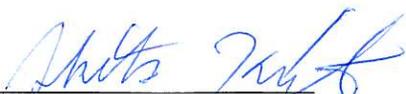


**Catalina Foothills Watercourse Studies:
Technical Data Notebook for Hydrologic and Hydraulic Mapping of the
Canyon del Salto Wash,
Pima County Arizona.**

FEMA FIRM Panel 04019C-1667L



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Pima County Regional
FLOOD CONTROL
DISTRICT



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Exhibit

- Exhibit 1 100-yr Floodplain Limit Map for the Canyon del Salto Wash
- Exhibit 2 Annotated Flood Insurance Rate Map

Attached CD

Canyon del Salto Wash TDN with supporting models and GIS data.

Section 1: Introduction

1.1 Purpose

The purpose of this study is to provide flood and erosion hazard information for the Canyon del Salto Wash for use by the Pima County Regional Flood Control District (District) in floodplain use permitting and floodplain management. More specifically, it provides:

- discharge values for sub-basins and important concentration points;
- hydrographs for use with floodplain mapping;
- floodplain mapping for channels with contributing areas greater than 1 square mile, and channels with 100-yr discharges greater than 2000 cfs, which are treated differently under the Pima County Ordinance.

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.

1.3 Project Location

The study was performed to provide drainage information for the Canyon del Salto Wash. The site includes Sections 13, 24, 25, 26, 35, and 36 of Township 13 South, Range 16 East, Sections 16, 17, 18, 19, 20, and 30 of Township 13 South, Range 17 East, Sections 02 of Township 14 South, Range 16 East, Pima County, Arizona. The Canyon del Salto Wash watershed is in FEMA Zone X and Zone D, as shown on the current Flood Insurance Rate Map (FIRM) number 04019C-1667L.

The watershed is 8.18 square mile. The study watershed was divided into seven sub-basins (Fig.1.1). The study limits for the Canyon del Salto Wash extends from a confluence with Tanque Verde Creek to the downstream end of Zone D (Fig.1.2).

1.4 Methodologies Used for Hydrology and Hydraulics

Topographic, hydrologic and hydraulic analyses were performed to determine drainage conditions in the Canyon del Salto Wash. ArcGIS, Version 9.3.1, HEC-HMS Version 3.4 (HEC-HMS), HEC-RAS Version 4.0 (HEC-RAS), and HEC-GeoRAS, Version 4.1.1 (HEC-GeoRAS) were used for the analyses.

1.5 Acknowledgements

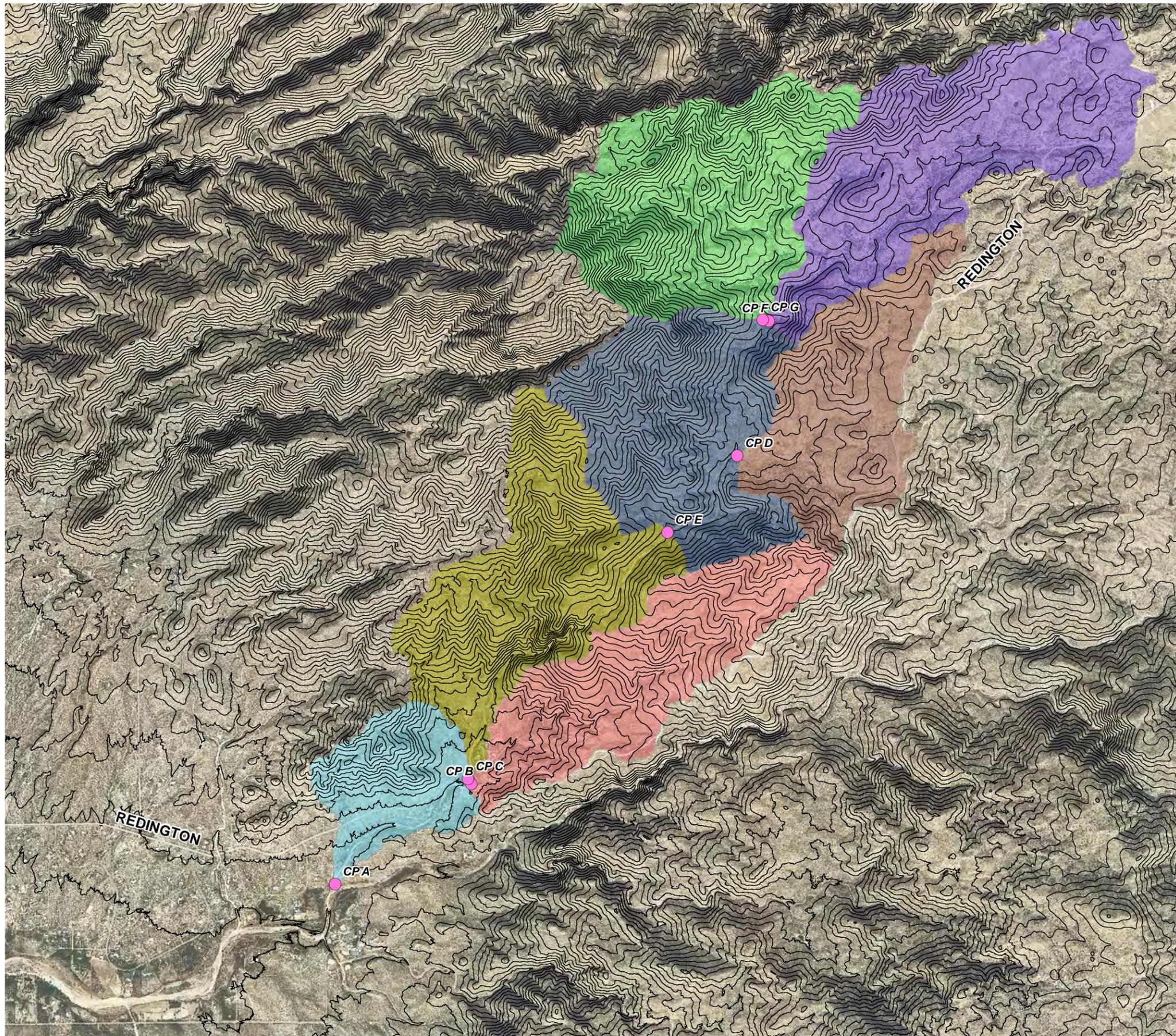
This study relied on assistance of RFCD GIS staff, who were integral to the development of the models and maps.

