Base Level Engineering Technical Support Data Notebook

Base Level Engineering for Southern Sandoval County Arroyo Flood Control Authority, New Mexico

August 16, 2019

Federal Emergency Management Agency
Department of Homeland Security
800 N. Loop 288
Denton, TX 76209

TECHNICAL SUPPORT DATA NOTEBOOK (TSDN)

for

Southern Sandoval County Arroyo Flood Control Authority, New Mexico

BASE LEVEL ENGINEERING

ANALYSIS TSDN

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Figures

Tables

Appendices

ACRONYMS AND ABBREVIATIONS

2D	Two-dimensional
AOMI	Areas of Mitigation Interest
BLE	Base Level Engineering
CN	Curve Number
CNMS	Coordinated Needs Management Strategy
DEM	Digital Elevation Model
estBFE	Estimated Base Flood Elevation
EDAC	University of New Mexico’s Earth Data Analysis Center
ESP	ESP Associates, Inc.
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HUC-8	8-digit Hydrologic Unit Code
LiDAR	Light Detection and Ranging
NED	National Elevation Dataset
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
QL2	USGS Quality Level 2
SSCAFCA	Southern Sandoval County Arroyo Flood Control Authority
TSDN	Technical Support Data Notebook
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WSEL	Water Surface Elevation

1.0 INTRODUCTION

1.1 SUMMARY OF BASE LEVEL ENGINEERING METHODOLOGY

A Base Level Engineering (BLE) analysis was completed for the area within the jurisdictional boundary of the Southern Sandoval County Arroyo Flood Control Authority (SSCAFCA), located just north of Albuquerque, New Mexico. Hydrologic and hydraulic computations and analyses of the BLE study consisted of determining excess precipitation amounts and calculating Water Surface Elevations (WSELs) for the 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance flood events, as well as the 1-percent plus and minus events. Light Detection and Ranging (LiDAR) data of U.S. Geological Survey (USGS) Quality Level 2 (QL2) standards was acquired from the University of New Mexico's Earth Data Analysis Center (EDAC). This LiDAR data is a compilation of collections by the Natural Resources Conservation Service and the Mid-Region Council of Governments. These collections each took place in January of 2018. Hydrologic analyses were completed using HEC-HMS rainfall-runoff modeling to determine excess precipitation values for all flooding events in the project area. Two-dimensional (2D) hydraulic models were developed for the project area using HEC-RAS version 5.0.7. Figure 1 provides an overview of the modeled areas and generally scoped streamlines (only results within the SSCAFCA jurisdictional bounds are considered as part of this BLE analysis).

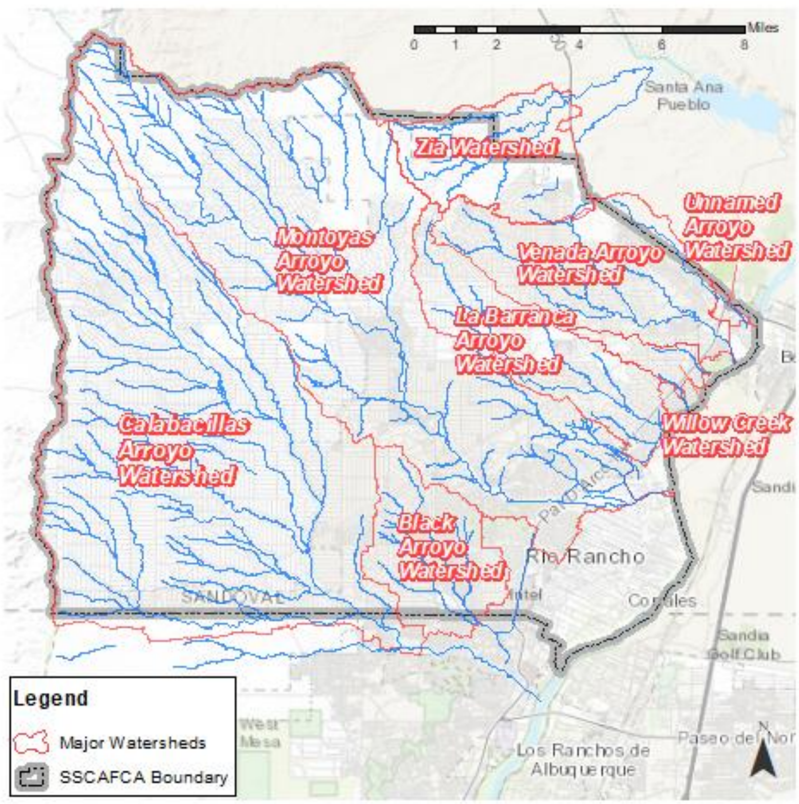

Figure 1: Model Watershed Overview for BLE Analysis

1.2 PROJECT WORK SCOPE

ESP Associates, Inc. (ESP) has contracted with EDAC to conduct BLE analyses for the area within the SSCAFCA jurisdictional boundary. BLE studies are meant to help communities better predict their flooding risk using Estimated Base Flood Elevations (estBFEs). Within areas of effective mapping that do not have corresponding elevations, estBFEs are derived from an approximate BLE analysis to assist in determining flood depths at critical locations. Following is the outline of the Scope of Work for ESP related to this project.

Scope: ESP will determine the excess precipitation depths and resulting modeled elevations of all scoped study areas for the 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance storm events as well as the 1-percent-plus and minus floods. For this study, which uses HEC-RAS 2D hydraulic modeling capabilities, the 1-percent-plus and minus floods are determined using the upper and lower limits of the Atlas 14 90% confidence interval for 100-year, 24-hour precipitation estimates. Existing HEC-HMS models held by SSCAFCA will be utilized to tabulate the excess precipitation values.

Standards: All work adheres to FEMA Region VI Submittal Guidance – Base Level Engineering, April 2019.

EDAC provided ESP with a Digital Elevation Model (DEM) generated from LiDAR data of USGS QL2 standards. Additional terrain processing discussion is included in Section 3.0.

All excess precipitation depth calculations will be completed based upon the accepted hydrologic models provided by SSCAFCA.

Deliverables: As part of this submittal, ESP will make the following products available to FEMA, EDAC, and SSCAFCA:

- 2D HEC-RAS models of each study area.
- BLE Database containing all required feature classes and tables with corresponding FGDC-compliant metadata.
- Supplemental data including an updated Coordinated Needs Management Strategy (CNMS) Validation Database and Hazus *.hpr file.

If the data is changed at any time during the project, updated deliverables will be submitted.

1.3 BACKGROUND

1.3.1 Historic Flooding

Principal flooding problems are described in the effective Flood Insurance Study (FIS) reports for Sandoval County, NM. The effective FIS for Sandoval County, NM (March 18, 2008) describes sedimentation-erosion problems that are common to the City of Rio Rancho and the Village of Corrales due to minimal ground cover for the highly erodible fine silt and sands. Flooding has also been prevalent along the Rio Grande in many low-lying areas where residential and commercial development as well as levees and irrigation channel embankments have created an increased flood hazard. On August 19, 1976, the Village of Corrales received no rain but experienced major flooding from the Arroyo de los Montoyas when a flash flood broke the levees along the main channel in Corrales. Levee construction along the Rio Grande in 1933 has thus far prevented major flooding due to the Rio Grande in the Town of Bernalillo. Cochiti Dam is about 35 miles upstream of the Village of Corrales and helps control flooding from the Rio Grande along with several other upstream flood-control structures.

1.3.2 Existing Hydrologic and Hydraulic Studies

Within Sandoval County, a hydrologic analysis was completed within the City of Rio Rancho using the AHYMO194 program to bulk flood hydrographs and account for sediment. The previous Arroyo de los Montoyas hydrologic analysis incorporated AHYMO392 hydrographs into a HEC-1 model to combine hydrographs using the Muskingum-Cunge method in natural reaches and kinetic wave methods in concrete channels. Additionally, the U.S. Army Corps of Engineers (USACE) performed a flood frequency study that found dams within the Rio Grande system completely controlled floods originating upstream of Cochiti Dam up to the 1-percent-annual-chance flood. Due to this determination, the USACE decided to separate out portions of flows that are now regulated to help determine expected discharges along the Rio Grande. All previously developed hydraulic analyses utilized the HEC-2 step-backwater program.

2.0 HYDROLOGIC ANALYSIS

2.1 APPROACH

The hydrologic approach used for this BLE analysis assesses the watershed response and calculates excess precipitation using rainfall-runoff models developed and provided by SSCAFCA. These models were developed in either HEC-HMS version 3.5 or 4.2.1, and ESP updated each model to add simulations reflecting multiple return periods. Excess precipitation values for storm events with 10%, 4%, 2%, 1%, 0.2%, and 1% plus and minus annual chance of exceedance have been developed for each study area. The Village of Corrales is not represented within any of the HEC-HMS models provided; therefore, results within this area are not supported by hydrologic modeling and should only be used to determine general flooding patterns.

Table 1 provides an overview of each model version, routing method, and loss method. The following sections provide additional supporting information for the modification ESP made to each model.

Table 1: HEC-HMS Watershed Modeling Summary

Watershed	Drainage Area (Sq. Miles)	HEC-HMS Version	Routing Method	Loss Method	Transform Method
Black Arroyo	11.5	3.5	Muskingum-Cunge	Initial and Constant	Clark UH
Calabacillas Arroyo	69.2	3.5	Muskingum-Cunge	Initial and Constant	Clark UH
La Barranca Arroyo	12.0	3.5	Muskingum-Cunge	Initial and Constant	Clark UH
Montoyas Arroyo	60.4	4.2.1	Muskingum-Cunge	SCS CN	Clark UH
Unnamed Arroyo (aka Coronado Arroyo)	0.4	3.5	Muskingum-Cunge	Initial and Constant	Clark UH
Venada Arroyo	16.4	3.5	Muskingum-Cunge	Initial and Constant	Clark UH
Willow Creek	2.0	3.5	Muskingum-Cunge	Initial and Constant	Clark UH
Zia	11.1	4.2.1	Muskingum-Cunge	SCS CN	SCS UH

2.2 HEC-HMS STUDY DATA DEVELOPMENT

2.2.1 Rainfall Determination

Each provided HEC-HMS rainfall-runoff model included the 1% annual chance rainfall event. Precipitation depth data for the 10%, 4%, 2%, and 0.2% annual chance events and partial duration based 24-hour point precipitation frequency was obtained from NOAA Atlas 14. 1% plus and minus precipitation depths were established as one standard deviation above and below the 1%, 24-hour rainfall, respectively.

Table 2 below shows precipitation depths used in the HEC-HMS models for each study area. These precipitation depths were fit to the existing rainfall distribution within the provided HEC-HMS model as shown in the rainfall accumulation spreadsheets provided as supplemental data. The Calabacillas model includes several different rainfall zones and therefore has multiple listings below.

Table 2: Precipitation Depth vs. Recurrence Interval

Annual Chance Event	10% (in.)	4% (in.)	2% (in.)	1% (in.)	0.2% (in.)	1%+ (in.)	1%- (in.)
Black Arroyo	1.83	2.18	2.44	2.856	3.38	3.07	2.64
Calabacillas Zone 1	2.06	2.45	2.76	2.92	3.83	3.16	2.68
Calabacillas Zone 2	1.97	2.34	2.63	2.82	3.65	3.05	2.59
Calabacillas Zone 3	1.89	2.24	2.51	2.73	3.49	2.95	2.51
Calabacillas Zone 4	1.82	2.16	2.43	2.63	3.37	2.84	2.42
Calabacillas Zone 5	1.78	2.11	2.37	2.54	3.27	2.75	2.33
Calabacillas Zone 6	1.73	2.05	2.30	2.45	3.17	2.65	2.25
La Barranca Arroyo	1.95	2.32	2.61	2.90	3.62	3.12	2.68
Montoyas Arroyo	1.95	2.32	2.60	2.90	3.61	3.12	2.68
Unnamed Arroyo	1.84	2.19	2.45	2.90	3.37	3.09	2.71
Venada Arroyo	1.91	2.27	2.55	2.84	3.53	3.05	2.63
Willow Creek	1.89	2.24	2.52	2.90	3.48	3.11	2.69
Zia	1.94	2.31	2.59	2.89	3.60	3.10	2.68

2.3 HEC-HMS MODEL DEVELOPMENT

2.3.1 HEC-HMS Modeling

The following sections describe the typical naming practices used in developing components for each of these HEC-HMS models. HEC-HMS models are included in the digital data accompanying this report (Supplemental Data folder).

2.3.1.1 HEC-HMS Meteorology

For the HEC-HMS models, no existing meteorological models were removed. The meteorological models added to reflect multiple return periods were typically named by combining the return period and the rainfall duration (24 hours). These added meteorological models were developed with precipitation depths for each recurrence interval determined as reported above in Section 2.2.1.

2.3.1.2 HEC-HMS Model Controls

HEC-HMS control specifications were not revised from the initially provided models. Time steps, durations, and starting and ending dates vary between models.

The time window of the control specification is primarily arbitrary and should have no effect on model results.

2.4 RESULTS

From HEC-HMS, the overall, area-weighted direct runoff volume (excess precipitation) was calculated, and these excess precipitation values are given in Table 3 below. For Black Arroyo, Unnamed Arroyo, and Willow Creek, these excess precipitation values were generally applied over the entire watershed during the hydraulics analysis. Area-weighted runoff values for the other watersheds were determined from groupings of basin elements. These procedures are described further in Section 3.0.

Table 3: Summary of Excess Precipitation Values from HEC-HMS Model

Watershed	Annual Probability	Total Precipitation (in)	Excess Precipitation (in)
Black Arroyo	10%	1.83	0.67
	4%	2.18	0.87
	2%	2.44	1.02
	1%	2.86	1.28
	0.2%	3.38	1.62
	1% +	3.07	1.42
	1% -	2.64	1.14
Calabacillas Arroyo	10%	Multiple Values	0.16
	4%	Multiple Values	0.27
	2%	Multiple Values	0.35
	1%	Multiple Values	0.42
	0.2%	Multiple Values	0.68
	1% +	Multiple Values	0.49
	1% -	Multiple Values	0.34
La Barranca Arroyo	10%	1.95	0.28
	4%	2.32	0.43
	2%	2.61	0.57
	1%	2.90	0.70
	0.2%	3.62	1.09
	1% +	3.12	0.82
	1% -	2.68	0.60

Watershed	Annual Probability	Total Precipitation (in)	Excess Precipitation (in)
Montoyas Arroyo	10%	1.95	0.36
	4%	2.32	0.54
	2%	2.60	0.69
	1%	2.90	0.90
	0.2%	3.61	1.32
	1% +	3.12	1.00
	1% -	2.68	0.74
Unnamed Arroyo	10%	1.84	1.07
	4%	2.19	1.33
	2%	2.45	1.53
	1%	2.90	1.88
	0.2%	3.37	2.25
	1% +	3.09	2.03
	1% -	2.71	1.73
Venada Arroyo	10%	1.91	0.34
	4%	2.27	0.50
	2%	2.55	0.63
	1%	2.84	0.77
	0.2%	3.53	1.13
	1% +	3.05	0.88
	1% -	2.63	0.66
Willow Creek	10%	1.89	0.55
	4%	2.24	0.74
	2%	2.52	0.89
	1%	2.90	1.06
	0.2%	3.48	1.49
	1% +	3.11	1.25
	1% -	2.69	0.99

Watershed	Annual Probability	Total Precipitation (in)	Excess Precipitation (in)
Zia	10%	1.94	0.37
	4%	2.31	0.56
	2%	2.59	0.72
	1%	2.89	0.91
	0.2%	3.60	1.39
	1% +	3.10	1.05
	1% -	2.68	0.78

3.0 HYDRAULIC ANALYSIS

3.1 APPROACH

A 2D analysis was used to perform the BLE analysis and mapping using HEC-RAS 5.0.7. 2D modeling in HEC-RAS performs “rain-on-grid” analysis by dividing the study area into a grid of cells with no more than 8 faces and performing cell-by-cell 2D hydraulic calculations. The model calculates runoff flows, water surface elevations/depths, and similar parameters for all cells in the grid, which can subsequently be used to develop floodplain boundaries. Any impacts of Karst topography or arid hydrology were not accounted for in this model development.

Grid cell spacing ranged from 25- to 100-ft for the hydraulic models; the cell spacing is reduced when breaklines are used in the model. The default time step was set to 20-seconds for each model, with the possibility of a reduction to 2.50-seconds to maintain stability when necessary. Table 4 shows the HEC-RAS model information including the model area, number of grid cells, and 100-yr event model run time for each study area. The model run time for HEC-RAS 2D hydraulic models is dependent on the setup and performance specifications of the machine used for the analysis.

Table 4: HEC-RAS Model Development Summary

Study Area	Model Area (sq. mi.)	Grid Cells	100-yr Model Run Time (hh:mm:ss)
Black Arroyo	10.6	28,652	00:06:14
Calabacillas Arroyo	97.3	271,542	03:14:36
La Barranca Arroyo	14.9	42,627	01:18:32
Montoyas Arroyo	71.9	198,382	07:07:02
Unnamed Arroyo	1.2	3,248	00:00:29
Venada Arroyo	18.8	53,537	00:35:40

Study Area	Model Area (sq. mi.)	Grid Cells	100-yr Model Run Time (hh:mm:ss)
Willow Creek	5.9	16,256	00:03:33
Zia	12.3	33,849	00:20:38

Primary components of model development are discussed in the following section. During initial model development, it was observed that the Montoyas 2D hydraulic model failed to produce similar discharges, volumes, and flood timing when compared to the SSCAFCA-calibrated HEC-HMS model for the same watershed. ESP tested numerous scenarios to determine the best approach for the Montoyas model and recommended to produce models incorporating multiple 2D flow areas with 100-ft maximum cell spacing and adjusted Manning's n values to produce a more reasonable solution. This approach was agreed upon by SSCAFCA and was then applied to all other watersheds as well. ESP delivered this data to SSCAFCA on May 14, 2019 and this report is included in Appendix A of this report. The summary report and supporting data are also included within the provided supplemental data.

The HEC-RAS models developed include the Village of Corrales and support the mapping provided for Corrales based on the rainfall patterns within nearby basins. Since there was no hydrologic information available for this area, the results should be considered to generally describe flooding patterns in this area. A separate HEC-RAS model was developed specifically for this area for SSCAFCA to use in conjunction with any known rainfall information to develop flooding conditions for this region, and this model is provided within the supplemental data folder of this submittal.

3.2 HEC-RAS MODEL DEVELOPMENT

3.2.1 Terrains

EDAC provided terrain data for this project in the form of an elevation grid with 2-ft cell spacing. ESP sampled the provided dataset up to a 5-ft elevation grid to help reduce the size of data files associated with each hydraulic model. This data was the product of a QL2 LiDAR dataset covering the entire SSCAFCA jurisdiction. This raster dataset was created in New Mexico State Plane with vertical units in feet. All HEC-RAS models were thus developed in New Mexico Central State Plane with a vertical datum of NAVD88 in feet. HEC-RAS compiles a combined terrain file once the separate files are imported to the model.

3.2.2 Manning's n Development

The Manning's n-values used for these studies were developed using various published references accepted by the engineering community. For this study, SSCAFCA provided a Montoyas Arroyo hydrologic model calibrated to multiple historic storm events in the area and found to be reasonably accurate. A range of Manning's values were tested during the initial model creation as presented in Appendix A. The NLCD dataset was also reviewed against aerial imagery, and it was noted that the classification 'Developed, Open Space' was frequently documented for large open desert zones in the project area. Manning's values on the low end of the accepted range were found to align most reasonably with the calibrated Montoyas model. These values were used throughout the SSCAFCA jurisdictional area, as the Montoyas Arroyo Watershed contains the most significant amount of recorded data. Within HEC-RAS, the 2011 NLCD dataset was imported and n-values were assigned relative to the land cover types as shown in Table 5.

Table 5: Manning's n-value Summary for HEC-RAS Model Development

NLDC Land Cover Value	Description	Manning's n-value
11	Open Water	0.02
21	Developed, Open Space	0.02
22	Developed, Low Intensity	0.04
23	Developed, Medium Intensity	0.06
24	Developed, High Intensity	0.08
31	Barren Land	0.025
41	Deciduous Forest	0.06
42	Evergreen Forest	0.06
52	Shrub/Scrub	0.035
71	Herbaceous	0.025
81	Hay/Pasture	0.025
82	Cultivated Crops	0.04
90	Woody Wetlands	0.10
95	Emergent Herbaceous Wetlands	0.035

Following initial model runs, discussions with SSCAFCA led to the implementation of what are defined as 'override regions' in the hydraulic model. These are areas where the default n-value as assigned by the NLCD dataset is not desired. There are several small paved channels within the project area, most notably the Harvey Jones Channel located in the Montoyas Arroyo watershed. For these paved channels, an override region was placed on the hydraulic surface and the Manning's n-value was set to 0.02 regardless of the NLCD classification in the location. Paved channels were also accounted for in the Black Arroyo, Calabacillas Arroyo, and Venada Arroyo modeling.

