Hampton Arroyo Master Drainage Report

Hydrologic and Hydraulic Analysis
City of Aztec
San Juan County, New Mexico

Prepared for the:

Prepared by:

AECOM

MARC MCINTOSH
NEW MEXICO
23532
PROFESSIONAL ENGINEER
06.30.17

June 2017

Table of Contents

List of Figures

List of Tables

Appendices

Introduction

The Hampton Arroyo is an existing drainage corridor located in the north central portion of Aztec, New Mexico. The Arroyo collects and conveys storm water runoff from a predominately undeveloped 4.5-square mile watershed that extends nearly 5 miles upstream toward Navajo Dam Road from its outfall into the Animas River. The lower reaches of the Hampton arroyo splits the Kokopelli Subdivision, situated on each side of the arroyo.

Purpose

AECOM Technical Services (AECOM) was contracted to provide professional engineering consulting services to the City of Aztec (Client) for this *Hampton Arroyo Flood Hazard Assessment* and the preparation of this *Hampton Arroyo Master Drainage Report*. This report includes a hydrologic analysis for the contributing Hampton Arroyo Watershed and hydraulic analysis for the lower 1.5 linear miles of the Hampton Arroyo, upstream from the Animas River Outfall. This *Hampton Arroyo Drainage Report* documents existing drainage conditions, analysis criteria used herein, and hydrologic/hydraulic analysis results.

Location

The Hampton Arroyo is located in the north central portion of the City of Aztec in San Juan County, New Mexico. The project location map is shown in **Figure 1.**

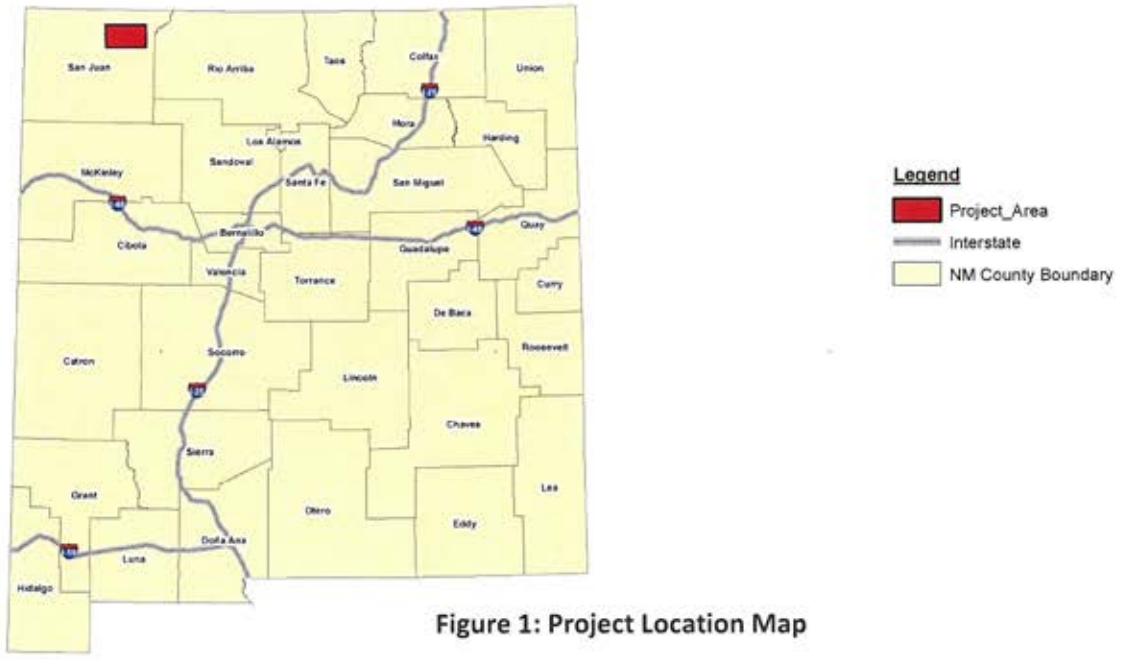


Figure 1: Project Location Map

Description

The Hampton Arroyo watershed encompasses 4.5 square miles ranging in elevation from 6374 feet near Navajo Dam Road to 5601 feet near the Animas River outfall. The Hampton arroyo generally extends east to west through the Kokopelli Subdivision and beneath Aztec Boulevard (U.S. Highway 550). The contributing watershed is generally undeveloped with the exception of the Kokopelli Subdivision and lower reaches of the Arroyo located downstream of Aztec Boulevard.

Five (5) existing culverts / bridge facilities are located along the Hampton Arroyo, at the following locations:

- Navajo Dam Road Pipe Culvert
- Sabena Street Bridge
- Aztec Boulevard Bridge
- McCoy Avenue Bridge
- Martinez Lane Pedestrian Crossing Pipe Culvert

A series of five (5) grade control structures have been constructed within the Hampton Arroyo reach located between and including Aztec Boulevard and McCoy Avenue. These grade control structures were generally constructed from rock filled baskets. Field observation indicates that in some cases, portions of the structures have collapsed or in other cases have been undermined / eroded.

The upper boundary of the Hampton Arroyo watershed is highly erosional due to non-cohesive sand and gravel materials that easily migrate downstream during high intensity rainfall events. The erosion and incision in the upstream reaches of the arroyo contribute to sediment transport downstream and deposition where topographic relief is reduced. The change in grade causes sedimentation and subsequent flooding in the Kokopelli subdivision and other downstream portions in Aztec. Neighborhoods and roadways have had significant flooding and sediment deposition.

The Aztec area including the Hampton Arroyo has experienced significant historic flooding and erosion problems resulting from monsoon rainfall events. However, it should be noted that the Hampton Arroyo displayed sufficient conveyance capacity during these events until it reached an undersized culvert near the outfall to the Animas River where the culvert was plugged with sediment and debris. Recent rainfall and flooding occurring in August 2015 within the study area prompted the development of this Master Drainage Report.

FEMA Floodplain Classification

The Federal Emergency Management Agency (FEMA) indicates that the Hampton Arroyo is encompassed by Flood Insurance Rate Map (FIRM) Panel 35045C0730F, dated August 5, 2010. The FIRM Panel indicates that the Hampton Arroyo is located within Flood Zones "X", "A", and "AE". Flood Zone

"X", "A", and "AE" are defined by the Federal Emergency Management Agency (FEMA) and the FIRM Panel as follows:

Floodzone "X":

Other Flood Areas; Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with with drainage areas less than one square mile; and areas protected by levees from 1% annual chance flood.

Floodzone "A":

Special Flood Hazard Areas (SFHAs) subject to inundation by the 1% annual chance flood; No Base Flood Elevations determined.

Floodzone "AE":

Special Flood Hazard Areas (SFHAs) subject to inundation by the 1% annual chance flood; Base Flood Elevations determined.

The effective FIRM panels are attached in Appendix A.

Survey and Mapping Information

The City of Aztec provided 1-ft contour Light Detection and Ranging (LiDAR) topographic data for use in the watershed delineation and hydrologic/hydraulic analysis. The topographic data provided by the City of Aztec is based on the following datums:

- Horizontal Datum: Re-projected into the New Mexico State Plane West, North American Datum 1983 (NAD83) coordinate system North American Datum 1983 (NAD83), projected to State Plane New Mexico West projection
- Vertical Datum: North American Vertical Datum 1988 (NAVD88)

The contour data was deemed suitable for use in this study due to the high density of point data used in the survey collection process which increases the accuracy and reliability of the data set. The LiDAR data was collected in April 2015. Aerial imagery was also collected and provided by the City of Aztec.

Public Outreach

AECOM assisted Aztec with public outreach and coordination. Several community outreach meetings were conducted to interact with residents. Residents and community leaders expressed their concerns and related their individual flood stories. Large displays were created to show modeling results to the public and explained them to homeowners. Residents reviewed the model results and shared their

public and explained them to homeowners. Residents reviewed the model results and shared their observations according to flooding events. The observations and input were received and used to calibrate the model results based on resident input.

Hydrology

A multi-frequency hydrologic analysis was prepared for the Hampton Arroyo watershed. A unit hydrograph based hydrologic analysis was prepared with the use of the U.S. Army Corps of Engineers Hydrologic Modeling System (HEC-HMS) Version 4.1, in conjunction with analysis criteria established in the New Mexico State Highway and Transportation Department (NMSHTD) Hydrology Manual Volume 1. The Environmental Systems Research Institute's (ESRI) ArcGIS mapping platform was also used to identify all sub-basin hydrologic parameters within the watershed.

Peak storm flows were computed throughout the Hampton Arroyo Watershed for the following events.

- 2-year, 24-hour
- 10-year, 24-hour
- 25-year, 24-hour
- 50-year, 24-hour
- 100-year, 24-hour

Research was also performed on the recent high magnitude storm that occurred in August of 2015. Anecdotal information obtained from residents within the watershed was used to characterize the frequency / magnitude of the storm for comparison to 25- and 100-year events.

A detailed discussion of the analysis criteria, development of hydrologic parameters, and modeling results obtained as part of the hydrologic analysis is included in the following sections.

Watershed Delineation

A contributing watershed and sub-basin delineation were prepared for the Hampton Arroyo based on the detailed digital topography provided by the City of Aztec. Sub-basins were generally delineated based on uniformity of sub-basin size, topography, and land surface characteristics. Watershed concentration points were established at key analysis points throughout the watershed including junctions and points of inflow into the Kokopelli Subdivision along its north and east boundary. A series of fourteen sub-basins were delineated within the Hampton Arroyo watershed. Sub-basin areas were identified with ArcGIS for use in the HEC-HMS model.

The watershed and sub-basin delineation superimposed on aerial imagery is graphically illustrated on Figure 2.

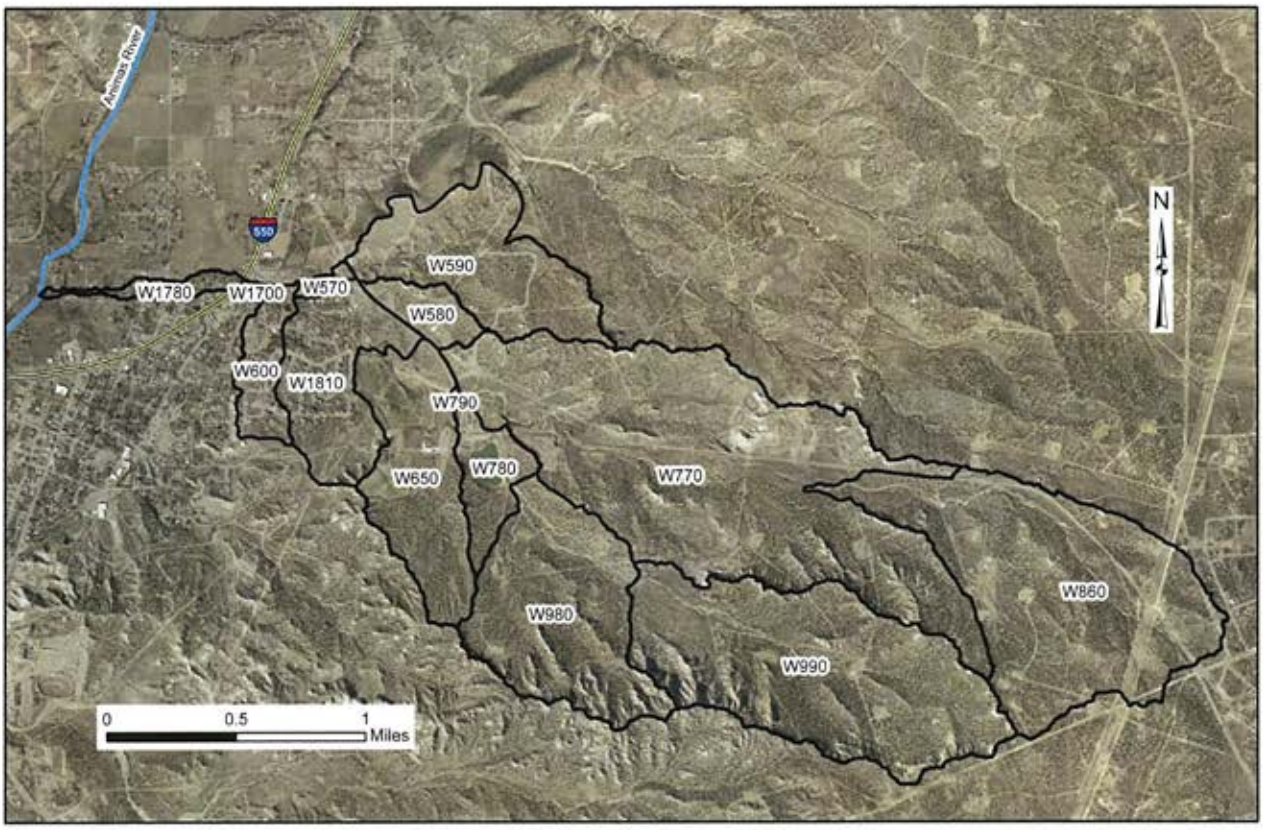


Figure 2: Watershed and Sub-Basin Boundary Map

The sub-basin delineation and routing schematic developed within the HEC-HMS model is graphically illustrated on Figure 3.

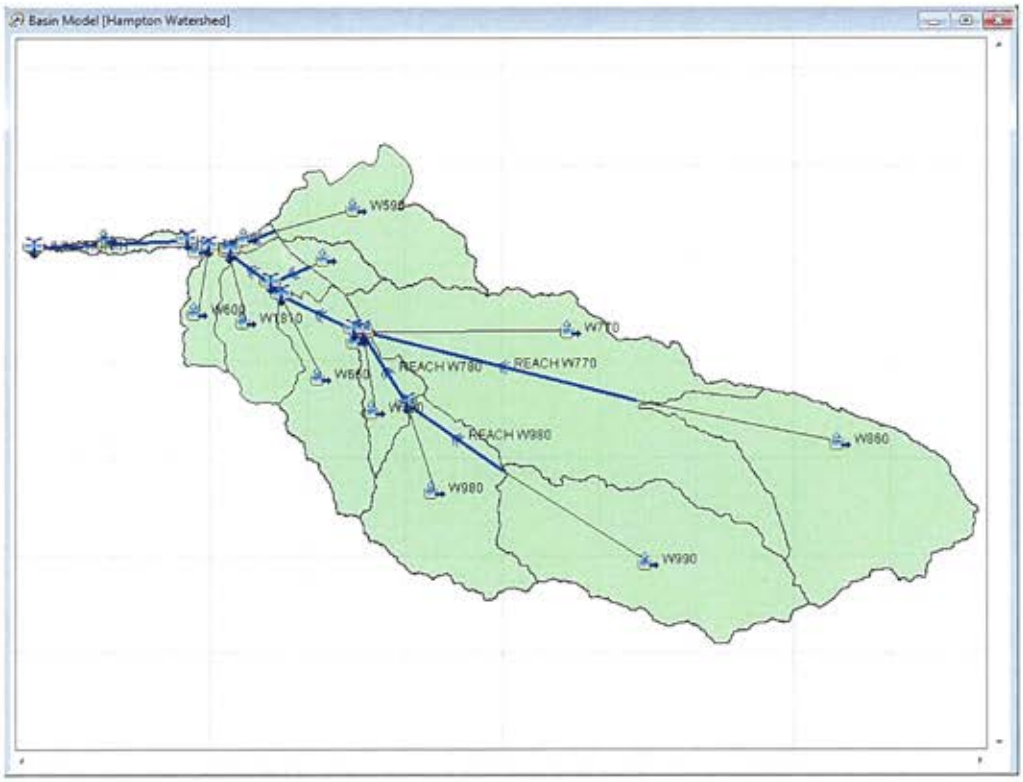


Figure 3: HEC-HMS Hampton Arroyo Schematic

Time of Concentration

Sub-basin times of concentration or the time required for water to flow within the primary watercourse from the hydraulically furthest point in the watershed to the downstream concentration point were estimated based on the detailed topography provided by the City of Aztec. The *New Mexico State Highway and Transportation Department (NMSHTD) Hydrology Manual Volume 1* requires use of the upland method coupled with the stream hydraulic method for estimation of sub-basin time of concentration unit hydrograph analyses. Three (3) flow patterns considered in the development of time of concentration include sheet flow, shallow concentrated flow, and open channel flow.

Sheet flow characteristics were assumed to occur in the upper 300 feet of the sub-basin areas, transitioning to shallow concentrated flow until a defined channel is reached. The sum of the three components yields the total time of concentration. A sub-basin lag time equivalent to 60% of the time of concentration required for unit hydrograph transformation was used for each hydrograph.

Sub-basin time of concentration and lag time values are summarized in Appendix A.

Soil Infiltration

Soil infiltration parameters were estimated for each sub-basin for incorporation into the HEC-HMS model. The *New Mexico State Highway and Transportation Department (NMSHTD) Hydrology Manual*

Volume 1 requires use of the Soil Conservation Service (SCS) Curve Number (CN) Method for soil infiltration parameters. Aerially weighted CN values for each sub-basin were estimated based on land cover type(s) and hydrologic soil group(s) identified by soil surveys available from the United States Department of Agriculture's Natural Resources Conservation Service.

Initial abstraction (IA) values were also estimated for each sub-basin within the watershed with a global cap of 0.350 inches applied to provide a more conservative estimate of peak storm flows.

Hydrograph Routing

The *New Mexico State Highway and Transportation Department (NMSHTD) Hydrology Manual Volume 1* requires use of Muskingum-Cunge hydrograph routing methodology within the HEC-HMS model. Routing or translation of hydrographs is performed by characterization of a routing reach with eight-point cross-sectional geometry, channel slope, and Manning's roughness coefficients. Cross-sectional geometry and channel slopes were estimated based on slopes and reach lengths identified from the detailed digital topography.

Rainfall Distribution

AECOM incorporated precipitation data into the hydrologic models in accordance with NMSHTD guidelines coupled with National Oceanic and Atmosperic Administration (NOAA) Atlas 14 precipitation data for each of the storms indicated previously. The precipitation depth, duration, frequency data based on the centroid of the Hampton Arroyo Watershed is summarized in the Table 1.

Table 1: NOAA 14 Precipitation Depths

PRECIPITATION DEPTH [inches]								
DURATION	STORM FREQUENCY							
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR
5-min	0.151	0.194	0.261	0.316	0.395	0.460	0.530	0.714
10-min	0.229	0.295	0.397	0.481	0.601	0.701	0.807	1.09
15-min	0.284	0.366	0.493	0.596	0.745	0.869	1.00	1.35
30-min	0.383	0.493	0.663	0.803	1.00	1.17	1.35	1.82
60-min	0.474	0.610	0.821	0.994	1.24	1.45	1.67	2.25
2-hr	0.548	0.697	0.924	1.11	1.39	1.62	1.87	2.53
3-hr	0.597	0.752	0.974	1.16	1.43	1.65	1.90	2.55
6-hr	0.718	0.892	1.12	1.32	1.60	1.83	2.08	2.74
12-hr	0.860	1.07	1.32	1.53	1.81	2.03	2.26	2.83
24-hr	0.972	1.22	1.54	1.81	2.17	2.46	2.76	3.51

Notes:
1. Precipitation data based on watershed centroid at Latitude 36.8202°, Longitude -107.9537°.

For hydrologic studies in the State of New Mexico, a modified NOAA-SCS rainfall distribution is used for modelling storm events. This distribution establishes the peak rainfall intensity at hour six in a 24-hour storm event.The procedure for development of the distribution is found in the *New Mexico State Highway and Transportation Department (NMSHTD) Hydrology Manual Volume I* in section 3.3.1.2.3. The rainfall distribution is unique to the Hampton Arroyo Watershed and developed for each of the 2-, 10-, 25-, 50-, and 100-year; 24-hour events modeled herein. Each frequency specific distribution is summarized in Table 2.

Table 2: Frequency Specific Distribution

DURATION [hours]	CUMULATIVE DEPTH [%]					
	2-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR	500-YEAR
0	0	0	0	0	0	0
1	0.024	0.019	0.016	0.014	0.011	0.004
2	0.049	0.039	0.032	0.027	0.022	0.009
3	0.073	0.058	0.048	0.041	0.033	0.013
4	0.111	0.087	0.075	0.065	0.054	0.031
4.5	0.130	0.102	0.088	0.077	0.065	0.040
5.0	0.153	0.116	0.097	0.083	0.071	0.043
5.25	0.171	0.132	0.114	0.101	0.089	0.063
5.5	0.189	0.148	0.131	0.118	0.107	0.083
5.75	0.236	0.201	0.187	0.175	0.165	0.144
6.0	0.536	0.530	0.530	0.528	0.527	0.528
3.5	0.641	0.644	0.647	0.650	0.654	0.662
4.0	0.689	0.697	0.703	0.707	0.712	0.724
5.0	0.706	0.713	0.720	0.725	0.730	0.744
6.0	0.724	0.729	0.737	0.742	0.748	0.764
7.0	0.747	0.743	0.747	0.748	0.754	0.766
8.0	0.766	0.758	0.760	0.760	0.764	0.775
9.0	0.804	0.787	0.786	0.785	0.786	0.793
10.0	0.828	0.807	0.802	0.798	0.797	0.798
11.0	0.853	0.826	0.818	0.812	0.808	0.802
12.0	0.877	0.845	0.834	0.825	0.819	0.806
14.0	0.898	0.871	0.862	0.854	0.849	0.839
16.0	0.918	0.897	0.889	0.883	0.879	0.871
18.0	0.939	0.923	0.917	0.913	0.909	0.903
20.0	0.959	0.948	0.945	0.942	0.939	0.935
22.0	0.980	0.974	0.972	0.971	0.970	0.968
24.0	1.00	1.00	1.00	1.00	1.00	1.00

A storm event simulation using the basin, soil, and routing parameters as well as the precipitation distributions were developed for each identified storm frequency. Storm simulations were executed for 24-hour periods to characterize the time and magnitude of peak flows within the watershed.

The details of the rainfall distribution and hydrologic calculations are attached in Appendix B.

Results

Peak flows at specific concentration points within the watershed are summarized in Table 3. Comprehensive peak flow summaries are included in **Appendix B**.

Table 3: Peak Flow Summary

CONC PT(1)	DESC	AREA [mi^2]	PEAK FLOW [ft^3/sec]				
			2-YR	10-YR	25-YR	50-YR	100-YR
JUNCTION 1E	Kokopelli Sub	3.694	120	394	660	946	1293
W590	Navajo Rd	0.350	13	55	92	130	174
JUNCTION 1H	Aztec Blvd	4.488	215	502	828	1171	1588
JUNCTION 1I	Animas River	4.526	216	502	832	1176	1593

Notes:
1. Concentration point identifier indicated based on HEC-HMS model .

Historical Storm Investigation

AECOM performed an investigation to characterize the magnitude of the historical August 2015 storm event in addition to the simulations mentioned previously. Research into available historic rainfall data in the vicinity of the Hampton Arroyo Watershed however yielded limited information. No United States Geological Survey (USGS) or National Weather Service (NWS) gages were found within the vicinity of the Hampton Arroyo watershed. The closest gage to the Hampton Arroyo Watershed was found to be a gage located over 16 miles away at the Farmington Regional Airport operated by the New Mexico State University (NMSU) Climate Center. The gage measures and reports rainfall quantities on single day time intervals. Review of the daily rainfall data in a timeframe similar to the storm that occurred in Aztec however did not reveal a similar or significant magnitude storm.

AECOM therefore collected anecdotal storm and rainfall information from constituents during the public involvement phase of this project at the request of the City of Aztec. Anecdotal measurements provided by residents suggested estimates of 3.5 inches in a 24-hour period, in the area. A simple comparison to NOAA Atlas 14 precipitation data in Table 1 suggests that the Aztec area may have experienced a storm event similar in magnitude to a 500-year event (3.51 inches) in August of 2015. A modified NOAA-SCS rainfall distribution based on the 500-year NOAA Atlas 14 precipitation data was therefore developed and incorporated into a Historic Condition HEC-HMS model to simulate the August 2015 event. The peak flow results are summarized in the following Table.

Table 4: Peak Flow Results

CONC PT	DESC	AREA [mi^2]	Q_{500yr} [ft^3/sec]
JUNCTION 1E	Kokopelli Sub	3.694	2315
W590	Navajo Rd	0.350	306
JUNCTION 1H	Aztec Blvd	4.488	2822
JUNCTION 1I	Animas River	4.526	2833

Comprehensive peak flow summaries for the historic event are included in **Appendix B**.

