WITTMANN PHASE V
Flooding Character Analysis in the Wash 2 West Area

Contract FCD 2011C003

September 21, 2012

Prepared for:
The Flood Control District of Maricopa County
2801 West Durango Street
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Engineer

A344.919

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CONTRACT FCD 2011C003 Assignment 2

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September 21, 2012

Wittmann Phase V
Flooding Character Analysis

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Introduction

The Wash 2 West floodplain delineation was originally planned to be part of the Wittmann Phase V Floodplain Delineation Study. This floodplain was to be delineated from the limits of the Wittmann Area Drainage Master Study Update (WADMSU, contract FCD 2002C029) Wash 2 West floodplain (south of Lone Mountain Road) to the US-60. The initial site visit for the field data collection revealed that Wash 2 West loses definition and conveyance south of Dove Valley Road as it enters the single lot residential community. Wash 2 West downstream of Dove Valley Road becomes shallow with multiple flow paths. This is further complicated by the homes and block walls that have been constructed in this area.

The Flood Control District of Maricopa County (FCDMC) contracted RBF Consulting to perform a FLO-2D analysis of the Wash 2 West area based on the existing two foot contour interval topographic mapping from the WADMSU.

The purpose of this FLO-2D study is to identify the local flooding character and to determine if additional floodplain delineation in the Wash 2 West area is warranted. The study area is located within unincorporated Maricopa County and within the City of Surprise Special Planning Area (SPA) 5. The FLO-2D analysis area was focused from Dove Valley Road south between 223rd Avenue and 227th Avenue to just north of Montgomery Road (Refer to Figure 1). The criteria used to determine if additional floodplain delineation are warranted include evaluating the FLO-2D results such as maximum depth of flow, peak flow, and maximum velocity.

Methodology

Modeling was performed using FLO-2D version 2009.06 by FLO-2D Software Inc.

Grid Element Size

The FLO-2D model uses a network of square, contiguous grid elements that are used to represent the ground surface and other hydraulic parameters. Each grid element is assigned one elevation and a roughness value. The model allows flow to pass in any eight directions through the grid element sides and diagonals. The selection of the grid size is primarily controlled by the level of detail required to adequately model and represent the floodplain. The grid size is also constrained by the computational time and project budget. Generally speaking, the smaller the grid element is, the better the model detail can be shown within the accuracy of the original data. However, smaller grid elements significantly increase both the data manipulation and computational time required to model an area.

The grid element size selected for this study is 20 feet, which is considered adequate for the purpose of the study. There are 90,748 grid elements in the FLO-2D model.

Grid Element Elevations

The grid element elevations for this model were developed using the mapping provided by the FCDMC. RBF was provided a digital elevation model (DEM) in ASCII Grid format that had a grid size of four feet. This DEM was developed from the two foot contour data developed by Landata Airborne Systems, Inc. from digital ortho-photos that were flown in 2002 for the WADMSU mapping. The horizontal coordinate system is based on North American Datum (NAD) 1983, Arizona State Plane – Central Zone. The vertical coordinate system is North American Vertical Datum (NAVD) 1988.

The FLO-2D pre-processor program GDS was used to compute the average elevation for each grid element. A comparison between the ASCII grid elevations and FLO-2D grid element elevations were made at select locations within the Wittmann Phase V FLO-2D area. Refer to Appendix A for this comparison. In general, the elevations are represented well in the FLO-2D model for these locations. There does appear to be some smoothing but that is expected from the interpolation and using the average elevation in the grid element.

Hydrology

Rainfall and rainfall losses over the grid area were not modeled as part of the FLO-2D study. Instead, peak flows were obtained from the WADMSU Hydrology for both the 100-year 6-hour and 100-year 24-hour storms for Concentration Point CTW446. This concentration point is south of Dove Valley Road. The 100-year 6-hour storm was the larger storm event and was used to develop the inflow hydrograph for the FLO-2D model. The 100-year 6-hour peak flow is 634 cfs at CTW446. To simulate the hydraulic response, the hydrograph was spread over four adjacent grid elements upstream of Dove Valley Road where the wash is better defined.

Obstructions to Flow

Obstructions to flow were determined using the October 2010 aerial photographs provided by the FCDMC for the project area and site investigations. RBF created a shapefile of the structures that was used to develop the Area Reduction Factors (ARF). These structures include homes, sheds, garages, and horse facilities that will block the flow. If a structure was open and could pass flow it was not included in the shapefile. If it was difficult to determine if it blocked flow, it was assumed that it would block flow to be conservative. The structure shapefile was imported into the GDS and was used to code the ARF onto each impacted grid element.

There are multiple masonry block walls with openings that influence the direction and conveyance of the flow within the study area. Refer to Appendix A for a sample of the typical walls encountered in the study area. These were incorporated into the FLO-2D model using the Width Reduction Factor (WRF). Based on the openings, the block walls were modeled with a 94% WRF. Figure 2 in Appendix B shows the structures and walls that were incorporated into the FLO-2D model. It is important to note that there are some unimproved properties within the study area. The model is a representation of the improvements as captured during the aerial photographic analysis and site visit and does not reflect any other condition. Additional improvements may impact or alter the results shown in the model.

Manning's n-value

The FCDMC provided a land surface characterization polygon shapefile. This shapefile was developed using the aerial image and existing cartography files with the Feature Analyst software program. The following surface features were collected: asphalt, bare ground, compacted bare ground, dense vegetation, sparse desert vegetation, and structures. The Manning's n values for each surface feature category are shown in the table below. The shapefile contained 14,754 different individual polygons and was therefore too large to process the spatially varied Manning's n value in FLO-2D, so an alternate method had to be used to compute the Manning's n value for each grid element.

Surface Feature	Manning's n Value
Asphalt	0.020
Bare Ground	0.045
Compacted Bare Ground	0.032
Dense Vegetation	0.065
Sparse Desert Vegetation	0.050
Structures	0.040

The alternate method used included converting the land surface characterization shapefile to an ASCII raster file with a four foot grid cell. The Manning's n values in the ASCII raster file were multiplied by 1,000 to maintain the level of detail without truncating the n values during the next step. Then, this file was imported into the GDS and used as if it were an elevation point file to interpolate the n value to each grid element. The elevations computed during this step are shown out to two decimal places consequently that is why the n value was multiplied by 1,000. The elevations (n values) were interpolated using the ASCII raster file and written to the floodplain.dat file. Then, the elevations (n values) were copied out of the floodplain.dat file and divided by 1,000 and pasted into the floodplain.dat file in the Manning's n value column that contains the correct elevation column.

Modeling Controls

Modeling controls utilized for this FLO-2D model include the following parameters in the CONT.DAT input file:

Floodplain Limiting Froude Number – 0.95
Simulation Time and Output Interval – 12 hours / 0.25 hours
Shallow Flow n-Value – 0.13
A limiting Froude number of 0.95 was used to maintain a subcritical flow regime within the model. The 12-hour simulation time was used to span the time period associated with the 100-year 6-hour inflow hydrograph. A shallow flow n-value of 0.13 was used based on discussions with the FCDMC and previous FLO-2D modeling experience.

Summary of Results

Several exhibits were created using the results of the FLO-2D analysis to evaluate if additional floodplain delineation should be performed in this area. These include maximum depth, maximum depth with existing floodplain, maximum velocity, and combined flow. Figure 3 – FLO-2D Results - Max Depth in Appendix B shows the resulting maximum depth for the study area. The majority of the study area shows the maximum depth is less than one foot except in the vicinity of Dove Valley Road and the two main wash channels downstream of Laura Street. The results also show that the water spreads out as shallow sheet flow downstream of Dove Valley Road in multiple directions before reaching greater depths in the washes downstream. Figure 4 – FLO-2D Results - Max Depth in Appendix B is the same as Figure 3 except it shows the WADMSU floodplain boundaries. The floodplain delineation of Wash 2 West covers most of the area where flow depths exceed one foot.

Figure 5 – FLO-2D Results - Max Velocity shows the resulting maximum velocity for the study area. The vast majority of the study area has velocities less than three feet per second except for some isolated locations. The results displayed in Figure 3 and Figure 5 indicate a relatively shallow and slow moving flood hazard for this area.

Figure 6 – FLO-2D Results - Combined Flow shows the flow at each grid element. Five cross sections have been added to indicate the extents and cumulative flow rate at key locations. The cross sections are located at Dove Valley Road, Ocupado Drive, and three locations along Laura Street. These cross sections demonstrate how the flow spreads out and is less concentrated as it travels south within the study area.

Based on the FLO-2D results there is a flood hazard within this area. However, due to the lack of a confined channel, the shallow nature of flooding, low flow velocities, and the lack of concentrated flow it was determined that a delineated floodplain would not be warranted in this area.