3.2.3 Boundary Conditions

A normal depth boundary condition was placed on the 2D modeling surface at the outlet of each HEC-RAS model. A unique aspect of the BLE project is that most of the HEC-RAS models were developed with multiple 2D flow areas. These were delineated with the intent to maintain 2D flows across the modeled area and included 2D boundary connections at areas of expected flow. In some instances, there may be minor ponding along a 2D boundary. These areas were assumed to represent local drainage issues that are not relevant to the determination of FEMA flood hazard areas.

The majority of the watersheds in the SSCAFCA jurisdictional boundary drain to the Rio Grande (only the Zia watershed does not directly drain into the Rio Grande). The Rio Grande is not intended to be a focus of this BLE analysis; however, each model (except for the Black and Zia watersheds) includes a portion of the Rio Grande to help define backwater conditions. The March 18, 2008 FIS report for Sandoval County describes the efforts of the USACE to route a flood wave through the Rio Grande floodplain to determine discharges for the Village of Corrales. This 2008 analysis took flow readings from a gage in the Town of Bernalillo and removed regulated flows from the final discharges. Results from this study are reported in the effective FIS report and have been used as the initial conditions for this 2D BLE analysis. Table 6 below presents the peak flow routed through the Rio Grande during each respective modeled event.

Table 6: Rio Grande Flows Used to Simulate Potential Backwater

Annual Probability	Rio Grande Flow (cfs)
10%	4,000
4%	7,350
2%	11,850
1%	17,860
0.2%	37,900
1% Plus	17,860
1% Minus	17,860

3.2.4 Precipitation

As previously mentioned in Section 2.0, this study uses excess precipitation from HEC-HMS rainfall-runoff models as inflow for the HEC-RAS 2D analysis. HEC-DSSVUE was used within HEC-RAS to directly reference the incremental excess precipitation values. Area weighting of excess precipitation was completed within an individual spreadsheet for each watershed and is provided within a supplemental data folder. Sub-basins within each modeling area yield varying amounts of excess precipitation based on their characteristics. An area-based average was determined in each modeling area, where sub-basins with a larger area would be considered more representative of the appropriate excess precipitation than a smaller sub-basin.

For the models containing multiple flow areas, the sub-basins present in the HEC-HMS models provided by SSCAFCA were used to support grouping of sub-basins with similar hydrologic responses to modeled events. The maximum cumulative excess precipitation was reviewed in conjunction with the spatial location of each sub-basin to determine which sub-basins were appropriate to group together. Sub-basins were grouped together based on these variables, and excess precipitation values were then weighted based on sub-basin areas within each group. A representative hyetograph was selected from within each group, and the area-weighted runoff for the group was fit to the selected hyetograph and input to the hydraulic model. Figure 2 shows an example of this grouping from the Montoyas Arroyo watershed.

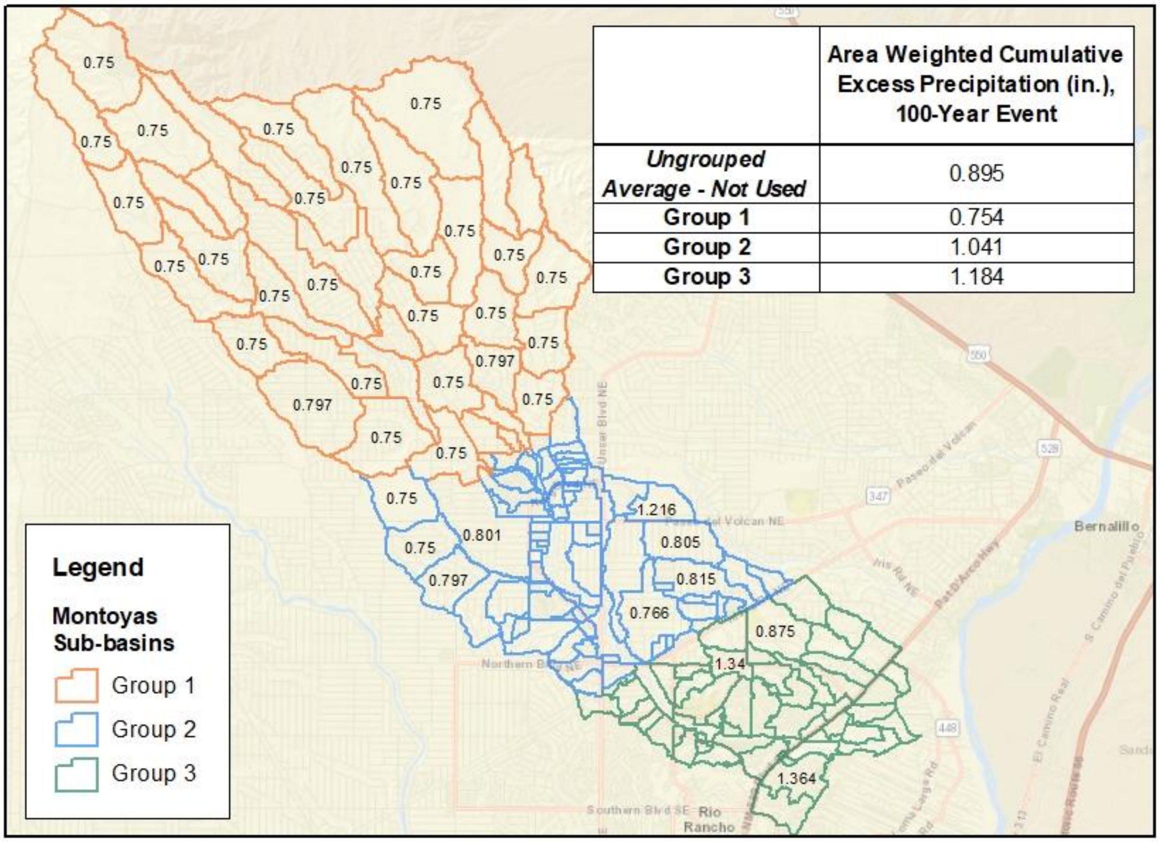

Figure 2: Montoyas 100-Year Cumulative Excess Precipitation (in.) and Hydrologic Sub-Basin Grouping

Multiple flow areas were utilized for the larger models: Calabacillas Arroyo, Montoyas Arroyo, La Barranca Arroyo, Venada Arroyo, and Zia. The Black Arroyo, Willow Creek, and Unnamed Arroyo watersheds were modeled using a single flow area.

3.2.5 Structures and Breaklines

No structures (i.e. dams, roadways, levees, etc.) were modeled in detail as a part of the BLE analysis. The project area contains many roadway crossings, concrete-lined channels, and dams/reservoirs throughout the watershed. Survey information is not readily available for these structures, and incorporating them is beyond the scope/intent of the BLE; therefore, structures were not directly incorporated into the models. Because the scope of a BLE analysis does not include modeling structures, one benefit to a 2D analysis for BLE is that it can inherently represent impacts from embankments and other features such as storage areas.

Breaklines were used in the HEC-RAS models to represent significant features impacting the conveyance of water through each watershed. This included minor unnamed dams, berms, raised roadways, boundaries of detention basins, and large facilities such as the Campus Dam located within the La Barranca Arroyo Watershed. Additionally, they were added along the following road classifications: Minor Arterial, Minor Collector, Principal Arterial, and Major Collector. Breaklines align adjacent cell faces along the desired feature to allow the model to account for any impacts of the topographic feature. They also ensure that the direction of flow is appropriate within these areas (perpendicular to an embankment). Figure 3 below shows how breaklines adjust the cell faces within the computational mesh.

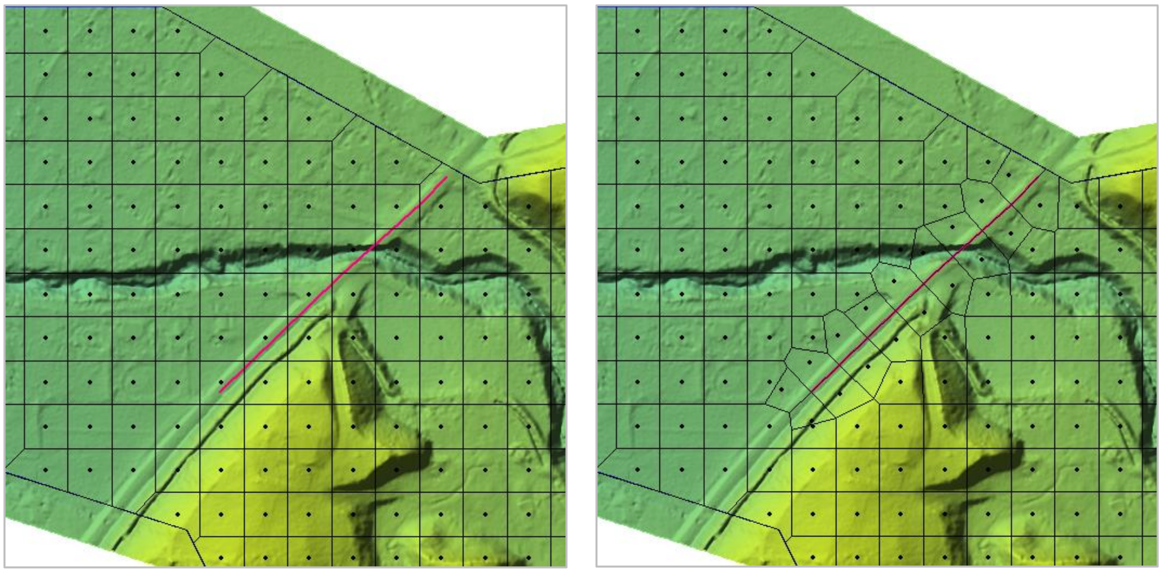

Figure 3: Breakline Cell Adjustment in HEC-RAS

Breaklines are typically placed at major stream crossings and along embankments of dams and reservoirs. For bridge crossings, the final DEM typically ignores bridge points and generally represents the channel shape through the bridge (as shown in Figure 3). In these instances, a breakline may be drawn straight along the roadway embankment.

An alternative approach is required to prevent the artificial ponding of flood water behind an embankment that clearly contains a structure. Figure 4 shows an area where the calculation mesh has been adjusted so that one cell can span the width of an embankment. This figure also includes a plot of the terrain profile across the embankment. The red lines shown on the figure are at the approximate locations of the cell faces bounding the structure. Calculations in HEC-RAS account for the terrain at each cell face, and the cell faces bounding the structure have approximate minimum elevations of 5,492 feet and 5,490 feet. Without the breakline adjustment to move the cell face from the crest of the roadway, the calculation at the upstream side of the structure would be based upon an elevation of approximately 5,501 feet. Water would be unable to cross the structure until this elevation was exceeded on the upstream side, potentially modeling an artificial ponding of water. This method of breakline adjustment is understood to be an overly simplistic attempt to represent structures without directly incorporating them into the HEC-RAS model. FEMA

Region VI has recommended this approach to enable better representation of community flooding risk in contrast to treating each roadway embankment like a dam that protects downstream areas from flooding. Figure 5 shows an example of this approach as applied at 17th Avenue in Rio Rancho near Canyon Park.

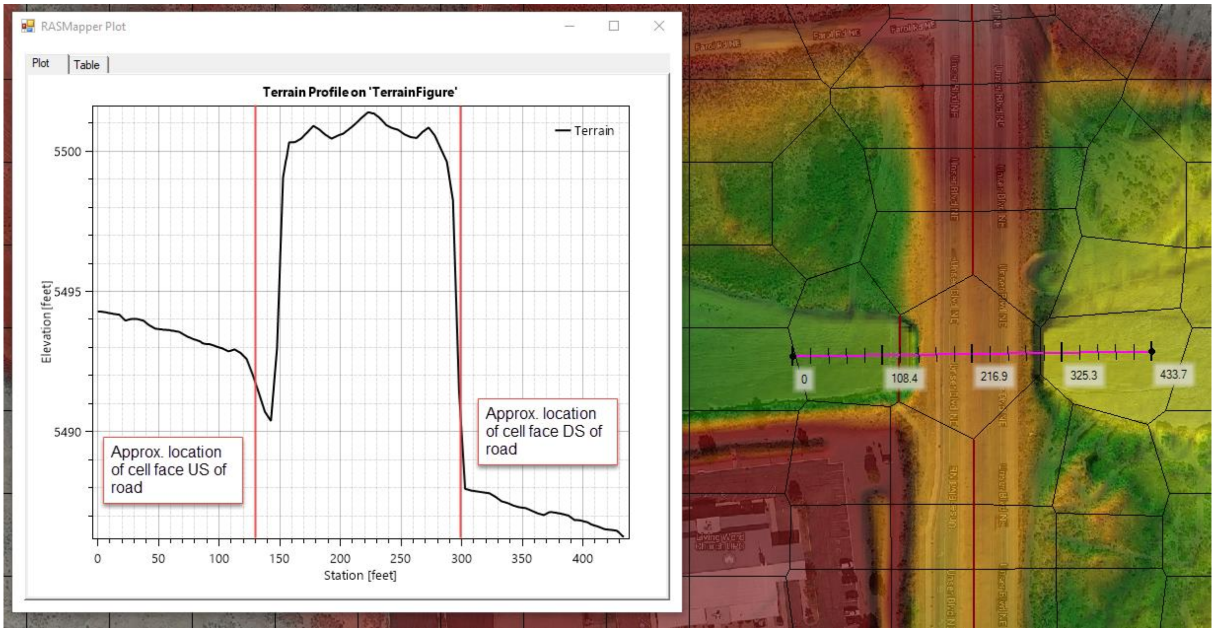

Figure 4: Offset Breakline and Terrain at Unser Blvd NE in Rio Rancho

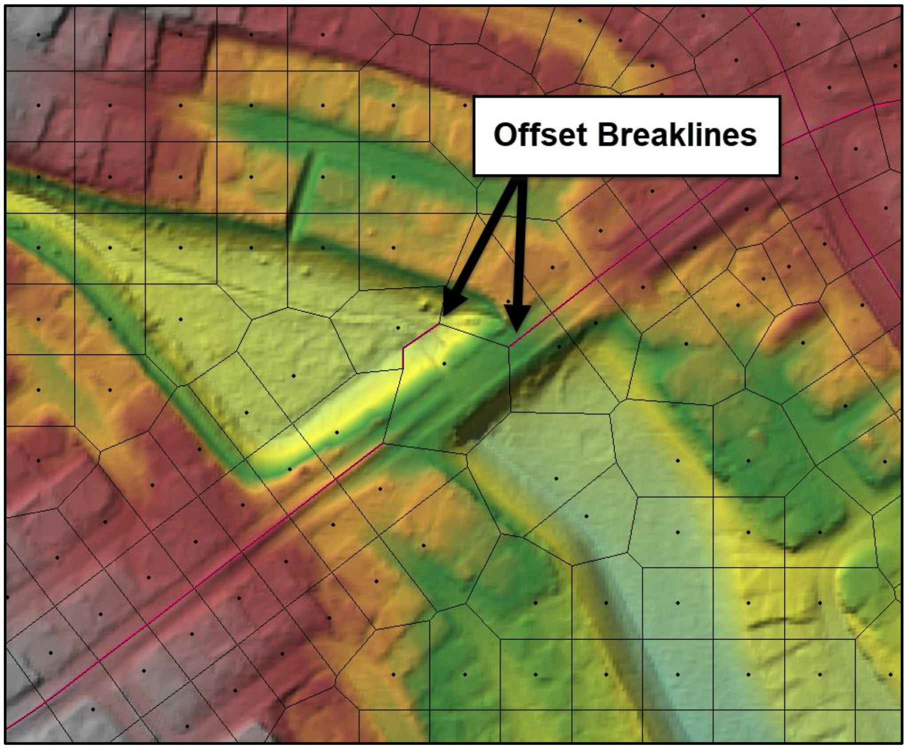

Figure 5: Offset Breakline Placement at 17th Avenue in Rio Rancho

3.2.6 Calculation Time Step

HEC-RAS 5.0.7 includes an option to run the model with a variable time step which adjusts the calculation time step based on whether a desired Courant Number is achieved. This option typically produces the most efficient model run times. The Courant number is calculated as follows:

$$C = \frac{V_w \Delta T}{\Delta X} \leq 1$$

where:

C = Courant Number
ΔT = Time step (seconds)
ΔX = Average cross section spacing (feet)
V_w = Wave speed (feet per second)

When developing a 2D model for a large flood event (such as the 100-yr flood), the maximum velocity expected is usually around 10 ft/s. Time step and grid spacing (ΔX) are variable with the grid spacing often fixed by the modeler. Therefore, it is up to the modeler to find a balance between time step and grid spacing to ensure appropriate model results.

3.3 MODELING RESULTS

3.3.1 Initial Results Review

Once a model was developed using the procedures highlighted in the previous sections, the model was run and model results were available for review using the tool RAS Mapper within HEC-RAS. Several initial checks were completed before finalizing the model run. First, the downstream boundary outflow curve was reviewed to ensure that the model ran long enough to capture the peak discharge throughout the study area. After the model run time was confirmed, the model results were then reviewed to ensure that model velocities were stable and model surging was not present.

3.3.2 Hydrologic and Hydraulic Model Comparison Summary

Each 2D hydraulic model was compared to the corresponding SSCAFCA HEC-HMS model to observe the differences in each approach and highlight future areas for model improvement. Table 7 below highlights these comparisons and hydrographs at select locations are provided in Figure 6, Figure 7, and Figure 8.

