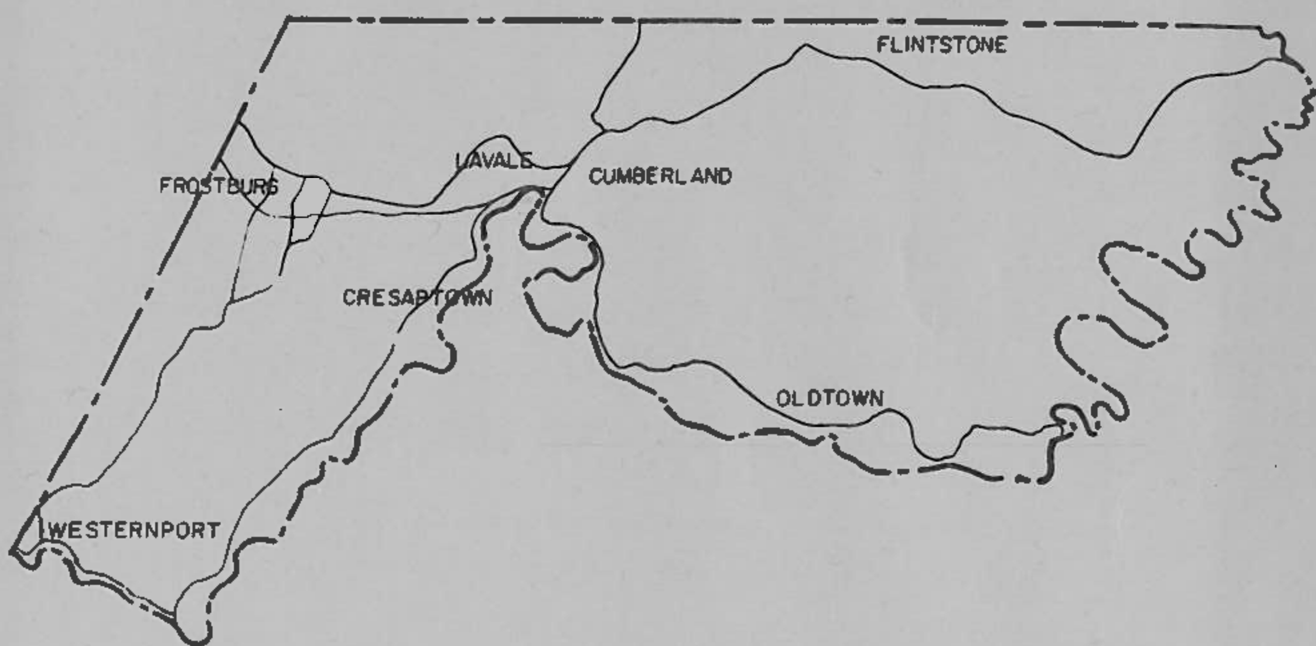
ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY
TRIBUTARY TO BRADDOCK RUN



SEPTEMBER 1986

PREPARED FOR

WATER RESOURCES ADMIN.
MARYLAND DEPARTMENT
OF NATURAL RESOURCES

ALLEGANY COUNTY
COMMISSIONERS

PREPARED BY

PURDUM & JESCHKE
CONSULTING ENGINEERS

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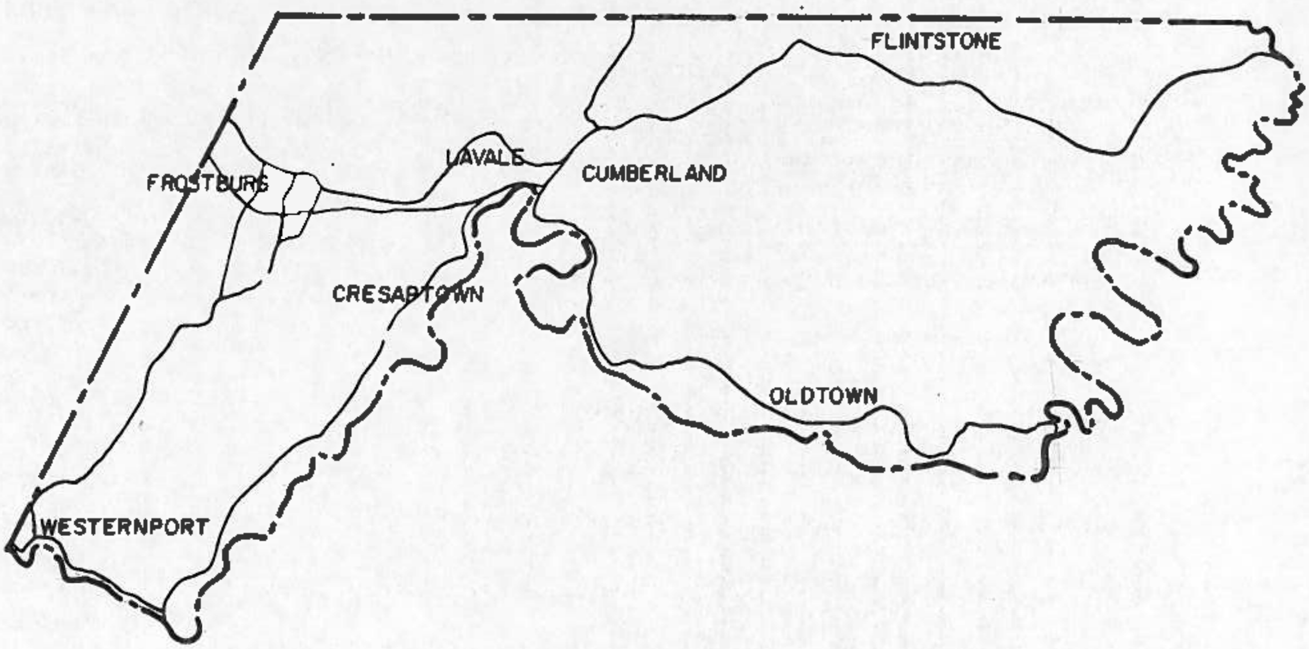

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CONSULTING ENGINEERS AND LAND SURVEYORS

September 30, 1986

Mr. Arthur T. Bond, President
Allegany County Commissioners
County Office Building
3 Pershing Street
Cumberland, Maryland 21502

Subject: Allegany County Flood Management Study
Tributary to Braddock Run Watershed

Dear Mr. Bond:

We are pleased to submit herewith the final copies of the Tributary to Braddock Run Watershed Flood Management Study.

We accomplished the following:

(1) Developed a hydrologic (TR-20) model of the watershed for existing and planned development conditions.

(2) Developed hydraulic (HEC-2) models of the designated stream reaches.

(3) Delineated the 100-year flood hazard zone.

(4) Defined and evaluated the effectiveness of flood hazard mitigation alternatives.

(5) Prepared a report summarizing the above efforts.

Purdum and Jeschke is pleased to have had the opportunity to perform this interesting and challenging study and stands ready to assist you in the future.

Very truly yours,

PURDUM AND JESCHKE

Cay G. Weinel, Jr.

Cay G. Weinel, Jr., P.E.
Partner

CGW/jm
Attachment

1029 N. CALVERT STREET/BALTIMORE, MARYLAND 21202/301-837-0194

ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY

TRIBUTARY TO BRADDOCK RUN WATERSHED

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ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY

TRIBUTARY TO BRADDOCK RUN WATERSHED

I. INTRODUCTION

The Allegany County Planning and Zoning Commission and the State of Maryland Water Resources Administration, Department of Natural Resources, have contracted Purdum and Jeschke to perform a study of the Tributary to Braddock Run watershed. The purpose of the study is to identify the existing flood hazard areas and evaluate measures to prevent or reduce future flood damages.

The following items have been submitted under separate cover:

1. 1" = 200' mylar subbasin overlay maps to the County topographic maps.

2. 1" = 200' mylar TR-20 schematic overlay maps to the County topographic maps.

3. 1" = 500' mylar TR-20 schematic overlay map and subbasin map.

4. Bound computational data book containing subbasin data. This includes geographic data base attribute files, HYDPAR generated Soil Conservation Service (SCS) runs, runoff curve numbers (RCN), and time of concentration (t_c) computations.

5. The hydrologic (TR-20) computer model for the watershed for existing and ultimate conditions.

6. Bound computational book for the hydraulic data. This includes survey notes, cross-section location map and plots.

7. The hydraulic (HEC-2) computer model for the watershed for existing and ultimate conditions.

8. 1" = 200' scale floodplain delineation maps.

9. Bound computations for flood dollar damage computations.

10. 1" = 600' scale floodplain delineation maps for overlay on the County Tax Maps.

CITIZENS' PARTICIPATION

Two public meetings were held to coordinate the study activities with local and state officials, the consultant, residents, and interested and/or affected organizations. On July 31, 1985, an organizational meeting was held to explain and to coordinate the study effort. At the July 16, 1986 public meeting the results of the floodplain modeling were presented, and a discussion of the possible flood hazard mitigation alternatives prior to their detailed evaluation was undertaken.

A third public meeting will be scheduled following the completion of the final report. At this meeting the detailed evaluation of the alternatives and final report will be presented.

Through the course of this study citizen participation and input has been greatly received. Information on historical flooding was obtained from flood damage survey questionnaires distributed to the residents. Valuable information was also obtained from interviews in the field and at the public meetings.

II. SCOPE OF STUDY

Purdum and Jeschke's agreement with Allegany County and the Water Resources Administration requires that the following tasks be undertaken in order to define the flood hazard areas and evaluate alternative measures.

1. Collect and review all available information, mapping, and reports pertinent to the study. Determine the acceptability and applicability of the data.

2. Field reconnaissance of the watershed and designated stream study reaches. This will include examination of existing conditions, visual inspection of channels and overbanks areas, and interviews with residents.

3. Develop a hydrologic computer model (TR-20) for the Tributary to Braddock Run watershed and develop peak stream flows for the 2, 10, 50, 100, and 500-year frequencies for both existing conditions and ultimate development conditions based on the current zoning maps.

4. Develop a hydraulic computer model (HEC-2) for the designated stream reaches. This will include the delineation of the 100-year floodplain.

5. Investigate flood hazard mitigation alternatives for the watershed and recommend action to alleviate flooding problems.

6. Prepare a report summarizing the computations, data, alternatives, and recommendations.

III. DESCRIPTION OF WATERSHED

A. NATURAL DRAINAGE BOUNDARIES

The Tributary to Braddock Run drainage area is approximately 268 acres in size and is shown in Figure 1, Vicinity Map, Appendix A. The confluence of Tributary to Braddock Run and Braddock Run, east of National Highway (U.S. Route 40), is the eastern boundary of the watershed. The watershed boundaries to the west and north are in the foothills of Piney Mountain. The drainage area extends south through LaVale to hilly regions north of U.S. Route 40.

B. SUBBASINS

The total drainage area of the Tributary to Braddock Run is divided into nine subbasins ranging from eight acres to 66 acres, with 30 acres the average size. Subbasins are delineated so that stream flow rates can be computed to design points in the channel flow path. These design points are defined at change in channel characteristics, bridges and culverts, road crossings, and at branch tributaries.

C. SOILS

Soil Conservation Service Hydrologic Soil Groups A, B, and C occur in the Tributary to Braddock Run drainage area. Eight-six percent of the watershed contains Type C soil which has a slow infiltration rate and a high runoff potential. Group B, which occurs in approximately eight percent of the area, has a moderate infiltration rate and a correspondingly moderate storm water runoff rate. Soil Type A, covering only six percent of the watershed, has high infiltration rate and low runoff potential.

D. SLOPE

Watershed slopes vary considerably. Slopes range from two percent in low-lying areas near the main stream to ten percent in hilly areas in upper LaVale to as high as 50 percent in wooded, mountainous regions.

E. LAND USE AND ZONING

Forty-eight percent of this watershed is wooded, which covers sections to the north and west. Forty-eight percent is residential and rural residential, located mainly in the central and eastern sections of the watershed. The remaining four percent is in parks, schools, and commercial land use.

Ninety-eight percent of the watershed is zoned residential and rural residential. The remaining two percent is zoned for commercial use.

IV. FIELD INVESTIGATION

Field investigations were necessary to ensure proper modeling of the Tributary to Braddock Run watershed. The data gathered during field investigations are summarized as follows:

A. HYDRAULICS OF DESIGNATED STREAM REACHES

Field investigations were made of the designated stream reaches in the Tributary to Braddock Run watershed. Channel size and shape were noted in order to develop reach cross-section data for the TR-20 modeling and for hydraulic analysis of the study reaches.

B. DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS

The main stream and the four tributaries, as shown on the Location Map, Figure 3, Appendix A, were examined to determine ground conditions of the channel and overbanks. Existing ground conditions were records on 1" = 200' scale Allegany County topographic maps. Photographs were taken at various points along the streams to document field conditions. This information was used to determine the Manning's roughness coefficients for the HEC-2 model flood depth calculations.

The procedure to estimate 'n' values is described in the Guide for Selecting Roughness Coefficient 'n' Values for Channels (SCS Manual TR-24). It involved selecting a base roughness coefficient and adding modifying values that reflect: (a) degrees of surface irregularity, (b) variation of shape and size of cross-section, (c) obstructions, (d) vegetation, and (e) meandering of channel within the flood plain. Photographs with assumed roughness coefficients were compared to similar photographs appearing in SCS Manual TR-24 and in Roughness Characteristics of Natural Channels (Geological Survey Water Supply Paper 1849).

C. EXAMINATION OF STRUCTURES

All structures along the main stream and tributaries were examined for evidence which might aid in better computer modeling. High water marks identified by debris suspended from the underside of a structure or along the brush on the stream banks indicated frequent flooding and provided insights into the hydraulic performance of the structure. Identification of likely flow paths for overtopping floods helped to later define the weir cross-section as well as other hydraulic modeling data for bridges and culverts.

D. STUDY METHOD DETERMINATION

From field investigations of the stream reaches and with the aid of existing topographic mapping, a determination was made as to which study method should be used to analyze each particular stream reach. The stream reaches were studied by either a detailed HEC-2 computer model or by other computational methods.

