2. Watershed Hydrology

Previous detailed hydrologic analysis has been completed for the Black Arroyo Watershed, most recently the *Black Watershed Park Management Plan Technical Addendum* (Smith, 2013). The intent of this analysis is to revise the hydrologic model for the Black Arroyo in accordance with the updated *SSCAFCA Hydrology Manual* (2020). BHI created new hydrologic modeling for this study using the U.S. Army Corps of Engineers' (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) version 4.6.1 to model the 100-year rainfall event using NOAA Atlas 14, Volume 1, Version 5, Point Precipitation Frequency Estimates to determine rainfall events' hyetographs.

2.1. Basin Delineation

Preliminary basin delineation was completed using USACE's Hydrologic Engineering Center's Geospatial Hydrologic Modeling Extension (HEC-GeoHMS) tools in ArcGIS. Input for the tools for basin delineation and other hydrologic parameters was a digital elevation model (DEM) created from the LiDAR-derived elevation data produced by the Mid-Region Council of Government's (MRCOG) 2018 Digital and Orthophotography and Elevation Data Project. The LiDAR supports a 2-foot contour interval, and the DEM was generated with a 5-foot cell size.

Basin boundaries were then modified based on visual inspection of the 2018 MRCOG orthophotography with respect to runoff controlling features not picked up by the DEM such as neighborhood walls, medians in roads, and storm drain inlets. The aerial imagery was also referenced to subdivide, and merge basins based on land use characteristics to attain homogeneity. Basins were further modified to create analysis points in the hydrologic model at major crossing structures and existing and proposed pond locations. Digital storm drain data and record drawings provided by the City of Albuquerque and the City of Rio Rancho were consulted to further inform basin delineation and routing. Additional consideration was given to the basins previously delineated for the Black Arroyo Watershed by Smith Engineering Co. as part of the Black Watershed Park Management Plan Technical Addendum (2013). Basin boundaries were also clarified at several locations in the field where the DEM and the aerial imagery provided insufficient information. Several locations in neighborhoods with walls and no available storm drain information were checked for validation of drainage patterns as well as sites where flow paths crossed graded roads with no visually apparent downstream flow path. The western boundary of the basin near the Los Diamontes development was modified, as a portion of the basin was found to drain towards the Calabacillas Arroyo. The resulting basin boundaries are shown in Figure 2.1 with color coding based on major tributaries.

2.2. Reach Routing

Routing reaches preliminarily created from the HEC-GeoHMS tools were used as the starting point for routing flows in the hydrologic model. The reaches were then edited based on the basin edits mentioned above and digital storm drain data to create reaches with homogeneous slope, cross-sectional geometry, and channel type. Slopes and lengths were calculated using the HEC-GeoHMS tools. For open channels, representative transects were cut from the DEM and input into HEC-HMS as simplified eight-point cross sections. Overland flow and flow in streets were represented by idealized rectangular shaped reaches, and storm drains were modeled as closed conduits based on available data for size and shape. Roughness coefficients (Manning's n values) were taken from Table 5 of the *SSCAFCA Hydrology Manual* (2020) and for reference are included below in Table 2.1.

Table 2.1: Recommended base values of Manning's n values from *SSCAFCA Hydrology Manual* (2020).

Channel Type	Manning's n value
Sand channel/arroyo	0.020 – 0.035*
Troweled concrete	0.013
Streets (asphalt)	0.017
Reinforced concrete pipe	0.013
Corrugated metal pipe	0.025

*depending on bed material and flow regime.

Roughness coefficients for sand channels/arroyos were preliminarily set to 0.020 and increased incrementally in reaches with supercritical flows to bring results closer to more natural conditions of subcritical or borderline critical flow. There were several reaches which still reported supercritical flow after increasing the n value to 0.035, with Froude numbers of up to 1.4. However, this was deemed acceptable based on SSCAFCA's observations of high flow conditions in the arroyos in the study area. See Appendix A for details of routing parameter inputs.

2.3. Existing Land Use

The majority of the Black Arroyo Watershed is in the City of Rio Rancho with a small portion at the southern end in the City of Albuquerque. Urban development covers most of the land in the Watershed with some more sparsely developed neighborhoods located in the northern and western portions of the study area. For the purposes of this study, parcel and zoning GIS data were obtained directly from the City of Rio Rancho on August 27, 2020 and from the City of Albuquerque's online database on August 13, 2020. Land use types in the cities' data were generalized into project specific categories to facilitate hydrologic input parameter calculations. These categories were based on the major land use and urban land use categories with associated pervious curve numbers in Table 2 of the *SSCAFCA Hydrology Manual* (2020). Land use classification in the City of Rio Rancho's database was highly specific with regards to commercial land and by visual inspection of the aerial imagery, was generalized into more broad categories of high, medium, and low density. Neighborhoods were delineated based on typical densities of development as well.

Additional consideration was given to residential neighborhoods as this land use category covers approximately 60% of the Watershed. From the aerial imagery, it was determined that the study area was best represented by eight neighborhoods divided primarily by the major roads of Unser Boulevard, Southern Boulevard, Golf Course Road, and Idalia Road. The residential parcels in these neighborhoods have similar levels of impervious cover and landscaping features. Based on aerial imagery, it was determined that the residential density of the neighborhood in the City of Albuquerque was similar to that of the neighborhood between Unser and Golf Course in Rio Rancho. The neighborhoods are outlined in Figure 2.1.

2.4. Existing Conditions Loss Parameters

Precipitation losses and excess runoff were calculated using the Natural Resource Conservation Service (NRCS) Curve Number method per the *SSCAFCA Hydrology Manual* (2020). Curve numbers for the pervious areas of the various land use categories were taken from Table 1 of the *SSCAFCA Hydrology Manual* (2020).

Building footprints were available from BHI for the portion of the Watershed in the City of Rio Rancho. Average impervious coverage was calculated for the project specific land use categories using the area of building footprints relative to the parcel area. Other impervious areas, such as driveways and parking lots, were approximated by taking sample measurements in GIS of representative lots in each category. From these averages, portions of directly connected impervious area (DCIA) and disconnected impervious area were quantified based on the guidance in Table 1 of the *SSCAFCA Hydrology Manual* (2020). Table 2.2 outlines the generalized land use categories used in this study as well as their specific corresponding loss parameters.

Table 2.2: Existing conditions land use categories and loss parameters.

Land Use Category	% Impervious	% DCIA	Pervious CN
Commercial - HIGH	95%	100%	96
Commercial - MEDIUM	85%	100%	87
Commercial - LOW	75%	100%	77
Drainageway	10%	0%	77
Multi-Family Residential	41%	50%	80
Open Space	0%	0%	Soil Specific
Park, Lawn	5%	0%	68
Paved Roads (including right-of-way)	80%	100%	86
School	30%	50%	68
Single-Family Residential	Neighborhood Specific	50%	Neighborhood Specific
Unpaved Roads (including right-of-way)	0%	0%	82

Lastly, designated open space and vacant lots were analyzed individually to determine loss parameters specific to soil types. Per guidance from the *SSCAFCA Hydrology Manual* (2020), approximately 10 soil samples were analyzed per square mile of open space using the NRCS field guide for estimating soil texture by feel. Ground cover was estimated during site visits and from aerial imagery to be between 30-70%, and most of the samples were sand-type soils. Three of the sample locations had some clay in the soils, and the higher curve number associated with clays was spatially distributed throughout the subbasin in which the sample was collected using the NRCS Soil Survey Geographic (SSURGO) database map unit boundaries. See Figure 2.1 for the locations of the samples and Appendix A for a summary table of soil sample results. Details are also included in Appendix A for DCIA and curve number assignments for specific neighborhoods.

2.5. Projected Future Land Use

The generalized categories used for the existing conditions land use were also used for the future conditions. Zoning GIS data was obtained from the City of Rio Rancho and the City of Albuquerque, and zones were associated with the generalized categories based on visual inspection of fully developed zones. Additionally, the City of Rio Rancho's Specific Area Plan for Unit 10 (2018) and Northern-Unser Specific Area Plan (2011) were referenced to modify zoning categories in the area covered by the Plans. All zones were assumed to develop as platted and no vacant lots were included in the projected future land use. Residential lots were assumed to develop to the same level as existing nearby developed lots.

Some zones had to be overridden or otherwise manually adjusted based on existing conditions development. Special use zones were assigned to a land use category on a case-by-case basis based on aerial imagery and parcel information. The projected future land uses were cross checked with existing land uses to ensure that development conditions increased in all areas. For example, some areas that the zoning data had classified as residential have already been developed as commercial areas and required manual re-categorization.

For the previous *Black Arroyo Watershed Management Plan*, completed by Smith Engineering (2013), the developed land use zones were modified based on discussions with SSCAFCA. The decisions made for adjusting land use categories in the Technical Addendum were also included in this analysis. Lots along Golf Course Road Southeast, and along the west side of Unser Boulevard Northeast between Abrazo Road Northeast and 5th Street Southeast, that were zoned as residential were adjusted to projected commercial levels of future development based on surrounding existing land use. Also, the lots along the West Branch of the Black Arroyo between Southern Boulevard and 19th Avenue were reclassified to open space as they are owned by SSCAFCA and are unlikely to be developed. See Figure 2.1 for future land use categories in the study area.

2.6. Developed Conditions Loss Parameters

For the developed conditions hydrologic model, loss parameters were calculated using the projected future conditions discussed in the previous section and the land use categories and associated losses discussed in Section 2.4. See Appendix A for details of loss parameters calculated for each subbasin.

2.7. Transform Method

The SCS unit hydrograph method in HEC-HMS was used to transform rainfall data to runoff hydrographs for each subbasin in accordance with the *SSCAFCA Hydrology Manual* (2020). Times of concentration and resulting lag times were calculated using the velocity method outlined in the *National Engineering Handbook Chapter 15* (USDA, 2010). HEC-GeoHMS tools were utilized for preliminary delineation of the longest flow paths for each subbasin. Flow paths were manually adjusted based on aerial imagery to account for walls, medians, and other hydraulicly controlling features. The longest flow paths were split into reaches representing sheet flow, shallow concentrated flow, and channel flow. Based on these segments, travel times were calculated for each reach. Refer to Appendix A for detailed calculations required for transform input parameters in HEC-HMS.

2.8. Sediment Bulking

In order to account for the large amounts of sediment common in stormwater runoff in the study area, a bulking factor was applied for all subbasins in the Black Arroyo Watershed. Based on SSCAFCA guidance, a factor of 6% was applied for urbanized areas and a factor of

18% for open space and vacant lots. An area weighted average was calculated for each subbasin based on assigned land use categories and input to HEC-HMS as a flow ratio proportional to one. Results of these calculations are included in Appendix A.

2.9. Existing Ponds

Within the study area there are 10 ponds which influence stormwater runoff. The effects of pond routing were included in the hydrologic model with the use of rating curves developed from available record drawings and engineering documents. The rating curves for each pond included elevation-storage and storage-discharge curves accounting for multiple outlets and spillways for each pond. Lisbon Pond and the Lisbon Auxiliary Pond are currently under contract for construction and, for the purposes of this study, were considered to be built and therefore were included in the existing conditions analysis. See Appendix B for documentation of pond characteristics.

2.10. Design Storm

Point precipitation frequency estimates from the NOAA Atlas 14, Version 1, Volume 5 online precipitation frequency data server (NOAA, 2020) were obtained in January 2021 at the centroid of the Watershed and used to develop a hypothetical storm for the purposes of this analysis. Table 2.3 below summarizes the NOAA point precipitation frequency estimates for the 100-year recurrence interval, and the full report is included in Appendix A.

Table 2.3: Point precipitation frequency estimates for the 100-year recurrence interval in the Black Arroyo Watershed.

Duration	Point Precipitation Estimate (in)
5 minutes	0.56
15 minutes	1.07
1 hour	1.78
2 hours	2.04
3 hours	2.13
6 hours	2.3
12 hours	2.43
1 day	2.72

2.11. Existing and DEVEX Conditions Results

Hydrologic models were created in HEC-HMS for existing conditions and developed conditions with existing infrastructure (DEVEX). Throughout most of the study area, peak flow rates and runoff volumes increased with simulated increased development. In some portions of the Watershed, which are currently considered fully developed, there was no change in results between existing and conditions and DEVEX. The results from both conditions are summarized in tables and peak discharge profiles for main reaches in Appendix C.

The Federal Emergency Management Agency (FEMA) conducted a Flood Insurance Study (FIS) for Sandoval County, New Mexico and Incorporated Areas, FIS Number 35043CV000A in 1996 and the FIS was last revised in 2008. Table 2.4 below summarizes peak discharges from the FIS alongside corresponding analysis points from the Smith Engineering 2013 report and this study for comparison purposes. The discrepancies between results can be attributed to varying methods in the calculation of hydrologic parameters as well as the addition of flood control facilities between 2008, 2013, and this study.

Table 2.4: Results comparison summary.

Analysis Point			Peak Discharge (cfs)				
FEMA FIS Location	Smith HMS ID	BHI HMS ID	FEMA FIS	Existing		DEVEX	
				Smith	BHI	Smith	BHI
Arkansas Channel	108_J1	I_101_J + I_102	299	288	303	288	303
East Branch at the downstream limit of study	255_J	EB_111_J + EB_112	3,203	3,295	3,411	3,655	3,629
Nicklaus Channel at confluence with the East Branch	216_J1	EB_401_J + EB_402	351	383	353	382	356
Player Channel	217A	EB_602	289	264	211	319	211
Spur Channel	112_J	A_102_J + A_103	390	356	443	358	472
Sugar Channel at confluence with the West Branch	106.9_J1	SG_105_J + L_108	433	523	360	595	455
Tributary A at confluence with the West Branch	154_J + 155.2 + 155.1	WB_104_J + WB_105	393	830	503	1,119	833
Tributary B at confluence with the East Branch	251_J	Cabezon Tract 17 Pond + EB_704	732	674	879	730	989
West Branch at the downstream limit of study	155_J2 + PH_J + 160	W_103_J + B_106	2,986	4,477	2,934	5,348	3,796

2.12. Structure Capacities and Major Deficiencies

The capacity of major crossing structures in the study area were analyzed based on available record drawings, field measurements, and GIS data. Capacities were compared to the 100-year peak discharge results from the existing and DEVEX conditions to determine deficiencies. Table 2.5 and Figure 2.2 summarizes the results of this analysis. Green shading indicates capacity under both modeled scenarios, yellow shading indicates capacity for the existing conditions scenario only, and red shading represents insufficient capacity for both modeled scenarios. See Appendix E for detailed capacity calculations and photos from field investigations.

Table 2.5: Major crossing structures, capacities and peak discharges from existing and developed conditions with existing infrastructure (DEVEX).

Crossing	Location	HMS ID	Existing Q_p* (cfs)	DEVEX Q_p* (cfs)	Capacity (cfs)
1	Lisbon Channel at Tarpon Ave.	L_107_J	307	366	909
2	Lisbon Channel at Southern Blvd.	L_110_J	835	948	1883
3	Ivory Channel at Southern Blvd.	A_102_J	332	332	383
4	Unser Channel at Commercial Dr.	U_104_J	707	743	415
5	Unser Channel at 14th Ave./Cabezon Blvd.	U_105_J	851	912	1011
6	West Branch at Unser Blvd.	B_105_J	2458	3048	2904
7	Nicklaus Channel (East Branch) at Southern Blvd.	EB_104_J	1792	1897	797

*Q_p values reported in this table are based on HEC-HMS model runs that include depth-area reduction factors based on the overall drainage area to each structure.

2.13. Lateral Erosion Envelope

Lateral migration of natural arroyos was analyzed using methods and guidance outlined in the *SSCAFCA Sediment and Erosion Design Guide* (Mussetter, 2008). The results of this analysis are lateral erosion envelopes (LEE). Unlined arroyos in the study area with existing conditions 100-year peak discharges greater than 500 cfs had the LEE calculated and mapped. This envelope represents that maximum expected migration the arroyo may potentially erode over 30-50 years. Properties and infrastructure within the LEE are at risk of being affected by erosion. Figure 2.3 shows the mapped LEE in the study area and detailed calculations are included in Appendix D.

2.14. References

CoRR (City of Rio Rancho) (2011). *Unit 10 Specific Area Plan*. Rio Rancho, NM. https://rrnm.gov/2774/Unit-10 (accessed Aug. 2020).

CoRR (City of Rio Rancho) (2011). *Unser Boulevard North Specific Area Plan*. Rio Rancho, NM. https://rrnm.gov/1543/Specific-Area-Plans (accessed Aug. 2020).

Mussetter, B. (2008). *Sediment and Erosion Design Guide*. Southern Sandoval County Arroyo Flood Control Authority (SSCAFCA), Rio Rancho, NM.

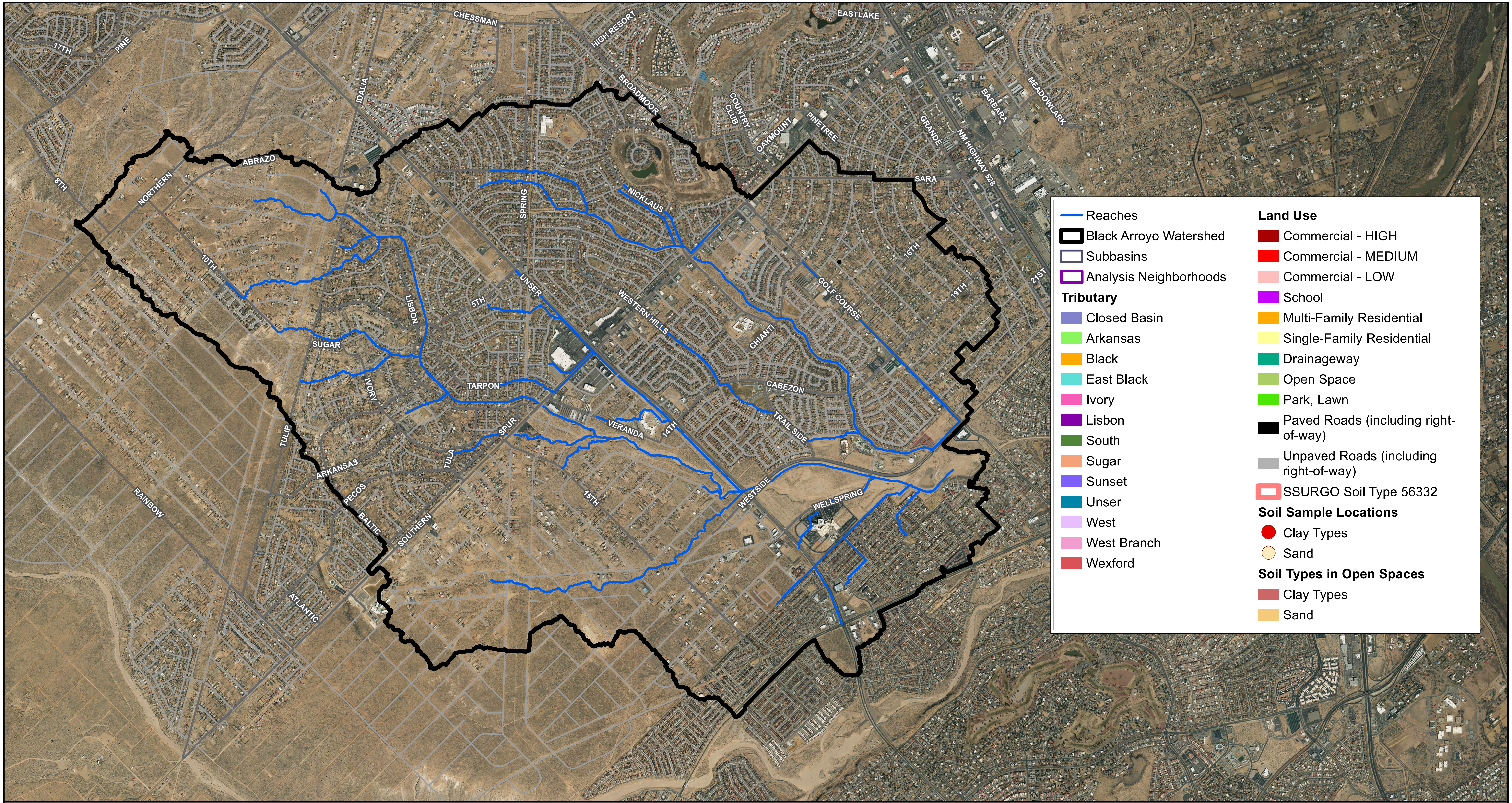
Federal Emergency Management Agency (FEMA) (2008). *Flood Insurance Study for Sandoval County, New Mexico and Incorporated Areas, Number 35043CV000A*.

NOAA (National Oceanic and Atmospheric Administration) (2020). *NOAA atlas 14 point precipitation frequency estimates: NM*. (https://hdsc.nws.noaa.gov/hdsc/pfds/)

Smith Engineering Company (Smith) (2013). *Black Watershed Park Management Plan Technical Addendum*. Albuquerque, NM.

SSCAFCA (2020). *SSCAFCA Hydrology Manual*. Rio Rancho, NM.

USDA (United States Department of Agriculture) (2010). *Natural Resources Conservation Service (NRCS) Part 630 Hydrology National Engineering Handbook, Chapter 15: Time of Concentration*.



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Layer Control Instructions:
The Map Controls above set the visibility of the layers automatically for the selected map. Additional layer control is available through the "Layers" Navigation Panel which can be accessed from the View Menu under the Navigation Panel. In the Panel, the visibility of layers and layer groups can be changed by clicking the square left of the layer/group. An eye in the square indicates that the layer is on. An empty square indicates that the layer is off. Layer groups can be expanded and reduced by clicking the +/- symbol left of the layer group.

Interactive Figures:
Select text below to view each figure:
Study Area
Hydrology Overview
Existing Conditions: Land Use
Future Conditions: Land Use
Soils

N E S W

0 0.25 0.5 1 Mile
1 inch = 0.5 miles

Black Watershed Park Management Plan

Figure 2.1
Interactive Hydrology Map

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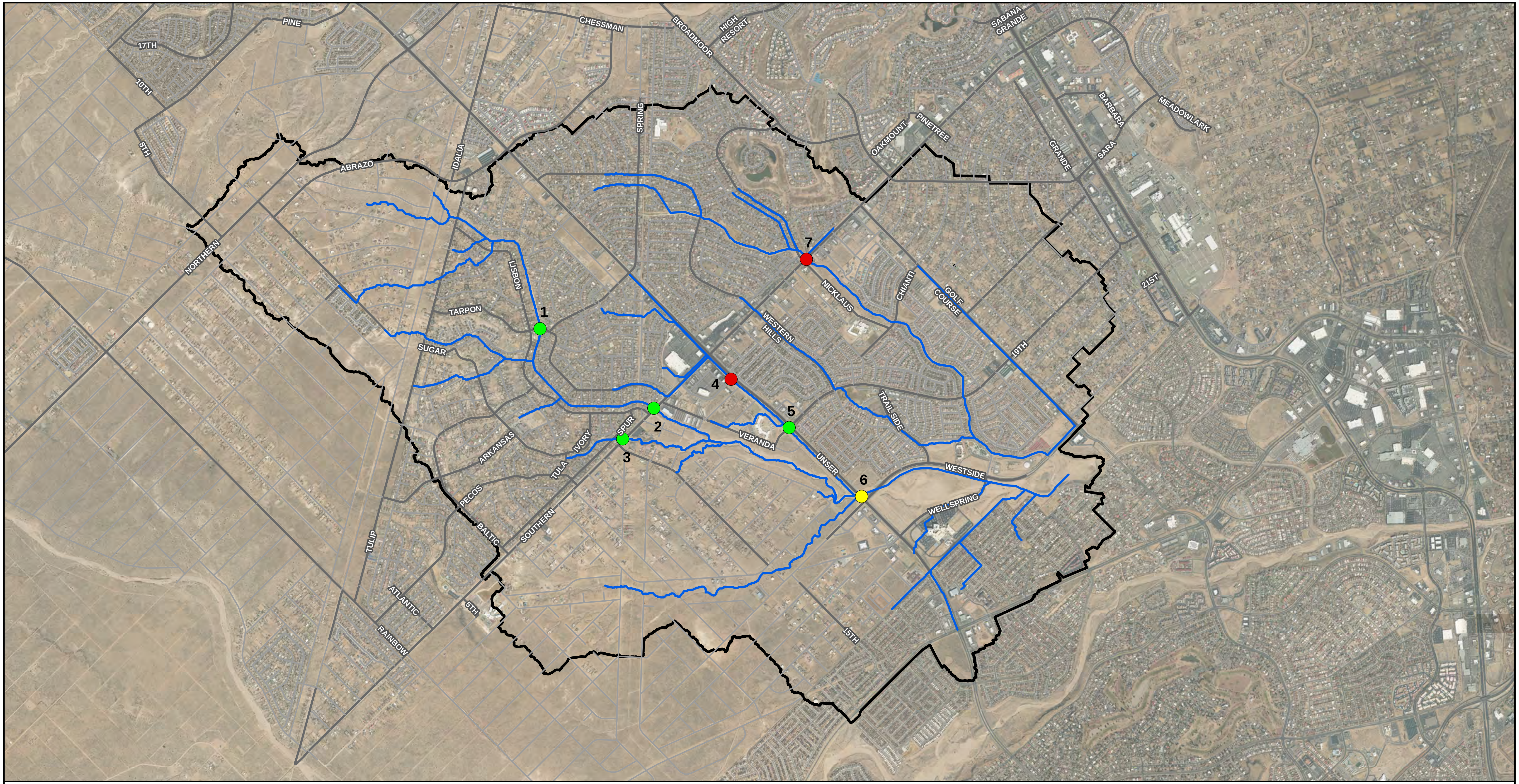
Author: SThompson

March 2021



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Reaches
Black Arroyo Watershed

Crossing Structures

Adequate capacity
Capacity exceeded, DEVEX conditions
Capacity exceeded, Existing and DEVEX conditions

N E W S

0 0.25 0.5 1 Miles
1 " = 0.5 miles

Black Watershed Park Management Plan

Figure 2.2
Major Crossing Structures & Deficiencies

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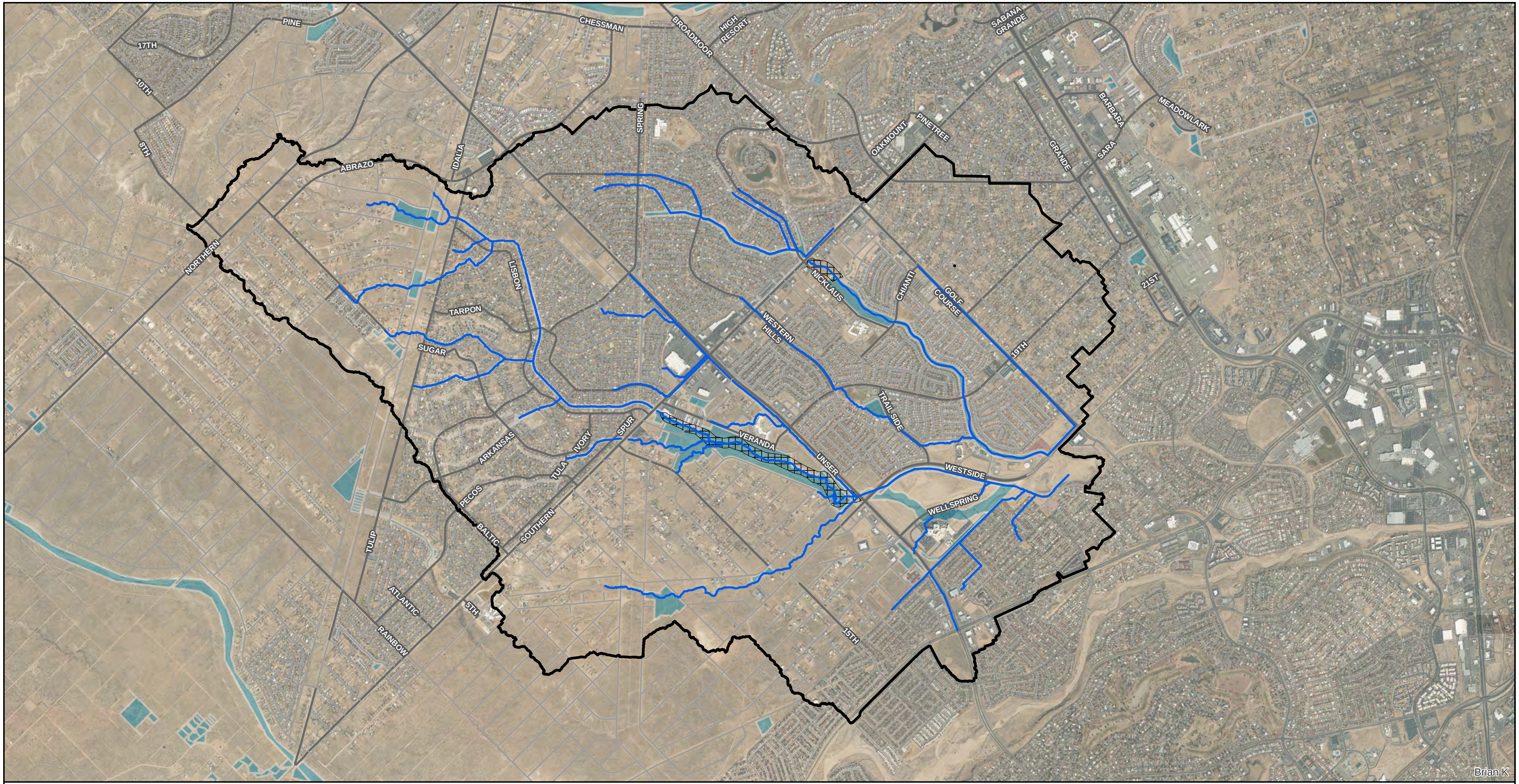
Author: SThompson

March 2021



Reaches
Black Arroyo Watershed
Updated LEE Lines
SSCAFCA ROW

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N E W S

0 0.25 0.5 1 Miles
1 " = 0.5 miles

Black Watershed Park Management Plan

Figure 2.3
Lateral Erosion Envelopes

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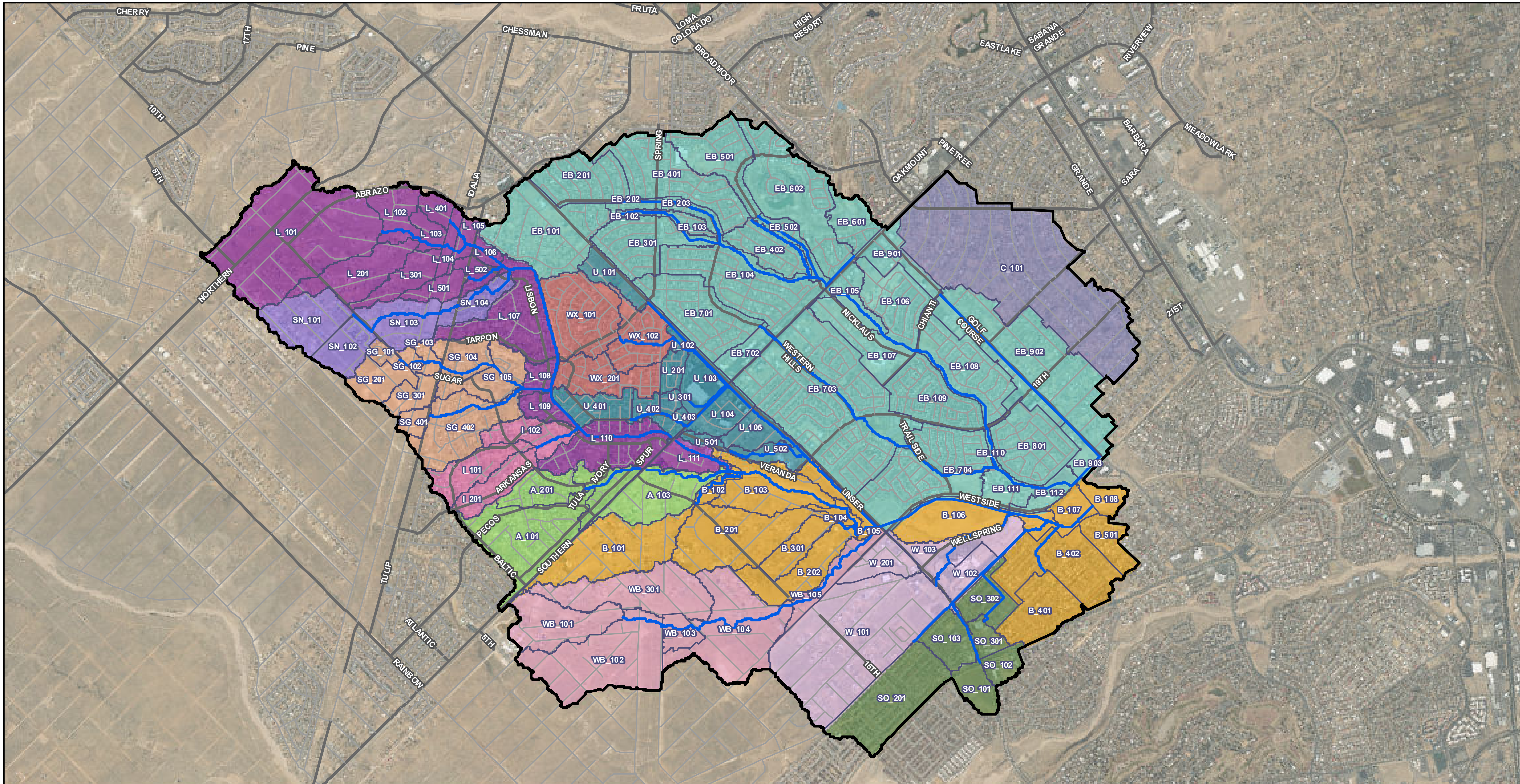
Author: SThompson

March 2021

Appendix A

Model Parameters



Reaches	**Tributary**	
Subbasins	Closed Basin	Ivory
Black Arroyo Watershed	Arkansas	Lisbon
	Black	South
	East Black	Sugar
		Sunset
	Unser	
	West	
	West Branch	
	Wexford	

0 0.25 0.5 1 Miles

1" = 0.5 miles

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Black Watershed Park Management Plan

Figure 2.1a
Hydrology Overview

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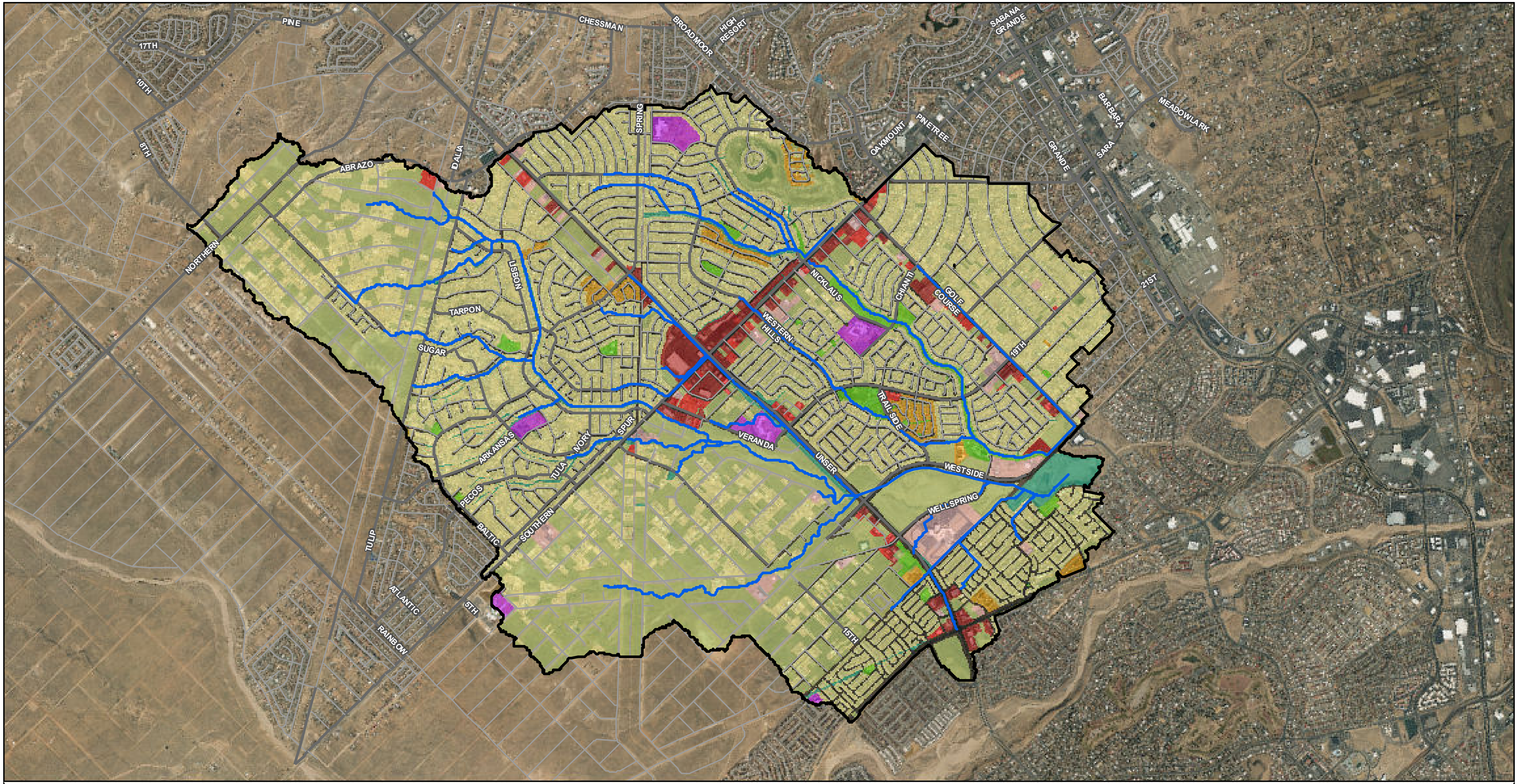
Author: molivas

March 2021



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Reaches	Commercial - LOW	Open Space
Black Arroyo Watershed	School	Park, Lawn
Existing Land Use	Multi-Family Residential	Paved Roads (including right-of-way)
Commercial - HIGH	Single-Family Residential	
Commercial - MEDIUM	Drainageway	Unpaved Roads (including right-of-way)

N E S W

0 0.25 0.5 1 Miles
1 " = 0.5 miles

Black Watershed Park Management Plan

Figure 2.1b
Existing Conditions: Land Use

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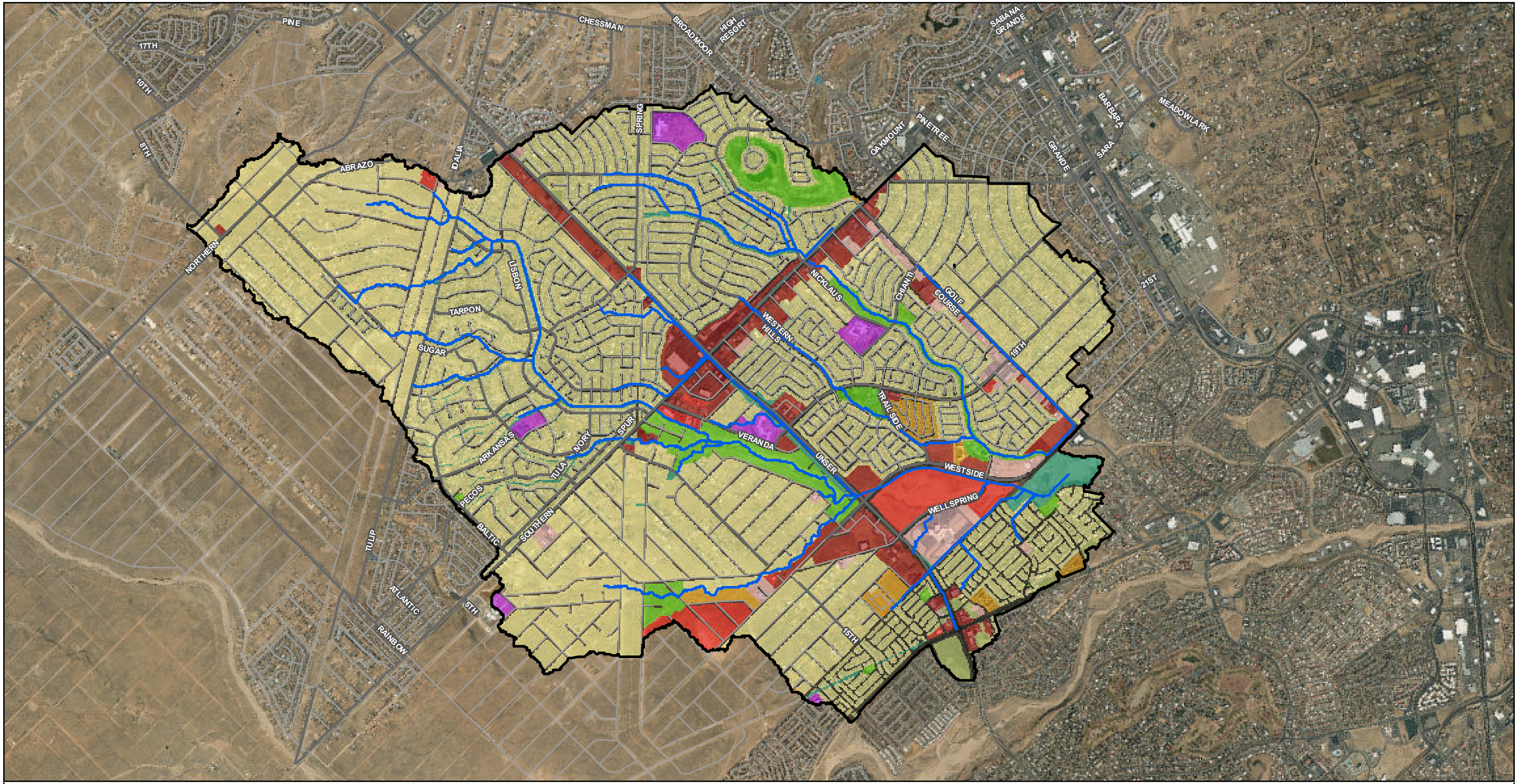
Author: molivas

