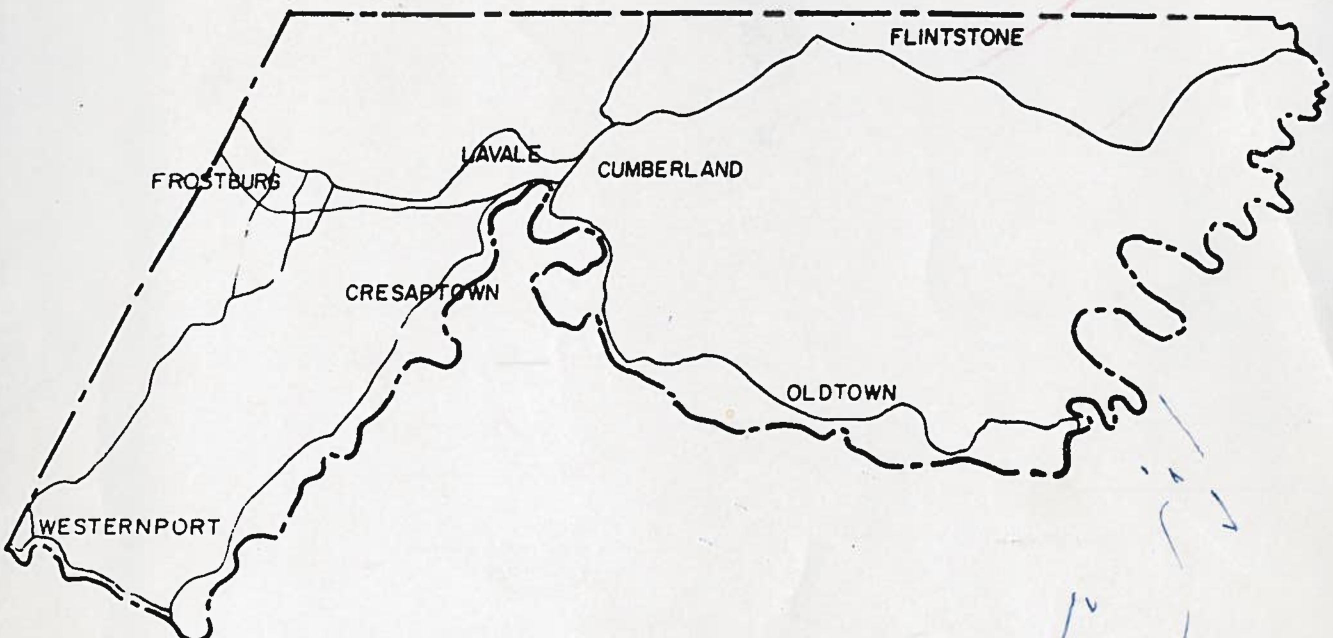
ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY
WARRIOR RUN



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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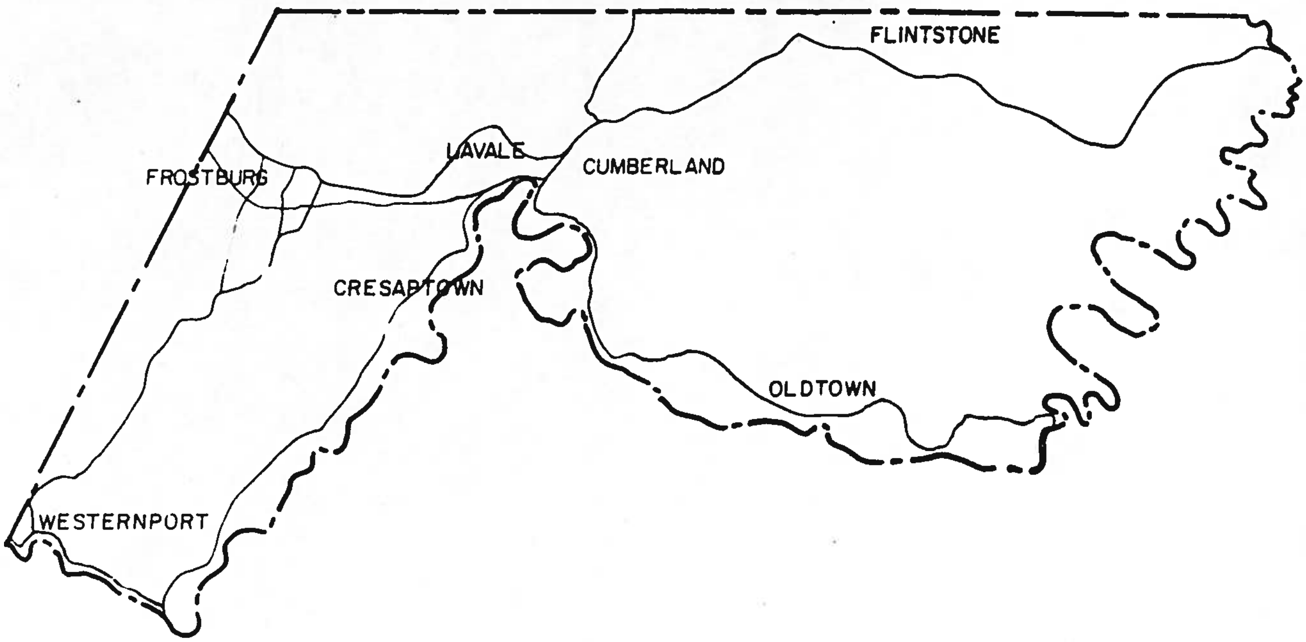

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September 30, 1986

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

Subject: Allegany County Flood Management Study
Warrior Run Watershed

Dear Mr. Bond:

We are pleased to submit herewith the final copies of the Warrior 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., P.E.
Partner

CGW/jm
Attachment

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

ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY

WARRIOR RUN WATERSHED

Table of Contents

WARRIOR RUN WATERSHED

Table of Contents (continued)

ALLEGANY COUNTY

FLOOD MANAGEMENT STUDY

WARRIOR 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 Warrior 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" = 1,000' 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 Warrior 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 Warrior Run drainage area is approximately 4,603 acres in size and is shown in Figure 1, Vicinity Map, Appendix A. The confluence of Warrior Run and the North Branch Potomac River, east of U.S. Route 220, is the southeastern boundary of the watershed. The eastern boundary extends into the Haystack Mountains. The boundaries to the north and west are in the Dans Mountains. The drainage area extends south through Cresaptown to a boundary at Brant Road.

B. SUBBASINS

The total drainage area of the Warrior Run is divided into 42 subbasins ranging from 1 acre to 455 acres, with 110 acres the average size. Subbasins are delineated so that stream flow rates can be computed to design points in the main channel and tributary. These design points are defined at changes in channel characteristics, bridges and culverts, road crossings, and at branch tributaries.

C. SOILS

Soil Conservation Service (SCS) Hydrologic Soil Groups A, B, C, and D occur in the Warrior Run drainage area. Sixty-four percent of the watershed contains Type C soil which has a low infiltration rate and a high runoff potential. Group B, which occurs in approximately 27 percent of the area, has a moderate infiltration rate and a correspondingly moderate storm water runoff rate. Soil Type A, with a high infiltration rate and low runoff potential, occurs in seven percent of the watershed. Soil Type D, covering only one percent of the watershed, has the lowest infiltration rate and highest runoff potential.

D. SLOPE

The watershed slopes vary considerably, ranging from one percent in low-lying areas near the main stream to ten percent in hilly areas and as high as 46 percent in wooded, mountainous regions.

E. LAND USE AND ZONING

The existing land use of the watershed was determined from field reconnaissance, aerial photographs, and existing topographic mapping. Wooded area comprises 71 percent of the watershed, located in the western section and east of Route 53. The southern part of the watershed consists of meadow and pastureland, which makes up 11 percent of the land area. The remaining 12 percent is residential and rural residential, located adjacent to the main roads.

The current zoning maps indicated that 71 percent of the watershed is zoned for residential or rural residential use. Twenty-one percent is zoned for agriculture and conservation. The remaining eight percent is zoned for business and industry.

IV. FIELD INVESTIGATION

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

A. HYDRAULICS OF DESIGNATED STREAM REACHES

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

B. DETERMINATION OF MANNING'S ROUGHNESS COEFFICIENTS

The main stream and 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 recorded 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 roughness coefficients 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 tributary 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 Warrior Run watershed the main stream and Tributaries No. 1, 3, and 4B were 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 Warrior Run watershed, Tributaries No. 2, 4A, 5, and 5A 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 25 percent response from the questionnaires distributed. No first floor flooding was reported by any of the responses but some basement flooding was reported.

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 Warrior Run watershed, a cell size of 100 feet by 100 feet (0.23 ac.) was selected as an appropriate size for calculation of hydrologic parameters for subbasins as small as one acre. 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 Allegany County 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 Warrior 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 Warrior Run watershed is shown as Point Number 3 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.

The flows from the TR-20 model were also compared to the flows from the Allegany County Flood Insurance Study prepared by the Federal Emergency Management Agency (FEMA). The flows from the TR-20 model are higher than those generated in the FEMA study.

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

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

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.

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 and Tributaries No. 1, 3, and 4B of Warrior Run meet 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. The main stream church culvert and Structures 8, 9, 11, 14, and 15 along Tributary No. 1 were modeled by the normal bridge method. The normal bridge routine was used to model all culverts along Tributary No. 3 and Tributary No. 4B. The remaining five main stream culverts were modeled with the special bridge method as were the remaining five Tributary No. 1 culverts.

VI. STREAM STUDY REACHES

A. DESCRIPTION OF STREAM STUDY REACHES

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

1. Main Stream

The Warrior Run main stream begins at a confluence with Tributaries No. 1 and 5, approximately 550 feet north of the Warrior Drive and Route 53 intersection. The stream flows southward and has culvert crossings at Route 53 and the west side of Warrior Drive. The main stream then heads northeasterly, with underground crossings at the east side of Warrior Drive at the church along Route 220 and at Route 220. Open channel flow continues through a park east of Darrows Lane. The stream then has two B & O Railroad crossings before reaching its confluence with the North Branch of the Potomac River. The main stream is approximately 7,690 feet long, with a slope of 1.5 percent. Overbank areas consist of heavy brush and trees.

2. Tributary No. 1

Tributary No. 1 flows adjacent to Winchester Road for most of its length. The study reach originates northwest of Center Road. A pipe system exists at Center Road. The underground flow extends past Fritz Drive. The stream then flows in a southeasterly direction through a trailer park and a culvert crossing at Winchester Road. After flowing along the east side of the road for a stretch, Tributary No. 1 crosses under Winchester Road again. Open channel flow continues through the Trade Winds Trailer Park. The stream has a culvert crossing at Craddock Road and then reaches its junction with the main stream and Tributary No. 5. Tributary No. 1 is 8,710 feet in length. The slope of the channel is 2.7 percent. Overbank areas consist of high grass and heavy brush.

3. Tributary No. 2

Tributary No. 2 begins approximately 600 feet north of Briarwood Drive. It originates as swale flow in the foothills. The tributary becomes roadside ditch flow as it enters Oakwood Estates. The ditch flow is adjacent to Briarwood Drive with driveway culvert crossings. It runs parallel to Sobil Drive, turns south along Hilltop Drive, and then flows along Fritz Drive to Route 53. The flow is adjacent to Route 53 down to the confluence with Tributary No. 1 but does not follow a specifically definable path. There is a stormwater management pond west of Sobil Drive with an outlet structure that discharges to the ditch along Sobil Drive. Tributary No. 2 has a length of approximately 1,910 feet and a slope of 7.4 percent. The overbank areas consist of lawns and grass.

4. Tributary No. 3

Tributary No. 3 begins approximately 2,400 feet west of Winchester Road and flows in an easterly direction adjacent to Fir Tree Lane. It has culvert crossings at Redwood and Spruce Streets (dirt roads) and at Fir Tree Lane. The stream is piped for a stretch just west of Route 53 and then crosses in a culvert under the state road. Tributary No. 3 resumes open channel flow to its confluence with the main stream. The stream study reach is 2,480 feet long. The channel slope is 3.1 percent. Overbanks consist of heavy brush areas with lawns and grass along Fir Tree Lane.

Two drainways flow from Brant Road to Tributary No. 3. One originates as a swale west of Illinois Avenue. The other begins west of the Connecticut Street and Brant Road intersection.

5. Tributary No. 4A

Tributary No. 4A originates west of Howard Street, southwest of the Warrior Drive and Route 220 intersection. The stream flows in a northeasterly direction and has culvert crossings at Howard and Wood

Streets. It enters a pipe system west of Oakwood Avenue and extends along Meadow View Drive. Breaking away from Meadow View Drive, the system opens to ditch flow toward Darrows Lane. The stream has a culvert crossing under Darrows Lane and then flows through a park, where it joins the main stream. Tributary No. 4A is approximately 2,260 feet in length with an average slope of 1.7 percent. Overbank area consist of lawns and grass.

6. Tributary No. 4B

Tributary No. 4B originates at the west end of Florida Avenue. The flow is overland toward Connecticut Avenue and along the road. Swale flow begins west of the intersection of Lone Oak Street and Route 220. From a culvert crossing under Route 220 the stream flows in a northeasterly direction. It flows adjacent to Grant Street and enters a pipe system that crosses Winchester Road. After a short stretch of open channel flow, the stream is piped underground along Main Street and then across under the street. The stream enters a culvert to cross Route 220 and then joins with the main stream. The length of Tributary No. 4B is approximately 3,540 feet, and the slope of the channel averages 2.8 percent. The overbank areas consist of grass and lawns.

7. Tributary No. 5

The Tributary No. 5 study reach begins adjacent to a dirt road that extends from Craddock Road. The stream flows on the west side of the dirt road for a short stretch and then crosses in a culvert to the east side. It flows alongside the dirt road and then adjacent to Craddock Road. Open channel flow continues to its confluence with Tributary No. 1 and the main stream, with culvert crossings at Craddock Road, another dirt road, and Seasons Avenue. The Tributary No. 5 study reach is approximately 4,000 feet in length with a slope of three percent. Overbank areas consist of heavy brush and trees.

8. Tributary No. 5A

The Tributary No. 5A study reach begins just upstream of a double bridge crossing under McDonald Road southwest of Craddock Road. The stream flows adjacent to McDonald Road for a stretch and then crosses the road in a culvert to join Tributary No. 5 just south of the McDonald Road and Craddock Road intersection. The Tributary No. 5A study reach is approximately 2,120 feet long. The slope of the channel is 2.7 percent. Overbank areas consist of heavy brush and trees.

B. MANNING'S ROUGHNESS COEFFICIENT

Manning's roughness 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

Forty-one 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 Warrior Run 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 Stream

The 100-year flood zone for the Warrior Run main stream averages 220 feet in width from the confluence with its tributaries to the area south of Warrior Drive. Overtopped culverts at Route 53 and Warrior Drive are included in this flood zone. There are 19 houses in this section of the floodplain. Nine of these houses experience first floor flooding (Houses CX, CY, CZ, DA, DB, DB-1, DC, CW, and CV-2). Nine houses have basement flooding (Houses DY-1, DY-2, DY-3, CV, CV-1, CV-3, CV-4, CV-5, and EH). Flooding at these 18 homes is caused by the rise in elevation of the stream above channel banks. One house (CV-3A) is above flood elevations.

The flood zone expands to an average of 350 feet in width downstream of the confluence with Tributary No. 4B to the east Warrior Drive culvert. In this floodplain section there are eight houses that experience first floor flooding (Houses CP-1, CM, CNO, CL, CQ, CR, CS, and CS-1), and four houses with basement flooding (Houses CP, CT, CU, and CV-6). The 100-year flood elevations near these houses are increased by the backwater at the undersized Warrior Drive culvert.

From the Warrior Drive culvert to the main stream confluence with Tributary No. 4A, the floodplain averages 250 feet in width. The Route 220 culvert in this flood zone area is overtopped. There are eight houses with first floor flooding (Houses CK, CF, CG, CH, CD, CD-1, CD-3, and CE) and two houses with basement flooding (Houses CI and CJ).

Downstream of Tributary No. 4A to the confluence with the North Branch Potomac River, the floodplain expands to an average of 1,400 feet. The flooding overtops the two railroad culverts and submerges the fly-ash lagoon. There are no houses in this section of the floodplain.

2. Tributary No. 1

The 100-year flood zone for Tributary No. 1 from the limit of study at Mount Royal Road to Winchester Road averages 70 feet in width. Culverts at Center Road, Trescher Drive, and the trailer park road are all overtopped. There are two houses that receive flood damage, one with first floor flooding (House DM), and the other with basement flooding (House DL).

For the Tributary No. 1 stretch along Winchester Road, between the two Winchester Road culvert crossings, the floodplain width averages 200 feet. The Winchester Road culverts are overtopped, and there are two houses in this flood zone. Houses DJ and DK receive first floor flooding

The remaining section of Tributary No. 1 which extends to the confluence with the main stream has a floodplain with an average width of 300 feet. This section of the stream flows through a trailer park, and 39 trailers are flooded by 100-year elevations (Trailers DH, DI, and DG are shown). One house is subject to first floor flooding (House DD-13), and two houses have basement flooding (Houses DE and DF).

3. Tributary No. 2

The Tributary No. 2 flood zone averages 50 feet in width in the wooded highlands. At Briarwood Drive the flood zone is 100 feet wide and includes flow on and alongside the road. At Sobil Drive, the floodplain continues south as a 100-foot wide zone extending down to Tributary No. 1 near Fritz Drive and Center Road. The stormwater management pond at the end of Sobil Drive also overflows to Tributary No. 1 during the 10 and 100-year storms. The culvert at Fritz Drive is overtopped during the 100-year storm. The ditch flow along Sobil Avenue, Hilltop Drive, and

Fritz Drive have a 40-foot wide flood zone, which includes flow on the roads. A floodplain down Route 53 to Tributary No. 1 was not delineated since the flow does not follow a specifically definable path. There are no houses subjected to flood damage due to the 100-year flooding of Tributary No. 2.

4. Tributary No. 3

The flood zone for Tributary No. 3, from the limit of study to the area of the first culvert, is approximately 70 feet wide. There are no houses in this reach. The remaining flood zone has an average width of 100 feet. All five culverts along this stretch of stream are overtopped by the 10 and 100-year storms. There are two houses in this floodplain. One house experiences basement flooding (House DY), and one house has first floor flooding (House DX-1). There are three more houses in the floodplain, but these have first floors above flood elevations.

There is no flood zone defined for the drainways. Water that does not follow these flow paths will travel overland as sheet flow toward Tributary No. 3. There are no flooded homes in this reach.

5. Tributary No. 4A

The flood zone at the origin of Tributary No. 4A is 50 feet wide, and the 10 and 100-year storms overtop the Howard Street culvert. At Wood Street the culvert is overtopped for the 10 and 100-year storms. The flood zone expands to 200 feet in width at this point flooding Meadow View Drive. There are five houses in this floodplain section. Two houses have first floor flooding (Houses EI-2 and EI-4), and three houses have basement flooding (Houses EI-3, EI-5, and EI-10). The flood zone then recedes to 60 feet in width. The pipe system along Meadow View Drive undersized. Six homes are flooded here. Four of the houses receive basement flooding (Houses EJ-1, EJ-2, EI-7 and EI-9), and one house has first floor flooding (House EI-6). The remaining house is above flood elevations. As the tributary returns to open channel flow, the floodplain averages 100 feet in width to the confluence with the main stream. The Darrows Lane culvert is overtopped. There is one house (EJ-4) which is flooded at Darrows Lane.

6. Tributary No. 4B

The Tributary No. 4B floodplain is approximately 40 feet wide from its swale flow origin to the developed area southwest of Lee and Grant Streets. There are no flooded houses in this reach. The remainder of Tributary 4B from behind Grant Street, across Winchester Road and Main Street to the confluence with the main stream, averages 100 feet in width. All four culvert are overtopped by the 100-year storm. There are six houses in the 100-year flood zone in this reach. Four houses receive basement flooding (Houses FB, ES, EM, and EH-1), and two houses are above flood elevations (Houses ER and EJ).

7. Tributary No. 5

The Tributary No. 5 flood zone averages 80 feet in width from the study limits downstream to the confluence with Tributary No. 5A. There are no houses that experience flood damage. However, culverts at a dirt road and at Craddock Road are overtopped by the 100-year storm. The remaining section of Tributary No. 5, which extends to its confluence with the main stream and Tributary No. 1, has an approximately 200-foot wide flood zone. This section of the floodplain floods 10 houses. Eight houses have first floor flooding (Houses DD, DD-2, DD-3, DD-4, DD-6, DD-10, DD-11, and DD-12), and two houses have basement flooding (Houses DD-5 and DD-7). The culverts at Seasons Avenue and at a private drive are overtopped during the 100-year storm.

8. Tributary No. 5A

Tributary No. 5A has a flood zone that averages 200 feet in width. The three culvert crossings along this stream are all overtopped by the 2, 10, and 100-year storm elevations. There is no flood damage to houses along this tributary.

E. FLOOD ZONE COMPARISON

The FEMA Flood Insurance Study presents a 100-year flood zone for the main stream of Warrior Run and Tributary No. 1. The FEMA study begins at the confluence with the Potomac River and extends upstream to the second Tributary No. 1 culvert crossing of Winchester Road. The flood delineation of this study is similar to the FEMA study except for a 1,200-foot stretch above the Winchester Road crossing where the floodplain is wider than the FEMA study. Flood elevations for the main stream and Tributary No. 1 flood zones higher than the FEMA elevations.

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-year storm, one-half day of service is estimated. One day of service is estimated for the 10 and 100-year storms. 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 four laborers would be required for two days to clean up the debris from a 2-year storm. The 10 and 100-year storms would require 10 and 12 workers for three and four days of clean-up, respectively. 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 two days of clean-up for each utility. The 100-year storm requires three 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 Warrior Run for existing and ultimate conditions is $393,000 and $525,000, 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 Warrior Run is $4,400,000 and $5,900,000 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 SCREENING

The initial investigation of flood hazard mitigation alternatives involved a screening of possible alternatives to determine which measures may be applicable to the 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 an present value basis. When project costs exceed benefits, it is an indication that the alternative is not economically justifiable.

C. PROPOSED FLOODPLAIN MITIGATION ALTERNATIVES

1. Main Stream

There is one culvert along the main stream that was considered for improvement or replacement. Structure No. 4 at the east side of Warrior Drive is undersized for the 10 and 100-year storms. Due to this condition, backwater flooding causes damage to 12 houses and overflows along U.S. Route 220. However, an additional culvert at Warrior Drive is not practical, because the area is heavily developed in commercial use. Removal of at least three flood damaged buildings along Warrior Drive would be necessary for the additional culvert installation. A larger replacement culvert cannot be used since the ground around the culvert is flat. Required headwater would continue to cause house damage and flooding of Route 220 in level areas adjacent to the stream.

The backwater of Warrior Drive causes first flood flooding of Structures CP-1, CM, CNO, CL, CQ, and CR during the 10 and 100-year storms. Structures CS and CS-1 experience first floor flooding during the 100-year storm and basement flooding due to the 10-year storm. Structures CP, CT, CU, and CV-6 have basement flooding during the 10 and 100-year storms. Due to the heavy commercialization in this area, purchase of these structures with first floor flooding is infeasible. These owners should purchase flood insurance to reduce flood damage costs. For structures with basements, use of floodproofing methods is recommended.

There are 17 houses along the main stream which receive first floor flooding due to the rise in stream elevations beyond channel banks. No structural alternatives are proposed to alleviate the flood damage. The following houses whose first floors are flooded during the 10 and 100-year storm events are purchase candidates: CX, CY, CZ, DA, DB, DB-1, and DC. House CV-2, with first floor flooding from the 100-year storm and basement flooding from the 10-year storm, is also a purchase candidate. House CD-3, an Army garage, receives 0.5 feet of flooding from the 100-year storm. Storage in this building should be limited to items not subject to flood damage. Houses CW, CE, CD, and CD-1 receive first floor flooding from the 100-year storm. However, these buildings are used commercially, so purchase is not feasible. CG, a church, has first floor flooding from the 10 and 100-year storms. CH is the church annex which is built directly over ths stream. This building is flooded during the 2, 10 and 100-year storms. Two other church-owned buildings, CK and CF, are flooded at first floor elevations during the 100-year storm. CG, CH, CK, and CF are eligible for purchase, but purchase is not probable. For the buildings that are not candidates for acquisition, the owners should consider purchasing flood insurance and also using floodproofing methods for basements.

