ANALYSIS OF FLOODING
WILLS CREEK
ALLEGANY COUNTY, MARYLAND

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Water Resources Administration
Flood Management Division

Maryland Department of Natural Resources

Tawes State Office Building
Annapolis, Maryland 21401

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1. INTRODUCTION

This study was performed for the Allegany County Department of Planning and Zoning, at the request of the County Commissioners. In August 1984, Allegany County suffered severe damages as Wills Creek flooded in the Cumberland area. Residents in Locust Grove and in Ellerslie a few miles north, experienced the most damage. Approximately 12 homes were flooded in these two areas, some with as much as three feet of water above the first floor. Due to this recent flood and citizen inquiries, the County has expressed an interest in expanding its current acquisition program to include flood-prone homes along Wills Creek. In order to receive matching funds from the State's Flood Management Grant Program the qualifying homes must have a history of repeated flood damage or be identified by a technical watershed study. Prior to this current study the only available data were contained in the 1981 Flood Insurance Study (FIS) which was shown to be inaccurate following the 1984 flood. The purposes of this study are to revise the flood insurance study data and to identify structures within the 100-year floodplain. This information can be utilized by the County to request a change in the FIS and to develop a list of residences eligible for acquisition. Based on available County matching funds, applications to the Comprehensive Flood Management Grant Program may be made over the next few years.

2. SCOPE OF STUDY

The study area includes Wills Creek from Locust Grove upstream to the Pennsylvania line, including two small tributaries which drain through Ellerslie (Figure 1). Figures 2 and 3 indicate homes in the study area which were included in the investigation.

The scope of study consists of the following:

1. Re-compute the 2, 10 and 100-year discharges for Wills Creek
2. Extend the existing HEC-2 (FIS) to include Ellerslie
3. Develop discharges and HEC-2 model for 2 small tributaries in Ellerslie
4. Survey houses along Wills Creek in Locust Grove and Ellerslie to determine eligibility for acquisition
5. Investigate alternatives other than acquisition that might reduce the flood hazards
6. Re-map the 100-year floodplain using updated discharges

