COMMONWEALTH OF PENNSYLVANIA
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THE STATE WATER PLAN

SUBBASIN 17

CENTRAL ALLEGHENY RIVER

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INTRODUCTION

The history of Pennsylvania can be traced through the development of its water and related land resources. From its founding as a settlement in the port of Philadelphia to its present position as a leading industrial, agricultural, and financial center, Pennsylvania's growth has depended on its varied and ample water resources. As the Commonwealth continues to mature and change, its dependency on these water resources will increase dramatically; consequently, the value of water itself will increase as more diversified uses compete for this renewable, but limited resource.

Such competition is leading to increasingly complex problems regarding the management of our vital water resources. The past decade has seen heavy emphasis placed on the environment, and water resources in particular, through the adoption of more sophisticated laws, policies and institutional arrangements at the State and Federal levels to protect, conserve, and manage water.

The Central Allegheny River subbasin, which is the subject of this report, encompasses many forms of man's effect on the environment and its effect upon him. The present and future importance of water and related land resources is realized throughout this area, as it is throughout the Commonwealth.

In recognition of the growing urgency for statewide management of water and related land resources, the General Assembly charged the former Department of Forests and Waters with the responsibility of developing water resources management policy. This authority was then transferred to the Department of Environmental Resources through Act No. 275 of 1970, which created the new Department.

The State Water Plan has been developed as a management tool to guide the conservation, development, and administration of the Commonwealth's water and related land resources on a comprehensive and coordinated basis. Only through the practice of such management will the Commonwealth be able to maintain its current prosperity, provide adequate flood control for its citizens and assure the supplies of good quality water necessary to meet its future needs.

This report is one of 23 reports being published as a result of the initial investigations and studies conducted in connection with the State Water Plan. The first report in the State Water Plan series, "Planning Principles SWP-1", was published in March 1975. That report, which expressed the goals, objectives, standards and criteria, and outlined the work program as well as described planning methodology, is referred to throughout this report. Three other reports; "Statewide Summary Report", "Water Laws and Institutional Arrangements", and "Water Resources Data System—WARDS", like "Planning Principles" deal with their respective subjects in a statewide manner. Nineteen subbasin summary reports deal with the water resources problems and solutions to those problems for each of the 20 subbasins[1] delineated in the Commonwealth for this study. This subbasin report provides background material, identifies problems, and presents alternative and recommended solutions to both the short- and long-term problems in Subbasin 17, the Central Allegheny River subbasin.[2]

Development of the Plan in itself will achieve little. Successful implementation of the Plan, including continued development and use of the planning resource, is the key to Pennsylvania's future. Such implementation will be carried out under the laws and policies established by the General Assembly to manage our water resources in the interests of all the Commonwealth's citizens, including generations yet to come.

This report, along with the others comprising the State Water Plan, is intended to provide the General Assembly, State and local governments, business, industry, water suppliers, and all interested citizens with the information necessary to comprehend the scope of Pennsylvania's water problems and to enable administrators to wisely manage the Commonwealth's water and related land resources through the use of the developed planning resources including data bases, analytical methods and staff expertise.

[1]Because of its relatively small land area, Subbasin 14 is included in the Subbasin 16 report.

[2]The terms "subbasin" and "watershed" as used throughout this report are not used in their true hydrologic sense, but rather refer to water resources study areas which were arbitrarily defined, taking into account similar hydrologic and physical features of the Commonwealth's land mass.

I. SUMMARY AND RECOMMENDATIONS

The purpose of this report is to provide a general understanding of the water resources of the Central Allegheny River subbasin and sufficient insight into the relationships between man, economy and environment to rationally examine the problems associated with water resources and determine viable solutions which could support man's continued well-being while living in harmony with his surroundings. The report examines the physical features of the basin and the impacts from man's development of the area's natural resources. Both population and economy were forecast based on existing trends. Those forecasts were used as the future baseline upon which water resources problems could be examined. In the absence of actions to change existing trends, these forecasts are estimates of conditions which are likely to occur. The forecasts provided the basis for examining the range and costs of available alternatives for identified problems if current trends prevail.

While the problems and identified solutions are derived from trend conditions, it is important to note that State government and many regions throughout the Commonwealth are questioning the desirability of perpetuating existing trends. At the State level, recommendations of the Land Policy Program and policies adopted for the State's Environmental Master Plan propose policies which would result in changes to past trends and resource management practices. Currently, through the Comprehensive Water Quality Management Plan program, local values important for maintaining community character and protecting the environment are being utilized as the basis for developing various alternative futures. This subbasin report, while describing the impacts and consequences of existing trends, is also providing useful information for decision-makers to determine whether or not trend forecasts should be modified.

As State policies, regional plans, and community actions continuously define the desired character of future development, the ongoing State Water Plan program can readily identify potential impacts and propose subbasin alternatives consistent with State policy and compatible with community goals.

The scope of this study includes major aspects of water use and water management which can be affected by changing conditions in the future. Pennsylvania's intense water resources development dictated that problems be explored on a watershed, municipality and even company basis. For each problem which was identified, feasible solution alternatives have been examined and discussed, with consideration given to their physical, economic, environmental and social implications in order to determine and recommend solutions. In some instances, no single solution was recommended because more detailed studies are required.

In deriving its summary and recommendations this study has: (1) utilized the trend analyses as well as the many assumptions expressed in this text and "Planning Principles SWP-1", (2) solicited extensive public participation and reflected local desires and wishes to the maximum extent possible, and (3) considered both the natural physical features and socio-political jurisdictions and restrictions imposed by society.

Subbasin 17 is characterized by a very rugged terrain typical of the Appalachian Plateaus Province. The northern half of the basin is in the Allegheny High Plateaus Section having high, dissected plateaus with deep-streamed valleys and very little flat land located on the valley bottoms and on the mountain divides. The southern section of the basin lies in the Pittsburgh Plateaus Section having roughly the same terrain except that the hills are less rugged because the underlying rock types are shales rather than the sandstones of the high plateau section. Roughly two-thirds of the basin is forested and about one-sixth is in agriculture, with woodlands to the north and farms in the south. The economy of the basin is largely based on its minerals. Coal, gas and oil have all been mined very heavily in the past, with coal being the major mineral resource being mined today. Also stone, clay and glass products are very important to the economy. The mineral industry development has had its impact on the water resources of the basin. The abandoned coal mines, both deep and strip, as well as abandoned oil wells and gas wells are responsible for degradation of many streams by acidity and iron. The scenic streams in this rugged terrain are valuable resources that have been dispoiled by pollution. The quality of fishing in most of the streams is generally low with exceptions being those streams which haven't been polluted. Most of the towns are located in the stream valleys and are flood prone due to rapid runoff from the mountainous streams. Flood potential has been reduced by many Federal and State flood control projects. Several streams in the subbasin have been nominated as candidates for inclusion in the Pennsylvania Scenic Rivers System. Some of these same streams are being looked upon for industrial and energy development, which will necessitate careful planning to preserve the environmental integrity of the region as the water quality problems are eliminated. Various water resources needs must be addressed for the future; the following sections summarize the more prominent problems of the subbasin and their recommended solutions.

A. WATER QUALITY

The major water quality problems in the basin are associated with acid mine drainage. Another major problem is nutrient enrichment from raw and primary treated municipal and industrial waste discharges. The water quality of the Allegheny River itself is generally good as it flows through Subbasin 17 with some localized degradation noted in the Ford City-Kittanning area from industrial discharges.

The West Branch Clarion River is polluted from Halsey to Wilcox by brines emitted from abandoned gas wells. The East Branch Clarion River has had abatement projects constructed to reduce the impact of mine drainage and has shown improvement. Elk Creek in the vicinity of St. Marys is affected by both municipal and industrial discharges, as well as acid mine drainage. At Johnsonburg, the Clarion River is affected by color and suspended solids discharges from an industrial source.

Serious acid mine drainage pollution occurs in Little Toby Creek (Elk County), Mill Creek (Clarion and Jefferson Counties), Toby Creek (Clarion County), Piney Creek, Deer Creek, and Licking Creek, degrading most of the main stems plus many miles of their tributaries. Department of Environmental Resources mine drainage abatement projects in the Little Toby Creek watershed in Elk County, primarily in the headwaters, will help reduce the acid loading in that stream.

Bear Creek in Butler County is affected by acid mine drainage from abandoned deep mines, strip mines, and oil and gas wells on the north branch of Bear Creek and by industrial discharges from the south branch. Proposed mine drainage abatement projects by DER will improve ten miles of this stream.

Redbank Creek is polluted by inadequately treated municipal discharges near Reynoldsville, Brookville and New Bethlehem. Planned upgrading of the treatment facilities at each location will alleviate these problems. Raw sewage from the Falls Creek area is degrading three miles of Sandy Lick Creek. Acid mine drainage is a major problem in Catfish Run, Fiddlers Run, Leisure Run, Town Run, Welch Run, and Runaway Run.

The acid mine drainage pollution of the headwaters and many tributaries of Mahoning Creek, Limestone Run, Pine Creek, Cowanshannock Creek, Glades Run and Garretts Run is also a major problem in the subbasin. Acid mine drainage in Crooked Creek is being addressed by DER abatement projects in the upper portions of the stream with the greatest improvement to be achieved through the recently completed mine drainage treatment plant at the Borough of Creekside.

While the surface waters in the basin are largely polluted by acid mine drainage, the groundwaters are generally good. The exception occurs in the Clarion County area where previous mining activities and interconnected abandoned gas wells have caused widespread groundwater pollution.

Water quality problems of Subbasin 17 are being examined and water quality standards and wastewater treatment plans are being developed in the Comprehensive Water Quality Management Plan (COWAMP) currently underway within the Department. These plans will determine the facilities, costs and institutional arrangements to meet existing and future water quality needs. COWAMP is being prepared as part of the overall State Water Plan and will be presented under separate reports.

B. WATER SUPPLY

The heaviest water use in the subbasin occurs in the southern portion, Watershed E, which has two existing electric power stations, Armstrong and Keystone, and 77 mgd[3] of self-supplied industrial water use. These uses alone account for 312 mgd out of a total of 368 within the basin. Consumptive water use in the subbasin amounts to 30.0 mgd currently and is projected to increase to 64.0 mgd in 1990 primarily because of the proposed construction of two electric generating stations by the Allegheny Power System, Inc. in the subbasin. These stations, one of which the location has not been determined, will require approximately 28 mgd of water for consumptive use. The Lower Armstrong station is located in Watershed D and will require approximately one-half of this consumptive water quantity. From the water supply viewpoint, the remaining quantity of consumptive water can best be accommodated in Watershed C. These increases in consumptive use may necessitate flow augmentation during low flow periods. Alternative solutions to this problem are listed in Table 26 of Chapter V. It is recommended that low head

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[3]mgd: million gallons per day.

hydropower studies be conducted by interested parties within the subbasin.

There are 56 public water suppliers in the basin, of which 48 have developed their own sources of supply. Currently, seven of these suppliers would have inadequate supply to meet their existing demand during a drought. By 1990 and 2020, there will be 10 and 17 suppliers having this problem unless they develop additional sources and/or reduce their demand. It is strongly recommended that applicable conservation measures be applied by all suppliers whose residential gpcd[4] exceeds 50 or whose industrial water use appears excessive. These should be the initial measures to alleviate existing and projected deficiencies. The specific conservation measures applicable to each individual water supplier who has water supply problems are listed in Table 23 of Chapter V. The Knoxdale Water Company can meet its needs by either installing meters or applying residential conservation measures which will reduce future demands to within its delivery capacity. Of those companies showing a yield deficiency in their source of supply, all but the Knoxdale Water Company can meet their future deficiencies through additional groundwater development. Twenty-three suppliers will have to increase their treated storage capacity; howver, these individual needs are small. Eleven suppliers will have to increase their filtration plant capacity either by an expansion or a new development of their filtration plant; but basically, these suppliers are small with the exception of the DuBois Water Department which has a filtration plant capacity deficienty of 12 mgd in 2020.

C. FLOOD DAMAGE REDUCTION

Flooding within this subbasin at one time was the most serious water resources problem. During the past 40 years, six major floods have occurred. At the present time, there are 26 identified flood damage centers and eight damage reaches. The average annual damages which would occur in this basin would be $7.3 million per year were it not for the many State and Federal flood protection projects already constructed which have reduced the damages to the current level of approximately $633,000 per year. The Corps of Engineers has done channel improvement work in the towns of Johnsonburg, Ridgway, Brookville, DuBois, Reynoldsville, Big Run Borough, Sykesville and Punxsutawney and has built a floodwall in Kittanning. Major upstream reservoirs which reduce flood stages in the basin include East Branch Clarion River Lake, Mahoning Creek Reservoir, Crooked Creek Reservoir, Allegheny Reservoir and Tionesta Reservoir. The Department of Environmental Resources has constructed levees which protect the town of Brockway.

After analyzing many possible measures which could further reduce existing damages in the subbasin, it is recommended that further study be made of the Conewango Creek Reservoir above Waterboro, New York. This potential project would reduce damages in 13 municipalities in Subbasin 17 in addition to reducing damages along the Allegheny and Ohio Rivers by approximately $1.8 million per year. This project should be analyzed from a multipurpose standpoint including water supply, flow augmentation and recreation. A levee or floodwall should be constructed along Smith Run entering Toby Creek at Brockway. Construction funds for this project are being requested by the Department of Environmental Resources. Two small upstream reservoirs (#20-2 and #20-4) should be further studied for their potential in reducing damages that occur in the Wilcox area.

As this area is extremely flood prone because of the terrain and the fact that most development occurs in the valleys along the waterways, it is very important that floodplain management be implemented to manage the area adjacent to the streams to prevent development in the future which would increase flood damage potential. All of the damage centers and reaches having existing problems have had their floodplains mapped, making it possible for floodplain zoning. Also, all but four of the damage centers have become eligible under the National Flood Insurance Program, which will help alleviate damages following floods. It is also recommended that other nonstructural solutions such as flood proofing, flood forecasting and relocation be considered.

D. WATER-RELATED OUTDOOR RECREATION

There are numerous streams within the basin that provide various types of water-related outdoor recreational experiences. Streams which provide warm-water fishing and are suitable for boating include the Allegheny River, Mahoning Creek, Red Bank Creek and the Clarion River. Generally speaking, sport fishing in the basin is of low to moderate quality because of poor water quality, with exceptions being Spring Creek, Bear Creek and the West Branch Clarion River which are very good trout streams. There are five State parks in the basin which offer fishing, boating, camping, picnicking and swimming opportunities. In the northern portion of the basin, the Allegheny National Forest and several State game land areas provide hunting opportunities.

There is a need for development of additional picnicking and swimming pool facilities in the subbasin. Picnic area development is recommended for Bendigo, Cook Forest, Clear Creek and Crooked Creek State Parks. Swimming pool needs should be alleviated by local development where possible.

E. WILD AND SCENIC RIVERS

Subbasin 17 contains nine reaches of streams and rivers which have been nominated as candidates for the State Scenic Rivers System. These nine stream reaches involve 349 miles of stream of which six candidates,

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[4]gpcd: gallons per capita per day.

having 289 miles of stream, are in the first priority classification. Three candidates involve segments of the Allegheny River between Kinzua Dam and the confluence of the Kiskiminetas River. The other candidates are the Clarion River, North Fork of Redbank Creek and Bear Creek within the Allegheny National Forest in Elk County. All of these candidates and the other lower priority candidates are listed in Table 42 and mapped on Figure 19.

The Commonwealth recognizes the irreplaceable qualities of many of its waterways. The management of these resources for aesthetic and utilitarian purposes is dependent upon the diligence of both the government and private sectors. Water resources projects whose necessity has been proven by thorough study of the alternatives must be planned so as to minimize disruption of the natural environment.

Because of their oustanding characteristics, all streams listed in Table 42 of Chapter V should be subject to careful environmental assessments with full consideration of all alternate solutions before any projects are proposed which may affect their designated reaches. Streams listed including second or third priority, although not receiving immediate in-depth investigation by the Scenic Rivers Program, should be preserved or improved to the extent possible by all levels of government as well as private interests until such time as they may be considered for legal adoption as components of the Pennsylvania Scenic Rivers System.

F. NAVIGATION

The Allegheny River Navigation System, which extends up river to East Brady is widely used for recreation in this subbasin. Commercial use of the system occurs primarily from Pool #4 down river into Subbasin 18. The major commodities being transported are coal, sand and gravel. Traffic growth, particularly in the Subbasin 17 portion of the system is not expected to increase significantly in the future.

II. GOALS AND OBJECTIVES

The Commonwealth recognizes the importance of citizen participation in any program which has the potential for such direct impact upon the everyday lives of the public as does the State Water Plan. In order that an effective level of citizen participation might be achieved in this important program, the Department established through the North Central Pennsylvania Regional Planning & Development Commission, a Water Resources Advisory Committee. Membership on this committee was open to the general public and participants included representatives from many public, industrial and governmental organizations.

Development of the materials contained in this report was coordinated with this committee through a series of meetings conducted in DuBois. As work on various sections of the report was completed, meetings were held to allow discussion of the information which had been developed to that point. Modifications and corrections were then incorporated.

One of the committee's coordinative functions was the development of a set of subbasin goals and objectives which, when merged with those for the overall State, would provide the basis upon which decisions could be made in the water resources planning process for this area. This section outlines the Subbasin Goals and Objectives which are the final product of that effort.

A. WATER SUPPLY

1. *Goal*

Water supplies of adequate quantity and quality to meet both short- and long-term needs.

2. *Objectives*

a. Inventory the available surface and groundwater resources.

b. Identify existing and potential water supply problems.

c. Identify feasible alternative solutions taking into account physical, social, political, economic, and environmental factors, to make possible the selection of practicable solutions.

d. Encourage the reuse of water, and the development and use of new water-saving technology.

e. Stress conservation measures to help ensure the future availability of water resources.

f. Suggest those changes in water laws and institutional arrangements deemed necessary to ensure the adequacy of present and future water supplies and the equitable distribution thereof.

g. Protect public drinking water supplies from degradation of quality and reduction in yield.

h. Develop water resources to ensure adequate supplies during water shortages, droughts, and other possible emergencies.

i. Review and control future interbasin transfers of water and/or water allocation quantities on an individual basis and so design them as to protect and enhance the economic, social and environmental well-being of the local area.

j. Initiate public education and awareness.

k. Establish local priorities, and direct assistance from State and Federal agencies to meet those priorities.

B. FLOOD DAMAGE REDUCTION

1. *Goal*

The mitigation of existing flood problems with the resulting minimization of future flood damages and loss of life.

2. *Objectives*

a. Establish a list of urgent flood hazard reduction needs for the purpose of guiding investments.

b. Identify feasible alternatives (i.e., structural measures and nonstructural measures) to the flood problem, taking into account physical, social, political, economic, and environmental factors.

c. Promote floodplain management and its integration with local land use management.

(1) Encourage appropriate State legislation to manage floodplains.

(2) Regulate new structural development in flood prone areas.

(3) Require that construction of essential development on flood prone areas be flood proofed and designed to minimize obstruction to flood flows.

(4) Encourage the relocation of floodplain development to nonflood prone areas, where economically feasible.

d. Advocate and apply a basinwide system approach to flood damage reduction measures.

e. Stress the interrelationship between traditional State-Federal flood control measures and urban storm drainage.

f. Encourage municipalities to participate in the National Flood Insurance Program.

g. Initiate public education and awareness.

C. OUTDOOR RECREATION

1. *Goal*

Adequate water and related land resources to meet present and future water-oriented and water-enhanced recreational needs.

2. *Objectives*

a. Protect natural and free flowing streams to preserve their recreational potential.

b. Inventory all water-related and water-enhanced public recreation facilities.

c. Examine existing and potential recreational facilities and water projects to determine future potential for recreation development.

d. Determine water-related recreation needs to guide recreation investment in conjunction with water resources project development.

e. Give highest priority to those recreation projects that meet the greatest needs within minimum required travel time.

f. Provide adequate fishing and boating opportunities through the development of access areas on public water and by promoting access to additional private waters.

g. Coordinate the water-related outdoor recreation planning activities and responsibilities of Federal, State, local and private entities.

h. Coordinate water-related outdoor recreation planning with other related State planning efforts.

i. Encourage local government participation in the development of future recreation opportunity.

j. Recommend laws, regulations and guidelines that are flexible so as to adequately address local needs, problems and solutions.

k. Initiate public education and awareness.

l. Establish local priorities, and direct assistance from State and Federal agencies to meet those priorities.

D. WATER QUALITY MANAGEMENT

1. *Goal*

Prevent further pollution of the waters of the Commonwealth, and restore to an unpolluted condition all presently polluted waters, so that future uses will be protected.

2. *Objectives*

a. Establish water quality standards designed to protect all probable uses of the Commonwealth's waters.

b. Provide for the development of water quality management programs which include both individual and regional waste collection and treatment systems designed to protect and conserve the Commonwealth's waters.

c. Identify and develop institutional arrangements for implementation of regional or basinwide water quality plans.

d. Control nonpoint source pollution and prevent pollution incidents by requiring adequate product and waste handling safeguards.

e. Develop and institute programs for control and abatement of acid mine drainage from mines.

f. Recommend laws, regulations and guidelines that are flexible so as to adequately address local needs, problems and solutions.

g. Initiate public education and awareness.

h. Establish local priorities, and direct assistance from State and Federal agencies to meet those priorities.

E. RIVER NAVIGATION

1. *Goals*

Plan to meet present and future water-borne transportation requirements consistent with water resources needs.

2. *Objectives*

a. Identify future water transportation needs of subbasin industries.

b. Determine the locational priorities of replacements in the navigation system to maximize benefits for the greatest number of citizens.

c. Evaluate river-oriented recreation needs to maximize compatability with commercial transportation activities on the river.

d. Identify and coordinate the actions and responsibilities of Federal, State, local and private entities to maintain and improve the many faceted navigational use of the river.

F. ENVIRONMENTAL QUALITY

1. *Goal*

Management of water and related land resources to abate and prevent pollution, protect and preserve environmental values, and enhance and maintain ecosystems.

2. *Objectives*

a. Protect wetlands, wild areas, natural areas and other resources which may be fragile, rare or endangered.

b. Develop criteria to maintain aquatic ecosystems and protect other instream environmental values.

c. Protect the character of streams having wild and scenic values, and prevent degradation of streams.

d. Encourage land and water resources management which is compatible with the protection of prime farmlands.

e. Promote floodplain management which maintains the floodplain ecosystems, protects natural resource values and provides community open space opportunities.

f. Develop a groundwater management program to prevent groundwater contamination, facilitate recharge and reduce runoff.

g. Manage water and related land resources to protect habitats for fisheries and wildlife resources.

h. Identify areas where frequent or severe low flows caused by man's activities may threaten environmental values.

i. Encourage environmentally sensitive land and water planning by all levels of government such that the natural hydrologic character of watersheds is respected.

III. PHYSICAL FEATURES & RESOURCES

The term *water resources management* typically brings to mind the concept of controlling rivers and streams to provide water for man's use. However, one should be reminded that what is really being managed is a resource that is all-pervasive. Groundwater saturates much of the Commonwealth's bedrock. Surface water in the form of streams and lakes occupies over one percent of the Commonwealth's land surface. Water vapor, or moisture in the air, while not readily available for man's use, is the source of water in its other usable forms. Physical features of the environment affect water in all forms by controlling flows, natural storage, evaporation and precipitation.

Physical features of the land also affect water resources management, not only because of their direct effects on water in quantity and quality, but also because of their indirect effects on its use, resulting from their influence on man's activities. This chapter discusses in general terms the physical features of Subbasin 17. For the reader who is unfamiliar with the area, it should provide a description sufficient to understand the physical characteristics of the subbasin; and for all readers it should provide insight into the general relationships between physical land features and water resources.

Much of the material presented in this chapter was either developed by other State or Federal agencies, or was developed from information provided by those agencies, including the Pennsylvania Fish and Game Commissions, the U.S. Weather Bureau, the Bureau of Topographic and Geologic Survey of DER, the U.S. Department of Agriculture's Soil Conservation Service and Forest Service, as well as the State Forestry and Soil Conservation Bureaus. In some cases the planning process involves the use of information of greater detail than that which is presented here. It is not intended that this report present a detailed description of physical features. More detailed information is available in reports and publications from the respective agencies with specific authority in given program areas. In addition, development of more localized physical features data will occur as the State Water Plan program examines in greater detail those water resources problems which have been identified as being of urgent concern to Pennsylvania's future.

A. BASIN ORIENTATION

Located in west central Pennsylvania, the Central Allegheny River subbasin is referred to as Subbasin 17. This includes all of Jefferson County, almost all of Clarion and Armstrong Counties, the western two-thirds of Elk County, the northern half of Indiana County and smaller parts of Butler, Forest, McKean and Clearfield Counties. Overall, the drainage of this subbasin covers 2,930 square miles.

The Central Allegheny forms a triangular shaped subbasin as shown on Figure 1. The subbasin is approximately 65 miles long from Wilcox in the northeast to Ford City in the southwest, and averages 39 miles in width. Surrounding the Central Allegheny are four subbasins. To the north and south, Subbasin 17 is bordered by two Allegheny River subbasins, the Upper, Subbasin 16 and the Lower, Subbasin 18. To the east and west, Subbasin 17 is bounded by the Upper West Branch Susquehanna River subbasin (Subbasin 8), and the Ohio River subbasin within Pennsylvania (Subbasin 20), respectively.

Subbasin 17 falls within the Appalachian Plateaus Province which includes the Allegheny High Plateaus Section in the north and the Pittsburgh Plateaus Section in the south. The Allegheny High Plateaus Section is characterized by high dissected plateaus with deep-streamed valleys. The Pittsburgh Plateaus Section is similar except that hills are less rugged and rock types are generally of shale instead of the more resistant sandstones of the northern section.

The largest population concentration in the subbasin is in DuBois, located along the eastern boundary of the subbasin in Clearfield County. Punxsutawney in Jefferson County is the second largest population center. In Elk County, population is concentrated in St. Marys, the third largest population center, and Ridgway, the county seat. Clarion and Kittanning are the county seats and have the largest population concentrations in Clarion and Armstrong Counties, respectively.

Major transportation routes in the subbasin include Interstate 80, U.S. Routes 422, 322, 219, 119 and Pa. 28. Interstate 80 traverses the center of the subbasin linking eastern and western Pennsylvania. Paralleling Interstate 80 through the subbasin, U.S. 322, the Twenty-Eighth Division Highway, connects Clarion, Brookville and DuBois with Franklin and State College. Another east-west route is U.S. 422 which links Kittanning with Butler and Indiana. The major north-south route in the subbasin is U.S. Route 219 from Bradford to Johnstown. Below DuBois, it branches into U.S. Route 119, and connects with U.S. Route 22 to

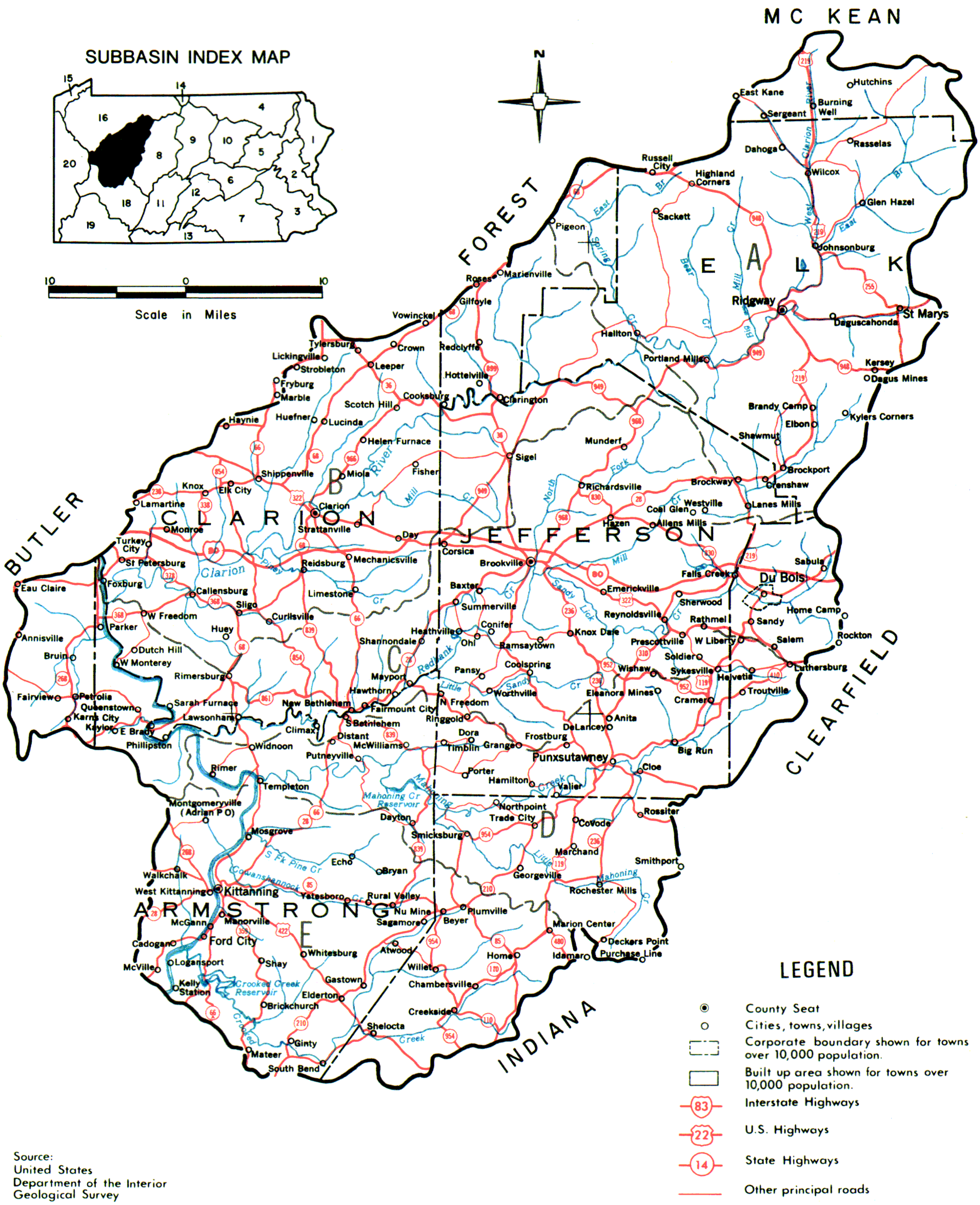

FIGURE 1. Basin Orientation

Table 1

MAJOR RIVERS AND WATERWAYS

Watershed	Drainage Area (Sq.Mi.)	Major Waterway	Minor Waterway
A	631	Clarion River	Toby Creek East Branch Clarion River West Branch Clarion River Spring Creek
B	618	Clarion River	Piney Creek Mill Creek Paint Creek
C	728	Allegheny River	Redbank Creek North Fork Creek Sandy Lick Creek
D	444	Allegheny River	Mahoning Creek Little Mahoning Creek
E	502	Allegheny River	Cowanshannock Creek Crooked Creek
Total	2,923		

Pittsburgh. Through these two routes Ridgway, DuBois and Punxsutawney are linked with Indiana. Brookville and Kittanning are connected with Pittsburgh by Pa. 28.

The major mining and manufacturing industries in the subbasin are bituminous coal mining and stone-clay-glass products. Other industries include electrical machinery, leather and apparel products, primary and fabricated metals, and lumbering. Major agricultural products are field crops, livestock and forest products.

Water orientation of the subbasin is along the axis of the Allegheny River as it flows south through the subbasin. As indicated by Table 1, the Allegheny River is the major waterway in three of the five watersheds. In Watersheds A and B, the Clarion River is the dominant waterway. Watersheds in the Allegheny River System comprise approximately 57 percent of the subbasin's total drainage. Watershed C with a drainage area of 728 square miles is the largest individual watershed in the subbasin. Minor waterways in each of the five watersheds are also listed in Table 1.

B. CLIMATE

The study area is dominated by atmospheric flow patterns relevant to the Humid Continental type climate. Most of the weather systems that influence the study area originate either in Canada or the Central Plains of the United States and are steered eastward by the prevailing westerly winds aloft. Another flow pattern and primary source of precipitation associated with cyclonic circulation is from the Gulf of Mexico northward through the study area. As a result of the dominant westerly air flow into the area, the moist air flow from the Atlantic Ocean is a modifying rather than a controlling climatic factor. The Great Lakes contribute small amounts of moisture to the area in comparison to the Gulf of Mexico flow pattern and have a minor influence on the study area's climate as the weather systems formed over the Great Lakes region migrate eastward. A disturbance moving northward from the Gulf of Mexico adds moisture to the area and usually causes temperatures to climb for brief periods during the winter months. On other occasions, cold Canadian air masses combined with clear skies and snow cover on the ground allow maximum radiative losses which result in sub-zero temperatures for the area.

The normal succession of high and low pressure systems moving eastward across the United States produce weather changes in the area every few days in the winter and spring of the year. In summer and fall, the weather changes are less frequent due to a slowing down of the general atmospheric circulation during the warmer months. Low pressure cyclonic systems usually dominate the area with southerly winds, rising temperatures and some form of precipitation. The high pressure anticyclonic systems normally bring west to northwest winds, lowering temperatures and clearing skies to the area.

Hurricanes or tropical disturbances, as they move northward, follow a northeasterly path in the middle latitudes and produce heavy rainfalls and strong winds in the study area. Frequently affecting water supplies and causing floods, these tropical storms are observed during the hurricane season, June through November.

Table 2

STREAMFLOW STATISTICS FOR SELECTED GAGING STATIONS

Station	Period And Years of Record Used	Drainage Area (Sq. Mi.)	Average Annual Runoff (csm[a])	Mean Annual Flood (csm[a])	Ratio of 100-Year to Mean Annual Flood	7-Day 10-Year Low Flow (csm[a])
Clarion River at Cooksburg	1938–72 34	807	1.7	24.0	3.1	0.08
Redbank Creek at St.Charles	1918–72 54	528	1.6	26.5	3.2	0.06
Mahoning Creek at Punxsutawney	1938–72 34	158	1.7	30.3	3.5	0.09
Crooked Creek at Idaho	1937–72 35	191	1.5	30.6	3.2	0.03

[a]Cubic feet per second per square mile.

Source: United States Geological Survey.

The weather elements or activities of the atmosphere, such as precipitation, temperature, wind direction and speed, relative humidity and sunshine are measurable quantities which affect the study area.

Precipitation in both liquid and solid forms is the initial source of all water supplies. The study area normally receives about 41 inches of precipitation annually. The normal monthly precipitation totals average from a minimum of 3.4 inches in January to a maximum of 4.3 inches in June. The snowfall is moderately heavy, averaging about 43 inches annually. The mean annual number of days with snow cover of one inch or more is about 80 days.

Air temperature is important to the management of water resources and water quality. The average annual temperature for the study area is about 48°F. The mean annual freeze-free period is about 130 days. Because of the topography, the freeze-free season is variable, ranging from 115 days in the north to 145 days in the south. Temperatures have been recorded as high as 101°F at Brookville during the month of July and as low as -30°F during the month of February. The summer mean temperature is about 69°F and the winter mean about 27°F.

Winds are important hydrologic factors because of their evaporative effects and their association with major storm systems. The prevailing wind in the spring is westerly and averages 10 mph. In the fall, the prevailing wind is southerly and averages 9 mph.

Relative humidity also affects evaporation processes. The mean monthly relative humidities for the months of January, April, July and October are about 75 percent, 65 percent, 70 percent and 71 percent, respectively.

Sunshine, which varies with latitude and time of the year, is a factor to be considered in the various aspects of waste treatment processes. The mean annual sunshine in hours per year for the study area is about 2,300 hours.

The evaporation process is controlled by temperature, wind, sunshine and humidity. The rate of evaporation during the warmer months has an important impact on water storage in reservoirs and on irrigation. High evaporation rates can cause humid regions to become vulnerable to droughts. The mean May to October evaporation for the study area accounts for about 75 percent of the annual total evaporation.

References

1. U.S. Weather Bureau, *Climates of the States - Pennsylvania, Climatography of United States No. 60-36*, (U.S. Department of Commerce, Washington, D.C., 1960–1971).
2. U.S. Weather Bureau, *Climatic Date - Section 87 - Western Pennsylvania*, (U.S. Department of Agriculture, Washington, D.C., 1930).
3. Department of Interior, Geological Survey, *The National Atlas of the United States*, (Washington, D.C., 1970).

C. HYDROLOGY

Management of water resources requires a knowledge of the quantity of water which is available for use and which must be managed in order to provide for the safety and welfare of the public. For studies of water use and quality, low flow conditions are of general concern; whereas, for flood management it is necessary to know the high flow characteristics of streams. Hydrologic factors discussed in this section include main stream systems, annual basin runoff, low flows, and flooding.

The Allegheny River is the major waterway draining Subbasin 17. Three of its main tributaries and their respective watersheds include the Clarion River (Watersheds A and B), Redbank Creek (Watershed C) and Mahoning Creek (Watershed D). These tributaries drain approximately 76 percent of the subbasin. An 87 mile section of the Clarion River, from Ridgway to the Allegheny River, has been nominated for designation as a scenic river. Also, a 14 mile segment of the Allegheny River has been nominated for similar designation.

Average annual runoff ranges from 22 inches to 24 inches and is primarily influenced by precipitation distribution. However, other factors such as land cover and use, geology and physiography influence the variability of flows from individual watersheds. Table 2 contains average annual runoff values for selected gaging stations within the subbasin[5].

Runoff has a distinct seasonal variation, with the period of highest runoff occurring in late winter or early spring, and the period of lowest runoff occurring in late summer and early fall. The seasonality of evapotranspiration accounts for most of this variation.

Low flow deficiencies develop after prolonged periods of little or no precipitation and persist until sufficient rainfall relieves the situation. Flow deficiencies of significant duration may cause new water supply problems and may magnify existing water quality problems.

The 7-day 10-year low flow, a common description of low flow characteristics, is frequently used as a basis for water management. Table 2 lists values of this statistic for selected gaging sites in Subbasin 17. For other stream gaging stations in the subbasin, the magnitude and frequency of low flows for this and other durations are contained in two bulletins (Bulletin No. 7[6] and Bulletin No. 12[7]) published by the Pennsylvania Department of Environmental Resources.

Although floods occur in all seasons, studies of the relationships among storm intensity, duration, affected area, and seasonality suggest a tendency for flooding on principal streams to occur in winter and for floods on small streams to occur mostly in summer. Large area floods are caused by storms of low rainfall intensity and long duration covering the entire area of principal watersheds. Small area floods, on the other hand, are caused by storms of high rainfall intensity and relatively short duration. An exception to this is tropical storms which normally occur during the summer months and cause extensive flooding over large areas.

Magnitudes of mean annual floods for selected gaging sites in Subbasin 17 are given in Table 2. This data was obtained from a U.S. Geological Survey computer analysis of annual peak discharge records for a statewide study of flood magnitude and frequency relations.

D. TOPOGRAPHY

The topography, or the physical land features, of the study area determines the drainage patterns and surface flow characteristics. Steeper slopes cause increased runoff and erosion and discourage infiltration to the water table. Unconfined (nonartesian) groundwater flow direction is controlled in part by the topography.

Subbasin 17 is located within the Appalachian Plateaus Province as shown on Figure 2. The Appalachian Plateaus Province is comprised of two areas, the Allegheny High Plateaus Section in the northern portion of the subbasin and the Pittsburgh Plateaus Section in the southern portion of the subbasin. Both sections are characteristic of a high, maturely dissected plateau. Stream valleys are deep and have steep sides with areas between larger valleys divided by numerous small tributaries. A dendritic flow pattern is evident. Most land surface is sloping and only small tracts of flat land are on valley bottoms and stream divides. Upland flats are believed to represent the last remnants of an erosional surface that formed several million years ago when most of Pennsylvania was near sea level. Subsequent uplift resulted in renewed stream erosion and downcutting. Elevations of hilltops gradually decrease to the south and west reaching a maximum of 1,700 feet in Armstrong County.

The boundary between the Allegheny High Plateaus and the Pittsburgh Plateaus Sections of the subbasin is not distinct. Generally, it follows a line marking the transition from shale rock types to the south and more resistant sandy rock types to the north. As a result, the Allegheny High Plateaus Section is more rugged. Maximum relief between hilltops and adjacent stream valleys is nearly 1,000 feet. In the Pittsburgh Plateaus Section, topography is more moderate and averages 500 feet. In both sections, most of the smaller streams flow over bedrock. However, the valleys of larger streams and rivers which drained the glaciated regions to the northwest frequently contain thick accumulations of glacial outwash.

E. GEOLOGY AND GROUNDWATER

Bedrock geology has ultimate control on the storage, transmission, and utilization of groundwater. Geologic factors such as rock type, intergranular spacing, rock strata inclination, faults, joints, folds, bedding planes, and solution channels affect groundwater movement and availability. Natural groundwater quality is a result of the interaction between the groundwater and the bedrock with which it is in contact. The more soluble bedrock types will allow more compounds to become dissolved in the groundwater. For example, groundwater in highly soluble limestone aquifers will commonly have high hardness values. Groundwater quality will eventually affect surface water quality as it percolates into surface streams as base flow.

Unconsolidated deposits of Quaternary age overlie the bedrock in the major stream valleys of Subbasin 17. These deposits are called alluvium and glacial outwash and consist of clay, silt, sand and gravel. Yields of wells

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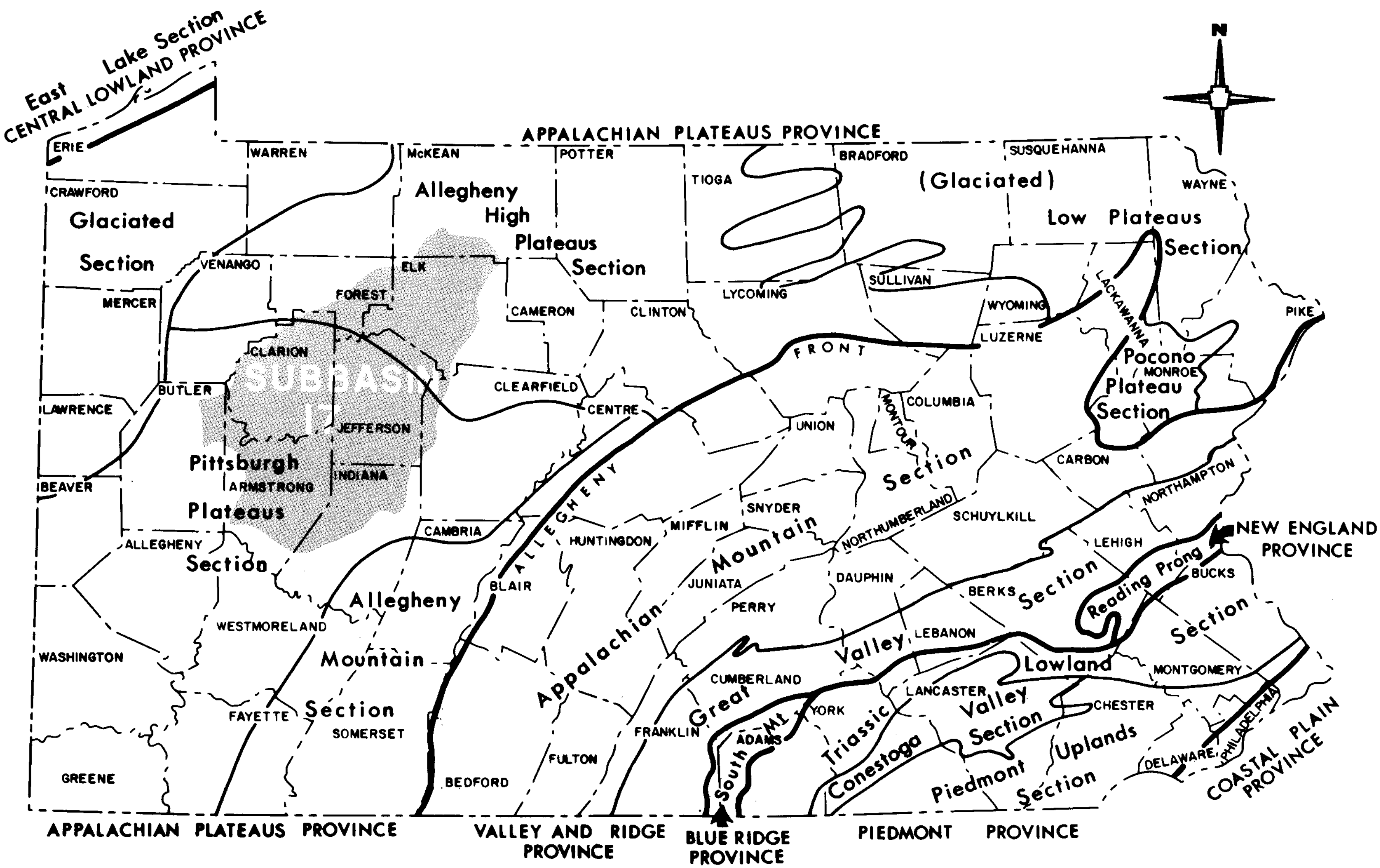
[5]U.S. Geological Survey, *Water Resources Data for Pennsylvania, Part 1: Surface Water Records,* (1972).

[6]Office of Engineering and Construction, *Water Resources Bulletin No. 7, Long Duration Low Flow of Pennsylvania Streams,* (Pennsylvania Department of Environmental Resources, 1972).

[7]L. V. Page and L. C. Shaw, *Water Resources Bulletin No. 12, Low Flow Characteristics of Pennsylvania Streams,* (Pennsylvania Department of Environmental Resources, 1977).



Source:
Commonwealth of Pennsylvania
Topographic and Geologic Survey

FIGURE 2. Physiographic Provinces

Table 3

CHARACTERISTICS OF WELLS IN PRINCIPAL GEOLOGIC UNITS[a]

Map Symbol	Rock Units		Well Depth (Feet)	Number of Wells Sampled	Casing Length (Feet)	Number of Wells Sampled	Static Water Level (Feet)	Number of Wells Sampled	Drawdown (Feet)	Number of Wells Sampled	Well Yield (Gal./Min.)	Number of Wells Sampled	Remarks
	Alluvium and glacial outwash	m[b]	53	33	43	23	22	22	14	18	300	27	Well screen needed. Sufficient thicknesses found only in larger valleys. Occasional iron problem.
		R[c]	30–317		20–185		6–51		2–45		10–846		
Pm	Monongahela Gp.		–		–		–		–		–		No wells. Very limited area
Pc	Conemaugh Gp.	m	154	76	60	68	50	26	30	11	40	71	Mahoning sandstone is principal water-bearing unit. Hard water and high iron are common.
Pc	Conemaugh Gp.	R	48–368		19–152		1–240		30–116		3–315		
Pa	Allegheny Gp.	m	160	124	51	90	50	74	16	35	32	114	Kittanning sandstone is a major water-bearing unit. High iron is a common problem. Higher yields from sandstones.
		R	65–523		18–230		F[d]-465		2–230		3–400		
Pp	Pottsville Gp.	m	150	46	48	25	20	25	66	11	50	38	Contains salt water where deeply buried. Water from upper part of unit may be hard and have a high iron content. Capable of supplying very small communities.
		R	52–437		18–265		F-87		3–115		2–325		
Mp	Pocono Gp.	m	216	82	30	45	24	37	42	19	75	53	Capable of supplying small communities. Salt water where deeply buried. Occasional iron problems.
		R	51–417		14–170		F-225		8–165		6–500		

[a]Data are primarily from public and industrial water supply wells. In instances where there is an insufficient number of public and industrial wells domestic wells are used to supplement data. Median well characteristics, in most cases, correspond to typical values obtained from randomly located wells. Considerably larger well yields may be obtained by using scientific well location and development techniques.

[b]Median

[c]Range

[d]Static water level above land surface (flowing well).

which penetrate these materials may vary significantly over short distances due to changes in sorting, grain size and thickness of the deposits. High yields are possible, with the maximum reported being over 800 gpm[8] and the median being 300 gpm. The areal distribution of the surficial consolidated rock units is shown on the Geologic Map (Figure 3 in cover pocket). Typical characteristics of wells which penetrate these units are given in Table 3. The youngest rock unit, the Monongahela Group, underlies only a very small area in this subbasin and is, therefore, unimportant with respect to water supply. None of the inventoried wells are in this unit.

The Conemaugh Group includes all of the rock between the base of the Pittsburgh coal and the top of the Upper Freeport coal. This unit consists primarily of shale and siltstone with interbeds of sandstone. Coal and limestone beds occur, but are thin and laterally discontinuous. Sandstones vary in thickness, composition and areal extent. The Morgantown, Saltsburg, Buffalo and Mahoning members are the most persistant sandstones in the Conemaugh.

The shale and siltstone of the Conemaugh Group yield little groundwater to wells. The pore spaces are very small, and the fractures and bedding planes do not provide sufficient permeability for the development of high-yield wells. Sandstones yield considerably more water because they have larger pore spaces and are more susceptible to fracturing than the shales. Therefore, well yields in the Conemaugh will generally depend on the number and thickness of sandstone layers penetrated. Median yield of all inventoried wells in the Conemaugh is 40 gpm.

The Allegheny Group consists of the rock between the Upper Freeport coal and the top of the Homewood sandstone. This unit contains several thick and extensive coal beds separated by shales, sandstones, limestones and clay. The water-bearing characteristics of the rocks in the Allegheny Group are similar to the Conemaugh Group. The sandstones are the best producers followed by the limestones and shales. Median yield of the Allegheny Group is 32 gpm, primarily from the sandstones.

The Pottsville Group, which contains a greater percentage of sandstone than the Allegheny or Conemaugh Groups, consists primarily of sandy shale, coal and sandstone. The Homewood sandstone often occurs at the top of the Pottsville Group and is generally a coarse-grained, cross-bedded, massive rock unit. The Mercer coals and shale lie between the Homewood sandstone and the Connoquenessing sandstone, also a coarse, massive rock unit. Shales, fire clays, limestones and some mineable coals are present locally in the Pottsville. The relative abundance of sandstone within this group makes it the best yielding aquifer of all the Pennsylvanian units, with a median yield of 50 gpm.

The Pocono Group of Mississippian age is exposed only in the valley bottoms of major streams. The upper member, the Burgoon sandstone, is a medium to coarse-grained sandstone, and in places contains lenses of shale. The Burgoon sandstone is a reliable source of groundwater with well yields dependent primarily upon the amount of shale interbedded in the sandstone or the number of fractures the well intersects. Beneath the Burgoon are shales and sandy shales of minor importance as aquifers. Median yield of the Pocono Group is 75 gpm reflecting the productivity of the Burgoon sandstone.

F. MINERAL RESOURCES

Mined mineral resources that are near the water table can have a large influence on groundwater quality, as evidenced by acid mine drainage in the coal mining districts. Mine shafts and quarries commonly alter the groundwater flow pattern by developing new flow channels. Where the water table must be lowered to continue mining activity, large cones of depression will develop that may adversely affect local groundwater availability and stream baseflows.

Surface mining produces large areas of disturbed land that is highly erodible, and if techniques for sediment control are not used, large quantities of sediment are contributed to surface streams. In addition, the processing of many mined materials produces large quantities of silt which can be damaging to surface streams. Where possible, settling ponds or lagoons should be used to allow suspended solids to settle out so clear water can be recycled. Closed water circuits are often used for economic reasons for the prevention of stream pollution.

In general, the noncoal mining industries in the study area cause only siltation problems. However, one possible exception is the mining of shale associated with coal, in which case acid mine drainage is produced because of the pyrite in the shale.

Major mineral resources in Subbasin 17 include bituminous coal, oil, gas and nonfuel minerals such as sand, gravel, limestone, sandstone, clay and shale as shown on Figure 4.

1. *Coal*

Coal deposits constitute the greatest mineral resource in the subbasin. All important seams are Pennsylvanian and occur in the Allegheny Group. In 1973, six of these seams, the Upper and Lower Freeport, Middle and Lower Kittanning, Clarion and Brookville, accounted for 95 percent of the total coal production in the subbasin. Lesser amounts were obtained from the Pittsburgh seam.

a. *Important Seams*

The Upper and Lower Freeport seams have an average seam thickness of 40 inches. In addition, they contain the largest amount of coal reserves in the subbasin. The Freeport seams, which are found in every county in the subbasin, are extracted by strip and deep mine operations.

The Middle Kittanning seam has a relatively limited areal extent although it is found in all counties in the subbasin. Coal from this seam is relatively thin, generally less than two feet thick. However, it is excellent quality coal and economically mineable. In 1973 production was limited to strip mining; before that date the seam had been recovered by both deep (underground) and strip mining.

[8] gpm: gallons per minute.

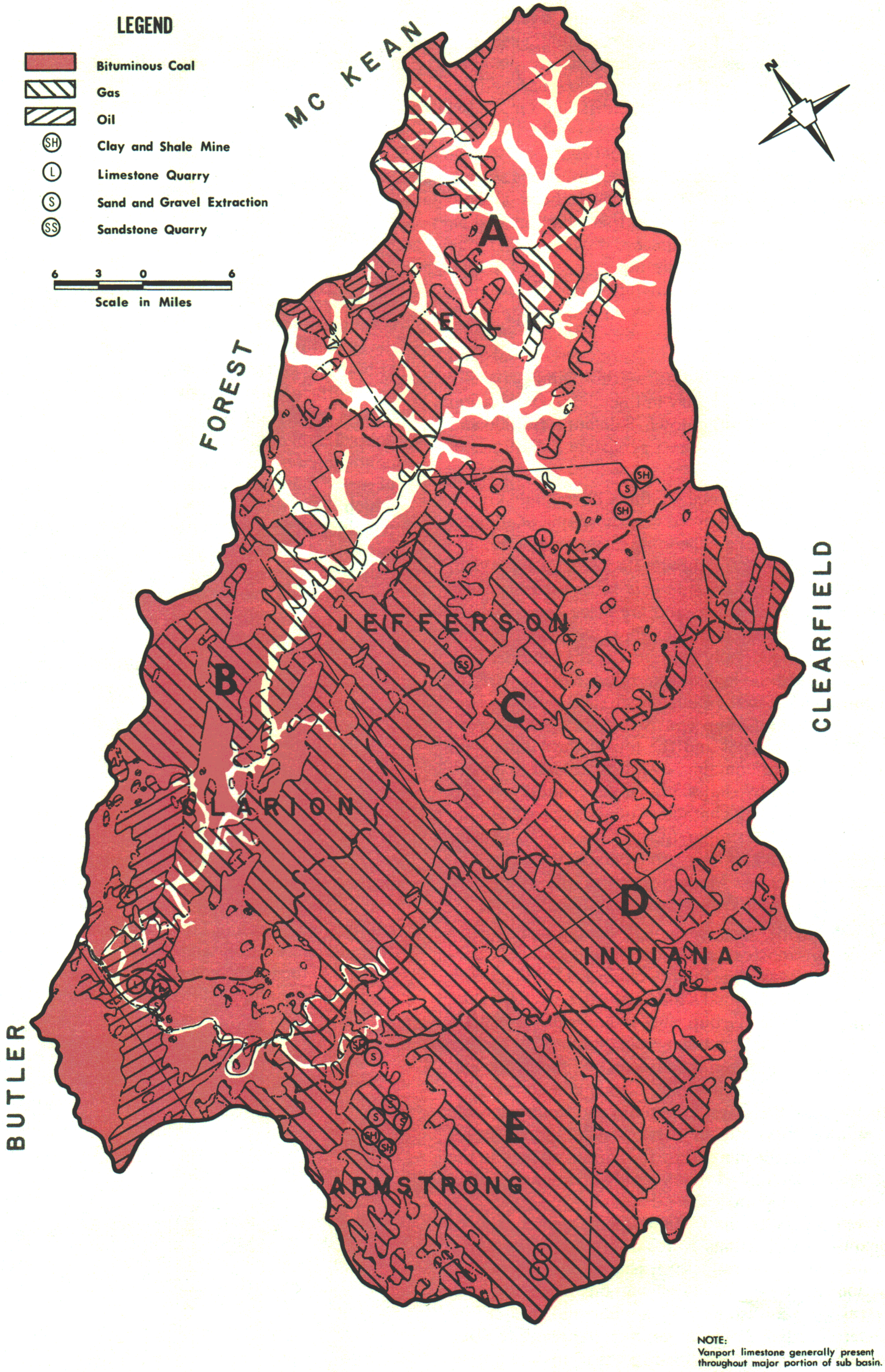


FIGURE 4. Mineral Resources

Table 4

STRIPPABLE COAL RESERVES[a]
(1,000 Tons)

Seam	Clarion County	Elk County	Jefferson County	Armstrong County	Indiana County
Pittsburgh				2,600	400
Upper Freeport	9,200		12,800	28,700	18,300
Lower Freeport	10,400		9,300	14,100	7,200
Upper Kittanning				4,800	
Middle Kittanning	1,800				
Lower Kittanning	16,000		6,800	16,100	6,200
Clarion	11,500				
Brookville	14,600		9,100		
Upper Mercer	7,600				

[a]Estimates based on total reserves in seams greater than 28 inches thick, minus deep mining reserves. Includes auger mining.
Source: Edmunds, 1972.

