CITY OF BASTROP, TEXAS

DRAINAGE MASTER PLAN AND DRAINAGE FUND STUDY

Prepared by:

halff

TBPELS Firm No. 312

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April 2023

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Fabiola M. de Carvalho, MIAM
Director of Engineering and Capital Project Management
City of Bastrop
P.O. Box 427
Bastrop, TX 78602

RE: City of Bastrop Drainage Master Plan and Drainage Fund Study Report

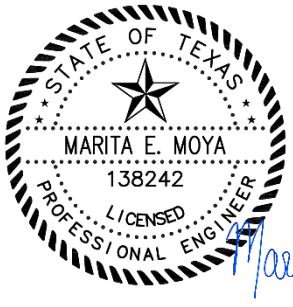
Dear Ms. de Carvalho:

Halff Associates, Inc. presents the *City of Bastrop Drainage Master Plan* including the *Drainage Project Cost Analysis and Potential Funding Study* report. This report presents a prioritized drainage CIP project list and operation and maintenance items for the City of Bastrop to adopt that will aid in reducing flooding throughout the city. Also included is Drainage Project Cost Analysis and Potential Funding Study performed by NewGen Strategies and Solutions, LLC for the City to consider funding source opportunities to operate and maintain existing drainage infrastructure around the city and potential funding to design and construct identified drainage CIP projects.

It has been a privilege for Halff Associates, Inc. to prepare this important document for the City of Bastrop. Halff and NewGen are especially appreciative of the cooperation of the members of the City Staff who assisted in developing this report.

We are pleased to continue assisting the City of Bastrop. Do not hesitate to contact us if you have any questions or comments regarding future implementation of this plan.

Sincerely,



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List of Acronyms and Abbreviations

ACE	Annual Chance of Exceedance
CIP	Capital Improvement Plan
City	City of Bastrop
DEM	Digital Elevation Model
DMP	Drainage Master Plan
ETJ	Extra- Territorial Jurisdiction
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
HEC	Hydrologic Engineering Center
HMS	Hydrologic Modeling System
LCC	Lower Colorado-Cummins
LiDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
NFHL	National Flood Hazard Layer
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
O&M	Operations and Management
RAS	River Analysis System
SH	State Highway
SSURGO	Soil Survey Geographic Database
TNRIS	Texas Natural Resource Information System
TSDN	Technical Study Data Notebook
UPRR	Union Pacific Railroad
USACE	US Army Corps of Engineers
USDA	US Department of Agriculture
USGS	US Geological Survey

1.0 INTRODUCTION

1.1 Background

In the recent decade, the City of Bastrop (City) has experienced a steady increase in population and advancement in commercial and industrial sectors. Increased development can lead to greater volumes of stormwater runoff in streams, causing higher water surface elevations and greater flood risk to property and infrastructure. Increased runoff also increases channel velocities, leaving systems more susceptible to erosion and potentially threatening public infrastructure. Ultimately, flooding impacts from the City's streams and other local sources may result in greater public risk and impede growth. During the 2015 Memorial Day flood event, the City experienced significantflooding in the Gills Branch watershed. During the rainfall event the banks of Gills Branch were overwhelmed by floodwaters, resulting in overland flow that overtopped the Union Pacific Railroad (UPRR), flowing westward to the Colorado River, flooding structures and roadways. As a result, the City participated in the Bastrop County Flood Protection Planning (FPP) grant in 2017, conducting a floodplain study of both Piney Creek and Gills Branch to determine flood risk and develop potential riverine flood mitigation solutions. In addition, the City updated the Stormwater Drainage Design Manual (Revised August 2019) to redefine drainage plan submittal requirements to prevent additional riverine and localized flooding.

The City is taking a proactive approach to more effectively plan drainage improvements aimed to reduce flooding by developing a comprehensive Drainage Master Plan (DMP) to identify both riverine and local flood risks throughout the city.

The objective of the City of Bastrop Drainage Master Plan is to:

1. Conduct a comprehensive evaluation of the existing drainage conditions throughout the city to develop an understanding of the drainage infrastructure.
2. Develop conceptual engineering solutions to mitigate flood risk through proposed drainage Capital Improvement Plan (CIP) projects.
3. Prepare drainage cost analysis for the City to consider funding sources to implement the drainage CIP projects and to maintain the City's drainage infrastructure.

1.2 Approach

The DMP was developed leveraging current floodplain information and data. The hydrologic and hydraulic data was reviewed and updated as needed to meet the DMP objectives. Input from both City staff and public input was a critical component in fulfilling the goals of the DMP. The DMP efforts began with a public meeting to discuss the goals and objectives and to receive input directly from the public. An online resident questionnaire was used as another avenue to obtain public feedback.

Hydrologic and hydraulic analysis was conducted to determine riverine and local flood risk. Models were developed to define limits of existing flooding, to identify flood problem areas, and to develop conceptual flood mitigation solutions.

Halff conducted riverine floodplain analysis for creeks within the city limits, all which discharge to the Colorado River. Existing floodplains were established for the following Colorado River tributaries (with creek alpha identification):

- Piney Creek (PC)
- Gills Branch (GB)
- Copperas Creek (CC)
- SpringBranch (SB)
- Pine Forest Creek (PFC)

Flood impacts from the Colorado River are based on the effective FEMA Flood Insurance Rate Maps (FIRM) dated January 19, 2006.

A two-dimensional (2D) direct rainfall analysis was conducted to identify local flood problems within the city historic downtown area. This 2D rapid assessment analysis only considered localized overland flow and did not consider storm drain systems. Localized flooding is the way runoff navigates through private property and public right-of-way within the city before ultimately reaching a defined creek. Local flooding and riverine flooding were both considered to properly identify the various causes of flooding. Conceptual flood mitigation solutions were developed for riverine and local flood problem areas to create a drainage CIP that prioritizes projects using a drainage scoring matrix.

The City of Bastrop's DMP is a planning level document to aid the City in implementing drainage improvements. **Figure 1-1** depicts the various stages a design project undergoes from DMP to bid and construction of the project. DMP projects are developed at the conceptual level during the master planning phase and need to be further vetted through a feasibility analysis. The feasibility analysis will refine project constraints, including permitting and utility concerns, to support the design efforts which will eventually lead to final design and construction. Designing and building these projects are heavily dependent on funding and available resources. As projects advance through the project stages more detailed information is gathered and considered to refine the design elements and probable cost estimates.

Figure 1-1: Project Stages from Drainage Master Plan to Bid/Construction

2.0 DATA COLLECTION

Halff obtained and reviewed data from a variety of sources to provide information for a comprehensive understanding of flooding issues throughout the city. **Table 2-1** outlines relevant data collected and corresponding sources.

Table 2-1: Data Collection

Data	Source	Notes
GIS data	Various	Various
Terrain	TNRIS	2017
Soils	NRCS	SSURGO data
FEMA DFIRM	FEMA	Bastrop County Effective January 2006
FEMA LOMR	FEMA	November 2008, April 2011, September 2019, November 2019, April 2020
Lower Colorado Cummins Preliminary Map Revisions	FEMA Mapping Inventory Platform (MIP)	Gills Branch and Piney Creek Hydrology and Hydraulic – April 2020
Property Parcels	City of Bastrop	Received April 2022
Stormwater Drainage Utility Map	City of Bastrop	Received 2015
Piney Creek Bend Phase II Subdivision Improvement Plans	City of Bastrop	October 2019

GIS data included terrain (LiDAR) data, land use/zoning, FEMA floodplains, political boundaries, development and subdivisions, aerials, and parcel information.

Halff also collected and considered the following current City of Bastrop master plans to ensure consistency and to identify potential project overlap.

- 2036 Comprehensive Plan (2016)
- Parks and Open Space Master Plan Update (2016)
- Transportation Master Plan (2017)
- Water Master Plan (2022)

Additional items used in development of the DMP include feedback from a public meeting and a resident questionnaire to gather public input, field survey and field reconnaissance.

2.1 Public Outreach – Public Meeting

A public meeting was held at the Bastrop Convention Center on January 26, 2022, with 15 participants in attendance. The public meeting incorporated a presentation demonstrating the need for a Drainage Master Plan and an overview of the procedure to develop a drainage master plan for the City of Bastrop. Resident

attendees provided feedback regarding drainage concerns to City staff and engineers in attendance. Data was collected on two large poster boards using markings to indicate known flooding.

In addition to the in-person meeting, Bastrop residents had the opportunity to provide feedback through an online questionnaire available from January 26 – March 11. The questionnaire asked residents to share details about flooding and thoughts on potential drainage funding sources. The survey collected responses from 81 residents which helped identify flood problem areas within the city limits. Survey questions and results are available in **Appendix A**.

2.2 Riverine Watershed Studies

The City's downtown area has two major riverine watersheds: Piney Creek, which relatively follows the northwestern city limit of Bastrop, and Gills Branch which flows through the downtown district on the east side of the Union Pacific Railroad. Both Piney Creek and Gills Branch watersheds were analyzed and updated by Halff in 2020 as part of the Lower Colorado-Cummins (LCC) Watershed Phase 2 Risk Identification and Assessment during the Texas Water Development Board Mapping Activity Statement No. 14. The effort included updating the hydrologic and hydraulic models to reflect the best available data and modeling methodologies at the time of the study. Two key components of the update included updating terrain data (TNRIS 2017 LiDAR) and updating rainfall data to NOAA Atlas 14 rainfall depths, released in September of 2018. The hydrologic and hydraulic models developed during the LCC effort were used to define the existing conditions of the City of Bastrop Drainage Master Plan. Minor adjustments were made to the Piney Creek hydraulic model to extend the model to the project limits, up to the 1-mile extra-territorial jurisdiction, and to account for new development. Further discussion of these hydraulic revisions is discussed later in this report.

Additional riverine systems analyzed as part of the DMP include Copperas Creek, Pine Forest Creek, and Spring Branch. Copperas Creek is located immediately downstream of the Bastrop State Park Lake Dam which conveys the dam's discharge to the Colorado River. Pine Forest Creek watershed is bounded by Gills Branch and Copperas Creek watersheds, encompassing the Pine Forest Unit 6 subdivision area of Bastrop. Both Copperas Creek and Pine Forest Creek have been a part of local watershed studies which were updated to incorporate 2017 LiDAR and Atlas 14 rainfall data. Spring Branch is located on the west side the City of Bastrop with headwaters originating near Hunter's Crossing Park. All models were developed to the 1-mile ETJ. **Figure 1-1** shows the location of the studied streams in relation to the City of Bastrop. Model development and methodology is discussed in later sections of this report.

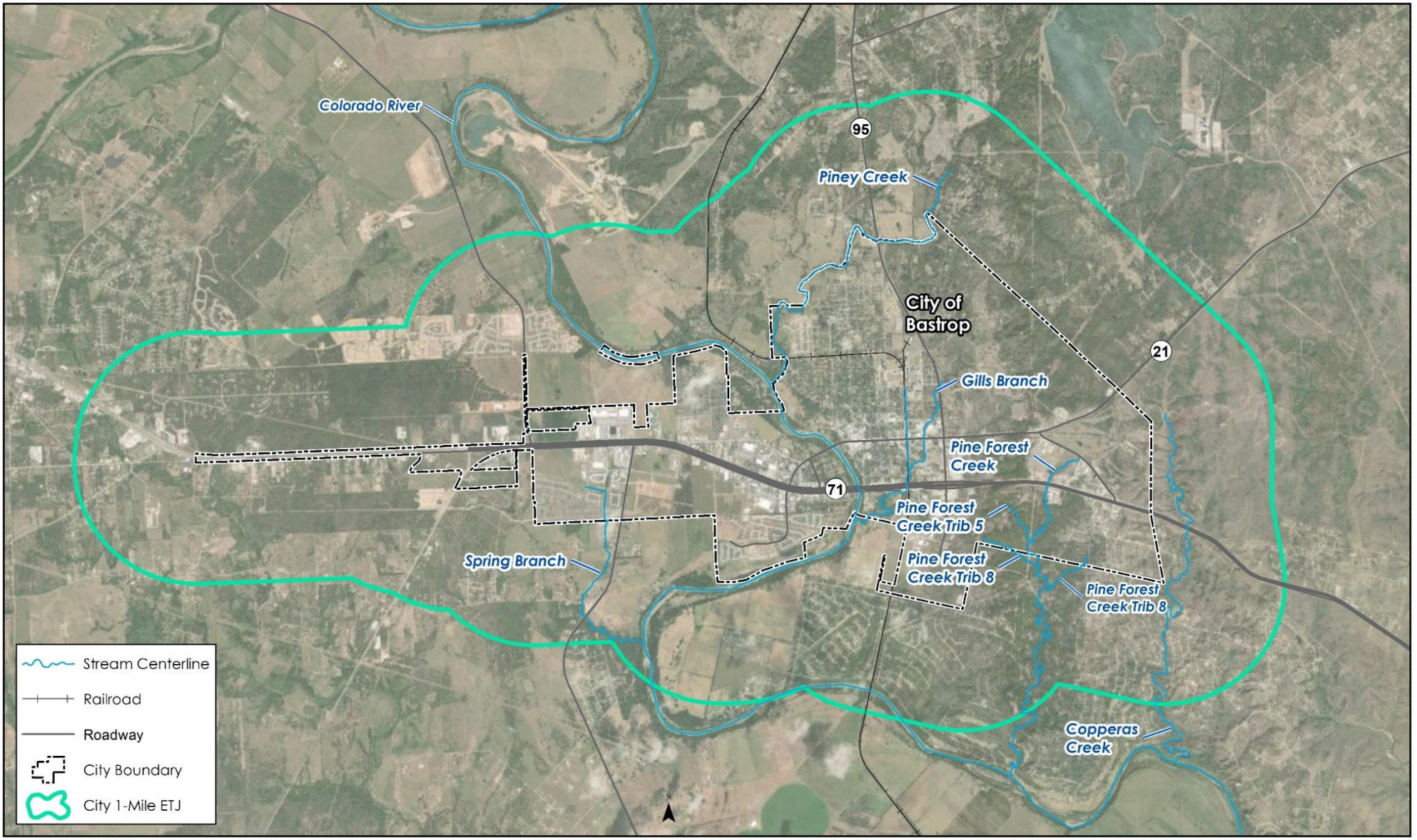


Figure 2-1: Bastrop DMP Study Streams

2.2.1 Gills Branch Flood Mitigation Design

Gills Branch has caused numerous flooding challenges for the City of Bastrop in recent years. The significant rainstorm event Memorial Day of 2015 resulted in several consecutive days of floodwater inundation throughout Bastrop County. Specifically, within the City of Bastrop, the Gills Branch channel was overwhelmed, which led to overflow of the riverine banks causing extensive property damage and significant flooding throughout the historic downtown area of the City. Due to these known challenges, the City has increased stormwater regulations within the Gills Branch watershed and invested in detailed hydraulic modeling and design efforts of Gills Branch to ultimately support the Gills Branch Flood Mitigation Improvements design, completed March 2021. The design project's goal is to minimize channel overflow from leaving Gills Branch during heavy rainfall events to reduce flooding impacts. The flood mitigation improvement project includes approximately 5,050 LF of channel benching and improvements to three (3) roadway creek crossings upstream of the UPRR. The City is seeking funds to implement construction of the Gills Branch Flood Mitigation Improvement project. The Gills Branch Flood Mitigation Improvement design was included in the City of Bastrop Drainage Master Plan as one of the proposed CIP projects.

2.3 Storm Drain Field Survey

The existing storm drain system was surveyed, to the extent possible, within the city limits and right of way, during Spring of 2022. Survey points included storm drain inlets, manhole elevations, pipe flowlines and dimensions, and outfall flow lines and dimensions. The survey team captured approximately 360 storm drain inlets, 80 manholes, and 35 outfalls. The data collected will support the development of a digital storm drain database, further discussed in the following section.

2.4 Storm Drain Database

A storm drain database was developed for the City of Bastrop to map and detail existing storm drain infrastructure within city limits. This will be the first digital spatial inventory the city will have to use and update as new drainage infrastructure is constructed. The survey was supplemented and supported by data provided by the City listed in **Table 2-2**.

Table 2-2: Storm Drain Database Sources

Data	Notes
Stormwater Data from City	
Stormwater Drainage Utility Map	2016
Storm Drain Geodatabase for Hunter's Crossing	*Provided* 2022
As-Built Plans from City	
Public Improvement Plans for Bastrop Grove Phase 1A	January 2021
Public Improvement Plans for Bastrop Grove Phase 1B	March 2022
Pecan Park Subdivision Section 1A	June 2018
Pecan Park Subdivision Section 1B	February 2021
Pecan Park Subdivision Section 2	August 2019
Construction Plans for Pecan Park Section 3A	September 2016
Pecan Park Subdivision Section 3B & 3C	June 2018
Pecan Park Subdivision Section 3D & 3E	March 2019
Pecan Park Subdivision Section 3F	September 2018
Construction Plans for Pecan Park Residential Revised Section 4	February 2016
Construction Plans for Pecan Park Residential Section 5A	April 2015
Construction Plans for Pecan Park Residential Section 5B	June 2016
Construction Plans for Pecan Park Section 6A	September 2019
Construction Plans for Pecan Park Section 6B	October 2017
Pecan Park Subdivision Section 7	July 2020
Pecan Park Commercial Block 8, Lot 1	July 2018
Piney Creek Bend Phase II	October 2019
Convention Center Site Development Plan	December 2009
Field Survey	
Gills Branch Flood Mitigation Design Survey	March 2020
Drainage Master Plan Field Survey	Spring 2022

2.5 Field Reconnaissance

Field reconnaissance was conducted during the development of the DMP. Halff conducted field visits to supplement models with field measurements and to better understand flood problems. Data collected in the field supported the development of existing conditions and flood mitigation solutions. City staff also conducted field reconnaissance of existing storm drain infrastructure to assist in determining system connectivity.

3.0 Existing Condition Flood Risk

Existing flood risk was identified by preparing hydrologic and hydraulic models to analyze the riverine features and the City's urban core. The model results help identify flood risk and challenges within the city. Hydrologic and hydraulic analyses were performed for Piney Creek, Gills Branch, Spring Branch, Copperas Creek, and Pine Forest Creek watersheds to define riverine flood risk throughout the city and up-to the 1-mile ETJ. Recently completed Piney Creek and Gills Branch studies, prepared by Halff in 2020 as part of the LCC study, were leveraged in support of the DMP efforts. Model development and results for the existing conditions of Piney Creek and Gills Branch watershed LCC study should be referenced in the LCC TSDN. Copperas Creek and Pine Forest Creek models were updated from previous local studies. The Spring Branch model was prepared as part of the planning effort. All riverine analyses were used to identify existing flood risk in the City of Bastrop. A 2D Rapid Assessment of Bastrop's downtown area was completed to better understand local drainage challenges in the city's urban core.

3.1 Hydrologic Modeling

The hydrologic methodology was derived from Piney Creek and Gills Branch hydrologic models developed during the LCC study to ensure modeling techniques between the LCC study and the DMP remained consistent. No changes were made to the Piney Creek and Gills Branch hydrologic models. The hydrologic parameters and methodologies used to determine peak flows for the 50, 10, 4, 2, 1 and 0.2% ACE storm events are outlined in the following sections. **Exhibits 2.1 – 2.5** in **Appendix A** depict the drainage subbasins for each watershed included in the City of Bastrop DMP.

3.1.1 Rainfall Data

A new rainfall study called Atlas 14 was released by NOAA in September 2018. The study included an additional 20 years of rainfall data not accounted for in the previous rainfall study conducted by the USGS. Generally, Atlas 14 rainfall totals are higher in central Texas compared to the previous USGS rainfall data. Bastrop County saw an average of 2.6-inch increase for the 1% ACE event between USGS and Atlas 14 rainfall depths. An increase in rainfall depths equates to more runoff volume, increased flood elevations, and wider floodplains. The City adopted the new rainfall depths into the City's Stormwater Drainage Design Manual in 2019 to account for the increase in severity of storm events.

The Atlas 14 rainfall data produced by NOAA was used to determine precipitation depths for all watersheds. To maintain consistency with the LCC study of Piney Creek and Gills Branch, the same Atlas 14 rainfall data was used for the Copperas Creek, Pine Forest Creek, and Spring Branch watershed models. The rainfall data was based on the centroid of the Bastrop County (Latitude 30.0983, Longitude -97.3083). This rainfall data is reported below in **Table 3-1**. The City's Stormwater Drainage Design Manual outlines the Atlas 14 rainfall depths to be used throughout the City. The values reported in **Table 3-1** are all within ±0.01 inches when compared to those in the Drainage Design Manual with one exception of a 0.1-inch difference for the 50-year 24-hour rainfall depth.

Table 3-1: Bastrop County Atlas 14 Rainfall Depths

Frequency-Depth-Duration (Inches)						
Duration	50% ACE (2-yr)	10% ACE (10-yr)	4% ACE (25-yr)	2% ACE (50-yr)	1% ACE (100-yr)	0.2% ACE (500-yr)
5-min	0.54	0.78	0.93	1.04	1.15	1.43
15-min	1.08	1.56	1.85	2.07	2.29	2.83
1-hr	2.01	2.90	3.45	3.87	4.29	5.44
2-hr	2.47	3.71	4.52	5.15	5.82	7.70
3-hr	2.75	4.22	5.22	6.02	6.89	9.36
6-hr	3.22	5.10	6.43	7.53	8.77	12.30
12-hr	3.68	5.94	7.60	9.02	10.60	15.40
24-hr	4.17	6.82	8.82	10.60	12.60	18.50

3.1.2 Hydrologic Parameters

Existing hydrologic parameters were reviewed and updated to match those of the LCC study. Subbasin and longest flow path delineations were revised as necessary to align to 2017 LiDAR. Supporting hydrologic data such as land use and soils data were updated to reflect best available data. Hydrologic parameter development and significance is outlined below.

Land Use Data

The land use was updated using recent aerial imagery and the National Land Cover Database (NLCD) 2019 land cover data as references to identify areas of land cover changes. New residential developments, commercial developments, and transportation corridors were considered when accounting for impervious cover throughout the watershed. **Table 3-2** outlines the impervious value used for each land use classification. Land use spatial data used in support of this planning effort for each watershed can be found in the supporting digital DMP Geodatabase.

Table 3-2: Percent Impervious and Urbanization by Land Use Classification

Land Use Classification	Percent Impervious	Percent Urbanization
Open Water	100	100
Developed - Open Space. Impervious surfaces account for less than 12% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes	12	10
Developed - Low Intensity Impervious surfaces account for 30-49% of the total cover. These areas most commonly include ¼ acre lots.	38	30
Developed - Medium Intensity. Impervious surfaces account for 50-79% of the total cover. These areas most commonly include single-family housing units.	65	90
Developed - High Intensity. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100% of the total cover.	85	95
Barren Land	0	0
Forest	0	0
Shrub/Scrub	0	0
Grassland/Herbaceous	0	0
Hay/Pasture	0	0
Cultivated Crops	0	0
Woody Wetlands	100	100
Emergent Herbaceous Wetlands	100	100
Transportation	100	50

Block and Uniform Loss Rate Method

Using the Fort Worth District US Army Corps of Engineers (USACE) loss rates, the percent sand is a primary indicator for projecting both rainfall losses and unit hydrograph lag times. On a subbasin scale, the percent sand generally ranges from zero to one hundred (percent) with zero representing areas with highly impermeable clayey soils and one hundred representing areas with highly permeable sandy soils. Soil data was downloaded from the United States Department of Agriculture (USDA) NRCS Web Soil Survey online database for the Copperas Creek, Pine Forest Creek, and Spring Branch watersheds.

Area-weighted percent sand values were developed for each subbasin based upon best available soil data. The percent clay values are the complement of the percent sand values for each subbasin.

The subbasin loss rates were calculated using the area weighted percent sand and percent clay values to assign Block and Uniform Loss Rates for each subbasin. The default loss rates vary in relation to runoff frequency based on the historic tendency for infrequent flood events to be temporally associated with wet periods having had antecedent events capable of significantly saturating the upper soil profile. The default loss rates for 100% clay and 100% sand are shown in **Table 3-3** (NUDALLAS Documentation, USACE Fort Worth District, 1986).

Table 3-3: Block and Uniform Loss Rates for 100% Clay and 100% Sand

Annual Chance Event	Hydrologic Loss Rates			
	Clay		Sand	
	Block (in)	Uniform (in/hr)	Block (in)	Uniform (in/hr)
50%	1.5	0.2	2.1	0.26
10%	1.12	0.14	1.5	0.18
4%	0.95	0.12	1.3	0.15
2%	0.84	0.1	1.1	0.13
1%	0.75	0.07	0.9	0.1
0.2%	0.5	0.05	0.6	0.08

Unit Hydrograph

The Snyder Unit Hydrograph method was used for the watershed studies to develop the hydrographs and corresponding peak discharges for each subbasin. The Snyder Unit Hydrograph method requires two parameters: the Snyder standard lag (Tp) and the Snyder peaking coefficient (Cp). Snyder's Tp is defined as the time from the excess rainfall's center of mass to the peak discharge of a subbasin. The USACE Fort Worth District Urbanization Curves were used to calculate the lag time for each subbasin using calculated parameters such as length of longest flow path, weighted subbasin slope, and length of centroidal longest flow path. The lag time is also influenced by the soil type and the degree of urbanization of the subbasin. Urbanization corresponds to land use type and reflects the percentage in which a subbasin has been developed or improved through channelization and/or a stormwater collection network. Each land cover type was assigned a percent urbanization in accordance with "Determination of Percent Urbanization/Imperviousness in Watersheds" USACE, 1986 (**Table 3-2**). The longest flow paths and centroidal longest flow paths determined for each subbasin are included in the digital DMP Geodatabase. A peaking coefficient of 0.65, similar to the value used in the Piney Creek and Gills Branch hydrologic analysis (0.75), was used for Copperas Creek, Pine Forest Creek and Spring Branch. A high peaking coefficient (>0.65) is reflective of the steep slopes in Bastrop. A slightly lower peaking coefficient was selected for the Copperas Creek, Pine Forest Creek and Spring Branch due to the more rural nature of the watersheds.

Hydrologic Flood Routing

Flood routing is used in hydrologic models to account for storage and timing of a hydrograph as it travels downstream. Muskingum-Cunge routing was used for Copperas Creek, Pine Forest Creek, and Spring Branch channel routing approach. Muskingum-Cunge considers length, slope, channel roughness and a representative 8-point cross section along a hydraulic channel. Due to the steep nature of these watersheds, Muskingum-Cunge was determined an appropriate approach for channel routing.

Hydrologic Reservoir Routing

Reservoir routing was accounted for in watersheds when applicable to model flood control structures that provide a flood retention benefit. The reservoirs were modeled using the reservoir routing elements in HEC-HMS to define the reservoirs characteristics.

The following reservoirs were modeled in the DMP watersheds:

- Copperas Creek– Bastrop State Park Dam
- Pine Forest Creek– Mayfest Park Pond just north of Hwy. 71 and Tahitian Village Dam located just south of Hwy. 71
- Spring Branch– Hunter's Crossing Detention Pond

Summary of Parameters

As a summary, five watersheds were considered during the development of the Bastrop DMP. No changes were made to the Piney Creek or Gills Branch hydrology models from the LCC study. The watersheds are relatively small, ranging between 2 to 5 square miles except for Piney Creek. The City of Bastrop and surrounding area remains relatively undeveloped with relatively steep terrain. **Table 3-4** below summarizes the hydrologic parameter characteristics.

Table 3-4: Summary of Hydrologic Characteristics

Watershed	Source of Study	DMP Model Development	Watershed Area (mi^2)	Characteristics
Copperas Creek	Bastrop State Park Dam Reconstruction (2019)	Updated Analysis	4.6	7% Urbanized 2% Average Slope
Gills Branch	LCC	Leveraged	2.8	31% Urbanized 1.6% Average Slope
Piney Creek	LCC	Leveraged	38.0	10% Urbanized 1% Average Slope
Pine Forest Creek	Pine Forest Unit 6 Drainage Study (2017)	Updated Analysis	2.1	14% Urbanized 5% Average Slope
Spring Branch	n/a	New Analysis	4.3	17% Urbanized 1% Average Slope

3.1.3 Hydrologic Results

The watersheds in the City of Bastrop all have steep slopes resulting in fast response times during a storm event. Hydrologic modeling yielded peak discharges that were used to support the hydraulic modeling effort to determine flood inundation impacts. The peak discharges of each watershed were compared to each other to validate the results. **Figure 3-1** below displays the peak discharges for the 1% ACE event. The graph demonstrates a general trend between area and peak discharge. This suggests consistent hydrologic results. The points that are lower than the general trend are due to the physical characteristics of the subbasin. For example, the Pine Forest Creek outlier is attributed to the Tahitian Village Dam, which decreased the peak discharge. Additionally, the Gills Branch data points that are lower include subbasins with shallower slopes resulting in lower peak discharges in comparison to data points with similar contributing areas.

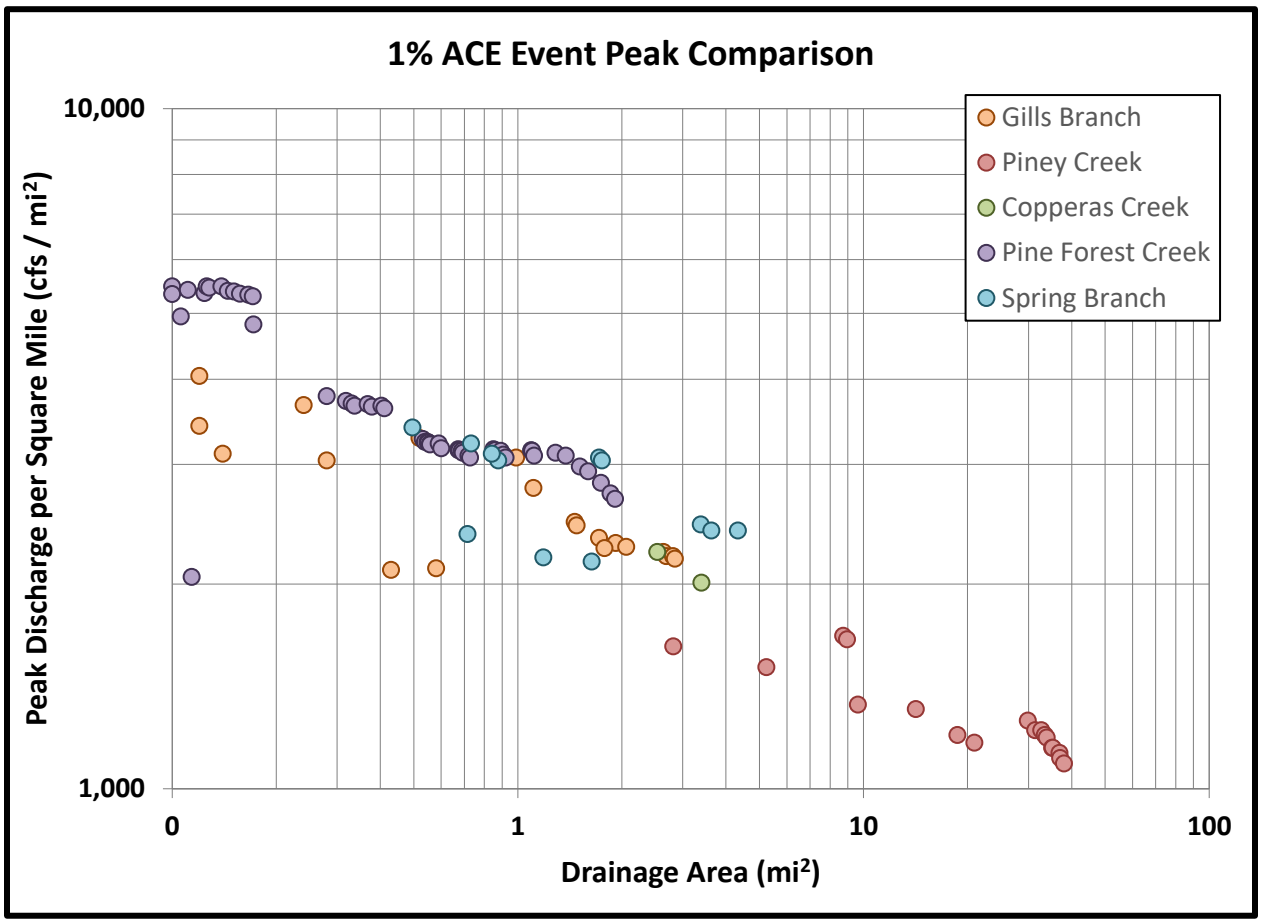


Figure 3-1: 1% ACE Peak discharge per square mile versus drainage area comparison

3.2 Hydraulic Modeling

Hydraulic models were leveraged and developed to model the resulting water surface elevations for the 50, 10, 4, 2, 1, and 0.2% ACE storm events. The Piney Creek and Gills Branch hydraulic models were leveraged from the recent LCC study. Piney Creek model was extended upstream to reach the 1-mile ETJ study area limit while Gills Branch was not extended since the model limits already spans the FEMA effective study limits. Copperas Creek and Pine Forest Creek hydraulic models were updated and extended, as necessary, to the study area limits. Spring Branch hydraulic model was developed as part of the DMP effort. **Exhibits 3.1 – 3.5** in **Appendix A** display the hydraulic work maps for each study stream included in the City of Bastrop Drainage Master Plan. The hydraulic work maps include the hydraulic cross sections and resulting 1% ACE floodplain extents.

3.2.1 Cross Section Development

Hydraulic models were updated and developed so that the cross sections reflect 2017 LiDAR and have the appropriate Manning's n-values based on current land cover. In addition to the five mainstem studies, three Pine Forest Creek tributaries were also studied as part of the DMP modeling effort: Pine Forest Creek

Tributary 5, Pine Forest Creek Tributary 8, and Pine Forest Creek Tributary 10. **Table 3-5** summarizes the hydraulic streams modeled and mapped for the City of Bastrop during the development of the DMP.

Table 3-5: Summary of Hydraulic Modeling Extents

Stream	Source of Study	DMP Model Development	Stream Length (mi)	No. of Structures
Copperas Creek	Bastrop State Park Dam Reconstruction (2019)	Updated Analysis	4.70	3
Gills Branch	LCC	Leveraged	2.00	5
Piney Creek	LCC	Leveraged, Extended 0.8 mile upstream	4.09	6
Pine Forest Creek	Pine Forest Unit 6 Drainage Study (2017)	Updated Analysis	3.23	3
Pine Forest Creek Tributary 5			0.41	1
Pine Forest Creek Tributary 8			0.58	0
Pine Forest Creek Tributary 10			0.33	1
Spring Branch	n/a	New Analysis	2.19	5

3.2.2 Hydraulic Results

Resulting water surface elevations determined the delineation of the 1% ACE floodplain for all hydraulic study streams as shown in **Exhibits 3.1 – 3.5** in **Appendix A**. Floodplain extents were used to identify flood risk for road crossings, residential and commercial structures, and critical facilities during a 1% ACE storm event. All road crossings were identified and evaluated based on the level of service. Bridges and culverts should be capable of conveying the 1% ACE storm to be in compliance with the City's design criteria. **Table** 3-6 summarizes the road crossings in the city limits and the associated frequency the structure is able to convey. Based on the results, all major road crossings in the city are unable to convey the 1% ACE event.

Table 3-6: Summary of Hydraulic Results at Road Crossings within City Limits.

Study Stream	Road Crossing	Existing Level of Service (ACE)
Gills Branch	SH-95	20%
	Farm St	10%
	Chestnut St	10%
	Pine St	20%
	Martin Luther King Dr	50%
Piney Creek	SH-95	4%
	Main St	10%
	Main St Pedestrian Crossing	10%
	Reids Bend	10%
	US Railroad	0.2%
	Riverwood Dr	None
Pine Forest Creek Tributary 5	Mauna Loa Ln	None
Spring Branch	Hunter's Crossing Blvd	10%
	Pedestrian Crossing Downstream of Hunters Crossing	None
	Hunters Point	1%
	Private Drive at County Border	None

3.3 Local 2D Rapid Assessment

An existing conditions 2D rapid assessment was conducted to identify local drainage patterns and problem areas for the 50%, 4%, and 1% storm events. The 2D model was used to determine the characteristics of overland flow in the City of Bastrop downtown urban core. The urban area was defined as east of the Colorado River and bounded to the south by State Highway 71, the east by State Highway 95, and a few Piney Creek and Gills Branch subbasins. **Figure 3-2** below shows the 2D area boundary. The analysis did not incorporate storm drain or subsurface conveyance. HEC-RAS version 6.1.0 was utilized for the 2D rapid assessment.