Basement flooding due to elevated stream levels is experienced by 10 houses along the main stream. Houses DY-1, DY-2, DY-3, CV, CV-5, CI, and CJ are flooded due to the 2, 10, and 100-year storms. Houses CV-1 and CV-4 are flooded by the 10 and 100-year storms, and House EH by the 100-year storm. Floodproofing and purchase of flood insurance are recommended action for these homeowners.

2. <u>Tributary No. 1</u>

There is one structural improvement alternative considered for the Tributary No. 1 flood hazards. Houses DF and DE experience basement flooding due to backwater effects of Structure No. 8. Replacement of the existing 11' x 5' box culvert with three 6' x 4' box culverts would convey the 2-year storm. Ten-year and 100-year designs will require replacement with more than five culverts of this size. The 10 and 100-year designs are infeasible for the existing culvert location, so only the 2-year design will be considered for flood damage reduction comparisons.

The cost of the three 6' x 4' box culverts would be $21,400. Dollar damage reduction on a present worth basis is $25,500.

Identification codes DG, DH, and DI are used to designate representative trailers in a 39-unit trailer park along both sides of the stream. DH receives 1.5 feet of flooding from the 100-year storm and has base line first floor flooding during the 10-year storm. At Trailers DI and DG, flood elevations just reach the first floor during the 100-year storm. The 10 and 100-year flood elevations at these trailers suggest that other trailers in the park also receive flood damage. In lieu of removal of the trailer park from the flood zone, residents should purchase flood insurance to reduce their personal losses.

At House DD-13, near the confluence of Tributary No. 1 and No. 5, the 100-year elevation reaches the first floor. This house is a purchase candidate.

Two businesses off of Route 53 that are located in the 100-year floodplain of Tributary No. 1 receive first floor flooding due to the rise of the stream above bank elevations. DM has base line and one foot of first floor flooding for the 10 and 100-year storms, respectively. DJ has 0.5 foot of first floor flooding just for the 100-year storm. No structural alternatives are proposed to eliminate these flood hazards. The owners of these buildings should purchase flood insurance to mitigate their losses.

House DL receives basement flooding from the 100-year storm. Floodproofing and purchase of flood insurance by the homeowner are recommended for this house.

3. Tributary No. 2

There are no houses in the 100-year floodplain of this tributary. The ditch flow paths, however, overflow during the 10 and 100-year storms. Also, the capacity of the stormwater management pond below Briarwood Drive will be reached before the peak of the 10 and 100-year storms occurs. Overflow from the pond and culverts at Sobil and Briarwood Drives will flow overland down to Fritz Drive, overtop the culvert, and then merge with Tributary No. 1. There is no flood damage along this overflow path, so a structure to enclose the flow is not economical or necessary under existing conditions. If there is future development in this overflow area, then a pipe system may be desirable.

4. Tributary No. 3

House DX-1 is located at the confluence of the Tributary No. 3 and main stream floodplains. This house receives first floor flooding for the 10 and 100-year storms. Because this house is located in such close proximity to the stream, the purchase option is the most reasonable alternative.

House DY receives basement flooding. Structural improvements will not eliminate this basement flooding. The homeowner can use floodproofing methods and also purchase flood insurance to reduce his flood losses.

Houses EA and EZ are in the floodplain situated adjacent to the stream but are above flood elevations. Safety hazards due to high velocity flow have been recognized for the stream reach near these houses. Stream enclosure to eliminate the swift open channel flow condition is not economical. A more reasonable approach is to exercise caution in this area at all times and provide supervision of the children, especially during flood conditions.

5. Tributary No. 4A

The culverts and pipe system along Tributary No. 4A are undersized for the 2, 10, and 100-year storms. The flow that cannot enter this system causes first floor flooding at Houses EI-2, EI-4, and EI-6. Houses EI-3, EI-5, EI-7, EI-9, EI-10, EJ-1, and EJ-2 will experience basement flooding.

A properly sized drainage system could be installed in the location of the existing culverts and pipe system. This would reduce flood damage to the 10 houses. The 2-year storm design would require two 15-inch CMP's and two 21-inch CMP's at the Howard Street and Wood Street crossings, respectively. Two 27-inch CMP's would be needed for the system crossing Oakwood Street and extending adjacent to Meadow View Drive, and three 24-inch CMP's are required at Darrows Lane to carry the 2-year storm. Due to restrictions on headwater depth, the 10 and 100-year designs would need more than three culverts for the Wood Street crossing, the Meadown View system, and the Darrows Lane crossing. Space limitations deem these designs infeasible.

The cost of the 2-year design is approximately $175,000. Reductions in damages on a present value basis amounts to $97,000.

House EJ-4 receives over two feet of first floor flooding from the 2, 10, 100-year storms. Replacement of the Darrows Lane culvert will not eliminate the first floor flooding. Therefore, House EJ-4 is a candidate for purchase.

6. Tributary No. 4B

House EH-1, located directly upstream of the confluence of the Tributary No. 4B and main stream floodplains, experiences basement flooding from the 10 and 100-year storms. Stream flow over channel banks causes the EH-1 flood damage. Residents of this house should purchase flood insurance and also use floodproofing methods to reduce flood damage costs.

Houses EM and ES located adjacent to the Winchester Road culvert have basement flooding resulting from the 2, 10, and 100-year storms. Winchester Road culverts improvement would not eliminate this flooding. Homeowners should consider floodproofing their basements and purchasing flood insurance.

The 2, 10, and 100-year flood elevations cause basement flooding of House FB, located at the Lee and Grant Streets intersection. Stream flow at the 12-inch private culvert behind House FB overtops the culvert for all three storm events. Removal of the culvert and increasing the channel slope in its place should lower flood depths. Residents of House FB can fine grade around the house to divert flood water away from the structure. Floodproofing and flood insurance should also be considered for House FB.

7. <u>Tributary No. 5</u>

Ten houses along Tributary No. 5 receive flood damage due to the rise of the stream above channel elevations. No structural improvements are proposed that will reduce flood damage.

House DD, located at the stream bank near the Tributary No. 1 confluence, has flooding to the first floor elevation due to the 100-year storm. This home is a good candidate for purchase.

Houses DD-5 and DD-7 will receive basement flooding due to the 100-year storm event. These homeowners should use floodproofing methods and purchase flood insurance to limit costs of property damage.

Houses DD-4, DD-6, and DD-10 will receive one-half foot of first floor flooding due to the 100-year storm. The 100-year flood elevation at

Houses DD-2, DD-3, and DD-12 is above the first floor. At House D-11 the 100-year elevation is 2 feet above the first floor. These seven houses that receive first floor flooding are eligible for purchase. However, since these houses were recently constructed, purchase may not be desirable. Purchase of flood insurance and floodproofing of basements is more practical for homeowners in this area.

8. Tributary No. 5A

There are no flood mitigation alternatives proposed for Tributary No. 5A. No houses are located in the floodplain. Future development along McDonald Road should be restricted to areas outside of the Tributary No. 5A floodplain.

IX. RECOMMENDATIONS

Table 6 of Appendix B lists the proposed flood mitigation alternatives for the Warrior Run watershed.

On the main stream of Warrior Run structural improvements are not feasible. The areas adjacent to the stream are fully developed with commercial businesses along U.S. Route 220.

All of the residential structures on the main stream subject to first floor flooding are recommended for purchase. The homes are identified as CX, CY, CZ, DA, DB, DB-1, DC, CV-2, CM, DQ, and CR.

Many businesses and commercial properties are also subject to first floor flooding. The only feasible alternative for these owners is to purchase flood insurance. Floodproofing methods could be employed for those units with basements. The fire department buildings, the church buildings, and the Army Reserve buildings also fall into this category.

There are six residential structures which will have more than one foot of flooding around the basement. These six houses (DY-1, DY-2, DY-3, CV, CJ, and CI) will have an access problem during flooding and are also recommended as purchase candidates. In lieu of this, flood insurance should be purchased and floodproofing methods practiced.

The replacement of Structure No. 8 on Tributary No. 1 is economically justified. This improvement alternative is will reduce the flood damage to Structures DE and DF.

Structure DD-13 on Tributary No. 1 is recommended for purchase due to first floor flooding and an access problem during flooding. The three commercial structures (DM, DJ, and DK) with first floor flooding should purchase flood insurance. The trailer park on this tributary should, ideally, be relocated; but since this is not likely, flood insurance should be purchased by all owners.

No improvements are recommended on Tributary No. 2. Roadside ditch and shallow sheet flooding will occur on this tributary but will cause no major problems.

On Tributary No. 3, House DX-1 is recommended for purchase due to first floor flooding. Access problems exist for Houses EB, EA, DZ, and DY during flooding. These houses are also recommended for the purchase option. If not purchased, flood insurance should be obtained to reduce damage costs.

The Tributary No. 4A storm drainage system replacement costs more to implement than the dollar damage reduction. However, the County may choose to provide the additional funding for this project to eliminate the frequent nuisance flooding. Four houses, EJ-4, EI-6, EI-2, and EI-4, will experience first floor flooding without improvements, and House EI-3 will have an access problem during flooding. These houses are candidates for the purchase option, but the purchase of flood insurance is more feasible. The remaining houses on this tributary should also purchase insurance and practice floodproofing methods.

On Tributary No. 4B, the removal of the private culvert adjacent to House FB will reduce the flooding it experiences. Access problems may exist for Houses ES and ER during a flood having greater than a 100-year storm frequency.

On Tributary No. 5, House DD is recommended for purchase due to first floor flooding. House DD-5 has an access problem during flooding and is a likely candidate for purchase. Houses DD-2, DD-3, DD-4, DD-6, DD-7, DD-10, DD-1, and DD-12 experience first floor and/or basement flooding. Since these homes are newly constructed, purchase is not recommended. Flood insurance should be purchased and floodproofing methods practiced.

Homeowners can obtain flood insurance to cover any losses that may occur due to first floor or basement flooding. Floodproofing methods can be used for houses with 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 walls.

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 H-10, I-10, J-10, and J-11, April 1963.

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

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.

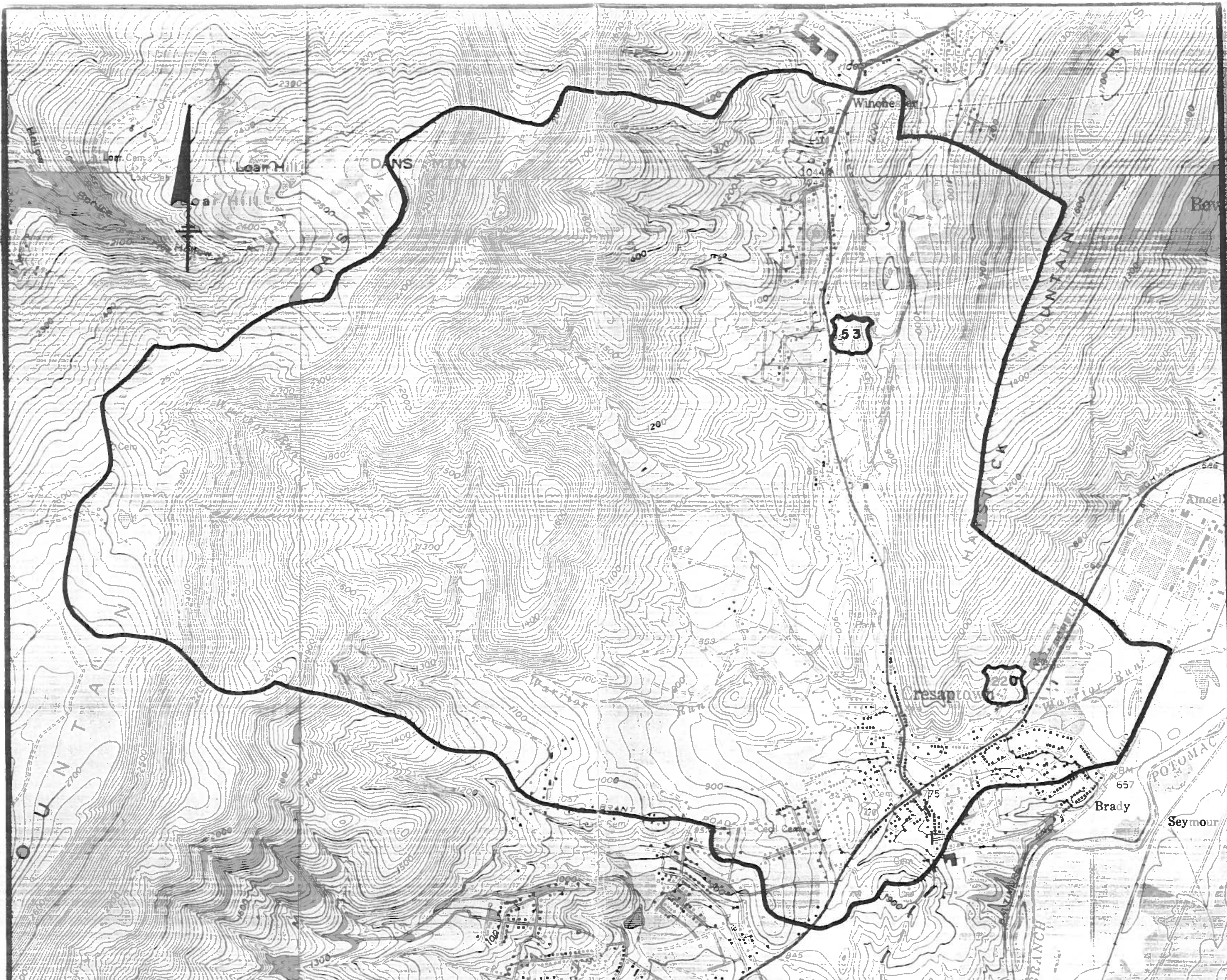
18. U.S. Department of Commerce, Bureau of Public Roads, *Hydraulic Analysis of Box Culverts*, BPR Program HY-3, Washington, DC, January 1964.

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



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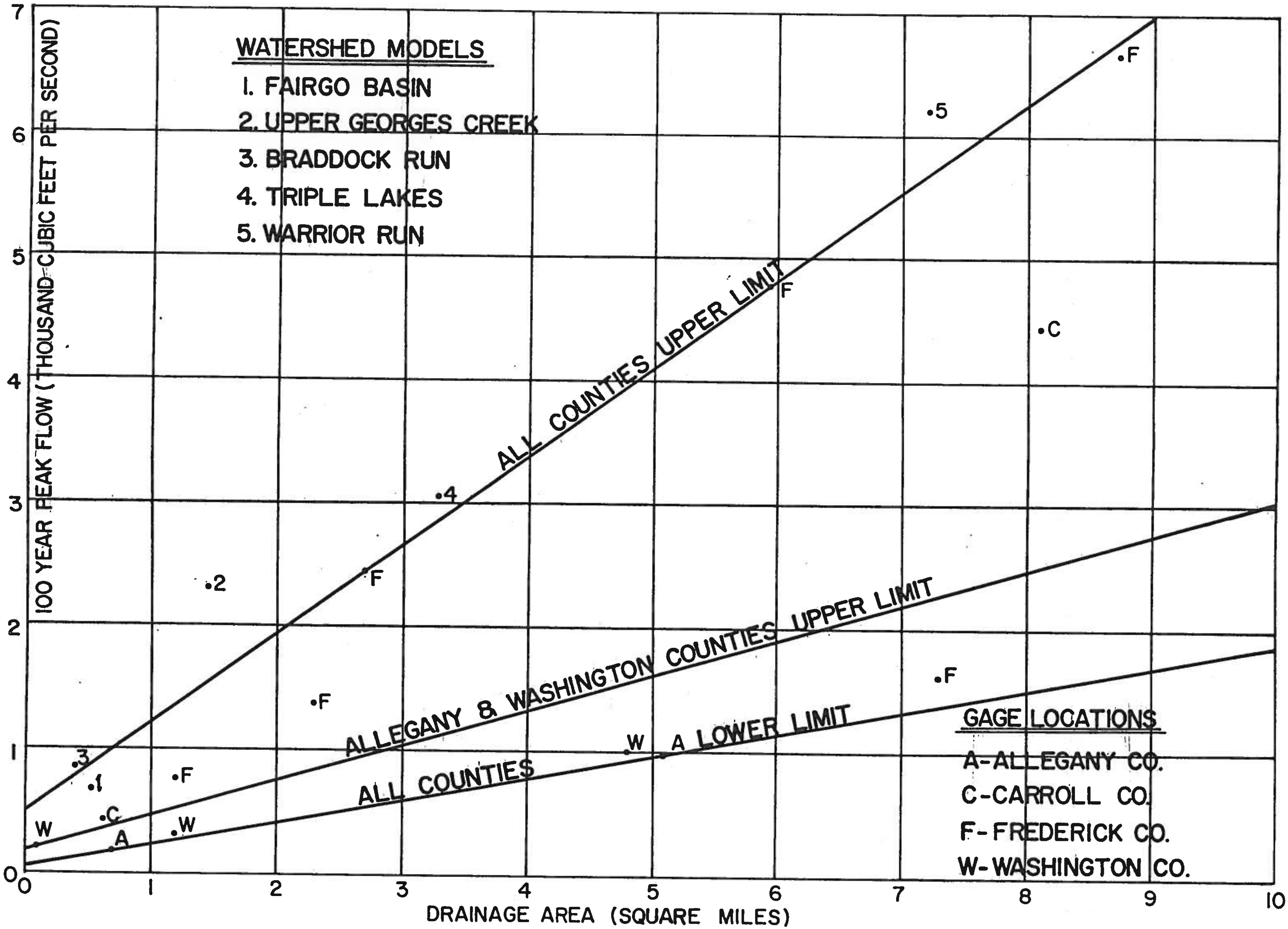
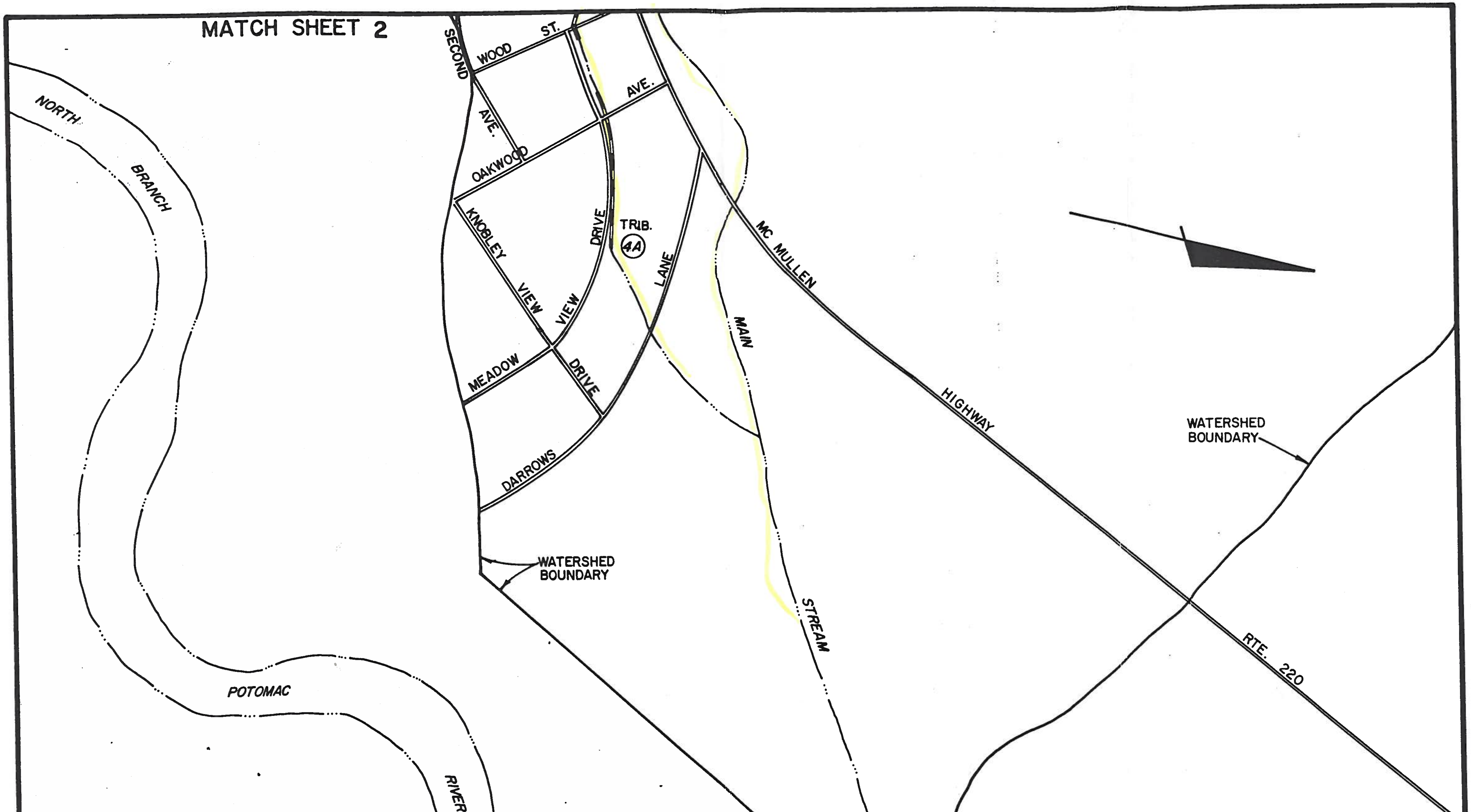
WARRIOR RUN WATERSHED
VICINITY MAP

2000 0 2000

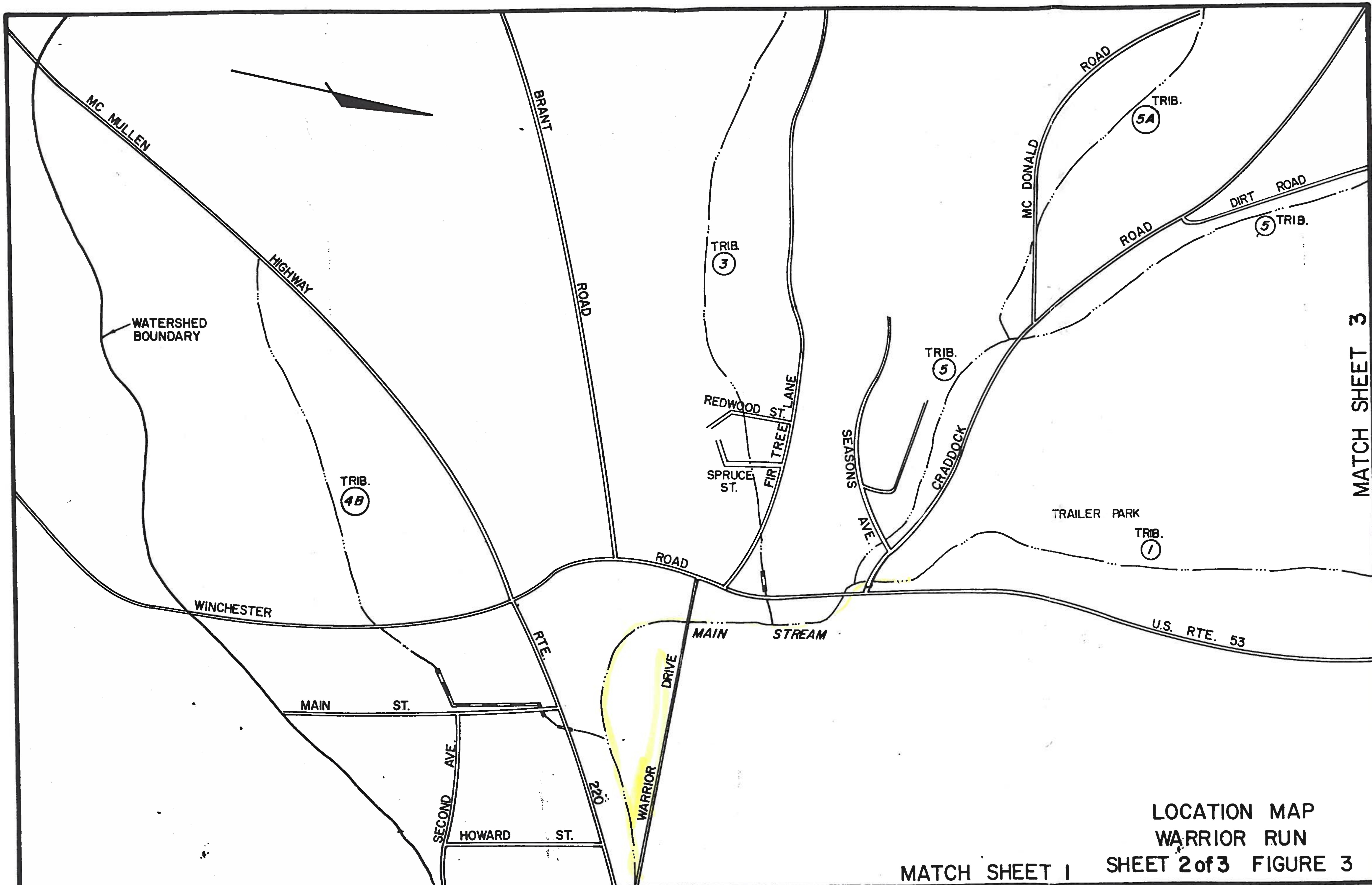
SCALE 1" = 2000'

