON BIOMEDICAL SCIENCES INC	0034452	EAST MILLSTONE	COLONIAL PARK CREEK	COOLING WATER	
CARTER-WALLACE INC.	0002666	CRANBERY TWP	CRANBURY BROOK	COOLING & SANIT	.44
PVC CONTAINER CORP	0034711	EATONTON	CRANBURY BROOK		
LINCOLN PROPERTY COMPANY	0024104	PLAINSBORO TWP	CRANBURY BROOK	SANITARY	.35
IBM CARD MANUFACTURING PLANT	0000426	SO. BRUNSWICK TWP	CUL DEVILS BK	COOLING & SANIT	
FIRMENICH INCORPORATED	0031445	PLAINSBORO	DEVILS BROOK	PROCESS & SANIT	
CITIES SERVICE CORP	0000191	SOUTH BRUNSWICK TWP	HEATHCOTE BROOK		.05
HUB SERVALL RECORD MFG	0031950	SOUTH BRUNSWICK TWNS	HIGHLAND BROOK	COOLING WATER	
NORTH AMERICAN PHILIPS LIGHTIN	0033821	HIGHTSTOWN	HIGHTSTOWN SEWER TO ROCKY BR		
HOPEWELL TOWNSHIP MUA	0022560	HOPEWELL TWP	HONEY BR TRIB STONY BROOK	SANITARY	
PRINCETON IND.PROPERTIES LTD	0033316	PRINCETON	LITTLE BEAR BROOK		
PRINCETON INDUSTRIAL PROP LTD	0031798	WEST WINDSOR	LITTLE BEAR BROOK		
FUSION ENERGY CORPORATION	0030660	WEST WINDSOR TWP.	LITTLE BEAR BROOK	COOLING WATER	
MC LEAN ENGINEERING LABORATORY	0003794	WEST WINDSOR TWP	LITTLE BEAR CR	PROCESS WASTE	
RCA CORP ASTRO-ELECTRONICS DIV	0002534	EAST WINDSOR	MILLSTONE RIVER		
EAST WINDSOR MUA	0023787	EAST WINDSOR TWP	MILLSTONE RIVER	SAN/SIG INDUS	1.62
NL INDUSTRIES	0004243	EAST WINDSOR TWP	MILLSTONE RIVER		.01
FRANKLIN FIELDS WTP	0035751	FRANKLIN TOWNSHIP	MILLSTONE RIVER		
ENERGY RESEARCH DEV. ADM.	0023922	PLAINSBORO TWP	MILLSTONE RIVER		
FMC CORP	0027731	PLAINSBORO TWP	MILLSTONE RIVER	PROCESS WASTE	.08
INGERSOLL RAND RESEARCH INC	0032565	PRINCETON	MILLSTONE RIVER	SANITARY	.01
STONY BROOK REGIONAL S.A.	0031119	PRINCETON	MILLSTONE RIVER	SANITARY	4.50
PRINCETON SEWER OPER. COMM.	0020796	PRINCETON /TWP/	MILLSTONE RIVER	SANITARY	4.20
ROCKY HILL WATER DEPT	0034380	ROCKY HILL	MILLSTONE RIVER		
COMPO INDUSTRIES	0002844	ROCKY HILL BORO	MILLSTONE RIVER		.15
RCA CORP	0000272	WEST WINDSOR TWP	MILLSTONE RIVER	SANITARY	.10
BOROUGH OF HIGHTSTOWN-WTP	0003832	HIGHTSTOWN BORO	ROCKY BROOK		.05
PRODELIN INC DIV M/A COMM	0033979	MILLSTONE TWP	ROCKY BROOK	COOLING WATER	
BOROUGH OF HIGHTSTOWN-STP	0029475	HIGHTSTOWN BOROUGH	ROCKY BROOK-MILLSTONE RIVER	SAN/SIG INDUS	.70
VALLEY ROAD SEWERAGE CO.	0022772	HILLSBOROUGH TWP	ROYCE BR.	SANITARY	
US DEPOT - BELLE MEADE	0020036	HILLSBOROUGH TWP.	PIKE BROOK	SANITARY	.02
D. A. STUART OIL CO.	0027936	HILLSBOROUGH TWP	ROYCEFIELD CREEK	COOLING WATER	
OKONITE COMPANY	0023523	NORTH BRUNSWICK TWP	SEVEN MILE RUN	COOLING WATER	.04
STANDARD PKG./NAT'L METAL. DIV	0032611	CRANBURY	SHALLOW BROOK	COOLING WATER	
TELEDYNE TURNER TUBE	0031976	SOUTH BRUNSWICK TWNS	SHALLOW BROOK	COOLING WATER	.01
MOBIL RESEARCH & DEV. CO.	0000795	HOPEWELL TWP	STONY BROOK	PROCESS & COOL.	.30
WESTERN ELECTRIC ENG RESEARCH	0000809	HOPEWELL TWP	STONY BROOK		
EDUCATIONAL TESTING SERVICE	0022110	LAWRENCE TWP	STONY BROOK	SANITARY	

DISCHARGE INVENTORY - - - MILLSTONE RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
HOPEWELL VALLEY REG. SCHOOL	0032905	PENNINGTON	STONY BROOK	SANITARY	
STONY BROOK REGIONAL SEW AUTH	0035319	PRINCETON	STONY BROOK		
ELIZABETHTOWN WATER CO.	0000981	PRINCETON /TWP/	STONY BROOK		.25
PRINCETON SEWER OPER. COMM.	0020770	PRINCETON BORO	STONY BROOK	SANITARY	
PRINCETON THEOLOGICAL SEMINARY	0023205	WEST WINDSOR TWP	STONY BROOK	SANITARY	.05
KOOLTRONIC INC	0001040	HOPEWELL TWP	TR BEDEN BROOK	SANITARY	
VALLEY ROAD SEWERAGE CO.	0022764	HILLSBOROUGH TWP	MILLSTONE RIVER	SANITARY	
HOLIDAY INN	0021822	PLAINSBORO TWP.	MILLSTONE RIVER	SANITARY	
B HELLER & CO	0034690	HILLSBOROUGH	STORM SEWER		
STATE OF NJ NEURO-HOSP	0022390	MONTGOMERY TWP	ROCK BROOK	SANITARY	.23
COSDEN OIL & CHEMICAL CO	0031933	W WINDSOR	BEAR BROOK		
THE BEDENS BROOK CLUB	0032417	SKILLMAN	BEDENS BROOK	SANITARY	
CARRIER CLINIC	0023663	MONTGOMERY TWP	CRUISERS BROOK	SANITARY	
TOWNSHIP OF MONTGOMERY	0023124	MONTGOMERY TWP.	KING'S CREEK	SANITARY	
JOHNSON & JOHNSON BABY PRODS.	0026140	MONTGOMERY TWP	BACK BROOK	PROCESS & SANIT	.03
MINNESOTA MINING & MFG CO.	0003255	MONTGOMERY TWP	ROARING BROOK		.10
TOWNSHIP OF MONTGOMERY STP#1	0026891	MONTGOMERY TWP.	BACK BROOK	SANITARY	
TOWNSHIP OF MONTGOMERY STP#2	0026905	MONTGOMERY TWP	MILLSTONE RIVER	SANITARY	.18
TOWNSHIP OF MONTGOMERY STP#3	0026913	MONTGOMERY TWP	PIKE BROOK		.04

V. LAWRENCE BROOK AND SOUTH RIVER

Basin Description

The Lawrence Brook and South River watersheds drain central Middlesex County, and eastern Middlesex and west-central Monmouth Counties, respectively, to the Raritan River downstream of New Brunswick. The Lawrence Brook watershed has approximately 45 square miles in its drainage area and contains four man-made instream ponds (Deans Pond, Davidsons Mill Pond, Farrington Lake and Westons Mill Pond) along its length. Major tributaries to the Lawrence Brook include Ireland Brook, Beaverdam Brook and Oakeys Brook. Lawrence Brook, at the outlet of Farrington Lake has an average adjusted flow (to 1980) of 39 cfs (34 square mile drainage area). The South River watershed drains 133 square miles, 58 percent of this in Middlesex County. This watershed originates in the Monmouth County municipalities of Freehold, Marlboro and Millstone Townships. The South River begins at the outlet of Duhernal lake in Spotswood. Duhernal Lake is man-made and fed primarily from the two major branches of the South River, Manalapan and Matchaponix Brooks. Tributaries to Matchaponix Brook include Wemrock Brook, McGellairds Brook, Weamaconk Creek and Barkley Brook. Major tributaries to South River are Deep Run and Tennants Brook. Average flow for the South River to 1980 at Old Bridge (95 square mile drainage area) is 142 cfs. Lawrence Brook is tidal to the Westons Mill Pond dam, while South River is tidal upstream to the outlet of Duhernal Lake.

Lawrence Brook and tributaries flow through, suburban, commercial and agricultural/rural lands. The watershed upstream of Farrington Lake is primarily agricultural, with corn and grain production predominating. Suburban development mixed with commercial and industrial activities occurs in the lower half of the watershed, specifically in Milltown, North Brunswick, New Brunswick and East Brunswick. Development potential is greatest in the upper Lawrence Brook watershed as reflected in population increases in South Brunswick (20 percent) and North Brunswick (30 percent) from 1970 to 1980. Municipal sewer service is provided by the Middlesex County Utilities Authority to Milltown, East Brunswick, New Brunswick, North Brunswick and portions of South Brunswick. 201 wastewater facilities planning in the Lawrence Brook watershed is the responsibility of the Middlesex County Utilities Authority. At present, seven dischargers have been identified in the Lawrence Brook basin, all having small discharge flows.

Farrington Lake and Westons Mill Pond are used as sources of potable water by local municipalities. In addition, waters from Lawrence Brook are used for farm and non-farm irrigation, and industrial purposes. Other water uses in the basin are recreational. Fishing and boating occurs in Davidsons Mill Pond, Farrington Lake, Milltown Pond and Westons Mill Pond. Fishing is best for largemouth bass, pickerel, catfish, yellow perch, crappie and sunfish. The NJ Division of Fish, Game and Wildlife (DFGW) stocks trout in Lawrence Brook, Ireland Brook and Farrington Lake.

The South River basin has land use patterns similar to Lawrence Brook. Agriculture and forests make up the majority of the watershed upstream of Duhernal Lake, although developed areas exist in the headwaters of Matchaponix Brook in Monmouth County. Newer development has and is occurring in the upstream segments of Deep Run in Middlesex and Monmouth Counties. The Manalapan Brook watershed, with the exception of Jamesburg Borough, is agricultural and forested. Cropland is devoted primarily to soybean and corn. Extensive development, both old and recent, is present in Spotswood, East Brunswick, Old Bridge and Sayreville along the South River. In addition, numerous industrial facilities are located in the South River downstream of Duhernal lake. Population growth between 1970 and 1980 reflects the high growth potential for the upstream areas of the South River basin. Increases were heaviest in Marlboro (38 percent) and Manalapan (33 percent) in Monmouth County and Monroe (74 percent) in Middlesex County. Municipal sewage collection facilities primarily exist in the South River basin downstream of the confluence of Matchaponix and Manalapan Brooks in Middlesex County, throughout portions of Manalapan, Marlboro and Freehold Townships, and in all of Freehold Borough. Western Monmouth Regional Sewerage Authority is the facilities planning agency for the sections of the watershed in Monmouth County (except for Freehold Borough as part of the Manasquan Regional Sewerage Authority), while the Middlesex County U.A. covers Middlesex County drainage to the South River. Nineteen dischargers are present in the South River basin, the largest being the Western Monmouth U.A. wastewater discharge (2.9 mgd) to Manalapan Brook.

The South River watershed has a number of varied water uses. South River is heavily utilized for potable and industrial purposes through infiltration wells at Duhernal Lake, infiltration wells at Tennent Pond and its associated canal system, and through pumpage by Sayreville to off-stream lagoons and associated infiltration wells. Diversions for irrigation purposes occur along Manalapan Brook and Tepehemus Brooks in Monmouth County. The lakes in the watershed also provide for recreational opportunities. Manalapan Lake, East Brunswick Park Lake and DeVoe Lake in Middlesex County permit bathing, while the following lakes allow fishing and boating: Dallenbach Pond, Duhernal Lake and Helmetta Lake in Middlesex County and Englishtown Mill Pond, Millhurst Mill Lake and Topanemus Lake in Monmouth County. Monmouth Battlefield State Park is located in the South River basin in Monmouth County as are a number of municipal and county parks. The NJDFGW stocks trout in Englishtown Mill Pond and Topanemus Lake.

NJ Water Quality Standards classify the Lawrence Brook watershed as FW-2 Nontrout from headwaters to the Westons Mill Pond dam, with the remainder TW-1. The South River watershed is classified FW-2 Nontrout from headwaters to the intake of the Sayreville Water Department and Tennett Brook above Tennett Pond dam. Waters downstream of these points are TW-1.

Water Quality Assessment

Conventional Parameters

Generally good water quality conditions were exhibited in Lawrence Brook from 1977 to 1981 at Westons Mill, while waters in the South River drainage area were marginal based on water quality analyses at Spotswood (Matchaponix Brook) and Old Bridge (South River).

Dissolved oxygen levels in Lawrence Brook were sufficient throughout the period and showed no significant reduction during low flows associated with drought conditions in 1980. The South River basin stations, however, did display slight declines during the dry periods in the summers of 1979 and 1980, but remained within the criterion for nontrout streams. Biochemical oxygen demand at the Old Bridge site on South River and at Spotswood on Matchaponix Brook were at moderate levels during the dry periods, causing a reduction in dissolved oxygen concentrations. Five-day biochemical oxygen demand was acceptable at Westons Mill (Lawrence Brook) and did not cause any significant dissolved oxygen depletions.

Lawrence Brook showed a modest overall decline in 1980 and into 1981 of fecal coliform concentrations, but 36 percent of the data acquired over the period exceeded 200 MPN/100 ml. The South River also exhibited a slight improvement in bacterial quality with generally declining fecal coliform concentrations, particularly after 1979. Matchaponix Brook at Spotswood, upstream of the confluence with Manalapan Brook at Duhernal Lake, exhibited normally lower levels.

Lawrence Brook displayed generally stable, neutral pH values at the Westons Mill Pond outlet. On the other hand, pH values in the South River watershed fluctuated between slightly acid and neutral levels, particularly in Matchaponix Brook where acid soil conditions in the headwaters area may have an impact on pH levels. Matchaponix and Lawrence Brooks exhibited consistently low concentrations of total dissolved solids throughout the period. The elevation of total dissolved solids in the South River in 1979-1980 was attributed to the upstream migration of the salt line during a low flow (drought) period.

Total phosphorus concentrations in Lawrence Brook at the outlet of Westons Mill Pond were generally acceptable for streams, but frequently contravened the standard for lakes (0.05 mg/l). A similar situation occurred at the Matchaponix Brook station, located approximately 0.5 miles upstream from eutrophic Duhernal Lake, which also receives a significant nutrient load from Manalapan Brook. Complete uptake of the phosphorus into Duhernal Lake was not apparent as levels downstream at Old Bridge often exceeded the criterion.

Nitrate + nitrite concentrations were at generally low levels (up to 1.50 mg/l) at all stations for the period with only one moderate increase occurring in Matchaponix Brook in 1980. The Spotswood station also exhibited periodic elevated concentrations of total and un-ionized ammonia. The South River and Lawrence Brook monitoring sites displayed generally low to moderate total and un-ionized ammonia for the period.

Biological assessments for the Lawrence Brook and South River basins were not conducted between 1977 and 1980.

Water quality conditions in Lawrence Brook and the South River are generally similar now to what has been reported in prior 305(b) reports. In Lawrence Brook at Westons Mills water has shown to contain somewhat higher total phosphorus levels and lower fecal coliform concentrations lately, while in Matchaponix Brook fecal coliform and pH levels have shown overall drops since the mid-1970s.

Toxic Parameters

Matchaponix Brook was sampled in Spotswood and at Route 527 in Monmouth County and found to be free of toxic contamination.

Lawrence Brook at Weston Mills had high trihalomethane levels in one set of samples. Subsequent resampling did not confirm these levels, however, moderate levels of organic solvents were found. This is an indication of industrial land use within the basin and reflects the general water quality conditions.

In 1979 to 1980, samples of aquatic organisms were collected along the South River at South River Marina in Sayreville. Species collected at Sayreville varied from bluefish, Pomatomus saltatrix, and striped bass Morone saxatilis, to brown bullhead, Ictalurus nebulosus, and white perch, Morone americana. Trace levels of nearly all of the organochlorine pesticides examined and PCB Arochlor 1254 were found in these samples. These same parameters were also found at trace levels in the sediment as well. Results of chlordane and DDD were near the allowable limits in fish tissue of brown bullhead.

Problem Assessment

Water quality in Lawrence Brook is generally good, while water quality in South River is marginal. Fecal coliforms have been occasionally high, although the general trend since 1979 has been towards decline in concentrations. Excessive levels of nutrients have also been recorded.

Previous 305(b) reports have noted that non-point sources including agricultural runoff contribute substantial levels of nutrients to these waterways. Such sources are still a major factor, especially in the Lawrence Brook watershed. While most of these basins are sewered, there are a few septic tank problem areas. South Brunswick, Helmetta Boro and East Brunswick are municipalities which have experienced on-site disposal problems in Middlesex County. Septic problems also exist in Marlboro Township in Monmouth County. The South River basin is number seven on a 1979 Statewide Water Quality Management list of watersheds requiring soil erosion pollution abatement. It has an estimated annual soil loss of 11.0 tons per acre. Stormwater runoff from urban and suburban areas probably is a source of nutrients in the major lakes within the watersheds.

Four intensive surveys were conducted by the NJ Lakes Management Program in 1979 on lakes in these watersheds. Davidson's Mill Lake (Pond) in the Lawrence Brook watershed was found to be eutrophic with excessive nutrients, likely from agricultural activities and suburban runoff. Topanemus Lake (Monmouth County), DeVoe Lake and Manalapan Lake (Middlesex County) were also studied. All three lakes were classified as eutrophic. Nutrients in Topanemus Lake are originating from residential and forest lands runoff and possibly septic systems. Manalapan Lake is affected by agricultural and suburban runoff, while DeVoe Lake receives nutrients from two municipal and one industrial discharges and urban/suburban runoff. All four lakes sampled also contained high concentrations of DDT and its derivatives in sediment, indicating possible hazardous conditions.

In addition to these non-point sources, there are influences on water quality by industry and other point sources, primarily in the South River basin. Sampling of Lawrence Brook at Westons Mills revealed moderate levels of organic solvents, which are an indication of industrial land use within the basin. The CPS Chemical Company and Madison Industries, which are under enforcement action, have discharged volatile organics and heavy metals which have detrimentally affected Tennents Pond. Burnt Fly Bog, a major hazardous waste dump is present in the headwaters of Deep Run. JIS Landfill in South Brunswick, a polluter of local wells, is also present in the South River basin.

Goal Assessment and Recommendations

South River and Lawrence Brook both do not meet the water quality goal for swimmable waters. Matchaponix Brook, however, is marginally swimmable. The streams are all fishable although several samples were of a low pH. The streams have a moderate diversity of fish, as fifteen species reportedly occur in Lawrence Brook and fourteen occur in the South River. The many lakes in this segment were once important regional bathing and fishing centers, but degraded water quality and lake conditions have eliminated many of the uses.

Due to the high rate of soil loss in this segment, it is recommended that agricultural best management practices be implemented where such actions are needed. Other non-point sources, primarily stormwater runoff and septic system problems, should be studied further in this basin, and if a problem, corrected.

Because of the number of industrial discharges within this area and persistence of their discharged compounds in organism tissues, an expansion of the sampling program may be necessary to develop an understanding of the fate and uptake of toxic contaminants by aquatic biota.

Dredging is recommended for DeVoe Lake and portions of Manalapan, Topanemus and Davidson's Mill lake. Further sampling is needed in the sediments of these lakes to determine the extent of DDT contamination, especially if corrective actions are implemented to improve recreational opportunities of these lakes. Coordinated management activities in the DeVoe and Manalapan Lakes watershed are necessary if improvements are to be made.

The County of Middlesex is currently performing water resource planning for the South River basin. They are reviewing actions needed to protect both water quality and water supply in a basin that is rapidly becoming overutilizied.

Additional studies are also needed in Deep Run, Tennent Brook and South River to determine the extent of toxic contamination by Burnt Fly Bog, along with clean-up of the hazardous waste dump site.

LAWRENCE BROOK AND SOUTH RIVER STATION LIST

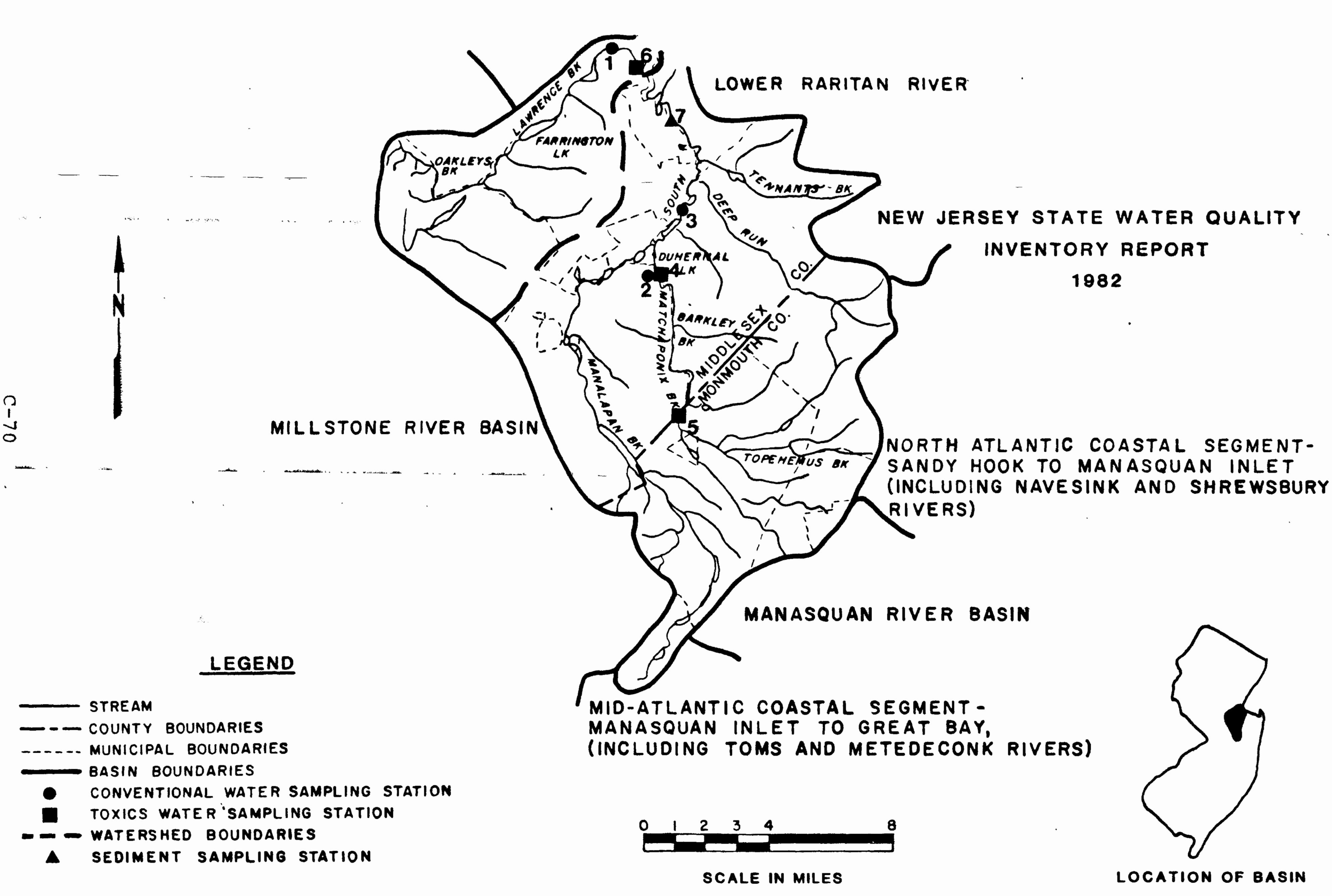
A. Ambient Monitoring Stations

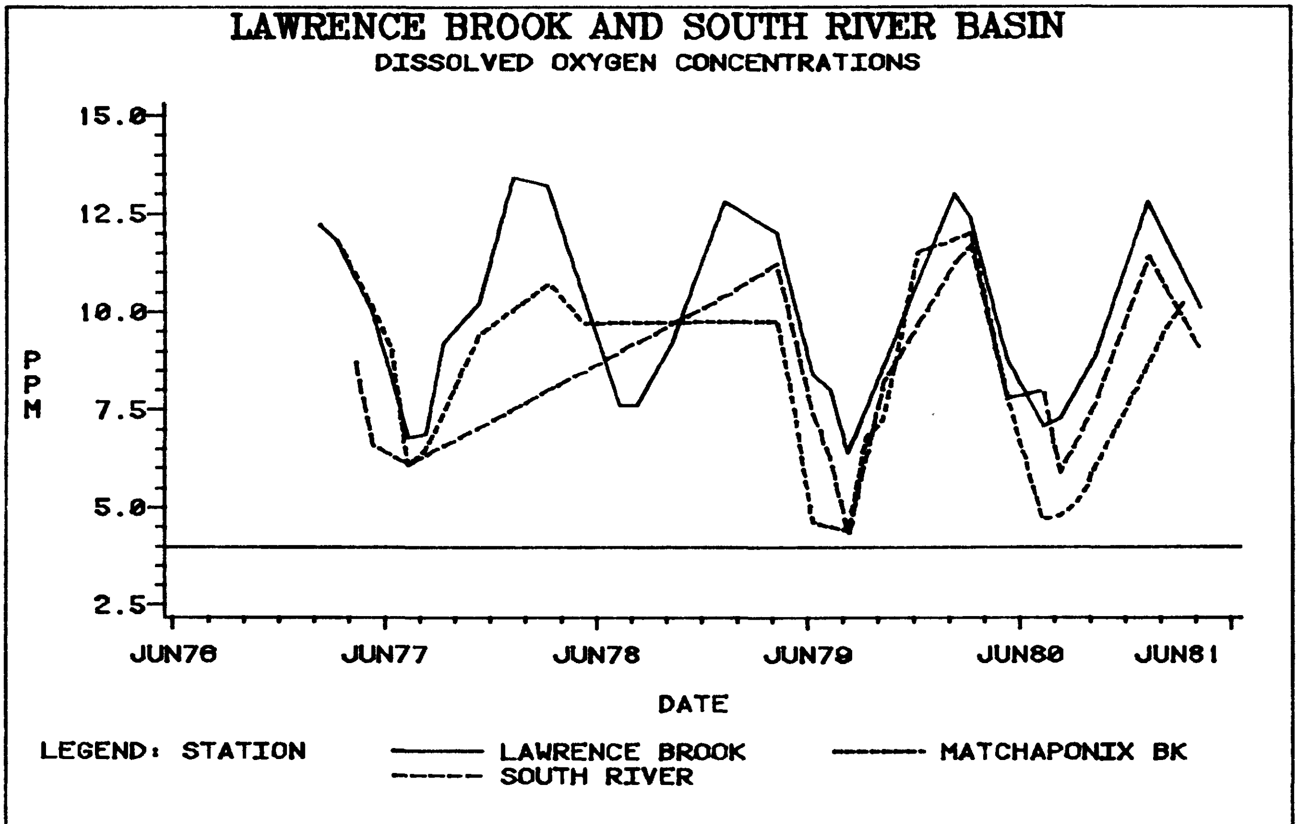
STORET Number	Station Description	Map Number
01405030	Lawrence Brook at Westons Mills, Middlesex County Latitude 40°28'59" Longitude 74°24'45" TW-1 USGS/DEP Network At Burnet Street bridge in Westons Mills, 200 feet downstream from outflow of Westons Mill Pond and 0.5 miles northwest of N.J. Turnpike Interchange 9.	1
01405302	Matchaponix Brook at Spotswood, Middlesex County Latitude 40°23'22" Longitude 74°22'55" FW-2 Nontrout USGS/DEP Network At Mundy Avenue bridge, 0.2 miles upstream from mouth at South River and 0.5 miles east of DeVoe Lake.	2
01405700	South River at Old Bridge Latitude 40°25'00" Longitude 74°21'43" FW-2 Nontrout USGS/DEP Network At bridge on Old Bridge - South Amboy Road, 7.4 miles upstream from mouth.	3

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Matchaponix Brook at Spotswood	Water column	4
Matchaponix Brook at Route 527, Monmouth County	Water column	5
Lawrence Brook at Westons Mills	Water column	6
South River at Sayreville	Sediments	7

LAWRENCE BROOK AND SOUTH RIVER BASINS





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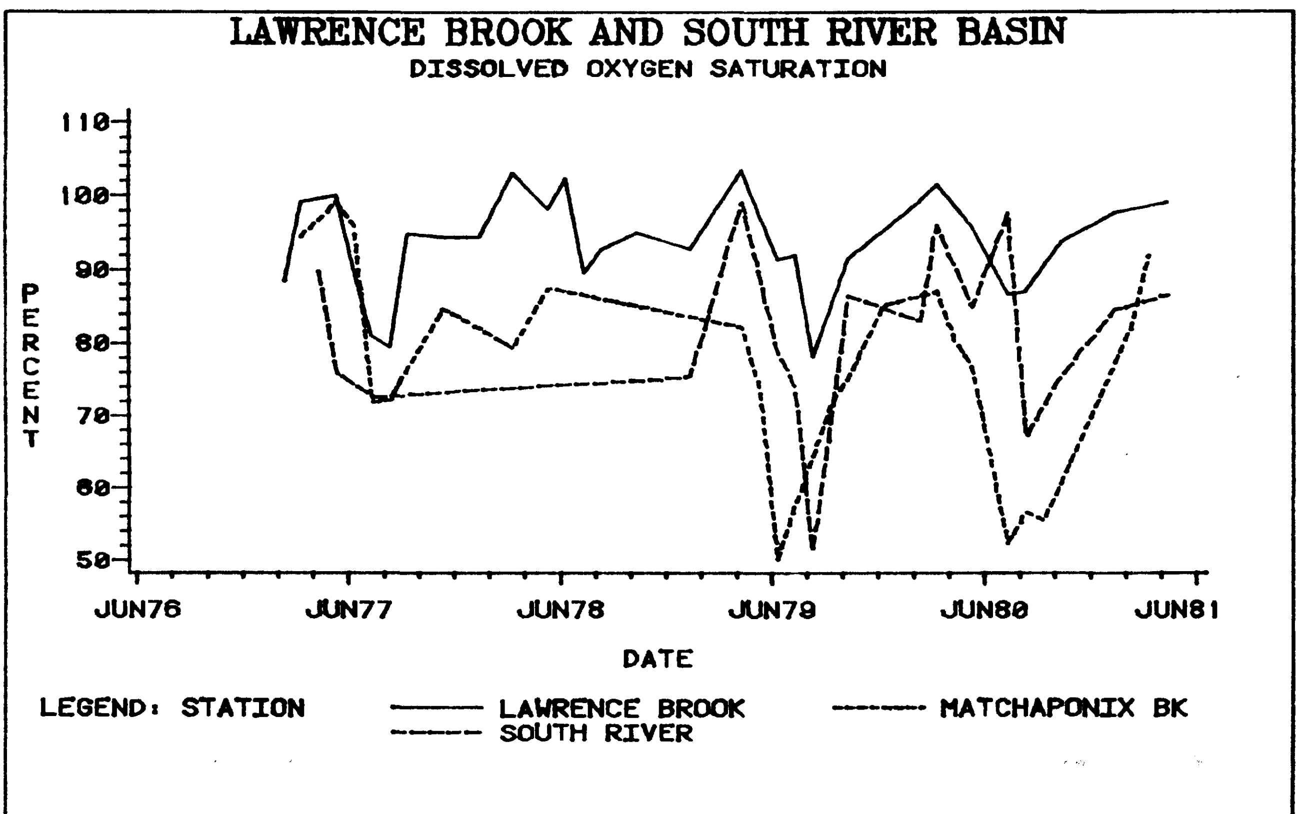

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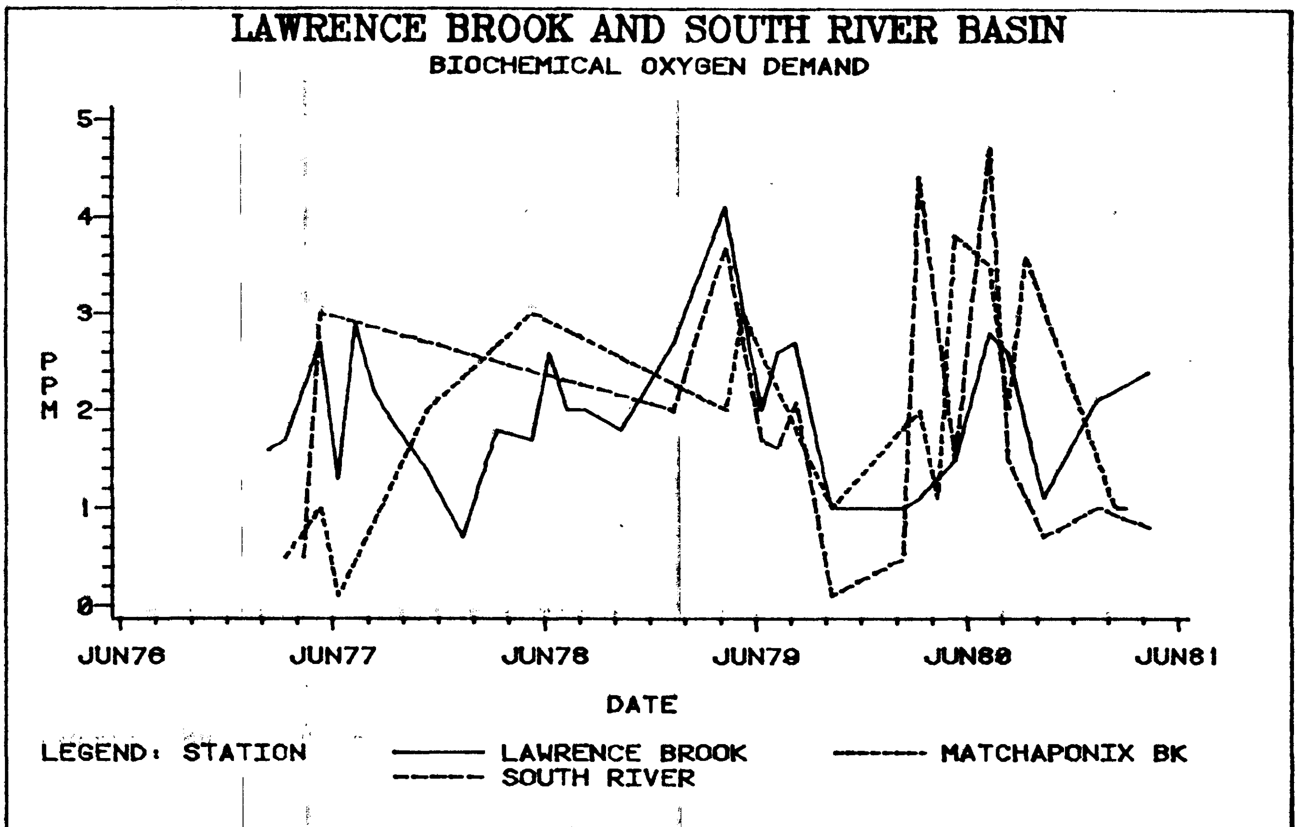

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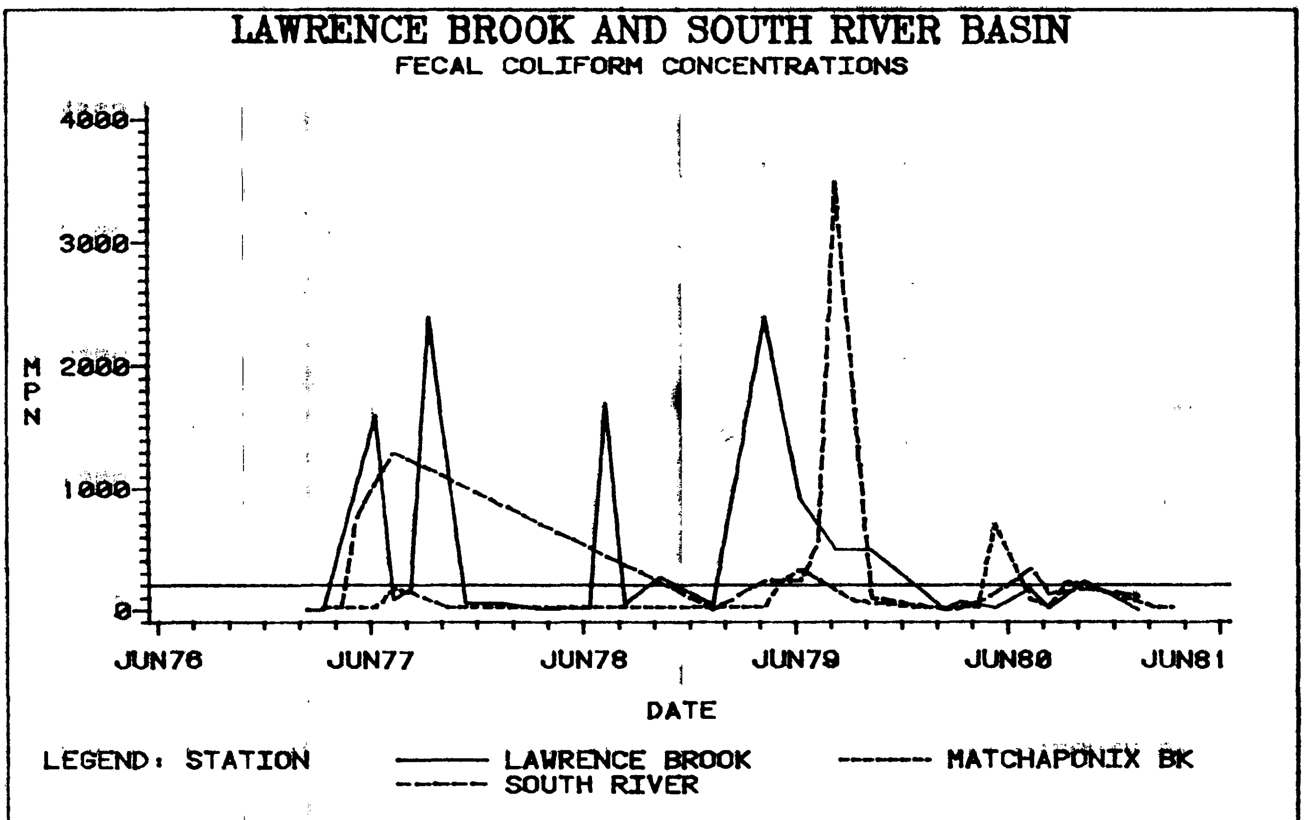

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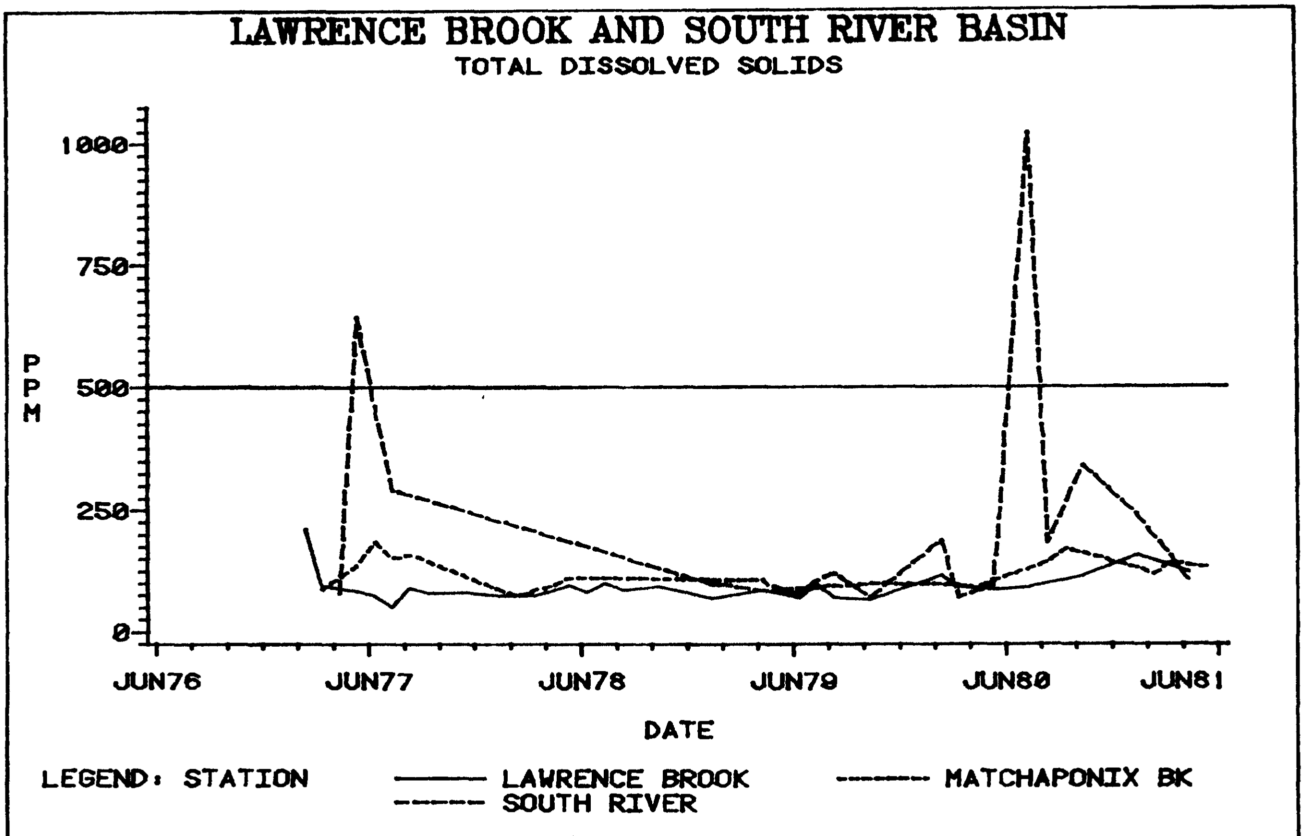

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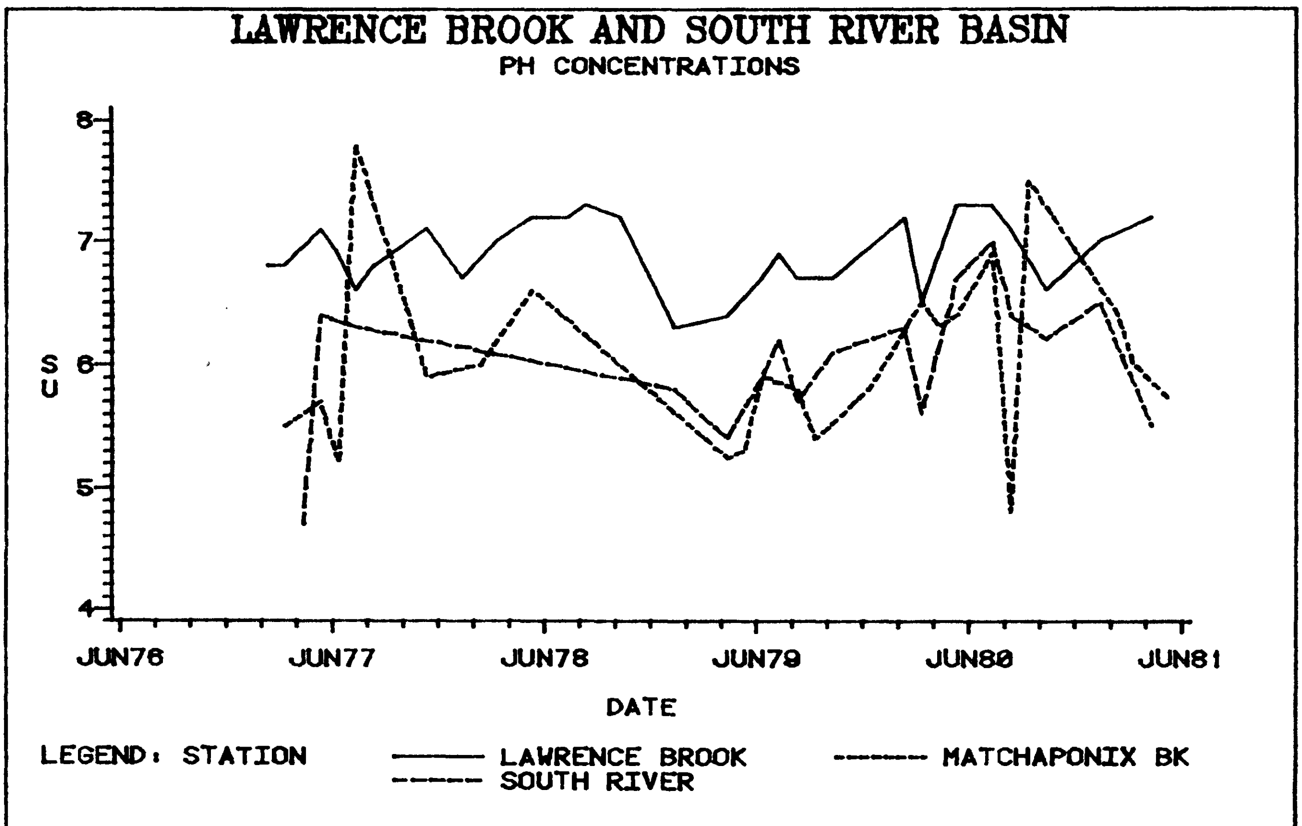

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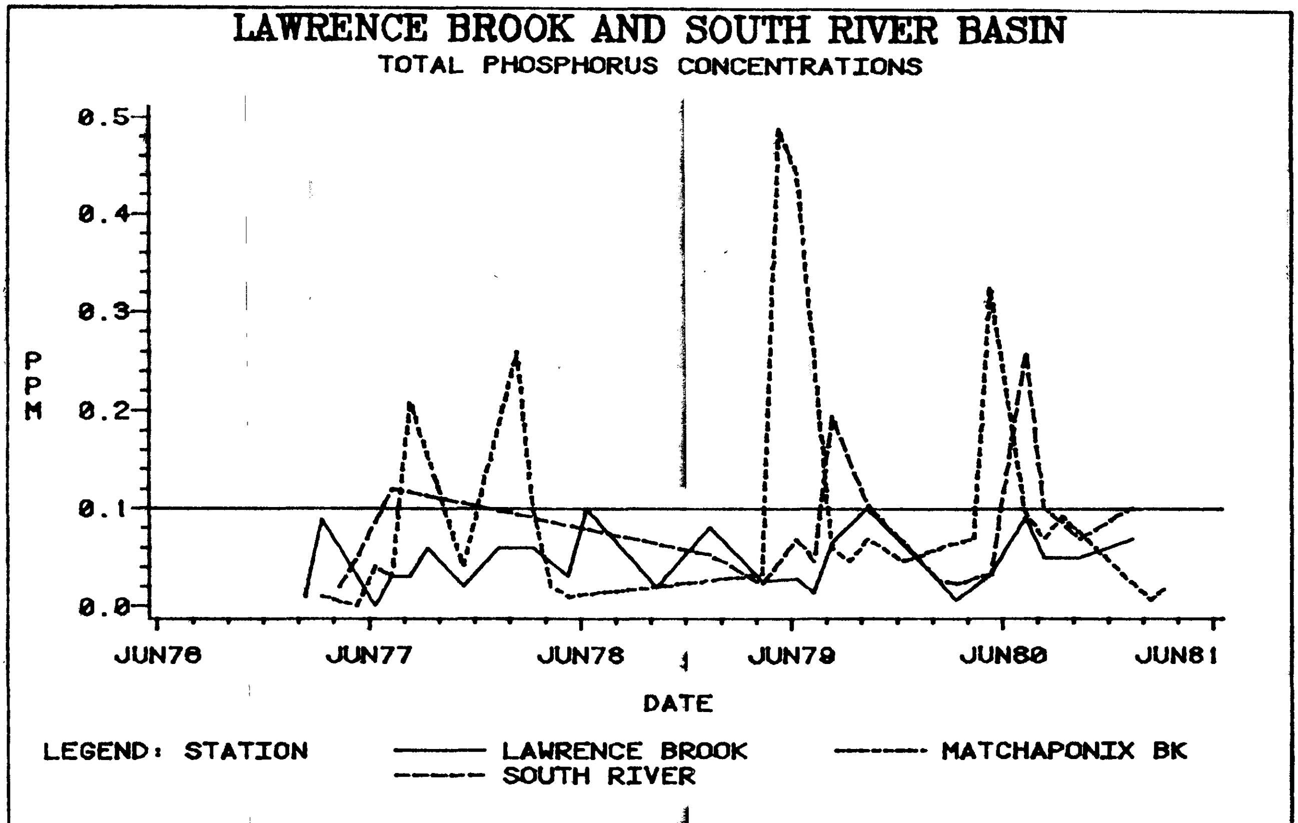

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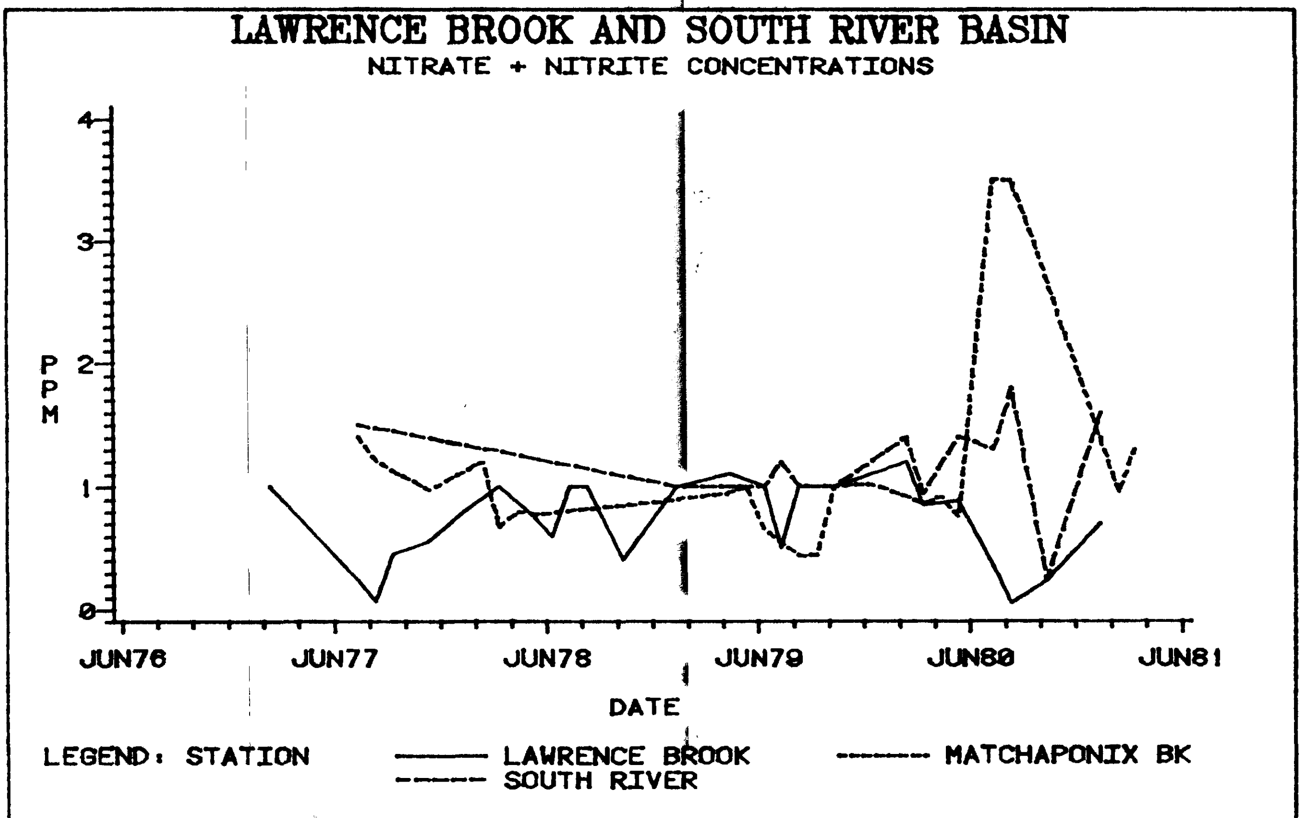

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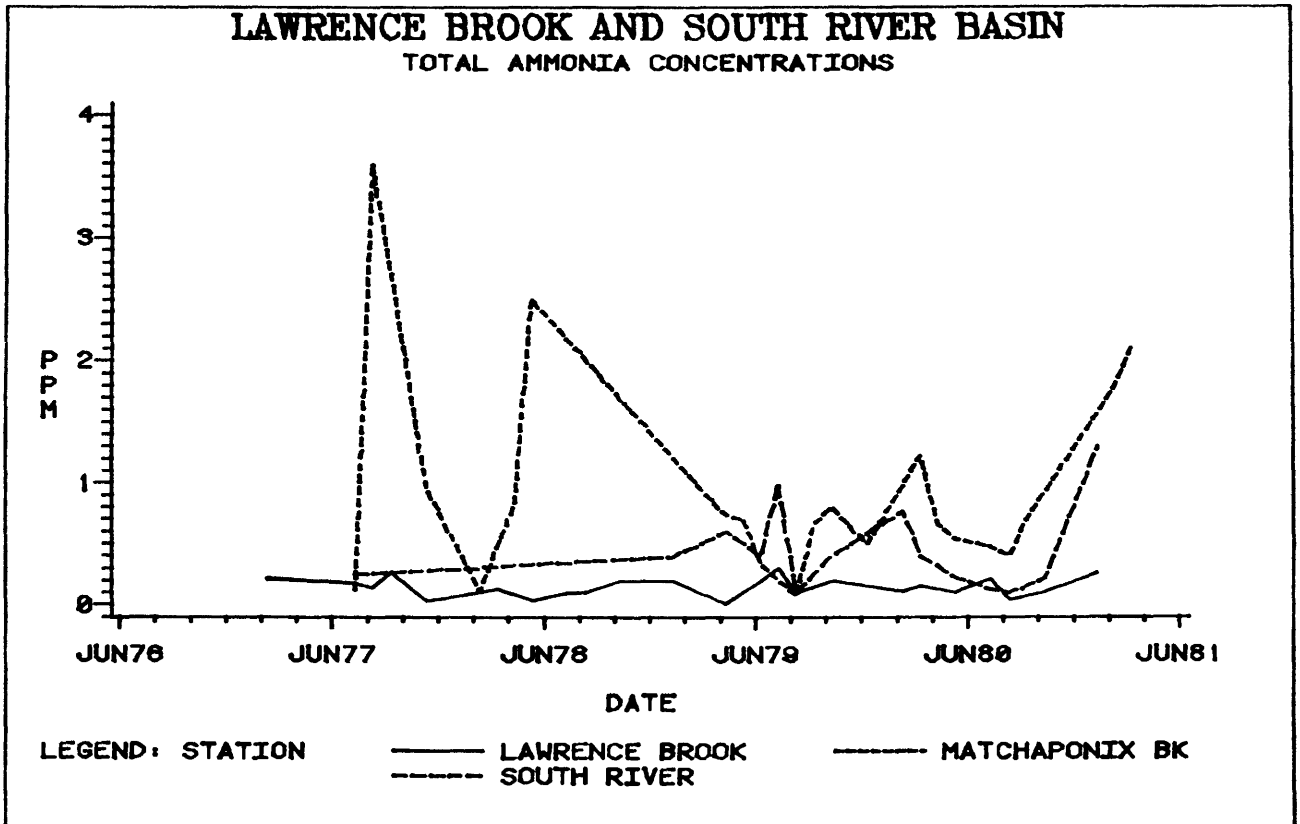

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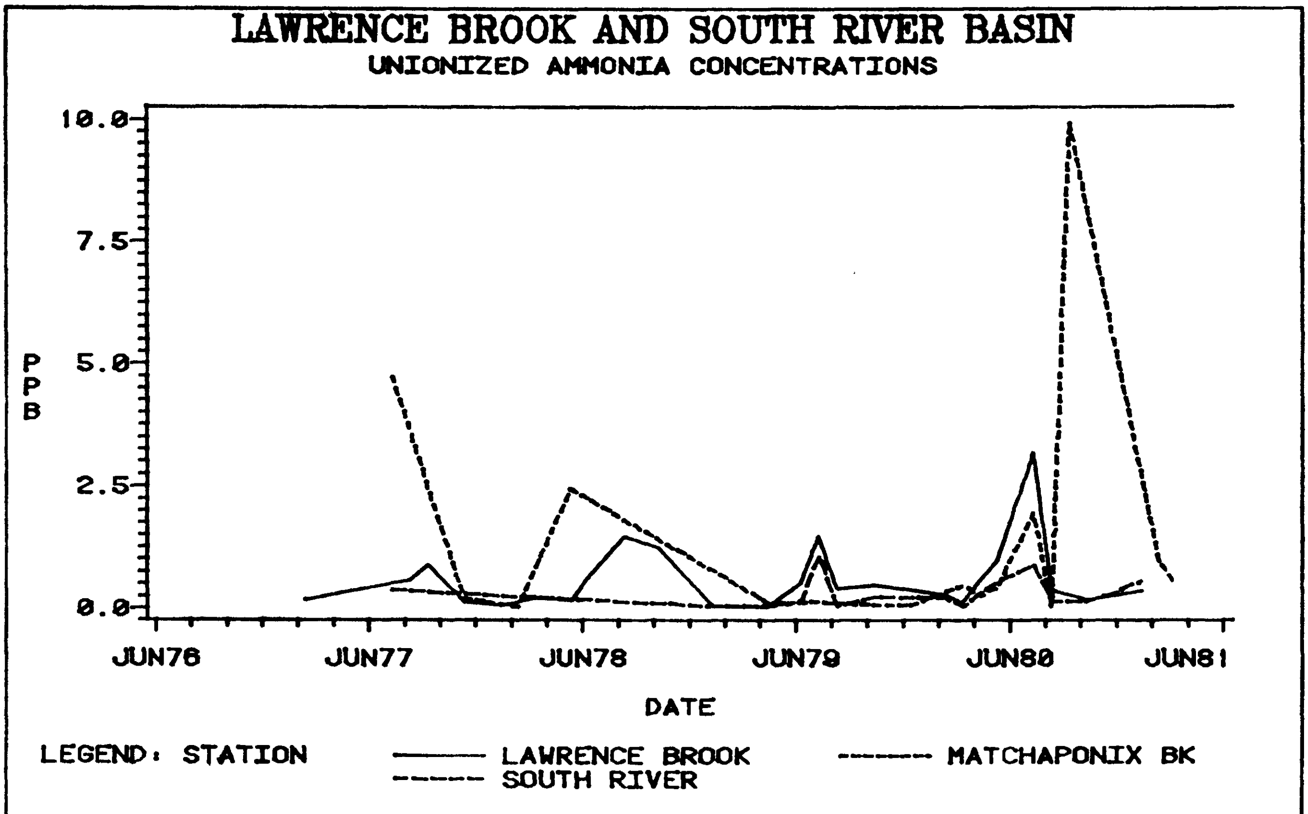

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DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
SOUTH BRUNSWICK TOWNSHIP	0033961	DEANS	DAVIDSON MILL POND		
QUIGLEY COMPANY, INC.	0028771	E. BRUNSWICK TWP	DEEP RUN & SOUTH RIVER	PROCESS & SANIT	
EAST BRUNSWICK WATER UTILITY	0032069	EAST BRUNSWICK	IRELAND BROOK	PROCESS WASTE	.01
SOUTH BRUNSWICK TWP. BD OF ED	0022241	SO. BRUNSWICK TWP	LAWRENCE BR.	SANITARY	
BOROUGH OF SPOTSWOOD	0035378	SPOTSWOOD	MANALAPAN BR		
BOROUGH OF ENGLISHTOWN	0003921	ENGLISHTOWN /BORO/	MATCHAPONIX BR	PROCESS WASTE	.01
TRAINING SCHOOL FOR BOYS	0028479	MONROE TWP	MATCHAPONIX BROOK	SANITARY	.07
BOROUGH OF FREEHOLD WAT.TR.PL.	0029190	FREEHOLD BOROUGH	MCGALLAIRDS BROOK	WATER TREATMENT	1.56
STEARNS & FOSTER CO	0034754	MONMOUTH JUNCTION	OAKEYS BROOK		
FLAG POST MOTOR LODGE	0031356	SOUTH BRUNSWICK TWP	OAKLEYS BROOK	SANITARY	.01
E I DU PONT DE NEMOURS	0000159	SAYREVILLE BORO	POND CREEK	COOLING WATER	1.20
EDGEBORO DISPOSAL INC	0031071	EAST BRUNSWICK	SOUTH RIVER		
SOUTH RIVER SAND CO	0034908	EAST BRUNSWICK	SOUTH RIVER		
BUSCH INDUSTRIAL PRODUCTS CORP	0002470	EAST BRUNSWICK TWP	SOUTH RIVER	PROCESS & COOL.	1.60
REBEL ONE CORP	0030465	OLD BRIDGE	SOUTH RIVER		.00
SOUTH RIVER SAND CO	0035688	OLD BRIDGE	SOUTH RIVER		.23
HERCULES INC	0001023	SAYREVILLE BORO	SOUTH RIVER	COOLING WATER	.24
OLDBRIDGE BOARD OF EDUCATION	0022306	E. BRUNSWICK TWP.	TONNETTS BROOK	SANITARY	.00
PREMIUM PLASTICS, INC.	0028789	METUCHEN	TRIB. OF LAWRENCE BROOK		.00
WESTERN MONMOUTH UTIL'IES AUTH	0023728	MANALAPAN TWP	MATCHAPONIX BROOK	SANITARY	2.90
MIDEAST ALUMINUM INDUSTRIES CO	0025259	SO. BRUNSWICK TWP	GREAT DITCH		.04
WICKATUNK VILLAGE INC	0026816	MARLBORO TWP.	DEEP RUN	SANITARY	
MARLBORO MUA	0031887	WICKATUNK	DEEP RUN	PROCESS WASTE	
VIVIANI CORP	0031763	ENGLISHTOWN	MANALAPAN BROOK	SANITARY	
GENERAL CIGAR & TOBACCO CO.	0001759	HELMETTA BORO	MANALAPAN BROOK		.03
BOROUGH OF JAMESBURG	0023574	JAMESBURG BORO	MANALAPAN BROOK	SANITARY	.60

W. LOWER RARITAN RIVER BASIN

Basin Description

The lower Raritan River basin contains lands that drain to the Raritan River downstream of the confluence of the North and South Branches to Raritan Bay, as well as Raritan Bay tributaries in eastern Middlesex and northern Monmouth Counties. The three largest tributaries to the Raritan River, the Millstone River, Lawrence Brook and South River, are discussed in separate analyses. The Raritan River mainstem generally flows in an easterly direction after the confluence of the North and South Branches in Branchburg Township; draining portions of central Middlesex and Somerset Counties and western Union County. Important tributaries to the Raritan River mainstem in this segment include Middle Brook, Green Brook and Mile Run. Adjusted flow in the Raritan River at Bound Brook (785 square mile drainage area) averages 1,289 cfs based on 41 years of discharge data to 1980. Flows in the Raritan River are regulated by Spruce Run and Round Valley reservoirs. New Jersey law (P.L. 1958. c.34 as amended by P.L. 1981, c.10) states that a 90 mgd (or 139 cfs) passing flow requirement be met in the Raritan River at the Bound Brook gaging station, unless a drought emergency has been declared by executive order, at which time the passing flow requirement can be altered. A number of low dams exist on the Raritan River, the most notable being Calco Dam upstream of Bound Brook and Fieldsville Dam downstream of Bound Brook. The Raritan River is tidal to Fieldsville Dam, the head of tide (mean high water) is located approximately 2.5 miles downstream of Fieldsville Dam. The Delaware and Raritan (D&R) Canal flows directly adjacent to the Raritan River from the Millstone River confluence to where it empties at New Brunswick. Extensive tidal marshes are present along the Raritan River downstream of New Brunswick to Raritan Bay.

Land use in the lower Raritan River basin is primarily urban/suburban, with industrial and commercial centers common throughout. Large industrial facilities are present along the Raritan River in the Somerville and Manville area, as well as near Raritan Bay in Sayerville and Perth Amboy. Older population centers include Somerville, Manville, Bound Brook, Plainfield, New Brunswick, Metuchen, Perth Amboy and South Amboy. Newer residential and commercial development has and is occurring in Hillsborough, Franklin, and Bridgewater Townships in Somerset County, and in Piscataway and Edison Townships in Middlesex County. Moderate population gains between 1970 and 1980 were reported in many of the larger townships in the basin, but declines occurred in the older population centers.

Municipal sewers are present in much of the lower Raritan River basin. The Somerset-Raritan Valley Sewerage Authority serves portions of Somerset County and discharges over 7.0 mgd to Cuckels Brook. The Middlesex County Utilities Authority provides treatment for municipal sewage in portions of Middlesex, Somerset and Union Counties and discharges to western Raritan Bay. Wastewater facilities planning agencies cover the entire lower Raritan River basin. Discharges total 105 in the basin, many discharging large amounts of industrial (process and cooling) wastewater.

The Raritan River is utilized by diversion for a number of purposes. Industrial facilities use Raritan River water for cooling and process needs. Johns-Manville Products Corporation intakes over 4 mgd from the Raritan River, while the American Cyanamid Company diverts approximately 8 mgd from the river. The Elizabethtown Water Company diverts water from the Raritan and Millstone Rivers just upstream of their confluence, at a rate of approximately 95 mgd. A pumping station along the Millstone River just upstream from its confluence with the Raritan River allows the NJ Water Supply Authority to pump a mixture of Raritan River and Millstone River water into the D&R Canal, a source of potable water supply, when upstream flow in the Canal is interrupted or inadequate. Diversion of waters from the Raritan for golf course irrigation occurs in Piscataway and Franklin Townships and Somerville Borough.

Water-based recreational activities are present at various locations in the Raritan River basin. State, county and municipal parks such as the Delaware and Raritan Canal State Park, Johnson Park and Carbide Park provide for shore fishing along the Raritan River and D&R Canal. Watchung Lake in Watchung, which drains to Green Brook, contains a private bathing area. New Market Pond (Dunellen), Roosevelt Park Pond (Menlo Park), Spring Lake (South Plainfield) and Victor Crowel Park Pond (Middlesex) in Middlesex County; Cedar Brook Pond (Plainfield), Green Brook Pond (Plainfield) and Surprise Lake (Mountainside) in Union County, and Best Pond (Watchung) in Somerset County are used for recreational fishing (primarily for carp, catfish and sunfish). The NJ Division of Fish, Game and Wildlife stocks trout in the Raritan River to the dam at Edgewater Road (Somerset County) and the East Branch Middle Brook (Bridgewater). Watchung Reservation, maintained and owned by the Union County Parks Systems, is an intensively used upland park in the headwaters area of Green Brook.

NJ Surface Water Quality Standards have classified waters in the Raritan River Basin as either FW-2 Trout Maintenance, FW-2 Nontrout or TW-1.

Streams which drain directly to Raritan Bay in eastern Middlesex and northern Monmouth Counties contain small watersheds, have large areas of tidal marsh, and are tidal for most of their lengths. These streams include Cheesequake Creek in Middlesex County, and Matawan, Luppatotong, Chingarora, Flat, Waackaack and Compton Creeks in Monmouth County. These streams drain the older population centers of Keyport, Keansburg, Matawan and Atlantic Highlands; while newer residential and commercial centers are utilizing the remaining space in the region. Population in the Raritan Bay drainage basin has stabilized during the period from 1970 to 1980. Municipal sewers are found in most developed areas of the basin, although septic systems are still used in various locations. The entire Raritan Bay drainage basin is within existing 201 facilities planning areas.

Water uses in this region are primarily limited to the inland lakes and along the shore of Raritan Bay. Cheesequake State Park in Old Bridge Township, Middlesex County, contains bathing and fishing facilities, as does Lefferts Lake near Matawan. Municipal bathing facilities are present on the northern coast of Monmouth County by Keansburg, Matawan and Aberdeen Township, and in Middlesex County by South Amboy, Old Bridge Township and Sayerville. Shellfish harvesting waters are condemned for all the streams in the Raritan Bay basin, as are parts of Raritan Bay from Perth Amboy to Keansburg. East of Keansburg, Raritan Bay is designated as a Special Restricted Area.

Much of the surface waters in the Lower Raritan River basin are part of a December, 1982 fishing advisory issued jointly by the DEP and Department of Health because of PCB contamination. The advisory warns that striped bass, bluefish (greater than 6 pounds or 24 inches), white perch, white catfish and American eel taken from the Raritan River below New Brunswick, Raritan Bay and Sandy Hook Bay should not be consumed more than once weekly. PCB concentrations from these fish and waters periodically exceeded FDA limits.

Waters in the Raritan Bay drainage basin are classified by the NJ Water Quality Standards as either FW-2 Nontrout or TW-1.

Water Quality Assessment

Conventional Parameters

Water quality conditions in the Raritan River were measured at four locations (in downstream order) - Raritan, Manville, near South Bound Brook, and Perth Amboy at Victory Bridge.

Most of the parameters examined in this assessment illustrated a decline in water quality in the downstream direction from the confluence of the North and South Branches of the Raritan River (nontidal) to the estuary at Perth Amboy. The non-tidal segment exhibited marginal water quality due to frequently high fecal coliform and moderate to high nutrient levels. The Raritan River near South Bound Brook can be described as having moderate to poor water quality due to frequently excessive levels of BOD_5, total ammonia and un-ionized ammonia and dissolved solids. The water quality at Victory Bridge, Perth Amboy, assessed as poor, was based on data collected up to 1979 and does not reflect any recent water quality changes that may have occurred in this estuarine segment as a result of improved treatment by the Middlesex County Utilities Authority.

Daytime dissolved oxygen levels were generally sufficient through the period at the Raritan station as biochemical oxygen demand was relatively low. Dissolved oxygen levels at Manville showed some overall increase from 1977 to 1981, while no individual measurement fell below the 4.0 mg/l standard. DO saturation in the summers of 1977 and 1978 exceeded 130 percent, with normal levels around 90 percent. BOD_5 at Manville was usually low with highest levels found in 1977. DO in the Raritan River at South Bound Brook was for the most part above the standard, with the lowest levels in the summer of 1979. A special low flow survey in August, 1981 showed that DO concentrations in the Raritan River between Bound Brook and New Brunswick are subject to large diurnal variations. At New Brunswick DO fell below 4.0 mg/l in the early morning but exceeded 16 mg/l in the afternoon during the survey. BOD_5 at South Bound Brook was highest in the summer months as measurements fluctuated around the 5.0 mg/l level. The elevated BOD_5 levels at Perth Amboy, did appear to adversely affect dissolved oxygen concentrations, which contravened the minimum criterion of 4.0 mg/l during the summer months.

Fecal coliform concentrations were frequently high at Raritan, Manville and Perth Amboy, but were generally more extreme (5,000 + MPN/100 ml) at Victory Bridge. The estuarine fecal coliform levels may have resulted from a combination of upstream sources compounded by tidal activity dispersing waters from New York Harbor.

No total dissolved solids problems were indicated from the levels measured at the freshwater stations, except at South Bound Brook when in mid-1978 two TDS values reached 500 mg/l or greater and exceeded the standard. The pH values at each station fluctuated between neutral and slightly alkaline, particularly at Raritan.

Generally moderate to high nutrient enrichment was exhibited in the lower Raritan River. Total phosphorus standard contraventions were relatively frequent at Raritan (39 percent) but persistently higher levels may have been precluded by the assimilation of at least some of the phosphorus by the dense macrophyte and algal communities in portions of the lower Raritan. The Raritan station exhibited a trend of increasing total phosphorus concentrations with levels reaching 0.3 mg/l as well as periodic elevations of nitrate + nitrite nitrogen. Total phosphorus at Manville also exceeded the standard a number of times from 1979 to 1981. Concentrations as high as .44 mg/l occurred in July, 1979. Nitrate + nitrite levels were uniformly under 2.0 mg/l over the period at Manville, with total ammonia and un-ionized ammonia at non-problematic readings during 1977-1981. Nutrients in the Raritan at South Bound Brook were frequently excessive, especially total and un-ionized ammonia and total phosphorus. Total phosphorus readings, frequently at the .50 mg/l level, were for the most part above the .10 mg/l standard during the 1977 to 1981 period. The extreme total phosphorus value was .85 mg/l in early 1981. Although no trend was observed from 1977 to 1981, un-ionized ammonia concentrations exceeded 150 ug/l five times during this period, with conditions most severe during late spring and summer months. The Victory Bridge station at Perth Amboy experienced a general decline in both total and un-ionized ammonia.

The Raritan River has generally the same water quality now as it did in the mid to late 1970s. This conclusion is based on a comparison of the assessment above with assessments in earlier 305(b) reports. Some slight trends were noted, however. The river at Raritan appears to have somewhat higher total phosphorus levels, while at Manville dissolved oxygen has shown moderate increases. At the mouth of the Raritan River, total and un-ionized ammonia concentrations have shown reductions.

Toxic Parameters

Samples of aquatic organisms have been collected along the Raritan River mainstem at ten locations from Bound Brook to the confluence with Raritan Bay. Sampling, which began in 1975, includes various resident species and anadromous species. Samples collected at the Bound Brook region downstream to Fieldville Dam were composed predominantly of freshwater and anadromous species. Samples taken below Fieldsville Dam to the confluence with Raritan Bay contained mainly estuarine species.

Trace or high levels of PCB Arochlor 1254 have been recorded in virtually all of the tissue samples examined. This has resulted in the advisory mentioned above. Elevated results were found in 1977 for several species collected near Kin Buc Landfill. These samples include species that are considered commercially or recreationally significant and include white perch, Morone americana, striped bass, Morone saxatilis, and American eel, Angullia rostrata. Sample collection from this location was repeated in 1979 - 1980 with results similar to those previously obtained. In addition, samples of striped bass and American eel analyzed for various organochlorine pesticides were found to contain levels near the allowable limits established for pesticides in fish tissue used for human consumption. Continued sampling may provide useful information concerning the extent of resource contamination within this river section.

Tissue samples collected in 1978 along the Raritan River at New Brunswick were analyzed for various heavy metals. Results show trace levels of both mercury and arsenic and low concentrations of zinc and copper. These results appear to be consistent with samples taken from similar waterways throughout the State. Occasional cadmium, lead, and nickel results also appeared in the forage species mummichog, Fundulus hetroclitus, and golden shiner, Notemigonus crysoleucas. Generally, no significant levels of heavy metals were found in the aquatic organisms collected from this location.

The mainstem Raritan River from the confluence of the North Branch and South Branch Raritan to Raritan Bay has also received much attention by OCTSR with regard to sampling for toxic pollutants in the water column. The water quality of this portion of the Raritan River basin has been a major concern of the NJDEP for several reasons including its use for potable water, and because it feeds Raritan Bay, which contains a heavily utilized fisheries resource.

The overall assessment for toxics in the mainstem Raritan River is divided into two segments; the nontidal portion, downstream to the Fieldsville Dam, and the tidal segment from the Fieldsville Dam to the mouth of the Raritan River.

The nontidal stretch of the Raritan River has been sampled at numerous locations by OCTSR between 1978 and the present. Nine of these sites are chosen as representative sampling areas in this assessment. The sites chosen represent a variety of surrounding land uses ranging from undeveloped land at Duke's Island Park (site #1) to the heavily developed suburban areas of Bound Brook. In addition to the nine sites discussed, all major tributaries to the Raritan have been sampled, as well as the effluents of sixteen industrial or sewage treatment plants which discharge to tributaries or the mainstem of the Raritan River.

The results of sampling the nine sites on the mainstem of the Raritan River indicate the presence of low concentrations of several volatile organic compounds in the water column. Sediment results show the presence of heavy metals reflecting concentrations common in the sediments of New Jersey surface waters. Very low concentrations of several persistant pesticides were also detected in sediment samples collected along the Raritan.

(The detection of low concentrations of pesticides in surface water sediments also appears to be common in New Jersey waters.) In general, the water quality of the mainstem of the Raritan, with regard to toxics, was comparable to other surface waters throughout the State which flow through developed areas.

However, the data generated by sampling point source discharges in the Raritan River basin has shown a different profile of water quality. Many of the point sources sampled contained toxic pollutants, primarily volatile organic compounds (degreasers, solvents); although some discharges also contained heavy metals, polynuclear aromatic hydrocarbons, or pesticides. The concentrations of pollutants detected often exceeded 1000 ug/l indicating some serious problems in localized portions of the lower Raritan River basin. The fact that toxic pollutants were detected near various sources but not necessarily in the mainstem of the Raritan indicates the dynamic state of environmental contaminants and possibly the effects of dilution. Many of the volatile compounds escape from aquatic systems under turbulent conditions, and other compounds such as heavy metals and pesticides can adsorb onto, or form complexes with organic or inorganic materials and settle into the sediments. These sediments can later be transported downstream during periods of high flow.

A study of sedimentology in the mainstem Raritan above the Fieldsville Dam, funded by OCTSR, has provided interesting data on the channel characteristics and distribution of sediments in the river. In general, the mainstem Raritan above the Fieldsville dam is considered erosional, the river channel consists largely of bedrock with small pockets of coarse grained sandy sediments. Therefore, sediments entering the mainstem Raritan from tributary streams are transported downstream to areas where deposition can occur. The low concentrations of heavy metals collected from sediments in this stretch are probably a reflection of sediment characteristics and lack of sediment deposition and accumulation.

Other studies which OCTSR is currently conducting in the mainstem Raritan above Fieldsville Dam are related to the sublethal effects of toxic pollutants on aquatic organisms. Three inter-related research projects are ongoing in an attempt to develop an early warning biological monitoring system. By studying the sublethal effects of toxics on aquatic organisms it may be possible to detect contaminant related stress at very low pollutant concentrations, as well as beginning to understand the effects of several pollutants occurring together under natural conditions.

Problem Assessment

Water quality in this segment varies from marginal to poor. Generally, the quality of the river decreases in a downstream direction. Water quality problems include fecal coliform, dissolved solids, nutrients, BOD and un-ionized ammonia. Excessive bacteria concentrations have caused the complete closure of shellfish harvesting waters in the Raritan River and the majority of waters in Raritan Bay, while elevated PCB concentrations in certain fishes has resulted in a fishing advisory in the tidal Raritan River, Raritan Bay and Sandy Hook Bay.