Table 5

DEEP MINING COAL RESERVES
(Million Tons)

Seam	Clarion County	Elk County	Jefferson County	Armstrong County	Indiana County
Pittsburgh				5.1	4.0
Mahoning			1.6	8.1	
Upper Freeport	5.3	0.6	91.3	359.1	568.3
Lower Freeport	4.1	2.4	67.3	172.6	424.0
Upper Kittanning	4.6	4.9	6.6	14.7	1.3
Middle Kittanning	10.1	7.4	10.5	6.9	13.6
Lower Kittanning	209.7	2.8	149.4	463.7	694.1
Clarion	336.3	68.0	8.5	6.8	
Brookville	62.5		72.3	56.0	11.7
Lower Mercer	7.5				

Source: U.S. Bureau of Mines, 1974.

In terms of total production, the Lower Kittanning seam ranks second in the subbasin and first in total reserves. Existing over a wide area of Clarion, Jefferson, Elk, Armstrong and Indiana Counties, it has an average thickness of about two feet. Presently, Lower Kittanning production is by strip and deep mining operations.

Seams in the Clarion-Brookville complex comprise important beds in the subbasin with respect to strip mine production over a limited extent. The complex is made up of several discrete lenses and tongues of coal which combine, split, pinch out and reappear from place to place. Within the complex, however, it generally is possible to make a division between an upper and a lower seam. The upper seam is referred to as Clarion coal; the lower seam has been correlated to Brookville coal. As expected, Clarion County is the site of the largest deposit of Clarion-Brookville coal.

The Pittsburgh seam has historically dominated the bituminous coal mining industry in the state. Averaging 68 inches in width, the seam is relatively thick but has a limited areal extent. In this subbasin the Pittsburgh seam is located in small areas of Armstrong and Indiana Counties where it lies near or is exposed to the surface. Most of the coal in the Pittsburgh seam is strip mined although it does provide small amounts of deep mined coal as well.

Table 6

STRIP MINE PRODUCTION FOR 1973[a]
(Thousand Tons)

Seam	Clarion County	Elk County	Jefferson County	Armstrong County	Indiana County
Pittsburgh				767.6 (10)	29.9 (4)
Mahoning				42.4 (3)	
Upper Freeport	249.2 (10)	53.0 (6)	241.1 (16)	936.1 (37)	974.1 (25)
Lower Freeport	60.2 (4)	42.4 (4)	234.6 (16)	247.8 (10)	226.2 (9)
Upper Kittanning	68.1 (8)	50.7 (2)	95.8 (3)	9.8)1)	78.2 (4)
Middle Kittanning	567.3 (14)	77.6 (7)	328.2 (14)	66.9 (6)	40.5 (4)
Lower Kittanning	1,386.5 (33)	386.4 (14)	358.2 (15)	302.6 (17)	151.2 (9)
Clarion	2,650.4 (30)		12.6 (1)		
Brookville	83.8 (2)		12.6 (1)		

[a]Includes auger mining. Number of mines shown in parentheses.

Source: DER, Office of Mines and Land Protection, 1974.

b. *Coal Reserves*

Strippable coal reserves are listed by county and seam in Table 4. Strippable coal in the subbasin is estimated at 207.5 million short tons, two-thirds of which is found in Clarion and Armstrong Counties. The largest source of strippable coal is the Upper Freeport seam which comprises one-third of the total. This seam along with the Lower Kittanning, Lower Freeport and Brookville represents slightly less than three-fourths of the subbasin's total strippable coal reserves.

Deep mining coal reserves are listed by county and seam in Table 5. Deep mining reserves represent almost 19 times the tonnage of strippable coal reserves amounting to more than 3.9 billion tons. More than 71 percent of the total deep mined reserves are found in Armstrong and Indiana Counties. In this subbasin, the Upper Freeport and Lower Kittanning seams contain 64 percent of the total deep mined coal reserves. New technology is capable of economically mining much of these reserves, particularly at the new price levels.

c. *Coal Production*

Strip mined coal production for 1973 is shown by county and seam in Table 6. As indicated by the table, almost 11 million tons of coal were produced from 339 strip mines. Clarion County produced 46 percent of the total strip mine coal from 101 mines. A second leading county, Armstrong, produced one-fifth of the total from 84 mines. The three largest strip mining seams include the Clarion, Lower Kittanning and Upper Freeport which combined to account for 71 percent of the total strip mine production. Of the three seams the largest number of strip mines, 94, occurs in the Upper Freeport Seams.

Deep mined coal production by county and seam for 1973 is shown in Table 7. As indicated by the table, a little over 11 million tons of coal were produced from 38 mines. Deep mined coal is produced in Armstrong and Indiana Counties. Of the two counties, Indiana is responsible for 63 percent of total deep mine production from 26 mines. The largest source of deep mined coal is the Upper Freeport seam which produces 40 percent of the total from 10 mines. Two other seams, the Lower Freeport and Lower Kittanning, are responsible for 59 percent of the total deep mined coal from 11 and 14 mines, respectively.

An assessment of coal as a valuable commodity and resource in the study area must consider the economic trend of the Nation and the new interest in domestic, substitutes for oil and gas. Present conditions (cost to mine versus price per ton) relegate much of the spectacular numerical reserves to the status of "well worth mining". Increases in price or uses, as in conversion from oil or gas, coupled with new advances in mining technology, could render mining more of this coal a worthwhile opportunity.

Table 7

DEEP MINE PRODUCTION (1973)
(Thousand Tons)

Seam	Armstrong County	Indiana County
Pittsburgh		1.0(1)
Mahoning	4.4(1)	
Upper Freeport	2,101.6(5)	2,554.5(5)
Lower Freeport	1,615.4(1)	1,937.4(10)
Upper Kittanning	1.5(1)	
Lower Kittanning	413.9(4)	2,836.9(10)

Source: DER, Office of Mines and Land Protection, 1974.

Note: Number of mines shown in parenthesis.

2. ***Oil***

Oil production may cause water contamination which adversely affects water resources. Spills from petroleum production and leakage of oil field brines from water flooding of wells have resulted in polluted ground and surface water in some areas of the subbasin.

Table 8

CRUDE OIL PRODUCTION

County	1970 Barrels	1970 Wells	1971 Barrels	1971 Wells	1972 Barrels	1972 Wells	1973 Barrels	1973 Wells	1974 Barrels	1974 Wells
Armstrong	8,696	81	9,207	90	8,793	76	9,769	110	11,859	120
Clarion	18,980	390	19,627	548	21,124	522	22,955	548	24,087	541
Elk	31,791	66	30,407	74	25,646	77	18,150	154	36,565	213
Jefferson	1,486	52	1,743	141	1,370	131	1,714	109	2,392	109

Crude oil production and the number of producing wells by county for selected years 1964 to 1974 are summarized in Table 8. As indicated by the table, crude oil production has declined over a nine year period. However, from 1973 to 1974 crude oil production increased by 22,000 barrels in the subbasin. Also during a six year period, 1964 to 1970, the number of oil wells in the subbasin declined. Since 1970, however, there has been a gradual increase in the number of wells to a new four year high of 983 in 1974. During the ten-year period, Elk County has been the leader in crude oil production although Clarion County has the greatest number of producing wells.

There is no reason to expect a great surge of petroleum exploration and development in the area despite the recent two to three-fold increase in crude oil prices. All exploration is confined to the oil belt whose boundaries were determined at the turn of the century and thus only a major technological breakthrough in secondary or tertiary recovery techniques will rejuvenate the belt. Successful wildcatting outside the oil belt undoubtedly will delay the decline somewhat and will outline areas for limited expansion.

Table 9

DEEP GAS PRODUCTION IN 1972

County	Field	Production (million cu. ft.)
Armstrong	Goheenville	29,010
Clarion	Clarion-Miola	Closed in 1965
Jefferson-Elk	Punxsutawney-Driftwood	226,352
Jefferson	Elk Run	44,012

3. *Natural Gas*

Deep gas production totals for 1972 by county and field are summarized in Table 9. The largest producing field, Punxsutawney-Driftwood, extends from the northeast corner of Jefferson County into Elk and Clearfield Counties. In Jefferson County the Punxsutawney-Driftwood field includes the Boone Mt., Reed-Deemer and Sykesville pools. A small part of northwest Clearfield County which lies in the subbasin includes the DuBois, Helvetia and Rockton pools. The Punxsutawney-Driftwood field, discovered in the early 1950's has been an excellent production area. An average Oriskany well in any of several pools associated with the field averages about 5 million cubic feet of natural gas per day. Other small natural gas deposits in the subbasin are found near Big Run in Jefferson County and Goheenville in Armstrong County. A previously producing natural gas field in Clarion County between Clarion and Miola has been shut down since 1965.

It is likely that natural gas exploration in the subbasin will continue to be focused on deep reservoirs, principally Cambrian and Ordovician Rocks and Silurian Lockporte Dolomite. Because of high drilling costs, a large percentage of these deeper rocks are untested. If natural gas prices increase, exploratory drilling and production undoubtedly will increase.

4. *Nonfuel Minerals*

Nonfuel mineral resources, or industrial rocks, are mined in every county in the subbasin. Included in the classification of industrial rocks are sand and gravel, limestone, sandstone, clay and shale. The construction industry uses more than half the total output in value, and even more in tonnage, in the form of crushed stone, dimension stone, and raw materials for clay, brick and tile. Clay-shale, supplemented by other minerals, goes to the ceramics and refractory industries. Molding and fire clay are used in metallurgical process.

Clarion County is the principal producer of limestone with lesser amounts occurring in Armstrong and Jefferson Counties. Most of this limestone is quarried from either Vanport Limestone of the Pottsville Group or Loyalhanna Limestone of the Mississippian Group.

Clay and shale are produced principally in Armstrong County. Jefferson and Elk Counties also have some production. Both clay and shale beds are found in the Mississippian and Pennsylvanian strata. Purer types (fire clays) are found in association with coal seams and frequently are mined along with coal.

Sandstone accounts for a small percentage of total stone production in the subbasin. It is marked by both dimension and crushed stone and is found in Jefferson County.

Table 10

SOIL ASSOCIATIONS

A. Soils formed in materials weathered from noncarbonate sedimentary rocks

- A2. Substrata of yellowish and brownish sandstone, shale, and siltstone
  - A2b. Cookport-Clymer-Hazleton Association
  - A2c. Cookport-Cavode-Wharton Association
  - A2i. Gilpin-Ernest-Wharton Association
  - A2k. Hazleton-Cookport Association
  - A2l. Hazleton-Gilpin-Ernest Association
  - A2m. Rayne-Wharton-Ernest Association

- A3. Substrata of reddish, yellowish and brownish clay shale
  - A3a. Cavode-Wharton-Gilpin Association

E. Soils formed in unconsolidated water sorted materials

- E1. Substrata of stratified fluvial, sand, silt, and gravel
  - E1d. Monongahela-Philo-Melvin Association
  - E1f. Wayland-Chenango-Braceville Association

Sand and gravel are major nonfuel minerals produced in the subbasin, with three-fourths of the production used by the construction and paving industries. Sand and gravel from unconsolidated alluvial and glacial deposits are produced in Clarion and Jefferson Counties. Most sand and gravel deposits in the subbasin are adjacent to streams and rivers. As a result, there is potential for severe damage to water quality from siltation.

Much of the information utilized in this section was derived from the Comprehensive Water Quality Management Plan (COWAMP) program for regions 8 and 9.

References

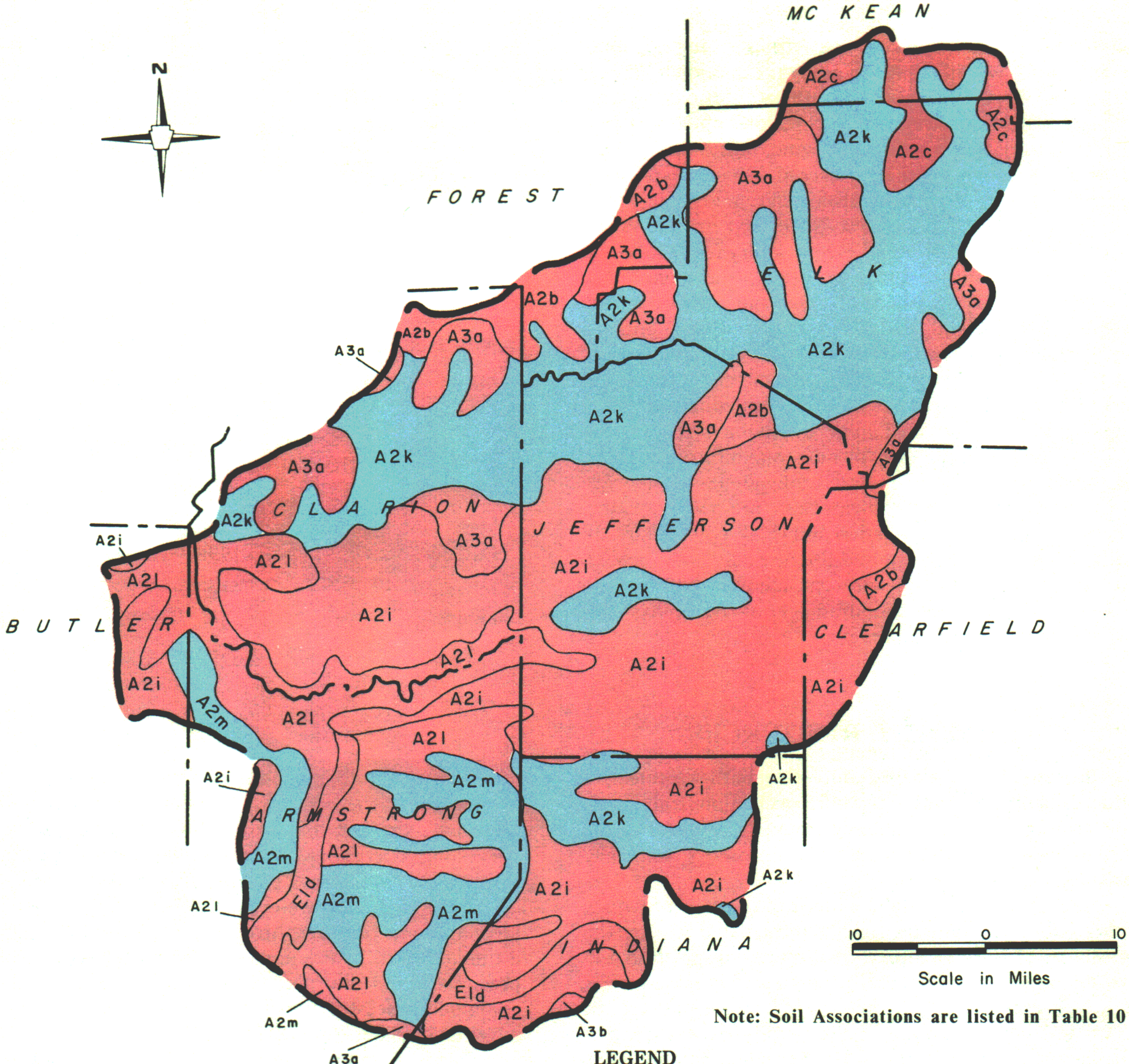
1. J.J. Schany, Jr., *Historical Statistics of Pennsylvania's Mineral Industries, 1951–1955*, (Pennsylvania State University, Mineral Industries Expt. Station, Bulletin 69, 1957).
2. J.J. Schany, Jr., *Historical Statistics of Pennsylvania's Mineral Industries, 1956–1960*, (Pennsylvania State University, Mineral Industries Expt. Station, Bulleton 79, 1963).
3. J. J. Schany, Jr., *Historical Statistics of Pennsylvania's Mineral Industries*, 1961-1965, (Pennsylvania State University, Earth and Mineral Sciences Experiment Station, Bulletin 84, 1967).
4. M.A. Sholes, and V.W. Skema, *Bituminous Coal Resources in Western Pennsylvania*, (Pennsylvania Department of Environmental Resources, Bureau of Topographic and Geologic Survey, Mineral Resource Report 68, 1974).
5. W.R. Wagner and W.S. Lytle, *Geology of Pennsylvania's Oil and Gas*, (Pennsylvania Geological Survey, 4th Series, Educational Series No. 8, 1968).

G. SOILS

Soil characteristics influence precipitation after it comes in contact with the earth's surface. Coarse-textured soils enhance infiltration to the water table, while fine-textured soils have slow infiltration rates and produce higher surface runoff. Water in contact with soil may leach out soil ions, thereby changing the chemical composition of both the infiltrating water and the soil. The general properties of soils help to determine their suitability for on-lot disposal and land disposal through their wastewater renovating potential. Poor soil suitability means disposal systems will eventually pollute the groundwater or surface waters, or both. The suitability of subbasin soils for waste disposal is mapped and discussed in more detail in the Comprehensive Water Quality Management Plan (COWAMP) study area reports.

The soils of Subbasin 17 can be divided into two broad groups based on association with a specific parent material. These groups are: 1) soils formed in materials weathered from noncarbonate sedimentary rocks, and 2) soils formed in unconsolidated water sorted materials. The groups are listed in Table 10 along with soil substrata and association, and displayed on a general soil map, Figure 5. In addition, soils can be further categorized by hydrologic groups, which are also listed on Figure 5. The hydrologic groups are determined by a soil's infiltration rate, which is dependent on the soil's physical and chemical composition, dominant slope and depth of soil profile as discussed in Appendix A-1.

The northern half of Subbasin 17 lies within the Allegheny High Plateaus Section of the Appalachian Plateaus Province, while the southern half of the subbasin lies within the Pittsburgh Plateaus Section of the same province. However, all of the soils within this subbasin



LEGEND

Hydrologic Group

A	(Low runoff potential.) Soils having high infiltration rates even when thoroughly wetted. These consist chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission in that water readily passes through them.
A—B	Combined properties of soil groups A and B.
B	Soils having moderate infiltration rates when thoroughly wetted. These consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.
B—C	Combined properties of soil groups B and C.
C	Soils having slow infiltration rates when thoroughly wetted. These consist chiefly of soils with a layer that impedes downward movement of water or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.
C—D	Combined properties of soil groups C and D.
D	(High runoff potential.) Soils having very slow infiltration rates when thoroughly wetted. These consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

FIGURE 5. General Soils and Hydrologic Characteristics

SOURCE:
GENERAL SOIL MAP OF PA.
USDA. SCS 1972

were formed in materials weathered from noncarbonate sedimentary rocks. The only exceptions to this are two narrow bands of soils that run along the Allegheny River and Crooked Creek in the southern portions of the subbasin. These soils were formed in unconsolidated water sorted materials composed of sand, silt and gravel. Furthermore, their depth may exceed 60 inches and they are characteristic of the C hydrologic group.

The substrata of the soils formed in materials weathered from noncarbonate sedimentary rocks follow a pattern throughout the subbasin. The northern one-third of the subbasin is largely sandstones and conglomerates with thin shales and coals. The middle third contains cyclic sequences of sandstone, shale, limestone and coal, while the south and southeastern portions of the subbasin encompass cyclic sequences of shales and siltstones with thin limestones and coal. The overlying soils are all characterized by either slow or moderate infiltration rates and are, thus, of the C or B hydrologic class. The soils that are of the B hydrologic class are those of the Hazleton-Cookport Association and the Rayne-Wharton-Earnest Association. In addition, the soil depths throughout the subbasin vary considerably between 30 and 72 inches while the drainage of the hilly and mountainous terrain is moderate.

H. FOREST RESOURCES

Forests affect water resources in both a protective and a depletive manner. They offer protection from floods and erosion, while at the same time contributing to the depletion of streamflows. The latter occurs primarily during the growing season.

Forest soils are covered with litter (leaves and twigs), which acts as a protective layer to the soil and reduces the possibility of sheet erosion caused by raindrop splash and impact on soil. In addition, litter decays and becomes humus, which helps to form a highly permeable layer of soil, in which infiltration rates usually exceed rainfall intensities[9]. This retards runoff from heavy rainfall, thus reducing downstream flood peaks.

However, where the forest floor becomes disturbed the potential for erosion increases. Soil loss then becomes a function of soil erodibility as well as the length and steepness of slopes.

The amount of soil reaching a stream is affected by the care used in locating and draining the logging road system and maintaining it after logging. For example, one study found that the maximum turbidity from a cutover watershed with no road plan and no provision for drainage was 56,000 parts per million.[10] However, on a similar cutover watershed, with careful planning and drainage, the maximum turbidity was only 25 ppm.[11] For an uncut watershed, the maximum was 15 ppm.

A more recent study in central Pennsylvania reported similar results[12]. Maximum storm turbidity during logging was 550 ppm and could be traced to scarified log loading areas. This decreased immediately after completion of logging and averaged only 11 ppm the following year. On an adjacent uncut watershed, storm turbidity never exceeded 25 ppm during the logging period and averaged less than 5 ppm after logging. These studies emphasize the fact that with careful planning of timber harvesting operations, water quality can be preserved through the reduction of erosion and sedimentation.

Table 11

FOREST LAND DISTRIBUTION

County	Total Acres Within Subbasin (1,000's)	Forested Acres (1,000's)	Percent Forested
Armstrong	332	175	53
Butler	47	27	57
Clarion	346	248	72
Clearfield	74	59	80
Elk	348	209	60
Forest	68	34	50
Indiana	199	117	59
Jefferson	414	292	71
McKean	49	45	92
Total	1,877	1,206	64

Source: U.S.D.A. Forest Service, 1974

Forests reduce water yield because they consume large amounts of water through transpiration. It has been estimated that, in the northeast, 40 to 60 percent of all precipitation is returned to the atmosphere through the combined processes of evaporation and transpiration and never reaches the groundwater or streams[13].

In view of this, the potential for increasing water yield through properly managed forest cutting practices exists. Several studies, carried out by the U.S. Forest Service, The Pennsylvania State University, and others have documented this potential. Maximum annual increases in water yield by harvest cutting under an even-

[9]H. W. Lull and K. G. Reinhart, *Research Paper NE-226, Forests and Floods in the Eastern United States*, (USDA Forest Service, Upper Darby, Pennsylvania, 1972).

[10]K. G. Reinhart, A. R. Eschner and G. R. Trimble Jr., *Research Paper NE-1, Effect on Streamflow of Four Forest Practices in the Mountains of West Virginia*, (USDA Forest Service, Upper Darby, Pennsylvania, 1963).

[11]ppm: parts per million.

[12]J. A. Lynch, W. E. Sopper, E. S. Corbett and D. W. Aurand, *Technical Report NE-13, Effects of Management Practices on Water Quality and Quantity: The Penn State Experimental Watersheds*, (USDA Forest Service, Upper Darby, Pennsylvania, 1973).

[13]H. W. Lull and K. G. Reinhart, *Paper NE-66, Increasing Water Yield in the Northeast by Management of Forested Watersheds*, (USDA Forest Service, Upper Darby, Pennsylvania, 1967).

Table 12

FOREST LAND BY FOREST COVER TYPE

Forest Cover Type	Acres	Percent
Oak-Hickory	419,691	34.8
Maple-Beech-Birch	335,270	27.8
Aspen-Birch	177,283	14.7
Red Maple	167,635	13.9
White Pine	73,567	6.1
Other Oak Types	16,884	1.4
Virginia-Pitch Pine	15,678	1.3
Total	1,206,008	100.0

Source: U.S.D.A. Forest Service, 1975

aged management program, with provision for a protective ground cover, have been found to be about 10 inches or 270,000 gallons per acre cut[14]. In contrast, for an equal volume of timber removed, a selection cutting will provide no more than one-fourth of the increase resulting from the clearcut[13].

Experiments have shown that streamflow increases are largest the first year after timber harvesting. In subsequent years, as regrowth continues, the transpiring surface area increases and the streamflow increase diminishes[15]. Therefore, if maintaining the maximum yield is the primary objective of the watershed management program, forest regrowth will have to be controlled. This will eventually result in a closed cover of herbaceous and low shrubby growth which will prevent site deterioration and adverse water quality effects. Because of variability in factors such as climate, slope, direction of slope, soils, and geology, a considerable variation in the amount and timing of the water yield increase may exist between different watersheds.

Presently 64 percent or 1,206,008 acres of Subbasin 17 is forested. However, by 2020 this is expected to increase to 71 percent or 1,310,211 acres. Most of this increase will be due to abandoned crop and pasture land reverting to forest cover. Nearly 8 percent of the subbasin's present forestland is within the Allegheny National Forest, which is managed by the U.S. Forest Service. Table 11 indicates the forested acreage within the subbasin portion of each county in Subbasin 17.

Major forest cover types existing in the subbasin include oak-hickory and maple-beech-birch. Other cover types include aspen-birch, red maple, white pine, other oaks, and Virginia-pitch pine. Table 12 contains the acreage distribution of each of these categories.

In 1975, Elk County had 79,200 acres of timber defoliated by the fall cankerworm while Jefferson County had no problem with this insect. However, in 1976 Elk County's defoliation increased to 325,000 acres and Jefferson County experienced 9,910 acres of timber defoliated. This was part of a widespread outbreak that developed in many areas of the state, primarily in the northern counties.

If infestation continues as expected, serious timber losses could be incurred since two to three years of defoliation may cause hardwood mortality. The fall cankerworm's preferred food is elm and apple foliage. However, in a forest situation many other hardwoods such as oak, hickory and maple, which constitute most of the subbasin's timber resources, may be utilized with severe defoliation resulting.

I. FISH, WATERFOWL, AND FURBEARER RESOURCES

1. *Fish*

With the exception of Watershed A, the overall fishery of Subbasin 17 is poor. This is due primarily to acid mine drainage and siltation from past and present mining activities.

Presently, the subbasin has a total of 55 streams approved for trout stocking by the Pennsylvania Fish Commission. With the exception of a few isolated areas, there are no wild trout populations; therefore, the stocking program provides the bulk of the trout fishery in this subbasin. One of the areas having wild trout reproduction is the Redbank Creek drainage upstream from Brookville. In addition, this drainage provides the majority of stocked streams in this subbasin. Limited trout fishing is also provided by East Branch Lake, Cloe Lake, Ridgway Reservoir and Twin Lakes.

Major warm-water fisheries in Subbasin 17 are limited to the Allegheny River, portions of the Clarion River, and Redbank, Mahoning and Crooked Creeks. The Allegheny River is the only high quality warm-water stream in the subbasin. However, the Clarion River is rapidly improving in its ability to support a fishery. From Piney Dam to Cooksburg, it has a viable smallmouth population and has recently been stocked with brown trout fingerlings in the area between Cooksburg and Hallton. Periodic reports of bass, walleye and esocid catches have been received from Piney Dam.

Warm-water lakes providing good fishing include Kyle, Cloe, East Branch, Mahoning Creek, Crooked Creek, Keystone, Hemlock and Kahle Lakes. Many of these lakes were recently developed or have recently begun to provide fisheries recreation. Figure 6 shows the streams which presently support cold- and warm-water fisheries.

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[13]H. W. Lull and K. G. Reinhart, *Paper NE-66, Increasing Water Yield in the Northeast by Management of Forested Watersheds,* (USDA Forest Service, Upper Darby, Pennsylvania, 1967).

[14]H. W. Lull, *Effects of Trees and Forests on Water Relations,* (University of Massachusetts, Symposium on Trees and Forests in an Urbanizing Environment, 1972).

[15]James E. Douglas and W. T. Swank, *Research Paper SE-94, Streamflow Modification through Management of Eastern Forests,* (USDA Forest Service, 1972).

Table 13

TOTAL NUMBERS OF FISH STOCKED

County	Cold-Water 1970[a]	Cold-Water 1975[a]	Warm-Water 1970[a]	Warm-Water 1975[a]	Total 1970[a]	Total 1975[a]
Armstrong	43,340	50,950	81,350	1,508,150	124,690	1,559,100
Clarion	12,110	24,400	647,250	28,550	659,360	52,950
Clearfield	102,180	74,500	–	3,166,400	102,180	3,240,900
Elk	106,130	129,720	246,500	1,525,400	352,630	1,655,120
Jefferson	72,750	73,030	650	1,530	73,400	74,560

[a]Fiscal year (1970 would be June 1, 1970 to June 30, 1971).

Source: Pennsylvania Fish Commission

The total numbers of fish stocked in the subbasin during 1970 and 1975 are listed in Table 13. These totals are subject to change from year to year for two reasons. First, the total number of fish available from the hatcheries varies. Second, the methods used in allocating these fish to each county are based on inherently variable criteria. For example, cold-water fish stocking is based on three weighted factors: (1) acres of public land (30 percent), (2) number of licenses sold (60 percent), and (3) population (10 percent). In contrast, warm-water fish stocking is based on a field survey needs determination by Pennsylvania Fish Commission personnel.

2. *Waterfowl and Furbearers*

Subbasin 17 is located on a major waterfowl migration route which is part of the Atlantic flyway. Besides being used by black ducks and Canada geese, it is also the general route taken by pintails, baldpate, teal and wood ducks, as well as diving ducks enroute to and from their breeding grounds.

On a regional basis there are no significant wetlands providing waterfowl habitat within the subbasin, although open bodies of water may serve as resting areas for migrating waterfowl. However, there may be some wetlands which are locally significant as waterfowl habitat and produce waterfowl on a sustained basis. Usually, the resident species include black, mallard, and wood ducks. Locally important wetlands are not always dependable waterfowl producers because their existence is often threatened by changing land use patterns and natural disturbances such as floods.

Furbearers needing water as a habitat include beaver and muskrat. In addition, mink prefer water courses as part of their habitat. All of these species are found within this subbasin.

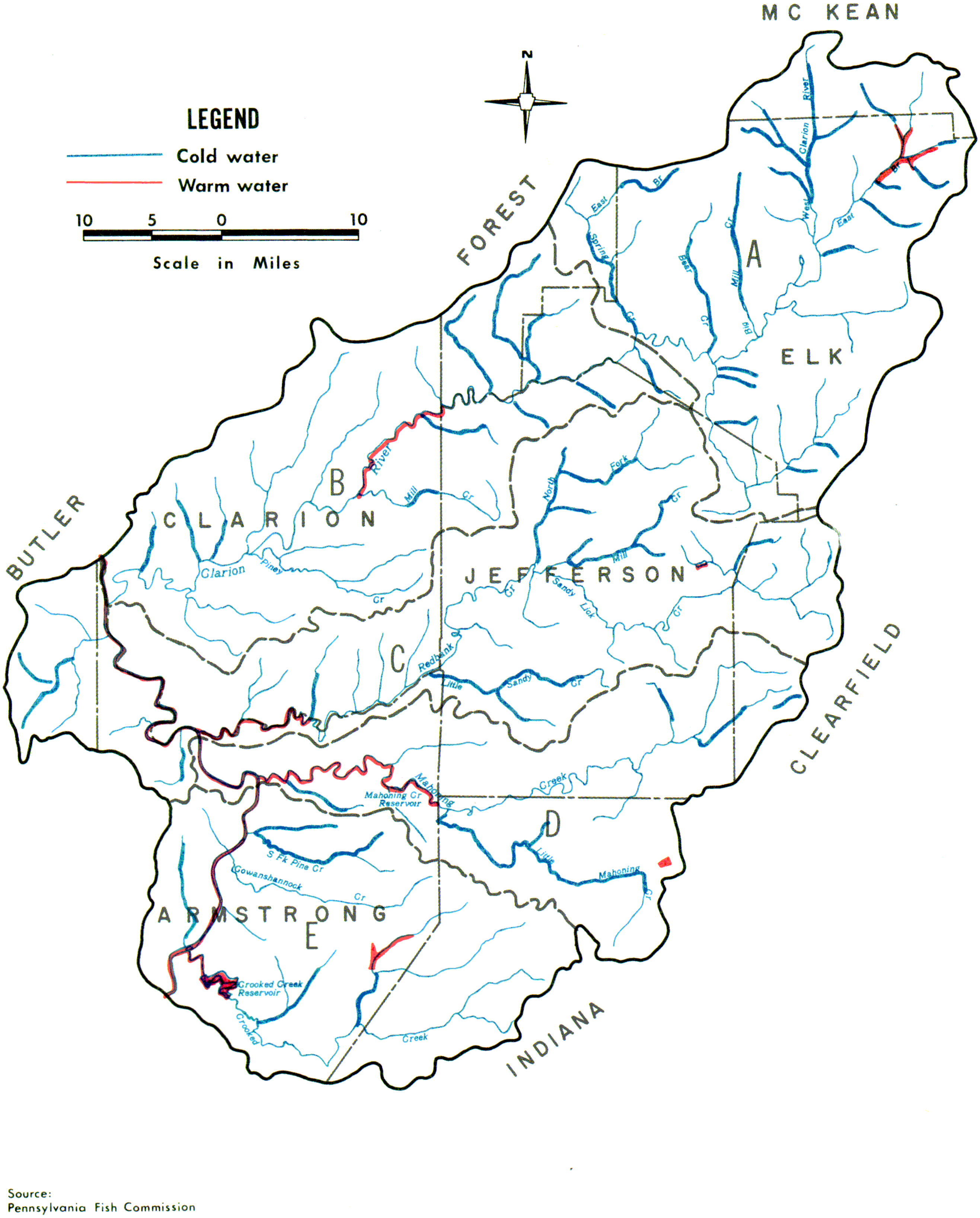

FIGURE 6. Warm- and Cold-Water Fisheries

IV. SOCIO-ECONOMIC FEATURES

Water resources cannot be managed based on physical characteristics alone. Socio-economic factors play just as much a part in water management as do physical and environmental factors. This chapter, after an initial discussion of the historical development of the area, describes the basic social and economic characteristics which were used in developing this study's conclusions and recommendations. As was true of Chapter III, the information presented in this chapter was developed by or from information provided by other agencies. The Office of State Planning and Development was responsible for much of the information presented in this chapter, along with the U.S. Department of Agriculture's Economic Research Service.

Again the discussions in this chapter are not rigorous. More detailed data for the subjects presented is available from the responsible agencies. In the particular case of land use, significantly more detailed data is now available from several sources including the LUDA system of the United States Geological Survey. Although this more recent land use data was not available for use in the development of this planning report, future water resources planning in conjunction with the State Water Plan will certainly make use of the most up-to-date information available.

It should also be emphasized that statewide plans involving economic development and land use management as well as transportation planning are currently in progress within the responsible State agencies, and coordination with those planning efforts has been a key element in the development of the State Water Plan.

A. HISTORICAL SETTING

Waterways in the area played an important role in the subbasin's development. The rivers were the arteries of transportation linking Pittsburgh with the subbasin, as well as powering flour mills, sawmills, forges and factories. The earliest homesteaders arrived in 1791, but many, discouraged by Indian attacks and uncertain land titles, continued westward. The first permanent settlement was made after 1796 by Germans and Scotch-Irish.

Because this area was rich in natural resources the first settlements were lumber communities established along the streams and rivers which powered the sawmills. After the timber was cut the logs were floated or rafted downstream to Pittsburgh until 1884. Around this date an alliance was made between the lumber and tanning interests in the subbasin. Pennsylvania tanneries needed hemlock bark to tan hides used in the leather industry. As a result tanneries stripped the trees of their bark and the lumber industry used the largest portion of the tree for wood. The merging of the tanning and lumber interests created the largest industrial development of the forest resources of northern Pennsylvania.

In the western part of the subbasin, vast resources of coal and iron stimulated growth in the iron industry. The exploitation of anthracite and soft coal and the accompanying growth of the iron industry was the most important factor in industrialization. In 1839, the Great Western Iron Works opened, marking the beginning of a 40 year boom that gave employment to thousands. The iron industry was stimulated by the introduction of the hot blast system and the use of coke instead of charcoal as fuel. At the height of activity, 40 blast furnaces roared in the wilderness of Clarion County.

Coke made from bituminous coal was used in blast furnaces because of its freedom from impurities. The earliest coke could not withstand blast furnace pressure, and after considerable experimentation, demised. The beehive oven produced good coke but allowed the escape of coal tar, ammonia and benzol. These ovens were made of brick, earth covered and built in rows. Soft coal was burned in the oven for two to four days, and when the mass reached the proper state it was sprayed with water and then drawn out. Beehive ovens were numerous in the subbasin.

Brady's Bend Iron Company in Armstrong County made the most extensive use of coke in a large scale iron making operation. This was one of the first vertically integrated industries where the company owned the land, the village and the factory which rolled large quantities of iron rails.

A technical change in coking precipitated the region's decline with beehive ovens being replaced with by-product ovens. The by-product oven, introduced into the United States in 1892, preserved by-products, produced more coke per ton of coal than the beehive and completed the process in far less time. Installation and operation of the by-product oven was extremely expensive and few were constructed in this area. Local bituminous coal fed the beehive oven, and when it declined in use the demand for local coal declined.

Shortly after 1850, iron furnaces, glass works, tanneries, brick yards, oil wells and farming supplemented coal mining activities. Oil discovery in the area resulted in a short-lived economic boom and temporary employment. Although farming was practiced, commercial agriculture was not widespread because of poor soil. The extraction of minerals and resources has dominated the landscape and

Table 14

HISTORICAL AND PROJECTED EMPLOYMENT BY INDUSTRY

	Labor Market Area					
	Kittanning/ Ford City		Indiana		Clarion	
Industry	1970	1990	1970	1990	1970	1990
Agriculture	1,100	456	1,700	692	900	415
Mining[a]	1,806	2,127	2,022	1,585	640	593
Contract Construction	483	1,092	840	1,595	689	886
Manufacturing	5,070	6,292	5,639	7,676	2,759	2,857
Transportation, Communication and Public Utilities	1,597	1,769	1,153	1,602	973	1,207
Wholesale and Retail Trade	3,135	4,061	4,577	6,479	2,196	2,993
Finance, Insurance and Real Estate	535	878	551	703	222	662
Services	3,355	4,192	2,903	4,327	1,520	1,783
Government	3,000	4,438	5,300	8,431	2,400	4,127
Totals	20,081	25,305	24,685	33,090	12,299	15,523

[a]Employment in mining category may be affected by recent National energy policies.

Source: Pennsylvania Office of State Planning and Development, *Pennsylvania Projection Series*, 1973.

development in the subbasin. This has been especially true with regard to bituminous coal. The coal lying near the surface is strip mined, or literally scraped from the earth. Great scars are left, and if the surface is not reclaimed, serious erosion, despoiling and water pollution are the result.

Although coal mining is still important to the subbasin, since World War II coal has suffered a major decline. Much industrial use of coal has been replaced by other energy sources, electricity, gas or oil. Nevertheless, the subbasin is an area of great natural beauty and would benefit from the development of tourism and recreation. One of the problems facing the area is the present incompatibility between strip mining and maintaining areas of scenic beauty to attract tourists.

B. ECONOMY AND EMPLOYMENT

Economic development is closely related to the availability, development, and use of water resources. Past economic conditions have dictated the extent to which water resources have been utilized. Therefore, a forecast of economic conditions will help to determine when and to what extent future water resources development is likely to occur. The most fundamental concept which can be used to define Pennsylvania's future economy is employment[16]. By observing which types of employment exist in the subbasin and the trends of each type, general observations concerning the possible trends in water resources development and use can be made.

Subbasin 17 falls within five labor market areas whose boundaries do not strictly coincide with those of the subbasin. The Kittanning-Ford City Labor Market area includes all of Armstrong County, most of which is located in the subbasin. Although all of Indiana County is in the Indiana Labor Market Area, only the northern half of the county is actually in the subbasin. Most of the Clarion Labor Market Area in Clarion County is a part of the subbasin. All of Jefferson County, which is in the Punxsutawney Labor Market Area, is located within the subbasin. Only the western two thirds of Elk County fall within the subbasin, yet the entire county is part of the St. Marys Labor Market Area.

Employment by industry for 1970 and projections for 1990 for each of the five labor market areas are listed in Table 14[17]. Most of the categories in all five labor market areas are expected to increase in employment during the 20-year period. Those categories expected to decline in employment include *Agriculture* in all five labor market areas and *Mining* in all except the Kittanning-Ford City Labor Market Area.

Employment trends in *Agriculture, Mining, Contract Construction* and *Manufacturing* industries are more closely related to water use than are the remaining

[16]Office of State Planning and Development, *Pennsylvania's Economy, Interim Report Technical Working Memorandum No. 1, Pennsylvania Economic Program for Balanced Growth*, (Harrisburg, 1974), p.1.

[17]Office of State Planning and Development *Employment, Pennsylvania Projection Series*, (Harrisburg, 1973).

Table 14 (Cont.)

HISTORICAL AND PROJECTED EMPLOYMENT BY INDUSTRY

	Labor Market Area			
	Punxsutawney		Saint Marys	
Industry	1970	1990	1970	1990
Agriculture	900	357	200	103
Mining[a]	425	167	107	74
Contract Construction	381	893	255	416
Manufacturing	5,350	5,742	8,037	11,282
Transportation, Communication and Public Utilities	820	940	834	987
Wholesale and Retail Trade	3,094	3,922	1,689	2,541
Finance, Insurance and Real Estate	224	358	217	426
Services	2,304	2,801	1,826	2,342
Government	1,700	2,865	800	1,157
Totals	15,198	18,045	13,965	19,328

[a]Employment in mining category may be affected by recent National energy policies.

Source: Pennsylvania Office of State Planning and Development, *Pennsylvania Projection Series*, 1973.

five categories in Table 14. Although employment in the *Agriculture* category is projected to decline, two key factors, the value of farm produce and total acres harvested, have both increased during the past five years[18]. In addition, the amount of vegetable acres, on which irrigation may be used, has also increased. Therefore, even though employment in *Agriculture* is projected to decline, it would appear the use of water, especially for irrigation, is going to continue to expand. Similarly, although the number of employees in mineral industries is expected to decline, figures from a recent five year trend indicate that production of coal in Venango County is increasing. Also, DER information indicates that water use by mineral industries will continue to grow gradually for the next 20 years. As a result, it can be expected that water use in mineral industries will continue to rise. For all five labor market areas, increases in employment are projected in the *Contract Construction* industry. Some of this construction represents new development, including urbanization. Water use will increase with this apparent build-up. The most important category as far as water use is concerned is *Manufacturing*, which also shows an increase in employment. This implies increased production which could require more water use. In this subbasin, primary water using industries include primary metals, food processors, rubber, glass, chemical and paper producers.

Another measure of the subbasin's economy is found in the ranking of individual counties with regard to two factors: 1) Economic Growth and 2) Level of Economic Development. Economic Growth is based on a composite of equally weighted factors which generally describe each county's growth in terms of changes in population, market value of real estate, aggregate personal income and value added by manufacture. The level of Economic Development is also based on a composite of equally weighted factors which generally describe each county's status in terms of standards of living, industrial sophistication, economic diversification, urbanization, and infrastructure development. Growth was not a factor used in determining a county's development status. By utilizing a breakdown of counties into five categories: (1) high, (2) moderately high, (3) moderate, (4) moderately low, and (5) low, rankings of economic growth and economic development have been established by the Office of State Planning and Development[19]. Three counties, Indiana, Clarion, and Armstrong experience a moderately high, moderate, and moderately low level of economic growth, respectively. The fifth or lowest level of economic growth exists in Elk and Jefferson Counties.

Unlike economic growth only three of the five levels of economic development exist in the subbasin. Indiana County has a moderate level of economic development. The fourth or moderately low level of economic development exists in Elk, Clarion, and Armstrong Counties. Jefferson County has the fifth or lowest level of economic development.

[18]Bureau of Statistics, *Pennsylvania Statistical Abstract 1971 and 1973*, (Department of Commerce, Harrisburg).

[19]Fritz J. Fichtner Jr. and Fong L. Ou, *Comparative Study of Economic Development in Pennsylvania*, (Office of State Planning and Development, Harrisburg, 1973).

Table 15

WATERSHED AND COUNTY POPULATIONS

Watershed	1970	1980	1990	Percent Increase
A	34,658	35,667	39,411	13.7
B	29,795	31,090	33,879	13.7
C	55,257	54,912	58,366	5.6
D	27,993	27,952	30,079	7.5
E	51,756	53,520	60,853	17.6
Total	199,459	203,141	222,588	

Source: DER allocations of O.S.P.D. county projections, 1973.

County	1970	1980	1990	Percent Increase
Clarion	38,486	39,370	42,332	10.0
Armstrong	75,590	76,284	89,577	18.5
Jefferson	43,699	43,998	47,707	9.2
Clearfield	74,757	72,812	75,156	0.5
Elk	37,848	39,853	44,827	18.4
Indiana	79,574	85,860	93,358	17.3
Forest	4,934	4,878	4,498	–9.7

Source: Office of State Planning and Development, 1973.

C. POPULATION

Population projections for each of Pennsylvania's counties have been developed by the Office of State Planning and Development. Their projections of population are conceptually tied to the projections of economic trends, as discussed in the Economy and Employment section. To allocate the projected county populations to the watershed areas, population allocation models developed by State Water Plan staff were employed.

Projected populations were used directly to evaluate future water supply and waste treatment requirements. In addition, population distributions and concentrations are important factors in the analysis of the flood damage reduction needs, including urban storm runoff management, and industrial water supply and power generation cooling requirements.

Population figures and projections for Subbasin 17 from 1970 to 1990 are listed by watershed and county in Table 15. The majority of watersheds and counties are projected to experience increases in population from 1970 to 1990. Only Watersheds C and D, and Clearfield County, are projected to decrease in population for one 10-year period, 1970 to 1980. During the overall 20-year period, however, all watersheds and counties are expected to increase in total population. The largest percentage increase in population is expected to occur in Watershed E, located in Armstrong County. By 1990 Watershed E will surpass Watershed C as the most populated watershed in the subbasin.

At the present time, population in Watershed E is concentrated along the Allegheny River in the communities of Kittanning and Ford City in Armstrong County. Located along Sandy Lick Creek, the largest population is found in Watershed C centered on the communities of DuBois in Clearfield County, and Reynoldsville and Brookville in Jefferson County. The communities of Ridgway, Saint Marys and Johnsburg are the centers of the third largest population in Watershed A, located in Elk County. The smaller population concentrations are found in Watersheds B and D centered on the communities of Clarion and Punxsutawney in Clarion and Jefferson Counties, respectively.

Table 16

EXISTING AND PROJECTED SUBBASIN LAND USE

Land Use	1974 Acres	1974 Percent of Total Area	2020 Acres	2020 Percent of Total Area	Change Acres	Change Percent
Urban	110,448	6	123,253	7	12,805	12
Agriculture or Open	319,418	17	149,656	8	-169,762	-53
Forest	1,206,008	65	1,310,211	71	104,203	9
Other	212,219	12	264,973	14	52,754	25

Source: U.S. Department of Agriculture, Economic Research Service

D. TRANSPORTATION

Transportation has been and will continue to be a key factor in the economic viability in any area. Good transportation facilities are mandatory if an area is to experience any substantial economic growth. In more recent times, highway networks have affected water resources development in many ways. Construction of the National Defense Interstate Highway System in Pennsylvania was used to spur economic development in the Commonwealth's more remote areas. Interstate spurs and State highway projects open new areas to all forms of residential, commercial and industrial construction. Such development creates new demands on water as well as land resources. Highway construction may also affect water resources directly by interfering with natural drainage patterns over extensive areas.

The most important method of transportation available today in terms of moving people and goods, as well as influencing land development is the highway system. The major arterial highway traversing the center of Subbasin 17 is Interstate 80, the Keystone Shortway. This east-west highway affords the most direct route between the larger eastern seaboard and the mid-continental industrial heartland. Two other east-west highways cross the central and southern portions of the subbasin. U.S. Route 322, the Twenty-Eighth Division Highway, paralleling Interstate 80, connects DuBois with Franklin. The southern east-west route, U.S. 422, the Benjamin Franklin Highway, links Indiana with Butler. Two major north-south routes pass through the central and eastern portions of the subbasin. Pa. 28 and 66 connect Pittsburgh with Interstate 80, while U.S. 119 and 219, the Buffalo-Pittsburgh Highway, links Indiana with Ridgway.

Railroads provide a necessary service to industrial and commercial establishments, both in the provisions of raw materials and the distribution of finished products. Most of the railroad freight service in the subbasin is provided by the former Penn Central Railroad, now part of the Conrail System. Other railroads servicing the subbasin include the Baltimore and Ohio, Erie Lackawanna and the Erie Railroad together with their myriad of spurs and sidings. Almost all railroad tracks in the subbasin follow lowland areas created by rivers, creeks or streams. Some of the waterways utilized by the railroads include the Allegheny and Clarion Rivers, Mahoning and Redbank Creeks, and Pine Run. The latter three waterways flowing northeast to southwest represent the most intense area of railroad trackage in the subbasin. Passenger service to the subbasin was eliminated in 1968 when Penn Central discontinued the Buffalo to Harrisburg rail service which stopped at Ridgway.

Although there are several airfields scattered throughout the subbasin, the only commercial airline service is found at DuBois-Jefferson County Airport. From this airport Allegheny Airlines offers two scheduled flights daily to Pittsburgh where connecting flights may be arranged to most major cities in the United States.

Bus transportation is provided daily by the Edwards Lakes to Sea Line. This system provides daily service east to west through the subbasin. These routes provide direct service to State College, Elmira, Buffalo, Williamsport, Pittsburgh, Cleveland, Philadelphia, Allentown and New York City.

E. LAND USE

1. *Water Resources Implications*

The wise utilization of our land and water resources has emerged as an important concern during this decade. Because of the close environmental interrelationship existing between land use and water management, land and water resources cannot be viewed as separate entities. Land use patterns and decisions can exert a tremendous impact on the quantity, quality, and utilization of surface and groundwater. Also, hydrologic processes and water resources management decisions profoundly influence existing and future land use patterns in the subbasin.

Land uses have been broken into four categories for this report: *Urban or Built-Up, Agriculture* (including open, cropland and pasture), *Forest*, and *Other* (including Federal noncropland, water areas, disturbed land, and miscellaneous uses). Each of the land use categories can have a significant impact on water resources.

Urban or Built-Up areas consist of residential, commercial and industrial development. If the location, intensity and type of urban development is not properly planned and compatible with the surrounding natural environment, urbanization can adversely effect an area's water resources and overall environmental quality. For example, increases in impervious ground cover and the alteration of natural drainage patterns associated with urban development lead to increased surface runoff. Increased surface runoff causes greater flood magnitudes to occur more frequently, and increases the potential for increased erosion of the land and sedimentation of the streams. Impervious surfaces also decrease the amount of water infiltrating into the soil, thereby reducing recharge of groundwater supplies and lowering streamflows during droughts.

In addition, urbanization can also adversely influence surface water and groundwater quality. Water pollutants emanating from urban environments include discharges from sewage treatment facilities and industrial plants, as well as contaminants picked up by stormwater runoff. Finally, urban development of the floodplain increases flood damages and destroys the valuable resources and amenities of the floodplain environment.

Agricultural lands are important environmental resources because of their capability to produce food and fiber, to serve as valuable wildlife habitat and open space, and to provide attractive landscapes. Agricultural lands can serve as important groundwater recharge areas. Geological formations associated with prime agricultural soils often yield high quantities of groundwater.

Mismanagement of agricultural lands can create water pollution problems. Groundwater near agricultural areas becomes contaminated with nitrates and bacteria unless proper precautions are taken. Soil erosion increases the amount of sediment entering streams. Excessive applications of fertilizers and pesticides also degrade the water quality of surrounding streams.

Forests and woodlands provide valuable timber resources, wildlife habitat, recreational opportunities, and are important components of basin hydrology and water resources management. Vegetative cover decreases storm runoff, thereby reducing flood potential and soil erosion. Vegetative cover also increases the infiltration of water into the ground, which enhances groundwater recharge and supplies. Streams located in forested areas often serve as public water supplies, and properly managed forests will assure the protection of these supplies. However, the misuse of forest resources can degrade forest resource values and aggravate water resources problems.

The impacts of *Other* lands on water resources will depend upon the type of land use. Federal noncropland, water areas, and miscellaneous lands preserve land and water areas which can be used for water storage and supply. Disturbed lands or areas utilized for mineral extraction, on the other hand, could adversely affect water resources. Mineral extraction, especially for coal, can have a significant impact upon environmental quality and water resources management. The potential for blighted landscapes, interference with groundwater recharge, and water pollution are some of the problems which may be related to mining.

Conversely, water resources also play an important role in determining land use patterns. The Historical Setting section in this chapter describes how water resources influenced past settlement and economic development patterns in the subbasin. Water resources and decisions affecting their use will continue to exert a significant impact on emerging land use patterns.

For example, the construction of reservoirs may lead to the inundation of agricultural, forested and urban land, as well as increasing secondary development in surrounding areas by enhancing water supply and recreational opportunities. The extension of public sewer and water supply systems into rural areas can accelerate the conversion of agricultural and forested lands to urban uses. Floodplain management by local governments can decrease the amount of urban development occurring on the floodplain. Water supply deficiencies and consumptive water makeup requirements could also impact upon the expansion of urban development and agricultural water use in many watersheds throughout the State.

Many existing water resources problems have been precipitated and augmented by past land use practices. The historical development of Pennsylvania's floodplains has magnified the devastation and hardship created by recent floods. The impact of historic mining abuses continues to blight Pennsylvania's landscape and pollute water resources. Because of these precedents, current and future decisions affecting the management and development of land and water resources should not overlook the inherent and complex interrelationships between these resources.

The careful consideration of environmental factors in land and water resources planning and decision-making processes will help minimize environmental quality and resource management problems. Although environmental concerns comprise only one aspect of water resources management plans and decisions, their consideration in the planning process can establish a sound basis upon which social and economic land use objectives can be guided.

2. *Existing Land Use*

The number of acres and the percent in each land use category in the subbasin are shown in the left side of Table 16 and illustrated on Figure 7. At the present time *Forest* is the dominant land use comprising 1,206,008 acres, which accounts for 64 percent of the subbasin's total area. A second less extensive land use, *Agriculture*, encompasses 319,418 acres which amounts to 17 percent of the subbasin's area. A slightly smaller land use, *Other*, occupies 212,219 acres amounting to 11 percent of the land area. *Urban* land use contains 110,448 acres, or 6 percent of the subbasin's total area.