Table 7: HMS vs. RAS Comparisons for the 1% Annual-Chance Simulations

Watershed	HMS Element	HMS Peak Discharge, 1% Annual Chance (cfs)	RAS Connection	RAS Peak Discharge, 1% Annual Chance (cfs)	% Difference
Montoyas	L_104_J	1,479	L_104_J	1,218	-17.6
Montoyas	J_106_J3	3,405	J_106_J3	2,234	-34.4
Montoyas	A_106_J1	6,703	A_106_J1	4,301	-35.8
Montoyas	Sportsplex	6,259	Sportsplex	4,478	-24.1
Montoyas	HJC	6,415	HJC	2,916	-54.5
Black	Black Dam Outfall	3,045	Outlet	2,483	-18.5
Calabacillas	A_105_RAS	2,413	2dConnection7	1,583	-34.4
Calabacillas	A_100_J	5,191	A_110_J	2,626	-49.4
Calabacillas	A_103_J2	1,527	A_103_J2	1,068	-30.1
Venada	401A1-J	462	2dConnection11	735	+59.1
Venada	404-J	2,421	2dConnection7	2,130	-12.0
Venada	EH104-J	1,252	2dConnection8	758	-39.5
Zia	A_500_J1	5,994	A_500_J1	1,420	-76.3
Zia	A_500_J2	6,742	A_500_J2	1,755	-74.0

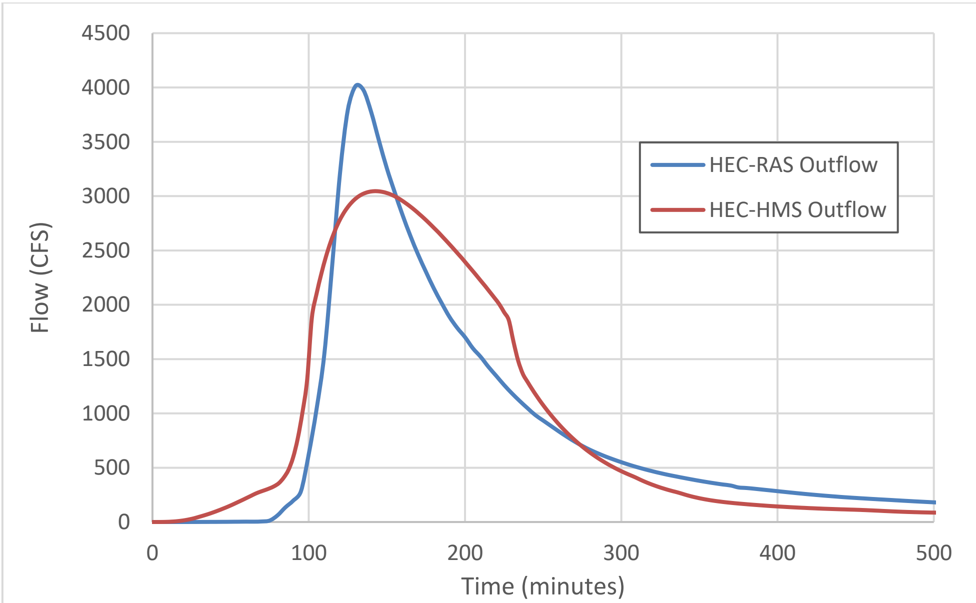

Figure 6: Black Arroyo Dam Outlet

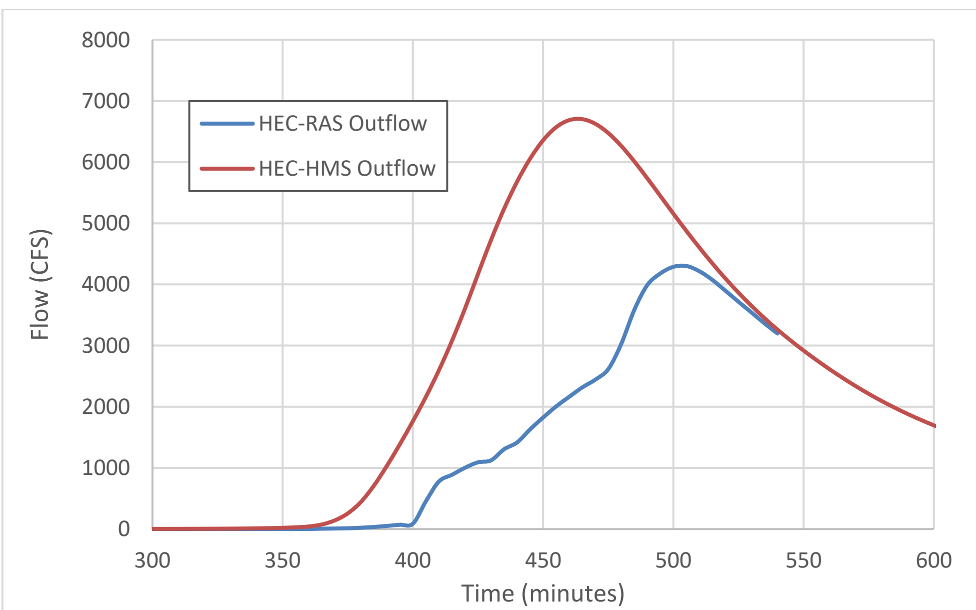

Figure 7: Montoyas Arroyo Junction A_106_J1

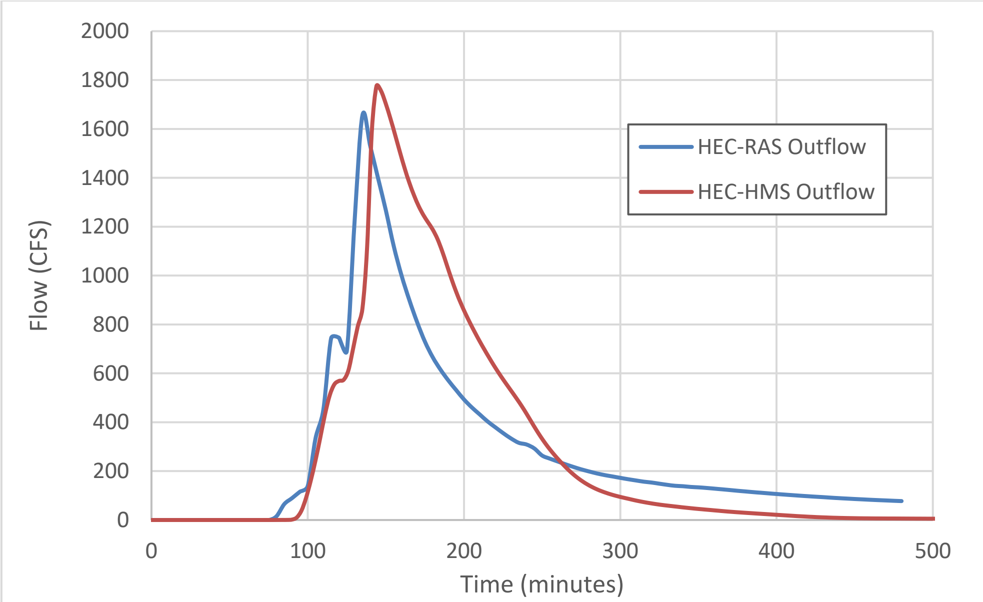

Figure 8: Venada Arroyo Junction 404-J

The differences in routing approaches used for a HEC-HMS rainfall-runoff model and 2D HEC-RAS analysis can create challenges when comparing flows. A rainfall-runoff model is unlikely to consider every storage area within a river basin and assumes each sub-basin completely drains to its outlet. Similarly, there are assumptions within the transform, loss, and routing methods that tend to present a more theoretical and idealistic view of flow within a watershed (fitting runoff to a predetermined curve). On the contrary, the HEC-RAS rain-on-grid hydraulic approach is able to account for every storage area within the watershed and its impact on the overall flow distribution throughout the watershed. However, a 2D hydraulic analysis over a large watershed is unlikely to support a fine mesh that captures every element of the terrain, and water sometimes artificially passes over embankments that would impact the travel of floodwaters. In the end, the modeler is left with adapting the model to best represent known storm events and results. As previously discussed in Section 3.1, SSCAFCA performed this type of model calibration for the Montoyas watershed and ESP attempts to best match these results guided the 2D BLE model development throughout the rest of the project area.

Large discrepancies such as those observed at the Harvey Jones Channel gage are not unexpected since structures and local survey information are not included in BLE model development. Similarly, the Zia watershed generated the greatest discrepancies between HEC-HMS and HEC-RAS discharges, and this is understood to be a result of the differences in routing approaches as described above. For a 2D analysis, overbank flow diversions may cause a significant flow reduction along major flow paths. These areas should receive additional attention during any future detailed studies. Some of these areas are highlighted in Section 5.3.

3.4 MODEL VALIDATION

As mentioned in Section 3.1, extensive model testing took place to compare the results of the Montoyas Arroyo 2D hydraulic model with the calibrated HEC-HMS rainfall-runoff model. A summary of this effort is provided in Appendix A. Results from this testing process influenced the model development for the rest of the project area.

Additionally, two steady state, 1D hydraulic models were developed for select reaches within the Zia watershed to compare their results with the 2D hydraulic model. The discharges used within these reaches were obtained from the Zia HEC-HMS model provided by SSCAFCA. As shown in Figure 9 and Figure 10, results compared reasonably well considering the differing methodologies for modeling and mapping along with the topographic relief in this area of the SSCAFCA district. These two additional models and their mapping are provided within the supplemental data.

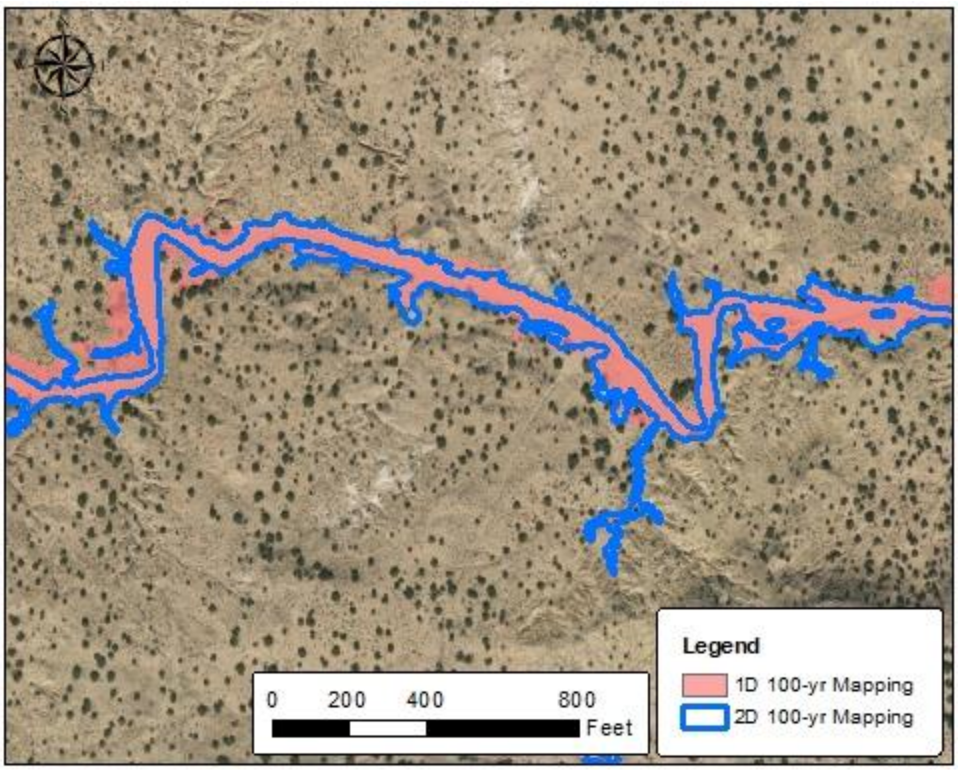

Figure 9: Zia Watershed 1D vs. 2D Mapping Comparison Within Santa Ana Pueblo

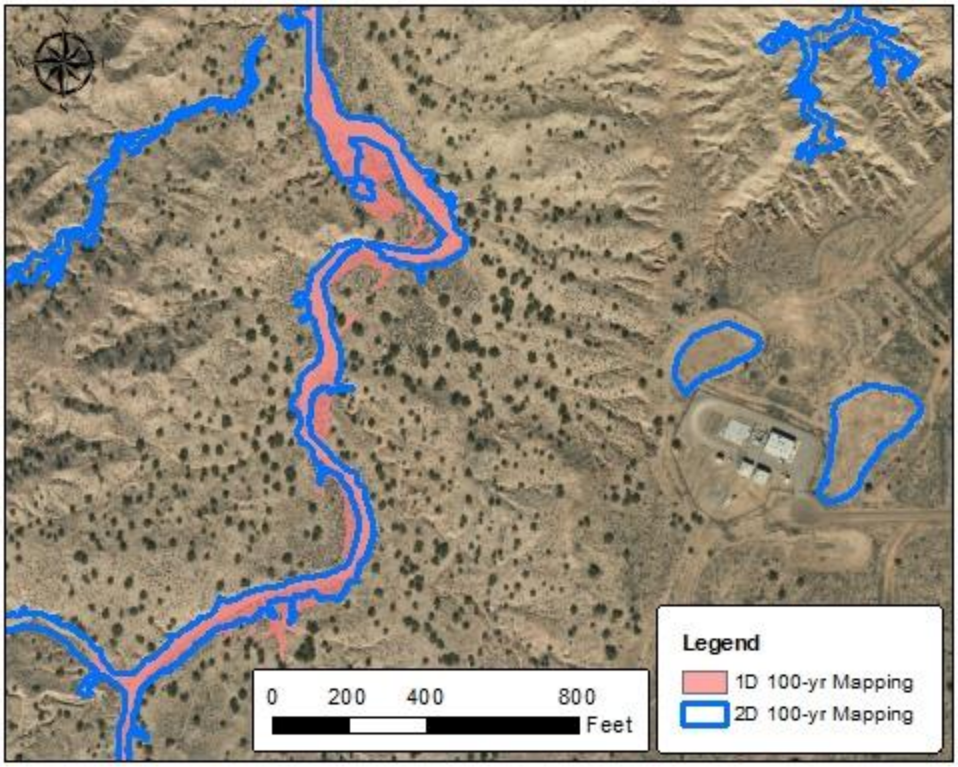

Figure 10: Zia Watershed 1D vs. 2D Mapping Comparison Near Hanley Road

4.0 RESULTS OVERVIEW

4.1 BLE DATABASE

A BLE database was compiled following the FEMA Region VI BLE Deliverable Guidance document dated April 2019. This database includes flood hazard areas for 10-, 1-, and 0.2-percent-annual-chance flood events, estimated base flood elevations, stream centerlines, and streamlines representing existing detailed study areas. The database also includes water surface elevation and depth grids as well as census blocks that include Hazus risk assessment information.

The following sections describe in further detail the datasets contained within the BLE database.

4.2 FLOODPLAIN MAPPING METHODOLOGY

Flood hazard mapping was generated using RAS Mapper within HEC-RAS 5.0.7. 2D modeling covers the entire study area, and therefore provides mapping for the entire study area where water is stored during the calculation time step. Assumptions have to be made during mapping for what constitutes a valid flood hazard area and what should not be included in the final results. In general, mapping connected to NHD lines or FEMA recognized stream lines was maintained. Outside of these areas, mapping was selected based off a limiting area and depth of flooding. Following an initial review of modeled results, a limiting depth of 0.5-ft of ponding and an area of 0.5-acre was selected to restrict mapping results. To provide a consistent product across the project area, manual editing of results was limited. Some areas along the Rio Grande with less than 0.5-ft flooding depth were retained to reduce model tie-in discrepancies.

4.3 FLOODPLAIN MAPPING RESULTS

It should be noted that BLE results are meant to provide updated information in areas that are currently approximate or unknown, such as Zone A or Zone D. The Rio Grande is included within the mapping results as the river was included in the modeling for backwater purposes. However, the majority of the river contains Zone AE effective mapping; therefore, the effective mapping will be retained as the best available data.

BLE mapping results vary in relation to existing mapping due to a different methodology (2D hydraulics) and the significant increase in detail from the QL2 LiDAR data that was collected by EDAC. Figure 11 shows areas near Zia Park in Rio Rancho along Montoyas Arroyo where the draft BLE floodplains are substantially different from the effective mapping, most notably downstream of King Boulevard where effective Zone A mapping is shifted out of the channel and instead overlaps several homes. Figure 12 shows an area within the Venada Arroyo watershed south of Mountain View Middle School in Rio Rancho. This area shows areas where draft BLE floodplains are substantially different than the effective mapping and also provides a look at the greater level of inundation information provided with 2D models as urban street flooding is displayed east of the school.

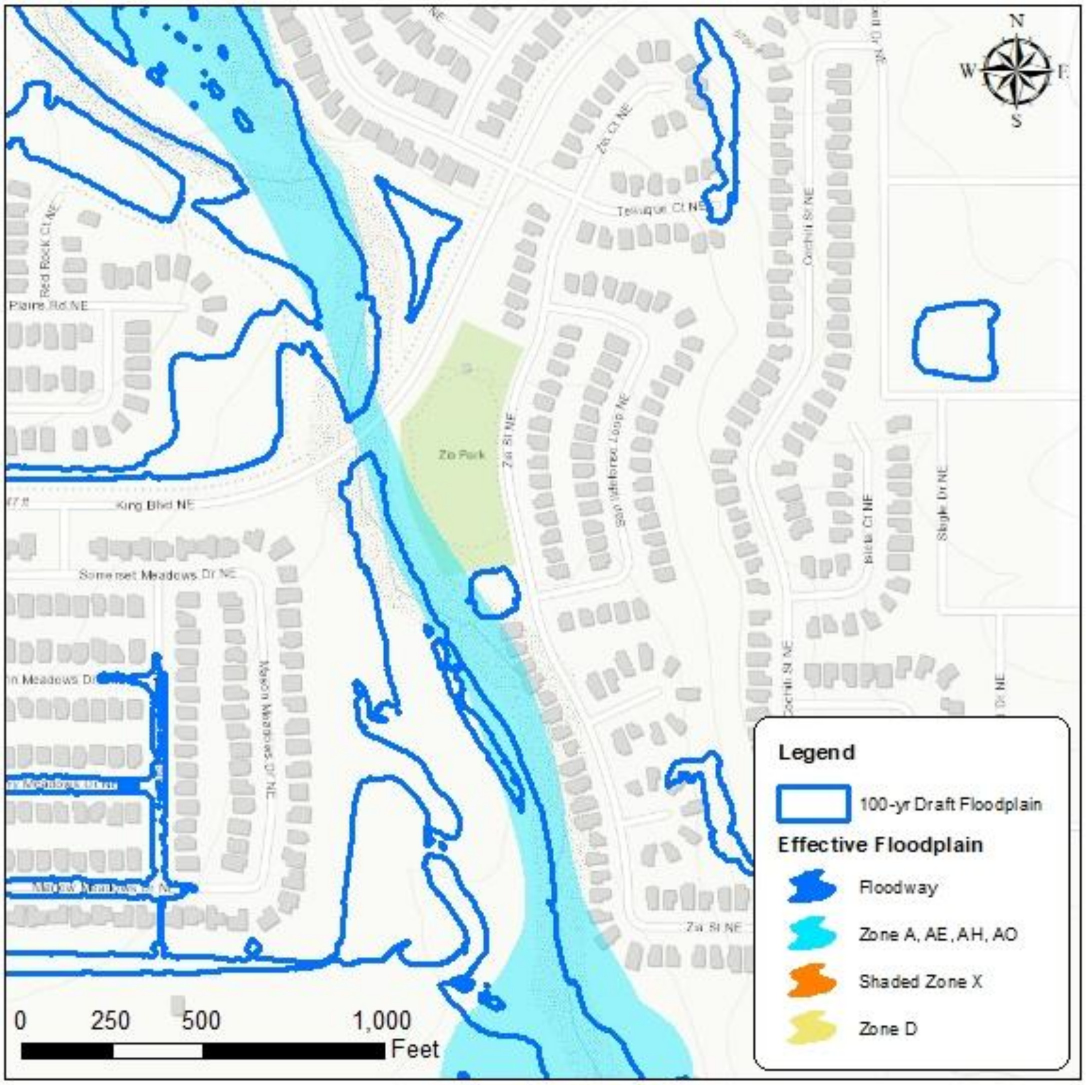

Figure 11: Effective Mapping Comparison Near Zia Park in Rio Rancho, NM

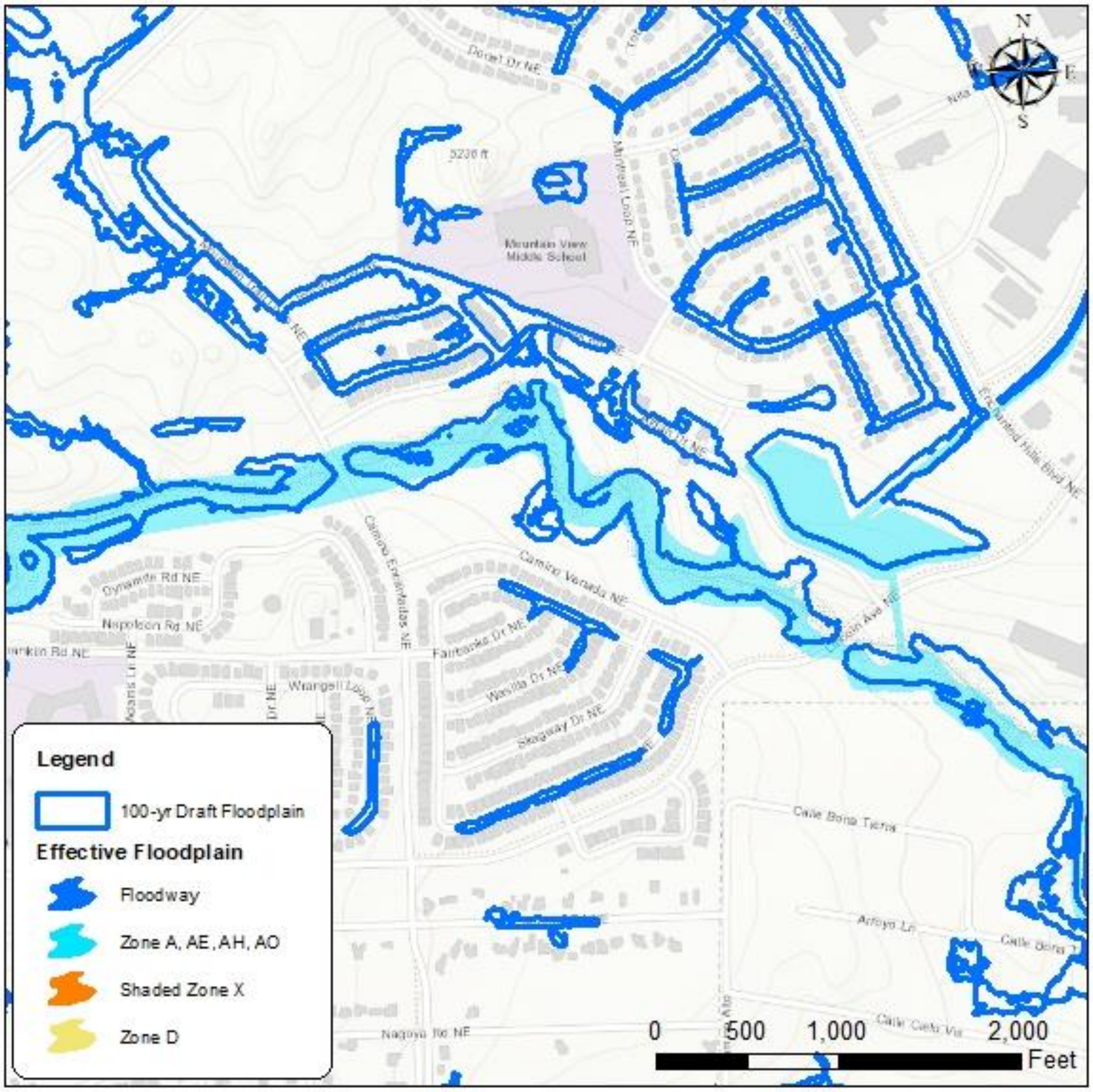

Figure 12: Effective Mapping Comparison South of Mountain View Middle School

4.4 CNMS VALIDATION

Coordinated Needs Management Strategy (CNMS) Validation was determined for the watershed based on the CNMS Database User's Guide dated February 2018 and FEMA Region VI Submittal Guidance – Base Level Engineering dated April 2019. Validation points were developed along the boundary of effective Zone A floodplains. These points compare best available terrain information and nearest 1-percent plus and minus WSELs against vertical and horizontal tolerances to determine whether the point passes or fails the validation.