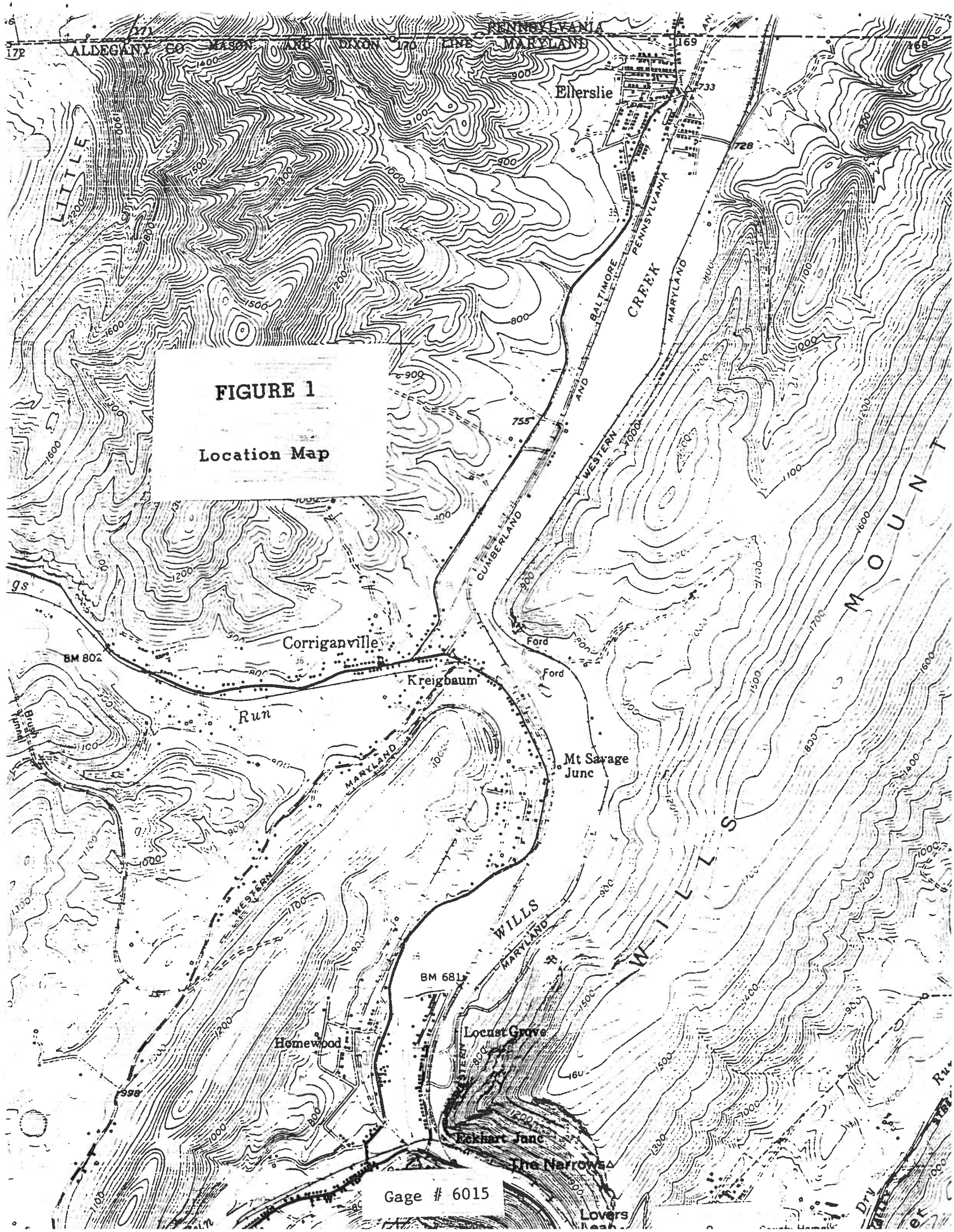
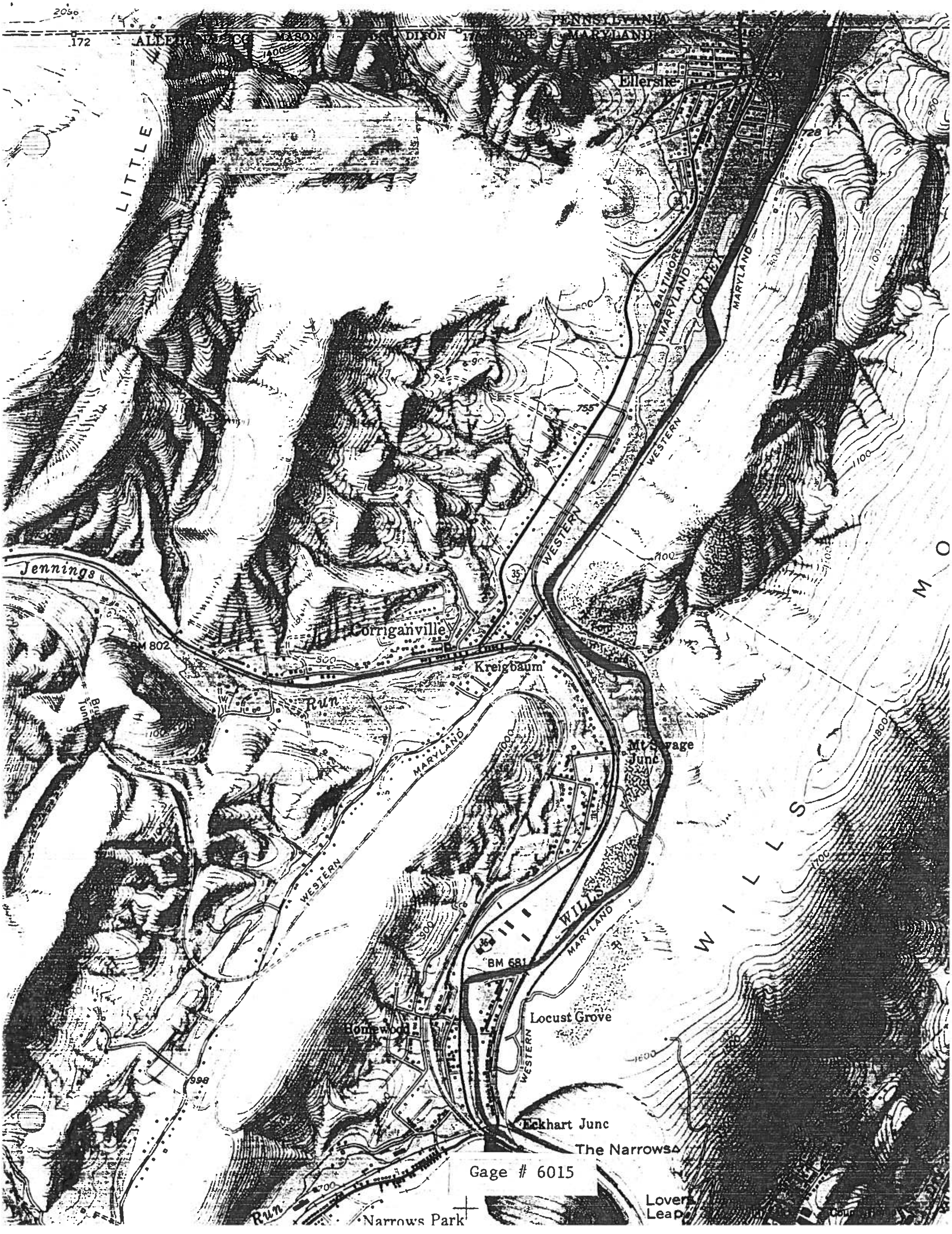


FIGURE 1
Location Map
PENNSYLVANIA
ALLEGANY CO MASON AND DIXON LINE MARYLAND
Ellerslie
LITTLE
CREEK
BALTIMORE AND
PENNSYLVANIA
MARYLAND
CUMBERLAND AND WESTERN
Corriganville
Kreigbaum
BM 802
Run
Ford
Mt Savage Junc
WILLS MOUNT
WILLS
MARYLAND
WESTERN
BM 681
Locust Grove
Homewood
Eckhart Junc
The Narrows
Lovers
Brush Tunnel
Gage # 6015


PENNSYLVANIA
MARYLAND
Ellerslie
LITTLE
BALTIMORE
MARYLAND
CREEK
WESTERN
MARYLAND
WESTERN
Jennings
BM 802
Corriganville
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Homewood
WESTERN
Eckhart Junc
The Narrows
Gage # 6015
Run
Narrows Park