Hydraulics

AECOM developed a one-dimensional, standard step backwater riverine hydraulic analysis for the lower 1.5 linear miles of the Hampton Arroyo, upstream from the Animas River Outfall. The hydraulic analysis was based on the use of the U.S. Army Corps of Engineer's River Analysis System, HEC-RAS, Version 4.1.0 coupled with the more detailed digital topography of the watershed provided by the City of Aztec.

As mentioned previously, the lower portion of the Hampton Arroyo is located within an effective Floodzone "A" / "AE" Special Flood Hazard Area. The hydraulic analysis and delineation presented herein are based on more detailed methodology and topography.

Methodology

Elements of the methodology associated with the Hampton Arroyo HEC-RAS Hydraulic Analysis are discussed in the following sections.

Hydraulic Baseline

The hydraulic baseline was extended along the flow line of the Arroyo from the outfall at the Animas River upstream toward the limits of this detailed study based on the detailed topography.

Cross-Section Geometry

A series of fifty-nine hydraulic cross-sections were oriented normal to flow and along the corridor at approximate 200-foot intervals. Additional cross-sections were incorporated where additional detail was needed such as at hydraulic structures and arroyo crossings. The cross-sections were cut from the detailed digital topography provided and identified by river stations measured from the confluence with the Animas River outfall.

Manning's N-Value

Manning's roughness coefficients for left and right overbanks and channel components were selected for use in the Hampton Arroyo based on values identified in the *New Mexico State Highway and Transportation Department (NMSHTD) Hydraulics Manual Volume II.* A value of 0.100 was used for left and right overbanks based on an assumption of natural channels with medium to dense brush in summer. A value of 0.045 was used for the channel component based on an assumption of obervations of the channel bed and obstructions.

Culverts/Bridges

Existing bridges at Sabena Road, Aztec Boulevard and McCoy Avenue were analyzed in the HEC-RAS model using information collected during the field reconnaissance and the existing terrain

data. As-built plans were not available for the bridges. An existing culvert is located near the outfall of the arroyo into the Animas River and was not included in the hydraulic analysis due to its propensity to become clogged during larger storm events. The culvert will be upgraded as part of a future project.

Expansion / Contraction Coefficients

Expansion and contraction coefficients used for the hydraulic analysis were based on the values recommended in the HEC-RAS Hydraulic Reference Manual (USACE, 2016). The coefficients used were:

- Cross sections: Expansion and contraction coefficients of 0.1 and 0.3, respectively
- Bridges and culverts: Expansion and contraction coefficients of 0.3 and 0.5, respectively

Further details of the hydraulic calculation are attached in Appendix C.

Results

The results of the HEC-RAS model and Work Maps are shown in Appendix C. The HEC-RAS model results indicate that the flooding is contained within the channel throughout the sub-division area except at the confluence with Animas River from a 25-year storm event. Similar results are shown for the 100-year event.

Conclusions and Recommended Plan

- The 2010 effective flood maps water elevations are generally 1 to 3 feet lower when compared to the new floodplain study. The difference is attributed to the updated topography, culvert assumptions and hydrology method used.
- The water surface elevation from the historic August 2015 event was compared to the water surface elevation from the 100-year storm event. The water surface from the historic 2015 storm event was higher by an average of 2.5 feet. The results indicate that the historic 2015 storm event was closer to the 500-year storm event. The floodplain from the historic 2015 event showed that the flooding is contained with the channel except at Sabena Street and near the confluence with Animas River.
- Field visit to the Hampton Arroyo indicated that there are several grade control structures constructed from rock filled baskets, and portions of the structures have collapsed in some areas. It is recommended to repair these structures and retrofit the rock filled baskets to prevent further erosion of the channel.

- The grade controls and culvert locations need to periodically maintained to avoid overtopping and loss of conveyance.

References

United State Army Corps of Engineers (USACE), 2015. Hydraulic Engineering Center Hydrologic Modeling System (HEC-HMS) [software package]. Version 4.1 July 2015.

United State Army Corps of Engineers (USACE), 2016. Hydraulic Engineering Center River Analysis System (HEC-RAS) [software package]. Version 4.1 January 2010.

United States Department of Commerce, National Oceanic and Atmospheric Administration, *NOAA Atlas 14, Volume 1, Version 5*, 2009.

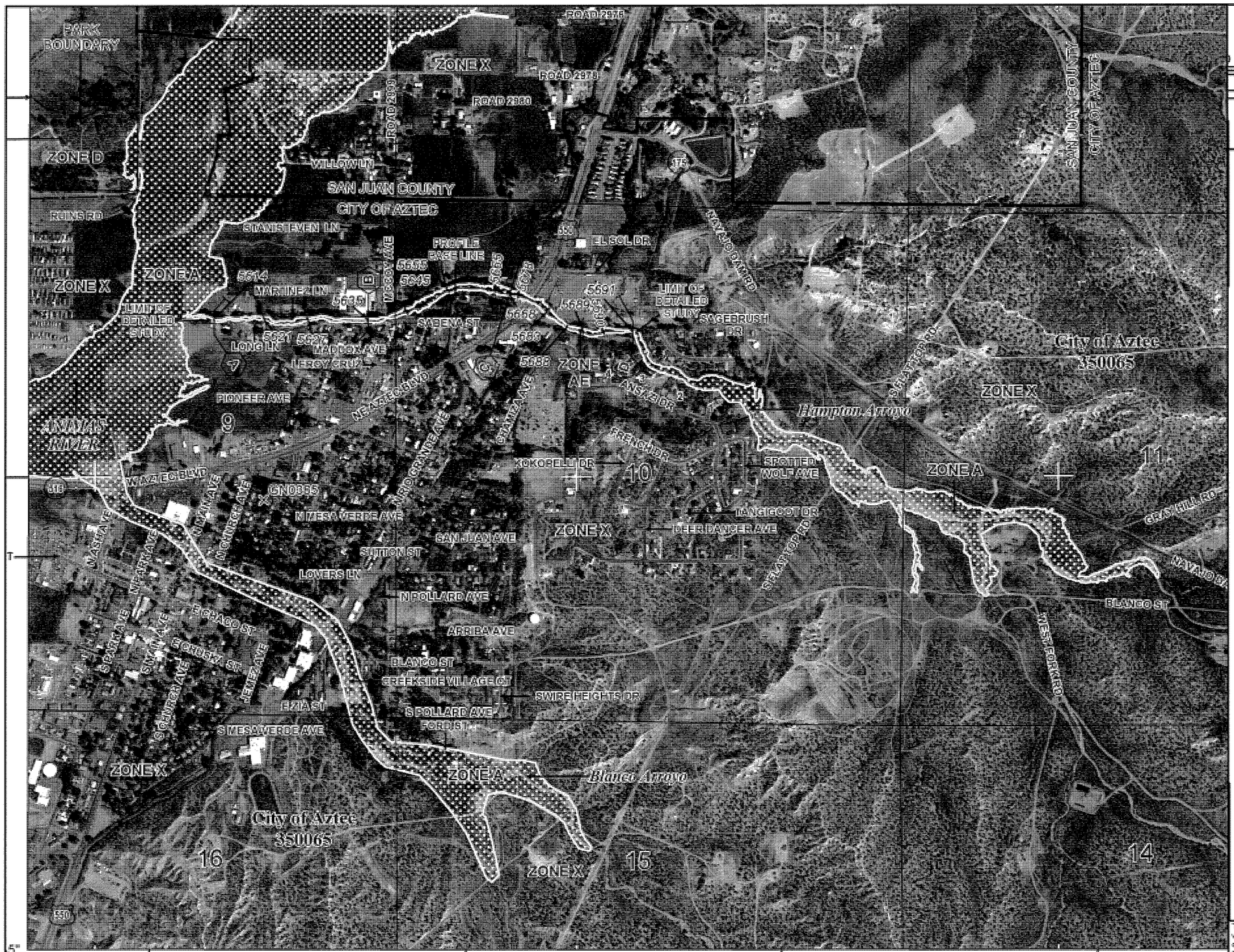
United States Department of Agriculture, Natural Resources Conservation Service, *Custom Soil Resource Report,* January 2016

United States Department of Agriculture, Soil Conservation Service, *Urban Hydrology for Small Watersheds*, June 1986.

New Mexico State and Highway Transportation Department. *Drainage Manual Volume I: Hydrology* December 1995.

New Mexico State and Highway Transportation Department. *Drainage Manual Volume II: Hydraulics, Sedimentation, and Erosion*, November 1998.

Appendix A – FEMA Effective FIRM Panel



This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix B – Hydrologic Calculation

AECOM	Calculation Sheet				
Project Name:	Hampton Arroyo			**Calculation Number:**	1A
Client Name:	City of Aztec, New Mexico			**Revision Number:**	0
Project Number:	**Job No.**	**Cost Code**	**Parent (if any)**	**Prepared By/Date:**	PDC / 4-28-2016
	60487360	20000	N/A		
Title:	Hydrologic Analysis Using HEC-HMS				

PROBLEM STATEMENT:

The purpose of this calculation package is to document the hydrologic analysis prepared by AECOM for the watershed draining toward the Hampton Arroyo using HEC-HMS version 4.1.

REQUIRED DELIVERABLES:

- Multi-frequency (2; 10; 25; 50; 100-year; and Historic; 24-hour) peak flows along the Hampton Arroyo.
- Estimated magnitude of the August 2015 storm event peak flows based on limited approximate information provided by residents.

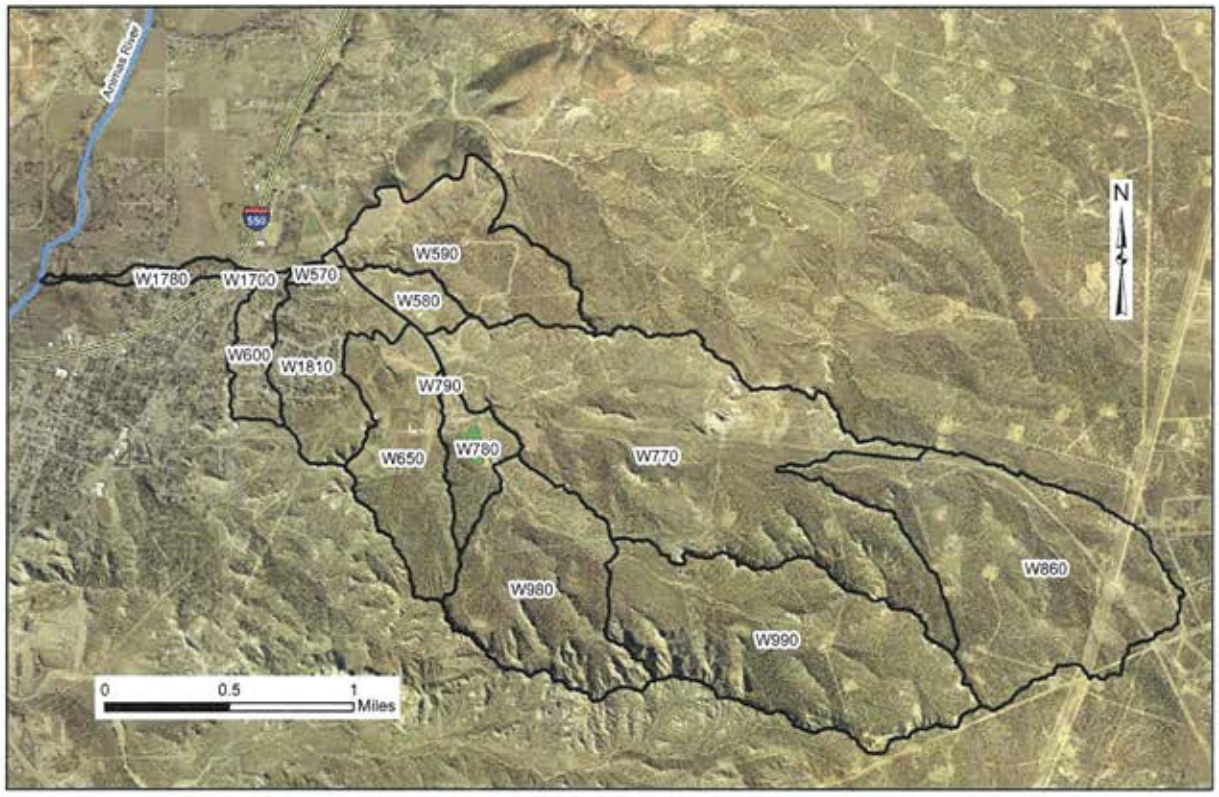
DATA /ASSUMPTIONS:

- Drainage area was delineated using 1-ft contour LiDAR data provided by the City of Aztec.
- Rainfall data for the watershed was obtained from NOAA Atlas 14, Volume 1; Version 5.
- SCS Unit Hydrograph Methodology.
- Modified NOAA-SCS rainfall distribution based on New Mexico Department of Transportation (NMDOT) procedures.
- Rainfall loss methodology based on the SCS Curve Number methods.
- Hydrologic soil group (HSG) was determined using the USDA NRCS Soil Report for Aztec, New Mexico. The watershed area consists of HSG classes A, B, C and D soil types.
- Soil impervious area percentages were estimated from readily available aerial imagery.
- Cover type was selected to be "Desert Shrub" in poor condition for the undeveloped areas due to the lack of vegetative cover observed in the field or visible on readily available aerial imagery. One area in the project areas is a cemetery and is marked as fair condition due to the percentage of vegetative cover. Runoff curve numbers were selected using TR-55 Table 2-2a and 2-2d.
- Residential properties outside of the subdivision were assumed to be 1/3 acre lots. Residential properties inside the subdivisions were assumed to be 1/4 acre lots.

Variable Definitions

T_c	Time of Concentration	P_2	2-year, 24-hour rainfall	V	*Velocity*
T_{tn}	Travel time for location 'n'	n	Manning's n value	T_t	Lag time
L	Length of drainage segment	CN	Curve Number	s	Channel slope
r	Hydraulic radius	I_a	Initial abstraction		

Figure 1 – Watershed Delineation Map



HYDROLOGIC ANALYSIS

METHODOLOGY:

Watershed Delineation: The contributing watershed shown in Figure 1 was delineated using 10ft contour data provided by the City of Aztec.

Time of Concentration: Time required for water to flow from the hydraulically furthest point in the watershed to the concentration point. The time of concentration can be represented by sheet flow, shallow concentrated flow, and open channel flow components.

$$T_c = T_{t1} + T_{t2} + T_{t3}$$

Sheet flow: According to TR-55 Methodology, the first 300ft of the drainage area can be modeled as sheet flow. The sheet flow travel time can be determined using the following equation.

$$T_{t1} = \frac{0.007 * (nL)^{0.8}}{P_2^{0.5} * s^{0.4}}$$

Shallow Concentrated Flow: After the 300ft of sheet flow, shallow concentrated flow begins and continues until a defined channel is reached. The travel time for this segment of the drainage area is estimated using Figure 3-1 from TR-55 along with the calculated slope to find the corresponding T_{t2}.

Open Channels: Once a defined channel is reached, the flow transitions from Shallow Concentrated Flow to Open Channel Flow. Open channel flow is modeled with a variation of Manning's equation in which velocity is the unknown. Velocity is estimated using the following equation.

$$V = \frac{1.49 * r^{\frac{2}{3}} * s^{\frac{1}{2}}}{n}$$

The estimated velocity is then used in the following equation to determine the travel time for Open Channel Flow.

$$T_{t3} = \frac{L}{3600 * V}$$

Lag Time: When modeling the drainage area in HEC-HMS using the SCS Unit Hydrograph transform, a lag time is needed for the model to run. Lag time is determined using the following equation.

$$T_l = 0.6 * T_c$$

Initial Abstraction: Storm water that is lost to the environment before rainfall-runoff occurs is referred to as initial abstraction. This value I_a determined using the following equation.

$$I_a = 0.2 * X$$

Where:

$$X = \frac{1000}{CN} - 10$$

Engineering judgement was used in consideration of precipitation values in the area and runoff estimates to apply a global cap of 0.350 inches for initial abstraction in the HEC-HMS model. This better reflects the drainage conditions encountered in the Hampton Arroyo watershed and provides a more conservative estimate of peak storm flows.

All inputs regarding impervious area, CN runoff numbers, and Lag Time calculations are provided in Attachment 1.

Hydrologic Results:

Table 1: Sub-Basin Parameters Summary

Sub-basin	A (mi^2)	Length (ft)	Tc (hrs)	Lag Time (mins)	CN	I_A (inches)	Impervious Area (%)
W570	0.015	1,482	0.195	7.02	80	0.350	10%
W580	0.070	2,248	0.114	4.10	81	0.350	3%
W590	0.350	7,665	0.452	16.27	84	0.350	5%
W600	0.096	3,398	0.387	13.93	77	0.350	45%
W650	0.328	7,168	0.362	13.03	70	0.350	10%
W770	1.229	3,383	0.372	13.39	78	0.350	10%
W780	0.111	4,440	0.356	12.82	75	0.350	20%
W790	0.003	300	0.037	1.33	72	0.350	30%
W860	0.799	10,676	0.440	15.84	78	0.350	5%
W980	0.468	6,458	0.445	16.02	83	0.350	1%
W990	0.756	8,650	0.583	20.99	82	0.350	2%
W1700	0.006	693	0.090	3.24	88	0.273	80%
W1780	0.038	4,364	0.159	5.72	73	0.350	25%
W1810	0.257	3,229	0.189	6.80	77	0.350	60%

Table 1 summarizes the sub-basin parameters used for the watershed area that were input into the HEC HMS model. The details of the hydrologic calculations for each of sub-basins are attached in Attachment A. Tables 2a through 2f summarize the HEC HMS summary table with the peak discharge from the sub-basins and concentration points. Table 3 summarizes the HEC-HMS summary table for the August 2015 storm event.

Table 2a: 100-year; 24-hour HEC HMS Summary

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time to Peak
W990	0.756	292.70	01Jan2050, 00:42
REACH W980	0.756	292.30	01Jan2050, 00:49
W980	0.468	206.40	01Jan2050, 00:36
JUNCTION 1B	1.224	462.60	01Jan2050, 00:45
REACH W780	1.224	462.30	01Jan2050, 00:49
W780	0.111	65.90	01Jan2050, 00:26
JUNCTION 1C	1.335	496.60	01Jan2050, 00:48
W860	0.799	318.00	01Jan2050, 00:35
REACH W770	0.799	317.50	01Jan2050, 00:50
W770	1.229	591.40	01Jan2050, 00:29
JUNCTION 1A	3.363	1209.40	01Jan2050, 00:44
REACH W790	3.363	1209.40	01Jan2050, 00:45
W790	0.003	3.50	01Jan2050, 00:15
JUNCTION 1D	3.366	1210.10	01Jan2050, 00:45
REACH W650	3.366	1209.50	01Jan2050, 00:47
W650	0.328	129.60	01Jan2050, 00:28
JUNCTION 1E	3.694	1293.40	01Jan2050, 00:46
REACH W1810A	3.694	1292.80	01Jan2050, 00:47
W580	0.070	49.70	01Jan2050, 00:17
REACH W1810B	0.070	49.10	01Jan2050, 00:20
JUNCTION 1EA	3.764	1309.00	01Jan2050, 00:47
REACH W1810C	3.764	1307.90	01Jan2050, 00:48
W1810	0.257	403.10	01Jan2050, 00:18
JUNCTION 1F	4.021	1396.60	01Jan2050, 00:48
W590	0.350	173.70	01Jan2050, 00:35
REACH W570	0.350	173.60	01Jan2050, 00:37
W570	0.015	10.00	01Jan2050, 00:20
JUNCTION 1FA	4.386	1545.60	01Jan2050, 00:48
REACH W600	4.386	1544.00	01Jan2050, 00:49
W600	0.096	92.30	01Jan2050, 00:25
JUNCTION 1G	4.482	1587.00	01Jan2050, 00:49
REACH W1700	4.482	1585.70	01Jan2050, 00:49
W1700	0.006	13.50	01Jan2050, 00:15
JUNCTION 1H	4.488	1588.00	01Jan2050, 00:49
REACH W1780	4.488	1584.30	01Jan2050, 00:54
W1780	0.038	33.60	01Jan2050, 00:18
JUNCTION 1I	4.526	1593.20	01Jan2050, 00:54

Table 2b: 50-year; 24-hour HEC HMS Summary

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time to Peak
W990	0.756	215.10	01Jan2050, 00:43
REACH W980	0.756	214.90	01Jan2050, 00:50
W980	0.468	150.90	01Jan2050, 00:37
JUNCTION 1B	1.224	339.40	01Jan2050, 00:47
REACH W780	1.224	339.10	01Jan2050, 00:51
W780	0.111	52.40	01Jan2050, 00:26
JUNCTION 1C	1.335	364.90	01Jan2050, 00:50
W860	0.799	235.50	01Jan2050, 00:35
REACH W770	0.799	235.00	01Jan2050, 00:52
W770	1.229	447.60	01Jan2050, 00:29
JUNCTION 1A	3.363	886.10	01Jan2050, 00:47
REACH W790	3.363	886.00	01Jan2050, 00:47
W790	0.003	2.90	01Jan2050, 00:15
JUNCTION 1D	3.366	886.60	01Jan2050, 00:47
REACH W650	3.366	885.80	01Jan2050, 00:49
W650	0.328	99.00	01Jan2050, 00:28
JUNCTION 1E	3.694	946.10	01Jan2050, 00:49
REACH W1810A	3.694	945.80	01Jan2050, 00:49
W580	0.070	35.60	01Jan2050, 00:17
REACH W1810B	0.070	35.50	01Jan2050, 00:20
JUNCTION 1EA	3.764	958.60	01Jan2050, 00:49
REACH W1810C	3.764	958.20	01Jan2050, 00:51
W1810	0.257	342.10	01Jan2050, 00:18
JUNCTION 1F	4.021	1031.60	01Jan2050, 00:51
W590	0.350	129.50	01Jan2050, 00:36
REACH W570	0.350	129.40	01Jan2050, 00:38
W570	0.015	7.50	01Jan2050, 00:20
JUNCTION 1FA	4.386	1138.60	01Jan2050, 00:50
REACH W600	4.386	1136.70	01Jan2050, 00:52
W600	0.096	77.30	01Jan2050, 00:25
JUNCTION 1G	4.482	1169.50	01Jan2050, 00:51
REACH W1700	4.482	1168.50	01Jan2050, 00:52
W1700	0.006	11.60	01Jan2050, 00:15
JUNCTION 1H	4.488	1170.50	01Jan2050, 00:52
REACH W1780	4.488	1168.10	01Jan2050, 00:57
W1780	0.038	27.10	01Jan2050, 00:18
JUNCTION 1I	4.526	1175.50	01Jan2050, 00:57

Table 2c: 25-year; 24-hour HEC HMS Summary

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time to Peak
W990	0.756	149.80	01Jan2050, 00:43
REACH W980	0.756	149.60	01Jan2050, 00:52
W980	0.468	104.30	01Jan2050, 00:38
JUNCTION 1B	1.224	235.80	01Jan2050, 00:49
REACH W780	1.224	235.70	01Jan2050, 00:54
W780	0.111	40.90	01Jan2050, 00:25
JUNCTION 1C	1.335	254.70	01Jan2050, 00:53
W860	0.799	166.40	01Jan2050, 00:36
REACH W770	0.799	166.00	01Jan2050, 00:55
W770	1.229	326.30	01Jan2050, 00:29
JUNCTION 1A	3.363	618.90	01Jan2050, 00:50
REACH W790	3.363	618.80	01Jan2050, 00:50
W790	0.003	2.30	01Jan2050, 00:15
JUNCTION 1D	3.366	619.30	01Jan2050, 00:50
REACH W650	3.366	619.10	01Jan2050, 00:53
W650	0.328	73.50	01Jan2050, 00:28
JUNCTION 1E	3.694	660.40	01Jan2050, 00:53
REACH W1810A	3.694	660.40	01Jan2050, 00:53
W580	0.070	24.00	01Jan2050, 00:18
REACH W1810B	0.070	23.80	01Jan2050, 00:21
JUNCTION 1EA	3.764	670.10	01Jan2050, 00:53
REACH W1810C	3.764	669.80	01Jan2050, 00:55
W1810	0.257	286.40	01Jan2050, 00:18
JUNCTION 1F	4.021	730.00	01Jan2050, 00:55
W590	0.350	91.80	01Jan2050, 00:37
REACH W570	0.350	91.80	01Jan2050, 00:39
W570	0.015	5.40	01Jan2050, 00:20
JUNCTION 1FA	4.386	802.50	01Jan2050, 00:54
REACH W600	4.386	802.10	01Jan2050, 00:55
W600	0.096	63.80	01Jan2050, 00:25
JUNCTION 1G	4.482	826.30	01Jan2050, 00:55
REACH W1700	4.482	825.80	01Jan2050, 00:56
W1700	0.006	9.80	01Jan2050, 00:15
JUNCTION 1H	4.488	827.50	01Jan2050, 00:56
REACH W1780	4.488	826.10	01Jan2050, 01:02
W1780	0.038	21.40	01Jan2050, 00:18
JUNCTION 1I	4.526	831.90	01Jan2050, 01:02

