LA CUEVA ARROYO SURVEY AND HYDRAULIC ANALYSIS PROJECT

HYDRAULIC ANALYSIS SUMMARY REPORT

ALBUQUERQUE, NEW MEXICO

Project No. IO11.405

Prepared For:

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1 Introduction

The Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) has contracted with ESP Associates, Inc. (ESP) to develop an analysis of the La Cueva Arroyo in the North Albuquerque Acres Neighborhood. The basis of the study is to determine the existing flood extents of the La Cueva Arroyo and identify potential encroachments into the drainage area. The determined flood extents will serve to evaluate flood risk in the study area for existing and future development.

Figure 1: La Cueva Study Area

2 Location

The study area is located in the North Albuquerque Acres neighborhood in Bernalillo County and is roughly bounded by Barstow Street to the west, Tennyson Street to the east, Signal Avenue to the south, and the Sandia Pueblo boundary to the north. The La Cueva Arroyo is the major drainage feature within this area of the North Albuquerque Acres neighborhood. In the study area, La Cueva Arroyo crosses Browning Street, Eubank Boulevard, Holbrook Street, and Ventura Street and terminates in the La Cueva Channel Diversion north of Alameda Boulevard at Barstow Street. Multiple unnamed tributaries converge with La Cueva Arroyo in this study area.

3 Summary of Available Data

The main data sources used to support this study are historical Drainage Management Plans, record drawings and other as-built information, previous studies, and newly collected topographic data. Terrain data was developed from lidar collected within the scope of this project. Building footprints for incorporation into the terrain data were received from Mid-Region Council of Governments (MRCOG) and manually reviewed against the aerial imagery collected by the ESP team on July 7, 2022 as described in Appendix A. Aerial imagery was reviewed for the presence of hydraulically significant structures within the study area. Once any significant hydraulic structures were identified, as-built information was requested to have detailed specifications for later hydraulic modeling.

Several structures near the intersection of Eubank Boulevard and Richfield Avenue were identified as potentially impacting a tributary that is part of the study area. These structures were part of a Bernalillo County project to elevate Eubank Boulevard and then provide a multi-use trail alongside Eubank Boulevard. As-builts were not available for this area, so a field reconnaissance survey was conducted for these structures. That data is provided as a digital attachment included with this report.

Additional survey data was collected for each property containing an AMAFCA easement. This survey data was collected to confirm whether there are any existing encroachments within the easement and to support any actions that may be needed to mitigate adverse flooding the encroachments may cause. This data is also provided as a digital attachment with this report.

The 1998 North Albuquerque Acres Master Drainage Plan was consulted for flow data in the La Cueva Arroyo and its tributaries within the study area for the 100-year flood event. Surface roughness values were assigned by manual delineation using aerial imagery based on the National Land Cover Dataset and previous studies within the region.

4 Lidar Collection

ESP was tasked with the acquisition and processing of aerial-based lidar topographic and orthophotography data for the North Albuquerque Acres Subdivision area defined in Figure 2. The lidar collection boundary is shown in blue, contrasted with the hydraulic analysis study area shown in red and the survey ground control points shown in yellow. This lidar data will be used to support the modeling needs of this project and will also provide AMAFCA with the opportunity to use accurate lidar for other study areas within the North Albuquerque Acres Subdivision. The summary report of this lidar collection effort is provided in Appendix A. For this report, only the DEM mosaic is provided in support of the hydraulic modeling.