1.6 Study Results

The modeled discharge for the Canyon del Salto Wash at the confluence with the Tanque Verde Creek is 4743 cfs, where the area is 8.18 square miles.

The Canyon del Salto Wash watershed is partially located within Federal land (national forest, FEMA Zone D). The floodplain was mapped downstream of the Zone D on the Canyon del Salto Wash.

**Figure 1.1
Watershed Map
Canyon Del Salto Wash**



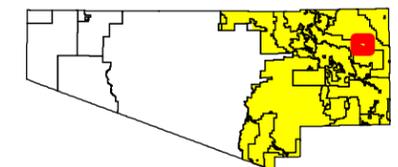
- Discharge Point
- Contour 50 foot
- Streets

Subbasins

- CDS A
- CDS B
- CDS C
- CDS D
- CDS E
- CSD F
- CSD G

Aerial : 2006 Pima Association of Governments
 Topo: 2008 Pima Association of Governments
 Datum: NAVD 1988

Pima County Index Map



Index Map Scale 1:5,250,000

The information depicted on this display is the result of digital analysis 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.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

Pima County Regional Flood Control District

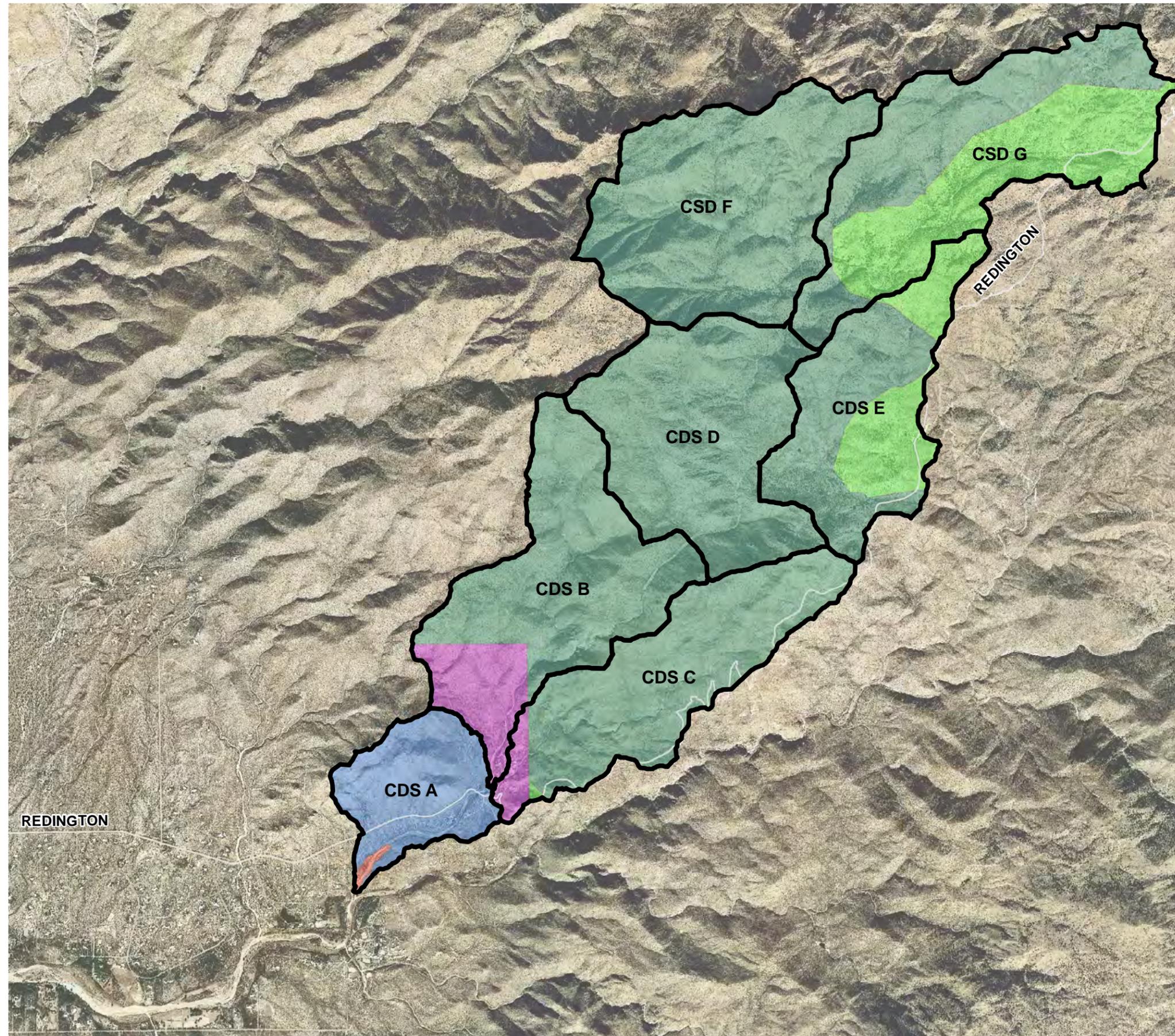


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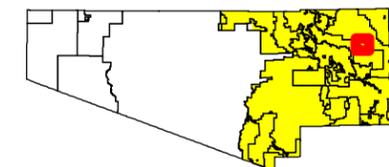
**Figure 1.3
Soil Classification Map
Canyon Del Salto Wash**



- Subbasins**
- Soil Classification**
- Soil Group: A (100%), ARIZO-RIVERWASH COMPLEX, 0 TO 3 PERCENT SLOPES
 - Soil Group: B (100%),
 - Soil Group: B (50%) C (50%), PALOS VERDES-SAHUARITA COMPLEX, 2 TO 8 PERCENT SLOPES
 - Soil Group: C (50%), D (50%)
 - Soil Group: D (100%), CELLAR-LAMPSHIRE-ROCK OUTCROP COMPLEX, 15 TO 60 PERCENT SLOPES
 - Soil Group: D (100%), CELLAR-LEHMANS COMPLEX, 5 TO 25 PERCENT SLOPES

Aerial : 2006 Pima Association of Governments

Pima County Index Map



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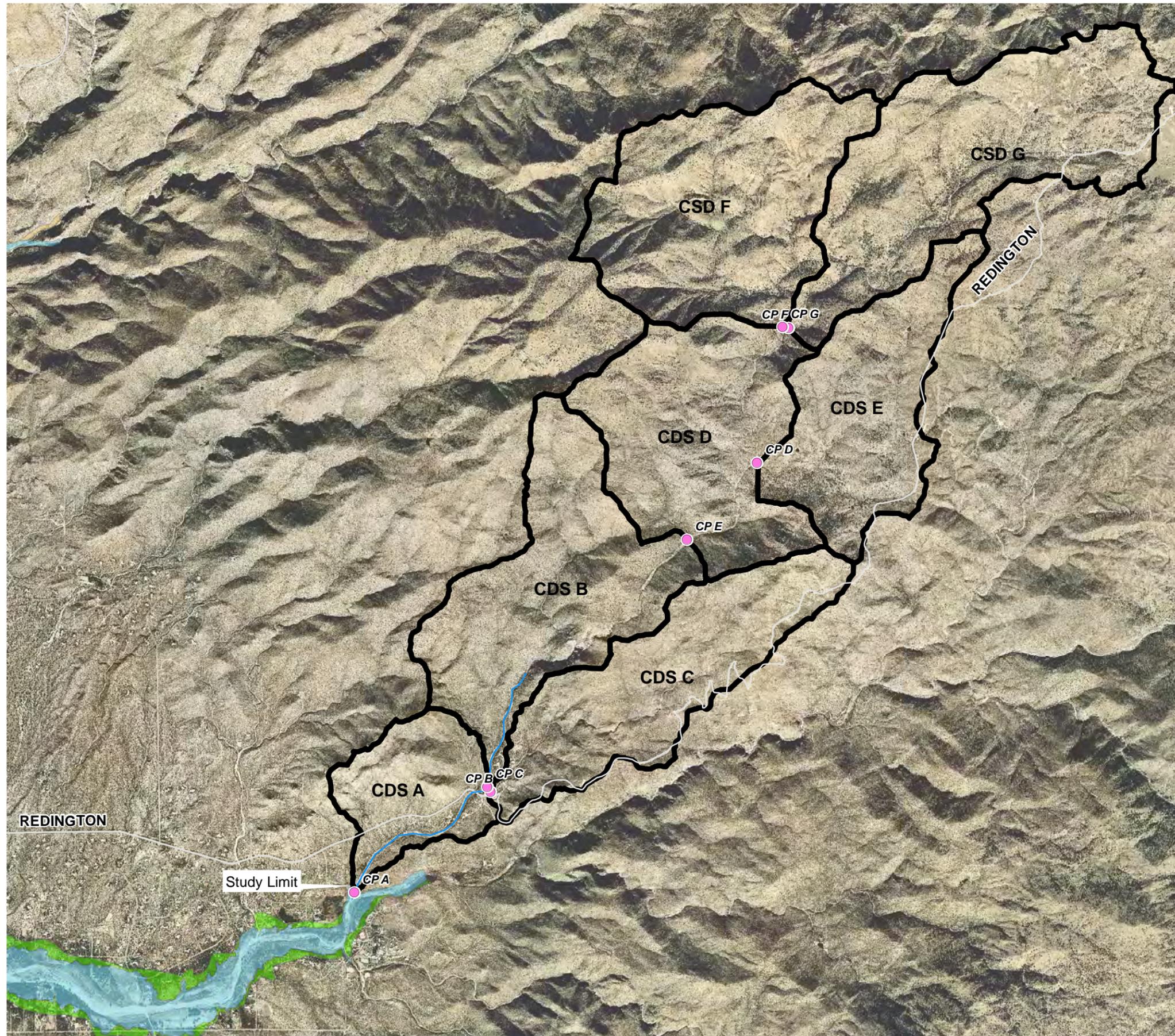