March 2021



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- Reaches
- Black Arroyo Watershed

Future Land Use

- Commercial - HIGH
- Commercial - MEDIUM
- Commercial - LOW
- School
- Multi-Family Residential
- Single-Family Residential
- Drainageway
- Open Space
- Park, Lawn
- Paved Roads (including right-of-way)
- Unpaved Roads (including right-of-way)

N E S W

0 0.25 0.5 1 Miles

1 " = 0.5 miles

Black Watershed Park Management Plan

Figure 2.1c
Future Conditions: Land Use

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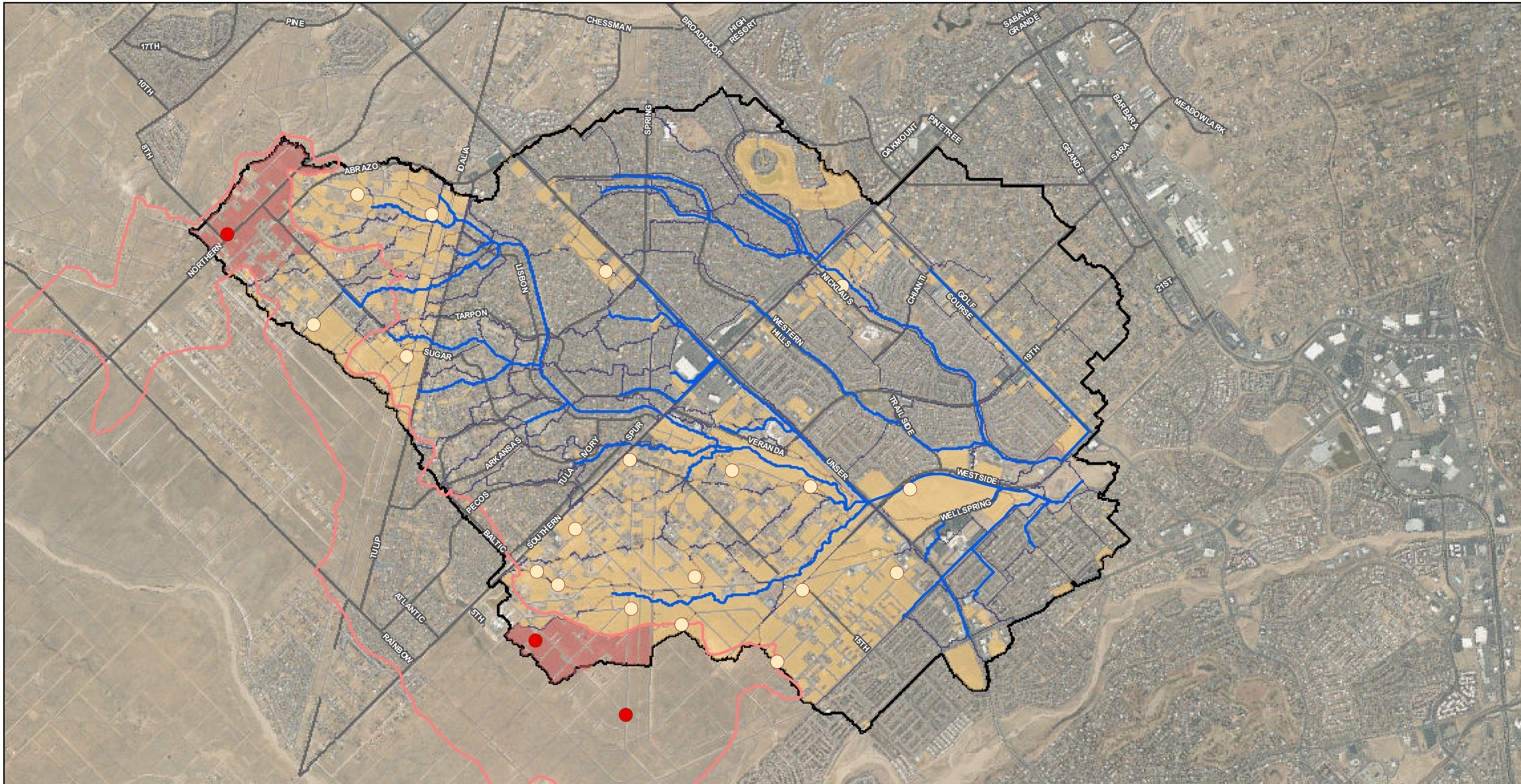
Author: molivas

March 2021



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Reaches
Black Arroyo Watershed
Subbasins
SSURGO Soil Type 56332

Soil Sample Locations
Clay Types
Sand

Soil Types in Open Spaces
Clay Types
Sand

N E W S

0 0.25 0.5 1 Miles
1 " = 0.5 miles

Black Watershed Park Management Plan

Figure 2.1d
Soils Map

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Author: molivas

March 2021

Subbasin parameters

Subbasin Parameters			Loss Model Parameters				Bulking Factor		Unit Hydrograph Parameters	
Basin ID	Area		Existing Conditions		Developed Conditions		Existing Conditions	Developed Conditions	Lag Time	
	(ac)	(mi^2)	Curve Number (CN)	Impervious (%)	Curve Number (CN)	Impervious (%)			(hr)	(min)
A_101	117.8	0.184	82	23%	82	23%	1.06	1.06	0.28	16.9
A_102	33.4	0.052	82	23%	82	23%	1.06	1.06	0.12	7.1
A_103	72.5	0.113	76	10%	79	18%	1.11	1.06	0.18	10.8
A_201	38.5	0.060	82	21%	82	21%	1.06	1.06	0.24	14.3
B_101	113.9	0.178	75	9%	79	19%	1.11	1.06	0.28	16.6
B_102	11.7	0.018	72	1%	73	4%	1.16	1.06	0.23	14.0
B_103	77.9	0.122	73	5%	74	13%	1.14	1.06	0.27	16.0
B_104	10.5	0.016	70	0%	70	0%	1.18	1.06	0.19	11.4
B_105	23.3	0.036	77	26%	81	41%	1.11	1.06	0.15	8.8
B_106	78.0	0.122	72	5%	86	77%	1.16	1.06	0.35	21.1
B_107	23.3	0.036	80	7%	80	7%	1.06	1.06	0.10	6.0
B_108	18.6	0.029	79	2%	79	2%	1.06	1.06	0.10	6.0
B_201	114.4	0.179	76	5%	79	15%	1.11	1.06	0.24	14.5
B_202	61.4	0.096	75	11%	79	15%	1.12	1.06	0.16	9.9
B_301	33.1	0.052	75	3%	79	15%	1.12	1.06	0.29	17.2
B_401	63.5	0.099	84	37%	84	37%	1.07	1.07	0.14	8.3
B_402	102.3	0.160	84	33%	84	33%	1.06	1.06	0.11	6.9
B_501	30.7	0.048	84	33%	84	33%	1.07	1.07	0.10	6.0
C_101	379.8	0.594	82	18%	82	18%	1.07	1.06	0.34	20.4
EB_101	128.3	0.200	82	28%	85	36%	1.07	1.06	0.20	11.9
EB_102	5.5	0.009	84	37%	84	37%	1.06	1.06	0.11	6.6
EB_103	12.3	0.019	84	28%	84	28%	1.06	1.06	0.10	6.0
EB_104	127.5	0.199	84	31%	84	32%	1.06	1.06	0.21	12.7
EB_105	33.5	0.052	78	31%	84	48%	1.10	1.06	0.10	6.0
EB_106	66.8	0.104	82	31%	85	40%	1.08	1.06	0.14	8.2
EB_107	54.2	0.085	77	23%	80	29%	1.08	1.06	0.16	9.7
EB_108	89.5	0.140	82	30%	83	31%	1.06	1.06	0.12	7.1
EB_109	77.6	0.121	85	40%	85	40%	1.06	1.06	0.17	10.2

Subbasin Parameters			Loss Model Parameters				Bulking Factor		Unit Hydrograph Parameters	
Basin ID	Area		Existing Conditions		Developed Conditions		Existing Conditions	Developed Conditions	Lag Time	
	(ac)	(mi^2)	Curve Number (CN)	Impervious (%)	Curve Number (CN)	Impervious (%)			(hr)	(min)
EB_110	3.9	0.006	70	1%	70	1%	1.06	1.06	0.10	6.0
EB_111	28.4	0.044	74	28%	80	48%	1.09	1.06	0.26	15.5
EB_112	20.9	0.033	81	66%	83	71%	1.07	1.06	0.10	6.0
EB_201	68.6	0.107	83	29%	83	29%	1.06	1.06	0.11	6.8
EB_202	10.4	0.016	84	28%	84	28%	1.06	1.06	0.10	6.0
EB_203	15.4	0.024	84	30%	84	30%	1.06	1.06	0.11	6.5
EB_301	73.5	0.115	83	25%	83	25%	1.06	1.06	0.20	12.2
EB_401	107.6	0.168	83	27%	83	28%	1.06	1.06	0.23	14.0
EB_402	44.5	0.070	83	26%	83	27%	1.06	1.06	0.16	9.8
EB_501	68.2	0.107	81	26%	81	26%	1.06	1.06	0.20	11.8
EB_502	20.7	0.032	83	30%	84	31%	1.06	1.06	0.14	8.3
EB_601	35.5	0.055	76	10%	75	11%	1.13	1.06	0.15	8.8
EB_602	134.0	0.209	78	18%	79	18%	1.11	1.06	0.26	15.7
EB_701	95.9	0.150	84	31%	84	30%	1.06	1.06	0.13	7.8
EB_702	24.2	0.038	93	85%	94	89%	1.06	1.06	0.10	6.2
EB_703	301.3	0.471	83	40%	86	46%	1.07	1.06	0.28	16.6
EB_704	146.8	0.229	82	35%	87	50%	1.08	1.06	0.17	9.9
EB_801	83.0	0.130	85	36%	85	37%	1.06	1.06	0.13	7.6
EB_901	37.5	0.059	84	65%	88	79%	1.08	1.06	0.20	11.9
EB_902	205.0	0.320	82	29%	82	32%	1.07	1.06	0.30	17.8
EB_903	17.7	0.028	78	34%	91	89%	1.13	1.06	0.10	6.0
I_101	46.4	0.073	82	20%	82	20%	1.06	1.06	0.17	10.3
I_102	40.3	0.063	81	20%	81	19%	1.06	1.06	0.14	8.7
I_201	39.8	0.062	82	18%	82	18%	1.06	1.06	0.14	8.6
L_101	247.8	0.387	81	7%	81	16%	1.13	1.06	0.39	23.5
L_102	40.4	0.063	75	6%	79	14%	1.11	1.06	0.13	7.9
L_103	15.9	0.025	71	0%	79	13%	1.17	1.06	0.21	12.8
L_104	13.4	0.021	72	5%	79	19%	1.16	1.06	0.10	6.1
L_105	14.2	0.022	75	7%	82	24%	1.13	1.06	0.17	10.2

Subbasin Parameters			Loss Model Parameters				Bulking Factor		Unit Hydrograph Parameters	
Basin ID	Area		Existing Conditions		Developed Conditions		Existing Conditions	Developed Conditions	Lag Time	
	(ac)	(mi^2)	Curve Number (CN)	Impervious (%)	Curve Number (CN)	Impervious (%)			(hr)	(min)
L_106	10.9	0.017	82	14%	82	14%	1.06	1.06	0.12	7.0
L_107	94.7	0.148	82	18%	82	18%	1.06	1.06	0.39	23.5
L_108	17.4	0.027	80	15%	82	16%	1.06	1.06	0.10	6.0
L_109	19.8	0.031	82	15%	82	14%	1.06	1.06	0.14	8.3
L_110	83.4	0.130	82	23%	82	23%	1.06	1.06	0.14	8.3
L_111	29.8	0.047	75	23%	76	30%	1.14	1.06	0.11	6.7
L_201	63.8	0.100	76	6%	79	12%	1.09	1.06	0.26	15.8
L_301	35.8	0.056	76	4%	79	16%	1.11	1.06	0.19	11.5
L_401	14.8	0.023	76	25%	82	37%	1.13	1.06	0.10	6.0
L_501	21.5	0.034	77	6%	81	19%	1.11	1.06	0.38	23.0
L_502	17.2	0.027	80	17%	82	18%	1.08	1.06	0.17	10.1
SG_101	9.6	0.015	80	25%	80	26%	1.07	1.06	0.10	6.0
SG_102	6.7	0.010	76	5%	80	18%	1.10	1.06	0.10	6.0
SG_103	11.3	0.018	75	4%	81	23%	1.12	1.06	0.10	6.0
SG_104	35.2	0.055	81	18%	82	19%	1.07	1.06	0.19	11.4
SG_105	48.3	0.076	81	18%	82	19%	1.06	1.06	0.11	6.4
SG_201	34.8	0.054	71	0%	79	12%	1.17	1.06	0.29	17.6
SG_301	25.2	0.039	73	4%	81	23%	1.15	1.06	0.31	18.4
SG_401	12.9	0.020	72	7%	81	19%	1.16	1.06	0.17	10.0
SG_402	86.7	0.135	81	18%	82	18%	1.07	1.06	0.30	18.1
SN_101	66.0	0.103	77	6%	79	14%	1.09	1.06	0.28	16.7
SN_102	38.4	0.060	74	7%	80	18%	1.13	1.06	0.26	15.6
SN_103	54.2	0.085	77	6%	79	16%	1.09	1.06	0.15	9.2
SN_104	33.4	0.052	81	14%	82	17%	1.07	1.06	0.35	20.9
SO_101	27.6	0.043	75	26%	75	26%	1.14	1.14	0.31	18.5
SO_102	20.4	0.032	86	61%	86	61%	1.09	1.09	0.10	6.0
SO_103	38.4	0.060	85	50%	85	50%	1.06	1.06	0.14	8.1
SO_201	108.3	0.169	84	39%	84	39%	1.06	1.06	0.10	6.0
SO_301	17.3	0.027	85	61%	85	61%	1.09	1.09	0.14	8.4

Subbasin Parameters			Loss Model Parameters				Bulking Factor		Unit Hydrograph Parameters	
Basin ID	Area		Existing Conditions		Developed Conditions		Existing Conditions	Developed Conditions	Lag Time	
	(ac)	(mi^2)	Curve Number (CN)	Impervious (%)	Curve Number (CN)	Impervious (%)			(hr)	(min)
SO_302	36.9	0.058	85	37%	85	37%	1.06	1.06	0.10	6.0
U_101	27.1	0.042	76	28%	91	77%	1.13	1.06	0.34	20.2
U_102	6.4	0.010	85	48%	85	48%	1.06	1.06	0.10	6.0
U_103	36.6	0.057	92	84%	94	91%	1.07	1.06	0.15	9.0
U_104	34.6	0.054	89	85%	92	89%	1.06	1.06	0.14	8.5
U_105	30.5	0.048	77	27%	84	46%	1.11	1.06	0.11	6.8
U_201	15.9	0.025	84	28%	84	28%	1.06	1.06	0.14	8.6
U_301	8.2	0.013	83	28%	84	30%	1.06	1.06	0.10	6.0
U_401	35.8	0.056	84	29%	84	29%	1.06	1.06	0.13	7.7
U_402	19.8	0.031	84	34%	84	34%	1.06	1.06	0.11	6.3
U_403	3.9	0.006	83	29%	85	39%	1.07	1.06	0.10	6.0
U_501	8.2	0.013	89	84%	91	88%	1.07	1.06	0.10	6.0
U_502	23.0	0.036	75	22%	76	23%	1.08	1.06	0.20	12.2
WB_101	73.5	0.115	74	4%	79	15%	1.12	1.06	0.23	13.7
WB_102	142.7	0.223	81	0%	81	15%	1.16	1.06	0.61	36.3
WB_103	19.7	0.031	70	0%	70	3%	1.18	1.06	0.17	10.5
WB_104	131.4	0.205	73	5%	83	47%	1.15	1.06	0.34	20.3
WB_105	33.7	0.053	73	9%	85	55%	1.15	1.06	0.33	19.9
WB_301	92.9	0.145	83	27%	83	27%	1.13	1.06	0.31	18.4
WX_101	58.7	0.092	83	33%	84	34%	1.07	1.06	0.21	12.6
WX_102	58.1	0.091	83	30%	84	30%	1.07	1.06	0.18	10.9
WX_201	270.0	0.422	74	12%	82	28%	1.06	1.06	0.25	14.9
W_101	31.0	0.049	78	74%	78	74%	1.13	1.06	0.10	6.0
W_102	52.5	0.082	76	46%	83	80%	1.06	1.06	0.23	13.7
W_103	34.2	0.053	76	28%	94	92%	1.11	1.06	0.13	8.0
W_201	0.0	0.000	0	0%	0	0%	1.14	1.06	0.00	0.0

Routing parameters

Routing Reach ID	Length (ft)	Slope (ft/ft)	Manning's n (-)	Shape	Diameter (ft)	Width (ft)	Side Slope (xH:1V)
A_101_R	967	0.033087	0.035	Eight Point			
A_101_R2	805	0.031355	0.013	Eight Point			
A_102_R	2825	0.025652	0.035	Eight Point			
B_101_R	2060	0.031405	0.035	Eight Point			
B_102_R	3057	0.018416	0.035	Eight Point			
B_103_R	1265	0.016351	0.020	Eight Point			
B_104_R	666	0.014993	0.020	Eight Point			
B_105_R	5301	0.018586	0.013	Eight Point			
B_106_R	1233	0.018505	0.035	Rectangle		50	
B_201_R	809	0.027204	0.020	Rectangle		50	
B_401_R	1730	0.041954	0.020	Rectangle		50	
EB_104_R2	1193	0.010701	0.017	Eight Point			
EB_101_R	1475	0.017379	0.020	Rectangle		50	
EB_102_R	1999	0.019887	0.020	Eight Point			
EB_103_R	3290	0.021886	0.020	Eight Point			
EB_104_R	1040	0.023467	0.013	Eight Point			
EB_105_R	994	0.012304	0.013	Eight Point			
EB_107_R	3343	0.01603	0.013	Eight Point			
EB_109_R	1234	0.024319	0.013	Eight Point			
EB_110_R	1516	0.018737	0.013	Eight Point			
EB_111_R	812	0.014785	0.013	Eight Point			
EB_201_R	1132	0.020314	0.017	Rectangle		50	
EB_202_R	2172	0.012889	0.017	Rectangle		50	
EB_401_R	2512	0.017676	0.020	Eight Point			
EB_402_R	537	0.025289	0.020	Eight Point			
EB_501_R	2594	0.020261	0.017	Rectangle		50	
EB_601_R	1114	0.037327	0.013	Circle	2		
EB_701_R	552	0.023556	0.013	Circle	3		
EB_702_R	5156	0.018302	0.013	Circle	4		
EB_703_R	3051	0.022689	0.013	Circle	6		
EB_901_R	5408	0.021266	0.013	Circle	2		
EB_902_R	1976	0.021551	0.013	Circle	2		
I_101_R	1434	0.036096	0.035	Eight Point			
L_101_R	1338	0.016434	0.035	Eight Point			
L_104_R	512	0.022231	0.035	Trapezoid			
L_105_R	1253	0.019945	0.035	Eight Point			
L_106_R	3594	0.006476	0.035	Eight Point			
L_107_R	1015	0.010836	0.035	Eight Point			
L_108_R	1349	0.01465	0.035	Eight Point			
L_109_R	2770	0.025717	0.035	Eight Point			
L_110_R	1903	0.023497	0.035	Eight Point			
L_111_R	379	0.021112	0.035	Eight Point			
L_501_R	330	0.021216	0.017	Rectangle		50	
L_501_R2	831	0.032145	0.020	Eight Point			

Routing Reach ID	Length (ft)	Slope (ft/ft)	Manning's n (-)	Shape	Diameter (ft)	Width (ft)	Side Slope (xH:1V)
SG_101_R	949	0.032675	0.020	Eight Point			
SG_102_R	532	0.028565	0.020	Eight Point			
SG_103_R	1651	0.025898	0.017	Circle	3.5		
SG_104_R	1123	0.026704	0.035	Eight Point			
SG_105_R	834	0.026663	0.035	Eight Point			
SG_401_R	3071	0.036066	0.035	Eight Point			
SN_101_R	688	0.015992	0.017	Rectangle		50	
SN_102_R	2397	0.02327	0.017	Eight Point			
SN_103_R	2940	0.023455	0.035	Eight Point			
SO_102_R	1838	0.010881	0.013	Circle	5.5		
SO_103_R	1757	0.028464	0.013	Circle	6		
SO_201_R	1532	0.008488	0.013	Circle	6		
SO_301_R	2454	0.017115	0.013	Circle	7		
SO_302_R	1803	0.030496	0.013	Circle	7		
U_101_R	3313	0.026559	0.013	Circle	2.5		
U_102_R	1644	0.022095	0.013	Circle	4		
U_103_R	734	0.022707	0.013	Trapezoid		15	2
U_104_R	2020	0.020791	0.013	Eight Point			
U_105_R	2909	0.019137	0.020	Eight Point			
U_301_R	1805	0.013628	0.025	Circle	4		
U_401_R	1703	0.0229	0.017	Rectangle		50	
U_402_R	394	0.020324	0.025	Circle	4		
U_403_R	1375	0.018187	0.025	Circle	4		
U_501_R	2714	0.023795	0.017	Rectangle		50	
WB_101_R	1310	0.03207	0.035	Eight Point			
WB_102_R	1108	0.024368	0.035	Eight Point			
WB_103_R	3344	0.021832	0.035	Eight Point			
WB_104_R	3779	0.022408	0.035	Eight Point			
WX_101_R	1876	0.018115	0.017	Rectangle		50	
WX_102_R	467	0.025717	0.013	Circle	3.5		
W_101_R	711	0.01921	0.017	Rectangle		50	
W_102_R	2794	0.01551	0.013	Circle	6		

Time of concentration calculations

Basin	Area		Flow path				Sheet Flow					Shallow Flow					Channel Segment 1 Flow						Channel Segment 2 Flow						Time of Concentration	Lag Time
			Upstream Elev.	Downstream Elev.	Slope	Length	Length	Slope	Surface Description	Manning's n	Travel Time	Length	Slope	Surface Description	Velocity	Travel Time	Description	Slope	Length	Manning's n	Average Velocity	Travel Time	Description	Slope	Length	Manning's n	Average Velocity	Travel Time		
	(sq ft)	(ac)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/ft)		(-)	(min)	(ft)	(ft/ft)		(ft/sec)	(min)		(ft/ft)	(ft)	(-)	(ft/sec)	(min)		(ft/ft)	(ft)	(-)	(ft/sec)	(min)	(min)	(min)
A_101	5131633	117.8	5682	5508	0.029	6019	100	0.030	Smooth Surfaces	0.011	1.6	2482	0.011	Pavement and small upland gullies	2.2	19.2	Street	0.046	2328	0.017	8.9	4.3	A_101_R	0.033	1109	0.035	6.2	3.0	28.1	16.9
A_102	1454155	33.4	5557	5467	0.035	2551	100	0.030	Smooth Surfaces	0.011	1.6	2160	0.038	Pavement and small upland gullies	4.0	9.1	A_101_R	0.017	290	0.035	4.4	1.1			--				11.8	7.1
A_103	3157031	72.5	5556	5369	0.036	5260	100	0.020	Smooth Surfaces	0.011	1.9	2514	0.045	Pavement and small upland gullies	4.3	9.7	A_102_R	0.027	2646	0.035	6.9	6.4			--				18.0	10.8
A_201	1677106	38.5	5636	5518	0.037	3214	103	0.019	Range (natural)	0.130	14.5	1290	0.045	Pavement and small upland gullies	4.3	5.0	Street	0.029	1172	0.017	7.1	2.7	A_101_R	0.037	649	0.035	6.5	1.7	23.9	14.3
B_101	4961913	113.9	5624	5426	0.033	5959	100	0.080	Range (natural)	0.130	8.0	998	0.050	Nearly bare and untilled (overland flow)	2.2	7.5	Overland - WIDE	0.032	2650	0.035	7.0	6.3	Overland - WIDE	0.025	2211	0.035	6.2	5.9	27.7	16.6
B_102	508964	11.7	5428	5361	0.032	2069	100	0.020	Range (natural)	0.130	13.9	357	0.036	Nearly bare and untilled (overland flow)	1.9	3.2	B_101_R	0.032	1613	0.035	4.3	6.2			--				23.3	14.0
B_103	3394050	77.9	5411	5305	0.024	4425	100	0.040	Smooth Surfaces	0.011	1.5	1573	0.024	Nearly bare and untilled (overland flow)	1.6	16.9	B_102_R	0.023	2753	0.035	5.5	8.3			--				26.6	16.0
B_104	456835	10.5	5335	5285	0.026	1890	100	0.037	Range (natural)	0.130	10.9	454	0.024	Nearly bare and untilled (overland flow)	1.6	4.9	Street	0.026	1336	0.017	6.8	3.3			--				19.1	11.4
B_105	1015091	23.3	5354	5279	0.024	3112	100	0.053	Smooth Surfaces	0.011	1.3	666	0.030	Nearly bare and untilled (overland flow)	1.7	6.5	Overland - WIDE	0.021	2346	0.035	5.7	6.9			--				14.7	8.8
B_106	3398928	78.0	5281	5176	0.020	5264	100	0.010	Range (natural)	0.130	18.4	348	0.035	Nearly bare and untilled (overland flow)	1.9	3.1	Overland - WIDE	0.015	3356	0.035	4.7	11.9	B_105_R	0.030	1460	0.013	13.0	1.9	35.2	21.1
B_107	1016941	23.3	5197	5152	0.028	1612	100	0.034	Smooth Surfaces	0.011	1.6	311	0.060	Nearly bare and untilled (overland flow)	2.4	2.1	B_106_R	0.019	1201	0.035	4.3	4.6			--				10.0	6.0
B_108	808455	18.6	5188	5148	0.024	1674	100	0.010	Smooth Surfaces	0.011	2.5	433	0.058	Nearly bare and untilled (overland flow)	2.4	3.0	Overland - WIDE	0.013	1141	0.035	4.4	4.3			--				10.0	6.0
B_201	4984200	114.4	5512	5307	0.033	6220	100	0.025	Smooth Surfaces	0.011	1.8	1436	0.053	Nearly bare and untilled (overland flow)	2.3	10.5	Street	0.030	1705	0.017	7.3	3.9	Overland - WIDE	0.025	2979	0.035	6.2	8.0	24.1	14.5
B_202	2676250	61.4	5427	5285	0.029	4970	100	0.020	Smooth Surfaces	0.011	1.9	950	0.026	Pavement and small upland gullies	3.3	4.8	Overland - WIDE	0.029	3920	0.035	6.7	9.8			--				16.5	9.9
B_301	1440946	33.1	5389	5307	0.029	2876	100	0.013	Range (natural)	0.130	16.8	862	0.046	Nearly bare and untilled (overland flow)	2.1	6.7	Street	0.021	1915	0.017	6.1	5.2			--				28.7	17.2
B_401	2768202	63.5	5306	5247	0.022	2718	100	0.010	Smooth Surfaces	0.011	2.5	1499	0.021	Pavement and small upland gullies	3.0	8.5	Street	0.024	1119	0.017	6.4	2.9			--				13.9	8.3
B_402	4457804	102.3	5252	5195	0.023	2542	100	0.024	Smooth Surfaces	0.011	1.8	970	0.018	Pavement and small upland gullies	2.7	6.0	Street	0.026	1472	0.017	6.7	3.6			--				11.5	6.9
B_501	1337715	30.7	5280	5178	0.044	2315	100	0.056	Smooth Surfaces	0.011	1.3	1157	0.060	Pavement and small upland gullies	5.0	3.9	Street	0.025	1058	0.017	6.6	2.7			--				10.0	6.0
C_101	16545990	379.8	5378	5225	0.017	9089	100	0.025	Smooth Surfaces	0.011	1.8	869	0.008	Pavement and small upland gullies	1.8	7.9	Street	0.018	8119	0.017	5.6	24.4			--				34.1	20.4
EB_101	5589156	128.3	5604	5495	0.021	5261	100	0.020	Smooth Surfaces	0.011	1.9	488	0.033	Nearly bare and untilled (overland flow)	1.8	4.5	Street	0.019	4674	0.017	5.8	13.3			--				19.8	11.9
EB_102	237873	5.5	5497	5470	0.017	1566	100	0.020	Smooth Surfaces	0.011	1.9	1466	0.017	Pavement and small upland gullies	2.7	9.1			--						--				11.1	6.6
EB_103	535995	12.3	5467	5435	0.020	1600	103	0.078	Smooth Surfaces	0.011	1.1	1001	0.016	Pavement and small upland gullies	2.6	6.5	Street	0.016	496	0.017	5.3	1.6			--				10.0	6.0
EB_104	5553199	127.5	5467	5355	0.020	5468	100	0.032	Smooth Surfaces	0.011	1.6	1489	0.020	Pavement and small upland gullies	2.9	8.6	Street	0.020	3879	0.017	5.9	10.9			--				21.1	12.7
EB_105	1458014	33.5	5364	5306	0.025	2294	100	0.020	Smooth Surfaces	0.011	1.9	587	0.065	Nearly bare and untilled (overland flow)	2.5	3.9	EB_104_R	0.011	1607	0.013	13.1	2.0			--				10.0	6.0
EB_106	2909602	66.8	5389	5307	0.022	3789	100	0.020	Smooth Surfaces	0.011	1.9	606	0.020	Pavement and small upland gullies	2.9	3.5	Street	0.022	3083	0.017	6.2	8.3			--				13.7	8.2
EB_107	2363112	54.2	5369	5303	0.018	3625	100	0.010	Smooth Surfaces	0.011	2.5	594	0.025	Nearly bare and untilled (overland flow)	1.6	6.2	Street	0.019	2241	0.017	5.8	6.4	EB_105_R	0.010	690	0.013	12.6	0.9	16.2	9.7
EB_108	3896930	89.5	5353	5244	0.023	4652	100	0.010	Smooth Surfaces	0.011	2.5	1540	0.038	Pavement and small upland gullies	4.0	6.5	EB_107_R	0.016	3012	0.013	18.1	2.8			--				11.8	7.1
EB_109	3381929	77.6	5322	5240	0.020	3996	100	0.028	Smooth Surfaces	0.011	1.7	1295	0.017	Pavement and small upland gullies	2.6	8.1	Street	0.021	2601	0.017	6.0	7.2			--				17.1	10.2
EB_110	171779	3.9	5254	5211	0.036	1170	100	0.206	Smooth Surfaces	0.011	0.8			--			EB_109_R	0.021	1070	0.013	19.8	0.9			--				10.0	6.0
EB_111	1239150	28.4	5243	5187	0.026	2163	100	0.020	Range (natural)	0.130	13.9	1249	0.035	Nearly bare and untilled (overland flow)	1.9	11.2	EB_110_R	0.014	814	0.013	18.6	0.7			--				25.9	15.5
EB_112	910978	20.9	5228	5191	0.018	2037	100	0.020	Smooth Surfaces	0.011	1.9	468	0.015	Pavement and small upland gullies	2.5	3.1	Street	0.019	1469	0.017	5.7	4.3			--				10.0	6.0
EB_201	2989305	68.6	5540	5486	0.020	2671	100	0.020	Smooth Surfaces	0.011	1.9	779	0.024	Pavement and small upland gullies	3.1	4.2	Street	0.019	1792	0.017	5.8	5.2			--				11.3	6.8
EB_202	451489	10.4	5505	5463	0.023	1816	100	0.040	Smooth Surfaces	0.011	1.5	711	0.023	Pavement and small upland gullies	3.1	3.9	Street	0.022	1005	0.017	6.2	2.7			--				10.0	6.0
EB_203	669672	15.4	5471	5435	0.016	2244	100	0.030	Smooth Surfaces	0.011	1.6	720	0.025	Pavement and small upland gullies	3.2	3.7	Street	0.011	1424	0.017	4.3	5.5			--				10.9	6.5
EB_301	3200517	73.5	5510	5433	0.018	4285	100	0.050	Smooth Surfaces	0.011	1.3	2382	0.016	Pavement and small upland gullies	2.6	15.5	EB_102_R	0.019	1803	0.020	8.5	3.6			--				20.4	12.2
EB_401	4688417	107.6	5526	5408	0.020	5939	100	0.020	Smooth Surfaces	0.011	1.9	1995	0.025	Pavement and small upland gullies	3.2	10.4	Street	0.020	2791	0.017	6.0	7.8	EB_401_R	0.010	1054	0.020	5.5	3.2	23.4	14.0
EB_402	1940546	44.5	5437	5363	0.023	3139	100	0.020	Smooth Surfaces	0.011	1.9	2144	0.020	Pavement and small upland gullies	2.9	12.4	Street	0.032	895	0.017	7.5	2.0			--				16.3	9.8
EB_501	2969833	68.2	5462	5409	0.013	4054	100	0.024	Smooth Surfaces	0.011	1.8	1160	0.017	Pavement and small upland gullies	2.6	7.3	Street	0.011	2793	0.017	4.4	10.5			--				19.6	11.8
EB_502	899666	20.7	5413	5351	0.021	2943	100	0.010	Smooth Surfaces	0.011	2.5	1145	0.019	Pavement and small upland gullies	2.8	6.8	Street	0.023	1697	0.017	6.3	4.5			--				13.8	8.3
EB_601	1545906	35.5	5414	5383	0.013	2393	100	0.020	Smooth Surfaces	0.011	1.9	355	0.013	Nearly bare and untilled (overland flow)	1.1	5.3	Overland - WIDE	0.012	1938	0.035	4.4	7.4			--				14.6	8.8
EB_602	5836593	134.0	5440	5354	0.014	6041	100	0.040	Smooth Surfaces	0.011	1.5	1012	0.017	Pavement and small upland gullies	2.6	6.4	Overland - WIDE	0.010	3644	0.035	3.8	15.8	EB_401_R	0.023	1285	0.020	8.5	2.5	26.2	15.7
EB_701	4177680	95.9	5502	5387	0.027	4202	100	0.057	Smooth Surfaces	0.011	1.3	716	0.029	Pavement and small upland gullies	3.5	3.4	Street	0.026	3386	0.017	6.7	8.4			--				13.1	7.8
EB_702	1054744	24.2	5411	5375	0.016	2243	100	0.053	Smooth Surfaces	0.011	1.3	617	0.018	Pavement and small upland gullies	2.7	3.8	Street	0.013	1526	0.017	4.8	5.3			--				10.4	6.2
EB_703	13123458	301.3	5397	5281	0.017	6632	100	0.020	Smooth Surfaces	0.011	1.9	1879	0.018	Pavement and small upland gullies	2.7	11.6	Street	0.017	4653	0.017	5.5	14.0			--				27.6	16.6
EB_704	6392609	146.8	5304	5211	0.018	5043	96	0.007	Smooth Surfaces	0.011	2.8	1252	0.018	Pavement and small upland gullies	2.7	7.6	Stormdrain	0.020	3695	0.013	10.2	6.0			--				16.5	9.9
EB_801	3615794	83.0	5274	5194	0.023	3554	100	0.020	Smooth Surfaces	0.011	1.9	643	0.031	Pavement and small upland gullies	3.6	3.0	Street	0.021	2811	0.017	6.0	7.8			--				12.7	7.6
EB_901	1634365	37.5	5391	5349	0.013	3251	100	0.034	Smooth Surfaces	0.011	1.6	1697	0.011	Pavement and small upland gullies	2.1	13.5	Street	0.014	1454	0.017	5.0	4.9			--				19.9	11.9
EB_902	8930342	205.0	5354	5190	0.025	6528	100	0.030	Range (natural)	0.130	11.8	570	0.021	Pavement and small upland gullies	2.9	3.2	Street	0.025	5858	0.017	6.7	14.6			--				29.7	17.8
EB_903	771008	17.7	5249	5188	0.029	2118	96	0.006	Smooth Surfaces	0.011	3.1	626	0.022	Pavement and small upland gullies	3.0	3.4	Street	0.033	1396	0.017	7.6	3.1			--				10.0	6.0
I_101	2021573	46.4	5684	5547	0.035	3945	100	0.010	Smooth Surfaces	0.011	2.5	2034	0.032	Pavement and small upland gullies	3.7	9.3	I_101_R	0.039	1811	0.035	5.7	5.3			--				17.1	10.3
I_102	1753526	40.3	5620	5494	0.036	3502	100	0.020	Smooth Surfaces	0.011	1.9	2103	0.036	Pavement and small upland gullies	3.9	9.1	Street	0.023	538	0.017	6.3	1.4	I_101_R	0.047	762	0.035	6.3	2.0	14.5	8.7
I_201	1733754	39.8	5684	5547	0.041	3335	100	0.020	Smooth Surfaces	0.011	1.9	2766	0.042	Pavement and small upland gullies	4.2	11.0	I_101_R	0.038	469	0.035	5.7	1.4			--				14.3	8.6
L_101	10796163	247.8	5798	5623	0.027	6518	100	0.020	Range (natural)	0.130	13.9	2924	0.034	Pavement and small upland gullies	3.7	13.0	Overland - WIDE	0.019	1440	0.035	5.5	4.4	L_101_R	0.022	2054	0.035	4.4	7.8	39.2	23.5
L_102	1760430	40.4	5691	5602	0.031	2848	100	0.028	Smooth Surfaces	0.011	1.7	1847	0.035	Pavement and small upland gullies	3.8	8.1	L_101_R	0.024	901	0.035	4.5	3.3			--				13.1	7.9
L_103	693113	15.9	5644	5594	0.031	1622	100	0.050	Range (natural)	0.130	9.7	918	0.035	Nearly bare and untilled (overland flow)	1.9	8.2	L_102_R	0.022	603	0.035	2.9	3.4			--				21.3	12.8
L_104	583447	13.4	5621	5584	0.026	1393	100	0.030	Smooth Surfaces	0.011	1.6	735	0.034	Nearly bare and untilled (overland flow)	1.8	6.7	Overland - WIDE	0.016	558	0.035	5.0	1.9			--				10.2	6.1
L_105	618412	14.2	5604	5574	0.025	1195	100	0.050	Range (natural)	0.130	9.7	453	0.032	Nearly bare and untilled (overland flow)	1.8	4.3	L_104_R	0.017	642	0.035	3.4	3.2			--				17.1	10.2
L_106	476248	10.9	5602	5549	0.030	1789	100	0.010	Smooth Surfaces	0.011	2.5	707	0.051	Pavement and small upland gullies	4.6	2.6	L_105_R	0.016	982	0.035	2.5	6.6			--				11.7	7.0
L_107	4125909	94.7	5645	5526	0.023	5172	100	0.020	Range (natural)	0.130	13.9	2940	0.027	Pavement and small upland gullies	3.4	14.6	Stormdrain	0.034	749	0.013	13.4	0.9	L_106_R	0.007	1383	0.035	2.4	9.7	39.2	23.5
L_108	758151	17.4	5566	5515	0.035	1448	100	0.060	Smooth Surfaces	0.011	1.2	538	0.065	Nearly bare and untilled (overland flow)	2.5	3.5	L_107_R	0.013	810	0.035	4.2	3.2			--				10.0	6.0
L_109	864025	19.8	5564	5494	0.029	2378	100	0.018	Smooth Surfaces	0.011	2.0	1022	0.050	Nearly bare and untilled (overland flow)	2.2	7.7	L_108_R	0.014	1256	0.035	5.1	4.1			--				13.8	8.3
L_110	3634789	83.4	5575	5437	0.033	4140	100	0.020	Smooth Surfaces	0.011	1.9	1459	0.045	Pavement and small upland gullies	4.3	5.6	Street	0.027	2581	0.017	6.9	6.2			--				13.8	8.3
L_111	1296507	29.8	5466	5369	0.032	3050	100	0.020	Smooth Surfaces	0.011	1.9	1178	0.036	Pavement and small upland gullies	3.9	5.1	L_110_R	0.029	1772	0.035	7.1	4.1			--				11.1	6.7
L_201	2779694	63.8	5740	5651	0.020	4376	100	0.060	Smooth Surfaces	0.011	1.2	782	0.040	Nearly bare and untilled (overland flow)	2.0	6.6	L_201_R	0.028	3493	0.035	3.1	18.5			--				26.4	15.8
L_301	1558644	35.8	5685	5596	0.027	3352	100	0.020	Smooth Surfaces	0.011	1.9	1223	0.025	Pavement and small upland gullies	3.2	6.4	L_201_R	0.028	2029	0.035	3.1	10.8			--				19.1	11.5
L_401	643320	14.8	5654	5606	0.036	1326	100	0.033	Smooth Surfaces	0.011	1.6	465	0.034	Nearly bare and untilled (overland flow)	1.8	4.2	Street	0.038	761	0.017	8.2	1.6			--				10.0	6.0
L_501	934980	21.5	5649	5583	0.027	2432	100	0.005	Range (natural)	0.130	24.2	1069	0.026	Nearly bare and untilled (overland flow)	1.6	11.1	Overland - WIDE	0.030	1263	0.035	6.8	3.1			--				38.4	23.0
L_502	747645	17.2	5611	5549	0.035	1762	100	0.048	Smooth Surfaces	0.011	1.4	923	0.035	Nearly bare and untilled (overland flow)	1.9	8.3	L_501_R	0.034	739	0.017	1.7	7.2			--				16.8	10.1
SG_101	417621	9.6	5691	5657	0.027	1252	100	0.050	Smooth Surfaces	0.011	1.3	948	0.022	Pavement and small upland gullies	3.0	5.2	Street	0.039	204	0.017	8.3	0.4			--				10.0	6.0
SG_102	290073	6.7	5669	5626	0.033	1304	100	0.010	Smooth Surfaces	0.011	2.5	773	0.038	Pavement and small upland gullies	3.9	3.3	Overland - WIDE	0.030	430	0.035	6.8	1.1			--				10.0	6.0
SG_103	492078	11.3	5662	5613	0.037	1321	100	0.040	Smooth Surfaces	0.011	1.5	576	0.042	Nearly bare and untilled (overland flow)	2.0	4.7	SG_102_R	0.033	645	0.020	3.3	3.3			--				10.0	6.0
SG_104	1531959	35.2	5641	5567	0.030	2472	100	0.040	Range (natural)	0.130	10.6	1201	0.032	Pavement and small upland gullies	3.6	5.5	Street	0.027	1171	0.017	6.9	2.8			--				18.9	11.4
SG_105	2105345	48.3	5616	5537	0.036	2176	100	0.080	Smooth Surfaces	0.011	1.1	1093	0.042	Pavement and small upland gullies	4.2	4.4	SG_104_R	0.025	983	0.035	3.1	5.3			--				10.7	6.4
SG_201	1513826	34.8	5731	5663	0.028	2439	100	0.010	Range (natural)	0.130	18.4	935	0.037	Nearly bare and untilled (overland flow)	1.9	8.1	Overland - WIDE	0.041	1404	0.035	7.9	2.9			--				29.4	17.6
SG_301	1095903	25.2	5714	5614	0.043	2337	100	0.010	Range (natural)	0.130	18.4	1371	0.048	Nearly bare and untilled (overland flow)	2.2	10.5	Overland - WIDE	0.038	865	0.035	7.6	1.9			--				30.7	18.4
SG_401	561336	12.9	5708	5649	0.050	1175	100	0.030	Range (natural)	0.130	11.8	458	0.041	Nearly bare and untilled (overland flow)	2.0	3.8	Overland - WIDE	0.060	616	0.035	9.6	1.1			--				16.7	10.0