FIGURE 1

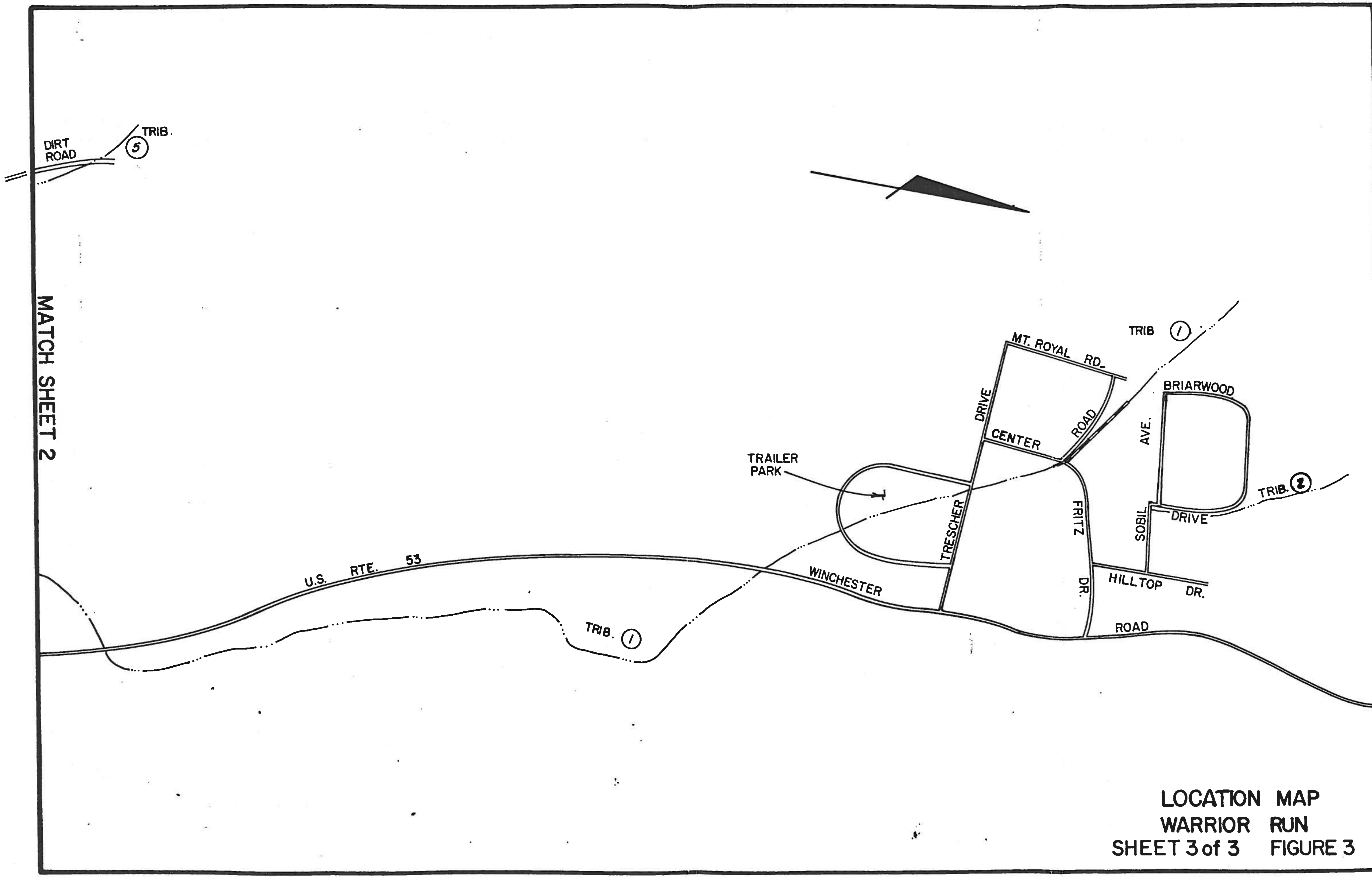

WATERSHED MODELS
1. FAIRGO BASIN
2. UPPER GEORGES CREEK
3. BRADDOCK RUN
4. TRIPLE LAKES
5. WARRIOR RUN
ALL COUNTIES UPPER LIMIT
ALLEGANY & WASHINGTON COUNTIES UPPER LIMIT
ALL COUNTIES LOWER LIMIT
GAGE LOCATIONS
A-ALLEGANY CO.
C-CARROLL CO.
F-FREDERICK CO.
W-WASHINGTON CO.
100 YEAR PEAK FLOW (THOUSAND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



LOCATION MAP
WARRIOR RUN
SHEET 1 of 3 FIGURE 3



LOCATION MAP
WARRIOR RUN
SHEET 2 of 3 FIGURE 3



LOCATION MAP
WARRIOR RUN
SHEET 3 of 3 FIGURE 3

APPENDIX B - TABLES

TABLE 1- DRAINAGE AREA SUMMARY

WARRIOR RUN

Area	Acreage	Existing CN	Ultimate CN	t_c (hrs.)
1.	179.86	72.7	79.6	.20
2.	216.43	68.0	72.4	.58
3.	32.66	44.7	86.9	.17
4.	35.19	75.4	77.0	.12
5.	1.38	82.0	82.0	.02
6.	174.57	66.8	71.4	.32
7.	11.96	81.5	81.5	.09
8.	133.63	73.0	76.2	.18
9.	72.22	76.7	76.9	.55
10.	95.22	72.4	79.0	.17
11.	19.32	73.4	88.2	.09
12.	366.85	60.5	74.7	.56
13.	72.22	69.6	74.1	.12
14.	128.34	62.0	65.7	.30
15.	67.39	75.2	75.2	.14
16.	455.63	65.8	70.7	.39
17.	165.60	69.2	69.2	.12
18.	189.06	66.1	66.6	.56
19.	89.01	61.8	61.8	.44
20.	197.57	62.9	62.9	.41

TABLE 1- DRAINAGE AREA SUMMARY

WARRIOR RUN

Area	Acreage	Existing CN	Ultimate CN	t_c (hrs.)
21.	155.02	68.5	70.5	.43
22.	142.14	66.8	71.8	.21
23.	114.54	71.8	73.6	.13
24.	86.25	71.7	71.7	.17
25.	164.45	70.3	76.3	1.45
26.	339.71	72.2	76.2	.43
27.	32.20	72.1	78.0	.83
28.	41.17	75.2	80.6	.45
29.	84.64	73.9	77.8	.25
30.	180.78	67.2	77.9	.16
31.	42.09	51.5	64.4	.17
32.	13.11	73.5	82.0	.12
33.	28.98	74.1	76.7	.20
34.	34.27	79.8	82.3	.16
35.	56.81	78.1	86.3	.25
36.	66.24	47.3	72.5	.55
37.	47.61	77.2	82.7	.18
38.	20.24	79.8	85.7	.12
39.	49.68	72.3	79.0	.28
40.	181.93	74.1	84.2	.57
41.	10.35	80.4	84.9	.07
42.	15.41	78.9	82.0	.08
Total Acreage	4603.08			
Weighted CN		68.3	73.9	

TABLE 2 - WARRIOR RUN STRUCTURES

Structure No.	Location	Description	From Surveys	From Field Reconnaissance
	Main Stream			
1	Baltimore & Ohio Railroad	7.4' x 5.5' Twin Cells	X	
2	U.S. Route 220	18' x 3.7' Twin Cells	X	
3	Church Culvert	20' x 5.2' Box	X	
4	Warrior Drive	18' x 6.2' Box	X	
5	Warrior Drive	36" CMP	X	
6	U.S. Route 53	17' x 3.6' Twin Cells	X	
	Tributary No. 1			
7	Craddock Road	15' x 5' Box	X	
8	Station 5+75	11' x 5' Box	X	
9	Trade Winds Extension	14' x 5.4' Box	X	
10	U.S. Route 53	15.5' x 4' Twin Cells	X	
11	Station 34+60	26.4' Wide Steel Beam Bridge	X	
12	Furniture Store Rd	48" Steel Pipe	X	
13	U.S. Route 53	7' x 5' Box	X	
14	Trailer Park Road	72" Steel Pipe	X	
15	Tresher Drive	42" CMP	X	
16	Fritz Drive	36" CMP	X	
	Tributary No. 2			
17	Fritz Drive	12" x 10" CMPA		X
18	Hill Top Drive	18" x 12" CMPA		X
19	Briarwood Drive and Sobil Drive	24" CMP		X
20	3 Driveways	24" CMPS		X
	Tributary No. 3			
21	Winchester Road	6' x 4' Box	X	
22	Station 1+30	4' x 4' Box	X	
23	Fir Tree Lane	60" CMP	X	
24	Spruce Street	6' x 1' Box		X
25	Redwood Street	3' x 1.5' Box		X
	Tributary No. 4A			
26	Darrows Street	15" CMP		X
27	Oakwood Avenue System	12"-9"-6"-9" CMP		X
28	Wood Street	12" CMP		X
29	Howard Street	12" CMP		X

TABLE 2-WARRIOR RUN STRUCTURES (continued)

Structure No.	Location	Description	From Surveys	From Field Reconnaissance
	<u>Tributary No. 4B</u>			
30	U.S. Route 220	36" CMP	X	
31	Main Street	24" RCP	X	
32	Winchester Street	24" RCP	X	
33	Station 20+60	12" CMP	X	
34	U.S. Route 220	5' x 3' CMPA	X	
	<u>Tributary No. 5</u>			
35	Season Avenue	12.5' x 3.5' Box	X	
36	Dirt Road	8' x 4' Box		X
37	Craddock Road	3' x 2' CMPA		X
38	Dirt Road	5' Steel Pipe		X
	<u>Tributary No. 5A</u>			
39	Dirt Path	12' x 5' Box		X
40	Dirt Road	5' Steel Pipe		X
41	Double Bridges	36" Steel Pipe		X
		5' Steel Pipe		X

TABLE 3

WARRIOR 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}	$WSEL_{100}$
124.0	1010	643.7	3131	650.1	6217	651.9	1614	644.3	4236	650.1	7760	651.9
124.1		644.5		649.4		651.9		644.9		649.4		651.9
124.2		644.9		650.9		653.7		646.3		651.3		653.9
125.0		645.3		651.9		654.1		647.1		653.0		654.4
126.0		647.3		652.0		654.2		647.6		653.1		654.6
127.0		654.4		656.1		656.3		655.8		656.1		656.5
128.0		659.4		661.2		662.6		660.2		662.5		663.1
129.0	1088	664.9	3261	667.5	6372	668.0	1704	666.4	4363	667.8	7896	668.4
130.0		673.5		676.6		678.3		675.0		677.4		678.9
131.0		685.2		688.0		689.5		686.7		688.8		690.2
131.1		688.5		690.9		694.1		689.5		691.5		694.9
132.0		688.6		693.4		695.8		689.7		694.6		697.1

TABLE 3

WARRIOR 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 STREAM												
133.0	1088	689.5	3261	695.5	6372	698.0	1704	691.6	4363	696.6	7896	698.8
134.0	1084	696.1	3243	698.2	6335	699.4	1696	696.8	4339	698.8	7849	700.0
134.1		695.9		699.6		701.2		695.9		700.4		701.7
134.2		698.7		701.3		702.8		700.1		701.9		703.9
134.3		700.5		702.8		704.2		701.4		703.4		704.8
134.4		700.7		703.1		704.6		701.7		703.7		705.3
135.0		701.3		704.4		707.2		702.5		705.4		708.2
136.1		706.0		712.5		715.2		707.7		714.1		715.7
136.2		708.9		711.2		717.1		711.7		715.3		718.0
137.0		710.1		717.7		719.7		713.1		718.2		720.6
138.0		711.7		717.9		720.0		713.7		718.4		720.9
150.0		721.2		723.2		725.6		721.5		724.1		726.1

TABLE 3

WARRIOR 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}	$WSEL_{100}$
151.0	1057	725.6	3193	729.6	6222	731.5	1633	727.4	4199	730.4	7609	732.3
152.0		731.4		734.2		736.2		732.2		735.0		736.7
152.1		732.2		737.6		738.6		733.6		738.0		739.0
152.2		732.8		738.2		740.6		733.8		739.1		741.5
154.0		734.1		740.3		742.7		737.5		741.3		743.5
158.0	979	739.3	2987	741.4	5834	743.8		739.4		742.4		744.6
159.1		741.8		745.2		747.4		743.5		745.9		748.2
159.2		734.0		743.6		747.8		744.8		746.0		748.9
161.0		743.0		747.1		750.4		745.0		748.5		751.4

TABLE 3

WARRIOR 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												
161.0	979	743.0	2987	747.1	5834	750.4	1505	745.0	3916	748.5	7099	751.4
162.0	423	743.7	1302	747.6	2545	750.7	768	745.7	1922	748.8	3387	751.6
162.1		744.0		747.1		750.4		745.6		748.1		751.4
163.0		744.3		748.3		750.8		747.4		749.5		751.7
164.1		750.7		751.8		752.5		751.2		752.3		753.1
164.2		753.0		754.9		755.6		754.5		755.3		755.8
164.3		755.2		755.5		756.5		755.2		756.1		757.1
164.4		755.3		756.2		757.2		755.5		756.7		757.7
164.5		755.4		756.6		757.8		755.9		757.2		758.4
164.6		755.4		756.7		757.9		755.9		757.3		758.5
164.7		757.0		758.7		760.3		757.8		759.5		760.8

TABLE 3

WARRIOR 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}	$WSEL_{100}$
165.0	423	761.0	1302	762.5	2545	763.6	768	761.6	1922	763.2	3387	764.4
165.0		764.7		766.6		767.8		765.6		767.3		768.4
165.2		765.7		770.3		771.3		766.6		770.9		771.8
165.3		765.9		770.7		772.2		767.5		771.6		773.0
165.4		766.0		771.6		773.3		767.6		772.6		773.8
165.5		766.1		772.3		774.0		768.4		773.3		774.8
165.6		767.2		772.4		774.1		770.0		773.3		774.8
166.0		773.3		775.4		776.4		774.1		776.0		776.8
167.0		785.9		787.7		787.8		787.1		787.9		787.8
168.0		791.4		793.4		794.0		793.0		793.7		794.4

TABLE 3

WARRIOR 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}	$WSEL_{100}$
169.1	455	796.7	1351	798.2	2557	800.1	838	797.1	1996	799.1	3406	802.4
169.2		796.9		799.3		801.1		798.3		800.7		802.6
170.0		800.9		802.9		804.4		801.9		803.8		805.1
171.1		810.9		812.4		813.5		811.8		813.1		814.0
171.2		812.3		814.2		816.5		813.1		815.5		817.9
171.3		812.6		816.5		820.7		814.7		818.9		823.0
171.4		812.7		816.5		820.7		814.7		818.9		823.1
171.5		812.9		817.0		820.9		815.0		819.2		823.2
171.6		813.5		817.1		820.9		815.1		819.2		823.2
171.9		816.2		817.5		820.9		816.8		819.2		823.2

TABLE 3

WARRIOR 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}	$WSEL_{100}$
172.0	455	825.0	1351	826.5	2557	826.9	838	825.7	1996	826.5	3406	827.4
172.1		829.6		830.7		831.9		830.4		831.4		832.5
173.1	425	836.6	1206	836.7	2154	836.7	665	836.6	1568	836.6	2600	836.7
173.2		839.0		840.2		841.2		839.4		840.6		841.6
173.3		839.0		840.2		841.1		839.4		840.5		841.4
173.4		845.2		846.8		847.9		845.9		847.3		848.2
174.0		855.0		856.6		857.9		855.5		857.2		858.4
175.0		866.6		868.4		869.6		867.4		868.9		870.1
176.0	243	885.1	682	886.6	1223	886.6	312	885.6	793	886.6	1343	886.7
177.1		891.5		895.9		896.6		892.2		896.1		896.7

TABLE 3

WARRIOR 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}	$WSEL_{100}$
177.2	243	893.8	682	896.8	1223	898.0	312	895.2	793	897.1	1343	898.1
178.0		895.5		897.1		897.9		896.5		897.2		898.0
179.0	106	913.0	331	914.9	612	915.7	152	914.1	404	915.2	699	915.9
181.1		917.6		918.5		919.5		917.6		918.8		919.8
181.2		920.1		922.5		925.0		920.6		923.1		925.1
181.3		920.8		922.7		928.4		921.5		923.1		928.6
181.4		921.7		923.8		929.2		922.2		924.1		929.3
181.5		922.5		927.5		929.5		923.3		929.1		929.7
181.6		927.1		928.6		929.8		927.5		928.9		930.0

TABLE 3

WARRIOR 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}	$WSEL_{100}$
181.7	106	937.0	331	938.5	612	940.0	152	937.4	404	938.8	699	940.1
182.1		945.7		947.4		948.7		946.2		947.8		949.0
182.2		955.6		958.1		958.0		956.5		958.2		958.1
182.3		955.7		959.9		960.4		959.5		960.0		960.4
182.4		957.8		960.8		961.5		960.1		961.0		961.7
182.5		960.6		960.9		961.6		960.1		961.1		961.8
184.0		960.5		962.2		963.4		961.0		962.6		963.6
184.5		974.8		975.8		976.7		975.0		976.0		976.9
185.1	70	989.2	242	990.4	472	991.5	111	989.6	310	990.7	560	991.8
185.2		992.8		995.1		995.0		993.7		995.2		995.1

TABLE 3

WARRIOR 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}	$WSEL_{100}$
185.3	70	1016.9	242	1021.6	472	1022.5	111	1020.5	310	1021.9	560	1022.6
188.0		1018.6		1021.8		1022.9		1020.6		1022.2		1023.3
TRIBUTARY NO. 2												
188.3	45	1072.5	112	1073.5	192	1073.5	51	1072.5	120	1073.5	201	1073.5
188.4		1099		1100		1100		1099		1100		1100

TABLE 3

WARRIOR 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. 3												
154.1	139	734.1	430	740.3	861	742.7	291	737.9	702	741.4	1214	743.6
154.2		734.3		740.3		742.7		737.9		741.4		743.6
155.1		734.5		740.3		742.7		737.9		741.4		743.6
155.2		734.6		740.3		742.7		737.9		741.4		743.6
155.3		734.8		740.3		742.7		737.9		741.4		743.6
155.4		735.0		740.3		742.7		737.9		741.4		743.6
155.5		744.5		745.2		745.8		744.9		745.6		746.2
155.6		744.9		745.8		746.6		745.5		746.3		747.0
156.0		750.6		752.1		752.8		751.8		752.6		753.1
156.1		752.8		753.7		754.3		753.3		754.1		754.8
156.2		752.9		753.7		754.4		753.4		754.2		754.8
156.3		753.3		754.1		754.7		753.8		754.5		755.1

TABLE 3

WARRIOR 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}	$WSEL_{100}$
156.4	139	753.4	430	754.1	861	754.8	291	753.8	702	754.6	1214	755.2
157.0		756.0		756.4		756.8		756.3		756.7		757.1
157.1		756.3		756.8		757.3		756.6		757.1		757.6
157.2		756.5		757.1		757.6		756.8		757.4		758.0
157.3		756.6		757.2		757.8		756.9		757.6		758.1
157.4		765.6		766.3		766.8		766.0		766.7		767.1
157.5		766.0		766.9		767.4		766.6		767.2		767.8
157.6		766.5		767.3		767.9		767.0		767.7		768.3
157.7		766.5		767.3		768.0		767.0		767.8		768.4
157.8		767.0		768.2		769.2		767.8		768.9		769.7
157.9		781.1		782.9		784.5		782.2		784.0		785.7

TABLE 3

WARRIOR 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. 4A												
129.1	41	685.2	77	685.7	125	685.7	42	685.2	87	685.7	143	685.7
129.2	7	713.0	16	713.4	25	713.4	9	713.0	18	713.4	27	713.4

TABLE 3

WARRIOR 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. 4B						
139.0	79	723.4	161	724.0	258	724.5	106	724.1	203	724.2	335	724.7
139.1		725.4		725.3		725.6		725.3		725.5		725.6
140.0		731.9		732.3		732.4		732.0		732.3		732.5
140.1		732.2		732.5		732.8		732.3		732.7		733.0
141.0		733.7		734.0		734.1		733.9		734.1		734.3
141.1		736.3		736.9		737.4		736.6		737.1		737.7
142.0		746.5		746.8		747.1		746.6		746.9		747.3
142.1		746.8		747.3		747.7		747.0		747.5		748.0
142.2	59	746.8	140	747.3	237	747.8	88	747.0	193	747.5	308	748.1
143.1		753.9		753.9		753.8		753.9		753.9		753.8
143.2		754.8		755.0		755.1		754.9		755.1		755.2

TABLE 3

WARRIOR 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}	$WSEL_{100}$
144.0	59	757.3	140	757.6	237	757.6	88	757.4	193	757.6	308	757.8
144.1		757.5		757.8		758.1		757.6		757.9		758.2
145.0		757.4		757.9		758.3		757.6		758.1		758.4
146.0		768.0		768.4		768.7		768.2		768.6		768.9
146.1		770.1		770.5		770.5		770.1		770.4		770.6
146.2		770.3		770.6		770.7		770.4		770.6		770.8
146.3		775.2		775.2		775.3		775.1		775.3		775.4
146.4		775.2		775.4		775.6		775.3		775.5		775.7
147.0	1.0	775.2	8.0	775.4	37	775.7	34	775.3	92	775.6	164	775.9
147.1		782.4		782.9		783.7		783.6		784.5		785.1
148.0		802.6		803.1		803.9		803.8		804.9		805.1
148.1		810.1		810.5		811.3		811.2		812.3		813.3

TABLE 3

WARRIOR 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}	$WSEL_{100}$
149.1	1.0	810.7	8.0	811.3	37	812.4	34	812.3	92	813.6	164	816.9
149.2		813.8		814.3		814.6		814.6		815.0		816.9

TABLE 3

WARRIOR 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}	$WSEL_{100}$
163.7	148.	792.9	540	795.0	1073	796.0	247	793.6	710	795.3	1293	796.5
163.8		803.8		806.9		808.5		804.7		807.6		809.2
163.9		816.9		819.0		820.5		817.8		819.5		821.2
203.0		829.6		832.0		833.7		830.3		832.7		834.1
203.1		838.0		840.0		841.4		838.8		840.4		841.9
203.2		848.4		850.9		852.2		849.2		851.5		852.7
203.3		861.4		863.4		865.3		862.0		864.2		865.7

