Catalina Foothills Watercourse Studies:
Technical Data Notebook for Hydrologic and Hydraulic Mapping of the Hydraulic Mapping of Woodland and Tres Lomas Watersheds
Pima County Arizona.

FEMA FIRM Panels 04019C-1670K and 1690K

Prepared by

Evan Canfield, PhD, PE
Civil Engineering Manager
07/29/15

Approved by

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

Suzanne Shields, PE
Director
8/3/15

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

PIMA COUNTY
FLOOD CONTROL

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Exhibit

Exhibit 1 100-yr Floodplain Limit Map for the Woodland Wash.
Exhibit 2 Peak Velocity at 100-Yr Discharge

Attached CD

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 Soldier Canyon 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;
- 100-yr floodplain maps for the alluvial fan on Woodland and Tres Lomas Canyon

1.2 Project Authority

The State of Arizona has delegated the responsibility to each county flood control district to delineate or require the delineation of floodplains and to regulate development within floodplains (ARS § 48-3609):

1.3 Project Location

The study was performed to provide drainage information for the Woodland and Tres Lomas Washes. The watershed extends to Sections 10, 11, 12, 13, 14, 15, 22, 23 and 24 of Township 13 South, Range 15 East Pima County, Arizona. Flow on the alluvial fan at the base of this watershed is distibutary. The lower portions of the washes near the confluence with Sabino Creek are mapped as an Zone A as shown on the current Flood Insurance Rate Map (FIRM) number 04019C-1670K.

Because flow is distributary on the fan, the flow area is not precisely known. However, Tres Lomas has an area of approximately 2.4 sq mi. at the confluence with Woodland and Woodland is approximately 5.9 sq mi at the confluence with Sabino Canyon. In total, these two have an area of approximately 8.3 sq mi. The full limits of the watershed are shown in Figure 1.1.

While not considered an Active Alluvial Fan by FEMA, the potential for avulsion and flow migration exists on the fan below the apex of the nine tributaries that feed into the fan. This study mapped the flow using the FLO-2D model to account for the distributary flow on the fan. The floodplain mapping limits extend from Catalina Highway to Sabino Creek (Fig.1.2).

1.4 Hydrologic and Hydraulic Methods

Hydrologic analysis was performed to estimate 100-yr peak discharges using HEC-HMS Version 3.5 (HEC-HMS). Parameterization followed Technical Policy 018 (Tech 018, Appendix A) developed by Pima County Regional Flood Control District. The proposed regulatory discharge is a flow rate that has a 1-percent chance of being equaled or exceeded each year ("100-year" discharge). Soils used in this analysis are summarized in Figure 1.3. Soils, cover types and impervious cover including roadways was used to derive Curve Number values used in the hydrologic analysis (Figure 1.4). Hydraulic analysis was performed to determine a 100-yr floodplain boundary using ArcMAP and

FLO-2D Pro using a 20' grid spacing. Roadways were explicitly identified and impervious cover Manning's roughness value of 0.015 was used to represent the lower roughness in the FLO-2D Model as shown in Figure 1.5.

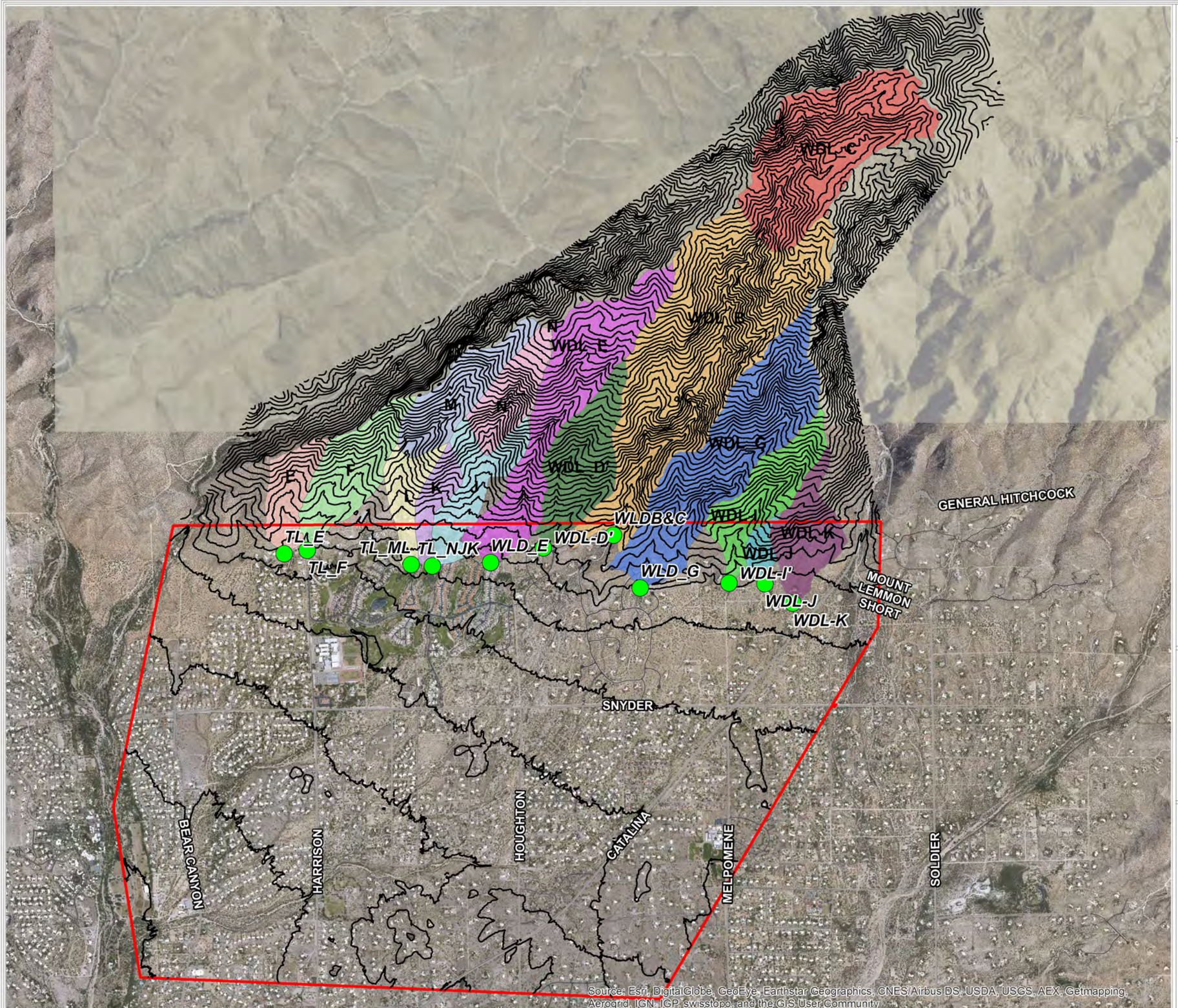
1.5 Acknowledgements

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 100-yr discharges were calculated for the Tres Lomas and Woodland Wash subbasins. Subbasin boundaries and corresponding CPs are illustrated in Figure 1.1. Hydrologic characteristics for the studied subbasins are presented in Table 4.2. Calculated discharges are summarized in Table 4.3. The calculated discharges are compared with the USGS Regional Regression Equation (Table 4.4). The comparison shows that the peak discharges calculated shows that the modeled discharge is higher than the regression equations in all cases. Given that these are steep watersheds and rainfall depths are higher than average in the Tucson region, the modeled discharges in this study appear reasonable.

Figure 1.1
Watershed Map
Woodland Wash



Discharge Point

Contour 50ft.