The HEC-2 computer model was used on stream reaches where a gradually varied flow condition and relatively similar cross-section existed. For these reaches, the surveying services of SPECS, Inc. of Cumberland, Maryland were used to obtain surveyed stream cross-sections, bridge and culvert measurements, and house first floor elevations.

In the Tributary to Braddock Run watershed the main stream was studied using the HEC-2 computer program.

Computational methods such as Manning's equations, culvert headwater nomographs, and capacity charts were used for those stream reaches exhibiting any of the following characteristics:

1. The majority of the reach was a closed storm drain system.

2. The reach consisted of roadside ditches with culverts crossing under the streets.

3. The reach was a steep sloped swale which conveyed water only during flood events.

4. The reach was located in areas which were undeveloped and where flood damages were unlikely to occur.

In the Tributary to Braddock Run watershed, Tributary No. 1 met the above criteria.

E. DISTRIBUTION OF QUESTIONNAIRES

Questionnaires were distributed during the field reconnaissance to residents living adjacent to the stream reaches. The questionnaires were designed to obtain information on past flooding events. Questions asked included: the number of years in residence, type of home, dates of most severe flood events, depth of flooding in basement or first floor, and known high water marks inside or outside of the home.

A copy of the questionnaire is found in Appendix C of this report. There was a 52 percent response from the questionnaires distributed. No first floor flooding was reported by any of the responses but some basement flooding was reported. The backup of sewers and drains was frequently mentioned.

V. COMPUTER APPLICATIONS

The use of microcomputers for digital mapping, automated computation of hydrologic parameters, and hydrologic and hydraulic computations greatly reduced the volume of manual work normally associated with watershed studies of this size. All applications were performed on an IBM PC with peripheral equipment including hard disk storage, digitizer, and color monitor.

A. DIGITAL MAPPING - GEOGRAPHIC INFORMATION SYSTEM

The Aeronca Electronics Geographic Information System (AE-GIS) was used to store, display, and analyze map data which included watershed boundaries, subbasins, existing land use, zoning classifications, Soil Conservation Service (SCS) soil types, and stream reaches. The microcomputer based AE-GIS stores map data as well as any form of demographic data in grid cell form based on any cell size and reference data. For the Tributary to Braddock Run watershed, a cell size of 50 feet by 50 feet (0.06 ac.) was selected as an appropriate size for calculation of hydrologic parameters for subbasins as small as eight acres. The reference datum selected was the Maryland State Plane Coordinate System.

B. IDENTIFICATION OF LAND COVER

Existing land cover identification was made from Allegany County 200-foot-scale topographic maps with updates from field observations and 1982 aerial photographs from the Soil Conservation Service. Ultimate land cover was determined from existing zoning maps. Land cover was classified into one of the following eight land cover classes: Wooded, Parks/Schools, Rural Residential, Residential, Commercial, Industrial, Meadow/Pasture, Water.

C. AUTOMATED COMPUTATION OF HYDROLOGIC PARAMETERS

Hydrologic parameters were computed by using HYDPAR, a program module added to the AE-GIS software. Utilizing the grid cell data bases created for soil types, land use, zoning, and subbasins; the HYDPAR program computes the runoff curve numbers (RCN) and area for each of the nine subbasins. RCN values were computed for existing and ultimate conditions. The RCN value for each subbasin is shown in the Drainage Area Summary, Table 1 in Appendix B.

D. WATERSHED HYDROLOGIC MODELS USING SCS TR-20

1. Description of TR-20 Model

The U.S. Department of Agriculture SCS program, TR-20 (1983 version), was used to model hydrology in the Tributary to Braddock Run watershed. This program uses the SCS runoff and unit hydrograph procedure, stage-discharge reservoir routing, and modified attenuation-kinematic routing procedure to generate stream flow rates at all design points along the main stream and tributary.

2. Times of Concentration

Times of concentration were determined by charting flow paths on Allegany County topographic maps with divisions for overland flow (forest, open, urban, or combined), swale or ditch flow, and stream flow. Velocities were obtained from:

Figure 3-1, SCS, Urban Hydrology for Watersheds, TR-55.

Figure SHA-61.1-402.2, Maryland State Highway Administration, Highway Drainage Manual, December 1981.

3. Reach Cross-sections

In order to route the runoff hydrograph through stream reaches, discharge-end area tables were input into the TR-20 model. The discharge-end area tables were developed by running multiple flows through the reaches using the HEC-2 computer program. Channel cross-section shapes and roughness coefficients for HEC-2 input were determined during field investigations.

4. Rainfall

The standard SCS Type II 24-hour rainfall storm distribution with a rainfall increment of 0.25 hours and a main time increment of 0.10 hours was initially used in the TR-20 modeling. The results of the modeling showed that the reach routings were defaulting, and no attenuation of flow was occurring due to the main time increment size. A smaller main time increment could not be used with this rainfall table because of the limiting value in the TR-20 program of 300 points per output hydrograph. This was not sufficient to obtain the peak flows for some subbasins.

A portion of the standard SCS Type II 24-hour rainfall distribution from hour 7.5 to 13.5 with a rainfall increment of 0.10 hours was used in the final modeling. This rainfall table allowed the use of a main time increment of 0.02 hours. The output hydrographs began at 7.5 hours because there is no runoff from hour zero to 7.5 hours. The peak flows for all subbasins were obtained within the 300 point limit of the program. The reach routings now were attenuating all flows.

5. Flow Comparison

The estimated 100-year frequency storm discharges for gaged streams of similar size watersheds in Allegany and the three neighboring counties of Frederick, Carroll, and Washington was obtained from the U.S. Geological Survey. The discharge versus drainage area was plotted for the gaged streams and is presented as Figure 2 in Appendix A. An upper and lower limit line was drawn for the gage data for the four counties along with a separate upper limit line for Allegany and Washington Counties. The 100-year discharge for existing development from the TR-20 model of the Upper Georges Creek watershed is shown as Point Number 2 on this plot.

The TR-20 discharge is above the upper limit line for all four counties, indicating that the TR-20 modeling is predicting higher 100-year flood discharges than would be expected based on stream gage data. Changing the TR-20 model watershed parameters within reasonable engineering limits could not produce discharges that were compatible with the regional gage information. This fact led to the examination of the standard Type II rainfall distribution. The Type II rainfall distribution contained rainfall intensities that were higher than what has been experience in the Allegany County area.[1] Input of the lower intensity rainfall into the TR-20 model produced 100-year frequency discharges which fall within the upper and lower limits of the regional gage data. The Type II rainfall distribution is required by the State regulations.

E. HYDRAULICS

1. Description and Input Data Requirements

The HEC-2 program is designed to model the stream hydraulics. The program will compute the water surface profile, flow velocities, energy gradient, and friction losses. Additionally, it will accommodate hydraulic structures such as bridges, culverts, weirs, and any combination of flow through or over these structures. Input information used in programming HEC-2 includes cross-section geometry, Manning's roughness coefficients, stream flow rate, and minor losses due to expansion and contraction of the cross-sectional areas.

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[1] Maryland Department of Transportation, State Highway Administration, Highway Drainage Manual, Table S.H.A. - 61.1-403.1, December 1981.

Peak discharges for the 2, 10, 50, 100, and 500-year frequency storms for both existing and ultimate land use, developed by the TR-20 models, were programmed into HEC-2. Water surface profiles were calculated for each frequency storm.

2. Accuracy of HEC-2

The accuracy of any computer model is, in part, dependent on the basic assumptions inherent in the modeling technique. The HEC-2 computer program is a one-dimensional model based on the assumption of steady, gradually varied flow. The accuracy of the model is partially dependent on how closely the prototype conforms to these basic assumptions. As a general rule, the steady gradually varied flow assumption yields good results for streams with gentle slopes (10 percent or less) and relatively constant cross-sections. The main stream of Upper Georges Creek meets both of these requirements.

The other factors affecting the accuracy of the HEC-2 model are as follows:

a. Stream flow rate and variation along length of reach.

b. Manning's roughness coefficient for determining resistances to flow from channel and overbank surfaces.

c. Stream geometry - such as cross-sectional form and channel slopes.

The flow rates at design points along the length of the stream are computed by using the Soil Conservation Service computerized hydrograph method for runoff determination (TR-20) as described previously.

The assignment of Manning's roughness coefficients were chosen by applying data from careful field observation to the techniques presented in SCS publication, TR-24. Several roughness coefficients were chosen for each cross-section in the study areas.

Stream geometry is defined by locating cross-sections along the stream. The impact each cross-section has on the model is dependent on the distance between cross-sections. Sections were chosen where it was necessary to describe changes in cross-section shape, channel or overbank roughness coefficients, channel slope, or in flow rate at a location of stepped increase. Cross-section information was obtained from field surveys performed by SPECS, Inc. of Cumberland, Maryland.

3. Development of HEC-2 Models

The HEC-2 models were developed in two steps. First, all bridges were analyzed individually to determine the best HEC-2 modeling application. Second, each reach between the structures was analyzed to determine general stage-discharge and flow regime characteristics which aided in development of the final stream model.

4. Structures

Each of the structures in the detailed study areas was analyzed separately to determine which of the following two techniques would provide the most accurate model for use in the final HEC-2 programs.

a. Calculating the energy loss using the HEC-2 normal bridge routine.

   The normal bridge routine handles a bridge cross-section in the same manner as a natural river cross-section with the following exception. The area of the bridge structure that is below the water surface is subtracted from the total area, and the wetted perimeter is increased where the water is in contact with the bridge structure. This routine is most applicable when friction losses are the predominant consideration.

b. Calculating the energy loss using the HEC-2 special bridge routine.

The special bridge routine computes losses through the structure for either low flow (water surface below low chord of structure), pressure flow (water surface above low chord of structure), weir flow (flow around bridge and/or over bridge deck), or for a combination of these. The profile through the bridge is calculated by using hydraulic formulas to determine the change in energy and water surface elevation through the bridge. Although this technique is capable of solving a wide range of flow problems, it is most applicable for structures operating under pressure flow conditions with road embankments having well-defined weir surfaces.

c. In this study the culvert at Station 12+10 was modeled with the normal bridge routine. The Oaklawn Avenue and U.S. Route 40 culverts were studies by the special bridge routine.

V. STREAM STUDY REACHES

A. DESCRIPTION OF STREAM STUDY REACHES

The stream reaches studied in this watershed are described below and are depicted on Figure 3, Location Map, in Appendix A.

1. Main Stem

The main stem of the Tributary to Braddock Run begins approximately 300 feet southeast of Weires Avenue at the confluence with Tributaries 3 and 4. The stream flows in a southeasterly direction parallel to LaVale Court. It then flows in an easterly direction toward the intersection of Harold Street and U.S. Route 40. The stream flows under U.S. Route 40 via a culvert system and continues in an easterly direction until it confluences with Braddock Run. The stream goes through a culvert under Oaklawn Drive and for a short stretch south of U.S. Route 40. The stream is 3,290 feet long with an average stream slope of 3 percent.

The channel averages 2 feet in depth and 10 feet in width above U.S. Route 40 and 3.5 feet deep and 15 feet in width below U.S. Route 40. The stream overbank areas consist mainly of lawns and grasses.

2. Tributary No. 1

Tributary No. 1 begins on the Parkside School property and flows in a northeasterly direction toward Parkside Boulevard. At the boulevard the stream goes into a closed storm drainage system and empties into the main stem at LaVale Court. The stream/storm drainage system is approximately 1,940 feet long with an average slope of 4 percent.

3. Tributary No. 2

Tributary No. 2 consists of open grass swale behind the homes on Weires Avenue draining in a southwesterly direction toward Harold Street. The swale empties into a culvert system at Harold Street that parallels Weires Avenue for 430 feet. The culvert then goes under Weires Avenue in a southeasterly direction and empties into the main stream. The entire system is 1,490 feet long with an average slope of 5 percent.

4. Tributary No. 3

Tributary No. 3 is a roadside ditch on the west side of Harold Street. The ditch flows in a southwesterly direction and drains into a roadside grate at Weires Avenue. The flow then combines with Tributary No. 2. The ditch has an average slope of 10 percent in its 580-foot length.

5. Tributary No. 4

Tributary No. 4 is an open backyard grass swale paralleling Eleanor Street until Weires Avenue. The stream flows in a southeasterly direction and enters a culvert at Weires Avenue emptying into the main stem. The stream is 1,280 feet in length with an average stream slope of 6 percent.

B. MANNING'S COEFFICIENT

Manning's 'n' coefficients average 0.06 for the channel section of the streams. A value of 0.06 for lawns, 0.07 for high grass and shrubs, and 0.10 for wooded areas was used in the overbank areas.

C. STRUCTURES

Eight culvert structures were identified within the stream study reaches and were examined in the field. The size of each was determined from either field surveys or from field reconnaissance as indicated on Table 2, Appendix B.

D. IDENTIFICATION OF FLOOD HAZARDS

The water surface elevations for the 2, 10, 50, and 100-year frequency storms were developed for both existing development conditions and ultimate development conditions, based on the current zoning maps. The elevations are presented in Table 3, Appendix B. The water surface elevations for ultimate conditions showed an average increase of less than 0.5 foot over existing conditions. Hence, the full development of the Upper Georges Creek watershed based on the current zoning maps will show little change from the existing flooding conditions. Existing flooding conditions can, therefore, be said to equal the ultimate flooding conditions.

The water surface profiles for the 2, 10, and 100-year frequency storms, existing conditions, are shown in Appendix D. The water surface profiles also depict the first floor and basement elevations of flooded structures in the floodplain. These have a letter and/or number code. The bridges and culverts within the study reaches are also shown on the profiles.

The delineation of the 100-year flood zone, ultimate conditions, is presented in Appendix E. A description of the flooding conditions on each study reach is given below.

1. Main Stem

The 100-year floodplain on the main stem of the Tributary to Braddock Run averages 100 feet in width above U.S Route 40 and 150 feet below. Three (A, D-2, E) structures receive first floor flooding, three (B, C, E-3) receive basement flooding, and seven structures (D, D-1, D-3, F, G, G-1, H-1) have foundation flooding.

