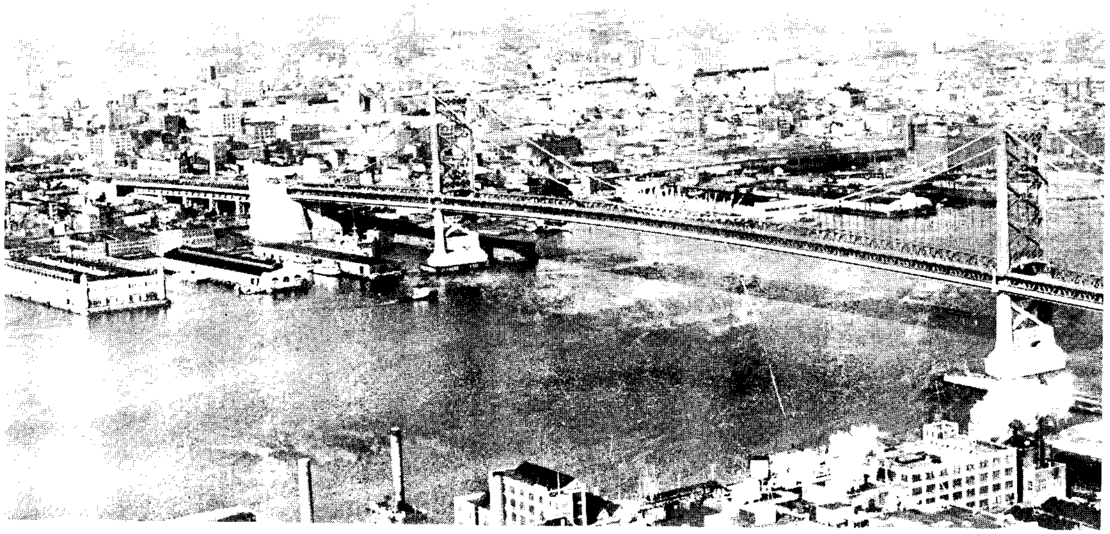
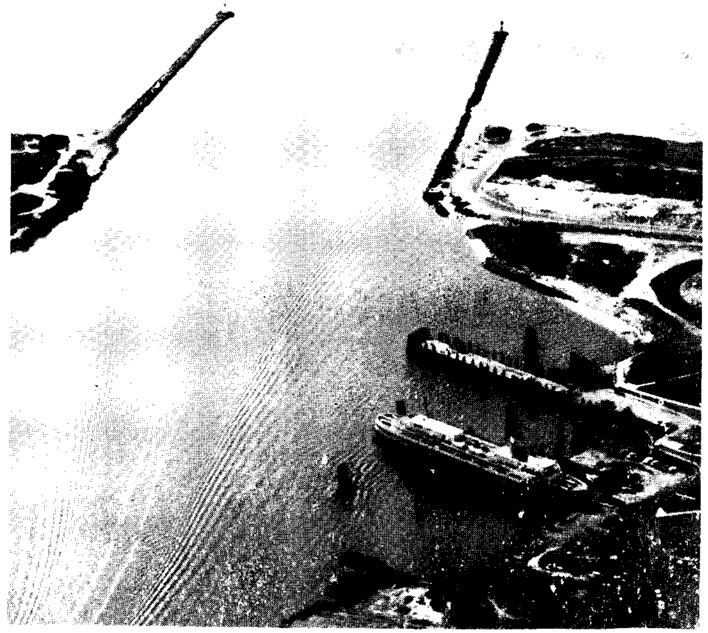
THE DELAWARE RIVER BASIN

THE FINAL REPORT AND ENVIRONMENTAL IMPACT STATEMENT OF THE LEVEL B STUDY - MAY 1981

THE DELAWARE RIVER BASIN COMMISSION





THE DELAWARE RIVER BASIN COMPREHENSIVE (LEVEL B) STUDY

Delaware River Basin Commission
P. O. Box 7360
West Trenton, New Jersey 08628

May 1981

The report cover illustrates the diversity of Delaware Basin waters. Shown are Canoeing on the Upper Delaware, municipal and industrial uses at Easton, the port complex at Camden/ Philadelphia, and the Chesapeake and Delaware Canal.

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EXECUTIVE DIRECTOR

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WEST TRENTON, N J

May 1, 1981

Members of the Delaware River Basin Commission

Gentlemen:

I am pleased to submit the final report and environmental impact statement of the Commission's Level B Study. This report is the culmination of a planning process initiated October 15, 1976, funded by the U.S. Water Resources Council, the Basin States, and the Delaware River Basin Commission. The study was conducted in accordance with U.S. Water Resources Council guidelines and under policy direction of the Delaware River Basin Commission. Through participation of the Study Steering Committee, which included representatives of the Delaware Basin states, the concerned federal agencies, and the public, and the Study Advisory Committee and associated Work Groups, about 200 individuals contributed to the study. Hundreds of individuals participated in public workshops at many locations in the Basin, in 1977, 1978, and 1979. Public hearings on the October 1979 Draft Final Report and Environmental Impact Statement were held throughout the Basin in November 1979.

Even while the Level B Study was under way, many of its findings and conclusions were being implemented. For example, water conservation policies and regulations have been enacted; a "ground water protected area" was delineated and is being administered in southeastern Pennsylvania; the mathematical model of the relationship between fresh water inflow to the Estuary and ocean salinity intrusion was used as a tool by the Governors in making management decisions during the 1980-81 drought; and the spirit of cooperation and understanding developed during the Study materially benefited efforts to arrive at agreements relating to exportations and downstream releases by the City of New York during time of drought as a basis of temporary modifications of the U.S. Supreme Court Decree (347 US 995-1954).

As this phase of the work is completed, we acknowledge that much remains to be done; the Commission's Comprehensive Plan needs to be amended to include policy directions identified during the course of the Level B process. This will require public hearings. Shortfalls in water supply have been quantified and means identified for overcoming them; this will require support of the signatory party executive and legislative branches.

It has been a pleasure to have worked closely with your participating agency personnel during this process. Your continued interest and support in the often delicate management of the Basin's water resources is appreciated.

Sincerely,

Gerry Hansler

Gerald M. Hansler

THE COMMISSION

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James G. Watt
Member

Sherman W. Tribbitt
Alternate (Served until March 18, 1981)

Colonel James G. Ton
Advisor

PREFACE

The Delaware River Basin Comprehensive (Level B) Study was conducted under the general direction of the Delaware River Basin Commission in conformance with the guidelines established by the U. S. Water Resources Council.

The objective of the Study was to identify and resolve water resource problems. Policies, programs, and projects were considered that encompassed water conservation, water quality, water supply, flow maintenance, flood loss reduction, fish, wildlife and recreation, energy, and navigation.

The Level B Study addressed the roles of the Commission, the federal, state, and local governments, and the private sector in implementing the Level B Preferred Plan. In response to the original Level B Study objective of providing the basis for updating the Commission's Comprehensive Plan, specific amendments in the areas of policy, standards, and water projects are proposed.

Before any management measure is initiated, public hearings will be held. Similarly, before any projects are constructed, detailed engineering and environmental impact analysis will be required.

In compliance with Water Resources Council Guidelines and Commission directives, the Final Level B Report which includes the Preferred Plan and Proposed Comprehensive Plan amendments, has been prepared in a manner that serves as a Final Report and also constitutes a Final Environmental Impact Statement as required by Section 102(2)(c) of the National Environmental Policy Act (P.L. 91-190). The Draft Environmental Impact Statement was filed as cited in the Federal Register of November 19, 1979.

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Delaware River Basin Commission Staff

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This Study was directed by David D. Longmaid, through completion of the October 1979 Draft Report, in accordance with overall policy direction by the Commission. Others who assisted in the draft were:

Allison A. Anderson, Ph.D.	Senior Analyst
Andrew McInnes, Jr.	Public Information Officer
Bruce E. Stewart	Senior Planner
Paul J. Webber	Senior Engineer
Odette P. Taft	Graphic Artist
Lee A. Lawrence	Secretary

Others who assisted for limited periods in preparation of the 1979 draft were:

David Palmer	Assistant Study Manager
Edward David Blum	Economist
Sharon Keene	Public Information Officer
Michael H. Levin, Ph.D.	Ecologist
Elizsbeth Lamb	Secretary

The Final Report revisions were made in accordance with Commission directives and policies by the following Commission staff:

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*James F. Wright was Executive Director from onset of the Level B Study through his retirement in July 1, 1977.

A significant contribution to the Level B Study through completion of the October 1979 Draft Report was made by the following committee:

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CHRONOLOGY

MILESTONES

Level B Planning Proposal (revised)	September, 1975
Interim Steering Committee, first meeting	August 19, 1976
Initiation of Level B Study	October 15, 1976
Plan of Study adopted	May 25, 1977
Study Advisory Committee created	June 14, 1977
Work Group Directives	August, 1977
Initial Planning Analysis Summary	September, 1977
First Series of Public Workshops	September/October 1977
Progress Report to Public	April, 1978
Interim Report	May 31, 1978
Second Series of Public Workshops	May/June, 1978
Comments and Questions on Interim Report	July, 1978
Water Conservation Conference	September 11, 1978
Preliminary Draft Final Report	February 28, 1979
Third Series of Public Workshops	April, 1979
Draft Final Report, The Delaware River Basin Comprehensive (Level B) Study	October, 1979
Public Hearings on Draft Final	November, 1979

PUBLIC WORKSHOPS

FIRST SERIES: FALL, 1977

Purpose: Presentation and discussion of the Plan of Study and current management of the Delaware River Basin.

LOCATION	DATE	ATTENDANCE
Stroudsburg, PA	September 27	95
Trenton, NJ	September 29	30
Wilmington, DE	October 4	65
Philadelphia, PA	October 6	60
Monticello, NY	October 11	60

SECOND SERIES: SPRING, 1978

Purpose: Presentation and discussion of the Interim Report.

LOCATION	DATE	ATTENDANCE
Port Jervis, NY	May 31	30
Bethlehem, PA	June 1	50
Philadelphia, PA	June 5	30
Mount Holly, NJ	June 6	10
Wilmington, DE	June 8	30

THIRD SERIES: SPRING, 1979

Purpose: Presentation and discussion of the Preliminary Draft Final Report.

LOCATION	DATE	ATTENDANCE
Monticello, NY	April 2	180
Allentown, PA	April 4	100
Cherry Hill, NJ	April 5	20
Wilmington, DE	April 9	30
Philadelphia, PA	Arpil 11	30
Wilsonville, PA	April 17	800
Swiftwater, PA	April 24	200

PUBLIC HEARINGS: FALL, 1979

Purpose: Presentation and discussion of the Draft Final Report and Environmental Impact Statement.

LOCATION	DATE	ATTENDANCE
Monticello, NY	November 14	61
East Stroudsburg, PA	November 15	94
Wilmington, DE	November 19	18
Plymouth Meeting, PA	November 20	57
Willingboro, NJ	November 27	66
Honesdale, PA	November 29	200

For the purposes of this Level B Final Report, terms are used as defined below, except as may be otherwise qualified within the text.

acre-foot	The volume of water required to cover one acre of land one foot deep; equal to approximately 325,850 gallons.
anadromous fish	A marine species of fish that ascends a river to spawn in fresh water.
aquifer	A geologic formation that is water bearing, and which transmits water from one point to another.
assimilative capacity	The natural ability of a body of water to neutralize and break down wastes.
base flow	The amount of water carried in a stream or river that comes from ground water sources.
BOD	Biochemical oxygen demand; a measure of the amount of oxygen consumed in the biological process that breaks down organic matter in water.
cfs	Cubic feet per second; 1 cfs = 0.646 mgd = 1.983 acre-feet per day
catadromous fish	A freshwater species of fish that swims to the ocean to spawn.
cogeneration	Electricity produced as a by-product of industrial steam production.
combined sewers	A sewerage system that carries sewage and stormwater runoff in the same pipe.
compact	Delaware River Basin Compact (P.L. 87-328, 75 Stat. 688)
cone of depression	The depression, roughly conical in shape, produced in a water table or other piezometric surface by the extraction of water from a well at a given rate. The volume of the cone will vary with the rate of withdrawal of water.
conventional hydropower	Hydroelectric power generated by the flow of a river and the head developed by damming the river.
CZM	Coastal Zone Management, National Oceanic and Atmospheric Administration.
Delaware Estuary	The tidal portion of the Delaware River between Trenton, N.J. and River Mile 48, the head of Delaware Bay.
depletive use of water	Any use that permanently removes water from the river basin from which it was drawn, such as by exportation, evaporation, evapotranspiration, or other routes.
dissolved solids	Solids present in water in solution that cannot be removed by filteration.
diversion	The taking of water from a body of surface water by a canal, pipe line, or other conduit.
DCMP	Delaware Coastal Management Plan
DNREC	Delaware Department of Natural Resources and Environmental Control
DO	dissolved oxygen
DRBC	Delaware River Basin Commission
DRBEUG	Delaware River Basin Electric Utilities Group
DWGNRA	Delaware Water Gap National Recreation Area
EIS	environmental impact statement
EQ	environmental quality
ERS	Economic Research Service of U.S. Department of Agriculture

evapotranspiration	The loss of water from the soil both by evaporation and by transpiration from plants. Considered a depletive use of water.
exportation of water	The transfer of water out of the Delaware River Basin.
FERC	Federal Energy Regulatory Commission, U.S. Department of Energy
floodplain	The area adjoining the channel of a stream which has been or hereafter may be covered by flood water.
flow objective	A volume of water per unit time determined to be necessary at a specific location under specific conditions to achieve a desired goal.
good faith negotiations	Negotiations among the parties to the 1954 Supreme Court decree being undertaken pursuant to Delaware River Basin Commission Resolution 78-20.
gpd	gallons per day
greenway	Predominantly a stream-oriented corridor for which official actions have committed or planned the dominant land use as park and/or open space.
ground water	Water beneath the surface of the ground.
ground-water recharge	The addition of water to an aquifer by infiltration of precipitation through the soil, seepage from surface water, flow of ground water from another aquifer, pumpage of water into the aquifer through wells, or artificially spreading water on the surface.
head	The difference in elevation between two points in a body of water.
heavy metals	Metallic elements with relatively high molecular weights, generally toxic in low concentrations to plant and animal life. (Certain of these substances are essential or beneficial in trace amounts.)
importation of water	The transfer of water into the Delaware River Basin.
impoundment	A dam that stores water for a variety of purposes including flow augmentation.
instream use of water	Water that is used within the streams and other surface waterways of the Delaware River Basin. Uses include those for navigation, hydroelectric power generation, fish propagation and fishing, wildlife management, recreation, waste assimilation, and control of salinity intrusion.
Level A Study	A general assessment of resource concerns in a large area usually composed of several states.
Level B Study	A detailed examination of resource problems and issues performed for a region or river basin.
Level C Study	A study dealing with the design, feasibility, and implementation of management projects and programs.
LUDA	Land Use Data Acquisition; a USGS (United States Geological Survey) aerial photographic program.
managed flow	The flow of a river or stream that may be expected to occur as the result of manipulation of surface runoff and baseflow by storage reservoirs, imports, exports, diversions and changes in depletive uses.
mgd	Million gallons per day; 1 mgd = 1.547 cfs = 3.07 acre-feet per day
mg/l	milligrams per liter
MIP	Model Implementation Program; an agreement between the U.S. Department of Agriculture and the U.S. Environmental Protection Agency to explore (in selected areas) the most effective use of existing programs and activities to reduce nonpoint source pollution from agricultural and silvicultural activities.

Montague formula	The relationship between Delaware River flows at Montague, New Jersey, and diversions to New York City as established by the 1954 U.S. Supreme Court Decree.
msl	mean sea level
NARWRS	North Atlantic Regional Water Resources Study
natural flow	The flow of a river or stream that has occurred or may be expected to occur without regulation through storage facilities or other management facilities.
NED	National Economic Development
NEWS	Northeastern U.S. Water Supply Study
NJDEP	New Jersey Department of Environmental Protection
NJDOE	New Jersey Department of Energy
NOAA	National Oceanic and Atmospheric Administration, U.S. Department of Commerce
nonpoint source	A generalized discharge of waste into a water body which cannot be located as to a specific source, or which comes from many very small sources.
NPS	National Park Service, U.S. Department of the Interior
NPDES	National Pollutant Discharge Elimination System, which allows and sets limits on discharge of pollutants; permits are issued by states or EPA.
NYDEC	New York State Department of Environmental Conservation
OBERS	Population and economic projections prepared by the Bureau of Economic Analysis (formerly Office of Business Economics) of the Department of Commerce, and the Economic Research Service of the Department of Agriculture.
PADER	Pennsylvania Department of Environmental Resources
parties to the decree	The 1954 Supreme Court decree [347, U.S. 995 at 1001, 98L ed 1130 (June 7, 1954)] regulating flows in the Delaware River involves New York State, New York City, Pennsylvania, New Jersey and Delaware.
P.L.	Public law
point source	Any discernable, confined, and discrete conveyance from which pollutants are or may be discharged into a body of water.
potentiometric head	The distance above or below a referenced datum elevation to which the water in a confined aquifer would rise if free to do so.
ppm	parts per million
ppt	parts per thousand
Principles and Standards	Principles and Standards for Planning Water and Related Land Resources: guidelines promulgated by the Water Resources Council for programs and projects mandated by the Water Resources Planning Act (P.L. 89-80).
publicly supplied water	Water supplied by public systems, including that used for domestic, commercial, and industrial purposes.
pumped storage	A hydroelectric system in which electricity is generated during periods of greatest consumption by the use of water that has been pumped into a reservoir at a higher altitude during periods of low consumption.
Q7-10	A minimum consecutive 7-day average flow with a 10-year recurrence interval.
replacement factor	The factor applied to depletive uses of Delaware River water below the mouth of the Schuylkill River (approximately) for

	determining the amount by which flows must be augmented above the mouth of the Schuylkill to prevent the advance of the salt front.
river basin	The area drained by a river and its tributaries.
river master	Supervises diversions by New York City and releases to the Delaware River in accordance with 1954 Supreme Court Decree. USGS employee.
river mile	Distance up the Delaware River measured from the mouth of Delaware Bay.
runoff	The portion of rainfall, melted snow or irrigation water that flows across the ground's surface and returns to streams.
salinity intrusion	The invasion of salt water into a body of fresh water, occurring in either surface or ground-water bodies.
salt front	The location of the 250 mg/l chloride concentration in the Delaware Estuary.
SCORP	State Comprehensive Outdoor Recreation Plans
SCS	Soil Conservation Service, U.S. Department
self-supplied industrial	Water supplied by industries for meeting their own needs.
SIC	Standard industrial code
signatory parties	Delaware River Basin Compact signatory parties are the states of New Jersey, New York and Delaware, the Commonwealth of Pennsylvania and the United States of America.
sludge	Solids removed from wastewater during treatment.
stormwater	The water running off from the surface of a drainage area during and immediately following a period of rain.
subbasin	A drainage area subdivision that forms a convenient natural unit for purposes of resource management.
suspended solids	Solids that either float on the surface of, or are in suspension in, water or waste water, that can be removed by filtering.
sustainable flow	The volume of water per unit time derived through management of water resources and demands that may be delivered to specific locations under specific sets of conditions and that is intended to accomplish specific objectives.
SWCD	Soil and Water Conservation Districts
SWSC	Southeast Water Supply Commission
system of accounts	A display called for by the Water Resources Council's Principles and Standards that indicates the beneficial and adverse impacts of plans on national economic development, environmental quality, regional development, and social well-being. Provides a basis for comparing alternative plans or management options.
TDS	Total Dissolved Solids, salts or other substances present in water naturally or introduced by man's activities which cannot be removed by filtering.
thermal pollution	The degradation of water quality by the introduction of a heated effluent.
303(e)	Section 303(e) of the Clean Water Act of 1977 (P.L. 95-217) requiring states to develop water quality standards and plans to achieve them for all navigable waters within their jurisdiction.
208	Water quality management planning for states and designated areas, under Section 208 of the Clean Water Act of 1977 (P.L. 95-217).
201	Water treatment facilities planning and construction for local jurisdictions under Section 201 of the Clean Water Act of 1977 (P.L. 95-217).

toxic pollutant	Defined in the Clean Water Act as a pollutant or combination of pollutants including disease causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism either directly or indirectly cause death, disease, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), and physical deformations in such organisms and their offspring.
USCEQ	U.S. Council on Environmental Quality
USCOE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USHUD	U.S. Department of Housing and Urban Development
USWRC	U.S. Water Resources Council
wasteload allocation	The permissible waste discharge quantity defined under a water quality management strategy whereby a stream on river's waste assimilative capacity is apportioned among waste sources. In the Delaware River Basin the application of the doctrine of equitable apportionment is required.
watershed	The area drained by a given stream.
withdrawal	The quantity of water withdrawn from its source for any purpose.
withdrawal limits (ground-water)	Except as may be otherwise determined by the Commission to be in the public interest, withdrawals limited to the maximum draft of all withdrawals from a ground-water basin, aquifer or aquifer system that can be sustained without rendering supplies unreliable, causing long-term progressive lowering of groundwater levels, water quality degradation, permanent loss of storage capacity, or substantial impact on low flows of perennial streams. In confined coastal plain aquifers, the Commission shall consider and apply aquifer management levels, if any, established by a signatory state in determining compliance with criteria relating to "long-term progressive lowering of ground-water levels."

PART I SUMMARY OF PROCEEDINGS
MAJOR FINDINGS
CONCLUSIONS
PREFERRED PLAN

PART I--SUMMARY OF PROCEEDINGS, MAJOR FINDINGS, CONCLUSIONS, AND PREFERRED PLAN

A. Summary

The Delaware River Basin Compact mandates that "the commission shall develop and adopt and may from time to time review and revise a comprehensive plan for the immediate and long-range development and use of the water resources of the basin." On March 28, 1962, the Commission adopted a Comprehensive Plan and over the years has amended that Plan to broaden its scope. The cornerstone of the Plan adopted in 1962, as related to main stem flood control and lower basin water supply, was the Tocks Island Reservoir Project. Through the 1960's and early 1970's, the Commission took numerous steps endorsing implementation of the construction of the Tocks Island Project. However, in July 1975, in recognition of many factors, prominent among them environmental considerations, measures were taken to indefinitely delay construction of the Tocks Island Project.

The July 1975 decision made necessary the review of the entire Comprehensive Plan, including present and projected demands for water within the Basin, a comparison of those demands with available water supply, and the development of appropriate measures to keep the supply and demand in balance. This report records the review process, the findings of fact, the conclusions drawn, and sets forth certain proposals for modifying the Commission's Comprehensive Plan.

1. Authorization

Commission Resolutions No. 74-7 and 75-2 authorized the Executive Director to seek and expend funds for the purpose of the Level B Study. Federal authorization for such work is contained in Section 209 of P.L. 92-500 and Section 105(a)(7) of P.L. 89-80, as amended.

2. Study Approach

The Level B Study was conducted by a small task force appointed by the Executive Director. The work was led by a Program Director, assisted by specialists in the fields of engineering, planning, environmental considerations and public information. The task force drew upon the permanent staff of the Delaware River Basin Commission for assistance in several technical fields. The Level B Study Steering Committee aided the task force, also contributed to the study effort. The agencies and membership of the Committee are listed in the Organization. Contracts were awarded to agencies of the parties signatory to the Delaware River Basin Compact for the purpose of developing definable end products. Periodic status reports were made by the Program Director to the Commission, per se. The Study included a massive effort to achieve public participation. An environmental impact assessment was integrated into the day-to-day efforts associated with the Level B Study. The final EIS is included as part of this Report.

3. Planning Guidelines

The "Principles and Standards" as modified by the U. S. Water Resources Council for Level B studies was followed during the course of the Study. Further, the requirements of the Council that the Study be based upon existing data and "judgmental planning" were major constraints.

The Water Resources Council required use of a "system of public information accounts...that display [judgmentally] beneficial and adverse effects of each plan..." The Council has entitled these accounts National Economic Development, Environmental Quality, and Mixed Objective. This information-disclosure system was used in the decision making process to arrive at a "Preferred Plan" for managing the waters of the Delaware River Basin, which was derived mainly from a "Mixed Objective" plan aired publicly during the draft Final Plan phase.

The following planning assumptions were critical to the basic findings, conclusions, and selection of a Preferred Plan:

a. The Study shall cover the period to the year 2000.

b. The drought of the 1960's shall form the basis of determinations of dependable water supply.

c. The impact of changes in sea level shall be factored into projections of future water demands.

d. The water resources management plan shall set forth both water quantity and quality goals and shall protect the environment to the maximum practical extent.

e. The U. S. Supreme Court Decree of 1954 shall be respected in every detail during normal hydrologic periods.

f. Conservation of both water and energy shall be primary considerations in developing a water management plan of the Basin.

4. Organization of Report

This report includes three parts: Part I-Summary of Proceedings, Major Findings and Conclusions, and Preferred Plan; Part II-Detailed Considerations; and Part III-Final Environmental Impact Statement. These parts are followed by Table A-1, Listing of Alternative Plans; Table A-2, System of Accounts; and Table A-3, Responsibilities and Roles for Implementation of Mixed Objective Plan.

B. Major Findings and Conclusions

1. The Physical Environment

The physical behavior of the Delaware River water system can be compared to the behavior of a single pool being utilized for many purposes, and that pool varies in size depending upon annual precipitation patterns during any hydrologic year. If water is evaporated at any location, the dynamics of the system change; water stored during periods of high runoff for later release affects the degree to which sea salts are repulsed toward the ocean; and withdrawal of ground water, even if returned via waste treatment facilities to surface streams, alters the time/flow relationship of runoff in the Basin, as well as the absorptive/replenishment capacity of the natural underground reservoirs.

2. Water Supply

a. General

There is adequate water in the Delaware River Basin to meet needs during years of normal precipitation. Most water used within the Basin is returned after treatment and becomes available for reuse.

b. Surface Supply

The sustainable June-September average flow of the Delaware River at Trenton, New Jersey, under 1980 uses and 1960's drought conditions is estimated at 2587 cfs.

Under a recurrence of the 1960's drought conditions, the terms of the U. S. Supreme Court Decree of 1954 with respect to exportations to New York City and downstream releases to the Delaware River Basin cannot be met simultaneously with the 1980 reservoir storage capacity in New York City's reservoirs.

There is a need to augment flows in the Delaware River and major tributaries to offset increasing depletive water uses and to protect instream uses, such as fish migration and propagation, waste assimilation, recreation, and salinity repulsion.

c. Ground Supply

About 50 percent of the Potomac-Raritan-Magothy system recharge comes from the tidal Delaware River during normal water years and 1980 levels of pumping. The percentage of River recharge could be as high as 70 percent during a drought period in the year 2000.

Large withdrawals from the P-R-M have caused a series of deep cones of depression which have reversed the hydraulic gradient from discharge to the Estuary to recharge from the Estuary. This exposes the P-R-M aquifer system to degradation from spills of toxic or hazardous materials, and intrusion of sea salts from the Estuary.

The Basin's water resources are capable of being developed conjunctively so that the P-R-M aquifers are not overdrawn.

Ground water pumpage in the Triassic Lowlands portions of the Basin has exceeded replenishment during dry as well as drought years. Many areas overlying the Triassic Lowlands have experienced rapid growth since 1950 and have relied upon ground water supplies and on-lot waste water disposal systems. Regional waste treatment plants have been substituted for on-lot waste water disposal systems and may bear upon the problem. Water purveyors and individual homeowners have recently experienced water shortages.

d. Water Quality

Water quality in most of the Basin streams has improved over the last several years. However, D.O. concentrations have been below DRBC Water Quality Standards for as long as six months in the summer of recent years, even though D.O. concentrations have been improving over previous years. Upgrading the Philadelphia, Trenton, and Camden sewage treatment plants in the early to mid-1980's will result in a high percentage of dischargers being in compliance with the DRBC effluent requirements.

Increasing the flow of the Delaware River at Trenton, New Jersey, from 2000 cfs to 3475 cfs would increase the D.O. in Zone 2 by as much as 1 mg/l. This amount of flow change would only cause a D.O. increase of 0.08 mg/l at River Mile 94 (the bottom of the oxygen sag or the most critical area of the Estuary from an oxygen depletion standpoint).

To maintain the Commission's present chloride standard (not more than 250 mg/l at River Mile 92.5) under year 2000 uses, the minimum four-month summer flow at Trenton would have to be about 3900 cfs.

Controlling salinity at River Mile 98 in the Estuary to a 30-day maximum of 121 mg/l of chloride (67 mg/l of sodium) will protect the quality of water in the P-R-M aquifer system to New Jersey's sodium standards. The actual 1980 flow needed at Trenton so as not to exceed that standard is 2800 cfs.

e. Water Demands

The 1980 population of the Delaware River Basin was 7,240,000, and is projected to increase to 8,057,000 by the year 2000.

The estimated 1980 in-Basin June-September depletive water use was 684 mgd (1058 cfs) and will increase to 1191 mgd (1842 cfs) by the year 2000.

The depletive water uses below Trenton, New Jersey, in 1980 were 553 mgd (855 cfs) and will increase to 970 mgd (1500 cfs) by year 2000; the 1980 depletive water use above Trenton will increase from 131 mgd (202 cfs) to 221 mgd (342 cfs) in year 2000.

As stated above, a flow of about 2800 cfs is required in the Delaware River at Trenton, New Jersey, to meet 1980 downstream depletive uses and control the 30-day average maximum chloride level to 121 mg/l at River Mile 98; and a flow of about 3072 cfs will be needed to meet these collective demands by year 2000.

A supplemental flow capability of 750 cfs will be needed to overcome present deficiencies and meet year 2000 demands, even assuming that 15 percent of the depletive uses will be conserved during periods of drought.

f. Flood Loss Reduction

Areas adjacent to the Delaware River and its major and minor tributaries are subject to periodic flooding.

The U. S. Army Corps of Engineers has begun (1978) a comprehensive study of the Delaware River Basin to determine the current potential for flood damage in developed areas along the Delaware River below Tocks Island, and the costs, effectiveness, feasibility, and acceptability of nonstructural measures and local protection works.

g. Water-Based Recreation

There is a lack of water-based recreation easily accessible to major urban centers.

h. Fishery

The extensive commercial fishery of the 19th Century in the Delaware River and Bay declined in the 1920's due to deterioration of water quality and over-harvesting of fish. Fishery conditions have improved during the last several years.

Salinity over the natural seed-oyster beds in upper Delaware Bay should be consistently less than a chloride concentration of 8,303 mg/l during the period from early May to mid-July for protection against predators. The projected levels of flow regulation and depletive use in the year 2000 would have less effect on the May-July salinity levels over the oyster beds than the normal variation of runoff from year-to-year.

Existing dissolved oxygen standards in the central portions of the Delaware Estuary do not maximize the fishery potential.

i. Conservation

Conservation is proposed as the cornerstone of the water management plan for the Basin. Conservation measures that reduce water usage also have the beneficial effects of reducing demands upon reservoirs and minimizing impacts upon ground water tables. The reductions in water use are reflected in the cost of treating waste water and energy to transport and treat both the basic supply and the return flows.

The following conservation options are considered to have the most beneficial impacts:

(1) Building and plumbing codes requiring the use of water-saving plumbing in new construction and renovation of existing buildings,

(2) Leakage control programs in major cities,

(3) Emergency conservation measures and contingency plans.

C. Preferred Plan

A major portion of the Level B Study was designed to establish present and projected demands for Delaware River Basin water and to identify those measures appropriate to keeping supply and demand in balance. Further, the Study carefully evaluated alternative policies that should be adopted by the Commission as features of its Comprehensive Plan to guide use and development of the Basin's water and water-related resources. Accordingly, pre-Study policy and physical features of the Comprehensive Plan were reviewed and those elements needing modification due to passage of time and changing philosophies were identified. By definition, the term Preferred Plan, as used herein, means those policies or physical features of the Comprehensive Plan which were found to be in need of a change.

1. Salinity Control

Salinity shall be controlled so that the maximum 30-day average concentration at River Mile 98 does not exceed 121 mg/l of chloride or 67 mg/l of sodium. This standard shall replace the current Comprehensive Plan policy of a maximum of 250 mg/l of chlorides at River Mile 92.47, 200 mg/l throughout Zone 3, and a maximum 15-day average of 50 mg/l in Zone 2.

2. Flow Maintenance

Flows of not less than 3100 cfs and 1750 cfs shall be maintained at Trenton, New Jersey, and Montague, New Jersey, respectively, during normal hydrologic conditions.

Flows necessary to limit salinity in accordance with the salinity control policy shall be maintained at Trenton, New Jersey, during declared drought warning and drought conditions. During such periods, the U. S. Supreme Court Decree of 1954 in New Jersey v. New York, shall be temporarily modified as shown in the following tabulation:

	Decree	Drought Warning	Drought
Maximum diversion to New York City	800 mgd	600 mgd	480 mgd
Maximum diversion to northern New Jersey	100 mgd	75 mgd	60 mgd
Flow objective--Delaware River at Montague, New Jersey	1750 cfs	1650 cfs	1600 cfs

3. Water Storage Projects

The environmental aspects of the following projects shall be thoroughly investigated and, if found acceptable, construction of said projects be expedited:

Project	Water Supply Storage A.F.	Individual 120-day yield cfs*
Francis E. Walter-Mod	69,500	290
Prompton - Mod.	30,900	130
Cannonsville-Mod.	40,800	85
Hackettstown	30,500	130
Merrill Creek	52,500	220

* The combined yield of these projects (which, as a system, is not additive) is approximately 750 cfs, as explained in Part II.

The Maiden Creek Project shall be removed from the Comprehensive Plan.

The Aquashicola, Evansburg, Newark, Tocks Island, and Trexler Projects shall be retained in the Comprehensive Plan for possible development after year 2000.

The following 14 possible reservoir sites considered during the Level B Process will not be offered for inclusion in the Comprehensive Plan:

- McMichael
- Shohola Falls
- Girard
- Tobyhanna
- Hawley
- Lackawaxen
- Cherry Creek
- Equinunk
- Flat Brook
- Little Martins Creek
- Milanville
- Pidcock Creek
- Mill Creek
- Red Creek

4. Water Conservation

The goal of a 15 percent reduction in depletive water use shall be established for application during declared water emergencies.

5. Conjunctive Ground/Surface Water Use

Systems shall be developed to permit conjunctive use of surface and ground water in the Potomac-Raritan-Magothy service area, and in the Triassic formation service area so that extractions from the underground supplies will not exceed the "withdrawal limit" policy contained in the Comprehensive Plan.

6. Water Quality--Estuary

It shall be the goal of the Commission to seek improvement of the Delaware River Estuary water quality so as to permit a continuously improving fishery.

PART II DETAILED CONSIDERATIONS

PART II DETAILED CONSIDERATIONS

A. Introduction

1. Background of Delaware River Basin Water Resources Management

The Delaware River Basin Commission (DRBC) formed in 1961 and comprised of the governors of the four Basin states (Pennsylvania, New York, New Jersey and Delaware) and an appointee of the President of the United States, has the responsibility under interstate compact of managing the water and water-related resources of the Basin. Since 1962, a Comprehensive Plan has been maintained which sets forth the Commission's programs, proposed projects, policies, and standards. Part of the Comprehensive Plan since its inception has been a system of eight reservoirs proposed by the U.S. Army Corps of Engineers and supported by the states and local governments at the time of its adoption. Two of these reservoirs, Beltzville and Blue Marsh, have been built; the others are Aquashicola, Francis E. Walter Modification, Maiden Creek, Prompton Modification, Tocks Island, and Trexler.

Major policy issues affecting water resource management decisions have also arisen in recent years. Consequently, the Commission recognized the necessity for a reassessment of its Comprehensive Plan for managing the resources of the Delaware River Basin. The Commission's request to the U. S. Water Resources Council in February 1975 for support of a Delaware River Basin Comprehensive Study (Level B Study) was approved by the Council, and a memorandum of agreement between the Council and the Commission was signed in October 1976.

2. Background of the Level B Study

Two federal acts establish the authority for the Delaware River Basin Level B Study: the Water Resources Planning Act of 1965 (P.L. 89-80) and the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). Level B studies are designed to seek solutions to problems involving both the conservation and use of water supplies and water-related resources. The studies are intended to examine controversial and complex problems in the areas of water quality, water supply, flow maintenance, fish and wildlife, recreation, energy and navigation. Furthermore, these studies provide a basis for the coordination of plans by federal, state, and local governments and the private sector. The Delaware River Basin Level B Study has been specifically directed to provide the basis for updating the Delaware River Basin Commission's Comprehensive Plan, to prepare an Environmental Impact Statement for the Level B Study's Preferred Plan, and to take into consideration federal and state environmental laws and resource plans.

The Level B Study has been conducted in accordance with the guidelines of the U. S. Water Resources Council which require studies to be based on judgmental planning, existing data and studies; participation and leadership of the states; participation of federal agencies; and active public participation. Guidance for the development of alternative plans has been provided by the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources." (Water Resources Council, September 1973).

Funding for the Level B Study amounted to a federal share of $1,100,000, contributions from the Basin states and local sources of $200,000, and a contribution from the Delaware River Basin Commission of $232,000. Of the total Level B Study budget of $1,532,000, roughly $732,000 was allocated to a Study staff and $800,000 was allocated for the purchase of services from the federal and state agencies.

3. Organization of the Level B Study

The organization of the Level B Study was defined by the Plan of Study (DRBC, May 1977), and was approved by the DRBC and the Water Resources Council. Agencies, committees, and staff responsible for the Study were as follows:

a. Delaware River Basin Commission--The Delaware River Basin Commission, under the Agreement with the Water Resources Council was responsible for the development, approval, fiscal management of the Level B Study, and is responsible for the implementation of the Level B Plan.

b. Study Steering Committee--The membership of the Study Steering Committee consisted of designated representatives from the four states signatory to the Delaware River Basin Compact, and eight federal agencies involved in water and land resource planning and development programs. State representatives were drawn from state departments responsible for managing the states' resources and environment. The federal agencies represented were the Army Corps of Engineers, Federal Energy Regulatory Commission, Environmental Protection Agency, and the Departments of the Interior, Agriculture, Commerce, Housing and Urban Development, and Transportation. The Study Steering Committee, chaired by the Study Manager, was the policy advisory body for the Level B Study. State and federal representatives were also responsible for providing information in accordance with the specific state and agency work plans defined in the Plan of Study, for providing review of draft material prepared by Level B Study and work groups, and for participating in technical committees. In particular, members of the Study Steering Committee provided for the interagency coordination required between ongoing programs under their respective agencies and the Level B Study.

c. Level B Study Staff--The Commission, with concurrence of the Water Resources Council, selected the Study Manager, David D. Longmaid, to supervise the Study from onset to completion of the October 1979 Draft Report and the Public Hearings the following month. The Study Manager and Level B Study staff directed, scheduled and prepared all draft reports and presentations and the public participation program. Commission staff was responsible for completion of this Final Report, in accordance with Commission directives.

d. Work Groups--Work groups were organized and met periodically between December 1977 and September 1978 to discuss technical issues and to assist with the development of Study recommendations. Work groups were composed of federal and state agency representatives, and representatives of various interest groups.

e. Public Participation--Some 11,000 brochures were distributed early in the Study to organizations interested in participating in or observing the work as it proceeded. These organizations included public interest groups, environmental groups, chambers of commerce, sportsmen's clubs, and regional planning agencies.

A Study Advisory Committee was established, composed through open membership of individuals and representatives of various public agencies and public interest groups. The Advisory Committee met ten times between June 1977 and August 1978. The elected chairman of this committee, Mr. Paul M. Felton, Executive Director of the Water Resources Association of the Delaware River Basin, was appointed by the Commission to sit on the Study Steering Committee. The meetings of the Committees were open to the public.

Three series of workshops were conducted at critical stages in the planning process between 1977 and 1979. The purpose of the workshops was to obtain public response to the Level B Study's program as it developed and if necessary to amend the program to be responsive to public views. Each series included at least one meeting in each Basin state (Pennsylvania, New York, New Jersey and Delaware). During the last round of workshops before the Draft Final Report a total of some 1,360 persons attended. Hearings on the October 1979 Draft Final Report were held at six locations, at least one in each state, during the period November 14 to 29, 1979. Comments on the Draft were duplicated and made available for public inspection at 15 locations in the Basin.

4. Ongoing Special Studies and Programs

Concurrent with the Level B Study, other significant studies were undertaken in the Basin; some were completed. Significant ongoing studies include "Good Faith" negotiations by the parties to the 1954 U. S. Supreme Court Decree regarding diversions from and releases to the Delaware Basin; the Corps of Engineers (COE)/DRBC Salinity Study; the New Jersey DEP/DRBC Joint Hazardous Waste Management Program; daily reservoir operation modeling studies; Commission ground water study and programs, ground water protected area designation and industrial water reuse investigation.

B. Environment and Problems of the Basin

The Delaware River Estuary and Bay, at the time of discovery by Europeans, comprised an ever-evolving system, accepting and discharging to the Atlantic Ocean the fresh water and silts from the mountains and plains. The Estuary and Bay were seasonally invaded by sea water. Salt-tolerant finfish and shellfish and their food chains established themselves where these seasonal variations in fresh water flows and fluctuations in salt content suited their needs. The natural underground water reservoirs (aquifers) were full and generally discharged to surface streams. In this dynamic system, the activities of man were nearly inconsequential.

Today, the activities of man vastly affect the behavior of water and the ecology of the Delaware River Basin. The Estuary and Bay have been dredged to accommodate deeper draft ships, thereby altering the tidal prism; dredge spoil has been deposited on lowlands previously available to accept flood flows; people have settled where supplies of fresh water are periodically inadequate; waste products have been discharged into the stream system without regard to effect on aquatic habitat; much of the watershed land use has been modified by agriculture and urbanization, altering the erosion, surface runoff, and the delicate balance between land and water in the rivers, bays and marshes; major ground water reservoirs have been pumped to a point where water now flows from surface streams to the aquifer instead of from the aquifer to the streams; and surface storage reservoirs have been constructed to conserve water during periods of high flow for release during periods of low flow to meet the ever-increasing demands of man. In the Delaware River Basin, as in much of the world, the environmental balance has been upset by man and his indifference toward other forms of life.

The physical behavior of the Delaware River water system can be compared to the behavior of a single pool being utilized for many purposes. If water is evaporated (at any location), the dynamics of the system changes; water stored during periods of high runoff affects the degree to which sea salts are repulsed toward the ocean; and withdrawal of ground water, even if returned via waste treatment facilities to surface streams, alters the time/flow relationship of runoff in the Basin, and the absorptive/replenishment capacity of the natural underground reservoirs.

This study of the Delaware River Basin recognizes the impacts man has made upon the historic conditions and considers steps necessary to achieve an improved balance between man and nature.

1. The Physical Environment--Land and Water Resources of the Basin

The Delaware River Basin drainage area encompasses 12,765 square miles, draining 1 percent of the land of the United States. These lands are varied in both terrain and use, from rolling farmland and forest to sprawling urban and industrial areas, to marshes and fishing villages along the Bay. The Basin's topography and physiography were shaped by the advance and retreat of the glaciers of the last ice age (Figures 1 and 2). Its climate is primarily continental, with rather cold winters and warm or hot summers. The average annual precipitation is 45 inches and is distributed as shown in Figures 3 and 4.

The tidal Delaware River extends 133.4 miles upstream from the Atlantic Ocean as far as Trenton, New Jersey. The effects of tidal flows are thus significant for management decisions through the most heavily used portions of the River. During a tidal cycle, water is carried an average of 8 miles up and downstream. Variation in elevation of the tidal Delaware is considerable (Figure 5). Concentrations of sea salts measured at a particular point vary over the course of each cycle.

A major test of any water management plan is to determine whether it is compatible with the hydrologic cycle and related natural systems of the Basin--patterns of precipitation, streamflow, dependence on surface and ground water, ground water recharge and storage. Table 1 presents observed streamflows at selected locations in the Basin.

Many areas of the Basin require careful preservation, conservation or management, for example coastal and interior wetlands, historical and archeological sites, habitats of endangered or threatened species, and floodplains. Participants in the Level B Study have been particularly concerned with the need for a coherent set of policies for the management of important farmlands (Figure 6). The DRBC, state, federal, and other agencies have policies and regulatory programs for many of these areas.

To discuss water resource issues in both their hydrologic and political contexts, an appropriate system of geographic units is essential. The DRBC has developed a river mileage system to identify points along the Delaware River and its major tributaries. For the main stem, river mile locations are measured upstream from the mouth of Delaware Bay. In consultation with the states, the Level B Study developed a set of areal units relating watershed and state boundaries and compatible with other subbasin systems used by DRBC and by the U.S. Water Resources Council. Maps of these units (Figure 7) and of major river mile locations (Figure 8) are presented here. Figure 8 also shows the Delaware Estuary zones (DRBC, May 24, 1978) used to facilitate the management of water quality.

