The stated purpose of the Pennsylvania Flood Plain Management Act is to: 1) encourage planning and development in flood plains which are consistent with sound land use practices, and 2) authorize a comprehensive and coordinated program of flood plain management. The Act gives the Department of Community Affairs and the Department of Environmental Resources the authority to review and process municipal flood plain management programs and, where municipal plans are inadequate, to implement the provisions of the Act. A major mechanism of control in the Act is the regulation of particular obstructions in the flood plain.

Section 301 of the Act states that no construction, enlargement, or expansion of certain obstructions listed in the Act can be undertaken unless a special permit has been issued. Section 205 requires the state to adopt regulations establishing criteria and standards for the coordination and uniform enforcement of municipal flood plain management regulations. Thus, the Act requires the state to develop minimum standards for land use management in floodways.

The intent of the Pennsylvania law is similar to that of the New Jersey law. That is, to regulate or prohibit structures in the "flood area". The enforcement of the law is given primarily to the local governments. The implementation of this law would result in a significant slowing of any growth in the "flood area" which would have otherwise occurred.

Another flood related program in Pennsylvania is for the management of storm water runoff. Pennsylvania has recently passed legislation requiring municipal and countywide storm water management planning, however, funding for this legislation has not yet been appropriated. This program would be critical in urbanizing areas on a scale from individual buildings to entire watersheds, to prevent increased future flood risks. Upstream development outside the flood plain often leads to increased flood damage potential downstream. Greater areas of impervious surface lead to less absorption, faster storm runoff, and sharper, more intense flood crests. Increased sedimentation and erosion associated with such development reduces stream channel capacity, resulting in more frequent local flooding; existing reservoirs downstream will suffer from increased siltation.

. Local Programs. In general, the local programs are the communities' implementation of, and compliance with, the Federal and state programs. The actual application and administration of the programs vary greatly. Some communities have truly established exemplary programs. In terms of local government control of flood plain management, some counties have taken a strong lead and, in other cases, strong municipalities overshadow their county and the rest of the communities. Local programs and activities will be further discussed later in this report.

EXISTING CONDITIONS

32. Contained in this section is a concise discussion of the existing natural and human-influenced conditions in the study area. For a more detailed discussion as well as projections of future conditions see Appendix A.

33. The Delaware River Basin extends approximately 265 miles southward from the western slopes of the Catskill Mountains in New York to the Atlantic Ocean at the mouth of Delaware Bay. The basin width varies from 40 miles to 80

miles. The total area of the basin, excluding Delaware Bay, is 12,765 square miles. It occupies a part of four states: New York, New Jersey, Pennsylvania and Delaware. Location of the basin is shown on Figure 2.

34. As shown on Plate 1, the East and West Branches of the Delaware River rise on the western slopes of the Catskill Mountains and flow southwesterly to make right angle turns in a valley descending southeasterly to Port Jervis, New York. In this valley, the West Branch is joined by the East Branch near Hancock, New York to form the main stem of the Delaware River. From its source to the mouth of Delaware Bay between Cape May, New Jersey and Cape Henlopen, Delaware, the flowing waters travel a distance of 350 miles.