Water quality is in great part affected by the presence of numerous point source dischargers to the river and bay. Also affecting water quality are the following factors, as compiled by the Lower Raritan/Middlesex County WQM Planning Program: Land use encroachment, erosion and sedimentation, urban runoff, combined sewer discharges, (New Brunswick and Perth Amboy) and landfill leachate (e.g., Edison Municipal, Industrial Land Reclaiming, Kin-Buc, Edgeboro).

There are several sewage treatment plants which are providing only primary treatment and are discharging to Raritan Bay. These plants are impacting the bay with loadings of BOD and suspended solids; and each is under enforcement action. The plants include: the Morgan and Melrose sewage treatment plants in Sayreville Borough, the South Amboy Sewage Treatment Plant, the City of Perth Amboy Sewage Treatment Plant, and the Lawrence Harbor plant.

In addition, there are enforcement actions against the American Cyanamid Company in Bridgewater Township (organics in ground water), Blue Spruce International in Bound Brook Borough (pesticides), Conrail in Raritan Borough (oil, grease, turbidity and total suspended solids) and National Metal Finishings in Bound Brook Borough (volatile organics).

Goal Assessment and Recommendations

The waters of the Raritan River are not of swimmable quality due to the frequency in which fecal coliform levels exceeded 200 MPN/100 ml. The waters above New Brunswick are fishable despite some samples with dissolved oxygen, pH and un-ionized ammonia levels which contravened the standards. However, the Raritan River below New Brunswick and all of Raritan Bay and Sandy Hook Bay are not considered fishable because of PCB contamination in certain common anadromous fishes found in these waters. The fish diversity was fairly high as twenty-nine species, including trout, have reportedly been found in the Raritan River.

It is recommended that stormwater runoff controls, (especially in localities along Ambrose, Green, Stony and Bound Brooks which are easily prone to flooding), be explored; including the possible adoption of municipal stormwater ordinances. It is also recommended that the primary wastewater treatment plants be upgraded to provide a secondary level of treatment, or eliminated. The feasibility of corrective action to restore the condemned shellfish beds of Raritan Bay to productivity should be studied. In addition, consideration should be given to the feasibility of halting leachate migration from one or more of the landfills in the watershed. Correction of the problem point sources is also needed.

LOWER RARITAN RIVER BASIN STATION LIST

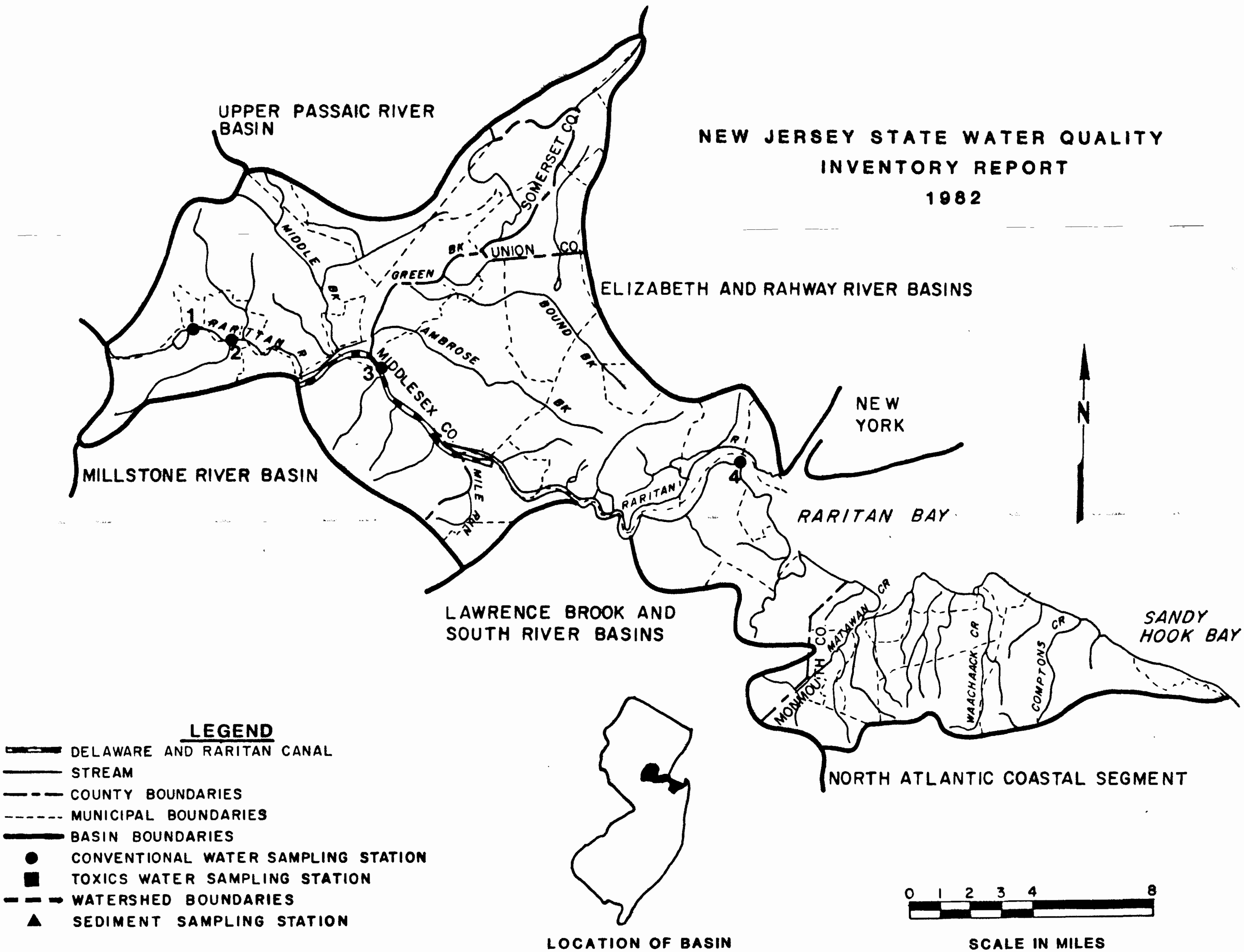
A. Ambient Monitoring Stations

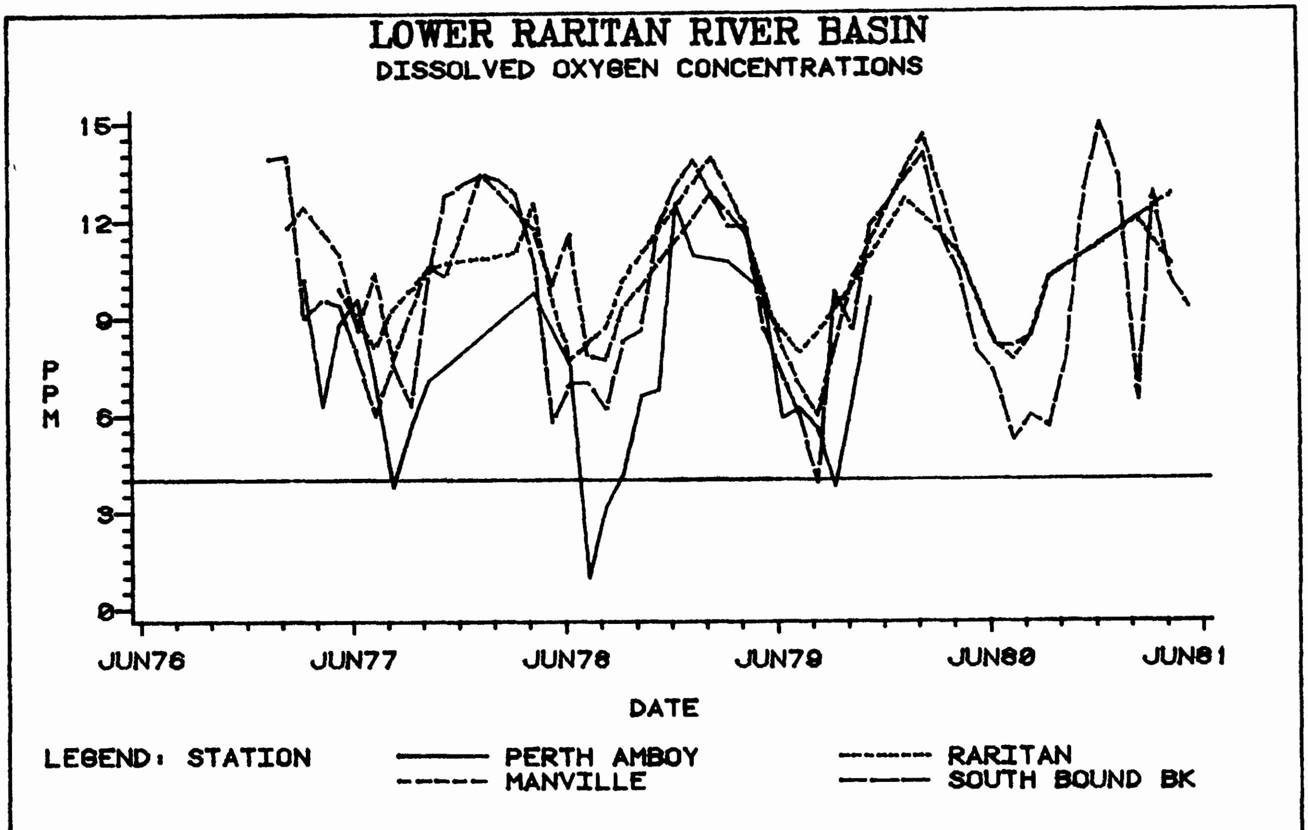
STORET Number	Station Description	Map Number
01400120	Raritan River at Raritan, Somerset County Latitude 40°33'52" Longitude 74°38'10" FW-2 Nontrout USGS/DEP Network At bridge on South Branch - Raritan Road in Raritan	1
01400500	Raritan River at Manville, Somerset County Latitude 40°33'18" Longitude 74°35'02" FW-2 Nontrout USGS/DEP Network On left bank at downstream side of highway bridge at Manville	2
01404100	Raritan River near South Bound Brook, Somerset County Latitude 40°30'47" Longitude 74°32'24" FW-2 Nontrout USGS/DEP Network, National Stream Quality Accounting Network At bridge on Interstate Route 287, 0.2 miles downstream from Fieldsville Dam, and 1.5 miles southeast of South Bound Brook	3
RR-3	Raritan River at Victory Bridge, Perth Amboy Latitude 40°29'45" Longitude 74°16'52" TW-1 Basic Water Monitoring Program At Route 35 (Victory Bridge), 0.5 miles from mouth, adjacent to mouth of Arthur Kill.	4

B. Toxics Monitoring Stations

Sampling Location	Sampling Regime	Map Number
Intensive survey of Raritan Raritan Bay	Water column	-

LOWER RARITAN RIVER





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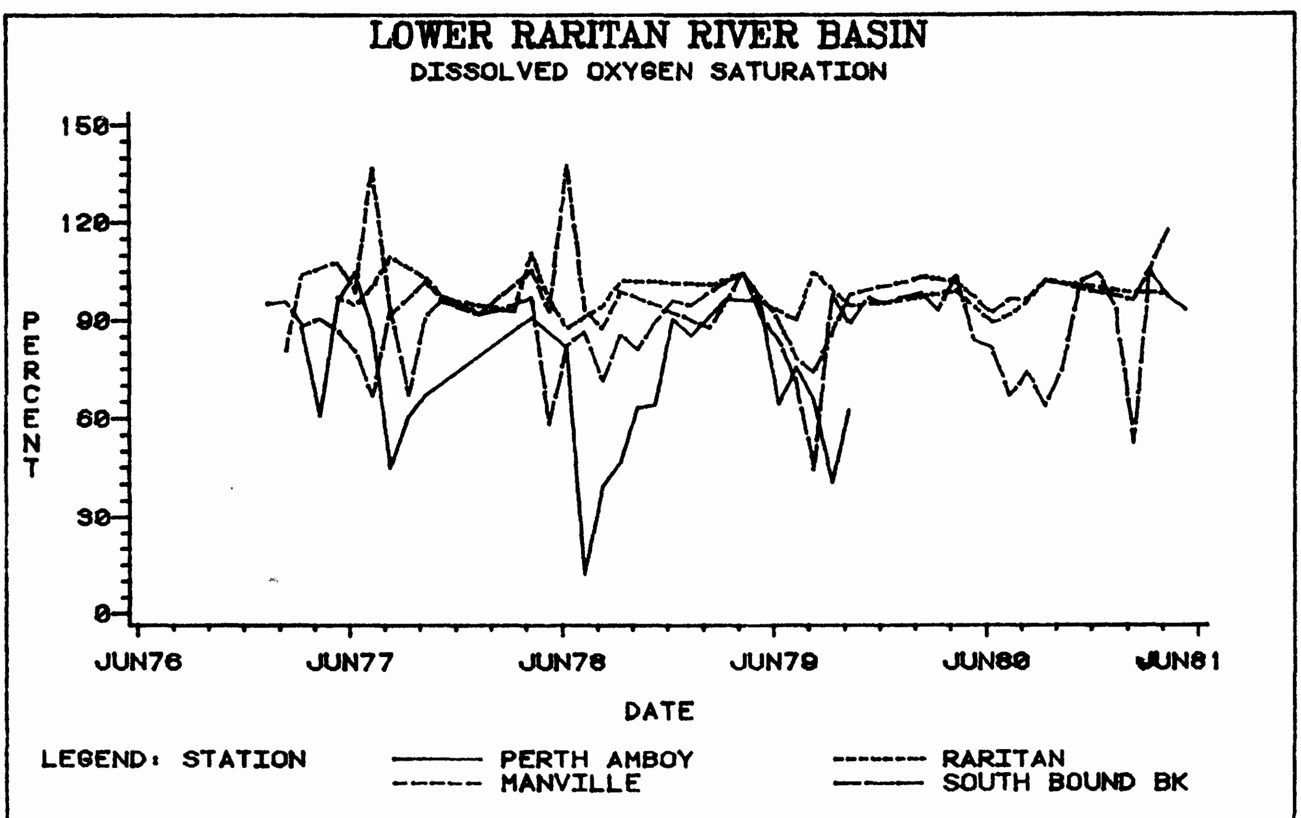

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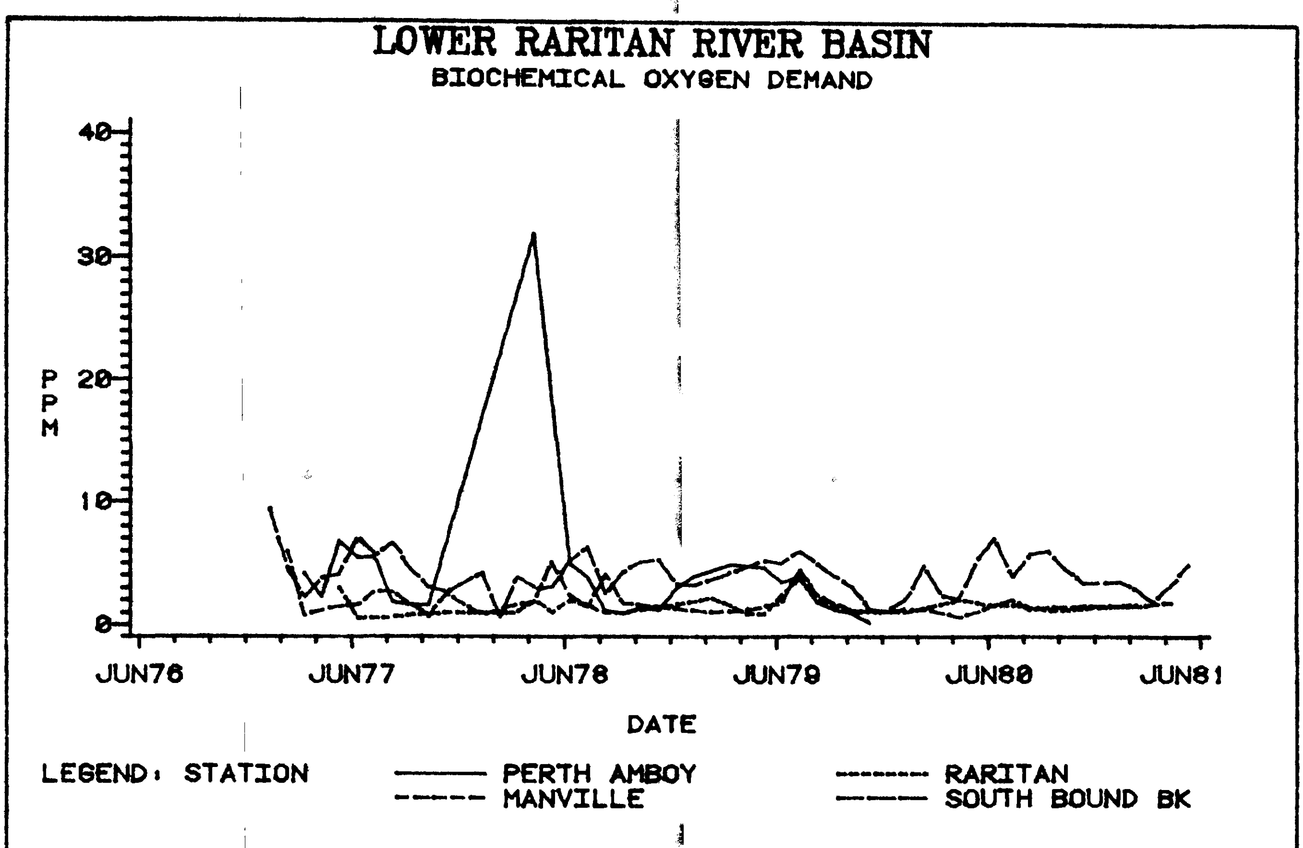

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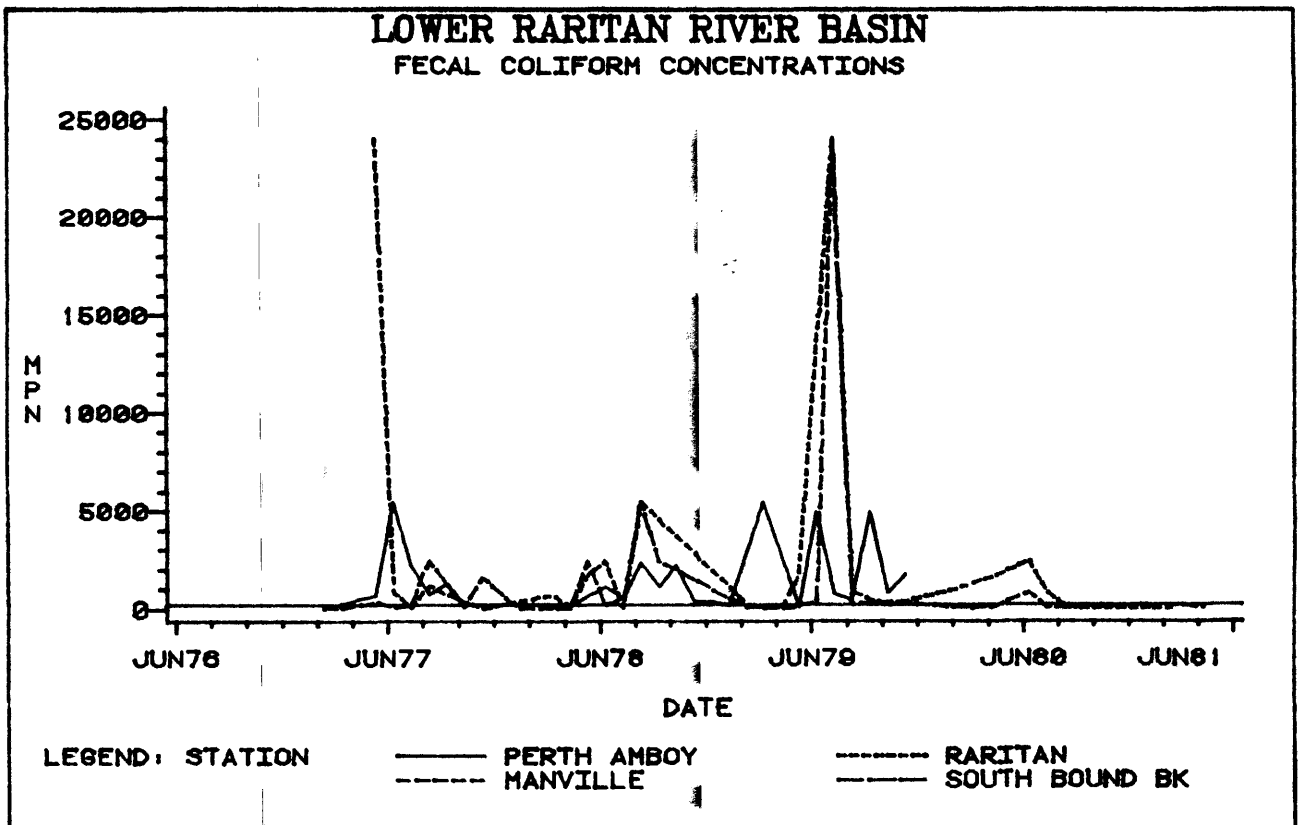

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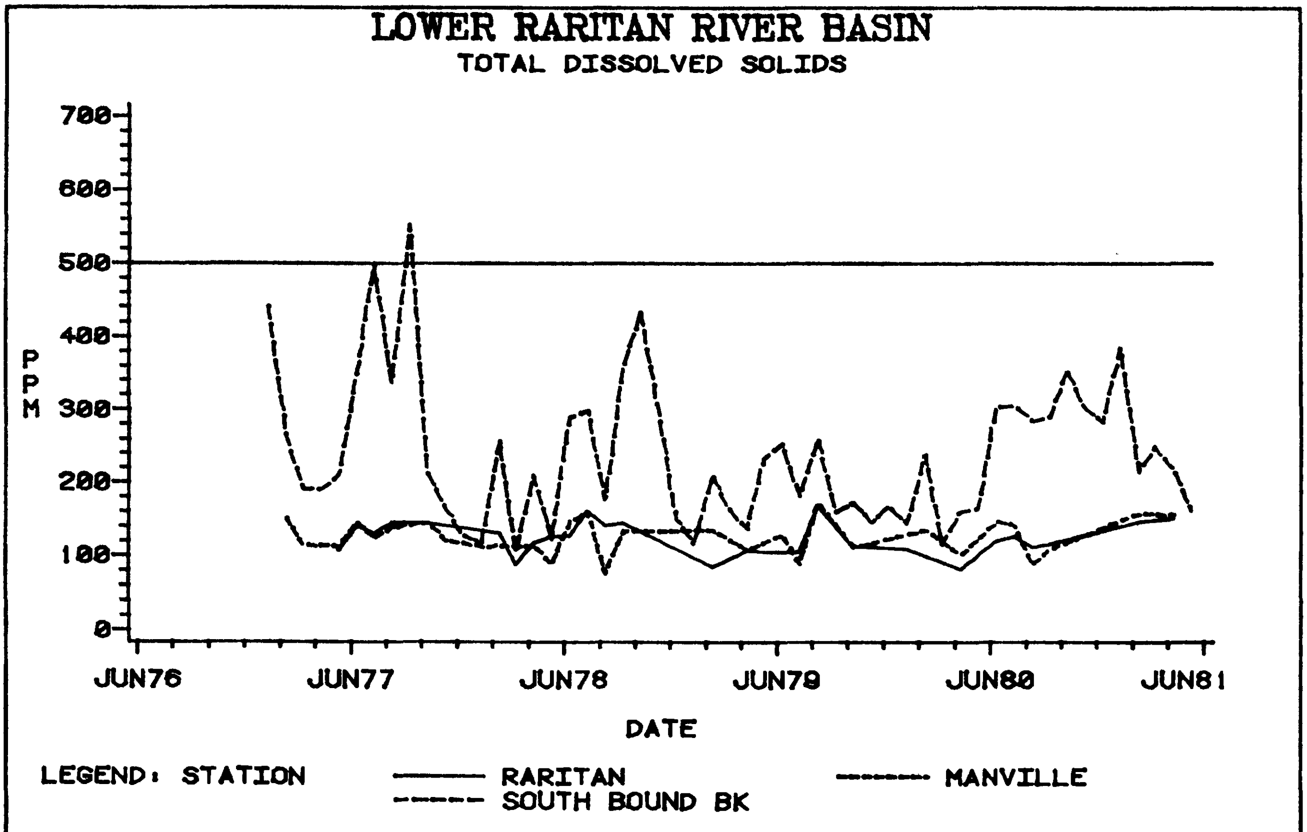

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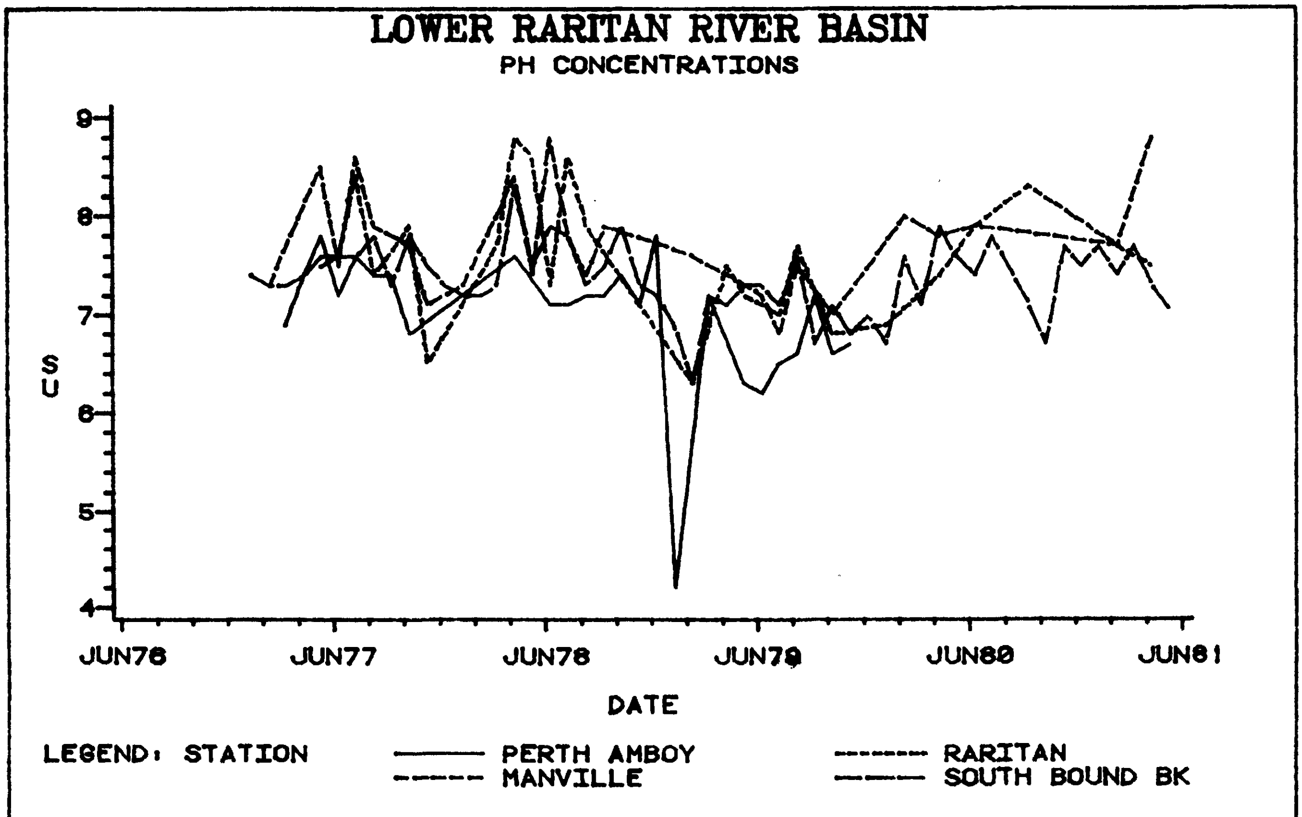

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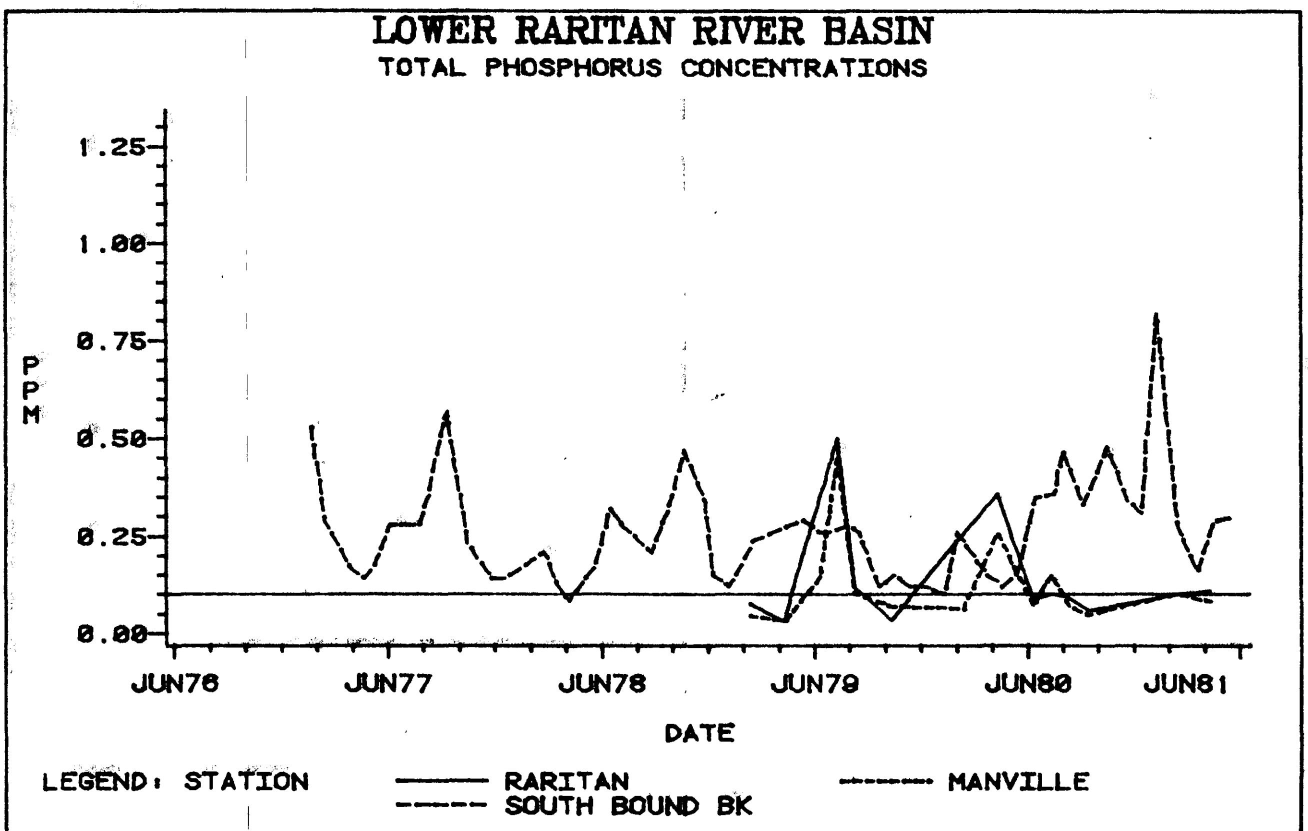

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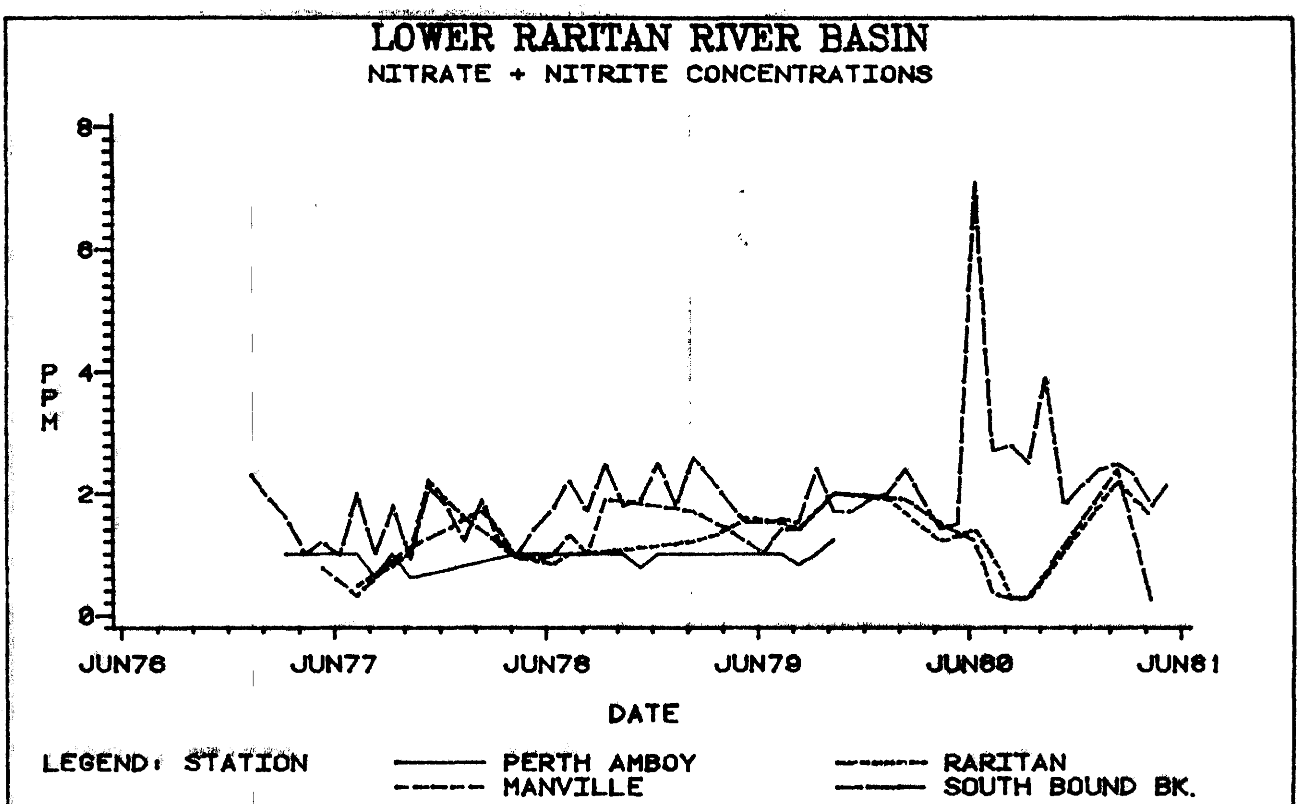

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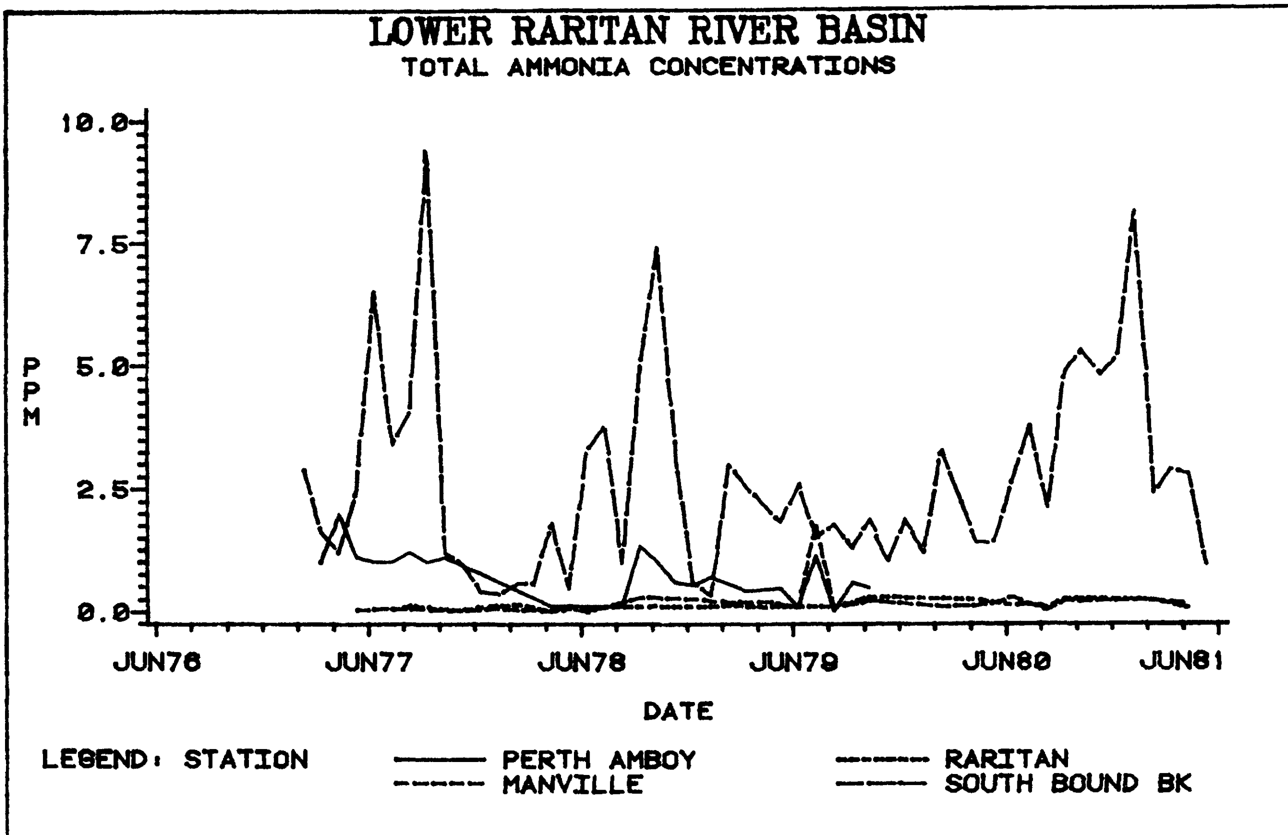

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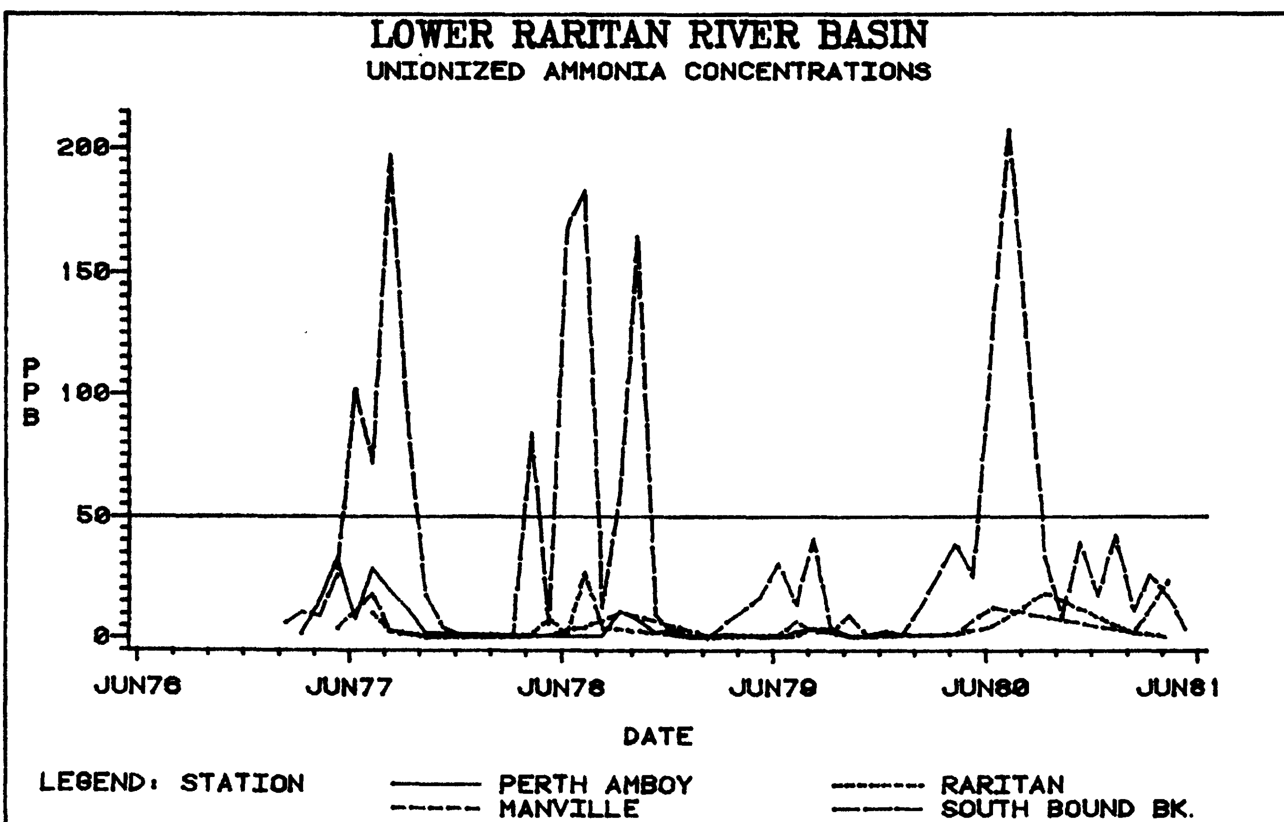


Figure: W -10

DISCHARGE INVENTORY - - - RARITAN RIVER MAINSTEM AND RARITAN BAY DRAINAGE BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
NATL STARCH & CHEMICAL CORP	0001333	BRIDGEWATER	GREEN BROOK	COOLING WATER	
FANWOOD CRUSHED STONE CO	0001228	WESTFIELD/TOWN	GREEN BROOK		
ZAPPA RESEARCH MOLDING CORP	0030309	GREEN BROOK	GREEN BROOK RIVER	PROCESS WASTE	.15
ACADEMY DIE CASTING	0034495	EDISON	AMBROSE BROOK		
INMONT CORPORATION	0033545	MIDDLESEX	AMBROSE BROOK	COOLING WATER	
AIR PRODUCTS & CHEMICALS	0002186	MIDDLESEX BORO	AMBROSE BROOK	COOLING WATER	
CAPTIVE PLASTICS INC	0030571	PISCATAWAY	AMBROSE BROOK	COOLING WATER	.01
EVANS PARTNERSHIP	0033723	PISCATAWAY	AMBROSE BROOK		
NATIONAL CAN CORPORATION	0031143	PISCATAWAY	AMBROSE BROOK	COOLING WATER	.07
REVLON INC	0033073	EDISON	BOUND BROOK		
MOBIL CHEMICAL CO.	0026255	EDISON TWP	BOUND BROOK		
EASTERN STEEL BARREL CORP	0034797	PISCATAWAY	BOUND BROOK		
PARKWAY PLASTICS INC	0032042	PISCATAWAY	BOUND BROOK	COOLING WATER	.01
DESIGN & MOLDING SERVICES INC.	0029629	PISCATAWAY TWP	BOUND BROOK	PROCESS WASTE	
KENTILE FLOORS-SO.PLAINFIELD	0030023	SO PLAINFIELD	BOUND BROOK	PROCESS & COOL.	.30
SCIENTIFIC GAS PRODUCTS INC	0033707	SO PLAINFIELD	BOUND BROOK		
GAILSTYN-SUTTON	0033243	SOUTH PLAINFIELD	BOUND BROOK	COOLING WATER	
MANCRETE INC	0032328	SOMERVILLE	CHAMBERS BROOK		
BOROUGH OF MANVILLE	0028762	MANVILLE BORO	CONFLUENCE RARITAN & MILLSTONE	SANITARY	1.26
RANDEF INTERNATIONAL PROD. INC	0032859	NORTH PLAINFIELD	CRAB CREEK		
UNION CARBIDE CORP-LINDE DIV.	0000175	WOODBRIDGE TWP.	CROWS MILL CR		
SOMERSET RARITAN VALLEY S.A.	0024864	BRIDGEWATER TWP	CUCKEL'S BR.	SANITARY	7.47
TINGLEY RUBBER CORPORATION	0020672	SOUTH PLAINFIELD	DISMAL SWAMP	SANITARY	
DOCK WATCH QUARRY PIT INC	0020095	BRIDGEWATER TWP	DOCK WATCH HOLLOW BROOK		
L A DREYFUS CO	0001210	SO. PLAINFIELD BORO	DRAINAGE DITCH TO BOUND BROOK	COOLING WATER	.33
STC CORP HILLSBOROUGH	0034045	HILLSBOROUGH TWP	DUKES BROOK		
CRESTLINE DIV OF N A PRODUCTS	0029921	RARITAN BORO	GASTON AVE BROOK		.03
NEW JERSEY TRANSIT CORP	0023914	RARITAN BORO	GASTON BROOK	PROCESS WASTE	
JOHNS MANVILLE SALES CORP	0033090	EDISON	KAREN PLACE BROOK	COOLING WATER	.08
SAINT BERNARDS CHURCH	0020991	BRIDGEWATER TWP	LOCHIEL CREEK	SANITARY	
KIN BUC INC	0034355	EDISON	MARTIN'S CREEK		
STABILIZED PIGMENTS INC	0032344	EDISON	MARTIN'S CREEK		
TOWNSHIP OF WARREN SEW AUTH	0023761	WARREN /TWP/	MIDDLE BR.	SANITARY	.01
TOWNSHIP OF WARREN SEW AUTH	0023752	WARREN /TWP/	MIDDLE BR.	SANITARY	.03
GAF CORPORATION	0021806	BRIDGEWATER TWP	MIDDLE BROOK	PROCESS WASTE	.07
STAVOLA CONSTRUCTIONS MATERIAL	0002895	BRIDGEWATER TWP	MIDDLE BROOK		.02
CONDREN CORPORATION	0032760	NORTH BRUNSWICK	MILE RUN	COOLING WATER	.01
UNITED STEEL CONTAINER CORP	0032034	NORTH BRUNSWICK	MILE RUN	COOLING WATER	
DELCO REMY DIVISION G M C	0030392	NEW BRUNSWICK	MILE RUN BROOK		
LUMMUS COMPANY	0027391	NEW BRUNSWICK	MILE RUN BROOK	PROCESS WASTE	.01
OXFORD DIVISION HARTFORD	0032557	NEW BRUNSWICK	MILE RUN BROOK	PROCESS WASTE	
RHONE POULENC INC	0000060	NEW BRUNSWICK/CITY	MILE RUN BROOK	COOLING WATER	
TRIANGLE CONDUIT & CABLE CO	0000558	NEW BURNSWICK/CITY	MILE RUN BROOK	PROCESS WASTE	.30
EDISON TWP/DIV. OF WATER	0031941	EDISON	MILLBROOK		
BD OF ED-BRIDGEWATER VALL. SCH	0029823	BRIDGEWATER TWP	PETER'S BROOK	SANITARY	
ETHICON INC	0001139	BRIDGEWATER TWP	PETERS BROOK	COOLING WATER	
SOMERSET COUNTY SHOPPING CTR.	0027324	BRIDGEWATER TWP	PETERS BROOK	SANITARY	
DEVRO INC	0001961	SOMERVILLE BORO	PETERS BROOK	PROCESS WASTE	
RONNIE PACKAGING CO	0034886	SOUTH PLAINFIELD	RAINWATER DITCH		
INDUSTRIAL TUBE CORPORATION	0023019	SOMERVILLE BORO	RARITAN RIVER TRIB	COOLING WATER	
E I DU PONT DE NEMOURS & CO	0000167	SAYREVILLE BORO	SELOVER CREEK	PROCESS & COOL.	2.40

DISCHARGE INVENTORY - - - RARITAN RIVER MAINSTEM AND RARITAN BAY DRAINAGE BASIN

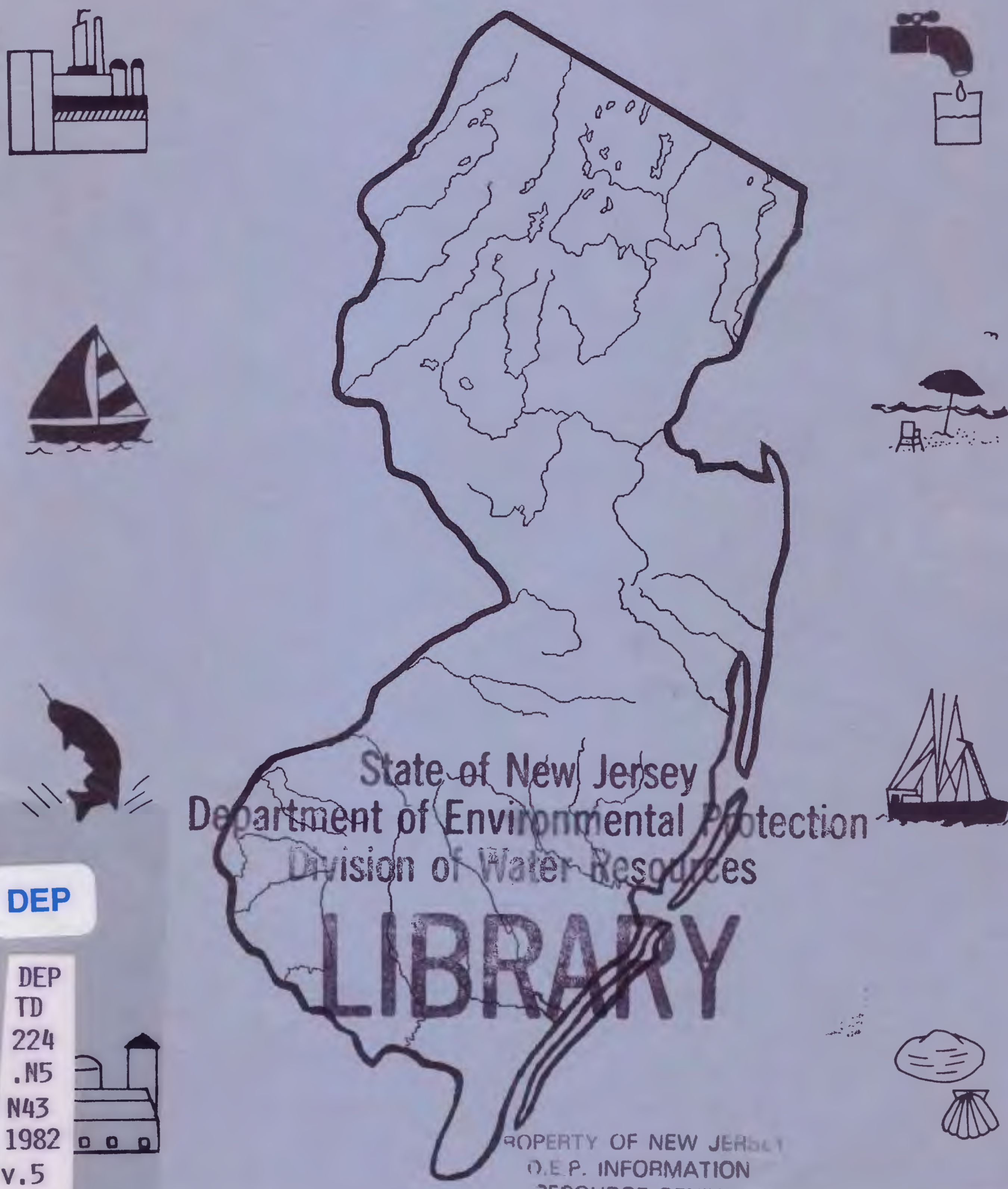
DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
FOLEY MACHINERY INC	0000043	PISCATAWAY TWP	SEWER TO AMBROS	COOLING WATER	
GULTON INDUSTRIES, INC.	0028720	METUCHEN BORO	STORM CREEK FLOWING INTO RARIT	PROCESS WASTE	.03
CONTINENTAL CORRUGATED CONT CO	0033324	DUNNELLEN	STORM SEWER TO GREEN BROOK	COOLING WATER	
RARITAN RIVER STEEL CO.	0031178	PERTH AMBOY	STORM SEWER TO RARITAN RIVER		
UNION STEEL CORP.	0001015	PISCATAWAY	TRIB OF RARITAN RIVER	SANITARY	
BELL TELEPHONE LABS	0000442	MURRAY HILL	TRIBUTARY GREEN BROOK		
SAYTECH INC	0031470	SAYREVILLE	TRIBUTARY TO BURTS CREEK		
MARISOL INC	0032301	MIDDLESEX	TRIBUTARY TO RARITAN RIVER	COOLING WATER	
REAGENT CHEMICAL &RESEARCH INC	0033251	MIDDLESEX	TRIBUTARY TO RARITAN RIVER	COOLING WATER	
COASTAL OIL COMPANY	0027863	SO. PLAINFIELD BORO	UNNAMED DITCH		
COLORGUARD CORPORATION	0033111	RARITAN	WOODMERE BROOK		
NATIONAL STARCH & CHEM. CORP.	0032506	BRIDGEWATER	RARITAN RIVER	COOLING WATER	
RESEARCH COTTRELL	0029904	BRIDGEWATER	RARITAN RIVER		
AMERICAN CYANAMID CO.	0002313	BRIDGEWATER TWP	RARITAN RIVER	PROCESS & COOL.	
ELIZABETHTOWN WATER CO.	0000965	BRIDGEWATER TWP	RARITAN RIVER		
RCA CORP SOLID STATE PLANT	0002569	BRIDGEWATER TWP	RARITAN RIVER	PROCESS & SANIT	
ITT CONTINENTAL BAKING CO	0034088	EAST BRUNSWICK	RARITAN RIVER		
VALVOLINE OIL CO	0030503	EDISON	RARITAN RIVER		
PUBLIC SERVICE ELEC & GAS	0000582	EDISON /TWP/	RARITAN RIVER		
PUBLIC SERVICE ELEC & GAS EDIS	0003603	EDISON /TWP/	RARITAN RIVER	SANITARY	
TENNECO PLASTICS	0001791	EDISON /TWP/	RARITAN RIVER		
SUMMIT RESEARCH LABS INC	0030279	FRANKLIN TWP	RARITAN RIVER	COOLING WATER	
WILSON PROD CO DIV DART IND	0003051	HILLSBOROUGH TWP.	RARITAN RIVER		
JOHNS-MANVILLE PROD CORP	0001678	MANVILLE BORO	RARITAN RIVER	COOLING WATER	
REAGENT CHEMICAL & RESEARCH IN	0033791	MIDDLESEX	RARITAN RIVER	COOLING WATER	
CITY OF NEW BRUNSWICK	0033219	NEW BRUNSWICK	RARITAN RIVER		
MIDDLESEX COUNTY	0028835	NEW BRUNSWICK CITY	RARITAN RIVER	SANITARY	
WELDON CONCRETE	0000345	PERTH AMBOY CITY	RARITAN RIVER	PROCESS & COOL.	
CHESEBROUGH-PONDS CORP.	0002381	PERTH AMBOY/CITY	RARITAN RIVER	PROCESS & COOL.	
CITY OF PERTH AMBOY	0023213	PERTH AMBOY/CITY	RARITAN RIVER	SAN/SIG INDUS	
RESERVE TERMINAL CORP	0001392	PERTH AMBOY/CITY	RARITAN RIVER	RUNOFF OIL & GR	
BEECHAM LABORATORIES	0035491	PISCATAWAY	RARITAN RIVER		
ENVIRON. SAFETY&SER SPECIALIST	0025798	PISCATAWAY TWP	RARITAN RIVER		
UNION CARBIDE CORP.	0000256	PISCATAWAY TWP	RARITAN RIVER	PROCESS & COOL.	
ATLANTIC RESOURCES CORP	0035734	SAYREVILLE	RARITAN RIVER		
JERSEY CENTRAL POWER & LIGHT	0002747	SAYREVILLE BORO	RARITAN RIVER	PROCESS WASTE	
NL INDUSTRIES	0000931	SAYREVILLE BORO	RARITAN RIVER	PROCESS & COOL.	
OLIVETTI CORP. OF AMERICA	0032581	SOMERVILLE	RARITAN RIVER	COOLING WATER	
TAYLOR OIL COMPANY	0029271	SOMERVILLE	RARITAN RIVER		
JERSEY CENTRAL POWER & LIGHT	0002755	SOUTH AMBOY/CITY	RARITAN RIVER		
SILVATRIM CORP OF AMERICA	0030881	SOUTH PLAINFIELD	RARITAN RIVER	PROCESS WASTE	
STONY BROOK OF WATCHUNG	0026727	WATCHUNG	RARITAN RIVER	SANITARY	
CARBORUNDUM CO.	0002950	WOODBRIDGE TWP	RARITAN RIVER	COOLING & SANIT	
INTERMEDIATES DIV-TENN. CHEM.	0000116	WOODBRIDGE TWP	RARITAN RIVER	PROCESS & COOL.	
TOWNSHIP OF WOODBRIDGE	0020401	WOODBRIDGE TWP	RARITAN RIVER	SAN/SIG INDUS	
JEFFCO INDUSTRIES INC	0035165	MIDDLESEX	NONE		
ESSEX CHEMICAL CORP.	0003093	SAYREVILLE	DITCH TO BURT C	COOLING WATER	
NEW JERSEY STEEL & STRUCTURAL	0030147	SAYREVILLE	ARRARAT CREEK		
FORD MOTOR CO.-METUCHEN ASS.PL	0002691	EDISON /TWP/	MILL BROOK	PROCESS & COOL.	.24
MIDDLESEX WATER CO.	0002992	EDISON /TWP/	MILL BROOK	PROCESS WASTE	.00
BEST BLOCK CO INC	0026069	EDISON TWP	MILL BROOK	PROCESS & COOL.	
METZ METALLURGICAL CORP	0034835	SO PLAINFIELD	MIDDLESEX COUNTY		
L&L OIL SERVICE INC	0034631	MATAWAN	NONE LISTED		
U.S.E.P.A.KIN.BUC LANDFILL	0035858	EDISON	EDMONDS CREEK		
IMPERIAL OIL CO. INC.	0035874	MARLBORO TOWNSHIP	LAKE LEFFERTS		

DISCHARGE INVENTORY - - - RARITAN RIVER MAINSTEM AND RARITAN BAY DRAINAGE BASIN

U.S. E.P.A.- EDISON LANDFILL	0035866 EDISON	RARITAN RIVER		
CARVEL 750	0029980 BELFORD	COMPTON'S CREEK	PROCESS WASTE	1.90
OWENS-ILLINOIS INC.	0001775 HOLMDEL TWP	DITCH TO MAHORA		
WEST KEANSBURG WATER CO.	0025453 HAZLET /TWP/	EAST CREEK		.04
WEST KEANSBURG WATER CO.	0025461 HOLMDEL TWP	EAST CREEK		.07
THE WINDMILL CLUB ASSOCIATION	0026646 MATAWAN	GROUND HOG BROOK	SANITARY	
BOROUGH OF UNION BEACH W.D.	0025437 UNION BEACH BORO	LITTLE CREEK		.05
MIDLAND GLASS COMPANY INC	0033651 CLIFFWOOD	LONG NECK CREEK	COOLING WATER	.10
MIDLAND GLASS CO INC	0030651 MATAWAN	LONG NECK CREEK	PROCESS WASTE	.00
BIDDLE SAWYER INC	0030872 KEYPORT	LUPATACONG CREEK	COOLING WATER	
BOROUGH OF ATLANTIC HIGHLANDS	0034924 ATLANTIC HIGHLANDS	MANY MIND CREEK		
ABERDEEN TWP MUA	0022829 ABERDEEN	MATAWAN CREEK	SANITARY	.20
ABERDEEN TOWNSHIP MUA	0022543 MATAWAN /TWP/	MOHINGSON CR.	SANITARY	.69
OLD BRIDGE MUA LAURENCE HARBOR	0033057 LAWRENCE HARBOR	RARITAN BAY		
OLD BRIDGE TWP S.A	0022471 MADISON TWP	RARITAN BAY	SANITARY	.70
OLD BRIDGE MUA BROWNTOWN	0033065 OLD BRIDGE	RARITAN BAY		
BOROUGH OF SAYREVILLE	0023833 SAYREVILLE BORO	RARITAN BAY	SANITARY	
BOROUGH OF SAYREVILLE	0023825 SAYREVILLE BORO	RARITAN BAY	SANITARY	.23
BOROUGH OF SAYREVILLE	0023833 SAYREVILLE BORO	RARITAN BAY	SANITARY	
MIDDLESEX CN'TY SEW. AUTH.	0020141 SAYREVILLE BORO	RARITAN BAY	SAN/SIG INDUS	83.00
CITY OF SOUTH AMBOY DPW-STP	0020541 SOUTH AMBOY/CITY	RARITAN BAY	SANITARY	.60
CITY OF SOUTH AMBOY-WTP	0003913 SOUTH AMBOY/CITY	RARITAN BAY	SANITARY	.04
JERSEY CENTRAL POWER & LIGHT	0003981 UNION BEACH BORO	RARITAN BAY		
MCCONNELL FUEL OIL CO	0000868 ATLANTIC HIGHLANDS	SANDY HOOK BAY	RUNOFF OIL & GR	.00
BOROUGH OF ATLANTIC HIGHLANDS	0025402 ATLANTIC HIGHLANDS B	SANDY HOOK BAY	SANITARY	.40
US EPA OFFICE R&M	0005762 LEONARDO	SANDY HOOK BAY		1.30
SEACOAST PRODUCTS INC	0000779 MIDDLETOWN TWP	SANDY HOOK BAY	COOLING WATER	2.06
ABERDEEN TOWNSHIP MUA	0022535 MATAWAN TWP	WHALE CR.	SANITARY	.48
ABERDEEN TOWNSHIP MUN UTLITIES	0034142 MONMOUTH	WILKSON CREEK		
PRECISION CASTING CO.	0033294 MIDDLETOWN TWNSHP	WRACKAACK CREEK		

New Jersey 1982
State Water Quality Inventory Report

Appendix–Northeast New Jersey Waters



New Jersey Department of Environmental Protection ▪ Division of Water Resources

NEW JERSEY 1982 STATE WATER QUALITY INVENTORY REPORT

APPENDIX - NORTHEAST NEW JERSEY WATERS

A REPORT ON THE STATUS OF WATER QUALITY IN NEW JERSEY
PURSUANT TO THE NEW JERSEY WATER POLLUTION CONTROL
ACT AND SECTION 305(b) OF THE FEDERAL CLEAN WATER ACT

WATER RESOURCES REPORT 39-C: 1.D

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June, 1983

APPENDIX 1 - WATER QUALITY INVENTORY

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APPENDIX 1-D

WATER QUALITY INVENTORY

NORTHEAST NEW JERSEY WATERS
Includes the Passaic, Hackensack, Elizabeth and Rahway River Basins, and Interstate Sanitation Commission Waters

INTRODUCTION

This appendix contains a review of surface water quality in New Jersey's rivers, streams, coastal bays and lakes. This water quality review represents the biennial assessment of the State's waters as required by Section 305(b) of the federal Clean Water Act. For the 1982 305(b) report the State has been divided into 31 segments (Table 1-i) that are generally either single or grouped watersheds. The breakdown of the State into these segments is also similar to the segments used in prior New Jersey 305(b) reports, and therefore, allows comparison of water quality in a segment from one reporting period to the next. All segments were analyzed for water quality by the NJ Department of Environmental Protection with the exception of segments "DD" (Delaware River Basin) and "EE" (Interstate Sanitation Commission jurisdictional waters) which were prepared by the Delaware River Basin Commission and the Interstate Sanitation Commission, respectively.

The 29 NJDEP-prepared segment analyses contain four written sections, (Basin Description, Water Quality Assessment, Problem Assessment, and Goal Assessment and Recommendations), in addition to a segment map, water quality data charts and a wastewater discharge inventory. Numerous offices throughout NJDEP, and especially the Division of Water Resources, contributed information and or text to the segment analyses. In cooperation with the Bureau of Planning and Standards, DWR, the Bureau of Monitoring and Data Management, DWR, prepared the Water Quality Assessment - Conventional Parameters sub-section and the water quality data charts. Also in the DWR, the Bureau of Industrial Waste Management prepared the discharge inventories based on information in their New Jersey Pollutant Discharge Elimination System (NJPDES) computer files. The Office of Cancer and Toxic Substances Research (OCTSR), NJDEP, wrote the Toxic Parameters subsection for each Water Quality Assessment section. Their review of water column, sediment and fish tissue toxics sampling data represents the first such statewide watershed by watershed analysis since the program began in the mid-1970s. Following below is a description of the four sections that comprise the 29 NJDEP produced segment analyses.

Basin Description

The Basin Description characterizes each segment from a geographical and land use perspective in addition to noting what known surface water uses are present. Water uses identified included diversions of surface waters for potable supplies, agricultural irrigation and industrial processes; monitored swimming locations; fishing opportunities and resources; shellfish harvesting; and other specific uses that may be unique to a region of the State. The sources of information for this

TABLE 1-i SEGMENTS ANALYZED IN THE WATER QUALITY INVENTORY

A. Wallkill River
B. Flat Brook and Paulins Kill
C. Pequest and Musconetcong Rivers
D. Pohatcong and Lopatcong Creeks
E. Delaware River Tributaries - Hunterdon/Mercer Counties
F. Assunpink Creek
G. Crosswicks and Assiscunk Creeks
H. Rancocas Creek
I. Pennsauken Creek, Big Timber Creek and Cooper River
J. Woodbury, Mantua and Raccoon Creeks
K. Oldmans, Salem and Alloways Creek
L. Cohansey and Maurice Rivers
M. Southern Atlantic Coastal Basin - Cape May to Great Bay
N. Great Egg Harbor River
O. Mullica River
P. Mid-Atlantic Coastal Basin - Great Bay to Manasquan Inlet
Q. Manasquan River
R. North Atlantic Coastal Basin - Manasquan Inlet to Sandy Hook
S. North Branch Raritan River
T. South Branch Raritan River
U. Millstone River
V. Lawrence Brook and South River
W. Lower Raritan River Basin
X. Elizabeth and Rahway Rivers
Y. Upper Passaic River - Headwater to Livingston
Z. Mid-Passaic River - Livingston to Little Falls
AA. Mid-Passaic River Tributaries (Whippany, Rockaway, Pequannock, Wanaque, Ramapo and Pompton Rivers)
BB. Lower Passaic River - Little Falls to Newark Bay
CC. Hackensack River
DD. Status Report on the Delaware River
EE. Status Report on Interstate Sanitation Commission Waters

section included a number of different agencies in state, federal and local governments.

In the process of gathering water use data for the 29 segments of the State numerous information deficiencies were found to exist. Formost was the lack of statewide inventories dealing with monitored bathing beaches, and the presence of agricultural and industrial surface water diversions. Since bathing beaches are routinely monitored by local health departments under state guidelines and no statewide reporting requirements have been instituted there exists no regularily updated list of swimming areas found in the State. As a result of this data gap the Bureau of Planning and Standards mailed questionaires to all local health departments in the State requesting a list of bathing beaches and areas under their jurisdiction. The identification of surface water diversions for agricultural, industrial and other purposes is limited to where surface water diversion permits have been issued under the provisions of NJSA 58:1-36 by the State of New Jersey. Only diversions in excess of 70 gallons per minute (gpm) are required to obtain a permit. Therefore, numerous unreported diversions exist across the State which are pumping under 70 gpm. The information deficiencies described above exemplifies the difficulties uncovered while developing the Basin Description. These difficulties point to the need for a more coordinated water resource approach when identifing and understanding water quality problems, so that long-term direct use impacts can be measured.

Water Quality Assessment

The Water Quality Assessment section is a review of surface water quality data collected in a segment from 1977 to 1981. Water quality is analyzed for a group of standard indices (Table 1-ii) in the Conventional Parameters subsection, while known and suspected carcinogenic or toxic substances (Table 1-iii) identified in the segments water bodies are discussed in the Toxic Parameters subsection. In each Conventional Parameters subsection there is a brief review of overall water quality trends which have been found in that segment. This review of trends is a comparison of water quality conditions as described in the 1977 and 1980 305(b) reports against conditions as found today.

The ten conventional parameters reviewed were selected because of their values for indicating pollution, making swimmable and fishable determinations and for compatibility with data reviewed in prior 305(b) reports. These ten parameters were evaluated at 78 monitoring stations throughout the State.

The ambient monitoring stations reviewed in the Conventional Parameters subsection represents approximately one half of the total long-term monitoring stations present in the State. Those stations used were selected on the basis of their location in a

TABLE 1-ii PARAMETERS LIST AND CRITERIA FOR WATER QUALITY ASSESSMENTS - CONVENTIONAL PARAMETERS

Parameter	Criteria Source
1. Dissolved oxygen Concentrations and Saturation	N.J. Water Quality Standards
2. Biochemical oxygen demand (5 day)	N.J. Water Quality Standards Comparison to statewide ambient data
3. Fecal coliform	N.J. Water Quality Standards
4. Total dissolved solids	N.J. Water Quality Standards
5. pH	N.J. Water Quality Standards
6. Total phosphorus	N.J. Water Quality Standards
7. Nitrate + nitrite nitrogen	Quality Criteria for Water, 1976, USEPA National Interim Primary Drinking Water Regulations, 1976, USEPA
8. Total ammonia	Comparison to statewide ambient data
9. Un-ionized ammonia	N.J. Water Quality Standards

TABLE 1-iii TOXIC CHEMICALS ANALYZED IN THE WATER QUALITY ASSESSMENT - TOXIC PARAMETERS

Group 1 - Metals	Lower Analytical Limit ug/l (ppb)	EPA Standard for Drinking Water ug/l (ppb)
Arsenic	1	50
Beryllium	1	-
Cadmium	1	10
Chromium	1	50
Copper	1	1000[a]
Lead	1	50
Nickel	5	-
Selemium	2	10
Zinc	5	5000[a]
Group 2 - Pesticides and Related Compounds		
PCBs	0.06	-
Arochlor 1016	0.06	-
Arochlor 1242	0.06	-
Arochlor 1248	0.01	-
Arochlor 1254	0.01	-
α-BHC	0.01	-
β-BHC	0.01	-
Lindane (γ-BHC)	0.01	4
Heptachlor	0.01	0.1
Heptachlor epoxide	0.01	0.1
Aldrin	0.01	-
Dieldrin	0.01	-
Chlordane	0.01	-
Toxaphene	0.06	5
Methoxychlor	0.08	100
Mirex	0.02	-
Endrin	0.01	0.2
o,p-DDT	0.04	-
p,p'-DDT	0.04	-
o,p-DDE	0.01	-
p,p'-DDD	0.02	-

Group 3 - Low Molecular Weight Halogenated Organics b,c

Methylene chloride	90
Methyl chloride	6.0
Methyl bromide	1.0
Chloroform	0.8
Bromoform	1.0
Trichloroethylene	0.3
1,1,2,2-Tetrachloroethane	0.3
1,1,2-Trichloroethane	1.0
Dibromochloromethane	0.1
Trifluoromethane	0.5
Carbon tetrachloride	0.1
1,2-Dibromoethane	0.1
1,2-Dichloroethane	1.6
1,1,1-Trichloroethane	2.0
Vinyl chloride	0.5
Tetrachloroethylene	0.1
o-Dichlorobenzene	2.2
m-Dichlorobenzene	1.3
p-Dichlorobenzene	1.3
Trichlorobenzene	2.0
Diiodomethane	0.3
Dichlorobromoethane	0.5

a - secondary standards
b - Group 3 tested in water column only, not in sediments and fish tissue
c - Trihalomethanes: The EPA drinking water standard is 100 ppb for total trihalomethanes

watershed, the presence of other stations in the segment, the amount of data collected for each station, the ability of a monitoring station to reflect existing land use and known pollution sources, and the limitations in staffing and support services which prevented the review of all ambient monitoring stations statewide.

The DWR, through the Bureau of Monitoring and Data Management (BMDM) maintains and/or participates in several surface water quality monitoring programs throughout New Jersey. The most extensive program, the Primary Water Quality Monitoring Network, is a cooperative effort involving the BMDM and the United States Geological Survey's Water Resources Division in Trenton, N.J. The network, instituted in 1976, is composed of 135 stations from which samples are collected six times annually. In addition to the routine or conventional water column parameter schedule, a supplemental set of 75 samples is collected biannually from the water column for trace organic and metals analysis, and annually from the sediments at 50 stations. In 1982, the Primary Water Quality Monitoring Network was reduced to approximately 100 stations statewide.

EPA's National Basic Water Monitoring Program (BWMP) is comprised of thirty one stations in New Jersey. Samples are collected monthly at each station. Beginning in January, 1981, a revised parameter schedule was implemented with the approval of EPA Region II, as certain parameters were collected biannually rather than monthly. This change occurred at stations where there was no indication of consistently excessive concentrations of pollutants. These parameters include chemical oxygen demand, chloride, petroleum hydrocarbons, metals and dissolved minerals.

Biomonitoring was also conducted at each of the BWMP stations during the report period. Macroinvertebrate samples were acquired at each station using three Hester-Dendy samplers with the invertebrates later identified and enumerated in the laboratory. Diversity index, percent abundance and equitability of sample population were among the items evaluated. Five replicate periphyton samples were obtained at each station using clean glass slides mounted in a floating sampler, while chlorophyll a concentrations were measured using the acetone extraction method.

In addition, electrofishing and analysis of fish tissue samples for trace metals and pesticides were initiated in 1980 at most of the BWMP stations in New Jersey. The fish were identified and prepared in the BMDM's biological laboratory and then forwarded to the New Jersey Department of Health Laboratory for analysis.

Additional ambient surface water monitoring is conducted by the Ocean County Health Department, the Passaic Valley Water Commission, the Interstate Sanitation Commission, the Delaware River Basin Commission and other agencies throughout the State.

Their data was used in this report when applicable. In the future it is anticipated that many other counties will participate in expanded monitoring activities. Station selection in all monitoring networks were generally in accordance with the criteria cited in the EPA publication entitled Basic Water Monitoring Program (EPA 440/9-76-025, revised May, 1978).

The water quality data used to make each Conventional Parameter assessment is presented in the form of graphs (concentration versus time), and is found in the segment analyses following the text. The graphs show all raw data points collected for the ten parameters from 1977 to mid 1981. Conventional water quality data was compared against New Jersey Surface Water Quality Standards (N.J.A.C. 7:9-4.1 et seq) where applicable for dissolved oxygen concentration and saturation, biochemical oxygen demand (five day), total dissolved solids, pH, total phosphorus and un-ionized ammonia. Table 1-iv present the surface water classification and its appropriate water quality standards. A standard line is used on the water quality graphs for those parameters with standards for comparitive purposes. Although there is a state standard for fecal coliform (for most freshwater the criteria is a geometric average of 200/100 ml, or no more than 10 percent of the total samples taken during any 30 day period exceeding 400/100 ml), the frequency with which fecal coliform samples are collected in current statewide monitoring programs in regarded as not being of sufficient frequency to compare to existing standards.

The Toxic Parameters subsection was provided by the Office of Cancer and Toxic substances Research (OCTSR), NJDEP, specifically for this report. This subsection describes the preliminary results of water column, sediment and fish tissue sampling for toxic and carcinogenic substances in New Jersey's aquatic environment. The surface water monitoring for toxic pollutants began at OCTSR in 1977 when there was practically no background data concerning the occurrence of toxic pollutants in surface waters throughout New Jersey. In addition standardized sampling techniques and methods for analysis had not been defined for determining toxic contamination in water, sediment, and aquatic biota.

The approach taken to generate a data base for toxics in New Jersey's surface waters involved the collection of grab samples of water at various sites throughout the State in accordance with the State Water Quality Management Program surface water studies carried out by NJDEP and designated regional and county agencies. The water column samples were analyzed for all three groups of chemicals shown in the Table 1-iii. As the program progressed, the collection of sediments samples was incorporated at many sites to access the partitioning and accumulation of toxic pollutants in the sediments. Sites usually were sampled once per year, but sites which were found to be contaminated or suspected to receive toxic inputs were sampled at least twice. Sediments and fish tissue were tested for substances in groups 1 and 2 in

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARD (NJDEP, 1981)

	Classification				
Parameter	FW-Lower Mullica and Wading Rivers Central Pine Barrens	FW-Central Pine Barrens	FW-2 Trout Production	FW-2 Trout Maintenance	FW-2 Nontrout
pH (Standard Units)	4.5-6.0	3.5-5.5	6.5-8.5	6.5-8.5	6.5-8.5
5 day Biochemical oxygen demand (mg/l)	Maximum of 5.0 at any time.	Maximum of 5.0 at any time. None which would render the waters unsuitable for the designated uses.			
Dissolved oxygen	No less than 85% saturation at any time.	Not less than 85% saturation at any time.	Not less than 7.0 mg/l at any time.	24 hour average not less than 6.0 mg/l. Not less than 5.0 mg/l at any time.	i. 24 hour average not less than 5.0 mg/l, but not less than 4.0 mg/l at anytime, except as noted in paragraph ii. below. ii. Not less than 4.0 mg/l at any time in the freshwater tidal portions of tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive.
Bacterial quality (MPN/100 ml)	1. Except as noted in paragraph two below, fecal coliform levels shall not exceed a geometric average of 200/100 ml., nor should more than 10 per cent of the total samples taken during any 30-day period exceed 400/100 ml. 2. Fecal coliform levels shall not exceed a geometric average of 770/100 ml. in the freshwater tidal portion of tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive. 3. Samples shall be obtained at sufficient frequencies and at locations and during periods which will permit valid interpretation of laboratory analyses. Appropriate sanitary surveys shall be carried out as a supplement to such sampling and laboratory analyses. As a guideline and for the purpose of these regulations, a minimum of five samples taken over a 30-day period should be collected, however, the number of samples, frequencies and locations will be determined by the department in any particular case.				

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARDS (NJDEP, 1981)

			Classification		
Parameter	FW-Lower Mullica and Wading Rivers Central Pine Barrens	FW-Central Pine Barrens	FW-2 Trout Production	FW-2 Trout Maintenance	FW-2 Nontrout
Total dissolved solids - filterable residue (mg/l)	Maximum of 100 at anytime	Maximum of 100 at anytime	1. Not to exceed 500 mg/l or 133 per cent of background whichever is less. Notwithstanding this criterion, the department, after notice and opportunity for hearing, may authorize increases exceeding these limits provided the discharge responsible for such increases can demonstrate to the satisfaction of the department that such increases will not significantly affect the growth and propagation of indigenous aquatic biota or other designated uses, including public water supplies. 2. Any authorization by the department of such increases shall be conditioned upon utilization of the maximum practicable control technology.		
Ammonia (un-ionized; Maximum concentration ug/l)	50.0	50.0	20.0	20.0	50.0
Phosphorus (mg/l)	Maximum of 0.7 at anytime; phosphorus as phosphate.		1. Lakes: Phosphorus as total P shall not exceed 0.05 in any reservoir, lake, pond, or in a tributary at the point where it enters such bodies of water, unless it can be demonstrated that total P is not a limiting factor considering the morphological, physical, chemical, and other characteristics of the water body. 2. Streams: Phosphorus as total P shall not exceed 0.1 in any stream, except at those locations in paragraph one above, where total P is determined to have a detrimental effect on stream use or to be the limiting factor considering the morphological, physical, chemical, and other characteristics of the water body.		