FIGURE 1

PHYSIOGRAPHY OF DELAWARE RIVER BASIN

Source: USGS 1964

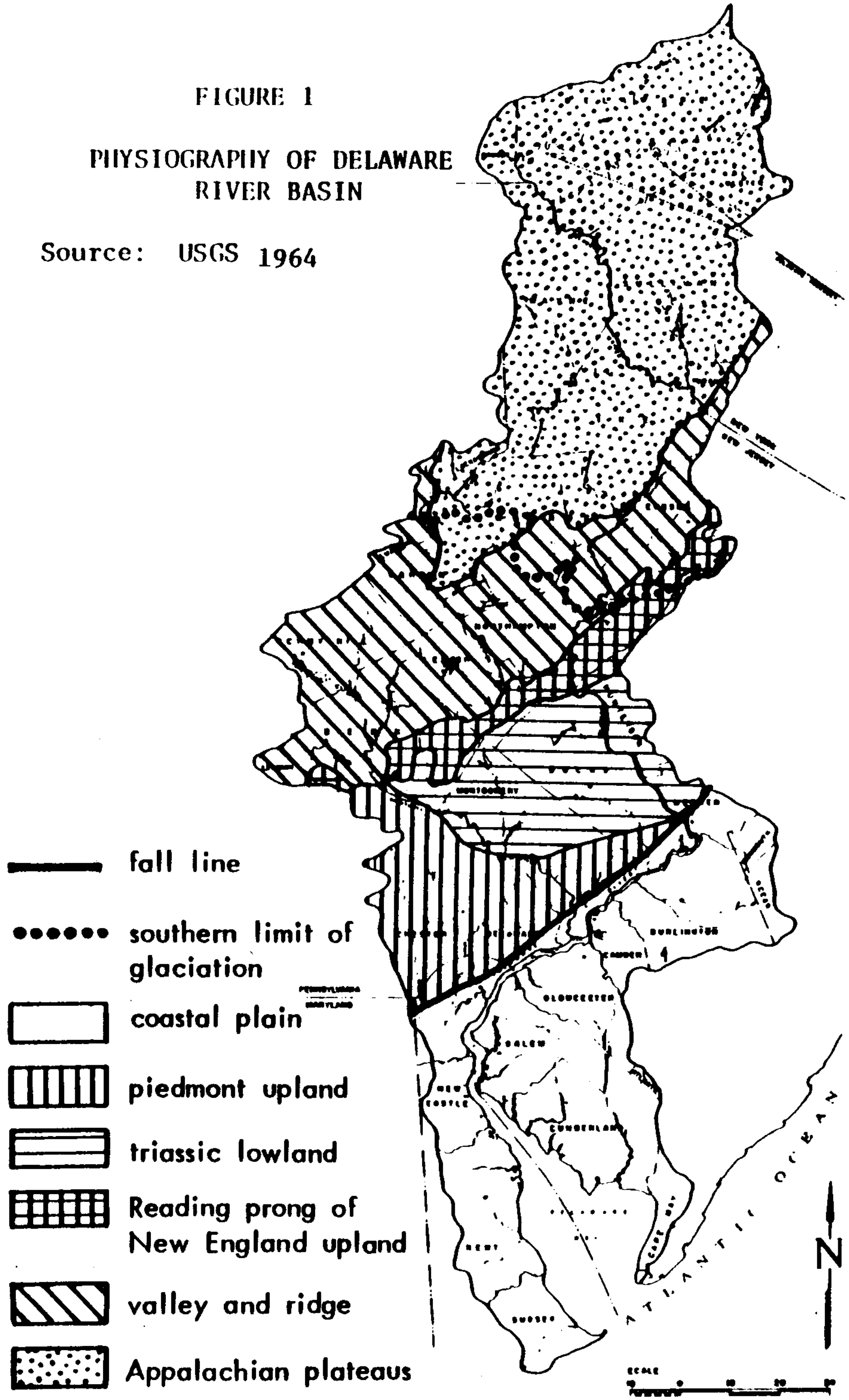


FIGURE 2

DEPOSITS OF ALLUVIUM AND GLACIAL OUTWASH IN THE DELAWARE RIVER BASIN

Source: USGS 1964

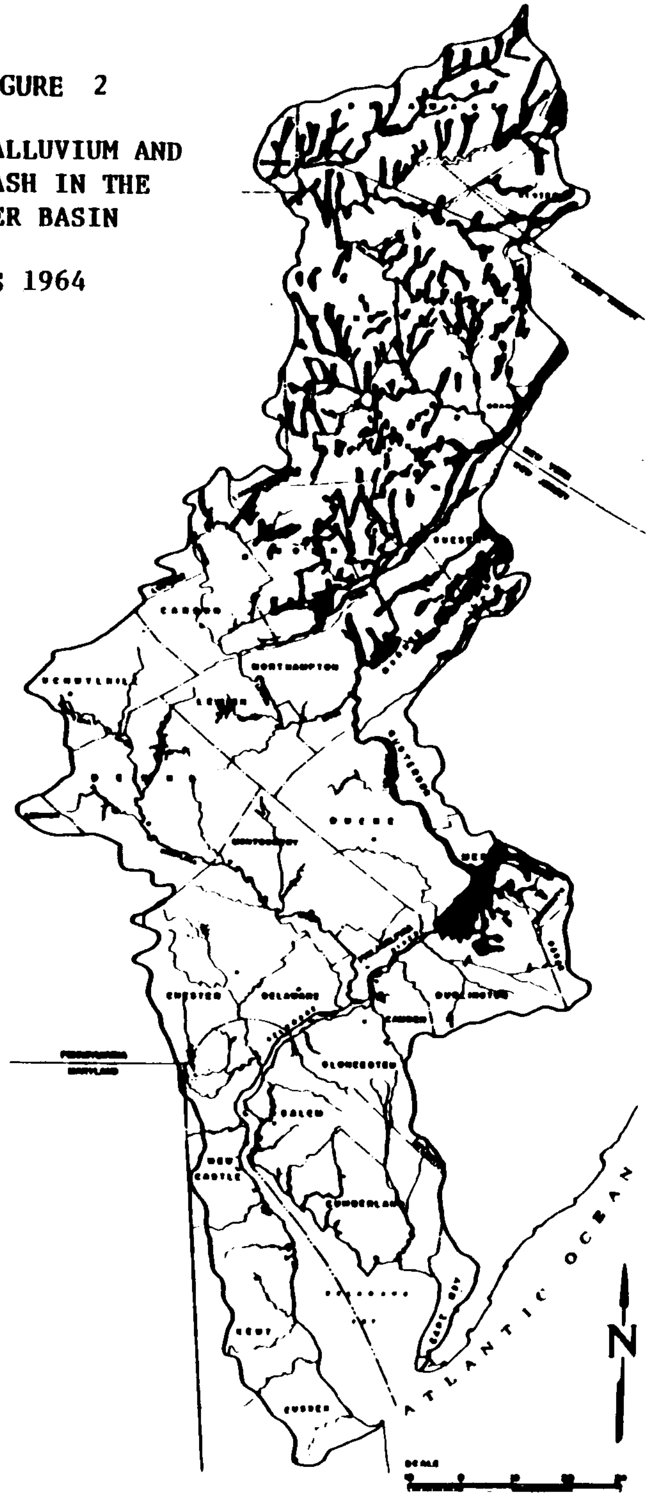


FIGURE 3

AVERAGE ANNUAL PRECIPITATION IN DELAWARE RIVER BASIN 1941-1970 (Inches)

Source: USGS Preliminary data developed for Level B Study

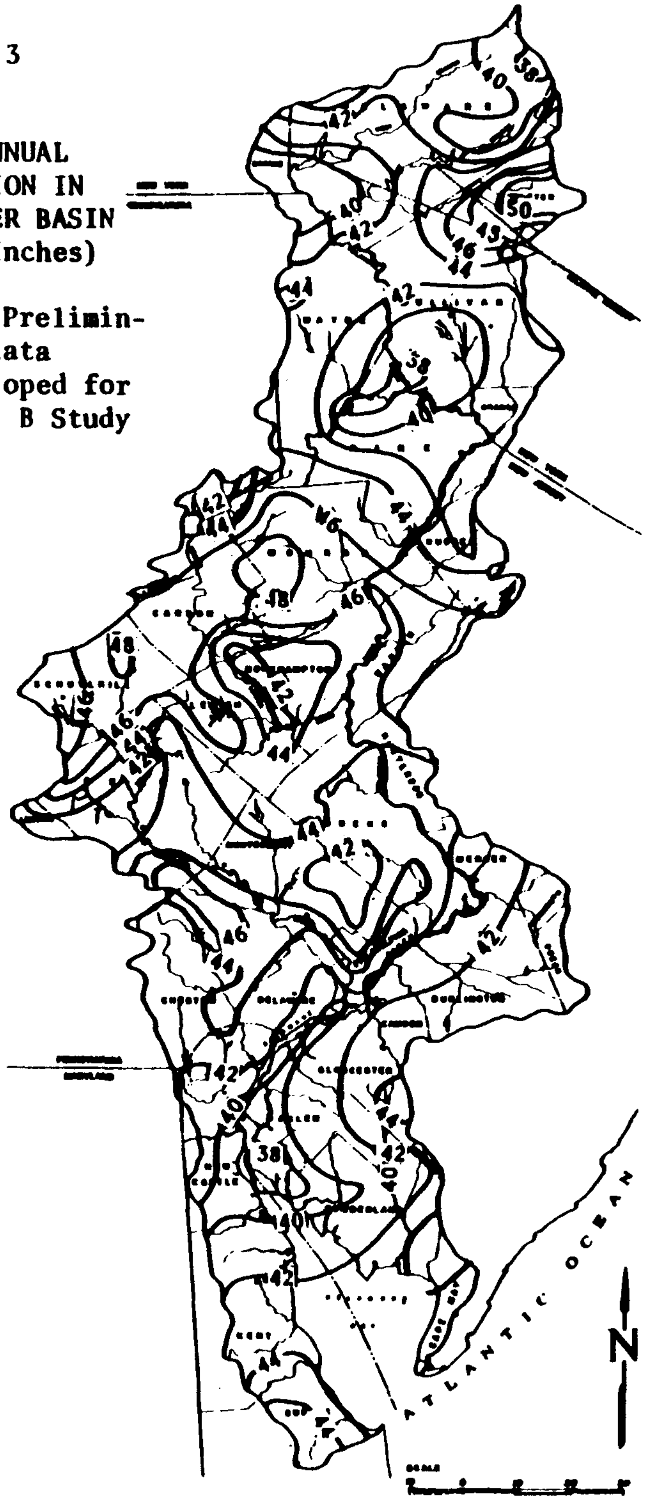


FIGURE 4

PERCENT OF AVERAGE ANNUAL DELAWARE RIVER FLOW AND RAINFALL BY MONTH, AT TRENTON, NEW JERSEY

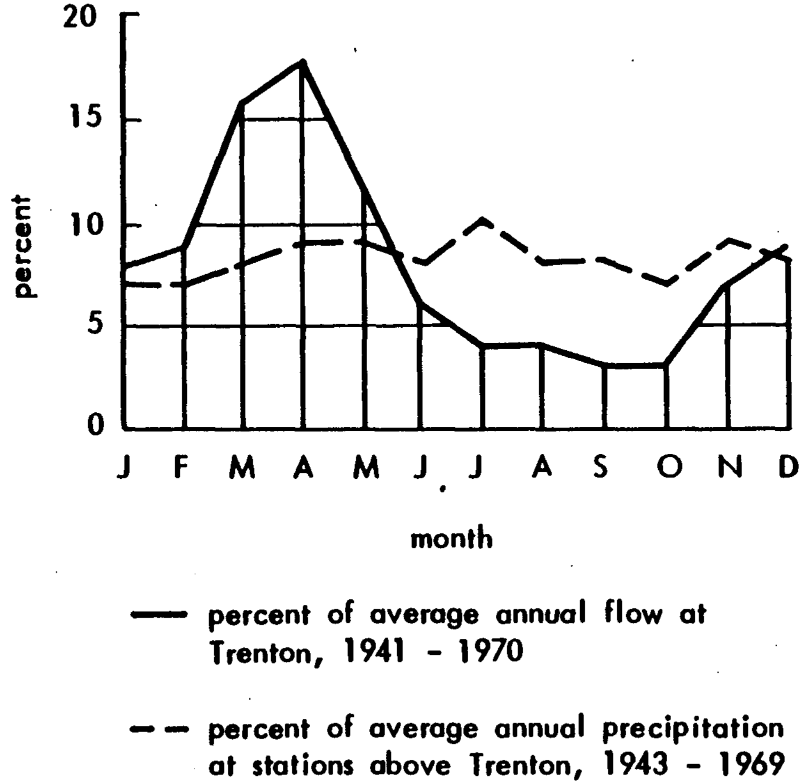
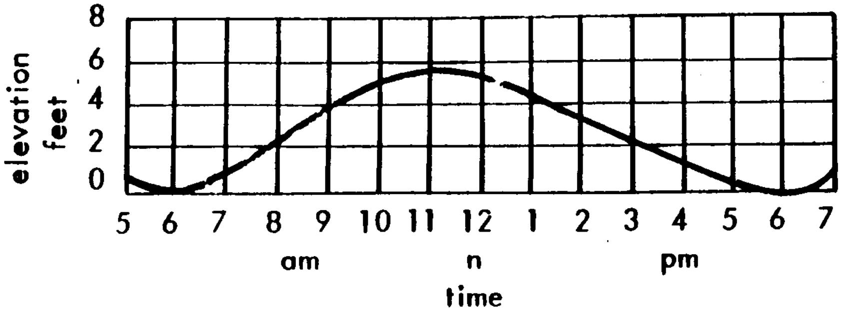


FIGURE 5

TYPICAL TIDAL CYCLE IN DELAWARE ESTUARY



Elevation at Delaware River Gage at Burlington-Bristol Bridge (river mile 118), August 16, 1956. Mean flow at Trenton was 3860 cfs.

Source: Miller, Observations of Tidal Flow in the Delaware River, USGS, 1962, Figure 6

TABLE 1

OBSERVED STREAMFLOWS - SELECTED LOCATIONS

U.S.G.S. Station Number	Stream & Location	Period of Record	Drainage Area sq. mi.	Av. Flow cfs	Minimum Flow Month mo/yr	Minimum Flow Month cfs	Minimum 7-day flow of record cfs
4385*	Delaware River at Montague, N. J.	1940 -70	3,480	5,715	8/54	715	565
4530	Lehigh River at Bethlehem, Pa.	1903-04 1910-70	1,279	2,225	9/64	334	260
4635**	Delaware River at Trenton, N.J.	1913 -70	6,780	11,360	7/65	1,548	1,309
4745	Schuylkill River at Philadelphia, Pa.	1932 -70	1,893	2,764	7/66	116	24
4815	Brandywine Creek at Wilmington, Del.	1947 -70	314	431	10/63	81	59

* Strategic measurement location mandated by U. S. Supreme Court in 1954. N.Y. City, as compensation for exports from the Basin, is required to maintain a minimum flow of 1750 cfs at Montague, as of March 31, 1967. Minimum flows shown are prior to this date.

** Strategic measurement location chosen by DRBC.

FIGURE 6

IMPORTANT FARMLANDS

IN THE DELAWARE RIVER BASIN

more than 75% prime farmland

25%-75% prime farmland

greater than 25% land of statewide importance, but less than 25% prime farmland

less than 25% important farmland (includes populated areas)

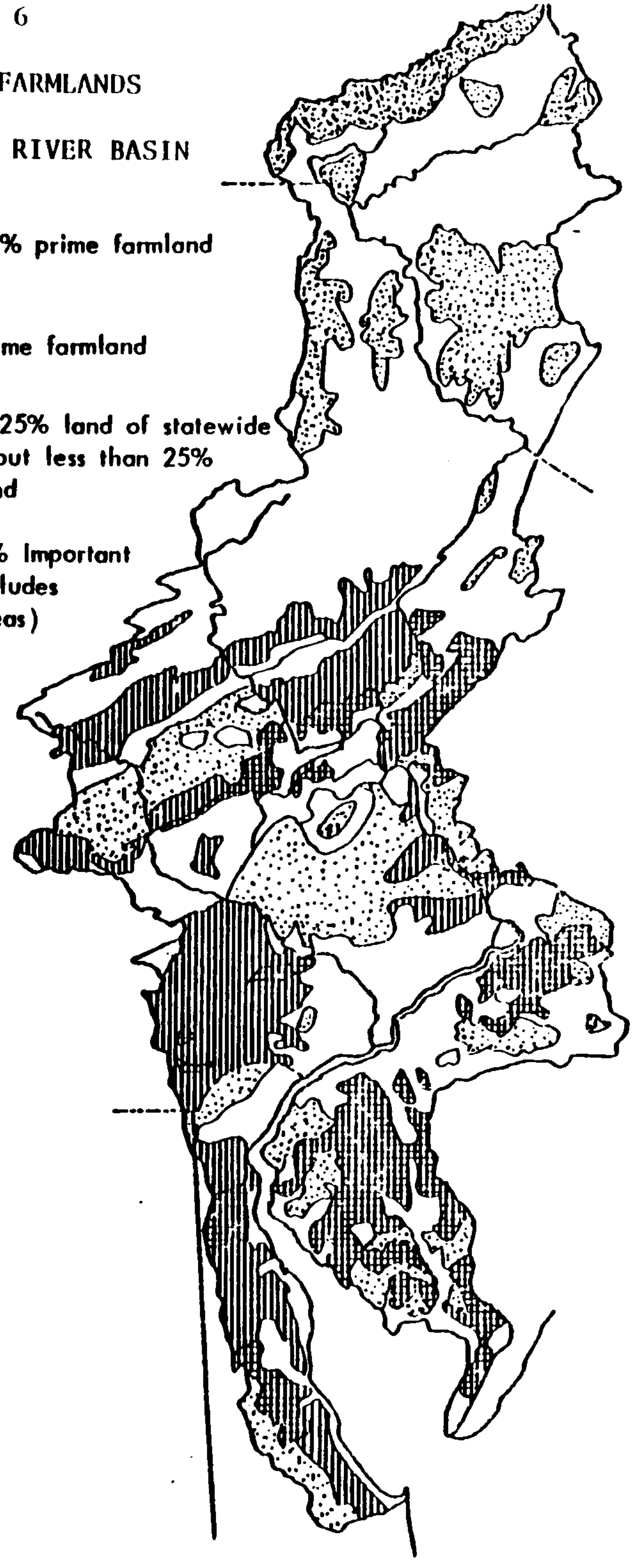


FIGURE 7

LEVEL B HYDROLOGIC AREAL SYSTEM

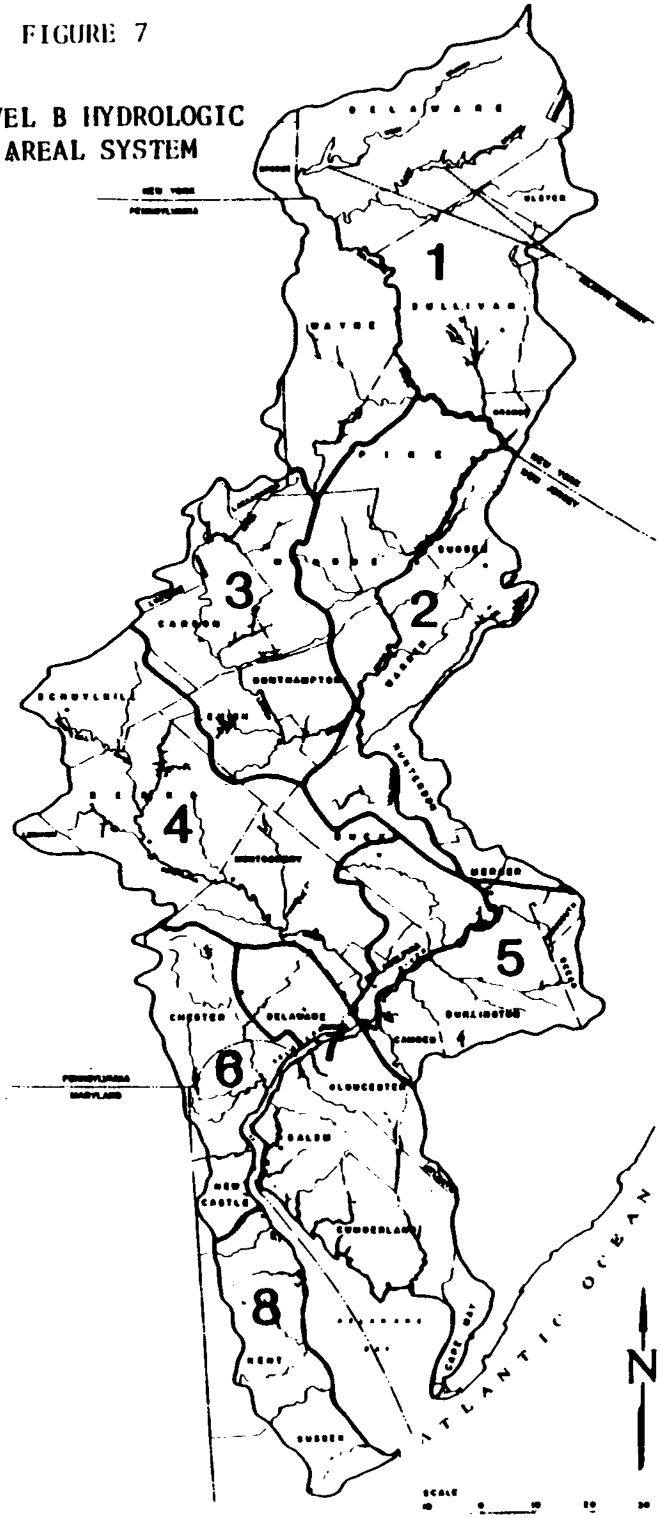
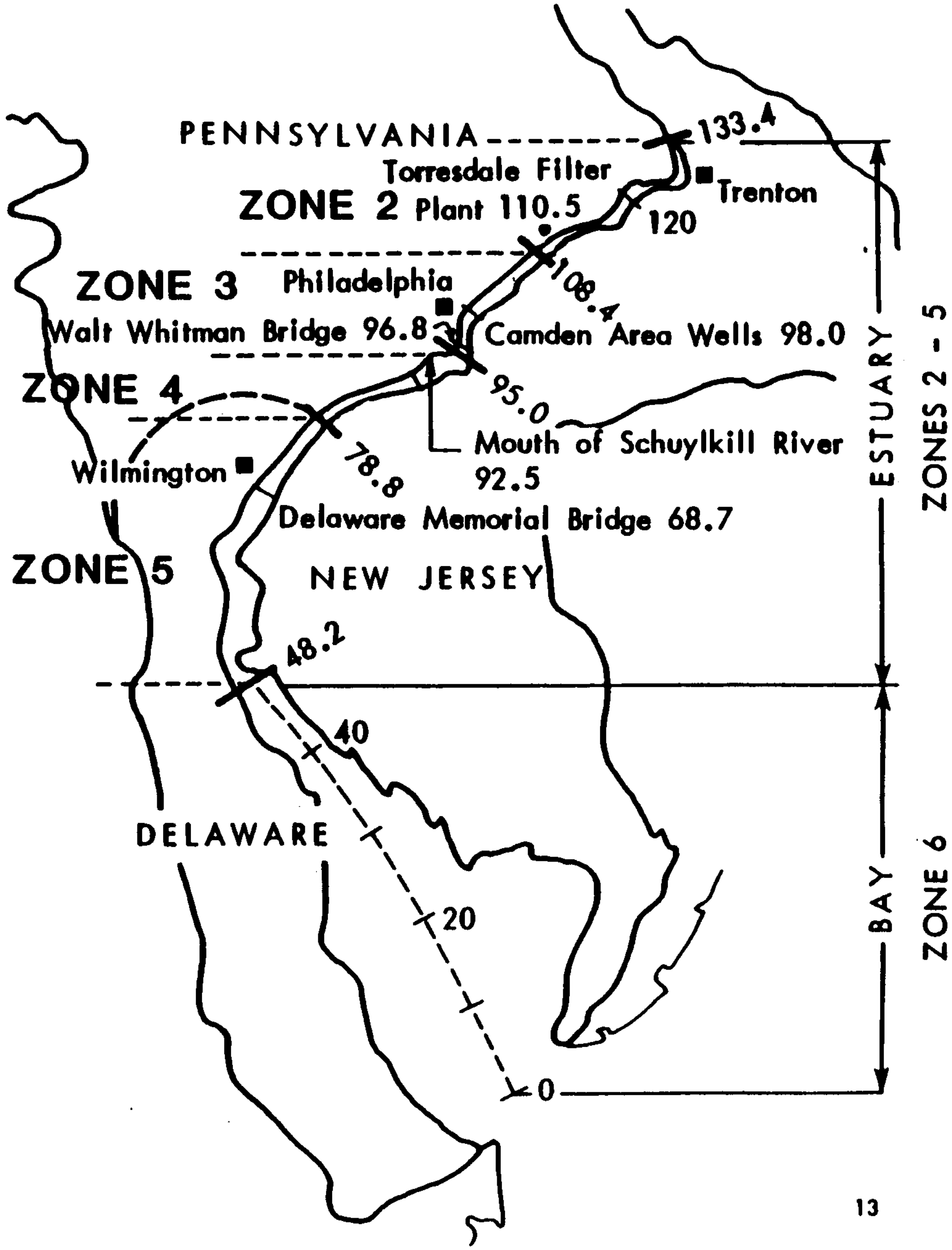


FIGURE 8

RIVER MILE LOCATIONS ALONG THE DELAWARE ESTUARY AND BAY



2. The Human Environment - Our Interaction with the Resources of the Basin

Population projections were developed through the year 2000, for the Delaware River Basin portions of the four Basin states, and for the Level B hydrologic areas. These projections are derived from the 1977 Bureau of Economic Analysis revised 1972 OBERS projections. They are shown in Tables 2 and 3.

TABLE 2

DELAWARE RIVER BASIN POPULATION PROJECTIONS BY LEVEL B AREAL UNITS (1000'S)

Sub Basin	1975	1980	1985	1990	2000
1.	144	146	149	152	154
2.	509	532	558	582	621
3.	492	500	515	528	537
4.	1,288	1,300	1,334	1,366	1,383
5.	2,519	2,578	2,663	2,746	2,852
6.	544	592	642	691	752
7.	1,459	1,481	1,522	1,557	1,598
8.	103	116	130	143	161
Basin Total	7,058	7,245	7,513	7,766	8,057

TABLE 3

DELAWARE RIVER BASIN POPULATION PROJECTIONS BY STATE (1000'S)

	1975	1980	1985	1990	2000
Delaware	496	550	605	658	729
New Jersey	1,608	1,691	1,776	1,858	2,015
New York	106	107	109	111	113
Pennsylvania	4,848	4,897	5,023	5,138	5,200
Basin Total	7,058	7,245	7,513	7,766	8,057

3. Water Supply and Water Conservation

Table 4 shows the largest surface water withdrawals in the Basin. Figure 9 shows the percentage distribution of the various categories of depletive water use and its variation throughout the year. Most water used within the Basin is returned to a stream downstream of the intake and is available for reuse. Depletive uses, on the other hand, permanently remove water from the Basin and are of more concern to water resources managers than total withdrawals. Table 5 shows depletive use for the Basin both in terms of seasonal and annual averages. Table 6 indicates the distribution both above and below Trenton, New Jersey, of depletive uses during the critical June through September season.

TABLE 4

LARGEST SURFACE WATER WITHDRAWALS - 1975*

	Million Gallons Per Day
Public Service Electric & Gas Company--Salem	1095 (1977)
Public Service Electric & Gas Company--Mercer	581
Philadelphia Electric Company--Eddystone	562
Delmarva Power & Light Company--(EdgeMoor)	459
Philadelphia Water Department	396
Getty Oil Company	310
Atlantic City Electric--Deepwater	289
Metropolitan Edison--Portland	276
Philadelphia Electric Company--Cromby	256
Bethlehem Steel Company	233
Public Service Electric & Gas Company--Burlington Station	232
U. S. Steel--Fairless	232
Philadelphia Electric Company--Delaware Station	168
E.I. duPont deNemours--Chamber Works	130
Metropolitan Edison Company--Titus Station	123
Philadelphia Electric Company--Southwark	121
Pennsylvania Power & Light Company--Martins Creek	100
BP Oil Company	113
Sun Oil Company	103
Philadelphia Electric Company--Schuylkill	97
TOTAL	5,876

* Total surface water withdrawals in 1978 were 9,640 mgd.

Conservation measures that reduce water use have the beneficial effects of reducing the rate of lowering of levels in water supply reservoirs and in ground water tables. In addition, the volume of wastewater requiring treatment is reduced. The reductions in both water used and wastewater treated results in reduced energy usage and reduced total cost of these services.

For purposes of Delaware River flow and protection from salinity intrusion, the conservation measures that would reduce depletive use are most significant. [Water not depleted is returned to the river system.] Also the conservation measures that reduce depletive use in the free-flowing and tidal freshwater portions of the Delaware are more effective, than measures taken in the salty, more downstream portion of the Delaware.

4. Water Quality

The water quality reports prepared by DRBC and the four Basin states indicate that while serious specific problems remain, water quality in most of the Basin's streams has improved over the last several years. Water quality planning programs are complete or under way throughout the Basin, to address the problems remaining and to ensure continued improvement. Under the National Pollutant Discharge Elimination System, most municipal and industrial dischargers along the Estuary have been issued permits and compliance schedules. The completion of upgrading the Philadelphia, Trenton and Camden sewage treatment plants in the early to mid-1980's will result in a high percentage of dischargers being in compliance with the DRBC water quality standards.

5. Flow Maintenance

Whether or not there is a need to sustain streamflows along the Delaware River and Estuary, and, if so, what these flows should be, and how they can be achieved, are critical policy issues. The DRBC's current standards for chlorides in the Estuary are 50 mg/l (maximum 15-day average) at Philadelphia's Torresdale intake and 250 mg/l (maximum at any time) at the mouth of the Schuylkill River. These standards are designed to protect municipal and industrial water supplies, including the Potomac-Raritan-Magothy aquifer system (heavily used for water supply for a large part of New Jersey). Based on studies conducted during the 1960's, (and therefore reflecting depletive uses as estimated for 1970 rather than as projected for the year 2000), flow objectives to maintain these standards were set at 3000 cubic feet per second (cfs) at Trenton, and 3600 cfs below the mouth of the Schuylkill River. A 3000 cfs flow at Trenton is currently used as the design flow for DRBC's Estuary Water Quality Standards.

TABLE 5

DELAWARE RIVER BASIN DEPLETIVE USE

Estimated and Projected In-Basin 122-Day Average (June-September) (mgd)	1970	1975	1980	1985	1990	2000
Municipal	99	117	118	129	139	158
Rural	5	6	7	7	8	9
Industrial	143	156	170	216	251	312
Steam Electric	48	25	59	108	156	176
Irrigation - Agriculture	195	215	235	272	314	391
Golf & Institutions	63	74	85	98	111	137
Livestock	8	9	10	10	9	8
Total	561	602	684	840	988	1,191

Estimated and Projected In-Basin Average Annual Depletive Use of Water (mgd)*	1970	1975	1980	1985	1990	2000
Municipal	92	103	111	121	131	147
Rural	4	5	6	7	8	8
Industrial	127	139	151	186	222	294
Steam Electric	43	22	52	97	139	157
Irrigation - Agriculture	70	77	84	98	113	140
Golf & Institutions	31	37	43	49	56	69
Livestock	8	9	10	10	9	9
Total In-Basin Depletive	376	393	458	568	678	824
Estimated and Projected Average Annual Exports and Imports of Water (mgd)*						
Export**	651	695	911	911	911	911
Import	30	31	47	47	47	66
Total of In-Basin Average Annual Depletive Use Plus Net Exports of Water (mgd)*						
	997	1057	1322	1432	1542	1669

The volumes cited in Table 5 include depletive uses for brackish waters.
Projections are based on a compilation of other studies (USCOE, NARWRS, 1972), (DRBUEC, 1978), (USDA, Feb. 22, 1979).
The projections to year 2000 will be subject to continuing review. The effects of the past economic slowdown and recent technology changes may cause a lessened growth of municipal, industrial and steam electric depletive water use.
An example is the difference between the estimated and actual average annual consumptive use of steam electric plants, where the actual 1980 use was 32 mgd, compared with the previously estimated use of 52 mgd. About half of that difference is due to the Salem Generating Station not operating as planned, although planned operational levels should be achieved shortly. The balance may be explained by economic slowdown.

*All figures are based on a 365 day year (annual use divided by 365 days).

**Assumes 100 mgd exports to N.J.

TABLE 6

SUMMARY OF 122 DAY AVERAGE (JUNE-SEPTEMBER) IN-BASIN DEPLETIVE USES ABOVE AND BELOW TRENTON, NEW JERSEY 1970-2000 IN MGD

	1970			1980			2000		
Type of Use	Above Trenton	Below Trenton	Total	Above Trenton	Below Trenton	Total	Above Trenton*	Below Trenton	Total
Municipal	15	84	99	18	100	118	23	135	158
Rural	1	3	4	2	5	7	2	7	9
Industrial	29	114	143	34	136	170	67	245	312
Power	5	43	48	13	46	59	22	154	176
Irrigation Agriculture	20	175	195	24	211	235	47	344	391
Golf & Institutions	26	37	63	35	50	85	56	81	137
Livestock	5	3	8	5	5	10	4	4	8
TOTAL	101	459	560	131	553	684	221	970	1,191

*Does not include the effect of the proposed Point Pleasant Project's diversion, which is included in the "Below Trenton" category.

FIGURE 9

ESTIMATED PERCENT OF TOTAL DEPLETIVE WATER USE BY CATEGORY DISTRIBUTED BY MONTH - 1970

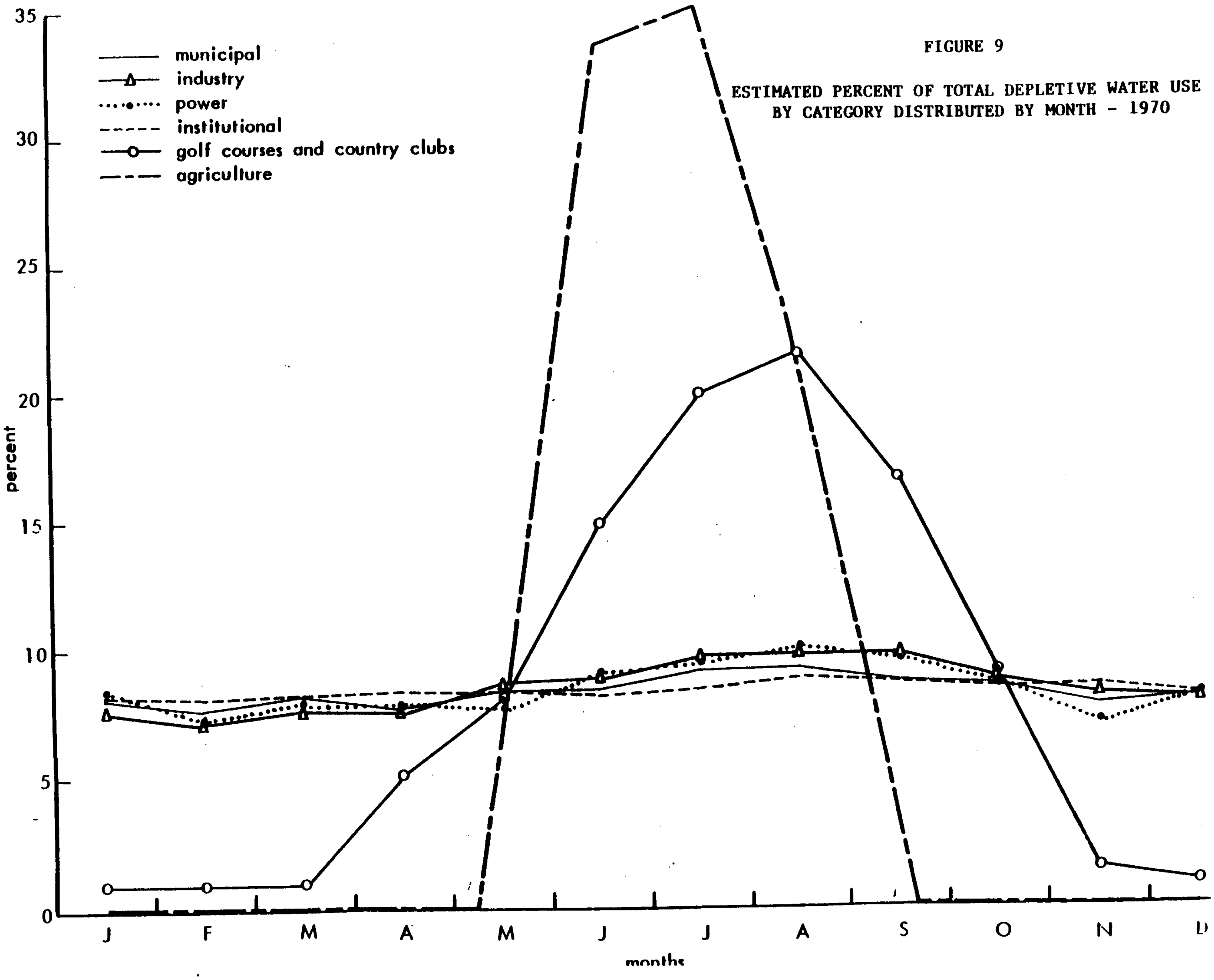
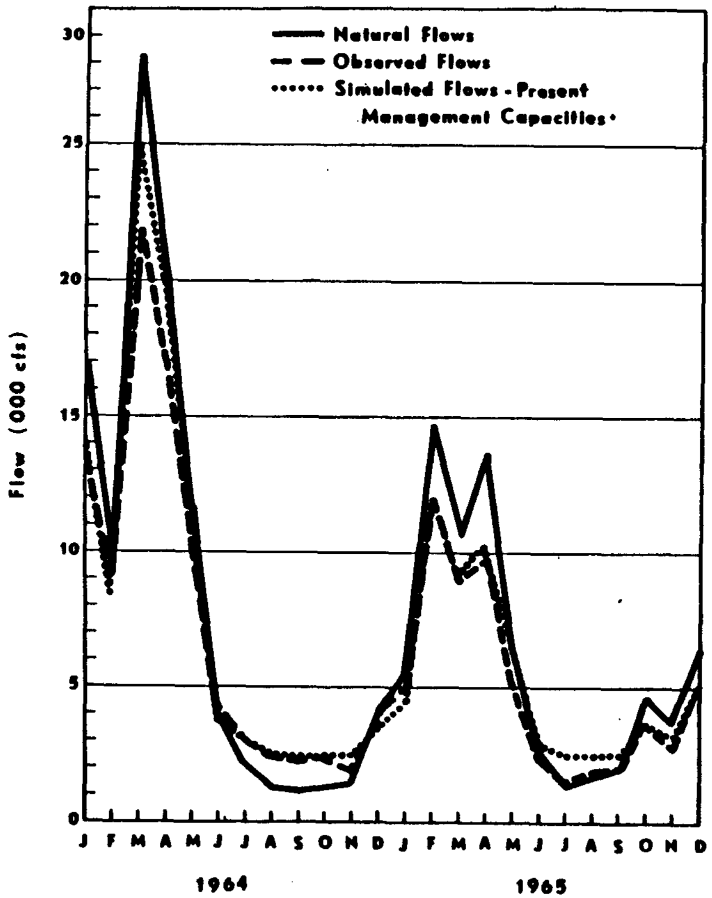


FIGURE 10

DELAWARE RIVER FLOW AT TRENTON, NEW JERSEY
CALENDAR YEARS 1964-65



* Includes operation of Neversink, Pepacton, Cannonsville, Beltzville, Blue Marsh, with 1750 cfs flow maintained at Montague gaging station.

Source: USGS natural and observed data, DRBC staff calculations

Figure 10 shows the monthly flows at Trenton which would have occurred under "natural" conditions over the drought period of the 1960's, the actual flows which were achieved during that period by operation of available reservoirs (including hydroelectric impoundments), and flows which might be achieved using present reservoir capacity in an optimal way. The various proposed impoundments reevaluated are discussed in later sections of this report. The analysis also explores the use for flow maintenance of other existing impoundments (routinely or under emergency conditions), conjunctive use of surface and groundwater, and of strong conservation measures to reduce depletive uses.

Results of recent analyses using an improved mathematical salinity model are discussed in detail later in this report. They suggest that with a minimum four-month flow of 2340 cfs or more in the Delaware River at Trenton, current chloride standards at Torresdale would not be threatened during a Year 2000 recurrence of drought of 1960's conditions. Heavy pumpage of the Potomac-Raritan-Magothy aquifer has induced recharge from the Estuary in several areas. Levels of salinity (as well as the presence of toxic substances) in these regions are therefore of concern and have been investigated. Additional information is needed on the hydraulic connection between the Estuary and the aquifers.

6. Flood Loss Reduction

In the Delaware River Basin, as in many regions of the Nation, many of man's activities have concentrated in or near the floodplains of streams and rivers. Development over the last decades has proceeded rapidly along many tributary streams, both directly in the floodplains and in upland areas where greater runoff leads to increased downstream flood potential. Average annual flood damages in the Basin have been estimated at $12 million (1972 dollars) (COE, 1972).

7. Recreation, Fish and Wildlife

The Delaware Basin offers a wide range of water-related recreational resources to the people of the area. Many of these opportunities are threatened. Significant increases in recreational opportunities are possible through the improvement of water quality in streams, multiple use of impoundments, selective acquisition and use of floodplain areas (preferably as part of a coordinated program for flood loss reduction and restoration of waterfront areas), development of areas for conservation and preservation of fragile environments, and fish and wildlife habitat. Level B's emphasis has been on opportunities which interrelate with achievement of water quality and supply objectives, focusing in particular on use of stream corridors for greenways and the improvement and restoration of urban waterfront areas which are readily accessible to the densely populated urban areas.

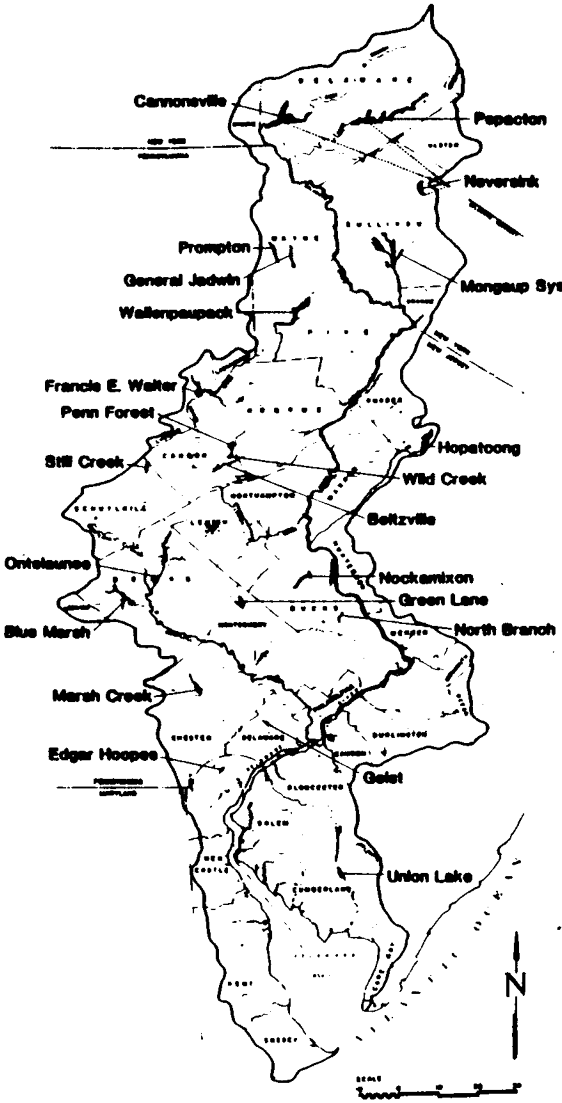
The extensive commercial fishery of the 19th century in the Delaware River and Bay declined in the 1920's, due to deterioration of water quality and over-harvesting. Fishery conditions have improved in the last several years. An objective now must be to maintain and continue the improvement, and to avoid problems such as contamination of fish flesh with traces of toxic substances. A special committee of fisheries experts was established by the Commission to reexamine the water quality (minimum dissolved oxygen levels in particular) requirements for an improved fishery in the Estuary. The Committee's findings are discussed elsewhere in this report (Part II, B, 2).

8. Water Management Facilities

Impoundments have traditionally played a major role in water resource management in the Delaware Basin, as in most areas of the country. Reservoirs have been constructed for many purposes: direct water supply, flow maintenance (for salinity repulsion or water quality), flood-loss reduction, lake habitat for fish and wildlife, hydroelectric power, and recreation. Water supply storage capacity, for example, has been provided in impoundments ranging from small farm ponds with surface areas less than an acre, to reservoirs with storage of a half-million acre-feet. Most large reservoirs are designed for more than one of these purposes.

In Figure 11 the locations of major existing impoundments in the Delaware Basin are presented. Their purposes and storage capacities are described in a later chapter. Several impoundments were built to supply water directly to local users, and therefore cannot reasonably be considered available for regional downstream flow maintenance even during emergencies. However, each has a minimum conservation release requirement at the dam site. Cannonsville, Neversink, and Pepacton in New York were constructed as water supply reservoirs for New York City; New York State requires releases for conservation purposes and the United States Supreme Court Decree of 1954 requires releases to augment flows at the Montague, New Jersey, gaging station. Nockamixon and Marsh Creek were built by Pennsylvania for recreation and water supply. Wallenpaupack and the six-reservoir Mongaup system are hydroelectric impoundments; they were used during the drought of the 1960's for emergency flow maintenance. Blue Marsh and Beltzville are multi-purpose U. S. Army Corps of Engineers projects with storage dedicated specifically for regional low-flow augmentation, and designed for flood control as well. Storage for low-flow augmentation is the financial and operating responsibility of DRBC. Prompton, Francis E. Walter, and Jadwin are designed primarily for flood control; during the 1960's drought emergency, Walter was used for water supply. Prompton has a permanent pool for recreation use and subsequent to the drought was modified to permit temporary storage of water. Other impoundments shown in Figure 11, while contributing to overall Basin water resources, are more locally important than of Basinwide significance.

FIGURE 11
PRESENT MAJOR IMPOUNDMENTS
USED FOR WATER SUPPLY, FLOW AUGMENTATION, FLOOD
CONTROL, RECREATION, AND HYDROELECTRIC GENERATION



C. Problem Statements and Management Options

This section on alternative plans is organized by the major water and land resource problem areas identified during the course of the Level B Study. They are:

1. Water Conservation
2. Water Quality
3. Flow Maintenance
4. Water Supply
5. Flood Loss Reduction
6 Fish, Wildlife and Recreation
7. Energy
8. Navigation

The following sections present in summary form the specific problems and background information for each problem area. Economic, environmental and social consequences for each policy, program, project, management option, are shown in the Appendix tables. These tables constitute the "system of accounts" called for by the U.S. Water Resources Council (WRC, Sept. 1973).

The management options reflect comments received during the course of the study and after public hearings on the October 1979 Draft Report. The updated management options have been assigned to three alternative plans. To obtain consistency in the assignment process, the guidelines of the U.S. Water Resources Council, which call for each plan to achieve a national objective, were used. In their simplest terms the guidelines define the plans as follows:

--The Environmental Quality Plan is designed to emphasize management options that seek to conserve natural resources and improve the quality of the natural and human environment.

--The National Economic Development Plan is designed to emphasize policies, programs and projects to increase the value of the nation's output of goods and services and improve national economic efficiency, and

--The Mixed Objective Plan represents the preferred mix of policies, programs and projects that balance the objectives of environmental quality and national economic development.

The Water Resources Council guidelines do not specifically consider the issues of public health, although adequate water quality for public health protection is certainly as environmentally important as other environmental concerns. Because of concern for water supply and protection of the Potomac-Raritan-Magothy aquifer from chlorides and sodium infiltration from the Estuary, public health is a central consideration in the development of the alternative plans. These plans, presenting alternative courses of action were presented to the public in the Draft 1979 Level B Report and comprise the basis for the environmental impact statement process.

It is noted that "regional development" impacts of the alternative plans are not included. It was determined that insufficient information was available to make a realistic distinction between these impacts and the economic impacts.

