Compendium to the Stormwater Management Strategic Plan

City of Santa Fe, New Mexico

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A. SANTA FE RIVER AND ARROYO DE LOS CHAMISOS MODELING REPORT

Santa Fe River and Arroyo de Los Chamisos Modeling Report

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PRESENTED TO

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GLOSSARY

EPA – United States Environmental Protection Agency

GIS – Geographic Information System

HEC-HMS – US Army Corps of Engineers Hydrologic Engineering Center Hydrologic Modeling System

HEC-RAS – US Army Corps of Engineers Hydrologic Engineering Center River Analysis System

LSPC – Loading Simulation Program C

MS4 – Municipal Separate Storm Sewer System

SWMM – Stormwater Management Model

XPSWMM – A commercially available interface to the SWMM modeling system produced by XP Software

EXECUTIVE SUMMARY

This report contains the updates to the Santa Fe River and Arroyo de Los Chamisos Drainage Master Plans that were completed in 1997 and 1998 respectively. The report provides the background on development of new EPA SWMM based flood event models and LSPC based water quality models of the two watersheds. In addition, recommendations for new data collection efforts, modeling, stormwater program implementation and monitoring are provided.

As described in the scope of work, Tetra Tech has adopted a modeling approach to aid in the update of the drainage management plan for the Santa Fe River and Arroyo de Los Chamisos watersheds. Two major considerations for the modeling were flood control and water quality. Subtask 2.4 of the project describes building stormwater and flood management, and water quality models for assessing flooding conditions, erosion, and pollutant loading in the Santa Fe River and Arroyo de Los Chamisos watersheds. Pre-processing of data provided by the city was accomplished using ArcMap, and XPSWMM and LSPC models were built based on the existing and field collected data. The models were used to update the Santa Fe Watershed Plan previously developed in the late 1990's.

Based on the outputs of the XPSWMM and LSPC models, and the Arroyo Threat Assessment Report (Santa Fe Watershed Assocoation, 2016), Tetra Tech recommends four priority pilot areas for Green Infrastructure (GI) implementation:

1. The drainage areas in the City of Santa Fe downtown area are of highest priority.
2. The areas draining to the Arroyo Cloudstone and Arroyo Foothill are also of concern because of high cumulative sediment and nutrient loading from upstream subcatchments.
3. The drainage areas in Arroyo de Los Chamisos (North Fork) are currently experiencing flooding issues during storm events.
4. The areas near the mouth of the Santa Fe River are recommended for GI implementation. High runoff, sediment, and nutrient loads are predicted for some subcatchments.

The list below summarizes the team's recommendations based on the current modeling effort and ties the recommendations to other stormwater program efforts where synergies exist or where the information developed would serve multiple purposes.

- Stormwater System Infrastructure Collection – Priority 1
    - The City's record of stormwater infrastructure needs a comprehensive program to identify all street inlets, underground pipes, manholes, roadway culvert crossings and outfalls. This information is necessary for refined watershed modeling, siting water quality BMPs, determining monitoring locations, building an asset management program, and documenting maintenance concerns and compliance with MS4 program requirements.
- Detailed impervious cover database – Priority 2
    - A detailed impervious cover dataset based on the existing LiDAR data and a new high-resolution aerial image acquired for the purpose of impervious cover identification is recommended for use across several areas of the stormwater program. The detailed dataset can be used to better refine the LSPC and XPSWMM models, develop a parcel by parcel equitable stormwater utility fee (based either on impervious cover area or stormwater runoff generated per parcel), plan future expansion of the city by limiting impervious cover in sensitive areas) and identify unpermitted or unreported buildings and development across the city.
- Refine stormwater system criteria for water quality and sediment transport – Priority 1
    - The City's current stormwater criteria requires all infrastructure to meet the 100-year storm. This causes a singular focus on flood events and doesn't recognize the concerns of water quality, stream stability, sediment transport, and stormwater volume management. In concert with forthcoming water quality based requirements, the City's stormwater management criteria should

be expanded to address culvert design, stable channel design, and sediment transport to reduce flooding, maintenance and future erosion issues.

- Include stream flow monitoring in water quality monitoring program – Priority 3
    - The proposed MS4 permit requires monitoring for pollutants of concern with the City of Santa Fe's boundary. The monitoring program should address both the need for water quality information and the need for additional runoff rate and volume measurements to verify watershed scale modeling and local design parameters. The LSPC watershed models developed under this work assignment are largely uncalibrated because of limited monitoring data to aid in the parameterization of the model. The model performance for hydrology and water quality should be reviewed in the future based on streamflow and water quality monitoring data. Such an exercise will increase confidence on model estimates of sediment and nutrient loading.

The SWMM models developed in this report are intended for use by planners, designers, and agency staff who need to assess the impacts or benefits of proposed changes in the watershed. SWMM models are readily adapted to many modeling scenarios and information can be exchanged with other freely available models such as HEC-HMS and HEC-RAS.

1.0 INTRODUCTION

As described in the scope of work, Tetra Tech has adopted a modeling approach to aid in the update of the drainage management plan for the Santa Fe River and Arroyo de Los Chamisos watersheds. Two major considerations for the modeling were flood control and water quality. Subtask 2.4 of the project describes building stormwater and flood management, and water quality models for assessing flooding conditions, erosion, and pollutant loading in the Santa Fe River and Arroyo de Los Chamisos watersheds. Pre-processing of data provided by the city was accomplished using ArcMap, and XPSWMM and LSPC models were built based on the existing and field collected data. The models were used to update the Santa Fe and Arroyo de Los Chamisos Watershed Plan previously developed in the late 1990’s. In the following sections, the steps taken to prepare or gather required data in support of model development, and results for stormwater and water quality modeling are summarized.

2.0 DATA PREPARATION

2.1 WATERSHED DELINEATION AND STREAM DEFINITION

The headwaters Santa Fe River (HUC ID: 130202010102, Area: 54.37 mi2) and Arroyo de Los Chamisos (HUC ID: 130202010103, Area: 26.20 mi2) watersheds are in Region 13 (Rio Grande Region) of the USGS Hydrologic Unit Map (Seaber, Kapinos, & Knapp, 1987). Watershed delineation and stream definition was based on the database provided by the City of Santa Fe and other publicly available data. An approximately 2 ft. resolution digital elevation model (DEM) data provided by Santa Fe County was available for the whole watershed and was generally used as the basis for watershed analyses. Contour lines generated from the LiDAR data acquired from Santa Fe County were used to aid in the delineation of subcatchment boundaries and identify areas susceptible to water-ponding or culverts located under highways/streets. An approximately 0.5 ft. resolution aerial image (dated 2014) was geo-referenced and used as background to identify ambiguous features that are not visible in the DEM or LiDAR data. It should be noted that Google Maps (https://www.google.com/maps) shows that some areas have experienced development/urbanization since 2014. However, in the absence of updated elevation/DEM data for these newly developed areas, it was assumed that the best source of information is provided by the combination of DEM, LiDAR, and aerial image.

A stream network shapefile (provided by the City of Santa Fe) and National Hydrography Dataset (NHD) data for the watersheds were used to guide stream network definition and connectivity of reaches. Delineation of subcatchments were generally based on the existing Drainage Management Plans for the Santa Fe River and Arroyo de Los Chamisos watersheds (City of Santa Fe, 1997; 1998). Subcatchment boundaries were however edited based on the LiDAR based contours and the DEM as deemed necessary. Newly developed properties and additional annexation areas were added to the models as well as reach connections to underground culverts and conduits to better represent contributing areas. A site visit was also performed to define (and refine) boundaries between some subcatchments that were not obvious in the DEM/contour data or street/satellite imagery. ***Figure 1*** represents watershed boundaries, delineated subcatchments, and stream definition for both watersheds used in the models.

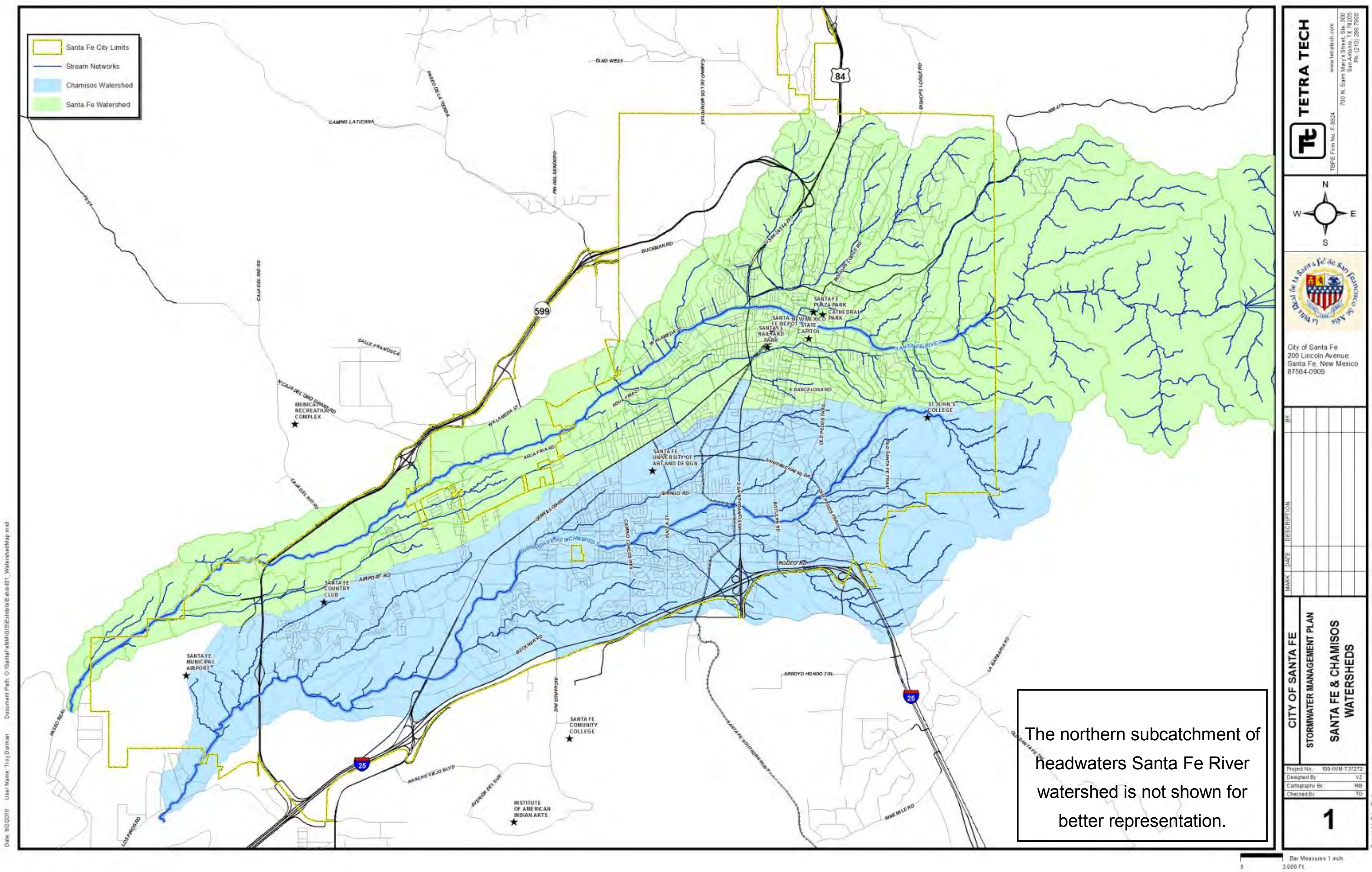


Figure 1. Headwaters Santa Fe River and Arroyo de Los Chamisos Watersheds, subcatchments, and stream networks.

2.2 SUBCATCHMENT NAMING CONVENTION

To establish a unique identifier for each individual subcatchment, the USGS Hydrologic Unit Code (HUC) numbering system was adopted. HUC 12 IDs are available for both Santa Fe River and Arroyo de Los Chamisos watersheds but further sub-classification is not available. The 12-digit numbering system for Santa Fe watershed is provided below as an example.

13: Region: Rio Grande

02: Sub-Region: Elephant Butte

02: Account Unit: Rio Grande-Elephant Butte

01: Cataloging Unit: Rio Grande-Santa Fe

01: Watershed: Santa Fe River

02: Subwatershed: Headwaters Santa Fe River

The HUC 12 IDs therefore represent the Headwaters Santa Fe River and Arroyo de Los Chamisos watersheds but not their subcatchments. Each individual tributary and subcatchment were therefore given HUC 14 and 16 IDs based on the *Federal Standards and Procedures for the National Watershed Boundary Dataset (WBD)* (USGS & USDA, 2013). In the HUC 16 numbering system, the HUC 12 ID is followed by tributary ID (13th and 14th digits) and then the subcatchment ID (15th and 16th digits). Each tributary was also assigned a name based on the effective FEMA Digital Flood Insurance Rate Map data, USDA Hydrography dataset (where available), or nearest street (***Table 1***) to facilitate identification.

Table 1. Source of the naming for tributaries.

Headwaters Santa Fe River		Arroyo de Los Chamisos	
Tributary Name	Source	Tributary Name	Source
Arroyo Barranca	FEMA Data	Arroyo de Los Amigos	FEMA Data
Arroyo de La Piedra		Arroyo de Los Chamisos	
Arroyo Del Rosario		Arroyo de Los Chamisos (North Fork)	
Arroyo Mascaras		Arroyo En Medio	
Arroyo Ranchito		NE Arroyo de Los Pinos	
Arroyo Saiz		Arroyo de La Paz	Stormwater Management Plan (City of Santa Fe, 1998)
Arroyo Torreon		Arroyo de Los Pintores	
Canada Ancha		Cloudstone Arroyo	
Canada Rincon		Foothill Arroyo	
Santa Fe River		Sawmill Arroyo	

<table>
<tr><th colspan="2">Headwaters Santa Fe River</th><th colspan="2">Arroyo de Los Chamisos</th></tr>
<tr><th>Tributary Name</th><th>Source</th><th>Tributary Name</th><th>Source</th></tr>
<tr><td>Acequia de Los Pinos</td><td>USDA Hydrography Dataset</td><td>Sheriff's Arroyo</td><td></td></tr>
<tr><td>Camino Carlos Real</td><td rowspan="15">Street closest to stream</td><td>Mesa Del Oro</td><td rowspan="11">Street closest to stream</td></tr>
<tr><td>Vista de Cristo</td><td>Jaguar Drive</td></tr>
<tr><td>Calle Don Jose</td><td>N Arroyo Chamisos Urban Trail</td></tr>
<tr><td>El Ranch Rd</td><td>Governor Miles Road</td></tr>
<tr><td>Arroyo de Las Cruces Road</td><td>Camino Carlos Rey (Street)</td></tr>
<tr><td>Camino de Chelly</td><td>Nizhoni Drive</td></tr>
<tr><td>San Jose Ave</td><td>Camino Lado</td></tr>
<tr><td>Agua Fria Road</td><td>Old Pecos Trail</td></tr>
<tr><td>Airport Road</td><td>Calle de Sebastian</td></tr>
<tr><td>Arroyo Tenorio</td><td>Conejo Dr</td></tr>
<tr><td>Canyon Road</td><td>Old Santa Fe</td></tr>
<tr><td>Camino Pequeno</td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>Los Arboles Drive</td></tr>
<tr><td>Alamo Dr</td></tr>
<tr><td>Avenida Rincon</td></tr>
</table>

2.3 LAND USE, SOIL, AND CURVE NUMBER MAP

Urban Hydrology for Small Watersheds (USDA, 1986), often referred to as TR-55, represents simplified procedures for calculation of different hydrological components in small urban areas. To estimate runoff from storm events, the SCS curve number method is a broadly accepted method that relates runoff volume to rainfall depth and water abstractions in the area. The Curve Number (CN) is the most important parameter in the SCS method. CN ranges between 0 to 100 and relates land use and soil types to a number that represents potential for runoff generation. The higher a CN, the more runoff generation during storm events. TR-55 has developed several tables that estimates CN values based on the hydrologic soil group (A, B, C, or D) and land use (urban, agricultural, etc.). ***Table 2*** represents runoff curve numbers for urban areas based on the cover type and hydrological soil group. Impervious covers such as parking lots, rooftops, and streets have high CN values (80-

100), while other areas that have more pervious surfaces like residential lots and desert urban areas have lower CN values which is an indicator of less runoff generation potential.

Table 2. Runoff curve numbers for urban areas (USDA, 1986).

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94

The existing parcels file (available from the Santa Fe County Assessor's Office) has a column labeled "Property_C" which specifies the classification of each parcel in the city. However, the land use classification specified in the parcels file is more aligned with tax purposes and does not classify lots and parcels in a way that can be readily refined for hydrologic modeling. In addition, several thousand parcels in Santa Fe ranging from a few hundred square feet to tens of acres are missing any type of property classification.

To prepare the parcels file for estimating CN values, large unclassified lots were first compared with areal imagery or National Land Cover Dataset (NLCD) to identify land use class. However, there are many small unclassified lots and visual inspection was not possible for all of them. Any unclassified lot smaller than 3 acres was therefore assumed as residential. Other types of classes that were not aligned with hydrologic purposes (such as CITY or EXEM) were converted to the closest class that matched the nature of their activity. The parcels were reclassified into the following classes: Commercial, Forest, Industrial, Open space (good and poor condition), Residential, and Road (***Table 3***). Each land use class was subsequently assigned a unique code ***Table 4***. Residential 1 to 6 classes are defined based on their size and are classified as shown in ***Table 5*** (recommended method by TR-55).

Table 3. Land use classification of parcels data.

Property Classification	Land Use Class
Vacant (VAC)	Open Space (Poor)
Common Areas (COMA)	
Open Space (OPEN)	Open Space (Good)
Parks (PARK)	
Single Residential (SRES)	Residential
Multi Residential (MRES)	
Residential Lot (LOTR)	
CRES	
CITY and EXEM	Other classes based on their usage
Unclassified	
Commercial (COMM)	Commercial

Table 4. land use coding based on the classes.

Land Use Class	Land Use Code
Residential1	1
Residential2	2
Residential3	3
Residential4	4
Residential5	5
Residential6	6
Commercial	7
Forest	8
Industrial	9
Open Space (Good)	10
Open Space (Poor)	11
Road	12

Note - Forest class was chosen based on the "*Woods (good condition)*" in TR-55 for northern areas in both watersheds.

Table 5. Residential areas classification based on their size.

Residential Class	Reported Areas in TR-55 (acre)	Suggested Areas (acre)
Residential1	1/8 or less	1/8 or less
Residential2	1/4	1/8 to 1/4
Residential3	1/3	1/4 to 1/3
Residential4	1/2	1/3 to 1/2
Residential5	1	1/2 to 1
Residential6	2 or more	1 or more

The Soil Survey Geographic Database (SSURGO) contains physical and chemical properties associated with soils covering most of the Continental US produced by the National Cooperative Soil Survey (NRCS, Soil Survey Staff, 2017). SSURGO data was used to classify most soils in the study area except areas upstream of McClure Reservoir in Headwaters Santa Fe River watershed that did not have SSURGO coverage. For those areas, the Digital General Soil Map of the United States (STATSGO2) (NRCS, Soil Survey Staff, 2017) data was used to create a combined soil map (***Figure 2***). The land use coverage (***Figure 3***) was eventually used in conjunction with combined soils dataset to generate curve numbers for each subcatchment (***Figure 4***). Also, TR-55 has average percent of impervious cover for each of the urban districts that are listed in ***Table 2*** and ***Figure 4***.

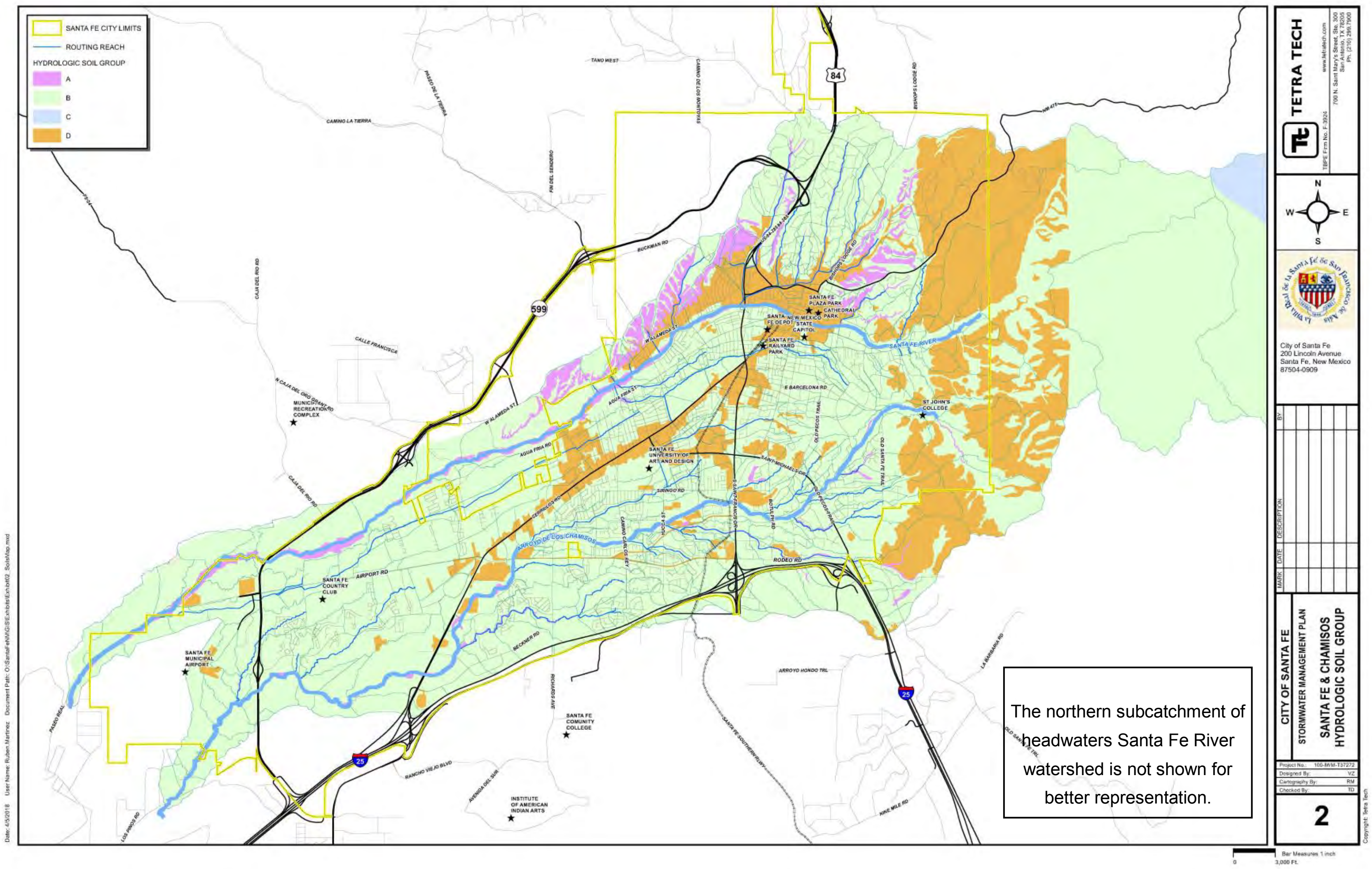


Figure 2. Soil map for headwaters Santa Fe River and Arroyo de Los Chamisos watersheds.

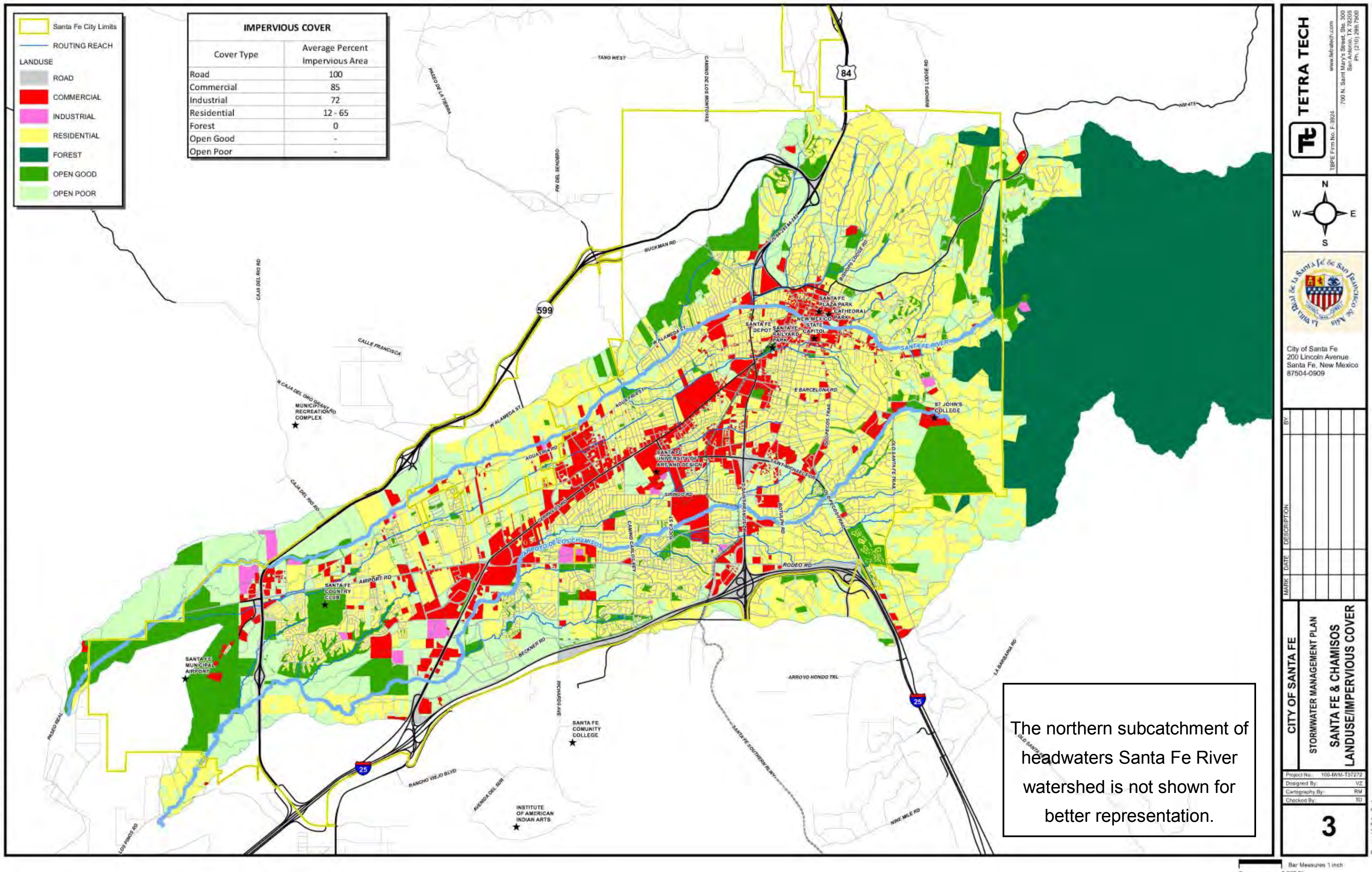


Figure 3. Land use map for headwaters Santa Fe River and Arroyo de Los Chamisos watersheds.

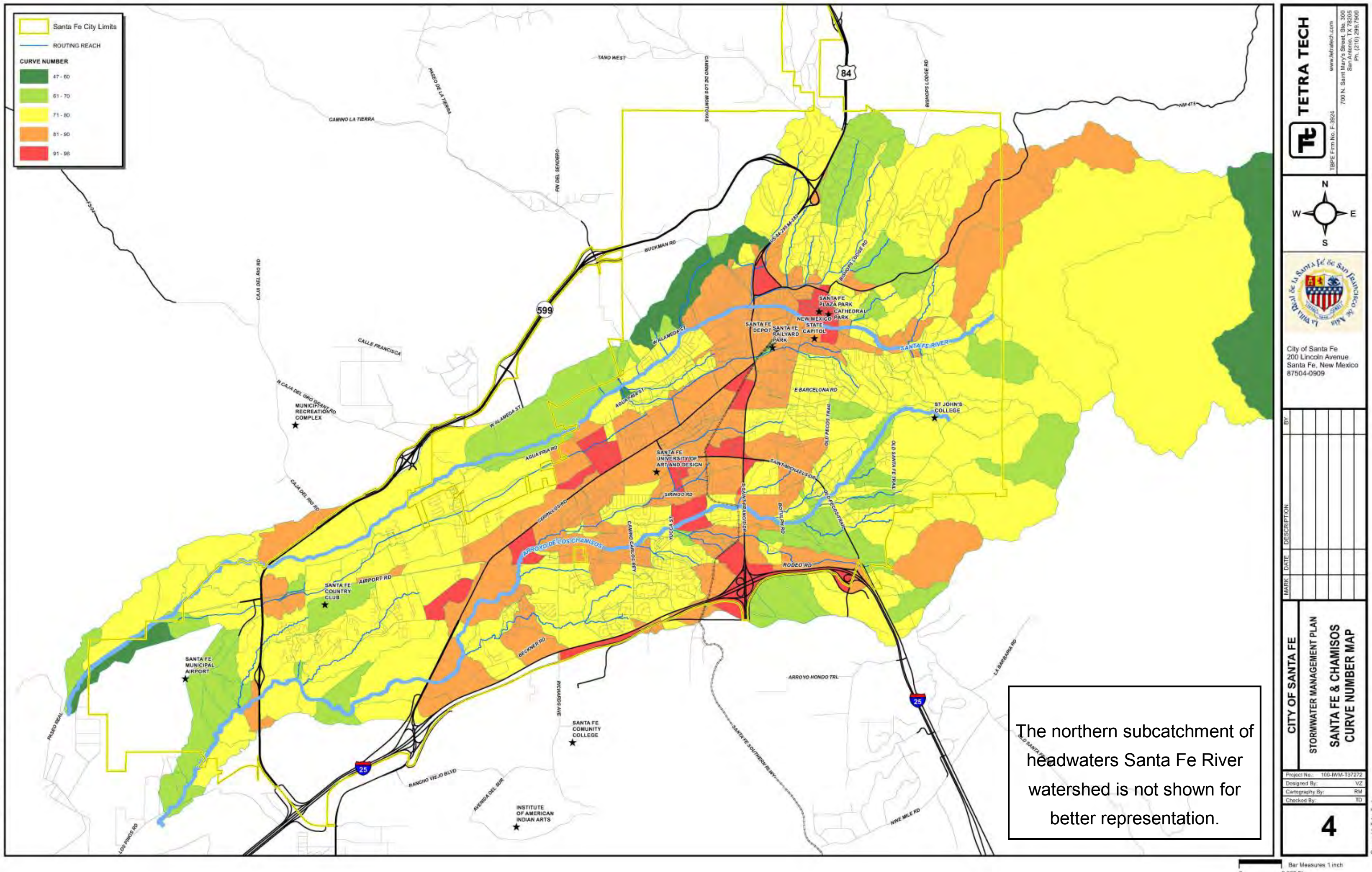


Figure 4. Curve number map for headwaters Santa Fe River and Arroyo de Los Chamisos watersheds.

2.4 STORMWATER CONVEYANCE SYSTEM

To assess the capacity of the current stormwater collection system, accurate data regarding size and type of culverts and conduits are necessary, and is of vital importance in stormwater modeling. Data associated with some culverts were available in *Drainage Management Plan* reports (City of Santa Fe, 1997; 1998) but others were missing. City staff indicated that most improvements identified in the drainage management plans were complete so the proposed culvert sizing table was used to assign the culvert size within the model. The database made available to Tetra Tech by the City of Santa Fe, consists of many shapefiles associated with stormwater infrastructure but they do not cover the entire watershed and attribute tables are often lacking size, material type, and length information necessary for modeling.

Two separate site surveys were therefore completed by Tetra Tech staff to collect information regarding the type and sizes of main roadway crossing culverts located in the watersheds, and upstream and downstream pictures were taken to assess the condition of culverts. ***Figure 5*** shows the location of both surveyed and collected data and ***Appendix A*** and ***Appendix B*** summarize collected information - culvert location, material, size, and number of barrels. The GIS datasets collected for this study will be submitted as part of a separate data deliverable of the storm drainage system

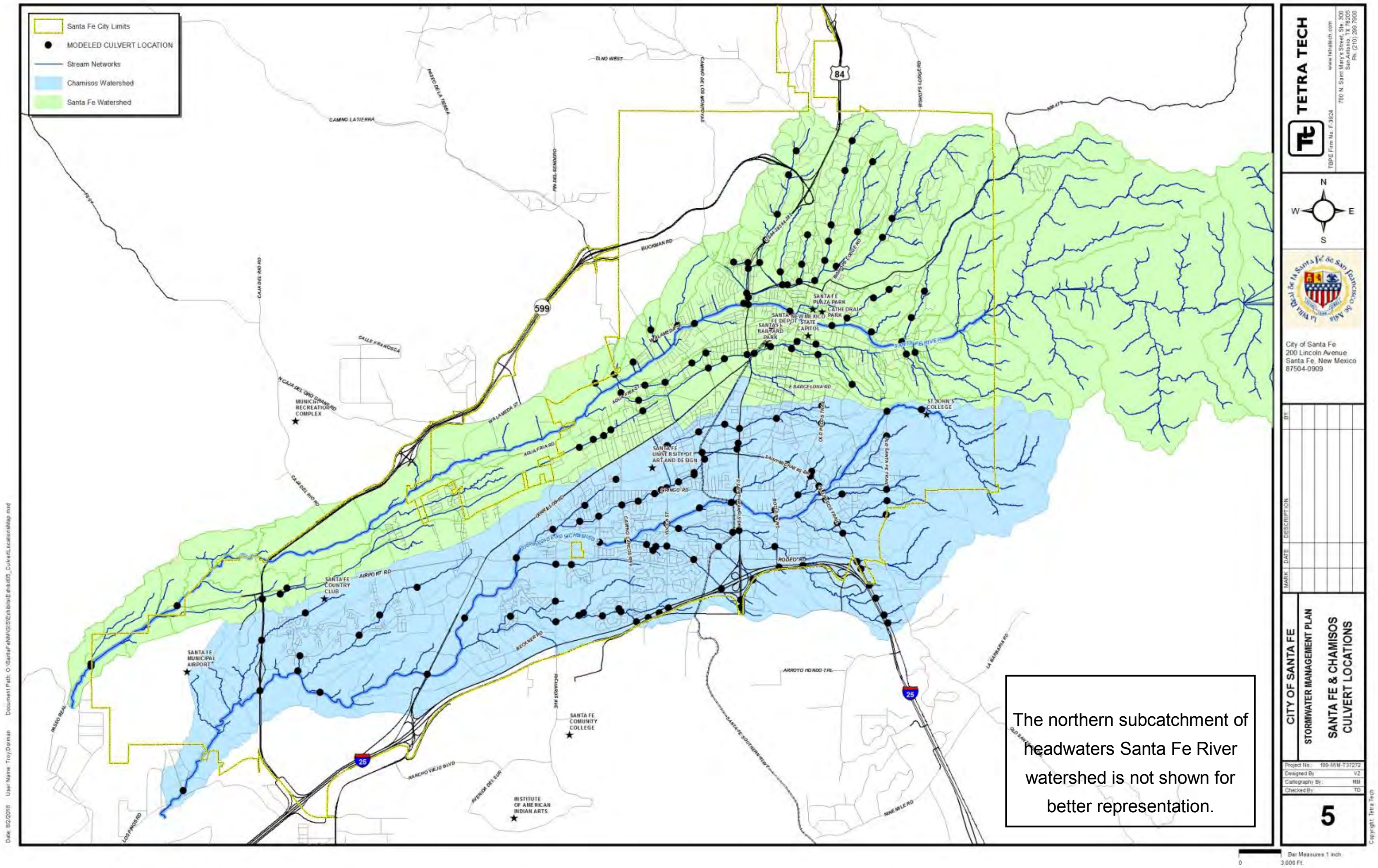


Figure 5. Location of data points (surveyed and collected) for pipes and culverts.