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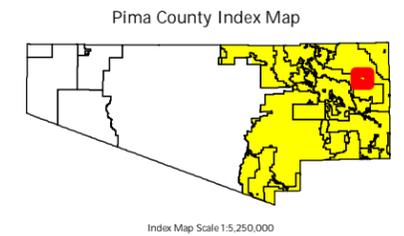
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**Figure 1.2
Study Limit Map
Canyon Del Salto Wash**



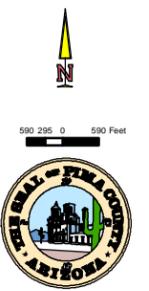
- Discharge Point
- River
- Streets
- Subbasins
- Existing FEMA Floodplain**
- ZONE A
- ZONE AE
- ZONE X - SHADED

Aerial : 2006 Pima Association of Governments



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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Section 2 Summary of Key Facts

2.1: General Information

- 2.1.1 Community:** Pima County Regional Flood Control
- 2.1.2 Community Number:** NFIP Community Number 04019C
- 2.1.3 County:** Pima
- 2.1.4 State:** Arizona
- 2.1.5 Date Study Accepted:** Not Accepted
- 2.1.6 Study Contractor:** Pima County Regional Flood Control District – Akitsu Kimoto
- 2.1.7 State Technical Reviewer:** Not Applicable
- 2.1.8 Local Technical Reviewer:** Suzanne Shields
- 2.1.9 River or Stream Name:** Canyon del Salto Wash
- 2.1.10 Reach Description:** Canyon del Salto Wash
- 2.1.11 Study Type:** Hydrology and Hydraulics study of a Riverene System

2.2: Mapping Information

- 2.2.1 FIRM Panels:** 04019C-1667L
- 2.2.2 Mapping for Hydrologic Study:** Lidar based on 2008 flight used to derive 10' contour interval maps using ARC-GIS 9.3.1
- 2.2.3 Mapping for Hydraulic Study:** Lidar based on 2008 flight used to derive a DEM (5-ft cell size) for use with GeoRAS

2.3: Hydrology

- 2.3.1 Model or Method Used:** HEC-HMS (v. 3.4) model parameterized using methods of RFCDDraft Tech Policy 018
- 2.3.2 Storm Duration:** 3-hr
- 2.3.3 Hydrograph Type:** SCS Unit Hydrograph
- 2.3.4 Frequencies Determined:** 100 yr
- 2.3.5 List of Gages used in Frequency Analysis or Calibration:** None
- 2.3.6 Rainfall Amounts and Reference:** SCS Type II, NOAA 14 Upper 90% Confidence Interval
- 2.3.7 Unique Conditions and Problems:** None
- 2.3.8 Coordination of Q's:** Comparison with previous studies on file with RFCDD and discharge estimates

2.4: Hydraulics

- 2.4.1 Model or Method Used:** HEC-RAS 4.0, GeoRAS to parameterize
- 2.4.2 Regime:** Modeled as subcritical
- 2.4.3 Frequencies for which Profiles were computed:** 100 yr
- 2.4.4 Method of Floodway Calculation:** No Floodway
- 2.4.5 Unique Conditions and Problems:** Boundary set at normal depth.

2.5: Additional Study Information:

None

Section 3: Survey and Mapping Information

3.1 Field Survey Information

No field survey was used.

3.2 Mapping

The 2008 Light Detection and Ranging (LiDAR) data was used for the analysis.

Coordinates were in Pima County projection:

Projection = State Plane, Arizona Central Zone

Datum = NAD83 HARN

Units = International Feet

North American Vertical Datum of 1988 (NAVD, 1988)

The LiDAR was used to derive a Digital Elevation Model (DEM) and a contour map. DEM derived on 5' centers provided the basis for delineating the watershed and sub-basins. DEM was also used to characterize the topography along channels used for the floodplain mapping process. Contour maps derived from the DEM allowed modelers to visualize topographic differences in making decisions on how to model different areas.

Section 4: Hydrology

4.1 Method description.

For the floodplain mapping, a 100-yr discharge is required. The 100-year peak discharges for the sub-basins of the Canyon del Salto Wash (CDS A, B, C, D, E, F and G; Figure 1.1) were calculated using U.S. Army Corps of Engineers Computer Hydrologic Modeling System, (HEC-HMS) version 3.4. The HEC-HMS model requires the parameters regarding rainfall, topography, soil, vegetation, and channel characteristics to determine runoff volume and peak discharge. Those parameters were determined according to the Pima County Regional Flood Control District Technical Policy 018 (Tech-018). Tech-018 is included in Appendix A.

4.2 Parameter estimation.

Methods are summarized in Table 4.1. The data processing methods are summarized in Fig. 4.

According to the Tech-018, the 3-hour storm shall be used as rainfall data in the HEC-HMS model in the case that a time of concentration (T_c) is equal or less than three hours. A 3-hour storm was selected, since T_c was less than 3 hours in all the sub-basins. A point 3-hour rainfall depth at the coordinates of the centroid of the watershed was obtained from NOAA Atlas 14, upper 90% confidence interval precipitation frequency estimate (NOAA 14 rainfall). An areal reduction factor was applied to watersheds larger than 1 square mile, as described in Tech-018.

