Unnamed Wash 1 Letter of Map Revision
Technical Data Notebook

Prepared by:

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Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701

Registered Professional Engineer (Civil)
CERTIFICATE NO.
15610
SUZANNE J.
SHIELDS
DATE SIGNED 6/17/2010
ARIZONA U.S.A.

Approved by

Suzanne Shields, PE
Director

Pima County Regional Flood Control District
97 E Congress Street
Tucson Arizona, 85701

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Section 1 Introduction

1.1 Propose

This Technical Data notebook (TDN) has been prepared for a Letter of Map Revision (LOMR) application for a portion of the Unnamed Wash 1 (UN1) located in Pima County, Arizona. The objective of the TDN and LOMR submission is provide regulatory discharge rates and floodplain limits along the Unnamed Wash 1 using better topographic, hydrologic, and hydraulic data.

This TDN was prepared in accordance with the "Instructions for Organizing and Submitting Technical Documentation for Flood Studies" prepared by the Arizona Department of Water Resources, Flood Mitigation Section (Arizona State Standard, SSA 1-97) and FEMA Guideline. FEMA LOMR forms are included in this TDN.

1.2 Project Authority

The State of Arizona has delegated the responsibility to each county flood control district to adopt floodplain regulations designed to promote the public health, safety and general welfare of its citizenry as provided under the Arizona Revised Statutes, Title 48, Chapter 21, Article 1, Sections 48-3601 through 3627. More specifically, A.R.S. 3609 directs county flood control districts to adopt floodplain regulations that:

> A. Regulate all development of land, construction of residential, commercial or industrial structures or uses of any kind which may divert, retard or obstruct flood water and threaten public health or safety or the general welfare; and
> B. Establish minimum flood protection elevations and flood damage prevention requirements for uses, structures and facilities which are vulnerable to flood damage; and
> C. Comply with state and local land use plans and ordinances, if any.
> In conformance with A.R.S. 3609, this ordinance provides for protection of the public health safety and welfare by regulation of flood and erosion hazard areas to control flood hazards and prevent repetitive loss from flood damage.
> D. The flood hazard areas of Pima County are subject to periodic inundation which may result in loss of life and property, create health and safety hazards, disrupt commerce and governmental services, require extraordinary public expenditures for flood protection and relief, and impair the tax base, all of which adversely affect the public health, safety, and general welfare.
> E. These flood losses are caused by the cumulative effect of obstructions in areas of special flood hazards which increase flood heights, flow velocities, and cause flood and erosion damage. Uses that are inadequately flood-proofed, elevated, or otherwise protected from flood damage, also contribute to the flood loss. (Ord. 2005 FC-2 § 2 (part), 2005).

Section 16 of the Pima County Ordinance describes the provisions for floodplain regulation in Pima County.

This study has been prepared by the Pima County Regional Flood Control District (RFCD):

Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701

The project was prepared by:

Akitsu Kimoto, Ph.D., C.F.M., Principal Hydrologist.
Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701

1.3 Project Location

The study reach of the Unnamed Wash 1 (UN1) is located within a Federal Emergency Management Agency (FEMA)-designated "Zone A" flood-hazard area, as depicted on FIRM Map Panel Number 04019C1605K (February 8, 1999). No documented hydraulic analyses were found to determine the "Zone A", and the existing "Zone A" depiction is not consistent with current topography. The objective of the TDN and LOMR submission is provide regulatory discharge rates and floodplain limits along the Unnamed Wash 1 using better topographic, hydrologic, and hydraulic data.

The study reach of the Unnamed Wash 1 is located primarily west of Silverbell Rd. Section 2 and 11, Township 13 South, Range 12 East, Pima County, Arizona (Fig. 1.1). The Unnamed Wash 1 enters study limit from the west and flows east until it converges with the Santa Cruz River. The study limit for the Unnamed Wash 1 is from approximately 1000 ft southwest of Belmont Rd. to the confluence with the Santa Cruz River in Section 2 of Township 13 South, Range 12 East.

1.3 Hydrologic and Hydraulic Methods

Hydrologic analysis was preformed to estimate regulatory discharge rate at Silverbell Rd using PC-Hydro Version 5.4.2 (PC-Hydro). The parameters for PC-Hydro, such as rainfall intensity and subbasin characteristics (e.g. soil, vegetation, slope, flow distance, roughness), were selected using PC-Hydro User Guide (Arroyo Engineering, 2007). The proposed regulatory discharges are flow rates that have a 1-percent chance of being equaled or exceeded each year ("100-year" discharge rates). Hydraulic analysis was performed to delineate floodplain limit along the study reach of the Unnamed Wash 1 using U.S. Army Corps of Engineers Computer Backwater Model, HEC-RAS.