3.0 HYDROLOGIC AND HYDRAULIC MODELING

3.1 PRECIPITATION DATA

Precipitation data for the modeling was extracted from NOAA Atlas 14 online server for the area of City of Santa Fe (NOAA, 2011). The 10-year and 100-year design storms for a 24-hour duration were selected for modeling purposes and entered into the model as the source of rainfall (***Table 6***). These design storms are typically used for sizing culvert and storm drain systems as well as mapping floodplains.

Table 6. Design storm values for Santa Fe area (inches)

Duration	Average recurrence interval (years)	
	10	100
24 hour	2.15	3.16

3.2 RAINFALL-RUNOFF GENERATION

Snyder's unit hydrograph (Snyder, 1938) was selected as the rainfall-runoff routing method. It is a synthetic unit hydrograph based on a study of ungauged watersheds in the Appalachian Highlands in US. More importantly, there are relationships in this method to estimate the unit hydrograph parameters from watershed characteristics. Area of the subcatchments (in acres), lag time (tp), and storage coefficient (Cp) are the parameters required for unit hydrograph generation in XPSWMM. Lag time was calculated based on the CN lag method for each subcatchment (NRCS, National Engineering Handbook, 1972). Initial Cp values were adopted based on the development condition and average slope of the basin using the information in ***Table 7***.

Table 7. Typical values of Cp (iSWM, 2010).

Typical Drainage Area Characteristics	C_p
Undeveloped Areas w/ Storm Drains	
Flat Basin Slope (less than 0.50%)	0.55
Moderate Basin Slope (0.50% to 0.80%)	0.58
Steep Basin Slope (greater than 0.80%)	0.61
Moderately Developed Area	
Flat Basin Slope (less than 0.50%)	0.63
Moderate Basin Slope (0.50% to 0.80%)	0.66
Steep Basin Slope (greater than 0.80%)	0.69
Highly Developed/Commercial Area	
Flat Basin Slope (less than 0.50%)	0.70
Moderate Basin Slope (0.50% to 0.80%)	0.73
Steep Basin Slope (greater than 0.80%)	0.77

To categorize development and slope condition of each subcatchment in order to match the classes in ***Table 7***, a methodology was applied based on the average CN and Slope of each subcatchment. Development condition was identified based on CN value and steepness was calculated based on average Slope value for each subcatchment (***Table 8***).

Table 8. Curve Number and Slope classification.

Development Classification	Curve Number Value		Slope Classification	Slope Value
Undeveloped	CN < 65		Flat	Slope < 0.1
Moderately Developed	65 ≤ CN < 80		Moderate	0.1 ≤ Slope < 0.2
Highly Developed	CN ≥ 80		Steep	Slope ≥ 0.2

3.3 XPSWMM MODEL

XPSWMM is listed as a "*Nationally Accepted Hydrologic and Hydraulic*" model in FEMA's website (FEMA, 2018). It handles hydrologic and hydraulic modeling based on a collection of nodes, links, and rivers. Subcatchment data are directly served to nodes which handle routing and hydrology tasks (XPSWMM, 2014). For hydraulic modeling of the stream network, well-defined channels were selected for importing into the XPSWMM model which includes the majority of FEMA floodplains (***Figure 6***). In the upstream subcatchments, the longest flow paths including shallow channel sections were represented in the hydrologic analysis of Time of Concentration. Representative cross-sections were selected to define the shape of natural channels and the associated roughness for hydraulic modeling and hydrologic routing. Data were imported directly into XPSWMM from HEC-RAS software. The hydraulic cross-sections are not intended for mapping floodplains but rather to get a general sense of the shape, velocity, and erosivity of the major reaches.

There are two reservoirs located at the headwaters of the Santa Fe River watershed and both are incorporated into the XPSWMM model. They control streamflow from mountainous areas and allow the City of Santa Fe to capture and manage its water resources for water supply. ***Figure 6*** shows the location and ***Table 9*** summarizes basic information for each reservoir. It should be noted that there was another reservoir (Two-mile) downstream of Nichols reservoir but it was breeched in 1994 due to potential failure of the dam (Lewis & Borchert, 2009). ***Appendix C*** and ***Appendix D*** represent Elevation-Area-Storage information used for modeling the reservoirs inside XPSWMM model (Lewis & Borchert, 2009).

Table 9. Reservoirs in Headwaters Santa Fe River watershed.

Reservoir name	Longitude	Latitude	Establishment year	Capacity (ac-ft)
McClure	-105.831	35.689	1926	3255.6
Nichols	-105.877	35.691	1943	684.2

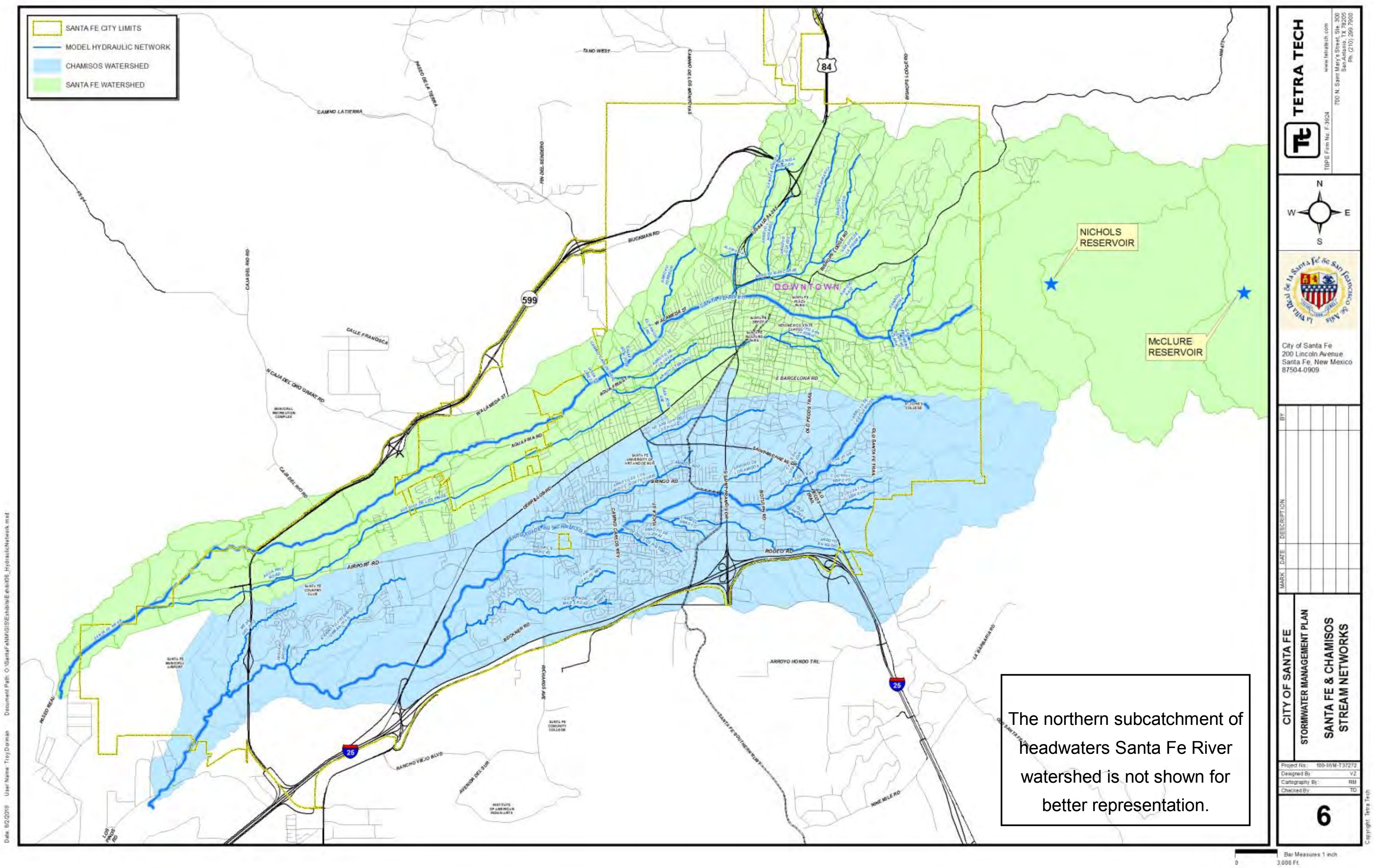


Figure 6. Stream networks selected for hydraulic modeling inside XPSWMM.

4.0 WATER QUALITY MODELING

4.1 LSPC MODEL DEVELOPMENT

LSPC watershed models were developed for the Santa Fe River and Arroyo de Los Chamisos watersheds to establish existing levels of sediment and nutrient loading at the subwatershed scale. The LSPC model for the Arroyo de Los Chamisos watershed consists of 180 subwatersheds while the Santa Fe River watershed is comprised of 176 subwatersheds. Each subwatershed in an LSPC model is comprised of smaller entities known as deluids. A deluid is the identification number assigned to the smallest landuse units in an LSPC model for which all physical processes like infiltration, runoff generation, sediment and nutrient load generation are simulated. A deluid is a unique combination of properties like land cover, soil properties, geology, slope, etc. The deluids in the Santa Fe River and Arroyo de Los Chamisos LSPC models are based on a combination of land cover and HSG. Loads generated by the deluids in a subwatershed are routed through the associated stream and downstream reaches at the model simulation time-step (hourly in this case). The LSPC models for the watersheds are setup for hourly simulation of hydrology, sediment and nutrients from 1/1/2005 to 12/31/2017.

LSPC is a hydrologic model and not a hydraulic model. Reach segments in an LSPC model are represented as one-dimensional fully mixed reactors which maintain mass balance but do not explicitly conserve momentum. The simulation of hydrographs in response to storm events in the model is dictated by Functional Tables (FTables) or depth-area-volume-discharge relationships. FTables in the models are based on physiographic region-specific regression relationships against drainage area (Bieger et al., 2015). The following equations were used for bankfull width (Wm, in meters) and bankfull depth (Ym, in meters) based on drainage area (DA, in square kilometers) we used in the LSPC for automated generation of FTables during runtime.

$$W_m = 2.56(DA)^{0.351}$$

$$Y_m = 0.38(DA)^{0.191}$$

It should be noted that FTable details primarily have an impact on the shape of a storm hydrograph but not the total flow volume.

Gridded products have been used to develop meteorological time-series forcings for the watershed models. Precipitation in the models is based on daily gridded PRISM (Parameter-elevation Relationships on Independent Slopes Model) data disaggregated to an hourly time-step using NLDAS (North American Land Data Assimilation System) version 2 gridded data. PRISM because of a finer spatial resolution is expected to provide better estimates of rainfall in these watersheds compared to NLDAS which are coarser. Other meteorological forcings (air temperature, solar radiation, wind speed and dew point temperature) are based on hourly gridded NLDAS data. Potential evapotranspiration in the model is based on the Penman Pan method with a pan evaporation coefficient appropriate for this region of the US.

5.0 RESULTS AND DISCUSSION

5.1 XPSWMM MODEL

5.1.1 Model Calibration

The hydrologic and hydraulic results of the XPSWMM modeling were compared to the effective FEMA model results for Headwaters Santa Fe River and Arroyo de Los Chamisos watersheds (***Table 10*** and ***Figure 9***). The results were reasonable and compare well with the USGS gage data and Regional Regression equations used to develop the FIS #35049CV001B dated December 4, 2012 (FEMA, 2012). The City of Santa Fe requires all stormwater systems to meet the 100-year storm event design criteria. As a result, all storm evens up to the 100-year would be expected to have similar model parameters and calibration comparisons.

Table 10. 100-year flow comparison between FEMA and XPSWMM data.

Location	Longitude	Latitude	100-yr Flow FEMA FIS (cfs)	100-yr Flow XPSWMM (cfs)
Headwaters Santa Fe River Watershed				
Canada Ancha at Confluence with Santa Fe River	-105.917	35.681	1,150	978
Santa Fe River at The Confluence of Arroyo Mascaras	-105.955	35.688	4,190	4,286
Santa Fe River at approximately 0.46 mile downstream of Alejandro Street	-105.985	35.673	4,390	5,587
Santa Fe River at the Confluence of Arroyo Calabasas	-106.117	35.610	5,930	5,915
Arroyo de Los Chamisos Watershed				
Arroyo de Los Amigos at Confluence with Arroyo de Los Chamisos	-105.958	35.65	600	404
Ne Arroyo de Los Pinos at Upstream of St. Michaels Drive	-105.976	35.66	570	604
Arroyo de Los Chamisos – North Fork	-106.006	35.642	1,800	1,674
Above Confluence with Arroyo Hondo (Cross Section 0A)	-106.095	35.588	4,400	4,898

Model calibration is the process of modifying effective model parameters to match model results with measured data. In order to calibrate model parameters (specially Cp), measured streamflow data are required at the outlet or certain locations of watersheds. Four USGS streamflow gauges are located at the upstream of headwaters Santa Fe River watershed (before and after reservoirs) but since their drainage area are mountainous with woods in good condition, it is not necessarily representative of urban areas (which contain most of the subcatchments). Currently, there are no streamflow measurements in either watershed that are appropriate for calibration. Adjacent watersheds were explored to find subcatchments with similar characteristics in order to calibrate model parameters using their data but no streamflow gauge was found in urbanized areas that could represent development condition in subcatchments. Since flow comparison of XPSWMM model with FEMA data provides reasonable results and no other type of data is available for calibration, we determined that the XPSWMM model is calibrated and ready to be used for further analysis.

5.1.2 Slope Analysis

Digital Elevation Model data was used to calculate the slope of each individual reach segment that has been modeled inside XPSWMM. The output of this analysis identifies reach segments and culverts with low slope that are vulnerable for sediment deposition and pipe clogging during storm events. ***Figure 7*** represents slope analysis results for modeled reach segments and displays them as assorted colors. Comparing results of slope analysis with ***Figure 10*** reveals that most of flood reported locations and pipe surcharges happen in areas with low to moderate slope. Mountainous regions with high slopes located at the upstream of both watersheds drain stormwater faster to flat areas and result in culvert surcharge or flooding when culverts are undersized or plugged. Arroyo Cloudstone, Arroyo Foothills (south-east of Arroyo de Los Chamisos watershed), and Arroyo Mascaras (north of Santa Fe Downtown) are examples of this issue. Also, the Arroyo Threat Assessment Report (Santa Fe Watershed Assocoation, 2016) listed these Arroyo as high priority areas for channel improvement and infrastructure damage.

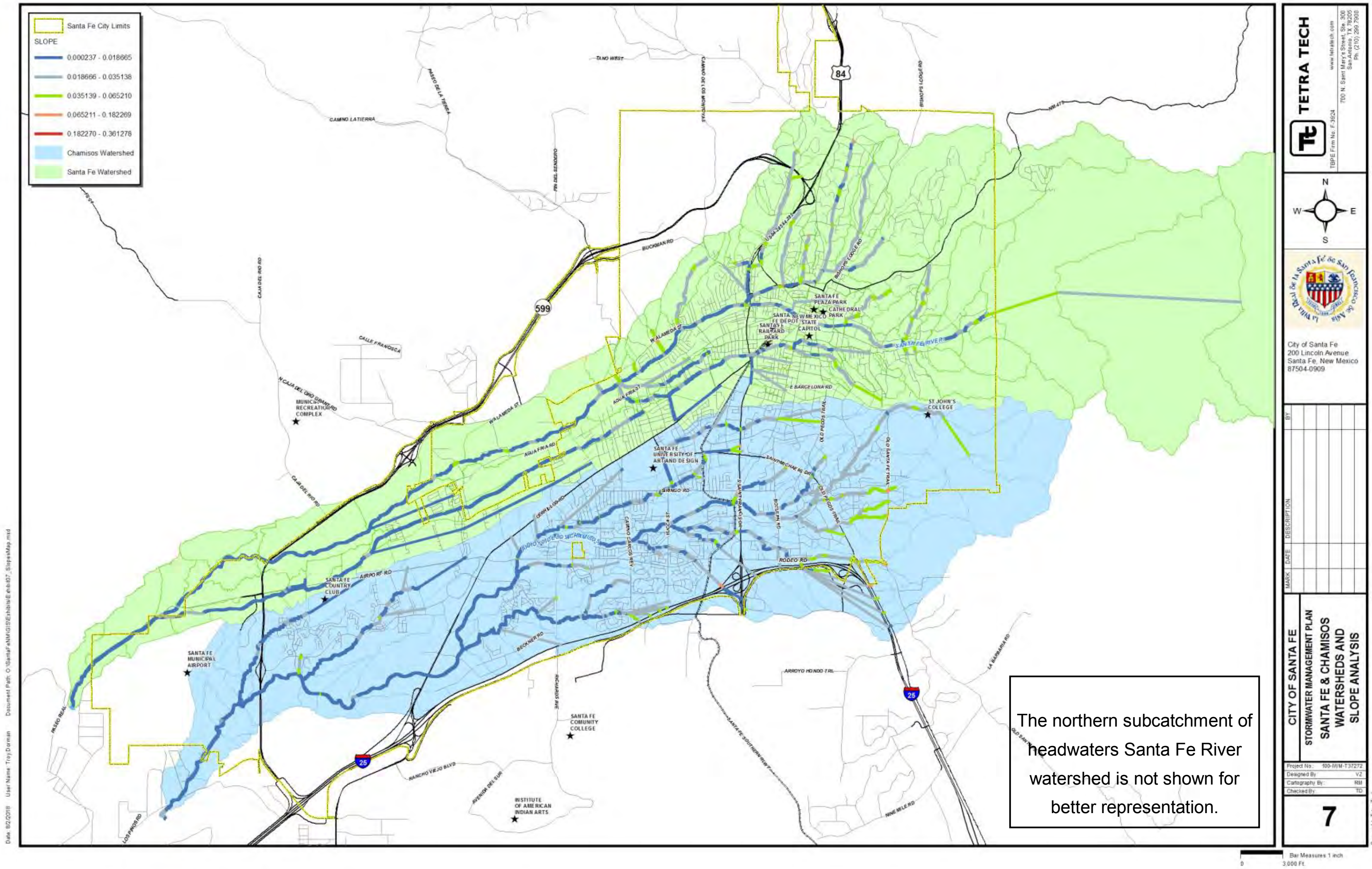


Figure 7. Average slope in reach segments.

5.1.3 Velocity Analysis

The XPSWMM model was run for the 100-year storm event precipitation and velocity profile was generated for each of the reach segments. ***Figure 8*** represents maximum velocity in reach segments. It ranges from 0.01 to 46 ft/s which depends on the slope and geometric characteristics of the reach cross-section. Areas with high velocity are potential for erosion and scour of bridge piers.

Overlaying maximum velocity with slope map reveals valuable information regarding channelization of some reaches. In the high slope areas, higher velocity values are expected but there are some culverts that have moderate or flat slope with high velocity. This issue is due to decreasing cross-section area and forcing flow to pass through the culvert which causes upstream flooding and increased velocity downstream, leading to higher erosion potential. In addition, culverts that have a flat slope or multiple openings at the same elevation cause lower flows to spread out and drop sediments. The combination of factors will create deposition and plugging upstream of a culvert and accelerate erosion downstream of the culvert even during frequent smaller events that produce runoff several times per year.

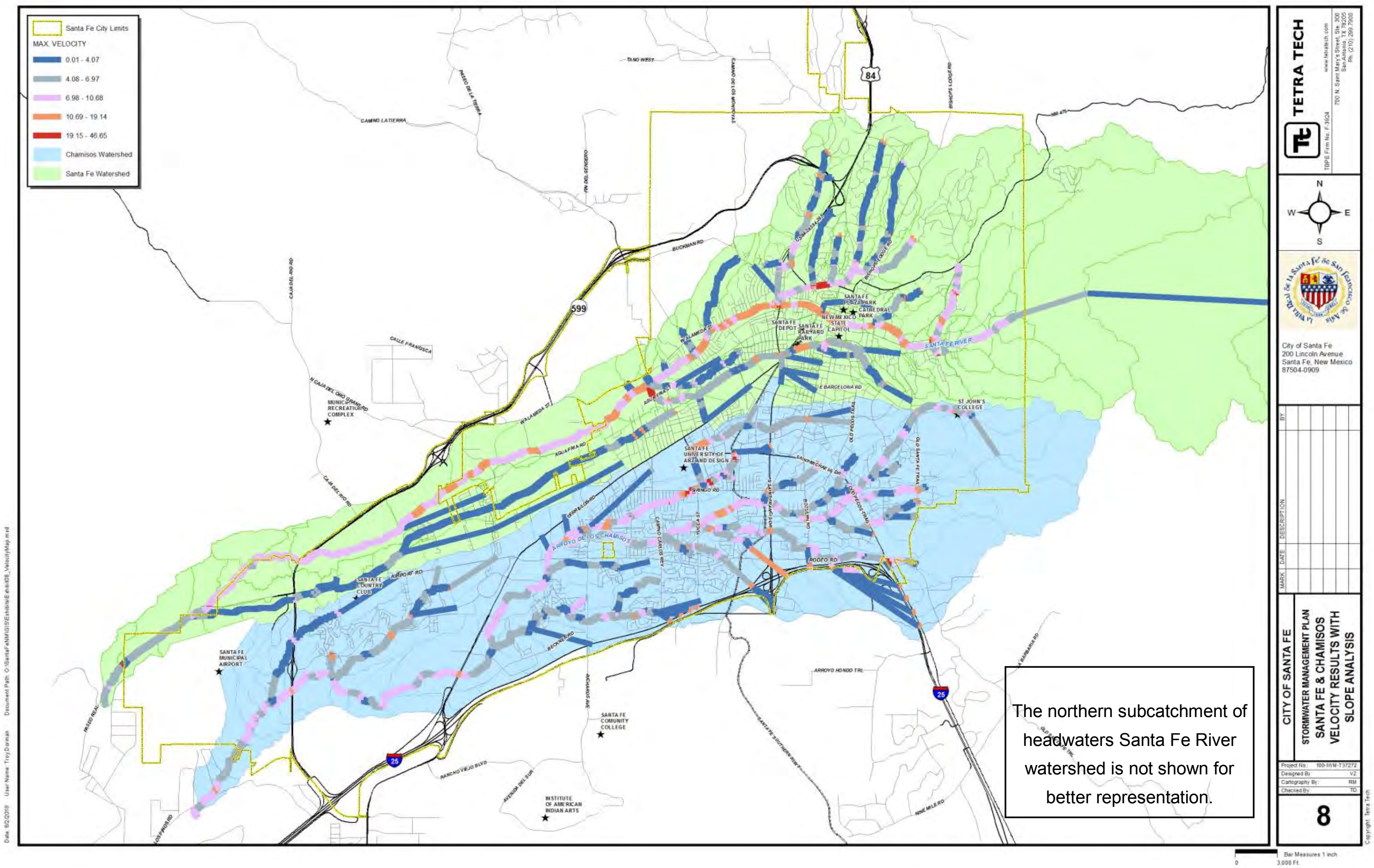
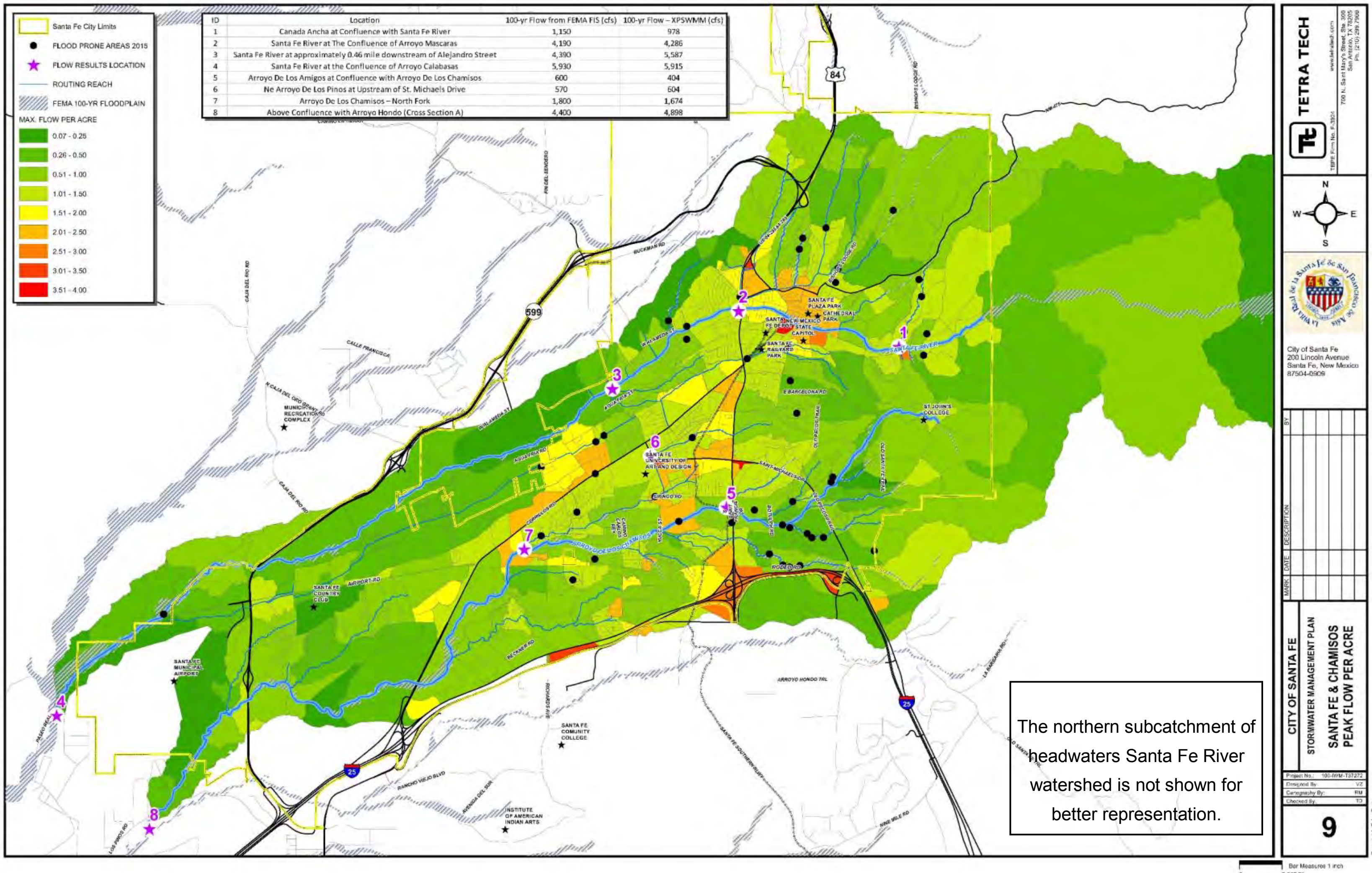


Figure 8. Maximum velocity in reach segments.

5.1.4 Peak Flow Analysis

Each of the subcatchments generates a hydrograph during rainfall-runoff routing and drains to the outlet. In the Snyder's unit hydrograph method, it is a function of lag time and storage coefficient that incorporates other characteristics of the watershed into these two parameters. A useful comparison of watersheds can be made, by dividing the peak of the hydrograph by subcatchment area, to reveal the potential of each subcatchment for generating high flows. ***Figure 9*** represent maximum flow per acre of each subcatchment. Most subcatchments with high flow are located in the highly urbanized part of the watersheds and in the vicinity of highways or major roads. This result is highlighted in the Curve Number map (***Figure 4***) where areas around Downtown Santa Fe, Cerrillos Rd., and S. Saint Francis Dr. have the highest Curve Number values that leads to higher runoff potential during storm events. These areas show a high potential for sediment transport due to high flow and increased erosion. Urbanization and impervious cover create additional runoff above baseline natural conditions which results in increased stream channel erosion.

Overlaying XPSWMM results for slope, velocity, and peak flow reveals that areas around Downtown Santa Fe are generating a high amount of peak flow and velocity while slope is low to moderate. On the other hand, since these areas have flat slope and are mostly channelized, velocities are increased, leading to higher risk for erosion. The Arroyo Threat Assessment report (Santa Fe Watershed Assocoation, 2016) mentioned Arroyo Mascaras (north of Downtown Santa Fe) as the highest potential for infrastructure damage and has recommended measures for channel stabilization.



ID	Location	100-yr Flow from FEMA FIS (cfs)	100-yr Flow – XPSWMM (cfs)
1	Canada Ancha at Confluence with Santa Fe River	1,150	978
2	Santa Fe River at The Confluence of Arroyo Mascaras	4,190	4,286
3	Santa Fe River at approximately 0.46 mile downstream of Alejandro Street	4,390	5,587
4	Santa Fe River at the Confluence of Arroyo Calabasas	5,930	5,915
5	Arroyo De Los Amigos at Confluence with Arroyo De Los Chamisos	600	404
6	Ne Arroyo De Los Pinos at Upstream of St. Michaels Drive	570	604
7	Arroyo De Los Chamisos – North Fork	1,800	1,674
8	Above Confluence with Arroyo Hondo (Cross Section A)	4,400	4,898

Figure 9. Maximum flow per acre of each subcatchment. Flow Comparison locations are shown by star and listed in the above table.

5.1.5 Culvert Capacity Analysis

Culverts and pipes that were incorporated into the XPSWMM model were analyzed to determine if they convey the 100-year design flow without surcharge. Surcharge occurs when the flow rate exceeds pipe capacity, which results in upstream flooding and even roadway closures when the water overtops the road surface. A list of reported areas with flooding issues was made available to Tetra Tech by City of Santa Fe. However, frequency of associated storm event, exact location of river tributary that flooding occurred, and the source of incoming water were not identified in the list. In cases where a specific culvert could not be determined from the reported flood issue, Tetra Tech staff selected the closest model each or main roadway crossing culvert for assessment. ***Figure 10*** presents the locations of surcharged pipes and culverts during 10-year and 100-year design storms, as well as flood prone areas reported by the City of Santa Fe. A 10-year storm is the minimum required frequency for design of roadside ditches and inlets (NMDOT, 2016). Based on the results, there are a total 17 culverts in both watersheds that are under sized for the 10-year storm event. The predicted number of surcharged culverts increased to 43 when the 100-year storm event was analyzed. Most of the locations are within reported flood prone areas which indicates the neighborhoods are having problems with undersized culverts or culvert blockage.

In order to identify minimum pipe and culvert size to convey flow without surcharge, XPSWMM was used to given iterative runs to with 10-year storm event to design new dimensions for undersized pipes and culverts. When a surcharge condition is encountered (flow exceeds full flow capacity), XPSWMM automatically increases the diameter of circular pipes or width of rectangular culverts in fixed increments until the structure is no longer surcharged. Conduits that are neither circular nor rectangular will be converted to circular if they need to be resized. Although, XPSWMM provides an estimate of the culvert size to convey the 10-year flow, a detailed analysis of each structure based on surveyed inverts and road elevations would be necessary to develop a final design. The results presented in the ***Table 11*** are useful for budgeting and initial project scoping for a Capital Improvements Program. The first 17 locations are in the Santa Fe River watershed and the last five are in the Arroyo de Los Chamisos Watershed.

Table 11. Designed conduit dimensions to convey 10-year storm event.