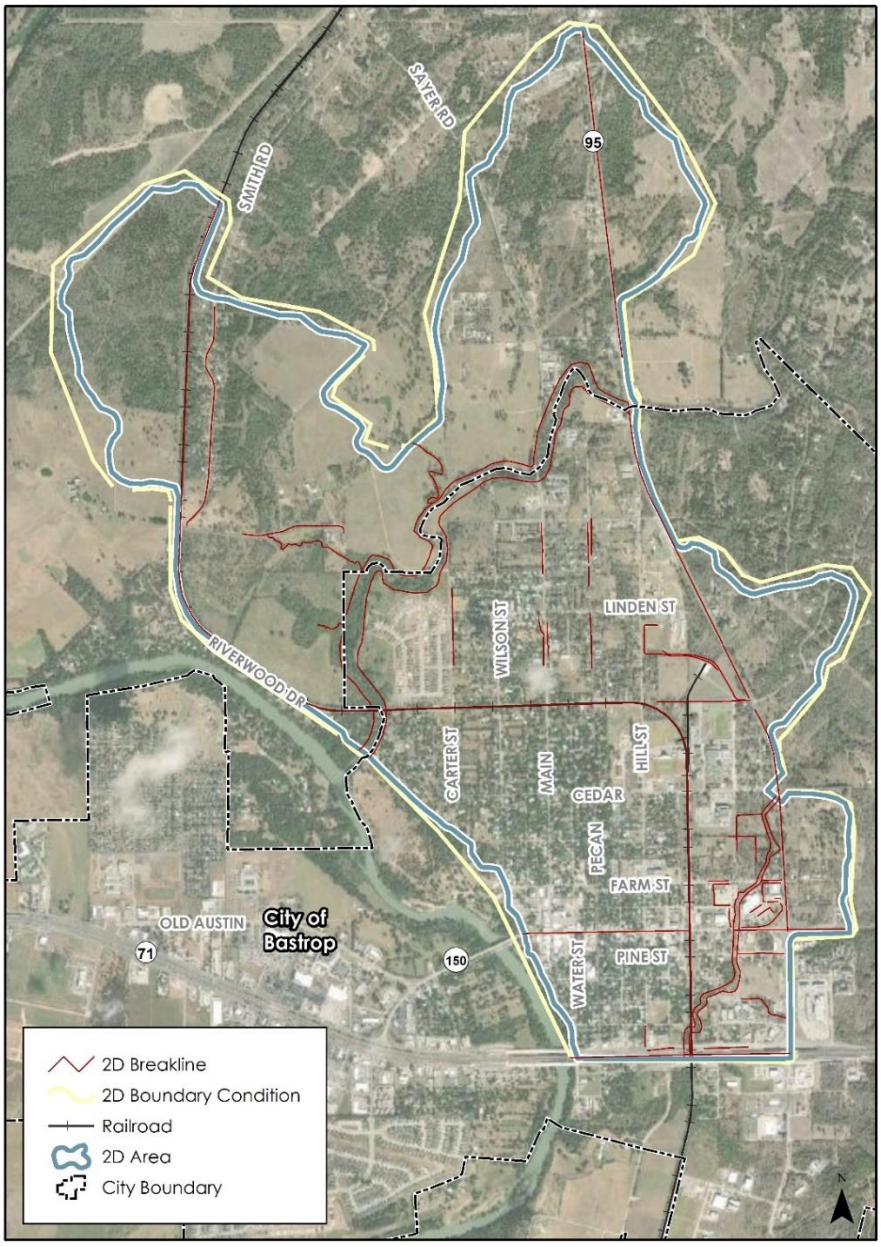


Figure 3-2: 2D Model Study Area

3.3.1 2D Hydrologic Methodology

The 2D study area was modeled by applying direct excess rainfall onto the 2D surface. Direct excess rainfall was calculated using HEC-HMS version 4.2. The 2D area was treated as a single subbasin in HEC-HMS to independently evaluate the rainfall losses due to infiltration for the area as a whole. The 2D area loss parameters were populated using the same simulation parameters and rainfall depths as in the overall Piney and Creek and Gills Branch watershed studies. The excess rainfall calculated by HEC-HMS was used to develop the rainfall hyetograph used to represent the direct excess rainfall in the hydraulic model.

The rainfall was applied uniformly across the 2D study area extents. Piney Creek and Gills Branch cumulative contributing drainage area upstream of the 2D study area were accounted for using inflow hydrographs taken from the LCC HEC-HMS model.

3.3.2 2D Hydraulic Methodology

2D Surface

The 2D surface was developed using 2017 LiDAR data. Inputs for the 2D surface are described below:

- **Breaklines** – Breaklines were added to better define the 2D surface within HEC-RAS. Breaklines are placed along features such as the top of road, around drainage structures, large drainage ditches, and creek bank tops to add additional definition.
- **Maximum/Minimum Cell Sizes** – The standard cell size set for the 2D surface was 100 feet x 100 feet. A minimum cell size of 50 feet x 50 feet was enforced to ensure greater detail around breaklines at significant topological changes.
- **Roughness Zones** – A roughness zone shapefile was created in GIS and imported into HEC-RAS. Manning's n-values were set using the landuse shapefile prepared in the LCC study with hand edits if newer developments were seen in the recent aerial imagery. The selected n-values can be found in **Table 3-7**. Homes and structures (Buildings in **Table 3-7**) were simulated using a higher n-value instead of using voids.
- **Boundary Condition -** Normal depth boundary conditions were placed at locations where flow exits the 2D model area. The three main areas of discharge were at the downstream ends of Piney Creek and Gills Branch, a drainage ditch under State Highway 71, and the 2D area's boundary with Colorado River. The normal depth slopes were based on the slope of the channel at the 2D area boundary. Additional normal depth boundary conditions were placed wherever there was substantial flow leaving the 2D surface with the slope being reflective of the grade of the surface in the direction of flow.

Table 3-7: 2D Rapid Assessment Manning's n-values

Land Use	Manning's n-value
Buildings	5.0
Bare - Grass	0.04
Commercial	0.025
Dense Trees	0.09
Industrial	0.025
Multi-family Residential	0.025
Pond	0.023
Shrub Land	0.06
Single-family Residential, High Intensity	0.06
Single-family Residential, Low Intensity	0.08
Trees	0.08

3.3.3 2D Model Results

The existing 2D model produced floodplain results for the 50%, 4% and 1% ACE storm events. The 2D results demonstrate inundation extents and depths in the Bastrop urban core. The floodplain results compared areas of known flood risk. Areas of known flood risk were populated based on data collected at the beginning of the DMP effort. These sources include, areas identified by City staff, the resident questionnaire (2022), and documented flood damage from a May 2016 storm event provided by the City. The 4% and 1% ACE results are shown on **Exhibit 4.1.-4.2**. The flooded areas in the 2D results generally match the locations of the flood risk points.

The flooding depths and flood extents of the existing 50%, 4% and 1% ACE frequency events were compared to the location of residential homes and other pertinent locations. There were 8 areas identified with property or street flooding. These areas were used to help locate the flooding "hot spots."

4.0 Drainage Problem Identification

Halff reviewed all relevant data including the Piney Creek, Gills Branch, Pine Forest Creek, Copperas Creek, and Spring Branch Watershed Studies, 2D hydraulic rapid assessment, City of Bastrop resident feedback from the Drainage Master Plan public meetings, and input provided by City of Bastrop staff. All data points were populated spatially to identify area clusters to define flood problem area "hot spots."

These "hot spots" include local flooding and riverine flooding concerns. Local flooding is characterized by street and structure flooding throughout an urbanized region due to undersized drainage infrastructure while riverine flooding is characterized by overtopping roadways and inadequate channel capacity directly attributed to overflowing streams. Sixteen (16) flood problem areas were identified throughout the City of Bastrop. All locations were verified by city staff as challenges during progress meetings. **Table** 4-1 lists the flood problem areas with a unique flood problem area (FPA) ID. **Exhibit 5** shows the location of all FPAs throughout the city.

These FPAs are considered areas of flooding challenges based on existing conditions in the City of Bastrop. The DMP effort was unable to evaluate solutions for all sixteen problem areas however this list will be a resource for potential future projects the City can monitor and pursue in the future.

Table 4-1: List of Flood Problem Areas

Flood Problem Area (FPA)	Description	Watershed	Flooding Type
FPA-1	SH 95 at Piney Creek	Piney Creek (PC)	Riverine
FPA-2	Mercedes Cv, N Pecan St	Piney Creek (PC)	Riverine
FPA-3	N Main St at Piney Creek	Piney Creek (PC)	Riverine
FPA-4	Mesquite, Maple, Water St	Piney Creek (PC)	Local
FPA-5	Reids Bend at Piney Creek	Piney Creek (PC)	Riverine
FPA-6	Linden, Pecan St	Piney Creek (PC)	Local
FPA-7	Hunters Crossing	Spring Branch (SB)	Riverine/Local
FPA-8	Riverwood Dr at Piney Creek	Piney Creek (PC)	Riverine
FPA-9	Cedar, Main St	Gills Branch (GB)	Local
FPA-10	SH 95 at Gills Branch	Gills Branch (GB)	Riverine
FPA-11	Railroad, Cedar St	Gills Branch (GB)	Local
FPA-12	Farm St, Chestnut St, Pine St, MLK Dr at Gills Branch	Gills Branch (GB)	Riverine
FPA-13	Chestnut, Jefferson, Hill St	Gills Branch (GB)	Local
FPA-14	Walnut, MLK	Gills Branch (GB)	Local
FPA-15	Perkins Street, Basin RV Resort	Colorado River (CR)	Riverine
FPA-16	SH 71 Culvert	Gills Branch (GB)	Local

5.0 Drainage Solutions

Sixteen (16) flood problem areas throughout the City of Bastrop were identified and resulted in development of ten (10) drainage Capital Improvement Plan (CIP) projects, three (3) Operation and Maintenance (O&M) projects, and two (2) voluntary buyouts. Riverine solutions include proposals for culvert replacements, bridge expansions, channel clearing, and channel benching. Local solutions include proposals to increase storm drain capacity at select locations throughout the City's urban core. All solutions were developed following the City's drainage criteria which considers a balance of economy and capacity. For each project, a one-page project summary sheet was prepared. Each summary sheet includes a project description, a project location image, project benefits and challenges, opinion of probable cost estimates, and a project score. All project summary sheets along with the probably cost estimates can be found in **APPENDIX B**. **Table 5-1** lists the drainage CIP projects developed during the DMP effort.

Table 5-1: Capital Improvement Plan Project Summary List by Solution Type

Project ID	Project Name	Solution Type
GB-01	SH-95 at Gills Branch	Riverine
GB-02	Gills Branch Flood Mitigation Improvements	Riverine
GB-03	Water, Spring, & Cedar St. Drainage	Local
GB-04	Hill, Pecan, & Pine St. Drainage	Local
GB-05	Pecan, Beech, & Haysel to Gills Branch	Local
PC-01	SH-95 at Piney Creek	Riverine
PC-02	Riverwood Dr. at Piney Creek	Riverine
PC-04	Local Storm Drain Improvements Near Piney Creek	Local
PC-05	Pecan St. Bypass & Pond Diversion	Local
SB-01	Detention Pond at Hunters Crossing	Riverine

Additionally, three (3) operation and maintenance (O&M) projects were identified to support ongoing city efforts and immediate needs. These O&M projects include the development of a creek maintenance plan, conducting CCTV of existing storm drains and updating the City's drainage criteria. Summary sheets similar to the drainage CIP project summary sheets were prepared for the O&M projects, including an opinion of probable cost estimate. Since these projects intended to be implemented as programs for the City to begin in the near future, project scores were not assigned to the O&M projects. **Table 5-2** summarizes the O&M projects along with the assigned project ID.

Table 5-2: Operation and Maintenance Projects

Project ID	Project Name
COB-01	Creek Maintenance Plan
COB-02	Storm Drain Evaluation
COB-03	Drainage Criteria Update

Finally, there were two (2) voluntary buyouts identified as potential future voluntary buyouts. The City is aware of the flood risk at both these locations and have emergency and building requirements in place to ensure safety of the residents. The voluntary buyouts are identified in **Table 5-4** and are included in the summary sheets with a probable cost based on current property value.

Table 5-3: Voluntary Buyouts

Project ID	Project Name
CR-01	Basin RV Resort at the Colorado River
PC-03	Mercedes Cove at Piney Creek

5.1 Solution Development

Mitigation solutions were developed to provide the City with probable project cost estimates, ranking, and prioritization of the drainage CIP projects. Hydrologic and hydraulic models from Piney Creek, Gills Branch, and Spring Branch were used in the development of the solutions. The rational method to estimate peak flows was employed when developing solutions to mitigate local flooding concerns.

Riverine solutions aimed to remove roadways and surrounding structures from the 1% ACE floodplain, as per the City criteria where possible. However, to ensure project feasibility, a decreased level of service design approach was considered to lower flood risk to the extent practicable. Local solutions aimed to convey the 4% ACE flood event per the City criteria, which was successfully achieved.

5.2 Opinion of Probable Cost Estimates

An opinion of probable cost was prepared for each of the identified drainage CIP projects and O&M projects. Local and regional TxDOT average low-bid unit costs provided a basis for estimating unit costs. A 40% contingency was applied to the project subtotal to account for uncertainties in the conceptual design development. At the DMP planning phase, proposed mitigation projects are high level conceptual solutions developed with several assumptions. These mitigation projects will need to be further analyzed and vetted, therefore, a high contingency accounts for unforeseen costs. Anticipated engineering design, environmental permitting costs, and utility relocation were added as a percentage of the base total. The total project costs are displayed on each project summary sheet and detailed cost estimates are provided in **APPENDIX B**.

5.3 Project Ranking

After mitigation solution development and the determination of opinion of probable cost estimates, each drainage CIP project was scored and subsequently ranked, not including the O&M or Voluntary Buyout projects. To score each project, a categorical scoring matrix was established and agreed upon by City of Bastrop staff. The scoring matrix includes five (5) major categories including Public Safety, Economic Impact, Project Timing, Environmental Impact, and Social Impact with each major category assigned a weight. Each category was then broken into subcategories and assigned a weight, the sum of which is equal to the major category's total assigned weight. Projects are scored between 0 to 3 for each subcategory and then multiplied by the assigned weight to produce a subcategory score. The subcategory

scores are then added together for the total project score. The highest possible project score is 100 where the higher score results in a higher priority project. **Table 5-4** shows the total project score for each of the ten (10) drainage CIP mitigation projects ranked from highest to lowest. It is important to note that project PC-01 is listed twice and is the same location but each project differs based on the level of service achieved. The scoring matrix is available in **APPENDIX C,** and each project score is included in the respective project summary sheet (**APPENDIX B**).

Table 5-4: Drainage CIP Project Ranking

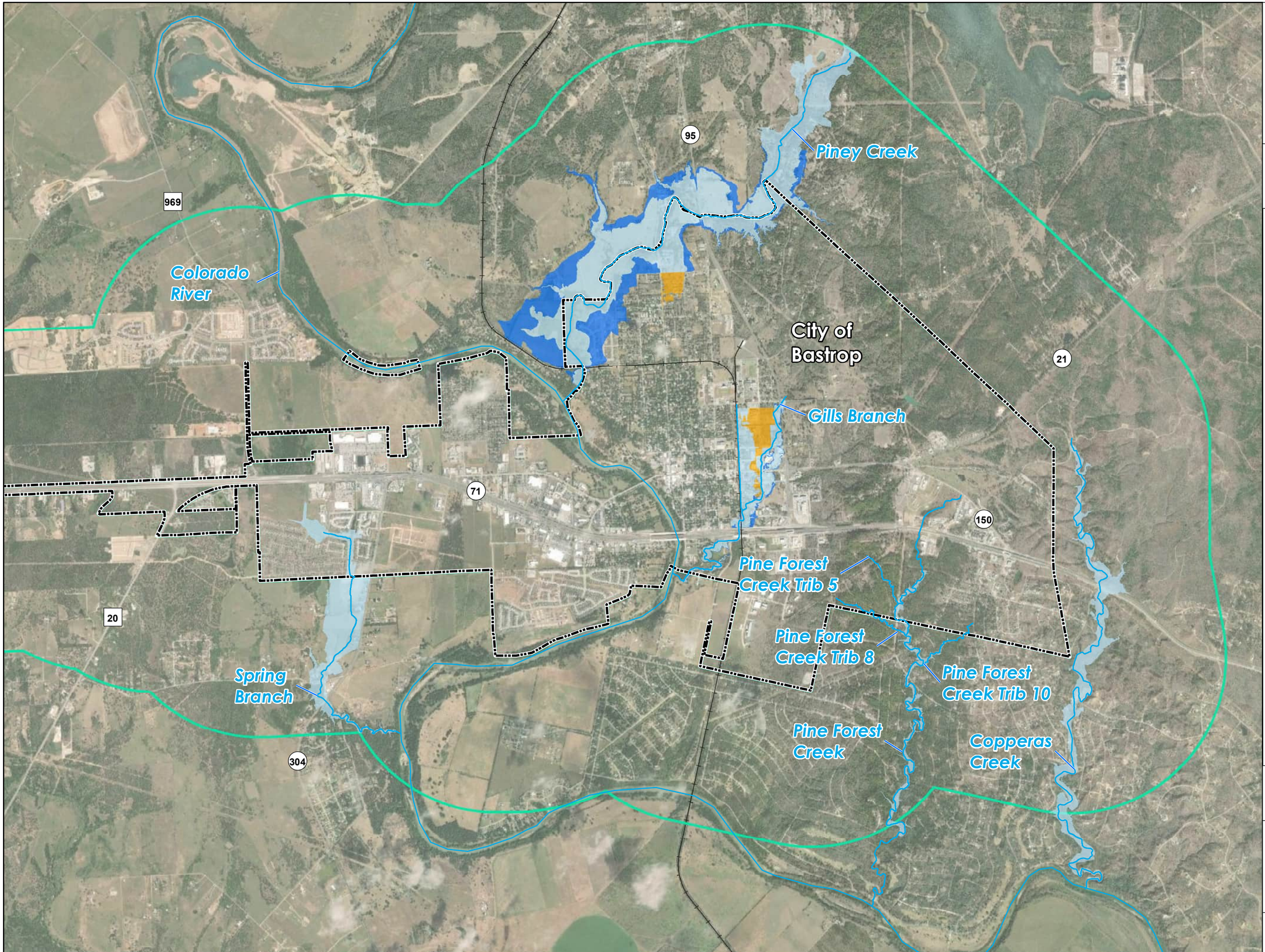
Ranking	Project ID	Project Name	Estimated Project Cost	Ranking Value
Mitigation Projects				
1	SB-01	Detention Pond at Hunters Crossing	$709,000	83.3
2	GB-02	Gills Branch Flood Mitigation Improvements	$14.05 M	73.3
3	GB-01	SH-95 at Gills Branch	$688,000	71.7
4	PC-02	Riverwood Dr. at Piney Creek	$2.29 M	68.3
5	GB-03	Water, Spring, & Cedar St. Drainage	$25.66 M	66.7
6	PC-04	Local Storm Drain Improvements Near Piney Creek	$5.14 M	63.3
6	PC-05	Pecan St. Bypass & Pond Diversion	$23.73 M	63.3
6	GB-04	Hill, Pecan, & Pine St. Drainage	$8.70 M	63.3
9	GB-05	Pecan, Beech, & Haysel to Gills Branch	$20.56 M	61.7
10	PC-01	SH-95 at Piney Creek (2% ACE LOS)	$6.72 M	60.0
11	PC-01	SH-95 at Piney Creek (1% ACE LOS)	$13.61 M	58.3

6.0 Drainage Project Cost Analysis and Potential Funding

Establishing options for drainage funding is a viable strategy for local governments to respond to the challenge of generating reliable revenue to support stormwater management activities. Identifying funding allows a community to proactively develop and maintain a City's drainage infrastructure. A drainage utility fee provides the means to a dedicated fund allowing the construction of the drainage capital improvements identified in this DMP report and fund ongoing operation and maintenance related to drainage infrastructure.

NewGen Strategies, a sub-consultant to Halff, was tasked with conducting a cost analysis and potential funding for the City of Bastrop. The report prepared by NewGen Strategies entitled "Drainage Project Cost Analysis and Potential Funding Study" serves as a companion report to this Drainage Master Plan and is provided in **APPENDIX D.**

Exhibits



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Railroad
- City Boundary
- City 1-Mile ETJ

Atlas 14 Floodplains

- Shallow Flooding
- 1.0% ACE
- 0.2% ACE

Exhibit 1
Overview

N

0 3,000 6,000 Feet

halff

BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerlines
- Contours - 10'
- Roadway
- Railroad
- Subbasin Boundary
- City of Bastrop
- City 1-Mile ETJ

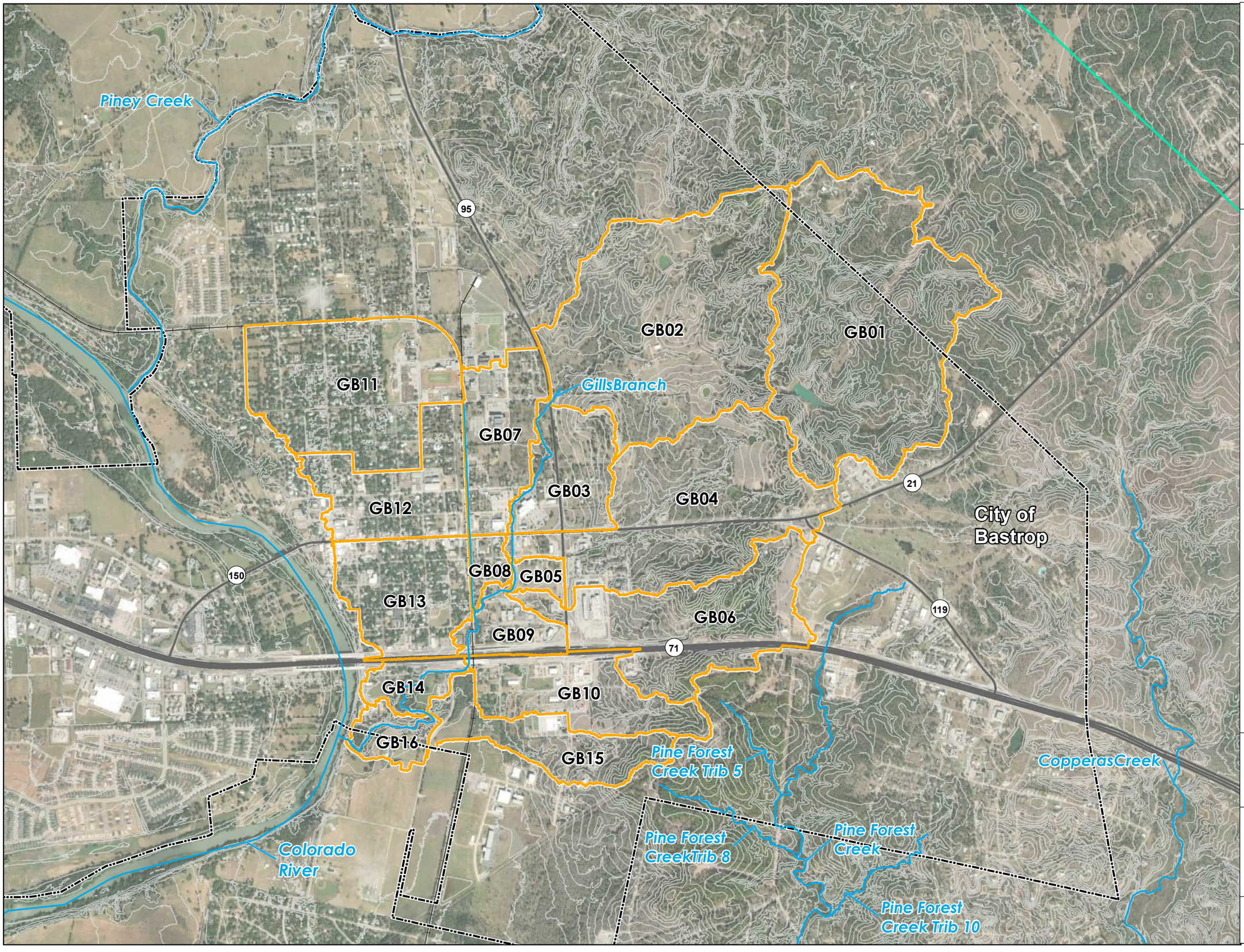
PC001
PC002
PC003
PC004
PC005
PC006
PC007
PC008
PC009
PC010
PC011
PC012
PC013
PC014
PC015
PC016
PC017
PC018
2336
290
95
1441
21
969
Piney Creek
Colorado River
City of Bastrop
GillsBranch
CopperasCreek

Exhibit 2.1
Piney Creek Subbasin Map

N

0 5,500 11,000 Feet

halff



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Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

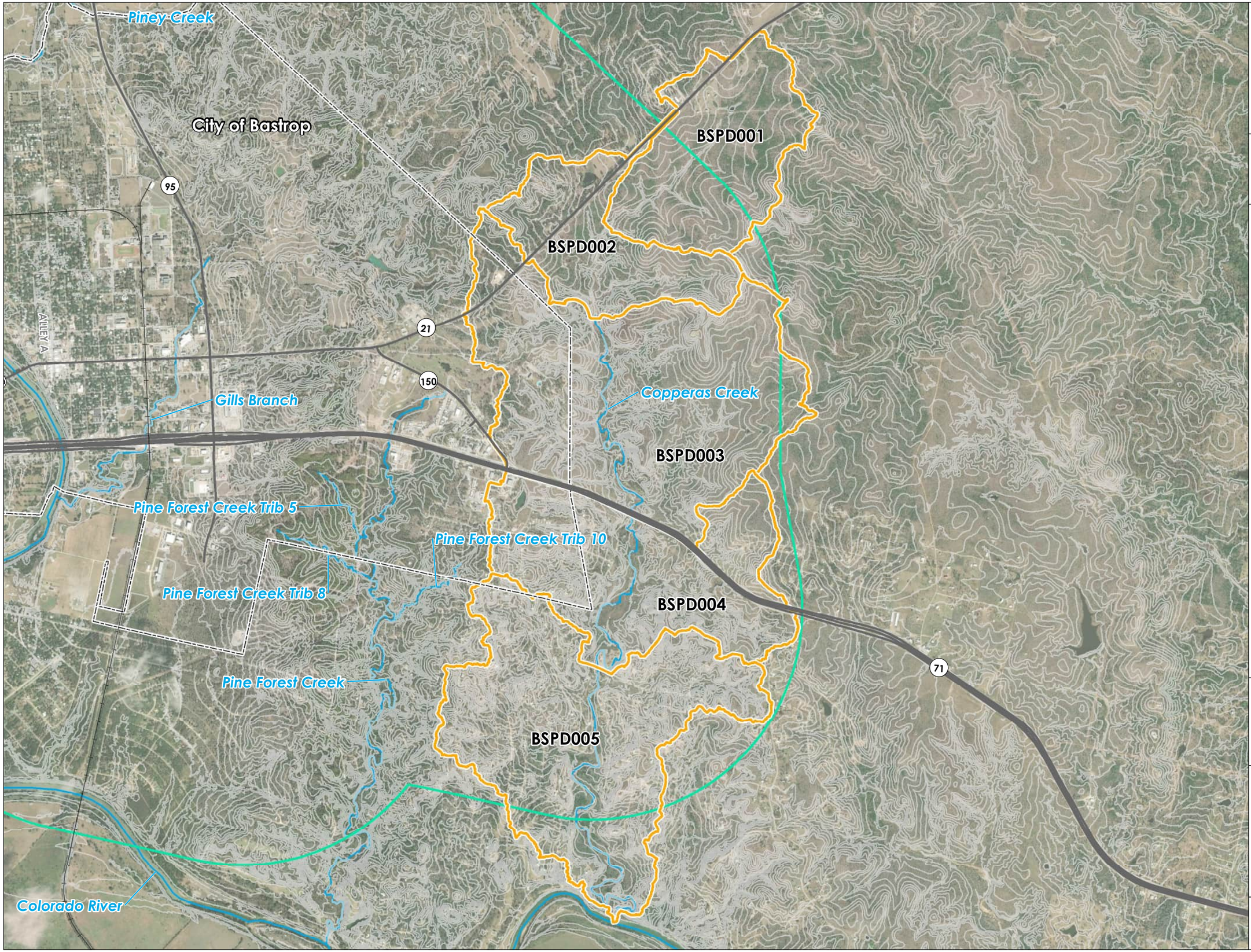
- Stream Centerlines
- Contours - 10'
- Roadway
- Railroad
- Subbasin Boundary
- City of Bastrop
- City 1-Mile ETJ

Exhibit 2.2
Gills Branch
Subbasin Map

N

0 1,500 3,000 Feet

halff



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Heart of the Lost Pines
Est. 1832

City of Bastrop
Drainage Master Plan

- Stream Centerline
- Contour - 10'
- Roadway
- Railroad
- Subbasins Boundary
- City Boundary
- City 1-Mile ETJ

Exhibit 2.3
Copperas Creek
Subbasin Map

N

0 2,200 4,400
Feet

halff

City of Bastrop
Drainage Master Plan

- Stream Centerline
- Contour - 10'
- Roadway
- Subbasin Boundary
- City Boundary
- City 1-Mile ETJ

Panel 1 of 3

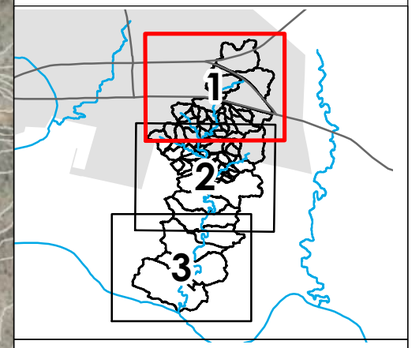

Exhibit 2.4
Pine Forest Creek
Subbasin Map

N

0 600 1,200 Feet

halff

UPFC01
UPFC02
UPFC03
UPFC04
UPFC04
UPFC05
UPFC06
UPFC07
UPFC08
UPFC09
UPFC10
UPFC11
UPFC12
UPFC13
UPFC14
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UPFC16
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UPFC22
UPFC23
UPFC24
UPFC25
UPFC26
UPFC27
UPFC28
UPFC29
UPFC37
UPFC38
UPFC40
UPFC52
Pine Forest Creek
Pine Forest Creek Trib 5
21
71
150

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Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Contour - 10'
- Roadway
- Subbasin Boundary
- City Boundary
- City 1-Mile ETJ

Panel 2 of 3

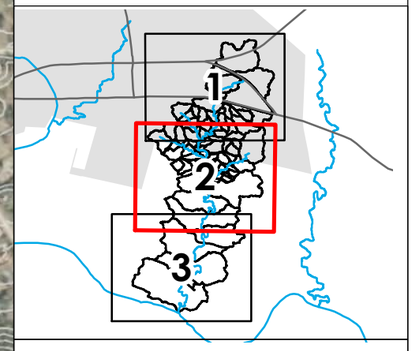

Exhibit 2.4
Pine Forest Creek Subbasin Map

N

0 600 1,200 Feet

halff

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Heart of the Lost Pines
Est. 1832

City of Bastrop
Drainage Master Plan

- Stream Centerline
- Contour - 10'
- Roadway
- Subbasin Boundary
- City Boundary
- City 1-Mile ETJ

Panel 3 of 3

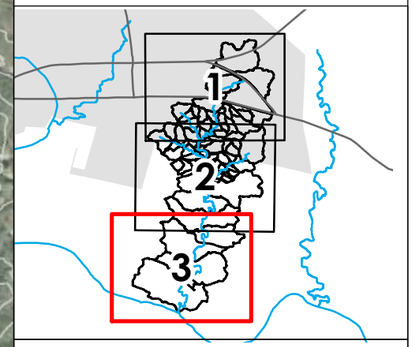
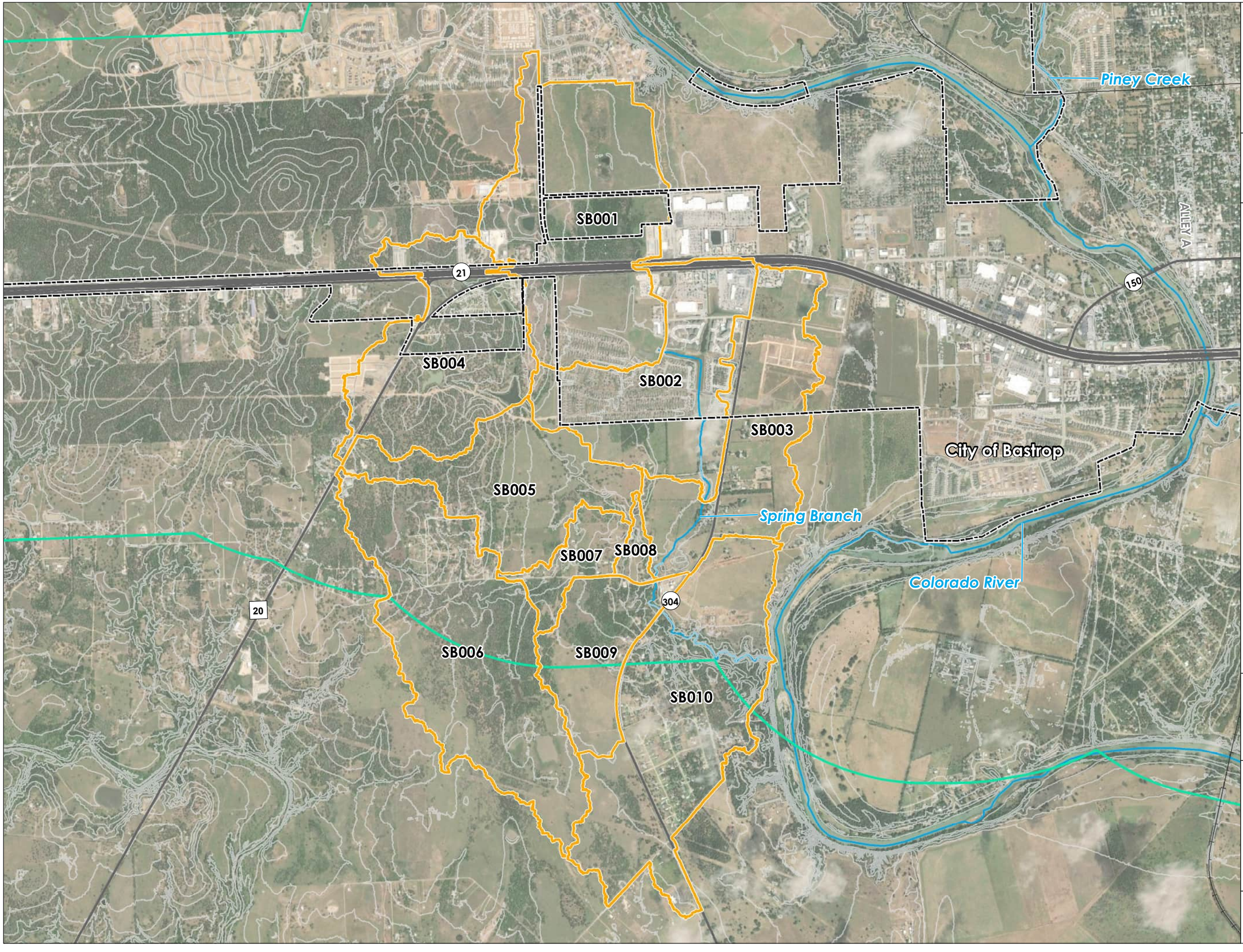


Exhibit 2.4
Pine Forest Creek
Subbasin Map

N

0 600 1,200
Feet

halff



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Heart of the Lost Pines
Est. 1832