The three culverts on this stream are all overtopped by the 2, 10, and 100-year storms. The Oaklawn culvert is also clogged with debris on the upstream side.

2. Tributary No. 1

The 100-year floodplain for Tributary No. 1 averages 30 feet in width on the Parkside School property. The flood water will overtop the culvert system at Parkside Boulevard and flow overland down the roads and properties until it meets the main stem. The culvert outfall at the main stem is collapsed and in need of repair. Minor property flooding may be experienced due to the overflow of the culvert.

3. Tributary No. 2

The 100-year floodplain for Tributary No. 2 consists of a 30-foot wide swale flow behind the homes on Weires Avenue. This flow will combine with the flow from Tributary No. 3 at Harold Street. Except for minor property flooding, no homes will be affected.

4. Tributary No. 3

The 100-year flood zone for Tributary No. 3 consists of ditch flow along Harold Street. The flow which cannot enter the culvert system at Weires Avenue will flow along the road and cross it. The house (F-4) at the corner of Harold Street will be affected by the back-up of the culvert.

5. Tributary No. 4

The 100-year floodplain for Tributary No. 4 is made up of swale flow 60 feet in width behind the homes on Eleanor Street. At Weires Avenue the flow enters the culvert system and empties into the main stem. This culvert is overtopped during the 100-year storm. Three homes (F-1, F-2, F-3) are located within the flood zone which may experience basement and foundation flooding.

VII. ESTIMATED FLOOD DAMAGE COSTS

The dollar damages that would be caused by a 2, 10, and 100-year storm were estimated. These damages consisted of public and private sector damages as well as abstract losses described below. The damages computed for these three storms were converted to an average annual flood damage cost. This is the amount of dollar damage that can be expected to occur on the average every year. The purpose of computing the average annual flood damage cost is to enable comparison with the annual cost of flood mitigation alternatives or projects. The average annual flood damage costs were converted to a single present value based on a nominal interest rate for a 30-year period. This present value represents the maximum expense that could be justifiably spent at today's dollars to alleviate all the flood damages. Spending this amount of money on improvements may not remove all flood damages.

A. PRIVATE SECTOR DAMAGE COSTS

Three types of flood damage costs are computed to determine the private sector losses. These costs consist of flood damages to the home and its contents, damage to exterior property, and damage to vehicles.

Flood damage losses for private homes are dependent on the depth of flood water within the home, the value of the home, and the value of its contents. The average value of each home and its contents are estimated based on the method found in the Corps of Engineers' Institute for Water Resources, Pamphlet No. 4 titled, "Cost Report on Non-Structural Flood Damage Reduction Measures For Residential Buildings Within the Baltimore District" (Reference 1).

The base structural value of a home is determined from the type of home, the structural composition, and type of foundation. Table III-2, shown in Appendix C, taken from Reference 1, gives a high and low base structural value of a home. This table reflects a seven percent annual inflation adjustment. Base value adjustment factors are used for location, quality of construction, condition of house, and size according to the age of the house. Table III-4, Appendix C, is used with the low base value of the home for structures over 25 years in age. Table III-5, Appendix C, is used with the high base value of the home for newer structures less than 25 years in age. The adjusted base values of the homes in the floodplain ranged from $39,000 to $68,000. The adjusted base value for trailers averaged $22,000.

The value of the contents of a home is based on the square footage of the first floor, shown in Table 2-5, Appendix C, taken from the Corps of Engineers "DAPROG2, Flood Damage Assembly Computer Program" (Reference 2). The values on this table also reflect a seven percent annual inflation adjustment. The average contents value of the homes and trailers within the study area ranged from $18,000 to $21,000.

The dollar damage to the home and its contents is based on the flood depth of the 2, 10, and 100-year frequency storms determined from the flood profiles and floodplain delineation. The computed flood depth is referenced to the first flood level (Stage Zero). Flood stage above the first floor is indicated by a positive value while flood stage below the first floor (basement flooding) is a negative value. The percent damage to the structure and its contents is based on this flood stage. The percent damage is determined from Table 5, Appendix C, taken from Reference 1. These percentages are multiplied by the house and contents values determined above to determine the dollar damages. Damages are calculated in this manner for the 2, 10, and 100-year frequency storms.

A clean-up cost for exterior flood damage is estimated for each property. This includes removal of debris left by the storm and repair of lawns and plantings. Also, an estimated cost to repair or replace damaged fences and sheds and their contents is included in the exterior property damages.

The final item considered under private sector losses is vehicular damages. One car per household is used for damage cost calculations.

The total private sector losses for the watershed are shown in Table 4, Appendix B, for existing conditions and Table 5, Appendix B, for ultimate conditions.

B. PUBLIC SECTOR DAMAGE COSTS

Public sector losses are computed for emergency police service to assist residents and divert traffic from flooded roadways, city clean-up services within the public rights-of-way, and private utility clean-up services.

The estimated cost of emergency police service includes one police car and two policemen for each flooded intersection. For the 2 and 10-year storms, one-half day of service is estimated. One day of service is estimated for the 100-year storm. The cost of a police car is based on a rental vehicle rate of $50 per day. The wages for a police officer is estimated to be $120 per day.

The clean-up costs of public road rights-of-way includes the labor and equipment costs for the community maintenance crews. It is estimated that a dump truck and a front-end loader would be the minimum equipment required to load and haul debris left by a storm. A rental rate of $44 and $54 per hour is used for the dump truck and front-end loader, respectively, which includes the cost of the equipment and driver. Laborers are also needed to pick up and clean up the debris prior to being handled by the equipment. It is estimated that two laborers would be required for one day to clean up the debris from a 2-year and 10-year storms. The 100-year storm would require four workers for two days of clean-up. The average wage cost is estimated at $10 per hour.

Estimated costs are also made for private utility clean-up and repairs. Lump sum estimates of $300 per day are used for telephone and electrical clean-up. This amount includes the cost of equipment and manpower. The 2-year and 10-year storms require one day of clean-up for each utility. The 100-year storm requires two days for telephone and gas and electric utilities.

The total public sector losses for the study area for existing and ultimate conditions are shown in Tables 4 and 5 of Appendix B.

C. ABSTRACT LOSSES

Flood damage costs are computed for a loss of income to homeowners who will take time off from work to clean their home and property after a storm.

The loss of income to homeowners is based on the days off from work and the average daily wage earned per household. The clean-up times estimated for the 2, 10, and 100-year storms are one, one, and two days, respectively. The number of flooded households is determined for each storm from the flood delineation maps. An average wage of $15 per hour ($120 per day) per household is multiplied by the days out of work and then by the number of households. The results are also shown in Tables 4 and 5 of Appendix B.

D. AVERAGE ANNUAL FLOOD DAMAGE COST

The total dollar damages for the private, public, and abstract loss are added together for the 2, 10, and 100-year storms. The computational method presented by the Corps of Engineers in "Computations of Expected Annual Damages" is used to convert the total dollar damages for the 2, 10, and 100-year storms to average annual damages (Reference 3). The average annual flood damages are costs that would occur every year on the average. The average annual damages for Tributary to Braddock Run for existing and ultimate conditions is $25,200 and $28,600, respectively.

E. PRESENT VALUE OF AVERAGE ANNUAL FLOOD DAMAGE COST

The amount of money you would need to have in the bank today at a nominal interest rate of 8 percent which would pay average annual flood damage costs every year for the next 30 years is called the present value of the average annual flood damages.

The present value of the flood damages can be estimated based on the calculated annual flood damages and a discount rate of eight percent. The present value is a lump sum equivalent to an unending annual series of payment or, in this case, losses. A discount rate of eight percent is customarily used for flood protection projects. It represents the relative value of money today compared to money in the future. The inflation rate can be ignored since it will not affect the calculations.

The present value of the average annual flood damages for the Tributary to Braddock Run is $284,000 and $322,000 for existing and ultimate conditions, respectively.

These dollar values represent the maximum amount of money that could be spent on improvements. However, spending this amount of money may not eliminate all flood damages. There still may be residual damage costs.

VIII. FLOOD MANAGEMENT ALTERNATIVES

A. PRELIMINARY ALTERNATIVES

The initial investigation of flood hazard mitigation involved a screening of proposed alternatives to determine which measures are applicable to the study watershed. Both structural and non-structural measures were considered. Structural improvements involve construction in the floodplain to reduce damages, while non-structural considerations are plans and policies to control effects of flood damage without altering the floodplain itself. A combination of structural and non-structural measures are often utilized in flood mitigation projects. The following is a list of alternatives that were considered:

Structural Improvements:

(1) Bridge and culvert replacement
(2) Retention structure
(3) Detention structure
(4) Stream relocation
(5) Stream enclosure
(6) Levees
(7) Flood walls
(8) Channelization
(9) Foundation raising
(10) Floodproofing

Non-Structural Considerations:

(1) Acquisition
(2) Flood insurance
(3) Flood warning system
(4) Zoning and land use runoff characteristics and regulations
(5) Stormwater management regulations

Each of the above alternatives was evaluated for feasibility within the watershed, and a preliminary list of applicable alternatives was compiled. A meeting was held between the representatives of the Consultant, Allegany County, and the Water Resources Administration to review the preliminary list of alternatives, and a final list of improvement alternatives was developed for a more detail analysis.

B. COST BENEFIT COMPARISON

In order to assess the economic efficiency of each of the floodplain management mitigation alternatives, projects costs, and benefits were determined. Project costs as defined in this study are labor, equipment, materials and construction costs, operation and maintenance costs, and administration costs. Benefits are defined as reduction in physical damage, reduction in emergency costs, and reduction in income losses. The project cost and benefits are compared on a present value basis. When project costs exceed benefits, it is an indication that the alternative is not economically justifiable.

C. PROPOSED IMPROVEMENT ALTERNATIVES

1. Oaklawn Avenue Culvert Replacement

The Oaklawn Avenue culvert is not adequate to contain the 2, 10, and 100-year storms. This condition causes the road to be overtopped and Houses B and C to have basement flooding. Two 60-inch culverts would contain the 2-year frequency storm. Four 60-inch culverts are adequate for the 10-year storm event. More than six culverts of this same size are required for the 100-year frequency storm. Piping is the only feasible alternative for this area.

The cost to replace the existing culvert with two 60-inch culverts is approximately $106,000. The reduction in damage costs amounts to a present value of $26,000. Four or more culverts are not feasible to be placed under Oaklawn Avenue, so only the 2-year design was considered.

The culvert under Oaklawn Avenue consists of the County culvert under the road and a private culvert connected to the County culvert on the upstream side. The private culvert system aggravates the flooding conditions and should be removed.

2. U.S. Route 40 Culvert Improvement

U.S. Route 40 is overtopped during the 2, 10, and 100-year frequency storms. The existing 48-inch culvert system is inadequate for these storm events. To contain the 2-year frequency storm, two 48-inch culverts are needed. Four 60-inch culverts are necessary to contain the 10-year frequency storm, and over six culverts of this size are needed to pass the 100-year frequency storm.

An additional 48-inch culvert can be added to the existing system for an approximate cost of $90,000. The reduction in flood damage costs due to this project is approximately $7,300. A design of four or more culverts at Route 40 is not practical, so cost estimates for the 10 and 100-year designs were not determined. A bridge or box culvert under U.S. Route 40 is not feasible.

3. Tributary No. 1 Stormwater Management Pond

The culvert system at Parkside Boulevard is inadequate to contain the 10 and 100-year frequency storms. The flood water that cannot enter the culvert system will have an overland flow path in residential areas and down roads. A 1.7 acre-feet stormwater management pond can be located directly upstream of the inlet to the Tributary No. 1 pipe system. The pond will reduce peak flows so that the system will carry the 10-year and 100-year flow rates.

The cost of this stormwater management pond for Tributary No. 1 is $20,000. No flood damages were computed for existing conditions because only minor property flooding occurs and no structures are affected. No reduction in flood damage costs will be experienced by the construction of this stormwater management pond.

IX. RECOMMENDATIONS

Table 6 of Appendix B lists the proposed flood mitigation alternatives for the Tributary to Braddock Run watershed.

There are two homes (A, D-2) that are recommended for purchase because they experience first floor flooding. The other structure (E) with first floor flooding is a business which receives only trace flooding from the 100-year storm. Flood insurance should be obtained to cover any losses to this structure.

The Oaklawn Avenue and U.S. Route 40 alternatives cost more to implement than the value in dollar damage reductions. Non-structural improvements by homeowners in the immediate area of these culverts is more practical. The same situation exists for the Weires Avenue culverts.

Residents of the remaining five homes (B, C, E-3, F-2, F-4) experience basement flooding and should purchase flood insurance and use floodproofing methods. The flood depths will be less than one foot around the basements. Some measures for floodproofing are the following: clearing basement of items subject to water damage, permanent blocking of basement openings, providing a sump pump, and waterproofing of exposed interior and exterior basement walls.

General maintenance of all drainage structures along the study reaches is recommended to assure their function at design capacity. From field investigation it was determined that the following culverts are in need of maintenance as first priority. The main stream Oaklawn Avenue culvert (Structure No. 1) is clogged with debris at the upstream end (private section). The culvert is also collapsing before crossing under Oaklawn Avenue. Restoration or removal of this section of the culvert will prevent frequent flooding of Oaklawn Avenue and Houses B and C. The Tributary No. 1 culvert (Structure No. 5) at the confluence with the main stream is also collapsing. Restoration of this culvert will prevent water from spreading onto lawns near the confluence.

The stormwater management pond at Tributary No. 1 would reduce overland and street flow in the residental area north of U.S. Route 40. This improvement may be made on a lesser priority, if deemed necessary by the County and if funding is available.

REFERENCES

1. U.S. Army Corps of Engineers, Institute of Water Resources, Cost Report on Non-Structural Flood Damage Reduction Measures For Residential Buildings Within the Baltimore District, Fort Belvoir, Virginia, July 1977.

2. U.S. Army Corps of Engineers, Baltimore District, DAPROG2, Flood Damage Assembly Computer Program, Users Manual, Program Version 12, Updated January 1984.