	Original			Designed		
Location	**Height**	**Width**	**Barrels**	**Height**	**Width**	**Barrels**
Old Santa Fe Trail and Arroyo Tenorio St.	1.5	6	1	1.5	8	1
Arroyo Mascaras at Rosario Blvd	3.33	5.42	2	3.33	5.42	3
El Camino Real at Airport Rd	4	4	2	4	4	4
Arroyo Mascaras at W Alameda St	6	10	7	6	10	8
Old Santa Fe Trail and Pino Rd	2	6	1	2	6	3
Paseo de Peralta and W Santa Fe Ave	3	4	1	3	6	1
Paseo de Peralta and W Santa Fe Ave	3	4	1	3	5	1
Galisteo St and W Booth St	3	4	1	3	5	1
Felipe St	2.75	4.08	3	2.75	4.08	5
Agua Fria St and Camino de Chelly	8	8	1	9	9	1
Santa Fe River at E Alameda St	4	10	1	4	10.5	1
Santa Fe River at E Alameda St	4	10	1	4	12	1
Acequia de Los Pinos at Maez Rd	2	4	1	2	5	1
Acequia de Los Pinos at Harrison Rd	2	2	2	2	2	4
Santa Fe River at Calle Debra	6	21	1	6	38	1
Acequia de Los Pinos at Clark Rd	1.55	1.55	1	1.8	1.8	5
Acequia de Los Pinos at Siler Rd	2	2	2	2	2	8
Pinos at Liano St.	3	3	3	3	3	5
Culvert at Governor Miles Rd.	2	2	1	2	2	4
Pinos at Practilliano Dr.	3.5	7.5	2	3.5	7.5	4
Pinos at Camino Carlos Rey	4	8	2	4	8	3
Culvert at Camino Carlos Rey	3	3	1	3	3	4

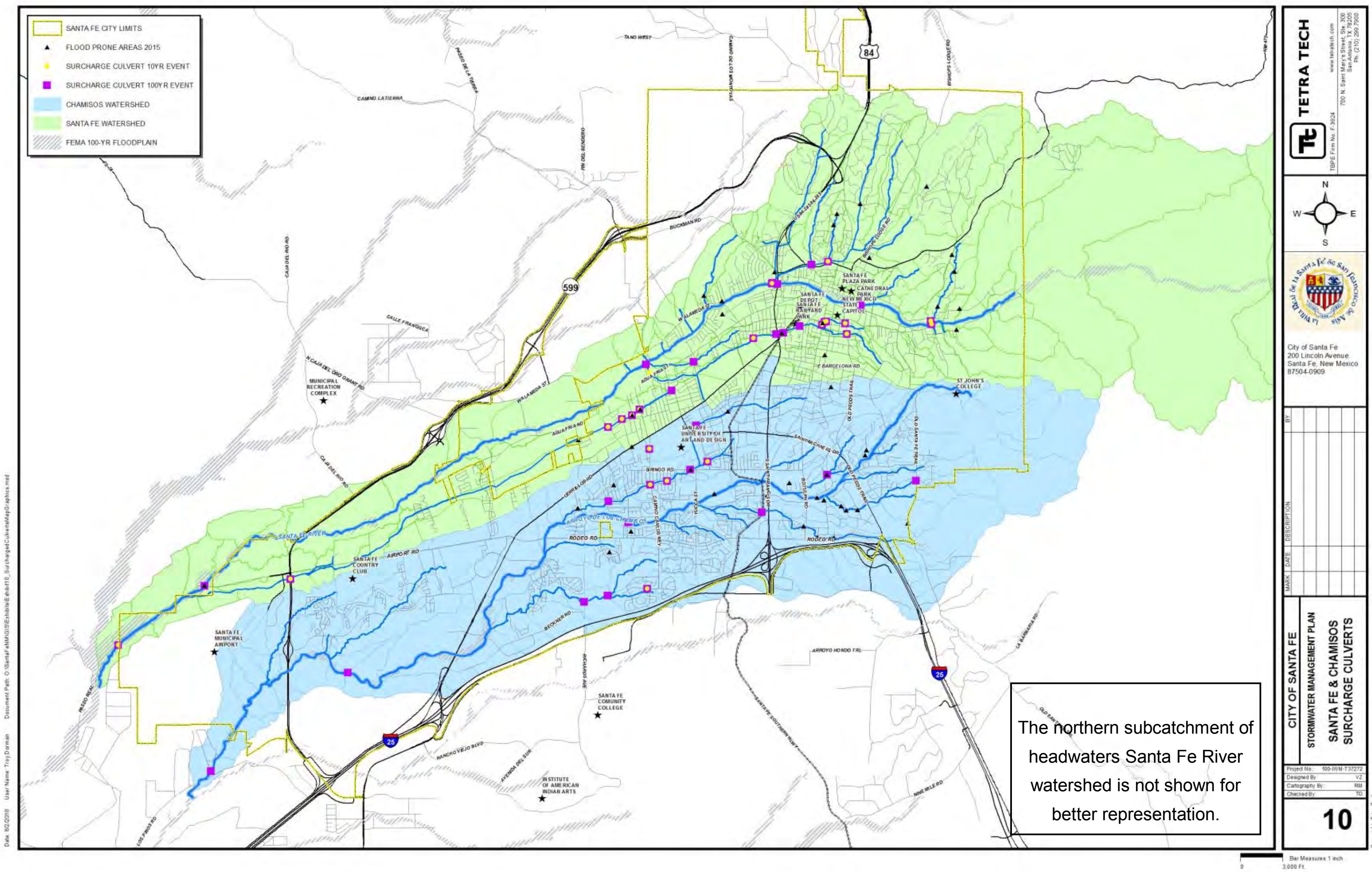


Figure 10. Location of surcharged pipes and culverts for 10-year and 100-year storm events and areas with reported flooding issues.

5.2 LSPC MODEL

5.2.1 Hydrology Simulation

As noted above, both watersheds generally lack streamflow and water quality data to enable comprehensive calibration and validation of the watershed models. Parameterization of the LSPC models was therefore based on prior HSPF (Hydrologic Simulation Program - FORTRAN) models for this region (Moltz et al., 2009; Butcher et al., 2013).

The simulated water balance for the Santa Fe River and Arroyo de Los Chamisos watersheds are shown in

Figure 11. Evapotranspiration is expected to be the largest part of the water balance and is approximately 85% of the precipitation, and in a similar range (of 80% to 99%) reported for this region by Sanford and Selnick (2013). The ratio of LSPC simulated average annual surface runoff to precipitation is shown at the subcatchment scale in ***Figure 13***. As expected, this ratio is generally higher for the more urbanized areas (with high imperviousness) of the watersheds. The flow duration curve for combined daily simulated streamflow from Santa Fe River and Arroyo de Los Chamisos (***Figure 12***) shows that the simulated streamflow generally ranges from 100 cfs to less than 1 cfs.

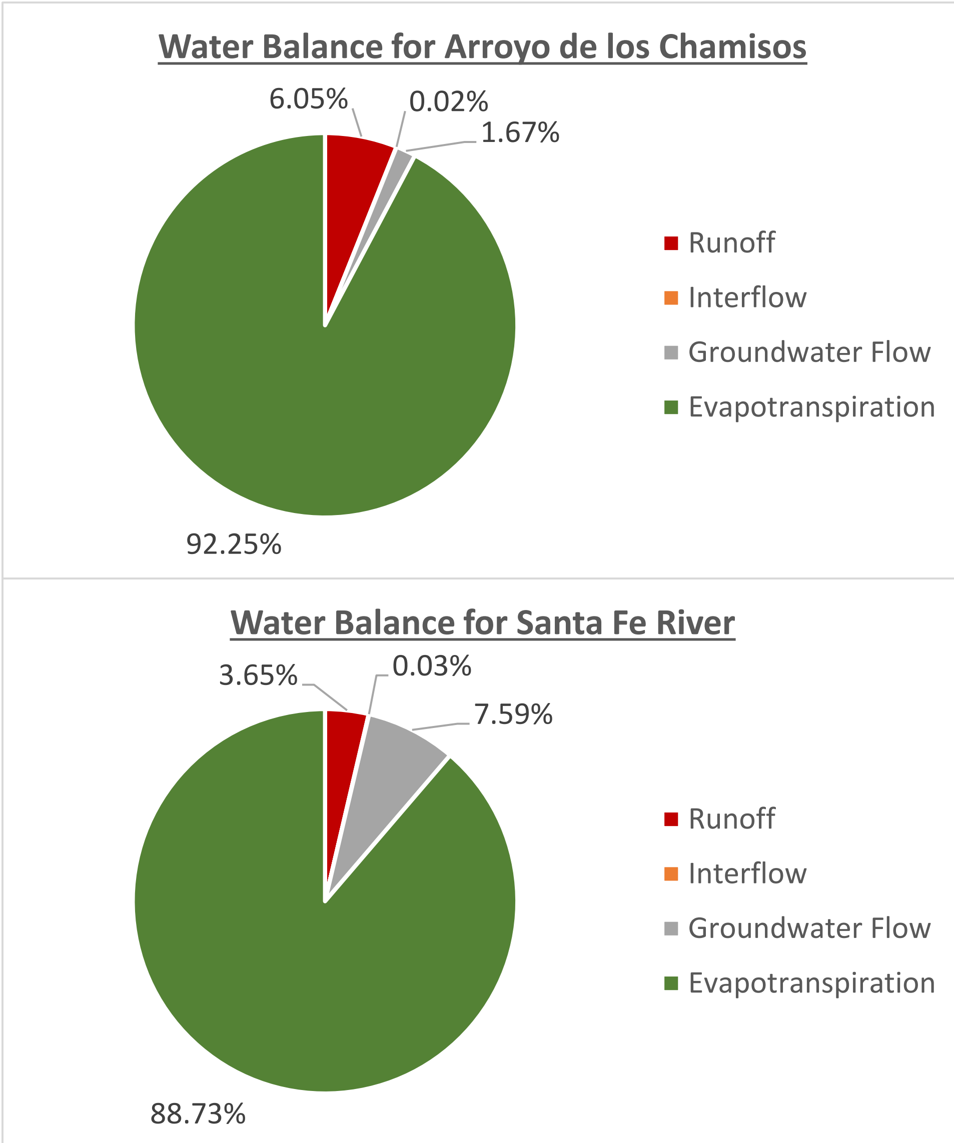


Figure 11. Simulated water balance for the Arroyo de Los Chamisos and Santa Fe River LSPC models.

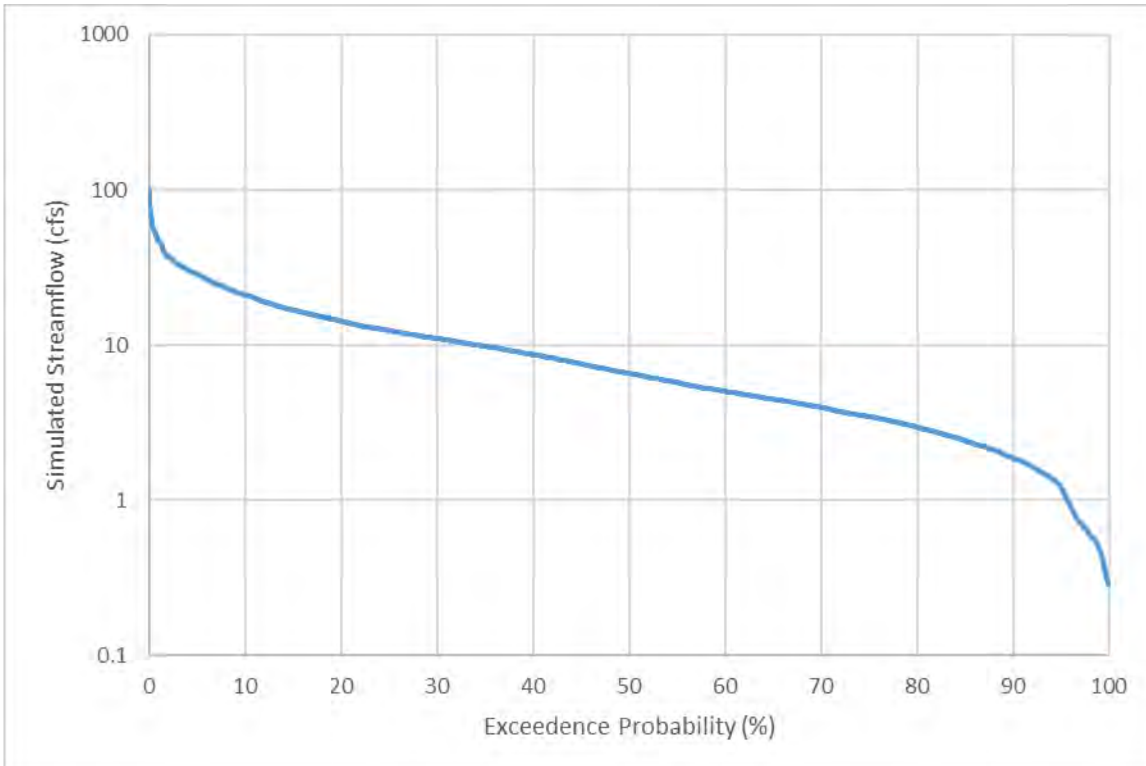


Figure 12**.** Simulated streamflow duration for the Santa Fe River and Arroyo de Los Chamisos.

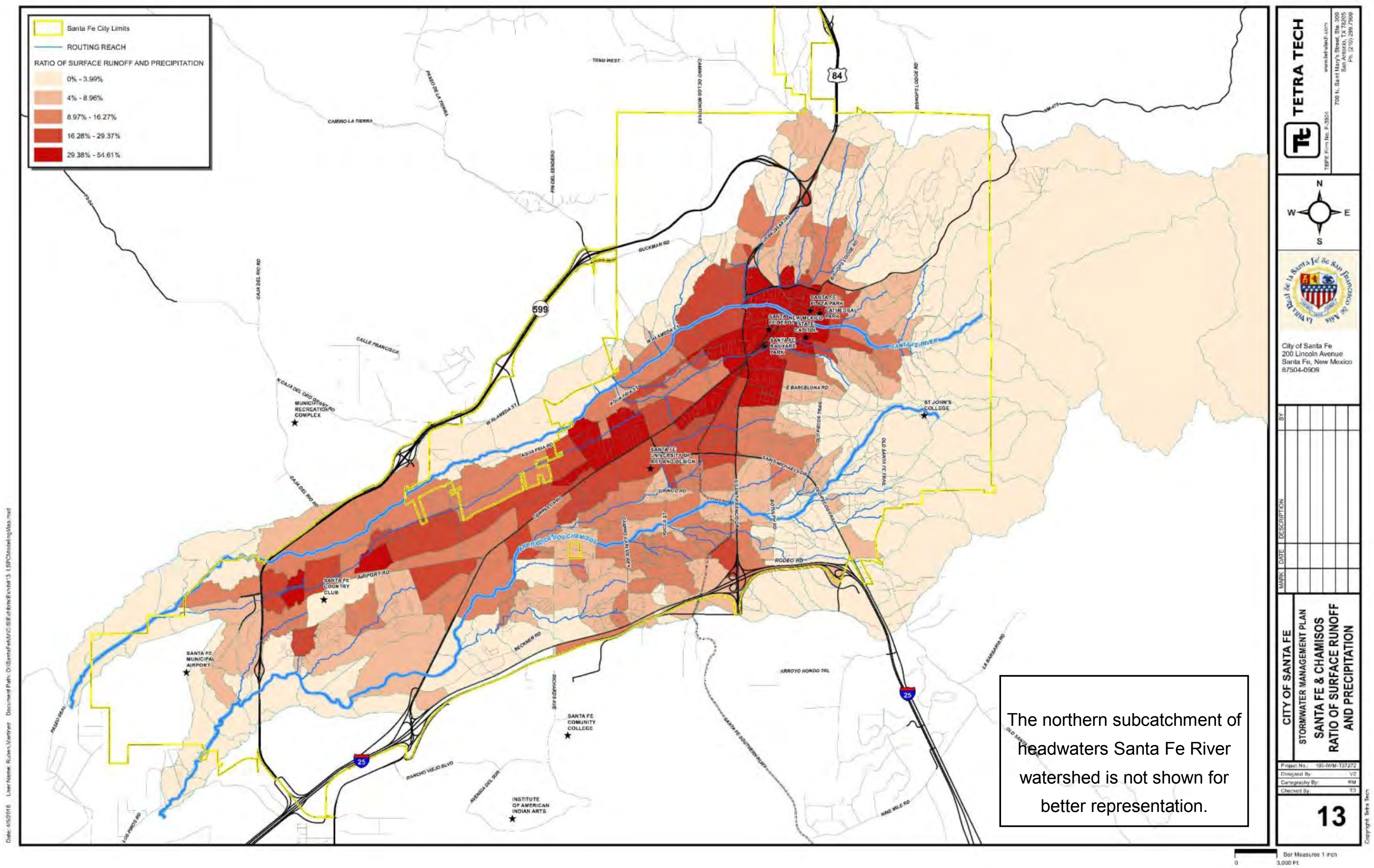


Figure 13. Ratio of LSPC simulated surface runoff to precipitation for the Santa Fe River and Arroyo de Los Chamisos watersheds.

5.2.2 Water Quality Simulation

Given limited water quality monitoring, at this time the sediment and nutrient loads predicted by the LSPC models are the best estimates of non-point source pollutant loading in the watershed. As and when more data are available, the watershed models should be re-evaluated for water quality simulation. Simulated annual average sediment, total nitrogen and total phosphorus loads simulated by the LSPC models are summarized in ***Table 12***.

Table 12. Simulated average annual sediment, total nitrogen and total phosphorus loads for the Santa Fe River and Arroyo de Los Chamisos LSPC models.

Constituent	Santa Fe River	Arroyo de Los Chamisos
Sediment (tons/yr)	2,341.7	555.1
Total Phosphorus (lbs/yr)	342.0	103.8
Total Nitrogen (lbs/yr)	5,868.5	689.5

Simulated non-point runoff associated sediment and nutrient loads at the subcatchment scale are shown in ***Figure 14*** to ***Figure 16***. The sediment and nutrient load show the same trend as runoff with higher loading rates predicted for subcatchments with higher levels of urbanization and imperviousness. Some subcatchments in the south-east part of the Arroyo de Los Chamisos watershed show high sediment and phosphorus loading rates despite being not as heavily urbanized as the rest of the watershed. The high loads are likely linked to poor soil conditions in this region of the Arroyo de Los Chamisos watershed.

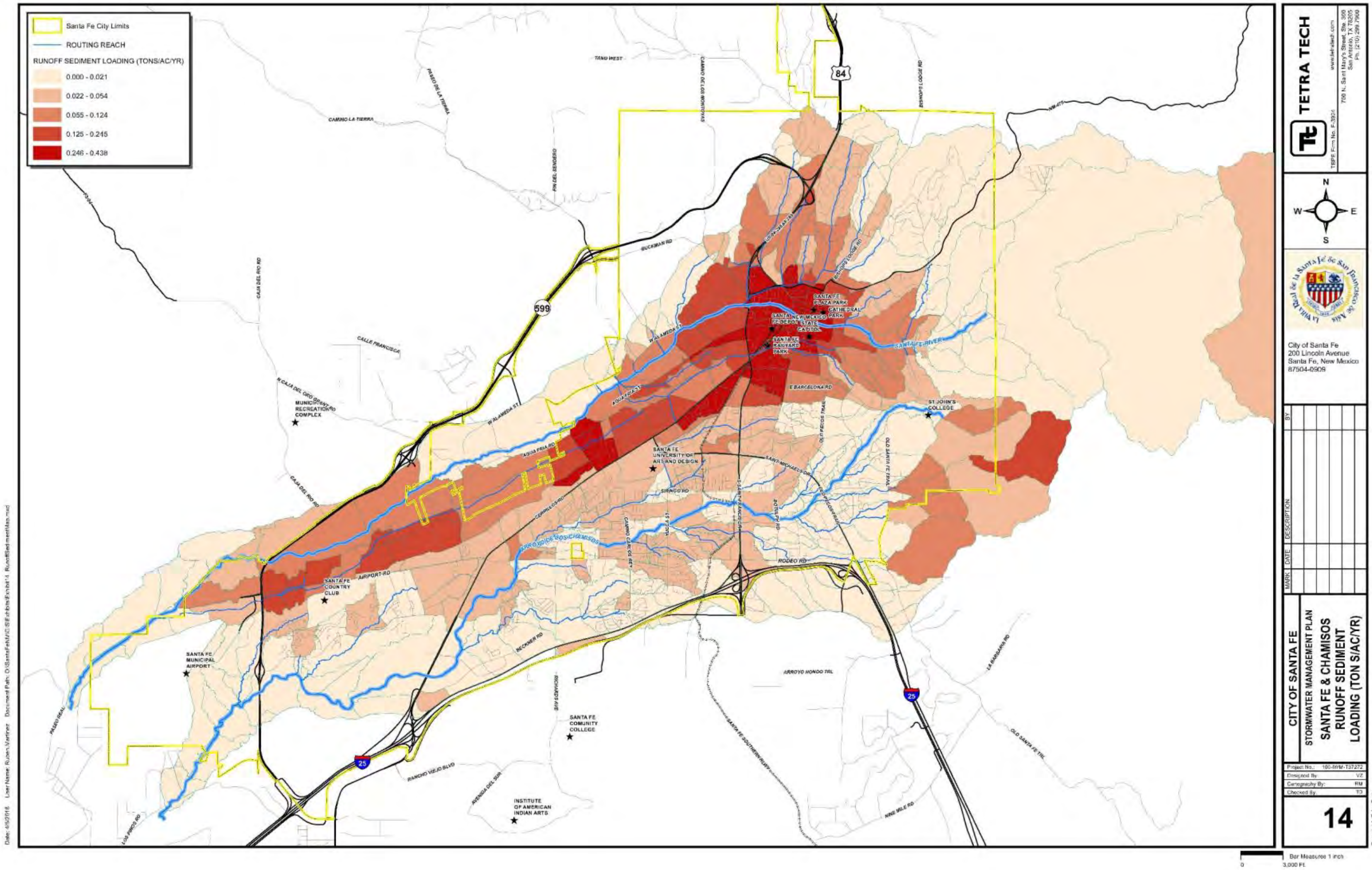


Figure 14. LSPC simulated annual average sediment load for the Santa Fe River and Arroyo de Los Chamisos watersheds.

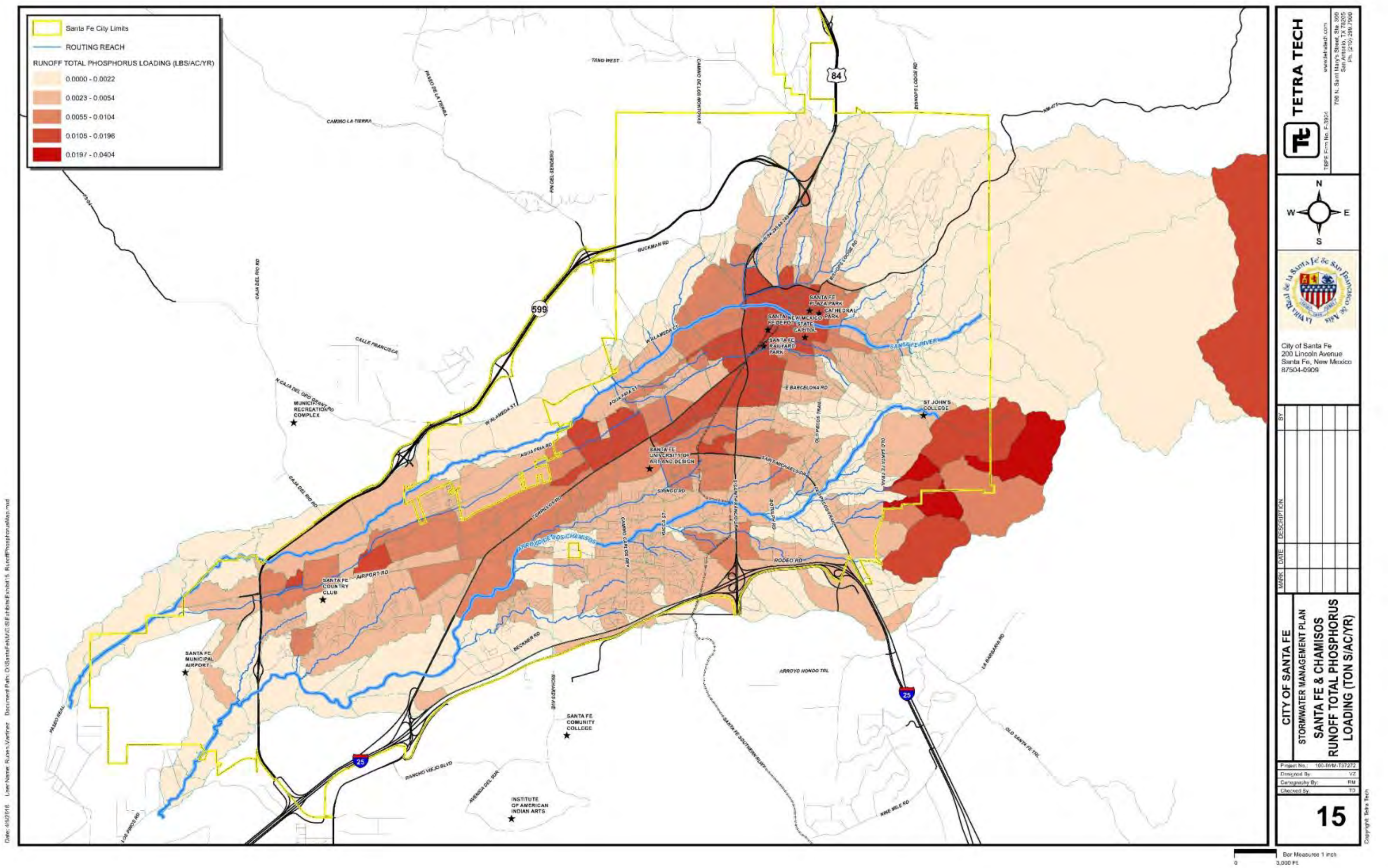


Figure 15. LSPC simulated annual average runoff phosphorus load for the Santa Fe River and Arroyo de Los Chamisos watersheds.

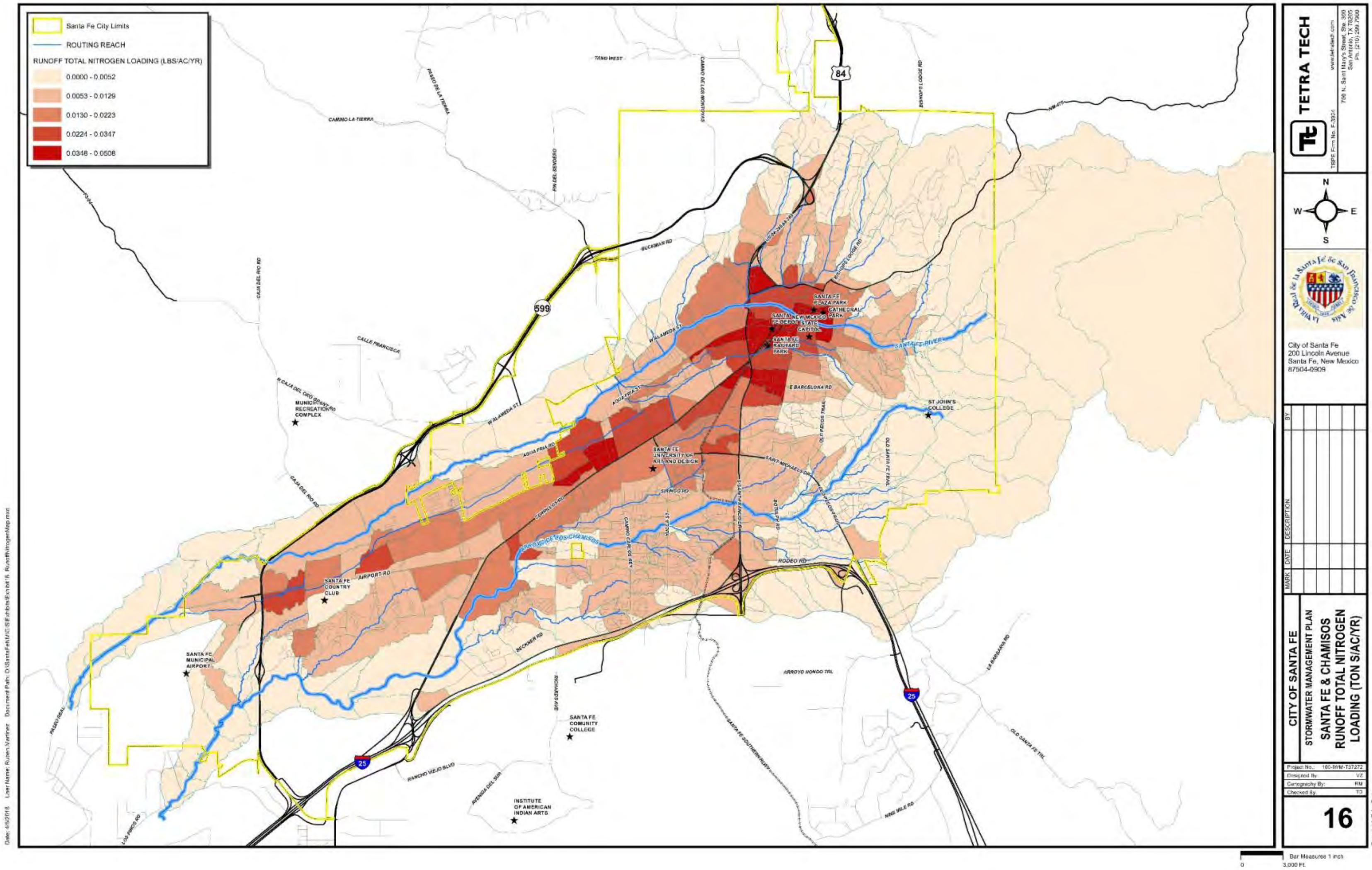


Figure 16. LSPC simulated annual average runoff nitrogen load for the Santa Fe River and Arroyo de Los Chamisos watersheds.

6.0 PRIORITY AREAS FOR GREEN INFRASTRUCTURE IMPLEMENTATION

Based on the outputs of the XPSWMM and LSPC models, and the Arroyo Threat Assessment Report (Santa Fe Watershed Assocoation, 2016), Tetra Tech recommends four priority pilot areas for Green Infrastructure (GI) implementation (***Figure 17.*** Priority areas for GI implementation.

):

1. The subcatchments in the City of Santa Fe downtown area are of highest priority. High peak flow rates, runoff volumes, sediment and nutrient loads, and pipe surcharges are simulated for these areas and flooding issues have been reported frequently. Some subcatchments in this area drain to the Arroyo Mascaras, parts of which have been rated as “high” infrastructure damage/risk in the Arroyo Threat Assessment Report.

2. The subcatchments draining to the Arroyo Cloudstone and Arroyo Foothill are also of concern because of high cumulative sediment and nutrient loading from upstream subcatchments. Also, downstream of these Arroyo have been reported as flood prone areas and based on the hydraulic modeling, some culverts are likely to surcharge during 100-year events. In addition, sections of the Arroyo Cloudstone are already identified as “high” infrastructure damage/risk.

3. The subcatchments in Arroyo de Los Chamisos (North Fork) are currently experiencing flooding issues during storm events. Although the Arroyo Threat Assessment Report generally rates the infrastructure in this region as “good”, the modeling results elaborate that some culverts are likely undersized for conveyance of 10-year and 100-year events. Sediment and nutrient loads predicted for this area are also moderately high.

4. Lastly, the areas near the mouth of the Santa Fe River are recommended for GI implementation. High runoff, sediment and nutrient loads are predicted for some subcatchments. Given the high velocity values along the Santa Fe River, it has high potential for erosion too. Also, culvert capacity analysis suggests that some culverts are likely under-sized for conveyance of 10-year and 100-year events and flooding have been a reported issue, especially in Acequia de Los Pinos.

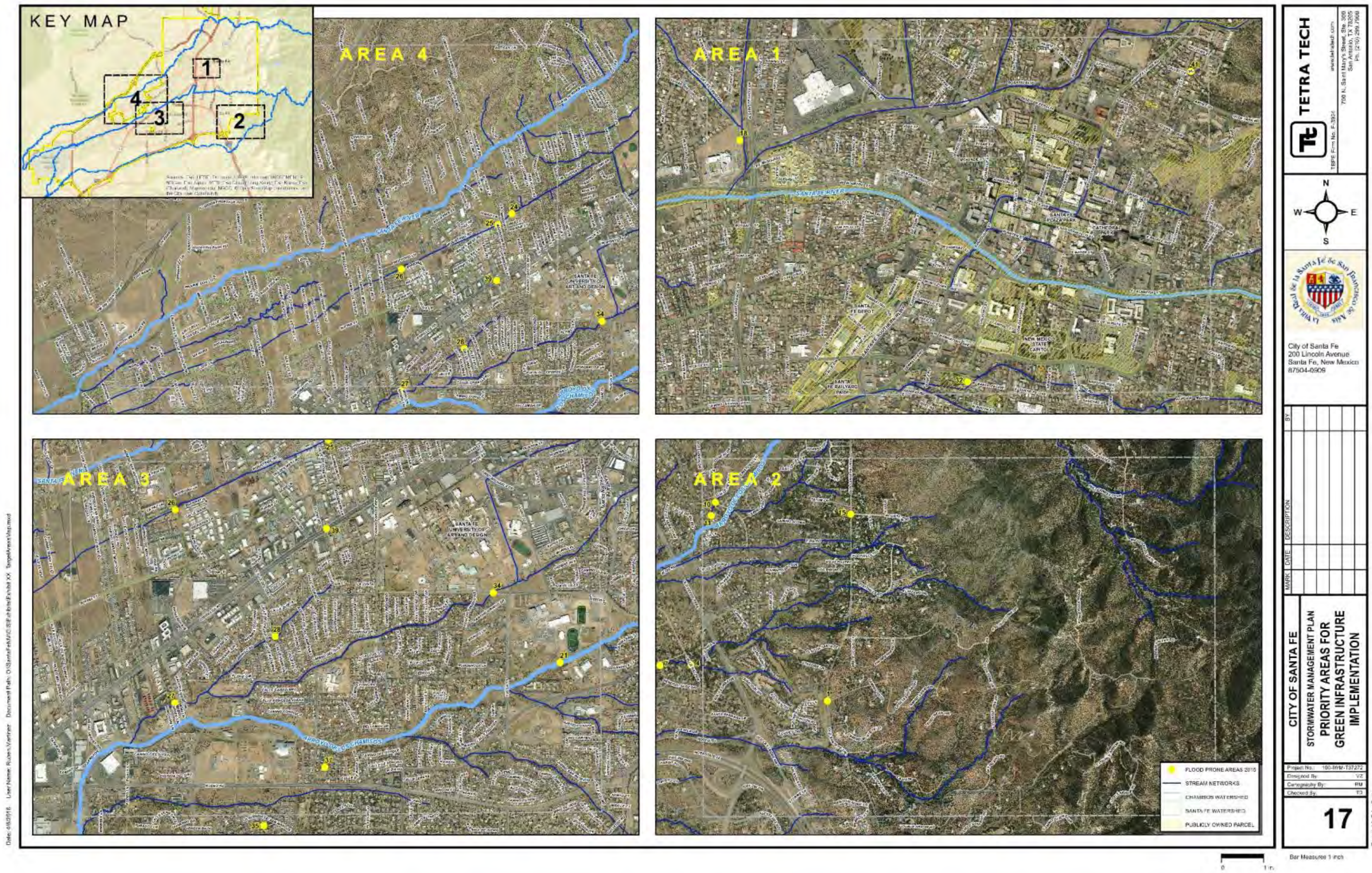


Figure 17. Priority areas for GI implementation.

7.0 FUTURE MODEL ENHANCEMENTS

The LSPC watershed models developed under this work assignment are largely uncalibrated because of limited monitoring data to aid in the parameterization of the model. The model performance for hydrology and water quality should be reviewed in the future based on streamflow and water quality monitoring data. Such an exercise will increase confidence on model estimates of sediment and nutrient loading.

Since urban areas are the focus of non-point pollution in these watersheds a more detailed impervious coverage dataset should be developed for the study area. Such an enhanced impervious coverage dataset should also be used to improve the representation of urban areas in the XPSWMM and LSPC models

Lastly watershed models are most useful in providing existing pollutant loads and also for evaluation of best management practices (BMPs) to mitigate increased volume pollution. LSPC is well-designed to link to the SUSTAIN model to evaluate the impacts of BMPs on pollutant loads and associated costs. The watershed model at this time provides relative estimates of subcatchments that have high sediment and nutrient loading rates. Targeted application of BMPs using the LSPC-SUSTAIN linked model may be readily evaluated for some of these problematic subcatchments for cost effective pollution abatement.

8.0 STORMWATER PROGRAM RECOMMENDATIONS

A high-level review of the model development process and model results presented in this report provides insights into the City of Santa Fe's broader stormwater program. As described above the modeling is useful for identifying areas where urbanization, watershed characteristics and transportation features are resulting in flood prone areas. In combination with the Santa Fe Watershed Association's arroyo assessment, the model results help identify stream segments that are experiencing accelerated erosion and will result in higher maintenance and repair costs for the City. The model also indicates hotspots for water quality concerns that can be addressed as part of the upcoming Phase II MS4 permit implementation. However, there are a few model refinements that would allow a more detailed look within the watersheds and provide better certainty on the level of water quality enhancements. In addition, there are specific design criteria that are recommended to address water quality and flooding issues. The list below summarizes the team's recommendations based on the current modeling effort and ties the recommendations to other stormwater program efforts where synergies exist or where the information developed would serve multiple purposes.