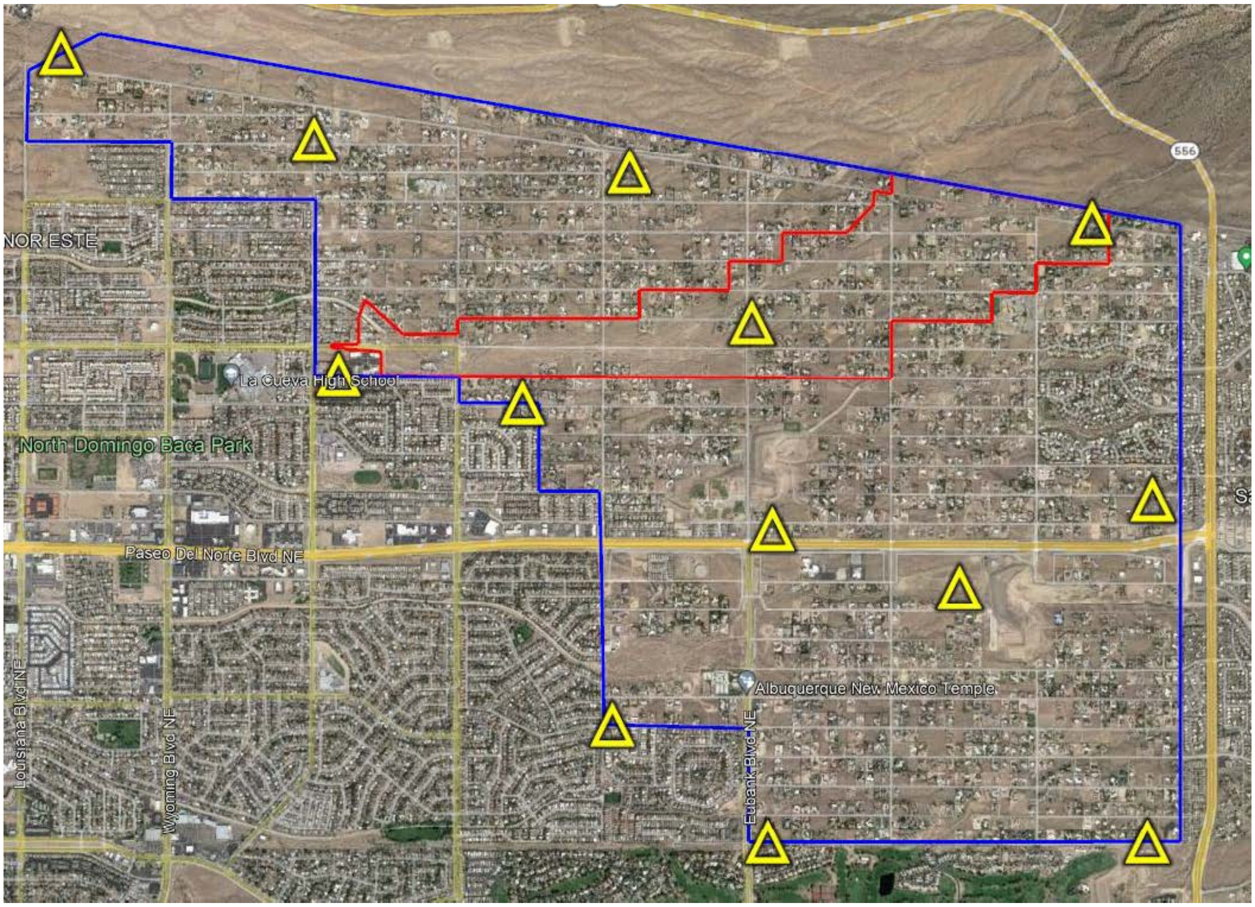

Figure 2: La Cueva Arroyo Lidar Area (Blue), Hydraulic Analysis Project Area (Red), and Survey Ground Control Points (Yellow)

5 Hydraulic Analysis

The US Army Corps of Engineers (USACE) public domain software Hydrologic Engineering Center – River Analysis System (HEC-RAS) was used in the study. The most updated approved version (HEC-RAS 6.3.1) was used which provides several 2D modeling and mapping features. All HEC-RAS models were developed in the New Mexico Central State Plane coordinate system with a vertical datum of NAVD88 in US Survey feet.

5.1 Hydrology

Flows for the project were sourced from the 1998 North Albuquerque Acres Master Drainage Plan as discussed in Section 3. Inflow was applied at the La Cueva Arroyo main channel northeast of the intersection of Elena Drive and Lowell Street, the tributary located west of the La Cueva main channel near Elena Drive and Browning Street (designated Tributary 1), and the tributary at Signal Avenue west of Browning Street (designated Tributary 2). A summary of the flow schemes used in the model can be found in Table 1 below. In each modeling scenario, constant inflow values were applied for the entire model run, except for the first hour where inflow was gradually increased up to the constant value. Increasing flow for the first hour of each run contributed to increased modeling stability, which can be a concern in 2D modeling.

Table 1: Modeling Inflow Summary

Inflow Source	100-yr Flow (cfs)
La Cueva Arroyo Main Channel (Elena Dr and Lowell St)	2,554
Tributary 1 (Elena Dr and Browning St)	399
Tributary 2 (Signal Ave)	230

Additional flow was added within the study area to more closely match downstream flow from the Drainage Master Plan. These supplementary inflows can be found below in Table 2.

Table 2: Downstream Supplementary Inflow Summary

Inflow Source	100-yr Flow (cfs)
La Cueva Arroyo 1 (Eagle Rock Ave)	179
La Cueva Arroyo 2 (Ventura St)	63
Tributary 3 (Browning St)	259
Tributary 4 (Eubank Blvd)	175

5.2 Mesh Development

The mesh size was initially set to a 20-feet by 20-feet grid covering the project area. Breaklines and targeted cell size adjustments were used to refine the mesh for the unique geometry found within the study area. Figure 3 below shows how breaklines adjust the positioning of cell faces within the HEC-RAS computational mesh. The final geometry for existing conditions contains 98,939 cells ranging in size from 1 square feet to 1,046 square feet with an average size of 230 square feet.