PHYSIOGRAPHY

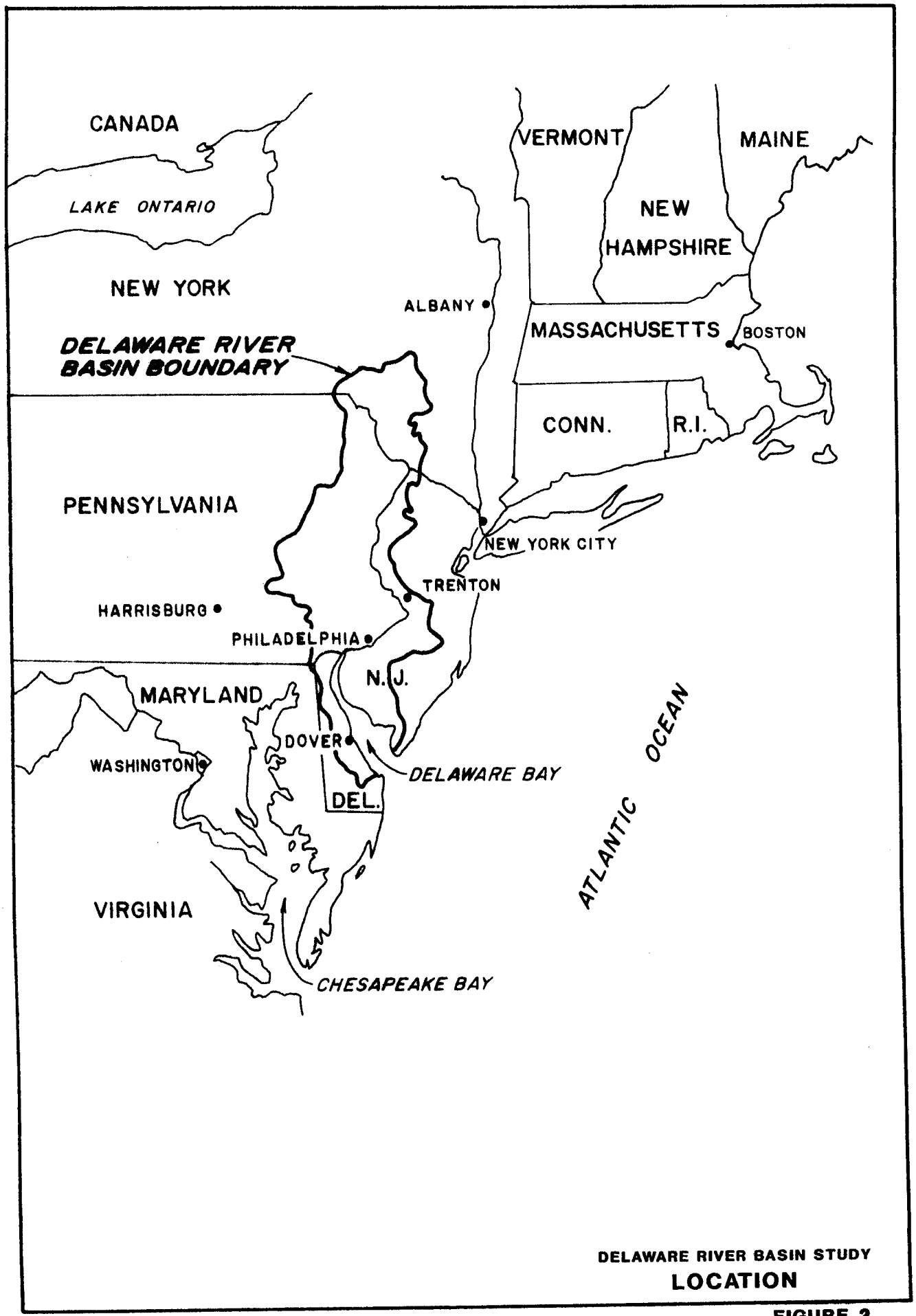
35. The Delaware River Basin lies across five of the major physiographic provinces of the eastern United States. These provinces, as shown on Figure 3, are the Catskill Mountains and the southern New York Section of the Appalachian Plateaus Province; the Great Valley and the valleys and ridges north of the Blue Mountain of the Valley and Ridge Province; the Reading prong of the New England Province; the Piedmont Upland and Piedmont Lowland sections of the Piedmont Province and the Coastal Plain Province. The natural characteristics of the basin including geology, soils, vegetation, ground water, regimen of streams and runoff lend themselves to three general physiographic definitions, namely, the Upper Region, the Central Region and the Lower Region. The upper limit of the Central Region is not distinctly defined; however, it may be considered as the Valley and Ridge physiographic province at Stroudsburg, Pennsylvania. The region is more clearly marked at its lower boundary by the fault line near Trenton, New Jersey, where there is a drop of about 250 feet to 350 feet in elevation to the Atlantic Coastal Plain. This Central Region includes the reach of the main stem Delaware River that is the subject of this report.