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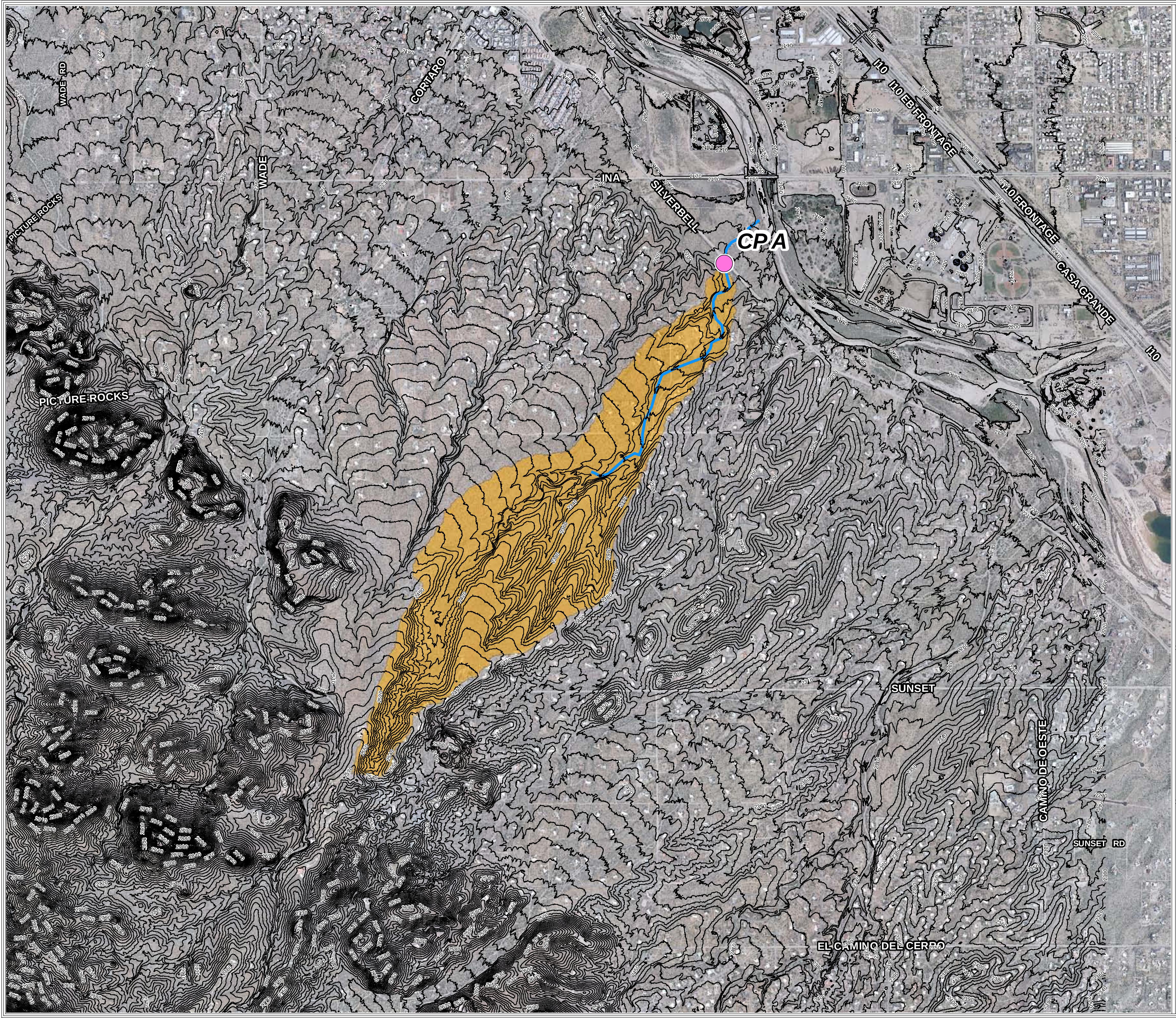
1.4 Acknowledgment

This study relied on assistance of RFCD GIS staff, who were integral to the development of the models and maps.

1.5 Study Results

The regulatory peak discharge rate was calculated at Silverbell Rd (CP A; Fig. 1.3). The estimated regulatory discharge rate is 1229 cubic feet per second (cfs) with a drainage area of 0.81 square mile at CP A.

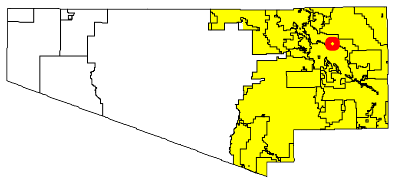
Figure 1.1
Watershed Map
Unnamed Wash 1



- Discharge Point
- Contour 10 foot
- River
- Watershed

Aerial: 2008 Pima Association of Governments
Topo: 2008 Pima Association of Governments

Pima County Index Map



Index Map Scale 1:5,250,000

The information depicted on this display is the result of digital analyses performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Regional Flood Control Department makes no claims regarding the accuracy of the information depicted herein.

