Town of Christiansburg
Downtown Watershed Study

www.christiansburg.org/watershed

June 12, 2018

17.0626.001

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LIST OF APPENDICES

Introduction

The Town of Christiansburg recently received a 2017 Dam Safety, Flood Prevention, and Protection Assistance Fund (DSFPPAF) grant from the Virginia Department of Conservation and Recreation (DCR) to conduct a downtown watershed study.

The goal of this study is to evaluate drainage and flooding concerns along Town Branch (a tributary to Crab Creek that flows through Downtown Christiansburg) and its floodplains, and to develop a list of recommended drainage improvements for the Town, to reduce or eliminate flooding concerns in the watershed. These potential projects would be prioritized and ranked to assist the Town in capital improvement planning.

The Town Branch Watershed at its confluence with Crab Creek encompasses 1,284 acres of contributing drainage area that include the downtown area and surrounding residential neighborhoods. Runoff originates in three primary watersheds that come together in downtown Christiansburg. The combined runoff then drains along S. Franklin Street to Depot Street, and then into the Town Branch floodplain towards Crab Creek, going through Depot Park.

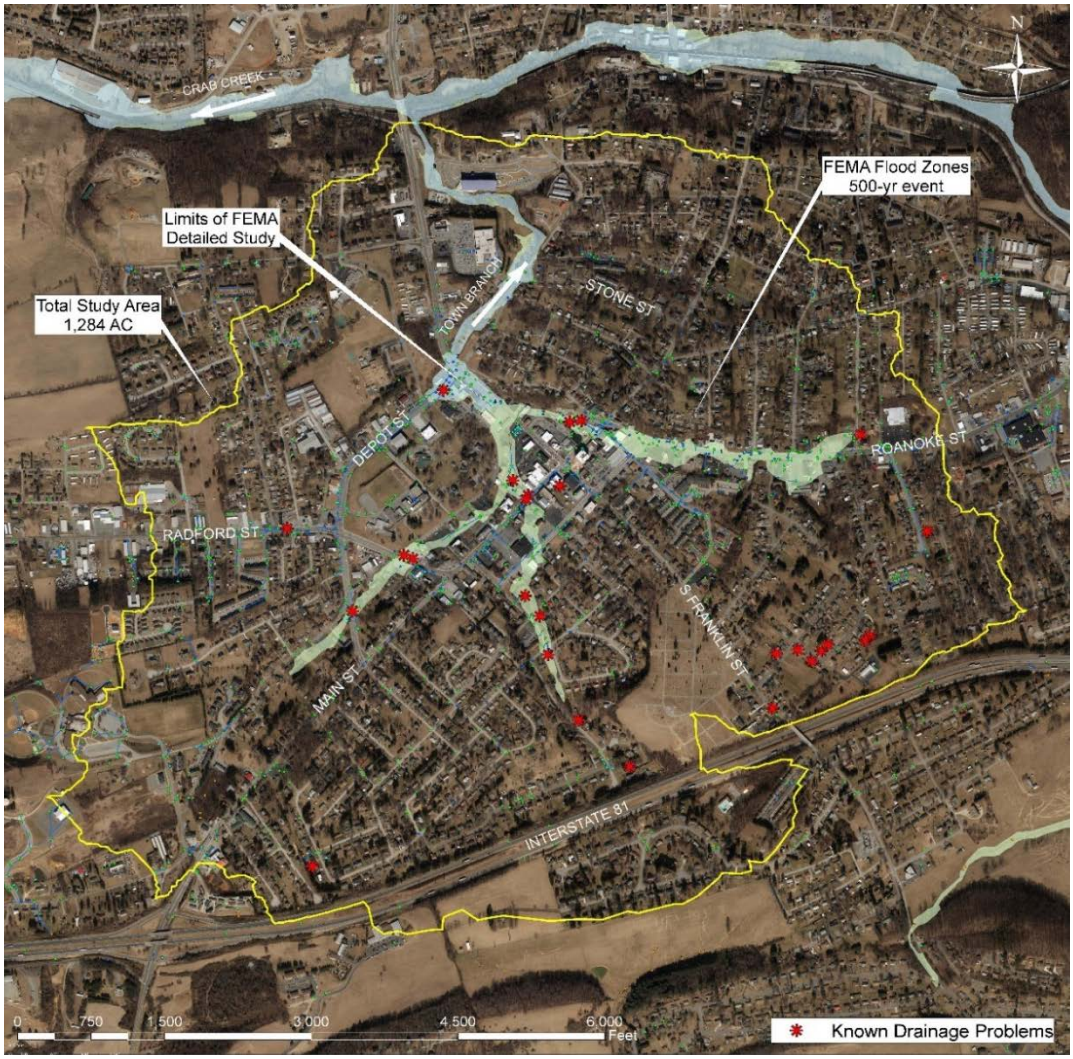


Exhibit A – Watershed Map

Flood History

A storm event occurring on September 29, 2015, resulted in flooding at several locations throughout the watershed. One area of concern, was the residential properties along Phlegar and Chrisman Streets that are located along the middle reach of the watershed, running north-south from I-81 into the downtown area. After the 2015 storm event, a preliminary Town estimate of $1.5 million was developed for improving drainage in this area, primary benefitting 27 residences.

Exhibit B – Flooding on Chrisman Street

Other initial concerns related to flood history include areas of standing water, public drainage systems underneath existing buildings, and the overtopping of Stone Street at Town Branch.

Scope of Work

This study will help to identify and understand the drainage concerns through a review of available Town records and a community meeting. Then using hydrology and hydraulics, the study will provide a closer look at the reported drainage problems, to develop recommended solutions with preliminary sizing of drainage improvements. Solutions will include preliminary budgets for project costs, and a ranking of the recommended drainage improvements. Results will be presented during a second community meeting, and then presented to Town Council for adoption of this plan as the basis for future drainage improvements in the Town Branch Watershed.

Task 1 – Data Collection and Review

A. Morton Thomas and Associates, Inc. (AMT) was retained on October 27, 2017 to prepare this watershed study. The first task was to collect and review available information about past flooding, and other related baseline information as summarized below.

Town GIS Data

The Town provided geographical information system (GIS) databases and mapping for the entire study area, including aerial map images, topography, drainage infrastructure, public utilities, soil classifications, floodplains, waterways, roadways, land use mapping and property ownership (parcel data). A data request agreement was signed by AMT on August 28, 2017 for the Town to release the information for this study. GIS information was then collected through a project FTP site, and setup for mapping and analysis of the watershed.

Record Drawings (Town & VDOT)

AMT compiled more than 40 electronic PDF copies of design / record drawings from within the study area, from both VDOT and the Town, depicting roadways, parking lots, and other infrastructure. This information included AutoCAD drawing files for downtown development plans along West Main and North Franklin Street. These records were utilized to evaluate and close gaps in the Town's GIS database, and to improve the accuracy of the engineering evaluations and modeling developed for this study.

Records of Drainage Complaints

Past history of drainage complaints including flood photos were obtained and reviewed to help establish the initial GIS mapping for known drainage problem locations. Each complaint was geo-located with a comment as to the type of problem being encountered. Additional information on drainage complaints was also obtained during Community Meeting No. 1, for this study, and incorporated into the new GIS database developed with this study.

Town Branch Stream Restoration Project

Hydraulic modeling of the existing Town Branch floodplain from N. Franklin Street to Crab Creek was initially based on Town provided HEC-RAS hydraulic models. The models were developed by Wetland Studies and Solutions, Inc. (WSSI) as part of the stream restoration design project in Depot Park, which was recently built. The resulting hydraulic models for this project utilized the "proposed conditions" modeling by WSSI to reflect the anticipated conditions post-construction in this section of Town Branch.

North Franklin Street Drainage Improvements, Phase I

The survey base mapping for a drainage improvement project on North Franklin Street, recently developed by Gay and Neal Inc. (GNI) was obtained for our use on this study. Subsequently, the engineering design plans being developed by GNI for the Town were provided and coordinated with this study, so that the resulting hydrologic and hydraulic modeling for this study could be utilized by the Town as supporting information for the GNI design.

Hickok Street Drainage Improvements, Phase I

This study includes the preparation of a consultant study to supplement a VDOT revenue sharing application package submitted by the Town to VDOT in late October 2017. The requested VDOT funding is to address known drainage problems near West Main Street and Hickok Street in the

downtown area. For this, prior West Main Street improvement plans, including AutoCAD drawing files were provided by the Town for review and use as a basis for this study.

Church, Rigby and Ellet Drainage Improvements

The Town provided the 2017 bid results for this recent project, to utilize in developing engineering estimates of anticipated construction costs for the planned drainage improvements in this study. Similar construction work is planned by the Town in these study recommendations.

FEMA Floodplain Data

The Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Montgomery County was reviewed and utilized as a basis for this study. Hydrologic and hydraulic results for Town Branch were used as a basis for comparison, as well as the floodplain limits depicted on the floodplain delineations included in the Town GIS data and the FEMA Flood Insurance Rate Map (FIRM Panel #51121C0143C, effective date September 25, 2009).

NRCS Soils Data

Web soils survey data that is available through the Natural Resources Conservation Service (NRCS) online was collected and utilized to augment the Town GIS database, to establish prevailing soil types throughout the watershed and for use in the hydrology modeling.

Task 2 – Supplemental Surveying

Based on the compiled data for this study under Task 1, a plan to conduct field and supplemental surveying of existing drainage systems was established for this project. Surveying included the following services for this study.

- Survey notification by the Town as to the planned fieldwork to survey and investigate drainage problems in the watershed.
- Work maps showing the areas where record drawings for existing drainage systems were unavailable or unclear, requiring supplemental surveying.
- Surveying for the floodplain and existing storm drain systems, as required for this study. This includes field photos, sketches, and benchmarks tied to other recent surveys in the downtown area, as a basis for this study.
- Surveying and photographs of any high-water marks.
- Aerial imagery collected by flights in the upstream and downstream directions through each of the three reaches of Town Branch including the downtown area, and the downstream floodplain to the confluence with Crab Creek.

The supplemental survey data collected for this study will also be provided to the Town in a GIS compatible electronic format, for documentation of the existing drainage systems in the areas of drainage concern.

Exhibit C – Aerial Imagery of Town Branch at Stone Street

Task 3 – Community Meeting No.1

Known drainage concerns were initially mapped based on coordination meetings with Town staff, then supplemented through a review of record drawings. AMT worked with Hill Studios, as a communications consultant for this study, then worked with the Town to develop a plan for Community Meeting No.1 which was held on October 26, 2017.

Community Meeting No.1 was used to initially present the goals for the study to the public, to collect additional information about known drainage and flooding concerns within the study area, and to talk about the next steps in completing this study. Presentation boards were displayed, along with looped flood photos in a PowerPoint presentation.

Written public comments were received during the meeting and afterwards through the Town's watershed study web page, with written comment sheets. The Town web page also provided the option to sign-up to receive future study updates. Hand written comments on the maps and post-it notes were used to show the location and type of known drainage issues discussed during the community meeting.

All reported drainage concerns were GIS mapped after the meeting, as shown on the watershed map (Exhibit A) depicted in the introductory section of this report. Written comment sheets and flood photos that were received are also in the report appendices.

Task 4 – Conceptual Plan for Hickok Street, Phase I

Early in this study, AMT provided a report containing engineering recommendations and a cost estimate for the Hickok Street Improvements (Phase I). These street improvements include drainage upgrades to portions of Hickok Street and West Main Street. The consultant study was submitted by the Town with a VDOT revenue sharing grant application in October 2017, and the study is also included as an appendix to this report for documentation. The findings of the consultant study can be summarized as follows:

Project Narrative: The Hickok Street Improvements (Phase I) includes a new box culvert along Hickok Street, crossing West Main Street and then turning at Commerce Street to tie back into the existing storm drain system. Hydraulic sizing for the 10-year event ranges from a proposed 8'x3' box culvert to a 10'x4' box culvert, and the project length is approximately 575 linear feet. The project also requires abandonment in place, for the existing storm drain system which crosses diagonally through private properties and under existing commercial buildings in this downtown location creating potential safety concerns. The new drainage system will increase capacity and improve long-term maintenance.

Budget: The preliminary cost estimate for this project (including soft costs and a 20% contingency) is $2,675,722. VDOT revenue sharing funds, if approved, could provide a 50% cost share to the Town for this downtown improvement need.

Schedule: The availability of VDOT revenue sharing funds should be determined no later than July 2018, for the current round of grant applications, and the preliminary project schedule provided to VDOT is summarized as follows:

Design Phase	September 2018 to September 2020
Bid Phase	September 2020 to March 2021
Construction Phase	April 2021 to January 2022

Exhibit D – Town Branch going under a Downtown Building

Task 5 – Watershed Hydrology

The Town Branch watershed is approximately 1,284 acres at its confluence with Crab Creek just downstream of Depot Park. Crab Creek then generally drains to the northwest, until it empties into the North Fork of the Roanoke River. Crab Creek also continues upstream of the confluence with Town Branch, wrapping around downtown Christiansburg to the east and south (southern side of Interstate 81), with topography that makes the contributing drainage area to Town Branch very well defined.

Land uses within the Town Branch watershed are mostly urban, with residential neighborhoods surrounding the downtown area. Land cover is highly impervious including a portion of Interstate 81 in the upper watershed. Storm drain systems collect runoff along three main reaches that combine near the intersection of Depot Street and North Franklin Street. The remaining downstream portion of the Town Branch watershed then drains directly into a natural stream reach, which begins at North Franklin Street and runs in a northeasterly direction through Depot Park to its confluence with Crab Creek near the Aquatic Center.

For the purposes of developing watershed hydrology, GIS software was used to delineate 10 sub-watersheds for contributing runoff estimates as shown in the map below.

Exhibit E – Hydrologic Sub-Watershed Delineations

These sub-watersheds can be described narratively as follows.