This section reports on the process used in selecting the Mixed Objective Plan. Upon consideration of the public comments, a Preferred Water Management Plan was prepared.

1. Water Conservation

a. Problem Statement

--Water is still considered an inexpensive commodity and it is often wastefully used.

--While the Delaware River Basin Commission has adopted policy and implemented certain programs on water conservation, more effort is required.

b. Background

An increasing awareness that water and energy are limited and will become more costly in the future has focused attention on the need to conserve both. These concerns, together with increasing concern for the environment, have pointed toward conservation with its attendant savings in dollars and natural resources. As a result, the public supports conservation and is increasingly reluctant to accept reservoir storage as the single solution for meeting water supply needs.

The only effective method of water conservation to reduce the need for storage to augment downstream water uses is to reduce in-Basin depletive uses and out-of-Basin exports. That is because conservation of non-depletive in-Basin use-and-return water does not change overall stream flows during drought periods.

The importance of developing a long-term conservation plan governing day-to-day use of water, as well as stringent control measures for emergency periods, has been strongly stated by representatives of the four Basin states. Former President Carter, in his May 1977 environmental message to the Congress, stated that water conservation would be the cornerstone of a new national water resources policy. Conservation initiatives noted in the President's message included:

--Modification of federal grant conditions for municipal water and sewer facility construction to require conservation programs.

--Modifications of housing assistance programs to require use of water-saving technology in new construction; requirement of conservation at federal facilities.

--Provision of increased technical assistance to farmers and urban dwellers for conservation programs; particular attention to be given to water-short areas dependent upon ground water.

--Requirement of conservation programs as a condition of contracts for storage or delivery of municipal and industrial water supplies from federal projects.

In planning the development of water conservation programs, several points should be considered:

--In the Delaware Basin there appears to be adequate water to meet needs during normal precipitation years. Drought conditions are of great concern because of the need to maintain flows to control salinity.

--Some of the water withdrawn from surface or ground water sources and used for municipal, private, industrial, steam electric generation, and agricultural water supplies is depleted and does not return to the Basin streams.

--Practical conservation programs should be designed to reduce total water use and depletive uses in each of the major use categories. This is the goal of achieving long-term conservation.

--Research on water conservation techniques is underway at all levels of government. Many practical devices, policies, programs, and legislation have been developed, described in literature, and put into effect throughout the country including some places in the Basin.

--The intensity of conservation measures to be enacted in the Delaware Basin will depend upon the willingness of the public to support such measures, the degree of drought protection desired by Basin residents, and the methods selected to develop additional sources of water.

--In times of severe drought, the Delaware River Basin Compact authorizes the declaration of a water emergency and the promulgation of stringent emergency water use reduction measures. The governors of the signatory states have the power to take emergency measures during water-short periods.

c. Management Options

In 1976, the DRBC adopted a conservation policy to maximize efficient water use by industrial, municipal, and agricultural users. In September 1978, the Commission convened a water conservation conference to determine practical steps that could be taken to encourage reduced water use in the Basin.

Table 7 presents many of the conservation strategies discussed.

TABLE 7

POSSIBLE CONSERVATION STRATEGIES

- Development of a public education program regarding practical conservation measures and popularizing conservation.
- Legislation requiring metering and water saving plumbing where appropriate.
- Development of a research program, including consideration of an incentive program to encourage reduction of depletive losses.
- Monitor major depletive water users for changes in usage.
- Continue present requirement of metering of water in all new construction, major rehabilitation and major new development areas on public systems and encourage a program to meter existing public water users not metered. Encourage metering of all users of water exported from the Basin.
- Consider the development of effective municipal, commercial, and industrial water rate structures designed to reduce peak and seasonal usage.
- Institute a system of effluent charges (quantity and quality) on industrial and municipal waste water dischargers.
- Require revised building codes to provide water saving plumbing fixtures in all new construction, reconstruction, and renovation.
- Encourage retrofitting of existing structures with water saving plumbing fixtures.
- Even though there is a risk of increased depletive water use, encourage conservation of energy and capital expenditures for waste water treatment facilities through industrial recycling by voluntary means and improved technology.
- Undertake intensive program of leak detection and correction of municipal water supply systems.
- Encourage reuse of municipal waste water for non-potable uses with due regard for health.
- Utilize highly treated waste water for recharge of depleted aquifers when soil, aquifer and streamflow conditions permit.
- Identify, designate, and require protection of aquifer recharge areas when such protection is needed to continue use of the aquifer(s).
- Require interconnection of public and private water supply systems to increase system reliability and equitable water distribution during emergencies.
- Institute a ground water withdrawal charge as an element of ground water management.
- Promote improved irrigation techniques for agriculture and golf course application, e.g., drip, tube, and regulated sprinkler systems.
- Develop a conjunctive surface and ground water system for the Camden, New Jersey, area (150 square miles).
- Consider pressure reduction in public water systems.
- Investigate use of dry cooling towers for electric generation stations.

Based on the September 1978 conservation conference, the following options are significant:

(1) <u>Conduct Studies to Determine the Effectiveness of Conservation Measures to Reduce Depletive Use</u>

The Commission will have to quantify the effectiveness of conservation measures to reduce depletive use. The Commission has received a grant from the Office of Water Research and Technology, Department of Interior, to determine the effect of industrial water conservation and reuse techniques on evaporative loss. This study began in September 1980 and will be completed in two years.

Other similar investigations are needed to better determine what fraction of total water used is depleted, how conservation measures will best reduce depletive usage and how reduction in depletive use affects other water management goals.

(2) <u>Develop Public Information and Education Programs</u>

These programs should clearly explain the distinction between depletive water uses and water which is used, treated, and returned to a watercourse. The former use is of paramount importance for management of the Delaware River. Conservation of total water withdrawal is of value for lessening or preventing drought impacts for those systems which derive water supply directly from reservoirs, small streams, or from ground water. The incentive for residential conservation is based first on the use of smaller amounts of energy to heat lesser quantities of water. The returns are savings of fuel, electricity, water, and deferral of capital expenditures for new or expanded water treatment facilities. It was concluded from the conservation conference that significant savings could be made of energy and money through conservation programs directed toward municipal uses.

(3) <u>Revise Plumbing and Building Codes to Require the Use of Water Saving Plumbing in New Construction and Renovation of Existing Buildings</u>

Standard toilets use between 5-7 gallons/flush, shower heads from 5-15 gallons/minute and washing machines from 35-50 gallons/load cycle. Low water using plumbing fixtures include 3.5 gallons or less flush toilets, 2.0 gallons/minute shower heads and front loading washing machines with a 40 percent reduction (Sharpe, Oct. 14, 1980). These examples illustrate the savings that could result from the required use of water-saving plumbing via revised codes.

(4) Require Conservation Plans of New and Existing Water Users

Present Commission policy requires maximum feasible efficiency in the use of water by new industrial, municipal, and agricultural users. A definite conservation plan should be required of new water users setting forth a quantified conservation objective and methods by which the objective is to be achieved. Similar plans should be required of applicants for the expansion of existing water systems and further, conservation plans should be required of existing water users to encourage application of water saving technology.

(5) Examine Water Systems of all Major Cities in the Basin for Excessive Leakage and Support Rehabilitation of Leaky Systems

Leakage and loss or "unaccounted for" water in some cases amounts to as much as 50 percent of the capacity of some community water systems. Wasted water in New York City has contributed to an increase in the per capita use of water from 140 gpd in 1960 to 170 gpd at present (Berle, 1977). This has resulted in increased exportation from the Delaware River Basin.

Reduction in water exported to New Jersey and New York, through conservation measures, e.g., metering, leak correction and prudent use can be a direct benefit to the Delaware River Basin in terms of additional water released to the Delaware River. Leakage in the New York City system was estimated to be 84 mgd in 1970 (SWSC, Nov. 1978). It was further estimated that metering New York City would reduce forecast water usage 220 mgd from 1980 to 2020. It was estimated that universal metering of the City would cost nearly $93.4 million, or an annual expense of $110 per/million gallons conserved (1972 cost level) and bring in additional revenue of $49.2 million (SWSC, Nov. 1973).

Leakage correction programs in Philadelphia resulted in substantial reductions in waste water (Baxter, 1961). Per capita use in Philadelphia decreased from 174 gpd in 1953 (partially metered) to 164 gpd in 1962 (fully metered), partially due to the effect of metering on usage, rate changes, and the increased ability to detect and correct excessive leakage.

It is estimated that serious leakage problems occur throughout the Basin. It is also apparent that universal metering is fundamental to developing sound leak correction programs. Metering is also fundamental to reviewing the adequacy and effectiveness of water rate structures and pricing systems.

The Commission's policy requiring metering for all new public and private water systems and extension of existing systems serving over 250 connections or distributing over 100,000 gpd should continue in effect.

Federal agencies having grants and/or loans for upgrading water supply systems are the U. S. Department of Housing and Urban Development, Small Business Administration, Farmers Home Administration, Appalachian Regional Commission and the Economic Development Commission.

(6) Develop Incentives to Reduce Depletive Uses of Water by Industry

In response to the requirements of the Clean Water Act, industry, nationally, is making major changes in processing techniques and wastewater treatment practices. The least cost method of meeting strict water quality standards has induced reuse, recycling, and use of evaporative cooling towers instead of former once-through cooling practices. As a result of the economics of wastewater treatment and water reuse, recycling rates by industry have increased from an average plant rate of 2:1 - 5:1 a few years ago to the rates projected for year 2000 of 11:1 for pulp and paper and 40:1 for petroleum. A 25-year forecast by the U. S. Department of Commerce covering 98 percent of national industrial water use projects a two-thirds decline in water withdrawals and a more than doubling of depletive water use (Davis, 1978). As a consequence of increased recycling, the depletive losses, primarily through evaporation, have been projected to increase by substantial amounts, varying by industry type. Although water is lost through incorporation into products, it is the water lost depletively through evaporation that is of chief concern in the Basin.

As a result, in the Delaware River Basin, industrial depletive uses are shown in this report as increasing by the year 2000.

A price/cost sensitivity analysis of industrial water use was conducted by the Department of Commerce. The study indicated that increased water reuse rates and the associated costs of treatment and reuse are such that to encourage further reuse by price increases would require raw water charges of 75¢/1000 gallons and $4/1000 gallons to increase recycling at a pulp mill and induce a shift to dry cooling towers at a power generating plant, respectively. In short, total water withdrawals would be reduced, but depletive use would be further increased (USDOC, 1976).

(7) Commission Consider Recommending to the Congress the Repeal of Section 15.1(b) of the Compact that Granted Entitlement of Water so that all Water Users can be Subject to the Commission's Water Charges

Section 15.1(b) of the Delaware River Basin Compact provides that the Commission shall not impose any charge for water withdrawals if such withdrawals could lawfully have been made without charge on the effective date of the Compact. Working within this constraint, the DRBC has identified the municipal and industrial withdrawers of surface water and has established their entitlement to these waters without charge. As of 1978, these entitlements equaled 11,037 mgd, while total surface withdrawals equaled 9,640 mgd.

Until the volume of water granted under an entitlement is exceeded, the withdrawer need not pay for the water withdrawn. New water uses since 1971 are subject to the Commission's water pricing policy for water withdrawal charges. It is clear that water conservation measures, by using water pricing, cannot be made effective as long as the vast majority of water used is a free commodity under the entitlement provisions. The entitlements based upon installed pumping capacity should be reviewed and appropriately modified.

Neither entitlement nor charges have been applied to ground-water withdrawals. Permits are required by the Commission for wells of greater than 100,000 gallons/day. Wells of smaller capacities are not regulated by the Commission, except in a recently-delineated ground water protected area in southeastern Pennsylvania (Montgomery County and portions of Berks, Bucks, and Chester Counties), where withdrawals greater than 10,000 gallons/day are regulated.

(8) Develop Emergency Conservation Measures and Contingency Plans

During years of normal precipitation, sufficient water is stored in New York City reservoirs to meet both New York City exports and Montague flow augmentation requirements. During a repetition of the 1960's drought, both requirements cannot be met. Recognizing this situation, the Commission established a task group in 1977 for appraisal of upper basin reservoir systems, drought emergency criteria, and conservation measures. The task group, comprised of representatives of the Basin states, New York City, the River Master, and DRBC, has been working to develop (1) criteria defining the onset and stages of drought or water-shortage emergencies, and (2) emergency diversion, water allocation and release plans specifying actions which the Commission would intend to take at various stages of a future emergency. The group has established reservoir storage conditions that may be defined as Normal, Drought Warning and Emergency storage volumes, and has analyzed operating and release schedules and resulting flows and diversions under both drought and long-term hydrologic conditions.

Criteria for emergency actions and stringent conservation measures that may be ordered during a drought have been studied by the task group. Illustrative of the type of plan to be developed would be the following:

(a) Drought-Warning Actions (First Stage)

--DRBC declare drought warning.

--A straight percentage decrease would be imposed on all existing diversions from the Basin. A decrease of 15 percent to 25 percent would probably be appropriate, depending on the freshwater flows of the lower Basin.

--An allocation of allowable depletive use, and/or an increase in the DRBC price of depletive water use.

--Voluntary conservation measures by all water users.

(b) Drought Emergency Actions (Second Stage)

--DRBC declare emergency stage of drought.

--Existing flood-control reservoirs should store water when appropriate for later releases. The dams would have to be examined to see if they are properly designed and constructed to store water for several months at a time. This action would apply to Francis E. Walter, Jadwin, and Prompton reservoirs.

--Staged reduction in diversions and/or further increase in the DRBC price of water.

--Mandatory conservation measures.

The task group developed criteria to determine when a drought has begun. This concept is extremely important so that ample warning can be given to water users and special conservation efforts can begin. Public understanding of drought warning action is needed in order to properly implement stringent conservation measures which, if instituted early enough with full public cooperation and response, may defer or eliminate the need to take drastic actions and incur severe hardships. It will be important in an education program to stress that a drought warning notice that is not followed by a drought of some severity is not a false notice, but an interpretation of relatively hard-to-predict hydrologic data followed by prudent action.

The "Good Faith negotiations" (see glossary) had the results of the task group's evaluation. These were considered during the deliberations and the resultant input to the Preferred Plan.

(9) Summary of Emergency Management Options

--Arrive at policy for equitable apportionment of available water between diversions to New York City and flows at Montague during drought emergencies.

--Prepare and hold hearings on a "Drought Emergency Water Plan," which would include a water rationing and conservation plan designed to reduce water depletion Basinwide and by the largest consumers with least impact on the social and economic structure of the Basin. This plan should include all recent practical means to insure reduction of water use and provide for monitoring and enforcement to insure compliance.

--Undertake a study of the legal and physical problems under a drought-emergency situation of tapping appropriate natural and man-made water storage within the Basin for use in flow augmentation.

(10) Proposed Conservation Objectives

Responding to public support conservation is proposed as the cornerstone for future water management in the Basin. Implementing policies, programs, and projects to accomplish water conservation goals would be jointly accomplished by the Delaware River Basin Commission, federal, state and local government and the private sector. The DRBC could establish the framework and the implementation would be done on the state level.

The conservation measures quantified by Level B are those applied to depletive uses during a drought emergency. Conservation, during a drought emergency, takes the form of rationing or allocating available water supplies and regulations to curtail water use.

The drought-emergency conservation reductions of water use adopted by the Study distinguish between the National Economic Development Plan, Mixed Objective Plan, and the Environmental Quality Plan. Table 8 shows the Level B Study's projected depletive water use by type of user for the year 2000 and the percentage reductions to be achieved through water conservation for each plan.

The proposed reductions are based on the assumption that the objective of the National Economic Development alternative is best served by providing adequate supplies of water for all water users at all times. The Environmental Quality alternative reflects the maximum reduction judged practical, reflecting the objective of conservation of water resources. Increased dry weather flows in the upper Estuary result in enhanced environmental quality for that area by improving water quality for all the various uses.

With the present state of knowledge, the conservation reductions can only be considered as goals.

TABLE 8

DEPLETIVE WATER USES AND PROPOSED CONSERVATION REDUCTIONS, YEAR 2000 (122-DAY AVERAGE FLOW, JUNE-SEPTEMBER) (mgd)

Type Use	Projected Depletive Use Year 2000* (mgd)	Conservation Reductions: National Economic Development Plan mgd	%	Mixed Objective Plan mgd	%	Environmental Quality Plan mgd	%
Municipal	158	15.8	10%	39.5	25%	79.0	50%
Industrial	312	15.6	5%	15.6	5%	31.2	10%
Steam Electric	176	8.8	5%	17.6	10%	26.4	15%
Agriculture	391	19.5	5%	39.1	10%	58.6	15%
Golf & Institutions	137	13.7	10%	68.5	50%	102.7	75%
Livestock	8	0.0	0%	0.0	0%	0.0	0%
Other	9	0.4	5%	0.9	10%	1.3	15%
Total	1,191	73.8	6%	181.2	15%	299.2	25%

* Depletive water use projected for the year 2000 without any correction for use of salt water in the lower Delaware Estuary and Bay area.

(11) Current Status of Commission Conservation Efforts

The Commission has been actively promoting conservation practices and technologies for several years. A 1973 Resolution requires metering on new systems (Resolution 73-1). Resolution 76-17 calls for maximum feasible efficiency in the use of water. Resolution 77-5 supports regional water systems and the construction of interconnections between established systems. Resolution 81-9 strengthens Resolution 76-17 requiring leak detection and control programs and drought emergency plans.

2. Water Quality

a. Problem Statement

Philadelphia, Camden and Trenton are major Estuary dischargers which have not met the treatment levels required under the National Pollutant Discharge Elimination System and the Commission waste load allocations. No management options are included for this problem statement, since the cases are being handled on an individual basis. Compliance is expected by the mid-1980's.

Dissolved oxygen standards in the central portion of the Delaware Estuary do not maximize the fisheries potential of the Delaware River.

Increased coordination among water quality planning programs would improve their effectiveness.

There is increasing concern about the possible threat of toxic substances in the surface and ground waters of the Basin.

b. Water Quality in the Delaware Estuary

The dissolved oxygen standards chosen for Zones 3, 4, and part of 5 of the Delaware Estuary are less than the usual criteria for "fishable" waters under the Clean Water Act. These standards were accepted by EPA in 1973 as the highest feasible under treatment requirements then considered realistic. The development of a new, more sophisticated mathematical model for water quality in the Estuary provides the opportunity to reexamine the existing standards.

This reexamination has several aspects. First, an ad hoc Task Force to Evaluate Dissolved Oxygen Requirements of Indigenous Estuary Fish was appointed by the DRBC. The Task Force was established to provide fisheries expertise and guidance to both Level B and to DRBC's program now under way to reevaluate its current wasteload allocations. A determination was needed of the amount of fisheries resource in the Estuary which would satisfy the "fishable" goal, and the dissolved oxygen levels required to attain the goal. The Task Force met five times between September 1978 and January 1979. The final recommendations (DRBC, Ad-Hoc Task Force, March 1979) of the Task Force included two sets of recommended dissolved oxygen standards. For immediate consideration was a set of standards recommending an Estuary-wide minimum dissolved oxygen standard of not less than 5.0 mg/l except in the critical reach of the Estuary where a minimum of 4.0 mg/l was deemed acceptable. The critical reach represents the area of greatest dissolved oxygen deficit in the Philadelphia-Camden area. Ultimate standards of 6.0 mg/l and 5.0 mg/l (critical reach) were recommended for future consideration.

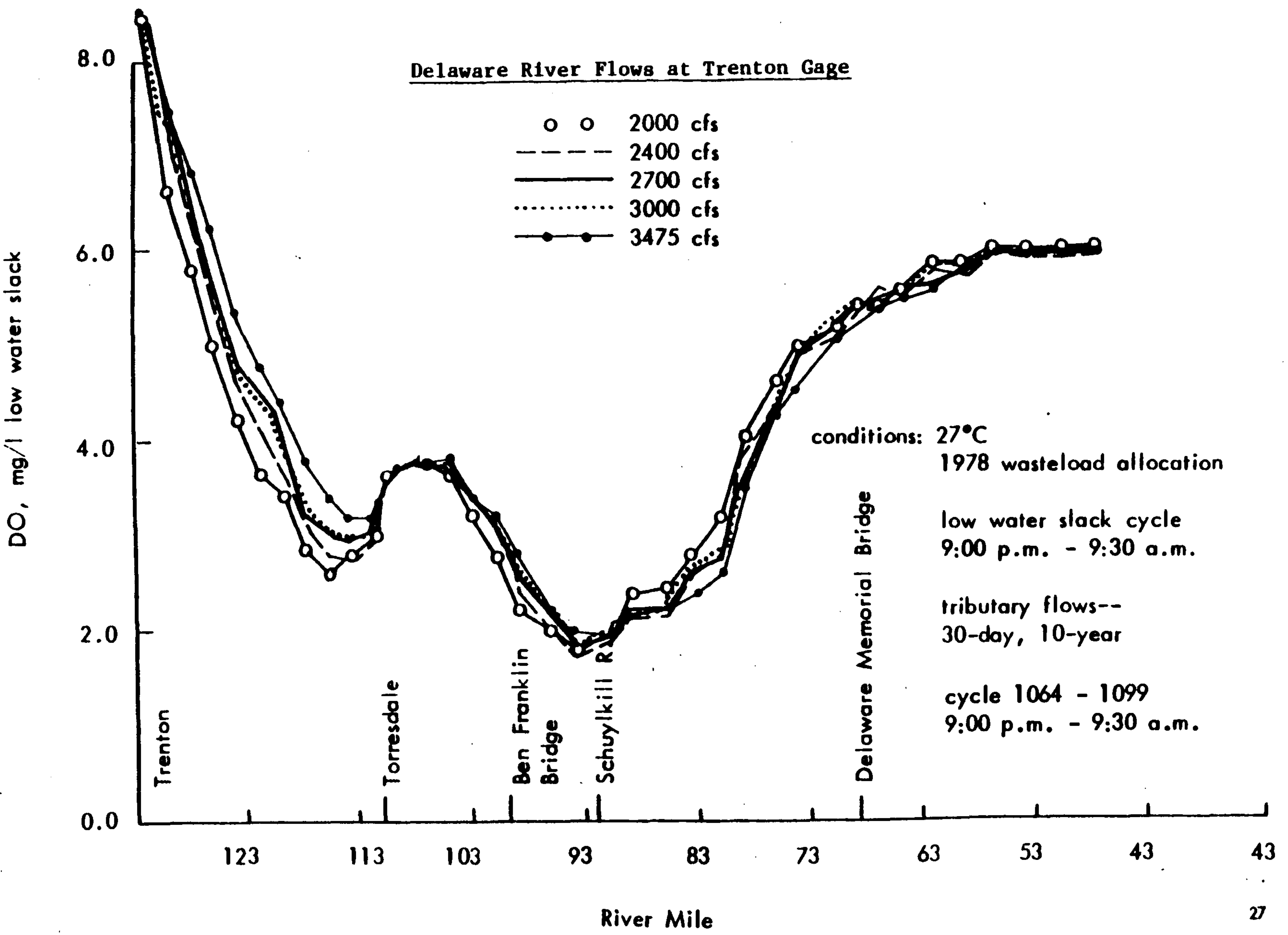
The new water quality model for the Estuary is being used to estimate the dissolved oxygen levels which can be achieved under present and increased degrees of pollutant reduction. The model will consider both dry-weather and storm conditions, nitrogenous as well as carbonaceous oxygen demand, and the effects of tributary wasteloads and accumulated sediment deposits.

Concurrent with the determination of a feasible dissolved oxygen "target", the most cost-effective mix of measures must be determined to reduce oxygen-demanding wasteloads affecting the Estuary. These loads, as implied above, include municipal and industrial discharges, combined sewer overflows and other storm runoff, tributaries as well as the main stem Delaware River as it enters the tidal reaches, and bottom deposits. With decreased discharge loads because of the DRBC wasteload allocations program and the requirements of the Clean Water Act, the non-point sources become relatively more important. Treating these sources may be less costly than increasing treatment levels for point source dischargers. However, much detailed analysis remains to be done to determine best management practices for non-point pollution sources. Non-point source treatment will be compared to additional point source treatment before resorting to additional point source treatment.

Figure 12 shows computed dissolved oxygen (DO) profiles along the tidal Delaware River from Trenton to Liston Point, for low-water slack tide, under different levels of flow regulation. These DO curves were determined with the one-dimensional version of DRBC's current water-quality model of the Estuary. The model simulations indicate that increasing the Trenton flow from 2,000 cfs to 3,475 cfs would cause a DO increase of 0.13 mg/l at river-mile 98, on the downslope of the DO "sag", and 0.08 mg/l at the bottom of the sag. Seaward of the critical sag point, as water quality improves with distance, DO levels tend to be slightly lower at higher flows. Flow changes have a significant impact on DO in Zone 2, from Trenton to about mile 113, where DO increases of a mg/l or more may result. The effects shown should be taken as relative rather than absolute, since the sensitivity of the model results to changes in waste loads has not been fully tested.

FIGURE 12

DISSOLVED OXYGEN AND FLOWS
PRELIMINARY RUNS, DELAWARE ESTUARY MODEL



Other water quality issues in the Estuary include thermal loads and the threat of contamination with toxic substances. The ad hoc Task Force, while directing its effort to dissolved oxygen, agreed on the importance of these factors for an improved fishery in the Estuary. The new Estuary model will explore the relationship between temperature and dissolved oxygen levels at critical periods. It is not designed to evaluate the problem of contamination of the Estuary waters with trace quantities of toxic substances. These are addressed later in this section.

The new model will be used to investigate point and non-point source controls for various dissolved oxygen criteria for a range of low-flow conditions consistent with the various flow maintenance objectives at Trenton.

In Zone 2, the upper portion of the Estuary, more detailed investigations of water quality issues are needed: (1) the effect of bottom deposits on water quality should be examined, (2) water quality characteristics of the River as it enters the zone should be monitored, and (3) the effects of flow changes (which are more significant here than for the lower Estuary zones) should be evaluated. Zone 2 is impacted by drainage from 60 percent of the Delaware River Basin. The background carbonaceous and nitrogenous loads carried by the Delaware River as it enters the Estuary at Trenton are immense. Studies have demonstrated that loads entering the Estuary from the non-tidal river are predominately from non-point sources of pollution, suggesting that a truly interstate impact is being thrust upon Zone 2. A proposed Study by DRBC would determine practical methods of removing the effects of organic loads from the River and distributing the cost of the solution equitably to the contributing areas.

c. Other Water Quality Management Issues

The consequences of a lowered flow maintenance objective for the River above Trenton may also need to be explored. A water-quality model is available for this analysis for this section of the River.

d. Overall Water Quality Management and Improvement

Non-point source problems and the measures to mitigate them can be conveniently divided according to the types of land uses involved: urban areas, suburban/developing areas, and rural or predominantly agricultural lands. To varying degrees, for each of these categories only limited information is available on specific causes of observed water-quality problems and the effectiveness of potential management measures, which may be costly and difficult to enforce. The detailed investigations which may be required to resolve such issues are also likely to be costly. In this context EPA has been slow to specify Best Management Practices to serve as guidelines for local management. Yet in many areas, non-point source problems should be resolved before point source controls are imposed.

In urban areas, after currently required treatment levels have been achieved, trade-offs must be considered between higher degrees of waste treatment and treatment of combined sewer overflows or storm flows. Such stormwater management measures may prove to be less costly for Philadelphia and other metropolitan areas in the Basin than tertiary sewage treatment for the same degree of stream improvement.

In suburban and developing areas, facilities planning for the last decade has focused on local or regional sewage treatment facilities large enough to handle anticipated increases in loads. At the same time, suburban growth has proceeded on the implicit assumption that sewers would follow. In many cases, housing patterns have been too dense to allow continued use of traditional onsite systems, and too scattered to allow sewering at a reasonable cost. The result has been an expensive network of sewers feeding a regional plant, with problems of diminished streamflow and depleted ground water in the areas served.

Several completed "208" reports take such problems into account. In particular, proposals have been made to achieve conservation by maintenance of onsite systems wherever possible, and to plan at a community level for land application of waste. Under the federal Clean Water Act, land application measures are to receive a high level of consideration.

A variety of state, county, and local ordinances apply to sediment and erosion control and storm runoff in developing areas, some with the goal of accelerating rather than preventing runoff. Stormwater management policies or regulations normally have consequences for flood control and conservation as well as water quality, and planning must consider all these purposes together.

In rural areas, land treatment and other measures carried out under the programs of the Soil Conservation Districts have been directed primarily at reducing erosion and sedimentation and improving farm productivity.

The West Branch of the Delaware River above Cannonaville Reservoir was chosen by the New York Department of Environmental Conservation for analysis by the Soil Conservation Service. Management practices were identified which appear both to be acceptable to landowners and to show promise in mitigating water-quality problems. Implementation of many of these measures has begun. A long-term sampling and monitoring program has been proposed to verify the effectiveness of the water-quality improvement measures. Partly as a result of the West Branch Study, the area has since been chosen by EPA/USDA as one of seven national Model Implementation Program (MIP) areas providing the opportunity for further analysis and funding assistance in putting recommended management practices into effect. To conduct such intense studies in every watershed in the Basin would be both expensive and time consuming, yet in some areas, whether expensive advanced waste treatment facilities are required for small rural communities may depend on such detailed knowledge. The results of the West Branch and similar studies suggest that water-quality benefits can be obtained most economically by investigations to identify the most critical areas, and by concentrating treatment measures on these areas.

A strong interstate, interagency attack has been launched on the problems of the Delaware Estuary. Better coordination should strengthen the "208" planning process for other streams. Timing of implementation has been a problem: facilities plans have been completed, funded, and constructed out of phase with the Basin or areawide plans with which they are supposed to be consistent. Facilities planning has often not reflected either watershed level concerns, long-term projections of population growth and distribution or water-conservation policies. Nonpoint source control measures have been difficult to defend in the face of unclear cause-and-effect relationships, and in many cases lack of basic data. Finally, the implications of new laws, for example, the federal Safe Drinking Water Act, Toxic Substances Control Act, Resource Conservation and Recovery Act, and changes in the Clean Water Act, have begun to be felt too late to be reflected in earlier "208" studies.

For the Delaware River above Trenton, water quality models have been developed. Water-quality planning in the Pennsylvania and New Jersey regions bordering the River should jointly address problems of occasionally high fecal coliform levels, occasionally low localized DO values, and high turbidity during storms and coordinate proposed solutions emphasizing nonpoint source issues. This problem is particularly crucial since the main stem Delaware River is the major "tributary" to the Estuary.

e. Toxic Substances/Residuals Management

Concern for toxic and hazardous substances in the surface water and especially the ground water of the Delaware Basin is growing among citizens as well as government and regulatory agencies. Of particular urgency is the threat to the waters of the Potomac-Raritan-Magothy aquifer system posed by operating and closed landfills, waste disposal sites, and recharge waters from the Delaware Estuary.

EPA is promulgating standards for a list of toxic pollutants. The list, expanded from an original 65 substances, includes elements (mostly heavy metals), organic compounds, and families of compounds, some suspected carcinogens, and is cited specifically in the Clean Water Act. Several special sampling studies for trace contaminants in the nation's waters have been conducted in the last few years, for both surface and ground water, and raw and finished drinking water supplies. Study results were examined to determine the presence in the waters of the Delaware River Basin of substances designated in the list. Sampling for many such substances is also carried out as part of routine monitoring programs, and the data entered in EPA's computerized files. These files were also examined for the 65 pollutants originally contained in the list, and 36 were noted as detected in surface or ground water of the Basin. In almost all cases, the quantities involved were minute, but their presence in any degree is a matter of concern.

Inspection of a list of permitted dischargers to the streams of the Basin showed that of 1,250 dischargers, 951 are in categories which have been considered as potential sources of toxic substances. (Of these, 361 are municipal facilities, however, not all receive industrial wastes.) The emphasis on non-conventional and toxic pollutants under the National Pollutant Discharge Elimination System (NPDES) should do much to reduce pollutant loads from these dischargers. The provisions and requirements of important federal legislation, such as the Resource Conservation and Recovery Act, are only beginning to affect activities in the Basin. Effective long-term management of industrial residuals is essential to prevent increased risks of ground and surface water contamination. Currently, efforts are under way by EPA and the states to establish and implement treatment requirements as specified in the Clean Water Act.

Routine sampling and monitoring for potentially toxic substances in the surface or ground waters are not extensive in the Basin or at landfills or other waste disposal sites. Proposals have been made for an expanded program, including bioassay procedures. Proposed revised water-quality standards for New Jersey would establish parameters for some toxics. New Jersey's Department of Environmental Protection has conducted baseline sampling studies of wells throughout the state. Active waste disposal sites have been surveyed in the course of some "208" planning programs; little information is available on closed sites.

Under the requirements of the Safe Drinking Water Act, sampling and analysis of water supplies are required for certain specific potentially toxic or carcinogenic substances. Sampling results proving to contain these specific substances must be reported to the customers of the vendors concerned. The National Interim Primary Drinking Water Regulations specify analysis and sampling for Endrin, Lindane, Methoxychlor, Toxaphene, 2,4-D, and 2,4,5-7P. EPA has further proposed regulations requiring granular activated carbon filtration as part of water treatment for all vendors serving 75,000 or more customers, unless it can be demonstrated that threshold levels of organic contaminants are not present before or after chlorination. This approach is conservative, likely to be quite costly in urban areas, and has met with much criticism. The potential costs involved have raised the issue that an upstream source of water might be required for Philadelphia and Camden.

3. Flow Maintenance

a. Problem Statement

There is a need to sustain streamflows, to offset increasing depletive water uses, in the Delaware River and major tributaries during extended periods of dry weather to protect instream uses, including fish migration and fish production, treated-waste assimilation, recreation, and salinity repulsion in the Delaware Estuary which if uncontrolled would invade adjacent ground water aquifers of New Jersey.

b. Design Drought

The most severe drought of record, that of the 1960's, is estimated to have a recurrence interval of several hundred years in the upper Basin and about 100 years for the Delaware River Basin at the mouth of the Schuylkill River (DRBC, February 1975). Estimates of the need for sustaining flows are based on a recurrence of this drought with a year 1965 severity of drought occurring simultaneously with year 2000 depletive use and ocean levels.

c. Projections of Depletive Use

The study projected each of several types of depletive water use within the Basin in the year 2000. Projections were made also of both exported and imported water. Together, in-basin depletive use and net export of water represent total depletive uses--water permanently removed from the Basin--and they are therefore of major concern in the management of water resources. Projected average annual depletive use from the Basin above Trenton in the year 2000 is 1132 mgd (221 mgd in-basin depletive use plus 911 mgd net export). Depletive use below Trenton must also be considered in determining the need for flow to control salinity in the Delaware Estuary.

d. Salinity Control

The salinity levels in the Estuary at the time of maximum sea-water penetration reflect the repulsion and dilution of sea water by the fresh-water flows into the Estuary. Through use of DRBC's new (1978) mathematical salinity model, it was found that antecedent flows covering a period of 12 to 15 months must be considered to show the salinity impacts of large changes in fresh-water inputs. Therefore, the levels of flow maintenance for salinity control presented in this report are based on model simulations of 15 months. For convenience, the level of flow regulation is designated by the average flow during the four-month (122-day) seasonal dry period (June through September). Flow regulation to augment dry-period flows requires storage of water and reduction of flows during periods of relatively high flows. However, relatively low percentages of high flows stored permit substantial augmentation of low flows.

Extensive use of the salinity model recently has shown that regulation of streamflows can provide control of salinity, chloride, and sodium concentrations in the Estuary; the degree of control depends on natural streamflow and flow augmented, when needed, by releases from storage. Additional control of critical peak estuarine concentrations could be attained to the extent that depletive use can be reduced by conservation measures, especially during late summer and fall.

The beneficial salinity-control effects of conservation measures vary with location, as well as with time. The impact of conservation measures on salinity diminishes with distance below Trenton, New Jersey. For example, a reduction of depletive use in the St. Jones River in Delaware would reduce salinities much less than an equal reduction in use above Trenton.

Salinity, whether caused by sea-water intrusion or by the discharge of wastewaters containing dissolved solids, is a major concern in the Delaware Estuary. The salinity studies considered inputs of non-ocean salts during calibration and verification of the mathematical model. Investigation of these non-ocean salts, from both natural and man-made sources, indicated that during extreme low-flow periods, such as occurred in 1965, the chloride concentrations in the tidal river above the upstream limit of sea salts would be about 50 mg/l.

High concentrations of salts increase water-treatment and equipment-maintenance costs to industries using water for processing and cooling, and to households in terms of the life of plumbing and water-using equipment. There are significant health effects associated with excessive ingestion of sodium. These can contribute to hypertension, circulatory, coronary and other problems (DRBC, April 1976). Evidence suggests general harmful effects of continued ingestion of water containing 100 mg/l or more (Tuthill and Calabrese, 1978). The American Heart Association recommends a level of not more than 20 mg/l in drinking water for persons on diets calling for severe to moderate restriction of sodium intake. This criterion was adopted by Massachusetts as a drinking water standard. New Jersey currently has a recommended drinking water standard of 50 mg/l sodium; higher values may be cause for rejection of the supply.

Of particular concern are the consequences of Estuary water infiltrating the Potomac-Raritan-Magothy aquifer system. During normal water years and present levels of pumping about 50 percent of the system's recharge comes from the tidal Delaware River. For a projected drought period in the year 2000, the percentage of river recharge could be as high as 70 percent, because of greater drawdown (USGS, May 1980, Barksdale, June 15, 1970). The remainder of the water reaching these aquifers is derived from percolating rain and melted snow, as well as leakage from overlying aquifers. Leachates from municipal and industrial landfills, which contain a variety of salts and often much more dangerous compounds, are also of concern.

While the Potomac-Raritan-Magothy aquifer system is believed to be hydraulically connected to the tidal river between river-miles 70 and 90, it is generally accepted that the major area of river recharge lies above mile 98.

The potential for excessive levels of dissolved salts, including sodium, in the Potomac-Raritan-Magothy system and the resultant adverse impact on health and property are cause for a need to provide adequate fresh-water flows to protect this system. Once contaminated, the Potomac-Raritan-Magothy system might be effectively destroyed as a source of public water supplies.

e. Sea Level

The penetration of sea water into the Delaware Estuary is controlled in part by the level of the sea, which changes constantly with the phase of the tidal cycle. In addition, a long-term trend of rising sea level in relation to the land elevation has been observed since the turn of the century. This trend is projected to continue at least until the year 2000, the end of projections made in this study. The projected sea level has been taken into account in modeling salinity distributions in the Estuary.

f. Chlorides, Sodium, and Dissolved Oxygen vs. Trenton Flows

The relationships between Delaware River flows at Trenton and the concentrations of chlorides, sodium, and dissolved oxygen in the Estuary have been analyzed. [It is of note that the Delaware River flow at Trenton is only a portion of the contrôl for repulsion of salinity intrusion. All tributary flows below Trenton and above the saline waters of the Bay help in repulsion of salinity.] Locations of particular concern that were considered and the reasons for their importance are as follows:

--River-mile 110.4 (see Table 9)--The Philadelphia water intake at Torresdale. Present DRBC standards limit the maximum 15-day average chloride concentration to 50 mg/l at any point in Zone 2 of the Estuary (Trenton to river-mile 108.4, including the Torresdale intake location).

--River-mile 98.--The estimated seaward limit of the major connection between the Estuary and the Potomac-Raritan-Magothy aquifer system. Protection of this vital source of water from contamination by sea water is critical.

--River-mile 92.5.--The location of the mouth of the Schuylkill River, where the present DRBC standard for chlorides is a maximum instantaneous concentration of 250 mg/l. The maximum concentration occurs approximately at the time of high-water slack following a flood tide. This location and standard provided the basis for the present DRBC sustained flow objective of 3,000 cfs at Trenton, based on 1970 levels of depletive water use and Year 1970 sea level.

To maintain the present chloride standard at river-mile 92.5 and provide for projected year-2000 depletive use below Trenton, the minimum four-month "summer" flow at Trenton would have to be in excess of 3,900 cfs.

--River-miles 24.2 to 48.5--The location of natural seed-oyster beds. The most critical need for salinity control to protect these beds, on which the New Jersey and Delaware oyster industries depend, is high fresh-water flows in the spring and early summer. These high flows protect the seed oysters from predators such as the oyster drill and competitors for space, by limiting salinity to levels unfavorable to the oyster enemies during the critical time of year. If the salinity were not lowered too much, the oysters could survive periods of exposure to the lowered salinities. The desirable salinity range to protect the oyster and control the oyster drill in the spring and early summer is from about 5 ppt (5 parts per thousand) to 15 ppt.

The new water-quality model was run for various levels of flow regulation (2,000 cfs to 3,475 cfs at Trenton) to study the effects of different flows on dissolved oxygen in the Estuary. In the upper reaches of Zone 2 (Trenton to about mile 113) flow reductions lead to significant (up to a mg/l or more) reductions in DO; elsewhere in the Estuary flow changes have lower (0.13 mg/l or less) effects.

In the analyses of salinity response to flows in the Estuary, various levels of 15 month flow regulation, represented by average four-month "summer" (June-September) flows over a range from below 2,000 cfs to over 4,000 cfs were modeled. This provided comparative data on concentrations of chlorides and sodium at the critical locations; the instantaneous maximum 30-day, 60-day, and 120-day concentrations of sodium and chloride were determined for each level of flow regulation. The mathematical model was also used to determine salinity levels over the seed-oyster beds during late spring and early summer for different levels of fresh-water flows into the Estuary. These oyster bed analyses included a comparison between (1) 60-day average salinities over the beds from May 17 through July 15, 1965, without flow regulation associated with the exports to New York City and northeastern New Jersey; and (2) the same 60-day average assuming maximum rates of these two exports permitted by the 1954 decree of the Supreme Court and projected year-2000 depletive water use.

The modeled chloride and sodium concentrations at three locations of primary interest for different levels of flow regulation are shown in Table 9. All values in the table reflect the same projected year-2000 level of depletive use. Thus, the different chloride and sodium concentrations show the beneficial effect of year-round manipulation of the waters remaining after total annual depletive use is taken into account. For example, as a result of increasing the average flow for the dry summer months from 2,340 cfs to 3,072 cfs by reservoir manipulation, the maximum instantaneous chloride concentration at mile 92.5 was reduced from 685 mg/l to 438 mg/l, a reduction of 36 percent. Similar reductions were shown at all locations and for maximum concentrations averaged over 30-day to 120-day periods.

The values in Table 9 take into account the projected rise in sea level to the year 2000, refinements to the model to date, and proposed conservation measures, which are considered in later sections of this report.

The U. S. Fish and Wildlife Service (1979) has suggested that to protect the natural seed-oyster beds in upper Delaware Bay from oyster predators and other oyster enemies, salinity over the beds should not be consistently over 15 parts per thousand (ppt), corresponding to a chloride concentration of 8,303 mg/l, during the period from early May to mid-July. Figure 13 shows the 60-day average chloride concentration over the seed-bed area as modeled for three sets of conditions. The first set of conditions (lower curve in Figure 13) represents the "unregulated" flows of 1964-1965 (after adjustments to remove the effects of New York City Reservoirs and diversions to New York City and northeastern New Jersey). The second set of conditions (middle curve) represents the actual conditions observed in 1964-1965. The third set of conditions (upper curve) represents maximum diversions

TABLE 9

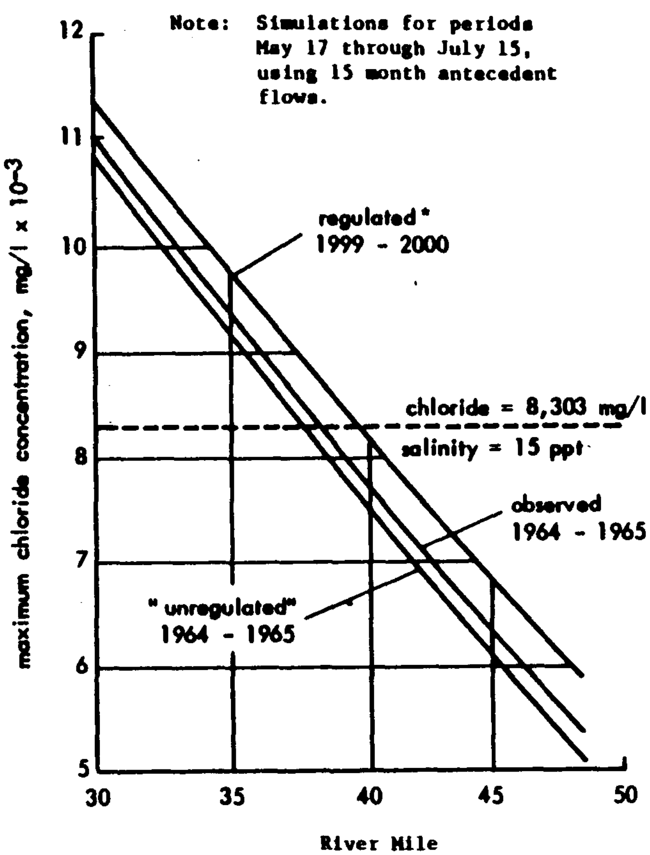
MAXIMUM CHLORIDE AND SODIUM CONCENTRATIONS
AT SELECTED LOCATIONS VS. SELECTED FLOWS, YEAR 2000
(122-DAY AVERAGE FLOW--JUNE-SEPTEMBER)*

Location and Averaging Period	Chloride and Sodium Concentrations (mg/l) vs. Flow at Trenton (cfs)		
	2,340 cfs	2,605 cfs	3,072 cfs
Mouth of Schuylkill River (River Mile 92.5)			
Instantaneous	685/381	595/331	438/244
30-Day	420/234	360/200	255/142
60-Day	370/206	315/175	232/129
120-Day	326/181	274/152	205/114
Potomac-Raritan-Magothy Aquifer (River Mile 98)			
Instantaneous	380/211	320/178	218/121
30-Day	220/122	180/100	121/ 67
60-Day	185/103	155/ 86	107/ 60
120-Day	164/ 91	133/ 74	96/ 53
Torresdale Intake (River Mile 110.4)			
Instantaneous	60/ 33	47/ 26	31/ 17
30-Day	29/ 16	28/ 15	20/ 11
60-Day	29/ 16	24/ 13	18/ 10
120-Day	28/ 16	22/ 12	18/ 10

*Table 9 is a revision of Table C-1 from the draft report of October 1979. The three Trenton flows in the above table correspond to the Table C-1 flows of 2,700 cfs, 3,000 cfs, and 3,475 cfs, respectively. The two lowest flows of Table C-1 have been dropped because they are no longer being considered. The three remaining flow alternatives are lower than in the October 1979 draft partly because of model-input refinements (sea-level rise and tide data for the critical period of salinity intrusion in the fall), and partly because of adjustments to model outputs to account for (1) the diversion of water from the Delaware River at Point Pleasant, (2) by-passes around the Trenton streamflow gage for water supply in the Yardley-Morrisville-Trenton area, and (3) proposed conservation measures to reduce depletive use by 15 percent.