The results of this study have been presented to Maricopa County Planning and Development and to residents through a public meeting to discuss the results. The public meeting was held on August 14, 2012 with interested property owners. Several property owners expressed a lack of good access during storm events due to the conditions on the unimproved dirt roads.

Recommendations

Although a regulatory floodplain is not being proposed for this area, there is still a flood hazard. Since this area is located within unincorporated Maricopa County, it is recommended that Maricopa County Planning and Development use the results to help guide future development within this area. Due to the uncertainty of the flow path and the impact of additional improvements it is recommended that property owners consider adding an additional six inches to the existing pad elevation requirements for any new development. Also, as development occurs in the area the FLO-2D model should be updated to reflect the addition of structures and walls which could influence the flooding characteristics.

References

FLO-2D Data Input Manual Version 2009.06

Wittmann Area Drainage Master Study Update Hydrology Report Final Addendum, Contract FCD 2002C029 (July 2005) prepared by Entellus for the Flood Control District of Maricopa County.

Wittmann Area Drainage Master Study Update Technical Data Notebook, Contract FCD 2002C029 (September 2005) prepared by Entellus for the Flood Control District of Maricopa County.

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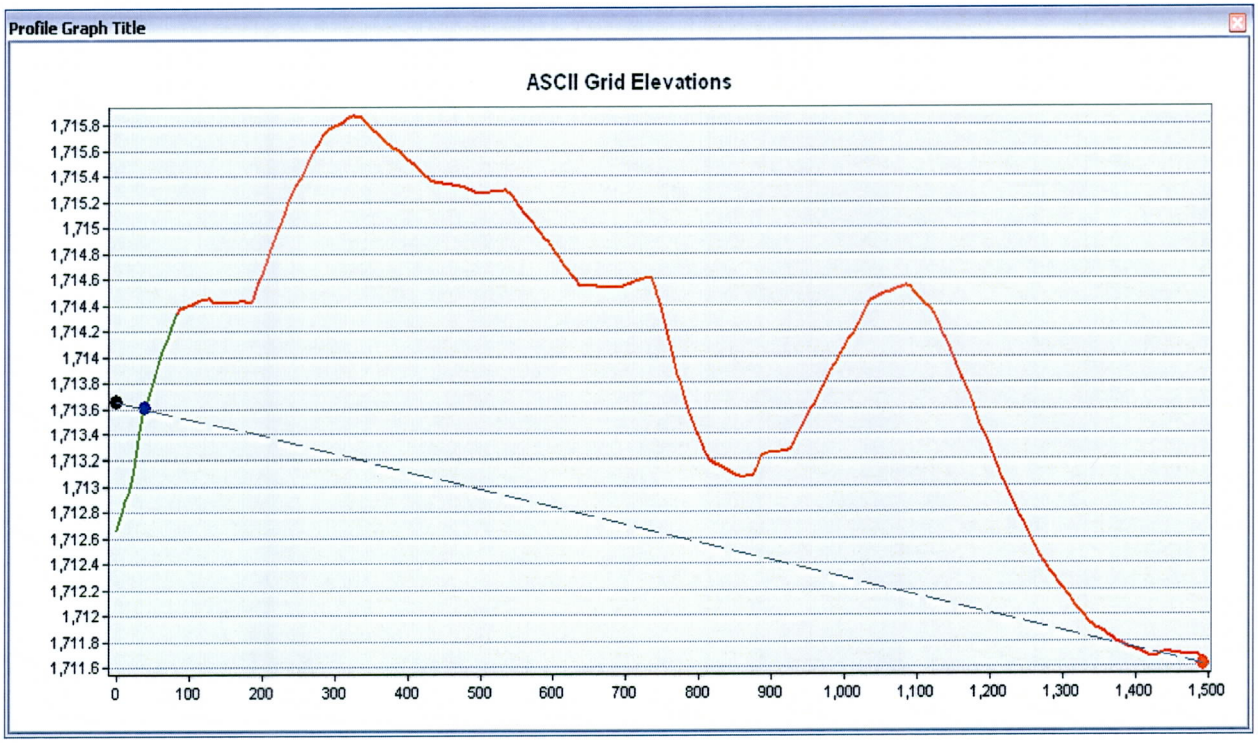
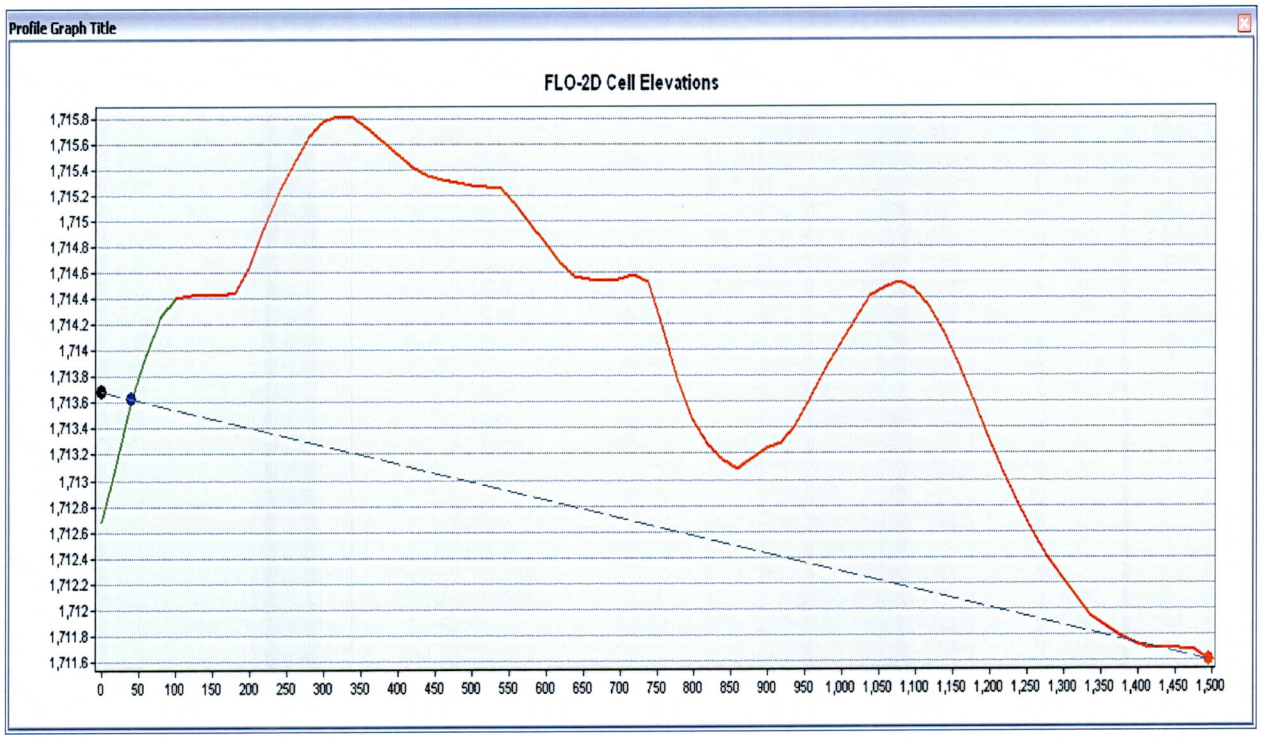
Appendix A Supporting Information

This section contains profile comparisons between the ASCII Grid elevations and FLO-2D cell elevations at select locations as well as representative wall photos.