- Stormwater system infrastructure collection – Priority 1
    - The City's record of stormwater infrastructure needs a comprehensive program to identify all street inlets, underground pipes, manholes, roadway culvert crossings and outfalls. This information is necessary for refined watershed modeling, siting water quality BMPs, determining monitoring locations, building an asset management program, and documenting maintenance concerns and compliance with MS4 program requirements.
- Detailed impervious cover database – Priority 2
    - A detailed impervious cover dataset based on the existing LiDAR data and a new high-resolution aerial image acquired for the purpose of impervious cover identification is recommended for use across several areas of the stormwater program. The detailed dataset can be used to better refine the LSPC and XPSWMM models, develop a parcel by parcel equitable stormwater utility fee (based either on impervious cover area or stormwater runoff generated per parcel), plan future expansion of the city by limiting impervious cover in sensitive areas) and identify unpermitted or unreported buildings and development across the city.
- Refine stormwater system criteria for water quality and sediment transport – Priority 1
    - The City's current stormwater criteria requires all infrastructure to meet the 100-year storm. This causes a singular focus on flood events and doesn't recognize the concerns of water quality,

stream stability, sediment transport, and stormwater volume management. In concert with forthcoming water quality based requirements, the City's stormwater management criteria should be expanded to address culvert design, stable channel design, and sediment transport to reduce flooding, maintenance and future erosion issues.

- Include stream flow monitoring in water quality monitoring program – Priority 3
    - The proposed MS4 permit requires monitoring for pollutants of concern with the City of Santa Fe's boundary. The monitoring program should address both the need for water quality information and the need for additional runoff rate and volume measurements to verify watershed scale modeling and local design parameters.

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APPENDIX A. SURVEYED DATA OF STORMWATER COLLECTION SYSTEM IN HEADWATERS SANTA FE WATERSHED

Name	Lat.	Long.	Material	Shape	Height [ft]	Width [ft]	# Barrels
Santa Fe River at Calle Debra	35.618	-106.112	CMP	Arch	6	20	1
Santa Fe River at Calle Debra	35.618	-106.112	CMP	Round	3	3	2
Santa Fe River at Calle Debra	35.618	-106.112	CMP	Oval	2	3	3
Santa Fe River at Paseo Real	35.630	-106.092	CMP	1/2 Round	6	12	7
Acequia de Los Pinos at Clark Rd	35.662	-105.991	CMP	Round	2	2	1
Acequia de Los Pinos at Siler Rd	35.660	-105.995	CMP	Round	2	2	2
Acequia de Los Pinos at Harrison Rd	35.663	-105.989	Concrete	Oval	1.5	2.5	2
Acequia de Los Pinos at Maez Rd	35.664	-105.987	Concrete	Oval	2.5	4.5	1
Acequia de Los Pinos at Osage Ave	35.668	-105.979	CMP	Arch	2.5	4.5	1
W Alameda St	35.673	-105.991	Concrete	Round	5	5	2
W Alameda St and Camino Carlos Rael	35.675	-105.986	CMP	Round	5	5	2
W Alameda St and Calle Nopal	35.677	-105.982	Stone & Concrete	Square	2.25	6	1
N El Rancho Rd and Paseo de Las Vistas	35.684	-105.978	Concrete	Square	1 to 2	6	1
W Alameda St and N El Rancho Rd	35.682	-105.977	Concrete	Square	4.75	8	1
El Camino Real at Airport Rd	35.631	-106.071	CMP	Round	4	4	2
Agua Fria St and Camino de Chelly	35.671	-105.985	Concrete	Round	8	8	1
Osage Ave and San Ildefonso Rd	35.670	-105.980	Concrete	Square	5	8	2
Cristobal Colon and Agua Fria St	35.677	-105.968	CMP	Arch	4	6	1

Name	Lat.	Long.	Material	Shape	Height [ft]	Width [ft]	# Barrels
Baca St and Hickox St	35.679	-105.964	CMP	Arch	2.25	4.5	1
Velarde St and Agua Fria St	35.673	-105.974	CMP	Round	3	3	1
Agua Fria St and Camino Solano	35.673	-105.979	CMP	Arch	4	6	1
Baca St and Potencia St	35.676	-105.964	CMP	Arch	3	5	2
Felipe St	35.678	-105.960	CMP	Arch	2.5	4	3
S St Francis Dr and Mercer St	35.679	-105.954	CMP	Round	4.5	4.5	2
Cerrillos Rd and Don Diego Ave	35.680	-105.949	Concrete	Round	3.5	3.5	1
Galisteo St and W Booth St	35.680	-105.944	Concrete	Square	3	5	1
Old Santa Fe Trail and Arroyo Tenorio St.	35.679	-105.937	Concrete	Square	1 to 1.5	6	1
Camino Corrales and Garcia St	35.673	-105.929	Concrete	Square	5.5	10	1
Old Santa Fe Trail and Pino Rd	35.681	-105.938	Concrete	Square	2.5	6	1
Paseo de Peralta and W Santa Fe Ave	35.681	-105.942	Concrete	Square	3	4	1
Santa Fe River and Camino Alire	35.685	-105.967	Concrete	Bridge	15	65	1
Gregg Ave and Michelle Dr	35.697	-105.958	CMP	Arch	4.5	7	1
Alamo Dr and N St Francis Dr	35.697	-105.954	Concrete	Square	4	6	1
Arroyo Mascaras at Las Mascaras St	35.690	-105.954	Concrete	Square	6	10	5
Canada Rincon at Camino Francisca	35.714	-105.944	CMP	1/2 Round	4	8	2
Canada Rincon at Avenida Rincon	35.706	-105.947	CMP	Round	4	4	7
Vera Dr and Los Lovatos Rd	35.696	-105.941	CMP	Arch	3	5.5	2
Arroyo Ranchito at Murales Rd	35.696	-105.933	CMP	Arch	3.25	4.5	2
Arroyo Barranca at Chula Vista St	35.715	-105.931	CMP	Round	6	6	1

Name	Lat.	Long.	Material	Shape	Height [ft]	Width [ft]	# Barrels
Arroyo de La Piedra at Cam Chamisa	35.702	-105.922	CMP	Round	6	6	5
Santa Fe River at Guadalupe St	35.687	-105.944	Concrete	Bridge	15	45	1
Arroyo Saiz at E Palace Ave	35.686	-105.930	Concrete	Square	6	15.5	1
Arroyo Saiz and Avenida Primera S	35.690	-105.924	CMP	Round	4	4	1
Santa Fe River at Paseo de Peralta	35.684	-105.934	Concrete	Bridge	10	45	1
Arroyo Saiz at Avenida Primera S	35.691	-105.920	CMP	Round	3.5	3.5	1
E Palace Ave and Los Lobatos Rd	35.683	-105.925	Concrete	Square	4	10	1
Upper Canyon Rd and Canyon Rd	35.679	-105.916	Concrete	Round	5	5	1
Upper Canyon Rd and Apodaca Hill St	35.679	-105.914	Stone & Concrete	Trapezoid	8	12 to 18	1
Alarid St and Mercer St	35.679	-105.953	CMP	Round	3	3	2
Arroyo Del Rosario at Griffin St	35.695	-105.946	CMP	Round	3.5	3.5	3
Arroyo Barranca at Loma Entrada	35.701	-105.935	CMP	Arch	6	16	1
Culvert at Los Arboles Dr	35.702	-105.940	CMP	Round	3	3	1

APPENDIX B. SURVEYED DATA OF STORMWATER COLLECTION SYSTEM IN ARROYO DE LOS CHAMISOS WATERSHED

Name	Lat.	Long.	Material	Shape	Height [ft]	Width [ft]	# Barrels
Culvert at Veterans Memorial Hwy	35.62	-106.07	CMP	Round	4.5	4.5	2
Culvert on Chamisos Trib.	35.62	-106.06	CMP	Round	3	3	1
Culvert at Jaguar Dr.	35.62	-106.06	CMP	Round	5	5	1
Chamisos at Las Cuatro Milpas	35.61	-106.06	Concrete	Square	8	6	1
Chamisos at Governor Miles Rd.	35.63	-106.02	Concrete	Square	10	10	8
Pinos at Kachina Ridge Dr.	35.64	-106.00	CMP	Round	7	7	4
Chamisos at Urban Trail	35.65	-105.97	CMP	Pipe Arch	14	26	1
Chamisos at Rail Road	35.65	-105.96	Steel, concrete, wood	Bridge	~16	~35	-
Chaparral at E Sawmill Rd.	35.64	-105.95	CMP	Round	6	6	6
Culvert at Jaguar Dr.	35.62	-106.05	CMP	Round	7	7	2
Culvert at Dancing Ground Rd.	35.63	-106.01	CMP	Pipe Arch	5.5	7	7
Culvert at Pueblos Del Sol Park	35.63	-105.99	Concrete	Square w filled corners	2.5 to sand	16	1
Culvert at Governor Miles Rd.	35.63	-105.99	CMP	Round	2	2	1
Culvert at Nizhoni Dr.	35.63	-105.98	Concrete	Square w filled corners	5 to dirt	16	1
Culvert at Calle Tecolote	35.65	-105.94	CMP	Round	2	2	3
Culvert at St. Michael's Dr.	35.65	-105.94	CMP	Round	4	4	1
Chamisos at Paseo de Angel N	35.59	-106.09	CMP	Pipe Arch	7.5	26	2

Name	Lat.	Long.	Material	Shape	Height [ft]	Width [ft]	# Barrels
Culvert at South Meadows Rd.	35.63	-106.03	CMP	Pipe Arch	5	7.5	4
Culvert at Governor Miles Rd.	35.63	-105.99	CMP	Round	4	4	1
Culvert at Paseo Del Sol W	35.63	-106.06	CMP	Round	5	5	1
Culvert at Ravine Rd.	35.63	-105.99	CMP	Round	4	4	3
Chamisos at La Rambla	35.67	-105.91	CMP	Pipe Arch	7 to sand	14	1
Chamisos at Botulph Rd.	35.65	-105.95	Concrete	Square	4 to sand	10	4
Culvert at Botulph Rd.	35.65	-105.95	Concrete	Square	5.5 to sand	12	1
Pintores at W Zia Rd.	35.64	-105.98	Concrete	Round	2.5	2.5	4
Sheriff's at Paseo de Los Pueblos	35.64	-106.00	CMP	Round	3.5	3.5	2
Foothill at Calle Cacique	35.65	-105.93	CMP	Round	7	7	1
Foothill at Old Santa Fe Trail	35.65	-105.92	CMP	Pipe Arch	5	7	1

APPENDIX C. ELEVATION-AREA-STORAGE DATA FOR MCCLURE RESERVOIR

Elevation (ft)	Area (acres)	Capacity (ac-ft)
7782	0.02	0.05
7786	0.2	0.61
7790	0.57	2.46
7794	1.28	6.78
7800	3.55	23.21
7804	5.14	42.14
7806	6.02	54.18
7810	8.33	85.18
7814	10.03	123.66
7816	11.14	145.94
7820	13.54	197.71
7824	16.13	259.62
7826	18.11	295.84
7830	21.73	379.39
7834	24.84	475.57
7836	26.52	528.62
7840	30.45	646.27
7842	32.45	711.18
7844	34.64	780.46
7846	37.06	854.57
7848	39.24	933.05
7850	41.4	1015.85
7852	43.77	1103.39
7854	46.24	1192.86

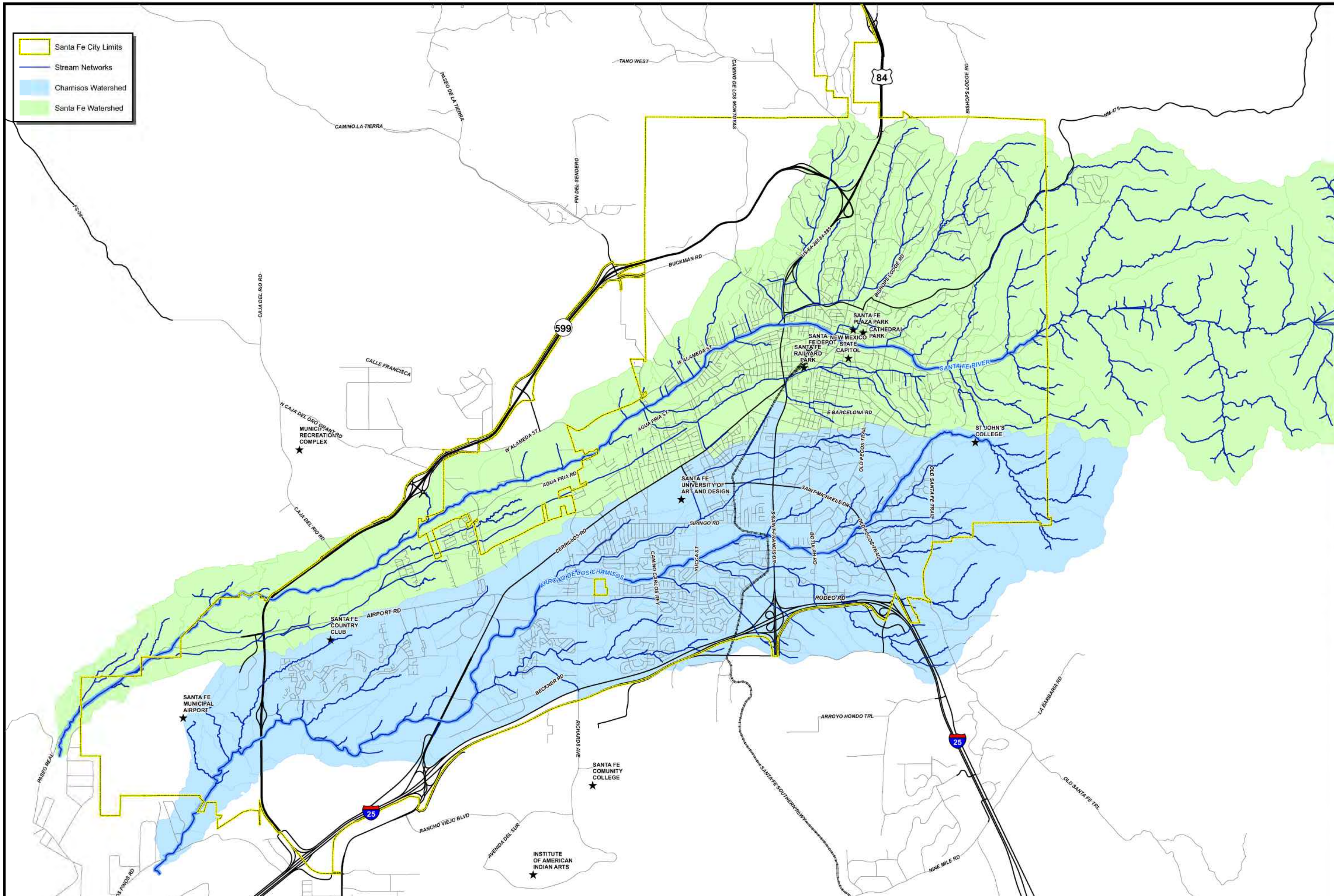
Elevation (ft)	Area (acres)	Capacity (ac-ft)
7856	48.66	1293.18
7858	51.25	1395.69
7860	54.24	1504.17
7862	57.59	1619.36
7864	59.78	1738.92
7866	61.18	1861.28
7868	62.63	1986.54
7870	64.29	2115.13
7872	66.24	2247.61
7874	68.06	2383.72
7876	69.83	2523.37
7878	71.58	266.53
7880.16 (Previous Spillway)	73.49	2825.26
7882	74.28	2963.65
7884	76.8	3117.25
7885.79 (Current Spillway)	77.63	3257.45
7886	78.34	3273.93
7888	79.91	3433.75
7890	81.5	3596.76
7892	83.15	3763.01

APPENDIX D. ELEVATION-AREA-STORAGE DATA FOR NICHOLS RESERVOIR

Elevation (ft)	Area (acres)	Capacity (ac-ft)
7424	0	0
7426	0.1	0
7428	0.3	0.4
7430	0.6	1.3
7432	0.93	2.8
7434	1.34	5
7436	1.84	8.1
7438	2.5	12.3
7440	3.29	18.1
7442	4.13	25.5
7444	5.02	34.7
7446	5.93	45.6
7448	6.85	58.4
7450	7.9	73.0
7452	9.01	90.0
7454	9.98	109.0
7456	10.94	129.9
7458	12.01	152.8
7460	13.21	177.9
7462	14.56	205.6
7464	15.8	236.2
7466	16.95	268.9
7468	18.23	304.0
7470	19.69	341.8

Elevation (ft)	Area (acres)	Capacity (ac-ft)
7472	21.34	382.7
7474	22.99	427.1
7476	24.65	474.7
7478	26.44	525.7
7480	28.14	580.5
7482	29.63	638.3
7483 (Spillway)	30.36	668.3
7484	30.92	699.0
7486	32.04	761.9
7488	33.15	827.1
7490	34.22	894.5
7492	35.26	964.0
7494	36.25	1035.6

B. MODELING EXHIBITS



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CITY OF SANTA FE
STORMWATER MANAGEMENT PLAN

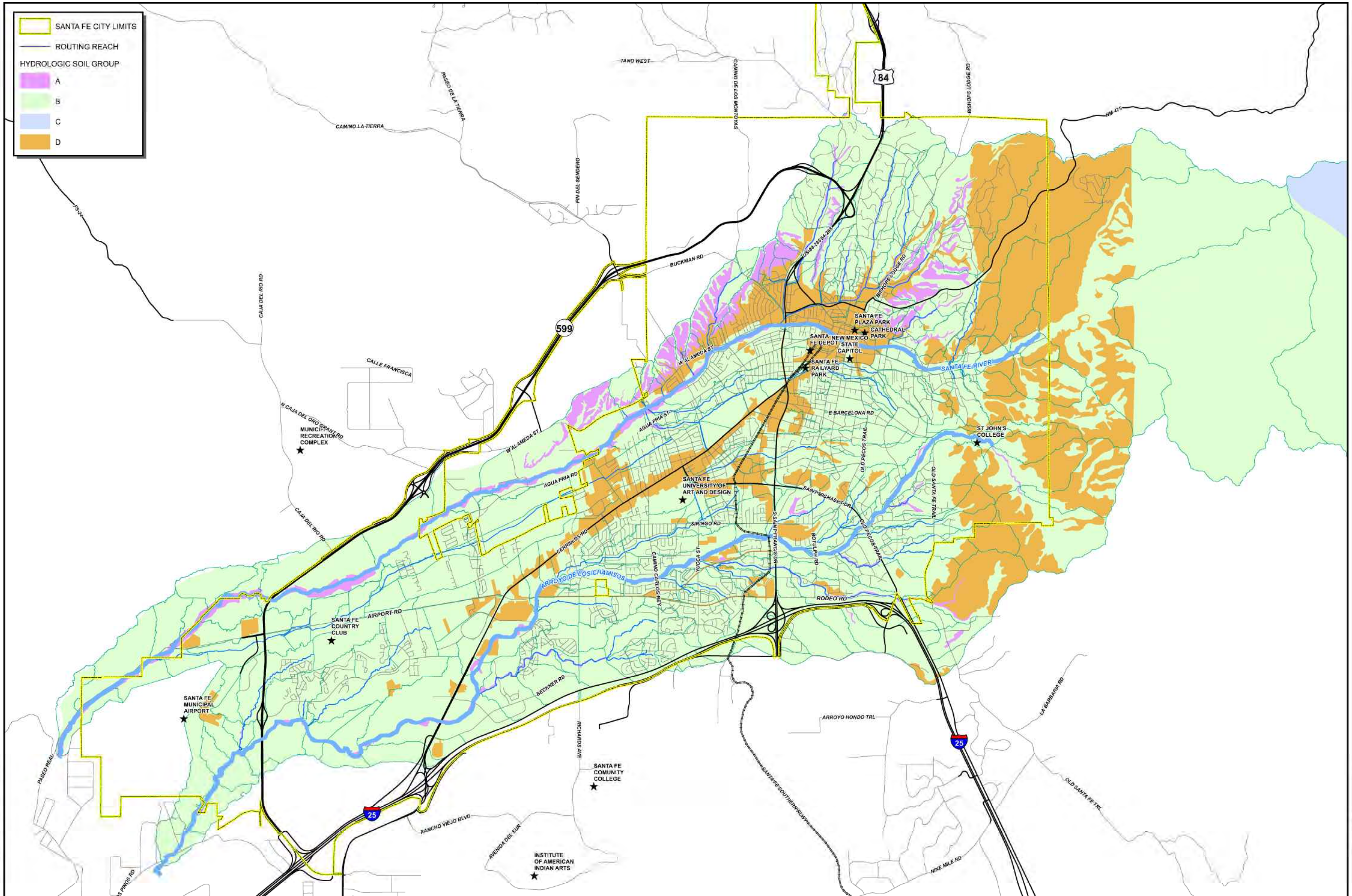
SANTA FE & CHAMISOS WATERSHEDS

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

1

Bar Measures 1 inch
0 3,000 Ft.

Date: 8/2/2018 User Name: Troy.Dorman Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit01_WatershedMap.mxd



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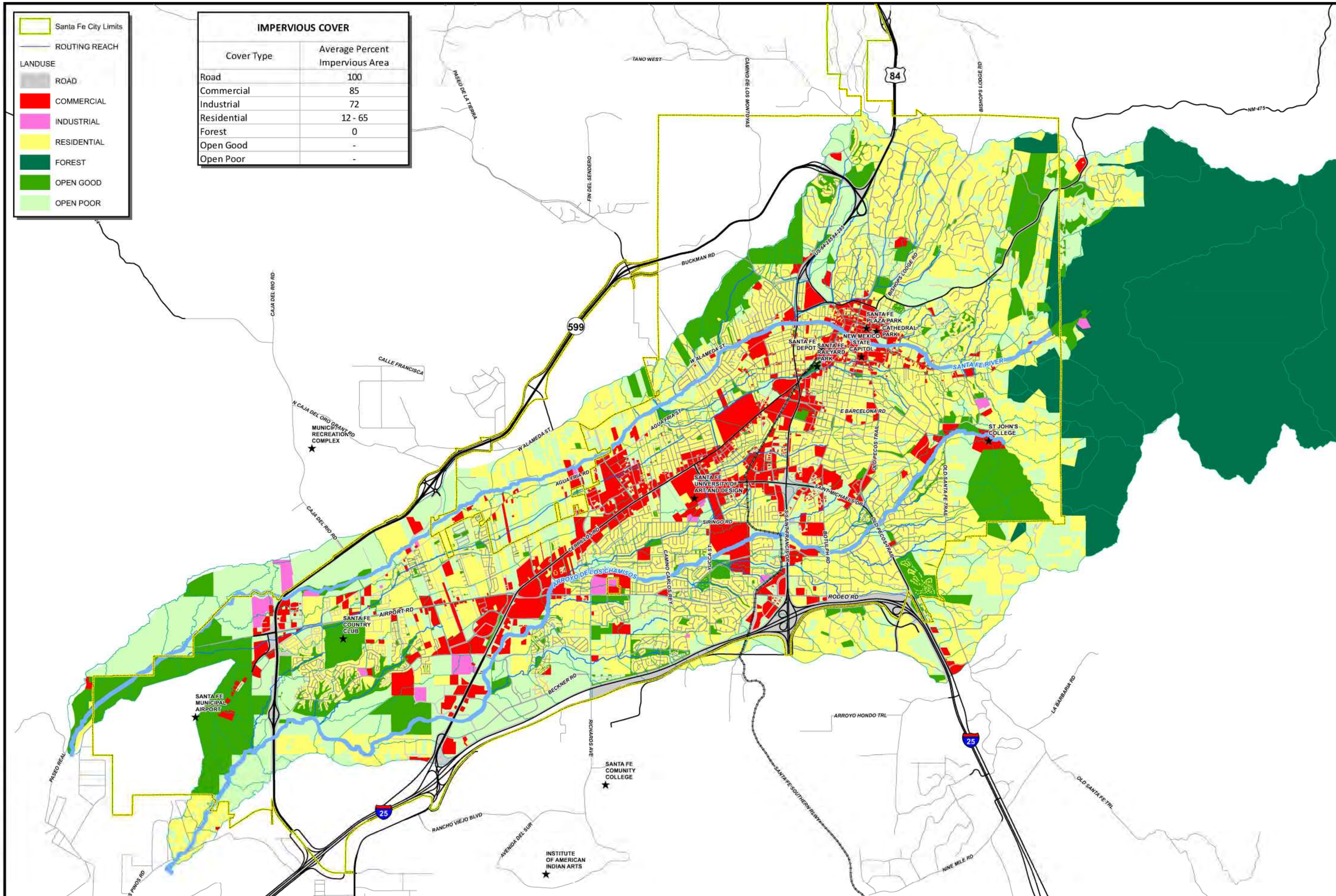
STORMWATER MANAGEMENT PLAN
SANTA FE & CHAMISOS
HYDROLOGIC SOIL GROUP

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

2

Bar Measures 1 inch
0 3,000 Ft.



IMPERVIOUS COVER

Cover Type	Average Percent Impervious Area
Road	100
Commercial	85
Industrial	72
Residential	12 - 65
Forest	0
Open Good	-
Open Poor	-

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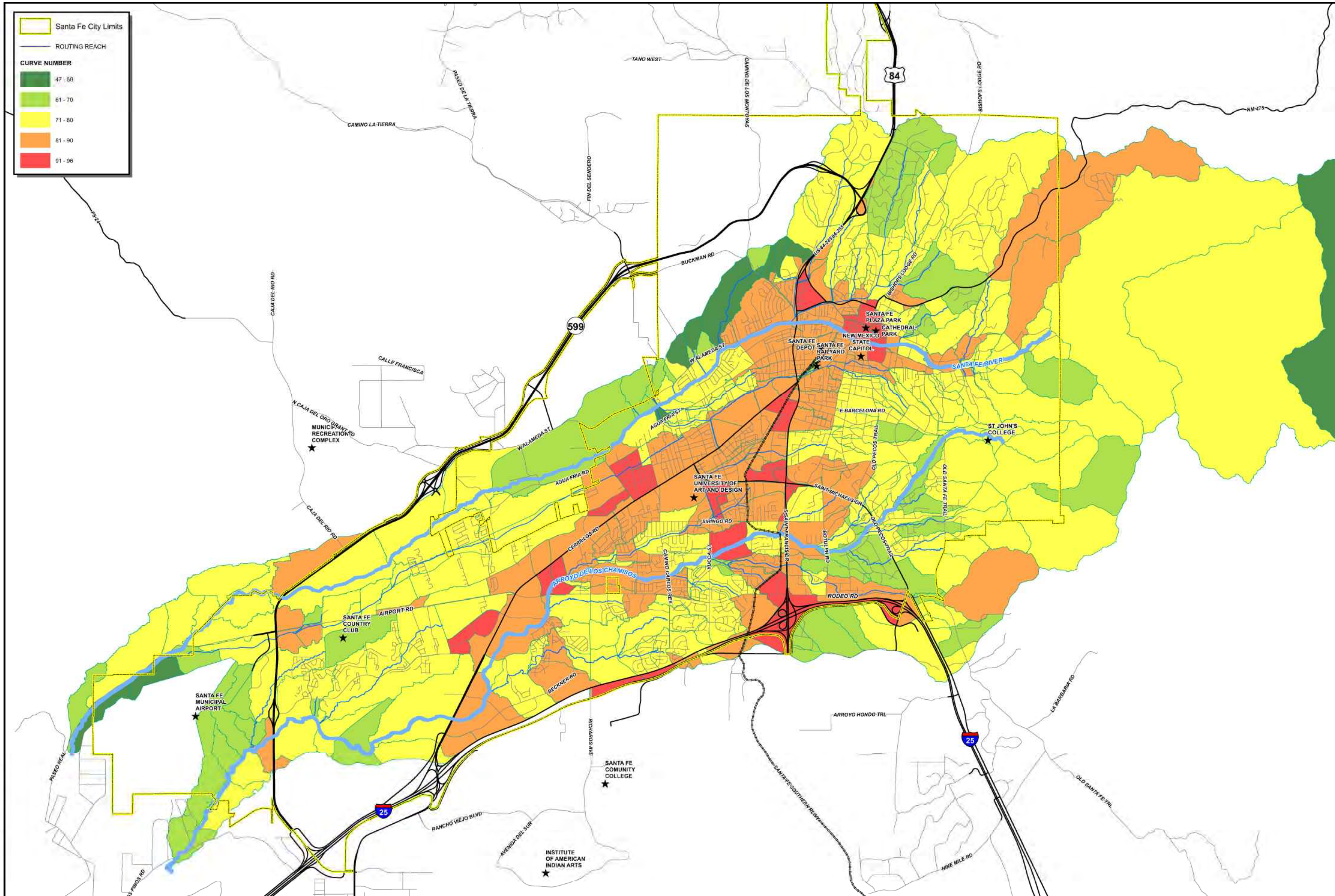
STORMWATER MANAGEMENT PLAN

SANTA FE & CHAMISOS LANDUSE/IMPERVIOUS COVER

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

3

Bar Measures 1 inch
0 3,000 Ft.



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STORMWATER MANAGEMENT PLAN

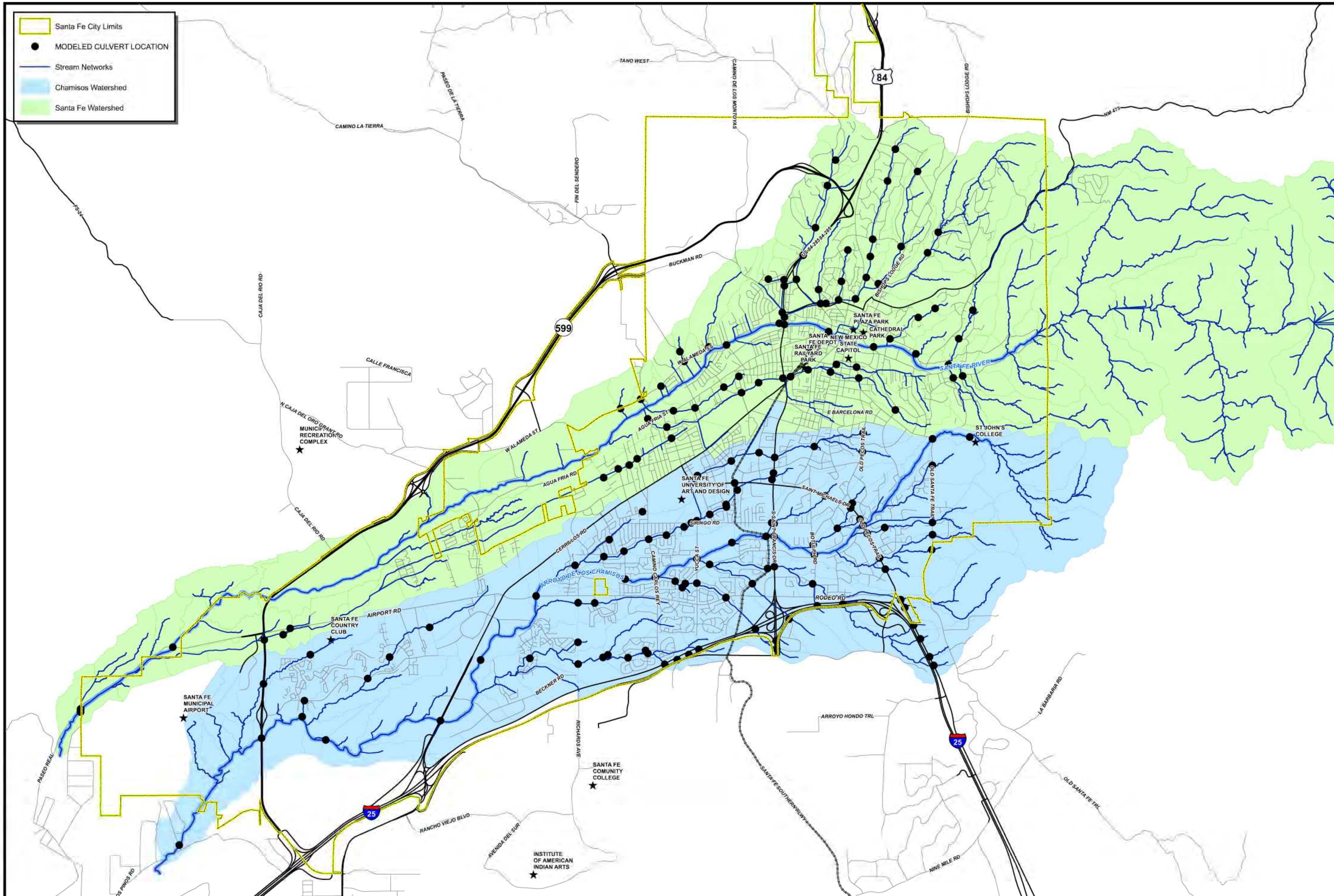
SANTA FE & CHAMISOS CURVE NUMBER MAP

Project No.: 100-IWM-T37272
Designed By: VZ
Cartography By: RM
Checked By: TD

4

Bar Measures 1 inch
0 3,000 Ft.