Table 4.1 - Methods used for a HEC-HMS analysis

	Selected Method
Rainfall Depth	NOAA 14, upper 90% Confidence Interval
Rainfall Distribution	3-hr SCS Type II Storm
Rainfall Loss	SCS Curve number
Time of Concentration	SCS Segmental Method
Transform	SCS Unit Hydrograph
Routing	Modified-Puls and Kinematic Wave

4.2.1 Drainage area boundaries.

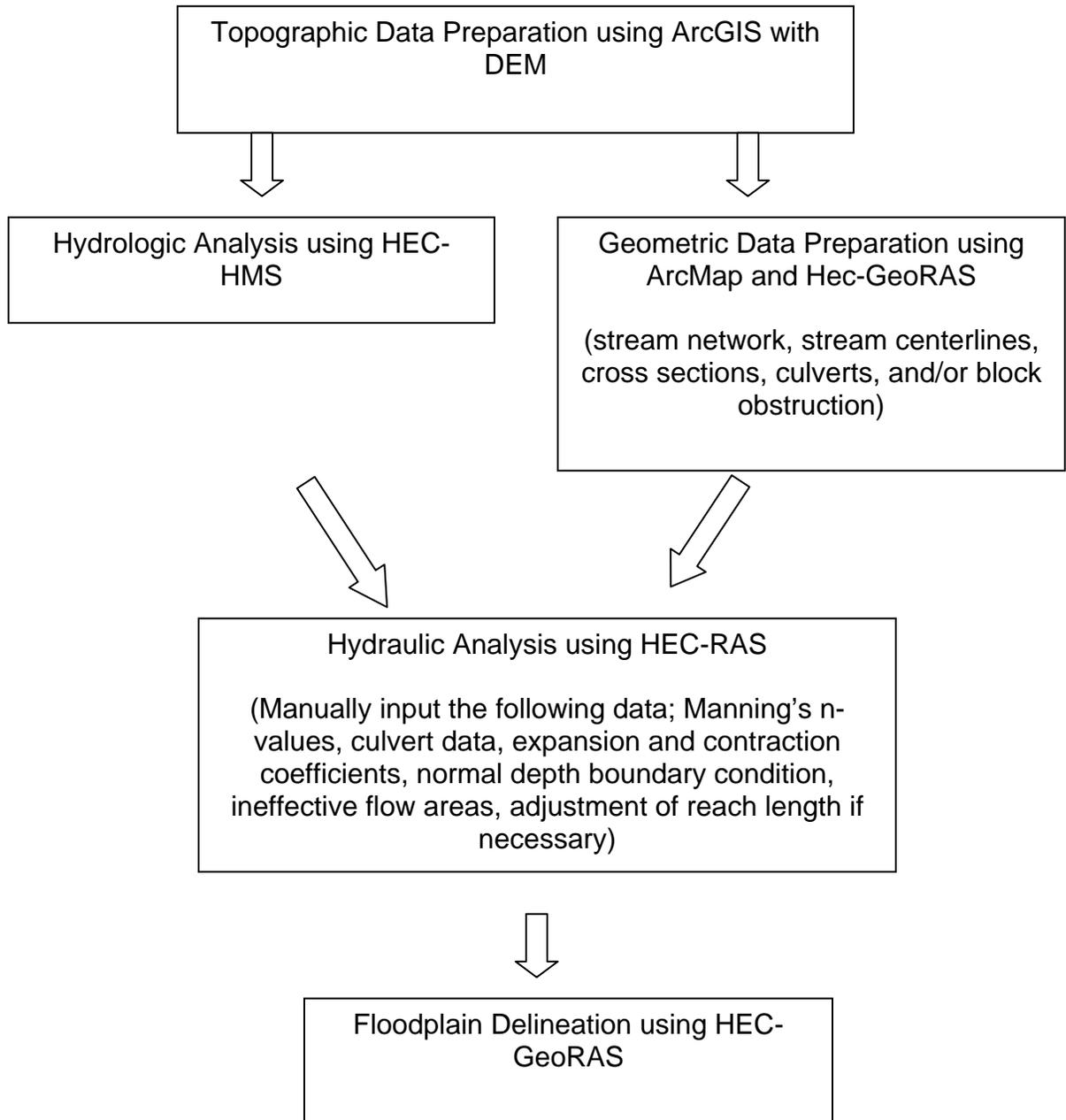
The limits of this study are shown in Fig.1.2. The Canyon del Salto Wash watershed is partially located within Federal land (national forest, FEMA Zone D), as shown on the current Flood Insurance Rate Map (FIRM) number 04019C-1700 and 2285 K. The floodplain was mapped in the downstream area of the Canyon del Salto wash.

The watershed is 8.18 square mile. The study watershed was divided into seven sub-basins (Fig.1.1). The upstream study limits is the upstream limit of Zone D along the Canyon del Salto wash, while the downstream limit is the confluence with the Tanque Verde Wash (Fig.1.2).

4.2.2 Watershed work maps

Watershed work map is shown in Exhibit 1. The boundary of the watershed and internal sub-basins were determined using Hydrology function in ArcGIS with DEM derived from the 2008 Lidar. The sub-basins reflected predominant topographic, soils, cover and development conditions, so that the sub-basins would represent hydrologic response from the sub-basin. The locations of the stream centerline, cross-sections, culverts, and other physical attributes of the wash were determined by using the 10-ft interval contour map and 2002 aerial photo.