City of Bastrop
Drainage Master Plan

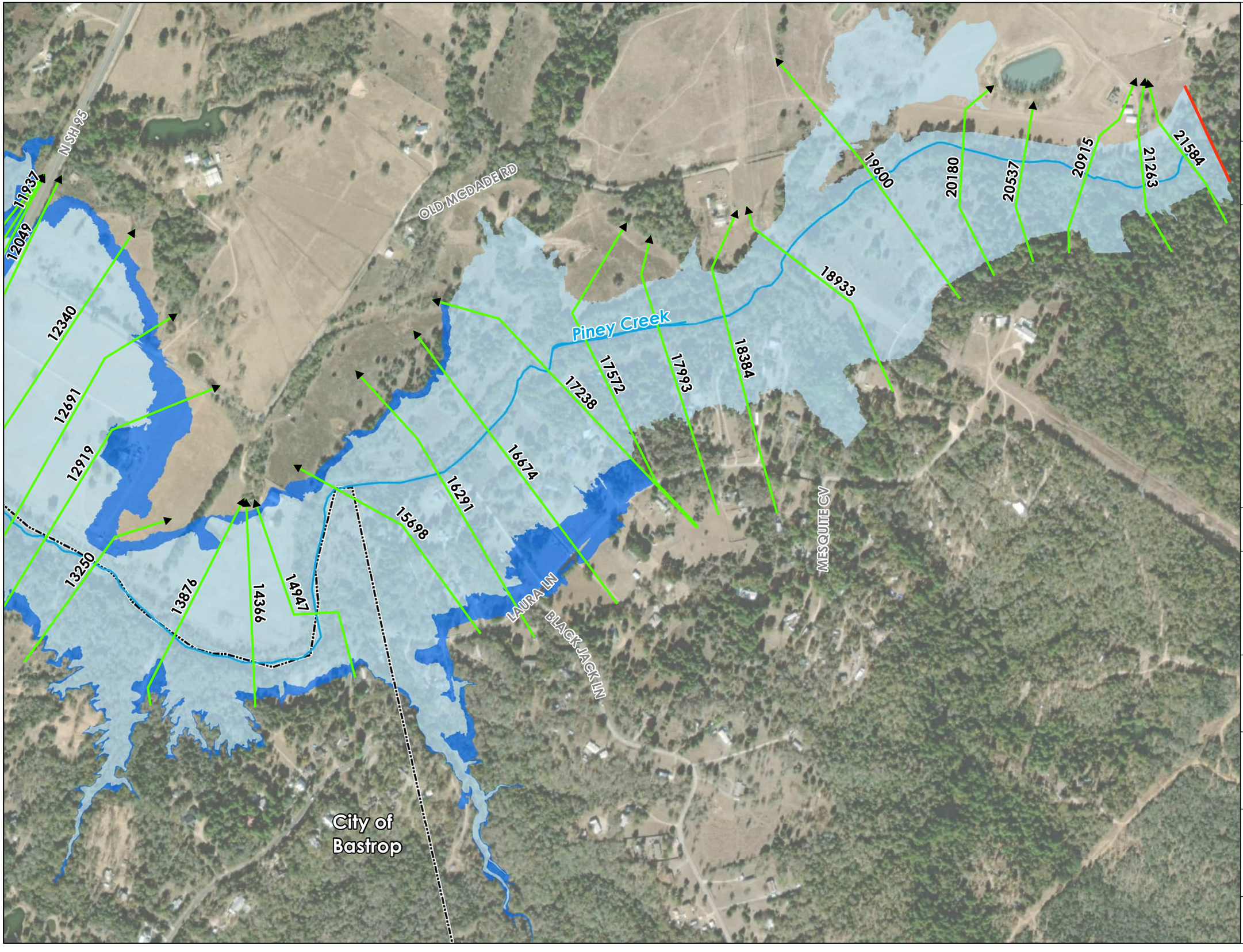
- Stream Centerline
- Contour - 10'
- Roadway
- Railroad
- Subbasin Boundary
- City Boundary
- City 1-Mile ETJ

Exhibit 2.5
Spring Branch
Subbasin Map

N

0 1,900 3,800
Feet

halff



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Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Cross Section
- Limit of Study
- Railroad
- City Boundary

Atlas 14 Floodplains

- Shallow Flooding
- 1.0% ACE
- 0.2% ACE

Panel 1 of 3

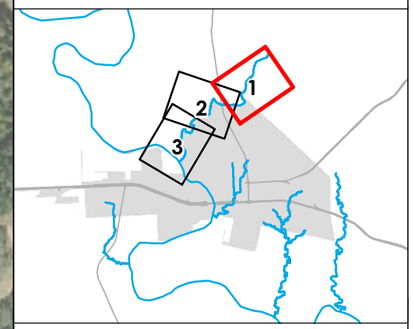
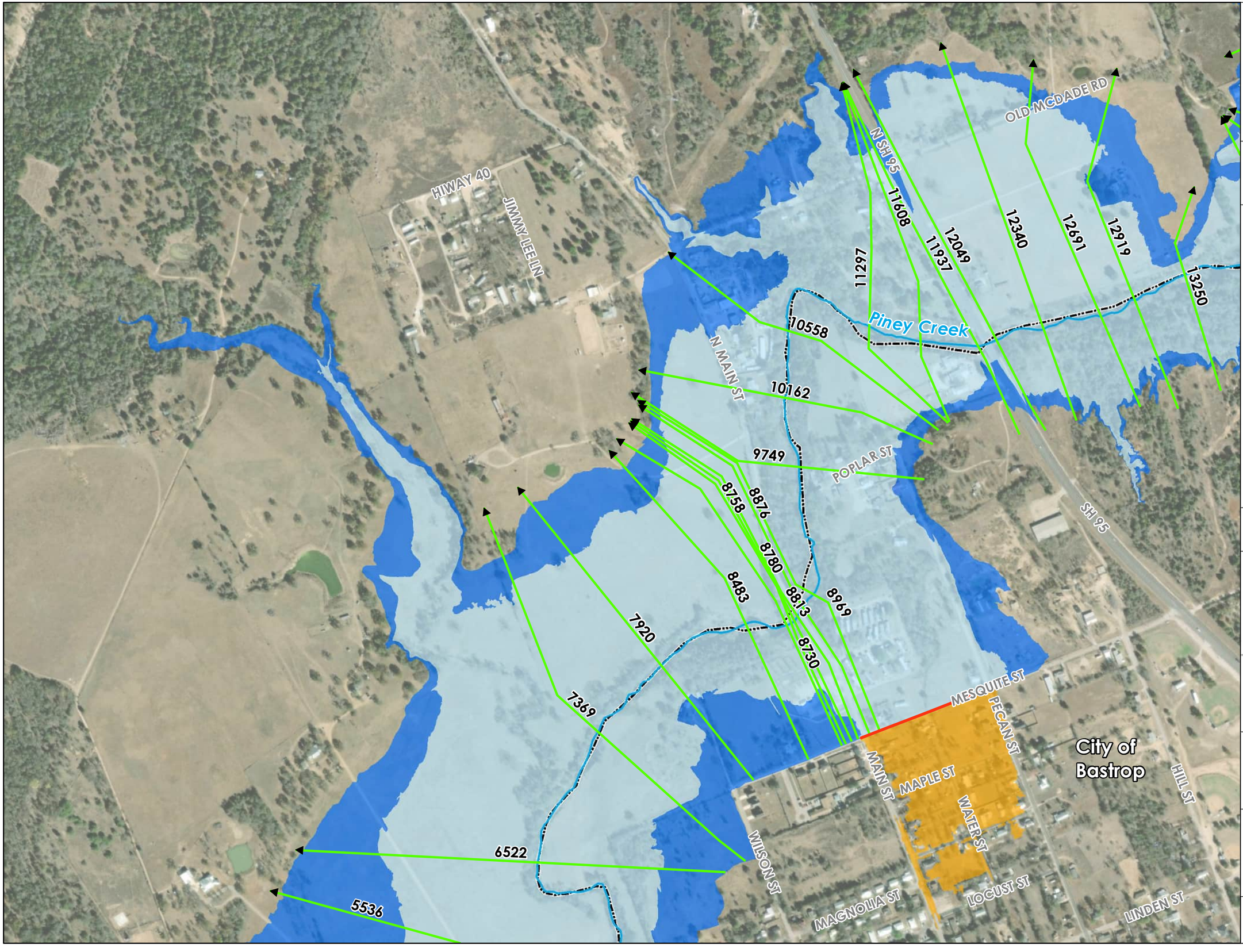


Exhibit 3.1
Piney Creek
Hydraulic Work Maps

N

0 500 1,000 Feet

halff



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Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Cross Section
- Limit of Study
- Railroad
- City Boundary

Atlas 14 Floodplains

- Shallow Flooding
- 1.0% ACE
- 0.2% ACE

Panel 2 of 3

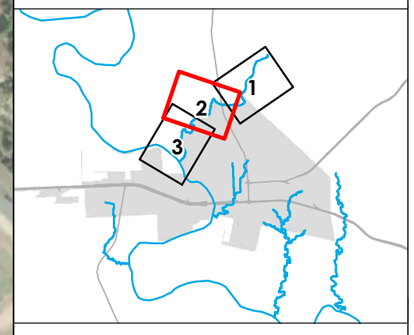

Exhibit 3.1
Piney Creek
Hydraulic Work Maps

N

0 500 1,000 Feet

halff

City of Bastrop Drainage Master Plan

- Stream Centerline
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- Railroad
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Atlas 14 Floodplains

- Shallow Flooding
- 1.0% ACE
- 0.2% ACE

Panel 3 of 3

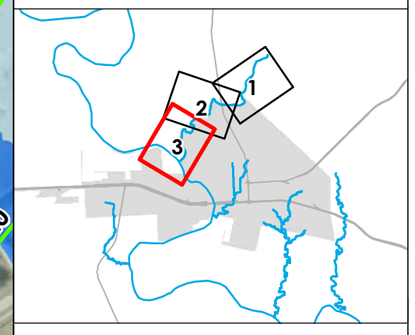

Exhibit 3.1
Piney Creek
Hydraulic Work Maps

N

0 500 1,000 Feet

halff

PATTON LN
N LORI CIR
ANNIKA WAY
BELINDA CT
CHARLES BLVD
NICOLE WAY
BLAIR AVE
SCHAEFER BLVD
ELIZABETH LN
REBECCA LN
HASLER SHORES DR
SHORELINE DR
MY ROAD
LOWER WOOD LN
RIVERWOOD DR
AL JONES ST
PHONES RD
REIDS BEND
Piney Creek
Colorado River
City of Bastrop
LINCOLN DR
BUSH CV
ROOSEVELT ST
GARFIELD ST
ELM ST
CARTER ST
JUNIPER ST
LAUREL ST
OAK ST
PERSIMMON ST
WILSON ST
VISTA WEST CT
PEA JAY CV
LINDEN ST
MAGNOLIA ST
MAIN ST
LOCUST ST
3631
2525
5334
5281
5536
6522
7369
7920
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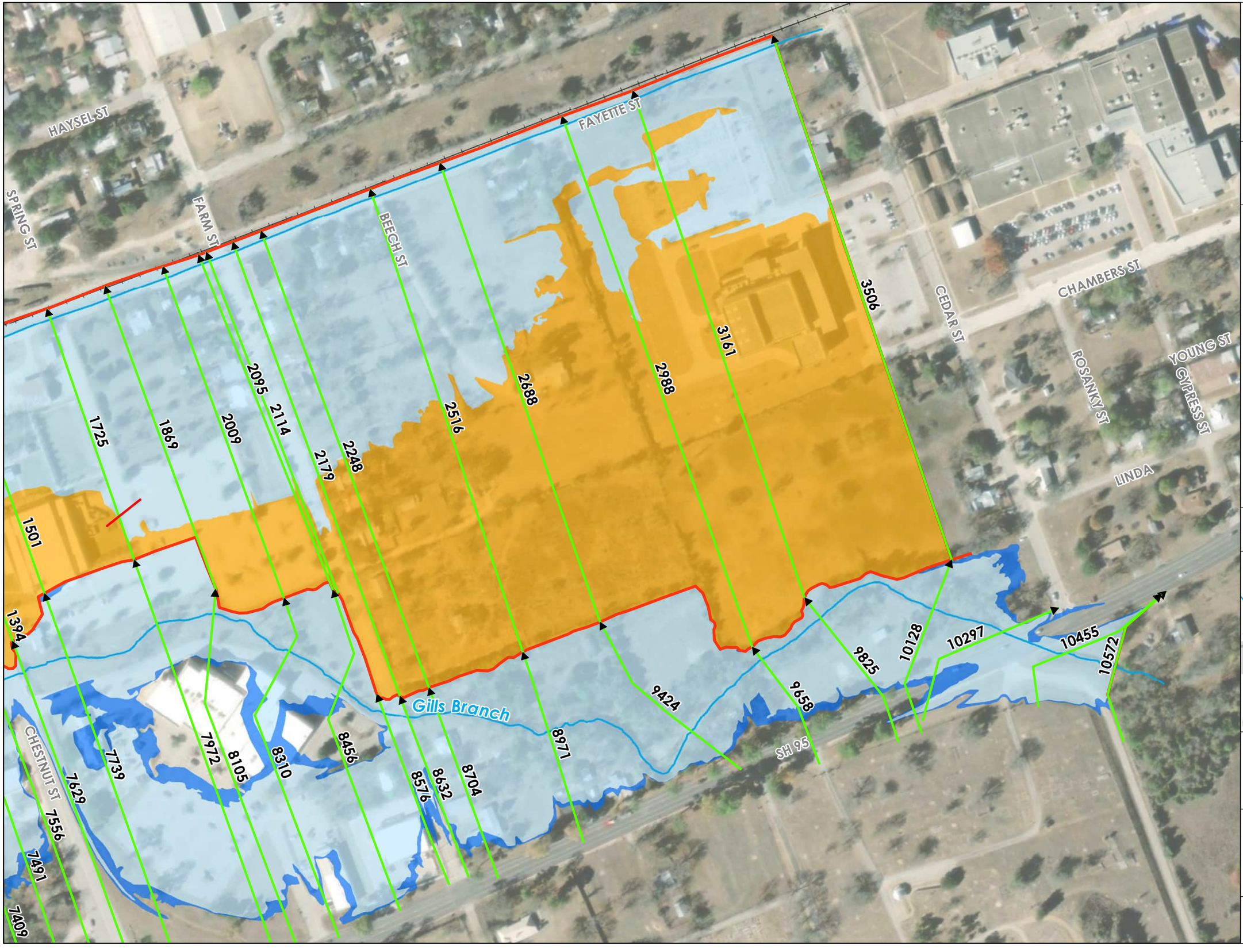
1288
1246
1308
1165
1226
931
809



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Cross Section
- Limit of Study
- Railroad
- City Boundary

Atlas 14 Floodplains

- Shallow Flooding
- 1.0% ACE
- 0.2% ACE

Panel 1 of 3

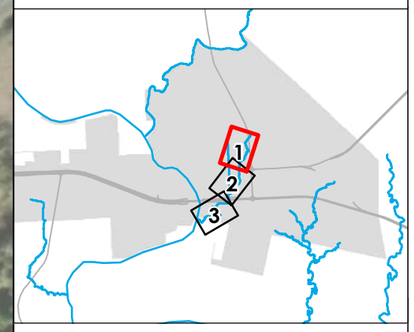
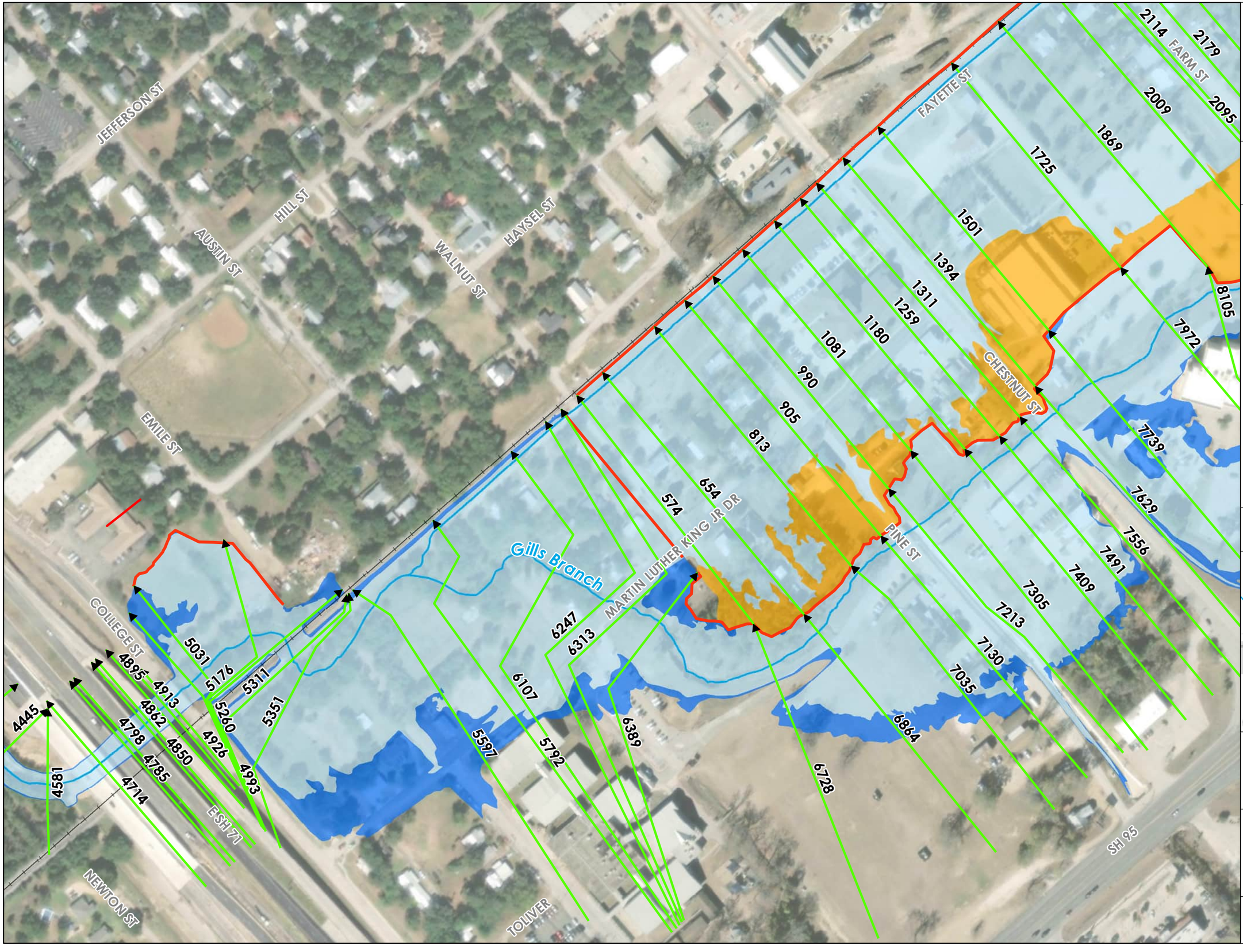


Exhibit 3.2
Gills Branch
Hydraulic Work Maps

N

0 200 400 Feet

halff



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Cross Section
- Limit of Study
- Railroad
- City Boundary

Atlas 14 Floodplains

- Shallow Flooding
- 1.0% ACE
- 0.2% ACE

Panel 2 of 3

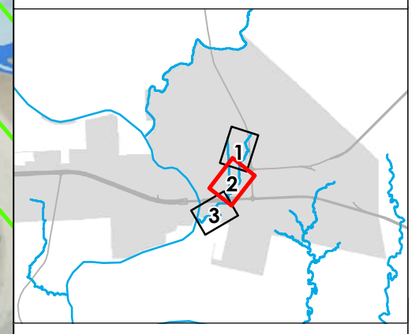


Exhibit 3.2
Gills Branch
Hydraulic Work Maps

N

0 200 400 Feet

halff

BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Cross Section
- Limit of Study
- Railroad
- City Boundary

Atlas 14 Floodplains

- Shallow Flooding
- 1.0% ACE
- 0.2% ACE

Panel 3 of 3

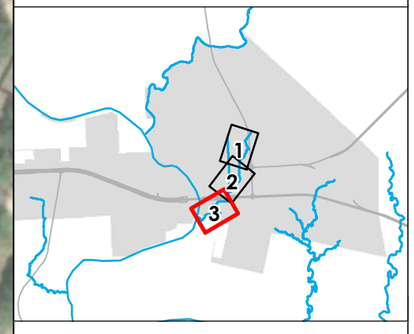


Exhibit 3.2
Gills Branch
Hydraulic Work Maps

N

0 200 400 Feet

halff

BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop
Drainage Master Plan

Stream Centerline
Cross Section
Limit of Study
City Boundary

Atlas 14 Floodplains

1.0% ACE

Panel 1 of 4

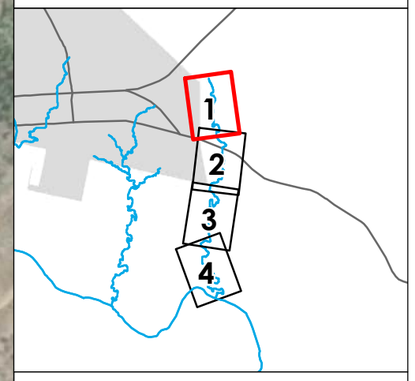


Exhibit 3.3
Copperas Creek
Hydraulic Workmap

N

0 300 600 Feet

halff

BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop
Drainage Master Plan

Stream Centerline

Cross Section

Limit of Study

City Boundary

Atlas 14 Floodplains

1.0% ACE

Panel 2 of 4

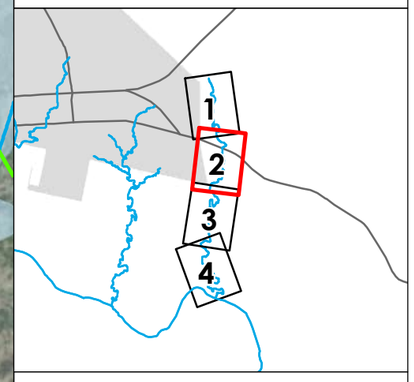


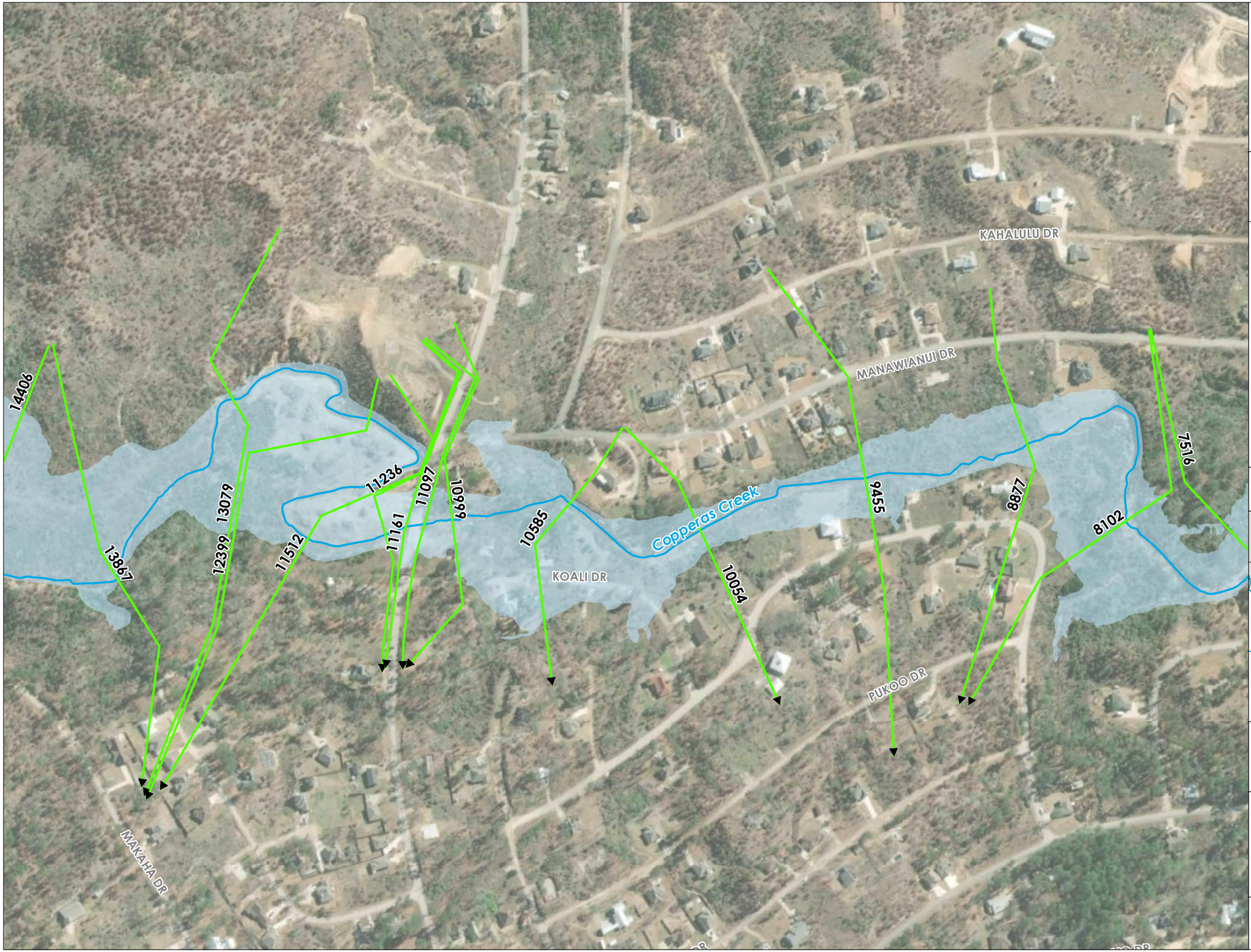
Exhibit 3.3
Copperas Creek
Hydraulic Workmap

N

0 300 600 Feet

halff

18791
18298
18144
18000
17891
17562
16438
15796
15105
13867
19311
18242
18485
17410
17103
14406
20030
20444
71
LANAI CT
ALOHA LN
Copperas Creek



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop
Drainage Master Plan

Stream Centerline

Cross Section

Limit of Study

City Boundary

Atlas 14 Floodplains

1.0% ACE

Panel 3 of 4

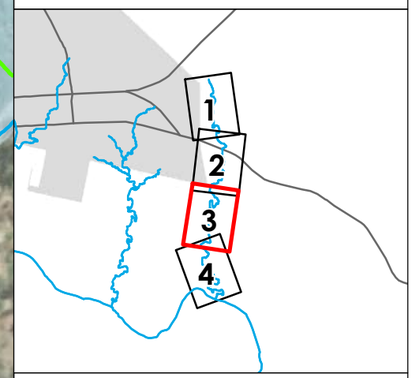


Exhibit 3.3
Copperas Creek
Hydraulic Workmap

N

0 300 600 Feet

halff

KAHALULU DR
TIMBER LN
KIPAHULU DR
ULUPAU CIR
Copperas Creek
Colorado River
8877
8102
7516
6761
6505
6095
5719
5374
5108
4744
4333
3941
3692
3153
2780
2510
1702
1042
395

BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

Stream Centerline
Cross Section
Limit of Study
City Boundary

Atlas 14 Floodplains

1.0% ACE

Panel 4 of 4

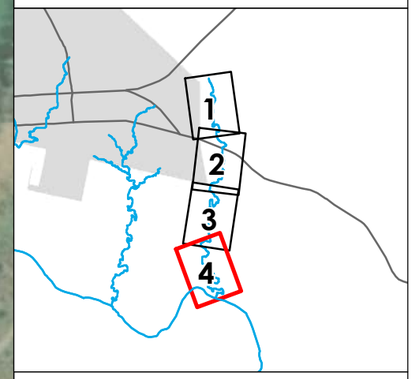
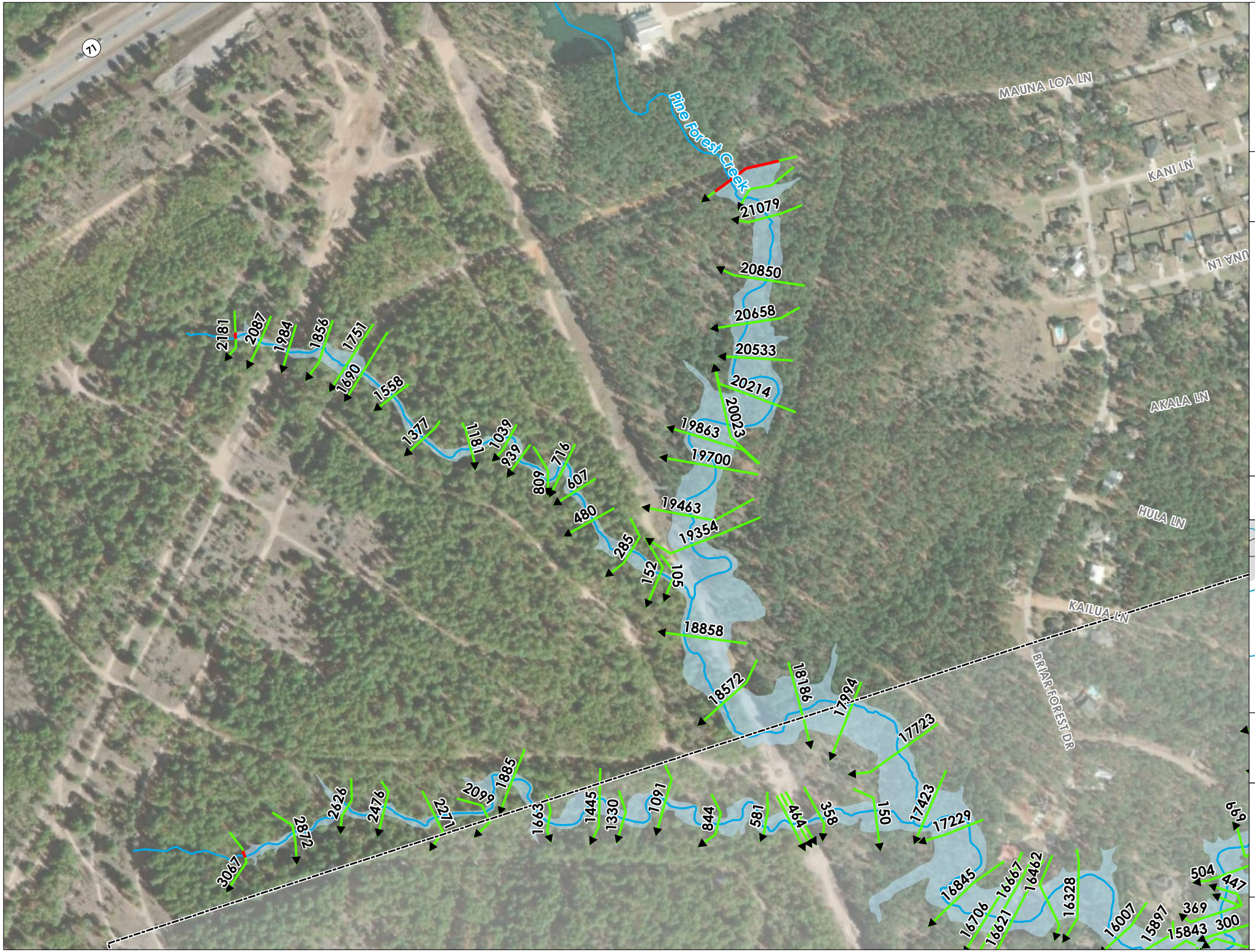


Exhibit 3.3
Copperas Creek
Hydraulic Workmap

N

0 300 600 Feet

halff



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Cross Section
- Limit of Study
- City Boundary

Atlas 14 Floodplains

- 1.0% ACE

Panel 1 of 3

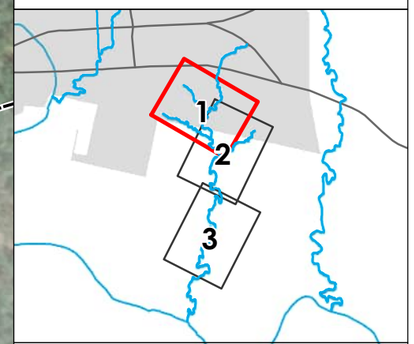
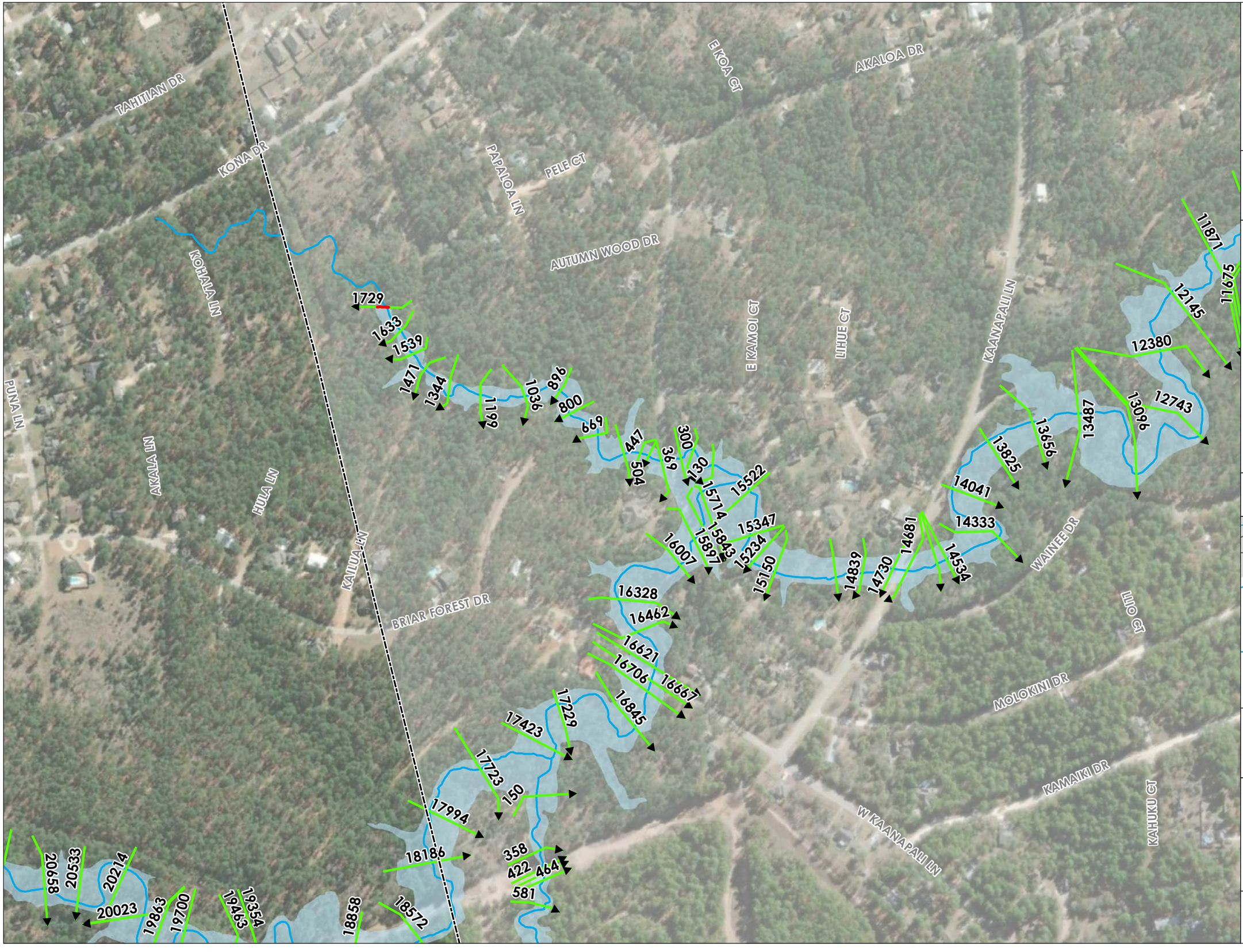