Sub-Basin	Table 1 - Watershed Descriptions
1	Begins at the Sunset Cemetery and drains east along Alleghany and Epperly, then north towards Roanoke Street, in residential drainage systems. Then combines with runoff entering the upper portion of the box culvert under Roanoke Street.
2	A smaller contributing drainage area to the lower portion of the box culvert under Roanoke Street, combined with #1, including a portion of the downtown area's runoff from the Courthouse and Town Hall complexes.
3	Begins with runoff from I-81 draining onto the upper portion of a residential drainage system along Chrisman Street and residential areas.
4	The lower portion of the middle watershed, collecting runoff from #3 and draining through the lower portion of a residential drainage system into some larger culverts entering downtown. Once downtown, the runoff from #5 and #6 are also combined with this drainage system.
5	Begins with runoff at Christiansburg Middle School and then residential areas on both sides of West Main Street forming a large branch off the middle reach.
6	This collects runoff from #5 and conveys it to #4 combining near the intersection of Hickok and West Main Street. Includes residential areas becoming more commercial near the intersections with Chrisman and Phlegar, where additional contributing runoff is combined.
7	Begins near 144 Warren Street, which is a light industrial site and then runs along Lee Highway (Radford Street) east to a left turn on Depot Street, which it follows to the intersection of North Franklin Street. Uses are mixed with both commercial and residential properties.
8	Begins on Overlook Drive and drains east towards North Franklin Street, then south to Town Branch. Combining with downtown runoff at North Franklin Street near Depot Street, #8 continues to the Stone Street crossing of Town Branch (behind Kroger).
9	A large residential area draining under Depot Street into Town Branch at Depot Park.
10	A small residential area draining towards North Franklin Street and then north towards the railroad tracks near Crab Creek.

Sub-basin characteristics are noted in the summary table below, with Area #2 having the highest curve number (CN) at 87, and all the curve numbers representing the existing urbanization within the watershed at an average of 80.

Table 2 – Curve Number Data

Sub-basin	Area (sq mi.)	CN	Tc (min)
1	0.359	78	48.5
2	0.084	87	21.4
3	0.309	78	24.4
4	0.126	84	21.6
5	0.268	76	35.6
6	0.162	84	26.1
7	0.245	83	28.2
8	0.102	74	25.6
9	0.276	81	29.2
10	0.075	78	24.0
Total =	**2.006**	**80**	**71.8**

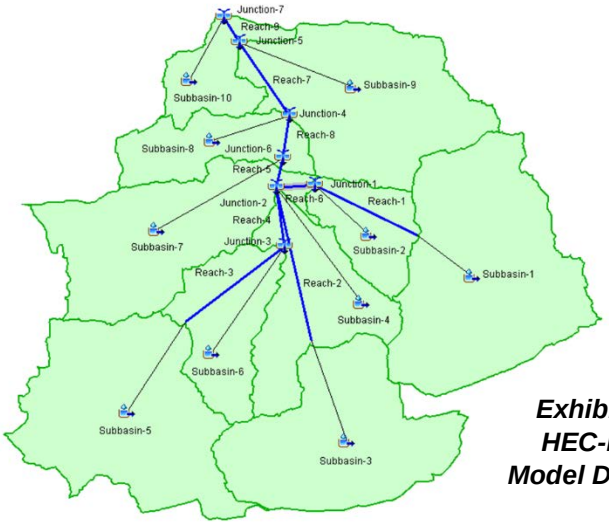


Exhibit F – HEC-HMS Model Diagram

A soil characteristic known as the hydrologic soil group (HSG) for each watershed, was imported into GIS from the NRCS web soil survey and overlaid on the basin delineations. In total, 82.2% of the Town Branch watershed is within the hydrologic soil group (HSG) designation C, as summarized below.

Table 3 – Soils Data

Hydrologic Soil Group	Area (acre)	Percent Area (%)
A	0.0	0.0
B	171.79	13.4
C	1,055.05	82.2
D	56.66	4.4
Total =	**1,284**	**100**

** - Unknown soils were considered to be part of HSG D-soils for this study.*

Exhibit G – Soils Map

Comparison of Peak Discharges

A comparison of peak discharges near the downstream terminus of the Town Branch watershed was made to evaluate model accuracy. A comparison of the HEC-HMS hydrologic modeling results for this study, to other methods including USGS StreamStats, FEMA published data, a single-basin TR-55 model for the watershed, and the peak discharges in the HEC-RAS modeling provided by the Town (WSSI model) are shown below.

Table 4 – Comparison of Peak Discharges

Hydrology Methods	Q2 (cfs)	Q10 (cfs)	Q100 (cfs)
HEC-HMS Model Results	746	1,459	2,830
USGS StreamStats	699	1,340	2,840
FEMA Published Data	N/A	1,360	2,390
TR-55 Model	611	1,320	2,652
WSSI HEC-RAS Model	530	1,515	2,653

HEC-HMS Model results for this study were generally found to be slightly conservative when compared to other applicable methods of estimating peak discharges, which can result in the sizing of drainage improvements that are slightly conservative in the recommendations.

Task 6 – Floodplain Mapping

Using the provided HEC-RAS modeling for the Town Branch Stream Restoration Project, AMT expanded the proposed conditions modeling both upstream and downstream using GIS data and supplemental survey data. The expanded floodplain model now includes Town Branch from its confluence with Crab Creek (downstream) to North Franklin Street (upstream) with cross sections in the locations shown on the map exhibit below.

Exhibit H – HEC-RAS Hydraulic Modeling Reach

Maps delineating the limits of the 2-, 10-, 25-, 50-, 100- and 500-year storms are included in the appendices to this report, along with the HEC-RAS profile and cross-sectional views of the model results. Additionally, the map above shows a comparison between the proposed limits of the special flood hazard area (SFHA) in this study and the existing regulatory limits (Zone AE) to help consider the impacts of a FEMA map revision for the planned drainage improvements.

Here are some observations of the culvert crossings studied within the floodplain:

- The arch pipe under Mill Lane conveys all storm events, up to and including the 500-year storm without overtopping the adjacent roadways.
- The culverts under the access road to the skate park are overtopped for all storm events including the 2-year storm, however the mapped flood limits stay within the lower parking

lot for the Aquatic Center, and do not cause any known flooding concerns. No drainage improvements are currently recommended in this area.

- The culverts under the back entrance road to Kroger (at Stone Street) are overtopped for all evaluated storm events including the 2-year storm, resulting in frequent flooding problems on Stone Street and Depot Street at the stream crossing. The low-lying roadways make it difficult to increase pipe sizes enough to convey the 10-year event. For this reason, we reduced the basis of design, to the 2-year storm (without roadway overtopping). This is still a significant increase in pipe size for the recommended culvert improvement in this location, and a reduction in the peak flood stage at this culvert. Some shallow flooding could still occur as a result, however, for the 10-year event in this location based on this analysis.

Comparison of Peak Flood Stage

Historic flood events were evaluated to be used as a comparison for HEC-RAS model parameters. Two key storm events were identified that outline high water marks and rack lines through field photos taken during the events. Manning's n-values and other hydraulic modeling factors were then adjusted as necessary to establish a good comparison between the flood photos and model results.

This first of these events occurred on September 29, 2015 (see photos in this study) and mentioned flooding due to 1.5" (or 1.6") of rainfall on June 14th within less than two hours, however no additional calibration or comparisons were made to this event since the depth and duration was somewhat unclear. A second event comprised of 4.39" of rainfall over a 6-hour duration on July 5, 2016 was modeled using a 6-hr synthetic storm distribution. Model results were verified and calibrated using a combination of historic photos and field survey elevations.

Special Flood Hazard Area (SFHA)

The HEC-HMS and HEC-RAS modeling results can be utilized as the basis for a Letter of Map Revision (LOMR) to more accurately depict the SFHA boundaries on the FEMA regulatory map for Town Branch. Established hydrology and hydraulics, as well as the supporting models in this study, can also be used as the basis for the design of a culvert replacement at Stone Street.

Assuming the use of the proposed conditions hydraulic model for the LOMR, a Conditional Letter of Map Revision (CLOMR) may be pursued first. This would provide conditional approval by FEMA that the recent construction work on the Town Branch Stream Restoration Project, combined with the culvert replacement at Stone Street, and any future projects on Town Branch could be used for a map revision later. Further coordination with FEMA and DCR is underway as a result of this study to determine the best approach to securing a map revision for Town Branch.

Task 7 – Storm Drain Analysis

Existing storm drain systems were analyzed using Bentley StormCAD software in the locations of known flooding concerns, based on a combination of GIS data, record drawings, supplemental survey, field verification, and design analysis to approximate the capacity to convey the 10-year storm event. Proposed storm drain systems were then analyzed using StormCAD to determine the required pipe and ditch sizes to convey the 10-year storm event without overtopping roadways. The recommended improvements (proposed conditions) are shown on a series of hydraulic grade lines (HGL's) in the report appendices.

Further evaluation of a range of smaller and larger storm events, was not included in this study, but should be evaluated as part of the final engineering design for each recommended drainage improvement going forward.

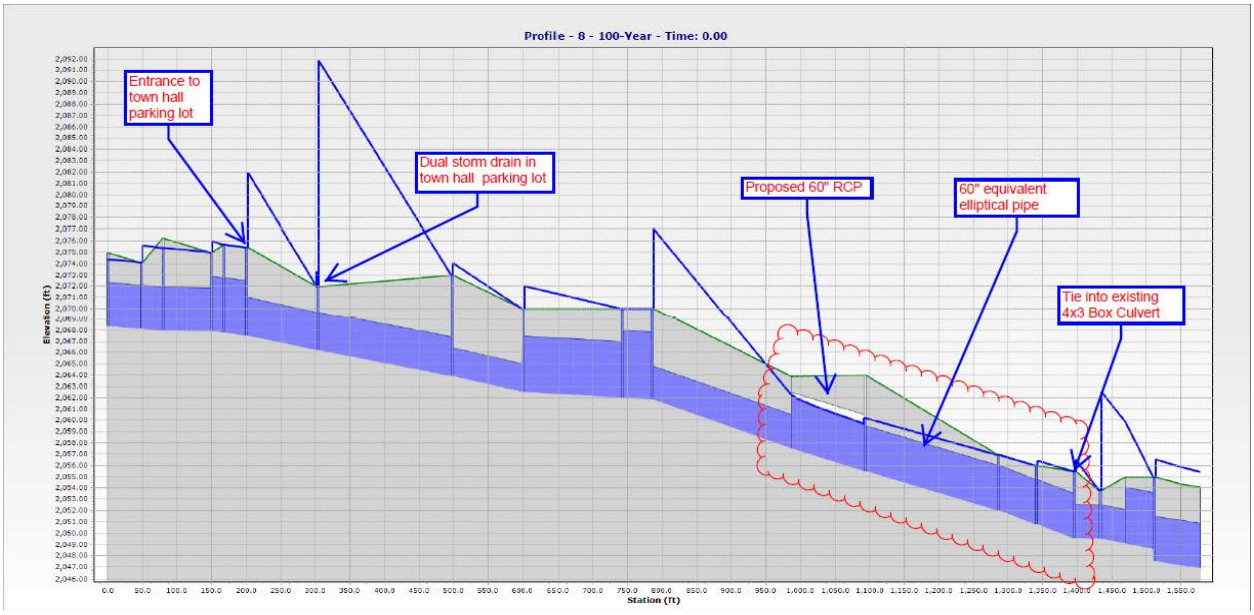


Exhibit I – StormCAD Hydraulic Grade Line (Existing Conditions)

Task 8 – Conceptual Drainage Improvement Plans

The report appendices include conceptual drainage improvement plans developed using GIS and AutoCAD software, that show existing condition (E-1 to E-7) and proposed conditions (P-1 to P-7) storm drain systems in the areas of concern. The maps depict the required pipe sizes in ten (10) locations, totaling an estimated $18 million in recommended improvements to reduce or eliminate flooding concerns in the Town Branch watershed. An opinion of probable cost was developed for each of the recommended drainage improvement projects. In each case, soft costs and a 30% contingency were included in the estimates as a conservative approach to budgeting. Details for each estimate can be found in the report appendices, and a brief narrative description of each drainage improvement is provided below.

Table 5 – Project Descriptions

ID	Project Name	Budget	Description
1	Chrisman / Phlegar Street Drainage Improvements: Phase I	$2,800,000	This project collects runoff from existing 30" RCP and 48" RCP pipes under Interstate 81, and conveys the runoff in a closed drainage system along Chrisman Street, then crossing over to Phlegar Street following the alignment of the existing pipes. Recommended pipe sizes increase from 36" initially, to between 48" and 60" in diameter at 3rd Street SW.
2	Chrisman / Phlegar Street Drainage Improvements: Phase II	$1,300,000	Starting at the intersection of Phlegar Street and 3rd Street SW, this project is a series of small box culverts and open channels that convey runoff from the upper watershed to an existing triple 5'x3' box culvert under 1st Street. The channel alignment requires easements across some private properties, and may include stream stabilization measures.
3	Hickok Street Drainage Improvements: Phase I	$2,700,000	This project conveys runoff in a proposed 10'x4' box culvert under Hickok Street SW to the intersection with Commerce Street, removing a section of drainage conveyance that goes under the existing buildings on West Main Street. Runoff is conveyed either north along Commerce Street to a connection with the existing 72" CMP or west along Hickok Street to College Street, where it connects to the College Street Drainage Improvements (Phase I).
4	College Street Drainage Improvements: Phase I	$4,250,000	This project improves drainage by connecting the Hickok Street Drainage Improvement to a proposed 10'x4' box culvert under College Street, which conveys runoff to Depot Street. At Depot Street, a 12'x4' box culvert connects to a recommended quadruple 5'x5' box culvert for the last section of piping, to the outfall into Town Branch. This improvement also requires a connection to the 48" RCP in Depot Street and the Triple 5'x4' box culvert in North Franklin Street, as parallel drainage systems.
5	College Street Drainage Improvements: Phase II	$2,750,000	This project improves drainage, starting with known flooding concerns at the intersection of College Street / Radford Street, and running along College Street in a 6'x4' box culvert. At Hickok Street, the 6'x4' box culvert combines with the runoff from the Hickok Street Drainage Improvement, to be conveyed downstream under College Street (Phase I).
6	North Franklin Street Drainage Improvements	$1,500,000	This project is currently being designed for the Town, using VDOT revenue sharing funds. It requires a combination of 42" and 60" pipes to collect runoff from below the parking lots at Town Hall, and improves conveyance of this runoff to the outfall at Town Branch. It also eliminates a section of existing storm drain that is going under some buildings on North Franklin Street.
7	Radford Street Drainage Improvements	$1,100,000	This project is smaller than some others in the downtown area, and addresses clogged inlets and undersized pipes along the north side of Radford Street. By increasing the pipe size from 15" to 24" and adding adequately sized throat lengths on the drainage inlets, runoff can be intercepted and conveyed into the existing 36" RCP at Lee Hy Court, then draining along Radford Street to Depot Street and into the downtown area. New sidewalks may also be considered for this area.
8	Alleghany St / Canaan Rd / Epperly Drive: Drainage Improvements	$750,000	This project helps address surface water and groundwater concerns from the Sunset Cemetery and Alleghany Street in areas along Canaan Road and Epperly Drive, by replacing existing 15" pipes with 24" and 30" pipes. Runoff is then conveyed into the rear yards on the south side of Epperly Drive, behind the First Church of God, with a pipe extension to an existing stormwater management basin (dry detention). During engineering design, the Town may choose to retrofit the existing basin to help proect existing drainage systems downstream and to promote improved water quality in the watershed.
9	Stone Street Culvert Replacement at Town Branch	$640,000	This project replaces an existing quadruple 48" CMP with a dual 10'x5' box culvert, providing increased capacity to convey the 2-year storm under Stone Street without overtopping onto Depot Street. 10-year and 100-year flood depths are reduced with this culvert replacement. Possible impacts of the larger pipes on the stream restoration project in Depot Park will need to be evaluated, as well as the flood reduction benefits of eliminating the abandoned bridge near Stone Street. Enhanced water quality can also be considered with this project, by developing a stream restoration project from Stone Street to North Franklin Street, creating a linear park or greenway concept.
10	Roanoke Street Drainage Improvements	$210,000	This project begins at an existing curb inlet near Wade's Foods which has a small diameter pipe draining to Craig Street. The recommendation is to eliminate runoff from Craig Street into the open channel behind 500 Roanoke Street by installing a storm drain system that conveys runoff from the Wade's Foods parking lot and Craig Street to Roanoke Street, where it ties into the existing storm drain system.