FIGURE 13

EFFECT OF REGULATED VS. UNREGULATED FLOWS ON
60-DAY AVERAGE CHLORIDES OVER NATURAL SEED OYSTER
BEDS, MAY 17-JULY 15 (15-MONTH SIMULATIONS)



*Derived from 1964-65 observed flows adjusted to reflect assumed operation of Year 1980 reservoirs, 800 mgd and 100 mgd diversions to New York City and New Jersey, and projected year 2000 depletive uses, with no conservation measures to reduce depletive use. Sea level was assumed to remain at 1965 level.

permitted by the 1954 decree of the Supreme Court and projected 1999-2000 depletive use, with reservoirs existing in 1980 operated to maximize four-month summer flows at Trenton. The Figure 13 curve for these regulated conditions does not take into account the 35-year rise in sea level or recent refinements in tide data for use in the modeling process. The net effect of these two refinements would be to reduce the chloride concentrations for the 60-day period depicted for the year 2000, and the curves would be somewhat closer together than shown in Figure 13. Without these refinements comparison of the lower and upper curves shows the relative effect of the assumed diversions and assumed flow regulation by reservoirs existing in 1980. Comparison of the lower and middle curves shows the combined effect of the 1965 diversions to New York City and northeastern New Jersey and the operation of the City's upper-Basin reservoirs.

Figure 13 indicates that the changes from the observed conditions of 1965 to the projected and assumed conditions of the year 2000 would increase the average 60-day chlorinity (mid-May to mid-July) by about 0.46 ppt at mile 40 in the middle reach of the seed-oyster area. The 15-ppt isohaline would move upstream about 1.5 miles. Comparison of the curves for the "unregulated" and observed conditions for 1964-65 indicates that the mile-40 chlorinity increased by about 0.2 ppt in 1965 due to New York City's reservoir operations, the diversion to the City, and the diversion to northeastern New Jersey.

Analysis by the State of Delaware (Apgar 1979) showed that the projected levels of flow regulation and depletive use in the year 2000 would have much less effect on May-July salinity levels over the oyster beds than does the normal variation of runoff from year to year. For example, in the dry year 1965, the May-July chlorinities at mile 24 were up to 3 ppt higher than in the normally wet year of 1970. At the same location, the effect of the 35-year changes in flow regulation and depletive use estimated in developing Figure 13 was a chlorinity increase of less than 0.35 ppt. Thus, the natural fluctuations in runoff have a much greater impact on oyster ecology than would any level of flow regulation considered in this study. The natural variation of salinity over the seed-oysters is at least an order of magnitude (ten times) greater than the variation caused by man in the past or as projected to the year 2000.

Droughts adversely affect the oysters. This problem may be aggravated by increasing exports, in-basin depletive use, flow regulation for other purposes, and rising sea level. The adverse effects of droughts are temporary, as evidenced by the 1979 condition of the oyster beds, which was reported by the New Jersey State Oyster Biologist to be in the best condition observed within the last 30 or more years.

Normally, low-flow augmentation is not provided to control salinity for the benefit of oysters. Augmentation is provided to repel ocean salinity intrusion during periods when undesirably high concentrations of sodium would otherwise invade the water aquifers. Augmentation of flows in the low-flow months of June and July 1965, when the observed flows averaged only 2,572 cfs and 1,548 cfs, respectively, would tend to lower salinities over the oyster beds during the latter part of the critical period for control of oyster enemies. However, this beneficial effect would be offset partially by reduction of natural flows caused by storage of a portion of the available runoff in the preceding months of April and May. The adverse effect in May could be mitigated or eliminated, by refraining from storing water in April and May.

Figure 12 displays the relationship between dissolved oxygen levels and flows indicated in preliminary "runs" of the new water quality model. Low flows have a greater effect on dissolved oxygen in the upper region of the Estuary than farther downstream. Further analysis of the relationship between flow and temperature at critical flow periods is necessary.

Since temperature increases can lead to significant decreases in DO levels in the Estuary [model runs at 30°C (86°F) produced DO values about 1 mg/l less than at 27°C (80.5°F) for the same flow and tide conditions], concern has been expressed for the potential effect of a lower flow objective at Trenton. A mathematical model of temperature distribution in the Estuary, developed for DRBC by Edinger Associates (1978) indicated that a decrease in Trenton low flow from 3,000 cfs to 2,700 cfs would result in a Zone 2 temperature increase of up to 0.25°C, with less effect downstream. Simulations with the water-quality model for temperatures of 27°C and 27.25°C throughout the Estuary showed no difference in DO levels.

The temperature-related DO consequences of a flow change greater than 300 cfs have not been investigated.

g. Relation Between Flows at Montague and Trenton, N.J.

Under a recurrence of 1960's drought conditions, the terms of the U.S. Supreme Court Decree of 1954 with respect to exportations to New York City and downstream releases to the Delaware River Basin cannot be met simultaneously with the 1980 reservoir storage capacity available in New York City's upper-Basin reservoirs, even if private hydroelectric power reservoirs above the Montague gaging station are operated, as they were in the 1960's, to augment the Montague Gage flows on the Delaware River.

Parties to the 1954 Supreme Court Decree, the States of Delaware, New Jersey, New York, Pennsylvania and the City of New York, are currently (1981) negotiating "in good faith" to revise the Decree as it pertains to exportations and Montague flows. Good Faith assumptions have been made on a set of "rule-curve" exportations and Montague flows, based on levels of storage available in New York City's reservoirs (Pepacton, Cannonsville, and Neversink). Under the assumed rule-curve formula, the sustained flow at Montague would be 1,750 cfs under non-drought hydrologic conditions, 1,650 cfs under "drought-warning" conditions, and 1,600 cfs under "drought" conditions. Corresponding exportations to New York City would be limited to 800 mgd, 600 mgd, and 480 mgd, respectively, and the exportations to northeastern New Jersey would be limited to 100 mgd, 75 mgd, and 60 mgd, respectively.

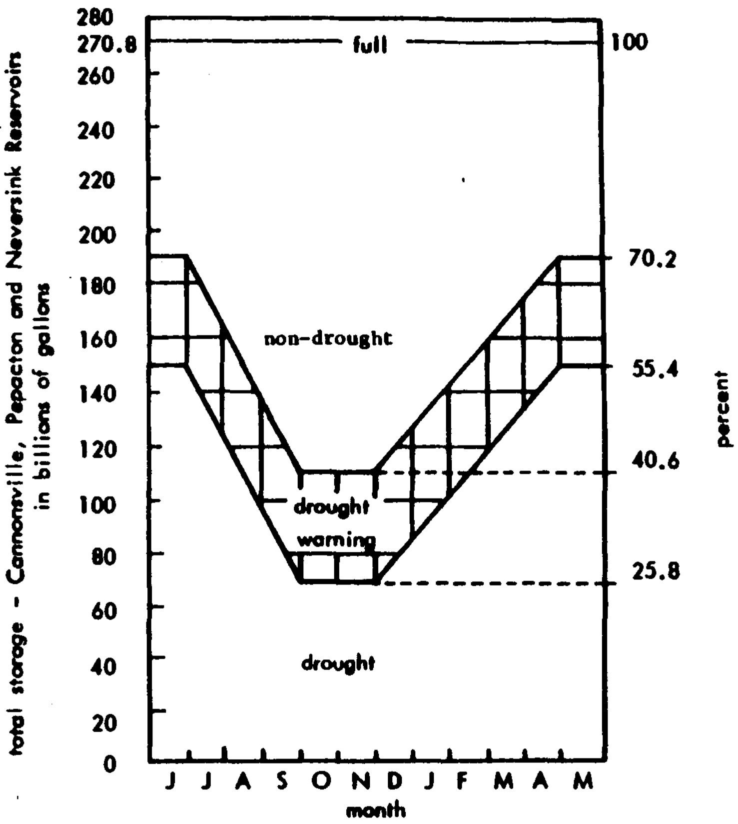
The rule curve would define non-drought, drought-warning, and drought conditions in terms of the water in storage at given times of the year (Figure 14). This curve, if acceptable to all parties to the 1954 Decree and the U.S. Supreme Court, would establish tha sustainable Montague flow at 1,600 cfs during the depths of a severe drought. This drought flow would pass downstream to Trenton, augmented by natural runoff below Montague and by releases from Beltzville Reservoir, but diminished by Year 2000 projected depletive use, to provide a sustainable four-month "summer" flow of 2,315 cfs at Trenton in the design drought with currently-available storage. This flow assumes conservation measures resulting in a reduction of 15 percent of the year 2000 projected level of in-Basin depletive use.

Assuming the modification of the 1954 Decree were adopted, the new Montague rule-curve formula would become a keystone in any plan adopted for management of the Basin's water resources during droughts.

FIGURE 14

Drought Emergency Operating Conditions
for the New York City Delaware System

The "Rule Curve"



h. Water Conservation

The proposed rule-curve operation would call for a reduction of up to 360 mgd (557 cfs) in the depletive use represented by the Decree-permitted exportations of 900 mgd to New York City and northeastern New Jersey. This is a reduction of 40 percent.

Similarly, conservation measures could reduce depletive use within the Basin. The target savings for the National Economic Development (NED) plan would be 6 percent, for the Mixed-Objective (MO) plan--15 percent, and for the Environmental Quality (EQ) plan--25 percent. The savings target adopted would be achieved through measures contained in a drought-contingency plan.

In determining the required year-2000 flow at Trenton, New Jersey, as opposed to the flow available with 1980 storage capacity, the mathematical models (salinity and water quality) have been used to derive estimated flow obtainable in the absence of special new conservation measures. The effect of reducing depletive use below Trenton on estuarine salinity depends on the location of the depletive use. Conservation measures will decrease in salinity-controlling effectiveness with distance below Trenton, diminishing to insignificant levels in the lower Delaware Bay.

To save time and modeling expense, techniques have been developed for translating reductions in consumptive use below Trenton to equivalent savings above Trenton. The latter values can then be subtracted directly from the required salinity-control flow at Trenton derived earlier with the model on the basis of no conservation measures, for a given salinity objective in the Estuary. Thus, the salinity objective would not be changed by the reduction in the Trenton flow requirement related to the reduction in downstream depletive use.

Reductions of depletive use of as high as 25 percent would have no significant effect on dissolved oxygen levels in the Estuary. Therefore, no corrections are necessary in the relationships between DO and flow shown in Figure 12. Once a Trenton flow objective for salinity control is selected, taking into account the water conservation measures seaward of Trenton, that flow can be used directly in the water-quality model to determine the corresponding DO profile in the Estuary. Also, the DO profile can be estimated by graphic interpolation in Figure 12.

i. Adjustment of Modeled Salinity-Control Flows at Trenton Gage

Model simulations of Delaware River salinity-control flows at the Trenton Gage did not reflect (1) the proposed conservation measures to reduce depletive use, (2) the proposed Point Pleasant diversion, nor (3) the projected post-1965 increases in withdrawals from the River above the Trenton Gage for water supply in the Yardley-Morrisville-Trenton area with return flows discharged to the River below the Trenton Gage. Table 10 shows adjustments to various modeled salinity-control flows to take these three factors into account.

Evaluations of Delaware River salinity control flows at Trenton, New Jersey, provided resultant salinity gradients in the Estuary. These evaluations considered year 2000 depletive use but did not consider potential conservation reductions of the year 2000 depletive use.

The depletive uses associated with water users of the potential Point Pleasant Project were assumed to occur within their natural drainage basins--all with natural stream discharge below Trenton. These stream dischargers are located above or slightly below the 250 mg/l choride salt front, dependent on selection of a salinity gradient. The water not consumed by Point Pleasant Project water users would enter the Estuary with nearly comparable salinity repulsion effect as if it were derived from the natural watershed. The net effect of the Point Pleasant Project would have minimal impact on salinity intrusion.

Table 10 shows the adjustments to various modeled salinity control flows, as measured at the Trenton Gage, to take into account the proposed Point Pleasant diversion and withdrawals from the Delaware River just above the gage in the Yardley-Morrisville-Trenton area, as well as the proposed 15 percent conservation reduction in year 2000 depletive use in the Basin. These factors were not included in the model simulations.

TABLE 10

ADJUSTMENT OF MODELED SALINITY-CONTROL FLOWS AT TRENTON GAGE TO ACCOUNT FOR UNMODELED FACTORS (YEAR 2000)

Modeled Salinity Control Flow at Trenton Gage, cfs*	2,690	2,940	3,400
Conservation Reduction, Depletive Use Below Trenton	- 143	- 128	- 121
Point Pleasant Project Diversion	- 147	- 147	- 147
Yardley-Morrisville-Trenton Bypass, etc.	- 60	- 60	- 60
Adjusted, salinity-control flow at Trenton Gage, cfs.	2,340	2,605	3,072

* These flows correspond to flows of 2,700, 3,000, and 3,475, respectively, in the October 1979 Draft Level B Report. The differences are due to rising sea level and other refinements of the salinity model.

j. Alternative Delaware River Flows at Trenton, N.J.

Based on the review of flow maintenance issues, the ranges of Delaware River flows shown in Table 11 were selected for the alternative plans. These are revised flows from those shown on the October 1979 Draft Level B Report. These flows are for year 2000 depletive use projections and for a drought of the severity of that of the 1960's.

TABLE 11

SALINITY CONTROL FLOWS

Alternative Plan	Salinity Control Flow at Trenton Gage, Year 2000 Conditions
NED	Greater than 3,100 cfs
MO	2,300 to 3,100 cfs
EQ	That possible with presently available storage up to 2,300 cfs

k. Proposed Selection of Policy Sets

Early during the planning process, 75 possible alternative sets of policies were considered. These involved various combinations of Montague flow, Trenton flow for salinity control, and the three alternative targets for conservation measures. Table 12 shows 45 of these policy sets. The other 30 sets have been eliminated during the study and selection process.

Table 13 shows 16 alternative combinations of diversions, minimum Montague flows with a variety of "rule-curve" operations, various objectives for chloride and sodium concentrations at river-mile 98, sustainable four-month flows at Trenton, and the corresponding required minimum four-month "summer" flow in the Delaware River at Trenton in the year 2000. The required minimum flows were determined with the aid of the mathematical salinity model, taking into account the projected rise in sea level, as well as the best available data on tides at the mouth of Delaware Bay. The Trenton flows needed for salinity control are for the four-month "summer" period from June through September, but reflect year-round lagged effects of depletive use and storage on salinity in the Estuary.

Alternative 13 given in Table 13 shows the level of flow regulation necessary to meet the current DRBC standard for salinity control, an instantaneous maximum chloride concentration of 250 mg/l (equal to 72 mg/l chloride at R.M. 98 as a 30-day average) at the mouth of the Schuylkill River.

Column 9 in Table 13 shows the average four-month Trenton flow deficit below the required salinity-control flow. Column 10 gives the flow deficit rounded to the nearest multiple of 50 cfs. These rounded flow shortages range from 50 cfs for the highest (least stringent) chloride/sodium objective considered with rule-curve operation to 1,600 cfs for the current standard.

As the parties to the 1954 Decree have considered certain assumptions in the Good Faith discussions, to modify flows to provide for rule-curve operation as shown in Alternatives 10, 11, and 12, they have been used for planning purposes. Thus, the range of after-conservation flow deficits is 700 cfs (from 50 cfs for a high 30-day chloride standard of 220 mg/l at mile 98 to 750 cfs for a more stringent standard of 121 mg/l). This latter chloride objective, that of the Preferred Plan, would represent a major relaxation of the current instantaneous standard of 250 mg/l at mile 92.5, which is equivalent to only 72 mg/l as a maximum 30-day average at mile 98.

TABLE 12

POLICY SETS*
(in cfs)

	NED (6% Conservation Reduction)			MO (15% Conservation Reduction)			EQ (25% Conservation Reduction	
Policy Set	Montague Flow 1965 122 Day Average	Trenton Flow Objective 122 Day Average	Policy Set	Montague	Trenton	Policy Set	Montague	Trenton
7	915	2340	8	915	2340	9	915	2340
10		2605	11		2605	12		2605
13		3072	14		3072	15		3072
22	1105	2340	23	1105	2340	24	1105	2340
25		2605	26		2605	27		2605
28		3072	29		3072	30		3072
37	1470	2340	38	1470	2340	39	1470	2340
40		2605	41		2605	42		2605
43		3072	44		3072	45		3072
52	1650	2340	53	1650	2340	54	1650	2340
55		2605	56		2605	57		2605
58		3072	59		3072	60		3072
67	1752	2340	68	1752	2340	69	1752	2340
70		2605	71		2605	72		2605
73		3072	74		3072	75		3072

*Table 12 is a revision of Table C-3 on page 59 of the October 1979 draft of the Level B Report. Table C-3 included 75 policy sets, 30 of which have been eliminated during the study and selection process. The flows shown in the revised table have been modified to reflect the projected rise in sea level and other factors not taken into account in the earlier draft.

TABLE 13

New York City and New Jersey Exports vs. Flow Capability at Montague and Trenton in Year 2000
During Recurrence of the 1964-1965 Drought Conditions

Alternative Number (1)	Hydrologic Condition (2)	Exports, mgd NYC (3)	Exports, mgd NJ (4)	Montague Flow, cfs (5)	Trenton Flow Capability cfs[1/] (6)	Chloride (Sodium) Objective at RM 98- mg/l[2/] (7)	Trenton Flow Needed for Salinity Control, cfs[5/] (8)	Shortfall Trenton, cfs (9)	Additional Flow Required at Trenton (nearest 50 cfs) (10)
	Normal	800	100	1,750					
1	Drought warning	750	95	1,200					
	Drought	720[3/]	90	950[3/]	1,618	121 (67)	3,072	1,454	1,450
	Normal	800	100	1,750					
2	Drought warning	750	95	1,200					
	Drought	720[3/]	90	950[3/]	1,618	180 (100)	2,605	987	1,000
	Normal	800	100	1,750					
3	Drought warning	750	95	1,200					
	Drought	720[3/]	90	950[3/]	1,618	220 (122)	2,340	722	700
	Normal	800	100	1,750					
4	Drought warning	650	80	1,525					
	Drought	600[3/]	75	1,230	1,921	121 (67)	3,072	1,151	1,150
	Normal	800	100	1,750					
5	Drought warning	650	80	1,525					
	Drought	600[3/]	75	1,230[3/]	1,921	180 (100)	2,605	684	700
	Normal	800	100	1,750					
6	Drought warning	650	80	1,525					
	Drought	600[3/]	75	1,230[3/]	1,921	220 (122)	2,340	419	400
	Normal	800	100	1,750					
7	Drought warning	680	85	1,650					
	Drought	527[3/]	65	1,400[3/]	2,107	121 (67)	3,072	965	950
	Normal	800	100	1,750					
8	Drought warning	680	85	1,650					
	Drought	527[3/]	65	1,400[3/]	2,107	180 (100)	2,605	498	500
	Normal	800	100	1,750					
9	Drought warning	680	85	1,650					
	Drought	527[3/]	65	1,400[3/]	2,107	220 (122)	2,340	233	250

1/ 1980 Storage (excluding Nockamixon), year 2000 depletive use, and no additional storage. Reflects conservation reduction of 15 percent in depletive use above Trenton, as well as the Point Pleasant diversion and the Yardley-Morrisville-Trenton bypasses around the Trenton gage.

2/ Maximum 30-day average.

3/ Includes drought operation of Lake Wallenpaupack and Mongaup System.

4/ Equivalent to current standard: instantaneous maximum of 250 mg/l at mouth of Schuylkill River (Mile 92.47).

5/ The significant difference between Trenton flow needed (year 2000) with this model run and previous runs is caused partly by model inputs of actual ocean salinities and tides and other factors for the last quarter of calendar-year 1965, which factors were not available in time for the earlier model runs and had to be estimated. Also adjustments have been made to account for several factors not included in the salinity-model simulations, including the Point Pleasant diversion, the Yardley-Morrisville-Trenton area by-passes around the Trenton Gage, and the assumed year-2000 15-percent reduction in depletive use.

TABLE 13 (continued)

New York City and New Jersey Exports vs. Flow Capability at Montague and Trenton in Year 2000
During Recurrence of the 1964-1965 Drought Conditions

Alternative Number (1)	Hydrologic Condition (2)	Exports, mgd NYC (3)	Exports, mgd NJ (4)	Montague Flow, cfs (5)	Trenton Flow Capability cfs1/ (6)	Chloride (Sodium) Objective at RM 98- mg/l2/ (7)	Trenton Flow Needed for Salinity Control, cfs5/ (8)	Shortfall Trenton, cfs (9)	Additional Flow Required at Trenton (nearest 50 cfs) (10)
10 6/	Normal	800	100	1,750					
	Drought warning	600	75	1,650					
	Drought	480 3/	60	1,600 3/	2,315	121 (67)	3,072	757	750
11	Normal	800	100	1,750					
	Drought warning	600	75	1,650					
	Drought	480 3/	60	1,600 3/	2,315	180 (100)	2,605	290	300
12	Normal	800	100	1,750					
	Drought warning	600	75	1,650					
	Drought	480 3/	60	1,600 3/	2,315	220 (122)	2,340	25	50
13	Drought	480	60	1,600	2,315	72 (40) 4/	3,912	1,597	1,600
14	Normal	800	100	1,750					
	Drought warning	600	75	1,650					
	Drought	480	60	1,450	2,165	121 (67)	3,072	907	900
15	Normal	800	100	1,750					
	Drought warning	600	75	1,600					
	Drought	480	60	1,450	2,165	180 (100)	2,605	440	450
16	Normal	800	100	1,750					
	Drought warning	600	75	1,600					
	Drought	480	60	1,450	2,165	220 (122)	2,340	175	200

1/ 1980 Storage (excluding Nockamixon), year 2000 depletive use, and no additional storage. Reflects conservation reduction of 15 percent in depletive use above Trenton, as well as the Point Pleasant diversion and the Yardley-Morrisville-Trenton bypasses around the Trenton gage.
2/ Maximum 30-day average.
3/ Includes drought operation of Lake Wallenpaupack and Mongaup System.
4/ Equivalent to current standard: instantaneous maximum of 250 mg/l at mouth of Schuylkill River (Mile 92.47).
5/ The significant difference between Trenton Flow needed (year 2000) with this model run and previous runs is caused partly by model inputs of actual ocean salinities and tides and other factors for the last quarter of calendar-year 1965, which factors were not available in time for the earlier model runs and had to be estimated. Also adjustments have been made to account for several factors not included in the salinity-model simulations, including the Point Pleasant diversion, the Yardley-Morrisville-Trenton area by-passes around the Trenton Gage, and the assumed year-2000 15-percent reduction in depletive use.
6/ Preferred Plan.

4. Water Supply

a. Problem Statement

--Southern New Jersey withdrawals of groundwater have exceeded the capacity of the aquifer to provide a reliable supply from land area recharge sources.

--Portions of the groundwater-based development in the Triassic Lowlands have exceeded groundwater supplies during drought years.

--One of Philadelphia's three sources of water, the Delaware River at Torresdale, is protected from salinity intrusion to the year 2000 if the downstream aquifer recharge areas are adequately protected from saltwater contamination. However, the tidal River at Torresdale, Pennsylvania, is of questionable quality. Like many water supply sources this intake is exposed to potential spills of toxic materials and other contaminants. The spill problem relates also to the Queen Lane and Belmont water treatment plants, which use the Schuylkill River as their sources of water. The Philadelphia water supply system has inadequate storage capacity (less than a 24-hour supply), as well as inadequate interconnection between the Delaware and Schuylkill River sub-systems.

--The water supplies of over 100 Pennsylvania municipalities are projected to be inadequate in yield, storage, or sufficient allocation by year 2000. The Schuylkill River Basin is presently over-committed and its users are vulnerable in drought periods. Much of the Schuylkill Basin overlays a geologic formation that yields low annual base flows, the Triassic Lowlands. With the recent extensive development of the area numerous ground- and surface-water quality problems have arisen. The limited additional water storage sites for flow augmentation impoundments have high environmental and social costs.

b. Tri-County Area (New Jersey)

The principal source of water supply in Camden, Gloucester, and Burlington Counties to meet industrial and municipal needs is the Potomac-Raritan-Magothy aquifer.

The aquifer, situated in the Coastal Plain, dips toward the Atlantic Ocean. In its natural state, the aquifer discharged an estimated 50 million gallons a day (mgd) of freshwater to the tri-county area's waterways (Barksdale, 1958). Since development occurred, withdrawals have exceeded the natural recharge from precipitation and the freshwater flows to the Estuary ended. Records indicate that between 1956 and 1973 ground water withdrawals increased ninety percent, from 71 mgd to 137 mgd. During this seventeen year period the average annual increase in withdrawals was 5.3 percent, but during the period from 1970 to 1973 the average annual rate of increase was only 0.7 percent (USCOE, March 1977).

New Jersey regulation of ground water withdrawals began in 1947, with permits required for withdrawals greater than 100,000 gpd. No charge is made for the use of ground water, and much of the water withdrawn is returned to the Estuary via municipal and industrial waste treatment systems.

A study (USCOE, March 1977) by the U. S. Army Corps of Engineers in cooperation with the U. S. Geological Survey indicated for the Camden, Gloucester and Burlington area that:

--Estimated safe yield (defined to mean the yield withdrawn from the aquifer if no recharge is induced from the Estuary and there is virtually no movement of the salt/freshwater interface in the southern part of the Potomac-Raritan-Magothy) is between 40 and 60 mgd.

--The 1973 average annual withdrawal rate was 136 mgd.

--Approximately 50 percent of the water withdrawn from the aquifer is induced flow from the Delaware Estuary during normal water years. During drier years it is greater.

--Withdrawal permits amounting to 275 mgd as a maximum monthly withdrawal rate have been granted by New Jersey.

--Large withdrawals from the aquifer have caused a series of deep cones of depression or decline in the potentiometric head, which reversed the hydraulic gradient from discharge to the Estuary to recharge from the Estuary. This induced recharge exposes the aquifer and its water users to the effects of potential spills of toxic or hazardous materials, and intrusion of sea salts (chlorides and sodium) from the Estuary during droughts.

Barksdale (1970) described in general terms the degree to which the Potomac-Raritan-Magothy (PRM) aquifer is shielded by layers of clay from complete hydraulic contact with the Estuary. The clay layers are thin and discontinuous from river mile 98 upstream toward Trenton and thus identify the area in which the aquifer receives a large part of its recharge. In discussing the impact of chlorides on the Camden area well fields, Barksdale (1970) noted that maintenance of the 250 mg/l isochlor at the mouth of the Schuylkill River for up to two months would probably not seriously impair the well fields, although there would likely be a noticeable increase in chloride concentrations in area wells. Barksdale did not discuss the sodium problem that would accompany any increase in ocean chlorides.

The threat of contamination by salt water exists from the salt water/fresh water interface deep in the aquifer in the southern part of the PRM aquifer as well as from the Estuary. Because of the depressed gradient, the salt/fresh water interface in the aquifer is gradually moving toward pumping centers at varying rates. At the present rate of withdrawal, 140 mgd (USGS, May 1980) the interface may be expected to migrate inland about one half mile by the year 2000 and contaminate approximately 10-15 square miles of the aquifer system.

Each of the following options will reduce demand pressures on the Potomac-Raritan-Magothy aquifer and thereby reduce the level of induced recharge from the Delaware Estuary. The ultimate selection of a specific desirable level of induced recharge can be made only after additional information has been evaluated on the following factors: quality of ground water, quality of surface waters that recharge the PRM, migration of salt front in the PRM, migration of salt front in the River, effects of reduced pumping, and the availability of alternate sources of supply.

(1) Program of Conjunctive Use of Surface and Ground Water

The Level B Study funded a reconnaissance study (USCOE, October 1978) by the U. S. Geological Survey and the Corps of Engineers to assess the potential for a conjunctive ground/surface water system for the tri-county area and to estimate the response of the aquifer to such a system. Using known data regarding water pumpage and induced and natural recharge to the Potomac-Raritan-Magothy, growth in population and water use was projected first at rates of 1 percent and then at rates of 3 percent to the year 2000 to simulate aquifer response. Streamflow records indicated that sufficient water was available from the Delaware River near Trenton to allow withdrawal to supply water to the 150 square mile area surrounding Camden for seven months per year. The study simulated response of the Potomac-Raritan-Magothy system to increased growth in pumpage by replacing that pumpage with river water, gallon for gallon, under both natural aquifer recharge and artificial recharge (at 90 percent of pumpage) conditions. Aquifer response to several conjunctive use schemes is shown in Table 14.

TABLE 14

PROJECTED RESPONSE OF THE POTOMAC-RARITAN-MAGOTHY SYSTEM IN 2000 TO ALTERNATIVE CONJUNCTIVE USE OPERATION

Withdrawal System and Conjunctive Use Operation	Potentiometric Head Level at Center of Cone of Depression Southwest of Camden, in Feet Below Sea Level	
	1973	2000
1. Present Withdrawal System	-60	
2. At 3% Growth Rate*		
a. Replace pumpage 7 mos./year		-100
b. Replace pumpage 7 mos./year with recharge at 90%		- 60
c. Without conjunctive use		-160
3. At 1% Growth Rate*		
a. Replace pumpage 7 mos./year		- 60
b. Replace pumpage 7 mos./year with recharge at 90%		- 40
c. Without conjunctive use		-100

* 1 percent and 3 percent represent combined effects of population growth and increased per capita water usage.

The study results suggest that there is sufficient River flow available to develop a conjunctive-use system for the study area. Successful recharge by artificial methods is considered risky, but in need of detailed study. This option, as well as others, is being considered in the DRBC's Special Ground Water Study.

To develop a conjunctive-use program, local storage, a water treatment plant, river intake, and transmission mains to deliver treated water to the existing distribution system would be needed. Two treatment plant and intake sites were investigated by the Corps of Engineers and cost estimates prepared. Estimated construction costs for 152 mgd systems are $151.1 million and $57.4 million for the Trenton and Delanco treatment plant intake sites, respectively. Practical application of such a program would result in reduction of ground water pumping and preservation of the natural ground water reservoir.

It may be concluded from the discussion that without remedial action, the Potomac-Raritan-Magothy system will continue to be heavily pumped with falling potentiometric surface, increasing threat from salt and other contaminants, increasing energy requirements for pumping, and perhaps eventual loss as a water supply source. A conjunctive-use plan would entail additional costs to water customers as a result of a treatment plant and transmission facilities and the energy needed for their operation, plus maintenance of the present well system and pumping equipment. As displayed in Table 14, even with a conjunctive-use program, the Potomac-Raritan-Magothy system will remain heavily pumped and threatened by contamination from salt intrusion and from land surface waste disposal practices, but to a lesser degree than without such a system.

(2) Transfer Water from Wharton Tract/Cohansey Sand

The Cohansey sand aquifer east of the Camden-Burlington-Gloucester County area, part of which lies in the Wharton Tract, is recognized as an important aquifer in the New Jersey Coastal Plan. The Wharton Tract, originally purchased by the State of New Jersey for water supply, is a heavily forested, sparsely populated 150 square mile area. It is capable of yielding an estimated 150 mgd. (USCOE, October 1978). Cost figures and the impact of withdrawals on streamflows and wetlands and other environmental, economic, and social consequences at the present are major considerations that might preclude use of this aquifer as a principal source. However, detailed studies to determine the practicality of using this supply during periods of drought emergency should be undertaken.

(3) Develop Program to Institute Ground Water Pricing

The use of water may be curtailed to some degree by its price. Ground water in the Delaware Basin is a free commodity subject to costs of extraction, treatment and conveyance. A specific effort should be undertaken to assess the impact of ground water pricing as a means of regulating its use. There is potential for eliminating waste and reducing water use by municipal, commercial, and industrial consumers through development of appropriate municipal and industrial rate structures to take advantage of the elasticity of some water uses in response to price. Out-door municipal (residential) water uses (lawn watering and car washing) and agricultural uses are expected to be responsive to seasonal or peak load pricing schemes. These measures may be successful only when water is assumed to have a value as a commodity and priced accordingly.

Curtailment of ground water use during dry periods could decrease the flow of treated waste water, much of which would flow to the Estuary. This curtailment might aggravate the problem of salinity control for the Estuary. Ground water use curtailment during the summer season would impose severe hardships on agricultural irrigators. Complex legal questions must also be addressed prior to instituting a ground water pricing policy.

c. The Triassic Lowlands

The Triassic Lowland portion of the Piedmont subprovince includes the Pennsylvania counties of Bucks and Montgomery and portions of Berks, Chester and Lehigh Counties, as well as part of Hunterdon and Mercer Counties, in New Jersey. The 1,140 square mile area is characterized by its crystalline and sedimentary rocks of Triassic age (180-230 million years old) including diabase, shale, basalt and sandstone. Although these rock types contain some good yielding aquifers, they store and transmit considerably less water than the Coastal Plain aquifers.

Many areas overlying the Triassic Lowlands have experienced very rapid growth since 1950 and have relied almost entirely on ground water and on-lot waste water disposal systems. In recent years many water purveyors and individual homeowners have experienced water shortages because of increased water demands and several dry years, which lowered water tables and limited water supplies. Regional waste treatment plants being substituted for on-lot waste water disposal systems may compound the problem in populous areas. Waste water that was recharging the aquifer is being transported out of the watersheds in which ground water withdrawals are being made. Recharge of the aquifers is also reduced by increases of impervious areas, such as streets, homes, etc. Many springs have stopped flowing and once-perennial streams now are mapped as intermittent by USGS.

Between 1970 and 1978, the Pennsylvania municipalities of Warminster, Upper Dublin, Doylestown, Hatfield, Worcester, and those areas served by the North Penn and North Wales Water Authorities imposed various levels of water use restraints on their customers in order to conserve limited supplies. The frequency with which new wells are being drilled in the area clearly indicates the need for a regional ground water management plan with firm regulation, conservation, interconnections among suppliers, and sound land-use management.

Urban and suburban development in many areas of the Triassic Lowlands can no longer be supported by ground water during a drought period (Betz, 1977) (Pennoni, 1977). Studies by Bucks and Montgomery Counties have shown that ground water supplies will be inadequate to meet projected demands during drought periods. Lowered water tables and dry wells expose the population and business activities to genuine hardships and economic losses.

In areas where development has far exceeded ground water yields, conservation measures designed to decrease the stress on the aquifer supplies should be undertaken and local ground water supplies should be augmented by reliable surface water sources. Plans of local communities for future development should be based on a clear analysis of ground water availability and recognize that support of continued growth may require development of alternative sources of water.

The Delaware River Basin Commission, with concurrence of Pennsylvania, has declared much of the Triassic Lowlands and some adjacent areas as a ground water protected area. The Commission's ongoing special ground water study will direct special attention to ground water yield and management strategies for the area (DRBC Resolution Numbers 80-18 and 80-27).

The Evansburg Project, proposed for construction by the Commonwealth of Pennsylvania, would provide a surface water supply resulting from 25,000 acre feet of storage on Skippack Creek in Montgomery County, Pennsylvania. This supply could augment deficient ground water supplies.

(1) Point Pleasant Pumping Station and Related Water Treatment Plant or Other Surface Water Source Equivalent

A pumping station at Point Pleasant, Pennsylvania, has been proposed by several agencies to draw water from the Delaware River. This water would be delivered to an existing reservoir some 10 miles inland and, following treatment at a water filtration plant, would be available as treated water, wholesale, to water purveyors in central parts of the Pennsylvania counties (Bucks and Montgomery) in the Triassic Lowland area. This supply would supplement existing ground water systems, provide for recovery of stressed aquifers and assure an adequate supply of water to sustain planned growth through drought periods. The pumping station would also provide additional water to the Philadelphia Electric Company generating station under construction at Limerick, Pennsylvania on the Schuylkill River. The design capacity and estimated cost of the pumping station, filtration plant, and transmission mains for the bi-county water system are summarized in Table 15. Sources of water for the project include natural flow plus existing upstream storage and additional storage to be provided by the electric power industry. Downstream low flows on the Delaware River would not be significantly affected.

TABLE 15

DESIGN CAPACITY AND ESTIMATED COST OF THE PROPOSED BUCKS -MONTGOMERY COUNTY WATER SUPPLY SYSTEM

	Capacity (mgd) 1981	Capacity (mgd) 2010	Estimated Construction Cost
Point Pleasant Pumping Station	95	95	$ 8,175,000.[1]
North Branch Water Treatment Plant	10	40	23,690,000.[2]
Reservoir PA-617 (Completed 1972)			(2,100,000.)
Bucks County	2.7	10.9	
Montgomery County	7.3	28.2	
Water Loss (10%)	1.5	4.4	
Minimum Flow Releases	5.3	5.3	
Philadelphia Electric Co. (Limerick)	46	46	
Bradshaw Reservoir[3]			8,700,000.[4]

1. Includes: pumping station, and combined and North Branch transmission mains (April 1979 price level).
2. Includes: filtration plant and transmission mains (April 1979 price level).
3. Needed upon completion and start-up of Limerick Station.
4. Includes: reservoir, pump station and transmission main (July 1979 price level).

Data source: Application and Environmental Reports submitted by Philadelphia Electric Company and Neshaminy Water Resources Authority to DRBC.

The Point Pleasant Project has been endorsed by Bucks and Montgomery Counties, included in the DRBC Comprehensive Plan, Pennsylvania State Water Plan and county plans and may be implemented in the near future. The project is an example of conjunctive use of surface and ground water in local areas of stress.

The Merrill Creek Project augmentation of Delaware River flow would offset the depletive use of the Limerick station during low-flow periods.

Water that is not evaporated by municipal usage would be returned to the Estuary above the Schuylkill River.

d. Philadelphia--Torresdale Water Plant Intake

Philadelphia's Torresdale water-treatment plant intake is subject to contamination from industrial and municipal wastes including treated waste water from one of the City's sewage treatment plants. Leakage from chemical storage tanks or from chemicals being transported by rail or truck to a storage facility or from unlikely ship accidents are among possible threats.

Relocation of the Philadelphia water intake above Torresdale to reduce the risk of chemical contamination and to reduce the future cost for water treatment has been considered. URS/ Madigan Praeger estimated the 1975 cost of relocating the intake from Torresdale to Morrisville at 60 million dollars, with an additional 155 million dollars cost for granulated activated carbon filtration (URS Madigan-Praeger, June 1975). This management option was not included in the Mixed Objective Plan because toxic pollutant removal is mandated under the Clean Water Act, spills of toxic chemicals can occur anywhere along the main stem Delaware and the Torresdale intake does not appear to be in danger of unacceptable salinity levels for flows within the flow range of 2,000 cfs to 3,000 cfs at Trenton.

e. Water Supply Needs of Municipalities

Water purveyors in many municipalities face specific problems which have been classified as deficiencies in terms of (1) yield of the specific water source, (2) allocation of water by the agency with jurisdiction, and (3) adequate storage to provide for at least a one-day supply (based on average daily usage).

Over 100 individual water purveyors in the Delaware Basin were identified in the Pennsylvania State Water Plan as having water supplies expected to be deficient in one or more of the categories of yield, storage, or allocations based upon water demands projected to the year 2020.

Deficiencies in storage or allocation are not discussed here since they have been analyzed and described in the Pennsylvania State Water Plan and alternative solutions to solve the problem of yield deficiencies have specific recommendations for each water purveyor.

As a further note, about 16 water purveyors in the Pennsylvania portion of the Basin were identified by a Public Utility Commission sponsored interagency study as having problems or potential problems related to adequacy of supply sources during the 1960's drought (PUC, 1969). As of 1978, all of these purveyors noted in the study had acted to take immediate steps or plan longer-term solutions for their potentially deficient water sources, or are identified in the Pennsylvania State Water Plan with solutions recommended.

New Jersey is developing water supply plans for its portion of the Basin. Concerns include (1) water quality in the Estuary as affected by non-point sources as well as lack of adequate waste water treatment facilities; (2) storm water runoff control; (3) ground water contamination; and (4) the combined effects of increasing water withdrawals and depletive losses of water.

New York State has adopted a comprehensive water resources plan for its portion of the Basin. The plan includes an evaluation of water supply needs and recommendations for water supply system improvements.

Delaware has an ongoing planning process to resolve water supply needs.

5. Flood Loss Reduction

a. Problem Statement

Areas adjacent to the Delaware River or to its major and minor tributaries are subject to periodic flooding. Continued floodplain development and upstream urbanization without effective storm water management will lead to increased future flood risk.

The Level B Study did not devote much effort to flood control considerations as the Basin States and DRBC are engaged in such studies under the National Flood Insurance Program grant assistance program.

b. Delaware River

The URS/Madigan-Praeger study (1975) of the Tocks Island Lake project and alternatives reports that in the 1955 flood, damages totalling $22,766,900 (U.S. COE, 1962) occurred in the reach of the Delaware River main stem between Belvidere and Burlington, New Jersey. The Delaware River at Trenton reached a flood stage of 28.6 feet. Flood control facilities have been constructed on tributaries of the Delaware River since 1955, but it is calculated that with a repetition of 1955 conditions the observed Delaware River flood stage at Trenton would be reduced by only 1.3 feet to 27.3 feet. The National Weather Service estimated that if Hurricane Agnes in 1972 had been centered over the Delaware Basin, the River at Trenton would have reached a flood stage of 31 feet.

The Madigan-Praeger study developed estimates of the capital and operation and maintenance costs, and annual benefits for flood loss prevention along of the River for the Tocks Island Project and its alternatives. The study concluded that only a mix of nonstructural measures could be economically justified as an alternative to the Tocks Island Project.

Local flood protection works for certain damage centers consistently showed benefit/cost ratios less than unity. The nonstructural approach for a considerable portion of the damage-prone areas gave substantial flood-loss reduction benefits, with lower costs than all other approaches.

However, the report stressed that the cost estimates for nonstructural measures are "hypothetical," and that there may be significant gaps in "enabling legislation and local capabilities to fully implement the nonstructural approach."

As a result of a request to Congress by DRBC, the U. S. Army Corps of Engineers has begun a "comprehensive study of the Delaware River Basin." Its major purposes are to determine more precisely the current potential for flood damage in existing developed areas along the Delaware main stem below the Tocks Island site, and the costs, effectiveness, feasibility, and acceptability of nonstructural measures and local protection works.

The "Stage I" Reconnaissance Report was approved in August 1979. Certain conclusions were reached based on evaluations of the flood damage reduction programs formulated for the Stage I planning effort, but the report warned that the evaluations were based on outdated and incomplete data, and thus subject to possible change during later planning efforts. The preliminary conclusions were that the "no action" alternative plan (with the implementation of the provisions of the National Flood Insurance Program) would act to restrict development in the flood plain and reduce the magnitude of potential future flood damage, but that the magnitude of damages to existing structures would increase with time; the implementation of a flood damage reduction program using non-structural measures would appear to meet the objectives of the Delaware River Basin Commission; and that a combination of structural and non-structural techniques might be employed to achieve a higher degree of protection than would be afforded through the use of non-structural measures alone. The U. S. Army Corps of Engineers is working on Stage II which defines the study objectives more specifically and refines the resource management alternatives without concentrating on detailed engineering or design considerations. After evaluation of the alternative plans has been conducted, those plans that deserve more detailed consideration before plan selection will be recommended for investigation in Stage III. Stage III studies will produce an array of alternative plans which specify the type and location of the measures involved, their significant impacts and their beneficial and adverse contributions to the planning objectives. This information will form the basis for selecting one of the detailed plans and recommending it, if appropriate, for modification of the DRBC Comprehensive Plan, and congressional authorization for construction.

c. <u>Tributary Damage Centers</u>

Ninety-nine lives were lost in the Delaware Basin in the 1955 flood, and others in the 1972 flood. Loss of life occurred on tributary streams rather than the Delaware main stem, and in 1955 in particular, in several camping areas located along Brodhead Creek in Pennsylvania, where little warning of the approaching flood crest was possible. Damages throughout the Basin were substantial (PaDER, DRM, March 1975).

A variety of measures have been explored by the U.S. Department of Agriculture (Soil Conservation Service), Corps of Engineers and other agencies to reduce potential flood damages in various areas. Some important results of recent studies by these agencies are summarized here.

First, few of the tributary damage centers would receive a significant amount of protection from major currently proposed upstream water storage projects. The future atatus of most of these projects is unclear.

Second, possible local flood protection works have recently been found economically feasible only at a few locations. In other areas, no local sponsor could be found for the projects. Active local opposition has arisen as it has to larger scale projects. Citizen concern has been expressed over project costs, property which would benefit versus property that would be taken by project construction, environmental and aesthetic effects of projects, and the degree of protection which would actually be provided. In the Southern New Jersey Water Resources Study, for example, ten major damage centers were identified. Structural measures were found to be economically feasible for only two centers; neither of these has been pursued because local cooperation could not be guaranteed. Similarly, local protection works proposed in the Christina Basin study were strongly opposed by New Castle County and the State of Delaware.

In this context, local protection works cannot be taken for granted as a feasible solution to flood loss problems. Various nonstructural measures must therefore be examined more carefully than in the past.

Several recent studies by the Corps of Engineers have estimated the feasibility and costs of nonstructural measures for existing development; the Corps has also prepared a summary of general material on such measures, including floodproofing, permanent floodplain evacuation through land acquisition, flood warning and preparedness planning, and flood insurance.

In the Chester Creek Basin, for example, it was estimated that floodproofing could reduce average annual damages for residential, commercial/ industrial, and public buildings by 20%, 30%, and 20%, respectively. Costs of relocation of structures or their contents were in general higher than the market value of the property (USCOE, Spring 1978).

Floodproofing has not in general been acceptable for federal implementation because equal protection cannot be achieved for entire damage centers. Such measures can be pursued at a local level.

Flood warning and emergency preparedness systems should be further explored for many of these areas. Cost estimates prepared for the Chester and Christina basins suggested that local (watershed level) systems would be economically feasible. As part of the Southern New Jersey Water Resources Study, integration of such a system with other disaster planning was investigated to a limited extent. Warning and forecast systems would be coordinated with the activities of the U.S. Weather Service River Forecast Center in Harrisburg. The Susquehanna River Basin Commission has participated with local areas in the development of warning networks, and will shortly complete a basinwide analysis of the potential for such programs. Cost for program development for a watershed was estimated at $25,000-$30,000 (SRBC, 1978). A recent study by the U.S. Weather Service suggests that damage reductions of up to 10% may be achieved by an effective warning system; large numbers of lives might be saved along "flashy" streams. However, local flood warning systems, to be effective, require continuing active local involvement.