Exhibit 3.4
Pine Forest Creek
Hydraulic Work Maps

N

0 300 600 Feet

halff



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

Stream Centerline

Cross Section

Limit of Study

City Boundary

Atlas 14 Floodplains

1.0% ACE

Panel 2 of 3

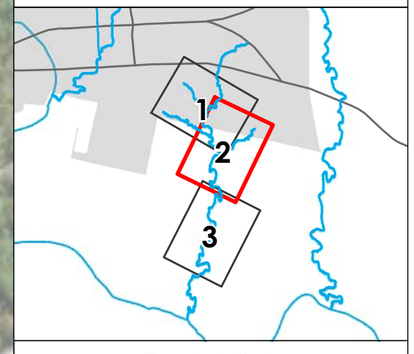
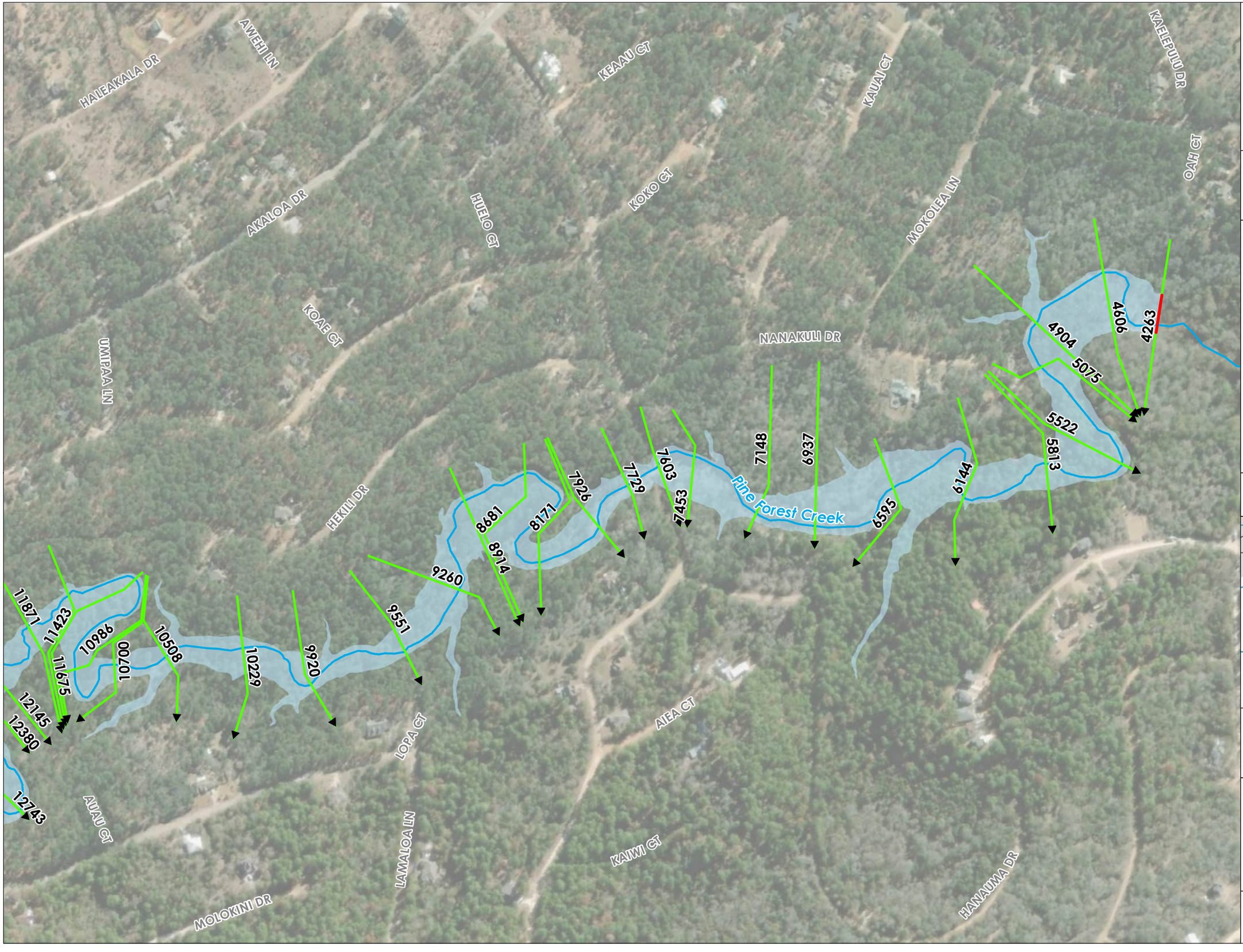


Exhibit 3.4
Pine Forest Creek
Hydraulic Work Maps

N

0 300 600 Feet

halff



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

Stream Centerline

Cross Section

Limit of Study

City Boundary

Atlas 14 Floodplains

1.0% ACE

Panel 3 of 3

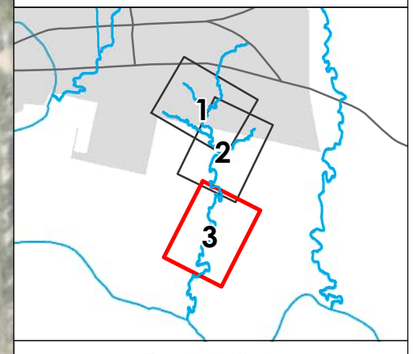
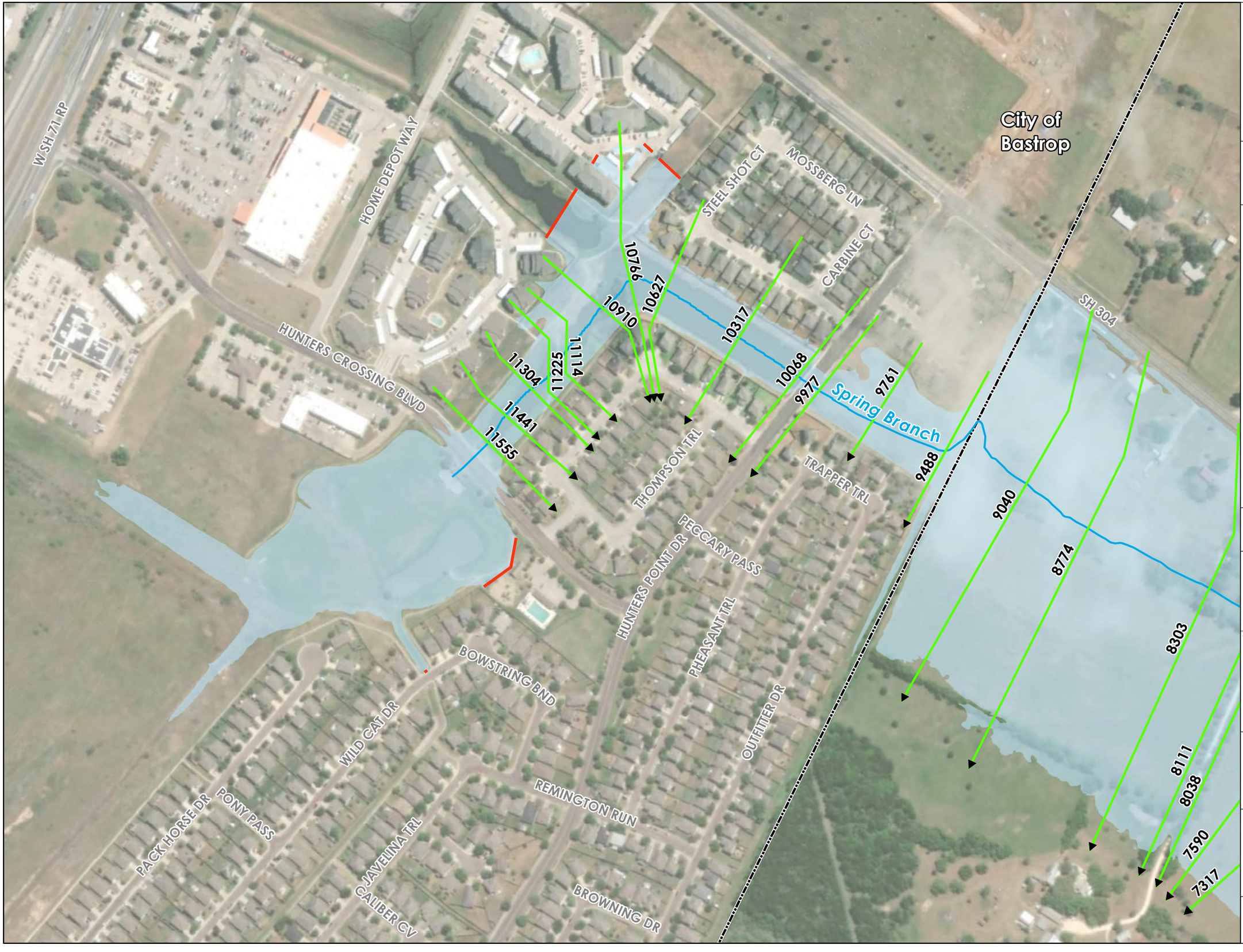


Exhibit 3.4
Pine Forest Creek
Hydraulic Work Maps

N

0 300 600 Feet

halff



City of Bastrop Drainage Master Plan

- Stream Centerline
- Cross Section
- Limit of Study
- City Boundary

Atlas 14 Floodplains

- 1.0% ACE

Panel 1 of 2

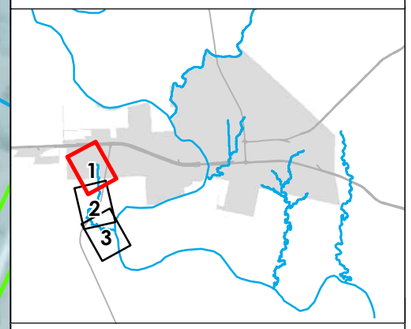
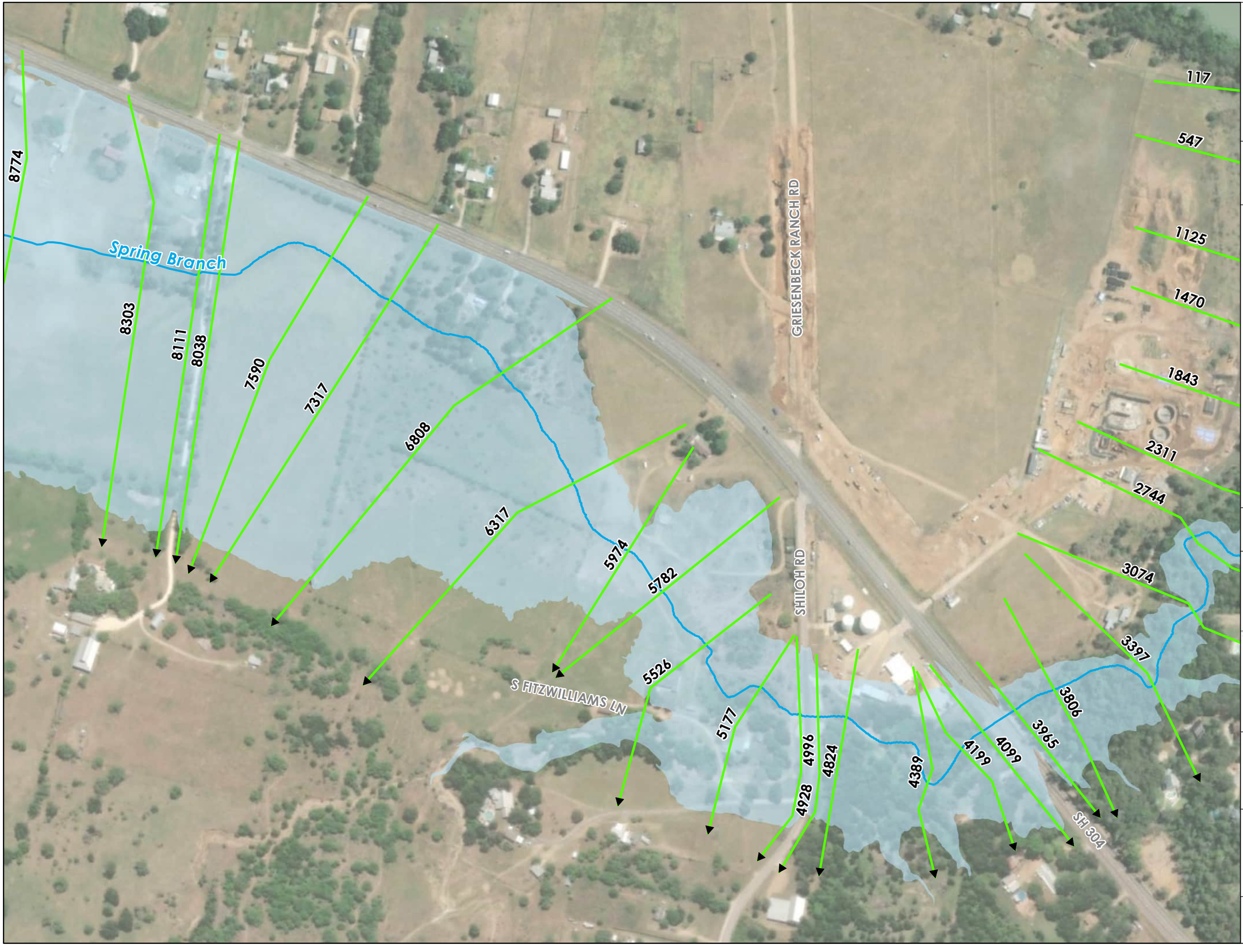


Exhibit 3.5
Spring Branch
Hydraulic Work Maps

N

0 300 600 Feet

halff



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Cross Section
- Limit of Study
- City Boundary

Atlas 14 Floodplains

- 1.0% ACE

Panel 2 of 2

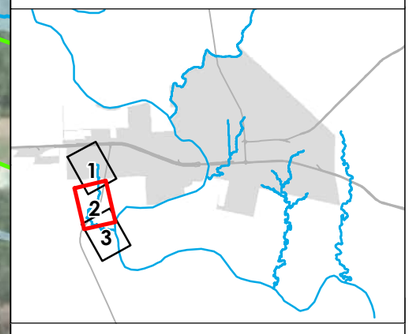


Exhibit 3.5
Spring Branch
Hydraulic Work Maps

N

0 300 600 Feet

halff

BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

Stream Centerline

Cross Section

Limit of Study

City Boundary

Atlas 14 Floodplains

1.0% ACE

Panel 3 of 2

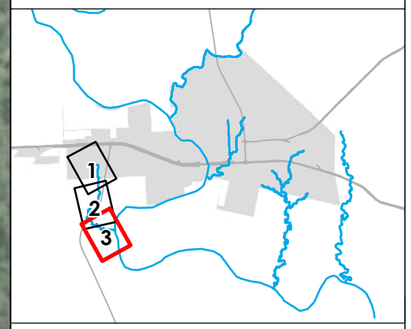
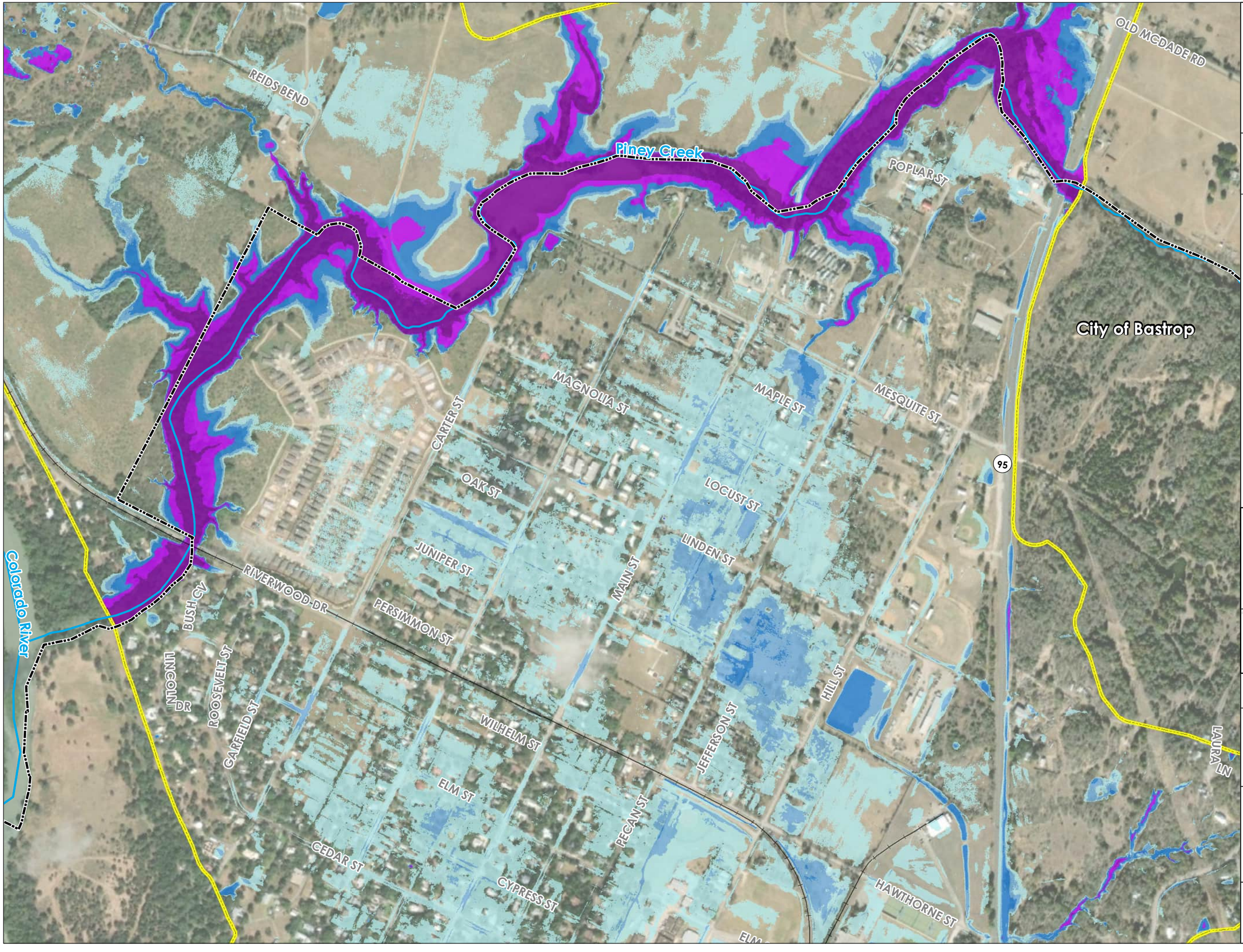


Exhibit 3.5
Spring Branch
Hydraulic Work Maps

N

0 300 600 Feet

halff



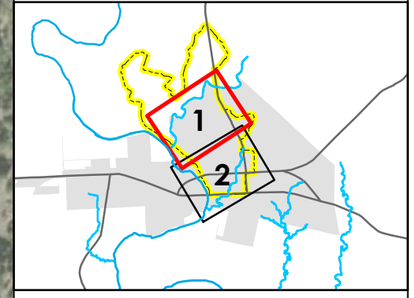
BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Railroad
- 2D StudyZone
- Bastrop City Limit

Local 4.0% ACE Flood Inundation

- 1 in - 1 ft
- 1 - 2 ft
- 2 - 5 ft
- 5 - 10 ft
- 10 - 17 ft



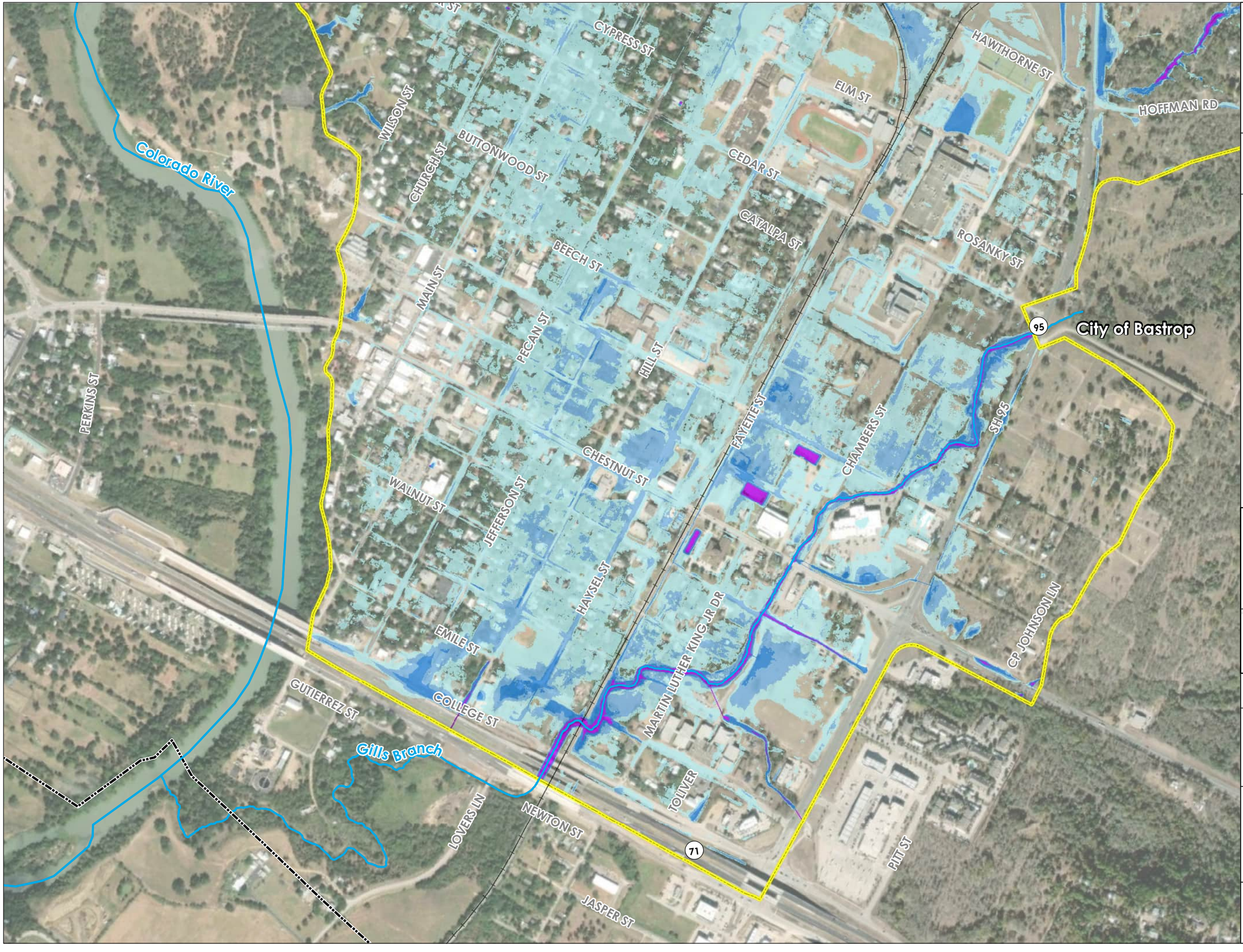
Panel 1 of 2

Exhibit 4.1
4.0% ACE
2D Rapid Assessment Results

N

0 600 1,200 Feet

halff



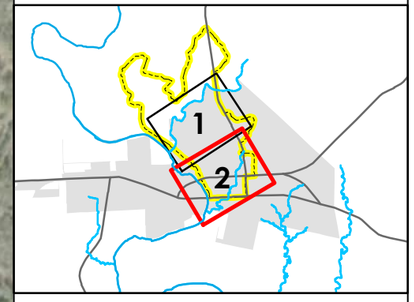
BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Railroad
- 2D StudyZone
- Bastrop City Limit

Local 4.0% ACE Flood Inundation

- 1 in - 1 ft
- 1 - 2 ft
- 2 - 5 ft
- 5 - 10 ft
- 10 - 17 ft



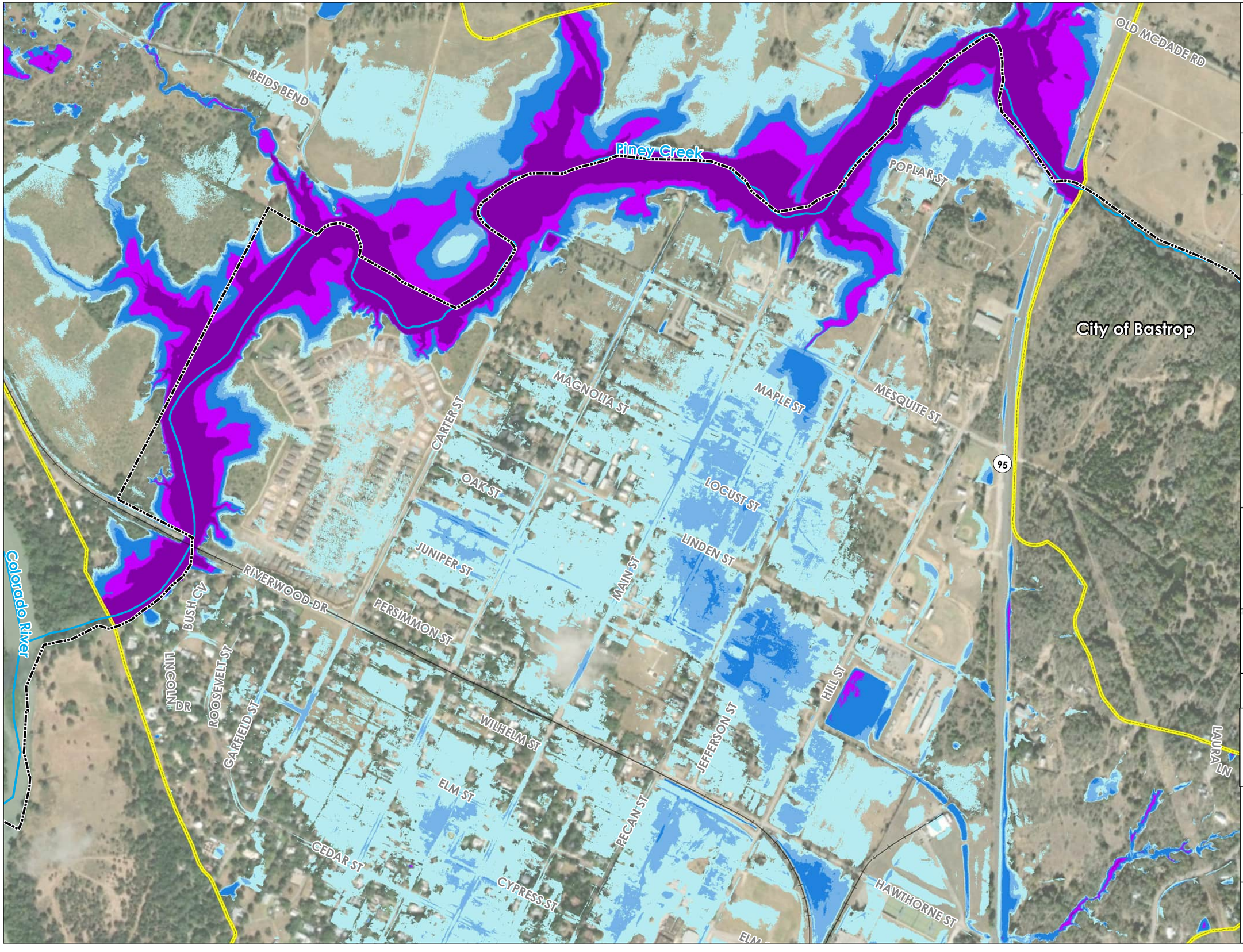
Panel 2 of 2

Exhibit 4.1
4.0% ACE
2D Rapid Assessment Results

N

0 600 1,200 Feet

halff



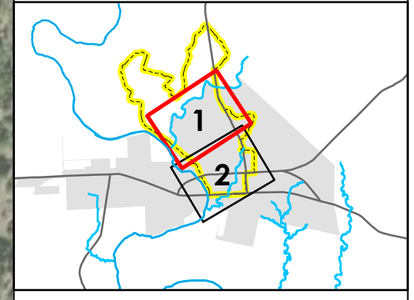
BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Railroad
- 2D StudyZone
- Bastrop City Limit

Local 1.0% ACE Flood Inundation

- 1 in - 1 ft
- 1 - 2 ft
- 2 - 5 ft
- 5 - 10 ft
- 10 - 30 ft



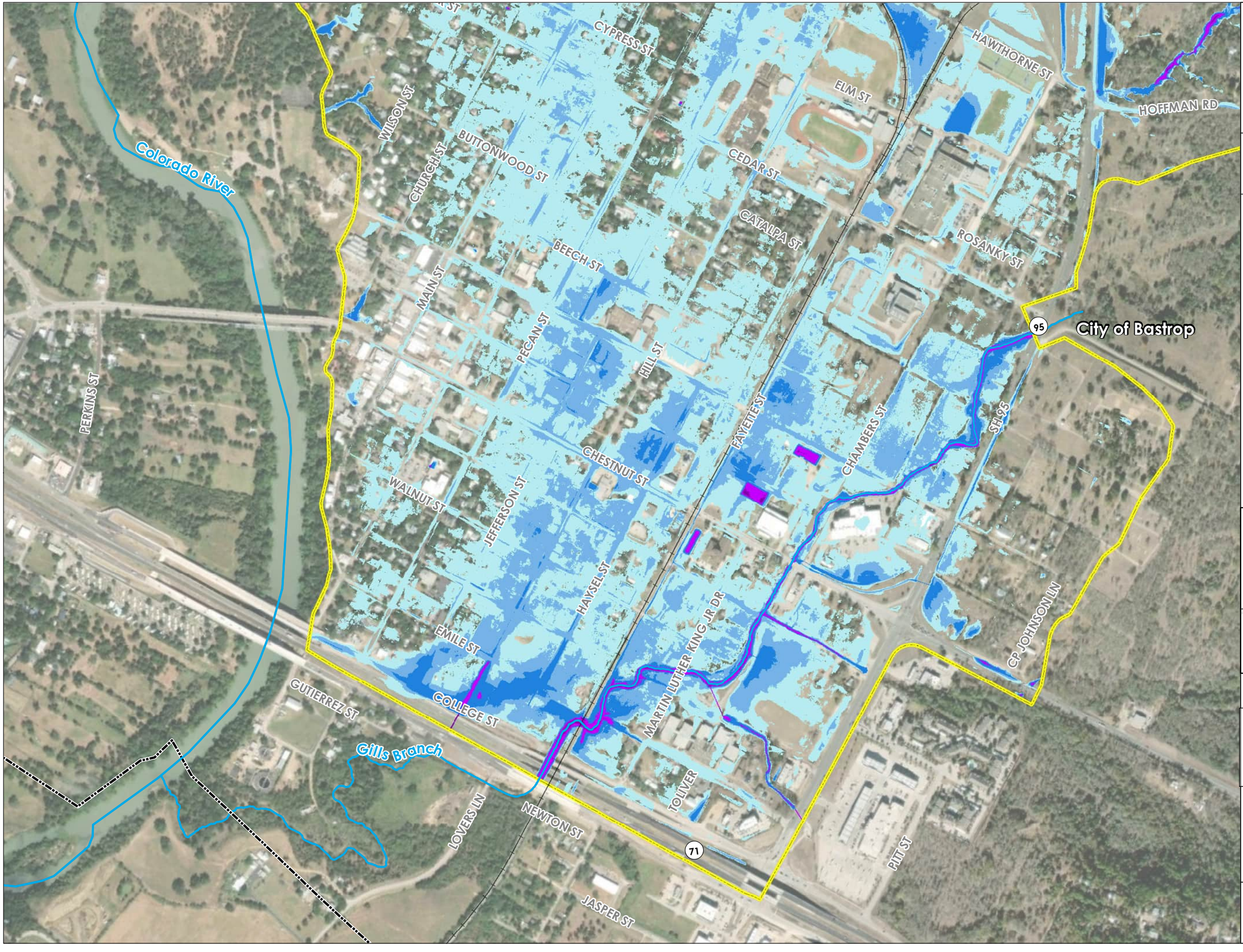
Panel 1 of 2

Exhibit 4.2
1.0% ACE
2D Rapid Assessment Results

N

0 600 1,200 Feet

halff



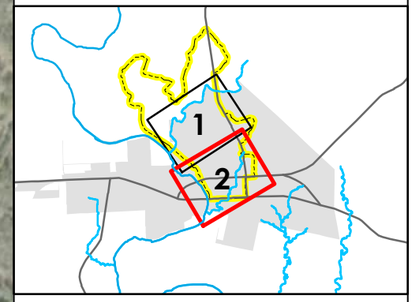
BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Railroad
- 2D StudyZone
- Bastrop City Limit

Local 1.0% ACE Flood Inundation

- 1 in - 1 ft
- 1 - 2 ft
- 2 - 5 ft
- 5 - 10 ft
- 10 - 30 ft



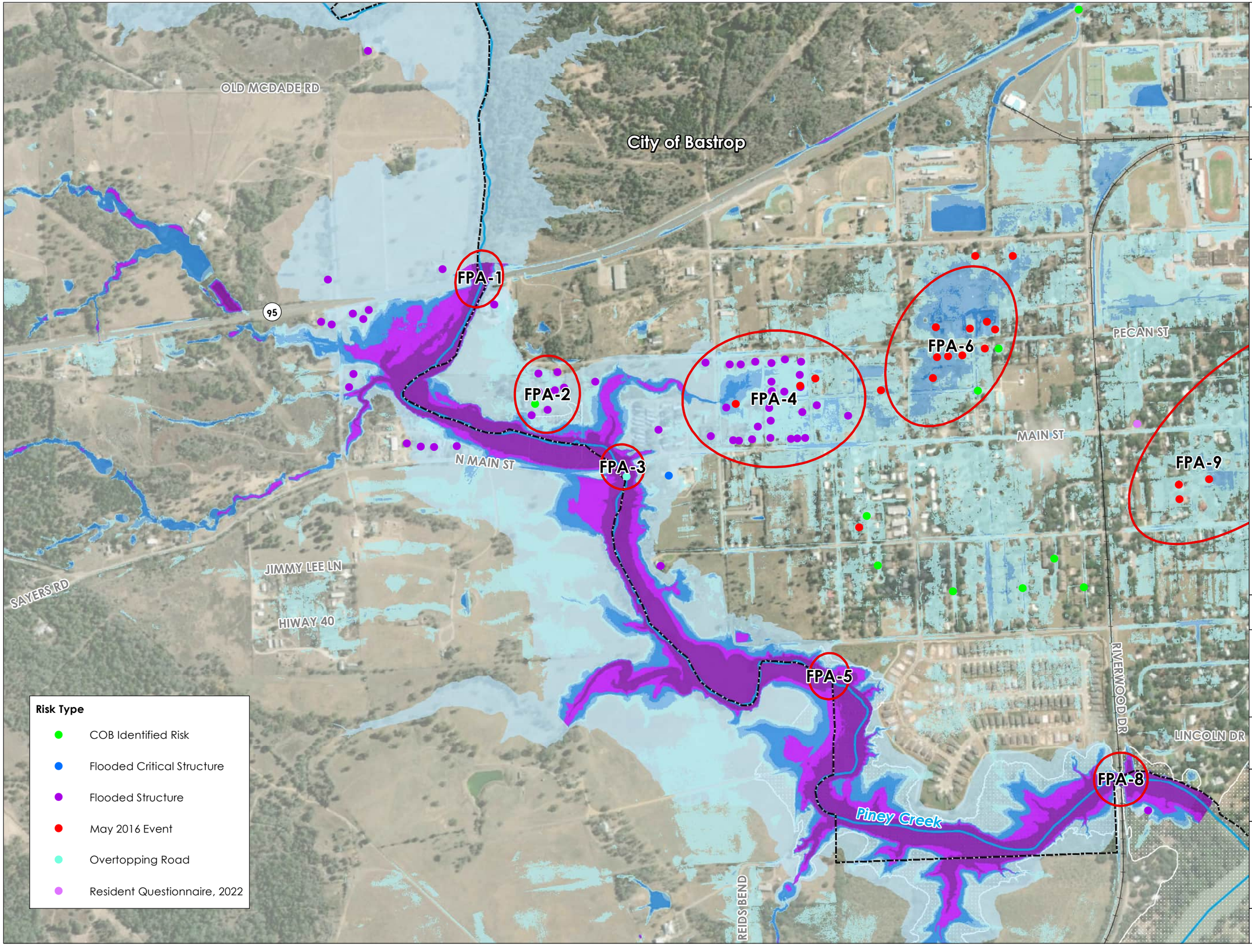
Panel 2 of 2

Exhibit 4.2
1.0% ACE
2D Rapid Assessment Results

N

0 600 1,200 Feet

halff



Risk Type

- COB Identified Risk
- Flooded Critical Structure
- Flooded Structure
- May 2016 Event
- Overtopping Road
- Resident Questionnaire, 2022

BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Railroad
- Flood Problem Area
- City Boundary