Initially, CNMS validation points were grouped by their HUC-12 basin in order to determine pass/fail status. Based on an assumed Risk Class C, any HUC-12 containing at least 85% passing points was considered to pass validation and all streams within the HUC-12 deemed "VALID;" all other streams in failing HUC-12 basins were deemed "UNVERIFIED." This process did not produce any passing HUC-12 basins (represented in Figure 13 below); therefore, an alternative approach was taken that looks at individual stream reaches. Validation points were then assigned to the nearest features within the CNMS database to determine the validation status of each reach segment using the same requirement for percentage of passing points to obtain a "VALID" status. FEMA guidance also requires that at least 20 points be used to determine validation status. The results still reflected that all streams failed the validation process. It is expected that this is due to new topographic data which potentially represents updated flow paths (see Figure 11 for an example of these discrepancies). Additionally, the 2D hydraulic methodology is different than any existing methods and would contribute to differences in results.

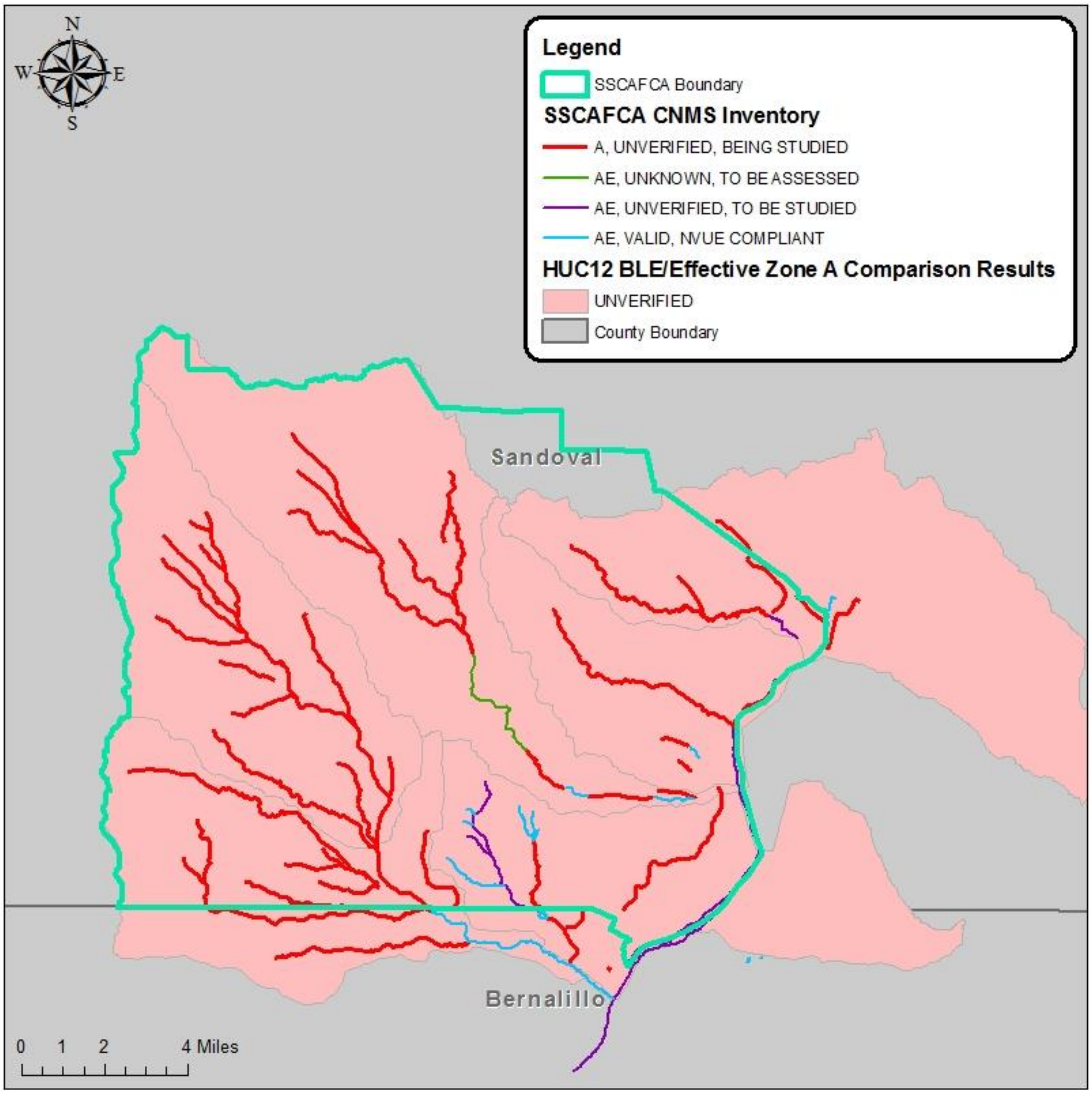

Figure 13: SSCAFCA CNMS Validation Summary

The SSCAFCA area contains 6 HUC-12 basins that also include Zone A flood hazard areas. These 6 HUC-12 basins contain approximately 127 miles of effective Zone A mapping that were checked for CNMS Validation. None of the streamlines were validated during this process; this validation is summarized in the 'S_Studies_Ln' feature class included in the associated BLE database.

4.5 HAZUS

A Hazus analysis was prepared using the 1- and 0.2-percent-annual-chance depth grids discussed in Section 2.1. Hazus version 4.0 was used to run the analysis. The Hazus output file (.hpr) has been exported and provided as part of this deliverable along with the census blocks used in the analysis. The loss analysis results are summarized for each community in the tables below. While this study is intended to cover the SSCAFCA jurisdictional area, there were a few areas studied outside of these limits in an effort to provide a complete analysis. Additionally, any communities not represented were determined to have no flooding impacts. It should be noted that the damages indicated in the tables below only represent those flood risks determined from this analysis and should not be considered wholly representative of the risk within each community.

Table 8: Loss Analysis Results for Bernalillo County

	Bernalillo County					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	**% of Total**	**Dollar Losses[1]**	**% of Total**	**Dollar Losses[1]**	**Loss Ratio[2]**
Residential Building and Contents Losses	$ 8,817,400,000	82%	$24,300,000	<1%	$51,000,000	1%
Commercial Building and Contents Losses	$1,158,000,000	11%	$4,700,000	<1%	$9,700,000	1%
Other Building and Contents Losses	$795,800,000	7%	$2,000,000	<1%	$4,000,000	1%
Total Building and Contents Losses[3]	$10,771,300,000	100%	$31,000,000	<1%	$64,700,000	1%
Business Disruption[4]	$0	N/A	$400,000	N/A	$800,000	N/A
TOTAL[5]	$10,771,300,000	N/A	$31,400,000	<1%	$65,600,000	1%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

Table 9: Loss Analysis Results for City of Albuquerque

	City of Albuquerque					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$66,392,600,000	75%	$17,400,000	<1%	$24,100,000	<1%
Commercial Building and Contents Losses	$16,470,400,000	19%	$7,300,000	<1%	$10,600,000	<1%
Other Building and Contents Losses	$6,145,800,000	7%	$1,100,000	<1%	$1,400,000	<1%
Total Building and Contents Losses[3]	$89,008,800,000	100%	$25,800,000	<1%	$36,100,000	<1%
Business Disruption[4]	$0	N/A	$500,000	N/A	$700,000	N/A
TOTAL[5]	$89,008,800,000	N/A	$26,300,000	<1%	$36,700,000	<1%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

Table 10: Loss Analysis Results for Sandoval County

	Sandoval County					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$1,278,600,000	84%	$700,000	<1%	$1,200,000	<1%
Commercial Building and Contents Losses	$147,700,000	10%	$30,000	<1%	$60,000	<1%
Other Building and Contents Losses	$90,700,000	6%	$10,000	<1%	$30,000	<1%
Total Building and Contents Losses[3]	$1,517,000,000	100%	$700,000	<1%	$1,200,000	<1%
Business Disruption[4]	$0	N/A	$0	N/A	$0	N/A
TOTAL[5]	$1,517,000,000	N/A	$700,000	<1%	$1,300,000	<1%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

Table 11: Loss Analysis Results for Town of Bernalillo

	Town of Bernalillo					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$488,800,000	79%	$6,700,000	1%	$14,500,000	3%
Commercial Building and Contents Losses	$92,600,000	15%	$100,000	<1%	$500,000	1%
Other Building and Contents Losses	$39,700,000	6%	$40,000	<1%	$500,000	1%
Total Building and Contents Losses[3]	$621,100,000	100%	$6,800,000	1%	$15,500,000	2%
Business Disruption[4]	$0	N/A	$40,000	N/A	$100,000	N/A
TOTAL[5]	$621,100,000	N/A	$6,900,000	1%	$15,600,000	3%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

Table 12: Loss Analysis Results for Pueblo of Sandia

	Pueblo of Sandia					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$29,600,000	63%	$2,700,000	9%	$4,200,000	14%
Commercial Building and Contents Losses	$15,600,000	33%	$100,000	1%	$200,000	1%
Other Building and Contents Losses	$1,700,000	4%	$20,000	1%	$30,000	2%
Total Building and Contents Losses[3]	$47,000,000	100%	$2,900,000	6%	$4,400,000	9%
Business Disruption[4]	$0	N/A	$10,000	N/A	$10,000	N/A
TOTAL[5]	$47,000,000	N/A	$2,900,000	6%	$4,400,000	9%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

Table 13: Loss Analysis Results for Village of Corrales

	Village of Corrales					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$1,483,200,000	85%	$46,200,000	3%	$88,800,000	6%
Commercial Building and Contents Losses	$179,400,000	10%	$5,200,000	3%	$12,500,000	7%
Other Building and Contents Losses	$83,500,000	5%	$2,300,000	3%	$5,300,000	6%
Total Building and Contents Losses[3]	$1,746,100,000	100%	$53,600,000	3%	$106,600,000	6%
Business Disruption[4]	$0	N/A	$400,000	N/A	$800,000	N/A
TOTAL[5]	$1,746,100,000	N/A	$54,000,000	3%	$107,400,000	6%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

Table 14: Loss Analysis Results for Village of Los Ranchos de Albuquerque

	Village of Los Ranchos de Albuquerque					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$846,000,000	77%	$1,700,000	<1%	$4,000,000	<1%
Commercial Building and Contents Losses	$194,500,000	18%	$90,000	<1%	$300,000	<1%
Other Building and Contents Losses	$62,700,000	6%	$40,000	<1%	$200,000	<1%
Total Building and Contents Losses[3]	$1,103,300,000	100%	$1,900,000	<1%	$4,600,000	<1%
Business Disruption[4]	$0	N/A	$10,000	N/A	$40,000	N/A
TOTAL[5]	$1,103,300,000	N/A	$1,900,000	<1%	$4,600,000	<1%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

Table 15: Loss Analysis Results for City of Rio Rancho

	City of Rio Rancho					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$11,295,900,000	90%	$36,400,000	<1%	$46,400,000	<1%
Commercial Building and Contents Losses	$938,200,000	7%	$1,700,000	<1%	$2,500,000	<1%
Other Building and Contents Losses	$380,900,000	3%	$800,000	<1%	$1,400,000	<1%
Total Building and Contents Losses[3]	$12,615,000,000	100%	$38,900,000	<1%	$50,300,000	<1%
Business Disruption[4]	$0	N/A	$200,000	N/A	$300,000	N/A
TOTAL[5]	$12,615,000,000	N/A	$39,100,000	<1%	$50,600,000	<1%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

Table 16: Loss Analysis Results for Sandia Indian Reservation

	San Felipe Indian Reservation					
	Total Inventory		1% (100-yr)		0.2% (500-yr)	
	Estimated Value	% of Total	Dollar Losses[1]	% of Total	Dollar Losses[1]	Loss Ratio[2]
Residential Building and Contents Losses	$393,000,000	80%	$6,200,000	2%	$23,300,000	6%
Commercial Building and Contents Losses	$46,000,000	9%	$90,000	<1%	$400,000	<1%
Other Building and Contents Losses	$53,700,000	11%	$200,000	<1%	$600,000	1%
Total Building and Contents Losses[3]	$492,800,000	100%	$6,500,000	1%	$24,300,000	5%
Business Disruption[4]	$0	N/A	$50,000	N/A	$100,000	N/A
TOTAL[5]	$492,800,000	N/A	$6,500,000	1%	$24,500,000	5%

Source: Hazus analysis results stored as the Flood Risk Assessment Dataset in the Flood Risk Database.
In the event losses decrease for lower exceedance probabilities, losses were maintained from the higher percent-annual-chance event.
[1]Losses shown are rounded to nearest $10,000 for values under $100,000 and to the nearest $100,000 for values over $100,000.
[2]Loss ratio = Dollar Losses ÷ Estimated Value. Loss Ratios are rounded to the nearest integer percent.
[3]Total Building and Contents Losses = Residential Building and Contents Losses + Commercial Building and Contents Losses + Other Building and Contents Losses.
[4]Total Loss = Total Building and Contents + Business Disruption

5.0 CONCLUSIONS

5.1 PROJECT SUMMARY

ESP developed hydrologic and hydraulic analyses for over 180 square miles of 2D, BLE riverine modeling and mapping within portions of Sandoval County and Bernalillo County, New Mexico. This work received an external review, independent of the production team, before a final review from FEMA Region VI. Documentation associated with these reviews are included in Appendix B.

BLE studies include a cursory modeling effort that provides communities with floodplains in previously unmapped areas and the opportunity for point-and-click estBFEs using the WSEL raster products. One goal of the BLE process is to produce models that can be refined by communities and later adopted as detailed studies. This BLE study should not be considered for advancement as a regulatory product until it is thoroughly reviewed by the impacted communities.

All new Risk Mapping, Assessment, and Planning (MAP) watersheds to undergo discovery will require BLE on all flooding sources within the watershed to identify areas with potential flooding changes from the effective flood mapping as well as communicate flood risk in previously unmapped areas. Section 4.3 discusses some of the areas of potential flooding changes identified by this BLE analysis.

Since BLE studies present a valid Zone A elevation, they can be used for permitting requirements, insurance rating, and Letter of Map Amendments (LOMAs). Community floodplain managers interested in using this information should visit www.riskmap6.com for more information.

All hydraulic calculations and modeling meet FEMA Region VI BLE guidance specifications. A complete set of spatial files and model input and output files, where applicable, were developed and provided in accordance with the FEMA Region VI Submittal Guidance – Base Level Engineering (April 2019). This data is available on FEMA's estBFE viewer (https://webapps.usgs.gov/infrm/estBFE/) in support of FEMA's Risk MAP program.

5.2 AREAS OF INTEREST

Areas of Mitigation Interest (AOMI) have been identified during this study process and are included in the BLE database as a point feature class. These areas represent structures and other hindrances to flow where survey and incorporation into the 2D hydraulic models would increase the accuracy of model results. Additionally, these points may represent areas where local survey information may refine results affected by issues with terrain data.

5.3 MODEL REFINEMENT SUGGESTIONS

A more detailed 2D approach should be applied within urban areas to ensure that all structures are properly accounted for within the 2D modeling. In addition, the inability to duplicate the calibrated HEC-HMS model discharges, flow volumes, and flow timing within the Montoyas Arroyo watershed reveals that a more detailed approach may be needed which falls outside of the scope of a BLE analysis. Focusing the 2D approach to smaller areas that can be well represented by hydrographs from the calibrated HEC-HMS model is one alternative that would eliminate any concern over mismatched results.

For any future studies, additional attention should be given to the area upstream of the Harvey Jones Channel gage near Corrales, NM. In discussion with SSCAFCA, it was mentioned that this channel was designed to carry the 1% annual-chance event. The 2D BLE analysis does not include structures or any survey data apart from the QL2 LiDAR. Flooding was not contained within the Harvey Jones Channel during the 2D analysis despite several different model adjustments as described in Figure 14. Spillover flooding for the 1% annual-chance event is generally limited to 1-ft of flooding depth. A future analysis should include local information and survey to ensure the channel is appropriately represented and all embankments are captured by the 2D grid.

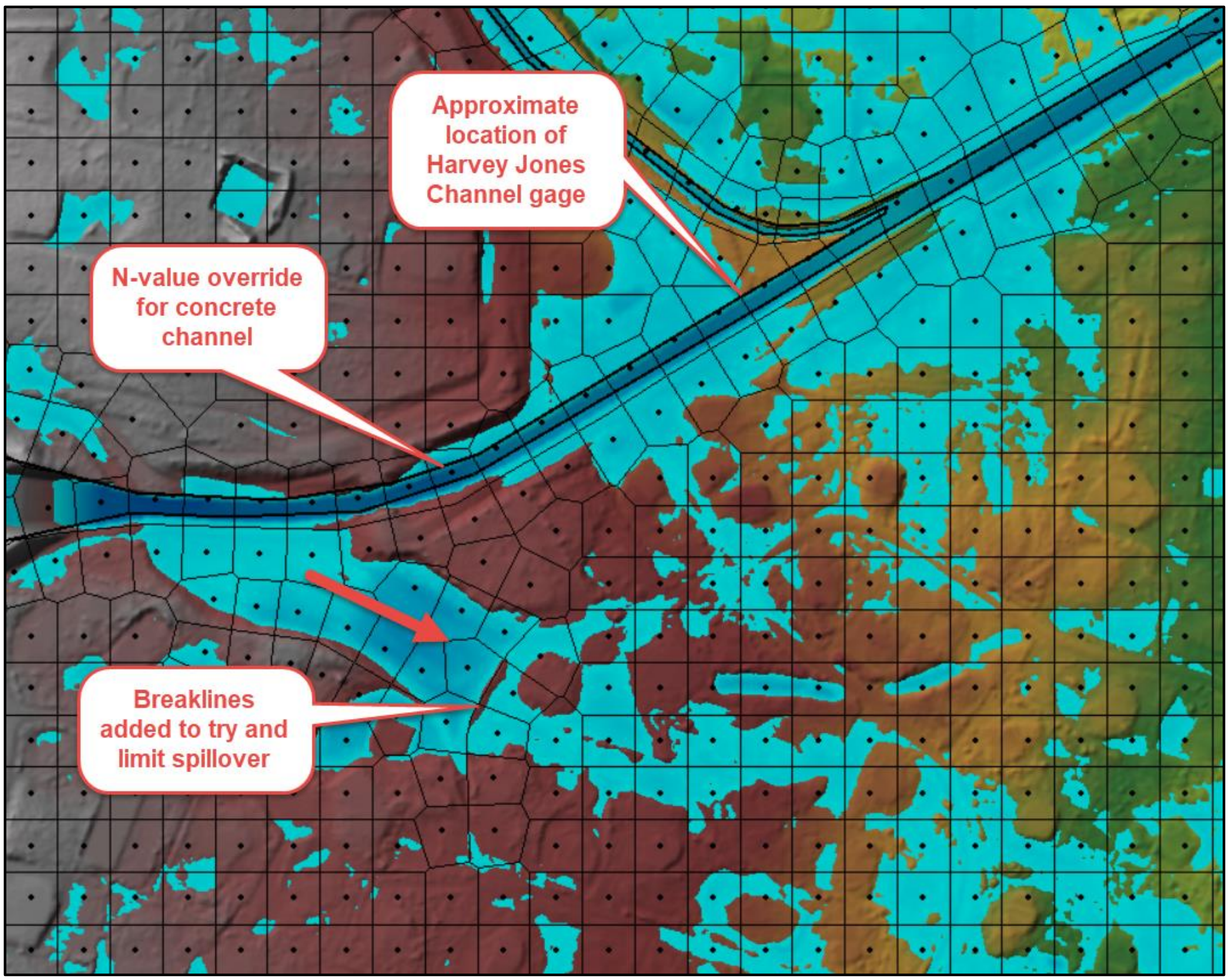

Figure 14: Harvey Jones Channel Spillover Description

Several potential areas of improvement have been identified where the BLE hydraulic models may be refined and updated into detailed studies. See Table 17 below for suggestions of potential updates.