TABLE 1-iv SURFACE WATER CLASSIFICATIONS AND APPROPRIATE WATER QUALITY STANDARDS USED IN THE WATER QUALITY ASSESSMENT - CONVENTIONAL PARAMETERS FROM: N.J. SURFACE WATER QUALITY STANDARDS

Parameter	TW-1
pH (Standard Units)	6.5-8.5
Dissolved oxygen (mg/l)	24 hour average not less than 5.0. Not less than 4.0 at any time.
Bacterial quality (MPN/100 ml)	1. Approved shellfish harvesting waters: where shellfish harvesting is permitted, requirements established by the National Shellfish Sanitation Program as set forth in its current manual of operation shall apply. 2. All other waters: Fecal coliform levels shall not exceed a geometric average of 200/100 ml, nor should more than 10 per cent of the total samples taken during any 20-day period exceed 400/100 ml.
Total dissolved solids - Filterable residue (mg/l)	None which would render the water unsuitable for the designated uses.

KR:305B2:b

Table 1-iii. Methodology to accurately test for volatiles had not been developed at the time.

Throughout the Toxic Parameters subsections general statements of contaminant levels are identified. This is due to the lack of surface water quality standards for the majority of the substances. In general, when a parameter was found in the water column in concentrations greater than 100 ug/l it was considered in high levels. Moderate levels fell between 10 and 100 ug/l, while low levels meant under 10 ug/l. With regard to sediments and fish tissue analyses, contamination is generally related to the presence of PCBs (polychlorinated biphenols), chlordane, and DDT and its metabolite substances. Elevated levels of PCBs are considered above 3.0 ppm, low levels from 1.0 to 3.0 ppm and trace levels below 1.0 ppm. For chlordane elevated levels were .3 ppm or more, moderate levels are .1 to .3 ppm, with trace levels below .1 ppm. Total DDT was considered elevated when at 5.0 ppm or more, at low levels from 1.0 to 2.0 ppm, and at trace levels below 1.0 ppm. The elevated concentrations reflect the U.S. Food and Drug Administration action levels for fish tissue which is used for human consumption.

As preliminary results were being reviewed, various shortcomings in this sampling approach were identified, but the need for baseline data was imperative and the results generated have proved very useful in identifying areas where further and more intensive studies are needed. Several of the problems discovered during the surface water survey deserve mention in order that the data be viewed in proper perspective. One problem is the limitation of collecting grab water samples for toxic pollutant analysis. The presence of toxics is often variable due to many factors including intermittant discharges, toxic spills, illegal dumping etc.; grab samples provide only an instantaneous look at the water quality of a particular system. The OCTSR has found that composite samples (samples collected over time) provide a more representative picture of true water quality; however, collecting and analyzing composite samples is much more expensive than grab samples.

The natural variability of surface water samples has been another interesting finding of the OCTSR's survey. Toxic pollutants in surface waters are dynamic; compounds present in one stretch of stream will not necessarily be detected in another area. This has led to a need for greater understanding of the physical and chemical processes relating to the partitioning of chemical compounds into different environmental compartments. With the development of the data base, it is now possible to predict where different classes of compounds are most likely to be found, whether in water, sediment, or aquatic biota. The knowledge and experience gained from the survey has resulted in more cost-effective sampling programs designed to gain a maximum amount of information for each dollar spent for analysis.

The OCTSR wrote a brief description on the risks of chemical contaminants on human health. This report, entitled "Health Effects of Chemical Contaminants" is a working paper for the 305(b) report and is available upon request from the Bureau of Planning and Standards, DWR.

Problem Assessment Section

The Problem Assessment is an evaluation of the probable and known water pollution sources within each segment. An attempt was made to identify pollution sources as specifically as possible; but in most cases only wastewater discharges under Department enforcement and administrative actions, and identified by the DWR Enforcement and Regulatory Affairs Element were named as specific sources. Other information sources included the 12 Water Quality Management (WQM) Plans prepared in late 1970s, the 1980 State 305(b) Report, DWR Construction Grants Administration project descriptions, designated WQM Agency supplied information; as well as a variety of other sources. One source which contains alot of useful information on the origin of water pollution were the Lakes Management Program's intensive surveys conducted in 1978 and 1979. However, these surveys were performed on only a local basis and on selected lakes.

Unfortunately the statewide surface water monitoring programs described above are not designed to identify water pollution sources, but rather to determine long-term changes in overall water quality. This makes it difficult, if not impossible, to reliably identify sources of pollution and the impacts they may be having on stream quality. The inherent variabilities and limitations of periodic grab samples from a water body were also expressed above in the description of the OCTSR Program. Unless source specific intensive surveys above and below suspected pollution sources can be performed, then accurate determinations on the contribution of various wastewater facilities, storm drains and land uses to pollution loads can not be made. In the Problem Assessment, therefore, while pollution sources are identified, in most cases their impacts are not truely known.

Goal Assessment and Recommendations Section

The ability of surface waters within each of the 29 segments to meet the swimmable and fishable goals of the federal Clean Water Act is presented in this section. In addition, corrective actions to allieviate water pollution problems identified in the Water Quality Assessment and Problem Assessment sections are recommended.

The Clean Water Act states that surface waters of the nation must be swimmable and fishable (provide for the propagation and protection of a balanced population of shellfish, fish and wildlife) by July 1, 1983. Because this 305(b) report reflects

conditions as of late 1981 and that surface waters will not generally experience significant waters quality differences from late 1981 to mid 1983, the swimmable and fishable determinations made in this report can be interpretated as 1983 goal attainability.

Criteria were developed for this report in order to make the swimmable/fishable goal determination. The swimmable status was assigned to a segment if bathing beaches were known to exist throughout its waters, or if fecal coliform bacteria were of sufficient levels to allow bathing. Fecal coliform data were assessed at monitoring stations used in the segment analyses for the frequency of samples greater than 200/100 ml (surface water standard) during warm weather (May - September) periods. If over 25 percent of the samples were greater than 200 MPN/100 ml then the waters are considered not swimmable; 0-25 percent over 200 MPN/100 ml was construed to mean the waters are marginally swimmable; and when all fecal coliform samples were under 200 MPN/100 ml then the waters are swimmable. It should be noted that irregardless of the swimmable classification assigned to a segment, swimming is recommended only in those waters routinely monitored for bathing.

The fishable determination was based on a number of criteria. This included the presence of trout production or trout maintenance waters (as defined in the state water quality standards); water quality data for dissolved oxygen, pH and un-ionized ammonia which would indicate stressful or acute toxicity to fishlife; and the species of fish identified to exist in the segment by the report Establishment of a Statewide List of Bioassay Organisms Pursuant to the New Jersey Surface Water Quality Standards (Rutgers University, 1979). All waters of the State can be classified as fishable (fishing is allowed) with the exception of portions of the Pennsauken Creek, Cooper River and Woodbury Creek watersheds. Determining the ability of a watershed to support a balanced fish community is difficult since a great variety of factors are involved. What is needed, but is not available, is continuous monitoring of fish communities in the State's waters through various collection and identification programs.

Recommendations for the improvement of water quality within a segment were based generally on the pollution sources identified in the Problem Assessment and what actions are needed to alleviate these problems.

X. ELIZABETH AND RAHWAY RIVERS

Basin Description

The Elizabeth River and Rahway River drainage basins are located in the northeastern part of the State. These rivers are narrow in their non-tidal portions and flow southeasterly to the Arthur Kill. The Elizabeth River watershed is located within the Counties of Union and Essex and includes all or part of such population centers as Irvington, Newark, Elizabeth, Kenilworth and Union. The Rahway River basin is located within Middlesex, Union and Essex Counties and includes all or part of such municipalities as Rahway, Woodbridge, Clark, Springfield and Cranford. The average discharge of the Elizabeth River at Ursino Lake (drainage area of 17 square miles) to 1980 was 25.8 cfs. The average discharge of the Rahway River at Rahway (41 square miles drainage area) was 47.1 cfs for 1980. The Elizabeth River frequently floods and the U.S. Army Corps of Engineers is presently in the final stages of a flood control project to relieve the flooding problem.

The Elizabeth River basin is characterized by the following land use types: residential (38 percent), commercial (5 percent), industrial (16 percent), and other (parks, undeveloped) for the remainder (41 percent). The Rahway River basin is: residential (48 percent), commercial (3 percent), industrial (4 percent) and other (45 percent). The population is stable to slightly declining, as several of the municipalities in the two watershed areas showed decreases in population for the period 1970 to 1980.

The waters of the Rahway River are classified as FW-2 Nontrout (for the river and tributaries above the Pennsylvania Railroad bridge), TW-2 (for the tidal portion of the river and tributaries from the Routes 1 and 9 crossing upstream to the Pennsylvania Railroad bridge and the tidal portion of the South Branch Rahway River to the head of tide), and TW-3 (tidal portion of the Rahway River from its mouth at the Arthur Kill to the Routes 1 and 9 crossing). The waters of the Elizabeth River are classified as FW-2 Nontrout for the river and its tributaries above the Broad Street bridge in Elizabeth and as TW-3 for the tidal portion of the river downstream of the Broad Street bridge.

The Rahway River as well as Ash Brook are stocked with trout by the NJ Division of Fish, Game and Wildlife (DFGW). The Rahway River is also used as a source of potable water for the Rahway Water Department. Middlesex Water Company also takes water from the Robinson's Branch (or Middlesex) Reservoir for Woodbridge's supply. Nine lakes and ponds have been identified by the DFGW as recreation areas in the Elizabeth and Rahway watersheds. These water bodies include Diamond Mill Pond, Briant Park Pond, Lower and Upper Echo Park Ponds, Milton Lake, Mindowaskin Park Lake, Nomahegan Pond, Rahway River Park Pond and Warinanco Pond. They all provide shorefishing for sunfish, crappie, carp, catfish and largemouth bass and some permit boating.

There are fifty-one point source dischargers in the areas drained by the Rahway and Elizabeth Rivers. Among the larger dischargers are the Rahway Valley Sewerage Authority plant and the Essex and Union County Joint Meeting plant. The Rahway V.S.A. plant serves the municipalities of Rahway, Woodbridge, Clark, Scotch Plains, Winfield, Garwood, Cranford, Westfield, Mountainside, Springfield, Kenilworth and part of Roselle Park. The Essex and Union County Joint Meeting plant serves Roselle (part), New Providence, Berkeley Heights (part), Newark, Roselle Park (part), East Orange, Hillside, Irvington, Maplewood, South Orange, Livingston (part), Millburn, Summit, Union, West Orange and Elizabeth.

Water Quality Assessment

Conventional Parameters

Data from the three stations (Elizabeth River at Ursino Lake, Rahway River at Rahway and Robinson's Branch of the Rahway River at Rahway) used in the water quality assessment of this basin were available only from January 1979 to the present. Based on this limited amount of data, the Elizabeth River which flows through a heavily industrial zone can be classified as a seriously degraded stream having periodic and abnormally high daytime dissolved oxygen levels, in addition to excessive total phosphorus, total ammonia and un-ionized ammonia concentrations. Water quality in the Rahway River declined from marginal conditions in the non-tidal upstream segments to poor conditions near the tidal confluence with the Arthur Kill. Robinson's Branch, a major tributary to the Rahway River, exhibited generally marginal water quality conditions through the period.

As mentioned above, the Elizabeth River exhibited rising dissolved oxygen levels which became very high in 1980. Dissolved oxygen saturation levels were over 150 percent during the daylight hours at the Elizabeth station through the summer of 1980. This occurrence was accompanied by a decline in biochemical oxygen demand to some of the lowest levels for the period. The Rahway River exhibited occasional supersaturated dissolved oxygen levels during the winter months at the Rahway station. Biochemical oxygen demand was moderate to excessive at Rahway but was not sufficient to depress dissolved oxygen concentrations below the standard at any time during the period. Robinson's Branch exhibited similar conditions at the monitoring station in Rahway.

Fecal coliform concentrations in the Elizabeth River were generally excessive over the period with periodic extreme levels (greater than 10,000 MPN/100 ml) being recorded at Elizabeth. Less extreme concentrations (normally less than 5,000 MPN/100 ml) were present in the Rahway River and values usually below 1,000 MPN/100 ml were noted in Robinson's Branch at Rahway.

The total dissolved solids standard was contravened twice during the period in the Elizabeth River, which exhibited a wide variation of values, for the most part between 100 and 500 mg/l. The majority of the total dissolved solids data for the Rahway River and Robinson's Branch stations in Rahway was less than 300 mg/l. Overall, the pH values for the three streams were slightly alkaline. The Rahway River exhibited a slight decline to neutral levels in late 1980, but a return to slightly alkaline pH values ensued.

Total phosphorus concentrations were moderately excessive in the Elizabeth River at Elizabeth until early 1981 when a critically high value of approximately 16.0 mg/l was recorded. At the same time, the total ammonia concentration rose to 57 mg/l and un-ionized ammonia increased to more than 320 mg/l. These excessive values indicated a critical problem. Only periodic contravention of the total phosphorus standard occurred in the Rahway River and Robinson's Branch over the period but concentrations were generally below 0.30 mg/l. Nitrate + nitrite levels were generally elevated in the Rahway and Elizabeth Rivers with the highest value in the Rahway River in late 1980. Low to moderate levels were found in Robinson's Branch over the three year period. Total ammonia concentrations were generally acceptable and un-ionized was within the criteria throughout the period in the Rahway River and Robinson's Branch at Rahway.

Biological assessments of the Elizabeth and Rahway River basins were not conducted during the 1977-1981 period.

Determination of long-term water quality trends in the Rahway and Elizabeth watersheds is not possible because these waters have not been discussed in earlier 305(b) reports. Short-term trends (1979-1981) cannot be made due to a lack of data.

Toxic Parameters

Water samples collected from the Elizabeth River above Salem Road in Elizabeth were found to have low levels of trihalomethanes and several organic solvents. The Elizabeth River was also sampled at Route 28 in Elizabeth where moderate levels of trihalomethanes and low levels or organic solvents were detected. These concentrations are not unexpected in a river system such as the Elizabeth considering the industrial land use that exists within the basin.

The Rahway River at Route 22 had low levels of organic solvents. These same contaminants were also found downstream at Route 27 at lower levels. This can be attributed to the volatility of these compounds along with dilution effects.

The Robinson's Branch of the Rahway was shown to be free of toxic contamination.

Tissue samples were collected from the Rahway River at Robinson's Branch and at Route 27 in 1979. These samples were analyzed for PCB Arochlor 1254 and a select group of organochlorine pesticides including chlordane and DDT. Species samples included, but were not limited to, American eel, <u>Anguillia rostrata</u>; redbreasted sunfish, <u>Lepomis auritis</u>; white sucker, <u>Catostomus commersoni</u>; and largemouth bass, <u>Micropterus salmoides</u>. Results for the majority of samples indicate only trace levels of PCB Arochlor 1254 and some pesticides. Elevated levels of PCBs, chlordane, DDD and DDE have been noted for catadromous American eel. Sediment analyses performed on samples from these sites produced only trace amounts of the same compounds.

Problem Assessment

The Elizabeth and Rahway Rivers have water quality problems which seem to be mostly the result of non-point sources originating from intensively developed urban and suburban watersheds. Both rivers show signs of excessive nutrients which temporarily creates artifically high dissolved oxygen concentrations due to high photosynthetic activity.

The Elizabeth River bacterial pollution is probably due to non-point sources but this has not been confirmed. However, high concentrations of ammonia are being found without any apparent source. The lower segments, which are tidal, are impacted by the 31 combined sewer overflows (CSOs), which sometimes even flow in dry weather. In addition, the lower tidal reaches have problems that are due to the poor quality of the Arthur Kill's waters and from industrial and large municipal point sources discharging to that waterway. The very high total phosphorus, fecal coliform, total ammonia and un-ionized ammonia levels recorded in the Elizabeth River at Ursino Dam from mid-1980 to early 1981 were probably a combined result of low stream flows and periodic water pollution occurrences from an unknown source. A major hazardous pollution event occurred on the banks of the Elizabeth River near the Arthur Kill in the spring of 1980 when the Chemical Control facility caught on fire. The fire burned numerous drums containing volatile and hazardous chemical wastes.

The Rahway River mainstem has problems with bacterial contamination which is also probably the result of non-point pollution. The Rahway tributary, Robinson's Branch, appears to be much less affected. The stream is a source of potable water and has in the past been affected by spills. The lower segment of the Rahway River has problems similar to those of the Elizabeth River (tidal waters of the Arthur Kill and point sources). The Rahway River is also affected by combined sewer overflows in its lower reaches. CSOs are present in Carteret Borough and in the City of Rahway.

The impact of these CSOs on lower Rahway River quality is probably short-term in nature.

An intensive survey was conducted in 1979 by the NJ Lakes Management Program on Echo Lakes, located on Nomahegan Brook, a Rahway River tributary. The lakes (a series of three lakes) were all found to be eutrophic as a result of large urban runoff pollution loads (containing nutrients, bacteria and oxygen demanding substances), and very shallow depths which allow light penetration to the substrate encouraging aquatic plant growth.

Goal Assessment and Recommendations

The waters of the Elizabeth and Rahway Rivers do not meet the swimmable quality goal due to the frequency with which samples exceeded a fecal coliform concentration of 200 MPN/100 ml. The rivers do meet the fishable goal, however extreme stress may occur to fishlife in the Elizabeth River because of severe organic material contamination causing significant DO fluctuations.

In addition, the Elizabeth River has high un-ionized ammonia levels that may be restricting the population of aquatic organisms. The Rahway River (mainstem) reportedly has a fish species diversity of nine. No information was available for the Elizabeth River.

It is recommended that for the control of excess fecal coliform and nutrients, both watersheds use best management practices currently available for controlling urban/suburban stormwater run-off (this includes street sweepings, control of animal wastes, education of residents as to the proper use of fertilizers). The lower portion of the Elizabeth River requires the reduction or elimination of its combined sewer overflows and possible upgrading of its industrial point sources. This will only be effective if there is water quality improvement with the adjacent Arthur Kill. Additional sampling should be performed if the extreme pollutant levels detected recently in the Elizabeth River are found again.

The tidal portion of the Rahway River is also greatly affected by the Arthur Kill and would benefit from its improvement. Correction of eutrophic conditions in the Echo Lakes would be possible only with expensive runoff controls with nutrient inactivation techniques.

ELIZABETH AND RAHWAY RIVERS STATION LIST

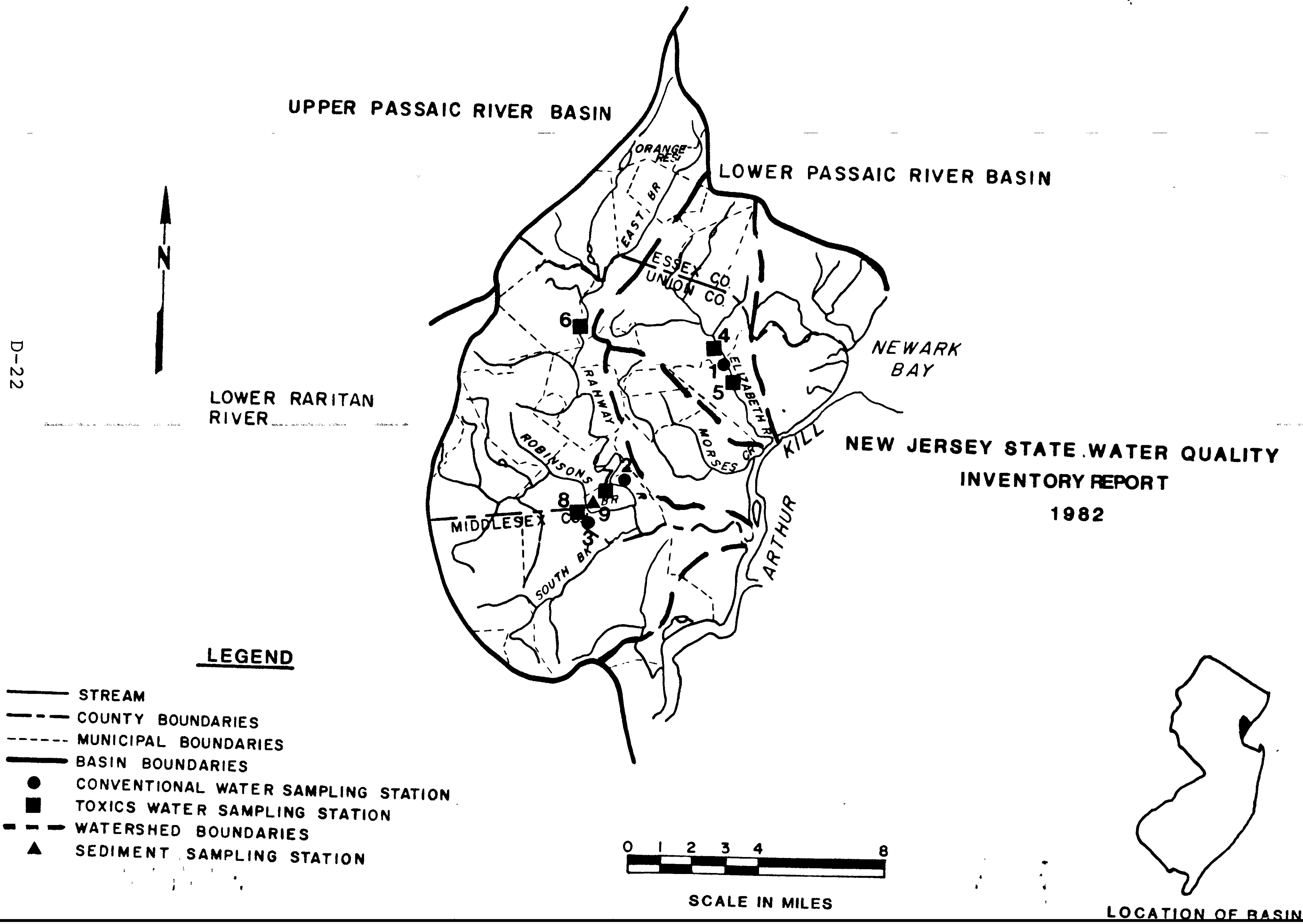
A. Ambient Monitoring Stations

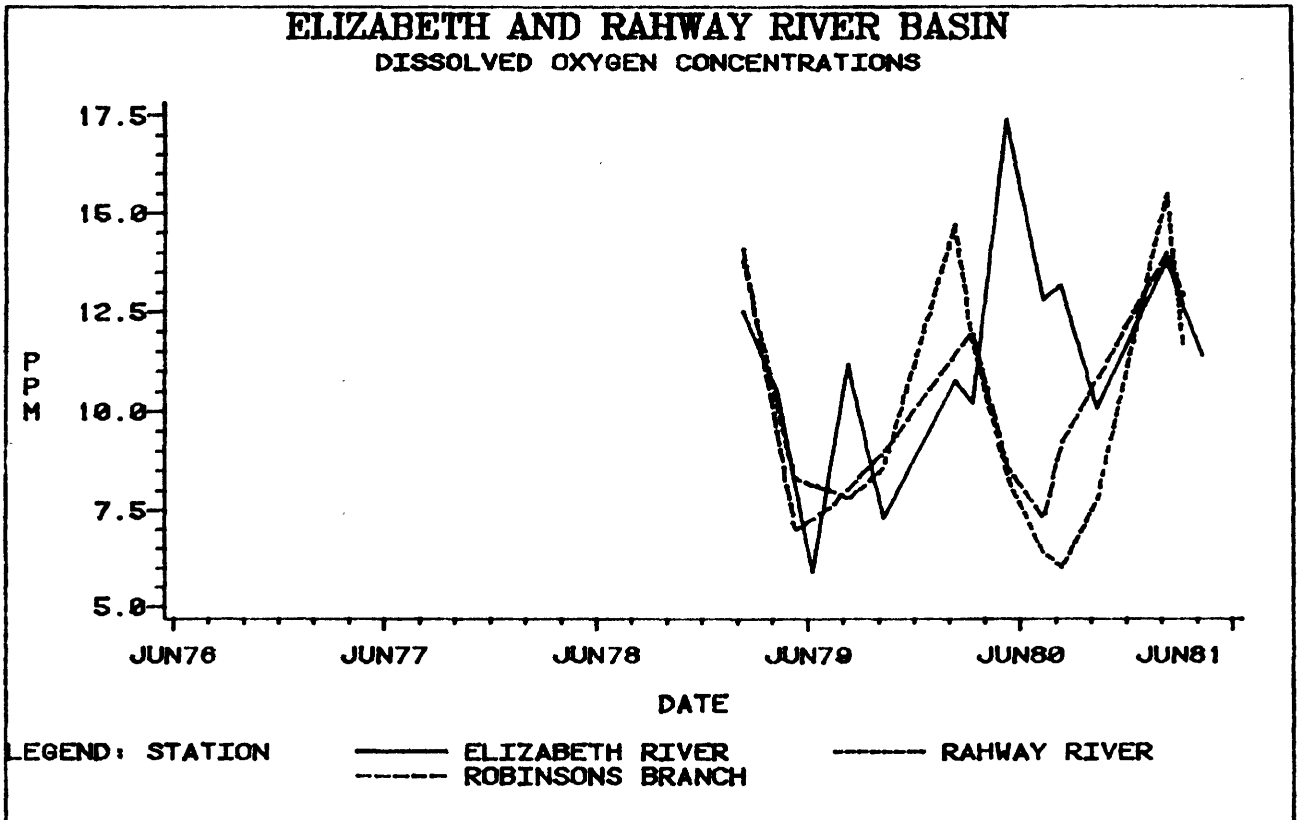
STORET Number	Station Description	Map Number
01393450	Elizabeth River at Ursino Lake, Union County Latitude 40°40'30" Longitude 74°13'20" FW-2 Nontrout USGS/DEP Network At Ursino Lake Dam, 75 feet upstream of Trotter's Lane bridge and 3.8 miles upstream from mouth.	1
01395000	Rahway River at Rahway, Union County Latitude 40°37'05" Longitude 74°17'00" FW-2 Nontrout USGS/DEP Network 100 feet upstream from St. Georges Avenue bridge and 0.9 miles upstream from Robinson's Branch.	2
01396001	Robinson's Branch Rahway River at Rahway, Union County Latitude 40°36'26" Longitude 74°17'40" FW-2 Nontrout USGS/DEP Network At Maple Avenue bridge, 2,000 feet downstream from Milton Lake and 1.2 miles upstream from mouth.	3

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Elizabeth River at Salem Road	Water column	4
Elizabeth River at Route 28	Water column	5
Rahway River at Route 22	Water column	6
Rahway River at Route 27	Water column	7
Robinsons Branch	Water column	8
Robinsons Branch	Sediment	9

ELIZABETH AND RAHWAY RIVER BASINS





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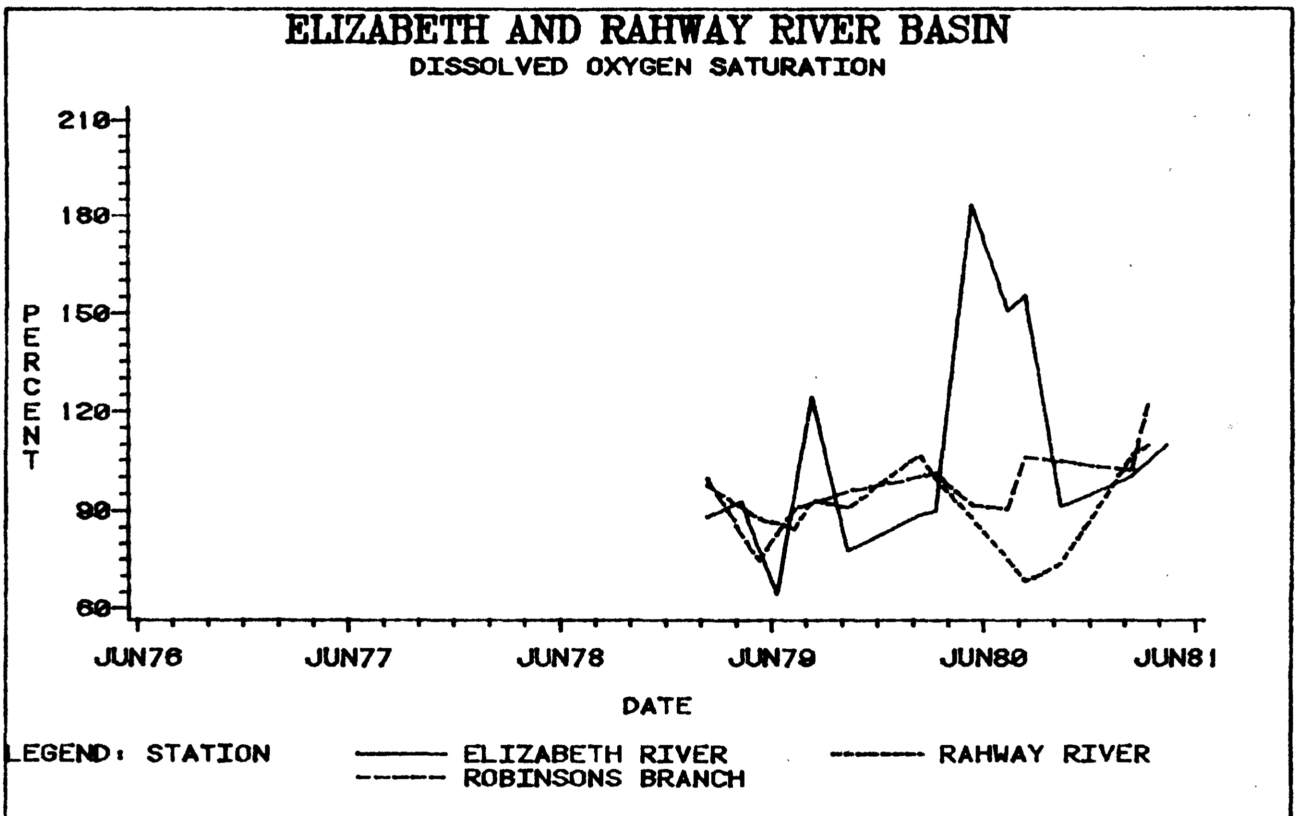

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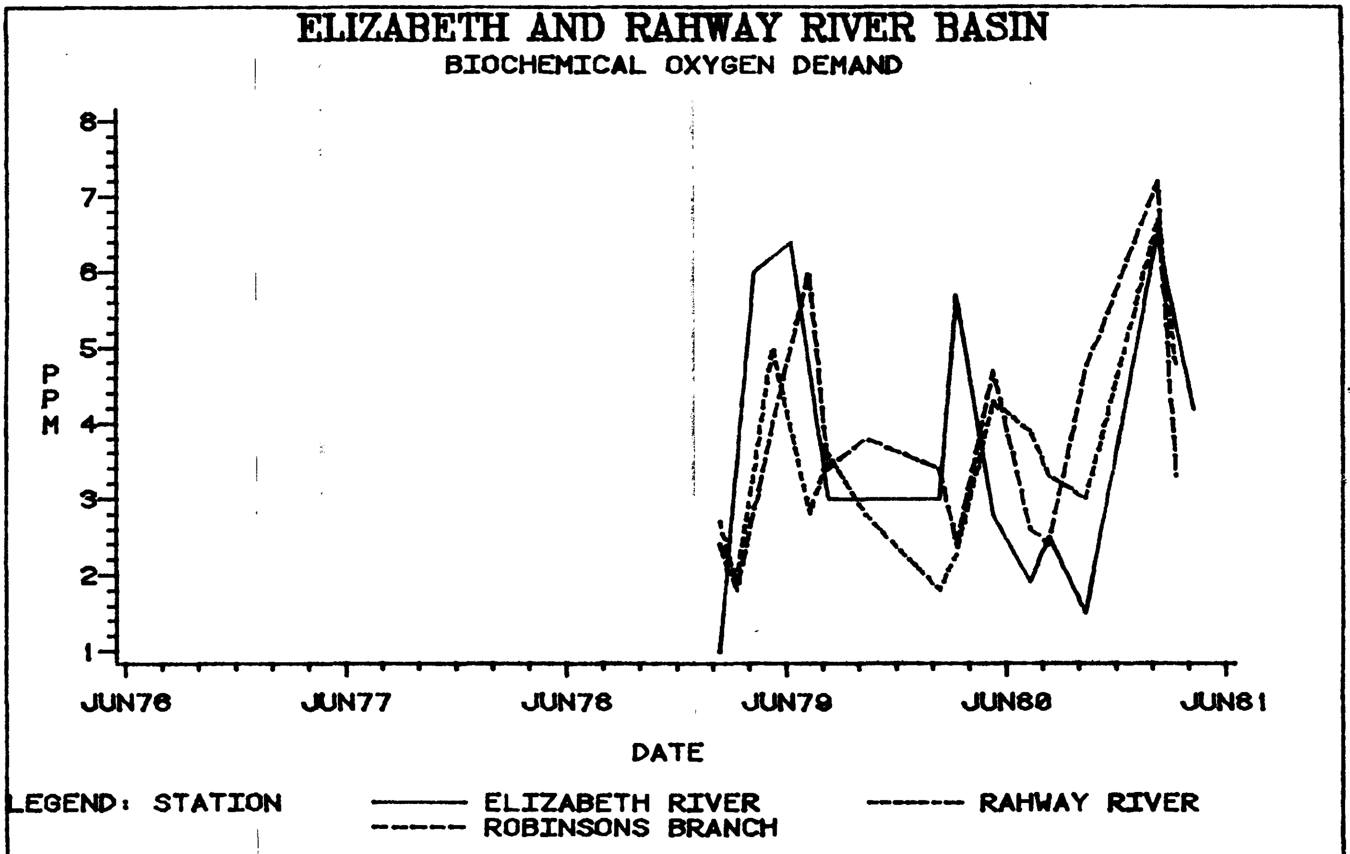

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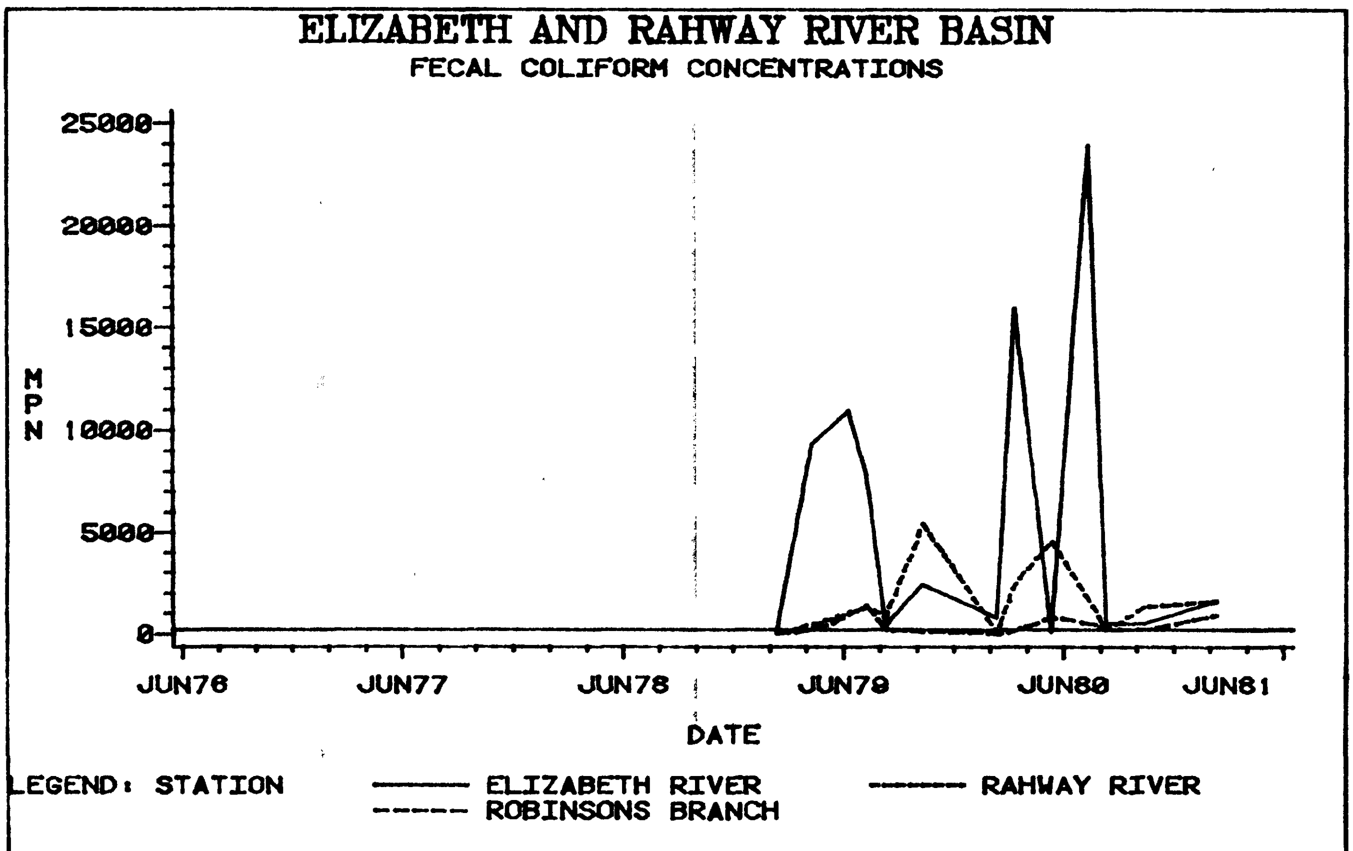

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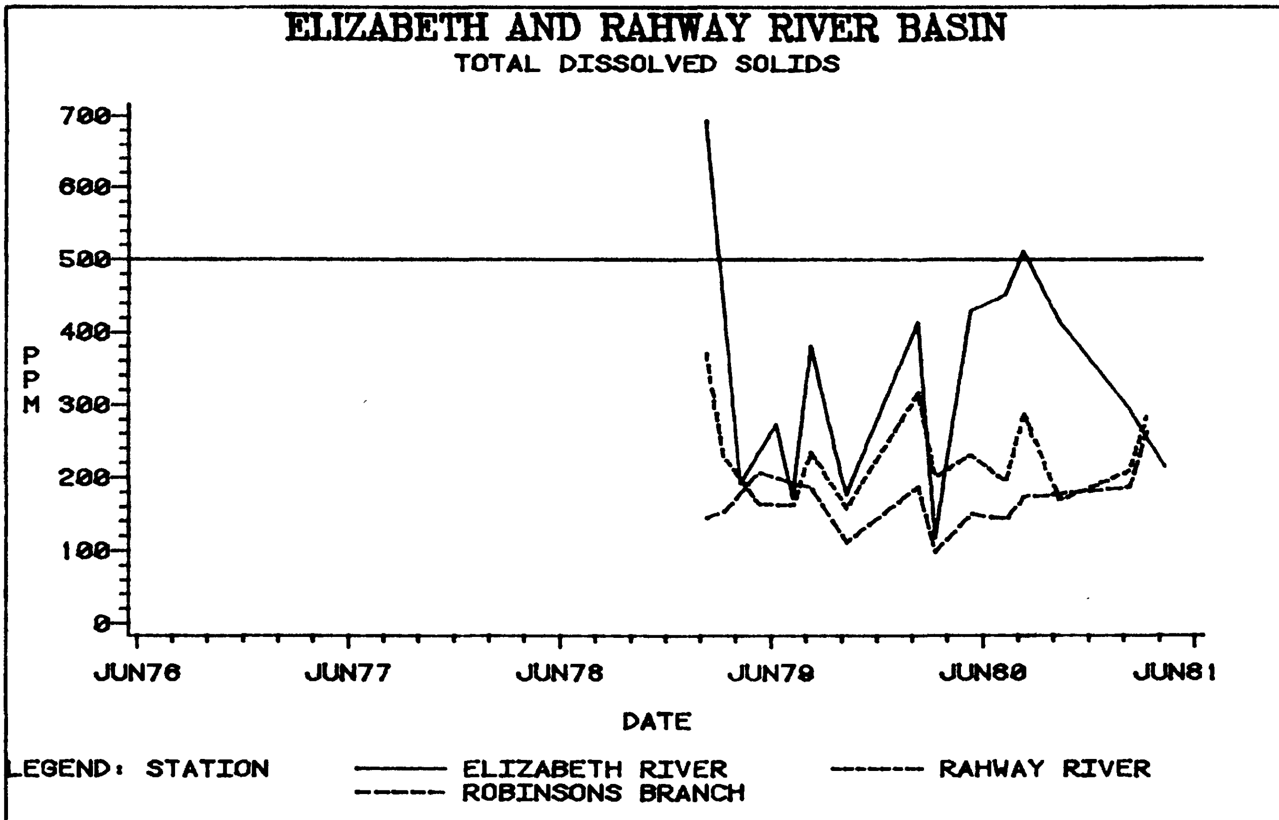

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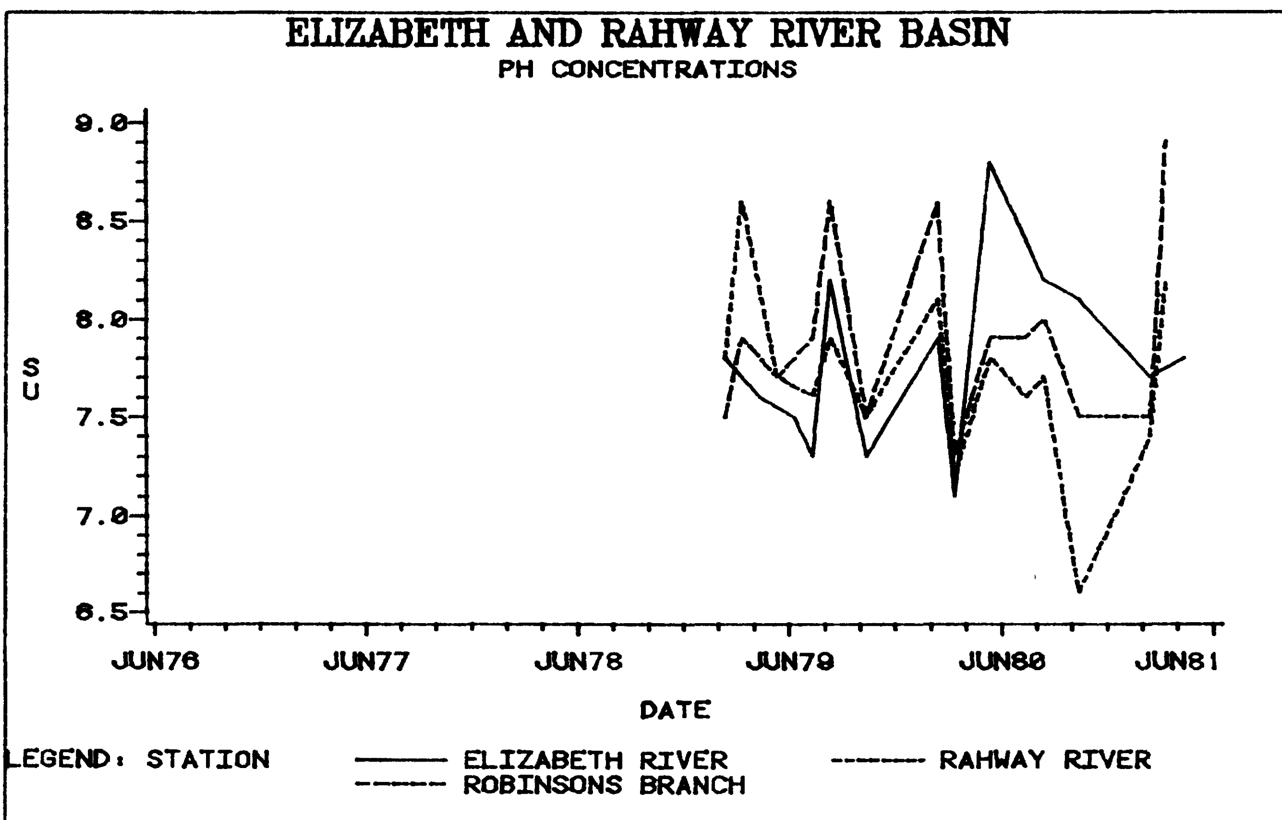

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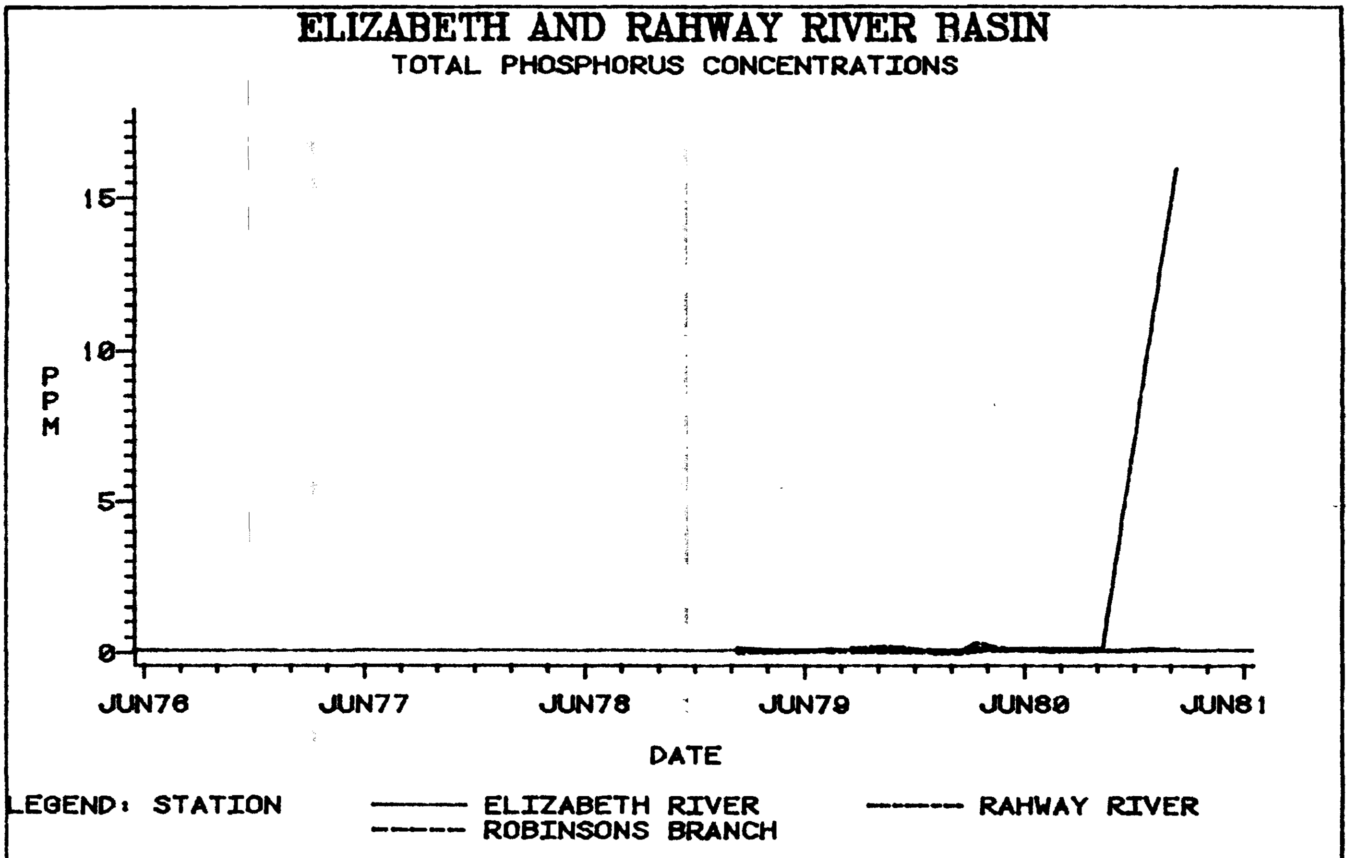

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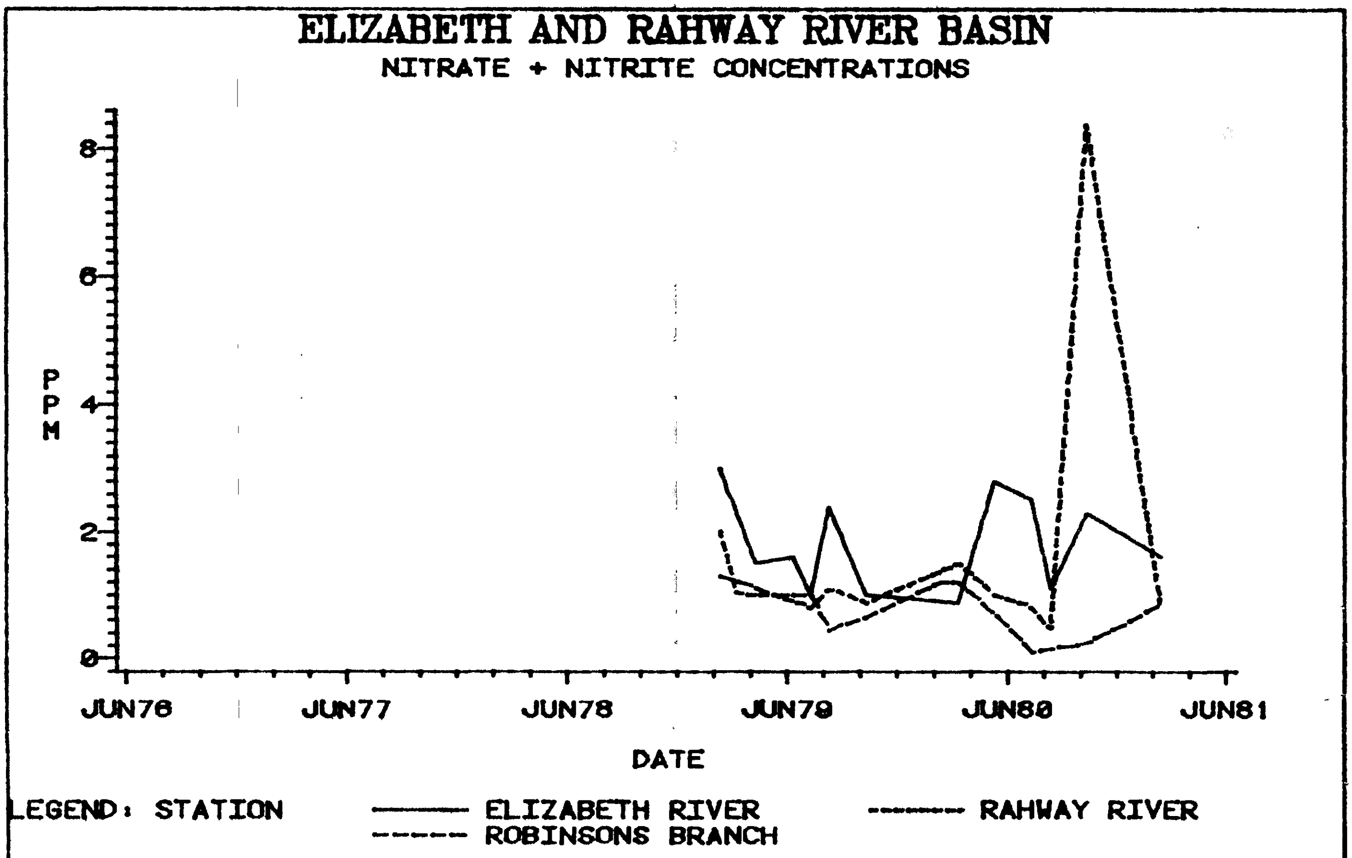

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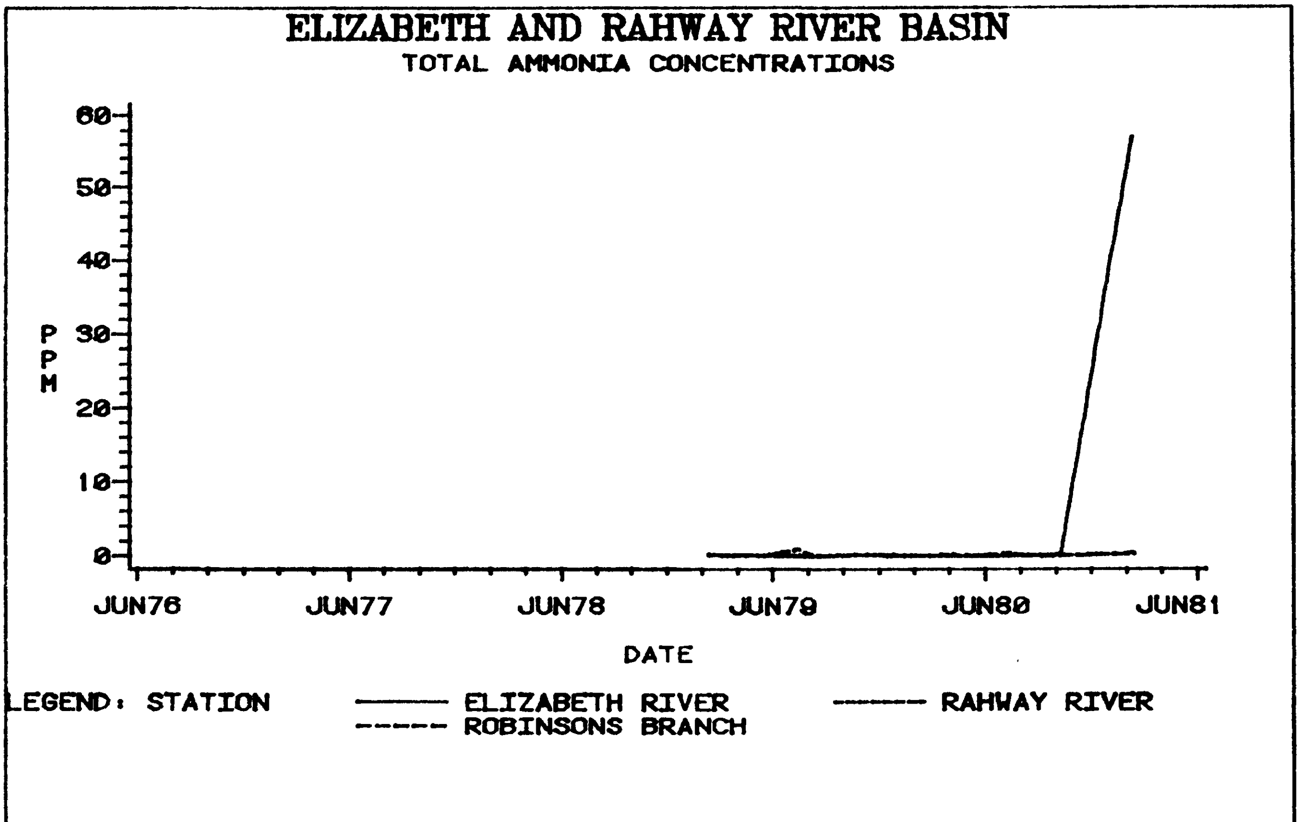

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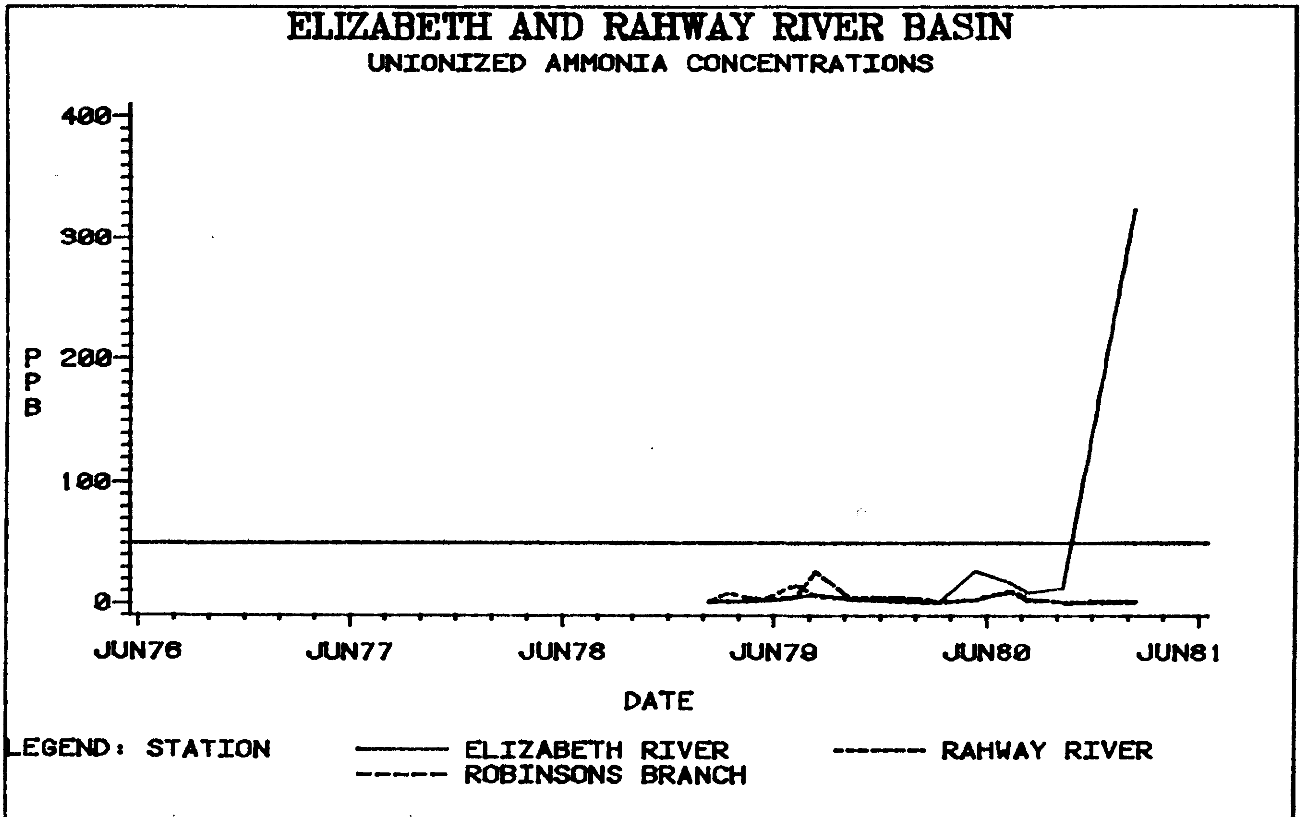

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DISCHARGE INVENTORY - - - ELIZABETH AND RAHWAY RIVER BASINS

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
GULF OIL CO LINDEN	0000311	LINDEN/CITY	BK RAHWAY RIVER	RUNOFF OIL & GR	
CONTINENTAL CAN CO.	0001121	CARTERET	DRAINAGE DITCH TO RAHWAY RIVER	PROCESS WASTE	
INTERNATIONAL BUSINESS MACHINE	0020061	CRANFORD TWP	DRAINAGE DITCH TO RAHWAY RIVER	PROCESS WASTE	.15
WALWORTH COMPANY	0035203	LINDEN	KINGS CREEK		
MERCK & CO INC	0002348	LINDEN/CITY	KINGS CREEK	PROCESS & COOL.	.14
SUPERMARKET SERVICES INC	0022225	LINDEN/CITY	KINGS CREEK	COOLING & SANIT	
TURTLE AND HUGHES INC	0025429	LINDEN/CITY	KINGS CREEK	SANITARY	
EXXON COMPANY U S A	0026671	LINDEN CITY	MARSHES CREEK	RUNOFF OIL & GR	
PABST BREWING COMPANY	0028088	NEWARK CITY	MAYBAUM CREEK-RAHWAY RIVER	SAN/SIG INDUS	.20
GATX TERMINALS CORP	0026280	CARTERET BORO	RAHWAY RIVER	RUNOFF OIL & GR	
NEW DEPARTURE HYATT BEARING	0001066	CLARK TWP	RAHWAY RIVER	COOLING WATER	
TUFF LITE CORPORATION	0032883	EDISON	RAHWAY RIVER	COOLING WATER	
MONSANTO COMPANY	0001554	KENILWORTH BORO	RAHWAY RIVER	COOLING WATER	.30
SCHERING CORP.	0002305	KENILWORTH BORO	RAHWAY RIVER	COOLING WATER	
HATFIELD WIRE & CABLE GROUP	0033855	LINDEN	RAHWAY RIVER		
AMERICAN CYANAMID CO.	0001058	LINDEN/CITY	RAHWAY RIVER	PROCESS WASTE	21.98
BP OIL CORP-NJ TERMINAL	0000515	LINDEN/CITY	RAHWAY RIVER	RUNOFF OIL & GR	.03
BUCKEYE PIPE LINE CO	0003522	LINDEN/CITY	RAHWAY RIVER	RUNOFF OIL & GR	
CITIES SERVICE OIL COMPANY	0024554	LINDEN/CITY	RAHWAY RIVER	RUNOFF OIL & GR	
EXXON COMPANY U S A	0026662	LINDEN/CITY	RAHWAY RIVER	RUNOFF OIL & GR	
SOLAR COMPOUNDS CORP	0003395	LINDEN/CITY	RAHWAY RIVER	PROCESS & COOL.	
CITY OF ORANGE WATER FIL PLANT	0034592	ORANGE	RAHWAY RIVER	PROCESS WASTE	
HUFFMAN & KOOS CO INC	0003883	RAHWAY/CITY	RAHWAY RIVER	COOLING WATER	.47
INVESTMENT CASTING CORP	0034525	SPRINGFIELD	RAHWAY RIVER	COOLING WATER	
DUREX INC	0031127	UNION	RAHWAY RIVER		
ENGELAARD MIN. & CHEM.	0001180	UNION	RAHWAY RIVER		
TEXEDYNE ADAMS	0029416	UNION	RAHWAY RIVER	COOLING WATER	
WESTERN ELECTRIC CO INC	0002267	UNION TWP	RAHWAY RIVER	COOL.TWR.BLOWDN	
ST CLOUD SWIMMING POOL	0033031	WEST ORANGE	RAHWAY RIVER	SANITARY	
KOPPERS COMPANY INC	0032751	WESTFIELD	RAHWAY RIVER	COOLING WATER	
CITY OF RAHWAY DPW	0025585	RAHWAY/CITY	RAHWAY RIVER MAIN BRANCH		.50
AIR PRODUCTS AND CHEMICALS INC	0021300	WOODBRIDGE TWP.	SOUTH BRANCH RAWAY RIVER	SANITARY	.01
EMERY INDUSTRIES INC	0034011	LINDEN	STORM SEWER TO KING'S CREEK	COOLING WATER	
STOKES MOLDED PRODUCTS	0031411	CLARK	STRM SWR TO ROBINSNS BR RAHWAY	COOLING WATER	
ROTARY PEN CORP	0034568	KENILWORTH	KENILWORTH BROOK	COOLING WATER	.10
ELIZABETH PORT AUTH. MARINA	0030511	ELIZABETH	ELIZABETH CHANNEL		
CITY OF ELIZABETH	0020648	ELIZABETH /C/	ELIZABETH R.		
E C D INC	0031186	HILLSIDE	ELIZABETH RIVER	PROCESS WASTE	
VOLCO BRASS & COPPER	0003107	KENILWORTH BORO.	ELIZABETH RIVER	PROCESS WASTE	
MCMILLAN BLOEDEL CONT. INC.	0029611	UNION	ELIZABETH RIVER	COOLING WATER	
SCHERING CORP.	0002291	UNION	ELIZABETH RIVER	PROCESS & COOL.	.16
TUSCAN DAIRY FARMS INC	0034266	UNION	ELIZABETH RIVER		
UNION STEEL CORP	0035556	UNION	ELIZABETH RIVER		
HOUDAILLE CONSTRUCTION MAT. CO	0002887	SPRINGFIELD /TWP/	BRIANT BROOK		.03
TROY CHEMICAL CORPORATION	0031453	NEWARK	PIERSON'S CREEK		
ENGELHARD MIN. & CHEM. CORP.	0001171	NEWARK/CITY	PIERSONS CREEK	PROCESS & COOL.	
AMERACE ESNA CORP	0003433	UNION TWP	STORM SEWER TO LIGHTNING BROOK	PROCESS & COOL.	
SPRINGFIELD DIE CASTING CO INC	0034070	KENILWORTH	WEST BROOK	COOLING WATER	
COASTAL OIL COMPANY	0027880	CLARK TWP	TRIBUTARY TO CLARK RESERVOIR		

Y. UPPER PASSAIC RIVER (HEADWATERS TO LIVINGSTON)

Basin Description

The Passaic River originates in eastern Somerset County and southern Morris County near Washington Corner and Morristown National Historical Park and flows south through the Great Swamp east of Basking Ridge. Most of the headwaters area is undeveloped with pockets of development in Bernards and Passaic Townships. After the confluence with the Dead River, the river bends northeast toward Chatham Township through low density suburban lands. The river borders the Town of Chatham then meanders north through marsh areas until it joins the Whippany and Rockaway Rivers at Hatfield Swamp. The total drainage for the upper Passaic basin, from its source to the confluence of the Whippany and Rockaway Rivers, is approximately 135 square miles.

The basin, according to the Upper Passaic 201 Facilities Plan (1977), is approximately 44 percent developed land (of which approximately 57 percent is residential, 7 percent is commercial/industrial and 36 percent is other developed lands). The remainder, 56 percent of the total basin area, is still undeveloped. Two factors, steep slopes and poor natural drainage, are influencing development in the available vacant lands. According to the 1980 census, the area's population has declined very slightly. However, this decrease does not apply to the entire region, as the reduction was due to offsetting increases and decreases within the basin. Mendham Township and Borough showed the greatest growth with increases of approximately 22 percent and 31 percent, respectively.

The basin receives over 19.1 mgd of effluent from approximately 40 point source dischargers. Some of the major municipal dischargers are Bernards (.9 mgd), Madison-Chatham (3.0 mgd), Livingston (2.9 mgd), Florham Park (.7 mgd), Berkeley Heights (1.4 mgd), and New Providence (1.6 mgd), all of which are scheduled for upgrading of their treatment processes to advanced wastewater treatment.

The headwaters region of the basin, as well as a few segments downstream, offer many opportunities for fishing. The Division of Fish, Game and Wildlife stocks the Passaic River with trout from White Bridge to the Dead River approximately six times during the year. The largest public open space is the Great Swamp National Wildlife Refuge extending into Chatham, Harding, and Passaic Townships for approximately 6,000 acres. Many other smaller recreational areas, county and municipal, are scattered throughout the basin. There are no public swimming areas along the river, however, canoeing is available and common. The segment has been ranked number 2 in the state by the NJ Wild and Scenic Rivers Program which lists the above recreational benefits, as well as nature observation and picnicking, as activities of public interest and potential.

The Passaic River is an important potable supply source for over 277,300 people that are served by the Commonwealth Water Company, which diverts about 8.0 mgd from the Passaic River, Osborn Pond, and Canoe Brook Reservoir. The area is greatly dependent on ground water resources which supplies more than 12.0 mgd. An area called the Buried Valley Aquifer system of southeast Morris and western Essex Counties has been designated as a "Sole Source Aquifer". (The sole source aquifer is an aquifer which supplies 50 percent or more of the drinking water for an area.) The designation, signed by the US Environmental Protection Agency in May, 1980, requires that before any federally funded project be located on a site within the designation area, it must be proven that there will be no adverse impacts on the ground water supply.

The NJ Water Quality Standards designates the upper Passaic River basin as FW-2 Nontrout except for the following areas which are FW-2 Trout Maintenance: Indian Grove Brook (Somerset County), Passaic River source to Van Doren's Mill Pond, and Primrose Brook (Harding Township) from source to the Route 20 Bridge.

Water Quality Assessment

Conventional Parameters

Generally stable water quality conditions were maintained in the upper Passaic River until 1980, when a serious rainfall deficit and sharply reduced flow elevated many parameters. These poor conditions continued to the end of the period based on water quality sampling near Millington (Passaic Township) and near Chatham (Chatham Township). Daytime dissolved oxygen concentrations generally increased until 1980, when levels declined to below the 4.0 mg/l standard at Millington and Chatham. Biochemical oxygen demand increased concurrently with the dissolved oxygen decline near Chatham. Biochemical oxygen demand remained generally low to moderate at Millington. Despite the improvement measured over the period, fecal coliform levels generally continued to exceed the 200 MPN/100 ml level, particularly at the Chatham station. The most excessive fecal coliform levels in this segment appeared to be isolated incidents largely due to treatment plant malfunctions.

Total dissolved solids concentrations also increased in the downstream direction and periodically exceeded the 500 mg/l standard near Chatham during the summer of 1977 and 1978. Subsequent levels were in compliance with the standard. Total dissolved solids concentrations were generally less than 200 mg/l at Millington. The pH values at Millington and Chatham exhibited a wide seasonal range with maximum levels in the summers, until

1979 after which pH values remained generally above 7.0 su for the remainder of the period.

While nutrient levels were somewhat elevated at Millington, they were frequently excessive near Chatham. The Millington station exhibited moderately high total phosphorus concentrations (generally less than 0.30 mg/l), of which 63 percent contravened the standard. At Chatham, 90 percent of the measurements contravened the 0.10 mg/l phosphorus standard with values frequently exceeding 0.50 mg/l during the summer months. Nitrate + nitrite concentrations were also frequently elevated at the downstream station near Chatham, while acceptable levels (up to 1.0 mg/l) continued to be recorded at Millington. Substantial increases of total phosphorus and nitrate + nitrite levels were particularly evident at Chatham during the drought period after 1979.

Total and un-ionized ammonia levels were also higher at Chatham over the period. Un-ionized ammonia concentrations exceeded the 50 ug/l standard for nontrout streams at Chatham during the low flow period in 1980.

No biological data was acquired from this segment during the 1977-1981 period.

Water quality in the upper Passaic River near Millington and Chatham has shown some improvement with regard to fecal coliform concentrations. Nutrients and summertime dissolved oxygen levels continue to remain in critical amounts.

Toxic Parameters

The upper Passaic River was sampled at four locations: near Chatham, at Route 527 in Millington, at South Maple Avenue in Millington and at Central Avenue in Berkeley Heights. In each sample there was no evidence of toxic contamination.

The Canoe Brook was sampled at Reservoirs 1, 2, and 3 and in each case there were low levels of organic solvents.

As the river proceeds downstream, the amount of toxic contamination gradually increases. At Eagle Rock Avenue in Caldwell low levels of organic solvents were detected. In Lincoln Park low levels of trihalomethanes and organic solvents were detected, also. This increase in toxic contamination is related to the change in land use patterns along the Passaic and correlates well with other water quality information.

Presently, no aquatic organisms have been collected for toxic evaluation. Sampling will be conducted in response to a known source, illegal discharge or to establish a database for this basin.

Problem Assessment

The upper Passaic's water quality problems increase downstream due the cumulative effects of numerous point sources. The river experiences dissolved oxygen problems which are accentuated during periods of low flow. The amount of point sources and the characteristics of the river (low flows, slow moving, and meandering) do not allow the river to biologically and chemically recover. In addition, the tributaries of the river which pass through the Great Swamp add to BOD loads, due to the natural characteristics of a swamp and the location of two point sources in the headwaters of the Great Swamp. Studies have been proposed for the Great Swamp watershed to determine what is causing water quality degradation and how it is affecting the wildlife refuge.

The river's elevated levels of dissolved solids, ammonia, and nutrients are also probably the result of the point source loadings. Fecal coliform concentrations, which are above the State Surface Water Quality Standards, appear to be the result of non-point pollution according to the Northeast Water Quality Management (WQM) Plan (1979). Some septic system problems occur in the region, but are generally corrected as the problems are discovered. One area currently experiencing severe septic problems is Bernards Township.

Because of summer low flows and the large number of dischargers present, municipal treatment plants discharging to the Passaic River mainstem have been required to meet advanced (level four) treatment. STPs in this basin now awaiting construction grants funding to construct advanced treatment facilities include Florham Park SA, Madison-Chatham Joint Meeting, New Providence, Townships of Passaic and Warren, Livingston Township and Berkeley Heights. If a pipeline transferring stream water from the Raritan River basin to the Passaic River basin for the purpose of low flow augmentation occurs, then revised waste load allocations are necessary for the above treatment plants, in addition to those in the mid and lower Passaic.

Goal Assessment and Recommendations

The waters of the upper Passaic River do not meet the goals of swimmable quality due to the frequency which samples exceeded a fecal coliform concentration of 200 MPN/100 ml. The river does meet the fishable goal, however low dissolved oxygen concentrations and high un-ionized ammonia levels are problems in the lower portion of this segment during the summer months. The upper Passaic reportedly has a fish species diversity of 25, which includes trout. The occurrence of trout in the upper Passaic is probably due to stocking by the Bureau of Fish, Game and Wildlife and is generally limited to water above the Dead River confluence.

It is recommended that the point sources be upgraded as stated in the Northeast WQM Plan as these are responsible for the low dissolved oxygen and high nutrient loadings. These upgrades should also be dependent on the results of an intensive survey to be conducted in the summer of 1982, that is designed to help develop proper waste load allocations. Non-point source controls, where cost-effective, may help to alleviate the high fecal coliform concentrations.

Additional water quality studies are recommended for the Great Swamp watershed for the purposes of determining what water quality degradation is occurring in the watershed and what the sources of pollution are.