FLO2D Depth to Cell

Tres Loma Subbasins

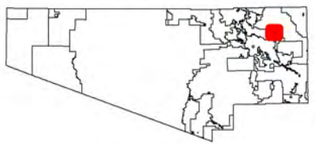
- E
- F
- J
- K
- L
- M
- N

Woodland Subbasins

- WDL-K
- WDL-I'
- WDL-J
- WDL_B
- WDL_C
- WDL_D'
- WDL_E
- WDL_G

Aerial : PictOrtho2014
Topo: 2008 Pima Association of Govemments
Datum: NAVD 1988

Pima County Index Map



Index Map Scale 1:5,250,000

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Pima County Regional Flood Control District

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1,200 600 0 1,200 Feet

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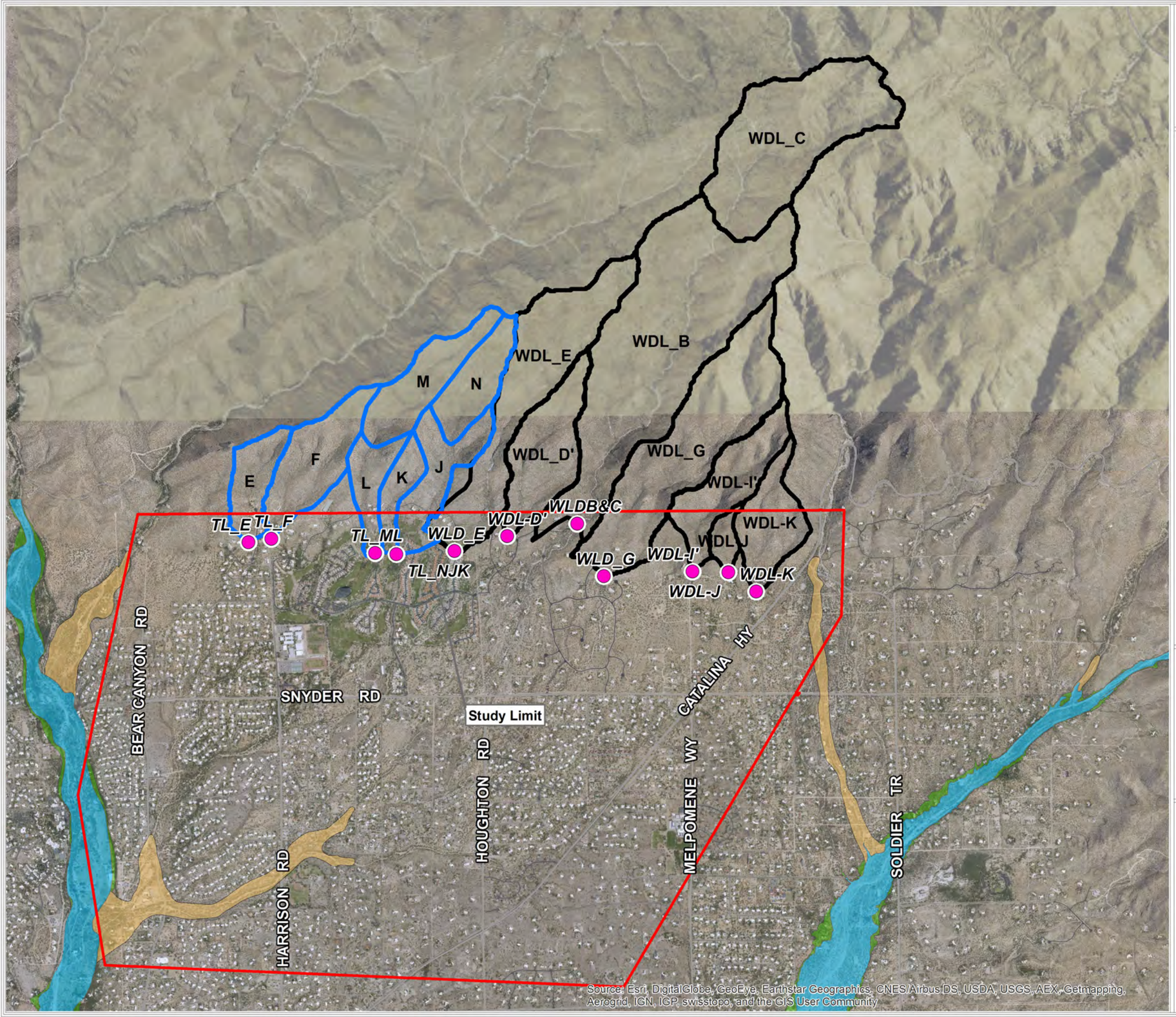

Figure 1.2
Study Limit
Woodland Wash

Discharge Point
FLO2D Depth to Cell area
Tres Lomas Subbasin
Woodland Subbasin

Existing FEMA Floodplain

ZONE A
ZONE AE
ZONE X - SHADED

Aerial :PictOrtho2014

Pima County Index Map

Index Map Scale 1:5,250,000

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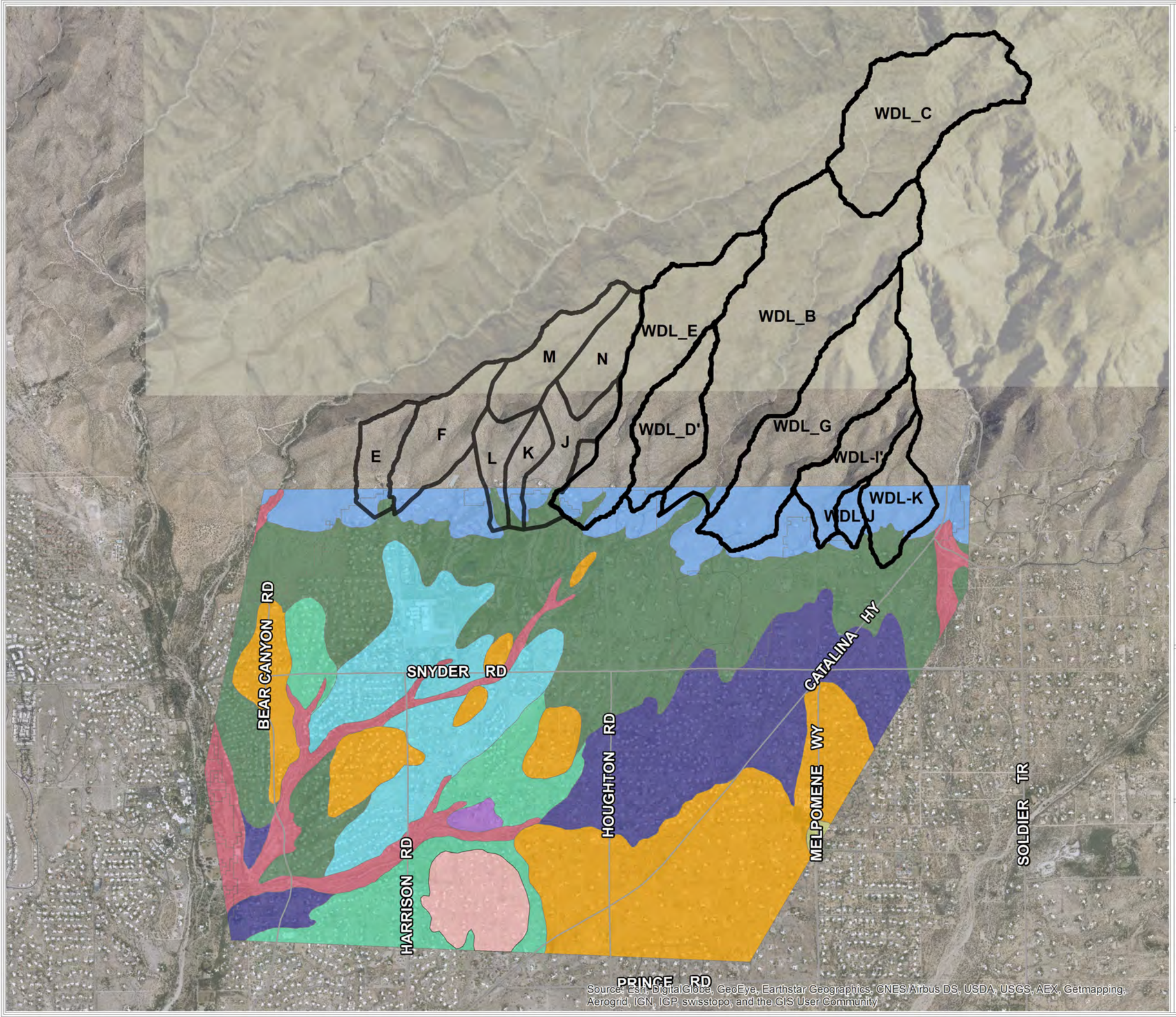
Figure 1.3
Soil Classification
Woodland Wash