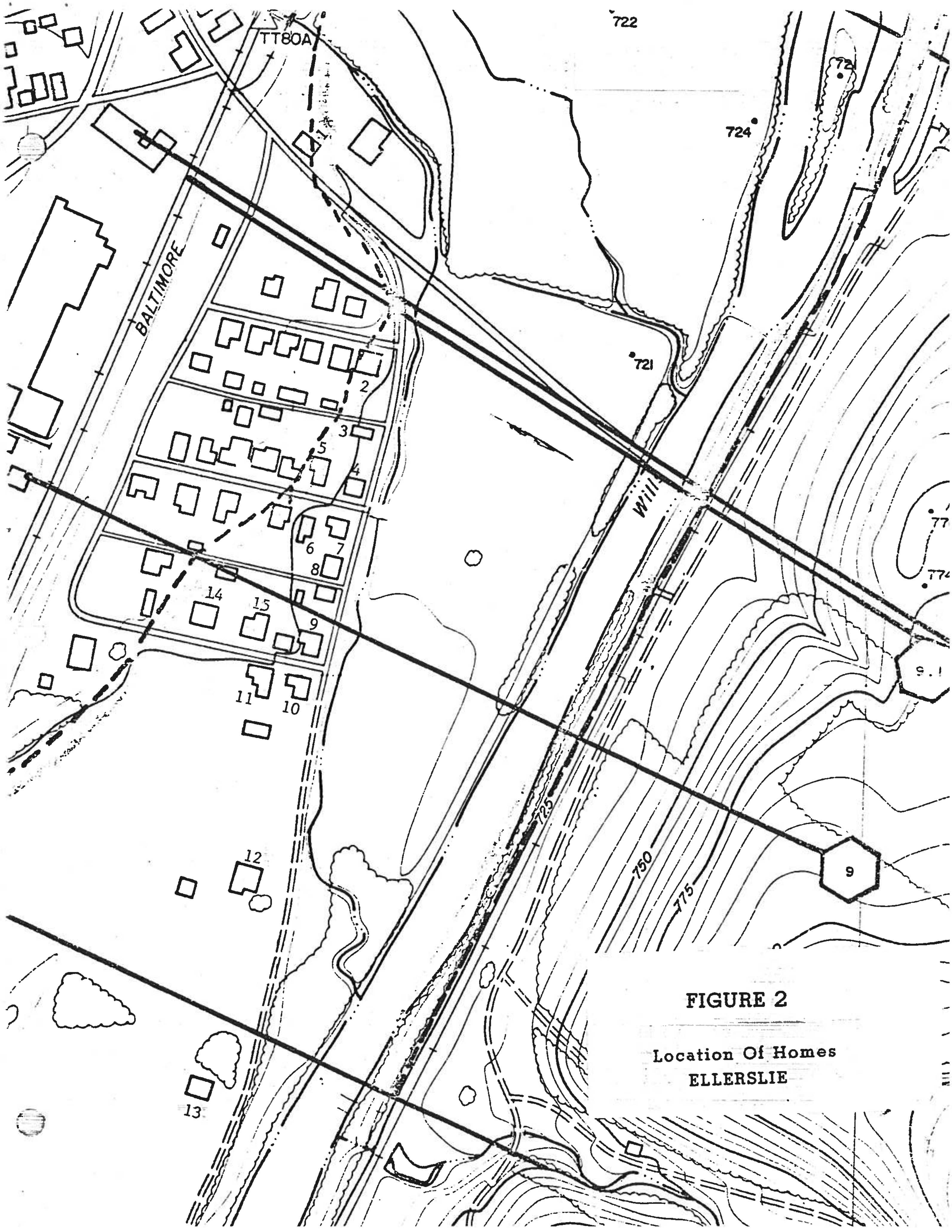

FIGURE 2

Location Of Homes
ELLERSLIE

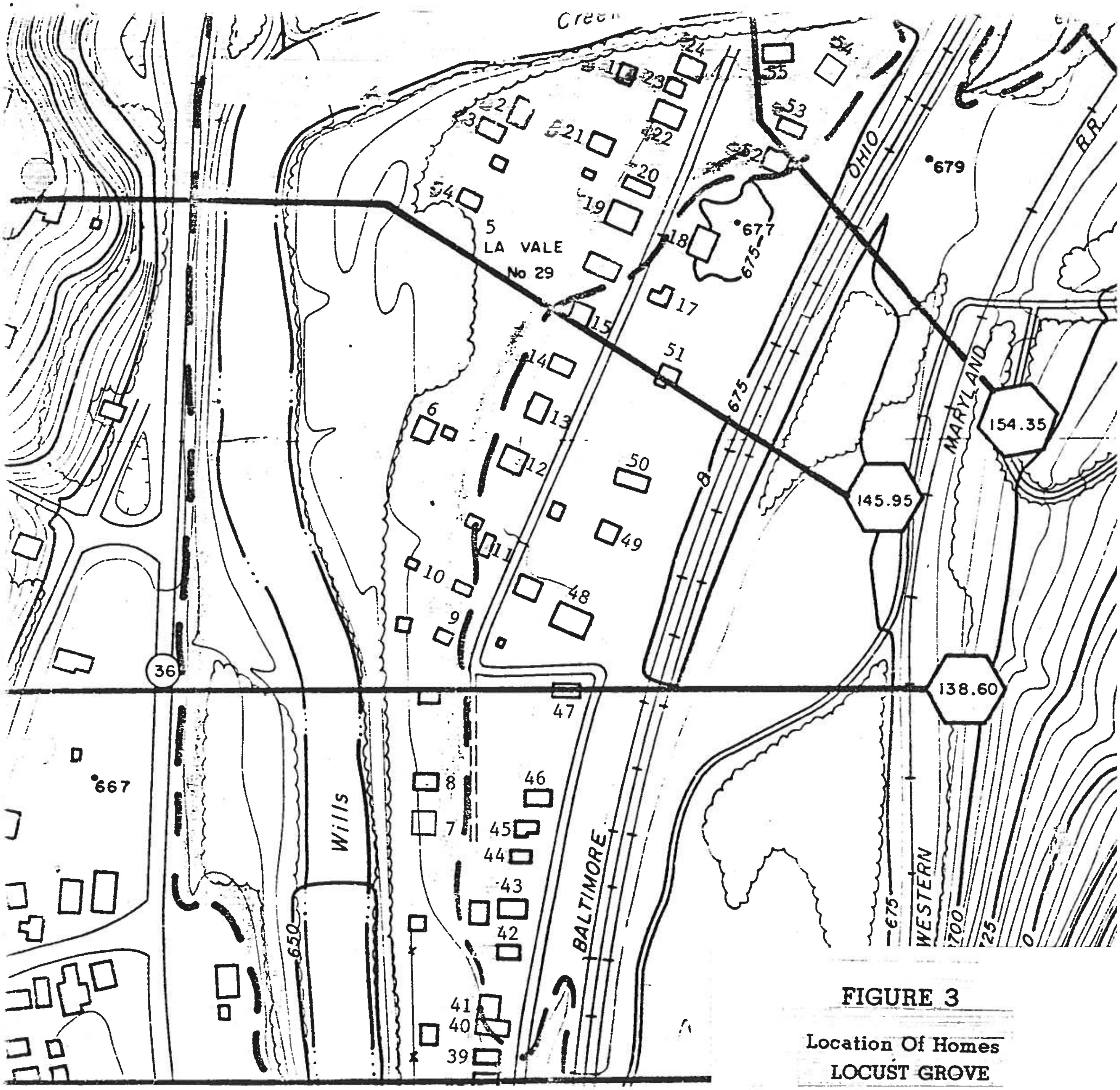

FIGURE 3

Location Of Homes

LOCUST GROVE

3. HYDROLOGIC ANALYSIS

A Log-Pearson Type III analysis was performed to determine the 2, 10 and 100-year peak discharges for the Wills Creek study area shown on Figure 1. There are two USGS stream gages located on Wills Creek; one in Cumberland (#6015) and the other in Hyndman, Pennsylvania (#6010). The Cumberland gage has a drainage area of 247 square miles and 55 years of record. At Hyndman, Wills Creek drains 146 square miles and has 31 years of record. Using the results of the Log-Pearson analysis a series of discharge-drainage area curves (Figure 4) were plotted on log paper for the 2, 10, and 100-year frequencies. These curves were used to determine discharges for the areas along Wills Creek upstream of Jennings Run. Below the confluence of Jennings Run the Cumberland gage data were used. This assumes that Braddock Run does not contribute significantly to the peak discharge since it enters Wills Creek just a few hundred feet upstream of the gage and drains an area of only 16 sq. miles which is small compared to the total drainage area.

TABLE 1

Discharges for Wills Creek (cfs)

Frequency	Gage #6015	Above Jennings Run
2-year	6,150	5,300
10-year	13,300	10,600
100-year	28,750	20,500

In addition to the main stem of Wills Creek, two unnamed tributaries in Ellerslie were studied. The southern Tributary #1 has a drainage area of 1.9 square miles. Tributary #2 to the north drains 0.3 square miles. Discharges were computed using the U.S.D.A. Soil Conservation Service TR-55, Urban Hydrology for Small Watersheds. This procedure offers the user a choice of methods. The tabular method allows routing and produces a flood hydrograph while the graphical method produces a peak discharge only. Input parameters consist of drainage area, time of concentration (Tc), travel time (Tt), runoff curve number (RCN), and rainfall amount. Initially, the graphical method was used to develop a peak discharge. For comparison purposes, the drainage area was subdivided and the tabular method applied to route the flood hydrographs to a selected point. Both methods yielded similar results and are summarized in Table 2.