3. U.S. Army Corps of Engineers, Notes From Seminar of Computation of Expected Annual Damages, February 1981.

4. Barnes, H. H. Jr., Roughness Characteristics of Natural Channels, Water Supply Paper 1849, U.S. Geological Survey, 1977.

5. U.S. Department of Agriculture, Soil Conservation Service, Guide for Selecting Roughness Coefficient 'n' Values for Channels, Technical Release No. 24, December 1963.

6. U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

7. U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 5, Hydraulics, August 1972.

8. U.S. Department of Agriculture, Soil Conservation Service, Urban Hydrology for Watersheds, Technical Release No. 55, January 1975.

9. U.S. Department of Commerce, Weather Bureau, Technical Paper No. 40.

10. U.S. Department of Agriculture, Soil Conservation Service, TR-20 Project Formulation Hydrology, May 1983, Second Draft.

11. Bonner, Vernon R., Application of the HEC-2 Bridge Routines, Training Document No. 6, U.S. Army Corps of Engineers, Hydrologic Engineering Center, Davis, California, June 1974.

12. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2, Water Surface Profiles Users Manual, Davis, California, August 1979.

13. Allegany County Topographic Maps, Scale 1" = 200', 5-foot contour intervals, Alster & Assoc., Inc., Sheets F-11 and F-12, April 1963.

14. U.S. Department of the Interior, Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24,000, Cumberland.

15. U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, black and white aerial photographs, scale 1" = 1,320', 1982.

16. U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Analysis of Circular Culverts, BPR Program HY-1, Washington, DC, July 1965.

17. U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Analysis of Pipe-Arch Culverts, BPR Program HY-2, Washington, DC, August 12, 1964.

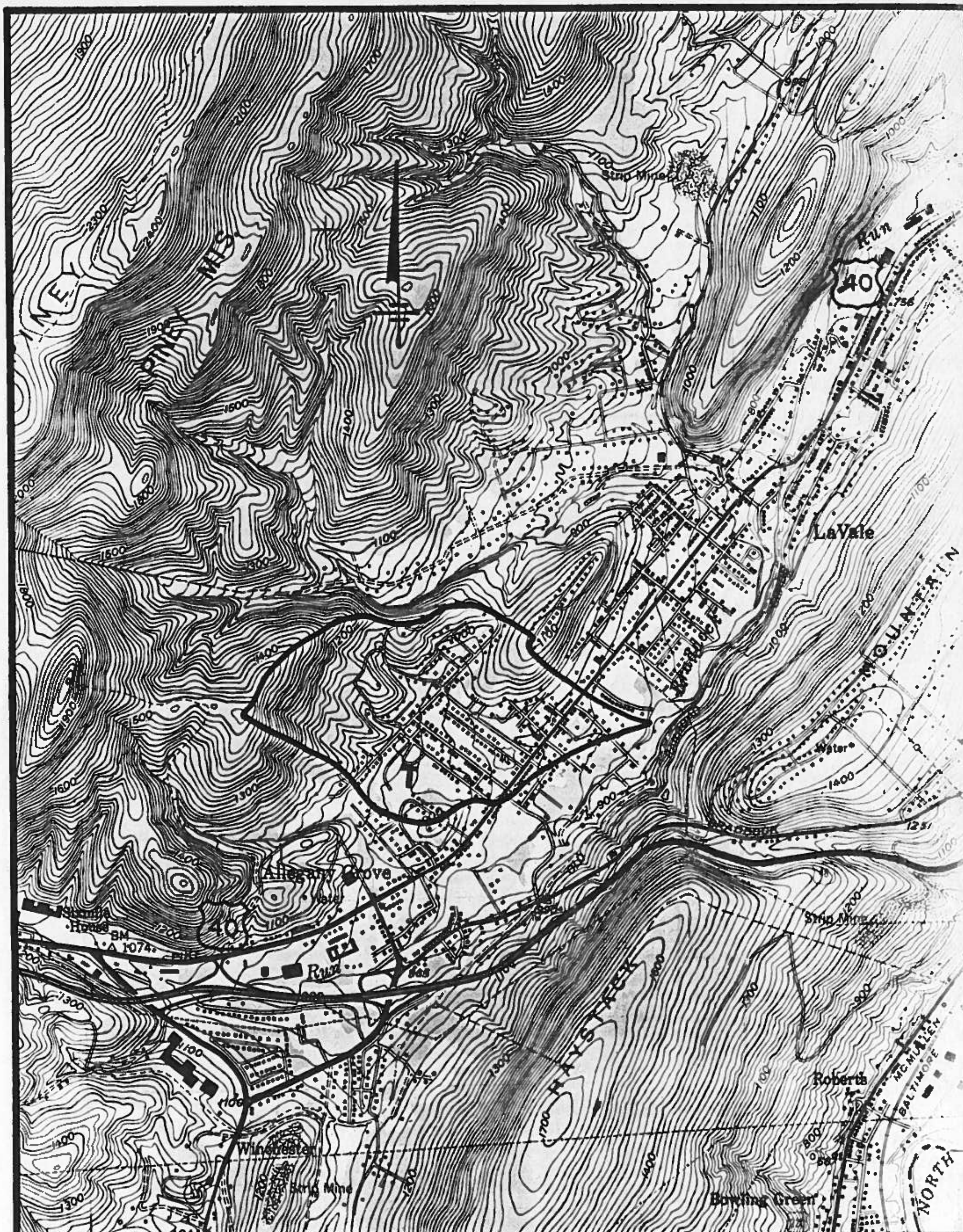
18. U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Analysis of Box Culverts, BPR Program HY-3, Washington, DC, January 1964.

19. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Hydrologic Parameters, HYDPAR Users Manual, November 1978.

20. Maryland Department of Transportation, State Highway Administration, Highway Design Manual, December 1981.

21. Federal Emergency Management Agency, Allegany County, Maryland, Flood Insurancey Study, September 30, 1983.

APPENDIX A - FIGURES



PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202

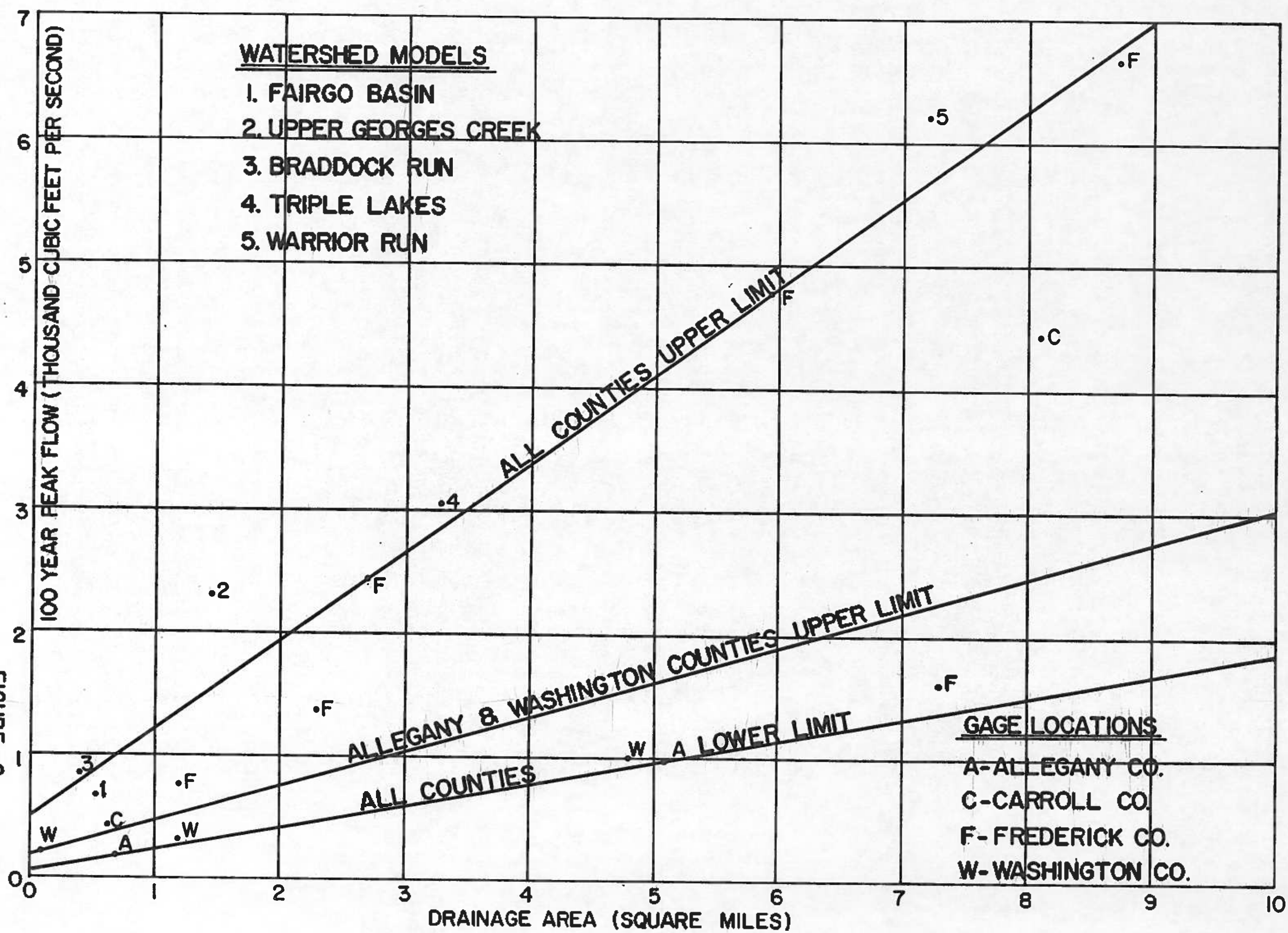
TRIB. TO BRADDOCK RUN
WATERSHED

VICINITY MAP

2000 0 2000

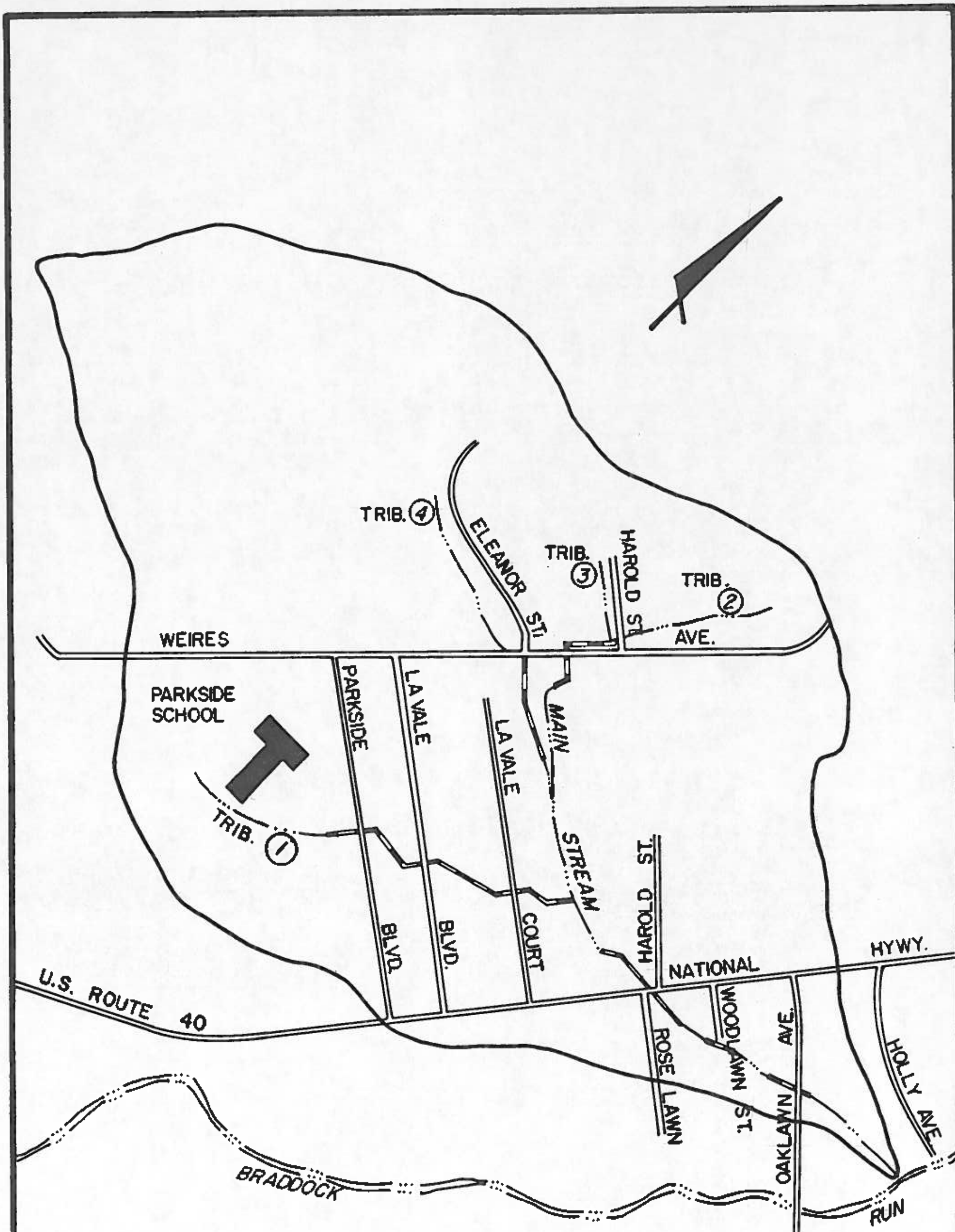
SCALE: 1" = 2000'

FIGURE 1



WATERSHED MODELS
1. FAIRGO BASIN
2. UPPER GEORGES CREEK
3. BRADDOCK RUN
4. TRIPLE LAKES
5. WARRIOR RUN
ALL COUNTIES UPPER LIMIT
ALLEGANY & WASHINGTON COUNTIES UPPER LIMIT
ALL COUNTIES LOWER LIMIT
GAGE LOCATIONS
A-ALLEGANY CO.
C-CARROLL CO.
F-FREDERICK CO.
W-WASHINGTON CO.
100 YEAR PEAK FLOW (THOUSAND CUBIC FEET PER SECOND)
DRAINAGE AREA (SQUARE MILES)