SOILS

36. The soils in the Delaware River Basin fall within three major divisions: the Mountainous and Upland Plateau; the Ridge and Valley and Piedmont Plateau Area, including the Triassic Basin and the Southern New England Upland and Northern Shale and Limestone Belt; and the Coastal Plain Area. The second and third divisions contains the reach of the subject main stem of the Delaware River.

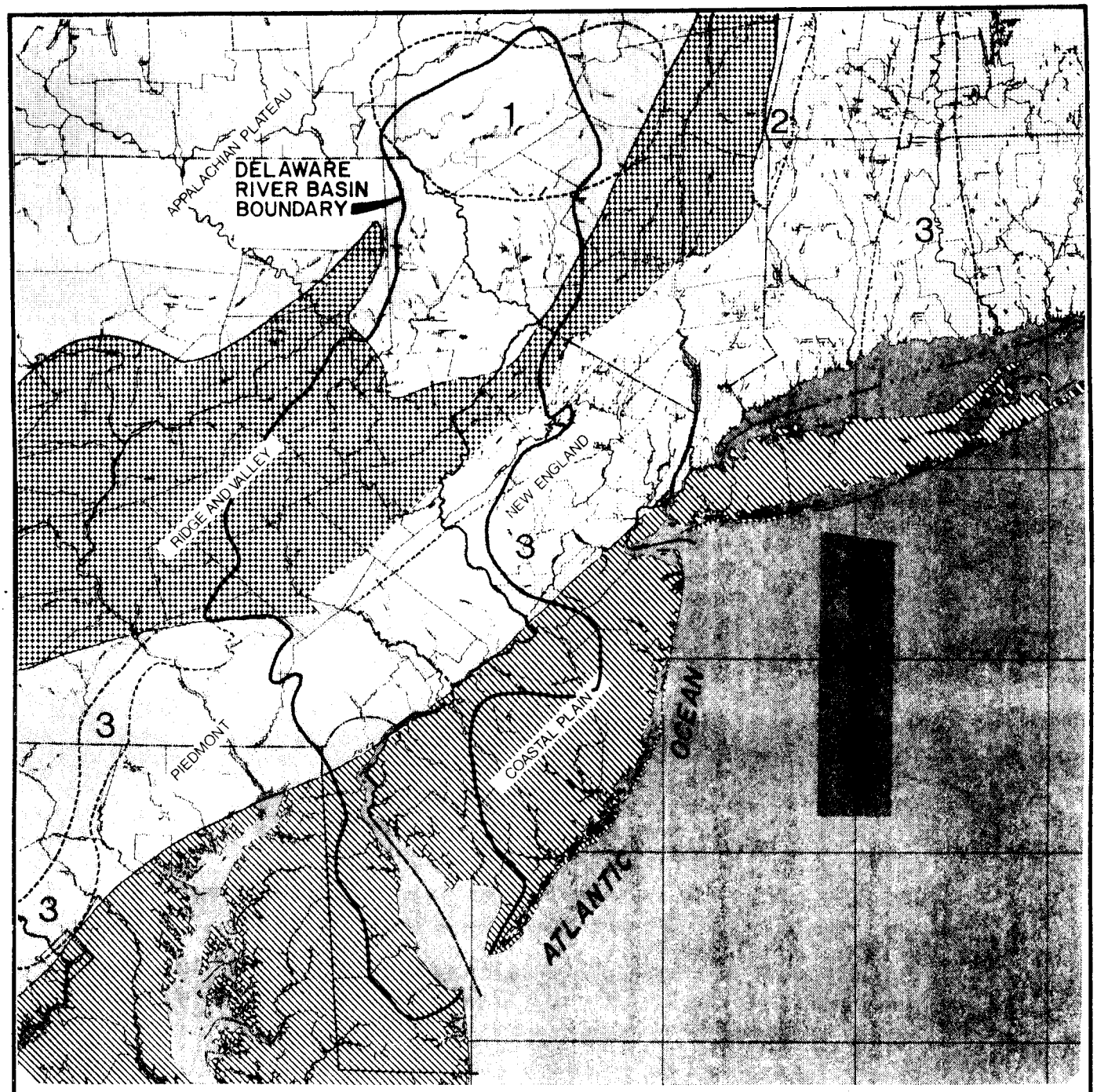
37. RIDGE AND VALLEY AREA. The Ridge and Valley area forms a belt running across the Delaware River Basin from northern New Jersey through eastern Pennsylvania. The two principal subdivisions are the predominantly limestone areas along the south side of the area and the shale and slate belts to the north. The limestones in this area extend from Berks County to the Delaware River and soils derived from these parent rocks belongs to the Ryder and Duffield series. The principal soil derived from the glacical deposits belongs primarily to the Washington Series. In the shale and slate sections the principal soils are Kistler, Weikert and Berks.