Table 17: Model Refinement

Model Name	Data Requirements
All Models	Addition of breaklines and survey data to reflect structures within the floodplain or better define flow paths. If an analysis of the Rio Grande is desired, modeling the levees, determining upstream overbank flow, and incorporating breaklines and structures would be necessary in properly reflecting the available conveyance areas. Recommend acquiring local gages to monitor flooding and allow for calibration of additional models using corresponding rain and streamflow gages at particular areas of interest following significant storm events. Communities may decide to revise the hydrology to reflect regional specific characteristics. For a future, detailed analysis, it would be beneficial to focus the analysis on a particular area which would allow for smaller cell sizes.
Black	Model covers highly urban area. Effects of local drainage systems should be considered for any analysis within this model. Additionally, there are several ponds and other collectors (including the outlet of the model) that could use survey data and additional breaklines within the model to ensure storage capacities are reflected and drainage areas are directed at each location.
Calabacillas	Headwaters of basin are undeveloped. Future studies for this area could determine a flow from these undeveloped areas using gage information which could be input upstream of developed areas. This would allow for a finer resolution grid, more focused analysis, and shorter run times.
Montoyas	As discussed within this report, comparison with HEC-RAS and the SSCAFCA calibrated HEC-HMS model could be improved by the implementation of surveyed structure and channel information as well as more refined focus areas of study. Through developed areas, the level of mapping provided should be determined through clear communication with locals who can provide a thorough understanding of local drainage.

6.0 CORRESPONDENCE

EDAC and ESP held bi-weekly calls throughout the course of the project and meeting minutes from those calls have been documented and saved in Appendix C. Monthly calls were held that included SSCAFCA and those meeting minutes are included in Appendix C as well. Appendix C also includes items from the community stakeholder meetings. Community stakeholder meetings were held September 18, 2019 in Rio Rancho, NM.

7.0 REFERENCES

Federal Emergency Management Agency, Coordinated Needs Management Strategy (CNMS) Technical Reference, *CNMS Database User's Guide*. Washington, DC, November, 2016.

Federal Emergency Management Agency, *Flood Insurance Study, Sandoval County, New Mexico and Incorporated Areas.* Washington, DC, March 18, 2008.

Federal Emergency Management Agency, *Region 6 Base Level Engineering Submittal Guidance*. Denton, TX, April 2019.

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354

"Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 5.0, G. M. Bonnin, D. Marting, B. Lin, T. Parzybok, M. Yekta, and D. Riley, NOAA, National Weather Service, Silver Spring, Maryland, 2011.

APPENDIX A
Model Testing Summary

This report summarizes the testing completed by ESP Associates to determine an approach for developing 2-D HEC-RAS models that fulfill the requirements of FEMA's Base Level Engineering efforts, best represent existing SSCAFCA HEC-HMS model discharges, and maintain the ability to be easily updated for future model revisions by local communities. A test model and associated spreadsheets have been included with this report to document the approach. Five, separate locations throughout the watershed (highlighted in Figure 1 below) have been selected to compare peak discharges and volumes calculated by HEC-HMS and HEC-RAS.

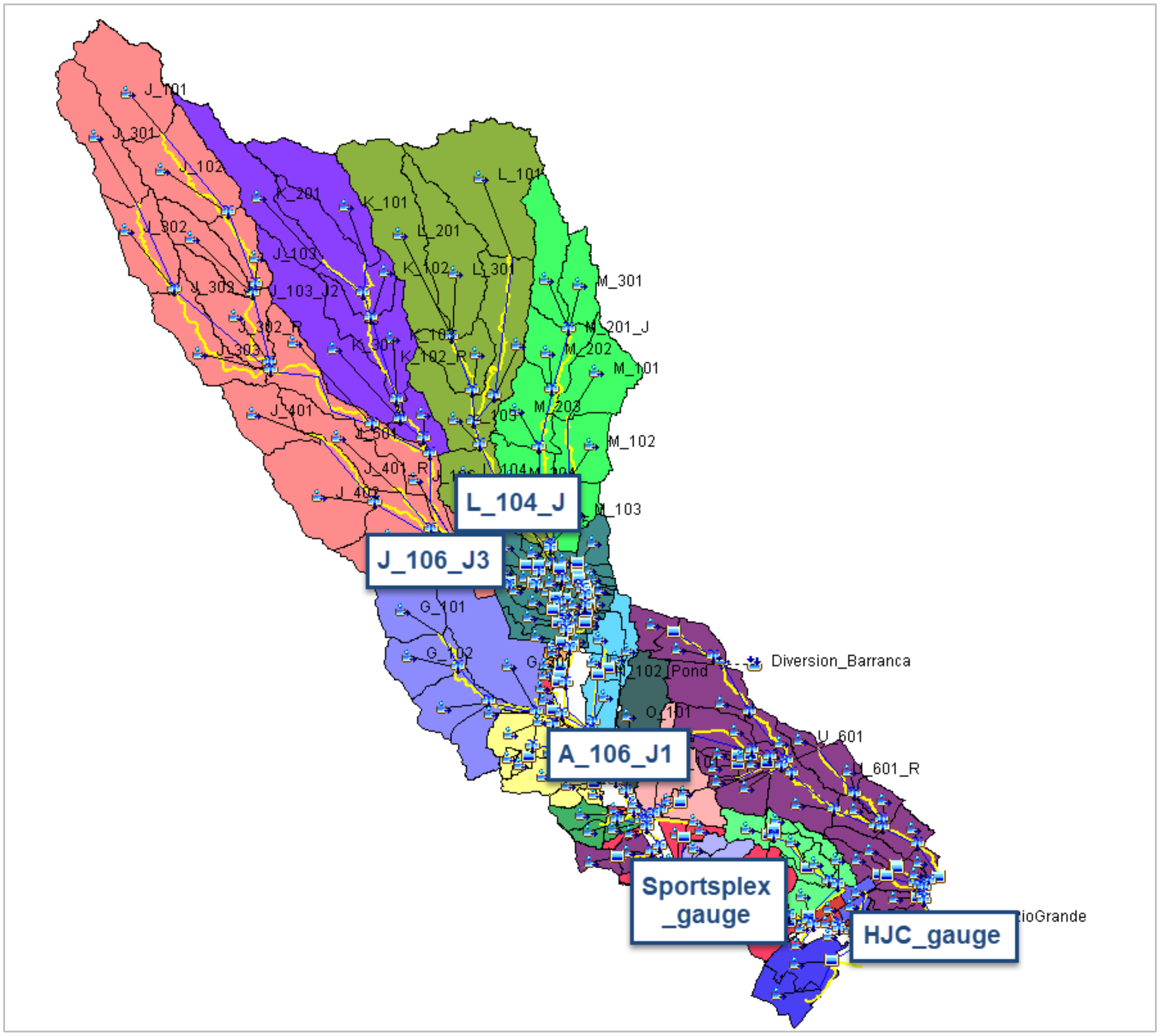

Figure 1: Map of Five Comparison Locations Between HEC-HMS and HEC-RAS

The following charts show a comparison of the different tests and their comparison to HMS results for flow and volume. The blue line represents the 100-yr discharges from HMS at each of the 5 comparison locations. The bars represent 100-yr discharges from the 2-D RAS model. Comparing blue to gray shows the slight difference when the developed space n-value is lowered. Blue to orange shows the flow increase when decreasing nominal cell spacing (200-ft to 150-ft), and tan shows the increase from orange when using developed space n-value adjustments and further decreasing nominal cell spacing (150-ft to 100-ft). The red dots show the variation (percentage-wise) between the tan value and the HMS target value.

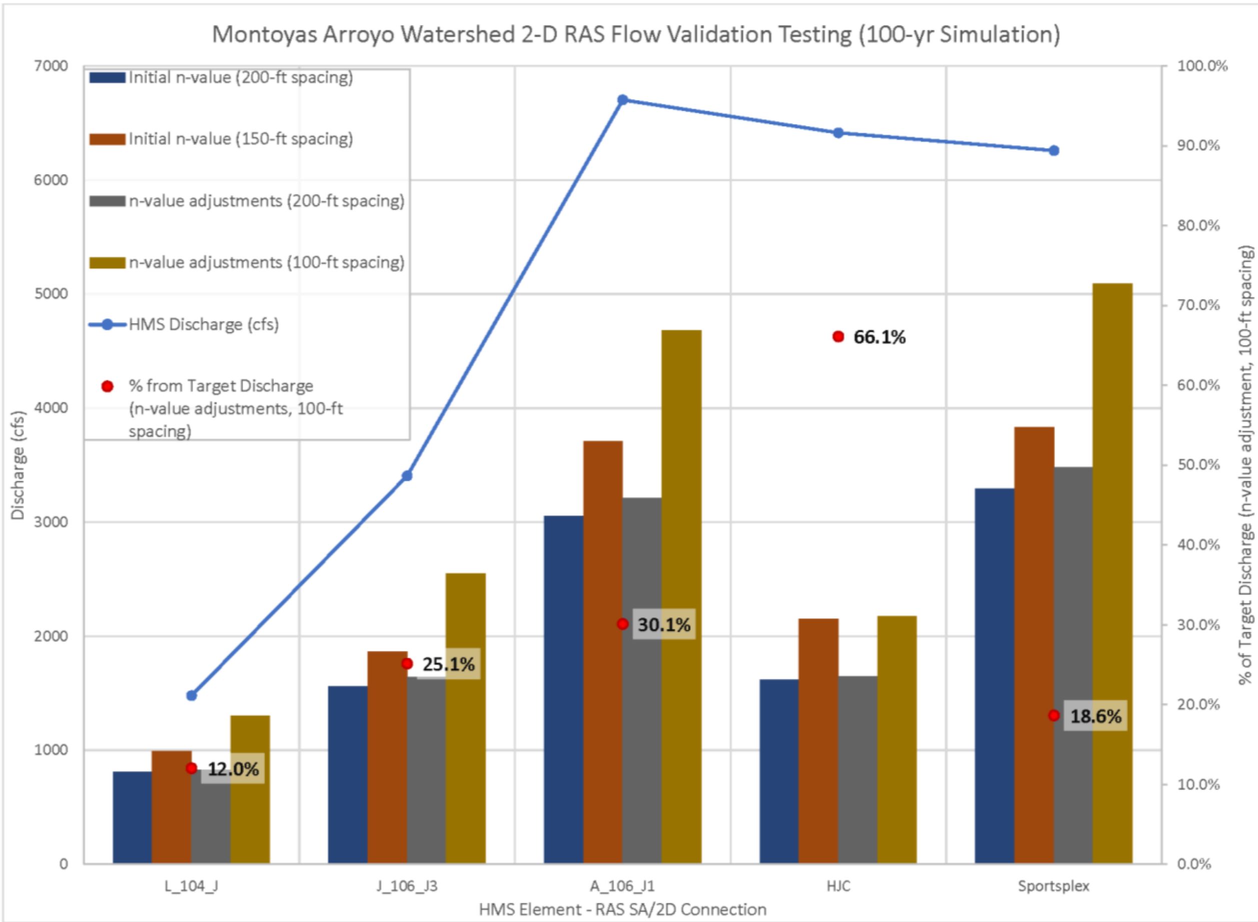

Figure 2: Flow Comparison Between HEC-HMS and HEC-RAS 2-D

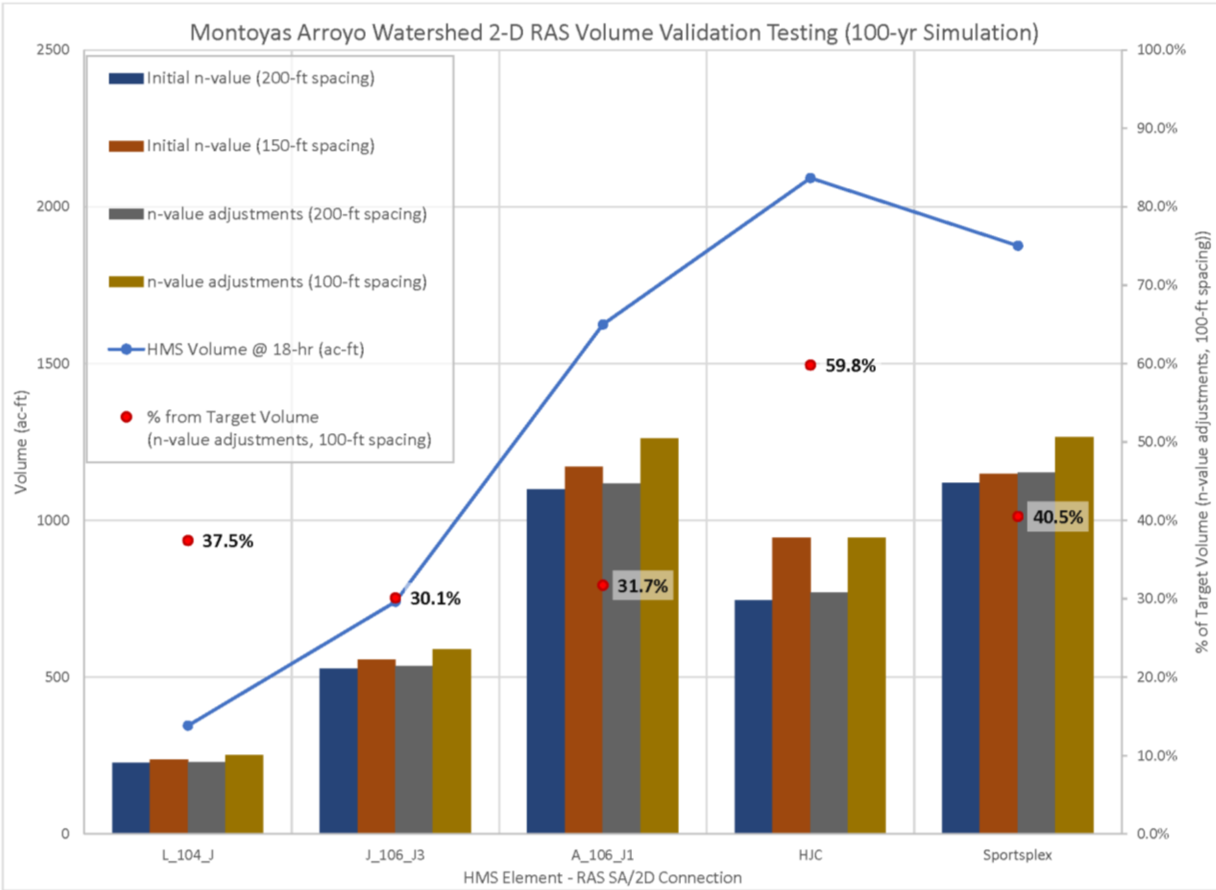

Figure 3: Volume Comparison Between HEC-HMS and HEC-RAS 2-D

From this testing, and from what we have seen when comparing other HEC-HMS models (e.g. the Zia Watershed), taking excess rainfall and applying it to a 2-D model grid for hydraulics does not always result in similar discharges. This is because of the routing that occurs at each cell in the 2-D hydraulic model which is not occurring in a HEC-HMS model and has a significant impact on travel times throughout the basin. This impact on travel times means that contributing hydrographs may have different peak timing in a 2-D hydraulic model which produces different peak flows than the HEC-HMS model (shown in the figures below of the same location in HEC-HMS compared to HEC-RAS). One example is demonstrated within the red box shown in Figure 5 highlighting part of the simulation where HEC-HMS and HEC-RAS hydrographs differ, likely the result of different timing of upstream flooding sources.

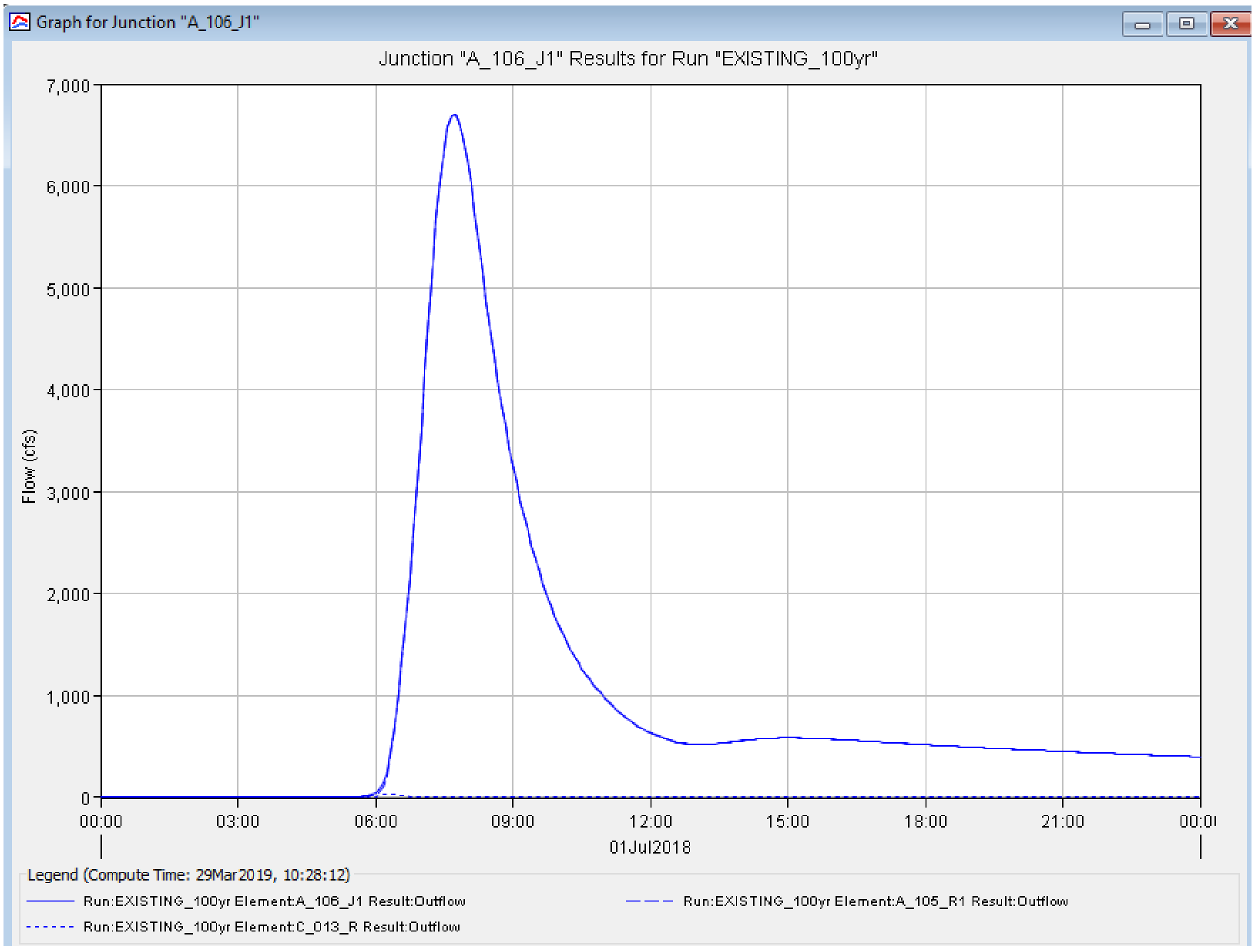

Figure 4: Hydrograph for HMS Junction A_106_J1

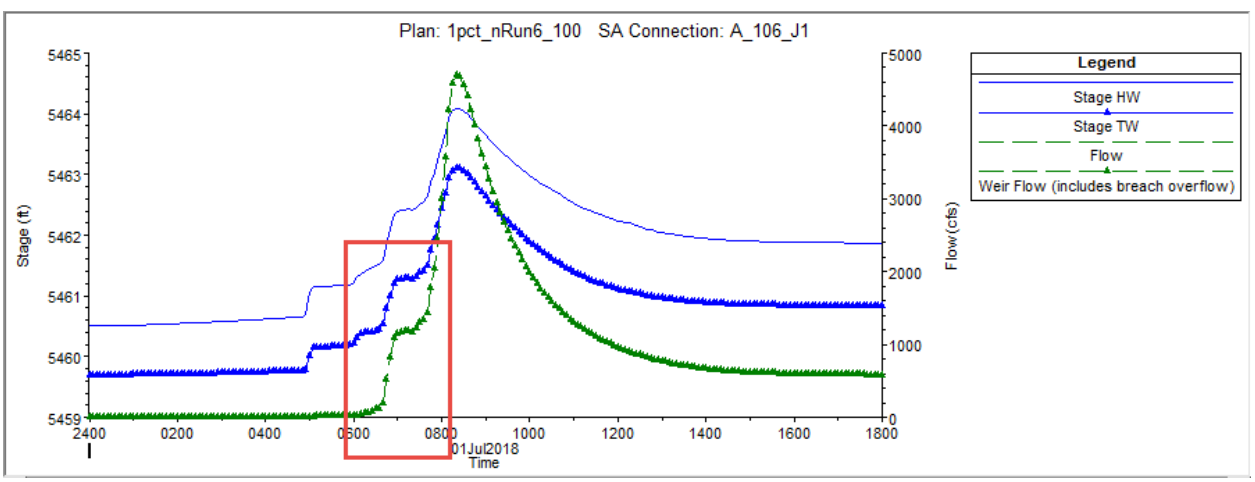

Figure 5: HMS Junction A_106_J1 Corresponding HEC-RAS Hydrograph

It is our conclusion that these areas will be too challenging to validate for a BLE effort, especially when they involve structures that are not being included within the BLE model. The location with the biggest discrepancy is the Harvey Jones Channel gage. A big reason for this may be the area upstream of the gage where our model shows water spilling out towards the south and bypassing the channel (figure below). The 2-D grid we are using attempts to limit this overflow, but this area could likely be revised with local information and survey. Similarly, it is difficult to compare with the gage readings at locations such as the Harvey Jones Channel and the Sportsplex pond because the structures are influencing gage readings but are not being represented in the model.