FIGURE 2



LOCATION MAP

TRIBUTARY TO BRADDOCK RUN

FIGURE 3

APPENDIX B - TABLES

TABLE 1- DRAINAGE AREA SUMMARY

TRIBUTARY TO BRADDOCK RUN

Area	Acreage	Existing CN	Ultimate CN	t_c (hrs.)
1.	15.05	79.4	81.9	0.09
2.	8.04	78.0	82.0	0.15
3.	37.05	75.0	79.7	0.23
4.	31.69	74.3	78.5	0.30
5.	33.40	72.2	78.3	0.32
6.	20.41	71.0	76.6	0.08
7.	36.42	73.6	77.8	0.21
8.	65.21	74.1	77.6	0.30
9.	18.75	80.5	85.1	0.31
Total Acreage	267.85			
Weighted CN		74.6	78.9	

TABLE 2-TRIBUTARY TO BRADDOCK RUN

Structure No.	Location	Description	From Surveys	From Field Reconnaissance
	<u>Main Stream</u>			
1	Oaklawn Avenue	36" RCP	X	
2	Station 12+10	36" RCP	X	
3	U.S. Route 40	48" RCP	X	
4	Station 31+90	18" RCP		X
	<u>Tributary No. 1</u>			
5	Station 0+00 to Parkside Blvd.	Culvert Stream 18" RCP		X
	<u>Tributary No. 2</u>			
6	Station 0+70	18" CMP		X
7	Weires Avenue to Harold Street	12" CMP		X
	<u>Tributary No. 4</u>			
8	Weires Avenue	24" RCP		X

TABLE 3

TRIBUTARY TO BRADDOCK RUN

Computed Water Surface
Elevations for Each Cross Section

Q in cfs; WSEL in feet

SECTION	EXISTING DEVELOPMENT CONDITIONS						ULTIMATE DEVELOPMENT CONDITIONS					
	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$
MAIN STEM												
30.0	174	852.9	467	853.5	832	854.0	244	853.1	565	853.7	946	854.2
31.0		859.4		860.2		860.7		859.6		860.3		860.8
31.1		865.1		865.2		865.6		865.0		865.2		865.7
33.1		872.3		872.8		873.2		872.4		872.9		873.2
33.2		873.2		874.6		875.7		873.6		875.1		876.0
33.3		879.0		879.2		879.6		879.0		879.3		879.7
33.4		879.5		880.3		880.9		879.7		880.5		881.0
33.5		882.3		882.9		883.3		882.4		883.0		883.3
34.1	185	882.7	468	883.4	821	883.9	253	882.9	563	883.6	931	884.1
34.2		883.8		884.6		885.1		884.1		884.7		885.2
36.0		885.0		886.5		887.3		885.6		886.8		887.5
36.1		895.0		897.4		898.7		896.0		897.9		898.9
37.0	117	903.4	282	904.1	476	904.6	161	903.8	338	904.3	543	904.7
38.0	87	919.6	210	920.0	360	920.4	113	919.7	249	920.1	405	920.5
38.1		928.8		929.3		929.6		928.9		929.3		929.7

TABLE 3

TRIBUTARY TO BRADDOCK RUN

Computed Water Surface
Elevations for Each Cross Section

Q in cfs; WSEL in feet

SECTION	EXISTING DEVELOPMENT CONDITIONS						ULTIMATE DEVELOPMENT CONDITIONS					
	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$	Q_2	$WSEL_2$	Q_{10}	$WSEL_{10}$	Q_{100}	$WSEL_{100}$
TRIBUTARY NO. 1												
37.1	21	953.0	60	953.6	110	953.8	21	953.0	60	953.6	110	953.8
37.2		969.6		970.1		970.3		969.6		970.1		970.3
TRIBUTARY NO. 2												
38.2	29	958.7	63	959.0	103	959.3	33	958.7	69	959.0	110	959.3
38.3		978.6		978.9		979.2		978.6		979.0		979.2
TRIBUTARY NO. 3												
38.4	37	958.3	86	958.6	142	958.8	37	958.3	86	958.6	154	958.9
38.5		978.8		979.1		979.3		978.8		979.1		979.4
TRIBUTARY NO. 4												
38.6	58	958.0	148	958.3	259	958.5	58	958.0	148	958.3	295	958.6
38.7		983.8		984.2		984.4		983.8		984.2		984.5

BRSUM

TRIBUTARY TO BRADDOCK RUN
TABLE 4 - FLOOD DAMAGE ESTIMATES EXISTING CONDITIONS

ITEMIZED LOSSES	2-YEAR STORM EXISTING CONDITONS	10-YEAR STORM EXISTING CONDITIIONS	100-YEAR STORM EXISTING CONDITIONS
PRIVATE LOSSES			
-STRUCTURES	$ 13,624	$ 16,456	$ 25,439
-CONTENTS	4,871	5,943	17,519
-EXTERIOR PROPERTIES	2,600	5,500	12,750
-VEHICLES	3,000	6,000	12,000
TOTAL PRIVATE LOSSES	$ 24,095	$ 33,899	$ 67,708
PUBLIC LOSSES			
-EMERGENCY POLICE SERVICES	$ 435	$ 435	$ 870
-CITY CLEAN-UP SERVICES	944	944	2208
-UTILITIES REPAIR SERVICES	300	300	600
TOTAL PUBLIC LOSSES	$ 1,679	$ 1,679	$ 3,678
ABSTRACT LOSSES			
-LOST WAGES	$ 960	$ 1,320	$ 3,600
-EXTRA MILEAGE COST	0	0	0
TOTAL ABSTRACT LOSSES	$ 960	$ 1,320	$ 3,600
TOTAL OF ALL LOSSES	$ 26,734	$ 36,898	$ 74,986

AVERAGE ANNUAL DAMAGES = .45(2-YEAR TOTAL)+.245(10-YEAR TOTAL)+.055(100-YEAR TOTAL)= $ 25,195

PRESENT VALUE OF THE AVERAGE ANNUAL DAMAGES(TAKEN FOR 30 YEARS AT AN INTEREST RATE OF 8%)= $ 283,635

BRSUM

TRIBUTARY TO BRADDOCK RUN
TABLE 5- FLOOD DAMAGE ESTIMATES ULTIMATE CONDITIONS

ITEMIZED LOSSES	2-YEAR STORM ULTIMATE CONDITIONS	10-YEAR STORM ULTIMATE CONDITIONS	100-YEAR STORM ULTIMATE CONDITIONS
PRIVATE LOSSES			
-STRUCTURES	$ 14,889	$ 20,277	$ 32,339
-CONTENTS	5,231	9,143	27,919
-EXTERIOR PROPERTIES	2,600	5,500	12,750
-VEHICLES	3,000	6,000	12,000
TOTAL PRIVATE LOSSES	$ 25,720	$ 40,920	$ 85,008
PUBLIC LOSSES			
-EMERGENCY POLICE SERVICES	$ 435	$ 435	$ 870
-CITY CLEAN-UP SERVICES	944	944	2200
-UTILITIES REPAIR SERVICES	300	300	600
TOTAL PUBLIC LOSSES	$ 1,679	$ 1,679	$ 3,670
ABSTRACT LOSSES			
-LOST WAGES	$ 960	$ 1,320	$ 3,600
-EXTRA MILEAGE COST	0	0	0
TOTAL ABSTRACT LOSSES	$ 960	$ 1,320	$ 3,600
TOTAL OF ALL LOSSES	$ 28,359	$ 43,919	$ 92,286

AVERAGE ANNUAL DAMAGES = .45(2-YEAR TOTAL)+.245(10-YEAR TOTAL)+.055(100-YEAR TOTAL)= $ 28,597

PRESENT VALUE OF THE AVERAGE ANNUAL DAMAGES(TAKEN FOR 30 YEARS AT AN INTEREST RATE OF 8%)= $ 321,944

Table 6. FLOOD MANAGEMENT ALTERNATIVES

TRIBUTARY TO BRADDOCK RUN WATERSHED

House ID Code	Basement	100-Year Flood Elevation in Relationship to 1st Floor Elevation	100-Year Flood Depth Around Foundation or Basement Equal To or Greater Than One Foot	ALTERNATIVES				Comments
				Flood Proof	Flood Insur.	Purchase Candidate	Structural Improvements	
A	X	0	-			X	Replace Oaklawn Ave. culvert with two 60" RCP's for the 2-year storm ($106,000). Not economically justified.	
B	X	-3.5	-	X	X			
C	X	-5.5	-	X	X			
D		-						FF above flood elevation
E		0			X		Replace Route 40 culvert with two 48" RCP's for the 2-year storm ($90,000). Not economically justified.	
E-3	X	-4.0	-	X	X			
F		-						FF above flood elevation
G		-						
H		-						Out of flood zone
I		-						Out of flood zone
J		-						Out of flood zone
K		-						Out of flood zone
L		-						Out of flood zone
M		-						Out of flood zone
N		-						Out of flood zone
O		-						Out of flood zone
P		-						Out of flood zone
Q		-						Out of flood zone
R		-						Out of flood zone
S		-						Out of flood zone
D-1		-						FF above flood elevation
D-2		1.0			X			
D-3		-						FF above flood elevation
E-2		-						Out of flood zone
F-1	X	-	-					Basement above flood elevation
F-2	X	-1.5	-	X	X			
F-3	X	-	-					Basement above flood elevation
F-4	X	-2.5	-	X	X			
G-1		-						FF above flood elevation
H-1		-						FF above flood elevation
Tributary No. 1 at Parkside Boulevard		Overland flow in residential areas and down roads					Stormwater management pond ($20,000). Not economically justified.	

APPENDIX C

DAMAGE REFERENCE TABLES

NORTH BRANCH POTOMAC WATERSHED STUDY
FLOOD SURVEY

Name: ____________________ Date: ____________________

Address: ____

City: ______________ State: ________ Zip Code: ________

Phone (Optional): Home: ____________ Work: ____________

Please accept our thanks in advance for taking your time to read and complete this questionnaire.

1. Number of years at present residence? ____ Years

2. What type of house do you live in?

   ___ 1-Story with no basement ___ 1-Story with basement

   ___ 2-Story with no basement ___ 2-Story with basement

   ___ Other - Describe: ____________________

3. Where is your furnace or hot water heater located? ____________________

4. What were the dates and depths of the most severe floods that affected your property?

Date	Depth of Water Outside of House	Depth of Water in Basement	Depth of Water Above First Floor
____Month ____Year	________feet	________feet	________feet
____Month ____Year	________feet	________feet	________feet
____Month ____Year	________feet	________feet	________feet
____Month ____Year	________feet	________feet	________feet

5. Where did the water enter your home? ____________________

   ____

6. Are there visible watermarks from interior flooding? ___ Yes ___ No

   Indicate date. ________ Month ________ Year

   Describe location. ____________________

   ____

NORTH BRANCH POTOMAC WATERSHED STUDY
FLOOD SURVEY

7. Can you indicate a definite water level on the outside of your home or on another landmark? ___ Yes ___ No

   Indicate date. __________ Month _______ Year

   Describe location. ____

   ____

8. Do you have photographs which show the flooding on or around your property? ___ Yes ___ No

   If yes, would you loan these photographs to the Allegany County Commissioners in order that we may reproduce them. ___ Yes ___ No

9. Do you have any other comments or information you can present? _______________________________

   ____

   ____

   ____

   ____

Please return this questionnaire in the enclosed self-addressed, stamped envelope to our consultants:

Purdum and Jeschke
1029 North Calvert Street
Baltimore, Maryland 21202

(Attention: North Branch Potomac Watershed Study)

Table III-2 (Reference 1)
HOME PRICE RANGES

Type of Home	Structural Composition	Foundation Construction	Dwelling Only ($) Low - High
Split Level	Brick	Block	40,000 - 80,000
Split Level	Frame	Block	38,000 - 76,000
Slab on Grade	Brick	N/A	40,000 - 70,000
Slab on Grade	Frame	N/A	38,000 - 66,000
One or Two Story w/Basement	Brick	Block or Stone	32,000 - 80,000
One or Two Story w/Basement	Frame	Block or Stone	30,000 - 76,000
One Story w/o Basement	Brick	Block or Stone	36,000 - 74,000
One Story w/o Basement	Frame	Block or Stone	34,000 - 71,000

Table 2-5 (Reference 2)
RESIDENTIAL CONTENT VALUES

Total Square Footage	Furnishings Value	Content Value
$0 < x \leq 1000$	High	$33,000
	Average	18,100
	Low	10,200
$1000 < x \leq 1500$	High	$37,200
	Average	20,600
	Low	11,100
$1500 < x \leq 2000$	High	$46,400
	Average	25,700
	Low	14,000
$x > 2000$	High	$54,100
	Average	30,000
	Low	16,500

TABLE III-4 (Reference 1)
Numerical Rating Values
Houses Over 25 Years Old
Not Remodeled
Flood Plain Area

Adjustment Factors	Rating			
	Poor	Fair	Good	Excellent
Location	0.00	0.033	0.067	0.10
Quality of Construction	0.00	0.033	0.067	0.10
Condition of House	0.00	0.033	0.067	0.10
	Square Foot Area			
	Small 800 to 999	Sm/Med 1,000 to 1,199	Med/Lge 1,200 to 1,399	Large 1,400 to 1,600+
Size	0-0.06	0.06-0.12	0.12-0.18	0.18-0.24
	Years			
	100+	75-100	50-75	25-50
Age	0.00	0.033	0.067	0.10

TABLE III-5 (Reference 1)
Numerical Rating Values
Houses Less Than 25 Years Old
Or Completely Remodeled Old House
Flood Plain Area