38. PIEDMONT PLATEAU SECTION. The Piedmont Plateau section is split by the Triassic Basin into two areas. The northern area forms a belt across the basin from central New Jersey into eastern Pennsylvania. The southern part of the Piedmont Plateau lies in a broad belt across the extreme southeastern part of Pennsylvania and northern Delaware into south central New Jersey. The soils of the Piedmont Plateau are mostly derived from gneisses, schists and quartzites. The principal soils are Chester, Glenelg, Manor, and Glenville.



DELAWARE RIVER BASIN STUDY
LOCATION

FIGURE 2



BASE MAP SOURCE: REGIONAL PLAN ASSOCIATION

0 13 26 51

SCALE IN MILES

LEGEND

- APPALACHIAN PLATEAU PROVINCE
- NEW ENGLAND PROVINCE
- RIDGE AND VALLEY PROVINCE
- COASTAL PLAIN PROVINCE
- PIEDMONT PROVINCE
- 1 CATSKILL MOUNTAIN SUB PROVINCE
- 2 TACONIC MOUNTAIN SUB PROVINCE
- 3 TRIASSIC LOWLAND SUB PROVINCE

DELAWARE RIVER BASIN STUDY

PHYSIOGRAPHY

FIGURE 3

GEOLOGY AND MINERALS

39. Rock formations of the Delaware River Basin range in age from 150 million years to perhaps a billion years. They have been folded, faulted, thrust up into high mountains, worn down into lowlands and encroached upon by ancient seas. The ridge and valley structures which characterize much of the study area can be attributed to alternating strata of resistant, semiresistant, and nonresistant formations. Although there are areas of both igneous intrusion and metamorphism, the rock formations are predominately sedimentary and range from sandstones and conglomerates, which are relatively resistant to erosion processes, to less resistant carbonate limestone and shales. The strata directly relate to the physiographic regions discussed earlier in this section and shown on Figure 3.

CLIMATE

40. The Delaware River Basin is situated in the mid-Atlantic temperate zone and is influenced by two major North American weather systems. Low pressure cells originating in the south move along the coast bringing substantial rainfalls. Canadian high pressure systems bring heavy snowfall and cold temperatures to the upper northwest portions of the region. Cold temperatures are modified in the south and east by coastal influences.

41. Average temperatures vary with elevation; the upper region of the basin is 5 to 10 degrees cooler than southern areas. Annual rainfall varies from 42 to 60 inches in the upper region; from 42 to 50 inches in the central region, and about 43 inches in the lower region. The highest monthly rainfall generally occurs in July or August, comprising 10 percent of the annual total. February and October have the lowest average monthly precipitations.