Table 2d: 10-year; 24-hour HEC HMS Summary

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time to Peak
W990	0.756	86.00	01Jan2050, 00:45
REACH W980	0.756	86.00	01Jan2050, 00:55
W980	0.468	59.00	01Jan2050, 00:40
JUNCTION 1B	1.224	135.60	01Jan2050, 00:53
REACH W780	1.224	135.50	01Jan2050, 00:58
W780	0.111	29.00	01Jan2050, 00:25
JUNCTION 1C	1.335	147.90	01Jan2050, 00:58
W860	0.799	99.20	01Jan2050, 00:37
REACH W770	0.799	109.40	01Jan2050, 00:53
W770	1.229	205.90	01Jan2050, 00:30
JUNCTION 1A	3.363	382.30	01Jan2050, 00:53
REACH W790	3.363	372.70	01Jan2050, 00:53
W790	0.003	1.70	01Jan2050, 00:15
JUNCTION 1D	3.366	373.00	01Jan2050, 00:53
REACH W650	3.366	368.70	01Jan2050, 01:01
W650	0.328	48.30	01Jan2050, 00:27
JUNCTION 1E	3.694	394.20	01Jan2050, 00:57
REACH W1810A	3.694	393.90	01Jan2050, 01:01
W580	0.070	12.50	01Jan2050, 00:18
REACH W1810B	0.070	12.30	01Jan2050, 00:22
JUNCTION 1EA	3.764	400.50	01Jan2050, 01:01
REACH W1810C	3.764	400.40	01Jan2050, 01:04
W1810	0.257	223.10	01Jan2050, 00:17
JUNCTION 1F	4.021	444.70	01Jan2050, 01:01
W590	0.350	54.70	01Jan2050, 00:38
REACH W570	0.350	54.60	01Jan2050, 00:41
W570	0.015	3.30	01Jan2050, 00:20
JUNCTION 1FA	4.386	487.10	01Jan2050, 01:01
REACH W600	4.386	486.30	01Jan2050, 01:03
W600	0.096	48.90	01Jan2050, 00:24
JUNCTION 1G	4.482	502.20	01Jan2050, 01:03
REACH W1700	4.482	501.30	01Jan2050, 01:05
W1700	0.006	7.70	01Jan2050, 00:15
JUNCTION 1H	4.488	502.10	01Jan2050, 01:05
REACH W1780	4.488	500.30	01Jan2050, 01:11
W1780	0.038	15.40	01Jan2050, 00:17
JUNCTION 1I	4.526	502.10	01Jan2050, 01:11

Table 2e: 2-year; 24-hour HEC HMS Summary

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time to Peak
W990	0.756	19.80	01Jan2050, 01:09
REACH W980	0.756	19.80	01Jan2050, 01:26
W980	0.468	12.70	01Jan2050, 01:06
JUNCTION 1B	1.224	30.90	01Jan2050, 01:09
REACH W780	1.224	30.90	01Jan2050, 01:18
W780	0.111	15.40	01Jan2050, 00:23
JUNCTION 1C	1.335	34.20	01Jan2050, 01:16
W860	0.799	26.80	01Jan2050, 00:36
REACH W770	0.799	26.80	01Jan2050, 01:15
W770	1.229	84.20	01Jan2050, 00:24
JUNCTION 1A	3.363	100.00	01Jan2050, 00:24
REACH W790	3.363	99.90	01Jan2050, 00:24
W790	0.003	0.90	01Jan2050, 00:15
JUNCTION 1D	3.366	100.20	01Jan2050, 00:24
REACH W650	3.366	100.00	01Jan2050, 00:29
W650	0.328	22.60	01Jan2050, 00:23
JUNCTION 1E	3.694	120.40	01Jan2050, 00:29
REACH W1810A	3.694	120.30	01Jan2050, 00:30
W580	0.070	2.60	01Jan2050, 00:32
REACH W1810B	0.070	2.50	01Jan2050, 00:38
JUNCTION 1EA	3.764	122.00	01Jan2050, 00:30
REACH W1810C	3.764	121.80	01Jan2050, 00:33
W1810	0.257	133.90	01Jan2050, 00:17
JUNCTION 1F	4.021	178.80	01Jan2050, 00:32
W590	0.350	13.40	01Jan2050, 00:41
REACH W570	0.350	13.40	01Jan2050, 00:45
W570	0.015	1.30	01Jan2050, 00:17
JUNCTION 1FA	4.386	191.40	01Jan2050, 00:32
REACH W600	4.386	191.00	01Jan2050, 00:33
W600	0.096	28.60	01Jan2050, 00:24
JUNCTION 1G	4.482	213.70	01Jan2050, 00:33
REACH W1700	4.482	213.30	01Jan2050, 00:34
W1700	0.006	4.50	01Jan2050, 00:15
JUNCTION 1H	4.488	214.60	01Jan2050, 00:34
REACH W1780	4.488	213.40	01Jan2050, 00:41
W1780	0.038	8.50	01Jan2050, 00:16
JUNCTION 1I	4.526	215.50	01Jan2050, 00:41

AECOM prepared a hydrologic analysis to estimate the magnitude of the August 2015 storm event. Anecdotal rain gage measurements and rain gage information provided by residents at the request of the City of Aztec suggested estimates of 3.5 inches in a 24-hour period, in the area. Comparison to NOAA Atlas 14 records suggested that the Aztec area may have experienced a storm event similar in magnitude to a 500-year event in August of 2015. This storm event was modeled in HEC-HMS and is listed as 'Historic'. The results from HMS are in Table 3.

Table 3: Historical Storm Event HEC HMS Summary

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time to Peak
W990	0.756	526.10	01Jan2050, 00:40
REACH W980	0.756	525.10	01Jan2050, 00:49
W980	0.468	374.20	01Jan2050, 00:34
JUNCTION 1B	1.224	816.10	01Jan2050, 00:45
REACH W780	1.224	815.60	01Jan2050, 00:48
W780	0.111	106.80	01Jan2050, 00:26
JUNCTION 1C	1.335	872.70	01Jan2050, 00:47
W860	0.799	571.60	01Jan2050, 00:33
REACH W770	0.799	570.30	01Jan2050, 00:46
W770	1.229	1031.10	01Jan2050, 00:28
JUNCTION 1A	3.363	2161.90	01Jan2050, 00:42
REACH W790	3.363	2161.60	01Jan2050, 00:42
W790	0.003	5.50	01Jan2050, 00:15
JUNCTION 1D	3.366	2162.70	01Jan2050, 00:42
REACH W650	3.366	2160.70	01Jan2050, 00:44
W650	0.328	224.90	01Jan2050, 00:27
JUNCTION 1E	3.694	2315.30	01Jan2050, 00:43
REACH W1810A	3.694	2315.20	01Jan2050, 00:44
W580	0.070	93.10	01Jan2050, 00:17
REACH W1810B	0.070	92.10	01Jan2050, 00:19
JUNCTION 1EA	3.764	2341.80	01Jan2050, 00:44
REACH W1810C	3.764	2340.30	01Jan2050, 00:45
W1810	0.257	574.00	01Jan2050, 00:18
JUNCTION 1F	4.021	2473.70	01Jan2050, 00:45
W590	0.350	306.00	01Jan2050, 00:33
REACH W570	0.350	305.80	01Jan2050, 00:35
W570	0.015	17.70	01Jan2050, 00:20
JUNCTION 1FA	4.386	2743.90	01Jan2050, 00:44
REACH W600	4.386	2742.60	01Jan2050, 00:44
W600	0.096	135.10	01Jan2050, 00:25
JUNCTION 1G	4.482	2820.20	01Jan2050, 00:44
REACH W1700	4.482	2819.00	01Jan2050, 00:45
W1700	0.006	18.80	01Jan2050, 00:15
JUNCTION 1H	4.488	2822.20	01Jan2050, 00:45
REACH W1780	4.488	2819.30	01Jan2050, 00:48
W1780	0.038	53.20	01Jan2050, 00:18
JUNCTION 1I	4.526	2833.10	01Jan2050, 00:48

REFERENCES:

United State Army Corps of Engineers (USACE), 2015. Hydraulic Engineering Center Hydrologic Modeling System (HEC-HMS) [software package]. Version 4.1 July 2015.

United States Department of Commerce, National Oceanic and Atmospheric Administration, *NOAA Atlas 14, Volume 1, Version 5*, 2009.

United States Department of Agriculture, Natural Resources Conservation Service, *Custom Soil Resource Report*, January 2016

United States Department of Agriculture, Soil Conservation Service, *Urban Hydrology for Small Watersheds*, June 1986.

AECOM

Attachment 1

Table 1: Sub-basin Inventory

Basin Name	Area (sq. ft)	Area (sq. Mi)	Impervious Area Estimated From Aerial (%)
W570	431,304.561	0.015	10%
W580	1,961,005.211	0.070	3%
W590	9,746,153.481	0.350	5%
W600	2,687,261.479	0.096	45%
W650	9,155,415.474	0.328	10%
W770	34,262,389.653	1.229	10%
W780	3,107,575.041	0.111	20%
W790	86,269.786	0.003	30%
W860	22,265,260.162	0.799	5%
W980	13,060,458.342	0.468	1%
W990	21,062,524.723	0.756	2%
W1700	165,546.014	0.006	80%
W1780	1,063,010.834	0.038	25%
W1810	7,176,971.733	0.257	60%

Table 2: Sub-basin Runoff Curve Numbers

Basin Name	Soil Type Group A			Soil Type Group B			Soil Type Group C			Soil Type Group D			Composite CN	I_a (inches)
	Cover Type	Percent within Subbasin	CN	Cover Type	Percent within Subbasin	CN	Cover Type	Percent within Subbasin	CN	Cover Type	Percent within Subbasin	CN		
W570	Urban District: Industrial	70%	81	Desert shrub	30%	77							80	0.500
W580	Streets and roads: Paved; open ditches	2%	83							Streets and roads: Paved; open ditches	2%	93	81	0.469
	Desert shrub	31%	63							Desert shrub	66%	88		
W590				Urban District: Industrial	1%	88				Residential: 1/3 acre	1%	86	84	0.381
				Desert shrub	44%	77				Desert shrub	54%	88		
W600	Open space: Cemetery Fair condition (30-70% vegetative cover)	15%	49	Residential: 1/4 acre	20%	75				Desert shrub	25%	88	77	0.597
	Residential: 1/4 acre	5%	61	Open space: Fair condition	10%	69				Residential: 1/4 acre	25%	87		
W650	Desert shrub	50%	63							Desert shrub	16%	88	70	0.857
	Open space: Cemetery Fair condition (30-70%)	17%	49							Urban Districts: Commercial and business	17%	95		
W770	Desert shrub	40%	63							Desert Scrub	60%	88	78	0.564
W780	Desert shrub	55%	63							Desert Scrub	45%	88	75	0.667
W790	Streets and roads: Paved; open ditches	35%	83										72	0.778
	Graded areas: Pervious; no vegetation	15%	77											
	Desert shrub	50%	63											
W860	Desert shrub	40%	63							Desert Scrub	60%	88	78	0.564
W980	Desert shrub	20%	63							Desert Scrub	80%	88	83	0.410
W990	Desert shrub	25%	63							Desert Scrub	75%	88	82	0.439
W1700				Urban District: Industrial	100%	88							88	0.273
W1780	Desert shrub	40%	63	Desert shrub	45%	77	Desert Shrub	5%	85				73	0.740
	Urban District: Industrial	5%	81	Urban District: Industrial	5%	88								
W1810	Residential: 1/4 acre	20%	61	Residential: 1/4 acre	5%	75				Residential: 1/4 acre	30%	87	77	0.597
	Desert shrub	20%	63							Desert scrub	25%	88		

Notes:

1. Initial abstraction is capped at 0.35 inches

Table 3: Time of Concentration and Lag Time Calculations

Basin Name	Sheet Flow Distance (ft)	Upslope Elevation (ft)	Downslope Elevation (ft)	Slope	Shallow Concentrated Flow (ft)	Upslope Elevation (ft)	Downslope Elevation (ft)	Slope	Channelized Flow (ft)	Channel Width (ft)	Depth (ft)	Upslope Elevation (ft)	Downslope Elevation (ft)	Wetted Perimeter (ft)	Flow Area (ft^2)	Slope	Tc (hours)	Lag Time (mins)
W570	142.00	5,772.00	5,756.00	0.11	180.00	5,756.00	5,746.00	0.06	1,160.00	13.36	3.00	5,746.00	5,694.00	26.78	58.08	0.045	0.195	7.02
W580	245.00	5,916.00	5,896.00	0.08	386.00	5,896.00	5,848.00	0.12	1,617.00	21.54	1.00	5,848.00	5,764.00	26.01	23.54	0.052	0.114	4.10
W590	101.00	5,989.00	5,980.00	0.09	216.00	5,980.00	5,965.00	0.07	7,348.00	18.66	1.00	5,965.00	5,694.00	23.13	20.66	0.037	0.452	16.27
W600	180.00	5,858.00	5,840.00	0.10	3,062.00	5,840.00	5,700.00	0.05	156.00	10.26	5.00	5,700.00	5,697.00	32.62	101.30	0.019	0.387	13.93
W650	248.00	6,005.00	5,971.00	0.14	503.00	5,971.00	5,940.00	0.06	6,417.00	51.08	5.00	5,940.00	5,732.00	73.44	305.40	0.032	0.362	13.03
W770	265.00	6,300.00	6,260.00	0.15	1,920.00	6,260.00	6,137.00	0.06	1,198.00	56.97	3.00	6,137.00	5,796.00	70.39	188.91	0.285	0.372	13.39
W780	167.00	5,951.00	5,935.00	0.10	972.00	5,935.00	5,881.00	0.06	3,301.00	29.12	2.00	5,881.00	5,787.00	38.06	66.24	0.028	0.356	12.82
W790	99.00	5,796.00	5,792.00	0.04	172.00	5,792.00	5,781.00	0.06	29.00	86.82	3.00	5,781.00	5,778.00	100.23	278.45	0.103	0.037	1.33
W860	197.00	6,458.00	6,441.00	0.09	869.00	6,441.00	6,380.00	0.07	9,610.00	39.95	4.00	6,380.00	5,989.00	57.84	191.80	0.041	0.440	15.84
W980	162.00	6,156.00	6,150.00	0.04	1,457.00	6,150.00	5,995.00	0.11	4,839.00	36.28	3.00	5,995.00	5,839.00	49.70	126.84	0.032	0.445	16.02
W990	279.00	6,379.00	6,320.00	0.21	3,328.00	6,320.00	6,085.00	0.07	5,043.00	27.46	2.00	6,085.00	5,927.00	36.40	62.92	0.031	0.583	20.99
W1700	300.00	5,696.00	5,690.00	0.02	74.00	5,690.00	5,680.00	0.14	319.00	44.02	5.00	5,680.00	5,675.00	66.38	270.08	0.016	0.090	3.24
W1780	222.00	5,688.00	5,680.00	0.04	39.00	5,680.00	5,662.00	0.46	4,103.00	9.25	7.00	5,662.00	5,600.00	40.55	162.75	0.015	0.159	5.72
W1810	154.00	5,797.00	5,776.00	0.14	1,320.00	5,776.00	5,731.00	0.03	1,755.00	33.60	5.00	5,731.00	5,694.00	55.96	218.00	0.021	0.189	6.80

NOAA Atlas 14, Volume 1, Version 5
Location name: Aztec, New Mexico, US*
Latitude: 36.8202°, Longitude: -107.9537°
Elevation: 5902 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.151 (0.129-0.176)	0.194 (0.167-0.226)	0.261 (0.225-0.303)	0.316 (0.271-0.368)	0.395 (0.336-0.459)	0.460 (0.388-0.534)	0.530 (0.442-0.616)	0.606 (0.498-0.706)	0.714 (0.574-0.835)	0.804 (0.637-0.944)
10-min	0.229 (0.197-0.267)	0.295 (0.255-0.343)	0.397 (0.342-0.461)	0.481 (0.413-0.560)	0.601 (0.512-0.699)	0.701 (0.590-0.813)	0.807 (0.673-0.938)	0.923 (0.758-1.07)	1.09 (0.874-1.27)	1.22 (0.969-1.44)
15-min	0.284 (0.244-0.331)	0.366 (0.316-0.426)	0.493 (0.424-0.572)	0.596 (0.512-0.694)	0.745 (0.634-0.866)	0.869 (0.731-1.01)	1.00 (0.833-1.16)	1.14 (0.940-1.33)	1.35 (1.08-1.58)	1.52 (1.20-1.78)
30-min	0.383 (0.329-0.446)	0.493 (0.425-0.573)	0.663 (0.570-0.770)	0.803 (0.689-0.934)	1.00 (0.854-1.17)	1.17 (0.985-1.36)	1.35 (1.12-1.57)	1.54 (1.27-1.79)	1.82 (1.46-2.12)	2.04 (1.62-2.40)
60-min	0.474 (0.407-0.552)	0.610 (0.526-0.709)	0.821 (0.706-0.953)	0.994 (0.853-1.16)	1.24 (1.06-1.44)	1.45 (1.22-1.68)	1.67 (1.39-1.94)	1.91 (1.57-2.22)	2.25 (1.81-2.63)	2.53 (2.00-2.97)
2-hr	0.548 (0.480-0.636)	0.697 (0.610-0.809)	0.924 (0.809-1.07)	1.11 (0.971-1.29)	1.39 (1.20-1.60)	1.62 (1.38-1.86)	1.87 (1.57-2.15)	2.14 (1.77-2.47)	2.53 (2.06-2.94)	2.86 (2.28-3.34)
3-hr	0.597 (0.528-0.681)	0.752 (0.663-0.860)	0.974 (0.862-1.11)	1.16 (1.02-1.32)	1.43 (1.25-1.62)	1.65 (1.43-1.88)	1.90 (1.61-2.16)	2.16 (1.81-2.47)	2.55 (2.09-2.97)	2.87 (2.31-3.37)
6-hr	0.718 (0.647-0.806)	0.892 (0.805-1.00)	1.12 (1.01-1.26)	1.32 (1.18-1.48)	1.60 (1.42-1.79)	1.83 (1.61-2.05)	2.08 (1.81-2.33)	2.35 (2.01-2.64)	2.74 (2.29-3.10)	3.06 (2.51-3.48)
12-hr	0.860 (0.779-0.952)	1.07 (0.967-1.18)	1.32 (1.19-1.46)	1.53 (1.37-1.68)	1.81 (1.62-1.99)	2.03 (1.81-2.24)	2.26 (1.99-2.49)	2.50 (2.18-2.77)	2.83 (2.43-3.16)	3.12 (2.64-3.50)
24-hr	0.972 (0.895-1.06)	1.22 (1.12-1.32)	1.54 (1.42-1.67)	1.81 (1.66-1.95)	2.17 (1.97-2.35)	2.46 (2.23-2.66)	2.76 (2.49-2.99)	3.07 (2.75-3.34)	3.51 (3.11-3.82)	3.86 (3.38-4.21)
2-day	1.14 (1.05-1.23)	1.42 (1.31-1.54)	1.79 (1.65-1.93)	2.08 (1.92-2.25)	2.48 (2.28-2.68)	2.80 (2.56-3.03)	3.14 (2.84-3.39)	3.48 (3.13-3.78)	3.95 (3.52-4.31)	4.33 (3.82-4.73)
3-day	1.23 (1.13-1.33)	1.53 (1.42-1.66)	1.92 (1.78-2.08)	2.23 (2.06-2.41)	2.65 (2.44-2.87)	2.99 (2.74-3.23)	3.33 (3.03-3.61)	3.68 (3.33-4.00)	4.17 (3.73-4.54)	4.54 (4.03-4.97)
4-day	1.32 (1.22-1.42)	1.65 (1.53-1.78)	2.05 (1.91-2.22)	2.38 (2.20-2.57)	2.82 (2.60-3.05)	3.17 (2.91-3.43)	3.53 (3.22-3.82)	3.88 (3.53-4.22)	4.38 (3.94-4.77)	4.76 (4.25-5.20)
7-day	1.52 (1.41-1.65)	1.91 (1.76-2.06)	2.37 (2.19-2.57)	2.75 (2.53-2.97)	3.25 (2.98-3.51)	3.63 (3.32-3.92)	4.02 (3.66-4.35)	4.42 (4.00-4.79)	4.95 (4.44-5.38)	5.37 (4.77-5.85)
10-day	1.73 (1.60-1.88)	2.16 (2.00-2.34)	2.68 (2.48-2.92)	3.09 (2.85-3.36)	3.64 (3.35-3.95)	4.05 (3.71-4.40)	4.47 (4.08-4.86)	4.89 (4.45-5.33)	5.45 (4.92-5.96)	5.88 (5.27-6.45)
20-day	2.24 (2.07-2.43)	2.80 (2.58-3.04)	3.46 (3.19-3.76)	3.99 (3.67-4.33)	4.69 (4.29-5.09)	5.21 (4.76-5.67)	5.75 (5.22-6.26)	6.29 (5.69-6.86)	7.00 (6.28-7.67)	7.55 (6.73-8.29)
30-day	2.68 (2.48-2.91)	3.35 (3.09-3.64)	4.13 (3.81-4.49)	4.73 (4.35-5.15)	5.52 (5.06-6.00)	6.10 (5.58-6.65)	6.69 (6.08-7.30)	7.27 (6.58-7.95)	8.02 (7.20-8.80)	8.59 (7.67-9.44)
45-day	3.25 (3.01-3.52)	4.06 (3.76-4.40)	5.00 (4.62-5.42)	5.72 (5.28-6.21)	6.65 (6.11-7.22)	7.34 (6.72-7.99)	8.03 (7.30-8.74)	8.71 (7.87-9.51)	9.59 (8.61-10.5)	10.3 (9.15-11.3)
60-day	3.76 (3.47-4.08)	4.71 (4.35-5.11)	5.77 (5.32-6.27)	6.57 (6.04-7.14)	7.60 (6.96-8.26)	8.35 (7.63-9.09)	9.09 (8.28-9.90)	9.81 (8.89-10.7)	10.7 (9.67-11.8)	11.4 (10.2-12.5)

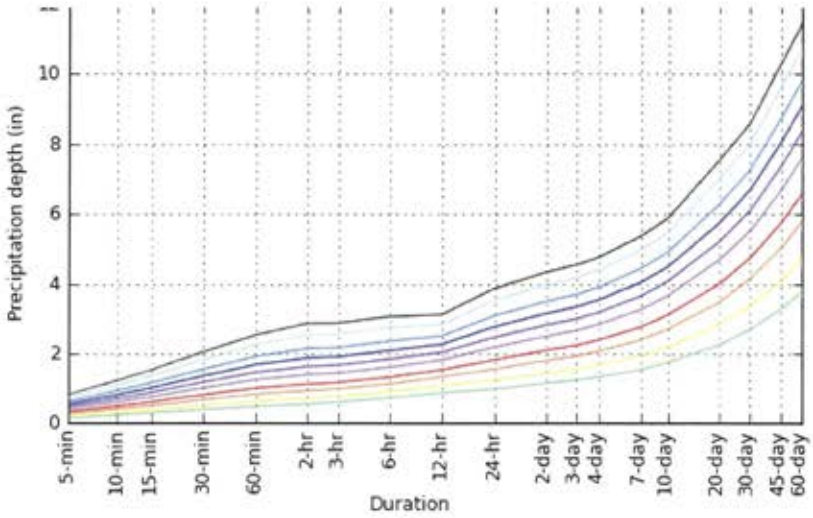
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

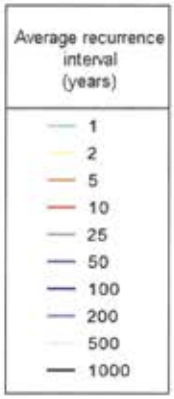
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

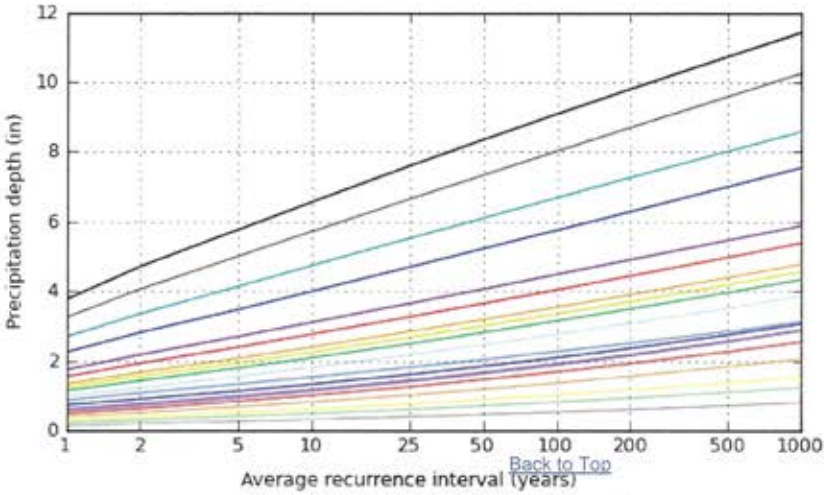
Please refer to NOAA Atlas 14 document for more information.