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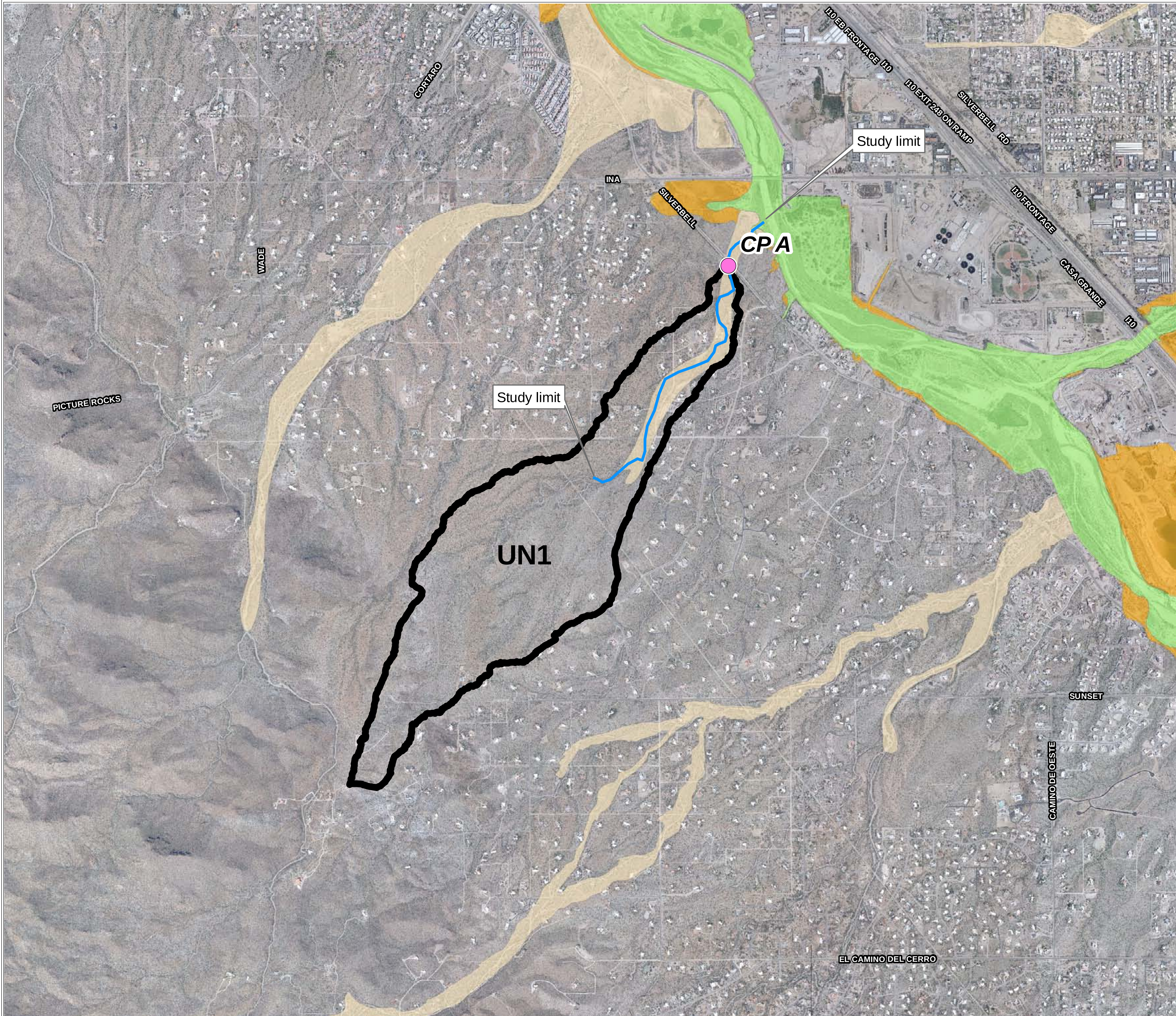
Figure 1.2
Study Limit Map
Unnamed Wash 1



Discharge Point

River

Watershed

Existing FEMA Floodplain

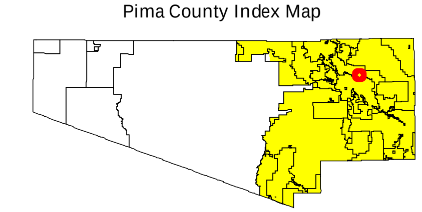
ZONE A

ZONE AE

ZONE X - SHADED

Aerial: 2008 Pima Association of Governments

Pima County Index Map



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Pima County Regional FLOOD CONTROL DISTRICT