GROUNDWATER

42. The Pleistocene deposits are a major source of groundwater and supplies good quality water to a large number of wells throughout the Delaware River Basin. Springs along the flank of the river valley supply potable water. These springs, however, are highly dependent on rainfall cycles. The ground water resources west of the Kittatinny Ridge are also dependent upon rainfall; whereas east of the Ridge, the area is heavily dependent on ground water transport through the limestone aquifers and joints and fractures of metamorphic and igneous rocks. The limestone zones east of the Ridge provide groundwater recharge. The water resources of the study area are also dominated by the Delaware River. Individual springs and wells provide potable water to rural areas throughout the region.

SURFACE WATER

43. The surface water resources of the study area include numerous lakes and streams. In the steep mountain areas, excessive rainfall and the rapid melting of snow produce periodic flash floods due to excessive runoff. Most of the region is dominated by the Delaware River and those tributaries which flow directly into it. The Delaware River is one of the largest on the East Coast, with a drainage area of 6,780 square miles and average flow of 12,000 cubic feet per second (cfs) at Trenton, New Jersey. The mean annual flow of the Delaware River at Tocks Island (upstream end of the study area) is approximately 6,735 cfs. Maximum and minimum daily stream flows at this location are estimated to be 230,000 and 513 cfs, respectively.

FLORA AND FAUNA

44. VEGETATION ALONG THE STUDY AREA. The vegetation in the Delaware River Basin can be divided into three major classifications based primarily on plant types and frequency of flooding: marshlands; riparian vegetation; and brush and forests. Differences in plant types occur also as result of variation in forest types as illustrated in Figure 4. Most of the study area is characterized by a free-flowing river containing a number of islands. The right bank of the river facing downstream consists of a fairly wide flood plain. The native, nutrient laden soils have been used for agriculture, thus disturbing a major portion of the native vegetation.

45. The slopes on both sides of the river in the study area are still heavily forested with oak and hickory forests. Portions of the river bank area are steep sided and contain a variety of cliff vegetation probably not found anywhere else in the basin.

