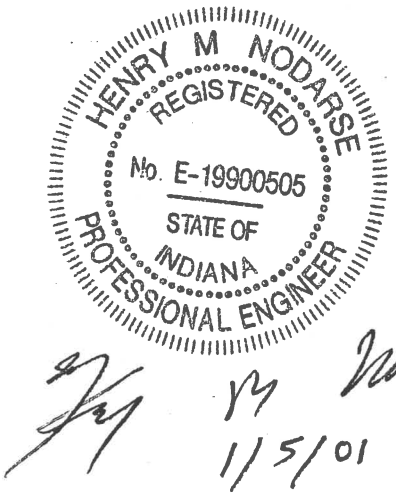
FLOODWAY STUDY
for
CASTLE CREEK SUBDIVISION
VANDERBURGH COUNTY, INDIANA

January 5, 2001



prepared for

Castle Creek Development
c/o Ms. Karen Mortensen
2626 Kotter Avenue
Evansville, IN 47715

prepared by

Bernardin, Lochmueller & Associates, Inc.
6200 Vogel Road, Evansville, IN 47715
PH (812) 479-6200 / FAX (812) 479-6262
BLA Project # 197-0181-DPD

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INTRODUCTION

PURPOSE OF STUDY

This Floodway Study was prepared to delineate the floodway of Rusher Creek in the immediate vicinity of the Castle Creek Subdivision, and to establish the Base Flood Elevation (BFE or 100-year flood elevation) associated with Rusher Creek in the immediate vicinity of the Castle Creek Subdivision. Please note that the purpose of this study is not to prepare documentation in support of requesting a Letter of Map Revision (LOMR), or any other documents, from the Federal Emergency Management Agency (FEMA).

LOCATION OF STUDY

The 39 acre Castle Creek Subdivision is located in Section 20, Township 4 South, Range 10 West, Scott Township, Vanderburgh County, Indiana. Please refer to the Castle Creek Subdivision Primary Plat in Appendix A, and please refer to the Haubstadt, IN. USGS 7.5 minute series quadrangle presented in Appendix B. Although Rusher Creek is shown on Flood Insurance Rate Map (FIRM) Community Panel 180256 0015 C (effective date of August 5, 1991), the associated FEMA Flood Insurance Study only studied the Floodway and Base Flood Elevation of Rusher Creek to a point approximately 150 feet west of the US 41. Please refer to the FIRM Community Panel 180256 0015 C (effective date of August 5, 1991), which is presented in Appendix C.

AUTHORITY AND ACKNOWLEDGMENTS

The Vanderburgh County Building Commission, who serves as the local Flood Plain Administrator, required that the floodway and 100 year flood elevation for Rusher Creek be established The developer of the Castle Creek Subdivision, who is Castle Creek Development, contracted with Bernardin, Lochmueller & Associates, Inc. to prepare this study.

AREA STUDIED

SCOPE OF STUDY

The section of Rusher Creek which this study examined begins at the point where the FEMA Flood Insurance Study ends. That point is approximately 150 feet west of US 41. This study examined Rusher Creek upstream for 2000 feet to the east, which is approximately 340 feet upstream from the east boundary of the Castle Creek Subdivision.

COLLECTION OF DATA

As part of the work to prepare this study, hydraulic, hydrological, and topographical information was either researched or collected. The research and collection efforts are described below.

We researched our archives and retrieved the FEMA Flood Insurance Study (FIS) for Vanderburgh County, Indiana (Unincorporated Areas) and FIRM Community Panel #180256 0015 C, both with an effective date of August 5, 1991. Please review Appendix C for the FIRM and Appendix D for selected pages of the Flood Insurance Study. We also retrieved the Haubstadt, IN. USGS 7.5 minute series quandrangle, dated 1989. A copy of this quadrangle is presented in Appendix B.

On June 14, 2000, we requested the Indiana Department of Natural Resources (INDNR) to provide the discharge, which is the 100-year flow, of Rusher Creek at the site.