TABLE 3

WARRIOR 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. 5												
161.0	979	743.0	2987	747.1	5834	750.4	1505	743.0	3916	748.5	6099	751.4
161.1	562	747.7	1682	750.5	3260	751.0	755	749.5	1993	750.6	3680	751.5
161.2		750.3		751.2		752.0		750.5		751.4		752.0
161.3		750.3		751.2		751.9		750.5		751.4		752.0
161.4		750.5		751.6		752.5		750.8		751.8		752.6
163.0		750.6		751.5		752.4		750.8		751.7		752.5
163.1	559	753.9	1704	755.7	3326	756.9	756	754.4	2028	756.0	3762	757.2
163.2		763.5		765.0		765.7		763.9		765.2		766.0
163.3		766.6		769.1		770.6		767.4		769.5		770.9
163.4		772.2		774.0		775.5		772.6		774.4		775.8
163.5	148	777.7	540	779.9	1073	780.9	247	778.4	710	780.1	1293	781.3
163.6		782.3		784.5		786.8		783.0		785.2		786.8

TABLE 3

WARRIOR 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. 5A												
163.4	559	772.2	1704	774.0	3326	775.5	756	772.6	2028	774.4	3762	775.8
200.0	441	779.0	1306	781.1	2511	782.3	556	779.5	1483	781.3	2744	782.6
201.0		787.8		790.4		792.3		788.1		790.8		792.6
202.0		798.1		800.4		802.0		798.5		800.7		802.3
203.0	429	808.2	1273	811.1	2453	812.3	538	808.5	1441	811.4	2674	812.5
204.0		816.0		817.9		820.3		816.5		818.2		820.6
205.0		825.3		827.9		829.8		825.6		828.3		830.1

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WARRIOR RUN WATERSHED
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	$ 128,231	$ 365,799	$ 825,555
-CONTENTS	60,595	173,430	412,590
-EXTERIOR PROPERTIES	28,600	54,500	99,450
-VEHICLES	44,000	109,000	234,000
TOTAL PRIVATE LOSSES	$ 261,426	$ 702,729	$ 1,571,595
PUBLIC LOSSES			
-EMERGENCY POLICE SERVICES	$ 1,015	$ 4060	$ 4060
-CITY CLEAN-UP SERVICES	3,776	9456	16384
-UTILITIES REPAIR SERVICES	1,200	1200	1800
TOTAL PUBLIC LOSSES	$ 5,991	$ 14,716	$ 22,244
ABSTRACT LOSSES			
-LOST WAGES	$ 10,560	$ 13,080	$ 28,080
-EXTRA MILEAGE COST	0	0	0
TOTAL ABSTRACT LOSSES	$ 10,560	$ 13,080	$ 28,080
TOTAL OF ALL LOSSES	$ 277,977	$ 730,525	$ 1,621,919

AVERAGE ANNUAL DAMAGES = .45(2-YEAR TOTAL)+.245(10-YEAR TOTAL)+.055(100-YEAR TOTAL)= $ 393,274

PRESENT VALUE OF THE AVERAGE ANNUAL DAMAGES(TAKEN FOR 30 YEARS AT AN INTEREST RATE OF 8%)= $ 4,427,398

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WARRIOR RUN WATERSHED
TABLE 5 -FLOOD DAMAGE ESTIMATES ULTIMATE CONDITIONS

ITEMIZED LOSSES	2-YEAR STORM ULTMATE CONDITIONS	10-YEAR STORM ULTIMATE CONDITIIONS	100-YEAR STORM ULTIMATE CONDITIONS
PRIVATE LOSSES			
-STRUCTURES	$ 184,378	$ 596,872	$ 994,177
-CONTENTS	82,475	270,215	533,850
-EXTERIOR PROPERTIES	28,600	54,500	99,450
-VEHICLES	44,000	109,000	234,000
TOTAL PRIVATE LOSSES	$ 339,453	$ 1,030,587	$ 1,861,477
PUBLIC LOSSES			
-EMERGENCY POLICE SERVICES	$ 1,015	$ 4060	$ 4060
-CITY CLEAN-UP SERVICES	3,776	9456	16384
-UTILITIES REPAIR SERVICES	1,200	1200	1800
TOTAL PUBLIC LOSSES	$ 5,991	$ 14,716	$ 22,244
ABSTRACT LOSSES			
-LOST WAGES	$ 10,560	$ 13,080	$ 28,080
-EXTRA MILEAGE COST	0	0	0
TOTAL ABSTRACT LOSSES	$ 10,560	$ 13,080	$ 28,080
TOTAL OF ALL LOSSES	$ 356,004	$ 1,058,383	$ 1,911,801

AVERAGE ANNUAL DAMAGES = .45(2-YEAR TOTAL)+.245(10-YEAR TOTAL)+.055(100-YEAR TOTAL)= $ 524,655

PRESENT VALUE OF THE AVERAGE ANNUAL DAMAGES(TAKEN FOR 30 YEARS AT AN INTEREST RATE OF 8%)= $ 5,906,458

Table 6. FLOOD MANAGEMENT ALTERNATIVES

WARRIOR 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: Flood Proof	Flood Insur.	Purchase Candidate	Structural Improvements	Comments
				MAIN STREAM				
CX		3.0				X		
CY		4.0				X		
CZ		5.5				X		
DA		3.0				X		
DB		2.0				X		
DB-1		1.5				X		
DC		2.0				X		
DY-1	X	-1.0	X	X	X	X		
DY-2	X	-0.5	X	X	X	X		
DY-3	X	-1.5	X	X	X	X		
CW	X	1.0		X	X			Commercial use
CV	X	-1.5	X	X	X	X		
CV-1	X	-5.0	-	X	X			
CV-2	X	0.5				X		
CV-3	X	-2.0	-	X	X			
CV-3A		-						FF above flood elevation
CV-4	X	-3.5	-	X	X			
CV-5	X	-1.5	-	X	X			
EH	X	-6.0	-	X	X			
CP	X	-0.5	-	X	X			Commercial use
CP-1		[illegible]	-	X	X			Commercial use
CM		6.0				X		
CNO		3.0			X			Fire hall
CL		3.5			X			Commercial use
CQ	X	4.0		X	X	X		
CR	X	2.0	X	X		X		
CS	X	1.5	X	X				Commercial use
CS-1	X	1.5	X	X				Commercial use
CT	X	-0.5	-	X	X			Tavern
CU	X	-3.5	-	X	X			
CV-6	X	-0.5	-	X	X			
CK		1.0			X			Recreation facility
CJ	X	-1.0	X	X	X	X		
CI	X	-1.0	X	X	X	X		
CH		5.5			X			Church
CG	X	1.5		X	X			Church
CF	X	2.0		X	X			Church-owned building
CE		0.5			X			Commercial use
CD		4.0			X			Commercial use
CD-1		5.5			X			Commercial use
CD-3		0.5			X			Army garage
CD-2		-						Out of flood zone

Table 6. FLOOD MANAGEMENT ALTERNATIVES (continued)

WARRIOR 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: Flood Proof	ALTERNATIVES: Flood Insur.	ALTERNATIVES: Purchase Candidate	ALTERNATIVES: Structural Improvements	Comments
TRIBUTARY NO. 1								
DW		-						Out of flood zone
DV		-						Out of flood zone
DU		-						Out of flood zone
DT		-						Out of flood zone
DS		-						Out of flood zone
DR		-						Out of flood zone
DQ		-						Out of flood zone
DP		-						Out of flood zone
DO		-						Out of flood zone
DN		-						Out of flood zone
DM		1.5			X			Commercial use
DL	X	-6.5	-	X	X			
DH-19		1.5			X			Trailers
DI-6		0			X			Trailers
DG-14					X			Trailer - FF above flood elevations
DE	X	-1.0	-	X	X		Replace 11' x 5' box culvert with three 6' x 4' box culverts for a 2-yr. design ($21,400)	
DF	X	-3.0	-	X	X			
DD-13		0	X			X		
DJ		0.5			X			Commercial use
DJ-1		-						Out of flood zone
DK		-			X			Commercial use
TRIBUTARY NO. 3								
DX		-						Out of flood zone
DX-1		4.5				X		
DY	X	-5.0	X	X	X	X		
DZ		-	X		X	X		FF above flood elevation
EA		-	X		X	X		FF above flood elevation
EB		-	X		X	X		FF above flood elevation
EC		-						Out of flood zone
ED		-						Out of flood zone
EE		-						Out of flood zone
EF		-						Out of flood zone
EG		-						Out of flood zone
TRIBUTARY NO. 4A								
EJ-4	X	2.5			X	X		Purchase not recommended
EJ-3		-						FF above flood elevation
EJ-2	X	-1.0	-	X	X			
EJ-1	X	-2.5	-	X	X			
EI-9	X	-0.5	-	X	X		Replace storm drainage system with a 2-year design system ($175,000). Not economically justified.	
EI-7	X	-5.0	-	X	X			
EI-6		1.0			X	X		Purchase not recommended
EI-5	X	-1.0	-	X	X			
EI-4	X	1.0		X	X	X		Purchase not recommended
EI-3	X	-1.0	X	X	X	X		
EI-2		3.0			X			Purchase not recommended
EI-10	X	-1.0	-	X	X			

Table 6. FLOOD MANAGEMENT ALTERNATIVES (continued)

WARRIOR 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: Flood Proof	Flood Insur.	Purchase Candidate	Structural Improvements	Comments
TRIBUTARY NO. 4B								
EH-1	X	-4.5	-	X	X			
EI-1		-						Out of flood zone
EI		-						Out of flood zone
EJ		-						FF above flood elevation
EK		-						Out of flood zone
EL		-						Out of flood zone
EM	X	-5.0	-	X	X			
EN		-						Out of flood zone
EO		-						Out of flood zone
EP		-						Out of flood zone
EQ		-						Out of flood zone
ER		-						FF above flood elevation
ES	X	-3.0	-	X	X		Remove culvert adjacent to House FB	
ET		-						Out of flood zone
EU		-						Out of flood zone
EV		-						Out of flood zone
EW		-						Out of flood zone
EX		-						Out of flood zone
EY		-						Out of flood zone
EZ		-						Out of flood zone
FA		-						Out of flood zone
FB	X	-1.0	-	X	X			
FC		-						Out of flood zone
FD		-						Out of flood zone
TRIBUTARY NO. 5								
DD	X	0				X		
DD-1		-						Out of flood zone
DD-2	X	2.5		X	X			Purchase not recommended
DD-3	X	2.5		X	X			Purchase not recommended
DD-4	X	0.5		X	X			Purchase not recommended
DD-5	X	-3.0	X	X	X	X		
DD-6	X	0.5		X	X			Purchase not recommended
DD-7	X	-2.0		X	X			
DD-8		-						Out of flood zone
DD-9		-						Out of flood zone
DD-10	X	0.5		X	X			Purchase not recommended
DD-11	X	2.0		X	X			Purchase not recommended
DD-12	X	2.5		X	X			Purchase not recommended

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. ______________________________

   ____

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
$0 < x \le 1000$	High	$33,000
	Average	18,100
	Low	10,200
$1000 < x \le 1500$	High	$37,200
	Average	20,600
	Low	11,100
$1500 < x \le 2000$	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		2		3		4	
	1 STORY WITH BASEMENT		1 STORY W/O BASEMENT		1 1/2 & 2 STORY W/ BASEMENT		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.	28.
5	33.	39.	29.	40.	33.	39.	22.	33.
6	38.	44.	41.	45.	35.	44.	24.	[illegible]
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.	78.
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.

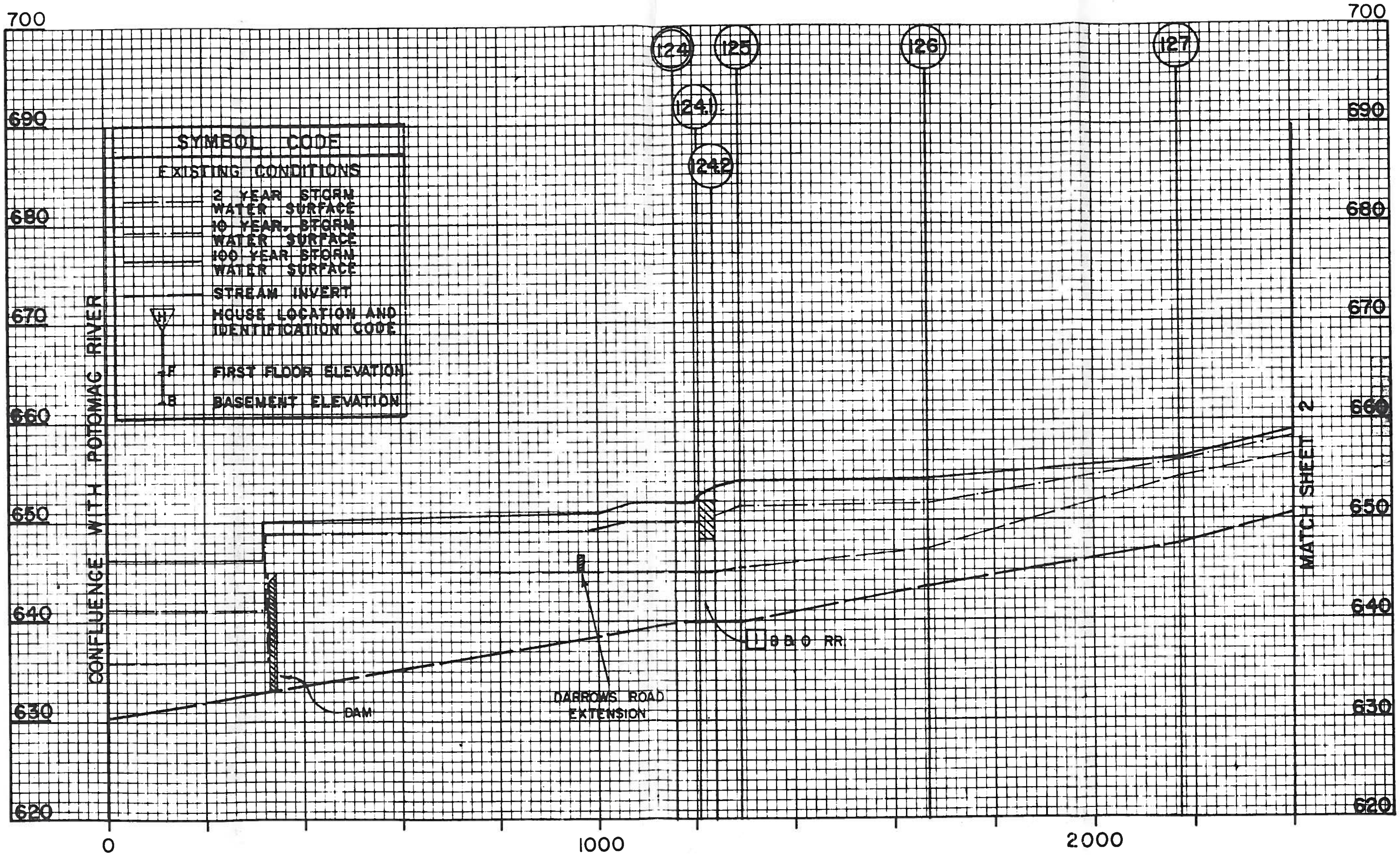
Table 5

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.	85.
13	56.	80.	48.	80.	82.	85.
14	58.	80.	49.	81.	82.	85.
15	59.	80.	50.	81.	82.	85.
16	60.	80.	50.	81.	82.	85.
17	60.	80.	50.	81.	82.	85.
18	60.	80.	50.	81.	82.	85.
19	60.	80.	50.	81.	82.	85.
20	60.	80.	50.	81.	82.	85.
21	60.	80.	50.	81.	82.	85.
22	60.	80.	50.	81.	82.	85.
23	60.	80.	50.	81.	82.	85.
24	60.	80.	50.	81.	82.	85.
25	60.	80.	50.	81.	82.	85.
26	60.	80.	50.	81.	82.	85.
27	60.	80.	50.	81.	82.	85.
28	60.	80.	50.	81.	82.	85.
29	60.	80.	50.	81.	82.	85.
30	60.	80.	50.	81.	82.	85.

APPENDIX D

WATER SURFACE PROFILES



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

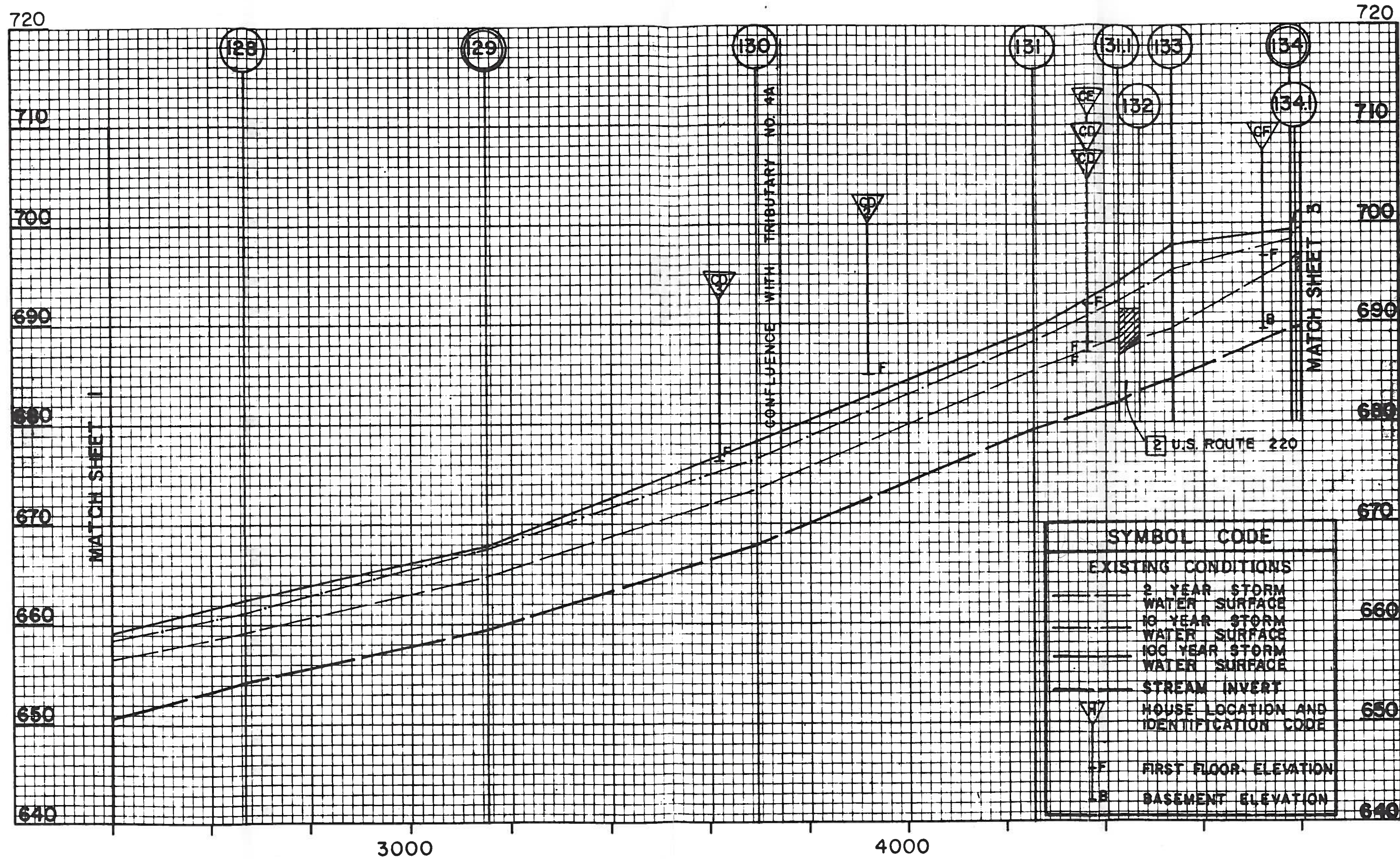
[3] STRUCTURE NUMBER

((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN MAIN STREAM.

SHEET NO.
1 OF 4



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

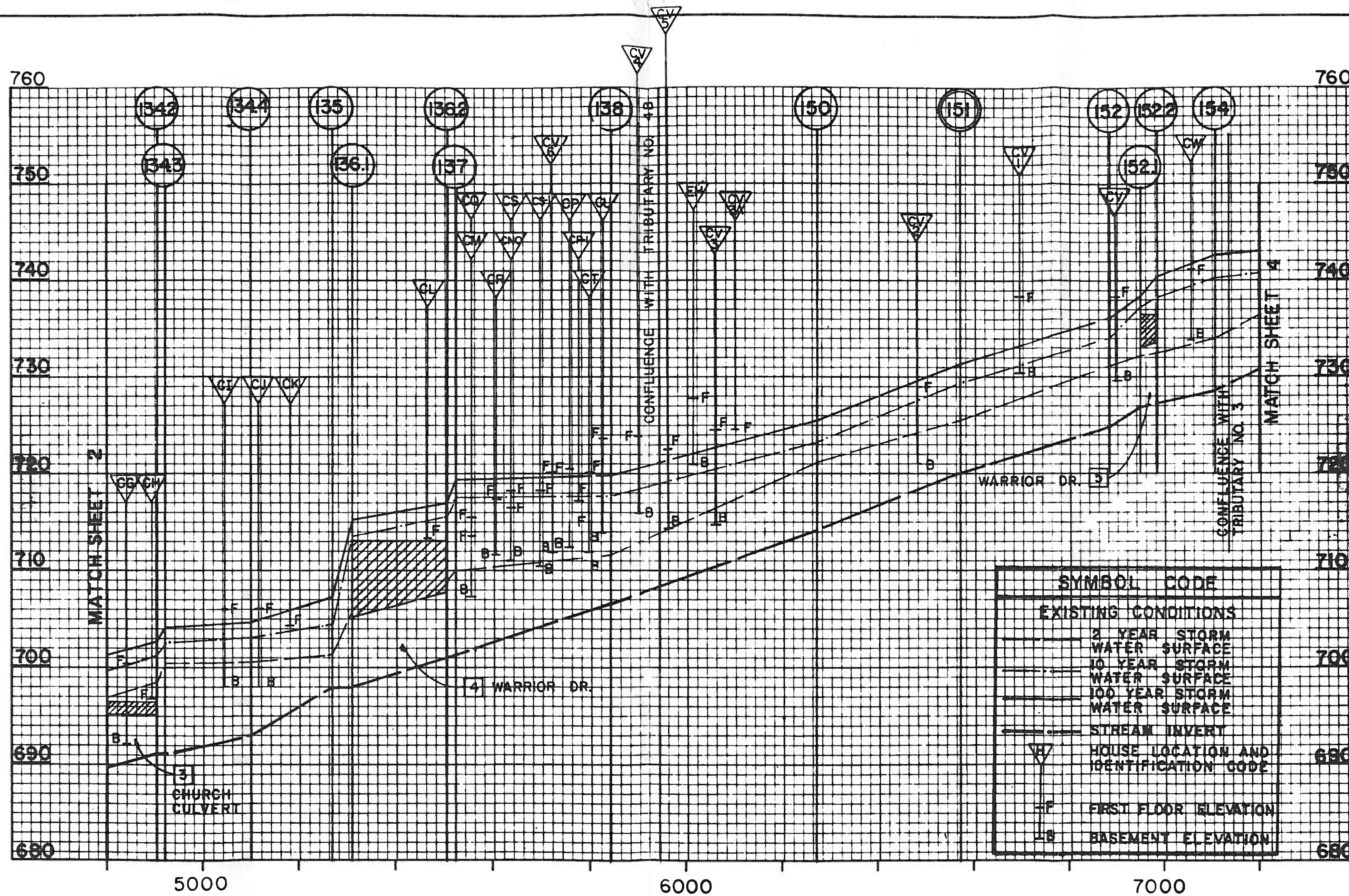
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN MAIN STREAM