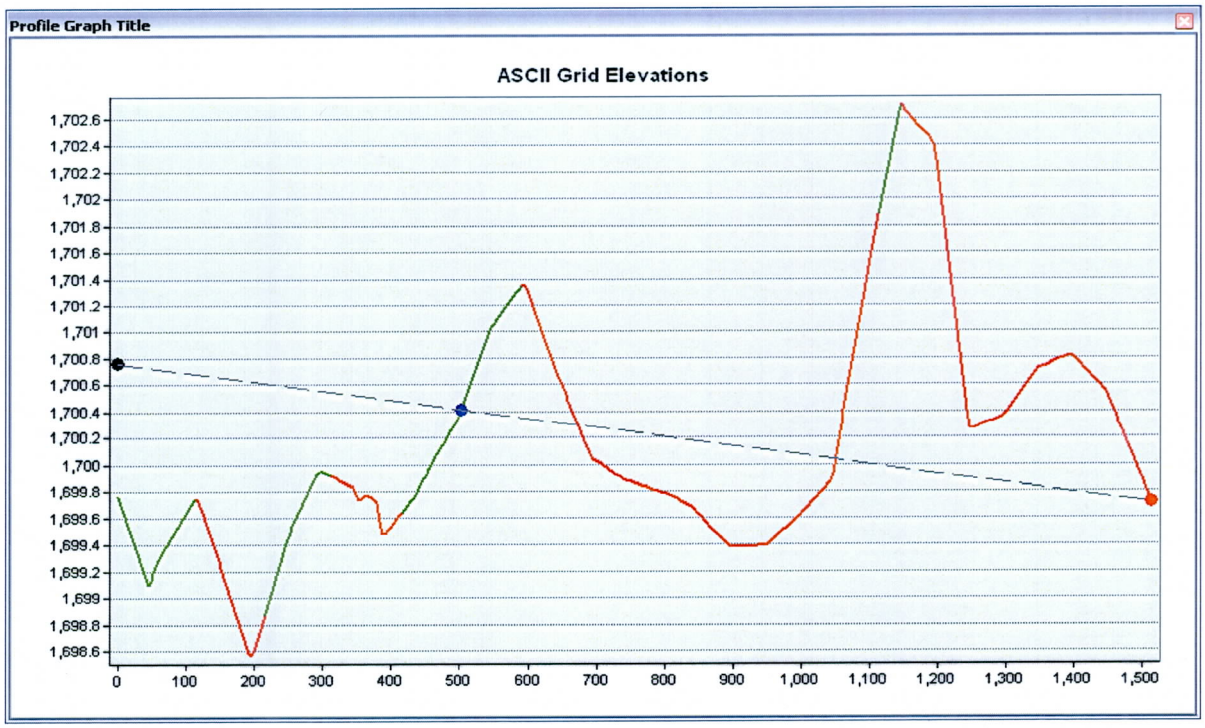
The green portion of the profile comparison line is what is visible from the starting point along the line of sight and red is what is obstructed from the starting location. The dots are located at the starting point, the point where it intersects the profile, and the end point.

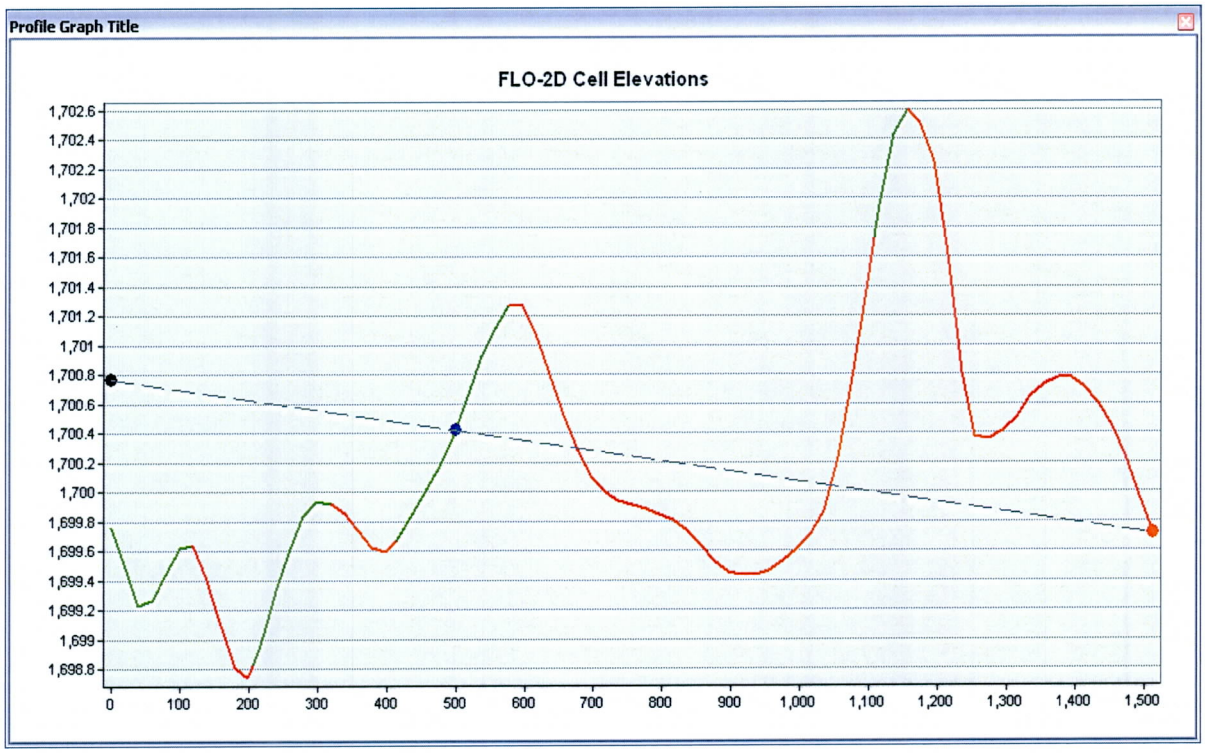
Dove Valley Road – From 235th Avenue east approximately 1,500 feet