Basin	Area		Flow path				Sheet Flow					Shallow Flow					Channel Segment 1 Flow						Channel Segment 2 Flow						Time of Concentration	Lag Time
			Upstream Elev.	Downstream Elev.	Slope	Length	Length	Slope	Surface Description	Manning's n	Travel Time	Length	Slope	Surface Description	Velocity	Travel Time	Description	Slope	Length	Manning's n	Average Velocity	Travel Time	Description	Slope	Length	Manning's n	Average Velocity	Travel Time		
	(sq ft)	(ac)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft/ft)		(-)	(min)	(ft)	(ft/ft)		(ft/sec)	(min)		(ft/ft)	(ft)	(-)	(ft/sec)	(min)		(ft/ft)	(ft)	(-)	(ft/sec)	(min)	(min)	(min)
SG_402	3776211	86.7	5701	5537	0.037	4469	100	0.020	Range (natural)	0.130	13.9	2090	0.040	Pavement and small upland gullies	4.1	8.5	SG_105_R	0.034	2279	0.035	4.9	7.7	--						30.2	18.1
SN_101	2873895	66.0	5772	5682	0.026	3503	100	0.020	Range (natural)	0.130	13.9	1399	0.016	Pavement and small upland gullies	2.5	9.1	Overland - WIDE	0.033	2004	0.035	7.1	4.7	--						27.8	16.7
SN_102	1672903	38.4	5746	5676	0.027	2561	100	0.020	Range (natural)	0.130	13.9	1208	0.043	Nearly bare and untilled (overland flow)	2.1	9.7	Stormdrain	0.015	1253	0.013	8.7	2.4	--						26.1	15.6
SN_103	2361204	54.2	5685	5617	0.024	2811	100	0.060	Smooth Surfaces	0.011	1.2	871	0.025	Nearly bare and untilled (overland flow)	1.6	9.2	Street	0.022	1840	0.017	6.2	5.0	--						15.4	9.2
SN_104	1454691	33.4	5640	5546	0.026	3545	100	0.010	Range (natural)	0.130	18.4	604	0.036	Nearly bare and untilled (overland flow)	1.9	5.3	SN_103_R	0.025	2841	0.035	4.2	11.2	--						34.9	20.9
SO_101	1203548	27.6	5327	5300	0.015	1820	100	0.010	Range (natural)	0.130	18.4	705	0.019	Nearly bare and untilled (overland flow)	1.4	8.5	Overland - WIDE	0.012	1015	0.035	4.3	3.9	--						30.8	18.5
SO_102	887250	20.4	5322	5302	0.024	832	200	0.105	Smooth Surfaces	0.011	1.7	632	0.015	Pavement and small upland gullies	2.5	4.2	--						--						10.0	6.0
SO_103	1672026	38.4	5313	5286	0.011	2368	100	0.020	Smooth Surfaces	0.011	1.9	720	0.019	Pavement and small upland gullies	2.8	4.2	Street	0.007	1547	0.017	3.5	7.4	--						13.6	8.1
SO_201	4717197	108.3	5411	5296	0.031	3726	100	0.082	Smooth Surfaces	0.011	1.1	118	0.034	Pavement and small upland gullies	3.7	0.5	Street	0.029	3508	0.017	7.2	8.2	--						10.0	6.0
SO_301	754489	17.3	5302	5268	0.021	1608	100	0.030	Smooth Surfaces	0.011	1.6	866	0.018	Nearly bare and untilled (overland flow)	1.4	10.7	Street	0.023	642	0.017	6.4	1.7	--						14.0	8.4
SO_302	1607311	36.9	5281	5247	0.019	1818	100	0.023	Smooth Surfaces	0.011	1.8	338	0.032	Pavement and small upland gullies	3.6	1.6	Street	0.015	1380	0.017	5.2	4.4	--						10.0	6.0
U_101	1178721	27.1	5534	5479	0.021	2641	100	0.010	Range (natural)	0.130	18.4	1076	0.029	Nearly bare and untilled (overland flow)	1.7	10.7	Street	0.016	1465	0.017	5.3	4.6	--						33.7	20.2
U_102	280943	6.4	5458	5426	0.035	905	100	0.020	Smooth Surfaces	0.011	1.9	805	0.037	Pavement and small upland gullies	3.9	3.4	--						--						10.0	6.0
U_103	1596320	36.6	5432	5401	0.015	2047	100	0.023	Smooth Surfaces	0.011	1.8	1947	0.015	Pavement and small upland gullies	2.5	13.2	--						--						15.0	9.0
U_104	1508070	34.6	5434	5377	0.020	2934	100	0.020	Smooth Surfaces	0.011	1.9	1403	0.021	Pavement and small upland gullies	2.9	8.0	Street	0.018	1431	0.017	5.7	4.2	--						14.1	8.5
U_105	1330655	30.5	5410	5330	0.024	3316	100	0.040	Smooth Surfaces	0.011	1.5	518	0.027	Nearly bare and untilled (overland flow)	1.6	5.3	Street	0.025	946	0.017	6.6	2.4	U_104_R	0.022	1752	0.013	13.7	2.1	11.3	6.8
U_201	691497	15.9	5446	5426	0.009	2084	100	0.033	Smooth Surfaces	0.011	1.6	934	0.010	Pavement and small upland gullies	2.1	7.5	Street	0.006	1050	0.017	3.3	5.2	--						14.3	8.6
U_301	356172	8.2	5447	5418	0.028	1045	100	0.040	Smooth Surfaces	0.011	1.5	796	0.016	Pavement and small upland gullies	2.6	5.1	Street	0.079	150	0.017	11.8	0.2	--						10.0	6.0
U_401	1557798	35.8	5526	5463	0.025	2527	100	0.008	Smooth Surfaces	0.011	2.9	1413	0.024	Pavement and small upland gullies	3.1	7.5	Street	0.029	1014	0.017	7.1	2.4	--						12.8	7.7
U_402	861487	19.8	5475	5425	0.022	2292	100	0.013	Smooth Surfaces	0.011	2.3	819	0.020	Pavement and small upland gullies	2.9	4.7	Street	0.024	1373	0.017	6.4	3.6	--						10.6	6.3
U_403	170684	3.9	5435	5416	0.027	696	100	0.020	Smooth Surfaces	0.011	1.9	375	0.027	Pavement and small upland gullies	3.3	1.9	Street	0.032	221	0.017	7.5	0.5	--						10.0	6.0
U_501	357947	8.2	5433	5395	0.025	1565	100	0.050	Smooth Surfaces	0.011	1.3	790	0.021	Pavement and small upland gullies	3.0	4.5	Street	0.025	675	0.017	6.6	1.7	--						10.0	6.0
U_502	1000513	23.0	5401	5335	0.023	2875	100	0.040	Range (natural)	0.130	10.6	757	0.025	Pavement and small upland gullies	3.2	3.9	Overland - WIDE	0.021	2018	0.035	5.7	5.9	--						20.3	12.2
WB_101	3201515	73.5	5634	5501	0.031	4239	100	0.020	Smooth Surfaces	0.011	1.9	1202	0.011	Pavement and small upland gullies	2.1	9.5	Street	0.039	1625	0.017	8.3	3.3	WB_101_R	0.041	1312	0.035	2.7	8.1	22.8	13.7
WB_102	4761109	109.3	5624	5459	0.032	5226	100	0.010	Range (natural)	0.130	18.4	1477	0.018	Nearly bare and untilled (overland flow)	1.3	18.6	WB_101_R	0.038	3648	0.035	2.6	23.5	--						60.5	36.3
WB_103	859780	19.7	5486	5432	0.038	1437	100	0.050	Range (natural)	0.130	9.7	698	0.047	Nearly bare and untilled (overland flow)	2.2	5.4	WB_102_R	0.025	640	0.035	4.4	2.4	--						17.4	10.5
WB_104	5722568	131.4	5464	5360	0.026	4028	100	0.030	Range (natural)	0.130	11.8	1014	0.029	Nearly bare and untilled (overland flow)	1.7	10.0	WB_103_R	0.025	2914	0.035	4.0	12.0	--						33.9	20.3
WB_105	1466016	33.7	5392	5281	0.025	4488	100	0.070	Range (natural)	0.130	8.4	759	0.040	Nearly bare and untilled (overland flow)	2.0	6.3	WB_104_R	0.020	3629	0.035	3.3	18.4	--						33.1	19.9
WB_301	4575389	105.0	5642	5422	0.037	6026	100	0.010	Smooth Surfaces	0.011	2.5	754	0.061	Nearly bare and untilled (overland flow)	2.5	5.1	Overland - WIDE	0.044	1555	0.035	8.2	3.2	WB_101_R	0.029	3617	0.035	2.3	26.6	37.5	22.5
WX_101	4045201	92.9	5544	5474	0.016	4526	100	0.043	Smooth Surfaces	0.011	1.4	2890	0.009	Pavement and small upland gullies	1.9	25.5	Street	0.027	1536	0.017	6.8	3.7	--						30.6	18.4
WX_102	2558781	58.7	5526	5439	0.025	3523	100	0.020	Smooth Surfaces	0.011	1.9	1356	0.028	Nearly bare and untilled (overland flow)	1.7	13.5	Street	0.023	2067	0.017	6.3	5.5	--						21.0	12.6
WX_201	2530265	58.1	5531	5447	0.021	4040	100	0.010	Smooth Surfaces	0.011	2.5	1461	0.017	Pavement and small upland gullies	2.7	9.2	Street	0.024	2478	0.017	6.4	6.4	--						18.1	10.9
W_101	11759676	270.0	5467	5268	0.035	5719	100	0.050	Range (natural)	0.130	9.7	951	0.020	Pavement and small upland gullies	2.9	5.5	Street	0.037	4669	0.017	8.1	9.6	--						24.8	14.9
W_102	1352280	31.0	5284	5228	0.029	1945	100	0.010	Smooth Surfaces	0.011	2.5	317	0.076	Nearly bare and untilled (overland flow)	2.7	1.9	Street	0.020	1528	0.017	6.0	4.3	--						10.0	6.0
W_103	2285493	52.5	5282	5198	0.018	4630	100	0.020	Smooth Surfaces	0.011	1.9	985	0.006	Pavement and small upland gullies	1.6	10.4	Overland - WIDE	0.018	2626	0.035	5.2	8.5	Overland - WIDE	0.033	919	0.035	7.1	2.2	22.9	13.7
W_201	1489863	34.2	5331	5270	0.020	3092	100	0.050	Smooth Surfaces	0.011	1.3	970	0.024	Pavement and small upland gullies	3.1	5.2	Overland - WIDE	0.016	2022	0.035	5.0	6.8	--						13.3	8.0

Neighborhood loss parameters

Neighborhood	Percent Impervious	CN for Pervious Areas	Notes
Cabezon	42%	80	Residential yard in mass-graded subdivision
E of Golf Course	16%	80	Residential yard in mass-graded subdivision
E of Unser N of Southern	30%	80	Residential yard in mass-graded subdivision
N of Idalia	13%	77	Natural Desert Landscaping
W of Unser N of Southern HD	27%	80	Residential yard in mass-graded subdivision
W of Unser N of Southern LD	16%	80	Residential yard in mass-graded subdivision
W of Unser S of Southern	13%	77	Natural Desert Landscaping
City of Albuquerque	42%	80	No building footprints but estimated to be approximately the same density as the Cabezon neighborhood. Residential yard in mass-graded subdivision
Multi-Family Residential	41%	80	Residential yard in mass-graded subdivision

Soil sample location information

Sample Number	Subbasin	X Coordinate	Y Coordinate	Soil Texture	Source
1	W_101	1506294	1535886	Sand	Estimated using NRCS field guide
2	W_101	1504109	1537405	Sand	
3	W_101	1502229	1536461	Sand	
4	WB_104	1501087	1539056	Sand	
5	WB_301	1502275	1539742	Sand	
6	N/A*	1498211	1538395	Silt Loam	
7	WB_102	1500387	1540365	Sand	
8	WB_102	1497925	1541615	Silty Clay	
9	WB_301	1499303	1542921	Sand	
10	WB_101	1499452	1542266	Sand	
11	B_101	1500861	1543010	Sand	
12	A_103	1503308	1543302	Sand	
13	B_103	1505079	1541092	Sand	
14	B_104	1506286	1539262	Sand	
15	SG_201	1500961	1549673	Sand	
16	SN_102	1499766	1552118	Sand	
17	L_101	1499839	1555567	Clay	
18	L_101	1503137	1553804	Sand	
19	L_103	1504212	1551958	Sand	
20	WX_101	1506498	1547439	Sand	
21	EB_105	1510831	1542547	Sand	
22	B_106	1508186	1537252	Sand	

*Outside Black Arroyo Watershed - used to determine extents of soil type distribution in the area.

NOAA Atlas 14, Volume 1, Version 5
Location name: Rio Rancho, New Mexico, USA*
Latitude: 35.2399°, Longitude: -106.6989°
Elevation: 5393.04 ft**
* source: ESRI Maps
** source: USGS

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	0.170 (0.146-0.198)	0.219 (0.188-0.257)	0.295 (0.251-0.346)	0.354 (0.301-0.413)	0.434 (0.367-0.507)	0.498 (0.419-0.580)	0.564 (0.472-0.658)	0.635 (0.527-0.739)	0.731 (0.601-0.852)	0.807 (0.659-0.940)
10-min	0.258 (0.222-0.301)	0.334 (0.286-0.391)	0.449 (0.383-0.526)	0.538 (0.458-0.628)	0.661 (0.559-0.772)	0.757 (0.638-0.883)	0.859 (0.718-1.00)	0.966 (0.802-1.13)	1.11 (0.914-1.30)	1.23 (1.00-1.43)
15-min	0.320 (0.275-0.373)	0.414 (0.354-0.484)	0.557 (0.474-0.652)	0.667 (0.568-0.779)	0.820 (0.693-0.956)	0.939 (0.791-1.10)	1.07 (0.890-1.24)	1.20 (0.994-1.40)	1.38 (1.13-1.61)	1.52 (1.24-1.77)
30-min	0.431 (0.370-0.502)	0.558 (0.476-0.652)	0.749 (0.639-0.878)	0.899 (0.765-1.05)	1.10 (0.933-1.29)	1.26 (1.07-1.48)	1.43 (1.20-1.67)	1.61 (1.34-1.88)	1.86 (1.53-2.16)	2.05 (1.67-2.39)
60-min	0.533 (0.458-0.622)	0.690 (0.590-0.807)	0.928 (0.790-1.09)	1.11 (0.946-1.30)	1.37 (1.16-1.59)	1.56 (1.32-1.83)	1.78 (1.48-2.07)	2.00 (1.66-2.32)	2.30 (1.89-2.68)	2.54 (2.07-2.96)
2-hr	0.623 (0.530-0.744)	0.799 (0.677-0.955)	1.06 (0.895-1.26)	1.27 (1.07-1.50)	1.56 (1.30-1.84)	1.79 (1.49-2.11)	2.04 (1.68-2.40)	2.30 (1.88-2.70)	2.66 (2.16-3.14)	2.96 (2.37-3.49)
3-hr	0.676 (0.580-0.802)	0.860 (0.736-1.02)	1.13 (0.966-1.33)	1.34 (1.14-1.58)	1.64 (1.38-1.93)	1.88 (1.58-2.20)	2.13 (1.78-2.50)	2.40 (1.99-2.82)	2.77 (2.27-3.25)	3.08 (2.50-3.62)
6-hr	0.778 (0.674-0.915)	0.984 (0.854-1.16)	1.27 (1.10-1.49)	1.49 (1.29-1.75)	1.80 (1.55-2.10)	2.04 (1.74-2.38)	2.30 (1.95-2.68)	2.56 (2.16-2.98)	2.93 (2.44-3.41)	3.23 (2.67-3.76)
12-hr	0.870 (0.763-0.998)	1.10 (0.962-1.26)	1.39 (1.22-1.59)	1.63 (1.42-1.86)	1.94 (1.68-2.21)	2.18 (1.88-2.49)	2.43 (2.09-2.77)	2.69 (2.30-3.07)	3.05 (2.58-3.48)	3.34 (2.79-3.82)
24-hr	1.00 (0.887-1.14)	1.26 (1.11-1.43)	1.58 (1.39-1.80)	1.83 (1.62-2.08)	2.18 (1.91-2.47)	2.44 (2.13-2.77)	2.72 (2.37-3.08)	3.00 (2.60-3.39)	3.38 (2.91-3.82)	3.67 (3.15-4.16)
2-day	1.05 (0.936-1.19)	1.32 (1.18-1.49)	1.66 (1.47-1.87)	1.92 (1.70-2.16)	2.28 (2.01-2.56)	2.55 (2.25-2.87)	2.84 (2.49-3.19)	3.13 (2.73-3.51)	3.52 (3.05-3.96)	3.82 (3.29-4.30)
3-day	1.19 (1.08-1.32)	1.49 (1.35-1.65)	1.85 (1.67-2.05)	2.13 (1.92-2.35)	2.51 (2.26-2.77)	2.80 (2.51-3.09)	3.10 (2.76-3.42)	3.40 (3.02-3.75)	3.80 (3.36-4.20)	4.10 (3.61-4.54)
4-day	1.33 (1.22-1.46)	1.66 (1.52-1.81)	2.04 (1.87-2.22)	2.34 (2.14-2.54)	2.74 (2.50-2.98)	3.05 (2.77-3.32)	3.36 (3.04-3.65)	3.66 (3.31-3.99)	4.08 (3.67-4.44)	4.39 (3.93-4.79)
7-day	1.53 (1.41-1.67)	1.90 (1.75-2.07)	2.32 (2.14-2.52)	2.65 (2.43-2.87)	3.08 (2.82-3.33)	3.40 (3.11-3.68)	3.72 (3.40-4.03)	4.03 (3.68-4.36)	4.43 (4.03-4.80)	4.73 (4.29-5.13)
10-day	1.68 (1.55-1.83)	2.09 (1.93-2.27)	2.56 (2.36-2.78)	2.93 (2.70-3.17)	3.42 (3.14-3.70)	3.79 (3.47-4.09)	4.16 (3.80-4.49)	4.52 (4.12-4.88)	4.99 (4.54-5.40)	5.34 (4.84-5.79)
20-day	2.13 (1.95-2.31)	2.64 (2.43-2.87)	3.20 (2.95-3.48)	3.63 (3.34-3.93)	4.18 (3.84-4.52)	4.57 (4.20-4.94)	4.95 (4.54-5.35)	5.31 (4.87-5.74)	5.77 (5.27-6.23)	6.09 (5.55-6.59)
30-day	2.55 (2.35-2.76)	3.16 (2.91-3.42)	3.81 (3.51-4.11)	4.29 (3.95-4.62)	4.89 (4.49-5.26)	5.31 (4.88-5.71)	5.72 (5.24-6.14)	6.09 (5.58-6.55)	6.55 (5.99-7.04)	6.87 (6.27-7.39)
45-day	3.11 (2.88-3.36)	3.85 (3.57-4.16)	4.59 (4.25-4.95)	5.12 (4.74-5.51)	5.77 (5.33-6.20)	6.20 (5.74-6.67)	6.60 (6.11-7.09)	6.96 (6.43-7.46)	7.36 (6.81-7.89)	7.61 (7.04-8.15)
60-day	3.58 (3.31-3.86)	4.43 (4.10-4.78)	5.28 (4.89-5.69)	5.89 (5.46-6.34)	6.62 (6.13-7.13)	7.12 (6.60-7.66)	7.58 (7.02-8.16)	7.99 (7.40-8.60)	8.45 (7.84-9.11)	8.75 (8.12-9.42)

[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.

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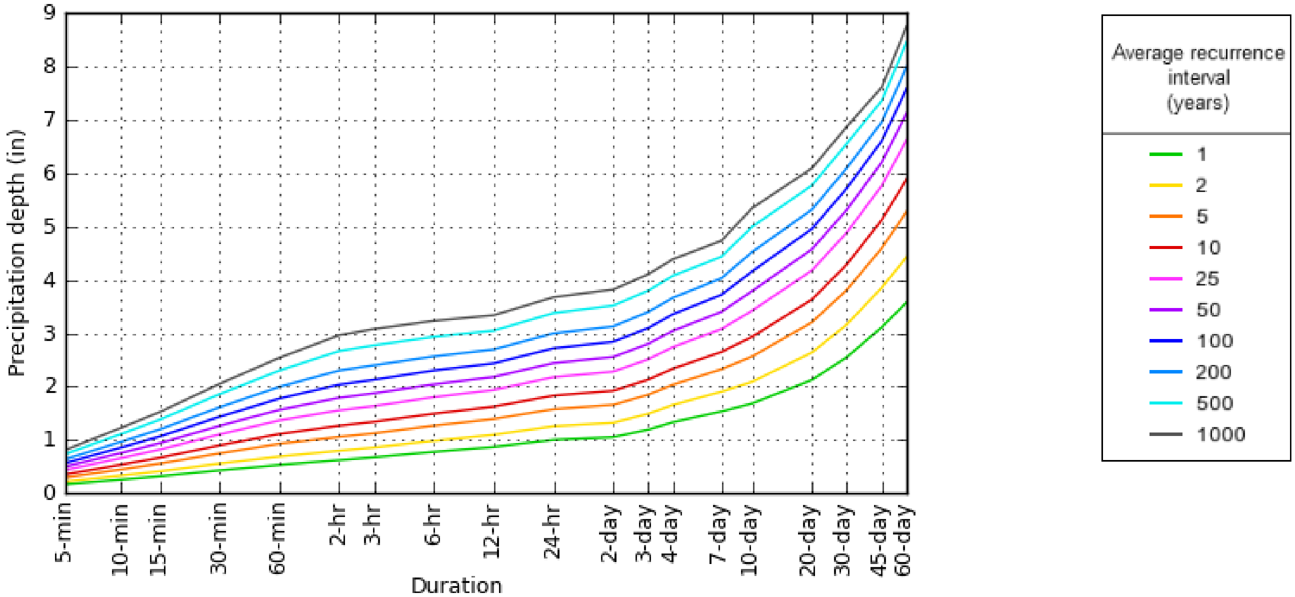
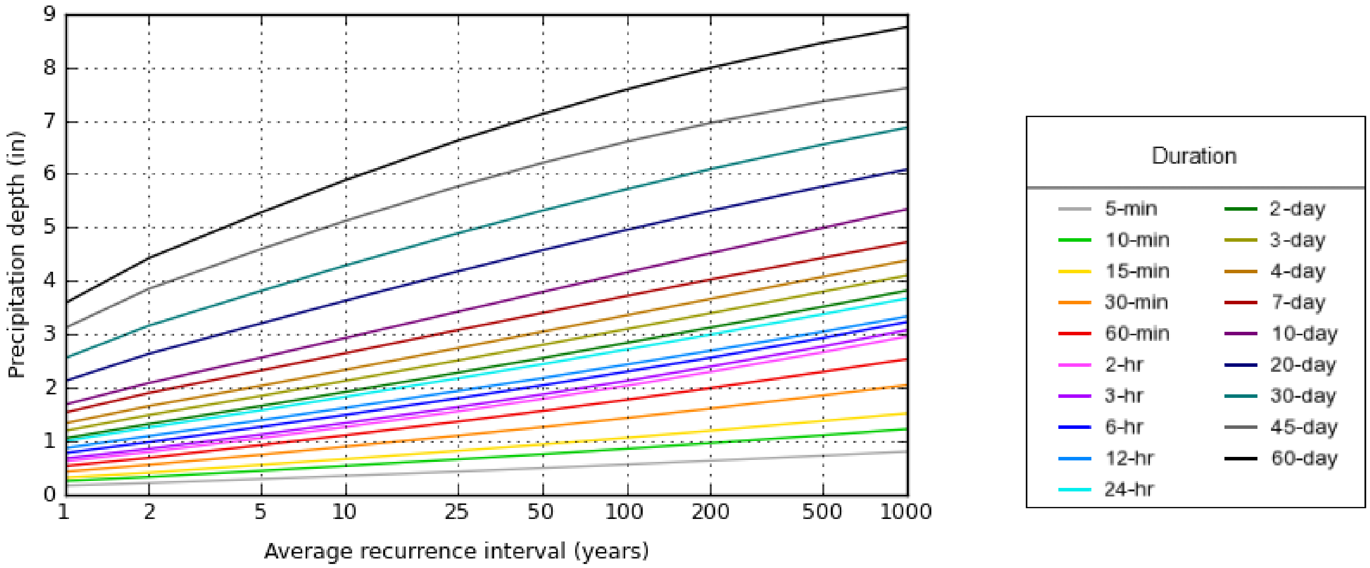
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 35.2399°, Longitude: -106.6989°





NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Fri Jan 15 17:49:41 2021

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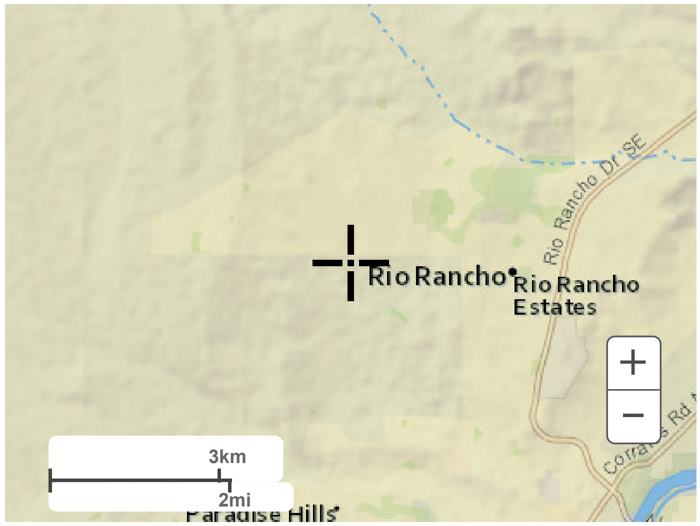
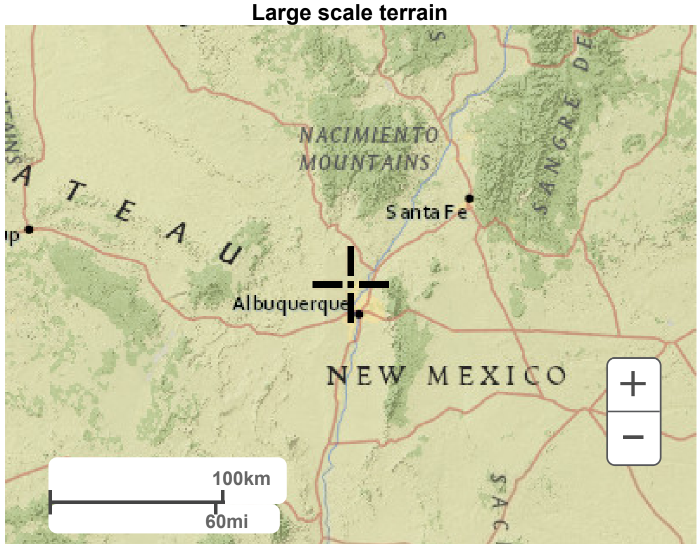
Maps & aerials

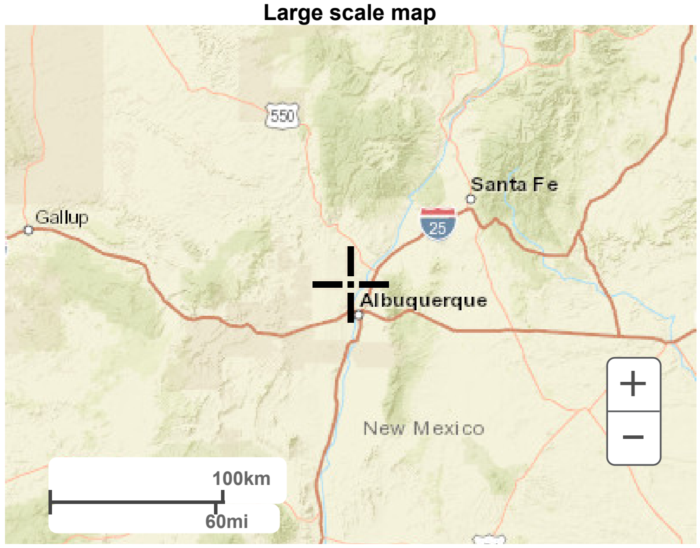
Small scale terrain



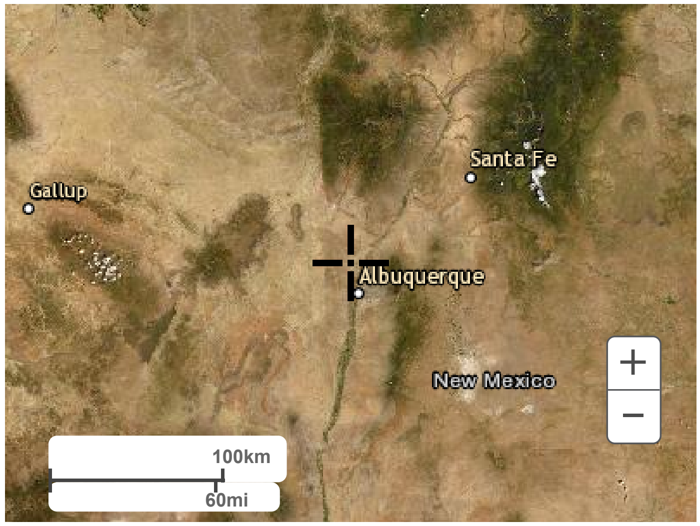
Large scale terrain



Large scale map



Large scale aerial



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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

Appendix B

Existing Ponds

Existing Detention Pond Data

1. Black Dam – Source: Based on as-built (1-23-2009) Construction Plans for Regional Water Quality Structure at Black Arroyo Dam, Albuquerque New Mexico. Prepared for AMAFCA by Wilson & Company, March 2008.
2. Cabezon Subdivision – Tract 17 Detntion Pond – Source: AHYMO_97 Model Input File for Cabezon Communities Phase I Drainage Management Plan (Unit 16) Wilson & Company, February 2004.
3. Gateway Pond – Source: Drainage Analysis Report. Prepared for SSCAFCA by Bohannan Huston, November 2010.
4. Sugar Ridge Subdivision Detention Pond – Source: Based on as-built topographic survey prepared by Smith Engineering Company and documented in Letter of Map Revision for Sugar Channel, Rio Rancho, NM. Prepared for City of Rio Rancho by Smith Engineering Company, December 2009.
5. Sunset Pond – Source: Based on as-built plans (February 2009). Prepared for SSCAFCA by ASCG Inc., January 2008.
6. Wexford Pond – Source: Obtained from AHYMO from Black Arroyo Watershed Management Plan. Prepared for SSCAFCA by ASCG Inc., August 2002.
7. Stone Bridge Detention Pond – Source: Developed by Smith Engineering based on 2010 LiDAR contour mapping along with field observation and measurements as a part of the Black Watershed Park Management Plan prepared for SSCAFCA by Smith Engineering, April 2013.
8. Lisbon Pond and Lisbon Auxiliary Pond – Source: Appendix C – Routing Tables from Lisbon Pond Design Analysis Report prepared for SSCAFCA by RESPEC, Inc., April 2020.

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

The Great Seal of the City of Rio Rancho, New Mexico ★1981★

SOUTHERN SANDOVAL COUNTY ARROYO FLOOD CONTROL AUTHORITY

CONSTRUCTION PLANS FOR REGIONAL WATER QUALITY STRUCTURE AT BLACK ARROYO DAM ALBUQUERQUE, NEW MEXICO

AMAFCA

AMAFCA

INDEX

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	VICINITY MAP
3	HYDROLOGY/HYDRAULICS
4	WATER QUALITY STRUCTURE GRADING PLAN
5	WEST BRANCH ARROYO DROP STRUCTURE PLAN & PROFILE
6	EAST BRANCH CHANNEL PLAN & PROFILE
7	WATER QUALITY STRUCTURE DETAILS
8	LOW FLOW IN-TAKE STRUCTURE
9	SITE DETAILS
10	SITE DETAILS
11	TESCM EROSION & SEDIMENT CONTROL MEASURES
12	TESCM SILT FENCE INSTALLATION AND CHECK DAMS
13	TESCM PIPE SLOPE DRAIN & SEDIMENT TRAPS
14	DROP INLET & CULVERT PROTECTION

BLACK ARROYO DAM PROPERTIES	
MAXIMUM GRADE ABOVE EXISTING GRADE AT CENTERLINE	22.5 FT
LENGTH	3,273 FT
MAXIMUM WIDTH AT BASE	200 FT
CREST WIDTH	15 FT
SLOPE UPSTREAM FACE	3:1 FT/FT
SLOPE DOWNSTREAM FACE	2.5:1 FT/FT
ELEVATION OF THE DAM CREST (TOD)	5175.0 FT
ELEVATION OF THE EMERGENCY SPILLWAY CREST	5165.75 FT
WATER SURFACE ELEVATION 1/2 PMP, 6-HOUR LOCAL EVENT	5173.25 FT
WATER SURFACE ELEVATION 100-YEAR 24-HOUR EVENT	5160.99 FT
ELEVATION OF THE OUTLET CONDUIT UPSTREAM	5146.00 FT
ELEVATION OF THE OUTLET CONDUIT DOWNSTREAM	5144.08 FT
OUTLET CONDUIT SIZE AND TYPE	2 – 8.5' x 8.5' CBCs
OUTLET CONDUIT CAPACITY AT TOD ELEVATION 5175.0'	3865 CFS
DRAINAGE AREA	6,347 ACRE
HAZARD CLASSIFICATION	HIGH
1/2 PMP 6 HOUR LOCAL STORM DESIGN RAINFALL	7.12 IN
FREEBOARD	9.25 FT
LOCATION OF OUTLET WORKS INTAKE STRUCTURE (@ ℄ OF UPSTREAM HEADWALL)	N 1534254.33 E 1512979.54

AS-BUILT

SURVEYOR'S CERTIFICATION

I, Dan B. Holmes, New Mexico Land Surveyor No. 9243, do hereby certify that the as-built elevations shown on these plans were surveyed under my supervision and that they are true and correct to the best of my knowledge and belief.

Dan B. Holmes

02-11-09
Date

DAN D. HOLMES NEW MEXICO 9243 REGISTERED PROFESSIONAL LAND SURVEYOR

State of New Mexico)
)ss.
County of Bernalillo)

I, Daniel S. Aguirre, PE, CFM, state that I am a qualified professional engineer licensed in the state of New Mexico, that I have inspected the **REGIONAL WATER QUALITY STRUCTURE AT THE BLACK ARROYO DAM** and appurtenant structures and find them to be in accordance with the record construction drawings and specifications and are now in satisfactory condition for acceptance.

Daniel S. Aguirre, PE, CFM

License Number 11955

Date submitted 2/9/09

DANIEL S. AGUIRRE NEW MEXICO 11955 PROFESSIONAL ENGINEER

STATE OF NEW MEXICO)
SS.
COUNTY OF BERNALILLO)

I, JOHN P. KELLY, P.E., BEING FIRST DULY SWORN, UPON MY OATH, STATE THAT I AM THE EXECUTIVE ENGINEER FOR THE ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY, ALBUQUERQUE, NM; A GOVERNMENTAL ENTITY ORGANIZED UNDER THE LAWS OF THE STATE OF NEW MEXICO, THAT THE ACCOMPANYING CONSTRUCTION DRAWINGS CONSISTING OF 14 SHEETS FOR THE REGIONAL WATER QUALITY STRUCTURE AT BLACK ARROYO DETENTION DAM WERE MADE UNDER THE AUTHORITY OF THE BOARD OF DIRECTORS OF SAID ENTITY AND THAT, IN THEIR BEHALF, I HAVE READ AND EXAMINED THE STATEMENTS AND REPRESENTATIONS AND ALL THAT SHOWN HEREIN IS DONE WITH THEIR FREE CONSENT AND IN ACCORDANCE WITH THEIR WISHES AND STATE THAT THE SAME ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

JOHN P. KELLY, P.E. EXECUTIVE ENGINEER DATE 2-28-08

SUBSCRIBED AND SWORN TO BEFORE ME THIS 28th DAY OF Feb., 2008.

NOTARY PUBLIC

MY COMMISSION EXPIRES 9-22-08

OFFICIAL SEAL Pamela S. WOODRUFF Notary Public State of New Mexico My Commission Expires 9-22-08

STATE OF NEW MEXICO)
SS.
COUNTY OF BERNALILLO)

I, DANIEL S. AGUIRRE, P.E., CFM HEREBY CERTIFY THAT I AM A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF NEW MEXICO, QUALIFIED IN CIVIL ENGINEERING; THAT THE ACCOMPANYING DESIGN REPORT WAS PREPARED BY ME OR UNDER MY SUPERVISION; THAT THE ACCOMPANYING CONSTRUCTION DRAWINGS CONSISTING OF 14 SHEETS WAS PREPARED BY ME OR UNDER MY SUPERVISION; THAT THE ACCOMPANYING CONSTRUCTION DRAWINGS CONSISTING OF 14 SHEETS IS IN COMPLIANCE WITH THE DAM DESIGN, CONSTRUCTION AND DAM SAFETY REGULATIONS(19.25.12 NMAC) AND THAT THE SAME ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

________, LICENSE 11955,
DANIEL S. AGUIRRE, P.E., CFM

DATE SUBMITTED 3/10/08

STATE OF NEW MEXICO)
SS.
COUNTY OF SANTA FE)

HEREBY CERTIFY THAT THE ACCOMPANYING CONSTRUCTION DRAWINGS I FOR THE REGIONAL WATER QUALITY STRUCTURE AT THE BLACK ARROYO DETENTION DAM AND APPURTENANT STRUCTURES HAS BEEN DULY EXAMINED BY ME AND ACCEPTED FOR FILING ON THE ______ DAY OF ______________, 200__.