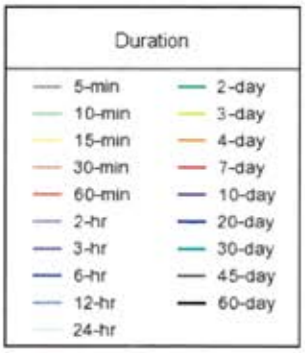
Back to Top

PF graphical









Back to Top

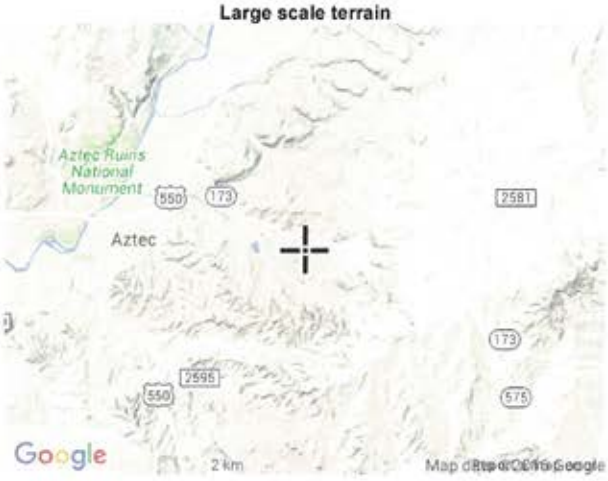
Maps & aerials

NOAA Atlas 14, Volume 1, Version 5

Created (GMT): Tue Mar 22 21:40:49 2016

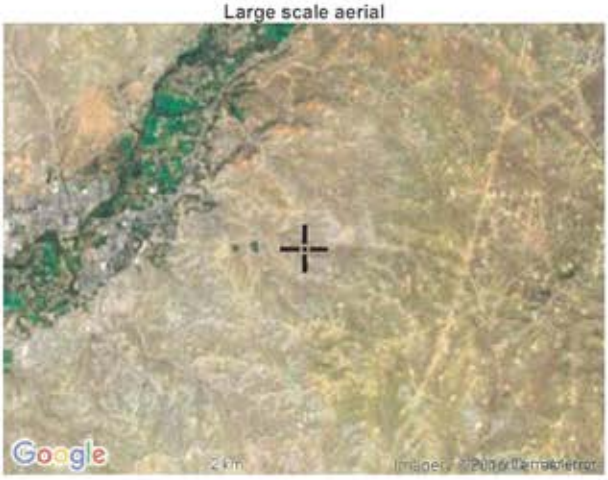
Small scale terrain

Large scale terrain



Large scale map

Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910

Questions?: HDSC.Questions@noaa.gov

Disclaimer

CITY OF AZTEC, NEW MEXICO
HAMPTON ARROYO WATERSHED
MODIFIED NOAA-SCS RAINFALL DISTRIBUTION

NOAA 14 Depth Duration Frequency Data [100-YEAR] [1] :

DURATION	[hours]	[inches] [3]
0	0	0
5-min	0.0833	0.530
10-min	0.1667	0.807
15-min	0.2500	1.000
30-min	0.5000	1.350
	0.7500	1.510
1-hr	1.0000	1.670
	1.2500	1.720
	1.5000	1.770
	1.7500	1.820
2-hr	2.0000	1.870
	2.5000	1.885
3-hr	3.0000	1.900
	3.5000	1.930
	4.0000	1.960
	5.0000	2.020
6-hr	6.0000	2.080
	7.0000	2.110
	8.0000	2.140
	9.0000	2.170
	10.0000	2.200
	11.0000	2.230
12-hr	12.0000	2.260
	14.0000	2.343
	16.0000	2.427
	18.0000	2.510
	20.0000	2.593
	22.0000	2.677
24-hr	24.0000	2.760

Modified NOAA-SCS Rainfall Distribution [2] :

n	TIME [hours]	CUMULATIVE DEPTH [inches]	INCREMENTAL DEPTH [inches]	HYETOGRAPH TIME PERIOD (hrs)	n [REARRANGED]	INCREMENTAL DEPTH [inches]	CUMULATIVE DEPTH [inches]	CUMULATIVE DEPTH [%]
0	0	0		0.00 TO 1.00	19	0.03	0.03	0.011
1	0.25	1	1	1.00 TO 2.00	17	0.03	0.06	0.022
2	0.5	1.35	0.35	2.00 TO 3.00	15	0.03	0.09	0.033
3	0.75	1.51	0.16	3.00 TO 4.00	13	0.06	0.15	0.054
4	1	1.67	0.16	4.00 TO 4.50	11	0.03	0.18	0.065
5	1.25	1.72	0.05	4.50 TO 5.00	9	0.01	0.19	0.071
6	1.5	1.77	0.05	5.00 TO 5.25	7	0.05	0.24	0.089
7	1.75	1.82	0.05	5.25 TO 5.50	5	0.05	0.29	0.107
8	2	1.87	0.05	5.50 TO 5.75	3	0.16	0.45	0.165
9	2.5	1.885	0.015	5.75 TO 6.00	1	1.00	1.46	0.527
10	3	1.9	0.015	6.00 TO 6.25	2	0.35	1.81	0.654
11	3.5	1.93	0.03	6.25 TO 6.50	4	0.16	1.97	0.712
12	4	1.96	0.03	6.50 TO 6.75	6	0.05	2.02	0.730
13	5	2.02	0.06	6.75 TO 7.00	8	0.05	2.07	0.748
14	6	2.08	0.06	7.00 TO 7.50	10	0.01	2.08	0.754
15	7	2.11	0.03	7.50 TO 8.00	12	0.03	2.11	0.764
16	8	2.14	0.03	8.00 TO 9.00	14	0.06	2.17	0.786
17	9	2.17	0.03	9.00 TO 10.00	16	0.03	2.20	0.797
18	10	2.2	0.03	10.00 TO 11.00	18	0.03	2.23	0.808
19	11	2.23	0.03	11.00 TO 12.00	20	0.03	2.26	0.819
20	12	2.26	0.03	12.00 TO 14.00	21	0.08	2.34	0.849
21	14	2.343	0.083	14.00 TO 16.00	22	0.08	2.43	0.879
22	16	2.427	0.084	16.00 TO 18.00	23	0.08	2.51	0.909
23	18	2.51	0.083	18.00 TO 20.00	24	0.08	2.59	0.939
24	20	2.593	0.083	20.00 TO 22.00	25	0.08	2.68	0.970
25	22	2.677	0.084	22.00 TO 24.00	26	0.08	2.76	1.000
26	24	2.76	0.083					

Notes:
1. Precipitation depth, duration, frequency data based on NOAA Atlas 14 Online Precipitaiton Data Frequency Server.
2. Modified NOAA-SCS rainfall distribution developed based on procedures prescribed by New Mexico State Highway and Transportation Department's *Drainage Manual, Volume I*, 1995.
3. Rainfall data based on Hampton Arroyo watershed centroid located at Latitude 36.8202 °N Longitude 107.9537° W

NOAA 14 Depth Duration Frequency Data [50-YEAR][1] :

DURATION	[hours]	[inches][1]
0	0	0
5-min	0.0833	0.460
10-min	0.1667	0.701
15-min	0.2500	0.869
30-min	0.5000	1.170
	0.7500	1.310
1-hr	1.0000	1.450
	1.2500	1.493
	1.5000	1.535
	1.7500	1.578
2-hr	2.0000	1.620
	2.5000	1.635
3-hr	3.0000	1.650
	3.5000	1.680
	4.0000	1.710
	5.0000	1.770
6-hr	6.0000	1.830
	7.0000	1.863
	8.0000	1.897
	9.0000	1.930
	10.0000	1.963
	11.0000	1.997
12-hr	12.0000	2.030
	14.0000	2.102
	16.0000	2.173
	18.0000	2.245
	20.0000	2.317
	22.0000	2.388
24-hr	24.0000	2.460

Modified NOAA-SCS Rainfall Distribution[2] :

n	TIME [hours]	CUMULATIVE DEPTH [inches]	INCREMENTAL DEPTH [inches]	HYETOGRAPH TIME PERIOD (hrs)			n [REARRANGED]	INCREMENTAL DEPTH [inches]	CUMULATIVE DEPTH [inches]	CUMULATIVE DEPTH [%]
0	0	0.000		0.00	TO	1.00	19	0.033	0.033	0.014
1	0.25	0.869	0.869	1.00	TO	2.00	17	0.033	0.067	0.027
2	0.5	1.170	0.301	2.00	TO	3.00	15	0.033	0.100	0.041
3	0.75	1.310	0.140	3.00	TO	4.00	13	0.060	0.160	0.065
4	1	1.450	0.140	4.00	TO	4.50	11	0.030	0.190	0.077
5	1.25	1.493	0.043	4.50	TO	5.00	9	0.015	0.205	0.083
6	1.5	1.535	0.043	5.00	TO	5.25	7	0.043	0.248	0.101
7	1.75	1.578	0.043	5.25	TO	5.50	5	0.043	0.290	0.118
8	2	1.620	0.043	5.50	TO	5.75	3	0.140	0.430	0.175
9	2.5	1.635	0.015	5.75	TO	6.00	1	0.869	1.299	0.528
10	3	1.650	0.015	6.00	TO	6.25	2	0.301	1.600	0.650
11	3.5	1.680	0.030	6.25	TO	6.50	4	0.140	1.740	0.707
12	4	1.710	0.030	6.50	TO	6.75	6	0.043	1.783	0.725
13	5	1.770	0.060	6.75	TO	7.00	8	0.043	1.825	0.742
14	6	1.830	0.060	7.00	TO	7.50	10	0.015	1.840	0.748
15	7	1.863	0.033	7.50	TO	8.00	12	0.030	1.870	0.760
16	8	1.897	0.033	8.00	TO	9.00	14	0.060	1.930	0.785
17	9	1.930	0.033	9.00	TO	10.00	16	0.033	1.963	0.798
18	10	1.963	0.033	10.00	TO	11.00	18	0.033	1.997	0.812
19	11	1.997	0.033	11.00	TO	12.00	20	0.033	2.030	0.825
20	12	2.030	0.033	12.00	TO	14.00	21	0.072	2.102	0.854
21	14	2.102	0.072	14.00	TO	16.00	22	0.072	2.173	0.883
22	16	2.173	0.072	16.00	TO	18.00	23	0.072	2.245	0.913
23	18	2.245	0.072	18.00	TO	20.00	24	0.072	2.317	0.942
24	20	2.317	0.072	20.00	TO	22.00	25	0.072	2.388	0.971
25	22	2.388	0.072	22.00	TO	24.00	26	0.072	2.460	1.000
26	24	2.460	0.072							

Notes:

1. Precipitation depth, duration, frequency data based on NOAA Atlas 14 Online Precipitation Data Frequency Server.
2. Modified NOAA-SCS rainfall distribution developed based on procedures prescribed by New Mexico State Highway and Transportation Department's *Drainage Manual, Volume I,* 1995.
3. Rainfall data based on Hampton Arroyo watershed centroid located at Latitude 36.8202° N Longitude 107.9537° W

NOAA 14 Depth Duration Frequency Data [25-YEAR] [1] :

DURATION	[hours]	[inches] [3]
0	0	0
5-min	0.0833	0.395
10-min	0.1667	0.601
15-min	0.2500	0.745
30-min	0.5000	1.000
	0.7500	1.120
1-hr	1.0000	1.240
	1.2500	1.278
	1.5000	1.315
	1.7500	1.353
2-hr	2.0000	1.390
	2.5000	1.410
3-hr	3.0000	1.430
	3.5000	1.458
	4.0000	1.487
	5.0000	1.543
6-hr	6.0000	1.600
	7.0000	1.635
	8.0000	1.670
	9.0000	1.705
	10.0000	1.740
	11.0000	1.775
12-hr	12.0000	1.810
	14.0000	1.870
	16.0000	1.930
	18.0000	1.990
	20.0000	2.050
	22.0000	2.110
24-hr	24.0000	2.170

Modified NOAA-SCS Rainfall Distribution [2] :

n	TIME [hours]	CUMULATIVE DEPTH [inches]	INCREMENTAL DEPTH [inches]	HYETOGRAPH TIME PERIOD (hrs)			n [REARRANGED]	INCREMENTAL DEPTH [inches]	CUMULATIVE DEPTH [inches]	CUMULATIVE DEPTH [%]
0	0	0.000		0.00	TO	1.00	19	0.035	0.035	0.016
1	0.25	0.745	0.745	1.00	TO	2.00	17	0.035	0.070	0.032
2	0.5	1.000	0.255	2.00	TO	3.00	15	0.035	0.105	0.048
3	0.75	1.120	0.120	3.00	TO	4.00	13	0.057	0.162	0.075
4	1	1.240	0.120	4.00	TO	4.50	11	0.028	0.190	0.088
5	1.25	1.278	0.037	4.50	TO	5.00	9	0.020	0.210	0.097
6	1.5	1.315	0.038	5.00	TO	5.25	7	0.038	0.248	0.114
7	1.75	1.353	0.038	5.25	TO	5.50	5	0.037	0.285	0.131
8	2	1.390	0.037	5.50	TO	5.75	3	0.120	0.405	0.187
9	2.5	1.410	0.020	5.75	TO	6.00	1	0.745	1.150	0.530
10	3	1.430	0.020	6.00	TO	6.25	2	0.255	1.405	0.647
11	3.5	1.458	0.028	6.25	TO	6.50	4	0.120	1.525	0.703
12	4	1.487	0.028	6.50	TO	6.75	6	0.038	1.563	0.720
13	5	1.543	0.057	6.75	TO	7.00	8	0.037	1.600	0.737
14	6	1.600	0.057	7.00	TO	7.50	10	0.020	1.620	0.747
15	7	1.635	0.035	7.50	TO	8.00	12	0.028	1.648	0.760
16	8	1.670	0.035	8.00	TO	9.00	14	0.057	1.705	0.786
17	9	1.705	0.035	9.00	TO	10.00	16	0.035	1.740	0.802
18	10	1.740	0.035	10.00	TO	11.00	18	0.035	1.775	0.818
19	11	1.775	0.035	11.00	TO	12.00	20	0.035	1.810	0.834
20	12	1.810	0.035	12.00	TO	14.00	21	0.060	1.870	0.862
21	14	1.870	0.060	14.00	TO	16.00	22	0.060	1.930	0.889
22	16	1.930	0.060	16.00	TO	18.00	23	0.060	1.990	0.917
23	18	1.990	0.060	18.00	TO	20.00	24	0.060	2.050	0.945
24	20	2.050	0.060	20.00	TO	22.00	25	0.060	2.110	0.972
25	22	2.110	0.060	22.00	TO	24.00	26	0.060	2.170	1.000
26	24	2.170	0.060							

Notes:

1. Precipitation depth, duration, frequency data based on NOAA Atlas 14 Online Precipitation Data Frequency Server.
2. Modified NOAA-SCS rainfall distribution developed based on procedures prescribed by New Mexico State Highway and Transportation Department's *Drainage Manual, Volume I,* 1995.
3. Rainfall data based on Hampton Arroyo watershed centroid located at Latitude 36.8202° N Longitude 107.9537° W

NOAA 14 Depth Duration Frequency Data [10-YEAR][1]:

DURATION	[hours]	[inches][1]
0	0	0
5-min	0.0833	0.316
10-min	0.1667	0.481
15-min	0.2500	0.596
30-min	0.5000	0.803
	0.7500	0.899
1-hr	1.0000	0.994
	1.2500	1.023
	1.5000	1.052
	1.7500	1.081
2-hr	2.0000	1.110
	2.5000	1.135
3-hr	3.0000	1.160
	3.5000	1.187
	4.0000	1.213
	5.0000	1.267
6-hr	6.0000	1.320
	7.0000	1.355
	8.0000	1.390
	9.0000	1.425
	10.0000	1.460
	11.0000	1.495
12-hr	12.0000	1.530
	14.0000	1.577
	16.0000	1.623
	18.0000	1.670
	20.0000	1.717
	22.0000	1.763
24-hr	24.0000	1.810

Modified NOAA-SCS Rainfall Distribution[2]:

n	TIME [hours]	CUMULATIVE DEPTH [inches]	INCREMENTAL DEPTH [inches]	HYETOGRAPH TIME PERIOD (hrs)	n [REARRANGED]	INCREMENTAL DEPTH [inches]	CUMULATIVE DEPTH [inches]	CUMULATIVE DEPTH [%]
0	0	0.000		0.00 TO 1.00	19	0.035	0.035	0.019
1	0.25	0.596	0.596	1.00 TO 2.00	17	0.035	0.070	0.039
2	0.5	0.803	0.207	2.00 TO 3.00	15	0.035	0.105	0.058
3	0.75	0.899	0.096	3.00 TO 4.00	13	0.053	0.158	0.087
4	1	0.994	0.095	4.00 TO 4.50	11	0.027	0.185	0.102
5	1.25	1.023	0.029	4.50 TO 5.00	9	0.025	0.210	0.116
6	1.5	1.052	0.029	5.00 TO 5.25	7	0.029	0.239	0.132
7	1.75	1.081	0.029	5.25 TO 5.50	5	0.029	0.268	0.148
8	2	1.110	0.029	5.50 TO 5.75	3	0.096	0.364	0.201
9	2.5	1.135	0.025	5.75 TO 6.00	1	0.596	0.960	0.530
10	3	1.160	0.025	6.00 TO 6.25	2	0.207	1.167	0.644
11	3.5	1.187	0.027	6.25 TO 6.50	4	0.095	1.262	0.697
12	4	1.213	0.027	6.50 TO 6.75	6	0.029	1.291	0.713
13	5	1.267	0.053	6.75 TO 7.00	8	0.029	1.320	0.729
14	6	1.320	0.053	7.00 TO 7.50	10	0.025	1.345	0.743
15	7	1.355	0.035	7.50 TO 8.00	12	0.027	1.372	0.758
16	8	1.390	0.035	8.00 TO 9.00	14	0.053	1.425	0.787
17	9	1.425	0.035	9.00 TO 10.00	16	0.035	1.460	0.807
18	10	1.460	0.035	10.00 TO 11.00	18	0.035	1.495	0.826
19	11	1.495	0.035	11.00 TO 12.00	20	0.035	1.530	0.845
20	12	1.530	0.035	12.00 TO 14.00	21	0.047	1.577	0.871
21	14	1.577	0.047	14.00 TO 16.00	22	0.047	1.623	0.897
22	16	1.623	0.047	16.00 TO 18.00	23	0.047	1.670	0.923
23	18	1.670	0.047	18.00 TO 20.00	24	0.047	1.717	0.948
24	20	1.717	0.047	20.00 TO 22.00	25	0.047	1.763	0.974
25	22	1.763	0.047	22.00 TO 24.00	26	0.047	1.810	1.000
26	24	1.810	0.047					

Notes:

1. Precipitation depth, duration, frequency data based on NOAA Atlas 14 Online Precipitation Data Frequency Server.
2. Modified NOAA-SCS rainfall distribution developed based on procedures prescribed by New Mexico State Highway and Transportation Department's *Drainage Manual, Volume I*, 1995.
3. Rainfall data based on Hampton Arroyo watershed centroid located at Latitude 36.8202° N Longitude 107.9537° W

NOAA 14 Depth Duration Frequency Data [2-YEAR](1):

DURATION	[hours]	[inches][3]
0	0	0
5-min	0.0833	0.194
10-min	0.1667	0.295
15-min	0.2500	0.366
30-min	0.5000	0.493
	0.7500	0.552
1-hr	1.0000	0.610
	1.2500	0.632
	1.5000	0.654
	1.7500	0.675
2-hr	2.0000	0.697
	2.5000	0.725
3-hr	3.0000	0.752
	3.5000	0.775
	4.0000	0.799
	5.0000	0.845
6-hr	6.0000	0.892
	7.0000	0.922
	8.0000	0.951
	9.0000	0.981
	10.0000	1.011
	11.0000	1.040
12-hr	12.0000	1.070
	14.0000	1.095
	16.0000	1.120
	18.0000	1.145
	20.0000	1.170
	22.0000	1.195
24-hr	24.0000	1.220

Modified NOAA-SCS Rainfall Distribution[2]:

n	TIME [hours]	CUMULATIVE DEPTH [inches]	INCREMENTAL DEPTH [inches]	HYETOGRAPH TIME PERIOD (hrs)	n [REARRANGED]	INCREMENTAL DEPTH [inches]	CUMULATIVE DEPTH [inches]	CUMULATIVE DEPTH [%]
0	0	0.000		0.00 TO 1.00	19	0.030	0.030	0.024
1	0.25	0.366	0.366	1.00 TO 2.00	17	0.030	0.059	0.049
2	0.5	0.493	0.127	2.00 TO 3.00	15	0.030	0.089	0.073
3	0.75	0.552	0.059	3.00 TO 4.00	13	0.047	0.136	0.111
4	1	0.610	0.059	4.00 TO 4.50	11	0.023	0.159	0.130
5	1.25	0.632	0.022	4.50 TO 5.00	9	0.028	0.187	0.153
6	1.5	0.654	0.022	5.00 TO 5.25	7	0.022	0.208	0.171
7	1.75	0.675	0.022	5.25 TO 5.50	5	0.022	0.230	0.189
8	2	0.697	0.022	5.50 TO 5.75	3	0.059	0.289	0.236
9	2.5	0.725	0.028	5.75 TO 6.00	1	0.366	0.655	0.536
10	3	0.752	0.028	6.00 TO 6.25	2	0.127	0.782	0.641
11	3.5	0.775	0.023	6.25 TO 6.50	4	0.059	0.840	0.689
12	4	0.799	0.023	6.50 TO 6.75	6	0.022	0.862	0.706
13	5	0.845	0.047	6.75 TO 7.00	8	0.022	0.884	0.724
14	6	0.892	0.047	7.00 TO 7.50	10	0.028	0.911	0.747
15	7	0.922	0.030	7.50 TO 8.00	12	0.023	0.934	0.766
16	8	0.951	0.030	8.00 TO 9.00	14	0.047	0.981	0.804
17	9	0.981	0.030	9.00 TO 10.00	16	0.030	1.011	0.828
18	10	1.011	0.030	10.00 TO 11.00	18	0.030	1.040	0.853
19	11	1.040	0.030	11.00 TO 12.00	20	0.030	1.070	0.877
20	12	1.070	0.030	12.00 TO 14.00	21	0.025	1.095	0.898
21	14	1.095	0.025	14.00 TO 16.00	22	0.025	1.120	0.918
22	16	1.120	0.025	16.00 TO 18.00	23	0.025	1.145	0.939
23	18	1.145	0.025	18.00 TO 20.00	24	0.025	1.170	0.959
24	20	1.170	0.025	20.00 TO 22.00	25	0.025	1.195	0.980
25	22	1.195	0.025	22.00 TO 24.00	26	0.025	1.220	1.000
26	24	1.220	0.025					