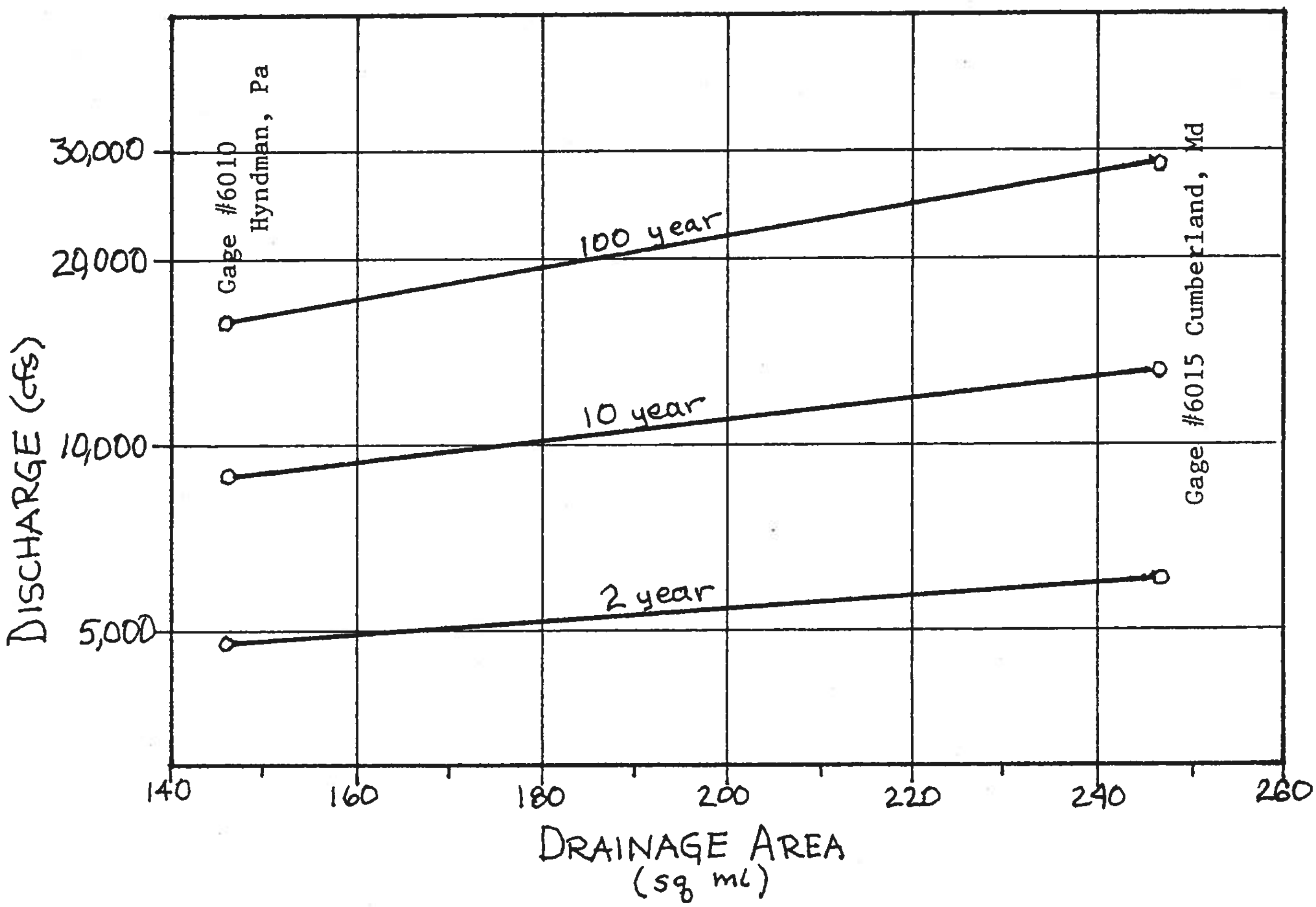

FIGURE 4

Discharge-Drainage Curves

TABLE 2

Discharges for Tributaries in Ellerslie (cfs)

Frequency	Tributary 1	Tributary 2
2-year	76	14
10-year	502	92
100-year	1,173	214

4. HYDRAULIC ANALYSIS

Water surface profiles were developed for the 2, 10 and 100-year frequency events using the U.S. Army Corps of Engineers HEC-2 water surface profile computer program. The study reaches include Wills Creek from Locust Grove to the Pennsylvania line, and two small tributaries in Ellerslie. The 1981 FIS study generated a HEC-2 model for Wills Creek through Cumberland to a point above the confluence with Jennings Run. Cross sections from the FIS model were used in this study except in Locust Grove where three bridges were resurveyed. For the area above Jennings Run and for the two small tributaries in Ellerslie, new bridge and valley cross sections were surveyed. All surveys were referenced to the National Geodetic Vertical Datum of 1929.

Starting water surface elevations required as input to the hydraulic model were obtained from a USGS rating curve for the Cumberland gage (#6015). In Ellerslie, the slope area method was used to provide these elevations.

Calibration for the HEC-2 models was performed using a series of high water marks from the 1984 flood. This storm closely approximates the 100-year event and proved extremely helpful in tuning the model. The model was assembled using the necessary input parameters. Some of the variables (e.g. frictional loss coefficients for channels, floodplains and bridges) are not known exactly and are based on field evaluation. Calibration is performed by running the model with a known discharge (1984 storm) and by adjusting unknown variables until the model closely approximates the actual observed flood elevations. Once accomplished, the model is ready to generate water surface elevations for the 2, 10, and 100-year frequency events based on rainfall associated with these events. The close comparison of the HEC-2 model results with observed highwater marks is shown below:

TABLE 3

Calibration Results - Elevations
(feet above MSL)

Location	1984 Storm	HEC-2
Above abandoned R.R. bridge at Locust Grove	661.2	661.5
1500' above abandoned R.R. bridge	667.5	666.8
Corner of house #9 in Ellerslie	725.3	725.3
Above bridge in Ellerslie	726.8	726.8

The two methods used internally by the HEC-2 model to compute bridge losses are known as the normal and special bridge methods. The normal bridge method computes water surface elevations based on the standard step method except the obstructed area of the bridge and piers below the water surface is subtracted from the cross sectional area and the wetted perimeter is increased. The special bridge method, which requires that the bridge opening be represented by a trapezoid, computes elevations based on hydraulic formulas for low flow, pressure flow, weir flow, and combinations of these flow types. Careful consideration must be given to the choice of method used since the resulting water levels may vary considerably.