Date: 4/5/2018 User Name: Ruben Martinez Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit04_CurveNumberMap.mxd



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CITY OF SANTA FE
STORMWATER MANAGEMENT PLAN

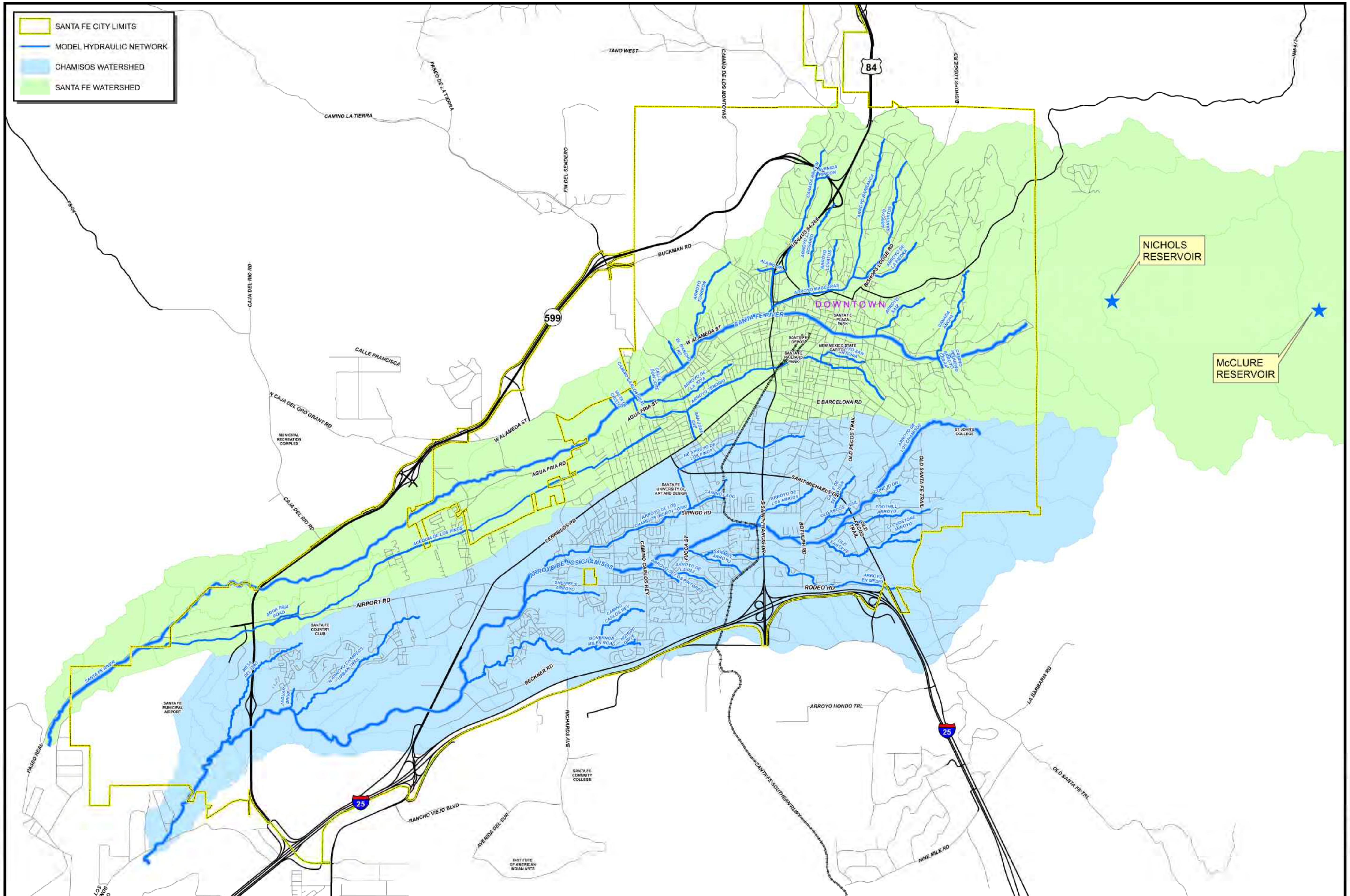
SANTA FE & CHAMISOS
CULVERT LOCATIONS

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

5

Bar Measures 1 inch
0 3,000 Ft.

Date: 8/2/2018 User Name: Troy Dorman Document Path: O:\SantaFeNMGIS\Exhibits\Exhibit05_CulvertLocationsMap.mxd



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STORMWATER MANAGEMENT PLAN

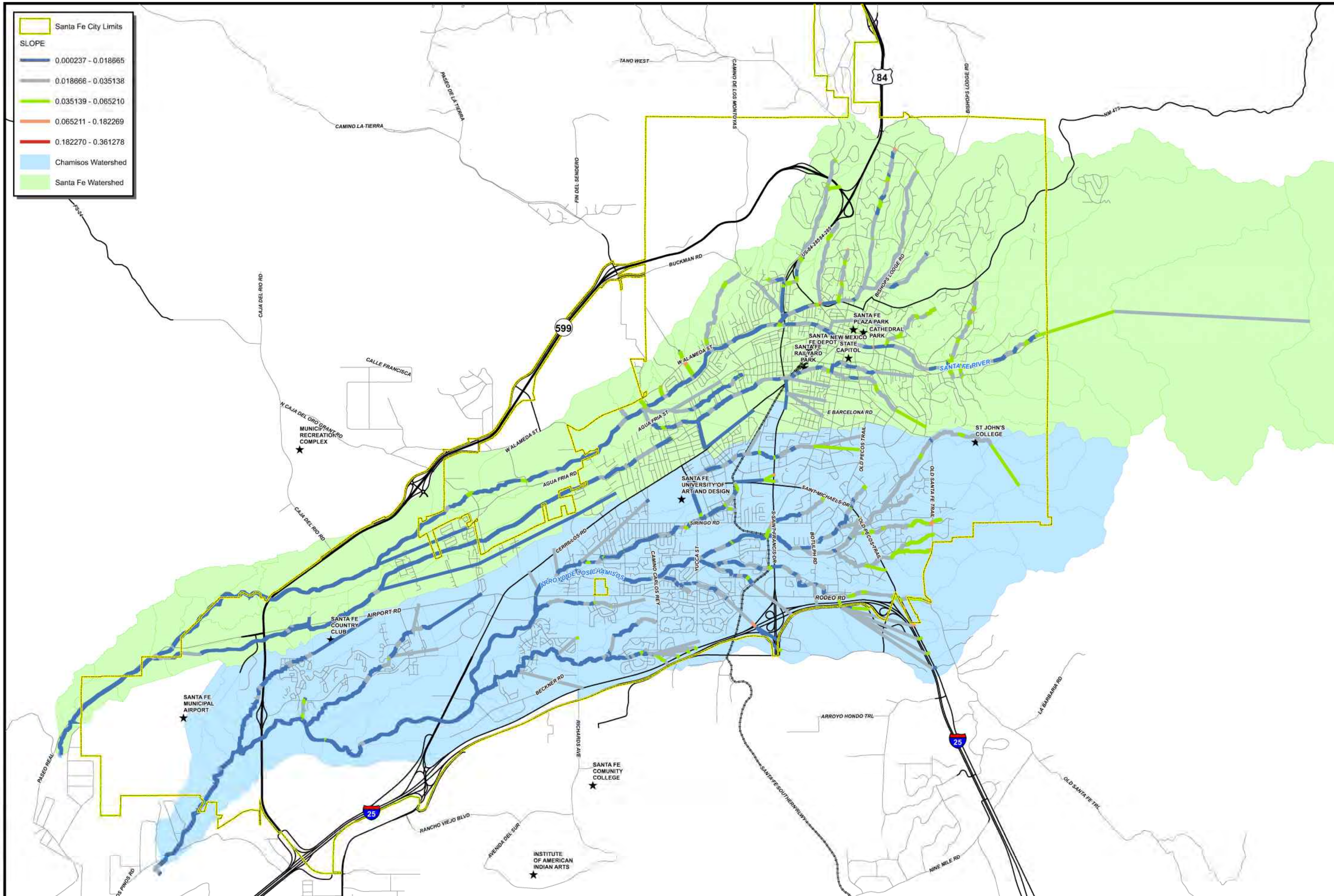
SANTA FE & CHAMISOS STREAM NETWORKS

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

6

Bar Measures 1 inch
0 3,000 Ft.

Date: 8/2/2018 User Name: Troy Dorman Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit06_HydraulicNetwork.mxd



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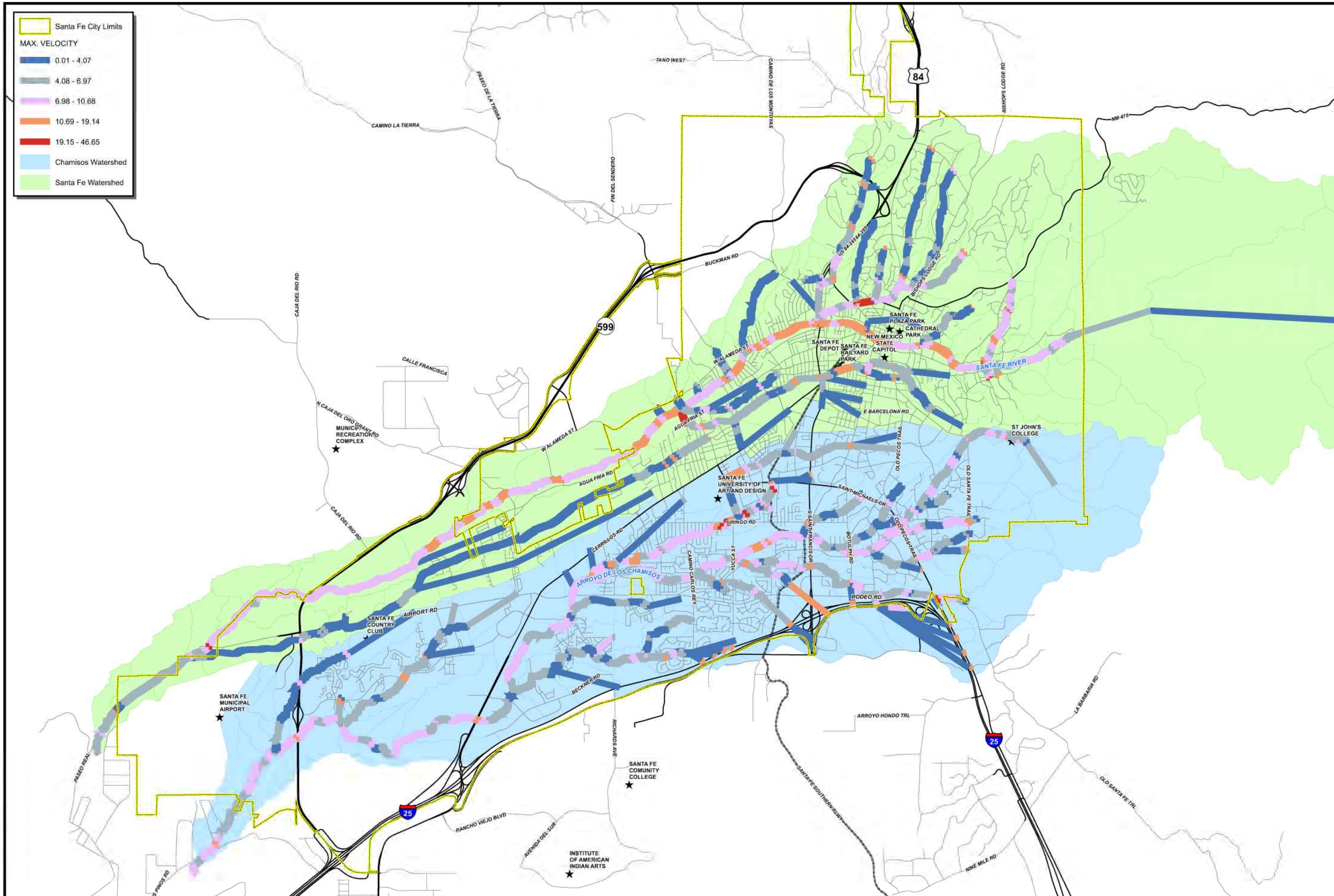
CITY OF SANTA FE
STORMWATER MANAGEMENT PLAN
SANTA FE & CHAMISOS WATERSHEDS AND SLOPE ANALYSIS

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

7

Bar Measures 1 inch
0 3,000 Ft.

Date: 8/2/2018 User Name: Troy.Dorman Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit07_SlopesMap.mxd



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Bar Measures 1 inch
0 3,000 Ft.

Date: 8/2/2018 User Name: Troy.Dorman Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit08_VelocityMap.mxd

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STORMWATER MANAGEMENT PLAN

SANTA FE & CHAMISOS VELOCITY RESULTS WITH SLOPE ANALYSIS

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
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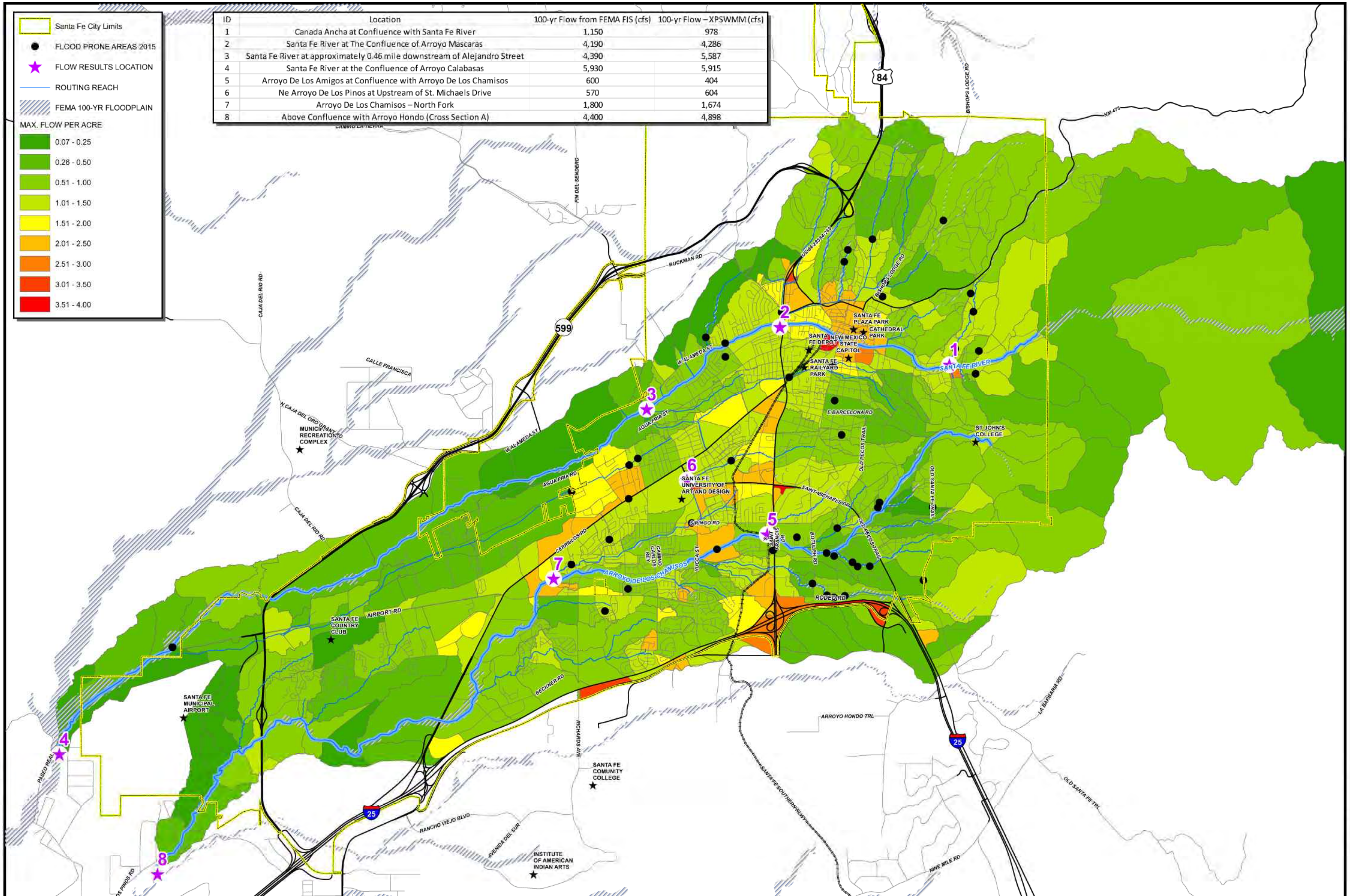
8



ID	Location	100-yr Flow from FEMA FIS (cfs)	100-yr Flow – XPSWMM (cfs)
1	Canada Ancha at Confluence with Santa Fe River	1,150	978
2	Santa Fe River at The Confluence of Arroyo Mascaras	4,190	4,286
3	Santa Fe River at approximately 0.46 mile downstream of Alejandro Street	4,390	5,587
4	Santa Fe River at the Confluence of Arroyo Calabasas	5,930	5,915
5	Arroyo De Los Amigos at Confluence with Arroyo De Los Chamisos	600	404
6	Ne Arroyo De Los Pinos at Upstream of St. Michaels Drive	570	604
7	Arroyo De Los Chamisos – North Fork	1,800	1,674
8	Above Confluence with Arroyo Hondo (Cross Section A)	4,400	4,898

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STORMWATER MANAGEMENT PLAN

SANTA FE & CHAMISOS PEAK FLOW PER ACRE

Project No.:	100-IWM-T37272
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Cartography By:	RM
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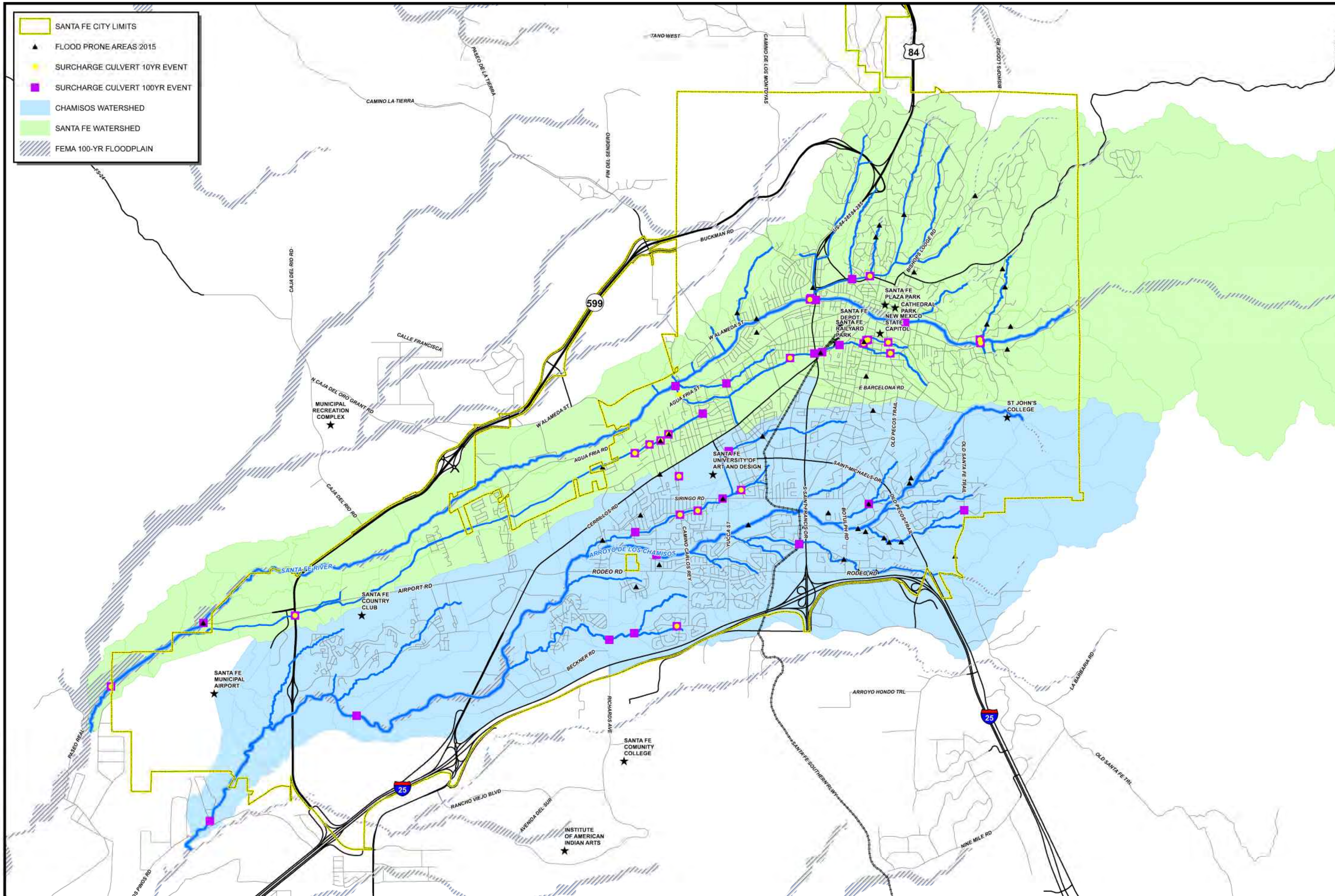
9

Bar Measures 1 inch
0 3,000 Ft.

Date: 4/5/2018 User Name: Ruben.Martinez Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit09_PeakFlowMap.mxd



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STORMWATER MANAGEMENT PLAN

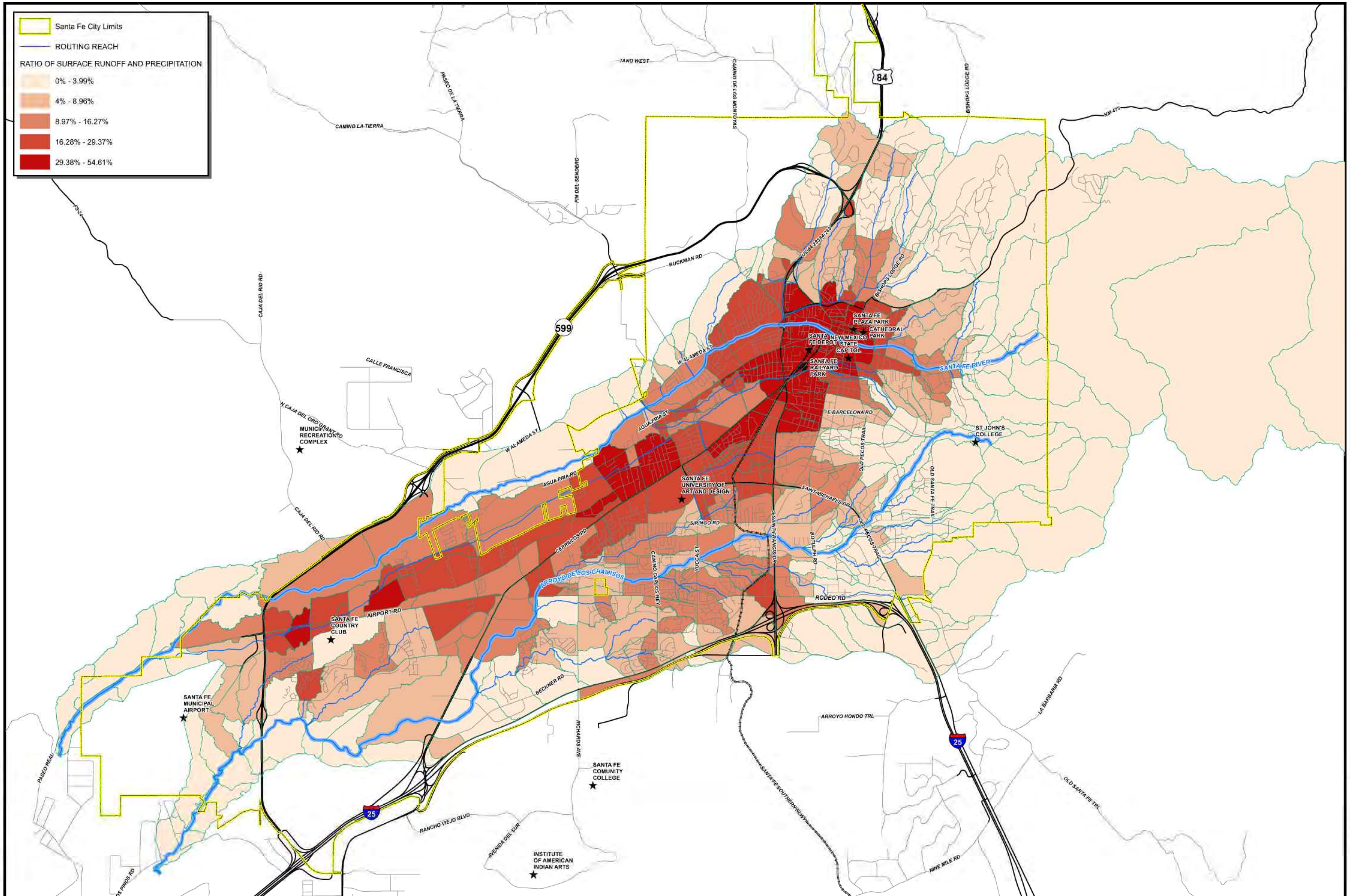
SANTA FE & CHAMISOS SURCHARGE CULVERTS

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

10

Bar Measures 1 inch
0 3,000 Ft.

Date: 8/2/2018 User Name: Troy Dorman Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit10_SurchargedCulvertsMapGraphics.mxd



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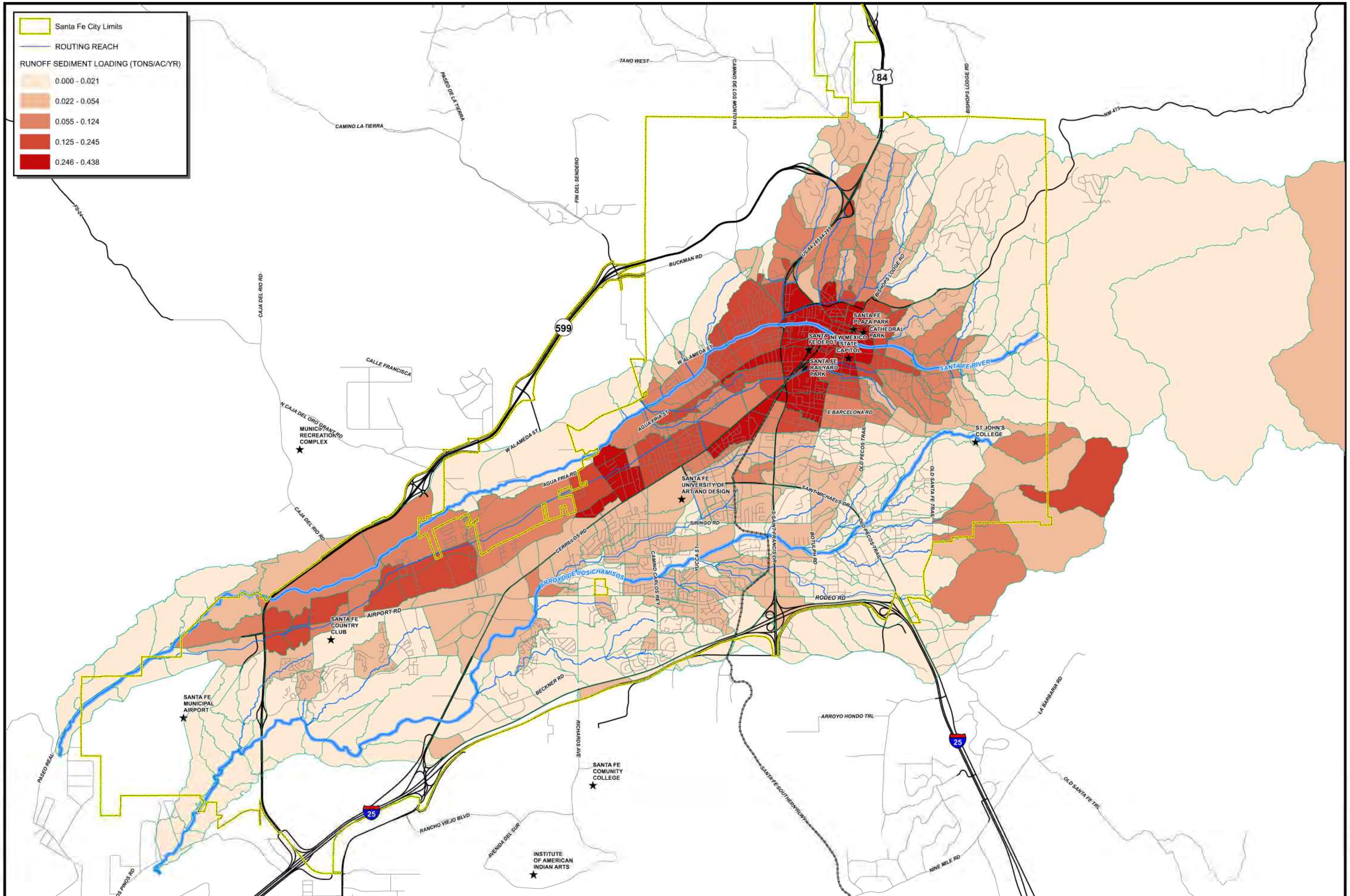
STORMWATER MANAGEMENT PLAN
SANTA FE & CHAMISOS RATIO OF SURFACE RUNOFF AND PRECIPITATION

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

13

Bar Measures 1 inch
0 3,000 Ft.

Date: 4/5/2018 User Name: Ruben Martinez Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit13_LSPCModelingMap.mxd



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STORMWATER MANAGEMENT PLAN

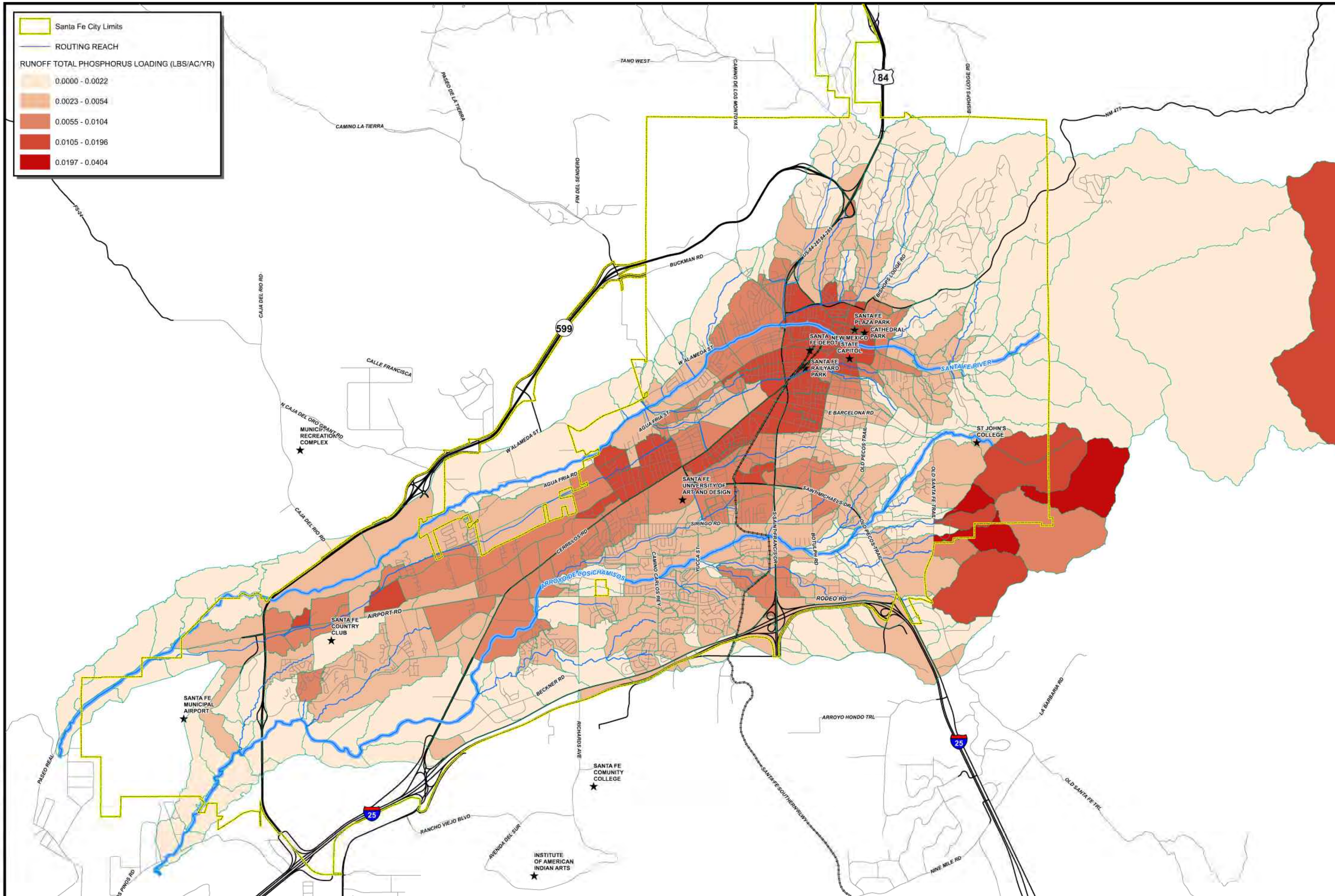
SANTA FE & CHAMISOS RUNOFF SEDIMENT LOADING (TON S/AC/YR)

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

14

Bar Measures 1 inch
0 3,000 Ft.