Figure 4.1 – Flow Chart of Mapping Process



4.2.3 Gage Data.

None Available

4.2.4 Statistical parameters

None Available

4.2.5 Precipitation.

Rainfall depth was selected from the NOAA 14 Upper 90% rainfall data used in PC Hydro. The point rainfall depth for the 3-hour storm was obtained, based on the coordinates of the centroid of the watershed (Latitude: 32.278, Longitude: 110.65). Areal reduction factor was applied to watersheds larger than 1 square mile as noted in Tech-018. The 3-hr, SCS Type II rainfall distribution described in Haan et al (1994) was used.

4.2.6 Physical parameters.

A hydrologic soils group map for the study watershed is presented in Fig.1.3. The study watershed is mostly covered with Desert brush. Hydrologic Soil Group C and D are the dominant soil types in the Canyon del Salto Wash watershed. The SCS Curve Number was determined using maps obtained from NRCS (<http://soildatamart.nrcs.usda.gov/>) as a basis for preparing a Hydrologic Soil Group Map for Pima County. The CN charts in the PC Hydro Manual (Arroyo Engineering, 2007) were the basis for CN selection. A vegetation cover density of 30% was used to select the SCS Curve Number for the hydrologic calculation of the mountainous watersheds. Impervious cover percentage from 5-7%, were selected based on lot size, the fraction of the sub-basin that is developed and the tables in the PC Hydro manual. Sub-basin characteristics are summarized in Table 4.2 The detail of the CN calculation is included in Appendix D.

Table 4.2 - Sub-basin Characteristics

Sub-Basin	Area (sq mi)	CN	Impervious Area (%)	Vegetation Cover (%)	Lag Time (min)
CDS A	0.53	90.4	7	30	12.1
CDS B	1.34	87.0	5	30	14.1
CDS C	1.08	89.1	5	30	18.7
CDS D	1.24	86.2	5	30	11.4
CDS E	0.98	86.6	5	30	17.8
CDS F	1.42	86.2	5	30	11.2
CDS G	1.59	84.5	5	30	31.7

The SCS TR-55 segmental Time of Concentration (Tc) method with a combination of kinematic wave method was used. The hydraulically most distant point on the sub-basin was identified. The length of sheetflow was estimated at 100 feet, the distance from the end of the sheetflow to a well-defined channel was selected as the shallow concentrated portion of the flow path, and the channel portion was the path from the well-defined channel to the sub-basin outlet was the ‘channel flow’ portion of the flow path.

Tc is the sum of the travel time for sheetflow, shallow concentrated flow and channel flow. The travel time for sheetflow was calculated using kinematic wave method. The travel time for shallow concentrated flow was calculated using the methods described in the TR-55 manual (USDA-1986). The travel time for channels used estimates from a HEC-RAS model. The lag time was calculated as 0.6 Tc. The detail of the Tc calculation is included in Appendix D.

The SCS unit hydrograph method was used to produce hydrographs at the outlet of the sub-basin in HEC-HMS. Runoff from sub-basins was routed using the Modified-Puls method. A storage discharge table for the channel routing was developed using the cross sections and slopes derived from HEC-HMS. Modified Puls routing employed the methods described in the HMS manual. The detail of the calculation of the number of subreach is included in Appendix D. Sub-basin discharges are summarized on Table 4.3.

Table 4.3 – 100-yr Sub-basin discharges

Sub-Basin	Area (sq mi)	Rainfall Depth (in)	Runoff Volume (in)	Peak Discharge (cfs)
CDS A	0.53	3.57	2.55	1557
CDS B	1.34	3.57	2.25	3229
CDS C	1.08	3.57	2.43	2377
CDS D	1.24	3.57	2.18	3237
CDS E	0.98	3.57	2.21	2025
CDS F	1.42	3.57	2.18	3729
CDS G	1.59	3.57	2.04	2017

4.3 Problems encountered during the study.

None

4.3.1 Special problems and solutions

4.3.2 Modeling warning and error messages

The time interval of the rainfall data used in this study is 5 minutes, while the simulation time interval is 1 minute. The HEC-HMS model interpolated the 5-minute time interval of the rainfall data to 1-minute time interval.

4.4 Calibration

No Calibration

4.5 Final results

4.5.1 Hydrologic analysis results

As described above, this study mainly focuses on drainage information in the downstream of the Canyon del Salto wash (Subbasins A and B). The 100-year peak discharge at CPs A and B were determined using the HEC-HMS. Six hours were simulated on a 1 minute time step with rainfall occurring in the first three hours. The following discharges were obtained from the hydrologic analysis:

Table 4.4 – Summary of 100-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q100 HMS (cfs)	Time to Peak
CP A	Confluence with Tanque Verde Creek	8.18	2.93	1.66	4743	1:47
CP B	Southwest of the National Forest	6.57	3.00	1.67	2695	1:57
CP C	Southwest of the National Forest	1.08	3.57	2.43	2377	1:42

Table 4.5 – Summary of 25-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q25 HMS (cfs)	Q25 RRE (cfs)	Time to Peak
CP A	Confluence with Tanque Verde Creek	8.18	2.29	1.1	3224	2438	1:47
CP B	Southwest of the National Forest	6.57	2.34	1.11	1752	2173	1:38
CP C	Southwest of the National Forest	1.08	2.43	1.71	1673	761	1:42

Table 4.6 – Summary of 500-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q500 HMS (cfs)	Time to Peak
CP A	Confluence with Tanque Verde Creek	8.18	3.81	2.43	7182	1:45
CP B	Southwest of the National Forest	6.57	3.90	2.45	4379	1:53
CP C	Southwest of the National Forest	1.08	3.57	2.92	3317	1:42

4.5.2 Verification of results.

Results are reasonable when compared with USGS Regression Equation 13 (Thomas et al, 1997, Table 4.7). The equation 13 results were generally lower than the HMS results, which would be expected, because these steep watersheds could be expected to produce higher than average discharge on average. A 25-yr peak discharge for CP B derived from the Regression Equation 13 is higher than the one derived from HEC-RAS. No regulatory discharge point data is available along the Canyon del Salto Wash.