On August 1, 2000, INDNR responded to our discharge request in writing. Please refer to a copy of the INDNR Correspondence in Appendix E.

On August 4, 2000, we visited the offices of the, Vanderburgh County Surveyor (which provides technical assistance to the Vanderburgh County Drainage Board) and the Vanderburgh County Building Commission. Neither of the offices contained any information applicable to this study. The office of the Vanderburgh County Surveyor did contain several drainage reports for relatively recent developments located along the west side of US 41, but the information submitted was not applicable.

The Office of the Vanderburgh County Engineer did not have any applicable information.

On May 23, May 24, June 7, June 21, and August 22 of this year, our survey crews performed detailed field surveys using total station survey equipment in Rusher Creek, the Castle Creek Subdivision, the US 41 Right-of-Way, and adjacent areas.

On September 19 and September 25, 2000, we photographed Rusher Creek and the topography along the banks. These photographs are presented in Appendix F.

On September 21, 2000, long-time local residents and employees at the State Police Post (which is located directly across Schroeder Road from the Castle Creek Subdivision) were interviewed. A record of these interviews is presented in Appendix G.

On many occasions over the last few months, the site was investigated and reviewed. In particular, we searched for high water marks, or evidence of high water, but none were found.

STUDY AREA DESCRIPTION

The area to be studied includes Rusher Creek from a point that is approximately 150 feet east from US 41 to a point 2000 feet upstream. Areas that are approximately 200 feet north of Rusher Creek and approximately 1500 feet south of Rusher Creek were initially studied and surveyed as possible floodplain areas. Please review to the Floodway/Floodplain Map in Appendix H.

The Rusher Creek watershed was not extensively studied because INDNR estimated the watershed to be approximately 1.2 square miles, or approximately 768 acres. We did verify this, and we do concur that the watershed is approximately 1.2 square miles.

PRINCIPLE FLOOD PROBLEMS

Flooding in portions of the Castle Creek Subdivision has been reported by local residents. Local residents and employee of the State Police Post also reported that flood waters have never reached the level of US 41.

FLOOD PROTECTION MEASURES

No flood protection measures have been constructed, other than the widening of US 41 from a undivided two-lane road to a four-lane divided road. However, the bridge over Rusher Creek was simply extended.

ENGINEERING METHODS

ENGINEERING METHODS

To determine water surface elevations, and thus the floodway, standard hydraulic study methods were used.

To process topographical and hydraulic data, a hydraulic analysis of Rusher Creek within the Study Area was made utilizing the River Analysis System (version 2.2 w/ patch, dated September, 1998), developed by the Hydrological Engineering Center of the US Army Corps of Engineers (referred to as HEC-RAS). HEC-RAS is new-generation software for one-dimensional steady flow water surface profile simulations that superceeds the HEC-2 Water Surface Package.

HYDROLOGIC ANALYSIS

Because of the fact that INDNR provided the discharge, a hydrological study was not necessary.

HYDRAULIC ANALYSIS

Prior to performing the hydraulic calculations, full-valley cross-sections of the Rusher Creek were field-surveyed and the areas that are approximately 200 feet north of Rusher Creek and approximately 1500 feet south of Rusher Creek were also field-surveyed. These survey limits were determined after several site inspections and preliminary hydraulic calculations, such that it appeared that the flood plain limits would be within these limits. Spacings between cross-sections varied depending on topography, but generally, they were approximately 100 feet apart, except where the creek bends and in areas of hydraulic structures. In those areas, additional cross-sections were surveyed. Each cross-section included, at least, elevations of the bottom of the creek, the toes of the banks, and the tops of the banks. Structures, such as the US 41 bridge and the concrete driveway to access the property to the north of the Castle Creek Subdivision, were detailed. Additional cross-sections were surveyed just upstream and downstream of US 41bridge and the driveway.