Discharge Point

Subbasins

Soil Classification

- Soil Group: A (100%), ARIZO-RIVERWASH COMPLEX, 0 TO 3 PERCENT SLOPES
- Soil Group: B (100%), ANTHONY FINE SANDY LOAM, 0 TO 3 PERCENT SLOPES
- Soil Group: B (100%), HAYHOOK SANDY LOAM, 1 TO 5 PERCENT SLOPES
- Soil Group: B (100%), HAYHOOK-SAHUARITA COMPLEX, 1 TO 5 PERCENT SLOPES
- Soil Group: B (100%), PINALENO VERY COBBLY SANDY LOAM,1 TO 8 PERCENT SLOPES
- Soil Group: B (100%), PINALENO-STAGECOACH COMPLEX, 5 TO 16 PERCENT SLOPES
- Soil Group: B (100%), YAQUI FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES
- Soil Group: B (50%) C (50%), PALOS VERDES-SAHUARITA COMPLEX, 2 TO 8 PERCENT SLOPES
- Soil Group: C (47%) D (53%), PANTANO-GRANOLITE COMPLEX,5 TO 25 PERCENT SLOPES
- Soil Group: C (53%) D (47%), PALOS VERDES-JAYNES COMPLEX, 2 TO 8 PERCENT SLOPES
- Soil Group: D (100%), CELLAR-LAMPSHIRE-ROCK OUTCROP COMPLEX,15 TO 60 PERCENT SLOPES

Aerial : PictOrtho2014

Pima County Index Map

Index Map Scale 1:5,250,000

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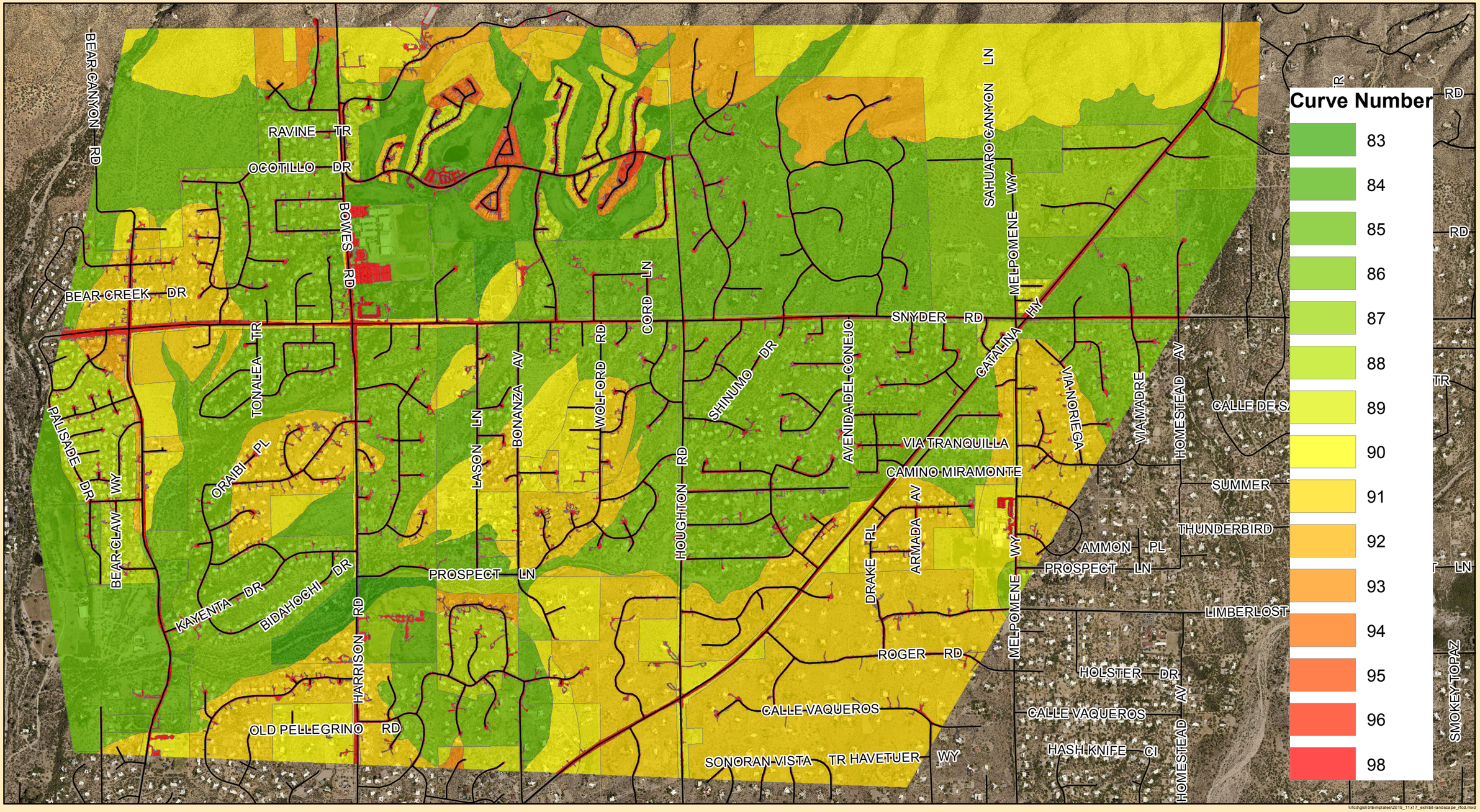

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Pima County Regional Flood Control District
97 E Congress - 3rd Floor
Tucson, Arizona 85701-1207
(520) 724-4600, FAX: (520) 724-4621
http://www.rfcd.pima.gov

Figure 1.4 Curve Numbers

N
W E
S

1 inch = 1,500 feet

0 375 750 1,500 2,250 3,000 Feet

Date:

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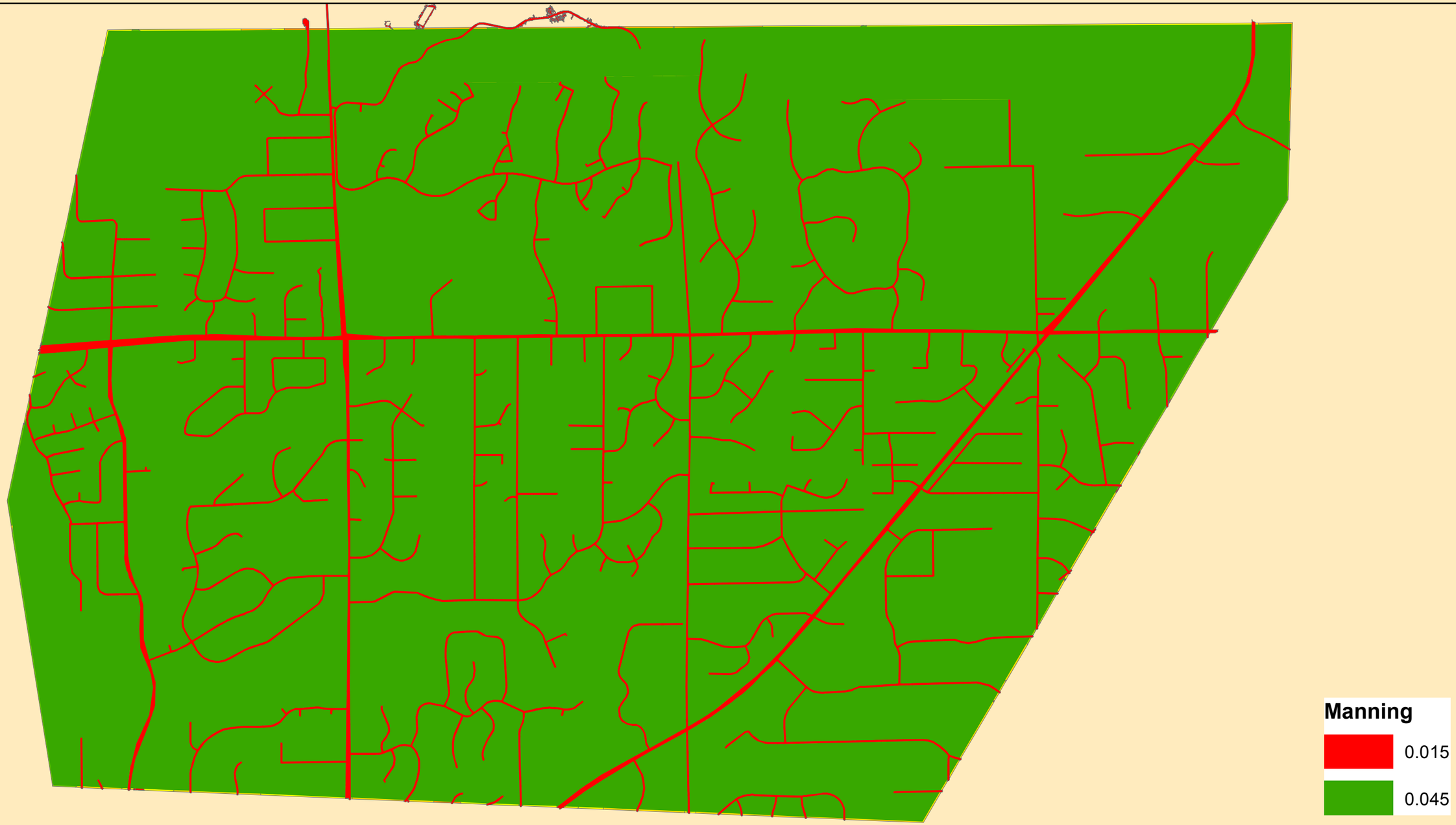