THE SEAL OF PIMA COUNTY ARIZONA

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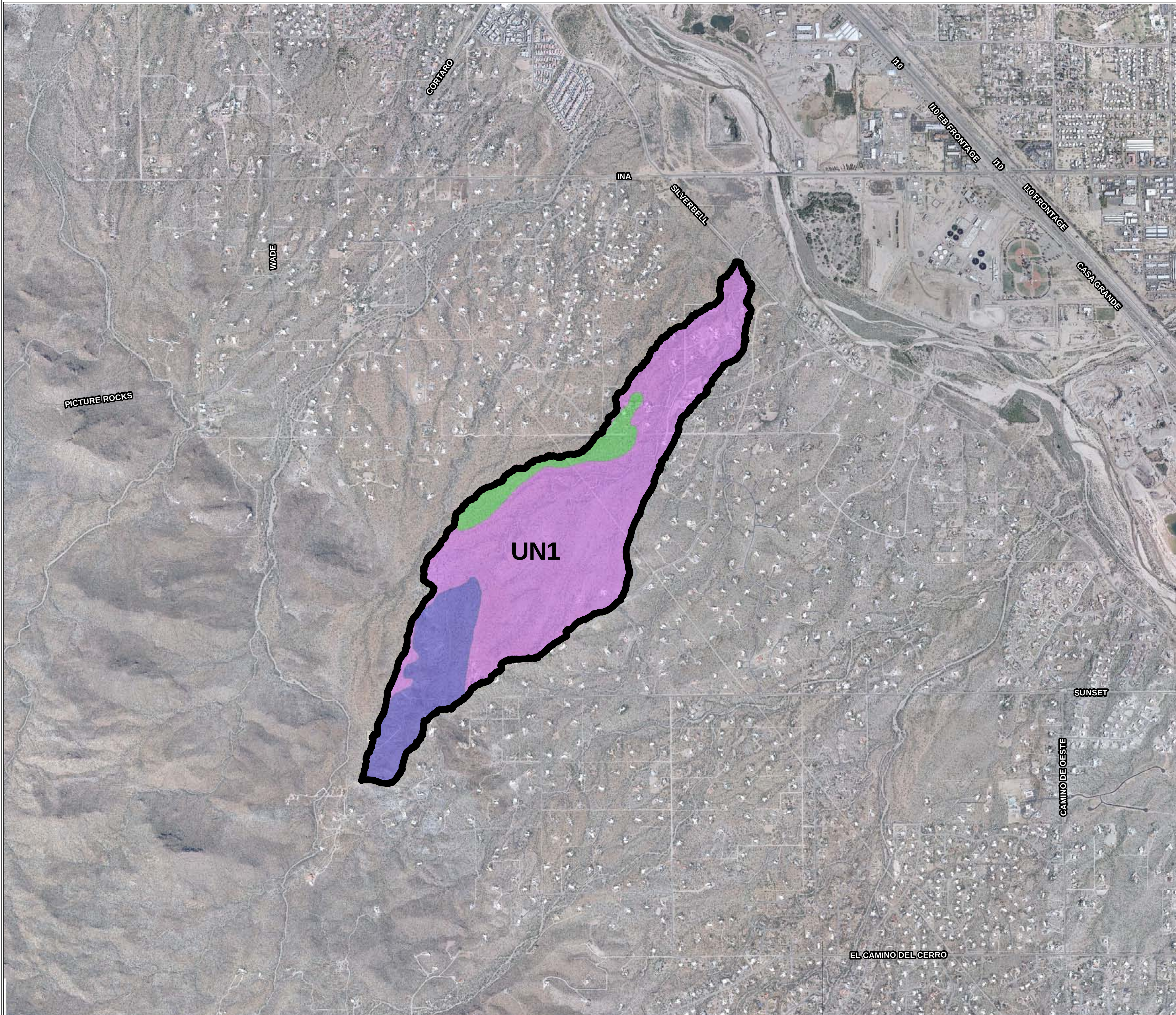
Figure 1.3
Soil Classification Map
Unnamed Wash 1



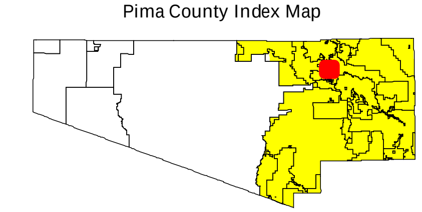
Unnamed Wash 1 Watershed

Soil Classification

- Soil Group: B (82%) C (18%), PINALENO-STAGECOACH-PALOS VERDES COMPLEX, 10 TO 35 PERCENT SLOPES
- Soil Group: C (100%), TUBAC GRAVELLY LOAM, 1 TO 8 PERCENT SLOPES
- Soil Group: C (47%) D (53%), PANTANO-GRANOLITE COMPLEX, 5 TO 25 PERCENT SLOPES

Aerial: 2008 Pima Association of Governments

Pima County Index Map



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Section 2 FEMA Forms

2.1 Study Documentation Abstract for FEMA submittals

2.1.1 Date Study Accepted: ________________

2.1.2 Study Contractor:

Planning and Development Division,
Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701
(520) 243-1800

Prepared by Akitsu Kimoto, Ph.D, C.F.M., Principal Hydrologist.

2.1.3 Local Technical Reviewer:

Bill Zimmerman, Division Manager and Terry Hendricks, C.F.M, Chief Hydrologist
Planning and Development Division,
Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701
(520) 243-1800

2.1.4 Reach Description

The study reach of the Unnamed Wash 1 is located within a Federal Emergency Management Agency (FEMA)-designated “Zone A”, as depicted on FIRM Map Panel Number 04019C1605K (February 8, 1999). The study reach of the Unnamed Wash 1 is located primarily west of Silverbell Rd., Pima County, Arizona (Fig. 1.1). The study reach of the Unnamed Wash 1 is primarily composed of sand and gravel channel. The overbank of the reach is covered with desert brush.

2.1.5 USGS Quad Sheets

Not available for this study

2.1.6 Unique Conditions and Problems

None.

2.1.7 Coordination of Peak Discharges

The 100-year regulatory discharge rate at the Silverbell Rd. was computed using PC-Hydro. The parameters for PC-Hydro, such as rainfall intensity and subbasin characteristics (e.g. soil, vegetation, slope, flow distance, roughness), were selected using PC-Hydro User Guide (Arroyo Engineering, 2007). The discharge rate was acceptable per Suzanne Shield, Director of the Pima County Regional Flood Control District.

2.2 FEMA Forms

The FEMA MT-2 forms are included in Appendix B.

Section 3 Survey and Mapping Information

3.1 Field Survey Information

None.

3.2 Mapping

The topographic data was obtained using HEC-GeoRas and ArcGIS. Digital Elevation Model (DEM) derived from 2008 Light Detection and Ranging (LiDAR) data was used to create 5-foot interval contour map. The documentation showing that this Lidar data set is FEMA-compliant is included in Appendix C.