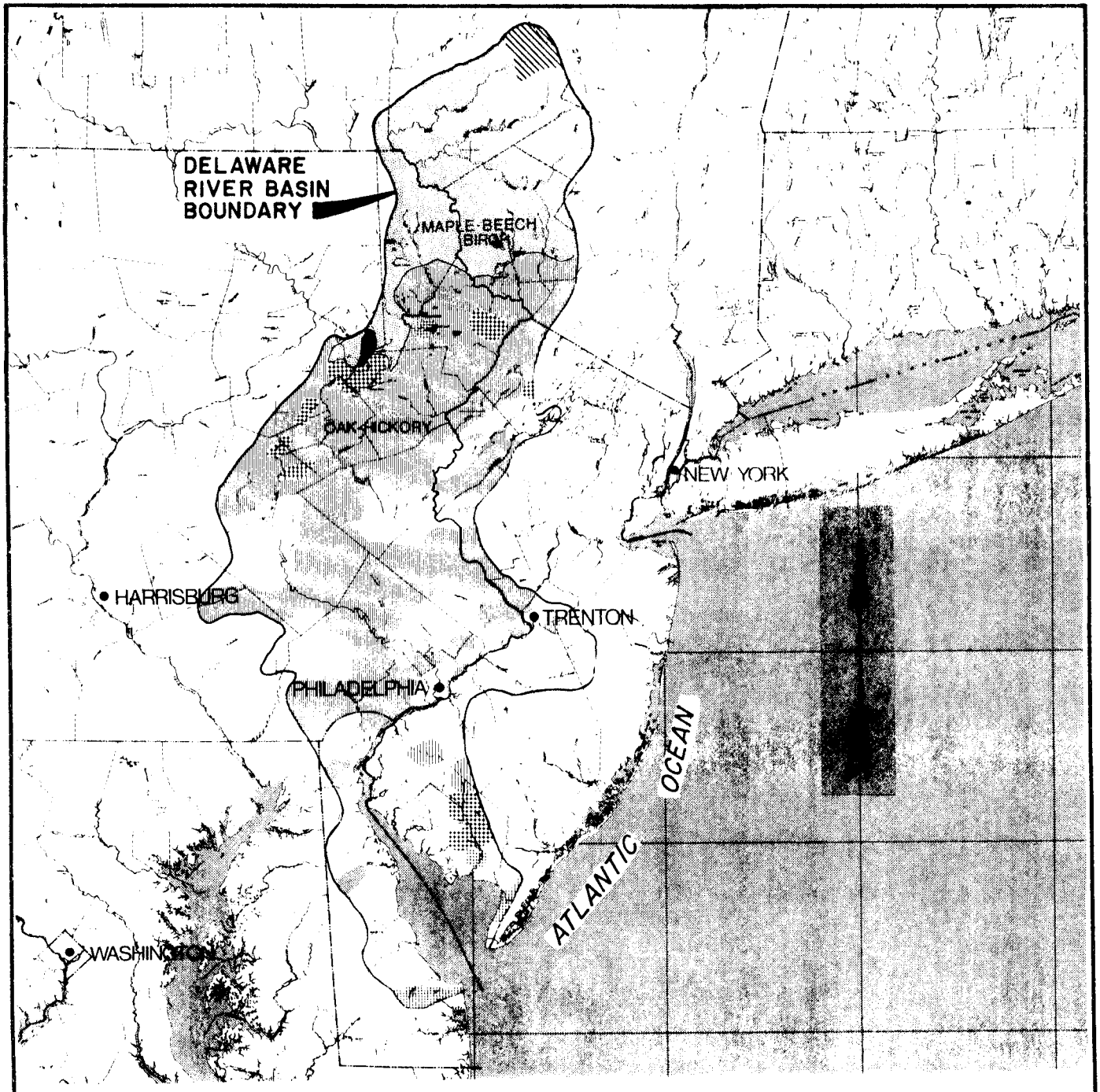
46. FISH AND WILDLIFE. The fish and wildlife resources in the Delaware River upstream of Trenton, New Jersey, and in many of its tributaries, are diverse and abundant. Habitat in these areas is of high quality and undisturbed. Downstream from Trenton, and in other particular problem areas, degradation of water quality and the environment in general has adversely affected these resources. Water quality downstream from Trenton is improving and current conditions provide the potential for a revival of the fishery resource.

47. Other major problems which affect the fish and wildlife resources in the Delaware River Basin are streamflow regimens, temperature fluctuations, degradation of water quality from both point (sewage) and nonpoint (stormwater and agricultural runoff) sources, impingement and entrainment, salinity levels and the need for protection of wetlands and other critical habitat areas. Detailed documentation of the fish and wildlife resources of the study area was provided by the United States Fish and Wildlife Service and this data served as a basis for this reports' environmental evaluation.

DEVELOPMENT AND ECONOMY

48. Following is the summation of social, demographic and economic conditions of the study area. For a complete statistical tabulation of the various conditions, refer to Appendix A.

49. The upper Delaware River has played a major role in national development. The river was a means of transportation, less hazardous and more direct than overland routes in mountain forest terrain. The Appalachian Trail, crossing the Upper Delaware River near Columbia, New Jersey, provided a significant river access and transportation link to early Indian cultures and, later, to pioneer settlers. The inhabitants of this region during the eighteenth century found the main stem convenient for movement of manufactured goods to downstream markets and the adjacent flatlands suitable for agriculture. Statesmen, business leaders and others influential in the affairs of the nation settled near the river in established towns. Modernization during the Industrial Revolution of the 1800's changed the commercial emphasis to downstream areas with better port facilities. A decline of commercial activity was replaced with an increase in manufacturing.