SHEET NO.
2 OF 4



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

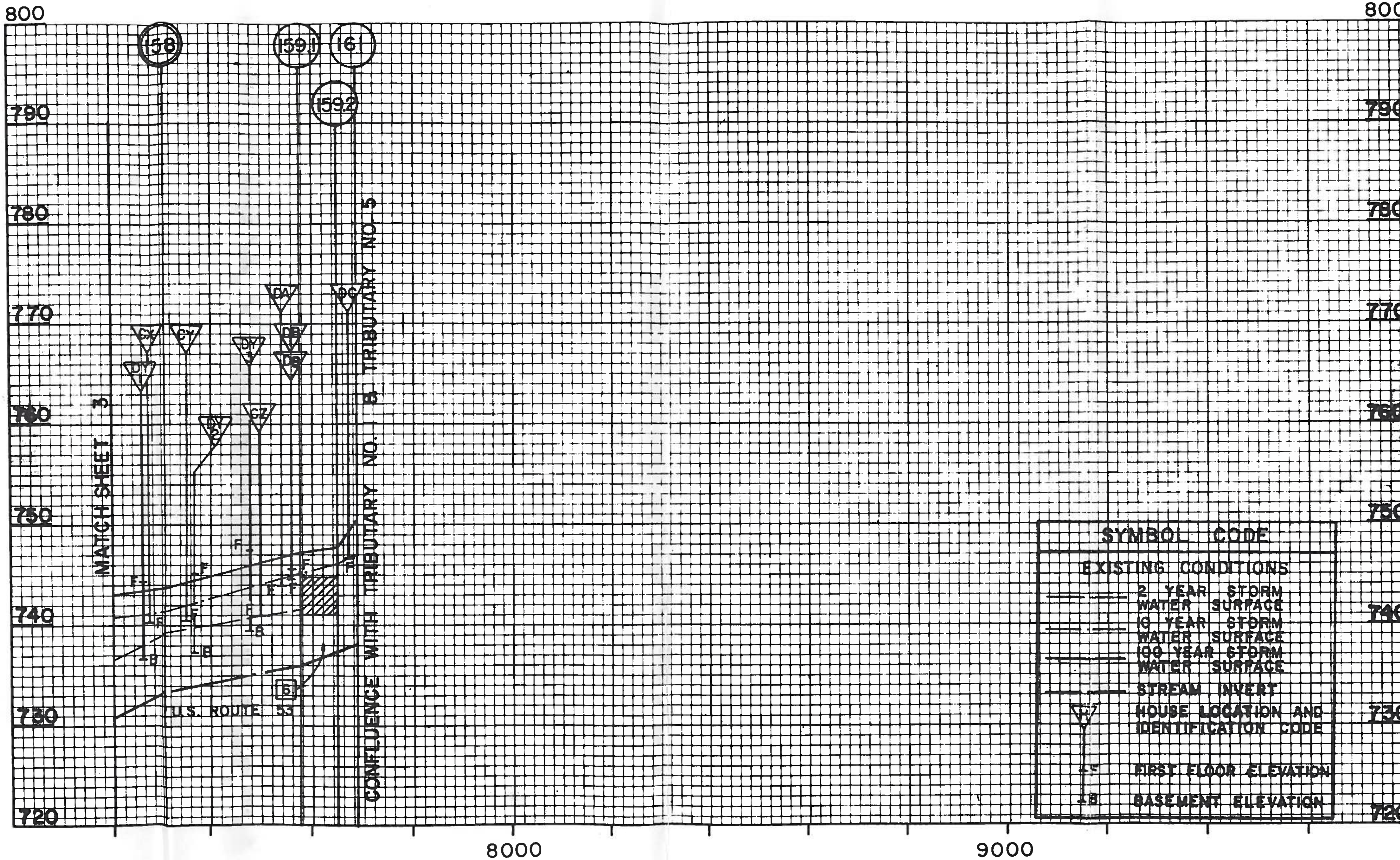
[3] STRUCTURE NUMBER

((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN MAIN STREAM

SHEET NO.
3 OF 4



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CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

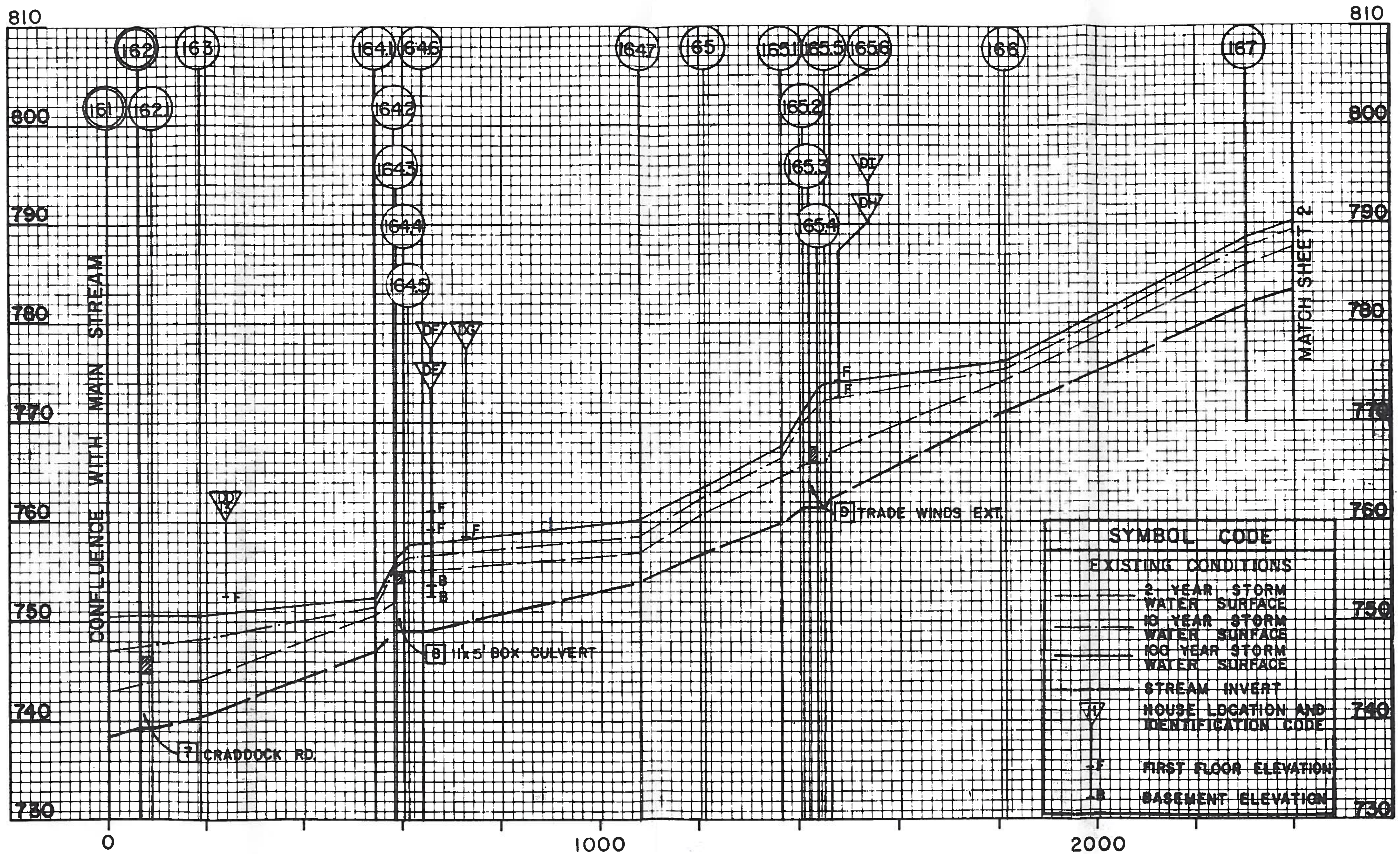
[3] STRUCTURE NUMBER

((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN MAIN STREAM

SHEET NO. 4 OF 4



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

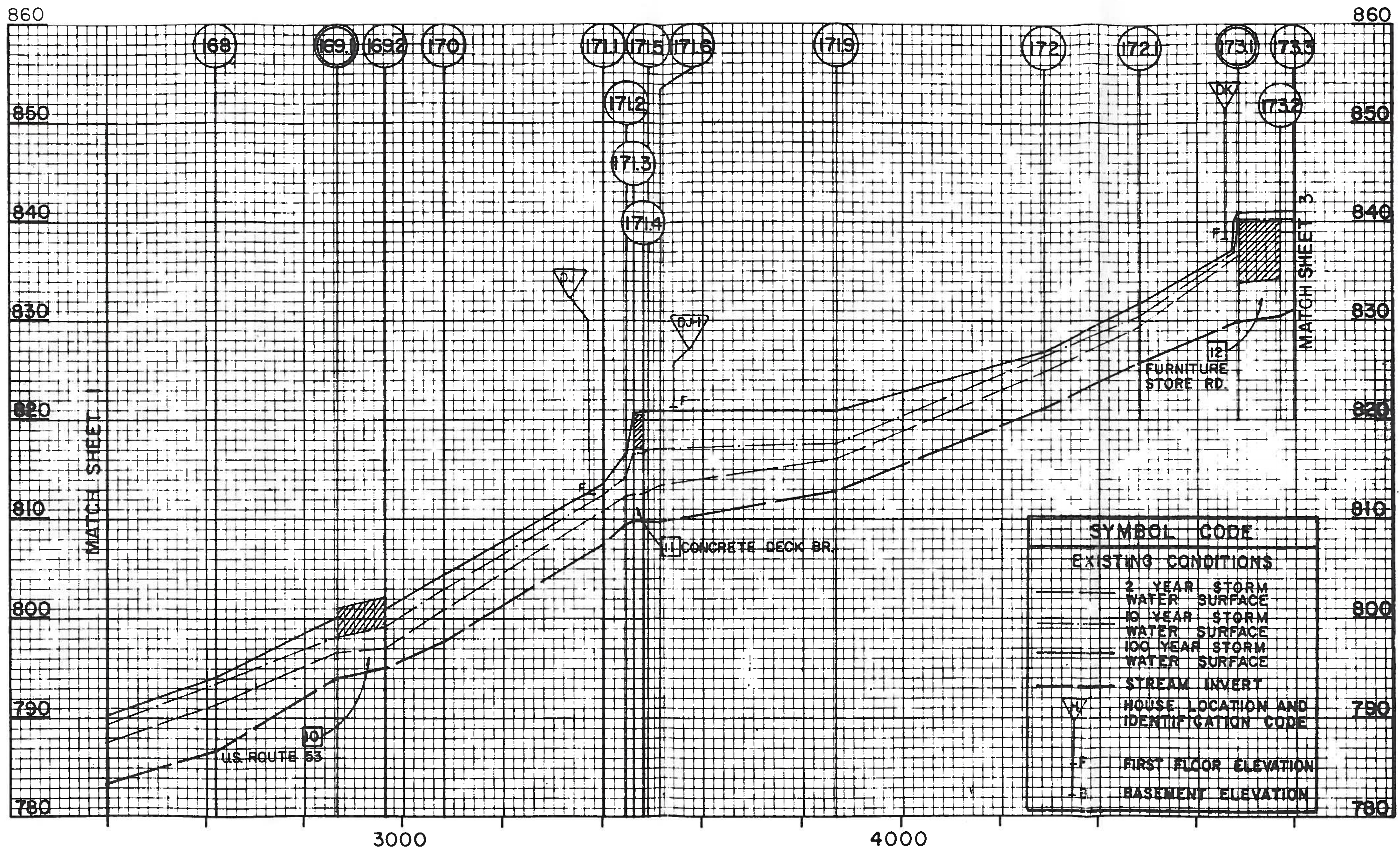
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 1

SHEET NO.
1 OF 5



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

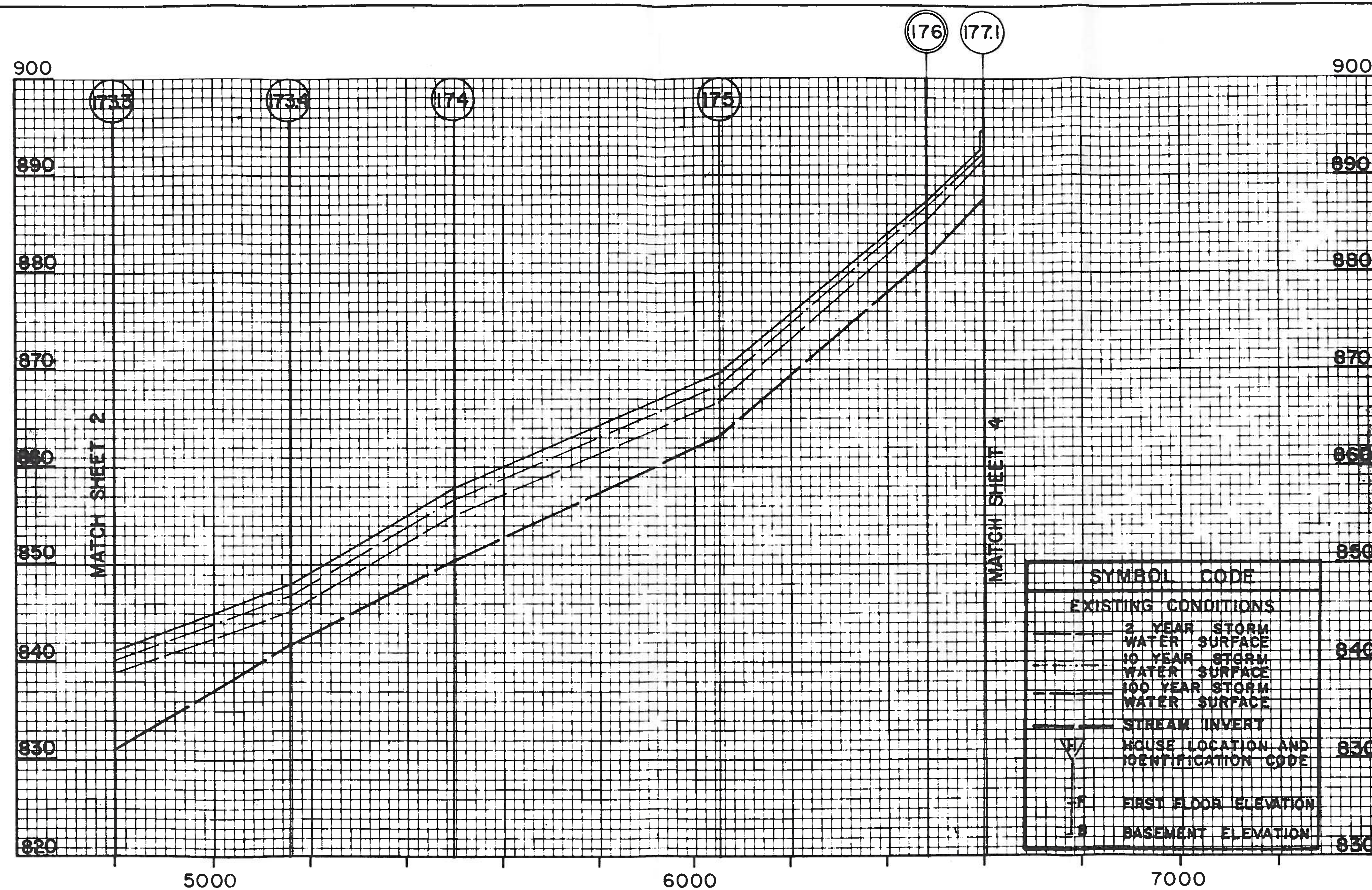
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 1

SHEET NO. 2 OF 5



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

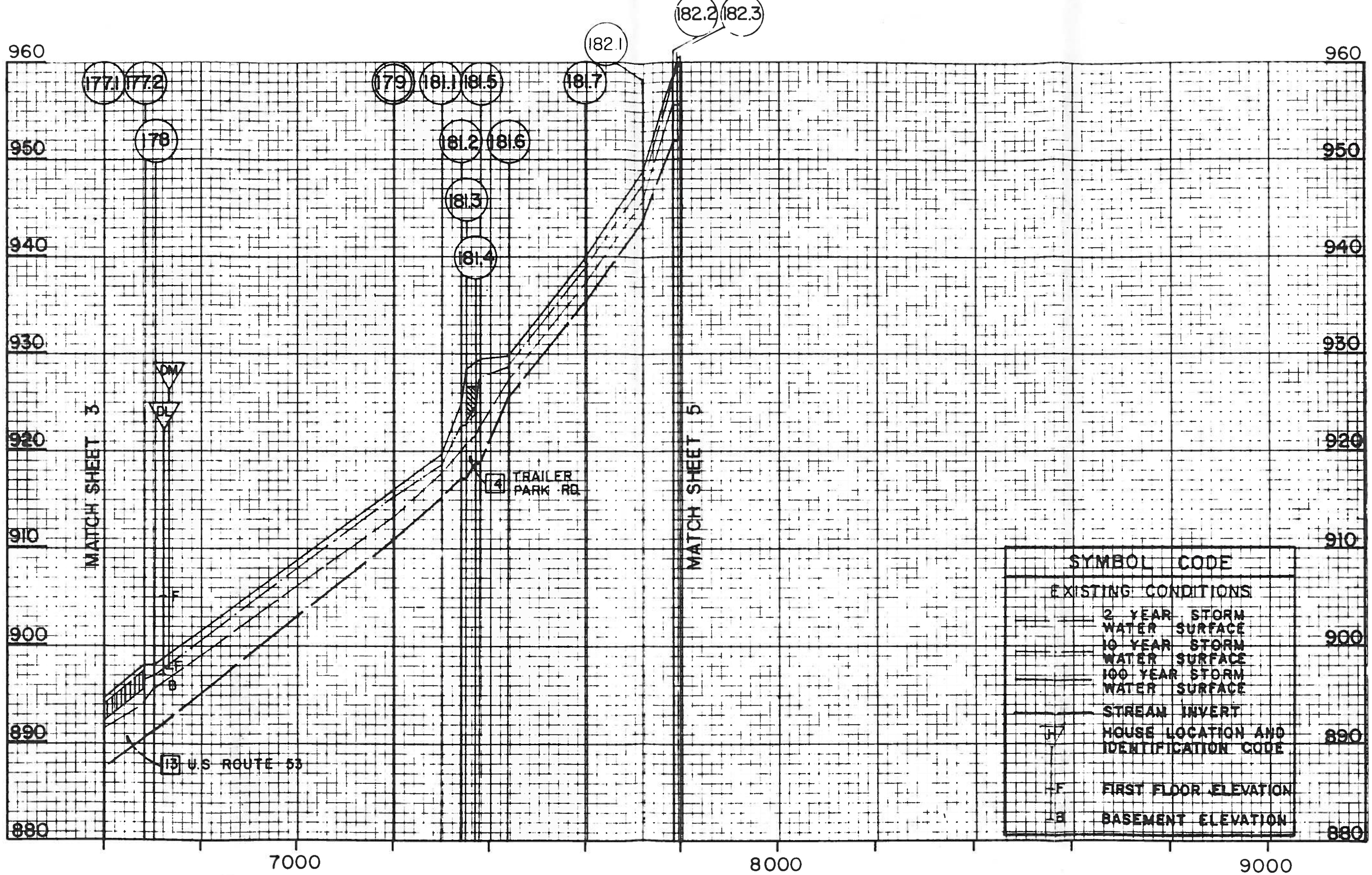
[3] STRUCTURE NUMBER

((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 1

SHEET NO. 3 OF 5



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

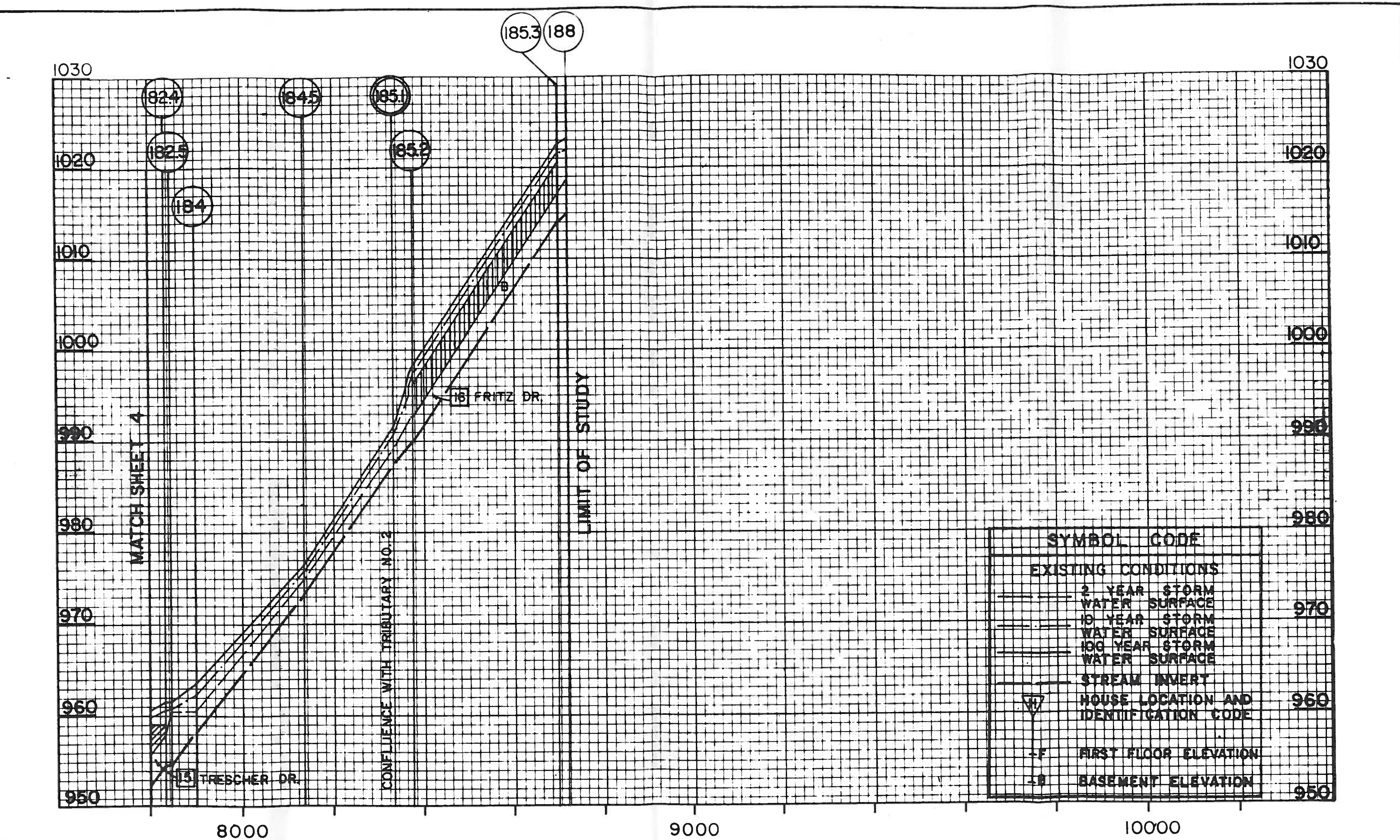
[3] STRUCTURE NUMBER

((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 1

SHEET NO.
4 OF 5



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

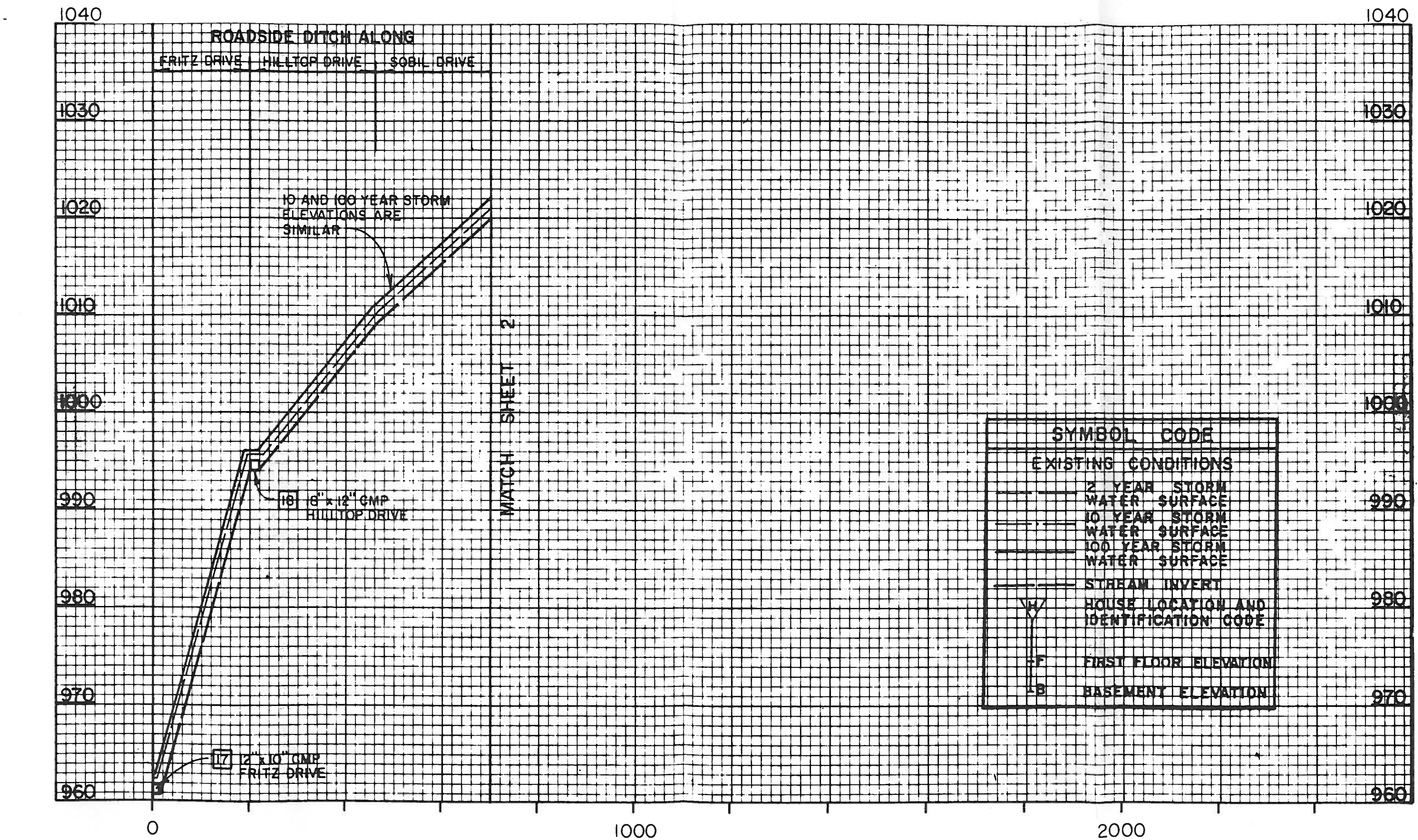
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 1