UPPER PASSAIC RIVER STATION LIST

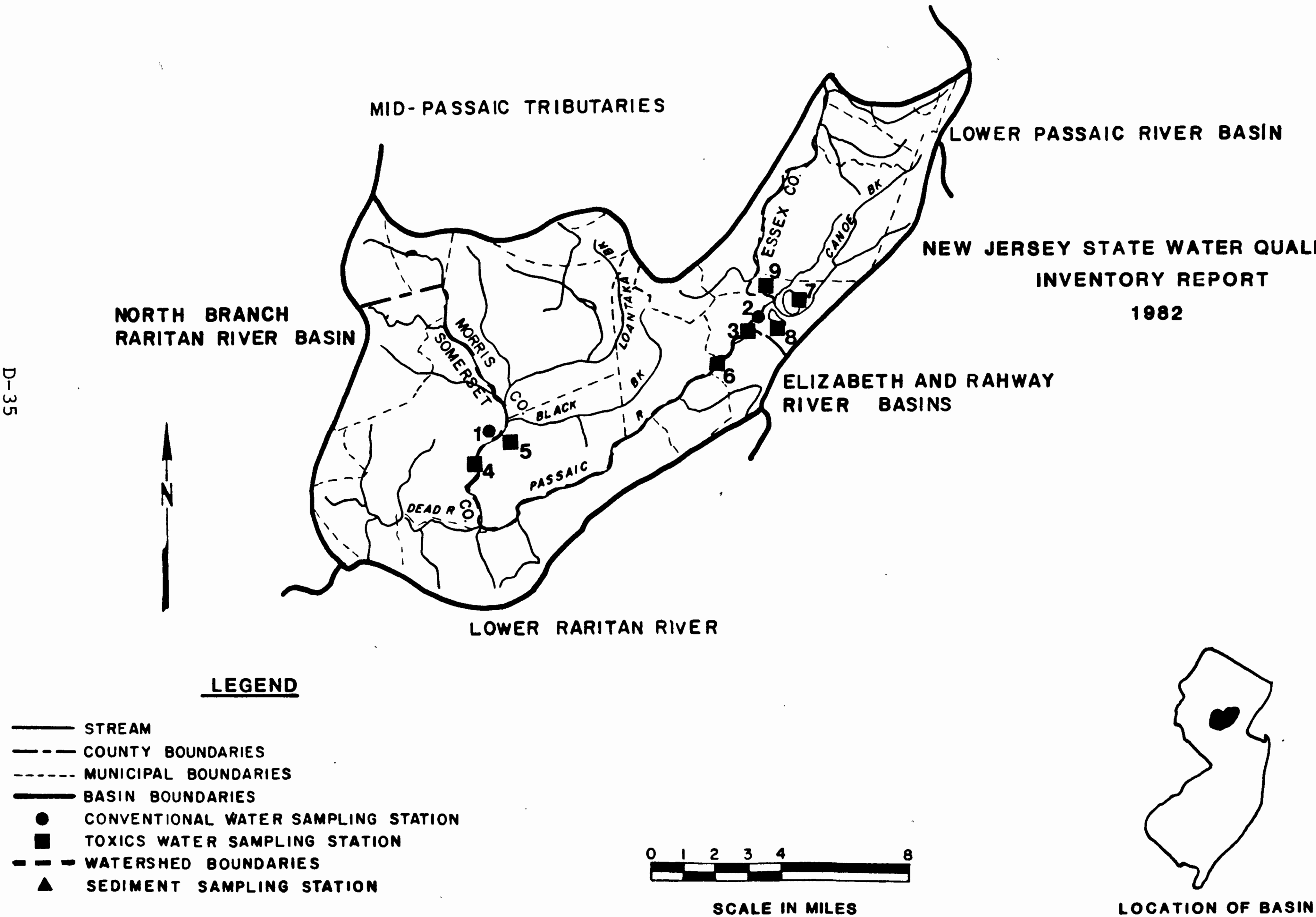
A. Ambient Monitoring Stations

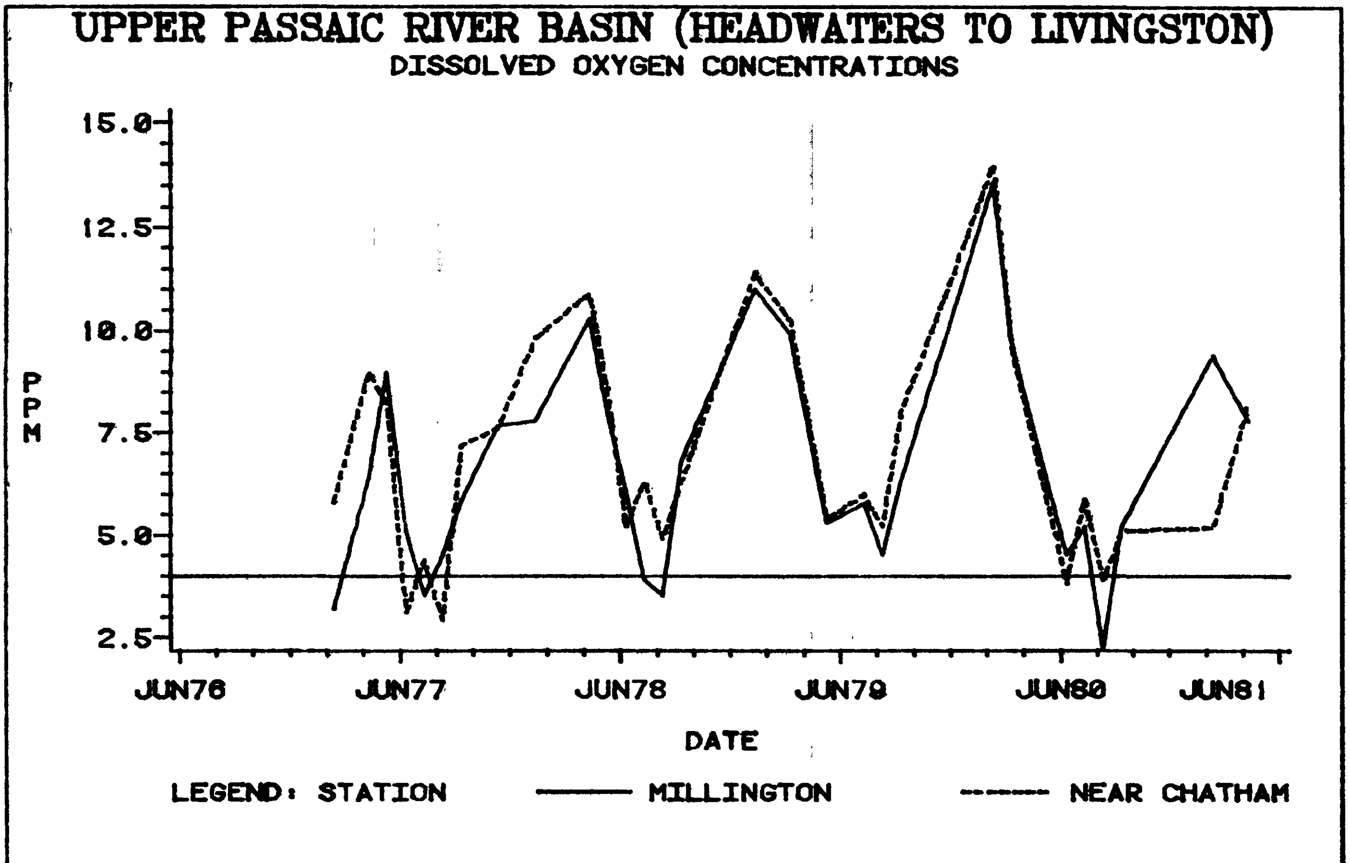
STORET Number	Station Description	Map Number
01379000	Passaic River near Millington, Morris County Latitude 40°40'48" Longitude 74°31'45" FW-2 Nontrout USGS/DEP Network 200 feet downstream of Davis Bridge and 0.7 miles northwest of Millington.	1
01379500	Passaic River near Chatham, Morris County Latitude 40°43'31" Longitude 74°23'23" FW-2 Nontrout USGS/DEP Network At Stanley Avenue bridge in Chatham, 3.0 miles upstream from Canoe Brook.	2

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Passaic River near Chatham	Water column	3
Passaic River at Valley Road, Millington	Water column	4
Passaic River at S. Maple Avenue, Millington	Water column	5
Passaic River at Central Avenue, Berkeley Heights	Water column	6
Canoe Brook, Reservoirs 1,2 and 3	Water column	7,8,9

UPPER PASSAIC RIVER BASIN





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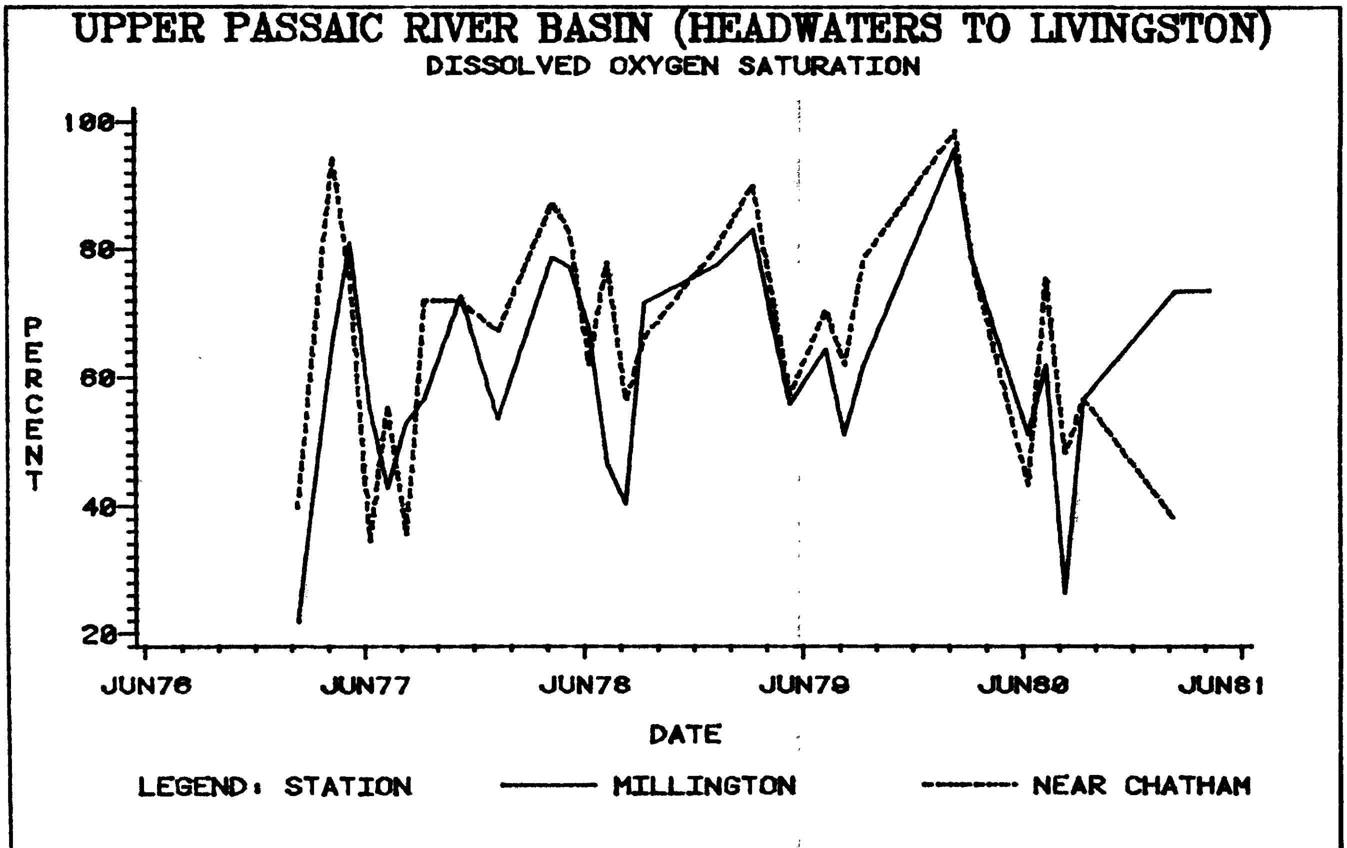

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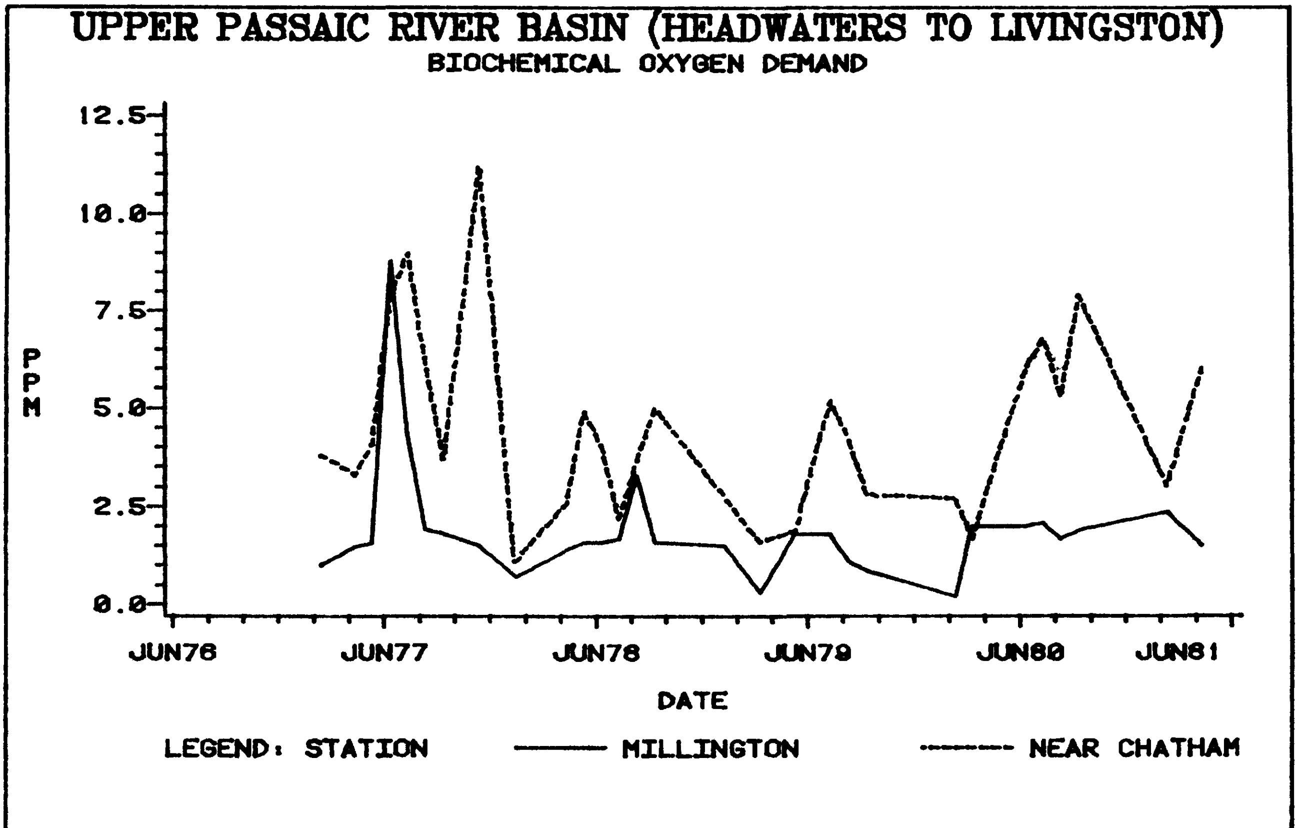

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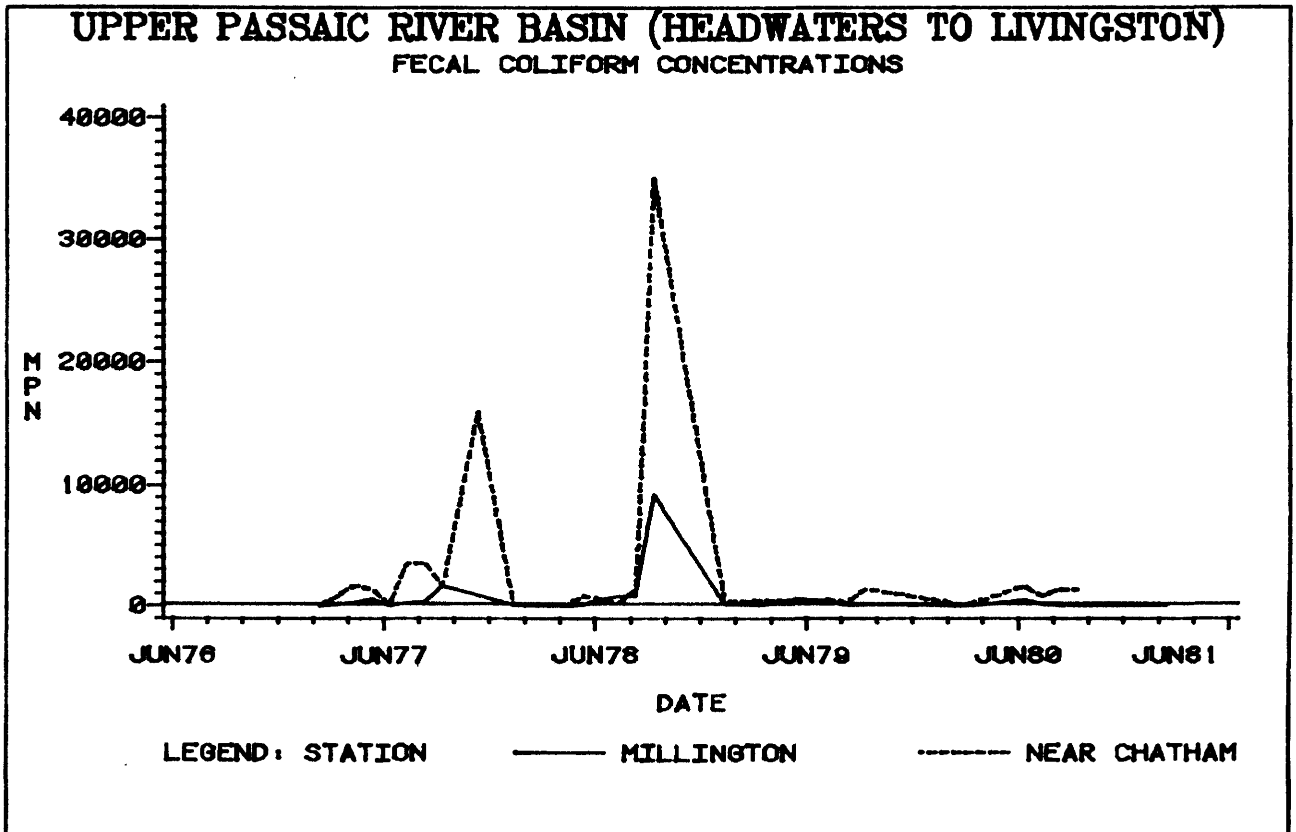

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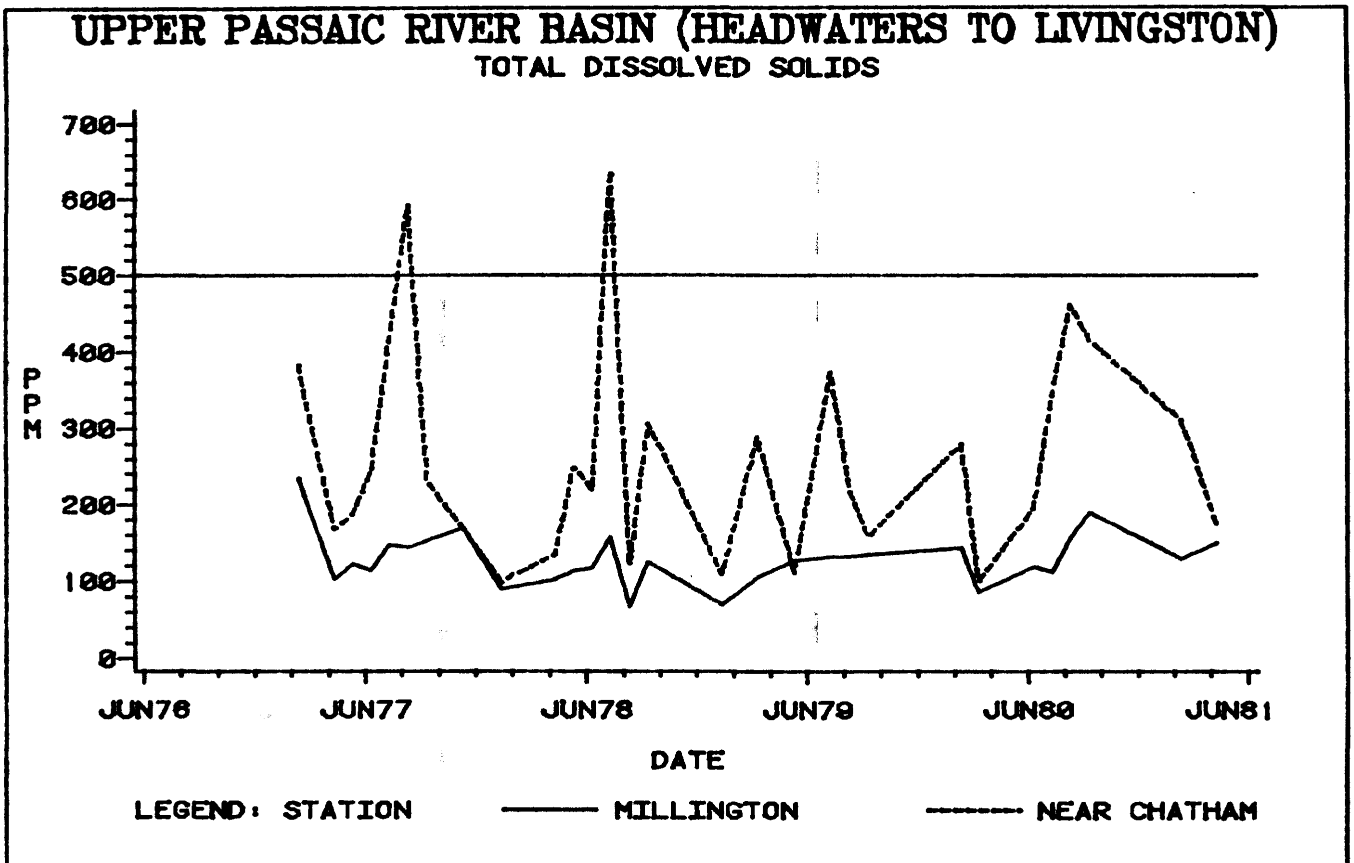

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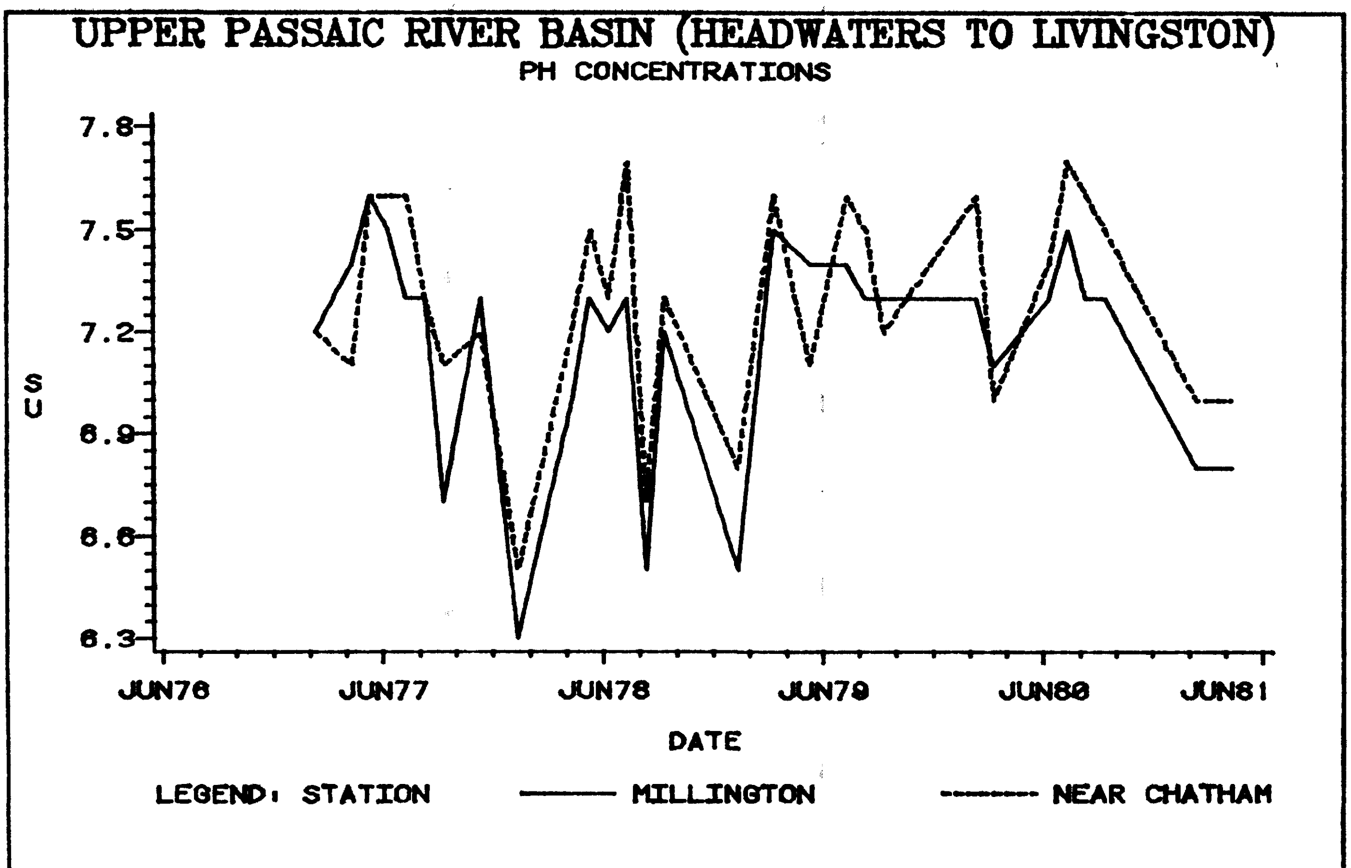

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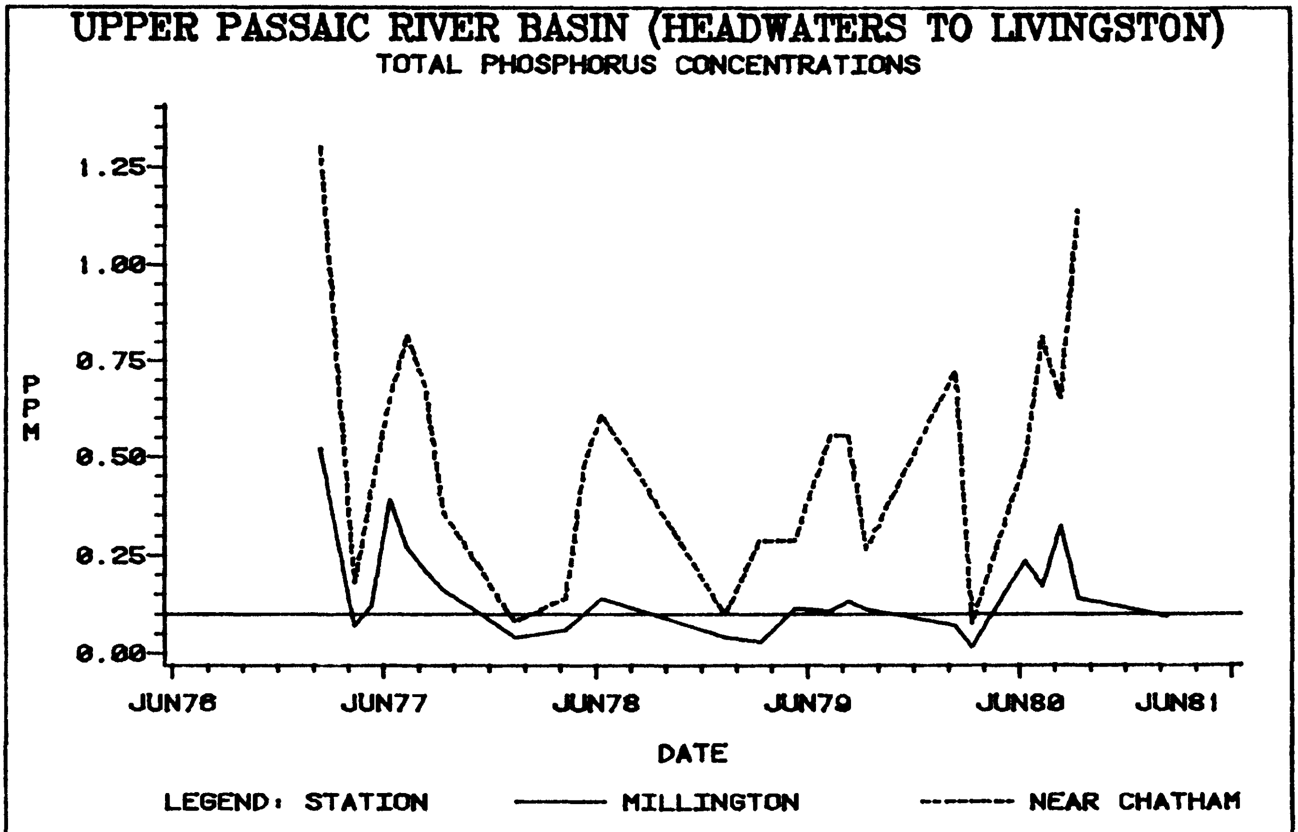

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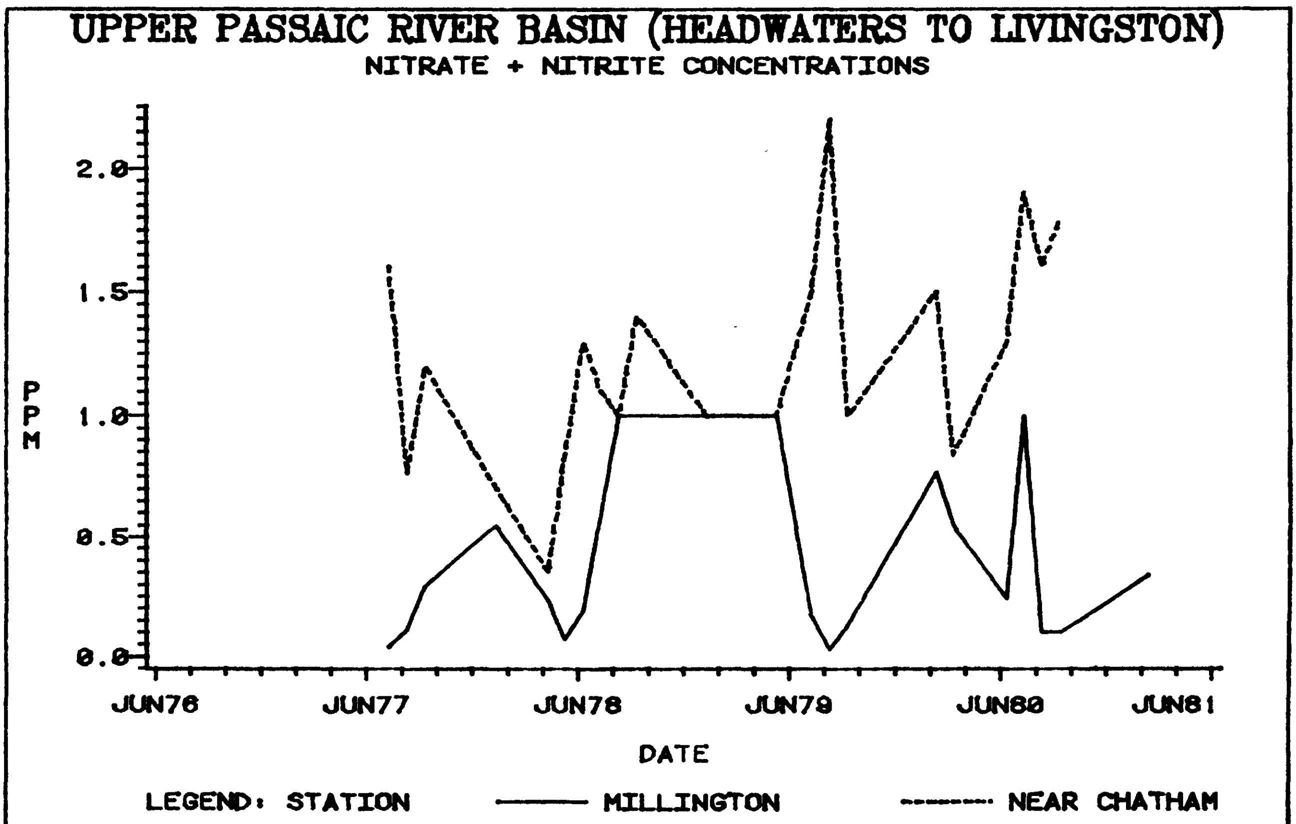

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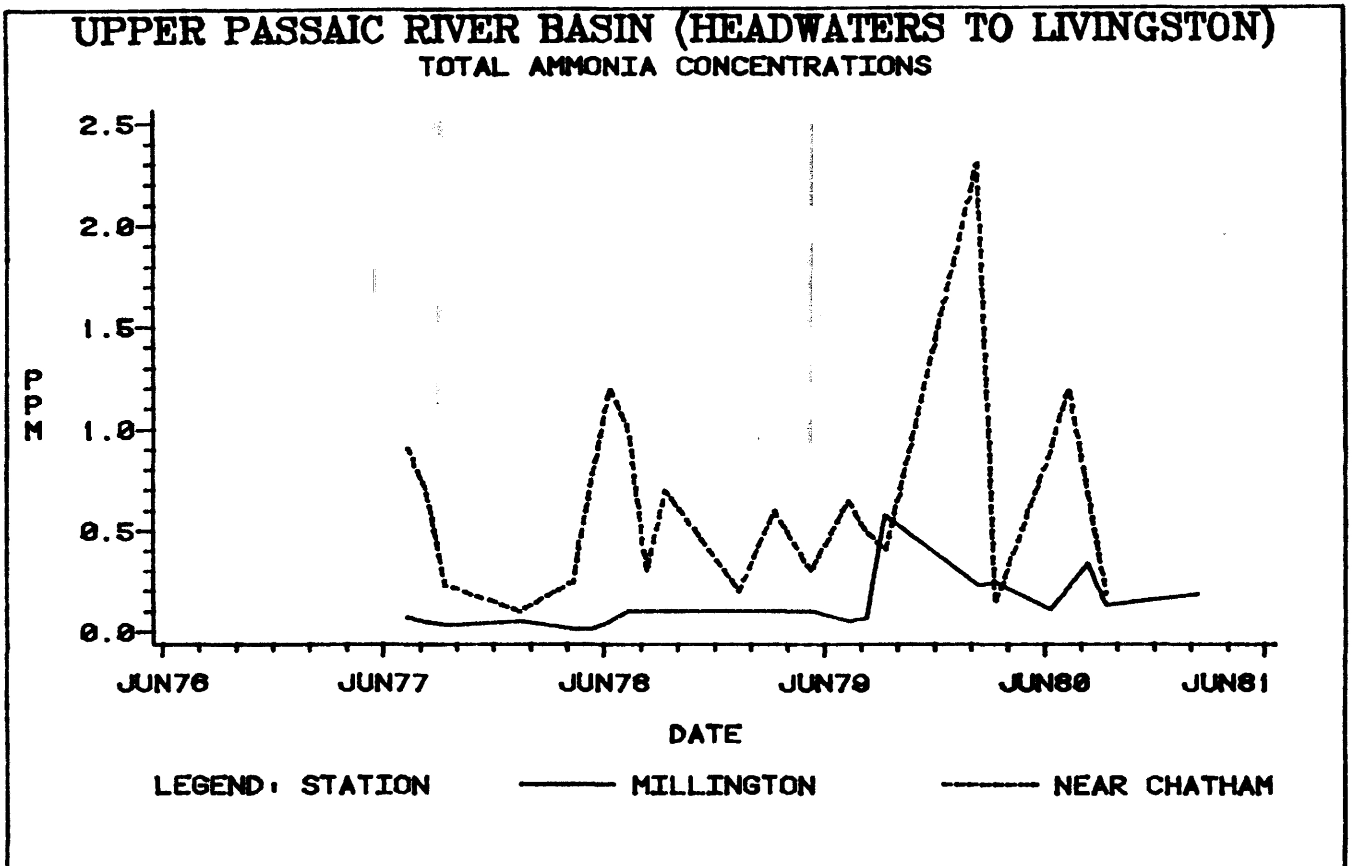

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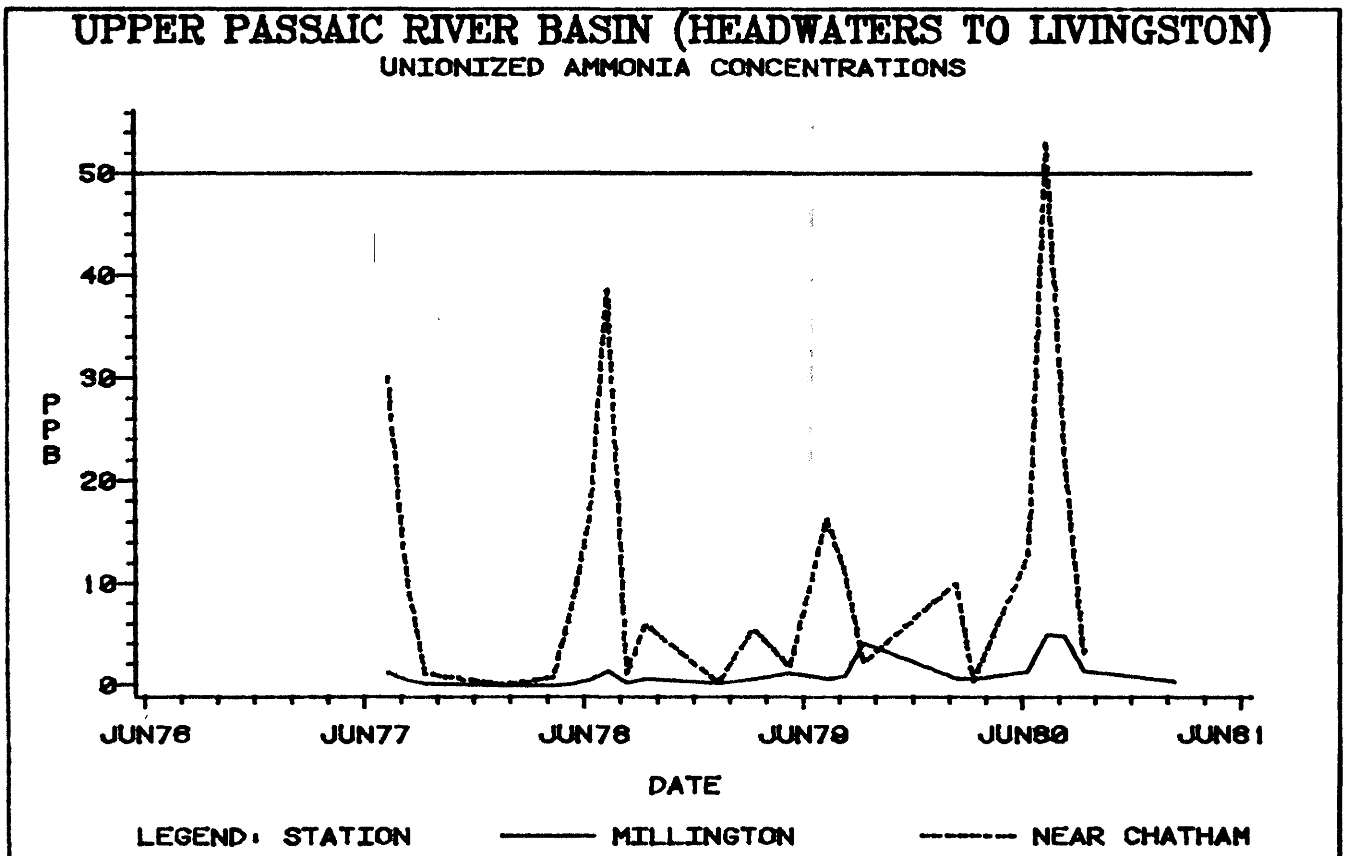


Figure: Y -10

DISCHARGE INVENTORY - - - UPPER PASSAIC RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
REHEIS CHEMICAL CO.	0002551	BERKELEY HEIGHTS TWP	TRIB PASSAIC R	PROCESS WASTE	.59
AUTOMATIC SWITCH CO	0002003	FLORHAM PARK	TRIB PASSAIC R	COOLING WATER	
TOWNSHIP OF WARREN S.A.	0022497	WARREN /TWP/	DEAD RIVER	SANITARY	.30
TOWNSHIP OF BERNARDS S.A.	0022845	LIBERTY CORNER	DEAD RIVER TRIBUTARY OF PASSAI	SANITARY	1.00
BURROUGHS CORP ELEC COMP DIV	0002607	WARREN /TWP/	CORYS BROOK	PROCESS & COOL.	.04
COMMONWEALTH WATER COMPANY	0033596	MILLBURN	CANOE BROOK TRIBUTARY PASSAIC	SANITARY	
TOWNSHIP OF CHATHAM	0020290	CHATHAM TWP	BLACK BROOK	SANITARY	.74
AMAX-SPECIALTY METALS	0001881	EAST HANOVER TWP	BLACK BROOK	PROCESS WASTE	.19
SANDOZ INC	0001155	EAST HANOVER TWP	BLACK BROOK		.50
SISTERS OF CHARITY-ST. ELIZABE	0026654	FLORHAM PARK	BLACK BROOK	SANITARY	.09
MILLINGTON QUARRY INC	0002925	MILLINGTON	LONG HILL BROOK	COOLING WATER	.12
NABISCO INC	0002577	FAIRLAWN	HENDERSON BROOK	COOLING WATER	.17
TOWNSHIP OF MORRIS SEWER DEPT	0024929	MORRIS /TWP/	LOANTAKA BR.	SANITARY	1.10
VILLAGE OF RIDGEWOOD	0024791	GLEN ROCK	HOHOKUS BROOK	SANITARY	2.60
NORTHWEST BERGEN COUNTY S.A.	0024813	WALDWICK	HOHOKUS BROOK	SANITARY	
NEW JERSEY DOT	0029912	HARDING TOWNSHIP	GREAT BROOK	SANITARY	
WHITE METAL MFG CO	0030953	HAWTHORNE	GOFFLE BROOK		
M POLANER & SON INC	0003743	ROSELAND	FULLERTONS BK	COOLING WATER	.40
GLASFLEX CORP	0029963	STIRLING	TRIB OF PASSAIC RIVER	COOLING WATER	
MADISON-CHATHAM JOINT MEETING	0024937	CHATHAM	PASSAIC R.	SANITARY	2.69
PARK CENTRAL INC	0020281	CHATHAM TWP	PASSAIC R.	SANITARY	
US ARMY NIKE 79/80 E HANOVER	0021938	EAST HANOVER TWP	PASSAIC R.	SANITARY	
TOWNSHIP OF LIVINGSTON	0024511	LIVINGSTON TWP	PASSAIC R.	SANITARY	3.12
VETERANS ADM. HOSPITAL	0021083	LYONS	PASSAIC R.	SANITARY	.27
BOROUGH OF NEW PROVIDENCE WTP	0021636	NEW PROVIDENCE	PASSAIC R.	SAN/SIG INDUS	.79
TOWNSHIP OF WARREN S.A.	0022489	WARREN /TWP/	PASSAIC R.	SANITARY	.27
WILKINSON SWORD INC.	0028266	BERKELEY HEIGHTS	PASSAIC RIVER	COOLING WATER	
GIBSON TUBE INC	0034801	BERKELEY HTS	PASSAIC RIVER		
TOWNSHIP OF BERKELEY HEIGHTS	0027961	BERKELEY HTS	PASSAIC RIVER	SAN/SIG INDUS	1.63
CHATHAM PLASTICS INC	0031496	CHATHAM	PASSAIC RIVER	PROCESS WASTE	
CULLIGAN SOFT WATER	0028193	CHATHAM	PASSAIC RIVER	COOLING WATER	.00
ORANGE PRODUCTS INC	0001490	CHATHAM	PASSAIC RIVER	COOLING WATER	
NATIONAL MANUFACTURING COMPANY	0032573	CHATMAM	PASSAIC RIVER	COOLING WATER	
CHEMSERVICES INC.	0035637	EAST HANOVER	PASSAIC RIVER		
ROYAL LUBRICANTS INC	0035645	EAST HANOVER	PASSAIC RIVER		
FRITZCHE DODGE & OLCOTT	0001651	EAST HANOVER TWP	PASSAIC RIVER	PROCESS WASTE	.53
FLORHAM PARK SEW. AUTH.	0025518	FLORHAM PARK	PASSAIC RIVER	SANITARY	.90
ALLIED CHEMICAL CORPORATION	0031305	MORRISTOWN	PASSAIC RIVER		
ST MARY'S ABBEY	0026751	MORRISTOWN	PASSAIC RIVER	SANITARY	
RESISTOFLEX CORP	0029955	ROSELAND	PASSAIC RIVER	PROCESS WASTE	.04
TOWNSHIP OF PASSAIC	0024465	STIRLING	PASSAIC RIVER	SANITARY	.80
CIBA-GEIGY CORP	0000540	SUMMIT	PASSAIC RIVER		.20
CITY OF SUMMIT CHATHAM RD PUMP	0033464	SUMMIT	PASSAIC RIVER		
ANTHONY FERRANTE & SONS,INC.	0029637	BERNARDSVILLE	MINE BROOK	PROCESS WASTE	.22
CELANESE RESEARCH COMPANY	0033197	SUMMIT	BRIANT POND.	COOLING WATER	
CELANESE RESEARCH CO	0035327	SUMMIT	BRYANT ROAD		
PALNUT DIVISION OF TRW INC	0035530	MOUNTAINSIDE	ECHO BROOK		
THE STELLA PRODS CORP	0024180	LIVINGSTON TWP	PASSAIC RIVER	COOLING WATER	

Z. MID-PASSAIC RIVER (LIVINGSTON TO LITTLE FALLS)

Basin Description

The Mid-Passaic River basin begins at the confluence of the Passaic River with the Whippany and Rockaway Rivers and includes lands downstream to Little Falls. Major and minor tributaries enter the Passaic River after it bends to the east. The largest tributary is the Pompton River which adds substantial flow to the main stem of the Passaic. Other tributaries include Deepavall and Signac (or Preakness) Brooks, which contain numerous point source dischargers. The drainage area of this river segment is approximately 33 square miles. The Mid-Passaic basin is relatively flat and contains numerous marshes and swamps, of which the Great Piece Meadows is the largest. The average flow to 1980 for the Passaic River at Little Falls is 1169 cfs which includes waters from the Pompton River tributary.

The Mid-Passaic, not including the major tributaries of the New and Pompton Rivers, is approximately 67 percent undeveloped consisting mostly of marsh lands. The next largest land use is the residential sector which accounts for 27 percent. This type of development occurs along the boundaries of the wetlands. Commercial and industrial development (6 percent) is limited by the available land within the basin. Much of the basin is susceptable to flooding. The DEP and the Army Corps of Engineers are currently investigating mitigating measures to control flood waters. The population for two of the four municipalities within the basin have shown a decrease from 1970 to 1980. The two municipalities with substantial growth were Fairfield and Montville Township whose populations increased approximately 16 percent and 20 percent, respectively. The only municipal sewage treatment plant in the Mid-Passaic basin is the Caldwell Plant which has a capacity of 4.5 mgd. There are 47 additional point sources which are mostly small industrial dischargers.

The Mid-Passaic River is an important potable water source. At Little Falls, the Passaic Valley Water Commission has an intake which withdraws about 50 mgd. Also, many industrial facilities utilize Passaic River water for industrial cooling, processing and fire protection purposes.

Mid-Passaic recreational opportunities are entirely non-contact and include fishing, boating and nature study. Numerous municipal parks are present. The New Jersey Wild and Scenic River System has ranked this basin as second in the State for inclusion in the system (this portion is included with the Upper Passaic boundaries for ranking). The New Jersey Water Quality Standards list the entire Mid-Passaic basin as FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

The segment of the Passaic River between Livingston and Little Falls exhibited poor water quality from 1977-1981, particularly during the drought period after 1979. This represents an overall decline from the conditions seen in the upstream segment (headwaters to Livingston). This conclusion is based on the sampling results from the Passaic River at Two Bridges (Morris County and Little Falls (Passaic County).

Daytime dissolved oxygen levels were generally sufficient during the winter months at Two Bridges, but fell below the 4.0 mg/l minimum criterion each summer. These reductions correspond to percent saturation levels of less than 30 percent. Increased stream velocities and aeration in rocky segments below Two Bridges resulted in higher dissolved oxygen concentrations at Little Falls (daytime values remained within the compliance standard year-round). A slight decline in dissolved oxygen values was recorded at Little Falls during 1980 due to low flow conditions. The drought also resulted in a general increase in biochemical oxygen demand, which was at moderate to high levels throughout the period at both stations.

Fecal coliform concentrations were for the most part excessive throughout the segment during the period. Values less than 200 MPN/100 ml accounted for only 15 percent of the data from both stations during 1977 to 1981.

Total dissolved solids concentrations were within the criterion for the period, normally ranging from 100 to 400 mg/l. The pH concentrations at Two Bridges and Little Falls were in general neutral through the period with slightly alkaline values occuring at Little Falls toward the end of the period.

Nutrient levels were also excessive with 93 percent of the total phosphorus data acquired at both Two Bridges and Little Falls exceeding the standard. In addition, values exceeding 1.0 mg/l were measured at Little Falls during the dry period in 1980. A rough pattern of winter rises and summer declines was apparent for the nitrate + nitrite data in the segment indicating some assimilation of the nutrients by the aquatic flora. The winter peak levels generally exceeded 2.0 mg/l at Two Bridges. Total and un-ionized ammonia concentrations were periodically elevated or even excessive throughout the segment. The dry or low flow period beginning in 1980 resulted in extreme values for both total and un-ionized ammonia at Little Falls. In fact, two un-ionized ammonia values recorded during 1980 at Little Falls exceeded 200 ug/l, indicative of a serious problem.

Biological sampling for periphyton and macroinvertebrate communities in the Mid-Passaic River was performed in 1977 and 1978 at Signac. Although the station showed signs of organic degradation, the periphyton chlorophyll a values were relatively low. The dominant macroinvertebrate taxonomic groups were chironomids (midges), trichopterans (caddisflies) and oligochaetes (worms). In 1977, the worm Nais josinae comprised 50% of the individuals collected.

Water quality trends in this stretch of the Passaic River are not evident. Conditions are similar in the Passaic at Two Bridges, while no comparisons are possible at Little Falls since water quality here was not discussed in prior 305(b) reports.

Toxic Parameters

The assessment of toxic pollutants in the Mid-Passaic reach covers the river stretch from the junction of the Rockaway and Whippany Rivers to the Fairlawn Avenue crossing of the Passaic River. Data generated by OCTSR in the Mid-Passaic includes grab samples at nine sites along the main stem, as well as samples collected from major tributaries to the Passaic River during the recent drought (December, 1980), in the vicinity of the Passaic Valley Water Commission (PVWC) plant which provided composite results over a 96-hour time period.

Results show the presence of several volatile organic compounds occurring along the stretch of river sampled. The compounds detected occurred at low concentrations, generally less than 10 ug/l (ppb); these concentrations are not uncommon in New Jersey surface waters flowing through developed areas. At one site, PCB concentrations greater than 100 ug/l were measured; this value is quite high for surface waters.

The other baseline data which OCTSR has generated in the Mid-Passaic River has centered around PVWC. Two sites were chosen along the river: one at the PVWC intake point and one downstream at Fairlawn Avenue. The other sites sampled included treated drinking water collected within the plant and one sampling site for delivered water. It should be noted that samples for volatile organic analysis were collected as grab samples at the beginning of each 24-hour sampling interval.

The results of the four day composite sampling effort indicate an increase in the number and concentrations of toxic contaminants detected in the Passaic River at the Fairlawn Avenue site in comparsion to the upstream site at PVWC. The concentrations of individual compounds are low, but the number of compounds detected reflect the effect that numerous industrial point source discharges have on this section of the Passaic River. The pollutant concentrations measured during the four day study cannot be considered "typical" for the Passaic River because of the drought conditions which resulted in decreased river flow. These results should be viewed as one example of extreme conditions in the Passaic River; more sampling is needed to characterize another extreme condition which is the effect that storm conditions and urban runoff have on the Passaic River.

The occurrence of toxic contaminants entering the Passaic River during storm events is an area of interest at OCTSR, and a storm water sampling program has been designed for implementation in the vicinity of PVWC. The Passaic River drainage basin is among the top priorities for present and future surface water studies to be performed by OCTSR. These studies will be conducted in well defined river segments where intense sampling programs of surface water, sediments, and aquatic biota are needed.

Problem Assessment

The Mid-Passaic's water quality is the result of similar, but more demanding conditions, than noted in the upper Passaic River basin. The river is dominated by point sources both in the beginning and at the end of the segment. The mid portion, a slow meandering swamp, also contributes to a lack of dissolved oxygen. Point sources are the main contributors of nutrients, ammonia, and dissolved solids. Some septic tank problems in remote areas were reported and resolved, but this would be insignificant for this area. The high levels of fecal coliform found are probably the result of urban/suburban runoff and occasional point source treatment malfunctions.

The Mid-Passaic also appears to be affected by the numerous industrial discharges, as in evidenced by the frequency in which toxic substances were found in the water column. The low flow or drought period (mid-1980 to through mid-1981) also had profound impacts on water quality in this area of the Passaic River. In late 1980 and early 1981 natural flows in the Passaic at Little Falls were so low that approximately 75 percent of the total flows were comprised of upstream wastewater discharges.

Goal Assessment and Recommendations

The waters of the Mid-Passaic River basin do not meet the goals of swimmable quality due to the frequency with which samples exceeded the fecal coliform concentration of 200 MPN/100 ml. The segment does meet the fishable goal; however, the dissolved oxygen and un-ionized ammonia concentrations frequently do not meet state Surface Water Quality criteria. Very stressful conditions for fishlife (warm water species) must occur in this segment during summer months. It is recommended that the point source discharges be upgraded for this segment, as stated in the Northeast Water Quality Management Plan and based on the 1982 Passaic River intensive survey.

In addition, it is recommended that continued and intensive sampling for toxic parameters be maintained because of the importance the Passaic has for supplying potable water. Storm-water controls, for the purpose of improving runoff quality, is needed along with point source controls if water quality is to be improved in the Mid-Passaic River. Biomonitoring of the Passaic River is lacking and, therefore, should be implemented at various sites on the river.

MID-PASSAIC RIVER STATION LIST

A. Ambient Monitoring Stations

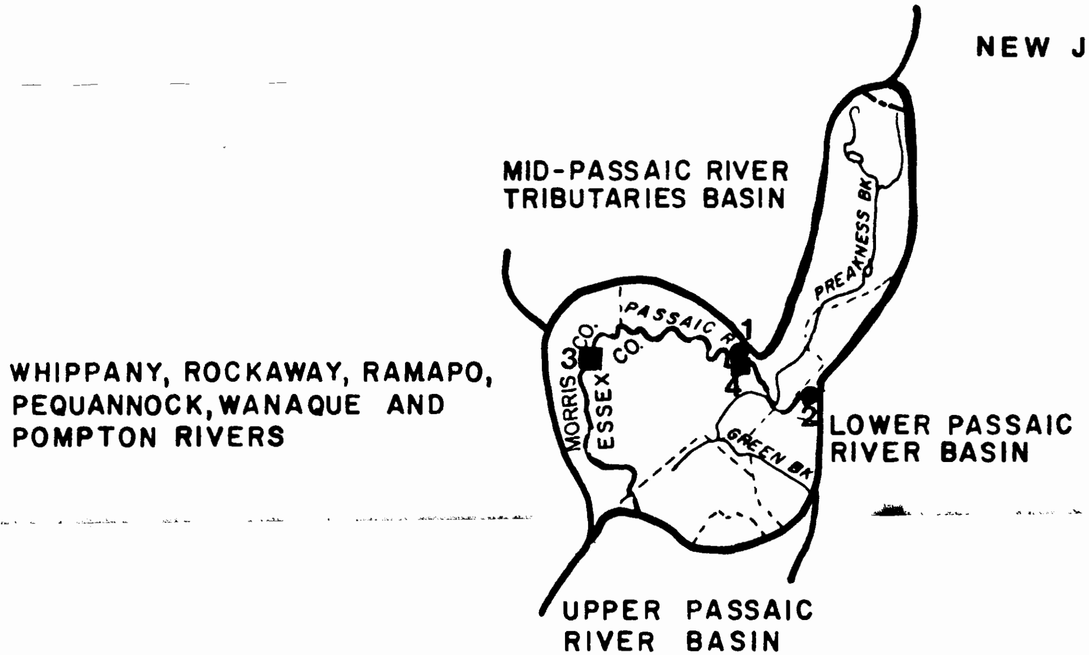
STORET Number	Station Description	Map Number
01382000	Passaic River at Two Bridges, Morris County Latitude 40°53'40" Longitude 74°16'23" FW-2 Nontrout USGS/DEP Network At bridge on Two Bridges Road in Two Bridges, 50 feet upstream from Pompton River.	1
01389500	Passaic River at Little Falls, Passaic County Latitude 40°53'05" Longitude 74°13'35" FW-2 Nontrout USGS/SEP Network Passaic Valley Water Commission monitoring station. 0.6 miles downstream from Beatie's Dam in Little Falls and 1.0 mile upstream from the Peckman River.	2

B. Toxics Monitoring Stations

Station Location	Sampling Regime	Map Number
Passaic River at Eagle Rock Avenue, Caldwell	Water column	3
Passaic River at Lincoln Park	Water column	4
Intensive survey of Mid-Passaic River (nine stations)	Water column	-

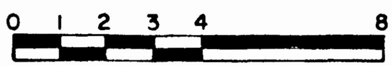
MID-PASSAIC RIVER BASIN

NEW JERSEY STATE WATER QUALITY INVENTORY REPORT 1982

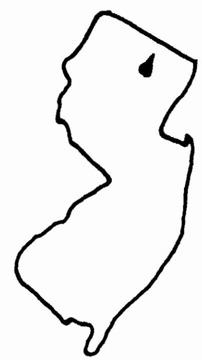


LEGEND

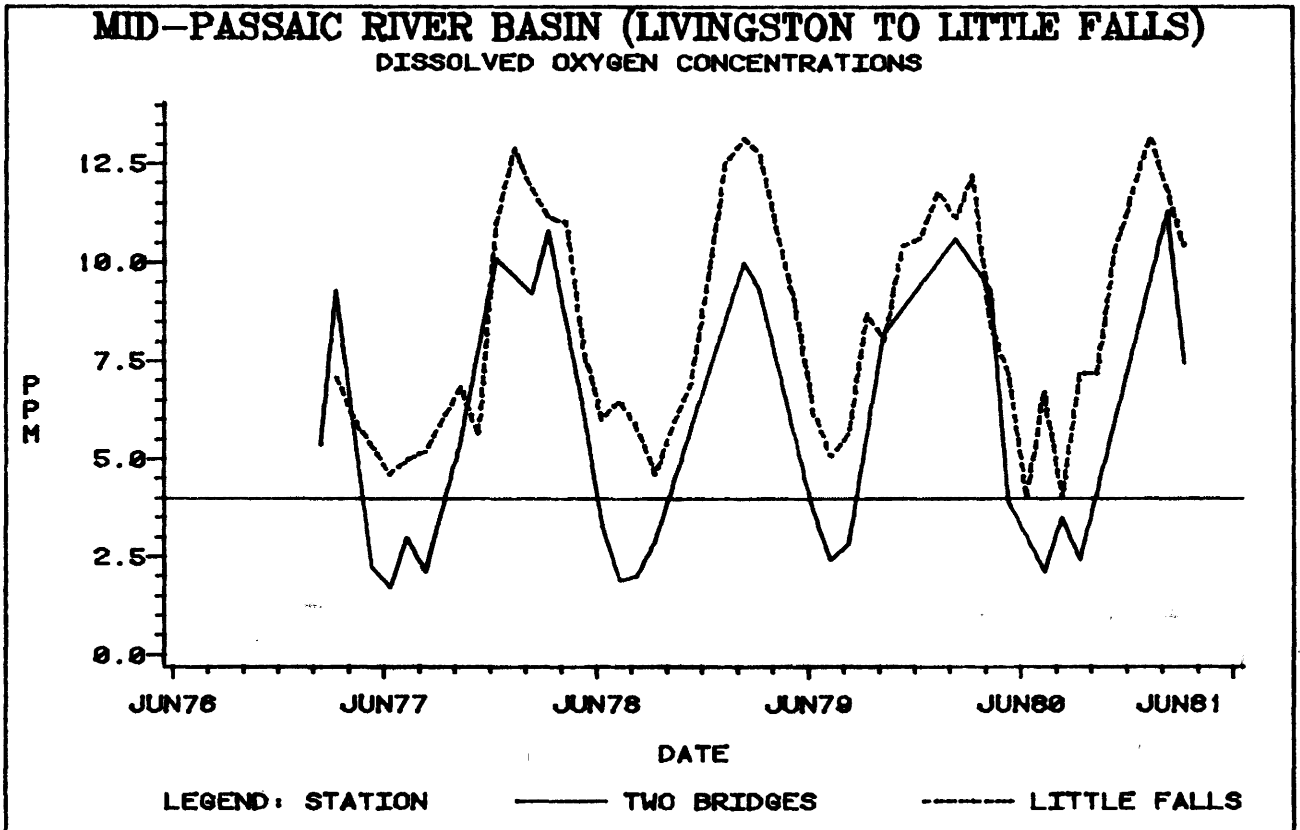
- STREAM
- COUNTY BOUNDARIES
- MUNICIPAL BOUNDARIES
- BASIN BOUNDARIES
- ● CONVENTIONAL WATER SAMPLING STATION
- ■ TOXICS WATER SAMPLING STATION
- WATERSHED BOUNDARIES
- ▲ SEDIMENT SAMPLING STATION
- ○ FISH TISSUE SAMPLING STATION



SCALE IN MILES



LOCATION OF BASIN



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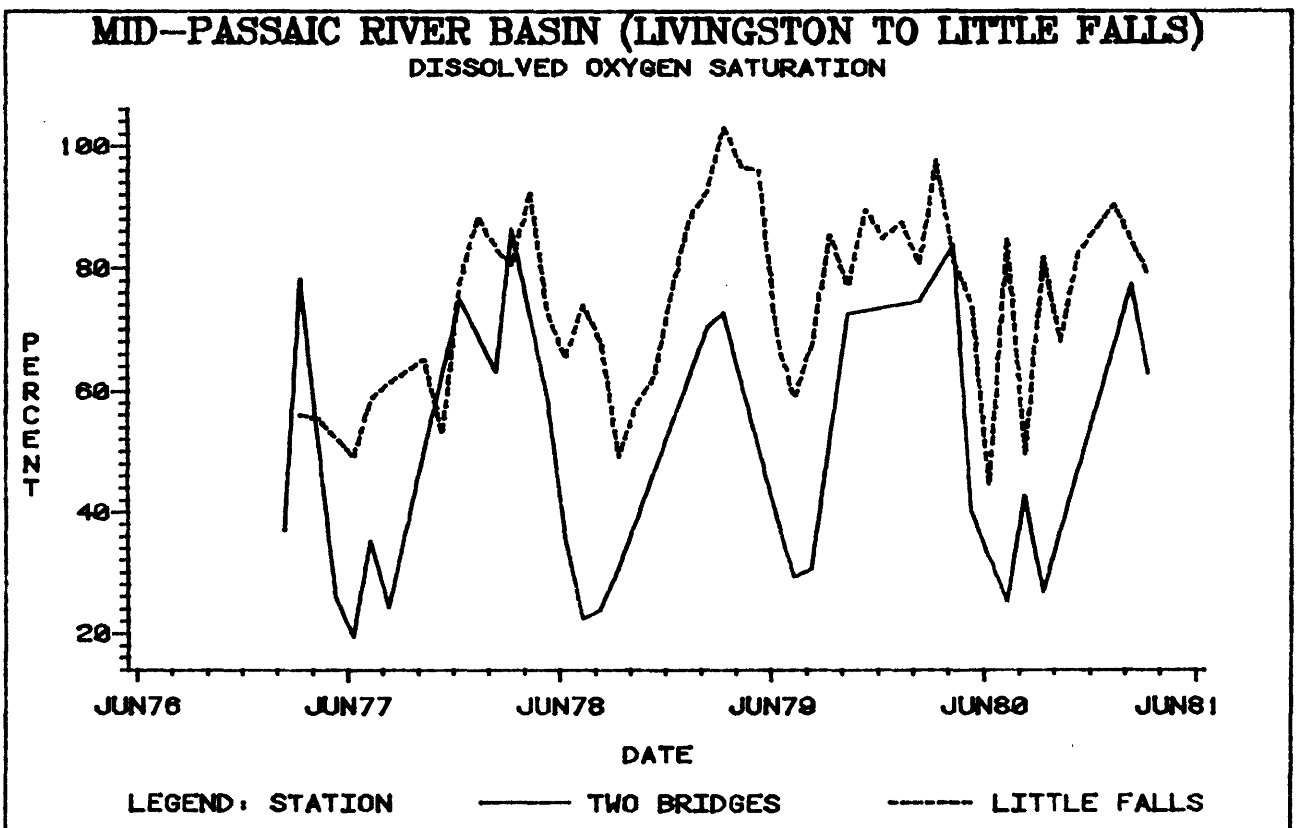

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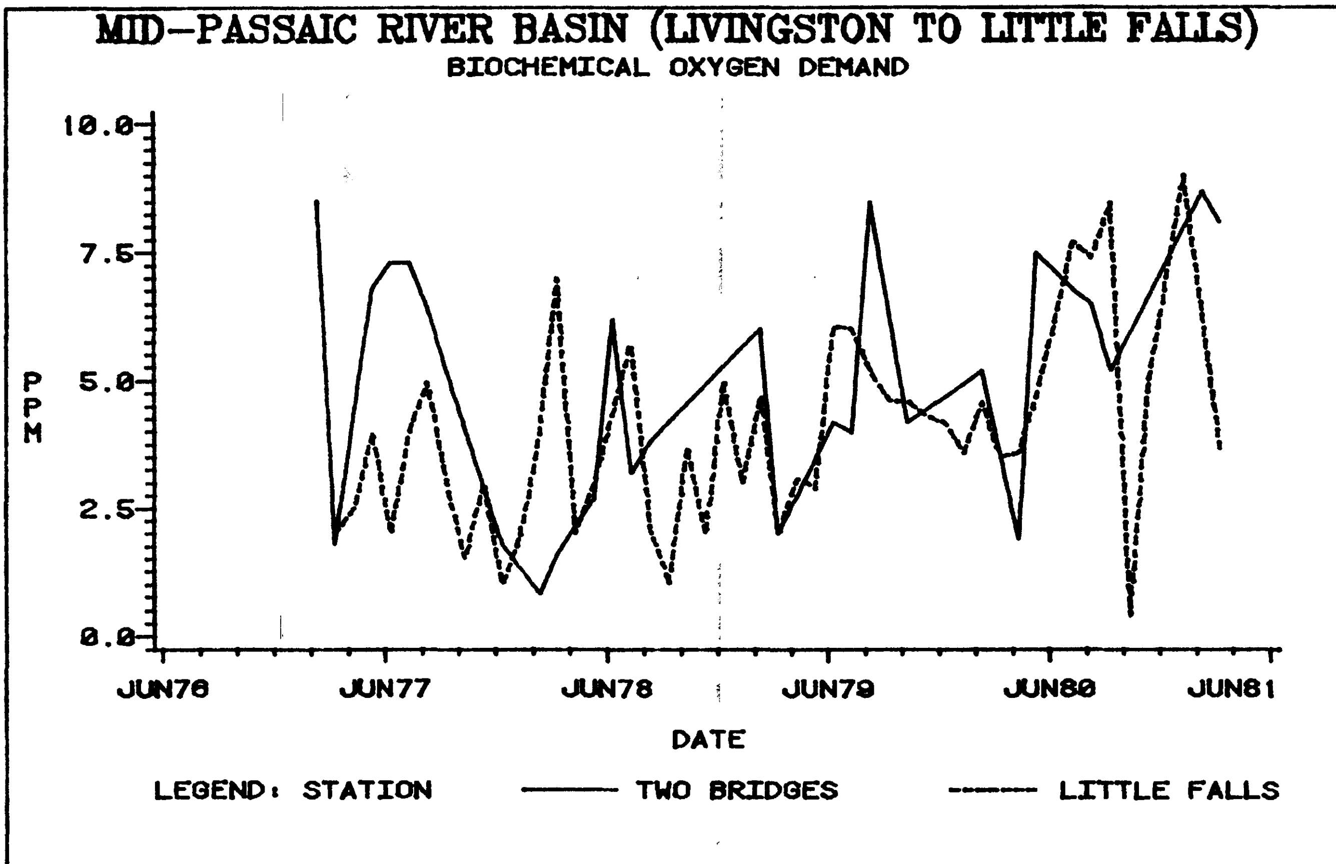

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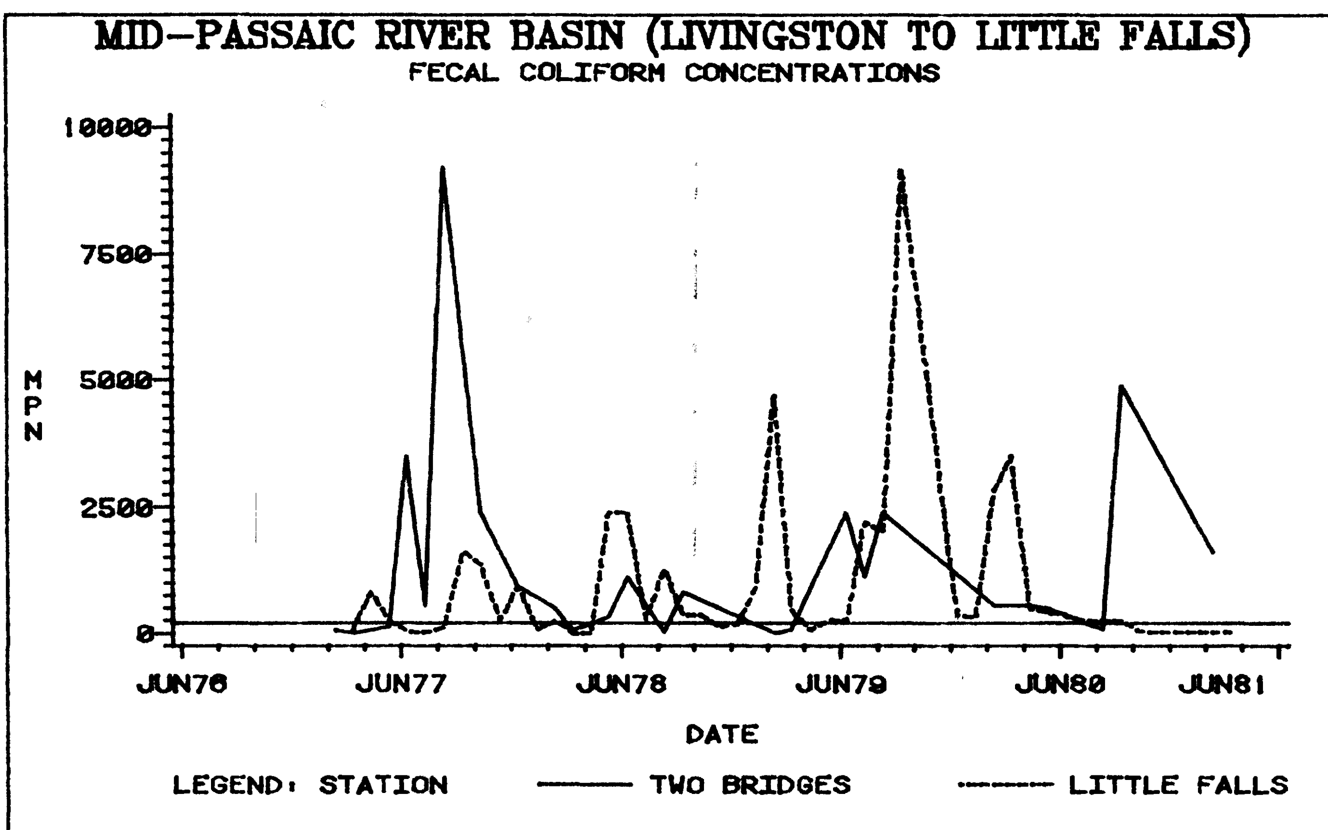

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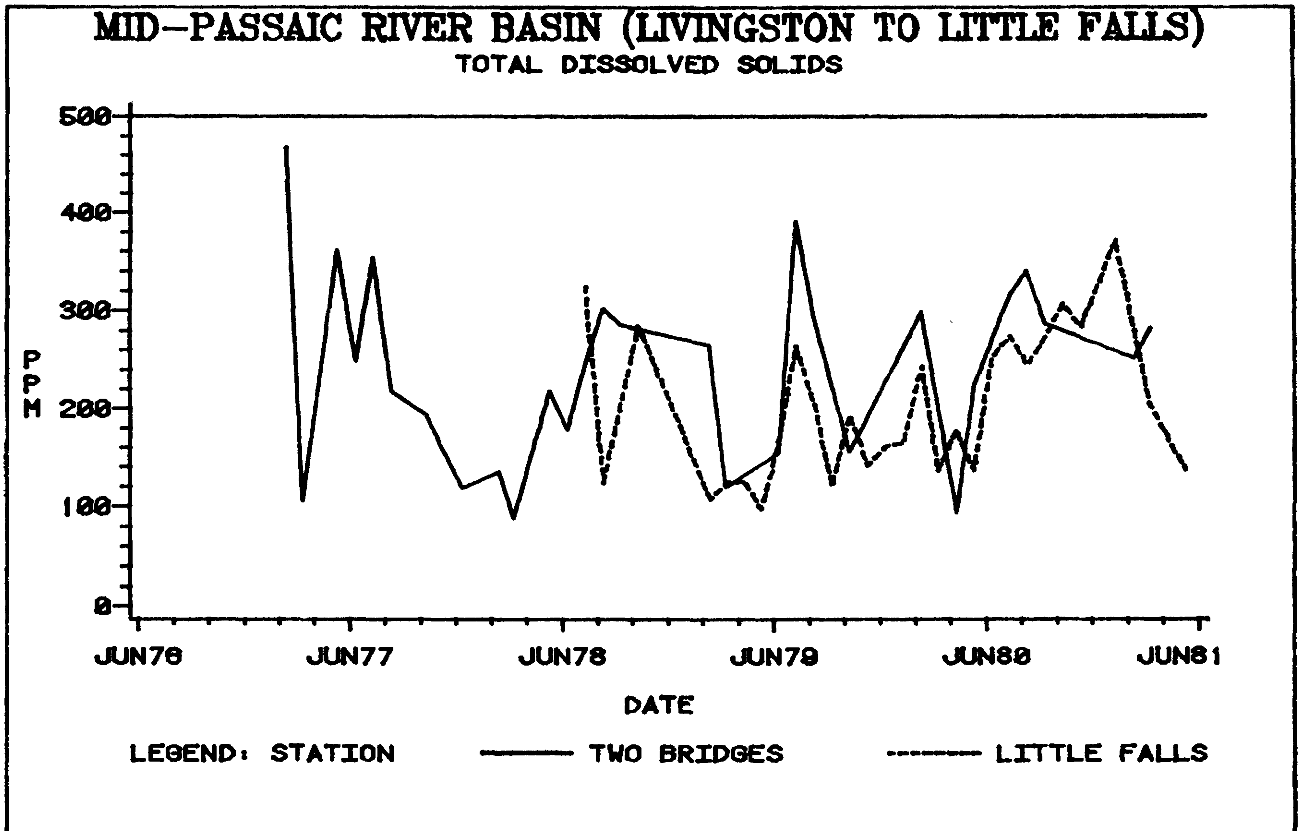

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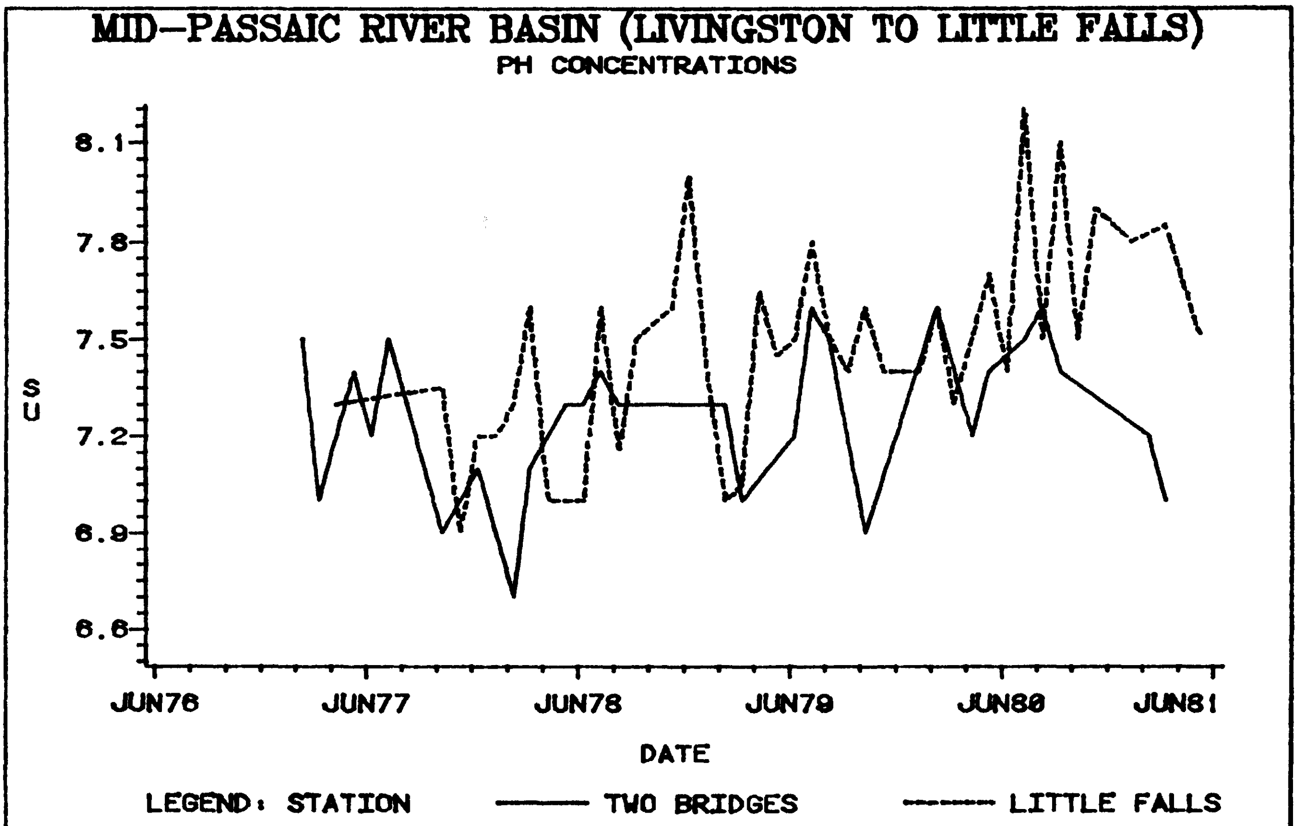

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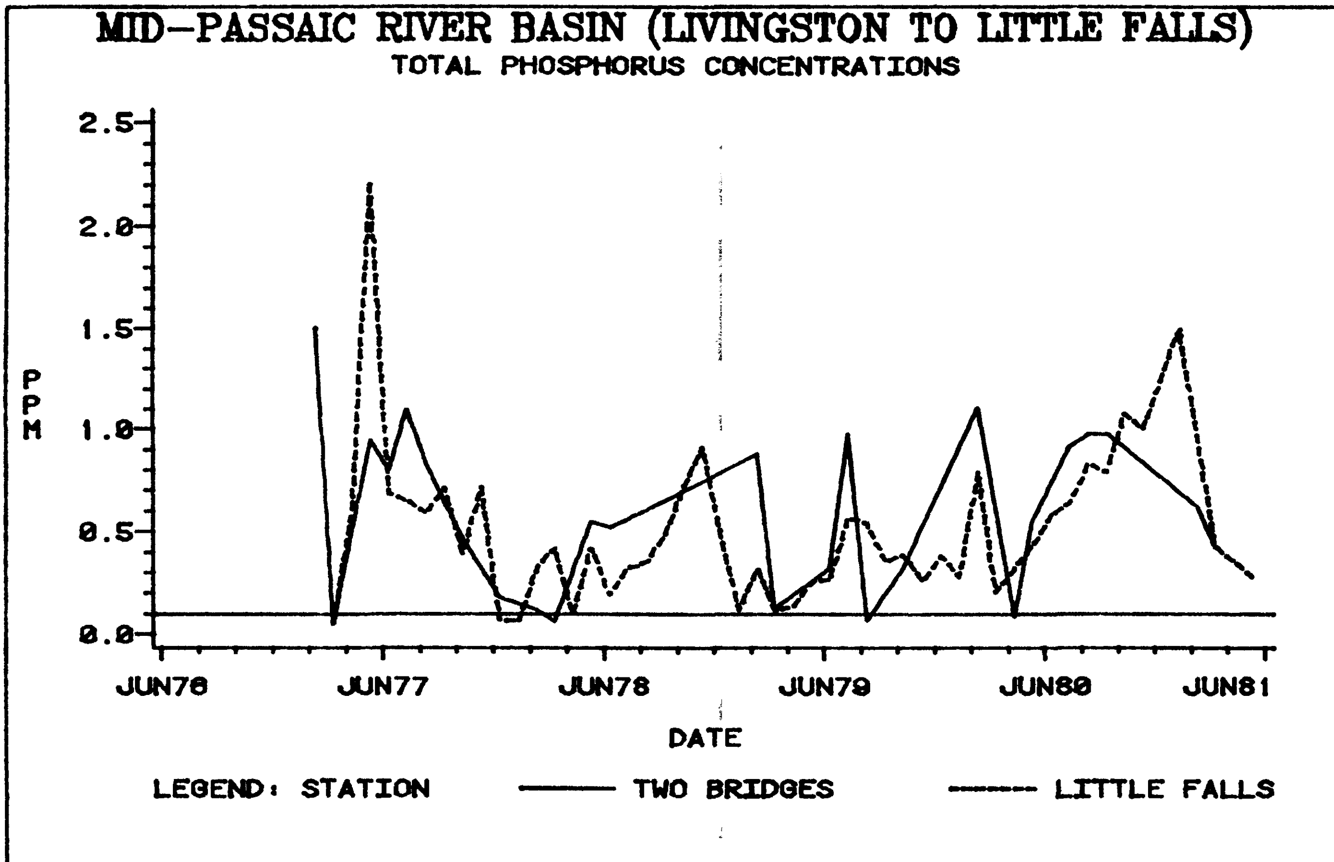