Date: 4/5/2018 User Name: Ruben Martinez Document Path: O:\SantaFeNMGIS\Exhibits\Exhibit14_RunoffSedimentMap.mxd



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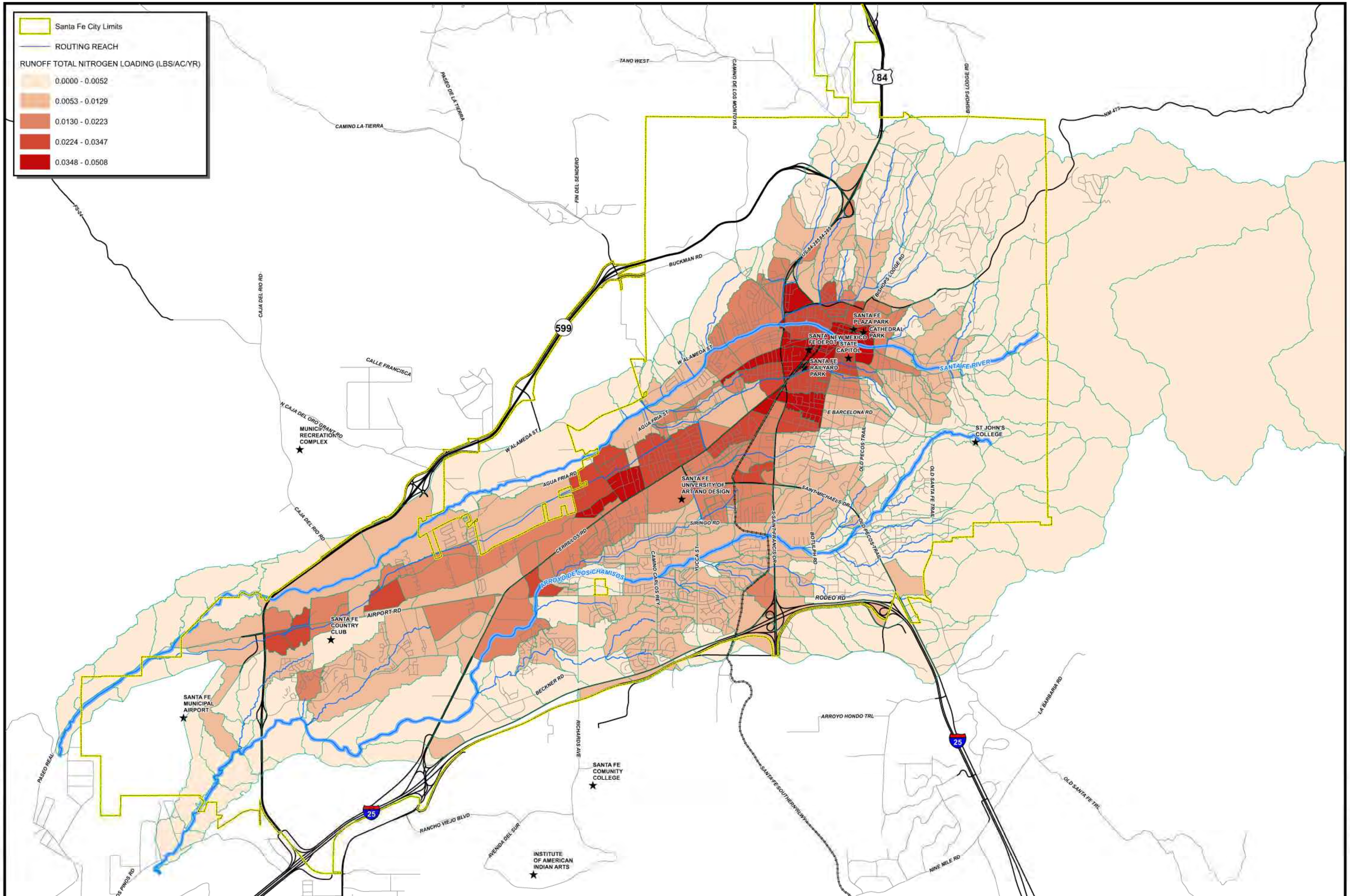
STORMWATER MANAGEMENT PLAN

SANTA FE & CHAMISOS RUNOFF TOTAL PHOSPHORUS LOADING (TON S/AC/YR)

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

15

Date: 4/5/2018 User Name: Ruben Martinez Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit15_RunoffPhosphorusMap.mxd



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MARK	DATE	DESCRIPTION	BY

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STORMWATER MANAGEMENT PLAN

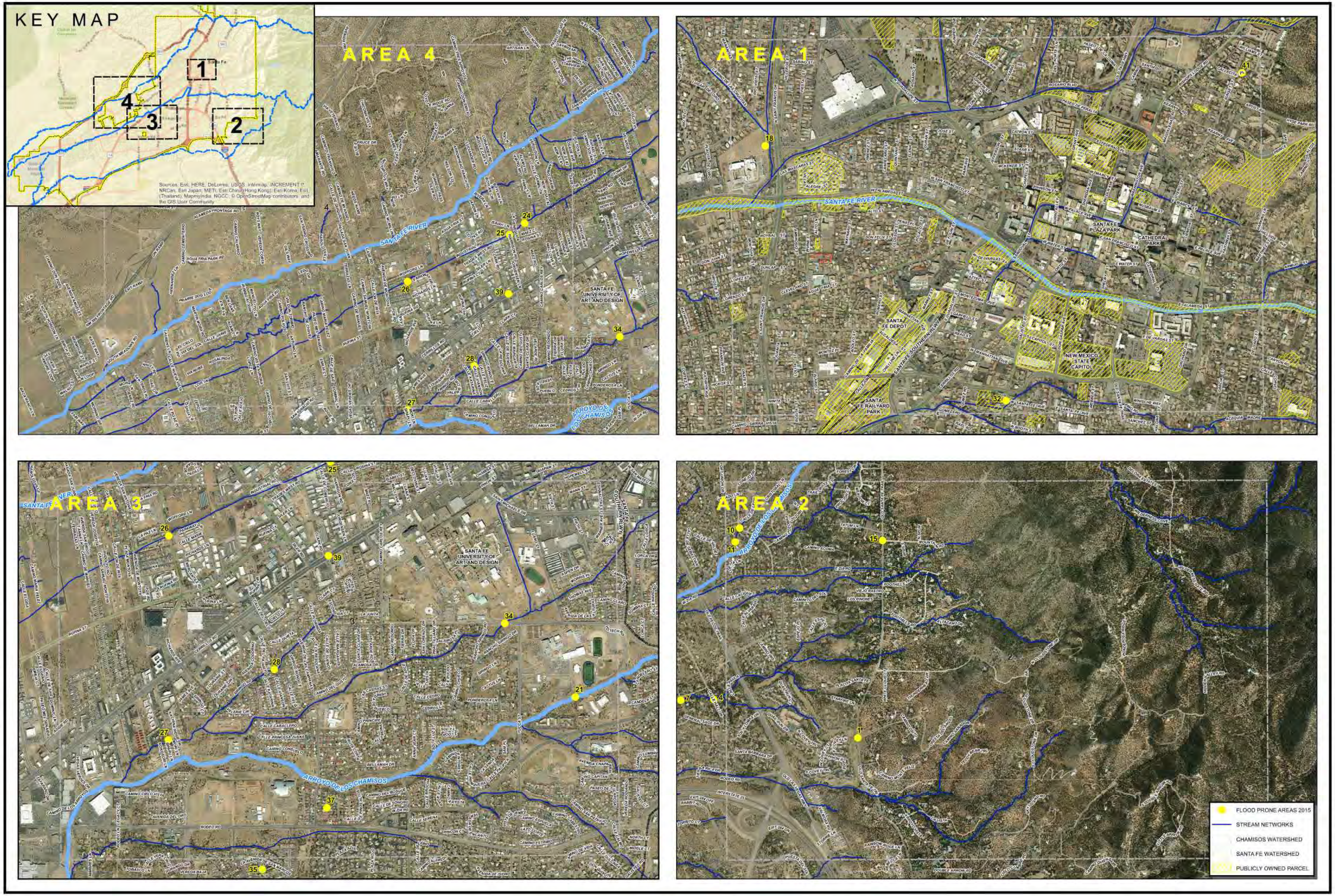
SANTA FE & CHAMISOS RUNOFF TOTAL NITROGEN LOADING (TON S/AC/YR)

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

16

Bar Measures 1 inch
0 3,000 Ft.

Date: 4/5/2018 User Name: Ruben.Martinez Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit16_RunoffNitrogenMap.mxd



TETRA TECH

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Santa Fe, New Mexico
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MARK	DATE	DESCRIPTION	BY

CITY OF SANTA FE

STORMWATER MANAGEMENT PLAN

PRIORITY AREAS FOR GREEN INFRASTRUCTURE IMPLEMENTATION

Project No.:	100-IWM-T37272
Designed By:	VZ
Cartography By:	RM
Checked By:	TD

17

0 1 in.

Bar Measures 1 inch

Date: 4/6/2018 User Name: Ruben Martinez Document Path: O:\SantaFeNM\GIS\Exhibits\Exhibit XX_TargetAreasMap.mxd

C. WATER QUALITY MEMO

TETRA TECH

MEMO

To:	Melissa McDonald
Cc:	Leroy Pacheco
From:	Troy Dorman, PE Amy King, Senior Environmental Scientist
Date:	December 15, 2017; Revised January 12, 2018
Subject:	Final Subtask 2.4.3 Data Compilation and Preliminary Data Review

Watershed models of the Santa Fe River and Arroyo de Los Chamisos watersheds are being developed to support updates of their drainage management plans, including updated pollutant source characterization. Existing water quality monitoring data are being compiled to support this effort. This memorandum identifies the studies and data evaluated, inventories available data for the pertinent parameters, and discusses how these data will be incorporated into the watershed model. A list of data gaps is also provided. Addressing these gaps will improve the ability of the model to estimate loadings by source category.

1.0 AVAILABLE DATA AND STUDIES

Tetra Tech has discussed project goals and associated data needs with the City. Data files were subsequently provided via email. The majority of data were collected by New Mexico Environment Department (NMED). These data include the following sampling efforts:

- **Santa Fe River monitoring**: Routine monitoring conducted along the Santa Fe River and La Cienega Creek for 2010 through 2017. Analyses were performed for a wide variety of parameters, including nutrients, metals, ions, sediment, bacteria, and organics.
- **Santa Fe River bacteria sampling**: *E. coli* results collected at nine stations along the Santa Fe River in 2005 and 2008.
- **PCB Analyses**: Analyses for PCBs include total of seven samples collected at six stations in 2005. Stations included four stations on the Santa Fe River and two additional stations on drains/arroyos (mostly storm samples).
- **Santa Fe River outfall stormwater monitoring**: Sampling conducted in August 2016 below the Sandoval bridge. Results provided for base neutral acid parameters and bacteria.
- **Well and river water monitoring**: Samples collected at two locations upstream of Nichols Reservoir (well and river samples for comparison) in August 2014 and analyzed for nutrients and ions. Samples were collected to test a piezometer installed by the City, who found an odor of sulphur when it was purged.
- **Genetic marker study**: Results from a 2017 study evaluating presence of human, beaver, bird, dog, and ruminant bacteria. A total of 16 samples were collected at five different locations in the watershed.

The data identified above were compiled into a single consistent format (over 4,500 unique samples, not including quality control results). Data associated with the proposed modeling parameters (nutrients, total suspended solids [TSS], and bacteria) were flagged for further review (approximately 1,000 records).

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2.0 DATA INVENTORY FOR MODELING PARAMETERS

Water quality data for nutrients, sediment, and bacteria were collected at 19 stations in six different assessment units (Table 2-1). Seventeen of these stations represent conditions along the Santa Fe River from McClure reservoir to Cochiti Pueblo, two stations are on Cienega Creek, one station is in the wastewater treatment plant (WWTP) outfall channel, and two stations are associated with stormwater outfalls.

Data by station were compiled into a consistent format. These data include the studies described in Section 1.0 above. The date range and number of samples associated with the available data are summarized by pollutant and station in Table 2-2. All data in this table represent surface water samples unless noted. Most data are available for 2010 through 2017, while *E. coli* samples extend back to 2005. Some stations have a single sample for water quality concentrations while others have up to 16, depending on the parameter (although the average number of samples by station/parameter is less than 10). Overall, these data largely represent conditions within the Santa Fe River. Data from only five stations can be used to represent inputs to the river.

In addition to these stations, five locations in the watershed were sampled in September 2017 and genetic marker tests were performed for the presence of human, beaver, dog, bird, and/or ruminant bacteria. These locations included Cerro Gordo, Patty Smith Park, Paseo, Guadalupe, and Agua Fria. The presence of human and dog bacteria was analyzed at all five locations, while beavers were tested only at Cerro Gordo, ruminants were tested at Agua Fria, and bird bacteria were analyzed at all stations except Agua Fria.

Table 2-1. Water Quality Monitoring Stations by Assessment Unit

Assessment Unit	Station Identification Number	Station Name	Latitude	Longitude
Santa Fe River (Nichols Reservoir to headwaters)	30SantaF061.1	Santa Fe River above McClure Reservoir at gage - 30SantaF061.1	35.688611	-105.82222
	30SantaF059.1	Santa Fe River above Nichols Reservoir at gage 08316000 - 30SantaF059.1	35.686800	-105.843
Santa Fe River (Guadalupe St to Nichols Reservoir)	30SantaF052.4	Santa Fe River below Cerro Gordo Rd. - 30SantaF052.4	35.68148	-105.90910
	30SantaF050.5	Santa Fe River ~75m up stream of Sandoval St - 30SantaF050.5	35.6858	-105.9419
	NMR040000-SR01	City of Santa Fe stormwater outlet #1 into Santa Fe River downstream of Sandoval St. (southside)	35.68641	-105.94307
	NMR040000-SF02	City of Santa Fe stormwater outlet #2 into Santa Fe River downstream of Sandoval St. (northside)	35.68644	-105.94294
	30SantaFF050.3	Santa Fe River 5 meters u/s of Guadalupe St - 30SantaF050.3	35.68703	-105.94397
Santa Fe River (Santa Fe WWTP to Guadalupe St.)	30SantaF048.8	Santa Fe River below Cerro Gordo Rd. - 30SantaF048.8	unknown	unknown
	30SantaF047.9	Santa Fe River below St Francis Dr. - 30SantaF047.9	35.6884	-105.955
	30SantaF044.5	Santa Fe River below Frenchies Field - 30SantaF044.5	35.67283	-105.98618
	30SantaF042.6	Santa Fe River at Siler RD - 30SantaF042.6	35.664365	-105.997811
	30SantaF041.2	Santa Fe River at CRD 68A (San Isidro Crossing) - 30SantaF041.2	35.6597	-106.012
	30SantaF035.9	Santa Fe River above Hwy 599 - 30SantaF035.9	35.64016	-106.06408
	30SantaF032.9	Santa Fe River immediately upstream of WWTP effluent channel - 30SantaF032.9	35.630333	-106.09115
Santa Fe River (Cienega Creek to Santa Fe WWTP)	NM0022292-M	Santa Fe WWTP effluent channel outfall - NM0022292	35.629444	-106.091389
	SFR at effluent outfall	Santa Fe River at effluent channel outfall - NM0022292	unknown	unknown
	30SantaF030.5	Lower Santa Fe River Preserve - 30SantaF030.5	35.61842	-106.11178
	30SantaF028.4	Santa Fe River above CRD 56 downstream of river preserve - 30SantaF028.4	35.60279	-106.12134
Santa Fe River (Cochiti Pueblo bnd to Cienega Creek)	30SantaF013.6	Santa Fe River above La Bajada diversion - 30SantaF013.6	35.546769	-106.22363
	30SantaF012.9	Santa Fe River above Cochiti at USGS gage 08317200 - 30SantaF012.9	35.54726	-106.22922
Cienega Creek (Perennial part of Santa Fe River to headwaters)	30LaCien000.1	Cienega Creek NE 90 ft above mouth on SF River - 30LaCien000.1	35.55862	-106.14719
	30LaCien002.1	Cienega Creek 0.3 miles below bridge in La Cienega - 30LaCien002.1	35.560659	-106.129986

Table 2-2. Data Inventory by Parameter and Station

Station Identification Number	Start Date	End Date	Number of Samples	Notes
Chlorophyll *a* (9/24/2014 – 9/21/17; n = 6)				
30SantaF061.1	9/24/2014	9/24/2014	1	
30SantaF028.4	10/24/2014	9/17/2015	2	
30SantaF013.6	10/23/2014	9/21/2017	3	
Dissolved oxygen concentration (4/15/2010 – 9/21/2017; n = 115)				
30SantaF061.1	4/29/2010	7/20/2016	10	
30SantaF059.1	8/20/2014	8/20/2014	1	
30SantaF052.4	6/4/2012	11/14/2014	8	
30SantaF050.5	5/14/2013	5/6/2015	13	One sample collected after storms (2013)
30SantaF050.3	6/2/2016	8/5/2016	4	
30SantaF047.9	6/4/2012	6/4/2012	1	
30SantaF044.5	6/4/2012	5/6/2015	6	One sample collected after storms (2013)
30SantaF041.2	9/17/2013	8/5/2016	6	One sample collected after storms (2013)
30SantaF035.9	9/17/2013	5/28/2014	5	One sample collected after storms (2013)
30SantaF032.9	4/29/2010	10/8/2013	3	
NM0022292-M	4/29/2010	10/15/2014	10	Municipal waste
30SantaF30.5	4/29/2010	5/18/2010	2	
30SantaF028.4	4/15/2010	9/17/2015	16	
30SantaF013.6	3/20/2014	9/21/2017	12	
30SantaF012.9	4/29/2010	6/25/2014	8	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	9	
Dissolved oxygen saturation (4/15/2010 – 9/21/2017; n = 115)				
30SantaF061.1	4/29/2010	7/20/2016	10	
30SantaF059.1	8/20/2014	8/20/2014	1	
30SantaF052.4	6/4/2012	11/14/2014	8	
30SantaF050.5	5/14/2013	5/6/2015	13	One sample collected after storms (2013)
30SantaF050.3	6/2/2016	8/5/2016	4	
30SantaF047.9	6/4/2012	6/4/2012	1	
30SantaF044.5	6/4/2012	5/6/2015	6	One sample collected after storms (2013)
30SantaF041.2	9/17/2013	8/5/2016	6	One sample collected after storms (2013)
30SantaF035.9	9/17/2013	5/28/2014	5	One sample collected after storms (2013)
30SantaF032.9	4/29/2010	10/8/2013	3	
NM0022292-M	4/29/2010	10/15/2014	8	Municipal waste
30SantaF30.5	4/29/2010	5/18/2010	2	

Station Identification Number	Start Date	End Date	Number of Samples	Notes
30SantaF028.4	4/15/2010	9/17/2015	16	
30SantaF013.6	3/20/2014	9/21/2017	12	
30SantaF012.9	4/29/2010	6/25/2014	8	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	9	
Kjeldahl nitrogen (4/15/2010 – 9/21/2017; n = 89)				
30SantaF061.1	11/10/2011	11/14/2014	7	
30SantaF059.1	8/20/2014	8/20/2014	2	One sample represents well water
30SantaF052.4	10/8/2013	11/14/2014	5	
30SantaF050.5	10/8/2013	10/15/2014	9	
30SantaF044.5	10/8/2013	6/25/2014	2	
30SantaF041.2	10/8/2013	10/8/2013	1	
30SantaF035.9	10/8/2013	5/28/2014	4	
30SantaF032.9	4/29/2010	10/8/2013	3	
NM0022292-M	4/29/2010	10/15/2014	12	Municipal waste
30SantaF30.5	4/29/2010	5/18/2010	2	
30SantaF028.4	4/15/2010	10/15/2014	15	
30SantaF013.6	3/20/2014	9/21/2017	12	
30SantaF012.9	4/29/2010	4/22/2014	7	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	7	
Nitrogen, ammonia as N (4/15/2010 – 9/21/2017; n = 87)				
30SantaF061.1	11/10/2011	11/14/2014	7	
30SantaF059.1	8/20/2014	8/20/2014	2	One sample represents well water
30SantaF052.4	10/8/2013	11/14/2014	5	
30SantaF050.5	10/8/2013	10/15/2014	9	
30SantaF044.5	10/8/2013	6/25/2014	2	
30SantaF041.2	10/8/2013	10/8/2013	1	
30SantaF035.9	10/8/2013	5/28/2014	4	
30SantaF032.9	4/29/2010	10/8/2013	3	
NM0022292-M	4/29/2010	10/15/2014	12	Municipal waste
30SantaF030.5	4/29/2010	5/18/2010	2	
30SantaF028.4	4/15/2010	10/15/2014	15	
30SantaF013.6	3/20/2014	9/21/2017	10	
30SantaF012.9	4/29/2010	4/22/2014	7	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	7	
Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N (4/15/2010 – 9/21/2017; n = 87)				
30SantaF061.1	4/10/2011	11/14/2014	7	

Station Identification Number	Start Date	End Date	Number of Samples	Notes
30SantaF059.1	8/20/2014	8/20/2014	2	One sample represents well water
30SantaF052.4	10/8/2013	11/14/2014	5	
30SantaF050.5	10/8/2013	10/15/2014	9	
30SantaF044.5	10/8/2013	6/25/2014	2	
30SantaF041.2	10/8/2013	10/8/2013	1	
30SantaF035.9	10/8/2013	5/28/2014	4	
30SantaF032.9	4/29/2010	10/8/2013	3	
NM0022292-M	4/29/2010	10/15/2014	12	Municipal waste
30SantaF030.5	4/29/2010	5/18/2010	2	
30SantaF028.4	4/15/2010	10/15/2014	15	
30SantaF013.6	3/20/2014	9/21/2017	10	
30SantaF012.9	4/29/2010	4/22/2014	7	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	7	
Phosphorus as P (4/15/2010 – 9/21/2017; n = 89)				
30SantaF061.1	11/10/2011	11/14/2014	7	
30SantaF059.1	8/20/2014	8/20/2014	2	One sample represents well water
30SantaF052.4	10/8/2013	11/14/2014	5	
30SantaF050.5	10/8/2013	10/15/2014	9	
30SantaF044.5	10/8/2013	6/25/2014	2	
30SantaF041.2	10/8/2013	10/8/2013	1	
30SantaF035.9	10/8/2013	5/28/2014	4	
30SantaF032.9	4/29/2010	10/8/2013	3	
NM0022292-M	4/29/2010	10/15/2014	12	Municipal waste
30SantaF030.5	4/29/2010	5/18/2010	2	
30SantaF028.4	4/15/2010	10/15/2014	15	
30SantaF013.6	3/20/2014	9/21/2017	12	
30SantaF012.9	4/29/2010	4/22/2014	7	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	7	
Temperature, water (4/10/2010 – 9/21/2017; n = 117)				
30SantaF061.1	11/10/11	7/20/2016	10	
30SantaF059.1	8/20/2014	8/20/2014	1	
30SantaF052.4	6/4/2012	11/14/2014	8	
30SantaF050.5	5/14/2013	5/6/2015	13	One sample collected after storms (2013)
30SantaF050.3	6/2/2016	8/5/2016	4	
30SantaF047.9	6/4/2012	6/4/2012	1	
30SantaF044.5	6/4/2012	5/6/2015	6	One sample collected after storms (2013)

Station Identification Number	Start Date	End Date	Number of Samples	Notes
30SantaF041.2	9/17/2013	8/5/2016	6	One sample collected after storms (2013)
30SantaF035.9	9/17/2013	5/28/2014	5	One sample collected after storms (2013)
30SantaF032.9	4/29/2010	10/8/2013	3	
NM0022292-M	4/29/2010	10/15/2014	11	Municipal waste
30SantaF030.5	4/29/2010	5/18/2010	2	
30SantaF028.4	4/15/2010	9/17/2015	16	
30SantaF013.6	3/20/2014	9/21/2017	12	
30SantaF012.9	4/29/2010	6/25/2014	8	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	10	
***E. Coli* (3/23/2005 – 9/21/2017; n = 118)**				
30SantaF061.1	4/22/2014	11/14/2014	6	
30SantaF052.4	6/5/2008	11/14/2014	10	
30SantaF050.5	5/7/2013	10/15/2014	12	One sample collected after storms (2013)
30SantaT050.3	6/2/2016	8/5/2016	4	
NMR040000-SF02	8/5/2016	8/5/2016	1	Stormwater outfall
NMR040000-SR01	8/5/2016	8/5/2016	1	Stormwater outfall
30SantaF048.8	4/20/2005	4/20/2005	1	
30SantaF047.9	10/3/2008	6/4/2012	2	
30SantaF044.5	6/5/2008	6/25/2014	6	One sample collected after storms (2013)
30SantaF041.2	9/17/2013	8/5/2016	6	One sample collected after storms (2013)
30SantaF035.9	3/23/2005	5/28/2014	11	One sample collected after storms (2013)
30SantaF032.9	10/8/2013	10/8/2013	1	
NM0022292-M	10/8/2013	10/15/2014	9	Municipal waste
SFR at effluent outfall	3/23/2005	10/5/2005	9	
30SantaF030.5	7/12/2005	7/12/2005	1	
30SantaF028.4	10/8/2013	10/15/2014	9	
30SantaF013.6	3/20/2014	9/21/2017	10	
30SantaF012.9	3/23/2005	6/25/2014	11	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	7	
Total Coliform (6/4/2012 – 9/21/2017; n = 88)				
30SantaF061.1	4/22/2014	11/14/2014	6	
30SantaF052.4	6/4/2012	11/14/2014	8	
30SantaF050.5	5/7/2013	10/15/2014	12	One sample collected after storms (2013)
NMR040000-SF02	8/5/2016	8/5/2016	1	Stormwater outfall
NMR040000-SR01	8/5/2016	8/5/2016	1	Stormwater outfall

Station Identification Number	Start Date	End Date	Number of Samples	Notes
30SantaF050.3	6/2/2016	8/5/2016	4	
30SantaF047.9	6/4/2012	6/4/2012	1	
30SantaF044.5	6/4/2012	6/25/2014	5	One sample collected after storms (2013)
30SantaF041.2	9/17/2013	8/5/2016	6	One sample collected after storms (2013)
30SantaF035.9	9/17/2013	5/28/2014	5	One sample collected after storms (2013)
30SantaF032.9	10/8/2013	10/8/2013	1	
NM0022292-M	10/8/2013	10/15/2014	9	Municipal waste
30SantaF028.4	10/8/2013	10/15/2014	9	
30SantaF013.6	3/20/2014	9/21/2017	10	
30SantaF012.9	3/20/2014	6/25/2014	2	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	7	
Total suspended solids (8/16/2010 – 9/21/2017; n = 59)				
30SantaF061.1	11/10/2011	11/14/2014	7	
30SantaF059.1	8/20/2014	8/20/2014	2	One sample represents well water
30SantaF052.4	4/22/2014	11/14/2014	4	
30SantaF050.5	4/22/2014	10/1/2014	6	
30SantaF044.5	6/25/2014	6/25/2014	1	
30SantaF035.9	3/27/2014	5/28/2014	3	
NM0022292-M	3/27/2014	10/1/2014	7	Municipal waste
30SantaF028.4	8/16/2010	10/1/2014	9	
30SantaF013.6	3/20/2014	9/21/2017	9	
30SantaF012.9	8/16/2010	5/28/2014	5	
30LaCien000.1	4/22/2014	10/1/2014	6	
Turbidity (4/10/2010 – 9/21/2017; n = 113)				
30SantaF061.1	11/10/11	7/20/2016	11	
30SantaF059.1	8/20/2014	8/20/2014	1	
30SantaF052.4	6/4/2012	11/14/2014	8	
30SantaF050.5	5/14/2013	5/6/2015	12	One sample collected after storms (2013)
30SantaF050.3	6/2/2016	8/5/2016	4	
30SantaF047.9	6/4/2012	6/4/2012	1	
30SantaF044.5	6/4/2012	5/6/2015	6	One sample collected after storms (2013)
30SantaF041.2	9/17/2013	8/5/2016	6	One sample collected after storms (2013)
30SantaF035.9	9/17/2013	5/28/2014	5	One sample collected after storms (2013)
30SantaF032.9	4/29/2010	10/8/2013	3	
NM0022292-M	4/29/2010	10/15/2014	10	Municipal waste
30SantaF030.5	4/29/2010	5/18/2010	2	

Station Identification Number	Start Date	End Date	Number of Samples	Notes
30SantaF028.4	4/15/2010	9/17/2015	15	
30SantaF013.6	3/20/2014	9/21/2017	11	
30SantaF012.9	4/29/2010	6/25/2014	8	
30LaCien002.1	3/27/2014	3/27/2014	1	
30LaCien000.1	4/22/2014	10/15/2014	8	
Instantaneous Flow (64/10/2010 – 9/21/2017; n = 173)*				
30SantaF061.1	11/10/11	7/20/2016	17	
30SantaF059.1	8/20/2014	8/20/2014	1	
30SantaF052.4	6/4/2012	11/14/2014	13	
30SantaF050.5	5/7/2013	5/6/2015	22	One sample collected after storms (2013)
30SantaF050.3	6/2/2016	8/5/2016	4	
30SantaF047.9	6/4/2012	7/18/2012	3	
30SantaF044.5	6/4/2012	5/6/2015	11	One sample collected after storms (2013)
30SantaF042.6	5/13/2013	5/13/2013	1	
30SantaF041.2	9/17/2013	8/5/2016	6	One sample collected after storms (2013)
30SantaF035.9	9/17/2013	5/28/2014	8	One sample collected after storms (2013)
30SantaF032.9	4/29/2010	10/8/2013	5	
NM0022292-M	4/29/2010	10/15/2014	9	Municipal waste
30SantaF030.5	4/29/2010	5/18/2010	2	
30SantaF028.4	4/15/2010	9/17/2015	31	
30SantaF013.6	3/20/2014	9/21/2017	23	
30LaCien002.1	3/27/2014	3/27/2014	2	
30LaCien000.1	4/22/2014	10/15/2014	10	

*Some results are qualitative (i.e., low, moderate, high) rather than quantitative.

3.0 APPLICATION FOR POLLUTANT SOURCE CHARACTERIZATION

During model configuration, land categories that share hydrologic or pollutant loading characteristics will be grouped. It is assumed that the loading processes associated with *E. coli* and nutrient parameters that are not associated with sediment will be represented in the model using build-up/wash-off functions in which the pollutants are assumed to accumulate on the land surface during dry periods and are subsequently washed off during storm events. Sediment will be estimated using the sediment modules that simulate the production and removal of sediment from all land segments. Once the model represents the sediment transported to the stream channel by overland flow, transport, deposition, and scour of sediment in the stream channels can also be simulated. Additional water quality simulations will then be performed for any parameters that are correlated with sediment using wash-off potency factors.

The vast majority of stations with available data represent conditions within the Santa Fe River itself. Data for these stations will be useful for calibrating in-stream water quality concentrations. One exception is the station located at the Santa Fe WWTP effluent outfall channel (NM0022292). The datasets indicated that these samples represent municipal wastewater; therefore, data from this station will be used to characterize the immediate in-stream conditions associated with the WWTP contributions. In addition, the Cienega Creek stations can be used to characterize water quality conditions associated with that drainage area. All available data will also be useful to identify relationships between any parameters (i.e., are any of the nutrient species correlated with TSS?).

The genetic marker study is also useful to identify the relative contribution of various sources of bacteria in the watershed. Where data are available, loads associated with the five sources analyzed can be appropriately proportioned by source at the different locations. For locations without data on all of the five sources, the data will be used to the extent possible and assumptions can be made for the sources without measurements.

In the absence of land cover- or source-specific water quality data, water quality calibration will likely be conducted moving from upstream to downstream in the watershed as the upstream areas have more homogenous land cover. Calibrating water quality parameters at a station with a fairly homogenous drainage area helps to define the parameters for that land cover early in the modeling process. Model calibration will then continue at each station sequentially downstream, taking into consideration the additional land cover included in the upstream drainage area (depending on the proximity of the new land use[s] to the stream and the associated area). Literature values quantifying the relative difference in pollutant loading between land cover types will be used as a guide to ensure that model parameterization is realistic.

After the available data are used in model calibration for the Santa Fe River, the parameters will be transferred to the model for the Arroyo de Los Chamisos as there are no additional data for this waterbody to inform water quality calibration.

4.0 DATA GAPS

Additional data sources may be available that would enhance the spatial representation of the watershed model. These data gaps include:

- Arroyo de Los Chamisos is currently not represented by any of the data compiled to date. Any data for this waterbody would be useful to characterize local conditions.
- Additional water quality data representing storm drain outfalls and/or drainages with fairly homogenous land uses would be valuable to model calibration for specific pollutant sources.
- Sampling locations for the genetic marker study would be useful to identify drainage areas associated with the sources of bacteria.

D. ASSET MANAGEMENT MEMO

TETRA TECH

MEMO

To:	Melissa McDonald
Cc:	Leroy Pacheco, PE
From:	Troy Dorman, PE
Date:	July 9, 2018
Subject:	Asset Management Inventory and Program Recommendations - Final

1.0 INTRODUCTION

Starting a discussion about asset management requires defining what it is. According to the EPA:

Asset management is maintaining a desired level of service for what you want your assets to provide at the lowest life cycle cost. Lowest life cycle cost refers to the best appropriate cost for rehabilitating, repairing or replacing an asset. Asset management is implemented through an asset management program and typically includes a written asset management plan.

Our focus during development of this memo was to adapt the "textbook" idea of asset management into a practical set of recommendations for Santa Fe. The information gained during Tetra Tech's review of the existing stormwater program guided the creation of Asset Management Goals specifically for the City of Santa Fe. These goals will improve asset tracking, operation and maintenance while advancing watershed-based stormwater management outcome desired by the City. The goals are

- Document and guide maintenance of the storm drain system
- Provide basis for study, design, modeling and fixing drainage issues
- Guide creation of a stormwater monitoring program
- Develop programs and processes to maintain existing and incorporate new asset management data

As the City looks at actions to implement stormwater asset management, keeping a few questions in mind can help provide focus. Answering the questions when considering new expenditures and processes can guide decision makers to the optimal approach.

You should ask:

How do our current efforts improve the public's perception of the Santa Fe stormwater team's service?
What have we learned since last year that can improve our asset management system and processes?
How does the current system inhibit the City of Santa Fe meeting MS4 permit requirements?
How does the current system help the City of Santa Fe meet MS4 permit requirements?

2.0 ASSET MANAGEMENT FRAMEWORK

Once goals are set, it is necessary to develop a plan to implement them and achieve the desired outcomes. There a many national and instate guidance documents for how to achieve asset management using financial, GIS, and planning tools. Based on our understanding of the City of Santa Fe, the team adapted steps that ESRI developed from more than 20 years of GIS based asset management.

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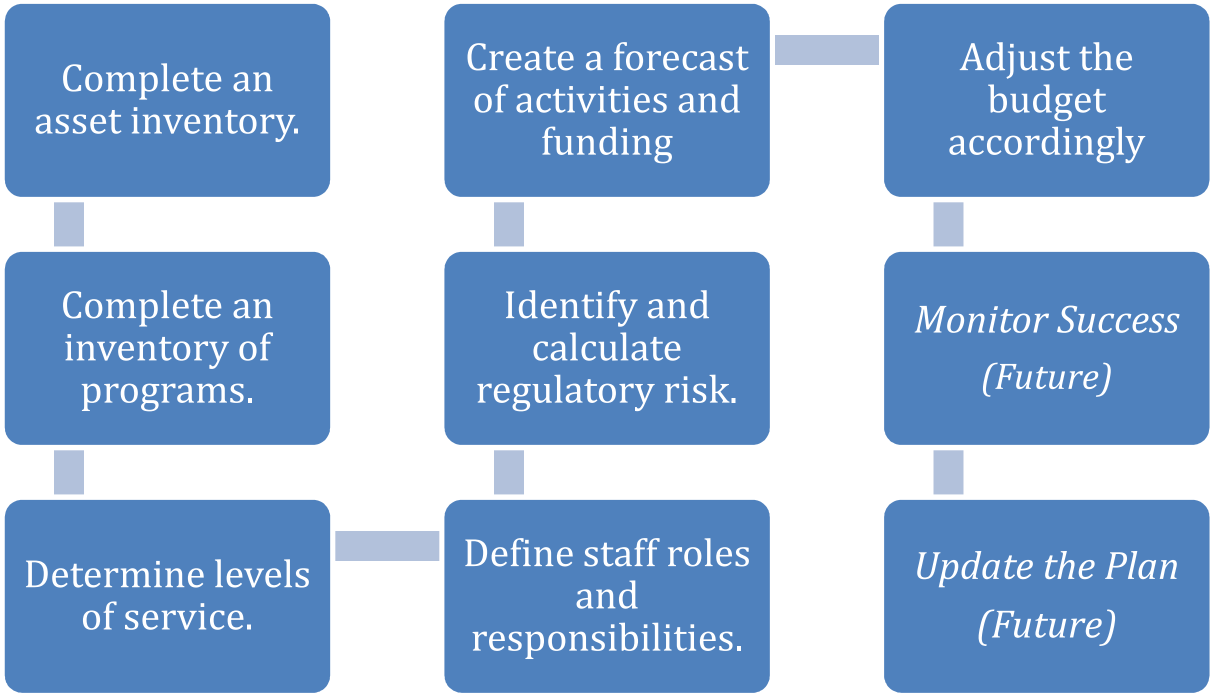


These steps provide a road map for Santa Fe to create a successful asset management program that improves customer service, reduces cost, and maps out the funding necessary to maintain and expand the stormwater management system. The following sections discuss these steps and provide specific recommendations for Santa Fe. The last two future steps are considered self-explanatory and are not discussed in this memo.

2.1 EXISTING STORMWATER DATA

To complete an asset inventory, Santa Fe needed a data inventory and review. Staff provided Tetra Tech with a wide variety of data sources including GIS information, text files, aerial photography and LiDAR data. Tetra Tech evaluated the available data for purposes of stormwater management planning and asset management and to identify gaps in data.