The following data was used in this TDN;

The aerial photo: 2008 PAG aerial photo
Projection: UTM, Zone 12
Units: International feet
The contour interval of the topographic map is 2 feet.

Section 4 Hydrology

4.1 Method Description

The 100-year peak discharges for the watershed outlet of the Unnamed Wash 1 (CP A; Fig. 1.3) were calculated using PC-Hydro Version 5.4.2 (PC-Hydro). The PC-Hydro uses a semi-empirical method, which is similar to the Rational Formula. The method is unique to Pima County. Pima County has been using the Pima County Hydrology Procedures (PC-Hydro method) for over 30 years for a floodplain management. The method has been deemed as a FEMA-accepted hydrologic method for prediction of 100-yr peak discharge in Pima County. The method was used for the Friendly Village LOMR (case# 08-09-0473P) and it was approved by FEMA. The PC-Hydro method generally produces higher discharge values compared to HEC-HMS or USGS Regression equations. Peak discharge values produced by the PC-Hydro would be conservative, compared to using HEC-HMS or USGS Regression equations. The PC-Hydro model requires the parameters regarding rainfall, topography, soil, and vegetation to determine peak discharge. Those parameters were determined following the PC-Hydro User Guide (Arroyo Engineering, 2007). The PC-Hydro model is included in Appendix D.

4.2 Parameter Estimation

4.2.1 Drainage Area

Subbasin boundaries were delineated using the hydrology function of ArcGIS with 2008 Lidar Data. A 2-ft contour map was used to make sure if the subbasin delineation was reasonable.

4.2.2 Watershed Work Map

A watershed work map is included in Exhibit 1. A 100-year peak discharge at Silverbell Rd. (CP A) was used for HEC-RAS hydraulic analysis.

4.2.3 Gage Data

No gage data were used in this TDN.

4.2.4 Spatial Parameters

No spatial parameters were used in this TDN.

4.2.5 Precipitation

One-hour rainfall was used to estimate 100-year peak discharge at the Silverbell Rd. The rainfall intensity at the time of concentration for the Unnamed Wash 1 watershed is 3.78 inches. No area reduction factor was applied.

4.2.6 Physical Parameters

Methods are summarized in Table 1. The PC-Hydro model calculates runoff coefficients using adjusted Curve Number (CN), which has been developed based on the results of the USDA-ARS research. This procedure assumes that high intensity, short duration storms result in raindrop impacts causing the surface of soils to seal up, resulting in reducing infiltration (Caliche Effect). The CN in the PC-Hydro model increases with increasing rainfall depth and intensity. The detail of the method was described in PC-Hydro User Guide (Arroyo Engineering, 2007).

Table 1 Methods used for a PC-Hydro analysis

	Selected Method
Rainfall Depth	NOAA 14, upper 90% Confidence Interval
Rainfall Loss	Adjusted SCS Curve number
Time of Concentration	Pima County Hydrology Procedure

Table 2 Watershed Characteristics

Sub-Basin	Area (acre)	CN	Impervious Area (%)	Vegetation Cover (%)
UN1	519	85.3	10.0	20

4.3 Problems Encountered During the Study

4.3.1 Special Problems and Solutions

There were no problems with the hydrologic modeling.

4.3.2 Modeling Warning and Error Messages

None

4.4 Calibration

No calibration was conducted in this study.

4.5 Final Results

4.5.1 Hydrologic Analysis Results

The 100-year peak discharges at CP A (at Silverbell Rd.) were determined using the PC-Hydro. The results are summarized Tables 3.

Table 3 Summary of the Hydrologic Analysis

Sub-Basin	Area (sq mile)	CN	Impervious Area (%)	Vegetation Cover (%)
UN1	0.81	85.3	10.0	20

4.5.2 Verification of results

The estimated peak discharge at CP A was also compared with the peak discharge obtained from USGS Regression Equation 13 (Thomas et al., 1997) (Table 4). The comparison showed that the PC-Hydro-derived peak discharge is 12.5% higher than the one derived from the Regression Equation.

Table 4 Comparison of a peak discharge

Concentration Point	Location	Area (acre)	Q100 PC-Hydro(cfs)	Q100 RRE (cfs)
CP A	**at Silverbell Rd.**	0.81	1229	1092

RRE: USGS Regression Equation 13

Section 5 Hydraulics

5.1 Method Description

The hydraulic modeling for the Unnamed Wash 1 was performed using Hec-Ras, Version 4.0 (HEC-RAS), HEC-GeoRAS, Version 4.1.1 (HEC-GeoRAS), and ArcGIS, Version 9.3. Corrected model is proposed in this study. The model name is Und, and the plan name is Plan 01.

As previously mentioned, DEM derived from 2008 LiDAR data was used to create a 5-foot contour map. The locations of the stream centerline, cross-sections, and bank of the Unnamed Wash 1 were determined using the contour map and 2008 PAG aerial photos. The physical attributes of the wash were digitized in ArcGIS using the HEC-GeoRAS extension and then exported to HEC-RAS to create geospatially referenced geometric data (cross section, reach profile). Other parameters for the steady-state analysis, such as Manning's n-values, expansion and contraction coefficients, boundary condition, and ineffective flow areas were manually added in the HEC-RAS model. The hydraulic data obtained from HEC-RAS were then imported into HEC-GeoRAS to delineate a floodplain boundary of the Unnamed Wash 1.