Adjustment Factors	Rating			
	Poor	Fair	Good	Excellent
Location	0.10	0.067	0.033	0.00
Quality of Construction	0.10	0.067	0.033	0.00
Condition of House	0.10	0.067	0.033	0.00
	Square Foot Area			
	Small 800 to 999	Sm/Med 1,000 to 1,199	Med/Lge 1,200 to 1,399	Large 1,400 to 1,600+
Size	0.24-0.18	0.18-0.12	0.12-0.06	0.06-0.00
	Years			
	75-100+	50-75	25-50	New-25
Age	0.10	0.067	0.033	0.00

Table 5

FIA 1974 RESIDENTIAL DAMAGE CURVES
(VALUES IN PERCENT DAMAGE)

	1 1 STORY WITH BASEMENT		2 1 STORY W/O BASEMENT		3 1 1/2 & 2 STORY W/ BASEMENT		4 1 1/2 & 2 STORY W/O BASEMENT	
STAGE	STRUCTURE	CONTENT	STRUCTURE	CONTENT	STRUCTURE	CONTENT	STRUCTURE	CONTENT
-9	0.	0.	0.	0.	0.	0.	0.	0.
-8	0.	0.	0.	0.	0.	0.	0.	0.
-7	1.	1.	0.	0.	1.	1.	0.	0.
-6	3.	2.	0.	0.	2.	2.	0.	0.
-5	4.	3.	0.	0.	3.	3.	0.	0.
-4	5.	4.	0.	0.	4.	4.	0.	0.
-3	6.	5.	0.	0.	5.	5.	0.	0.
-2	7.	7.	0.	0.	6.	6.	0.	0.
-1	8.	8.	0.	0.	7.	9.	0.	0.
0	11.	15.	7.	10.	7.	11.	5.	7.
1	18.	20.	10.	17.	11.	17.	9.	9.
2	20.	22.	14.	23.	17.	22.	13.	17.
3	23.	28.	26.	29.	22.	28.	18.	22.
4	28.	33.	28.	35.	28.	33.	20.	26.
5	33.	39.	29.	40.	33.	39.	22.	32.
6	38.	44.	41.	45.	35.	44.	24.	39.
7	44.	50.	43.	50.	38.	49.	26.	44.
8	49.	55.	44.	55.	40.	55.	31.	50.
9	51.	60.	45.	60.	44.	61.	36.	55.
10	53.	60.	46.	60.	46.	64.	38.	58.
11	55.	60.	47.	60.	48.	71.	40.	65.
12	57.	60.	48.	60.	50.	76.	42.	72.
13	59.	60.	49.	60.	52.	78.	44.	76.
14	60.	60.	50.	60.	54.	79.	46.	79.
15	60.	60.	50.	60.	56.	80.	47.	80.
16	60.	60.	50.	60.	58.	81.	48.	81.
17	60.	60.	50.	60.	59.	81.	49.	81.
18	60.	60.	50.	60.	59.	81.	49.	81.
19	60.	60.	50.	60.	59.	81.	49.	81.
20	60.	60.	50.	60.	59.	81.	49.	81.
21	60.	60.	50.	60.	59.	81.	49.	81.
22	60.	60.	50.	60.	59.	81.	49.	81.
23	60.	60.	50.	60.	59.	81.	49.	81.
24	60.	60.	50.	60.	59.	81.	49.	81.
25	60.	60.	50.	60.	59.	81.	49.	81.
26	60.	60.	50.	60.	59.	81.	49.	81.
27	60.	60.	50.	60.	59.	81.	49.	81.
28	60.	60.	50.	60.	59.	81.	49.	81.
29	60.	60.	50.	60.	59.	81.	49.	81.
30	60.	60.	50.	60.	59.	81.	49.	81.

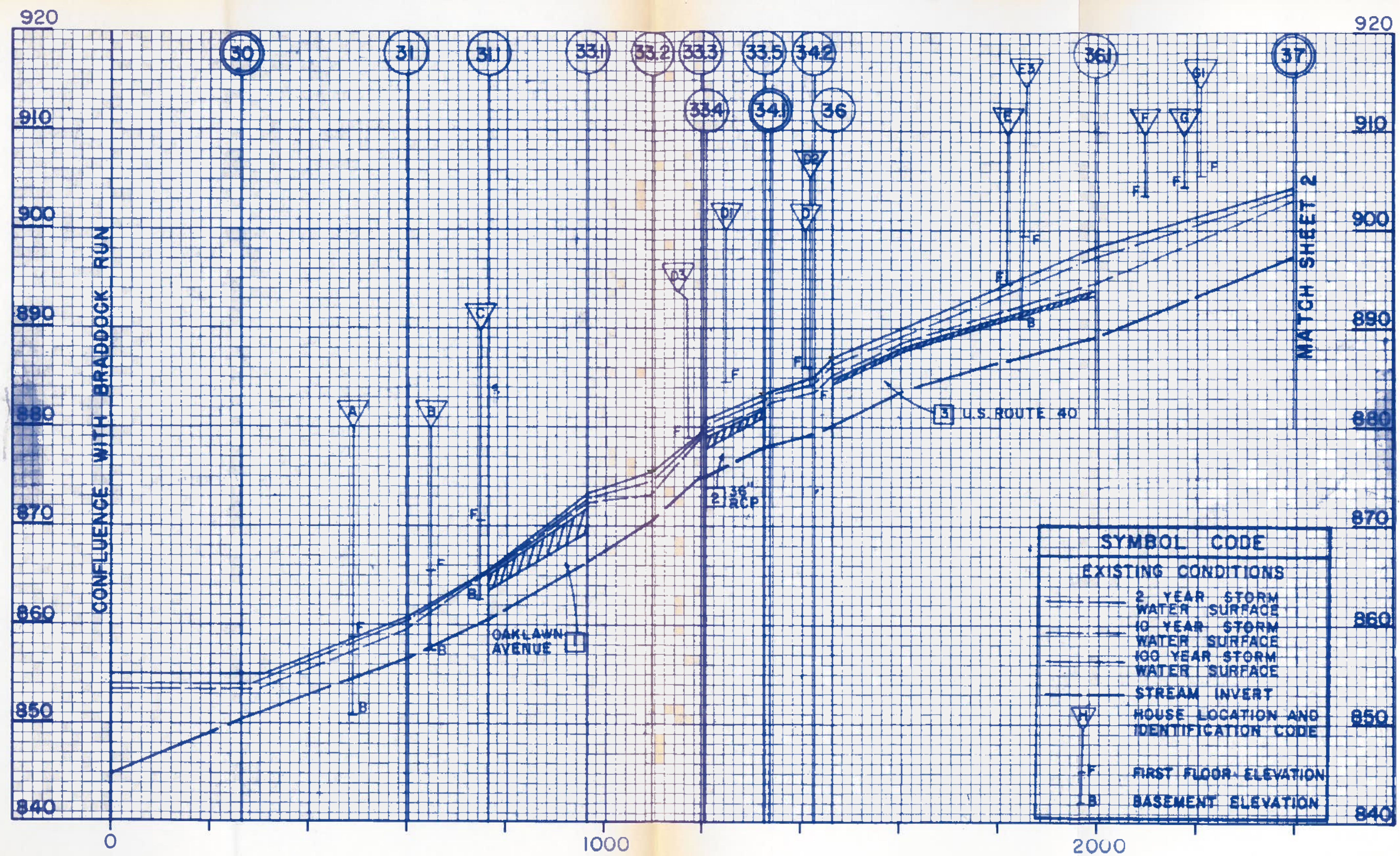
Table 5

FIA 1974 RESIDENTIAL DAMAGE CURVES
(VALUES IN PERCENT DAMAGE)

	5		6		7	
	SPLIT LEVEL W/ BASEMENT		SPLIT LEVEL W/O BASEMENT		TRAILERS	
STAGE	STRUCTURE	CONTENT	STRUCTURE	CONTENT	STRUCTURE	CONTENT
-9	0.	0.	0.	0.	0.	0.
-8	0.	0.	0.	0.	0.	0.
-7	1.	1.	0.	0.	0.	0.
-6	2.	2.	0.	0.	0.	0.
-5	2.	4.	0.	0.	0.	0.
-4	3.	6.	0.	0.	0.	0.
-3	3.	8.	0.	0.	0.	0.
-2	4.	10.	0.	0.	0.	0.
-1	5.	15.	0.	0.	0.	0.
0	6.	18.	3.	2.	8.	0.
1	16.	31.	9.	19.	45.	20.
2	19.	44.	13.	32.	64.	50.
3	22.	52.	25.	41.	74.	60.
4	27.	58.	27.	47.	79.	70.
5	32.	61.	28.	51.	80.	73.
6	35.	63.	33.	53.	81.	76.
7	36.	64.	34.	55.	82.	79.
8	44.	66.	41.	56.	82.	82.
9	48.	69.	43.	62.	82.	85.
10	50.	73.	45.	69.	82.	85.
11	52.	76.	46.	75.	82.	85.
12	54.	79.	47.	78.	82.	65.
13	56.	80.	48.	80.	82.	65.
14	58.	80.	49.	81.	82.	65.
15	59.	80.	50.	81.	82.	65.
16	60.	80.	50.	81.	82.	65.
17	60.	80.	50.	81.	82.	85.
18	60.	80.	50.	81.	82.	65.
19	60.	80.	50.	81.	82.	65.
20	60.	80.	50.	81.	82.	65.
21	60.	80.	50.	81.	82.	65.
22	60.	80.	50.	81.	82.	65.
23	60.	80.	50.	81.	82.	65.
24	60.	80.	50.	81.	82.	65.
25	60.	80.	50.	81.	82.	65.
26	60.	80.	50.	81.	82.	65.
27	60.	80.	50.	81.	82.	65.
28	60.	80.	50.	81.	82.	65.
29	60.	80.	50.	81.	82.	85.
30	60.	80.	50.	81.	82.	65.

APPENDIX D

WATER SURFACE PROFILES



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

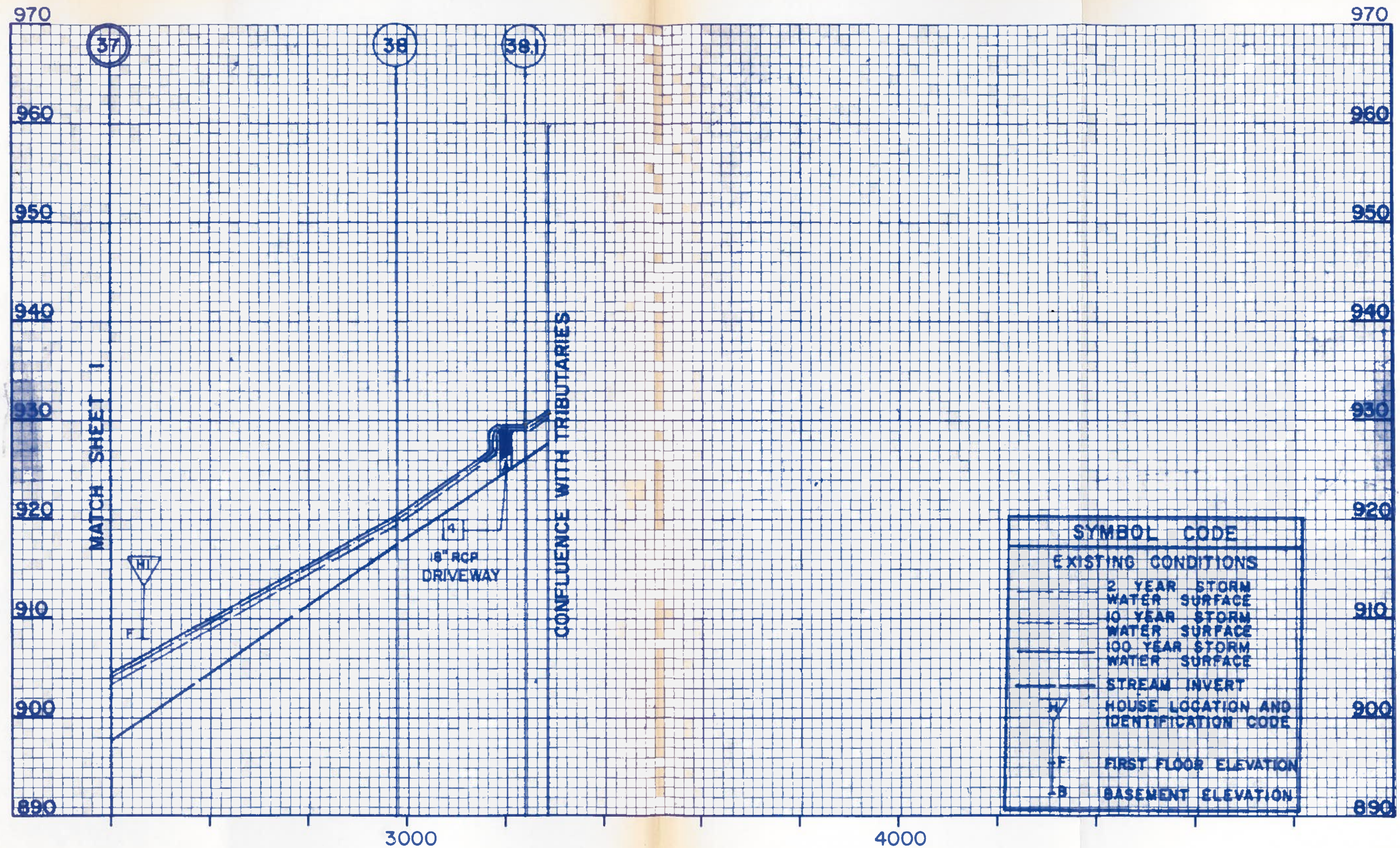
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1" = 200'
VERTICAL : 1" = 10'

STREAM PROFILE
TRIBUTARY TO BRADDOCK MAIN STREAM

SHEET NO. 1 OF 2



PURDUM & JESCHKE
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LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