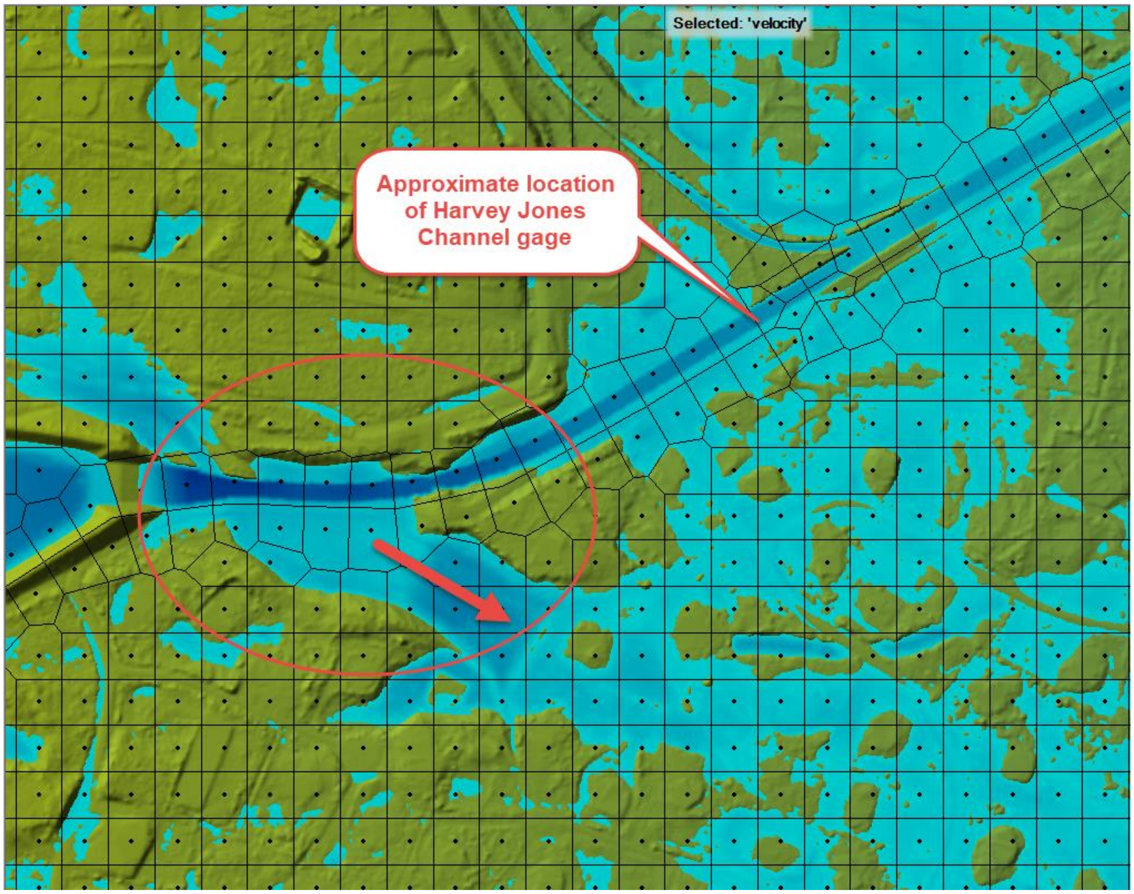

Figure 6: 2-D Flow Patterns Upstream of the Harvey Jones Channel Gage near Corrales, NM

Planned Approach

Considering our testing and assumptions, our planned approach for all of the watersheds is to split the larger watersheds into multiple 2-D flow areas and model at 100-ft cell spacing. 100-ft spacing seems to make a significant difference in discharges compared to 200-ft spacing in the Montoyas model, and it still provides somewhat reasonable run times (around 2 hours for the entire model). By splitting the model into several 2-D flow areas, we will allow future users the ability to break the model up quickly and focus on particular areas of interest by sourcing in additional flows as needed. By using the smaller 2-D flow areas to focus on an area of interest, future users will also significantly shorten the model run time. Additionally, future users can make unique adjustments to each 2-D flow area for calibration. If general adjustments are made to an entire watershed in an effort to match a downstream peak flow, this could cause a large discrepancy upstream where the changes may have a greater impact.

APPENDIX B
Quality Assurance / Quality Control

QC Hydrologic Analysis

Project Name	*SSCAFCA BLE*	**Date**	*3/28/2019*
Reviewer(s)	*Katie Betz, PE, CFM*		
Comments (this section not to be used for QC calls)			

Review Item	Yes No N/A	Reviewer Comment(s)	Originator Disposition *	Originator Response	Reviewer Verification (initials)
General					
Correct existing model used	Yes				
Appropriate rainfall values selected from NOAA Atlas 14	No	Verify that appropriate confidence intervals were used for 100+/- calculations - Atlas 14 depth for 100yr event does not match 100yr depth used in HMS, however, Atlas 14 confidence intervals were used in determining +/- flows for the following basins: Black, Calabacillas, UA, and WC For flows other than 100+/- in Montoyas amd Zia Watersheds, use Atlas 14 depths for the associated durations instead of percentages currently used For Zia Watershed, only the 100yr flow matches the Atlas 14 values shown in the spreadsheet. Please verify and update as appropriate	C	For Black, Calabacillas, UA, and WC an Atlas 14 point could not be found to match the HMS 100yr depth within the respective model basins so a point was used that most closely matched the HMS depth. The confidence intervals were used to determine a standard deviation that was applied to the HMS depth to calculate the +/- depths. Even if other confidence intervals that more closely match the 100yr HMS were used (eg 100yr-48hr or 200yr-24hr)the standard diviation would only vary slightly, therefore the 100yr-24hr interval was deemed appropriate. Montoyas and Zia rainfall accumulation and models have been updated.	KB

Rainfall accumulation spreadsheet calculations and references verified	No	In HMS, seems like 100- values for Barranca should get to 1.95 in 24 hours, but it seems that 2.68 value is reached within that time frame. Please verify and also verify that 1.95 should not be carried through days 2-4 as is done for other return periods	D	Discussed with Reviewer, ignoring comment	KB
HMS Results spreadsheet calculations, references, and results verified	Yes	Please update results spreadsheets once changes are made	C	Montoyas and Zia Updated	KB
Additional comments					
*** Disposition Codes**	**C = Will Comply; D = Delete Comment; N = Incorporate in Next Submittal**				

Originator Signature: Luke [signature] Date: 3/29/2019

Reviewer Signature: Katie Bef[signature] Date: 4/1/2019

Task Order/Study Manager Signature: [signature] Date: 4/1/2019

Model: Calabacillas and Black

Review Item & Narrative	Senior Review Check Completed (Initials)
Review Date	**3-Jul-19**
Overall Files and Structure Naming	
Model Name & Location Ensure model is in model directory and made in accordance with internal spec.	GG
Model Description Text Has standard model description text been added in the model description (company, county, state, project name, submitted by, and date)	GG
Model Inputs/Hydrology	
Hydrology Check Hydrology has been reviewed and finalized?	Originally checked by Katie/Luke in April. Grouping modified by Lauren in JUNE. GG did not check grouping but did check that the spreasheet math made sense and that data used to create DSS match DSS file values (spot checked random DSS records). checked all profiles to be sure correct DSS files are being referenced. 1%PLUS profile has a bad reference for Group 1
Hydraulic Modeling Extents Modeled terrain data covers full extent of modeled watershed unless inflow hydrographs are used.	GG
Runoff Depth and Inflow Hydrographs Runoff depth used matches hydrologic model? Inflow hydrographs included at upstream limits as needed? Inflow hydrographs match hydrologic model and timing matches between rainfall and all inflow hydrographs?	GG
Methodology and Setup *Some items in this section may be best reviewed in detail after the results are confirmed to produce reasonable calculations.*	
Boundary/Outflow Cells Confirm model boundary used and location of outflow cells. Need for additional outflow cells or removal of cells from the model that aren't representing the subbasin?	GG
Model Calculation Method Diffuse Wave used for calculations?	GG
Calculation Tolerances Review 2-D Computations Options and Tolerances from pdf p. 120 of 2-D User's	GG
Modeled Cell Size and Time Step Cell size can vary in HEC-RAS 2-D models, but confirm general cell size and time step used in model (see guidance to the right).	GG - OK. Model uses variable timestep
Starting WS Condition Normal depth should be used and value should reasonable compare with main	GG
Manning's n-values Confirm that Manning's n-value table matches internal guidance for n-values.	GG

Breaklines Confirm breaklines are used correctly or whether any additional breaklines are	GG
Model Results	
Mapped Extents Effective and newly scoped Zone A reaches included in the final results as	GG
Model Tie-in Confirm whether any existing modeling exists for tie-in checks and review to determine any needed tie-ins. Check backwater tie-ins at the downstream end of models where needed.	Consider using Rio Grande backwater calc'd in downstream models in upstream model as starting WSEL. Only Calabacillas/Black would use normal depth if modeled like this.
Velocities Average Velocities are reasonable (between 0.5 ft/s and 9 ft/s - especially in areas with expected steady flow). Confirm any extreme areas.	GG
Stream Centerlines Is stream line rectified to imagery and topo data? Is stream line within final rasters and floodplains?	No Streamlines for 2D
Rasters and Mapping Confirm through visual inspection that draft mapping seems to match imagery	GG
Review Rasters for Crossing Profiles Multiple Profile rasters (WSELs) should be reasonable. Perform a minus between WSEL rasters to ensure elevations don't cross).	Crossing profiles points to bad DSS references for rainfall. Check and correct all flow data links to DSS.
Computational Messages Review computational messages for any issues with the model run.	GG
Volume Accounting Select 'View Computation Log File' to ensure that volume is being appropriately accounted for in the modeling calculations.	GRP 1 and 2 have high vol error. I suspect 2d connections have instabilities (see flow instablity in 2dConnection2). Group boundaries along high ground would prevent ponding along 2D boundaries with no 2D connection. See area near 2dConnection2 for instance.
Additional Comments	

Model: Montoyas

Review Item & Narrative	Senior Review Check Completed (Initials)
Review Date	**3-Jul-19**
Overall Files and Structure Naming	
Model Name & Location Ensure model is in model directory and made in accordance with internal spec.	GG
Model Description Text Has standard model description text been added in the model description (company, county, state, project name, submitted by, and date)	GG
Model Inputs/Hydrology	
Hydrology Check Hydrology has been reviewed and finalized?	Originally checked by Katie/Luke in April. Grouping modified by Lauren in JUNE. GG did not check grouping but did check that the spreasheet math made sense and that data used to create DSS match DSS file values (spot checked random DSS records). checked all profiles to be sure correct DSS files are being referenced. 1%PLUS profile has a bad reference for Group 1
Hydraulic Modeling Extents Modeled terrain data covers full extent of modeled watershed unless inflow hydrographs are used.	GG
Runoff Depth and Inflow Hydrographs Runoff depth used matches hydrologic model? Inflow hydrographs included at upstream limits as needed? Inflow hydrographs match hydrologic model and timing matches between rainfall and all inflow hydrographs?	GG
Methodology and Setup *Some items in this section may be best reviewed in detail after the results are confirmed to produce reasonable calculations.*	
Boundary/Outflow Cells Confirm model boundary used and location of outflow cells. Need for additional outflow cells or removal of cells from the model that aren't representing the subbasin?	GG
Model Calculation Method Diffuse Wave used for calculations?	GG
Calculation Tolerances Review 2-D Computations Options and Tolerances from pdf p. 120 of 2-D User's	GG
Modeled Cell Size and Time Step Cell size can vary in HEC-RAS 2-D models, but confirm general cell size and time step used in model (see guidance to the right).	GG - OK. Model uses variable timestep
Starting WS Condition Normal depth should be used and value should reasonable compare with main	GG
Manning's n-values Confirm that Manning's n-value table matches internal guidance for n-values.	GG

Breaklines Confirm breaklines are used correctly or whether any additional breaklines are	GG
Model Results	
Mapped Extents Effective and newly scoped Zone A reaches included in the final results as	GG
Model Tie-in Confirm whether any existing modeling exists for tie-in checks and review to determine any needed tie-ins. Check backwater tie-ins at the downstream end of models where needed.	Consider using Rio Grande backwater calc'd in downstream model as starting WSEL instead of normal depth. However, not likely to make a big difference outside of the Rio Grande channel itself.
Velocities Average Velocities are reasonable (between 0.5 ft/s and 9 ft/s - especially in areas with expected steady flow). Confirm any extreme areas.	GG
Stream Centerlines Is stream line rectified to imagery and topo data? Is stream line within final rasters and floodplains?	No Streamlines for 2D
Rasters and Mapping Confirm through visual inspection that draft mapping seems to match imagery	GG
Review Rasters for Crossing Profiles Multiple Profile rasters (WSELs) should be reasonable. Perform a minus between WSEL rasters to ensure elevations don't cross).	GG
Computational Messages Review computational messages for any issues with the model run.	GG
Volume Accounting Select 'View Computation Log File' to ensure that volume is being appropriately accounted for in the modeling calculations.	GRP 1 has high vol error but this model as a whole looks better than the others. Group boundaries along high ground would prevent ponding along 2D boundaries with no 2D connection. See area near 2dConnection3 for instance. This ponding may be causing some vol error accumulation. Also looks like some instability and big WSEL differences going on at and across 2dConnection1 that may be contributing to vol errors (see snap shot at right). Cell alignment across 2d connections may be contributing.
Additional Comments	

Model: La Barranca

Review Item & Narrative	Senior Review Check Completed (Initials)
Review Date	**3-Jul-19**
Overall Files and Structure Naming	
Model Name & Location Ensure model is in model directory and made in accordance with internal spec.	GG
Model Description Text Has standard model description text been added in the model description (company, county, state, project name, submitted by, and date)	GG
Model Inputs/Hydrology	
Hydrology Check Hydrology has been reviewed and finalized?	Originally checked by Katie/Luke in April. Grouping modified by Lauren in JUNE. GG did not check grouping but did check that the spreasheet math made sense and that data used to create DSS match DSS file values (spot checked random DSS records). checked all profiles to be sure correct DSS files are being referenced. 1%PLUS profile has a bad reference for Group 1
Hydraulic Modeling Extents Modeled terrain data covers full extent of modeled watershed unless inflow hydrographs are used.	GG
Runoff Depth and Inflow Hydrographs Runoff depth used matches hydrologic model? Inflow hydrographs included at upstream limits as needed? Inflow hydrographs match hydrologic model and timing matches between rainfall and all inflow hydrographs? Inflow hydrographs include base flow and base flow is justified/supported by data?	Check DSS references for all plans and correct where necessary. 10% Rio Grande plan looks like incorrect reference used. **GG REVISED INCORRECT DSS REFERENCES - ALL PLANS RERUN AS NEEDED TO ADDRESS THIS COMMENT. FINAL**
Methodology and Setup *Some items in this section may be best reviewed in detail after the results are confirmed to produce reasonable calculations.*	
Boundary/Outflow Cells Confirm model boundary used and location of outflow cells. Need for additional outflow cells or removal of cells from the model that aren't representing the subbasin?	GG
Model Calculation Method Diffuse Wave used for calculations?	GG
Calculation Tolerances Review 2-D Computations Options and Tolerances from pdf p. 120 of 2-D User's	GG
Modeled Cell Size and Time Step Cell size can vary in HEC-RAS 2-D models, but confirm general cell size and time step used in model (see guidance to the right).	GG - OK. Model uses variable timestep
Starting WS Condition Normal depth should be used and value should reasonable compare with main	GG

Manning's n-values Confirm that Manning's n-value table matches internal guidance for n-values.	GG
Breaklines Confirm breaklines are used correctly or whether any additional breaklines are	GG
Model Results	
Mapped Extents Effective and newly scoped Zone A reaches included in the final results as	GG
Model Tie-in Confirm whether any existing modeling exists for tie-in checks and review to determine any needed tie-ins. Check backwater tie-ins at the downstream end of models where needed.	Consider using Rio Grande backwater calc'd in downstream model as starting WSEL instead of normal depth. However, not likely to make a big difference outside of the Rio Grande channel itself. **NOT A LARGE ENOUGH WSEL DIFFEREENCE TO JUSTIFY THIS CHANGE. PRIMARY PURPOSE OF THIS MODEL IS NOT MODEL RIO GRANDE.**
Velocities Average Velocities are reasonable (between 0.5 ft/s and 9 ft/s - especially in areas with expected steady flow). Confirm any extreme areas.	GG
Stream Centerlines Is stream line rectified to imagery and topo data? Is stream line within final rasters and floodplains?	No Streamlines for 2D
Rasters and Mapping Confirm through visual inspection that draft mapping seems to match imagery	GG
Review Rasters for Crossing Profiles Multiple Profile rasters (WSELs) should be reasonable. Perform a minus between WSEL rasters to ensure elevations don't cross).	GG
Computational Messages Review computational messages for any issues with the model run.	GG
Volume Accounting Select 'View Computation Log File' to ensure that volume is being appropriately accounted for in the modeling calculations.	GRP 1 has high vol error but this model as a whole looks better than some others. Group boundaries along high ground would prevent ponding along 2D boundaries with no 2D connection. This ponding may be causing some vol error accumulation. 2dConnections with odd cell alignment may be a factor. **GG REVISED 2DCONNECTIONS TO ALIGN CELLS- GOOD VOLUME ACCOUNTING NOW. ALL PLANS RERUN AND RASMAPPER MAPS RECREATED. FINAL MAPPING HAS NOT BEEN UPDATED YET!**

Model: Unnamed Arroyo

Review Item & Narrative	Senior Review Check Completed (Initials)
Review Date	**3-Jul-19**
Overall Files and Structure Naming	
Model Name & Location Ensure model is in model directory and made in accordance with internal spec.	GG
Model Description Text Has standard model description text been added in the model description (company, county, state, project name, submitted by, and date)	GG
Model Inputs/Hydrology	
Hydrology Check Hydrology has been reviewed and finalized?	Originally checked by Katie/Luke in April. Grouping modified by Lauren in JUNE. GG did not check grouping but did check that the spreasheet math made sense and that data used to create DSS match DSS file values (spot checked random DSS records). checked all profiles to be sure correct DSS files are being referenced. 1%PLUS profile has a bad reference for Group 1
Hydraulic Modeling Extents Modeled terrain data covers full extent of modeled watershed unless inflow hydrographs are used	GG
Runoff Depth and Inflow Hydrographs Runoff depth used matches hydrologic model? Inflow hydrographs included at upstream limits as needed? Inflow hydrographs match hydrologic model and timing matches between rainfall and all inflow hydrographs?	GG
Methodology and Setup *Some items in this section may be best reviewed in detail after the results are confirmed to produce reasonable calculations*	
Boundary/Outflow Cells Confirm model boundary used and location of outflow cells. Need for additional outflow cells or removal of cells from the model that aren't representing the subbasin?	GG
Model Calculation Method Diffuse Wave used for calculations?	GG
Calculation Tolerances Review 2-D Computations Options and Tolerances from pdf p. 120 of 2-D User's	GG
Modeled Cell Size and Time Step Cell size can vary in HEC-RAS 2-D models, but confirm general cell size and time step used in model (see guidance to the right).	GG - OK. Model uses variable timestep
Starting WS Condition Normal depth should be used and value should reasonable compare with main	GG
Manning's n-values Confirm that Manning's n-value table matches internal guidance for n-values.	GG