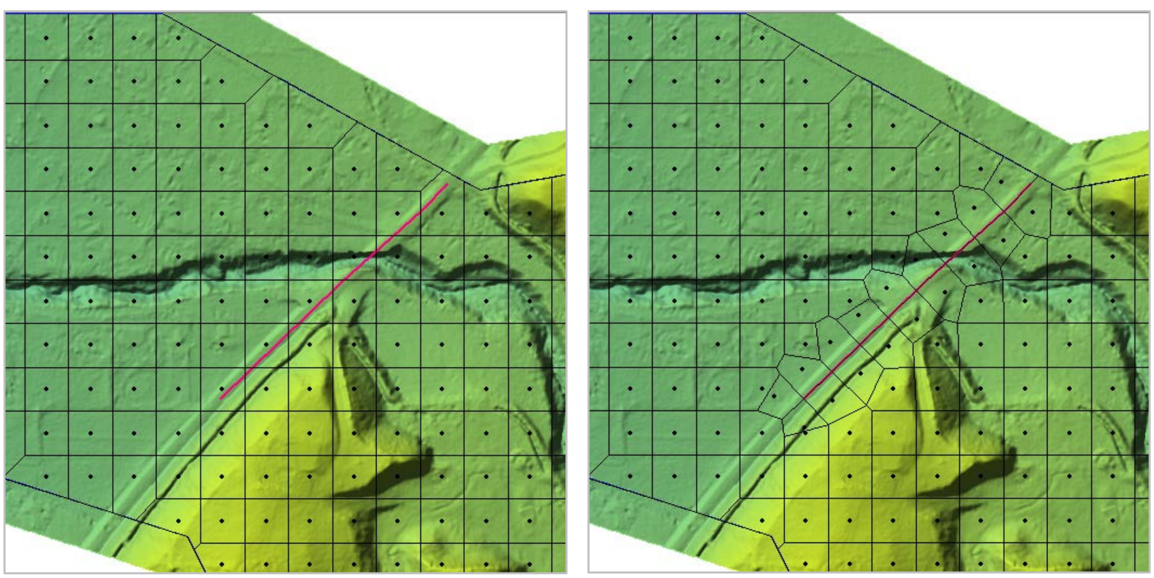

Figure 3: Breakline Cell Adjustment in HEC-RAS

Manning's roughness values used in the modeling were determined by delineating land cover using orthoimagery collected as discussed in Section 4. Manning's n-values were assigned to these land covers based on internal guidance for those that correspond to land covers found in the National Land Cover Dataset and typical Manning's n-values for channels (Chow, 1959). Table 3 below shows modeled n-values and their corresponding land cover.

Table 3: Manning's N-value Assignments by Land Cover

Manning's n-value	Land Cover Description	Source
0.02	Developed, Open space	Internal Guidance
0.04	Developed, Low intensity	Internal Guidance
0.06	Developed, Medium intensity	Internal Guidance
0.035	Shrub/Scrub	Internal Guidance
0.025	Grassland/Herbaceous	Internal Guidance
0.025	Barren Land	Internal Guidance
0.025	Pasture/Hay	Internal Guidance
0.015	Concrete Channel	Chow, 1959
0.02	Paved Road	Chow, 1959
0.03	Clean, straight, main channel (Chow 1a)	Chow, 1959
0.035	Main channel, some stones and weeds (Chow 1b)	Chow, 1959
0.04	Clean main channel, winding, some pools (Chow 1c)	Chow, 1959
0.045	Same as 1c, some weeds and stones (Chow 1d)	Chow, 1959
0.048	Same as 1d, lower stages, more ineffective sections (Chow 1e)	Chow, 1959

A normal depth boundary condition was placed on the 2D modeling surface at natural locations where flow leaves the project area. This included the La Cueva Channel Diversion at Alameda Boulevard and Barstow Road as well as several non-descript locations along the borders of the study area where the scoped area did not match the watershed boundary.

5.3 Structure Incorporation

Impacts of walls built in and around the arroyos was a primary goal of the hydraulic modeling. Walls were incorporated into modeling with line features that were drawn in ArcGIS using the latest orthoimagery, then imported into the HEC-RAS geometry as SA-2D Connections to create weirs. Walls were treated as 4-feet high, and elevations were set as 4-feet offsets from the terrain dataset except where boundary survey showed heights less than 4-ft. The walls included in the modeling are included as indicated on exhibits provided in Appendix B.

Buildings were also included in the modeling terrain. The MRCOG polygon building footprint features, with manual updates from the latest orthoimagery, were converted to an elevation raster where each building was assigned a standard height of 15-feet. The building elevation raster was combined with the terrain raster created from the Lidar Collection task to create a terrain that would block flow through buildings during hydraulic modeling. The effect of the buildings and walls on mapping products is shown in Figure 4.