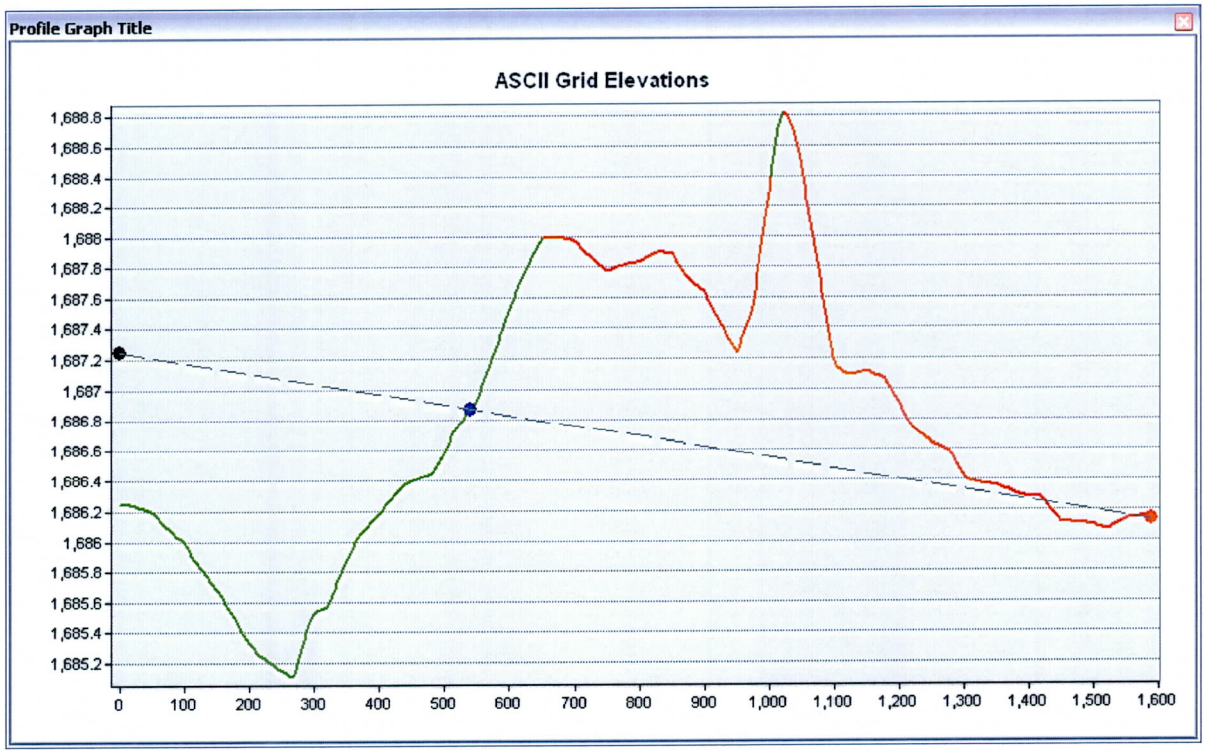


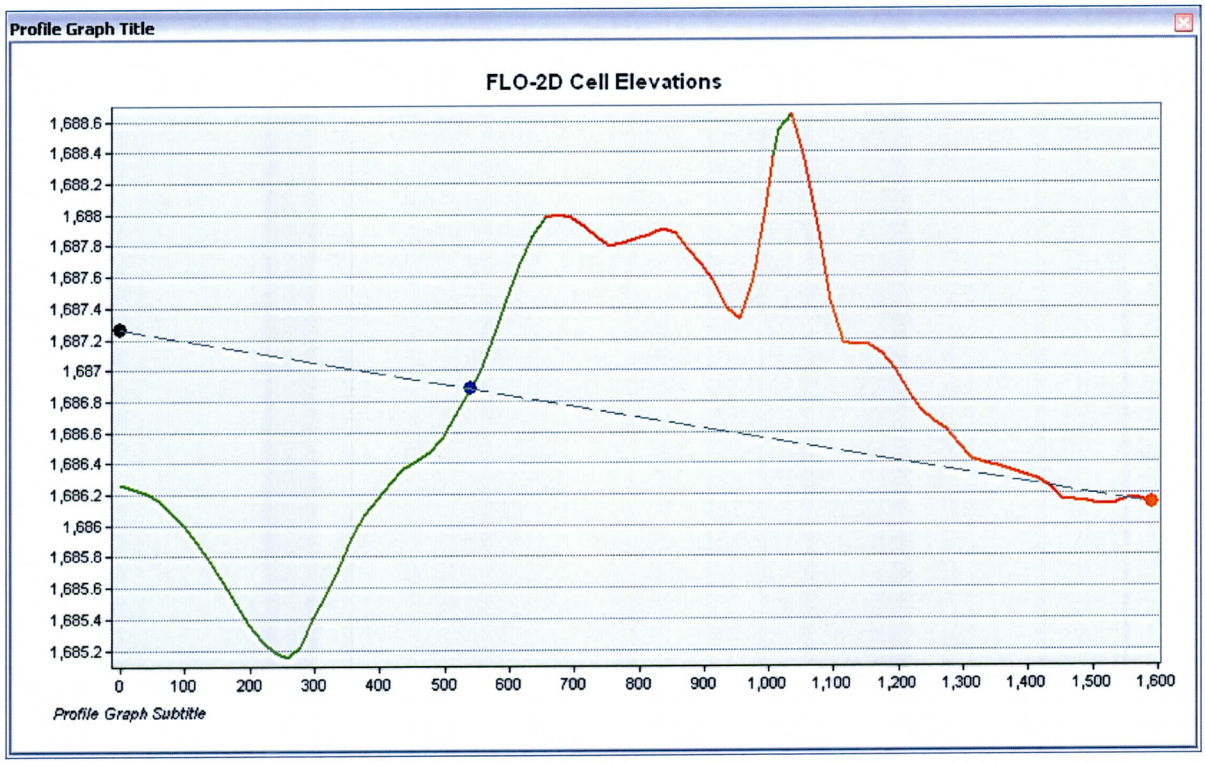
Ocupado Drive – From 235th Avenue east approximately 1,500 feet



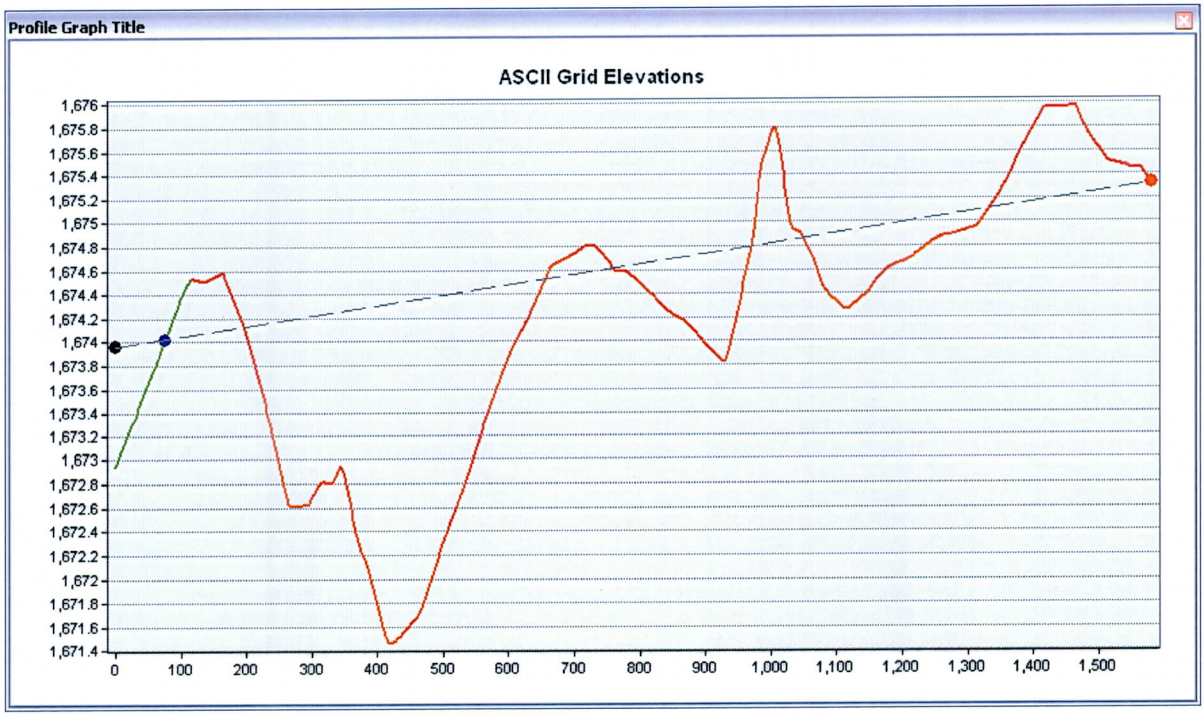


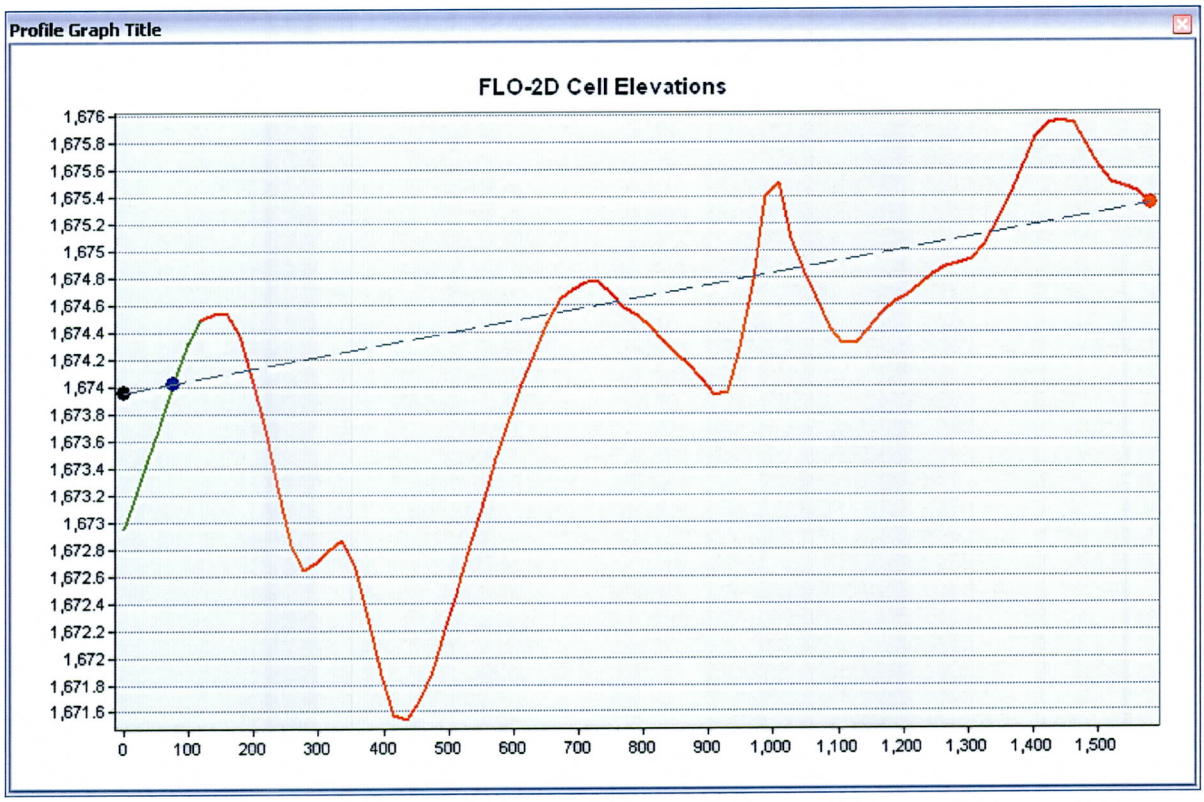
Myers Street – From 235th Avenue east approximately 1,600 feet