Also, we walked the entire length of the stream to be modeled, and took several photographs at various locations. The photographs are presented in Appendix F. The photograph locations and orientations are shown on the Floodway/Floodplain Map in Appendix J. As a result of our inspection and photographs, channel roughness factors were assigned using the Table 11.2, part D, of the HEC manual. A copy of the table for roughness factors has been inserted in Appendix I. The selected roughness factors are shown on the Floodway/Floodplain Map in Appendix H. We wish to point out that the selected roughness factors for the section of the stream that is east of US 41 of 0.040 for the overbanks and 0.060 for the main channel are actually slightly higher than those used in the Flood Insurance Study (0.045 for both), but we feel that the selected factors are more representative while the factors used in the FIS were used for the entire length of Rusher Creek (approximately one mile) on the west side of US 41. The selected roughness factors for the short section (150 feet) of the stream that is west of US 41 was 0.040 for the overbanks and 0.035 for the main channel. The reason for the lower factor for the channel is due to the fact that the channel that is west of US 41 has been excavated, is straight, and is uniform. Please note that because it has been poorly maintained however, an N factor of 0.027 (as used for Ca4 in Table 11.2 in Appendix I) was not used. Also, the N factor for the main channel for the section at the upstream face of the US 41 bridge (Station 2+62) and for the section at the upstream end of the wingwalls (Station 2+75) were 0.035 because the flow is confined within the concrete wingwalls. In fact, the N factor could have been as low as 0.017 according to Table 11.2 in Appendix I, but to be conservative, 0.035 was used.

All elevations are referenced to the National Geodetic Vertical Datum (NGVD) of 1929.

The hydraulic modeling substantially followed the "Suggested Division of Water Procedures for Hydraulic Modeling", dated October 26, 1994. Please note that although some of the cross-sections appear to cross other cross-sections in the model, those cross-sections followed the topography of adjacent cross-sections rather than crossing them. This is apparent after reviewing the Floodway/Floodplain Map.

The HEC-RAS program was designed to calculate water surface profiles for steady gradually varied flow. The basic computational procedure is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by the friction losses through Manning's equation and expansion/contraction losses. With the hydrologic and survey data entered in the HEC-RAS modeling software, the program calculated the elevation and area of the resulting water surface at the surveyed cross-sections. The model was calibrated and modified so that the results were reasonable. It was not possible to calibrate the model according to actual flooding because actual flooding limits and elevation were not available. However, the modeled water surface elevations did correlate well with the comments made by interviewees, and the water surface elevations certainly appeared to be reasonable.

Please note that the three left overbanks at Stations 3+38, 4+45, and 4+99 have been specified in the model to be areas of ineffective flow because they are immediately upstream from the US 41 bridge, they form valley depressions, and any flow would be shallow, slow (less than 1f/s), and would be mainly low flow.

Only two hydraulic structures exist within the section of Rusher Creek that was studied. One is the bridge that carries US 41 across Rusher Creek. The only other structure is a concrete driveway with a 12" vitrified clay pipe that carries very low flow.

The bridge consists of an 11 foot high by 35 foot wide concrete arch. The bridge is 112 feet long in the direction of flow, as it is located between Stations 1+50 and 2+62. At the downstream face of the bridge, the entire opening is free of any obstructions, and wing walls have been constructed. However, at the upstream face, approximately 36% of the opening is obstructed due to the construction of the west bank of a ditch that runs north from a point approximately 10 ten feet upstream from the upstream face of the bridge. The bridge was modeled as a bridge using the standard bridge module. A sketch of the upstream face with the obstruction has been presented in Appendix J.

The driveway with a culvert is an unusual structure. The structure is located between Stations 10+05 and 10+25. Apparently, the driveway was not constructed to permit high flows pass unobstructed because the driveway elevation is approximately 4 feet lower that the upstream and downstream banks. Below the driveway elevation, there is only a 12" vitrified clay pipe, which can only discharge negligible flows during high flow events because it will be acting as an orifice, and the water surface elevation difference between the upstream end and downstream will be negligible. Due to the unusual geometry of this structure, and because it acts as a dam during high flows, it was modeled as an In-Line Weir.