Local 4.0% ACE Flood Inundation

- 1 in - 1 ft
- 1 - 2 ft
- 2 - 5 ft
- 5 - 10 ft
- 10 - 17 ft

Atlas 14 Floodplains

- 1.0% ACE

FEMA Effective Floodplains

- 1.0% ACE

Panel 1 of 3

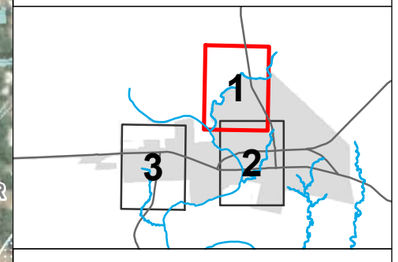
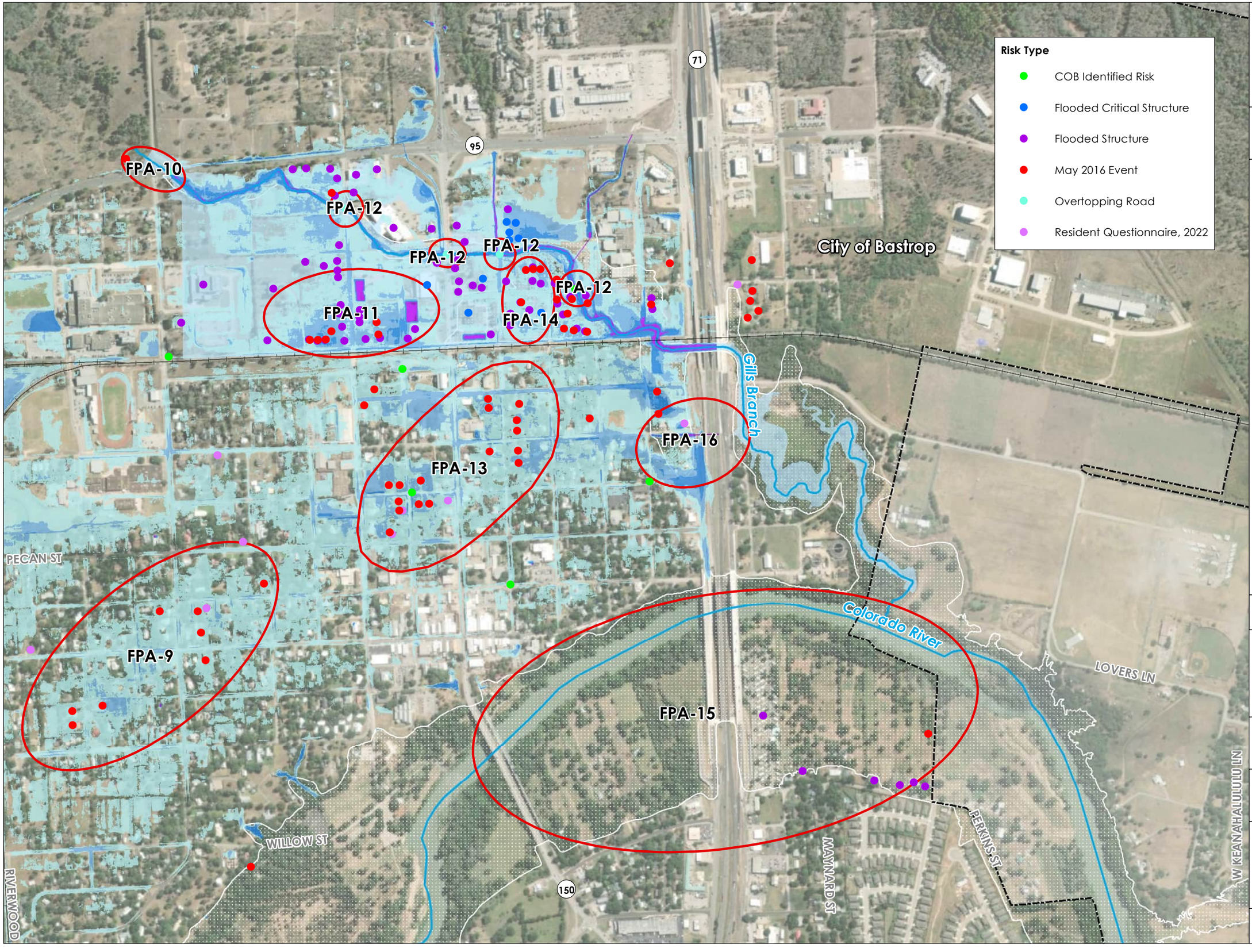


Exhibit 5
Flood Problem Areas

N

0 700 1,400 Feet

halff



Risk Type

- COB Identified Risk
- Flooded Critical Structure
- Flooded Structure
- May 2016 Event
- Overtopping Road
- Resident Questionnaire, 2022

BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Railroad
- Flood Problem Area
- City Boundary

Local 4.0% ACE Flood Inundation

- 1 in - 1 ft
- 1 - 2 ft
- 2 - 5 ft
- 5 - 10 ft
- 10 - 17 ft

Atlas 14 Floodplains

- 1.0% ACE

FEMA Effective Floodplains

- 1.0% ACE

Panel 2 of 3

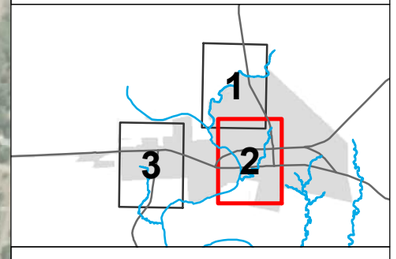
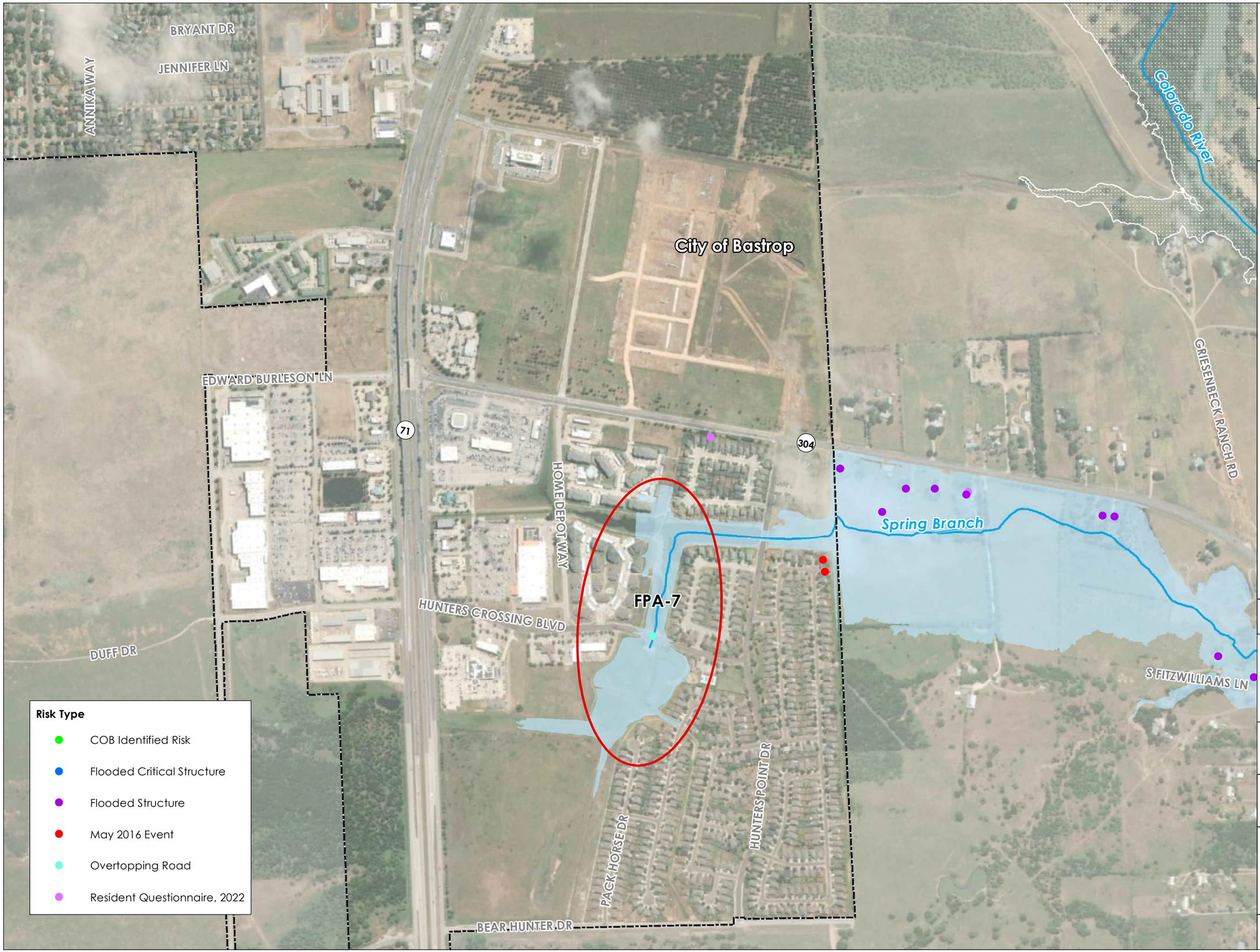


Exhibit 5
Flood Problem Areas

N

0 700 1,400 Feet

halff



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

Stream Centerline

Railroad

Flood Problem Area

City Boundary

Local 4.0% ACE Flood Inundation

1 in - 1 ft

1 - 2 ft

2 - 5 ft

5 - 10 ft

10 - 17 ft

Atlas 14 Floodplains

1.0% ACE

FEMA Effective Floodplains

1.0% ACE

Panel 3 of 3

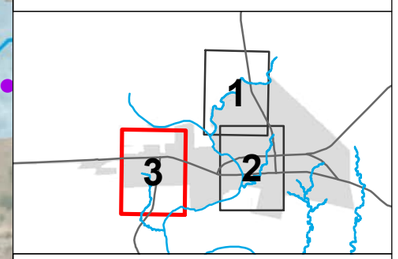
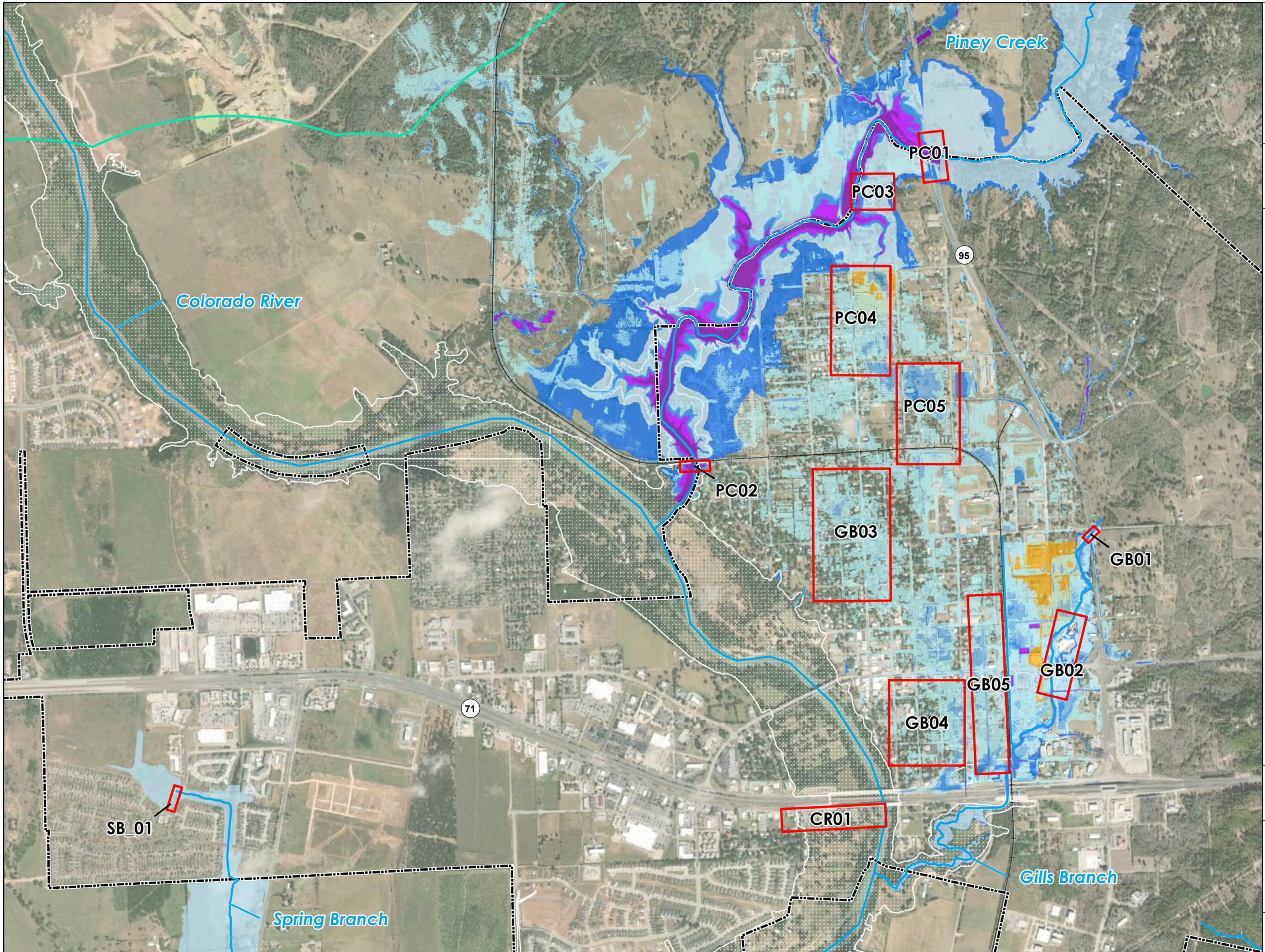


Exhibit 5
Flood Problem Areas

N

0 700 1,400 Feet

halff



BASTROPTX
Heart of the Lost Pines
Est. 1832

City of Bastrop Drainage Master Plan

- Stream Centerline
- Railroad
- CIP Project Location
- City Boundary
- City 1-Mile ETJ

Local 4.0% ACE Flood Inundation

- 1 in - 1 ft
- 1 - 2 ft
- 2 - 5 ft
- 5 - 10 ft
- 10 - 17 ft

Atlas 14 Floodplains

- Shallow Flooding
- 1.0% ACE
- 0.2% ACE

FEMA Effective Floodplains

- 1.0% ACE

Exhibit 6
CIP Projects

N

0 1,500 3,000 Feet

halff

Appendix A

Public Meeting Questionnaire Results

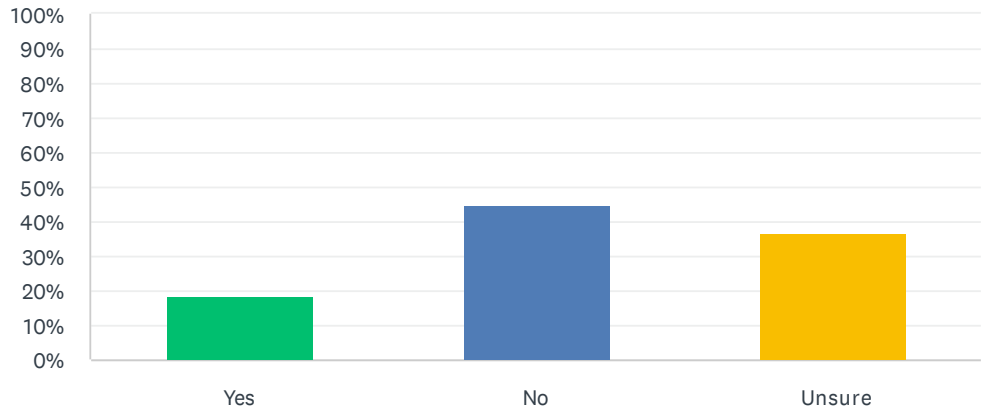
Q1 Contact Information

Answered: 84 Skipped: 0

ANSWER CHOICES	RESPONSES	
Name:	100.00%	84
Company	0.00%	0
Address:	100.00%	84
How long have you lived at this property?	100.00%	84
City/Town	0.00%	0
State/Province	0.00%	0
ZIP/Postal Code	0.00%	0
Country	0.00%	0
Email/Phone:	100.00%	84
Phone Number	0.00%	0

Q2 Is your residence within the FEMA regulated floodplain? Enter your address in the following link to view the National FEMA Flood Hazard Areas. (National Flood Hazard Layer Website)

Answered: 38 Skipped: 46



ANSWER CHOICES	RESPONSES	
Yes	18.42%	7
No	44.74%	17
Unsure	36.84%	14
TOTAL		38

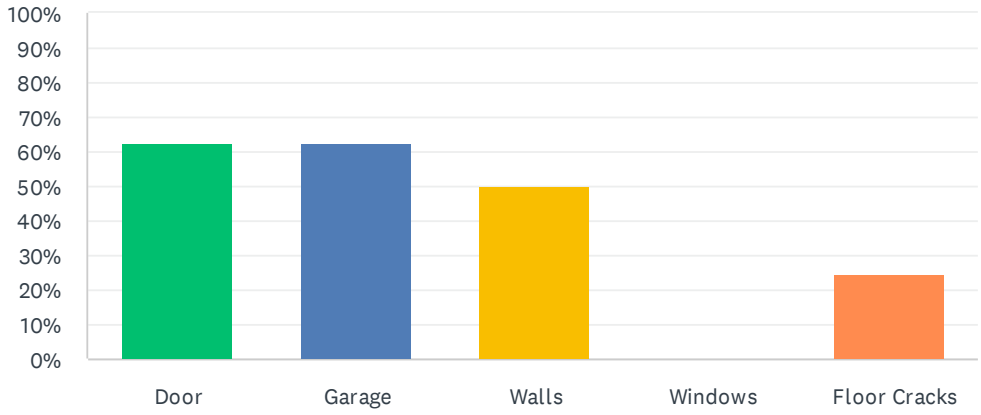
Q3 Please indicate to the best of your knowledge the dates, depths and location (i.e. house, yard, street, crawl space) of flooding that has occurred at your address.

Answered: 25 Skipped: 59

ANSWER CHOICES	RESPONSES	
Occurrence 1:	100.00%	25
Occurrence 2:	44.00%	11
Occurrence 3:	20.00%	5

Q4 Where is water entering your home?

Answered: 8 Skipped: 76



ANSWER CHOICES	RESPONSES	
Door	62.50%	5
Garage	62.50%	5
Walls	50.00%	4
Windows	0.00%	0
Floor Cracks	25.00%	2
Total Respondents: 8		

Q5 Please provide any other observations or comments you have relating to flooding or general storm drainage issues in your area including any street flooding with estimated duration of flooding.

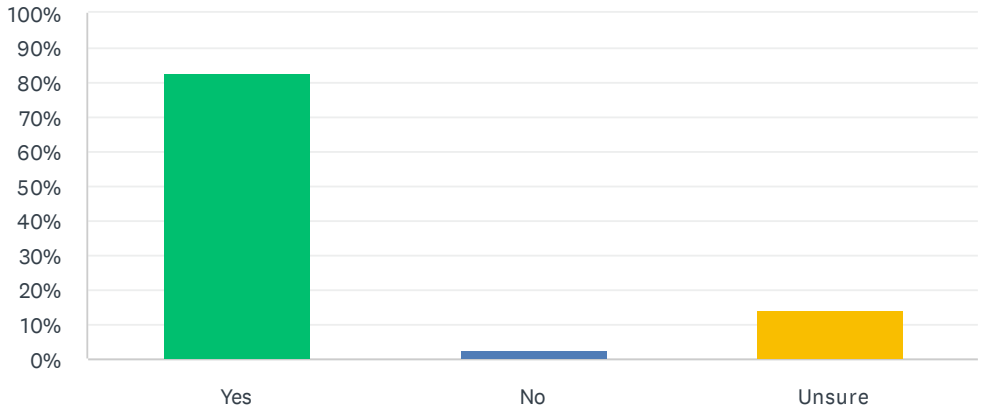
Answered: 23 Skipped: 61

Q6 Photos are also helpful. Do you have photos or videos from the flooding you would like to provide? Please upload your photos and videos below. You can also send them to Marita Moya by email at marita.moya@halff.com.

Answered: 4 Skipped: 80

Q7 Do you think the City needs to fund Stormwater and Drainage activities?

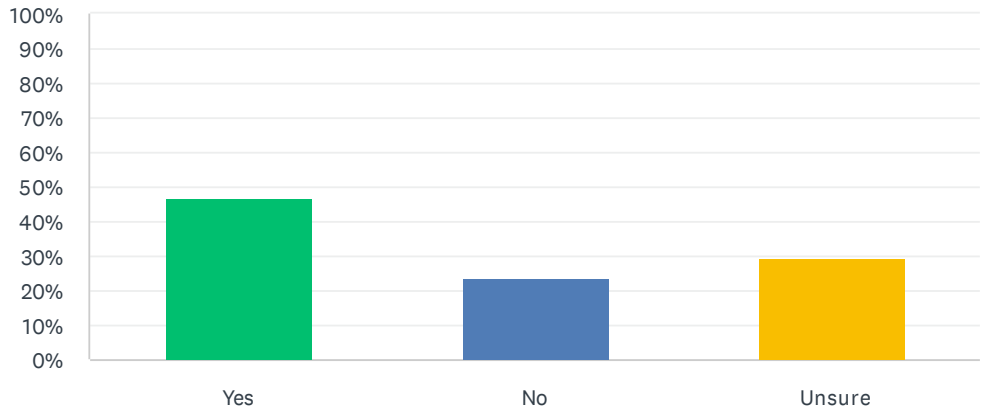
Answered: 35 Skipped: 49



ANSWER CHOICES	RESPONSES	
Yes	82.86%	29
No	2.86%	1
Unsure	14.29%	5
TOTAL		35

Q8 Do you agree in principle, that a user fee that directly relates a drainage fee to the relative stormwater runoff is a good way for the City to fund or partially fund stormwater and drainage infrastructure? To clarify with a simple parking lot example, a commercial property with parking for 40 cars could generate 4 times more runoff than a parking lot for 10 cars so the fee would also be 4 times more.

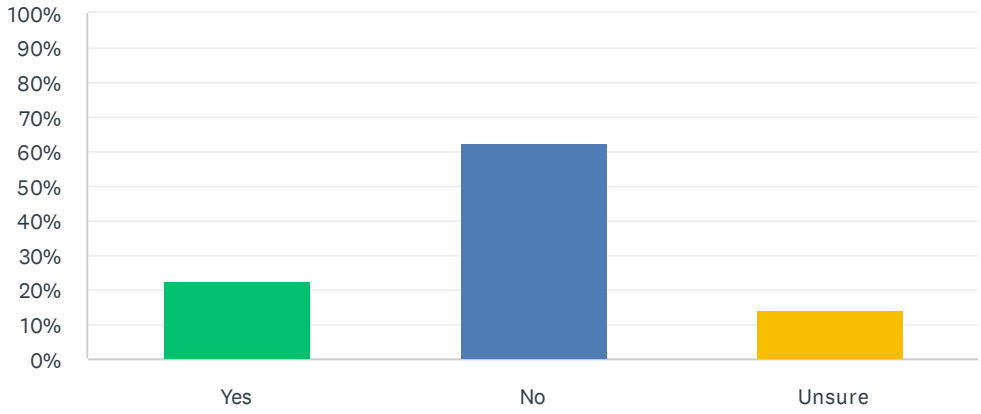
Answered: 34 Skipped: 50



ANSWER CHOICES	RESPONSES	
Yes	47.06%	16
No	23.53%	8
Unsure	29.41%	10
TOTAL		34

Q9 Would you favor additional property taxes as the primary means to fund or partially fund stormwater and drainage infrastructure?

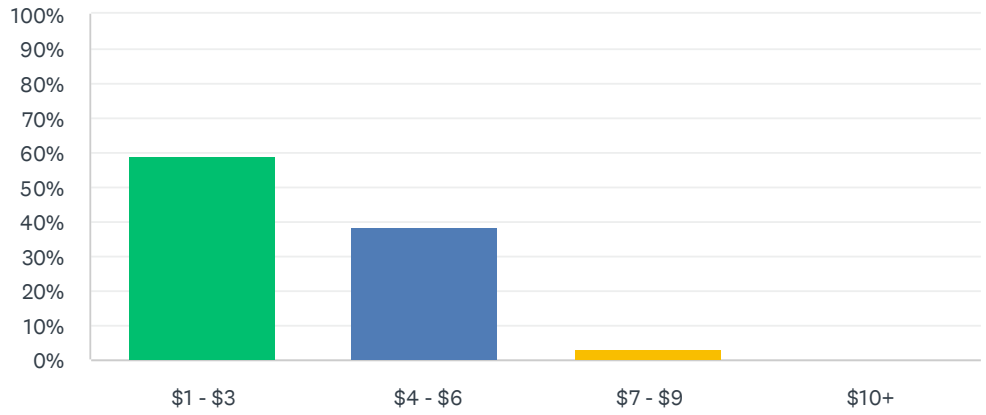
Answered: 35 Skipped: 49



ANSWER CHOICES	RESPONSES	
Yes	22.86%	8
No	62.86%	22
Unsure	14.29%	5
TOTAL		35

Q10 What do you consider a reasonable cost for a stormwater fee knowing the average fee for comparison communities is approximately $5.50 per month?

Answered: 34 Skipped: 50



ANSWER CHOICES	RESPONSES	
$1 - $3	58.82%	20
$4 - $6	38.24%	13
$7 - $9	2.94%	1
$10+	0.00%	0
TOTAL		34

Appendix B

Drainage CIP Project Summary Sheets & Probable Cost Estimate

halff

BASTROPTX
Heart of the Lost Pines / Est. 1832

CITY OF BASTROP DRAINAGE MASTER PLAN

GB-01 SH-95 at Gills Branch

PROJECT DESCRIPTION:

State Highway 95 becomes flooded by Gills Branch during the 10% ACE storm event. In order to alleviate flooding for the 4% ACE storm event, two (2) additional 8'x 8' culverts will be added to the existing 3 - 8'x 8' culverts.

In order to reduce roadway overtopping during the 1% ACE storm event, the Gills Branch Flood Mitigation Improvement project (GB-02) will need be implemented downstream of SH 95.

BENEFITS

- Provides 4% ACE protection from roadway overtopping

CHALLENGES

- Requires implementation of the Gills Branch Flood Mitigation Improvement projects to provide protection during the 1% ACE storm event
- Project requires coordination with TxDOT

QUICK FACTS:

- Project Score: **71.7**
- Additional 2 – 8' x 8' box culverts
- Provide 25-year protection
- 1% ACE protection requires Gills Branch Improvements (GB-02)

PROJECT COST ESTIMATE (2022):

Road Improvements:	**$ 43,000**
Culvert Cost:	**$ 222,000**
Headwall Costs:	**$ 11,000**
Other Costs:	**$ 186,000**
Total Cost Estimate:	**$ 688,000**

Project: GB-01 SH-95 Culvert Expansion

Stream: Gills Branch

Engineer's Estimate of Probable Construction Cost

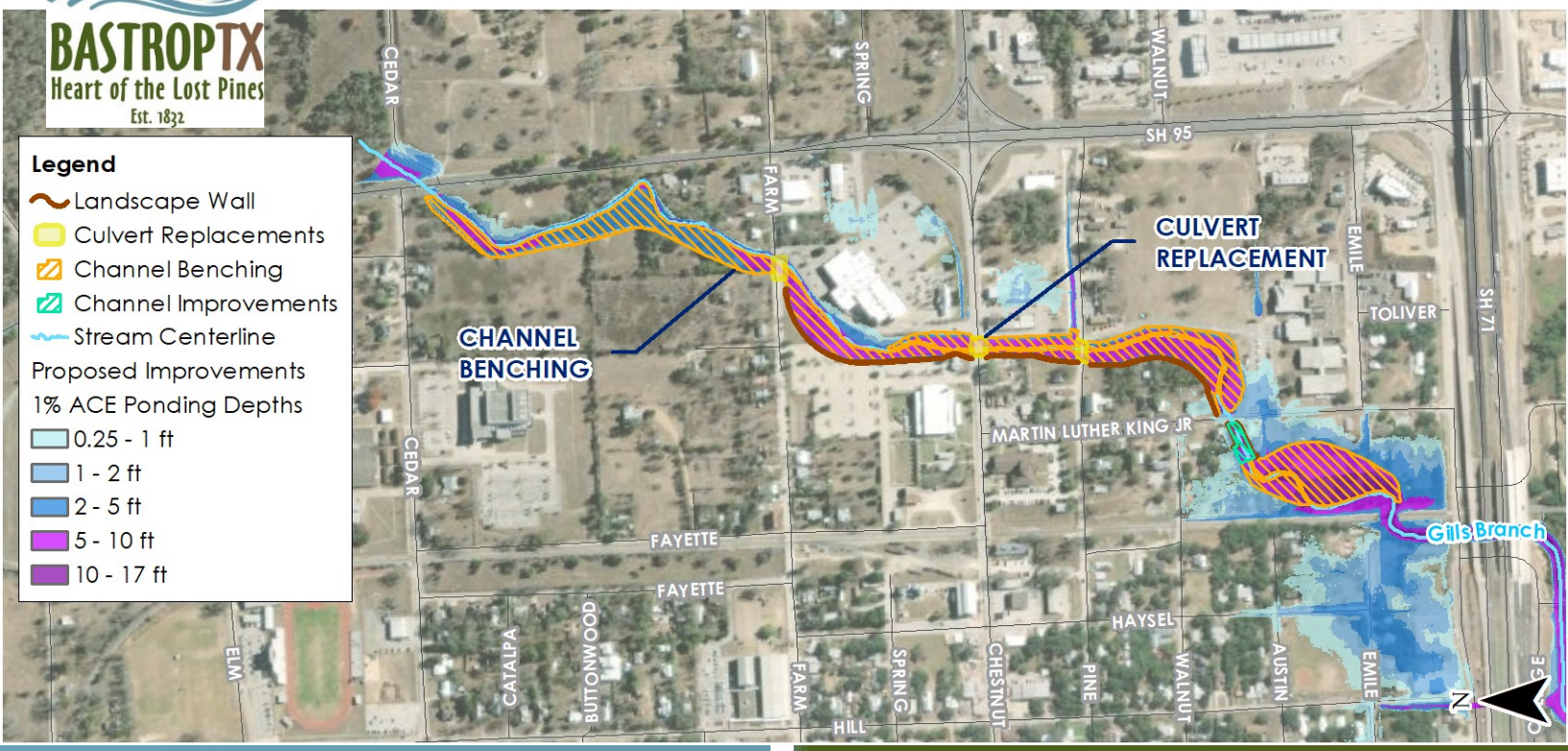
Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	LS	$5,000	1	$5,000
2	EXCAVATION (ROADWAY)	CY	$20	414	$8,284
3	BROADCAST SEED (PERM) (URBAN) (CLAY)	SY	$1	193	$193
3	COMPOST MANUF TOPSOIL (4")	SY	$5	193	$966
4	CUT & RESTORING PAV	SY	$113	304	$34,335
5	CONC BOX CULV (8 FT X 8 FT)	LF	$900	246	$221,400
6	CL C CONC (HEADWALL)	CY	$1,028	10	$10,277
7	REMOV STR (HEADWALL)	EA	$2,000	2	$4,000
8	UTILITY ADJUSTMENT / RELOCATION (5%)	LS	$14,200	1	$14,200
8	TRAFFIC CONTROL (1%)	LS	$2,800	1	$2,800
9	EROSION AND SEDIMENT CONTROL (10%)	LS	$28,400	1	$28,400
10	MOBILIZATION (10%)	LS	$28,400	1	$28,400
				PROJECT SUBTOTAL	**$358,300**
				40% CONTINGENCY	$143,400
				BASE TOTAL	$501,700
				Environmental Permitting (3%)	$15,100
				Engineering Design (12%)	$60,300
				Construction Administrative Services (5%)	$25,100
				Construction Inspection (10%)	$50,200
				Construction Material Testing (7%)	$35,200
				PROJECT TOTAL	**$687,600**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be held liable to Owner or third party for any failure to accurately estimate the cost of the project, or any part thereof. Unit prices are in current dollars and should be adjusted as required when letting schedule for project is determined.

CITY OF BASTROP DRAINAGE MASTER PLAN

GB-02 Gills Branch Flood Mitigation Improvements



PROJECT DESCRIPTION:

Gills Branch is unable to convey contributing flood waters within the channel banks for storm events as frequent as the 10% ACE event. Overflows from Gills Branch flood residential and commercial properties in the downtown area. The proposed flood mitigation improvements include channel benching, channel improvements, and creek crossing improvements to increase channel conveyance up to 1% ACE event and reducing creek flooding. Three creek crossings will be improved where the existing culverts will be replaced with slab beam bridges. Channel benching and improvements will begin upstream of the UPRR and end downstream of SH 95. The design also includes proposed landscaped wall, slope regrading, and bank stabilization.

BENEFITS

- 1% ACE future fully developed flows are contained within channel banks
- Increased level of services for Farm, Chestnut, and Pine St crossings
- 120 acres removed from 1% ACE floodplain, removing approximately 200 structures from riverine inundation

CHALLENGES

- Operation and maintenance needs to be conducted by the City to maintain design function
- Utility conflicts—some private utilities require City coordination with private enterprise

QUICK FACTS:

- Project Score: **73.3**
- **5,000** linear feet of channel benching
- **3** creek crossing improvements
- **120** acres removed from floodplain

PROJECT COST ESTIMATE (2022):

Channel Improvements:	**$ 2.79 M**
Bridge & Roadway:	**$ 1.64 M**
Removal Costs:	**$ 1.24 M**
Erosion Control:	**$ 1.10 M**
Land Acquisition	**$ 4.27 M**
Misc. & Other Costs:	**$3.01 M**
Total Cost Estimate:	**$ 14.05 M**

GILLS BRANCH FLOOD MITIGATION IMPROVEMENTS
PROBABLE PROJECT COST ESTIMATE

halff

DATE: 4/22/2022
PREPARED BY: HALFF ASSOCIATES
HA PROJ. NO.: 35510.002

REMOVAL

SPEC. NO.	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	SUB-TOTALS
100 6001	PREPARING ROW	AC	21	$13,200.00	$270,600
100 46001	TREE PROTECTION	EA	28	$715.00	$20,020
105 6015	REMOVING STAB BASE & ASPH PAV (8"-10")	SY	1,846	$17.00	$31,382
104 6001	REMOVING CONC (PAV)	SY	2,897	$6.00	$17,382
104 6009	REMOVING CONC (RIPRAP)	SY	819	$12.00	$9,828
104 6011	REMOVING CONC (MEDIANS)	SY	261	$15.00	$3,915
104 6029	REMOVING CONC (CURB OR CURB & GUTTER)	LF	1,198	$27.00	$32,346
104 6036	REMOVING CONC (SIDEWALK OR RAMP)	SY	183	$22.00	$4,026
496 6007	REMOV STR (PIPE)	LF	653	$19.00	$12,407
496 6006	REMOV STR (HEADWALL)	EA	7	$2,000.00	$14,000
496 6005	REMOV STR (WINGWALL)	EA	5	$1,400.00	$7,000
496 6043	REMOV STR (SMALL FENCE)	LF	1,403	$5.00	$7,015
496 6087	REMOV STR (DRAINAGE FLUME)	EA	1	$1,100.00	$1,100
496 6010	REMOV STR (BRIDGE CLASS CULVERT)	EA	3	$97,500.00	$292,500
496 6002	REMOV STR (INLET)	EA	2	$825.00	$1,650
752 6005	TREE REMOVAL (4" - 12" DIA)	EA	168	$1,400.00	$235,200
752 6006	TREE REMOVAL (12" - 18" DIA)	EA	80	$2,750.00	$220,000
752 6007	TREE REMOVAL (18" - 24" DIA)	EA	14	$2,000.00	$28,000
752 6008	TREE REMOVAL (24" - 30" DIA)	EA	7	$2,700.00	$18,900
752 6010	TREE REMOVAL (36" - 42" DIA)	EA	4	$3,000.00	$12,000
				SUBTOTAL REMOVAL	$1,239,271

CHANNEL IMPROVEMENTS

SPEC. NO.	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	SUB-TOTALS
110 6002	EXCAVATION (CHANNEL)	CY	79,420	$20.00	$1,588,400
132 6003	EMBANKMENT (FINAL)(ORD COMP)(TY B)	CY	447	$20.00	$8,944
407 6019	SHEET PILE (PZC - 18)	SF	7,310	$50.00	$365,500
420 6082	SHEET PILE - CL F CONC (CAP)	CY	45	$900.00	$40,500
450	SHEET PILE - PEDESTRIAN RAIL	LF	288	$105.00	$30,240
04 85 20	LANDSCAPE WALL	LF	1,425	$250.00	$356,250
420 6146	PARAPET WALL - CL F CONC (MISC)	LF	249	$270.00	$67,141
04 85 20	PARAPET WALL - STONE VENEER (3 SIDES)	LF	249	$60.00	$14,940
772 6003	POST AND CABLE FENCE (ALLOWANCE) - PCF-05	LF	300	$13.00	$3,900
550 6001	CHAIN LINK FENCE - CLF-10	LF	815	$24.00	$19,560
552 6004	WIRE FENCE - WF(2) - 10 (TY D)	LF	241	$27.00	$6,507
552 6008	WIRE FENCE (WATER GAP)	LF	65	$60.00	$3,900
466	STORM DRAIN HEADWALL - CH-FW-30 (54 IN PIPE)	EA	1	$11,000.00	$11,000
466	STORM DRAIN HEADWALL	EA	1	$3,500.00	$3,500
450	PEDESTRIAN RAIL ON STORM DRAIN HEADWALL (54 IN)	LF	55	$105.00	$5,775
432 6031	ROCK RIPRAP (12 IN D50)	CY	17	$170.00	$2,896
432 6033	ROCK RIPRAP (18 IN D50)	CY	1,395	$185.00	$258,137
				SUBTOTAL CHANNEL IMPROVEMENTS	$2,787,090

BRIDGE & ROADWAY IMPROVEMENTS

SPEC. NO.	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	SUB-TOTALS
PINE STREET					
247 6041	FL BS (CMP IN PLC)(TYA GR1-2)(FNAL POS)	CY	83	$60.00	$4,980
251 6023	REWORK BS MTL (TY A) (6") (DENS CONT)	SY	250	$28.00	$7,000
341 6085	HMAC PAVEMENT (2") (TY D)	TON	36	$145.00	$5,283
416 6001	DRILL SHAFT (18 IN)	LF	110	$108.00	$11,880
416 6002	DRILL SHAFT (24 IN)	LF	664	$265.00	$175,960
420 6013	CL C CONC (ABUT)	CY	35	$1,005.00	$34,673
420 6029	CL C CONC (CAP)	CY	9	$935.00	$8,789
420 6037	CL C CONC (COLUMN)	CY	3	$1,005.00	$2,814
422 6001	REINF CONC SLAB	SF	2,800	$16.00	$44,800
422 6013	BRIDGE SIDEWALK	SF	1,200	$13.00	$15,600
425 6011	PRESTR CONC SLAB BEAM (4SB15)	LF	79	$160.00	$12,629
425 6012	PRESTR CONC SLAB BEAM (5SB15)	LF	474	$200.00	$94,712
432 6013	RIPRAP (CONC)(5 IN)(HPC)	CY	115	$412.00	$47,380
442 6007	STR STEEL (MISC NON - BRIDGE)	LB	359	$7.00	$2,515
450 6032	RAIL (TY C223)	LF	215	$135.00	$29,025

