

order to allow separate computations of affluence and other growth in contents, if desired. The major portion of the AAD would occur to (RES) residential (39%), (IND) industrial (24%) and (COM) commercial (15%) land uses. The other land use types Historic (HIST), Agricultural (AGR), Service (SER), Public (PUB), Utility (UTL), Transportation (TRN), Emergency (EMR), and Not Elsewhere Classified (NEC) each account for five percent or less.

112. A comparison of the portion of the potential problem that each type land use contributes is presented below. The number indicates the percent of the total population of flood plain structures and AAD indicates the percent of the total recurrent damages. An asterisk (*) indicates less than one percent of the total.

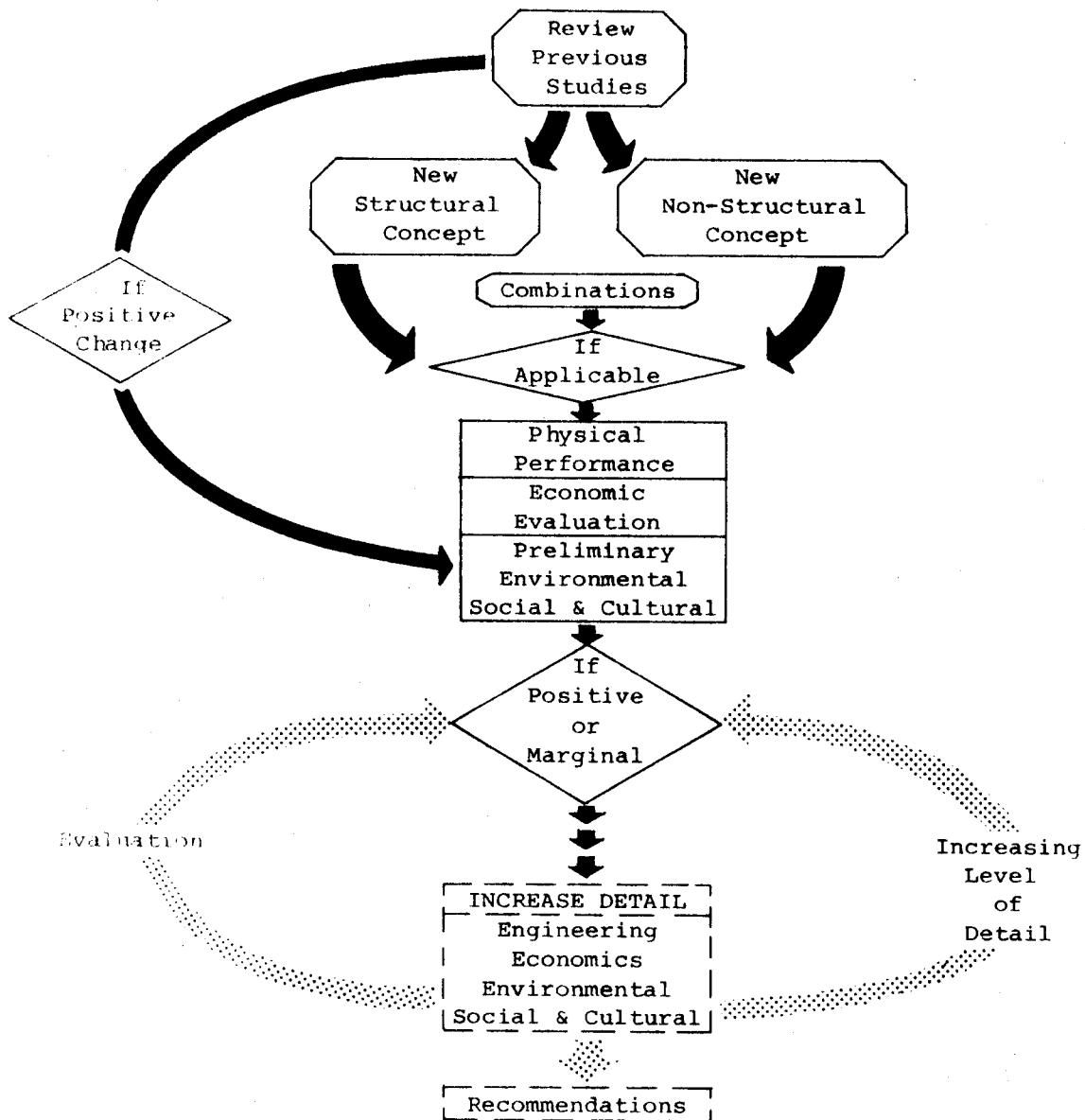
	RES	COM	IND	SER	PUB	UTL	TRN	AGR	HIS	NEC	EMR
Number(%)	83	12	1	2	1	*	N/A	N/A	*	1	N/A
AAD(%)	39	15	24	4	1	5	5	*	*	2	5

FORMULATION PROCESS

113. As shown conceptually in Figure 8, the formulation process was structured basically as a review of previous proposals and an introduction of new ones. It began with a check of the previous investigations to determine if changes have occurred which would affect the stated conclusions and recommendations. Those changes could be physical or analytical in nature and result from changes primarily in the proposed project site; hydrology and hydraulics; improved base data; economics, to include new sources of benefits; design requirements; or construction techniques. The level of detail of those reviews varied with the outlook for changing previous recommendations.