Although a detailed breakdown of the four land use categories by acres and percent is not available on a watershed basis, this information is presented at the

(Continued on page 34)

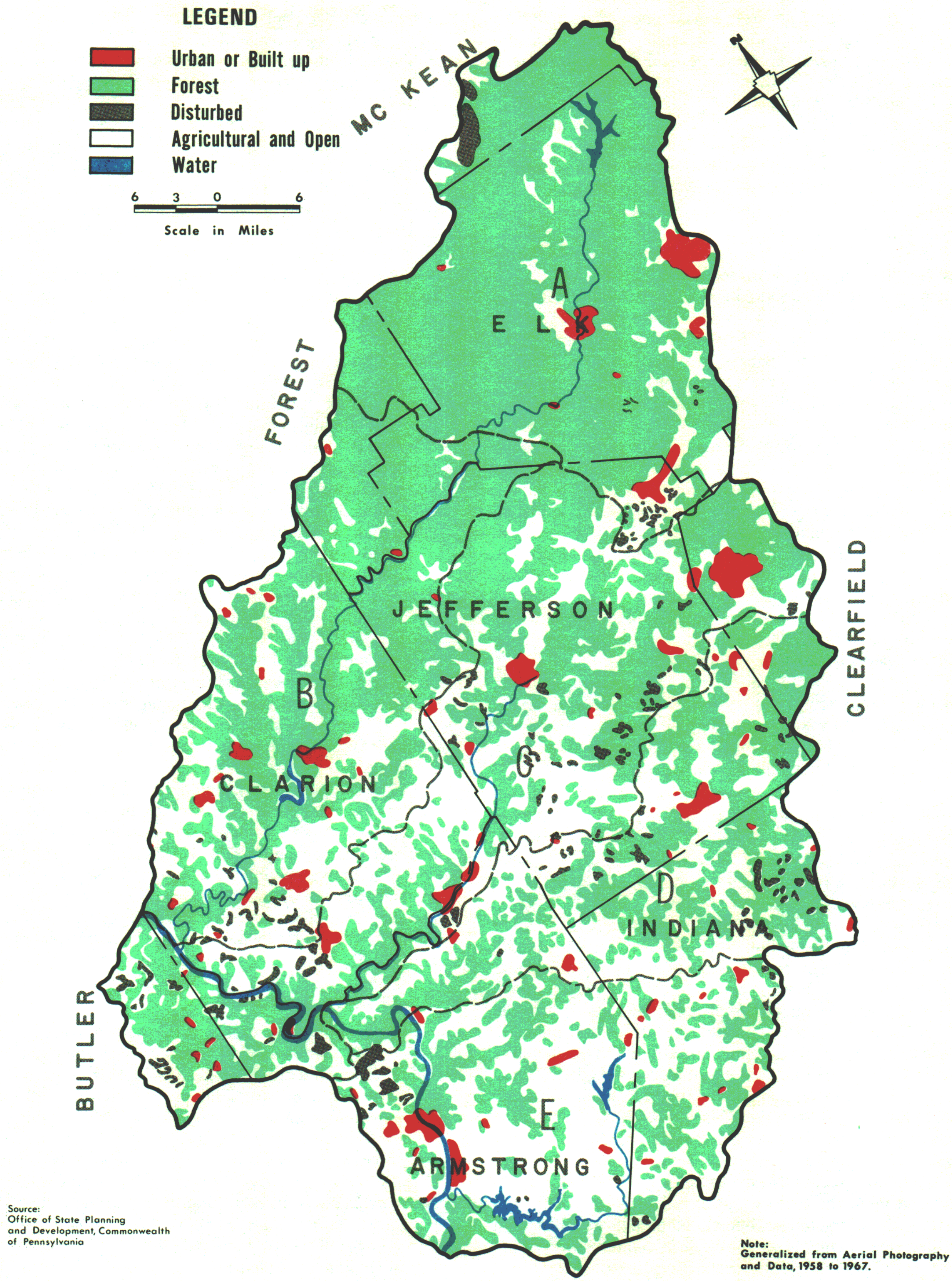

FIGURE 7. Land Use

Table 17

EXISTING COUNTY LAND USE

County	Urban Acres	Urban %	Agriculture Acres	Agriculture %	Forest Acres	Forest %	Other Acres	Other %	Total Acres	Total %
Clarion	24,720	6.5	77,410	20.2	270,816	70.6	10,434	2.7	383,360	100
Armstrong	26,640	6.4	117,566	28.0	218,379	52.4	57,255	13.6	419,840	100
Jefferson	30,181	7.2	61,800	14.8	292,813	70.2	32,486	7.8	417,280	100
Clearfield	37,920	5.2	54,000	7.4	607,980	83.0	32,260	4.4	732,160	100
Elk	13,790	2.7	18,300	3.5	360,366	69.8	124,024	24.0	516,480	100
Indiana	37,950	7.2	158,974	30.1	286,283	54.2	44,793	8.5	528,000	100

Source: U.S.D.A., Economic Research Service, 1974.

Table 18

EXISTING PRIME AGRICULTURAL SOILS

County	Class I Soils[a] Acres	Class I Soils[a] % in County	Class II Soils[a] Acres	Class II Soils[a] % in County	Classes I and II Acres	Classes I and II % in County
Armstrong	3,140	0.8	89,130	21.2	92,270	22.0
Clarion	3,670	0.9	99,196	25.9	102,866	26.8
Clearfield	700	0.1	161,200	23.4	161,900	23.5
Elk	2,800	0.7	79,901	20.6	82,701	21.3
Jefferson	4,283	1.0	113,676	27.2	117,959	28.2
Indiana	5,784	1.1	153,901	29.1	159,685	30.2

[a]Class I and II soils are often considered prime agricultural land or land with high potential productivity.

Source: U.S.D.A. Economic Research Service, 1974.

Table 19

PROJECTED CHANGE IN WATERSHED POPULATION AND URBANIZED LAND

Watershed	Population 1970	Population 1990	Population % Change	Percentage of Urbanized Land in Watershed 1970[a]	Percentage of Urbanized Land in Watershed 1990	Percentage of Urbanized Land in Watershed Change
A	34,658	39,411	13.7	2.6	3.0	.4
B	29,795	31,090	13.7	2.0	2.1	.1
C	55,257	58,366	5.6	3.6	3.8	.2
D	27,993	30,079	7.5	2.2	2.4	.2
E	51,756	60,853	17.6	4.1	4.8	.7

[a]Source: *Generalized Existing Land Use* map, Office of State Planning and Development, 1967.

county level in Table 17. Using this table in conjunction with the Land Use Map (Figure 7), certain inferences regarding land use in the subbasin can be made. Located in the mountainous sections of the Allegheny and Pittsburgh Plateaus, Watersheds A, B, and D in parts of Elk, Clarion, Indiana, and Jefferson Counties, have small populations and low levels of urbanization. As a result, the dominant land use in all these three watersheds is *Forest*, the original and least intensely developed of the four land use categories. Watershed C located in parts of Jefferson and Clarion Counties has a population almost double that of each of the three previous watersheds and a higher level of urbanization. Nevertheless, a larger population and a higher level of development are not reflected in the dominant land use which remains *Forest*. Almost identical in population to Watershed C, Watershed E located in parts of Armstrong and Indiana Counties is the most highly urbanized watershed in the subbasin. Here, the dominant land use is not *Forest*, as was the case with four previous watersheds, but rather *Agriculture*.

Some changes in land use patterns can be detected when comparing two land use maps compiled by the Office of State Planning and Development at the beginning and end of a thirty year interval. The amount of land classified as *Urban* on the 1967 map, Figure 7, compared to *Urban* land areas on a 1937 map (not shown), has increased only slightly. This slight expansion of urban land is confined, for the most part, to previously existing urban areas as noted on the older map. In the majority of cases, urban growth has taken place at the expense of land designated as average farmland according to the 1937 land use map. As new urban areas continue to expand into average farm land, the diminution of prime agricultural land in the subbasin will be assured. This is a near certainty since prime agricultural land, more so than any other land, has the optimum characteristics needed for urban development. The extent of possible loss in prime agricultural land is indicated in Table 18, which shows how much agricultural land is currently available and could potentially be lost to *Urban* expansion in the absnece of any zoning controls. According to the table, five counties in the subbasin could lose from 21 to 28 percent of their acreage, which is prime agricultural, to urban expansion. Indiana County could lose an even greater portion of its land to urbanization having slightly over 30 percent of its land area classified as highly productive agricultural. Nevertheless, the loss of prime agricultural land to urban use stimulates the cultivation of lands of lesser quality. The result is lower crop yield, higher cost, and more importantly increased erosion and sedimentation which, in turn, adversely affects water quality and supply. Some mechanisms to preserve agricultural land which is subject to intense urban development pressure are outlined in "A Land Policy Program for Pennsylvania"[20]. prepared by the Office of State Planning and Development.

3. *Future Changes*

A comparison of the subbasin's present land use with its projected 2020 land use is shown in Table 16. Also shown in the last columns are the projected acreage and percent of change within each land use category. From 1974 to 2020, the projected ranking of the four land use categories will vary slightly. Although *Forest* will remain the dominant land use, *Other* will surpass *Agriculture* land use. Agricultural land will drop from second to third place in the land use ranking with *Urban* land use remaining the fourth ranked land use in the subbasin.

By 2020, it is projected that 71 percent of the land area in the subbasin will be classified as *Forest*. This is an increase of 104,203 acres or nine percent over the 1974 *Forest* land use total. It appears that forestland will increase at the expense of marginal agricultural land which will revert back to its original forest cover. At the end of the 46-year period *Other* land use is projected to occupy 264,973 acres or 14 percent of the subbasin's total area, an increase of 52,754 acres or 25 percent. The increase in *Other* land use is expected to result from an expansion of mineral industries in the subbasin. *Agriculture* land use has the largest percentage and acreage change of all four land use categories. Agricultural land is projected to comprise only eight percent of the subbasin by 2020, a decrease of 169,762 acres or 53 percent from the 1974 land use totals. Agricultural land is expected to lose 157,000 of these acres to *Forest* and *Other* land uses. At the end of the 46-year period, *Urban* land use is projected to increase by 12,805 acres or 12 percent, encompassing seven percent of the subbasin's area. *Urban* land area is expected to increase at the expense of agricultural land.

As previously stated, present land use categories are based on the intensity of development as reflected in population concentrations. The projection of future land use categories by watershed can also be determined by intensity of development based on projected increases in population and urbanization. Urbanization of land is defined as clustered construction of residential, commercial, and industrial establishments, the extension of a sewage collection infrastructure, the extension and widening of roads, etc. This process includes suburbanization, which may be seen as an early stage in the urbanization process.

The projected percentage increases in population and urbanization from 1970 to 1990 for each watershed in the subbasin are listed in Table 19. As indicated in the table, Watershed E has the largest percentage change in population and urbanization of any watershed in the subbasin. As a result, *Urban* land use is expected to challenge the dominant *Agriculture* land use in this watershed. Of the remaining four watersheds, Watershed C has the largest population base; and Watershed A has the second largest percentage change in population and urbanization. However, in neither watershed is *Urban* likely to challenge *Forest*, the dominant and original land use.

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[20] Office of State Planning and Development, *Land Policy Program for Pennsylvania, an Interim Policy Report*, (Harrisburg, April 1976), p.40.

V. WATER RESOURCES PROBLEMS AND SOLUTION ALTERNATIVES

Based on analyses of existing and projected conditions, future water supply, flood control, water-related outdoor recreation, water quality, navigation, and wild and scenic rivers problems have been identified. Possible alternative solutions to water supply, flood control and water-related outdoor recreation problems have been identified and examined.

Through a preliminary reconnaissance level assessment of physical, economic, environmental and social factors, supplemented by regional Water Resources Advisory Committee comments and input, the alternative solutions have been narrowed. The "recommended projects or actions" listed in this chapter are those which merit further detailed consideration as indicated by initial analyses. It should be emphasized that full environmental, social or economic analyses have not been conducted for each alternative. The purpose of this assessment is to screen those potential projects, programs and actions which, as concepts, deserve further study, refinement and possible implementation. If detailed studies of an alternative have been conducted, including where necessary an assessment of social, environmental and economic effects, the State Water Plan may recommend implementation by the appropriate agencies or parties.

The State Water Plan is a plan for resource management; it has been prepared as a tool for decision-making at the State, regional and local levels. The Plan is also a prime input by the Commonwealth to the development of water management policy and actions at the national and interstate levels. The Plan's selection of recommended alternatives was based on an assessment of basinwide and State concerns. These recommended alternatives may not be the most expedient or easiest solutions to each local problem. Because water is a shared resource, whose use and conservation affects the citizens, economy and environment of entire watersheds and the Commonwealth, the State Water Plan has attempted to identify those alternatives which best address the problems and interests of the whole basin and region.

It should be further emphasized that a prime purpose of the Plan is to provide vital information regarding water resources availabilities and problems, for use by decision-makers in both the public and private sectors. The problems discussed in this chapter are based on projections of current trends. However, such trends may not be optimal, or even desirable. Based on information provided in this Plan, as well as other relevant factors, State, regional and local agencies and private citizens may adjust land use planning, regulatory policies and investment decisions in a manner which avoids or moderates projected problems. This Plan's data and analyses regarding water resources should be a major consideration in decisions regarding future population distributions, the location of major development, and selection of technologies and processes which involve water use. Future work on the State Water Plan, as part of the continuing planning process, will include periodic revision of projections based on updated information. It is also intended that an "alternative future" analysis be conducted in the continuing planning process, in order to provide more detailed information to public and private decision-makers regarding the implications of possible options in land use development patterns and the use of alternate technologies.

A. WATER USES

Water is used for a variety of purposes, generally classified in one of two categories, either *instream* uses or *withdrawal* uses. Instream uses, which utilize water in place in lakes and water courses, include navigation, swimming, boating, fish and wildlife habitat, water quality maintenance, hydropower, and general environmental and aesthetic values. Withdrawal water uses are those which require the prior removal of water from its source and include both consumptive and nonconsumptive uses, consumptive uses being those which preclude the return of some or all of the water to the source. This section deals primarily with withdrawal uses.

Parts 1 and 2 focus on uses which divert or withdraw surface and ground waters. Part 1 includes a broad examination of withdrawal uses on both the watershed and subbasin levels; while Part 2 concentrates on existing and projected uses and problems of public water suppliers based on detailed analyses, and further discusses alternative and recommended solution concepts.

Part 3 examines consumptive and interbasin transfer withdrawal uses which may affect the availability of water for instream uses, particularly during periods of low streamflow. Alternative solutions for consumptive water use makeup are also discussed; however, no recommendations are made because more detailed studies are needed.

1. WATERSHED WATER USES AND REUSE

a. *Watershed Total Water Uses*

Withdrawal water uses have been divided into six categories for study purposes:

(1) Public water supply – Water which is sold to the public by water supply companies, water authorities or municipalities.

(2) Self-supplied industrial – Water withdrawn by either manufacturing or mineral industries from their privately owned sources or intakes.

(3) Self-supplied electric power generation – Water withdrawn for cooling purposes by electric generating facilities from their privately owned sources or intakes.

(4) Self-supplied agricultural – Water withdrawn by agricultural enterprises from privately owned sources or intakes and used for either irrigation or livestock operations (does not include domestic uses on farms).

(5) Self-supplied institutional – Water withdrawn from privately owned sources or intakes for use by institutions including schools, hospitals, correctional institutions and golf courses.

(6) Self-supplied domestic – Water withdrawn from privately owned sources (usually wells) for domestic use in private residences.

The total water use projections for all six categories of water use in Watersheds A through E and the subbasin totals are listed in Table 20 and Table 21 respectively. The tables list the total and consumptive water uses in 1970 and projected uses for the years 1980 and 1990. The consumptive water use is the summation of consumptive losses and interbasin and/or interwatershed transfer losses. It can be seen from the tables that interbasin transfer losses mainly result from public water supply uses. This is because of the spatial distribution of their sources and discharge points. Interbasin transfers may occur if a water supplier's sources are located in a different watershed than the discharge point of the sewage treatment facilities. The tables list the net effect of interbasin transfers, taking into account both the export and import of water. Under the interbasin transfer column in the tables, a positive figure indicates a loss of water from the watershed or subbasin, whereas a negative figure indicates a gain of water to the watershed or subbasin.

Watershed A is the upper portion of the Clarion River Basin, which includes the drainage area upstream of the confluence between Spring Creek and the Clarion River. It is a rural and residential area with most of the population concentrated in Saint Marys, Johnsonburg, Ridgway and Brockway Boroughs. The East Branch Clarion River Lake with functions of flood control and low flow augmentation is located at the upstream portion of this area. As shown in Table 20 for Watershed A, the total water use in 1970 was about 21.4 mgd, of which about 15.4 mgd was self-supplied industry, 5.5 mgd was public water supply and about 0.5 mgd comprised the remaining categories of water use. The total water use in this area is projected to increase slightly to about 21.5 mgd in 1980 and 22.6 mgd in 1990.

The total consumptive water uses including interbasin and interwatershed transfers was about 1.9 mgd in 1970 and is projected to be about 2.6 mgd in 1980 and 2.7 mgd in 1990.

Watershed B is located at the downstream portion of the Clarion River Basin. It is a rural and mining area with about 30% of the total population in the area concentrated in Clarion Borough and Township. The Piney Hydroelectric Generating Station is also located in the watershed. As shown in Table 20 for Watershed B, the total water use in 1970 was about 3.5 mgd, of which about 1.4 mgd was mineral and manufacturing industry, 1.0 mgd was public water supply and about 1.1 mgd comprised the remaining categories of water use. The total water use in this area is projected to increase to about 4.4 mgd in 1980 and 5.2 mgd in 1990.

The total consumptive water uses including interbasin and interwatershed transfers was about 0.7 mgd in 1970 and is projected to be about 0.8 mgd in 1980 and 0.9 mgd in 1990.

Watershed C includes the entire Redbank Creek Watershed and a stretch of the Allegheny River main stem. It is a rural and residential area with more than 25 percent of its total population in this area concentrated in DuBois City and Brookville Borough. As shown in Table 20 for Watershed C, the total water use in 1970 was about 7.9 mgd of which 3.2 mgd was self-supplied industry, 2.5 mgd was public water supply and about 2.2 mgd comprised the remaining categories of water use. The total water use in this area is projected to increase to 9.1 mgd in 1980 and 45.0 mgd in 1990. The consumptive water use including interwatershed and intersubbasin transfers was about 0.5 mgd in 1970 and is projected to be about 1.1 mgd in 1980 and 16.0 mgd in 1990. From a water supply viewpoint, the total water use and consumptive losses for an as yet unlocated power generating station can best be accommodated in this watershed. Therefore, the 1990 total and consumptive water uses reflect an appropriate increase.

Watershed D includes the entire Mahoning Creek Watershed and a stretch of the Allegheny River main stem. It is a rural and residential area. The Mahoning Creek flood control reservoir is located on Mahoning Creek in this area. The water demands shown in Table 20 for Watershed D indicate that the total 1970 water use in this area was about 2.8 mgd in 1970 of which about 1.1 mgd was public water supply, 0.7 mgd was self-supplied domestic and about 1 mgd comprised the remaining categories of water use. The total water use in this area is projected to increase to about 4.1 mgd in 1980 and about 36.3 mgd in 1990. The consumptive water use including interwatershed and intersubbasin transfers was

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Table 20

WATERSHED WATER USE TOTALS

(Subbasin 17)	1970 Water Use (mgd[a])						1980 Water Use (mgd[a])			1990 Water Use (mgd[a])		
Type Use	Groundwater Withdrawal	Surface Water Withdrawal	Total Withdrawal	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses
Watershed A												
1) Public Water Supply:	0.517	4.905	5.422	5.469	0.547	–0.042	5.949	0.595	–0.046	6.891	0.689	–0.051
2) Self-Supplied Industry												
a) Mineral:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b) Manufacturing:	0.517	14.850	15.367	15.368	1.202	0.000	14.920	1.816	0.000	14.969	1.831	0.000
3) Self-Supplied Power[b]:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4) Self-Supplied Agriculture[c]												
a) Livestock:	0.074	0.001	0.075	0.075	0.056	0.000	0.090	0.068	0.000	0.103	0.077	0.000
b) Irrigation:	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.020	0.000	0.034	0.034	0.000
5) Other Self-Supplied												
a) Golf Course:	0.000	0.060	0.060	0.060	0.060	0.000	0.066	0.066	0.000	0.072	0.072	0.000
b) Institution:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6) Self-Supplied Domestic:	0.383	0.000	0.383	0.383	0.038	0.000	0.453	0.045	0.000	0.554	0.055	0.000
Totals:	1.491	19.816	21.307	21.355	1.903	–0.042	21.498	2.610	–0.046	22.623	2.758	–0.051

[a] mgd: million gallons per day

[b] Power projections are for thermoelectric power generation only and do not include hydroelectric water use. Thermoelectric power generation water withdrawals and total usages reflect plant requirements when operating at design capacity.

[c] Agricultural irrigation and livestock projections are preliminary estimates, not to be used for allocation or other regulation of water use.

Table 20 (Cont.)

WATERSHED WATER USE TOTALS

(Subbasin 17)	1970 Water Use (mgd[a])						1980 Water Use (mgd[a])			1990 Water Use (mgd[a])		
Type Use	Groundwater Withdrawal	Surface Water Withdrawal	Total Withdrawal	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses
Watershed B												
1) Public Water Supply:	0.499	0.508	1.007	0.931	0.093	0.113	1.374	0.137	0.117	1.751	0.175	0.120
2) Self-Supplied Industry												
a) Mineral:	0.170	1.065	1.235	1.235	0.096	0.000	1.543	0.118	0.000	1.853	0.140	0.000
b) Manufacturing:	0.161	0.000	0.161	0.161	0.021	0.000	0.144	0.028	0.000	0.105	0.031	0.000
3) Self-Supplied Power[b]:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4) Self-Supplied Agriculture[c]												
a) Livestock:	0.239	0.005	0.244	0.244	0.183	0.000	0.292	0.219	0.000	0.334	0.250	0.000
b) Irrigation:	0.000	0.011	0.011	0.011	0.011	0.000	0.028	0.028	0.000	0.028	0.028	0.000
5) Other Self-Supplied												
a) Golf Course:	0.044	0.041	0.085	0.085	0.085	0.000	0.094	0.094	0.000	0.102	0.102	0.000
b) Institution:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6) Self-Supplied Domestic:	0.800	0.000	0.800	0.800	0.080	0.000	0.889	0.089	0.000	1.008	0.101	0.000
Totals:	1.913	1.630	3.543	3.467	0.569	0.113	4.364	0.713	0.117	5.181	0.827	0.120

[a]mgd: million gallons per day

[b]Power projections are for thermoelectric power generation only and do not include hydroelectric water use. Thermoelectric power generation water withdrawals and total usages reflect plant requirements when operating at design capacity.

[c]Agricultural irrigation and livestock projections are preliminary estimates, not to be used for allocation or other regulation of water use.

Table 20 (Cont.)

WATERSHED WATER USE TOTALS

(Subbasin 17) Type Use	1970 Water Use (mgd[a]) Groundwater Withdrawal	Surface Water Withdrawal	Total Withdrawal	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	1980 Water Use (mgd[a]) Total Water Use	Consumptive Losses	Interbasin Transfer Losses	1990 Water Use (mgd[a]) Total Water Use	Consumptive Losses	Interbasin Transfer Losses
						Watershed C						
1) Public Water Supply:	0.244	1.222	1.466	2.490	0.249	−1.064	2.742	0.274	−1.149	3.131	0.313	−1.291
2) Self-Supplied Industry												
a) Mineral:	0.015	0.015	0.030	0.030	0.002	0.000	0.038	0.002	0.000	0.046	0.002	0.000
b) Manufacturing:	1.654	1.562	3.216	3.216	0.401	0.000	3.706	0.885	0.000	4.282	1.075	0.000
3) Self-Supplied Power[b]:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	34.580	14.650	0.000
4) Self-Supplied Agriculture[c]												
a) Livestock:	0.479	0.112	0.591	0.591	0.443	0.000	0.760	0.570	0.000	0.877	0.658	0.000
b) Irrigation:	0.000	0.048	0.048	0.048	0.048	0.000	0.116	0.116	0.000	0.116	0.116	0.000
5) Other Self-Supplied												
a) Golf Course:	0.034	0.241	0.275	0.275	0.275	0.000	0.303	0.303	0.000	0.330	0.330	0.000
b) Institution:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6) Self-Supplied Domestic:	1.256	0.000	1.256	1.256	0.126	0.000	1.407	0.141	0.000	1.668	0.167	0.000
Totals:	3.682	3.200	6.882	7.906	1.544	−1.064	9.072	2.291	−1.149	45.030	17.311	−1.291

[a]mgd: million gallons per day

[b]Power projections are for thermoelectric power generation only and do not include hydroelectric water use. Thermoelectric power generation water withdrawals and total usages reflect plant requirements when operating at design capacity.

[c]Agricultural irrigation and livestock projections are preliminary estimates, not to be used for allocation or other regulation of water use.

Table 20 (Cont.)

WATERSHED WATER USE TOTALS

(Subbasin 17)	1970 Water Use (mgd[a])						1980 Water Use (mgd[a])			1990 Water Use (mgd[a])		
Type Use	Groundwater Withdrawal	Surface Water Withdrawal	Total Withdrawal	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses
Watershed D												
1) Public Water Supply:	0.477	0.477	0.954	1.070	0.107	–0.118	1.200	0.120	–0.140	1.413	0.141	–0.166
2) Self-Supplied Industry												
a) Mineral:	0.007	0.006	0.013	0.013	0.002	0.000	0.015	0.003	0.000	0.017	0.003	0.000
b) Manufacturing:	0.058	0.274	0.332	0.332	0.021	0.000	0.698	0.235	0.000	0.709	0.235	0.000
3) Self-Supplied Power[b]:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	31.730	13.440	18.290
4) Self-Supplied Agriculture[c]												
a) Livestock:	0.262	0.111	0.373	0.373	0.280	0.000	0.507	0.380	0.000	0.609	0.457	0.000
b) Irrigation:	0.000	0.286	0.286	0.286	0.286	0.000	0.873	0.873	0.000	0.897	0.897	0.000
5) Other Self-Supplied												
a) Golf Course:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
b) Institution:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6) Self-Supplied Domestic:	0.717	0.000	0.717	0.717	0.072	0.000	0.788	0.079	0.000	0.929	0.093	0.000
Totals:	1.521	1.154	2.675	2.791	0.768	–0.118	4.081	1.690	–0.140	36.304	15.266	18.124

[a]mgd: million gallons per day

[b]Power projections are for thermoelectric power generation only and do not include hydroelectric water use. Thermoelectric power generation water withdrawals and total usages reflect plant requirements when operating at design capacity.

[c]Agricultural irrigation and livestock projections are preliminary estimates, not to be used for allocation or other regulation of water use.

Table 20 (Cont.)

WATERSHED WATER USE TOTALS

(Subbasin 17)	1970 Water Use (mgd[a])						1980 Water Use (mgd[a])			1990 Water Use (mgd[a])		
Type Use	Groundwater Withdrawal	Surface Water Withdrawal	Total Withdrawal	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses
Watershed E												
1) Public Water Supply:	1.143	1.443	2.586	2.586	0.259	0.000	2.657	0.266	-0.006	2.941	0.294	-0.014
2) Self-Supplied Industry												
a) Mineral:	0.002	1.000	1.002	1.002	0.091	0.000	1.240	0.109	0.000	1.478	0.127	0.000
b) Manufacturing:	0.270	75.487	75.757	75.757	5.138	0.000	86.715	5.873	0.000	96.024	6.498	0.000
3) Self-Supplied Power[b]:	0.000	235.200	235.200	235.200	20.160	0.000	235.200	20.160	0.000	235.200	20.160	-18.290
4) Self-Supplied Agriculture[c]												
a) Livestock:	0.336	0.069	0.405	0.405	0.304	0.000	0.534	0.400	0.000	0.624	0.468	0.000
b) Irrigation:	0.000	0.050	0.050	0.050	0.050	0.000	0.854	0.854	0.000	1.312	1.312	0.000
5) Other Self-Supplied												
a) Golf Course:	0.050	0.100	0.150	0.150	0.150	0.000	0.165	0.165	0.000	0.180	0.180	0.000
b) Institution:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6) Self-Supplied Domestic:	1.315	0.000	1.315	1.315	0.132	0.000	1.558	0.156	0.000	2.018	0.202	0.000
Totals:	3.116	313.349	316.465	316.465	26.284	0.000	328.923	27.983	-0.006	339.777	29.241	-18.304

[a] mgd: million gallons per day

[b] Power projections are for thermoelectric power generation only and do not include hydroelectric water use. Thermoelectric power generation water withdrawals and total usages reflect plant requirements when operating at design capacity.

[c] Agricultural irrigation and livestock projections are preliminary estimates, not to be used for allocation or other regulation of water use.

Table 21

SUBBASIN WATER USE TOTALS

(Subbasin 17)	1970 Water Use (mgd[a])						1980 Water Use (mgd[a])			1990 Water Use (mgd[a])		
Type Use	Groundwater Withdrawal	Surface Water Withdrawal	Total Withdrawal	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses	Total Water Use	Consumptive Losses	Interbasin Transfer Losses
1) Public Water Supply:	2.880	8.555	11.435	12.546	1.255	−1.111	13.922	1.392	−1.224	16.127	1.612	−1.402
2) Self-Supplied Industry												
a) Mineral:	0.194	2.086	2.280	2.280	0.191	0.000	2.836	0.232	0.000	3.394	0.272	0.000
b) Manufacturing:	2.660	92.173	94.833	94.834	6.783	0.000	106.183	8.837	0.000	116.089	9.670	0.000
3) Self-Supplied Power[b]:	0.000	235.200	235.200	235.200	20.160	0.000	235.200	20.160	0.000	301.510	48.250	0.000
4) Self-Supplied Agriculture[c]												
a) Livestock:	1.390	0.298	1.688	1.688	1.266	0.000	2.183	1.637	0.000	2.547	1.910	0.000
b) Irrigation:	0.000	0.395	0.395	0.395	0.395	0.000	1.891	1.891	0.000	2.387	2.387	0.000
5) Other Self-Supplied												
a) Golf Course:	0.128	0.442	0.570	0.570	0.570	0.000	0.628	0.628	0.000	0.684	0.684	0.000
b) Institution:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6) Self-Supplied Domestic:	4.471	0.000	4.471	4.471	0.448	0.000	5.095	0.510	0.000	6.177	0.618	0.000
Totals:	11.723	339.149	350.872	351.984	31.068	−1.111	367.938	35.287	−1.224	448.915	65.403	−1.402

[a]mgd: million gallons per day

[b]Power projections are for thermoelectric power generation only and do not include hydroelectric water use. Thermoelectric power generation water withdrawals and total usages reflect plant requirements when operating at design capacity.

[c]Agricultural irrigation and livestock projections are preliminary estimates, not to be used for allocation or other regulation of water use.

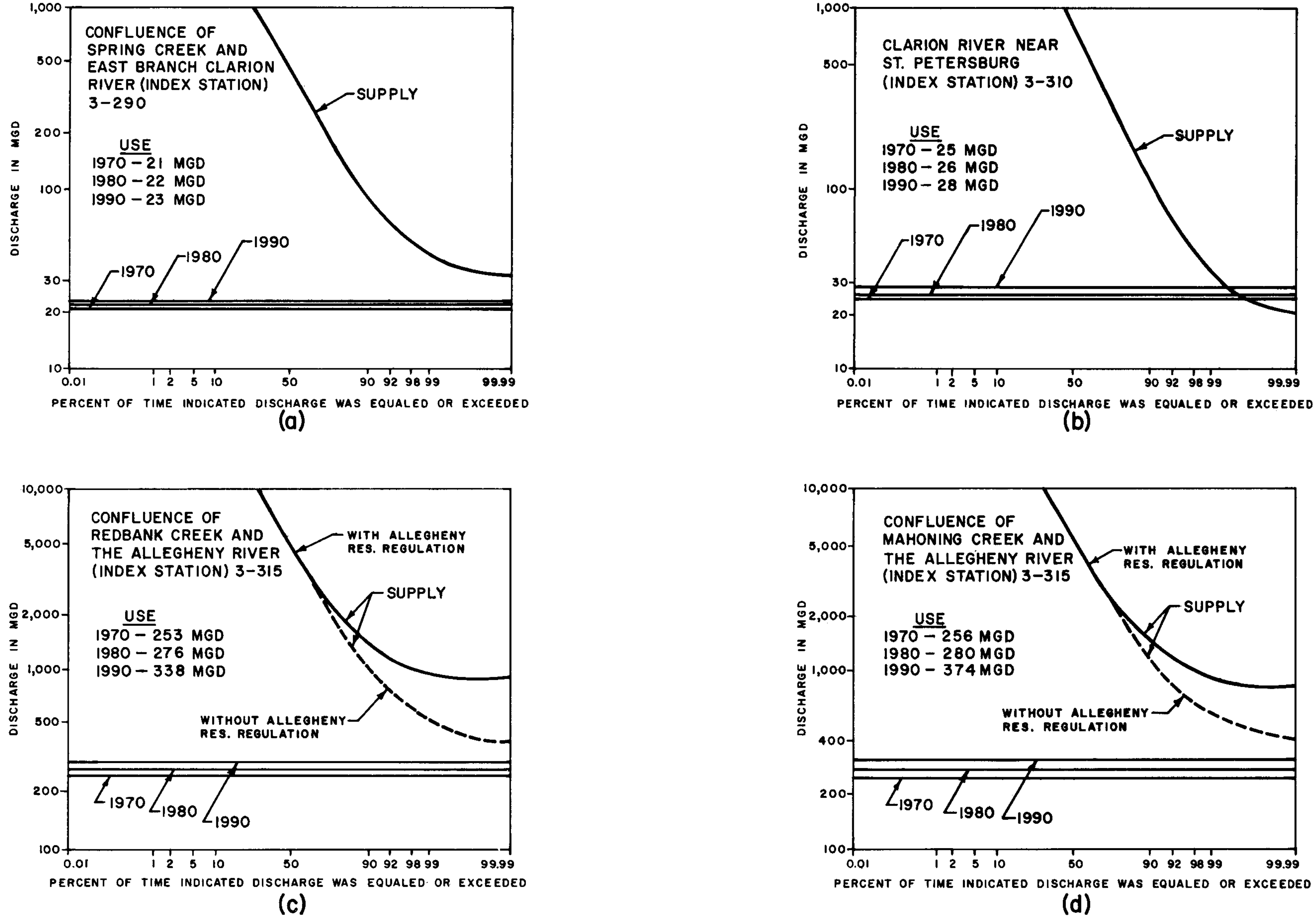

FIGURE 8. Comparisons of Supply and Use for Selected Drainage Areas

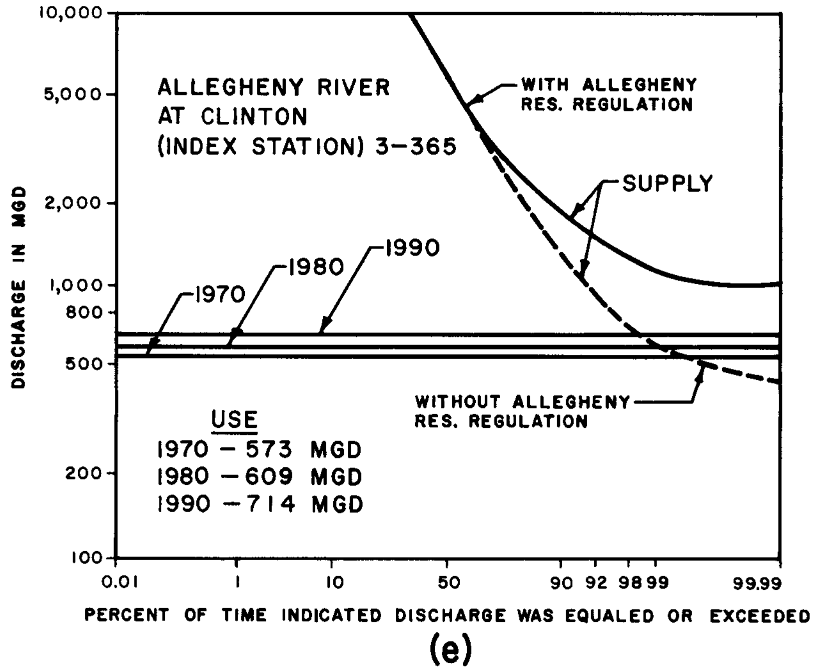

FIGURE 8. Comparisons of Supply and Use for Selected Drainage Areas (Continued)

0.7 mgd in 1970 and is projected to be 1.6 mgd in 1980 and 33.4 mgd in 1990. The sharp increase in 1990 water use and consumptive use is mainly due to the proposed Lower Armstrong Electric Generating Station and will gradually be brought into operation between 1983 to 1985 in the watershed.

Watershed E is located at the most downstream portion of the subbasin from the confluence of the Allegheny River with Mahoning Creek to the confluence of the Allegheny River with Taylor Creek. As shown in Table 20 for Watershed E, the total water use in 1970 was about 316 mgd, of which approximately 235 mgd was self-supplied power cooling used by the Armstrong Power Station on the Allegheny River and the Keystone Generating Station on Crooked Creek, about 77 mgd was self-supplied manufacturing and mineral industry and about 4 mgd comprised the remaining categories of water use. The total water use in this area is projected to increase to about 329 mgd in 1980 and 340 mgd in 1990. The total consumptive water use including interbasin and interwatershed transfers was about 26.2 mgd in 1970 and is projected to be about 28.0 mgd in 1980 and 10.9 mgd in 1990.

The total water use and consumptive water uses in the subbasin as shown in Table 21 were respectively about 352 mgd and 30 mgd in 1970. They are projected to be 368 mgd and 34.0 mgd respectively in 1980 and 449 mgd and 64.0 mgd in 1990. The abrupt increase in water demand and consumptive water use in 1990 is due to two proposed power generating stations which will be in operation by 1990.

b. *Use Intensity*

Figure 8 shows a comparison of total supply and total use at three gaging station locations in Subbasin 17. The supply is represented by a daily duration curve, which indicates the streamflow which is equalled or exceeded for any given percentage of time. These curves indicate not only the total flows available, but by their slopes also indicate the reliability of the flows. A flat duration curve would indicate a stream with very steady flows; whereas a steep duration curve applies to a flashy stream on which flows are exceptionally high during periods of rainfall but recede quickly as the weather clears. The ultimate example of a flashy stream would be an erosion gully in a field, which is dry most of the time and sustains flows only during a rain. Exceptionally steady streamflows occur in limestone areas where rainfall infiltrates to the groundwater rather than contributing heavily to runoff and where underground storage contributes heavily to streamflows during dry conditions, thus maintaining higher low flows. Streams draining larger areas also tend to have flatter duration curves because the effects of localized heavy rain or drought conditions are minimized by flows originating in other areas of the drainage basin.

By overlaying the line representing total water use above a selected location upon the graph of the duration curve for that location, it is possible to compare the supply and its reliability against the total use. Although this comparison is of limited hydrologic value, it does provide a visual indication of the intensity of water use upstream of the selected location or the probability for water reuse to occur.

Reuse occurs when water returned to the stream by upstream users is used again by downstream users. The probability of this occurring is indicated by the percentage of time that total water use exceeds flow, as shown on the duration curve. An important consideration regarding reuse is potential degradation of water quality. Although many other factors affect water quality more directly, intensive use usually results in some degree of water quality degradation. Because the potential for degradation increases with reuse, effective water quality management becomes increasingly important with reuse to protect not only the stream itself, including instream uses, but also the downstream users. As shown in Figure 8, the use intensities are very low in this subbasin. The flow of the Clarion River near St. Petersburg exceeds the projected 1990 total water use upstream of St. Petersburg 99.5 percent of the time. The flows of the Allegheny River at East Brady, Mahoning and Clinton, exceed even the projected 1990 total water uses upstream of those locations all the time. The low intensity use of those rivers is reflective of their natural scenic and recreational values. This also implies that more water resources development is possible in the subbasin provided that such development is environmentally acceptable. A proposed electric generating station may be located along the Allegheny River in Watershed C.

It should be noted that as shown in Figure 8 (c), (d) and (e) the higher low flow along the Allegheny River main stem is mainly contributed by low flow augmentations from the Allegheny River Reservoir for navigation and the improvement of water quality in the Allegheny River.

2. PUBLIC WATER SUPPLY

a. *Problems*

Because public water supply is more complex than other water use categories, involving larger service areas and populations, public water supplier problems have been studied individually. Dependable yields have been estimated for all existing sources, including stream withdrawals, reservoirs, wells, and springs located in or nearby the subbasin. These estimates are based on information contained in the reports B-12 "Low Flow Characteristics of Pennsylvania Streams",[21] B-7 "Long Duration Low Flow",[22] and "Planning Criteria for Determination of the Adequacy of Water Supply Sources"[23]. Projected uses for individual water suppliers were determined using projections of population and daily

(Continued on page 53)

[21]L. V. Page and L. C. Shaw, *Water Resources Bulletin No. 12, Low Flow Characteristics of Pennsylvania Streams,* (Pennsylvania Department of Environmental Resources, 1977).

[22]Department of Environmental Resources, *Water Resources Bulletin No. 7, Long-Duration Low Flow of Pennsylvania Streams,* (December 1972).

[23]Department of Environmental Resources, *Planning Principles, SWP-1,* (March 1975), Appendix A-2.

Table 22

PUBLIC WATER SUPPLY STATISTICS

Legend (See Figure 9)	Water Supplier	Estimated Population Served (1970)	Total System GPCD[a] (1970)	Residential GPCD (1970)	Average Daily Water Use (mgd[b]) 1970	1990	2020	Existing Sources	Yield (mgd)
	Watershed A								
1	Wilcox Water Company, Incorporated	605	39	34	.023	.041	.067	2 wells, 5 springs	.147
2	Johnsonburg Municipal Authority	4,304	95	29	.410	.807	1.215	5 wells, Powers Run Dam, Silver Creek Dam	1.70
3	Ridgway Borough Water Works	6,976	270	43	1.882	1.697	2.293	H. B. Norton Dam on Big Mill Creek	4.190
4	St. Marys Area Joint Water Authority	12,951	180	40	2.324	3.020	4.108	Laurel Run Reservoir	4.581
5	Municipal Authority Township of Fox	298	55	55	.016	.039	.070	Toby Valley Water Dam on Lost Run	.032
6	Fox Homes Improvement Association	521	59	59	.030	.062	.097	2 springs, 1 well	.247
7	Brockway Borough Municipal Authority	3,858	187	39	.737	.899	1.220	Reservoirs on Rattlesnake and Whetstone Runs, 2 wells	1.233
8	Brockport Area Water Association	279	50	43	.014	.018	.033	Purchase-Brockway Borough Municipal Authority	
	Watershed B								
9	Knox Borough Water	1,306	77	45	.099	.137	.187	7 wells	.750
10	Shippenville Municipal Water Works	641	75	53	.047	.073	.107	3 wells	.190
11	Corner Water Supply and Service Corporation	522	84	51	.044	.148	.212	2 wells, 2 standby wells	.400
12	WPWC-Clarion District	7,759	73	15	.565	1.550	2.194	1 well, Clarion River	14.532
13	St. Petersburg Water Authority	461	73	66	.033	.043	.072	2 springs	.040
14	Foxburg Area Water and Sewer Authority	380	61	7	.023	.026	.037	3 wells	.108
15	Sligo Borough Water Department	825	73	62	.060	.078	.125	1 well	.100
16	Clarion Township General Authority	0	0		.000	.033	.084	Purchase-WPWC Clarion	

[a]GPCD: Gallons per capita per day
[b]mgd: Million gallons per day
N/A: Not applicable

Yield Deficiency (mgd) 1970	Yield Deficiency (mgd) 1990	Yield Deficiency (mgd) 2020	Total Water Allocation (mgd)	Allocation Deficiency (mgd) 1970	Allocation Deficiency (mgd) 1990	Allocation Deficiency (mgd) 2020	Treated/Total Water Storage (mg)	Treated Filtration Storage Plant Capacity Deficiency (mg) 1970	Treated Filtration Storage Plant Capacity Deficiency (mg) 1990	Treated Filtration Storage Plant Capacity Deficiency (mg) 2020	Filtration Plant Capacity (mgd)	Deficiency (mgd) 1970	Deficiency (mgd) 1990	Deficiency (mgd) 2020
0	0	0	N/A	N/A	N/A	N/A	.070/.070	0	0	0	N/A	N/A	N/A	N/A
0	0	0	1.20	0	0	.230	1.20/8.40	0	0	.015	1.0	0	.735	1.717
0	0	0	N/A	N/A	N/A	N/A	2.4/274.4	0	0	0	3.46	0	0	0
0	0	0	N/A	N/A	N/A	N/A	3.18/873.18	0	0	.928	N/A	N/A	N/A	N/A
0	.007	.038	.030	.002	.048	.110	0/.50	.016	.039	.070	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.095/.235	0	0	.002	N/A	N/A	N/A	N/A
0	0	0	.200	0	.137	.670	1.15/45.15	0	0	.070	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.135/.135	0	.002	.052	.200	.110	.245	.408
0	0	0	N/A	N/A	N/A	N/A	.275/.275	0	0	0	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.646/.646	0	0	0	.110	0	.084	.178
0	0	0	2.0	0	0	1.737	1.28/1.28	0	.270	.914	1.00	0	1.945	3.169
0	.003	.032	N/A	N/A	N/A	N/A	.150/6.05	0	0	0	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.50/.50	0	0	0	N/A	N/A	N/A	N/A
.010	.046	.140	N/A	N/A	N/A	N/A	.110/.110	0	0	.015	N/A	N/A	N/A	N/A

Table 22

PUBLIC WATER SUPPLY STATISTICS

Legend (See Figure 9)	Water Supplier	Estimated Population Served (1970)	Total System GPCD[a] (1970)	Residential GPCD (1970)	Average Daily Water Use (mgd[b]) 1970	1990	2020	Existing Sources	Yield (mgd)
	Watershed C								
17	Corsica, Rose and Union Muncipal Authority	591	45	35	.026	.047	.112	Purchase-Brookville Borough Water Department	
18	Brookville Borough Water Department	4,814	105	34	.530	.690	1.067	Brookville Water Supply Dam on N. F. Redbank Creek	2.293
19	Falls Creek Borough Water Department	1,286	133	106	.170	.213	.283	Reservoirs on Falls Creek	.840
20	Peoples Water Company	816	42	34	.034	.032	.048	2 springs, 2 wells	.021
21	Perryville Water Association	133	47	47	.006	.012	.021	3 springs	.022
22	Parker City Municipal Authority	843	121	61	.102	.121	.148	Allegheny River	310.0
23	Rimersburg Water Works	1,352	53	48	.072	.103	.132	2 wells	.310
24	Knoxdale Water Company	152	54	54	.008	.013	.031	1 well	.043
25	Reynoldsville Water Authority	2,871	60	29	.172	.233	.373	4 springs, 4 wells, 5 reservoirs on North and East Branches of Pitchpine Run	.348
26	Brady Township-Troutville Borough Water Association	0	0		.000	.061	.092	2 wells	.288
27	Petrolia Water Company	465	50	43	.023	.032	.049	1 well, emergency supply from Witco and Koppers	.043
28	East Brady Water Works Company	1,181	44	41	.051	.068	.103	1 well, 1 spring	.668
29	Redbank Valley Municipal Authority	2,342	121	41	.317	.344	.439	Redbank Creek	14.29
30	Hawthorn Area Water Authority	832	64	35	.053	.091	.108	Redbank Creek	13.26
31	DuBois Water Department	13,038	98	33	1.395	3.726	6.799	Reservoir on Anderson Creek	4.88
	Watershed D								
32	Borough of Sykesville Water Department	1,210	100	88	.121	.195	.195	Purchase-DuBois Water Department	
33	Helvetia Water Company	154	65	65	.010	.007	.009	2 wells	.043
34	Village of Stump Creek	121	61	61	.007	.016	.035	1 well	.072
35	Mahoning Township Municipal Authority	459	76	55	.034	.038	.042	Purchase-Redbank Valley Municipal Authority	
36	Seminole Water Co-Op	187	58	58	.010	.011	.012	2 springs, 2 wells	.030
37	WPWC-Punxsutawney District	9,514	86	30	.816	1.052	1.537	3 wells, Reservoir on Clover Run, East Branch Mahoning Creek	3.09
38	Dayton Borough Water Department	742	86	72	.063	.082	.099	2 wells	.170
39	Rossiter Water Company	618	60	54	.036	.063	.129	Reservoir on Straight Branch Run	.296

[a]GPCD: Gallons per capita per day
[b]mgd: Million gallons per day
N/A: Not applicable

Yield Deficiency (mgd) 1970	Yield Deficiency (mgd) 1990	Yield Deficiency (mgd) 2020	Total Water Allocation (mgd)	Allocation Deficiency (mgd) 1970	Allocation Deficiency (mgd) 1990	Allocation Deficiency (mgd) 2020	Treated/Total Water Storage (mg)	Treated Storage Deficiency (mg) 1970	Treated Storage Deficiency (mg) 1990	Treated Storage Deficiency (mg) 2020	Filtration Plant Capacity (mgd)	Filtration Plant Capacity Deficiency (mgd) 1970	Filtration Plant Capacity Deficiency (mgd) 1990	Filtration Plant Capacity Deficiency (mgd) 2020
0	0	0	1.50	0	0	.207	2.75/19.75	0	0	0	1.55	0	0	0
0	0	0	N/A	N/A	N/A	N/A	.25/8.75	0	0	.033	.504	0	0	0
.022	.011	.059	N/A	N/A	N/A	N/A	.220/.230	0	0	0	N/A	N/A	N/A	N/A
0	.007	.028	N/A	N/A	N/A	N/A	.008/.008	0	.004	.013	N/A	N/A	N/A	N/A
0	0	0	.250	0	0	0	.154/.154	0	0	0	.432	0	0	0
0	0	.005	N/A	N/A	N/A	N/A	.100/.100	0	.003	.032	N/A	N/A	N/A	N/A
0	0	.004	N/A	N/A	N/A	N/A	.014/.014	0	0	.017	N/A	N/A	N/A	N/A
0	0	.025	N/A	N/A	N/A	N/A	.447/22.447	0	0	0	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.125/.125	0	0	0	N/A	N/A	N/A	N/A
.012	.034	.075	N/A	N/A	N/A	N/A	0/0	.023	.032	.049	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.164/.164	0	0	0	.200	0	0	0
0	0	0	.500	.007	.050	.202	.315/15.315	.002	.029	.124	.700	0	0	.002
0	0	0	.216	0	0	0	.150/.150	0	0	0	.200	0	0	0
0	0	1.919	N/A	N/A	N/A	N/A	4.0/619.0	0	0	2.799	4.0	0	3.266	11.978
0	0	0	N/A	N/A	N/A	N/A	.015/.015	0	0	0	N/A	N/A	N/A	N/A
0	0	.012	N/A	N/A	N/A	N/A	0/0	.007	.016	.035	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.010/.010	0	.001	.002	N/A	N/A	N/A	N/A
0	0	0	1.10	0	0	0	2.076/32.076	0	0	0	1.330	0	.334	1.208
0	0	0	N/A	N/A	N/A	N/A	.065/.065	0	.017	.034	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.150/11.150	0	0	0	.180	0	0	.074

Table 22

PUBLIC WATER SUPPLY STATISTICS

Legend (See Figure 9)	Water Supplier	Estimated Population Served (1970)	Total System GPCD[a] (1970)	Residential GPCD (1970)	Average Daily Water Use (mgd[b]) 1970	1990	2020	Existing Sources	Yield (mgd)
	Watershed E								
40	Templeton Water Company	591	60	54	.035	.037	.044	3 wells	.268
41	Kittanning Sub. Joint Water Authority	1,357	45	43	.061	.190	.504	Purchase-WPWC Kittanning District	
42	West Kittanning Municipal Authority	1,076	167	100	.180	.219	.282	Purchase-Applewold Water Authority	
43	WPWC-Kittanning District	7,336	143	63	1.360	1.659	2.354	Allegheny River	407.0
44	Applewold Water Authority	515	144	83	.074	.057	.070	Purchase-WPWC Kittanning District	
45	Manor Township Joint Municipal Authority	3,692	49	33	.180	.320	.506	3 wells	.760
46	Cowanshannock Water Company-Yatesboro	480	63	63	.030	.032	.046	2 wells	.040
47	Rural Valley Water Company	962	48	30	.046	.061	.097	2 wells	.058
48	Cowanshannock Water Company-Numine	215	55	55	.011	.012	.018	1 well	.012
49	Cowanshannock Water Company-Margaret	63	79	79	.005	.005	.007	1 well	.004
50	Cowanshannock Water Company-Sagamore	505	57	57	.028	.031	.045	4 wells	.115
51	Cadogan Water District	563	60	60	.033	.052	.076	Allegheny River	417.0
52	Ford City Municipal Water Works	4,749	160	112	.761	.900	.996	2 wells	2.20
53	Eastern Armstrong County Municipal Authority	549	47	22	.025	.039	.053	2 wells	.118
54	Creekside Water Company	348	60	60	.020	.043	.064	9 springs, 1 well	.080
55a	Indiana County Municipal Services Authority-Ernest	723	69	69	.050	.084	.140	McKees Run	.158
55b	Indiana County Municipal Services Authority-Fulton Run	88	31	31	.002	.001	.002	Fulton Run Spring	.010

[a]GPCD: Gallons per capita per day
[b]mgd: Million gallons per day
N/A: Not applicable

Yield Deficiency (mgd) 1970	1990	2020	Total Water Allocation (mgd)	Allocation Deficiency (mgd) 1970	1990	2020	Treated/Total Water Storage (mg)	Treated Storage Deficiency (mg) 1970	1990	2020	Filtration Plant Capacity (mgd)	Filtration Plant Capacity Deficiency (mgd) 1970	1990	2020
0	0	0	N/A	N/A	N/A	N/A	.066/.066	0	0	0	N/A	N/A	N/A	N/A
0	0	0	3.0	0	0	.531	.888/.888	.472	.771	1.466	3.0	0	0	.531
0	0	0	N/A	N/A	N/A	N/A	.670/.670	0	0	0	N/A	N/A	N/A	N/A
.030	.036	.070	N/A	N/A	N/A	N/A	.040/.040	0	0	.006	N/A	N/A	N/A	N/A
.038	.076	.170	N/A	N/A	N/A	N/A	.120/.120	0	0	0	N/A	N/A	N/A	N/A
.010	.013	.030	N/A	N/A	N/A	N/A	.020/.040	0	0	0	N/A	N/A	N/A	N/A
.005	.005	.010	N/A	N/A	N/A	N/A	.020/.020	0	0	0	N/A	N/A	N/A	N/A
0	0	0	N/A	N/A	N/A	N/A	.160/.160	0	0	0	N/A	N/A	N/A	N/A
0	0	0	0	.066	.104	.152	.075/.075	0	0	.001	.065	0	.037	.087
0	0	0	N/A	N/A	N/A	N/A	1.535/1.535	0	0	0	3.0	0	0	0
0	0	.009	N/A	N/A	N/A	N/A	.050/.050	0	0	.003	N/A	N/A	N/A	N/A
0	0	.033	N/A	N/A	N/A	N/A	.286/.286	0	0	0	N/A	N/A	N/A	N/A
0	0	0	.090	0	.019	.092	.027/1.027	.023	.057	.113	.050	.015	.059	.132
0	0	0	N/A	N/A	N/A	N/A	.005/.005	0	0	0	N/A	N/A	N/A	N/A

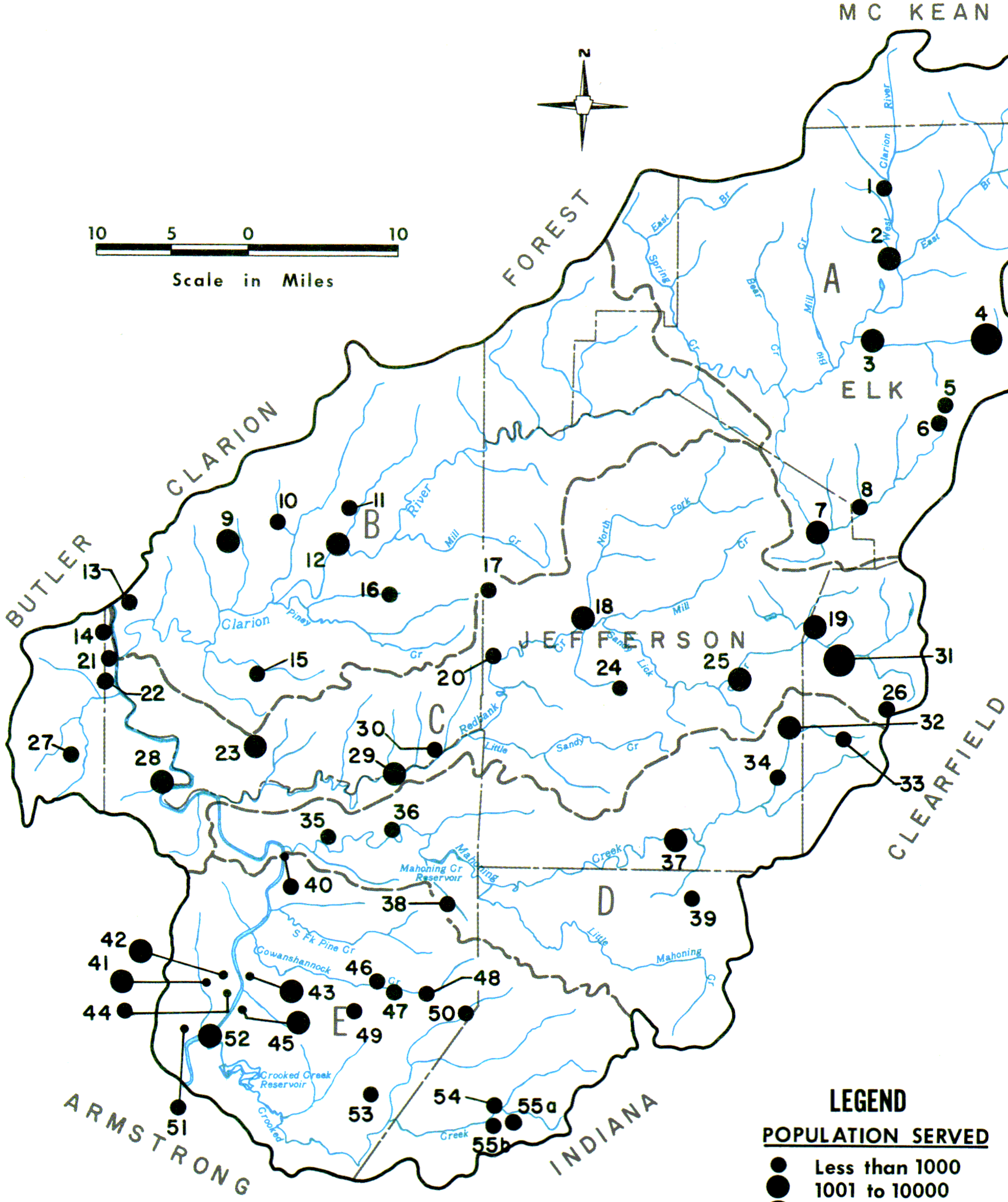

FIGURE 9. Location and Size of Public Water Suppliers

per capita uses. These projection methods are described in "Planning Principles". Finally, each water supplier which has its own sources was analyzed to identify existing or possible future yield, storage and, where applicable, allocation or filtration plant deficiencies.