Table 4.7 – Comparison of 100-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Q100 HMS (cfs)	Q100 RRE (cfs)
CP A	Confluence with Tanque Verde Creek	8.18	4743	4360
CP B	Southwest of the National Forest	6.57	2695	3884
CP C	Southwest of the National Forest	1.08	2377	1325

Section 5: Hydraulics

5.1 Method description.

Steady flow analysis was performed to determine 100-year water surface elevations in the study area by using HEC-RAS with the discharge obtained from HEC-HMS. Floodplain boundary within subbasins A and B is shown in this study.

5.2 Work study maps

As described above, geometric data for HEC-RAS including stream centerline, cross-sections, and culverts, were obtained from HEC-GeoRAS. The locations of cross sections and channels used for the 100-yr floodplain analysis are shown in Exhibit 1. The 100-yr floodplain limit is also shown in Exhibit 1.

5.3 Parameter estimation.

The watershed was modeled using methods consistent with District Tech Policy 019.

5.3.1 Roughness coefficients.

Manning's roughness coefficients for the channel and the over-bank areas were determined by using a 2002 aerial photo. Differentiation of channel and overbank 'n' values should be done only when channel flow is at least twice as deep as overbank flow (Phillips and Tadayon, 2006). The reach within Subbasin A is wide with several flow paths. Rather than assign a channel and overbank Manning's n, an average n for the whole cross-section of 0.045 was assigned.

5.3.2 Expansion and contraction coefficients.

Default HEC RAS expansion (0.3) and contraction (0.1) coefficients were used for the most cross sections.

5.4 Cross section description.

A 10-foot interval contour map derived from 2008 LiDAR data 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 Geo-RAS and ArcGIS.

5.5 Modeling considerations.

5.5.1 Hydraulic Jump and drop analysis.

No hydraulic jumps were encountered.

5.5.2 Bridges and culverts.

There are no culverts along the study reaches of the Canyon del Salto Wash.

5.5.3 Levees and dikes.

None.

5.5.4 Islands and flow splits.

None.

5.5.5 Ineffective flow areas.

Ineffective flow areas were noted on the study reach of the Canyon del Salto Wash. In general these ineffective flow areas were disconnected overbank areas that would not convey flow to the next downstream cross-section.

5.5.6 Supercritical flow.

No supercritical reaches.

5.6 Floodway modeling

No encroachment calculations were performed.

5.7 Problems encountered during the study.

5.7.1 Special problems and solutions.

None.

5.7.2 Modeling warning and error messages.

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. A summary of errors is available in Appendix E.

5.8 Calibration.

None.

5.9 Final results.

5.9.1 Hydraulic analysis results.

The HEC-RAS modeling results were summarized in Appendix E.

5.9.2 Verification of results.

Existing floodplain maps are not available along the Canyon del Salto Wash. The new map tends to follow the floodplain topography. The results suggest that the mapping is reasonable.

Section 6: Erosion and Sediment Transport

6.1 Method description.

None – not applicable

6.2 Parameter estimation.

None – not applicable

6.4 Modeling considerations.

None – not applicable

6.5 Problems encountered during the study.

6.5.1 Special problems and solutions.

None – not applicable

6.5.2 Modeling warning and error messages.

None – not applicable

6.6 Calibration.

None – not applicable.

6.7 Final results.

6.7.1 Erosion and sediment transport analysis results.

None – not applicable

6.7.2 Verification of results.

None – not applicable

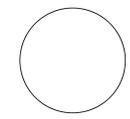
Section 7: Ratio of the top width of 100-yr and 25-yr floodplain

A map showing the cross sections with the ratio of the topwidth less than 1.25 is included in Addendum 1. The average ration of 100-yr to 25-yr floodplain topwidth for the study reaches are 1.11 for the Reach A (the reach runs through subbasin A) and 1.27 for the Reach B.

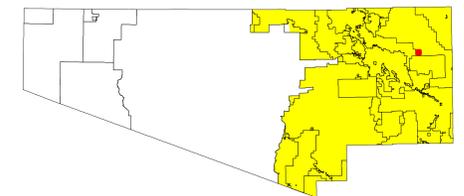
Exhibit 1 100-year Floodplain with cross sections Canyon Del Salto Wash

-  Discharge Point
-  Cross Sections AB
-  Cross Sections C
-  River
-  Contour 10ft
-  Proposed 100-yr Floodplain

Aerial : 2009 Landiscor Aerial Imagery
Topo: 2008 Pima Association of Governments
Datum: NAVD 1988



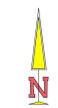
Pima County Index Map



Index Map Scale 1:1,500,000

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 Department of Transportation Technical Services Division makes no claims regarding the accuracy of the information depicted herein.