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Tucson, Arizona 85701-1207
(520) 724-4600, FAX: (520) 724-4621
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Figure 1.5
Manning's Roughness Values

N
W E
S

1 inch = 1,500 feet

0 375 750 1,500 2,250 3,000 Feet

Date:

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Section 2 Local Government Abstract

2.1 Project Contact Information

Contact Information:
Evan.Canfield
Pima County Regional Flood Control District
97E Congress, Tucson, AZ 85705
Evan.Canfield@pima.gov

Local Technical Reviewer:
Terry Hendricks
Pima County Regional Flood Control District
97E Congress, Tucson, AZ 85705
Terry.Hendricks@pima.gov

Date Study Submitted: _____

Date Study Approved: _____

2.2 General Information

Community: Pima County Regional Flood Control
County: Pima County
River or Stream Name: Woodland and Tres Lomas Washes
Reach Description: Wash in Catalina Foothills
Study Type: Hydrology and Hydraulics study of a Riverine System
Purpose of the Study: Estimate regulatory discharge and map a floodplain boundary

2.3 Survey and Mapping Information

Digital Projection Information: PAG 2011 orthophoto
USGS Quad Sheets if available:
Mapping for Hydrologic Study: LiDAR based on 2008 flight used to derive 2-ft contour interval maps using ArcGIS 10.0
Mapping for Hydraulic Study: LiDAR based on 2008 flight used to derive a DEM (20-ft cell size) for use with FLO-2D Pro.

2.4 Hydrology

Model or Method Used: HEC-HMS Version 3.5 (HEC-HMS).
Storm Duration: 3 hour
Hydrograph Type: SCS Type II 3-hr storm
Frequencies Determined: 100 yr
List of Gages used in Frequency Analysis or Calibration: None
Rainfall Amounts and Reference: NOAA 14 Upper 90% Confidence Interval

Unique Conditions and Problems: None
Coordination of Q's: Comparison with a USGS Regression Equation and existing regulatory discharges from the Woodland Wash study.

2.5 Hydraulics

Model or Method Used: HEC-GeoRAS, Version 10.1 (HEC-GeoRAS) and FLO-2D Pro.
Regime: Modeled as subcritical
Frequencies for which Profiles were computed: 100 yr
Method of Floodway Calculation: No Floodway
Unique Conditions and Problems: None

2.6 Erosion, Sediment Transport and Geomorphic Analysis

NA

2.7 Additional Study Information

None

Section 3: Survey and Mapping Information

3.1 Digital Projection Information

The data below are included in this TDN (see "GIS" folder)
Aerial Photo: PAG 2008 Orthophotos
Contour: 2 feet interval
Topographic Data: 10-ft DEM

Projection: State Plane, Arizona Central Zone
Horizontal Datum: NAD83-92 (HARN)
Vertical Datum: NSVD-88
Units: International Feet

3.2 Field Survey Information

NA

3.3 Mapping

Digital Elevation Model (DEM) derived from 2008 Light Detection and Ranging (LiDAR) data was used for the HEC-RAS analysis. The contour interval of the topographic map is 2 feet.

Following data are included in this TDN (see "GIS" folder):
Aerial Photo: PAG 2011 Orthophotos
Contour: 2 feet interval

Topographic Data: 5-ft DEM

Section 4: Hydrology

4.1 Method Description

Hydrologic analysis was performed using HEC-HMS, version 3.5. The HEC-HMS model requires the parameters such as rainfall, topography, soil, vegetation, and channel characteristics to determine runoff volume and peak discharge. Those parameters were determined by following the Pima County Regional Flood Control District Technical Policy 018 (Tech-018). Tech-018 is included in Appendix A. The data processing methods are summarized in Fig. 4.

4.2 Parameter Estimation.

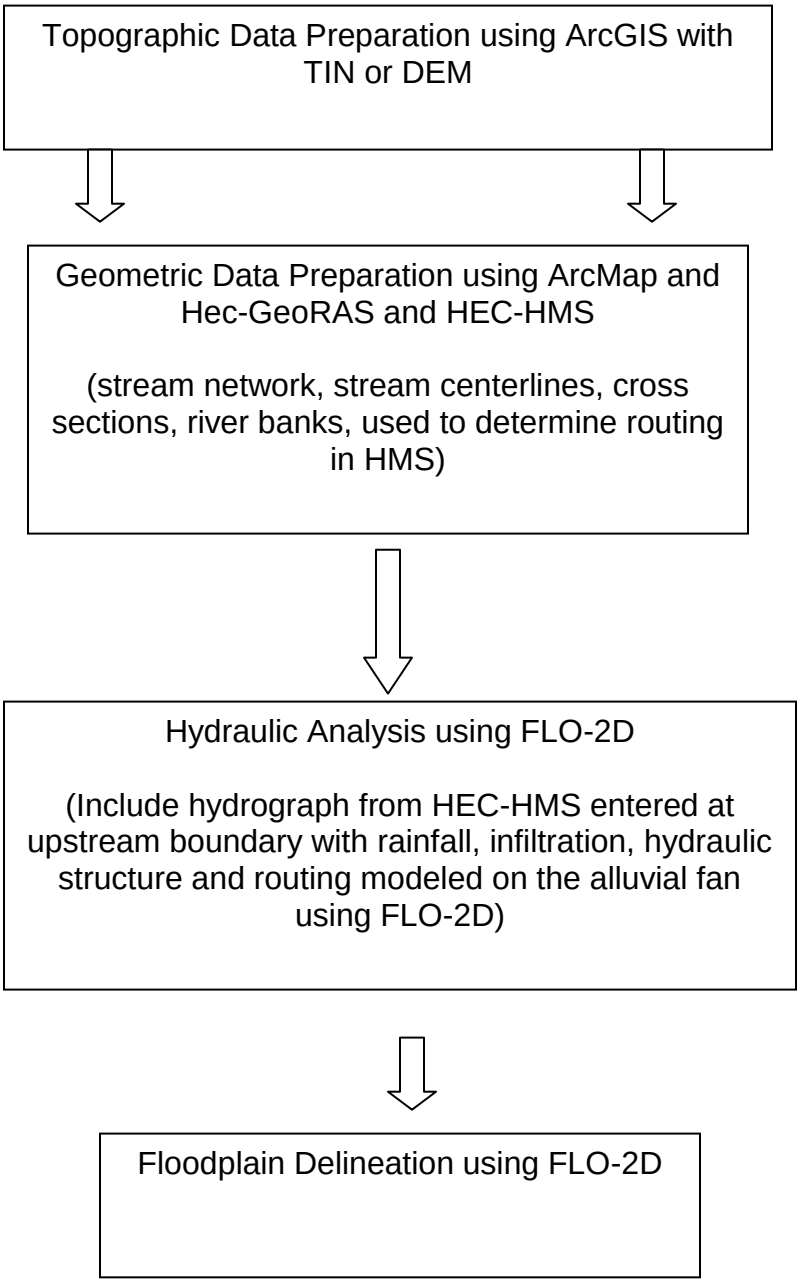
4.2.1 Drainage Area Boundaries

The study limit is shown in Fig.1.2. The Woodland and Tres Lomas Watersheds originate in National Forest Service lands (national forest, FEMA Zone D). These tributary watersheds drain into the alluvial fan which is dominated by distributary flow. Private land on the alluvial fan tends to be low density residential neighborhoods. (Fig.1.2). The mapped floodplains in the watershed is about 7 square miles.

4.2.2 Watershed Work Maps

A watershed work map with background aerial orthophoto is included in Exhibit 1. As mentioned previously, the study tributary watershed was divided into nine sub-basins (Exhibit 1). The work map includes subbasin boundaries, concentration points, flow center lines and cross sections with station numbers and water surface elevations.