The GIS data received from the City of Santa Fe include the following stormwater system shapefiles:

- Drop Inlet
- Outfall
- Storm Water Areas
- Storm Water Channels
- Storm Water Curb Openings
- Storm Water Inlets
- Storm Water Outlets
- Storm Water Pond Embankments
- Storm Water Ponds

None of the files cover the whole area of the watershed and the attribute tables are incomplete. Figure 1 shows the location of data that was provided by City staff. It is apparent that much of the city is not represented in the data. Field checks and review of aerial photography indicated that there is a large part of the stormwater system that is not represented in the existing data. Also, there are several files with the same type of information and they need to be accumulated and collected in one comprehensive database file. Missing (or incomplete) data for the proposed stormwater database includes: stormwater inlet and outlets, pipes, culverts, channels, manholes, and easement and cleanout locations.

> Key Recommendation #1 - The top priority is collection of complete stormwater system data including a condition assessment of all surface and subsurface assets.

2.2 INVENTORY OF SANTA FE ASSET MANAGEMENT PROGRAMS

The City of Santa Fe uses multiple “asset management” programs across the different departments. There are separate asset management needs and software programs for facilities, financials, human resources, utilities and billing. City staff and Tetra Tech met on March 8, 2018 to compare the asset management solutions in order to determine the best path forward for a Stormwater asset management approach. Full notes for the meeting are included at the end of this memo. The highlights from the meeting are:

- The city is in the process of implementing several enterprise-wide systems from Tyler Technologies, including Munis (for Financial and HR systems), EnerGov (for land management, licensing and permitting) and Tyler Enterprise Asset Management (EAM). Both EnerGov and EAM are fully integrated with ESRI GIS allowing display of ESRI shapefiles. According to Santa Fe’s IT department, Tyler EAM does not have the ability to edit geodatabases directly within the software.
- The Public Utilities department currently uses Cityworks for water transmission and distribution assets. All sewer lines are in a GIS database which is used internally by city staff and asset repairs and maintenance are tracked in a MS Access database. Additional software is used in the water/wastewater treatment plants to track asset work orders, data, and repairs. Utility billing is through a separate software program but there are plans to move to a system that works with Cityworks. Cityworks is a GIS based asset management tool that is developed on top of the GIS software created by ESRI.

Tetra Tech considered the existing programs and planned conversions of software to make recommendations for the stormwater department. A GIS based tool is the most beneficial for collecting, developing and maintaining the stormwater system asset management data. However, no one system within Santa Fe currently provides the functionality of a GIS interface for data with backend functions for billing, tracking changes, and creating system reports.

Key Recommendation #2 -Tetra Tech recommends using the ESRI stormwater data structure to standardize data collection in the next 9 to 12 months.

Key Recommendation #3 - Determine cost for City Works support to add Stormwater Asset Management to the Public Utilities department contract.

2.3 DETERMINE LEVELS OF SERVICE

The City of Santa Fe currently requires all stormwater infrastructure to be design for the 100-yr storm event. However, future stormwater permit requirements will most likely include a water quality design storm with retention, infiltration and beneficial uses that increase the time that water is discharging to the storm drain system. In addition, the city has experienced erosion and deposition issues within the natural/earthen channel network of arroyos. As part of the overall stormwater program master plan, Santa Fe is determining the aspirational goals for reducing erosion, increasing stream health, maximizing beneficial recharge, and improving water quality.

In addition, Santa Fe will need to define maintenance and street sweeping schedules that both meet resident’s expectations and implement stormwater permit requirements to assist with achieving water quality goals. Current water quality level of service goals are undefined.

Key Recommendation #4 – After completing Key Recommendation #2, assess level of service goals based on resident reports, maintenance records, and priority water quality or pilot areas.

2.4 DEFINE STAFF ROLES AND RESPONSIBILITIES.

Staff roles and responsibilities are included in the Stormwater Management Strategic Plan developed in concurrence with this memo.

2.5 IDENTIFY AND CALCULATE RISK.

Regulatory risk will be determined through the process of developing the Stormwater Management Program in response to the upcoming EPA Phase II MS4 permit. As the SWMP is developed, specific requirements will be worked out with NMED and the EPA. These requirements will define the risk associated with non-compliance.

There is also political risk associated with an underperforming stormwater management system. The public relies on effective drainage solutions to live in an urban area and often is less interested in water quality benefits. A comprehensive asset management program will allow the Stormwater Department to respond to customer complaints in a timely fashion while also justifying the cost of service through data driven reports.

Key Recommendation #5 – Develop a monitoring program based on critical water quality areas indicated by the stormwater management modeling. Collection of the local water quality data will assist Santa Fe with defining areas of concern and tailor approaches in the SWMP to address issues defined by local information.

2.6 CREATE A FORECAST OF ACTIVITIES AND FUNDING

The forecast of activities and associated costs need to be determined after the asset inventory is completed. For Santa Fe, this will include an understanding of the existing costs associated with maintenance of closed systems and repair of erosion issues. However, with the new MS4 regulations resulting in more stormwater BMPs on private property, this forecast will need to include costs associated with review of privately owned BMP plans, inspection and enforcement staffing needs.

Key Recommendation #6 – Begin building a Capital Improvement Plan based on existing projects and known drainage issues. Geolocate additional problem areas as citizens report drainage issues and hire local engineering firms to develop preliminary engineering reports to assist with budgeting.

Key Recommendation #7 – Develop a budget for collecting storm drain information for 10 priority areas in the next 3 months.

Key Recommendation #8 – Document maintenance activities and evaluate whether changes are necessary to meet proposed level of service.

2.7 ADJUST THE BUDGET ACCORDINGLY

As the city grows and stormwater management requirements become clearer, projections on a five-year cycle should be made to plan for programmatic costs, new construction, repair, and maintenance costs. At this time, the initial budgeting has been estimated as part of the funding discussion in the Stormwater Management Strategic Plan which has assessed the overall funding sources and expenditures under existing programs.

These seven steps provide a path forward for creating an asset management program.

3.0 DATA REVIEW AND CONVERSION PROCESS

Tetra Tech has developed the initial GIS based framework for asset data collection as part of the GIS Data collection and Review tasks associated with the Drainage Management Plan updates for the Santa Fe River and Arroyo De Los Chamisos. The GIS framework is based on the ESRI StormUtility database that is available for free and defines features classes and basic information fields that should be collected for a GIS based stormwater asset management system. Table 1 shows the connection between the available types of data that were provided by Santa Fe and the feature classes in the ESRI database. More details on the specific field mapping that was used to populate the database are included in the attachements to this memo. While the Stormwater team finalizes the asset management data system, the ESRI database provides a structure to focus stormwater system data collection and storage for a broad range of uses. The database is standardized but flexible enough to feed into Cityworks or a Cloud based solution such as those provided by ESRI.

4.0 SUMMARY OF RECOMMENDATIONS

We recommend that the City of Santa Fe Stormwater team develop an Asset Management Plan (AMP) that will be approved by City Council and provide the guidance and budgeting to implement stormwater asset management in support of the Stormwater Management Strategic Plan. The individual recommendations have been explained in the previous discussion. The efforts should be started immediately with recommendations 1 through 5 running concurrently. Recommendations 6 through 8 will be necessary to develop the AMP document but depend on tasks 1 through 5.

- Key Recommendation #1 - The top priority is collection of complete stormwater system data including a condition assessment of all surface and subsurface assets.
- Key Recommendation #2 -Tetra Tech recommends using the ESRI stormwater data structure to standardize data collection in the next 9 to 12 months.
- Key Recommendation #3 - Determine cost for City Works support to add Stormwater Asset Management to the Public Utilities department contract.
- Key Recommendation #4 – After completing Key Recommendation #2, assess level of service goals based on resident reports, maintenance records, and priority water quality or pilot areas.
- Key Recommendation #5 – Develop a monitoring program based on critical water quality areas indicated by the stormwater management modeling. Collection of the local water quality data will assist Santa Fe with defining areas of concern and tailor approaches in the SWMP to address issues defined by local information.
- Key Recommendation #6 – Begin building a Capital Improvement Plan based on existing projects and known drainage issues. Geolocate additional problem areas as citizens report drainage issues and hire local engineering firms to develop preliminary engineering reports to assist with budgeting.
- Key Recommendation #7 – Develop a budget for collecting storm drain information for 10 priority areas in the next 3 months.
- Key Recommendation #8 – Document maintenance activities and evaluate whether changes are necessary to meet proposed level of service.

E. EXTERNAL STAKEHOLDER SUMMARY & EXHIBITS

City of Santa Fe Stormwater Management

External Stakeholder Taskforce Meeting
Public Works Roundhouse Room – Railyard
AUGUST 24, 2018

Summary of Meeting

Facilitator: Rosemary Romero
Consultant: Troy Dorman, Tetra Tech
Staff: Melissa McDonald, Leroy Pacheco

Purpose of Session:

- Review updated modeling conducted by Tetra Tech
- Review elements of Stormwater Management Strategic Plan
- Overview of EPA
- Discussion and applicability of the model

Welcome, Introductions and Purpose: Participants introduced themselves noting their affiliation.

Overview of current efforts: Melissa McDonald, River and Watershed Coordinator for the City of Santa Fe gave a brief overview of the two efforts currently underway. She explained that the City of Santa Fe was chosen by EPA to help develop materials needed for implementation of stormwater management through handbooks and other materials. Tetra Tech was contracted to develop the modeling and strategic plan to prepare the City for meeting the upcoming MS-4 permitting that the City is required to do. The two efforts will dovetail with each other.

Overview of Strategic Plan: Christy Williams from Tetra Tech gave an overview of the Outline and themes for progressive stormwater management.

Outcomes from flood management and water quality modeling: Troy Dorman, project lead for the modeling aspect of the contract lead the discussion about how the modeling worked and potential design criteria changes.

- Potential land use management changes

- Data collection needs and new processes for private development?

Discussion:

Consider how land use looks at uses through “zones” that are overlay districts.

Impacts mostly come from development as noted by the recent storms and perhaps consideration could be to incorporate fees.

The modeling will be important as an analysis tool specific to sediment and terrain management and provided to developers. For example, the Arroyo de las Mascaras would be a relevant area to utilize the modeling.

Dual uses of stormwater are aesthetics and management. For example, a current issue that the City is dealing with are the maintenance and upkeep of medians. Plant selection could be helpful for weed management.

Design criteria should be varying depending on the circumstances. For new development changes to land use are doable – the issue will be for older areas of the city.

There is a potential for “pushback” from engineering for green infrastructure, mostly because of cost and design

Additional project areas could be those significantly affected by the July 23 flooding such as the Commons on West Alameda

Next Steps

The report to the governing body should be graphic and simple

It would be helpful to analyze Impact Fees and include needed budgetary information prior to discussion of the annual budget cycle

The IT department should work on how to integrate incoming information from developers and engineers. This may require a different kind of website to make it useful.

Follow-up Comments from Michael Gomez sent via email:

I have reviewed the Santa Fe River and Arroyo De Los Chamisos Modeling Report. The report is well done and is needed. I do have the following comments for consideration.

Executive Summary

- The Stormwater System priority 1 recommendations are appropriate. Especially constructing monitoring stations to obtain water quality, sediment load, hydrographs of real storms, as well as runoff quantities.

- The Detailed Impervious cover database priority 2 recommendations include identification of unpermitted, unreported buildings and development. In my experience, this does not happen in Santa Fe. Santa Fe is a small town and the residents are aware of known developments. A task to identify unpermitted, unreported buildings would obtain little information and would be waste of resources.
- The Refine Stormwater criteria contains some incorrect statements. SFCC 14-8.2 "Terrain and Stormwater Management" states "*the stormwater runoff peak flow rate discharged from a site shall not exceed pre-development conditions for any frequency storm event up to the one percent chance, twenty-four-hour storm event at each discharge point*;" and "*stormwater detention basins and overflow structures shall be sized and designed to adequately accommodate flows from one percent chance, twenty-four-hour storm events; provided, however, that such basins shall also be equipped with outflow structures that limit flow-through from lesser magnitude storms to runoff rates equal to or less than pre-development runoff rates*." SFEC does analyze various frequency storms for all projects. In addition, if sediment transport is to be included as a "design criteria" then the City needs to provide erosion rates, methodology and other data that is currently not available.

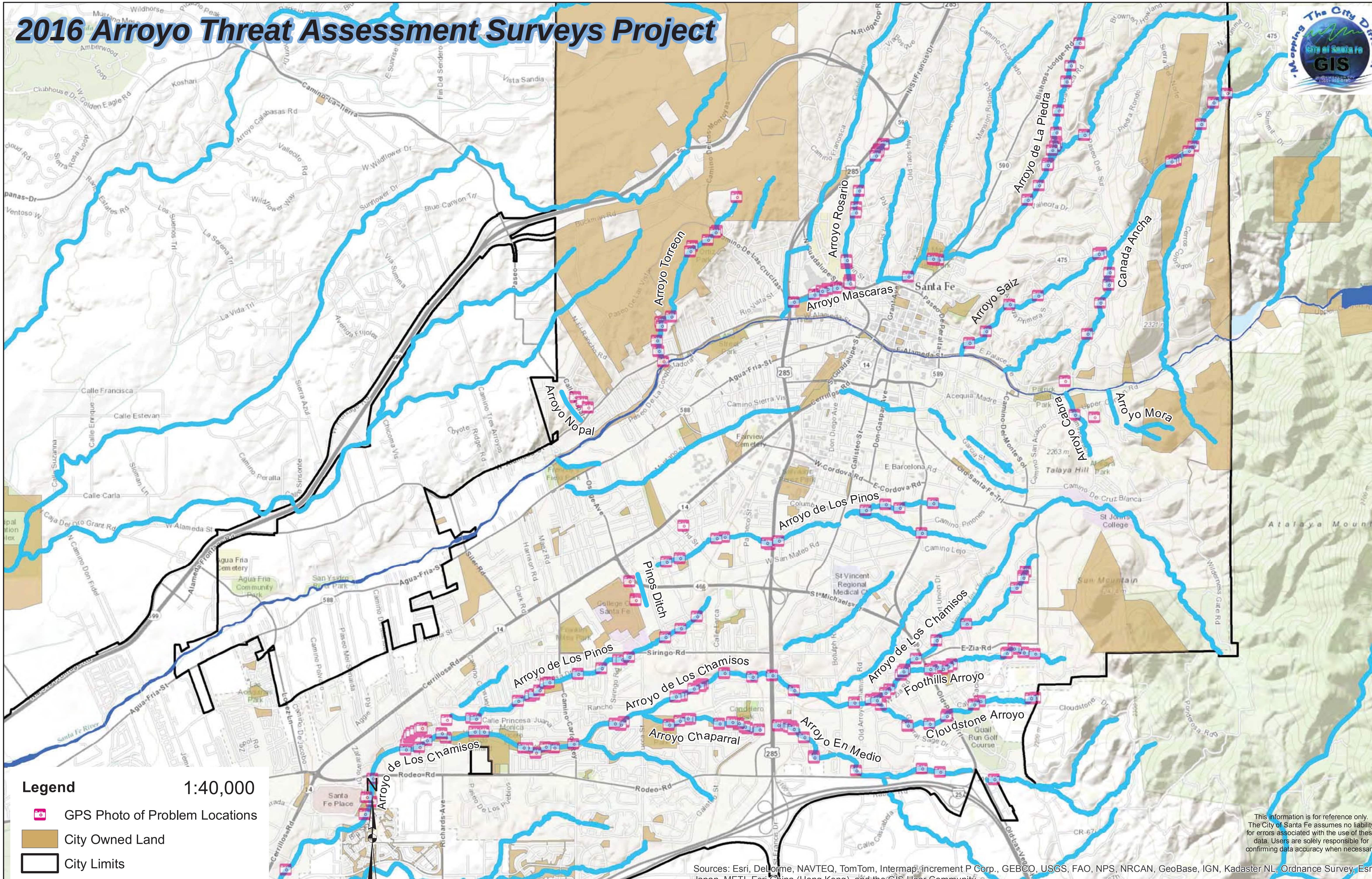
Report

- Section 3.2 Rainfall-Runoff Generation. The use of Snyder's unit hydrograph has been discouraged by the State Engineer on other projects. The SEO contend that Sniders unit hydrograph does not work well in the Southwest. They have in the past recommended that S graphs as presented in "Flood Hydrology Manual," (Chatsworth 1989) be used. When rainfall and runoff data is available and then site specific unit hydrographs could be developed.

- The graphics are difficult to read. Can better images be downloaded so that they do not become pixelated?

The City Staff and the consultant have done an excellent job. This is a good first step for stormwater management in the City of Santa Fe. Public participation in any code changes is essential. I look forward to the actual model.

2016 Arroyo Threat Assessment Surveys Project



Legend

1:40,000

- GPS Photo of Problem Locations
- City Owned Land
- City Limits

This information is for reference only. The City of Santa Fe assumes no liability for errors associated with the use of these data. Users are solely responsible for confirming data accuracy when necessary.

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

2018 Stormwater Strategic Plan Project List

Arroyo Name	Segment Location, Upstream	Segment Location, Downstream	Infrastructure Damage/Risk	Channel Character,	Cost Estimate
1. C. Arroyo de los Chamisos	Conejo Road	Saint Francis Drive	**1.2**	**1.6**	$ 1,100,000.00
1. D. Arroyo de los Chamisos	S.Saint Francis Drive	Yucca Street	**1.4**	**0.8**	$ 450,000.00
1. E. Arroyo de los Chamisos	Yucca Street	Carlos Camino Rey	**2.4**	**1.7**	$ 300,000.00
1. F. Arroyo de los Chamisos	Camino Carlos Rey	Ave de las Campanas	**1.7**	**1**	$ 1,750,000.00
1. G. Arroyo de los Chamisos	Ave de las Campanas	Rodeo Road	**1.7**	**1.3**	
1. H. Arroyo de los Chamisos	Rodeo Road	Governor Miles Road	**1.4**	**1.9**	$ 150,000.00
1. I. Arroyo de los Chamisos	Governor Miles Road	Cactus Flower Lane	**NA**	**NA**	$ 500,000.00
2. A. Arroyo Rosario	Below HWY 285-S	373 Calle Loma Norte	**1**	**1.7**	$ 300,000.00
2. B. Arroyo Rosario	373 Calle Loma Norte	388 Calle Loma Norte	**2.4**	**2.4**	-
2. C. Arroyo Rosario	388 Calle Loma Norte	Los Arboles	**NA**	**0.9**	$ 300,000.00
2. D. Arroyo Rosario	Los Arboles	Rio Grande Street	**2.2**	**1.4**	$ 300,000.00
2. E. Arroyo Rosario	Rio Grande Street	Paseo de Peralta [MASCARAS]	**2**	**2**	-
2. F. Arroyo Lovatos	Los Lovatos Road	Rosario Blvd [MASCARAS]	**NA**	**NA**	-
3. Arroyo Saiz	Begin at Hyde Park + Gonzalez Rd	**SANTA FE RIVER**	**1.7**	**1**	-
4. Arroyo Mora (Upper Canyon Road)	South of Calle Militar	**SANTA FE RIVER**	**NA**	**1.9**	$ 100,000.00
5. Arroyo Cabra (Cristo Rey Area)	Apodaca Hill	**SANTA FE RIVER**	**NA**	**1.9**	$ 100,000.00
6. Arroyo en Medio	Old Santa Fe Trail	St Francis Drive [CHAPARRAL]	**1.4**	**1.3**	$ 500,000.00
7. A. Arroyo Ancha	Near Ten Thousand Waves Spa	Cañada Sur	**0.9**	**NA**	$ 1,000,000.00
7. B. Arroyo Ancha	Cañada Sur	**SANTA FE RIVER**	**1.2**	**0.3**	$ 1,000,000.00
8. Arroyo de los Pinos *Upper A*	Camino Corrales/Lejo	Galisteo Street	**NA**	**0.9**	$ 1,000,000.00
8. Arroyo de los Pinos *Upper B*	Camino Corrales/Lejano	Don Gaspar Street	**2**	**1.1**	$ 500,000.00
8. Arroyo de los Pinos *Ditch*	St. Michael's Drive	Siringo Road	**1.4**	**1.8**	$ 500,000.00
8. B. Arroyo de los Pinos	St. Francis Drive	6th Street	**2.3**	**2.5**	-
8. C. Arroyo de los Pinos	St. Michael's Drive	Camino Carlos Rey	**1.9**	**1.9**	$ 500,000.00
8. D. Arroyo de los Pinos	Camino Carlos Rey	Richards Avenue	**2.7**	**2.2**	$ 500,000.00
8. E. Arroyo de los Pinos	Richards Avenue	**ARROYO DE LOS CHAMISOS**	**1.9**	**1.6**	$ 1,350,000.00
9. A. Arroyo Mascaras	Bishop's Lodge Road	**ARROYO BARRANCA**	**0.9**	**1.9**	$ 500,000.00
9. C. Arroyo Mascaras	Old Taos Highway	Paseo de Peralta Culvert	**0.9**	**0.7**	$ 500,000.00
9. D. Arroyo Mascaras	Paseo de Peralta Culvert	**SANTA FE RIVER**	**NA**	**1.2**	-
10. A Arroyo de la Piedra East Fork	Calle Conejo	Camino Real	**NA**	**0.9**	$ 250,000.00
10. B Arroyo de la Piedra West Fork	Brownell-Howland	Hyde Park Road [MASCARAS]	**1.1**	**1.1**	$ 250,000.00
10. B Arroyo de la Piedra	Hyde Park	Old Taos Highway [MASCARAS]	**NA**	**NA**	$ 500,000.00
11. Arroyo Foothill	Old Santa Fe Trail	**ARROYO DE LOS CHAMISOS**	**1.2**	**1.2**	$ 250,000.00
12. A. Arroyo Cloudstone	Old Santa Fe Trail	Old Pecos Trail	**0.8**	**0.5**	$ 250,000.00
12. B. Arroyo Cloudstone	Old Pecos Trail	**ARROYO DE LOS CHAMISOS**	**1.4**	**1**	$ 250,000.00
13. Arroyo Nopal	East of Calle Nopal	W. Alameda	**1.9**	**2.4**	
14. A. Arroyo Torreon	East of Buckman Rd	Camino de las Crucitas	**1.2**	**1.1**	$ 1,000,000.00
14. B. Arroyo Torreon	Camino de las Crucitas	**SANTA FE RIVER**	**0.9**	**0.7**	$ 5,000,000.00
15. B. Arroyo Chaparral	Galisteo Road	Esplendor Street	**1.7**	**2**	-
15. C. Arroyo Chaparral	Esplendor Street	**ARROYO DE LOS CHAMISOS**	**0.9**	**1**	$ 1,000,000.00
16. Acequia Madre Stormwater Separation	Arroyo Tenorio	Maez Road	**NA**	**NA**	$ 2,000,000.00
17 A. SF River - Reach 1	Cerro Gordo	Santa Fe River	**NA**	**NA**	$ 1,000,000.00
17 B. SF River - Reach 15	Sandoval	Guadalupe	**NA**	**NA**	$ 500,000.00
17 C SF River - Reach 19	Boys & Girls Club	St Francis Drive	**NA**	**NA**	
17 D. SF River - Reach 26	Ricardo	La Joya	**NA**	**NA**	$ 500,000.00
17 E. SF River - Reach 27	Don Jose	Camino Carlos Rael	**NA**	**NA**	$ 50,000.00
17 F. SF River - Reach 30	Paseo Rael	Waste Water Treatment Plant	**NA**	**NA**	$ 500,000.00
18. Culvert Capacity Improvement Study		City-Wide	**NA**	**NA**	$ 500,000.00
19. Asset Management Data Collection		City-Wide	**NA**	**NA**	$ 500,000.00
					$ 27,500,000.00

*Project List Derived from SF Watershed Arroyo Assessment, Acequia Madre mapping, Tt Model, 2015 and 2018 Storm effects (EOC/CRM)

** Cost estimates are based solely on city owned property/easements and don't include private development project costs

*** Project funding sources may vary: CIP Bonds, Utiltiy Fee, Living River, Grants, etc.

F. STORMWATER FINANCIAL MEMO

TETRA TECH

MEMO

To:	Melissa McDonald
Cc:	Leroy Pacheco, Christy Williams, Troy Dorman
From:	Rick Schaefer, PE
Date:	July 31, 2018
Subject:	Stormwater Utility Service Charge Rate Structure Assessment

In 2017, the Tetra Tech team (team) was hired by the City of Santa Fe to evaluate the City's stormwater management program for compliance with the new stormwater permit as well as opportunities for operational and administrative improvements. Based on this evaluation, Tetra Tech is developing a Stormwater Management Strategic Plan that outlines recommended actions to ensure compliance and increase the efficiency and effectiveness of the stormwater management program, Tetra Tech also is updating the City's drainage management plans, providing a fiscal analysis of stormwater fees and budget, and evaluating the City's asset management system. The strategic plan will include and align with the outcomes of these efforts as appropriate.

This memorandum presents the findings of the fiscal analysis of stormwater fees and budget.

The Tetra Tech team has reviewed operating budgets, annual reports, capital improvement plans, and other documentation of the stormwater program and related City divisions engaged in the design, construction, maintenance and operation of stormwater facilities and services. Interviews have been conducted with stormwater program staff and with the Public Works and Finance departments.

STORMWATER FUNDING

Current Funding

Storm Water Drainage expenditures have varied over recent years (Figure 1). Expenditures budgeted for FY17/18 of $2,082,930 exceed the estimated annual revenues of $1,570,000 generated by the Stormwater Utility Service Charge. The Storm Water Fund 21401 has a projected FYE balance of $973,474. At the current pace of revenues and expenditures, the balance surplus will be fully depleted during FY19/20.

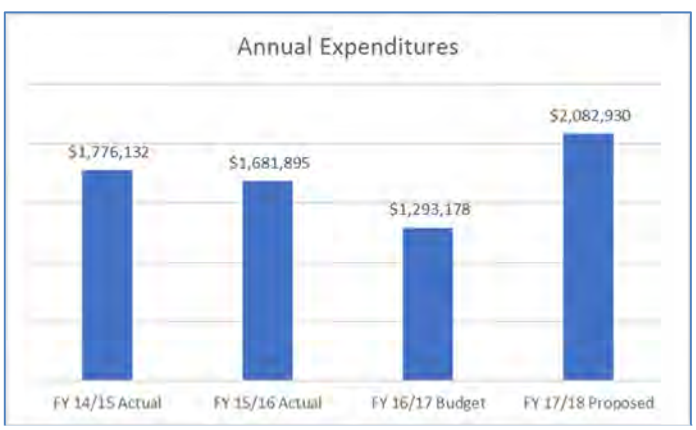


Figure 1 Annual Storm Water Expenditures

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Tel 210.299.7900 tetratech.com

Revenue sources funding stormwater activities have shifted over recent years. Funding for some staff has been alternately provided through Fund 21401 and the General Fund. Fund 21401 at times has paid for drainage components of street capital projects, the acquisition of a vactor truck, tipping fees, and staff salaries. Because of the variability in both funding sources and in expenditures, and variations in the availability of documentation by year, clear trends were not discernable over the past 4 fiscal years.

Fund 21401 revenues are primarily expended for maintenance. Maintenance of the storm drainage system is performed by the Streets and Drainage Maintenance Division of Public Works, and by the Parks Department. This work involves cleaning storm drainage pipes, culverts and catch basins; routine repairs and minor capital improvements; vegetation management in arroyos and roadway medians; erosion repairs and sediment management; and storm recovery (clearing debris). Annual maintenance expenditures for storm drainage, based on the FY16/17 base budget report, total $1.56M as allocated below:

- Fund 22401 Expenditures Storm Water Drainage $383K
- Fund 22402 Expenditures Storm Water Parks $249K
- Fund 22403 Expenditures Storm Water Streets $924K

Maintenance is currently considered understaffed, and additional maintenance positions have been requested.

Capital projects are partially funded from outside grant sources, but such funding is opportunistic and not reliably available for City projects. The City has the option of advancing capital improvements by leveraging a portion of stormwater fees using capital bonds in a manner similar to that commonly applied to other City capital projects. The City could leverage $500,000 of the annual stormwater fee revenues to service bond debt and, at current market interest rates, produce the capital project capacities shown in Table 1 below.

Table 1. Debt Financing Options

Term	Assumed Annual Interest Rate	Capital Project Capacity [1]
10 years	3.0 %	$4.98 million
15 years	3.5%	$7.47 million
20 years	4.0%	$9.95 million

[1] *Assumes annual debt service of $500,000*

Future Funding Requirements

The scope of stormwater related activities will expand to meet pending regulatory obligations and to address other operating and capital needs. These activities will require additional revenues beyond the currently allocated funding resources. Near-term priority actions that will require additional staffing and capital expense are identified below:

<u>Capital Program</u>

- Including post-construction stormwater management infrastructure in new City facilities. This would affect capital budgets of departments constructing the facilities.

<u>Operations & Maintenance</u>

- Conducting post-construction stormwater facility inspection, maintenance and operation consistently for City facilities.
- Consistently require and inspect erosion and sedimentation control practices on private development projects.

- Consistently require and inspect post-construction stormwater facility operation and maintenance on private facilities.
- Complete and maintain mapped inventory of public and private stormwater infrastructure assets.
- Develop and implement formal training on design, installation and maintenance of post-construction stormwater controls.

Planning & Engineering

- Complete a comprehensive inventory of stormwater infrastructure needed for watershed modeling, siting water quality BMPs, determining monitoring locations, building an asset management program, and documenting maintenance concerns and compliance with MS4 program requirements.
- Complete a detailed impervious cover dataset based on the existing LiDAR data and new high resolution aerial imagery acquired for support of several stormwater program elements including watershed and system modeling, developing a runoff based stormwater utility fee, and stormwater planning.
- Prepare and adopt refined stormwater system criteria addressing water quality, stream stability, sediment transport, and stormwater volume management.
- Update water quality monitoring program to comply with the proposed MS4 permit to both necessary water quality data acquisition and analysis, and to acquire runoff rate and volume measurements to verify watershed scale modeling and local design parameters.

Beyond the priorities identified above, other needs and associated costs will become better defined through further system planning, and as conditions change and system knowledge grows.

Conceptual Financial Model

A spreadsheet model was developed for use in evaluating stormwater program funding strategies and is appended to this memorandum with an explanatory narrative. The model has been developed with three scenarios: (1) a “pay-as-you-go” approach wherein rates are set to generate needed revenues; (2) the use of a 15-year bond to fund capital expenditures; and (3) a 20-year bond. An electronic copy of the spreadsheet model is provided separately to City staff.

Assumptions used in the model (e.g. annual capital investment, interest rates, cost escalation rates, customer growth rate) are explicitly identified and can be modified to examine alternative conditions or scenarios.

Fee revenues are premised upon the current rate structure and a presumed uniform annual growth rate. The monthly fee per residential water service can be modified over time to provide needed revenue and operating reserves.

The model was prepared with limited expenditure detail, considering the historical variability cited above, and because the scope of stormwater activities will change significantly. The spreadsheet model can be readily modified to add detail where it could better inform decision making.

To support the expansion of capital investment, the model’s functionality provides for debt financing. The two scenarios presented in the appendix proposes issuing bonds in FY18/19 over terms of 15 years and 20 years, respectively, at current market rates. The bond amounts in both scenarios were selected to result in annual debt service payments of approximately $500,000. Interest earned on unspent bond revenues is included with revenues.

STORMWATER UTILITY SERVICE CHARGE FEE RATE STRUCTURE

As noted in the preceding discussion, the present rate of revenue generated by the Stormwater Utility Service Charge Fee ("utility fee") is not sufficient to sustain the current scope of the stormwater program, and the scope of stormwater activities will necessarily expand to achieve regulatory compliance and meet other identified needs. To meet these financial needs, the City could elect to supplement the utility fee revenues from other sources, as it has supported specific efforts with General Fund revenues on past occasions. From a policy perspective, however, we strongly recommend that an ongoing utility service be sustained through a dedicated and reliable funding mechanism.

The Tetra Tech team reviewed the stormwater utility service charge rate structure currently in place in Santa Fe along with alternative approaches to generating charges. This following presents outcomes of the review in three parts:

1. Current stormwater charge rate structure
2. Scope of the stormwater utility service charge
3. Rate structure alternatives

Current Stormwater Charge Rate Structure

Stormwater utility service charges are collected through the City's water utility billing system, as set forth in SFCC Section 13-1. The charges are based on a flat monthly rate, with monthly charges assigned to customers based on the water meter size serving the property. The current rate structure, amended under Ordinance 2010-17, is presented in Table 1. Customers with household gross income not exceeding 120 percent of the most recent federal poverty guidelines may be exempted from the charge.

Table 2. Current Rate Structure Charges

Meter Size	Stormwater Utility Service Charge
Residential – All meters	$3.00
Commercial	
5/8-inch	$3.00
3/4-inch	$4.50
1 inch	$7.50
1-1/2 inch	$15.00
2-inch	$24.00
3-inch	$46.80
4-inch	$75.00
6-inch	$150.00
8-inch	$240.00

The present fee structure is efficient and inexpensive to administer. However, there is little to no nexus between water meter size and a property's contribution of runoff volume, rate or quality which define a parcel's "demand" for stormwater service. This produces a low level of equity across customer classes and between individual customers. As an example, a parcel occupied by a large parking lot, which does not have a water service, would not receive a charge for the stormwater it generates, whereas a residence with a relatively small footprint is charged a fee.

The present stormwater charge is inflexibly structured, and there is no basis for extending incentives or credits to customers for taking measures to reduce the rate or volume of storm runoff or to improve runoff water quality.

Scope of the Stormwater Service Charge

Revenues collected through the stormwater utility service charge are accounted for separately from other City funds, and designated uses of these revenues under SFCC 13-1.7 encompass the full scope of stormwater program activities:

- Acquisition, design, construction, maintenance and operation of the stormwater system, including capital improvements designated in the capital improvement program;
- Administration and enforcement of regulations and procedures relating to the stormwater system;
- Comprehensive drainage infrastructure planning and monitoring;
- Review of development plans and inspection for regulatory conformance;
- Enforcement of regulations protecting water quality and quantity; and,
- Other activities related to the improvement, maintenance and operation of the stormwater system.

As noted earlier, the City has occasionally supported selected stormwater projects and activities through other sources beyond the stormwater utility service charge, including the General Fund and outside grants.

Certain activities of the stormwater program are continuous ongoing functions which, in order to be sustained, should be reliably funded to meet City requirements, external regulatory obligations, and to assure properly functioning infrastructure. Examples of such activities include:

- MS4 compliance
- System maintenance and operation
- Administration and reporting
- Planning and programming
- Enforcement.

Because of their immediate relationship to the stormwater system and the intent of SFCC 13-1, these activities are most appropriately funded through the service charge.

