Floodplain Analysis for an unnamed wash at the Intersection of Hacienda Del Sol Road and River Road

For

Pima County Regional Flood Control

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Introduction

This study was performed to provide drainage information for the unnamed wash running along Hacienda Del Sol Road. The unnamed wash runs through Sections 16, 20 and 21 of Township 13 South, Range 14 East, Pima County, Arizona, and lies between Camino Real Wash and Hacienda Del Sol Wash. The entire watershed of the unnamed wash is in FEMA Zone X, as shown on the current Flood Insurance Rate Map (FIRM) number 04019C-1645K. While the watershed is in the Zone X, which is defined as non-flood hazard areas, a potential flood and erosion hazard is known in foothills areas where the unnamed wash is located. Limited drainage information is currently available in foothills areas.

The purpose of this study is to provide flood and erosion hazard information for the unnamed wash along Hacienda del Sol road. Topographic, hydrologic and hydraulic analyses were performed to determine drainage conditions in the wash. ArcGIS, Version 9.2, Pima County Hydrology Procedures (PC-Hydro), Version 5.3.1, HEC-RAS 4.0 Beta version (HEC-RAS), and HEC-GeoRAS, Version 4.1.1 (HEC-GeoRAS) were used for the analyses.

Description of the watershed

Most of the watershed of the unnamed wash is located in Pima County, while the southern part of the watershed is in the City of Tucson (south of River Rd. Fig. 1). The watershed is 227.4 acres with a mean slope of 0.03. The watershed is located in a suburban foothills area covered with desert brush. No riparian habitat is mapped along the wash, based on the 2005 Pima County Ordinance (Fig. 1). Zoning classification of the most of the watershed is CR-1 (single residence zone; Fig. 2).

Data processing procedures

Data processing method is summarized in Fig.3. Triangular Irregular Network (TIN) derived from Light Detection and Ranging (LiDAR) data was used to create a topographic map (Fig. 4). The contour interval is 5 feet. The boundary of the watershed and slope break points were determined using the contour lines. The locations of the stream centerline, cross-sections, river banks, culverts, and other physical attributes of the wash were determined by using a topographic map and 2005 PAG aerial photo (Fig. 4). Those physical attributes of the wash were digitized in ArcGIS with an extension of HEC-GeoRAS and then exported as an ASCII text file. The data were imported into HEC-RAS to create geospatially referenced geometric data. Other parameters for the steady analysis, such as Manning's n-values, culvert data, expansion and contraction coefficients, normal depth boundary condition, ineffective flow areas, and peak discharge rates obtained from PC-Hydro are manually input into HEC-RAS. The hydraulic data

obtained from HEC-RAS were imported into HEC-GeoRAS to delineate a floodplain in the study area.

Hydrologic analysis

The 100-year return interval peak discharge rate for the watershed was computed by using PC-Hydro (Arroyo Engineering, 2007). NOAA Atlas 14, upper 90% confidence interval, rainfall data was used for the analysis. Hydrologic soils group map for the watershed is presented in Fig. 5. Hydrologic Soil Group B is the dominant soil type in the watershed, which occupies 97% of the watershed. The watercourse was divided into ten segments (Reaches) using slope break points. Basin factors were based on the tables in the PC Hydro User Guide. The basin factor for each segment was determined by using a 2005 PAG aerial photo (Figs. 6-7.5). The Basin Factor used for the hydrologic analysis ranges from 0.040 to 0.045 which corresponds to Suburban-Valley (< 1 house/acre; Arroyo Engineering, 2007). A vegetation cover density of 30% was used to select the SCS Curve Number for the hydrologic calculation of the study watershed. Impervious cover percentage was 15%, which was determined using a 2005 PAG aerial photo.

The results of hydrologic analysis are included in Appendix 1. The 100-year peak discharge rate at Hacienda Del Sol Road is calculated to be 690 cubic feet per second (cfs). The Time of concentration (Tc) for the peak discharge is 25.2 minutes, and the rainfall intensity is 4.92 inches/hr at the time of concentration.

Hydraulic analysis

Steady flow analysis was performed to determine 100-year water surface elevations in the study area by using HEC-RAS. The study area for the analysis is from the confluence of an upstream tributary with a main channel to the confluence with Rillito River. As described above, geometric data for HEC-RAS including stream centerline, cross-sections, river banks, culverts, and block obstructions were obtained by using HEC-GeoRAS. The locations of cross sections used for the analysis are show in Fig. 8. There are four culverts in the study area (Fig. 8). The culverts were named Culvert #1, 2, 3, and 4 from upstream to downstream (Pictures of the culverts are included in Appendix 2). The dimensions of the culverts were summarized in Table 1. The data for Culvert #1, 2, and 4 were obtained from Pima county Department of Transportation and Flood Control District improvement plans (4BHDSR and 4TRRCA, Appendix 3). The data for Culvert #3 was obtained by a field measurement. Culvert #1 and 2 were designed to convey a 100-year discharge of 379 cfs. Culvert #4 was designed to convey 575 cfs.

Manning's roughness coefficients for the main channel and the over-bank areas were determined by using a 2005 PAG aerial photo. An area-weighted average of the Manning's roughness coefficients for the main channel and the over-bank areas was used to determine a water surface elevation at each cross section. The weighted average of the roughness coefficients was determined by estimating area for a main channel and over-bank areas and assigning weighing factors that are proportional to the total area (Jacb

Dividian, USGS, Technical of Water-Resources Investigations, Book 3, Chapter A15, see Appendix 4). The method to assign composite n value to an entire cross section is used in Maricopa County (Phillips and Tadayon, 2006)

Entrance loss coefficient and Manning's roughness coefficient of the culverts are obtained from HEC-RAS Hydraulic Reference Manual version 3.1. Culvert #4 has a horizontal bend between the entrance and exit. Bend can result in additional losses for the culvert operating under outlet control (Floodplain Online Book, provided by Haestad Methods, Inc.). The detail of the method is provided in Appendix 5. The bend loss was estimated following the method described in Floodplain Online Book. Angle of bend is approximately 25 degree (4TRRCA). The culvert opening is assumed to be equivalent to 3.56 feet diameter, based on the opening of Culvert #4. The estimated entrance coefficient for Culvert #3 is 0.64.

Contraction and expansion coefficients are 0.3 and 0.5 for just upstream and downstream of culverts, and 0.1 and 0.3 for other cross sections, which were obtained from HEC-RAS Hydraulic Reference Manual. Normal depth with a slope of 0.02 was used as a boundary condition for the steady flow analysis.

The results of hydraulic analysis are shown in Figs. 9, 10 and 11. A 100-year water surface elevation at each cross section is shown in Appendix 6. Fig. 9 shows the profile of a 100-year water elevation. Fig. 10 shows a spatial variation of flood depths in the study area. Fig.11 shows a floodplain limit in the study area. The flood prone area is relatively wide between Culvert #3 and Culvert #4 (Figs. 10 and 11). There is a divided flow at approximately 900 feet upstream of River Rd, based on the steady flow analysis using HEC-RAS. The flood elevation exceeds 4 feet at the upstream of Culvert #1 2, and #3 (Fig. 10). The water surface elevations at all the road crossings (Culverts #1, 2, 3, and 4) are higher than the roads (Fig. 9). This suggests flood water may run over the roads during a 100-year flood event.

References

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