Task 9 – Project Prioritization and Ranking

To prioritize and rank each of the ten (10) drainage improvements, this study includes scoring criteria applied to each project, including a cost effectiveness ranking based on dollars per watershed acre. The detailed calculations for rank and cost effectiveness are shown in the appendices, and the results are summarized below.

Table 6 – Prioritization of Drainage Improvements by Rank

Rank	ID	Description	Score
1	6	North Franklin Street Drainage Improvements	71
2	9	Hickok Street Drainage Improvements: Phase I*	68
3	3	Stone Street Culvert Replacement at Town Branch*	68
4	4	College Street Drainage Improvements: Phase I*	67
5	2	Chrisman / Phlegar Street Drainage Improvements: Phase II*	56
6	1	Chrisman / Phlegar Street Drainage Improvements: Phase I	56
7	8	Alleghany Street/Cannann Road/ Epperly Drive: Drainage Improvements*	53
8	5	College Street Drainage Improvements: Phase II	53
9	10	Roanoke Street Drainage Improvements	37
10	7	Radford Street Drainage Improvements	25

* Possible water quality improvement opportunity

This summary table does not include potential project details associated with water quality improvements, such as new best management practices (BMP's), BMP upgrades, and stream restoration opportunities within the Town Branch Watershed. These would be additional benefits that help address pollutant sources from urbanized runoff, but additional costs would also apply when incorporating them into the engineering design approaches for each project.

Community Meeting #2

A second community meeting was held on May 10, 2018, where the Town presented the initial drainage improvement recommendations and discussed the benefits of reducing flood risks through these projects within the Town Branch Watershed. Meeting materials are in the report appendices and include a preliminary matrix of project benefits and costs, as well as the ranking criteria utilized for the study recommendations. Based on input during the meeting and a public comment period to follow, these study recommendations were refined for a presentation of the final report and rankings to Town Council on June 12, 2018.

After the Town Council presentation, the results will be finalized with website updates and a final report, prior to closing out the DCR grant and securing a FEMA floodplain map revision.

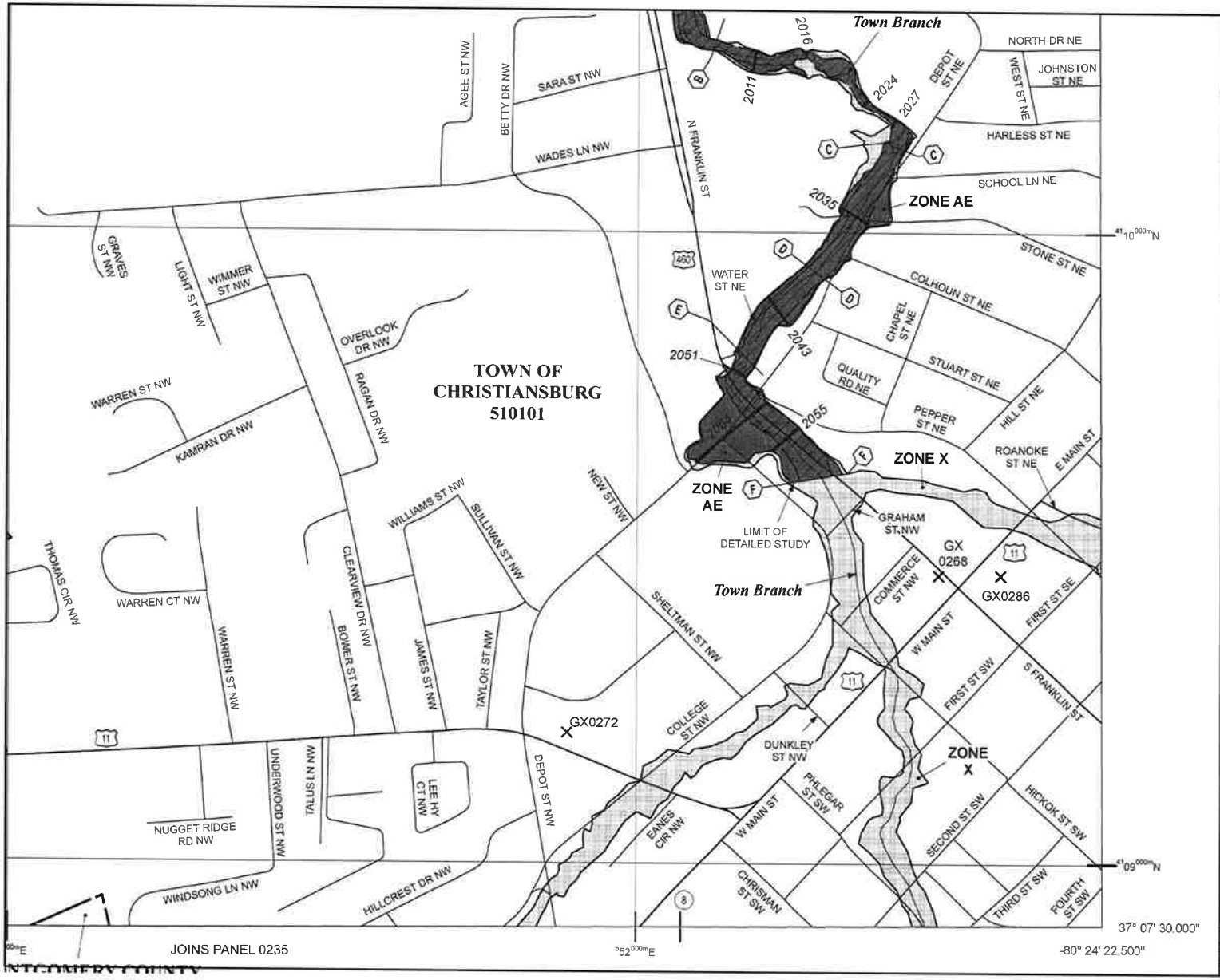
Walkable Watershed Concept

The drainage improvements proposed in this study provide the opportunity for an integrated planning approach to improve water quality and community health as a whole. Through a walkable watershed concept, the Town can address flooding issues along Town Branch, while developing a system of multi-use trails that better connect people to and within the Downtown Area.

These strategies include interpretive stream restoration projects along Depot Street and Graham Street, as well as a linear park extension to Depot Park. Stormwater management solutions are also incorporated in this concept and include green street design opportunities along Depot, College and Hickok Streets, including the road closure area for the Farmers Market om Hickok. These green streets connect downtown to the greenway trails extending to Depot Park downstream as Town Branch drains to Crab Creek..

Building upon the success of the Town Branch stream restoration project at Depot Park, completed earlier this year, the walkable watershed concept creates the potential for multiple benefits such as improved walkability, outdoor education, health, revitalization, community stewardship, and water quality.

APPENDIX A
FEMA Data



MAP SCALE 1" = 500'

50 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0143C

FIRM

FLOOD INSURANCE RATE MAP

MONTGOMERY COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 143 OF 345

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

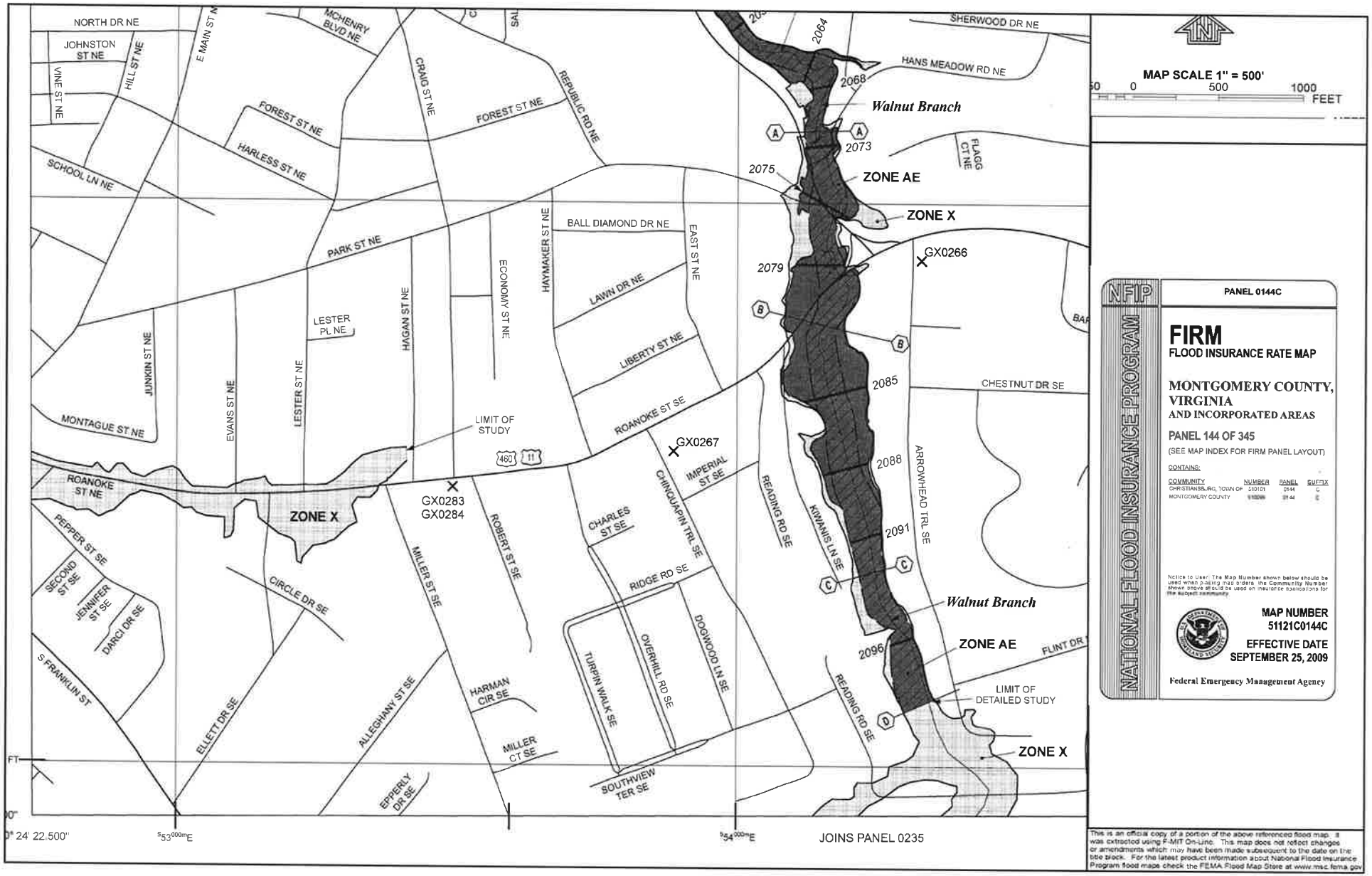
COMMUNITY	NUMBER	PANEL	SUFFIX
CHRISTIANSBURG, TOWN OF	510101	0143	D
MONTGOMERY COUNTY	510508	0143	C

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
51121C0143C

EFFECTIVE DATE
SEPTEMBER 25, 2009

Federal Emergency Management Agency



MAP SCALE 1" = 500'

50 0 500 1000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0144C

FIRM

FLOOD INSURANCE RATE MAP

MONTGOMERY COUNTY, VIRGINIA

AND INCORPORATED AREAS

PANEL 144 OF 345

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

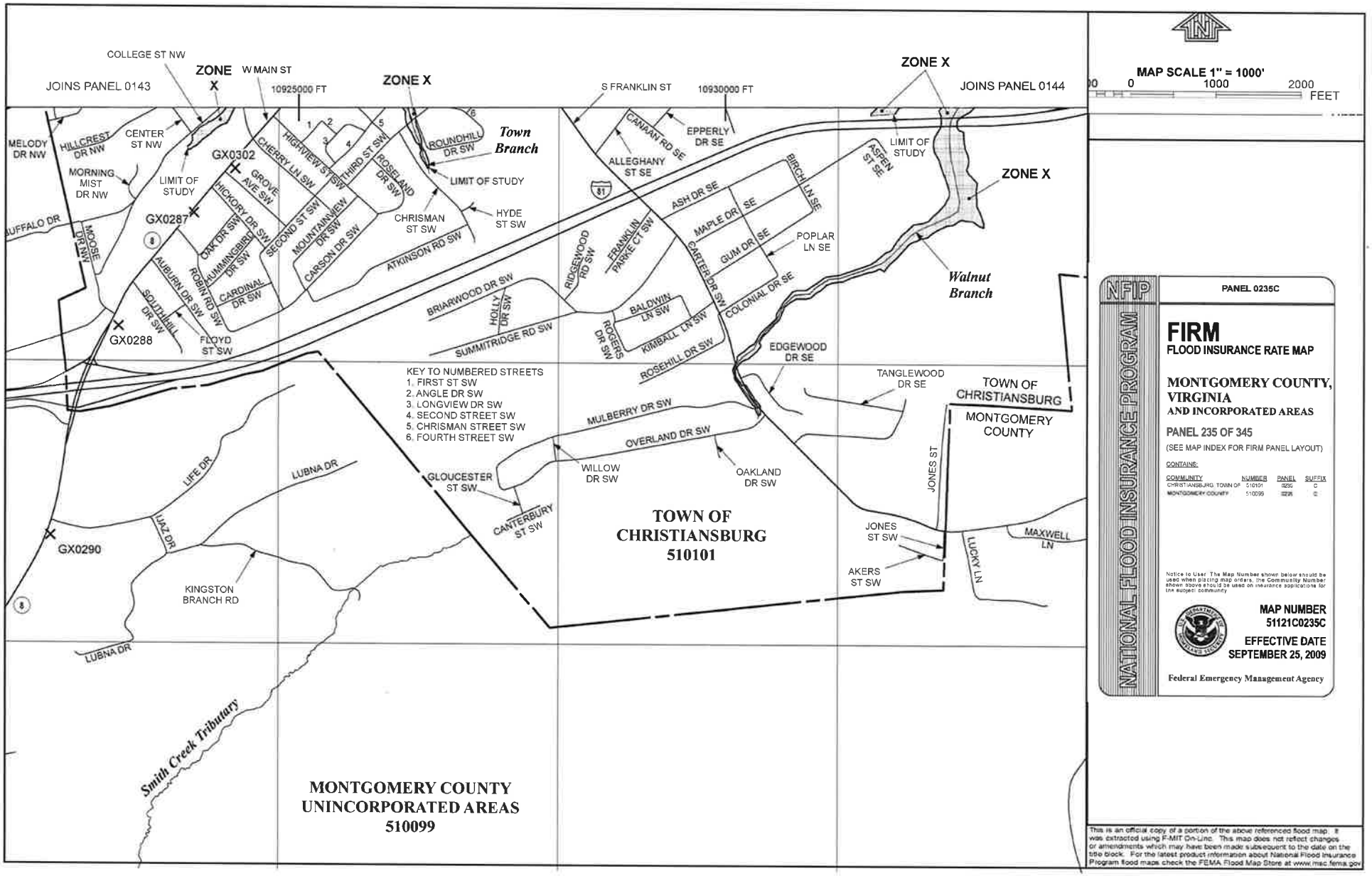
COMMUNITY	NUMBER	PANEL	SUFFIX
CHRISTIANSBURG, TOWN OF	510101	0144	C
MONTGOMERY COUNTY	[illegible]	0144	C