Hydraulic analysis was performed in the area currently mapped as FEMA Zone A. Steady flow analysis was performed to determine 100-year water surface elevations in the study area by using HEC-RAS. As described above, geometric data for HEC-RAS including stream centerline, flow paths and cross-sections were obtained using HEC-GeoRAS. Normal-depth with a slope of 0.02 was assumed for the upstream boundary condition for the western reach.

5.2 Work Study Maps

The work study map for the Unnamed Wash 1 is included in Exhibit 2.

5.3 Parameter Estimation

5.3.1 Roughness Coefficients

Manning’s n values were determined by a combination of a site visit and 2008 PAG aerial photo. Manning’s n value of 0.05-0.06 was assigned for the overbank with desert brush along the Unnamed Wash 1. The value of 0.04-0.045 was assigned to a channel.

5.3.2 Expansion and Contraction Coefficients

The channel of the Unnamed Wash 1 is assumed to have generally gradual transitions with minimum curvature. The expansion coefficient of 0.30 and contraction coefficient of 0.10 were used for the entire study reach.

5.4 Cross-Section Description

A 5-foot interval contour map was used to select the location of cross sections. Cross-section locations were determined primarily based on the channel topography. The cross-section lines were drawn to be perpendicular to flow paths in Hec-GeoRAS.

5.5 Modeling Consideration

5.5.1 Hydraulic Jump and Drop Analysis

No hydraulic, drop analyses or adjustment of the floodplain was conducted in this study.

5.5.2. Bridges and Culverts

None.

5.5.3 Levees and Dikes

There are no levees or dikes located within the study limit.

5.5.4 Island and Flow Splits

There were no islands or flow splits modeled.

5.5.5 Ineffective Flow Areas

Ineffective flow option was modeled in the situation that overbank areas are disconnected and would not convey flow to the next downstream cross-section.

5.6 Floodway Modeling

No floodway modeling was performed in this study.

5.7 Problems Encountered

5.7.1 Special Problems and Solutions

There are no special problems in the study limit.

5.7.2 Model Warnings and Errors

No errors occurred. The following warning messages occurred:

- Divided flow
- Energy loss greater than 1.0
- Energy equation could not be balanced and defaulted to critical.
- Cross-section extended vertically.
- Multiple critical depths calculated.

Conveyance ratio is less than 0.7 or greater than 1.4.

Inspection indicated that the modeling is accurate given the steep channel conditions. Most of these errors force a critical solution which is reasonable for these steep watercourses.

5.8 Calibration

The model was not calibrated in this study.

5.9 Final Results

5.9.1 Hydraulic Analysis Results

The HEC-RAS model is included in Appendix E.

5.9.2 Verification of Results

The floodplain limit produced in this Unnamed Wash 1 LOMR study was compared to the existing FEMA floodplain limit. The proposed floodplain limit tends to follow the existing floodplain limit. The results suggest that the proposed floodplain limit is reasonable based on the topography.

Section 6 Erosion and Sediment Transport

No erosion or sediment transport analysis was conducted in this study.

Section 7 Draft FIS Report Data

7.1 Summary of Discharges

Peak discharges at CP A was used for the hydraulic analysis in this study. The estimated regulatory discharge rates are 1229 cubic feet per second (cfs) with a drainage area of 0.81 square mile.

7.2 Floodway Data

Not applicable.