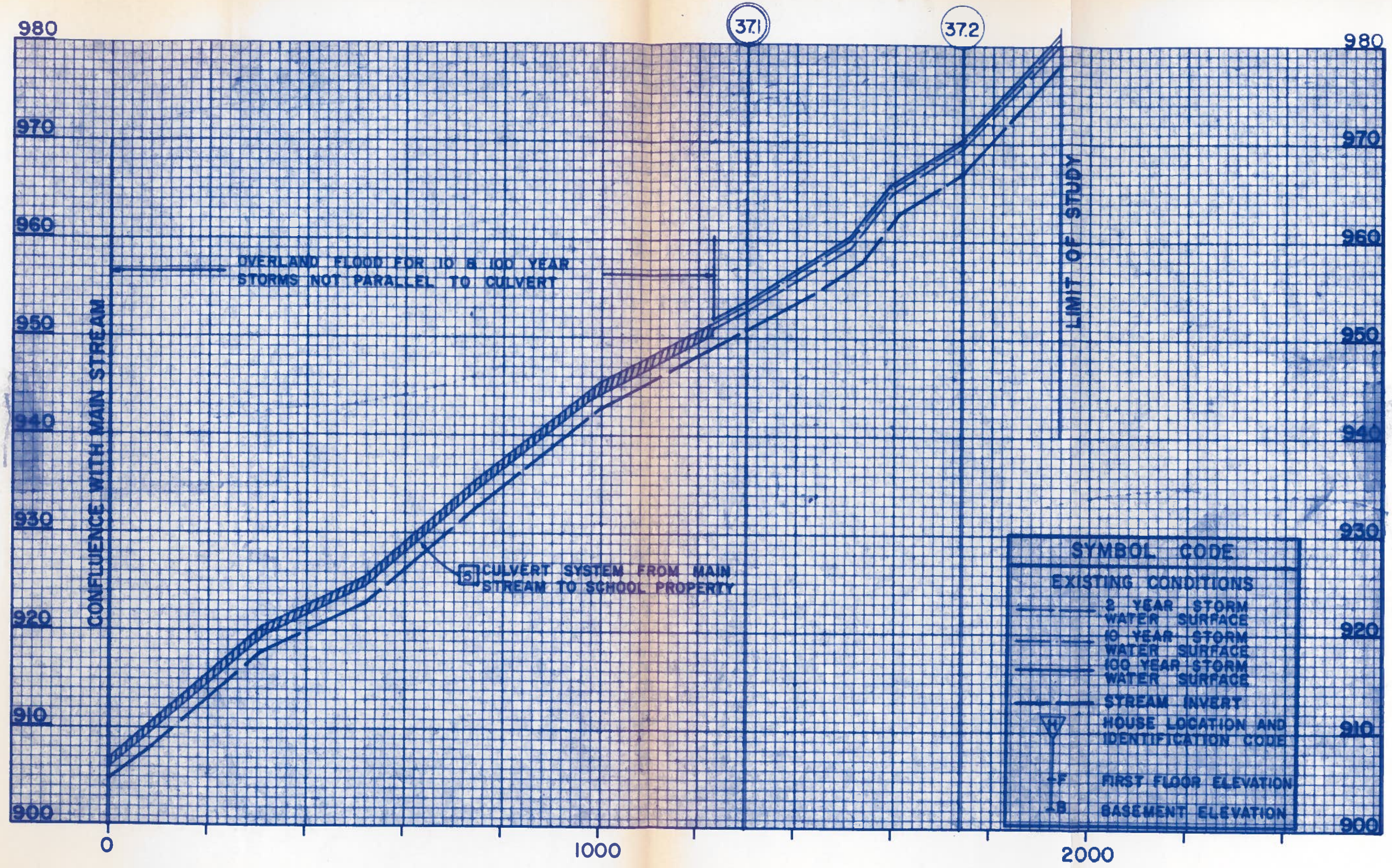
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1" = 200'
VERTICAL : 1" = 10'

STREAM PROFILE
TRIBUTARY TO BRADDOCK MAIN STREAM

SHEET NO. 2 OF 2



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

4.0 CROSS SECTION NUMBER AND LOCATION

3 STRUCTURE NUMBER

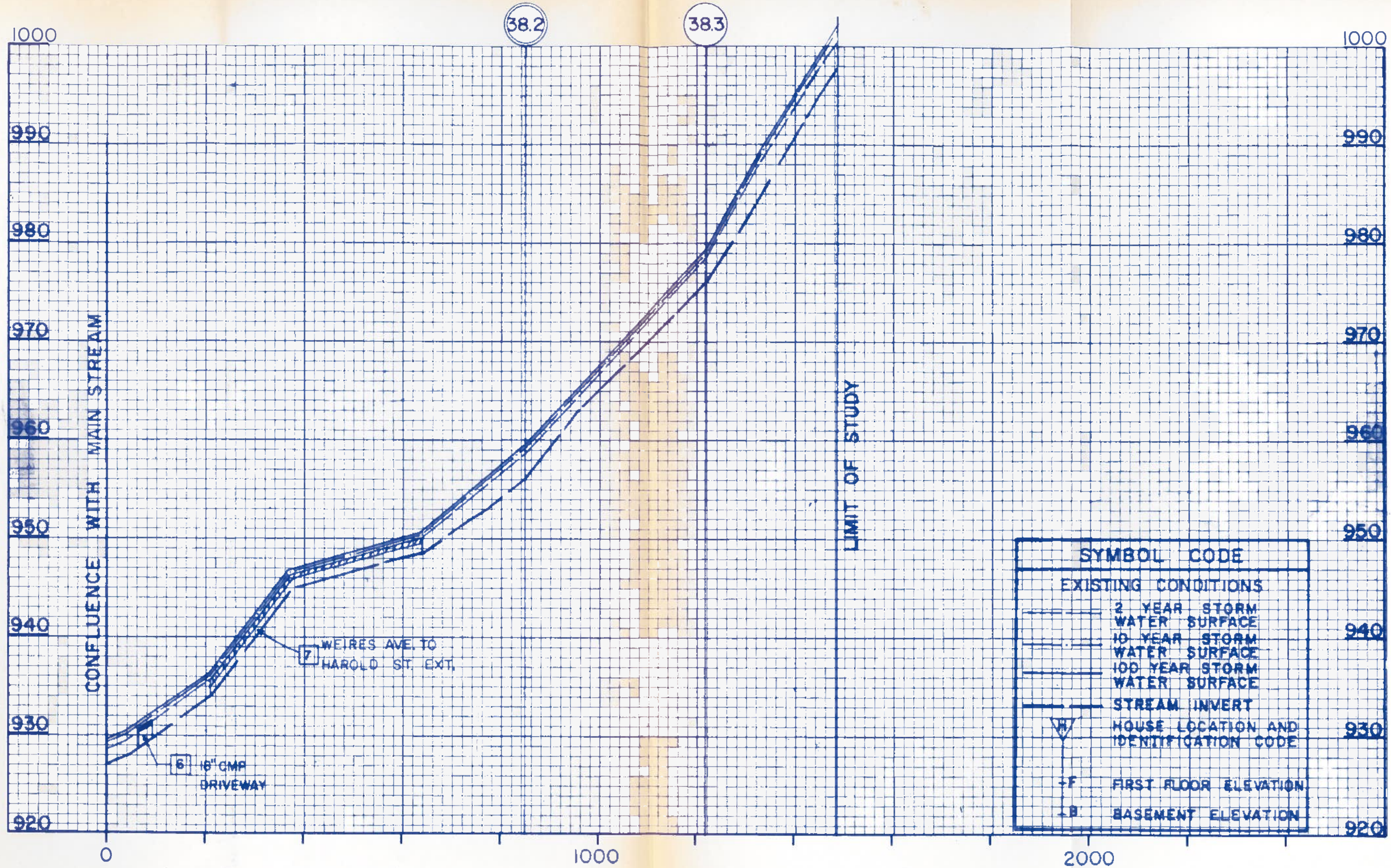
4.0 CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1"=200'
VERTICAL : 1"=10'

STREAM PROFILE

TRIBUTARY TO BRADDOCK TRIBUTARY NO. 1

SHEET NO.
1 OF 1



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LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

[3] STRUCTURE NUMBER

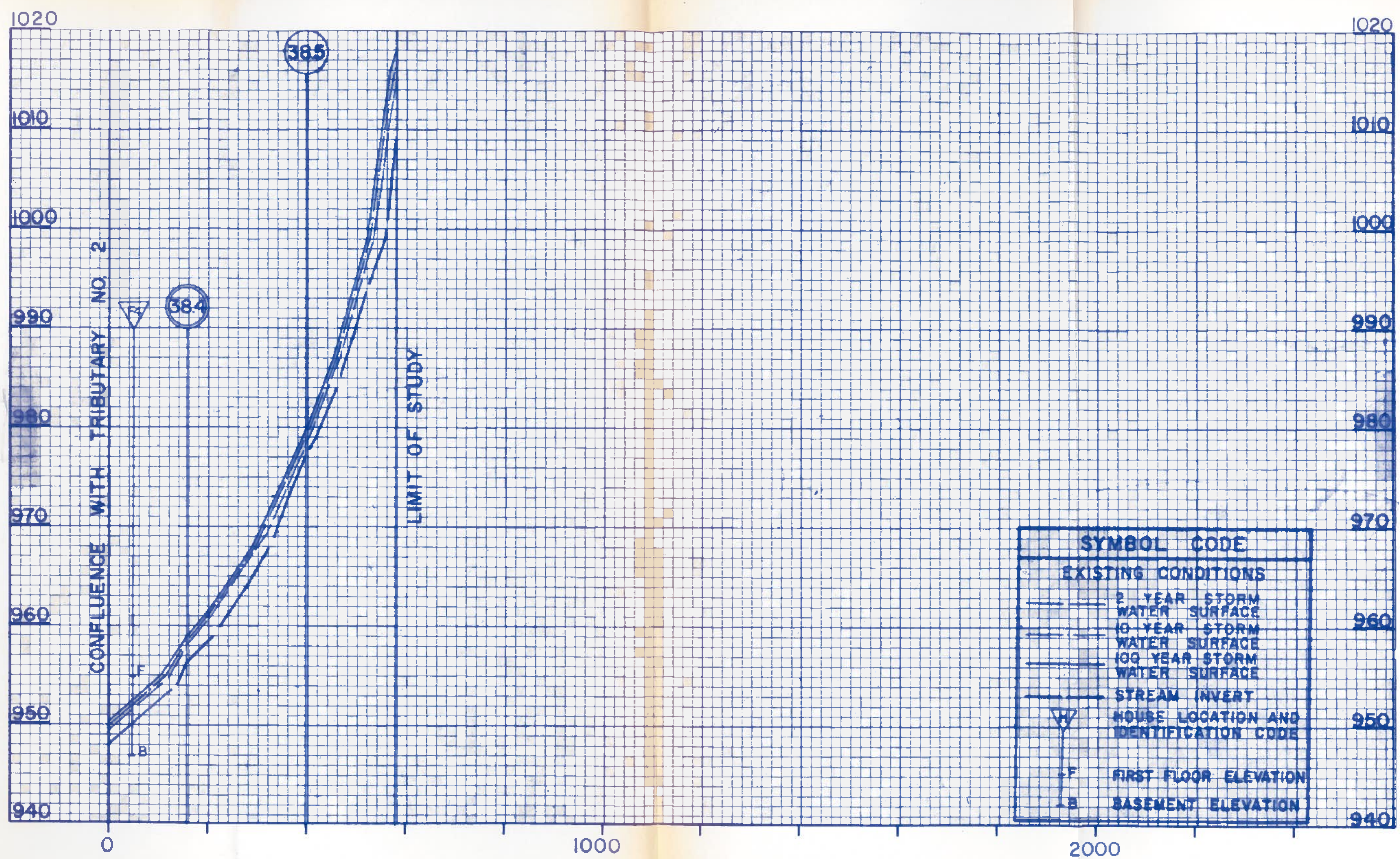
(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1" = 200'
VERTICAL : 1" = 10'

STREAM PROFILE

TRIBUTARY TO BRADDOCK TRIBUTARY NO. 2

SHEET NO. 1 OF 1



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LAND SURVEYORS

LEGEND

4.0 CROSS SECTION NUMBER AND LOCATION

3 STRUCTURE NUMBER

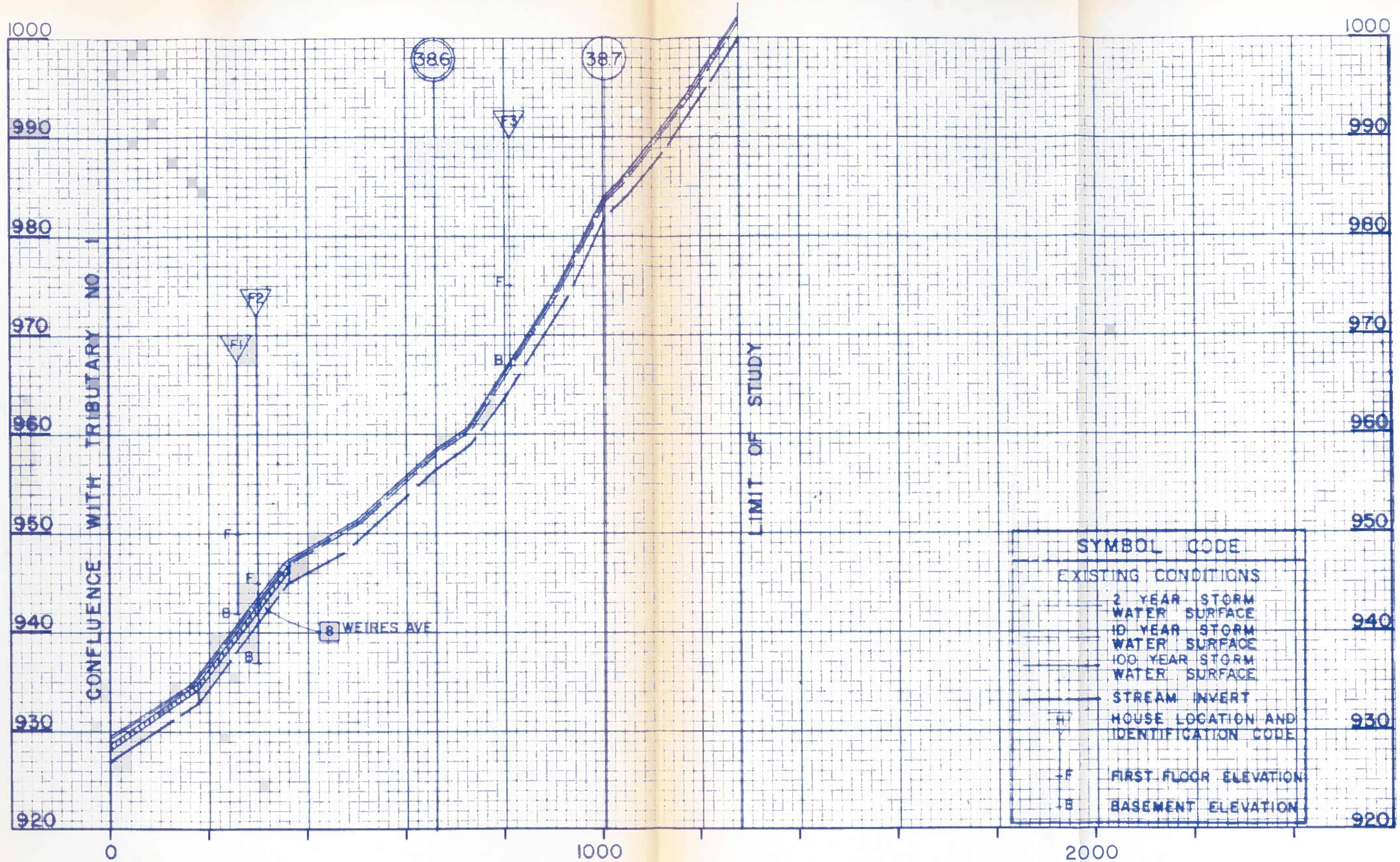
4.0 CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1"=200'
VERTICAL : 1"=10'