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
51121C0144C

EFFECTIVE DATE
SEPTEMBER 25, 2009

Federal Emergency Management Agency



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0235C

FIRM
FLOOD INSURANCE RATE MAP

MONTGOMERY COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 235 OF 345

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

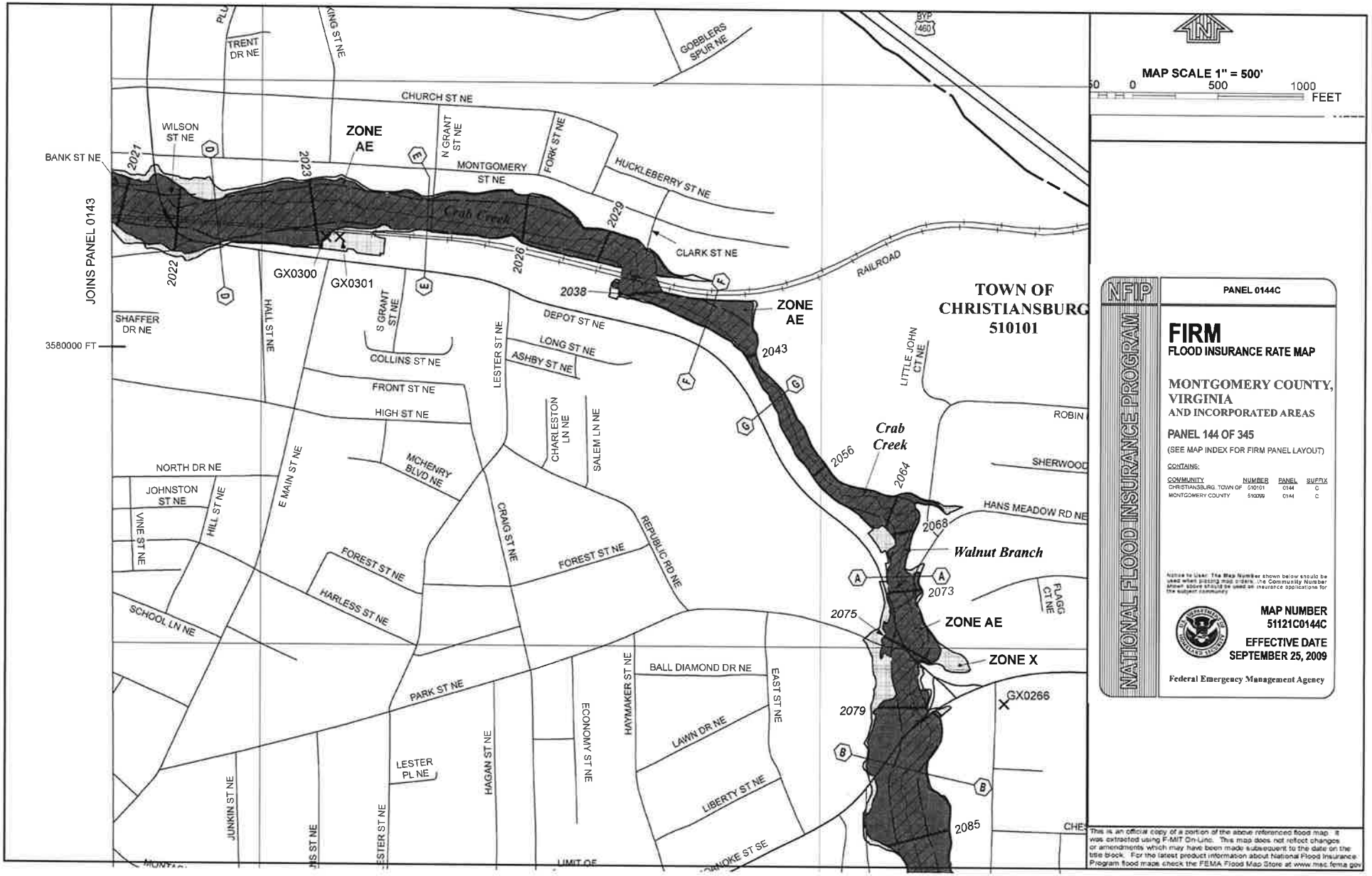
COMMUNITY	NUMBER	PANEL	SUFFIX
CHRISTIANSBURG, TOWN OF	510101	0235	C
MONTGOMERY COUNTY	510099	0235	C

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
51121C0235C

EFFECTIVE DATE
SEPTEMBER 25, 2009

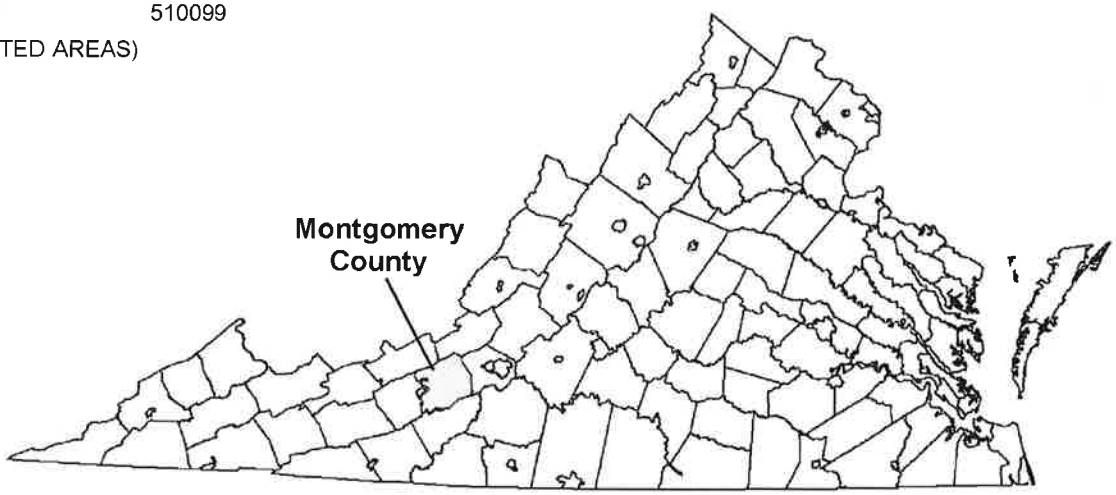
Federal Emergency Management Agency


MAP SCALE 1" = 500'
0 500 1000 FEET
NORTH
TRENT DR NE
KING ST NE
GOBBLERS SPUR NE
BYP 460
CHURCH ST NE
WILSON ST NE
ZONE AE
N GRANT ST NE
FORK ST NE
MONTGOMERY ST NE
HUCKLEBERRY ST NE
BANK ST NE
2021
2023
2029
Crab Creek
CLARK ST NE
2022
2026
RAILROAD
GX0300
GX0301
JOINS PANEL 0143
2038
ZONE AE
TOWN OF CHRISTIANSBURG 510101
SHAFFER DR NE
3580000 FT
HALL ST NE
S GRANT ST NE
COLLINS ST NE
DEPOT ST NE
LONG ST NE
ASHBY ST NE
LESTER ST NE
2043
LITTLE JOHN CT NE
FRONT ST NE
HIGH ST NE
CHARLESTON LN NE
SALEM LN NE
ROBIN
Crab Creek
2056
2064
SHERWOOD
NORTH DR NE
MCHENRY BLVD NE
JOHNSTON ST NE
E MAIN ST NE
HILL ST NE
VINE ST NE
CRAIG ST NE
REPUBLIC RD NE
HANS MEADOW RD NE
2068
Walnut Branch
FOREST ST NE
HARLESS ST NE
2073
FLAGG CT NE
2075
ZONE AE
SCHOOL LN NE
ZONE X
BALL DIAMOND DR NE
EAST ST NE
PARK ST NE
HAYMAKER ST NE
GX0266
LAWN DR NE
2079
LESTER PL NE
HAGAN ST NE
ECONOMY ST NE
LIBERTY ST NE
JUNKIN ST NE
2085
ROANOKE ST SE
LIMIT OF
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0144C
FIRM
FLOOD INSURANCE RATE MAP
MONTGOMERY COUNTY, VIRGINIA
AND INCORPORATED AREAS
PANEL 144 OF 345
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
CHRISTIANSBURG, TOWN OF 510101 0144 C
MONTGOMERY COUNTY 510099 0144 C
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.
MAP NUMBER
51121C0144C
EFFECTIVE DATE
SEPTEMBER 25, 2009
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

FLOOD INSURANCE STUDY

MONTGOMERY COUNTY, VIRGINIA AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
BLACKSBURG, TOWN OF	510100
CHRISTIANSBURG, TOWN OF	510101
MONTGOMERY COUNTY (UNINCORPORATED AREAS)	510099



REVISED:
JANUARY 6, 2012

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
51121CV000B

Blacksburg, Town of:	In the original study, the hydrologic and hydraulic analyses were prepared by the Wilmington District, U. S. Army Corps of Engineers (USACE), for the Federal Insurance Administration (FIA), under Inter—Agency Agreement No. IAA—H--10—77, Project Order No. 22. That work was completed in July 1978, covered all significant flooding sources in the Town of Blacksburg.
Christiansburg, Town of:	In the original study, the hydrologic and hydraulic analyses were prepared by the Wilmington District, U. S. Army Corps of Engineers (USACE), for the Federal Insurance Administration (FIA), under Inter—Agency Agreement No. IAA—H--10—77, Project Order No. 22. That work was completed in July 1978, covered all significant flooding sources in the Town of Christiansburg.
Montgomery County (Unincorporated):	In the original study, the hydrologic and hydraulic analyses were prepared by the Wilmington District, U. S. Army Corps of Engineers (USACE), for the Federal Insurance Administration (FIA), under Inter—Agency Agreement No. IAA—H--16—75, Project Order No. 21 and Inter—Agency Agreement No. IAA—H—7—76, Project Order No. 1. That work was completed in November 1976. In the 1994 revision, the hydrologic and hydraulic analyses for the Roanoke River, the North Fork Roanoke River, and the South Fork Roanoke River were prepared by the Wilmington District, USACE, for the Federal Emergency Management Agency (FEMA), under Inter—Agency Agreement No. EMW—91—E-529. That work was completed in March 1992.

Planimetric base map information is provided in digital format by the Commonwealth of Virginia and Montgomery County and the Towns of Christiansburg and Blacksburg. Users of this FIRM should be aware that

FLOOD INSURANCE STUDY

MONTGOMERY COUNTY, VIRGINIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs) and/or Flood Boundary and Floodway Maps (FBFMs) in the geographic area of Montgomery County, Virginia, including the towns of Blacksburg, Christiansburg, and unincorporated areas of Montgomery County (hereinafter referred to collectively as Montgomery County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Montgomery County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence, and the State (or other jurisdictional agency) shall be able to explain them.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended and the Flood Disaster Protection Act of 1973.

This FIS was prepared to include the unincorporated areas of, and incorporated communities within, Montgomery County in a countywide format FIS. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, has been compiled from their previously printed FIS reports.

In this countywide revision, no new hydrologic analysis has been performed.

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 2, "Summary of Discharges."