114. Flood protection measures suggested but never investigated and new concepts for providing protection were then screened for their applicability. Those investigations were initially conducted (conceptually) at a low level of detail. Measures were eliminated from further consideration as being impractical (if they lacked measurable physical performance); technically infeasible; or, obviously, too costly.

115. The major portion of the formulation effort was expended in performing the following steps. Potential flood protection measures were evaluated for physical and economic performance with consideration of critical environmental, cultural and social impacts. Physical performance was measured by decreases in discharges, decreases in stages and increases in levels of protection. Economic performance was measured by the amount of benefits to be derived, level of residual damages, and the ability to achieve the benefits for an equal or lower cost. In order not to prematurely eliminate a measure or plan, alternatives were retained for further consideration if they had a benefit to cost ratio (BCR) of 0.80 or greater. Assessments were conducted of the likely major or critical impacts of each plan. Major or critical impacts were defined as those which: make a plan unacceptable; result in substantial benefits which were not included in the economic analysis such as conservation, fish and wildlife enhancement or aesthetics; change primary components of the plan; or require mitigation costs which would obviously render the plan economically infeasible.



**DELAWARE RIVER BASIN STUDY
FORMULATION PROCESS**

FIGURE 8

PLANNING OBJECTIVES

116. The following planning objectives were used as a guide for this study:
- . Develop data and engineering and economic tools in sufficient detail to inspire a high degree of confidence in determining the flood risk potential for communities located within the study area and for evaluating solutions.
 - . Review past investigations and their recommendations to either confirm or reconsider their conclusions and recommendations.
 - . Develop new solution concepts, in particular nonstructural concepts and evaluate feasibility.
 - . Develop a program utilizing structural and nonstructural measures to minimize both flood damages and flood induced social economic disruption.
 - . Preserve, maintain, and, where possible, enhance existing open spaces, historic structures, archaeologically important sites and other environmentally critical areas.
 - . Give consideration to the wise and prudent use of land, to enhancement and conservation of fish and wildlife resources and to the overall enhancement of the environment and quality of life.
 - . Develop data sufficient to determine the impacts of plans on regional development.

PLANNING CRITERIA

117. The formulation, screening and evaluation of alternative plans were constrained by a set of general, technical, economic, social, and environmental criteria. Additional specific criteria often constrained some of the measures being considered. These individual criteria are the following:

118. TECHNICAL CRITERIA. The optimum level of flood protection that can be justified will be determined. Due to the urban nature of the area and the threat to life which would be caused by failure of protective works, protection should be provided, if justified, against a design storm equal to the Standard Project Flood (SPF). Protection must function without causing adverse effects in other areas (primarily downstream). When the National Economic Development (NED) plan is identified, the risk or uncertainty associated with the plan, that is, the magnitude of residual damages or potential catastrophic affects associated with failure above flood design levels, will be evaluated to determine if deviation from the NED plan may be acceptable. The design levels selected for both structural and nonstructural plans will be evaluated based upon those considerations.

119. ECONOMIC CRITERIA. Tangible benefits must exceed project economic costs to warrant further consideration. The scope of the project or program should be developed such as to provide the maximum net benefits. However, benefits may be considered which result from positive nonmonetary contributions to

social well being or environmental quality which cannot be quantified. All possible solutions, whether Federal, state or local responsibilities, will be investigated and evaluated on a comparable basis for accomplishing the same purposes.

120. SOCIAL CRITERIA. Plans should protect public health, safety and well being including possible loss of life. The desires of the affected communities should be reflected in order for plans to be realistic.

121. ENVIRONMENTAL CRITERIA. The development of pleasing aesthetics and other desirable environmental effects should be promoted. Plans should avoid, where possible, detrimental environmental effects, and include features to mitigate such effects if they are found unavoidable. Care should be taken to mitigate adverse effects on fish and wildlife resources.

MEASURES CONSIDERED

122. Many protective measures were considered but, due to the urban nature of the study area, emphasis was initially placed on those preventive measures which could provide SPF protection or a minimum 100-year flood protection. Any measures which would allow an area to still be flooded or which would only reduce damages by a small amount were not initially addressed in the same level of detail. If applicable, they were later considered to supplement other preventive measures or as a substitute if alternatives were not found to be technically feasible or socially and environmentally acceptable.

123. All of the measures which were considered are listed below. The letters (P) and (R) indicate that the measure was considered to be preventive or reductive, respectively. Except for flood or high flow skimming, these measures are local or individual in nature.

STRUCTURAL

- .Channel Modifications and Diversions (P)
- .Levees and Floodwalls with Interior Drainage System (P)
- .Flood or High Flow Skimming Impoundments (P)

NONSTRUCTURAL

- .Flood Insurance (R)
- .Flood Forecasting, Warning and Preparedness Planning (R)
- .Flood Plain Management (R)
- .Flood Proofing (P)
- .Permanent Flood Plain Evacuation (P)

124. Initially the flood damage/benefit analysis was based on the consideration of individual flood damage reaches which were delineated by dividing floodplains, once defined, on the basis of economic, physical, and hydraulic factors; political boundaries; existing flood control projects; and potential plans for improvement. After screening and analysis, the flood damage reaches were combined to yield a community level analysis and thus provide a uniform level of protection within a specific community.