DELAWARE RIVER BASIN STUDY

VEGETATION

FIGURE 4

50. In recent history, many of these manufacturing industries have declined; especially in the older more urban areas such as the flood plain communities. Manufacturing is generally being replaced by services, wholesale and retail trade, and government. However, this replacement is often located outside the flood plains.

51. POPULATION. Based on 1980 Bureau of Census data, the Delaware River Basin Study Area has a population of approximately 626,000. This figure includes only the population of towns, municipalities, boroughs, townships and cities that lie along the main stem from Stroudsburg, Pennsylvania to Burlington, New Jersey. The study area population has grown from 1950 to 1980 at a 1.52 percent annual rate and slowed to only a 0.47 percent annual rate from 1970 to 1980. This compares to a much higher 2.26 percent annual growth rate for the study area counties, as a whole, between 1950 and 1980. In fact, discounting the rapid 4.09 percent per annum increase for the flood plain municipalities in Bucks County, the remainder of the flood plain municipalities have virtually remained the same over the last 30 years. This slower population growth within the flood plain versus the immediate vicinity can be attributed to the lack of developable land. This lack of developable land can be attributed to the following: most of the flood plains are characterized by steep slopes; local communities have initiated nonstructural flood plain measures such as relocation of existing structures, zoning restrictions, and compatible community redevelopment plans; and the effects which the flood threat itself has on some decisions. Projections made using 1980 OBERS* regional statistics indicate continuation of an annual growth rate of only 0.26 percent over the next 50 years. However, based on the aforementioned factors, much of this growth will probably be concentrated outside rather than inside the flood plain.

52. The major population center within the study area is Trenton, New Jersey, in Mercer County. Trenton has lost approximately 36,000 people since 1950 and epitomizes the urban decline which characterizes other older communities within the Delaware River Basin such as Easton in Pennsylvania and Burlington and Philipsburg in New Jersey. The decline of population in these areas since 1950 is in sharp contrast to the rapid increase in the surrounding suburban communities. These two counteracting forces have tended to cancel one another, resulting in the little to no overall growth statistically in the flood plain communities within the last 30 years. These two trends can be expected to continue into the forseeable future. Since more recent flood plain development would have to be in compliance with local land use restrictions and National Flood Insurance Program criteria, it can be concluded that the flood damage potential up to the 100 year frequency has been moderated since 1955 and will continue to be constrained in the future.

53. Population density ranges from 114.0 persons per square mile in Monroe County to 1356.2 persons per square mile in Mercer County. For all the counties in the study area, it is interesting to note that although population increased from 1970 to 1980 at a 1.11 percent annual rate, the number of year round dwelling units increased by a 2.69 percent annual rate. This resulted from a drop of 3.25 people per house in 1970 to 2.78 people per house in

* 1980 OBERS, Bureau of Economic Analysis Regional Projections, Volume I, Methodology, Concepts and State Data, prepared by the U.S. Department of Commerce.

1980. Thus, although population is growing at a slower rate, the greater growth in the number of structures is a more significant factor when estimating and projecting physical flood damages. However, in light of the restrictive legislation and policies adopted since 1970 with respect to flood plain development, much of this development and future development will be situated above the 100-year flood elevation or entirely outside the flood plain.

54. PER CAPITA INCOME. Per capita income within the study area has grown steadily from 1950 to 1980. For 1980, per capita income ranges from a high of $11,173 in Mercer County to a low of $8,090 in Monroe County. Most counties in New Jersey are slightly above the U.S. average while counties in Pennsylvania are slightly below. As a whole, the study area can be characterized as "average middle class" with no major enclaves of poverty. With the exception of a few pockets of affluence, the range of incomes are generally typical. Based on 1980 OBERS regional projection, per capita income in Pennsylvania is expected to grow at a 1.21 percent per annum rate while New Jersey will grow at a slightly lower rate of 0.83 percent.