A yield deficiency was identified when the required daily withdrawal (determined considering peak and average daily water use as well as total raw and treated water storage) exceeds the safe yield of all combined surface and groundwater sources of a particular supplier. Because safe yield is based upon long term drought conditions, a yield deficiency indicates a supplier's inability to provide for normal uses during the occurrence of a major drought.

A storage deficiency was identified when the average daily water use exceeds the total available treated storage. Treated water storage equal to one day's normal use is a minimum public safeguard in case of electrical or mechanical failures or in case of temporary pollution of the source.

A deficiency in filtration capacity was identified when the required daily withdrawal (determined from peak and average daily water use in addition to treated water storage) exceeds total filtration capacity. This indicates that the supplier cannot treat water at a rate equal to which it is being used. A deficiency in filtration plant capacity will, therefore, affect water use on a continuous, daily basis.

All public water suppliers using stream withdrawals as supply sources are required to obtain a water allocation permit from DER, which specifies a maximum allowable daily withdrawal from that surface source. An allocation deficiency was identified when the peak daily water use exceeds the allocation permit and indicates that the supplier cannot legally withdraw water at a rate equal to which it would be used on a peak use day.

It is important to recognize that a water supplier may face many other types of problems. Water quality problems may affect sources and have led to the failure of some suppliers in the past. Many water suppliers, particularly smaller suppliers (generally less than 1,000 connections) with limited revenues, are plagued with deteriorating systems, resulting in wasteful leakage and frequent service interruptions. Institutional problems of public water suppliers are discussed in the State Water Plan document "Water Laws and Institutional Arrangements".

Sixty public water suppliers are associated with Subbasin 17. Out of these, 56 water suppliers are listed in Table 22 and shown on Figure 9 as having most of their service areas and discharge points within the subbasin. Public water suppliers appear in the watershed in which the greatest portion of their customers is served. The remaining four water suppliers, the Western Pennsylvania Water Company - Kane and Mt. Jewett Districts, Marienville Water Supply Company and West Lebanon Water Association have minor portions of their service areas in this subbasin. The detailed information concerning the first three suppliers and the last supplier are presented in the summary reports of Subbasin 16 and 18 respectively.

Table 22 shows existing sources and existing and future deficiencies for the 48 water suppliers which have their own sources of supply. Suppliers which purchase 100 percent of their water from another supplier are not analyzed. Their existing and projected uses are considered as part of that other supplier's uses. Only fourteen water suppliers show no deficiencies to the year 2020 in dependable yield, water allocation, storage, and filtration plant capacity. The other water suppliers show a deficiency at present or in the future in one or more of the items examined. Seven water suppliers have an immediate yield problem affecting about 4,000 people in their service areas. As shown in Table 22 and Figure 9, ten suppliers are projected to have yield deficiencies affecting 5,300 people by 1990, and by 2020, 17 suppliers serving a total of 66,700 people will fall into this category.

Currently, three suppliers have allocation deficiencies totalling 0.08 mgd. According to projections, five suppliers will have allocation deficiencies totalling 0.36 mgd. by 1990, and by 2020 nine suppliers will have deficiencies totalling 3.93 mgd.

Six water suppliers have immediate storage deficiencies totalling 0.54 mg. Twelve water suppliers will have deficiencies of 1.74 mg by 1990, and by 2020 storage deficiencies of 23 suppliers will total 6.82 mg.

Currently, two suppliers, the Knox Borough Water and the Indiana County Municipal Services Authority-Ernest, have filtration deficiencies totalling 0.125 mgd. By 1990, eight suppliers will have filtration deficiencies of 6.71 mgd and by 2020 eleven suppliers will have a combined filtration plant deficit of 19.50 mgd.

b. *Solution Alternatives*

Public water supply deficiencies may be overcome or relieved by either improved management of existing resources or, when necessary, new development. Pennsylvania's past enjoyment of abundant and dependable supplies of water has instilled in the public's mind an epicurean-like philosophy of convenience through wasteful water use without due regard to either environmental or in some cases social or economic effects. As increasing societal pressures on water supplies approach the limits of this finite resource, many Commonwealth water users will begin to realize the importance of water conservation practices. The costs to society, both monetary and environmental, of continued unnecessary or questionable development of water resources are becoming more difficult to bear as time passes. Until recently, many water conservation practices have been viewed as measures to be used only in emergency situations - during a drought, or while mechanical failures or floods or other natural events may temporarily shut down water supply systems either wholly or partially. Concerns other than convenience are now beginning to alter society's attitudes toward wanton abuse of the environment; as a result, resource conservation must be considered as the primary means of solving existing problems and avoiding future ones. Only when conservation has been utilized to the maximum extent practicable should further development of the resource be considered justified.

(Continued on page 68)

Table 23

PUBLIC WATER SUPPLY SOLUTION ALTERNATIVES

Public Water Supplier Map Legend – (DER Code)	Existing Source and Projected Deficiencies[a]	Solution Alternatives[b]
Johnsonburg Municipal Authority 2 – (24801101)	5 wells, Powers Run and Silver Creek	**1) Industrial conservation should be used to completely eliminate the storage deficiency and to partially reduce the remaining deficiencies**
	2020 AD = 0.230*	
	2020 SD = 0.015	**2) Increase treated storage**
	1990 FPD = 0.735 2020 FPD = 1.717	**3) Expand the existing filtration plant to meet the 1990 deficiency and build a new filtration plant to meet the 2020 deficiency**
St. Marys Area Joint Water Authority 4 – (24803101)	Laurel Run Reservoir	**1) Industrial conservation should be used to partially reduce the storage deficiency**
	2020 SD = 0.928	**2) Increase treated storage**
Municipal Authority of Fox Township 5 – (24906101)	Toby Valley Dam on Lost Run	**1) Residential conservation should be used to partially reduce deficiencies**
	1990 YD = 0.007	**2) Metering**
	2020 YD = 0.038	**3) Well development in the Allegheny Group**
	1990 AD = 0.048* 2020 AD = 0.110*	
	1990 SD = 0.039 2020 SD = 0.070	**4) Increase treated storage**
Fox Homes Improvement Association 6 – (24906102)	2 springs & 1 well	**1) Residential conservation should be used to eliminate the storage deficiency**
	2020 SD = 0.002	**2) Increase treated storage**
Brockway Borough Municipal Authority 7 – (33801101)	Brockway Reservoir on Rattlesnake Creek, reservoirs on Whetstone Run, and 2 wells	**1) Industrial conservation should be used to completely eliminate the storage deficiency and to partially reduce the allocation deficiency**
	1990 AD = 0.137* 2020 AD = 0.670*	
	2020 SD = 0.070	**2) Increase treated storage**
Knox Borough Water 9 – (16913101)	7 wells	
	1990 SD = 0.002 2020 SD = 0.052	**1) Increase treated storage**
	1990 FPD = 0.245 2020 PFD = 0.408	**2) Expand existing filtration plant in 1990; construct a new filtration plant in 2020**

[a]Includes the following quantitative deficiencies only: YD - Yield deficiency (million gallons per day); SD - Storage deficiency (million gallons); FPD - Filtration plant deficiency (million gallons per day); AD - Allocation deficiency (million gallons per day).

[b]Storage alternatives apply to storage deficiencies only and are supplement to yield, allocation and filtration solution alternatives. **Boldface** indicates recommended or preferred.

1990		2020		
Increased Capacity Requirement	Annual Cost ($1,000)[c]	Increased Capacity Requirement	Annual Cost ($1,000)[c]	Remarks
				*Streamflow is inadequate for increased allocation
		.015	1.44	3) The short-term (1990) cost is for expanding the existing filtration plant. The 2020 design capacity includes that of the 1990 design capacity; however, the long-term (2020) cost is for building a new .982 mgd capacity filtration plant.
.735	18.1	1.717	43.0	
		.928	15.96	
56%	1.60	18%	2.20	2) Would reduce the 1990 & 2020 yield deficiencies by 56% and 18% respectively 3) Coal resource area and mine drainage – Water may need treatment
.046	2.10	.046	2.10	* Inadequate yield for increased allocation
		.070	3.54	
		.002	.443	
				* Inadequate yield for increased allocation
		.070	3.54	
.002	.40	.052	3.00	2) The short-term (1990) cost is for expanding the existing filtration plant. The long-term cost is for constructing a new filtration plant with a .163 mgd capacity
.245	10.3	.408	13.9	

[c]Annual costs (1976 price level) are planning guidelines only, not to be used for project budgeting or design. Where alternatives include development of both source and treatment facilities, costs for treatment facilities are listed separately and are in addition to source development costs.

Note: The 2020 design capacity includes the 1990 design capacity, and long-term annual costs include the short-term annual costs unless otherwise noted in the remarks.

Table 23 (Cont.)

PUBLIC WATER SUPPLY SOLUTION ALTERNATIVES

Public Water Supplier Map Legend – (DER Code)	Existing Source and Projected Deficiencies[a]	Solution Alternatives[b]
Corner Water Supply & Service Corporation 11 – (16921101)	2 wells and 2 standby wells 1990 FPD = 0.084 2020 FPD = 0.178	**1) Residential conservation should be used to partially reduce the filtration deficiency** **2) Expand the existing filtration plant**
Western Pennsylvania Water Company – Clarion District 12 – (16801101)	Clarion River and 1 well 2020 AD = 1.737 1990 SD = 0.27 2020 SD = 0.914 1990 FPD = 1.945 2020 FPD = 3.169	**1) Increase the allocation at Clarion River** **2) Increase treated storage** **3) Build a new filtration plant**
St. Petersburg Borough Water Department 13 – (16931101)	2 springs 1990 YD = 0.003 2020 YD = 0.032	**1) Residential conservation should be used to completely eliminate the 1990 yield deficiency and to partially reduce the 2020 yield deficiency** **2) Well development in the Allegheny Group with filtration**
Sligo Borough Water Department 15 – (16930101)	1 well 1990 YD = 0.046 2020 YD = 0.140 2020 SD = 0.015	**1) Residential conservation should be used to partially reduce the following deficiencies** 2) Stream withdrawal from Licking Creek with filtration **3) Additional groundwater development in the Pottsville Group with filtration** **4) Increase treated storage**
Brookville Borough Water Department 18 – (33802101)	North Fork of Redbank Creek 2020 AD = 0.207	**1) Reduction of leakage & losses** **2) Increased allocation from existing source**
Falls Creek Borough Water Department 19 – (33912101)	Reservoir on on Falls Creek 2020 SD = 0.033	**1) Residential conservation should be used to completely eliminate the storage deficiency** **2) Increase treated storage**
Peoples Water Company 20 – (33926101)	2 wells & 2 springs 1990 YD = 0.011 2020 YD = 0.059	1) Stream withdrawal from Welch Run with filtration **2) Additional well development in the Allegheny Group with filtration**

[a]Includes the following quantitative deficiencies only: YD - Yield deficiency (million gallons per day); SD - Storage deficiency (million gallons); FPD - Filtration plant deficiency (million gallons per day); AD - Allocation deficiency (million gallons per day).

[b]Storage alternatives apply to storage deficiencies only and are supplement to yield, allocation and filtration solution alternatives. **Boldface** indicates recommended or preferred.

1990 Increased Capacity Requirement	1990 Annual Cost ($1,000)[c]	2020 Increased Capacity Requirement	2020 Annual Cost ($1,000)[c]	Remarks
.084	4.15	.178	9.1	
		1.737		
.270	7.77	.914	15.8	
1.945	156.4	3.169	214.7	
				2) Cost includes a 0.1 mgd capacity filtration plant
.046	12.24	.046	12.24	
				2) Stream withdrawal creates a CUM need of .014 mgd in 2020
.046	25.7	.140	32.0	
.072	12.4	.140	16.9	
		.015	1.44	
				1) Estimated 29% of the total water uses are leakage & losses
		.207		
		.033	2.3	
				1) Cost includes a 0.1 mgd capacity filtration plant
.011	26.9	.059	27.0	2) Coal resource area. Cost
.046	12.24	.059	12.8	includes a 0.1 mgd capacity filtration plant

[c]Annual costs (1976 price level) are planning guidelines only, not to be used for project budgeting or design. Where alternatives include development of both source and treatment facilities, costs for treatment facilities are listed separately and are in addition to source development costs.

Note: The 2020 design capacity includes the 1990 design capacity, and long-term annual costs include the short-term annual costs unless otherwise noted in the remarks.

Table 23 (Cont.)

PUBLIC WATER SUPPLY SOLUTION ALTERNATIVES

Public Water Supplier Map Legend – (DER Code)	Existing Source and Projected Deficiencies[a]	Solution Alternatives[b]
Perryville Water Association 21 – (16922101)	3 springs	
	1990 YD = 0.007	**1) Metering**
	2020 YD = 0.028	2) Purchase water from Parker City Municipal Authority (03928101)
		3) Well development in the Pocono Group
	1990 SD = 0.004	**4) Increase treated storage**
	2020 SD = 0.013	
Rimersburg Water Works 23 – (16927101)	2 wells	
	2020 YD = 0.005	**1) Well development with filtration in the Allegheny Group**
	1990 SD = 0.003	**2) Increase treated storage**
	2020 SD = 0.032	
Knoxdale Water Company 24 – (33916101)	1 well	**1) Residential conservation should be used to completely eliminate the yield deficiency and to partially reduce the storage deficiency**
	2020 YD = 0.004	**2) Metering**
		3) Additional well development in the Allegheny Group
	2020 SD = 0.017	**4) Increase treated storage**
Reynoldsville Water Authority 25 – (33804101)	2 Reservoirs on the North Branch of Pitchpine Run, 3 Reservoirs on the East Branch of Pitchpine Run, 4 springs and 4 wells	
	2020 YD = 0.025	1) Stream withdrawal from Sandy Lick Creek with filtration
		2) Stream withdrawal from Soldier Run with filtration
		3) Groundwater development in the Pottsville Group
Petrolia Water Company 27 – (10944101)	1 well, Emergency Supply from Witco	
	1990 YD = 0.034	**1) Metering**
	2020 YD = 0.075	2) Stream withdrawal from the South Branch of Bear Creek with filtration
		3) Additional well development in the Allegheny Group
	1990 SD = 0.032	**4) Increase treated storage**
	2020 SD = 0.049	

[a]Includes the following quantitative deficiencies only: YD - Yield deficiency (million gallons per day); SD - Storage deficiency (million gallons); FPD - Filtration plant deficiency (million gallons per day); AD - Allocation deficiency (million gallons per day).

[b]Storage alternatives apply to storage deficiencies only and are supplement to yield, allocation and filtration solution alternatives. **Boldface** indicates recommended or preferred.

1990 Increased Capacity Requirement	1990 Annual Cost ($1,000)[c]	2020 Increased Capacity Requirement	2020 Annual Cost ($1,000)[c]	Remarks
41%	.60	18%	.80	1) Would reduce 1990 & 2020 yield deficiencies by 41% and 18% respectively
.007	1.7	.028	6.1	
.108	2.60	.108	2.6	
.004	.70	.013	1.30	
		.046	12.24	1) Cost includes a 0.1 mgd capacity filtration plant
.003	.60	.032	2.2	
		100%	1.00	2) Would reduce the 2020 yield deficiency by 100% 4) County report lists proposals for construction of storage and treatment facilities
		.046	2.10	
		.017	1.50	
				1) Cost includes a 0.1 mgd capacity filtration plant
		.025	27.8	
		.025	29.0	
		.072	2.22	
23%	1.6	16%	1.94	1) Would reduce the 1990 & 2020 yield deficiencies by 23% and 16% respectively 2) Cost includes a 0.1 mgd capacity filtration plant 4) The company does not have any treated storage facility
.034	25.7	.075	25.9	
.046	2.10	.075	3.30	
.032	2.20	.049	2.90	

[c]Annual costs (1976 price level) are planning guidelines only, not to be used for project budgeting or design. Where alternatives include development of both source and treatment facilities, costs for treatment facilities are listed separately and are in addition to source development costs.

Note: The 2020 design capacity includes the 1990 design capacity, and long-term annual costs include the short-term annual costs unless otherwise noted in the remarks.

Table 23 (Cont.)

PUBLIC WATER SUPPLY SOLUTION ALTERNATIVES

Public Water Supplier Map Legend – (DER Code)	Existing Source and Projected Deficiencies[a]	Solution Alternatives[b]
Redbank Valley Municipal Authority 29 – (16920101)	Redbank Creek 1990 AD = 0.050 2020 AD = 0.202 1990 SD = 0.029 2020 SD = 0.124 2020 FPD = 0.002	**1) Reduction of leakage & losses** **2) Increase allocation at the existing source** **3) Increase treated storage** **4) Expand existing filtration plant**
DuBois Water Department 31 – (17001101)	Reservoir on Anderson Creek 2020 YD = 1.919	**1) Reduction of leakage & losses** **2) Groundwater development in the Conemaugh Group** **3) Proposed increase in the height of the existing reservoir on Anderson Creek to provide additional yield (see filtration costs below)** **4) Proposed reservoir, #001, on Laborde Branch (see filtration costs below)**
	2020 SD = 2.799	**5) Increase treated storage**
	1990 FPD = 3.266 2020 FPD = 11.978	**6) Expand the existing facility in 1990 and construct a new filtration plant in 2020**
Village of Stump Creek 34 – (33915101)	1 well	**1) Residential conservation should be used to partially reduce the following deficiencies**
	2020 YD = 0.012	**2) Metering** **3) Additional well development in the Conemaugh Group**
	1990 SD = 0.016 2020 SD = 0.035	**4) Increase treated storage**
Seminole Water Co-operative 36 – (03923101)	2 wells & 2 springs	**1) Residential conservation should be used to completely eliminate the 1990 storage deficiency and to partially reduce the 2020 deficiency**
	1990 SD = 0.001 2020 SD = 0.002	**2) Increase treated storage**

[a]Includes the following quantitative deficiencies only: YD - Yield deficiency (million gallons per day); SD - Storage deficiency (million gallons); FPD - Filtration plant deficiency (million gallons per day); AD - Allocation deficiency (million gallons per day).

[b]Storage alternatives apply to storage deficiencies only and are supplement to yield, allocation and filtration solution alternatives. **Boldface** indicates recommended or preferred.

1990		2020		
Increased Capacity Requirement	Annual Cost ($1,000)[c]	Increased Capacity Requirement	Annual Cost ($1,000)[c]	Remarks
.050		.202		1) Estimated 31% of the total water uses are leakage & losses
.029	2.11	.124	4.93	
		.002	0.15	
		1.919	70.7	1) Projected needs include anticipated development of Treasure Lake. Estimated 28% of the total water uses are leakage and losses.
		1.919		3) Cost estimate is not available at this time. Available yield would be 2.5 mgd.
		1.919	543.8	4) The total cost estimated by Chester Engineers is $9,556,000. Annual cost is based on a 50-year life span and a 5.25% interest rate. Available yield would be 4.0 mgd.
		2.799	16.8	
3.266	118.4	11.978	414.4	6) The short-term cost (1990) is for the expansion of the existing filtration plant. The 2020 design capacity includes the 1990 design capacity; thence, the long-term cost (2020) is for the construction of a 8.712 mgd capacity filtration plant.
		70%	1.00	2) Would reduce the 2020 yield deficiency by 70% 4) The company does not have any treated storage
		.058	2.10	
.016	1.50	.035	2.40	
.001	.30	.002	.40	

[c]Annual costs (1976 price level) are planning guidelines only, not to be used for project budgeting or design. Where alternatives include development of both source and treatment facilities, costs for treatment facilities are listed separately and are in addition to source development costs.

Note: The 2020 design capacity includes the 1990 design capacity, and long-term annual costs include the short-term annual costs unless otherwise noted in the remarks.

Table 23 (Cont.)

PUBLIC WATER SUPPLY SOLUTION ALTERNATIVES

Public Water Supplier Map Legend – (DER Code)	Existing Source and Projected Deficiencies[a]	Solution Alternatives[b]
Western Pennsylvania Water Company – Punxsutawney District 37 – (33803101)	Clover Run Reservoir on Clover Run, East Branch of the Mahoning Creek & 3 wells	**1) Reduction of leakage & losses**
	1990 FPD = 0.334 2020 FPD = 1.208	**2) Expand the existing filtration plant**
Dayton Borough Water Department 38 – (03914101)	2 wells	**1) Residential conservation should be used to partially reduce the storage deficiency**
	1990 SD = 0.017 2020 SD = 0.034	**2) Increase treated storage**
Rossiter Water Company 39 – (32911101)	Rossiter Reservoir on Straight Branch Run 2020 FPD = 0.074	**1) Residential conservation should be used to partially reduce the filtration deficiency** **2) Expand the existing filtration plant**
Western Pennsylvania Water Company – Kittanning District 43 – (03804101)	Allegheny River	**1) Residential conservation should be used to partially reduce the following deficiencies**
	2020 AD = 0.531	**2) Additional allocation from existing source**
	1990 SD = 0.771 2020 SD = 1.466	**3) Increase treated storage**
	2020 FPD = 0.531	**4) Expansion of existing filtration plant**
Cowanshannock Water Company – Yatesboro 46 – (03913103)	2 wells	**1) Residential conservation should be used to partially reduce the following deficiencies**
	1990 YD = 0.036 2020 YD = 0.070	**2) Metering** 3) Possible construction of SCS reservoir #28–5A on Cowanshannock Creek would provide adequate yield to permit stream withdrawal with filtration **4) Additional well development in the Conemaugh Group**
	2020 SD = 0.006	**5) Increase treated storage**
Rural Valley Water Company 47 – (03935101)	2 wells 1990 YD = 0.076 2020 YD = 0.170	1) Possible construction of SCS Reservoir #28–5A on Cowanshannock Creek would supply adequate yield to allow stream withdrawal with filtration **2) Well development in the Conemaugh Group**

[a]Includes the following quantitative deficiencies only: YD - Yield deficiency (million gallons per day); SD - Storage deficiency (million gallons); FPD - Filtration plant deficiency (million gallons per day); AD - Allocation deficiency (million gallons per day).

[b]Storage alternatives apply to storage deficiencies only and are supplement to yield, allocation and filtration solution alternatives. **Boldface** indicates recommended or preferred.

1990 Increased Capacity Requirement	1990 Annual Cost ($1,000)[c]	2020 Increased Capacity Requirement	2020 Annual Cost ($1,000)[c]	Remarks
				1) Estimated 26% of the total water uses are leakage & losses
.334	19.1	1.208	63.8	
.017	1.50	.034	2.30	
		.074	8.4	
				4) County report lists plans for additional treatment capacity
		.531		
.771	14.3	1.466	16.7	
		.531	23.2	
22%	1.10	15%	1.30	2) Would reduce the 1990 & 2020 yield deficiencies by 22% & 15% respectively
.036	26.4	.070	27.3	3) SCS Reservoir #28–5A available storage=280 mg. Cost includes a 0.1 mgd capacity filtration plant
.058	2.10	.070	2.60	
		.006	.80	
.076	27.5	.170	53.3	
.076	2.80	.170	6.30	

[c]Annual costs (1976 price level) are planning guidelines only, not to be used for project budgeting or design. Where alternatives include development of both source and treatment facilities, costs for treatment facilities are listed separately and are in addition to source development costs.

Note: The 2020 design capacity includes the 1990 design capacity, and long-term annual costs include the short-term annual costs unless otherwise noted in the remarks.

Table 23 (Cont.)

PUBLIC WATER SUPPLY SOLUTION ALTERNATIVES

Public Water Supplier Map Legend – (DER Code)	Existing Source and Projected Deficiencies[a]	Solution Alternatives[b]
Cowanshannock Water Company – Numine 48 – (03913101)	1 well 1990 YD = 0.013 2020 YD = 0.030	**1) Residential conservation should be used to partially reduce the yield deficiency** **2) Metering** **3) Additional well development in the Conemaugh Group** 4) Stream withdrawal from Cowanshannock Creek with filtration
Cowanshannock Water Company – Margaret 49 – (03913102)	1 well 1990 YD = 0.005 2020 YD = 0.010	**1) Residential conservation should be used to partially reduce the yield deficiency** **2) Metering** **3) Groundwater development in the Conemaugh Group**
Cadogan Water District 51 – (03912101)	Allegheny River 1990 AD = 0.104 2020 AD = 0.152 2020 SD = 0.001 1990 FPD = 0.037 2020 FPD = 0.087	**1) Residential conservation should be used to completely eliminate the storage deficiency and to partially reduce the remaining deficiency** **2) Increase allocation at existing source** **3) Increase treated storage** **4) Expand existing filtration plant**
East Armstrong County Municipal Authority 53 – (03916101)	2 wells 2020 YD = 0.009 2020 SD = 0.003	**1) Metering** **2) Well development in the Conemaugh Group** **3) Increase treated storage**
Creekside Water Company 54 – (32917101)	1 well & 9 springs 2020 YD = 0.033	**1) Residential conservation should be used to partially reduce the yield deficiency** **2) Metering** 3) Stream withdrawal from McKees Run or Crooked Creek with filtration **4) Additional well development in the Glacial Outwash with filtration**

[a]Includes the following quantitative deficiencies only: YD - Yield deficiency (million gallons per day); SD - Storage deficiency (million gallons); FPD - Filtration plant deficiency (million gallons per day); AD - Allocation deficiency (million gallons per day).

[b]Storage alternatives apply to storage deficiencies only and are supplement to yield, allocation and filtration solution alternatives. **Boldface** indicates recommended or preferred.

1990 Increased Capacity Requirement	1990 Annual Cost ($1,000)[c]	2020 Increased Capacity Requirement	2020 Annual Cost ($1,000)[c]	Remarks
				2) Would reduce the 1990 & 2020 yield deficiencies by 19% & 14% respectively
19%	.50	14%	.60	4) Cost includes a 0.1 mgd
.058	2.10	.058	2.10	capacity filtration plant
.013	25.5	.030	25.6	
				2) Would reduce the 1990 & 2020 yield deficiencies by 18% & 14% respectively
18%	.10	14%	.20	
.058	2.10	.058	2.10	
				2) Currently, the company does not have any allocation
		.001	.30	
.037	5.80	.087	12.7	
		100%	1.70	1) Would reduce the 2020 yield deficiency by 100%
		.058	2.10	
		.003	.60	
				2) Would reduce the 2020 yield deficiency by 34%
		34%	1.2	3 & 4) Cost includes a 0.1 mgd capacity filtration plant.
		.033	25.6	
		.432	27.2	

[c]Annual costs (1976 price level) are planning guidelines only, not to be used for project budgeting or design. Where alternatives include development of both source and treatment facilities, costs for treatment facilities are listed separately and are in addition to source development costs.

Note: The 2020 design capacity includes the 1990 design capacity, and long-term annual costs include the short-term annual costs unless otherwise noted in the remarks.

Table 23 (Cont.)

PUBLIC WATER SUPPLY SOLUTION ALTERNATIVES

Public Water Supplier Map Legend – (DER Code)	Existing Source and Projected Deficiencies[a]	Solution Alternatives[b]
Indiana County Municipal Authority Ernest District 55a – (32929101)	McKees Run	**1) Residential conservation should be used to partially reduce the following deficiencies**
	1990 AD = 0.019 2020 AD = 0.092	2) Yield of the stream is sufficient to increase the allocation to the 1990 need but is inadequate for the 2020 need
	1990 SD = 0.057 2020 SD = 0.113	**3) Increase treated storage**
	1990 FPD = 0.059 2020 FPD = 0.132	**4) Expand the existing filtration plant in 1990 and construct a new plant in 2020**

[a]Includes the following quantitative deficiencies only: YD - Yield deficiency (million gallons per day); SD - Storage deficiency (million gallons); FPD - Filtration plant deficiency (million gallons per day); AD - Allocation deficiency (million gallons per day).

[b]Storage alternatives apply to storage deficiencies only and are supplement to yield, allocation and filtration solution alternatives. **Boldface** indicates recommended or preferred.

1990 Increased Capacity Requirement	1990 Annual Cost ($1,000)[c]	2020 Increased Capacity Requirement	2020 Annual Cost ($1,000)[c]	Remarks
.019				4) The short-term cost (1990) is for expansion of the existing filtration plant. The 2020 design capacity includes the 1990 capacity. The long-term cost (2020) is for the construction of a new 0.1 mgd capacity filtration plant.
.057	3.13	.113	4.7	
.059	9.55	.132	22.7	

[c]Annual costs (1976 price level) are planning guidelines only, not to be used for project budgeting or design. Where alternatives include development of both source and treatment facilities, costs for treatment facilities are listed separately and are in addition to source development costs.

Note: The 2020 design capacity includes the 1990 design capacity, and long-term annual costs include the short-term annual costs unless otherwise noted in the remarks.

Although conservation has become a "household term" in the past few years, it is something whose practice cannot be limited to the household. In fact, many forms of significant water conservation do not apply to the household, but rather to industrial or power generation uses or even to the public water supply systems themselves. The costs of maintaining newly-mandated stream water quality standards are forcing industry to adopt recycling/reuse production techniques which demand less total water. Advances in industrial cooling technology have led to lower total water requirements, although this is offset somewhat by the resultant problem of increased evaporative loss, which is discussed in Part 3 of this section.

The major thrust of conservation as it relates to public water supply must be directed toward both the individual consumer and the supplier. Conservation education must be directed toward the consumer to enlighten him to both the importance of conservation and also the methods by which he can practice conservation.

Measures which must be applied by the supplier to either conserve water directly or promote conservation by the consumer include:

(1) reduction of leakage and loss in the system

(2) adoption of conservation-promoting pricing policies.

(3) rationing (primarily an emergency measure)

(4) the promotion of building codes which require the use of water-saving devices in new construction

(5) promotion of the use of water-saving devices by existing residential, commercial and industrial customers

(6) metering

(7) initiation of effective timber harvesting practices in water supply watersheds

Appendix B-1 provides a more detailed dicusssion of conservation techniques, particularly as they apply to the individual consumer.

The following alternatives have been considered as conceptual solutions to public water supply problems:

(1) Yield Deficit
  (a) Management of Existing Resources
  (b) New Development
    i. Stream withdrawal – taking water directly from a stream
    ii. Surface raw water storage – reservoir
    iii. Groundwater development – wells & springs
(2) Storage Deficit
  (a) Management of Existing Resources
  (b) Increase treated water storage (new development)
(3) Water Allocation Deficit
  (a) Management of Existing Resources
  (b) Increased Allocation
(4) Filtration Capacity Deficit
  (a) Management of Existing Resources
  (b) Increase Filtration Plant Capacity (expansion of existing facility and/or new development)

Management of existing resources includes the following measures:

(1) Reduction of demand through consumer conservation

(2) Metering (if not already being used)

(3) Purchasing from other suppliers which have excess supply (does not apply to storage deficit)

(4) Reduction of leakage and loss within the system

(5) Regionalization of water suppliers

Table 23 lists the present sources, projected short-term (1990) and long-term (2020) deficiencies, solution alternatives, and associated costs for those water suppliers which have been identified as having problems. The specific solution alternatives presented are the result of an examination of the conceptual solutions listed above, with regard to their feasibility for solving the identified problems. Conservation measures were examined in detail for suppliers whose residential gpcd exceeds 50 or whose industrial usage is significant. Metering was considered where it was not already being used. Structural measures were outlined and examined for obvious, overwhelmingly negative characteristics, either economic, social or environmental; only feasible solutions were then listed in Table 23. In all cases, if regional, county or utility plans were available, they were screened to obtain locally developed solution concepts or recommendations. Costs for new project development were estimated on an annual basis, at 1976 price levels using a 5–1/4 percent interest rate amortized over the assumed life period of the structure. These costs are preliminary planning estimates only, developed for use in reviewing alternatives, and should not be used for project budgeting or design.

Any reservoir solution alternatives listed in Table 23 are also located on Figure 10. Environmental and social parameters for major potential structural solution alternatives are listed and evaluated in Table 24. A discussion of the impacts associated with the major recommended structural solutions is presented in Chapter VI.

Figure 10 shows the least expensive solution along with any additional reservoir solution alternative to meet the short- and long-term yield deficiency of each public water supplier. As seen from this figure, except for installation of meters for the Knoxdale Water Company, groundwater development may be the most economical solution to satisfy the yield deficiency needs in the subbasin.

(Continued on page 73)

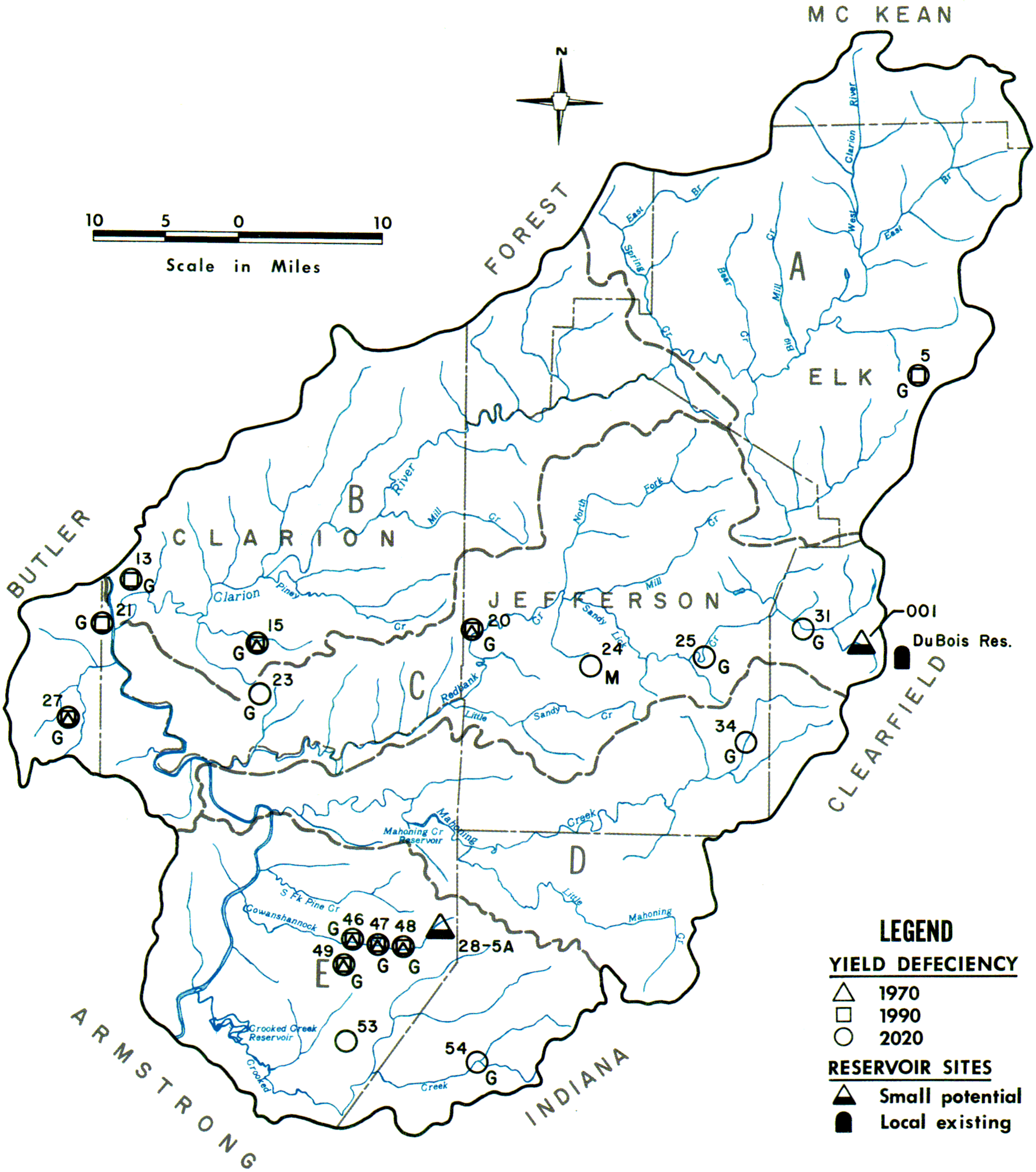

FIGURE 10. Water Supply Yield Deficiencies and Structural Solution Alternatives

Table 24

SCREENING ASSESSMENT OF WATER SUPPLY STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Stream withdrawal from Licking Creek with filtration		25.7 WS/t-1990 32.0 WS/t-2020	-Could serve as a public water supply source for the Sligo Borough Water Department	-Could alter aquatic life & fish habitat -Potential Vanport limestone area -Potential gas resource area -Potential coal resource area	-Additional groundwater development	Not recommended
Stream withdrawal from Welch Run with filtration		26.9 WS/t-1990 27.0 WS/t-2020	-Could serve as a public water supply source for the Peoples Water Company	-Potential coal resource area -Potential gas resource area -Could alter aquatic life & fish habitat	-Additional well development	Not recommended
Stream withdrawal from Sandy Lick Creek with filtration		27.8 WS/t-2020	-Could serve as a public water supply source for Reynoldsville Water Authority	-Could alter aquatic life & fish habitat -Potential Vanport limestone area -Potential coal resource area	-Groundwater development -Surface withdrawal from Soldier Run	Not recommended
Stream withdrawal from Soldier Run with filtration		29.0 WS/t-2020	-Could serve as a public water supply source for Reynoldsville Water Authority	-Could alter aquatic life & fish habitat -Potential Vanport limestone area -Potential coal resource area	-Groundwater development -Surface with-drawal from Sandy Lick Creek	Not recommended
Stream withdrawal from the South Branch Bear Creek with filtration		27.5 WS/t-1990 25.9 WS/t-2020	-Could serve as a public water supply source for Petrolia Water Company	-Could alter aquatic life & fish habitat significantly, since stream is stocked with trout	-Additional well development	Not recommended

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 24 (Cont.)

SCREENING ASSESSMENT OF WATER SUPPLY STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Stream withdrawal from Cowanshannock Creek with filtration		25.5 WS/t-1990 25.6 WS/t-2020	-Could serve as a public water supply source for Cowanshannock Water Company, Numine	-Potential coal resource area -Wild and Scenic River Candidate-3rd priority "Modified Recreation"	-Well development	Not recommended
Stream withdrawal from McKees Run or Crooked Creek with filtration		25.6 WS/t-2020	-Could serve as a public water supply source for Creekside Water Company	-Could alter aquatic life & fish habitat -Potential coal resource area	-Additional well development	Not recommended
Small Potential Reservoir #28–5A on Cowanshannock Creek		26.4 WS/t-1990 27.3 WS/t-2020	-Could serve as a public water supply source for Cowanshannock Water Company, Yatesboro	-Potential coal resource area -Wild and Scenic River Candidate-3rd priority "Modified Recreation	-Additional well development	Not recommended
		27.5 WS/t-1990 53.3 WS/t-2020	-Could serve as a public water supply source for Rural Valley Water Company	-Roads & Highways, Pa. Rt. 839 relocation -Potential gas resource area -Could alter aquatic life & fish habitat -Could be aesthetically intrusive -Could affect some vegetation & wildlife		

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 24 (Cont.)

SCREENING ASSESSMENT OF WATER SUPPLY STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Small Potential Reservoir #001 on Laborde Branch of Sandy Lick Creek		543.8 WS 2020	-Could serve as a public water supply source for DuBois Water Department	-Potential coal resource area -Could alter aquatic life & fish habitat -Could be aesthetically intrusive -Could affect some vegetation & wildlife -May require relocation of a local road, pipeline and power transmission line	-Groundwater development -Increase height of existing reservoir on Anderson Creek	Recommended

[a] Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

c. *Recommendations*

The feasible solution alternatives were examined in greater detail in order to determine which alternative or combination of alternatives appeared most capable of solving a given problem, not only from the standpoint of that problem, but also with respect to the overall water resources scenario of the subbasin. Some alternatives were rejected in favor of others after consideration was given to physical resource and environmental restrictions, such as Scenic Rivers candidates or already-taxed groundwater aquifers or in some cases known social-political considerations. For some problems two or more alternatives may appear equally satisfactory.

The alternatives which appear to most warrant further study for implementation are indicated by bold type in Table 23. In some cases, more than one total solution to a problem may be recommended if available information was not sufficient to determine the preference of one over the other. The recommendations include:

(1) It is strongly recommended that applicable conservation measures be applied by all suppliers whose residential gpcd exceeds 50 or whose industrial usage appears excessive. This should be the initial means to alleviate existing or projected deficiencies. Prior to consideration of any structural alternatives, industrial conservation measures such as water recycling or improvement of water-saving techniques should be used to eliminate the storage deficiencies of the Johnsonburg Municipal Authority and Brockway Borough; residential conservation should be considered to eliminate the storage deficiencies of Fall Creek Borough and the Cadogan Water District. Either residential conservation or metering will solve the yield deficiency of the Knoxdale Water Authority in 2020. In addition, installation of meters by nine companies and reduction of losses in the systems of four companies as listed in Table 23 should be considered to alleviate their water supply problems.

(2) Development of groundwater will meet short-term (1990) and long-term (2020) yield deficiencies of 10 and 17 public water suppliers, respectively. Raising the existing reservoir on Anderson Creek or a proposed reservoir on Laborde Branch also has to be considered with the groundwater solution alternative for the DuBois Water Department to meet its yield deficiency in 2020 due to the anticipated development of Treasure Lake.

(3) Issue new water allocation immediately at McKees Run to the Cadogan Water District which currently does not have any water allocation. Increase water allocations at Redbank Creek for the Redbank Valley Municipal Authority and at McKees Run for the Indiana County Municipal Authority by 1990 and for five water suppliers by 2020.

(4) Increase treated water storage capacity for 11 and 23 water suppliers with storage deficits in 1990 and 2020, respectively.

(5) Expansion of existing filtration plant capacity for 7 water suppliers by 1990 and 6 by 2020. Development of a new filtration facility for the Western Pennsylvania Water Company-Clarion District to satisfy its filtration deficiencies in 1990 and 2020. Development of new filtration facilities for four water suppliers by 2020 to satisfy filtration deficiencies in 2020.

These recommendations are made as possible solutions to public water supply problems. Prior to actual construction of a project or implementation of a program, detailed studies of all environmental, social and economic factors must be completed to assure optimum benefits and results.

3. CONSUMPTIVE USE MAKEUP

a. *Problems*

The protection of water uses from future source depletion is a primary concern of water resources management. One facet of water resources management, which is important to the protection of both instream and withdrawal uses, is the careful management of consumptive water uses.

Consumptive water uses can be divided into two categories: (1) direct consumptive water - the quantity of water discharged to the atmosphere or incorporated in the product of a process such as vegetative growth, food processing or an industrial process, and (2) indirect consumptive water - the quantity of water transferred from a source watershed to another watershed and never returned, or water transferred from an upstream intake point to a downstream discharge point bypassing inbetween users.

Consumptive water use thus results in a depletion of natural streamflows downstream of the intake point. Although the effects of limited and in some cases even significant depletions may be negligible under normal streamflow conditions, the impacts on instream as well as downstream withdrawal uses can become critical during periods of low streamflow.

In order to adopt a policy by which water use can be specially managed during low flow conditions, it was necessary to first define some characteristic of streamflow which could be observed in order to identify when the low flow is occurring. Stream discharge is the obvious characteristic to monitor; and a discharge less than or equal to $Q_{7\text{-}10}$[24] was adopted as the definition of low flow. The 7-day 10-year low flow is the average low flow for a period of seven consecutive days, which would occur on the average once every ten years. Although that low flow definition is the subject of continuing investigation, it was

[24]Average consecutive 7-day low flow having a 10-year return period of a 10 percent chance of occurrence each year.

Table 25

CONSUMPTIVE WATER USE MAKEUP NEEDS

Legend (See Figure 11)	Stream and (Watershed)	Public Water Supply[a] D.C.U. (mgd)	Public Water Supply[a] D.M.S.R. (mgd)	Public Water Supply[a] A.M.S.R. (mg)	Self-Supplied Industry[a] D.C.U. (mgd)	Self-Supplied Industry[a] D.M.S.R. (mgd)	Self-Supplied Industry[a] A.M.S.R. (mg)	Self-Supplied Power Cooling[a] D.C.U. (mgd)	Self-Supplied Power Cooling[a] D.M.S.R. (mgd)	Self-Supplied Power Cooling[a] A.M.S.R. (mg)
I	Powers Run (A)	.016	.02	.17						
II	Allegheny River (B & C)				.096	.12	2.40	14.7	18.38	312.46
III	Allegheny River (D)							31.7	39.6	673.20
IV	Allegheny River (E)	.032	.04	.56	1.22	1.53	23.01			
V	Clarion River (B)	.096	.12	6.41						
VI	Redbank Creek (C)	.016	.02	.59						
VII	Mahoning Creek (D)	.01	.01	.15	.12	.15	1.74			
	Subbasin 17 (not covered by preceding areas)									
	Total	.17	.21	7.88	1.436	1.80	27.15	46.4	57.98	985.66

[a]D.C.U. - Daily Consumptive Use; D.M.S.R. - Daily Makeup Source Requirement; A.M.S.R. - Annual Makeup Storage Requirement; mgd - million gallons per day; mg - million gallons.

[b]Includes all irrigation which is assumed to occur within two miles of the stream identified in Column 2.

[c]Includes all livestock, and the remainder of irrigation not assumed to occur within two miles of the streams identified in Column 2.

initially adopted on the premise that it is generally high enough to protect water quality standards and instream ecological uses, while at the same time being low enough so that it would be economically, socially and environmentally possible to provide the makeup water necessary during critical drought periods. Until further research possibly leads to a more comprehensive guideline, the Q_{7-10} is the adopted low flow level which should be protected against depletion by incremental consumptive water use.

In compiling past, present and future comsumptive water use information, it was recognized that while its impact on streamflows in the past was small, in the future, consumptive uses could cause significant instream problems during low flows. An objective was set stating that *existing* streamflows should be protected against the detrimental effects of consumptive use. As existing streamflow records already reflect past and present consumptive water uses, this plan addresses only new or increased consumptive uses. The analyses in this report assume a base year of 1970. Incremental consumptive use in any year is defined as the difference between consumptive use in that year and consumptive use in the base year; in other words, past consumptive water uses are "grandfathered".

Because the objective of consumptive use makeup is to protect the low flow against further depletion by consumptive use, a "trigger point" must be defined to indicate at what time a user must begin to make up his incremental consumption. When the flow is at a value equal to Q_{7-10} plus the total consumptive use, the user would be depleting the flow below his taking point to exactly the Q_{7-10} level; therefore, a flow equal to Q_{7-10} plus the total consumptive use has been assigned as the trigger point to guarantee that consumptive withdrawal water uses never contribute to depletion of streamflows below Q_{7-10}.

It must be emphasized that consumptive use makeup is not intended to maintain Q_{7-10}; it is intended to maintain the natural flow when the streamflow drops below Q_{7-10},

Self-Supplied Irrigation[a,b]			Self-Supplied Agriculture[a,c] and Golf Courses			Total[a]		
D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)	D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)	D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)
						.016	.02	.17
						14.8	18.5	314.86
						31.7	39.6	673.20
.01	.01	.62				1.26	1.58	24.19
						.096	.12	6.41
						.016	.02	.59
						.130	.16	1.89
			.70	.88	13.61	.70	.88	13.61
.01	.01	.62	.70	.88	13.61	48.72	60.88	1,034.92

whatever that natural flow may be. A user would never be required to return more water to the stream than was withdrawn. The user must only replace the water that was consumed, beyond the base year consumptive level. All makeup water must, however, be provided either at or upstream of the withdrawal point.

The 1990 consumptive water uses (including public water supply, self-supplied industry, power, agriculture and golf courses) were analyzed based on current trends to determine makeup requirements along seven streams and stream reaches and an as yet undetermined power generating site in Subbasin 17 (Figure 11). The needs listed in Table 25 represent the total daily incremental consumption based on projected water usage for the five categories of water users. In order not to underestimate the aggregate compensating reservoir storage requirements in this preliminary planning stage, projected consumptive water use data were uniformly increased by 25 percent, thereby increasing the required storage estimates presented by a comparable amount. This has the effect of an overall safety factor to recognize both a) the difficulty in precise projection of total consumptive use for the subbasin and b) possible inaccuracies in necessarily preliminary estimates of yields or makeup period durations. The table summarizes eight areas identified as having such needs, with a total daily need of about 61 mgd or an equivalent storage requirement of about 1,035 mg.

The consumptive water use makeup needs in Subbasin 17 have also been analyzed by taking into consideration the application of the best practicable control technology or best available technology economically achievable, to the self-supplied power and industrial water uses. This is in purusance of Public Law 92-500 of the Federal Water Pollution Control Act, as amended in 1972. As a practical matter not all "best available technology" pollution control devices are economical at existing sites. In some instances, it may result, for example, in an older electric generating plant retiring earlier or being replaced by a new plant at a new location. However, this aspect could not be analyzed herein. The implementation of this Act would certainly decrease the amount of water withdrawn and thermal pollution, but it would also increase consumptive water use.

Table 25 (Cont.)

CONSUMPTIVE WATER USE MAKEUP NEEDS
(With Best Available Technology)

Legend (See Figure 11)	Stream and (Watershed)	Public Water Supply[a]			Self-Supplied Industry[a]			Self-Supplied Power Cooling[a]		
		D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)	D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)	D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)
I	Powers Run (A)	.016	.02	0.17						
II	Allegheny River (B & C)				.096	.12	2.40	14.7	18.38	312.46
III	Allegheny River (D)							31.7	39.6	673.20
IV	Allegheny River (E)	.032	.04	.56	6.42	8.03	120.45	4.63	5.79	98.50
V	Clarion River (B)	.096	.12	6.41						
VI	Redbank Creek (C)	.016	.02	0.59						
VII	Mahoning Creek (D)	.01	.01	0.15	.12	.15	1.74			
	Subbasin 17 (not covered in preceding areas)									
	Total	.17	0.21	7.88	6.64	8.30	124.59	51.03	63.77	1,084.16

[a]D.C.U. - Daily Consumptive Use; D.M.S.R. - Daily Makeup Source Requirement; A.M.S.R. - Annual Makeup Storage Requirement; mgd - million gallons per day; mg - million gallons.

[b]Includes all irrigation which is assumed to occur within two miles of the stream identified in Column 2.

[c]Includes all livestock, and the remainder of irrigation not assumed to occur within two miles of the streams identified in Column 2.

The needs "with best available technology" were identified based on the following assumptions:

1. In the case of electric generating stations, convert all the existing once through cooling systems into wet cooling tower systems at their existing locations. The information from the Pennsylvania Master Siting Study published in June 1978 was used wherever it was available. Otherwise, three percent[25] of the existing once through cooling water quantity was estimated as a water consumption rate for a converted cooling tower.

2. In the case of industry, 12 percent of the total existing water use was estimated as a water consumption needed to comply with the "best available technology" requirement.

These needs identified under the foregoing assumptions are listed in Table 25, marked as "best available technology", and are located on Figure 11.

b. *Solution Alternatives*

When streamflows drop below the trigger point, consumptive users must be prepared to protect the natural streamflow. In order to avoid any additional depletion of streamflows, those users will be faced with a decision to either temporarily curtail consumptive uses until streamflows recover or else provide makeup water to replace what is being consumed. While curtailment or reduction of consumptive use may be the most desirable solution environmentally, it is not socially or economically the most effective because electric power generation

[25]Federal Power Commission, *The 1970 National Power Survey, Part I*, (U.S. Government Printing Office, Washington, D.C., 1971), p.I-10-17.