Figure 4.1 – Flow Chart of Mapping Process



4.2.3 Gage Data

NA

4.2.4 Statistical Parameters

NA

4.2.5 Precipitation

Rainfall depth was selected from the NOAA 14 Upper 90% rainfall data used in PC Hydro. Values were selected for both the upper and lower watershed. Total rainfall depth on the fan was 3.36 inches based on the coordinates of the centroid of the watershed (Latitude: 32.2948, Longitude: 110.7802; Snyder at Bonanza Ave). No aerial reduction factor was applied to watersheds because all tributary watersheds were smaller than 1.0 square miles. 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 area is presented in Fig. 1.3. In the mountains, Hydrologic Soil Group D is the dominant soil type, while Hydrologic Soil Group B is the dominant soil type on the alluvial fan. 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.

Table 4.1 Hydrologic Input Methods

	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

The PC Hydro vegetation map showed that this area was virtually all mapped as Desert Brush. 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 0-20%, were selected based on lot size, the fraction of the sub-basin that is developed and the tables in the PC Hydro manual. The CN selections and impervious cover selections for the sub-basins are summarized in Table 4.2.

Table 4.2 - Sub-basin Soils & CN Selection

Sub-Basin	Area	CN	Impervious Area	Vegetation Cover	Lag Time
	(sq mi)		(%)	(%)	(min)
TL E	0.096	84.7	10	30	6.8
TL F	0.172	91.0	10	30	6.6
TL L	0.08	87.9	10	30	8.1
TL M	0.09	88.5	10	30	8.7
TL N	0.12	88.5	10	30	8.1
TL J	0.14	87.9	10	30	9.4
TL K	0.062	88.5	10	30	8.6
WLD B	0.779	90.1	10	30	9.2
WLD C	0.439	87.0	10	30	8.5
WLD D'	0.195	89.8	10	30	8.9
WLD E	0.367	90.5	10	30	13.0
WLD G	0.441	91.0	10	30	11.8
WLD I'	0.165	90.2	10	30	8.9
WLD J	0.03	90.8	10	30	7.3
WLD K	0.138	89.5	10	30	7.1

The SCS Curve Number (CN) method was utilized in the HEC-HMS model. The CN was determined using the Curve Number table associated with the PC Hydro User Guide (Arroyo Engineering, 2007) and a Hydrologic Soils Group map. The CN was not adjusted for rainfall intensity or antecedent moisture conditions in the HEC-HMS model. The SCS Unit Hydrograph method was used as a transform method. Impervious cover was determined using the 2011 PAG orthophotos and Table 3 in the PC Hydro User Guide (Arroyo Engineering, 2007). The combination of the kinematic wave method and the U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (Tc) calculation method (USDA-NRCS, 1986) was used to determine Tc, following the recommendation on Tech-018. The Tc was calculated by summing the travel time for sheet flow, shallow concentrated flow and channel flow. The Tc for sheet flow was estimated using the kinematic wave equation. Manning's roughness coefficient for sheet flow was obtained using Table 3-1 in Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986). HEC-GeoRAS and HEC-RAS were used to estimate average velocity of channels.

Runoff from subbasins was routed using the Modified-Puls method. Storage discharge tables for the channel routing were developed using HEC-GeoRAS and HEC-RAS. Six different discharges were used for storage-discharge relations. Spreadsheets used for the calculations of those parameters are included in Appendix D.

4.3 Issues Encountered During the Study.

4.3.1 Special problems and solutions

NA

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 was performed.

4.5 Final Results

4.5.1 Hydrologic Analysis Results

Calculating Discharge for Tributary Watersheds

The SCS TR-55 segmental Time of Concentration (TC) methods were used. The hydraulically most distant point on the sub-basin was identified. The length of sheetflow was estimated at 100', 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.

The time of concentration (Tc) was calculated using the guidance of the TR-55 manual (USDA-1986). Travel times were the sum of the sheetflow, shallow concentrated flow and channel flow. Sheetflow and shallow concentrated flow were 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, and used to calculate sub-basin discharge using the 3-hr Type II storm. A single value of 3.39 inches was used for all Tres Lomas sub-basins and 3.36 inches for Woodland sub-basins based on a NOAA 14 estimate near the centroid of each watershed. The SCS unit hydrograph was used to produce hydrographs at the outlet of the sub-basin in HEC-HMS. Sub-basin discharges are summarized on Table 4.3.

Table 4.3 – Summary of Subbasin 100-yr Peak Discharge Values

Sub-Basin	Area (sq mi)	Rainfall Depth (in)	Runoff Volume (in)	Peak Discharge (cfs)
TL E	0.096	3.39	1.90	270
TL F	0.172	3.39	2.03	460
TL L	0.08	3.39	2.16	242
TL M	0.15	3.39	2.21	446
TL N	0.12	3.39	2.21	354
TL J	0.14	3.39	2.16	384
TL K	0.062	3.39	2.21	185
WLD B	0.779	3.36	2.35	2362
WLD C	0.439	3.36	2.06	1223
WLD D'	0.195	3.64	2.56	652
WLD E	0.367	3.36	2.38	970
WLD G	0.441	3.36	2.41	1237
WLD I'	0.165	3.63	2.58	558
WLD J	0.03	3.63	2.65	110
WLD K	0.138	3.63	2.52	492

Hydrographs were routed using kinematic wave or modified puls. For kinematic wave routing, a typical cross-section geometry was selected based on the RAS cross-sections used for calculating channel velocity for the segmented Time of Concentration calculation.

Hydrographs Introduced at the Apexes of the Coalescing Alluvial Fans

FLO-2D Hydrology on Alluvial Fan

Below the tributary watersheds on the alluvial fan, discharges are calculated using the three-hour rainfall. Losses are calculated at the grid scale using the Curve Number (CN) values shown in Figure 1.4. Because discharge is calculated at the grid scale, no aerial reduction is incorporated. Discharges are routed from the grid based on flow direction using a 20’ grid derived from the 2008 Lidar.

In this model, the impervious nature of the road was reflected in CN values of 98 indicating few losses, and Manning’s Roughness values of 0.015 reflecting the improved capability of roadways to convey flow (Figure 1.5)

4.5.2 Verification of results.

The modeled discharges are similar to the discharge estimates for the previous Woodland study completed in 2010. Peak discharge values for the previous HEC-HMS model and the FLO-2D model are shown in Table 4.4. The most significant differences occur in split flow areas, which suggests that flow direction in distributary flow areas the HEC-HMS may have been misidentified.

Table 4.4 – Comparison of Peak Discharge with Previous Study

		HEC-HMS & HEC-RAS				HEC-HMS & FLO-2D	
Concentration Point	**Location**	**Area (sq mile)**	**Rainfall Depth (in)**	**Runoff Volume (in)**	**Q100 HMS (cfs)**	**FLO-2D Cross-Section**	**Recording Cross-Section (cfs)**
CP_A	**Woodland at Sabino**	5.95	2.86	1.72	***5778***	39	***6485***
CP_B	**Woodland above Split**	0.78	3.36	3.3	***2362***	60	***2759***
CP_D	**Tributary 1 Upstream of Woodland**	1.29	3.36	2.22	***2650***	37	***1047***
CP_H	**CatHwy West of Houghton**	1.57	3.09	1.9	***2196***	87	***2101***
CP_J	**Woodland Upstream of CatHwy**	3.00	2.96	1.83	***4146***	38	***4552***
CP_K	**Woodland West Split**	a			***2185***	44	***891***
CP_M	**CatHwy East of Harrison**	2.58	2.96	1.8	***3090***	45	***3179***
CP_N	**Woodland below Split**	1.70	3.09	1.94	***2310***	43	***2457***
CP_N1	**Woodland below Split**	a		1.94	***800***	43	***2111***

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 FLO-2D with the discharge obtained from HEC-HMS at nine discharge points on the coalescing fan. On the fan, the 3-hr rainfall was used with runoff generated using the CN method on a 20' grid. Channel flow was not specifically modeled, and the area was modeled as 'floodplain' in FLO-2D. Parameters for the hydraulic analysis were selected following the District Tech Policy 019.

5.2 Work Study Maps

A work study map is shown in Exhibit 1. Geometric data for the FLO-2D model were derived from the 20' DEM prepared based on the 2008 LiDAR data. The GDS tool in FLO-2D parameterized the model. Upstream of the study watershed is located in Zone D (National Forest). This study mapped a 100-yr floodplain for the downstream of the National Forest.

5.3 Parameter Estimation

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

5.3.1 Roughness coefficients.

The Manning coefficient of 0.045 for grid cells was used in the FLO-2D model for most cells except those on streets, which were set to 0.015. The shallow n option was turned off so that the model used the values entered into the model which are shown in Figure 1.5.

5.3.2 Expansion and contraction coefficients.

Expansion and contraction were not modeled, because FLO-2D is a grid based model.