______________ DATE________
JOHN D'ANTONIO, P.E.
NEW MEXICO STATE ENGINEER

APPROVED FOR CONSTRUCT

DEVELOPER ________ CURB NORTH LLC

CITY OF RIO RANCHO ________ DEPARTMENT OF PUBLIC INFRASTRUCTURE

AMAFCA ________ EXECUTIVE ENGINEER

SSCAFCA ________ for EXECUTIVE DIRECTOR

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

WILSON & COMPANY
2600 THE AMERICAN ROAD SE
SUITE 100
RIO RANCHO, NEW MEXICO
87124
P: (505) 348-4000
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REGIONAL WATER STRUCTURE AT B

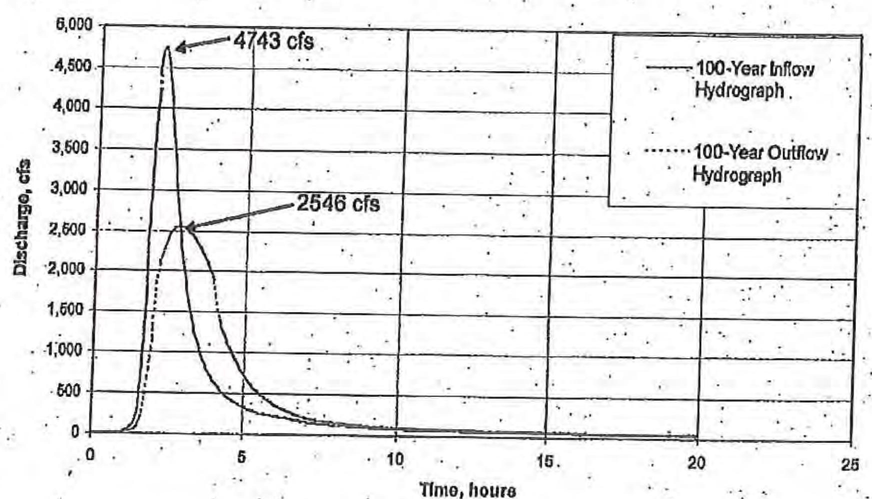
TITLE SHEE

DANIEL S. AGUIRRE NEW MEXICO 11955 REGISTERED PROFESSIONAL ENGINEER 2/28/08

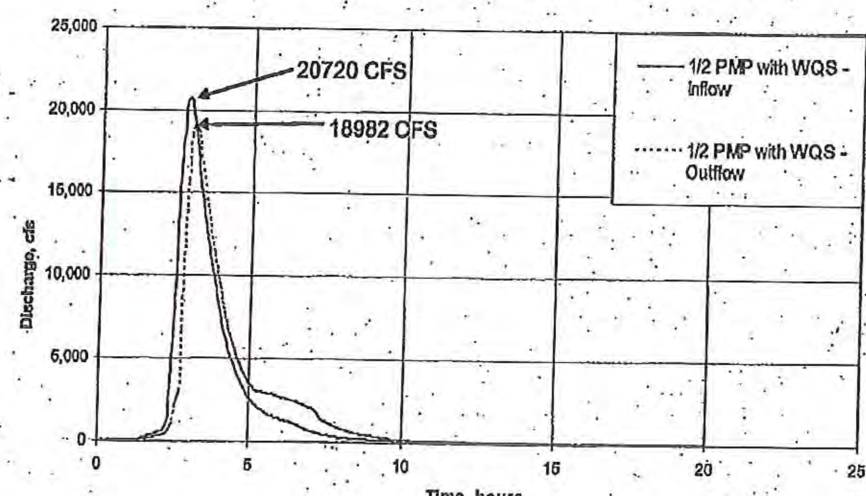
REVISIONS	NO.	DATE	REMA

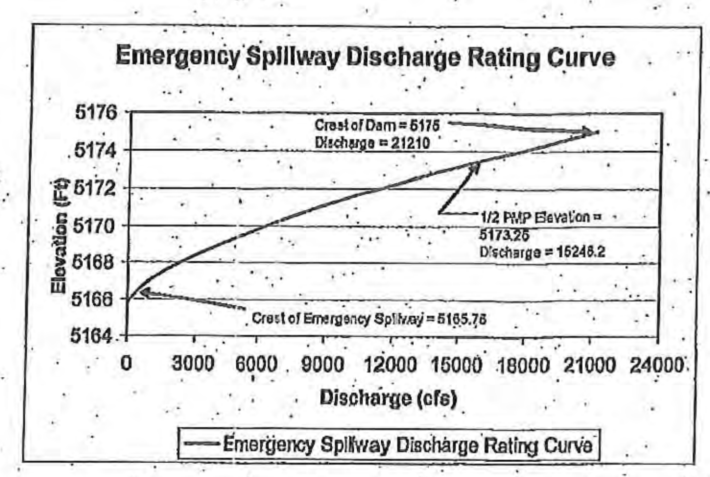
DESIGN	MJI	WCEA NO.	X4216
DRAWN	HLC	PROJECT NO.	N/A
CHECK	MJI		

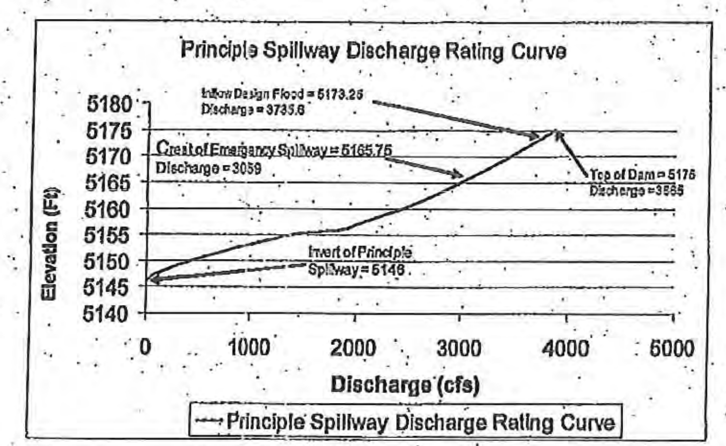
Inflow and Outflow Hydrographs for the Combined Black Arroyo Dam and Water Quality Structure, 100-year 24-hour Storm Event



Inflow and Outflow Hydrographs for the Combined Black Arroyo Dam and Water Quality Structure, 1/2 PMP, 6-Hour Local Storm Event







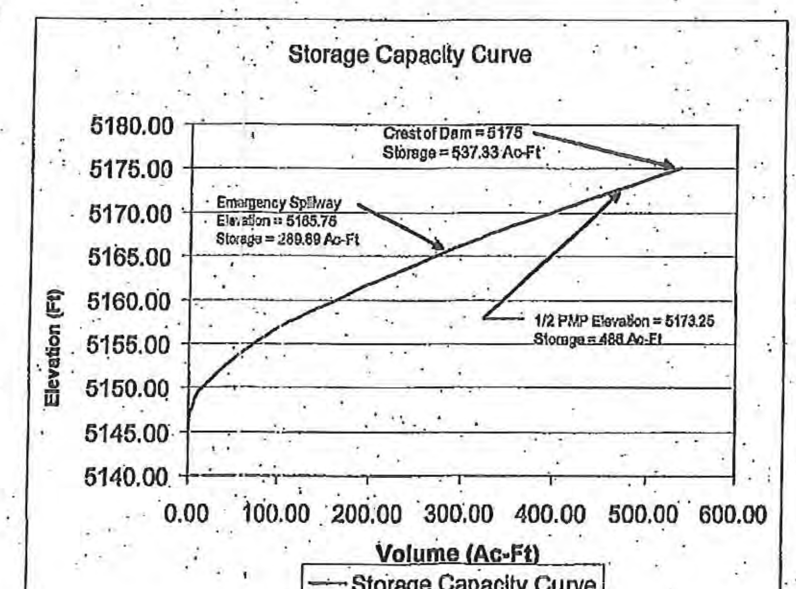


TABLE A

SOUTH 16-28"S x 20" R CMP			NORTH 16-28"S X 20" R CMP		
CMP	INVERT WEST	INVERT EAST	CMP	INVERT WEST	INVERT EAST
1	5157.66	5160.96	1	5158.12	5161.21
2	5157.61	5160.90	2	5157.99	5161.18
3	5157.62	5160.93	3	5157.95	5161.16
4	5157.72	5160.99	4	5158.07	5161.26
5	5157.83	5160.98	5	5158.01	5161.20
6	5157.80	5160.87	6	5157.93	5161.17
7	5157.83	5160.94	7	5157.84	5161.19
8	5157.84	5160.96	8	5157.94	5161.12
9	5157.77	5160.93	9	5157.90	5161.13
10	5157.77	5160.91	10	5157.91	5161.17
11	5157.72	5160.97	11	5158.01	5161.11
12	5157.78	5160.91	12	5157.94	5161.10
13	5157.71	5160.88	13	5157.92	5161.14
14	5157.78	5160.93	14	5157.92	5161.16
15	5157.74	5160.97	15	5157.96	5161.13
16	5157.78	5160.96	16	5157.93	5161.11

SOUTH & NORTH CMP'S BEGINNING WITH #1 @ SOUTH END OF EACH BATTERY FOR CMP'S & ENDING WITH #16. EQUAL INVERTS WEST & EAST FOR EACH CMP.

T:\Projects\X4218012\H\Water Qual Struct\01_Dam\8412HYDRAULICSL.dwg 2/28/2008 7:30:31 AM MST

BLACK ARROYO DAM PROPERTIES

MAXIMUM GRADE ABOVE EXISTING GRADE AT CENTERLINE	
LENGTH	
MAXIMUM WIDTH AT BASE	
CREST WIDTH	
SLOPE UPSTREAM FACE	
SLOPE DOWNSTREAM FACE	
ELEVATION OF THE DAM CREST (TOD)	
ELEVATION OF THE EMERGENCY SPILLWAY CREST	
WATER SURFACE ELEVATION 1/2 PMP, 6-HOUR LOCAL EVENT	
WATER SURFACE ELEVATION 100-YEAR. 24-HOUR EVENT	
ELEVATION OF THE OUTLET CONDUIT UPSTREAM	
ELEVATION OF THE OUTLET CONDUIT DOWNSTREAM	
OUTLET CONDUIT SIZE AND TYPE	2 –
OUTLET CONDUIT CAPACITY AT TOD ELEVATION 5175.0'	
DRAINAGE AREA	
HAZARD CLASSIFICATION	
½ PMP 6 HOUR LOCAL STORM DESIGN RAINFALL	
FREEBOARD	
LOCATION OF OUTLET WORKS INTAKE STRUCTURE (@ ℄ OF UPSTREAM HEADWALL)	

Proposed Black Arroyo Dam Rating Curve Information With WQS

Elevation (feet)	Surface Area (Acre)	Incremental Volume (Ac-Ft)	Storage (Ac-Ft)	Discharge** (CFS)	
5146.00	0.00	0.00	0.00	0.0	Principl Spillway
5147.00	3.00	1.50	1.50	51.9	
5148.00	3.63	3.32	4.82	146.7	
5149.00	4.25	3.94	8.76	269.4	
5150.00	9.22	6.74	15.49	414.8	
5151.00	10.10	9.66	25.15	579.7	
5152.00	11.23	10.67	35.82	762.0	
5153.00	12.48	11.86	47.67	960.3	
5154.00	13.57	13.03	60.70	1173.2	
5155.00	14.40	13.99	74.68	1400.0	
5156.00	14.46	14.43	89.11	1863.0	
5157.00	15.28/18.9*	14.87	103.98	2018.5	
5158.00	19.39	19.15	123.13	2162.9	
5159.00	19.88	19.64	142.76	2298.2	
5160.00	20.44	20.16	162.92	2428.0	
5161.00	20.97	20.71	183.63	2547.4	
5162.00	21.52	21.25	204.87	2663.2	
5163.00	22.12	21.82	226.69	2774.2	
5164.00	22.76	22.44	249.13	2881.0	
5165.00	23.31	23.04	272.17	2983.9	
5165.75	23.80	23.49	289.89	3058.8	Emerge Spillway
5166.00	23.96	23.64	295.80	3168.6	
5167.00	24.53	24.25	320.05	4150.7	
5168.00	25.15	24.84	344.89	5644.0	
5169.00	25.84	25.50	370.38	7523.3	
5170.00	26.53	26.19	396.57	9738.9	
5171.00	27.18	26.86	423.42	12255.3	
5172.00	27.86	27.52	450.94	15059.7	
5173.00	28.49	28.18	479.12	18136.9	
5173.25			486.40	18981.8	Design Elevatio
5174.00	29.09	28.79	507.91	21477.6	
5175.00	29.76	29.43	537.33	25074.8	Top of I

*There are 2 areas shown at Elevation 5157 for the calculations of the Volume. The 15.28 surface area used to calculate the incremental volume at elevation 5157. The 18.9 value is the surface area used to calculate the incremental volume at elevation 5158.

**Discharge includes total of Principle and Emergency Spillways

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

WILSON & COMPANY
2600 THE AMERICAN ROAD SE
SUITE 100
RIO RANCHO, NEW MEXICO
87124
(505) 898-8021

REGIONAL WATER QUALITY STRUCTURE AT BLACK DAM

HYDROLOGY/HYD

REVISIONS NO.	DATE	REMA

DESIGN	MJI	WCEA NO. X4218
DRAWN	HLC	PROJECT NO.
CHECK	MJI	N/A

RECORD DRAWING
DATE 1-23-2009

CABEZON TRACT 17 DETETION POND (3 PAGES)
ELEV. STORAGE DISHCARGE DATA

FROM

CABEZON COMMUNITIES PHASE I
DRAINAGE MANAGEMENT PLAN (Unit 16)
Wilson & Company, Feb. 2004

CD in report with AHYMO models

Copy of model beginning text and RESERVOIR ROUTING DATA

```
START                   0.0 HRS  PUNCH CODE=0  PRINT LINES=-1
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * *
*S      7/22/04
*S      WILSON & CO.'S CABEZON COMMUNITIES DRAINAGE MASTER PLAN, PHASE 2 OF
*S      DEVELOPMENT: THIS MODEL TAKES BOTH CABEZON PHASE 1 AND 2 INTO THE
*S      MODIFIED BLWMP MODEL DEVELOPED BY ASCG (1/20/04) TO ASSESS
CABEZON'S
*S      IMPACT ON BLACK DAM. IT MODELS DEVELOPED CONDITIONS IN ALL
SUBBASINS;
*S      SEDIMENT BULKING ADJUSTED TO 6% REFLECT THIS; ALSO, MUSKINGHAM
CUNGE
*S      ROUTING (COMMAND: ROUTE MCUNGE) CONSISTENTLY USED
*S      THIS MODEL USES A STEP OF 0.05 HR (3 MIN) SO THAT THE ENTIRE 24 HR
*S      HYDROGRAPH IS CAPTURED AND VOLUMETRIC RUNOFF IS MORE COMPLETELY
*S      ACCOUNTED FOR
*S * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * *
*S  01/20/2004 ADJUSTMENTS TO THIS MODEL FROM THE BLWMP
*S  "DOUBLE" COUNTING OF STREETS IN LAND TREATMENT REMOVED
*S  SUB-BASIN 211 ROUTED ADJUSTED TO EXISTING FIELD CONDITIONS (XING
SOUTHERN)
*S  NOTHING ELSE HAS BEEN ADJUSTED - USER ACCEPTS THIS MODEL AS IS AND
TAKES THE
*S  RESPONSIBILITY FOR CHECKING IT FOR ACCURACY PRIOR TO USE...
************************************************************************
*******
*       -------HYDROLOGY MODEL-----------
*S * * * FUTURE CONDITIONS MODEL - ALTERNATE B  * * * * * * * * * * * * * *
* * * *
*S * * * 3 DAMS ON THE WEST BRANCH                         * * * * * * * * *
*S * * * UNSER GATEWAY DAM, AND WATER QUALITY DIVERSIONS * * * * * * * * *
*S * * * ROUTING WITH MCUNGE METHOD AFTER WATER QUALITY DIVERSIONS ARE  *
* * * *
```

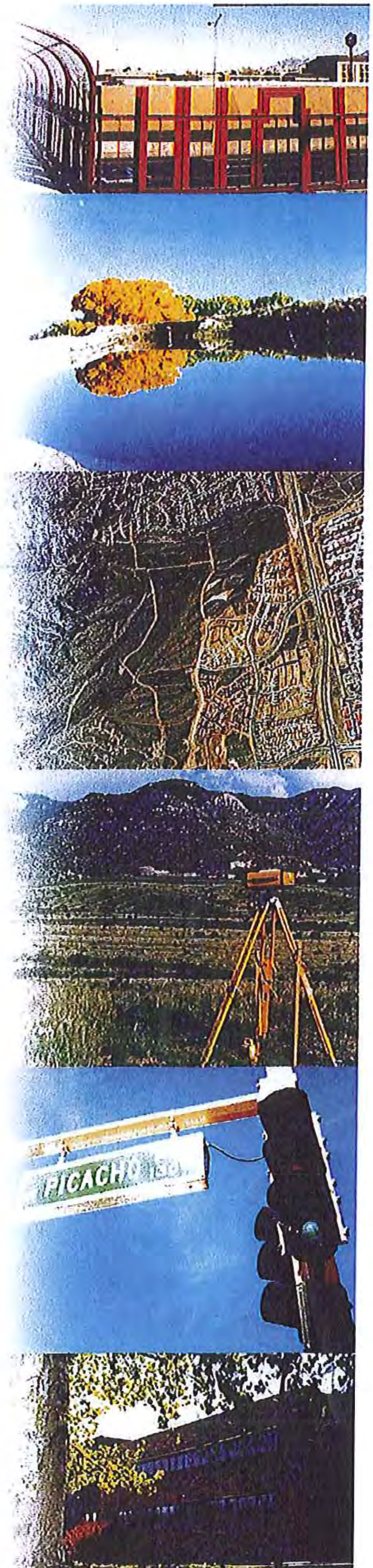
```
*S * * * UTILIZED TO ADJUST FOR THE UNSTABLE HYDROGRAPHS WITH A STEEP
SLOPE * * *
*S * * * AFTER MODIFICATION TO REDIRECT THE FIRST FLUSH OF 0.25" RUNOFF
FOR SWQ *
* LH
********************************************************************** * *
*
* LH FILE MODIFIED BY LH/ASCG TO REFLECT FULL DEVELOPMENT WITHIN THE BLACK
      *
* LH ARROYO WATERSHED USING THE SSCAFCA LAND TREATMENTS FOR LOTS AND
      *
* LH ZONING DEVELOPED FOR THE MONTOYAS ARROYO STUDY.
      *
* LH THIS MODEL IS INTENDED TO PROVIDE A BIG PICTURE STUDY FOR THE BLACK
      *
* LH ARROYO AND SHOULD NOT BE USED TO DEVELOP DETAILED SOLUTIONS.
      *
* LH THE FEMA RESTUDY MODEL HAS BEEN ADDED TO IVORY AND LISBON CROSSING
DESIGN*
* LH MODEL AND CHANGED TO DEVELOPED CONDITIONS.
      *
* LH                                                          *
* LH THE FOLLOWING THINGS WERE CHANGED IN THE MODEL:
      *
* LH                                                                *
* LH MODIFIED PRINT LINE COMMAND AND ROUTES CHANGED TO MANNINGS ROUTE FOR
      *
* LH ALL WELL DEFINED CHANNELS (ALSO CHANGED IN RESTUDY MODEL PORTION)
*
* LH MODIFIED SLOPE FOR ROUTING THRU BASIN 103 FROM 0.0179 TO 0.0214
FT/FT.     *
* LH SEE RUN CHRONOLOGY FOR OTHER CHANGES IN THE MODEL.
      *
*
LH**********************************************************************
* * *
*
*  ORIGINAL AHYMO MODEL DEVELOPED FOR:
*  FEMA RE-STUDY
*  SANDOVAL COUNTY, NEW MEXICO
*
*  RESTUDY AREA:  CITY OF RIO RANCHO
*  FLOODING SOURCE: BLACK ARROYO
*
************************************************************************
******
* LH   ALL SEDIMENT BULKING WAS MODIFIED TO USE THE SEDIMENT BULK COMMAND
AND
*  NOT THE DIVIDE HYD COMMANDS IN THE PREVIOUS FEMA RESTUDY MODELS.
*  SEE RUNCHRONOLOGY FOR AN EXPLANATION OF THE BULKING FACTORS.
*

*S  ROUTE FLOWS THROUGH Pond/Park in Unit 17
*S  Pond Based on final design grades with 7 ac-ft of
*S  low storage/WQ and then filling remainder of park/field
*S  graded at 2%
ROUTE RESERVOIR        ID=2  HYD NO=P.Out  INFLOW ID=1 CODE=4.2
```

OUTFLOW (CFS)	STORAGE (AF)	ELEV (FT)	
0.00	0.00	5263.00	Principal Spillway / Pond Bottom
0.06	0.25	5263.50	
0.46	0.51	5264.00	
1.48	0.83	5264.50	
3.31	1.15	5265.00	
6.04	1.50	5265.50	
9.66	1.85	5266.00	
14.01	2.22	5266.50	
18.71	2.59	5267.00	
23.07	2.99	5267.50	
25.83	3.39	5268.00	
24.31	3.81	5268.50	
235.80	4.23	5269.00	
254.70	4.68	5269.50	
272.28	5.13	5270.00	
288.80	5.60	5270.50	
304.42	6.08	5271.00	
319.28	6.58	5271.50	
333.47	7.09	5272.00	
347.09	7.62	5272.50	
360.19	8.16	5273.00	
372.84	8.72	5273.50	
385.06	9.29	5274.00	
396.91	10.08	5274.50	TOP OF 9.5 FT CMP PRINCIPAL SPILLWAY PIPE
408.42	10.87	5275.00	
419.61	12.09	5275.50	
430.51	13.31	5276.00	
441.14	14.84	5276.50	
451.53	16.36	5277.00	
461.67	18.00	5277.50	
471.60	19.63	5278.00	
481.33	21.33	5278.50	
490.86	23.02	5279.00	
500.21	24.72	5279.50	
509.39	26.41	5280.00	Top Of Pond - Emergency Spillway

```
*
PRINT HYD          ID=2  CODE=1
*
*
*S *************DIVIDE HYD TO UNBULK BY 3% *********************
DIVIDE HYD            ID=2    %=-97   ID I=2   HYD=P.Out.3
                                ID II=51 HYD=SEDIMENT
*
*
*S  Route unbulked pond outflow at 17 to east end of 15
*S  through a 60" pipe
```

Q:\SEC---PROJECTS\2012 Projects\112136 SSCAFCA - I, Black Arroyo\ENGINEERING\Calcs\Hydrology\Pond Routing Spreadsheets\CABEZON TRACT 17 DETETION POND.docx

GATEWAY POND DRAINAGE ANALYSIS REPORT



NOVEMBER 4, 2010

Prepared for:

SSCAFCA
1041 Commercial Dr. S.E.
Rio Rancho, NM 87124

Bohannan Huston Inc.

ENGINEERING
SPATIAL DATA
ADVANCED TECHNOLOGIES

Gateway Dam Elevation-Storage-Discharge Table

Elevation (FT)	Storage (AC-FT, see note 1)	Existing Discharge (CFS, see note 2)
5263	0.000	0.000
5264	0.871	58.161
5265	1.976	88.423
5266	3.326	168.753
5267	5.343	244.421
5268	8.507	303.831
5269	11.987	340.404
5270	17.216	371.140
5271	21.619	399.865

Notes:

1) DTM created from proposed contours provided by Goodwin, 9/9/10
2) 3 Existing 57" x 38" CMP Pipes

TABLE SR 1 CORRECT

ELEVATION - STORAGE-DISCHARGE DATA
SUGAR RIDGE SUBDIVISION DETENTION POND

(Elevations, contours, principal and emergency spillway measurements are based on the "as-built" condition as surveyed by Smith Engineering Company, October 2009)

Contour Elevation	Contour Area	Incremental Volume	Incremental Volume	Cumulative Volume	Principal Spillway - Orifice Flow Discharge Curve	Emergency Spillway Discharge	Total Discharge	Comments
	Principal Spillway Orifice Diameter (inches)				36			See Figure For sketch of
	Number of Orifices				1			pond principal and emergency
(ft)	(sq ft)	(cu ft)	(ac-ft)	(ac-ft)	(cfs)	(cfs)	(cfs)	spillways
	0			0.0000	(a) (c)	(b)		
5560	175	0	0.0000	0.0000	0.00	0.0	0.00	The storage volume below the vertical 5 ft. dia. principal spillway crest elevation 5564.42 is dead storage . The 3 ft. dia. CMP horizontal pipe is joined to the 5 ft. dia. vertical pipe. The 3 ft. dia. pipe invert elevation = 5561.13
5561	2633	1404	0.0322	0.0322	0.01	0.0	0.01	
5561.13	2919	361	0.0083	0.0405	0.02	0.0	0.02	
5562	4830	3371	0.0774	0.1179	0.03	0.0	0.03	
5563	6570	5700	0.1309	0.2488	0.04	0.0	0.04	
5564	7958	7264	0.1668	0.4155	0.05	0.0	0.05	
5564.42	8564	3470	0.0797	**0.4952**	0.06	0.0	0.06	After water overtops the 5 ft. dia CMP, the 3 ft. dia. CMP outfall pipe joined to 5 ft. CMP will control the discharge. Crest elev. Of emergency spillway is 5567.26
5565	9401	5210	0.1196	0.6148	7.5	0.0	7.5	
5566	10933	10167	0.2334	0.8482	30.1	0.0	30.1	
5567	12980	11957	0.2745	1.1227	55.9	0.0	55.9	
5567.26	13643	3461	0.0795	1.2021	83.0	0.0	83.0	
5568	15529	10794	0.2478	1.4499	87.9	72.6	160.4	
5569	17102	16316	0.3746	1.8244	94.0	261.7	355.7	
5570	18551	17827	0.4092	2.2337	99.8	517.0	616.9	
5571	19977	19264	0.4422	2.6759	105.3	824.5	929.9	
	Total Volume (ft^3) =	116563						
	Total Volume (ac-ft) =	2.6759						

Principal Spillway
Emergency – Spillway
Top – of Pond

TABLE SR 1

(a) Orfice flows were obtained from the use of Equation 4-10 and Table 4-3 from "Handbook of Hydraulics, Sixth Edition, by Brater and King" 1982."

Q = Ca (2gh)^1.5 C=0.591, g=32.2 ft/sec^2, a=area (sq ft) h=head (ft)

Principal Spillway Elevation is 5561.13

(b) Emergency Spillway flows were computed friom the use of equation 5-10 and Table 5-3 from "Handbook of Hydraulics" Sixth Edition, by Brater and King" 1982, and the following data

Q = CLH^ 1.5 C = discharge coeffient, L = spillway length perp. To flow, H = head (ft)

C = 3 L = 38.0000 Spillway Elev. 5567.26

(c) 36-inch CMP principal spillway pipe water areas when the pipe is not full (for orifice equation)

elev.	water depth	flow area	
	ft	sq ft	See Note regarding shaded area
5561.13	0.00	0.00	
5562.00	0.87	1.69	
5563.00	1.87	4.64	
5564.00	2.87	6.96	3 ft depth full pipe area = 7.07 sq ft

Note - the principal spillway flows in the shaded area were computed in TABLE SR 2 which computes the discharge as if the 36-inch cmp has head on it from the invert elev.. However, the 36-inch cmp will not take in water until the water depth exceeds the top of the 5 ft. dia. cmp vertical pipe elevation of 5564.42. As water overtops the crest elevation of the 5 ft. dia. cmp, the head on the invert of the 36-inch cmp will increase gradually until the water depth submerges the 5 ft. dia. cmp. Therefore the values from TABLE SR2 were inserted in the shaded area. At elevations greater than the crest of the 5 ft. dia. and greater, assume the full head is available on the 36-inch cmp.

PROJECT CONTROL NUMBER: A300060

NOTES:
ELEVATIONS SHOWN ARE NAVD 88 BASED UPON STATIC G.P.S. OBSERVATION OF N.G.S. CONTROL POINT "SAGE", ELEVATION = 5676.17'.
THIS IS NOT A BOUNDARY SURVEY.

PURPOSE OF THIS POND AS-BUILT SURVEY WAS TO ASSIST IN DEVELOPMENT OF THE HYDROLOGIC MODEL FOR THE TRIBUTARY ARROYO FOR WHICH THE LOMR APPLIES BEGINNING DOWNSTREAM OF BALI ROAD

CERTIFICATION

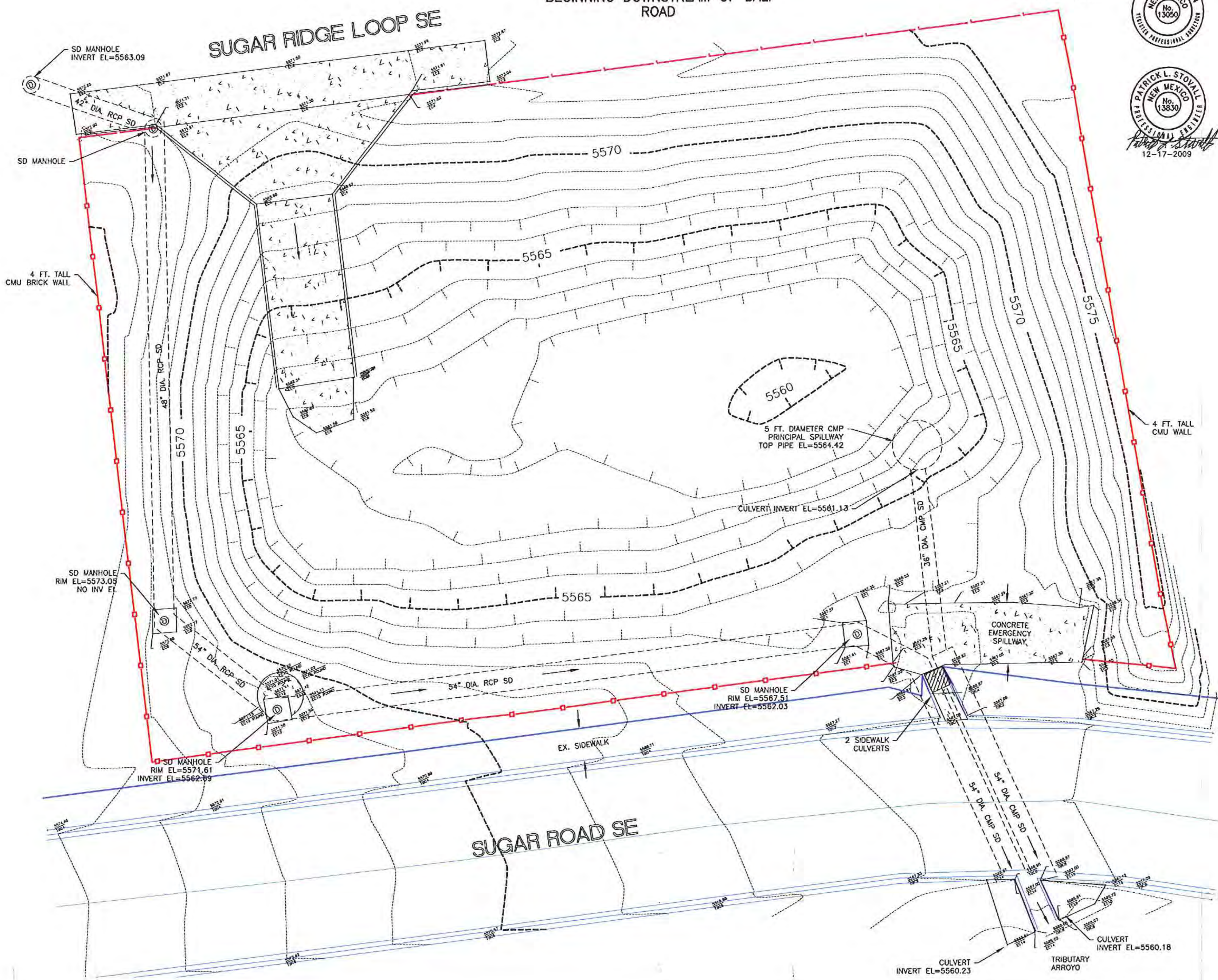
I W. DANIEL BOIVIN, NMPS NO. 13050, CERTIFY THAT THE TOPOGRAPHIC MAP WAS DEVELOPED BY ME OR UNDER MY DIRECT SUPERVISION AND IS CORRECT TO THE BEST OF MY KNOWLEDGE.

W. DANIEL BOIVIN P.S. NO. 13050 DATE:
2201 SAN PEDRO DR. NE
BUILDING 4, SUITE 200
ALBUQUERQUE, NM 87110
DATE OF SURVEY: 10/07/2009

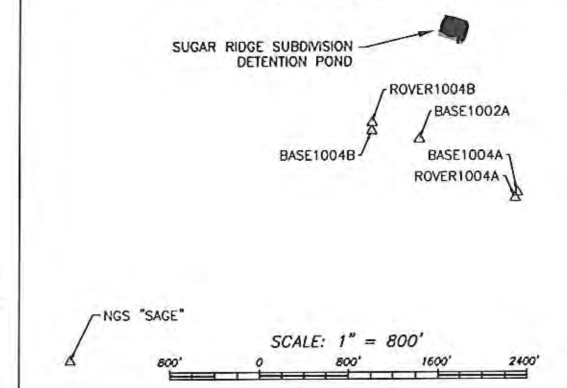
W. DANIEL BOIVIN NEW MEXICO No. 13050 REGISTERED PROFESSIONAL SURVEYOR

PATRICK L. STOVALL NEW MEXICO No. 13830 PROFESSIONAL ENGINEER

12-17-2009



BENCHMARKS



BENCHMARK COORDINATE TABLE

NAME	GROUND N (FT)	GROUND E (FT)	ELEV (FT)
NGS "SAGE"	1546139.353	1499776.710	5676.170
BASE1002A	1548107.370	1502899.131	5559.812
BASE1004B	1548182.352	1502473.570	5571.354
ROVER1004B	1548257.660	1502476.980	5574.178
BASE1004A	1547631.516	1547631.516	5533.270
ROVER1004A	1547583.462	1503758.284	5532.204

COORDINATES SHOWN ARE BASED UPON NEW MEXICO STATE PLANE COORDINATE SYSTEM, GRID ZONE CENTRAL, COMBINED SCALE FACTOR = 1.00034146.

LEGEND

- CURB AND GUTTER
- CENTERLINE OF ROAD
- SIDEWALK
- FENCE
- MAJOR CONTOUR
- MINOR CONTOUR
- EDGE OF CONCRETE
- CHAINLINK FENCE
- BLOCK FENCE
- STORM SEWER MANHOLE
- CONCRETE

SCALE: 1" = 10'
10' 0 10' 20' 30'

DECEMBER-2009

Smith Engineering Company

NO.	DESCRIPTION	DATE	BY
6			
5			
4			
3			
2			
1			

REVISIONS (OR CHANGE NOTICES)

LETTER OF MAP REVISION
FOR
SUGAR CHANNEL
RIO RANCHO, NEW MEXICO

CITY OF RIO RANCHO

SUGAR RIDGE SUBDIVISION
DETENTION POND
AS BUILT SURVEY
BY SMITH ENGINEERING COMPANY

FIGURE 4

SHEET NO. B-12

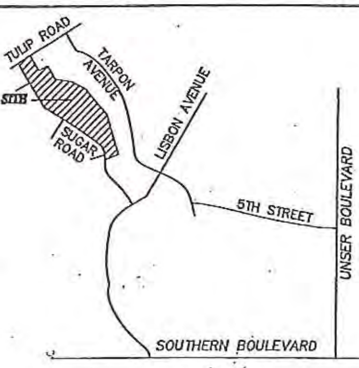
Q:\SEC--PROJECTS\...PROJECTS\109119 CORR SUGAR CHAN LOMR REVISION\LOMR APPLICATIONS\MAP POCKET\CD\APP. F2.1 CAD FIGURE 4\FIGURE 4.DWG