SPEC. NO.	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	SUB-TOTALS
529 6002	CONC CURB AND GUTTER (TY II)	LF	14	$22.00	$308
529 6030	CONC CURB & GUTTER (VALLEY GUTTER)	LF	50	$36.00	$1,800
529 6038	CONC CURB (RIBBON)	LF	49	$22.00	$1,078
540 6047	MTL W-BEAM GD FEN (NESTED)(STEEL POST)	LF	46	$28.00	$1,288
				SUBTOTAL PINE ST	$502,514
CHESTNUT STREET					
247 6041	FL BS (CMP IN PLC)(TYA GR1-2)(FNAL POS)	CY	90	$60.00	$5,400
251 6023	REWORK BS MTL (TY A) (6") (DENS CONT)	SY	268	$28.00	$7,504
341 6085	HMAC PAVEMENT (2") (TY D)	TON	65	$145.00	$9,489
360	CONCRETE PAVEMENT	SY	11	$19.00	$209
416 6002	DRILL SHAFT (24 IN)	LF	830	$162.00	$134,460
420 6013	CL C CONC (ABUT)	CY	37	$1,005.00	$37,487
420 6029	CL C CONC (CAP)	CY	13	$935.00	$12,342
420 6037	CL C CONC (COLUMN)	CY	4	$1,005.00	$4,121
422 6001	REINF CONC SLAB	SF	4,088	$17.00	$69,496
422 6013	BRIDGE SIDEWALK	SF	1,275	$13.00	$16,575
425 6011	PRESTR CONC SLAB BEAM (4SB15)	LF	74	$160.00	$11,840
425 6012	PRESTR CONC SLAB BEAM (5SB15)	LF	740	$200.00	$148,004
432 6013	RIPRAP (CONC)(5 IN)(HPC)	CY	122	$415.00	$50,630
442 6007	STR STEEL (MISC NON - BRIDGE)	LB	415	$7.00	$2,907
450 6032	RAIL (TY C223)	LF	179	$135.00	$24,165
528 6002	COLORED TEXTURED CONC (6")	SY	78	$72.00	$5,616
529 6002	CONC CURB AND GUTTER (TY II)	LF	72	$22.00	$1,584
531 6019	CURB RAMPS (TY 2)	EA	2	$2,200.00	$4,400
531 6024	CURB RAMPS (TY 7)	EA	1	$2,200.00	$2,200
636	SIGNS	EA	6	$825.00	$4,950
666 6182	REFL PAV MRK TY II (W) 24" (SLD)	LF	75	$6.00	$450
666 6198	REFL PAV MRK TY II (W) 18" (YLD TRI)	EA	8	$16.00	$128
666 6205	REFL PAV MRK TY II (Y) 4" (BRK)	LF	264	$3.50	$924
666 6207	REFL PAV MRK TY II (Y) 4" (SLD)	LF	264	$3.50	$924
450	PEDESTRIAN RAIL	LF	42	$116.00	$4,872
				SUBTOTAL CHESTNUT ST	$560,676
FARM STREET					
251 6023	REWORK BS MTL (TY A) (6") (DENS CONT)	SY	537	$28.00	$15,036
341 6085	HMAC PAVEMENT (2") (TY D)	TON	24	$145.00	$3,426
360	CONCRETE PAVEMENT	SY	300	$19.00	$5,700
360 6027	CURB (TYPE II)	LF	157	$173.00	$27,161
416 6002	DRILL SHAFT (24 IN)	LF	1,105	$162.00	$179,010
420 6013	CL C CONC (ABUT)	CY	55	$966.00	$53,033
420 6029	CL C CONC (CAP)	CY	13	$945.00	$12,380
420 6037	CL C CONC (COLUMN)	CY	4	$1,020.00	$4,182
422 6001	REINF CONC SLAB	SF	4,000	$16.00	$64,000
422 6013	BRIDGE SIDEWALK	SF	1,200	$11.00	$13,200
425 6011	PRESTR CONC SLAB BEAM (4SB15)	LF	79	$175.00	$13,813
425 6012	PRESTR CONC SLAB BEAM (5SB15)	LF	710	$205.00	$145,622
442 6007	STR STEEL (MISC NON - BRIDGE)	LB	359	$7.00	$2,515
450 6032	RAIL (TY C223)	LF	160	$135.00	$21,600
529 6002	CONC CURB AND GUTTER (TY II)	LF	53	$22.00	$1,166
531 6001	CONC SIDEWALKS (4")	SY	46	$55.00	$2,530
529 6030	CONC CURB & GUTTER (VALLEY GUTTER)	LF	50	$55.00	$2,750
540 6047	MTL W-BEAM GD FEN (NESTED)(STEEL POST)	LF	24	$28.00	$672
450	PEDESTRIAN RAIL	LF	74	$116.00	$8,584
666 6207	REFL PAV MRK TY II (Y) 4" (SLD)	LF	536	$3.50	$1,876
				SUBTOTAL FARM ST	$578,255

PARKING LOT

SPEC. NO.	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	SUB-TOTALS
360	CONCRETE PAVEMENT	SY	123	$19.00	$2,337
464 6003	RC PIPE (CL III)(18 IN)	LF	231	$72.00	$16,632
464 6005	RC PIPE (CL III)(24 IN)	LF	72	$80.00	$5,760
465 6002	MANH (COMPL)(PRM)(48IN)	EA	6	$5,000.00	$30,000
465 6021	INLET (COMPL)(PCO)(5FT)(NONE)	EA	3	$5,500.00	$16,500
500 86001	WHEEL STOPS	EA	2	$182.00	$364
529 6002	CONC SIDEWALKS (5")	SY	53	$59.00	$3,127
529 6002	CONC CURB AND GUTTER (TY II)	LF	1,303	$22.00	$28,666

SPEC. NO.	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	SUB-TOTALS
529 6038	CONC CURB (RIBBON)	LF	42	$22.00	$924
531 6024	CURB RAMPS (TY 7)	EA	2	$2,200.00	$4,400
636	SIGNS	EA	6	$825.00	$4,950
666 6170	REFL PAV MRK TY II (W) 4" (SLD)	LF	1,241	$3.50	$4,344
666 6182	REFL PAV MRK TY II (W) 24" (SLD)	LF	25	$3.50	$88
666 6197	REFL PAV MRK TY II (W) (SYMBOL)	EA	2	$155.00	$310
				SUBTOTAL PARKING LOT	$118,401

EROSION CONTROL

SPEC. NO.	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	SUB-TOTALS
160 6003	FURNISHING AND PLACING TOPSOIL (4")	SY	83,300	$3.00	$249,900
169 6002	SOIL RETENTION BLANKETS (CL 1) (TY B)	SY	83,300	$4.00	$333,200
164 6001	BROADCAST SEED (PERM) (RURAL) (SANDY)	SY	83,300	$2.00	$166,600
168 6001	VEGETATIVE WATERING	SY	83,300	$2.00	$166,600
193 6001	PLANT MAINTENANCE	MO	12	$5,500.00	$66,000
506 6041	BIODEG EROSN CONT LOGS (INSTL) (12")	LF	5,265	$6.00	$31,590
506 6043	BIODEG EROSN CONT LOGS (REMOVE)	LF	5,265	$2.00	$10,530
506 6002	ROCK FILTER DAMS (INSTALL) (TY 2)	LF	410	$36.00	$14,760
506 6011	ROCK FILTER DAMS (REMOVE)	LF	410	$13.00	$5,330
506 6020	CONSTRUCTION EXITS (INSTALL) (TY 1)	SY	850	$27.00	$22,950
506 6024	CONSTRUCTION EXITS (REMOVE)	SY	850	$15.00	$12,750
506	TEMPORARY BERM DIKE	LF	6,740	$3.00	$20,220
				SUBTOTAL EROSION CONROL	$1,100,430

MISCELLANEOUS

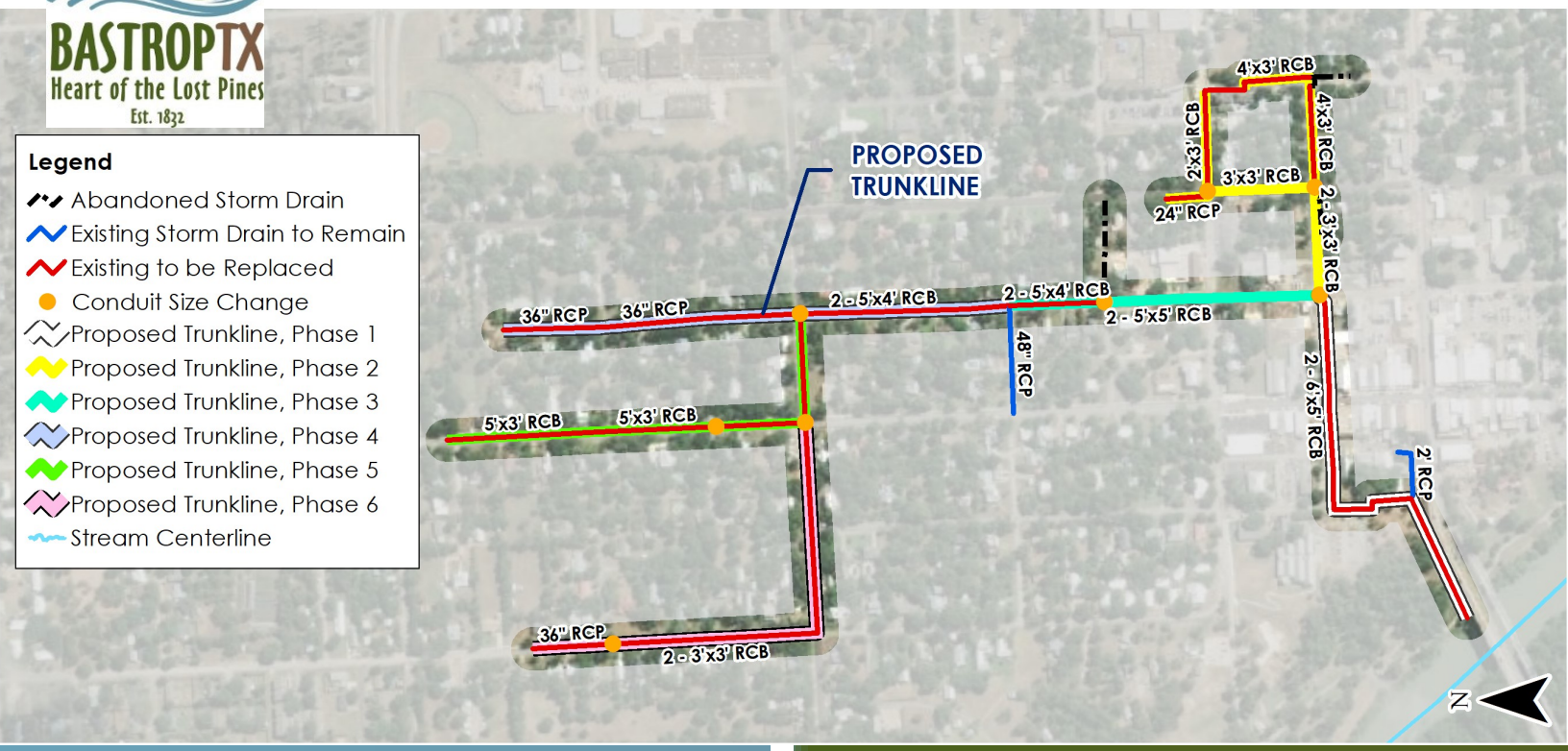
SPEC. NO.	DESCRIPTION	UNITS	QUANTITY	UNIT PRICE	SUB-TOTALS
500 6001	MOBILIZATION (10%)	LS	1		$704,864
502 6001	BARRICADES, SIGNS AND TRAFFIC HANDLING	MO	18	$9,000	$162,000
				SUBTOTAL MISCELLANEOUS	$866,864

SUBTOTAL - FLOOD MITIGATION IMPROVEMENTS	$7,753,510
CONTINGENCY (0%)	
TOTAL CONSTRUCTION COST	$7,754,000
Land Acquisition	$4,270,000
Utility Relocation Engineering Design & Construction	$475,000
Bid Phase Services (1%)	$77,500
Construction Inspection Service (12%)	$930,000
Material Testing Services (7%)	$543,000
TOTAL PROJECT COST	$14,049,500

UNIT PRICES ARE ENGINEER'S ESTIMATE BASED ON ENGINEER'S PREVIOUS EXPERIENCE AND QUALIFICATIONS WHICH REPRESENTS THE ENGINEER'S JUDGEMENT AS A DESIGN PROFESSIONAL FAMILIAR WITH THE CONSTRUCTION INDUSTRY. QUANTITIES IDENTIFIED IN THIS ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COSTS HAVE BEEN ESTIMATED BY HALFF ASSOCIATES, INC. THE ENGINEER NEITHER MAKES REPRESENTATION NOR ACCEPTS RESPONSIBILITY AS TO THE ACCURACY OF THESE QUANTITIES AS STATED ABOVE. THE ENGINEER CANNOT AND DOES NOT GUARANTEE THAT THE PROPOSALS, BIDS, OR ACTUAL CONSTRUCTION COSTS WILL NOT VARY FROM THESE ESTIMATES OF PROBABLE COSTS PREPARED FOR THE OWNER OR THE INTENDED RECIPIENT OF THIS DOCUMENT.

CITY OF BASTROP DRAINAGE MASTER PLAN

GB-03 Water, Spring, & Cedar St Drainage



PROJECT DESCRIPTION:

Water St, Spring St, Cedar St, and other streets in the surrounding residential area experience significant flooding due to the low-lying nature of the Downtown Bastrop terrain. To reduce ponding and flooding during rain events, an upgraded system is proposed to redirect runoff into the Colorado River. Improvements include 17,100 feet of storm drain to replace the existing undersized system. Pipes at Beech and Jefferson will be cut, plugged, and abandoned and flow will be directed through the new storm drain system. Existing laterals extending down Beech, Buttonwood, & Elm St are not depicted but will remain unchanged.

BENEFITS

- Reduces flooding along Water St, Spring St, Cedar St, and other surrounding streets
- Approximately 260 properties will benefit from the upgraded stormwater system, reducing private property flooding concerns
- Phased construction and budget flexibility

CHALLENGES

- Outfall needs flap gate due to high water surface elevations along Piney Creek to prevent backwater
- Downtown Bastrop is very flat, presenting challenge with roadway cover and slope—Pipes must be large to convey runoff

QUICK FACTS:

- Project Score: **66.7**
- **260** properties benefitted
- **17,100 feet** of storm drain
- Phased construction and budget flexibility

PROJECT COST ESTIMATE (2022):

Phase I Cost Estimate:	**$ 7.26 M**
Phase II Cost Estimate:	**$ 3.43 M**
Phase III Cost Estimate:	**$ 3.48 M**
Phase IV Cost Estimate:	**$ 3.95 M**
Phase V Cost Estimate:	**$ 3.69 M**
Phase VI Cost Estimate:	**$ 4.91 M**
Total Cost Estimate:	**$ 25.66 M**

Project: GB-03 Water St, Spring St, Cedar St Local Solution

Stream: Gills Branch

Engineer's Estimate of Probable Construction Cost

Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	AC	$52,000	4.01	$208,520
2	BROADCAST SEED (PERM) (URBAN) (CLAY)	SY	$1	1,953	$1,953
3	CUT & RESTORING PAV	SY	$113	17,197	$1,943,261
4	TRENCH EXCAVATION PROTECTION	LF	$7	11,345	$79,417
5	RC PIPE (CL III)(24 IN)	LF	$105	178	$18,690
6	RC PIPE (CL III)(36 IN)	LF	$160	1,386	$221,760
7	CONC BOX CULV (3 FT X 2 FT)	LF	$285	387	$110,295
8	CONC BOX CULV (3 FT X 3 FT)	LF	$400	4,251	$1,700,400
9	CONC BOX CULV (4 FT X 3 FT)	LF	$355	656	$232,766
10	CONC BOX CULV (4 FT X 4 FT)	LF	$410	803	$329,230
11	CONC BOX CULV (5 FT X 3 FT)	LF	$425	990	$420,750
12	CONC BOX CULV (5 FT X 4 FT)	LF	$570	2,242	$1,277,940
13	CONC BOX CULV (5 FT X 5 FT)	LF	$400	1,582	$632,800
14	CONC BOX CULV (6 FT X 5 FT)	LF	$810	3,194	$2,587,140
15	INLET (COMPL)(PCO)(5FT)(NONE)	EA	$7,750	78	$604,500
16	FLAP GATE	EA	$5,000	1	$5,000
17	ADJUSTING MANHOLES	EA	$1,120	19	$21,280
18	REMOV STR (INLET)	EA	$710	56	$39,760
19	REMOV STR (PIPE)	LF	$20	8,983	$179,660
20	CUT, PLUG, & ABANDON PIPE	EA	$2,000	2	$4,000
21	UTILITY ADJUSTEMENT/RELOCATION	LS	$531,000	1	$531,000
22	TRAFFIC CONTROL (1%)	LS	$106,200	1	$106,200
23	EROSION AND SEDIMENT CONTROL (10%)	LS	$1,061,900	1	$1,061,900
24	MOBILIZATION (10%)	LS	$1,061,900	1	$1,061,900
				PROJECT SUBTOTAL	**$13,380,200**
				40% CONTINGENCY	$5,352,100
				BASE TOTAL	$18,732,300
				Environmental Permitting (3%)	$562,000
				Engineering Design (12%)	$2,247,900
				Construction Administrative Services (5%)	$936,700
				Construction Inspection (10%)	$1,873,300
				Construction Material Testing (7%)	$1,311,300
				PROJECT TOTAL	**$25,663,500**

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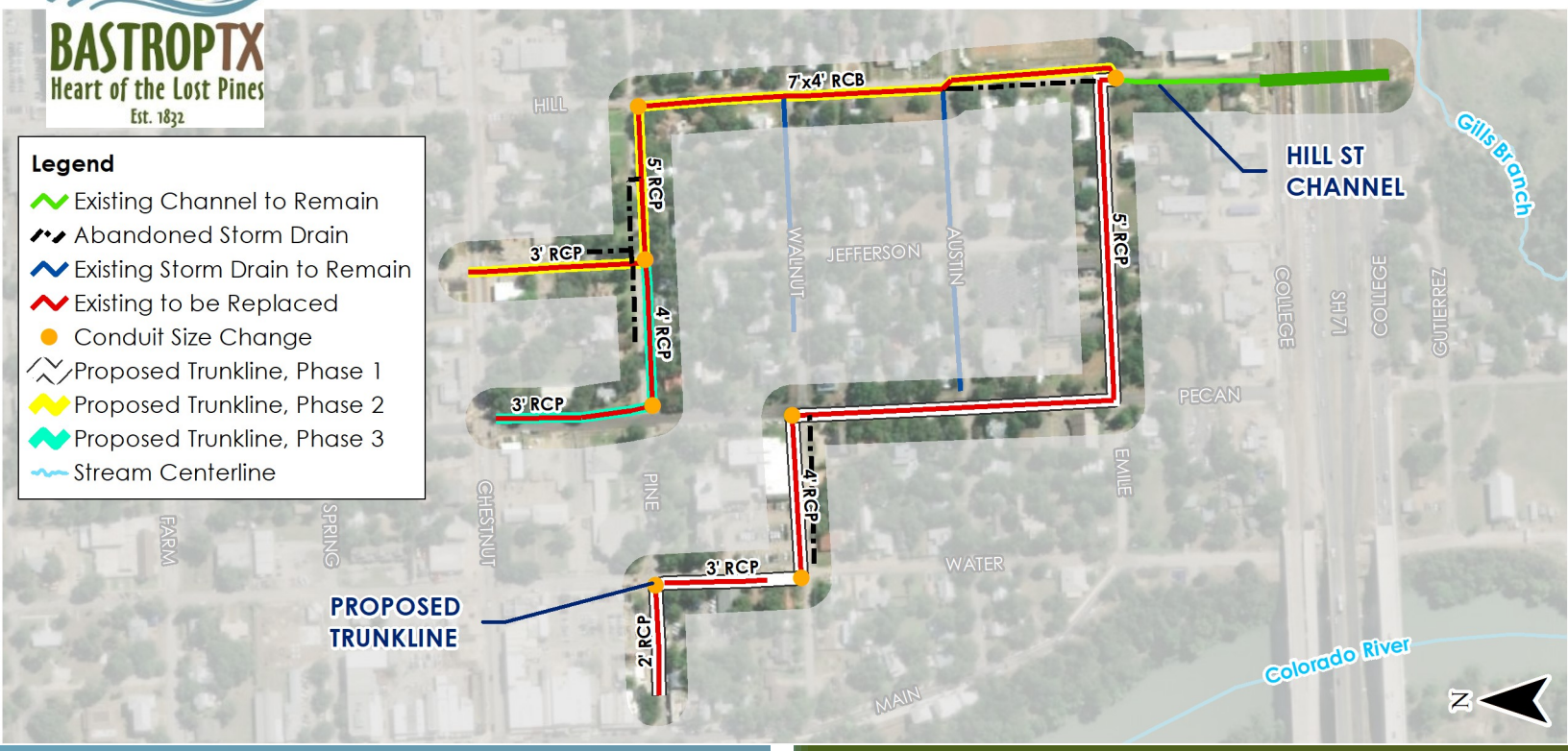
CITY OF BASTROP DRAINAGE MASTER PLAN

GB-04 Hill, Pecan, & Pine St Drainage



PROJECT DESCRIPTION:

Hill St, Pecan St, Emile St, Pine St, Jefferson St, and other streets in the surrounding residential area experience significant flooding due to the low-lying nature of the Downtown Bastrop terrain. To reduce ponding and flooding during rain events, an upgraded drainage system is proposed to convey runoff into Gills Branch. Improvements include approximately 5,940 feet of storm drain to replace the existing undersized storm drain system. The parallel pipes along Jefferson and Pine St will be cut, plugged, and abandoned and existing flow will be directed through the new, larger storm drain system. The new system will connect to the existing Hill St channel and then drain into Gills Branch.

BENEFITS

- Reduces flooding along Hill St, Jefferson St, Pecan St, Pine St, Emile St, and adjacent properties.
- Approximately 160 properties will benefit from the upgraded stormwater system, reducing private property flooding concerns
- Phased construction and budget flexibility

CHALLENGES

- Construction impact to residents
- Downtown Bastrop is very flat, restricting roadway cover and slope of pipes, resulting in large pipe sizes to convey runoff—roadway reprofiling may be needed in some locations

QUICK FACTS:

- Project Score: **63.3**
- **160** properties benefitted
- **5,940 feet** of storm drain
- Phased construction and budget flexibility

PROJECT COST ESTIMATE (2022):

Phase I Cost Estimate:	**$ 3.84 M**
Phase II Cost Estimate:	**$ 3.93 M**
Phase III Cost Estimate:	**$ 925,200**
Total Cost Estimate:	**$ 8.70 M**

Project: GB-04 Hill, Pecan, & Pine St Drainage

Stream: Gills Branch

Engineer's Estimate of Probable Construction Cost

Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	AC	$52,000	1.9	$98,800
2	CUT & RESTORING PAV	SY	$113	8,950	$1,011,350
3	TRENCH EXCAVATION PROTECTION	LF	$7	5,940	$41,580
4	RC PIPE (CL III)(18 IN)	LF	$80	570	$45,600
5	RC PIPE (CL III)(24 IN)	LF	$105	270	$28,350
6	RC PIPE (CL III)(36 IN)	LF	$160	1,175	$188,000
7	RC PIPE (CL III)(48 IN)	LF	$260	745	$193,700
8	RC PIPE (CL III)(60 IN)	LF	$380	1,990	$756,200
9	CONC BOX CULV (7 FT X 4 FT)	LF	$670	1,190	$797,300
10	INLET (COMPL)(PCO)(5FT)(NONE)	EA	$7,750	38	$294,500
11	REMOV STR (INLET)	EA	$710	35	$24,850
12	REMOV STR (PIPE)	LF	$20	5,255	$105,100
13	ADJUSTING MANHOLES	EA	$1,120	8	$8,960
14	CUT, PLUG, & ABANDON PIPE	EA	$2,000	3	$6,000
15	UTILITY ADJUSTMENT / RELOCATION (5%)	LS	$180,000	1	$180,000
16	TRAFFIC CONTROL (1%)	LS	$36,000	1	$36,000
17	EROSION AND SEDIMENT CONTROL (10%)	LS	$360,000	1	$360,000
18	MOBILIZATION (10%)	LS	$360,000	1	$360,000
				PROJECT SUBTOTAL	**$4,536,300**
				40% CONTINGENCY	$1,814,600
				BASE TOTAL	$6,350,900
				Environmental Permitting (3%)	$190,600
				Engineering Design (12%)	$762,200
				Construction Administrative Services (5%)	$317,600
				Construction Inspection (10%)	$635,100
				Construction Material Testing (7%)	$444,600
				PROJECT TOTAL	**$8,701,000**

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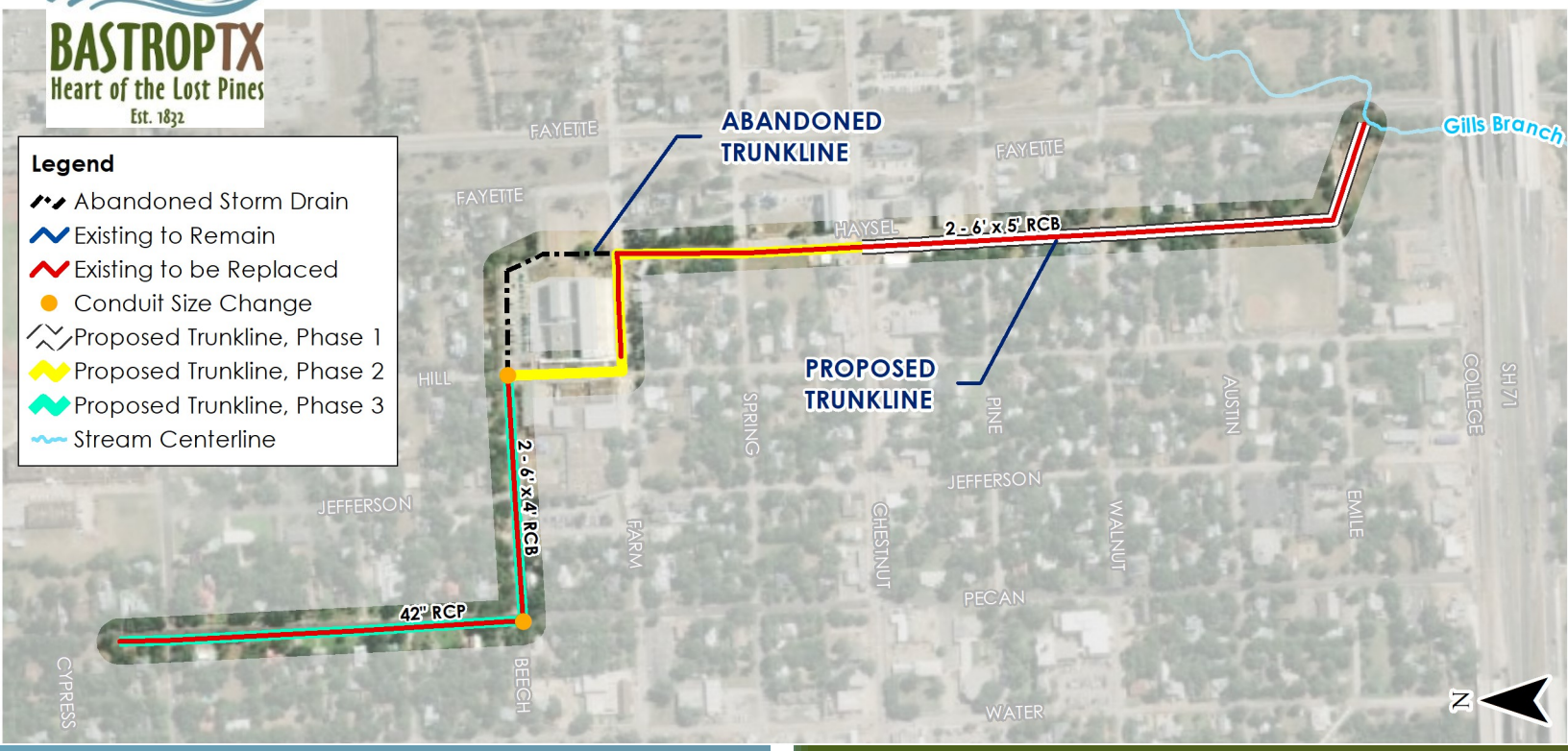
CITY OF BASTROP DRAINAGE MASTER PLAN

GB-05 Pecan, Beech, & Haysel to Gills Branch



PROJECT DESCRIPTION:

Haysel St, Farm St, Beech St, Pecan St, and other streets in the surrounding residential area experience significant flooding due to the low-lying nature of the Downtown Bastrop terrain. To reduce ponding and flooding during rain events, an upgraded system is proposed to convey runoff into Gills Branch. Improvements include 5,520 feet of storm drain to replace the existing undersized system. The existing pipe conveying flow through the Mina Elementary campus will be cut, plugged, and abandoned, and flow will be redirected from Pecan St through the Hill and Farm St rights-of-way, eventually rejoining the Haysel St trunkline.

BENEFITS

- Reduces flooding along Haysel, Beech, Pecan, Farm, and Hill St
- Approximately 180 properties will benefit from the new stormwater system, reducing private property flooding concerns
- Phased construction and budget flexibility

CHALLENGES

- Outfall needs flap gate due to high water surface elevations along Piney Creek to prevent backwater
- Downtown Bastrop is very flat, presenting challenge with roadway cover and slope—Pipes must be large to convey runoff

QUICK FACTS:

- Project Score: **61.7**
- **180** properties benefitted
- **5,520 feet** of storm drain
- Phased Construction and Budget Flexibility

PROJECT COST ESTIMATE (2022):

Phase I Cost Estimate:	**$ 8.65 M**
Phase II Cost Estimate:	**$ 7.25 M**
Phase III Cost Estimate:	**$ 4.67 M**
Total Cost Estimate:	**$ 20.56 M**

Project: GB-05 Pecan, Beech, & Haysel to Gills Branch

Stream: Gills Branch

Engineer's Estimate of Probable Construction Cost

Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	AC	$52,000	1.9	$98,800
2	CUT & RESTORING PAV	SY	$113	9,205	$1,040,165
3	TRENCH EXCAVATION PROTECTION	LF	$7	6,150	$43,050
4	RC PIPE (CL III)(18 IN)	LF	$80	600	$48,000
5	RC PIPE (CL III)(42 IN)	LF	$230	1,313	$301,990
6	CONC BOX CULV (6 FT X 4 FT)	LF	$610	1,604	$978,440
7	CONC BOX CULV (6 FT X 5 FT)	LF	$810	6,830	$5,532,300
8	INLET (COMPL)(PCO)(5FT)(NONE)	EA	$7,750	40	$310,000
9	FLAP GATE	EA	$5,000	1	$5,000
10	REMOV STR (INLET)	EA	$710	45	$31,950
11	REMOV STR (PIPE)	LF	$20	5,110	$102,200
12	ADJUSTING MANHOLES	EA	$1,120	11	$12,320
13	CUT, PLUG, & ABANDON PIPE	EA	$2,000	1	$2,000
14	UTILITY ADJUSTMENT / RELOCATION (5%)	LS	$425,300	1	$425,300
15	TRAFFIC CONTROL (1%)	LS	$85,100	1	$85,100
16	EROSION AND SEDIMENT CONTROL (10%)	LS	$850,600	1	$850,600
17	MOBILIZATION (10%)	LS	$850,600	1	$850,600
				PROJECT SUBTOTAL	**$10,717,900**
				40% CONTINGENCY	$4,287,200
				BASE TOTAL	$15,005,100
				Environmental Permitting (3%)	$450,200
				Engineering Design (12%)	$1,800,700
				Construction Administrative Services (5%)	$750,300
				Construction Inspection (10%)	$1,500,600
				Construction Material Testing (7%)	$1,050,400
				PROJECT TOTAL	**$20,557,300**

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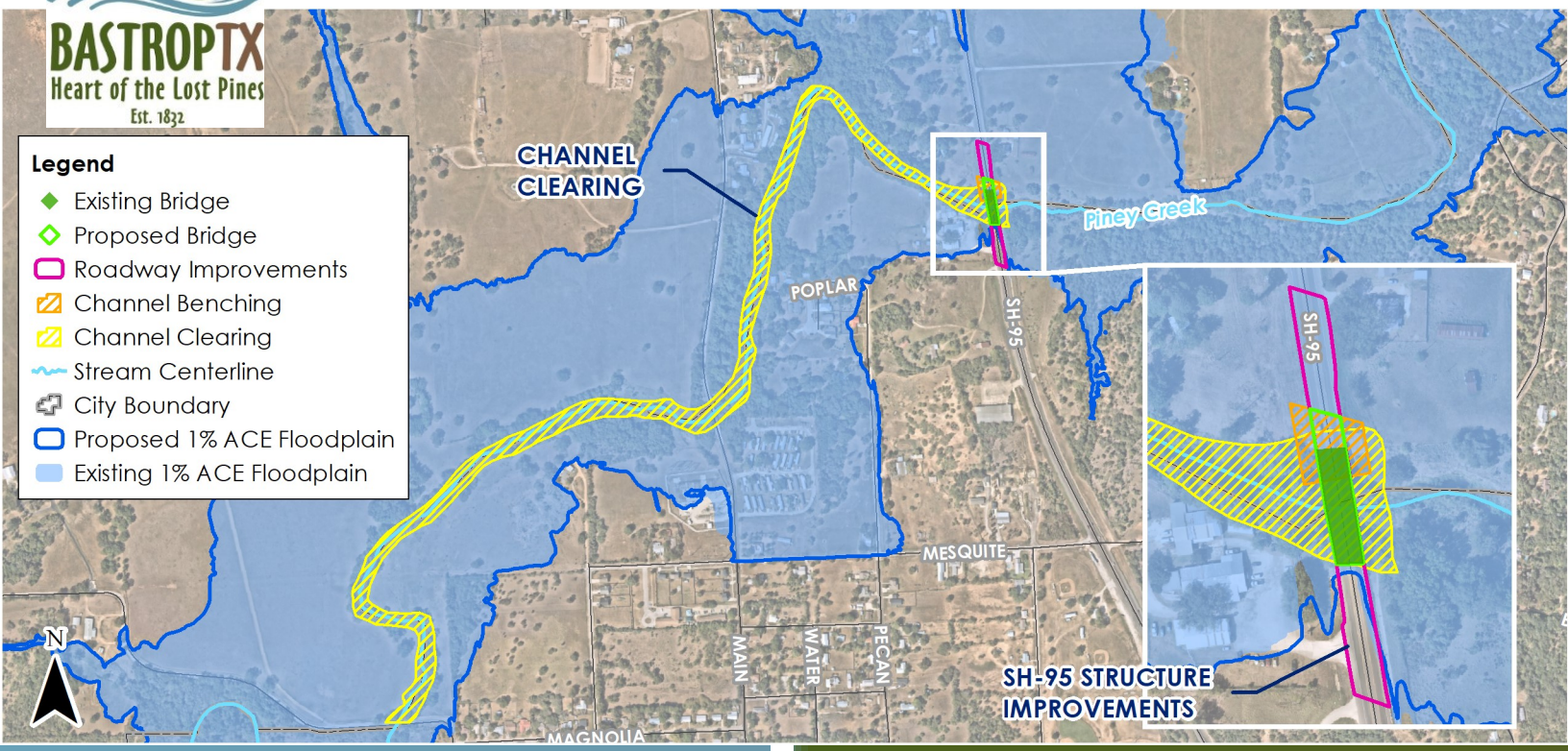
CITY OF BASTROP DRAINAGE MASTER PLAN

PC-01 SH-95 at Piney Creek (2% ACE LOS)



PROJECT DESCRIPTION:

SH-95 becomes flooded by Piney Creek during the 2% ACE storm event. Proposed improvements include raising the SH-95 roadway profile by up to 1.2 feet, 670 feet of roadway improvements, widening the bridge opening by 60 feet, 110 linear feet of channel improvements within the SH-95 right-of-way, and 6,635 linear feet of channel clearing.