Breaklines Confirm breaklines are used correctly or whether any additional breaklines are	GG
Model Results	
Mapped Extents Effective and newly scoped Zone A reaches included in the final results as	GG
Model Tie-in Confirm whether any existing modeling exists for tie-in checks and review to determine any needed tie-ins. Check backwater tie-ins at the downstream end of models where needed.	Consider using Rio Grande backwater calc'd in downstream model as starting WSEL instead of normal depth. However, not likely to make a big difference outside of the Rio Grande channel itself.
Velocities Average Velocities are reasonable (between 0.5 ft/s and 9 ft/s - especially in areas with expected steady flow). Confirm any extreme areas.	GG
Stream Centerlines Is stream line rectified to imagery and topo data? Is stream line within final rasters and floodplains?	No Streamlines for 2D
Rasters and Mapping Confirm through visual inspection that draft mapping seems to match imagery	GG
Review Rasters for Crossing Profiles Multiple Profile rasters (WSELs) should be reasonable. Perform a minus between WSEL rasters to ensure elevations don't cross).	GG
Computational Messages Review computational messages for any issues with the model run.	GG
Volume Accounting Select 'View Computation Log File' to ensure that volume is being appropriately	GG - good vol error (single 2D area so makes sense)
Additional Comments	

Model: Zia

Review Item & Narrative	Senior Review Check Completed (Initials)
Review Date	**3-Jul-19**
Overall Files and Structure Naming	
Model Name & Location Ensure model is in model directory and made in accordance with internal spec.	GG
Model Description Text Has standard model description text been added in the model description (company, county, state, project name, submitted by, and date)	GG
Model Inputs/Hydrology	
Hydrology Check Hydrology has been reviewed and finalized?	Originally checked by Katie/Luke in April. Grouping modified by Lauren in JUNE. GG did not check grouping but did check that the spreasheet math made sense and that data used to create DSS match DSS file values (spot checked random DSS records). checked all profiles to be sure correct DSS files are being referenced. 1%PLUS profile has a bad reference for Group 1
Hydraulic Modeling Extents Modeled terrain data covers full extent of modeled watershed unless inflow hydrographs are used.	GG
Runoff Depth and Inflow Hydrographs Runoff depth used matches hydrologic model? Inflow hydrographs included at upstream limits as needed? Inflow hydrographs match hydrologic model and timing matches between rainfall and all inflow hydrographs?	Check DSS references for all plans and correct where necessary. 4% plan and 02% looks like incorrect reference used.
Methodology and Setup *Some items in this section may be best reviewed in detail after the results are confirmed to produce reasonable calculations.*	
Boundary/Outflow Cells Confirm model boundary used and location of outflow cells. Need for additional outflow cells or removal of cells from the model that aren't representing the subbasin?	GG
Model Calculation Method Diffuse Wave used for calculations?	GG
Calculation Tolerances Review 2-D Computations Options and Tolerances from pdf p. 120 of 2-D User's	GG
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Breaklines Confirm breaklines are used correctly or whether any additional breaklines are	GG
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Mapped Extents Effective and newly scoped Zone A reaches included in the final results as	GG
Model Tie-in Confirm whether any existing modeling exists for tie-in checks and review to determine any needed tie-ins. Check backwater tie-ins at the downstream end of models where needed.	GG
Velocities Average Velocities are reasonable (between 0.5 ft/s and 9 ft/s - especially in areas with expected steady flow). Confirm any extreme areas.	GG
Stream Centerlines Is stream line rectified to imagery and topo data? Is stream line within final rasters and floodplains?	No Streamlines for 2D
Rasters and Mapping Confirm through visual inspection that draft mapping seems to match imagery	GG
Review Rasters for Crossing Profiles Multiple Profile rasters (WSELs) should be reasonable. Perform a minus between WSEL rasters to ensure elevations don't cross).	GG
Computational Messages Review computational messages for any issues with the model run.	GG
Volume Accounting Select 'View Computation Log File' to ensure that volume is being appropriately accounted for in the modeling calculations.	Grp 3 has high volume error. Likely related to 2d connection and cell alignment **- GG revised seveal 2d connections and is running 1% profile to check this -** GG REVISED 2DCONNECTIONS TO ALIGN CELLS - GOOD VOLUME ACCOUNTING NOW. ALL PLANS RERUN AND RASMAPPER MAPS REGENERATED. FINAL MAPPING HAS NOT BEEN UPDATED YET!
Additional Comments	

Model: Willow Creek

Review Item & Narrative	Senior Review Check Completed (Initials)
Review Date	**3-Jul-19**
Overall Files and Structure Naming	
Model Name & Location Ensure model is in model directory and made in accordance with internal spec.	GG
Model Description Text Has standard model description text been added in the model description (company, county, state, project name, submitted by, and date)	GG
Model Inputs/Hydrology	
Hydrology Check Hydrology has been reviewed and finalized?	Originally checked by Katie/Luke in April. Grouping modified by Lauren in JUNE. GG did not check grouping but did check that the spreasheet math made sense and that data used to create DSS match DSS file values (spot checked random DSS records). checked all profiles to be sure correct DSS files are being referenced. 1%PLUS profile has a bad reference for Group 1
Hydraulic Modeling Extents Modeled terrain data covers full extent of modeled watershed unless inflow hydrographs are used.	GG
Runoff Depth and Inflow Hydrographs Runoff depth used matches hydrologic model? Inflow hydrographs included at upstream limits as needed? Inflow hydrographs match hydrologic model and timing matches between rainfall and all inflow hydrographs?	Check 10% Rio Grande profile. It has a precip record in it that should not be there
Methodology and Setup *Some items in this section may be best reviewed in detail after the results are confirmed to produce reasonable calculations.*	
Boundary/Outflow Cells Confirm model boundary used and location of outflow cells. Need for additional outflow cells or removal of cells from the model that aren't representing the subbasin?	GG
Model Calculation Method Diffuse Wave used for calculations?	GG
Calculation Tolerances Review 2-D Computations Options and Tolerances from pdf p. 120 of 2-D User's	GG
Modeled Cell Size and Time Step Cell size can vary in HEC-RAS 2-D models, but confirm general cell size and time step used in model (see guidance to the right).	GG - OK. Model uses variable timestep
Starting WS Condition Normal depth should be used and value should reasonable compare with main	GG
Manning's n-values Confirm that Manning's n-value table matches internal guidance for n-values.	GG

Breaklines Confirm breaklines are used correctly or whether any additional breaklines are	GG
Model Results	
Mapped Extents Effective and newly scoped Zone A reaches included in the final results as	GG
Model Tie-in Confirm whether any existing modeling exists for tie-in checks and review to determine any needed tie-ins. Check backwater tie-ins at the downstream end of models where needed.	Consider using downstream model WSEL in Rio Gradne as starting condition. This probably wont make any difference to WSEL outside of the Rio Grande
Velocities Average Velocities are reasonable (between 0.5 ft/s and 9 ft/s - especially in areas with expected steady flow). Confirm any extreme areas.	GG
Stream Centerlines Is stream line rectified to imagery and topo data? Is stream line within final rasters and floodplains?	No Streamlines for 2D
Rasters and Mapping Confirm through visual inspection that draft mapping seems to match imagery	GG
Review Rasters for Crossing Profiles Multiple Profile rasters (WSELs) should be reasonable. Perform a minus between WSEL rasters to ensure elevations don't cross).	GG
Computational Messages Review computational messages for any issues with the model run.	GG
Volume Accounting Select 'View Computation Log File' to ensure that volume is being appropriately	GG
Additional Comments	

Model: Venada

Review Item & Narrative	Senior Review Check Completed (Initials)
Review Date	**3-Jul-19**
Overall Files and Structure Naming	
Model Name & Location Ensure model is in model directory and made in accordance with internal spec.	GG
Model Description Text Has standard model description text been added in the model description (company, county, state, project name, submitted by, and date)	GG
Model Inputs/Hydrology	
Hydrology Check Hydrology has been reviewed and finalized?	Originally checked by Katie/Luke in April. Grouping modified by Lauren in JUNE. GG did not check grouping but did check that the spreasheet math made sense and that data used to create DSS match DSS file values (spot checked random DSS records). checked all profiles to be sure correct DSS files are being referenced. **1%PLUS profile has a bad reference for Group 1**
Hydraulic Modeling Extents Modeled terrain data covers full extent of modeled watershed unless inflow hydrographs are used	GG
Runoff Depth and Inflow Hydrographs Runoff depth used matches hydrologic model? Inflow hydrographs included at upstream limits as needed? Inflow hydrographs match hydrologic model and timing matches between rainfall and all inflow hydrographs?	GG. **1%PLUS prifile nees correct DSS reference**
Methodology and Setup *Some items in this section may be best reviewed in detail after the results are confirmed to produce reasonable calculations*	
Boundary/Outflow Cells Confirm model boundary used and location of outflow cells. Need for additional outflow cells or removal of cells from the model that aren't representing the subbasin?	GG
Model Calculation Method Diffuse Wave used for calculations?	GG
Calculation Tolerances Review 2-D Computations Options and Tolerances from pdf p. 120 of 2-D User's	GG
Modeled Cell Size and Time Step Cell size can vary in HEC-RAS 2-D models, but confirm general cell size and time step used in model (see guidance to the right).	GG
Starting WS Condition Normal depth should be used and value should reasonable compare with main	GG
Manning's n-values Confirm that Manning's n-value table matches internal guidance for n-values.	GG

Breaklines Confirm breaklines are used correctly or whether any additional breaklines are	GG
Model Results	
Mapped Extents Effective and newly scoped Zone A reaches included in the final results as	GG
Model Tie-in Confirm whether any existing modeling exists for tie-in checks and review to determine any needed tie-ins. Check backwater tie-ins at the downstream end of models where needed.	Consider using Rio Grande backwater calc'd in downstream models in upstream model as starting WSEL. Only Calabacillas/Black would use normal depth if modeled like this.
Velocities Average Velocities are reasonable (between 0.5 ft/s and 9 ft/s - especially in areas with expected steady flow). Confirm any extreme areas.	GG. 1%PLUS prifile nees correct DSS reference
Stream Centerlines Is stream line rectified to imagery and topo data? Is stream line within final rasters and floodplains?	No Streamlines for 2D
Rasters and Mapping Confirm through visual inspection that draft mapping seems to match imagery	GG
Review Rasters for Crossing Profiles Multiple Profile rasters (WSELs) should be reasonable. Perform a minus between WSEL rasters to ensure elevations don't cross).	1%PLUS is bad. See Row 17 comment
Computational Messages Review computational messages for any issues with the model run.	GG - ok. Alot of switching between time steps is not likely causing issues
Volume Accounting Select 'View Computation Log File' to ensure that volume is being appropriately accounted for in the modeling calculations.	GROUP 1 has very high volume error. 2dconnection 1 and 4 may have instability. Connection 1 and 4 would be better if they followed high ground. Other 2D flow areas have higher than expected volume errors. 2d connections (ie. Group boundaries should probably follow high ground so 2D connections can follow high ground). I suspect volume errors are related to 2D connections/locations and "grid leakage". GG REVISED 2DCONNECTIONS TO ALIGN CELLS . ALL PLANS RERUN. VOLUME ERROS PERSIST.
Additional Comments	

APPENDIX C

Correspondence

Bi-Weekly and Monthly Call-In Meeting Minutes and Stakeholder Meeting Information

Bi-Weekly Conference Call Minutes

Animas and Curry-Roosevelt BLE, Upper Rio Grande BLE, Rio Chama, and SSCAFCA BLE

Attendees: Shawn Penman, Matt Lepinski, Jerry Clark, Mathew Hornack
Date: February 19, 2019
Time: 9:00 am MT

Items discussed:

- Animas and Curry-Roosevelt BLE Studies:
  - Shawn Penman to close out both projects on the MIP.

- Upper Rio Grande Watershed:
  - Travel has been booked and meetings scheduled for the week of March 4-8, 2019.
  - Taos Pueblo will be unavailable for a meeting at this time. Shawn Penman has agreed to have a follow-up meeting or webinar with Taos Pueblo at a later date to present the BLE information to them.
  - Mathew Hornack to provide Shawn Penman with slides for the community meeting presentations that highlight areas of interest within the Upper Rio Grande watershed. These areas will represent locations near Española as well as Taos.

- Rio Chama Watershed:
  - Mathew Hornack to send the Rio Chama Hydrology analysis for an external review this week. Hydraulic analysis is ongoing.
  - Jerry Clark to call USACE to follow-up on the request for Rio Chama dam information.
  - Matt Lepinski noted that Jen Knecht is following up with Colorado to see if any of the LiDAR data is available. Shawn Penman checked with NRCS and heard that the Colorado LiDAR data may not have been completely collected. FEMA to provide guidance as needed for identifying the appropriate upstream extent of the Rio Chama study.

- SSCAFCA BLE:
  - SSCAFCA BLE update to existing HEC-HMS models has begun.

- Other:
  - Shawn Penman has scheduled the Discovery meeting with Valencia County for Monday, March 4 from 1:00 to 3:00 PM MT. Mathew Hornack will help develop a summary of existing data as well as a comparison of newly acquired data and what to expect from the BLE analysis. Jerry Clark reminded the group that the main focus of the Valencia County Discovery meeting is listening to the community. Shawn Penman informed the group that Wendy Blackwell will join us at the Valencia County meeting as the State Hazard Mitigation Officer.
  - Bel Marquez to help set up the SSCAFCA monthly call.
  - Updated FEMA Region 6 BLE guidance was delivered and will be reviewed. Matt Lepinski stated that the primary changes are related to the packaging and delivery of the hydraulic models to increase the efficiency of distributing online.

Bi-Weekly Conference Call Minutes

Animas and Curry-Roosevelt BLE, Upper Rio Grande BLE, Rio Chama, and SSCAFCA BLE

Attendees: Shawn Penman, Matt Lepinski, Bel Marquez, Mathew Hornack
Date: March 19, 2019
Time: 9:00 am MT

Items discussed:

- Animas and Curry-Roosevelt BLE Studies:
  - Shawn Penman to close out both projects on the MIP.

- Upper Rio Grande Watershed:
  - Shawn Penman has scanned in the documents from the community meetings and mentioned that Gladys Valentin took photos at the meetings. Shawn Penman to provide these files for inclusion in the final TSDN.
  - Mathew Hornack to email miphelp to set up a MIP username that allows direct access to EDAC project tasks.
  - ESP to complete MIP tasks once data is received from the community meetings and MIP tasks are assigned.
  - Matt Lepinski mentioned receiving feedback from Peter at one of the community meetings with a question on whether his application of TR-55 for small watersheds would provide a sufficient comparison with the BLE information.

- Rio Chama Watershed:
  - Hydrology has been through the external review process and finalized.
  - Hydraulic analysis is ongoing. ESP presented the current schedule and announced that the Rio Chama status tracking application is current. The project is currently a week behind schedule and will be monitored moving forward to identify any required changes to the overall project schedule.
  - FEMA and USACE have had a call to discuss needed Rio Chama dam information and will be meeting in person next week in El Paso. The El Paso meeting is for a separate project, but FEMA will discuss the status of Rio Chama information at this meeting and report back to the team. A tentative deadline around the first week of May was proposed for receiving this information and including in the study with limited schedule impact.

- SSCAFCA BLE:
  - ESP to set up a tracking application for SSCAFCA BLE project status by next week.
  - SSCAFCA BLE Hydrology is under internal review and will be sent for external review this week.
  - Shawn Penman to set up a meeting invitation for a call on March 28, 2019 at 9:00 AM MT with SSCAFCA. SSCAFCA check-in calls will be monthly on weeks when the EDAC BLE call is not taking place. Bel Marquez will assist with meeting coordination.

SSCAFCA BLE Conference Call Minutes

Attendees: Shirley Baros, Shawn Penman, Brian Keller, Chuck Thomas, Gerhard Schoener, and Mathew Hornack
Date: March 28, 2019
Time: 9:00 am MT

Items discussed:

- SSCAFCA BLE:
  - A tracking application has been developed for the SSCAFCA BLE project and is available at the following link: SSCAFCA Status Tracker
    - The server hosting the data is in the process of being rebooted, so the data sourced by the application should be available by Friday (March 29).
  - Hydrology
    - Mathew Hornack reported that the external review of the hydrologic analysis is close to being complete.
    - Once the external review is complete, any comments will be sent to SSCAFCA for their review.
    - Mathew mentioned that several points had to be extrapolated for the pond curves in the Venada Arroyo Watershed model. Mathew will provide these to Gerhard Schoener for review.
  - Hydraulics
    - Mathew Hornack reported that hydraulics is ongoing.
    - ESP recommended that the terrain file for the HEC-RAS 2-D models be processed to a 5-ft cell size. This will reduce overall deliverable file sizes, making the data much more manageable while also maintaining accuracy of results. SSCAFCA agreed that this recommendation was ok as long as data validation does not require a finer grid.
    - ESP to send request to Shawn Penman for any additional terrain data that is needed and is outside of the SSCAFCA jurisdictional boundary.
    - ESP will make initial hydraulic model runs available to SSCAFCA.
  - Gage Data
    - SSCAFCA to provide available gage data for use in validating hydraulic models. Additionally, they will provide a previous report completed that summarizes past storm events and provides photographs of High Water Marks within the SSCAFCA area.
  - Corrales Model
    - ESP will develop a separate model for the Village of Corrales using a 2-ft raster. The purpose of this model will be to provide the community an idea of flood prone areas. The rainfall for the model will be an approximation.

SSCAFCA BLE Conference Call Minutes

Attendees: Shawn Penman, Matthew Lepinski, Elizabeth Savage, Chuck Thomas, Gerhard Schoener, and Mathew Hornack
Date: April 25, 2019
Time: 9:00 am MT

Items discussed:

- SSCAFCA BLE:
  - Hydrology
    - Gerhard Schoener to update the Barranca Watershed HEC-HMS model so that the headwaters are reflected by a basin element and not a source with a specified hydrograph. This will allow for better representation of the additional return periods.
    - Mathew Hornack mentioned the Zia Watershed and its large flow for a small drainage area. The flows coming out of the HEC-RAS model were around 10% of the HEC-HMS discharge. Gerhard mentioned that this is likely due to the peak timing of basin element hydrographs with similar travel times in the HEC-HMS model causing a higher discharge. The HEC-RAS model routes flow throughout the entire basin, so timing of the hydrograph peaks could be significantly different than the HEC-HMS model.
  - Hydraulics
    - Mathew Hornack reported that all initial runs have been completed.
    - Matthew Lepinski invited Elizabeth Savage on the call to discuss portions of the study area that are within the overall SSCAFCA boundary but downstream of the limit of the HEC-HMS models. Mathew Hornack noted that all models draining directly into the Rio Grande will include a constant discharge for the respective return period to model any potential backwater effects from the Rio Grande.
    - Mathew mentioned that ESP is still working on finding an appropriate approach to apply across the entire SSCAFCA area that will allow flows in the HEC-RAS models to more closely match HEC-HMS results. ESP is focusing on the Montoyas Watershed since this is a HEC-HMS model that is calibrated and trusted.
    - Mathew Hornack suggested that the initial targets for calibrating the Montoyas HEC-RAS model to the HEC-HMS results is to match flows within 30% and to match volumes within 10%. Mathew stated that ESP would add 2-D flow areas due to deviations in cumulative excess rainfall from urban to rural basins. Gerhard Schoener mentioned that adjustments to the rainfall may be necessary as well and requested that Mathew send the input excess rainfall hyetograph from RAS to Gerhard to consider any rainfall adjustments.
    - Mathew Hornack reviewed the project schedule and indicated that the calibration of the Montoyas model has caused delays in schedule, and mentioned that currently these should not affect the overall project delivery.