In Locust Grove there are three bridges across Wills Creek. The farthest downstream bridge provides access to the community. The other two structures are railroad bridges. Each bridge was field surveyed. The FIS, which modeled all three structures using the special bridge method was examined for proper choice of coding. The downstream railroad bridge is an old four-arch structure which is no longer in use. Each arch is 19 feet high, 40 feet wide, and separated by large piers. Since the bridge openings cannot be accurately represented by a trapezoid and the pier widths are large, the special bridge method was considered inappropriate. Highwater marks revealed that pressure flow did not occur at any of the bridges during the 1984 storm, supporting the contention that the special bridge method is not appropriate. Since the special bridge method is basically used for pressure and weir flow, neither of which existed, coding for all the bridges in this area was changed to normal bridge.

The floodplain in Ellerslie combines effects of the mainstream of Wills Creek and the two tributaries which drain through the community. The floodplain associated with the tributaries as computed by hydrologic and hydraulic models is defined in Table 4 and on Figure 5. Flooding problems in this area have been described as local runoff and drainage inadequacies which may be resolved by the installation of storm drains. The magnitude of flooding depicted in Figure 5 has not been approached in over thirty years.

TABLE 4

Water Surface Elevations - Ellerslie Tributaries
(feet above MSL)

		2-Year	10-Year	100-Year
Tributary #1				
Section	2.1	727.3	727.9	728.5
	2.3	729.4	731.6	734.7
	3.5	733.1	736.5	737.6
	4.5	734.8	737.3	738.5
	7.0	760.3	762.4	764.8
Tributary #2				
Section	14.5	734.0	735.4	737.8
	15.5	753.6	756.4	756.6

The cause for the extensive backwater floodplain below Route 35 is the severly restricted drainage structures under the Baltimore and Ohio Railroad embankments. Enlargement of these openings would significantly reduce the backwater and result in fewer impacted structures. In the upper reach of Tributary #1 flooding is caused by relatively flat grade combined with substantial development on the land immediately adjacent to the stream channel.

A complete set of floodplain maps for Wills Creek and the tributaries in Ellerslie is maintained by the Allegany County Department of Planning and Zoning (scale 1" = 200').

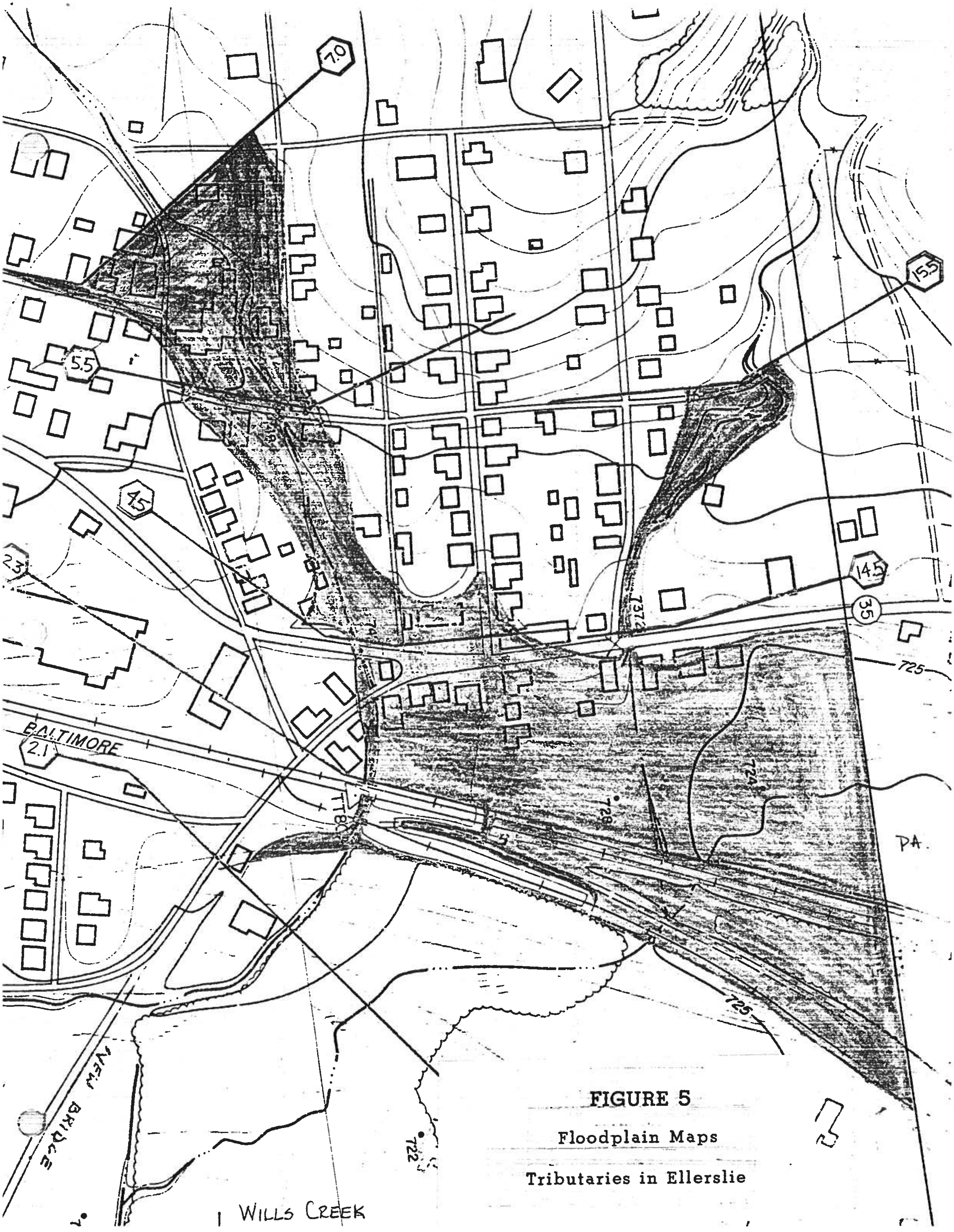

FIGURE 5

Floodplain Maps

Tributaries in Ellerslie

5. ALTERNATIVES CONSIDERED

A. General

Flood protection projects for a river as large as Wills Creek tend to be very costly. Channelization and levees, such as the U.S. Army Corps of Engineers project through Cumberland, could cost millions of dollars and require a lengthy period of design and construction. This type of project is usually associated with high density residential and commercial areas where flood damages are severe and extensive. Since the study areas are mainly more sparsely developed residential areas a less costly approach is recommended.