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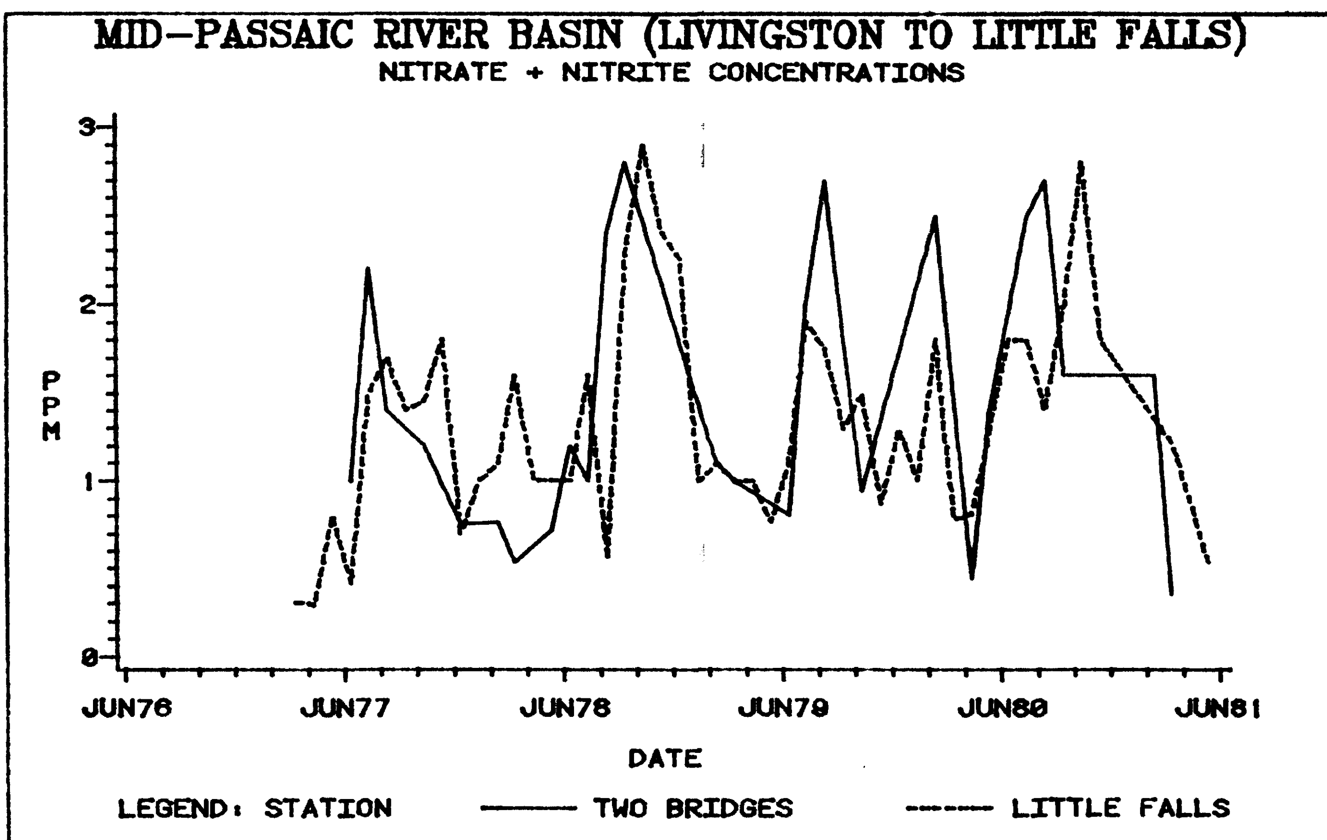

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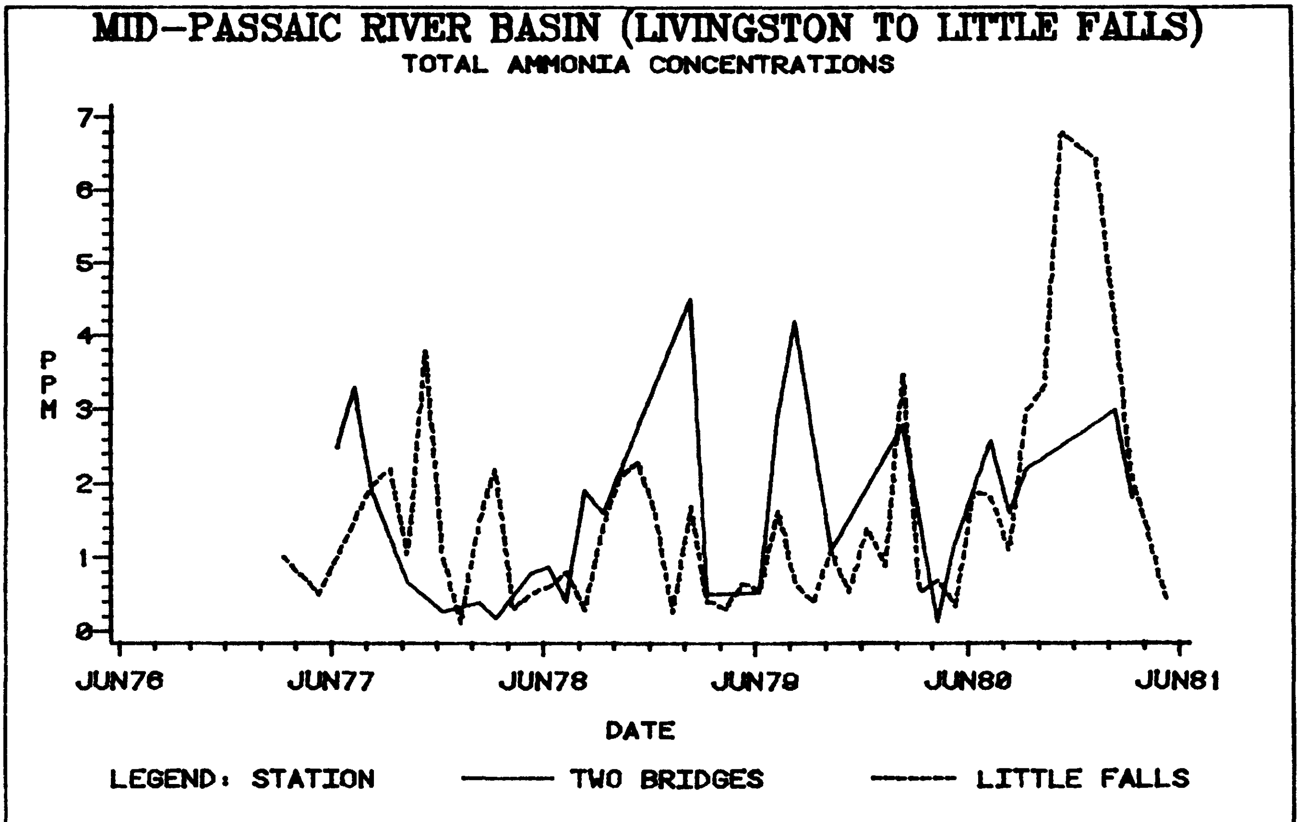

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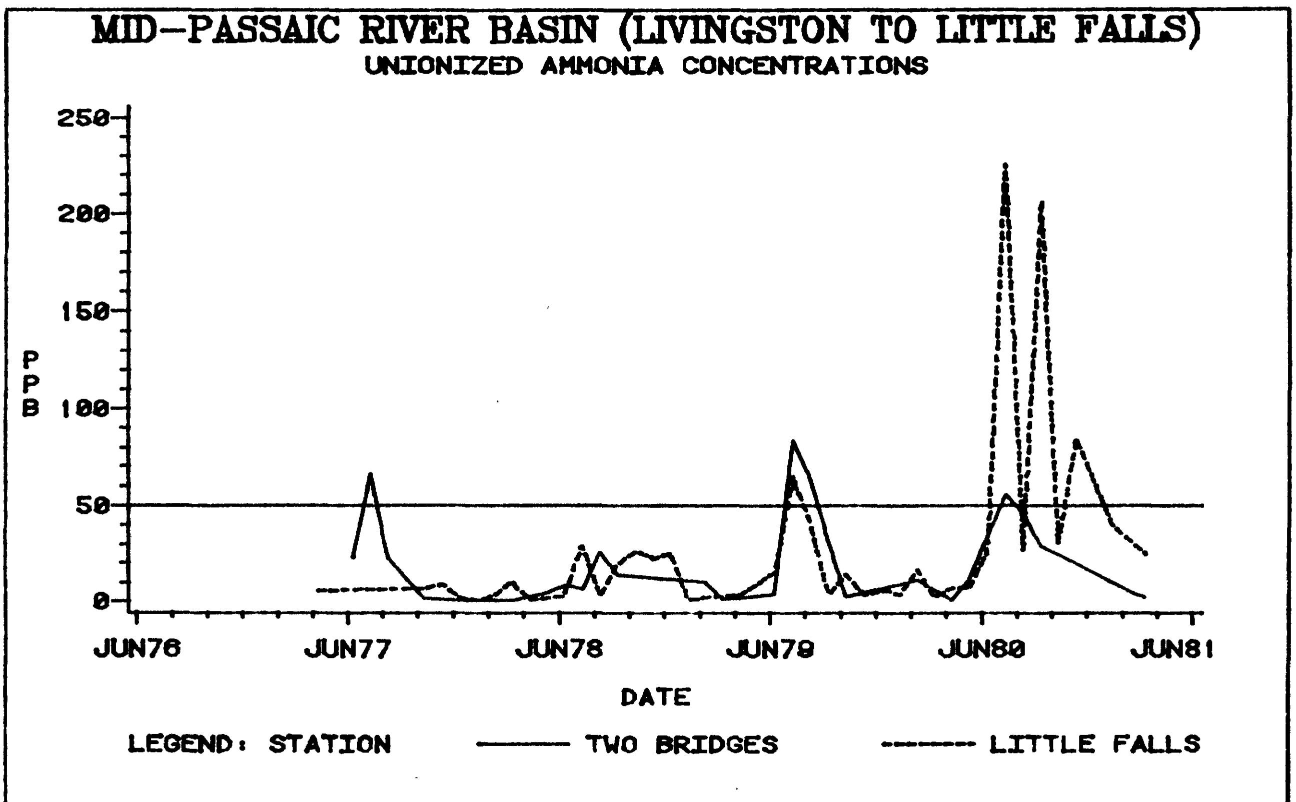


Figure: Z -10

DISCHARGE INVENTORY - - - MID-PASSAIC RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
CITY OF JERSEY CITY DIV OF WAT	0031712	LITTLE FALLS	UNNAMED DITCH TO PASSAIC RIVER	COOLING WATER	
POLLUTION CONTROL IND INC	0028096	WEST CALDWELL	TRIBUTARY TO PASSAIC RIVER		
UNIMATIC MFG CORP	0031003	FAIRFIELD	TRIBUTARY PASAIC RIVER	COOLING WATER	.02
FIDELITY INDUSTRIES INC	0031321	WAYNE	STORM SEWER TO PASSAIC RIVER	COOLING WATER	
JERSEY SPECIALTY CO INC	0031739	WAYNE	STORM SEWER TO PASSAIC R		.01
TOP REST. INC-HOWARD JOHNSON	0028975	WAYNE	SINGAC BROOK		.01
TOWNSHIP OF WAYNE	0028002	WAYNE	SINGAC BROOK	SAN/SIG INDUS	4.72
HOOKER CHEMICALS & PLASTICS	0000183	WEST CALDWELL	SEWER TO DEEPAV		
STATE OF NJ-TNG SCHOOL	0021261	TOTOWA BORO	NATCHUNK BR.	SANITARY	.10
WEST ESSEX PRINTING PLATES INC	0030155	FAIRFIELD	DEPAVALL BROOK		
BEE COATED FILM COMPANY	0020222	FAIRFIELD BOROUGH	DEEP DEVAAL BROOK		.07
ASR RECORDING SERVICES INC	0033871	FAIRFIELD	DEEPAVAAL BROOK	COOLING WATER	
ESGRAPH DIVISION OF WINSTON TE	0034428	FAIRFIELD	DEEPAVAAL BROOK	COOLING WATER	
F NINETY INC	0029866	FAIRFIELD	DEEPAVAAL BROOK	PROCESS WASTE	
R&L SHEET METAL	0029882	FAIRFIELD	DEEPAVAAL BROOK	COOLING WATER	
T-FAL	0030694	FAIRFIELD	DEEPAVAAL BROOK	PROCESS WASTE	
PRECISE MANUFACTURING CORP	0030210	FAIRFIELD	TRIB OF PASSAIC RIVER	PROCESS WASTE	
ATI CHEMICAL SPRAY DIVISION	0029751	TOTOWA	SINGAC BROOK	COOLING WATER	
BOROUGH OF CALDWELL	0020427	WEST CALDWELL BORO	PASSAIC R.	SAN/SIG INDUS	4.20
COPYGRAPHICS DIV OF MILLMASTER	0029599	FAIRFIELD	PASSAIC RIVER	SANITARY	.00
GENERAL HOSE PRODUCTS INC	0035068	FAIRFIELD	PASSAIC RIVER		
HEISLER MACHINE & TOOL CO	0031704	FAIRFIELD	PASSAIC RIVER		
PLASTINETICS INCORPORATED	0030538	FAIRFIELD	PASSAIC RIVER	COOLING WATER	.08
RECOMA INC	0035424	FAIRFIELD	PASSAIC RIVER		
REDM CORP AIR SPEC DIV	0030112	FAIRFIELD	PASSAIC RIVER	PROCESS WASTE	
REDM CORPORATION	0033359	FAIRFIELD	PASSAIC RIVER	COOLING WATER	
SUN DIAL & PANEL CORP	0030490	FAIRFIELD	PASSAIC RIVER		
TECHNICAL PHOTOGRAPHY INC	0033456	FAIRFIELD	PASSAIC RIVER	PROCESS WASTE	.01
WIRE FABRICATOR & INSUL. CO.	0031224	FAIRFIELD	PASSAIC RIVER	PROCESS WASTE	
CRAFT METAL FINISHING	0025275	FAIRFIELD BOROUGH	PASSAIC RIVER	SANITARY	
MIMI HOLDING COMPANY	0027723	LINCOLN PARK	PASSAIC RIVER	SANITARY	
SINGER CO KEARFOTT DIVISION	0030902	LITTLE FALLS	PASSAIC RIVER	COOLING WATER	
BEATTIE MFG COMPANY	0002658	LITTLE FALLS /TWP/	PASSAIC RIVER	PROCESS WASTE	
MONTVILLE TOWNSHIP MUA	0024431	MONTVILLE /T/	PASSAIC RIVER	SANITARY	
H & N CHEMICAL CO	0031623	TOTOWA	SINGAC BROOK	COOLING & SANIT	
MONTVILLE TWP BD OF ED	0021181	TOWACO-MONTVILLE TWP	PASSAIC RIVER	SANITARY	
VAPON INC	0031160	W CALDWELL	PASSAIC RIVER		
CARSAU CORP	0034053	WAYNE	PASSAIC RIVER		
REDM CORP	0030104	WAYNE	PASSAIC RIVER	COOLING WATER	
UNION CAMP CORPORATION	0031801	WAYNE	PASSAIC RIVER		
GAF CORPORATION	0028291	WAYNE TWP	PASSAIC RIVER		.04
ELTEE INC	0032174	WEST CALDWELL	PASSAIC RIVER		
GOOD HUMOR CORP	0035017	FAIRFIELD	NONE		
BORO OF TOTOWA WEST END	0022080	TOTOWA	TRIBUTARY TO PEQUANNOCK RIVER	SAN/SIG INDUS	.60
AMERACE-ELASTIMODE DIV.	0032638	FAIRFIELD	GREEN BROOK	COOLING WATER	
TURBODYNE CORP WORTHINGTON PRO	0034151	FAIRFIELD	GREEN BROOK	COOLING WATER	
RUNWAY REALITY	0034487	WEST CALDWELL	GREEN BROOK	COOLING WATER	
WELSH FARMS ICE CREAM INC	0000850	WEST CALDWELL	GREEN BROOK	PROCESS WASTE	

AA. MID-PASSAIC TRIBUTARIES (WHIPPANY, ROCKAWAY, POMPTON, PEQUANNOCK, WANAQUE, AND RAMAPO RIVERS)

Basin Description

There are two major tributaries (or sub-basins) to the Passaic River. One sub-basin consists of the Whippany and Rockaway Rivers. The other is the Pompton River sub-basin which includes the Pequannock, Wanaque, Ramapo and Pompton Rivers.

Whippany/Rockaway Sub-Basin
Whippany River

The Whippany River, located entirely within Morris County, has a drainage area of 72 square miles. The headwater reaches of the river consist of rapidly moving stretches with small pools and eddies. The Whippany widens downstream forming a slow, meandering watercourse in Morris Township. The river is interrupted just above Morristown by two small lakes: Speedwell and Pocahantas. Marshland, including the Troy Meadows and Black Meadows, border the lower reaches of the river in the vicinity of Hanover, East Hanover, and Parsippany-Troy Hills. The average flow for the Whippany River to 1980 is 587 cfs just before it joins with the Rockaway River to form the New River and enters the Passaic River less than a mile downstream.

The Whippany basin has a wide variety of land forms and uses. The headwaters region is characterized by gently rolling highlands with low density land uses. The residental sector accounts for only about 28 percent of the basins land use, while the industry/commercial proportion is only 6 percent of the basin. Vacant land, agriculture and parks are the major land uses in the basin, occupying the remaining 66 percent. The main agricultural usage is for beef and dairy cattle and chicken production.

Population is centered around Morristown, Parsippany-Troy Hills and Hanover. The basin has had a slight decline in population between the 1970 and 1980 census. However, Hanover and East Hanover have increased in population (which averaged about 15 percent) offsetting the decline in other municipalities.

There are four major municipal dischargers on the Whippany River: Parsippany-Troy Hills (16.0 mgd), Morristown (1.5 mgd), Morris-Butterworth treatment plant (2.0 mgd), and Hanover (3.0 mgd). The Parsippany-Troy Hills treatment plant is presently using only 7.5 mgd of its 12.0 mgd capacity, while the Morristown plant is currently operating about .5 mgd over capacity. There are 22 minor dischargers adding about .3 mgd to the River. The remainder of the watershed is served by septic systems.

The headwaters region supports fishing, but generally not bathing since there are no suitable locations. The two major municipal parks in which lake fishing is available are Burnham Park Pond (Morristown) and Speedwell Lake (Morristown). These lakes are also stocked with trout by the NJ Division of Fish, Game and Wildlife (DFGW). Sunrise Lake Park is the only county park located in the Whippany basin. This park also has fishing facilities available.

The Clyde Potts Reservoir, which serves as a potable water source for Morristown, is located in the headwaters of the Whippany River. An additional reservoir, the Washington Valley Reservoir, is considered a feasible water supply project on the Whippany River according to the State Water Supply Master Plan. It would yield 7 mgd in potable supplies. Many industrial and commercial facilities currently withdraw water for process and/or cooling purposes from the Whippany River.

NJ Water Quality Standards list this basin as FW-2 Nontrout except for some upstream waters which are classified FW-2 Trout Production.

Rockaway River

The Rockaway River lies almost entirely in Morris County, with a small portion in Sussex County. The river, which drains an area of 133 square miles, flows easterly to its confluence with the Whippany River at Pine Brook. The average discharge to 1980, for the river above the reservoir at Boonton, is 225 cfs.

Land drained by the Rockaway River is primarily undeveloped with parks, agriculture and vacant land accounting for 80 percent of the total land use. The remainder consists of 16 percent residential, 1 percent commercial and 3 percent industrial. The population of the basin held rather stable over the period 1970 to 1980 with municipalities generally showing both small increases to decreases. There are thirty-four permitted dischargers in the Rockaway River basin. Most of the Rockaway watershed is served by the Rockaway Valley Regional Sewerage Authority which operates a 9.0 mgd treatment plant.

The river basin is valuable for swimming, fishing and nature study. It also provides canoeing opportunities, including several rapids, some of which should only be attempted by experts. The basin includes the Berkshire Valley Wildlife Management Area which permits hunting, fishing and other forms of recreation. Waters stocked with trout by the DFGW include a portion of the Rockaway River mainstem, as well as portions of Beaver Brook, Hibernia Brook and Stickle Brook. The Rockaway watershed is an important source of drinking water for areas in northern New Jersey. The Boonton and Split Rock Reservoirs supply Jersey City's water and the Taylortown Reservoir is used by the Town of Boonton. A joint water supply power development project has been proposed by the State of New Jersey for Longwood Valley in

Jefferson Township. Two storage reservoirs, one on Beaver Brook and the other on the Rockaway, would be utilized with a total capacity of 7.9 million gallons (5.3 allocated to water supply).

Portions of Jackson Brook and Mill Brook are classified as FW-2 Trout Production; Hibernia Brook, Green Pond, Jersey City (Boonton) Reservoir, Russia Brook and Split Rock Reservoir are all or in part classified as FW-2 Trout Maintenance. A portion of Stephens Brook is classified as FW-1. The remainder of the waters are classified as FW-2 Nontrout.

Pompton Sub Basin
Pequannock River

The Pequannock River originates in Sussex County and flows east forming the boundaries of Morris and Passaic Counties; it then meanders south to its confluence with the Wanaque River. The Pequannock continues its southerly course until it joins the Ramapo River, forming the Pompton River. The drainage area of the river basin is approximately 90 square miles. The river's average flow to 1980 is 51.4 cfs (measured at the confluence with the Wanaque River). The headwaters of the Pequannock watershed have numerous lakes, ponds and reservoirs scattered throughout the highlands region. Only 8 percent of the basin's land use is residential. The remainder of the watershed, excluding the less than 2 percent for commercial/industrial uses, is a forested and protected watershed owned by Newark for water supply purposes and parklands. Heaviest development occurs along the river near the Townships of Butler and Bloomingdale. The basin's population, according to the 1980 census, has increased slightly from 1970. The largest growth area is the Township of West Milford which has increased by approximately 30 percent.

The Butler-Bloomingdale treatment plant (2.25 mgd) is the only major sewage treatment facility along the river. There are however, a total of fifteen dischargers using the river for disposal of sanitary wastes and/or cooling water.

The sparse development and the high quality of the river water provides excellent opportunities for fishing. Trout are stocked in the river from Smoke Rise to North Main Street, Butler. Hiking and nature observations are other forms of recreation also available within the basin.

The major use of the river is for potable water supply. There are five reservoirs or lakes (a total surface area of 63.7 square miles) that are used for water storage by the City of Newark. The water company has the water rights for 50 mgd. In addition, the Butler Water Department utilizes Kakeout Reservoir in Butler for potable supplies. The State Water Supply Master Plan has designated Dunker's Pond in West Milford Township, Passaic County as a possible future water supply source. Flows to Dunker's Pond would be supplemented with waters from local lakes, reservoirs and streams. The possible yield would be 5.6 mgd.

The NJ Surface Water Quality Standards lists the Pequannock River basin as FW-2 Trout Production, FW-2 Trout Maintenance and FW-2 Nontrout. In addition, waters within the City of Newark Watershed are classified as FW-1.

Wanaque River

The headwaters of the Wanaque River are located in New York State and are for the most part wet-weather brooks which are steeply sloped and contribute flows only during heavy rainfall or the spring. These brooks flow into Greenwood Lake, which is located at the boundary of the two states. From Greenwood Lake the Wanaque River flows southwest until it enters the Wanaque Reservoir. After leaving the reservoir the Wanaque River flows south through Lake Inez and on to its confluence with the Pequannock River. The Wanaque watershed has a drainage area of 108 square miles. The river's average adjusted flow to 1980 is 79.1 cfs (at the outlet of the Wanaque Reservoir). The Wanaque basin can be described as consisting of a number of hills with brooks and lakes located in the valleys. For the most part, the basin is sparsely developed with pockets of concentrated populations located around the numerous lakes. Only 9 percent of the Wanaque River basin has residential development and less than 2 percent of the land area is developed for commercial or industrial purposes. The remaining undeveloped land is comprised of vacant lands, reservoirs, parks, and farms. The basin's population has grown slightly (approximately 12 percent) between 1970 and 1980. The largest growth occurred in Ringwood and Wanaque Townships.

The largest sewage treatment facility in the Wanaque basin is the Wanaque M.U.A. plant (.3 mgd). This plant is scheduled to be replaced by the Wanaque Valley Regional S.A. in about three to five years. This new plant, to be sized for servicing flows of about 2.5 MGD, will serve all of Wanaque Township and 69 percent of Ringwood Township. There are also 18 additional minor dischargers within the river basin.

Recreational opportunities are similar to those in the Pequannock watershed. The Wanaque basin also has the following state parks and wildlife management areas: Abram S. Hewitt State Forest, Wanaque Wildlife Management Area, Ringwood State Park, and portions of the Ramapo Mountain Forest. The N.J. Division of Fish, Game and Wildlife stocks trout in the following lakes and streams: Belcher's Creek, Cooley's Brook, Greenwood Lake, Ringwood Brook and Sheppard's Lake.

The Wanaque River is an important potable water source. The Wanaque Reservoir operated by the North Jersey District Water Supply Commission which has the water rights to withdraw 94.0 mgd. The water is used by the following municipalities and commission:

Newark (38 mgd), Passaic Valley Water Commission (PVWC) (35.5 mgd), Kearny (11.3 mgd), Montclair (4.7 mgd), Bloomfield (3.8 mgd), Glen Ridge (.7 mgd), and Bayonne. In addition to the direct withdrawal at the reservoir, the water is used downstream by PVWC to mix with Passaic River water. There are extensive proposals by the Hackensack Water Company and North Jersey District Water Supply Commission for developing further water supplies in the Wanaque watershed. It is expected that these proposals will be a major factor for alleviating water shortages in northern New Jersey during periods of low flow.

NJ Surface Water Quality Standards give the Wanaque basin the various water quality classifications. The A.S. Hewitt State Forest has portions of two brooks, Cooley and Green Brooks, that are FW-1. The remaining section of these brooks not within the state forest are FW-2 Trout Production. In addition, Hewitt (West Milford) and West Brooks (West Milford) are also FW-2 Trout Production streams. The remaining waters in the watershed are either FW-2 Trout Maintenance or FW-2 Nontrout.

Ramapo River

The Ramapo River, which has its headwaters in the Ramapo Mountains of New York State, has a drainage area of 160 square miles (110 square miles of which are in New York). The river flows in a northeast to southwest direction and enters the Pequannock River to form the Pompton River at Wayne. The average flow to 1980 for the river at Pompton Lakes is 303 cfs.

The New Jersey portion of the basin has a mixture of suburban (20 percent) and undeveloped land uses (74 percent). The remaining land use is commercial and industrial (6 percent). The population of the basin has remained stable since 1970. Three municipalities (Mahwah, Ramsey and Franklin Lake) have grown slightly, but this growth was offset by decreases in the remaining municipalities.

Most of the suburban areas are currently utilizing on-site disposal systems with some areas being served by package treatment plants (of which there are 14). There are 10 industrial dischargers.

As with the Pequannock and Wanaque Rivers, the Ramapo basin's recreational opportunities are abundant. Fishing, canoeing and nature study are easily accessible. The entire river is stocked with trout six times a year by the NJ Division of Fish, Game and Wildlife. Within the watershed is a portion of the Ramapo Mountain Forest in which fishing and hiking is available. Although the Pompton Lakes have swimming beaches, they have remained closed due to high bacterial levels.

The river also serves as an important potable water supply source. An intake for the Point View Reservoir, owned by PVWC, withdraws water only during high flows. In addition, PVWC uses the passing water downstream at an intake on the Pompton River and at Little Falls.

NJ Surface Water Quality Standards classifies portions of the Ramapo River watershed either FW-2 Trout Production or FW-2 Non-trout.

Pompton River

The Pompton River basin has a drainage area of 24 square miles from its origin at the confluence with the Ramapo and Pequannock Rivers to the Passaic River. The Pompton River flows through a relatively flat, suburban area. The river is subject to flooding in Wayne and Lincoln Park during heavy rains. The average flow for the river to 1980 is 486 cfs at Pompton Plains. Suburban development utilizes about 26 percent of the basin. The commercial and industrial area occupies only 7 percent while the remainder of the basin, 67 percent, is undeveloped consisting of open lands, woods, marshes (Great Piece Meadows) and limited farming (truck farms). Although two municipalities (Kinnelon and Montville) have increased in population since 1970, the remaining municipalities have decreased to leave a small net loss of population within the basin.

There are two major sewage treatment plants on the Pompton River: Two Bridges (7.5 mgd capacity) and Pompton Lakes Borough M.U.A. (1.2 mgd). The Two Bridges plant was just completed and is only operating with a flow of 1.2 mgd. The Pompton Lakes Borough MUA plant is to be expanded and upgraded to about 3.5 mgd. There are four other smaller wastewater facilities and 2 cooling water dischargers to the river.

The Pompton River offers many recreational benefits such as canoeing, hiking, and fishing. The Division of Fish, Game and Wildlife stocks the river with trout from Pompton Lakes to the Newark-Paterson Turnpike (Routes 202 and 23). The river is used as a potable water supply by the PVWC. The intake on the Pompton River is blended with water taken from the mainstem Passaic River so as to produce a higher quality drinking water.

NJ Surface Water Quality Standards lists the Pompton River as FW-2 Nontrout.

Water Quality Assessment

Conventional Parameters

Water quality conditions were monitored at the following locations for this segment: Rockaway River at Pine Brook, Whippany River near Pine Brook, Ramapo River near Mahwah and the Pompton River at Packanack Lake. The generally good water quality conditions in the Rockaway River above Dover, as indicated by limited monitoring in 1980, declined to poor conditions in the downstream segment near the routine monitoring station at Pine Brook. Routine monitoring and intensive survey data from the Whippany River revealed the presence of marginal water quality in the Speedwell Lake areas and poor conditions from Morristown to the Rockaway River confluence at Pine Brook. Elevated fecal coliform, total phosphorus and biochemical oxygen demand were primarily responsible for the marginal water quality conditions in the Ramapo and Pompton Rivers. All four routine monitoring stations in the drainage area exhibited some water quality decline during the summer of 1980 due to exceptionally low flows.

Dissolved oxygen daytime concentrations were generally in compliance with the 4.0 mg/l minimum standard in the Rockaway, Ramapo and Pompton Rivers, with the exception of the dry period in 1980 when levels fell below the standard in the three rivers. The Whippany River exhibited more frequent contraventions of the dissolved oxygen standard during the summer months due to elevated biochemical oxygen demands. Moderate to high BOD_5 levels were recorded in the remainder of the basin, but other factors such as physical aeration and/or elevated primary productivity sustained dissolved oxygen concentrations above 4.0 mg/l during the daylight hours.

Fecal coliform concentrations were frequently above 200 MPN/100 ml in the Rockaway, Ramapo and Pompton Rivers while levels were often extreme (above 10,000 MPN/100 ml) in the downstream segment of the Whippany River at Pine Brook. Bacterial quality generally declined in the four rivers during the drought period beginning in 1980.

Total dissolved solids in the Mid-Passaic River tributaries generally ranged between 100 and 300 mg/l, the highest concentrations occurring in the summer months. The pH values for the period were generally neutral with slight elevations, possibly due to photosynthetic activity, during the summer months.

Total phosphorus concentrations were uniformly elevated at all four stations over the period; only 22 percent of the data complied with the 0.10 mg/l standard. The most serious problem overall occurred in the Whippany River at the Pine Brook station where elevated phosphorus levels were recorded and accounted for nearly 100 percent of the observations. The Whippany and Rockaway Rivers exhibited the most significant total phosphorus increases during the drought period beginning in 1980. These same two rivers displayed nitrate + nitrite concentrations in excess of 2.0 mg/l which were higher than levels in the Ramapo and Pompton Rivers. Total ammonia concentrations were also periodically elevated above 2.0 mg/l in the Rockaway and Whippany Rivers, but only the Whippany River at Pine Brook exhibited un-ionized ammonia levels (twice during the period) which contravened the 50 microgram per liter standard.

Biological assessments were made during the period in the Rockaway River at Boonton, upstream from Boonton Reservoir, and in the Pequannock River in the vicinity of Macopin Reservoir in West Milford. The biological data for both upstream locations indicated the presence of healthy communities.

The Pequannock macroinvertebrate community was generally dominated by several species of the ephemeropteran (mayfly) genus, Stenonema, which are relatively pollution tolerant. Water quality is apparently sufficient to support a healthy community, but species diversity and density is apparently limited by low flow conditions. Periphyton chlorophyll a concentrations were at low to moderate levels. The Rockaway data was quantitatively unreliable because of difficulties with sampler placement at that station, but it was presumed that this segment was of a relatively healthy biological condition. The samples recovered were of a low population density. Dominant taxa were ephemeropterans (mayflies), trichopterans (caddisflies) and the crustacean Gammarus.

Water quality in the Passaic River tributaries Rockaway, Whippany and Ramapo Rivers have shown little change in the last 5-7 years. The Rockaway River continues to have excessive biochemical oxygen demand and total phosphorus concentrations, while fecal coliform levels have shown a moderate overall decline. In the Ramapo River total phosphorus and fecal coliform are at levels similar to those report in earlier 305(b) reports. The Whippany River in its lower segment continues to have the worst water quality of all waters in this segment. BOD_5 and total phosphorus continue to be excessive with fecal coliform counts showing moderate increases.

Toxic Parameters

The Rockaway River was sampled at Route 46 in Pine Brook and found to have high levels of trihalomethanes. This may be attributed to a point source discharge along this segment of the river. The Whippany River at Pine Brook was sampled and found to be free of toxic contamination. Further upstream at Cedar Knolls and Morristown, low levels of organic solvents were detected. At Parsippany-Troy Hills low levels of trihalomethanes were detected. The Ramapo River was sampled at Route 17 in Mahwah. Moderate levels of trihalomethanes and organic solvents were detected at this site. The Pompton River at Packanack Lake showed no evidence of toxic contamination. Further downstream at Two Bridges, low levels of organic solvents were detected.

At this time no aquatic organisms have been sampled from this basin. Sampling will be conducted in response to a known contamination source, illegal discharge or to establish a data base for this basin.

An overall examination of the toxics data generated by samples collected at five sites along the Whippany River reveals the presence of several toxic pollutants at various sites along the stream, but at concentrations which are very low. Low level contamination of surface waters by heavy metals and certain chlorinated and petroleum hydrocarbons is not uncommon where streams flow through developed areas and can receive both point source and non-point sources of pollution.

The interpretation of toxics data collected from lotic systems is difficult due to several natural factors occurring within the stream which can alter pollutant concentrations. These factors include current velocity which affects the reaeration of the water and increases the volatilization of low molecular weight halogenated organic compounds and substrate composition which plays an important role in the removal of pollutants from the water column. The effect of changing current velocity between sites on the Whippany River should be taken into account when examining the concentrations of volatile organic compounds; one would expect to find lower values where samples were collected from riffle areas within the stream.

The substrate at the sampling sites along the Whippany River consisted of a rocky, sandy mixture; therefore, elevated pollutant concentrations in the sediment would not be expected due to the lack of absorption capacity of coarse grained sediment. This fact must be kept in mind when reviewing the toxics results.

An examination of the results reveals increased numbers of toxic pollutants identified at the station downstream of the Morristown Sewage Treatment Plant. Of particular interest are the chlorinated phenols which may be a consequence of wastewater treatment due to the reaction of chlorine with phenols present in the wastewater. These compounds are volatile and biologically degradable and appear to be removed from the Whippany River before a downstream sampling site. Several other toxic compounds were detected at the station near the Morristown STP including several polynuclear aromatic hydrocarbons and an industrial solvent. These compounds probably pass through the wastewater treatment plant unchanged by current primary and secondary wastewater treatment technologies.

A number of heavy metals were detected in water and sediment samples collected from all sites sampled along the Whippany River, which is not surprising due to the natural background occurrence of various metals in underlying rocks and soils. Heavy metal concentrations in the water column and sediments are in the range of expected background values for waters which flow through developed areas of New Jersey and do not appear to pose a toxicity problem in the Whippany River.

The Whippany River, due to residential and industrial development within the watershed, is suspected to be affected by non-point source pollution. However, the results of the samples collected during a single storm event on the Whippany River do not confirm this suspicion. In general, toxic pollutant concentrations did not increase during high flow, although the exception of an increased concentration of 5-nitrophenol downstream of the sewage treatment should be noted.

Conclusions which can be drawn from the toxics sampling along the Whippany River are that many different compounds are present at different points along the stream, but pollutant concentrations are very low and do not pose a threat to human health. However, certain compounds identified could prove toxic to aquatic species depending upon the bioavailability of the specific compound. A possible example in the Whippany River is the presence of copper in the water column which ranged from 10-51 ug/l. These concentrations are not toxic in regards to human consumption, but can be very toxic to aquatic life if present in ionic form; however, the chemical forms of the heavy metals sampled in the Whippany River were not determined. Because of the sensitivity of certain aquatic species to many pollutants and the lack of biological information, it is not possible to discuss the toxic effects of the pollutants identified on the aquatic biota of the Whippany River.

Problem Assessment

The water quality problems identified in the Mid-Passaic's tributaries occur mostly in the lower portions of the rivers and are mainly the result of point source discharges. The upper segments are influenced more by suburban development, its runoff and septic systems.

Municipal treatment plants discharging to the Mid-Passaic tributaries are required to meet advanced treatment (level 4) because of seasonal low flows, the number of existing discharges, and the amount of water used for potable purposes.

The Whippany River's high quality headwaters change above Speedwell and Pocahantas Lakes due to point sources (primarily Morris Township's Butterworth plant). Eutrophication of the lakes is the result of these sources. Additional point sources and urban runoff continue to degrade the water below the lakes. The poor water quality of the lower segment, below its confluence with the Rockaway River, is the result of upstream water quality and the physical characteristics of the Hatfield Swamp. Plants scheduled to be upgraded to level 4 include: Morristown, Morris Township-Butterworth and Hanover Township SA.

The headwaters of the Rockaway River are degraded by single family residences on septic systems. The effects of the on-site systems and their nutrient loadings can be seen by the eutrophic condition of the many lakes in the watershed. Boonton Reservoir, a supplier of drinking water for Jersey City, is considered to be in an accelerated eutrophic condition because of nutrient inputs from 13 discharges and residential runoff. The lower segment has dissolved oxygen and nutrient problems which are mainly the results of point sources. The last portion of the river, before it meets with the Whippany River, has poor water quality originating from point sources whose loadings are aggravated by the characteristics of Hatfield Swamp. The completion of the upgraded Rockaway Valley Regional SA treatment plant is long awaited because of existing sewer bans and septic system problems occurring in the proposed service area of the SA. The STP is scheduled to be sized so as to treat 12 mgd. Septic system problems are in the following municipalities within the Rockaway Valley Regional SA planning area: Randolph Township, Rockaway Township, Mine Hill Township, Montville Township, Denville Township and Wharton Borough.

The Pompton sub-basin (including the Pequannock, Wanaque, Ramapo, and Pompton Rivers) contains a wide range of water quality conditions. Generally, the Pequannock and Wanaque Rivers have the best water quality because of the lack of development and point source discharges. The Ramapo and Pompton Rivers contain poorer water quality than the Pequannock and Wanaque Rivers. The Pompton River is formed by the confluence of the Pequannock and Ramapo Rivers, and therefore, has quality similar to these rivers. The Ramapo River originates in New York State and passes through highly developed areas which greatly affects its water quality.

The Pequannock River's upper segments are well protected watersheds which maintain high water quality for potable use. Some failing septic systems may occasionally affect the river but the largest influences are the point sources which occur in its lower segment near Butler. Aeration of the river's water allows for organic pollution assimilation to take place. In the lower Pequannock River watershed the Butler-Bloomingdale STP is in need of upgrading to level 4 and enlargement because of sewer bans in effect. This plant, part of the Pequannock River Basin Regional SA, is scheduled to treat 2.5 mgd, up from its current 1.4 mgd size. In addition on-site septic systems are known problems in these municipalities in the Pequannock Watershed: Bloomingdale Borough, Kinnelon Borough, Riverdale Borough, Pequannock Township and West Milford Township.

The Wanaque River's water quality is also good. However, according to the Northeast WQM Plan (1979) the effects of development can be observed in water quality data for the upper Wanaque watershed. The data shows some elevated nutrient and fecal coliform values. These values increase as one goes downstream. The sources of these pollutants are thought to be septic systems that were designed for seasonal use, but which are now used throughout the year. In addition, a combination of point (municipal treatment plants) and the above noted non-point sources are the cause for eutrophic conditions in the lower portion of Greenwood Lake. The Wanaque Reservoir is classified as mesotrophic. Municipal treatment plants scheduled for elimination or upgrading by the Wanaque Valley Regional SA include the Birch Hill STP, West

Milford MUA STP, the Borough of Wanaque SA (Haskell STP) and Ringwood Borough SA.

The Ramapo River's water quality is affected by sources in New York State. A treatment plant in Suffern is the most significant discharger on the river. This plant is in the process of being upgraded. In New Jersey problems with high fecal coliform concentrations seem to be more related to non-point sources. Malfunctioning septic systems in the area add to the problem. However, sewering of the area is proposed. This may help water quality in the Pompton Lakes, which has been closed to bathing because of bacterial contamination. Localities proposed for sewering include Mahwah Township and Oakland Borough. In addition, elimination of treatment plants will result.

The Pompton River's water quality is the result of the blending of the Ramapo and Pequannock Rivers. Although overall quality meets State standards, its waters would improve with scheduled upgrading of the treatment facilities within the basin. Sewage disposal problems are occurring in the Wayne Township and Pequannock, Lincoln Park and Fairfield SA facilities planning areas. Correction of on-site problems and elimination of unnecessary treatment plants should help to improve Pompton River quality.

Goal Assessment and Recommendations

The lower portions of the Mid-Passaic tributaries generally do not meet the goals of swimmable quality due to the frequency which samples exceed a fecal coliform concentration of 200 MPN/100 ml. The upper portions, for the most part, do meet the swimmable criteria, however, this must be verified for specific areas. The rivers do meet the fishable goal, but the lower portions of the Rockaway and Whippany Rivers have problems with low dissolved oxygen, while the Whippany River experiences elevated un-ionized concentrations.

The Pompton, Whippany, Ramapo, Rockaway and Pequannock Rivers reportedly have a fish species diversity ranging from 18 (Pompton) to 28 (Pequannock), with all rivers having a trout population. The trout are present in the lower segments due to stocking by the Division of Fish, Game and Wildlife. However, the upper portions of the Whippany, Rockaway, Pequannock and Ramapo Rivers have trout production waters.

It is recommended that the point source dischargers be upgraded to level 4 as required in the Northeast WQM Plan. This will improve dissolved oxygen concentrations and reduce nutrient loadings in the downstream sections of the Mid-Passaic River tributaries. The upper segments, especially in the Whippany and Rockaway Rivers, require non-point source controls. These may include stormwater ordinances, septic tank management districts, and education for the home owner concerning proper septic tank management. Elimination of septic tank problems in the municipalities presented in the "Problem Assessment" is recommended. Sufficient construction grants funds are needed to improve water quality conditions in the lower reaches of all the Mid-Passaic tributaries, especially the Pompton, Whippany and Rockaway Rivers. Protection of water quality at potable intakes is crucial for the northeastern area of the state. In addition future water supply projects (Washington Valley, Longwood Valley and Two Bridges Reservoirs) are planned in this segment.

MID-PASSAIC TRIBUTARIES STATION LIST

A. Ambient Monitoring Stations

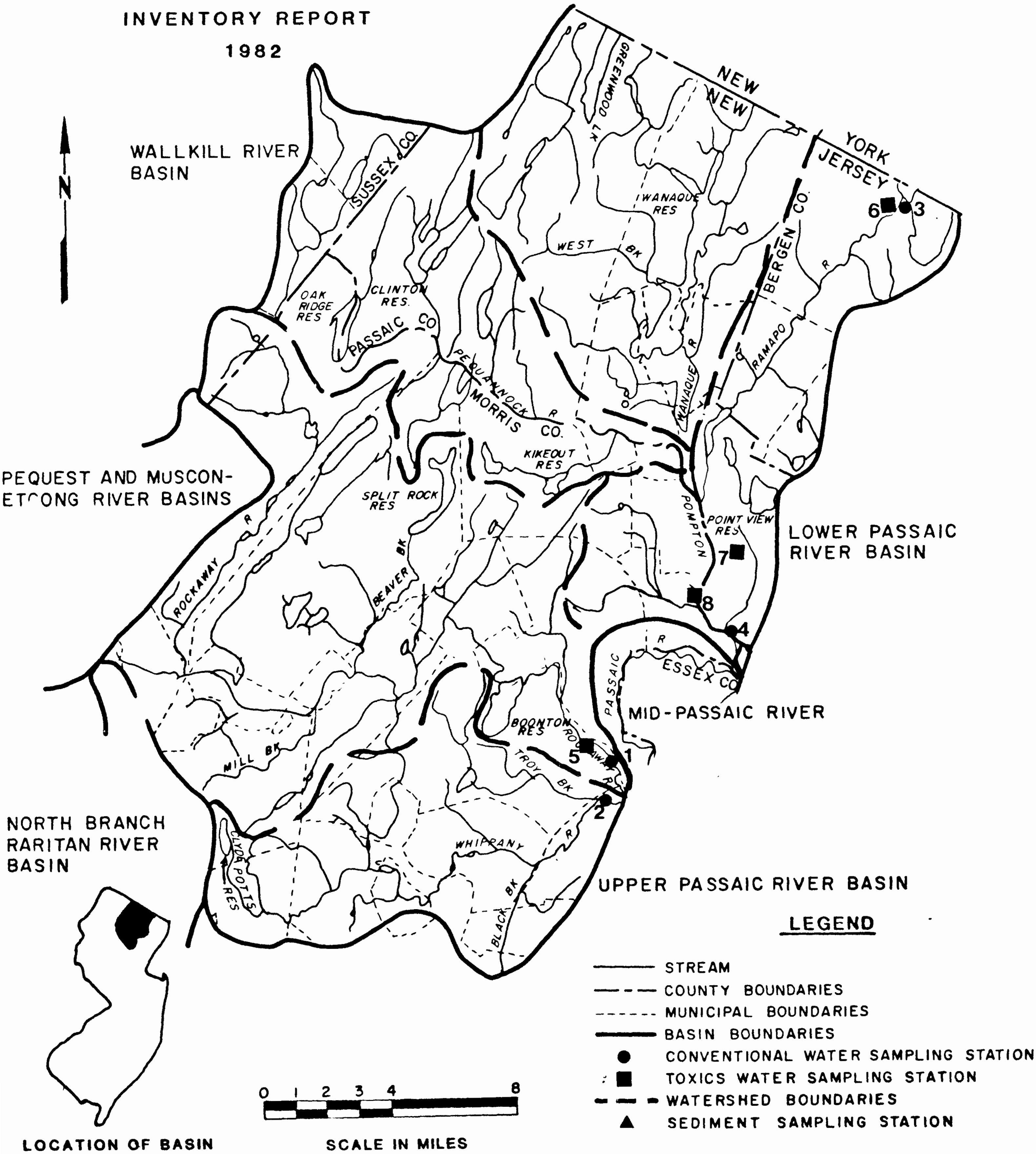
STORET Number	Station Description	Map Number
01381200	Rockaway River at Pine Brook, Morris County Latitude 40°51'29" Longitude 74°20'53" FW-2 Nontrout USGS/DEP Network At bridge on U.S. Route 46 at intersection with New Road in Pine Brook, 1.1 miles upstream of mouth	1
01381800	Whippany River near Pine Brook, Morris County Latitude 40°50'42" Longitude 74°20'51" FW-2 Nontrout USGS/DEP Network At bridge on New Road, 2,000 feet upstream of Rockaway River and 1.4 miles southwest of Pine Brook.	2
01387500	Ramapo River near Mahwah, Bergen County Latitude 41°05'51" Longitude 74°09'48" Fw-2 Nontrout USGS/DEP Network 350 feet downstream from Route 17 and 0.6 miles downstream from Mahwah River.	3
01388600	Pompton River at Packanack Lake, Morris County Latitude 40°56'36" Longitude 74°16'47" FW-2 Nontrout USGS/DEP Network At Route 504 bridge, 2.2 miles downstream from confluence of Pequannock and Wanaque Rivers.	4

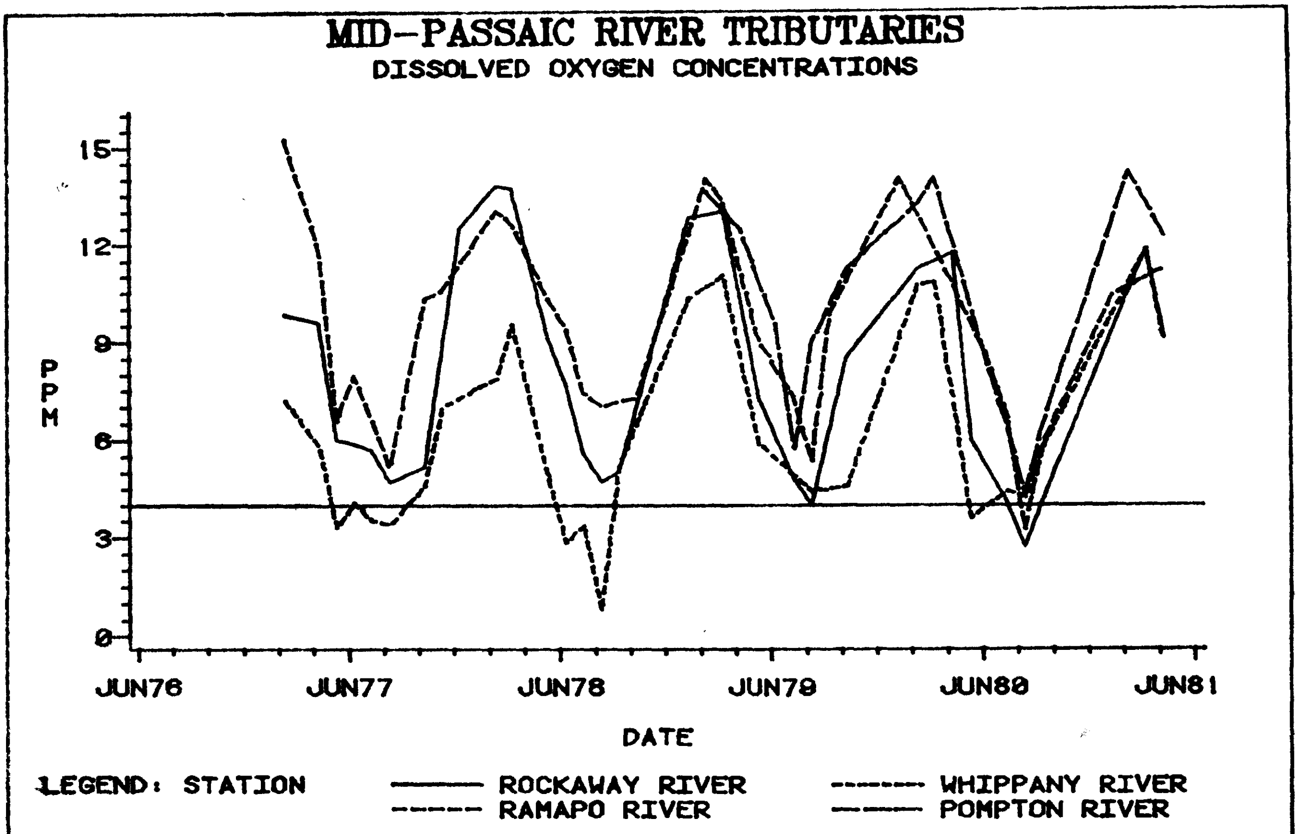
B. Toxic Monitoring Stations

Station Locations	Sampling Regime	Map Number
Rockaway River at Route 46	Water column	5
Ramapo River at Mahwah	Water column	6
Pompton River at Packanack Lake	Water column	7
Pompton River at Two Bridges	Water column	8
Intensive Survey of Whippany River	Water column	-

MID-PASSAIC RIVER TRIBUTARIES -WHIPPANY, ROCKAWAY, POMPTON, PEQUANNOCK, RAMAPO, AND WANAQUE RIVER BASINS

NEW JERSEY STATE WATER QUALITY INVENTORY REPORT
1982





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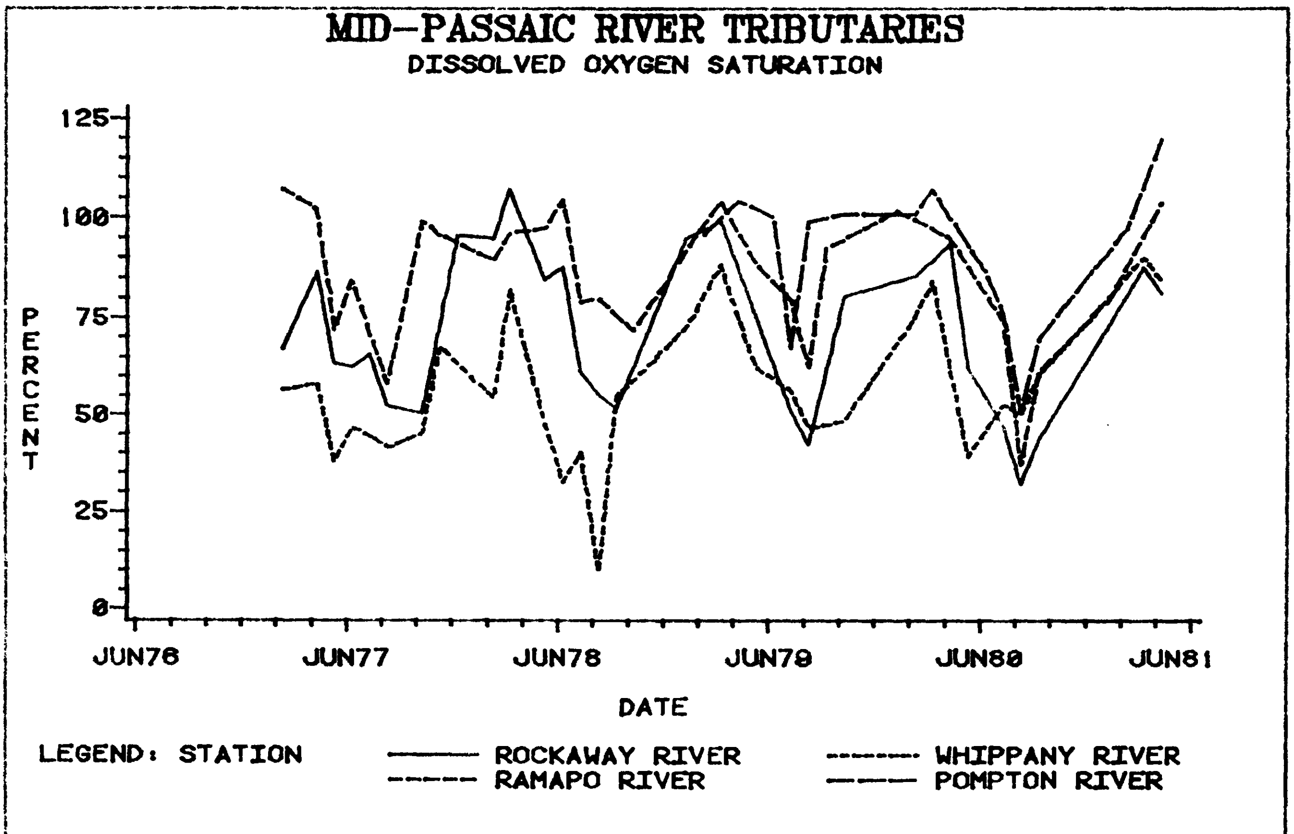

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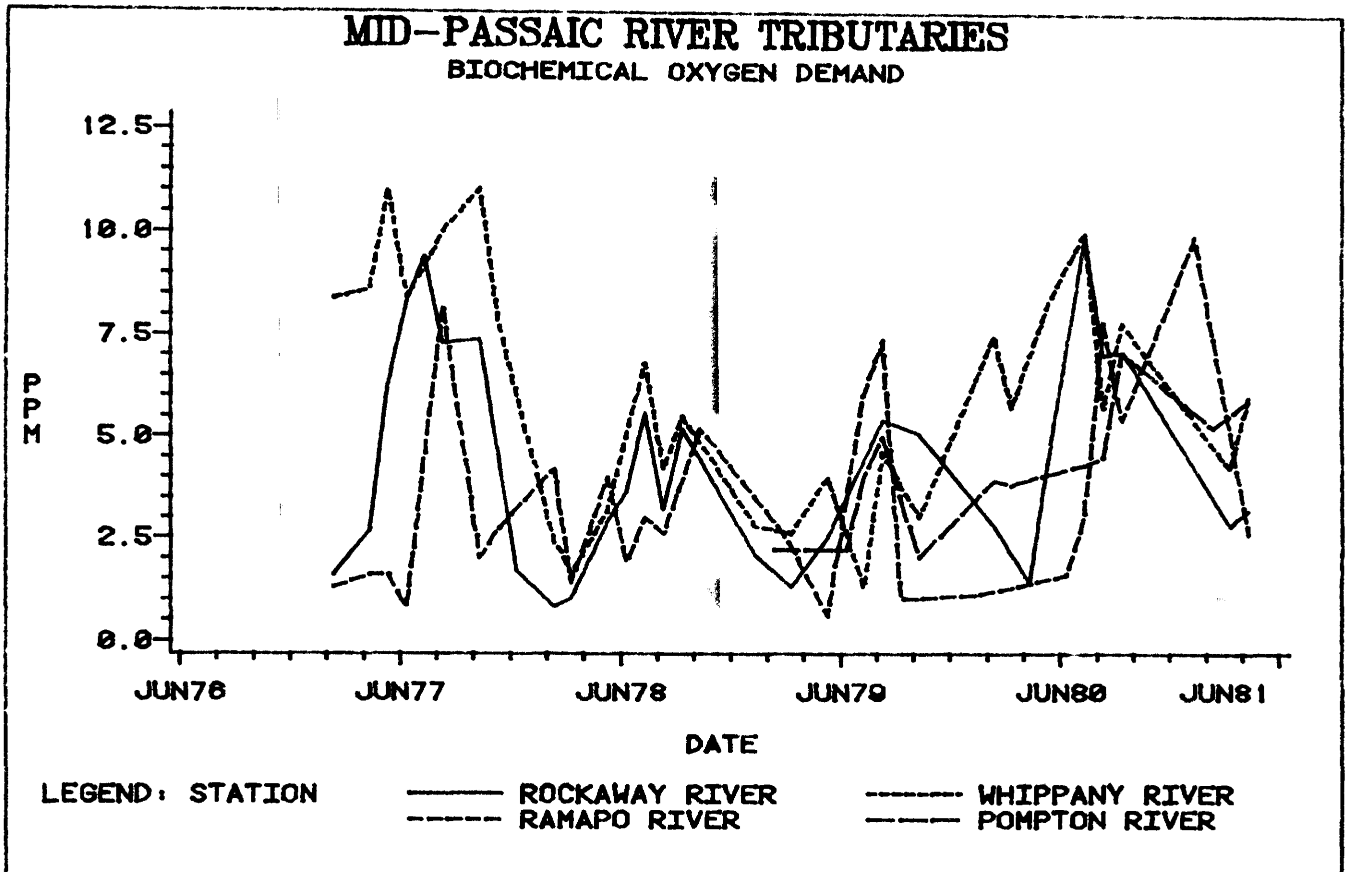

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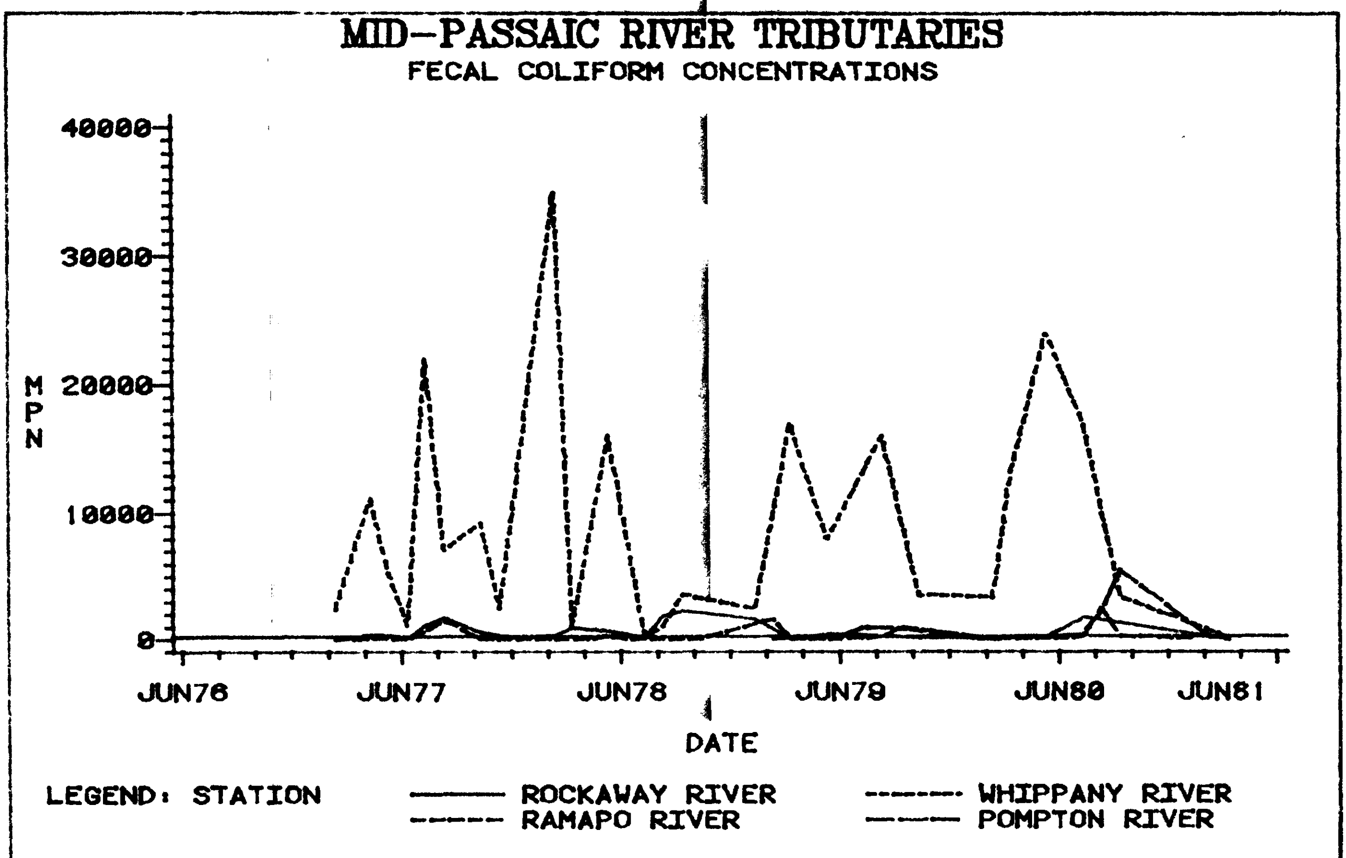

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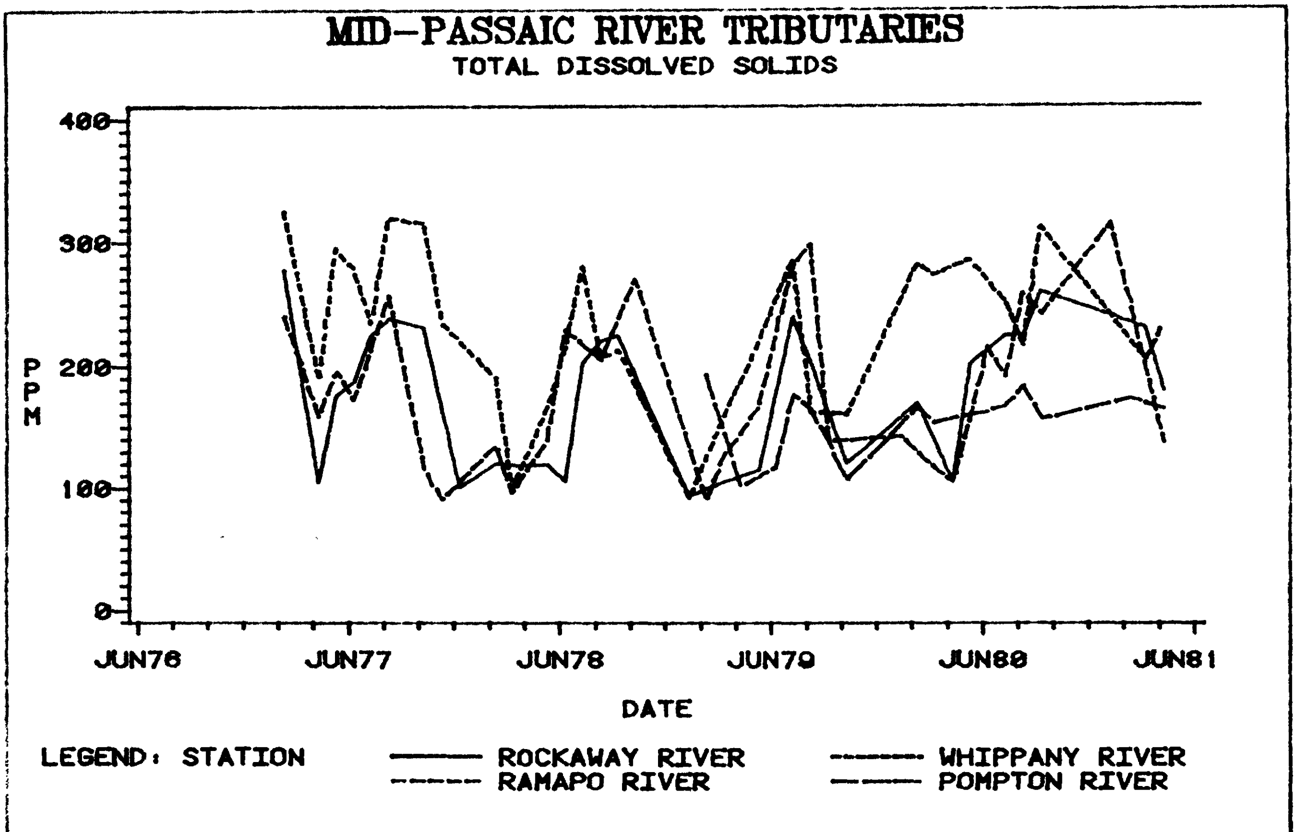

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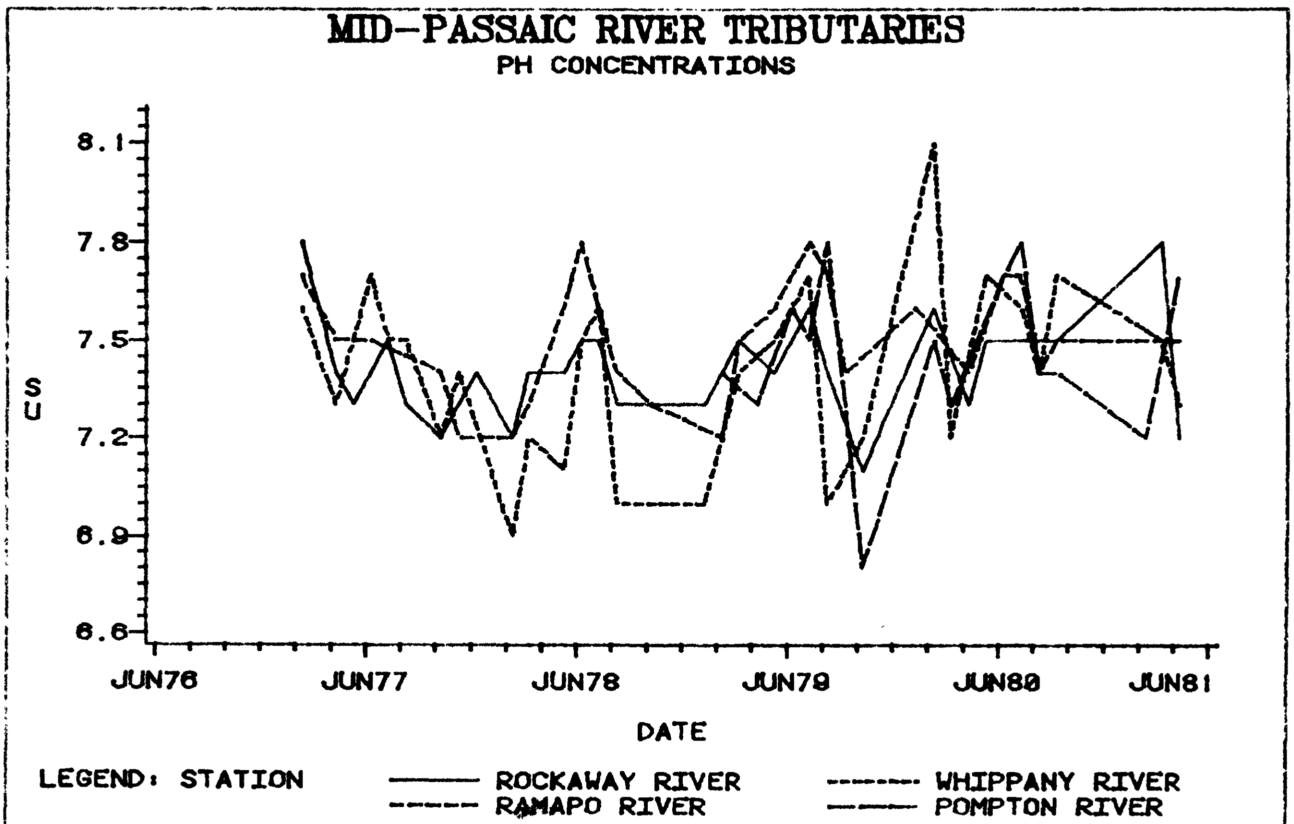

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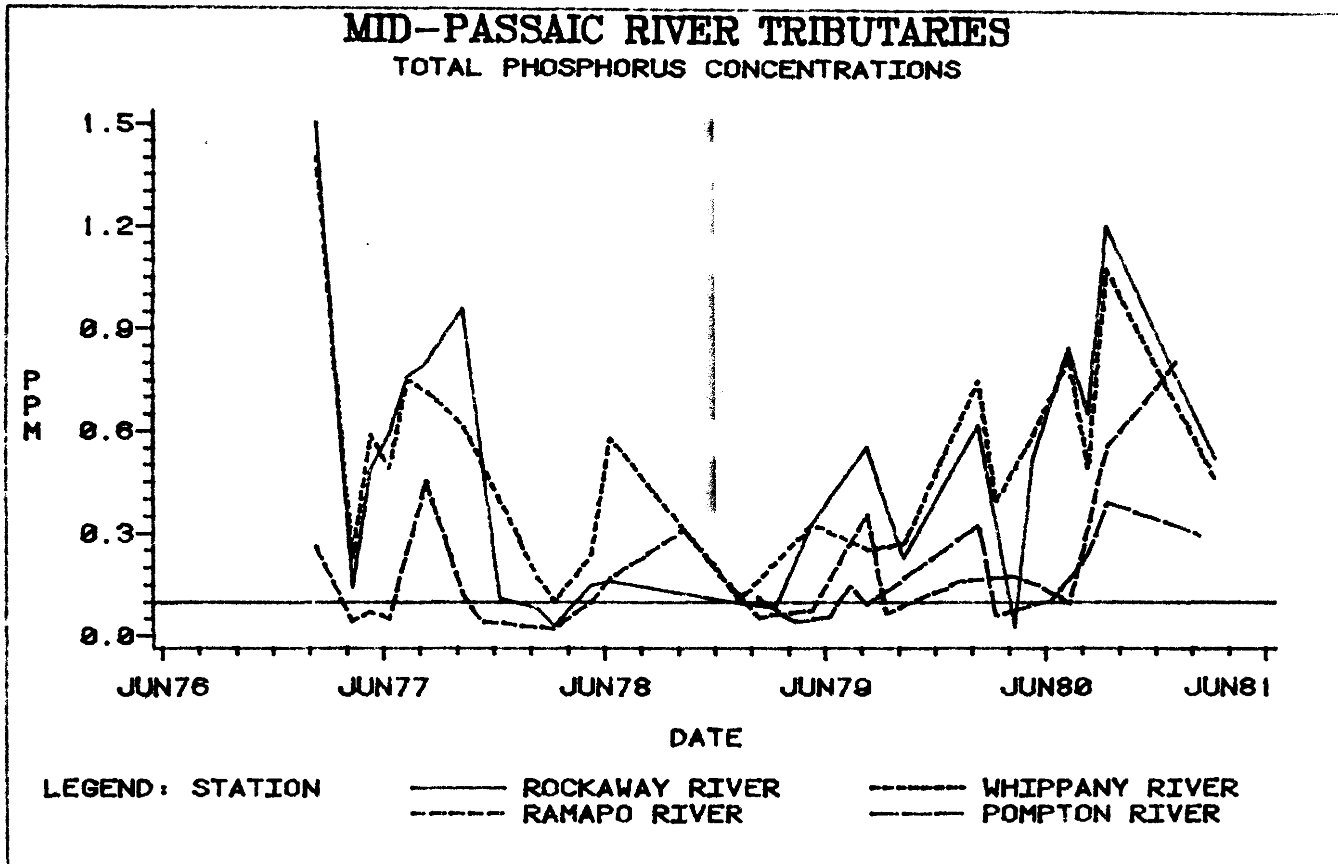

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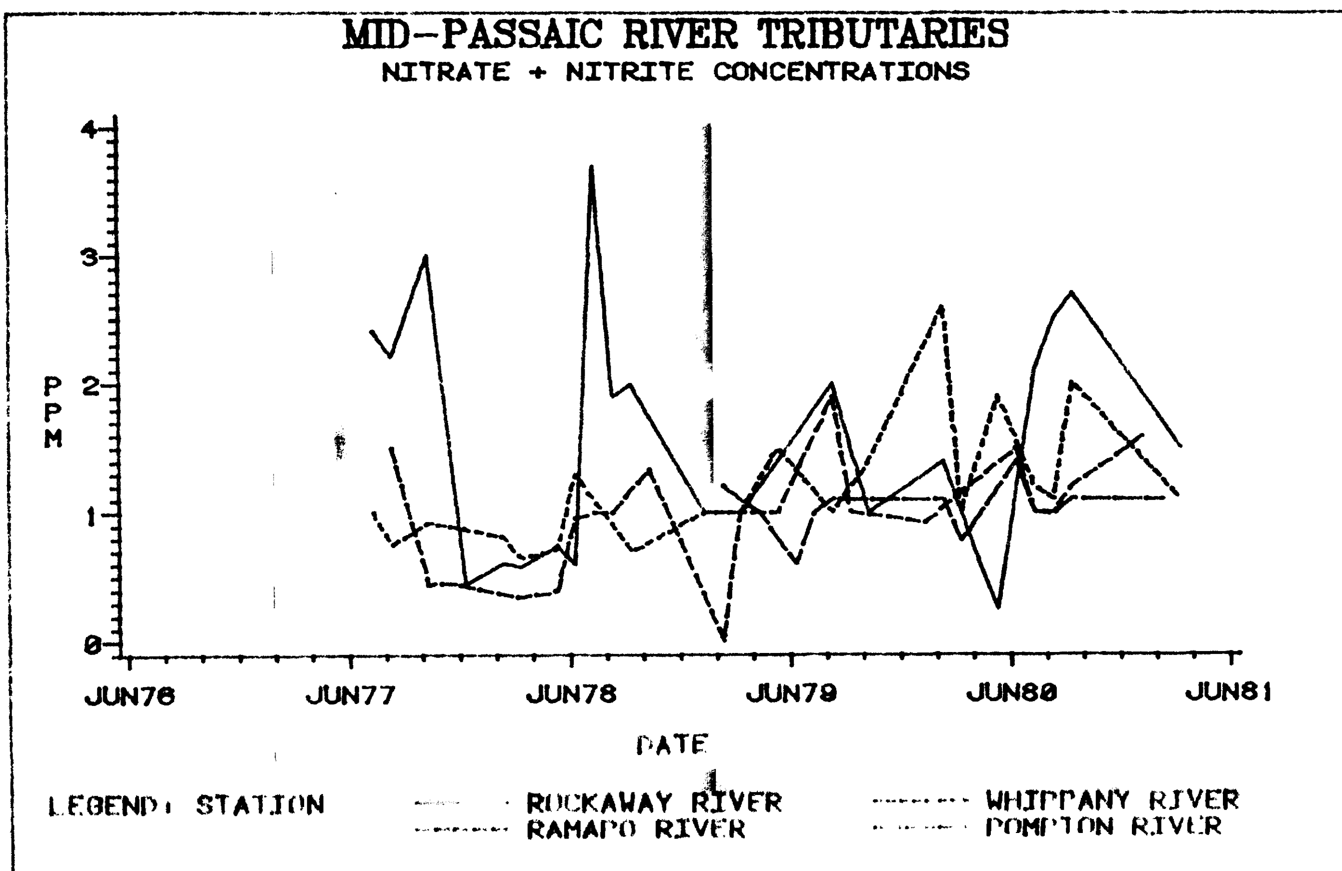
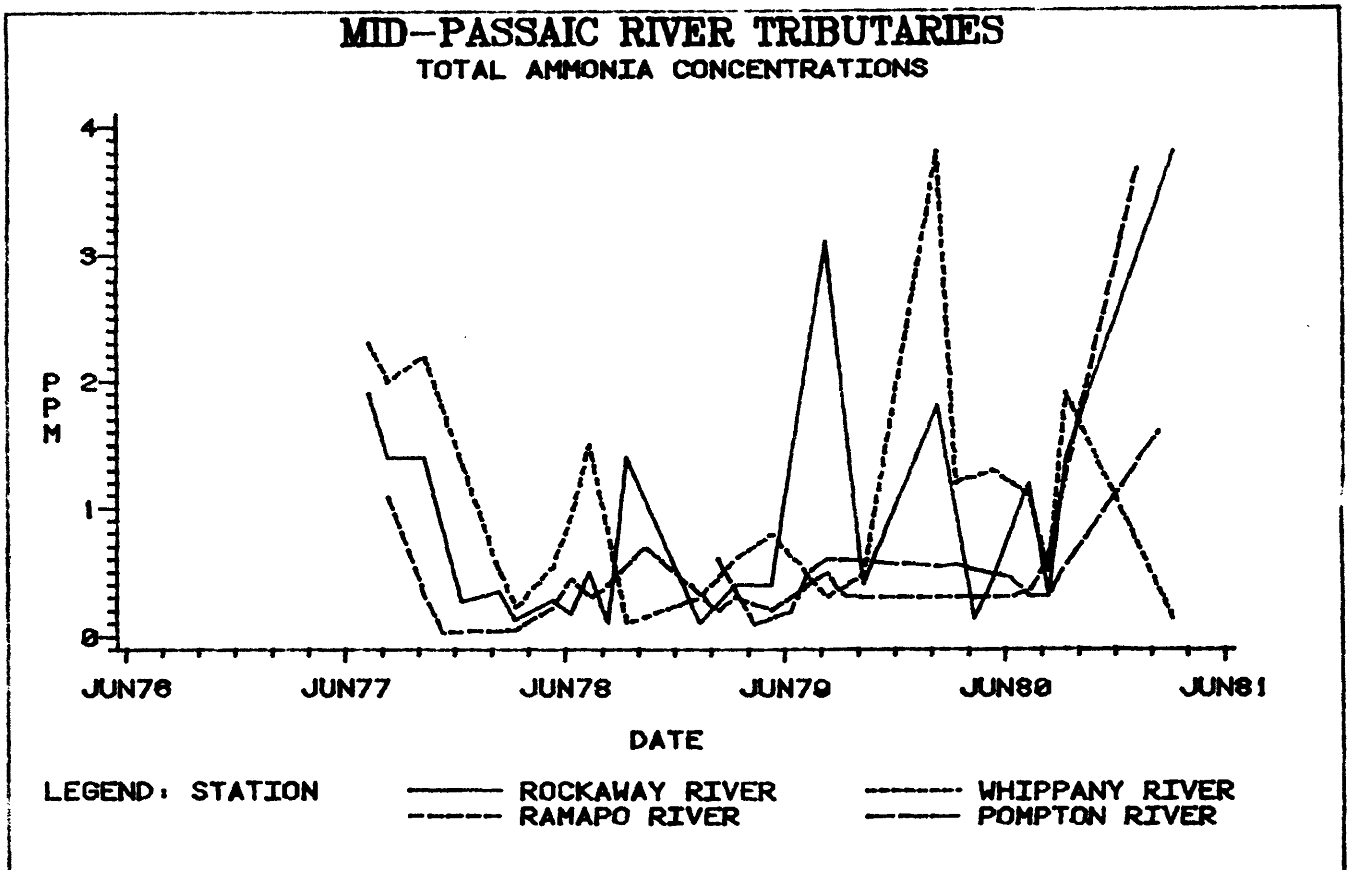