TABLE 2. SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2Percent-Annual-Chance
BOTTOM CREEK					
At confluence with South Fork Roanoke River	12.1	2,850	5,980	8,150	12,970
At limit of detailed study	11.91	2,600	5,250	7,950	12,550
BRADSHAW CREEK					
At confluence with North Fork Roanoke River	18.6	1,900	3,950	6,000	10,100
At Roanoke county line	9.7	1,100	2,650	4,100	7,600
CEDAR RUN					
Lower Study Limit	1.1	800	1,300	1,525	2,800
CRAB CREEK					
Lower Town Limit	5.8	2,300	3,400	3,800	5,980
CRAB CREEK - CONTINUED					
Above Town Branch	3.5	1,620	2,500	2,850	4,700
At Cambria Street	3	1,520	2,350	2,700	4,400
Below Walnut Branch (Upper Study Limit)	2.6	1,470	2,250	2,580	4,150
CRAIG CREEK					
At Craig County Line	10.9	1,900	4,000	6,000	10,200
At limit of detailed study	2.29	450	1,100	1,700	3,950
EAST BRANCH STROUBLES CREEK					
At Mouth	1.7	1,140	1,800	2,070	3,400

TABLE 2. SUMMARY OF DISCHARGES (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2Percent-Annual-Chance
Upper Study Limit	8.2	1,100	2,500	3,700	7,000
TOWN BRANCH					
At Mouth	2.1	1,360	2,090	2,390	3,690
At North Franklin St. (U.S. Route 460)	1.6	1,270	1,930	2,210	3,260
Upper Study Limit	1.5	1,230	1,870	2,140	3,160
WALNUT BRANCH					
At mouth	2.2	1,070	1,740	2,030	3,790
At U.S. Route 460	1.8	870	1,460	1,730	3,440
Upper Study Limit	1.3	680	1,170	1,400	3,000

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

Precountywide Analysis

In the 1978 study, cross-sectional data for streams in the area were obtained from aerial photographs. The below-water sections were obtained by field measurement. All bridges and culverts were surveyed to obtain elevation data and structural geometry in order to compute the significant backwater effects of these structures. In the 1994 revision, cross-sectional data were obtained from topographic maps supplemented by field survey. In the 2008 restudy of Plum Creek, cross-sectional data was obtained from LiDAR-derived elevation contours and field survey. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are now referenced to NAVD 88. In order to perform this conversion, effective NGVD 29 elevation values were adjusted downward by 0.402 feet. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This change may result in differences in base flood elevations across the corporate limits between the communities.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/June 1992, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey, SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
http://www.ngs.noaa.gov/

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1 percent annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual-chance flood elevations; delineations of the 1 percent and 0.2-percent annual-chance floodplains; and a 1 percent annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, and Floodway Data tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Bottom Creek								
A	550[1]	155	806	10.2	1,535.8	1,535.8	1,536.0	0.2
B	1,450[1]	400	1,591	5.2	1,543.4	1,543.4	1,544.3	0.9
C	4,225[1]	240	897	8.9	1,573.8	1,573.8	1,574.2	0.4
Bradshaw Creek								
A	400[2]	180	1,983	3.0	1,245.3	1,245.3	1,245.3	0.0
B	4,300[2]	200	726	7.4	1,250.7	1,250.7	1,250.7	0.0
C	9,340[2]	70	662	8.1	1,275.4	1,275.4	1,276.3	0.9
D	10,800[2]	125	968	5.5	1,282.8	1,282.8	1,282.8	0.0
E	13,000[2]	90	706	7.6	1,291.8	1,291.8	1,292.7	0.9
F	21,730[2]	345	838	6.4	1,338.4	1,338.4	1,338.5	0.1
G	27,770[2]	175	943	4.9	1,380.6	1,380.6	1,380.6	0.0
Cedar Run								
A	13,630[2]	55	230	6.6	1,978.9	1,978.9	1,978.9	0.0
B	14,650[2]	60	185	7.7	2,006.7	2,006.7	2,006.7	0.0
Crab Creek								
A	44,680[3]	160	854	4.5	1,972.1	1,972.1	1,972.6	0.5
B	47,740[3]	120	572	4.9	1,999.7	1,999.7	1,999.7	0.0
C	49,140[3]	170	409	6.6	2,011.0	2,011.0	2,011.0	0.0
D	50,140[3]	220	1,217	2.2	2,022.3	2,022.3	2,022.4	0.1
E	51,400[3]	175	869	3.1	2,023.8	2,023.8	2,023.9	0.1
F	53,350[3]	130	666	4.0	2,039.0	2,039.0	2,039.0	0.0
G	54,000[3]	90	303	8.7	2,048.4	2,048.4	2,048.4	0.0

[1] FEET ABOVE SOUTH FORK ROANOKE RIVER
[2] FEET ABOVE NORTH FORK ROANOKE RIVER
[3] FEET ABOVE NEW RIVER

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTGOMERY COUNTY, VA (AND INCORPORATED AREAS)

FLOODWAY DATA

BOTTOM CREEK, BRADSHAW CREEK, CEDAR RUN AND CRAB CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Toms Creek (continued)								
R	56,475[1]	200	1,124	4.5	1,905.7	1,905.7	1,905.7	0.0
S	58,090[1]	230	1,287	4.0	1,908.1	1,908.1	1,908.3	0.2
T	59,890[1]	270	1,148	4.4	1,911.1	1,911.1	1,911.5	0.4
U	63,280[1]	200	1,357	3.4	1,923.7	1,923.7	1,924.3	0.6
V	64,175[1]	280	1,398	3.3	1,924.2	1,924.2	1,925.2	1.0
W	64,840[1]	200	1,123	3.8	1,925.3	1,925.3	1,926.0	0.7
X	68,890[1]	320	1,001	4.0	1,934.2	1,934.2	1,934.2	0.0
Y	70,740[1]	120	460	8.6	1,942.7	1,942.7	1,942.7	0.0
Z	72,400[1]	250	1,422	2.8	1,948.9	1,948.9	1,949.6	0.7
AA	73,735[1]	235	521	7.6	1,952.2	1,952.2	1,952.2	0.0
AB	74,500[1]	180	937	4.2	1,955.8	1,955.8	1,955.8	0.0
Town Branch								
A	220[2]	55	214	11.2	1,995.3	1,995.3	1,995.3	0.0
B	1,160[2]	55	261	9.1	2,008.8	2,008.8	2,008.9	0.1
C	2,470[2]	80	273	8.3	2,030.2	2,030.2	2,030.2	0.0
D	3,290[2]	125	520	4.4	2,038.7	2,038.7	2,038.7	0.0
E	3,870[2]	85	270	8.4	2,048.6	2,048.6	2,048.6	0.0
F	4,740[2]	170	655	3.3	2,056.0	2,056.0	2,056.3	0.3

[1] FEET ABOVE NEW RIVER
[2] FEET ABOVE CRAB CREEK

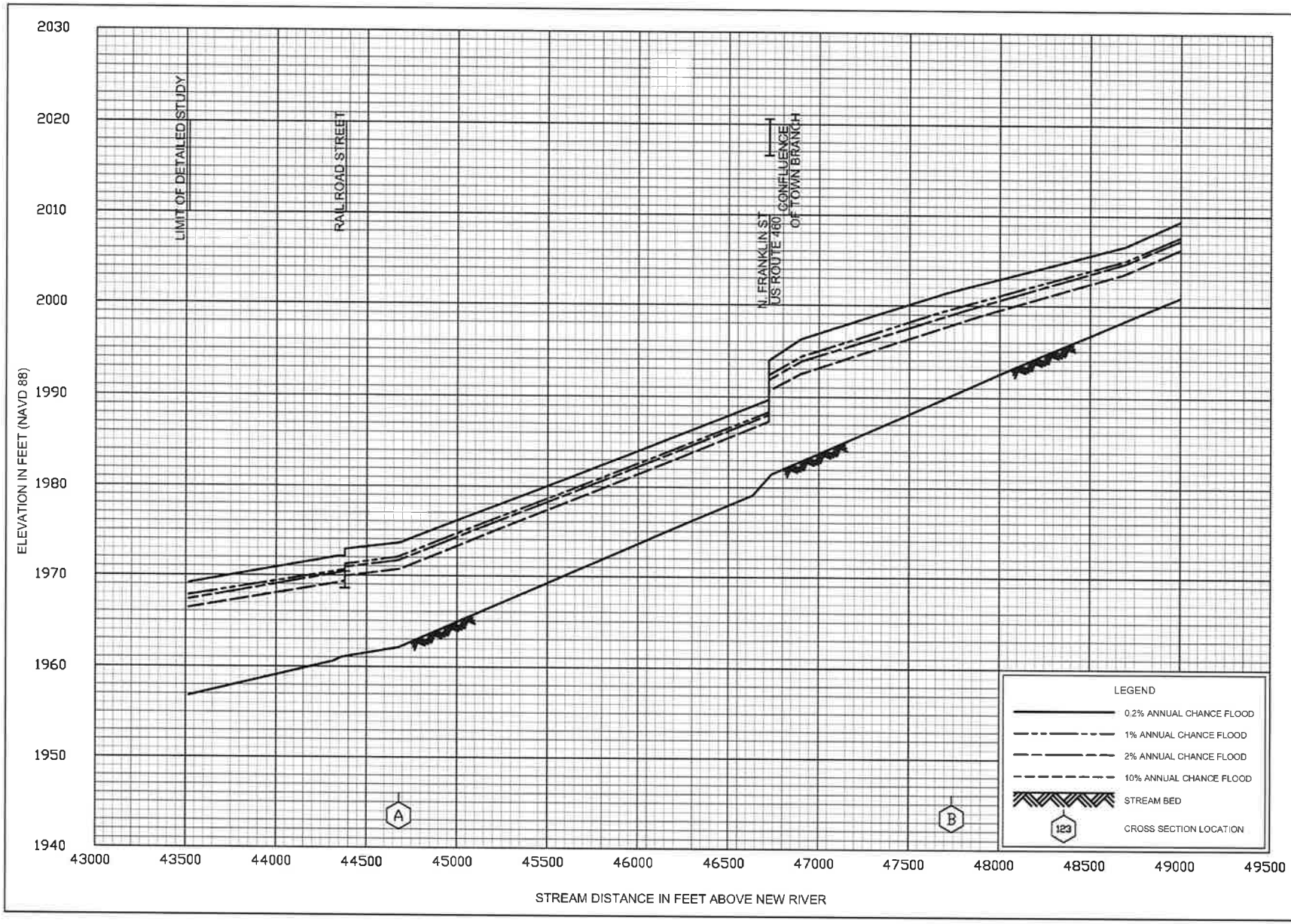
TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTGOMERY COUNTY, VA (AND INCORPORATED AREAS)

FLOODWAY DATA

TOMS CREEK AND TOWN BRANCH



FLOOD PROFILES

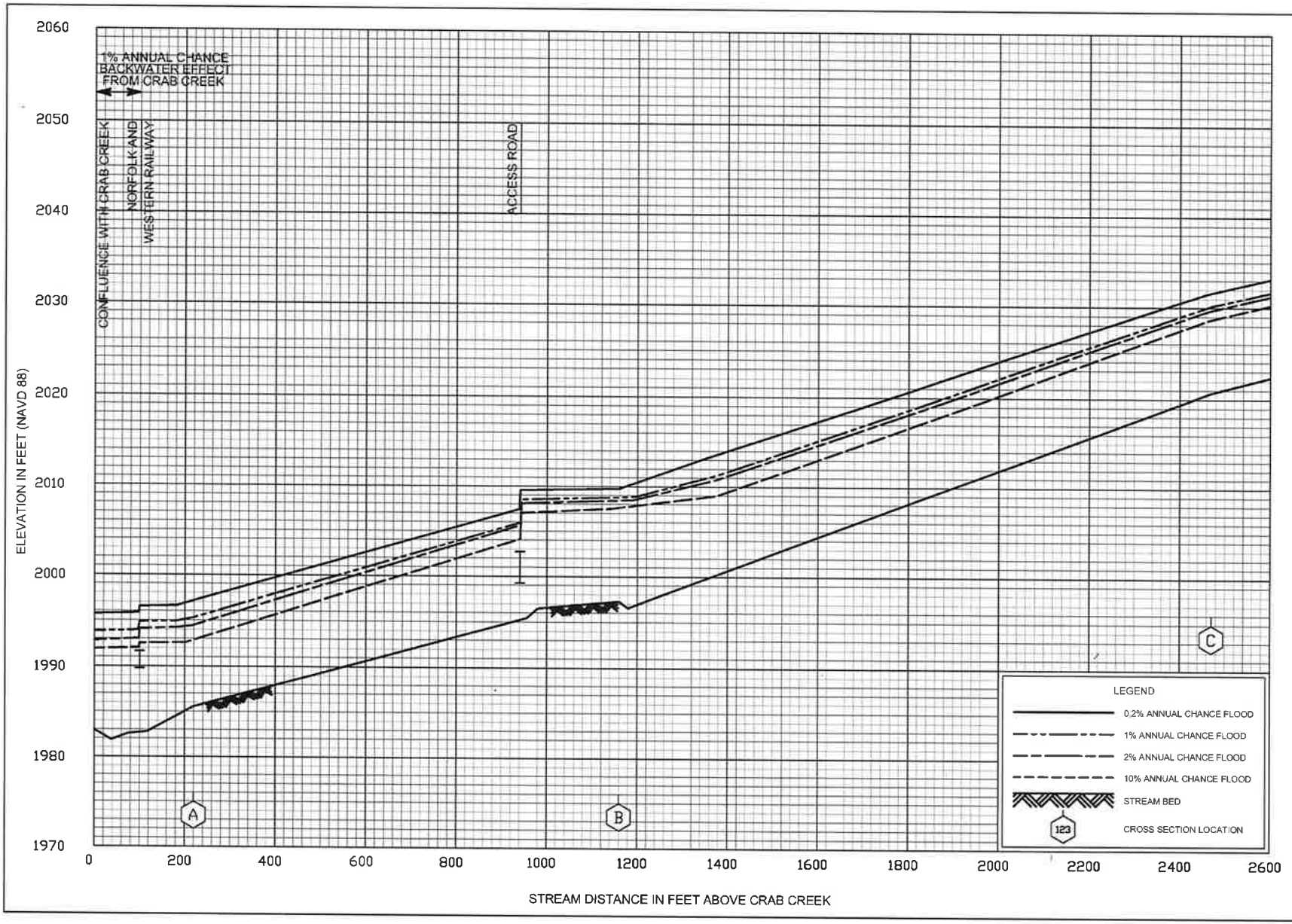
CRAB CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTGOMERY COUNTY, VA