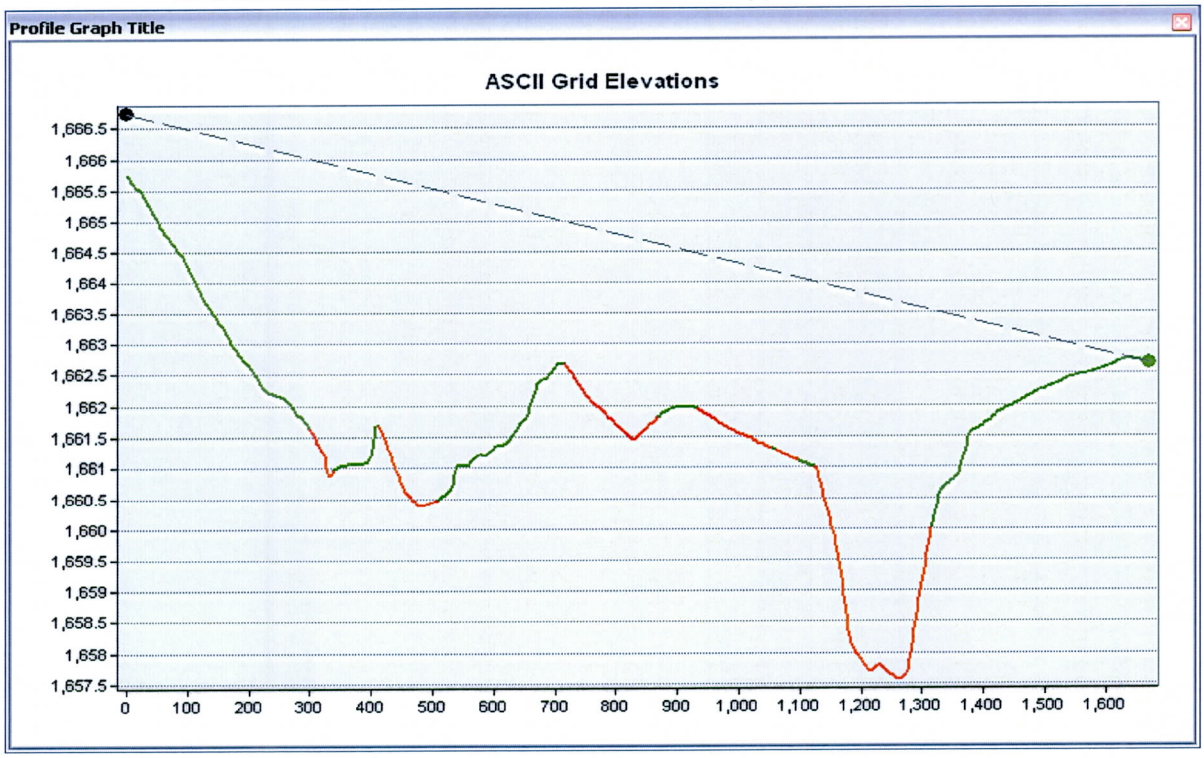


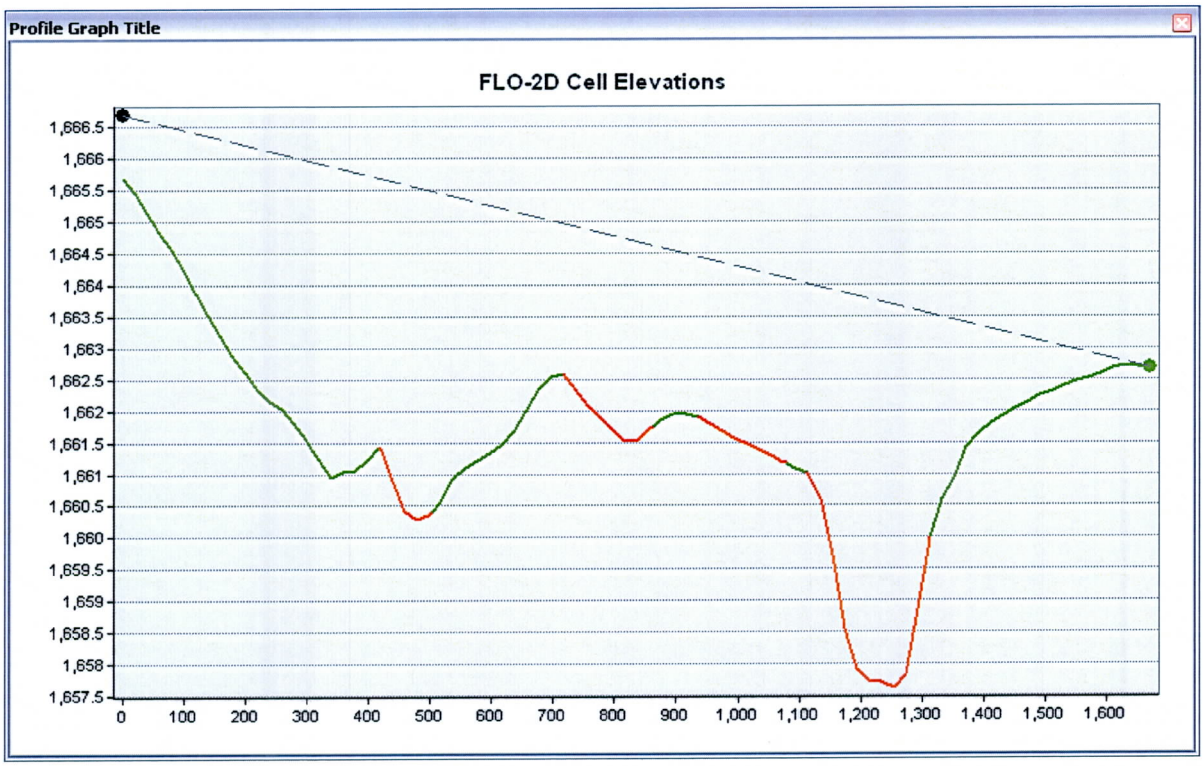
Laura Street – From 235th Avenue east approximately 1,600 feet