A DRBC staff study explored the development of a Basinwide flood-warning program for the Delaware Basin. Existing programs and responsibilities of federal, state, and local agencies are being reviewed. Local interest in implementing and maintaining a program was surveyed (DRBC, April 1980).

Floodplain evacuation or acquisition can be pursued either alone or in conjunction with other waterfront programs such as urban rehabilitation, open space or park development, "greenways" in particular (see Fish, Wildlife and Recreation section), or other planning. Funding assistance to municipalities or counties may thus be available under a variety of auspices not specifically aimed at flood loss reduction.

Strong floodplain management programs may result in parkland and open space as well as eliminating flood damages, but do not provide actual protection to existing development (beyond what can be accomplished by floodproofing and by adequate warning), and may have serious social impacts.

Local protective works, for example, provide protection for the flood level for which they are designed, but may be environmentally detrimental and may render a waterfront area unattractive or less useable for recreation or other purposes.

The possibility exists of converting storage in one or more existing reservoirs from flood control to a multiple use including water supply. Such conjunctive use requires careful management. The protection provided by the flood control structures has been assumed during development of the areas downstream, and possibly during construction of additional local protection works. Floodplain delineation and identification of hazard areas under the National Flood Insurance Program also assumes existing protection, and therefore might have to be redone for some areas. It is conceivable, however, that such multiple use might involve less cost and environmental and social impact than new construction of water supply reservoirs.

d. Future Flood Risk

The difficulties in designing flood management measures effective for existing development underscore the need to avoid increased flood damage potential in the future. Two basic methods are available to do this: land-use regulation in the floodplain, and prevention of increased runoff and flooding due to upstream development.

The National Flood Insurance Program under the Federal Emergency Management Agency is the major mechanism available for bringing about local regulation of development in the floodplain, in addition to providing the benefits of insurance for present damage areas. Federally subsidized flood-damage insurance is provided for flood prone areas in participating communities; as detailed floodplain studies are completed, communities must adopt regulations designed to prevent unwise future development in the floodplain. These include floodplain zoning, prevention of most further development in the floodway, and floodproofing and other requirements for construction that is permitted (floodproofing as part of new construction is often economically feasible). The Hydrology Coordinating Committee of DRBC works to assure consistency in flood stage and frequency estimations along the streams in the Basin. The DRBC is responsible for nearly 150 detailed studies as part of the National Flood Insurance Program.

Almost all Delaware Basin communities are participating at some stage of the program. The flood insurance studies have been completed for most flood-prone areas. Not all communities studied have effective regulations. In some cases, there has been confusion as to the types of zoning and regulatory measures required. Whether adopted regulations will be enforced remains to be proven.

Regulations at other governmental levels, particularly the states and DRBC, are also essential to floodplain management. The New York Department of Environmental Conservation has the authority to establish and administer flood hazard regulations for localities to meet minimum requirements for participation in the National Flood Insurance Program. New Jersey has authority and is implementing programs for delineation and management of floodplain areas. Pennsylvania passed the Flood Plain Management Act, which requires all municipalities with identified flood hazard areas to gain eligibility to participate in the program. The Delaware River Basin Commission's regulations are more stringent than those of the Federal Emergency Management Agency, but they are limited to areas located in the non-tidal portions of the Delaware River and its tributaries.

Stormwater control measures can be effective to reduce present flood risks, and are noted in several of the studies discussed earlier. Storm water runoff management is crucial in urbanizing areas, on a scale from individual buildings to entire watersheds, to prevent increased future flood risks. Upstream development outside the floodplain often leads to increased flood damage potential downstream. Greater areas of impervious surface lead to less absorption, faster storm runoff, and sharper, more intense flood crests. Increased sedimentation and erosion associated with such development reduces stream channel capacity, resulting in more frequent local flooding; existing reservoirs downstream will suffer from increased siltation. As noted in the Water Quality section of this report, storm water management may in many cases be much more effective than advanced waste water treatment in reducing stream pollutant loads, as well as in decreasing erosion and sedimentation.

To achieve both water quality and flood loss reduction benefits at a reasonable cost, it is essential that storm water management in developing areas be carefully planned and equally carefully maintained. As summarized in a 1975 DRBC staff report on storm water management alternatives (DRBC, February 1975), "control of stormwater will effectively contribute to the prevention of 1) upstream flooding, 2) increased flood stages, 3) decreased flows during dry periods, 4) reduction of groundwater supplies, 5) impairment of water quality and accelerated soil erosion, and 6) deposition of sediment in water-courses resulting from land development."

A wide range of laws and regulations, state, county, and local, directly or indirectly affect storm runoff control in the Basin. At one extreme are municipal drainage codes which require storm water to be carried as directly as possible from structures to the nearest natural stream. At the other are various approaches to the concept that development of a specific area not lead to increased peak discharge rates (for the 5-, 10- or 25- year storm) over those occurring before development. Pennsylvania has recently passed legislation requiring municipal and county-wide storm water management planning.

A wide range of research results and planning tools are becoming available to those concerned at the county, watershed or municipal level with storm-runoff control. As a major part of the flood control portion of the Southern New Jersey Water Resources Study, the Corps of Engineers has investigated three watersheds in a pilot modeling project. A hydrologic model is used to simulate the downstream flood runoff effects of land use changes projected in the Year 2000 Plan of the Delaware Valley Regional Planning Commission. An investigation of the extent of the 100-year floodplain as a result of projected year-2000 development has also been proposed for New Castle County, Delaware.

Soil conservation districts and the Soil Conservation Service have many decadea of experience in watershed management in fulfilling their charge to deal with erosion control and land management.

6. <u>Fish, Wildlife and Recreation</u>

a. <u>Problem Statement: Fish and Wildlife</u>

--There can be no appreciable improvement in the quality and quantity of fisheries resources in the Delaware in Zones 2 through 5 (the tidal Delaware Estuary) until water quality, dissolved oxygen, and toxic chemical concentration, are improved above present conditions.

--To maintain diverse, high quality fish and wildlife resources, it is essential that high quality habitat be developed, or restored and maintained.

--Because particular problem areas in the Basin affect fish and wildlife resources throughout the entire region, there is a need to develop a more cooperative and comprehensive approach to fish and wildlife management.

b. <u>Problem Statement: Recreation</u>

--There is a lack of water-based recreation easily accessible to urban residents.

--There is a lack of public awareness of unique and ecologically significant natural resources and historic and cultural resources.

c. General Discussion

The U. S. Clean Water Act links together fish, wildlife and recreation. The objective of the Act is to protect, maintain and restore the chemical, physical, and biological integrity of the nation's waters. The national goal of the Act is to achieve water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water by July 1, 1983. In the Delaware River above Trenton, and in many tributary streams, fish (sport and commercial) and wildlife resources are diverse and abundant. Habitat is of high quality and undisturbed. In the Estuary below Trenton, degradation of the environment, especially water quality, has adversely affected the natural resources while the Delaware Bay supports a large viable commercial and sport fishing industry. A revival of the commercial and sports fisheries, as well as improved recreational resources in the Estuary with their attendant economic benefits to the local and Basin population, can be realized with the implementation of water quality and other programs contained in this report.

Specific problems affecting fish and wildlife resources in the Delaware Basin include: streamflow regimen; temperature fluctuations; water quality and in specific geographic areas; eutrophication; impingement and entrainment; salinity levels in the Estuary and Bay; and inadequate protection of wetlands and other critical habitat areas. A draft technical report prepared by the U. S. Fish and Wildlife Service addresses these problems in detail(USFWS, December 1978).

Achieving acceptable water quality would help mitigate several problems throughout the basin. The Model Implementation Study in the West Branch Delaware River Watershed, designed to develop better rural management of agricultural and forest runoff for the Basin, is examining the relationship between nonpoint sources of pollution created by agricultural and forest management practices and nutrient loadings (USDA, November 1977). Improved nonpoint-source controls as well as better point source controls could help mitigate eutrophication problems and the proliferation of toxic and hazardous substances (PCBs, phenols, heavy metals and chlorine by-products).

Impingement and entrainment of fish and aquatic life take place primarily at large water intakes. The effect of this phenomenon on the entire Basin's aquatic resource is not known. A research study, especially in the Estuary, could yield better design and operation information for water intake structures to minimize this uncertainty. Public Service Electric and Gas, at its Salem Nuclear Generating Station at Artificial Island, New Jersey, is currently investigating these impacts.

Many of the water quality problems are concentrated in the Delaware Estuary. Pollution caused by point and nonpoint sources decreases Estuary dissolved oxygen. Estuarial pollution harms commercial and recreational fishing for anadromous and resident fishes in the Basin. By the early to middle 1980's there will be an approximate 97 percent compliance of current discharges in meeting pollutant limitations. At that time there will be significant enhancement in water quality of the Estuary, particularly in DO levels.

The main problem associated with the protection of fish and other aquatic life is that of dissolved oxygen. Temperature and biochemical oxygen demand (BOD) are key discharge parameters from industries and municipalities affecting DO levels. In the Estuary, DO concentrations have been below DRBC Water Quality Standard (3.5 mg/l minimum daily average) for as long as 3-6 months at a time. The Water Quality Criteria, (USEPA, 1972) includes a recommended minimal 4 mg/l becauae values less than this induce stress of various kinds on aquatic life including higher mortalities of embryonic fish familiar to the Estuary.

A long-range goal of Commission water quality management is to provide a minimum of 4 mg/l DO for the Estuary.

Wetlands serve as nurseries and habitat for the food chain of many species of fish and wildlife. While wetlands are now better protected by federal, state and DRBC regulations, substantial work still remains to be done. Of particular significance in wetland management is the permit program of the U. S. Army Corps of Engineers. A comprehensive planning effort to develop stronger methods to protect and preserve these resources is needed.

Wildlife in the Basin appears to be well managed. Agencies responsible for administering wildlife programs must continue to be alert to potential impacts on habitat caused by other agency actions. Impoundments, dredging, drainage of wetlands, and the disposal of toxic wastes exemplify activities that can change the quality and quantity of wildlife habitat. The present program for protecting rare and endangered species of animals and plants must be continued, and refined periodically by the responsible agencies.

The Delaware River Basin Commission can contribute to the establishment of programs insuring suitable habitat for a well balanced mixture of fish and wildlife species. The Commission, working with its Fish and Wildlife Technical

Advisory Committee (FAWTAC), initiated research studies on anadromous fisheries in the Basin. Currently, the Delaware River Basin Fish and Wildlife Management Cooperative is continuing this effort. A comprehensive, coordinated approach to fish and wildlife management in the Basin is needed. The Commission should review the updated anadromous fisheries study and consider the findings in support of continuing efforts to accomplish the broader objective of a fisheries and wildlife comprehensive plan for the Basin.

In 1977 New York State initiated an experimental program to assess the physical, chemical, biological, recreational and economic impacts of varying releases from the three New York City reservoirs. This program was conducted cooperatively by New York City, the four Basin states, the River Master and the Delaware River Basin Commission. Results of the program indicate a significant overall improvement in the aquatic habitat (NYDEC, January 1980).

The recreational part of the Delaware River Basin Comprehensive Plan in the past has been largely dependent on the decisions and actions taken in the areas of water quality, water supply and flood control. Increasingly, the Commission has become concerned with the broader implications of improved water quality and use of nonstructural solutions on recreational opportunities. Improvment of water quality will make certain reaches of the River and the Estuary much more desirable for recreational pursuits. Floodplain management, by reducing development pressure, should permit public acquisition of land at reduced costs. An integrated flood plain management plan would also insure greater public access to the rivers and the Estuary for water-related recreational activities. The Commission is committed to the preservation, conservation, and protection of wetland and other natural areas, which not only improve fish and wildlife habitat but provide passive recreation for birdwatchers and naturalists. Finally, the recent inclusion of the upper and middle Delaware River in the U. S. Wild and Scenic River System and the interest by the states in further designations has opened new opportunities for recreation. Careful planning by the Commission with the cooperation of the appropriate agencies of the signatory parties to the Compact can do much to effect a stronger, coordinated recreational program consistent with water management in the Basin.

Recreational demand is determined by the Basin's geographic location in and near the most populated urban corridors in the nation, and the extraordinary accessibility linking these urban areas to the Basin's naturel intrinsic attributes. This accessibility has been changed drastically by the elimination of much of the passenger rail service in the Basin above Trenton, and the introduction of the Interstate Highway System and reliance on the private automobile. Easy automobile access and increased leisure time has increased recreational demand, has taxed the rural areas' natural resources, and has increased demands for municipal services in formerly sparsely populated municipalities.

For urban centers troubled by high unemployment, deteriorating housing, poverty, ethnic isolation, and traffic congestion, distant recreational opportunities are of lesser importance. Local water related recreation has been limited due to poor water quality and limited facilities but can be developed to meet the demands of thousands of the Basin's citizens.

The states recognize these problems and are addressing the decisions needed to realize the potential of the Basin's recreational opportunities. The direction is toward the revitalization of rural economies and improvement of recreational opportunities nearer to urban dwellers. The burden of providing a broadened recreational base, improving access, providing more facilities as well as maintaining old ones, and increasing technical capabilities lies with the federal, state and local governments.

State plans have identified both urban and rural areas which are in need of special attention. One objective is to bring to the public an awareness of unique and ecologically significant natural resource areas and historic and cultural resources. There are now provisions to protect and promote these areas. The designation of two sections of the Delaware River as part of the National System of Wild, Scenic and Recreational Rivers is a recent action. The sections designated are a 37-mile segment of the middle Delaware River in the vicinity of the Delaware Water Gap (all within the Delaware Water Gap National Recreational area) and a 75 mile segment from Hancock, New York, to Cherry Island, New York. A management plan for the upper section is scheduled for completion in 1982.

Another unique natural resource, the 970,000 acre Pine Barrens area in New Jersey, (of which 10 percent is in the Basin), has been designated to be protected. The Secretary of the Interior will submit a plan that will conserve this unique natural resource. Twenty-six million dollars were originally allocated for land acquisition and project planning by the federal government.

Federal funds are available for the promotion of various outdoor recreation programs. These include: the Heritage

Conservation and Recreation Service Land and Water Conservation Fund; Community Development Act noncategorical funds; Department of Housing and Urban Development, Block Grant Community Development Program; Resource Conservation and Development programs, Soil Conservation Service; U.S. Army Corps of Engineers multipurpose projects; and National Park Service programs. These programs need support to insure that the recreational opportunities offered by these programs continue to be available.

The states' role is one of establishing priorities, working with local communities to implement goals and objectives specified in the State Comprehensive Recreation plans. The states and localities can promote tourism and improve depressed rural economies by improving recreational resources.

Current state efforts include advancing monies to urban areas to increase use of existing recreation facilities, promotion of mass transit alternatives to existing recreation facilities, and wildlife and forest management programs that provide opportunity for many recreational pursuits.

The Delaware River Basin Commission has a role to play in the advancement of recreational activities in the Basin. The Commission working with the states, the federal government and selected localities can identify the benefits of particular land areas that could be developed for recreational purposes. Development of strategies for these selected areas to allow federal and state agencies to jointly develop programs to meet recreation demands is an urgent need.

7. Energy

a. Problem Statement

Adequate energy must be provided for a mobile society highly dependent upon modern technology. Emerging national energy policies must be carefully observed to provide a foundation for the Basin's economic base.

Steam electric generation facilities are major evaporators of water, and once-through cooling techniques raise the temperature of the receiving waters.

In the past, the Commission has allocated water to new steam-electric generating stations with the caveat that during drought periods (1) said water be supplied from utility-developed sources or (2) the station be shut down. This practice can result in difficult priority choices if the supplemental storage project(s) have not been completed by the time the drought occurs.

—Entrainment and entrapment of fish and other biota deplete fisheries at the cooling water intakes.

—Fluctuating streamflows from hydroelectric plants, designed to serve peak loads, cause upset of stream biota immediately downstream of the plants.

b. Steam Electric Generation

The generation of electricity is accomplished by heating water to make steam and using the steam to turn turbines. The process requires cold water to cool the steam through a heat exchanger. The heat is normally discharged to a body of water or to the atmosphere. The water that is heated in the heat exchanger is referred to as "cooling water." Cooling water causes two problems: elevation of temperature of the natural river system into which the cooling water is discharged and the loss of water through increased evaporation due to higher temperatures.

Thermal discharge to water bodies from electric generation plants may be considerably reduced through use of either wet or dry cooling towers. Dry cooling towers lower the efficiency of the steam electric cycle resulting in higher fuel consumption per unit of electricity produced. The Federal Water Pollution Control Act (P.L. 92-500) allows thermal discharge to water if an operator can demonstrate that no harm will occur.

The choices of fuel for steam electric generation are oil, coal and nuclear. Due to economic and availability factors, coal (favored by national policy over oil) and nuclear fuels probably will be preferred by the utilities for near future generation of electricity. With present technology, coal and oil-fueled steam electric plants require less depletive water use than do nuclear plants. However, future coal-fired plants, except anthracite fired plants which have been exempted by the U.S. EPA, may require devices to control sulphur emissions which will require more water than oil-fired plants normally use. Depletive use of water can be considerably reduced by use of dry cooling towers, which, however, require substantially more fuel to produce the same amount of power. Table 16 shows the depletive use per 1000 megawatts generated for the different types of cooling systems discussed.

TABLE 16

1978 DEPLETIVE WATER USE/1000 MEGAWATTS GENERATED (DRBEUG, 1978)

System	Fuel	Depletive Use/ 1000 Mw (in mgd)
Once-through Cooling	Fossil	6.7
	Nuclear	10.0
Wet Cooling Towers	Fossil	12.0
	Nuclear	18.0
Dry Cooling Towers	Fossil	0.0
	Nuclear	0.0

The adverse effect of depletive use of fresh water can be reduced if power plants are sited adjacent to the Delaware Bay. The states of Delaware and New Jersey cautiously consider Delaware Bay siting possible, carefully weighing other environmental consequences.

The Delaware River Basin Electric Utilities Group (DRBEUG) periodically reports to the Commission on its planned siting for major electric generating projects (DRBEUG, 1978).

On December 30, 1977 DRBEUG submitted an application under Section 3.8 of the Delaware River Basin Compact for approval to build an off-stream storage impoundment on Merrill Creek, in Harmony Township, New Jersey, and for withdrawal of water from the Delaware River at about river mile 193. The project would cost approximately $80,000,000 and have an approximate 200 cfs yield (TAMS/ DRBEUG, 1977). This project is nearly identical to the Merrill Creek project identified by the Corps of Engineers for the Level B Study and discussed in Section D, Evaluation of Impoundments and Groundwater Pumpage.

The proposed project is DRBEUG's response to DRBC's requirement that the electric utility companies provide supplementary water storage to assure availability of water needed to replace depletive uses at the Limerick, Hope Creek, and 17 other generating stations during periods of low flow. Supplementary storage needed for generating stations is being coordinated and planned consistent with the Master Siting Study of Major Electric Generating Projects.

The Merrill Creek project is proposed for completion and reservoir filling during the spring of 1985. The reservoir would be operated to replace water evaporated by electric generating stations in the Basin when the Delaware flow as measured at the Trenton gage is below 3000 cfs.

The DRBC will seriously consider a new policy as steam-electric generating facilities. Such new policy should consider the availability of reliable storage or the pre-DRBC approval of such reliable storage before new major consumptive water use approvals are granted. Further, approval to any such major consumptive user to operate should be conditioned upon the existence of the reliable augmentation and related conveyance facilities.

The discharge of dissolved solids and heavy metals are two other environmental impacts of steam electric generation. There is also a problem of entrainment and entrapment of fish and smaller organisms through once-through cooling-water systems. This problem can be minimized through application of existing technology, or by banning once-through-cooling where critical fisheries exist.

c. Alternatives to Steam Electric Generation

There has been a recent strong initiative to develop novel energy systems, particularly those that would be driven by renewable or near-perpetual resources. Water resource problems diminish in many of these systems; many of these technologies exist today on a limited scale (Epstein, 1977). The technologies include wind energy machines, solar units, magnetohydrodynamics (generation of electrons from ionized gases).

One researcher reports on the sizeable potential in New Jersey for cogeneration. This by-product electricity from industrial steam production can be produced with one-half the fuel needed for conventional steam electric generation (Williams, 1977).

State and federal energy master plans and some energy experts bank heavily on conservation of electric useage. (NJDOE, 1978). Other experts disagree on this issue (Starr, 1976).

d. Hydroelectric Power

Although there are six hydroelectric facilities in the

Delaware River Basin, hydroelectric power provides a small fraction of the total electricity generated in the Basin.

Conventional hydroelectric projects dam rivers to harness the gravitational energy of flowing waters. Hydroelectric power has relatively low operation and maintenance costs, is highly reliable, and provides no toxic or thermal emissions. The ability to provide rapid changes in power output make hydroelectric plants valuable to serve peak loads, sudden demands for increased power and to provide the starting power to steam electric plants following a major power failure. Peaking releases can cause sudden, sometimes disruptive changes in streamflow, if re-regulating facilities are not provided.

In light of today's energy crisis and the rising cost and environmental concerns associated with both nuclear and fossil fuel generation, the alternative of hydroelectric power generation has become increasingly attractive. It has currently prompted the following investigations:

(1) The National Hydroelectric Power Study, U.S. Army Corps of Engineers (P.L. 94-587). A current and comprehensive estimate of the feasible hydropower potential of existing dams and undeveloped sites for the nation. Completion is scheduled for 1981.

(2) The Rural Electrification Study, U.S. Department of Energy is coordinating the activities of several federal agencies as part of the Presidential initative on energy for rural America.

(3) Hydropower Study on the Lehigh River Basin, Corps of Engineers. Authorized by resolution of the House Committee on Public Works and Transportation the study is included in the USCOE budget for 1981. The purpose of the study is to investigate the range of hydroelectric resources in the Lehigh Basin.

(4) Numerous feasibility investigations by public and private entities have been or will be started shortly under the small hydropower project program of the Federal Energy Regulatory Commission (FERC), as authorized under Section 4(f) of the Federal Power Act (16 VSC Section 797(f)). Preliminary permits are issued to responsible applicants. The purpose of the preliminary permit is to maintain priority of application for a license during the term of the permit while the permittee conducts investigations and secures data necessary to determine the feasibility of the proposed project and to prepare an acceptable application for a license. The DRBC has filed for four preliminary permits and, to date, has been issued permits for the Blue Marsh and Prompton Projects.

The value of relatively small amounts of electricity generated in this manner in the Basin will be determined in great measure by the results of broader energy policy and programs, including the nation's response to energy conservation measures, the effectiveness of national energy policy, development of alternative sources, and forces outside the nation.

Use of the Basin's water for hydroelectric power generation will sometimes be compatible with other uses of water in the Basin. Where hydropower is not compatible with other uses, public preferences must be taken into account.

e. <u>Pumped Storage</u>

Pumped storage is a hydroelectric system in which electricity is generated during periods of greatest consumption by the use of water that has been pumped into a reservoir at a higher elevation during periods of low consumption. There are potentially favorable sites for pumped storage in the Basin from a physical standpoint. These were not evaluated in the course of study.

8. <u>Navigation</u>

a. <u>Problem Statement</u>

--Shallow areas of the tidal Delaware have been destroyed through dredging and filling, particularly in the Philadelphia to Trenton reach; these areas are an important habitat for fish and other aquatic life.

--Dredging may expose fresh water aquifers to saline water intrusion.

--Disposal of dredged material from the tidal Delaware to maintain essential navigation in the River requires economically available and environmentally suitable disposal areas.

b. <u>Siting Criteria</u>

Siting criteria guide locations of development, particularly industrial. Such criteria include environmental design standards, operating procedures and aesthetic impacts.

c. <u>Shallow Areas</u>

A recent report stressed the importance of shallows (mean low water to the depth of ten feet) in supporting the tidal

Delaware aquatic life. The Delaware from Philadelphia to Trenton has had a reduction of 31 percent of shallow areas--2,276 acres to 1,579 acres from approximately year 1932 to 1965. This loss of shallows is a result of dredging and filling (Ichthyological Associates, 1978). Present practice of the Corps of Engineers is to use upland areas for dredged material disposal. Moreover, the Corps' present permit process for disposal of dredged or fill material discourages destruction of shallows or wetlands.

d. Dredging and Disposal of Dredged Spoils

Navigation requires periodic dredging of the tidal Delaware. The U. S. Army Corps of Engineers is conducting a Dredged Spoil Disposal Study for the Delaware River Basin. The goal is to develop a regional dredging plan for the Delaware River and its tidal tributaries in both public and private sectors. The plan will identify specific disposal sites which are practicable and consistent with environmental constraints. A study conducted by the Corps of Engineers (May 1978) for the Level B Study states that dredging requirements since 1971 have remained essentially constant. By inference, sediment deposited in the tidal Delaware has remained at a relatively uniform level in that period. The level of maintenance dredging (and by inference, sedimentation) has decreased appreciably since the 1950's and 1960's. The causes for this welcome trend in the Estuary have not been identified but undoubtedly include soil conservation practices, entrapment of sediment in impoundments, and removal of solids through waste water treatment.

Care must be exercised so that dredging navigation channels and anchorages does not remove clay or other lenses that prevent increased salt-water from entering fresh water aquifers.

D. Impoundments and Ground-Water Pumpage

Impoundments [reservoirs for water storage and/or temporary collection of stormwater runoff] can provide the benefits of flow augmentation, water supply, flood loss reduction, flat-water recreation and hydroelectric power generation. These benefits are tempered by the impacts of altered river systems and social disruption in and around the impoundment sites.

The Preferred Plan includes modifications of three existing reservoirs, Francis E. Walter, Prompton and Cannonsville; and two projects in New Jersey, Hackettstown and Merrill Creek. The Cannonsville and Hackettstown projects are not evaluated in the tables in this section. The possibility of enlarging Cannonsville developed late in the Level B planning process. Social and environmental impacts have not been fully examined. Detailed information on Hackettstown is not available because of the changing time frame and design uncertainty for this project.

The continuously evolving planning process requires flexibility in the evaluation process at this stage of plan development.

This section provides a review of existing major impoundments and an evaluation of the potential facilities analyzed by the Level B Study, including a relative ranking of cost per cubic foot per second (cfs) of flow augmentation of the Delaware River at Trenton, New Jersey, and of local economic, social and environmental costs.

The evaluation includes analysis of conventional on stream reservoirs, off-stream reservoirs, and alluvial deposit ground water pumpage projects. The distinction between conventional impoundments and off-stream impoundments is that the former are on-river facilities that impound high-flow water in the valleys through which rivers flow, while the latter skim high flows from rivers and pump it to off-river storage sites.

The evaluation of these projects is designed to provide the Commission, participating agencies, and the public, with the basis for determining which additional facilities, if any, are required to provide flow augmentation to meet the low-flow and instream water needs during a recurrence of the drought conditions of the 1960's.

1. Existing Major Facilities

The existing major impoundments in the Basin are listed in Table 17 and shown in Figure 11. They are grouped into four categories: "Primarily Water Supply" refers to facilities used to meet local needs. Impoundments used in this fashion yield some flow augmentation. Nockamixon (36,800 acre-feet of storage and a net yield at Trenton of 153 cfs) is used primarily for recreation (built with Pennsylvania recreational funds); flow augmentation during extreme drought conditions is possible, but was not considered in determining sustainable flows.

Sustainable Delaware River flow at Trenton using existing facilities if a drought of the severity of the 1960's were to recur was determined. This was done assuming Rule Curve (Figure 14) operation at Montague, for New York City reservoir releases and out-of-Basin exports; hydroelectric releases as they occurred in the mid-1960's; natural flow of mid-1960's for the reach of the Delaware River from the Montague Gage to Trenton Gage; and the Beltzville Project optimized for maximum sustainable flow at Trenton. With depletive uses and storage as of year 1980, the sustainable June-September average flow of the Delaware River at Trenton is 2,590 cfs; year 2000 depletive use would decrease the flow at Trenton to 2,315 cfs unless additional impoundments are provided. These flows are based on an assumed conservation reduction of 15 percent in the in-Basin depletive use above Trenton. The year 2000 takes into account the proposed Point Pleasant diversion and increased Trenton and Morrisville diversions.

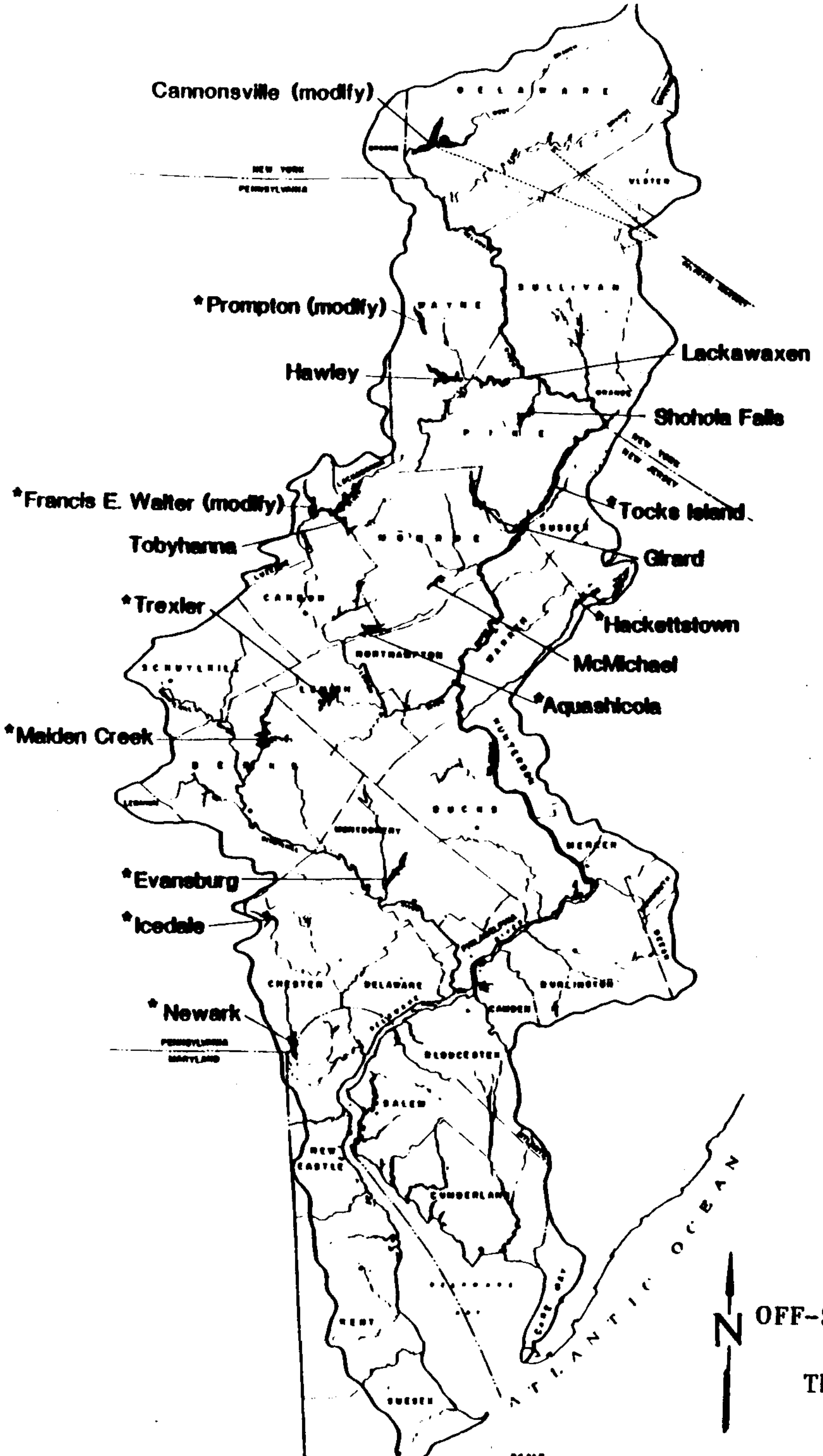
2. Summary of Potential Projects

Table 18 lists the 26 potential impoundments evaluated as part of the Level B Study. These include on-stream impoundments in the Commission Comprehensive Plan, both federal and state; on-stream impoundments selected by URS/Madigan-Praeger; and off-stream impoundments. The siting of the 26 projects [obviously not all needed] is shown in Figure 15.

a. Conventional, On-stream Impoundments

(1) Federal Projects in Commission Comprehensive Plan

The evaluation of four federal impoundments - Francis E. Walter Modification, Prompton Modification, Aquashicola and Maiden Creek, is shown in Table 19. These potential projects,

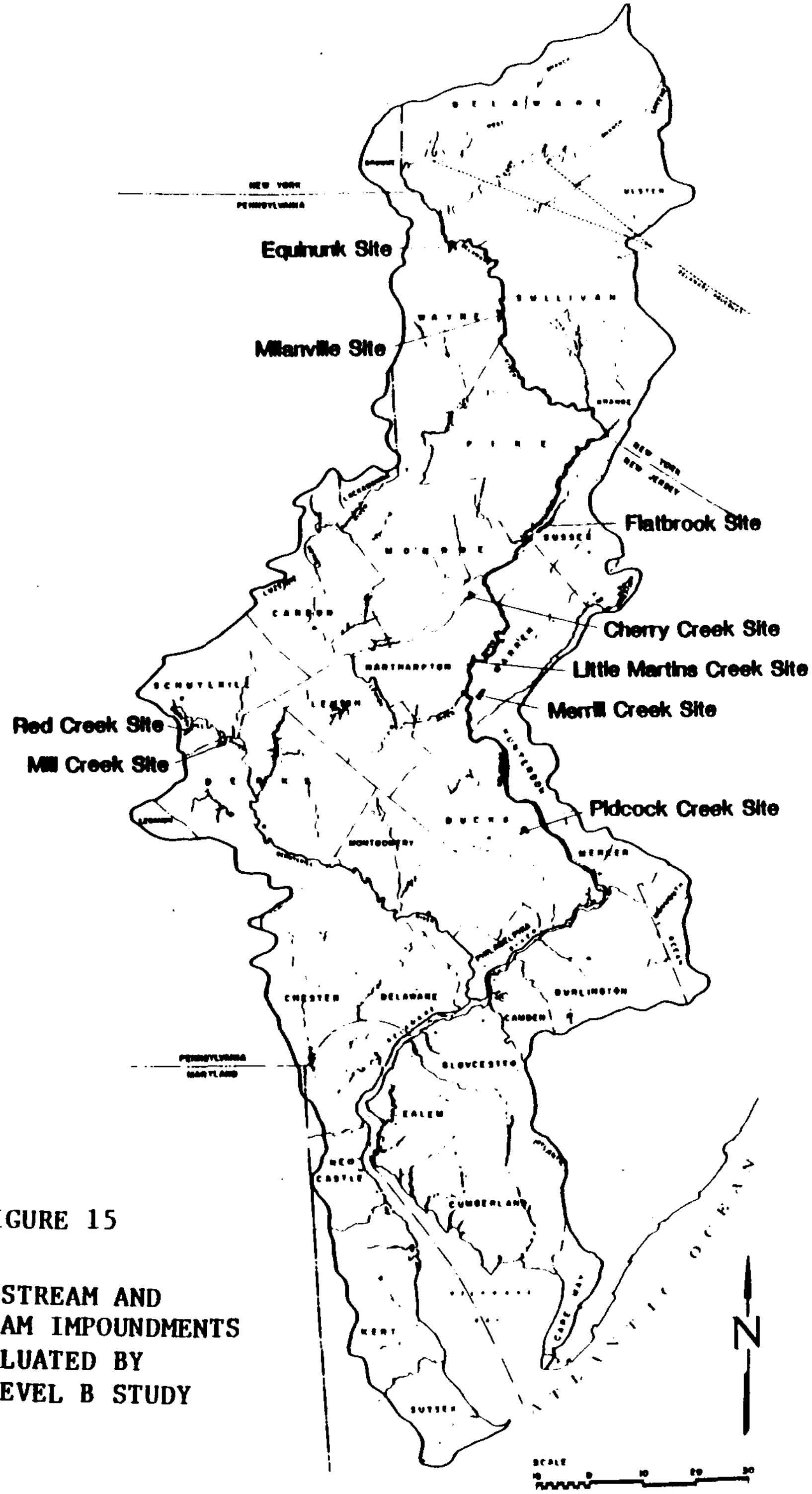


*In Commission's Comprehensive Plan

ON-STREAM IMPOUNDMENTS

FIGURE 15

ON-STREAM AND
OFF-STREAM IMPOUNDMENTS
EVALUATED BY
THE LEVEL B STUDY



OFF-STREAM IMPOUNDMENTS

TABLE 17

EXISTING MAJOR IMPOUNDMENTS

Impoundment	Purpose[1]	Storage, Acre-feet WS/WSA (total usable	Storage, Acre-feet FL	Location Stream, County, State
Primarily Water Supply				
Penn Forest	WS	19,980	none	Wild Creek; Carbon Co., PA
Wild Creek	WS	12,000	none	Wild Creek; Carbon Co., PA
Still Creek	WS	8,290	none	Still Creek; Schuylkill Co., PA
Ontelaunee	WS	11,640	none	Martins Creek; Berks Co., PA
Green Lane	WS	13,430	none	Perkiomen Creek; Montgomery Co., PA
Geist	WS	10,780	none	Crum Creek; Delaware Co., PA
Edgar Hoopes	WS	6,750	none	Tributary of Red Clay Creek; New Castle Co., DE
Union Lake	WS	9,750	none	Maurice River; Cumberland Co., PA
Hopatcong	WS[4]	18,400	none	Musconetcong River; Sussex, Morris Co., NJ
Nockamixon	WS[2]	36,800	none	Tohickon Creek; Bucks Co. Pa.
New York City Reservoirs				
Cannonsville	WS, WSA	302,000	none	West Branch Delaware River; Delaware Co., NH
Neversink	WS, WSA	109,200	none	Neversink River; Sullivan Co., NY
Pepacton	WS, WSA	454,000	none	East Branch Delaware River; Delaware Co., NY

Impoundment	Purpose[1]	Storage, Acre-feet WS/WSA	Storage, Acre-feet FL	Location Stream, County, State
Multipurpose or Flood Loss Reduction				
Prompton	WSA FL	5,600	20,300	West Branch Lackawaxen River; Wayne Co., PA
Beltzville	WSA FL	39,830	27,000	Pohopoco Creek; Carbon Co., PA
Marsh Creek	WS, WSA[3], FL	12,400	3,560	Marsh Creek, Chester Co., PA
Blue Marsh	WSA, FL	14,600	32,390	Tulpehocken Creek; Berks Co., PA
North Branch	WS FL	5,000	3,464	Neshaminy Creek; Bucks Co., PA
Francis E. Walter	FL	none	108,000	Lehigh River; Luzerne, Carbon Co., PA
General Jadwin	FL	none	24,500	Dyberry Creek; Wayne Co., Pa
Hydroelectric				
Wallenpaupack	H[2]	157,240		Wallenpaupack Creek, Wayne, Pike Co., PA
Mongaup System	H[2] approx.	65,630		Mongaup River; Orange, Sullivan Co., NY

[1]WS - Water supply primarily for local use.
WSA - Water supply primarily for flow augmentation to replace depletive uses and meet instream needs.
FL - Flood Loss reduction.
H - Hydroelectric Power, Onstream
Many reservoirs are also designed for fish and wildlife recreation.

[2]Potential use for flow maintenance.

[3]Used for flow maintenance in Brandywine.

[4]Used for water supply only on an emergency basis.

TABLE 18

DESCRIPTION OF POTENTIAL IMPOUNDMENTS

Evaluated by the Level B Study.

Impoundment	Purposes[1]	Storage Acre-feet WSA/WS (total usable)	FL	Location Stream, County, State
ON-STREAM IMPOUNDMENTS IN COMPREHENSIVE PLAN				
FEDERAL				
Tocks Island	WSA, FL, REC, PS	425,000	323,500	Delaware River; Warren, Sussex Co., NJ; Monroe, Pike Co., PA
Francis E. Walter (Modified)	WSA, FL, REC	69,500	108,700	Lehigh River; Carbon, Monroe, Lackawanna, Luzerne Co., PA
Maiden Creek	WSA, FL, REC	74,000	38,000	Maiden Creek; Berks Co., PA
Aquashicola	WSA, FL, REC	24,000	20,000	Aquashicola Creek; Carbon, Monroe, Wayne Co., PA
Prompton (Modified)	WSA, FL, REC	30,900	20,300	West Branch Lackawaxen River; Wayne Co., PA
Trexler	WSA, FL, REC	39,900	14,000	Jordan Creek; Lehigh Co., PA
STATE				
Hackettstown	WS or WSA, REC	30,500	none	Musconetcong River; Warren, Sussex Co., NJ
Newark	WS, REC	30,000	none	White Clay Creek; New Castle, DE; Chester Co., Pa.
Evansburg	WS, REC	25,000	none	Skippack Creek; Montgomery Co., PA
OTHER				
Cannonsville (Modified)	WS/WSA	40,800 (Modified)	none	W. Branch Delaware River, Delaware Co., NY
Icedale	WS/WSA, FL, REC	14,600	-	W. Branch Brandywine Creek, Chester Co., PA

Impoundment	Purposes[1]	Storage Acre-feet WSA/WS (total usable)	FL	Location Stream, County, State
ON-STREAM IMPOUNDMENTS SELECTED BY RUS/MADIGAN-PRAEGER				
McMichael	WSA, FL	19,500	25,000	McMichael Creek; Monroe Co., PA
Shohola Falls	WSA, FL	18,000	24,000	Shohola Creek; Pike Co., PA
Girard	WSA, FL	18,000	24,000	Bushkill Creek; Monroe Co., PA
Tobyhanna	WSA	86,700	none	Lehigh River; Carbon, Monroe, Lackawaxen, and Luzerne Co., PA
Hawley	WSA, R1	28,000	31,700	Middle Creek; Wayne Co., PA
Lackawaxen	WSA	176,000	none	Lackawaxen River; Pike Co., PA
OFF-STREAM IMPOUNDMENTS				
Cherry Creek	WS/WSA	430,000	none	Cherry Creek; Monroe Co., PA
Equinunk	WS/WSA	133,000	none	Equinunk Creek; Wayne Co., PA
Flat Brook	WS/WSA	247,000	none	Flat Brook; Sussex Co., NJ
Little Martins Creek	WS/WSA	88,000	none	Little Martins Creek; Northampton Co., PA
Merrill Creek	WS/WSA	52,500	none	Merrill Creek; Warren Co., NJ
Milanville	WS/WSA	131,000	none	Calkins Creek; Wayne Co., PA
Pidcock Creek	WS/WSA	150,000	none	Pidcock Creek; Bucks Co., PA
Mill Creek	WS/WSA	64,000	none	Mill Creek, Berks County, PA
Red Creek	WS/WSA	81,000	none	Red Creek, Schuylkill Co., PA

[1]WSA - Water supply primarily for flow augmentation to replace depletive uses and meet instream needs.
WS - Water supply primarily for local usage.
FL - Flood loss reduction.
REC - Recreation.
PS - Pumped storage (Hydroelectric Power).

TABLE 19

ANALYSIS OF FOUR FEDERAL IMPOUNDMENTS IN THE DRBC COMPREHENSIVE PLAN*

A. FRANCIS E. WALTER IMPOUNDMENT MODIFICATION PROJECT

Economic Impact	Environmental Impact	Social Impact
Beneficial Effects		
1. Increase sustainable flow by approximarely 290 cfs in Delaware River at Trenton. 2. Continues existing flood control benefit. 3. Annual recreation benefit of $1.2 million. 4. Project benefit-cost ratio of 1.6.	1. Increase existing 80 acre semi-permanent lake to 1295 acre semi-permanent lake; provide 69,500 acre-feet of long term storage for low-flow augmentation. 2. Project includes 1300 acres of recreation land not subject to inundation.	1. Recreation accomodation for an additional 943,600 visitors annually.
Adverse Effects		
1. Investment cost of $61 million. a. Includes real estate acquisition cost of $5.5 million. 2. Annual cost of project $4.5 million.	1. Loss of free-flowing characteristics of 7.0 miles of Lehigh River and 4.0 miles of Bear Creek. 2. Permanent inundation of 1215 acres of grass land and mixed hardwood forest. Periodic inundation of 560 acres of hardwood forest.	1. Loss/relocation of 8 homes.

B. PROMPTON IMPOUNDMENT MODIFICATION PROJECT

Economic Impact	Environmental Impact	Social Impact
Beneficial Effects		
1. Increase sustainable flow by approximately 130 cfs in Delaware River at Trenton. 2. Average annual flood loss reduction of $ .2 million (Life of existing capability is extended.) 3. Annual recreation benefit of $0.4 million. 4. Project benefit/cost ratio of 1.4	1. Increase existing 290 acre lake to 720 acres; provide 30,900 acre feet of long term storage for low-flow augmentation. 2. Project includes 997 acres of additional recreation land not subject to inundation.	1. Recreation accomodation for 250,000 visitors annually. Recreation was not an original purpose but there were 127,000 visitors in Year 1977.
Adverse Effects		
1. Investment cost of $28.5 million. a. Includes real estate acquisition cost of $3.2 million. 2. Annual cost of project of $2.4 million.	1. Loss of free-flowing characteristics of 4.4 mile of Lackawaxen River and portions of several tributaries. 2. Permanent inundation of an additional 380 acres of hardwood forest and grassland.	1. Loss/relocation of 17 homes. 2. Relocation of two sections of highway. 3. Relocation of small cemetery.

*Cost data presented in Year 1977 price levels, 6-5/8 percent discount rate and 100-year economic life.

TABLE 19 (contd.)

C. AQUASHICOLA IMPOUNDMENT PROJECT

Economic Impact	Environmental Impact	Social Impact
Beneficial Effects		
1. Increase sustainable flow by approximately 100 cfs in Delaware River at Trenton. 2. Average annual flood loss reduction of $.8 million. 3. Annual recreation benefit of $.2 million. 4. Project benefit/cost ratio 1.2.	1. Provide 900 acre semi-permanent lake 24,000 acre-feet of long term storage for low-flow augmentation. 2. Provide 20,000 acre-feet of flood control storage. 3. Project includes 1250 acres of recreation land not subject to inundation.	1. Flood stage reduction downstream of damsite, principal centers include Palmerton, Walnutport, Northampton, Hokendauqua, Catasauqua, Allentown, Bethlehem, Freemansberg, and Easton. 2. Recreation accomodations for 156,000 visitors annually.
Adverse Effects		
1. Investment cost of $92 million. a. Includes real estate acquisition cost of $7.6 million. 2. Annual cost of project of $6.7 million.	1. Loss of free-flowing characteristics of 5.7 miles of Aquashicola Creek, 3.4 miles of Buckwha Creek, and lower portions of numerous tributaries. 2. Permanent inundation of 900 acres; composed of 580 acres of forest, 170 acres of agriculture or abandoned fields, 120 acres of residential and commercial land, and 30 acres of stream. Periodic inundation of 290 acres, mostly wooded.	1. Loss/relocation of about 150 homes. 2. Loss of majority of communities of Little Gap and Walkton. 3. Loss of 10 farms, 12 businesses.