SUGAR RIDGE SUBDIVISION

CITY OF RIO RANCHO, SANDOVAL COUNTY, NEW MEXICO

IMPROVEMENTS FOR

GRADING, DRAINAGE, PAVING, AND UTILITIES



VICINITY MAP

INDEX TO DRAWINGS

APPROVED FOR CONSTRUCTION

DEPARTMENT OF PUBLIC SAFETY	DATE 11-13-02
CITY ENGINEER	DATE 12/9/02
WATER AND WASTEWATER DEPT.	DATE 11-12-02

COVER SHEET AND INDEX TO DRAWINGS

SUGAR RIDGE SUBDIVISION
SANDOVAL COUNTY, NEW MEXICO

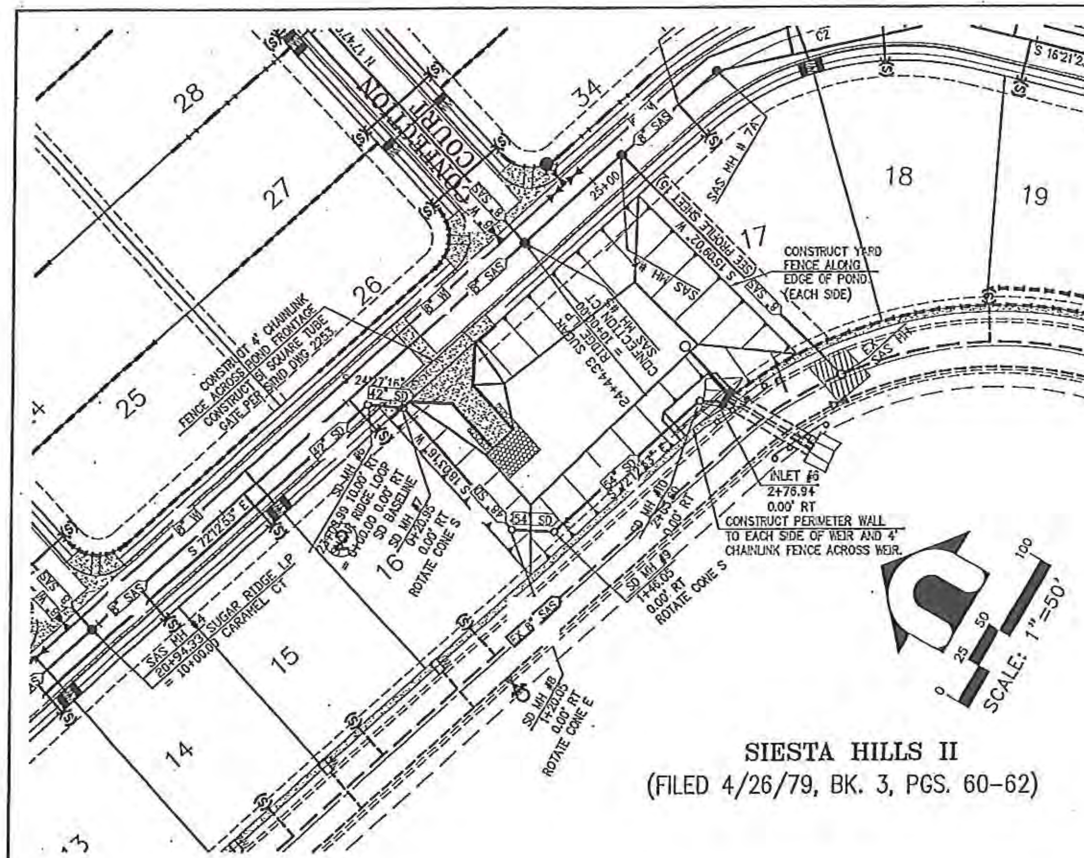
Sugar Ridge Hanging File Set

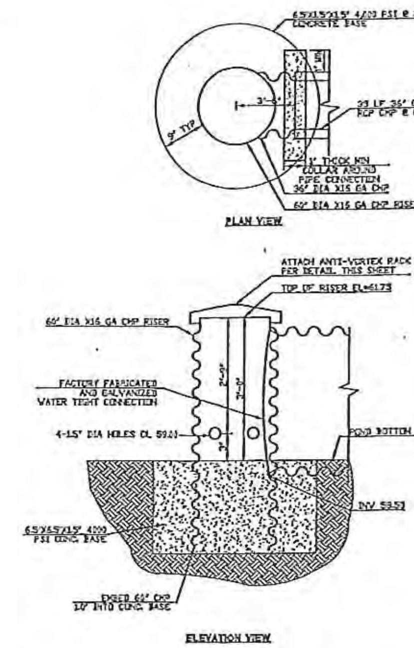
BEAM DESIGNS — BUILDING ENGINEERING AND MUNICIPAL DESIGNS

PROJECT NUMBER: AMRP0002

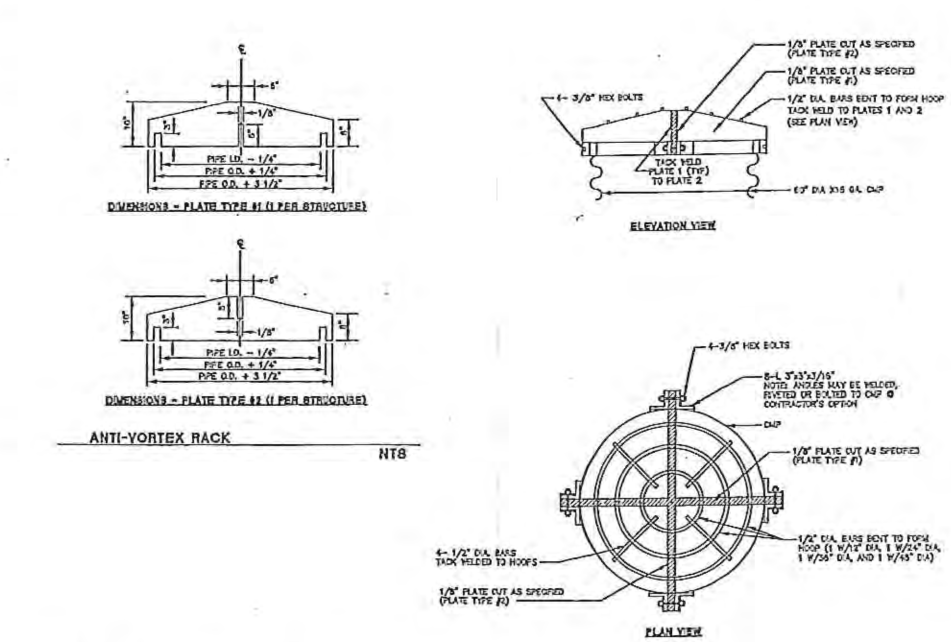
SHEET NO. 1 OF 22

H-File_145



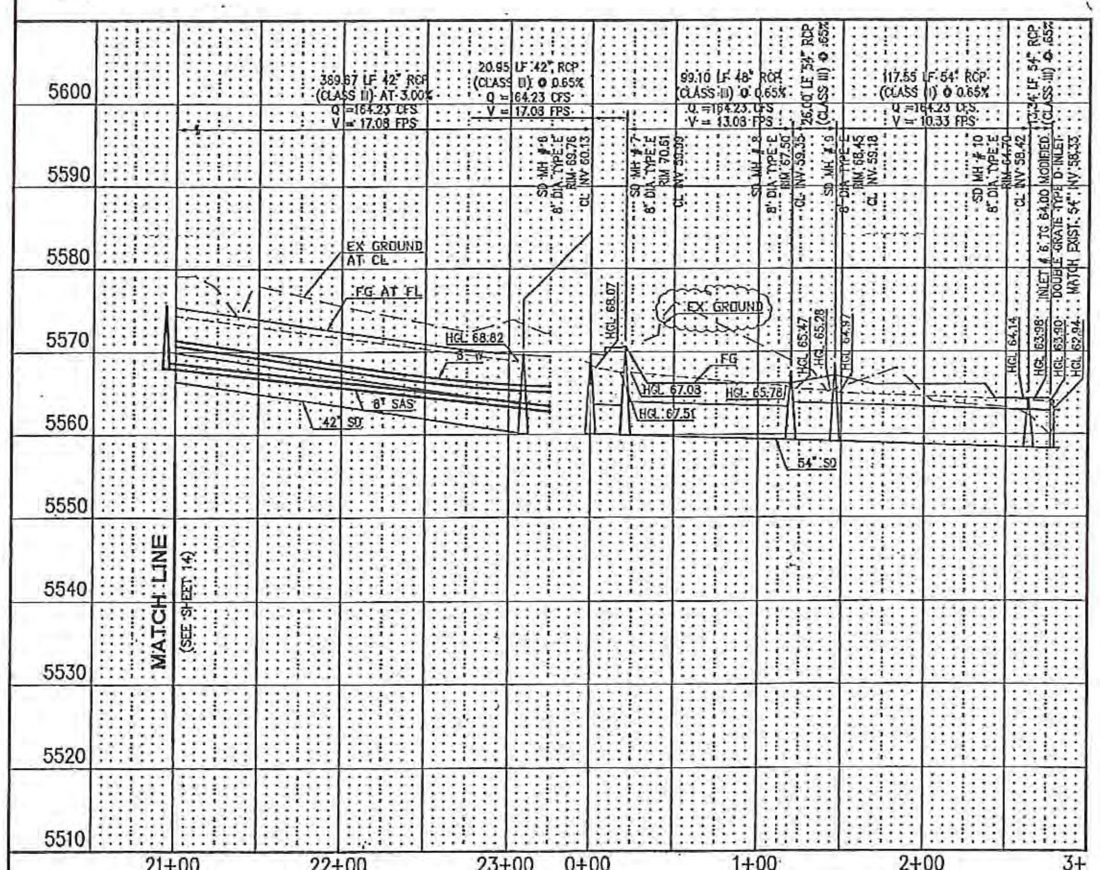


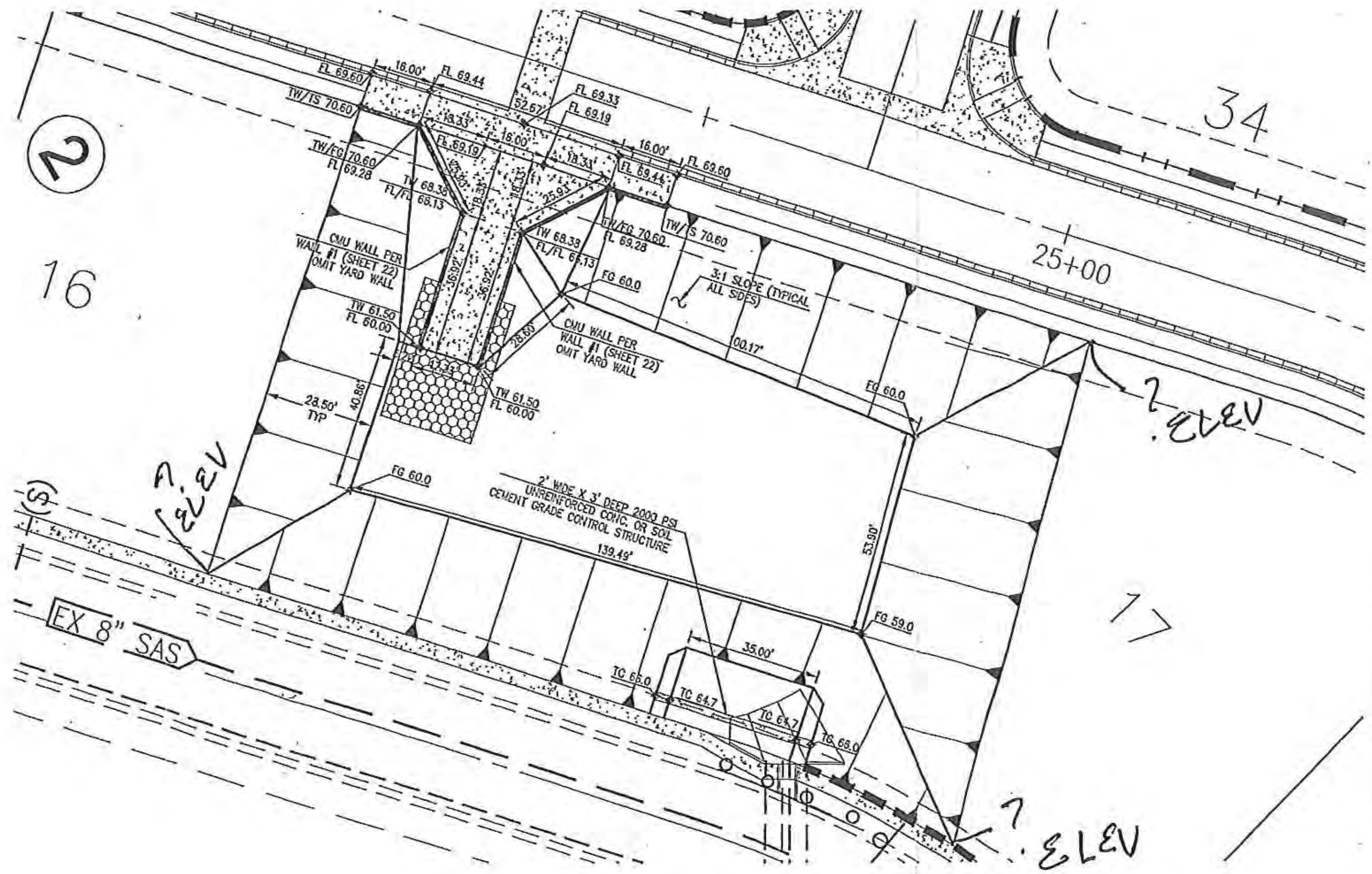
RISER PIPE DETAIL
NTS



POND OUTLET STRUCTURE
NTS

SUGAR RIDGE LOOP/STORM DRAIN BASELINE



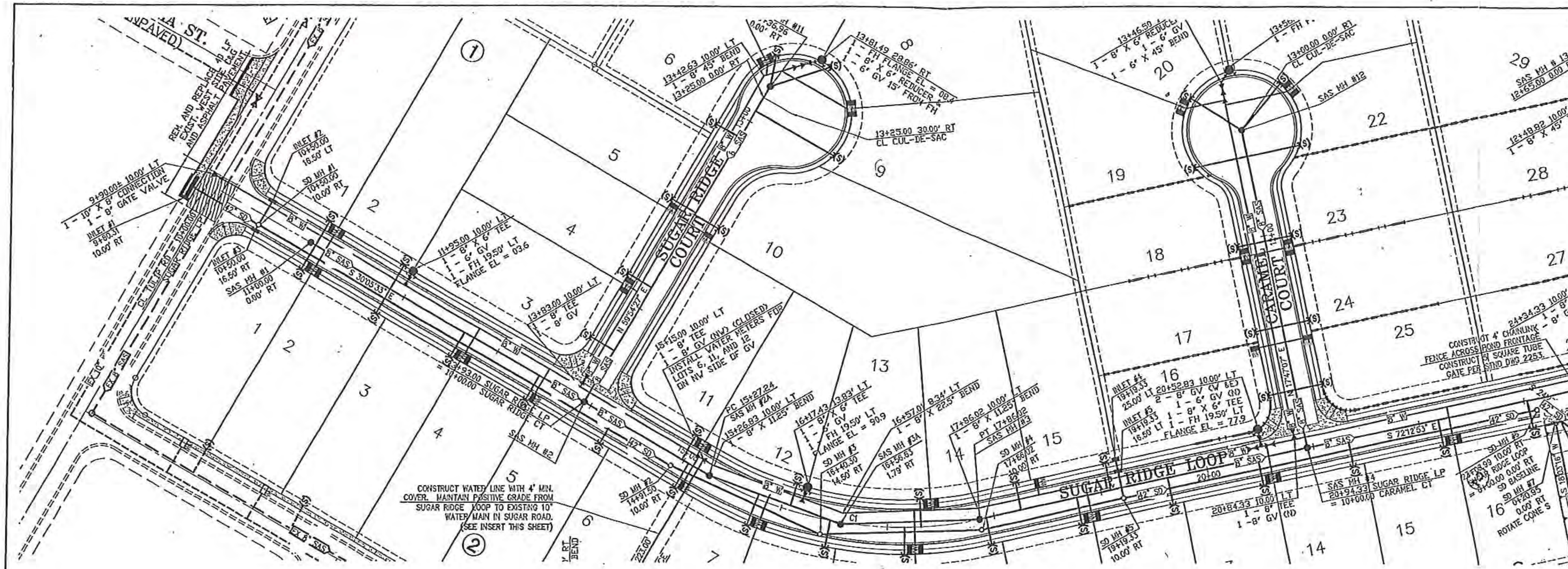


DETENTION BASIN PLAN VIEW
(SEE SHEET 7 FOR CROSS SECTION & SHEET 6 FOR ELEVATIONS)
SCALE: 1" 20'

GRADING AND DRAINAGE DETAILS
SUGAR RIDGE SUBDIVISION
SANDOVAL COUNTY, NEW MEXICO

BEAM DESIGNS
BUILDING ENGINEERING AND MUNICIPAL DESIGNS
855 POLARIS BLVD. SE
RIO RANCHO, NM 87124

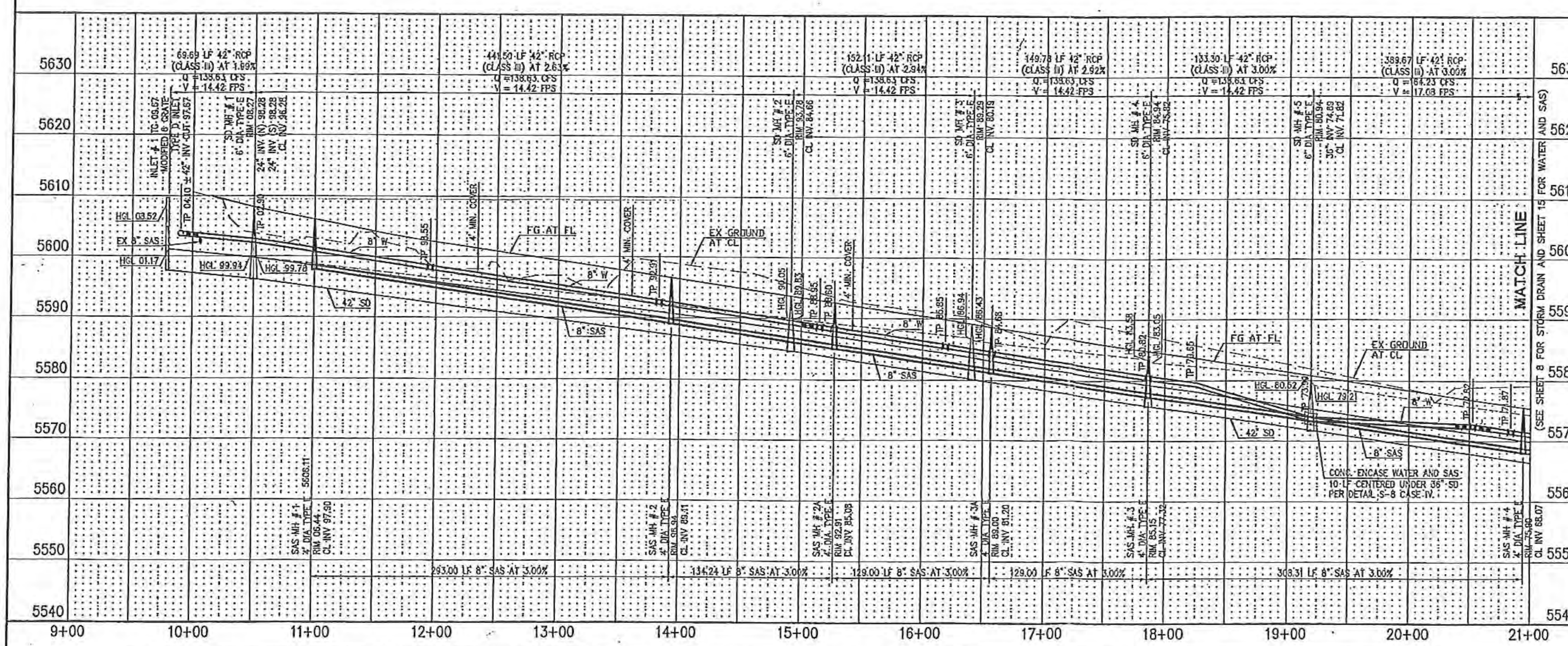
PROJECT NUMBER:
AMRP0002
SHEET NO.
8
OF 22

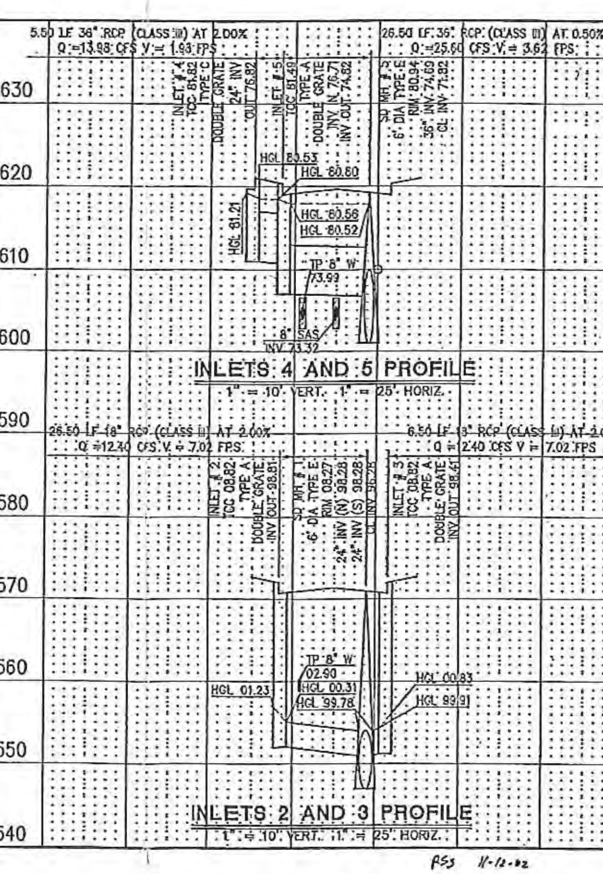


CENTERLINE CURVE DATA					
CURVE	ARC (FT)	DELTA	RADIUS (FT)	CH. LENGTH (FT)	CH. BRNG
C1	258.78	42°07'20"	352.00	252.99	S 51°09'13" E

SUGAR RIDGE LOOP

WATER LINE CONNECTION TO SUGAR ROAD





SUGAR RIDGE LOOP UTILITY PLAN AND PROFILE

SUGAR RIDGE SUBDIVISION
SANDOVAL COUNTY, NEW MEXICO

BEAM DESIGNS
BUILDING ENGINEERING AND MUNICIPAL DESIGNS
855 POLARIS BLVD. SE
RIO RANCHO, NM 87124
PHONE (505) 896-0301
FAX (505) 994-3052
beamdesigns@qwest.net

PROJECT NUMBER: AMRP0002

SHEET NO. 14 OF 22

(SEE PLANS FOR ITEMS WITHIN THIS PROJECT)

LEGEND

- SURVEY MONUMENT
- FOUND MONUMENT AS NOTED
- EXISTING GAS LINE MARKER
- EXISTING WATER VALVE
- EXISTING JUNIPER BUSH/TREE
- OR — EXISTING HYDRANT
- TV — EXISTING CATV PEDESTAL
- T — EXISTING TELEPHONE PEDESTAL
- 10"G — EXISTING GAS
- 10"W — LINE EXISTING WATER LINE
- EXISTING ELECTRICAL TRANSFORMER
- EXISTING SURVEY MONUMENT
- EXSITING TELEPHONE PEDESTAL
- EXSITING WATER METER
- EXISTING MAIL BOX
- EXISTING EXISTING TV CABLE PEDESTAL
- 5640 — DESIGN MAJOR CONTOUR
- DESIGN MINOR CONTOUR
- 5640 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- RIGHT OF WAY LINE
- EASEMENT LINE
- LOT LINE
- FENCE LINE
- GRADE/SLOPE
- NATURAL GROUND
- COMPACTED SUBGRADE
- RIPRAP / COBBLES / STONE
- CONCRETE
- SELECT SOIL MATERIAL
- SOIL CEMENT
- GRADED DIRT PATH W/ DRAINAGE SWALE
- GRADED DIRT PATH
- SANDSTONE FINISH
- AGGREGATE BASE COURSE PATH
- EXISTING PAVEMENT
- REMOVE AND REPLACE

ABBREVIATIONS

BOW	BOTTOM OF WALL
℄ or CL	CENTERLINE
COA	CITY OF ALBUQUERQUE
CORR	CITY OF RIO RANCHO
CONST	CONSTRUCTION
CMP	CORRUGATED METAL PIPE
DIA	DIAMETER
DIP	DUCTILE IRON PIPE
E	EASTING
EL/ELEV	ELEVATION
EX	EXISTING
FL	FLOW LINE
HORIZ	HORIZONTAL
HP	HIGH POINT
INV	INVERT
L	LENGTH
LP	LOW POINT
LT	LEFT
NAVD	NORTH AMERICA VERTICAL DATUM
N	NORTHING
OC	ON CENTER
ℙ	PROPERTY LINE
PVC	POINT OF VERTICAL CURVATURE
PVI	POINT OF VERTICAL INTERSECTION
PVT	POINT OF VERTICAL TANGENCY
R	RADIUS
RCP	REINFORCED CONCRETE PIPE
ROW	RIGHT OF WAY
RT	RIGHT
SD	STORM DRAIN
ST	STREET
STA	STATION
SW	SIDEWALK
SWPPP	STORM WATER POLLUTION PREVENTION PLAN
SWP3	STORM WATER POLLUTION PREVENTION PLAN
T	TANGENT
TBM	TEMPORARY BENCH MARK
TOC	TOP OF CURB
TOW	TOP OF WALL
TYP	TYPICAL
SSCAFCA	SOUTHERN SANDOVAL COUNTY ARROYO FLOOD CONTROL AUTHORITY
VERT	VERTICAL
VC	VERTICAL CURVE

SYMBOLS

SECTION NUMBER — 1

SHEET NUMBER WHERE SECTION TAKEN — B5

SHEET NUMBER WHERE SECTION IS DRAWN — B9

SUNSET POND PROPERTIES:

CREST WIDTH : RETAINING WALL - 1' - 4"
SLOPE UPSTREAM FACE: 17% (6:1)
SLOPE DOWNSTREAM FACE : VERTICAL @ 3' RETAINING WALL - 3% TO 5% DOWNSTREAM
ELEVATION AT EMERGENCY SPILLWAY CREST: 5620
ELEVATION OF PRINCIPAL OUTLET (FINISH GRADE OF POND) : 5608
WIDTH OF EMERGENCY SPILLWAY CREST: 380'
DISCHARGE CAPACITY OF EMERGENCY SPILLWAY : 2330 CFS
OUTLET CONDUIT SIZE AND TYPE: 24" DIP
OUTLET CONDUIT CAPACITY (ORIFICE CONTROL): 39 CFS
EVACUATION TIME: 11 HOURS
STORAGE CAPACITY @ EMERGENCY SPILLWAY: ~~17.7 ACRE FEET~~ 15.8 AF (1)
STORAGE CAPACITY @ ELEVATION 5617 (DOWNSTREAM NATURAL GROUND): ~~10.9 AF~~ 8.98 AF (1)
STORAGE CAPACITY @ BETWEEN NATURAL GROUND AND SPILLWAY: ~~7.4 AF~~ 6.9AF (1)
100 YEAR DRAINAGE AREA: 190 ACRES
100 YEAR 24 HOUR DESIGN RAINFALL: 2.6"
100 YEAR PEAK INFLOW TO POND: ~~479 CFS~~ 454 CFS (1)
100YEAR DETAINED VOLUME: ~~11.8 AC. FT.~~ 10.9 AF (1) (2)
100 YEAR WATER SURFACE ELEVATION:5618 (3)
100 YEAR PEAK OUTFLOW: 36 CFS (4)
100 YEAR FREEBOARD: 2'

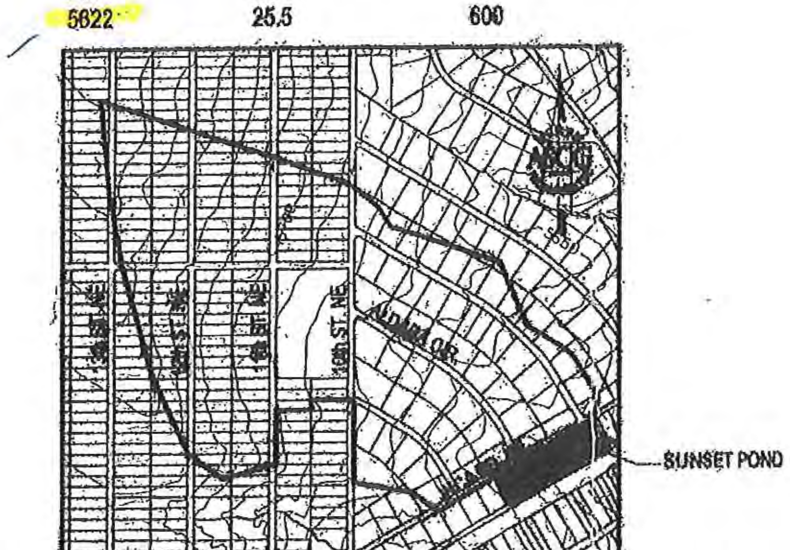
NOTE: THE SUNSET POND IS NOT A STATE ENGINEER PERMITTED FACILITY.

(1) RECORD DRAWING
Date: February, 2009
These drawings have been revised to reflect the best information available. Do not use without field verification.

(2) Note: Design 100yr detained volume was 11.08 ac. ft.
(3) Note: Design 100yr WSEL was 5617.3.
(4) Note: Design 100yr Peak Outflow was 35 cfs.

SUNSET POND RATING DATA

ELEVATION	STORAGE (AF)	OUTFLOW (cfs)
5606 (Pond Invert)	0	0
5608	~~0.14~~ 0.01	15
5610	~~1.18~~ 0.37	20.5
5612	~~2.08~~ 1.72 (1)	25
5614	~~4.79~~ 4.11 (1)	29
5616	~~8.32~~ 7.16	33
5618	~~12.7~~ 11.01	36
5620 (Emergency Spillway)	~~17.7~~ 15.82	39
5621	20.5	200
5622 (Top of Pond)	25.5	600



SUNSET POND DRAINAGE AREA MAP
SCALE: NONE

THIS SHEET HAS BEEN REDRAWN FOR RECORD PURPOSES. SEE ORIGINAL DRAWING FOR ENGINEER'S SIGNATURE AND SEAL.

THIS SHEET HAS BEEN REDRAWN FOR RECORD PURPOSES. SEE ORIGINAL DRAWING FOR ENGINEER'S SIGNATURE AND SEAL.

ASCG INCORPORATED

SOUTHERN SANDOVAL COUNTY ARROYO FLOOD CONTROL AUTHORITY

SUNSET POND AND STORM DRAIN
LEGEND, ABBREVIATIONS AND DRAINAGE DATA

REVISIONS
NUMBER | DATE

JOB NO: 277207
DATE: JAN., 2008
DRAWN BY: RRS
CHECKED BY: CD
DRAWING NO: G2

DEVELOPED

CONDITIONS

AHYMO

INPUT

DATA

WEXFORD DETENTION POND

FROM

ASCG

BLACK

ARROYO

WATERSHED

MANAGEMENT

PLAN

ASCG

Final

August ,

2002

DEVELOPED CONDITIONS AHYMO INPUT DATA FILE PRINTOUT

FUTURE COND. AHYMO

WEXFORD POND

BL10D35B

```
START                  0.0 HRS  PUNCH CODE=0  PRINT LINES=-1
 *
 *       -------HYDROLOGY MODEL-----------
 *S * * * FUTURE CONDITIONS MODEL - ALTERNATE B  * * * * * * * * * * * * * * * * *
 *S * * * 3 DAMS ON THE WEST BRANCH                               * * * * * * * * *
 *S * * * UNSER GATEWAY DAM, AND WATER QUALITY DIVERSIONS         * * * * * * * * *
 *S * * * ROUTING WITH MCUNGE METHOD AFTER WATER QUALITY DIVERSIONS ARE  * * * * *
 *S * * * UTILIZED TO ADJUST FOR THE UNSTABLE HYDROGRAPHS WITH A STEEP SLOPE * * *
 *S * * * AFTER MODIFICATION TO REDIRECT THE FIRST FLUSH OF 0.25" RUNOFF FOR SWQ *
 * LH ******************************************************************** * * *
 * LH FILE MODIFIED BY LH/ASCG TO REFLECT FULL DEVELOPMENT WITHIN THE BLACK      *
 * LH ARROYO WATERSHED USING THE SSCAFCA LAND TREATMENTS FOR LOTS AND            *
 * LH ZONING DEVELOPED FOR THE MONTOYAS ARROYO STUDY.                            *
 * LH THIS MODEL IS INTENDED TO PROVIDE A BIG PICTURE STUDY FOR THE BLACK        *
 * LH ARROYO AND SHOULD NOT BE USED TO DEVELOP DETAILED SOLUTIONS.               *
 * LH THE FEMA RESTUDY MODEL HAS BEEN ADDED TO IVORY AND LISBON CROSSING DESIGN  *
 * LH MODEL AND CHANGED TO DEVELOPED CONDITIONS.                                 *
 * LH                                                                            *
 * LH THE FOLLOWING THINGS WERE CHANGED IN THE MODEL:                            *
 * LH                                                                            *
 * LH MODIFIED PRINT LINE COMMAND AND ROUTES CHANGED TO MANNINGS ROUTE FOR       *
 * LH ALL WELL DEFINED CHANNELS (ALSO CHANGED IN RESTUDY MODEL PORTION)          *
 * LH MODIFIED SLOPE FOR ROUTING THRU BASIN 103 FROM 0.0179 TO 0.0214 FT/FT.     *
 * LH SEE RUN CHRONOLOGY FOR OTHER CHANGES IN THE MODEL.                         *
 * LH********************************************************************** * * *
 *  ORIGINAL AHYMO MODEL DEVELOPED FOR:
 *  FEMA RE-STUDY
 *  SANDOVAL COUNTY, NEW MEXICO
 *
 *  RESTUDY AREA:  CITY OF RIO RANCHO
 *  FLOODING SOURCE: BLACK ARROYO
 *
********************************************************************************
 * LH  ALL SEDIMENT BULKING WAS MODIFIED TO USE THE SEDIMENT BULK COMMAND AND
 *  NOT THE DIVIDE HYD COMMANDS IN THE PREVIOUS FEMA RESTUDY MODELS.
 *  SEE RUNCHRONOLOGY FOR AN EXPLANATION OF THE BULKING FACTORS.
 *
 *
RAINFALL              TYPE=2  RAIN QUARTER=0.0  RAIN ONE=1.799
                      RAIN SIX=2.205      RAIN DAY=2.703      DT=.05
 *
*S******************************************************************************
*S  BEGINNING OF THE BLACK ARROYO WEST BRANCH
*S******************************************************************************
*S  LISBON CHANNEL NORTH OF TULIP
*S * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* BULK FOR SEDIMENT
SEDIMENT BULK           CODE=1  BULK FACTOR=1.18
*
COMPUTE LT TP           LCODE=1    NK=4    ISLOPE=0
                        L=400    S=0.025          K=1
                        L=1300   S=0.014          K=2
                        L=1100   S=0.029          K=3
                        L=2200   S=0.023          K=4
                        KN=0.0   CD=0.0   Qp=420 cfs
*
COMPUTE NM HYD        ID=1     HYD=101       DA=0.3397    SQ MI
                      PER A=17      B=16      C=17     D=50
                      TP=0.0 HRS           RAIN=-1
*
PRINT HYD             ID=1     CODE=1
*
*C   ROUTE HYD.   101   TO  101.90
*
COMPUTE RATING CURVE CID=1   VS NO=1   NSEGS=3
                     ELMIN=0  ELMAX=6.3  CH SLP=.015 ft/ft  FP SLP=.015ft/ft
                     N=.045 DIST=15 N=-0.013 DIST=49  N=.045 DIST=64
                        DIST      ELEV
                        0         6.3
                        15        6.0
                        27        0.0
                        37        0.0
                        49        6.0
                        64        6.3
```

CROSS-SECTION

3 OF 3

PAT M. ELIM. POND WEX. / BASIN 400


```
 COMPUTE RATING CURVE CID=1  VALLEY SECTION=1  NUMBER OF SEGMENTS=3
                     MINIMUM ELEV=0.0 FT  MAXIMUM ELEV=1.5 FT
                     CHANNEL SLOPE=0.0043  FLOOD PLAIN SLOPE=0.0043
                     N=0.030  DIST=16.7  N=-0.017  DIST=48.1 N=0.030 DIST=64
                     DIST  ELEV   DIST   ELE    DIST   ELEV   DIST   ELEV
                     0.0   1.5    8.0    .9     16.7   .7     16.9   0.0
                     18.9  0.1    32.0   0.4    45.1   0.1    47.9   0.0
                     48.1  0.7    56.0   0.9    64.0   1.5
 COMPUTE TRAVEL TIME ID=3  REACH NO=1  VALLEY SECTIONS=1
                     LENGTH=875 FT  SLOPE=0.0043
 ROUTE               ID=3 HYD NO=320.90 INFLOW ID=10 DT=0.0
 PRINT HYD           ID=3  CODE=1
 ** ADD THE ROUTED FLOW FROM BASIN 320 TO THE FLOW AT THE INTERSECTION OF
 ** WEXFORD AND ARCTURUS
 ADD HYD             ID=4  HYD=320.10  ID I=4   ID II=3
 PRINT HYD           ID=4  CODE=1
 ** COMPUTE HYDROGRAPH FOR BASIN 400 THE DETENTION POND SITE
 COMPUTE NM HYD      ID=2  HYD=400  DA==0.0041 SM
                     %A=0.0  %B=50.0  %C=50.0  %D=0.0  TP=0.13333
                     MASS RAINFALL=-1
 PRINT HYD           ID=2  CODE=1
 ** ADD THE FLOW IN WEXFORD AT THE INTERSECTION WITH ARCTURUS TO THE DETENTION
 ** POND TO BE LOCATED ON THE SOUTH SIDE OF WEXFORD
 ADD HYD             ID=4  HYD=400.1  ID I=4   ID II=2
 PRINT HYD           ID=4  CODE=1
 ** ROUTE THE FLOW THROUGH THE DETENTION  POND
 *S ********  AP 400.30 ***********INFLOW INTO WEXFORD POND*************************
 *S*****************************************************************************
 ROUTE RESERVOIR     ID=5 HYD NO=400.90  INFLOW ID=4  CODE=24
                     OUTFLOW(cfs)     STORAGE(ac ft)     ELEV(ft)
                           0               0.0             31.5
                          10.00            0.01            32
                          60.0             0.19            33
                          78.0             0.60            34
                          92.0             1.23            35
                         102.0             2.35            36
                         120.0             5.52            38
   FLOW OVER SPILLWAY NIC  135.0           9.19            40
                         142.0            11.25            41
                         145.0            12.50            41.5
 *S *******************  AP 400.OUT  (BEFORE DIVIDE) *****************************
 PRINT HYD           ID=5  CODE=1
 *
 *S *************DIVIDE HYD TO UNBULK TO 3% **********************
 DIVIDE HYD          ID=5   %=-97        ID I=1  HYD=UNBULK
                                         ID II=53 HYD=SEDIMENT
 *S DIVIDE INTO PIPE AND SPILLWAY FLOWS  AP 400.OUT PIPE AND SPILL **************
 DIVIDE HYD          ID=1  Q=135   ID  I=1  HYD NO=400.81 PIPE
                                   ID II=3  HYD NO=400.82 SPILL
 *
 ** ROUTE THE OUTFLOW FROM THE POND (400.81) THROUGH A 42" STORM DRAIN
 ** TO THE CHANNEL ADJACENT TO 20TH. OUTFALL TO CHANNEL BELOW  ZARAGOSA ST.
 COMPUTE RATING CURVE CID=1  VALLEY SECTION NO=1  CODE=-1  SLOPE=0.018
                     PIPE DIA=42  N=0.013
 COMPUTE TRAVEL TIME ID=6  REACH=1  NUMBER OF VALLEY SECTIONS=1
                     LENGTH=900 FT  SLOPE=0.018
 ROUTE               ID=6 HYD NO=400.9' INFLOW ID=1  DT=0.0
 PRINT HYD           ID=6 CODE=1
 * ROUTE THE FLOW OVER THE SPILLWAY (400.82) THROUGH THE STREET TILL IT DUMPS
 * INTO THE STORM DRAIN
 COMPUTE RATING CURVE CID=1  VALLEY SECTION=1  NUMBER OF SEGMENTS=3
                     MINIMUM ELEV=0.0 FT  MAXIMUM ELEV=1.5 FT
                     CHANNEL SLOPE=0.0330  FLOOD PLAIN SLOPE=0.0330
                     N=0.030  DIST=16.7  N=-0.017  DIST=48.1 N=0.030 DIST=64
                     DIST  ELEV   DIST   ELE    DIST   ELEV   DIST   ELEV
                     0.0   1.5    8.0    .9     16.7   .7     16.9   0.0
                     18.9  0.1    32.0   0.4    45.1   0.1    47.9   0.0
                     48.1  '0.7   56.0   0.9    64.0   1.5
 COMPUTE TRAVEL TIME ID=2  REACH NO=1  VALLEY SECTIONS=1
                     LENGTH=900 FT  SLOPE=0.0330
 ROUTE               ID=2 HYD NO=400.91 INFLOW ID=3 DT=0.0
 PRINT HYD           ID=2  CODE=1
 *
 ADD HYD             ID=6  HYD=400.20  ID I=2   ID II=6
```

320.90

Wexford Det. Pond

WEXFORD POND

NO channel NOW

ADDED PIPE FLOW ID=6 TO EM. SPILL. FLOW ID=2 NOW TOTAL ID=6

TABLE

Stone Bridge Det. Pond

ELEVATION-STORAGE-DISCHARGE DATA

grey box means must input data

Contour Elevation NAVD 1988	Depth	Contour Area	Incremental Volume	Incremental Volume	Cumulative Volume	Principal Spillway	Emergency Spillway Discharge	Total Discharge	Comment
		Principal Spillway Orifice Diameter (inches)				24			
		Number of Orifices				1			
(ft)	(ft)	(sq ft)	(cu ft)	(ac-ft)	(ac-ft)	(cfs)	(cfs)	(cfs)	
(d)						(a)	(b)		
5246.00	0	0	0	0.0000	0.0000	0.0	0.0	0.0	Pond bottom. 24" SD pipe invert from field observation
5248.00	2.0	53162	53162	1.2204	1.2204	21.1	0.0	21.1	
5250.00	4.0	76682	129844	2.9808	4.2012	29.9	0.0	29.9	Emergency spillway (f)
5252.00	6.0	76823	153505	3.5240	7.7252	36.6	916.4	953.0	(f) Length assumed along top of pond and elevations extended above emergency spillway to allow for rating curve to function if flow spills over top
		Total Volume (ft^3) =	336511						
		Total Volume (ac-ft) =	7.73						

(a) Orifice flows based on Equation 4-10 and Table 4 from Hydraulics 6th Edition, Brater King, 1976

$$Q = Ca\sqrt{2gh}$$ C = 0.591 g=32.2 ft/sec^2, a=area (sq ft) h=head (ft)

d = depth of water in the pipe in feet

$$a = \pi D^2 / 4$$ **(full area formula)**

(b) Emergency Spillway flows were computed based on the following data used in the weir equation

Q = CLH^ 1.5 C = discharge coeffient, L = spillway length perp. To flow in ft, H = head (ft)

C = 3 L = 216

(d) Data Source 2010 Lidar topography and Field Observation and Measurements by Smith Engineering Company

LISBON POND

DESIGN ANALYSIS REPORT

PREPARED FOR

Southern Sandoval County Arroyo Flood Control Authority

PREPARED BY

RESPEC, Inc.
5971 Jefferson St. NE,
Suite 101
Albuquerque, NM 87109

SSCAFCA Project number BL P0025-03

APRIL 2020

Project Number 03898

I, Edward Christian Naidu, do hereby certify that this report was duly prepared by me or under my direction and that I am a duly registered Professional Engineer under the laws of the State of New Mexico.

Edward Christian Naidu, P.E.
NMPE No. 22997

04/22/2020

LISBON POND (Proposed)

Elevation - Volume - Discharge Data and Computations

grey box means must input data

Contour Elevation NAVD 1988	Depth	Contour Area	Incremental Volume	Incremental Volume	Cumulative Volume	(A) 1st Row of Reverse Incline Ports Discharge	(A) 2nd Row of Reverse Incline Ports Discharge	3rd Row of Reverse Incline Ports Discharge	4th Row of Reverse Incline Ports Discharge	(A) Principal Spillway Grate Discharge	Principal Spillway Outfall Pipe Discharge	Total Principal Spillway / Outfall Pipe Discharge	Emergency Spillway Discharge	Total Discharge Rating Curve	Comment
		Principal Spillway Orifice Diameter (inches)				7.8	6	6	6		30				
		Number of Orifices				4	4	4	4		1				
(ft)		(sq ft)	(cu ft)	(ac-ft)	(ac-ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
(d)						(a)	(a)	(a)	(a)	(b)	(a)	(e)	(b)		
5595.50	0	504.00	0	0.0000	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Pond bottom, principal spillway structure invert and Invert 1st row of reverse ports
5596.00	0.5	16642.60	4287	0.0984	0.10	4.4	0.0	0.0	0.0	0.0	2.3	2.3	0.0	2.3	
5596.40	0.9	23987.07	8126	0.1865	0.28	6.0	0.0	0.0	0.0	0.0	7.1	6.0	0.0	6.0	Invert of 2nd row of reverse incline ports
5597.00	1.5	35003.77	17697	0.4063	0.69	7.7	2.9	0.0	0.0	0.0	17.8	10.6	0.0	10.6	
5597.80	2.3	50407.24	34164	0.7843	1.48	9.5	4.4	0.0	0.0	0.0	33.9	13.9	0.0	13.9	Invert of 3rd row of reverse incline ports
5598.00	2.5	54258.11	10467	0.2403	1.72	9.9	4.7	1.7	0.0	0.0	36.7	16.3	0.0	16.3	
5599.00	3.5	74510.99	64385	1.4781	3.19	11.8	6.0	4.1	0.0	0.0	43.5	21.8	0.0	21.8	
5599.10	3.6	76740.17	7563	0.1736	3.37	11.9	6.1	4.2	0.0	0.0	44.1	22.3	0.0	22.3	Invert of 4th row of reverse incline ports
5600.00	4.5	96802.74	78094	1.7928	5.16	13.3	7.1	5.5	3.5	0.0	49.3	29.4	0.0	29.4	
5601.00	5.5	120821.72	108812	2.4980	7.66	14.7	8.0	6.7	5.1	0.0	54.5	34.5	0.0	34.5	
5602.00	6.5	145734.80	133278	3.0596	10.72	16.0	8.8	7.6	6.3	0.0	59.3	38.8	0.0	38.8	Top of principal spillway grate
5603.00	7.5	171801.22	158768	3.6448	14.36	17.2	9.6	8.5	7.3	72.0	63.6	63.6	0.0	63.6	
5604.00	8.5	199748.08	185775	4.2648	18.63	18.3	10.3	9.3	8.2	203.6	67.8	67.8	0.0	67.8	
5605.00	9.5	228924.69	214336	4.9205	23.55	19.4	10.9	10.0	9.0	374.1	71.6	71.6	0.0	71.6	
5606.00	10.5	257929.73	243427	5.5883	29.14	20.4	11.5	10.6	9.8	576.0	75.3	75.3	0.0	75.3	Emergency spill. Elev. = lowest top of embankment (f)
5607.00	11.5	273105.92	265518	6.0955	35.23	21.3	12.1	11.3	10.5	805.0	78.8	78.8	104.0	182.8	
5608.00	12.5	281839.27	277473	6.3699	41.60	22.2	12.7	11.9	11.1	1058.2	82.2	82.2	294.2	376.3	

Office equation and coefficient were obtained from Equation 4-10 and Table 4-3 from "Handbook of Hydraulics" Sixth Edition, by Brater & King, 1976.

$$Q = Ca\sqrt{2gh}$$

C = 0.590 g=32.2 ft/sec^2, a=area (sq ft) h=head (ft)

$$a = \pi D^2/4$$

(full area formula)

$$a = \frac{1}{2}r^2\left\{\left[2\cos^{-1}\left(\frac{r-d}{r}\right)\right]\frac{\pi}{180} - \sin\left[\left[2\cos^{-1}\left(\frac{r-d}{r}\right)\right]\frac{\pi}{180}\right]\right\}$$

(partial area formula)

Principal Spill. Pipe radius r in feet = 1.25

d = depth of water in the pipe in feet

Emergency Spillway flows were computed based on the following data used in the weir equation

Q = CLH^ 1.5 C = discharge coeffient, L = spillway length perp. to flow (ft), H = head (ft)

Emergergency Spillway C =	2.60	L =	40	Emer. Spill. El	5606
Grate / Weir C =	3.00	L =	24	El. 8'x8' grate	5602

Data Source : Lidar Contours provided by SSCAFCA

(e) The combined discharge of the reverse incline ports and the grate (A), will govern the discharge until the principal spillway outfall pipe becomes fully submerged. When the sum of (A)s is greater than outfall pipe capacity then outfall pipe capacity governs the discharge

Weir equation and "C" coefficients were obtained from Equation 5-10 and Table 5-3 from "Handbook of Hydraulics" Sixth Edition, by Brater & King, 1976.