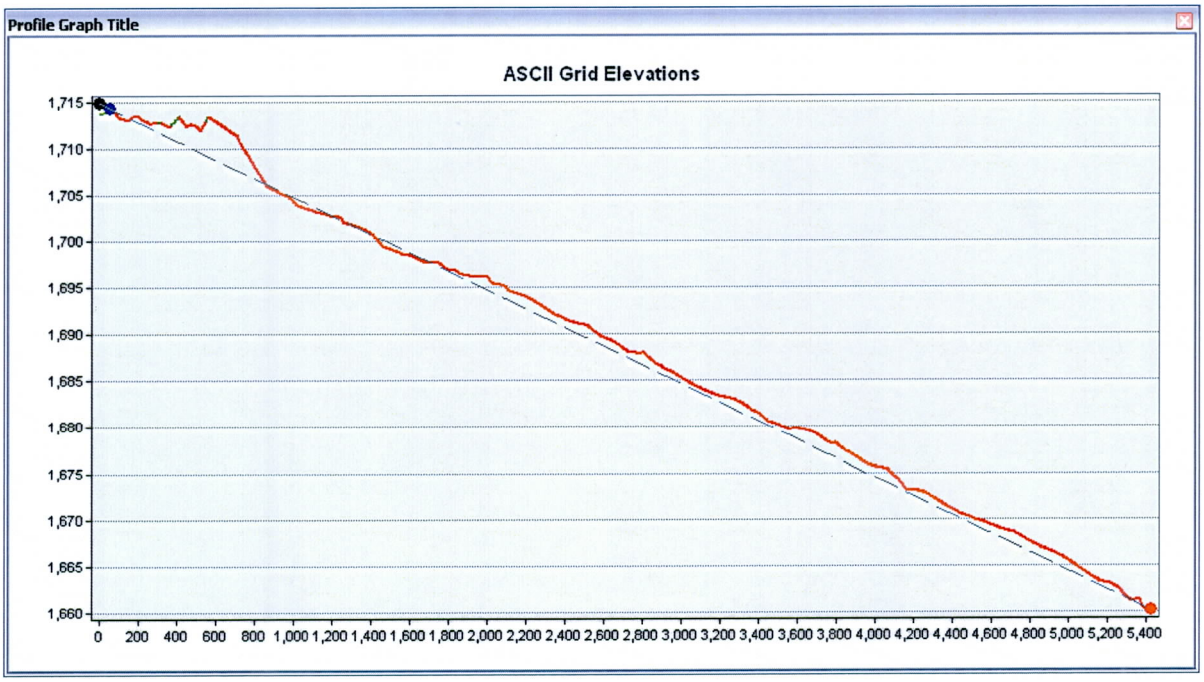


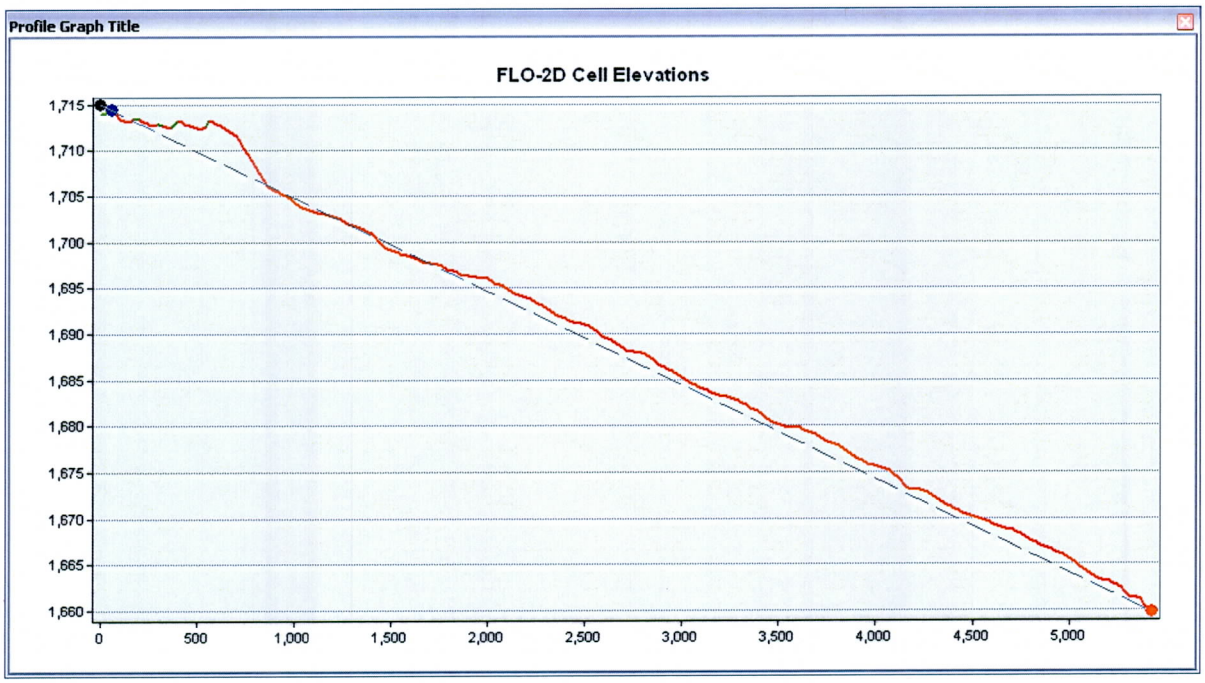
Lone Mountain Road – From 235th Avenue east approximately 1,650 feet





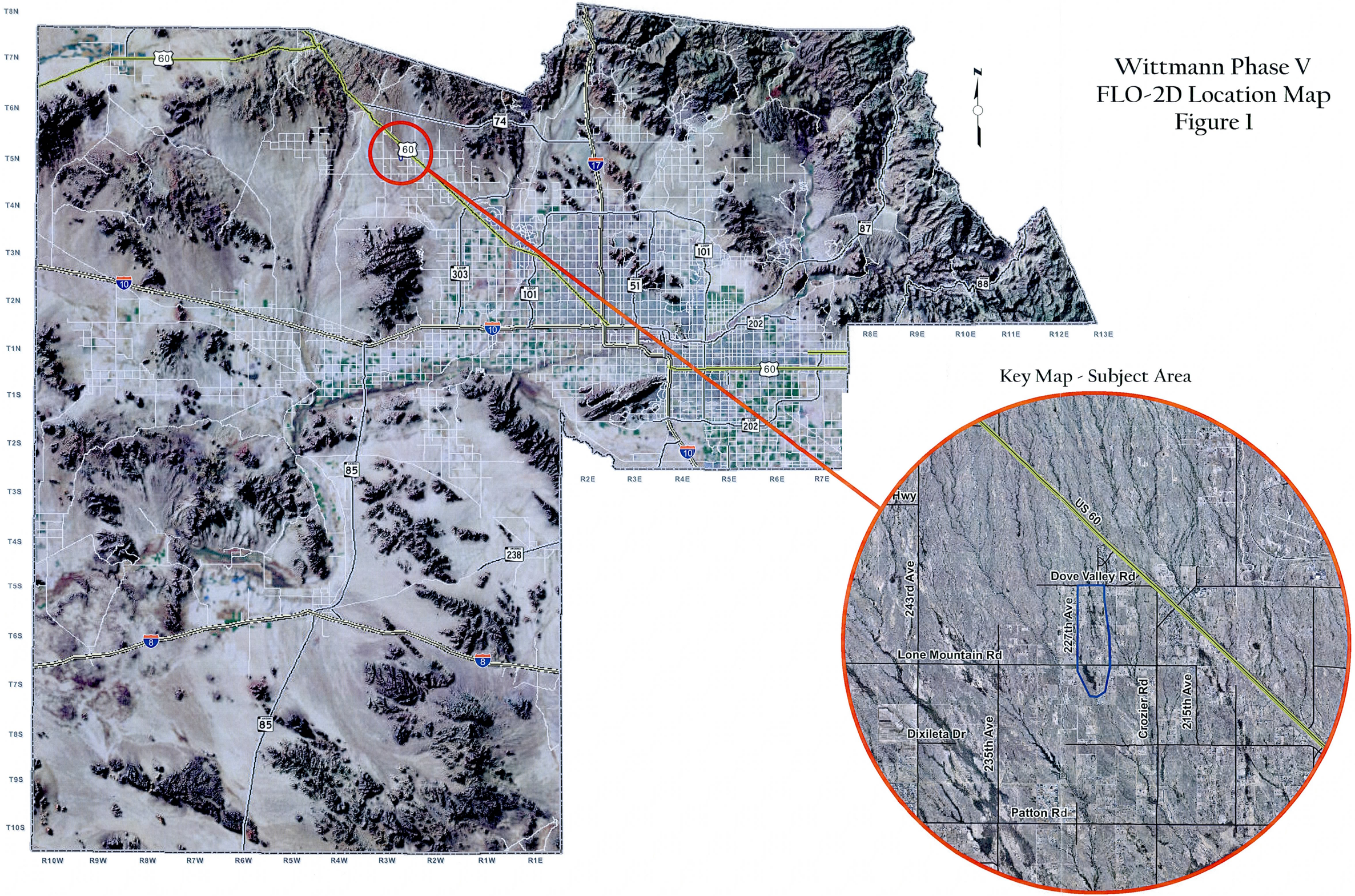
Wash 2 West Profile – Just north of Dove Valley Road to Lone Mountain Road





Appendix B Figures

Wittmann Phase V
FLO-2D Location Map
Figure 1



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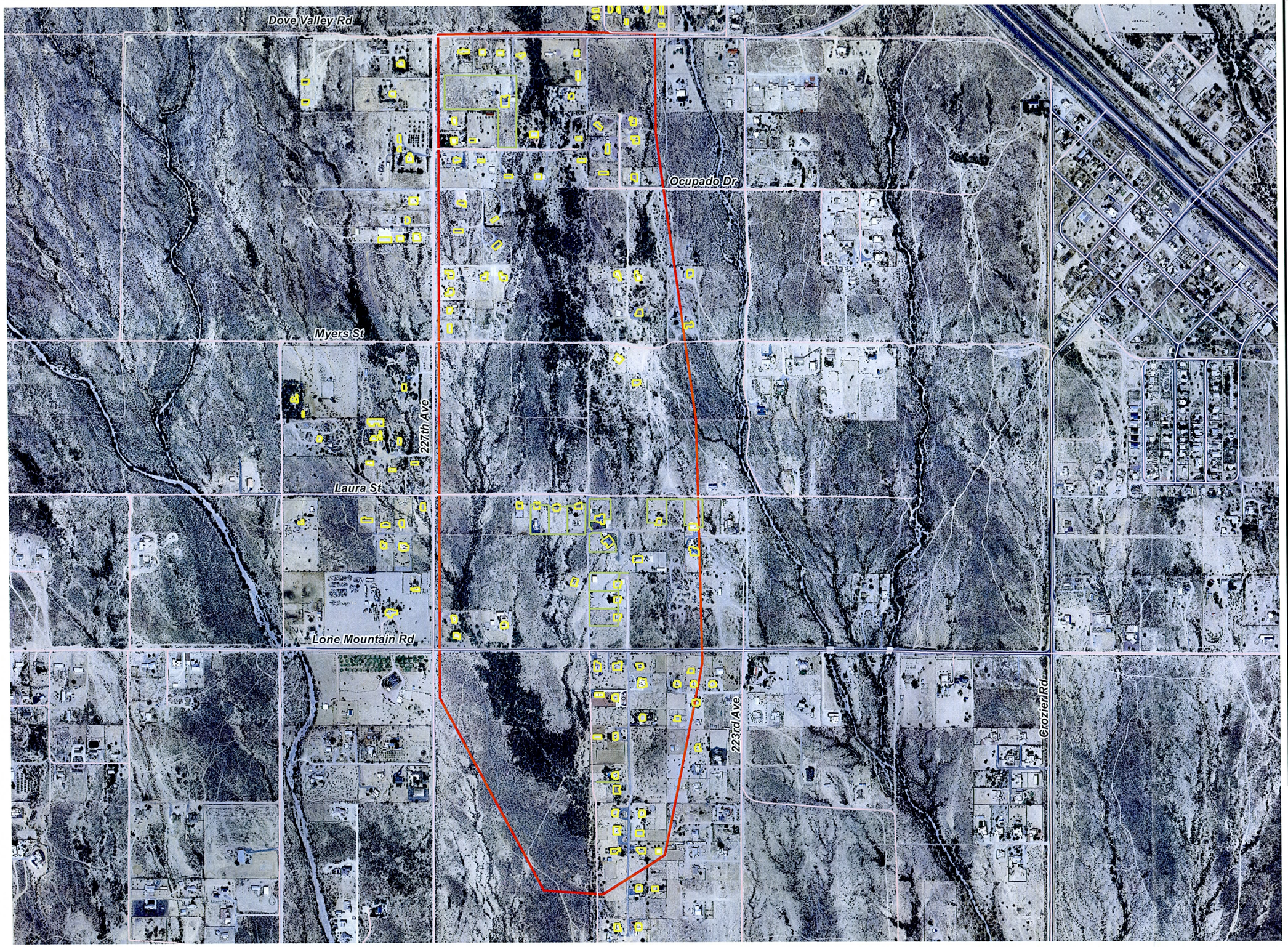