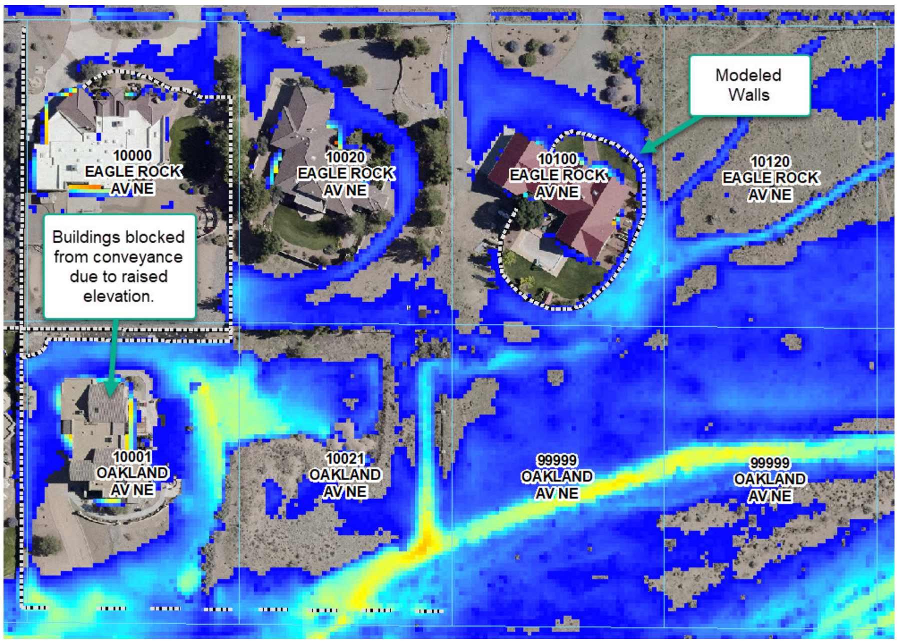

Figure 4: RAS Mapper Depth Results and Underlying Inputs

As described in Section 3, survey data was collected for several hydraulic structures near the intersection of Eubank Boulevard and Richfield Avenue. The September 2022 survey data showed a two-barrel culvert crossing Richfield Avenue east of Eubank Boulevard, a single-barrel culvert crossing Eubank Boulevard north of Richfield Avenue, and two five-barrel culverts crossing Eubank Boulevard south of Richfield Avenue. Surveyed culverts were included in the modeling as elliptical corrugated metal pipes (CMP) utilizing survey data provided in Appendix C and summarized in Table 4 below. Other culverts and pipes in the project area that provide flow capacity under private driveways and through yards were not considered in the model.

Table 4: Summary of Surveyed Culvert Dimensions

Culvert Name	CMP Dimensions (Height x Width, ft)	Number of Barrels
Eubank 1	2.1 x 2.9	5
Eubank 2	2.1 x 3.2	5
Richfield 1	2.7 x 3.0	2
Richfield Supplemental	1.7 x 2.3	1

5.4 Model Scenarios

Several plans were created to run the hydrologic flow scenarios of 100%, 75%, 50%, and 25% of the 100-year flood event. Separate scenarios were created to model flow along the La Cueva Arroyo main channel and the tributaries that enter the study area. The scenarios can be identified by the plan name (e.g., "100yr Main_Existing Condition" indicates a plan modeling the 100-year flood event in the main channel of the La Cueva Arroyo using geometry based on the existing condition with any walls in the study area modeled as weirs). Flows in the main channel and tributaries were separated in model plans in order to more accurately assess the continuity of flow in the main channel with downstream flows taken from the North Albuquerque Acres Master Drainage Plan, while also modeling expected flow patterns in the tributaries. Each plan was run in full momentum using an adaptable time step to mitigate convergence errors.

Two ground condition scenarios were used in the modeling: existing conditions including walls and fences modeled as weirs, and a duplicate scenario with the only change being the removal of the walls. The scenario without walls was developed by copying the existing conditions geometry and deleting the walls so that cell alignment would remain as unchanged as possible between the two geometries.

6 Modeling Results

For the final mapping products, a manual process was used. The maximum water surface elevation from each cell was exported from HEC-RAS and used to create a triangulated terrain network from which a water surface elevation raster was built. The modeling terrain was subtracted from the water surface elevation raster to create a depth grid. The final velocity grids were developed with a similar process. Appendix B shows map exhibits that reflect these final grids.

Modeling results were reviewed against the available terrain and imagery data and deemed reasonable. The main analysis plan "100yr Main_Existing Condition" was used as the basis for assessing accuracy in the modeling. The model reported a total percentage error of 0.02739%.

Analysis of structures around the conveyance paths was the primary concern of the project. Walls impacting the main conveyance path appear to be located at 10900 – 10904 Glendale Avenue and 10900 – 10932 Modesto Avenue shown in Figure 5. Walls surrounding properties at Signal Pointe Lane also impacted the flow conveyance in the La Cueva Arroyo main channel.

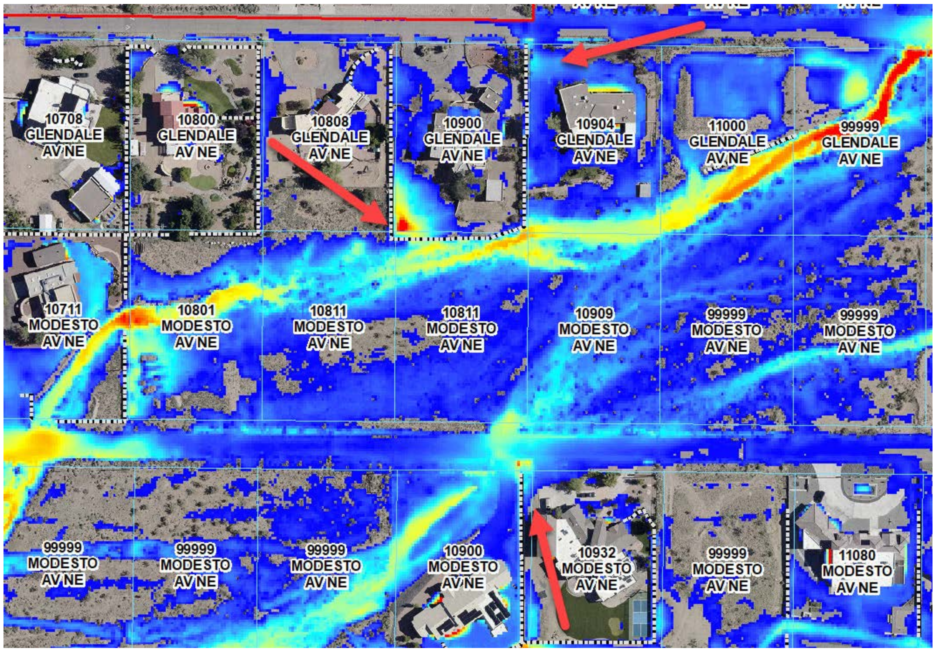

Figure 5: Walls Impacting Water Surface Depth Grid

At certain properties, including 9301 Alameda Boulevard shown in Figure 6, inundation was prevented by walls surrounding the property. Other areas, including properties at 10551 – 10651 Signal Avenue were subjected to increased inundation in modeling that included walls where flow was trapped by the structures and pooled.