Self-Supplied Irrigation[a,b]			Self-Supplied Agriculture[a,c] and Golf Courses			Total[a]		
D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)	D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)	D.C.U. (mgd)	D.M.S.R. (mgd)	A.M.S.R. (mg)
						.016	.02	0.17
						14.80	18.5	314.86
						31.7	39.6	673.2
.008	.01	0.62				11.09	13.87	220.13
						.096	0.12	6.41
						.016	0.02	0.59
						.130	.016	1.89
			.70	0.88	13.61	.70	0.88	13.61
.008	.01	0.62	.70	0.88	13.61	58.55	73.17	1,230.90

and agricultural irrigation account for nearly all the significant consumptive use in Subbasin 17.

Consumptive users who are unable to curtail use will need to employ makeup techniques. The means by which makeup requirements can be met may be categorized as follows:

(1) Improved Management of Existing Resources
- (a) Release from existing excess storage
- (b) Change in utilization of existing reservoirs
- (c) Temporary modification of production techniques or output
- (d) Effective use of alternate sources if more than one source is available.
- (e) Development of more efficient water use technology.

(2) New Development
- (a) Upstream reservoir storage
- (b) Groundwater development
- (c) Individual storage
- (d) Others

Users may already have storage for normal water use purposes onsite or in-system. It may be possible for those which have excess storage to use part or all of that excess to provide the necessary makeup water. On a broader scale, changes in the utilization of existing reservoirs represent an alternative which deserves serious consideration. Many reservoirs already in existence could possibly be used more effectively. In most cases, consumptive use makeup releases would be compatible with design or authorized uses. Makeup releases would only be required on an infrequent basis on most streams and would most likely occur after the summer months and not interfere with recreational uses.

In the case of Federal dams, for which Congress originally provided authorization and/or appropriations, it would be necessary to obtain a reauthorization. This would be accomplished by first submitting to the responsible Federal agency a proposal for new use of the project. If it is determined that the proposed use is

(Continued on page 93)

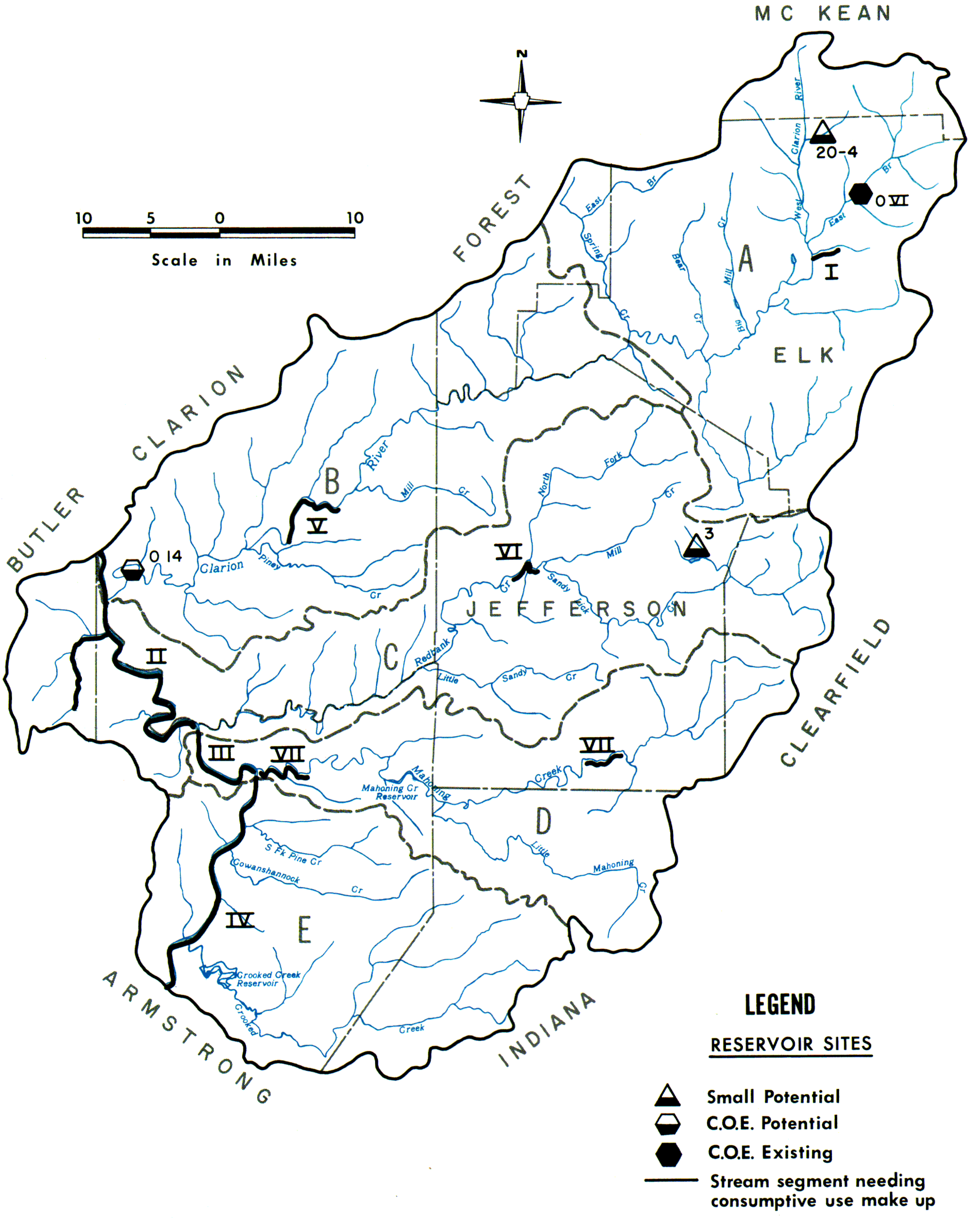

FIGURE 11. Consumptive Use Makeup Streams and Structural Solution Alternatives

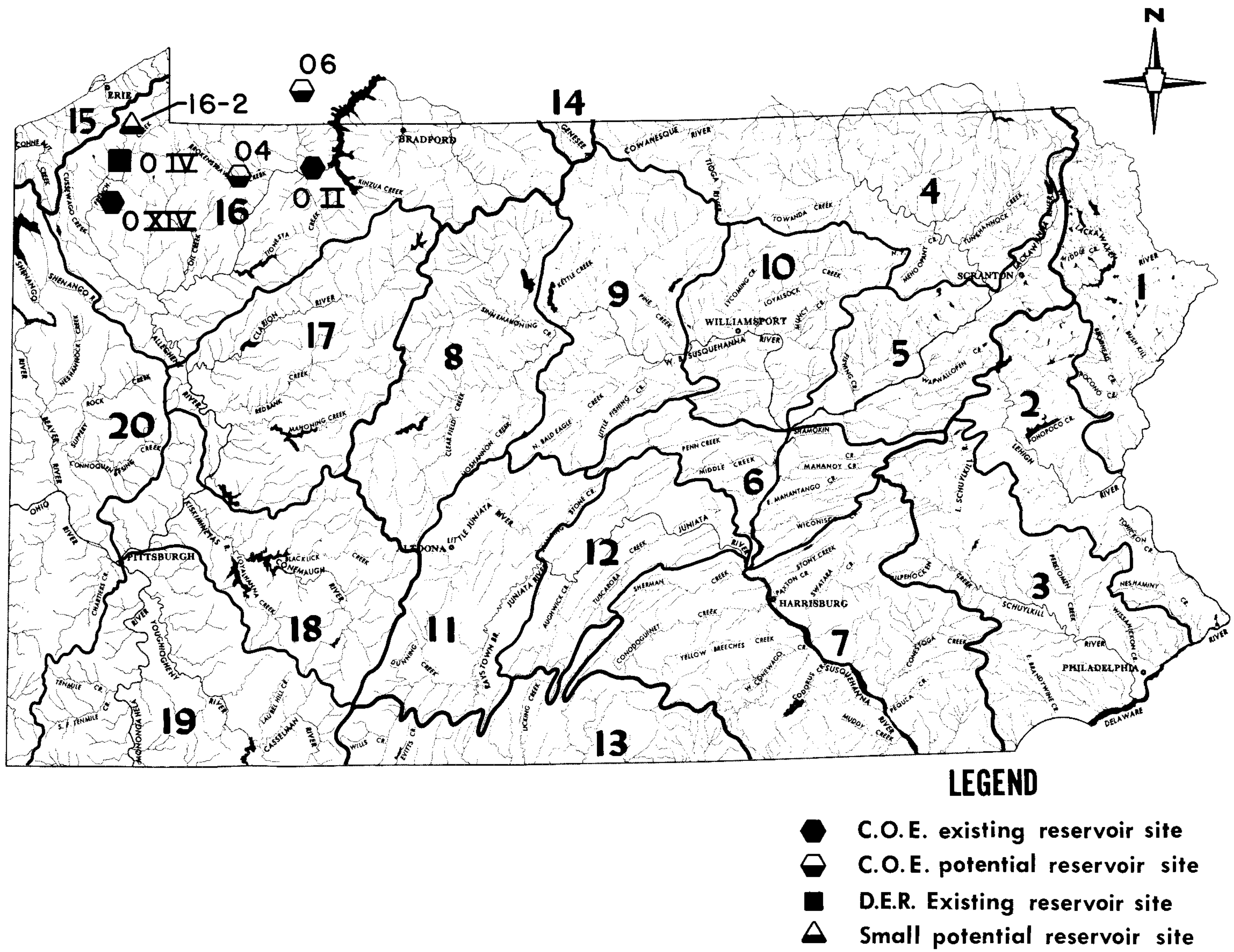

FIGURE 12. Extra-Basin Comsumptive Use Makeup Structural Solution Alternatives

Table 26

CONSUMPTIVE WATER USE MAKEUP SOLUTION ALTERNATIVES[a]

Legend (Figure 11):	I	II	III	IV	V	VI
Beneficial Areas[b] and 1990 Projected Makeup Requirement[c] / Solution Alternative	Powers Run ....A P.W.S.[g] ....0.02 mgd/0.17 mg Total[d] ....0.02 mgd/0.17 mg	Allegheny River ....B & C Industry ....0.12 mgd/2.4 mg Power ....18.4 mgd/312.5 mg Total[d] ....18.5 mgd/314.9 mg	Allegheny River ....D Power ....39.6 mgd/673.2 mg Total[d] ....39.6 mgd/673.2 mg	Allegheny River ....E P.W.S.[g] ....0.04 mgd/0.60 mg Industry ....1.53 mgd/23.01 mg Irrigation ....0.01 mgd/0.62 mg Total[d] ....1.60 mgd/24.2 mg	Clarion River ....B P.W.S.[g] ....0.12 mgd/6.41 mg Total[d] ....0.12 mgd/6.41 mg	Redbank Creek ....C P.W.S.[g] ....0.02 mgd/0.60 mg Total[d] ....0.02 mgd/0.60 mg
Potential COE Reservoir (Map Legend 06) on Conewango Creek (multipurpose)		100% 314.9 mg	100% 673.2 mg	100% 24.2 mg		
Potential COE Reservoir (Map Legend 04) on Brokenstraw Creek (multipurpose)		100% 314.9 mg	100% 673.2 mg	100% 24.2 mg		
Potential COE St. Petersburg Reservoir (Map Legend 014) on Clarion River (multipurpose)		100% 314.9 mg	100% 673.2 mg	100% 24.2 mg		
Small Potential Reservoir #16–2 on East Branch LeBoeuf Creek (multipurpose)		79% 249.9 mg				
Existing Allegheny Reservoir (Map Legend 0 II) on Allegheny River (multipurpose)		100% 314.9 mg	100% 673.2 mg	100% 24.2 mg		
Existing Woodcock Lake (Map Legend O XIV) on Woodcock Creek (multipurpose)		100% 314.9 mg				

[a]Table entries list the percentage of the total need which could be satisfied by the listed alternative and the equivalent allocated storage required to meet that percentage of the need. See Appendix B-3 for more detailed description of this table.

[b]Stream or stream reaches on which consumptive water use will occur by 1990 and the associated watershed(s).

[c]Makeup required by each category of water use. Daily requirements are listed in million gallons per day (mgd) and storage requirements for low flow periods are listed in million gallons (mg).

VII					
Subbasin 17........................Remainder Agriculture - Golf.........0.88 mgd/13.6 mg	Upstream Users In Subbasin 16	Downstream Users In Subbasins 18 and 20	Total Annual Available Storage[e] (million gallons)	Satisfied 1990 Need[f] (million gallons)	Remarks
	4.4 mg	1,640.6 mg	8,386	2,657.3	
	4.4 mg	1,640.6 mg	6,336	2,657.3	
		1,640.6 mg	116,325	2,652.9	
	23.1 mg		273	273	
	4.4 mg	1,640.6 mg	See Remark	2,657.3	Further study for possible reauthorization
	21.7 mg		See Remark	336.6	Further study for possible reauthorization

[d]Total Storage Requirement

[e]Total annual storage available for beneficial use. Does not include flood control storage.

[f]Summation of all needs which could be satisfied by the alternative identified in column 1.

[g]P.W.S.: Public water supply.

Table 26 (Cont.)

CONSUMPTIVE WATER USE MAKEUP SOLUTION ALTERNATIVES[a]

Legend (Figure 11):	I	II	III	IV	V	VI
Beneficial Areas[b] and 1990 Projected Makeup Requirement[c] / Solution Alternative	Powers Run ....A P.W.S.[g] ....0.02 mgd/0.17 mg Total[d] ....0.02 mgd/0.17 mg	Allegheny River ....B & C Industry ....0.12 mgd/2.4 mg Power ....18.4 mgd/312.5 mg Total[d] ....18.5 mgd/314.9 mg	Allegheny River ....D Power ....39.6 mgd/673.2 mg Total[d] ....39.6 mgd/673.2 mg	Allegheny River ....E P.W.S.[g] ....0.04 mgd/0.60 mg Industry ....1.53 mgd/23.01 mg Irrigation ....0.01 mgd/0.62 mg Total[d] ....1.60 mgd/24.2 mg	Clarion River ....B P.W.S.[g] ....0.12 mgd/6.41 mg Total[d] ....0.12 mgd/6.41 mg	Redbank Creek ....C P.W.S.[g] ....0.02 mgd/0.60 mg Total[d] ....0.02 mgd/0.60 mg
Small Potential Reservoir #20–4 on Rocky Run, Clarion River (multipurpose)	100% 0.2 mg	100% 314.9 mg	38% 257.5 mg		100% 6.4 mg	
Small Potential Reservoir #3 on Beaverdam Run (multipurpose)			65% 440 mg			
Existing East Branch Clarion River Lake (Map Legend O VI) on East Branch Clarion River (multipurpose)	100% 0.2 mg	100% 314.9 mg	100% 673.2 mg		100% 6.4 mg	
Individual Storage						
Release from existing excess storage (for Public Water Supply only)						100% 0.6 mg
Groundwater Development	100% 0.2 mg			100% 24.2 mg	100% 6.4 mg	100% 0.6 mg

[a]Table entries list the percentage of the total need which could be satisfied by the listed alternative and the equivalent allocated storage required to meet that percentage of the need. See Appendix B-3 for more detailed description of this table.

[b]Stream or stream reaches on which consumptive water use will occur by 1990 and the associated watershed(s).

[c]Makeup required by each category of water use. Daily requirements are listed in million gallons per day (mgd) and storage requirements for low flow periods are listed in million gallons (mg).

VII					
Mahoning Creek ....D P.W.S.[g] ....0.01 mgd/0.15 mg Industry ....0.15 mgd/1.74 mg Total[d] ....0.16 mgd/1.9 mg	Subbasin 17........Remainder Agriculture - Golf........0.88 mgd/13.6 mg	Downstream Users In Subbasins 18 and 20	Total Annual Available Storage[e] (million gallons)	Satisfied 1990 Need[f] (million gallons)	Remarks
			579	579	
			440	440	
		236.2 mg	See Remark	1,230.9	Further study for possible reauthorization
	100% 13.6 mg			13.6	Applicable to Agriculture and Golf courses with scattered and unknown locations
				0.6	Release from existing excess storage from the Brookville Borough Water Department will solve its total need
100% 1.9 mg				33.3	Groundwater development in Pottsville, Allegheny, Conemaugh, and/or Pocono Groups

[d]Total Storage Requirement

[e]Total annual storage available for beneficial use. Does not include flood control storage.

[f]Summation of all needs which could be satisfied by the alternative identified in column 1.

[g]P.W.S.: Public water supply.

Table 26 (Cont.)

CONSUMPTIVE WATER USE MAKEUP SOLUTION ALTERNATIVES[a]
(With Best Available Technology)

Legend (Figure 11):	I	II	III	IV	V	VI
Solution Alternative / Beneficial Areas[b] and 1990 Projected Makeup Requirement[c]	Powers Run ....A P.W.S.[g] ....0.02 mgd/0.17 mg Total[d] ....0.02 mgd/0.17 mg	Allegheny River ....B,C Industry ....0.12 mgd/2.4 mg Power ....18.4 mgd/312.5 mg Total[d] ....18.5 mgd/314.9 mg	Allegheny River ....D Power ....39.6 mgd/673.2 mg Total[d] ....39.6 mgd/673.2 mg	Allegheny River ....E P.W.S.[g] ....0.04 mgd/0.60 mg Industry ....8.03 mgd/120.5 mg Power ....5.79 mgd/98.5 mg Irrigation............0.01 mgd/0.62 mg Total............13.9 mgd/220.1 mg	Clarion River ....B P.W.S.[g] ....0.12 mgd/6.41 mg Total[d] ....0.12 mgd/6.41 mg	Redbank Creek ....C P.W.S.[g] ....0.02 mgd/0.60 mg Total[d] ....0.02 mgd/0.60 mg
Potential COE Reservoir (Map Legend 06) on Conewango Creek (multipurpose)		100% 314.9 mg	100% 673.2 mg	100% 220.1 mg		
Potential COE Reservoir (Map Legend 04) on Brokenstraw Creek (multipurpose)		100% 314.9 mg	100% 673.2 mg	100% 220.1 mg		
Potential COE St. Petersburg Reservoir (Map Legend O 14) on Clarion River (multipurpose)		100% 314.9 mg	100% 673.2 mg	100% 220.1 mg		
Small Potential Reservoir #16–2 on East Branch LeBoeuf Creek (multipurpose)		78% 246.0 mg				
Existing Allegheny Reservoir (Map Legend O II) on Allegheny River (multipurpose)		100% 314.9 mg	100% 673.2 mg	100% 220.1 mg		
Existing Woodcock Lake (Map Legend O XIV) on Woodcock Creek (multipurpose)		89% 280.9 mg				

[a]Table entries list the percentage of the total need which could be satisfied by the listed alternative and the equivalent allocated storage required to meet that percentage of the need. See Appendix B-3 for more detailed description of this table.

[b]Stream or stream reaches on which consumptive water use will occur by 1990 and the associated watershed(s).

[c]Makeup required by each category of water use. Daily requirements are listed in million gallons per day (mgd) and storage requirements for low flow periods are listed in million gallons (mg).

VII					
Subbasin 17..........................Remainder Agriculture-Golf............0.88 mgd/13.6 mg	Upstream Users In Subbasin 16	Downstream Users In Subbasins 18 and 20	Total Annual Available Storage[e] (million gallons)	Satisfied 1990 Need[f] (million gallons)	Remarks
	37.5 mg	3,511.3 mg	8,386.0	4,757.0	
	4.4 mg	3,511.3 mg	6,336.0	4,723.9	
		3,511.3 mg	116,325	4,719.5	
	27.0 mg		273.0	273.0	
	37.5 mg	3,511.3 mg	See Remarks	2,587.4	Further study for possible reauthorization
	25.4 mg		See Remarks	306.3	Further study for possible reauthorization

[d]Total Storage Requirement

[e]Total annual storage available for beneficial use. Does not include flood control storage.

[f]Summation of all needs which could be satisfied by the alternative identified in column 1.

[g]P.W.S.: Public water supply.

Table 26 (Cont.)

CONSUMPTIVE WATER USE MAKEUP SOLUTION ALTERNATIVES[a]
(With Best Available Technology)

Legend (Figure 11):	I	II	III	IV	V	VI
Beneficial Areas[b] and 1990 Projected Makeup Requirement[c] / Solution Alternative	Powers Run .... A P.W.S.[g] .... 0.02 mgd/0.17 mg Total[d] .... 0.02 mgd/0.17 mg	Allegheny River .... B,C Industry .... 0.12 mgd/2.4 mg Power .... 18.4 mgd/312.5 mg Total[d] .... 18.5 mgd/314.9 mg	Allegheny River .... D Power .... 39.6 mgd/673.2 mg Total[d] .... 39.6 mgd/673.2 mg	Allegheny River .... E P.W.S.[g] .... 0.04 mgd/0.60 mg Industry .... 8.03 mgd/120.5 mg Power .... 5.79 mgd/98.5 mg Irrigation .... 0.01 mgd/0.62 mg Total .... 13.9 mgd/220.1 mg	Clarion River .... B P.W.S.[g] .... 0.12 mgd/6.41 mg Total[d] .... 0.12 mgd/6.41 mg	Redbank Creek .... C P.W.S.[g] .... 0.02 mgd/0.60 mg Total[d] .... 0.02 mgd/0.60 mg
Small Potential Reservoir #20–4 on Rocky Run, Clarion River (multipurpose)	100% 0.2 mg	100% 314.9 mg	38% 257.5 mg		100% 6.4 mg	
Small Potential Reservoir #3 on Beaverdam Run (multipurpose)			65% 440.0 mg			
Existing East Branch Clarion River Lake (Map Legend O VI) on East Branch Clarion River (multipurpose)	100% 0.20 mg	100% 314.9 mg	100% 673.2 mg		100% 6.41 mg	
Individual Storage						
Release from existing excess storage (for Public Water Supply only)						100% 0.60 mg
Groundwater Development	100% 0.20 mg				100% 6.41 mg	100% 0.60 mg

[a]Table entries list the percentage of the total need which could be satisfied by the listed alternative and the equivalent allocated storage required to meet that percentage of the need. See Appendix B-3 for more detailed description of this table.

[b]Stream or stream reaches on which consumptive water use will occur by 1990 and the associated watershed(s).

[c]Makeup required by each category of water use. Daily requirements are listed in million gallons per day (mgd) and storage requirements for low flow periods are listed in million gallons (mg).

VII					
Mahoning Creek ....D P.W.S.[g] ....0.01 mgd/0.20 mg Industry ....0.15 mgd/1.70 mg Total[d] ....0.16 mgd/1.9 mg	Subbasin 17 ....Remainder Agriculture-Golf ....0.88 mgd/13.6 mg	Downstream Users In Subbasins 18 and 20	Total Annual Available Storage[e] (million gallons)	Satisfied 1990 Need[f] (million gallons)	Remarks
			579.0	579.0	
			440.0	440.0	
		1,341.7 mg	See Remarks	2,336.4	Further study for possible reauthorization
	100% 13.6 mg			13.6	Applicable to Agriculture and Golf courses with scattered and unknown locations
				0.60	Release from existing excess storage from the Brookville Borough Water Department will solve its total need
100% 1.90 mg				9.10	Groundwater development in Pottsville, Allegheny, Conemaugh and/or Pocono Groups

[d]Total Storage Requirement

[e]Total annual storage available for beneficial use. Does not include flood control storage.

[f]Summation of all needs which could be satisfied by the alternative identified in column 1.

[g]P.W.S.: Public water supply.

Table 27

SCREENING ASSESSMENT OF CONSUMPTIVE USE MAKEUP STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Potential COE Conewango Creek Reservoir above Waterboro, New York	For Further Details See Table 34					
Potential COE Brokenstraw Creek Site on Brokenstraw Creek above Garland, Pennsylvania -AT THE DAMSITE			-Enhance potential recreational development with a permanent surface water lake of 360 acres -Projected annual recreation visitation: 328,000 visitor-days -Potential for addition of 18,800 fisherman-days -Recreation facilities will draw visitors from other regions, increasing economic activity and remaining tax base -Increase in employment during construction	-Loss of agriculture land, forestland & state game land -Potential mineral resource area -Relocation of approximately 70 households -Relocation of Pa. 77, 426 and several local secondary roads -Affect utilities -Could affect Conrail -Could alter aesthetic quality -Could affect large and small game hunting -Could offset aquatic life & fish habitat significantly since stream is stocked with trout -Affect some wildlife and vegetation -Wild & Scenic River Candidate-1st priority -Permanent inundation of 360 acres and periodic inundation of 4,360 acres of land when storage is full	-Potential COE Conewango Reservoir -Potential COE St. Petersburg Reservoir -Possible reauthorization of use for consumptive use makeup for existing Allegheny Reservoir -Nonstructural flood control measures	

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 27 (Cont.)

SCREENING ASSESSMENT OF CONSUMPTIVE USE MAKEUP STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
-DOWNSTREAM EFFECTS	417 FC only	957 FC only	-Provides storage for consumptive use makeup needs on the Allegheny River in Subbasins 16,17 & 18 and Ohio River in Subbasin 20 -Reduces flood damages on Brokenstraw Creek and Allegheny River in Subbasins 16,17 & 18 -Protection of floodplain and openspace -Improve water quality during low flow periods -Provide flood protection to natural and geologically unique areas, historical and archaeological sites	-Could encourage more development or encroachment on the floodplain -Recreational development downstream may adversely offset the natural state of the area -Modifies fish production and movement		
Potential COE St. Petersburg Lake on Clarion River, 5 miles above the mouth						
-AT THE DAMSITE			-Enhances potential recreational development with a permanent surface water lake of 499 acres and 9 general recreation area with public use facilities –12-mile scenic river corridor linking recreation areas with existing state parks, forests, and game preserves and Allegheny National Forest -Potential development of power generation with a capacity of 420 megawatts	-Loss of agricultural and forestland, and partial loss in State Game Land Nos. 63, 72 & 74 -Relocation of approximately 150 families in Callensburg Borough & part of Sligo Borough -Relocation of 28 miles of state and township roads significantly, Pa. 338, 478 & 68 and U.S. 322 -Relocating a section of	-Potential COE Conewango Reservoir -Potential COE Brokenstraw Creek Reservoir -Possible reauthorization of use for consumptive use makeup in existing Allegheny Reservoir -Nonstructural flood control solutions	

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 27 (Cont.)

SCREENING ASSESSMENT OF CONSUMPTIVE USE MAKEUP STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
St. Petersburg (Cont.)			-Projected annual recreation visitation: 3,360,000 visitor-days -Acid drainage abatement and strip mine reclamation program for backfilling or otherwise treating about 20,000 acres of stripped and deep mined land -Increase in employment during construction -Potential development of about 30,000 acres in surrounding areas for industrial, commercial and residential use	Conrail and B & O Railroads and construction of 4 bridges and 2 tunnels -Relocation of 19 miles of gas lines & 12 miles of oil lines; plugging of 600 active and abandoned gas & oil wells -Possible relocation of 2 public cemeteries -Could affect utilities -Could alter aesthetic quality & large game hunting -Affect some wildlife and vegetation -Wild & Scenic River Candidate-1st priority "Scenic" -Permanent inundation of 499 acres and periodic inundation of 13,600 acres of land when storage is full		
-DOWNSTREAM EFFECTS	2,317 FC only within Pa.	9,018 FC only within Pa.	-Provides storage for consumptive use makeup needs on the Allegheny River in Subbasins 17 & 18 and the Ohio River in Subbasin 20 -Reduces flood damages on Clarion River and Allegheny River in Subbasins 17 & 18 and Ohio River in Subbasin 20	-Could encourage more development or encroachment on the floodplain -Modifies fish production and movement -Recreational development downstream may adversely offset the natural state of the area		

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 27 (Cont.)

SCREENING ASSESSMENT OF CONSUMPTIVE USE MAKEUP STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
			-Protection of floodplain and open space -Improve water quality during low flow periods -Provides flood protection to natural and geologically unique areas, historical and archaeological sites -Potential development of 2,500 acres of industrial land sites on Allegheny River			
Small Potential Reservoir #16–2 on East Branch LeBoeuf Creek	28.2 FC only	58.2 FC only	-Provides storage for consumptive use makeup needs on Allegheny River in Subbasin 17 and to upstream users in Subbasin 16 -Reduces flood damages -Potential recreational area	-Loss of forestland in Allegheny National Forest -Potential mineral resource area -Affect some vegetation and wildlife -Could affect aquatic life & fish habitat -Could affect large game hunting -Could alter aesthetic quality -Temporary inundation of 602 acres when reservoir is full	-Any one of these potential COE reservoirs: 1) Conewango Cr. 2) Brokenstraw Creek 3) St.Petersburg on Clarion River -Small potential reservoir #20–4 -Possible reauthorization of use for consumptive use makeup for any of these existing facilities: 1) Allegheny Res. 2) Woodcock Lake 3) E.Br.Clarion River Lake -Nonstructural flood control measures	

[a] Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 27 (Cont.)

SCREENING ASSESSMENT OF CONSUMPTIVE USE MAKEUP STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Small Potential Reservoir Site #20–4 on Rocky Run	For Further Details See Table 34					
Small Potential Reservoir #3 on Beaverdam Run			-Provides storage for consumptive use makeup needs on Allegheny River in Subbasins 17 & 18 and Ohio River in Subbasin 20 -Potential recreational use	-Loss of forest and agriculture land -Potential limestone resources area -Relocation of secondary roads and Pa.Rt.830 -Loss of vegetation and wildlife -Alters aquatic life and fish habitat -Could affect large and small game hunting -Could alter aesthetic quality	-Potential COE reservoir on Conewango Creek -Potential COE reservoir on Broken-straw Creek -Potential COE St.Petersburg Reservoir on Clarion River -Possible reauthorization of use for consumptive use makeup for existing Allegheny Reservoir or the East Branch Clarion River Lake	

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

significantly different than presently authorized uses, then a request would be submitted to Congress for funding a reauthorization study. The study, which would include public hearings, would be similar to a study conducted for original authorization. If the study results were favorable, then recommendations for reauthorization would be presented to Congress; and if approved by Congress, reauthorized uses would be instituted.

Temporary modifications of production techniques or output may be possible for some industrial users or possibly even agricultural irrigation users. Production of some product lines could be curtailed temporarily with emphasis shifted to other lines. Output could be reduced, with increased levels of production compensating later to achieve the same long-term production totals. Irrigators may alter their irrigation schedules to decrease the consumptive levels.

Many water users have more than one source of water. Industries may have surface or groundwater sources in addition to connections to public water supply systems. Interconnections also exist between public water suppliers. Some users have excess capacity through combinations of surface and groundwater sources. Alternative sources may allow these users to continue operations if low flow conditions do not affect all their sources concurrently.

If improved management of existing resources is insufficient to provide for makeup needs, then it will become necessary to consider new development of structural measures. Users may develop storage individually or collectively. Irrigators could construct ponds or dams on small watersheds. Industries and utilities could construct dams to provide storage or may be able to increase storage behind existing structures. Several users could jointly construct upstream reservoir storage or may purchase storage from public reservoirs upstream. Groundwater development may be a viable alternative for some users. Combinations of alternatives may be preferable or even necessary for other users.

Table 25 lists storage requirements which would be necessary to provide the daily consumptive use makeup during the critical duration period of the low flow if a user were to choose storage as a prefered alternative. The critical duration period was determined from historical streamflow records and equals the largest total number of days that streamflows were below $Q_{7\text{-}10}$ during any year of record. Storage was computed as the product of daily consumptive use multiplied by the number of days of critical duration. That product was then increased by a 25 percent safety factor as before.

Viable alternative solutions to the consumptive use makeup needs in Subbasin 17 are presented in Table 26. Existing or potential reservoirs which have been considered are mapped either on Figure 11 if located within the subbasin, or on Figure 12 if located upstream of the subbasin. Table 27 provides a quick examination of the economic, social and environmental factors associated with the structural solutions. Chapter VI presents a discussion of the physical, environmental and social implications of the major structural alternatives.

To briefly summarize Table 26, three potential Corps of Engineers reservoir sites and three small potential reservoirs have been investigated along with groundwater development and individual storage, and releases from existing excess storage (for public water supply only). Also, three existing reservoirs, Allegheny Reservoir on the Allegheny River, Woodcock Creek Lake on Woodcock Creek, and the East Branch Clarion River Lake on the East Branch Clarion River, which have recreation and/or low flow augmentation functions have been investigated as solution alternatives for consumptive water use makeup need in this subbasin. Currently, under Section 22, Public Law 93-251 (Water Conservation Plans), the Army Corps of Engineers, Pittsburgh District, is authorized to cooperate with the Commonwealth of Pennsylvania to prepare a report investigating the capability of Allegheny River Reservoir to provide storage for water supply (including consumptive use makeup) needs, either by operating rules revisions or by physical modifications to the structure. An encouraging result has been indicated in the study for solving the water supply problems along the Allegheny River main stem.

B. FLOOD DAMAGE REDUCTION

Floods are natural occurrences that cause damages and loss of life, primarily as a result of man's use of, and encroachment upon, the floodplains. Because of this continued encroachment, flood damages have been increasing on a regular basis.

The State Water Plan has addressed the problems associated with riverine flooding. The damage figures utilized in the analyses are based on historical damages and do not consider damages which may result from future development. The Plan has not examined stormwater runoff on a community basis; however, it is recognized that the problems associated with stormwater runoff are becoming increasingly serious. Development actions such as the removal of vegetation and large scale resurfacing and drainage systems are increasing both the quantity and rate of runoff, resulting in many new localized flood problems, as well as exacerbating existing ones.

1. PROBLEMS

Subbasin 17 has experienced a significant amount of flood damage during the past half century. However, flooding conditions in many communities and stream reaches have been averted by structural measures provided by Federal and State government.

Major floods have occurred in this subbasin in 1936, 1942, 1950, 1959, 1964 and 1972. The largest amount of damage ever recorded in the subbasin was caused by the 1936 flood. As a result of rain, melting snow and ice jams in the Allegheny River and its tributaries, this flood hit hard all over the subbasin. Flood damage from the 1972 flood has been recorded in Watersheds A, C and E with the largest damage occurring in Watershed C.

(Continued on page 96)

Table 28

FLOOD DAMAGE CENTERS

Watershed	Legend (See Figure 13)	Damage Center – Stream	Highest Flood Damages Recorded Prior to 1969		"Agnes" 1972
			Flood Date	Damages[a] ($1,000)	Damages[b] ($1,000)
A	1	Wilcox – West Branch Clarion River	7/42	514	
A	2	Johnsonburg Borough – Clarion River	7/42	1,131	72
A	3	Ridgway Borough – Clarion River	3/36	1,558	458
A	4	St. Marys Borough – Elk Creek	11/50	163	103
A	5	Brockway Borough – Little Toby Creek	3/36	1,991	
B	6	Clarion Borough – Clarion River	1/59	719	
C	7	Parker City – Allegheny River	1/59	1,158	
C	8	West Monterey – Allegheny River	1/59	440	
C	9	East Brady Borough – Allegheny River	2/61	136	53
C	10	New Bethlehem Borough – Redbank Creek	3/36	442	87
C	11	Brookville Borough – Sandy Lick and Redbank Creeks	3/36	3,023	
C	12	DuBois City – Sandy Lick Creek	3/36	2,172	1,233
C	13	Reynoldsville Borough – Sandy Lick Creek	3/36	10,335	226

[a]1976 Price Level

[b]Damages (1976 price level) are based on zip code areas which may not strictly coincide with municipal boundaries.

Table 28 (Cont.)

FLOOD DAMAGE CENTERS

Watershed	Legend (See Figure 13)	Damage Center – Stream	Highest Flood Damages Recorded Prior to 1969		"Agnes" 1972
			Flood Date	Damages[a] ($1,000)	Damages[b] ($1,000)
D	14	Sykesville Borough – Stump Creek	3/36	409	
D	15	Big Run Borough – Mahoning Creek	3/36	252	
D	16	Punxsutawney Borough – Mahoning Creek	3/36	12,344	
D	17	Rimer – Allegheny River	3/64	85	
D	18	Mahoning Township – Allegheny River	2/66	250	
E	19	Tarrtown – Allegheny River	3/65	78	
E	20	Kittanning Borough – Allegheny River	1/59	1,647	92
E	21	Applewood Borough – Allegheny River	3/36	188	
E	22	McCain – Allegheny River	3/36	60	
E	23	Manorville Borough – Allegheny River	3/36	172	
E	24	Ford City Borough – Allegheny River	1/37	141	54
E	25	Rosston – Allegheny River	3/36	98	
E	26	Logansport – Allegheny River	3/36	210	

[a]1976 Price Level

[b]Damages (1976 price level) are based on zip code areas which may not strictly coincide with municipal boundaries.

Table 29

CORPS OF ENGINEERS IDENTIFIED DAMAGE REACHES

Watershed	Legend (See Figure 13)	Damage Reach – Stream	Highest Flood Damages Recorded Prior to 1969		"Agnes" 1972
			Flood Date	Damages[a] ($1,000)	Damages[a] ($1,000)
D	C/R1	Headwaters to Mouth – Glade Run	3/36	40	

[a]1976 Price Level

Table 30

SOIL CONSERVATION SERVICE IDENTIFIED DAMAGE REACHES

Watershed	Legend (See Figure 13)	Damage Reach – Stream	Average Annual Flood Damages ($1,000[a])
A	S/R5	2-Mile Stretch from Mouth – Powers Run	2
C	S/R6	Brookville to Summerville – Redbank Creek	17
C	S/R7	Headwaters to Bruin – South Bear Creek	21
D	S/R3	6-Mile Stretch From Mouth – Little Mahoning Creek	10
D	S/R4	Salisgiver Run to Crooked Run – Little Mahoning Creek	6
E	S/R1	Curry Run to Plum Creek – Crooked Creek	4
E	S/R2	Headwaters to Mouth – Garrett Run	14

[a]1976 price level.

a. *Study Units, Flood Damage Centers and Reaches*

A damage center was identified wherever damages for one flood in a community totalled $25,000 or more at the 1969 price level ($45,000 or more at the 1976 price level). A damage reach was identified wherever the *average annual* flood damages per mile of stream length totalled $500 or more at the 1969 price level ($900 or more at the 1976 price level). Flood damage centers and reaches identified in this subbasin are listed in Tables 28, 29 and 30 and are shown on Figure 13. In all, 26 damage centers and 8 damage reaches have been identified in this subbasin.

After damage centers and reaches were identified, they were grouped into different watersheds based on their locations within the subbasin. A watershed or a group of watersheds was then used as a unit for studying basinwide flood damage reduction needs. According to similarities in watersheds and flood characteristics, four study units were delineated in this subbasin. These study units are: 1) Watersheds A and B, the Clarion River Basin, to the confluence with the Allegheny River, 2) Watershed C, the Allegheny River Basin, from the mouth of Clarion River to the mouth of Redbank Creek (including the Redbank Creek Basin), 3) Watershed D, the Allegheny River Basin, from the mouth of Redbank Creek to the

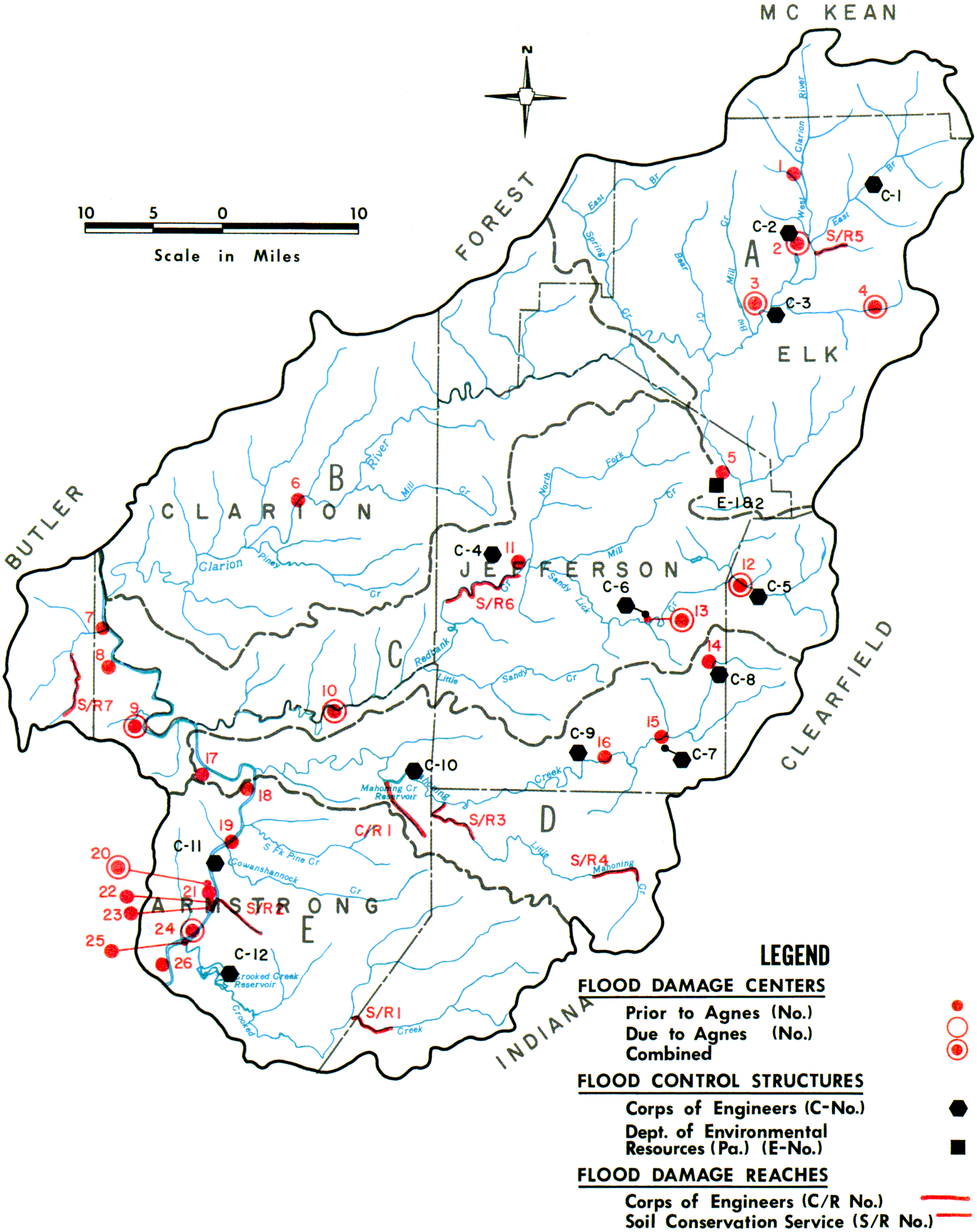

FIGURE 13. Flood Damage Areas and Flood Control Structures

Table 31

STUDY UNIT DAMAGES AND BENEFITS[a]

Study Unit	Drainage Area (Sq.Mi.)	Total Natural Annual Damages[b] ($1,000)	Total Annual Benefits of Existing Projects ($1,000)	Total Residual Annual Damages ($1,000)
Watersheds A,B	1,256	1,198	1,005	193
Watershed C	728	1,150	936	214
Watershed D	444	4,329	4,279	50
Watershed E	503	632	456	176

[a]Based on tangible damages only. All dollar figures are listed at 1976 price level.

[b]Average annual damage without any flood protection measures.

mouth of Mahoning Creek (including the Mahoning Creek Basin), and 4) Watershed E, the Allegheny River Basin, from the mouth of Mahoning Creek to the point where the Allegheny River flows out of this subbasin.

The Department of Environmental Resources regularly receives requests from government officials or citizens seeking assistance in connection with a specific flood problem in their community. Usually these communities have been identified in a State or Federal flood damage inventory and, therefore, are already identified as damage centers. However, there are exceptions. Documented flood damage surveys and inventories are generally expensive and difficult to conduct. As a result, a local problem may not be identified as a damage center. Those communities are listed in Table 32 as a *Special DER Study Area*.

b. *Existing Flood Damage Reduction Measures*

Flood damage reduction measures can be either structural or nonstructural. Structural measures including reservoirs, levees, floodwalls and channel modifications are currently being used to reduce flood damages in this subbasin. Flood control structures, both existing and under construction, are shown on Figure 13 and listed in Appendices C-1 and C-2.

The U.S. Army Corps of Engineers has 12 completed flood control projects, which are located in and benefitting this subbasin to a great extent. East Branch Clarion River Lake has been reducing flood damages along the Clarion River and along the Allegheny River, downstream from the mouth of the Clarion River. Mahoning Creek Reservoir has been reducing flood damages along Manoning Creek downstream from the location of the reservoir, and also along the Allegheny River, downstream from the mouth of Mahoning Creek. The Crooked Creek Reservoir has been reducing flood damages along Crooked Creek downstream from the location of the reservoir, and also along the Allegheny River, downstream from the mouth of Crooked Creek. In addition, two completed Corps of Engineers' reservoirs, namely Allegheny and Tionesta Reservoirs, located upstream in Subbasin 16, have been reducing flood damages along the Allegheny River within this subbasin. Eight channel improvement projects, two located in Watershed A in Johnsonburg Borough and Ridgway Borough; three in Watershed C in Brookville Borough, DuBois City and Reynoldsville Borough; and three in Watershed D in Big Run Borough, Sykesville Borough and Punxsutawney Borough have been reducing flood damages in these areas. Lastly a concrete floodwall in Watershed E, has been reducing flood damages in Kittaning Borough.

The Department of Environmental Resources has two completed local flood control projects in Brockway Borough in Watershed A, which have helped this area and its vicinity by reducing flood damages.

It should be noted that these structural measures are not total solutions to the flooding problem. A combination of increased runoff and more damage-prone investment in flood hazard areas erodes the effectiveness of structural measures. Flood protection projects are designed to protect a community against a certain design flood stage. If a flood occurs which exceeds the design criteria, flood damages will again occur. Another problem arises when the community fails to undertake effective stormwater planning and management. The results of such inaction may become obvious during periods of heavy rainfall.

c. *Residual Annual Damages*

Historical flood damage events and the frequency of their occurrence have been analyzed to develop the flood damage and frequency curves shown on Figure 14. These curves may be used to determine average annual flood damages. A weighted average of the frequent small flood events with the less frequent but larger flood events would yield *natural annual* flood damages, or the average damages that would occur on a yearly basis in the absence of existing flood control projects.

Existing flood control projects reduce the natural annual damage. By subtracting the total annual flood control benefits of all existing projects from the natural annual damage, the *residual* annual damage or the present day flood control need of the study unit was determined.

The results of those analyses are presented in Table 31.

In the future, the residual annual flood damages will certainly increase if present action is not taken to manage floodplain development. Areas that warrant immediate attention are areas that have projected population increases. From a flood control viewpoint, intelligent and proper management of this population development is absolutely essential for a community which may be concerned about reducing its flood damages.

d. *Flood Plain Information and Flood Warning System*

Nonstructural measures such as floodplain regulation or flood proofing require adequate flood plain information. Another nonstructural measure, flood forecasting, requires a timely and accurate flood forecasting and warning system. A final measure, flood insurance, which is designed to reduce the financial impact of a flood, also requires floodplain delineation. At this time, the availability of this information is limited. The status of floodplain information prepared or under preparation by the U. S. Army Corps of Engineers and the floodplain mapping effort completed by the U. S. Geological Survey (U.S.G.S.) are listed in Appendices C-3 and C-4. Currently, the U.S.G.S. in cooperation with the State is mapping the damage centers and reaches within the State.

Another effort, currently being conducted by the U.S. Department of Housing and Urban Development (HUD), is known as a Type 15 Flood Insurance Study. This study has been or will be completed for those communities which have qualified for flood insurance (See Table 32) under the National Flood Insurance Program. Contained in the study will be the identification of flood hazard areas, the development of flood frequency data, and the computation and mapping of proposed floodway data. Because of their detailed information, these HUD studies should be used in place of any other mapping. A list of completed HUD studies is provided in Appendix C-5.

The Pennsylvania Department of Community Affairs is the State coordinative agency for Federal Flood Insurance and urban development programs. It provides advisory and financial assistance to municipalities in implementing and administering various municipal programs related to floodplain management. It has adopted regulations concerning flood-proofing of buildings in State-assisted redevelopment projects.

2. ALTERNATIVE SOLUTIONS TO EXISTING FLOOD DAMAGE PROBLEMS

Alternative measures were examined as possible means of reducing the flood damage threat to existing floodplain development. Future development on the floodplain should comply strictly with effective floodplain management objectives and regulations, and in no case should future development be used as justification for funding flood protection measures. The measures investigated for flood damage reduction are as follows:

a. Nonstructural Measures (Managing existing resources)

   (1) Floodplain regulation promotes proper management of and control over the type of development that occurs in the flood plain.

   (2) Flood insurance lessens economic burden on floodplain occupants and leads to reduction of future damage potential.

   (3) Permanent flood proofing aids floodplain occupants and reduces future damage potential in areas where major structural solutions are not feasible.

   (4) Flood forecasting provides time for warning and response in order to save life and property damage.

b. Structural Measures (New development)

   (1) Levee and/or Floodwall

   (2) Channel Modification

   (3) Reservoirs, including small potential and Corps of Engineers potential reservoir sites.

The principles, advantages and disadvantages of these measures are discussed in "Planning Principles". It must be emphasized that the measures listed above may be investigated and utilized individually or in combination. Indeed, a combination of several measures may furnish the most desirable solution.

One nonstructural measure which is applicable in all small stream watersheds is the Self-Help Flood Forecasting and Warning System. This system, designed to issue flood forecasts to flood-prone communities, utilizes the following information:

a. Precipitation – type, amount and intensity

b. Runoff rate

c. Measured streamflow

d. Flood crest travel time

The National Weather Service has assisted some communities in assembling this information into a useful format. When a threat of flooding occurs, local officials will have the ability to issue a flood warning. As the name "Self-Help" implies, the success of this system depends upon the willingness of the local people to get involved during an emergency situation and help themselves.

All the nonstructural and structural concepts were investigated for each damage center or damage reach in an attempt to identify possible flood damage reduction alternatives. However, in an initial screening evaluation, certain structural alternatives were eliminated because of major economic, physical, social or environmental restraints. The remaining alternatives are listed in Table 32. The table lists the damage centers and reaches identified in this subbasin, the damage reduction due to existing and funded proposed structures as a percentage of natural annual damage, the residual annual damage (or current annual damage), and nonstructural and structural measures. For structural measures, the table also lists the estimated average annual benefit for a damage center or a damage reach. The entry of each column on this table is

(Continued on page 119)

Table 32

FLOOD DAMAGE REDUCTION SOLUTION ALTERNATIVES[a]

Legend (See Figure 13)	Damage Center or Reach (Stream)	Percentage Reduction In Natural Annual Damages Due to: Existing Projects or Projects Under Construction	Percentage Reduction In Natural Annual Damages Due to: Funded Proposed Projects	Residual Annual Damages ($1,000)	Nonstructural Measures: Flood Plain Regulation[b]	Nonstructural Measures: Eligible for Flood Insurance[c]	Nonstructural Measures: Permanent Flood Proofing	Nonstructural Measures: Flood Forecasting
	Study Unit A,B							
1	Wilcox (West Branch Clarion River)			48.9	◆	◆	◆	
2	Johnsonburg Borough (Clarion River)	99[(2)]		3.9	◆	◆		
3	Ridgway Borough (Clarion River)	87[(3)]		50.7	◆	◆		◆
4	St. Marys Borough (Elk Creek)			36.2	◆	◆		
5	Brockway Borough (Smith Run)	85[(5)]		34.8	◆	◆	◆	
6	Clarion Borough (Clarion River)	76[(7)]		16.3	◆	◆		◆
S/R5	2-Mile Stretch from Mouth (Powers Run)			2.2	◆	◆		

[a]All numbers are DER estimates unless otherwise noted. **See Appendix C-6 for more detailed explanation of this table.**

[b]Applies to all damage centers and reaches, more particularly to future than existing development; however, floodplain mapping is required for effective implementation. Indicates that floodplain mapping has been completed by U.S.G.S., the U.S. Army Corps of Engineers, or a consulting firm. *Indicates that floodplain mapping has not been completed.

		Structural Measures (Estimated Average Annual Benefit)[d]	Corps of Engineers Potential Reservoir Sites				
Levee or Floodwall	Channel Modification	Small Potential Reservoir Site	Conewango Creek Reservoir	Brokenstraw Creek Reservoir	St. Petersburg Reservoir	Combined Effects Of Corps of Engineers Potential Reservoirs	Remarks
		23.0[(1)]					(1) Small Potential Reservoirs #20–2 and #20–4
							(2) Completed COE project C2. See Appendix C-1 for detailed information.
	[(4)]						(3) Completed COE projects C1 & C3. See Appendix C-1 for detailed information. (4) Authorized COE project on Clarion River. Currently being restudied with respect to environmental issues.
	34.4						
	21.3[(6)]						(5) Completed DER projects E1 & E2. See Appendix C-2 for detailed information. (6) Fund requested by DER for construction of project on Smith Run.
							(7) Completed COE project C1. See Appendix C-1 for detailed information.

[c]Does not serve to reduce existing flood hazard, but rather lessens the economic burden of flooding on flood plain occupants. Land use regulations required for participation in HUD's National Flood Insurance Program will effectively reduce future damage potential and control future flood plain development. Indicates eligibility as of December, 1977.

[d]Average annual benefits in thousand dollars (1976 price level) are planning guidelines only, not to be used for project budgeting or design.

[e]Residual annual damage may be reduced because of an existing or a proposed Disaster Urban Renewal Project.

Table 32 (Cont.)

FLOOD DAMAGE REDUCTION SOLUTION ALTERNATIVES[a]

Legend (See Figure 13)	Damage Center or Reach (Stream)	Percentage Reduction In Natural Annual Damages Due to: Existing Projects or Projects Under Construction	Funded Proposed Projects	Residual Annual Damages ($1,000)	Nonstructural Measures: Flood Plain Regulation[b]	Eligible for Flood Insurance[c]	Permanent Flood Proofing	Flood Forecasting
	Study Unit C							
7	Parker City (Allegheny River)	94		6.7	◆	◆		◆
8	West Monterey (Allegheny River)	94		2.4	◆	◆		◆
9	East Brady Borough (Allegheny River)	94		2.4	◆	◆		◆
10	New Bethlehem Borough(8) (Redbank Creek)			81.6	◆	◆		
11	Brookville Borough (Sandy Lick & Redbank Creek)	97(9)		9.6	◆	◆		
12	DuBois City (Sandy Lick Creek)	96(10)		14.3	◆	◆		
13	Reynoldsville Borough (Sandy Lick Creek)	68(11)		59.9	◆	◆		
S/R6	Brookville to Summerville (Redbank Creek)			16.7	◆	◆		
S/R7	Headwaters to Bruin (South Branch Bear Creek)			20.8	◆	◆		
	Special DER Study Area							
	Reynoldsville Borough (Soldiers Run & Pitchpine Run)			(12)				

[a]All numbers are DER estimates unless otherwise noted. See Appendix C-6 for more detailed explanation of this table.

[b]Applies to all damage centers and reaches, more particularly to future than existing development; however, floodplain mapping is required for effective implementation. Indicates that floodplain mapping has been completed by U.S.G.S., the U.S. Army Corps of Engineers, or a consulting firm. *Indicates that floodplain mapping has not been completed.