SHEET NO.
5 OF 5



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

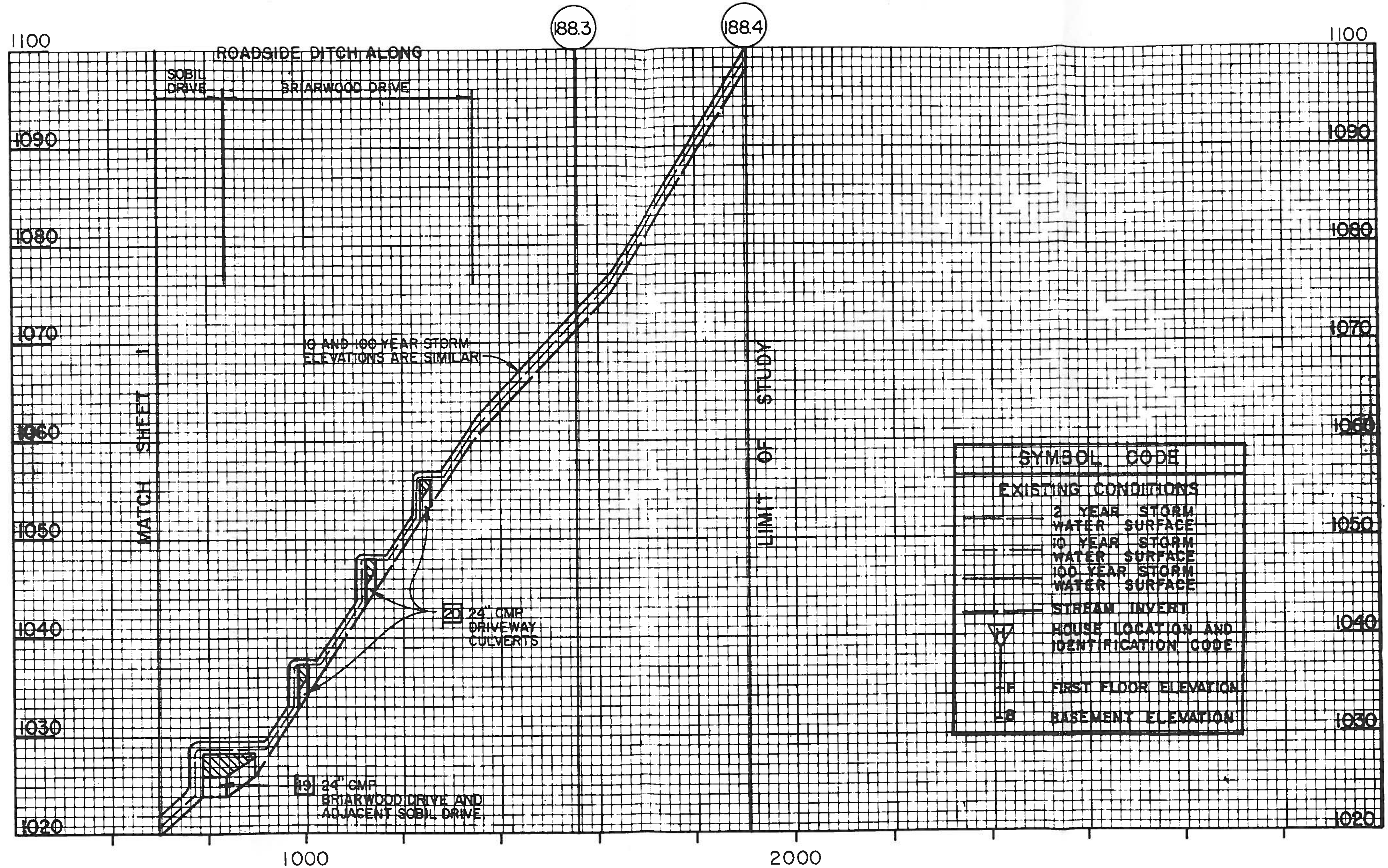
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 2

SHEET NO.
1 OF 2



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

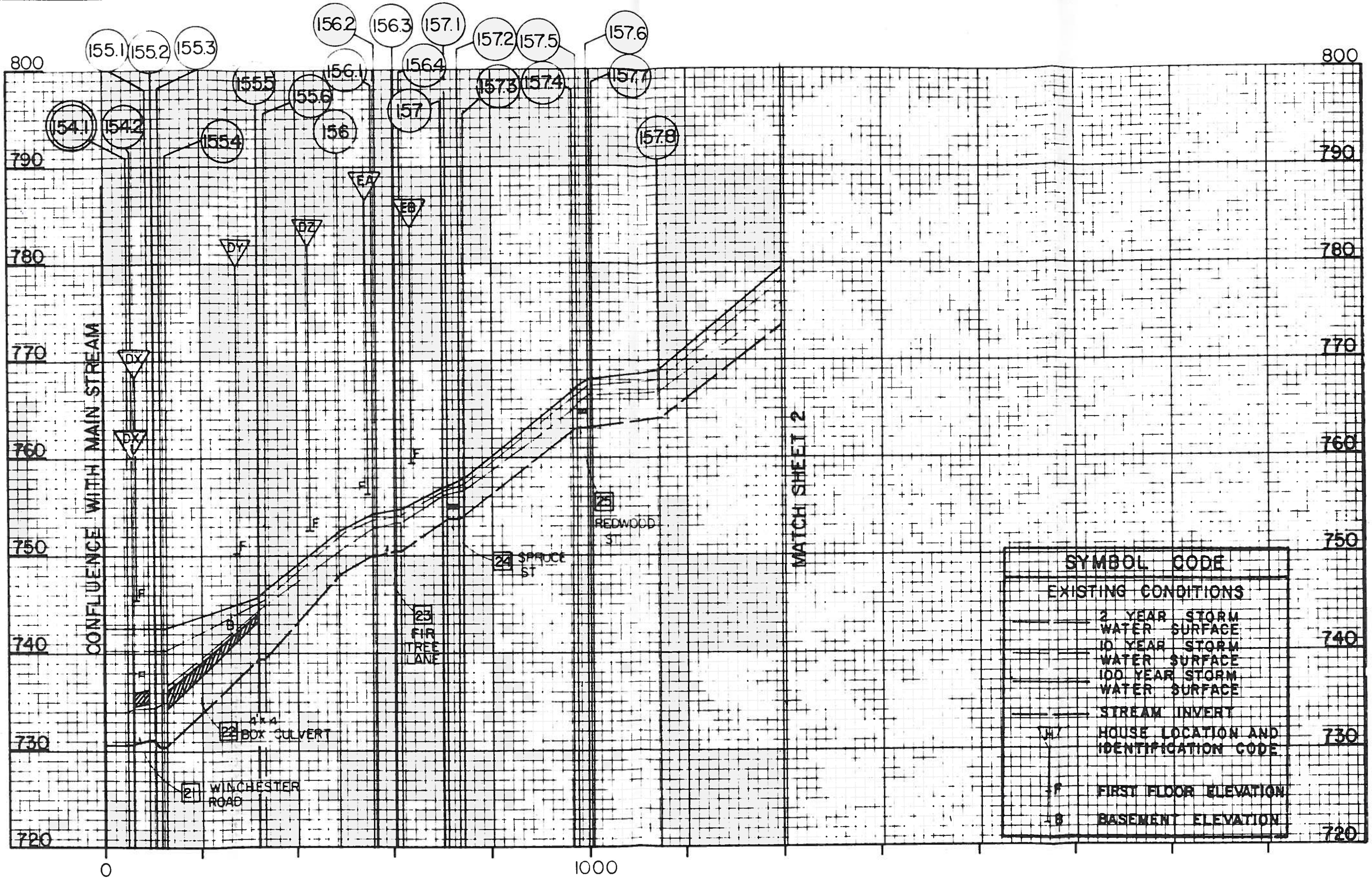
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 2

SHEET NO.
2 OF 2



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

[3] STRUCTURE NUMBER

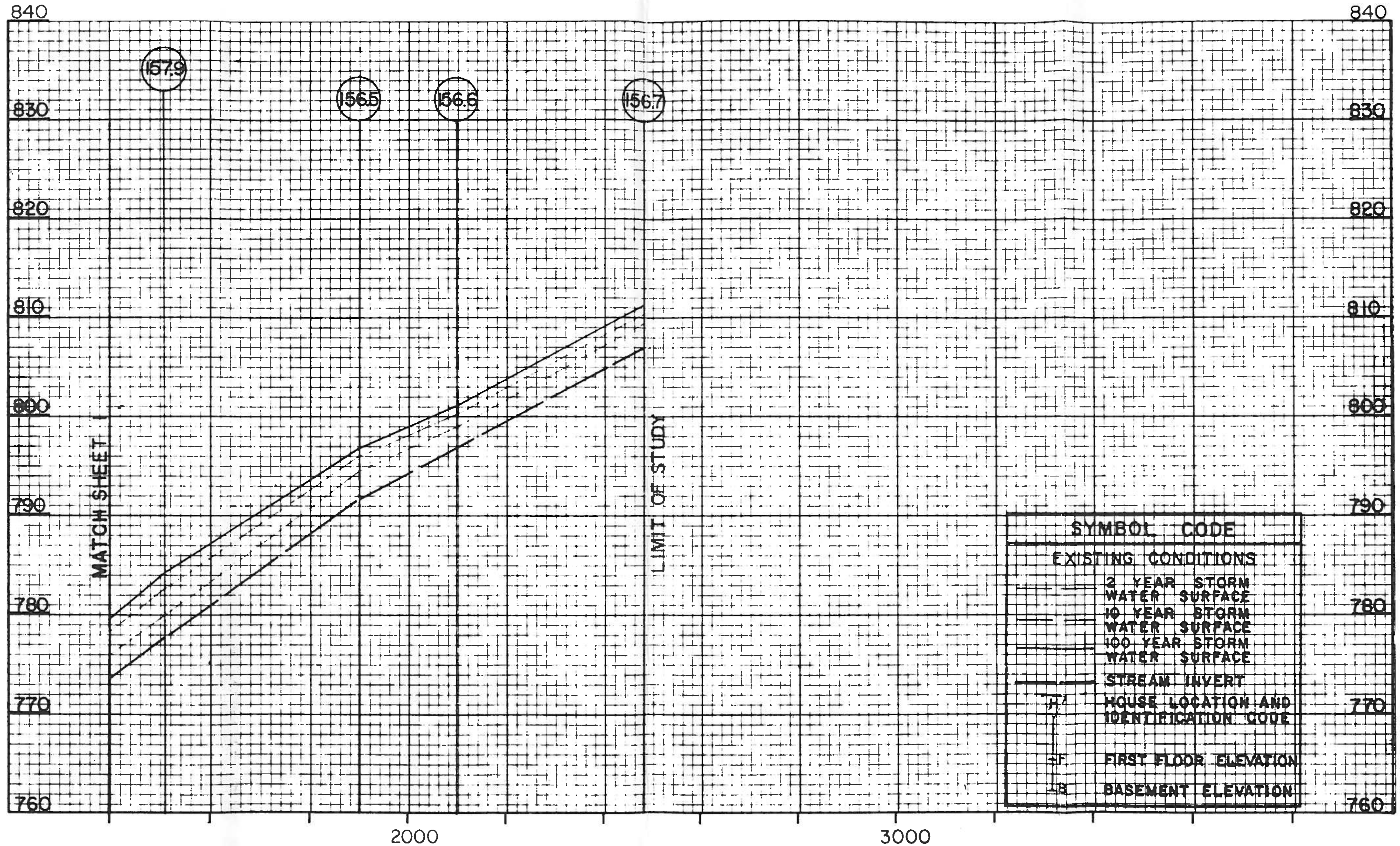
((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE

WARRIOR RUN TRIBUTARY NO. 3.

SHEET NO.
1 OF 2



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CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

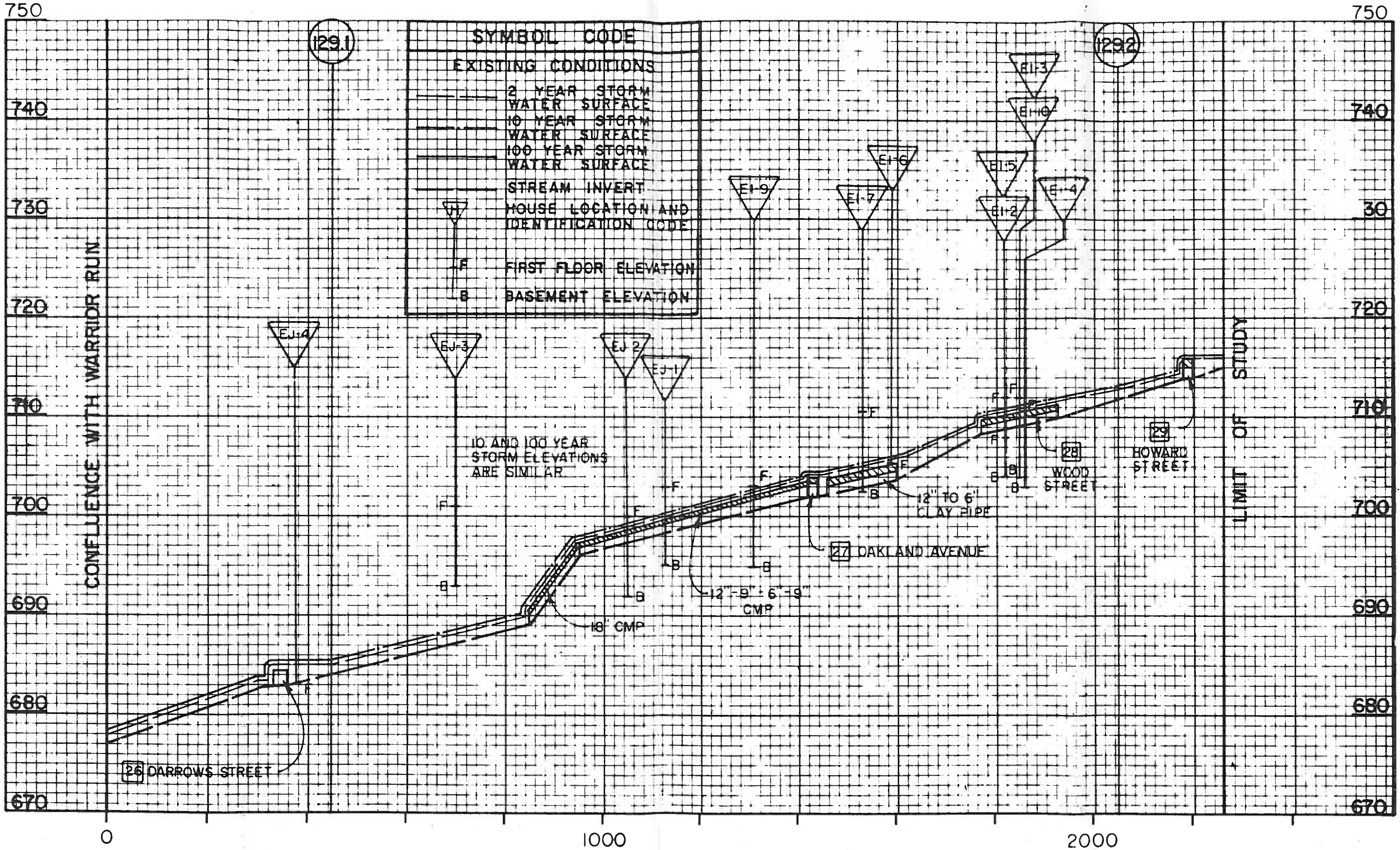
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 3

SHEET NO.
2 OF 2



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CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

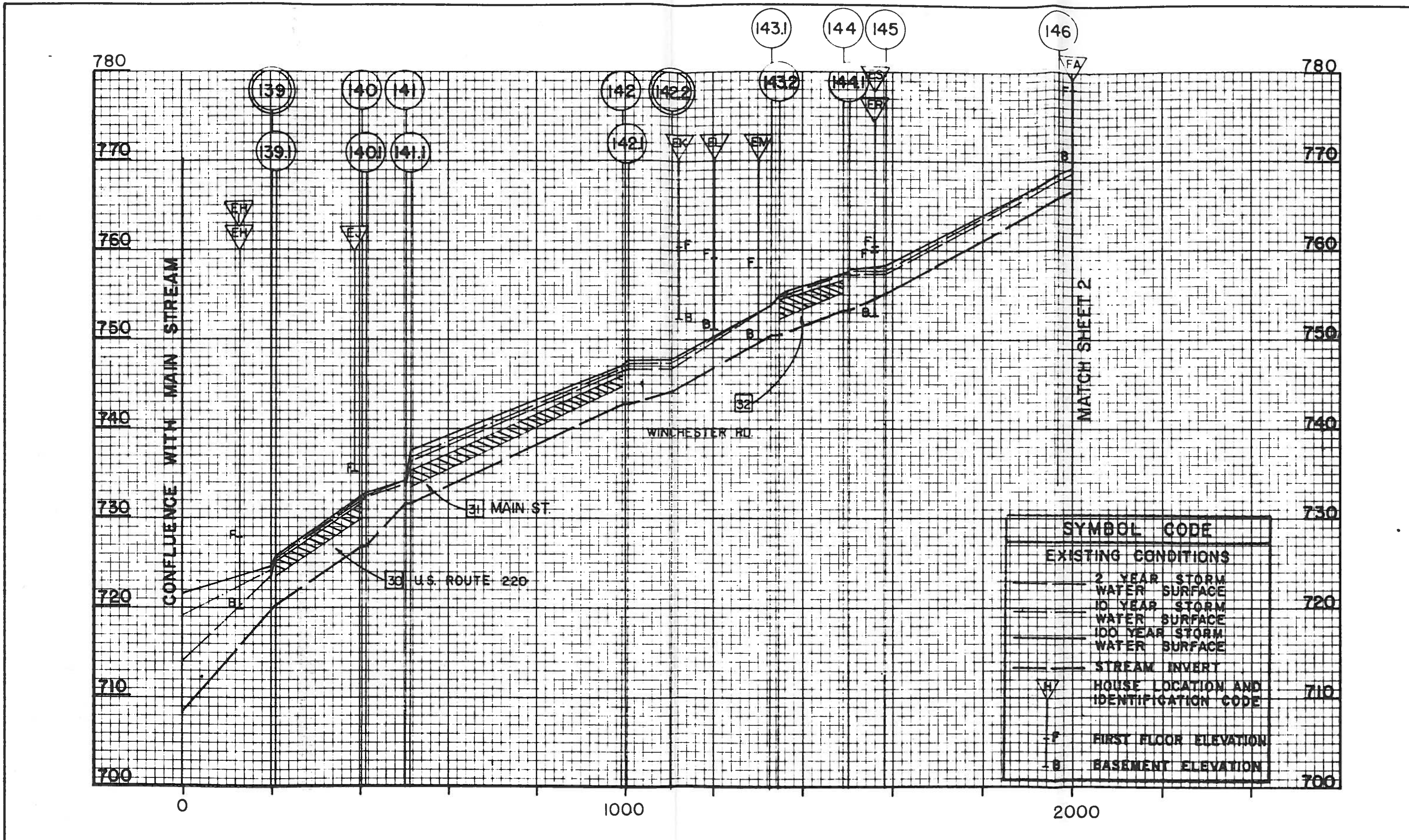
[3] STRUCTURE NUMBER

((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 4A

SHEET NO.
1 OF 1



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CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