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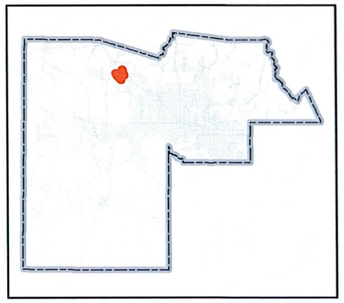

Wittmann Phase V
Floodplain Delineation Study

Legend

- Streets
- Walls
- Structures
- FLO-2D Study Limits

0 200 400 800 Feet

1 inch = 800 feet

FLO-2D-Structures

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FIGURE 2

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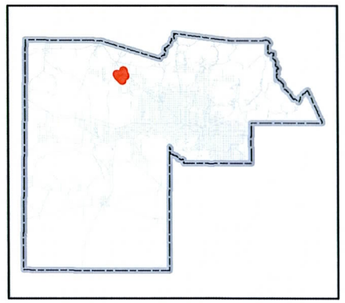

Wittmann Phase V
Floodplain Delineation Study

Legend

- Streets
- FLO-2D Study Limits
- 0.16 - 0.5 ft
- 0.5 - 1.0 ft
- 1.01 - 1.5 ft
- 1.51 - 2.0 ft
- 2.01 - 2.5 ft
- 2.5 - 3.0 ft
- 3.01 - 3.5 ft
- 3.51 - 4.0 ft
- 4.01 - 21.0 ft

0 200 400 800 Feet

1 inch = 800 feet

FLO-2D Results - Max Depth

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FIGURE 3

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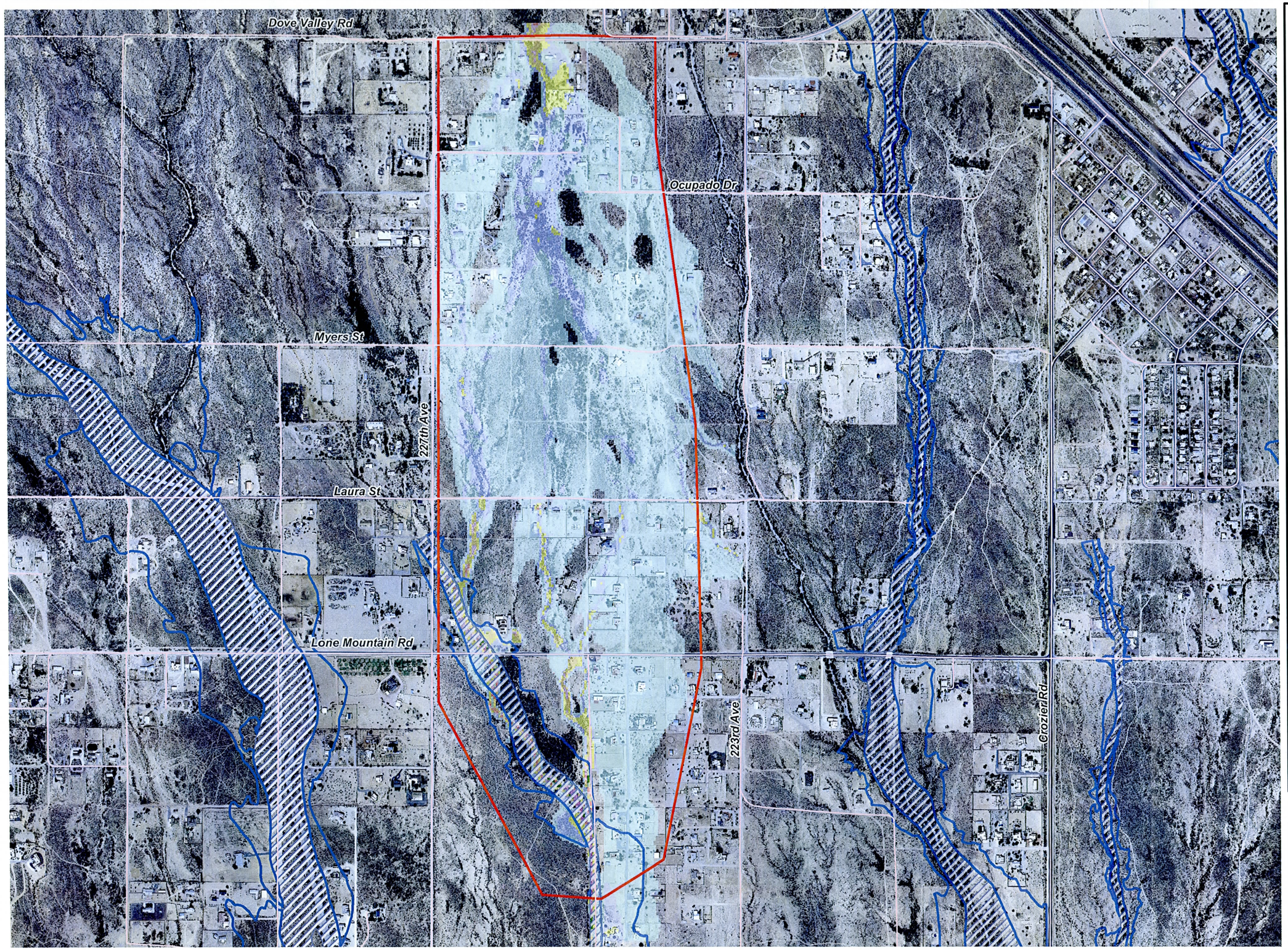

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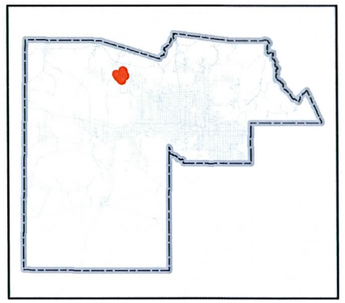

Wittmann Phase V
Floodplain Delineation Study

Legend

- Streets
- FLO-2D Study Limits
- Floodway
- Zone AE Floodplain
- 0.16 - 0.5 ft
- 0.5 - 1.0 ft
- 1.01 - 1.5 ft
- 1.51 - 2.0 ft
- 2.01 - 2.5 ft
- 2.5 - 3.0 ft
- 3.01 - 3.5 ft
- 3.51 - 4.0 ft
- 4.01 - 21.0 ft