Levee or Floodwall	Channel Modification	Small Potential Reservoir Site	Conewango Creek Reservoir	Brokenstraw Creek Reservoir	St. Petersburg Reservoir	Combined Effects Of Corps of Engineers Potential Reservoirs	Remarks
			Structural Measures (Estimated Average Annual Benefit)[d] Corps of Engineers Potential Reservoir Sites				
			4.7	3.1	6.3	6.3	
			1.6	1.1	2.2	2.2	
			1.6	1.1	2.2	2.2	
72.6							(8) COE Study completed
							(9) Completed COE project C4. See Appendix C-1 for detailed information.
							(10) Completed COE project C5. See Appendix C-1 for detailed information.
39.5							(11) Completed COE project C6. See Appendix C-1 for detailed information.
							(12) DER study completed

[c]Does not serve to reduce existing flood hazard, but rather lessens the economic burden of flooding on flood plain occupants. Land use regulations required for participation in HUD's National Flood Insurance Program will effectively reduce future damage potential and control future flood plain development. Indicates eligibility as of December, 1977.

[d]Average annual benefits in thousand dollars (1976 price level) are planning guidelines only, not to be used for project budgeting or design.

[e]Residual annual damage may be reduced because of an existing or a proposed Disaster Urban Renewal Project.

Table 32 (Cont.)

FLOOD DAMAGE REDUCTION SOLUTION ALTERNATIVES[a]

Legend (See Figure 13)	Damage Center or Reach (Stream)	Percentage Reduction In Natural Annual Damages Due to: Existing Projects or Projects Under Construction	Percentage Reduction In Natural Annual Damages Due to: Funded Proposed Projects	Residual Annual Damages ($1,000)	Nonstructural Measures: Flood Plain Regulation[b]	Nonstructural Measures: Eligible for Flood Insurance[c]	Nonstructural Measures: Permanent Flood Proofing	Nonstructural Measures: Flood Forecasting
	Study Unit D							
14	Sykesville Borough (Stump Creek)	98[13]		0.7	◆	◆		
15	Big Run Borough (Mahoning Creek)	98[14]		0.7	◆	◆		
16	Punxsutawney Borough (Mahoning Creek)	99[15]		27.3	◆	◆		◆
17	Rimer (Allegheny River)	90		0.5	◆			◆
18	Mahoning Township (Allegheny River)	89		1.8	◆			◆
C/R1	Headwaters to Mouth (Glade Run)			2.7	◆	◆		
S/R3	6-Mile Stretch from Mouth (Little Mahoning Creek)			10.5	◆			
S/R4	Salisgiver Run to Crooked Run (Little Mahoning Creek)			6.3	◆			

[a]All numbers are DER estimates unless otherwise noted. See Appendix C-6 for more detailed explanation of this table.

[b]Applies to all damage centers and reaches, more particularly to future than existing development; however, floodplain mapping is required for effective implementation. Indicates that floodplain mapping has been completed by U.S.G.S., the U.S. Army Corps of Engineers, or a consulting firm. *Indicates that floodplain mapping has not been completed.

Structural Measures (Estimated Average Annual Benefit)[d]							
			Corps of Engineers Potential Reservoir Sites				
Levee or Floodwall	Channel Modification	Small Potential Reservoir Site	Conewango Creek Reservoir	Brokenstraw Creek Reservoir	St. Petersburg Reservoir	Combined Effects Of Corps of Engineers Potential Reservoirs	Remarks
							(13) Completed COE project C8. See Appendix C-1 for detailed information.
							(14) Completed COE project C7. See Appendix C-1 for detailed information.
							(15) Completed COE project C9. See Appendix C-1 for detailed information.
			0.2	0.2	0.5	0.5	
			0.7	0.5	1.8	1.8	

[c]Does not serve to reduce existing flood hazard, but rather lessens the economic burden of flooding on flood plain occupants. Land use regulations required for participation in HUD's National Flood Insurance Program will effectively reduce future damage potential and control future flood plain development. Indicates eligibility as of December, 1977.

[d]Average annual benefits in thousand dollars (1976 price level) are planning guidelines only, not to be used for project budgeting or design.

[e]Residual annual damage may be reduced because of an existing or a proposed Disaster Urban Renewal Project.

Table 32 (Cont.)

FLOOD DAMAGE REDUCTION SOLUTION ALTERNATIVES[a]

Legend (See Figure 13)	Damage Center or Reach (Stream)	Percentage Reduction In Natural Annual Damages Due to: Existing Projects or Projects Under Construction	Percentage Reduction In Natural Annual Damages Due to: Funded Proposed Projects	Residual Annual Damages ($1,000)	Nonstructural Measures: Flood Plain Regulation[b]	Nonstructural Measures: Eligible for Flood Insurance[c]	Nonstructural Measures: Permanent Flood Proofing	Nonstructural Measures: Flood Forecasting
	Study Unit E							
19	Tarrtown (Allegheny River)	69		2.0	◆	◆	◆	◆
20	Kittanning Borough (Allegheny River)	75(16)		125.2	◆	◆		◆
21	Applewood Borough (Allegheny River)	70		7.2	◆	◆		◆
22	McCain (Allegheny River)	69		2.7	◆	◆	◆	◆
23	Manorville Borough (Allegheny River)	70		6.5	◆	◆	◆	◆
24	Ford City Borough (Allegheny River)	70		5.1	◆	◆		◆
25	Rosston (Allegheny River)	70		3.6	◆	◆	◆	◆
26	Logansport (Allegheny River)	70		5.3	◆	◆	◆	◆
S/R1	Curry Run to Plumb Creek (Crooked Creek)			4.2	◆	◆		
S/R2	Headwaters to Mouth (Garrett Run)			14.5	◆	◆		

[a]All numbers are DER estimates unless otherwise noted. See Appendix C-6 for more detailed explanation of this table.

[b]Applies to all damage centers and reaches, more particularly to future than existing development; however, floodplain mapping is required for effective implementation. Indicates that floodplain mapping has been completed by U.S.G.S., the U.S. Army Corps of Engineers, or a consulting firm. *Indicates that floodplain mapping has not been completed.

Structural Measures (Estimated Average Annual Benefit)[d]				Corps of Engineers Potential Reservoir Sites			
Levee or Floodwall	Channel Modification	Small Potential Reservoir Site	Conewango Creek Reservoir	Brokenstraw Creek Reservoir	St. Petersburg Reservoir	Combined Effects Of Corps of Engineers Potential Reservoirs	Remarks
			0.2	0.1	0.5	0.7	
			11.2	6.2	46.7	61.9	(16) Completed COE projects C1, C10 & C11. See Appendix C-1 for detailed information.
			0.5	0.4	2.2	2.9	
			0.2	0.1	0.7	1.1	
			0.5	0.2	2.0	2.7	
			0.4	0.2	1.6	2.2	
			0.4	0.2	1.1	1.5	
			0.7	0.2	1.5	2.2	
		2.4(17)					(17) Small Potential Reservoir #29-8.

[c] Does not serve to reduce existing flood hazard, but rather lessens the economic burden of flooding on flood plain occupants. Land use regulations required for participation in HUD's National Flood Insurance Program will effectively reduce future damage potential and control future flood plain development. Indicates eligibility as of December, 1977.

[d] Average annual benefits in thousand dollars (1976 price level) are planning guidelines only, not to be used for project budgeting or design.

[e] Residual annual damage may be reduced because of an existing or a proposed Disaster Urban Renewal Project.

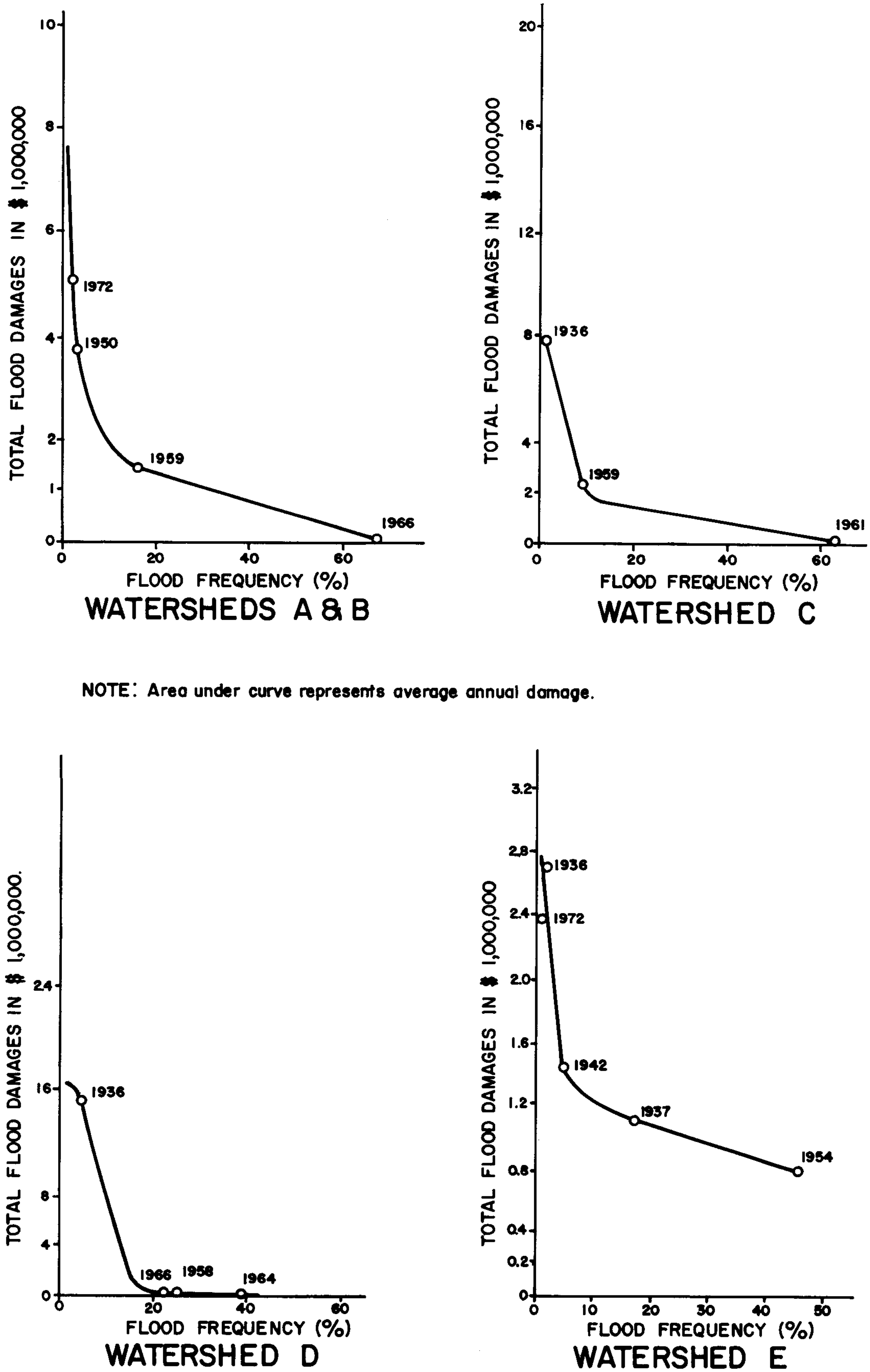

FIGURE 14. Flood Damage and Frequency Curves

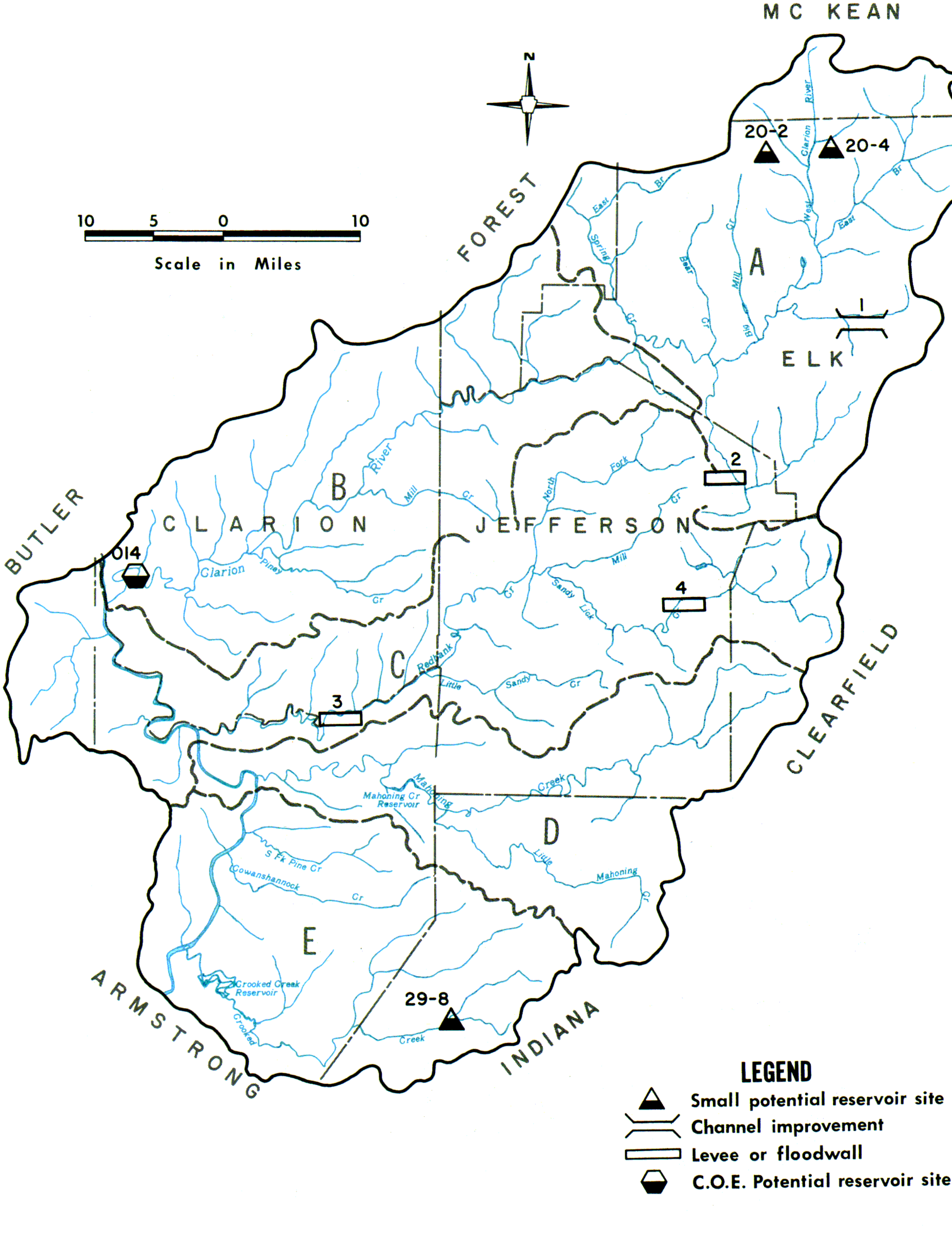

FIGURE 15. Flood Damage Reduction Structural Solution Alternatives

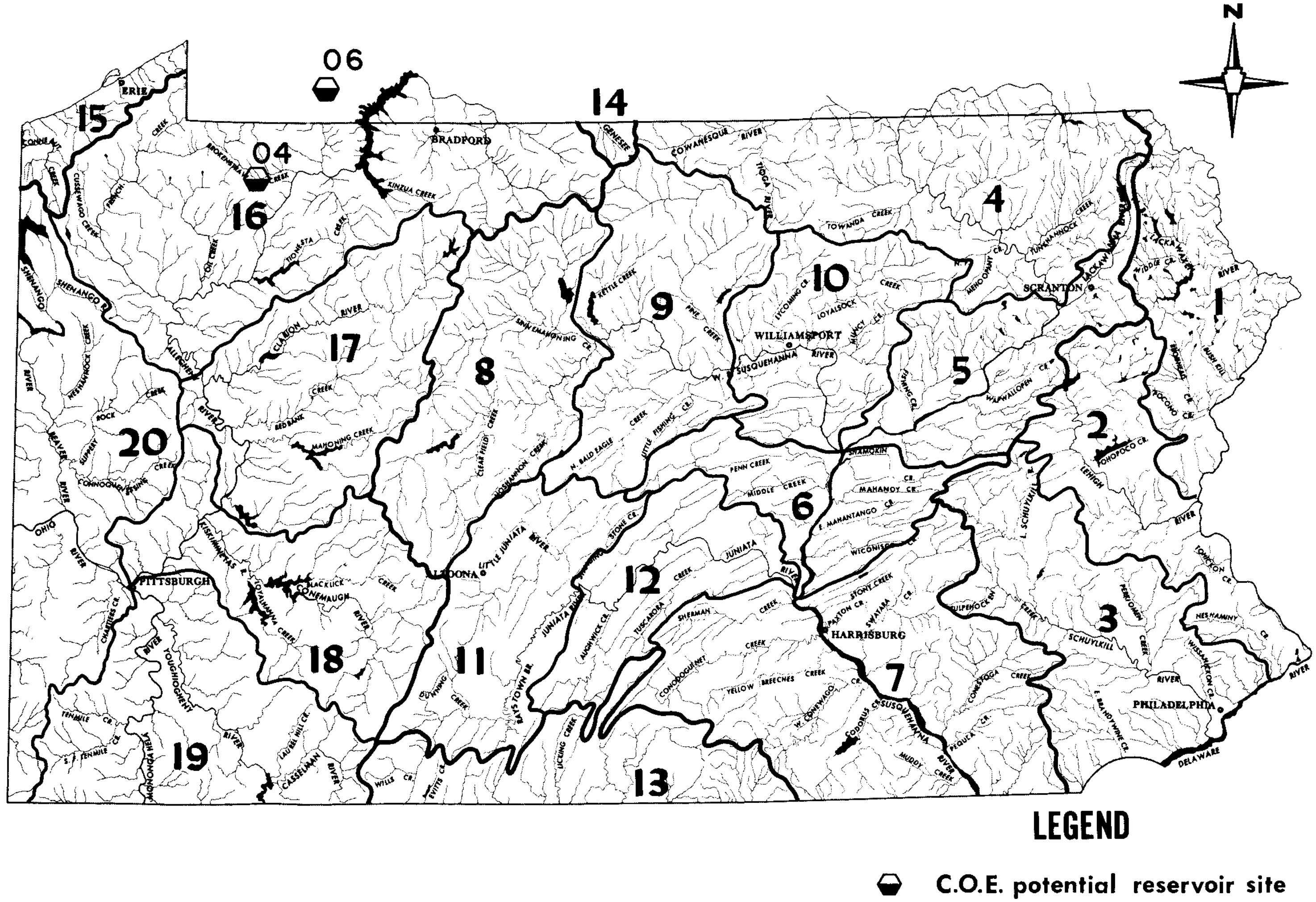

FIGURE 16. Extra-Basin Flood Damage Reduction Structural Solution Alternatives

Table 33

SUMMARY OF ALTERNATIVE STRUCTURAL SOLUTIONS

Legend (See Figures 15, 16)	Project Name	Location	Purpose	Flood Control Beneficial Area (See Table 32)	Estimated Total Annual Benefits[a]	Preliminary Total Annual Cost[a]	Remarks
	LEVEE/FLOODWALL						
4	Reynoldsville	Sandy Lick Creek	Local Flood Protection	Center 13 – Reynoldsville Borough in Study Unit C	39.5	100.7	
3	New Bethlehem	Redbank Creek	Local Flood Protection	Center 10 – New Bethlehem Borough in Study Unit C	72.6	101.8	
2	**Brockway**	**Smith Run**	**Local Flood Protection**	**Center 5 – Brockway Borough in Study Unit AB**	**21.3**	**21.4**	**Funds requested by DER for construction of project on Smith Run**
	CHANNEL MODIFICATION						
1	St. Mary's	Elk Creek	Local Flood Protection	Center 4 – St. Marys Borough in Study Unit AB	34.0	360.0	
	SMALL POTENTIAL RESERVOIR SITES						
	#20–2	**Hoffman Run**	**Multipurpose**	**Center 1 – Wilcox in Study Unit AB**	**7.2**	**7.67**	**Cost information from the Soil Conservation Service. Further study required.**
	#20–4	**Rockey Run**	**Multipurpose**	**Center 1 – Wilcox in Study Unit AB**	**15.8**	**17.20**	**Cost information from the Soil Conservation Service. Further study required.**
	#29–8	Crooked Creek	Multipurpose	Reach S/R1, in Study Unit E	2.4	51.13	Cost information from the Soil Conservation Service.

[a]All numbers are DER estimates unless otherwise noted. The annual benefits and costs (in thousand dollars, 1976 price level) are planning guidelines only, not to be used for project budgeting or design.

[b]Includes benefits and costs applicable to New York State.

Note: **BOLDFACE** indicates projects which are recommended for construction or further study.

Table 33 (Cont.)

SUMMARY OF ALTERNATIVE STRUCTURAL SOLUTIONS

Legend (See Figures 15, 16)	Project Name	Location	Purpose	Flood Control Beneficial Area (See Table 32)	Estimated Total Annual Benefits[a]	Preliminary Total Annual Cost[a]	Remarks
	CORPS OF ENGINEERS POTENTIAL RESERVOIR SITES						
06	**Conewango Creek Reservoir**	**Above Waterboro, New York**	**Multipurpose**	**Subbasin 17**	**22.9**		**This project is not currently authorized by Congress. The cost information is from the U.S. Army Corps of Engineers (Pittsburgh District).**
				Study Units CDE – Benefits the Allegheny River from the mouth of Clarion River to Clinton, Pa.			
				Subbasin 16	**31.3**		
				Subbasin 18	**907.1**		**This project is suggested for further study. The analysis should contain all multipurpose aspects including flood control, low flow augmentation, consumptive use makeup, recreation, fish and wildlife.**
				Subbasin 20	**836.5**		
				Total – Conewango Creek	**1,798.0**	**1,394.0**	
04	Brokenstraw Creek Reservoir	Above Garland, Penna.	Multipurpose	Subbasin 17	13.6		This project is not currently authorized by Congress. The cost information is from the U.S. Army Corps of Engineers (Pittsburgh District). The project does not appear to be economically feasible.
				Study Units CDE – Same area as in Conewango Creek Reservoir			
				Subbasin 16	15.1		
				Subbasin 18	388.5		
				Total – Brokenstraw Creek	417.2	956.8	
014	St. Petersburg Reservoir	Clarion River, 5.0 miles above junction with Allegheny River	Multipurpose	Subbasin 17			The project is not currently authorized by Congress. The cost information is from the U.S. Army Corps of Engineers (Pittsburgh District) The project does not appear to be economically feasible.
				Study Units CDE – Same area as in Conewango Creek Reservoir	69.3		
				Subbasin 18	1,080.3		
				Subbasin 20	1,167.7		
				Total – St. Petersburg	2,317.3	9,018.0	

[a]All numbers are DER estimates unless otherwise noted. The annual benefits and costs (in thousand dollars, 1976 price level) are planning guidelines only, not to be used for project budgeting or design.

[b]Includes benefits and costs applicable to New York State.

Note: **BOLDFACE** indicates projects which are recommended for construction or further study.

Table 34

SCREENING ASSESSMENT OF FLOOD DAMAGE REDUCTION STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Levee/Floodwall at Reynoldsville	39.5	100.7	-Reduces flood damages in residential, commercial, industrial properties, Reynoldsville Borough, utilities, local roads, highways, railroad, church & other public facilities -Flood related erosion and deposition eliminated behind levee -Protection of floodplain	-Could alter degradation of water quality, aquatic life during construction -Could be aesthetically intrusive -Potential coal resource area -Possible additional burden on area facilities from temporary population influx during construction -Could increase noise, dust & traffic interruption during construction -Could alter road & utility facilities	-Nonstructural flood control measures	Not recommended
Levee/Floodwall at New Bethlehem	72.6	101.8	-Reduces flood damages in residential, commercial, industrial properties, local roads, highways, church, school & other public facilities -Flood related erosion and deposition eliminated behind levee -Protection of floodplain	-Potential coal resources area -Could be aesthetically intrusive -Could alter degradation of water quality, aquatic life during construction -Possible additional burden on area facilities from temporary population influx during construction	-Nonstructural flood control measures	Not recommended

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 34 (Cont.)

SCREENING ASSESSMENT OF FLOOD DAMAGE REDUCTION STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Levee/Floodwall at New Bethlehem (Cont.)				-Could increase noise, dust & traffic interruption during construction -Could alter road and utility facilities		
Channel Modification at Brockway	21.3	21.4	-Reduces flood damages in residential, commercial, industrial properties, local roads, highways, churches, schools, other facilities, utilities & cemetery -Flood related erosion and deposition eliminated behind levee -Protection of floodplain	-Potential coal resource area -Could alter aesthetic quality -Potential limestone resource area -Alter local roads and Pa.Rt.28 -Possible inundation of prime agricultural land -Could alter degradation of water quality, aquatic life during construction -Possible additional burden on area facilities from temporary population influx during construction -Could increase noise, dust & traffic interruption during construction -Could alter road & utility facilities	-Nonstructural solution	Recommended

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 34 (Cont.)

SCREENING ASSESSMENT OF FLOOD DAMAGE REDUCTION STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Channel Modification at St. Marys Borough	34.0	360.0	-Reduces flood damages in residential, commercial, industrial properties, local roads, highways, churches, schools and other public facilities and utilities -Protection of floodplain	-Could alter aquatic life -Could alter aesthetic quality -Possible temporary interruption of traffic flow on Pa.255, Pa.120 & local roads during construction -Potential coal resource area	-Nonstructural solution	Not recommended
Small Potential Reservoir #20–2 on Hoffman Run	7.2 FC only	7.67 FC only	-Reduces flood damages in residential, commercial properties and Conrail -Protection of floodplain -Possible recreation area	-Possible inundation of forestland in Allegheny National Forest -Could alter aquatic life & fish habitat -Could alter aesthetic quality -Could alter fishing and launching area -Could affect large and small game hunting -Could affect vegetation and wildlife -Could affect oil and gas resources area -Affect surface water quality -Relocation of some local roads -Temporary inundation of 262 acres when reservoir is full	-Nonstructural flood control measures	Recommended

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 34 (Cont.)

SCREENING ASSESSMENT OF FLOOD DAMAGE REDUCTION STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Small Potential Reservoir Hoffman Run (Cont.)				-Temporary increase in noise, dust & traffic interruption		
Small Potential Reservoir #20–4 on Rocky Run	15.8 FC only	17.20 FC only	-Provides storage for consumptive use makeup needs on the Power Run, Allegheny River and Clarion River in Subbasin 17 -Reduces flood damages -Potential recreation use	-Loss of forestland -Potential gas resource area -Affect mineral resource area -Affect on roads and highways -Could effect aquatic life & fish habitat, significantly since stream is stocked with trout -Wild & Scenic River Candidate-3rd priority "Scenic" -Could affect some vegetation & wildlife -Could alter aesthetic quality -Could affect large and small game hunting -Temporary inundation of 156 acres when reservoir is full	-Possible reauthorization of use for consumptive use makeup of existing E.Br. Clarion River Lake -Nonstructural flood control measures	Recommended
Small Potential Reservoir #29–8 on Crooked Creek	2.4	51.1	-Reduces flood damages in residential, commercial properties, a church and cemetery -Flood protection for the towns of Gaibleton and Tanoma -Protection of floodplain -Possible recreation area	-Possible inundation of agricultural land -Could alter aesthetic quality -Could alter aquatic life & fish habitat -Could alter small game hunting	-Nonstructural flood control measures	Not recommended

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 34 (Cont.)

SCREENING ASSESSMENT OF FLOOD DAMAGE REDUCTION STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
				-Could affect vegetation and wildlife -Could affect coal resource area -Could affect water surface quality -Relocation of about 20–30 dwellings -Temporary inundation of pump station, coal mine, cemetery & Kintersburg Bridge -Relocation of some medium duty roads -Temporary inundation of 710 acres when reservoir is full -Temporary increase in noise, dust and traffic interruption -Could affect utilities		
Potential COE Conewango Creek Reservoir above Waterboro, New York -AT THE DAMSITE	1,798 FC only within Pa.	1,394 FC only within Pa.	-Enhances potential recreational development with a permanent surface water lake of 1,390 acres -Recreation facilities will draw visitors from other regions, increasing economic activity and remaining tax base -Increase in employment during construction -Projected annual recreation visitation: 800,000 visitor-days	-Loss of agricultural land & wetlands -Relocation of approximately 30 households -Relocation of local roads & highway -Relocation of Erie RR, public facilities and utilities -Could alter aesthetic quality -Could affect aquatic life & fish habitat -Affect some vegetation	-Potential COE reservoir on Brokenstraw Creek -Potential COE St. Petersburg Reservoir -Possible reauthorization of use for consumptive use makeup for existing Allegheny Reservoir -Nonstructural flood control measures	This project is recommended for further study, which would include an investigation of all uses that could be incorporated in the project

[a]Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

Table 34 (Cont.)

SCREENING ASSESSMENT OF FLOOD DAMAGE REDUCTION STRUCTURAL SOLUTION ALTERNATIVES

Alternative	Preliminary Estimate of Annual Benefit[a] ($1,000)	Preliminary Estimate of Annual Cost[a] ($1,000)	Major Beneficial Impacts	Major Adverse Impacts	Alternatives to This Proposal	Remarks
Potential COE Conewango Creek Reservoir (Continued)			-Potential for addition of 44,000 fisherman-days	and wildlife -Could affect large game hunting -Wild and Scenic River Candidate-"Scenic" in New York State		
-DOWNSTREAM EFFECTS			-Provides storage for consumptive use makeup needs on the Allegheny River in Subbasins 16,17, & 18 and Ohio River in Subbasin 20 -Reduces flood damages on Conewango Creek and Allegheny River in Subbasins 16,17 & 18 and Ohio River in Subbasin 20 -Protection of floodplain and open space -Improve water quality during low flow periods -Provides flood protection to natural and geologically unique areas, historical and archaeological sites	-Could encourage more development or encroachment on the floodplain -Modifies fish production and movement -Recreational development downstream may adversely offset the natural state of the area		
Potential COE Brokenstraw Creek site on Brokenstraw Creek above Garland, Pennsylvania	For Further Details See Table 27					
Potential COE St. Petersburg Lake on Clarion River, 5 miles above the mouth	For Further Details See Table 27					

[a] Annual costs and benefits (1976 price level) are planning guidelines only, not to be used for project budgeting or design.
WS - Water Supply
WS/t - Water supply including treatment costs
FC - Flood Control

further explained in Appendix C-6.

The structural measures investigated to reduce the residual annual flood damages in the damage centers and reaches are listed in Table 33. The table lists the information related to location, purpose, flood control beneficial area, estimated total annual flood control benefit and cost of a potential project. The structural alternatives investigated for this subbasin are shown on Figure 15 and Figure 16. Those located within this subbasin are shown on Figure 15, and those which are located upstream of this subbasin are shown on Figure 16. As shown in Table 33 and on Figures 15 and 16, three levees and/or floodwalls, one channel modification project, three small potential reservoirs and three Corps of Engineers potential reservoir sites have been considered for reducing the residual annual damages in this subbasin. The environmental and social impacts of the structural alternatives are listed in Table 34, and the impacts of the major structural alternatives are discussed in Chapter VI.

3. RECOMMENDATIONS

The flood control measures were examined in greater detail in order to determine those which appeared most capable of solving or reducing the flood control problems. Those alternatives which appear to warrant further study for possible implementation are indicated by bold face type in Table 33. The recommendations include:

a. Nonstructural measures including floodplain regulation, flood insurance, permanent flood proofing and flood forecasting are strongly recommended for the damage centers and reaches listed in Table 32. In addition, relocation of flood-prone activities and acquisition of lands or easements to assure flood-compatible development are suggested for investigation at the damage center level. In all small stream watersheds, the Self-Help Flood Forecasting and Warning System is recommended. It is imperative that every community undertake an effective stormwater planning and management program.

b) One potential Corps of Engineers multipurpose reservoir site, Conewango Creek Reservoir, which will be located on Conewango Creek above Waterboro in New York State, is recommended for further study. In addition to reducing flood damages in 13 damage centers along the main stem of the Allegheny River within this subbasin, this reservoir would also help to reduce the flood damages in New York, along Conewango Creek in Pennsylvania, along the Allegheny River in Subbasins 16 and 18, and the Ohio River in Subbasin 20, and the States of Ohio and West Virginia downstream. The benefit to cost ratio for flood damage reduction in the State of Pennsylvania is estimated to be more than one. In addition to flood damage abatement, this reservoir is also expected to provide benefits in water supply, low flow augmentation and recreation.

c) A channel modification on Smith Run at Brockway Borough has been recommended by DER for funding for flood damage reduction in this area.

d) Two small potential reservoir sites, namely #20-2 and #20-4 located in Hoffman Run and Rocky Run respectively in Watershed A, are recommended for further study to determine the feasibility for flood damage reduction in the Wilcox area.

These recommendations are made as possible solutions to the identified flood control problems. The costs shown in the tables are preliminary planning estimates only, developed for use in reviewing alternatives, and should not be used for project budgeting or design. Prior to actual construction of a project or implementation of a program, detailed studies of all environmental, social and economic factors must be completed to assure optimum benefits and results.

C. WATER-RELATED OUTDOOR RECREATION

Pennsylvania's recreational needs were examined in the State Recreation Plan (formerly the State Comprehensive Outdoor Recreation Plan – SCORP), which was developed by the Governor's Office of State Planning and Development in conjunction with an Interagency Recreation Planning Committee[26] and published in report form in July 1976. Whereas the State Recreation Plan studied 19 outdoor recreation activities, the State Water Plan is addressing only those outdoor recreation activities which are water-related; swimming, boating and fishing. Picnicking is also included because of its common association with many other activities, in particular boating and swimming, and also because the picnicking experience itself is enhanced by the proximity of water. State Water Plan recreation analyses were performed using data developed for the State Recreation Plan; however, the methods of analysis were developed separately because of the need to determine facilities usage directly at the watershed level.

Recreational opportunity may be derived from many sources including Federal, State and locally operated and maintained facilities, in addition to privately owned profit and nonprofit facilities. Water resources projects, including dams, usually offer excellent opportunities to develop associated recreation facilities. Floodplain management which results in relocation of development away from the floodplain provides new open space areas which can be used for recreational purposes with minimal risk of expensive losses due to future flooding.

[26]Departments of Community Affairs, Education, Environmental Resources, Public Welfare and Transportation in addition to the Pennsylvania Fish, Game, and Historical and Museum Commissions.

Table 35

TOTAL RECREATIONAL PARTICIPATION POTENTIAL[a] BY COUNTY

		Seasonal Activity-days (1,000's)		
Activity	County	1970	1990	2020
Picnic	Clarion	171	195	230
	Armstrong	325	395	481
	Jefferson	188	210	256
	Clearfield	317	331	362
	Elk	159	194	245
Swim	Clarion	801	1,051	1,242
	Armstrong	1,619	2,243	2,727
	Jefferson	870	1,171	1,426
	Clearfield	1,471	1,844	2,016
	Elk	736	1,081	1,363
Boat	Clarion	73	121	143
	Armstrong	147	255	311
	Jefferson	93	158	193
	Clearfield	157	249	272
	Elk	78	146	184
Fish	Clarion	73	121	143
	Armstrong	330	477	580
	Jefferson	193	258	314
	Clearfield	326	407	444
	Elk	163	238	300

[a]Participation potentials listed are the activity-days that would result from the populations of the identified counties; they do not relate to the potential of the recreational resources in the counties.

Although this Plan does not propose the use of recreation as justification for water resources development, it is recognized that water resources management and structural development frequently provide excellent opportunity for associated recreational development or for enhancement of recreational experiences. Neither the data nor the methods of analysis used for this study were intended to determine recreational *demands* or *needs* in the traditional sense, but rather the attempt was to determine where existing or future potential recreational participation is sufficient to justify the development of additional recreational facilities. Where there is shown to be such justification, recreation should be included in other project planning and design. The discussion that follows is structured to follow the traditional *demand/supply* concept. The total potential recreational participation is discussed first in the context of "demands". Then existing facilities are examined as "supplies". The *residual* participation potential is then presented, representing the resultant "need" and finally the State share of that "need" is discussed. Again it must be emphasized that the residual potentials and State shares are *not* true needs but rather an indication of how many additional recreational facilities would be likely to be used if they were provided in conjunction with water resources projects or programs.

1. *Total Participation Potential*

Participation potential is a measure of the public's willingness or desire to participate in given recreational activities. Information developed for the State Recreation Plan indicates what percentages of Pennsylvania's citizens have an interest in the various activities studied and how frequently they participate in those activities, on a regional basis. From that information in conjunction with existing and projected county populations, total participation potential was assessed for each county in terms of seasonal activity-days. An activity-day represents one person's participation in an activity during one day; and *seasonal* activity-days indicate the total number of activity-days which would occur during the 13-week summer recreational season. Table 35 lists the participation potential for the counties in Subbasin 17, although those numbers reflect a reduction from the total potential to account for the percentage of participation which normally occurs in privately restricted facilities such as those in backyards.

Table 36

EXISTING RECREATION FACILITY UNITS BY COUNTY (1974)

County	Picnic Tables	Beach (Linear feet)	Pool (Square feet)	Power Boating (Acres)	Nonpower Boating (Acres)	Fishing (Man-days per year)
Clarion	1,103	1,100	16,000	690.0	1,260.0	918,789
McKean	984	600	18,000	0.0	369.3	680,979
Indiana	720	0	58,000	81.0	136.6	720,082
Forest	364	900	16,000	1,428.9	1,482.3	1,105,308
Butler	1,819	1,200	57,000	3,444.2	3,444.2	1,927,468
Armstrong	2,070	1,300	111,000	7,449.5	7,949.5	1,801,297
Jefferson	589	1,000	27,000	1,550	1,465.5	1,447,353
Clearfield	1,443	3,800	54,000	1,190.0	2,650.1	1,583,744
Elk	361	0	16,000	1,240.0	1,676.4	1,977,160

In examining those numbers, it should be understood that participation desires vary according to the availability and quality of facilities, the amount of leisure time available, income levels and other factors. The State Recreation Plan studies measured varying levels of participation depending upon different assumptions regarding those influencing factors. The minimum levels of participation determined by that study were used in this study, so in reality, participation potentials could be higher than those listed in the table.

2. *Existing Facility Supply*

Existing recreational facilities were inventoried for the State Recreation Plan in 1974. The total number of facility units in each county and watershed in Subbasin 17 are listed in Table 36 and the center column of Table 37, respectively. The supply totals include Federal, State and local, as well as private profit and nonprofit facilities which are available for public use.

Existing and proposed State parks are mapped on Figure 17. A corresponding listing of those parks is provided in Table 38. Five existing parks are located within the subbasin; Bendigo and Elk State Parks in Watershed A, provide picnicking and fishing opportunity while Bendigo also provides swimming and Elk provides boating and camping. In Watershed B Cook Forest and Clear Creek State Parks offer picnicking, camping, swimming, boating and fishing. Crooked Creek State Park also offers boating in addition to these activities in Watershed E.

Cold- and warm-water fishing streams are shown on Figure 6 in the previous section entitled Fish, Waterfowl and Furbearer Resources. Fishing and boating lakes greater than ten acres, as well as fishing and boating access areas, are shown on Figure 17 and listed in Tables 39 and 40. Fishing opportunity in a watershed is determined by either the presence of fish, water area or access, whichever is the limiting factor. Table 41 summarizes the fishing mileage and acreage by county. These numbers represent the physical presence of fishable water but do not imply any ready access.

Figure 18 shows boatable streams as delineated by the Pennsylvania Fish Commission. Stream and lake acreages by county are listed in Table 36. Again these numbers do not imply any ready access. Any body of water suitable for both fishing and boating is included in both Tables 36 and 41.

3. *Residual Participation Potential*

The residual participation potential is the amount by which total participation potential exceeds the participation capacity of existing facility units. It is a measure of the quantity of additional facilities which would be likely to be used if they were developed. The 1970, 1990 and 2020 potential participations expressed in terms of facility units for the watersheds in Subbasin 17 are listed in the left three columns of Table 37.

Residual participation potentials are also listed in Table 37. They were computed as the difference between the total participation potential and the existing facility units. The absence of a residual potential entry in the table indicates that existing facilities exceed the number needed to accommodate the total participation desires if the facilities were used in a manner conforming to standards. Any number in the residual column indicates how many additional facility units would potentially be used if provided in the watershed, again assuming that their use would conform to regional standards, and also that access to and quality of the facilities is sufficient to ensure that recreationists would travel to the facilities from distances which conform to the travel-time standards for the activities studied.

Table 37 indicates deficits in picnicking and swimming pool facilities. Approximately 270 more picnic tables are needed throughout Watersheds A, C and D. By 1990 over 500 will be needed, and by 2020 needs will expand to 1,250 tables throughout all watersheds in the

(Continued on page 125)

Table 37

TOTAL AND RESIDUAL PARTICIPATION POTENTIAL[a]

Activity Units	Watershed	Total Participation Potential 1970	Total Participation Potential 1990	Total Participation Potential 2020	Existing Facility Units	Residual Participation Potential 1970	Residual Participation Potential 1990	Residual Participation Potential 2020	State Share Residual Potential 1970	State Share Residual Potential 1990	State Share Residual Potential 2020
Picnic Tables (10's)	A	58	74	100	36	22	38	64	7	13	21
	B	152	152	159	152			7			2
	C	43	50	64	39	4	11	25	1	4	8
	D	39	47	58	38	1	9	20		3	7
	E	132	132	141	132			9			3
Beach Linear feet (100's)	A										
	B	2	3	4	19						
	C	1	1	2	2						
	D										
	E	1	2	3	12						
Pool Square feet (1,000's)	A	29	41	51	23	6	18	28	1	2	3
	B	13	16	17	16						
	C	45	58	72	43	2	15	29		2	3
	D	3	4	4	4						
	E	25	40	40	40						
Power Boating Acres	A	1,059	1,191	1,378	1,212			166			166
	B	616	1,114	1,114	1,114						
	C	863	1,422	1,448	1,422			26			26
	D	325	417	501	430			71			430
	E	740	1,437	1,437	1,437						
Nonpower Boating Acres	A	490	824	988	2,804						
	B	336	559	665	2,487						
	C	292	488	582	1,934						
	D	195	327	391	1,179						
	E	274	457	547	1,799						
Fishing Man-days/Year (1,000's)	A	408	559	675	1,703						
	B	294	398	478	1,211						
	C	419	573	687	1,645						
	D	187	274	338	636						
	E	377	528	649	721						

[a]Participation potentials listed are a function of population rather than physical resources. Residual potentials indicate the number of additional facilities which would be likely to be used if developed.

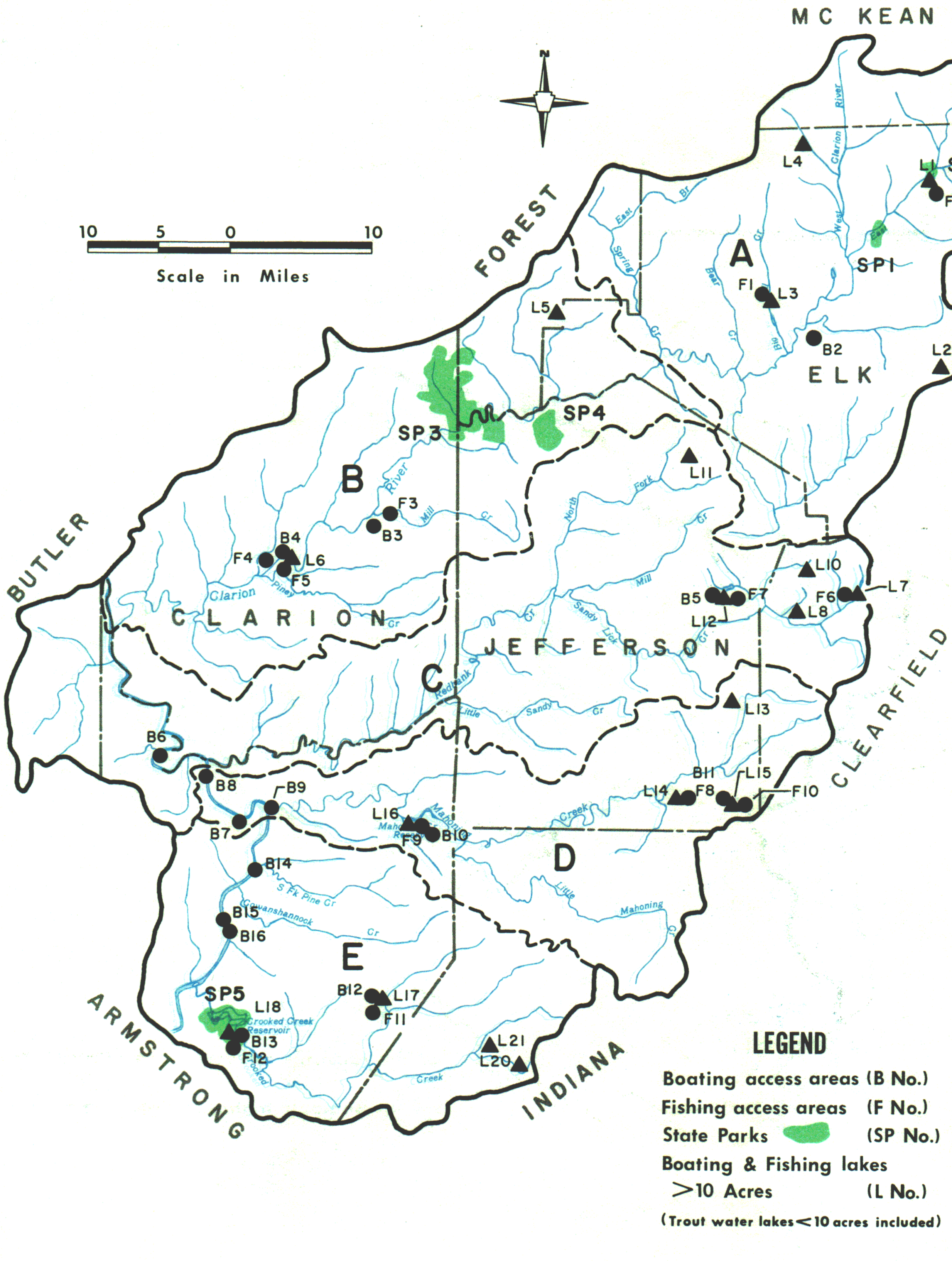

FIGURE 17. Recreation Areas and Facilities

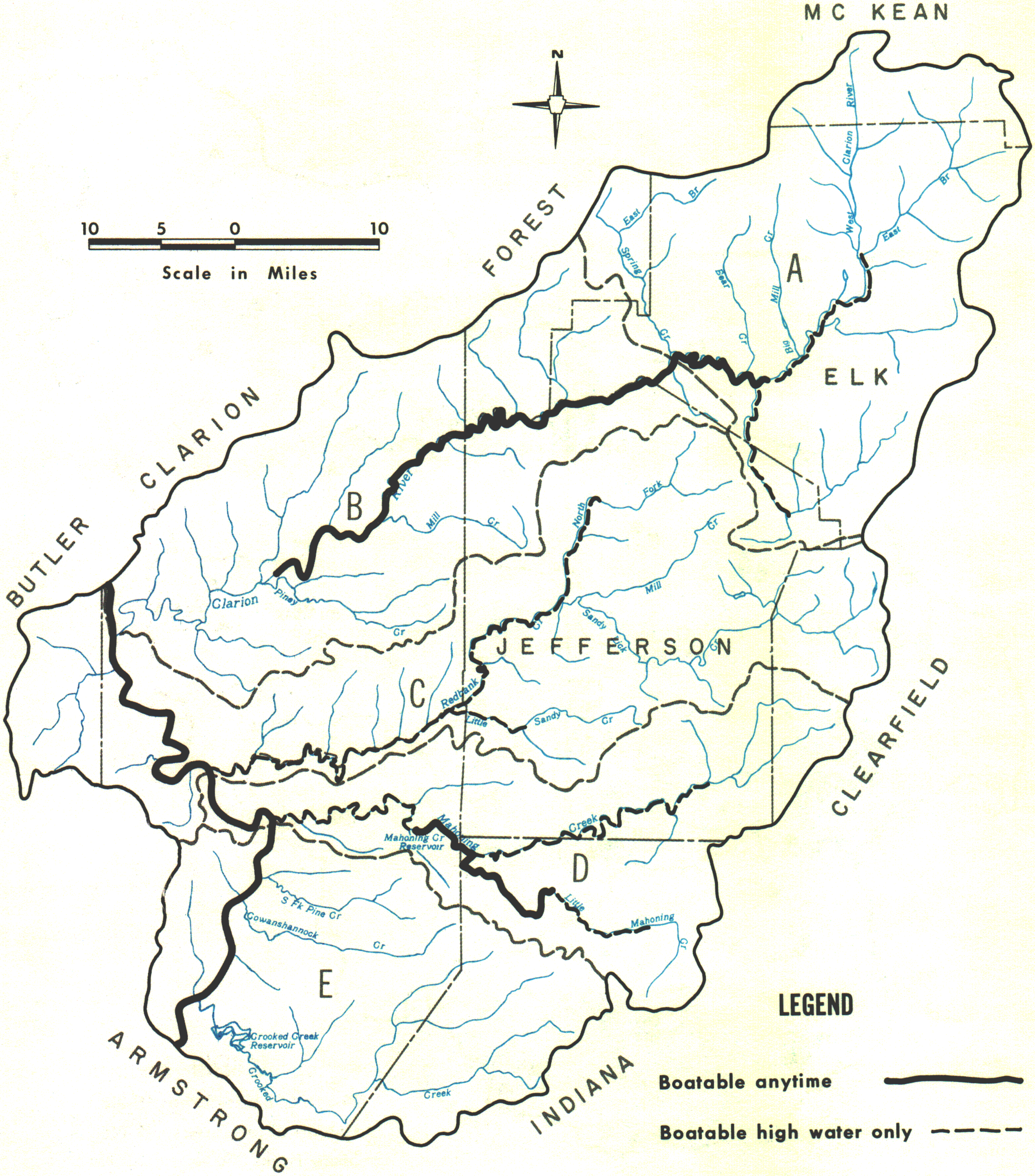

FIGURE 18. Boatable Streams

Table 38

STATE PARKS

Watershed	Legend (See Figure 17)	State Park	Land Area (Acres)	Water Area (Acres)	Total Area (Acres)	Facilities[a] Existing (1974)	Proposed	Remarks
A	SP1	Bendigo	99	1	100	A,C,E		
A	SP2	Elk	2,032	1,160	3,192	A,B,D,E		
B	SP3	Cook Forest	6,422	0	6,418	A,B,C,D,E		
B	SP4	Clear Creek	1,207	2	1,209	A,B,C,D,E		
E	SP5	Crooked Creek	2,139	350	2,439	A,B,C,D,E		

[a]Facility Codes: A - Picnicking; B - Camping; C - Swimming; D - Boating; E - Fishing.

subbasin. Additional swimming pool development will be needed by 1990 in Watersheds A and C. It should again be emphasized that the residual potentials presented in the table represent conservative estimates, according to State Recreation Plan results.

4. *State Responsibility*

Pennsylvania has invested heavily in outdoor recreation over the past 15 years. In many areas, facilities for selected activities have been developed to nearly the maximum of which the resource is capable. Most forms of outdoor recreation involve a specific use of land or water; consequently, recreation finds itself competing for both land and water surface area against many other forms of incompatible use. The avenues through which the State can directly provide water-related outdoor recreation opportunity are limited primarily to State or Federal water resources projects and their environs, to State parks and, to a lesser degree, State forest picnic areas. Responsibility for all these lies primarily with the Department of Environmental Resources.

It is not expected that the State will provide additional facilities to accommodate all of the residual recreational participation potential. As stated previously, there are many sources of recreation facilities, the State being one of them. State-owned or operated facilities currently account for approximately the following percentages of facilities usage:

a. picnicking – approximately 33 percent

b. pool swimming – approximately 10 percent

c. beach swimming, power and nonpower boating, and fishing – nearly 100 percent

Although the State provides only about 60 percent of existing fishing and boating access facilities, State Water Plan analyses are concerned with the future development of additional potential fishing or boating surface areas, which can only be accomplished by construction of lakes and will, therefore, be wholly accessible to the State for recreational development. The percentages shown reflect present usages and are not policy; they may vary in the future. The last two columns in Table 37 list the share of residual participation potential for which the State may be likely to provide additional facilities based on those percentages. Expansion of picnicking facilities at Bendigo State Park could provide 50 additional tables to partially alleviate shortages in Watershed A. Needs in Watersheds B and E could be solved by additional development of picnicking facilities in Cook Forest, Clear Creek and Crooked Creek State Parks.

5. *Recommendations*

Additional picnicking facilities should be provided at Bendigo, Cook Forest, Clear Creek and Crooked Creek State Parks as necessary to provide for existing and future needs in Watershes A, B and E. Swimming pool facilities should be developed locally to satisfy the future needs in Watersheds A and C. Power boating is a recreational activity of increasing popularity and demand, although resources for future development of power boating opportunity are limited statewide. Where demands cannot be satisfied by additional development, they may need to be solved by future shifts in recreation patterns away from power toward nonpower boating. The State should continue to expand boating and fishing access wherever possible to better provide for growth in both activities.

It is strongly recommended that recreational development or enhancement be considered as an integral part of any local floodplain management projects and programs. It is also recommended that the subbasin's recreation potential be justly considered in the formulation of plans for any State, regional or local water resources development activities; however, this report does not propose the use of recreation as a sole factor for the justification of water resources projects.

(Continued on page 129)

Table 39

EXISTING FISHING AND BOATING LAKES

Watershed	Legend (See Figure 17)	Lake	Stream	County	Recreational Area (Acres)	Ownership	Remarks
A	L1	Clarion Reservoir	E. Branch Clarion River	Elk	1,240	COE Pittsburgh Division	
A	L2	Laurel Run Reservoir	Elk Creek	Elk	100	St. Mary's Water Co. (Private, nonprofit)	
A	L3	Ridgway Reservoir	Big Mill Creek	Elk	75	Boro. of Ridgway (Private, profit)	
A	L4	Twin Lake	Hoffman Run	Elk	7.5	Allegheny National Forest	
A		Whetstone Reservoir		Elk	8.0	Private, nonprofit	posted
B	L5	Buzzard Swamps	Muddy Fork	Forest	8.5	Federal	
B	L6	Piney Dam	Clarion River	Clarion	15	Pa. Electric Co.	
C	L7	Sabula Lake	Sandy Lick Creek	Clearfield	42	Private, nonprofit	
C	L8	Tannery Dam	Sandy Lick Creek	Clearfield	5	City of DuBois	
C[a]	L9	Doverspike Dam	Cherry Run	Jefferson	14	Private, nonprofit	
C	L10	Treasure Lake	Wolf Run	Clearfield	400	Private, profit	
C	L11	Manner's Dam	Manners Run	Jefferson	2.6	PGC	
C	L12	Kyle Dam	Kyle Run	Jefferson	143	PFC	
D	L13	Reeds Dam	Bucks Run (Trib. of Stump Creek)	Jefferson	14	Private, nonprofit	
D	L14	Cloe Dam	Jackson Run	Jefferson	30	PFC	
D	L15	Hemlock Lake	Straight Run	Indiana	60	PFC	
D	L16	Mahoning Creek Reservoir	Mahoning Creek	Armstrong	200	COE Pittsburgh Division	
E	L17	Keystone Lake	N. Branch Plum Creek	Armstrong	1,000	Philadelphia Electric Company	
E	L18	Crooked Creek Reservoir	Crooked Creek	Armstrong	350	Federal	
E[a]	L19	Blue Spruce Lake	Crooked Creek	Indiana	12		
E	L20	Musser Lake	McKee Run	Indiana	30	Musser Forests, Inc.	
E	L21	Rayne Twp. Park Dam	Crooked Creek	Indiana	14	State owned County Commissioners	

[a]Not shown on figure.