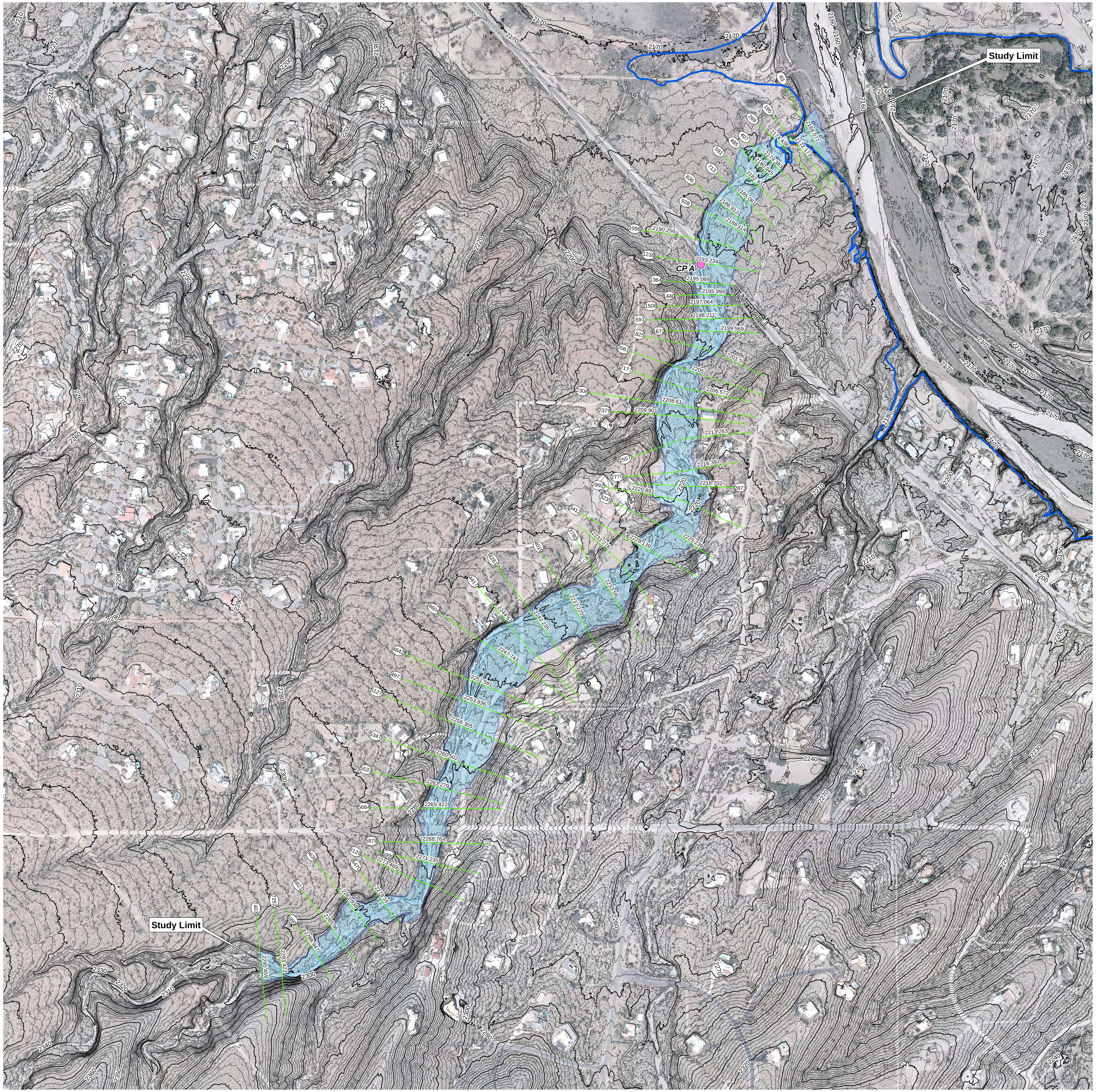
7.3 Annotated Flood Insurance Rate Map

An annotated Flood Insurance Rate Map (FIRM) is included in Exhibit 2.

7.4 Flood Profiles

Flood profiles are included in the HEC-RAS model in Appendix E.

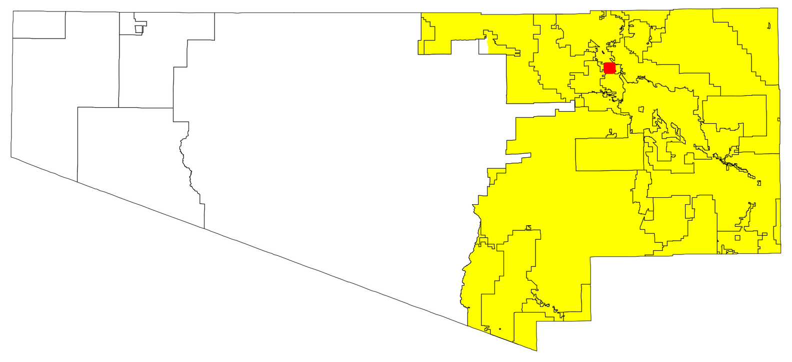
Exhibit 1
100-year Floodplain with cross sections Unnamed Wash 1



- Discharge Point
- River
- Cross Sections
- Countour 2ft
- Countour 10ft
- Existing Zone AE
- Proposed 100yr Floodplain

Aerial: 2008 Pima Association of Governments
Topo: 2008 Pima Association of Governments
Vertical Datum: NAVD 1988

Pima County Index Map



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Pima County Regional Flood Control District