Figure: AA -8



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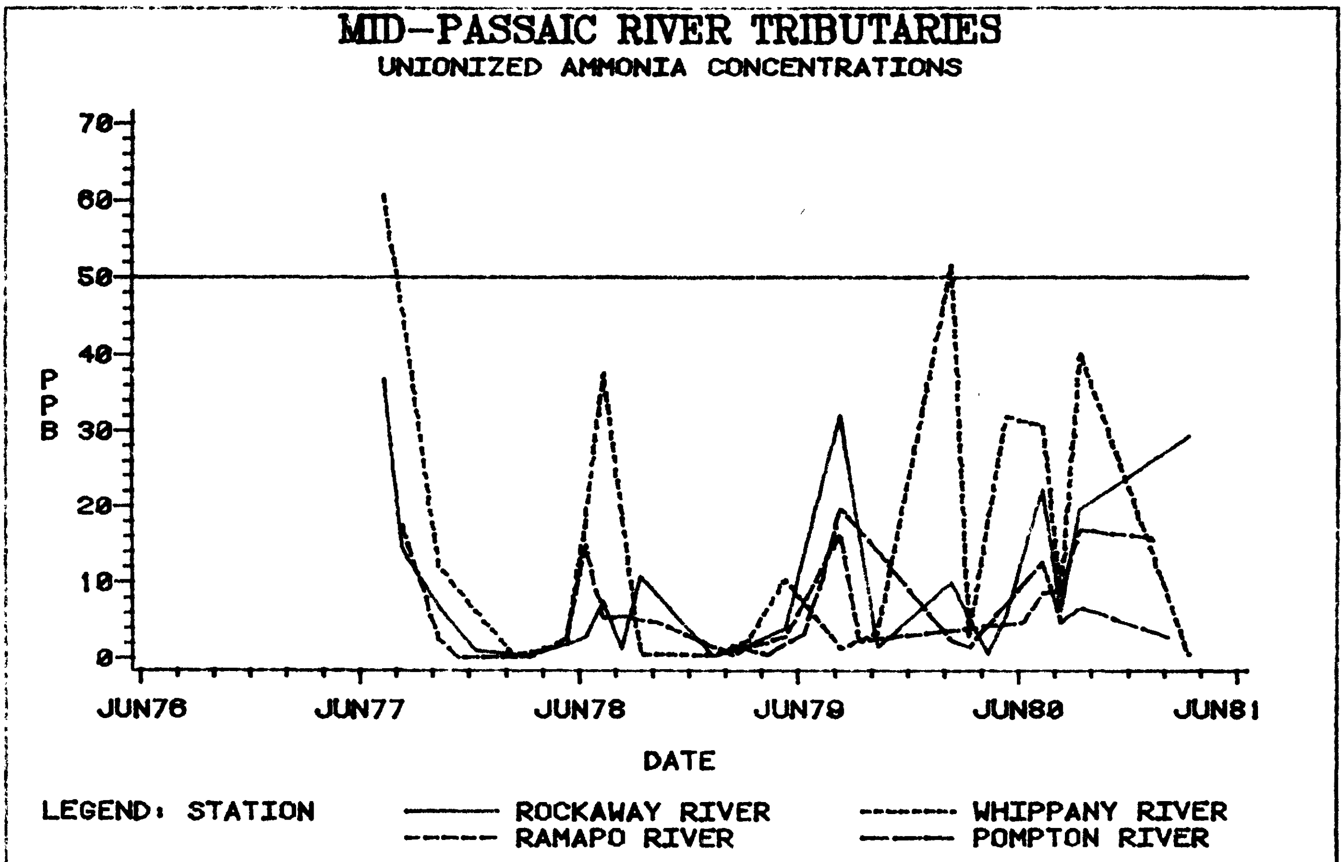


Figure: AA -10

DISCHARGE INVENTORY - - - MID-PASSAIC RIVER TRIBUTARIES - WHIPPANY RIVER

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
ROWE INTERNATIONAL INC	0001708	HANOVER TWN	PASSAIC BASIN	PROCESS WASTE	.03
ESSO RESEARCH & ENGINEERING	0003476	FLORHAM PARK	DRAIN TO BLACK BROOK	COOLING WATER	.02
LESLIE CO	0032221	PARSIPPANY	EASTMAN'S BROOK	PROCESS WASTE	
BIKSUM MANUFACTURING CO INC	0032166	PARSIPPANY	EASTMANS BROOK	COOLING WATER	
ENGR. DEPT.-GREYSTONE PARK	0026689	GREYSTONE PK-PARSIPP	JAQUI POND TO WHIPPANY RIVER	SANITARY	.30
NORDA INCORPORATED	0003506	PARSIPPANY	LAKE INTERVALE	PROCESS WASTE	.75
MAGULLIAN FUEL CORPORATION	0026093	HANOVER TWP	UNKNOWN		
PARKE DAVIS	0002542	MORRIS PLAINS BORO	WATNONG BROOK	PROCESS & COOL.	.07
MENNEN COMPANY	0035238	MORRISTOWN	WHIPPAN RIVER		
BP OIL INC	0025976	MORRISTOWN	WHIPPANY CREEK		
TOWNSHIP OF MORRIS SEWER DEPT	0024911	MORRIS /TWP/	WHIPPANY R.	SANITARY	1.44
TOWNSHIP OF PARSIPPANY	0024970	PARSIPPANY	WHIPPANY R.	SANITARY	7.49
HANOVER SEWERAGE AUTHORITY	0024902	WHIPPANY	WHIPPANY R.	SAN/SIG INDUS	1.85
NORDA INC	0003514	EAST HANOVER TWP	WHIPPANY RIVER	PROCESS & COOL.	.02
BELL TELEPHONE LABS	0000833	HANOVER	WHIPPANY RIVER	COOLING & SANIT	
COLLOID CHEMICAL LABORATORIES	0003697	HANOVER TWP	WHIPPANY RIVER	COOLING WATER	.02
TOWN OF MORRISTOWN SEWER DEPT	0025496	HANOVER TWP	WHIPPANY RIVER	SANITARY	2.3
AIRTRON DIV-LITTON IND	0025739	MORRIS PLAINS	WHIPPANY RIVER	PROCESS WASTE	.04
CHAMPION DAIRYPAK DIV	0033685	MORRISTOWN	WHIPPANY RIVER		
FABRICATED PLASTICS	0029734	MORRISTOWN	WHIPPANY RIVER	PROCESS WASTE	
TECH ART PLASTICS CO	0032425	MORRISTOWN	WHIPPANY RIVER	PROCESS WASTE	
ITT RAYONIER INC	0001325	WHIPPANY	WHIPPANY RIVER	PROCESS & SANIT	.06
WESTEX CORP	0000418	WHIPPANY	WHIPPANY RIVER	PROCESS WASTE	.00
MINNISINK OIL COMPANY	0028339	WHIPPANY-HANOVER TWP	WHIPPANY RIVER		
EXXON COMMUNICATIONS & COMP	0035777	FLORHAM PARK			
PFIZER INC.	0003450	PARSIPPANY	EASTMANS BROOK	COOLING WATER	

DISCHARGE INVENTORY - - - MID-PASSAIC RIVER TRIBUTARIES - ROCKAWAY RIVER

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
ANDREW MCMAHON	0035661	BOONTON	DIXONS POND		
PICATINNY ARSENAL	0002500	DOVER-ROCKAWAY TWP.	GREEN POND BRK	SANITARY	4.44
THATCHER GLASS MANUF CO	0034681	WHARTON	GROUND WATER		
HEWLETT-PACKARD CO	0003077	ROCKAWAY	HIBERNIA ROOK		
SCERBO BROTHERS INC	0030911	BOONTON	CROOKED BROOK		
PYAH INDUSTRIES INC.	0003441	BOONTON /T/	CROOKED BROOK	COOLING WATER	.38
R F L INDUSTRIES INC	0032972	BOONTON TOWNSHIP	R F L BROOK		
JEFFERSON TWP BD OF ED	0021091	MILTON	ROCKAWAY R.	SANITARY	
ADVANCE PRESSURE CASTINGS CORP	0034649	DENVILLE	ROCKAWAY RIVER		
CONDECOR INCORPORATED	0033863	DOVER	ROCKAWAY RIVER	PROCESS WASTE	
GREEN HAMMER METAL PRODUCTS	0034134	DOVER	ROCKAWAY RIVER	COOLING WATER	
NATIONAL HOSE COMPANY	0002712	DOVER	ROCKAWAY RIVER		
LAKESHIRE DEV.CO.	0035629	JEFFERSON TOWNSHIP	ROCKAWAY RIVER		
BERKSHIRE SAND & STONE CO. INC	0029394	OAK RIDGE	ROCKAWAY RIVER	PROCESS WASTE	.00
JIM SALERNO PONTIAC INC	0031755	RANDOLPH	ROCKAWAY RIVER	PROCESS WASTE	
MALANCO	0034720	ROCKAWAY	ROCKAWAY RIVER		
MC WILLIAMS FORGE CO INC	0002496	ROCKAWAY	ROCKAWAY RIVER	COOLING WATER	.40
ROCKAWAY TOWNSQUARE MALL	0032808	ROCKAWAY	ROCKAWAY RIVER		1.50
HOWMET CORP	0001635	ROCKAWAY TWP	ROCKAWAY RIVER	COOLING WATER	2.00
L E CARPENTER & CO	0003611	WHARTON	ROCKAWAY RIVER	PROCESS & COOL.	.06
AIR PRODUCTS & CHEMICALS CORP.	0000523	WHARTON BORO	ROCKAWAY RIVER	COOLING WATER	.02
INTERPACE CORP.	0002593	WHARTON BORO	ROCKAWAY RIVER	COOLING & SANIT	
A. M. BEST COMPANY	0028452	TEWKSBURY TWP.	NORTH BRANCH ROCKAWAY CREEK	SANITARY	
MT HOPE ROCKS PRODUCTS	0003409	ROCKAWAY TWP	WHITE MEADOW BK		.00
WHITE MEADOW LAKE PROP.OWNERS	0022802	ROCKAWAY	WHITE MEADOW BR.	SANITARY	
ROCKAWAY VALLEY REG S.A.	0022349	PARSIPPANY	PASSAIC R.	SANITARY	
W P REALTY CO	0035050	DENVILLE	BEAVER BROOK		
THERMAL AMERICAN FUSED QUARTZ	0032026	MONTVILLE	BEAVER BROOK	COOLING WATER	
RANDOLPH TOWNSHIP BD OF ED	0026603	RANDOLPH	MILL BROOK	SANITARY	
HIGH RIDGE SEWER CO.	0026867	OAK RIDGE-JEFFERSON	MITTS POND	SANITARY	
HIGH RIDGE WATER CO	0031852	JEFFERSON TWP	WHITE ROCK LAKE	PROCESS WASTE	
MONTVILLE TWNBP MUA-BROOK VALL	0030287	MONTVILLE	VALHALLA BROOK	SANITARY	
MONTVILLE TWNSP MUA-NORRLAND	0030317	MONTVILLE	VALHALLA BROOK	SANITARY	
ROCKAWAY TOWNSHIP WATER TRETMN	0035765	ROCKAWAY TOWNSHIP	BEAVER BROOK		

DISCHARGE INVENTORY - - - MID-PASSAIC RIVER TRIBUTARIES - PEQUANNOCK RIVER

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
BUTLER WATER DEPARTMENT	0025721	BUTLER	KAKEOUT BROOK	WATER TREATMENT	.26
OUR LADY OF THE MAGNIFICAT	0024457	KINNELON	BUTLER RESERVOIR	SANITARY	
KEUFFEL & ESSER	0001261	ROCKAWAY	BURNT MEADOW BK		.05
ACTION TECHNOLOGY COMPANY	0025674	ROCKAWAY	BURNT MEADOW BROOK	COOLING WATER	
PASSAIC RUBBER CO	0030457	WAYNE	PEEQUANNOCK RIVER	PROCESS WASTE	
HESS BROTHERS INC.	0001601	RIVERDALE BORO	PEQUANNOCK RIV		.30
BOROUGH OF BUTLER	0022039	BLOOMINGDALE BORO	PEQUANNOCK RIVER	SAN/SIG INDUS	1.5
COMAR PRODUCTS INC	0025712	BUTLER	PEQUANNOCK RIVER	COOLING WATER	
KINNELON BOARD OF EDUCATION	0022276	KINNELON	PEQUANNOCK RIVER	SANITARY	
PASSAIC CRUSHED STONE CO INC	0025500	POMPTON LAKES	PEQUANNOCK RIVER		.00
MACK WAYNE PLASTICS COMPANY	0030775	WAYNE	PEQUANNOCK RIVER	SANITARY	.25
PILOT METAL FABRICATORS INC	0033642	WAYNE	PEQUANNOCK RIVER	COOLING WATER	
KINNELON BOARD OF EDUCATION	0022284	KINNELON	TRIBUTARY PEQUANNOCK RIVER	SANITARY	
MILFORD MANOR NURSING HOME	0026981	W. MILFORD	TRIB OF NOSENGO POND	SANITARY	
WEST MILFORD TWP MUA	0027685	W MILFORD TWP	VREELAND POND	SANITARY	.06
CAMP VACAMAS ASSOC OF NJ	0030201	WEST MILFORD	TRIB OF HENION POND	SANITARY	

DISCHARGE INVENTORY - - - MID-PASSAIC RIVER TRIBUTARIES - WANAQUE RIVER

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
ROBERT ERSKINE SCHOOL	0029432	RINGWOOD	ERSKINE BROOK	SANITARY	
WEST MILFORD TWP. BD. OF EDUC.	0033308	WEST MILFORD	GREENWOOD LAKE NJ & NY	SANITARY	
RINGWOOD BD OF EDUCATION	0034169	RINGWOOD	HIGH MOUNTAIN BROOK		
WANAQUE BORO SEW. AUTH.	0030261	WANAQUE	HIGH MOUNTAIN BROOK	SANITARY	.09
RINGWOOD BOROUGH SEW. AUTH.	0027006	RINGWOOD	HIGH MT BROOK	SANITARY	.04
RINGWOOD PLAZA S T P	0032395	RINGWOOD	WANAQUE RIVER	SANITARY	
WEST MILFORD TWP MUA	0027669	WEST MILFORD TWP	WANAQUE RIVER	SANITARY	
ARTISTIC IDENT. SYSTEMS	0030091	POMPTON LAKES	WANAQUE RIVER	PROCESS WASTE	.02
SOLAR PRODUCTS	0029947	POMPTON LAKES	WANAQUE RIVER	PROCESS WASTE	.02
RIVERDALE PLASTICS INC	0030074	RIVERDALE	TRIB OF PASSAIC RIVER	PROCESS WASTE	.02
BIRCH HILL PARK DISPOSAL CO.	0028541	WEST MILFORD	MUSCONETCONG RIVER	SANITARY	
WOODLAND MANOR AT WEST MILFORD	0035297	WAYNE	BELCHER CREEK		
WEST MILFORD TWP MUA	0026174	WEST MILFORD TWP	BELCHER CREEK	SANITARY	
THEDORE LAPPAS ET AL	0024414	WEST MILFORD	BELCHER'S CR.	SANITARY	
REFLECTION LAKE GARDEN APTS.	0027201	NEWFOUNDLAND	BELCHERS CREEK	SANITARY	
WEST MILFORD TWP MUA	0027677	W MILFORD TWP	BELCHERS CREEK TRIB	SANITARY	.05
ARROW GROUP IND	0001317	HASKELL	POST BROOK	PROCESS & COOL.	
NATIONAL BERYLLIA CORP	0025470	HASKELL	POST BROOK	COOLING WATER	
WANAQUE MUA	0021741	HASKELL	POST BROOK	SANITARY	.25

DISCHARGE INVENTORY - - - MID-PASSAIC RIVER TRIBUTARIES - RAMAPO RIVER

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
ABEX CORPORATION.	0000108	MAHWAH TWP	MAHWAH RIVER	COOLING SAN/PRO	4.21
RAMAPO HILLS BD OF ED	0021253	OAKLAND	CRYSTAL BROOK	SANITARY	
AMERICAN CYANAMID CO	0032778	WAYNE	POINT VIEW RESERVOIR		4.01
URBAN FARMS SHOPPING CTR.	0026441	FRANKLIN LAKES	POND BROOK	SANITARY	
PAREID INC DER SWISS CHALET	0026573	RAMSEY	RAMAPO BROOK	SANITARY	.01
US ARMY NIKE 93/94 MAHWAH	0021946	MAHWAH	RAMAPO R.	SANITARY	
BOROUGH OF OAKLAND	0021342	OAKLAND	RAMAPO R.	SANITARY	
BEL-AIR NURSING HOME	0029858	HASKELL	RAMAPO RIVER	SANITARY	.02
CHAN'S HAWAII INC.	0028886	MAHWAH	RAMAPO RIVER	SANITARY	.01
PRIME EQUITIES INC	0023876	MAHWAH	RAMAPO RIVER	SANITARY	
RAMAPO COLLEGE OF NEW JERSEY	0024082	MAHWAH	RAMAPO RIVER	SANITARY	
TOWNSHIP OF MAHWAH	0023906	MAHWAH	RAMAPO RIVER	SANITARY	
MANITO SCHOOL BD OF ED	0030384	OAKLAND	RAMAPO RIVER	SANITARY	
SILICON TECHNOLOGY CORP.	0028428	OAKLAND, N.J.	RAMAPO RIVER	COOLING WATER	
GEM CAR WASH	0030139	WAYNE	RAMAPO RIVER		
OAK RIDGE MANOR NURSING CENTER	0026549	WAYNE	RAMAPO RIVER	SANITARY	
TRI CORNER REALTY CORP	0021245	FRANKLIN LAKES	RAMAPO RIVER FROM PULIS POND	SANITARY	
BOROUGH OF OAKLAND DPW	0027774	OAKLAND	UNNAMED TRIB RAMAPO RIVER	SANITARY	
FRANK A GREEK & SON INC	0023159	MAHWAH	MASONICUS BROOK	SANITARY	
FRANKLIN ASSOCIATES	0024198	MAHWAH	MASONICUS BROOK	SANITARY	.02
MAHWAH SEWER TREATMENT PLANT	0032646	MAHWAH	MASONICUS BROOK	SANITARY	.03
MCKEE BROS INC.	0033120	MAHWAH	MASONICUS BROOK		
PHILIPS ELECTPONIC INSTR INC	0033235	MAHWAH	MASONICUS BROOK		
OKONITE COMPANY	0027235	RAMSEY	MASONICUS BROOK	SANITARY	

DISCHARGE INVENTORY - - - MID-PASSAIC RIVER TRIBUTARIES - POMPTON RIVER

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
E.I DU PONT DE NEMOURS	0001350	POMPTON LAKES	POMPTON LAKE	COOLING WATER	.76
PEQUANNOCK LIN.PK.& FAIRF'LD S	0029386	LINCOLN PARK	POMPTON RIVER	SANITARY	1.17
BOROUGH OF NORTH HALEDON	0023060	NORTH HALEDON BORO	POMPTON RIVER	SANITARY	
PLAINS PLAZA	0026514	PEQUANNOCK	POMPTON RIVER	SANITARY	
PEQUANNOCK TOWNSHIP	0022926	PEQUANNOCK	POMPTON RIVER	SANITARY	
POMPTON LAKES BOROUGH M.U.A.	0023698	POMPTON LAKES	POMPTON RIVER	SANITARY	.80
SGL PRINTED CIRCUITS INC	0029653	WAYNE	POMPTON RIVER	COOLING WATER	
TOWNSHIP OF WAYNE-SHEFFIELD	0026841	WAYNE	POMPTON RIVER	SANITARY	1.40

BB. LOWER PASSAIC RIVER (LITTLE FALLS TO NEWARK BAY)

Basin Description

The lower Passaic River basin encompasses the drainage area of the Passaic River from the dam at Little Falls to its mouth at Newark Bay (a total area of 133 square miles). The Passaic River is freshwater from Little Falls to Dundee Dam, and is tidal downstream of the dam. The lower Passaic basin is highly urban/suburban and includes large scale industrial development. Water related activities of the Passaic River are now very limited in their intended use (industrial water supply, fishing and boating), because of poor water quality. The major tributary of the lower Passaic River is the Saddle River, which flows in a southerly direction from its headwaters in New York State and northern Bergen County.

The lower Passaic River basin is extensively developed with a large percentage of the total area consisting of older urban cities: Paterson, Newark, Clifton, and East Orange. Residential land use varies in density, ranging from approximately 5 to 20 dwelling units per acre. Industry, generally heavy manufacturing is located near rail, highway and water systems. Recreation and open space are at a premium. Generally, there was a loss of population between 1970 to 1980 throughout the basin. Over 160 point sources are located in the lower Passaic River basin, the majority being industrial. This large number of point sources indicates the density of the residential, commercial and industrial facilities in this basin. The lower Passaic River basin lies within four facilities planning areas designated by the NJ Department of Environmental Protection for municipal waste water treatment.

Potable water supplies in the lower Passaic River basin are derived primarily from surface water sources, all from outside the lower Passaic basin. Non-potable water use in the basin, primarily by industry, is derived from surface (108.6 mgd) and groundwater (17.7 mgd) sources. Work is currently underway to reactivate the hydroelectric power plant on the Passaic River at Great Falls in the City of Paterson. It is estimated that the plant would generate 75,000 kilowatts of electricity, equivalent to 2.5 million gallons of oil a year, for the City of Paterson.

Seven major lakes are located in the lower Passaic River basin, all of which are publicly owned and generally devoted to shore fishing, ice skating and boating. Dundee Lake, the largest (224 acres), provides good to fair angling quality for catfish, carp and sunfish.

The New Jersey Division of Fish, Game and Wildlife stocks trout in the following waters: Charles Pond and Verona Park lake in

Essex County, and Barbour's Pond and Oldham Pond in Passaic County.

The lower Passaic River (up to Dundee Dam) and Newark Bay had fishing closures and advisories issued in December, 1982 by the State because of PCB contamination in certain fishes. The sale of striped bass and American eel taken from these waters is prohibited; while the consumption of striped bass, bluefish (when the individual fish is greater than 6 pounds or 24 inches in length), white perch, white catfish and American eel taken from these waters is advised to be no more than once weekly. PCB contamination in the tissue of these fishes is above the average statewide and at times exceed the FDA action limits (5 parts per million). Adjacent interstate waters (Hudson River, Upper New York Bay, Kill Van Kull and the Arthur Kill) are also included in the advisory and closure.

NJ Surface Water Quality Standards give the lower Passaic River basin the following water quality classifications: FW-2 Trout Production, FW-2 Trout Maintenance, FW-2 Nontrout, TW-2 and TW-3.

Water Quality Assessment

Conventional Parameters

Water quality was generally poor throughout the period in both the Saddle River and lower Passaic River, based on samples collected at Elmwood Park (Passaic River) and Lodi (Saddle River). As in the two upstream segments of the Passaic River, the reduced stream flows which resulted from a severe rainfall deficit in 1980 displayed a marked impact on many parameters.

Dissolved oxygen levels were generally above the minimum criterion, the only exception occurring in the Passaic at Elmwood Park in the summer of 1980. The Saddle River sustained elevated five-day biochemical oxygen demand loads, particularly after June 1980, but daytime dissolved oxygen levels remained above the criterion. Biochemical oxygen demand data was not available for the lower Passaic River; however total organic carbon data indicated generally moderate to high concentrations of oxygen demanding carbonaceous material.

Fecal coliform levels in Saddle River were generally excessive through the period with the most extreme concentrations occurring in 1980. Bacteria data was not available for the Elmwood Park station on the Passaic River.

Saddle River exhibited higher total dissolved solids concentrations than in the lower Passaic River, but all values remained below the 500 mg/l standard during the period 1977 to 1981. Generally neutral pH values were exhibited in the lower Passaic and Saddle Rivers for the period with slightly alkaline values recorded at Elmwood Park in 1980.

Total phosphorus data from both stations for the most part contravened the standard throughout the period, with concentrations rising to extreme levels (greater than 1.5 mg/l in the Saddle River) in 1980. Total phosphorus concentrations were generally less than 1.0 mg/l at Elmwood Park. Nitrate + nitrite concentrations were generally higher in the Saddle River, increasing slightly in 1980. Total and un-ionized ammonia concentrations were uniformly elevated or excessive in each river through the period, with increasing concentrations exhibited during the dry period in 1980. The criterion for un-ionized ammonia was occasionally contravened at Lodi during the summers, while the lower Passaic River station exhibited an increase to over 100 micrograms per liter in 1980, probably due to low flow conditions.

The Passaic River at Elmwood Park showed symptoms of organic degradation through the presence of an unbalanced biological community. The periphyton chlorophyll a concentrations were high, suggesting enriched conditions. Pollution tolerant chironomids and oligochaetes dominated the macroinvertebrate samples at Elmwood Park. *Dero* spp. alone, comprised 50 percent of the individuals in the 1978 samples with *Nais obtusa*, also a worm, comprising another 22 percent.

Water quality in the lower Passaic River at Elmwood Park has shown no significant improvements in the last few years over what was described in earlier 305(b) reports. The only significant trend occurred in 1980 when low flows due to a short-term severe drought resulted in poor quality river water.

Toxic Parameters

The lower Passaic River was sampled at fifteen locations. In every sample, low to moderate levels of trihalomethanes and organic solvents were detected. These levels are common in waterways such as the Passaic, which have a high percentage of industrial land use and numerous discharges.

Fish tissue samples collected in 1979 along the Passaic River at Elmwood Park revealed trace levels of PCB Arochlor 1254 and various levels of chlordane and DDT metabolites. Species with elevated pesticide levels include American eel, *Anguilla rostrata*, and carp, *Cyprinus carpio*. Sediment analyses in 1979 and 1980 showed only trace levels of these same parameters. However, concentrations of PCBs in certain fishes were at such levels to warrant the advisory and closure mentioned in the "Basin Description".

Samples collected from the Passaic River at Fairlawn, East Rutherford and the Newark-Kearny area were analyzed for heavy metal content. American eel, and bluegill sunfish, *Lepomis macrochirus*, revealed unusual nickel values when compared to similar waterways. There appears to be little variation in results from these locations, with the exception being an increased incidence of nickel from the East Rutherford location. Overall, the fish tissue data for heavy metals exhibited the same pattern of results as has been seen from data obtained throughout the State.

Problem Assessment

The poor water quality found in the freshwater lower Passaic results from the influence of point sources, upstream water quality, and urban runoff. The point source discharges which successively enter the river are the major cause of this degradation. If the waterfalls (Little Falls and Great Falls) were not present, then water quality (especially dissolved oxygen) would be significantly poorer.

In addition to point sources, there are industrial diversions which remove water and lower possible dilution ratios. Industries discharging to the sanitary sewer system are also affecting the efficiency of wastewater treatment facilities. Excessive nutrients, BOD, and ammonia are mostly due to point sources adding to the existing elevated concentrations from the upstream waters. Sources of fecal coliform are not definitely known, but non-point sources (urban runoff, leaky sewers) and malfunctioning point sources are the prime causes for this type of contamination.

The tidal portion's depressed dissolved oxygen concentrations are replenished somewhat by aeration from Dundee Dam, but low quality Newark Bay water and additional point sources reduce the dissolved oxygen levels below the State's water quality standards. The fecal coliform levels in the TW-2 segment, according to the Northeast Water Quality Management Plan, contravenes the State's water quality standards. These elevated levels are probably due to the combined sewer overflows, urban runoff, and lower Newark Bay water quality. Due to the lack of a sampling network in the tidal basin, the specific origin is unknown. Another major problem in the lower tidal sections of the Passaic and Newark Bay are the large cooling water discharges from industrial facilities and powerplants. This heated cooling water also causes reduced DO concentrations.

In the Saddle River watershed, the Fairlawn Boro and Northwest Bergen County UA treatment plants are under study to be upgraded to higher levels of treatment. Septic system problems in the watershed are known to occur in Wyckoff and Ringwood Townships (Saddle River Watershed). Projects for sewage treatment facilities proposed in the lower Passaic include the following: Cedar Grove Township, Little Falls Township, Totowa - West

Paterson and Borough of Verona. In North Haledon Borough, areas served by on-site disposal systems and package treatment plants are in need of centralized sewage treatment. The Passaic Valley Sewerage Commissioners has recently completed an upgrade of their treatment plant to secondary levels. Their discharge of approximately 250 mgd is to upper New York Bay. In addition, combined sewer overflows (CSOs) still exist in many municipalities throughout the lower Passaic River basin. Areas with CSOs include Paterson City, service areas of the Passaic Valley Sewerage Commissioners and portions of Planning Area I, Hudson County UA.

An intensive survey was conducted in 1979 by the NJ Lakes Management Program of Verona Park Lake. The lake is located on the Peckman River and was classified as being eutrophic with possible sources of nutrients being golf course runoff, an overflowing sewage trunk line and other diffuse sources such as overfertilized lawns and road drainage.

A severe water quality problem in Newark Bay occurred in the spring and summer of 1980, when the Passaic Valley Sewerage Commissioners was allowed to discharge an average of 271 mgd of inadequately treated sewage (less than primary levels) to the Bay. This discharge, combined with abnormally low freshwater in-flows to the Bay, resulted in severely degraded DO levels. In fact, anaerobic conditions occurred throughout much of the warm weather period. By September 1980, this situation had rectified itself, following elimination of the discharge.

Goal Assessment and Recommendations

The waters of the lower Passaic segment do not meet the goals of swimmable quality due to the frequency with which samples exceeded a fecal coliform concentration of 200 MPN/100 ml. The river segment above Dundee Dam meets the fishable goal. However, these waters have problems with low dissolved oxygen concentrations. The Passaic River below Dundee Dam and Newark Bay are considered not fishable because of the PCB contamination problem of fish tissue in certain fishes. Also, poor water quality likely causes severe stress to fish at times in the tidal Passaic River.

The lower Passaic River reportedly has a fish species diversity of 17. The Saddle River, which is within this river basin, contains native trout in upstream waters.

It is recommended that municipal point sources be upgraded as stated in the Water Quality Management Plan. In addition, the repair of combined sewer overflows could benefit water quality conditions in the river. Non-point source controls for the urban areas should include, where economically feasible, street sweeping, and use of best management practices for street and industrial runoff to storm sewers, and for areas with severe sewer leakage and breaks. However, for these recommendations to have any effect, it is imperative that remedial measures be enacted to improve both the upstream segment (Upper Passaic, Mid-Passaic and Mid-Passaic tributaries) and Newark Bay waters (which includes improvements to New York Bay).

LOWER PASSAIC RIVER STATION LIST

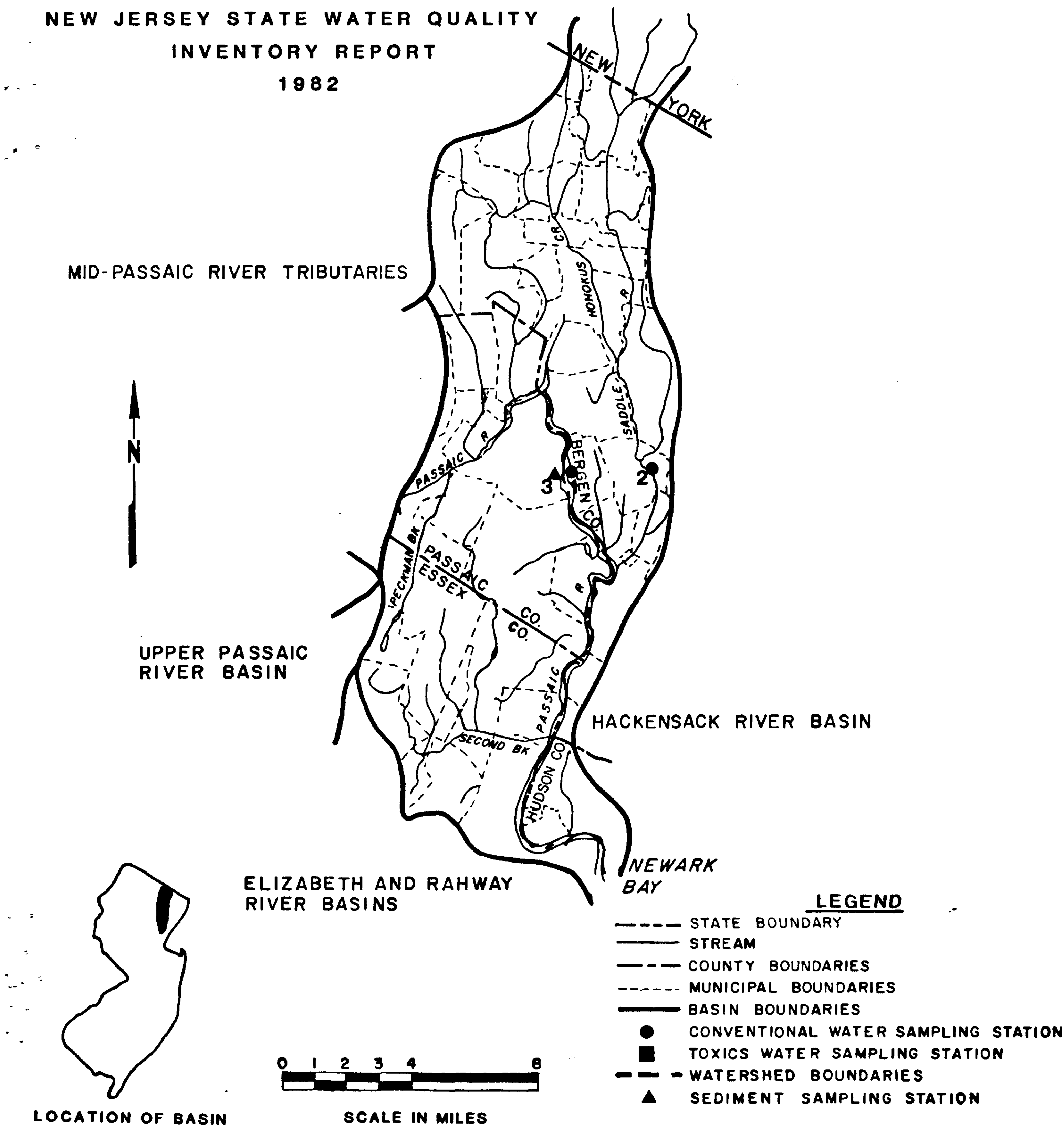
A. Ambient Monitoring Stations

STORET Number	Station Description	Map Number
01389880	Passaic River at Elmwood Park, Bergen County Latitude 40°53'37" Longitude 74°07'46" FW-2 Nontrout Basic Water Monitoring Program At bridge on U.S. Route 46 in Elmwood Park, 0.8 miles upstream from Dundee Dam.	1
01391500	Saddle River at Lodi, Bergen County Latitude 40°53'25" Longitude 74°04'51" FW-2 Nontrout USGS/DEP Network 560 feet upstream from Outwater Lane Bridge and 3.2 miles upstream from mouth.	2

B. Toxics Monitoring Stations

Station Locations	Sampling Regime	Map Number
Passaic River at Elmwood Park	Sediments	3
Intensive survey of the lower Passaic River (fifteen stations)	Water column	-

LOWER PASSAIC RIVER BASIN



LOWER PASSAIC RIVER BASIN (LITTLE FALLS TO NEWARK BAY)
DISSOLVED OXYGEN CONCENTRATIONS

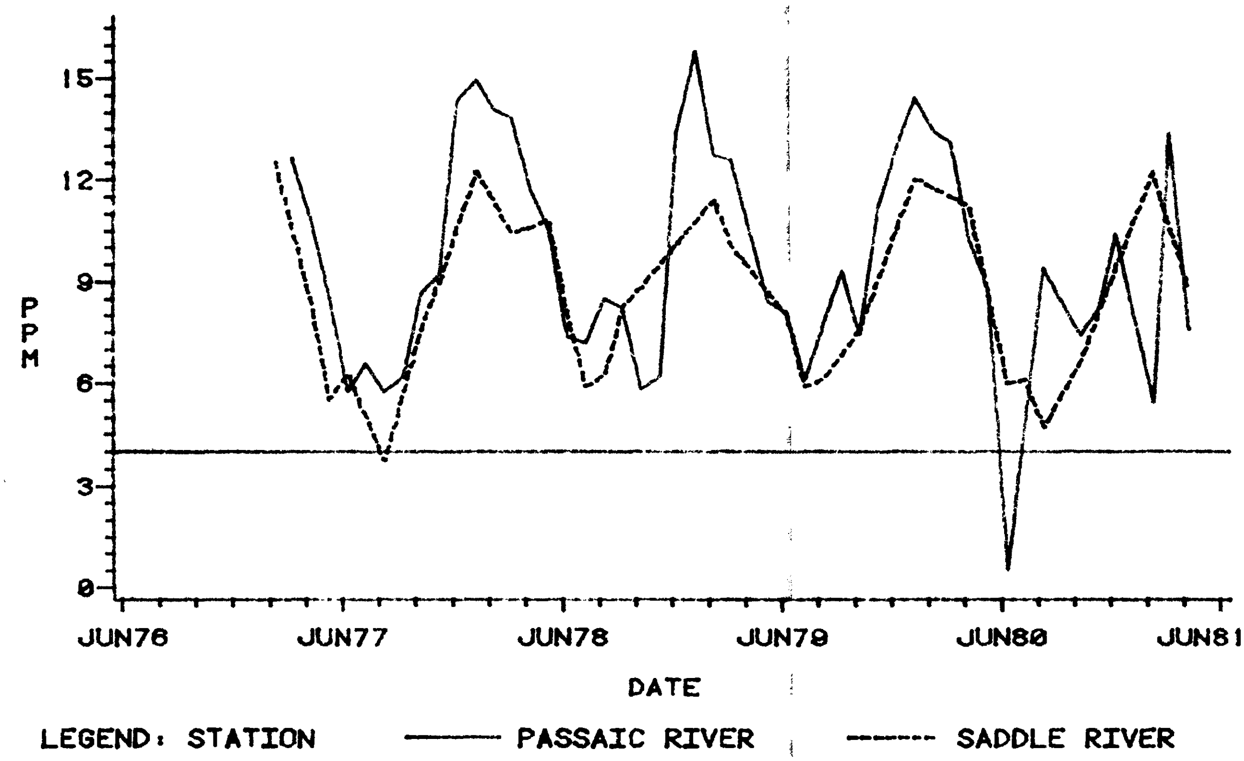
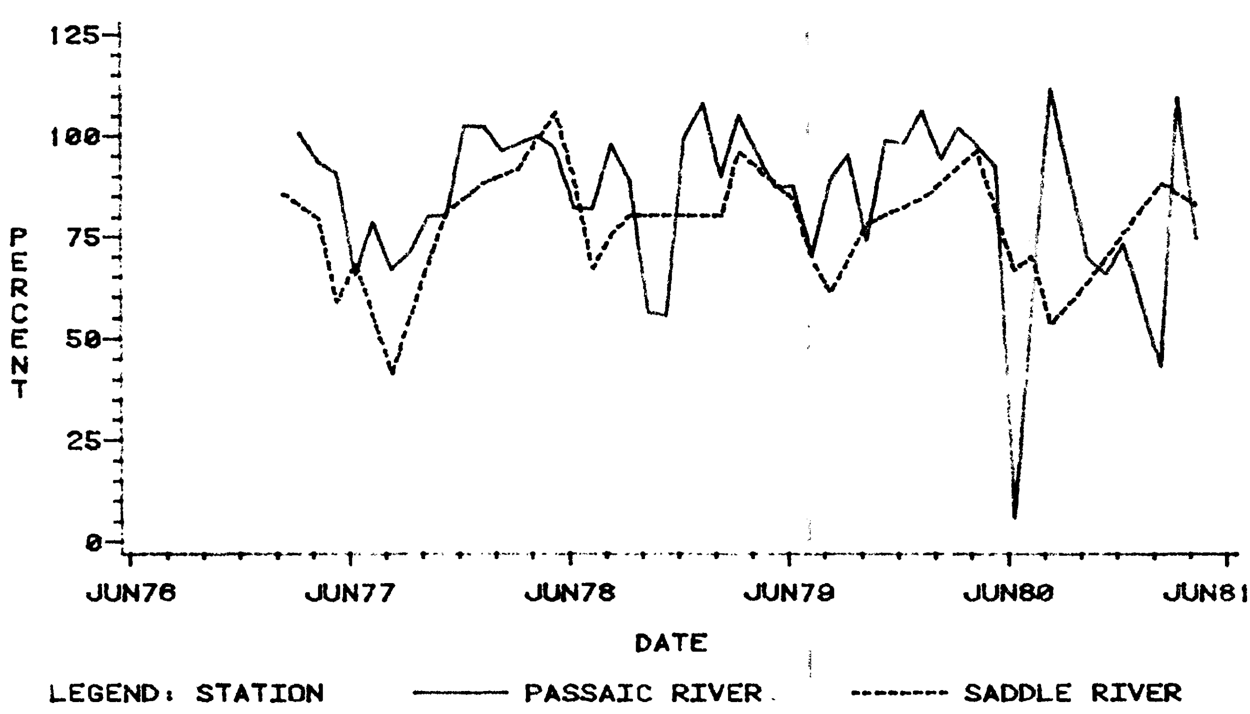


Figure: BB -1

LOWER PASSAIC RIVER BASIN (LITTLE FALLS TO NEWARK BAY)
DISSOLVED OXYGEN SATURATION



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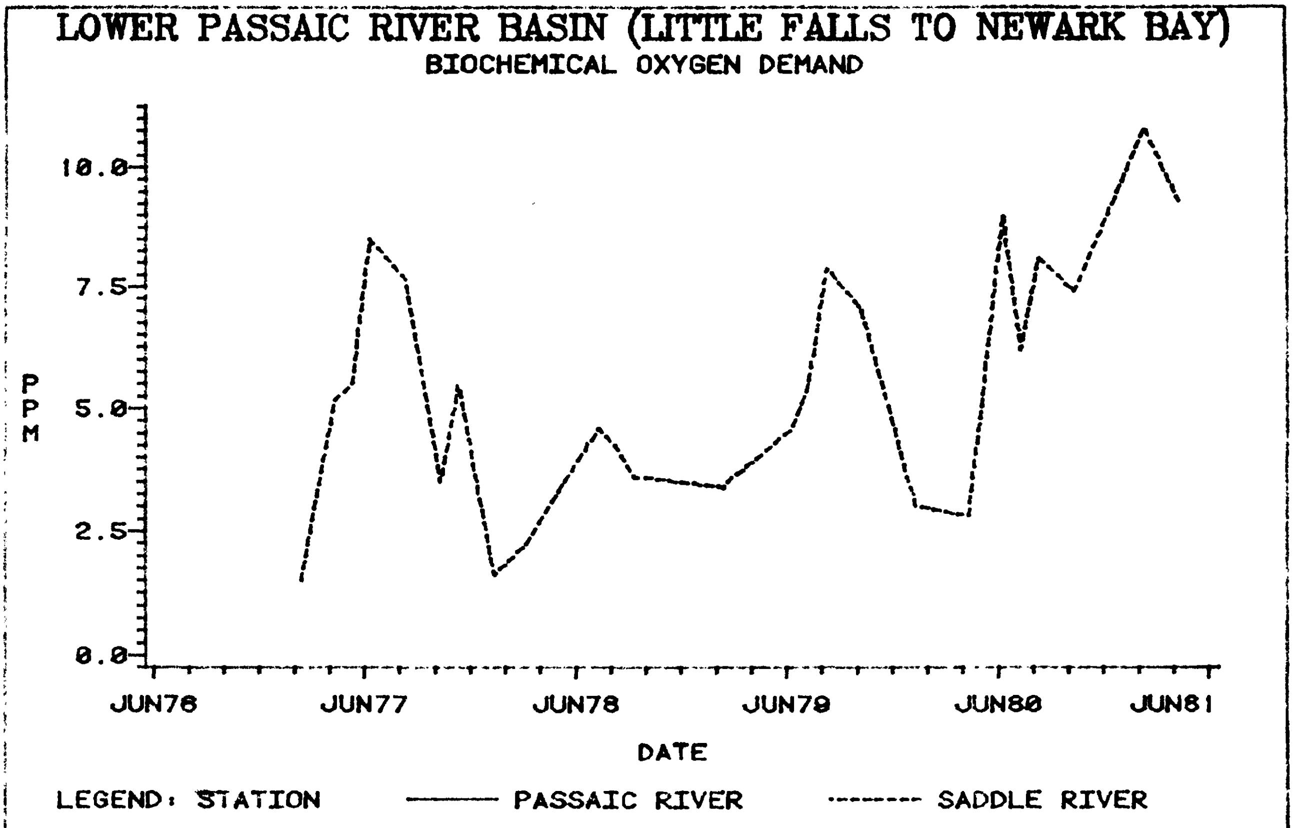

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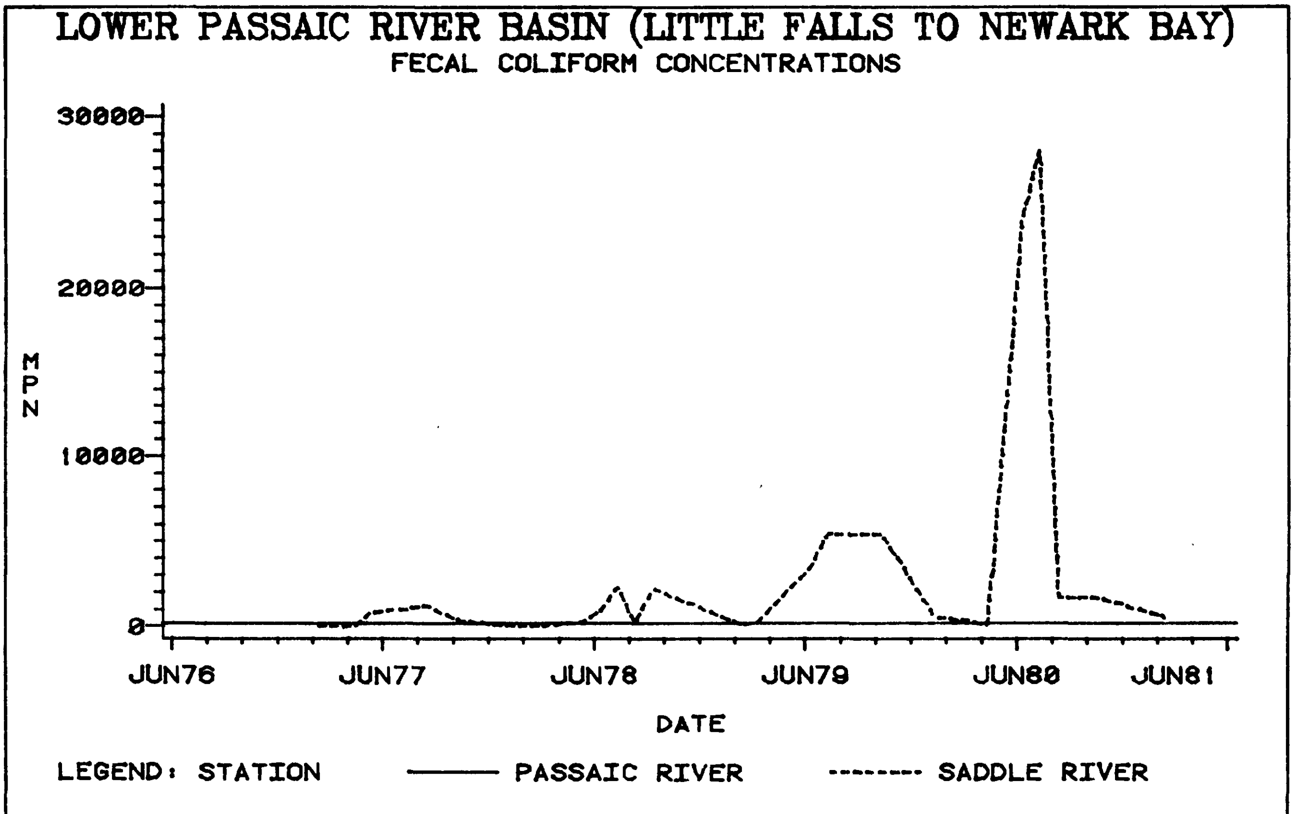


Figure: BB -4

LOWER PASSAIC RIVER BASIN (LITTLE FALLS TO NEWARK BAY)
TOTAL DISSOLVED SOLIDS

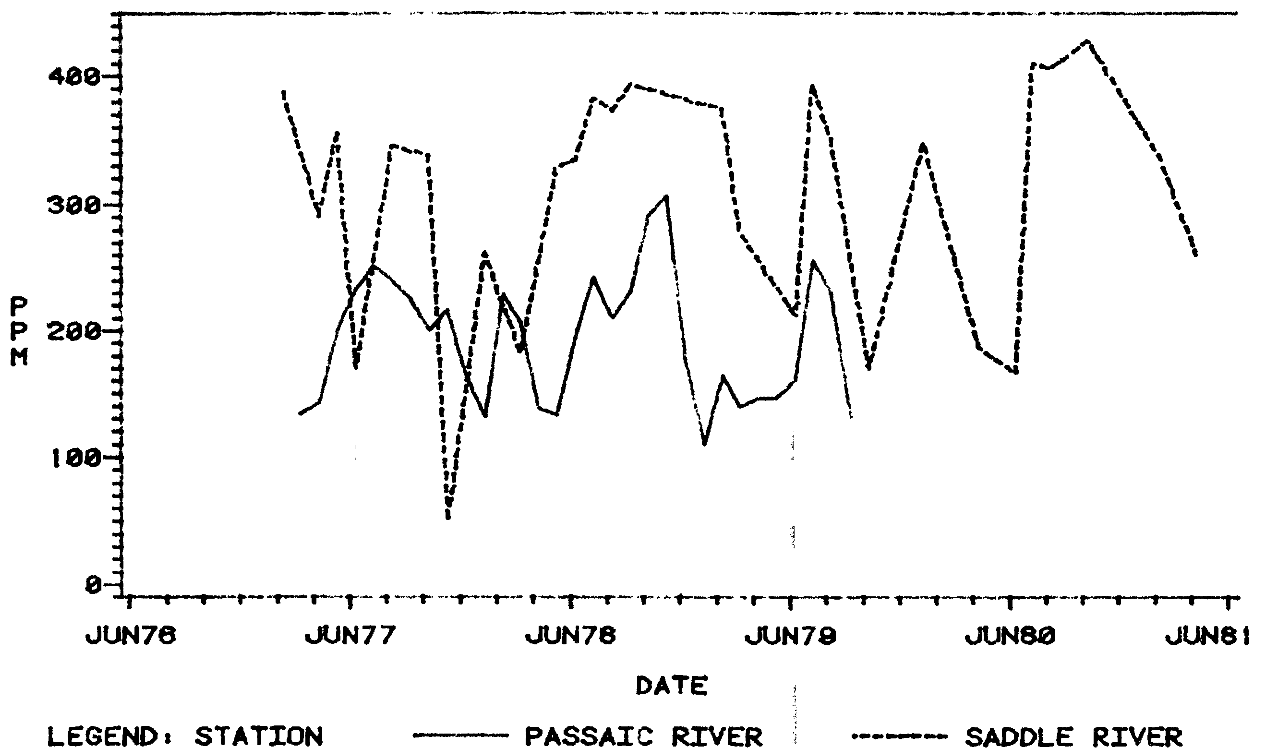


Figure: BB -5

LOWER PASSAIC RIVER BASIN (LITTLE FALLS TO NEWARK BAY)
PH CONCENTRATIONS

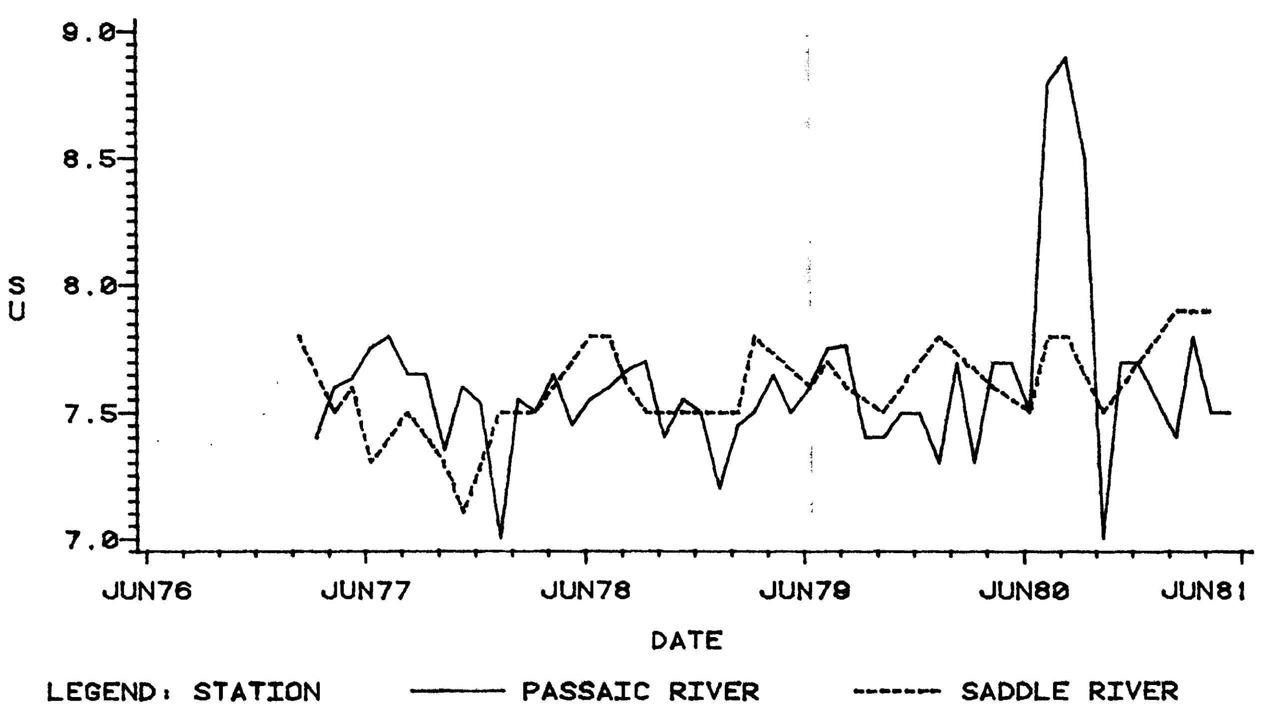


Figure: BB -6

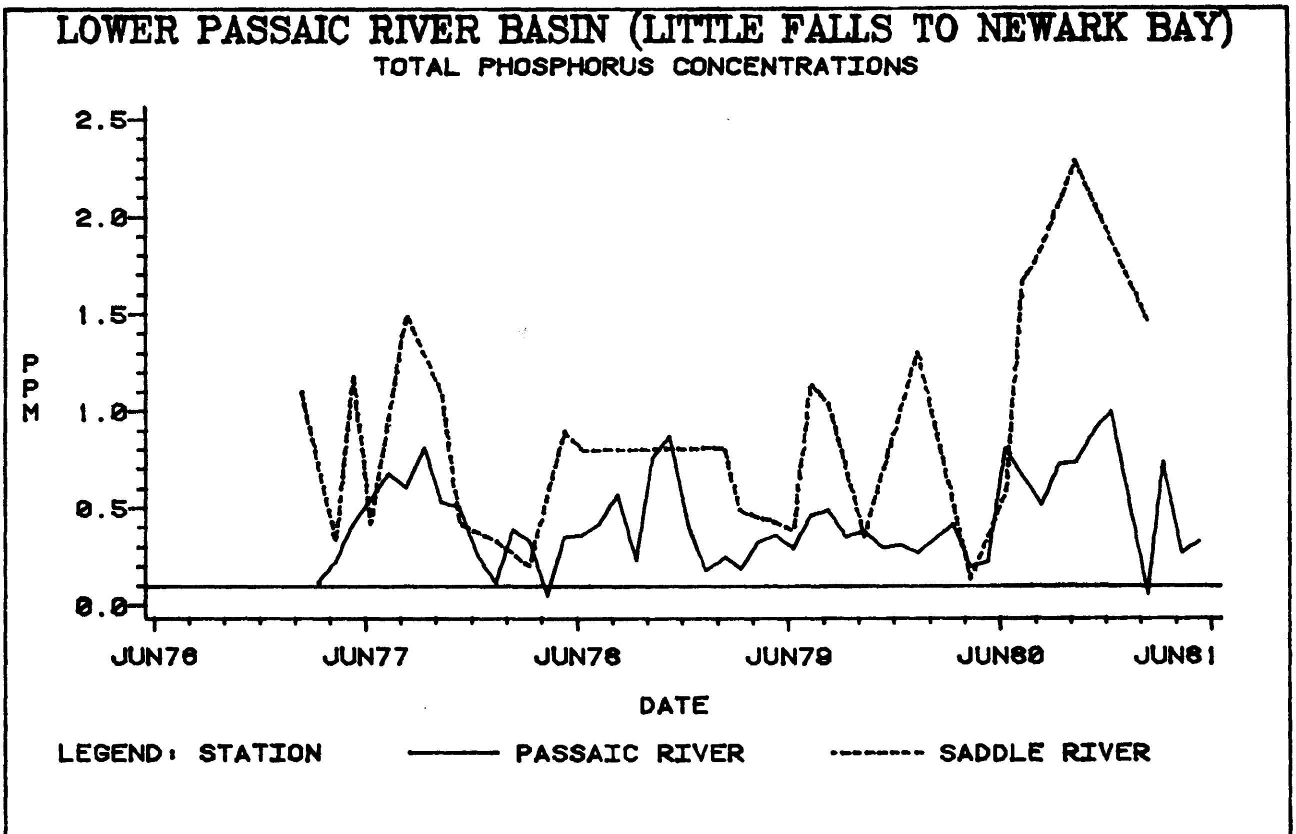


Figure: BB -7

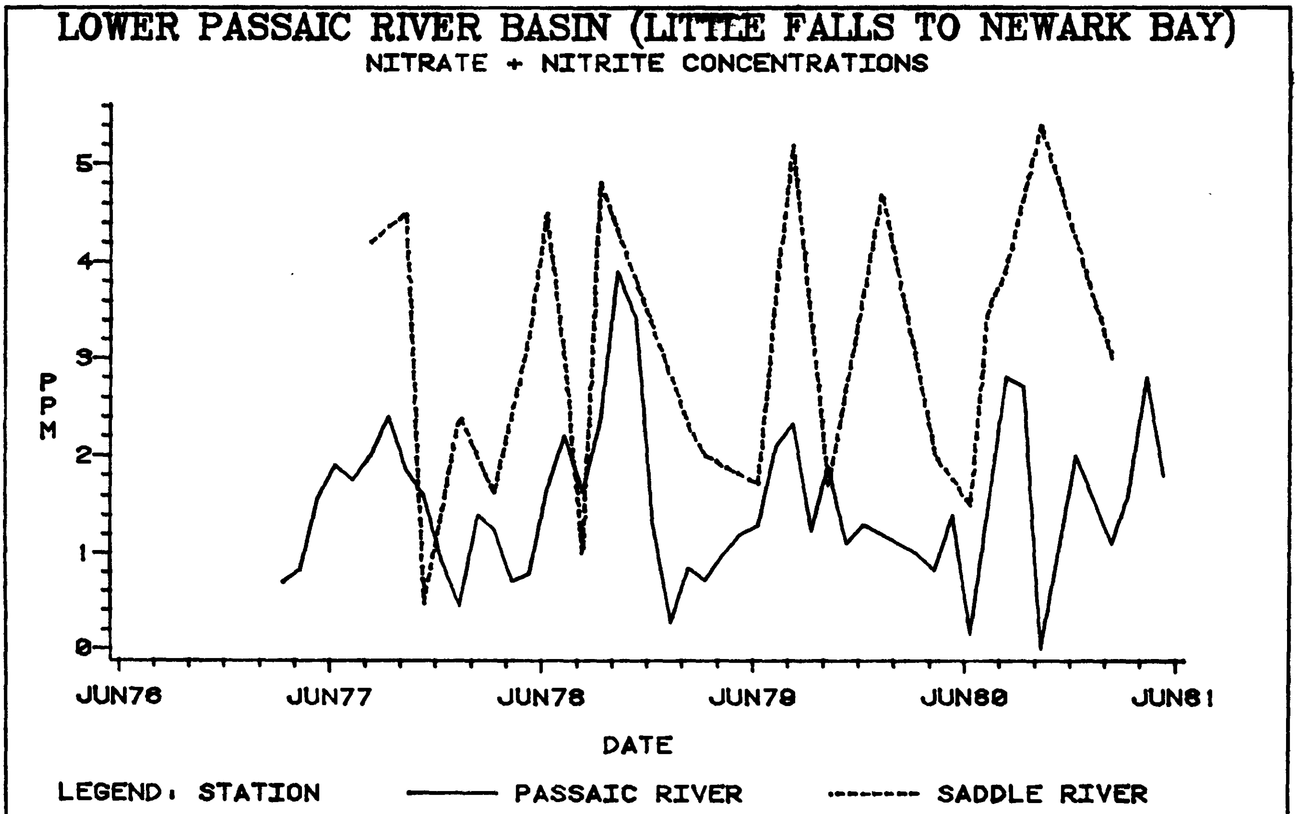
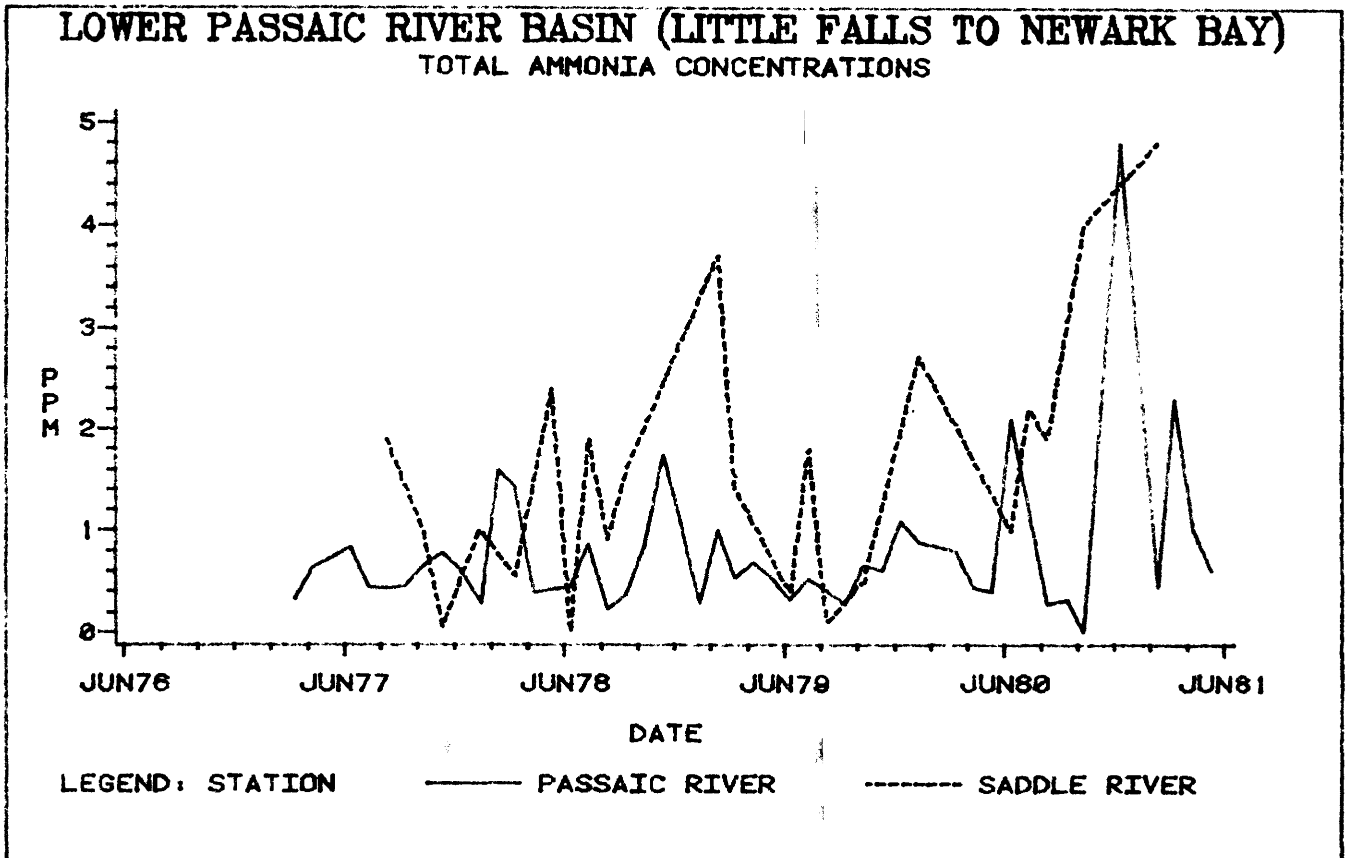


Figure: BB -8



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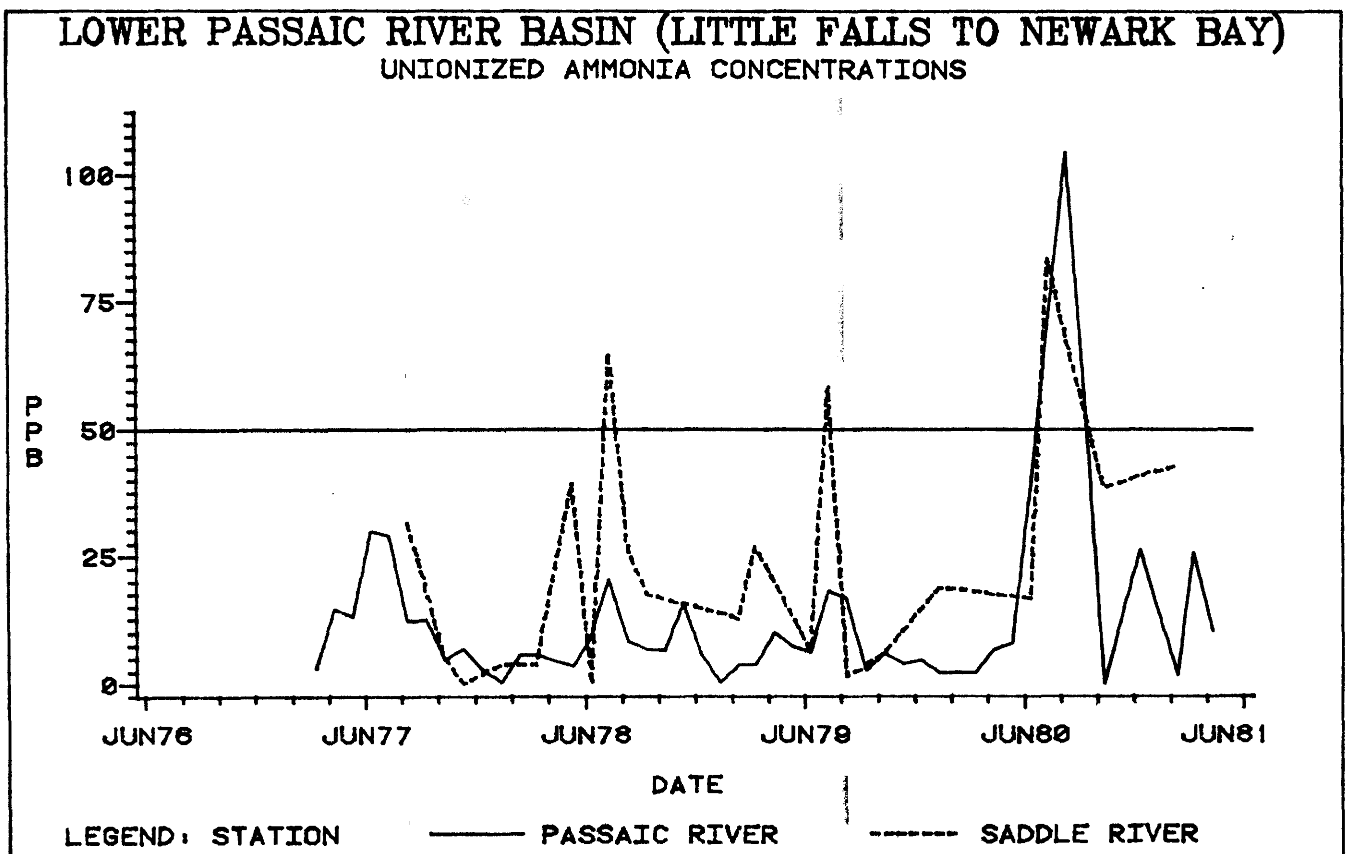


Figure: BB -10

DISCHARGE INVENTORY - - - LOWER PASSAIC RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
BOROUGH OF HAWTHORNE	0024767	HAWTHORNE	PASSAIC R.		
CITY OF NEWARK DPW	0024724	NEWARK	PASSAIC R.		
CLARA MAASS MEMORIAL HOSPITAL	0032280	BELLEVILLE	PASSAIC RIVER		
EASTERN MOLDING COMPANY INC	0029319	BELLEVILLE	PASSAIC RIVER	COOLING & SANIT	
MANSOL CERAMICS CO	0034223	BELLEVILLE	PASSAIC RIVER		
MANSOL CERAMICS COMPANY	0034193	BELLEVILLE	PASSAIC RIVER		
GENERAL PLASTICS CORP	0029173	BLOOMFIELD	PASSAIC RIVER	COOLING WATER	.04
WESTINGHOUSE ELECTRIC CORP LAM	0034312	BLOOMFIELD	PASSAIC RIVER	COOLING WATER	
MILES LABORATORIES INC	0022608	CLIFTON	PASSAIC RIVER	COOLING WATER	.57
FINETEX INC	0003573	EAST PATERSON	PASSAIC RIVER	PROCESS & COOL.	
MONSEY PRODUCTS INC	0001007	EAST RUTHERFORD	PASSAIC RIVER	BOILER BLOWDOWN	
ROYCE CHEMICAL CO	0002682	EAST RUTHERFORD	PASSAIC RIVER	COOLING WATER	.01
UNIFIED DATA PROD CORP	0034738	FAIR LAWN	PASSAIC RIVER		
KEM MFG CO INC	0000906	FAIRLAWN	PASSAIC RIVER	COOLING & SANIT	.01
SANDOZ-WANDER INC.	0001147	FAIRLAWN	PASSAIC RIVER	COOLING WATER	.30
DISOTEO FUEL SERVICE, INC.	0028151	GARFIELD	PASSAIC RIVER		
FCM INC	0035459	GARFIELD	PASSAIC RIVER		
GARDEN STATE PAPER CO INC	0000370	GARFIELD	PASSAIC RIVER	PROCESS & COOL.	.05
INTERMEDIATES DIV-TENN. CHEM.	0000124	GARFIELD	PASSAIC RIVER	PROCESS & COOL.	
STULL ENGRAVING CO	0031241	GARFIELD	PASSAIC RIVER	PROCESS & SANIT	
DIAMOND SHAMROCK CORP	0002801	HARRISON	PASSAIC RIVER	PROCESS WASTE	.02
OTIS ELEVATOR CO.	0002941	HARRISON	PASSAIC RIVER	COOLING & SANIT	.02
PSE&G CO HARRISON GAS PLANT	0000566	HARRISON	PASSAIC RIVER	COOLING WATER	23.20
TENNECO OIL COMPANY	0031348	HARRISON	PASSAIC RIVER		
AMERICAN CANDLE CO INC	0029769	HASKELL	PASSAIC RIVER	PROCESS WASTE	
INMONT CORP	0002453	HAWTHORNE	PASSAIC RIVER	PROCESS & COOL.	.26
PAN COMPANY	0030031	HAWTHORNE	PASSAIC RIVER	COOLING WATER	
BASF WYANDOTTE CORP	0001112	KEARNY	PASSAIC RIVER		.01
FRANKLIN PLASTICS CORP	0002194	KEARNY	PASSAIC RIVER	COOLING WATER	.01
WESTERN ELECTRIC CO	0020443	KEARNY TOWN	PASSAIC RIVER	COOLING WATER	.20
INMONT CORP	0001724	LODI	PASSAIC RIVER	COOLING WATER	
BENJAMIN MOORE & CO	0030414	NEWARK	PASSAIC RIVER	COOLING WATER	
CITY OF PATTERSON	0021971	NEWARK	PASSAIC RIVER		
DELISA PALLET CORP	0034584	NEWARK	PASSAIC RIVER		
ESSEX CHEMICAL CORP.	0002283	NEWARK	PASSAIC RIVER	COOLING WATER	6.24
FAIRMOUNT CHEMICAL CO INC	0033430	NEWARK	PASSAIC RIVER	COOLING WATER	
FINE PIGMENTS INC	0034746	NEWARK	PASSAIC RIVER		
GETTY REFINING & MARKETING CO	0026034	NEWARK	PASSAIC RIVER	RUNOFF OIL & GR	
MAAS & WALDSTEIN CO	0035173	NEWARK	PASSAIC RIVER		
MACARTHUR PETROL.& SOLVENT CO.	0027898	NEWARK	PASSAIC RIVER		
NATIONAL FUEL OIL CO	0035696	NEWARK	PASSAIC RIVER		
NATIONAL FUEL OIL INC	0025950	NEWARK	PASSAIC RIVER		
PUBLIC SERVICE ELEC & GAS	0000639	NEWARK	PASSAIC RIVER	COOLING WATER	
RONSON METAL CORP.	0035602	NEWARK	PASSAIC RIVER		
SUN OIL CO.-NEWARK	0002771	NEWARK	PASSAIC RIVER	RUNOFF OIL & GR	
AMERADA HESS CORPORATION	0001431	NEWARK/CITY	PASSAIC RIVER	RUNOFF OIL & GR	
Q PETROLEUM, INC.	0028185	NEWARK, N.J.	PASSAIC RIVER	RUNOFF OIL & GR	
ATLANTIC CHEMICAL MANUF CO	0034606	NUTLEY	PASSAIC RIVER		
INTERNATIONAL TEL. & TEL.	0020435	NUTLEY	PASSAIC RIVER	COOLING WATER	
ITT AVIONICS	0020214	NUTLEY	PASSAIC RIVER	COOLING WATER	.05
VEND A MART INC	0034240	NUTLEY	PASSAIC RIVER		
COASTAL OIL COMPANY	0027901	PASSAIC	PASSAIC RIVER		
HERCULES INDUSTRIES INC	0033600	PASSAIC	PASSAIC RIVER	COOLING WATER	
J L PRESCOTT CO	0002232	PASSAIC	PASSAIC RIVER	PROCESS & COOL.	.11
MONA INDUSTRIES INC	0035009	PASSAIC	PASSAIC RIVER	COOLING WATER	

DISCHARGE INVENTORY - - - LOWER PASSAIC RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
HOME FUEL OIL COMPANY	0027910	GLEN ROCK	DIAMOND BROOK		
L J & M LAPLACE IND CHEM.	0030376	ELMWOOD PARK	FLEISCHER BROOK	PROCESS WASTE	
J.P. STEVENS & CO INC	0024155	GARFIELD	FLEISCHER BROOK	COOLING WATER	.00
PRC MANUFACTURING CORP	0029939	ELMWOOD PARK	FLEISCHER'S BROOK	PROCESS WASTE	.12
CUSTOM CHEMICALS CO	0033146	EAST PATERSON	FLEISCHERS BROOK	COOLING WATER	
KREISLER INDUSTRIAL CORP.	0028711	ELMWOOD PARK	FLEISCHERS BROOK	COOLING WATER	.01
LIBERTY MILLS INC	0030601	KEARNY	FRANK CREEK		
INTERSTATE ROUTE 280	0034959	KEARNY	FRANK'S CREEK		
BERGEN WIRE ROPE	0035262	LODI	LODI BROOK		
STEPAN CHEMICAL CO.	0003182	MAYWOOD	LODI BROOK	COOLING WATER	2.30
DURO TEST CORPORATION	0029815	CLIFTON	MC DONALD'S BROOK	COOLING WATER	
GLOBE PRODUCTS CO INC	0034860	CLIFTON	MCDONALD BROOK		
PERMANENT LABEL CORP	0034878	BLOOMFIELD	PARKWAY STORM SEWER		
NJ DEPT OF HIGHER EDUCATION	0002909	MONTCLAIR /T/	PEARL BROOK	PROCESS & COOL.	.02
RAMSEY AUTO IMPORTS OF 17 INC	0033634	RAMSEY	RAMSEY BROOK		
GARFIELD MANUFACTURING CO	0027146	WALLINGTON	SADDLE BROOK	PROCESS WASTE	
MOSSTYPE CORPORATION	0032727	WALDWICK	SADDLE CREEK	COOLING WATER	
BOROUGH OF FAIR LAWN NJ	0023671	FAIRLAWN	SADDLE RIVER		1.60
APPLE RIDGE COUNTY GLUB	0028827	MAHWAH	SADDLE RIVER	SANITARY	
TOWNSHIP OF MAHWAH	0023931	MAHWAH	SADDLE RIVER	SANITARY	.01
ROCHELLE PARK SWIM CLUB	0035211	ROCHELLE PARK	SADDLE RIVER		
L O F GLASS PLANT NO 71-2	0035505	SADDLE BROOK	SADDLE RIVER		
WILLIAM TRICKER INC	0035432	SADDLE RIVER	SADDLE RIVER		
MILLBROOK FARMS INC	0025682	UPPER SADDLE RIVER	SADDLE RIVER		
FARMLAND DAIRIES.INC	0033511	WALLINGTON	SADDLE RIVER BROOK	COOLING WATER	
UNIVERSAL FOODS CORP.	0001201	BELLEVILLE	SECOND RIVER		.04
C M & SON TRUCKING INC	0029726	ALLENDALE	SMOKISVOLL BROOK		
ALL PURPOSE ROLL LEAF CORP	0003221	PARAMUS	SPROUT BROOK	COOLING WATER	.12
DART INDUSTRIES INC.	0001244	PARAMUS	SPROUT BROOK	COOLING WATER	.14
INTERNATIONAL BUSINESS MACHINE	0033987	PARAMUS	SPROUT BROOK	COOLING WATER	.15
BOROUGH OF NORTH HALEDON	0023078	NORTH HALEDON BORO	SQAW BR.	SANITARY	
HOFFMANN LA ROCHE INC	0034185	NUTLEY	ST PAUL'S BROOK	PROCESS & SANIT	
DUMONT THOMSON CSE COMPONENTS	0034410	CLIFTON	STORM SEWER TO HUGHES POND	COOLING WATER	
MOUNTAINSIDE HOSPITAL	0032115	MONTCLAIR	STORM SEWER TO THIRD RIVER		
WIGGINS PLASTICS INC	0027138	CLIFTON	THIRD RIVER	COOLING WATER	
MATCHLESS METAL POLISH CO.	0034614	GLEN RIDGE	TONEYS BROOK		
WARNER MFG CORP	0035513	BLOOMFIELD	TOWNSHIP BLOOMFIELD		
HALKEY ROBERTS CORPORATION	0032867	PARAMUS	TRIBUTARY SADDLE RIVER		
CLIFTON ENTERPRISES INC	0034932	CLIFTON	WEASEL BROOK	COOLING WATER	
NATIONAL STANDARD CORP.	0000035	CLIFTON	WEASEL BROOK	COOLING WATER	
SHULTON INC.	0001287	CLIFTON	WEASEL BROOK	COOLING WATER	1.00
OKONITE COMPANY	0002615	PASSAIC	WEASEL BROOK	COOLING WATER	
PANTASOTE COMPANY OF NEW YORK	0020478	PASSAIC	WEASEL BROOK	COOLING WATER	1.30
IBM CORPORATION	0020109	FRANKLIN LAKES	WEST BRANCH HOHOKUS BROOK	SANITARY	
CITY OF ORANGE DPW	0025925	ORANGE /C/	WIGWAM BROOK		
PEERLESS TUBE COMPANY	0029335	BLOOMFIELD	WIGWAM BROOK SECOND RIVER		
PEERLESS TUBE COMPANY	0029327	BLOOMFIELD	WIGWAM BROOK SECOND RIVER		
NATIONAL STARCH & CHEMICAL	0003760	BLOOMFIELD	YANTACAW RIVER	COOLING WATER	.34

DISCHARGE INVENTORY - - - LOWER PASSAIC RIVER BASIN

DISCHARGER NAME	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
MYCALEX	0029114	PASSAIC	PASSAIC RIVER	COOLING WATER	.08
P F LABORATORIES INC.	0035572	PASSAIC	PASSAIC RIVER		
PASSAIC ENGRAVING CO INC	0035181	PASSAIC	PASSAIC RIVER		
FARRAR COMPANY	0030350	PATERSON	PASSAIC RIVER	RUNOFF OIL & GR	
POPE CHEMICAL CORP	0027219	PATERSON	PASSAIC RIVER	COOLING WATER	
TILCON QUARRIES OF N J INC	0020486	PROSPECT PARK	PASSAIC RIVER	PROCESS WASTE	
THERMO ELECTRIC CO	0029441	SADDLE BROOK	PASSAIC RIVER	PROCESS WASTE	
ALFRED HELLER HEAT TREATING CO	0027430	CLIFTON	PASSAIC RIVER TRIB	COOLING WATER	.75
US POSTAL SER.-NO. JERSEY FAC.	0027758	KEARNEY TOWN	DEAD HORSE CREEK N J	SANITARY	.01
CURTISS-WRIGHT CORPORATION	0022004	SOUTH HACKENSACK TWP	FELD BROOK	SANITARY	.55
CLIFTON ADHESIVE	0029971	WAYNE	BURGESS PLACE	PROCESS WASTE	
KIDDE INC BLOOMFIELD PLANT	0035254	BLOOMFIELD	WELL & LOCAL CITY		
UNION CARBIDE CORP LINDE DIV	0029211	NEWARK	PLUM CREEK		
CARDINAL GLOVE CO INC	0035351	CLIFTON	NONE LISTED		
BOROUGH OF WEST PATERSON	0022098	WEST PATERSON	PASSAIC RIVER	SANITARY	1.20
SINGER CO KEARFOTT DIVISION	0021288	WEST PATTERSON BORO	PASSAIC RIVER	SANITARY	12.00
SINGER CO KEARFOTT DIVISION	0021270	WEST PATTERSON BORO	PASSAIC RIVER	SANITARY	.02
MOBAY CHEMICAL CORP.	0003174	HALEDON	MOLLYANN BROOK	PROCESS & COOL.	
BOROUGH OF NORTH HALEDON	0023051	NORTH HALEDON BORO	SQAW BR.	SANITARY	
V M SWENSON CO INC	0034983	KEARNY	NONE LISTED	COOLING WATER	
BOROUGH OF HALEDON WATER DEPT	0003964	NORTH HALEDON	MOLLY ANN BROOK		.09
BELDON GARDENS PACKAGE PLANT	0023043	NORTH HALEDON BORO	MOLLY ANN BROOK	SANITARY	
NORTH HALEDON BD OF ED	0022462	NORTH HALEDON BORO	MOLLY ANN BROOK	SANITARY	
STONE INDUSTRIES INC	0001589	HALEDON	MOLLY ANNS BROO	COOLING WATER	.04
GABRIEL INDUSTRIES	0029521	ELMWOOD PARK	DRAINAGE DITCH TO FLEISCHERS B	COOLING WATER	.20
MARCAL PAPER MILLS INC	0002674	ELMWOOD PARK	PASSAIC RIVER	PROCESS WASTE	.00
BOROUGH OF TOTOWA	0022071	TOTOWA	PASSAIC RIVER	SAN/SIG INDUS	1.22
PASSAIC VALLEY WATER COMM.	0025607	TOTOWA	PASSAIC RIVER	WATER TREATMENT	.07
UNGERER & COMPANY	0034444	TOTOWA	PASSAIC RIVER	COOLING WATER	
PRESTO LOCK, DIV OF KIDDE, INC	0035840	GARFIELD	PASSAIC RIVER		
SHAPE COMPONENTS INC	0034762	LITTLE FALLS	PECKMAN		
COUNTY OF ESSEX DPW	0021687	CEDAR GROVE TWP	PECKMAN R.	SANITARY	.45
TOWNSHIP OF LITTLE FALLS	0024732	LITTLE FALLS /TWP/	PECKMAN R.	SAN/SIG INDUS	1.58
BOROUGH OF VERONA	0024490	VERONA	PECKMAN R.	SANITARY	2.05
ART DECORATING CO INC	0034991	CEDAR GROVE	PECKMAN RIVER		
SERVOMETER CORPORATION	0027847	CEDAR GROVE TWP	PECKMAN RIVER	PROCESS WASTE	
MOLDS INTERNATIONAL INC	0033561	LITTLE FALLS	PECKMAN RIVER	COOLING WATER	
SCHMID PRODUCTS CO	0034941	PASSAIC	PECKMAN RIVER	COOLING WATER	
PAUL L KUZMICK MFG CO INC	0030121	VERONA	PECKMAN RIVER	PROCESS WASTE	.01

CC. HACKENSACK RIVER

Basin Description

The Hackensack River drainage basin is located in the northeastern corner of New Jersey. The river, which originates in Haverstraw, New York, flows south through the New Jersey counties of Bergen and Hudson, and empties into Newark Bay. The drainage area of the entire basin is 202 square miles. The Hackensack River lies on the Piedmont physiographic province which slopes generally to the east and south. Tributaries to the Hackensack River include Pascack Creek, Berry's Creek, Overpeck Creek and Wolf Creek. Average flow in the Hackensack River at New Milford (113 square mile drainage area) to 1980 was 105 cfs.