5.4 Cross section description.

No flow-recording cross-sections

5.5 Modeling considerations.

5.5.1 Hydraulic Jump and drop analysis.

No Hydraulic Jumps were encountered.

5.5.2 Bridges and culverts.

There were no culverts modeled though the the flow raster was modified in some places to allow flow.

5.5.3 Levees and dikes.

None.

5.5.4 Islands and flow splits.

There are numerous flow splits. One large one occurs near Lason Lane and Snyder Rd. A second large one occurs at Snyder and Houghton Rd.

5.5.5 Ineffective flow areas.

Ineffective flow was not modeled, because the ability of FLO-2D to model flow in the overbanks implicitly includes the modeling of ineffective flow areas.

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.

5.8 Calibration.

None.

5.9.1 Hydraulic analysis results.

The FLO-2D modeling results are included in Appendix E. The results were used to prepare the workmap in Exhibit 1, which includes four maps at 200' per inch. The flow depth is shown on a flow depth grid, and a floodplain map was derived using a flow depth of 0.2 foot or greater.

The peak velocity of the 100-yr flow on the floodplains is shown in Exhibit 2.

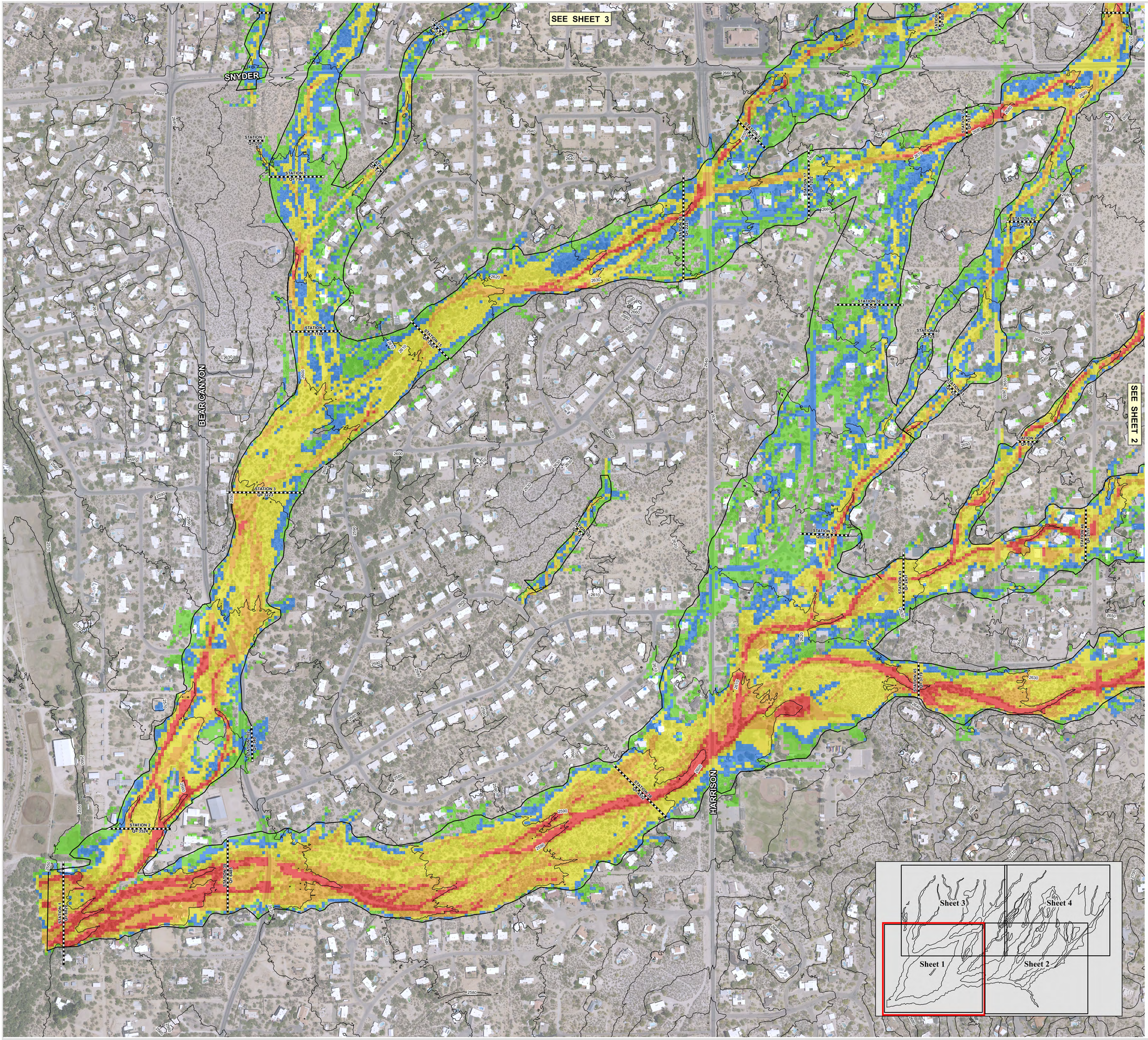
5.9.2 Verification of results.

Existing floodplain maps are available on Woodland Wash generated with one-dimensional HEC-RAS mapping. The new map tends to follow the floodplain topography, and the splits observed in the topography and aerial photos, while the existing map did not follow these features. The results suggest that the mapping is reasonable. It also suggests that the existing FEMA A-Zone is inaccurate.

Section 6: Erosion and Sediment Transport

Not available in this study

Exhibit 1a
Woodland Wash-Tres Lomas Special Study
Sheet 1 of 4



Discharge Points

Cross Section

Contour 10ft

100yr. Floodplain

Tres Lomas Subbasin

Woodland Subbasin

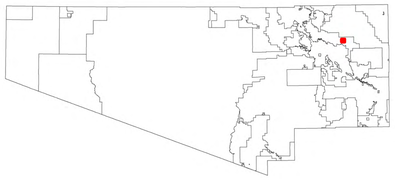
Flow Depth at Cell

- 0.200 - 0.500
- 0.501 - 1.000
- 1.001 - 2.000
- 2.001 - 3.000
- 3.001 - 19.200

Aerial : PictOrtho2014©
Topo: 2008 Pima Association of Governments
Datum: NAVD 1988

Note: On this scale 100yr & 500yr floodplains appear coincident on much of the map, because the floodplain tend to be confined.

Pima County Index Map



Index Map Scale 1:1,500,000

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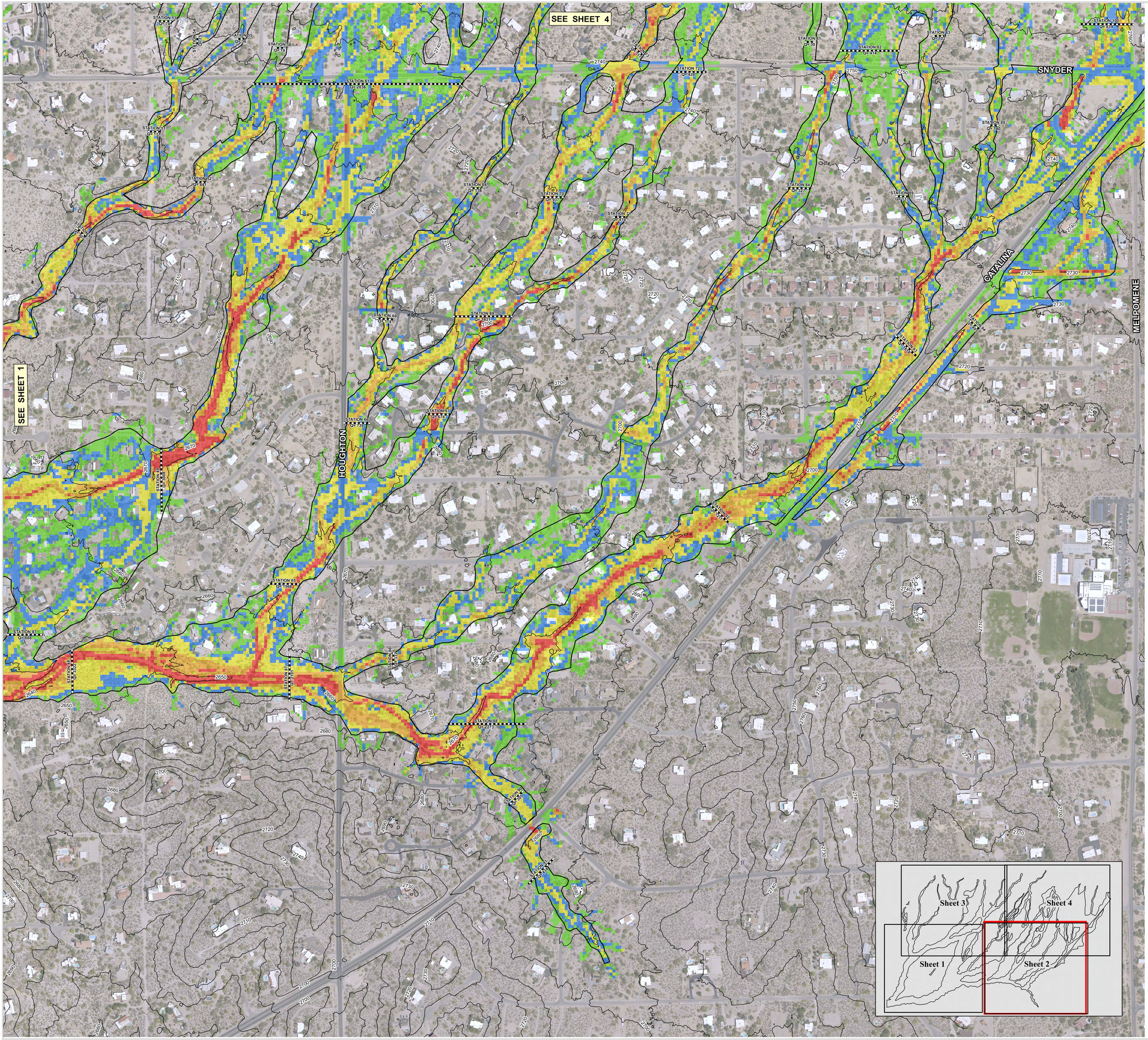
Exhibit 1b
Woodland Wash-Tres Lomas Special Study
Sheet 2 of 4