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Pima County Regional Flood Control District



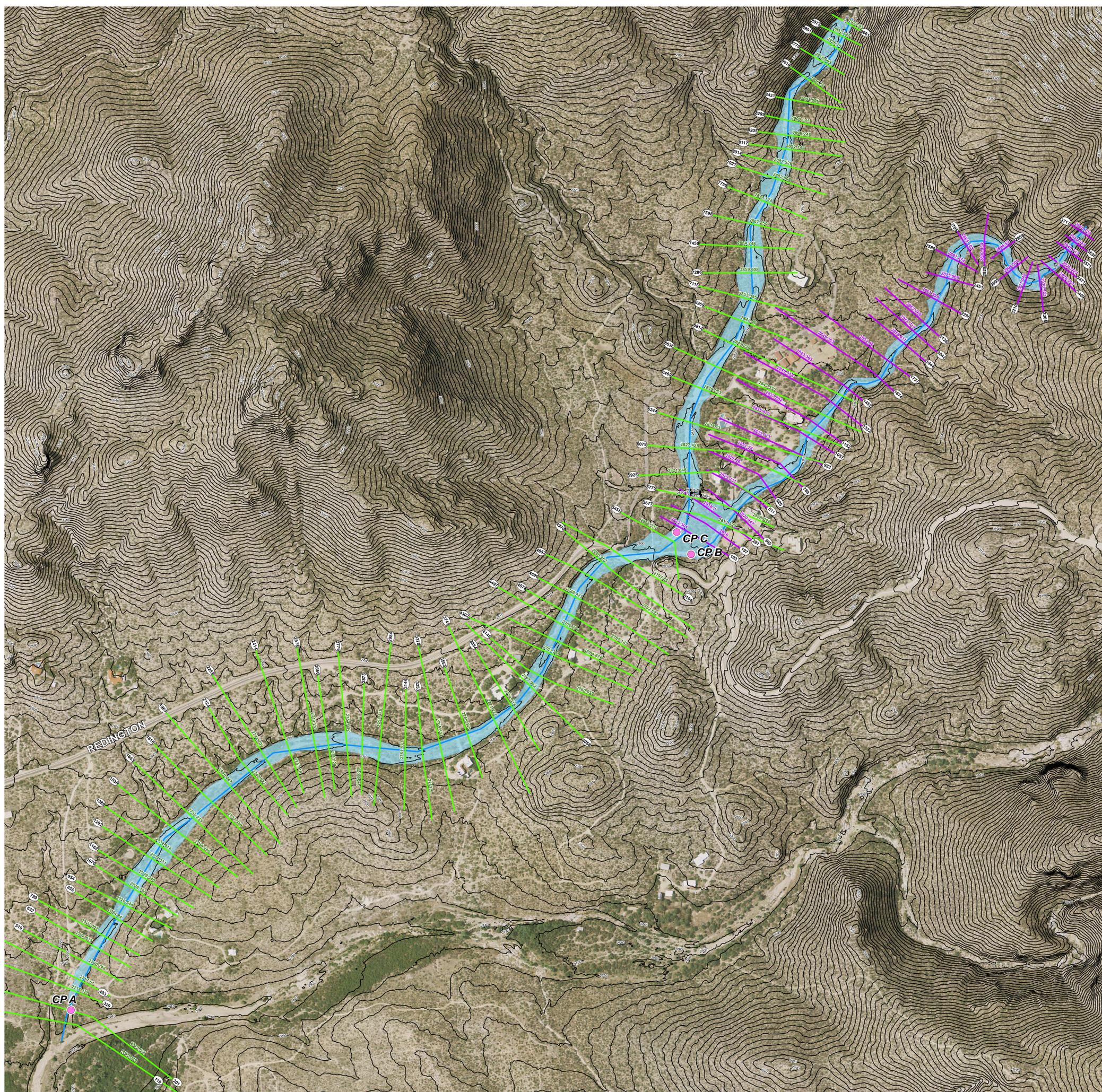
0 100 200 400 Feet



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08/2011

gislib/rfcd/projects/indj/xavi/indj/AKITSU/Canyon_Del_Salto/Canyon_Del_Salto_Exhibit_1.mxd



Appendix A: References

A.1 Data collection summary.

Include a list of previous studies, other applicable studies, published and unpublished historical flood information, and research contacts.

A.2 Referenced documents.

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

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.

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

NOAA, 2006. NOAA Atlas 14, Precipitation Frequency Atlas for the United States: Volume 1 - Version 4.0 The Semiarid Southwest. National Weather Service, Hydrometeorological Design Studies Center. Available on the internet at: http://hdsc.nws.noaa.gov/hdsc/pfds/sa/az_pfds.html

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.

Thomas, B.E., H.W. Hjalmanson, 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. 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). 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.

Appendix B: General Documentation & Correspondence

B.1 Special Problem Reports.

B.2 Contact (telephone) reports.

Provide copies of correspondence documenting notification of the client and the methods of addressing any special problems described in Sections 4.4.1, 5.5 and 6.5.

B.3 Meeting minutes or reports.

B.4 General Correspondence.

B.5 Contract Documents.

Provide a copy of the contract Scope of Work, not financial documents.

Appendix C: Survey Field Notes

C.1 Survey field notes for aerial mapping control.

C.2 Survey field notes for hydrologic modeling.

C.3 Survey field notes for hydraulic modeling.

Appendix D: Hydrologic Analysis Supporting Documentation

(models, spreadsheets and supporting information is provided digitally in the TDN disk)

Appendix E: Hydraulic Analysis and As-Built Drawings for Hydraulic Structures

(models, spreadsheets and supporting information is provided digitally in the TDN disk)