Notes:

1. Precipitation depth, duration, frequency data based on NOAA Atlas 14 Online Precipitation Data Frequency Server.
2. Modified NOAA-SCS rainfall distribution developed based on procedures prescribed by New Mexico State Highway and Transportation Department's *Drainage Manual, Volume I,* 1995.
3. Rainfall data based on Hampton Arroyo watershed centroid located at Latitude 36.8202° N Longitude 107.9537° W

NOAA 14 Depth Duration Frequency Data [HISTORIC] [1]:

DURATION	[hours]	[inches][1]
0	0	0
5-min	0.0833	0.714
10-min	0.1667	1.090
15-min	0.2500	1.350
30-min	0.5000	1.820
	0.7500	2.035
1-hr	1.0000	2.250
	1.2500	2.320
	1.5000	2.390
	1.7500	2.460
2-hr	2.0000	2.530
	2.5000	2.540
3-hr	3.0000	2.550
	3.5000	2.582
	4.0000	2.613
	5.0000	2.677
6-hr	6.0000	2.740
	7.0000	2.755
	8.0000	2.770
	9.0000	2.785
	10.0000	2.800
	11.0000	2.815
12-hr	12.0000	2.830
	14.0000	2.943
	16.0000	3.057
	18.0000	3.170
	20.0000	3.283
	22.0000	3.397
24-hr	24.0000	3.510

Modified NOAA-SCS Rainfall Distribution [2]:

n	TIME [hours]	CUMULATIVE DEPTH [inches]	INCREMENTAL DEPTH [inches]	HYETOGRAPH TIME PERIOD (hrs)			n [REARRANGED]	INCREMENTAL DEPTH [inches]	CUMULATIVE DEPTH [inches]	CUMULATIVE DEPTH [%]
0	0	0		0.00	TO	1.00	19	0.015	0.015	0.004
1	0.25	1.350	1.350	1.00	TO	2.00	17	0.015	0.030	0.009
2	0.5	1.820	0.470	2.00	TO	3.00	15	0.015	0.045	0.013
3	0.75	2.035	0.215	3.00	TO	4.00	13	0.063	0.108	0.031
4	1	2.250	0.215	4.00	TO	4.50	11	0.032	0.140	0.040
5	1.25	2.320	0.070	4.50	TO	5.00	9	0.010	0.150	0.043
6	1.5	2.390	0.070	5.00	TO	5.25	7	0.070	0.220	0.063
7	1.75	2.460	0.070	5.25	TO	5.50	5	0.070	0.290	0.083
8	2	2.530	0.070	5.50	TO	5.75	3	0.215	0.505	0.144
9	2.5	2.540	0.010	5.75	TO	6.00	1	1.350	1.855	0.528
10	3	2.550	0.010	6.00	TO	6.25	2	0.470	2.325	0.662
11	3.5	2.582	0.032	6.25	TO	6.50	4	0.215	2.540	0.724
12	4	2.613	0.032	6.50	TO	6.75	6	0.070	2.610	0.744
13	5	2.677	0.063	6.75	TO	7.00	8	0.070	2.680	0.764
14	6	2.740	0.063	7.00	TO	7.50	10	0.010	2.690	0.766
15	7	2.755	0.015	7.50	TO	8.00	12	0.032	2.722	0.775
16	8	2.770	0.015	8.00	TO	9.00	14	0.063	2.785	0.793
17	9	2.785	0.015	9.00	TO	10.00	16	0.015	2.800	0.798
18	10	2.800	0.015	10.00	TO	11.00	18	0.015	2.815	0.802
19	11	2.815	0.015	11.00	TO	12.00	20	0.015	2.830	0.806
20	12	2.830	0.015	12.00	TO	14.00	21	0.113	2.943	0.839
21	14	2.943	0.113	14.00	TO	16.00	22	0.113	3.057	0.871
22	16	3.057	0.113	16.00	TO	18.00	23	0.113	3.170	0.903
23	18	3.170	0.113	18.00	TO	20.00	24	0.113	3.283	0.935
24	20	3.283	0.113	20.00	TO	22.00	25	0.113	3.397	0.968
25	22	3.397	0.113	22.00	TO	24.00	26	0.113	3.510	1.000
26	24	3.510	0.113							

Notes:

1. Precipitation depth, duration, frequency data based on NOAA Atlas 14 Online Precipitation Data Frequency Server.
2. Modified NOAA-SCS rainfall distribution developed based on procedures prescribed by New Mexico State Highway and Transportation Department's *Drainage Manual, Volume I*, 1995.
3. Rainfall data based on Hampton Arroyo watershed centroid located at Latitude 36.8202 ° N Longitude 107.9537° W

Appendix C – Hydraulic Calculation

Appendix C.1 – HEC-RAS Calculations

Appendix C.2– Work Maps

AECOM	Calculation Sheet				
Project Name:	Hampton Arroyo			**Calculation Number:**	
Client Name:	City of Aztec, New Mexico			**Revision Number:**	
Project Number:	Job No.	Cost Code	Parent (if any)	**Prepared By/Date:**	TN / 5/4/2016
	60487360	20000	N/A		
Title:	Riverine Analysis using HECRAS				

METHODOLOGY:

- The USACE HEC-GeoRAS extensions for ArcGIS were used to create the spatial data used for hydraulic analysis.
- The USACE HEC-RAS program, version 4.1.0, was utilized to determine the water surface elevations along the Hampton Arroyo.
- 1-percent-annual-chance flow change locations were obtained from the HEC-HMS model developed to simulate the existing hydrologic conditions for the Hampton Arroyo.
- AECOM prepared a hydrologic analysis to estimate the magnitude of the August 2015 storm event and the storm event discharge was added to the model for comparison purpose.
- Aerial survey and topography data was provided by the City of Aztec. The data was processed to remove the buildings and other features to reflect the bare earth topo.
- The HEC-RAS analysis was done in horizontal projection – NM State Plane West NAD 83, feet.
- The water surface elevations were computed as if the main channel were containing all flows. Any overtopping flows were blocked using an ineffective area.
- Hydraulic model is provided with this report in digital format.

INPUT:

- Hydraulic Baseline – Stream centerline was generated in ArcGIS. It was delineated using the aerial and topography data provided by the City of Aztec. The stream centerline generally followed the invert of the contours and main channel.
- Cross Section geometry – Cross sections were generated in ArcGIS. Cross sections were placed at approximately 500 feet intervals along the hydraulic baseline. Additional cross sections were placed to account for significant profile inflection points and other drop structures to account for their effects on flow.
- Manning's N value - Selection of Manning N values were based on field observation. The Manning N value for "Clean, winding, some pools and shoals, but some week and stones", 0.045, was selected for the main channel. For the overbank, the Manning N of "medium to dense brush in summer", 0.1, was used for the overbank area.

- Culverts and Bridges – Structure dimensions were obtained during field observation. All structures were assumed free of blockage or debris. The culvert near the confluence with Animas River was assumed blocked.
- Obstruction – Obstruction such as buildings were modeled as ineffective flow and/or adding blockage. In case where water elevation is below the obstruction lowest elevation, the obstruction has no effect on the water elevation and obstruction was not included.
- Downstream Boundary Condition – Normal depth was used for Hampton Arroyo downstream boundary condition. Coincident peak was not assumed between Animas River and Hampton Arroyo because the Hampton Arroyo drainage area is much smaller than Animas River drainage area.

RESULTS:

- 1-percent-annual-chance water surface elevation was computed using HEC-RAS. According to the model, the 100 year flow is contained inside the main channel throughout the sub-division area, until it approach the confluence with Animas River.
- The 2010 effective flood map for San Juan County, NM (panel 35045C0730F) shows an effective flood Zone AE for Hampton Arroyo. The effective Zone AE extends from the confluence with Animas River to about 1000 feet upstream from US 550. The 2010 effective water elevations are generally 1 to 3 feet lower when compared to the new HEC-RAS model. The differences are resulted from different hydrology methodology and flow discharges.
- The August 2015 event water surface elevation was computed and compared to the 1-percent-annual chance. Generally, the historical event water surface elevation is higher than 1-percent-annual-chance by average of 2.5 feet. The HEC-RAS result showed that the historical event flood is contained in the channel except at Sabena Street and near the confluence of Animas River where it overtopped the channel bank. For detail information on the result, please see digital submittal of the HEC-RAS model.

HEC-RAS Results

HEC-RAS Plan: Hampton_Arroyo River: Hampton Arroyo Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	7992.366	1%	1293.40	5736.92	5742.52	5741.97	5744.27	0.011923	11.13	147.98	33.65	0.84
1	7992.366	Historic	2315.30	5736.92	5744.25	5744.11	5747.27	0.014532	14.77	208.93	36.78	0.97
1	7750	1%	1293.40	5733.39	5739.00	5739.00	5740.97	0.015376	11.85	144.89	42.73	0.93
1	7750	Historic	2315.30	5733.39	5740.96	5740.96	5743.65	0.014437	14.28	235.40	49.86	0.95
1	7500	1%	1396.60	5729.80	5733.99	5733.99	5735.76	0.018941	11.52	165.61	52.43	1.01
1	7500	Historic	2473.70	5729.80	5735.70	5735.70	5738.11	0.016873	13.74	262.34	60.76	1.01
1	7250.585	1%	1396.60	5725.31	5730.14	5729.97	5730.92	0.010823	8.40	320.53	160.01	0.75
1	7250.585	Historic	2473.70	5725.31	5731.28		5732.19	0.010312	9.73	506.54	165.69	0.77
1	7001.229	1%	1396.60	5721.71	5726.76	5726.76	5727.59	0.016904	9.29	302.91	206.87	0.90
1	7001.229	Historic	2473.70	5721.71	5727.58	5727.58	5728.74	0.019501	11.54	430.75	211.27	1.00
1	6750.098	1%	1396.60	5715.46	5722.20	5722.20	5723.34	0.011169	9.60	266.41	130.09	0.77
1	6750.098	Historic	2473.70	5715.46	5723.31	5723.31	5724.79	0.012793	11.78	414.98	137.95	0.85
1	6543.667	1%	1396.60	5711.81	5718.75	5718.75	5720.13	0.013814	10.47	219.94	89.52	0.85
1	6543.667	Historic	2473.70	5711.81	5720.08	5720.08	5721.91	0.014696	12.75	344.00	97.05	0.91
1	6513.252	1%	1396.60	5707.92	5713.77	5713.05	5715.40	0.010651	10.88	172.54	40.37	0.80
1	6513.252	Historic	2473.70	5707.92	5715.59	5715.59	5718.27	0.012471	14.15	263.84	59.40	0.91
1	6383.724	1%	1396.60	5706.94	5712.06	5712.06	5713.71	0.016453	11.55	190.12	63.57	0.95
1	6383.724	Historic	2473.70	5706.94	5713.64	5713.64	5715.89	0.016205	13.98	298.39	73.58	0.99
1	6253.428	1%	1396.60	5704.25	5709.51	5709.51	5710.86	0.016108	11.02	224.25	84.59	0.93
1	6253.428	Historic	2473.70	5704.25	5710.81	5710.81	5712.65	0.016935	13.44	338.51	89.93	0.99
1	6002.805	1%	1396.60	5700.98	5704.68	5704.68	5706.17	0.019023	9.96	157.74	59.04	0.97
1	6002.805	Historic	2473.70	5700.98	5706.07	5706.07	5708.17	0.017184	12.01	243.40	63.77	0.98
1	5748.244	1%	1396.60	5694.00	5699.93	5699.93	5701.49	0.015142	10.74	187.27	68.00	0.89
1	5748.244	Historic	2473.70	5694.00	5701.43	5701.43	5703.54	0.015155	13.02	293.36	73.54	0.94
1	5498.843	1%	1587.00	5691.49	5697.37	5696.42	5698.30	0.007785	8.51	271.56	75.27	0.67
1	5498.843	Historic	2820.20	5691.49	5698.68		5700.29	0.010341	11.44	374.42	81.84	0.80
1	5250.143	1%	1587.00	5690.15	5694.37	5694.25	5695.58	0.015983	9.85	243.95	94.21	0.91
1	5250.143	Historic	2820.20	5690.15	5697.86		5698.50	0.003941	7.66	698.74	189.92	0.51
1	5000.049	1%	1587.00	5685.43	5692.83		5693.54	0.004370	6.86	264.30	71.91	0.50
1	5000.049	Historic	2820.20	5685.43	5697.59		5697.92	0.001136	5.23	1015.03	221.60	0.28
1	4951.415	1%	1588.00	5684.08	5692.86		5693.32	0.002200	5.57	335.46	69.74	0.37
1	4951.415	Historic	2822.20	5684.08	5697.60		5697.86	0.000782	4.68	1182.17	246.18	0.24
1	4884.429	1%	1588.00	5683.58	5692.25	5689.74	5693.04	0.003747	8.01	283.70	103.76	0.50
1	4884.429	Historic	2822.20	5683.58	5697.59	5691.70	5697.77	0.000736	4.98	1651.01	317.74	0.24
1	4856.98		Bridge									
1	4829.326	1%	1588.00	5683.99	5689.20	5689.20	5691.22	0.016837	12.09	164.17	59.59	0.98
1	4829.326	Historic	2822.20	5683.99	5693.01	5691.12	5694.06	0.004926	9.68	645.42	212.33	0.58
1	4762.341	1%	1588.00	5680.55	5687.96	5687.96	5689.97	0.015915	11.84	170.06	48.96	0.90
1	4762.341	Historic	2822.20	5680.55	5689.56	5689.56	5692.82	0.019104	15.43	255.84	79.98	1.03
1	4519.523	1%	1588.00	5676.94	5682.96		5683.90	0.008084	8.12	242.64	65.41	0.67
1	4519.523	Historic	2822.20	5676.94	5684.97		5686.34	0.007418	9.92	385.29	91.95	0.68
1	4441.438	1%	1588.00	5675.08	5682.74	5680.52	5683.29	0.003774	6.82	364.67	80.97	0.48
1	4441.438	Historic	2822.20	5675.08	5684.81	5682.11	5685.65	0.004135	8.61	544.05	92.44	0.52
1	4391.404		Bridge									
1	4335.781	1%	1588.00	5674.64	5679.24	5679.24	5680.92	0.019329	10.59	166.21	54.19	0.99
1	4335.781	Historic	2822.20	5674.64	5680.78	5680.78	5683.22	0.017633	12.86	255.93	62.23	1.00
1	4312.409	1%	1593.20	5665.74	5672.96		5674.22	0.006578	9.15	196.26	36.60	0.63
1	4312.409	Historic	2833.10	5665.74	5675.82		5677.61	0.005916	11.05	310.02	43.50	0.63
1	4243.651	1%	1593.20	5663.29	5670.61	5670.61	5673.16	0.015521	13.64	159.70	36.88	0.96
1	4243.651	Historic	2833.10	5663.29	5673.17	5673.17	5676.54	0.013804	16.15	265.72	45.70	0.96

HEC-RAS Plan: Hampton_Arroyo River: Hampton Arroyo Reach: 1 (Continued)

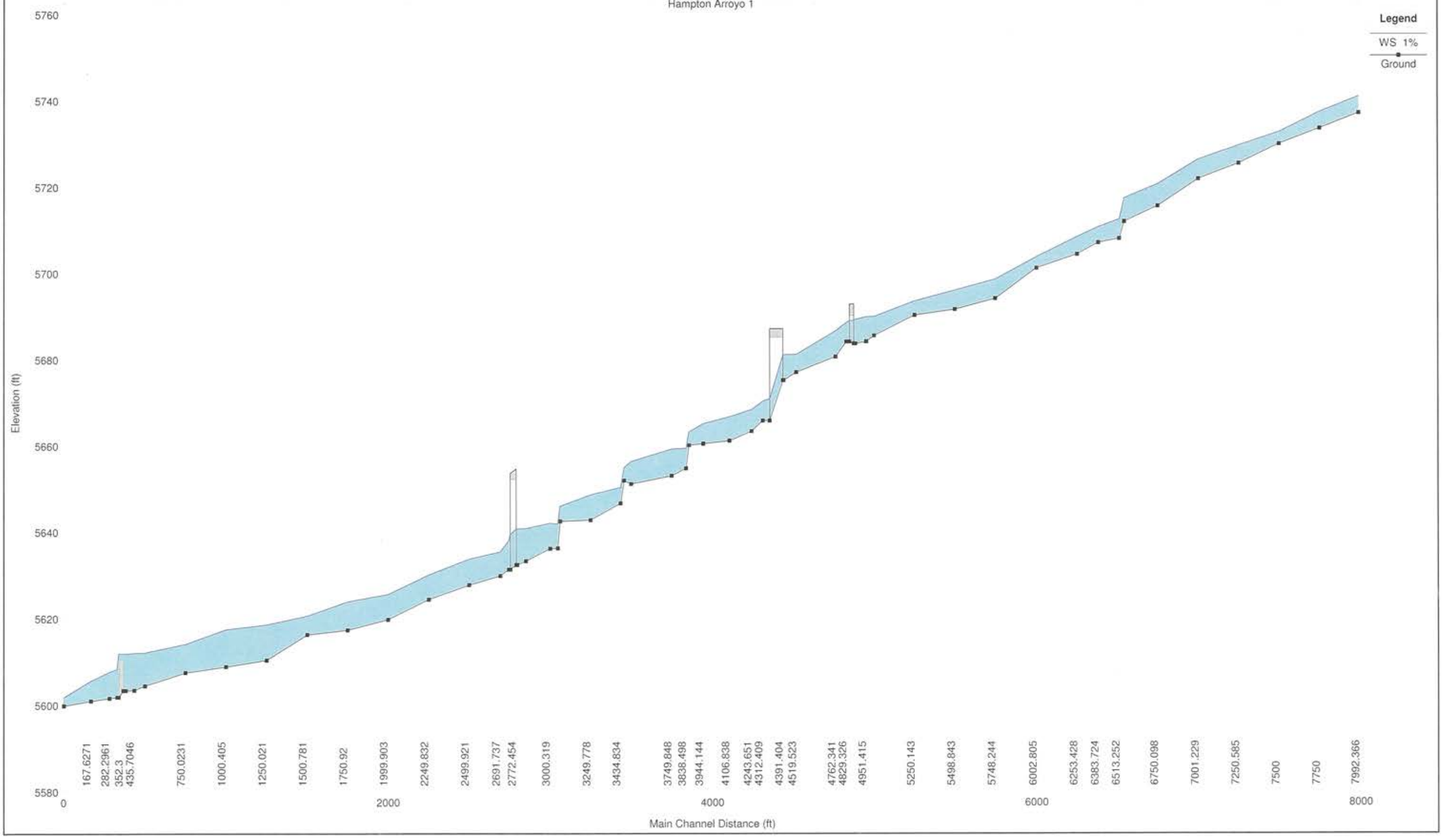
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	4106.838	1%	1593.20	5661.07	5668.38		5669.14	0.006590	8.79	333.98	76.06	0.62
1	4106.838	Historic	2833.10	5661.07	5670.49		5671.53	0.006593	10.68	500.18	81.51	0.65
1	3944.144	1%	1593.20	5660.41	5666.95	5666.00	5667.86	0.009192	9.41	296.49	75.77	0.72
1	3944.144	Historic	2833.10	5660.41	5669.31		5670.41	0.007176	10.64	485.47	84.10	0.68
1	3856.058	1%	1593.20	5660.02	5664.69	5664.69	5666.64	0.018673	11.70	165.17	46.12	1.01
1	3856.058	Historic	2833.10	5660.02	5666.55	5666.55	5669.32	0.016544	14.08	255.63	50.83	1.01
1	3838.498	1%	1593.20	5654.69	5661.12	5660.92	5663.43	0.014055	12.62	155.22	35.33	0.91
1	3838.498	Historic	2833.10	5654.69	5663.37	5663.37	5666.79	0.014001	15.61	242.84	42.51	0.96
1	3749.848	1%	1593.20	5652.93	5661.43		5662.33	0.004845	8.52	294.73	61.02	0.55
1	3749.848	Historic	2833.10	5652.93	5663.91		5665.17	0.004958	10.45	453.42	66.84	0.59
1	3500.007	1%	1593.20	5651.08	5658.16	5658.16	5660.20	0.015826	12.48	184.40	49.57	0.94
1	3500.007	Historic	2833.10	5651.08	5660.12	5660.12	5662.98	0.015623	15.21	287.27	55.14	0.98
1	3456.036	1%	1593.20	5651.82	5656.41	5656.41	5658.29	0.018296	11.39	166.74	49.03	0.99
1	3456.036	Historic	2833.10	5651.82	5658.20	5658.20	5660.86	0.016373	13.73	260.11	55.91	1.00
1	3434.834	1%	1593.20	5646.61	5652.31	5652.31	5654.72	0.016334	12.78	147.71	35.67	0.97
1	3434.834	Historic	2833.10	5646.61	5654.67	5654.67	5657.96	0.014249	15.20	239.98	42.56	0.96
1	3249.778	1%	1593.20	5642.71	5650.78	5649.98	5651.89	0.006677	9.98	297.77	87.71	0.65
1	3249.778	Historic	2833.10	5642.71	5653.49	5651.66	5654.50	0.004852	10.48	574.97	99.86	0.58
1	3060.801	1%	1593.20	5642.43	5647.79	5647.79	5649.89	0.016749	12.42	172.55	45.88	0.98
1	3060.801	Historic	2833.10	5642.43	5649.69	5649.69	5652.76	0.016513	15.30	265.63	52.39	1.03
1	3046.39	1%	1593.20	5636.18	5645.83		5646.90	0.003749	9.06	267.88	40.35	0.52
1	3046.39	Historic	2833.10	5636.18	5650.20		5651.46	0.002893	10.24	489.99	60.73	0.48
1	3000.319	1%	1593.20	5636.10	5646.23		5646.57	0.001518	5.63	473.39	64.33	0.32
1	3000.319	Historic	2833.10	5636.10	5650.71		5651.13	0.001175	6.42	793.79	79.17	0.30
1	2849.532	1%	1593.20	5633.19	5645.32		5646.20	0.003094	8.74	330.06	51.76	0.46
1	2849.532	Historic	2833.10	5633.19	5649.76		5650.81	0.002623	10.05	630.09	97.14	0.45
1	2796.492	1%	1593.20	5632.32	5645.21	5640.41	5646.03	0.002393	7.73	293.96	39.26	0.40
1	2796.492	Historic	2833.10	5632.32	5649.55	5643.32	5650.66	0.002285	9.33	494.00	54.40	0.41
1	2772.454		Bridge									
1	2745.02	1%	1593.20	5631.29	5641.33	5641.33	5644.93	0.016762	15.98	135.46	23.84	0.94
1	2745.02	Historic	2833.10	5631.29	5645.15	5645.15	5649.47	0.013572	18.24	249.20	36.05	0.90
1	2691.737	1%	1593.20	5629.81	5637.95		5639.83	0.008790	11.45	177.51	33.33	0.74
1	2691.737	Historic	2833.10	5629.81	5641.16		5643.65	0.007578	13.50	298.56	41.91	0.73
1	2499.921	1%	1593.20	5627.64	5636.96		5638.29	0.005950	9.84	226.75	43.30	0.61
1	2499.921	Historic	2833.10	5627.64	5640.79		5642.27	0.004339	10.84	416.50	55.36	0.55
1	2249.832	1%	1593.20	5624.35	5632.60	5632.60	5635.83	0.015495	14.99	136.65	25.07	0.96
1	2249.832	Historic	2833.10	5624.35	5635.79	5635.79	5640.19	0.013777	17.88	225.61	30.76	0.96
1	1999.903	1%	1593.20	5619.67	5628.61	5628.61	5631.90	0.014819	15.33	143.99	27.06	0.95
1	1999.903	Historic	2833.10	5619.67	5631.97	5631.97	5636.18	0.012856	17.96	250.05	36.31	0.93
1	1750.92	1%	1593.20	5617.29	5626.10	5625.05	5627.99	0.008752	11.73	189.70	37.27	0.74
1	1750.92	Historic	2833.10	5617.29	5628.23	5627.80	5631.40	0.011190	15.57	276.39	44.27	0.87
1	1500.781	1%	1593.20	5616.16	5622.77	5622.77	5625.13	0.014913	13.16	167.73	40.62	0.94
1	1500.781	Historic	2833.10	5616.16	5625.16	5625.16	5628.32	0.013617	15.70	274.75	48.91	0.95
1	1250.021	1%	1593.20	5610.50	5621.92	5617.12	5622.48	0.001736	6.49	354.04	69.82	0.35
1	1250.021	Historic	2833.10	5610.50	5624.99	5619.56	5625.97	0.002218	8.68	555.86	318.68	0.41
1	1000.405	1%	1593.20	5610.50	5620.46	5617.72	5621.75	0.004585	9.62	232.31	142.62	0.55
1	1000.405	Historic	2833.10	5610.50	5622.12	5620.64	5624.84	0.008035	14.17	318.39	216.87	0.75
1	750.0231	1%	1593.20	5610.50	5617.30	5617.30	5619.75	0.014627	12.93	155.14	87.49	0.92
1	750.0231	Historic	2833.10	5610.50	5619.97	5619.97	5622.49	0.010529	13.96	323.61	115.64	0.83
1	500.0542	1%	1593.20	5610.50	5616.03	5614.50	5616.59	0.004290	6.48	329.30	141.74	0.50
1	500.0542	Historic	2833.10	5610.50	5618.06	5615.82	5618.86	0.004083	7.88	490.13	141.74	0.52