Discharge Points

Cross Section

Contour 10ft

100yr. Floodplain

Tres Lomas Subbasin

Woodland Subbasin

Flow Depth at Cell

- 0.200 - 0.500
- 0.501 - 1.000
- 1.001 - 2.000
- 2.001 - 3.000
- 3.001 - 19.200

Aerial : PictOrtho2014©
Topo: 2008 Pima Association of Governments
Datum: NAVD 1988

Note: On this scale 100yr & 500yr floodplains appear coincident on much of the map, because the floodplain tend to be confined.

Pima County Index Map

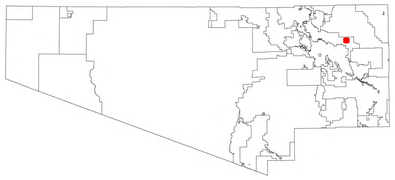


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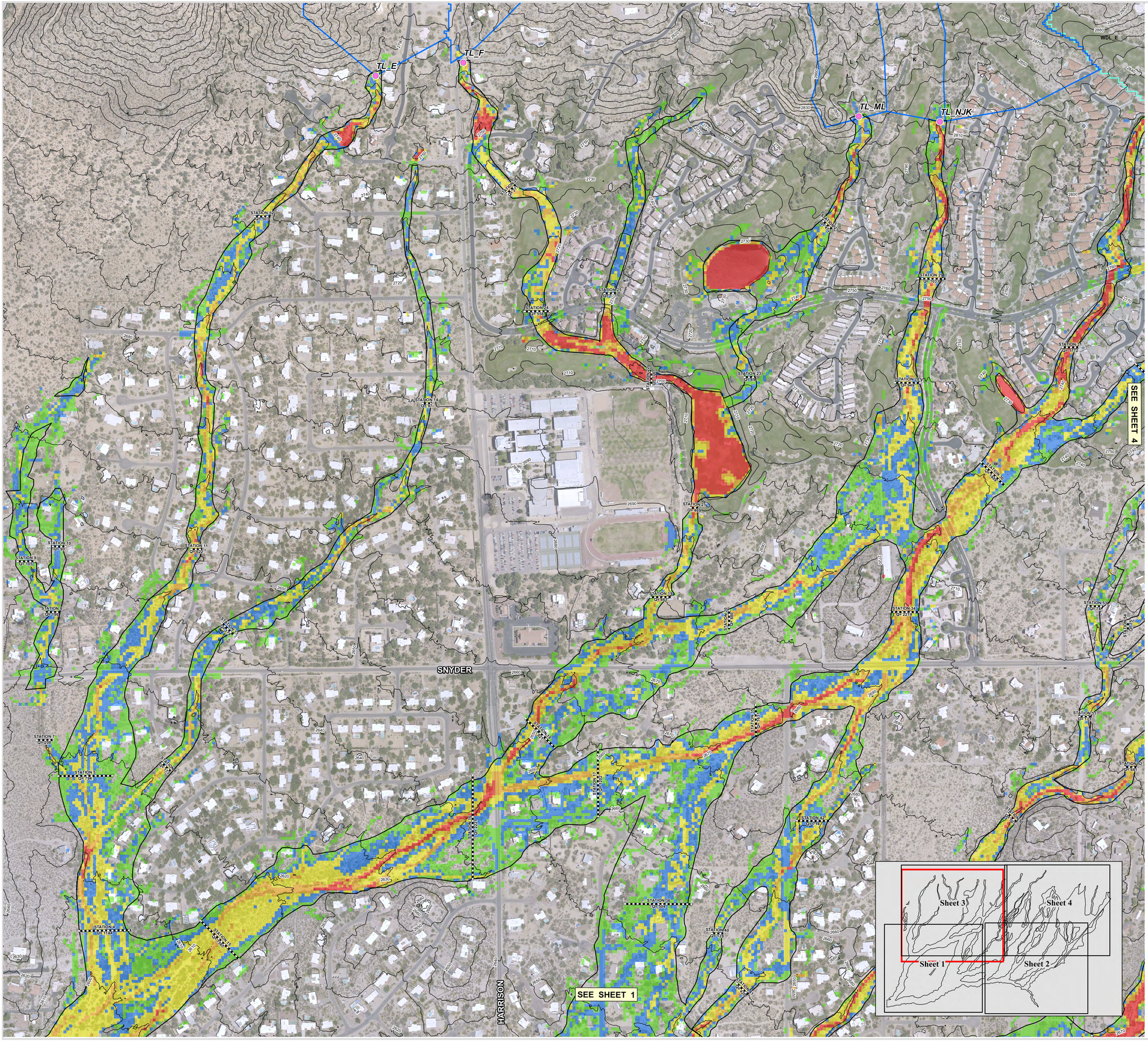
Exhibit 1c
Woodland Wash-Tres Lomas Special Study
Sheet 3 of 4



Discharge Points

Cross Section

Contour 10ft

100yr. Floodplain

Tres Lomas Subbasin

Woodland Subbasin

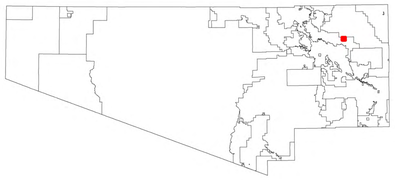
Flow Depth at Cell

- 0.200 - 0.500
- 0.501 - 1.000
- 1.001 - 2.000
- 2.001 - 3.000
- 3.001 - 19.200

Aerial : PictOrtho2014©
Topo: 2008 Pima Association of Governments
Datum: NAVD 1988

Note: On this scale 100yr & 500yr floodplains appear coincident on much of the map, because the floodplain tend to be confined.