AND INCORPORATED AREAS

06P



FLOOD PROFILES

TOWN BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTGOMERY COUNTY, VA

AND INCORPORATED AREAS

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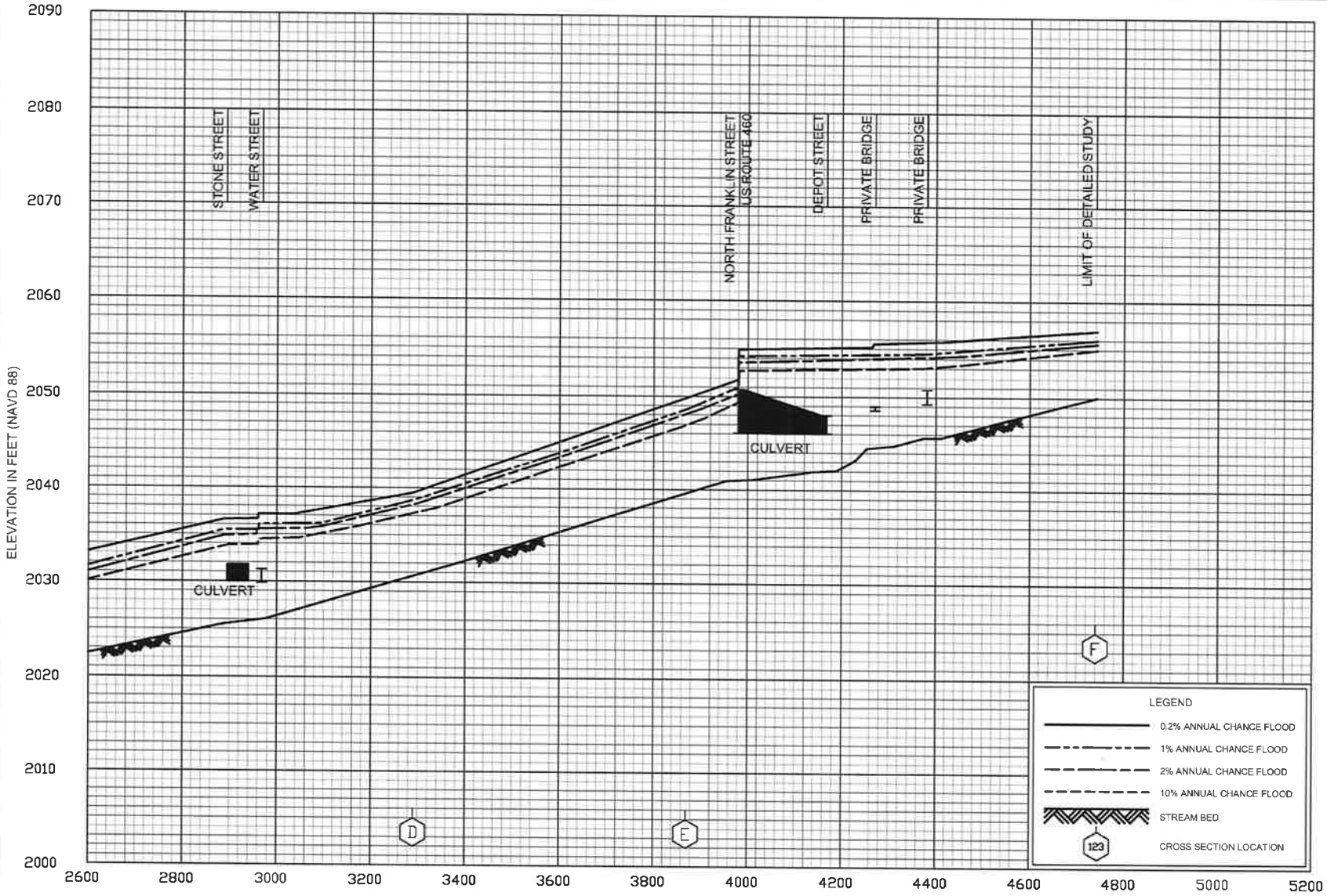


FLOOD PROFILES

TOWN BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

MONTGOMERY COUNTY, VA

AND INCORPORATED AREAS

91P

Federal Emergency Management Agency

U.S. Department of Homeland Security
FEMA Region III
615 Chestnut Street
One Independence Mall, Sixth Floor
Philadelphia, Pennsylvania 19106-4404

October 4, 2017

30 Day Engineering Models Notification

Mr. Craig Meadows
County Administrator, Montgomery County
755 Roanoke St. Ste 2E
Christiansburg, VA 24073

Dear Mr. Meadows:

This letter is to notify you of the engineering data models that will be used in the Federal Emergency Management Agency's (FEMA) ongoing flood risk project in Montgomery County, Virginia. FEMA is initiating updates to the Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) report for your community in the near future. FEMA's goal is to offer useful, credible data, and a fair process to help you make informed decisions to continue building a safer and stronger community.

These engineering data models will form the basis for the proposed Special Flood Hazard Areas (SFHAs) that will be presented on the Flood Insurance Rate Map (FIRM) for your community. A SFHA is an area that is subject to inundation by the 1-percent-annual-chance flood (also called the base flood). Over time, water flow and drainage patterns in your area may have changed dramatically due to surface erosion, land use, and natural forces. Rainfall amounts may have also changed over time. Given these factors, the likelihood of flooding in certain areas may have increased or decreased over time, changing the SFHA designations.

Upon receipt of this notification, your community will have 30 days to consult with FEMA Regional Office staff (identified in the last paragraph of this letter) regarding the appropriateness of the models selected for the project. Your community will have additional opportunities to comment on and provide feedback about the models and other draft flood hazard information throughout the project. If there are uncertainties about the mapping data that have been collected and analyzed, a formal appeals process and period will be available to help resolve any remaining questions before the flood hazard information becomes effective.

Draft flood hazard information for Montgomery County, Virginia, will be developed by FEMA's mapping partner, STARR II, a joint venture of Stantec, Atkins, and Dewberry. STARR II, will use the engineering models shown on the attached Engineering Models Summary Table, which lists the flooding sources to be studied, along with details regarding the selected models and the rationale for their use. The engineering models were selected based on a variety of factors including, but not limited to, the type of study performed

(e.g., base or enhanced, shallow flooding, coastal, alluvial fan, etc.), the size of the drainage area affecting the flooding source, and the type of terrain present (e.g., flat, hilly, mountainous, etc.).

The Federal Emergency Management Agency (FEMA) wants to ensure that the most up-to-date and accurate technical data are used to develop the flood risk products. FEMA relies on your feedback, partnership and knowledge during this important project to determine the extent of flood risk in your community, and in support of your efforts to reduce those risks. We look forward to working with community officials and other stakeholders in Montgomery County, Virginia to increase flood risk awareness and reduce the risk to life and property from flooding. Your initial feedback will not affect your community's ability to provide feedback later, or to formally appeal the flood hazard information during a future appeal period.

Please provide your comments related to the types of models selected for this project by November 3, 2017. To provide your comments or get answers to any other questions about this project, please contact the FEMA Project Officer, Lee Brancheau, GISP at legrande.brancheau@fema.dhs.gov or 267-240-2865.

Sincerely,

Kathryn Lipiecki, Chief
Risk Analysis Branch

Enclosures: Engineering Models Summary Table
Engineering Models Summary Map

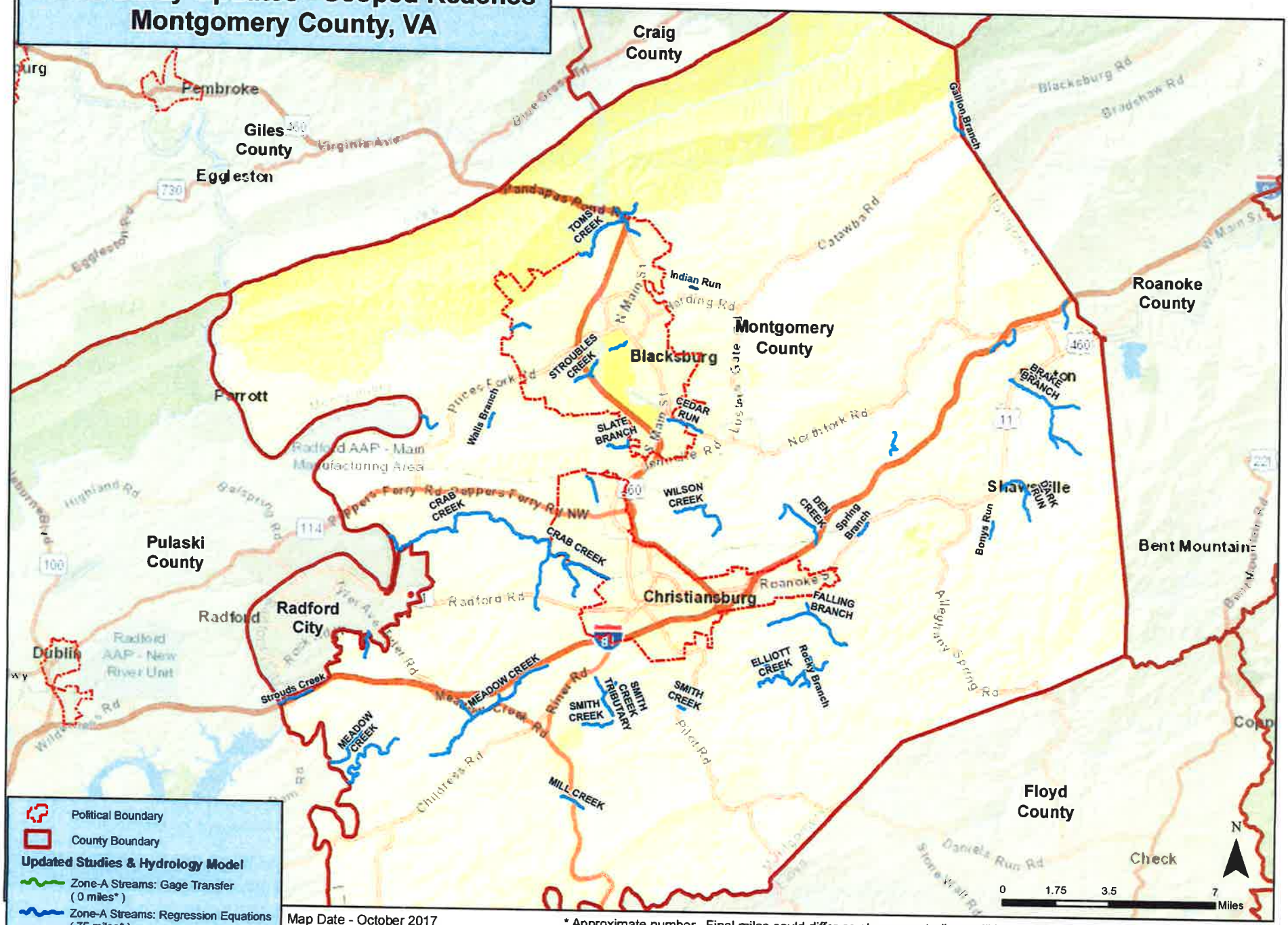
cc: Emily Gibson, Floodplain Administrator
Lee Brancheau, Project Officer, FEMA Region III
Charley Banks, State NFIP Coordinator
Kevin Donnelly, STARR II

Enclosures

Proposed Engineering Model Summary Table

Flooding Source	Reach	Hydrologic Model Proposed	Hydraulic Model Proposed	Rationale for Models Selected
All flooding sources shown as "Zone A, Gage Analysis" on the attached map.	All	Gaging Station Data	HEC-RAS, 1D Steady	Hydrologic Model: The study reach includes or is close to a gaging station and there are at least 20 years of data at the station. Hydraulic Model: Used where flow is steady in time, one-dimensional, generally gradually varied in space, and channel slope is generally less than 10%.
All flooding sources shown as "Zone A, Regression Equations" on the attached map.	All	Regression Equations	HEC-RAS, 1D Steady	Hydrologic Model: The regression equations are applicable to the streams being studied and peak discharges are sufficient for the hydraulic analysis. Hydraulic Model: Used where flow is steady in time, one-dimensional, generally gradually varied in space, and channel slope is generally less than 10%.

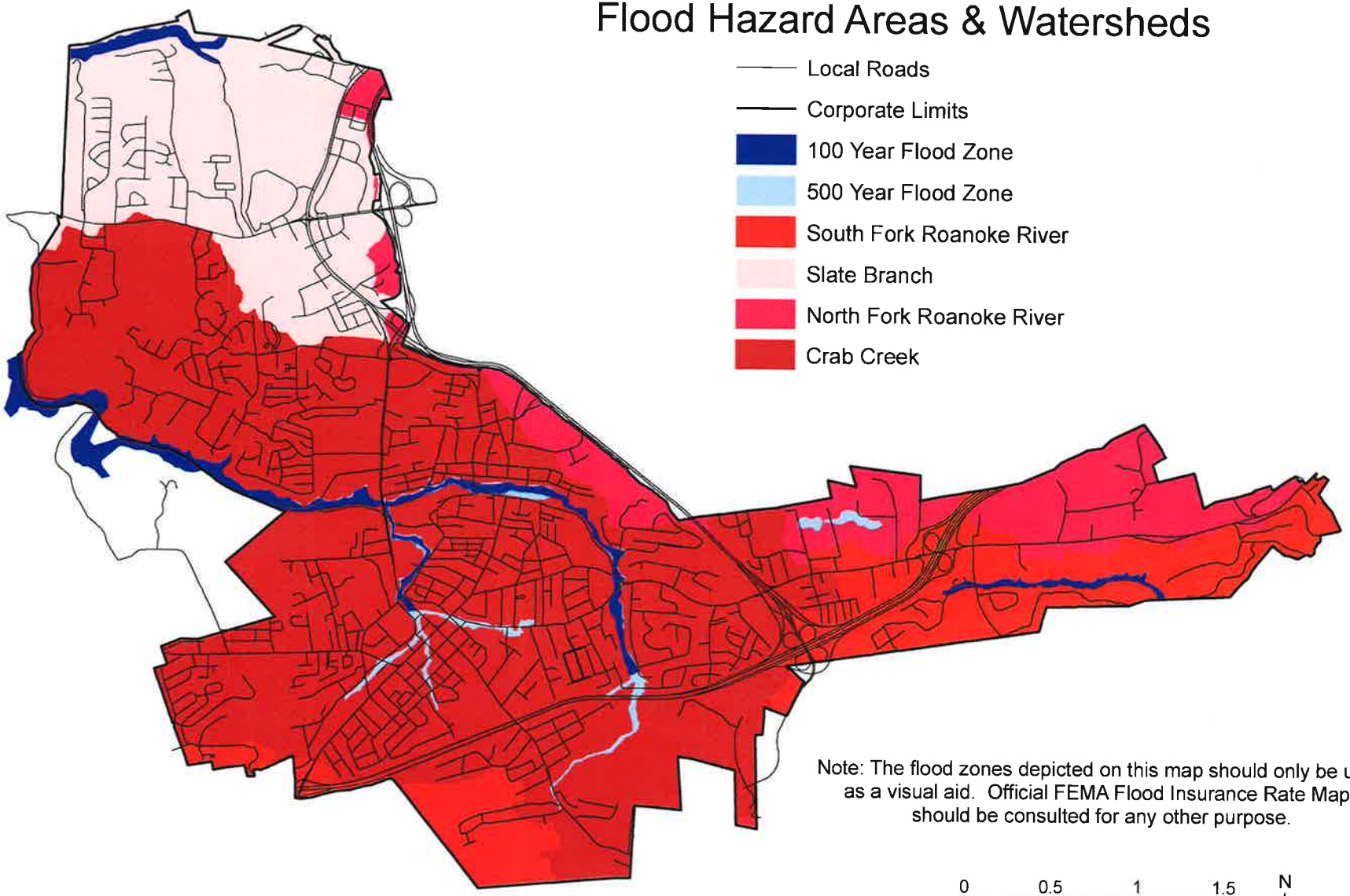
Flood Study Updates - Scoped Reaches
Montgomery County, VA



Map Date - October 2017

* Approximate number. Final miles could differ as stream centerlines will be digitized to follow LiDAR and aerial imagery.