55. LABOR FORCE AND EMPLOYMENT. The counties which comprise the Delaware River Basin Study area have a labor force which has grown from 586,100 in 1970 to 745,000 in 1980, or by 27 percent. Employment has grown from 565,000 to 696,400 in the same period. The total number of people unemployed has risen from 21,200 to 48,600 giving an unemployment rate of 3.6 percent of the labor force in 1970 and 6.5 percent in 1980. Both are below the national and state averages.

56. Regarding employment by industry, the largest percentage gain by any group during the 1955 to 1980 period was in services followed by wholesale and retail trade and then government. This was true for the counties within the study area, as well as for the rest of the nation. Although still the predominant group in terms of total employment, the manufacturing sector has been the slowest growing. The manufacturing group, which accounted for more than 50 percent of total employment in 1955, has decreased to roughly 25 percent in 1980. This decrease in the importance of manufacturing was largely mitigated by the service sector which had substantial increases in every county during this period. The shift in relative weight from manufacturing to the service group in the study area brings it more in line with national averages. The shift in the entire region from a manufacturing to service oriented industry is expected to continue into the forseeable future as the nation follows its international comparative advantage in the service sector and relies on imports for more of its basic industrial demands.

57. Within the manufacturing group, not only has there been a relative decrease with respect to total employment, but also a shift in relative importance of industries within the group. Although primary metals remains the predominant sector of employment in the counties which comprise the study area, its relative importance has diminished. In fact, in the New Jersey counties where primary metals was a leading group in 1955 employment, it has completely disappeared in 1980. The fastest growing group in the study area from 1955 to 1980 has been the Electrical and Electronics industry growing from only 6,200 in 1955 to 18,600 in 1980. Other groups of importance with respect to flood damage potential are Food and Kindred, Machinery and Paper and allied industries. Overall, the relative shift in manufacturing to more sophisticated technologies has tended to increase the flood damage

potential. This is true not only with industries which have located in the flood plain since 1955 but also with the more established activities which have undergone industrial intensification by switching from mechanical to electronic technologies.

58. TRANSPORTATION FACILITIES. The transportation system in the study area is extensive due to the high levels of population and economic development characterizing the region. Generally, the most extensive transportation networks in the study area accompany the high concentrations of industry and population along the Washington - Baltimore - Wilmington - Philadelphia - Trenton - New York axis of the northeast corridor. In the study area, as the distance from the corridor increases the major interconnectors remain but the local networks become less extensive. Ten separate branches of the Interstate Highway System traverse the region and other major national and state highways complement this system in interconnecting local road networks. In addition, the study area generally has ready access to both air and rail service. The existing transportation network within the study area counties is also described in more detail in Appendix A.

NONSTRUCTURAL PROFILE

59. Along the main stem of the Delaware River, inhabitants of the floodway have, to varying degrees, initiated individual nonstructural protection measures against potential flood damages. There is a broad range of alternative nonstructural measures and combinations that were utilized which will be subsequently detailed. For purposes of analysis the inhabitants of the main stem were categorized by land use type: residential, commercial, industrial, and other. Data on the type of nonstructural measures implemented by land use category were obtained by random sampling techniques employing questionnaires and follow-up interviews. Analysis of the data obtained is summarized in the following paragraphs.

60. Decidedly more residential and related activities have taken some form of nonstructural measure(s) to protect against floods than have commercial or industrial activities. This is due, in part, to different perceptions of the "threat" and, in part, to easier implementation of protective measures. Larger facilities often were constrained by plant operational requirements and other considerations. Some protective measures would have required more formal operation and periodic maintenance procedures. The percent rate of participation in nonstructural protective measures by land use category is shown below. The participation rate in flood insurance by land use category is also indicated.

Land Use	Have Flood Insurance 1/	Have Applied Non-Structural Measures 1/
Residential	59%	61%
Commercial	38%	37%
Industrial	37%	33%
Other	25%	56%

1/ Percentage of those who responded.