B. Railroad Bridge Removal

An alternative that was considered is the removal of the abandoned railroad bridge in Locust Grove. Local officials and citizens have complained that the bridge increases flooding depths upstream and has the potential to block with debris during high flows. A total of 13 homes are in the floodplain in this immediate area. The hydraulic model was run without the bridge to determine what benefits could be derived from its removal. Results of this simulation show that removal of the bridge will lower the 100-year water surface elevation two feet in the immediate vicinity of the bridge. As shown in Table 5, this effect gradually diminishes until it dampens out completely 1000 feet upstream.

Although six homes in the immediate vicinity of the bridge would no longer receive first floor flooding, they would still be in the floodplain. Flood waters would surround these homes, potentially causing damage to basements and foundations. The other seven homes would continue to be flooded severely and would only be minimally affected by this alternative. Considerably lesser benefits are seen on the 2 and 10-year events where water surface elevations are reduced by 0.3 and 0.6 feet respectively. Refer to Figures 3 and 4 for the location of specific houses identified by number which are affected by flooding in the area. Table 6 shows which houses would be affected by the bridge removal and the degree of relief provided.

The other concern expressed was the potential for this bridge to block with debris. This is certainly possible since any structure with piers has some potential to catch drifting trees and debris. However, simply removing the bridge is not a solution to the entire flooding problem. Damages would be reduced but not eliminated. Although the abandoned bridge currently has no value other than its historic character, the cost to demolish this structure could be prohibitive. (Several attempts were made to obtain an approximate cost. Contractors insisted that a site visit would be necessary before an estimate could be made.) Acquisition of flood-prone homes, discussed in Section C below, serves two needs: removal of endangered homes and preservation of an historic structure.

TABLE 5

Effects of Railroad Bridge Removal - Upstream

X-Sect	2-, 10-, & 100-Year Elevations (feet above MSL) W/Bridge	W/O Bridge	Elev'n Diff	Dist. above R.R. Bridge
2-Year				
122.22	653.3	653.0	0.3	0'
127.85	654.6	654.5	0.1	564'
132.85	658.3	658.3	0.0	1064'
10-Year				
122.22	657.0	656.4	0.6	0'
127.85	658.0	657.7	0.3	564'
132.85	661.4	661.4	0.0	1064'
100-Year				
122.22	663.4	661.6	1.8	0'
127.85	664.3	662.9	1.4	564'
132.85	666.6	666.5	0.1	1064'

TABLE 6

Effects of Railroad Bridge Removal - Houses

House #	FFE **	Water Surface Elevation (feet above MSL) 100-Year Existing	Bridge Removed	Depth of Water - 100-Year Existing	Bridge Removed
25	660.7	663.7	662.1	3.0*	1.4*
26	660.8	663.7	662.2	2.9*	1.4*
27	663.2	663.9	662.3	0.7*	
28	663.9	663.9	662.4	0.0	
29	662.0	664.0	662.5	2.0*	0.5*
30	663.8	664.2	662.8	0.4*	
31	665.0	664.3	662.9	3.3	1.9
32	663.8	664.5	663.2	0.7*	
33	665.1	664.8	663.6	3.3	2.1
34	667.3	665.0	664.3	2.7	2.0
35	665.5	665.5	664.7	0.0	
36	665.0	665.7	665.2	0.7*	0.2*
37	665.8	666.0	665.7	0.2*	

*Refers to depth of flooding above first floor
**First Floor Elevation

C. Flood Warning System

In some cases, a flood warning system can be a beneficial alternative that will reduce loss of life and some property damage. An effective flood warning system can provide valuable lead time needed by a community to protect its citizens and property. To determine the feasibility of a flood warning system in a particular community, the following factors are analyzed:

1) the hydrological characteristics of the watershed;
2) the frequency of flooding;
3) the flood loss potential; and
4) the warning time relative to the benefits.

The type of flood warning system most appropriate for a commmunity should also be based on the factors listed above. Automated flood warning systems use self-reporting precipitation and stream gages to collect and transmit data to a microcomputer. The computer then records and analyzes the data for subsequent use by community officials. Events reported in real time allow for better informed decisions relative to evacuations. It is also possible to extend lead time by assuming additional rainfall will occur if forecast by the National Weather Service. Manual flood warning systems enlist citizens to measure and report rainfall amounts and stream conditions. While this approach is less expensive, some elements may also be less dependable.

A flood warning system is only as effective as the response system developed to react to the flood warning. The combination of a reliable flood warning system and an effective community response system can provide time for citizens to evacuate flood-prone areas and/or take precautions to reduce property damage.