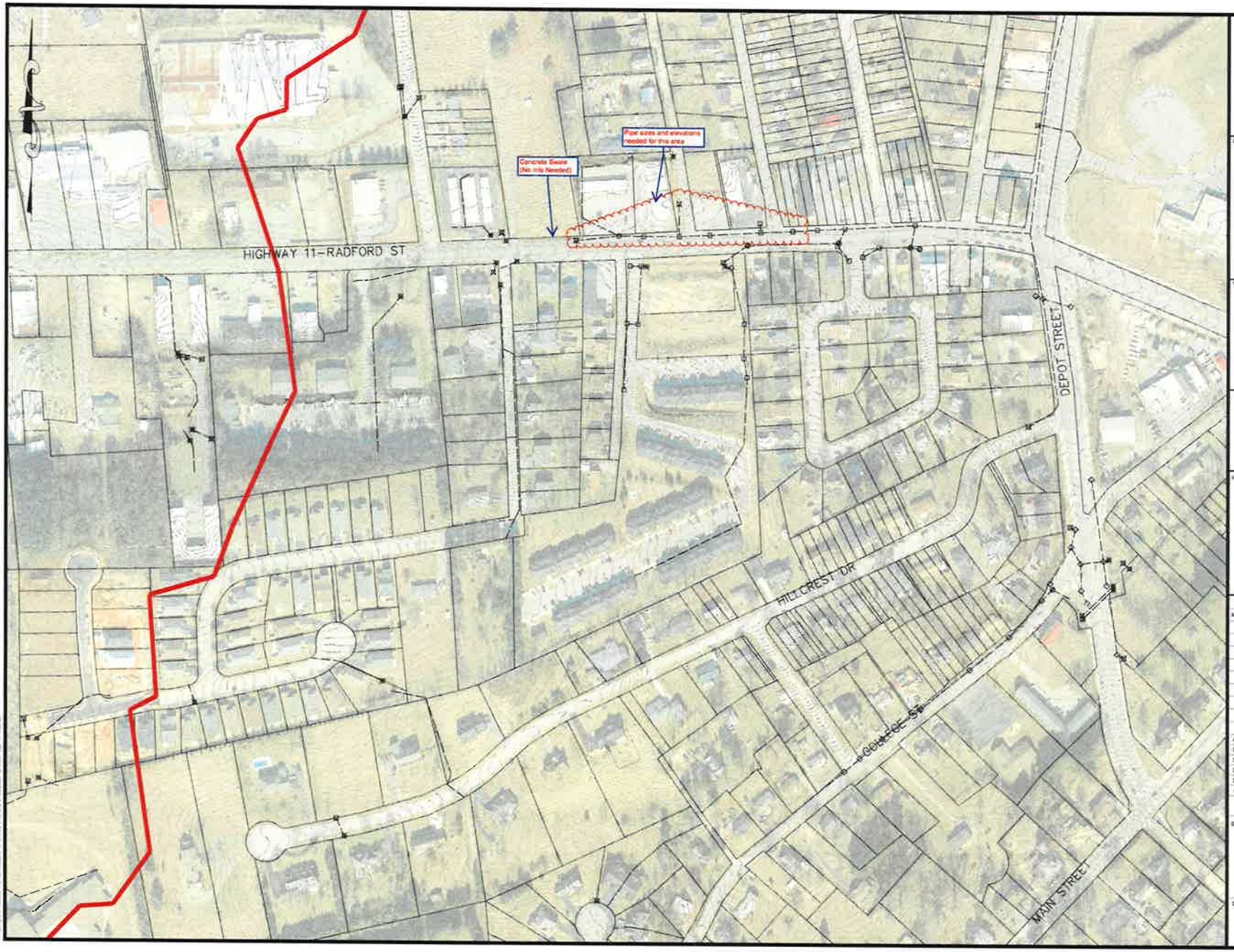
Town of Christiansburg
Flood Hazard Areas & Watersheds



Map prepared by Town of Christiansburg Engineering and Planning Departments. November 8, 2013.
T:\GIS\Planning\CompPlanMaps\2013Update\Environment\FloodHazardAreas&Watersheds.mxd

APPENDIX B

Work Maps for Survey Needs



A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS
100 GATEWAY CENTRE PARKWAY, SUITE 200
RICHMOND, VIRGINIA 23235
(804) 276-6221 FAX (804) 276-6233
WWW.AMTENGINEERING.COM

OWNER

TOWN OF CHRISTIANSBURG

REGISTRATION STAMP

PROJECT TITLE

DOWNTOWN DRAINAGE STUDY

TOWN OF CHRISTIANSBURG, VA
100 E. MAIN ST.
CHRISTIANSBURG, VIRGINIA

REVISIONS

MARK	DATE	DESCRIPTION

AMT FILE NO	17-0635.001
DATE	August, 2017
SCALE	1"=400'
DESIGNED BY	DJR
DRAWN BY	LAL
CHECKED BY	DJR

SHEET TITLE

BASE MAP

SHEET

C-1.0

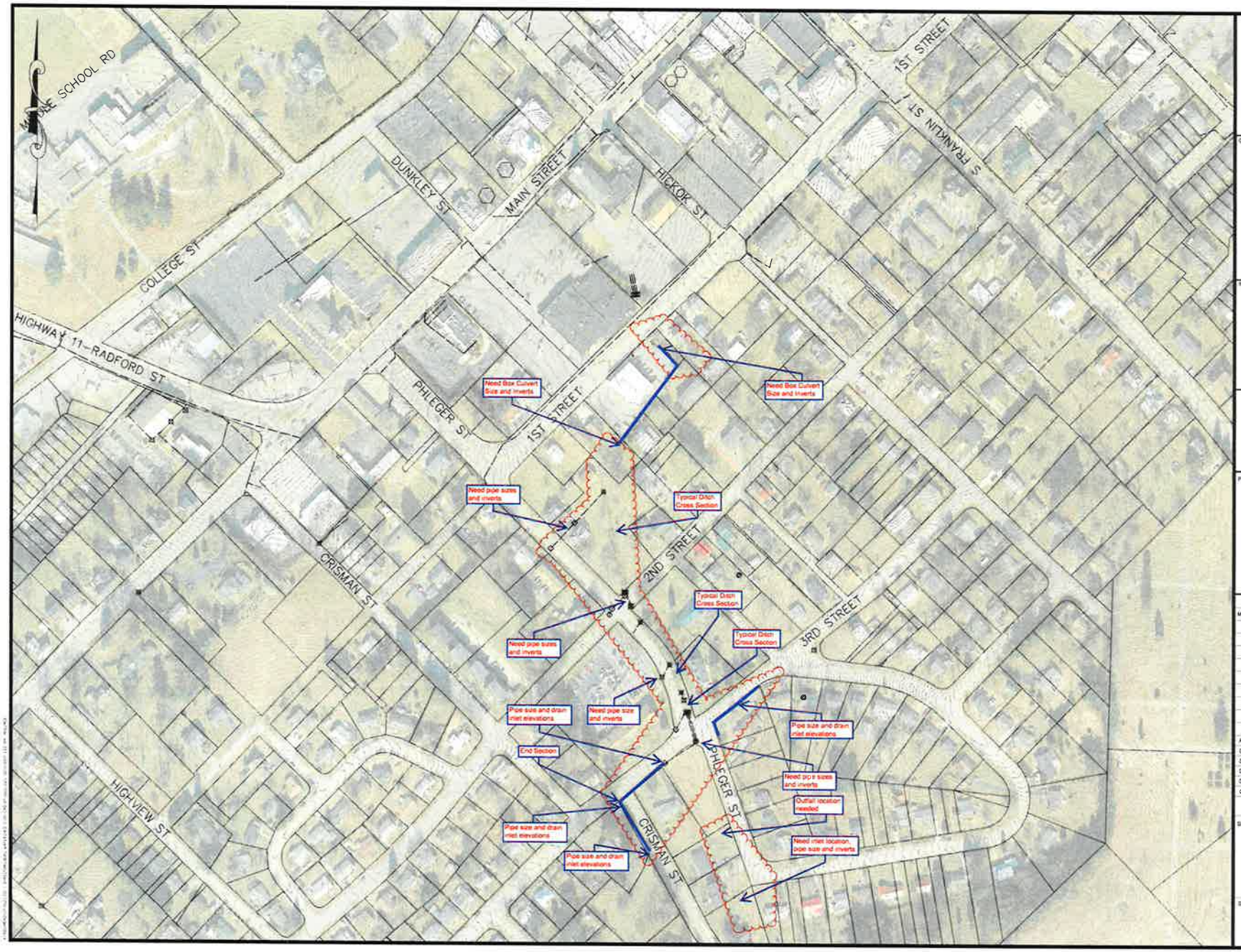
SHEET 1 OF TBD

Entrance of Radford St system

Second drain inlet downstream of headwall on Radford St. system.

Third drain inlet downstream of headwall on Radford St.

Third drain inlet downstream of headwall on Radford St. System. Located at corner of Bower St and Radford St.



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REGISTRATION STAMP

PROJECT TITLE

DOWNTOWN DRAINAGE STUDY

TOWN OF CHRISTIANSBURG, VA
100 E. MAIN ST.
CHRISTIANSBURG, VIRGINIA

REVISIONS

MARK	DATE	DESCRIPTION

AMT FILE NO.	17-0626.001
DATE	August, 2017
SCALE	1"=400'
DESIGNED BY	DJR
DRAWN BY	LAL
CHECKED BY	DJR

SHEET TITLE

BASE MAP

SHEET

C-2.0

SHEET 1 OF TBD

Existing Ditch along Chrisman Street

Existing Ditch along Chrisman Street

Existing Ditch looking at Chrisman Street

Junction box at Third and Phlegar

Downstream of junction box at Third and Phlegar

Existing Ditch facing north. Tan house is 460 Chrisman St. Outlet of culvert in background not found

Intersection of Second St and Phlegar St facing south

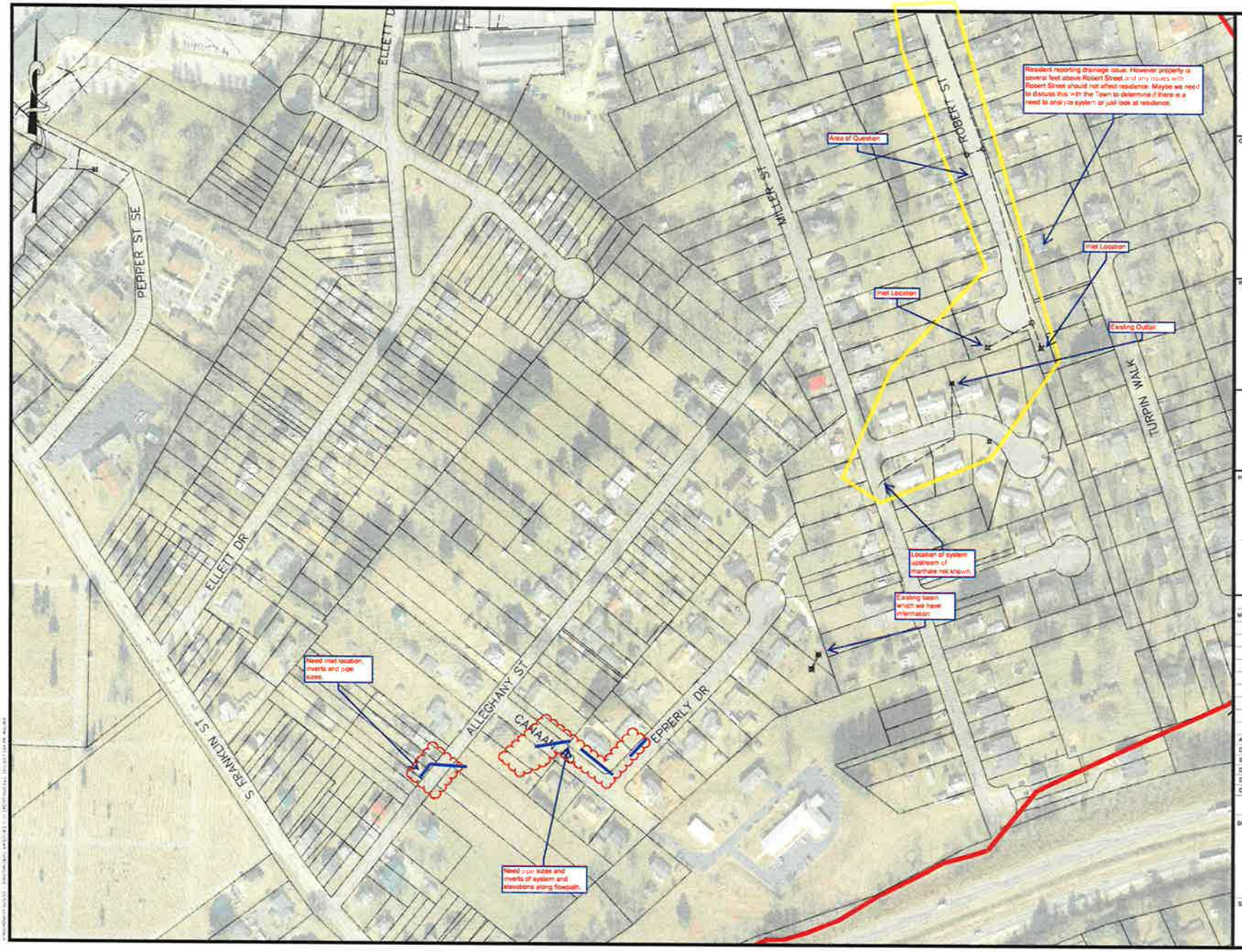
Intersection of Second St and Phlegar St facing north

Entrance of box culvert south of First St.

Box culvert south of First, facing toward entrance

Entrance of box culvert underneath First St.

Outlet of Box Culvert underneath First St.