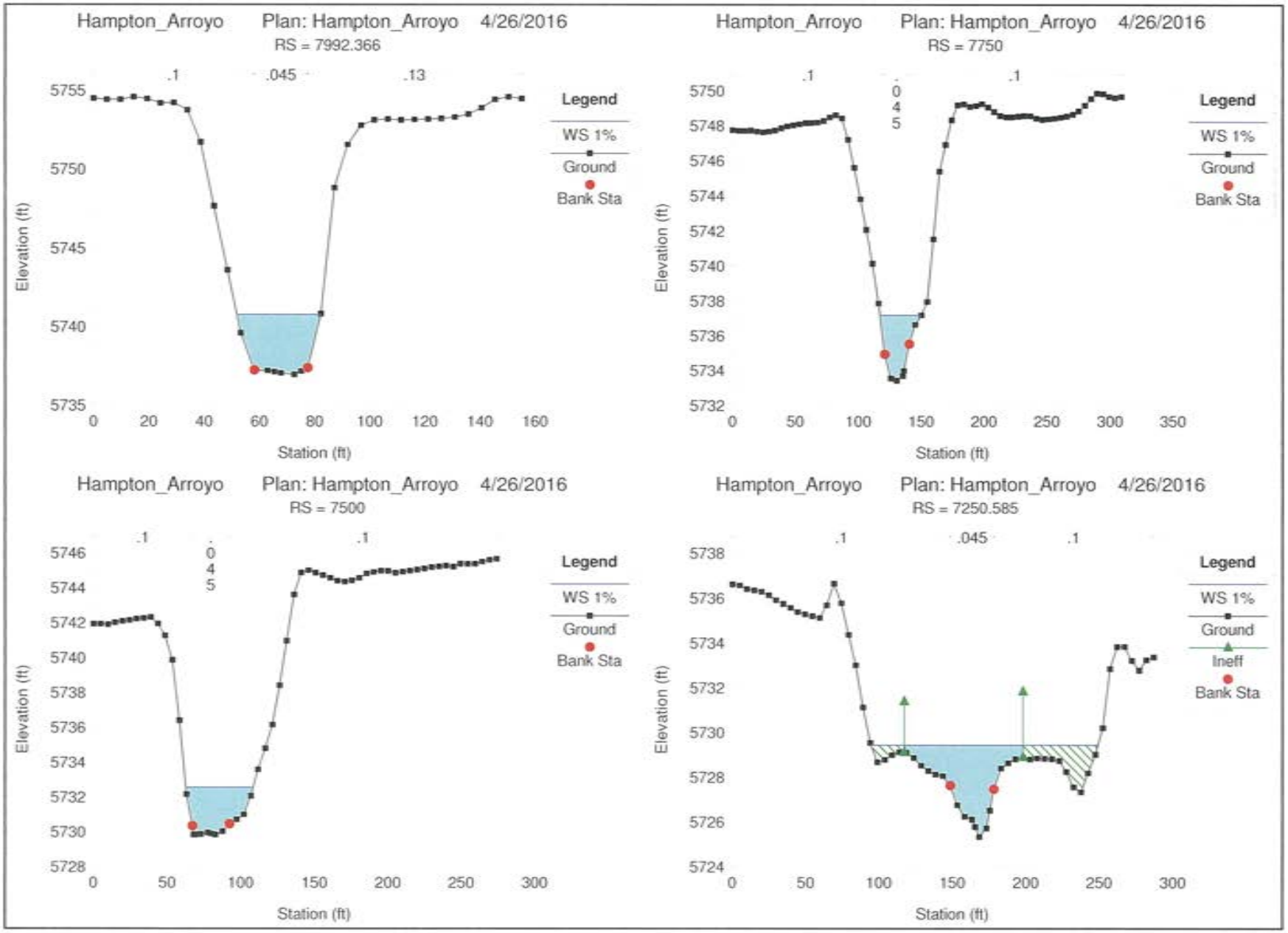
HEC-RAS Plan: Hampton_Arroyo River: Hampton Arroyo Reach: 1 (Continued)

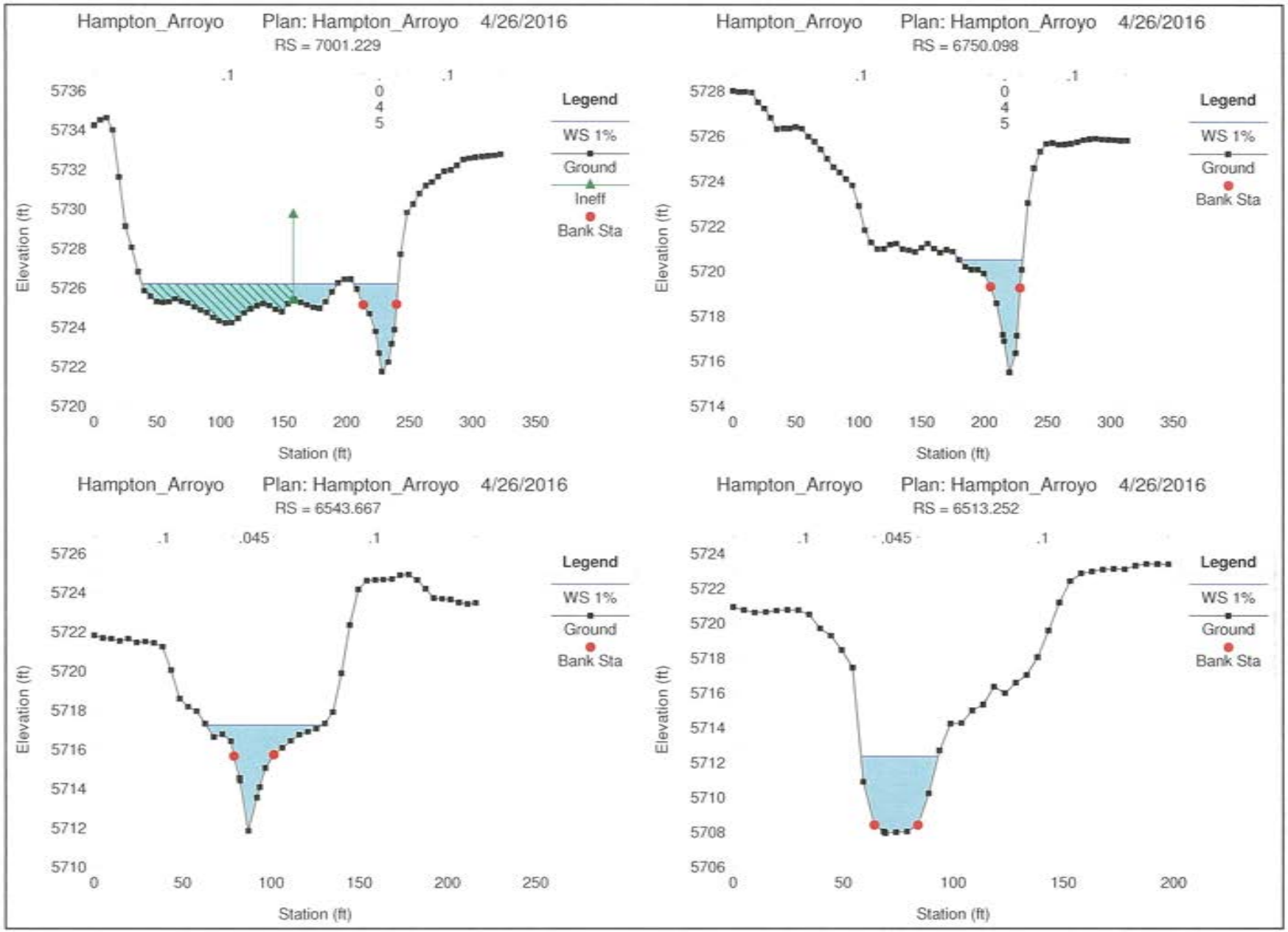
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	435.7046	1%	1593.20	5610.50	5614.41	5614.41	5616.00	0.017302	10.38	176.39	148.07	0.95
1	435.7046	Historic	2833.10	5610.50	5615.94	5615.94	5618.24	0.016260	12.67	263.13	148.07	0.98
1	383.5323	1%	1593.20	5610.50	5613.13	5613.13	5614.14	0.027797	10.15	264.17	179.70	1.13
1	383.5323	Historic	2833.10	5610.50	5614.08	5614.08	5615.56	0.027315	12.47	380.61	179.70	1.18
1	352.3		Inl Struct									
1	329.1534	1%	1593.20	5601.79	5610.45	5608.98	5611.71	0.006833	9.67	239.53	133.32	0.63
1	329.1534	Historic	2833.10	5601.79	5612.72	5611.43	5614.44	0.007195	11.85	415.67	167.30	0.67
1	282.2961	1%	1593.20	5601.55	5609.88	5609.50	5611.34	0.008546	10.55	260.08	113.28	0.70
1	282.2961	Historic	2833.10	5601.55	5613.01	5611.23	5613.94	0.004402	9.64	597.65	173.72	0.53
1	167.6271	1%	1593.20	5600.88	5607.71	5607.71	5609.97	0.015638	12.62	160.97	146.81	0.93
1	167.6271	Historic	2833.10	5600.88	5609.91	5609.91	5612.90	0.014354	15.01	256.39	169.37	0.94
1	2.254523	1%	1593.20	5599.81	5602.65	5601.73	5602.98	0.005565	4.61	356.52	145.66	0.51
1	2.254523	Historic	2833.10	5599.81	5603.70	5602.49	5604.21	0.005568	5.80	512.29	152.90	0.54

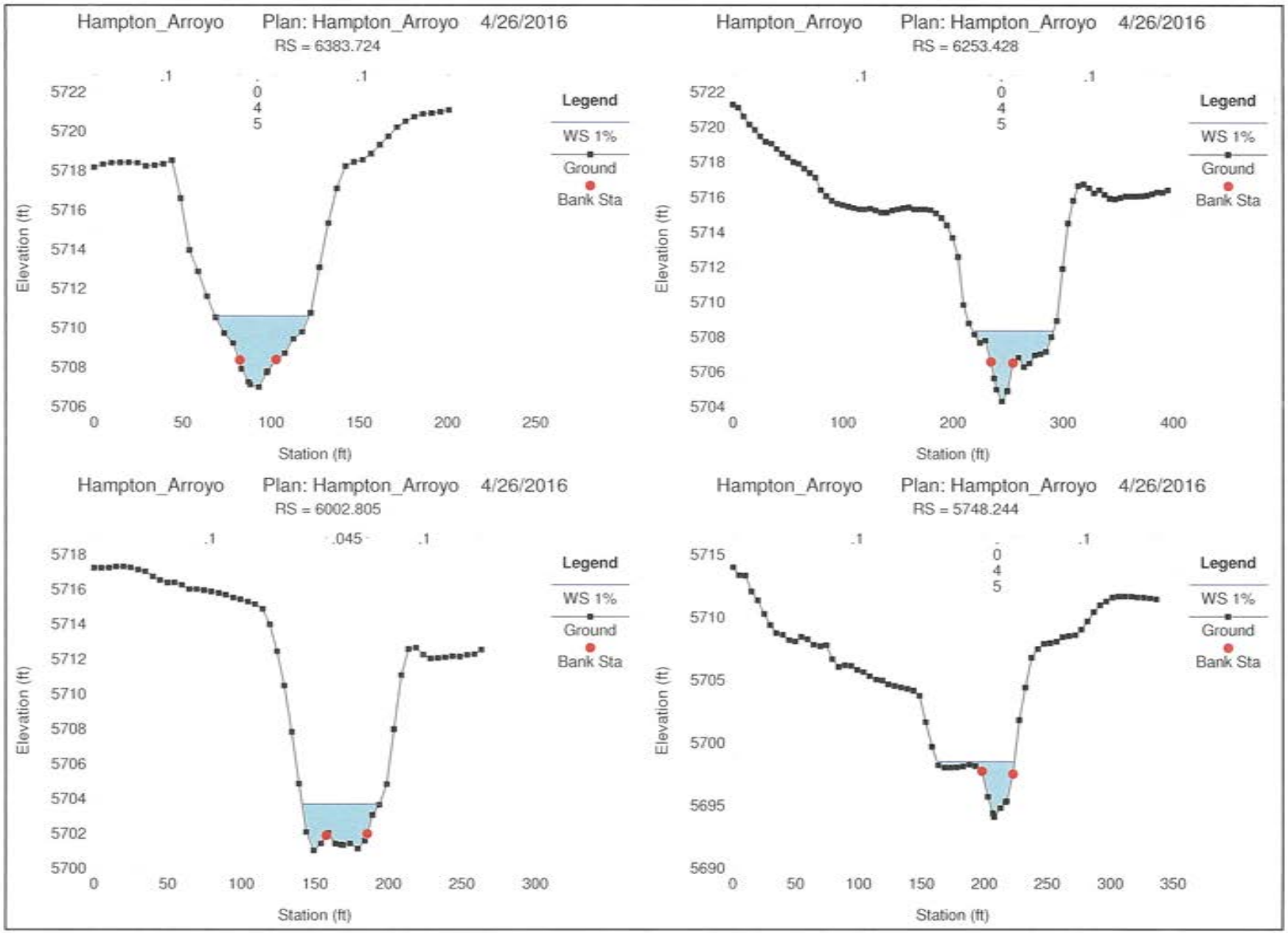
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016

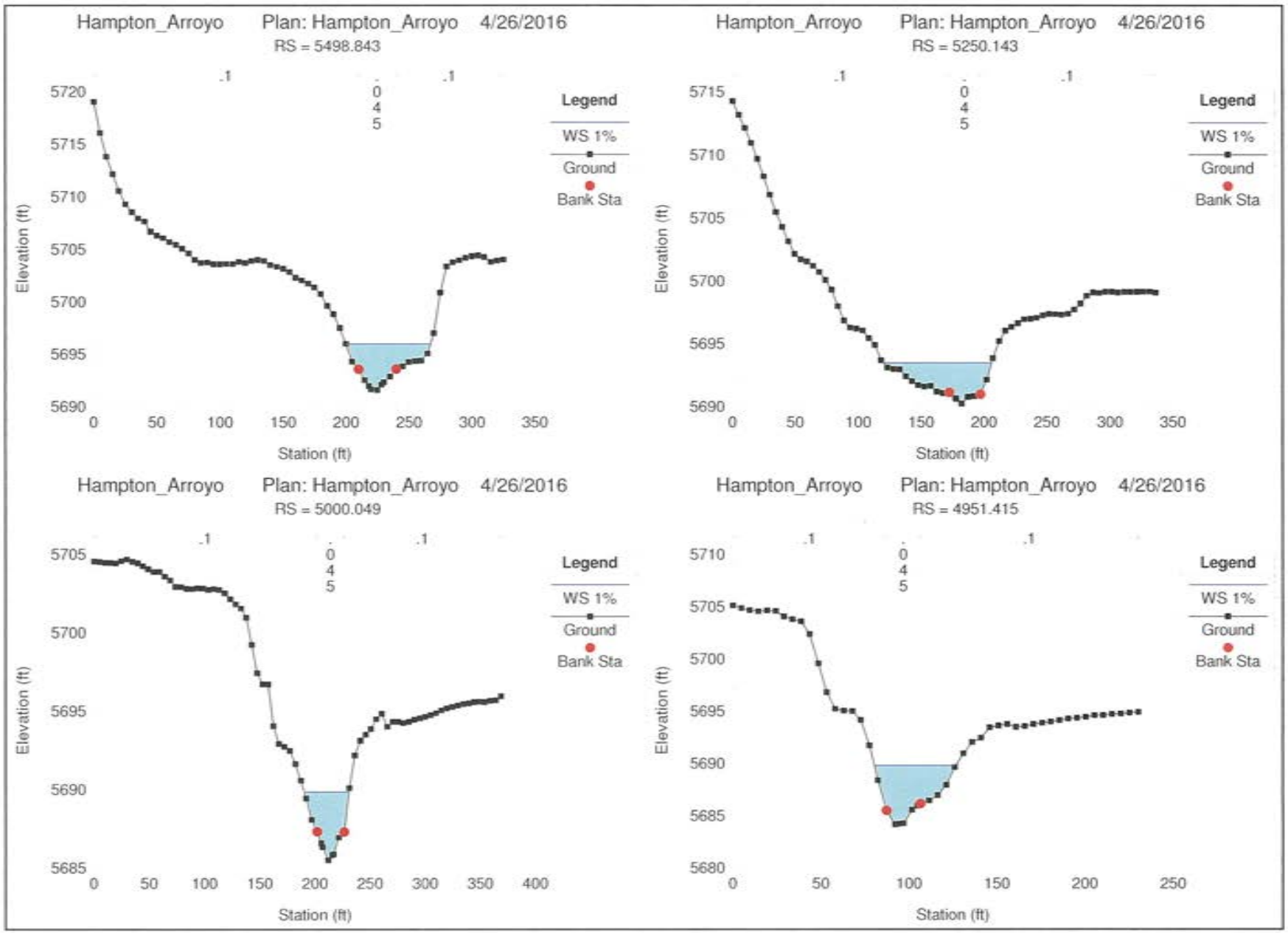
Hampton Arroyo 1

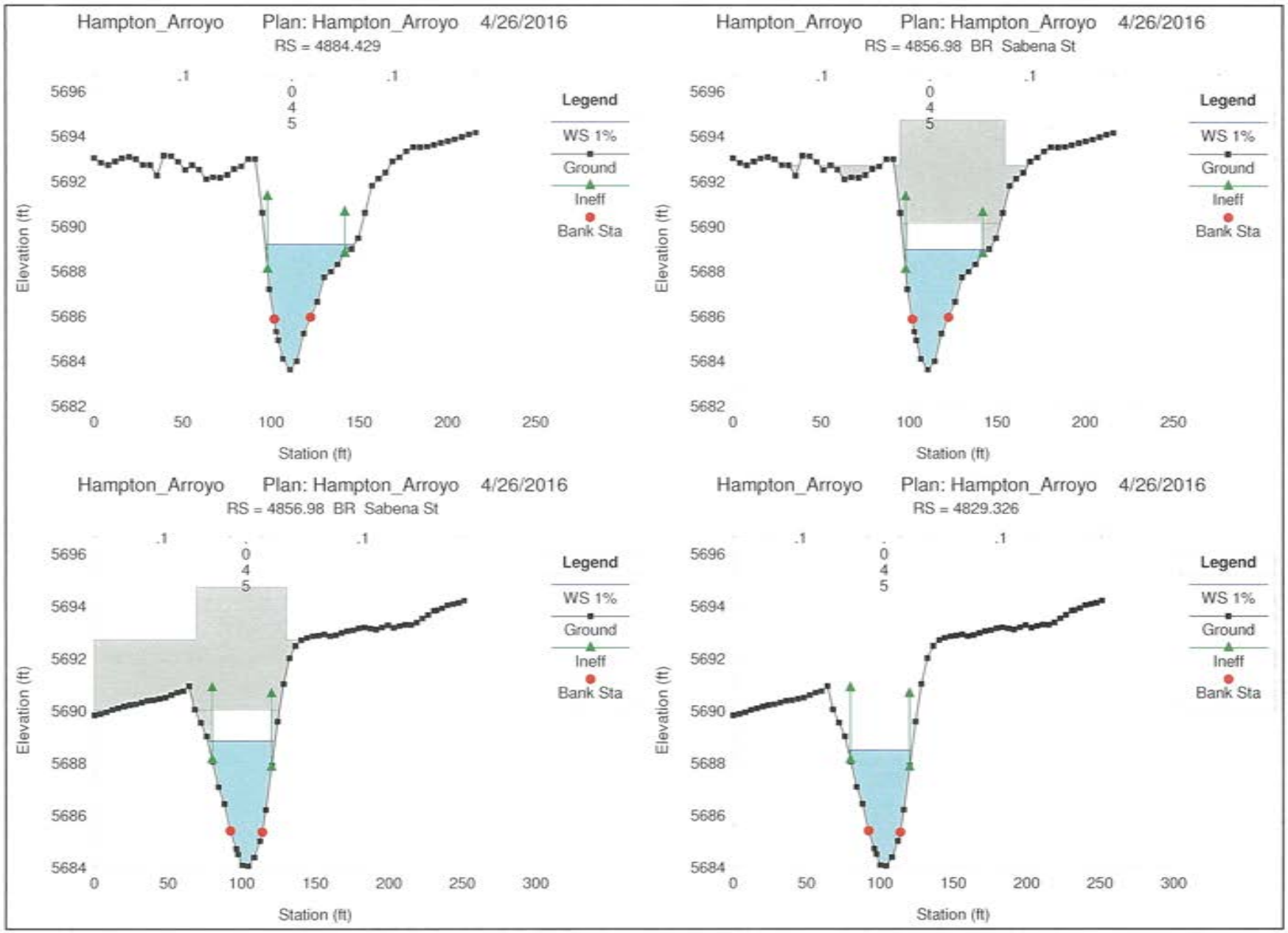


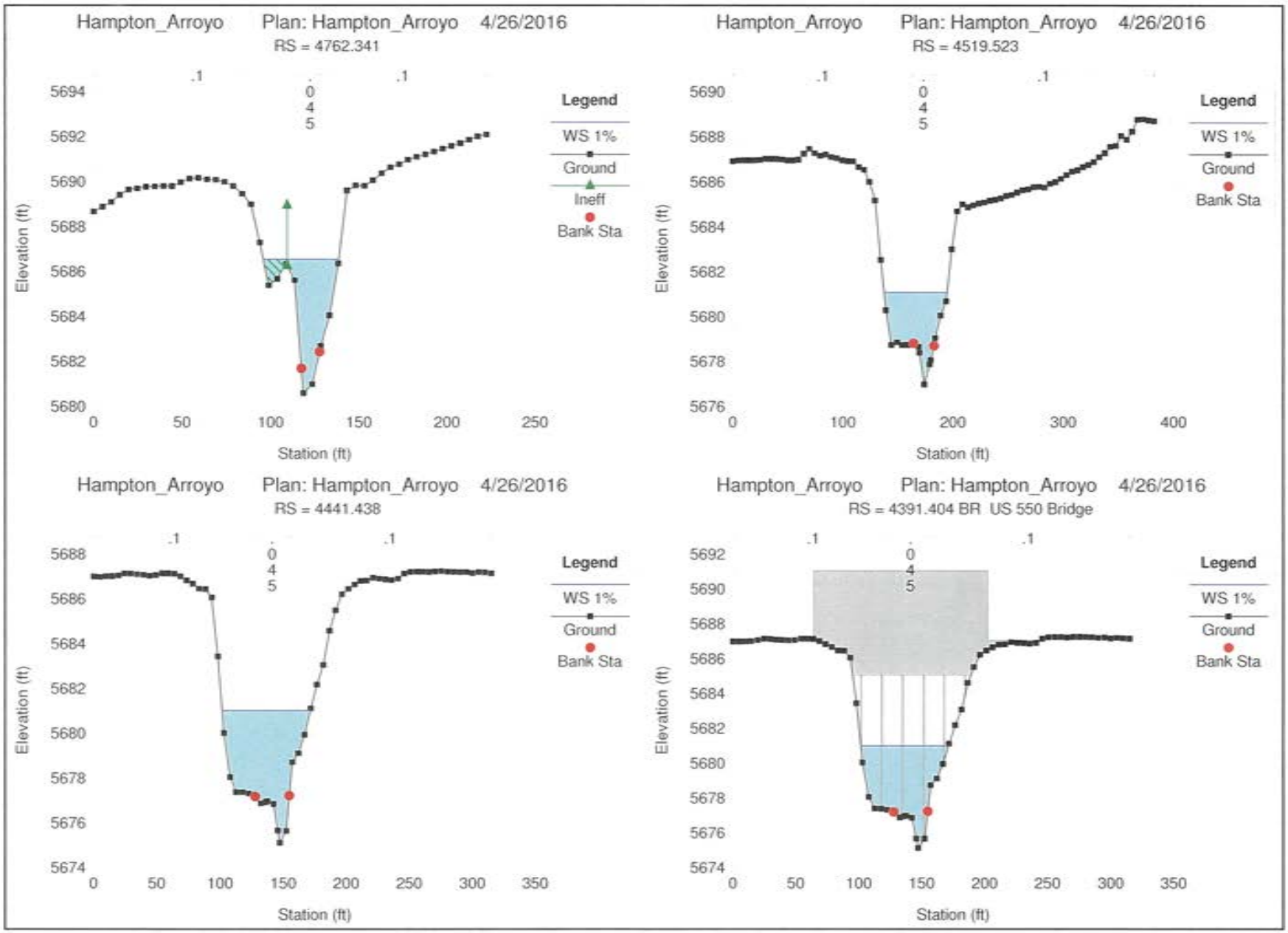

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 7992.366
.1 .045 .13
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 7750
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 7500
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 7250.585
.1 .045 .1
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