D. MAIDEN CREEK IMPOUNDMENT PROJECT

Economic Impact	Environmental Impact	Social Impact
Beneficial Effects		
1. Increase sustainable flow of approximately 310 cfs in Delaware River at mouth of Schuylkill River. 2. Average annual flood loss reduction of $1 million. 3. Annual recreation benefit of $1.3 million. 4. Project benefit/cost ratio of 1.1.	1. Provide 2500 acre semi-permanent lake and 74,000 acre-feet of long-term storage for low-flow augmentation. 2. Provide 38,000 acre-feet of flood control storage. 3. Project includes 5600 acres of recreation land not subject to inundation.	1. Flood stage reduction downstream of dam site, principal center include Reading, Pottstown, Birdsboro, Norristown, Conshohocken, Manayunk, and Philadelphia. 2. Recreation accomodations for 930,000 visitors annually.
Adverse Effects		
1. Investment cost of $149 million. a. Include real estate acquisition cost of $34.2 million. 2. Annual cost of project of $10.6 million.	1. Loss of free-flowing characteristics of 10 miles of Maiden Creek, 7 miles of Saxony Creek and portions of numerous small tributaries. 2. Permanent inundation of approximately 2500 acres, composed of 1700 acres of agricultural land, 650 acres of forest, 100 acres of residential land, and 50 acres of streams. Periodic inundation of approximately 820 acres, principally rolling farmland. 3. Appears to have considerable eutrophication potential. 4. Flooding of two limestone caves of significant natural importance.	1. Loss/relocation of 418 homes. 2. Loss of majority of communities of Lenhartsville and Virginville. 3. Loss of 64 farms. 4. Relocation of numerous roads.

in the DRBC Comprehensive Plan, were evaluated for beneficial and adverse economic, environmental and social impacts. Basic data were derived from material submitted to the Commission by the U. S. Army Corps of Engineers.

The Tocks Island and Trexler projects were not included in this analysis although both remain in the Comprehensive Plan and are authorized by Congress for construction by the U. S. Army Corps of Engineers. Both proposed projects have been recently studied and evaluated (Tocks in the URS/Madigan-Praeger report of 1975 and Trexler by the U. S. Army Corps of Engineers). The Commonwealth of Pennsylvania has dropped the Trexler Project from the State Water Plan.

Federal legislation to establish the Delaware Water Gap National Recreation Area and to designate the middle Delaware River as part of the national Wild and Scenic River System, while it does not deauthorize the Tocks Island Project, imposes legal difficulties which must be overcome if the project is to be actively considered. The Commission is obligated to protect all rights of the parties to the 1954 U. S. Supreme Court Decree. Therefore, before taking any action which might affect a main stem impountment, the Commission must be satisfied that such rights are fully preserved. The site is largely preserved in federal ownership, and the present policy of support for only non-intensive capital improvements within the park does not rule out its use for a reservoir.

(2) Hackettstown Project

New Jersey has indicated the intention to proceed with development of the Hackettstown Project. There was minimal detailed information available on the potential Hackettstown Project for use in the Level B Study. In addition to flow augmentation capability for the Delaware River, the project would provide long-term future water supplies and would provide immediate recreational benefits (NJDEP, June 1980).

(3) Other Projects in Commission's Comprehensive Plan

The Evansburg and Icedale Projects in Pennsylvania, and Newark Project in Delaware, all in the Commission Comprehensive Plan, are primarily proposed for water supply projects and not designed for flow augmentation. No change in this status appears warranted. Evansburg, a proposed state project with 25,000 acre feet of storage has a net yield of 36 cfs at the dam site. It could be used for flow maintenance in the Schuylkill River during a drought emergency. The State of Delaware has stated that the Newark Project on White Clay Creek will not be viable until after the year 2000.

The Icedale Project would have moderate benefits to the Estuary but is primarily for water supply benefit to Chester County, Pennsylvania, and other downstream users in Pennsylvania and Delaware.

(4) Projects Selected by URS/Madigan-Praeger

The URS/Madigan-Praeger study identified seven on-stream impoundments as a partial alternative to the Tocks Island Project. In addition to the Hackettstown Project these impoundments were: Girard, Hawley, Lackawaxen, McMichael, Shohola Falls and Tobyhanna. The location, cost and environmental concerns are displayed in Table 20.

(5) Cannonsville Modification

An enlargement of the New York City Cannonsville Reservoir using flashboards is described in a report of the Temporary State Commission on the Water Supply Needs of Southeastern New York (Dec. 15, 1973). This modification would increase storage in Cannonsville by 13.3 billion gallons. The reservoir level would be increased by eight feet. This extra storage would be of benefit to both New York City and other Delaware River users.

b. Off-Stream Storage Impoundments

Seven off-stream storage impoundments were selected from the 1976 report, "Site Study for Water Supply Reservoirs, Delaware River Basin" prepared for the Delaware River Basin Electric Utilities Group by Tippetts-Abbett-McCarthy-Stratton. The selection was based on an earlier U. S. Army Corps of Engineers analysis of the potential for off-stream reservoirs. The analysis was based on the assumption that no water would be taken from the Delaware River when Montague and Trenton, New Jersey, flows were less than 1750 cfs and 3000 cfs, respectively. Table 21 presents the economic, local environmental and local social impacts of these seven projects. These are the Equinunk, Milanville, Cherry Creek, Little Martins Creek, Merrill Creek, Pidcock Creek, Flat Brook, Red Creek, and Mill Creek Projects.

c. Hydrologic Evaluation of Impoundments

The augmentation yield of a given impoundment is the contribution made by said impoundment to a sustainable flow at an identified downstream point under prescribed drought conditions. The

TABLE 20

PRELIMINARY ANALYSIS OF SIX PROJECTS
RECOMMENDED BY URS/MADIGAN PRAEGER

Project	Benefit/Cost Ratio[1]	Major Environmental & Social Concerns
McMichael	$3.2 million/$5.2 million = .6[2]	Portion Route 209, 200 buildings in impoundment pool area.
Shohola Falls	$2.6 million/$3.0 million = .9[2]	Portion Interstate 84 would be inundated. There is an existing Pennsylvania Game Commission reservoir at project site.
Girard	$3.3 million/$6.4 million = .5[2]	50 buildings in impoundment pool area. Stream (Bushkill) has highest level priority as a state scenic river.
Tobyhanna	$9.1 million/$6.2 million = 1.5[3]	70 buildings, gravel pits, utilities, ski slopes in impoundment pool area. Some hydrologic conflict with Walter Dam.
Hawley	$4.1 million/$8.0 million = .5[2]	20 buildings, ski area in impoundment pool area.
Lackawaxen	$18.2 million/$20.1 million = .9[3]	190 buildings, a cemetery, gravel extraction, and a railroad which is extremely important to the prosperity of the local region, are in the impoundment pool area.

1
Average annual multipurpose benefits and costs, October 1977 price levels, 6-5/8 percent interest, 100 year economic life. (Corps of Engineers, September 1978)

2
It is unlikely that Congress would approve a project with a benefit/cost ratio less than 1.0.

3
A single purpose impoundment such as Lackawaxen or Tobyhanna would not need Congressional approval. The others are water supply augmentation and flood control projects.

*Source: Information prepared for Level B by U. S. Army Corps of Engineers, September 1978.

TABLE 21

ANALYSIS OF NINE OFF-STREAM STORAGE IMPOUNDMENTS

SYSTEM OF ACCOUNTS[5]

Project	Local Environmental	Local Social
Equinunk[1]	Inundate 1520 acres, 150 acres farm land; deer and trout habitat lost; pumping facilities in Scenic River portion; expose 100-400 acres at drawdown; survival of dislocated wildlife unknown; develop new lake fishery and recreation opportunities.	Loss/relocation of 35 residences, 5 farms, 2 businesses, 7 miles of road; disruption of popular deer hunting - trout fishing; some additional recreation traffic.
Milanville[1]	Inundate 1925 acres, 1640 acres forest; 400 acre farm; possible visual impact on Delaware River; pumping facilities in scenic river portion; expose 220-475 acres at drawdown less of wildlife habitat, survival potential for dislocated wildlife appears good.	Loss/relocation of 49 homes, 12 farms, 1 business, 10 miles of road; loss of 70 man days/year trout fishery.
Cherry Creek[1]	Inundate 3750 acres; 1900 acres farm land; expose some 590 acres at drawdown; convert cold water to warm water fishery; significant loss of wildlife habitat; loss of rare woodcock population; develop large lake with recreation potential, fishing, boating, vacation homes, provide new waterfowl habitat in North Atlantic Flyway.	Loss/relocation of 165 homes, 35 farms, 8 businesses, 22 miles of road; disrupt 4 large power lines, 1 telephone cable, 1 electric substation, 1 water pumping station, 3 churches, 2 schools, 3 cemetaries, 3 state historical sites, many 19th century homes, 1 golf course; reservoir would add recreation pressure and income.
Little Martins Creek[1]	Inundate 1260 acres, 800 acres farm land; expose 110-380 acres at drawdown; little loss of wildlife habitat; conversion of cold water to warm water fishery.	Loss/relocation of 42 homes, 15 farms, 1 business, 12 miles of road; relocate 2 electric and 1 gas line; loss of 1000 man days/year trout fishing.
Merrill Creek[1,6]	Inundate 670 acres, mostly forested, existing 10-acre lake; expose 520 acres at maximum drawdown; loss of wildlife habitat; loss of 1.8 miles of trout stream.	loss/relocation of 6 homes, some local roads, owners of 20-25 homes immediately downstream feel threatened; probable recreation development pressure and income.
Pidcock Creek[3]	Inundate estimated 4160 acres, 2700 acres prime agricultural land.	Loss/relocation of homes of 310 persons; 12 existing structures in state historic register and 25 structures proposed; 1 structure on National Historic Register; encroachment on Bowmans Hill Wildflower Preserve and Washington Crossing State Park; 1 church and historic cemetary.
Flat Brook[2,4]	Inundate 2940 acres and about 12 miles of high value trout stream.	Loss/relocation of 1 church, 2 cemeteries, approximately 140 houses and other structures, village of Wallpack Center, USGS gaging station. Relocation of about 16 miles of roads.
Red Creek[1]	Inundate 1160 acres, expose 390 acres at drawdown; expected to reduce flow in Schuylkill River because of pumping.	Loss/relocation of 24 homes, 17 farms, 1 business. Relocation of 5 miles of local roads, 1 bridge, local telephone and electric lines.
Mill Creek[1]	Inundate 1700 acres, disrupt good game bird habitat, possibly create new waterfowl habitat.	Loss/relocation of 1 cemetary, 62 homes, 20 farms, 2 businesses. Relocation of 6 miles of local roads and part of Old Highway 22; realign approximately 4 miles of I-76; relocate ARCO pipeline and pumping station, Township building and 1 power line. Loss of 1 State Historic Site and several 18th century buildings.

1 TAMS, 1976, "Site Study for a Water Supply Reservoir Delaware River Basin."

2 URS/Madigan-Praeger, Inc. 1975, "A Comprehensive Study of Tocks Island Lake Project and Alternatives;" Personnel Communication, New Jersey Department of Environmental Protection.

3 Personal communication, Bucks County and Upper Makefield Township Planning Commissions, Upper Makefield Township Board of Supervisors and Historic Commission of Upper Makefield Township.

4 DRBC Map Study.

5 Capital Cost shown in Table 23.

6 DRBC, Environmental Assessment for the proposed Merrill Creek Reservoir Project, March 1978.

sequencing of construction/ operation on impoundment in relation to other impoundments is critical to determining augmentation yield. The augmented yield for each additional unit of storage decreases as the total amount of storage increases.

For impoundments included in the Commission's Comprehensive Plan, the HEC-3 computer model (Hydrologic Engineering Center, Computer Program No. 3, developed by the U. S. Army Corps of Engineers) was used to determine the augmentation yield at Trenton. This analysis of impoundments simulates the operation of existing and proposed impoundments and can be used to determine the maximum sustainable monthly average flows at a selected control point, Trenton, New Jersey, in this case.

Because other impoundments were not readily subject to HEC-3 analyses, a less sophisticated, approximate method was employed to determine the augmentation yields for all projects. Total storage available for flow augmentation was assumed to be released from full to empty storage over a 120-day period. This method approximates the resultant augmentation yield in the Delaware River at Trenton for the drought-of-record. This approximate method gives unrealistically high augmented yields for very large amounts of storage because of the diminishing return of augmented yield per unit storage.

Following is a comparison of HEC-3, and the approximate method analyses, for augmentation yields:

TABLE 22

Augmentation Yields, for Selected Projects, at Trenton, N.J. Gage of Delaware River

Impoundment	HEC-3 Augmentation Yield, cfs	Approx. (Storage Divided by 120 Days) Augmentation Yield, cfs
Francis E. Walter Modification	285	290
Prompton Modification	130	130
Aquashicola	100	100
Maiden Creek	Not applicable to Trenton gage analysis	310
Trexler	140	165
Hackettstown	70	130

The largest discrepancy between the HEC-3 determined augmented yield and the approximate method determined yield in Table 22 is for Hackettstown. This is undoubtedly due to the fact that the Musconetcong River, which would be dammed by the project, did not behave in similar drought-of-sixties hydrologic fashion as the other five.

The Tocks Island Project augmented yield at Trenton is largely dependent on what Tocks Island dam site minimal release is selected. Because of this variability, and the relative certainty that this project would not be considered in the Preferred Plan, no HEC-3 analysis is presented. Because of the magnitude of the storage that would be provided by the Tocks Island Project, the approximate augmented yield method overstatea the true yield.

More sophisticated daily reservoir operation modeling being performed under the direction of the U. S. Army Corps of Engineers will provide a means to better estimate project augmented yields in the future.

d. Local Impacts of Impoundments

The Level B Study requested the assistance of the county planning commissions in the five Pocono area counties to assess the local economic, social and environmental impacts of both the URS/Madigan-Praeger suggested projects and the off-stream storage impoundments in that area. The data sought, as agreed to by representatives of the county planning commissions, the U. S. Army Corps of Engineers, the Pennsylvania Department of Environmental Resources and the DRBC staff were:

--Amount of land, homes and significant municipal facilities flooded by pool.

--Amount of lost farmland, tax base and disruption to local economy.

--Potential interference with local or regional transportation.

--Potential interference with other utilities (oil, gas, communication, electricity).

--Historical or archeological sites encompassed by the project.

--Effect of project on environmental resources, including loss of game or wildlife habitat, and alteration of fishery from cold to warm water.

--Assessment of public attitude toward the project.

e. Emergency Flow Augmentation from Ground Water Pumpage

The Level B Study undertook a reconnaissance study of the potential for use of ground water contained in glacial drift deposits to augment River flows. It was found that approximately 108 square miles of "highly productive" drift deposits lie above Trenton. Of these, "high yield" deposits could yield as much as 1220 cfs, of which 950 cfs would originate below New York City reservoirs (roughly 1 cfs per well) (Goodman, 1978).

Additional studies and pilot programs would be needed to determine the feasibility and environmental consequences of such a plan. The Level B Study identified the following impacts of the project:

Economic--Estimated cost to provide 1220 cfs (788 mgd) is $327,555/cfs; phased construction of wells would be practical; administrative cost to oversee, maintain, test and operate system would be required.

Environmental--There would be temporary, severe pumpage of certain aquifers, but little effect on land uses. The visual impact of numerous well houses and transmission mains would be reduced by underground placement.

Social--There would be possible competition with farmers for irrigation waters. This system would encourage less extensive development of flood plains.

3. Comparison of Potential Impoundments

Table 23 summarizes the cost and augmented yield at Trenton for 23 of the 26 potential impoundments.

Not listed, for reasons previously discussed are the Icedale, Evansburg and White Clay Projects.

The Merrill Creek Project, as shown in Table 23 was not analyzed from a cost and yield standpoint in identical manner to that being used in the Environmental Assessment prepared by the DRBC. The Assessment lists 46,000 acre-feet of usable water storage, a 200 cfs yield for 115 days, and a year 1977 cost of $79,800,000. The data presented in Table 23, provided by the U.S. Army Corps of Engineers, were based on earlier work, and is used so that all projects can be compared on a common statistical base.

4. Ranking of Projects

The evaluative information and data were reviewed by the Study's Plan Formulation Work Group. The Group recognized that:

--The quality and completeness of available information varied significantly among projects;

--Reconciliation of conflicting information, identification of all historic or archeological sites, and the presence of endangered species, as well as questions involving detailed engineering design cannot be answered until more detailed studies have been done.

The Study's Plan Formulation Work Group working with the Level B staff ranked the projects in three categories of environmental and social impacts, as shown in Table 24, recognizing these reservations.

The Cannonsville Modification, introduced after the Formulation Work Group's ranking, is considered to be in the "Least Environmental and Adverse Social Impact" category.

5. Selection of Projects for Preferred Plan

After consideration of all potential projects, discussion among state environmental officials, and analysis by Good Faith discussants, the following 5 projects were included in the Preferred Plan:

Francis E. Walter Modification
Prompton Modification
Hackettstown
Merrill Creek (offstream storage)
Cannonsville Modification

These projects have the following yields on a project-by-project basis:

Francis E. Walter Modification	290 cfs
Prompton Modification	130
Hackettstown	130
Merrill Creek	220
Cannonsville Modification	85

As a system, the combined yield of these projects would be approximately 750 cfs.

TABLE 23

COST AND AUGMENTED YIELD OF PROPOSED IMPOUNDMENTS FOR FLOW AUGMENTATION

Project	(A) Allocated Capital Cost for Flow Augmentation[1]	(B) Augmented Yield, cfs Delaware River at Trenton[2]	(A ÷ B) Capital Cost per cfs Augmented Yield
	Comprehensive Plan Impoundments		
Aquashicola	$ 70 million	100	$700,000
Maiden Creek	$101 million	310[3]	$330,000
Prompton (Mod.)	$ 19 million	130	$150,000
Tocks Island	$152 million	1790	$ 85,000
Trexler	$ 28 million	165	$170,000
Walter (Mod.)	$ 46 million	290	$160,000
	Impoundments Identified by URS/Madigan-Praeger		
Girard	$ 46 million	80	$570,000
Hawley	$ 73 million	120	$610,000
Hackettstown	$ 45 million[5]	130	$350,000
Lackawaxen	$261 million	740	$350,000
McMichael	$ 44 million	80	$550,000
Shohola Falls	$ 27 million	80	$340,000
Tobyhanna	$ 77 million	350	$220,000
	Other (Cannonsville Mod.)		
Cannonsville (Mod.)	$ 1 million[4]	85[4]	$ 12,000
	Off-Stream Impoundments		
Cherry Creek	$210 million	1800	$117,000
Equinunk	$133 million	560	$240,000
Flat Brook	$125 million	1050	$120,000
Little Martins Creek	$ 96 million	370	$260,000
Merrill Creek	$ 88 million	220	$400,000
Milanville	$115 million	550	$210,000
Pidcock Creek	$122 million	620	$200,000
Mill Creek	$ 79 million	270[3]	$290,000
Red Creek	$ 81 million	340[3]	$240,000

FOOTNOTES TO TABLE 23

[1] Costs for the on-stream impoundments (Comprehensive Plan impoundments, those identified by URS/Madigan-Praeger, and the Cannonsville modification) are based on October 1977 costs. Costs for off-stream impoundments based on the 3 percent higher June 1978 costs. There is no need for further refinement - costs and yields are approximate.

[2] Augmented yield estimated by dividing flow augmentation storage by 120 days; assumes full to empty storage uniform withdrawal for this period of time.

[3] Augmented yield at confluence of Schuylkill River with Delaware River. Same method as Note 2 used for determining equivalent flows for salinity repulsion purposes.

[4] Assumes half of project cost and storage dedicated for flow augmentation of Delaware River at Trenton.

[5] Cost discounted to 1977 dollars. No allocation for future Water supply or recreation benefits.

TABLE 24

RANKING OF PROJECTS FOR LOW-FLOW AUGMENTATION

		Environmental and Adverse Social Impact		
Facility	Capital Cost/cfs $	Least	Moderate	Significant
Cannonsville	12,000	x		
Tocks	85,000			x
Cherry Creek	117,000			x
Flat Brook	120,000			x
Prompton (modified)	150,000	x		
Walter (modified)	160,000	x		
Trexler	170,000			x
Pidcock Creek	200,000			x
Milanville	210,000			x
Tobyhanna	220,000			x
Equinunk	240,000			x
Red Creek	240,000		x	
Little Martins Creek	260,000		x	
Mill Creek	290,000		x	
Maiden Creek	330,000			x
Shohola Falls	340,000			x
Lackawaxen	350,000			x
Hackettstown	350,000		x	
Merrill Creek	400,000	EIS in preparation by DRBC		
McMichael	550,000			x
Girard	570,000			x
Hawley	610,000			x
Aquashicola	700,000		x	
Alluvial Ground Water Pumping	327,000	-----unknown-----		

This method of estimating augmented yield appears to produce slightly high yields. The HEC-3 model runs had the capability to include the Walter and Prompton Modifications, Hackettstown and other Comprehensive Plan Projects; but not Merrill Creek and the Cannonsville Modification. Examination of augmented yields from the various HEC-3 model runs indicates that the five project Preferred Plan system will provide an augmented yield of approximately 85% of the sum of individual project yields. Applying this 85 percent factor, the Preferred Plan system yield is approximately 750 cfs. This yield will meet the revised salinity standard of the Preferred Plan.

In modeling efforts using the drought of record it is possible to optimize reservoir operations with full knowledge of all conditions. Any future drought of comparable severity will not match the drought of record exactly. It is impossible to determine the severity of a drought until it is over. In an actual drought situation of comparable severity to the design drought, there will be flow capability advantages and disadvantages based upon the particular sequence of events. Operation of reservoirs during a future drought will be based upon judgmental decisions of the Commissioners made after careful consideration of a number of factors such as location of the salt front, storage in the New York City and other reservoirs, and ground water conditions. Improved modeling capability and more precise data will continue to refine optimum salinity control.

E. Comprehensive Plan Amendments

A major purpose of the Level B Study was to provide a basis for updating the Delaware River Basin Commission's Comprehensive Plan. Proposed Amendments to the Plan include specific recommendations for new and revised policies and standards, as well as inclusion and removal of projects from the Plan.

1. Background

The purpose of the Comprehensive Plan, as set forth in the Delaware River Basin Compact, is to provide a framework for the immediate and long-range development and use of the water resources of the Basin. The Plan should include all public and private programs and facilities which are required, in the judgment of the Commission, for optimum planning, development, conservation, utilization, management, and control of the water resources of the Basin.

2. Recent Commission Actions

Subsequent to the release of the draft Delaware River Comprehensive (Level B) Study in October 1979, the Commission implemented certain items detailed in the Study. These actions do not specifically address each of the problem statements for the major water and land resource problem areas; rather, they represent those management options inherent in the Commission's current programs. These actions were as follows:

a. Water Conservation

This program was initiated by inclusion of conservation policy in the Comprehensive Plan (Resolution No. 76-17, Nov. 10, 1976). The policy is committed to include regulatory and incentive measures for the promotion of conservation. The Commission's aim is to cut withdrawals of surface and ground water supplies, establish priorities among competing water users during a drought and support rehabilitation of old cities' water systems. Yet the net effect of some of these actions on depletive water uses is uncertain. Beginning September 29, 1980, the Commission undertook a 2-year study of the impact of industrial water conservation and reuse upon depletive use.

b. Water Quality

The Commission is seeking funding from the U.S. Water Resources Council (Resolution No. 80-12) to conduct a water quality study of Zone 2 of the Delaware Estuary (from R.M. 133.4 to R.M. 108.4). This reach of the Estuary receives major loads of pollutants with oxygen demand from upstream sources. The purposes of this study are to develop alternative solutions to the water quality problems manifested in Zone 2, and recommend an equitable distribution of solution costs.

c. Flow Maintenance

A management option for flow maintenance is the development of additional storage capacity. The Commission, by Resolution No. 80-7, has urged the U. S. Corps of Engineers to initiate detailed design studies of the Francis E. Walter project modification.

d. Water Supply

The Commission's ground water study, begun in 1979, has the ultimate objective of instituting a long-range Basinwide ground water management plan.

By Resolution No. 80-18, the Commission delineated and declared, under Article 10 of the Compact, a ground water protected area in southeastern Pennsylvania. The Resolution institutes an expanded management program, including restrictions on water use, extension of prior permit requirements, conservation requirements, and registration of existing withdrawals.

By Resolution No. 79-17, the Commission added its support of the federal authorization of a Stage 1 feasibility report on augmentation of metropolitan New York City's water supplies from the Hudson River Basin.

e. Fish and Wildlife

On May 25, 1977, (Docket No. D-77-20) the Commission approved modification of the release schedule for Cannonsville, Pepacton and Neversink reservoirs on an experimental basis to assess the physical, chemical, biological, recreational, and economic impacts of increased and more uniform releases.

f. Recreation

The Commission authorized the Executive Director on May 28, 1980, to enter into contracts with the National Park Service to provide staff services in the preparation of a management plan for the upper Delaware Scenic River. This is now under way.

g. Energy

By Resolution No. 79-24, the Commission encourages development of small-scale hydroelectric power at existing and proposed impoundments in the Delaware Basin. Further, subject to the availability of funds, the Commission will undertake feasibility studies of the hydroelectric power potential of Francis E. Walter, Beltzville, Blue Marsh and Prompton reservoirs.

By Resolution No. 80-8, the Commission subsequently identified the institutional framework to conduct such feasibility studies and the priority preference for energy developed at these facilities.

3. Proposed Additions and Amendments to the Comprehensive Plan

Portions of the Preferred Plan would require additions and amendments to the Delaware River Basin Commission's Comprehensive Plan. These are:

a. Policy

Planning will encompass conservation programs, New York City release schedules to maintain flows in the Delaware River at the Montague Gage, and scheduling of new and modified impoundments.

(1) Design Drought--A drought of a severity of that of the mid-1960's shall be used as the basis for all long-range flow maintenance plans.

(2) Rise in Sea Level __The continuing rise in sea level will be considered in projections of future flow requirements for salinity control, water supply, and water quality.

(3) Drought Operation--Releases from Commission-controlled impoundments will be made after consideration of the combined storage volume in the New York City Cannonsville, Pepacton and Neversink Reservoirs, the amount of storage in other impoundments and the extent of salinity intrusion into the Estuary.

(4) Conservation--Contingency plans shall be prepared by each Basin state for phased implementation during periods of drought warning and drought aimed at reducing depletive use of fresh water by 15%.

(5) Water Allocation--Under the Compact (Section 3.3) "The Commission shall ...in accordance with the doctrine of equitable apportionment... allocate the waters of the basin to and among the states..." Consistent with this authorization the Commission will equitably allocate available water for depletive use with consideration for each state's participation in flow management capability through impoundments or reduction in depletive use.

b. Standards

(1) Salinity--A maximum 30-day average of 121 mg/l of chlorides and/or 67 mg/l of sodium at River Mile 98.

(2) Flow Maintenance

--Delaware River at Trenton, New Jersey: not less than 3100 cfs at all times.

--Delaware River at Montague, New Jersey: not less than 1750 cfs except during drought conditions.

--[The magnitude of conservation and thermal stress releases from New York City Delaware River Basin reservoirs to enhance the Upper Basin's fisheries are not defined at this time].

(b) Drought Conditions--During drought warning or drought conditions based on storage levels in New York City's upper-Basin reservoirs, the following releases and flow objectives:

Item	Drought Warning	Drought Condition
--Max. diversion by City of New York	600 mgd	480 mgd
--Min. flow objective Del. R. at Montague	1650 cfs	1600 cfs
--Diversions by N.J. via Del. & Raritan Canal or other transmission systems	75 mgd	60 mgd

c. Projects

(1) Deleted Project--The Maiden Creek Project is to be deleted from the Comprehensive Plan:

(2) New and Modified Projects--The following projects are to be constructed or modified:

(a) Merrill Creek Project
(b) Francis E. Walter Project Modification
(c) Prompton Project Modification
(d) Hackettstown Project
(e) Cannonsville Project Modification

(3) Projects Retained in the Comprehensive Plan

The Aquashicola, Evansburg, Icedale and Newark Projects are retained in the Comprehensive Plan for future consideration.

The Trexler Project is to be retained only if needed to meet future water supply needs of Allentown and its environs.

The Tocks Island Project is to be retained in the Comprehensive Plan for consideration after the year 2000.

The Commission will give further consideration to the inclusion of the middle Delaware River as a scenic and recreational river in the Comprehensive Plan, provided that the rights of all of the parties to the 1954 Supreme Court Decree are fully protected.

PART III FINAL ENVIRONMENTAL IMPACT STATEMENT

PART III

FINAL ENVIRONMENTAL IMPACT STATEMENT

LEVEL B STUDY

DELAWARE RIVER BASIN

Responsible Lead Agency

DELAWARE RIVER BASIN COMMISSION

A. Abstract: Alternative management options are considered in each functional area. Each option is assessed with regard to environmental, economic and social impacts. Options and their likely impacts are presented together for citizen and agency comment. The EIS outlines how five EIS requirements of Section 102(c) of NEPA have been incorporated in the course of formulation of the Mixed Objective Level B Plan. For further information contact Mr. J. W. Thursby, Head of Environmental Unit, DRBC, (609)883-9500.

B. Environmental Impact Statement

Summary--The Level B Study presents "Summary of Proceedings, Major Findings, Conclusions, and Preferred Plan" in Part I. That Summary and Preferred Plan are applicable to this EIS.

1. Relation of EIS to the Level B Study--The goals of the Delaware River Basin Level B Study have been consistent with the six NEPA objectives since the program's inception, and the NEPA process was closely linked to plan formulation. Alternative management options were considered in each functional area. In keeping with the Water Resources Council's "Principles and Standards," each option was assessed with regard to environmental, economic and social impacts even before the decision as to which options should be included in the alternative plans was made. During the iterative public review process, the options and their likely impacts were presented together for citizen and agency comment. Consequently, the Level B planning process has met the requirements of NEPA as it proceeded, and the Level B report is, in itself, its own environmental impact statement. This chapter serves merely to outline how the five EIS requirements of Section 102(c) of NEPA have been incorporated in the course of formulation of the Mixed Objective Level B Plan. The Preferred Plan is drawn from the Mixed Objective alternative as amended in this Report to include a higher degree of salinity protection. Discussion of the Mixed Objective environmental impact encompasses the Preferred Plan.

Since this EIS is an integral part of the Level B Study, the cover sheet and contents - as well as the summary for that study, also apply to this EIS.

2. Need for and Objectives of Action--The Level B Study Part I outlines the need for the objectives of the Level B Study.

The need for and objectives of this EIS are to respond to the National Environmental Policy Act of 1969 (NEPA), wherein Congress set six specific national objectives for the environment, and assigned to federal agencies the responsibility for improving and coordinating their plans, functions, and programs so that they might be achieved.

--Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.

--Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.

--Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.

--Preserve important historical, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.

--Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.

--Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

To achieve these objectives, the Act requires all federal agencies to utilize a "systematic, multi-disciplinary approach" in decision-making when the environment may be affected; to solicit comments from appropriate agencies at all levels of government; and to prepare an environmental impact statement (EIS) on any major federal action.

The Council on Environmental Quality, in its 1979 revisions to the regulations implementing NEPA procedures (40 CFR 1500-1508), stressed the importance of integrating the NEPA process and the planning process so that they run concurrently rather than consecutively. Without such integration, it is difficult to have effective public participation in decisions affecting the environment and impossible to compare alternative actions on the basis of potential environmental impacts--two other

CEQ policy concerns expressed in the new regulations (40 CFR 1500.2).

DRBC, unlike federal agencies generally, must also amend its Comprehensive Plan to incorporate such projects, programs and policies of the Preferred Plan that it determines appropriate. The Level B process and this E.I.S. will form the basis for any subsequent action by DRBC concerning its Comprehensive Plan.

3. Alternatives to the Proposed Action--Alternative management options for water conservation, water quality, flow maintenance, water supply, flood loss reduction, fish and wildlife, recreation, energy and navigation were developed with extensive public input in the early phases of the Level B Study. These were compiled in the Preliminary Draft Final Report, released in February 1979. The report included evaluation of environmental, economic and social impacts of each plan. Following public workshops and meetings, the options were refined and the Level B staff, working with the Plan Formulation Work Group, tentatively sorted them into three alternative plans for review by the Commission in June 1979. (See "Briefing Statement for the Formulation of Alternative Water Management Plans"). A revised set of three alternative plans resulted--the National Economic Development Plan, the Environmental Quality Plan, and the Mixed Objective Plan. The three alternatives were compared in the Draft Final Report (October 1979) and the environmental, social, and economic impact assessment of plan components were included in the Appendix. This information is included in this Report's Appendix also.

4. Affected Environment--This Report's Part II, Section B presents the environment and problems of the Basin including physical facilities, population and land use, water conservation and supply, water quality, flow maintenance, flood loss reduction, recreation, fish and wildlife, and water management strategies.

5. Environmental Impacts of the Proposed Action--This Report's Part II, Section D presents beneficial and adverse effects associated with various impoundments in DRBC's Comprehensive Plan.

The Appendix presents a system of accounts that analyzes economic, social, and evnironmental impacts of management options used in the three alternative plans.

Because the action proposed by DRBC is the adoption of a plan, and a plan which applies to a large and diverse river basin, statements of environmental impact are, for the most part, necessarily broad. Many of the programs or projects which are recommended for implementation or further study in the plan will require more detailed environmental assessments and, perhaps, preparation of impact statements, as they approach the time when they are to be put into effect. At that time, in keeping with CEQ's policy of "tiering" impact statements to reduce paperwork and eliminate repetitive discussion of the same issues (40 CFR 1502.20), the detailed analysis can incorporate this report by reference, summarizing particularly relevant sections, and concentrate on specific items which could not be thoroughly dealt with in the Level B Study.

a. Significant Beneficial Impacts.--Specific environmental, social and economic impacts are listed for each management option in Table A-2 "System of Accounts" in the Appendix. Only highlights of the likely overall impacts of the Mixed Objective Level B Plan are given here.

The water conservation measures in the Mixed Objective Plan should lead to more efficient and informed use of Basin water resources at all times and reduction of the likelihood of protracted, disruptive environmental and socio-economic impacts during drought conditions. If the measures are successfully implemented, they will have an additional beneficial economic impact; less federal, state and local money will have to be expended on structural solutions for water supply and related functions.

The Mixed Objective water quality management options should result in better conditions in the ground and surface waters of the Delaware River Basin. Higher concentrations of dissolved oxygen will be achieved in the Estuary, soil erosion and stream sedimentation will be reduced, and aquatic ecosystems and public health will be better protected from toxic and hazardous materials.

Flow maintenance measures, in concert with those proposed for water conservation, should permit more knowledgeable and effective management of Delaware River flows. Flow maintenance requirements and procedures are being re-evaluated and increased reliance is being placed on conservation in order to minimize the need for construction of reservoirs.

Water supply management options stress conservation, improved reliability, protection from toxic substances, and management of ground water resources based on water budgets. They should contribute to alleviating local water supply problems and retard and perhaps reverse the recently observed effects of excessive withdrawals from certain aquifers.

Measures for fish and wildlife management, closely related to those recommended for water quality, flow maintenance, and energy, should continue and even accelerate the restoration of impaired habitat and protection of wetlands and other critical fish and wildlife resources. Secondary beneficial impacts will ensue in recreation, commercial fisheries, and ecological viability and stability in the Delaware River Basin.

Finding the proper mix of structural and nonstructural flood loss reduction measures would be an ongoing study program under the Mixed Objective Level B Plan. Additional flood loss protection benefits will result, and, to the extent that they can be achieved nonstructurally, further beneficial impacts can be projected. Nonstructural approaches will typically be less expensive, the cost will be more accurately distributed, and the adverse impacts of construction will be minimized.

The recreation components of the plan should lead to greater protection of scenic areas and naturally or culturally sensitive or unique resources. Planning to meet Basinwide, regional, and local recreational needs will be better coordinated. Additional lands will be acquired for public use. Recreational benefits should be distributed more evenly across the Basin, since the plan deals with water, water-related, and land recreation, urban and non-urban areas, and natural and cultural resources.

No specific projects for power generation are presented in the energy section of the Mixed Objective Level B Plan. There are, instead, a range of policy options for further investigation prior to selection. Common to all are provisions to minimize adverse ecological effects, such as entrainment of aquatic organisms, excessive thermal loadings and depletive uses, and fluctuating water levels in tributaries. At the same time, the socioeconomic importance of future power generation capacity expansion in the Basin was taken into account.

b. Significant Adverse Impacts.--A total of 26 potential Basin impoundments have been investigated. The number recommended by Level B for serious consideration has been reduced to five: Francis E. Walter Modification, Prompton Modification, Merrill Creek, Hackettstown, and Cannonsville Modification. The impact of the enlargement of Cannonsville has not yet been fully evaluated. Should the other four ultimately be necessary, there would be local adverse impacts. Somewhat more than 20 miles of free-flowing stream would be converted to a lake environment. On the order of 3000 acres, principally forest and agricultural land, would be inundated, resulting in loss of wildlife habitat, agricultural production, and a number of dwellings.

Water-budget based ground water supply management, a non-structural measure which may contribute to reduced need for impoundments in the future, has potential adverse impacts. Limitations on withdrawals in designated ground water protected areas may constitute restriction in population growth and land development. However, this short-term adverse economic impact appears negligible in comparison to the social and economic impacts of water supply failures or the environmental and economic impacts of providing alternative sources if withdrawal limitations are not imposed and widespread water supply failures occur.

(1) Measures to Enhance the Environment and Mitigate Impacts--DRBC's Level B Study presents a system of accounts in the Appendix that includes mitigating measures that may be imposed through management options used in the three alternative plans.

(2) Adverse Environmental Effects Which Cannot Be Avoided--Adoption of the Mixed Objective Level B Plan will in itself have no unavoidable adverse impacts. Some of the impoundments included for further consideration will almost certainly be necessary. Local short-term degradation of water quality and permanent loss of free-flowing stream segments and terrestrial resources will be unavoidable. However, as a larger number of impoundments would probably have been built in the absence of the Level B Study, the net effect of the plan will be to substantially reduce the extent of these unavoidable impacts.

(3) Irreversible and Irretrievable Commitments of Resources--Wherever possible, the Mixed Objective Plan has been formulated to be flexible. Emphasizing conservation is one way in which it has met this objective. Another has been to minimize irretrievable commitments of resources. Reliance on structural solutions to flood loss reduction, water supply and flow augmentation has been reduced to a minimum consistent with immediate needs for protection of public health and safety. The five impoundments which may be built (Merrill Creek and Hackettstown) or modified (Francis E. Walter, Prompton and Cannonsville) would entail commitment of land and materials which are irretrievable. But the nonstructural management programs which are central to the Mixed Objective Plan do not entail such commitments; they seek instead to avoid them, to keep options open for the future.

c. Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance of Long-Term Productivity

The Level B Study had as a primary goal planning for management of water and related land resources that would sustain the future economic and environmental viability of the Basin. In many cases fulfillment of certain short-term economic development needs can conflict with achievement of certain environmental quality objectives. Dredging and filling marshland for residential or industrial development is a classic example, and development of prime agricultural land is another. The Delaware River Basin has experienced both, and long-term reduction of productivity has resulted. Resources are not unlimited, and a prudent society must plan to use its natural wealth rationally and efficiently if it is to safeguard its standard of living and that of succeeding generations. At the same time, if environmental quality is to have meaning to all people in all economic strata, there must be assurance of a foundation of economic viability to produce jobs, family income, and educational and other opportunities.

The Mixed Objective Level B Plan recognizes and reflects these relationships. It began with the premise that in a truly long-term view, economic, environmental, and social goals are not in conflict but are interdependent. It is only in the short-term that real conflicts exist. Thus the Mixed Objective Plan draws heavily from both the Economic Development and Environmental Quality alternatives. Conservation of resources for future generations and maintenance of present and future quality of life are its cornerstones. The environmental quality improvements, resource management programs, and conservation measures in the Plan will all contribute to maintenance and enhancement of long-term productivity.

6. Preferred Plan Impacts

The five projects selected for the Preferred Plan are: F. E. Walter Modification, Prompton Modification, Hackettstown, Merrill Creek and Cannonsville Modification.

Three of the five projects are modifications of existing facilities. Each of these projects would have some short-term local adverse impacts. Detailed engineering studies and environmental impact statements will be done when the need for an individual project is indicated.

The uncertainty about future needs results from the fact that long-term conservation, water-budget based ground water supply mangement, and changes in energy generation will all influence water use in the short-term future.

7. Public Involvement--Public comments and agency response-- The following Section presents a summary of responses to many questions and issues related to a draft of "The Delaware River Basin Comprehensive (Level B) Study," October 1979. These comments deal with such topics as conservation; water quality; flow maintenance; water supply; flood loss reduction; fish, wildlife, and recreation; and navigation.

C. Preparers and Lead Agency

DRBC staff members listed earlier in the report made significant contributions to this assessment. While the final judgments are those of the Commission, they reflect expert opinions of personnel in agencies and DRBC and findings in reports prepared by their consultants. In preparing this report, the lead agency was the DRBC.

D. Response Summary

1. Introduction

Governmental agency, elected official, and public comments to the Draft Final Level B Report have been used extensively by the staff in preparing the Final Report.

The process initiated by the Level B Study is not finished with the Final Report. The Study has focused on several areas where better information is needed. New studies have already been started. There are also some parts of the data base which should be improved; more recent data and more precise measurements will contribute to more objective decision making.

The Commission will work to improve the data base, but it is also important that the exchange of information with the public and with other federal and state agencies continue. The Level B Study provides a foundation which should be built upon and periodically reevaluated. The Preferred Plan provides direction for the immediate future, but it is clear that development in the Basin and changes in technology and in social patterns will influence water use. Constant monitoring, improvement of the models, additional studies and refinement of cost/benefit analysis and forecasting techniques will all contribute to better decision making. There will be additional hearings and an Environmental Impact Statement for each specific facility in the Preferred Plan before implementation.

The public contribution to the Level B Study was exceptionally cogent. Continuation of the dialogue and improved coordination with government agencies is essential for the development of an efficient water management plan.

All of the comments have been read by several people and carefully considered. However, the responsibility for making final decisions remains with the Commission. The Commission and the Level B staff were impressed by the high level of the agency and public participation all through this Study. The exchange of information during workshop sessions was particularly valuable. The effort of the many people who evaluated the many reports which were circulated during the Level B process is appreciated.

2. Individuals Commenting on Draft Report

Comments have been grouped according to subject and individuals are identified by a Roman numeral and an Arabic number. The

Roman numeral indicates a group designation:

I. Federal and State agencies
II. Local government officials and agencies
III. State Representatives, organizations, citizen groups and individuals

The Arabic number identifies the individuals that commented on the group lists which appear at the end of this part (Tables 25, 26, and 27). A listing of those who commented at the public hearings for the Draft Report is not presented. It is very long and incomplete because of illegible signatures. These latter comments are coded as - (PH).

It has not been possible to include all the comments or provide complete citations of individuals, but those given are representative.

3. Summary of Comments and Responses

a. Conservation

(1) General and Emergency Plans:

--Comment: There is nearly universal support for the concept of reducing projected depletive use. Some support 6%, some 15% and some 25% reduction (the three choices offered in the Level B Draft) for depletive use conservation. A major concern is the lack of demonstrated technologies to reduce depletive usage. There is concern that conservation reductions might cause economic damage in general and in particular for agriculture (PH).

Response: The need to determine the effectiveness and economic impact of potential conservation practices is more clearly stated in the Final Report.

(2) Water Supply System Leakage

--Comment: More controls to stop leakage are needed (III-20, 52, 55, 59, 63, 86) (PH).

Federal support is not an important factor in rehabilitation of leaking water supply distribution systems, there are existing funding mechanisms (I-9). Leakage control should be resolved locally (II-13).

Response: The Draft Report stated the need for leak detection and correction.

Report Modification: The Final Report cites the current limited federal funding mechanisms.

(3) Metering

--Comment: Many state that the metering of New York City's water use would reduce depletive use of Delaware River water (III-55, 59, 63, 79, 86).

Response: Metering would be a positive step for New York City and would reduce depletive use. It is important to emphasize, however, that the Supreme Court Decree 347 U. S. 995 of 1954 is a legal constraint that prevents the Commission from involvement in New York City's internal water distribution. A metering program might not assure that additional water would be released to the Delaware River in the long-term. Rather, there might be a temporary gain until such time as New York City would take its full 800 mgd or its lesser "Rule-Curve" allotment.

(4) Entitlements

--Comment: Many stated the desirability of eliminating free entitlement to water as a means to conserve water. A considerable number wanted the free entitlements to continue; of these, many doubted that the elimination would provide much impetus to reduce water use.

Response: The Draft and the Final Report include a management option that would permit the imposition of charges for all surface and ground water users. The objective of this option is to reduce depletive uses. There is a question as to the effectiveness of the Commission's water pricing charge in reduction of water use.

b. Water Quality

(1) Achieving the Dissolved Oxygen Standard in the Estuary

--Comment: There can be no appreciable improvement of the Delaware River fisheries until the dissolved oxygen (D.O.) concentrations in the Estuary are improved (I-3).

Response: Language reflecting this comment has been included in the Problem Statement in those sections dealing with Water Quality and Fish and Wildlife.

(2) Upgrading the Dissolved Oxygen Standard of the Estuary

--Comment: There is support for the concept that D.O. levels be increased to allow adequate D.O., in the range of 4 to 5 mg/l. This support is tempered with concern that it be technically achievable and economically feasible (I-1, I-12).

Higher D.O. concentrations is a desired future goal (I-3).

A higher D.O. standard does not necessarily mean a net decline in employment, for the construction and operation of abatement facilities creates jobs (I-3).

Response: D.O. concentration standards in the Estuary should be increased if found to be technically achievable and economically feasible. Ongoing studies by the Commission will help determine this.

(3) Non-Point Treatment Costs

--Comment: Non-point source treatment costs are not presented (I-3). There should be more investigation of non-point pollution control (II-6, III-21, 85, 92, 95).