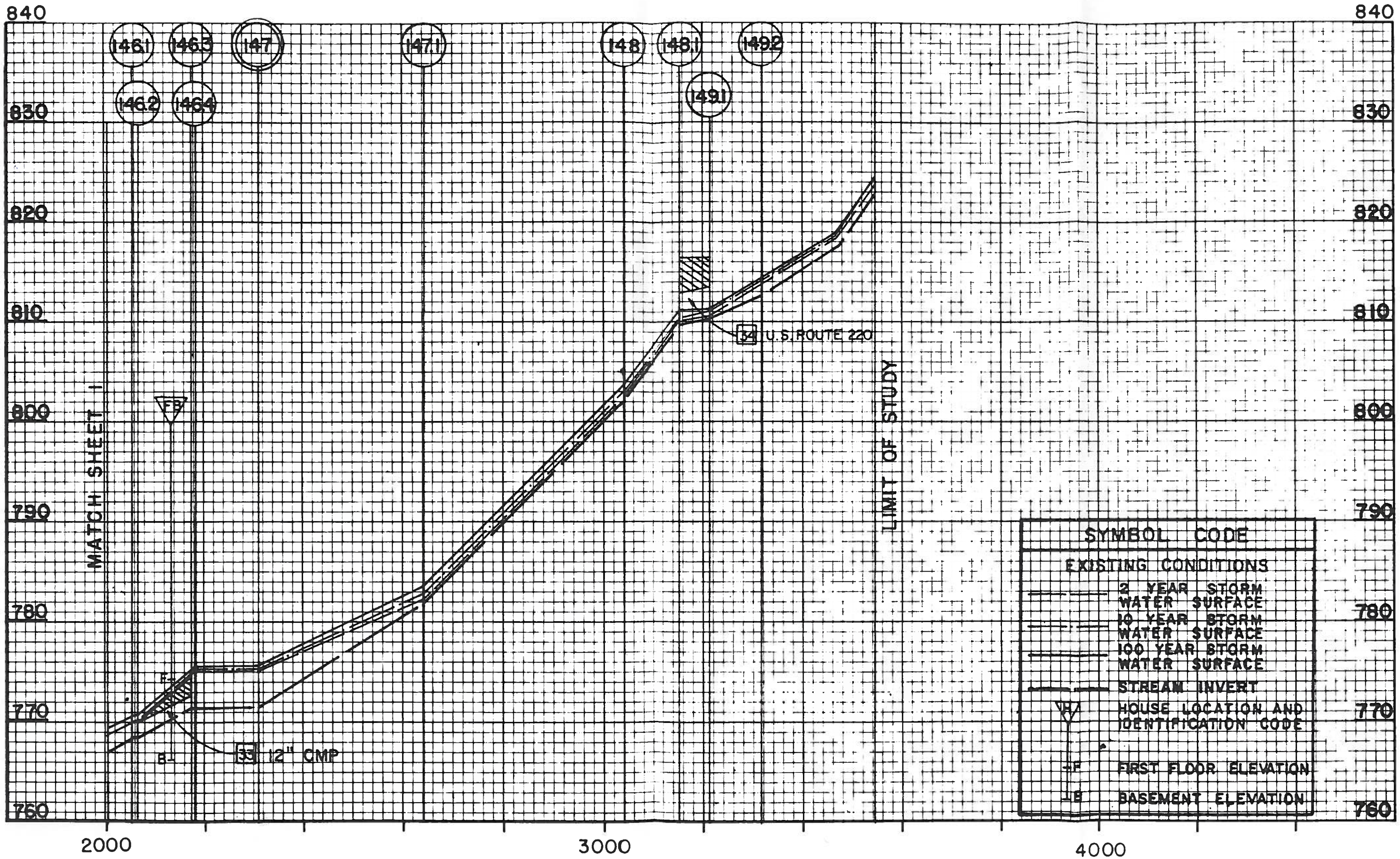
[3] STRUCTURE NUMBER

(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 4B

SHEET NO. 1 OF 2



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

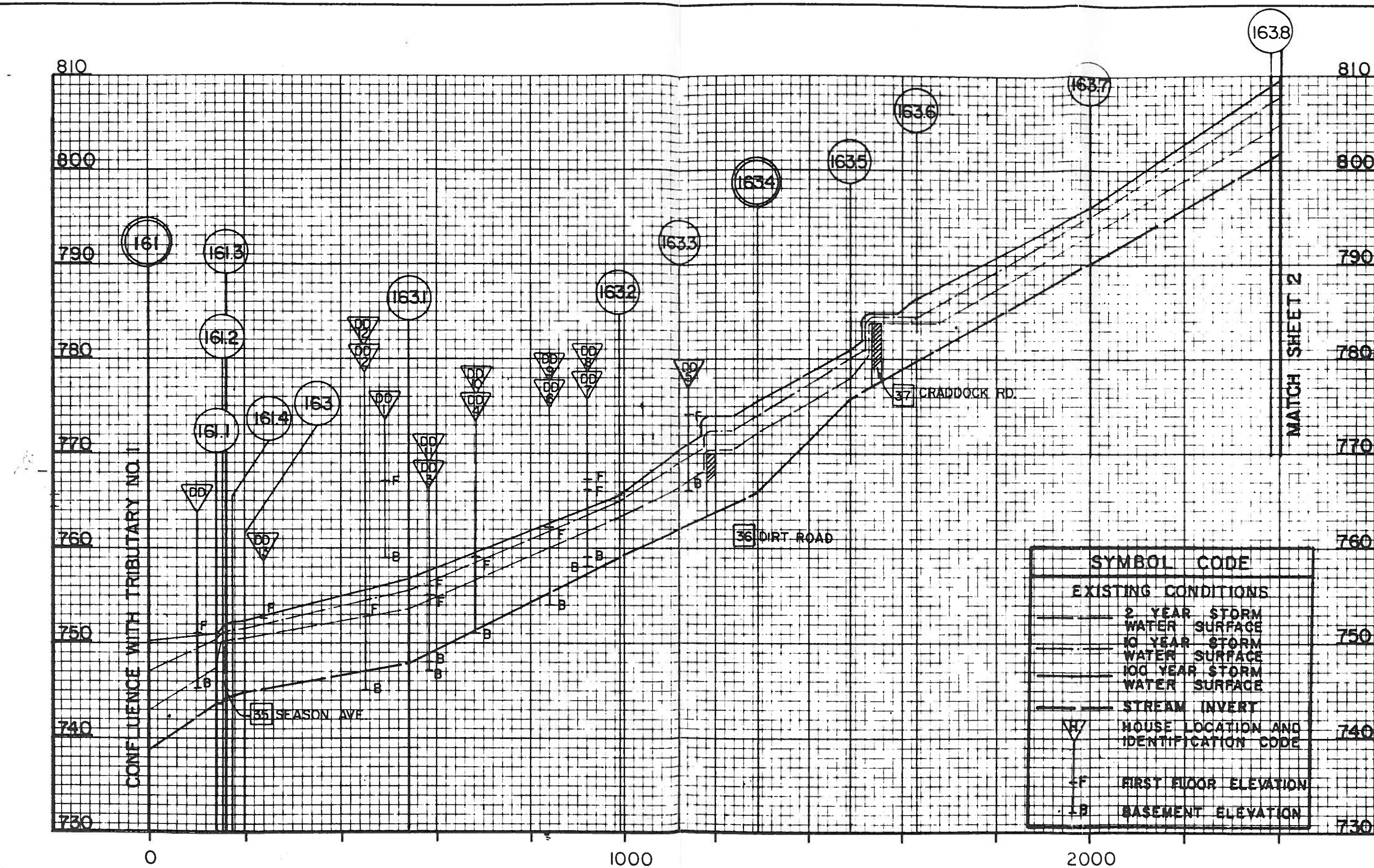
[3] STRUCTURE NUMBER

((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE
WARRIOR RUN TRIBUTARY NO. 4B

SHEET NO.
2 OF 2



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

[3] STRUCTURE NUMBER

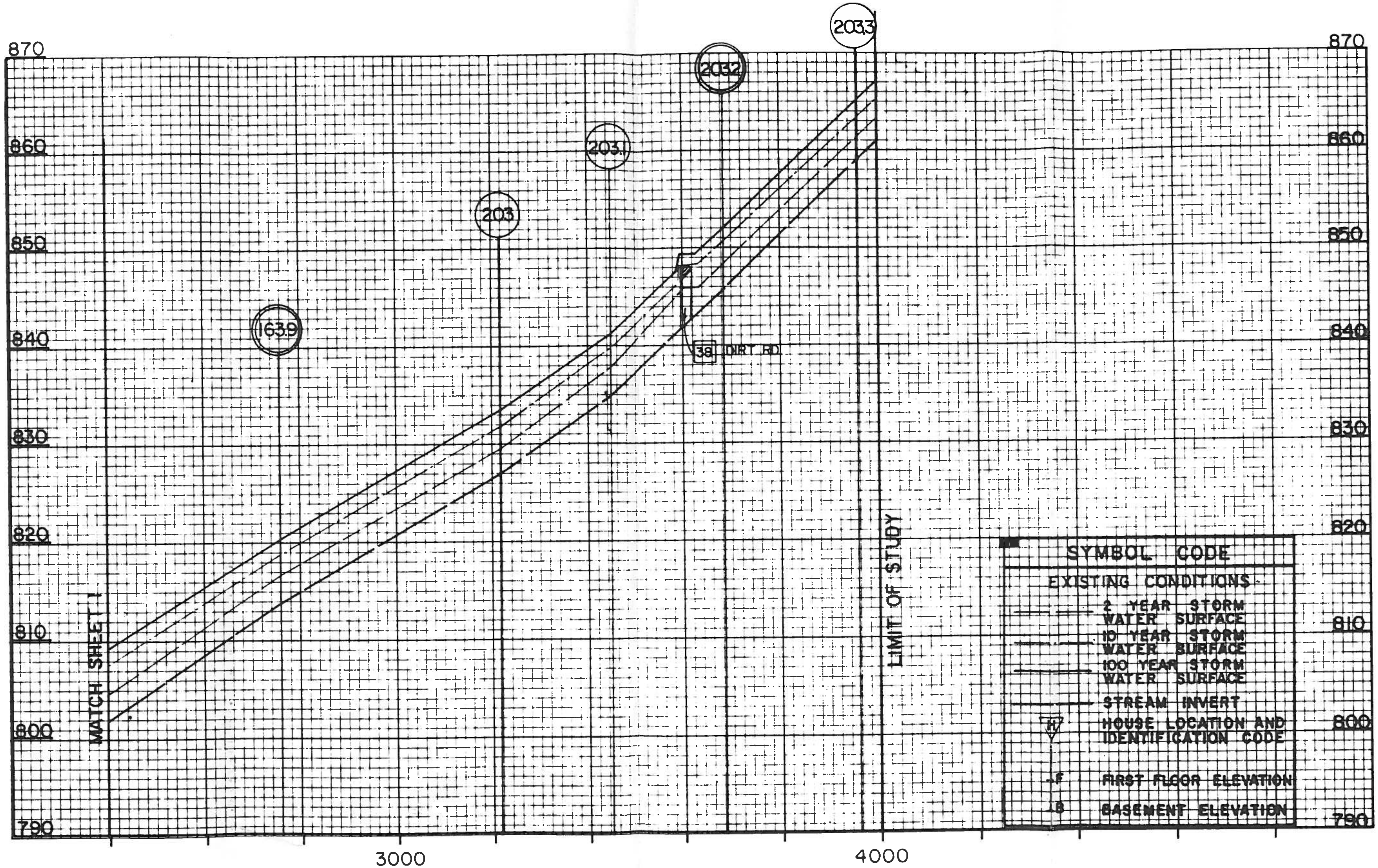
(4.0) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE

WARRIOR RUN TRIBUTARY NO. 5

SHEET NO.
1 OF 2



PURDUM & JESCHKE
CONSULTING ENGINEERS
LAND SURVEYORS

LEGEND

(4.0) CROSS SECTION NUMBER AND LOCATION

[3] STRUCTURE NUMBER

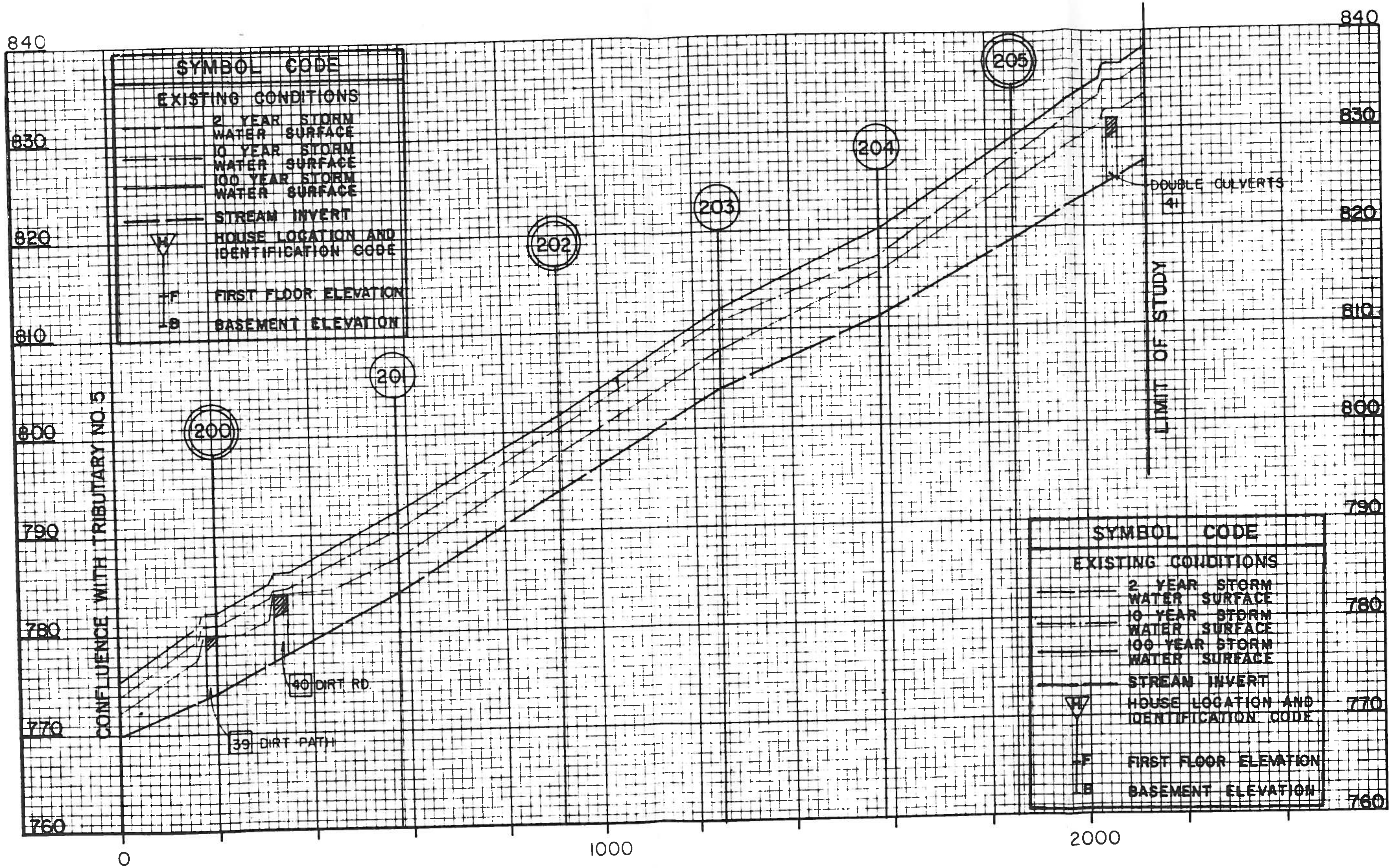
((4.0)) CROSS SECTION WHERE STREAM FLOW HAS CHANGED

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

STREAM PROFILE

WARRIOR RUN TRIBUTARY NO. 5

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'

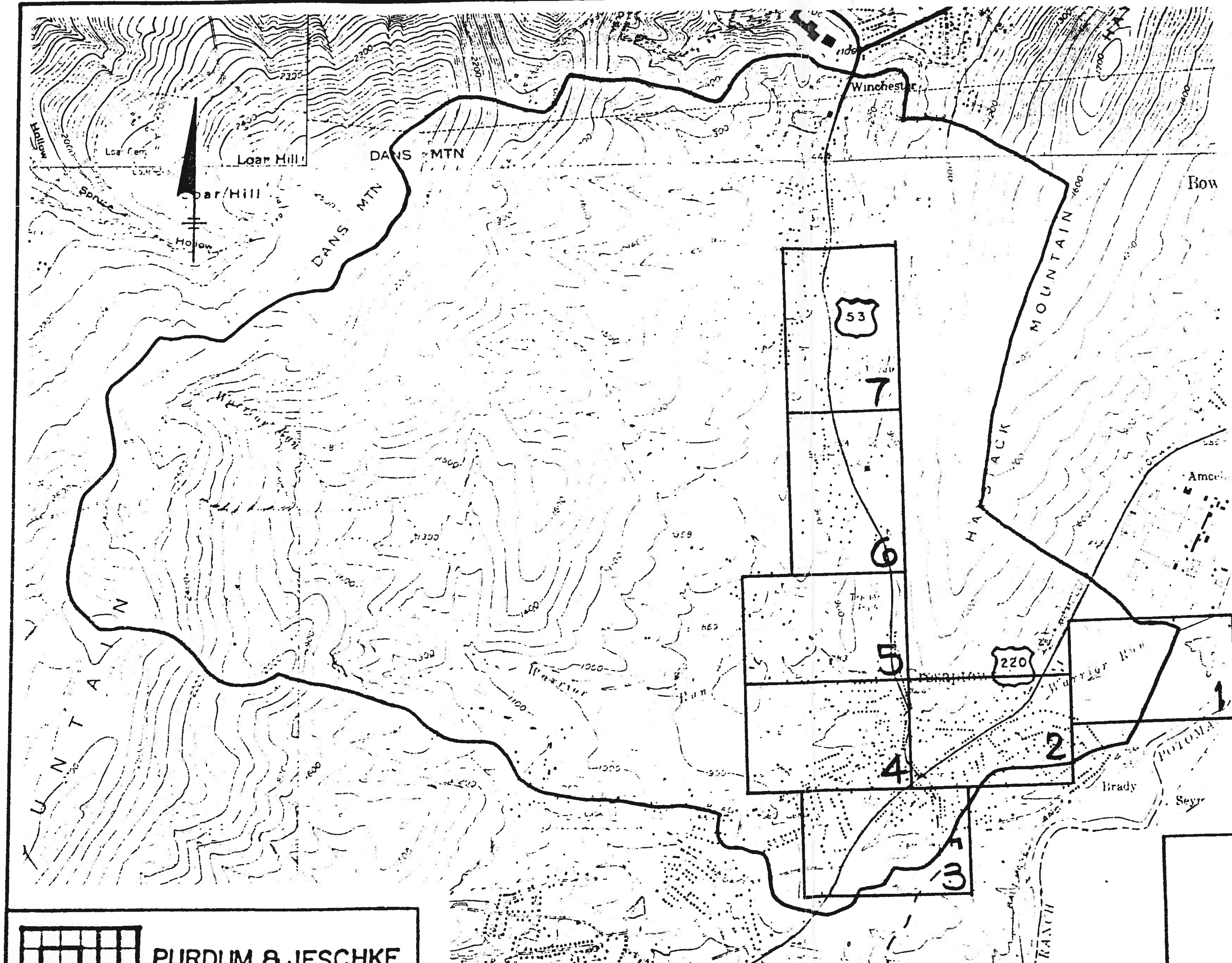
STREAM PROFILE

WARRIOR RUN TRIBUTARY NO. 5A

SHEET NO.
1 OF 1

APPENDIX E

100-YEAR FLOOD DELINEATION



LEGEND

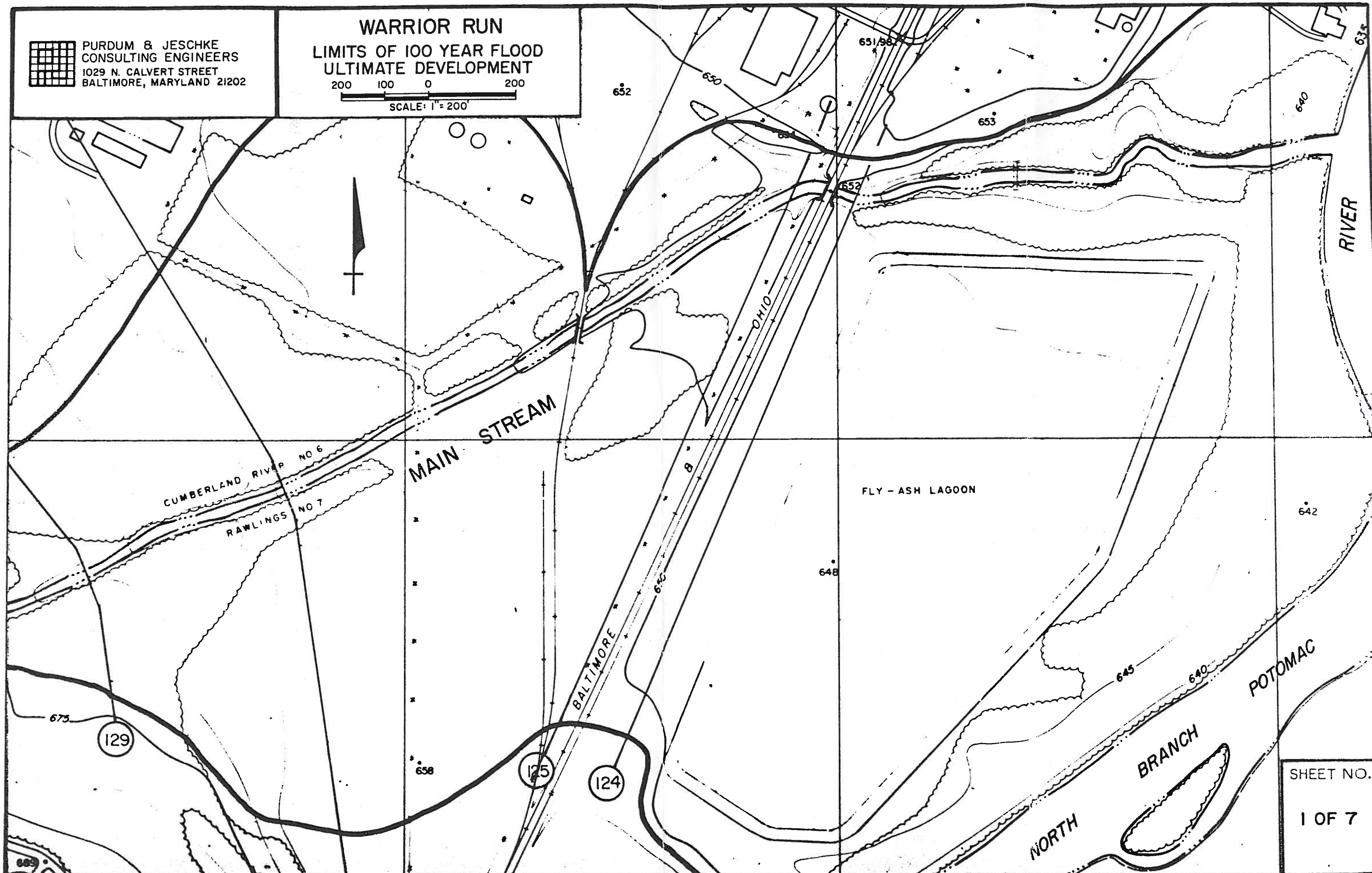
STREAM AND 100-YEAR FLOOD LIMITS
CULVERT
BRIDGE
CROSS SECTION NUMBER AND LOCATION
HOUSE IDENTIFICATION CODE