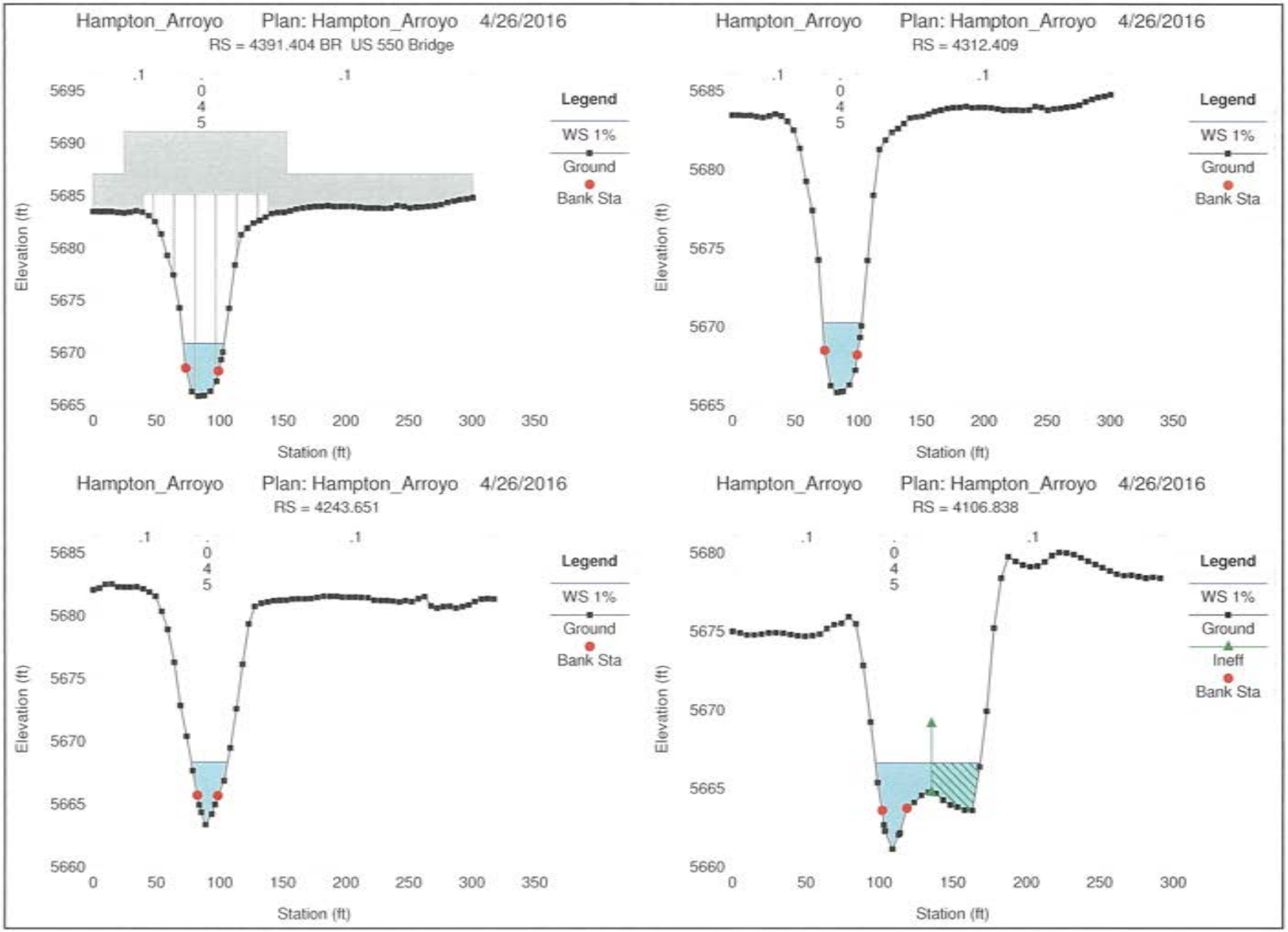

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 7001.229
.1 . .1
0
4
5
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
5736
5734
5732
5730
5728
5726
5724
5722
5720
0 50 100 150 200 250 300 350
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 6750.098
.1 . .1
0
4
5
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
5728
5726
5724
5722
5720
5718
5716
5714
0 50 100 150 200 250 300 350
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 6543.667
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
5726
5724
5722
5720
5718
5716
5714
5712
5710
0 50 100 150 200 250
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 6513.252
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
5724
5722
5720
5718
5716
5714
5712
5710
5708
5706
0 50 100 150 200
Station (ft)

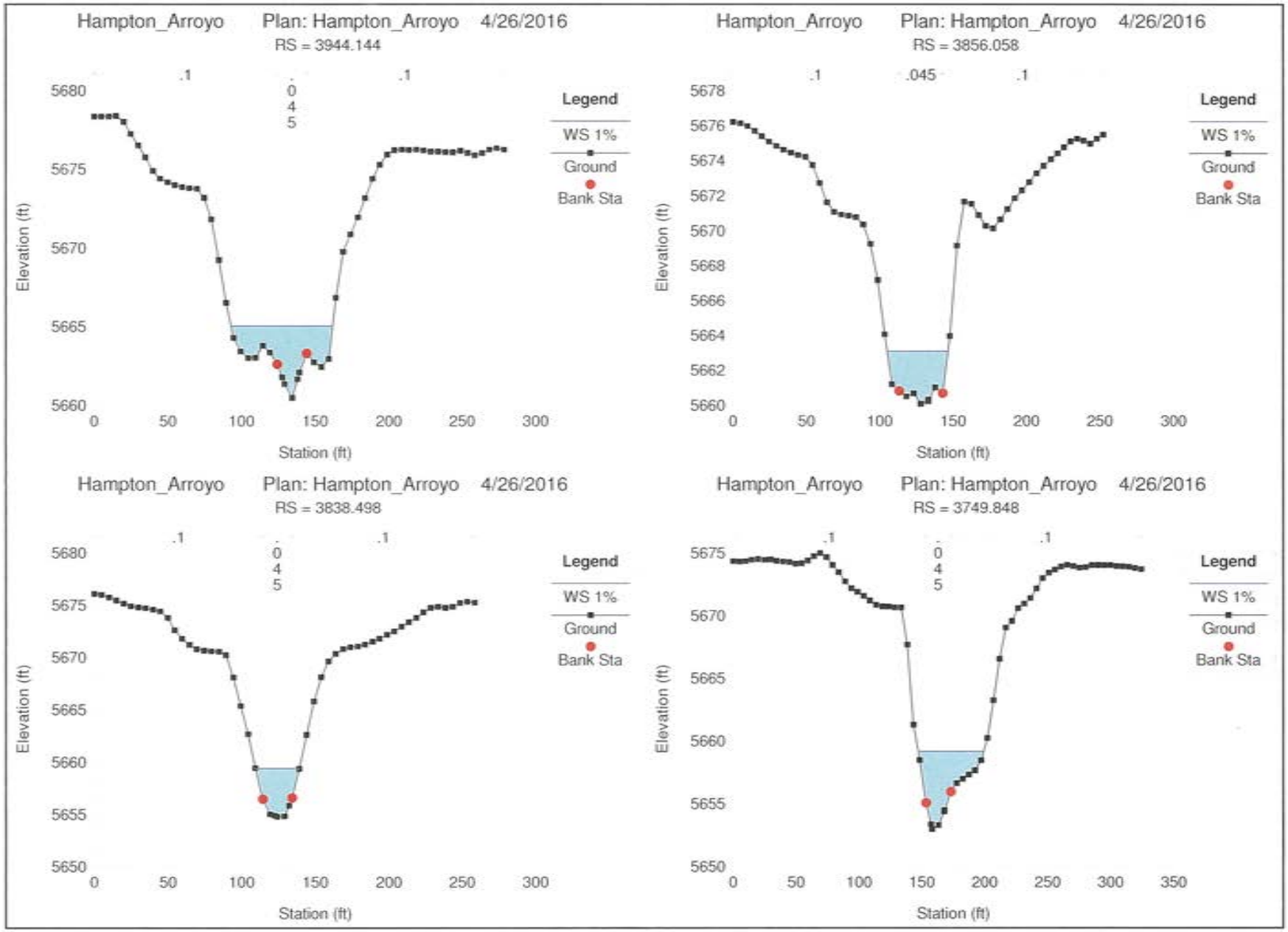

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 6383.724
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 6253.428
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 6002.805
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 5748.244
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)

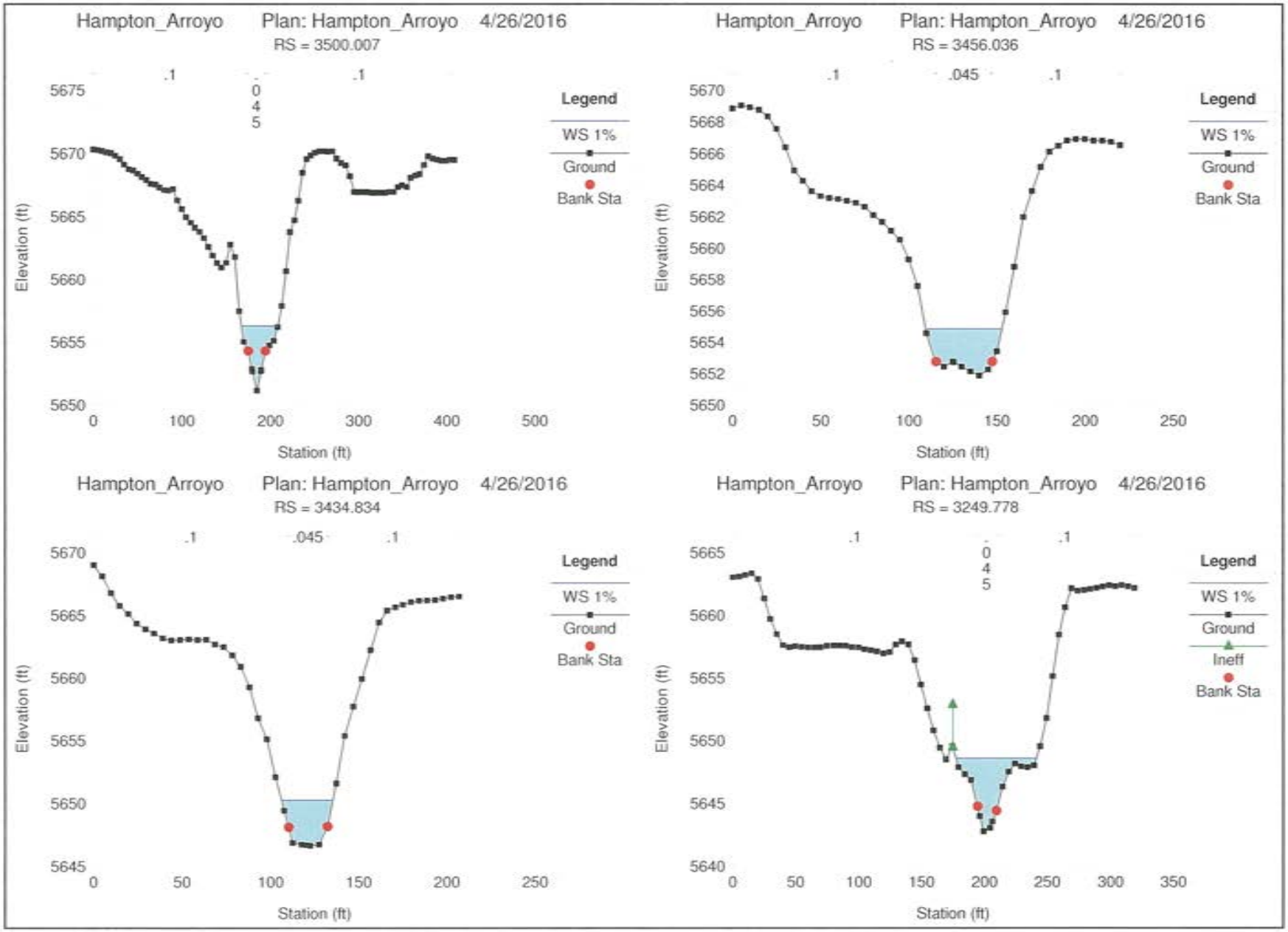

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 5498.843
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 5250.143
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 5000.049
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4951.415
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)

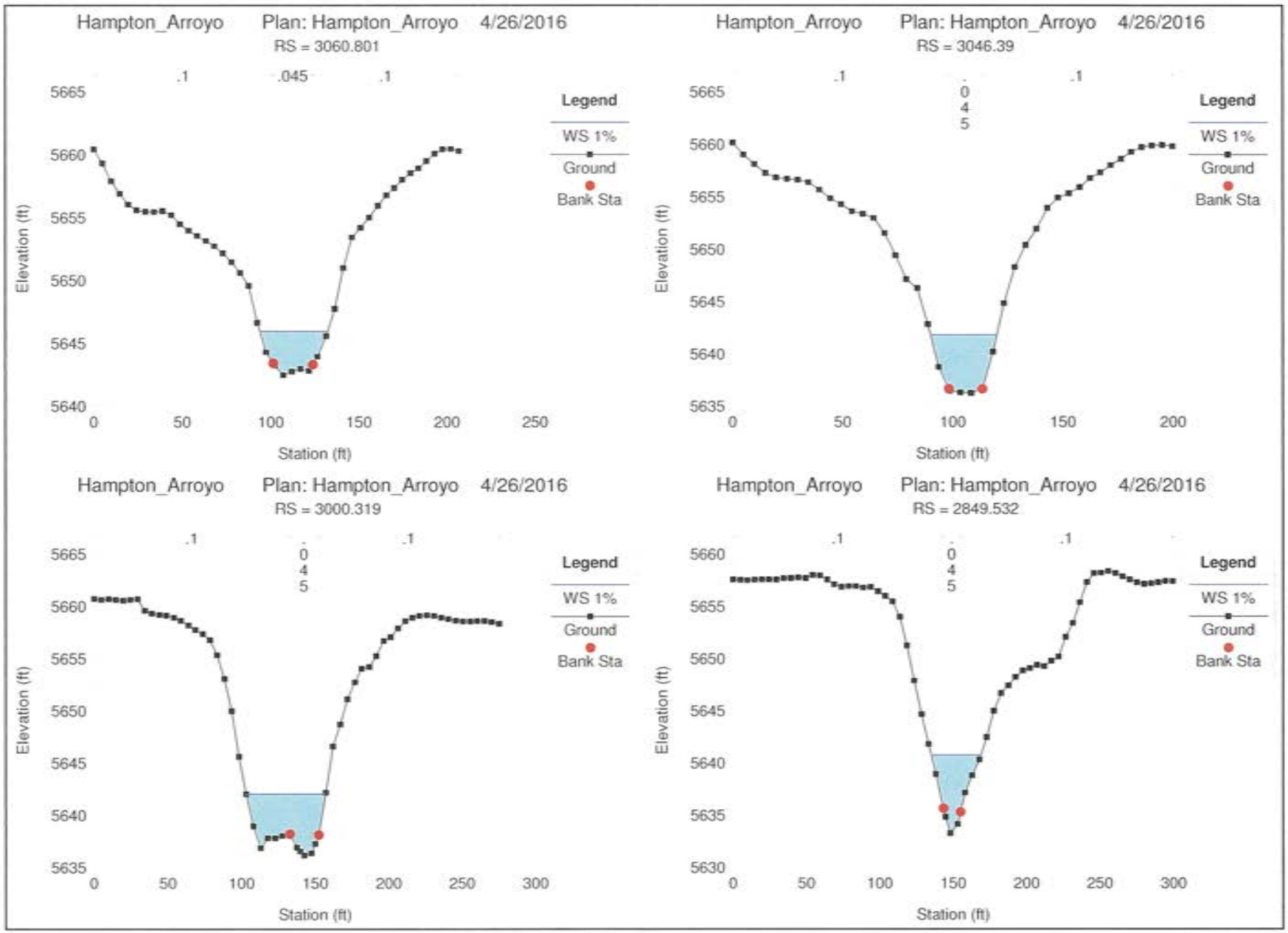

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4884.429
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4856.98 BR Sabena St
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4856.98 BR Sabena St
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4829.326
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

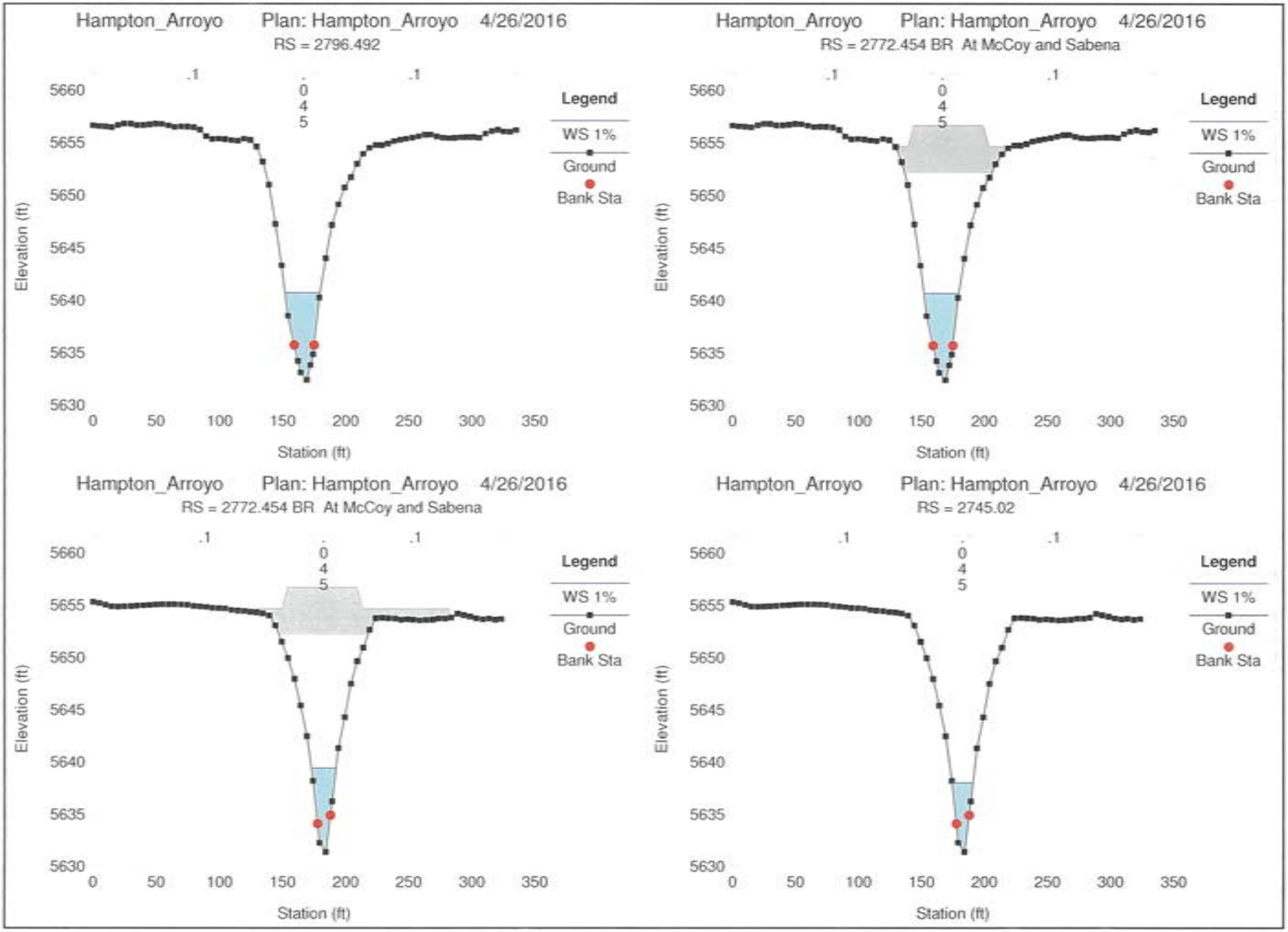

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4762.341
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4519.523
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4441.438
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4391.404 BR US 550 Bridge
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)

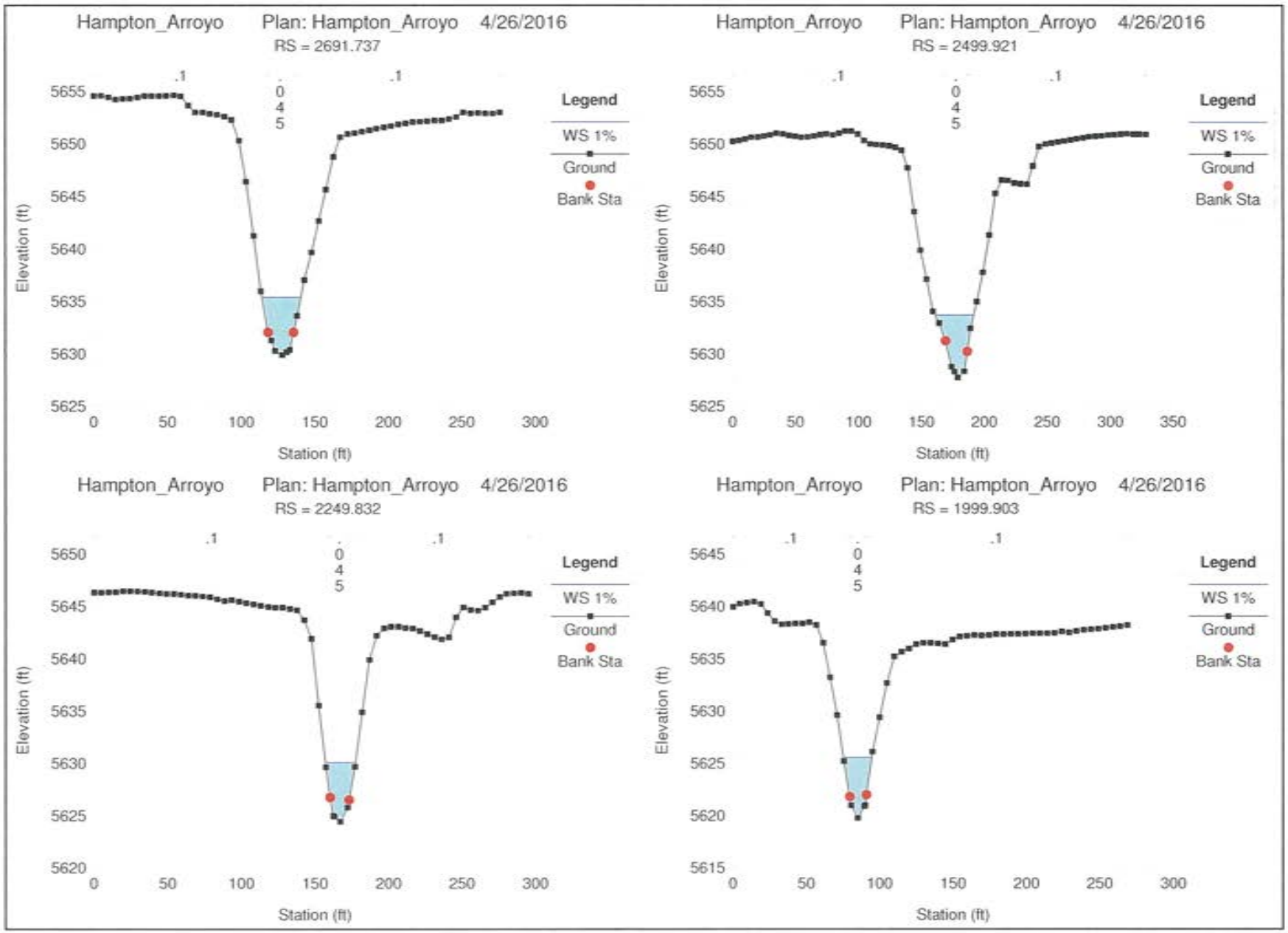

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4391.404 BR US 550 Bridge
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4312.409
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4243.651
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 4106.838
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