Note: PFC - Pennsylvania Fish Commission; DER - Pennsylvania Department of Environmental Resources; PGC - Pennsylvania Game Commission; COE - Corps of Engineers.

Source: Pennsylvania Fish Commission

Table 40

EXISTING FISHING AND BOATING ACCESS AREAS

Watershed	Legend (See Figure 17)	Access	County	Stream or Water Body	Ownership[b]	Remarks
A	F1	Ridgway Reservoir – 3 mi. W. Ridgway	Elk	Mill Creek	Private	
A	F2	Clairon River Reservoir – 6 mi. E. Wilcox	Elk	East Branch Clarion River	DER/COE	
B	F3	Mill Creek SGL #74	Clarion	Mill Creek	PFC	mooring
B	F4	Clarion River Dam (Piney Dam) 3 mi. SW Clarion	Clarion	Clarion River	Private, PFC Access	
B	F5	Clarion River Reservoir (Piney Dam) – 3 mi. SW Clarion	Clarion	Clarion River	COE	proposed
C	F6	Sabula Lake – 6 mi. NE Dubois	Clearfield	Sandy Lick Creek	Private	
C	F7	Kyle Reservoir – 2 mi. NW Falls Creek	Jefferson	Sandy Lick Creek	PFC	mooring
D	F8	Cloe Reservoir – 2 mi. E. Punxsutawney	Jefferson	Mahoning Creek	PFC	mooring
D	F9	Mahoning Creek Reservoir – 2 mi. N. Dayton	Armstrong	Mahoning Creek	COE	
D	F10	Hemlock Lake	Indiana	Canoe Creek	PFC	under construction
E	F11	Keystone Lake – near Attwood Borough	Armstrong	N.Br. Plum Creek	PFC	mooring
E	F12	Crooked Creek Reservoir – 6 mi. S. Kittanning	Armstrong	Crooked Creek	COE	
A	B1	East Branch Lake (Clarion River Reservoir) NE of Wilcox	Elk	East Branch Clarion River	COE	
A	B2	Ridgway Access - Ridgway	Elk	Clarion River		fishing good, canoeing
B	B3	PFC Access Area near Strattenville	Clarion	Clarion River	PFC	no HP restriction

[a]Not shown on Figure.

[b]PFC - Pa.Fish Comm.;PGC - Pa.Game Comm.;DER - Pa.Dept. of Envir.Res.;COE - Corps of Engineers.

Source: OSPD, State Recreation Plan facilities inventory.

Table 40

EXISTING FISHING AND BOATING ACCESS AREAS

Watershed	Legend (See Figure 17)	Access	County	Stream or Water Body	Ownership[b]	Remarks
B	B4	Piney Dam Tobey Creek Bridge - Routes 322 & 68	Clarion	Clarion River		
C	B5	Kyle Lake near Falls Creek	Jefferson	Wolf Run	PFC	electric motors only
C	B6	Cogley's Access – East Brady	Armstrong	Allegheny River		
D	B7	The Spot Access N.E. of Adrian	Armstrong	Allegheny River		launch fee
D	B8	Captain Charles Access N. of Sherrett	Armstrong	Allegheny River		
D	B9	Armstrong's Marina – Mahoning	Armstrong	Allegheny River		launch fee
D	B10	Mahoning Creek Lake 4 mi. N. of Dayton	Armstrong	Mahoning Creek	COE	
D	B11	Hemlock Lake 4 mi. N. Glen Campbell - Route 336	Indiana	Canoe Creek	PFC	electric motor only
E	B12	Keystone Lake 3 mi. N. of Elderton - Route 210	Armstrong	North Branch Plum Creek	Power Co., PFC	small boats only, 6 HP limit
E	B13	Crooked Creek State Park 6 mi. N. of Vandergrift	Armstrong	Crooked Creek Reservoir		
E	B14	Smith's Boat Docks – Mosgrove	Armstrong	Allegheny River		launch fee
E	B15	Kittanning Marina N. of Water Street at Colwell	Armstrong	Allegheny River		launch fee
E	B16	Kittanning Municipal Ramp Mulberry Street	Armstrong	Allegheny River		

Table 41

POTENTIAL FISHING SUPPLY

County	Stream (Miles)	Lake (Acres)
Armstrong	243.5	1,550.0
Butler	114.0	3,612.0
Clarion	293.0	690.0
Clearfield	628.8	1,507.6
Elk	431.0	1,455.5
Forest	335.7	119.5
Indiana	210.5	1,434.0
Jefferson	278.9	215.6
McKean	392.2	335.5

Source: Pennsylvania Fish Commission

D. WILD AND SCENIC RIVERS

The Commonwealth's policy is to protect and enhance those river segments representative of Pennsylvania's natural and cultural river heritage for the purposes of environmental protection and the general recreational enjoyment and educational benefit of the public. Toward this end the Governor signed into law in December 1972, Act No. 283, which authorized the establishment of the Pennsylvania Scenic Rivers System.

The Scenic Rivers Act established four classifications into which candidate streams could be assigned:

1. Wild river areas – those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted.
2. Scenic river areas – those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and undeveloped, but accessible in places by roads.
3. Recreational rivers – those rivers or sections of rivers that are readily accessible, that may have some development along their shorelines and may have undergone some impoundment or diversion in the past.
4. Modified recreational rivers – those rivers or sections of rivers in which the flow may be regulated by control devices located upstream. Low dams are permitted in the reach so long as they do not increase the river beyond bank-full width. These reaches are used for human activities which do not substantially interfere with public use of the streams or the enjoyment of their surroundings.

Using this classification system, the Department of Environmental Resources[27] compiled and published in December 1975 the "Pennsylvania Scenic Rivers Inventory"[28]. That inventory is a listing of all candidate streams which were recommended for future study to determine their eligibility for inclusion by law in the Scenic Rivers System. Since it was recognized that the completion of such detailed studies statewide would require many years, possibly several decades, the candidate streams were further categorized according to relative priority as assigned by the Scenic Rivers Task Force. These priority assignments were based on the stream's recognition as having national, statewide or primarily local significance. Under the first priority, or those with statewide and in some cases even national significance, the streams were subdivided into three subgroups (A, B, and C). First priority group "A" streams are those which have most immediate need for protection and urgent need for additional study.

The streams or stream segments in Subbasin 17 which have been nominated for inclusion in the Scenic Rivers System are listed in Table 42 according to priority ranking. Priorities were assigned to stream segments regardless of their classifications; consequently several classifications may appear within a priority group. The same stream segments are mapped on Figure 19. Four priority 1-A streams: 1) Allegheny River (from Clarion River to East Brady), 2) Allegheny River (from Kinzua Dam to Clarion River), 3) Clarion River and 4) North Fork, are located in the study area. Five other stream segments have also been nominated from this area in the three priority groups with a total of six of the nominations falling in the priority 1 group.

While responsibility for development of management programs to protect the Commonwealth's designated stream segments lies with the Scenic Rivers Program, the development of these management programs requires close coordination with the State Water Plan. The State Water Plan will not address management of the candidate streams as wild and scenic rivers; however, those stream nominations have been and will continue to be accounted for in all management schemes devised to solve the water resources problems presented in this report. Until a candidate stream becomes a legally adopted component of the Pennsylvania Scenic Rivers System, its nomination must be treated as an environmental constraint to any structural solution identified within the candidate segment. This does not represent a moratorium on development within the candidate segment, but does indicate a need for special emphasis on the examination of all factors when considering a possible structure within the area. After legal adoption, mandated restrictions on development within the segment would apply to any recommended structural solutions to water resources problems and would be strictly adhered to by the State Water Plan.

[27]The Department of Environmental Resources is the agency mandated by The General Assembly to administer the Pennsylvania Scenic Rivers Program.

[28]Pennsylvania Department of Environmental Resources, *Pennsylvania Scenic Rivers Inventory*, (December, 1975).

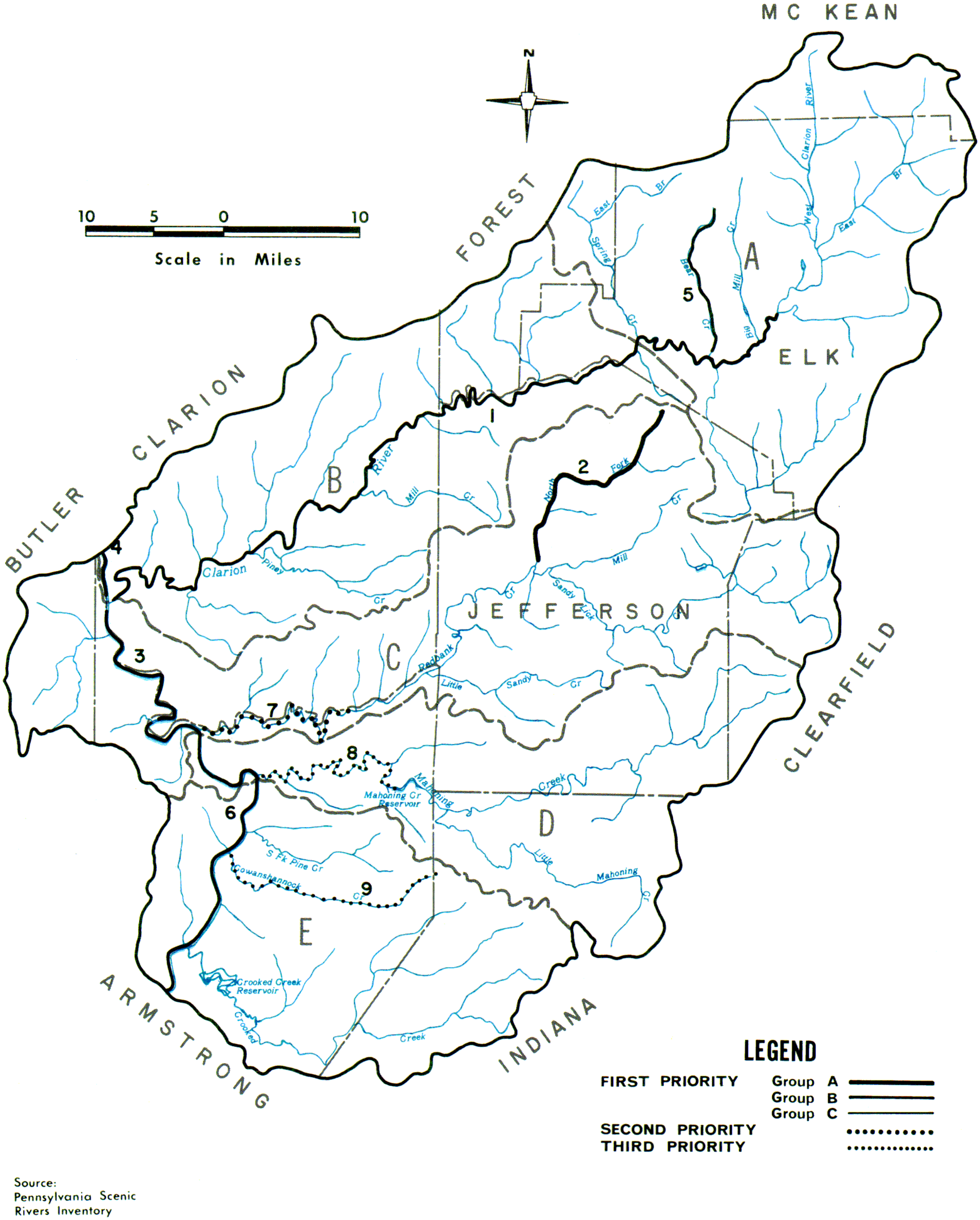

FIGURE 19. Pennsylvania Scenic Rivers Candidates

Table 42

PENNSYLVANIA SCENIC RIVERS CANDIDATES[a]

Legend (See Figure 19)	Stream Name	Priority Group	Proposed Segment Limits	Approx. Segment Length (miles)	Proposed Class	Water Quality
1	Clarion River	1-A	Ridgway - Allegheny River	87	S	3
2	North Fork	1-A	Headwaters - Redbank Creek	21	W,S	1
3	Allegheny River	1-A	Clarion River - East Brady	14	S	2
4	Allegheny River	1-A	Kinzua Dam - Clarion River	102	S,R MR	2
5	Bear Creek	1-B	Headwaters - Clarion River	12	S	1
6	Allegheny River	1-C	East Brady - Kiskiminetas River	53	S, MR	2
7	Redbank Creek	2	South Bethlehem - Allegheny River	23	S	3
8	Mahoning Creek	3	Mahoning Creek Lake - Allegheny River	29	R	3
9	Cowanshannock Creek	3	Junction of Branches - Allegheny River	8	S	3

[a]For explanation of columns see Appendix D-1.

Future coordination between the State Water Plan and the Scenic Rivers Program is required to insure that State Water Plan decisions account for any stream segments which may be nominated at future dates. The Scenic Rivers Program will provide annual updates of the Scenic Rivers Inventory so that streams which meet eligibility requirements in the future are not forgotten or ignored and so that existing classifications and priorities may be reviewed.

E. WATER QUALITY

The following information was derived primarily from the Comprehensive Water Quality Management Plan (COWAMP) program. More detailed information on the problems and their solutions discussed herein can be found in the individual COWAMP study area reports.

A major problem in determining the quality of subbasin streams is the sparse distribution of quantitative sampling locations. Although there may be considerable information regarding water quality in a given stream, the geographical distribution of the monitoring stations somewhat limits the ability to derive general conclusions regarding water quality throughout the subbasin.

Figure 20 shows the location of stream reaches having a degraded water quality. Degraded reaches were determined by the Pennsylvania Department of Environmental Resources (DER) and the Pennsylvania Fish Commission. DER aquatic biologists considered a stream seriously degraded if it did not possess a diverse population of invertebrates and if the majority of invertebrates found were pollution tolerant species. Other indications of poor stream quality include low pH and dissolved oxygen values, high iron values, and the presence of acidity. Fish Commission personnel based their evaluation of degradation on the presence of a low population of game fish in the presence of industrial, municipal, or acid mine drainage discharges.

Figure 20 also shows the location of DER water quality monitoring stations, while Table 43 contains a summary of analytical results from selected stations. Further information on the monitoring station data and the aquatic biologists' reports is available from DER's Bureau of Water Quality Management. Monitoring samples are collected under a variety of conditions and are not designed to provide detailed knowledge of water quality in a number of stream reaches or the daily variations of quality. However, they do provide an overall view of the water quality over an extended period of time.

The aquatic biologists' reports describe the biological condition of a stream during the sampling period. They include information on the variety and number of biological species, limited chemical analyses, and a qualitative description of the stream condition. The biological reports provide information regarding a given stream's biological condition produced by events occurring over a period of time. In contrast, the chemical analyses of the samples collected at the monitoring stations reflect water quality only at the time of sampling.

Groundwater presents a much less dynamic picture than a normal surface stream does. In a frequently pumped well, water quality would change over a much longer period than that of a surface stream. Thus, data values for a groundwater station are less dependent on sampling frequency than those collected from a surface stream. Nevertheless, there can be a considerable variation of sampling results from a given aquifer due primarily to monitoring a number of wells at various depths in that aquifer. Also, a given aquifer can possess a wide range of water quality because of variations in the infiltrated soil and strata.

(Continued on page 134)

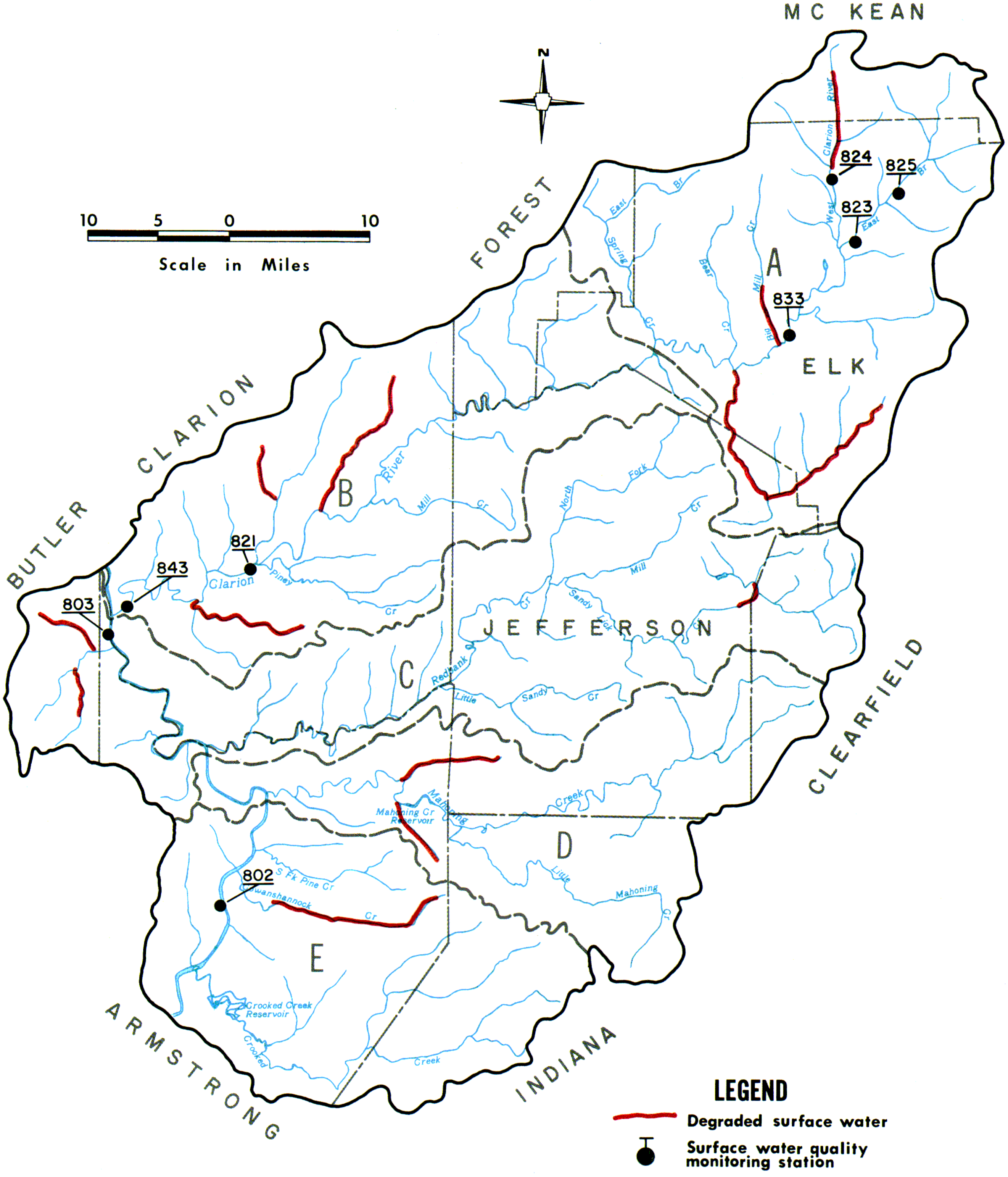

FIGURE 20. Water Quality

Table 43

WATER QUALITY MONITORING STATION[a] SUMMARY RESULTS

Parameter	Sampling Station 824	825	823	833	821	843	802	803
pH (S.U.)	6.6	5.2	6.2	5.3	5.2	5.6	7.1	7.3
DO (mg/l)	10.7	10.9	8.9	8.2	9.0	8.1	10.8	10.5
Total Iron (g/kl)	375	329	452	395	735	741	646	1,008
TDS (mg/l)	74	61	91	63	113	228	11	61
Temperature (° C)	10.7	11.4	13.5	12.4	12.0	24.8	12.8	11.5
Turbidity (JTU)	5.7	5.0	18.9	7.5	8.3	4.5	11.7	11.8
Ammonia (mg/l N)	0.08	0.9	0.15	0.25	0.18	0.15	0.23	0.14
Phosphorus (mg/l P)	0.02	0.02	0.05	0.06	0.05	0.02	0.05	0.12
Alkalinity (mg/l)	25.8	6.1	19.0	22.6	9.8	6.5	37.9	41.3
BOD (mg/l)	1.7	1.4	13.1	2.6	1.4	ND	2.0	1.9
Coliform (#/100 ml)	61,500	8	133,600	29,800	300	ND	7,800	32,600

[a]See Figure 20 for location of monitoring stations.

Source: Pennsylvania Comprehensive Water Quality Management (COWAMP) study area reports.

Table 44

CONSERVATION AREAS

1. Bear Creek
2. Beaver Creek
3. Big Mill Creek
4. Blyson Run
5. Callen Run
6. Cather Run
7. Cherry Run
8. Clear Creek
9. Clover Run
10. Coleman Run
11. Crow Run
12. East Branch Clarion River
13. East Branch Mahoning Creek from source to, but not including, Beaver Run
14. Falls Creek
15. Little Mill Creek (Elk County)
16. Little Mill Creek (Jefferson County)
17. Maple Creek
18. Maxwell Run (Clarion County)
19. Maxwell Run (Elk and Jefferson Counties)
20. Millstone Creek
21. North Fork Redbank Creek
22. Pine Creek
23. Schoolhouse Run
24. Silver Creek
25. South Branch Plum Creek from source to, but not including, Redding Run
26. Spring Creek
27. Sugarcamp Run
28. Troutman Run
29. Turkey Run
30. Upper Mill Creek
31. Wolf Run (Clarion River Basin)
32. Wolf Run (Redbank Creek Basin)
33. Wyncoop Run

In order to quantitatively evaluate the quality of a given stream, certain stream criteria must be examined. Values of specific water quality criteria established by the Commonwealth are contained in Chapter 93 of DER's "Rules and Regulations". In most cases, more than one criterion has been established for each constituent to reflect permissible variations, depending on water use.

Chapter 93 also contains streams having a conservation area water use classification. The definition of conservation area is as follows:

> Waters used within and suitable for the maintenance of an area now or in the future to be kept in a relatively primitive condition.

Subbasin streams or watersheds having a conservation area[29] classification are listed in Table 44.

To aid in the understanding of the following discussion, a glossary of water quality terms, a table listing chemical constituents in groundwater and their effects on water use, and a brief list of various pollutants and their effects are found in Appendices E-1 through E-3. Surface water quality in each watershed is discussed first, followed by groundwater quality.

Acid mine drainage primarily in the Clarion River basin, is the major water quality problem in this subbasin. However, the impact of this may be lessened in the future by a U.S. Army Corps of Engineers program for acid mine drainage abatement projects in the Clarion River basin. Since the program is just beginning, it will be several years before construction is underway. Sludge deposits, turbidity, and related problems due to raw or primary treated municipal and industrial waste discharges cause additional water pollution.

Generally, the Allegheny River is in good condition throughout the subbasin. However, some localized areas of degradation caused by inadequately treated municipal and industrial discharges may exist. Additionally, the Clarion River and Bear Creek cause degradation in the areas where they mix with the Allegheny River. These are not extensive though, because of dilution and the assimilative capacity of the river.

Elk Creek, in the vicinity of St. Marys in Watershed A, suffers from both municipal and industrial discharges, as well as acid mine drainage. Little Toby Creek is also degraded by inadequately treated municipal wastewater and acid mine drainage. An industrial discharge to Reily Run, a tributary of the Clarion River, causes high BOD (biological oxygen demand) loadings, suspended solids loadings, and discoloration of the Clarion River. The West Branch Clarion River is adversely affected by gas well brines from Halsey to Wilcox. Two streams in Elk County, Beaver Run and an unnamed tributary to Little Toby Creek, both in Fox Township, have been polluted by periodically malfunctioning surface mine drainage treatment facilities. Several abandoned oil wells and deep mines supplement the pollution from strip mines in the area.

Pollution problems originate in the headwaters of Little Toby Creek (Elk County) and continue throughout its length. An acid load of 7,500 ppd[30] has been measured at its mouth, with a somewhat heavier load being present in the headwaters. Completed or underway abatement projects will result in 2,700 ppd of acid being abated, while proposed projects and those in design will result in further improvement.

Acid mine drainage is the major water quality problem in Watershed B. It affects Mill Creek (Clarion

[29]Effective October 8, 1979, the *Conservation Area* stream designation was replaced by a *Special Protection* classification which consists of the categories ***High Quality Waters*** and ***Exceptional value Waters*** The Pennsylvania Fish Commission's ***Wilderness Trout Streams*** are considered ***Exceptional Value Waters.***

[30]ppd – pounds per day.

and Jefferson Counties), Toby Creek (Clarion County), Piney Creek, Deer Creek and Licking Creek. A demonstration project to test several potential strip mine reclamation methods for use in the area is being evaluated. Upon completion of the evaluation in 1980 it is possible that two strip mines, one in the Toby Creek watershed and one in the Piney Creek watershed will be reclaimed. Presently there is a deep mine sealing project under construction in the Deer Creek drainage.

Mill Creek is polluted for 15 miles upstream from its mouth and has 25 miles of tributaries also degraded by acid mine drainage. The acid load at the mouth of Mill Creek averages 16,200 pounds per day (ppd).

Toby Creek is polluted throughout its 14 mile length, with most of its tributaries also having evidence of mine drainage. The acid load at the mouth of Toby Creek is 41,200 ppd as a result of past mining, mainly strip mining and emanates from numerous discharges directly tied to the abandoned strip mines. Abandoned oil and gas well discharges, having the chemical characteristics of mine drainage, are also a principal source of stream pollution.

Piney Creek, from its mouth to its headwaters, is polluted by acid mine drainage from abandoned strip and deep mines. It has an acid load of 33,850 ppd at the mouth and 41 miles of degraded tributaries.

Deer Creek is polluted throughout its length, with many of its tributaries also having evidence of mine drainage. It has an acid load of 14,100 ppd at the mouth, primarily as a result of strip mining activities.

In the Licking Creek watershed, mine drainage seriously degrades 25 miles of the approximately 70 miles of watershed streams. At its confluence with the Clarion River, Licking Creek has an acid load of 14,200 ppd and 2,660 ppd of iron.

Occasionally malfunctioning surface mine drainage treatment facilities have caused additional water quality problems in Watershed B. The following Clarion County streams have been adversely affected by this: a tributary to Courtleys Run in Beaver Township, a tributary to Cherry Run in Toby Township, Piney Creek in Limestone Township, Brush Run in Monroe Township, an unnamed tributary to Deer Creek in Elk Township, a tributary to Toby Creek in Highland Township, Little Licking Creek in Limestone Township, and unnamed tributaries to Anderson Run and Licking Creek in Licking and Perry Townships.

Water quality in portions of Watershed C is degraded by raw or inadequately treated municipal waste discharges and acid mine drainage. Redbank Creek receives inadequately treated discharges near Reynoldsville, Brookville and New Bethlehem. Completion of the planned upgrading of the treatment facilities at each of these municipalities will alleviate any localized problems caused by the treatment plant discharges. Sandy Lick Creek has a three mile reach adversely affected by raw sewage discharges in the Falls Creek area.

Approximately 2,500 ppd of acid originating from abandoned deep mines, strip mines, and oil and gas wells degrade a 10 mile segment of the North Branch Bear Creek and results in adverse effects on Bear Creek. In addition to the acid mine drainage on the North Branch, Bear Creek is affected by industrial discharges from the South Branch. Proposed mine drainage abatement projects will result in 10 miles of stream being improved. Additional streams suffering from acid mine drainage include Catfish Run, Fiddlers Run, Leisure Run, Town Run, Welch Run and Runaway Run.

Acid mine drainage is the principal water quality problem in Watershed D. An 8.5 mile headwater reach of Mahoning Creek and 28 miles of tributary are degraded by mine drainage, with the most severe problem being a mine shaft discharge of 1,200 ppd of acid and 500 ppd of iron directly affecting the main stream. A stream channelization project is expected to result in 250 ppd of acid being abated. Other streams suffering from acid mine drainage include Pine and Glade Runs and their respective tributaries. Tributaries of Scrubgrass Creek have had some incidents of mine drainage pollution as a result of malfunctioning treatment systems.

Watershed D has a few industrial discharges, none of which have a significant effect on water quality. However, several fish kills in Mahoning Creek near Punxsutawney may have been caused by discharges from a concentration of plating industries in this area.

Several streams in Watershed E are degraded by mine drainage. Cowanshannock Creek has 18 miles of its 24 mile length affected, with iron being the principal cause of the poor water quality. However, due to current mining activities no abatement projects are being undertaking in this area. Malfunctioning mine drainage treatment systems have caused additional incidents of pollution in various streams including Crooked Creek and one of its tributaries, Limestone Run, Garretts Run and a tributary of the Allegheny River.

Cowanshannock Creek is also degraded by municipal waste discharges, primarily a raw sewage discharge at Rural Valley. This is only a localized problem though, since the stream recovers in its lower reaches. Industrial discharges enter the Allegheny River in the Ford City-Kittanning area.

Generally, groundwater in the subbasin is of good quality. However, various localized areas of degradation exist as a result of man's activities.

Man-made pollution sources can be a serious threat to the groundwater resources. A variety of noxious and sometimes toxic substances enter the ground, eventually reach the groundwater reservoirs and travel along the groundwater flow pattern to points of discharge. Various sources of contamination include septic tanks in unsuitable soils, landfills, oil tank leaks, seepage from industrial waste treatment or storage lagoons, pipeline breaks, and salt storage.

Although documentary data are available at relatively few locations, most landfill sites are believed to have caused localized degradation of groundwater. However, landfill leachate does not appear to have seriously affected subbasin water supplies even though the potential does exist.

Another potential source of groundwater pollution is the industrial waste storage lagoons scattered throughout the subbasin. These also present a localized problem only.

The Toby Creek watershed, in Clarion County, has severe groundwater problems. Abandoned oil and gas well discharges having the chemical characteristics of mine drainage give evidence to this fact. Contamination was originally caused by past mining when operators reportedly drilled into the strata below the coal to eliminate water from the operations. The extent of this pollution problem is currently being studied. One difficulty in establishing the extent of degradation due to coal mining, though, is the generally high background levels of iron and sulfate in the subbasin's groundwater.

F. EROSION AND SEDIMENTATION

Sediment is generally regarded as the greatest pollutant by volume in the waters of the Commonwealth. Because of this, participants in earthmoving activities are required to develop and follow a plan designed to prevent accelerated erosion and sedimentation. When an area to be disturbed is over 25 acres and meets certain criteria, the landowner is required to obtain a permit from DER prior to commencing the activity. Farmers are exempt from the permitting requirement. However, they must still have a workable plan.

Sediment has several adverse impacts. One of the more widepsread of these is its deleterious effect on the aquatic ecosystem. In addition, sediment can decrease the capacity of reservoirs through siltation and also cause clogging of filters in public water supply systems. Although sediment is produced by soil loss from streambanks, roadsides, gullies, and sheet and rill erosion[31], only sheet and rill erosion will be discussed here quantitatively.

The rate of sheet and rill erosion, and consequently the amount of sediment being produced, is significantly influenced by land use. Much of the state's land is used for agriculture or forests. Thus, on the basis of land area, cropland and pasture are potentially large contributors of sediment, with cropland being the major contributor. Due to the extensive area they cover, forests are also potentially large sources if not properly managed.

Of the subbasin's 319,419 acres in agriculture, 82 percent is used as cropland, with one-fourth of this being in row crops, which have the highest soil loss potential of all crops. In this subbasin, cropland has an average annual soil loss rate of 3.9 tons per acre and a gross loss of 1,017,000 tons (See Appendix F-2, Tables 1 and 2).

Only a portion of this gross loss is transported into the subbasin's streams, while the remainder is deposited as colluvium at the base of slopes and in swales. However, over a period of years this colluvium moves in stages to the stream system due to further erosion and soil creep. The amount of eroded material transported from the subbasin by water is the subbasin's sediment yield. For Subbasin 17 this averages 512,000 tons of soil per year (See Appendix F-2, Table 3), but may be significantly higher or lower depending upon rainfall characteristics and subsequent streamflow.

As stated previously, sheet and rill erosion are not the only mechanisms of soil loss. Gully and bank erosion are also responsible for a considerable amount of soil removal. In addition, soil loss and sediment yield are not equivalent. Sediment yield is the amount of soil actually transported from a watershed or subbasin by water, while soil loss is simply the removal of soil particles from their point of origin. Therefore, Table 2 (Appendix F-2) will show a greater amount of gross soil loss for the subbasin than is listed as sediment yield in Table 3 (Appendix F-2).

The soil loss from cropland may be reduced by the use of conservation practices such as minimum tillage, strip-cropping, contour farming, crop rotations, and the installation of sod waterways and diversion terraces. However, since a farm is an individual management unit, the methods used to control erosion must be part of the farming operation and will be influenced by the owner's decisions. Erosion control measures and practices must be selected, designed and installed to meet the situation on individual farms, with soil loss being reduced to feasible and acceptable levels. It should be noted that agricultural erosion control involves both environmental and economic common sense. Erosion control protects the farmer's investment in crops, fertilizers and the soil, while at the same time improving water quality in the Commonwealth's streams. For the most part, agricultural erosion control practices are more a matter of good crop rotations, cultural practices and tillage activity control than expensive investment in physical facilities.

As indicated in Table 45, approximately five percent of the subbasin's cropland is in Capability Classes V through VIII. Capability groupings indicate, in a general way, the suitability of soils for most kinds of field crops, and are made according to the limitations of the soils when used in this capacity. Land in Classes I through IV is suited for cultivation and other uses, while land in Classes V through VIII is generally not suited for cultivation and should be limited as to its use. Thus, nearly 12,000 acres of existing cropland in the subbasin is not suitable for use as cropland and should be converted to less intensive uses to reduce erosion to acceptable levels.

A second component of agricultural land use is pasture. This has an average annual soil loss rate of 4.2 tons per acre and an average annual gross loss of 589,000 tons. In comparison to cropland, the potential for sediment pollution from pasture is low. However, heavy grazing on the steeper slopes, which are generally used for pasture, and in small areas close to streams greatly increases the erodibility of pasture land.

Over 13 percent or 7,922 acres of the subbasin's pastureland is in the least desirable capability classes. Although this land is generally suited for pasture, special care must be taken to insure that proper management is used to prevent excessive erosion.

Forestland, comprising 64 percent of the subbasin's total land area, is normally very resistant to erosion. However, disturbances, either natural or man-made, to a forest ecosystem can create conditions with a large pollution potential. For example, fire can destroy both the vegetative cover and the organic material covering the

[31]For a detailed methodology on determining soil loss by sheet and rill erosion see Appendix F-1.

Table 45

LAND CAPABILITY CLASSES

Land Use	Acres	I	II	III	IV	V	VI	VII	VIII	I – IV	V – VIII
		Capability Class (Percent)									
Cropland	260,734	0.9	34.5	42.1	17.9	0.0	3.6	1.0	0.0	95.4	4.6
Pasture	58,684	0.1	25.2	38.8	22.4	0.0	6.8	6.7	0.0	86.5	13.5
Forest	1,206,008	0.5	18.2	23.8	26.7	0.1	17.3	12.5	0.9	69.2	30.8

DEFINITIONS OF LAND CAPABILITY CLASSES

Land Suited for Cultivation and Other Uses

Class I	Soils have few limitations that restrict their use.
Class II	Soils have some limitations that reduce the choice of plants or require moderate conservation practices.
Class III	Soils have severe limitations that reduce the choice of plants, or require special conservation tactics, or both.
Class IV	Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Land Limited In Use – Generally Not Suited for Cultivation

Class V	Soils subject to little or no erosion but have other limitations such as rocks, impractical to remove, that limit their use largely to pasture, woodland, or wildlife food and cover.
Class VI	Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, woodland, or wildlife food and cover.
Class VII	Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.
Class VIII	Soils and land forms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife or water supply; or to aesthetic purposes.

Source: U.S. Department of Agriculture, Soil Conservation Service

forest floor, thus severely reducing the forest's erosion resistant nature. Improper road and skid trail location and maintenance during timber harvesting can also have a similar detrimental effect. Normally, though, the effects of these disturbances last only for part of one growing season or until the natural succession of lesser vegetation takes place.

Additional activities contributing significant amounts of sediment to the Commonwealth's streams include construction and mining. Grading and excavation for construction projects expose soil that is then easily eroded and provides the potential for the production of significant amounts of sediment. Construction activities having the potential for contributing large amounts of sediment include the development of industrial parks, shopping centers, residential areas, dams and pipelines, in addition to highway construction. Contractors engaged in these activities are required by DER to prepare erosion and sedimentation control plans, and in some instances secure permits. as discussed previously.

Erosion from construction sites can be restricted through numerous techniques ranging from selecting the proper season for construction to the building of engineering works. Basically, these techniques include (1) reducing the area and duration of exposure of soils to erosion, (2) covering exposed soils with mulch or vegetation, (3) mechanically reducing the velocity of storm runoff, (4) trapping sediment carried by the storm runoff, and (5) planning land clearing operations to coincide with periods of minimum rainfall.

One of the sources of sediment from current surface mining operations is from activities associated with haul roads. Problems from this source can be expected, especially after major storms. However, the primary source of sediment is backfilled areas immediately after replacement of topsoil and prior to establishment of an adequate vegetative cover. These and other sediment sources associated with surface mining can be held to a minimum by effective erosion and sedimentation control measures.

Surface mining techniques, as practiced in Pennsylvania, help to minimize the amount of bare ground exposed at any one time, and therefore, the amount of erosion. The major methods of surface mining practiced here are Contour Mining, also called the Box Cut Method, and the Block Cut Method of Mining.

The Department of Environmental Resources, through the Federal "Surface Mining Control and Reclamation Act of 1977", the Commonwealth's "Surface Mining Conservation & Reclamation Act", and the "Clean Streams Law", is responsible for regulating sedimentation from surface mining operations. Under these laws, all mined areas are to be reclaimed in accordance with conditions of the permits, with failure to comply resulting in forfeiture of bond and loss of operation privileges. The Department of Environmental Resources also has a program for initiating the reclamation of previously mined areas. This program specifically addresses surface reclamation and acid mine drainage abatement from abandoned surface mines with a reduction in erosion resulting.

Specific erosion and sedimentation control practices that are adaptable to various sites and situations can be found in the "Directory of Soil Erosion and Sedimentation Control Practices" published by the Pennsylvania Department of Environmental Resources. These practices include both vegetative methods such as seeding and mulching, and structural methods such as constructing sediment traps and interceptor channels. In addition, simply minimizing the amount of disturbed and impervious areas results in significant decreases in erosion and sedimentation.

G. NAVIGATION

The Allegheny River Navigation System extends from the river's mouth at Pittsburgh, Pennsylvania to a point above East Brady, Pennsylvania, a distance of 72.0 miles. The minimum navigable depth throughout this canalized reach is nine feet over a channel width that varies from a minimum of 200 feet to practically the full width of the river at its mouth. Slackwater in the system is assured by the eight locks and dams described in Table 46, and located on Figure 21. Only four of these locks and dams, L/D #6 through L/D #9, fall within the Subbasin 17 portion of the Allegheny River.

Although joining the heavily used Monongahela and Ohio River navigation systems, the Allegheny River commercial traffic pales in comparison. As shown in Table 47, traffic recorded for the canalized reach, while trending upward in the long run, has leveled out in recent years at a little over 5,500,000 tons per year.

The great majority of the recorded commercial traffic only travels the lower reach of the river, up to and including Pool #4. The entire project, however, is well used by recreation craft. The scenic, relatively undeveloped upper 50 miles of the navigation system attracts the boating, fishing and swimming public by the thousands.

Although a wide variety of commodities can be seen in barges on the waterway, the pronounced leaders are coal, sand, and gravel, whose combined total of 4,000,000 tons accounted for over 77 percent of the reported 1974 traffic. As shown in Table 48, this distribution has been moderating somewhat as the quantities of other goods have increased, albeit slightly, and now represent a larger share of the total.

Currently, because of the nature of the river, with its heavy recreational orientation and moderate commercial use, traffic growth is projected to be moderate and concentrated, as far as absolute tonnage is concerned, in the current leaders (coal for power plant and steel mill use, and sand and gravel for construction needs).

In addition, the future pattern of use should continue as at present, with commercial traffic confined for the most part to the lower river and with recreational use throughout.

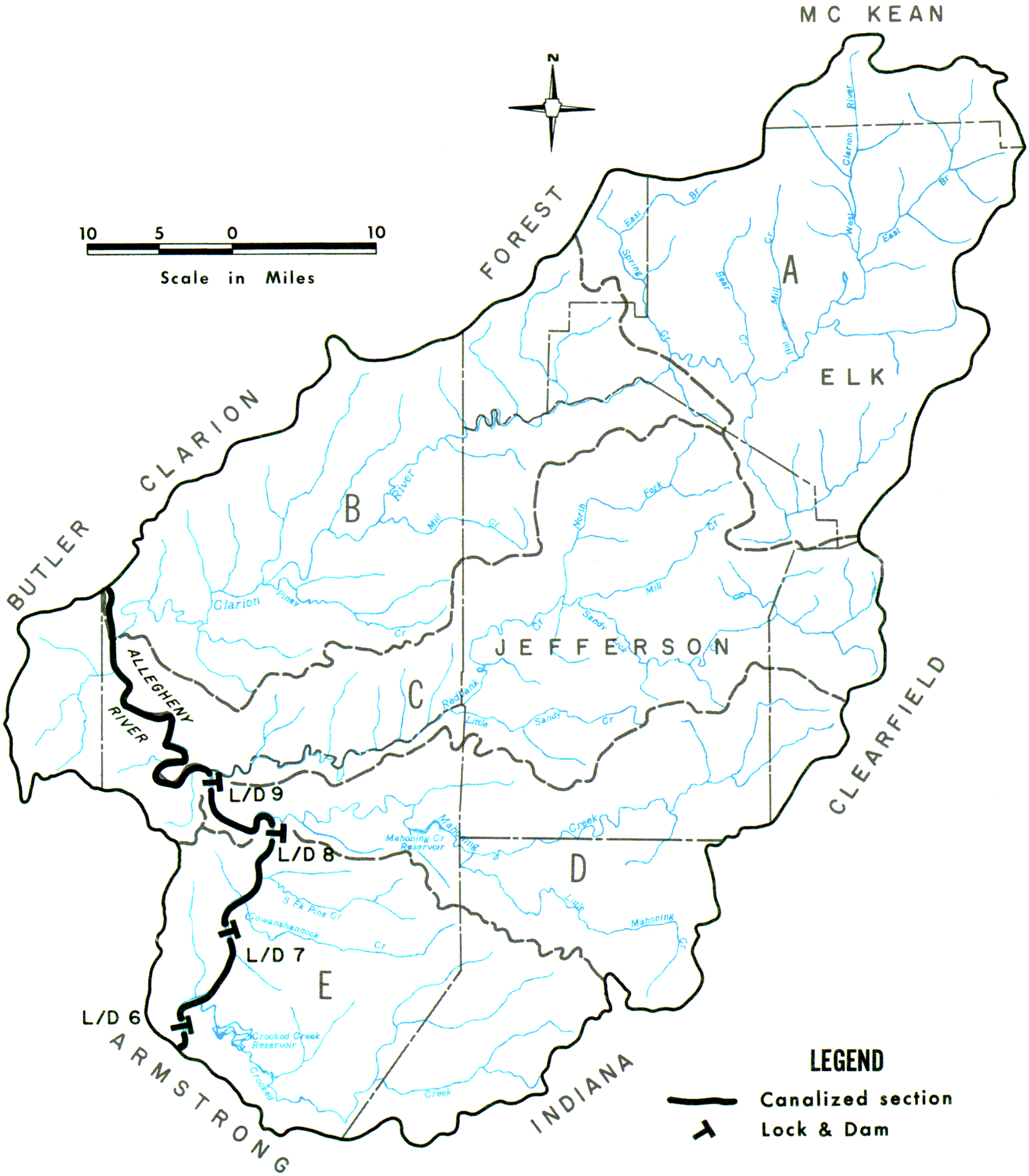

FIGURE 21. Allegheny River Navigation System

Table 46

ALLEGHENY RIVER NAVIGATION STRUCTURES

Structure	Location (River Mile Above Mouth)	Upper Pool (Level[a])	Lock Chamber Size (Feet)	Lift from Lower Pool to Upper Pool (Feet)	Type of Dam
L/D #2[b]	6.7	721.0	56x360	11.0	Fixed Crest
" #3	14.5	734.5	"	13.5	"
" #4	24.2	745.0	"	10.5	"
" #5	30.4	756.8	"	11.8	"
" #6	36.3	769.0	"	12.2	"
" #7	45.7	782.1	"	13.1	"
" #8	52.6	800.0	"	17.9	"
" #9	62.2	822.0	"	22.0	"

[a]Elevation in feet above mean sea level.

[b]The Emsworth Locks and Dams on the Ohio River maintain the pool level at the "Point" in Pittsburgh at elevation 710.0.

Table 47

COMPARATIVE YEARLY TRAFFIC

Year	Tons	Year	Tons
1954	3,773,074	1965	5,351,161
1955	4,633,179	1966	5,193,255
1956	5,153,902	1967	4,974,612
1957	5,241,136	1968	4,645,017
1958	4,551,291	1969	5,646,593
1959	4,034,026	1970	5,661,147
1960	3,832,781	1971	5,946,165
1961	4,381,566	1972	5,425,369
1962	4,441,004	1973	5,317,340
1963	4,746,509	1974	5,532,052
1964	4,866,638		

Table 48

COMMODITY DISTRIBUTION

Commodity	1962 (Thousands of Tons)	Percent	1970 (Thousands of Tons)	Percent	1974 (Thousands of Tons)	Percent
Coal	2,805	63.2	2,891	51.1	2,634	47.6
Sand & Gravel	1,006	22.7	1,616	28.6	1,631	29.5
Lubrication Oil and Grease	33	0.7	170	3.0	256	4.6
Asphalt, Tar and Pitch	72	1.6	90	1.6	171	3.1
Gasoline	203	4.6	214	3.8	155	2.8
Distillate Fuel Oil	34	0.8	114	2.0	137	2.5
Nonmetallic Minerals	8	0.2	211	3.7	94	1.7
Iron and Steel Scrap	45	1.0	53	1.0	79	1.4
Ferroalloys	36	0.8	66	1.2	56	1.0
Residual Fuel Oil	22	0.5	1	0.0	43	0.8
Iron and Steel Plates & Sheets	–	–	22	0.4	35	0.6
Clay	–	–	9	0.2	23	0.4
Wheat Flour and Semolina	15	0.3	26	0.5	27	0.5
Naptha and Petroleum Solvents	11	0.2	14	0.2	22	0.4
All Others	151	3.4	164	2.7	169	3.1
Totals	4,441	100.0	5,661	100.0	5,532	100.0

Source: *Waterborne Commerce of the United States; Calendar Years 1962, 1970, and 1974; Part 2, Waterways and Harbors, Gulf Coast, Mississippi River System and Antilles,* U.S. Department of the Army, Corps of Engineers.

VI. PRINCIPAL PHYSICAL CHARACTERISTICS AND ENVIRONMENTAL AND SOCIAL IMPACTS OF STRUCTURAL ALTERNATIVES

Many water resources projects have been examined as possible solutions to existing or future problems in Subbasin 17. In some cases, projects located outside the subbasin have been studied. While considerable staff effort was devoted to the investigation of alternatives and professional engineering judgment was applied during that effort, these important activities are not afforded any degree of visibility or exposure to the reader of this report. Specific project or program proposals were rejected before they even reached the "alternative" stage, because of overwhelmingly negative economic, environmental, social or physical constraints, if it was obvious that more acceptable alternatives were available.

This chapter provides a description of the basic characteristics and impacts which were considered in the examination of alternative structural solutions to the problems in this subbasin. The discussion includes: 1) all potential multipurpose Corps of Engineers projects which were considered in this subbasin study, 2) all alternatives which were considered for consumptive water use makeup, and 3) the alternatives which were *recommended* for flood control or public water supply.

The consideration and analyses of impacts only deals with those which are direct; there is no discussion of impacts which may be considered secondary or tertiary, such as development pressures which may follow the construction of a major project, or economic or social benefits which may accrue as a result of the direct benefits.

A. POTENTIAL MULTIPURPOSE CORPS OF ENGINEERS PROJECTS

Three multipurpose projects have been investigated in the study of alternatives for this subbasin. The potential Conewango Creek project, on Conewango Creek in New York State, has been recommended for further study for flood control, water supply, low flow augmentation, recreation, and fish and wildlife. The other potential reservoirs, which have been investigated as alternatives, are the Brokenstraw Creek Reservoir and the St. Petersburg Reservoir.

1. CONEWANGO CREEK RESERVOIR

The U.S. Army Corps of Engineers potential Conewango Creek Reservoir (located on Conewango Creek above Waterboro, in New York State) would provide multipurpose functions. Possible multipurpose aspects of the impoundment include flood control, low flow augmentation, water supply, recreation, and fish and wildlife. However, flood control and consumptive use makeup benefits have been the focus of analyses at this time. When the need arises for other purposes, a detailed feasibility study should be made. The dam would be an earthfill structure and would control runoff from a drainage area of 283.3 square miles. At a maximum pool elevation of 4,281 feet, the total storage would be 100,000 acre-feet with an average flood control storage of 63,000 acre-feet and a beneficial storage of 33,000 acre-feet. The estimated construction cost of the project would be approximately $39.2 million. The readily apparent environmental and social impacts of this dam have been analyzed in two stages: a) at the damsite and the lake area, and b) downstream of the damsite.

a. *At The Damsite*

Environmental and social considerations of this dam would include the permanent inundation by the conservation pool of approximately 1,400 acres of farm, agricultural and openland. With the inclusion of full storage, an additional area of about 10,700 acres would temporarily be inundated. This inundation would affect scattered farms, approximately 30 residences and a state drainage ditch line. A few improved and unimproved secondary roads and a section of the Erie Railroad would be affected by the reservoir and may need relocation. Vegetation and wildlife would be displaced from 1,400 acres that would be permanently inundated; however, this could be partially offset by adequate watershed management to mitigate these losses. No species of wildlife or vegetation are known to be unique within the lake area. No industrial or commercial development is anticipated within the lake area. The reservoir affects some of the surrounding land use as the result of potential recreational development. Project-occasioned soil erosion and resulting stream siltation may have adverse effects on surface water quality and aquatic life. Control during construction of the project would be required to minimize such conditions. Average annual benefits would result from the utilization of labor and other resources required for project construction and operation and maintenance during the life of the project. Benefits would also accrue from annual visititation of persons utilizing the public use facilities provided as a component of multipurpose reservoir development. The stream is classified as "scenic" in New York State. The project can be aesthetically intrusive; however, this can be minimized by the use of environmentally oriented design concepts.

b. *Downstream Of The Damsite*

Numerous monetary benefits would be attributable to multipurpose reservoir development in Conewango Creek. In addition, many unmeasurable effects would accrue to the surrounding area. Flood control benefits would extend downstream to areas along Conewango Creek, the Allegheny River and the Ohio River. The average annual flood control benefits within the State of Pennsylvania are estimated at approximately $1.8 million. Benefits would result from inclusion of storage for consumptive water use makeup. This reservoir would be able to provide sufficient storage to satisfy the entire consumptive water use makeup needs on the Allegheny River and Ohio River in Subbasins 16, 17, 18 and 20. This reservoir would also be able to satisfy the entire consumptive water use makeup needs in the stream reaches as mentioned above even if the needs are analyzed by taking into consideration the application of the best practicable control technology or best available technology economically achievable to the self-supplied power and industrial effluent limitation. The total beneficial storage (other than flood control) available annually in this reservoir would be roughly 8,500 mg. This would certainly help to improve water quality by augmenting flows to assure maintenance of quality water consistent with its expected use. This reservoir will also benefit navigation on the Allegheny and Ohio Rivers.

2. BROKENSTRAW CREEK RESERVOIR

The U.S. Army Corps of Engineers potential Brokenstraw Creek Reservoir site is located on Brokenstraw Creek above Garland, Pennsylvania, and would provide multipurpose functions. Possible multipurpose aspects of the impoundment include flood control, low flow augmentation, water supply, recreation, and fish and wildlife. However, flood control and consumptive use makeup benefits have been the focus of analyses at this time. When the need arises for other purposes, a detailed feasibility study should be made. The dam would be an earthfill structure and would control runoff from a drainage area of 164.2 square miles. At a maximum level of 1,392 feet, the total storage would be 86,000 acre-feet, with an average flood control storage of 39,900 acre-feet and a beneficial storage of 39,900 acre-feet. The estimated construction cost of the project would be approximately $34 million. The readily apparent environmental and social impacts of this dam have been analyzed in two stages: a) at the damsite and the lake area, and b) downstream of the damsite.

a. *At The Damsite*

Environmental and social considerations of this dam would include the permanent inundation by the conservation pool of approximately 360 acres of agriculture and forestland. With the inclusion of full storage, an additional area of about 4,000 acres would be temporarily inundated. Part of the lake area falls within State Game Land #143. Vegetation and wildlife would be displaced from the 360 acres that would be permanently inundated; however, this could be partially offset by adequate watershed management to mitigate this displacement. Potential sand and gravel deposits exist within the lake area and these may be affected by the construction of the impoundment. The proposed dam may displace approximately 70 households from the damsite. There would be a need for relocation of Pennsylvania Routes 77 and 426. Also a few secondary roads, a section of the Penn Central Railroad and a section of pipeline may need relocation. Fishing may be adversely affected since the stream is stocked with trout. The reservoir could affect some of the surrounding land use as the result of potential recreational development. Project occasioned soil erosion and resulting stream siltation and eutrophication may have adverse effects on surface water quality and aquatic life since the stream is of good water quality; however, control during construction of the project would be required to minimize such conditions. Average annual benefits would result from the utilization of labor and other resources required for the project construction, and operation and maintenance during the life of the project. The stream is classified as a "scenic river" and delineated as "first priority (Group A)" in the Pennsylvania Scenic Rivers Inventory. Benefits would also accrue from annual visitation of persons utilizing the public use facilities provided as a component of multipurpose reservoir development. The project can be aesthetically intrusive; however, this can be minimized by the use of environmentally oriented design concepts.

b. *Downstream Of The Damsite*

Numerous monetary benefits would be attributable to multipurpose reservoir development in Brokenstraw Creek. In addition, many immeasurable effects would accrue to the surrounding area. Flood control benefits would extend downstream to areas along Brokenstraw Creek and the Allegheny River in Subbasins 16, 17 and 18. The flood control benefit/cost ratio for this reservoir is estimated to be 0.44. Benefits would result from inclusion of storage for consumptive water use makeup. This reservoir would be able to provide sufficient storage to satisfy the entire consumptive water use makeup needs on the Allegheny and Ohio Rivers in Subbasins 16, 17, 18 and 20. This reservoir would also be able to satisfy the entire consumptive water use makeup needs in the stream reaches as mentioned above even if the needs are analyzed by taking into consideration the application of the best practicable control technology or best available technology economically achievable to the self-supplied power and industrial effluent limitations. The total beneficial storage (other than flood control) available annually in this reservoir would be roughly 6,400 mg. This would certainly improve water quality by augmenting flows to assure maintenance of quality water consistent with its expected use. This reservoir will also benefit navigation on the Allegheny River.