(f) Length assumed along top of pond embankment and elevations extended above emergency spillway to allow for rating curve to function if flow spills over top

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Table C-5 AUXILARY POND ROUTING

AUX POND (Proposed)

Elevation - Volume - Discharge Data and Computations

grey box means must input data

Contour Elevation NAVD 1988	Depth	Contour Area	Incremental Volume	Incremental Volume	Cumulative Volume	(A) 1st Row of Reverse Incline Ports Discharge	(A) 2nd Row of Reverse Incline Ports Discharge	(A) Principal Spillway Grate Discharge	Principal Spillway Outfall Pipe Discharge	Total Principal Spillway / Outfall Pipe Discharge	Emergency Spillway Discharge	Total Discharge Rating Curve	Comment
		Principal Spillway Orifice Diameter (inches)				6	6		30				
		Number of Orifices				4	3		1				
(ft)		(sq ft)	(cu ft)	(ac-ft)	(ac-ft)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	
(d)						(a)	(a)	(b)	(a)	(e)	(b)		
5585.00	0	458	0	0.0000	0.0000	0.0	0.0	0.0	0.0	0.0	0	0.0	Pond bottom, principal spillway structure invert and 1st row of ports
5586.00	1.0	3631	2044	0.0469	0.0469	0.0	0.0	0.0	23.2	0.0	0	0.0	Invert 2nd row of reverse incline ports
5587.00	2.0	6516	5073	0.1165	0.1634	3.7	2.8	0.0	32.9	6.5	0	6.5	
5588.00	3.0	11115	8816	0.2024	0.3658	5.3	3.9	0.0	40.3	9.2	0	9.2	
5589.00	4.0	21294	16205	0.3720	0.7378	6.4	4.8	0.0	46.5	11.3	0	11.3	
5590.00	5.0	34867	28080	0.6446	1.3824	7.4	5.6	0.0	52.0	13.0	0	13.0	Top of principal spillway grate
5591.00	6.0	47952	41409	0.9506	2.3331	8.3	6.2	18.8	56.9	33.4	0	33.4	
5592.00	7.0	62079	55015	1.2630	3.5960	9.1	6.8	53.3	61.5	61.5	0	61.5	
5593.00	8.0	76426	69252	1.5898	5.1858	9.8	7.4	97.9	65.7	65.7	0	65.7	
5594.00	9.0	90217	83321	1.9128	7.0986	10.5	7.9	150.7	69.7	69.7	0	69.7	Emergency spill. Elev. = lowest top of embankment (f)
5595.00	10.0	104778	97498	2.2382	9.3369	11.2	8.4	210.6	73.5	73.5	390	463.5	

Office equation and coefficient were obtained from Equation 4-10 and Table 4-3 from "Handbook of Hydraulics" Sixth Edition, by Brater & King, 1976.

$$Q = Ca\sqrt{2gh}$$

C = 0.590 g=32.2 ft/sec^2, a=area (sq ft) h=head (ft)

$$a = \pi D^2 / 4$$

(full area formula)

$$a = \frac{1}{2} r^2 \left\{ \left[2\cos^{-1}\left(\frac{r-d}{r}\right) \right] \frac{\pi}{180} - \sin\left[\left[2\cos^{-1}\left(\frac{r-d}{r}\right) \right] \frac{\pi}{180} \right] \right\}$$

(partial area formula) Not Used

Principal Spill. Pipe radius r in feet = 1.25

d = depth of water in the pipe in feet

(e) The combined discharge of the reverse incline ports and the grate (A), will govern the discharge until the principal spillway outfall pipe becomes fully submerged. When the sum of (A)s is greater than outfall pipe capacity then outfall pipe capacity governs the discharge

Emergency Spillway flows were computed based on the following data used in the weir equation

Q = CLH^ 1.5 C = discharge coeffient, L = spillway length perp. to flow (ft), H = head (ft)

Weir equation and "C" coefficients were obtained from Equation 5-10 and Table 5-3 from "Handbook of Hydraulics" Sixth Edition, by Brater & King, 1976.

Emergergency Spillway C =	2.60	L =	150	Emer. Spill. El	5594	
Grate / Weir C =	3.00	L =	6	El. 24 Inch Circular Pipe Grate	5589	

(f) Length assumed along top of pond embankment and elevations extended above emergency spillway to allow for rating curve to function if flow spills over top

Data Source : Lidar Contours provided by SSCAFCA

Appendix C

Model Results

Hydrologic model results

Notes:

(1) Model results reported in this table are for the 100-year design storm using no depth-area reduction factor. Please modify the storm area in the HEC-HMS model for analyses with larger contributing areas.

(2) Qp and V values for ponds correspond to peak outflow and outflow volume, respectively. For detailed pond routing including peak inflow, peak storage and peak elevation values, please consult the HEC-HMS model.

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
L_101	0.387	309	28.3
L_101_J	0.387	309	28.3
L_101_R	0.387	309	28.3
L_201	0.100	72	5.5
L_102	0.063	62	3.4
L_102_J	0.550	385	37.2
Lisbon	0.550	68	37.2
L_301	0.056	47	3.0
L_103	0.025	12	0.9
L_103_J	0.081	58	3.9
L_401	0.023	39	1.8
L_104	0.021	19	1.0
L_401_J	0.044	57	2.8
Lisbon Aux	0.125	35	6.7
L_104_J	0.675	97	43.9
L_104_R	0.675	98	43.9
L_105	0.022	20	1.2
L_105_J	0.697	102	45.1
L_105_R	0.697	102	45.1
SN_101	0.103	76	5.9
SN_101_J	0.103	76	5.9
SN_101_R	0.103	76	5.9
SN_102	0.060	40	3.2
SN_102_J	0.163	116	9.1
SN_102_R	0.163	116	9.1
SN_103	0.085	87	4.9
Sunset Pond	0.248	31	14.0
SN_103_R	0.248	31	14.0
L_501	0.034	21	2.0
L_501_J	0.034	21	2.0
L_501_R	0.034	21	2.0
L_501_J2	0.034	21	2.0
L_501_R2	0.034	21	2.0
SN_104	0.052	46	3.9

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
L_101	0.387	326	29.8
L_101_J	0.387	326	29.8
L_101_R	0.387	325	29.8
L_201	0.100	92	6.8
L_102	0.063	86	4.4
L_102_J	0.550	423	40.9
Lisbon	0.550	70	40.9
L_301	0.056	65	4.0
L_103	0.025	26	1.7
L_103_J	0.081	92	5.7
L_401	0.023	51	2.3
L_104	0.021	34	1.6
L_401_J	0.044	85	3.8
Lisbon Aux	0.125	60	9.5
L_104_J	0.675	122	50.4
L_104_R	0.675	122	50.4
L_105	0.022	34	1.9
L_105_J	0.697	130	52.4
L_105_R	0.697	130	52.4
SN_101	0.103	95	7.2
SN_101_J	0.103	95	7.2
SN_101_R	0.103	95	7.2
SN_102	0.060	64	4.6
SN_102_J	0.163	157	11.7
SN_102_R	0.163	157	11.7
SN_103	0.085	111	6.1
Sunset Pond	0.248	34	17.8
SN_103_R	0.248	34	17.8
L_501	0.034	30	2.7
L_501_J	0.034	30	2.7
L_501_R	0.034	30	2.7
L_501_J2	0.034	30	2.7
L_501_R2	0.034	30	2.7
SN_104	0.052	50	4.2

Existing Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
L_502	0.027	36	2.1
L_106	0.017	29	1.3
L_106_J	1.075	189	68.4
L_106_R	1.075	188	68.4
L_107	0.148	133	12.1
L_107_J	1.223	310	80.5
L_107_R	1.223	310	80.5
SG_101	0.015	28	1.3
Wallen Pond	0.015	1	1.3
SG_101_R	0.015	1	1.3
SG_201	0.054	22	2.0
SG_102	0.010	12	0.5
SG_102_J	0.079	27	3.8
SG_102_R	0.079	27	3.8
SG_301	0.039	21	1.8
SG_103	0.018	19	0.9
SG_103_J	0.136	55	6.6
Sugar Ridge Flow Diversion	0.136	5	1.6
SG_103_R	0.136	7	1.6
SG_104	0.055	73	4.4
Sugar Ridge Pond	0.191	64	5.7
SG_104_J	0.191	114	10.7
SG_104_R	0.191	114	10.7
SG_401	0.020	15	1.0
SG_401_J	0.020	15	1.0
SG_401_R	0.020	15	1.0
SG_402	0.135	138	10.7
SG_105	0.076	132	6.0
SG_105_J	0.422	315	28.4
SG_105_R	0.422	315	28.4
L_108	0.027	44	2.0
L_108_J	1.672	590	110.9
L_108_R	1.672	590	110.9
I_101	0.073	108	6.1
I_201	0.062	99	5.1
I_101_J	0.135	205	11.1
I_101_R	0.135	206	11.1
I_102	0.063	98	5.1
L_109	0.031	49	2.4
L_109_J	1.901	751	129.5
L_109_R	1.901	753	129.5
L_110	0.130	221	11.2
L_110_J	2.031	849	140.7

DEVEX Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
L_502	0.027	40	2.2
L_106	0.017	29	1.3
L_106_J	1.075	242	80.6
L_106_R	1.075	241	80.6
L_107	0.148	133	12.1
L_107_J	1.223	369	92.7
L_107_R	1.223	369	92.7
SG_101	0.015	28	1.3
Wallen Pond	0.015	1	1.3
SG_101_R	0.015	1	1.3
SG_201	0.054	47	3.7
SG_102	0.010	17	0.8
SG_102_J	0.079	54	5.7
SG_102_R	0.079	54	5.7
SG_301	0.039	41	3.3
SG_103	0.018	34	1.5
SG_103_J	0.136	108	10.4
Sugar Ridge Flow Diversion	0.136	5	2.0
SG_103_R	0.136	5	2.0
SG_104	0.055	77	4.5
Sugar Ridge Pond	0.191	72	6.2
SG_104_J	0.191	176	14.6
SG_104_R	0.191	176	14.6
SG_401	0.020	29	1.6
SG_401_J	0.020	29	1.6
SG_401_R	0.020	29	1.6
SG_402	0.135	143	11.0
SG_105	0.076	139	6.3
SG_105_J	0.422	405	33.5
SG_105_R	0.422	405	33.5
L_108	0.027	49	2.2
L_108_J	1.672	715	128.4
L_108_R	1.672	713	128.4
I_101	0.073	108	6.1
I_201	0.062	99	5.1
I_101_J	0.135	205	11.1
I_101_R	0.135	206	11.1
I_102	0.063	98	5.1
L_109	0.031	48	2.4
L_109_J	1.901	883	147.0
L_109_R	1.901	884	147.0
L_110	0.130	221	11.2
L_110_J	2.031	964	158.2

Existing Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
L_110_R	2.031	851	140.7
A_101	0.184	214	15.8
A_201	0.060	76	5.1
A_101_J	0.244	288	20.9
A_101_R	0.244	288	20.9
A_101_J2	0.244	288	20.9
A_101_R2	0.244	288	20.9
A_102	0.052	95	4.5
A_102_J	0.296	332	25.3
A_102_R	0.296	332	25.4
A_103	0.113	111	6.8
L_111	0.047	71	3.5
L_111_J	2.487	1306	176.4
L_111_R	2.487	1303	176.4
B_101	0.178	126	10.1
B_101_J	0.178	126	10.1
B_101_R	0.178	126	10.1
B_102	0.018	9	0.7
B_102_J	2.683	1423	187.2
B_102_R	2.683	1421	187.2
B_103	0.122	72	5.9
B_103_J	2.805	1492	193.1
B_103_R	2.805	1492	193.2
B_201	0.179	134	9.8
B_301	0.052	32	2.6
B_201_J	0.231	164	12.4
B_201_R	0.231	164	12.4
B_202	0.096	95	5.7
B_104	0.016	8	0.6
B_104_J	3.148	1717	211.8
B_104_R	3.148	1715	211.8
WB_101	0.115	76	5.6
WB_101_J	0.115	76	5.6
WB_102	0.223	123	15.2
WB_101_R	0.115	76	5.6
WB_102_J	0.338	160	20.8
WB_102_R	0.338	160	20.8
WB_301	0.164	78	7.7
WB_103	0.031	15	1.1
WB_103_J	0.533	241	29.6
WB_103_R	0.533	241	29.6
WB_104	0.205	105	9.9
WB_104_J	0.738	329	39.5
WB_104_R	0.738	329	39.5

DEVEX Conditions			
HMS ID	Area (mi^2)	Q_p (cfs)	V (ac-ft)
L_110_R	2.031	964	158.2
A_101	0.184	214	15.8
A_201	0.060	76	5.1
A_101_J	0.244	288	20.9
A_101_R	0.244	288	20.9
A_101_J2	0.244	288	20.9
A_101_R2	0.244	288	20.9
A_102	0.052	95	4.5
A_102_J	0.296	332	25.3
A_102_R	0.296	332	25.4
A_103	0.113	140	8.3
L_111	0.047	76	3.7
L_111_J	2.487	1434	195.6
L_111_R	2.487	1431	195.6
B_101	0.178	176	13.3
B_101_J	0.178	176	13.3
B_101_R	0.178	176	13.3
B_102	0.018	10	0.8
B_102_J	2.683	1601	209.6
B_102_R	2.683	1604	209.6
B_103	0.122	87	6.9
B_103_J	2.805	1690	216.4
B_103_R	2.805	1689	216.5
B_201	0.179	181	12.6
B_301	0.052	48	3.7
B_201_J	0.231	228	16.3
B_201_R	0.231	228	16.3
B_202	0.096	119	6.8
B_104	0.016	8	0.6
B_104_J	3.148	1985	240.1
B_104_R	3.148	1985	240.1
WB_101	0.115	120	8.1
WB_101_J	0.115	120	8.1
WB_102	0.223	138	17.0
WB_101_R	0.115	120	8.1
WB_102_J	0.338	199	25.1
WB_102_R	0.338	199	25.1
WB_301	0.164	127	11.6
WB_103	0.031	16	1.1
WB_103_J	0.533	336	37.7
WB_103_R	0.533	336	37.7
WB_104	0.205	272	22.3
WB_104_J	0.738	576	60.1
WB_104_R	0.738	576	60.1

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
WX_101	0.145	174	13.4
WX_101_J	0.145	174	13.4
WX_101_R	0.145	174	13.4
WX_102	0.092	145	9.0
WX_102_J	0.237	391	30.4
Wexford Pond	0.237	136	30.4
WX_102_R	0.237	136	30.4
U_201	0.025	47	2.4
U_102	0.010	26	1.1
U_102_J	0.272	165	33.9
U_102_R	0.272	165	33.9
WX_201	0.091	150	8.6
Wexford Diversion	0.091	41	0.7
U_301	0.013	28	1.2
U_301_J	0.104	61	1.9
U_301_R	0.104	61	1.9
U_401	0.056	112	5.4
U_401_J	0.056	112	5.4
U_401_R	0.056	112	5.4
U_402	0.031	70	3.1
U_402_J	0.087	171	8.5
U_402_R	0.087	170	8.5
U_403	0.006	13	0.6
U_403_J	0.093	181	9.1
U_403_R	0.093	180	9.1
U_101	0.042	40	3.5
U_101_J	0.042	40	3.5
U_101_R	0.042	40	3.5
U_103	0.057	160	8.4
U_103_J	0.568	570	56.8
U_103_R	0.568	571	56.8
U_104	0.054	153	7.8
U_104_J	0.622	710	64.6
U_104_R	0.622	711	64.6
U_501	0.013	42	1.9
U_501_J	0.013	42	1.9
U_501_R	0.013	42	1.9
U_105	0.048	81	3.9
U_502	0.036	38	2.5
U_105_J	0.719	856	72.9
U_105_R	0.719	852	72.9
WB_105	0.053	31	2.8
B_105	0.036	53	2.9
B_105_J	4.694	2487	330.0

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
WX_101	0.145	174	13.4
WX_101_J	0.145	174	13.4
WX_101_R	0.145	174	13.4
WX_102	0.092	149	9.2
WX_102_J	0.237	397	30.7
Wexford Pond	0.237	137	30.7
WX_102_R	0.237	137	30.7
U_201	0.025	47	2.4
U_102	0.010	26	1.1
U_102_J	0.272	166	34.2
U_102_R	0.272	166	34.2
WX_201	0.091	155	8.8
Wexford Diversion	0.091	46	0.8
U_301	0.013	29	1.3
U_301_J	0.104	67	2.1
U_301_R	0.104	67	2.1
U_401	0.056	112	5.4
U_401_J	0.056	112	5.4
U_401_R	0.056	112	5.4
U_402	0.031	70	3.1
U_402_J	0.087	171	8.5
U_402_R	0.087	170	8.5
U_403	0.006	15	0.6
U_403_J	0.093	183	9.1
U_403_R	0.093	181	9.1
U_101	0.042	74	6.0
U_101_J	0.042	74	6.0
U_101_R	0.042	74	6.0
U_103	0.057	163	8.6
U_103_J	0.568	606	60.0
U_103_R	0.568	606	60.0
U_104	0.054	156	8.0
U_104_J	0.622	746	68.0
U_104_R	0.622	746	68.0
U_501	0.013	43	1.9
U_501_J	0.013	43	1.9
U_501_R	0.013	43	1.9
U_105	0.048	114	5.3
U_502	0.036	40	2.6
U_105_J	0.719	916	77.8
U_105_R	0.719	914	77.8
WB_105	0.053	78	6.3
B_105	0.036	68	3.6
B_105_J	4.694	3156	387.9

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
B_105_R	4.694	2485	330.0
W_101	0.422	327	24.8
W_201	0.053	83	4.4
Gateway Pond	0.475	250	29.2
W_101_R	0.475	250	29.2
W_102	0.049	138	6.2
W_101_J	0.524	274	35.5
W_102_R	0.524	274	35.5
W_103	0.082	122	8.2
W_103_J	5.300	2840	373.7
SO_201	0.169	402	17.7
SO_201_J	0.169	402	17.7
SO_201_R	0.169	399	17.7
SO_101	0.043	41	3.4
SO_102	0.032	93	4.1
SO_102_J	0.075	110	7.5
SO_102_R	0.075	110	7.5
SO_103	0.060	139	6.9
SO_103_J	0.304	648	32.1
SO_103_R	0.304	647	32.1
SO_301	0.027	67	3.4
SO_301_J	0.027	67	3.4
SO_301_R	0.027	67	3.4
SO_302	0.058	140	6.1
SO_302_J	0.389	838	41.6
SO_302_R	0.389	840	41.6
B_401	0.099	204	10.2
Stone Bridge Pond	0.099	80	10.2
B_401_R	0.099	83	10.2
B_402	0.160	345	16.0
B_106	0.122	58	5.7
B_106_J	6.070	3386	447.2
B_106_R	6.070	3378	447.2
B_107	0.036	53	2.4
B_107_J	6.106	3393	449.5
EB_101	0.200	302	18.3
EB_101_J	0.200	302	18.3
EB_101_R	0.200	301	18.3
EB_102	0.009	20	0.9
EB_102_J	0.209	313	19.2
EB_102_R	0.209	314	19.2
EB_201	0.107	217	10.0
EB_201_J	0.107	217	10.0
EB_201_R	0.107	218	10.0

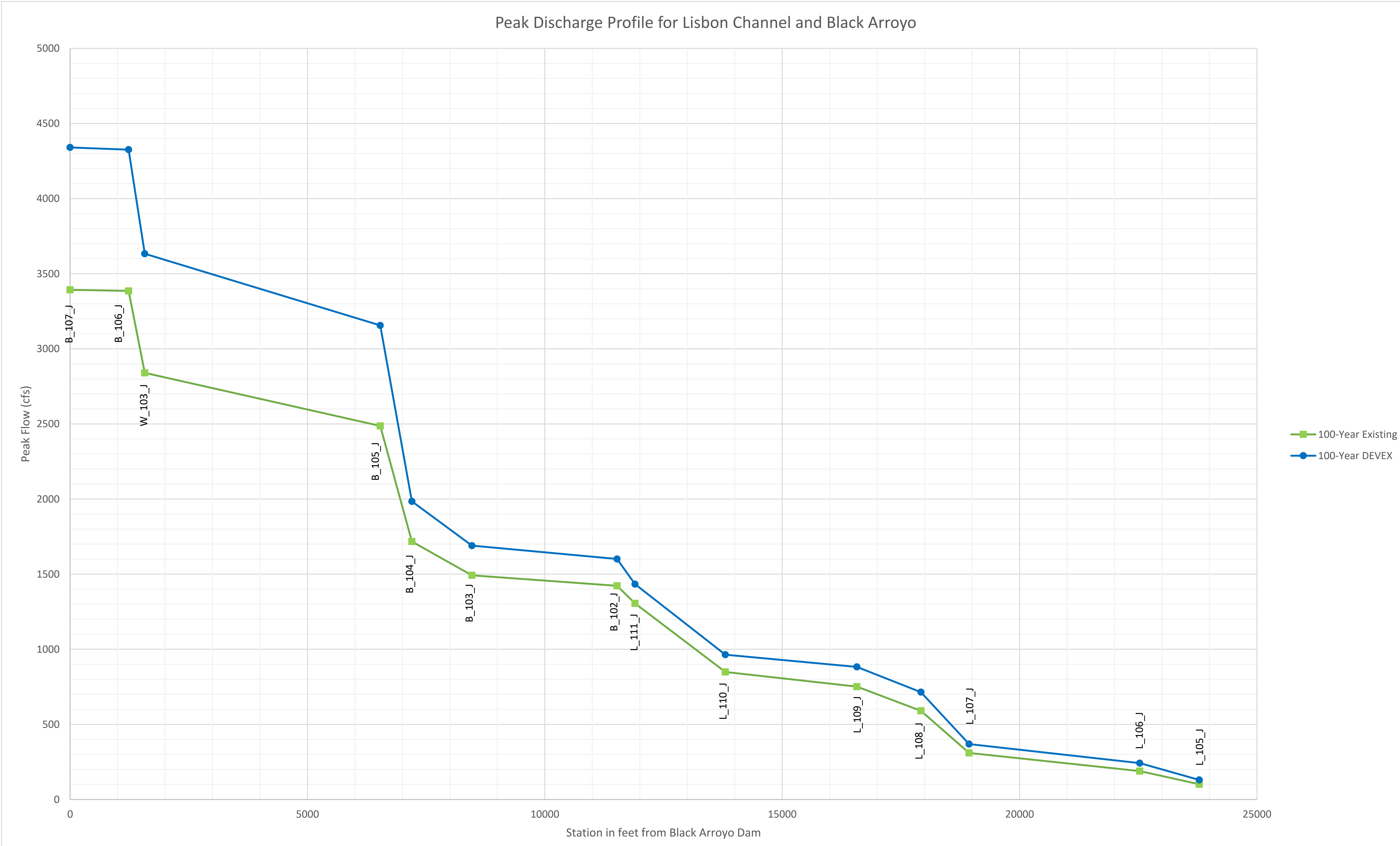
DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
B_105_R	4.694	3161	387.9
W_101	0.422	555	38.1
W_201	0.053	160	8.0
Gateway Pond	0.475	339	46.1
W_101_R	0.475	339	46.1
W_102	0.049	138	6.2
W_101_J	0.524	361	52.4
W_102_R	0.524	361	52.4
W_103	0.082	179	11.7
W_103_J	5.300	3633	452.0
SO_201	0.169	402	17.7
SO_201_J	0.169	402	17.7
SO_201_R	0.169	399	17.7
SO_101	0.043	41	3.4
SO_102	0.032	93	4.1
SO_102_J	0.075	110	7.5
SO_102_R	0.075	110	7.5
SO_103	0.060	139	6.9
SO_103_J	0.304	648	32.1
SO_103_R	0.304	647	32.1
SO_301	0.027	67	3.4
SO_301_J	0.027	67	3.4
SO_301_R	0.027	67	3.4
SO_302	0.058	140	6.1
SO_302_J	0.389	838	41.6
SO_302_R	0.389	840	41.6
B_401	0.099	204	10.2
Stone Bridge Pond	0.099	80	10.2
B_401_R	0.099	83	10.2
B_402	0.160	345	16.0
B_106	0.122	219	18.3
B_106_J	6.070	4326	538.1
B_106_R	6.070	4325	538.1
B_107	0.036	53	2.4
B_107_J	6.106	4341	540.5
EB_101	0.200	351	20.9
EB_101_J	0.200	351	20.9
EB_101_R	0.200	351	20.9
EB_102	0.009	20	0.9
EB_102_J	0.209	364	21.8
EB_102_R	0.209	363	21.8
EB_201	0.107	217	10.0
EB_201_J	0.107	217	10.0
EB_201_R	0.107	218	10.0

Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
EB_202	0.016	35	1.5
EB_202_J	0.123	250	11.6
EB_202_R	0.123	250	11.6
EB_301	0.115	171	10.4
EB_203	0.024	52	2.3
EB_103	0.019	42	1.8
EB_103_J	0.490	772	45.3
EB_103_R	0.490	772	45.3
EB_401	0.168	235	15.5
EB_401_J	0.168	235	15.5
EB_401_R	0.168	235	15.5
EB_402	0.070	117	6.4
EB_402_J	0.728	1096	67.2
EB_402_R	0.728	1097	67.2
EB_501	0.107	151	9.2
EB_501_J	0.107	151	9.2
EB_501_R	0.107	151	9.2
EB_601	0.055	61	3.4
EB_601_J	0.055	61	3.4
EB_601_R	0.055	61	3.4
EB_602	0.209	211	15.5
EB_104	0.199	315	19.5
EB_502	0.032	60	3.0
EB_104_J	1.330	1859	117.8
EB_104_R	1.330	1858	117.8
EB_104_J2	1.330	1858	117.8
EB_104_R2	1.330	1858	117.8
EB_105	0.052	99	4.5
EB_105_J	1.382	1902	122.4
EB_105_R	1.382	1899	122.3
EB_106	0.104	196	9.9
EB_107	0.085	112	6.4
EB_107_J	1.571	2107	138.6
EB_107_R	1.571	2104	138.6
EB_108	0.140	273	12.9
EB_109	0.121	236	13.0
EB_109_J	1.832	2409	164.6
EB_109_R	1.832	2410	164.6
EB_701	0.150	307	15.0
EB_701_J	0.150	307	15.0
EB_701_R	0.150	308	15.0
EB_702	0.038	125	5.6
EB_702_J	0.188	424	20.6
EB_702_R	0.188	420	20.6

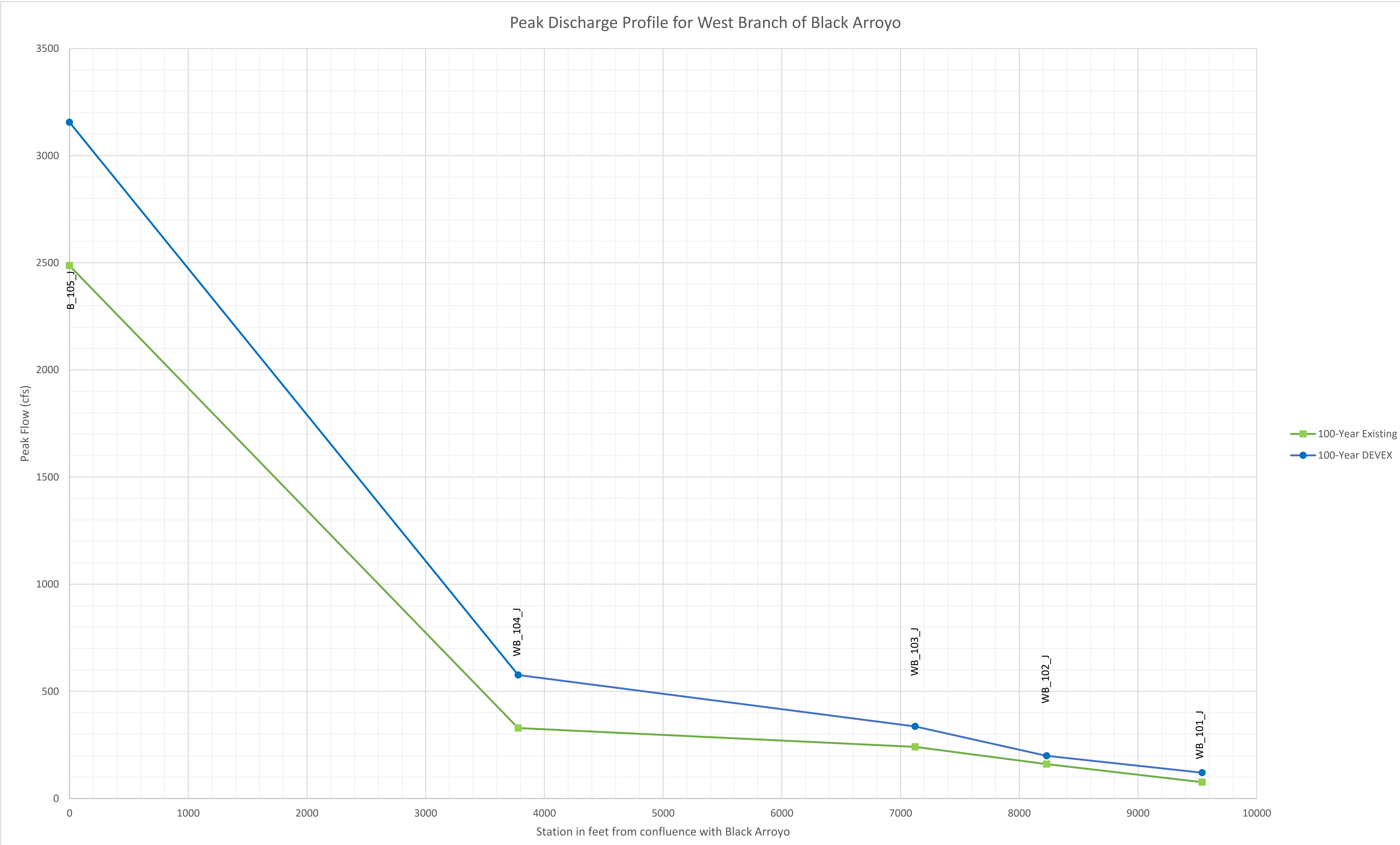
DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
EB_202	0.016	35	1.5
EB_202_J	0.123	250	11.6
EB_202_R	0.123	250	11.6
EB_301	0.115	171	10.4
EB_203	0.024	52	2.3
EB_103	0.019	42	1.8
EB_103_J	0.490	825	48.0
EB_103_R	0.490	826	48.0
EB_401	0.168	237	15.6
EB_401_J	0.168	237	15.6
EB_401_R	0.168	237	15.6
EB_402	0.070	118	6.4
EB_402_J	0.728	1152	70.0
EB_402_R	0.728	1152	70.0
EB_501	0.107	151	9.2
EB_501_J	0.107	151	9.2
EB_501_R	0.107	151	9.2
EB_601	0.055	58	3.3
EB_601_J	0.055	58	3.3
EB_601_R	0.055	58	3.3
EB_602	0.209	211	15.4
EB_104	0.199	317	19.7
EB_502	0.032	63	3.1
EB_104_J	1.330	1917	120.7
EB_104_R	1.330	1916	120.7
EB_104_J2	1.330	1916	120.7
EB_104_R2	1.330	1916	120.7
EB_105	0.052	132	5.8
EB_105_J	1.382	1970	126.5
EB_105_R	1.382	1966	126.5
EB_106	0.104	225	11.2
EB_107	0.085	132	7.4
EB_107_J	1.571	2202	145.0
EB_107_R	1.571	2203	145.0
EB_108	0.140	284	13.4
EB_109	0.121	236	13.0
EB_109_J	1.832	2515	171.4
EB_109_R	1.832	2517	171.4
EB_701	0.150	305	14.9
EB_701_J	0.150	305	14.9
EB_701_R	0.150	305	14.9
EB_702	0.038	126	5.7
EB_702_J	0.188	423	20.6
EB_702_R	0.188	418	20.5

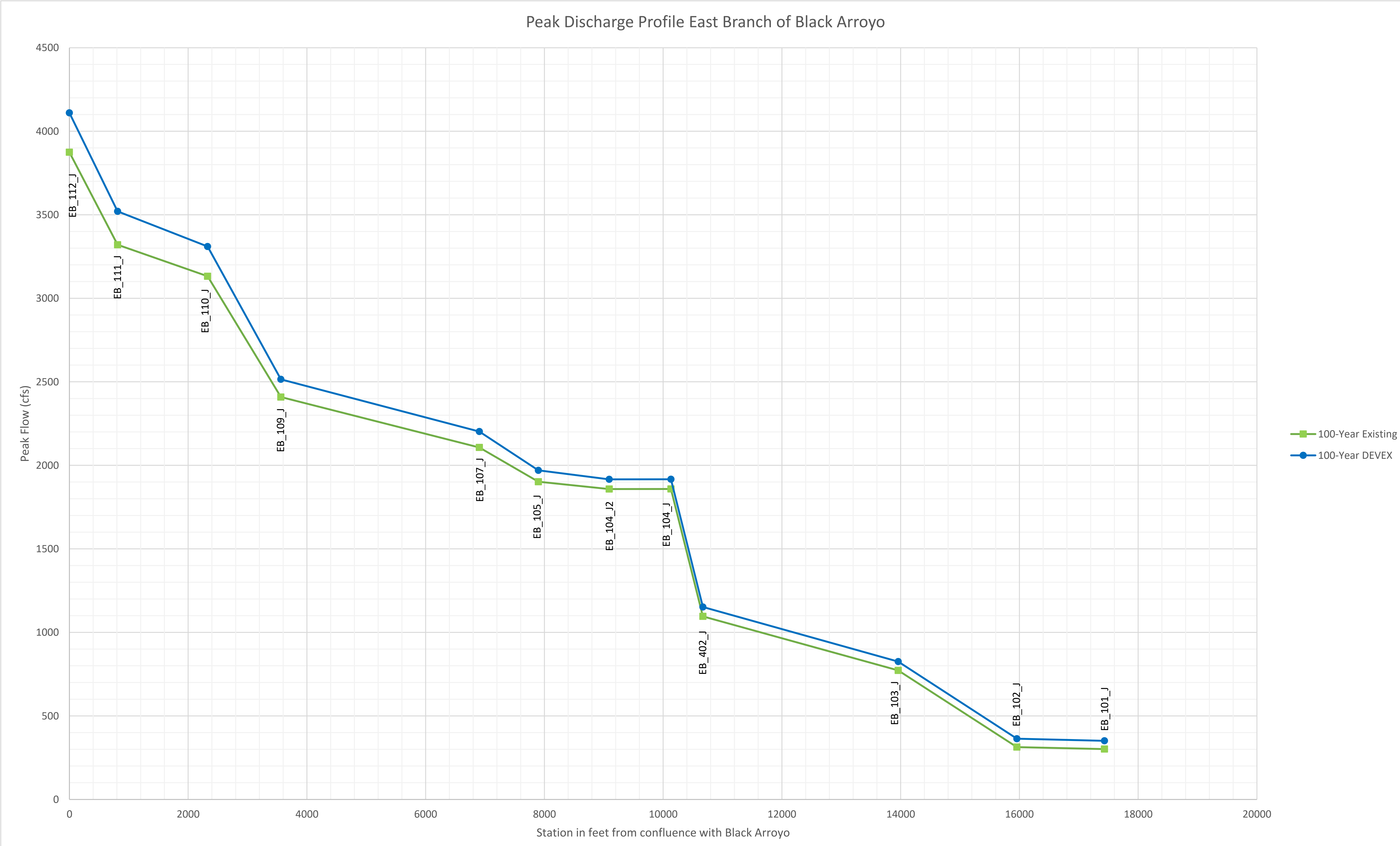
Existing Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
EB_703	0.471	673	48.9
Cabezon Tract 17 Pond	0.659	472	69.4
EB_703_R	0.659	472	69.4
EB_704	0.229	407	22.5
EB_110	0.006	4	0.2
EB_110_J	2.726	3132	256.7
EB_110_R	2.726	3131	256.7
EB_801	0.130	284	13.6
EB_111	0.044	44	3.3
EB_111_J	2.900	3320	273.5
EB_111_R	2.900	3319	273.5
EB_901	0.059	124	7.5
EB_901_J	0.059	124	7.5
EB_901_R	0.059	124	7.5
EB_902	0.320	387	29.5
EB_902_J	0.379	507	37.0
EB_902_R	0.379	507	37.0
EB_112	0.033	91	4.1
EB_903	0.028	57	2.6
EB_112_J	3.340	3875	317.3
B_501	0.048	110	4.8
B_108	0.029	37	1.7
Black Arroyo Dam	9.523	2784	773.3
Outfall	9.523	2784	773.3
C_101	0.594	585	48.4
Closed Basin Outlet	0.594	585	48.4

DEVEX Conditions			
HMS ID	Area	Q_p	V
	(mi^2)	(cfs)	(ac-ft)
EB_703	0.471	750	53.8
Cabezon Tract 17 Pond	0.659	485	74.2
EB_703_R	0.659	485	74.2
EB_704	0.229	503	27.3
EB_110	0.006	4	0.2
EB_110_J	2.726	3310	273.1
EB_110_R	2.726	3310	273.1
EB_801	0.130	285	13.7
EB_111	0.044	65	4.6
EB_111_J	2.900	3521	291.3
EB_111_R	2.900	3524	291.3
EB_901	0.059	137	8.3
EB_901_J	0.059	137	8.3
EB_901_R	0.059	137	8.3
EB_902	0.320	394	30.0
EB_902_J	0.379	526	38.3
EB_902_R	0.379	526	38.3
EB_112	0.033	96	4.3
EB_903	0.028	93	4.1
EB_112_J	3.340	4110	338.0
B_501	0.048	110	4.8
B_108	0.029	37	1.7
Black Arroyo Dam	9.523	3024	885.0
Outfall	9.523	3024	885.0
C_101	0.594	585	48.4
Closed Basin Outlet	0.594	585	48.4



Peak Discharge Profile for Lisbon Channel and Black Arroyo
Peak Flow (cfs)
Station in feet from Black Arroyo Dam
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
5000
10000
15000
20000
25000
B_107_J
B_106_J
W_103_J
B_105_J
B_104_J
B_103_J
B_102_J
L_111_J
L_110_J
L_109_J
L_108_J
L_107_J
L_106_J
L_105_J
100-Year Existing
100-Year DEVEX


Peak Discharge Profile for West Branch of Black Arroyo
Peak Flow (cfs)
3500
3000
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Station in feet from confluence with Black Arroyo
B_105_J
WB_104_J
WB_103_J
WB_102_J
WB_101_J
100-Year Existing
100-Year DEVEX


Peak Discharge Profile East Branch of Black Arroyo
Peak Flow (cfs)
Station in feet from confluence with Black Arroyo
0
500
1000
1500
2000
2500
3000
3500
4000
4500
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
EB_112_J
EB_111_J
EB_110_J
EB_109_J
EB_107_J
EB_105_J
EB_104_J2
EB_104_J
EB_402_J
EB_103_J
EB_102_J
EB_101_J
100-Year Existing
100-Year DEVEX

Appendix D

Later Erosion Envelope Calculations

LEE offset caluclations

Tributary	Reach	Existing Q_{100}	Dominant Discharge Q_{100}	Slope S_0	Critical Slope S_0	Maximum Lateral Erosion Distance Δmax	Est. Channel Width W_D	Offset
		(cfs)	(cfs)	(ft/ft)	(ft/ft)	(ft)	(ft)	(ft)
Black Arroyo	L_110_R*	851	170	0.023	0.019	90	36	90
	L_111_R	1303	261	0.021	0.018	111	43	133
	B_102_R	1421	284	0.018	0.017	117	44	139
	B_103_R	1492	298	0.016	0.017	122	45	144
	B_104_R	1715	343	0.015	0.017	133	48	158
East Branch	EB_104_R*	1858	372	0.023	0.017	136	49	136

* Well defined channels - Bankline Setback method used to calculate offset and map LEE

Appendix E

Existing Structure Capacities

Crossing Structure 1 – Lisbon Channel at Tarpon Avenue

Upstream face

Downstream face

Crossing Structure 2 – Lisbon Channel at Southern Boulevard

Upstream channel

Upstream face

Downstream face

Downstream channel

Crossing Structure 3 – Ivory Channel at Southern Boulevard

Upstream face inaccessible due to vegetation. Photo taken at upstream crossing at Spur Road.