The design prevents SH-95 from overtopping during the 2% ACE storm event and reduces, but does not eliminate, overtopping during the 1% ACE storm event.

BENEFITS

- Prevents SH-95 from overtopping during 2% ACE storm event
- Reduces overtopping of SH-95 during 1% ACE storm event

CHALLENGES

- This solution causes increases in the 1% ACE floodplain that will require future mitigation which will necessitate further financial investment by the City
- TxDOT coordination required for SH-95 construction

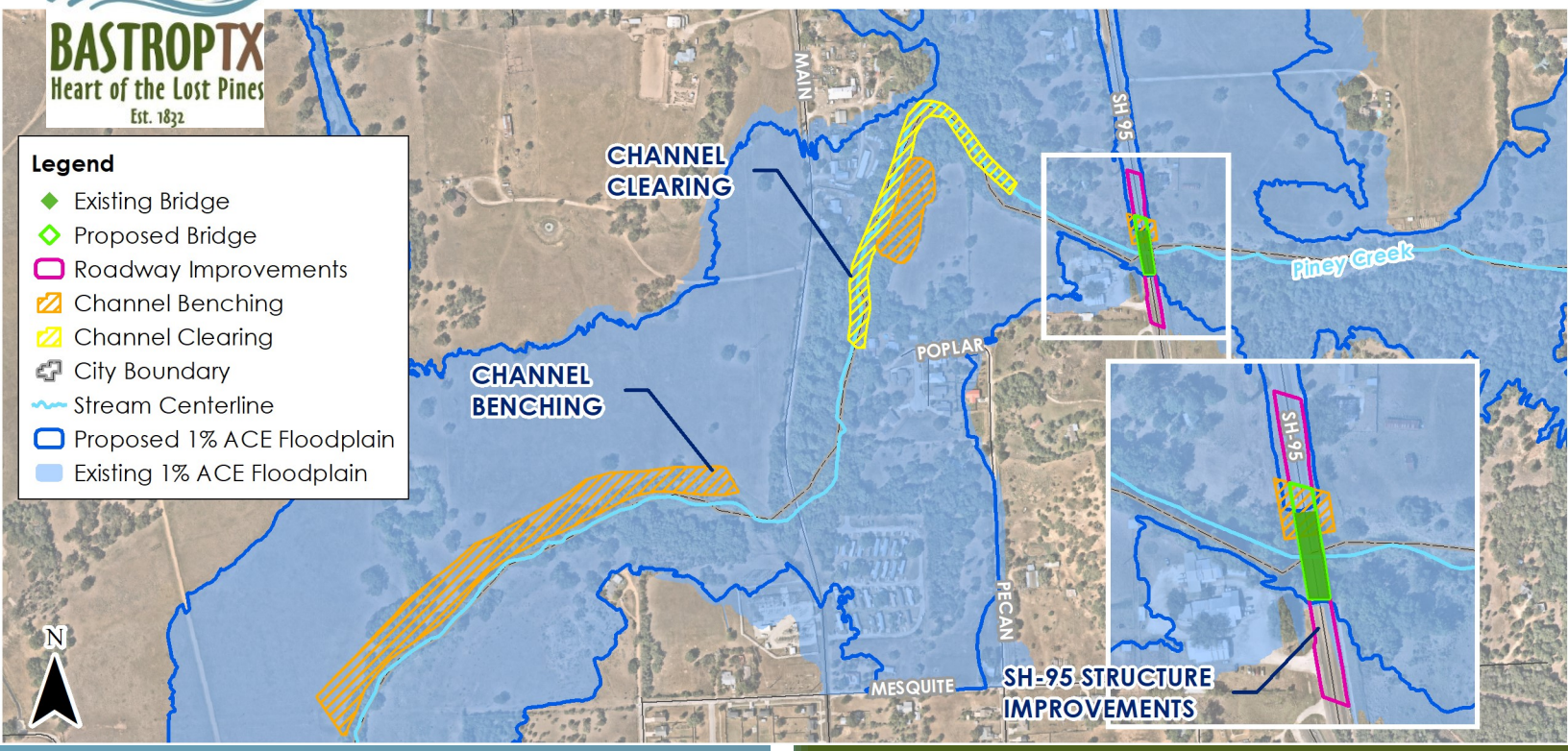
QUICK FACTS:

- Project Score: **60.0**
- Passes **2% ACE** storm event
- **670** feet of roadway profile adjustments
- **6,635** feet of channel clearing

PROJECT COST ESTIMATE (2022):

Road Improvements:	**$ 2.85 M**
Channel Improvements:	**$ 328,500**
Other Costs:	**$ 3.54 M**
Total Cost Estimate:	**$ 6.72 M**

PC-01 SH-95 at Piney Creek (1% ACE LOS)



PROJECT DESCRIPTION:

SH-95 becomes flooded by Piney Creek during the 2% ACE storm event. Proposed improvements include raising the SH-95 roadway profile by up to 1.2 feet, 670 feet of roadway improvements, widening the bridge opening by 60 feet, 2,650 linear feet of channel improvements, and 1,550 feet of channel clearing.

The design prevents SH-95 from overtopping during the 1% ACE storm event, providing Bastrop residents all weather roadway egress.

BENEFITS

- Prevents SH-95 from overtopping during 1% ACE storm event
- Provides an all weather roadway access for Bastrop residents

CHALLENGES

- Channel excavation in heavily wooded area and coordination with city residents
- TxDOT coordination required for SH-95 construction

QUICK FACTS:

- Project Score: **58.3**
- **1,550** feet of channel clearing
- **2,650** feet of channel improvements
- **670** feet of roadway profile adjustment

PROJECT COST ESTIMATE (2022):

Road Improvements:	**$ 2.85 M**
Channel Improvements:	**$ 3.60 M**
Other Costs:	**$ 7.16 M**
Total Cost Estimate:	**$ 13.61 M**

Project: PC-01 SH95 (2% ACE LOS)

Stream: Piney Creek

Engineer's Estimate of Probable Construction Cost

Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	AC	$52,000	0.85	$44,200
2	REMOVING CONC (RIPRAP)	SY	$8	1,100	$8,800
3	EXCAVATION (ROADWAY)	CY	$10	10,146	$101,460
4	BROADCAST SEED (PERM) (URBAN) (CLAY)	SY	$1	2,600	$2,600
5	CUT & RESTORING PAV	SY	$113	2,795	$315,835
6	RIPRAP (CONC)(5 IN)	SY	$490	1,100	$539,000
7	BRIDGE (plan view)	SF	$150	11,665	$1,749,750
8	REMOV STR (BRIDGE 100 - 499 FT LENGTH)	EA	$94,000	1	$94,000
9	TREE TRIMMING / BRUSH REMOVAL(CHANNELS)	AC	$3,075	12.75	$39,206
10	TRAFFIC CONTROL (1%)	LS	$28,900	1	$28,900
11	EROSION AND SEDIMENT CONTROL (10%)	LS	$289,500	1	$289,500
12	MOBILIZATION (10%)	LS	$289,500	1	$289,500
				PROJECT SUBTOTAL	**$3,502,800**
				40% CONTINGENCY	$1,401,200
				BASE TOTAL	$4,904,000
				Environmental Permitting (3%)	$147,200
				Engineering Design (12%)	$588,500
				Construction Administrative Services (5%)	$245,200
				Construction Inspection (10%)	$490,400
				Construction Material Testing (7%)	$343,300
				PROJECT TOTAL	**$6,718,600**

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Project: PC-01 SH95 (1% ACE LOS)

Stream: Piney Creek

Engineer's Estimate of Probable Construction Cost

Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	AC	$52,000	0.85	$44,200
2	REMOVING CONC (RIPRAP)	SY	$8	1,100	$8,800
3	EXCAVATION (ROADWAY)	CY	$10	10,146	$101,460
4	EXCAVATION (CHANNEL)	CY	$10	300,212	$3,002,120
5	BROADCAST SEED (PERM) (URBAN) (CLAY)	SY	$1	2,600	$2,600
6	CUT & RESTORING PAV	SY	$113	2,795	$315,835
7	RIPRAP (CONC)(5 IN)	SY	$490	1,100	$539,000
8	BRIDGE (plan view)	SF	$150	11,665	$1,749,750
9	REMOV STR (BRIDGE 100 - 499 FT LENGTH)	EA	$94,000	1	$94,000
10	TREE TRIMMING / BRUSH REMOVAL(CHANNELS)	AC	$3,075	2.5	$7,688
11	TRAFFIC CONTROL (1%)	LS	$58,700	1	$58,700
12	EROSION AND SEDIMENT CONTROL (10%)	LS	$586,500	1	$586,500
13	MOBILIZATION (10%)	LS	$586,500	1	$586,500
				PROJECT SUBTOTAL	**$7,097,200**
				40% CONTINGENCY	$2,838,900
				BASE TOTAL	$9,936,100
				Environmental Permitting (3%)	$298,100
				Engineering Design (12%)	$1,192,400
				Construction Administrative Services (5%)	$496,900
				Construction Inspection (10%)	$993,700
				Construction Material Testing (7%)	$695,600
				PROJECT TOTAL	**$13,612,800**

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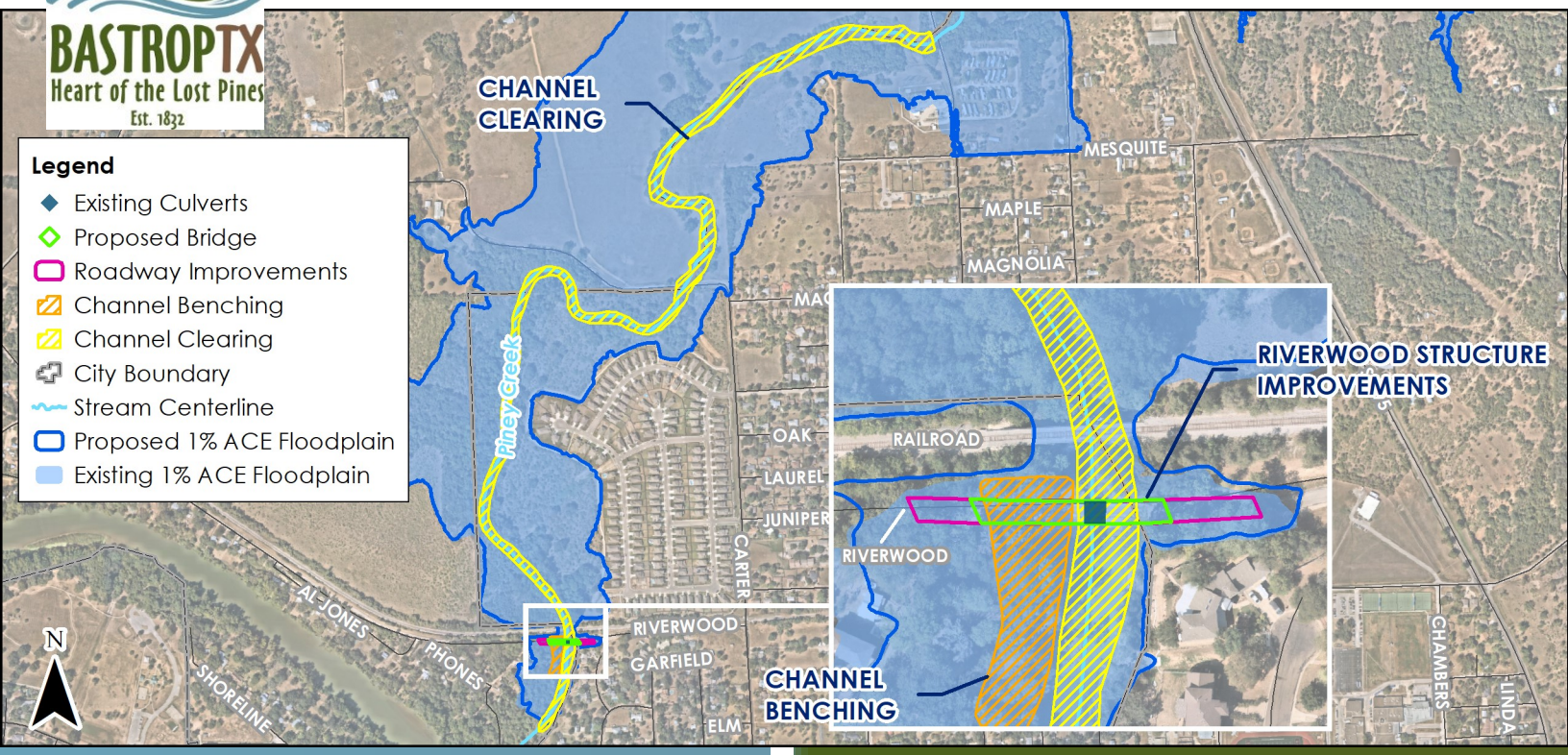
CITY OF BASTROP DRAINAGE MASTER PLAN

PC-02 Riverwood Dr at Piney Creek



PROJECT DESCRIPTION:

Riverwood Dr becomes flooded by Piney Creek during the 50% ACE storm event. Proposed improvements include raising Riverwood Dr by approximately 17.25 feet, 375 feet of roadway improvements, replacing the existing culverts with a 210-foot bridge, and 8,125 linear feet of channel clearing, and approximately 280 linear feet of channel improvements.

The design prevents Riverwood Dr from overtopping during the 10% ACE storm event and reduces, but does not eliminate, overtopping during the 4% ACE storm event.

BENEFITS

- Prevents Riverwood Dr from overtopping during the 50% and 10% ACE storm events, greatly reducing Riverwood Dr flooding frequency
- Reduces overtopping during the 4% ACE storm events

CHALLENGES

- This solution causes increases in the 1% ACE floodplain that will require future mitigation
- Solution does not pass 1% ACE storm event
- May require City-County project coordination
- Risk of erosion along eastern bank or Riverwood Drive

QUICK FACTS:

- Project Score: **68.3**
- Passes **10% ACE** storm event
- **375 feet** of roadway improvements
- **25 feet** of channel improvements

PROJECT COST ESTIMATE (2022):

Road Improvements:	**$ 932,100**
Channel Improvements:	**$ 151,500**
Other Costs:	**$ 1.21 M**
Project Total:	**$ 2.29 M**

Project: PC-02 Riverwood Drive

Stream: Piney Creek

Engineer's Estimate of Probable Construction Cost

Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	AC	$52,000	0.25	$13,000
2	REMOVING CONC (RIPRAP)	SY	$8	200	$1,600
3	REMOVING CONC (SIDEWALKS)	SY	$14	200	$2,800
4	EXCAVATION (ROADWAY)	CY	$10	673	$6,730
5	EXCAVATION (CHANNEL)	CY	$10	1,222	$12,220
6	BROADCAST SEED (PERM) (URBAN) (CLAY)	SY	$1	2,200	$2,200
7	CUT & RESTORING PAV	SY	$113	610	$68,930
8	RIPRAP (STONE PROTECTION)(18 IN)	CY	$150	100	$15,000
9	BRIDGE (plan view)	SF	$150	5,358	$803,700
10	REMOV STR (BOX CULVERT)	LF	$70	54	$3,780
11	REMOV STR (WINGWALL)	EA	$1,450	2	$2,900
12	CONC SIDEWALKS (4")	SY	$65	200	$13,000
13	TREE TRIMMING / BRUSH REMOVAL(CHANNELS)	AC	$3,075	13.25	$40,744
14	TRAFFIC CONTROL (1%)	LS	$9,900	1	$9,900
15	EROSION AND SEDIMENT CONTROL (10%)	LS	$98,700	1	$98,700
16	MOBILIZATION (10%)	LS	$98,700	1	$98,700
				PROJECT SUBTOTAL	**$1,194,000**
				40% CONTINGENCY	$477,600
				BASE TOTAL	$1,671,600
				Environmental Permitting (3%)	$50,200
				Engineering Design (12%)	$200,600
				Construction Administrative Services (5%)	$83,600
				Construction Inspection (10%)	$167,200
				Construction Material Testing (7%)	$117,100
				PROJECT TOTAL	**$2,290,300**

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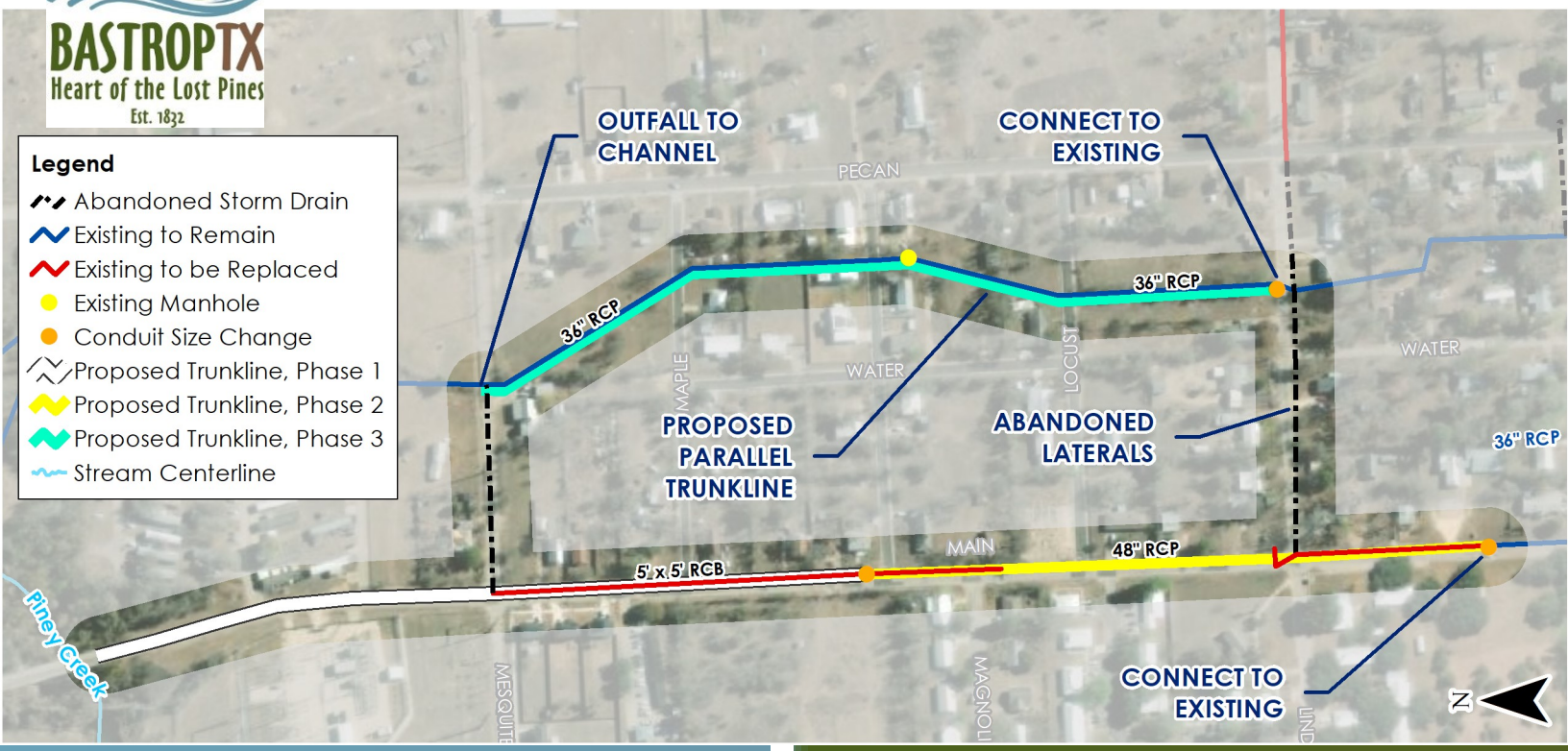
CITY OF BASTROP DRAINAGE MASTER PLAN

PC-04 Local Storm Drain Improvements Near Piney Creek



PROJECT DESCRIPTION:

Downtown Bastrop experiences flooding due to the low-lying nature of the local terrain. To reduce ponding and flooding during rain events, a new storm drain system is proposed to redirect runoff from Main St into Piney Creek. A parallel storm drain is also proposed to increase conveyance along the existing trunkline. Improvements include approximately 2,930 ft of storm drain to follow the Main St right-of-way and convey water directly into the creek, bypassing the existing storm drain system to the east, a 36-in pipe extending approximately 1,580-ft, from Linden St to Mesquite St, and two storm drain inlets every 300-ft to capture runoff. Existing pipes following Mesquite and Linden St will be cut, plugged, and abandoned to reduce flow through the existing storm drain system. Drainage at Mesquite and Linden St will be captured and conveyed through the Main St system. Refer to summary sheet PC05 for additional details regarding the newly proposed system along Pecan St.

BENEFITS

- Reduces flooding along the Main St corridor
- Approximately 115 properties will benefit from the new Main St and parallel stormwater systems, reducing private property flooding concerns
- Phased construction and budget flexibility

CHALLENGES

- Construction impact to residents and businesses
- Outfalls need flap gates due to high water surface elevations along Piney Creek to prevent backwater
- Downtown Bastrop is very flat, restricting roadway cover and slope of pipes, resulting in large pipe sizes to convey runoff—roadway re-profiling may be needed in some locations

QUICK FACTS:

- Project Score: **63.3**
- **115** properties benefitted
- **4,510 feet** of storm drain
- Relieves pressure on existing system

PROJECT COST ESTIMATE (2022):

Phase I Cost Estimate:	**$ 2.44 M**
Phase II Cost Estimate:	**$ 1.58 M**
Phase III Cost Estimate:	**$ 1.11 M**
Total Cost Estimate:	**$ 5.14 M**

Project: PC-04 Main Street & Parallel Trunk - Local Flooding

Stream: Piney Creek

Engineer's Estimate of Probable Construction Cost

Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	AC	$52,000	2	$104,000
2	BROADCAST SEED (PERM) (URBAN) (CLAY)	SY	$1	1,640	$1,640
3	CUT & RESTORING PAV	SY	$113	4,250	$480,250
4	TRENCH EXCAVATION PROTECTION	LF	$7	4,681	$32,767
5	RC PIPE (CL III)(18 IN)	LF	$80	450	$36,000
6	RC PIPE (CL III)(36 IN)	LF	$160	1,575	$252,000
7	RC PIPE (CL III)(48 IN)	LF	$260	1,185	$308,100
8	CONC BOX CULV (5 FT X 5 FT)	LF	$400	1,475	$590,000
9	INLET (COMPL)(PCO)(5FT)(NONE)	EA	$7,750	30	$232,500
10	HEADWALL (CH - PW - 0) (DIA= 36 IN)	EA	$9,500	1	$9,500
11	HEADWALL (CH - PW - 0) (DIA= 60 IN)	EA	$19,500	1	$19,500
12	FLAP GATE	EA	$5,000	2	$10,000
13	REMOV STR (INLET)	EA	$710	15	$10,650
14	REMOV STR (PIPE)	LF	$20	1,405	$28,100
15	CUT, PLUG, & ABANDON PIPE	EA	$2,000	2	$4,000
16	ADJUSTING MANHOLES	EA	$1,120	7	$7,840
17	UTILITY ADJUSTMENT / RELOCATION (5%)	LS	$106,300	1	$106,300
18	TRAFFIC CONTROL (1%)	LS	$21,300	1	$21,300
19	EROSION AND SEDIMENT CONTROL (10%)	LS	$212,700	1	$212,700
20	MOBILIZATION (10%)	LS	$212,700	1	$212,700
				PROJECT SUBTOTAL	**$2,679,900**
				40% CONTINGENCY	$1,072,000
				BASE TOTAL	$3,751,900
				Environmental Permitting (3%)	$112,600
				Engineering Design (12%)	$450,300
				Construction Administrative Services (5%)	$187,600
				Construction Inspection (10%)	$375,200
				Construction Material Testing (7%)	$262,700
				PROJECT TOTAL	**$5,140,300**

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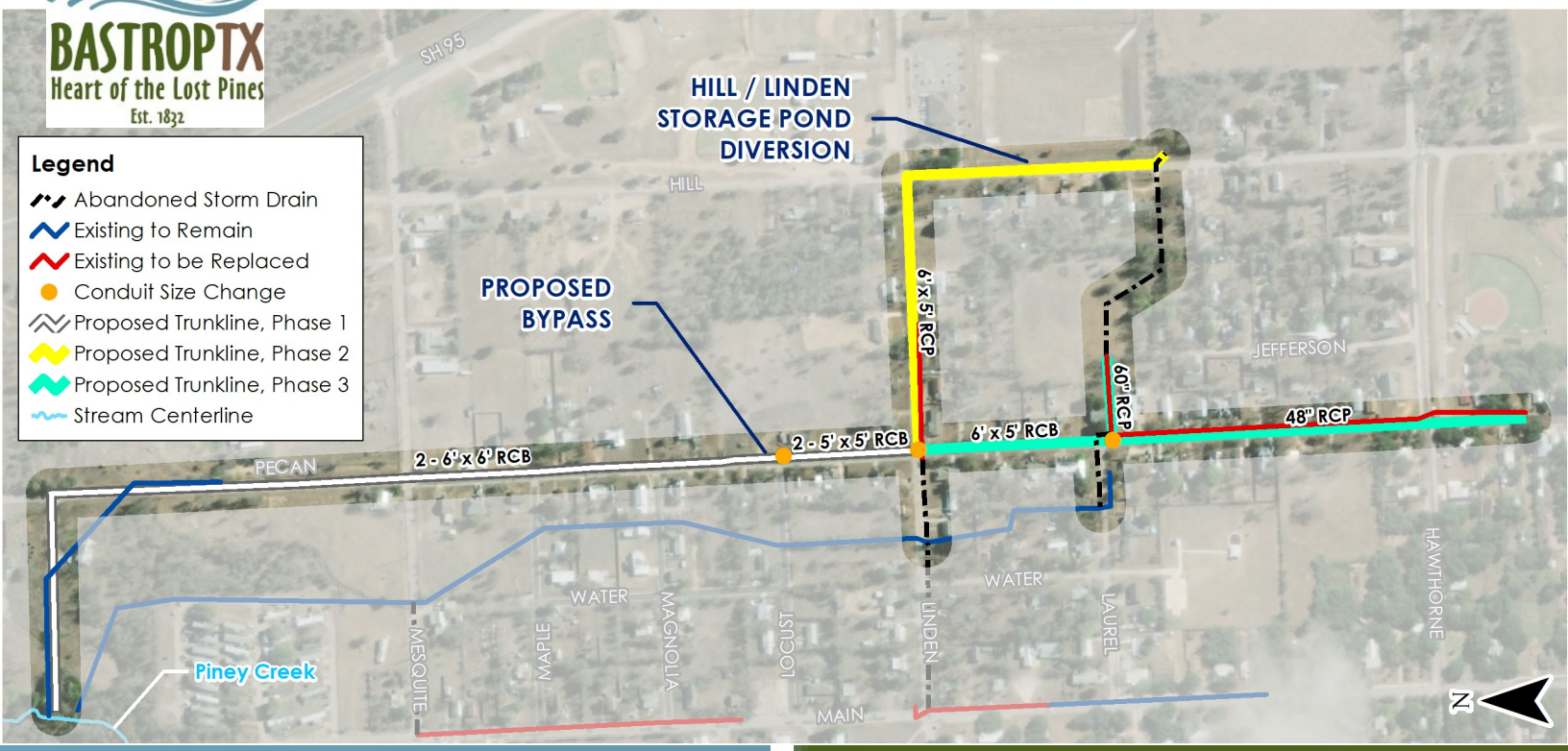
CITY OF BASTROP DRAINAGE MASTER PLAN

PC-05 Pecan St Bypass & Pond Diversion



PROJECT DESCRIPTION:

Downtown Bastrop experiences significant flooding due to the low-lying nature of the local terrain. To reduce ponding and flooding during rain events, a Pecan St bypass is proposed to divert flow from the existing storm drain system. The bypass will include a 1,600-ft diversion conveying outflow from the Hill / Linden storage pond, approximately 8,900 ft of storm drain that will follow the Pecan St right-of-way, and a 250-ft pipe to collect runoff between Hawthorne and Linden St. Existing pipes on Linden and Laurel St will be cut, plugged, and abandoned to reduce flow through the existing storm drain system. Refer to summary sheets PC04 and PC05 for additional details regarding storm drain improvements along Main, Linden, and Mesquite St.

BENEFITS

- Reduces flooding along Pecan St corridor
- Approximately 135 properties will benefit from the new Pecan St / Diversion stormwater system, reducing private property flooding concerns
- Phased construction and budget flexibility

CHALLENGES

- Construction impact to residents and businesses
- Outfall needs flap gate due to high water surface elevations along Piney Creek to prevent backwater
- Downtown Bastrop is very flat, presenting challenge with roadway cover and slope—Pipes must be large to convey runoff

QUICK FACTS:

- Project Score: **63.3**
- **135** properties benefitted
- **10,750 feet** of storm drain
- Relieves pressure on existing system

PROJECT COST ESTIMATE (2022):

Phase I Cost Estimate:	**$ 15.9 M**
Phase II Cost Estimate:	**$ 4.26 M**
Phase III Cost Estimate:	**$ 3.52 M**
Total Cost Estimate:	**$ 23.73 M**

Project: PC-05 Pecan St, Hill / Linden Storage Pond Diversion

Stream: Piney Creek

Engineer's Estimate of Probable Construction Cost

Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	PREPARING ROW	AC	$52,000	2.4	$124,800
2	BROADCAST SEED (PERM) (URBAN) (CLAY)	SY	$1	1,525	$1,525
3	CUT & RESTORING PAV	SY	$113	9,940	$1,123,220
4	TRENCH EXCAVATION PROTECTION	LF	$7	7,505	$52,535
5	RC PIPE (CL III)(18 IN)	LF	$80	600	$48,000
6	RC PIPE (CL III)(48 IN)	LF	$260	1,233	$320,580
7	RC PIPE (CL III)(60 IN)	LF	$380	252	$95,760
8	CONC BOX CULV (5 FT X 5 FT)	LF	$400	804	$321,600
9	CONC BOX CULV (6 FT X 5 FT)	LF	$810	2,185	$1,769,850
10	CONC BOX CULV (6 FT X 6 FT)	LF	$980	5,666	$5,552,680
11	INLET (COMPL)(PCO)(5FT)(NONE)	EA	$7,750	40	$310,000
12	HEADWALL (CH - PW - 0) (DIA= 72 IN)	EA	$28,400	1	$28,400
13	FLAP GATE	EA	$5,000	1	$5,000
14	REMOV STR (INLET)	EA	$710	29	$20,590
15	REMOV STR (PIPE)	LF	$20	1,875	$37,500
16	CUT, PLUG, & ABANDON PIPE	EA	$2,000	3	$6,000
17	UTILITY ADJUSTMENT / RELOCATION (5%)	LS	$490,900	1	$490,900
18	TRAFFIC CONTROL (1%)	LS	$98,200	1	$98,200
19	EROSION AND SEDIMENT CONTROL (10%)	LS	$981,800	1	$981,800
20	MOBILIZATION (10%)	LS	$981,800	1	$981,800

PROJECT SUBTOTAL	**$12,370,800**
40% CONTINGENCY	$4,948,400
BASE TOTAL	$17,319,200
Environmental Permitting (3%)	$519,600
Engineering Design (12%)	$2,078,400
Construction Administrative Services (5%)	$866,000
Construction Inspection (10%)	$1,732,000
Construction Material Testing (7%)	$1,212,400
PROJECT TOTAL	**$23,727,600**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be held liable to Owner or third party for any failure to accurately estimate the cost of the project, or any part thereof. Unit prices are in current dollars and should be adjusted as required when letting schedule for project is determined.

CITY OF BASTROP DRAINAGE MASTER PLAN

SB-01 Detention Pond at Hunters Crossing

PROJECT DESCRIPTION:

Hunters Crossing becomes flooded by Spring Branch during the 4% ACE storm event. Proposed improvements include a redesigned outlet weir structure for the detention pond, a new 170 foot long 0.5 ft tall berm bordering Hunters Crossing Park, and 120 feet of existing berm improvements along Hunters Crossing

The proposed improvements prevents overtopping at Hunters Crossing during the 1% ACE storm event as well as overflow into Hunters Crossing Park.

BENEFITS

- Removes Hunters Crossing from 1% ACE floodplain
- Berm improvements prevent over flows to the south from detention pond into Hunters Crossing Park

CHALLENGES

- Berm along Hunters Crossing Park will impact the existing sidewalks
- Improvements are on private property and the City will need to coordinate with owners

QUICK FACTS:

- Project Score: **83.3**
- **170** feet of new berm proposed
- **120** feet of existing berm improvements
- **180** foot new outlet weir structure

PROJECT COST ESTIMATE (2022):

Berm Improvements:	**$ 1,200**
Existing Weir Removal:	**$ 79,600**
Outlet Weir Structure:	**$ 213,000**
Other Costs:	**$ 192,000**
Total Cost Estimate:	**$ 709,000**

Project: SB-01 Hunters Crossing/ Detention Pond

Stream: Spring Branch

Engineer's Estimate of Probable Construction Cost

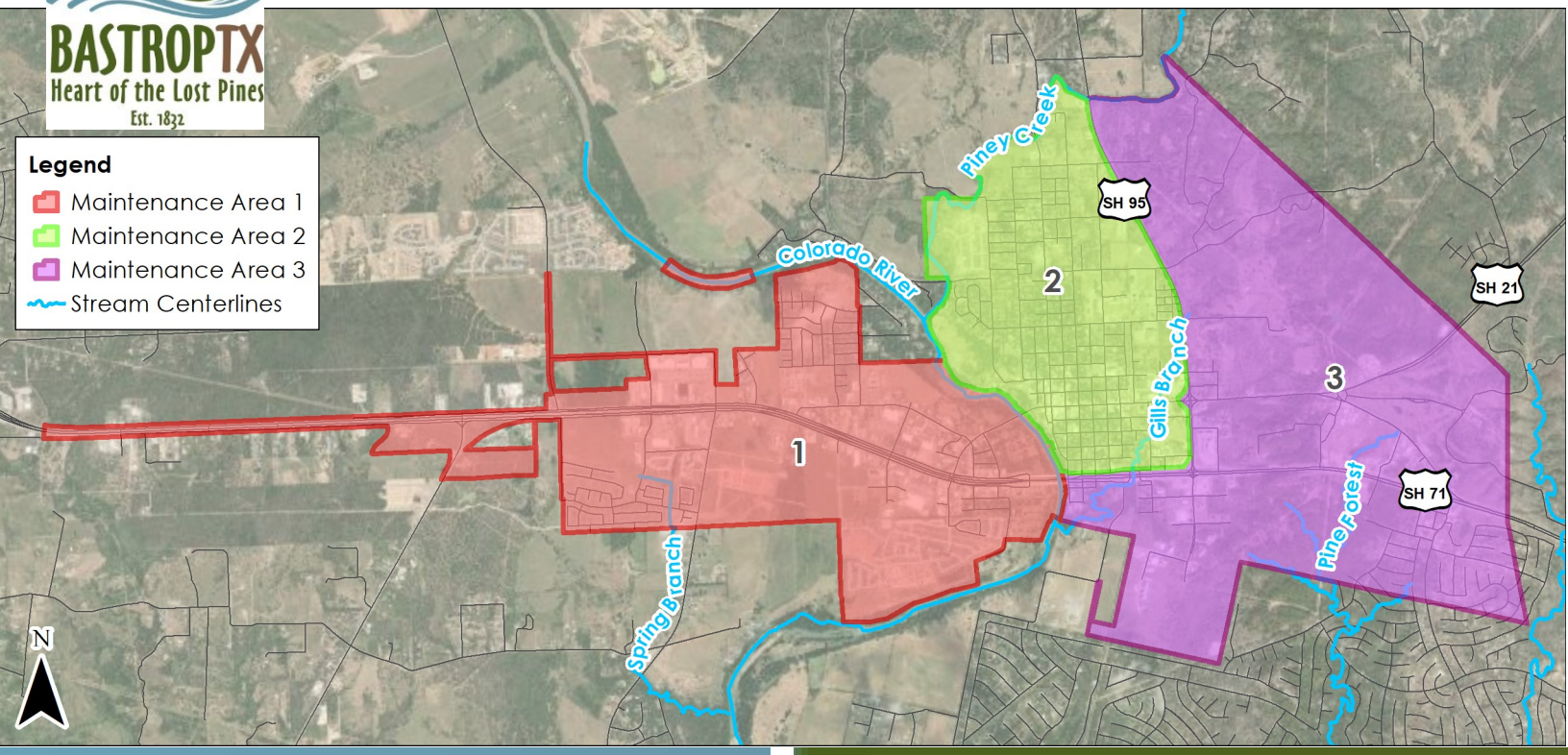
Date: December 2022

PAY ITEM NO	DESCRIPTION	UNITS	UNIT PRICE	QTY	TOTALS
1	REMOVING CONC (HEADWALL)	CY	$370	215	$79,550
2	EMBANKMENT (FINAL)(ORD COMP)(TY A)	CY	$20	55	$1,109
3	CL C CONC (HEADWALL)	CY	$1,030	206	$212,386
4	UTILITY ADJUSTMENT / RELOCATION (5%)	LS	$14,700	1	$14,700
5	TRAFFIC CONTROL (1%)	LS	$2,900	1	$2,900
6	EROSION AND SEDIMENT CONTROL (10%)	LS	$29,300	1	$29,300
7	MOBILIZATION (10%)	LS	$29,300	1	$29,300
				PROJECT SUBTOTAL	**$369,300**
				40% CONTINGENCY	$147,800
				BASE TOTAL	$517,100
				Environmental Permitting (3%)	$15,600
				Engineering Design (12%)	$62,100
				Construction Administrative Services (5%)	$25,900
				Construction Inspection (10%)	$51,800
				Construction Material Testing (7%)	$36,200
				PROJECT TOTAL	**$708,700**

This statement was prepared utilizing standard cost estimate practices. It is understood and agreed that this is an estimate only, and that Engineer shall not be held liable to Owner or third party for any failure to accurately estimate the cost of the project, or any part thereof. Unit prices are in current dollars and should be adjusted as required when letting schedule for project is determined.