Response: The Commission, through its 106 Program (EPA funded water quality grant to the Commission), will determine Estuary non-point source treatment costs. These costs will be compared with point source treatment costs to determine the most cost-effective treatment method. Implementation of future waste reduction programs will be guided by the cost-effectiveness of the control options.

Report Modification: Additional language has been added to Part II to reflect the above.

(4) Toxic Substances

--Comment: Sampling and analysis under the National Interim Drinking Water Regulation are limited to six specific compounds from the standpoint of organic substances (I-9).

Response: Part II of the Final Report has been modified to show the limitation.

--Comment: The Mixed Objective Plan for Toxic Substances/ Residuals Management should note that EPA's Region II and III Water Supply Branches be included in any newly developed warning plans (I-9).

Response: The Report has been modified to include the above language.

--Comment: The report fails to identify the need for a toxic dischargers' inventory (I-14).

Response: This is an activity that has been assumed by some of the Basin states. Also, the Resource Conservation and Recovery Act (RCRA) requires a manifest system of following the hazardous product from development to final repository.

--Comment: More emphasis is needed on the control of toxic pollutants (TCE and others) (I-14) (II-7) (III-21 23, 26, 62, 78, 87, 92).

Response: The Preferred Plan has been expanded to include this emphasis.

--Comment: Water Quality Alternative No. 1, MO Plan, for "Toxic Substances/Residuals Management" should be expanded to include sludge. There is concern that toxic compounds might become distributed in food producng soil via sludge disposal (I-14).

Response: The alternative has been modified to reflect this comment.

c. Flow Maintenance

(1) Delaware Seasonal Sustainable Flow vs. Average Annual Flow

--Comment: What governs seasonal or average annual flow from a river management standpoint? (I-3, II-12, 13, 22).

Response: In the Delaware River the most important factor which affects sustainable flow objectives is the maintenance of salinity limits in the lower Delaware Estuary. From this standpoint, seasonal flow is more significant than average annual flow, although the level of average annual flow has some impact. Managing the Delaware River by storing water during low salinity periods and augmenting flow during seasons of peak salinity has been shown by salinity model runs to reduce salinity levels. The season selected for augmentation was June through September. This was a period of critically low flow during the 1960's drought.

While low flow of several weeks or less can affect dissolved oxygen concentrations, it is not possible to significantly ameliorate this effect throughout the Estuary by releasing stored water because of the vast amounts required to be significant.

Report Modification: The Preferred Plan states salinity control levels, sustainable seasonal flow objectives and the required flow augmentation and conservation to meet the objectives.

(2) Equivalent vs. Actual Flow

--Comment: Several opposed the concept of equivalent flow (II-18) (III-20, 38).

Report Modification: This concept is eliminated in the Final Report. There were corrections applied to modeled Delaware River flows at Trenton, New Jersey that appear in the Draft Report, to show the target Trenton Gage, Delaware River flows for the year 2000. This is described in detail in the Flow Maintenance section of Part II.

(3) Salinity Standard

--Comment: Control of salinity intrusion into the Estuary is the most important factor in flow maintenance (III-22,62,82,85).

Response: More information on the subject, including results of the latest salinity model runs, is presented.

--Comment: Are de-icing salts for roads a problem? (III-21)

Response: Increased use of road salts in the past decade has contributed to chloride concentrations so high that some wells near highways have been abandoned. For the Estuary, the impact of ocean salinity intrusion far exceeds the impact of road salting.

--Comment: The report does not address the impact on the oyster grounds of moving the 15 ppt salinity line two miles upstream by the year 2000 (I-3).

Response: The movement upstream is only applicable for a severe drought. The impact appears to be minor compared to the impact of much greater natural salinity variations.

Report Modification: More information on the subject is presented.

--Comment: The existing Commission salinity standard, 50 mg/l (maximum 15 day average) for Zone 2 is too stringent (III-26).

Response: The Preferred Plan includes a salinity standard more lenient than the existing Commission salinity standards.

--Comment: Water can be desalted to increase supply. Why not direct attention to desalting (III-75)?

Response: Desalinization is costly in terms of both dollars and energy. No change has been made in the report.

--Comment: The importance of salinity intrusion has been overstated (III-75).

Response: Recent medical literature emphasizes the importance of restricting sodium content of drinking water. This, together with the older concerns related to excessive salinity levels in municipal and industrial water supplies, makes the control of salinity more important than ever. Nevertheless, a salinity standard less stringent than the current standards is now being proposed.

(4) Drought Frequency

--Comment: Many questioned the meaning of, and significance of, drought frequency. Many felt that use of the drought of record was overly conservative and is used as an excuse to build dams (I-17) (II-20) (III-13,15,26,32,37,82,85,87,93,95).

Response: It is agreed that meeting a given flow objective for a drought of the severity of the drought of record would require more water storage than would be required for a less severe drought. However, if a less severe design drought than the drought-of-record is used for determination of a given flow objective, and if reservoirs are operated to sustain this flow objective, a problem will arise when a drought more severe than the design drought occurs. Reservoirs would be near empty part way through the drought. [Use of the drought-of-record for planning purposes does not imply that all water demands would be met during such a severe drought. The Preferred Plan assumes that water demand will be reduced by conservation measures.]

(5) Supreme Court Decree

--Comment: Many comments expressed opposition to the existing 1954 Supreme Court Decree regulating New York City's diversion from the Delaware River Basin. Most of those favoring the Decree opposed any action that would diminish the New York City release requirements at the Montague gage on the Delaware. Included in specific comments were: revision of the Decree should precede any Level B Plan implementation, New York City should provide sufficient releases to the Delaware to maintain pre-New York City water supply system salinity intrusion conditions, New York City should reduce wasted water (leaks) and otherwise conserve water, and New York City should look to the Hudson River for future water supply (PH).

Response: The above items were factored into the "Good Faith" discussions, which provide a basis for this Final Report's Preferred Plan. The DRBC has no authority to revise the Decree, but this report assumes modifications to the Decree resulting from the "Good Faith" discussions among the parties to the Decree.

(6) Conservation Releases

--Comment: Many supported the beneficial aesthetic, fish and wildlife, recreational, and economic impacts of the experimental augmented conservation releases from the New York City reservoirs. Some suggested changes in the conservation release program based on the New York Department of Environmental Conservation Reservoir Monitoring Program (III-12, 37, 88).

Response: Changes are currently under consideration.

(7) Out-of-Basin Imports

--Comment: Consider the potential of a Susquehanna River Basin transfer of water to meet the future demands of New York City (I-18) (II-13).

Response: Such a project is beyond the jurisdiction of the DRBC.

d. Water Supply

(1) Depletive Use Projections

--Comment: Projections for municipal, industrial, and irrigation usage are below Pennsylvania State Water Planning projections (I-17). The accuracy of power demand projections used to substantiate the need for downstream power plants was questioned (I-16). Several questioned the accuracy of the depletive use projections (III-16,26,27,36,55,87). Table 5-5 "Basinwide Depletive Use", figures are high for the year 2000, especially in the following categories: agricultural, golf courses, and steam electric (III-93). The utilities have overestimated electric growth, particularly in recent years (III-91). Permanently poisoned water has not been considered in projecting depletive uses (III-23).

Response: DRBC will continue to refine the forecasting procedures used. These projections represent a reasonable estimate for depletive water use. Continued revisions based on refined economic projections, the Water Users' Inventory, and estimates of the effects of long-term conservation may result in revised projected use figures.

(2) Population Projections

--Comment: How often will the population projections be revised? (III-21). The methodology used to project population should be expressed (III-26).

Response: The Commission will decide when new projections are needed. The population levels used in the final draft are considerably below those originally developed for Level B. At present this seems consistent with 1980 census results. Differences between DRBC projections and those developed by the States are considered to be not significant for water management decisions.

(3) Future Water Needs

--Comment: The report should address how future needs will be met. Conservation is not enough (I-3).

Response: The report offers several alternatives that would provide future water supply.

(4) Limiting Depletive Use

--Comment: List the projected Delaware River Basin water supply deficiency or surplus for the planning period (III-87).

Response: Deficiency or surplus is a function of many factors: multiple usage of water, conservation practices, selected salinity repulsion flow and other factors. This is demonstrated in this report's Table 13 "New York City and New Jersey Exports vs. Flow Capability at Montague and Trenton in Year 2000 During Recurrence of the 1964-1965 Drought Conditions".

Report Modification: None

(5) Ground-Water Use

--Comment: There were many comments that the Triassic Lowlands ground water problems are critical(PH).

Response: A ground-water protected area has been established, and the Commission ground-water study will provide information needed for the development of optimum management strategies for this area. This is noted in this report.

--Comment: Many stated that ground water quality and quantity is a growing problem, is very complex, and needs more attention.

Response: This is noted and stressed more fully in this report.

(6) Torresdale

--Comment: The Torresdale water intake is not threatened by salinity intrusion at 2700 cfs flow at Trenton (III-26,32,93).

Response: Agreed, this is more clearly stated in this report.

(7) Interconnections

--Comment: Support interconnections (II-8). Interconnection is costly to consumers (III-78). Interconnection will be effective during an emergency drought situation (III-78,85,93). Interconnection should not be considered a substitute for water supply (III-85).

Response: Resolution No. 77-6 expresses DRBC policy supporting interconnection.

e. Flood Loss Reduction

(1) Non-Structural Flood Control

--Comment: There is agreement that non-structural flood loss control measures should be stressed (I-12,17). Provide greater emphasis on the need to substantially reduce development on the flood plain (III-26). How is a house flood proofed? (III-21). Support non-structural measures and modification of some existing structures for flood loss reduction (III-34,83).

Response: Federal incentives and state legislation are contributing to strengthening flood plain management procedures. The National Flood Insurance Program provides the legislative tool to restrict development on flood plains. The Level B Report addresses future means of flood protection. Techniques for flood proofing include strengthening the foundation, construction of parking areas on ground-floor and offices on second-floor, and providing for storm water runoff.

(2) Main Stem

--Comment: Some support the idea that the Corps of Engineers expedite its study of flood control needs and make the findngs public as soon as possible (III-36,37,85).

Response: The timing of the Corps study is independent of the Level B Report.

f. Fish, Wildlife and Recreation

(1) Access to Delaware River

--Comment: The existing and increasing need for additional access to the Delaware River in the Philadelphia to Delaware City stretch should be considered (I-3).

Response: There is considerable activity in reclaiming industrial waterfront for recreational purposes in the northeast. Improvement of water quality in the Estuary will make recreational activity possible in areas where access has been restricted by industrial development, highways or railroad tracks. Specific efforts in these areas have been initiated through the States' Coastal Zone Management Programs.

(2) Management Program

--Comment: The Commission should coordinate rather than assume a lead role in anadromous and catadromous fish studies (I-3,17).

Response: This is stated in this report.

(3) Wild and Scenic River System

--Comment: The DRBC should work with the National Park Service on the Upper Delaware River Wild and Scenic River plan (PH). Support the Environmental Quality Plan but only with the middle Delaware as a Scenic River in its entirety (III-68). Comprehensive Plan amendment regarding the middle Delaware River does not require the unanimous consent of parties to the 1954 U.S. Supreme Court Decree (III-26).

Response: The DRBC, by legislative authority, is a participant in the development of the Management Plan for the upper Delaware River segment. The Commission will give further consideration to the inclusion of the middle Delaware River area scenic and recreational river in the Comprehensive Plan provided that the rights of all parties to the 1954 Decree are fully protected.

g. Energy

(1) Steam Electric Generation Plant Siting

--Comment: Locating new power plants along the Delaware Estuary shoreline would violate Delaware's Coastal Zone Management Plan (CZMP) and Wetlands Act (I-12).

Response: While Delaware's CZMP prohibits construction of new refineries in wetlands and area of coastal strip, Delaware's CZMP permits power plants inland and on the strip. This recognizes the national interest of the energy crisis, and suggests coal fired plants in preference to other plants.

--Comment: Siting of power plants should be related to their location on the Delaware River or Estuary (I-18).

Response: The river mile location is one important criteria for siting. The further downstream the siting, the less the adverse impact of depletive use.

(2) Entrapment and Entrainment

--Comment: The Level B report should include a listing of the types of fish killed and the frequency of this occurrence (III-73). A fish kill prevention alternative is needed because of the blocking at the site of intakes (III-20,73).

Response: The full impact of impingement and entrapment has not been evaluated. Such work is recommended in the Fish and Wildlife section of the report. Also suggested is research to find ways to minimize these problems.

h. Navigation

(1) Dredging

--Comment: There is concern that enlarging navigation channels in the Estuary could create a path for accelerated intrusion of salinity into aquifers (I-12).

Response: Agreed, and this is stated in this Final Report.

i. Projects

(1) Yields of Projects

--Comment: Several comments expressed concern that the method of determining reservoir yield, the dividing of reservoir storage by 120 days, is only an approximate method.

There is concern for the environmental impact of total drainage of a reservoir for maximum usage for flow augmentation (I-17).

Response: The dividing of reservoir storage by 120 days is only an approximate method, and the main fault of using this method is the overstatement of the amounts of augmentation calculated for large amounts of storage. A more accurate determination of yields from reservoirs will be possible with the new Corps of Engineers "Section 22" model.

Total drainage of a reservoir would cause some environmental damage, however, the evaluation of facilities was to determine which facilities, if any, are required to sustain streamflow with full usage of that storage dedicated to flow augmentation during a recurrence of the drought conditions of the 1960's. The more reservoirs available, the less overall drawdown. The actual operation of flow-augmentation reservoirs during severe droughts will be tempered by judgment based on overall environmental needs. Total reservoir storage will not be completely emptied.

(2) Selection of Projects

--Comments: Several comments requested protection of certain areas, Wayne, Pike and Monroe Counties, the Poconos (III-2a,76).

Response; Project sites are determined initially through geographic considerations. Mountainous areas are, geographically, the better reservoir locations.

--Comment: A schedule of impoundment projects should be given listing in-service dates and a timetable of important actions and activities needed to develop each project (III-87). List all potential projects for overall development (III-83).

Response: A schedule for the projects requires further investigation. The fundamental work done by the Level B Study involved screening of projects.

--Comment: Many oppose dams and the enlargement of present dams due to adverse effects on the environment and the surrounding communities; there is concern for the safety of dams.

Response: The Preferred Plan proposes those projects which are believed to provide the greatest overall benefits with the least environmental and social impact. Dam design includes very conservative safety factors; the Corps of Engineers has never had one of its dams fail.

--Comment: More flood storage is needed (PH).

Response: The Corps of Engineers and other agencies are evaluating alternative measures to reduce flood damage. That information will be used in developing the detailed plans.

--Comment: Many oppose the Point Pleasant Project. The transfer from Merrill Creek to Point Pleasant to Limerick is not a rational scheme. Suggest Limerick switch to coal generation, which is 1/3 less in depletive water use.

Response: An Environmental Assessment for the Point Pleasant Pumping project has been completed. That document addresaes these concerns in detail.

(3) Compensatory Releases

--Comment: Water users should provide compensatory storage (II-6). Philadelphia has not built reservoirs as did New York City (II-12). The Commission should sponsor storage, not the individual states (II-13).

Response: Merrill Creek is to be constructed by a group of utility companies; only the utilities have been considered for compensatory releases. The City of Philadelphia takes water from both the Delaware and Schuylkill Rivers and returns the water, after treatment, to the Delaware River whereas New York City exports water from the Delaware River Basin. The Commission has a Basinwide management role. In that role, the Commission has acquired the right to use and control water supply facilities associated with Federal Comprehensive Plan projects (DRBC Resolution No. 64-16A). In addition the Commission will consider new projects for construction scheduling when economically justified (DRBC Resolution No. 71-4).

(4) Alluvial Pumping

--Comment: Lowering the water table by alluvial pumpage would cause wetlands and marshes to dry up places vital to wildlife (III-79) (PH). Electrical energy use associated with pumping ground water would occur in the low flow period when energy conservation might be necessary and steam electric consumptive use reduction might also be required (III-62). Question the feasibility of alluvial pumping (III-22,36). Support pilot test program for alluvial pumping (III-22,36,85).

Response: All the above effects would be evaluated during additional studies and pilot programs that would be needed to determine the feasibility of alluvial pumpage.

(5) Desalinization

--Comment: Need more investigation of desalinization (II-9,22,23).

Response: Additional investigation of desalinization is beyond the scope of the Level B study. At the present time, it is considered costly in terms of both dollars and energy.

Report Modification: This is stated in the report.

(6) Aquashicola Project

--Comment: Aquashicola data should be revised (II-17) (III-57). Opposed to the Aquashicola project because there is a pipeline in the area (III-66).

Response: More detailed investigation would resolve such matters. Aquashicola is not in the Preferred Plan but is retained in the Comprehensive Plan.

(7) Tocks Island Project

--Comment: The project should be developed, partly because of the economic inefficiencies of the alternatives (III-35,37,62). A mix of non-structural measures would provide an alternative for the Tocks Island Project proposal (III-26). Tocks should be compared to other alternative projects and their adverse effects (III-87). A considerable number of comments oppose Tocks. The potential damage has already occurred at Tocks (II-13). Many feel the Tocks Island project should be de-authorized and deleted from the Comprehensive Plan, especially since the area has been designated in the Wild and Scenic River system (III-13,27,79,93). What is the position of the New Jersey Governor regarding the de-authorization of Tocks Island (III-26)? If Tocks is needed in the future it could be reactivated (III-13,26). When New Jersey voted against the Tocks Island project, they did not surrender diversion rights (III-26).

Response: Tocks Island Dam has not been included in the Preferred Plan but it is retained in the Comprehensive Plan. On July 31, 1975, the members of the DRBC voted against funding of this project. The members also urged that land acquisition be continued but failed to act on a motion to recommend that Congress de-authorize the project.

(8) Cannonsville

--Comment: The modification of Cannonsville should be given serious consideration (I-2,21) (III-22,32,36,37,62,85), (PH).

Response: The modification is part of the Preferred Plan.

(9) Hackettstown

--Comment: Generally favor Hackettstown or equivalent New Jersey alternative (I-17,21). Recommend the adoption of the Hackettstown project (I-2A).

Response: The Hackettstown reservoir is part of the Preferred Plan.

(10) Little Martins Creek

--Comment: Generally oppose Little Martins Creek (I-12) (II-1). Oppose the Little Martins Creek project because of its adverse impact on the community (III-8,10,11,56). Some feel that the project has been proposed in order to provide water for power plants (III-14,56,69).

Response: The project is not in the Preferred Plan and is not considered for future development.

(11) Milanville

--Comment: The Milanville skim dam would require a pumping station (III-7).

Response: This is true. It is not considered for future development.

(12) Merrill Creek

--Comment: The Merrill Creek reservoir results in less social impact and loss of land than its alternatives (I-17). The Philadelphia Water Department recommends the Merrill Creek project (I-21). Many oppose this project. Many of those opposed stressed the fact that the water would be used for nuclear power plants (III-19,66,95). Many support Merrill Creek.

Response: The Merrill Creek project is included in the Preferred Plan as a compensatory release reservoir for post-1971 utility depletive use. An environmental impact statement is being prepared which will address the public and agency concerns.

Report Modification: An update to the current status of ongoing investigations is provided.

(13) Prompton Modification Project

--Comment: Many stated that water from Prompton should not be used to replace releases from the New York City reservoirs. A detailed study of the Prompton site should be done to assure that the foundation and embankment are sufficiently strong (I-12). Many question the safety of the proposed modification (III-2A,39,40,60,61,63,67,70,72,74,77,79), (PH). Opposed to Prompton modification because of adverse effects on the community (III-1,39,63,64,65,70,72,77). Many oppose the reduction of existing flood control storage at Prompton.

Response: The Prompton Modification is part of the Preferred Plan. Detailed engineering studies will be done before final environmental assessment. The extra yield from this project is not considered as part of the NYC Montague flow obligation in the determination of flow augmentation requirements. The authorized flood control storage for Prompton would be retained as the project is modified.

(14) Red Creek Project and Mill Creek Project

--Comment: The water quality and aquatic life of Red Creek and Mill Creek would be adversely affected by the addition of lower quality water pumped from the Schuylkill River (I-17). There is opposition to Red Creek Dam due to the adverse effects on the community and the environment (PH).

Response: These projects are not in the Preferred Plan.

(15) Trexler Dam

--Comment: The Commission should solicit views of county and municipal governments and water supply agencies to determine whether there is any interest in keeping the "local option" open (PH). If there is no local interest Trexler Lake should be dropped from the Comprehensive Plan (I-17). Several expressed interest in potential "banking" of this site as a future local option. The Lehigh Valley is facing problems created by rapid increases in ground water withdrawals--Lehigh and Northampton Counties may have to develop additional surface water sources (I-10). Many cited the referendum of November 8, 1977 that came out three to one against the project.

Response: All actions by the Commission are conducted in public and comments are solicited. The Trexler Project was authorized by Congress in 1962 and was included in the Comprehensive Plan along with a number of other multi-purpose projects. The water supply needs of this project are both local and regional. The regional need goes well beyond the boundaries of Lehigh County. The Trexler Project remains in the Comprehensive Plan, but is not included in the Preferred Plan.

(16) Francis E. Walter Modification Project

--Comment: Many view the Francis E. Walter modification as a viable option recognizing that a detailed site study is needed to evaluate the economic, environmental and social impacts. Efforts should be made to preserve historic sites (I-17). Favor lowering the design elevation of the authorized modification (II-17,25) (III-32). The modification would have adverse impact on the community. Suggest that hydroelectric development be considered at Francis E. Walter (II-26).

Response: The Francis E. Walter Modification Project is part of the Preferred Plan. Prior to construction detailed studies will analyze the economic, environmental, social and other impacts of the project including potential strategies to mitigate deleterious impacts. The existing flood control protection will be maintained. The feasibility of installing hydroelectric generating facilities at the Walter site will be considered as a highly desirable feature.

(17) Maiden Creek

--Comment: Oppose Maiden Creek project and recommend that it be dropped from the Comprehensive Plan because of the adverse effects on the community (III-22,36,37).

Response: The Maiden Creek Project is not in the Preferred Plan, it is proposed to be dropped from the Comprehensive Plan.

(18) Hydroelectric Power

--Comment: The peaking use of planned hydroelectric power development must have mitigative measures for the potential varying flow below the generation point (I-14).

Response: This problem will be considered in current studies on hydroelectric development for the Basin.

--Comment: Many supported hydroelectric development in the Delaware River Basin.

(19) Conjunctive Use

--Comment: Support optimum conjunctive use whereby the ground and surface water withdrawals would be managed to meet our water needs (III-36,85). Conjunctive use is not presently feasible in most of the Triassic region because neither the topography nor the recharge characteristics of the Triassic rocks readily provide locations for surface water storage (III-46). A monitoring system to recognize the need for base flow in the streams and control on water usage is needed (III-46).

Response: Conjunctive use is being evaluated in ongoing Commission studies.

Report Modification: A more detailed and updated description of ongoing studies provided.

(20) Evansburg

--Comment: Before further consideration is given to the Evansburg project, it should be reexamined especially if the ground water problems in the area become more serious (III-36). Question the cost figures for Evansburg (PH).

Response: Evansburg is retained in the Comprehensive Plan but is not in the Preferred Plan.

(21) Wallenpaupack

--Comment: Wallenpaupack should be considered for flow augmentation in time of drought (III-26,95). Many opposed flow augmentation from Wallenpaupack because of potential loss of recreational values around the reservoir.

Response: The Level B report recognizes that Wallenpaupack has a potential for flow augmentation during severe drought. The reservoir was used for this purpose in the 1960's drought.

j. Environmental

(1) Wetlands

--Comment: The study should compile state policies and consider Level B consistency with applicable state Coastal Zone Management Plans (I-3,12,16).

Response: The Level B Study has been coordinated with CZM Plans.

(2) Farmland Preservation

--Comment: Support the need for preserving important farmland (I-11,14).

Response: While the preservation of important farmland is needed, recommendations directed towards preserving particular land uses are not appropriate for a water oriented plan. Prime farm land and other unique land uses or areas should be considered by specific project EIS's.

(3) Unique Area Protection

--Comment: There is a need to provide management options to protect unique ecosystems such as wetlands, prime farmlands, headwater streams and certain other unique areas (I-17).

Response: Same as for (2) Farmland Preservation, above.

(4) Overall Environmental Review

--Comment: The EIS is satisfactory (I-5,7). The EIS needs more information (I-16). The EIS is not satisfactory because there is no consideration of importing water from the West (I-13).

Response: The Level B EIS could not cover those issues that required the gathering of new detailed data. Imports to the Basin were not considered.

(5) Power Plant Siting

--Comment: Once through cooling can be used below river mile 58.9 (III-62). DRBC policy should require power plants to reduce their use of fresh water (III-95).

Response: Sites for power plants are selected on the basis of many criteria including economic, environmental, logistical and other considerations. DRBC requires cooling when appropriate and makeup storage when water consumption is an issue. These and other strategies are used to mitigate the various impacts of power facilities and to protect the Basin's water resource.

(6) Endangered Species

--Comment: No specific mention is made of endangered species (I-3).

Response: Specific project EIS's will cover threats to endangered species. The Level B Study is too broad to handle these matters.

k. Alternative Plans

(1) Environmental Quality vs National Economic Development Plan

--Comment: How can raising the salt concentration be considered compatible with EQ (I-3,17)?

Response: Salt concentration in an Estuary is a natural occurrence. Reducing salt concentrations during low flow periods (when they would otherwise be higher) is a goal of river management made necessary by man's use of water. The methods of reducing salt concentrations (storage etc.) have impacts which are themselves deleterious to the environment. For these reasons permitting salt concentrations in line with natural conditions is considered compatible with EQ.

(2) Implementation

--Comment: The study treated important issues in such general terms that it may not be useful for implementation (I-3). The study should recognize existing county level programs which could carry out recommendations more effectively if provided with additional resources (I-14). The Level B Study should refer to local government water plans (III . DRBC should take a subordinate role to the state wildlife agencies (III-50). The management initiatives should be taken by the states with DRBC in a secondary role (III-78).

Response: It was not the purpose of Level B to integrate all local and state planning programs or to adopt such programs into the Level B plan. By its nature Level B addresses issues of basin or interstate significance. This broad perspective does not necessarily translate down to state or local implementation without additional planning. The framework for such action is, however, provided. Similarly, whether or not DRBC plays a primary or secondary role in implementation of various management initiatives is not important as long as implementation is carried out on behalf of DRBC by or for its signatory parties. Because of its mandate, however, DRBC has to ensure that all programs are carried out in a manner that benefits the Basin's resources and does not result in additional interstate problems.

(3) DRBC Role

--Comment: The Commission should resist becoming involved in local water disputes (I-12).

Response: DRBC's role is as stated. DRBC will become involved in, so called, local water disputes if requested by its signatory party or if issues of Basin or interstate significance are likely to arise. DRBC may play a third party role to resolve disputes that appear headed for stalemate.

(4) Public Participation

--Comment: Almost every aspect of the planning effort has been exposed to public scrutiny and active public involvement (I-17). There should be more public education on water conservation and recycling (III-52).

Response: The public participation in the Level B Study was important in establishing the direction of the Study. Efforts were made to involve a broad cross section of the public and to provide them with adequate information. The Level B staff felt the contribution of the public was extremely useful.

TABLE 25

I. FEDERAL/STATE AGENCY AND ADVISORS TO THE DELAWARE RIVER BASIN COMMISSION
COMMENTS ON THE LEVEL B STUDY OCTOBER 1979
DRAFT FINAL REPORT

Letters are listed chronologically by date written

	Federal/State Agency	Author	Date
1.	Pennsylvania Department of Environmental Resources	C.H. McConnell	October 19, 1979
2.	Delaware River Basin Commission	U.S. Commissioner, Sherman W. Tribbitt	October 30, 1979
3.	Delaware Division of Fish and Wildlife	Roy W. Miller	November 14, 1979
4.	Department of Transportation/U.S. Coast Guard	Commander J.C. Haldeman	November 14, 1979
5.	U.S. Environmental Protection Agency	John R. Pomponio	November 29, 1979
6.	New Jersey Statewide Water Supply Master Plan	Evelyn Bonner	November 30, 1979
7.	Delaware Division of Historical and Cultural Affairs	Daniel R. Griffith	November 30, 1979
8.	State of New Jersey/Water Policy Supply Council	Hermia Lechner	December 1, 1979
9.	U.S. Environmental Protection Agency	Edward V. Geismar	December 5, 1979
10.	Pennsylvania Department of Environmental Resources	C.H. McConnell	December 14, 1979
11.	New Jersey Department of Agriculture	Phillip Alampi	December 18, 1979
12.	Delaware Division of Environmental Control	Thomas P. Eichler	December 21, 1979
13.	New Jersey Division of Budget and Program Review	Karl B. Weber, III	December 26, 1979
14.	New York Department of Environmental Conservation	Eldred Rich	December 26, 1979
15.	U.S. Environmental Protection Agency	Richard T. Dewling	December 31, 1979
16.	U.S. Environmental Protection Agency	William N. Hedeman, Jr.	Received December 31, 1979
17.	Pennsylvania Department of Environmental Resources	Clifford L. Jones	December 31, 1979
18.	New Jersey Department of Environmental Protection	Dirk C. Hofman	December 31, 1979
19.	New Jersey Department of Environmental Protection	Dirk C. Hofman	January 3, 1980
Advisors to the Delaware River Basin Commission			
20.	Department of the Army, Corps of Engineers	Colonel James G. Ton	December 21, 1979
21.	City of Philadelphia	Carmen F. Guarino	December 26, 1979
22.	New York Department of Environmental Protection	George Mekenian	December 28, 1979

TABLE 26

II. LOCAL GOVERNMENT OFFICIALS AND AGENCIES COMMENTS ON THE LEVEL B STUDY OCTOBER 1979 DRAFT FINAL REPORT

Letters are listed chronologically by date written

	Local Government Official/Agency	Author	Date
1.	County of Northampton	Richard T. Grucela	November 13, 1979
2.	Board of Chosen Freeholders of Warren County	Russell A. Miles	Public Hearing on November 5, 1979
3.	Buck Township Board of Supervisors	Alice Glawe	November 16, 1979
4.	City of Easton, Pennsylvania	Joseph J. Mauro	November 16, 1979
5.	Chester County Water Resources Authority	David C. Yaeck	Public Hearing on November 19, 1979
6.	Bucks County Planning Commission	Robert E. Moore	November 20, 1979
7.	Commissioner-elect, Montgomery County, Pennsylvania	Rita Banning	Public Hearing on November 20, 1979
8.	Worcester Township, Montgomery County	Bruce S. Katcher	Public Hearing on November 20, 1979
9.	Monroe County Conservation District	unsigned	Received November 21, 1979
10.	Board of Chosen Freeholders of Burlington County	A. Jerome Walnut	November 27, 1979
11.	Commissioners of Wayne County	Robert V. Carmody	November 29, 1979
12.	Director of Planning, Wayne County, Pennsylvania	William E. Douglass	Public Hearing on November 29, 1979
13.	Joint Planning Commission Lehigh-Northampton Counties	Allen R. O'Dell	November 30, 1979
14.	Damascus Township Planning Commission	Fred Albers	Received December 3, 1979
15.	Borough of East Stroudsburg Pennsylvania	Larry Comunale	Received December 7, 1979
16.	County of Lehigh	Linda K. Flick	December 13, 1979
17.	Carbon County Planning Commission	Bruce E. Conrad	December 18, 1979
18.	Borough of Morrisville	Robert T. Steward	December 19, 1979
19.	Pike County Conservation District	Norman B. Lehde	December 20, 1979
20.	Four-County Task Force on Tocks Island Dam	unsigned	December 21, 1979
21.	Tobyhanna Township Supervisors	William L. Hopkins, Jr.	December 26, 1979
22.	Commissioners' Office, Monroe County	Nancy Shukaitis	December 26, 1979
23.	Board of Chosen Freeholders of the County of Warren	Christopher Maier; Garabed Haytaian; Raymond W. Stem	December 27, 1979
24.	Bear Creek Township	Willard Kresge	December 27, 1979
25.	Carbon County Planning Commission	Bruce E. Conrad	December 27, 1979
26.	Economic Development Council of Northeastern Penna.	Howard J. Grossman	December 31, 1979

TABLE 27

III. STATE REPRESENTATIVES, ORGANIZATIONS, CITIZEN GROUPS AND PRIVATE CITIZENS COMMENTS ON THE LEVEL B STUDY
OCTOBER 1979--DRAFT FINAL REPORT

Letters are listed chronologically by date written

	State Representative		Date
1A.	Henry C. Messinger		November 5, 1979
2A.	William Foster	Public Hearing on	November 29, 1979
3A.	Kurt D. Zwikl		December 12, 1979
4A.	William K. Klingaman, Sr.		December 13, 1979

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	Organization/Citizen Group/Private Citizen	Author		Date
1.	Private Citizens	John/Helen Beam		September 27, 1979
2.	Camping Journal Columnist	Jorma Hyypia		October 15, 1979
3.	Private Citizen	Muriel Kielar		October 24, 1979
4.	Private Citizen	Nancy Zimmerman		November 2, 1979
5.	Citizens Northwestern Lehigh Coalition	J. Robert Miller		November 5, 1979
6.	Private Citizen	Ann Owen Broadhurst		November 10, 1979
7.	Private Citizen	JoAnn Daly		November 11, 1979
8.	Private Citizen	Elizabeth Bush		November 12, 1979
9.	Sierra Club/Pennsylvania	Jeffry K. Schmidt		November 12, 1979
10.	Conaerned Citizens of Martins Creek Petition	Howard A. Pysher		November 12, 1979
11.	Private Citizen	M/M Kenneth Miller		November 13, 1979
12.	New York State Council of Trout Unlimited	Carolyn Hobbs		November 14, 1979
13.	League of Women Voters of Monroe County	Barbara Keiser		November 15, 1979
14.	Anti-Dam Spokesman	H.J. Stolten	Public Hearing on	November 15, 1979
15.	Monroe County Engineer	John H. Dennis	Public Hearing on	November 15, 1979
16.	Private Citizen	Joseph A. Geiser	Public Hearing on	November 15, 1979
17.	Private Citizen	Bruce Berryman		November 15, 1979
18.	Private Citizen	John L. Butler		November 15, 1979
19.	Private Citizen	Guy Gray		November 15, 1979
20.	Private Citizen	Marvin I. Lewis		November 16, 1979
21.	Society of Natural History of Delaware	Albert S. Matlack		November 18, 1979
22.	Water Resources Association of the DRB	Bruce E. Stewart	Public Hearing on	November 20, 1979
23.	Private Citizen	Frank Akutowicz		November 19, 1979
24.	Pennsylvania State Council Trout Unlimited	James B. Harper	Public Hearing on	November 20, 1979
25.	Private Citizen	Miriam E. Eyre	Public Hearing on	November 20, 1979
26.	Save the Delaware Coalition	Harold A. Lockwood, Sr.	Public Hearing on	November 20, 1979
27.	Private Citizen	Phyllis Zitzer	Public Hearing on	November 20, 1979
28.	Federation of Sportsmen's Clubs in Lehigh County	Kenneth E. Harte	Public Hearing on	November 20, 1979
29.	The Lehigh River Restoration Association	Kenneth E. Harte	Public Hearing on	November 20, 1979
30.	Private Citizen	Scott Macan		November 26, 1979
31.	Private Citizen	Deborah M. Eyre		November 26, 1979
32.	Environmental Defense Fund	Langdon Warner	Public Hearing on	November 27, 1979
33.	Pollution Control Group of Lower Bucks County	Tom Iezzi	Public Hearing on	November 27, 1979
34.	New Jersey Public Interest Research Group	Pat O'Connor	Public Hearing on	November 27, 1979
35.	New Jersey State AFL/CIO	Thomas Foy	Public Hearing on	November 27, 1979
36.	Water Resources Association of the DRB	Robert Patrick	Public Hearing on	November 27, 1979
37.	Water Resources Association of the DRB	Bob Richert	Public Hearing on	November 27, 1979
38.	Pollution Control Group of Lower Bucks County	Gretchen Leahy	Public Hearing on	November 29, 1979
39.	Private Citizen	Adelaide/John Maerz		December 2, 1979
40.	Private Citizen	Evelyn O. DeReamer		December 3, 1979*
41.	Private Citizen	Mrs. Eugene Stull		December 3, 1979
42.	Allentown-Lehigh County Chamber of Commerce	Gilbert Schaffer		December 3, 1979
43.	Private Citizens	Paul/Irene Hangen		December 5, 1979

* Undated letters, Date shown is date received by DRBC.

III. STATE REPRESENTATIVES, ORGANIZATIONS, CITIZEN GROUPS AND PRIVATE CITIZENS (contd.)

	Organization/Citizen Group/Private Citizen	Author	Date
44.	Private Citizen	Florence E. Durbin	December 6, 1979
45.	Bear Creek Association	Lewis A. Trotzky	December 6, 1979*
46.	Private Citizen	Walter B. Satterthwaite	December 7, 1979
47.	Private Citizen	Harry Creveling	December 7, 1979
48.	Private Citizen	John Stoddart	December 8, 1979
49.	Private Citizen	Donald G. Sparks	December 10, 1979
50.	New Jersey State Federation of Sportmen's Clubs	William Meyer	December 10, 1979*
51.	Private Citizen	Joann Sparks	December 11, 1979
52.	Lower Toby Sportsmen's Club, Inc.	Ben Brodsky	December 11, 1979
53.	Lehigh River Citizens' Committee	Joseph Kovack	December 11, 1979
54.	Citizens Opposing Red Creek Dam	Edward Finnegan/Peggy Strouse	December 12, 1979
55.	Private Citizen	Lee Pearcy, Jr.	December 12, 1979
56.	Private Citizen	John/Stella Grucela	December 12, 1979
57.	Aquashicoa Valley Action Committee	Many signers	December 15, 1979
58.	Private Citizen	Diane Vega	December 18, 1979
59.	Hunterdon Alliance for Safe Energy	Tracy Carluccio	December 19, 1979
60.	Private Citizen	Charlotte Miller	December 19, 1979
61.	Private Citizen	Walter Miller	December 19, 1979
62.	Delaware River Basin Electric Utility Group	W.N. Strobel	December 20, 1979
63.	Private Citizen	Richard C. Romich	December 20, 1979
64.	Private Citizen	Lisa A. Zielinski	December 20, 1979
65.	Private Citizen	Dorothy L. Morgan	December 20, 1979
66.	Private Citizen	Margaret E. Bosco	December 20, 1979
67.	Private Citizen	Margaret E. Lesher	December 21, 1979
68.	Private Citizen	Enid R. Smith	December 22, 1979
69.	Private Citizen	Howard L. Eyre	December 24, 1979
70.	Private Citizen	Theodore R. Hauss	December 24, 1979
71.	DUPLICATE OF #9		
72.	Private Citizen	Vivian Haas	December 24, 1979
73.	Citizens Northwestern Lehigh Coalition	J. Bruce Mordant	December 26, 1979
74.	Private Citizen	John Zielinski	December 26, 1979*
75.	Private Citizen	W.H. Rinehart	December 26, 1979*
76.	Dream Mile Club, Inc.	William F. Wier	December 26, 1979
77.	Wayne County Sportsmen's Association	Ken Bailey	December 27, 1979
78.	New Jersey Water Company	W.R. Cobb	December 27, 1979
79.	Wayne-Pike Audubon Society	Daniel R. Merrill	December 27, 1979
80.	Private Citizen	Harry A. Dower	December 27, 1979
81.	Northern Wayne County Taxpayers Association, Inc.	Laurence C. Winum	December 27, 1979
82.	The Penjerdel Council	Fred C. Haab, Jr.	December 27, 1979
83.	O'Brien & Gere	Will M. Heiser	December 28, 1979
84.	Private Citizen	Frederick W. Sherrerd	December 28, 1979
85.	WRA/DRB	Bruce E. Stewart	December 28, 1979
86.	Private Citizen	Carol M. Schaffer	December 28, 1979
87.	American Society of Civil Engineers	Kenneth R. Broome	December 28, 1979
88.	N.J. Fish and Game	David MacMurray	December 28, 1979*
89.	Wayne County Sportsmen's Association	William Zielinski	December 30, 1979
90.	Private Citizen	Sue Curtis	December 30, 1979
91.	Limerick Ecology Action	Phyllis Zitzer	December 31, 1979
92.	Private Citizen	Edwin F. Beemer, Jr.	December 31, 1979
93.	Interleague Council of the Delaware River Basin	Edith Stevens	December 31, 1979
94.	Pollution Control Group of Lower Bucks County	Gretchen Leahy	December 31, 1979
95.	Merrill Creek Coalition	Unsigned	December 31, 1979

* Undated letters, date shown is date received by DRBC.

PART IV APPENDIX

TABLE A-1

LISTING OF ALTERNATIVE PLANS

WATER CONSERVATION

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
1. Conduct studies to determine the effectiveness of conservation measures to reduce depletive use.	1. Same as NED.	1. Same as NED.
2. Conduct a public education program.	2. Same as NED.	2. Same as NED.
3. Require water-saving plumbing in new construction and in renovation of existing buildings in Basin and Service area.	3. Same as NED.	3. Same as NED.
4. Require conservation plans from all applicants for new or expanded water systems.	4. Same as NED.	4. Same as NED.
5. Examine water systems for leakage, rehabilitate leaky systems.	5. Same as NED.	5. Same as NED.
		6. Develop incentives to reduce depletive industrial water uses.
		7. Recommend Congress review the entitlement provision of the DRBC Compact and impose a charge on all surface and ground water users.
8. Develop emergency conservation measures and contingency implementation plans.	8. Same as NED	8. Same as NED.

TABLE A-1

LISTING OF ALTERNATIVE PLANS

WATER QUALITY

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
A. Water Quality of the Delaware River		
1. Retain present DO standards. Use design flow (and frequency with which it is expected to be achieved) as determined by overall re-examination of flow requirements.	1. Raise DO standard if Estuary Model indicates that it can be achieved cost-effectively.	1. Raise DO standard if Estuary model indicates that it is technically feasible to do so.
2. Proceed with abatement program currently laid out.	2. Use additional measures (increased treatment levels, tightened allocations stormwater treatment decreased tributary and main stem loads) as indicated to reach DO levels chosen.	2. Use additional measures as indicated to reach DO levels chosen.
	3. Develop coordinated solutions for upper main stem, including model runs.	3. Same as MO.
	4. Determine need for tighter enforcement of thermal criteria for effluents; tighten requirements if necessary to maintain DO levels.	4. Same as MO.
B. Overall Water Quality Management and Improvement		
	1. Develop public information/education program.	1. Develop information program as under MO, increase role of local government in enforcement.
2. Develop a more coordinated program of sampling, monitoring, data management for the Basin, incorporating base provided by current agency programs.	2. NED options; also identify agency to maintain effective system for data management and dissemination.	2. NED, MO options plus increased sampling frequency, number of parameters. Include bioassays of effluents on a regular basis.
3. DRBC provide careful review of completed 208/303e and 201 plans and suggested Comprehensive Plan amendments to determine compatibility.	3. Same as NED.	3. Same as NED.

TABLE A-1

LISTING OF ALTERNATIVE PLANS

WATER QUALITY (cont.)

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
4. Reliance on current non-point source regulations except where additional measures can clearly be shown cost-effective. Improve street sweeping, litter, animal waste controls.	4. Use results from West Branch Delaware River Model Implementation Plan (MIP) and other studies as background for local approaches, through Soil and Water Conservation Districts (SWCD) to determine site-by-site solutions for nonpoint source problems. Commission recommend that additional funding be provided to the Agricultural Stabilization and Conservation Service to provide technical assistance to expedite implementation of the Agricultural Conservation Program within the basin.	4. MO options; also required application of measures where it is reasonable to expect positive effect and problems are severe.
	5. Strengthen erosion and stormwater controls.	
	6. Determine appropriate standards and management policies for sodium.	
	C. Toxic Substances/Residuals Management	
	1. Assess qualities of toxic substances discharged, past and present, to determine their sources and impact on man and the rest of the environment.	1. MO option.
	2. Monitoring, sampling programs as under overall water quality management. Include sampling at landfills, etc. Monitor sludge and other residuals that are to be applied on existing or food-producing land.	2. MO options, plus major investigative study by appropriate agency of open, closed disposal areas.
	3. DRBC complete current planning of industrial residuals; develop basinwide management strategy for toxic/hazardous substances. States continue policy development. At appropriate agency levels, maintain permanent records of permitted waste disposal sites. Improve local enforcement of controls on illegal waste dumping, etc.	
	4. Improve warning system for spills, coordinate if possible with flood and other disaster warning networks. Increase local reserve storage capacity for Philadelphia, other areas with vulnerable water supplies.	
	5. Proceed with carbon treatment of water supplies where clearly indicated. All suppliers meet EPA regulation when established.	

TABLE A-1

LISTING OF ALTERNATIVE PLANS

FLOW MAINTENANCE

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
	1. Examine feasibility of developing one or more off-stream (high-flow skim) dams or on-stream reservoirs for flow maintenance.	
	2. Conduct pilot study to examine feasibility of developing emergency flow maintenance by controlled pumping of glacial alluvial-deposit aquifers adjacent to streams and rivers in the central and upper Basins.	
3. Control major depletive water users in Basin by: 1) imposing a limit on depletive use as percent of total withdrawal; 2) require major depletive users to provide compensatory water storage; or 3) Commission sponsor construction and operate compensatory storage paid for by all (large and small) depletive users proportional to use.	3. Same as NED.	3. Same as NED.
4. Impose stringent water conservation measures in times of severe drought. Require drought contingency plans which detail specific actions required of water users and administering agency(s). Plans may be devised to be implemented automatically based upon triggering criteria or which require administrative action for implementation.	4. Same as NED.	4. Same as NED.
	5. Investigate a policy which permits specific levels of depletive uses to occur with consequences accepted, fully stated, and individual users held responsible for alternative solutions. Further study is needed to assess impact of low-flow conditions on users and to develop contingency plans.	5. Same as MO.
6. Establish a minimum flow objective for the Trenton gage which will maintain acceptable chloride, sodium and dissolved oxygen levels under drought of record conditions.	6. Same as NED.	6. Same as NED.