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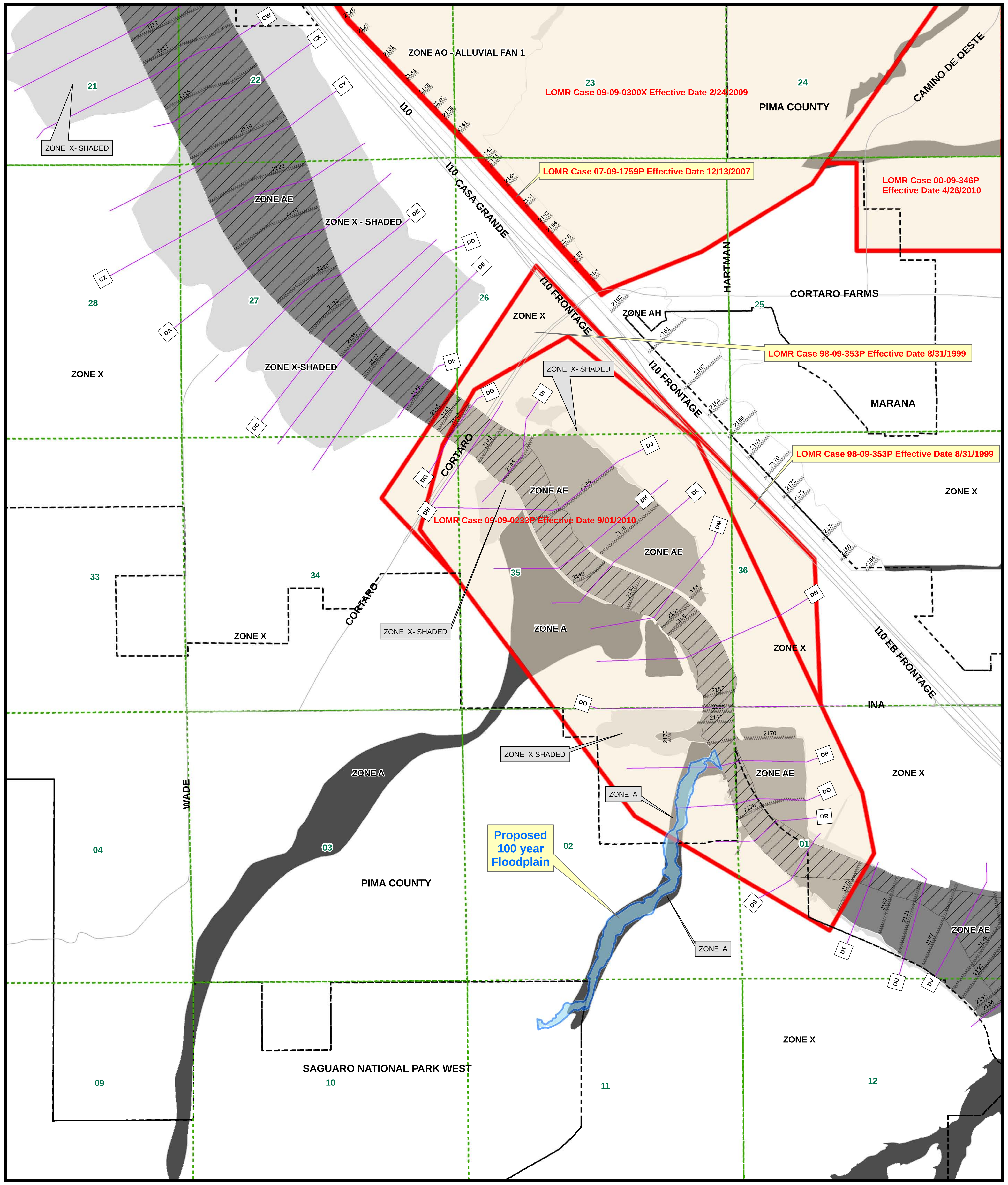


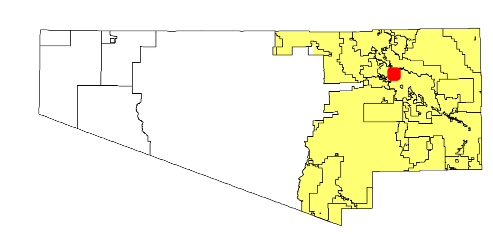
Exhibit 2
Annotated Flood Insurance Rate Map
04019C1605 K
Unnamed Wash 1

- UN1 100-yr Floodplain
- FIRM - Flood Insurance Rate Map
- FIRM X-Sections
- Base Flood Elevations
- Floodways
- Streets
- Sections
- Jurisdictions
- LOMR Case Studies

Existing Floodplain Zone

- A
- AE
- AO
- X
- X - (SHADED)

Pima County Index Map



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Pima County Regional Flood Control District

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A.1 Data Collection Summary

Aldridge, B. and J. Garrett. 1973. Roughness Coefficients for Stream Channels in Arizona. US Department of the Interior Geological Survey. Tucson, AZ.

Arizona Department of Water Resources, Flood Mitigation Section
“Instruction for Organization and Submitting Technical Document for Flood Studies” SSA1-97, November 1997

Arizona Department of Water Resources, Flood Mitigation Section
“Requirements for Flood Study Technical Documentation” SS1-97, November 1997

Arroyo Engineering. 2007. PC-Hydro User Guide. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona. Revised in 1998.

National Weather Service. 1984. Depth-Area Ratios in the Semi-Arid Southwest United States, NOAA Technical Memorandum NWS Hydro-40

Phillips, J., and S. Tadayon. 2006. Selection of Manning’s roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona: U.S. Geological Survey Scientific Investigations Report 2006–5108, 41 p.

Phillips, J., and T. Ingersoll. 1998. Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona. U.S. Geological Survey Professional Paper 1584.

Pima County Regional Flood Control District
“Pima County Mapguide Map”, 2008

U.S. Army Corps of Engineers (COE). 1998. HEC-1 Flood Hydrograph Package, Users Manual, CPD-1A, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2001. HEC-RAS, River Analysis System, Hydraulic
Reference Manual, CPD-69, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2003. Geospatial Hydrologic Modeling Extension HEC-GeoHMS, (v 1.1) CPD-77, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2006. HEC-HMS, Hydrologic Modeling System User’s Manual, (v. 3.1.0) CPD-74A, Hydraulic Engineering Center, Davis, CA.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Washington, DC.

A 2. Referenced Documents

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

Eychaner, J.H., 1984. Estimation of magnitude and frequency of floods in Pima County, Arizona, with comparisons of alternative methods: U.S. Geological Survey Water-Resources Investigations Report 84-4142, 69 p.

Haan, C.T., Barfield, B.J., Hayes, J.C. 1994. Design Hydrology and Sedimentology for Small Catchments, Academic Press.

Thomas, B.E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States. USGS Water Supply Paper 2433. 195 p.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Washington, DC.