CITY OF BASTROP DRAINAGE MASTER PLAN

COB-01 Creek Maintenance Plan



PROJECT DESCRIPTION:

Work with an engineering consultant to develop a city-wide creek maintenance plan. The creek maintenance plan will identify creek in need of maintenance to reduce flooding and propose mitigation strategies to improve creek conveyance and stability.

BENEFITS

- Debris removal or thinning to increase channel conveyance
- Flood reduction

CHALLENGES

- Additional crews and equipment may be needed
- Requires landowner participation and approval

QUICK FACTS:

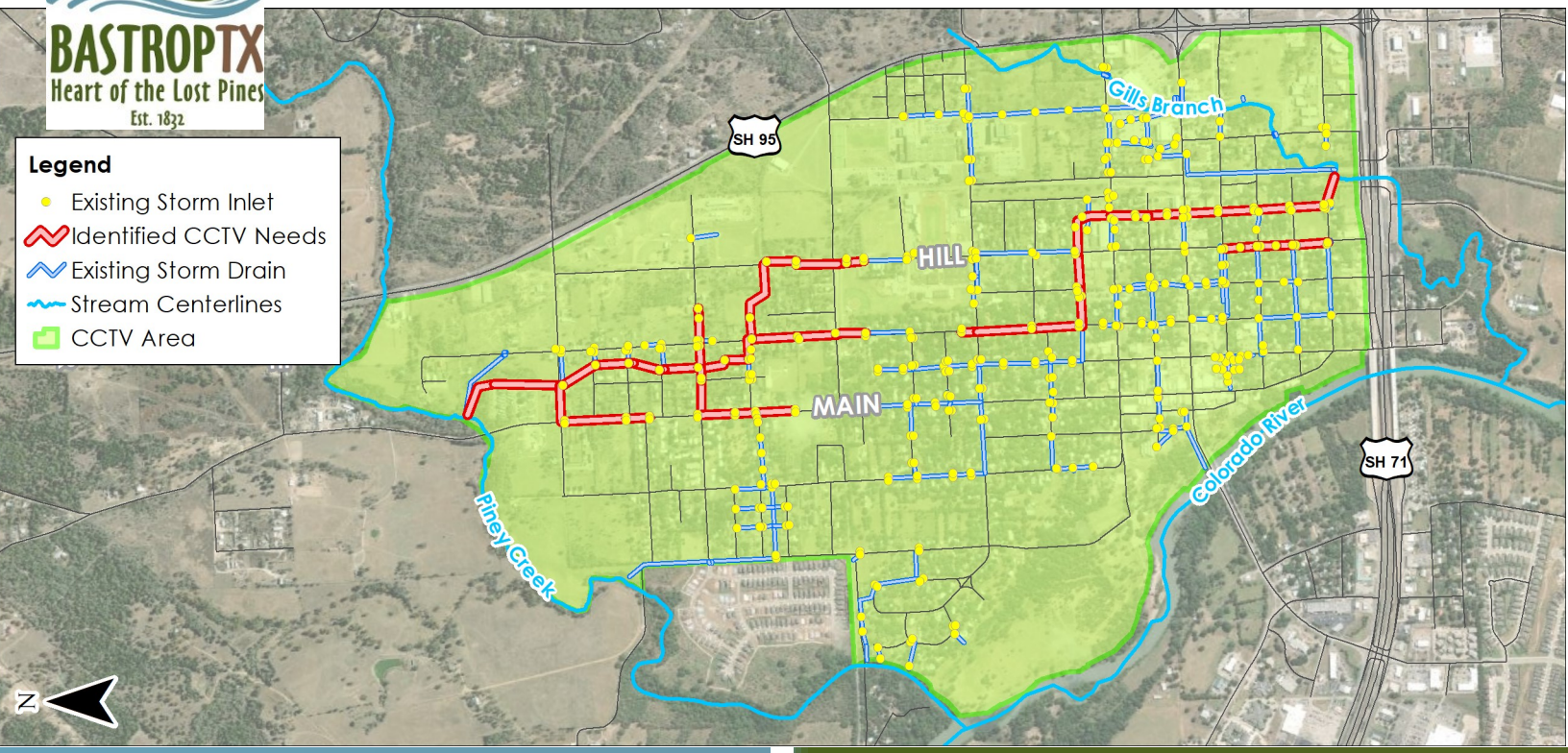
- Identify creek maintenance needs
- Identify crew and equipment needs
- Increase channel conveyance
- Flood reduction

PROJECT COST ESTIMATE (2022):

Engineering Fee:	**$ 20,000**

CITY OF BASTROP DRAINAGE MASTER PLAN

COB-02 Storm Drain CCTV Evaluation



PROJECT DESCRIPTION:

Work with an engineering consultant to assess the condition of the existing storm drain infrastructure within the urban core utilizing CCTV inspection. Inspection will analyze approximately 17,000 feet of storm drain infrastructure. Evaluation will allow design consultant to develop a storm drain maintenance plan.

BENEFITS

- Diagnose storm drain infrastructure in need of repair
- Develop storm drain maintenance plan based off CCTV footage

CHALLENGES

- Identification of existing storm drain infrastructure to analyze
- Accessibility to existing storm drains
- 17,000 total feet of storm drain to be analyzed

QUICK FACTS:

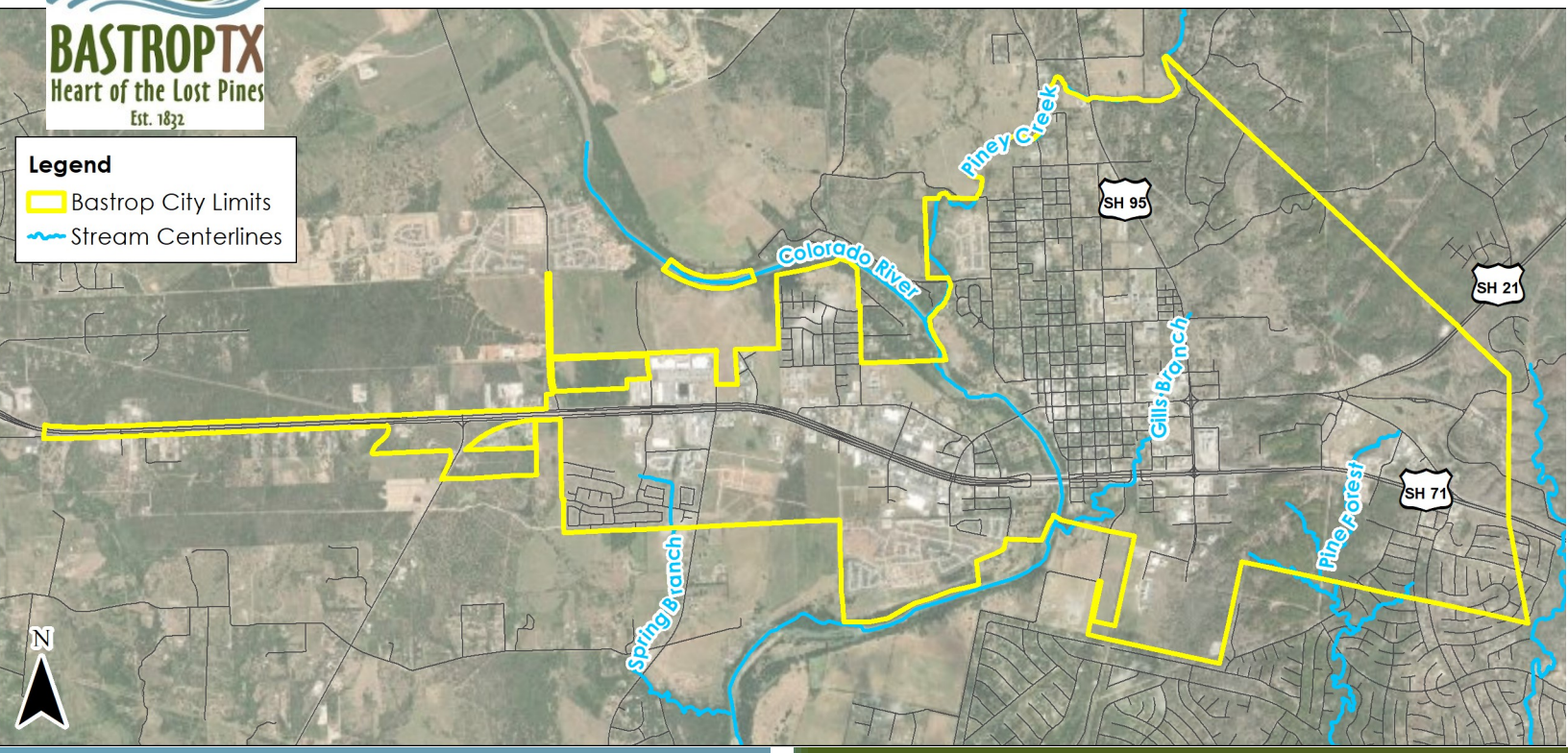
- 17,000 LF of storm drain inspection
- Evaluation of existing storm drains
- Develop storm drain maintenance plan

PROJECT COST ESTIMATE (2022):

Engineering Fee:	**$ 350,000**

CITY OF BASTROP DRAINAGE MASTER PLAN

COB-03 Drainage Criteria Update



PROJECT DESCRIPTION:

Work with an engineering consultant to update the City's drainage design manual. The goal of the updated drainage criteria is to meet current drainage standard practices to mitigate future drainage issues and adapt the criteria for increased growth occurring within the City of Bastrop.

BENEFITS

- Meet current drainage standard practices
- Update criteria for increasing residential and commercial land use
- Mitigate potential drainage issues

CHALLENGES

- Criteria must comply with current city ordinances and master plans

QUICK FACTS:

- Drainage criteria update to current standards
- Mitigate future drainage issues

PROJECT COST ESTIMATE (2022):

Engineering Fee:	**$ 30,000**

CITY OF BASTROP DRAINAGE MASTER PLAN

CR-01 Basin RV Resort at the Colorado River

PROJECT DESCRIPTION:

Basin RV Resort located at 98 State Hwy 71 becomes flooded during the 1% ACE storm event due to its close proximity to the Colorado River and the low-lying nature of the surrounding terrain. The floodplain is too wide to reduce the flood depths by traditional engineering mitigation techniques, and therefore, voluntary buyouts are recommended. The property is worth a total assessed value of $2.25 million and covers 8.63 acres of land. Flood depths range from 0.1 to 16.5 feet above ground elevation with an average range of 11.5 to 12.3 feet.

BENEFITS

- Gives landowner the option to sell their property and avoid future flood damage
- Protects long-term residents and visitors from loss of life and loss of valued resources

CHALLENGES

- Cannot mitigate flooding using traditional engineering techniques
- Requires landowner participation and approval

QUICK FACTS:

- Assessed value: **$2.25 million**
- **8.63** acres of land
- Owner participation is **voluntary**

PROJECT COST ESTIMATE (2022):

Optional Buyouts:	**$ 2.25 M**

CITY OF BASTROP DRAINAGE MASTER PLAN

PC-03 Mercedes Cove at Piney Creek

PROJECT DESCRIPTION:

Homes along Mercedes Cv, Pecan St, and Poplar St become flooded during the 1% ACE storm event due to their close proximity to Piney Creek and the low-lying nature of the surrounding terrain. The floodplain is too wide to reduce the flood depths by traditional engineering mitigation techniques, and therefore, voluntary buyouts are recommended. The 13 properties, including 8 dwellings and 5 residential lots, in this area are worth a total assessed value of $4.34 million and cover 5.8 acres of land. Flood depths range from 1 to 6.6 feet above ground elevation.

BENEFITS

- Removes 13 properties from the floodplain, including 8 dwellings and 5 residential lots
- Give residents the option to sell their property and avoid future flood damage
- Protects residents from loss of life and loss of valued resources

CHALLENGES

- Cannot mitigate flooding using traditional engineering techniques
- Requires landowner participation and approval

QUICK FACTS:

- Assessed value: **$4.34 million**
- **5.8** acres of land
- Owner participation is **voluntary**

PROJECT COST ESTIMATE (2022):

Optional Buyouts:	**$ 4.34 M**

Appendix C
Drainage CIP Project Ranking

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City of Bastrop - Drainage Project Ranking Criteria						GB-01 SH-95 at Gills Branch		GB-02 Gills Branch Flood Mitigation		GB-03 Water, Spring, & Cedar St Drainage		GB-04 Hill, Pecan, & Pine St Drainage	
Category	**Category**	**Category Weight**	**Sub Category Weight**	**Sub Category**	**Scoring**	Project Specific Score	Project Weighted Score	Project Specific Score	Project Weighted Score	Project Specific Score	Project Weighted Score	Project Specific Score	Project Weighted Score
Public Safety	Public Safety	35	5	Road Flooding and Mobility (Pre-Project Conditions)	1: Isolated Local Roadway Flooding 2: Collector Roadway Flooding 3: Moving water is likely to wash car off road (consider velocity and depth)	3	5.0	3	5.0	2	3.3	2	3.3
			10	Emergency Access (Pre-Project Conditions)	1: Passable 2: Passable but response time increased 3: Impassable	3	10.0	3	10.0	2	6.7	2	6.7
			10	Number of Structures within 1% ACE footprint (Pre-Project Condition)	1: 0-5 flooded 2: 5-10 flooded 3: 10+ flooded or critical facility effected	1	3.3	3	10.0	3	10.0	3	10.0
			5	Frequency Event at which structural flooding occurs (Pre-Project Condition)	1: ≥ 1% ACE 2: ≥ 4% ACE 3: < 4% ACE	3	5.0	3	5.0	3	5.0	3	5.0
			5	Level of Service (Post-Project Protection)	1: < 4 % ACE 2: ≥ 4% ACE 3: ≥ 1 % ACE	2	3.3	3	5.0	2	3.3	2	3.3
Economic	Economic	35	25	Project Cost	1: ≥ 5 Million 2: $2 - 5 Million 3: ≤ $2 Million	3	25.0	1	8.3	1	8.3	1	8.3
			10	Sustainability (operation & maintenance schedule)	1: Monthly maintenance 2: Bi-Annual maintenance 3: Annual + maintenance	2	6.7	2	6.7	3	10.0	3	10.0
Environment	Environmental	10	10	Impact to Existing Environmental Features (i.e. Riparian Corridor, Habitat, etc.)	1: Significant Negative Impact 2: Moderate Negative Impact 3: No Impact / Positive Impact	2	6.7	2	6.7	3	10.0	3	10.0
Project Timing	Project Timing	10	10	Dependency on other Projects	1: Dependent on other projects 3: No dependence on other projects	1	3.3	3	10.0	1	3.3	1	3.3
Social	Social	10	10	Element of Comprehensive Plan (Parks, Transportation, Planning, etc.)	1: No elements in other plans 2: Related to elements in other plans 3: Multiple elements other plan	1	3.3	2	6.7	2	6.7	1	3.3
							71.7		**73.3**		**66.7**		**63.3**
					PROJECT RANK:		**3**		**2**		**5**		**6**

City of Bastrop - Drainage Project Ranking Criteria						GB-05 Pecan, Beech, & Haysel St to Gills Branch		PC-01 SH-95 at Piney Creek 2% ACE LOS		PC-01 SH-95 at Piney Creek 1% ACE LOS		PC-02 Riverwood Dr. at Piney Creek	
Category	**Category**	**Category Weight**	**Sub Category Weight**	**Sub Category**	**Scoring**	Project Specific Score	Project Weighted Score	Project Specific Score	Project Weighted Score	Project Specific Score	Project Weighted Score	Project Specific Score	Project Weighted Score
Public Safety	Public Safety	35	5	Road Flooding and Mobility (Pre-Project Conditions)	1: Isolated Local Roadway Flooding 2: Collector Roadway Flooding 3: Moving water is likely to wash car off road (consider velocity and depth)	1	1.7	3	5.0	3	5.0	1	1.7
			10	Emergency Access (Pre-Project Conditions)	1: Passable 2: Passable but response time increased 3: Impassable	2	6.7	3	10.0	3	10.0	3	10.0
			10	Number of Structures within 1% ACE footprint (Pre-Project Condition)	1: 0-5 flooded 2: 5-10 flooded 3: 10+ flooded or critical facility effected	3	10.0	1	3.3	1	3.3	1	3.3
			5	Frequency Event at which structural flooding occurs (Pre-Project Condition)	1: ≥ 1% ACE 2: ≥ 4% ACE 3: < 4% ACE	3	5.0	2	3.3	2	3.3	3	5.0
			5	Level of Service (Post-Project Protection)	1: < 4 % ACE 2: ≥ 4% ACE 3: ≥ 1 % ACE	2	3.3	2	3.3	3	5.0	1	1.7
Economic	Economic	35	25	Project Cost	1: ≥ 5 Million 2: $2 - 5 Million 3: ≤ $2 Million	1	8.3	1	8.3	1	8.3	2	16.7
			10	Sustainability (operation & maintenance schedule)	1: Monthly maintenance 2: Bi-Annual maintenance 3: Annual + maintenance	3	10.0	2	6.7	1	3.3	3	10.0
Environment	Environmental	10	10	Impact to Existing Environmental Features (i.e. Riparian Corridor, Habitat, etc.)	1: Significant Negative Impact 2: Moderate Negative Impact 3: No Impact / Positive Impact	3	10.0	2	6.7	2	6.7	2	6.7
Project Timing	Project Timing	10	10	Dependency on other Projects	1: Dependent on other projects 3: No dependence on other projects	1	3.3	3	10.0	3	10.0	3	10.0
Social	Social	10	10	Element of Comprehensive Plan (Parks, Transportation, Planning, etc.)	1: No elements in other plans 2: Related to elements in other plans 3: Multiple elements other plan	1	3.3	1	3.3	1	3.3	1	3.3
							61.7		**60.0**		**58.3**		**68.3**
					PROJECT RANK:		**9**		**10**		**11**		**4**

City of Bastrop - Drainage Project Ranking Criteria						PC-04 Local Storm Drain Improvements Near Piney Creek		PC-05 Pecan St. Bypass & Pond Diversion		SB-01 Detention Pond at Hunter's Crossing	
Category	**Category**	**Category Weight**	**Sub Category Weight**	**Sub Category**	**Scoring**	Project Specific Score	Project Weighted Score	Project Specific Score	Project Weighted Score	Project Specific Score	Project Weighted Score
Public Safety	Public Safety	35	5	Road Flooding and Mobility (Pre-Project Conditions)	1: Isolated Local Roadway Flooding 2: Collector Roadway Flooding 3: Moving water is likely to wash car off road (consider velocity and depth)	2	3.3	2	3.3	1	1.7
			10	Emergency Access (Pre-Project Conditions)	1: Passable 2: Passable but response time increased 3: Impassable	2	6.7	2	6.7	3	10.0
			10	Number of Structures within 1% ACE footprint (Pre-Project Condition)	1: 0-5 flooded 2: 5-10 flooded 3: 10+ flooded or critical facility effected	3	10.0	3	10.0	2	6.7
			5	Frequency Event at which structural flooding occurs (Pre-Project Condition)	1: ≥ 1% ACE 2: ≥ 4% ACE 3: < 4% ACE	3	5.0	3	5.0	1	1.7
			5	Level of Service (Post-Project Protection)	1: < 4 % ACE 2: ≥ 4% ACE 3: ≥ 1 % ACE	2	3.3	2	3.3	3	5.0
Economic	Economic	35	25	Project Cost	1: ≥ 5 Million 2: $2 - 5 Million 3: ≤ $2 Million	1	8.3	1	8.3	3	25.0
			10	Sustainability (operation & maintenance schedule)	1: Monthly maintenance 2: Bi-Annual maintenance 3: Annual + maintenance	3	10.0	3	10.0	3	10.0
Environment	Environmental	10	10	Impact to Existing Environmental Features (i.e. Riparian Corridor, Habitat, etc.)	1: Significant Negative Impact 2: Moderate Negative Impact 3: No Impact / Positive Impact	3	10.0	3	10.0	3	10.0
Project Timing	Project Timing	10	10	Dependency on other Projects	1: Dependent on other projects 3: No dependence on other projects	1	3.3	1	3.3	3	10.0
Social	Social	10	10	Element of Comprehensive Plan (Parks, Transportation, Planning, etc.)	1: No elements in other plans 2: Related to elements in other plans 3: Multiple elements other plan	1	3.3	1	3.3	1	3.3
							63.3		**63.3**		**83.3**
					PROJECT RANK:		**6**		**6**		**1**

Appendix D

Drainage Project Cost Analysis and Potential Funding Study

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BASTROPTX
Heart of the Lost Pines / Est. 1832

NewGen Strategies & Solutions

www.newgenstrategies.net

REPORT

DRAINAGE PROJECT COST ANALYSIS AND POTENTIAL FUNDING STUDY

APRIL 2023

Prepared for:
City of Bastrop, TX

NewGen Strategies & Solutions

275 W Campbell Road
Suite 440
Richardson, TX 75080
Phone: (972) 680-2000

April 2023

Fabiola De Carvalho
Director of Engineering and Capital Project Management
City of Bastrop
1311 Chestnut Street
Bastrop, TX 78602

Subject: Drainage Project Cost Analysis and Potential Funding Study – Report

Dear Ms. De Carvalho:

In conjunction with the Drainage Master Plan and Drainage Fund Study (Study) being conducted by Halff Associates, Inc. (Halff), the City of Bastrop, TX (City) engaged NewGen Strategies & Solutions, LLC (Project Team) to prepare a financial plan specific to the City's cost of service associated with the provision of Stormwater services (Stormwater or Drainage) and to develop projected rates for the potential drainage funding specific to Fiscal Years (FY) 2023 through FY 2027. This report describes the analysis performed by the Project Team and makes recommendations with respect to prospective rates for a dedicated drainage funding source.

Drainage as a Utility

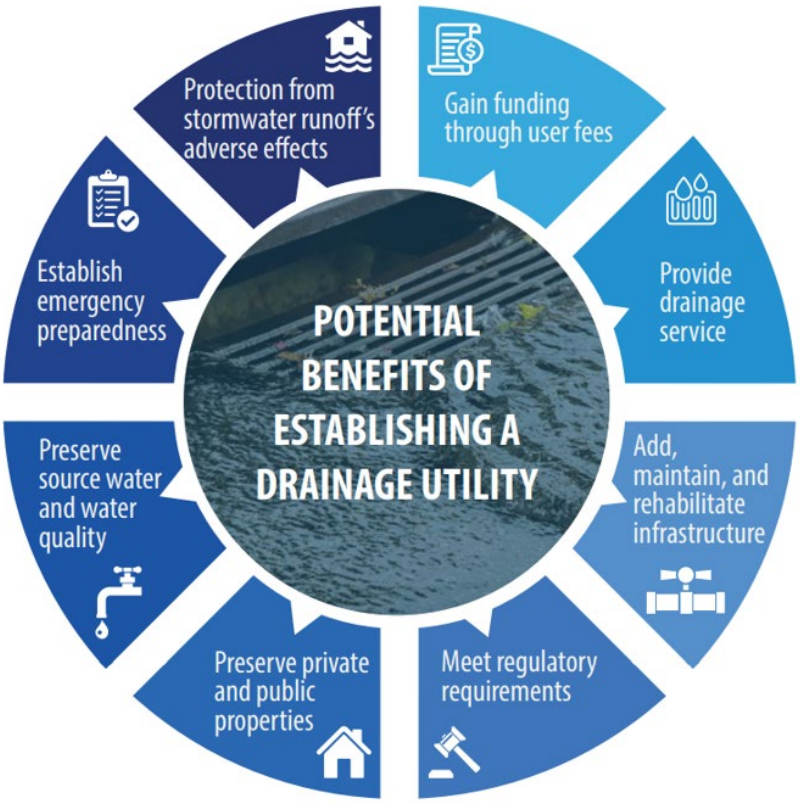
Establishing a Drainage or Stormwater Utility is a viable strategy for local governments to respond to the challenge of generating reliable revenue to support stormwater management activities. Setting up a drainage utility allows a community to establish a user fee based on the demands property owners place on the drainage system. It subsequently provides a dedicated revenue stream for stormwater programs.

There are several benefits to a local government of a dedicated drainage utility fee. These are visualized in Figure 1 on the next page, but the most commonly cited are described below:

- **Revenue** – A dedicated fee generates a stable source of revenue to fund stormwater BMPs.
- **Structure** – A distinct utility creates an organized entity to solve the problems regarding stormwater management including aging infrastructure, operation and maintenance, development, and legal challenges.
- **Environment** – Increased focus on stormwater issues such as erosion, flooding, preservation of source water and water quality can encourage environmental initiatives.
- **Regulation** – A dedicated Drainage Utility can focus on meeting the requirements of TPDES permits and other regulatory mandates.

Most importantly, a stormwater utility provides the means of collecting the revenue required to construct and maintain large stormwater capital improvements needed to help protect City businesses and residents from the effects of flooding.

Figure 1: Benefits of a Drainage Utility



There are several funding mechanisms that may be used to generate revenue for the operation of a stormwater utility. Examples are ad valorem taxes, rates based on lot size, and fees based on impervious area. Each funding mechanism has benefits and disadvantages. When deciding the funding mechanism of a stormwater utility a balance must be made between the administrative simplicity and understandability of the fee and the detail and equity by which it allocates costs to customers.

In all cases, assumptions and allocations must be made due to the impracticality of measuring the actual runoff contribution of each customer parcel within a stormwater system. In general, impervious area is considered the most equitable funding mechanism for a stormwater utility because it most accurately reflects the stormwater contribution of each customer's parcel to the system.

Financial Plan Development

To develop the forecasted costs and revenues for the City's potential Drainage Utility, NewGen coordinated City staff, as well as with Halff Associates. The forecasts contained herein are estimates based on the latest available data and may change materially with changes in assumptions and the timing at which decisions are made to implement key policies. As the City makes decisions on the path forward, NewGen recommends updating the forecast with the latest available data.

The Project Team met with City staff multiple times to consider the City's existing activities as well as any potential new activities/services. In development of the financial plan, the Project Team included costs as applicable and allowed under Section 522.044 of the Texas Local Government Code. Such costs may include the following:

- Cost of land acquisition;
- Capital cost of stormwater management facilities;
- Professional services fees including, but not limited to, architectural, engineering, planning, financial, and/or legal services;
- Operations & maintenance (O&M) and major repair and replacement expenses associated with stormwater facilities;
- Cost of rolling stock and other machinery and equipment;
- Interest and issuance costs associated with financing;
- Amortization of non-recurring costs (i.e., start-up costs, etc.);
- Direct and indirect administrative cost including, but not limited to, support services costs (i.e., utility billing, etc.); and;
- Any anticipated revenues from any ancillary funding mechanisms (i.e., revenue offsets).

The expenditures and estimated applicable revenues projected for FY 2023 and into the future based on the City's projected CIP and projected O&M costs, estimated annual inflation, and estimated customer growth are summarized in the remainder of this report.

Revenue Requirement

To develop the Test Year FY 2023 Revenue Requirement (i.e., the first year for which rates are developed), NewGen held discussions with City staff to determine the planned services and associated costs initially for this new utility. NewGen was able to meet with the City's Finance Director, Public Works Director as well as the Director of Engineering and Capital Project Management to gather cost details. This included the identification of a number of programs that could transition from the Streets and Administration Departments to this new utility. These and other future year additions were forecasted through FY 2027 as shown below.

Existing Operations and Debt Expenses

To estimate the current expenses for Stormwater activities, City staff estimated approximately ten percent of the Administration Department and twenty-five percent of the Streets Department were related and allocable to the prospective utility. A number of accounts were reviewed; some accounts were excluded since they were for street specific expenses. The sum of assigned expenses for Administration

and Streets were approximately $44,000 and $299,000 respectively. Expenses include general supplies, uniforms, personal protective equipment, along with various contractual services. Lastly, twenty percent of the most recent bond issuance, 2023 Certificates of Obligation was assigned as a possible expense for the Stormwater Utility. Payments for this portion would be approximately $500,000 annually.

New Personnel

Four total new employees are included in the five-year revenue requirement, with one Maintenance Worker being added in each of the last four years of the projection to support Stormwater operations. To reflect needed personnel specific to the increased management of stormwater within the City, NewGen worked with City staff to project personnel needs beginning in FY 2024 as listed in Table 1-1 below.

Table 1-1: Estimated Personnel Need

Position Description	Estimated Costs	First Year Funded
Maintenance Worker	$ 65,000	2024
Maintenance Worker	$ 65,000	2025
Maintenance Worker	$ 65,000	2026
Maintenance Worker	$ 65,000	2027

Annual wages and benefit cost estimates for the Maintenance Workers in FY 2023 dollars were provided by the Finance Department. These are assumed to increase by 5% per year.

Operational Expenses

In addition to staffing, other operational expenses were identified. Table 1-2 below reflects these needs and outlines a few specific funding requests. Additional professional services are expected for support with additional project management. The storm drain evaluation and drainage criteria review are both one-time projects and only impact the FY 2023 budget. The creek maintenance plan is expected to continue each year and will increase with inflation.

Table 1-2: Estimated Non-Personnel Operational Expenses

Position Description	Estimated Costs	First Year Funded
Professional Services	$ 50,000	2023
Creek Maintenance Plan	$ 20,000	2023
Storm Drain Evaluation (One-Time)	$ 350,000	2023
Drainage Criteria Review (One-Time)	$ 30,000	2023

Capital Projects

The Drainage-related CIP has been outlined in great detail in the Drainage Master Plan Document. The total listing of projects is over $128,400,000. Given that the Drainage Utility will be new and other operational expense demands, it is not currently assumed the Drainage Utility will undertake all the CIP projects provided in the Masterplan within the five-year financial forecast period. The ultimate rate to charge, if any, will be determined by the City Council. Based on the fee set, some expenses and projects may be delayed beyond FY 2027. Figure 2 below outlines a funding scenario for various CIP projects that could be funded over the next five years with corresponding rate impacts to the fee. For example, if $30 are added to the total fee for the new CIP, the City could undertake the top five projects with an orange check mark under the $30 fee column. This is in stark contrast to the listing of only two projects under the

blue $10 fee column. It is important to note that this is not the total fee, but rather only the portion expected for CIP.

This estimate is provided but warrants additional review in subsequent years given the rapidly changing capital cost and interest rate environment at the time of this review. Alternatively, if market conditions make the cost of borrowing higher than expected or desirable for the City, the City may choose to complete these over a longer timeframe such as 20-25 years.

Figure 2: CIP Project Listing by Funding Option

Project Name	Ranking Value	Base Cost FY 2023	$10 Funding for New CIP	$12 Funding for New CIP	$30 Funding for New CIP
Detention Pond at Hunters Crossing	83.3	$ 708,700	✓	✓	✓
Gills Branch Flood Mitigation Improvements	73.3	14,049,500	✓	✓	✓
SH-95 at Gills Branch	71.7	687,600		✓	✓
Riverwood Dr. at Piney Creek	68.3	2,290,300		✓	✓
Water, Spring, & Cedar St. Drainage	66.7	25,663,500			✓
Local Storm Drain Improvements Near Piney Creek	63.3	5,140,300			
Pecan St. Bypass & Pond Diversion	63.3	23,727,600			
Hill, Pecan, & Pine St. Drainage	63.3	8,701,000			
Pecan, Beech, & Haysel to Gills Branch	61.7	20,557,300			
SH-95 at Piney Creek (2% ACE LOS)	60.0	6,718,600			
SH-95 at Piney Creek (1% ACE LOS)	58.3	13,612,800			
Basin RV Resort at the Colorado River	0.0	2,250,000	*Not ranked based on nature of project*		
Mercedes Cove at Piney Creek	0.0	4,340,000	*Not ranked based on nature of project*		
Total		**$ 128,447,200**			

Inflation Assumptions in the Five-Year Financial Plan

The development of the five-year financial plan utilized FY 2023 as the base year for revenue requirement projections through FY 2027. Inflation factors were estimated and applied to the Test Year data. These factors are discussed in more detail below. It is worth noting that at the time of this Study and report, the United States has been recording record inflation figures relative to the last few decades. That said, the estimates derived in conversation and through City staff input are already informed with those adjustments. Therefore, the inflation adjustments scheduled for FY 2024-2027 rely heavily on the twenty-year historical averages.

- General – A general inflation factor of 3.2% was applied to all line-items not discussed specifically below per the 20 Year Average Municipal Cost Index developed by American City and County as of Dec 2022.
- Personnel – An inflation factor of 5.00% was applied to all salaries, wages and benefits costs, based on conversations with City staff.
- Construction Cost Index (CCI) - 20 Year Average Engineering News Record 3.45% as of February 2023.

- Growth – Growth was assumed to be 3.09% Residential Accounts per year, per the 2022 State Water Plan projected population growth for Bastrop.

Drainage Utility Fee Basis and Billing Units

The Project Team developed rate scenarios for stormwater based on Equivalent Residency Units (ERU). The Project Team relied on Halff Associates GIS analysis to calculate ERUs per customer based on impervious square footage. This impervious cover was determined for every parcel in the City. Then Single Family (State Code A1) parcels were averaged to determine Bastrop's ERU value as 3,238 sq ft.

From the same impervious surface analysis, Halff was able to determine that Non-Residential Parcels in Bastrop contain just over 22.23M sq ft of impervious area. To set the total paid by non-residential parcels equitably, we determine each parcel's relative number of ERUs. Dividing this total by the ERU value determined as 3,238 results in 6,866 Non-Residential ERUs. This calculated value plus the Residential count of 3,420 makes the total observed ERUs approximately 10,286.

Since neither the Project Team nor the City have completed the Utility Billing matching effort, it is assumed some of the values may not ultimately get assigned to an account or billed. NewGen made a five percent adjustment reducing the total billing units to account for this uncertainty. Additionally, since this is billed normally on water bills, which are occasionally inactive and unbilled, NewGen has made a second adjustment of 5% for non-billed and nonpayment potential. These adjustments reduce the monthly billable ERUs to 9,257.

Table 1-3 below reflects the expected billable ERUs less the adjustments mentioned, plus growth to derive annual revenues for several fee levels. Notably, FY 2023 only assumes six months of billed revenue to allow for City implementation of the fee and updates in the Utility Billing system.

Table 1-3: Calculated Drainage Utility Fee per ERU

	2023	2024	2025	2026	2027
Monthly ERU Assumption	9,257	9,543	9,838	10,142	10,455
$3 / ERU Annual Revenue	$ 166,626	$ 343,548	$ 354,168	$ 365,112	$ 376,380
$6 / ERU Annual Revenue	$ 333,253	$ 687,096	$ 708,336	$ 730,224	$ 752,760
$9 / ERU Annual Revenue	$ 499,879	$ 1,030,644	$ 1,062,504	$ 1,095,336	$ 1,129,140
$12 / ERU Annual Revenue	$ 666,506	$ 1,374,192	$ 1,416,672	$ 1,460,448	$ 1,505,520
$15 / ERU Annual Revenue	$ 833,132	$ 1,717,740	$ 1,770,840	$ 1,825,560	$ 1,881,900

It is worth noting here that the City has made no determination on discretionary exemptions. The City has some discretion in exempting or partially exempting the fee to a number of customer classes per the statute. Should the City choose to exempt any eligible property owners, the revenue potential for the utility may decrease equal to the ERUs exempted.

Drainage Fund Study Rate Recommendations

Given the results of operational revenue requirements and substantial capital needs, NewGen recommends the City consider the level of service desired and take steps to adopt a fee that supports the new utility based on this Study's findings.

NewGen Strategies & Solutions

THANK YOU!

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