Within the basin is an area of 19,730 acres, which has been designated by the State of New Jersey as the Hackensack Meadowlands District. The District includes that portion of the Hackensack River basin from Little Ferry south to approximately two miles north of Newark Bay. The District is under the jurisdiction of the Hackensack Meadowlands Development Commission, which was established by the state legislature in 1969. The Hackensack Meadowlands Development Commission seeks to encourage balanced development between residential, commercial, industrial, recreational and other uses. The NJ Sports Complex, containing a racetrack, football stadium and indoor arena, has been constructed in the Meadowlands in the last 10 years.

The Hackensack River basin is characterized by the following land uses: residential (32 percent), commercial (4 percent), industrial (10 percent), and other uses such as parks and undeveloped areas (54 percent). Among the major population centers, partly or entirely in the basin are: Teaneck, Hackensack, Englewood, Fort Lee, and Jersey City. The population in the municipalities of the basin generally held stable or declined during the period of 1970 to 1980. The population of the basin is served by four sewage treatment agencies. The Bergen County Utilities Authority serves forty-three municipalities; the Tri-Borough Joint Meeting serves the municipalities of Carlstadt, Rutherford and East Rutherford; the North Arlington-Lyndhurst Joint Meeting serves North Arlington and Lyndhurst; and the Hudson County Sewerage Authority serves most of that county. Over 100 dischargers are present in the Hackensack River basin.

A portion of the Hackensack River, below Oradell Reservoir, is stocked with trout by the NJ Division of Fish, Game and Wildlife. In addition, Pascack Creek, Tienekill Creek and Indian Lake are stocked with trout. The Hackensack Meadowlands area is especially important as a breeding ground for waterfowl and other marsh wildlife; and it is also in the flight path of many migratory bird species. There are a number of county and municipal parks along streams and lakes in the basin. Crystal Lake, Oradell Reservoir, Electric Light Pond and Wooddale Park Pond all contain fishing facilities. The Hackensack also serves as a source of water supply for the Hackensack Water Company, which draws from both the river and the Oradell Reservoir. The Hackensack River is also used by communities in New York State as a source of drinking water.

The Hackensack River up to Oradell Dam, like the other tidal interstate waters of the Northeast New Jersey region, has a fishing closure and advisory issued by the State because of PCB tissue contamination in certain fishes. Striped bass and American eel taken from the tidal Hackensack are prohibited from being sold. In addition, the consumption of striped bass, American eel, white perch, white catfish and bluefish (when larger than 6 pounds or 24 inches) is advised to be no more than once per week.

The waters of the Hackensack basin are classified as FW-2 Non-trout for that portion of the basin above Oradell Dam; TW-1 for the river and tidal portions of its tributaries from Oradell Dam to the confluence with Overpeck Creek; TW-2 for that portion of the river from Overpeck Creek to the confluence with Berry's Creek; and TW-3 for the river downstream of Berry's Creek.

Water Quality Assessment

Conventional Parameters

Water quality in the non-tidal segment of the Hackensack River from the New York/New Jersey border to New Milford was generally good based on sampling at River Vale and New Milford from 1977 to 1981. Conditions declined to poor in the tidal segment from New Milford to Newark Bay.

Dissolved oxygen concentrations uniformly complied with the non-trout standard through the period with the exception of a serious episode at New Milford in the summer of 1980, during which daytime DO levels declined to less than 1.0 mg/l, resulting in a fish kill. An increase in BOD_5 levels brought about, at least in part, by drought conditions and very low flows coming from Oradell Reservoir were responsible for the reduction in DO at this location during the summers of 1980 and 1981. Conversely, levels appeared to remain stable upstream at River Vale during this period.

Fecal coliform concentrations were frequently above 200 MPN/100 ml as recorded at River Vale, but chlorination at Oradell Dam for potable water purposes by the Hackensack Water Company, contributed to lower levels at New Milford.

Total dissolved solids levels were within the criterion at River Vale, with data from New Milford insufficient to make an assessment. The pH values were slightly alkaline, with little variation, at the River Vale station. The generally alkaline pH values at New Milford exhibited greater variability over the period, possibly due to the occasional addition of alum to the river at Oradell Dam.

The Hackensack River exhibited increasing total phosphorus concentrations over the period at New Milford, particularly during the 1980-81 drought period when levels exceeded 1.0 mg/l. The River Vale station, although exhibiting periodic values exceeding the 0.10 mg/l standard, did not display a similar increase in total phosphorus levels. Nitrate + nitrite concentration increased in 1977 and 1978, generally stabilizing between 0.5 and 1.0 mg/l for the remainder of the period. Total ammonia concentrations rose slightly in the segment above Oradell Reservoir, but were at generally acceptable levels at both stations over the period. Un-ionized ammonia concentrations showed relatively clear seasonal cycles at each of the Hackensack River stations, with summertime peaks well within the 50 microgram per liter standard for FW-2 Nontrout streams.

Biological data was acquired just downstream of the outlet of the eutrophic Oradell Reservoir. Due to the station's location, high periphyton production would be expected, but mean periphyton chlorophyll a concentrations were very low in 1977 and 1978. In 1979, the mean periphyton chlorophyll a concentration was high, but was questionable because of a high standard deviation (10.1). The macroinvertebrate community was sparse both in density and taxa. Trichopterans (caddisflies) dominated in 1977 and 1978, comprising 88 and 76 percent of the community, respectively. In 1979, dominance was shared by the caddisflies (34 percent) and various crustaceans (44 percent), which probably originated in the reservoir. The poor biological productivity at this station can probably be attributed to the addition of chlorine, alum and polymers at the reservoir outfall for potable water purposes.

The Hackensack River experienced worsening of water quality at New Milford through the period reviewed in this report. Water quality at River Vale, however, remained at similar levels throughout and compares favorably with assessments in earlier 305(b) reports. The poorer quality of the Hackensack at New Milford in 1980 and 1981 is likely due to very low flows being released over Oradell Dam during the drought period and poor dilution of treated wastewaters discharged into the river.

Toxic Parameters

The Hackensack River was sampled at the following locations: above Oradell Reservoir, at Oradell Reservoir, at Route 3, at the New Jersey Turnpike, and at Route 9. In each case, low levels of trihalomethanes and organic solvents were found. These same levels were also found in Overpeck Creek at Route 46 in Ridgewood and at Route 17. This type of toxic contamination is not uncommon in river basins such as the Hackensack, where there is much industrial land use.

A rather unique situation occurs within Berry's Creek, a tributary to the Hackensack River, which has been the site of massive mercury contamination. It is estimated that several hundred tons of elemental mercury is currently residing in the Berry's Creek ecosystem. Fortunately, the tidal action appears to have trapped this contamination within the Berry's Creek area.

Further studies are planned to assess the proper course of action to mitigate this problem. The site will be monitored by this Department for various water quality parameters. Studies will be conducted in order to determine the forms of mercury in the ecosystem and to examine how environmental and physical factors may effect the mobility of the mercury.

Samples of various aquatic organisms collected along the Hackensack River from Riveredge to Penhorn Creek reveal trace levels of PCB Arochlor 1254. Fish tissue samples in 1977 near Kingsland Creek exhibited low levels of PCB Arochlor 1254 in white perch, Morone americana. Despite this fishing advisories and closures have been issued for the tidal Hackensack because of fish tissue contaminated with PCBs. Sediment analyses produced only trace levels of this parameter.

Tissue samples collected from the Hackensack River at Overpeck Creek Park, Sawmill Creek, and Berry's Creek were analyzed for heavy metal content. Trace levels of mercury and arsenic, as well as low levels of zinc and copper appear to be consistent with results from other waterways with similar characteristics. An increase in the incidence of cadmium, lead, and nickel was also noted for several species collected from these locations. Levels in these fish samples reached, and in some cases exceeded, established criteria for heavy metals. One species of forage fish, mummichog, Fundulus heteroclitus, contained the highest levels observed.

Problem Assessment

The freshwater segment (above Oradell Reservoir) of the Hackensack River has generally good water quality due to the absence of point source discharges in New Jersey. Non-point sources likely add nutrients and bacteria which can be a problem in the summer. Some septic system failures above the Oradell Reservoir are occurring, which may be adding to the nutrient and bacteria loadings. The New Milford monitoring station is affected by pre-chlorination which occurs in the stream just above the sampling site.

The tidal segment's water quality is poor but has shown signs of some improvement according to the Hackensack Meadowlands Commission. The river has many point source discharges, the largest in the form of cooling water, which reduces the capacity of water to retain oxygen. In addition, there are combined sewers further complicating the identification of specific problems. The treatment of municipal point sources is hindered by the volume of industrial waste flows to publicly-owned treatment works.

The reduced flow of freshwater from the upstream impoundments slows the time of travel to the bays. This effect and the action of the tide blocks the removal of the pollutants; and instead they wash back during incoming tides. This incoming Newark Bay water, which also has poor quality, has made improvement difficult.

In the lower sections of the Hackensack watershed, numerous construction grants planning and construction activities are underway or proposed. The Rutherford, East Rutherford and Carlstadt Joint Meeting STP is operating at less than primary levels, as does the North Arlington-Lynhhurst Joint Meeting STP. Upgrades to advanced treatment have been proposed for the Borough of Wood-Ridge and Bergen County UA treatment plants. Combined sewer overflows are problems in Hackensack, and in communities served by both the Bergen County UA and Hudson County UA.

Lincoln Park Lake (Jersey City) and Overpeck Lake (Teaneck and Ridgefield Park) were the subject of intensive surveys by the NJ Lakes Management Program in 1979. Both lakes were classified as hypereutrophic because of excessive inputs of nutrients. In addition, levels greatly in excess of appropriate USGS limits of DDT and its metabolites were found in Lincoln Park Lake sediments.

A major water quality problem in the Hackensack basin is the mercury contamination of Berrys Creek. The impacts of this mercury could be both significant with respect to short-term and long-term effects on aquatic life.

Goal Assessment and Recommendations

The waters of the Hackensack River do not meet the goals of swimmable quality due to the frequency with which samples exceeded a fecal coliform concentration of 200 MPN/100 ml. It should be noted however, that the sampling site at New Milford had bacteria levels that were not in violation of the State Water Quality Standards. This is due to the use of in-stream chlorination above the sampling site. The river above Oradell Dam does meet the fishable goal. This freshwater segment which contains relatively good water quality has a fish species diversity of 12. The tidal Hackensack is not fishable because of the identified PCB problem in fish tissue. Fish community data on the tidal segment was not available, but is known to accommodate anadromous fish.

It is recommended that the freshwater segment institute non-point source controls, possibly local stormwater ordinances. The establishment of septic tank management districts could resolve the occurences of septic problems in upstream regions. The lower tidal segment requires the reduction of point source loads by improving treatment levels or removing discharges to the river. Cooling water discharges should reduce their outfall temperatures to prevent adverse effects on the ability of the ambient water to retain dissolved oxygen. Finally, for any of the above actions to show any remedial effects, Newark Bay water must be improved so that the tidal influence on the river does not have a negative effect.

Further fish tissue and sediment sampling for mercury in Berry's Creek is recommended. The extent of the contamination and its impact on aquatic biota (both resident and transient) should be determined.

HACKENSACK RIVER STATION LIST

A. Ambient Monitoring Stations

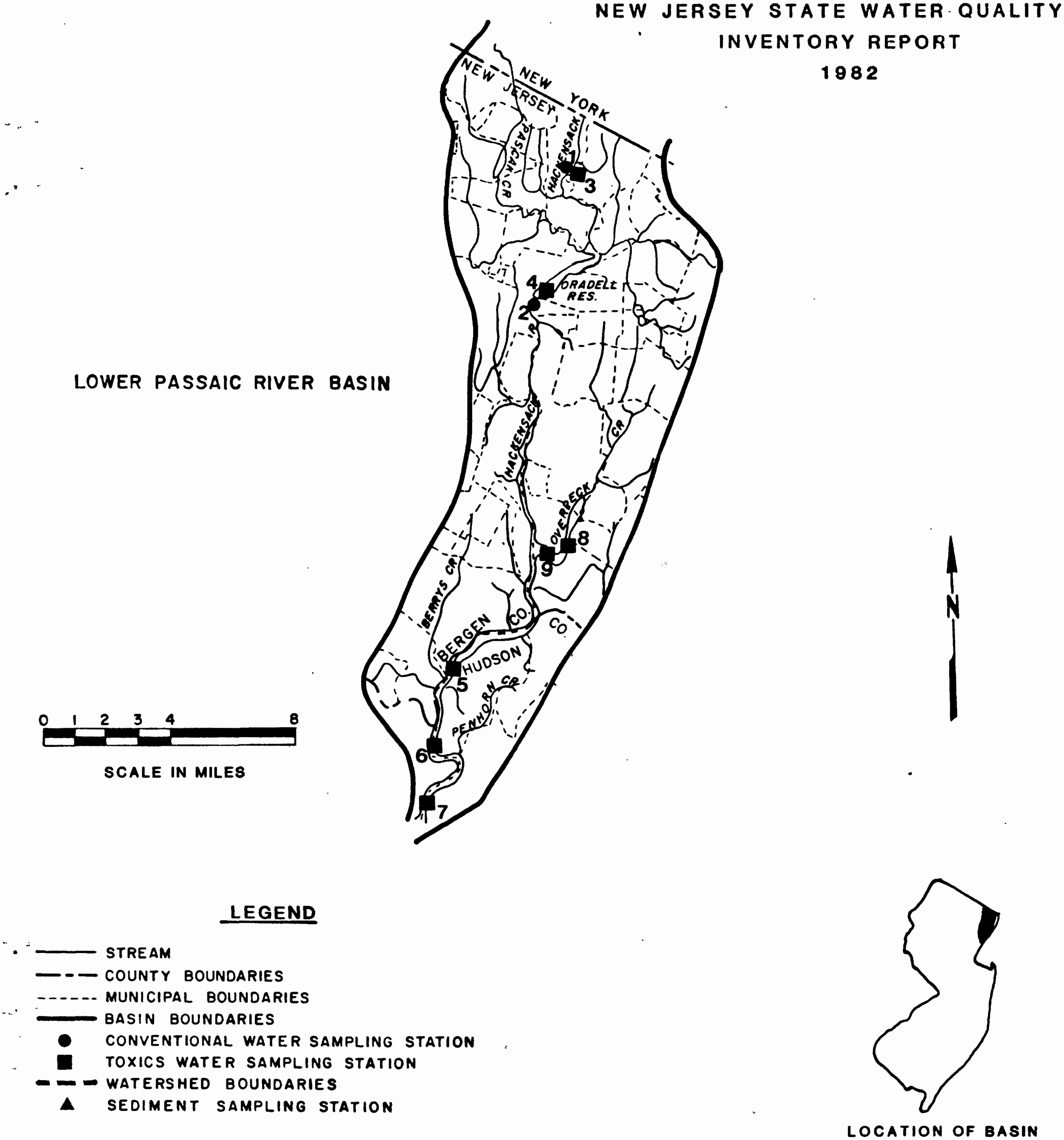
STORET Number	Station Description	Map Number
01377000	Hackensack River at River Vale, Bergen County Latitude 40°59'55" Longitude 73°59'27" FW-2 Nontrout USGS/DEP Network At Westwood Avenue Bridge, 1.5 miles upstream from Pascack Brook and 4.6 miles upstream from Oradell Dam.	1
01378500	Hackensack River at New Milford, Bergen County Latitude 40°56'52" Longitude 74°01'34" FW-2 Nontrout Basic Water Monitoring Program At Oradell Avenue bridge, 500 feet downstream from Oradell Dam and 21.7 miles upstream from mouth at Newark Bay.	2

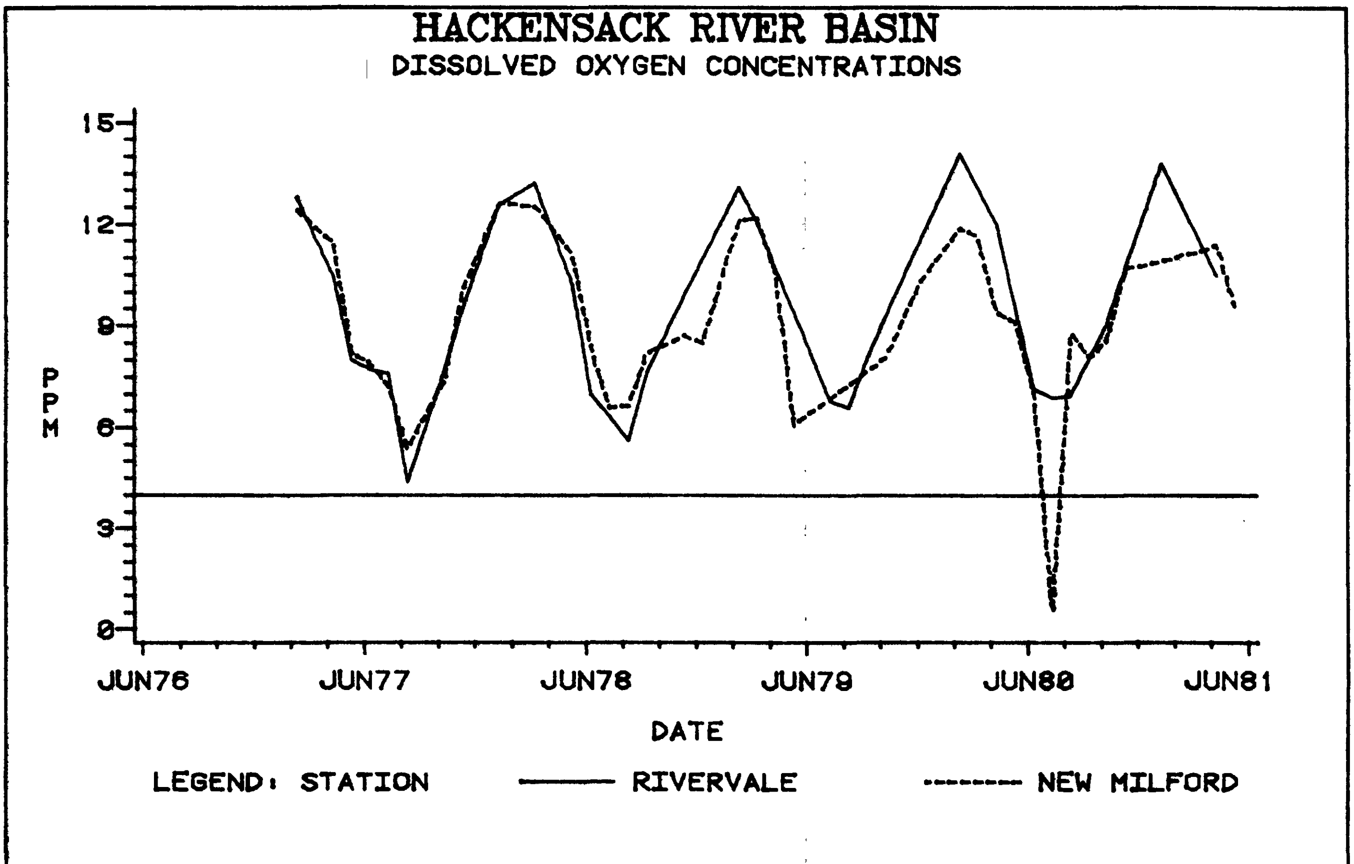
B. Toxics Monitoring Stations

Station Locations	Sampling Regime	Map Number
Hackensack River above Oradell Reservoir	Water column	3
Hackensack River at Oradell Reservoir	Water column	4
Hackensack River at Route 3	Water column	5
Hackensack River at NJ Turnpike	Water column	6
Hackensack River at Route 9	Water column	7
Overpeck Creek at Route 46, Ridgewood	Water column	8
Overpeck Creek at Route 17	Water column	9

HACKENSACK RIVER BASIN

NEW JERSEY STATE WATER QUALITY
INVENTORY REPORT
1982





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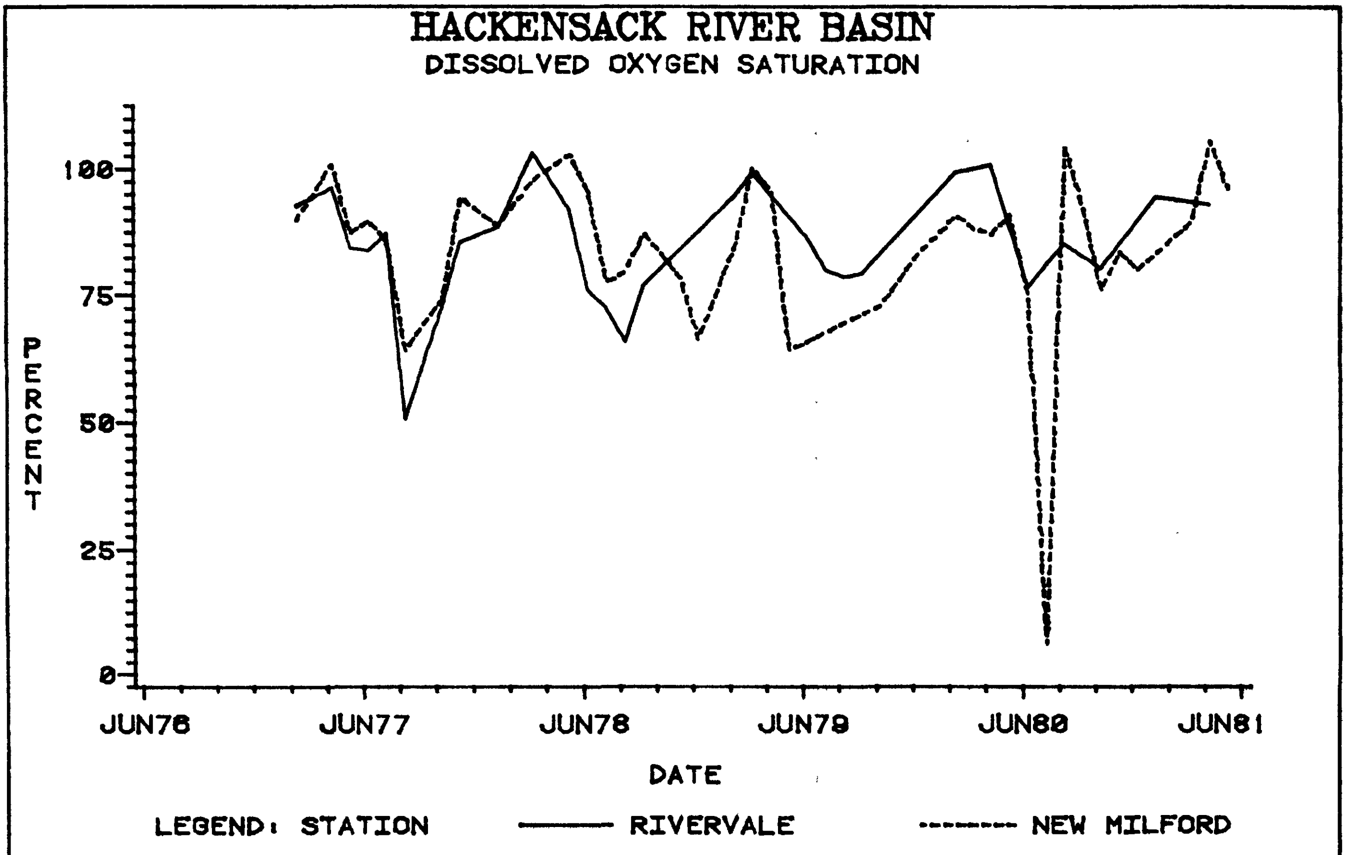

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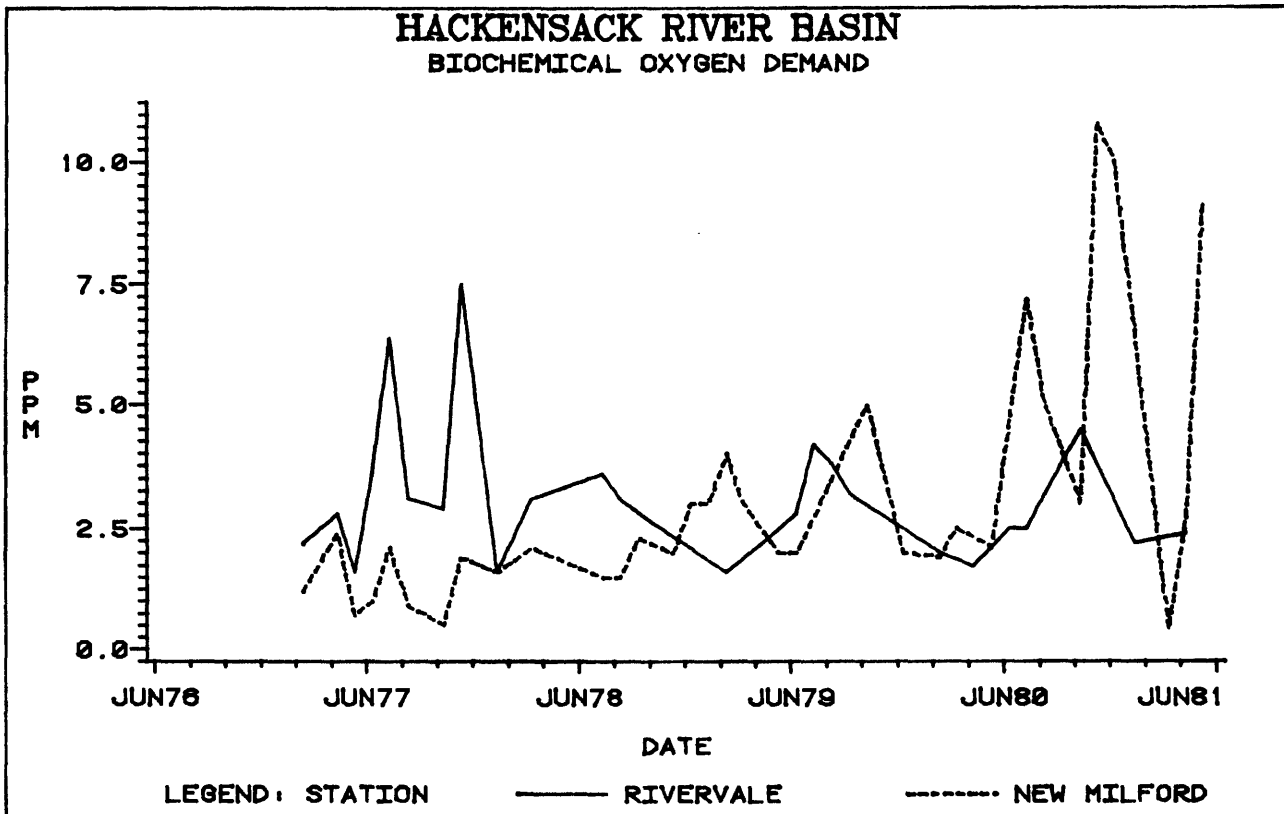

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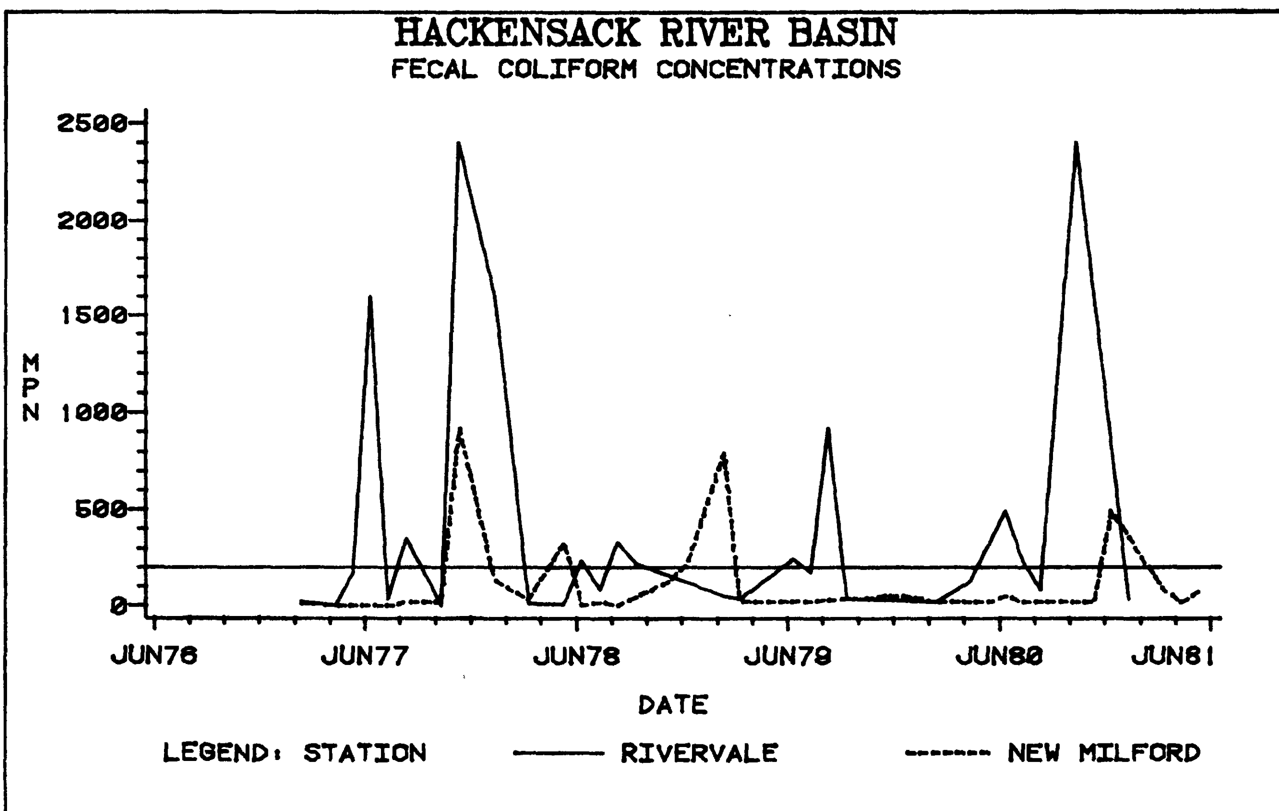

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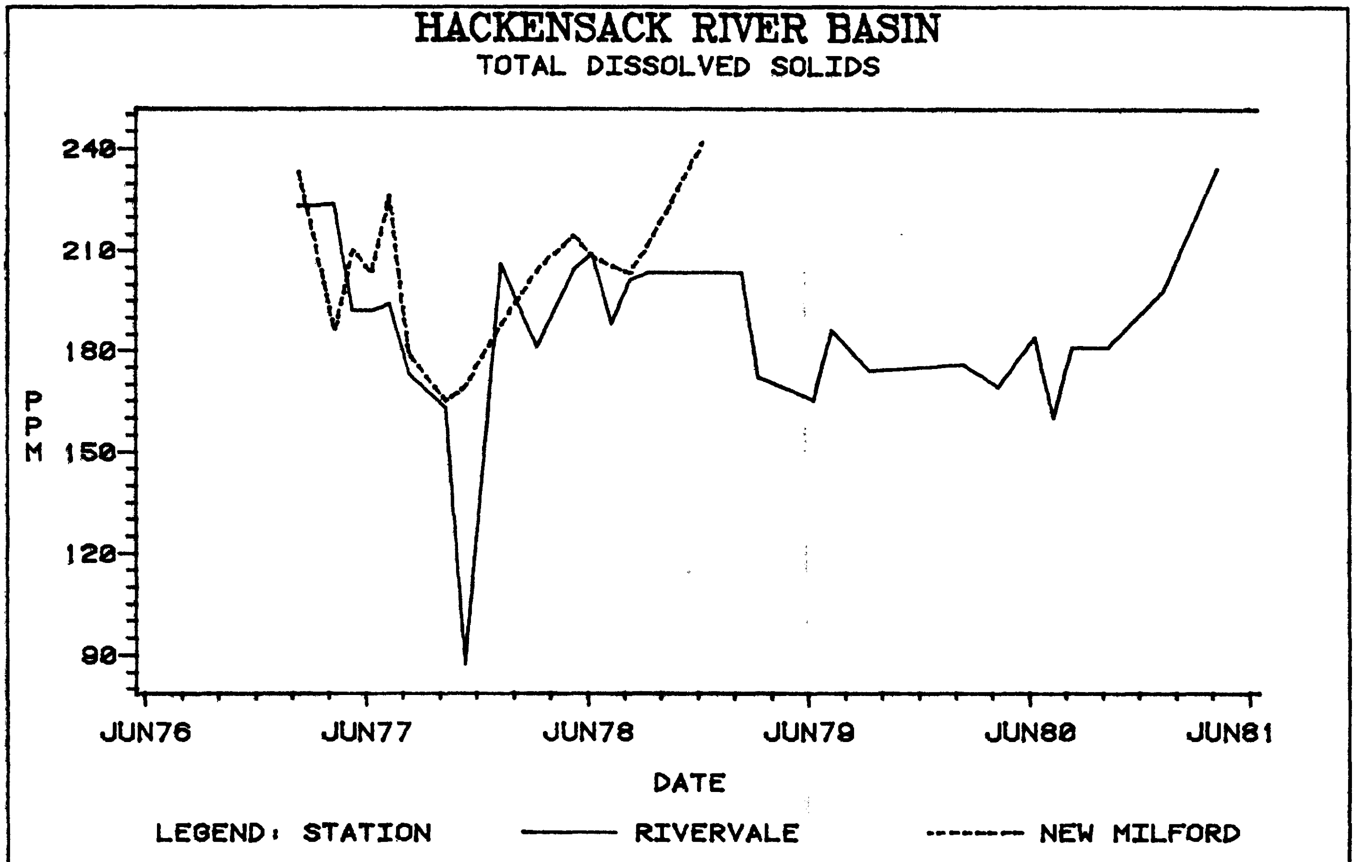

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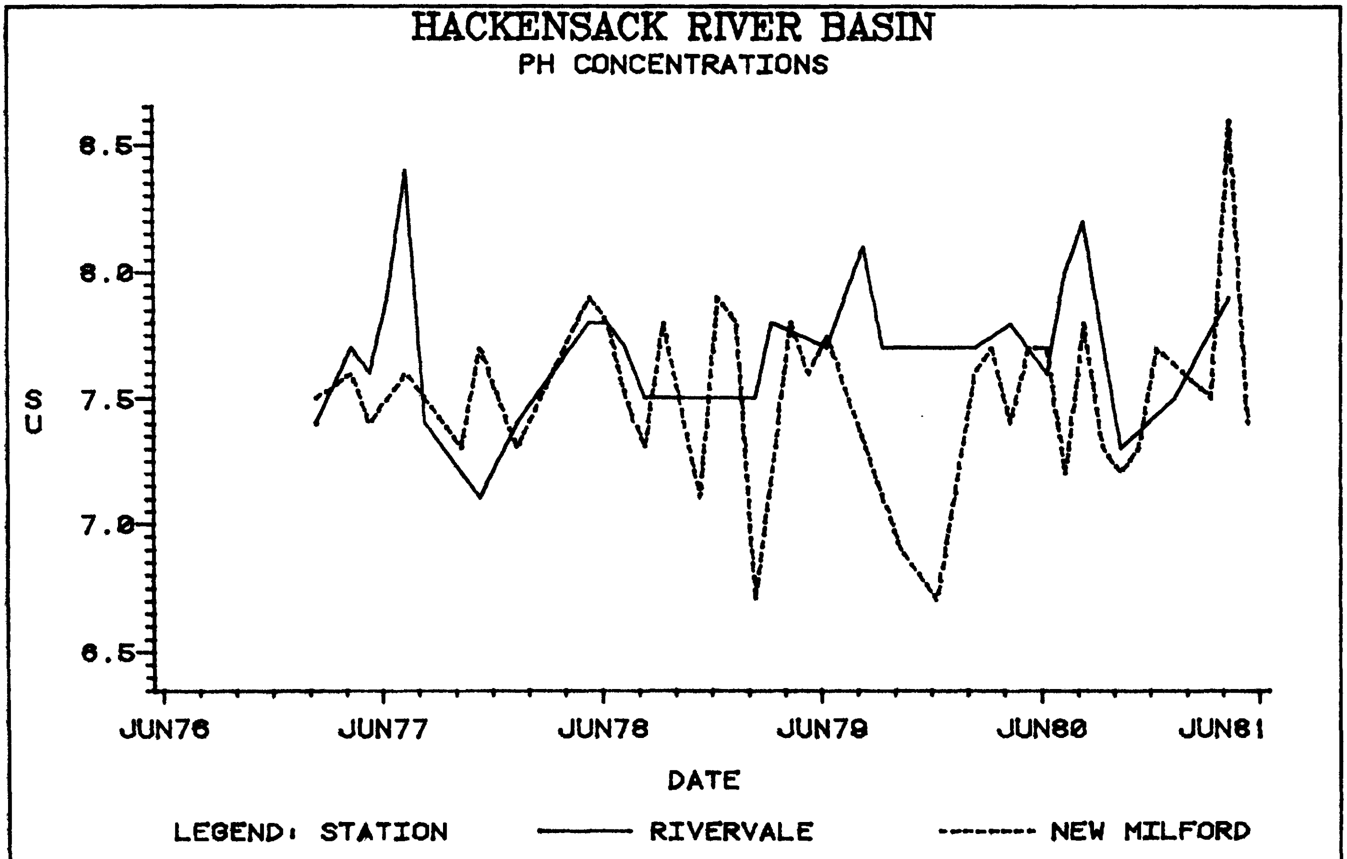

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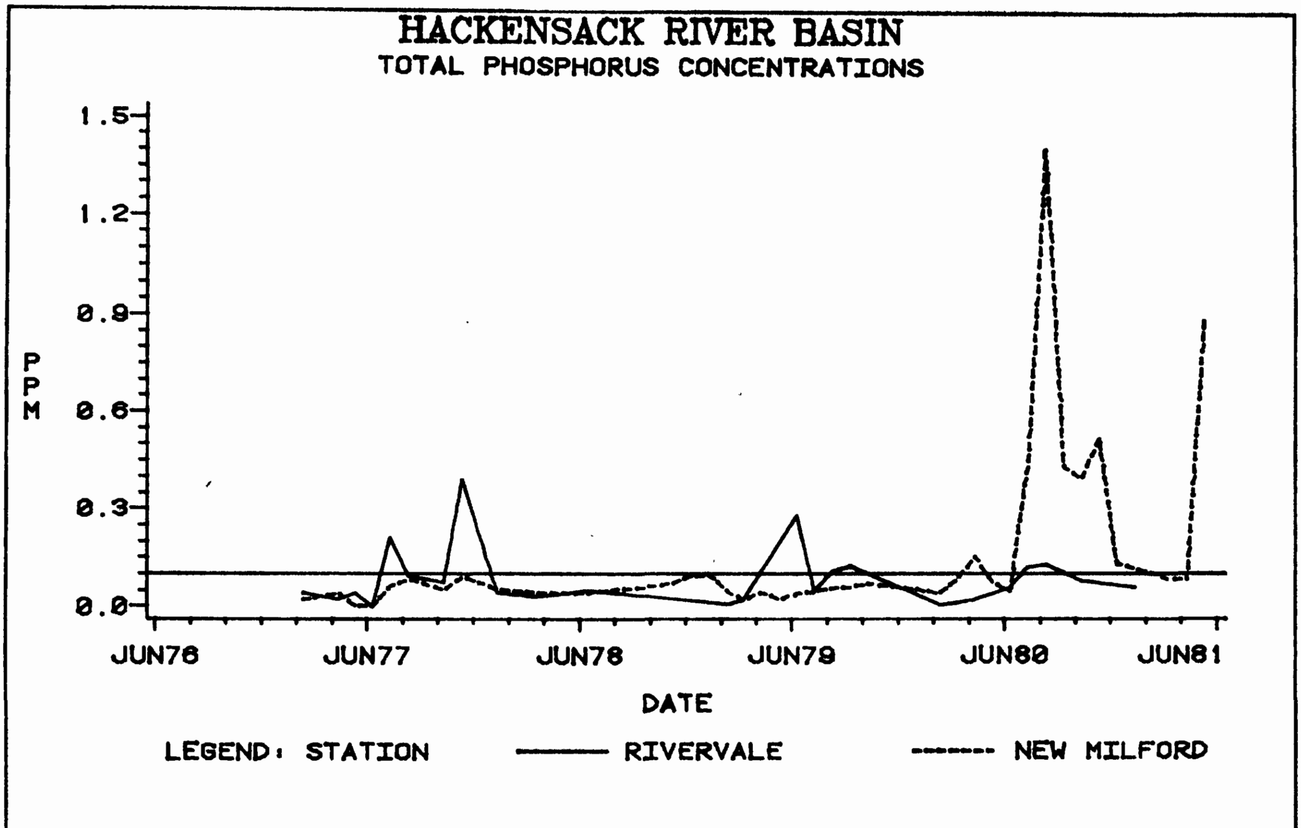

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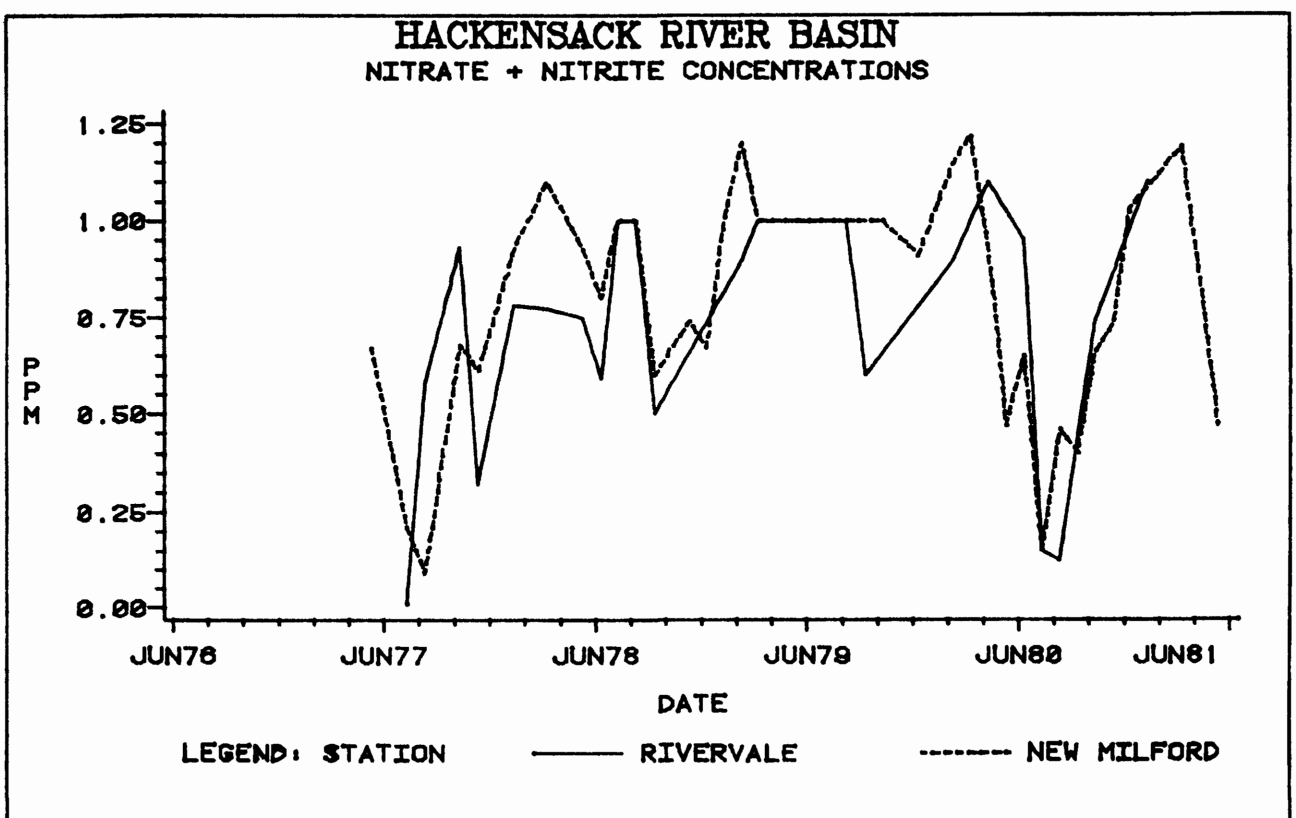

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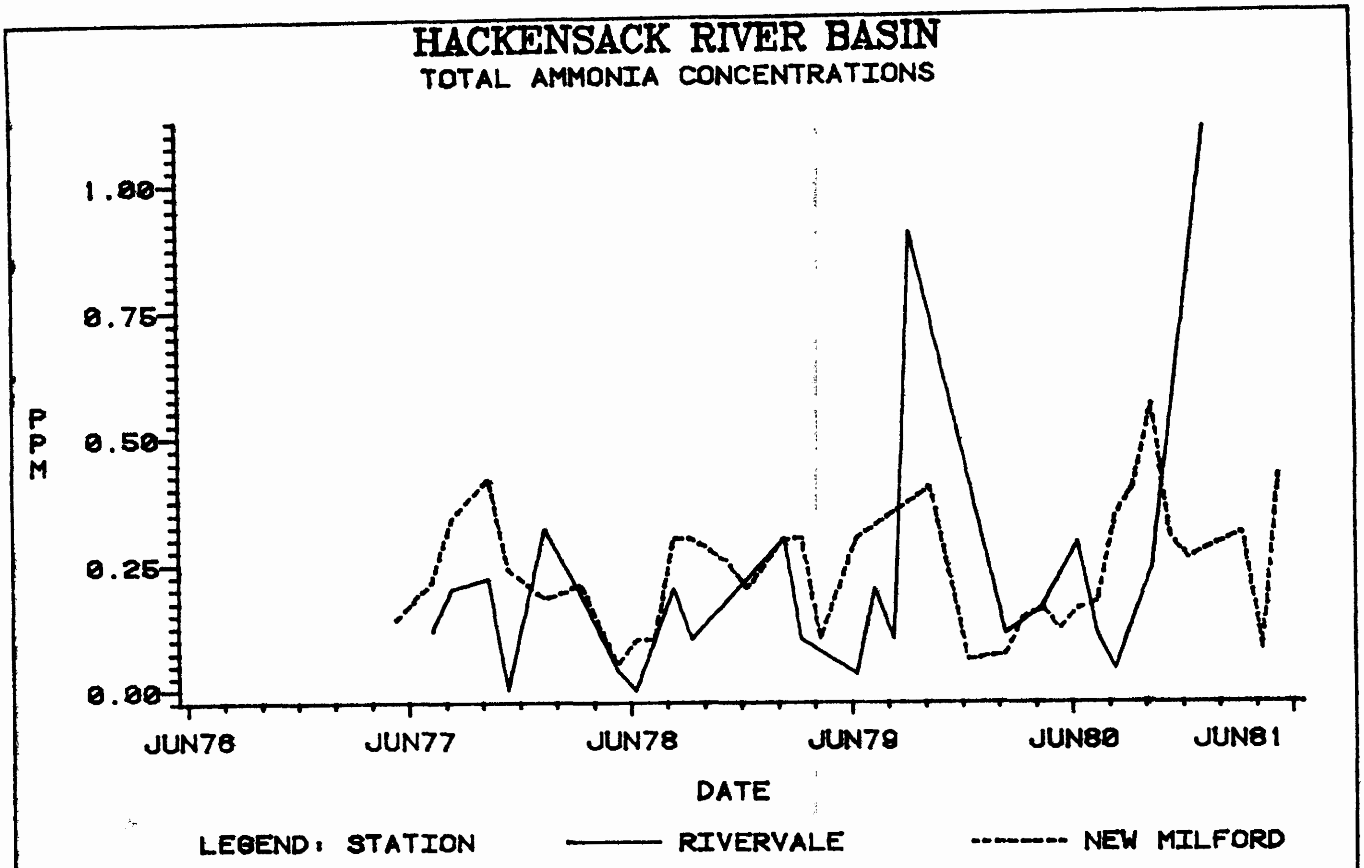

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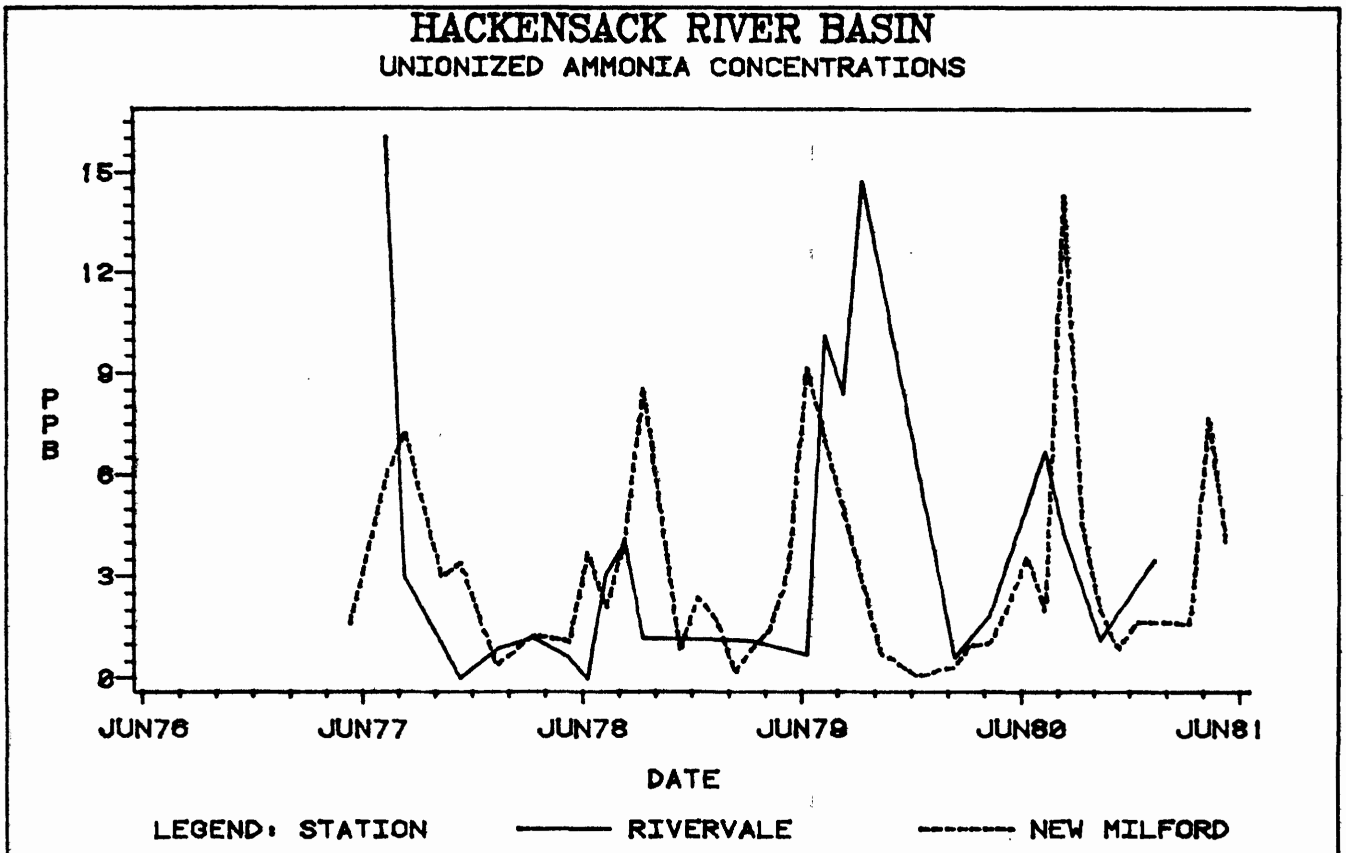

Figure: CC -10

DISCHARGE INVENTORY - - - HACKENSACK RIVER BASIN

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
MATHESON GAS PROD. CO.	0002721	EAST RUTHERFORD	ACKERMANS CREEK	PROCESS WASTE	.04
PARAMUS BOY'S CLUB INC	0028053	PARAMUS	BEHNKE BROOK PARAMUS N J		5.00
NORTH BERGEN DPW	0029092	NORTH BERGEN TWP	BELLMANS CREEK	SANITARY	1.70
WOOD-RIDGE	0025186	WOOD-RIDGE	BERRY CR.	SANITARY	.50
HOWMEDICA INC	0003468	RUTHERFORD BORO	BERRY CREEK	COOLING WATER	.05
STRANAHAN FOIL	0033375	SO HACKENSACK	BERRY CREEK	COOLING WATER	
JOINT MTG RUTH-E.RUTH-CARL.	0022756	RUTHERFORD BORO	BERRY'S CR.	SAN/SIG INDUS	3.20
ARSYNCO INC	0030970	CARLSTADT	BERRY'S CREEK		.00
COSAN CHEMICAL CORPORATION	0032522	CARLSTADT	BERRY'S CREEK	COOLING WATER	
RANDOLPH PRODUCTS CO	0028991	CARLSTADT	BERRY'S CREEK		.00
SIKA CHEMICAL CORP	0002011	LYNDHURST	BERRY'S CREEK	COOLING & SANIT	.06
SUN CHEMICAL CORPORATION	0033553	TETERBORO	BERRY'S CREEK	COOLING WATER	
TETERBORO AIRPORT	0028941	TETERBORO	BERRY'S CREEK		
NEW JERSEY SPORTS & EXPO AUTH	0023345	EAST RUTHERFORD	BERRYS BROOK	SANITARY	7.00
DIAMOND SHAMROCK CORP.	0002798	CARLSTADT	BERRYS CREEK	COOLING WATER	1.92
TECHNICAL OIL PRODUCTS INC	0005754	CARLSTADT	BERRYS CREEK	PROCESS & SANIT	3.49
YOO-HOO BEVERAGE CO	0003344	CARLSTADT	BERRYS CREEK	COOLING WATER	
UNITED STATES PRINTING INK	0003646	EAST RUTHERFORD	BERRYS CREEK	PROCESS WASTE	.01
NORTH BERGEN DPW	0029076	NORTH BERGEN TWP	CROMAKILL CREEK	SAN/SIG INDUS	1.90
NO.ARLINGTON LYNDHURST JNT MTG	0025291	NORTH ARLINGTON BORO	DITCH TO HACKENSACK RIVER	SAN/SIG INDUS	2.60
CHARLES P.HULL CO.INC.	0030708	NORTH ARLINGTON	DITCH TO KINGSLAND CREEK	PROCESS WASTE	
TEC CAST	0033405	CARLSTADT	DRAINAGE DITCH TO BERRY'S CREE	PROCESS WASTE	
HUDSON CNTY BD OF CHOSEN FREE.	0023566	SECAUCUS	DRAINAGE DITCH TO HACKENSACK	SANITARY	.23
METAL IMPROVEMENT CO	0003719	CARLSTADT	DRAINAGE DITCH TO MOONACHIE CR	COOLING WATER	.01
SPINNERIN YARN CO INC	0002038	SOUTH HACKENSACK TWP	EAST RISER DIT		.02
COMPO INDUSTRIES INC	0029122	CARLSTADT	EAST RISER DITCH	COOLING WATER	.00
ST JOE CONTAINER CO	0034789	S HACKENSACK	HACKENSACK		
BERGEN COUNTY UTILITIES AUTH.	0020028	LITTLE FERRY /BORO/	HACKENSACK R.	SAN/SIG INDUS	61.70
TRANSCONTINENTAL GAS PIPE LINE	0002101	CARLSTADT	HACKENSACK RIV		
CONRAIL	0001929	JERSEY CITY	HACKENSACK RIV	PROCESS WASTE	.02
DIAMOND SHAMROCK CORPORATION	0002402	JERSEY CITY	HACKENSACK RIV		.02
PUBLIC SERVICE ELEC & GAS	0000671	JERSEY CITY	HACKENSACK RIV	COOLING WATER	1.90
PUBLIC SERVICE ELEC & GAS	0000647	JERSEY CITY	HACKENSACK RIV	AIR PREHEATER	835.00
MARZAHL CHEMICAL CO	0000451	KEARNY	HACKENSACK RIV	PROCESS & COOL.	.00
PUBLIC SERVICE ELEC & GAS	0000655	KEARNY	HACKENSACK RIV		212.00
STANDARD CHLORINE CHEMICAL CO	0001856	KEARNY	HACKENSACK RIV	COOLING WATER	.05
BENEDICT-MILLER INC	0001031	LYNDHURST	HACKENSACK RIV	COOLING & SANIT	.10
HACKENSACK WATER COMPANY	0003310	ORADELL	HACKENSACK RIV		.08
PUBLIC SERVICE ELEC & GAS	0000621	RIDGEFIELD BORO	HACKENSACK RIV	COOLING WATER	455.00
AMERADA HESS CORPORATION	0001414	BOGOTA	HACKENSACK RIVE	RUNOFF OIL & GR	
AMERADA HESS CORPORATION	0001406	LITTLE FERRY /BORO/	HACKENSACK RIVE	RUNOFF OIL & GR	
AMERADA HESS CORPORATION	0001368	SECAUCUS	HACKENSACK RIVE	RUNOFF OIL & GR	
ASTRA PRODUCTS INC	0033383	CARLSTADT	HACKENSACK RIVER	COOLING WATER	
GENERAL AUTOMOTIVE SPEC. CO.	0030996	CARLSTADT	HACKENSACK RIVER	COOLING WATER	
GROBET FILE CO OF AMERICA	0029378	CARLSTADT	HACKENSACK RIVER		
HERMETITE DIV OF MUNDET INDUST	0003131	CARLSTADT	HACKENSACK RIVER	COOLING WATER	
SPEAR PACKING CORPORATION	0032590	CARLSTADT	HACKENSACK RIVER	COOLING WATER	
DUBOIS CHEMICALS DIV. CHEMED	0035769	EAST RUTHERFORD	HACKENSACK RIVER		
RESSAC HOLDING CO	0032689	ENGLEWOOD	HACKENSACK RIVER		
CITY OF HACKENSACK	0030805	HACKENSACK	HACKENSACK RIVER		
PHILLIPS FUEL CO	0032603	HACKENSACK	HACKENSACK RIVER		
POWER MATE CORP	0025801	HACKENSACK	HACKENSACK RIVER		
REINAUER PETROLEUM COMPANY	0028029	HACKENSACK	HACKENSACK RIVER		

DISCHARGE INVENTORY - - - HACKENSACK RIVER BASIN

DISCHARGE INVENTORY	NPDES NUMBER	MUNICIPALITY	RECEIVING WATERS	TYPE OF WASTE WATER	AVG. FLOW MGD
DEGEN OIL & CHAMICAL COMPANY	0030791	JERSEY CITY	HACKENSACK RIVER		
EASTERN OF NEW JERSEY INC	0031747	JERSEY CITY	HACKENSACK RIVER	RUNOFF OIL & GR	
MIDWEST EMERY FREIGHT SYSTEM C	0034037	JERSEY CITY	HACKENSACK RIVER		
PUBLIC SERVICE ELEC & GAS	0000574	JERSEY CITY	HACKENSACK RIVER	COOLING WATER	5.00
WELLEN OIL INC	0028011	JERSEY CITY	HACKENSACK RIVER		
CONRAIL - KEARNY ENGINE HOUSE	0031992	KEARNY	HACKENSACK RIVER	SANITARY	
KLEER KAST INC	0031313	KEARNY	HACKENSACK RIVER		.28
TOWN OF KEARNY	0022161	KEARNY/TOWN	HACKENSACK RIVER	SAN/SIG INDUS	3.10
BP OIL INC	0025984	LITTLE FERRY	HACKENSACK RIVER		
STANDARD TOOL & MANUFACT CO	0035131	LYNDHURST	HACKENSACK RIVER		
MYRON MANUFACTURING CORP	0033715	MAYWOOD	HACKENSACK RIVER	PROCESS & COOL.	
RAGEN PRECISION INDUSTRIES INC	0027979	NO. ARLINGTON	HACKENSACK RIVER	PROCESS WASTE	.03
GOLDING MFG. CO.	0028355	NORTH ARLINGTON, N.J	HACKENSACK RIVER	PROCESS WASTE	
NEW JERSEY MOTOR VEHICLES DIV.	0026930	SECAUCUS	HACKENSACK RIVER	SANITARY	
SECAUCUS MUN UTILITIES AUTH	0032921	SECAUCUS	HACKENSACK RIVER	SANITARY	.00
GILBERT SYSTEMS INC	0028584	SECAUCUS NEW JERSEY	HACKENSACK RIVER	SANITARY	
TEXACO INC (IASD)	0031194	SO HACKENSACK	HACKENSACK RIVER	RUNOFF OIL & GR	
COLUMBIA TERMINAL INC.	0025631	SOUTH KEARNY	HACKENSACK RIVER		
INTERNATIONAL FLAVORS & FRAGRA	0033669	TETERBORO	HACKENSACK RIVER	COOLING WATER	
PENRECO	0031607	LYNDHURST	KINGSLAND CREEK		
TOWN OF SECAUCUS	0025038	SECAUCUS	MILL CR.	SANITARY	1.40
WEYERHAUSER COMPANY	0032620	CLOSTER	ORADELL RES		
PHILIP A HUNT CHEMICAL CO	0030732	PALISADES PARK	OVERPECK CREEK	COOLING WATER	
CLIPPER EXPRESS COMPANY	0027251	JERSEY CITY	PENHORN CREEK	SANITARY	
SEARS ROEBUCK AND COMPANY	0020508	NORTH BERGEN /TWP/	PENHORN CREEK	SANITARY	
UNITEX CORP	0031518	SECAUCUS	PENHORN CREEK		
SQUARE D CO.-SECAUCUS PL.	0001716	SECAUCUS/CITY	PENHORN CREEK		
HOWARD JOHNSON COMPANY	0028410	SECAUCUS, N.J.	PENHORN CREEK	SANITARY	
SUPERIOR TAPE CORP	0001309	SOUTH HACKENSACK TWP	RISER DITCH	COOLING WATER	
KRISCHER METAL PRODUCTS INC	0035092	MOONACHIE	RISER TIDAL CREEK		
ALPHA METALS,INC	0029718	KEARNY	SAW MILL CREEK		
HAWARD CORPORATION	0023868	NORTH ARLINGTON BORO	SAW MILL CREEK	PROCESS WASTE	.01
HMDC SOLID WASTE BALING FACILI	0033448	SECAUCUS	SAWMILL CREEK		
BECTON DICKINSON CO INC	0001074	EAST RUTHERFORD	SEWER BERRYS CR	COOLING WATER	
HOLLAND HOUSE BRANDS INC	0003808	RIDGEFIELD PARK	SKEET HILL CR	PROCESS & SANIT	
COLORITE PLASTICS CO	0000132	RIDGEFIELD BORO	SKEETKILL CREEK	COOLING & SANIT	
PUBLIC SERVICE ELEC & GAS	0000710	SECAUCUS	STORM SEWER TO HACKENSACK RIVR	SANITARY	
HOKE INC	0003786	CRESSKILL	TENAKILL BROOK	COOLING WATER	.08
VERSA PRODUCTS	0021784	PARAMUS	TRIB TO HACKENSACK RIVER	COOLING WATER	
BEACON LOOMS INC	0035289	TEANECK	UNKNOWN CREEK		
GALLO ASPHALT CO	0003557	SECAUCUS	UNNAMED TRIB TO HACKENSACK		.00
BENDIX CORP.	0002097	TETERBORO	WEST DITCH		
POLYCAST TECHNOLOGY CORP	0034819	HACKENSACK	WEST RISER		
METRO OIL & CHEMICAL CORP	0031500	RIDGEFIELD	WOLFS CREEK		2.27
H GOODMAN & SONS INC	0029505	KEARNY	DEAD HORSE CREEK		
HALCON CATALYST INDUSTRIES	0034347	LITTLE FERRY	DEPEYSTER CREEK	COOLING WATER	
WELLA CORPORATION	0035246	BERGEN	NONE LISTED		

STATUS REPORT ON THE INTERSTATE SANITATION DISTRICT WATERS

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MARCH 1982

SUMMARY

Interstate Sanitation District waters exhibited some improvement compared to previous years. District waters meet dissolved oxygen requirements during the winter; however, in some locations, dissolved oxygen values in the summer drop below 1 mg/l for extended periods. Some waters are also high in heavy metals, oil and grease, and bacterial contamination.

INTRODUCTION

New Jersey surface waters located within the New Jersey-New York Metropolitan Area form part of the jurisdiction of the Interstate Sanitation Commission.

The Commission's programs for the improvement of these waters, in cooperation with the states, include the following:

(1) to establish and attain minimum dissolved oxygen requirements for all surface waters;

(2) to establish necessary pollutant removals for discharges into District waters;

(3) to monitor surface waters by analysis of samples obtained from continuous automatic sampling stations and from regularly scheduled boat surveys;

(4) to do routine sampling and analysis of municipal and industrial dischargers to determine whether Compact requirements are being met;

(5) to assist the states and the U.S. EPA with NPDES/SPDES compliance monitoring;

(6) to monitor surface waters for coliforms within the Interstate Sanitation District in cooperation with the U.S. EPA and the State of New Jersey, as related to New Jersey's disinfection policy; and

(7) to supply water quality data to STORET, the U.S. EPA data storage and retrieval system.

The waters described in this report and their tributary treatment plants are shown in Figure 1. These waters are:

ISC Class A Waters - NJ TW 1 Waters: Sandy Hook Bay
Raritan River
Raritan Bay

ISC Class B-1 Waters - NJ TW 2 Waters: Hudson River
Upper New York Bay
Arthur Kill South of the Outerbridge Crossing

ISC Class B-2 Waters - NJ TW 3 Waters: Kill Van Kull
Newark Bay
Arthur Kill North of the Outerbridge Crossing

The water classes and uses described below were promulgated by the Interstate Sanitation Commission and are compatible with New Jersey's classifications and uses, namely:

Class A Waters - Suitable for primary contact recreation and in designated areas for shellfish harvesting

Class B-1 Waters - Suitable for fishing and secondary contact recreation

Class B-2 Waters - Suitable for passage of anadramous fish and for maintenance of fishlife

These water classifications are defined in the Interstate Sanitation Commission Water Quality Regulations effective October 15, 1977. The Commission's water quality and effluent regulations were revised to help achieve higher quality waters throughout the District.

EXTENT OF WATER POLLUTION

Although the condition of the waters in this area has shown improvement since the last 305(b) inventory was compiled, further improvement is necessary to meet applicable regulations and uses.

The municipal treatment plants in the District providing primary treatment do not provide adequate pollutant removal and many of the biological treatment plants require upgrading. Figure 1 shows the location and degree of treatment at the sewage treatment plants within the Interstate Sanitation District. The quality of the District's waters is continuously degraded by: (1) untreated municipal and industrial discharges entering the Harbor waters daily, (2) combined sewers releasing raw sewage into the waterways during heavy rainfalls, and (3) large concentrations of both heavy metals and oil entering the waters from inadequately treated municipal and industrial wastes.

Evaluation of the water quality has been determined from the following:

(1) graphs of the seasonal variation of dissolved oxygen, temperature, pH, and conductivity derived from ISC remote automatic water quality monitors located within New Jersey and interstate (NJ-NY) waters;

(2) a statistical analysis of the dissolved oxygen data obtained from the remote water quality monitoring stations; and

(3) statistical analyses of pollutant parameters such as dissolved oxygen, heavy metals, nutrients, temperature, etc. derived from the analysis of samples obtained from ISC boat runs "A", "B", and "E".

The remote automatic water quality monitor locations are shown in Figure 2, station descriptions in Table 1, graphs of the monthly values in Figures 3 and 4, and dissolved oxygen data in Table 2. Figures 3 and 4 show, for the past five years, the monthly maximum, minimum and average values for each parameter at each station. The monthly maximum and minimum represent the single highest value and the single lowest value for the month, respectively. The monthly average is the average of the daily average values for the month. Dotted lines indicate a month for which less than ten days of data was available.

The boat surveys were run approximately once per month in the winter and twice per month in the summer. Figure 5 is a map of the six boat survey routes. Listings of the sampling stations for boat runs "A", "B", and "E" are found in Tables 3-5. Cumulative frequency distributions of 1980-1981 data are given in Tables 7-14. 1981 pesticides and PCB's data collected on Commission boat surveys are summarized in Table 15.

Tables 7-14 show cumulative frequency distributions for each parameter in each waterway. These cumulative frequency distributions were computed from data collected at all sampling stations within that waterway. The range of values for any particular parameter varies greatly from station to station within any particular waterway; therefore, the cumulative frequency distributions should be used with extreme care. The values at a sampling station within a waterway can vary greatly from the values shown for the entire waterway.

In previous years the Commission's boat survey data were presented as average (arithmetic means) ranges and numbers of values for each parameter in each waterway. This year these data are presented as cumulative frequency distributions for each parameter in each waterway. The arithmetic mean is a measure of the location of central tendency, it is most generally recognized as an average and it is easily understood. However, the arithmetic mean may be greatly effected by extreme values and, therefore, may not be a typical representation of the data. The frequency distribution (or cumulative frequency distribution) is an arrangement of numerical data according to size or magnitude. It is more meaningful than the average because it shows the distribution of the data over the range of values. This presentation of the data supplies a more complete picture from which to draw conclusions, whereas averages do not.

CURRENT WATER CONDITIONS

General

Analysis of the data indicates that the effect of a constant influx of pollutants to the Metropolitan New York Area waters is especially pronounced during the summer months. As in the past, the waters exhibit low levels of dissolved oxygen. Although bacterial contamination has lessened, further improvements must be made in order to open many of the waters for their full intended uses. Thermal pollution is also a problem in some areas. Table 16 shows the current status of wastewater treatment plants in New Jersey that are within the Interstate Sanitation District. A comparison of each treatment plant's status since the last 305(b) inventory is also shown.

Dissolved Oxygen

Although Figures 3 and 4, Table 2, and Tables 7-14 show a general overall improvement since the last 305(b) inventory was compiled, District waters are still plagued by low dissolved oxygen values during the summer months. From Table 2 it can be seen that the Commission's dissolved oxygen requirements were being met less than 40% of the time during the summer in the Arthur Kill; this is still unacceptable. The overall general improvement, however, is promising and is due in part to wastewater treatment projects being completed and less continuous bypassing of untreated sewage into District waters.

Additional dissolved oxygen data were analyzed from a review of boat survey samples. These data, especially in the Arthur Kill and the Kill Van Kull, show generally higher values than those compiled from the remote monitor data. These values for dissolved oxygen are artificially high since provisions for tidal and other effects are not reflected in the boat survey data. Therefore, the boat survey data is misleading unless considered with the data from the continuous water monitors.

Other Parameters

A review of the boat survey data (Tables 7-14) shows that District waters are still degraded by oil and grease, heavy metals, and coliform bacteria.

This year, 55 water column samples were taken from District waters for pesticides and PCB's analyses. The compounds analyzed for were: alpha-BHC; beta-BHC; Lindane; Heptachlor; Heptachlor Epoxide; Aldrin; Endrin; Chlordane; Endosulfan; Methoxychlor; p,p'-DDE; o,p'-DDE; p,p'-DDD; o,p'-DDD; p,p'-DDT; o,p'-DDT; and PCB's. The results of the analyses are shown in Table 15.

Biological sampling for chlorophylls was done in May, July, and August, at all stations. Additional samples were taken from the Newark Bay stations with each "A" boat run. A phytoplankton bloom was observed at the Raritan Bay stations during July when chlorophyll "a" levels reached a peak of 0.108 mg/l. Slightly increased chlorophyll "a" and chlorophyll "c" levels were also noted in the Arthur Kill and Lower New York Bay.