Pima County Index Map



Index Map Scale 1:1,500,000

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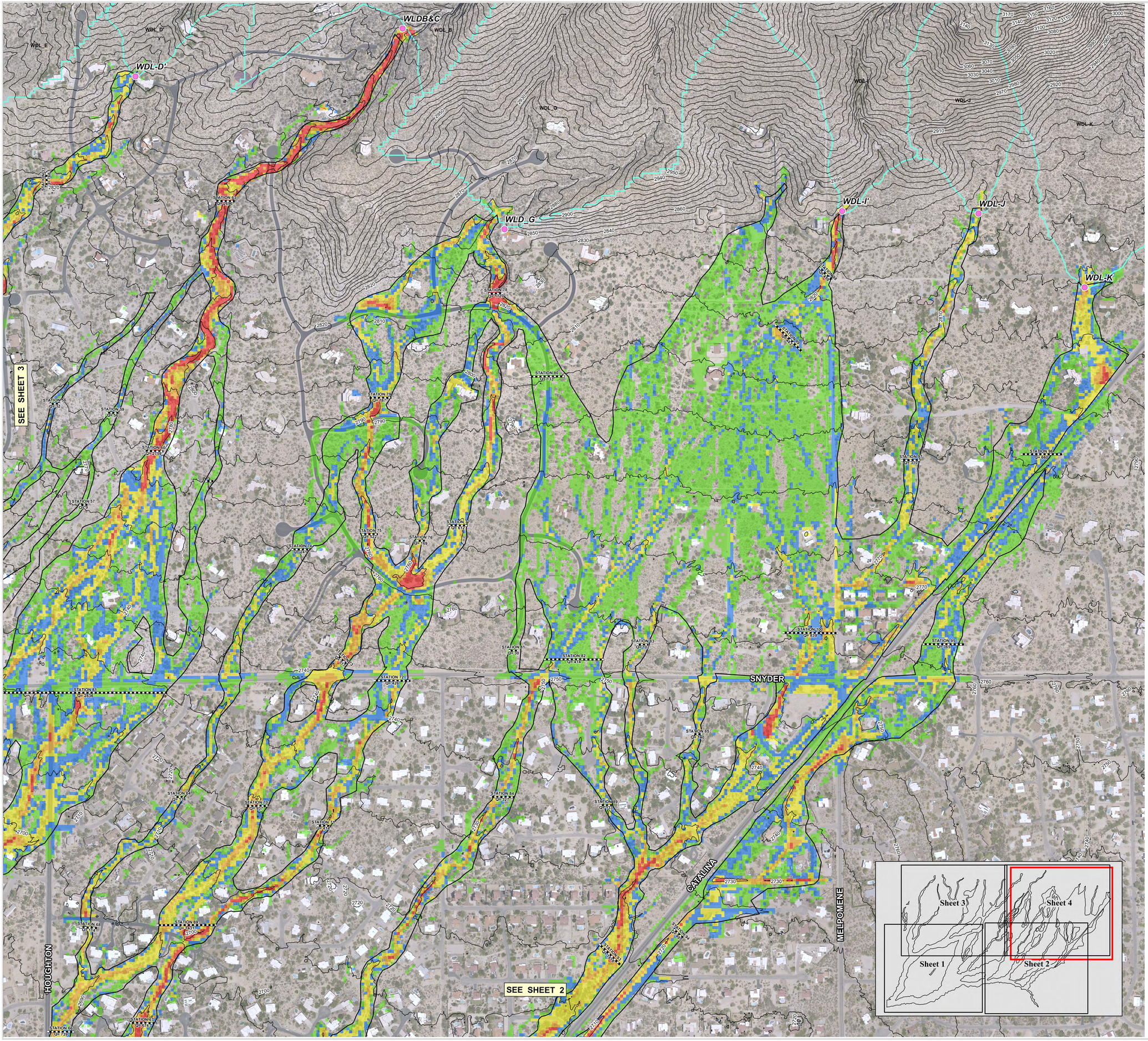
Exhibit 1d
Woodland Wash-Tres Lomas Special Study
Sheet 4 of 4



Discharge Points

Cross Section

Contour 10ft

100yr. Floodplain

Tres Lomas Subbasin

Woodland Subbasin

Flow Depth at Cell

- 0.200 - 0.500
- 0.501 - 1.000
- 1.001 - 2.000
- 2.001 - 3.000
- 3.001 - 19.200

Aerial : PictOrtho2014©
Topo: 2008 Pima Association of Governments
Datum: NAVD 1988

Note: On this scale 100yr & 500yr floodplains appear coincident on much of the map, because the floodplain tend to be confined.

Pima County Index Map

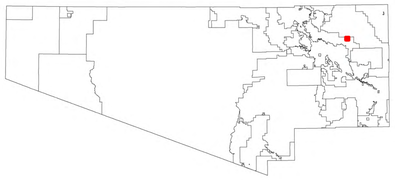


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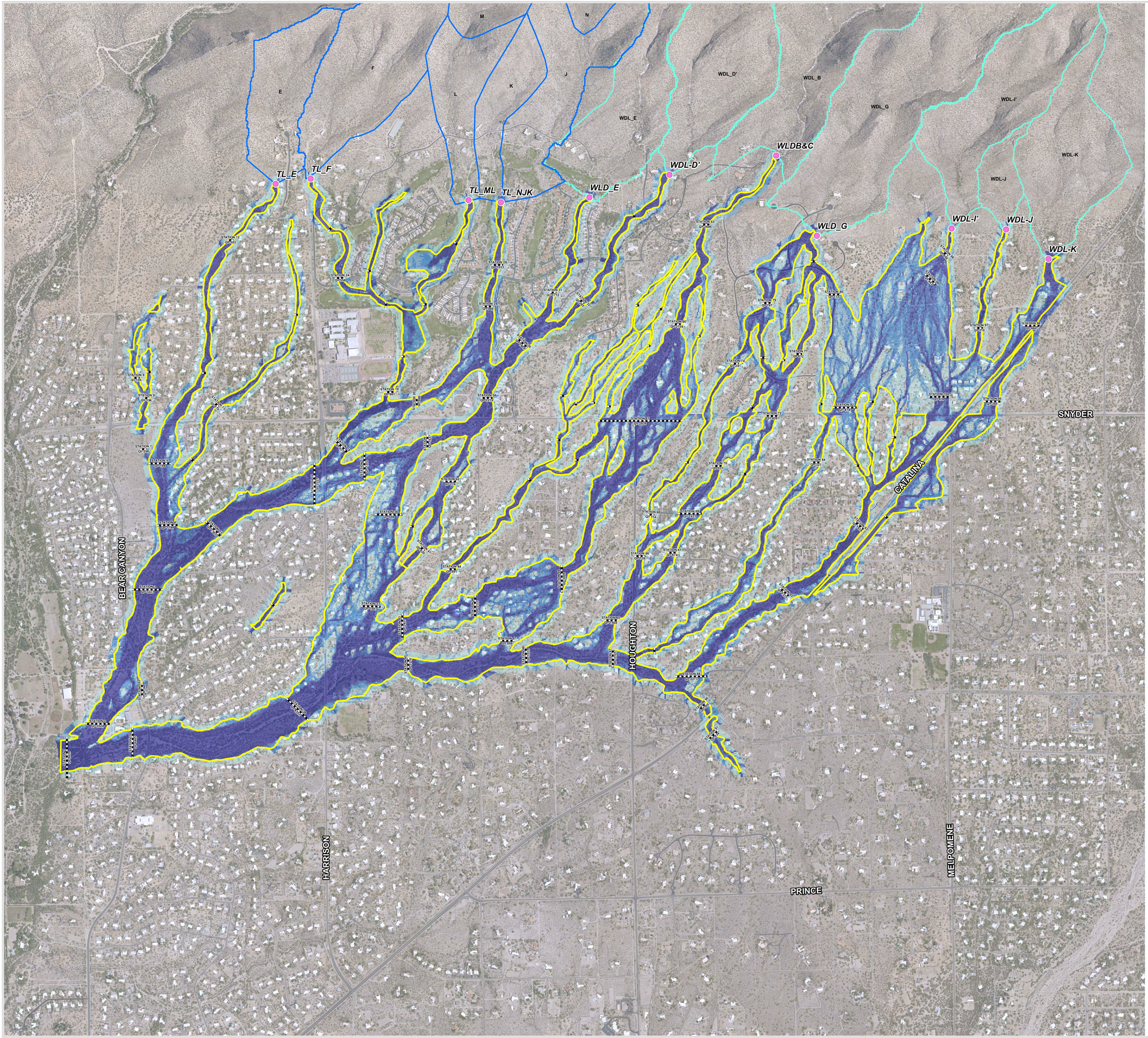
Exhibit 2
Woodland Wash-Tres Lomas Special Study Velocity Map



Discharge Points

Cross Section

100yr. Floodplain

Tres Lomas Subbasin

Woodland Subbasin

Velocity

- 0.200 - 0.500
- 0.501 - 1.000
- 1.001 - 2.000
- 2.001 - 3.000
- 3.001 - 21.479

Aerial : PictOrtho2014©
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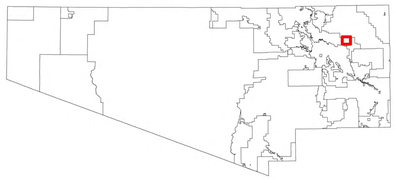
Note: On this scale 100yr & 500yr floodplains appear coincident on much of the map, because the floodplain tend to be confined.

Pima County Index Map



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