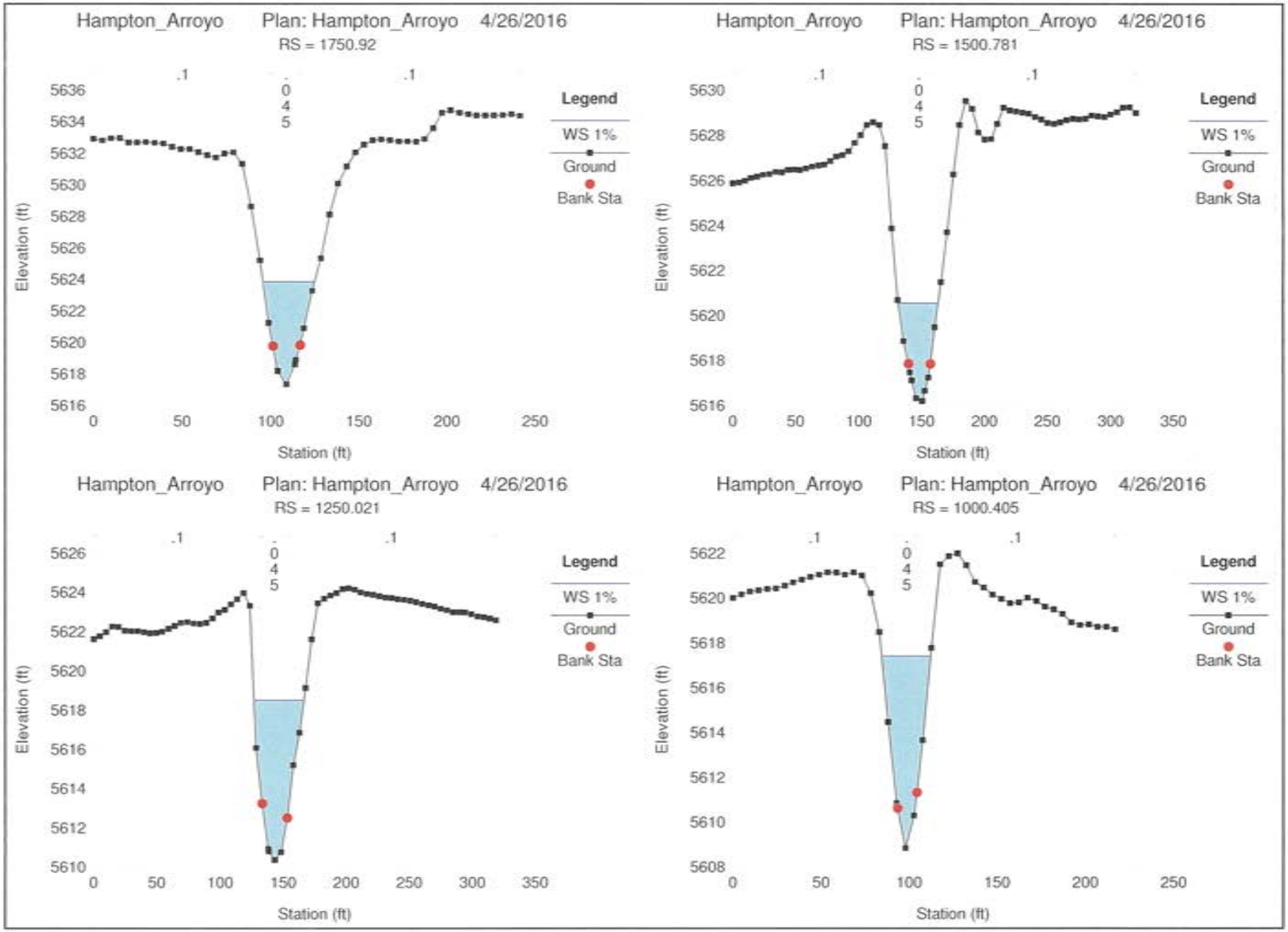

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3944.144
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3856.058
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3838.498
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3749.848
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)

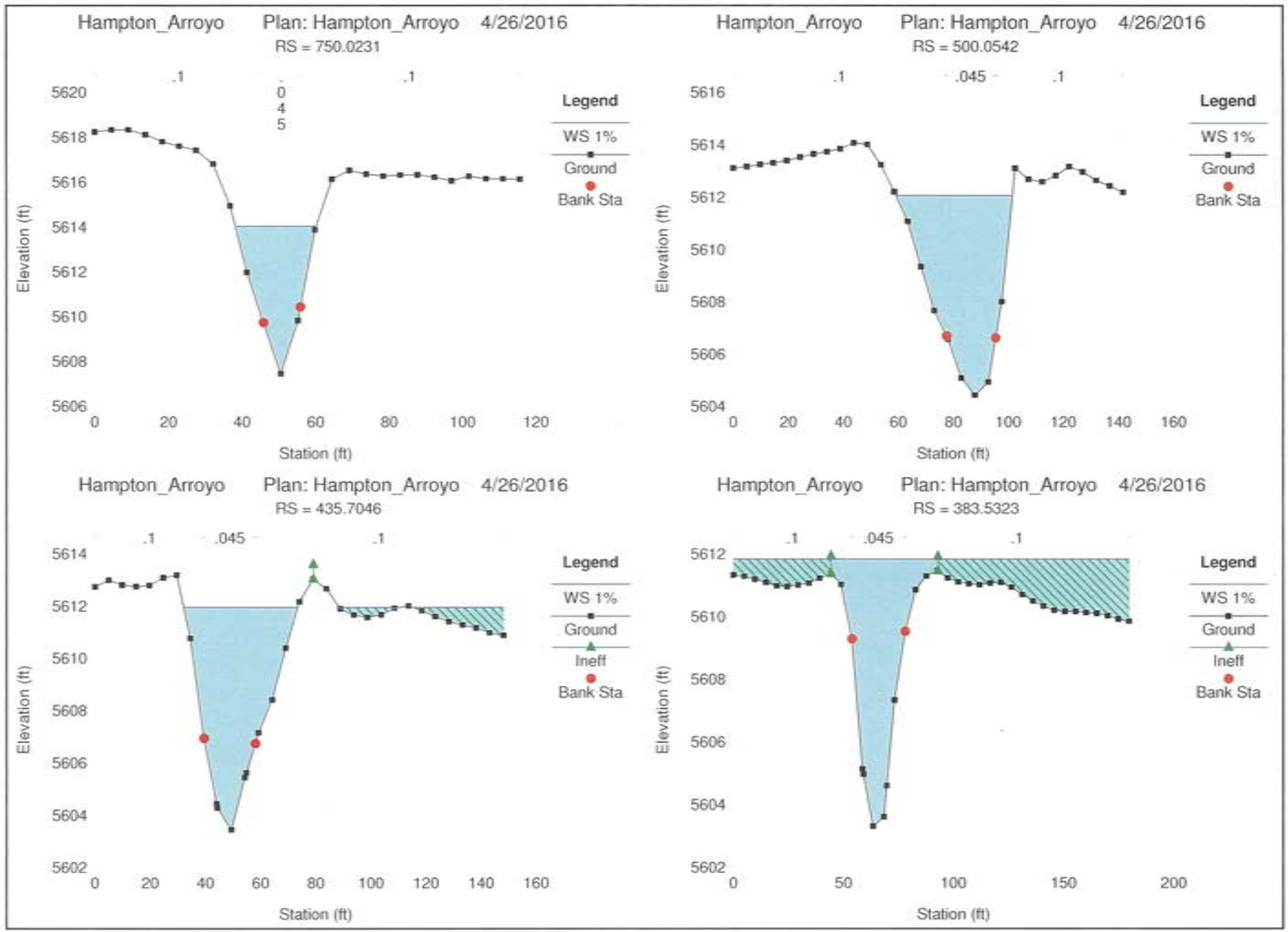

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3500.007
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3456.036
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3434.834
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3249.778
.1 .045 .1
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

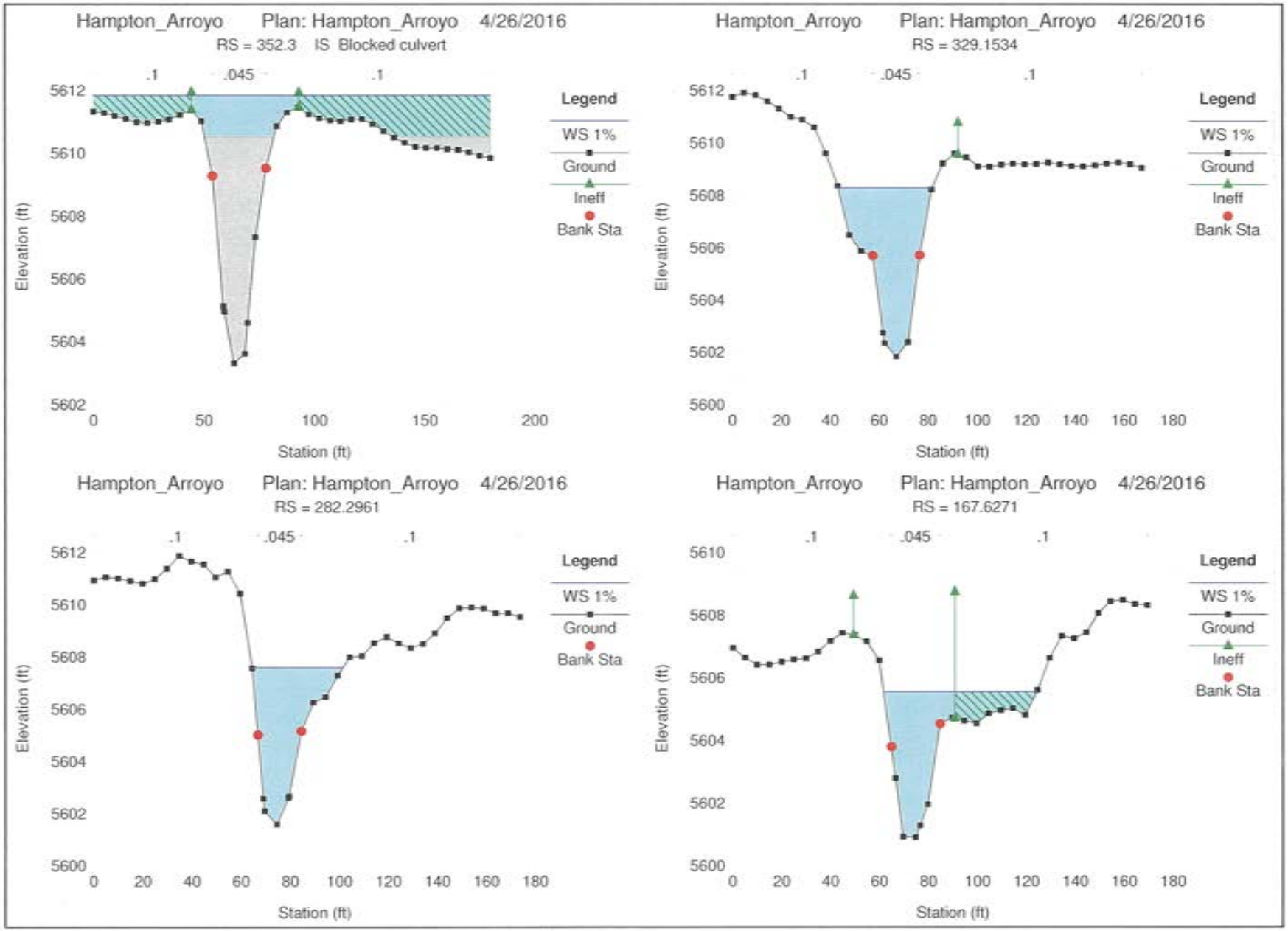

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3060.801
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3046.39
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 3000.319
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2849.532
.1 .045 .1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)

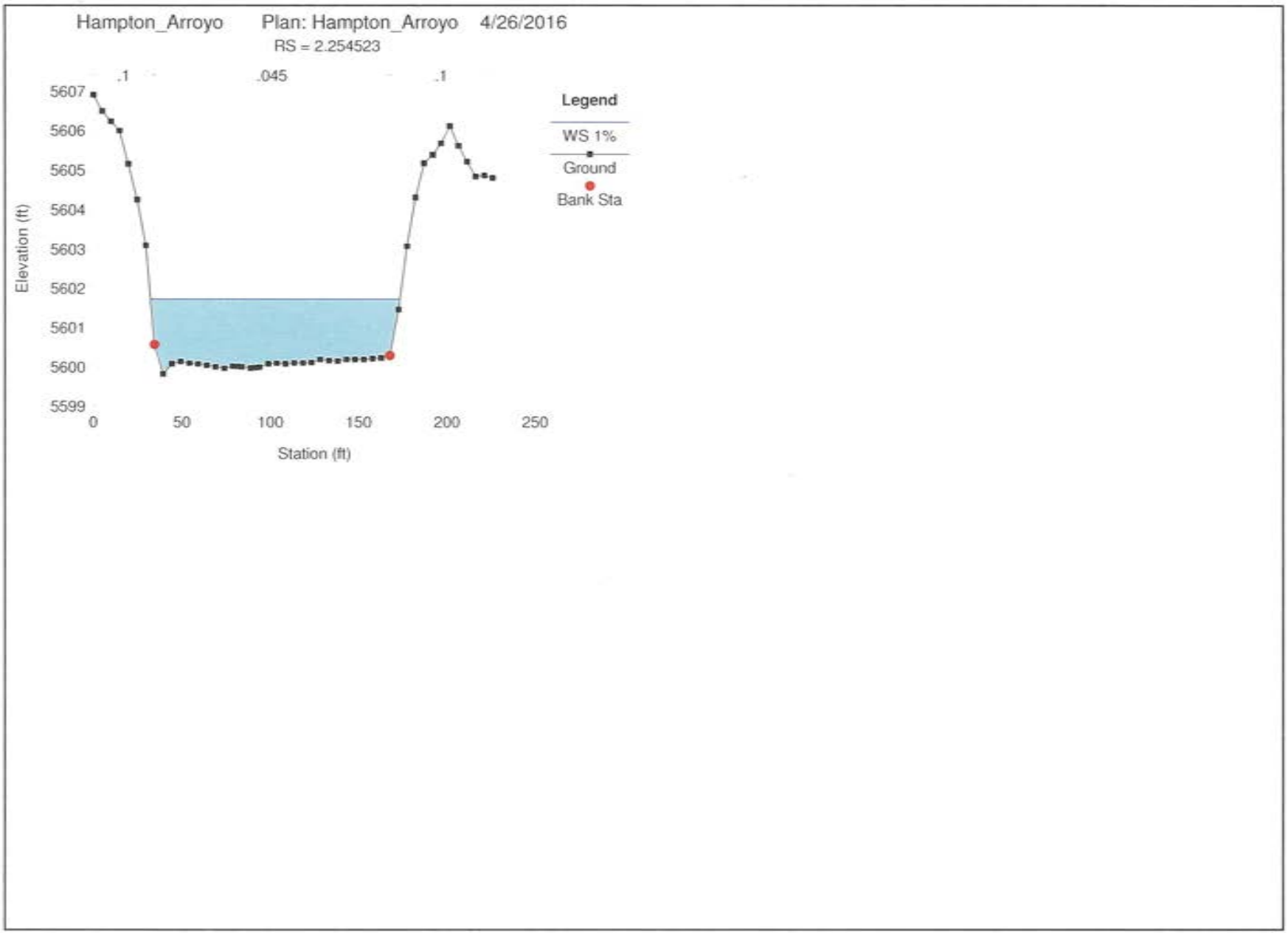

Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2796.492
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2772.454 BR At McCoy and Sabena
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2772.454 BR At McCoy and Sabena
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2745.02
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)


Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2691.737
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2499.921
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2249.832
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 1999.903
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)


Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 1750.92
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 1500.781
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 1250.021
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 1000.405
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)


Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 750.0231
.1
.1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 500.0542
.1
.045
.1
Legend
WS 1%
Ground
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 435.7046
.1
.045
.1
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 383.5323
.1
.045
.1
Legend
WS 1%
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 352.3 IS Blocked culvert
.1 .045 .1
Elevation (ft)
Station (ft)
Legend
WS 1%
Ground
Ineff
Bank Sta
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 329.1534
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 282.2961
Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 167.6271


Hampton_Arroyo Plan: Hampton_Arroyo 4/26/2016
RS = 2.254523
.1
.045
.1
5607
5606
5605
5604
5603
5602
5601
5600
5599
Elevation (ft)
0
50
100
150
200
250
Station (ft)
Legend
WS 1%
Ground
Bank Sta

URS

Job CITY OF AZTEC (KOKOPELI, HAMPTON, BLANCO) Project No. _____ Page 1 of 7

Description FIELD MEASUREMENTS Computed by SC Sheet _____ of _____

Checked by _____ Date 3.17.2016

Reference

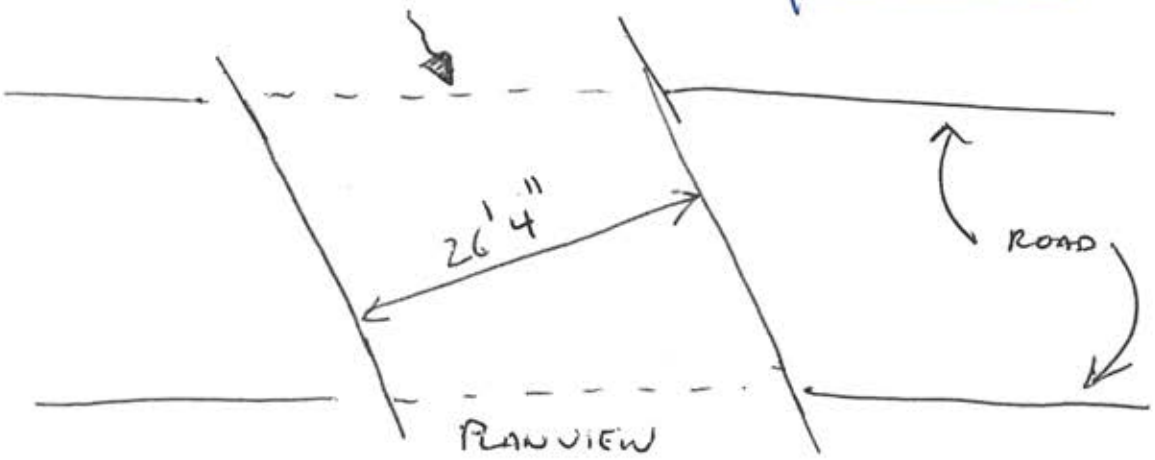
~~04021C0735F~~

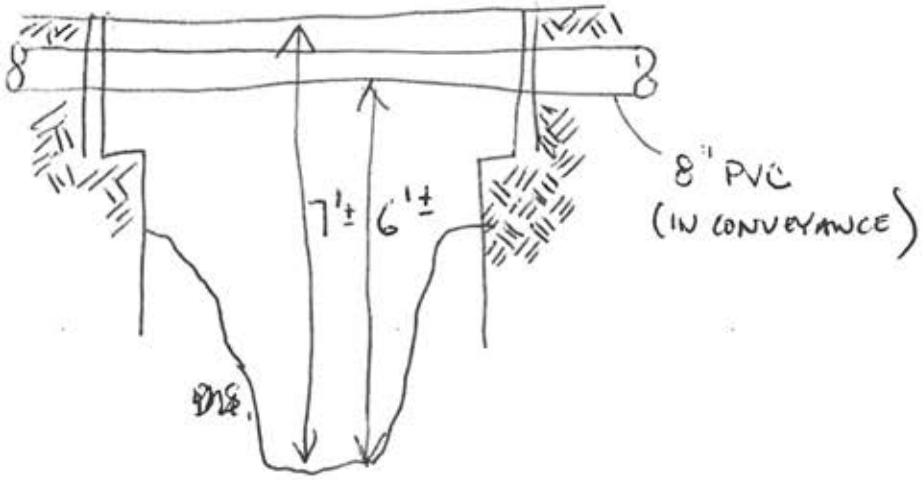
*~~04021C0755F~~

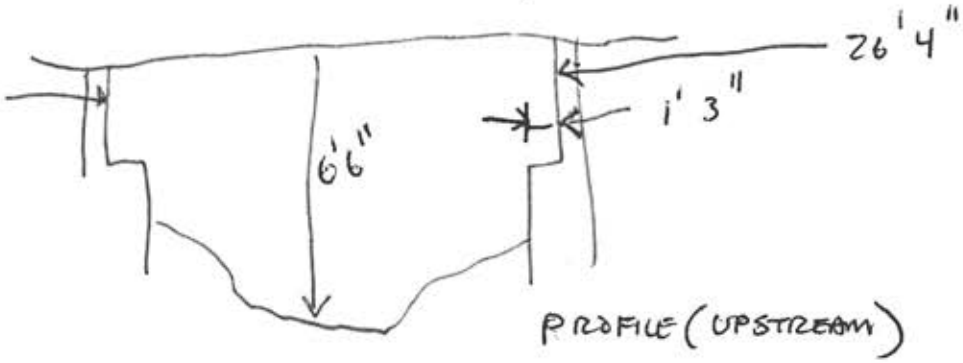
1 of

* CHAMIZA/Sabeena

Hampton







AECOM

DATE 4.21.16
PROJECT NO. BLANCO / HAMPTON
PAGE NO. 1 OF 1 BY MAC

BLANCO
Aztec Blvd

6.6 x 14.5 CBC / BRIDGE

D.S. Channel about 4' Deep.

MAIN ST.

± 4.0 x 21 double barrel Box
Left Barrel clogged.

Lovers Ln.

60" CMP

Hampton -

School Bridge

2.5 foot thick bridge deck

City of Aztec
Floodplain Study

Hampton Arroyo

Map Date:June 9, 2016

0 100 200 400 600 800 Feet

0 25 50 100 150 200 Meters

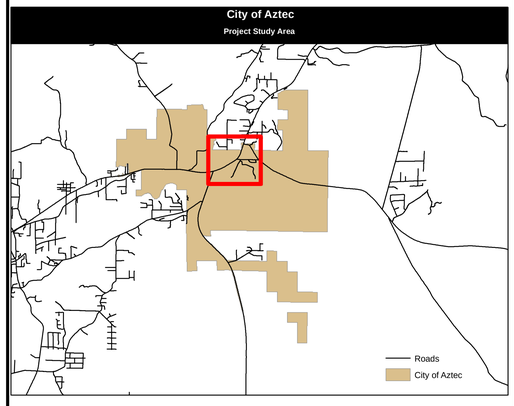
1 inch = 250 feet

Map Projection:
New Mexico State Plane West;
North American Datum 1983; Vertical Datum: NAVD 88 (Feet)

Legend

- 5743 Hampton BFE
- Limit of Study
- Roads
- Hampton Arroyo Flooplain
- Effective Floodplain
- IrrigationDitches

City of Aztec
Project Study Area



Created By:

AECOM