3. ST. PETERSBURG RESERVOIR

The U.S. Army Corps of Engineers potential St. Petersburg Reservoir (located on the Clarion River, five miles above the junction with Allegheny River) would provide multipurpose functions. Possible multipurpose aspects of the impoundment include flood control, low flow augmentation, water supply, recreation, fish and wildlife, and hydroelectric power. However, consumptive water use make up and flood damage reduction benefits have been the focus of analysis at this time. When the need arises for other purposes, a detailed feasibility study should be made. The dam would be a concrete structure and would control runoff from a drainage area of 1,244.6 square miles. It is tentatively planned to have a total storage of 981,000 acre-feet, with an average flood control storage of 380,900 acre-feet and a beneficial storage of 588,100 acre-feet. The estimated construction cost of the project would be approximately $425 million. The readily apparent environmental and social impacts of this dam have been analyzed in two stages: 1) at the damsite and the lake area, and 2) downstream of the damsite.

a. *At The Damsite*

Environmental and social consideration of this dam would include the permanent inundation by the conservation pool of approximately 500 acres of agricultural and forestland. This may result in possible losses of vegetation and wildlife from the damsite and lake area; however, this could be partially offset by adequate watershed management to mitigate these losses. With the inclusion of full storage, an additional area of about 13,000 acres would be temporarily inundated. Sections of the lake area fall within State Game Lands Nos. 63, 72 and 74.

Several productive gas and oil wells would be encountered within the lake area. These would be irretrievably lost if this impoundment is built. The settlements in Callensburg Borough and part of Sligo Borough in Clarion County will be eliminated by the proposed dam, resulting in displacement of about 150 families, a few industrial and commercial facilities, a couple of churches and a cemetery. The possibility exists of inundation of Piney Generating Station along with a substation and power transmission lines which fall within the lake area. Construction of this dam would result in relocation of a few major and secondary roads, either partially or wholly. The significant roads are Pa. Route Nos. 338, 478 and 68; and U.S. Route No. 322. A section of Conrail may need relocation. The possibility exists of the loss of a geologically unique area. Fishing may be adversely affected since Beaver Creek, Canoe Creek, Mill Creek and a section of the Clarion River, which would be inundated by the proposed dam, are stocked with trout. The reservoir could affect some of the surrounding land use as the result of potential recreational development. The existing water quality in the Clarion River is not very good; it is mainly polluted by acid mine drainage from intensive mining activities in the surrounding area. The proposed dam would in no way adversely affect the water quality of the stream; however, project-occasioned soil erosion and resulting stream siltation and eutrophication may be a problem which could be minimized by taking adequate precaution during the construction of the project. Average annual benefits would result from the utilization of labor and other resources required for project construction, and operation and maintenance during the life of the project. The stream has been classified as a "scenic river" in the Pennsylvania Scenic Rivers Inventory and is delineated as "first priority" (Group A). This project may be aesthetically intrusive; however, this can be minimized by the use of environmentally oriented design concepts.

b. *Downstream Of The Damsite*

Numerous monetary benefits would be attributable to multipurpose reservoir development in the Clarion River. In addition, many immeasurable effects would accrue to the surrounding area. Flood control benefits would extend downstream to areas along the Clarion River, the Allegheny River and the Ohio River in Subbasins 17, 18 and 20. Flood control benefits from this reservoir would also extend to the States of Ohio and West Virginia. The flood control benefit/cost ratio for this reservoir within the Commonwealth of Pennsylvania is estimated to be 0.26. Benefits would result from inclusion of storage for consumptive water use makeup. This reservoir would be able to provide sufficient storage to satisfy the entire consumptive water use makeup needs on the Allegheny and Ohio Rivers in Subbasins 17, 18 and 20. This reservoir would also be able to satisfy the entire consumptive water use makeup needs in the stream reaches as mentioned above even if the needs are analyzed by taking into consideration the application of the best practicable control technology or best available technology economically achievable to the self-supplied power and industrial affluent limitations. The total beneficial storage (other than flood control) available annually in this reservoir would be roughly 116,500 mg. This would certainly improve water quality by augmenting flows to assure maintenance of quality water consistent with its expected use. This reservoir would also benefit navigation on the Allegheny and Ohio Rivers. Benefits would also accrue from annual visitation of persons utilizing the public use facilities provided as a component of multipurpose reservoir development.

B. POTENTIAL CONSUMPTIVE USE MAKEUP ALTERNATIVES

Consumptive water use makeup is a serious problem facing the Commonwealth if instream and existing withdrawal uses are to be protected in the future. No recommendations are made for solutions to the projected consumptive use makeup problems in Subbasin 17, because further study of the identified alternatives is necessary to assess their remedial characteristics in conjunction with any individual solutions which consumptive users may choose to adopt. The following discussions include all the alternative structures which were considered in this study.

1. *Small Potential Reservoir #16–2*

The small potential reservoir #16–2 would be located on East Branch Leboeuf Creek, approximately 2.5

miles upstream from its junction with Leboeuf Creek, Erie County, and could serve as a multipurpose structure. However, consumptive water use makeup and flood damage reduction benefits have been the focus of analyses at this time. When the need arises for other purposes, a detailed feasibility study should be made. The 50-foot high dam would be an earthfill structure and would control runoff from a drainage area of 21.6 square miles. The dam, as proposed, would have a total storage of 5,100 acre-feet with a beneficial storage of 1,427 acre-feet, provisional flood water storage of 3,430 acre-feet and a sediment pool of 243 acre-feet. The estimated construction cost of the project would be $1.4 million.

Environmental and social considerations of this dam would include periodic inundation of approximately 602 acres of forestland (Allegheny National Forest) when the dam is at full storage capacity. This may result in possible loss of vegetation and wildlife from the damsite and the lake area; however, this could be partially offset by adequate watershed management to mitigate these losses. The dam's obstruction to the free-flowing nature of the stream may have an adverse effect on fishing and aquatic life. This reservoir would be able to provide storage to satisfy the consumptive water use makeup needs on French Creek and the Allegheny River in Subbasins 16 and 17 respectively. The total beneficial storage (other than flood control) available annually in this reservoir would be approximately 273 mg. This reservoir would also be able to provide flood damage reduction to Waterford Borough along Leboeuf Creek, and for a seven-mile stretch of stream from the mouth.

The flood control benefit/cost ratio for this reservoir is estimated to be 0.5. The reservoir could affect some of the surrounding land use as a result of possible recreational development. During construction, soil erosion and stream siltation would temporarily have some minor effect on surface water quality. The project can be aesthetically intrusive; however, this can be minimized by the use of environmentally oriented design concepts.

2. *Small Potential Reservoir #20–4*

The small potential reservoir #20–4 would be located on Rocky Run approximately 0.5 miles upstream from its junction with West Branch Clarion River, Elk County, and could serve as a multipurpose structure. However, consumptive water use makeup and flood damage reduction benefits have been the focus of analyses at this time. When the need arises for other purposes, a detailed feasibility study should be made. The 80-foot high dam would be an earthfill structure and would control runoff from a drainage area of 9.1 square miles. The dam, as proposed, would have a total storage of 3,750 acre-feet with a beneficial storage of 1,455 acre-feet and a sediment pool of 110 acre-feet. The estimated construction cost of the project would be $695 thousand.

Environmental and social consideration of this dam would include periodic inundation of approximately 156 acres of forestland when the dam is at full storage capacity. This may result in possible losses of vegetation and wildlife from the damsite and the lake area; however, this could be partially offset by adequate watershed management to mitigate these losses. The Clarion River is a stocked trout stream. Therefore, the dam's obstruction to the free-flowing nature of the stream may have an adverse effect on fishing and aquatic life. The reservoir will provide flood protection for residential and commercial properties, and roads and highways in the Borough of Wilcox. Conrail will get flood protection. This reservoir would be able to provide storage to satisfy the consumptive water use makeup needs in the Clarion River and the Alleghen River in Subbasin 17. The total beneficial storage (other than flood control) available annually in this reservoir would be approximately 333 mg. This reservoir would also be able to provide flood damage reduction in Wilcox Borough.

The flood control benefit/cost ratio for this reservoir is estimated to be 0.92. The reservoir could affect some of the surrounding land use as a result of possible recreational development. During construction, soil erosion and stream siltation would have some minor effects on surface water quality. This stream has been classified as a "scenic river" in the Pennsylvania Scenic Rivers Inventory and is delineated as "third priority". The project may be aesthetically intrusive; however, this can be minimized by the use of environmentally oriented design concepts.

3. *Small Potential Reservoir #3*

The small potential reservoir #3 would be located on Beaverdam Run, approximately one mile upstream from its junction with Falls Creek in Jefferson County, and could serve as a multipurpose structure. However, consumptive water use makeup has been the focus of analyses at this time. When the need arises for other purposes, a detailed feasibility study should be made. The 38-foot high dam would be an earthfill structure and would control runoff from a drainage area of 4.7 square miles. The dam, as proposed, would have a total storage of 3,620 acre-feet with a beneficial storage of 2,760 acre-feet, provisional floodwater storage of 750 acre-feet and a sediment pool of 110 acre-feet. The estimated construction cost of the project would be $2.1 million.

Environmental and social consideration of this dam would include periodic inundation of approximately 270 acres of forestland and agricultural land when the dam is at full storage capacity. This may result in possible losses of vegetation and wildlife from the damsite and the lake area; however, this could be partially offset by adequate watershed management to mitigate these losses. The dam's obstruction to the free-flowing nature of the stream may have an adverse effect on fishing and aquatic life. This reservoir would be able to provide storage to satisfy the consumptive water use makeup needs on the Allegheny River in Subbasin 17. The total beneficial storage (other than flood control) available annually in this reservoir would be approximately 440 mg.

The reservoir could affect some of the surrounding land use as a result of possible recreational development. Construction of this dam would result in relocation of secondary roads and part of Pa. Route 830. During construction, soil erosion and stream siltation would temporarily have some minor effects on surface water quality. The project may be aesthetically intrusive; however, this can be minimized by the use of environmentally oriented design concepts.

C. PROJECTS RECOMMENDED FOR WATER SUPPLY OR FLOOD CONTROL

Numerous structural measures were examined as possible solutions to public water supply or flood damage problems in Subbasin 17. In the interest of brevity, only the following structures, which are recommended for further study or construction, are discussed here.

1. *Small Potential Reservoir #001*

The small potential reservoir #001 would be located on Laborde Branch, near the borderline between Sandy and Union Townships in Clearfield County, and could serve as a public water supply source for DuBois Water Department. The 90-foot high dam would be an earthfill structure and would control runoff from a drainage area of 7.6 square miles. The dam, as proposed, would have a total storage of 13,000 acre-feet. The estimated construction cost of the project would be $9.6 million.

Environmental and social consideration of this dam would include periodic inundation of approximately 390 acres of forestland and openland when the dam is at full storage capacity. This may result in possible losses of vegetation and wildlife from the damsite and the lake area; however, this could be partially offset by adequate watershed management to mitigate these losses. The dams obstruction to the free-flowing nature of the stream may have an adverse effect on fish and aquatic life. This reservoir would be able to serve as a public water supply source for DuBois Water Department.

The construction of this impoundment may result in the relocation of a medium duty road, a pipeline and a power transmission line which may fall within the lake area. The possibility exists that a few gas wells, which fall within the lake area, may be affected. The reservoir could affect some of the surrounding land use as a result of possible recreational development. During construction, soil erosion and stream siltation would have some minor effects on surface water quality. The project may be aesthetically intrusive; however, this can be minimized by the use of environmentally oriented design concepts.

2. *Channel Modification at Brockway*

The potential structural solution to reduce flood damages at Brockway Borough would be located on Smith Run, a tributary of Little Toby Creek. The project would consist of extending an existing 4'0" by 8'0" culvert along Clark Street, a distance of 480 feet to provide for interior drainage. A flap gate would be installed at the terminus of the culvert to prevent flows from Toby Creek from backing up in the culvert. The estimated construction cost of the project would be approximately $346,000.

Environmental and social consideration of this project would include occupation of land in the floodplain. This may affect some mineral extraction activities, especially coal and limestone. The project would benefit several residences, industrial and commercial facilities, a church and Wildwood Cemetery, which are subject to flooding in this area. A railroad, Pa. Route 28 and local secondary roads would also benefit. Project-occasioned soil erosion and resulting stream siltation may have some effect on surface water quality and aquatic life. Control during construction of the project would be required to minimize such conditions.

3. *Small Potential Reservoir #20–2*

The small potential reservoir #20–2 would be located on Hoffman Run approximately four miles upstream from the Borough of Wilcox in Elk County, and could serve as a multipurpose structure. However, flood damage reduction benefits have been the focus of analyses at this time. When the need arises for other purposes, a detailed feasibility study should be made. The 80-foot high dam would be an earthfill structure and would control runoff from a drainage area of 4.1 square miles. The dam, as proposed, would have a total storage of 6,500 acre-feet with a beneficial storage of 5,781 acre-feet, provisional floodwater storage of 656 acre-feet and a sediment pool of 63 acre-feet. The estimated construction cost of the project would be $1.2 million.

Environmental and social consideration of this dam would include periodic inundation of approximately 262 acres of forestland (Allegheny National Forest) when the dam is at full storage capacity. This may result in possible losses of vegetation and wildlife from the damsite and the lake area; however, this could be partially offset by adequate watershed management to migitage these losses. The dam's obstruction to the free-flowing nature of the stream may have an adverse effect on fishing and aquatic life. This reservoir could reduce flood damages in the Borough of Wilcox. Flood protection provided by this reservoir will benefit residential and commercial properties (in the Borough of Wilcox), local roads and highways, the Penn Central Railroad, and oil and gas production facilities. Fishing and launching areas could be partially affected by the reservoir.

The flood control benefit/cost ratio for this reservoir is estimated to be 0.94. The reservoir could affect some of the surrounding land use as a result of possible recreational development. During construction, soil erosion and stream siltation would have some minor effects on surface water quality. The project can be aesthetically intrusive; however, this can be minimized by the use of environmentally oriented design concepts.

APPENDIX A

SOILS

Appendix A-1

CHARACTERISTICS OF SOILS

Soil Assn. Symbol	Soil Association Name	Percent of Each Soil in Assn.[a]	Percent of Each Assn. In the Subbasin	Dominant Slope (Percent)	Drainage Class[b]	Depth of Soil (Inches)	Hydro-logic Group
A2b	Cookport	30	3.4	0–12	MW	50	C
	Clymer	15		0–15	W	50	B
	Hazleton	15		3–20	W	50	B
A2c	Cookport	20	2.8	0–12	MW	50	C
	Cavode	20		0–15	SWP	72	C
	Wharton	10		3–20	MW	72	C
A2i	Gilpin	40	35.3	3–20	W	30	C
	Ernest	20		0–15	MW	72	C
	Wharton	5		3–20	MW	60	C
A2k	Hazleton	40	26.0	3–20	W	60	B
	Cookport	20		0–12	MW	60	C
A2l	Hazleton	25	11.1	3–20	W	60	B
	Gilpin	25		3–20	W	30	C
	Ernest	10		0–15	MW	72	C
A2m	Rayne	35	7.1	3–15	W	60	B
	Wharton	10		3–20	MW	60	C
	Ernest	10		0–15	MW	72	C
A3a	Cavode	30	11.3	0–15	SWP	60	C
	Wharton	15		3–20	MW	60	C
	Gilpin	15		3–20	W	30	C
E1d	Monongahela	20	1.4	0–8	MW	60+	C
	Philo	20		0–3	MW	60+	B
	Melvin	10		0–3	P	60+	D
E1f	Wayland	30	1.6	0–3	P	60+	C/D
	Chenango	15		0–20	W	60+	A
	Braceville	10		0–8	SWP	60+	C

[a]Percentages do not total 100 because of minor soils in each association.

[b]W - Well drained; MW - Moderately well drained; SWP - Somewhat poorly drained; P - Poorly drained

Source: Soil Conservation Service

APPENDIX B

WATER USE

Appendix B-1

WATER CONSERVATION

The Commonwealth enjoys a relatively abundant supply of water when compared to many other states in the Nation. During the past ten years, normal and above normal annual precipitation totals have provided many of Pennsylvania's water suppliers with the quantities of water needed to support growth in service populations, increased use of water-using household conveniences, and the general growth in per capita daily usages associated with the rising standard of living of a society largely unaccustomed to conserving resources.

Unfortunately, many suppliers have just been able to keep one step ahead of rising demands, by relying on existing streamflow or groundwater conditions during relatively good times. Thus, many of those suppliers have rendered themselves extremely vulnerable to the ill effects of even a mild drought. Several areas in the state would be subject to extreme social and economic disruption if a severe or prolonged drought were to occur at this time.

Because of the continually growing demands being placed upon this finite resource by an innovative society driven by the urge to attain a high standard of living, it is becoming increasingly important that, as more citizens are able to avail themselves of modern conveniences, they realize the water "pie", in a sense, is being shared by more people. Therefore, each person will be required to accept a smaller share.

By practicing effective conservation techniques it will be possible for more of society to enjoy the benefits of modern technology without placing any additional immediate demands upon the resource. It is strongly recommended that all water users in Pennsylvania strive to practice good conservation. Good conservation can accomplish the following:

1. Buy time for planners to formulate detailed studies which would determine the adequacy of system facilities and existing sources.
2. Delay the need for expansion of both water supply facilities and sewage treatment plants. Highly successful conservation campaigns may even eliminate any need for expansion, which would eliminate possible degradation of the environment associated with new development.
3. Save water – This is the major area in which the general public can really get involved. By saving water, one can also reduce energy consumption and, therefore, realize not only a monetary reward for himself but also the companies involved in supplying the water. Energy utilized in supplying water is consumed in treatment processes, transmission of water in both untreated and treated form and in heating processes. Because power plants are major water users, any reduction in power requirements will result in even further reduction of water use.

Conservation measures are generally not emphasized to any great degree unless an emergency such as a drought or a flood arises. During periods of drought, water supplies become critically low. During periods of flooding, water is plentiful but often is unsafe to drink. Existing supplies become contaminated, and treatment plants inundated with high waters are unable to treat the water. In either case, as potable water supplies decrease, water users may pass through three phases of cutbacks or curtailments. These are 1) voluntary water conservation, 2) mandatory water conservation and 3) mandatory water rationing. In order to comply with either Phase 1 or Phase 2, the water user must not only be willing to save but must know how to save. If water conservation is already being practiced, the user may find it much easier to adjust to further curtailment during an emergency situation. However, if the user has no idea about the best ways to conserve water, Phase 3 conditions could be imposed very early during a crisis. Therefore, it is imperative that water conservation be encouraged immediately.

Consider the following example of how water is used in a typical household, and how much water could be saved. Assume that one household, or a family of four people, uses 255 gallons of water per day (gpd). The initial usage breakdown is listed in Table 1. Also assume that this family wants to conserve water and decides to introduce two water-saving devices into their household. These devices, with a comparison of usage before and after installation, are as follows:

1. Maximum 3.0 gallon per minute (gpm) shower head.

   Present conventional system: 5 gpm x 4 minutes/day x 4 persons = 80 gpd.

   New system: 3 gpm x 4 minutes/day x 4 persons = 48 gpd. If this device were installed, a 12 percent savings would be made as noted in Table 1.
2. 3.5 gallons per flush water closet.

   Present conventional system: 5 gallons/flush x 5 flushes/day x 4 persons = 100 gpd.

   New system: 3.5 gallons/flush x 5 flushes/day x 4 persons = 70 gpd. If this device were installed, a 12 percent savings would be made as noted in Table 1.

A combination of these devices would result in a savings of 62 gpd, or a 24 percent reduction in total water use. Based on a system serving 1,000 people or 250 households,

Table 1

TYPICAL HOUSEHOLD WATER USAGE AND POTENTIAL REDUCTION

	Initial Usage (gpd)	Usage With 3.0 GPM Shower Head (gpd)	Usage With 3.5 Gal./Flush Water Closet (gpd)
Toilet Flush	100	100	70
Bathing/Showers	80	48	80
Laundry	35	35	35
Kitchen	27	27	27
Lavatory	8	8	8
Utility Sink	5	5	5
Total	255	223	225
Total Savings		32	30
% Savings		12%	12%

566,000 gallons of water could be saved each year, if only 10 percent of the customers would use these devices (See Table 2).

It should be emphasized that these figures are used only as an example. A household may be able to save more or less water than indicated in these tables, depending upon its present usage. However, the fact remains that water will be conserved. In certain communities, the new water closet may not be applicable because of potential sewer problems associated with decreased flows. Nevertheless, a water company should consider encouraging the installation of these devices wherever possible.

In addition to these devices, there are other water-saving devices which may be utilized. These would include faucet aerators, spray taps, flow control devices and toilet tank inserts. In general, installation of these devices is very easy and quite inexpensive.

There are many other areas throughout the house where water conservation could be practiced. The following list will point out just a few of these:

1. Repair any leaky faucets, connections, pipes or toilets. To check for toilet leaks, put a few drops of food coloring in the tank; then check to see if the coloring appears in the bowl.
2. Check for leaks between the water meter and the home. Turn off all water uses in the home; then observe the meter to see if it continues to register any water usage.
3. Do not use the toilet for trash disposal. Approximately 5 to 7 gallons of water are used per flush in a conventional toilet.
4. Do not wash dishes, shave, brush teeth, or wash hands utilizing an open faucet. Use a stopper as often as possible.
5. Take shorter showers. Use a timer and time your showers. Remember, the longer the shower, the more water used. If practical, turn off shower while soaping up.
6. Dislodge particles of dirt with a brush or wash cloth instead of using the force of the water.
7. Operate a washing machine or dishwasher only with a full load. If the washing machine has a suds saver, use it and save 16–19 gallons of water per load. Avoid long pre-wash and scrub cycles for automatic dishwashers.
8. Avoid using the garbage disposal on items that could be used for composting or disposed of in the garbage can.
9. Keep a container of drinking water cold in the refrigerator instead of allowing the water to run to obtain a cold drink.
10. Reuse washwater to water plants, lawns, gardens or even to wash cars.
11. Do not water the driveways/sidewalk along with the lawn or garden.
12. When watering the lawn or garden, do it in the early morning to reduce evaporation losses.

Table 2

TYPICAL ANNUAL WATER SAVINGS
PER 1000 PERSONS (Million Gallons)

Percentage of Customers Using Water-Saving Devices	Savings Utilizing Device "A" (3 GPM Shower Head)	Savings Utilizing Device "B" (3.5 Gallon/Flush Water Closet)	Savings Utilizing "A" and "B"
10	0.292	0.274	0.566
20	0.584	0.548	1.132
30	0.876	0.821	1.697
40	1.168	1.095	2.263
50	1.460	1.369	2.829
60	1.752	1.643	3.395
70	2.044	1.916	3.960
80	2.336	2.190	4.526
90	2.628	2.464	5.092
100	2.920	2.738	5.658

Appendix B-2

PUBLIC WATER SUPPLY SOLUTION ALTERNATIVES

Table 23 in Chapter V lists the alternatives which were examined as solutions to public water supply deficiencies in Subbasin 17. The columns in Table 23 are explained here.

Column 1: Public Water Supplier Name, Map Legend Number, and DER Numerical Code.

Column 2: List of present sources and projected deficiencies for 1990 and 2020. Deficiencies include yield, allocation, treatment plant (filtration) and storage deficiencies.

Column 3: List of solution alternatives which could serve to decrease or eliminate deficiencies. Increased storage alternatives apply only to storage deficiencies and will not help to solve other deficiencies. They are supplemental to yield, allocation and treatment solution alternatives.

Column 4: Increased capacity which would be required to provide for projected 1990 usages, measured against existing capacity.

Column 5: 1990 Annual Costs in 1976 dollars for alternatives listed in Column 3.

Column 6: Increased capacity which would be required to provide for projected 2020 usages, measured against existing capacity.

Column 7: 2020 Annual Costs in 1976 dollars for alternatives listed in Column 3.

Column 8: Remarks applicable to specific solution alternatives.

Appendix B-3

CONSUMPTIVE WATER USE MAKEUP SOLUTION ALTERNATIVES

Table 26 in Chapter V lists the alternatives which were examined as possible solutions to the consumptive water use makeup needs in Subbasin 17. The streams or stream reaches on which consumptive water uses should be made up are listed in that table along with the various solution alternatives investigated to satisfy those needs. The columns in that table are described here.

Row 1: The legend for each of the streams or stream reaches on which consumptive water use is required to be made up. (See Figure 11)

Column 1: The various solution alternatives such as potential reservoirs, existing reservoirs, groundwater development, individual storage, etc., investigated to satisfy the needs.

Row 2/Column 2 through Column 11: The streams or stream reaches and/or unidentified locations on which the consumptive water uses are required to be made up. For each stream or stream reach, the table lists the associated watersheds, the need for each category of water use and the total need. The daily need is given in mgd and the storage required during low flow periods is given in mg. The upstream users in Subbasin 16, and the downstream users in Subbasins 18 and 20, whose consumptive water use makeup needs could be satisfied by the alternatives in Column 1 are also listed.

Column 12: The total annual storage in million gallons available for beneficial uses in potential reservoirs. (For multipurpose reservoirs the flood control storage is excluded.)

Column 13: The total needs in million gallons satisfied by a solution listed in Column 1. This is the summation of all the needs.

Column 14: Alternative remarks applicable to specific solution.

A consumptive water use makeup need, which is satisifed by a specific solution alternative is identified in the box corresponding to that need column and solution alternative row. The entries made in the box are the percentage of the need satisifed by that specific solution alternative and the equivalent storage allocated to meet, that need in million gallons. For example, if the entry is 100 percent, then the storage allocated will be equal to the total needs for that particular stream or stream reach.

APPENDIX C

FLOOD DAMAGE REDUCTION

Appendix C-1

CORPS OF ENGINEERS PROJECTS

Watershed	Legend (See Figure 13)	Location	Status	Purpose	Type of Structure	Drainage Area (sq.mi.)	Design Life-time (Year)	Length (ft.)	Width (feet)	Height or Depth (ft.)	Diameter (feet)	Flood Pool Surface Area (acres)	Flood Control Volume (Acre-Feet)	Total Construc-tion Cost ($1,000)[a]	Total Annual Cost ($1,000)[b]	Beneficial Area (See Figure 13)
A	C1	East Branch Reservoir	Completed (1952)	Flood Control & Low Flow Augmen-tation	Earth Fill Structure	72.40	100	1,725	1,115 (base) 20 (top)	184			38,700	17,772	1,041	3,6,7, 8,9,17, 18,19,20, 21,22,23, 24,25,26, & Subbasins 18 & 20
A	C2	Johnsonburg	Completed (1957)	Flood Protection	Channel Improvement Earth Dike Concrete Flood Walls		50	4,800 1,800 449						2,594	161	2
A	C3	Ridgway	Completed (1962)	Flood Protection	Channel Improvement Pilot Channel		50	5,882 6,490						1,852	114	3
C	C4	Brookville	Completed (1962)	Flood Protection	Channel Improvement Pilot Channel		50	16,800 15,000						3,314	145	11
C	C5	DuBois	Completed (1977)	Flood Protection	Channel Improvement Pilot Channel		50	21,000 4,600						6,322	284	12
C	C6	Reynoldsville	Completed (1957)	Flood Protection	Channel Improvement		50	11,400						1,298	80	13
D	C7	Big Run	Completed (1964)	Flood Protection	Channel Improvement		50	13,460						985	46	15
D	C8	Sykesville	Completed (1961)	Flood Protection	Channel Improvement		50	7,260						525	22	14

[a] 1976 Price Level

[b] Total annual cost (1976 price level) consists of annual construction cost amortized at the rate of 5.25% over the respective life periods plus annual operation and maintenance cost.

[c] 7, 8, 9, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26 & Subbasins 16, 18 and 20.

Note: 1) In some cases, for fiscal or other reasons, flood control projects are designed and constructed as two or more units; however, all units acting in tandem are required to achieve the design flood damage reduction. Units are listed separately.

2) Structures without a legend number are located in the watershed as listed, and provide flood protection to this subbasin.

Appendix C-1 (Cont.)

CORPS OF ENGINEERS PROJECTS

Watershed	Legend (See Figure 11)	Location	Status	Purpose	Type of Structure	Drainage Area (sq.mi.)	Design Life-time (Year)	Length (ft.)	Width (feet)	Height or Depth (ft.)	Diameter (feet)	Flood Pool Surface Area (acres)	Flood Control Volume (Acre-Feet)	Total Construc-tion Cost ($1,000)[a]	Total Annual Cost ($1,000)[a]	Beneficial Area (See Figure 13)
D	C9	Punxsu-tawney	Completed (1950)	Flood Protection	Channel Improvement Earth Dike Wall		50	18,770 12,055 2,454						16,563	1,053	16
D	C10	Mahoning Creek Reservoir	Completed (1941)	Flood Control	Concrete Gravity Structure	340.00	100	926	154 (base)	162		2,200	69,700	54,865	3,124	18,19,20, 21,22,23, 24,25,26, & Subbasins 18 & 20
E	C11	Kittanning	Completed (1940)	Flood Protection	Concrete Flood Wall		50	4,590						1,218	74	20
E	C12	Crooked Creek Reservoir	Completed (1940)	Flood Control	Earthfill Structure	277.0	100	1,480	975 (base)	143		1,590	89,400	38,915	2,232	Subbasins 18 & 20
16B		Allegheny Reservoir	Completed (1967)	Flood Control & Low Flow Augmen-tation	Earth Embankment & Concrete Gravity Structure	2,180.00	100	1,098.5 798.5	1,050 (base) 195 (base)	179			940,000	107,418	5,951	See (c)
16F		Tionesta Reservoir	Completed (1940)	Flood Control & Recrea-tion	Earthfill Structure	478.00	100	1,050	1,080 (base) 25 (top)	154			125,600	8,688	706	See (c)

[a] 1976 Price Level

[b] Total annual cost (1976 price level) consists of annual construction cost amortized at the rate of 5.25% over the respective life periods plus annual operation and maintenance cost.

[c] 7, 8, 9, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26 & Subbasins 16, 18 and 20.

Note: 1) In some cases, for fiscal or other reasons, flood control projects are designed and constructed as two or more units; however, all units acting in tandem are required to achieve the design flood damage reduction. Units are listed separately.

2) Structures without a legend number are located in the watershed as listed, and provide flood protection to this subbasin.

Appendix C-2

DEPARTMENT OF ENVIRONMENTAL RESOURCES PROJECTS

Watershed	Legend (See Figure 11)	Location	Status	Purpose	Type of Structure	Drainage Area (sq.mi.)	Design Life-time (Year)	Length (ft.)	Width (feet)	Height or Depth (ft.)	Diameter (feet)	Flood Pool Surface Area (acres)	Flood Control Volume (Acre-Feet)	Total Construc-tion Cost ($1,000)[a]	Total Annual Cost ($1,000)[a]	Beneficial Area (See Figure 13)
C	E1	Brockway C33:2 Unit #1	Completed (1958)	Flood Protection	Channel Improvement		50	11,000	80–100 (bottom)					733	45	5
					Earth Levee			13,200	10 (top)							
C	E2	Unit #2	Completed (1959)		R.C.C. Floodwall			200						98	5	5

[a]1976 Price Level

[b]Total annual cost (1976 price level) consists of annual construction cost amortized at the rate of 5.25% over the respective life periods plus annual operation and maintenance cost.

Note: In some cases, for fiscal or other reasons, flood control projects are designed and constructed as two or more units; however, all units acting in tandem are required to achieve the design flood damage reduction. Units are listed separately.

Appendix C-3

FLOOD PLAIN INFORMATION REPORTS BY U.S. ARMY CORPS OF ENGINEERS

Watershed	Report	Date Completed
A	Clarion River and Silver Creek – Johnsonburg, Elk County	12/1971
C	Allegheny River – Clarion County	6/1974
C	Sandy Lick Creek & Tributaries – DuBois, Clearfield County	6/1975
D & E	Allegheny River – Armstrong County	12/1973

Appendix C-4

FLOOD PRONE AREAS MAPPED BY
U.S. GEOLOGICAL SURVEY

Watershed	Stream(s)	U.S.G.S. Topographic Map	Date Completed
A	East Branch Clarion River, Fivemile Run, Sevenmile Run, Smith Run, Buck Run, County Line Run, Doe Run & Cold Spring	Hazel Hurst	1974
A	Clarion River, West Branch Clarion River, East Branch Clarion River, Powers Run, Elk Creek & Mohan Run	Ridgway	1973
A	Powers Run, Laurel Run, Elk Creek, Iron Run & Silver Run	Saint Marys	1974
A	Little Toby Creek, Whetstone Branch & Rattlesnake Creek	Sabula	1974
A	Little Toby Creek, Boggy Run, Mead Run, Brandy Camp Creek, Phalen Run & Sawmill Run	Brandy Camp	1973
A	Clarion River, Little Toby Creek & Walburn Run	Carman	1973
B	Clarion River, Deer Creek, Paint Creek, Truot Run, Toby Creek, Courtleys Run, Piney Run, Brush Run, Gathers Run & Reids Run	Clarion	1974
B	Parsins Run, Sloan Run, Glade Run & Poe Run	New Bethlehem	1974
C	Big Run & McCraken Run	Valier	1974
C	Redbank Creek, Pine Run, Town Run, Middle Run, Leisure Run, Long Run & Leatherwood Creek	New Bethlehem	1974
C	Redbank Creek, Pine Creek, Runaway Run, Carrier Run, Beaver Run, Eckler Run, Tarkiln Run, Red Run, Patton Run, Little Sandy Creek, Ferguson Run, Reitz Run, Cherry Run & Nolf Run	Summerville	1974
C	Redbank Creek, Goder Run, Clement Run, Sandy Lick Creek, Mill Creek, Little Mill Creek, Fivemile Run, Swamp Run, North Branch Redbank Creek, Lick Run, Sugar Camp Run, Burns Run, Perkin Run, Craft Run & Shippen Run	Brookville	1974

Appendix C-4 (Cont.)

FLOOD PRONE AREAS MAPPED BY
U.S. GEOLOGICAL SURVEY

Watershed	Stream(s)	U.S.G.S. Topographic Map	Date Completed
C	Sandy Lick Creek, Wolf Run, Narrows Creek, Muddy Run, Coal Run, Gravel Lick Run, Beaver Run, Juniata Run & Clear Run	Sabula	1974
C	Soldier Run, McCreight Run, Trout Run, Fehley Run, Sandy Lick Creek & Pent Run	DuBois	1974
C	Sandy Lick Creek	Reynoldsville	1970
C	Sandy Lick Creek, Beaver Run, Laborde Branch, Luthersburg Branch, Sugarcamp Run & Stony Run	Luthersburg	1974
C	Bear Creek, South Branch Bear Creek, North Branch Bear Creek, Allegheny River & Clarion River	Parker	1973
C	Silver Creek, Bear Creek & North Branch Bear Creek	Hilliards	1974
C	Bear Creek	East Butler	1974
C	South Branch Bear Creek, Sugar Creek, Pine Run, Cove Run, Hart Run & Holder Run	Chicora	1974
C	Redbank Creek	Distant	1974
D	Mahoning Creek, Little Mudlick Creek, Pine Run, Mudlick Creek, Camp Run & Scrubgrass Creek	Distant	1974
D	Pine Run, Mudlick Creek, Sugarcamp Run, Painter Run, Eagle Run, Caylor Run, Middle Branch, Nye Branch, Foundry Run, Hamilton Run & Glade Run	Dayton	1974
D	Mahoning Creek, Sawmill Run, Little Elk Run, Elk Run, Cold Spring Run, Rock Run, Trout Run, Big Run, Windfall Run, Jackson Run, Canoe Creek, Ugly Run & Pointer Run	Punxsutawney	1974
D	East Branch Mahoning Creek, Mahoning Creek, Stump Creek, Laurel Run, Clover Run, Lost Run & Stony Run	McGees Mills	1974

Appendix C-4 (Cont.)

FLOOD PRONE AREAS MAPPED BY
U.S. GEOLOGICAL SURVEY

Watershed	Stream(s)	U.S.G.S. Topographic Map	Date Completed
D	Little Mahoning Creek, Crooked Run, Leasure Run, Broadhead Run, Beech Run, Barrett Run, Straight Run, Salsgiver Run, East Run, Rairigh Run & North Branch Little Mahoning Creek	Rochester Mills	1974
D	Little Elk Run, Sawmill Run, Rose Run, Dutch Run, Crossman Run, Foundry Run, Perryville Run & Mahoning Creek	Valier	1974
E	Allegheny River, Limestone Run, Cowanshannock Creek, Garretts Run, Tubmill Run, Glade Run, Nicholson Run	Kittanning	1974
E	Allegheny River, Pine Creek, South Fork Pine Creek, Deaver Run, Hays Run, Cowanshannock Creek, Long Run, Mill Run, Rupp Run & Garrett Run	Mosgrove	1974
E	South Fork Pine Creek, North Branch Pine Creek, Cowanshannock Creek, Huskins Run & Craigs Run	Rural Valley	1974
E	Allegheny River, Nicholson Run, Taylor Run, Crooked Creek & Campbell Run	Leechburg	1974
E	Crooked Creek, Dark Hollow Run & Plum Creek	Elderton	1969
E	South Branch Plum Creek, Sugarcamp Run, Crooked Creek, McKee Run & Fulton Run	Ernest	1973
E	Campbell Run, Elbow Run, Camp Run, Cherry Run, North Branch Cherry Run, Pine Run, Long Run, Fagley Run, Sugar Run, Lindsay Run, Craig Run & Crooked Creek	Whitesburg	1974

Appendix C-5

FLOOD INSURANCE STUDIES COMPLETED FOR U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT FEDERAL INSURANCE ADMINISTRATION[a]

Watershed	Location of Study
A	Johnsonburg Borough
A	Ridgway Borough
A	Ridgway Township
A	Mount Jewett Borough
C	DuBois City
C	Reynoldsville Borough
D	Punxsutawney Borough

[a]Includes studies completed as of February, 1978.

Appendix C-6

FLOOD DAMAGE REDUCTION SOLUTION ALTERNATIVES

Table 32 in Chapter V lists the alternatives which were identified as possible solutions or partial solutions to existing flood damage problems in Subbasin 17. The columns in that table are described here.

Column 1: Legend No. of a damage center or reach (See Figure 13)

Column 2: Name of a damage center or reach and name of streams identified as causing the damage. For each damage center or reach, the first row identifies the name and the second row identifies the stream.

Column 3: Damage reduction due to existing or funded proposed structures expressed as a percentage of natural annual damage in a damage center or reach.

Column 4: Need expressed as residual annual damage (damage remaining after completion of existing flood control structures structures currently under construction, and funded proposed structures) in thousands of dollars (1976 price level).

Column 5: Nonstructural Solution

A. Floodplain regulation: requires floodplain information, as well as workable and strong legislative action (more applicable to future than existing development).

B. Flood Insurance: does nothing to reduce flood hazard or damages, but rather lessens the economic burden of flooding on floodplain occupants. However, the land use regulations required to participate in HUD's National Flood Insurance Program will effectively reduce future damage potential and control future floodplain development.

C. Permanent Flood Proofing: applicable primarily to existing residential, industrial and commercial developments on the floodplain, where structural flood control measures cannot be economically justified.

D. Flood Forecasting: applicable only where upstream gaging is sufficient to provide accurate forecasts of flood stages downstream. Effective along the main stem of a river but not in headwater areas or small tributaries, where there is insufficient time for warning and response.

Column 6: Structural Solutions includes levees or flood walls, channel modifications and potential small and Corps of Engineers reservoir sites. The average annual benefit in thousand dollars (1976 price level) for each damage center or reach resulting from each alternative structural solution is shown.

Column 7: Any remarks applicable to specific solution alternatives.

APPENDIX D

WILD AND SCENIC RIVERS

Appendix D-1

PENNSYLVANIA SCENIC RIVERS CANDIDATES

Table 42 in Chapter V lists the streams and stream reaches which were identified in the *Pennsylvania Scenic Rivers Inventory* as candidates for wild, scenic, recreational, or modified recreational designation by the General Assembly. The columns in that table are described here.

Column 1: Legend – Number code shown in this column corresponds with number code shown on Figure 19.

Column 2: Stream Name – Name of stream on which proposed segment is located.

Column 3: Priority Group – Waterways have been categorized into three priority groups. First priority waterways are considered to be of statewide, and in some instances, even national significance. Second and third priority waterways exhibit some outstanding values, yet not enough in quantity or quality to merit statewide recognition. These are primarily locally and regionally significant. First priority waterways have been further divided into three priority subgroups (A, B and C) based upon degrees of environmental quality, resource endangerment and recreational potential. First priority "A" group waterways are those which have the most urgent need for protection and immediate need for additional study. First priority "B" and "C" groups are of less than immediate concern; however, lower priority ratings should not be equated with a de-emphasized need for protection.

Column 4: Proposed Segment Limits – Upstream and downstream limits of the candidate segment.

Column 6: Proposed Class – Candidate segments have been designated according to the following classes:

W - Wild river areas—those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted.

S - Scenic river areas—those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and undeveloped but accessible in places by roads.

R - Recreational rivers—those rivers or sections of rivers that are readily accessible, that may have some development along their shorelines and that may have undergone some impoundment or diversion in the past.

MR - Modified recreational rivers-those rivers or sections of rivers in which the flow may be regulated by control devices located upstream. Low dams are permitted in the reach so long as they do not increase the river beyond bank-full width. These reaches are used for human activities which do not substantially interfere with public use of the streams or the enjoyment of their surroundings.

Column 7: Water Quality – As part of the scenic rivers inventory and evaluation process, the DER Bureau of Water Quality Management provided information related to the water quality of each nominated stream. All waterways have been placed in one of the following three groups:

Group 1 - Stream presently meets or exceeds state water quality standards.

Group 2 - Stream does not presently meet state water quality standards, but will within 10 years.

Group 3 - Stream does not presently meet state water quality standards, but will beyond 10 years.

APPENDIX E

WATER QUALITY

Appendix E-1

GLOSSARY OF WATER QUALITY TERMS

Acidity (Mineral)	–	The capacity of an aqueous media to neutralize a base; usually reported in mg/1 as $CaCO_3$.
Alkalinity	–	The capacity of an aqueous media to neutralize an acid; usually reported in terms of mg/1 as $CaCO_3$.
Ammonia-Nitrogen	–	A gas (NH_3) released by the microbiological decay of plant and animal proteins. Reported in the study as mg/1 of nitrogen.
Biochemical Oxygen Demand (BOD)	–	A measure of the quantity of oxygen used in the oxidation of organic matter by natural biological processes in a specified time under standard conditions. For the purposes of this report, all values are expressed as oxygen demand in mg/1 exerted over a period of five days.
Chlorides	–	A measure of the concentration of chloride ions, predominately Cl, expressed in this report as mg/1.
Dissolved Oxygen (DO)	–	A measure of the quantity of oxygen gas in solution; generally expressed in mg/1.
Hardness	–	A characteristic of water caused by divalent cations, primarily calcium and magnesium, that are capable of reacting with soap to form precipitates.
Nitrate-Nitrogen	–	The final decomposition product (NO_3) of the organic nitrogen compounds, expressed in this study as mg/1 of nitrogen.
pH	–	The reciprocal of the log of the hydrogen ion activity coefficient. It ranges from 0 (acidic) to 14 (basic) with neutral water having a value of 7.
Sulfate	–	The final decomposition product (SO_4) of organic sulfur compounds; generally occurs in areas affected by acid mine drainage and expressed in this report as mg/1.
Total Phosphorus	–	Primarily the total of the complexed forms of phosphorus, orthophosphate, polyphosphate, as well as organic phosphorus (P). In this report, concentrations of phosphorus compounds are expressed as mg/1 of phosphorus. Phosphorus compounds are normally found in domestic and agricultural wastewater and many forms of industrial wastewater.
Turbidity	–	A condition caused by the presence of suspended matter in water resulting in the scattering and absorption of light; generally expressed in Jackson Turbidity Units (JTU).

Appendix E-2

CHEMICAL CONSTITUENTS IN GROUNDWATER AND THEIR CHARACTERISTIC EFFECTS ON WATER USE

Constituents	*Concentration*	*Characteristic Effects On Water Use*
Iron (Fe)	Less than 0.3 mg/1 in the eastern and southwestern sections of the Plateau regions; elsewhere on Plateau and throughout folded Appalachians, approximately half the formations yield groundwater with excessive concentrations.	More than 0.3 mg/1 stains laundry, utensils and fixtures reddish brown.
Manganese (Mn)	Commonly less than 0.05 mg/1, but as high as 0.29 mg/1 in the far northern Plateau, 0.19 mg/1 in the southwestern Plateau, and up to 0.26 in sections of the folded Appalachians.	Iron and manganese together should not exceed 0.3 mg/1. Concentrations of Mn in excess of 0.05 mg/1 may cause laundry stains and impair taste of beverages.
Sulfate (SO_4)	Rarely less than 1 mg/1 or more than 100 mg/1 commonly one to 20 mg/1.	Concentrations in regions are not high enough to cause trouble.
Chloride (Cl)	Seldom less than one mg/1 or more than 40 mg/1, commonly one to 20 mg/1.	Salty taste to water having more than a few hundred milligrams per liter.
Nitrate (NO_3)	Rarely more than 5.0 mg/1, commonly less than 1.0 mg/1.	Where concentration is greater than 4.5 mg/1, contamination from sewage may be suspected. Water of concentrations greater than 10 mg/1 may be harmful to babies.
Dissolved Solids	Total of all mineral matter rarely more than 300 mg/1, commonly 100 to 300 mg/1.	Water containing more than 1,000 mg/1 of dissolved solids is unsuitable for most purposes.
Hardness as equivalent $CaCO_3$	Rarely less than 10 mg/1 or more than 300 mg/1, commonly 70 to 300 mg/1.	Causes consumption of soap before lather will form. Hard water forms scale in boilers and hot water heaters. Water whose hardness is less than 60 mg/1 is considered soft; 61 to 120 mg/1, moderately hard; 121 to 180 mg/1, hard; more than 180 mg/1, very hard.

Appendix E-3

WATER POLLUTANTS

Municipal Wastewater

This normally consists of domestic wastewater plus nominal amounts of commercial and industrial wastewater. Following treatment, the remaining portions of organic matter and nutrients in the effluent are discharged to subbasin streams. These pollutants can produce depressed dissolved oxygen levels, promote algae growths that cause fish kills and create overall degradation of the aquatic environment. Where municipal wastewater is held in leaking lagoons or where inadequate septic systems or spray irrigation systems are used, the groundwater system may be polluted.

Industrial Wastewater

The types of materials processed during manufacturing determine the composition of this wastewater. Toxic compounds, organic matter and metals may be released and produce conditions deleterious to aquatic life and surface water quality. The groundwater system may also be polluted where leaking waste lagoons are used or where spray irrigation or septic systems are inadequate or malfunctioning.

Acid Mine Drainage

This is formed in both active and abandoned surface and deep coal mines when iron sulfide chemically reacts with water and oxygen. The reaction produces acid, sulfate and iron which commonly pollute both surface and groundwaters.

Urban Runoff Pollutants

These come from debris, animal wastes, fertilizers, fallout from air pollution, stockpiled materials, automobile wastes and other sources. Pollutants on impervious areas are washed off during the initial part of a storm, resulting in a high initial pollutant concentration that decreases as the storm progresses. Long intervals between storms will result in large amounts of pollutants collected on urban surfaces, with resultant higher concentrations of the pollutants during runoff. Where combined sewers are used, heavy storms often cause a large portion of the total waste load (municipal wastewater and urban runoff) to overflow or bypass the treatment processes, resulting in the passage of urban runoff and untreated wastewater to the subbasin streams.

Solid Waste Leachate

This is highly contaminated water contained in or associated with refuse disposal sites such as dumps and sanitary landfills. Leachate is produced when solid waste decomposes and the products are dissolved and carried with the water that infiltrates the landfill or dump. Once the disposal site reaches its water holding capacity, the leachate flows from it into the groundwater or nearby surface water. Municipal refuse leachate is highly variable in its chemical composition, but commonly shows high values for BOD, COD, iron, ammonia-nitrogen, chloride and sulfate.

Septic System Wastewater

On-lot disposal systems, commonly in the form of septic systems, currently serve the wastewater needs of most rural areas, many suburban single-family dwellings and some small industries. Effluent from these systems percolates through the soil, and a portion of the effluent, carrying those pollutants that have not been filtered out in the soil, eventually reaches the groundwater system. Given the proper soil thickness and soil properties, many pollutants are removed; however, certain dissolved solids may infiltrate to the local groundwater system.

Thermal Wastes

These may cause a significant increase in overall stream temperature and can seriously alter biological communities in the receiving streams. Thermal discharges can originate from nuclear and coal-fired power plants and from certain industrial processes.

Agricultural Runoff

This may carry sediment, fertilizers, animal wastes and pesticides into streams. Sediment problems in agricultural areas can be a problem especially when ground disturbance coincides with heavy rains. Fertilizer nutrients constitute a problem when the runoff carries them away before they can be used by the crops. Animal wastes can become a particular problem where animals are grouped in feedlots and poultry farms. Pesticides and insecticides can be a pollution hazard when precipitation occurs soon after their application.

APPENDIX F

EROSION AND SEDIMENTATION

Appendix F-1

METHODOLOGY

Erosion Rates

The rates of sheet and rill erosion for each of the 20 subbasins in the state were calculated using methods described in Technical Release No. 51 (Rev.), USDA, Soil Conservation Service. This publication outlines methods of using the Universal Soil-Loss Equation (USLE) to estimate soil loss for Soil Conservation Service projects such as watershed and river basin studies.

The complete USLE is A = RKLSCP where A is the computed loss in tons per acre; R is the rainfall factor; K is the soil-erodibility factor; L is the slope-length factor; S is the slope-gradient factor; C is the cropping management factor; and P is the erosion-control practice factor.

To determine the factors to be used in the USLE for each of the 20 subbasins, methods were devised to obtain average values for an entire subbasin. The following discussion is an explanation of how these factors were determined.

Rainfall Factor (R)

The average annual "R" factor values for each subbasin were obtained from Figure 1 of Technical Release No. 51 (TR-51).

Soil-Erodibility Factor (K)

The "K" factor values are assigned to named kinds of soil and are given in the Pennsylvania Technical Guide, Section III-B. The "General Soils Information", published earlier as part of the Pennsylvania Analytical Summary, lists each soil association and percent of each association in the subbasin. To obtain a "K" value for an entire subbasin, an average "K" value was computed for each soil association. The average "K" value for each soil association and the percent of each association in the individual subbasin were used to calculate a "weighted" average "K" value for the subbasin. These "K" values were then correlated with the "K" values for "forest soils" prepared by the Forest Service of the USDA.

Slope Length (L) and Slope Gradient (S)

The "weighted" average "S" factors for cropland, forest and pasture in each subbasin were computed by using land use percentage by capability class and the average slope assigned to each capability. An average slope was assigned to each capability class according to the following table.

Class	*Avg. Slope*	*Class*	*Avg. Slope*
I	2%	V	2%
II	5%	VI	20%
III	12%	VII	35%
IV	20%	VIII	15%

The "L" factor was determined based on the "weighted" average slope according to the following table.

Slope (%)	*Slope Length (Feet)*
0–10	400
11–19	300
20	200

For convenience in the application of these factors, they are combined into a single topographic factor (LS). The "LS" factor was obtained from Table 1, TR-51, using calculated "S" and corresponding "L" factors.

Crop Cover or Cropping Management Factor (C)

The "C" factor values for cropland in each subbasin were estimated based on cropping sequence and management. A theoretical crop rotation was determined for an entire subbasin by analysis of the percent of row crops, small grains and hayland in the subbasin. Using this theoretical crop rotation, "C" values were obtained from Table 6 of the Technical Guide, Section III-B.

The "C" factor values for forestland were assumed to be similar for the entire state. An average condition, that would represent the majority of forestland across the state, was determined to be tree canopy on 40 to 70 percent of the area and forest litter on 75 to 85 percent of the area. Assuming this average condition, a "C" value of 0.002 for forestland was obtained from Table 3 of TR-51.

The "C" factor values for pastureland were also assumed to be similar for the entire state. An average condition, that would represent the majority of the pastureland in the state, was determined to be trees, but no appreciable low brush, with canopy covering less than 25 percent of the area and 80 percent ground cover with up to two inches of litter and mostly broadleaf herbaceous plants. Assuming this average condition, a "C" value of 0.025 was obtained from Table 2 of TR-51.

Erosion-Control Practice Factor (P)

The "P" factor values for cropland were determined assuming contouring as an average condition across the state and using the appropriate value based on land slopes as given in the following table.

Land Slope (%)	*"P" Value*
2–7	0.5
8–12	0.6
13–18	0.8
19–24	0.9

The "P" factor values for forest and pastureland are by definition equal to 1.0.

Appendix F-2

SOIL LOSS AND SEDIMENT YIELD

Table 1

RATES OF AVERAGE ANNUAL SOIL LOSS FROM SHEET AND RILL EROSION[a]
(Tons Per Acre)

	Land Use		
Subbasin	Cropland	Forest[b]	Pasture and Other Land
1	3.0	0.2	3.7
2	12.2	0.2	3.7
3	15.3	0.2	5.2
4	4.2	0.8	2.7
5	7.2	0.8	4.4
6	10.0	0.8	5.3
7	7.3	0.8	4.8
8	8.4	0.3	3.7
9	6.1	0.8	3.6
10	5.8	0.8	4.0
11	6.1	0.3	4.6
12	11.6	0.8	4.1
13	7.1	0.5	3.8
14 & 16	7.5	0.4	2.9
15	3.5	0.2	3.0
17	3.9	0.3	4.2
18	3.8	0.3	5.2
19	6.5	0.3	5.4
20	3.8	0.3	5.4

[a]Soil Conservation Service draft report *Erosion and Sediment Pollution Potential*, 1976.

[b]U.S. Forest Service

Table 2

GROSS AVERAGE ANNUAL SOIL LOSS FROM SHEET AND RILL EROSION[a]
(Thousand Tons)

	Land Use			
Subbasin	Cropland	Forest[b]	Pasture And Other Land	Total Loss
1	446	160	515	1,121
2	3,185	117	348	3,650
3	6,247	108	1,268	7,623
4	2,060	1,506	1,027	4,593
5	1,604	565	461	2,630
6	2,412	528	379	3,319
7	8,494	889	1,736	11,119
8	693	465	268	1,426
9	898	1,193	211	2,302
10	1,219	730	381	2,330
11	1,362	265	436	2,063
12	2,387	576	315	3,278
13	1,789	413	458	2,660
14 & 16	1,312	681	710	2,703
15	333	35	230	598
17	1,017	613	589	2,219
18	1,132	359	1,266	2,757
19	1,921	492	1,933	4,346
20	1,648	397	2,146	4,191
Totals	40,159	10,092	14,677	64,928

[a]Soil Conservation Service draft report *Erosion and Sediment Pollution Potential*, 1976.

[b]U.S. Forest Service

Table 3

SUBBASIN LAND USE AND SEDIMENT YIELD

Subbasin	Area (Sq.Mi.)	Land Use (%) Cropland	Pasture	Forest	Other	Average Annual Sediment Yield (1000 Tons)
1	1,816	13	6	64	17	273
2	1,943	21	2	46	31	491
3	2,708	24	7	28	41	722
4	3,286	23	12	53	12	630
5	1,759	20	3	56	21	382
6	1,448	26	4	57	13	327
7	4,157	44	7	32	17	1,017
8	2,631	5	1	85	9	295
9	2,539	9	2	84	5	287
10	1,809	18	3	66	13	219
11	1,943	18	4	61	17	174
12	1,462	22	4	66	8	138
13	1,584	25	7	54	14	319
14 & 16	4,573	13	5	62	20	460
15	511	29	6	36	29	37
17	2,931	14	3	64	19	512
18	2,393	20	5	53	22	436
19	2,736	17	8	48	27	485
20	3,080	21	10	37	32	533
State	45,309	20	5	55	20	7,737