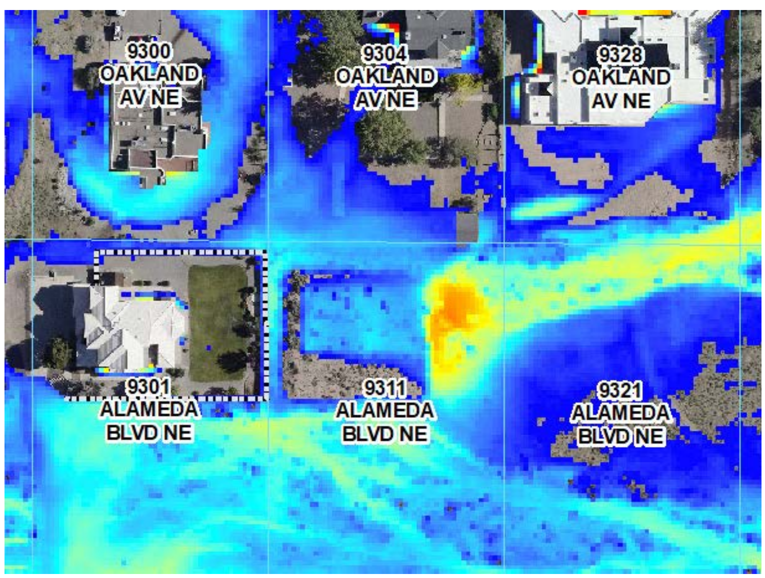

Figure 6: Inundation Prevented by Walls

It should be noted that this project was scoped to cover the La Cueva Arroyo watershed and flows obtained from the North Albuquerque Acres Master Drainage Plan appear to assume that all flow moves downstream. When modeling the drainage plan flows as constant discharges, there are several locations where flooding escapes the La Cueva Arroyo watershed. While the modeled inflows match determined discharges, this spillover results in reduced downstream discharges from those expected as defined in the North Albuquerque Acres Master Drainage Plan.

Within the 100-year event with walls, the diversion channel outlet has a flow of 1,998 cfs. The expected discharge here is 2,796 cfs, but flow is escaping the watershed at several locations causing the reduction at the outlet. Figure 7 below highlights model locations with significant outflows, with detailed views of each location in Figures 8 - 13. These are important locations to review since these outflows may be unexpected and provide increased flood risk at nearby structures. Without expanding the model area, the model results should be assumed to represent the 100-year floodplain resulting from a 100-year event within the La Cueva Arroyo watershed.