Other significant stormwater program expenditures which can be funded both through service charges as well as other fees and revenue sources include development and permit reviews and capital works.

When establishing a rate structure and setting rates, it is recommended that accompanying policies be adopted that prioritize which expenditures are to be paid for primarily through the stormwater utility service charges. Such policies provide the stability required to carry on programmatic activities. Such policies also provide a basis for allocating the charges to various customers and customer classes, and for defining the basis for credits or incentives in a resulting rate structure. It is recommended that service charges provide the underlying funding of programmatic activities, plus whatever share of capital projects can be supported by stormwater rates.

Other services are provided that are customer-specific, such as permitting review and facility inspections, and demand for these services fluctuate over time. It is increasingly common for utilities to recover the costs for such activities through specific service fees, and this approach should be considered when establishing the governing policies.

Rate Structure Alternatives

There are many issues and policies to evaluate when designing a rate structure and rate incentives, but generally the objectives of a rate structure address the following:

> The rate structure establishes a rational nexus between the services provided and fee charged. The rate structure should provide an equitable allocation of costs among customers and customer classes.
>
> The rate structure is legally defensible and is authorized by statute.

The administrative feasibility of establishing individual charges, and setting up and maintain accounts. The data exists or can be developed to characterize conditions on a parcel and assign charge appropriate to the parcel.

The basis for the charge is easy to understand and to communicate, and the rate structure is transparent.

The rate structure promotes revenue stability over time, and is not subject to volatility generated by external factors.

Rate structures can take several forms, as demonstrated by the variety found across jurisdictions. The trend is toward structures that provide enhanced equity between customers and also incentivize customers to take onsite measures that support water management goals.

Example rate structures are described below. We have omitted from the discussion the concept of an ad valorem tax, as it would constitute simply a dedicated extension of the general property tax treatment of parcels.

Flat Rate

Flat rate structures allocate cost uniformly to each land parcel, irrespective of parcel size, level of development or other features. This approach would capture in the ratepayer base undeveloped parcels and other properties which are not served by water, but otherwise offers a less-equitable approach than the current rate structure, whereby meter size infers a coarse indication of the level of development on the property.

Gross Parcel Area

This structure allocates program costs in proportion to the gross area of a land parcel. The data exists to support such a charge in assessor databases, and the administrative costs would be relatively low. Parcels which are not served by the water utility would need to be added to the billing database. There is an equity tradeoff when comparing this gross parcel area approach to the current meter size basis, in that gross parcel area does not reflect the nature of development and impervious area on the parcel; whereas, the presence of a meter and the meter size infer the scale of development on the property, albeit in a coarse manner.

Factored Gross Area

Some communities apply an approach that is based on gross parcel area to which a land use factor (or runoff factor) is applied to approximate the intensity of development on the parcel and, hence, the runoff it generates. This approach was originally developed to approximate an impervious area method (described further below) when aerial imagery and mapping capabilities were much less robust than today's technologies. This approach can improve on equity between customer classes (such as among parcels having similar zoning classifications) but does not offer substantial enhancement over the current meter size basis.

Impervious Surface Area

Using a parcel's impervious area footprint (encompassing rooflines, pavements, and vehicle-traveled gravel surfaces) is the method applied for the most equitable types of rate structures, as it provides a more robust nexus between a land parcel and the volume and rate of runoff. With the availability of high-resolution LiDAR and photo imagery, and geographic information systems for managing parcel data, appropriate charges can be accurately determined for individual parcels. The nature of impervious area (such as parking versus rooftop) and other features (presence of BMPs) can also be captured to incorporate water quality-based rate factors and rate credits.

Often single family residential properties are grouped into a uniform residential rate or into rate tiers that reflect large distinctions in impervious footprint between residential zoning classifications. Because single family residential comprises most parcels in Santa Fe, this approach can significantly streamline the administrative effort in establishing accounts without compromising equity between highly similar properties.

Hybrid Rate Structures

There are options that can be developed to modify or combine the foregoing rate structure methods in order to address jurisdiction-specific conditions, policies or preferences. Examples of such hybrid rate structures include:

Flat Rate + Impervious Area. A two-component fee method combining the flat rate and the impervious area rate approaches would allocate by a flat fee costs for city-wide programmatic elements (planning, reporting, monitoring). Costs for capital improvements and other active measures directed at remediating stormwater impacts would be allocated to accounts on an impervious area basis.

Trip Generation**.** Where roadway-generated runoff quantity and water quality are prominent issues, trip generation methods have been incorporated to allocate responsibility for projects and activities driven by public roadway impacts.

Rate Credits

A variety of rate adjustments and credits have been adopted by jurisdictions a means to implement policies, to recognize differing conditions on properties within similar rate classes, or to incentivize beneficial on-site actions. When adopting credits and rate reductions, the City should establish a cap on the allowable compounded credits so as not to undermine the core support to the stormwater program. Some examples are cited below.

Low income/senior fixed income. Typically aligned with similar credits for other city charges.

Credits for on-site BMPs. This is used to recognized that more recently developed properties may have robust stormwater controls in place, whereas older properties do not control runoff as effectively.

NPDES-permitted properties. This credit recognizes that some industrial, commercial and agricultural properties are permitted and regulated under the NPDES program and are assumed compliant with their permit obligations to control runoff.

Alternately, the City could elect to provide incentives that do not impact rates. Such credits are offered as one-time rebates to underwrite the costs of installing rainbarrels, cisterns, rain gardens, and similar beneficial actions.

ADDITIONAL STORMWATER FUNDING STRATEGIES

With respect to the goals set out in Resolution 2016-25, some aspects of the analysis were considered by staff rather than made part of the consultant's scope. These strategies include the possibilities of a) creating a local flood-control authority financed by an annual property-tax assessment, b) holding periodic mill-levy elections for specific stormwater management projects, and c) obtaining new or amending existing impact fees for ongoing stormwater management work. The three strategies would require support at the highest levels of city management and possibly the approval of the state legislature and/or the electorate. A deeper analysis of these additional strategies would be the purview of the City Attorney (a) and (b), and the Land Use Department (c).

a. **Local Flood Control Authority:** By means of legislation passed by both houses of the state legislature and signed by the governor, municipalities in New Mexico can create a flood-control authority with the power to raise revenue through mill levies. Such an authority would allow property-tax assessments to be assigned to stormwater management with a levy not to exceed 1 mills (or $1 for every $1,000 of taxable property value). These authorities are independent of the governing bodies of the municipality, and their purpose is to fund an ongoing sediment and flood-control program. The major benefit of such an authority would be that its budget would be predictable on an annual basis. This would allow for meaningful long-term planning to be achieved and, therefore, the efficient use of financial resources to be the norm.

Two nearby flood-control authorities that have been in existence for decades include the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) and the Southern Sandoval County Arroyo Flood Control Authority (SSCAFCA). These authorities would serve as prototypes for the city to replicate with respect to organizational structure. Their proximity, ages, and history of effectiveness would also help alleviate concerns among property-tax payers.

Such a system, that taxes the properties that affect the watershed, is inherently more equitable than the current revenue-generating system for stormwater management, which relies on gross receipts taxes and stormwater fees. A significant public education-program would be required in order to generate the public support necessary to generate such a change.

b. **Project specific mill-levy:** According to state law[1, 2] municipalities can fund flood-control projects with specific mill levies for large, individual projects. This type of funding source does not provide the kind of ongoing funding that a flood-control authority would have, but it has the benefit of not creating an entity that would be separate from the city. With this option levies can be assessed up to 5 mills, but these monies are terminated after the completion of the associated stormwater project.

c. **Developer Impact Fees:** The city currently assesses and collects developer impact fees for four capital improvement categories: Roads, Parks, Fire/EMS, and Police. Per the City's current impact fee plan[3], the impact fee for roads is based on a traffic generation methodology, and that for parks is typically assessed on residential development. The city's next 5-year update of the plan will be required in 2020. A deeper examination of impact fee categories should be extended to consider drainage impacts beyond the roadway, and perhaps a "River and Arroyos" category should be assessed in future development in order to direct funds towards drainage specific mitigation impacts.

[1] Municipal Flood Control:
New Mexico Statutes-Municipalities Section § 3-41-1 - 3-41-5

[2] Arroyo and Flood Control Authority:
New Mexico Statues Section 72-19-1 through 72-19-103, 1990

[3] "Impact Fee Capital Improvements Plan 2020 for Road, Parks, Fire/EMS and Police" (adopted by City Council 8/27/14)

APPENDIX - CONCEPTUAL FINANCIAL MODEL

This appendix presents a spreadsheet model developed for use in evaluating stormwater program funding strategies for the City of Santa Fe. The model was initially constructed with three scenarios: (1) a "pay-as-you-go" approach wherein rates are set to generate needed revenues; (2) the use of a 15-year bond to fund capital expenditures; and (3) a 20-year bond. All three scenarios assume the same level of annual capital investment at $1 million (in FY18/19 dollars). Copies of each scenario are provided in this appendix. An electronic copy of the spreadsheet model is provided separately to City staff.

Assumptions used in the model (e.g. annual capital investment, interest rates, cost escalation rates, customer growth rate) are explicitly identified (Rows 36-39) and can be modified to examine alternative assumptions or scenarios. Interfund transfers have been used in the recent past; no future transfers are assumed in these scenarios, but the model allows for such transfers (see Row 23).

Fee revenues are premised upon the current rate structure and a presumed uniform annual growth rate. The monthly fee per residential water service can be modified over time (see Row 8) to provide needed revenue and operating reserves. In the scenarios, fees were set over time to approximate a FYE balance equal to 12 months' expenditures within a few years. Where debt financing is employed, interest on the prior year's unspent bond balance is accrued in Row 11; the rate of interest can be modified by year.

The model was prepared with limited expenditure detail, considering the historical variability of expenditures over recent years and because the scope of stormwater activities will change significantly going forward. The spreadsheet model can be readily modified (see "Other Expenditures", Row 20) to add detail where it could better inform decision making.

To support the expansion of capital investment, the model's functionality provides for debt financing. The two bond scenarios developed in the model propose issuing bonds in FY18/19 over terms of 15 years and 20 years, respectively, at current market rates. The bond amounts in both scenarios were selected to result in annual debt service payments of approximately $500,000. Interest earned on unspent bond revenues is included with revenues.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	**Financial Projections**	**Santa Fe Stormwater Program**			**Scenario: Pay-as-you-go**															
2		*actual*	*budget*	*projected*																
3		**FY16/17**	**FY17/18**	**FY18/19**	**FY19/20**	**FY20/21**	**FY21/22**	**FY22/23**	**FY23/24**	**FY24/25**	**FY25/26**	**FY26/27**	**FY27/28**	**FY28/29**	**FY29/30**	**FY30/31**	**FY31/32**	**FY32/33**	**FY33/34**	**FY34/35**
4	***FY Beginning Balance***	***$ (190,673)***	***$ 736,404***	***$ 989,474***	***$ 1,361,474***	***$ 1,686,574***	***$ 1,963,247***	***$ 2,187,874***	***$ 2,358,742***	***$ 2,473,036***	***$ 2,527,843***	***$ 2,521,142***	***$ 2,737,799***	***$ 2,889,571***	***$ 2,974,093***	***$ 2,986,878***	***$ 2,925,312***	***$ 3,240,649***	***$ 3,479,005***	***$ 3,637,355***
5																				
6	**Revenues**																			
7	No. of Equivalent Accounts	43,611	44,047	44,487	44,932	45,381	45,835	46,293	46,756	47,224	47,696	48,173	48,655	49,142	49,633	50,129	50,630	51,136	51,647	52,163
8	Monthly Rate	$ 3.00	$ 3.00	$ 4.50	$ 4.50	$ 4.50	$ 4.50	$ 4.50	$ 4.50	$ 4.50	$ 4.50	$ 5.00	$ 5.00	$ 5.00	$ 5.00	$ 5.00	$ 5.75	$ 5.75	$ 5.75	$ 5.75
9	Annual Fee Revenue	$ 1,570,000	$ 1,586,000	$ 2,402,000	$ 2,426,000	$ 2,451,000	$ 2,475,000	$ 2,500,000	$ 2,525,000	$ 2,550,000	$ 2,576,000	$ 2,890,000	$ 2,919,000	$ 2,949,000	$ 2,978,000	$ 3,008,000	$ 3,493,000	$ 3,528,000	$ 3,564,000	$ 3,599,000
10	Bond Revenue			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11	Interest Revenue				$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
12	Other Revenue																			
13	***Total Revenue***	***$ 1,570,000***	***$ 1,586,000***	***$ 2,402,000***	***$ 2,426,000***	***$ 2,451,000***	***$ 2,475,000***	***$ 2,500,000***	***$ 2,525,000***	***$ 2,550,000***	***$ 2,576,000***	***$ 2,890,000***	***$ 2,919,000***	***$ 2,949,000***	***$ 2,978,000***	***$ 3,008,000***	***$ 3,493,000***	***$ 3,528,000***	***$ 3,564,000***	***$ 3,599,000***
14																				
15	**Expenditures**																			
16	Direct Capital Investment		$ 1,082,930	$ 1,000,000	$ 1,040,000	$ 1,081,600	$ 1,124,864	$ 1,169,859	$ 1,216,653	$ 1,265,319	$ 1,315,932	$ 1,368,569	$ 1,423,312	$ 1,480,244	$ 1,539,454	$ 1,601,032	$ 1,665,074	$ 1,731,676	$ 1,800,944	$ 1,872,981
17	Bonded Capital Investment			$ -	$ -	$ -	$ -	$ -	$ -	$ -										
18	Debt Service		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
19	Operations	$ 1,293,178	$ 1,000,000	$ 1,030,000	$ 1,060,900	$ 1,092,727	$ 1,125,509	$ 1,159,274	$ 1,194,052	$ 1,229,874	$ 1,266,770	$ 1,304,773	$ 1,343,916	$ 1,384,234	$ 1,425,761	$ 1,468,534	$ 1,512,590	$ 1,557,967	$ 1,604,706	$ 1,652,848
20	Other Expenditure																			
21	***Total Expenditures***	***$ 1,293,178***	***$ 2,082,930***	***$ 2,030,000***	***$ 2,100,900***	***$ 2,174,327***	***$ 2,250,373***	***$ 2,329,133***	***$ 2,410,705***	***$ 2,495,193***	***$ 2,582,702***	***$ 2,673,342***	***$ 2,767,228***	***$ 2,864,478***	***$ 2,965,215***	***$ 3,069,566***	***$ 3,177,663***	***$ 3,289,644***	***$ 3,405,650***	***$ 3,525,829***
22																				
23	**Transfers**	***$ 650,255***	***$ 750,000***																	
24																				
25	***FY End Balance***	***$ 736,404***	***$ 989,474***	***$ 1,361,474***	***$ 1,686,574***	***$ 1,963,247***	***$ 2,187,874***	***$ 2,358,742***	***$ 2,473,036***	***$ 2,527,843***	***$ 2,521,142***	***$ 2,737,799***	***$ 2,889,571***	***$ 2,974,093***	***$ 2,986,878***	***$ 2,925,312***	***$ 3,240,649***	***$ 3,479,005***	***$ 3,637,355***	***$ 3,710,526***
26	Net Change	*$ 927,077*	*$ 253,070*	*$ 372,000*	*$ 325,100*	*$ 276,673*	*$ 224,627*	*$ 170,867*	*$ 114,295*	*$ 54,807*	*$ (6,702)*	*$ 216,658*	*$ 151,772*	*$ 84,522*	*$ 12,785*	*$ (61,566)*	*$ 315,337*	*$ 238,356*	*$ 158,350*	***$ 73,171***
27																				
28	**Debt Financing**																			
29	Bond Sale			$ -																
30	Interest Rate, %			4.00%																
31	Term, years			20																
32	Annual Debt Service			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
33	Balance			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
34	Interest rate on balance			1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
35	**Assumptions**																			
36	Account Growth Rate	1.0%	/year																	
37	Capital Cost Escalation	4.0%	/year																	
38	Operations Cost Escalation	3.0%	/year																	
39	Annual capital investment	$ 1,000,000	in FY18/19 dollar equivalents																	
40	*year -->*			*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	**Financial Projections**	**Santa Fe Stormwater Program**			**Scenario: 15-year Bond**															
2		*actual*	*budget*	*projected*																
3		**FY16/17**	**FY17/18**	**FY18/19**	**FY19/20**	**FY20/21**	**FY21/22**	**FY22/23**	**FY23/24**	**FY24/25**	**FY25/26**	**FY26/27**	**FY27/28**	**FY28/29**	**FY29/30**	**FY30/31**	**FY31/32**	**FY32/33**	**FY33/34**	**FY34/35**
4	***FY Beginning Balance***	***$ (190,673)***	***$ 736,404***	***$ 989,474***	***$ 1,061,796***	***$ 1,705,768***	***$ 2,328,513***	***$ 2,929,660***	***$ 3,507,793***	***$ 3,183,474***	***$ 2,455,603***	***$ 2,235,223***	***$ 1,952,203***	***$ 1,604,297***	***$ 1,189,141***	***$ 1,298,248***	***$ 1,338,004***	***$ 1,305,663***	***$ 1,198,341***	***$ 1,511,691***
5																				
6	**Revenues**																			
7	No. of Equivalent Accounts	43,611	44,047	44,487	44,932	45,381	45,835	46,293	46,756	47,224	47,696	48,173	48,655	49,142	49,633	50,129	50,630	51,136	51,647	52,163
8	Monthly Rate	$ 3.00	$ 3.00	$ 3.00	$ 4.00	$ 4.00	$ 4.00	$ 4.00	$ 4.00	$ 4.00	$ 5.00	$ 5.00	$ 5.00	$ 5.00	$ 6.00	$ 6.00	$ 6.00	$ 6.00	$ 6.00	$ 6.00
9	Annual Fee Revenue	$ 1,570,000	$ 1,586,000	$ 1,602,000	$ 2,157,000	$ 2,178,000	$ 2,200,000	$ 2,222,000	$ 2,244,000	$ 2,267,000	$ 2,862,000	$ 2,890,000	$ 2,919,000	$ 2,949,000	$ 3,574,000	$ 3,609,000	$ 3,645,000	$ 3,682,000	$ 3,719,000	$ 3,756,000
10	Bond Revenue			$ 1,000,000	$ 1,040,000	$ 1,081,600	$ 1,124,864	$ 1,169,859	$ 338,677	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11	Interest Revenue				$ 47,550	$ 37,150	$ 26,334	$ 15,085	$ 3,387	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
12	Other Revenue																			
13	***Total Revenue***	***$ 1,570,000***	***$ 1,586,000***	***$ 2,602,000***	***$ 3,244,550***	***$ 3,296,750***	***$ 3,351,198***	***$ 3,406,944***	***$ 2,586,064***	***$ 2,267,000***	***$ 2,862,000***	***$ 2,890,000***	***$ 2,919,000***	***$ 2,949,000***	***$ 3,574,000***	***$ 3,609,000***	***$ 3,645,000***	***$ 3,682,000***	***$ 3,719,000***	***$ 3,756,000***
14																				
15	**Expenditures**																			
16	Direct Capital Investment		$ 1,082,930						$ 877,976	$ 1,265,319	$ 1,315,932	$ 1,368,569	$ 1,423,312	$ 1,480,244	$ 1,539,454	$ 1,601,032	$ 1,665,074	$ 1,731,676	$ 1,800,944	$ 1,872,981
17	Bonded Capital Investment			$ 1,000,000	$ 1,040,000	$ 1,081,600	$ 1,124,864	$ 1,169,859	$ 338,677											
18	Debt Service		$ -	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678		
19	Operations	$ 1,293,178	$ 1,000,000	$ 1,030,000	$ 1,060,900	$ 1,092,727	$ 1,125,509	$ 1,159,274	$ 1,194,052	$ 1,229,874	$ 1,266,770	$ 1,304,773	$ 1,343,916	$ 1,384,234	$ 1,425,761	$ 1,468,534	$ 1,512,590	$ 1,557,967	$ 1,604,706	$ 1,652,848
20	Other Expenditure																			
21	***Total Expenditures***	***$ 1,293,178***	***$ 2,082,930***	***$ 2,529,678***	***$ 2,600,578***	***$ 2,674,005***	***$ 2,750,051***	***$ 2,828,811***	***$ 2,910,383***	***$ 2,994,871***	***$ 3,082,380***	***$ 3,173,020***	***$ 3,266,906***	***$ 3,364,156***	***$ 3,464,893***	***$ 3,569,244***	***$ 3,677,341***	***$ 3,789,322***	***$ 3,405,650***	***$ 3,525,829***
22																				
23	**Transfers**	***$ 650,255***	***$ 750,000***																	
24																				
25	***FY End Balance***	***$ 736,404***	***$ 989,474***	***$ 1,061,796***	***$ 1,705,768***	***$ 2,328,513***	***$ 2,929,660***	***$ 3,507,793***	***$ 3,183,474***	***$ 2,455,603***	***$ 2,235,223***	***$ 1,952,203***	***$ 1,604,297***	***$ 1,189,141***	***$ 1,298,248***	***$ 1,338,004***	***$ 1,305,663***	***$ 1,198,341***	***$ 1,511,691***	***$ 1,741,862***
26	Net Change	*$ 927,077*	*$ 253,070*	*$ 72,322*	*$ 643,972*	*$ 622,745*	*$ 601,147*	*$ 578,133*	*$ (324,319)*	*$ (727,871)*	*$ (220,380)*	*$ (283,020)*	*$ (347,906)*	*$ (415,156)*	*$ 109,107*	*$ 39,756*	*$ (32,341)*	*$ (107,322)*	*$ 313,350*	***$ 230,171***
27																				
28	**Debt Financing**																			
29	Bond Sale			$ 5,755,000																
30	Interest Rate, %			3.50%																
31	Term, years			15																
32	Annual Debt Service			$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678	$ 499,678
33	Balance			$ 4,755,000	$ 3,715,000	$ 2,633,400	$ 1,508,536	$ 338,677	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
34	Interest rate on balance			1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
35	**Assumptions**																			
36	Account Growth Rate	1.0%	/year																	
37	Capital Cost Escalation	4.0%	/year																	
38	Operations Cost Escalation	3.0%	/year																	
39	Annual capital investment	$ 1,000,000	in FY18/19 dollar equivalents																	
40	*year -->*			*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	**Financial Projections**	**Santa Fe Stormwater Program**			**Scenario: 20-year Bond**															
2		*actual*	*budget*	*projected*																
3		**FY16/17**	**FY17/18**	**FY18/19**	**FY19/20**	**FY20/21**	**FY21/22**	**FY22/23**	**FY23/24**	**FY24/25**	**FY25/26**	**FY26/27**	**FY27/28**	**FY28/29**	**FY29/30**	**FY30/31**	**FY31/32**	**FY32/33**	**FY33/34**	**FY34/35**
4	***FY Beginning Balance***	***$ (190,673)***	***$ 736,404***	***$ 989,474***	***$ 1,061,486***	***$ 1,715,548***	***$ 2,348,383***	***$ 2,959,620***	***$ 3,547,843***	***$ 4,111,590***	***$ 3,547,054***	***$ 2,753,364***	***$ 2,759,034***	***$ 2,702,818***	***$ 2,581,352***	***$ 2,690,149***	***$ 2,729,595***	***$ 2,696,944***	***$ 2,589,312***	***$ 3,021,674***
5																				
6	**Revenues**																			
7	No. of Equivalent Accounts	43,611	44,047	44,487	44,932	45,381	45,835	46,293	46,756	47,224	47,696	48,173	48,655	49,142	49,633	50,129	50,630	51,136	51,647	52,163
8	Monthly Rate	$ 3.00	$ 3.00	$ 3.00	$ 4.00	$ 4.00	$ 4.00	$ 4.00	$ 4.00	$ 4.00	$ 4.00	$ 5.50	$ 5.50	$ 5.50	$ 6.00	$ 6.00	$ 6.00	$ 6.00	$ 7.00	$ 7.00
9	Annual Fee Revenue	$ 1,570,000	$ 1,586,000	$ 1,602,000	$ 2,157,000	$ 2,178,000	$ 2,200,000	$ 2,222,000	$ 2,244,000	$ 2,267,000	$ 2,289,000	$ 3,179,000	$ 3,211,000	$ 3,243,000	$ 3,574,000	$ 3,609,000	$ 3,645,000	$ 3,682,000	$ 4,338,000	$ 4,382,000
10	Bond Revenue			$ 1,000,000	$ 1,040,000	$ 1,081,600	$ 1,124,864	$ 1,169,859	$ 1,216,653	$ 162,025	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
11	Interest Revenue				$ 57,950	$ 47,550	$ 36,734	$ 25,485	$ 13,787	$ 1,620	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)
12	Other Revenue																			
13	***Total Revenue***	***$ 1,570,000***	***$ 1,586,000***	***$ 2,602,000***	***$ 3,254,950***	***$ 3,307,150***	***$ 3,361,598***	***$ 3,417,344***	***$ 3,474,440***	***$ 2,430,645***	***$ 2,289,000***	***$ 3,179,000***	***$ 3,211,000***	***$ 3,243,000***	***$ 3,574,000***	***$ 3,609,000***	***$ 3,645,000***	***$ 3,682,000***	***$ 4,338,000***	***$ 4,382,000***
14																				
15	**Expenditures**																			
16	Direct Capital Investment		$ 1,082,930	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,103,294	$ 1,315,932	$ 1,368,569	$ 1,423,312	$ 1,480,244	$ 1,539,454	$ 1,601,032	$ 1,665,074	$ 1,731,676	$ 1,800,944	$ 1,872,981
17	Bonded Capital Investment			$ 1,000,000	$ 1,040,000	$ 1,081,600	$ 1,124,864	$ 1,169,859	$ 1,216,653	$ 162,025										
18	Debt Service		$ -	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988
19	Operations	$ 1,293,178	$ 1,000,000	$ 1,030,000	$ 1,060,900	$ 1,092,727	$ 1,125,509	$ 1,159,274	$ 1,194,052	$ 1,229,874	$ 1,266,770	$ 1,304,773	$ 1,343,916	$ 1,384,234	$ 1,425,761	$ 1,468,534	$ 1,512,590	$ 1,557,967	$ 1,604,706	$ 1,652,848
20	Other Expenditure																			
21	***Total Expenditures***	***$ 1,293,178***	***$ 2,082,930***	***$ 2,529,988***	***$ 2,600,888***	***$ 2,674,315***	***$ 2,750,361***	***$ 2,829,121***	***$ 2,910,693***	***$ 2,995,181***	***$ 3,082,690***	***$ 3,173,330***	***$ 3,267,216***	***$ 3,364,466***	***$ 3,465,203***	***$ 3,569,554***	***$ 3,677,651***	***$ 3,789,632***	***$ 3,905,638***	***$ 4,025,817***
22																				
23	**Transfers**	***$ 650,255***	***$ 750,000***																	
24																				
25	***FY End Balance***	***$ 736,404***	***$ 989,474***	***$ 1,061,486***	***$ 1,715,548***	***$ 2,348,383***	***$ 2,959,620***	***$ 3,547,843***	***$ 4,111,590***	***$ 3,547,054***	***$ 2,753,364***	***$ 2,759,034***	***$ 2,702,818***	***$ 2,581,352***	***$ 2,690,149***	***$ 2,729,595***	***$ 2,696,944***	***$ 2,589,312***	***$ 3,021,674***	***$ 3,377,857***
26	Net Change	*$ 927,077*	*$ 253,070*	*$ 72,012*	*$ 654,062*	*$ 632,835*	*$ 611,237*	*$ 588,223*	*$ 563,746*	*$ (564,536)*	*$ (793,690)*	*$ 5,670*	*$ (56,216)*	*$ (121,466)*	*$ 108,797*	*$ 39,446*	*$ (32,651)*	*$ (107,632)*	*$ 432,362*	*$ 356,183*
27																				
28	**Debt Financing**																			
29	Bond Sale			$ 6,795,000																
30	Interest Rate, %			4.00%																
31	Term, years			20																
32	Annual Debt Service			$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988	$ 499,988
33	Balance			$ 5,795,000	$ 4,755,000	$ 3,673,400	$ 2,548,536	$ 1,378,677	$ 162,025	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)	$ (0)
34	Interest rate on balance			1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
35	**Assumptions**																			
36	Account Growth Rate	1.0%	/year																	
37	Capital Cost Escalation	4.0%	/year																	
38	Operations Cost Escalation	3.0%	/year																	
39	Annual capital investment	$ 1,000,000	in FY18/19 dollar equivalents																	
40	*year -->*			*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*

G. CODE OF ORDINANCE PROPOSED REVISIONS

TETRA TECH

To:	Melissa McDonald, City of Santa Fe Leroy Pacheco, City of Santa Fe
From:	Christy Williams, Tetra Tech, Inc.
CC:	Troy Dorman, Tetra Tech, Inc. Rick Schaefer, Tetra Tech, Inc. Rosemary Romero
Date:	August 8, 2018
Subject:	Municipal Code Green Infrastructure Update – Key Revisions and Decision Points

Attached are sections of the Santa Fe Municipal Code deemed pertinent to stormwater management revised using redline strikeout. The revisions have been recommended either because 1) the draft USEPA Small Municipal Separate Storm Sewer System Permit No. NMR040000 requires municipal code updates or 2) code updates were necessary to address findings of Tetra Tech's stormwater management program evaluation.

This memo summarizes the ten primary recommended revisions to the Santa Fe Municipal Code and provides associated rationale. Additional revisions are included in the redline document, but were considered self-explanatory. The redline document also includes comments inserted to provide the reader additional explanation.

In addition, the memo points out a few critical decision points for the City to consider as it moves forward with code updates. These are by no means all of the decisions that will need to be made during the code update process, however, the Tetra Tech team felt it was important to highlight a few key questions to be addressed. Decision points are indicated by <u>underlined text</u> in the memo.

1. **Inclusion of post-construction stormwater management retention performance standard**. Revisions to § 14-8.2(D)(4)(b) are proposed to require all regulated projects to infiltrate a volume of water to ensure that runoff from the project, post-development, is equal to that which would leave the site under natural conditions (for the 90^{th} percentile storm event). This volume is termed "regulatory volume." The draft MS4 permit requires that this standard be applied to all projects of one acre or larger (Part I.D.5.b.). The draft permit does not specify the comparative condition for the project site, therefore, the Tetra Tech team recommends the condition be "natural" rather than "pre-development" to allow for some retrofit for redevelopment projects.
2. **Inclusion of post-construction stormwater management water quality treatment performance standard.** Revisions to § 14-8.2(D)(4)(b) are proposed to require all regulated projects to treat the regulatory volume to achieve a minimum of 85 percent removal of total suspended solids. This requirement is not included in the draft MS4 permit however, water quality of MS4 discharges is of primary importance to the City due to river conditions and TMDLs and the removal of sediment prior to discharge to the City's storm sewer system will also reduce maintenance needs. Meeting the retention standard required by the draft MS4 permit (and described in item no. 1 above) may provide the necessary

treatment to achieve this treatment standard, however, in the event that alternative compliance options are allowed for a project, it is highly recommended that the project still be required to treat on-site runoff to this standard prior to discharge.

3. **Selection of applicability threshold for new post construction performance standards**. The draft MS4 permit requires that the 90th percentile storm event retention standard apply all private projects of one acre or more, however, the City's existing drainage standards apply to much smaller projects (i.e. minor development projects which disturb more than 250 square feet but less than 5,000 square feet comply with discharge standards at §14-82(E) and other non-minor development currently must comply with discharge requirements found in §14-8.2(E)). <u>The City will need to decide what the threshold will be used to trigger the retention standard required by the draft MS4 permit as well as the water quality standard proposed based upon input from City staff.</u> The redline document presumes that the 90th percentile storm standard will not apply to minor developments.
4. **Type of alternative compliance option(s) authorized.** The Municipal Code has been revised to include a placeholder for alternative compliance options for the retention standard mandated by the draft MS4 permit (§14-8.2(B)). As previously stated, alternative compliance is not recommended for the proposed water quality standard or the existing channel protection (peak flow rate) standard. The draft MS4 permit allows for alternative compliance for the retention of the regulatory volume under specific circumstances (Part I.D.5.b.). <u>The City must decide if a) the city will allow alternative compliance options and b) which of options allowed by the draft MS4 permit can be utilized by applicants.</u> The draft MS4 permit allows the use of off-site mitigation, implementation of a groundwater replenishment project, a payment-in-lieu or another option approved by USEPA.
5. **Site constraints necessary for allowing alternative compliance rather than compliance onsite**. If the City chooses to allow for alternative compliance, <u>the criteria for determining that onsite retention is infeasible due to site constraints must be decided and codified.</u> The draft MS4 permit indicates that the following site constraints could make on-site volume management infeasible (Part I.D.5.b.(v)) – *A. too small a lot outside of the building footprint to create the necessary infiltrative capacity even with amended soils; B. soil instability as documented by a thorough geotechnical analysis; C. a site use that is inconsistent with capture and reuse of storm water; D. other physical conditions; or, E. to comply with applicable requirements for on-site flood control structures leaves insufficient area to meet the standard.*
6. **Tighten operation and maintenance planning requirements and add new requirement that owners of private post-construction stormwater control measures regularly inspect the measures and report on their condition to the City.** The draft MS4 permit requires that the City have procedures for site inspection and enforcement to ensure proper long-term operation, maintenance and repair of stormwater control measures (§ 14-8.2(K)). Tetra Tech recommends that the City develop a program which requires private property owners to regularly (e.g. once every three years) inspect all stormwater control measures and report on their condition and any maintenance or repairs conducted.
7. **Addition of administrative penalties for stormwater violations, generally**. The existing Code did not allow for the use of administrative penalties for stormwater violations. Section 13-2.15 has been revised to authorize this type of enforcement action. The draft MS4 permit request that the City have enforcement escalation procedures and the current Code has limited enforcement options therefore very little opportunity to escalate and address repeat offenders.
8. **Addition of specific enforcement actions authorized for active construction.** Further, the existing Code does not authorize the use of "stop work" or the revocation of a project's grading permit. These enforcement actions are typically quite effective during active construction and are integral to a typical enforcement escalation procedure for construction stormwater violations. Section 14-8.2(L) has been added to the Code to include these enforcement actions. This section could also refer to the enforcement actions authorized in Section 13-2.15 however, the power to suspend or revoke the grading permit should be expressly authorized in Section 14-8.2.
9. **Requirement that projects of a certain size must phase disturbance.** The existing Code indicates that phasing may be required on projects at the discretion of the city engineer. The Tetra Tech team recommends that phasing be required for all projects which will disturb five acres or more at a minimum.

This size is considered a “large” construction project and phasing projects of this size will help to control dust and surface erosion. The Code at 14-8.2(D)(2) has been revised to require this.

10. **Specified requirements for temporary and permanent site stabilization during and after construction**. Specific requirements for temporary (during construction) and permanent stabilization have been included in the redline document (§14-8.2(D)(7)). These requirements include more specific requirements for seeding or other stabilization treatments as well as daily stockpile protection.