Debris within the streams were not modeled, but some channel bottoms were probably covered with built-up silt, so some of the channel bottom elevations are probably slightly higher than the "natural" elevations.

The model initially assumed the flow regime to be sub-critical. This assumption was verified by the model, as the computed flow regimes for all reaches within Rusher Creek were sub-critical. With sub-critical flow, the only boundary condition to specify was the water surface elevation at the most downstream cross-section. This was determined by using the 100-year water surface elevation of 446.23, as published in the FEMA Flood Insurance Study.

Please note that this hydraulic model is just that, a model. The actual stations of features such as culverts and bridges, as well as the locations of some cross-sections may be a few feet off.

Once the base model was created, the floodway was determined by choosing the encroachment option Method 4, and executing the model iteratively until the water surface elevation increases in all cross-sections were less than .15' when comparing the "base model" with the "base model with floodway". The starting water surface elevation for the floodway was specified in the model to be 446.29. The resulting encroachment stations were then plotted on the Floodway/Floodplain Map in Appendix H. The resulting Floodway boundary was smoothed. The floodway was plotted exactly as modeled. Please note that no encroachment occurred within the channel. The 100-year floodplain has been modified to include an area that was not modeled, but appears realistically to be included. This modified floodplain area is delineated on the Floodway/Floodplain Map. The floodway, Base Flood Elevations, and Special Flood Hazard Area (SFHA or 100-year Floodplain) are delineated on the Floodway/Floodplain Map in Appendix H.

All Errors, Warnings, and Notes were analyzed. Some were addressed during refinement of the model. The remaining Errors, Warnings, and Notes have been deemed insignificant.

The HEC-RAS Model Schematic, Cross-Sections, Profile Output Tables, Cross-Section Output Tables (w/ Errors, Warnings & Notes), Profile, and Perspective Plot are presented in Appendices K through P. The complete HEC-RAS file is stored on the computer disc in Appendix Q under the filename of "Castle.*". The electronic file of the Floodway/Floodplain Map has also been included in the disk under the filename "Flood.dwg".

FLOODPLAIN MANAGEMENT APPLICATIONS

FLOODPLAIN

The floodplain, as paraphrased from FEMA literature, is the area corresponding to the water surface of the 100-year flood. The flood plain, also referred to as Special Flood Hazard Area (SFHA), as shown on FIRM Community Panel 180256 0015C (effective date August 5, 1991), is shown on the Floodway/Floodplain Map in Appendix H. The floodplain, as determined by the HEC-RAS hydraulic model, is also shown on that map. The purpose of this study is not necessarily to dispute the floodplain associated with the Rusher Creek, as shown on the FIRM. Rather, the purpose is to establish the Base Flood Elevation and the floodway. As a result however, the modeled 100-year floodplain is different than that shown on the FIRM, but there is no desire to change the floodplain as shown on the FIRM.

FLOODWAY

The boundary of the calculated floodway ranges from a maximum of approximately 155 feet beyond the banks to remain within the banks.

SUMMARY

This study was prepared to establish the Base Flood Elevations and floodway for Rusher Creek from where the FEMA Flood Insurance Study ended, which is a point approximately 150 feet west of US 41, to a point 2000 feet upstream. As a direct result, the Special Flood Hazard Area (the 100-year Floodplain) associated with Rusher Creek is different than that shown on the FIRM.

Extensive research and data collection was conducted prior to performing a hydraulic analyses of the discharge from the 100-year flood using the HEC-RAS computer modeling program. The water surface elevations computed by the HEC-RAS model specified the width of the floodway, Base Flood Elevations (100-year water surface elevation), and Special Flood Hazard Area (the 100-year Floodplain). These have been delineated on the Floodway/Floodplain Map presented in Appendix H.