- Corrales Model
  - ESP will develop a separate model for the Village of Corrales using a 2-ft raster. The purpose of this model will be to provide the community an idea of flood prone areas. The rainfall for the model will be an approximation.
- Other
  - Gerhard Schoener will be out of the country from May 27 through June 22.

EDAC | EARTH DATA ANALYSIS CENTER

Bi-Weekly Conference Call Minutes

Animas and Curry-Roosevelt BLE, Upper Rio Grande BLE, Rio Chama, and SSCAFCA BLE

Attendees: Shawn Penman, Matt Lepinski, Bel Marquez
Date: April 29, 2019
Time: 10:30 am MT

Items discussed:

- Animas and Curry-Roosevelt BLE Studies:
  - Shawn Penman to close out both projects on the MIP.
  - Mathew Hornack completed the re-running the 2D models to reduce the output file sizes made available on the estBFE viewer and has provided to FEMA. Matt Lepinski will send to USGS and see if they have any questions.
  - Looking at June to have the final meetings with the communities. Shawn looking into so that it does not conflict with fire season and graduations.

- Upper Rio Grande Watershed:
  - ESP to complete MIP tasks for Upper Rio Grande by the end of this week when Mat Hornack returns.

- Rio Chama Watershed:
  - Hydrology is complete.
  - Hydraulic analysis is ongoing. ESP presented the current schedule and announced that the Rio Chama status tracking application is current. Tasks are on schedule and the will be reflected at the next meeting.
  - ESP's Applications Team is developing a tool to help with the set up of the HEC RAS model skeleton for more efficiencies.

- SSCAFCA BLE:
  - SSCAFCA BLE Hydrology external review is complete.
  - Hydraulic analysis is ongoing. ESP has met with Gerhard of SSCAFCA concerning the hydrology for Montoya's watershed. He is revising it after lengthy discussions. Once it is received, we can proceed with the hydraulic models and mapping.
  - Pleased with Mat managing the expectations of the BLE work with SSCAFCA. Want to make sure they understand what they are getting and why.

Other:

- Need a write up on Jerry Clark for NMFMA to post on the site about his retirement. Matt Lepinski to provide to Shawn.
- Discussed the follow up meetings with Isleta Pueblo since we were not able to meet with them in March. Matt L. to contact them to see if they want to have a meeting via WebEx or in person. He has been coordinating with Shanene.
- Next call will be May 14th.

Bi-Weekly Conference Call Minutes

Animas and Curry-Roosevelt BLE, Upper Rio Grande BLE, Rio Chama, and SSCAFCA BLE

Attendees: Shawn Penman, Matt Lepinski, Bel Marquez, Mathew Hornack
Date: May 13, 2019
Time: 9:00 am MT

Items discussed:

- Animas and Curry-Roosevelt BLE Studies:
    - Shawn Penman to close out Curry-Roosevelt on the MIP.
    - Shawn Penman is coordinating the Discovery meeting for Curry and Roosevelt counties with Johnny Montiel. Meetings are projected for late July.

- Upper Rio Grande Watershed:
    - ESP completed MIP task for Upper Rio Grande. Matt Lepinski to review for approval. Shawn Penman to close out on the MIP when approved.

- Rio Chama Watershed:
    - Hydrology is complete.
    - Initial model development is complete. Internal review is nearly complete, and will be delivered for external review by Tuesday. ESP presented the current schedule and noted that they should finish the modeling tasks on time and are currently ahead of schedule on the mapping tasks.

- SSCAFCA BLE:
    - SSCAFCA BLE Hydrology external review is complete.
    - Hydraulic analysis is ongoing. ESP to submit the recent results of model testing to SSCAFCA and EDAC for confirmation of model approach before completing the modeling portion of this project.

Other:

- Matt Lepinski stated that FEMA has reached out to the Isleta Pueblo and will send a formal letter to document their outreach attempts if they do not hear any feedback from the Pueblo.
- Shawn Penman will be out of town from May 23 through May 29. Next call was schedule for May 28, but it was determined that the call will be held on Monday, June 3, 2019 at 10 AM MT.

SSCAFCA BLE Conference Call Minutes

Attendees: Brian Keller, Matthew Lepinski, Gerhard Schoener, Bel Marquez, and Mathew Hornack
Date: May 23, 2019
Time: 9:00 am MT

Items discussed:

- SSCAFCA BLE:
  - Hydrology
    - Gerhard Schoener previously sent an updated model for the Barranca Watershed that included the missing headwater basin. ESP confirmed that this will be incorporated into the final deliverable for averaging excess precipitation for hydraulic inputs.
  - Hydraulics
    - Gerhard Schoener mentioned that SSCAFCA discussed the approach proposed by ESP and feel it is appropriate for applying to the rest of the 2-D models. One concern was the spillover upstream of the Harvey Jones Channel gage. The Harvey Jones Channel has been calculated to contain the 100-yr discharge, so this spillover was unexpected. Gerhard requested that the summary document of the ESP proposed approach be included within the final report delivered at project completion and ESP assured that it would be reflected.
    - Mathew Hornack mentioned that ESP will take care to ensure proper cell alignment in the area upstream of the Harvey Jones Channel gage to give a clearer view of any overtopping potential. Additionally, they will review the cell faces to see if there are any unexpected terrain values represented within the channel.
    - Mathew Hornack requested any information SSCAFCA may have on the relief spillway in terms of expected overtopping elevations and recurrence intervals.
    - From a schedule standpoint, Mathew Hornack mentioned that the final BLE database development is scheduled to be completed on June 24, 2019. Mathew stated that ESP should be able to complete modeling and mapping by that date, but additional products (i.e. Hazus analysis, CNMS validation, BLE database development) may be delayed due to the dependence on final mapping. A final delivery date will be proposed on the next call with EDAC (June 3, 2019) and shared with SSCAFCA.
  - Corrales Model
    - ESP will develop a separate model for the Village of Corrales using a 2-ft raster. The purpose of this model will be to provide the community an idea of flood prone areas. The rainfall for the model will be an approximation.
  - Other
    - Gerhard Schoener will be out of the country starting May 27 and should return to the office on June 24.

Bi-Weekly Conference Call Minutes

Animas and Curry-Roosevelt BLE, Upper Rio Grande BLE, Rio Chama, and SSCAFCA BLE

Attendees: Shawn Penman, Matt Lepinski, Bel Marquez, Mathew Hornack
Date: June 3, 2019
Time: 10:00 am MT

Items discussed:

- Animas and Curry-Roosevelt BLE Studies:
  - Models have been delivered to USGS and should be available on the estBFE viewer.
  - Shawn Penman is coordinating the Discovery meeting for Curry and Roosevelt counties with Johnny Montiel. Meetings are projected for late July.

- Upper Rio Grande Watershed:
  - Shawn Penman to close out on the MIP when approved.

- Rio Chama Watershed:
  - Hydrology is complete.
  - Hydraulic models sent to external review, and the external review process started on June 3, 2019. Supporting data for mapping has been compiled and the draft mapping process is underway. ESP presented the current schedule and noted that all tasks should be back on schedule by the next call.
  - Once an internal mapping review has been completed, ESP will provide FEMA and EDAC a chance to review the mapping results.

- SSCAFCA BLE:
  - SSCAFCA BLE Hydrology external review is complete.
  - Hydraulic analysis is ongoing. Hydraulic model development should be complete and ready for internal review by the end of the week. Draft mapping should be completed by the end of the following week. ESP stated they will continue to monitor and keep SSCAFCA updated with regards to the schedule of this project.

Other:

- Matt Lepinski stated that FEMA has reached out to the Isleta Pueblo and will send a formal letter to document their outreach attempts if they do not hear any feedback from the Pueblo.
- Next call will be held at the regularly schedule time ofn Tuesday, June 11, 2019 at 9 AM MT.

Bi-Weekly Conference Call Minutes

Animas and Curry-Roosevelt BLE, Upper Rio Grande BLE, Rio Chama, and SSCAFCA BLE

Attendees: Shawn Penman, Matt Lepinski, Bel Marquez, Mathew Hornack
Date: June 11, 2019
Time: 9:00 am MT

Items discussed:

- Animas and Curry-Roosevelt BLE Studies:
  - Shawn Penman is coordinating the Discovery meeting for Curry and Roosevelt counties with Johnny Montiel. Meetings are projected for late July.

- Upper Rio Grande Watershed:
  - A final invoice had not been received from ESP. Bel to confirm with Julie at ESP to determine invoice status.
  - Shawn Penman to close out on the MIP when approved.

- Rio Chama Watershed:
  - External review of hydraulic modeling was submitting on June 6, 2019 and comments are being addressed.
  - Supporting data for mapping has been compiled and the draft mapping process is underway. Once an internal mapping review has been completed, ESP will provide the results to FEMA and EDAC for review.
  - The July 4th holiday falls in the middle of the mapping review schedule. The mapping review schedule will be revisited on the next call.
  - Matt Lepinski will perform a similar mapping review to Upper Rio Grande and requested that a timeline for review be identified when the data is submitted.

- SSCAFCA BLE:
  - Hydraulic analysis is ongoing. After an internal review and any revisions, modeling and mapping should be completed by the end of June. ESP will continue to keep SSCAFCA updated with regards to the project schedule. Any project schedule adjustments needed from the 2D model validation delays will be discussed at the next SSCAFCA call.

Other:

- Isleta Pueblo Discovery meeting to be held on June 27, 2019. Matt Lepinski, Shanene Thomas, and Shawn Penman will attend the meeting, and Matt will confirm with the Pueblo whether they have space for Shirley Baros to attend.
- Matt Lepinski asked for any relevant information pertaining to the Isleta Pueblo before the meeting. Bel Marquez will check and report any information discovered, and Shawn mentioned that the Conservancy District is trying to redo local levees but the local match is preventing these projects. Also, Bosque Farms is an area that typically has questions, so mapping for this area would be helpful.

Other:

- The Discovery meeting conflicts with the scheduled SSCAFCA call, so it is being tentatively rescheduled for June 25 at 10 AM MT. Shawn Penman to send out meeting invitation.

SSCAFCA BLE Conference Call Minutes

Attendees: Brian Keller, Shawn Penman, Matthew Lepinski, Gerhard Schoener, Chuck Thomas, Bel Marquez, and Mathew Hornack
Date: June 25, 2019
Time: 10:00 am MT

Items discussed:

- SSCAFCA BLE:
  - Hydrology
    - Barranca upstream basin included in HEC-HMS models used for this BLE analysis.
  - Hydraulics
    - The spillover concerns upstream of the Harvey Jones Channel gage were discussed. Mathew Hornack mentioned that ESP is reviewing this area of the Montoyas model to identify whether any adjustments may be made to prevent spillover. Gerhard Schoener requested, and Mathew confirmed, that this item will be thoroughly documented within the supporting report to discuss the limitations of BLE models pertaining to structures.
    - Mathew Hornack proposed a revised schedule to reflect the current status of the project and to account for delays associated with the unexpected efforts to reconcile the BLE model discharges with existing, calibrated hydrologic models from SCCAFCA. Mathew mentioned that he would push the schedule sooner, but he will be out of the office next week and would prefer to have a chance to give a final review before sending to SSCAFCA and EDAC. Modeling and mapping will be delivered to SSCAFCA and EDAC on July 10, 2019.
    - Based on the revised schedule, SSCAFCA noted that the week of August 19, 2019 will not work for the community meetings with Chuck Thomas and Gerhard's schedules. Mathew Hornack stated that ESP will connect with EDAC and FEMA at a later date to propose a date for community meetings that comes after August 26, 2019.
    - Mathew Hornack presented examples of current draft mapping for several watersheds. Gerhard Schoener asked about the process of cleaning up mapping results, and Mathew mentioned that there is a procedure for determining which results to maintain for the final mapping. This procedure will be included in the supporting report. Mathew also noted that all BLE mapping results will be easily exported from the 2-D HEC-RAS models in the event of interest in any areas not maintained within final BLE mapping.
    - Matt Lepinski added that any final FEMA regulatory mapping could differ from the BLE results because of the extra guidelines and requirements for FIRM panels.

- Corrales Model
  - ESP will develop a separate model for the Village of Corrales using a 2-ft raster. The purpose of this model will be to provide the community an idea of flood prone areas. The rainfall for the model will be an approximation.
- Other
  - The next call is scheduled for July 25, 2019.

SSCAFCA BLE Conference Call Minutes

Attendees: Shawn Penman, Matthew Lepinski, Gerhard Schoener, Bel Marquez, and Mathew Hornack
Date: July 25, 2019
Time: 9:00 am MT

Items discussed:

- SSCAFCA BLE:
  - Hydraulics
    - Gerhard Schoener mentioned that there were some comments on the report, so Mathew Hornack encouraged submitting them for inclusion into the final report.
    - Gerhard also mentioned that several of the SSCAFCA engineers will review the models, and comments will be submitted by the end of next week (August 2). Shawn Penman reminded those on the call that reviews should consider the scope of the BLE project and understand that these are not detailed models and do not include structures.
    - Mathew Hornack stated the schedule targets of submitting all data to FEMA by August 9th for review before the data is sent to USGS for upload to the estBFE viewer. Matt Lepinski mentioned that the final data uploaded to the viewer will be formatted to fit the standard schema for FEMA BLE data and that the 2-D models available for download on the viewer will have been re-run with a larger output timestep to reduce the final file sizes.
  - Other
    - Gerhard Schoener has not been able to ask Chuck Thomas if September 18th works for SSCAFCA. Gerhard stated that SSCAFCA would be able to host the meeting in their board room but may not have wi-fi available. Gerhard to get back with Shawn Penman today to confirm the community meeting date.
    - Matt Lepinski mentioned that a FEMA brown bag related to BLE is occurring on July 30th. The link to sign up for the virtual brown bags is https://r6virtualbrownbag.eventbrite.com/

From: Shawn Penman <spenman@edac.unm.edu>
Sent: Tuesday, January 28, 2020 3:28 PM
To: Lepinski, Matthew <matthew.lepinski@fema.dhs.gov>
Subject: SSCAFCA Lidar assessment

Matt,

RMS calculations on the SSCAFCA area Lidar. We were able to locate a total of 16 appropriate control points (we threw out the one on top of a water storage tank).

The RMS error for the Lidar derived DEM using control set by a local engineering firm for a 2104 Orthophoto collection was 0.53 ft. The RMS error for the Lidar derived DEM using the NOAA control set was 1.21 ft. Su and I examined calculations for the NOAA control points and there is one point that is causing the RMS error to be greater than one. It is a point on a ditch bank and was last physically checked in 2007. It is possible that the surface is not the same now as in 2007.

I have attached our spreadsheets for the RMS calculations and a map showing the locations of the control points, as well as an article discussing this method of evaluating Lidar elevation accuracy.

Only one of the Orthoimagery control points had a difference in elevation between the control points and the DEM greater than 1 ft (1.17ft). and the NOAA control had one value of -1.14ft and one of 2.77 ft (the point on a ditch bank).

RMS (Root Mean Square) Calculations

2014 Orthoimagery Control Points (8)	0.53 Ft
NOAA Control Points (8)	1.21 Ft

Does this level of accuracy fit within the BLE guidance? And we can move forward with getting the data on the viewer?

Thanks

Shawn

Shawn L. Penman, Ph.D., CFM, GISP

New Mexico CTP Coordinator

GIS Specialist/Programmer

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Following the incoming email, the CTP performed a site visit of the benchmark in question.

Photos collected are included below:

Benchmark FO1154
Latitude: 35.24699
Longitude: -106.60462

West bank side of Corrales Lateral

(Left) View from Sandia View Lane, looking east across the Corrales Lateral

(Right) Closer view of BM FO1154

Benchmark FO1154
Latitude: 35.24699
Longitude: -106.60462

Near Benchmark location

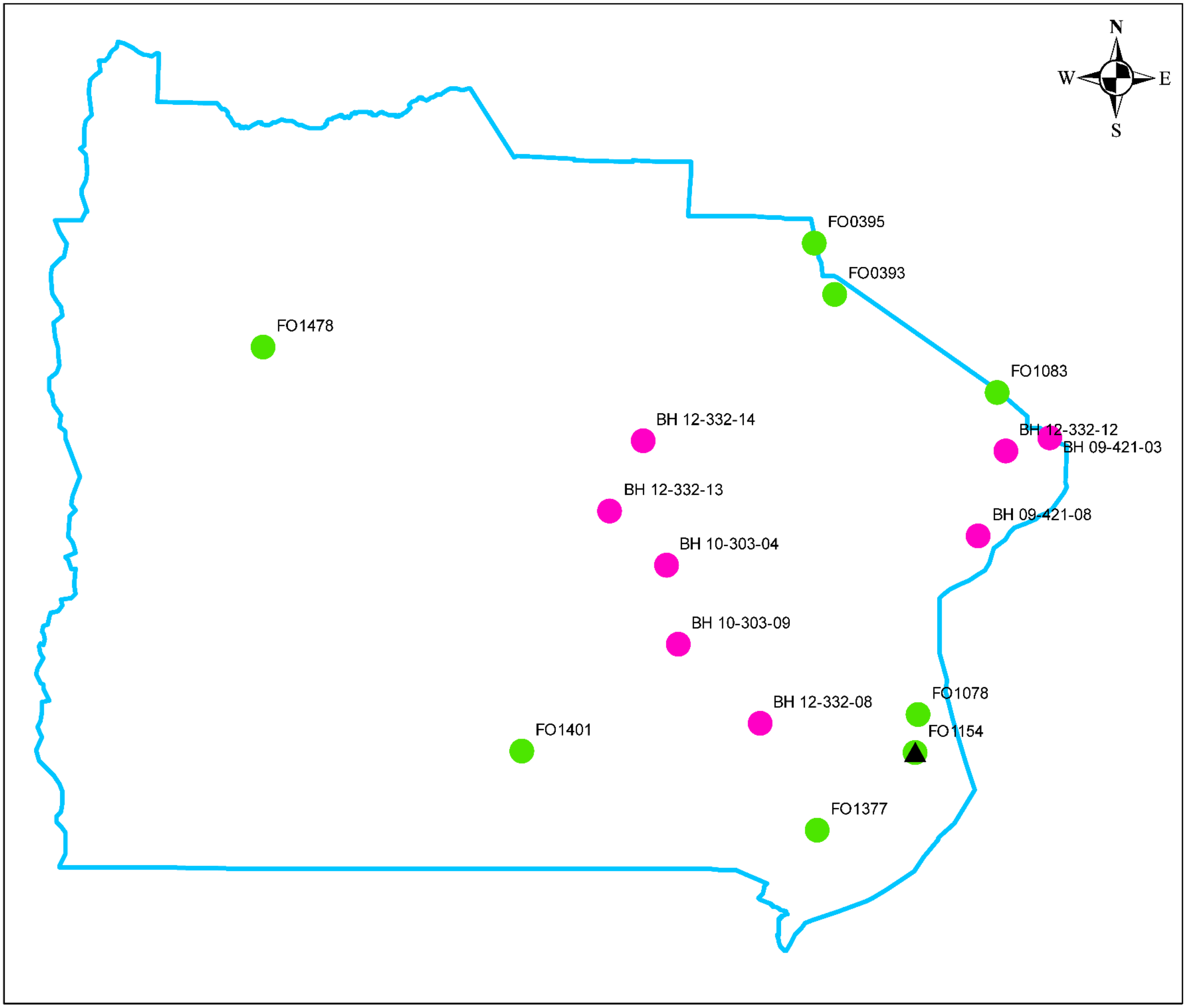
(Left) North of FO1154, looking in southward direction

(Right) South of FO1154, looking north towards Academy Drive/ Elm Drive NW

Benchmark FO1154
Latitude: 35.24699
Longitude: -106.60462

Photo looks down at BM location

Site visit verifies that BM has not been damaged or relocated.



Legend

- ▲ NOAA Station Outlier
- 2014 Orthoimagery Control Points
- NOAA Control Points
- SSCAFCA Boundary

RMS (Root Mean Square) Calculations

2014 Orthoimagery Control Points (8)	0.53 Ft
NOAA Control Points (8)	1.21 Ft

One NOAA Control Point (black triangle symbol) has a difference in elevation of 2.77 ft, which causes the RMS to be greater than 1.

2.5 1.25 0 2.5 Miles

3/5/2020

For more information about the BM visit: https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=FO1154

Given the location of the outlier benchmark, at the southeastern end of the study area, the following path forward was decided for the Base Level Engineering study:

- A terrain outlier indicator will be added to the S_AOMI_PT file (ID #154) indicating that additional survey should be collected and utilized prior to moving this stream forward in an update for the Flood Insurance Rate Map (FIRM).
- A memo (this document) will be prepared and included in the BLE Report for reference to all BLE data download users.