Upstream channel

Downstream face

Downstream channel

Crossing Structure 4 – Unser Channel at Commercial Drive

Upstream channel

Upstream face

Downstream face

Downstream channel

Crossing Structure 5 – Unser Channel at 14th Avenue/Cabezon Boulevard

Upstream channel

Upstream face

Downstream face

Downstream channel

Crossing Structure 6 – West Branch at Unser Boulevard

Upstream channel

Upstream face


Downstream channel


Downstream face

Crossing Structure 7 – Nicklaus Channel (East Branch) at Southern Boulevard

Upstream channel

Upstream face

Downstream channel

Downstream face

Culvert data summary table

Crossing Number	Location	Existing Structure Description	Dimension (ft)	Number of Barrels (-)	Manning's n (-)	Length (ft)	Max Allowable Headwater Depth (ft)	Max Allowable Headwater Elevation (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope (ft/ft)	Comments
1	Lisbon Channel at Tarpon Ave.	Trapezoidal Bridge	Irregular	N/A	0.035	36	6	106	100	100	0.009	Irregular shape see capacity analysis for dimensions
2	Lisbon Channel at Southern Blvd.	CBC	10'Sx4'R	1	0.015	138	11	5432	5421	5416	0.030	
3	Ivory Channel at Southern Blvd.	CBC	12'Sx6'R	2	0.015	174	7	5464	5457	5453	0.025	
4	Unser Channel at Commercial Dr.	Trapezoidal Culvert	Irregular	N/A	0.015	85	4	5376	5371	5370	0.020	Irregular shape see capacity analysis for dimensions
5	Unser Channel at 14th Ave./Cabezon Blvd.	CBC	10'Sx5'R	2	0.015	110	8	5334	5326	5325	0.005	Record drawings show RCP. CBC in the field
6	West Branch at Unser Blvd.	CBC	10'Sx7.5'R	4	0.015	641	10	5282	5272	5261	0.019	Record drawings show outlet at Westisde Blvd. but connection added to lined Black Arroyo
7	Nicklaus Channel (East Branch) at Southern Blvd.	CMP	4.5' Diam.	6	0.024	125	6	5452	5447	5443	0.028	

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

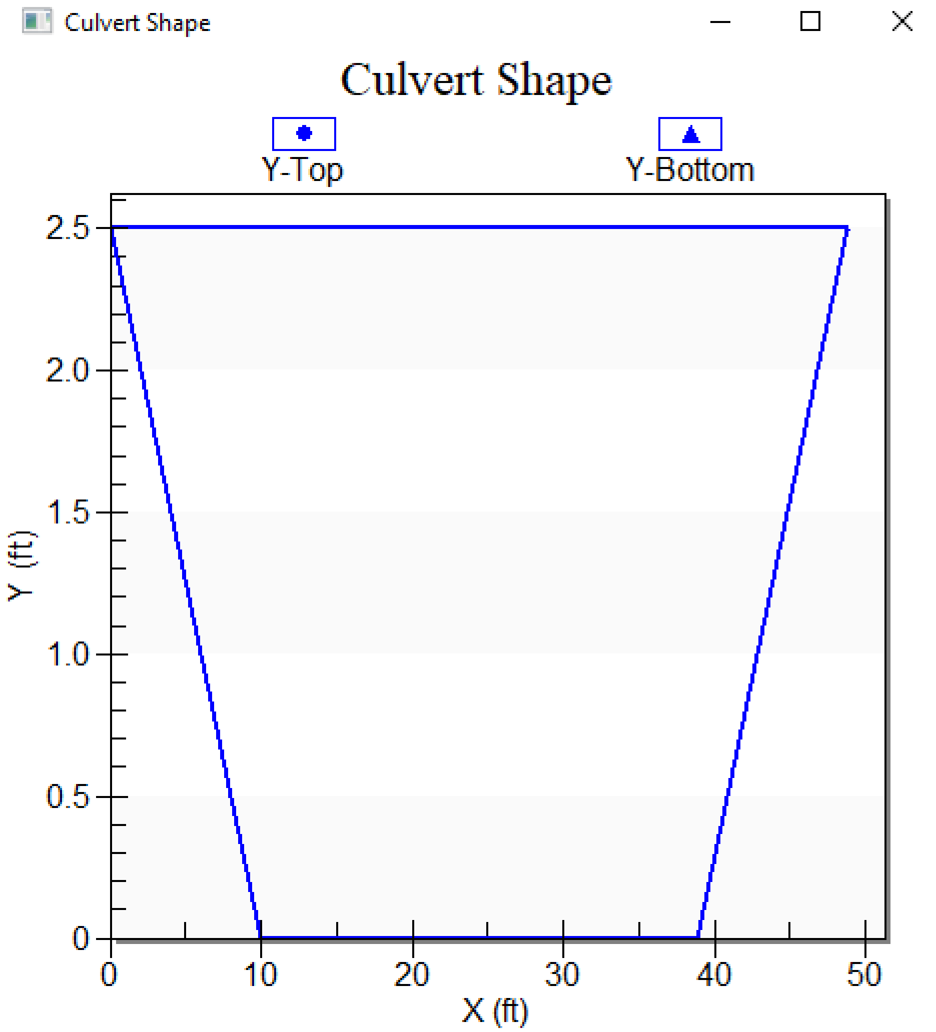

Culvert Shape
Culvert Shape
Y-Top
Y-Bottom
2.5
2.0
1.5
1.0
0.5
0
Y (ft)
0
10
20
30
40
50
X (ft)

Table 1 - Summary of Culvert Flows at Crossing: Lisbon Channel @ Tarpon Ave

Headwater Elevation (ft)	Total Discharge (cfs)	Trapezoidal bridge crossing Discharge (cfs)	Roadway Discharge (cfs)	Iterations
105.92	900.00	900.00	0.00	1
106.00	909.00	909.00	0.00	1
106.00	909.27	909.27	0.00	Overtopping

Rating Curve Plot for Crossing: Lisbon Channel @ Tarpon Ave

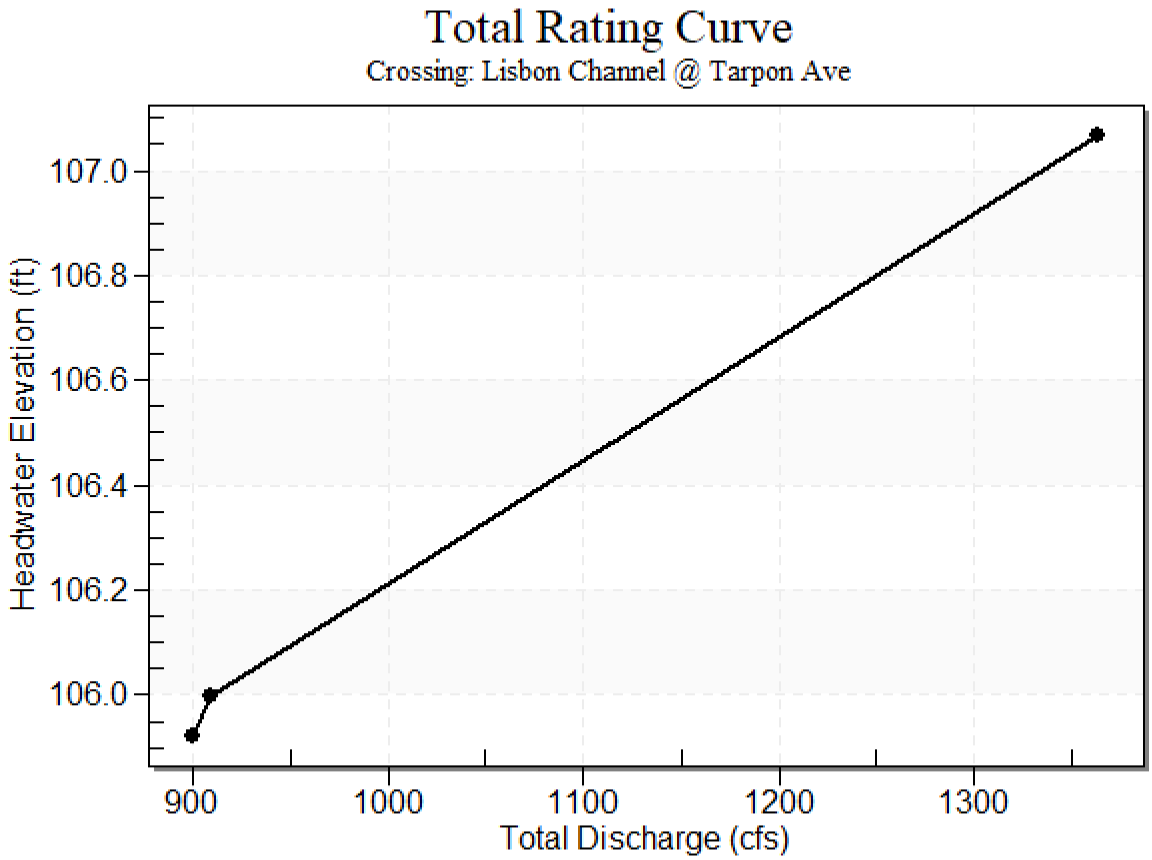


Table 2 - Culvert Summary Table: Trapezoidal bridge crossing

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
900.00	900.00	105.92	4.875	5.923	6-FFc	2.500	2.500	2.500	1.255	9.278	0.000
909.00	909.00	106.00	4.937	5.999	6-FFc	2.500	2.500	2.500	1.255	9.371	0.000

****

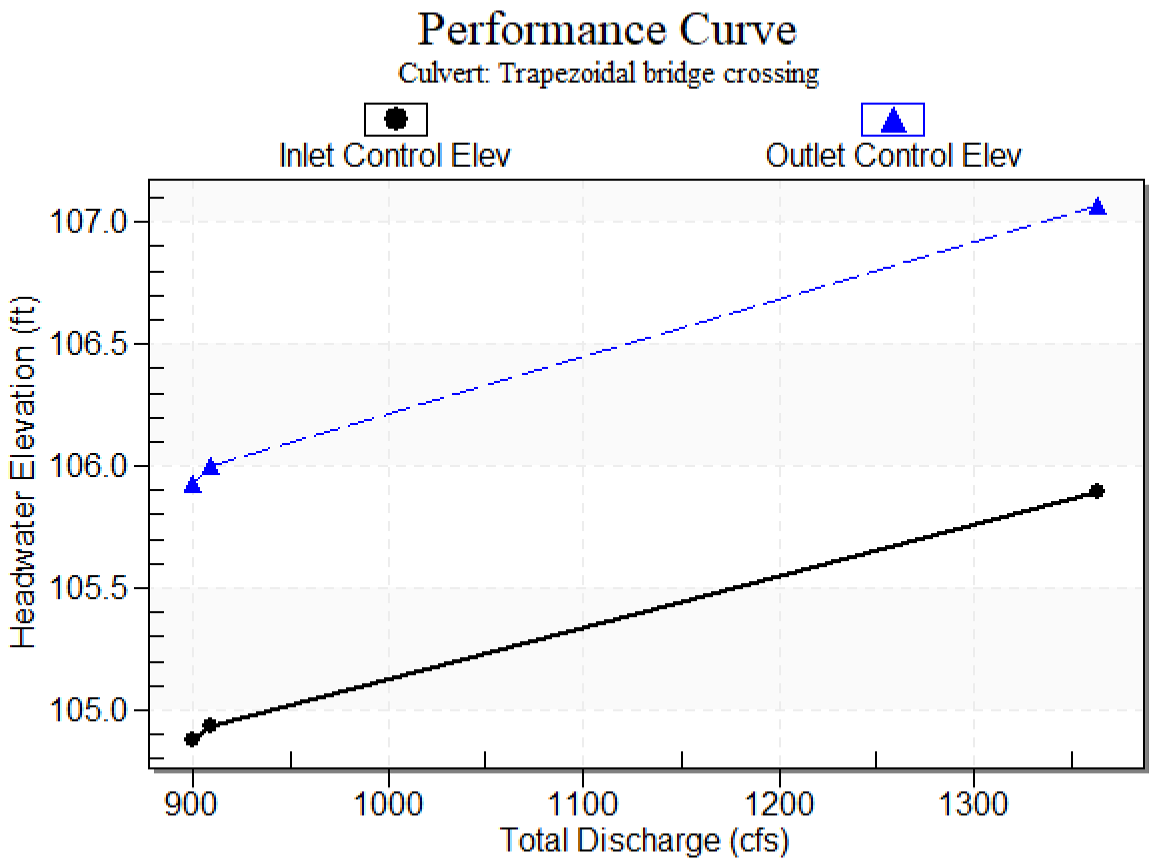
Straight Culvert

Inlet Elevation (invert): 100.00 ft,   Outlet Elevation (invert): 99.68 ft

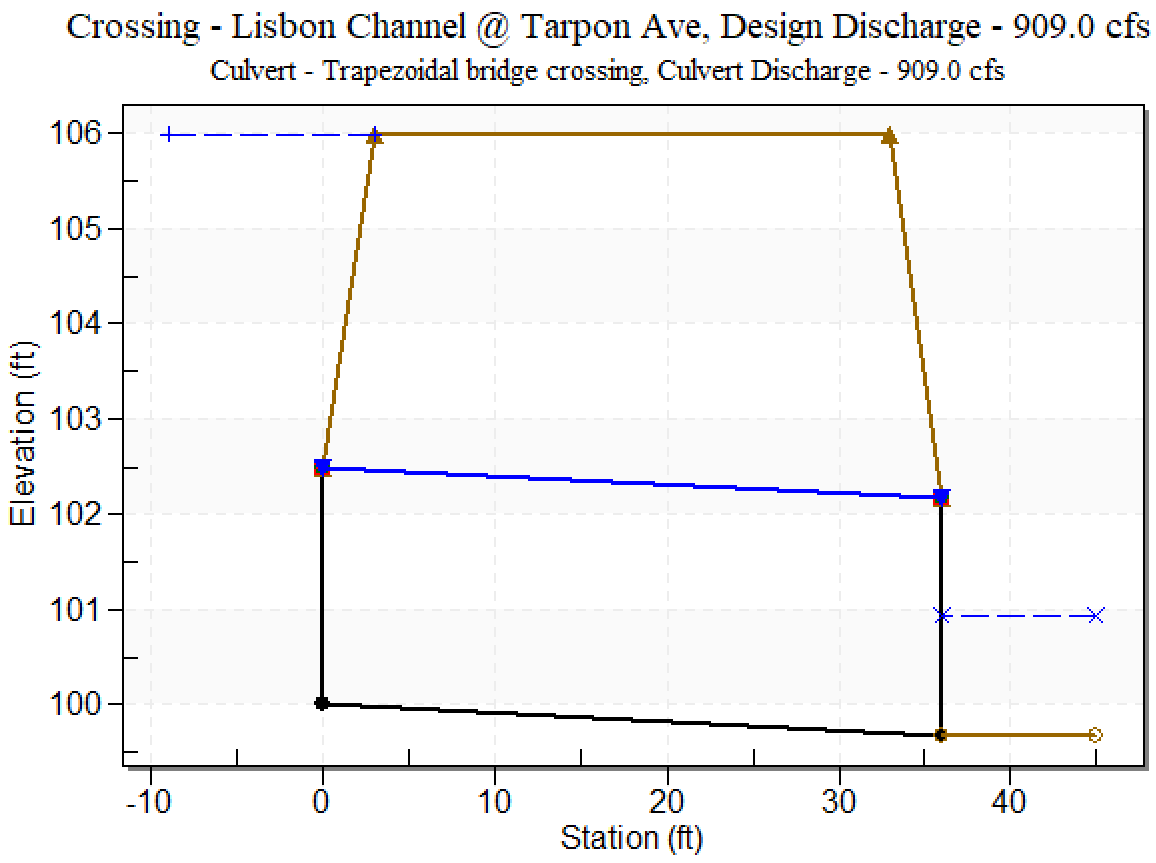
Culvert Length: 36.00 ft,   Culvert Slope: 0.0089

****

Culvert Performance Curve Plot: Trapezoidal bridge crossing



Water Surface Profile Plot for Culvert: Trapezoidal bridge crossing



Site Data - Trapezoidal bridge crossing

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 100.00 ft

Outlet Station: 36.00 ft

Outlet Elevation: 99.68 ft

Number of Barrels: 1

Culvert Data Summary - Trapezoidal bridge crossing

Barrel Shape: User Defined

Barrel Span: 48.80 ft

Barrel Rise: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Lisbon Channel @ Tarpon Ave)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
900.00	100.94	1.25
909.00	100.94	1.25

Tailwater Channel Data - Lisbon Channel @ Tarpon Ave

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 100.94 ft

Roadway Data for Crossing: Lisbon Channel @ Tarpon Ave

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 106.00 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 4 - Summary of Culvert Flows at Crossing: Lisbon Channel @ Southern Blvd

Headwater Elevation (ft)	Total Discharge (cfs)	CBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5431.97	1880.00	1880.00	0.00	1
5432.00	1883.00	1883.00	0.00	1
5432.00	1883.59	1883.59	0.00	Overtopping

Rating Curve Plot for Crossing: Lisbon Channel @ Southern Blvd

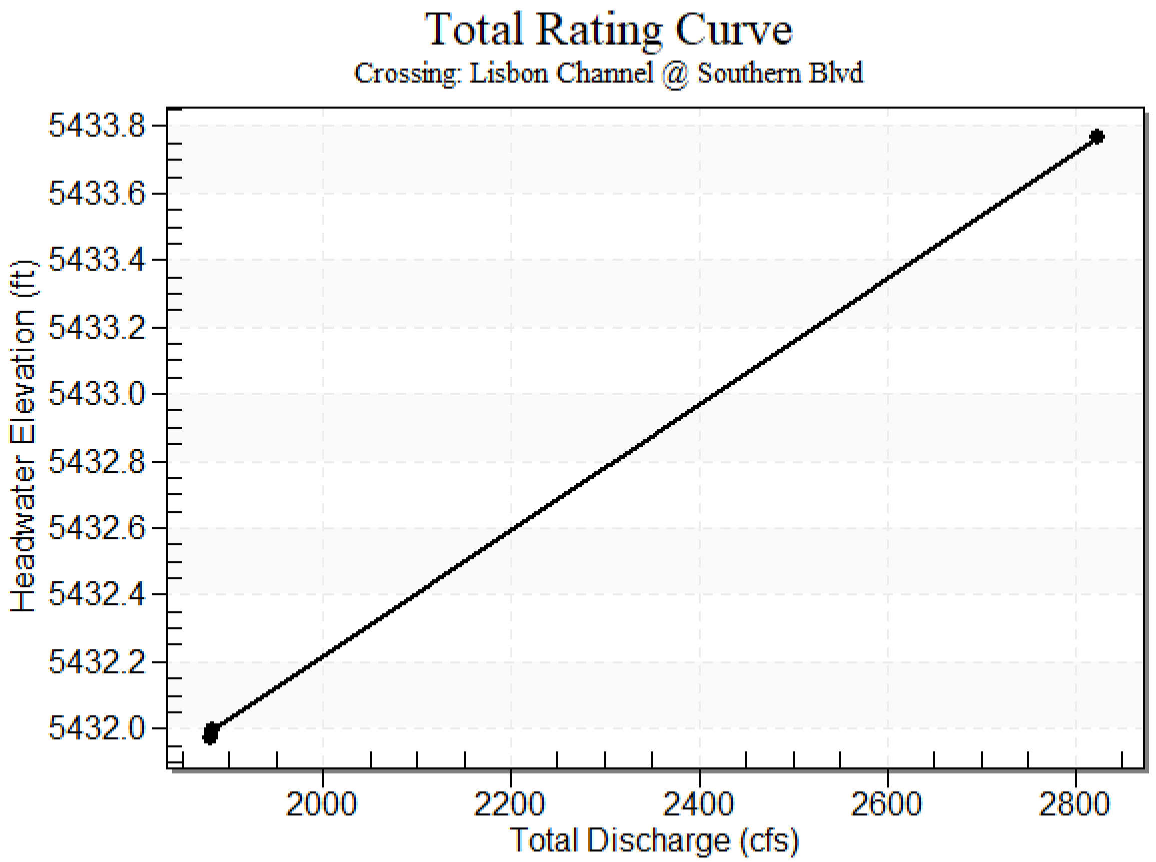


Table 5 - Culvert Summary Table: CBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1880.00	1880.00	5431.97	11.451	6.659	5-S2n	2.909	5.755	3.557	3.000	22.021	0.000
1883.00	1883.00	5432.00	11.473	6.678	5-S2n	2.913	5.761	3.562	3.000	22.029	0.000

****

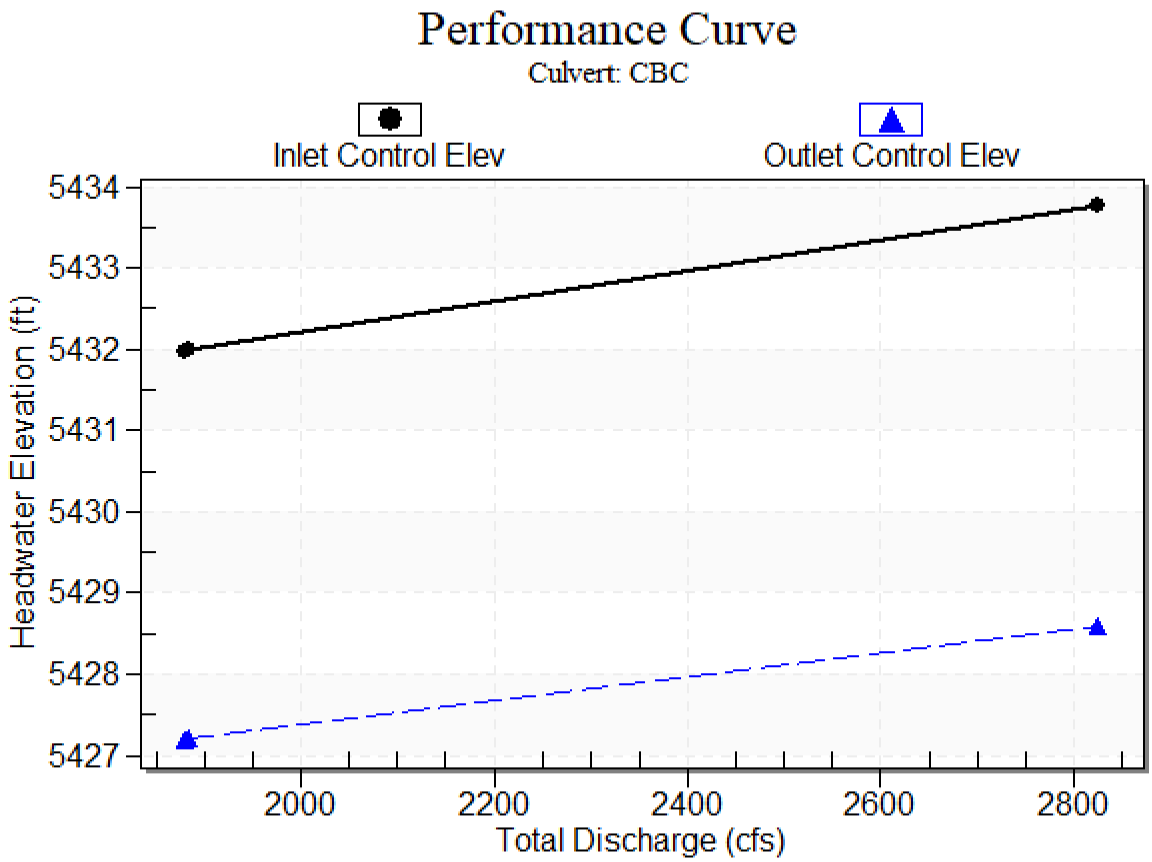
Straight Culvert

Inlet Elevation (invert): 5420.52 ft, Outlet Elevation (invert): 5416.39 ft

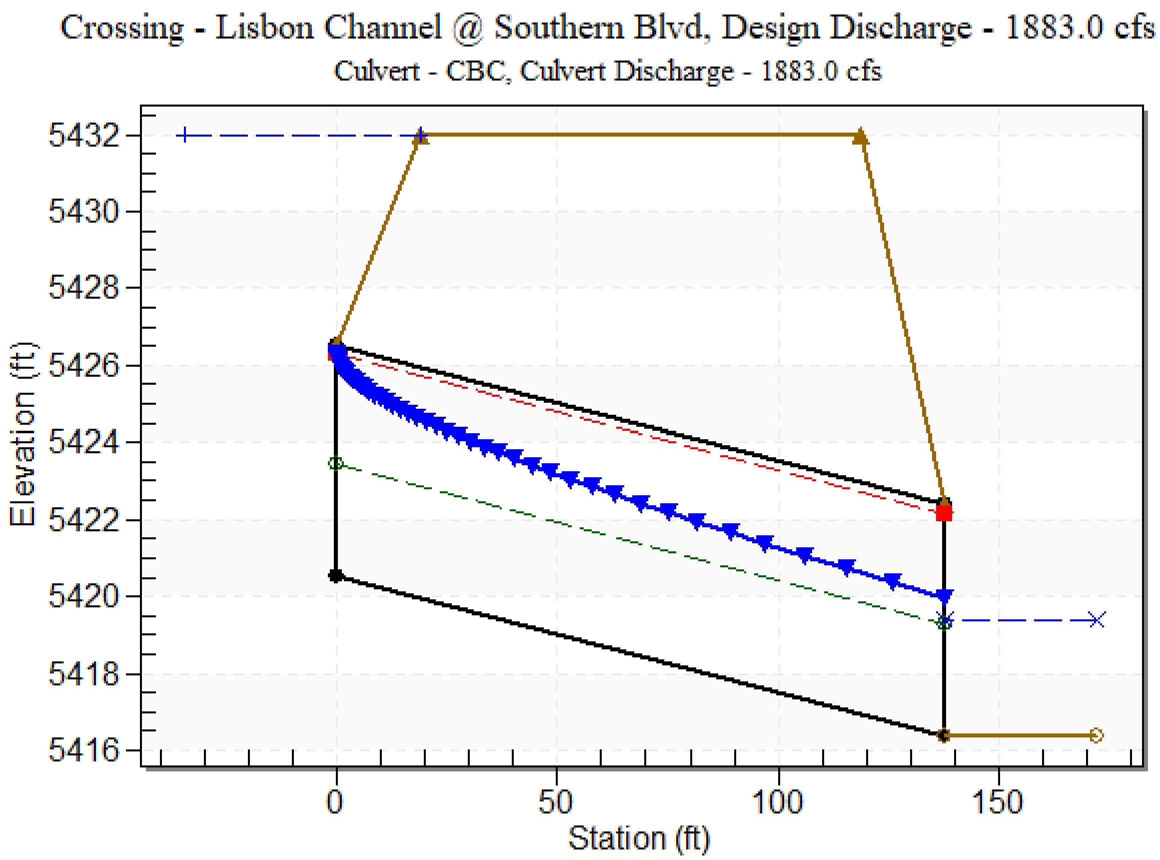
Culvert Length: 137.82 ft, Culvert Slope: 0.0300

****

Culvert Performance Curve Plot: CBC



Water Surface Profile Plot for Culvert: CBC



Site Data - CBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5420.52 ft

Outlet Station: 137.76 ft

Outlet Elevation: 5416.39 ft

Number of Barrels: 2

Culvert Data Summary - CBC

Barrel Shape: Concrete Box

Barrel Span: 12.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: Lisbon Channel @ Southern Blvd)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1880.00	5419.39	3.00
1883.00	5419.39	3.00

Tailwater Channel Data - Lisbon Channel @ Southern Blvd

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5419.39 ft

Roadway Data for Crossing: Lisbon Channel @ Southern Blvd

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 5432.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 7 - Summary of Culvert Flows at Crossing: Ivory Channel @ Southern Blvd

Headwater Elevation (ft)	Total Discharge (cfs)	CBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5463.93	380.00	380.00	0.00	1
5463.99	383.00	383.00	0.00	1
5464.00	383.53	383.53	0.00	Overtopping

Rating Curve Plot for Crossing: Ivory Channel @ Southern Blvd

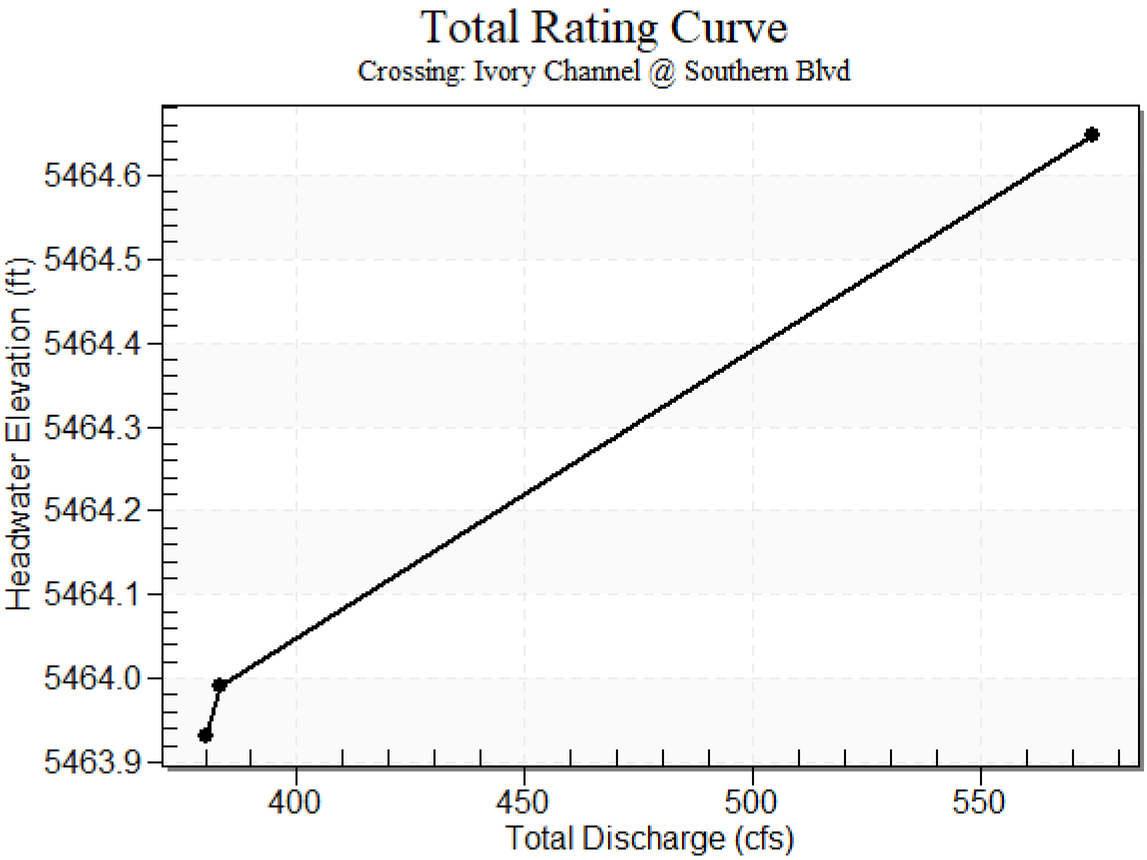


Table 8 - Culvert Summary Table: CBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
380.00	380.00	5463.93	6.702	2.517	5-S2n	1.937	3.553	2.103	2.000	18.072	0.000
383.00	383.00	5463.99	6.760	2.576	5-S2n	1.948	3.571	2.116	2.000	18.099	0.000

****

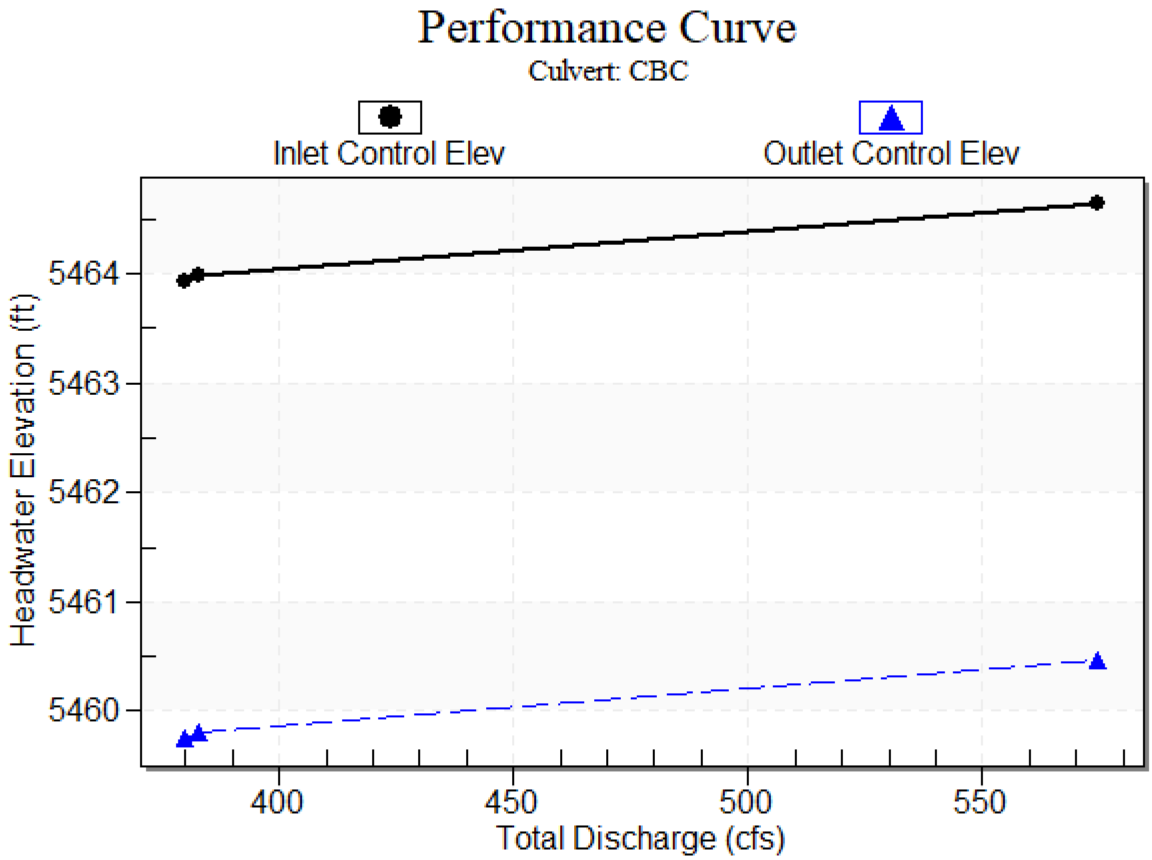
Straight Culvert

Inlet Elevation (invert): 5457.23 ft,   Outlet Elevation (invert): 5452.88 ft

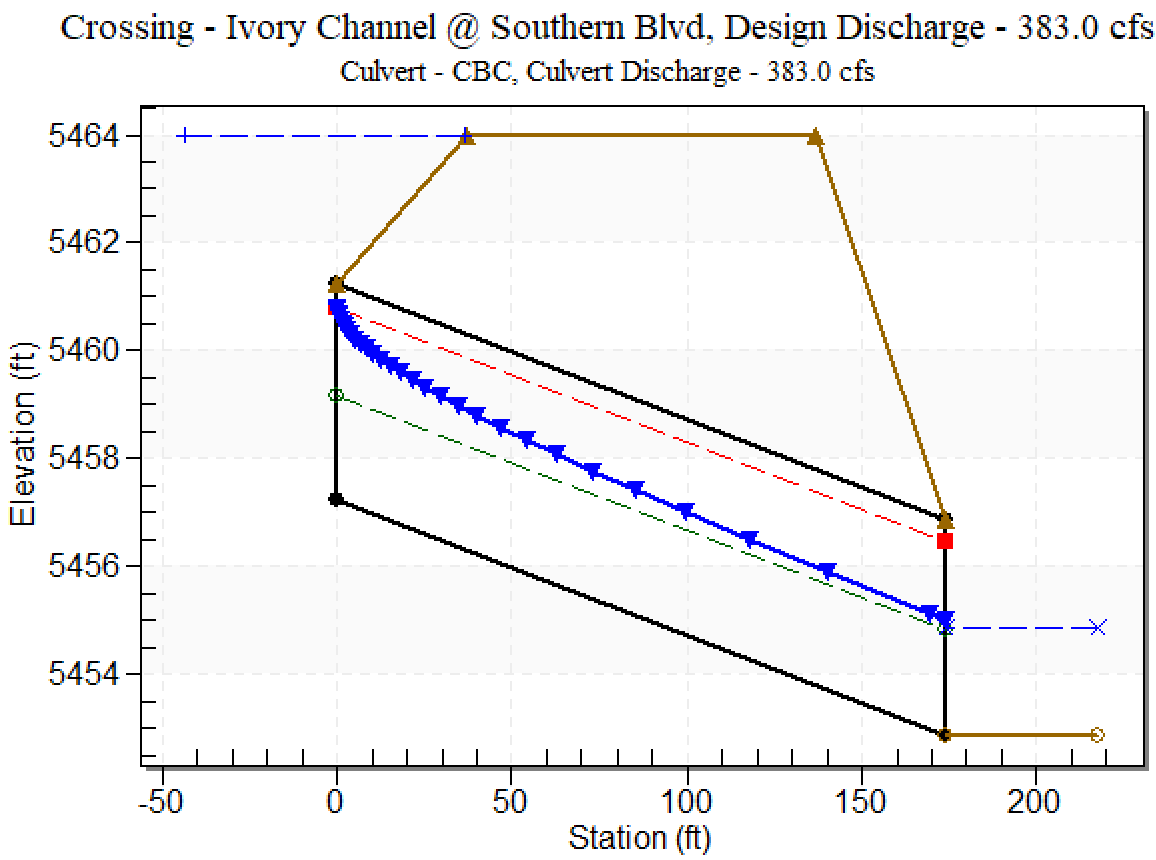
Culvert Length: 173.98 ft,   Culvert Slope: 0.0250

****

Culvert Performance Curve Plot: CBC



Water Surface Profile Plot for Culvert: CBC



Site Data - CBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5457.23 ft

Outlet Station: 173.93 ft

Outlet Elevation: 5452.88 ft

Number of Barrels: 1

Culvert Data Summary - CBC

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: Ivory Channel @ Southern Blvd)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
380.00	5454.88	2.00
383.00	5454.88	2.00

Tailwater Channel Data - Ivory Channel @ Southern Blvd

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5454.88 ft

Roadway Data for Crossing: Ivory Channel @ Southern Blvd

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

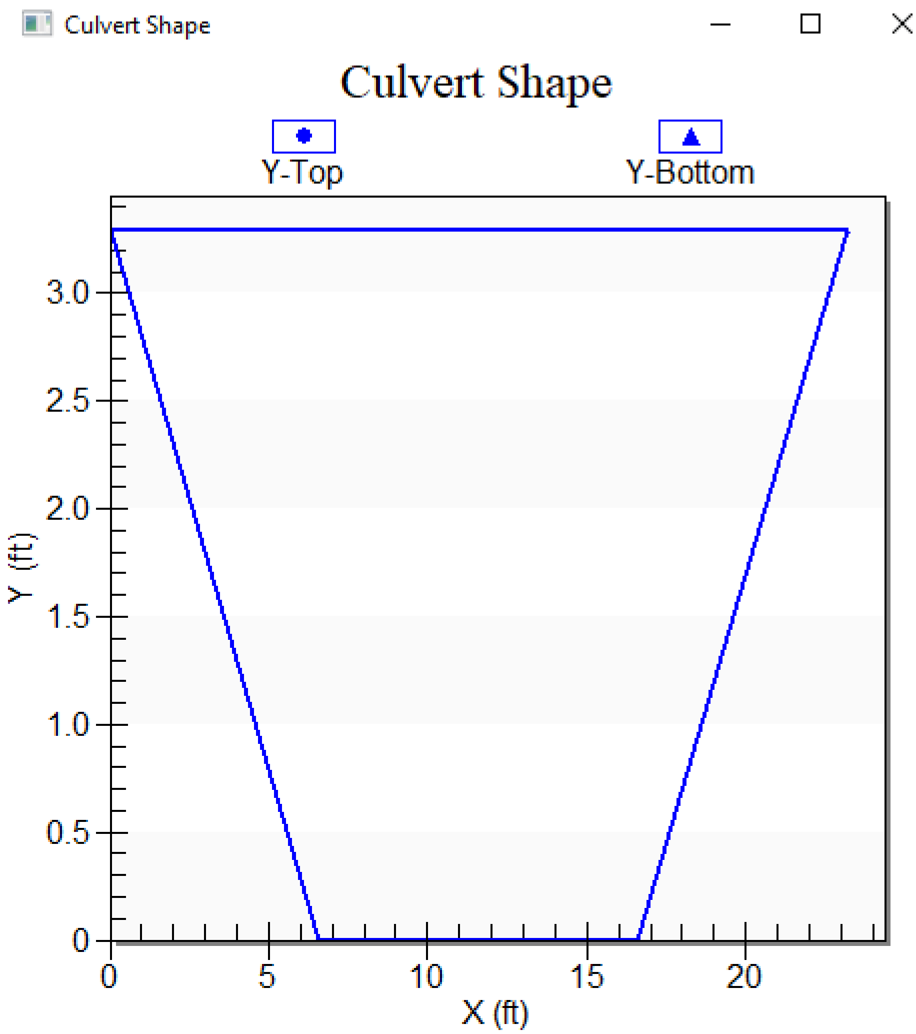
Crest Elevation: 5464.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined



Culvert Shape
Culvert Shape
Y-Top
Y-Bottom
3.0
2.5
2.0
1.5
1.0
0.5
0
Y (ft)
0
5
10
15
20
X (ft)

Table 10 - Summary of Culvert Flows at Crossing: Unser Channel @ Commercial Dr

Headwater Elevation (ft)	Total Discharge (cfs)	Trapezoidal culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5375.37	400.00	400.00	0.00	1
5375.54	415.00	415.00	0.00	1
5375.54	415.15	415.15	0.00	Overtopping

Rating Curve Plot for Crossing: Unser Channel @ Commercial Dr

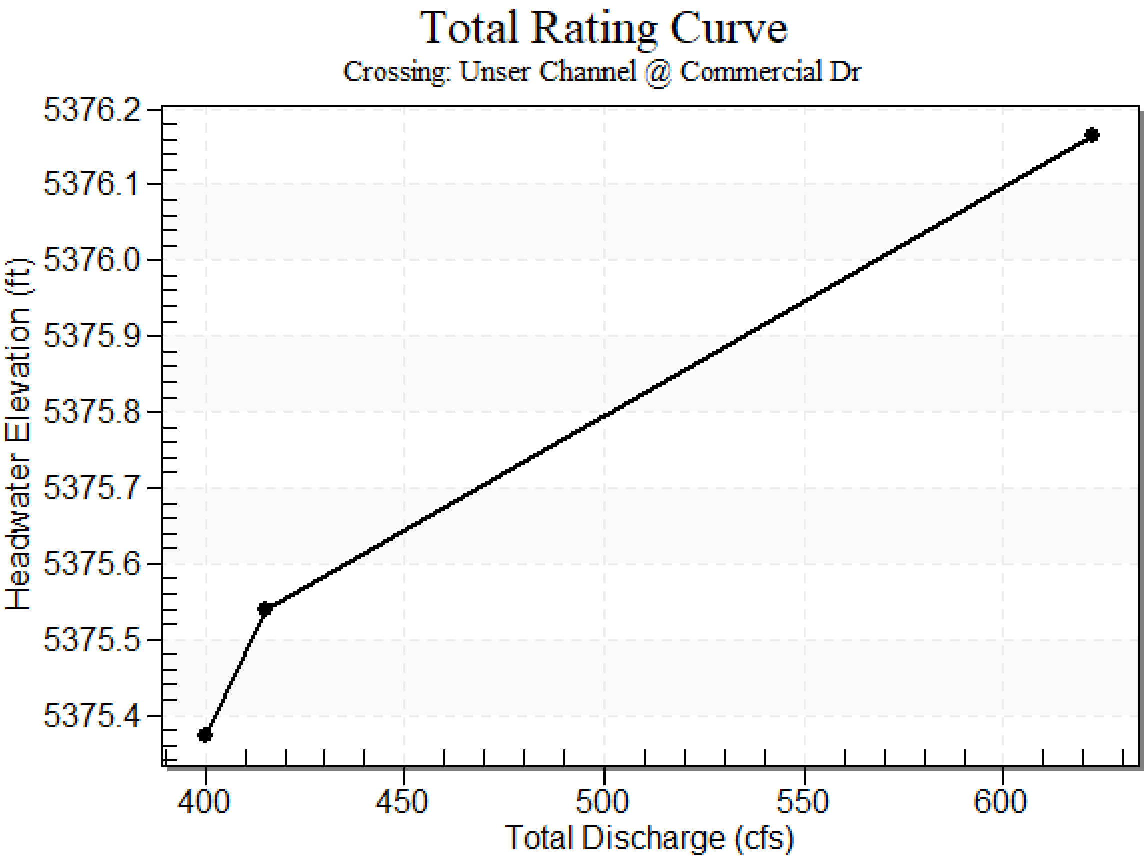


Table 11 - Culvert Summary Table: Trapezoidal culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
400.00	400.00	5375.37	4.154	3.087	5-S2n	1.752	2.989	2.034	1.646	13.965	0.000
415.00	415.00	5375.54	4.318	3.243	5-S2n	1.788	3.051	2.083	1.646	14.051	0.000