0 200 400 800 Feet

1 inch = 800 feet

FLO-2D Results - Max Depth

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FIGURE 4

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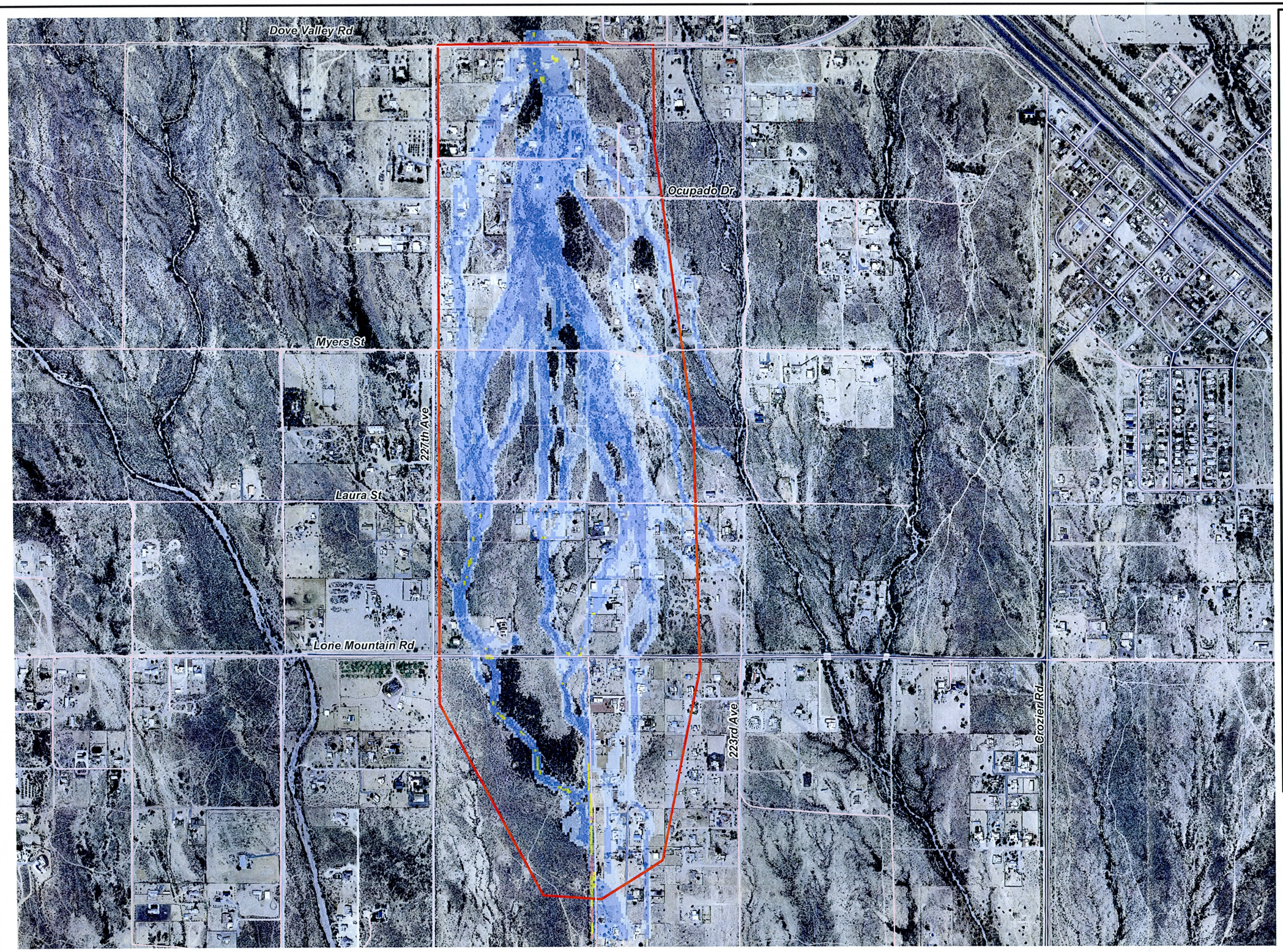
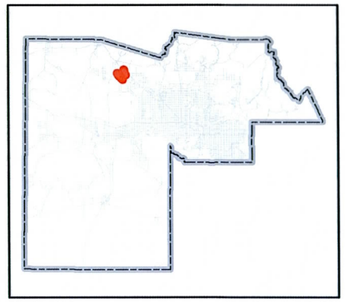


Flood Control District of Maricopa County



Wittmann Phase V
Floodplain Delineation Study

Legend

- Streets
- FLO-2D Study Limits
- 0.56 - 1 ft/s
- 1.01 - 3 ft/s
- 3.01 - 6 ft/s
- 6.01 - 9 ft/s
- 9.01 - 12 ft/s
- 12.01 - 34 ft/s

0 200 400 800 Feet

1 inch = 800 feet

FLO-2D Results - Max Velocity

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FIGURE 5

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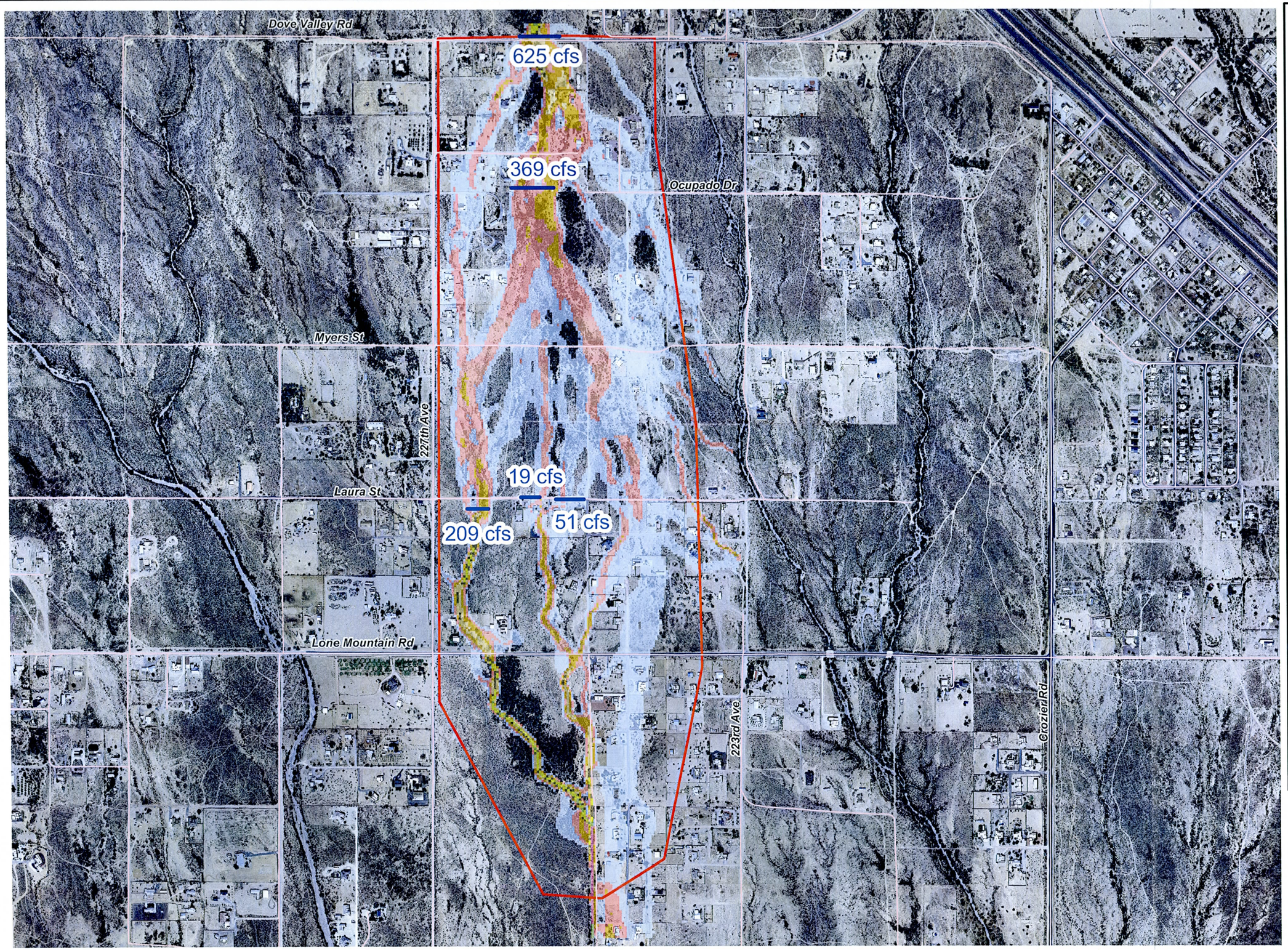
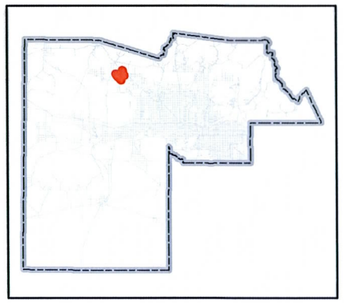


Flood Control District of Maricopa County



Wittmann Phase V
Floodplain Delineation Study

Legend

- Flow Section
- Streets
- FLO-2D Study Limits
- 0 - 1 cfs
- 1.01 - 10 cfs
- 10.01 - 10 cfs
- 10.01 - 25 cfs
- 25.01 - 50 cfs
- 50.01 - 75 cfs
- 75.01 - 100 cfs
- 100.01 - 150 cfs
- 150.01 - 200 cfs
- 200.01 - 4,082.29 cfs

0 200 400 800 Feet

1 inch = 800 feet

FLO-2D Results - Combined Flow

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FIGURE 6

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