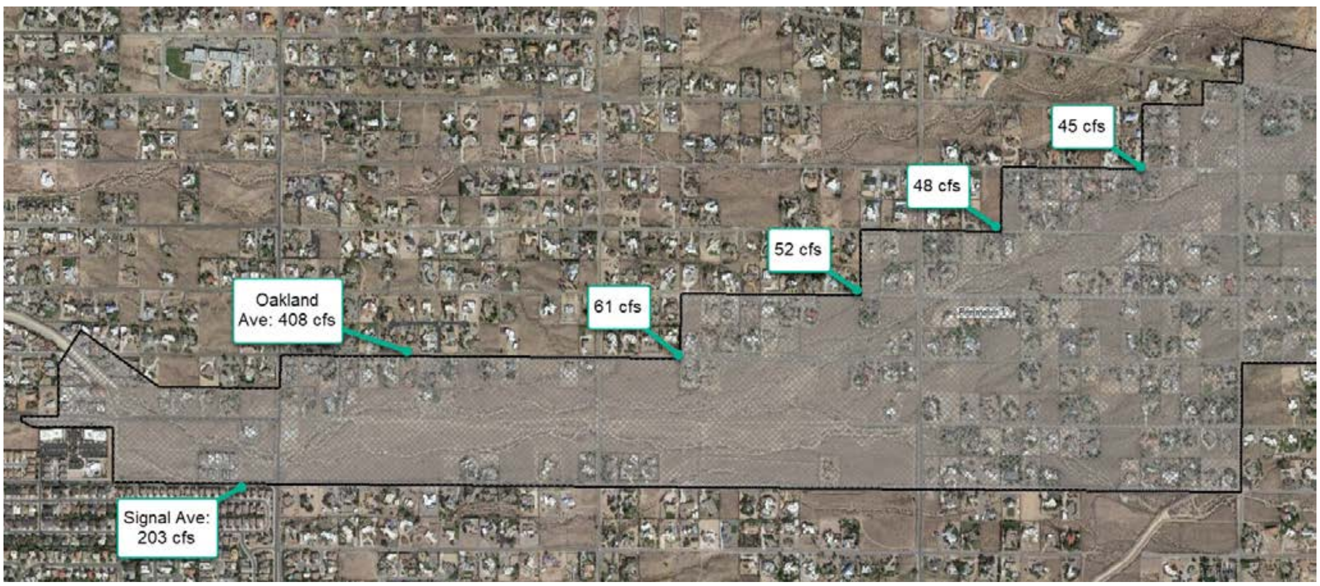

Figure 7: Significant Outflows at the La Cueva Arroyo Watershed Boundary

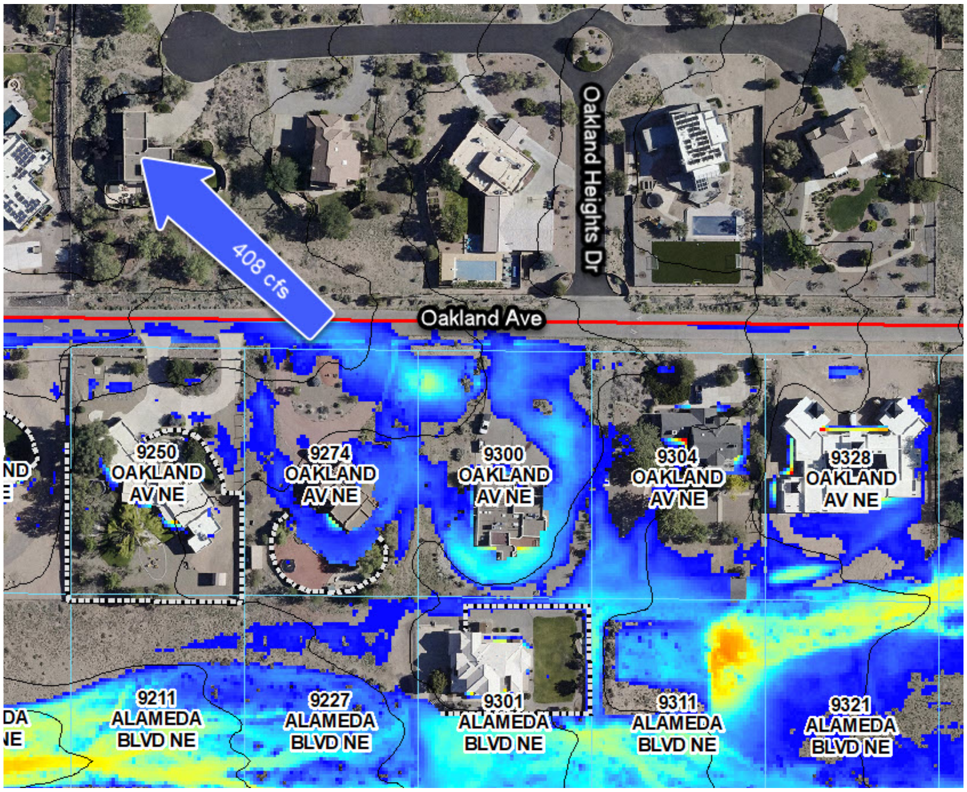

Figure 8: Flow escaping the model at Oakland Ave

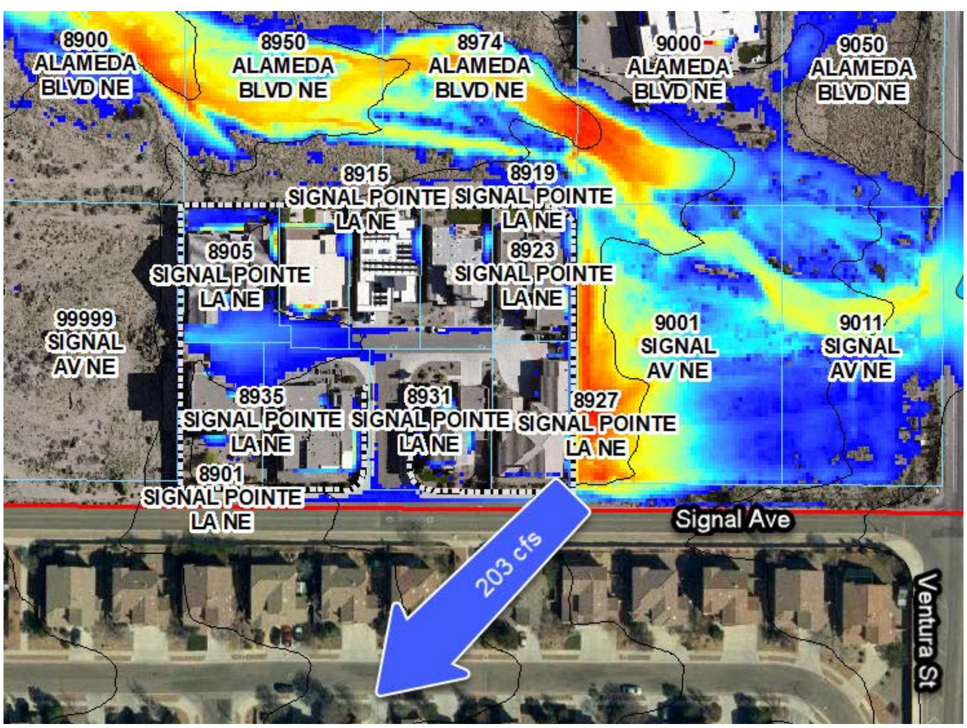

Figure 9: Flow escaping the model at Signal Ave

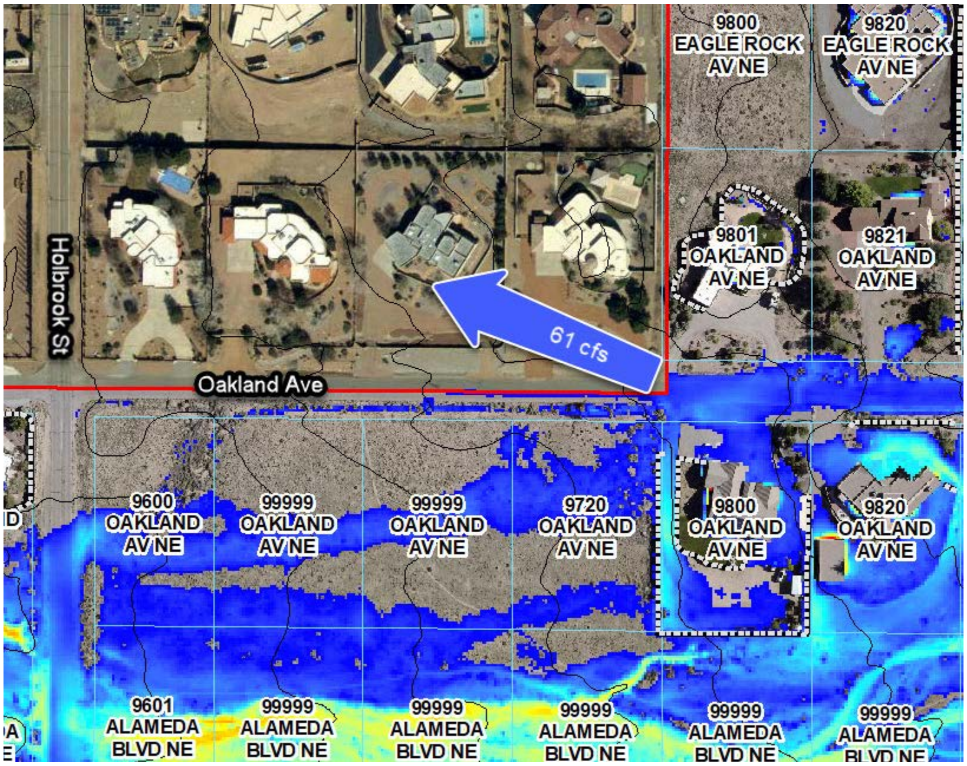

Figure 10: Flow escaping the model at Oakland Ave near Holbrook St

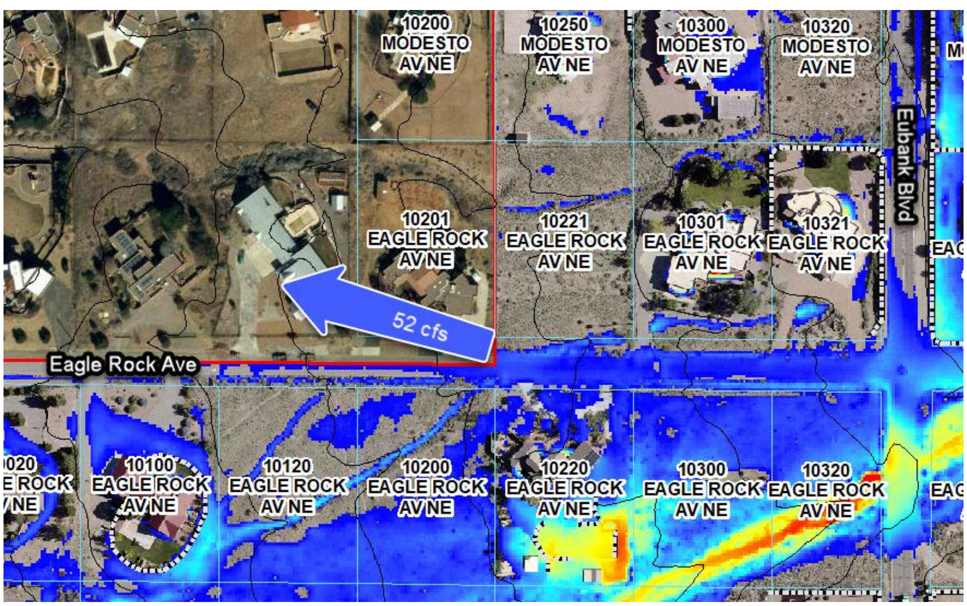

Figure 11: Flow escaping the model at Eagle Rock Ave

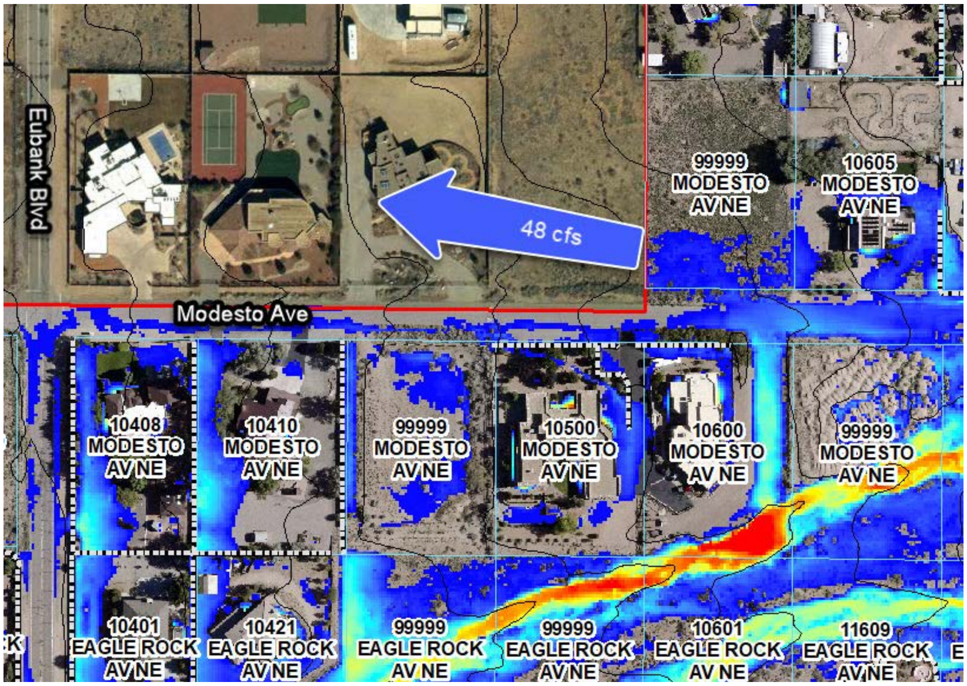

Figure 12: Flow escaping the model at Modesto Ave

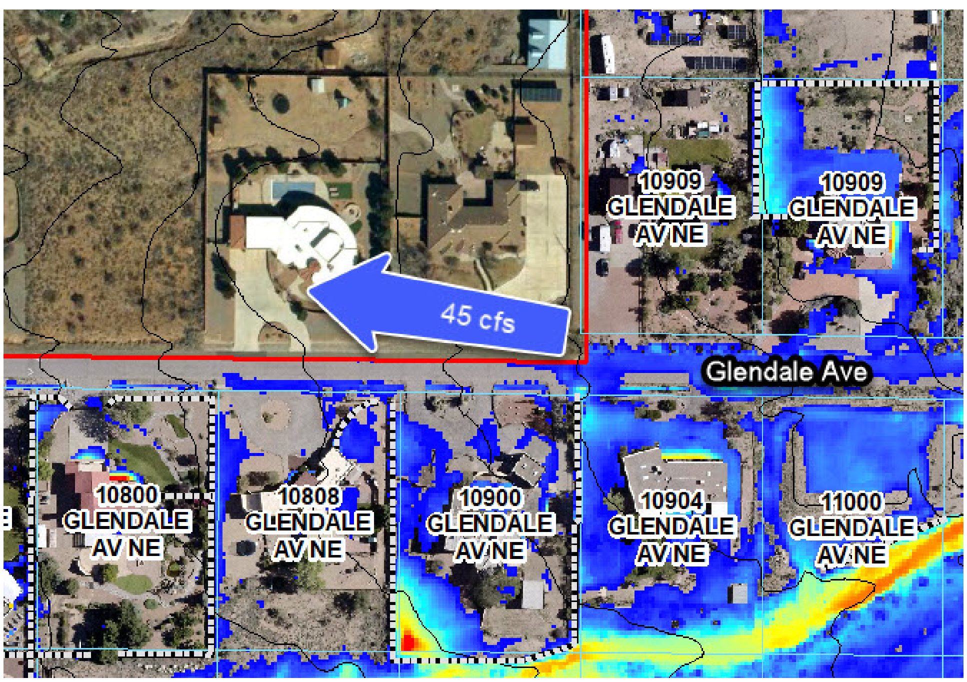

Figure 13: Flow escaping the model at Glendale Ave

The modeling completed to date is intended to be used as a baseline existing conditions model, which may be helpful in quantifying mitigation strategies to alleviate flooding concerns within this area.

7 Flood Mitigation Alternatives Assessment

This section is reserved for future tasks.

References

1. Albuquerque Metropolitan Arroyo Flood Control Authority, Final North Albuquerque Acres Master Drainage Plan, October 1998.
2. Chow, V.T. (1959) *Open Channel Hydraulics*. McGraw-Hill, New York.

Appendix A:

North Albuquerque Acres Lidar Collection Summary

Appendix B:
Exhibits

Appendix C:

Field Reconnaissance Survey Data Collection

Attachments

Drainage Management Plan

- Final North Albuquerque Acres Master Drainage Plan

Field Reconnaissance Survey Data

- Sealed survey report of collected data for 6 structures along Eubank Boulevard and Richfield Avenue
- CAD file containing the field reconnaissance survey data

Boundary Survey Information

- PDF exhibits of the boundary survey collection at 120 parcels
- CAD files containing boundary survey data

Lidar Data Collection

- DEM mosaic of collected lidar data that was used in hydraulic modeling

Raster Mapping Data

- Velocity and depth grid (.tif) for each model plan

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