FUTURE USES OF THE WATERS

In the future, use of the waters will more nearly approach their classifications compared to today. Although secondary treatment of municipal sewage will be the norm when present and planned construction is completed, its effectiveness may be significantly diminished because (1) combined sewers will continue to discharge untreated sewage into the waters during heavy rains; (2) lack of pretreatment requirements will permit large amounts of oils and heavy metals from industries to enter the District waters; and (3) heavy concentrations of both population and industry along certain narrow, confined waterways such as the Arthur Kill and the Kill Van Kull, will contribute large quantities of waste so that even when secondary treatment is completed, dissolved oxygen values of approximately 3 mg/l will be the maximum attainable level.

The universal application of secondary treatment and adequate pretreatment in the Interstate Sanitation District should render such stretches of water as the Lower New York Bay and Raritan Bay better for fishing and swimming. Another means of opening miles of beaches would be to build short dikes out from Fort Wadsworth, Staten Island, and Nortons Point, Brooklyn, to divert the flow from New York and New Jersey treatment plants through the Narrows away from beaches toward open sea. However, no practical amount of treatment technology will improve the Arthur Kill and the Kill Van Kull to the point at which the dissolved oxygen will be appreciably greater than 3 mg/l.

CONTROL ACTIONS AND COSTS

The population and industry in this region are continually placing increased demands upon the waters. The ability of many of the waters to assimilate waste material and thermal discharges has already been exceeded for a considerable portion of the year. Although many of the waters of this District will never be able to be used for swimming, not only is it essential to prevent further deterioration, it is also necessary to improve them to the point where they are suitable for their intended uses, to the extent practicable.

However, the planning and continued construction of secondary treatment plants throughout the region and the universal application of Best Practical Treatment Technology to industrial discharges constitute a program capable of rendering the District waterways aesthetically appealing and viable for both public and commercial users. It must be kept in mind, however, that much of the effectiveness of both secondary treatment and BPT Technology will be negated unless a conscientious effort is directed toward abating the following problems: (1) combined sewers, (2) heavy metals, (3) toxic organics, and (4) oily wastes.

(1) Combined Sewers - Very little advantage will be gained by having secondary treatment plants exist alongside uncontrolled combined sewers. Although the treatment plant will provide a high degree of pollutant removal and discharge effluent with minimal bacterial contamination, heavy rains will cause regulators to bypass raw sewage and industrial wastes directly into the waterways. Heavy flows that occur during rainfall release vast quantities of solids, heavy metals, and oils that have settled out in the combined sewers during dry weather. Since these wastes receive no treatment whatsoever, their bacterial count is high and renders the chlorine usage by the waste treatment plants ineffective. Secondary treatment represents a major step forward in pollution abatement, but the existence of combined sewers prevents it from being as effective as it should be. Elimination of combined sewers could cost billions of dollars, however, adequate pretreatment would be a viable option in preventing pollutants from entering the waterways.

(2) Heavy Metals - Heavy metals represent a particularly toxic group of elements that are discharged in large concentrations by many industries. During dry weather, much of the metal content of an industrial waste never reaches a treatment plant because the metals simply settle out of solution and concentrate in the sewers. During heavy rains, they are scoured out of the sewers and swept directly into a watercourse. Those metals that reach the treatment plant are only minimally removed and their presence lowers biological treatment efficiency.

(3) Toxic Organics - There is a large and growing number of toxic organic compounds which can find their way into the waters of the Interstate Sanitation District. It is probable that many of them are present in some or all of the waters to some degree. Because of either demonstrated or suspected carcinogenic properties and other dangers to health, there is much concern. However, very little sampling for these substances in the water column has been done. Accordingly, the amount of available data is very small. The data gap that exists for these parameters must be addressed and remedied in the future.

(4) Oily Wastes - The northeast region of the United States has an enormous need for petroleum products, especially heating oils and gasoline. As a result, the area has many oil refineries, oil terminals, and an extensive product transportation system. Because such a vast amount of both crude and refined products are handled, spillage is significant and a substantial amount of petroleum products enter receiving waterways of the District. To restore the quality of the waterways, all oil-laden wastes must be adequately treated. For this reason, the Interstate Sanitation Commission has an effluent requirement of "no noticeable oil" which is being implemented through the permit system via permit requirements and construction schedules.

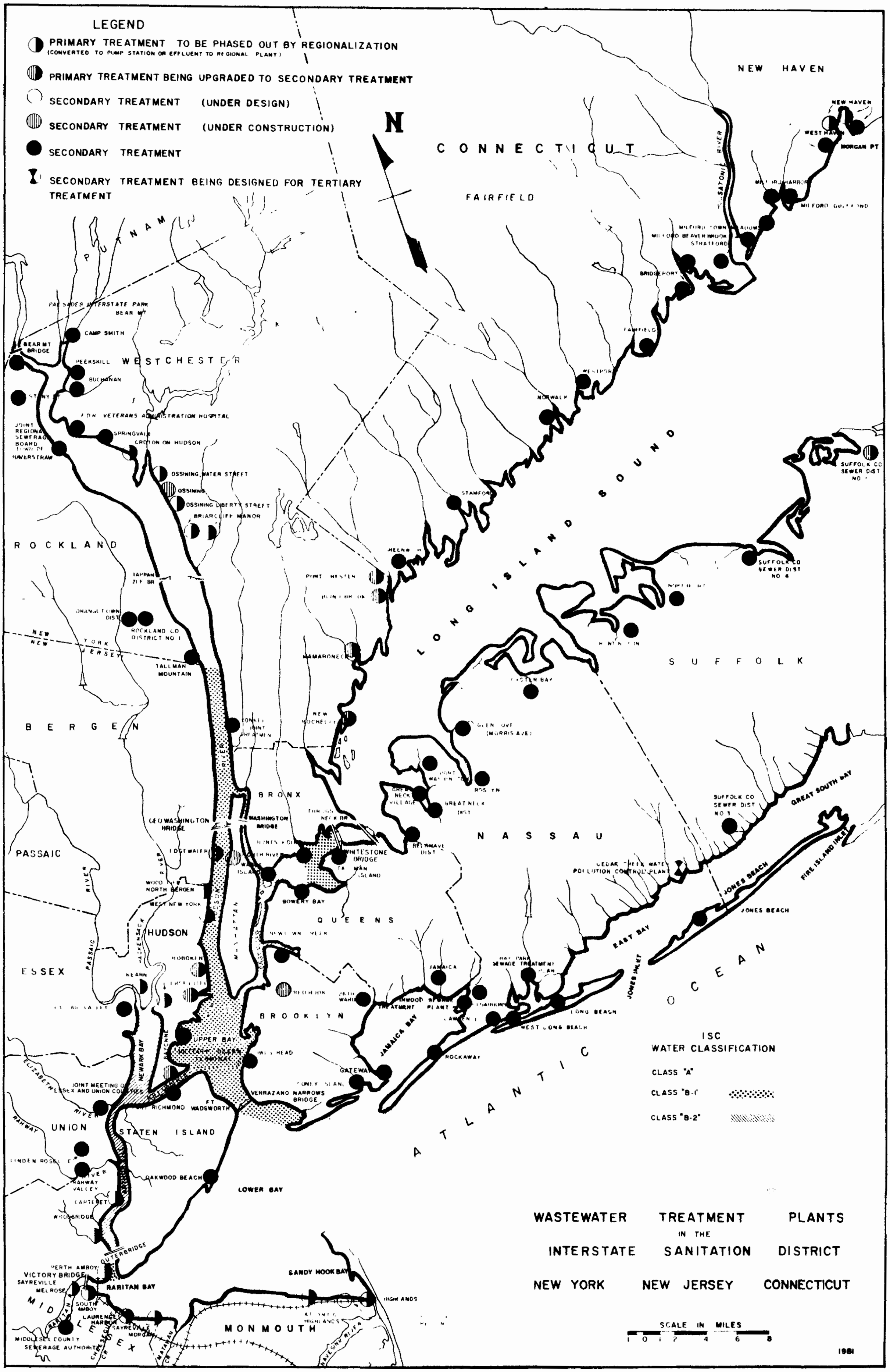
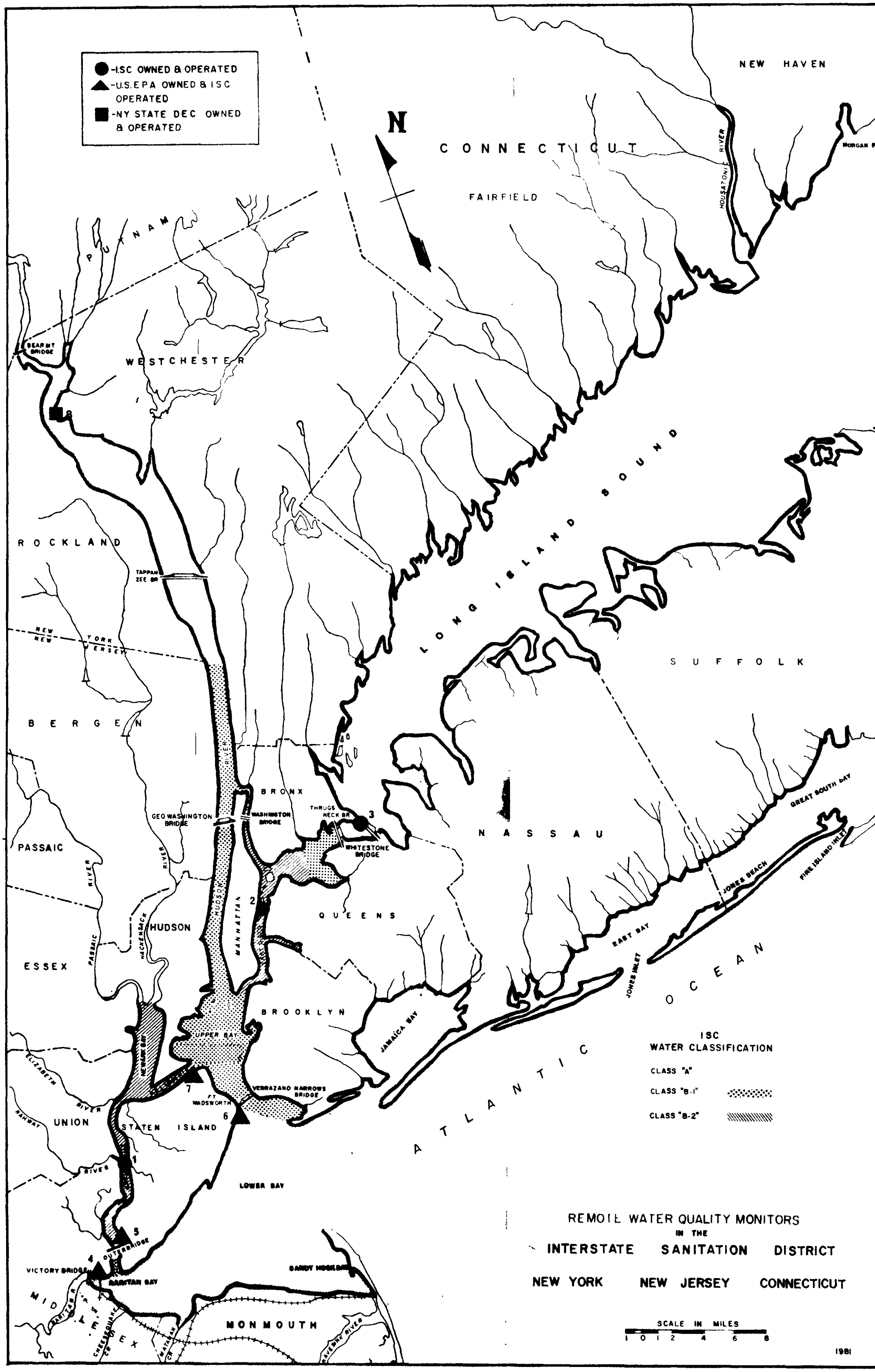

LEGEND
PRIMARY TREATMENT TO BE PHASED OUT BY REGIONALIZATION (CONVERTED TO PUMP STATION OR EFFLUENT TO REGIONAL PLANT)
PRIMARY TREATMENT BEING UPGRADED TO SECONDARY TREATMENT
SECONDARY TREATMENT (UNDER DESIGN)
SECONDARY TREATMENT (UNDER CONSTRUCTION)
SECONDARY TREATMENT
SECONDARY TREATMENT BEING DESIGNED FOR TERTIARY TREATMENT
N
CONNECTICUT
FAIRFIELD
NEW HAVEN
PUTNAM
WESTCHESTER
ROCKLAND
BERGEN
PASSAIC
ESSEX
HUDSON
UNION
BRONX
QUEENS
BROOKLYN
NASSAU
SUFFOLK
STATEN ISLAND
MONMOUTH
LONG ISLAND SOUND
ATLANTIC OCEAN
LOWER BAY
RARITAN BAY
SANDY HOOK BAY
GREAT SOUTH BAY
EAST BAY
JAMAICA BAY
NEWARK BAY
UPPER BAY
JONES BEACH
FIRE ISLAND INLET
JONES INLET
ISC
WATER CLASSIFICATION
CLASS "A"
CLASS "B-1"
CLASS "B-2"
WASTEWATER TREATMENT PLANTS
IN THE
INTERSTATE SANITATION DISTRICT
NEW YORK NEW JERSEY CONNECTICUT
SCALE IN MILES
1961

Figure 2



-I.SC OWNED & OPERATED
-U.S.E P A OWNED & I S C OPERATED
-NY STATE DEC OWNED & OPERATED
N
CONNECTICUT
FAIRFIELD
NEW HAVEN
HOUSATONIC RIVER
MORGAN PT.
PUTNAM
WESTCHESTER
BEAR MT BRIDGE
ROCKLAND
TAPPAN ZEE BR
NEW YORK
NEW JERSEY
BERGEN
PASSAIC
HUDSON
ESSEX
UNION
BRONX
MANHATTAN
QUEENS
BROOKLYN
NASSAU
SUFFOLK
LONG ISLAND SOUND
ATLANTIC OCEAN
HUDSON RIVER
GEO WASHINGTON BRIDGE
WASHINGTON BRIDGE
THROGS NECK BR
WHITESTONE BRIDGE
UPPER BAY
NEWARK BAY
VERRAZANO NARROWS BRIDGE
FT WADSWORTH
STATEN ISLAND
LOWER BAY
OUTERBRIDGE
VICTORY BRIDGE
RARITAN BAY
SANDY HOOK BAY
MONMOUTH
MIDDLESEX
JAMAICA BAY
EAST BAY
JONES INLET
JONES BEACH
GREAT SOUTH BAY
FIRE ISLAND INLET
ISC
WATER CLASSIFICATION
CLASS "A"
CLASS "B-I"
CLASS "B-2"
REMOIE WATER QUALITY MONITORS
IN THE
INTERSTATE SANITATION DISTRICT
NEW YORK NEW JERSEY CONNECTICUT
SCALE IN MILES
1 0 1 2 4 6 8
1981

Table 1
Remote Automatic Water Quality Monitoring Stations
in the
Interstate Sanitation District

INTERSTATE SANITATION COMMISSION OWNED AND OPERATED

1. Arthur Kill - Consolidated Edison Arthur Kill Generating Station, Staten Island, New York

2. East River - Consolidated Edison Ravenswood Generating Station, Long Island City, New York

3. East River - Throgs Neck Bridge, Fort Schuyler, Bronx, New York

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY OWNED AND INTERSTATE SANITATION COMMISSION OPERATED

4. Raritan River - Victory Bridge, Perth Amboy, New Jersey (1)

5. Arthur Kill - Outerbridge Crossing, Staten Island, New York (2)

6. The Narrows - Fort Wadsworth, Staten Island, New York (3)

7. Kill Van Kull - U.S. Gypsum Company, Staten Island, New York (4)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION OWNED AND OPERATED

8. Hudson River - Verplanck, New York

Notes:

(1) Out of service due to boat accident at Victory Bridge pier
(2) Being moved
(3) Out of service due to fire at Fort Wadsworth pier
(4) Approximately 150 feet east of U.S. Gypsum Plant

Figure 3

ARTHUR KILL — CON ED. (station no. 1)

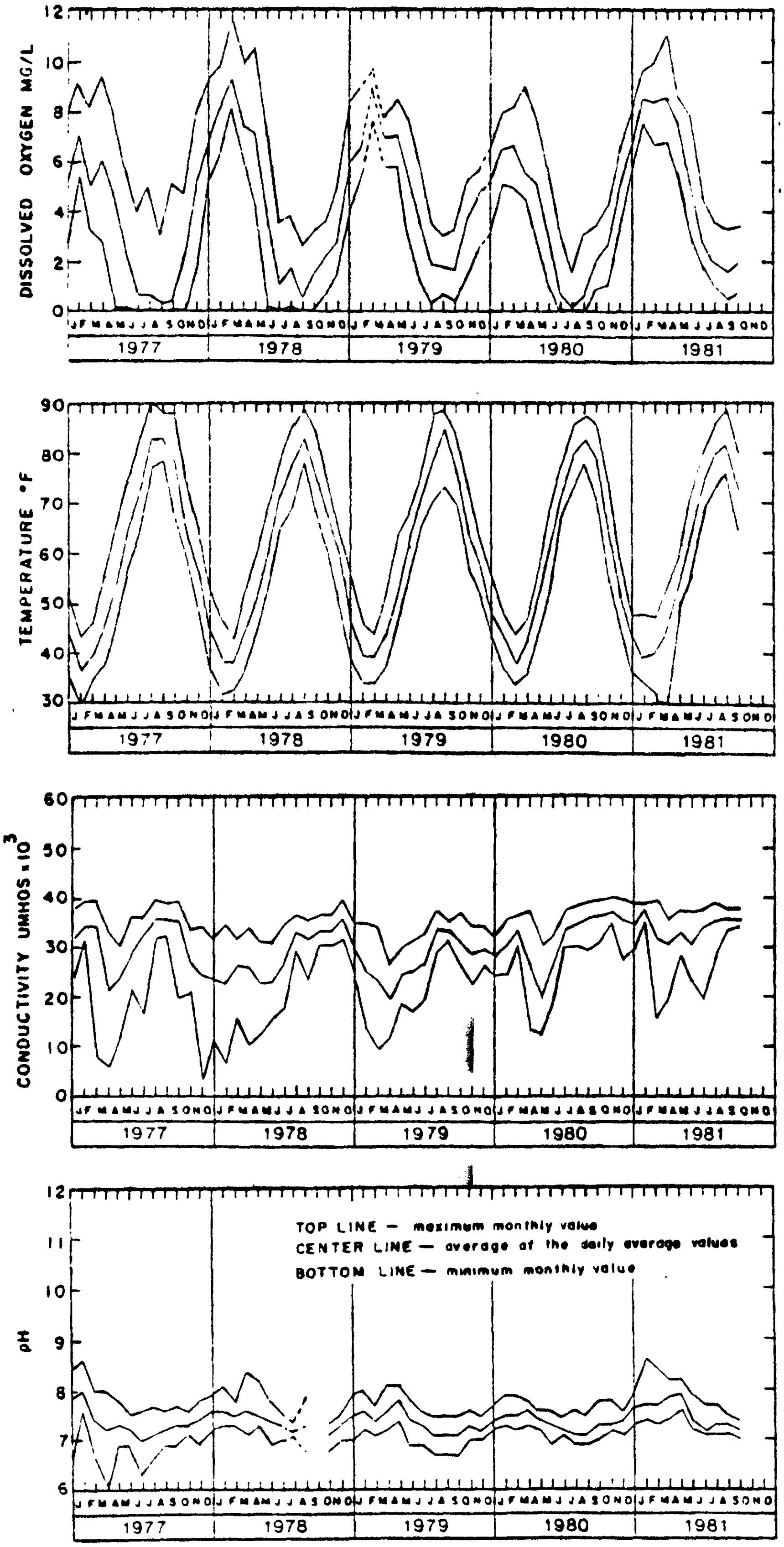


Figure 4

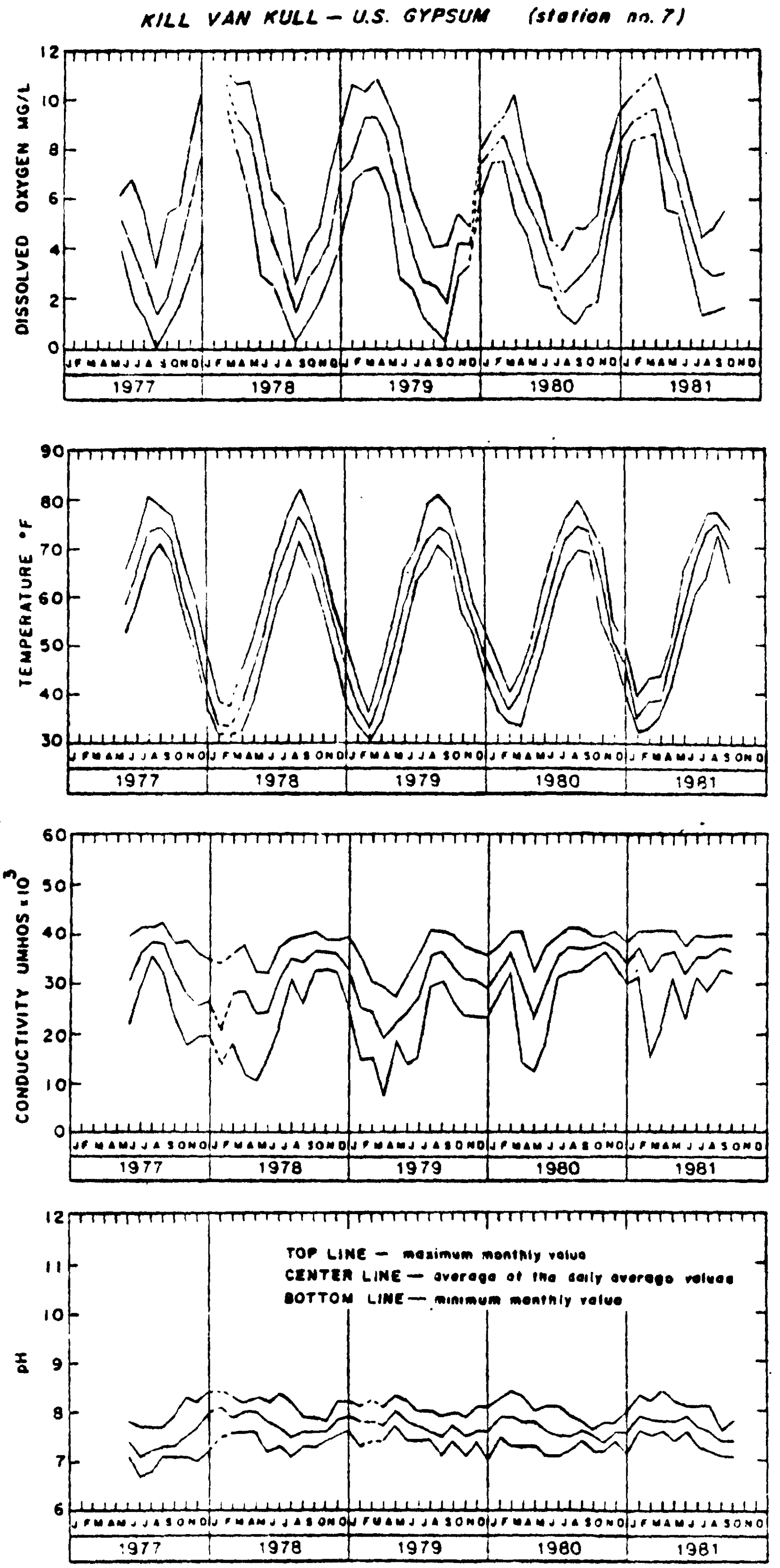

KILL VAN KULL – U.S. GYPSUM (station no. 7)
DISSOLVED OXYGEN MG/L
TEMPERATURE °F
CONDUCTIVITY UMHOS x 10^3
pH
1977
1978
1979
1980
1981
TOP LINE — maximum monthly value
CENTER LINE — average of the daily average values
BOTTOM LINE — minimum monthly value

Table 2

Interstate Sanitation Commission
Remote Automatic Water Quality Monitoring Data
Percent of Time I.S.C. Dissolved Oxygen Requirements Were Met for the Period of October 1, 1980 through September 30, 1981

MONTH	STATION 1 AK/CE	STATION 7 KVK/USG
October 1980	79.6	100.0
November 1980	100.0	100.0
December 1980	100.0	100.0
January 1981	100.0	100.0
February 1981	100.0	-
March 1981	100.0	100.0
April 1981	100.0	100.0
May 1981	100.0	100.0
June 1981	89.0	100.0
July 1981	38.5	95.7
August 1981	21.5	96.8
September 1981	54.2	94.2

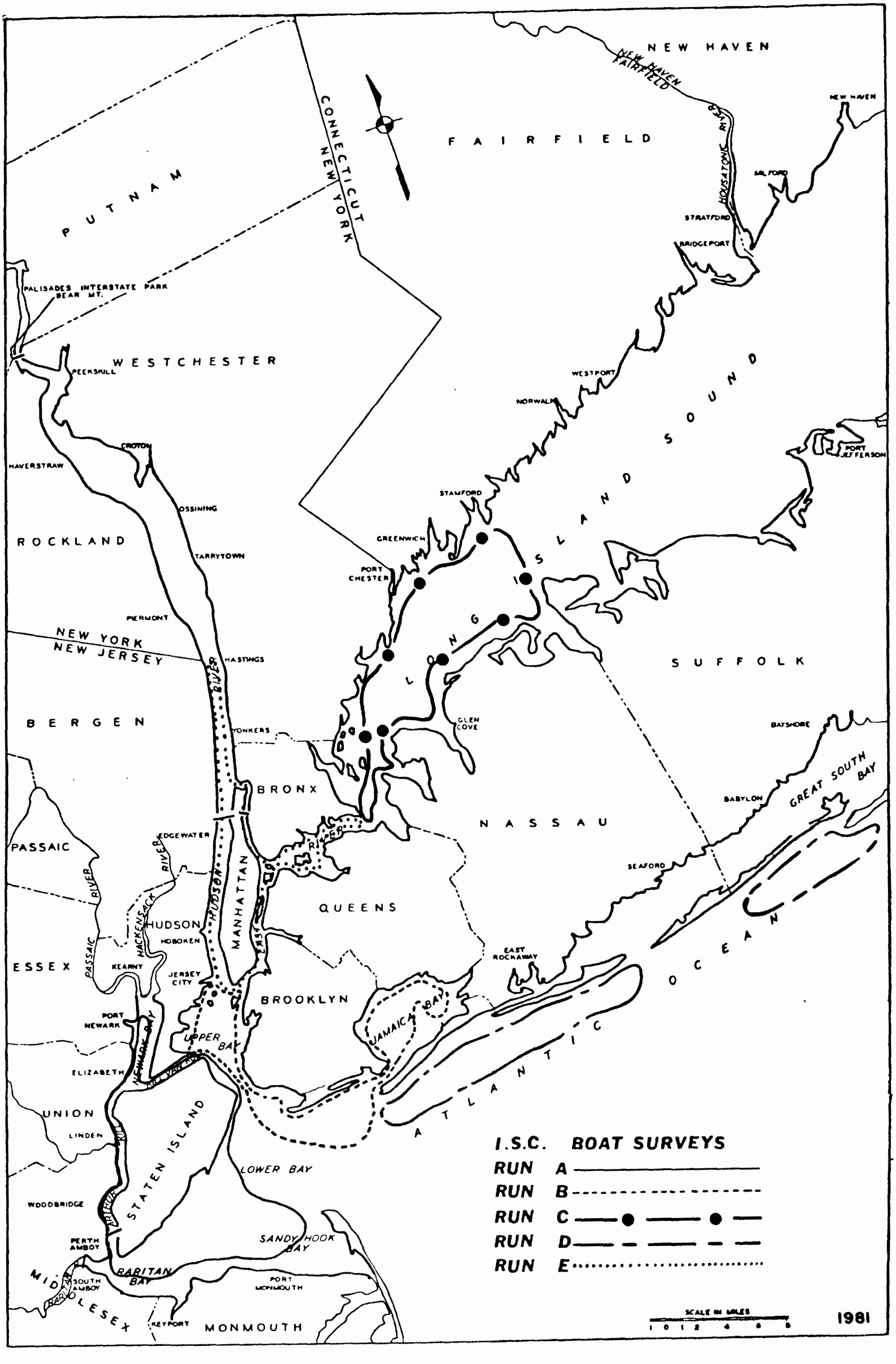

I.S.C. BOAT SURVEYS
RUN A
RUN B
RUN C
RUN D
RUN E
1981
FAIRFIELD
PUTNAM
WESTCHESTER
ROCKLAND
BERGEN
PASSAIC
ESSEX
HUDSON
UNION
MIDDLESEX
MONMOUTH
BRONX
MANHATTAN
QUEENS
BROOKLYN
STATEN ISLAND
NASSAU
SUFFOLK
LONG ISLAND SOUND
ATLANTIC OCEAN
NEW HAVEN
CONNECTICUT
NEW YORK
NEW JERSEY
HUDSON RIVER
EAST RIVER
UPPER BAY
LOWER BAY
JAMAICA BAY
SANDY HOOK BAY
RARITAN BAY
GREAT SOUTH BAY
HOUSATONIC RIVER
HACKENSACK RIVER
PASSAIC RIVER
NEWARK BAY
ARTHUR KILL

Table 3
Interstate Sanitation Commission
Sampling Stations - Boat Run "A"

STATION	LATITUDE NORTH D M S	LONGITUDE WEST D M S	DESCRIPTION
AK-03	40-38-18	74-11-45	At the center of & on the northside of the B&O R.R. Bridge
AK-07	40-35-35	74-12-22	Middle of mouth of Rahway River & in line with shoreline along Tremley Reach
AK-13	40-33-02	74-15-00	Mid-channel between Flashing Red Buoy #12 & Flashing Green, Black Buoy #1
AK-18	40-30-24	74-15-34	Mid-channel of Ward Point Bend (west) and opposite Perth Amboy Ferry Slip
LB-01	40-30-44	74-06-03	500 feet from Old Orchard Light in line with the beacon at Old Orchard Shore
LB-02	40-33-45	74-04-20	B.W. Bell off Midland Beach
NB-03	40-39-20	74-08-45	Northside of C.R.N.J. Bridge over the Newark Bay South Reach Channel (mid-channel)
NB-05	40-38-47	74-09-10	Midway between Flashing Red Buoy #14 and Buoy N "2A"
NB-12	40-41-57	74-07-10	Newark Bay North Reach at mid channel northside of LVRR Bridge
RB-07	40-27-39	74-02-47	Flashing Red Buoy R "4" off the tip of Leonardo (U.S.N.) Pier
RB-08	40-27-08	74-06-22	E-W: Line of Nun Buoy N "2" at channel entrance to Compton Creek & standpipe on Point Comfort. N-S: Approximately 200 yards west of Pews Creek.
RB-10	40-29-04	74-15-38	Qk Fl G "3" Buoy
RB-14	40-28-01	74-11-18	Buoy C "3" off Conaskonk Point at channel entrance to Keyport Harbor
RB-15	40-27-23	74-08-56	Private Fl G Buoy "1" on Belvedere Beach Point Comfort
UH-11	40-39-05	74-05-10	Located in the Kill Van Kull, in mid-channel & directly opposite Fl G & Black Buoy #3
UH-13	40-36-26	74-02-45	Middle of channel in Narrows under Verrazano Bridge

Table 4
Interstate Sanitation Commission
Sampling Stations - Boat Run "B"

STATION	LATITUDE NORTH D M S	LONGITUDE WEST D M S	DESCRIPTION
AO-01	40-31-47	73-56-37	Flashing Red R "2" Gong (4 sec.)
HR-01	40-42-20	74-01-36	Mid-channel of Hudson River N-S: Line of black buoys E-W: Fire Boat Pier (NY) and railroad pier (NJ)
JB-02	40-36-27	73-53-09	Mill Basin at east end of channel
JB-03	40-37-37	73-53-00	In channel 400 feet south of the end of Canarsie Pier
JB-05	40-35-45	73-48-40	At center pier of bridge over Beach Channel - Hammels
JB-07	40-38-52	73-49-20	At mouth of Bergen Basin, southeast of the sludge storage tank
JB-08	40-36-20	73-48-56	Under center of R.R. trestle
LB-03	40-34-03	73-59-00	200 feet south of Steeplechase Pier at Coney Island - N "2S"
LB-04	40-35-00	74-00-51	1/4 mile northeast of Norton Point, near the White Nun Buoy
RI-01	40-34-00	73-55-51	As near the outfall structure of the Coney Island plant as safety permits
RI-02	40-34-24	73-53-08	Under center of bridge from Barran Island to Rock-away
UH-03	40-39-14	74-03-35	Passaic Valley Outfalls E-W: Robbins Reef Light and forward water tower on Naval Dock N-S: Statue of Liberty and Black Bell Buoy #1-G
UH-13	40-36-26	74-02-45	Middle of channel in Narrows under Verrazano Bridge
UH-21	40-40-23	74-02-28	Main ship channel 10 yards to the west of Fl R Bell Buoy #30
UH-22	40-38-25	74-02-50	In mid-channel of Bay Ridge Channel E-W: Flashing Red Beacon on 69th St. Ferry Dock (Brooklyn) N-S: Fl G Bell Buoy #3 and Fl R Gong Buoy #22
UH-29	40-42-17	73-59-54	Mid-channel of East River in line with Pier #11 (Manhattan) and Pier #1 (Brooklyn)

Table 5
Interstate Sanitation Commission
Sampling Stations - Boat Run "E"

STATION	LATITUDE NORTH D M S	LONGITUDE WEST D M S	DESCRIPTION
ER-01	40-42-24	73-59-27	Under Manhattan Bridge - mid-channel
ER-02	40-42-48	73-58-20	Under Williamsburg Bridge - mid-channel
ER-03	40-44-05	73-58-05	Mid-channel of East River E-W: Pier #73 (School Slip) Manhattan with open pier, foot of Greene Street, Brooklyn N-S: Poorhouse Flats Range
ER-04	40-45-22	73-57-11	Under Queensboro Bridge in the East Channel
ER-09	40-47-26	73-54-53	Mid-channel of East River E-W: Fl R Bell Beacon on Wards Island with tall stack on Con Edison's Astoria Plant
ER-11	40-47-50	73-52-02	Mid-channel of East River E-W: Fl R Beacon (College Point) with stack on Rikers Island N-S: Line from center of Sanitation Pier (Hunts Point) with Fl R #4 Buoy (Station approximately 250 yards SE of #4 Buoy)
HA-01	40-48-40	73-56-02	Third bridge after Triboro Bridge
HA-02	40-50-44	73-55-45	Hamilton Bridge (middle bridge of 3)
HR-01	40-42-20	74-01-36	Mid-channel of Hudson River N-S: Line of black buoys E-W: Fire Boat Pier (NY) and railroad pier (NJ)
HR-02	40-45-17	74-00-58	Mid-channel of Hudson River E-W: Heliport (NY) and Seatrain pier (NJ)
HR-03	40-47-41	73-59-09	Mid-channel of Hudson River E-W: Soldiers & Sailors Monument (NY) and circular apartment buildings (NJ)
HR-04	40-51-04	73-57-04	Mid-channel of Hudson River under George Washington Bridge
HR-05	40-52-40	73-55-02	Mid-channel of Spuyten Duyvil Creek under Henry Hudson Bridge
HR-07	40-56-51	73-54-27	Mid-channel of Hudson River E-W: Opposite Phelps Dodge (Yonkers)

Table 6
Interstate Sanitation Commission
Explanation of Abbreviations Used in Cumulative Frequency Distributions

ABBREVIATION	EXPLANATION
TEMP-SM	Temperature - Summer (July, August, September) - degrees C
TEMP-WN	Temperature - Winter (December, January, February) - degrees C
D.O.-SM	Dissolved oxygen - Summer (July, August, September) - mg/l
D.O.-WN	Dissolved oxygen - Winter (December, January, February) - mg/l
BOD-SM	BOD - Summer (July, August, September) - mg/l
BOD-WN	BOD - Winter (December, January, February) - mg/l
F COLI-SM	Fecal coliforms - Summer (July, August, September) - /100 ml
F COLI-WN	Fecal coliforms - Winter (December, January, February) - /100 ml
T COLI-SM	Total coliforms - Summer (July, August, September) - /100 ml
T COLI-WN	Total coliforms - Winter (December, January, February) - /100 ml
PH	pH - standard units
CONDUCT	Conductivity - micromhos/cm
TURBIDITY	Turbidity - NTU
CHLOR A	Chlorophyll a - mg/l
CHLOR B	Chlorophyll b - mg/l
CHLOR C	Chlorophyll c - mg/l
TC	Total carbon - mg/l
TOC	Total organic carbon - mg/l
O & G	Oil and grease - mg/l
O PO4-P	Dissolved orthophosphate phosphorus - mg/l
TOT P-P	Total phosphorus - mg/l
NH3-N	Ammonia nitrogen - mg/l
NO2+NO3-N	Nitrite + nitrate nitrogen - mg/l
TKN	Total kjeldahl nitrogen - mg/l

Table 6 (continued)

ABBREVIATION	EXPLANATION
CU-SOL	Soluble copper - mg/l
CU-TOTAL	Total copper - mg/l
ZN-SOL	Soluble zinc - mg/l
ZN-TOTAL	Total zinc - mg/l
CR-SOL	Soluble chromium - mg/l
CR-TOTAL	Total chromium - mg/l
PB-SOL	Soluble lead - mg/l
PB-TOTAL	Total lead - mg/l
AL-SOL	Soluble aluminum - mg/l
AL-TOTAL	Total aluminum - mg/l
FE-SOL	Soluble iron - mg/l
FE-TOTAL	Total iron - mg/l
NI-SOL	Soluble nickel - mg/l
NI-TOTAL	Total nickel - mg/l
CD-SOL	Soluble cadmium - mg/l
CD-TOTAL	Total cadmium - mg/l
HG-TOTAL	Total mercury - mg/l
AG-SOL	Soluble silver - mg/l
AG-TOTAL	Total silver - mg/l
CO-SOL	Soluble cobalt - mg/l
CO-TOTAL	Total cobalt - mg/l
SN-SOL	Soluble tin - mg/l
SN-TOTAL	Total tin - mg/l
AS-TOTAL	Total arsenic - mg/l
PHENOLS	Phenols - mg/l

Table 7
Interstate Sanitation Commission Boat Survey Data
Cumulative Frequency Distributions
Hudson River - 1980/1981

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
TEMP-SM	17	19.0	20.0	22.0	23.0	23.5	25.0	25.0	25.0
TEMP-WN	5	1.0	1.0	2.0	2.5	3.0	3.0	3.0	3.0
D.O.-SM	17	3.0	3.6	4.0	4.7	5.0	5.2	5.3	5.3
D.O.-WN	5	10.4	10.4	10.5	11.0	11.1	11.2	11.2	11.2
BOD-SM	10	1.0	1.0	1.4	1.9	2.7	2.9	3.1	3.1
BOD-WN	5	3.2	3.2	3.5	4.2	4.6	5.4	5.4	5.4
F COLI-SM	9	170	170	1700	3300	5800	>10000	>10000	>10000
F COLI-WN	3	180	180	180	3000	4200	4200	4200	4200
T COLI-SM	9	170	170	4500	5400	14000	24000	24000	24000
T COLI-WN	3	3300	3300	3300	14000	83000	83000	83000	83000
PH	42	7.2	7.2	7.3	7.5	7.5	7.6	7.7	7.8
CONDUCT	42	15000	21000	25000	30000	37000	45000	47500	>50000
TURBIDITY	42	1	2	2	3	5	5	6	10
CHLOR A	15	0.000	0.000	0.000	0.003	0.004	0.009	0.011	0.011
CHLOR B	15	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.002
CHLOR C	15	0.000	0.000	0.000	0.000	0.002	0.006	0.007	0.007
TC	42	25	28	30	33	35	36	37	38
TOC	42	12	14	16	18	21	23	24	25
O & G	5	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3
O PO4-P	13	0.04	0.05	0.08	0.10	0.14	0.16	0.16	0.16
TOT P-P	17	0.08	0.09	0.14	0.16	0.18	0.26	0.28	0.28
NH3-N	17	0.16	0.30	0.33	0.37	0.43	0.51	0.54	0.54
NO2+NO3-N	15	0.28	0.33	0.36	0.48	0.53	0.57	0.63	0.63
TKN	8	0.53	0.53	0.55	0.76	0.91	1.14	1.14	1.14

Table 7 (continued)

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
CU-SOL	8	0.004	0.004	0.005	0.010	0.013	0.016	0.016	0.016
CU-TOTAL	8	0.008	0.008	0.009	0.015	0.023	0.039	0.039	0.039
ZN-SOL	8	0.016	0.016	0.020	0.023	0.026	0.043	0.043	0.043
ZN-TOTAL	8	0.023	0.026	0.029	0.032	0.037	0.045	0.045	0.045
CR-SOL	8	<0.0010	<0.0010	0.0018	0.0020	0.0050	0.0070	0.0070	0.0070
CR-TOTAL	8	<0.0010	<0.0010	0.0027	0.0036	0.0070	0.0100	0.0100	0.0100
PB-SOL	8	<0.005	<0.005	<0.005	0.005	0.010	0.017	0.017	0.017
PB-TOTAL	8	0.005	0.005	0.010	0.016	0.020	0.022	0.022	0.022
AL-SOL	8	<0.010	<0.010	0.024	0.040	0.098	0.120	0.120	0.120
AL-TOTAL	8	<0.010	<0.010	0.071	0.167	0.190	0.333	0.333	0.333
FE-SOL	8	0.013	0.013	0.015	0.119	0.157	0.392	0.392	0.392
FE-TOTAL	8	0.134	0.134	0.137	0.285	0.344	0.437	0.437	0.437
NI-SOL	8	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	0.006	0.006
NI-TOTAL	8	<0.005	<0.005	<0.005	<0.005	0.008	0.009	0.009	0.009
CD-SOL	8	<0.0005	<0.0005	<0.0005	0.0005	0.0007	0.0012	0.0012	0.0012
CD-TOTAL	8	<0.0005	<0.0005	<0.0005	0.0009	0.0012	0.0022	0.0022	0.0022
HG-TOTAL	8	<0.0001	<0.0001	<0.0001	0.0002	0.0003	0.0004	0.0004	0.0004
AG-SOL	8	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001
AG-TOTAL	8	<0.001	<0.001	<0.001	0.001	0.001	0.003	0.003	0.003
CO-SOL	8	<0.001	<0.001	<0.001	0.001	0.002	0.003	0.003	0.003
CO-TOTAL	8	<0.001	<0.001	<0.001	0.003	0.003	0.004	0.004	0.004
SN-SOL	8	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
SN-TOTAL	8	<0.050	<0.050	<0.050	<0.050	<0.050	0.100	0.100	0.100
AS-TOTAL	8	<0.002	<0.002	<0.002	<0.002	0.003	0.012	0.012	0.012
PHENOLS	4	<0.001	<0.001	<0.001	0.005	0.006	0.019	0.019	0.019

NOTE: All data was taken 5 feet below the surface during the period from October 1, 1980 through September 30, 1981.

Table 8
Interstate Sanitation Commission Boat Survey Data
Cumulative Frequency Distributions
Upper New York Bay - 1980/1981

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
TEMP-SM	15	19.0	19.0	20.0	21.0	23.0	23.5	24.0	24.0
TEMP-WN	3	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0
D.O.-SM	15	3.1	3.4	3.6	4.1	5.3	5.5	6.1	6.1
D.O.-WN	3	10.0	10.0	10.0	11.0	11.4	11.4	11.4	11.4
BOD-SM	6	0.4	0.4	0.8	1.0	4.0	5.2	5.2	5.2
BOD-WN	3	3.0	3.0	3.0	3.7	4.1	4.1	4.1	4.1
F COLI-SM	10	110	110	1400	3000	9100	12000	47000	47000
F COLI-WN	2	380	380	380	380	2100	2100	2100	2100
T COLI-SM	9	1500	1500	7300	20000	25000	35000	35000	35000
T COLI-WN	2	3000	3000	3000	3000	6800	6800	6800	6800
PH	30	7.2	7.2	7.4	7.5	7.7	7.8	7.8	7.9
CONDUCT	30	23000	23000	31000	38000	45000	>50000	>50000	>50000
TURBIDITY	30	1	1	2	2	3	5	10	11
CHLOR A	9	0.000	0.000	0.001	0.003	0.015	0.029	0.029	0.029
CHLOR B	9	0.000	0.000	0.000	0.001	0.002	0.014	0.014	0.014
CHLOR C	9	0.000	0.000	0.001	0.003	0.007	0.010	0.010	0.010
TC	30	23	26	30	32	36	38	40	41
TOC	30	12	14	16	18	23	25	26	26
O & G	3	0.1	0.1	0.1	0.2	0.6	0.6	0.6	0.6
O PO4-P	9	0.10	0.10	0.11	0.12	0.12	0.16	0.16	0.16
TOT P-P	15	0.10	0.13	0.14	0.17	0.19	0.20	0.22	0.22
NH3-N	16	0.20	0.20	0.27	0.33	0.52	0.62	0.83	0.83
NO2+NO3-N	16	0.08	0.15	0.22	0.31	0.45	0.62	0.65	0.65
TKN	12	0.49	0.60	0.60	0.73	0.91	1.01	1.39	1.39

Table 8 (continued)

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
CU-SOL	6	0.009	0.009	0.009	0.010	0.020	0.021	0.021	0.021
CU-TOTAL	6	0.011	0.011	0.012	0.018	0.037	0.054	0.054	0.054
ZN-SOL	6	0.014	0.014	0.020	0.021	0.056	0.057	0.057	0.057
ZN-TOTAL	6	0.021	0.021	0.027	0.042	0.061	0.086	0.086	0.086
CR-SOL	6	<0.0010	<0.0010	<0.0010	0.0020	0.0050	0.0060	0.0060	0.0060
CR-TOTAL	6	<0.0010	<0.0010	<0.0010	0.0020	0.0070	0.0080	0.0080	0.0080
PB-SOL	6	<0.005	<0.005	<0.005	<0.005	<0.005	0.030	0.030	0.030
PB-TOTAL	6	<0.005	<0.005	0.005	0.013	0.025	0.035	0.035	0.035
AL-SOL	6	0.023	0.023	0.023	0.024	0.027	0.068	0.068	0.068
AL-TOTAL	6	0.023	0.023	0.045	0.091	0.143	0.455	0.455	0.455
FE-SOL	6	<0.001	<0.001	0.006	0.007	0.019	0.380	0.380	0.380
FE-TOTAL	6	0.126	0.126	0.169	0.213	0.310	0.516	0.516	0.516
NI-SOL	6	<0.005	<0.005	<0.005	<0.005	0.007	0.008	0.008	0.008
NI-TOTAL	6	0.006	0.006	0.006	0.008	0.009	0.009	0.009	0.009
CD-SOL	6	<0.0005	<0.0005	<0.0005	<0.0005	0.0007	0.0007	0.0007	0.0007
CD-TOTAL	6	<0.0005	<0.0005	<0.0005	0.0005	0.0012	0.0013	0.0013	0.0013
HG-TOTAL	6	<0.0001	<0.0001	<0.0001	0.0003	0.0003	0.0003	0.0003	0.0003
AG-SOL	6	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	0.001
AG-TOTAL	6	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	0.001
CO-SOL	6	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.004	0.004
CO-TOTAL	6	<0.001	<0.001	<0.001	<0.001	0.002	0.004	0.004	0.004
SN-SOL	6	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
SN-TOTAL	6	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
AS-TOTAL	6	<0.002	<0.002	<0.002	<0.002	0.002	0.002	0.002	0.002
PHENOLS	4	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.004	0.004

NOTE: All data was taken 5 feet below the surface during the period from October 1, 1980 through September 30, 1981.

Table 9
Interstate Sanitation Commission Boat Survey Data
Cumulative Frequency Distributions
Lower New York Bay - 1980/1981

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
TEMP-SM	20	17.5	18.2	20.0	21.0	21.5	23.0	23.0	23.0
TEMP-WN	6	1.0	1.0	1.0	1.0	1.5	2.0	2.0	2.0
D.O.-SM	20	3.9	4.1	5.0	5.5	6.1	7.5	8.2	8.7
D.O.-WN	6	9.7	9.7	9.8	9.9	10.6	11.5	11.5	11.5
BOD-SM	6	0.3	0.3	0.7	1.8	6.0	6.2	6.2	6.2
BOD-WN	4	2.0	2.0	2.0	2.8	3.5	4.3	4.3	4.3
F COLI-SM	10	10	10	310	400	1500	1700	8200	8200
F COLI-WN	3	140	140	140	270	350	350	350	350
T COLI-SM	9	100	100	580	1600	3100	7000	7000	7000
T COLI-WN	1	2000	2000	2000	2000	2000	2000	2000	2000
PH	40	7.3	7.4	7.5	7.6	7.7	7.9	8.1	8.6
CONDUCT	40	31000	37000	43000	47500	>50000	>50000	>50000	>50000
TURBIDITY	40	1	2	2	2	3	3	3	6
CHLOR A	12	0.000	0.001	0.003	0.007	0.012	0.023	0.035	0.035
CHLOR B	12	0.000	0.000	0.000	0.001	0.001	0.002	0.003	0.003
CHLOR C	12	0.000	0.000	0.000	0.001	0.004	0.005	0.011	0.011
TC	39	30	30	31	33	36	39	40	45
TOC	39	12	14	16	18	21	24	25	33
O & G	4	0.1	0.1	0.1	0.2	0.2	0.4	0.4	0.4
O PO4-P	12	0.05	0.05	0.05	0.08	0.11	0.12	0.12	0.12
TOT P-P	12	0.08	0.09	0.12	0.13	0.14	0.19	0.22	0.22
NH3-N	12	0.09	0.20	0.22	0.29	0.31	0.37	0.41	0.41
NO2+NO3-N	12	0.13	0.14	0.17	0.18	0.23	0.37	0.39	0.39
TKN	4	0.61	0.61	0.61	0.61	0.77	0.94	0.94	0.94

Table 9 (continued)

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
CU-SOL	8	0.006	0.006	0.015	0.023	0.025	0.047	0.047	0.047
CU-TOTAL	8	0.012	0.012	0.020	0.035	0.059	0.086	0.086	0.086
ZN-SOL	8	0.025	0.025	0.025	0.039	0.049	0.092	0.092	0.092
ZN-TOTAL	8	0.026	0.026	0.026	0.042	0.063	0.103	0.103	0.103
CR-SOL	8	<0.0010	<0.0010	<0.0010	0.0019	0.0042	0.0050	0.0050	0.0050
CR-TOTAL	8	<0.0010	<0.0010	<0.0010	0.0040	0.0058	0.0063	0.0063	0.0063
PB-SOL	8	<0.005	<0.005	<0.005	<0.005	0.007	0.015	0.015	0.015
PB-TOTAL	8	0.008	0.008	0.008	0.013	0.021	0.030	0.030	0.030
AL-SOL	8	0.015	0.015	0.020	0.024	0.033	0.068	0.068	0.068
AL-TOTAL	8	0.029	0.029	0.045	0.071	0.080	0.148	0.148	0.148
FE-SOL	8	0.010	0.010	0.012	0.014	0.021	0.225	0.225	0.225
FE-TOTAL	8	0.099	0.099	0.100	0.118	0.152	0.341	0.341	0.341
NI-SOL	8	<0.005	<0.005	<0.005	<0.005	0.006	0.015	0.015	0.015
NI-TOTAL	8	<0.005	<0.005	<0.005	0.007	0.010	0.024	0.024	0.024
CD-SOL	8	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	0.0026	0.0026	0.0026
CD-TOTAL	8	<0.0005	<0.0005	<0.0005	0.0005	0.0012	0.0042	0.0042	0.0042
HG-TOTAL	8	<0.0001	<0.0001	0.0001	0.0004	0.0004	0.0005	0.0005	0.0005
AG-SOL	8	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	0.001
AG-TOTAL	8	<0.001	<0.001	<0.001	0.001	0.001	0.003	0.003	0.003
CO-SOL	8	<0.001	<0.001	<0.001	<0.001	0.002	0.006	0.006	0.006
CO-TOTAL	8	<0.001	<0.001	<0.001	0.001	0.003	0.009	0.009	0.009
SN-SOL	8	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
SN-TOTAL	8	<0.050	<0.050	<0.050	<0.050	<0.050	0.100	0.100	0.100
AS-TOTAL	8	<0.002	<0.002	<0.002	0.002	0.002	0.004	0.004	0.004
PHENOLS	4	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.004	0.004

NOTE: All data was taken 5 feet below the surface during the period from October 1, 1980 through September 30, 1981.

Table 10
Interstate Sanitation Commission Boat Survey Data
Cumulative Frequency Distributions
Kill Van Kull - 1980/1981

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
TEMP-SM	5	20.5	20.5	21.0	22.0	22.5	23.0	23.0	23.0
TEMP-WN	2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
D.O.-SM	5	3.0	3.0	3.5	4.5	5.0	6.6	6.6	6.6
D.O.-WN	2	10.0	10.0	10.0	10.0	11.3	11.3	11.3	11.3
BOD-SM	1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
BOD-WN	1	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
F COLI-SM	2	5400	5400	5400	5400	7300	7300	7300	7300
F COLI-WN	1	1700	1700	1700	1700	1700	1700	1700	1700
T COLI-SM	2	7000	7000	7000	7000	32000	32000	32000	32000
T COLI-WN	1	3200	3200	3200	3200	3200	3200	3200	3200
PH	10	7.2	7.2	7.3	7.4	7.6	7.6	7.7	7.7
CONDUCT	10	29000	29000	40000	44000	45000	47000	>50000	>50000
TURBIDITY	10	1	1	2	3	4	4	7	7
CHLOR A	3	0.004	0.004	0.004	0.004	0.007	0.007	0.007	0.007
CHLOR B	3	0.000	0.000	0.000	0.001	0.002	0.002	0.002	0.002
CHLOR C	3	0.000	0.000	0.000	0.002	0.002	0.002	0.002	0.002
TC	10	31	31	32	32	34	36	39	39
TOC	10	13	13	14	16	20	22	23	23
O & G	1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
O PO4-P	3	0.08	0.08	0.08	0.14	0.15	0.15	0.15	0.15
TOT P-P	3	0.20	0.20	0.20	0.21	0.29	0.29	0.29	0.29
NH3-N	3	0.49	0.49	0.49	0.50	1.07	1.07	1.07	1.07
NO2+NO3-N	3	0.25	0.25	0.25	0.32	0.33	0.33	0.33	0.33
TKN	1	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05

Table 10 (continued)

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
CU-SOL	2	0.006	0.006	0.006	0.006	0.023	0.023	0.023	0.023
CU-TOTAL	2	0.014	0.014	0.014	0.014	0.078	0.078	0.078	0.078
ZN-SOL	2	0.049	0.049	0.049	0.049	0.064	0.064	0.064	0.064
ZN-TOTAL	2	0.055	0.055	0.055	0.055	0.083	0.083	0.083	0.083
CR-SOL	2	0.0019	0.0019	0.0019	0.0019	0.0033	0.0033	0.0033	0.0033
CR-TOTAL	2	0.0038	0.0038	0.0038	0.0038	0.0075	0.0075	0.0075	0.0075
PB-SOL	2	<0.005	<0.005	<0.005	<0.005	0.010	0.010	0.010	0.010
PB-TOTAL	2	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
AL-SOL	2	0.016	0.016	0.016	0.016	0.050	0.050	0.050	0.050
AL-TOTAL	2	0.180	0.180	0.180	0.180	0.190	0.190	0.190	0.190
FE-SOL	2	0.007	0.007	0.007	0.007	0.030	0.030	0.030	0.030
FE-TOTAL	2	0.300	0.300	0.300	0.300	0.436	0.436	0.436	0.436
NI-SOL	2	<0.005	<0.005	<0.005	<0.005	0.014	0.014	0.014	0.014
NI-TOTAL	2	<0.005	<0.005	<0.005	<0.005	0.020	0.020	0.020	0.020
CD-SOL	2	<0.0005	<0.0005	<0.0005	<0.0005	0.0014	0.0014	0.0014	0.0014
CD-TOTAL	2	0.0005	0.0005	0.0005	0.0005	0.0018	0.0018	0.0018	0.0018
HG-TOTAL	2	0.0004	0.0004	0.0004	0.0004	0.0007	0.0007	0.0007	0.0007
AG-SOL	2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
AG-TOTAL	2	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
CO-SOL	2	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002
CO-TOTAL	2	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002
SN-SOL	2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
SN-TOTAL	2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
AS-TOTAL	2	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
PHENOLS	1	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

NOTE: All data was taken 5 feet below the surface during the period from October 1, 1980 through September 30, 1981.

Table 11
Interstate Sanitation Commission Boat Survey Data
Cumulative Frequency Distributions
Newark Bay - 1980/1981

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
TEMP-SM	10	21.0	21.0	21.0	22.5	24.0	25.0	25.0	25.0
TEMP-WN	2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
D.O.-SM	10	1.6	1.6	2.3	3.0	4.5	8.4	8.4	9.2
D.O.-WN	2	9.4	9.4	9.4	9.4	9.5	9.5	9.5	9.5
BOD-SM	2	0.9	0.9	0.9	0.9	1.2	1.2	1.2	1.2
BOD-WN	0								
F COLI-SM	5	300	300	500	600	3000	3200	3200	3200
F COLI-WN	1	600	600	600	600	600	600	600	600
T COLI-SM	5	640	640	2000	4500	7000	7000	7000	7000
T COLI-WN	1	1500	1500	1500	1500	1500	1500	1500	1500
PH	18	7.1	7.1	7.2	7.4	7.6	7.6	7.6	7.6
CONDUCT	18	26000	27000	38000	41500	47000	48000	>50000	>50000
TURBIDITY	18	2	2	3	3	4	4	5	5
CHLOR A	14	0.000	0.000	0.004	0.007	0.019	0.084	0.093	0.093
CHLOR B	14	0.000	0.000	0.000	0.001	0.002	0.003	0.004	0.004
CHLOR C	14	0.000	0.000	0.001	0.002	0.008	0.035	0.040	0.040
TC	18	32	32	33	35	38	39	43	43
TOC	18	13	14	15	18	22	24	28	28
O & G	2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
O PO4-P	6	0.15	0.15	0.17	0.23	0.30	0.35	0.35	0.35
TOT P-P	15	0.26	0.26	0.33	0.40	0.42	0.51	0.57	0.57
NH3-N	15	0.49	0.61	0.69	0.85	1.61	1.73	2.03	2.03
NO2+NO3-N	15	0.31	0.32	0.34	0.38	0.46	0.52	0.54	0.54
TKN	14	1.31	1.33	1.52	1.66	2.00	2.55	2.68	2.68

Table 11 (continued)

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
CU-SOL	3	0.006	0.006	0.006	0.018	0.021	0.021	0.021	0.021
CU-TOTAL	3	0.015	0.015	0.015	0.059	0.083	0.083	0.083	0.083
ZN-SOL	3	0.047	0.047	0.047	0.057	0.072	0.082	0.082	0.082
ZN-TOTAL	3	0.057	0.057	0.057	0.062	0.088	0.088	0.088	0.088
CR-SOL	3	<0.0010	<0.0010	<0.0010	0.0025	0.0029	0.0029	0.0029	0.0029
CR-TOTAL	3	<0.0010	<0.0010	<0.0010	0.0050	0.0057	0.0057	0.0057	0.0057
PB-SOL	3	<0.005	<0.005	<0.005	<0.005	0.010	0.010	0.010	0.010
PB-TOTAL	3	0.013	0.013	0.013	0.020	0.038	0.038	0.038	0.038
AL-SOL	3	<0.010	<0.010	<0.010	0.015	0.040	0.040	0.040	0.040
AL-TOTAL	3	0.115	0.115	0.115	0.176	0.180	0.180	0.180	0.180
FE-SOL	3	0.004	0.004	0.004	0.012	0.025	0.025	0.025	0.025
FE-TOTAL	3	0.150	0.150	0.150	0.263	0.448	0.448	0.448	0.448
NI-SOL	3	<0.005	<0.005	<0.005	0.015	0.018	0.018	0.018	0.018
NI-TOTAL	3	0.005	0.005	0.005	0.017	0.026	0.026	0.026	0.026
CD-SOL	3	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
CD-TOTAL	3	0.0006	0.0006	0.0006	0.0008	0.0015	0.0015	0.0015	0.0015
HG-TOTAL	3	0.0002	0.0002	0.0002	0.0003	0.0005	0.0005	0.0005	0.0005
AG-SOL	3	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
AG-TOTAL	3	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
CO-SOL	3	<0.001	<0.001	<0.001	0.002	0.003	0.003	0.003	0.003
CO-TOTAL	3	<0.001	<0.001	<0.001	0.002	0.007	0.007	0.007	0.007
SN-SOL	3	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
SN-TOTAL	3	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
AS-TOTAL	3	<0.002	<0.002	<0.002	0.002	0.003	0.003	0.003	0.003
PHENOLS	0								

NOTE: All data was taken 5 feet below the surface during the period from October 1, 1980 through September 30, 1981.

Table 12
Interstate Sanitation Commission Boat Survey Data
Cumulative Frequency Distributions
Arthur Kill - 1980/1981

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
TEMP-SM	20	21.5	21.5	22.5	23.0	24.0	24.5	26.0	27.0
TEMP-WN	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.O.-SM	20	2.3	2.4	2.8	3.6	4.5	5.2	5.4	6.5
D.O.-WN	8	8.3	8.3	9.2	9.7	10.5	11.8	11.8	11.8
BOD-SM	4	1.5	1.5	1.5	1.6	2.1	2.4	2.4	2.4
BOD-WN	4	4.0	4.0	4.0	4.0	4.6	4.9	4.9	4.9
F COLI-SM	13	300	410	1000	3000	3500	6400	9100	9100
F COLI-WN	5	120	120	280	440	550	1200	1200	1200
T COLI-SM	13	580	1500	5800	16000	21000	30000	>100000	>100000
T COLI-WN	5	200	200	1300	1500	2000	3600	3600	3600
PH	40	6.8	7.1	7.2	7.4	7.5	7.6	7.8	7.8
CONDUCT	40	25000	34000	38500	42000	45000	>50000	>50000	>50000
TURBIDITY	40	2	2	3	4	5	6	7	7
CHLOR A	12	0.000	0.000	0.000	0.003	0.005	0.028	0.031	0.031
CHLOR B	12	0.000	0.000	0.000	0.002	0.003	0.005	0.006	0.006
CHLOR C	12	0.000	0.000	0.000	0.002	0.005	0.010	0.012	0.012
TC	40	31	33	34	36	39	40	41	46
TOC	40	13	16	17	19	21	23	25	33
O & G	4	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
O PO4-P	12	0.05	0.10	0.10	0.16	0.26	0.29	0.32	0.32
TOT P-P	19	0.15	0.16	0.23	0.31	0.40	0.44	0.45	0.45
NH3-N	19	0.44	0.73	0.86	1.42	2.22	2.42	2.55	2.55
NO2+NO3-N	19	0.24	0.27	0.36	0.42	0.49	0.51	0.54	0.54
TKN	13	1.78	1.90	1.97	2.30	2.68	2.95	3.00	3.00

Table 12 (continued)

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
CU-SOL	8	0.005	0.005	0.009	0.016	0.030	0.038	0.038	0.038
CU-TOTAL	8	0.012	0.012	0.020	0.036	0.059	0.146	0.146	0.146
ZN-SOL	8	0.012	0.012	0.036	0.050	0.064	0.111	0.111	0.111
ZN-TOTAL	8	0.022	0.022	0.041	0.064	0.072	0.112	0.112	0.112
CR-SOL	8	<0.0010	<0.0010	<0.0010	0.0010	0.0033	0.0063	0.0063	0.0063
CR-TOTAL	8	0.0010	0.0010	0.0013	0.0039	0.0042	0.0100	0.0100	0.0100
PB-SOL	8	<0.005	<0.005	0.005	0.010	0.013	0.038	0.038	0.038
PB-TOTAL	8	0.010	0.010	0.018	0.020	0.033	0.050	0.050	0.050
AL-SOL	8	0.015	0.015	0.015	0.016	0.040	0.140	0.140	0.140
AL-TOTAL	8	0.100	0.100	0.103	0.180	0.262	0.280	0.280	0.280
FE-SOL	8	0.004	0.004	0.014	0.021	0.038	0.061	0.061	0.061
FE-TOTAL	8	0.119	0.119	0.145	0.171	0.349	0.509	0.509	0.509
NI-SOL	8	<0.005	<0.005	0.005	0.010	0.017	0.021	0.021	0.021
NI-TOTAL	8	<0.005	<0.005	0.006	0.014	0.017	0.025	0.025	0.025
CD-SOL	8	<0.0005	<0.0005	<0.0005	0.0008	0.0012	0.0017	0.0017	0.0017
CD-TOTAL	8	<0.0005	<0.0005	0.0010	0.0011	0.0016	0.0023	0.0023	0.0023
HG-TOTAL	8	0.0001	0.0001	0.0001	0.0004	0.0006	0.0010	0.0010	0.0010
AG-SOL	8	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001
AG-TOTAL	8	<0.001	<0.001	<0.001	0.001	0.002	0.013	0.013	0.013
CO-SOL	8	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001
CO-TOTAL	8	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001
SN-SOL	8	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
SN-TOTAL	8	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	0.050	0.050
AS-TOTAL	8	<0.002	<0.002	<0.002	0.003	0.003	0.006	0.006	0.006
PHENOLS	2	0.005	0.005	0.005	0.005	0.027	0.027	0.027	0.027

NOTE: All data was taken 5 feet below the surface during the period from October 1, 1980 through September 30, 1981.

Table 13
Interstate Sanitation Commission Boat Survey Data
Cumulative Frequency Distributions
Raritan Bay - 1980/1981

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
TEMP-SM	15	20.0	20.5	21.0	22.0	23.0	24.0	24.0	24.0
TEMP-WN	6	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
D.O.-SM	15	5.2	5.8	6.5	6.9	8.0	8.5	8.5	8.5
D.O.-WN	6	9.1	9.1	11.0	11.4	12.2	13.1	13.1	13.1
BOD-SM	3	1.3	1.3	1.3	1.4	1.5	1.5	1.5	1.5
BOD-WN	3	3.6	3.6	3.6	4.0	4.2	4.2	4.2	4.2
F COLI-SM	8	<10	<10	<10	<10	30	170	170	170
F COLI-WN	3	<10	<10	<10	20	73	73	73	73
T COLI-SM	7	<10	<10	10	90	460	1900	1900	1900
T COLI-WN	3	<10	<10	<10	120	160	160	160	160
PH	30	6.4	7.2	7.4	7.7	7.9	8.0	8.1	8.1
CONDUCT	30	33000	40500	48000	>50000	>50000	>50000	>50000	>50000
TURBIDITY	30	1	2	2	2	3	4	4	5
CHLOR A	9	0.000	0.000	0.005	0.011	0.055	0.108	0.108	0.108
CHLOR B	9	0.000	0.000	0.000	0.001	0.002	0.005	0.005	0.005
CHLOR C	9	0.000	0.000	0.000	0.004	0.024	0.040	0.040	0.040
TC	30	29	30	31	35	36	38	39	41
TOC	30	11	13	15	17	20	22	23	25
O & G	3	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3
O PO4-P	9	0.04	0.04	0.07	0.09	0.09	0.13	0.13	0.13
TOT P-P	9	0.12	0.12	0.12	0.13	0.17	0.24	0.24	0.24
NH3-N	9	0.04	0.04	0.08	0.20	0.44	0.98	0.98	0.98
NO2+NO3-N	9	0.17	0.17	0.23	0.26	0.28	0.51	0.51	0.51
TKN	3	0.63	0.63	0.63	0.72	0.84	0.84	0.84	0.84

Table 13 (continued)

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
CU-SOL	6	0.007	0.007	0.019	0.019	0.021	0.026	0.026	0.026
CU-TOTAL	6	0.016	0.016	0.019	0.024	0.032	0.037	0.037	0.037
ZN-SOL	6	0.019	0.019	0.023	0.031	0.051	0.075	0.075	0.075
ZN-TOTAL	6	0.024	0.024	0.032	0.040	0.052	0.098	0.098	0.098
CR-SOL	6	<0.0010	<0.0010	<0.0010	0.0010	0.0025	0.0025	0.0025	0.0025
CR-TOTAL	6	<0.0010	<0.0010	<0.0010	0.0025	0.0057	0.0058	0.0058	0.0058
PB-SOL	6	<0.005	<0.005	<0.005	<0.005	0.013	0.013	0.013	0.013
PB-TOTAL	6	0.006	0.006	0.013	0.013	0.015	0.017	0.017	0.017
AL-SOL	6	<0.010	<0.010	0.015	0.015	0.020	0.040	0.040	0.040
AL-TOTAL	6	0.020	0.020	0.029	0.050	0.080	0.131	0.131	0.131
FE-SOL	6	0.003	0.003	0.011	0.012	0.023	0.028	0.028	0.028
FE-TOTAL	6	0.025	0.025	0.060	0.061	0.079	0.191	0.191	0.191
NI-SOL	6	<0.005	<0.005	<0.005	<0.005	0.010	0.013	0.013	0.013
NI-TOTAL	6	<0.005	<0.005	<0.005	<0.005	0.013	0.018	0.018	0.018
CD-SOL	6	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.0005	0.0005
CD-TOTAL	6	<0.0005	<0.0005	<0.0005	0.0006	0.0008	0.0031	0.0031	0.0031
HG-TOTAL	6	0.0001	0.0001	0.0001	0.0002	0.0003	0.0004	0.0004	0.0004
AG-SOL	6	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001
AG-TOTAL	6	<0.001	<0.001	<0.001	<0.001	0.003	0.003	0.003	0.003
CO-SOL	6	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001
CO-TOTAL	6	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.002	0.002
SN-SOL	6	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
SN-TOTAL	6	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
AS-TOTAL	6	<0.002	<0.002	<0.002	0.002	0.002	0.004	0.004	0.004
PHENOLS	1	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006

NOTE: All data was taken 5 feet below the surface during the period from October 1, 1980 through September 30, 1981.

Table 14
Interstate Sanitation Commission Boat Survey Data
Cumulative Frequency Distributions
Sandy Hook Bay - 1980/1981

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
TEMP-SM	10	20.0	20.0	20.5	21.0	22.0	22.5	23.5	23.5
TEMP-WN	4	0.0	0.0	0.0	0.0	1.0	1.5	1.5	1.5
D.O.-SM	10	3.6	3.6	5.0	7.0	8.0	8.2	9.0	9.0
D.O.-WN	4	9.5	9.5	9.5	10.0	10.8	10.9	10.9	10.9
BOD-SM	2	0.9	0.9	0.9	0.9	1.9	1.9	1.9	1.9
BOD-WN	2	2.1	2.1	2.1	2.1	2.9	2.9	2.9	2.9
F COLI-SM	5	<10	<10	<10	10	200	2000	2000	2000
F COLI-WN	2	36	36	36	36	150	150	150	150
T COLI-SM	4	82	82	82	120	130	340	340	340
T COLI-WN	1	200	200	200	200	200	200	200	200
PH	20	7.3	7.3	7.5	7.7	7.8	8.0	8.0	8.4
CONDUCT	20	34000	43500	45000	48000	>50000	>50000	>50000	>50000
TURBIDITY	20	1	2	2	2	3	3	4	4
CHLOR A	6	0.000	0.000	0.005	0.008	0.080	0.103	0.103	0.103
CHLOR B	6	0.000	0.000	0.001	0.002	0.002	0.002	0.002	0.002
CHLOR C	6	0.000	0.000	0.001	0.001	0.033	0.041	0.041	0.041
TC	20	30	30	31	33	36	37	38	39
TOC	20	12	13	14	18	21	22	22	22
O & G	2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
O PO4-P	6	0.04	0.04	0.07	0.09	0.10	0.14	0.14	0.14
TOT P-P	6	0.11	0.11	0.11	0.12	0.21	0.25	0.25	0.25
NH3-N	6	0.12	0.12	0.13	0.20	0.34	0.37	0.37	0.37
NO2+NO3-N	6	0.15	0.15	0.17	0.18	0.23	0.30	0.30	0.30
TKN	2	0.76	0.76	0.76	0.76	0.78	0.78	0.78	0.78

Table 14 (continued)

PARAMETER	NO. VAL.	LOW VALUE	10 % VALUE	25 % VALUE	50 % VALUE	75 % VALUE	90 % VALUE	95 % VALUE	HIGH VALUE
CU-SOL	4	0.006	0.006	0.006	0.014	0.023	0.024	0.024	0.024
CU-TOTAL	4	0.011	0.011	0.011	0.027	0.038	0.083	0.083	0.083
ZN-SOL	4	0.023	0.023	0.023	0.027	0.035	0.064	0.064	0.064
ZN-TOTAL	4	0.027	0.027	0.027	0.031	0.036	0.074	0.074	0.074
CR-SOL	4	<0.0010	<0.0010	<0.0010	0.0029	0.0038	0.0042	0.0042	0.0042
CR-TOTAL	4	<0.0010	<0.0010	<0.0010	0.0038	0.0042	0.0048	0.0048	0.0048
PB-SOL	4	<0.005	<0.005	<0.005	0.005	0.007	0.013	0.013	0.013
PB-TOTAL	4	0.012	0.012	0.012	0.013	0.015	0.017	0.017	0.017
AL-SOL	4	<0.010	<0.010	<0.010	<0.010	0.016	0.030	0.030	0.030
AL-TOTAL	4	0.050	0.050	0.050	0.059	0.066	0.100	0.100	0.100
FE-SOL	4	0.011	0.011	0.011	0.011	0.013	0.013	0.013	0.013
FE-TOTAL	4	0.058	0.058	0.058	0.090	0.137	0.414	0.414	0.414
NI-SOL	4	<0.005	<0.005	<0.005	<0.005	0.005	0.013	0.013	0.013
NI-TOTAL	4	<0.005	<0.005	<0.005	<0.005	0.014	0.022	0.022	0.022
CD-SOL	4	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
CD-TOTAL	4	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	0.0018	0.0018	0.0018
HG-TOTAL	4	<0.0001	<0.0001	<0.0001	0.0003	0.0003	0.0004	0.0004	0.0004
AG-SOL	4	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001
AG-TOTAL	4	<0.001	<0.001	<0.001	<0.001	0.001	0.004	0.004	0.004
CO-SOL	4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CO-TOTAL	4	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001
SN-SOL	4	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
SN-TOTAL	4	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
AS-TOTAL	4	<0.002	<0.002	<0.002	<0.002	0.002	0.020	0.020	0.020
PHENOLS	1	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004

NOTE: All data was taken 5 feet below the surface during the period from October 1, 1980 through September 30, 1981.

Table 15
Interstate Sanitation Commission
1981 Pesticides and PCB's Data

WATERWAY	STATION	LATITUDE NORTH D M S	LONGITUDE WEST D M S	PESTICIDES/PCB's DETECTED COMPOUND	VALUE (ug/l)
ARTHUR KILL	AK-13	40-33-02	74-15-00	Alpha-BHC	0.055
HUDSON RIVER	HR-02	40-45-17	74-00-58	Aroclor 1242	0.283

NOTES: (1) Samples were analyzed for pesticides and PCB's at all stations on Boat Runs A, B and E. Pesticides or PCB's were found only at the stations included in this table. The table lists only stations in New Jersey or interstate (NJ-NY) waters.

(2) All samples were taken 5 feet below the surface.

Table 16
Current Status of New Jersey Wastewater Treatment Plants in the Interstate Sanitation District

WASTEWATER TREATMENT PLANT	DEGREE OF TREATMENT	DISCHARGE WATERWAY	AVERAGE DAILY FLOW (MGD) 1979	1981	COMPLIANCE WITH TREATMENT REQUIREMENTS 1979	1981	BASIS FOR NON-COMPLIANCE*
Carteret	primary	Arthur Kill	3.2	3.4	no	no	2
Joint Meeting of Essex and Union Counties	secondary activated sludge	Arthur Kill	64.8	54.6	yes	yes	-
Linden-Roselle	secondary activated sludge	Arthur Kill	11.9	8.9	no	yes	-
Rahway Valley Sewerage Authority	secondary activated sludge	Arthur Kill	32.8	24.5	yes	yes	-
Woodbridge	primary	Arthur Kill	3.4	2.7	no	no	2
Edgewater	primary	Hudson River	2.8	2.5	no	no	3
Hoboken	primary	Hudson River	15.5	15.5	no	no	3
Jersey City - East Side	primary	Hudson River	34.7	27.3	no	no	3
West New York	primary	Hudson River	9.0	10.6	no	no	3
Woodcliff - North Bergen	primary	Hudson River	2.6	1.8	no	no	3
Bayonne	primary	Kill Van Kull	13.2	11.9	no	no	3
Jersey City - West Side	primary	Newark Bay	21.2	18.7	no	no	3
Kearny	primary	Newark Bay	3.1	2.0	no	no	3
Passaic Valley Sewerage Commissioners	secondary activated sludge	Upper New York Bay **	250	250	no	yes	-

Notes: * 1. Secondary treatment required - Construction underway.

2. Secondary treatment required - Plant is to be converted to a pump station with flows diverted to a regional sewage treatment plant.

3. Secondary treatment required - Planning underway.

** Temporarily discharged to Newark Bay during plant construction in 1979. Normal discharge is to Upper New York Bay.

Table 16 (continued)

WASTEWATER TREATMENT PLANT	DEGREE OF TREATMENT	DISCHARGE WATERWAY	AVERAGE DAILY FLOW (MGD) 1979	1981	COMPLIANCE WITH TREATMENT REQUIREMENTS 1979	1981	BASIS FOR NON-COMPLIANCE*
Middlesex County Utilities Authority	secondary activated sludge - oxygen type	Raritan Bay	91.9	79.6	yes	yes	-
Old Bridge Township S.A.	primary	Raritan Bay	0.8	0.7	no	no	2
Perth Amboy	primary	Raritan Bay	4.7	3.7	no	no	2
Sayreville - Melrose	primary	Raritan Bay	0.06	0.06	no	no	2
Sayreville - Morgan	primary	Raritan Bay	0.3	0.2	no	no	2
South Amboy	primary	Raritan Bay	0.6	0.6	no	no	2
Atlantic Highlands	primary	Sandy Hook Bay	0.5	0.36	no	no	2
Highlands	primary	Sandy Hook Bay	0.4	0.5	no	no	2
Atlantic Highlands/ Highlands Regional S.A.	secondary activated sludge	Sandy Hook Bay	plant is in planning stage				
Military Ocean Terminal	secondary activated sludge	Upper N.Y. Bay	0.13	0.10	yes	yes	-

Notes: * 1. Secondary treatment required - Construction underway.

2. Secondary treatment required - Plant is to be converted to a pump station with flows diverted to a regional sewage treatment plant.

3. Secondary treatment required - Planning underway.