****

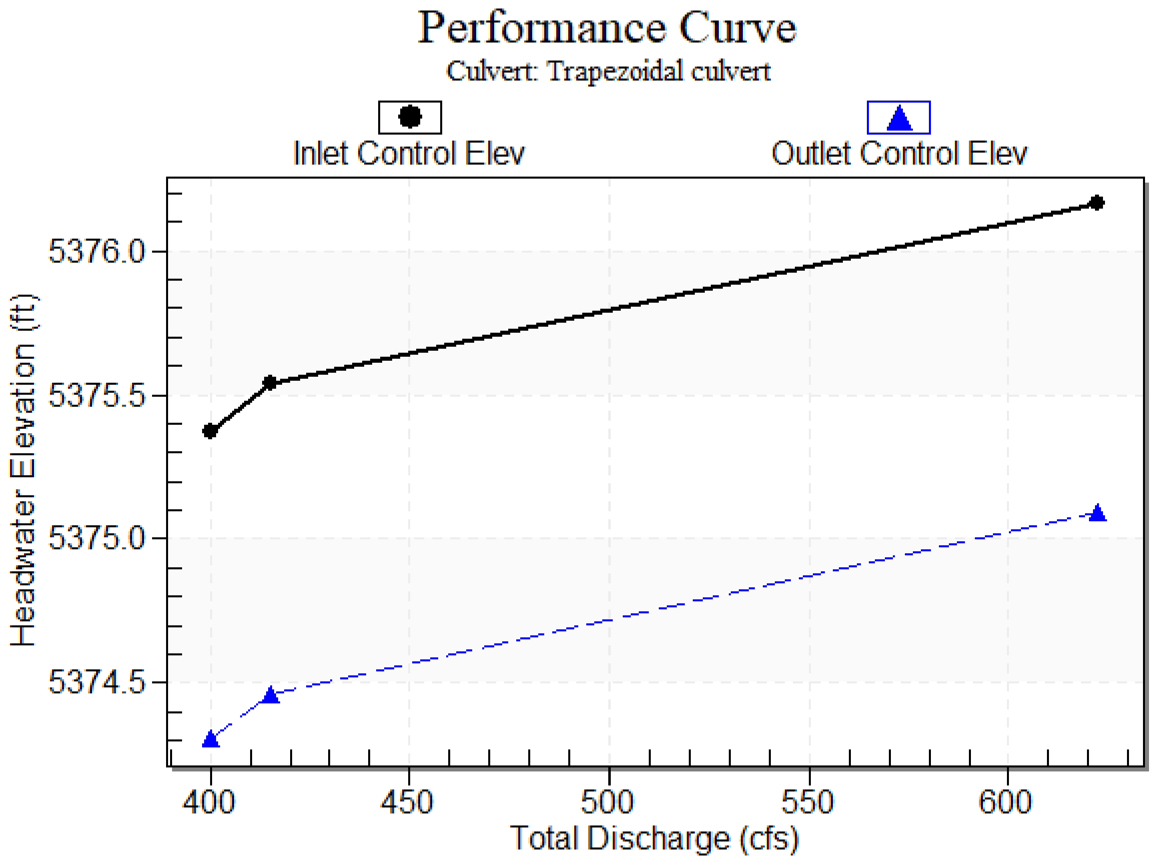
Straight Culvert

Inlet Elevation (invert): 5371.22 ft,   Outlet Elevation (invert): 5369.53 ft

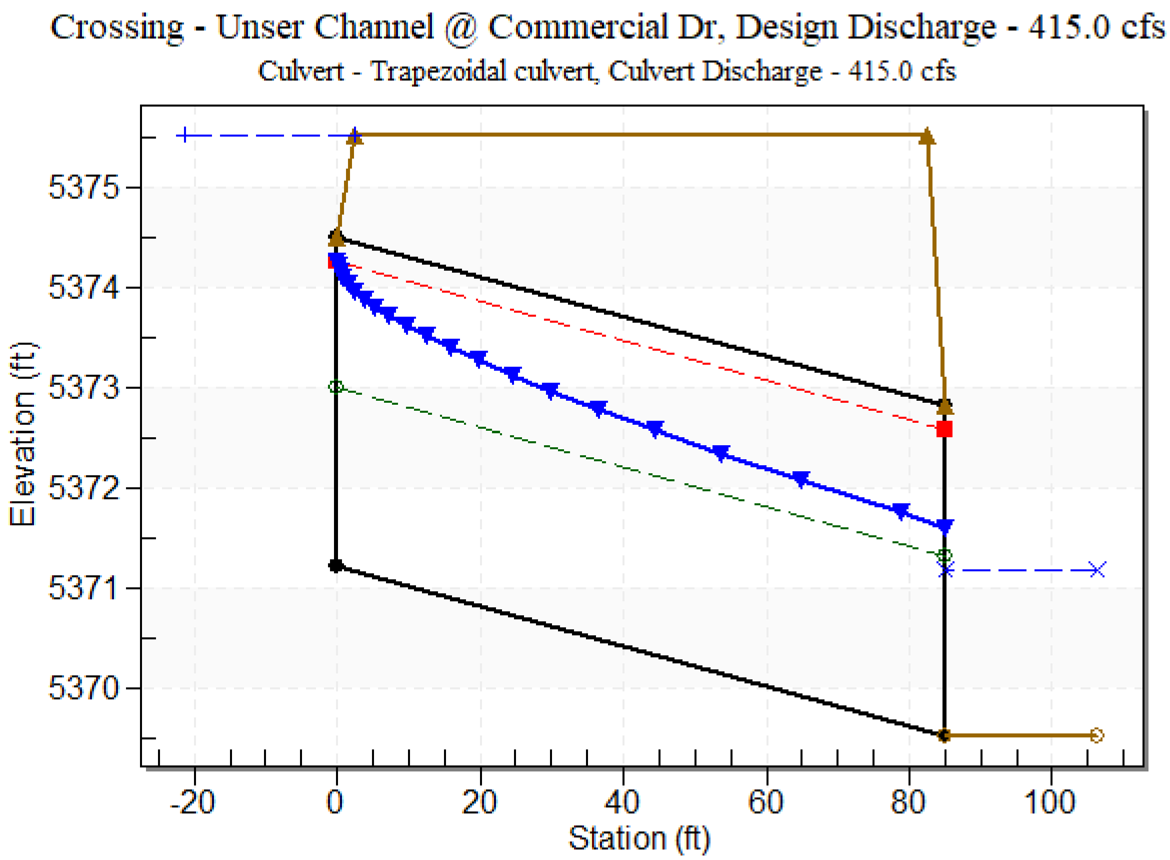
Culvert Length: 85.02 ft,   Culvert Slope: 0.0199

****

Culvert Performance Curve Plot: Trapezoidal culvert



Water Surface Profile Plot for Culvert: Trapezoidal culvert



Site Data - Trapezoidal culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5371.22 ft

Outlet Station: 85.00 ft

Outlet Elevation: 5369.53 ft

Number of Barrels: 1

Culvert Data Summary - Trapezoidal culvert

Barrel Shape: User Defined

Barrel Span: 23.20 ft

Barrel Rise: 3.29 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0150 (top and sides)

Manning's n: 0.0150 (bottom)

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: Unser Channel @ Comm

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
400.00	5371.18	1.65
415.00	5371.18	1.65

Tailwater Channel Data - Unser Channel @ Commercial Dr

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5371.18 ft

Roadway Data for Crossing: Unser Channel @ Commercial Dr

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 5375.54 ft

Roadway Surface: Paved

Roadway Top Width: 80.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 13 - Summary of Culvert Flows at Crossing: Unser Channel @ 14th Ave

Headwater Elevation (ft)	Total Discharge (cfs)	CBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5333.91	1000.00	1000.00	0.00	1
5334.00	1011.00	1011.00	0.00	1
5334.00	1011.09	1011.09	0.00	Overtopping

Rating Curve Plot for Crossing: Unser Channel @ 14th Ave

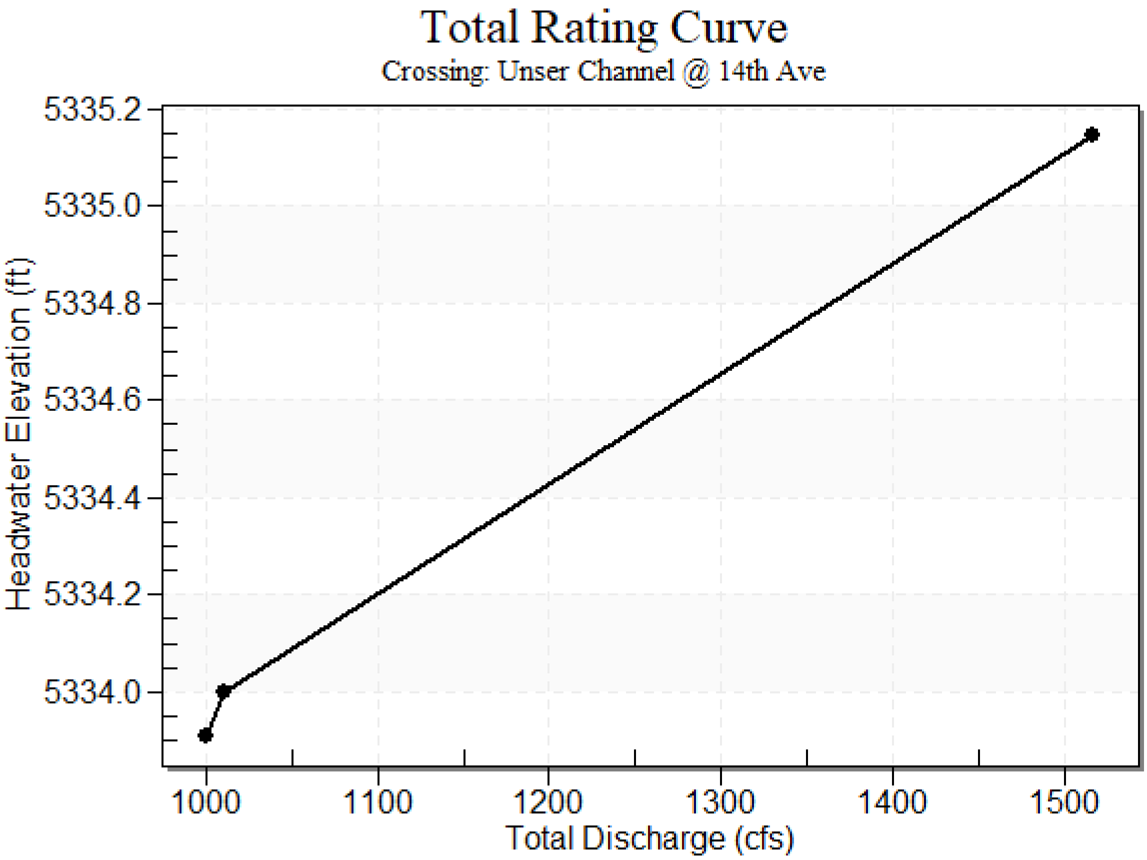


Table 14 - Culvert Summary Table: CBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1000.00	1000.00	5333.91	7.910	6.926	5-S2n	4.004	4.266	4.024	2.500	12.426	0.000
1011.00	1011.00	5334.00	8.000	7.006	5-S2n	4.036	4.297	4.056	2.500	12.463	0.000

****

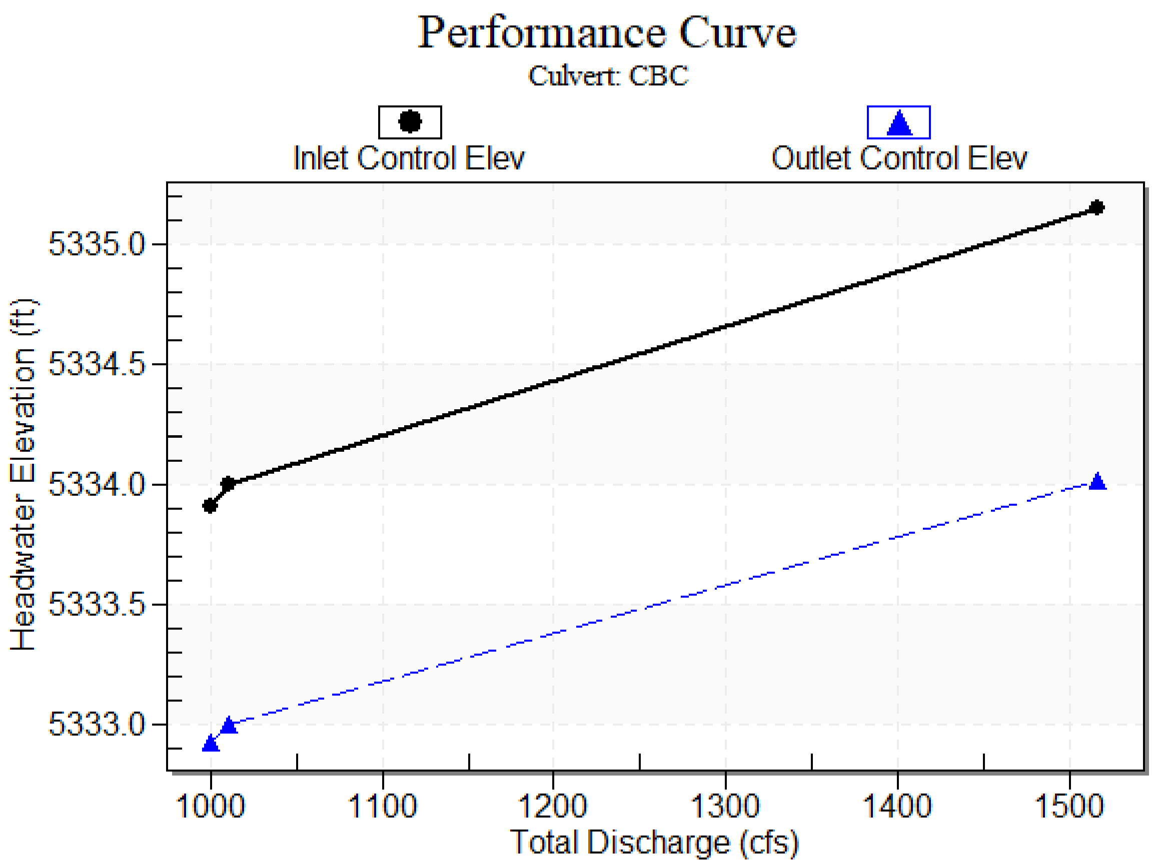
Straight Culvert

Inlet Elevation (invert): 5326.00 ft,   Outlet Elevation (invert): 5325.40 ft

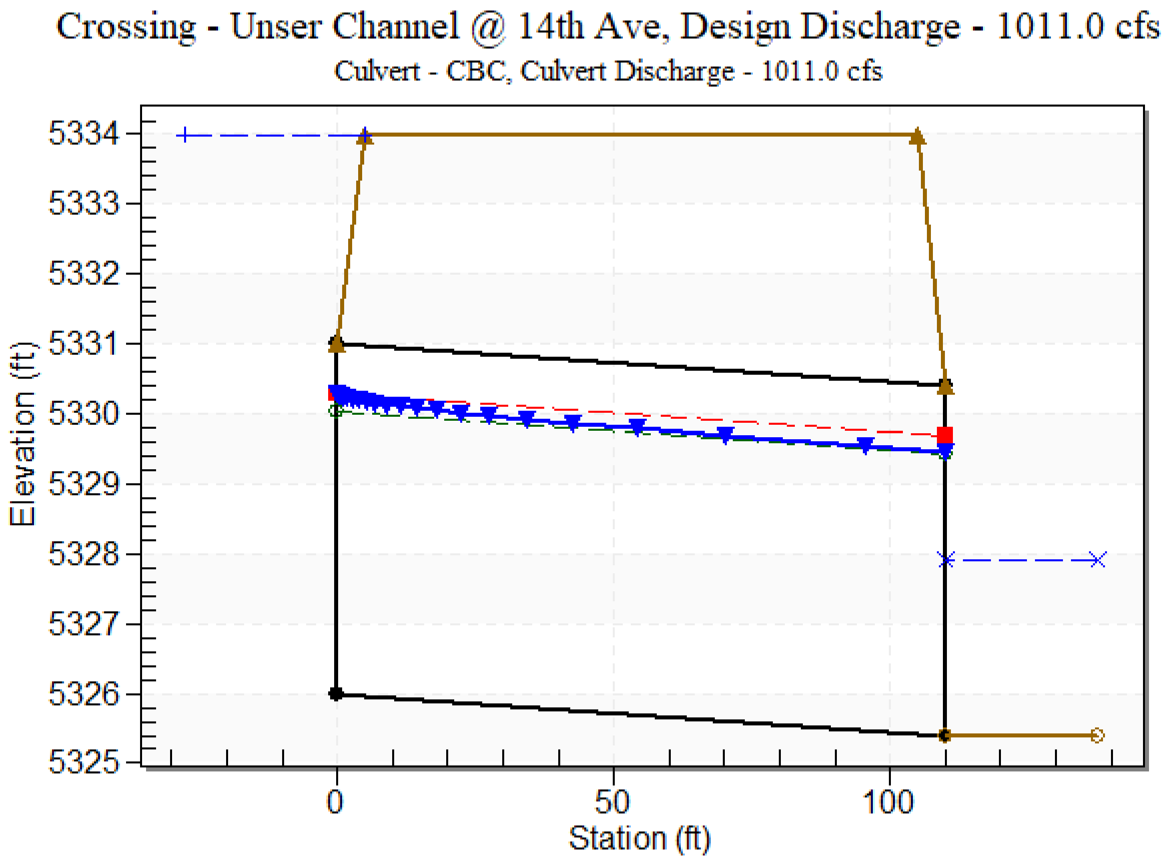
Culvert Length: 110.00 ft,   Culvert Slope: 0.0055

****

Culvert Performance Curve Plot: CBC



Water Surface Profile Plot for Culvert: CBC



Site Data - CBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5326.00 ft

Outlet Station: 110.00 ft

Outlet Elevation: 5325.40 ft

Number of Barrels: 2

Culvert Data Summary - CBC

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 15 - Downstream Channel Rating Curve (Crossing: Unser Channel @ 14th Ave)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1000.00	5327.90	2.50
1011.00	5327.90	2.50

Tailwater Channel Data - Unser Channel @ 14th Ave

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5327.90 ft

Roadway Data for Crossing: Unser Channel @ 14th Ave

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 5334.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 16 - Summary of Culvert Flows at Crossing: West Branch @ Unser Blvd

Headwater Elevation (ft)	Total Discharge (cfs)	CBC Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5281.82	2900.00	2900.00	0.00	1
5281.83	2904.00	2904.00	0.00	1
5281.83	2904.63	2904.63	0.00	Overtopping

Rating Curve Plot for Crossing: West Branch @ Unser Blvd

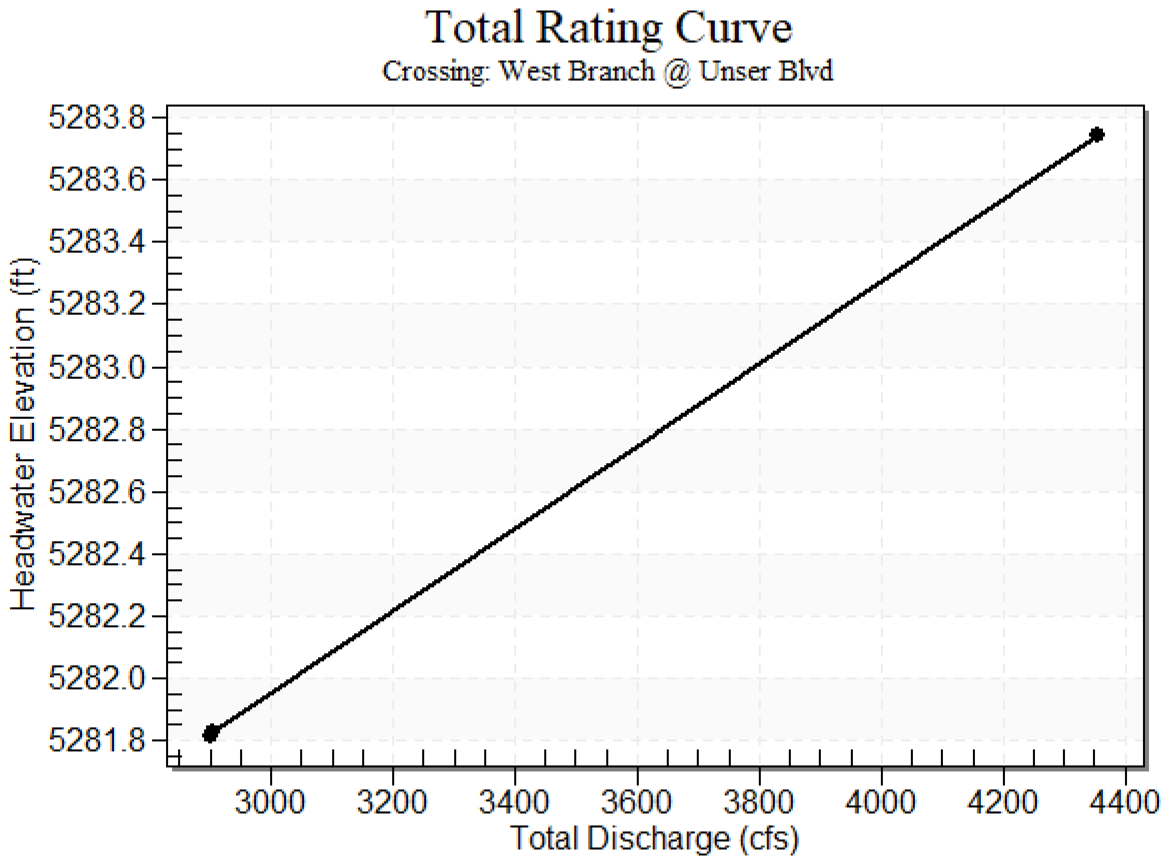


Table 17 - Culvert Summary Table: CBC

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2900.00	2900.00	5281.82	9.487	0.0*	5-S2n	3.372	5.465	3.413	3.750	21.240	0.000
2904.00	2904.00	5281.83	9.498	0.0*	5-S2n	3.375	5.470	3.418	3.750	21.243	0.000

* Full Flow Headwater elevation is below inlet invert.

****

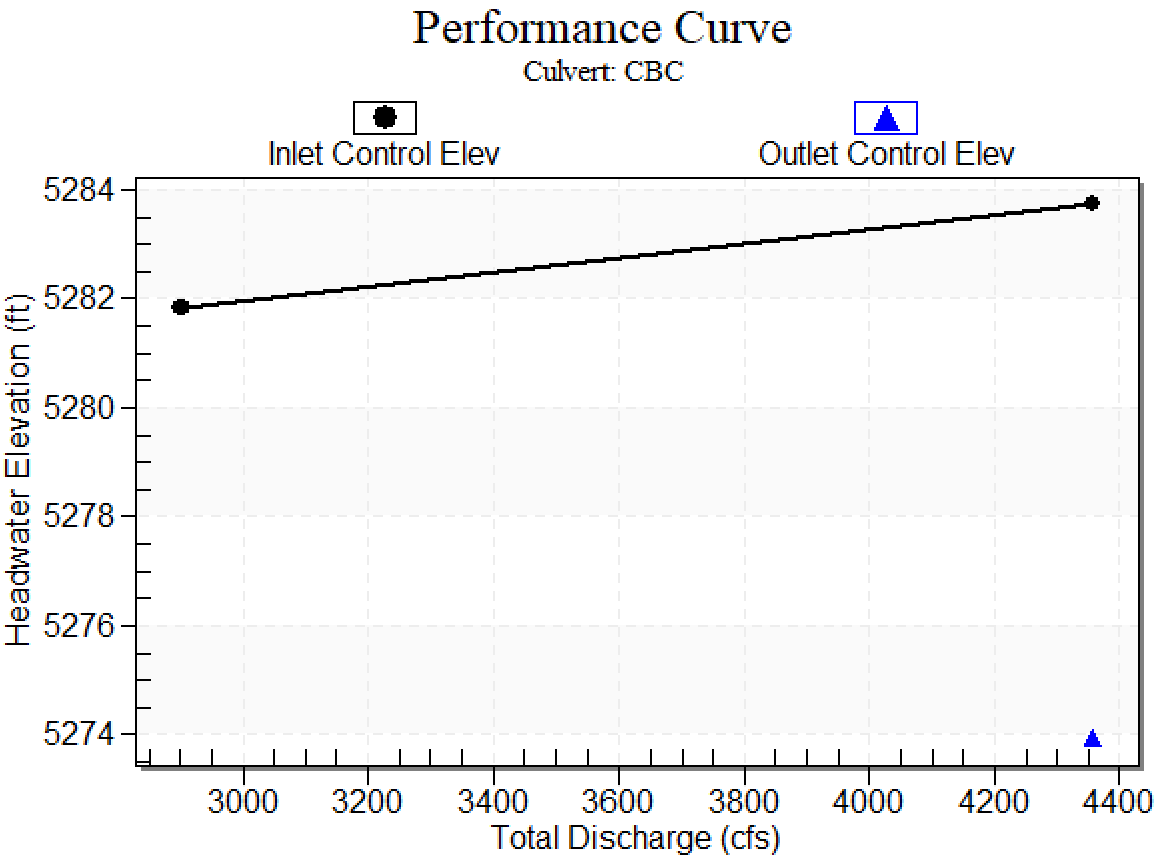
Straight Culvert

Inlet Elevation (invert): 5272.33 ft,   Outlet Elevation (invert): 5260.50 ft

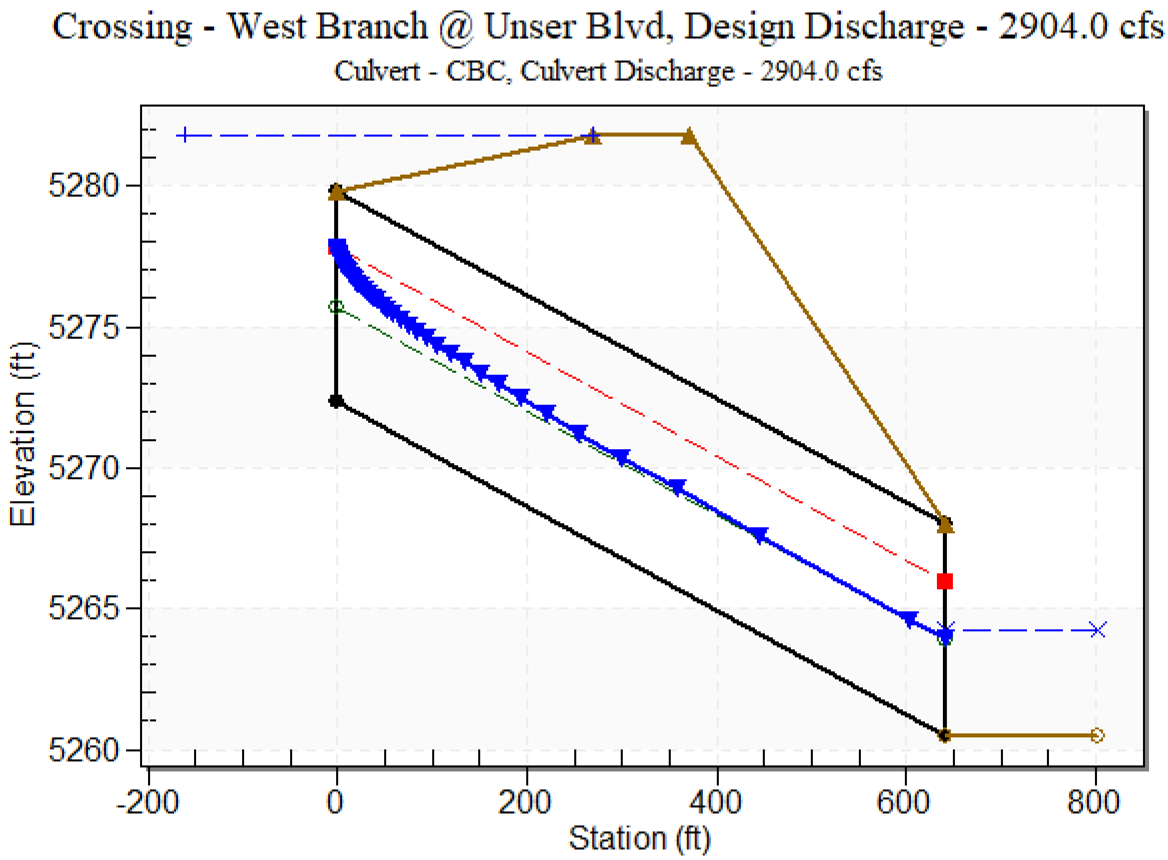
Culvert Length: 641.57 ft,   Culvert Slope: 0.0184

****

Culvert Performance Curve Plot: CBC



Water Surface Profile Plot for Culvert: CBC



Site Data - CBC

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5272.33 ft

Outlet Station: 641.46 ft

Outlet Elevation: 5260.50 ft

Number of Barrels: 4

Culvert Data Summary - CBC

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 7.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 18 - Downstream Channel Rating Curve (Crossing: West Branch @ Unser Blvd)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
2900.00	5264.25	3.75
2904.00	5264.25	3.75

Tailwater Channel Data - West Branch @ Unser Blvd

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5264.25 ft

Roadway Data for Crossing: West Branch @ Unser Blvd

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 5281.83 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 19 - Summary of Culvert Flows at Crossing: Nicklaus Channel (East Branch) @

Headwater Elevation (ft)	Total Discharge (cfs)	CMP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5452.15	790.00	790.00	0.00	1
5452.20	797.00	797.00	0.00	1
5452.20	797.16	797.16	0.00	Overtopping

Rating Curve Plot for Crossing: Nicklaus Channel (East Branch) @ Southern Blvd

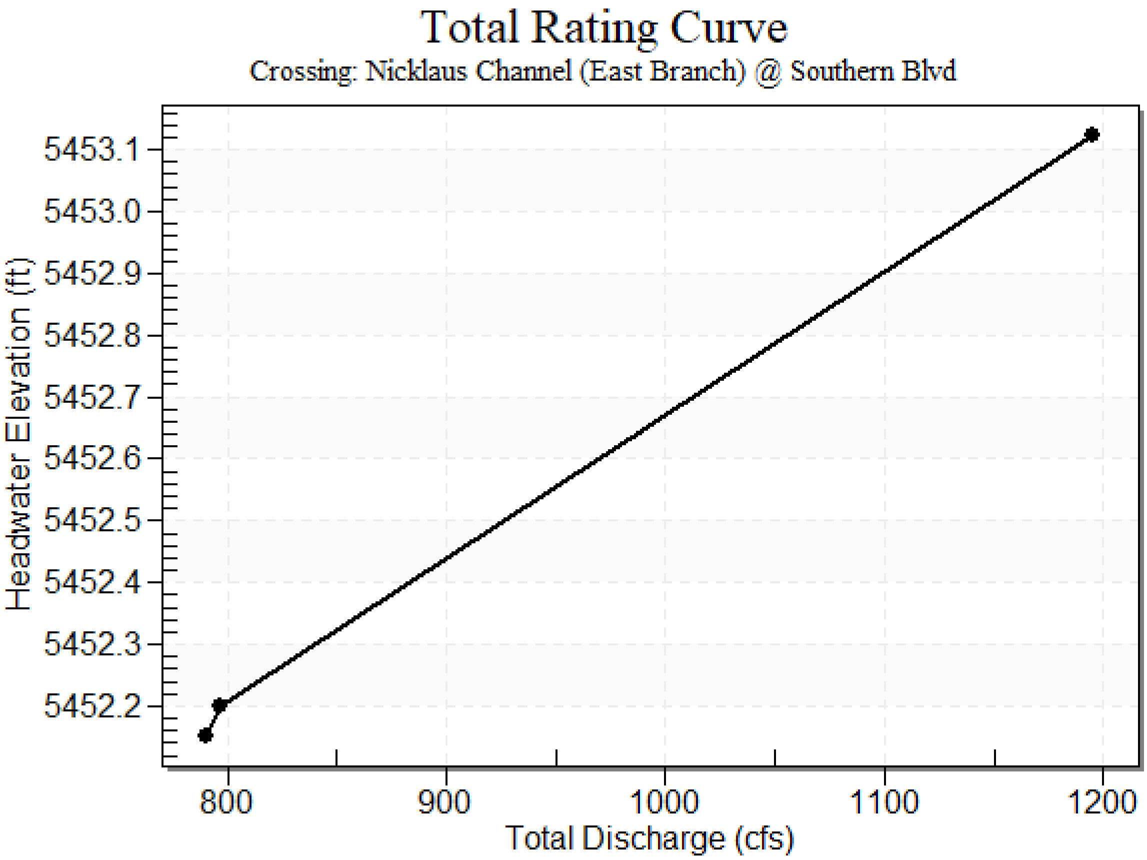


Table 20 - Culvert Summary Table: CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
790.00	790.00	5452.15	5.653	3.934	5-S2n	2.873	3.376	2.873	2.250	12.282	0.000
797.00	797.00	5452.20	5.700	4.004	5-S2n	2.891	3.391	2.891	2.250	12.303	0.000

****

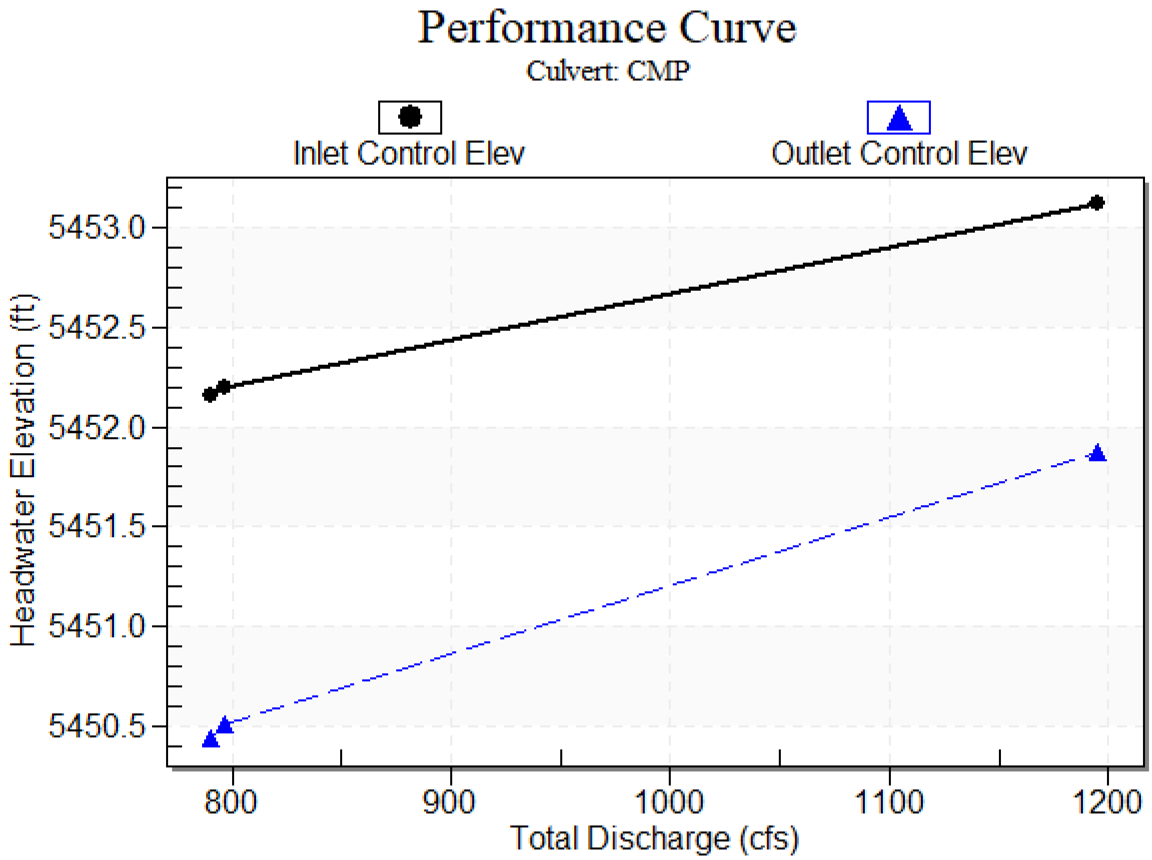
Straight Culvert

Inlet Elevation (invert): 5446.50 ft,   Outlet Elevation (invert): 5443.00 ft

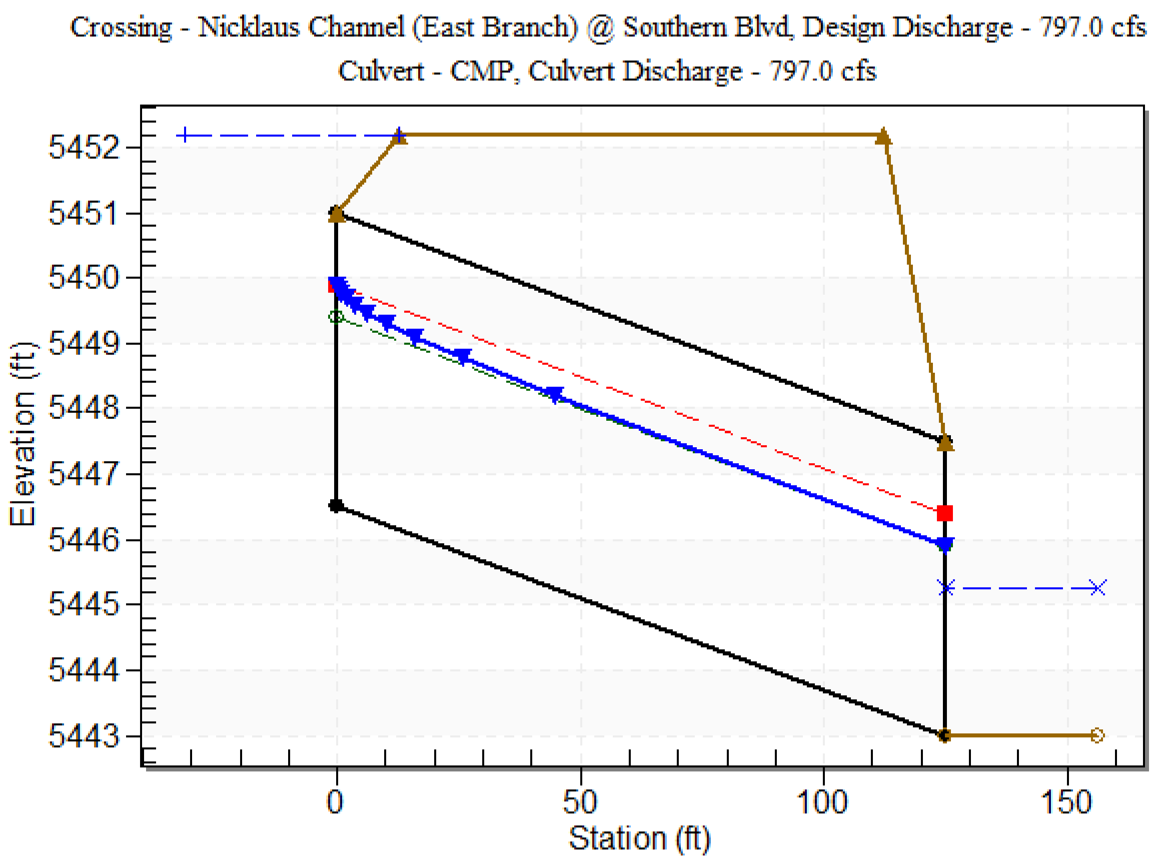
Culvert Length: 125.05 ft,   Culvert Slope: 0.0280

****

Culvert Performance Curve Plot: CMP



Water Surface Profile Plot for Culvert: CMP



Site Data - CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5446.50 ft

Outlet Station: 125.00 ft

Outlet Elevation: 5443.00 ft

Number of Barrels: 6

Culvert Data Summary - CMP

Barrel Shape: Circular

Barrel Diameter: 4.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 21 - Downstream Channel Rating Curve (Crossing: Nicklaus Channel (East Branc[illegible]

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
790.00	5445.25	2.25
797.00	5445.25	2.25

Tailwater Channel Data - Nicklaus Channel (East Branch) @ Southern Blvd

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5445.25 ft

Roadway Data for Crossing: Nicklaus Channel (East Branch) @ Southern Blvd

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 5452.20 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft