

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.

| <u>Land Use</u> | <u>Have Flood Insurance</u> ^{1/} | <u>Have Applied Non-Structural Measures</u> ^{1/} |
|-----------------|---|---|
| Residential | 59% | 61% |
| Commercial | 38% | 37% |
| Industrial | 37% | 33% |
| Other | 25% | 56% |

^{1/} Percentage of those who responded.

61. It should be noted that participation rate in flood insurance is similar to the nonstructural participation rate for each land use type. Responses to the questionnaires and interviews with owners of floodplain structures confirm that the key factor for all flood related activities is the perception of the degree of the flood threat. The low participation rate in nonstructural protective measures in the nonresidential land use types is directly related to calculated business decisions. Since most of the units have not experienced a flood in almost 30 years, the threat is considered small and the risk of being flooded is considered smaller than many of the other risks which are normally taken in business.

RESIDENTIAL

62. The homeowner's "feeling" of a threat to their home and family appears to be more emotional and intense than that of a business person for their business. After a period of threat, especially the 1955 flood, homeowners made quick and usually emotional decisions to apply protection. Most of the measures applied have been simple, inexpensive, and easy to implement usually requiring minimum operation or maintenance. A very disturbing response to the questionnaires and interviews was that only a small percentage of homeowners (26%) were aware of any flood warning system. Of these, most were not aware of any formal evacuation plan.

63. Of the homeowners who said they had taken some nonstructural measure to reduce flood damages, the most predominant measure was to raise items off the floor. This measure is more of a reaction requiring no prior investment. There is a good chance that there may not be enough time to react and that for major floods, items may not be removed entirely above the flood level. Other popular measures were installation of sump pumps, elimination of seepage in basement walls and floors, and permanently raising utilities to higher elevations.

COMMERCIAL

64. The business community views the flood threat as a disruption and an increase in the cost of doing business. Probabilities of recurrence and return of investment enters the decision process. Decisions are neither emotional nor quick and are not made by individuals but must enter the corporate justification process. This delay reduced the "feeling" of a threat and eventually allowed indefinite postponement. Eventually new owners and new work forces who "weren't here in 1955" were making the decisions regarding implementation of protective measures.

65. Many commercial and industrial activities have made the decision to remain self-insured against floods since the premium and deductible provisions would put added pressure on profitability. Businessmen are by nature risk takers and therefore more prone than the general population to take the chance of not being flooded. In addition, any damages actually experienced could more easily be absorbed by business than by individual homeowners.

66. The most popular nonstructural protective measure employed by commercial activities was relying on a flood warning system coupled with a temporary evacuation plan or simply a contingent reaction. They are relying on accurate forecasts and adequate warning to provide sufficient time to take protective or mitigative actions. They believe that they can dramatically reduce damages

at lower flood stages by moving items to higher floors when threatened with flooding. Once again there exists the chance that sufficient time will not be available to react or that the contents will not be moved high enough for major floods.

67. As with residential property owners, other measures such as raising structures, permanently sealing openings and installing flood shields are not popular measures. An additional reason for this is that many businesses rent their structures. Neither the owner nor the occupant appears enthused about investing scarce capital to "primarily benefit the other party."

INDUSTRIAL

68. Industries ran the gamut in flood awareness from two who had constructed earthen ring levees around all structures with protection above a 100 year frequency event to those not aware of a flood threat.

69. As with residential and commercial categories, the most popular nonstructural protective measure employed is a dependency on flood warning and planned or contingent reaction. The difference is that more industrial facilities have formal temporary evacuation plans. Unlike the other land use categories, there are plans for sandbagging around the property and effectively sealing windows and other openings. The higher intended use of sandbagging may be due to the greater availability of labor and equipment at their disposal. Sealing of openings seems to be more acceptable to industrial activities. There appears to be less concern over aesthetic appearance than expressed by homeowners or shopkeepers, and operational inconveniences and constraints do not appear to be as severe.