TABLE A-1

LISTING OF ALTERNATIVE PLANS

WATER SUPPLY

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
	A. Tri-County (Burlington, Camden, Gloucester) Area	
	1. Impose limitations on water use; develop ground water budget and management plan designed to alleviate stress on the aquifer; require conservation plans of new users; consider imposition of a ground-water withdrawal charge.	1. Same as MO.
2. Develop a conjunctive use system incorporating a surface water treatment plant on the Delaware River with transmission main(s) to existing distribution systems; incorporate ground water recharge if studies show feasibility.	2. Same as NED.	
3. Purchase treated water from Philadelphia for transmission directly to Camden-area distribution systems.		
	B. Triassic Lowlands, Pennsylvania	
	1. Establish ground water protected area and impose limitations on water use; develop land/water-use management plan and water budget; condition withdrawal permits on sound conservation plans; consider imposition of a ground-water withdrawal charge.	1. Same as MO.
2. Require interconnections among contiguous water purveyors as a means of defraying temporary water shortages.	2. Same as NED.	2. Same as NED.
3. Develop the Pt. Pleasant pumping facility, North Branch water treatment plant and related transmission mains to provide supplementary surface water supply to portions of central Bucks and Montgomery Counties.	3. Same as NED.	
4. Eventual development of Evansburg Reservoir, if needed, as additional surface water storage to offset ground water shortages.	4. Same as NED.	

TABLE A-1

LISTING OF ALTERNATIVE PLANS

WATER SUPPLY (cont.)

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
	C. Philadelphia Alternatives	
		1. Consider relocating Philadelphia's Torresdale intake upstream (Trenton area), pending development of appropriate EPA drinking water standards and regulations.
		2. Provide additional filtered water storage at Torresdale.
3. Determine feasibility of improving interconnection among Philadelphia's three treatment plant distribution systems.	3. Same as NED.	
	D. Municipalities in Basin States	
1. Review recommendations of PA, NJ, NY, and DE water supply plans as they become available, for inclusion in DRBC Comprehensive Plan.	1. Same as NED.	1. Same as NED.
	E. Philadelphia-Camden Interstate Region	
	1. Many of the management options for Sections, A, B, C, and D include individual components of the Philadelphia-Camden Metropolitan Area total water supply problems.	

TABLE A-1

LISTING OF ALTERNATIVE PLANS

FLOOD-LOSS REDUCTION

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
	A. Delaware River Main Stem	
	1. For main stem, COE complete current study to determine most effective mix of structural, nonstructural measures.	1. For main stem, explore aggressive, multipurpose floodplain acquisition/management program using programs of federal/state/local agencies.
	B. Tributary Damage Centers	
1. Continue to explore flood protection potential of currently proposed projects.	1. Rely on protection provided by existing projects, where modifications are proposed, insure no interference with flood control functions.	1. Re-evaluate flood control benefits of existing storage feasibility of converting some to water supply.
2. Consider construction of currently proposed local protection works where locally acceptable. Explore possibility of construction of structures with low benefit/cost ratios in special cases.	2. Develop local protection works where locally needed and acceptable.	2. As part of re-evaluation of existing storage, explore local works for reaches presently protected by upstream storage.
	3. Conduct pilot study on tributary watershed modeled after main stem work. Develop strong floodplain management package. Concentrate on transferability of results. Investigate stormwater retention management for existing developed areas.	3. Same as MO.
	4. Conduct pilot flood warning study; explore federal funding availability for implementation. Develop informational material on measures, funding, serve as expert advisor to localities.	4. Same as MO.
	C. Future Flood Risk	
	1. DRBC, states, adopt watershed management policy as outlined under Water Quality.	
	2. At regional, county or municipal level, require stormwater management measures with performance standards for new development.	
		3. Regional agency develop stormwater modeling capacity expertise to serve as advisor to local planning agencies or use directly.

TABLE A-1

LISTING OF ALTERNATIVE PLANS

FISH AND WILDLIFE

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
1. Develop a comprehensive coordinated approach to fish and wildlife management in the Basin; review and consider findings of the fisheries research developed by FAWTAC during the mid-1960's when it is completed by the Delaware River Basin Fish and Wildlife Management Cooperative.	1. Same as NED.	1. Same as NED.
2. Develop a comprehensive Basinwide instream flow policy which considers such factors as drainage area, discharge relationships, shellfish, fish and wildlife resources, temperature, water quality, and habitat.	2. Same as NED.	2. Same as NED.
3. Determine the effect of Basinwide impingement and entrainment of fish and other aquatic resources, encourage research to minimize problem.	3. Same as NED.	3. Same as NED.
4. Encourage the continuation of studies of anadromous and catadromous fishes and other fish and wildlife resources as needed.	4. Same as NED.	4. Same as NED.
5. Enforce toxic substance standards and compliance schedules as promulgated.	5. Same as NED.	5. Same as NED.

TABLE A-1

LISTING OF ALTERNATIVE PLANS

FISH AND WILDLIFE (cont.)

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
6. Implement wetland protection program and strengthen the resolve of regulatory agencies to preserve and enhance wetlands.	6. Same as Ned.	6. Same as NED.
7. Continue on a long-term basis augmented conservation releases from the New York City reservoirs for the upper Basin major waterways.	7. Same as NED.	7. Same as NED.

TABLE A-1

LISTING OF ALTERNATIVE PLANS

RECREATION

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
	1. Develop a comprehensive urban waterfront program.	1. Same as MO.
	2. Develop greenway program.	2. Same as MO.
	3. Cooperate in the development of the recreation plans for upper Delaware River in conjunction with its incorporation into the U.S. Wild, Scenic and Recreational Rivers System and consider results for Comprehensive Plan amendment.	3. Same as MO.
	4. Cooperate in the development of the recreation plan for middle Delaware River in conjunction with other recommendations affecting the potential for a main stem impoundment. Consider results for Comprehensive Plan amendment.	4. Same as MO.
	5. Support the recreation plan developed for the 970,000 acre Pine Barrens site in New Jersey, of which roughly 10% is in the Basin, and consider the state plan for Comprehensive Plan amendment.	5. Same as MO.
	6. Support practical water quality standards needed to provide suitable habitat for fish, wildlife and recreation.	6. Same as MO.
	7. Support ongoing federal, state and local programs which foster recreational opportunities such as existing fish and wildlife and forest management programs, historic, cultural and natural area preservation, ongoing greenway programming.	7. Same as MO.
	8. Acquire the River islands for public use.	8. Same as MO.
	9. Coordinate recreational planning for reservoirs which may be constructed with related local and regional programs and objectives.	9. Same as MO.
10. Establish recreational cost-sharing policies involving DRBC-controlled storage.	10. Same as NED.	10. Same as NED.
	11. Conserve present and potential drinking water supply watersheds through designation as recreation, conservation or similar use.	11. Same as MO.
	12. Protect sensitive or unique ecosystems.	12. Same as MO.

TABLE A-1

LISTING OF ALTERNATIVE PLANS

ENERGY

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
	A. Options for Siting and Cooling	
1. Utilities determine steam electric generating plant siting, with site-by-site selection of cooling water systems.	1. Encourage siting of steam electric generating plants to provide optimum use of freshwater. Require wet cooling towers to reduce thermal discharge and to minimize entrainment and entrapment.	1. Same as MO.
	2. Require retrofitting where necessary of once-through cooling systems to eliminate entrainment and entrapment.	2. Same as MO.
	B. Options for Cogeneration	
1. Cogeneration develops on its own merits in existing or lessened regulatory framework.	1. Encourage development of cogeneration, investigate appropriate policy or regulatory changes.	1. Change existing utility regulations to encourage cogeneration.

TABLE A-1

LISTING OF ALTERNATIVE PLANS

ENERGY (cont.)

NATIONAL ECONOMIC DEVELOPMENT PLAN (NED)	MIXED OBJECTIVE PLAN (MO)	ENVIRONMENTAL QUALITY PLAN (EQ)
C. Options for Hydropower		
1. Allow hydropower to be developed with allowance for peaking.	1. Encourage hydropower development. Peaking releases must be controlled or mitigative measures implemented below generation plant.	1. Same as MO
	2. Encourage development of small-scale hydropower facilities at existing dams.	2. Same as MO.
	3. Coordinate the study and development of hydroelectric potential (large and small) within the basin.	3. Same as MO.

TABLE A-2

SYSTEM OF ACCOUNTS

WATER CONSERVATION

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
1. NED/MO/EQ. Conduct studies to determine the effectiveness of conservation measures to reduce depletive use.	Conservation efforts may be most effective.	Provide better use of resources.	Impart more confident attitude towards conservation programs.
2. NED/MO/EQ. Conduct a public education program.	Costs largely administrative and advertising; savings to consumers through lower use of water and energy; possible deferment of facility expansion.	Extend use of existing water supply facilities; reduce consumption of electricity and power generating fuel.	Spirit of participation in worthy program; stimulate additional conservation programs.
3. NED/MO/EQ. Require water-saving plumbing in new construction and in renovation of existing buildings in Basin and service area.	Minimal costs for using new plumbing facilities.	Same as above.	Same as above.
4. NED/MO/EQ. Require conservation plans for all new and existing water supply applicants for expanded systems.	Largely administrative costs; some impact on consumers.	Potential reduction in use; same as above.	Same as above.
5. NED/MO/EQ. Examine water systems for leakage; rehabilitate early systems.	Study, repair, and replacement costs may be high; saved water will reduce costs and possibly defer construction of new facilities.	Extend use of existing water supply facilities; reduce consumption of electricity and power-generating fuel.	Spirit of participation in worthy program; stimulate additional conservation programs.
6. EQ. Develop incentives to reduce depletive industrial water uses.	Implementation of technology may be very costly.	Same as above.	Same as above.
7. EQ. Recommend Congress review the entitlement provision of tha DRBC Compact and impose a charge on all surface and ground water users or establish new entitlement based on 1980 usage, with charges to begin in 1990 for usage in excess of 1980 entitlement.	Immediate impact on all consumers when instituted (1990), depending on charge and volume used.	Same as above.	Same as above.
8. NED/MO/EQ. Develop emergency conservation measures and contingency implementation plans.	Requires investigation; dependent upon severity and duration of measures imposed.	Maintain level of streamflow; benefit to biota, fish, recreation opportunities, salinity control.	Spirit of participation in worthy program; support of conservation ethic.

TABLE A-2

SYSTEM OF ACCOUNTS

WATER QUALITY

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
A. Water Quality of the Delaware River			
1. Dissolved Dxygen Standards			
NED. Retain present DO standard unless higher standards are required by EPA under 1983 requirements. Use design flow (and frequency with which it is expected to be achieved) as determined by overall re-examination of flow requirements. (Numerical stream quality objectives for unregulated streams are based on a minimum consecutive 7-day flow with a 10-year recurrence interval. DRBC Resolution 67-7.)	Costs of measures as shown under A.2.	Water quality improved over past conditions. (Standard is 3.5 mg/l DO minimum 24 hour average.) Improved fishery.	Increased recreational opportunities, esthetic.
MO. Raise DO standard if it can be achieved cost-effectively.	Costs of measures as shown under A.2.		
EQ. Raise DO standard if it is technically feasible to do so.	Costs of measures as shown under A.2.	Water quality improvement (degree achievable not yet known). Further improved fishery.	Further increased recreational, other opportunities. Potentially large cost, regulatory commitment.
2. Abatement measures			
NED. Proceed with abatement program as currently laid out.	Costs to meet treatment requirements and municipal, DRBC wasteload allocations, no additional cost.	Impacts as shown in 1. above.	Impacts as shown in 1. above
MO. Use additional measures (increased treatment levels, tightened allocations, stormwater treatment, decreased tributary and main stem loads), as indicated to reach DO levels chosen.	Research, development costs, increased treatment costs. Potential benefit from improved fishery.	Impacts as shown in 1. above.	Impacts as shown in 1. above

TABLE A-2

SYSTEM OF ACCOUNTS

WATER QUALITY (continued)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
EQ. Use additional measures as indicated to reach DO levels chosen.	Increased costs, benefits.	Beneficial	Potential loss of some jobs.
3. Upper Main Stem			
MO/EQ. Develop coordinated solutions for upper main stem.	To be determined.	Possible benefits due to improved knowledge.	Unknown.
4. Thermal Criteria			
MO/EQ. Determine need for tighter enforcement of thermal criteria for effluents; tighten requirements if necessary to maintain DO levels.	Research costs (DRBC staff estimate, $100,000). Increased treatment costs.	Potential improved fish habitat.	Potential recreation improvement.
B. Overall Water Quality Management and Improvement			
1. Local Issues			
MO. Develop public information/ education program.	Not large.		Increased public concern, involvement with issues; increased public pressure for compliance.
EQ. Develop information program as under MO, increase role of local government in enforcement.	Administrative. Potential manpower costs.	Improved water quality due to improved enforcement.	Same as MO.
2. Sampling; Monitoring			
NED. Develop sound, coordinated program of sampling, monitoring, data management for the Basin, incorporating base provided by current agency programs.	None significant; increased efficiency of existing programs.	Potential water quality improvement due to better detection and characterization of problems.	
MO. Same as NED options, plus identify agency to maintain effective system for data management and dissemination.	Data system development, design costs.	Same as NED.	
EQ. Same as NED, MO options plus increased sampling frequency, number of parameters. Include bioassays on a regular basis.	Increased monitoring, analysis cost.	Water quality improvement due to earlier problem detection, better monitoring for toxic substances.	

TABLE A-2

SYSTEM OF ACCOUNTS

WATER QUALITY (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
3. Planning			
NED/MO/EQ. DRBC provide consultation, review, and coordination of 201, 208, and 303e plans to maintain consistency with Comprehensive Plan.	Optimum use of water quality expenditures.	Environmental goals attained most readily.	Least confusion.
4. Nonpoint Source Controls			
NED. Continue reliance on voluntary nonpoint source measures except where additional measures can clearly be shown cost-effective. Improve street sweeping, litter, animal waste controls.	Least costly approach in short run. May penalize point dischargers in some areas.	Some water quality improve- over present conditions.	Continued uncertainty as to effectiveness of improvement measures.
MO. Use results from West Branch Delaware River MIP and other studies as background for local approaches, through Soil and Water Conservation Districts (SWCD) to determine site-by-site solutions for nonpoint source problems.	Study and analysis costs. Should lead to effective use of funds in long run.	If done carefully should lead to water quality improvement in major problem areas.	Presumably would lead to equity among dischargers, land uses.
MO. Commission recommend that additional funding be provided to the Agricultural Stabilization and Conservation Service to provide technical assistance to expedite implementation of the Agricultural Conservation Program within the basin.			

TABLE A-2

SYSTEM OF ACCOUNTS

WATER QUALITY (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
EQ. Same as MO options, plus required application of measures where it is reasonable to expect positive effect and proglems are severe.	Higher cost in short run. May penalize certain land uses.	Greater general water quality improvement, but may not lead to expected results in particular problem areas.	Probably improved equity, also risk of over-regulation, use of measures which may not be effective.
5. Strengthen erosion control and storm water management	Decreases maintenance cost of existing facilities.	Improved erosion control, water quality, and flood reduction.	More localized involvement in solutions to regional problems.
6. Determine appropriate standards and management policies for sodium.	------See Flow Maintenance------		
	C. Toxic Substances/Residuals Management		
1. MO/EQ. Assess quantities of toxic substances discharged past and present, to determine their sources and impact on man and the environment.	Determine costs of correcting past adverse practices.	Allow for planning to correct past environmental damage.	Provide greater safeguards for public welfare.
2. Monitoring, Sampling.			
MO. Monitoring, sampling programs as under overall water quality management. Include sampling at landfills, etc. Monitor sludge and other residuals that are applied to existing or future food producing land.	Cost noted under overall management. Some additional sampling cost.	Potential prevention of environmental damage.	Warning of potential contamination problems.
EQ. Same as MO options, plus major investigative study by appropriate agency of open, closed disposal areas.	One-time costs.	Increased protection from damage.	Better warning system.

TABLE A-2

SYSTEM OF ACCOUNTS

WATER QUALITY (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
3. Planning			
MO. DRBC complete current planning of industrial residuals; develop basinwide management strategy for toxic/hazardous substances. States continue policy development. At appropriate agency levels, maintain permanent records of permitted waste disposal sites. Improve local enforcement of controls on illegal waste dumping, etc.	Study cost estimate: $270,000. Staff, long-term data management costs.	Improved water quality, prevention of future risk.	Long-term solution to problem.
4. Emergency Measures			
MO. Improve warning system for spills, coordinate if possible with flood and other disaster warning networks. Increase reserve storage capacity for Philadelphia, other areas with vulnerable water supplies.	Must be determined.	None significant.	Protection of water supplies.
5. Carbon Treatment			
MO. Proceed with carbon treatment of water supplies where clearly indicated. All suppliers meet EPA regulations when established.	Philadelphia estimate: $156,000,000 capital, $32,000,000 annual.	Unknown.	Protection of water supply. Increased cost to consumers.

TABLE A-2

SYSTEM OF ACCOUNTS

FLOW MAINTENANCE

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
1. MO. Examine feasibility of developing one or more pumped storage or on-stream reservoirs for flow maintenance.	---------- See Part II, C ----------		
2. MO. Conduct pilot study to examine feasibility of developing emergency flow maintenance by controlled pumping of glacial alluvial-deposit aquifers adjacent to streams and rivers in the central and upper Basins.	---------- See Part II, C ----------		
3. NED/MO/EQ. Control major depletive water users in Basin by: 1) imposing a limit on depletive use; 2) require major depletive users to provide compensatory water storage; or 3) Commission sponsor construction and operate compensatory storage paid by all (large and small) depletive users.	---------- See Impacts of Water Conservation Management Options ----------		
4. MO/EQ. Impose stringent water conservation measures in times of severe drought. Require drought contingency plans which detail specific actions required of water users and administering agency(s). Plans may be devised to be implemented automatically based upon triggering criteria or by administrative action.	Impact variable with application of priority of use policy; requires contingency plan and evaluation of impacts to assure equitable allocation of shortages.	Postponement of large capital investment in storage structures; may create additional but temporary stress on specific resources.	Develop high level of awareness of the value of water resourses; encourage development and suppor of conservation ethic and sound land use-water resource planning and management.
5. MO/EQ. Investigate a policy which permits specific levels of depletive uses to occur with consequences accepted, fully stated, and individual users held responsible for alternative solutions. - Further study is needed to assess impact of low-flow conditions on users and to develop contingency plans.	Impact variable; will impose hardships on salinity-sensitive industries; increased concentration of chlorides requiring improved treatment; impact of increased sodium may cause additional expense for bottled water.	Increase in chlorides in Potomac-Raritan-Magothy aquifer; likely increased stress on aquifer with related movement of salt front.	Same as above.

TABLE A-2

SYSTEM OF ACCOUNTS

FLOW MAINTENANCE (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
6. NED/MO/EQ. Select revised chloride standard with reference to appropriate level of sodium control; determine and establish a minimum flow objective for the Trenton Gage which will maintain the above chloride and sodium control as well as an acceptable level of dissolved oxygen under drought conditions.	Will vary with chloride standard selected and method chosen for achieving flow objectives, e.g., depletive use limitation, emergency ground water pumpage and one or more reservoirs (see "Impoundments and Ground Water Pumpage"; reduction of industrial water usage may result in infrequent employment and business slowdowns. Expense for bottled water.	Depending on standard and minimum flow, selected impacts range from maximum protection of water users, public health and fisheries to expecting occasional fish kills, reduced water useage and possible increased exposure to sodium in some Camden area wells and other public and private wells, and in surface supplies taken from the upper tidal Delaware River.	Impact varies with standard and flow objectives selected; impact of reservoirs selected are described in reservoir evaluation; health impacts of inadequate protection from sodium are not yet measureable.

TABLE A-2

SYSTEM OF ACCOUNTS

WATER SUPPLY

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
A. Tri-County (Burlington, Camden, Gloucester) Area			
1. MO/EQ. Impose limitations on water use; develop ground water budget and management plan designed to alleviate stress on the aquifer; require conservation plans of new users; consider imposition of a ground water withdrawal charge.	Temporary loss of development activity income, land sales. Varying impact on consumers. Moderate costs, largely administrative and research.	Possible maintenance of current groundwater levels. Prolong use of Potomac-Raritan-Magothy aquifer through reduced use.	Increased awareness of resource limits; stimulate conservation programs; disruption of real estate and home building interests.
2. NED/MO. Develop a conjunctive use system incorporating a surface water treatment plant on the Delaware River with transmission main(s) to existing distribution systems; incorporate ground water recharge if studies show feasibility.	Capital costs of $57.4 to $151.1 million, maintain dual system with higher than present cost to consumer.	Reduce estuary infiltration, recover groundwater levels, reduce saline and other contamination; retain and extend usefulness of aquifer.	Security from concern over contamination from chlorides and estuary contamination; guaranteed water supply.
3. NED. Purchase treated water from Philadelphia for transmission directly to Camden-area distribution system.	Moderate capital cost for transmission mains.	Reduce estuary infiltration, stop decline of PRM water level and allow gradual recovery to normal level.	Camden area not responsible for supply; Philadelphia assumes all responsibility; Camden subject to Philadelphia price and quality.
B. Triassic Lowlands			
1. MO/EQ. Establish ground water protected area and impose limitations on water use; develop land/water-use management plan and water budget; condition withdrawal permits on sound conservation plans; consider imposition of ground water withdrawal charge.	Temporary loss of development activity income, land sales. Potential stimulation to development of selected areas; potential disruption to development. Moderate costs, largely administrative and research. Some increased costs to consumers. Potential stimulus to plumbing and conservation businesses.	Maintenance of current groundwater levels; restore stream flows. Improve resource management through understanding natural systems and land use water management interface. Improved allocation of water based on budget will permit aquifer management within safe limits. Potential reduction in use will allow aquifer recovery, restore springs and dry weather streamflows.	Increased awareness of resource limits; Stimulation of conservation programs; disruption to real estate and home building interests. Improve municipal government planning, zoning, and development controls. Secure knowledge of a stable water supply; less frequent imposition of use restrictions.

TABLE A-2

SYSTEM OF ACCOUNTS

WATER SUPPLY (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
2. NED/MO/EQ. Require interconnections among contiguous water purveyors as a means of defraying temporary water shortages.	Potential economic stimulus if water is provided to now unserved areas.	Will permit more efficient distribution of available supply.	Strengthen regional awareness and management and planning efforts.
3. NED/MO. Develop the Pt. Pleasant pumping facility, North Branch water treatment plant and related transmission mains to provide supplementary surface water supply to portions of central Bucks and Montgomery Counties.	Remaining capital cost $27 million, self-sustaining operation; possible increased cost to consumers; permit additional municipal/industrial development.	Prolong use of aquifers; permit restoration of springs, streamflows and water levels; construction disruption at Pennsylvania Canal, Delaware River, transmission main routes and water plant.	Assured water supply, eliminate service interruptions, potential conflict with Pennsylvania Canal during construction.
4. NED/MO. Eventual development of Evansburg Reservoir, if needed, as additional surface water storage to offset ground water shortages.	See Chapter 7		
C. Philadelphia Alternatives			
1. EQ. Consider relocating Philadelphia's Torresdale intake upstream (Trenton area), pending development of appropriate EPA drinking water standards and regulations.	Capital cost $100 million; possible reduced treatment costs resulting from better raw water quality; possible impact on waste dischargers and water treatment plants from Trenton to Torresdale; permit additional industrial development above present intake.	Reduced streamflow in Trenton to Torresdale reach may degrade water quality.	Water suppply assured safe from existing contaminents and threats from accidental spills, chloride intrusion, and municipal/industrial waste dischargers.
2. EQ. Provide additional filtered water storage at Torresdale.	Requires investigation, possible increased treatment costs resulting from new regulations.	Minimal adverse impact.	Water supply more secure than at present.
3. NED/MO/EQ. Determine feasibility of improving interconnection among Philadelphia's three treatment plants.	Same as above.	Potential flow decreases in Lower Schuyikill River during drought conditions.	Same as above.

TABLE A-2

SYSTEM OF ACCOUNTS

WATER SUPPLY (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
D. Pennsylvania - New Jersey Water Supplies			
1. NED/MO/EQ. Review recommendations of PA, NJ, and NY, and DE, water supply plans as they become available, for inclusion in DRBC Comprehensive Plan.		Variable throughout each state subbasin, including wells, pumping stations, small impoundments. Environmental effects must be assessed on individual case basis.	Assumed safe supplies, providing stable basis for planning and guiding such future municipal, industrial and agricultural development as deemed advisable under guidance of comprehensive planning programs.
E. Philadelphia-Camden Interstate Region			
1. MO. Many of the management options for Sections A, B, C, and D include individual components of the Philadelphia-Camden Metropolitan Area total water supply problems. It is recommended that DRBC initiate exploratory talks with a view to developing a reasonable strategy for approaching these interrelated and complex problems on an interstate basis.			

TABLE A-2

SYSTEM OF ACCOUNTS

FLOOD LOSS REDUCTION

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
A. Delaware River Main Stem			
1. Mix of Measures			
MO. For main stem, COE complete current study to determine most effective mix of structural, non-structural measures. (Stage I reconnaissance report has been completed).	URS/Madigan-Praeger Study suggests that mix of nonstructural measures might be cost-effective.	Nonstructural measures would presumably have less environmental impact than local or upstream protection works.	Displacement of current residents, industry. Open space available for parks, etc.
EQ. For main stem, explore aggressive, multipurpose floodplain acquisition/management program, using programs of federal/state/local agencies.	Combination of programs under several federal agencies may give viable package.	Least environmental effect.	Increased effects as compared to RP option.
B. Tributary Damage Centers			
1. Major Structures			
NED. Continue to explore flood protection potential of currently proposed projects.	See Physical Facilities to Manage Water.	Detailed EIS prepared for Trexler, COE Level B analyses for others.	Strong local public opinion against impoundments.
MO. Rely on protection provided by existing projects; where modifications are proposed, insure no interference with flood control functions.	No significant costs. Flood loss damages not reduced.	No environmental effects when considered alone.	Maintenance of status quo.
EQ. Re-evaluate flood control benefits of existing storage, viability of converting some to water supply.	Study costs: $15,000 per reservoir. Additional significant costs for floodplain studies downstream.	Storage gained might eliminate need for other storage construction. Unknown effects of providing other protection for downstream areas.	Elimination of existing flood protection might have significant impact, e.g., in areas which are full participants in Regular Flood Insurance Program.

TABLE A-2

SYSTEM OF ACCOUNTS

FLOOD LOSS REDUCTION (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
B. Tributary Damage Centers (cont.)			
2. Local Structural Measures; Small Impoundments			
NED. Consider construction of currently proposed local protection works where locally acceptable. Explore possibility of construction of structures with low benefit/cost ratios in special cases.	By definition, relatively high initial costs. Fundability uncertain.	Effects already analyzed accepted.	Would only be pursued where strong local demand.
MO. Consider construction of currently proposed local protection works where locally acceptable. Continue to evaluate need for such protection.	Reflects current benefit/cost analyses.	Effects already analyzed, accepted.	Consistent with current preferences.
EQ. As part of re-evaluation of existing storage, explore local works for reaches presently protected by upstream storage.	Evaluation critical part of study under B,1 above. Feasibility study, $150,000 (DRBC staff estimate).	Evaluation needed.	Evaluation needed.
3. Mix of Nonstructural Measures MO/EQ. Conduct pilot study on tributary watershed in New Jersey or Pennsylvania modeled after main stem work. Develop strong floodplain managment package. Concentrate on transferability of results. Investigate stormwater retention management for existing developed areas.	Similar to other COE Basin studies. Evaluation necessary. COE/SCS groundwork may be available. Feasibility study: $250,000. (DRBC staff estimate).	Study would evaluate environmental, social effects. Evaluation necessary. Effects should be relatively small.	Study would evaluate environmental, social effects. Evaluation necessary. Effects should be relatively small.
4. Flood Warning			
MO/EQ. Conduct pilot flood warning study; explore federal funding availability for implementation. Develop informational material on measures, funding for floodplain management, serve as expert advisor to localities.	Administrative, research, manpower costs. Pilot flood warning study cost: $30,000 (Susquehanna River Basin Commission estimate). Regional agency activities: annual costs: $40,000 (1 man-year). (DRBC staff estimate).	None significant.	Would provide centralized information center, encourage local action.

TABLE A-2

SYSTEM OF ACCOUNTS

FLOOD LOSS REDUCTION (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
	C. Future Flood Risk		
1. Watershed Management			
MO. DRBC, states, adopt watershed management policy as outlined under Water Quality.	Program, costs same to large extent as proposals under Water Quality. Administrative, manpower costs to maintain modeling capacity.	--------------- Effects same as proposals under Water Quality---------	
2. MO. At regional, county, or municipal level, require stormwater management measures with performance standards for new development.	----------------------------------Same as proposals under Water Quality ------------		
3. EQ. Regional agency develop storm water modeling capacity, expertise to serve as advisor to local planning agencies or use directly.	Evaluation needed.	None significant.	Would encourage local action; provide information useful for planning.

TABLE A-2

SYSTEM OF ACCOUNTS

FISH AND WILDLIFE

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
A. Fish and Wildlife			
1. NED/MO/EQ. Develop a comprehensive, coordinated approach to fish and wildlife management in the Basin; review and adopt the comprehensive fisheries management plan developed by FAWTAC during the mid-1960's when it is updated and completed by the Delaware River Basin Fish and Wildlife Management Cooperative.	Administrative and program costs.	Improved fish and wildlife resources.	Increased recreation through improved fish and wildlife resources.
2. NED/MO/EQ. Develop a comprehensive Basin-wide low-flow policy which considers such factors as average flow, drainage area, shellfish, fish and wildlife resources, temperature, water quality, habitat and discharge relationships.	Administrative and program costs must be balanced against increased recreation and commercial fishing opportunities and the resulting economic benefits.	Improved ecology of the Basin.	Increased recreational opportunities.
3. NED/MO/EQ. Determine the effect of Basin-wide impingement and entrainment of fish and other aquatic resources; encourage research to minimize problem.	Administrative and research costs balanced with commercial and recreational benefits.	Improved fish and aquatic resources.	Improved public relations with industry; increased recreational and commercial opportunities.
4. NED/MO/EQ. Encourage the continuation of studies on anadromous and catadromous fishes and other fish and wildlife resources as needed.	Administrative costs balanced with fishery management benefits.		Increased commercial and recreational benefits.

TABLE A-2

SYSTEM OF ACCOUNTS

FISH AND WILDLIFE (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
5. NED/MO/EQ. Enforce toxic substance standards and compliance schedules as promulgated.			
6. NED/MO/EQ. Implement wetland protection program to preserve and enhance wetlands.	Administrative and program costs.	Protection of fish and wildlife habitat.	Aesthetic value of open space; increased mosquito infestation.
7. NED/MO/EQ. Continue on a long-term basis augmented conservation releases from the New York City reservoirs for the upper Basin major waterways.	Improved and increased fishing and other water-related recreation activity.	Improved habitat for fish and wildlife.	Increased aesthetic value of streams.

TABLE A-2

SYSTEM OF ACCOUNTS

RECREATION

	MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
1.	MO/EQ. Develop a comprehensive urban waterfront program.	Positive development of benefits, particularly on local level.	Compatible with environmental objectives.	Aid social well-being and recreational opportunity.
2.	MO/EQ. Develop greenway program.	Program development costs versus recreational benefits.	Environmentally compatible.	Same as 1 above. May require increased local police, services.
3.	MO/EQ. Cooperate in the development of the recreation plan for Upper Delaware River in conjunction with its incorporation into the U.S. Wild, Scenic and Recreation Rivers System and consider results for Comprehensive Plan amendment.	Developmental costs for land acquisitions; recreational benefits to localities unknown.	Environmental effects determined in plan development.	Social effects determined in plan development.
4.	MO/EQ. Cooperate in the develement of the recreation plan for Middle Delaware River in conjunction with other recommendations affecting the potential for a mainstem impoundment. Consider results for Comprehensive Plan amendment. (Comprehensive Plan amendment regarding Middle Delaware River will require unanimous consent of parties to 1954 Supreme Court decree.)	Some additional land acquisition may be necessary; recreational benefits to localities unknown.	Environmental effects determined in plan development.	Social effects determined in plan development.
5.	MO.EQ. Support the recreation plan developed for the 970,000 acre Pine Barrens site in New Jersey, of which roughly 10% is in the basin.	$26 million for land acquisition and program planning.	Preservation of a unique ecological area.	Improved passive and active recreational opportunities.
6.	MO/EQ. Support water quality standards needed to provide suitable habitat for fish, wildlife and recreation.	Economic costs and benefits should be determined.	Consistent with national environmental objectives.	Improved fishing and recreational opportunities.

TABLE A-2

SYSTEM OF ACCOUNTS

RECREATION (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
7. MO/EQ. Support ongoing federal, state and local programs which foster recreational opportunities such as existing fish and wildlife and forest management programs, historic,cultural, and natural area preservation, ongoing greenway programming.	Program development costs are considered less than benefits desired by the recreationist in his pursuit of the recreational opportunity.	Conservation and preservation of Basin's natural resources.	Improved recreational opportunities.
8. MO/EQ. Acquire the River Islands for public use.	Acquisition expenses.		
9. MO/EQ. Coordinate recreational planning for reservoirs which may be constructed with related local and regional programs and objectives.			
10. NED/MO/EQ. Establish recreational cost-sharing policies involving DRBC-controlled storage.			
11. MO/EQ. Conserve present and potential drinking water supply watersheds through designation as recreation, conservation or similar use.			
12. MO/EQ. Protect sensitive or unique ecosystems.			

TABLE A-2

SYSTEM OF ACCOUNTS

ENERGY

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
A. Options for Siting and Cooling			
1. New generation plants			
NED. Utilities determine steam, electric generating plant siting and cooling systems.	Least direct cost solution.	May provide undue stress on Basin waters.	
MO/EQ. Guide steam electric generating plant siting; require wet cooling towers.	May be least direct and indirect cost solution.	Minimizes environmental degradation of Basin waters.	
2. MO/EQ. Retrofit existing cooling water systems to eliminate entrainment and entrapment.	Increase cost of electricity. Increase value of fisheries.	Minimizes adverse impacts on fish and food chain.	

TABLE A-2

SYSTEM OF ACCOUNTS

ENERGY (cont.)

MANAGEMENT OPTIONS (Plans to which options have been assigned are indicated.)	ECONOMIC IMPACTS	ENVIRONMENTAL IMPACTS	SOCIAL IMPACTS
B. Options for Cogeneration			
1. NED. Cogeneration develops on own merits in existing regulatory framework.	Uncertain	Uncertain	Has benefit of minimal governmental regulations. However, an optimum energy/environmental solution may be foregone.
2. MO. Encourage development of cogeneration, investigate appropriate policy or regulatory changes.	Uncertain	Less depletive usage of water and less thermal discharge to receiving water.	More efficient use of energy resources.
3. EQ. Change existing utility regulations to encourage co-generation.	Less need for capital investment, generation stations and impoundments. Less fuel cost. Difficulty in meshing steam/electric production.	Less depletive usage of water and less thermal discharge to receiving waters.	More efficient use of energy resources. Less construction of impoundments, generation
C. Options for Hydropower			
1. NED/MO/EQ. Promote hydropower with adequate controls for peaking operations.	May minimize cost of electricity	May upset natural stream ecology.	Furthers national goal of energy independence.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

WATER CONSERVATION

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
1.	DRBC leads coordination of basinwide perspective and program. State, local and private agencies carry out.		v x y	a	v x		x	a b c	v w x	a b c	
2.	States and localities lead in enacting statutes/regulations.		v w x	a				a			x
3.	States or DRBC lead. Local and private agencies carry out and finance.	a		a				b c		b c	
4.	DRBC, states, localities make better use of existing programs.		v		v				v		
5.	DRBC leads in development of plan. River Master, DRBC, states and N.Y.C. control and implement actions under policies.	a	v w x y	a	v	a	x	b		b	
8.	States lead with DRBC support.		v w x	a							

*Direct:
(a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

**Collaborative (Indirect):
(v) Information/analysis/dissemination.
(w) Planning.
(x) Technical assistance/guidelines.
(y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

WATER QUALITY

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
A. 1.	DRBC leads in setting standards and tests with model. States and federal agenices provide technical aid.	a d			x		x				
2.	Joint, concurrent action by all parties.	a		a	x	a c	x	b c		b c	
3.	DRBC lead coordinated effort. State and federal agencies collaborate.	d		d		d					
4.	Joint coordinated action by all parties.	d		d		d					
B. 1.	DRBC leads in coordination of basinwide perspective and program. State and federal agencies implement.		v x y	a		a			v		v
2.	States/federal lead in data collection, dissemination and management; DRBC leads coordination of overall basinwide information program.	d	v w x y	b c d	v w x	b c d	v w x	b c		b c	
3.	DRBC leads in policy development and maintaining basinwide perspective. All others carry out and finance. State and local regulate as required.	a d	w x y	a b c d	w x	b c d	w x	a b c	w x	b c	
4.	Federal/State lead research/study programs. DRBC provide basinwide planning and oversight.	d	y	c d		c d		c d		c d	
5.	States/local government lead in enforcement.			a				a b c		b c	

*Direct:
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(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
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(d) Research/study.

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(y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

WATER QUALITY (contd.)

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
6.	EPA leads[1] in developing drinking water standards; DRBC leads in developing in-stream standards; and DRBC, federal, state agencies develop and implement management policies.	a d		a	x	a d	x				
C. 1.	States/federal lead in data collection; DRBC lead coordination of overall basinwide information program.	b c d	v w x y	b c		b c		b c		b c	
2.	DRBC lead in policy formulation resulting from studies; regulatory action by states and localities.	c d	v w x y	a c	v x	a c	x	a	w x	b c	x
3.	DRBC coordinates policy formulation and program development; implementation by federal, state and local agencies.		v w x y	a b c	v w x	a b c	v w x	a b c	w x	b c	
4.	Federal agency lead in establishing standards; state, local and private agencies implement.		v x	a	x	a c d	v x	b c		b c	
5.	EPA lead in developing standards; water purveyors implement.		v w x y	a	v w x y	a d		b c		b c	

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(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

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TABLE A-3

RESPONSIBILITIES AND ROLES FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

FLOW MAINTENANCE

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
1.	DRBC lead in formulating study on sites selected; joint concurrent action by all parties.	d		d		c d		d			x
2.	DRBC lead in formulating study on sites to be selected; joint concurrent action by all parties.	c d		c d		c d		d			x
3.	DRBC and states implement.	a	y	a			x	b c		b c	
4.	DRBC in cooperation with River Master leads and implements adopted policies; others execute tasks under their control.	a	v w x y	a b	v w x	a b	x	a b		b	
5.	Local and private agencies lead. Others provide basinwide overview and technical aid and information as required.		v w x y		v w x		v w x	b c		b c	
6.	EPA leads in developing drinking water standards; DRBC leads in developing in-stream standards; and DRBC, federal and state agencies develop and implement management policies.	a d		a	x	a d	x		x		x

*Direct:
- (a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
- (b) Construct/operate/maintain (e.g. facilities, monitoring installations).
- (c) Finance.
- (d) Research/study.

**Collaborative (Indirect):
- (v) Information/analysis/dissemination.
- (w) Planning.
- (x) Technical assistance/guidelines.
- (y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

WATER SUPPLY

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
A. 1.	New Jersey leads with support of DRBC.		v w x	a d			v w x				
2.	States, local and DRBC coordinates in formulating study; joint concurrent action by all parties.	d		d				d			x
B. 1.	DRBC lead agency under Article 10 and Section 3.B of Compact. State assumption of program when possible.	a d		a d			v w x	b	v w x	b	v
2.	State lead agency. Local and private agencies strengthen cooperative arrangements.		v w x	a d			v w x	a b		b	v w x
3.	DRBC lead in resolving issues related to Comprehensive Plan implementation.	a		b c				b c			
4.	State lead agency in resolving issues.		w x	a b c				b c			
C. 3.	City of Philadelphia lead agency.							d			

*Direct:
(a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

**Collaborative (Indirect):
(v) Information/analysis/dissemination.
(w) Planning.
(x) Technical assistance/guidelines.
(y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

WATER SUPPLY

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
D. 1.	DRBC lead agency with extensive public participation.	a									x
E. 1.	DRBC lead in formulating and coordinating solutions; joint concurrent action by all parties. Authorizations and financial assistance from appropriate federal program(s).	d		d		c d		d		d	

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(a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

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(v) Information/analysis/dissemination.
(w) Planning.
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(y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

FLOOD LOSS REDUCTION

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
A.1.	Federal government leads in conducting study. Joint concurrent action by all other parties.	d	x y	d	x	c d	v w x	d	x	d	x
B.1.	All parties implement and review proposed modifications for consistency.	a b	v w x y	a b c	v w x	a b c	v w x	b c	v w x	b c	x
2.	Federal, state agencies lead. Joint concurrent action by other parties.		v w x y	b c	v w x	b c	v w x	b c	v w x	b c	x
3.	DRBC leads in designing and supervising pilot study. State, local, federal agencies cooperate in study.	d	v w x y	d	v w x	d	v w x	d	v w x	d	v x
4.	DRBC leads in designing and conducting study. Provides information and technical assistance to local government. Federal and state agencies assist in implementation.	d	v w x	d	v w x	d	v w x	d	v w x	d	v w x

*Direct:
- (a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
- (b) Construct/operate/maintain (e.g. facilities, monitoring installations).
- (c) Finance.
- (d) Research/study.

**Collaborative (Indirect):
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- (w) Planning.
- (x) Technical assistance/guidelines.
- (y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

FLOOD LOSS REDUCTION (cont.)

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
C.1.	DRBC leads in policy development and maintaining basinwide perspective. State adopt and enforce policy. Federal government support with financial and technical aid under existing policies.	a d	w x y	a b c d	w x	b c d	w x	a b c	w x	b c	
2.	States lead in setting policy. Local government leads implementation.		v w x y	a	v w x		v w x	a b c	v w x	b c	

*Direct:
(a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

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(w) Planning.
(x) Technical assistance/guidelines.
(y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

FISH AND WILDLIFE

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
1.	DRBC in cooperation with Fish and Wildlife Management Cooperative coordinates basinwide perspective and program. Technical work and implementation by state and federal fishery agencies.		v w y	a b	v w x	a b	v w x		v x		v w x
2.	DRBC leads in studies for policy formulation. Joint concurrent action by all other parties.	d		d		d		d		d	
3.	DRBC together with Delaware River Basin Fish and Wildlife Management Cooperative lead in coordinating studies for policy formulation. State and federal agencies lead operational programs. Active participation of private sector essential.	d		d		d		d		d	
4.	DRBC in cooperation with Fish and Wildlife Management Cooperative lead in coordinating studies.			d		d		d		d	
5.	States lead enforcement of toxic substance control program, supported by federal agencies. DRBC basinwide oversight as related to protection of water quality.		y	a		a					

*Direct:
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(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

**Collaborative (Indirect):
(v) Information/analysis/dissemination.
(w) Planning.
(x) Technical assistance/guidelines.
(y) Basinwide oversight.

RESPONSIBILITIES AND ROLES FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

FISH AND WILDLIFE

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
6.	DRBC leads in policy development and maintains basinwide perspective. States, local governments lead in enforcing.	a	v w x y	a	v w x		v x	a	v w x		
7.	DRBC, River Master, and New York City coordinate and maintain Conservation Release Program.	b	v x y	b	v x	b	v x	b	v x		

*Direct:
(a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

**Collaborative (Indirect):
(v) Information/analysis/dissemination.
(w) Planning.
(x) Technical assistance/guidelines.
(y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

RECREATION

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
1.	Local agencies lead in planning and implementing program with state, federal and DRBC support.		v w x y	a c	v w x	a c	v w x	a b c	v w x	b c	x
2.	State and federal agencies support implementation through authorized programs and funds. Private and local agency cooperation essential.		v w x y	a c d	v w x	a c d	v w x	c d	v w x	c	x
3.	Federal, state and local agencies lead with DRBC support.		v w x	a b c	v w x	a b c	v w x	a	v w x		x
4.	Federal, state and local agencies lead with DRBC support.		v w x y	d	v w x	d	v w x	d	v w x		
5.	State lead development and implementation of recreational plan, supported by federal and local agencies and DRBC.		v w x	a b c	v w x	c	v w x	a b c			x
6.	States lead in enforcing adopted basin standards. DRBC provide basin oversight.		y	a	v w x		v w x	b c	v w x	b c	v x

*Direct:
(a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

**Collaborative (Indirect):
(v) Information/analysis/dissemination.
(w) Planning.
(x) Technical assistance/guidelines.
(y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

RECREATION (cont.)

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
7.	Joint concurrent action by all parties.	a	v w x y	a b c	v w x	a b c	v w x	a b c	v w x	b c	v w x
8.	Federal, state agencies cooperate.		v w x y	a c	v w x	a c	v w x		v x		x
9.	DRBC lead in establishing policies. Joint concurrent action by all other parties.	a b c	v w x y	a b c	v w x	a b c	v w x	a	v w x		x
10.	DRBC, state and federal agencies lead formulation of policies.	a b c	v w x y	a c	v w x	a b c	v w x		v w x		x
11.	DRBC lead in developing policy and program. Federal, state, local and private implement.	d	v w x y	a b c	v w x	a b c	v w x	a b c	v w x	b c	x
12.	Joint concurrent action by all parties.	a	v w x y	a b c	v w x	a b c	v w x	a b c	v w x	b c	x

*Direct:
- (a) Regulatory (e.g. statutory policy, regulations, enforcement, permits, supervision, consistency with Comprehensive Plan).
- (b) Construct/operate/maintain (e.g. facilities, monitoring installations).
- (c) Finance.
- (d) Research/study.

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- (x) Technical assistance/guidelines.
- (y) Basinwide oversight.

TABLE A-3

RESPONSIBILITIES AND ROLES
FOR IMPLEMENTATION OF MIXED OBJECTIVE PLAN

ENERGY

Management Options	Lead Roles for Implementation	DRBC		State		Federal		Local		Private	
		D*	C**	D	C	D	C	D	C	D	C
A. 1, 2.	DRBC lead in setting basin policy. States and federal agencies support with consistent siting policies.	d	v w x y	a	v w x	a	v x			b c	w
B. 1.	DRBC, states encourage private utility efforts.	d	v w x y	d	v w x					b d	v w x
C. 1.	DRBC in cooperation with Federal and state agencies set basinwide policy. Federal and state agencies enforce through licensing/operating requirements.	a	v w x y	a	v w x	a	v w x		v w x	b c	
C. 2.	State, Federal, private interests.			a d	v w x	a d	v w x		v w x	a d	v w x
C. 3.	States, Corps of Engineers, U. S. Dept. of Engergy and private utility efforts should be encouraged and coordinated by DRBC.	d	v w x y	b d	v w x	b d	v w x			b d	v w x

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(b) Construct/operate/maintain (e.g. facilities, monitoring installations).
(c) Finance.
(d) Research/study.

**Collaborative (Indirect):
(v) Information/analysis/dissemination.
(w) Planning.
(x) Technical assistance/guidelines.
(y) Basinwide oversight.

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