STREAM PROFILE

TRIBUTARY TO BRADDOCK TRIBUTARY NO. 3

SHEET NO. 1 OF 1



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LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

SCALE
HORIZONTAL : 1"=200'
VERTICAL : 1"=10'

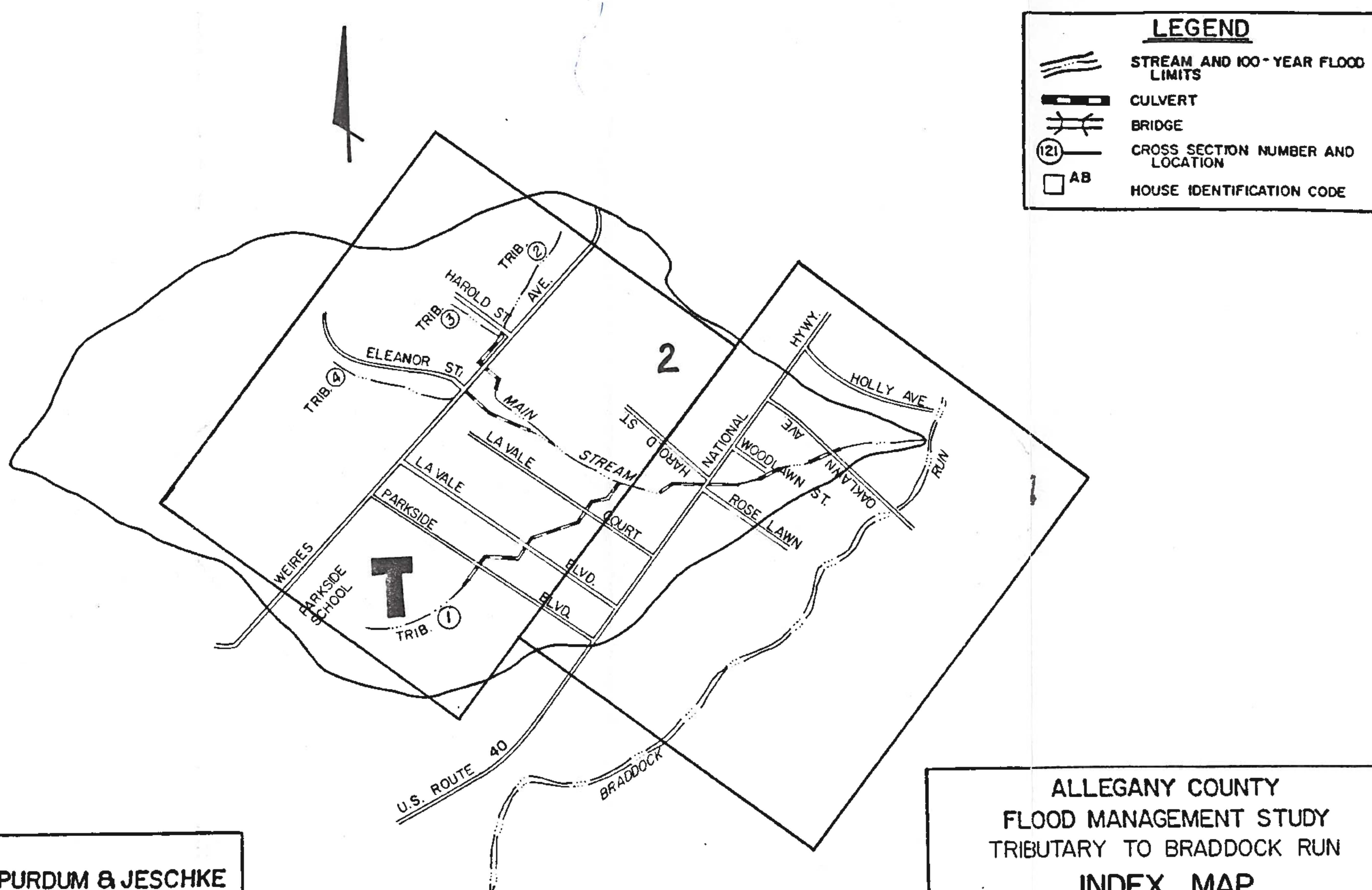
STREAM PROFILE

TRIBUTARY TO BRADDOCK TRIBUTARY NO. 4

SHEET NO. 1 OF 1

APPENDIX E

100-YEAR FLOOD DELINEATION



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AND
LAND SURVEYORS

ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY
TRIBUTARY TO BRADDOCK RUN
INDEX MAP
LIMITS OF 100-YEAR FLOOD
ULTIMATE DEVELOPMENT

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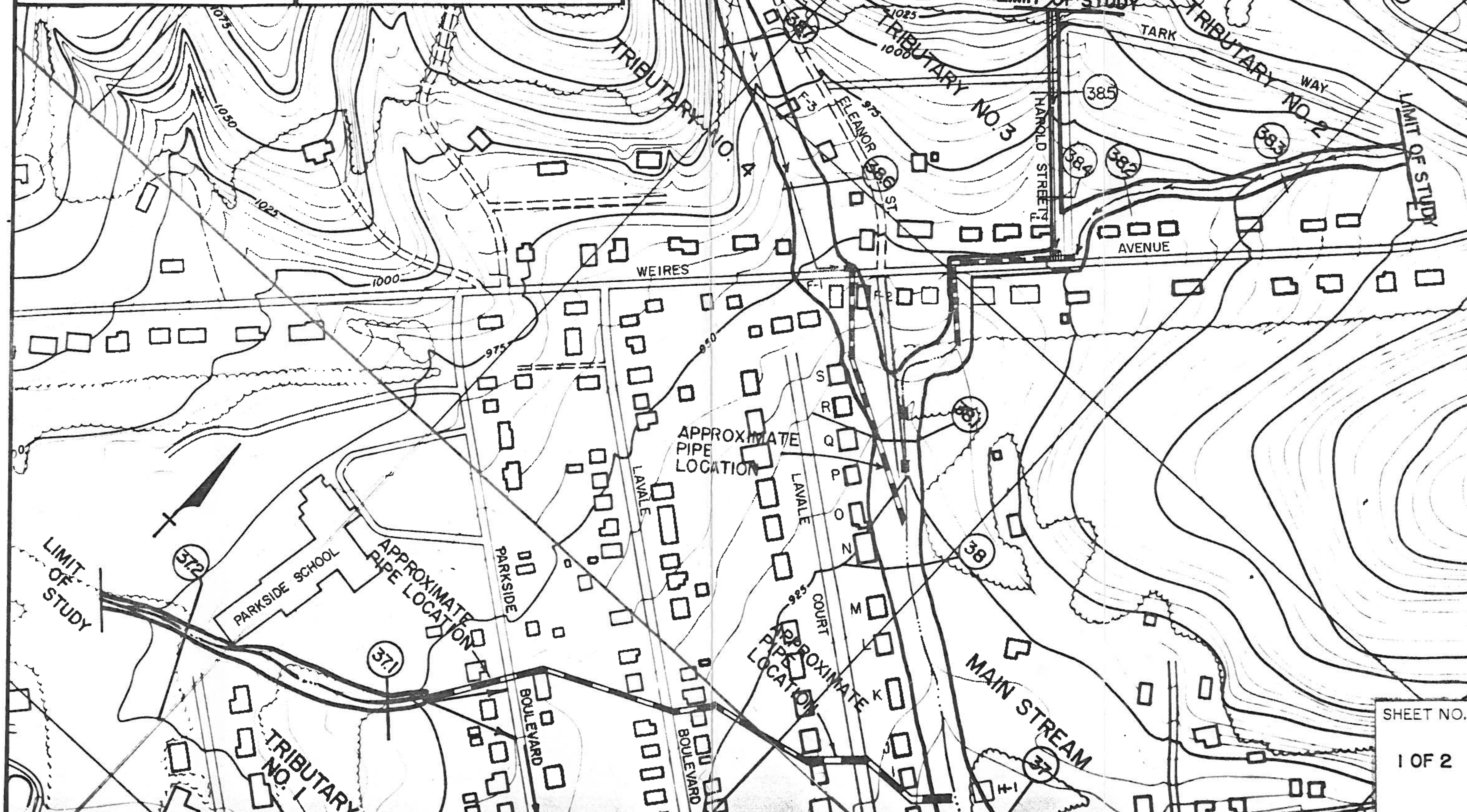
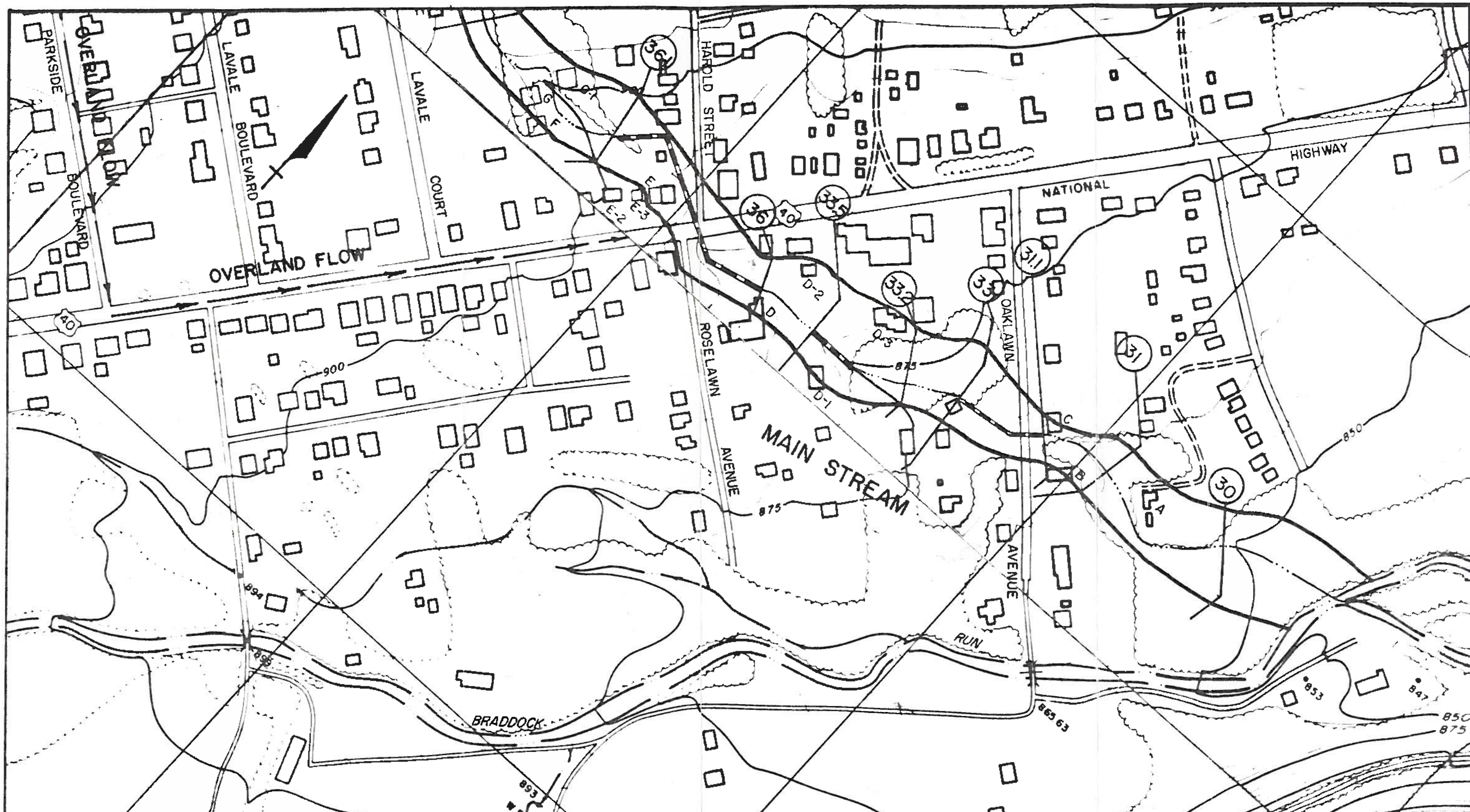
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202

TRIBUTARY TO BRADDOCK RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT

200 100 0 200
SCALE: 1" = 200'



SHEET NO.
1 OF 2



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BALTIMORE, MARYLAND 21202

TRIBUTARY TO BRADDOCK RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT

200 100 0 200
SCALE: 1" = 200'

SHEET NO.
2 OF 2