70. Overall, the majority of industries have neither applied nonstructural measures nor taken flood insurance. In many instances, the nature and type of products involves a "limited" threat and does not "warrant" such action. Even those who are well aware of a "threat" have chosen not to take any actions. They are willing to gamble that flooding will not occur during the time they occupy the structures.

OTHER LAND USES

71. For this discussion, the other land uses include all nonresidential-commercial-industrial land uses such as churches, schools, municipal buildings and historic structures. Although participation in the flood insurance program is the lowest of any group the percent taking nonstructural actions is second only to the residential category. Again the most popular measure is relying on flood warning and their own evacuation plans or contingent action.

72. With the information received, there appears to be no clear reasons why their participation rate in flood insurance is so low or why there exists such a nonpredictive pattern of participation. It is surmised that as they are public and quasipublic institutions, the concern of individuals often may not be sufficient to initiate new actions or programs. Also, this type of institution is more reactive in nature.

73. MUNICIPAL. As a result of the 1955 flood, a number of nonstructural, as well as structural, measures were implemented all along the major damage reaches. As expected, the greater the flood damages sustained in 1955 the greater the response of the community. With the passage of time and no major flooding since 1955, the only significant actions over the last decade have

been the participation (100%) of every community in the study area in the Federal Flood Insurance Program. It appears that advantages of making flood insurance available at subsidized rates has not gone unnoticed by the flood plain communities. Consequently, it is assumed that these communities are complying with flood plain land use regulations as is required by the Federal Flood Insurance Program.

74. Next to the flood insurance program, the most popular measure is flood warning. Of the 58 municipalities in the study area, 19 (approximately 33%) have some form of flood warning. This low percentage is surprising in light of the fact that flood warning systems are usually economically feasible. In addition to the saving of lives, the warning time afforded by an accurate forecast gives the entire community the time needed to carry out its evacuation and contingency plans. Some of the commercial and industrial activities which depend on warning are located within municipalities which, themselves, do not have a flood warning system. Most of the municipalities which have a system do not have corresponding evacuation plans for their community. Existing plans are usually limited to plans of action for their personnel and departments.

75. Of the 58 municipalities, 18, or 31 percent, have bought up flood plain lands giving them direct control over their use. Land use shifted from residential - commercial - industrial to recreational parks or open spaces. For the most part, damage potential has been substantially reduced, or essentially eliminated by these lesser land uses. In 14 communities, or 24 percent of the municipalities, areas damaged in 1955 have been redeveloped. This usually occurred in communities which had portions of their river front devastated by the flood. In most cases, a large portion of the areas were converted to open spaces and parking lots, with new structures being either flood-proofed or built above the 1955 flood stage. Only seven percent or four communities permanently evacuated (purchased and demolished) flood plain structures. Once again, they were ones which were severely damaged in 1955.

PROBLEM IDENTIFICATION

76. The Delaware River Basin periodically experiences large floods from heavy rains and spring thaws. Tropical hurricanes, northeasters, and localized thunderstorms have all resulted in record flows and significant flooding. Some streams have fairly frequent and severe flooding from summer storms, hurricanes and continental storms. Some natural detention is provided by undeveloped lowlands, but narrow, constricted channels downstream and generally flat slopes result in considerable channel overflow.

77. The aftermath of a flood causes suffering and inflicts damages, losses and other related costs. These consist of physical damages or costs directly due to floods; expenditures for flood fighting, rescue work, emergency measures and preventive maintenance; losses to business, production, profits, and wages; and losses due to interruption of traffic, communications and normal activities in the flooded area. Also, intangible costs occur which cannot be assigned a monetary value. Such costs include loss of human life; illness resulting from epidemics caused by unsanitary conditions; mental and emotional stress; inconvenience to both directly and indirectly affected parties; the detrimental effect on national production when flooded industrial plants are involved; and possible impact on national defense. In fully identifying the problem, all current and future flood related impacts had to be assessed.