An automated flood warning system for the Wills Creek watershed might cost $50,000 to $100,000. While this represents a considerable initial investment, savings in this amount could easily be realized for example by preventing a few cars from being destroyed by flood waters. Obviously, there can be no value placed on prevention of loss of life, a factor that makes evaluation of the benefits and costs of these systems extremely difficult. As with other flood management projects, automated flood warning systems are eligible for up to 50% funding under the Comprehensive Flood Management Grant Program.

D. Acquisition

Acquisition of flood-prone structures is the most reliable form of flood protection. Unlike other methods which have an associated design frequency that may be exceeded, acquisition is final. Once a house is removed from the floodplain, risks and damages are completely eliminated. Compared to structural projects, virtually no maintenance costs are associated with acquisition. For these reasons, the State prefers acquisition and considers it the most prudent investment of public monies.

Under the State's Comprehensive Flood Management Grant Program, local jurisdictions can apply and receive up to 50% funding for acquisition of flood-prone structures. To qualify, a house must have first floor flooding or have an average water depth of 1 foot around the foundation resulting from the 100 year event. As previously mentioned, the primary purpose of this study is to identify flood-prone structures in Locust Grove and Ellerslie. Each house was surveyed to obtain first floor and average ground elevations. Tables 7 and 8 list each house and the corresponding depth of flooding. A total of 28 houses receive first floor flooding with an additional 17 having depths greater than 1 foot around the foundation. Generally, emphasis should be placed on acquiring those structures that pose the greatest hazards to occupants.

E. Ellerslie

Detailed analyses of alternatives to solve the flooding problems caused by the two tributaries which drain through this community were not accomplished. Difficulties with the frequent occurrence of local drainage problems could most reasonably be resolved with a storm drain system. Ideally such a system should discharge to Wills Creek below the Baltimore and Ohio Railroad. This would help reduce the backwater flooding predicted by computer modeling. Maintenance of stream channels is always cited as one method for reducing both frequency and severity of flooding and could be effective in this area.

The benefits of acquisition of flood-prone property have been discussed in detail. While this is one approach, the lack of severe historical flooding may reduce its application in Ellerslie. Community residents may be receptive to implementing small scale mitigation efforts such as readiness plans, minor building modifications, increased awareness of flood insurance as well as a program of stream channel maintenance.

TABLE 7

Elevations for Homes in Locust Grove
(feet above MSL)

House #	First Floor Elevation	Average Ground	100 Year	Depth of Flooding
1	671.		673.8	2.8*
2	673.	669.4	672.7	3.3
3	671.9		672.7	0.8*
4	672.7	668.0	671.3	3.3
5	668.		671.1	3.1*
6	667.7		669.9	2.2*
7	667.6		668.0	0.4*
8	669.3	665.7	668.0	2.3
9	669.1	665.8	668.9	3.1
10	671.2	668.9	669.1	.2
11	673.7	670.7	669.4	-
12	675.9	671.4	669.8	-
13	675.5	672.5	670.1	-
14	674.8	672.5	670.4	-
15	676.8	673.3	670.9	-
17	675.3	674.8	671.1	-
18	676.1	674.1	674.3	.2
19	674.4	672.4	673.8	1.4
20	675.6	672.6	673.8	1.2
21	669.5		673.8	4.3*
22	674.9	672.4	674.3	1.9
23	674.7	673.	674.3	1.3
24	675.3	672.8	674.3	1.5
25	660.7		663.7	3.0*
26	660.8		663.7	2.9*
27	663.2		663.9	0.7*
28	663.9		663.9	0.0*
29	662.0		664.0	2.0*

TABLE 7 – continued

House #	First Floor Elevation	Average Ground	100 Year	Depth of Flooding
30	663.8		664.2	0.4*
31	665.0	661.	664.3	3.3
32	663.8		664.5	0.7*
33	665.1	661.5	664.8	3.3
34	667.3	662.3	665.0	2.7
35	665.5		665.5	0.0*
36	665.0		665.7	0.7*
37	665.8		666.0	0.2*
38	668.3	663.3	666.6	3.3
39	668.4	664.4	666.6	2.2
40	669.5	666.5	667.0	.5
41	671.1	667.1	667.0	–
42	670.9	667.6	667.3	–
43	671.9	668.4	667.5	–
44	671.9	670.2	667.8	–
45	670.4	668.8	667.9	–
46	673.7	669.9	668.0	–
47	671.6	669.1	668.6	–
48	674.2	671.2	669.1	–
49	676.6	672.6	669.5	–
50	673.8	672.8	669.7	–
51	675.7	672.7	670.6	–
52	–			
53	674.8	673.6	675.0	0.2*
54	–			
55	675.	672.5	675.0	0.0*

*Refers to depth of flooding above first floor

TABLE 8

Elevations for Homes along Wills Creek in Ellerslie
(feet above MSL)

House #	First Floor Elevation	Average Ground	100-year Elevation	Depth of Flooding
1	729.6		726.9	--
2	728.2	726.9	726.4	--
3	722.3		726.2	3.9*
4	724.3		726.1	1.8*
5	726.4	725.1	726.1	1.0
6	727.0	725.8	725.8	--
7	724.0		725.8	1.8*
8	721.4		725.8	4.4*
9	723.3		725.6	2.3*
10	722.8		725.6	2.8*
11	724.1		725.6	1.5*
12	725.9	723.7	724.3	0.6
13	723.6	723.1	723.2	0.1
14	726.4	724.4	725.6	1.2
15	725.3	723.4	725.6	0.3*

*Refers to depth of flooding above first floor