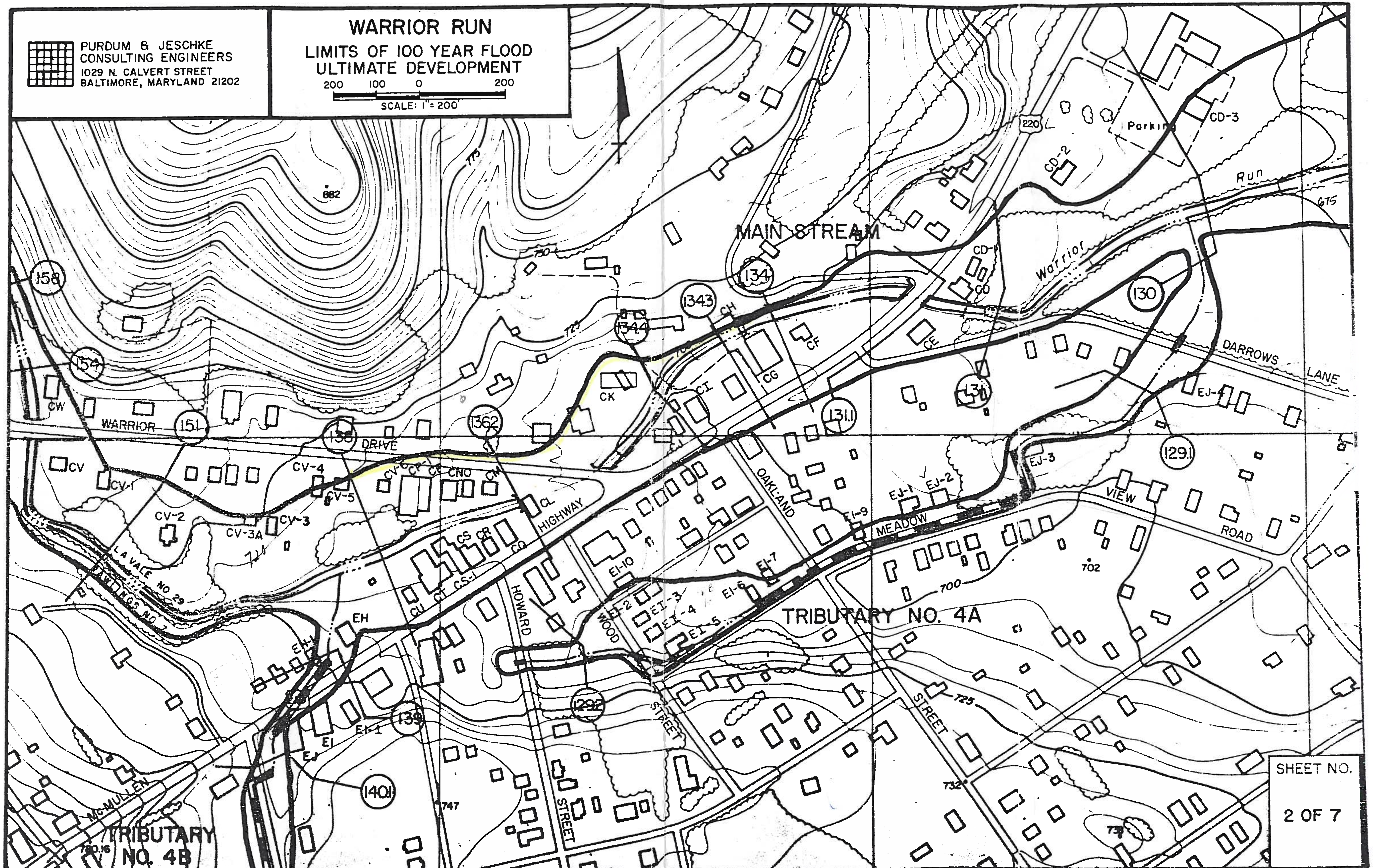
PURDUM & JESCHKE
CONSULTING ENGINEERS
AND
LAND SURVEYORS

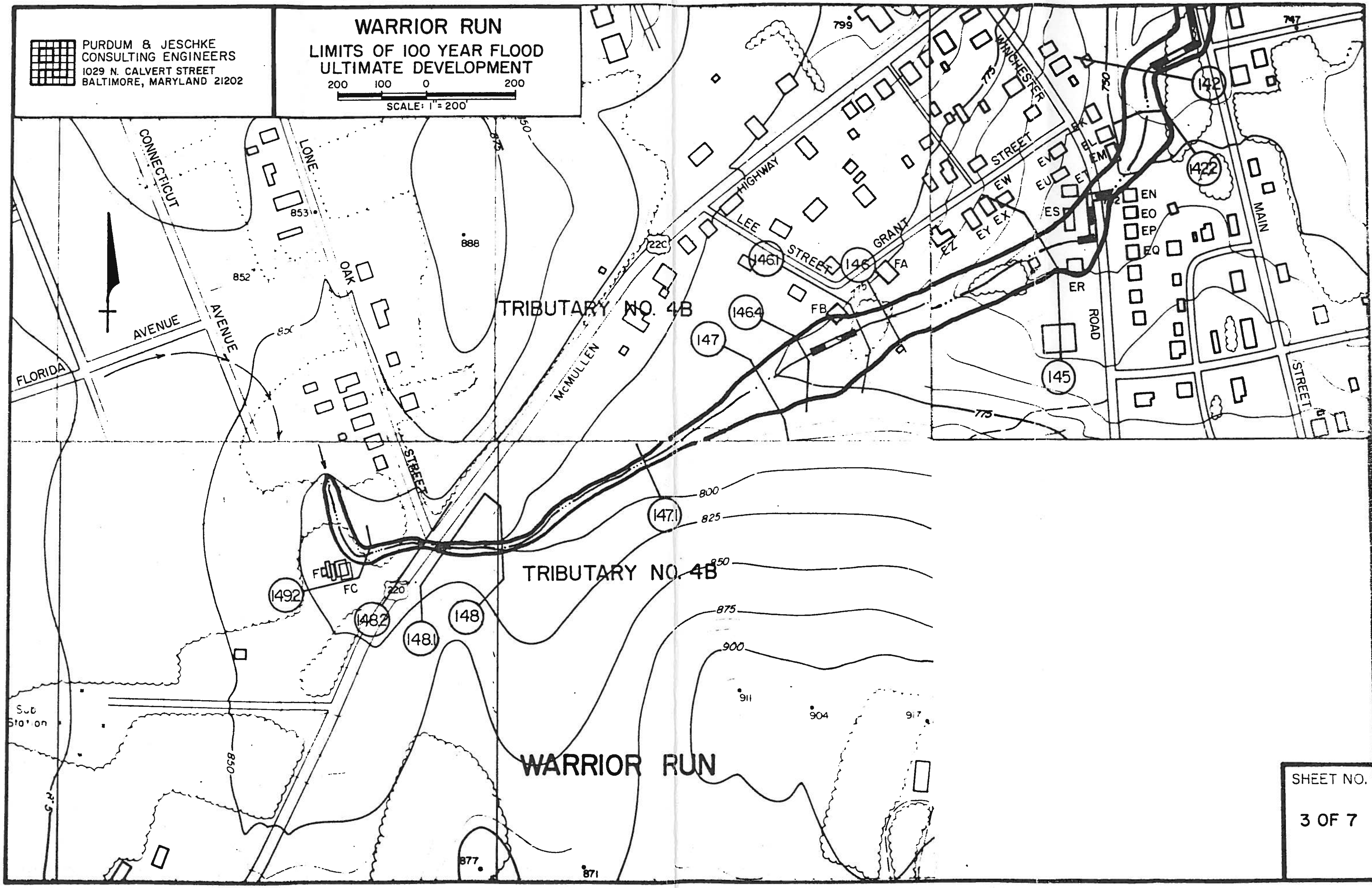
ALLEGANY COUNTY
FLOOD MANAGEMENT STUDY
WARRIOR RUN

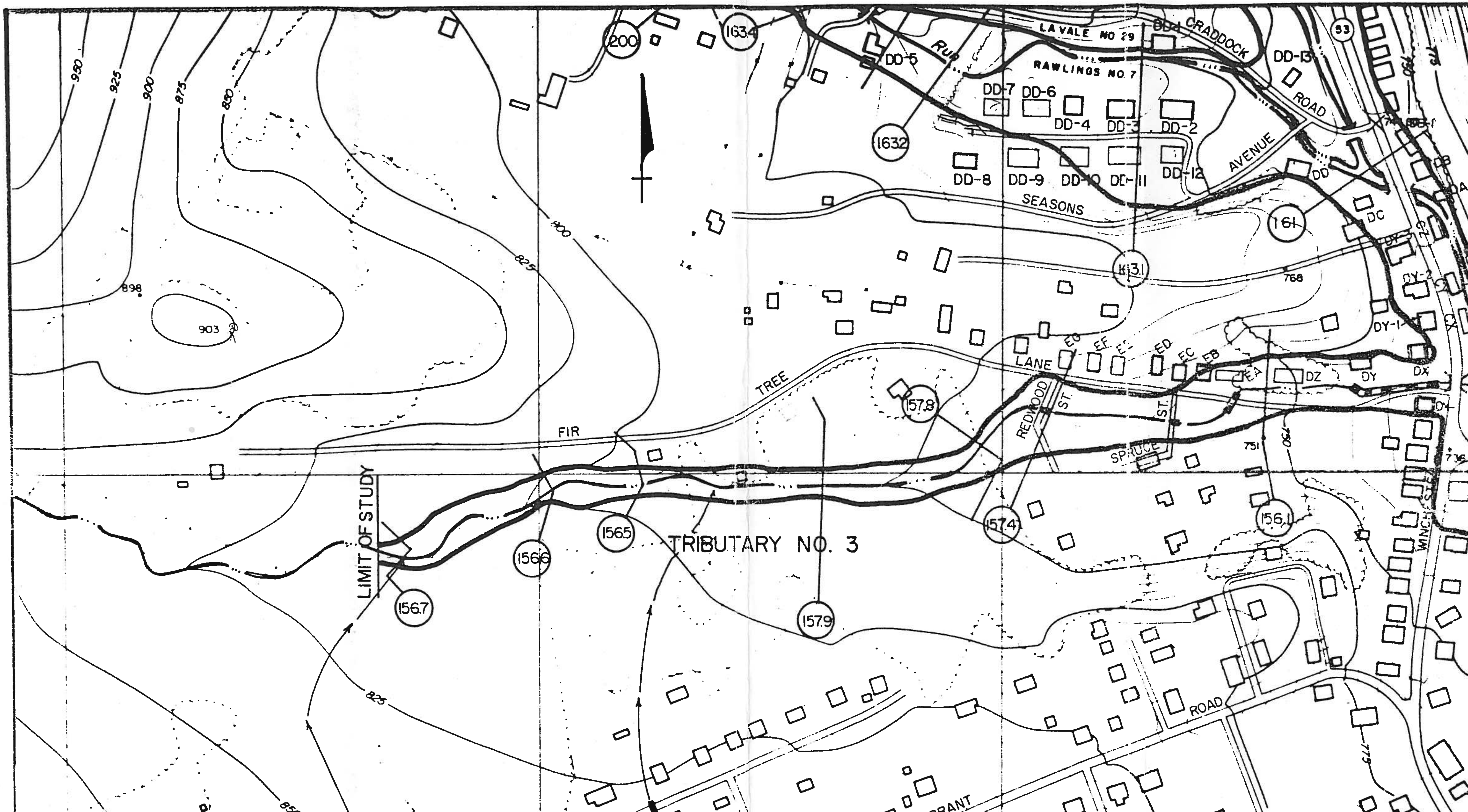
INDEX MAP

LIMITS OF 100-YEAR FLOOD
ULTIMATE DEVELOPMENT


PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202
WARRIOR RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT
200 100 0 200
SCALE: 1" = 200'
652
650
651/98
653
640
635
652
RIVER
OHIO
MAIN STREAM
CUMBERLAND RIVER NO 6
RAWLINGS NO 7
8
FLY - ASH LAGOON
642
648
650
BALTIMORE
675
129
658
125
124
645
640
POTOMAC
BRANCH
NORTH
SHEET NO.
1 OF 7


PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202
WARRIOR RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT
200 100 0 200
SCALE: 1" = 200'
MAIN STREAM
TRIBUTARY NO. 4A
TRIBUTARY NO. 4B
WARRIOR DRIVE
HIGHWAY
HOWARD STREET
WOOD STREET
OAKLAND STREET
MEADOW VIEW ROAD
DARROWS LANE
McMULLEN
LA VALE NO 29
Warrior Run
Parking
220
158
154
151
138
1362
1344
1343
134
131.1
131
130
129.1
1292
139
140.1
SHEET NO.
2 OF 7


PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202
WARRIOR RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT
200 100 0 200
SCALE: 1" = 200'
CONNECTICUT AVENUE
FLORIDA AVENUE
LONE OAK STREET
McMULLEN HIGHWAY
LEE STREET
GRANT STREET
WINCHESTER STREET
ROAD
MAIN STREET
TRIBUTARY NO. 4B
TRIBUTARY NO. 4B
WARRIOR RUN
Sub Station
149.2
148.2
148.1
148
147.1
147
146.4
146.1
146
145
142.2
142
220
22C
SHEET NO.
3 OF 7



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

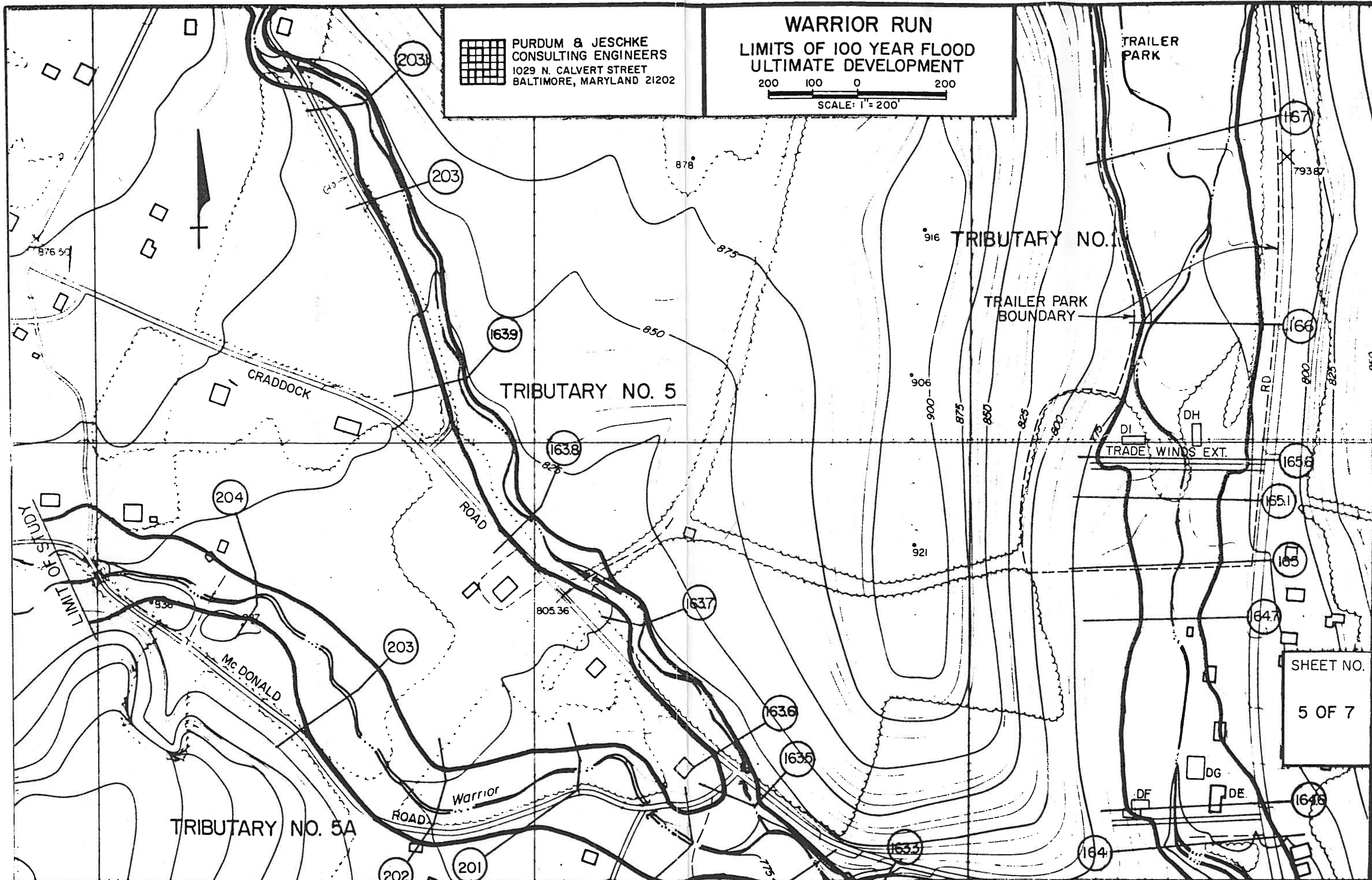
WARRIOR RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT

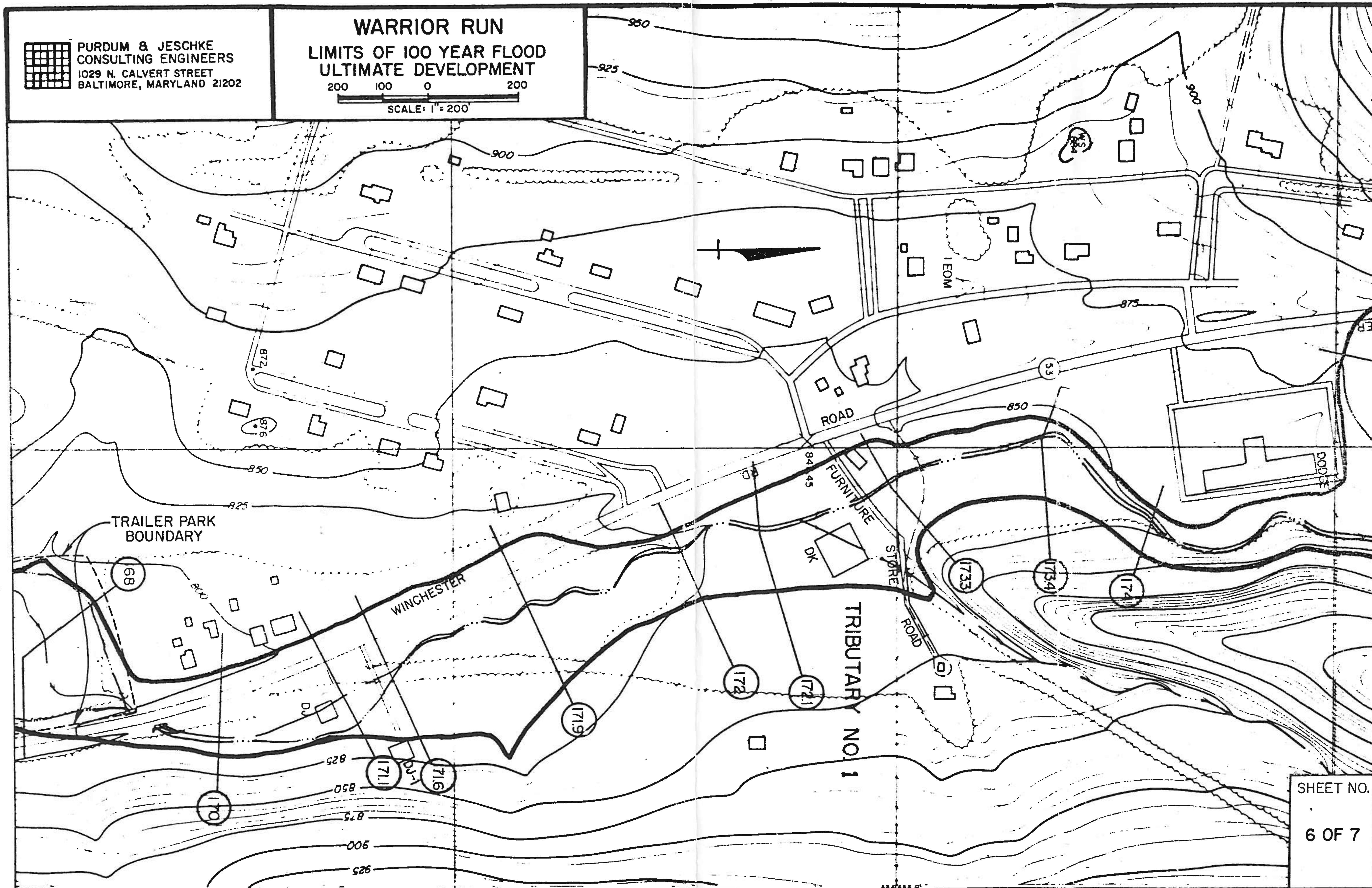
200 100 0 200

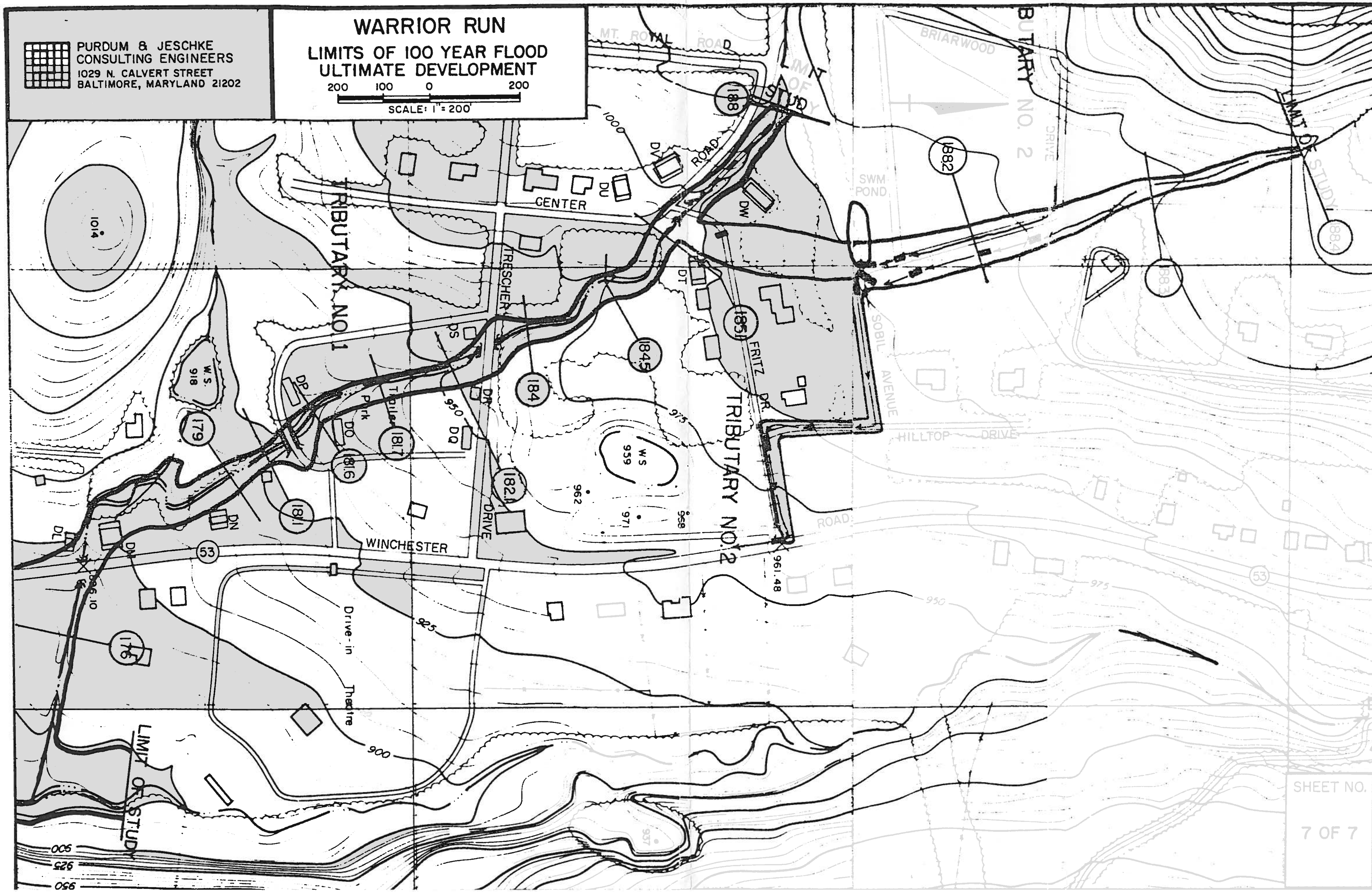
SCALE: 1" = 200'

SHEET NO.

4 OF 7


PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202
WARRIOR RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT
200 100 0 200
SCALE: 1" = 200'
TRIBUTARY NO. 5
TRIBUTARY NO. 5A
TRIBUTARY NO. 1
TRAILER PARK
TRAILER PARK BOUNDARY
CRADDOCK ROAD
McDONALD
Warrior ROAD
TRADE WINDS EXT.
RD
LIMIT OF STUDY
203.1
203
163.9
163.8
204
163.7
163.6
163.5
163.3
202
201
164
164.6
164.7
165
165.1
165.6
166
167
878
916
906
921
805.36
876.50
793.87
875
850
825
800
775
900
DH
DI
DG
DE
DF
SHEET NO.
5 OF 7


PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202
WARRIOR RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT
200 100 0 200
SCALE: 1" = 200'
TRAILER PARK
BOUNDARY
WINCHESTER
ROAD
FURNITURE
STORE
ROAD
TRIBUTARY NO. 1
DODGE
168
170
171.1
171.6
171.9
172
172.1
173.3
173.4
174
DJ
DJ-1
DK
53
950
925
900
875
850
825
SHEET NO.
6 OF 7



PURDUM & JESCHKE
CONSULTING ENGINEERS
1029 N. CALVERT STREET
BALTIMORE, MARYLAND 21202
WARRIOR RUN
LIMITS OF 100 YEAR FLOOD
ULTIMATE DEVELOPMENT
200 100 0 200
SCALE: 1" = 200'
TRIBUTARY NO. 1
TRIBUTARY NO. 2
WINCHESTER
DRIVE
TRESCHER
CENTER
ROAD
MT. ROYAL ROAD
FRITZ DR.
SOBIL AVENUE
HILLTOP DRIVE
BRIARWOOD
SWM POND
Drive-in Theatre
Trailer Park
LIMIT OF STUDY
961.48
SHEET NO.
7 OF 7