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TOWN OF CHRISTIANSBURG

REGISTRATION STAMP

PROJECT TITLE

DOWNTOWN DRAINAGE STUDY

TOWN OF CHRISTIANSBURG, VA
100 E. MAIN ST.
CHRISTIANSBURG, VIRGINIA

REVISIONS

MARK	DATE	DESCRIPTION

AMT FILE NO.	17-0626.001
DATE	August, 2017
SCALE	1"=400'
DESIGNED BY	GJR
DRAWN BY	LAL
CHECKED BY	GJR

SHEET TITLE

BASE MAP

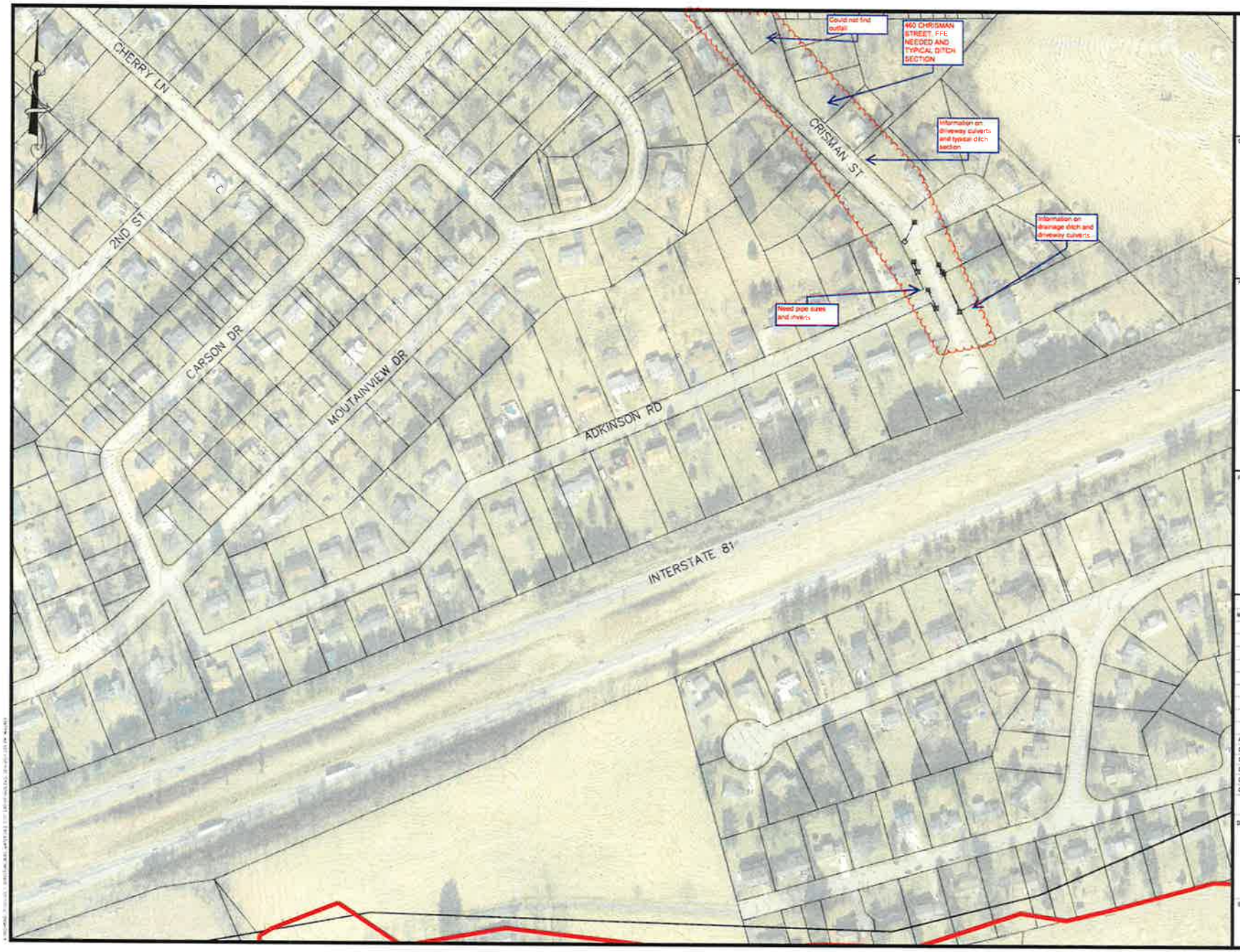
SHEET

C-3.0

SHEET 1 OF TBD

Alleghany Street inlet located at the red brick house with bushes on curb

Canaan Street culvert outlet



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OWNER

TOWN OF CHRISTIANSBURG

REGISTRATION STAMP

PROJECT TITLE

DOWNTOWN DRAINAGE STUDY

TOWN OF CHRISTIANSBURG, VA
100 E. MAIN ST.
CHRISTIANSBURG, VIRGINIA

REVISIONS

MARK	DATE	DESCRIPTION

AMT FILE NO	17-0826.001
DATE	August, 2017
SCALE	1"=400'
DESIGNED BY	DJR
DRAWN BY	LAL
CHECKED BY	DJR

SHEET TITLE

BASE MAP

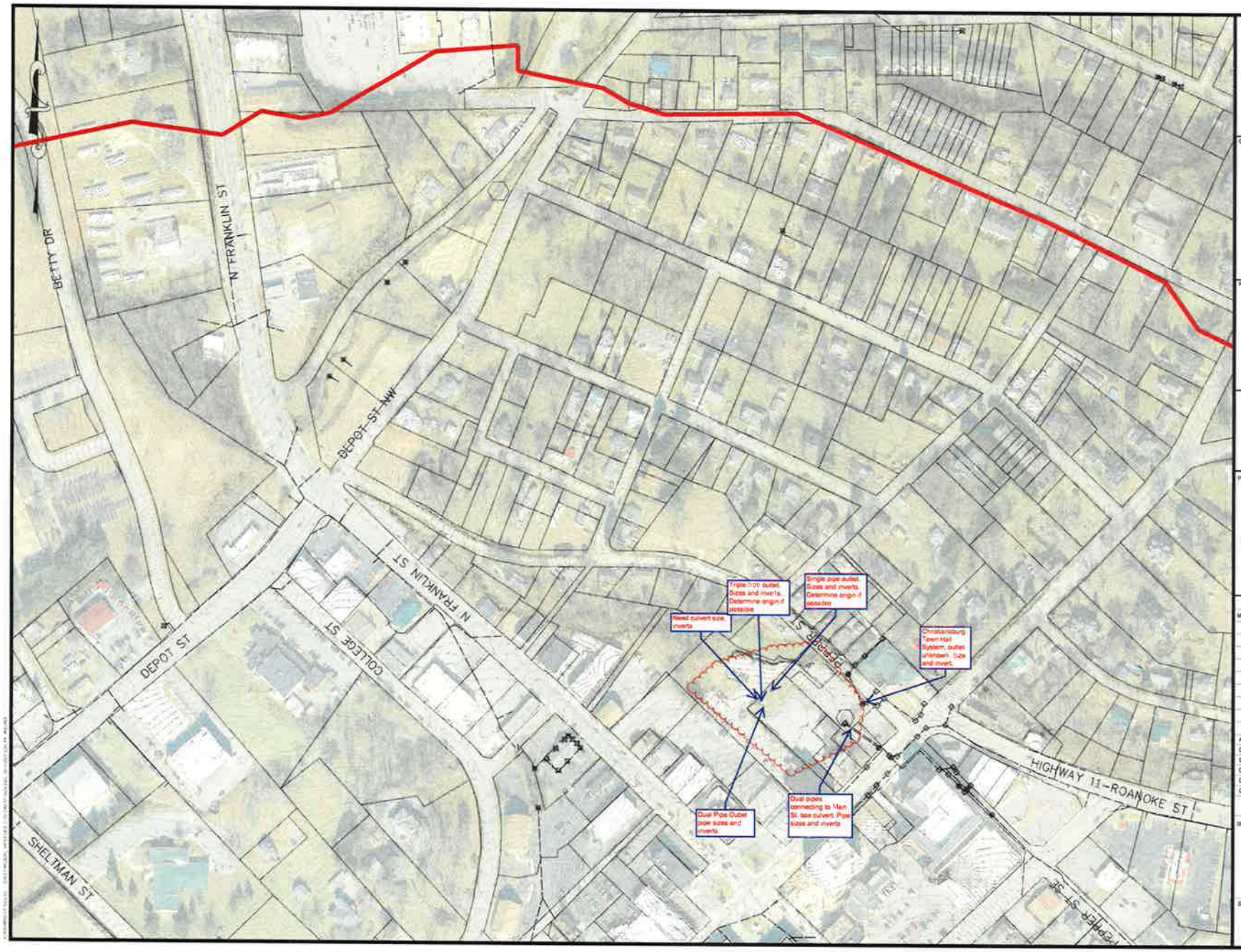
SHEET

C-4.0

SHEET 1 OF 180

Existing Ditch looking south along Chrisman Street

Existing Ditch looking north. Tan house is 460 Chrisman St. Outlet of culvert in background not found



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REGISTRATION STAMP

PROJECT TITLE

DOWNTOWN DRAINAGE STUDY

TOWN OF CHRISTIANSBURG, VA
100 E. MAIN ST.
CHRISTIANSBURG, VIRGINIA

REVISIONS

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DATE	August, 2017
SCALE	1"=400'
DESIGNED BY	DJR
DRAWN BY	LAL
CHECKED BY	DJR

SHEET TITLE

BASE MAP

SHEET

C-5.0

SHEET 1 OF TBD

Location of dual pipe that connects to Main St system.

Culvert inlet at Police Station

Dual Pipe that connects to Main St.

Unknown triple and single pipe outlets

Police Station culvert outlet

Entrance of box culvert that connects police station system to Franklin St system.

REQUIRED SURVEY

1. INTERSECTION OF AUBURN DRIVE AND MAIN STREET HAS AN UNKNOWN DRAIN INLET ON BOTH SIDES OF AUBURN DR.
2. INTERSECTION OF HICKORY DRIVE AND MAIN STREET HAS AN UNKNOWN HEADWALL THAT DISCHARGES ACROSS MAIN STREET.
3. THERE ARE TWO CURB INLETS AND A LOW SPOT ON MAIN STREET BETW CHERRY LANE AND HIGHVIEW STREET.
4. THERE IS AN STORM SYSTEM ALONG THE NORTH SIDE OF COLLEGE STRE FROM MORNING MIST DRIVE TO DEPOT STREET
5. THE SWALE BETWEEN COLLEGE STREET AND MAIN STREET APPEARS TO BEEN BUILT OVER.
6. THERE IS A STORM SYSTEM ALONG THE EAST SIDE OF LEE HY COURT
7. GIS IS MISSING A SECTION OF THE STORM SYSTEM ALONG RADFORD STR FROM CLEARVIEW DRIVE TO THE SUNOCO STATION.
8. AT THE INTERSECTION OF 3RD STREET AND CHRISMAN STREET , GIS HAS INFORMATION ON THE MANHOLE OR THE THREE PIPES THAT DISCHARG INTO THE CHRISMAN STREET ROADSIDE DITCH.
9. THE INTERSECTION OF 2ND STREET AND S FRANKLIN STREET HAS AN UNKNOWN DRAIN INLET.
10. THE INTERSECTION OF ELLETT STREET AND S FRANKLIN STREET HAS AN UNKNOWN DRAIN INLET.
11. HAGAN STREET HAS AN UNKNOWN DRAIN INLET.
12. LESTER STREET HAS AN UNKNOWN DRAIN INLET.
13. EVANS STREET HAS AN UNKNOWN DRAIN INLET.
14. JUNKIN STREET HAS AN UNKNOWN DRAIN INLET.
15. THERE IS A CULVERT UNDERNEATH HILL STREET.
16. THERE IS A DRAIN INLET JUST NORTH OF CHRISTIANSBURG PRIMARY SC ON BERRY DRIVE.
17. OVERHILL ROAD HAS AN UNKNOWN DRAIN INLET.
18. TURPIN WALK HAS AN UNKNOWN DRAIN INLET.

APPENDIX C

Community Meeting No. 1

The Christiansburg Downtown Watershed Study is underway!

the Town of Christiansburg recently received a grant from the Virginia Department of Conservation and Recreation to conduct a downtown watershed study. The goal of this study is to evaluate drainage and flooding problems along Towne Branch and its floodplains, and to develop a list of planned drainage improvements by the Town.

We need your help! To provide our consultant with the best information about known flooding issues, we are asking that you attend a community meeting on **Thursday, October 26th,** from **6pm to 8pm** at Town Hall. The Town's consultant will make a brief presentation about the study goals, and then we will be available to talk with all those in attendance about your concerns related to flooding and drainage issues in downtown Christiansburg.

For more information about this meeting, go to **www.christiansburg.org/index.aspx?NID=995**

Christiansburg Downtown Watershed Study

Presentation Boards for Community Meeting #1

October 26, 2017 – 6-8 p.m.

Town Council Chambers

Meeting Logistics?

AMT to provide 8 name tags, 3 presentation boards (30"x48"), sign-in sheet, 4 quadrant maps (30"x30"), box of pens, box of markers, sticky notes, and 50 copies of the comment sheet

Station #1: Welcome Station

- Greetings / Sign-In Sheet

Station #2: Town Stormwater Program and Project Overviews

- Board #1 – What is the Stormwater Enterprise Fund? Town program information?
- Handout Town Materials, as desired.
- Town Staff to handle this station

Station #3: Flooding and Drainage Issues

- Board #2 – What are the Goals of the Downtown Study? What is Stormwater Runoff?
- Board #3 – Note known problems and flooding downtown; Mark problems on quadrant maps with sticky backs and markers
- Ask folks to complete their comment sheets before leaving... *have pens to get written comment sheets*

Town to also post updates with comment sheet to the website!

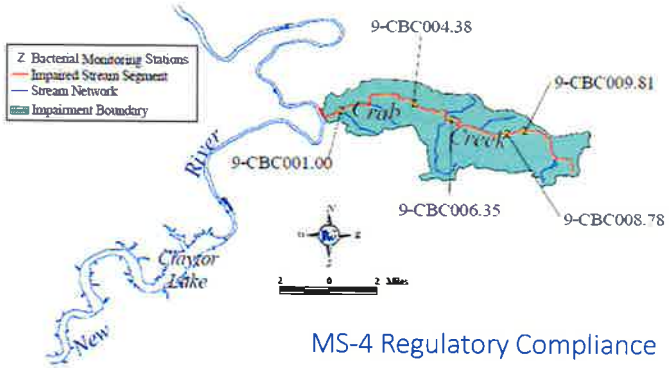
The Stormwater Enterprise Fund

On June 21, 2016, the Town Council approved a new Stormwater Utility Fee that is included in your monthly utility bill. The utility fee provides the resources needed to operate and maintain the Town's stormwater system.

Storm Drain System Improvements

Water Quality Treatment Facilities (BMPs)

Storm Drain System Maintenance



MS-4 Regulatory Compliance

The Town's Stormwater Billing Unit (SBU) is $6/monthly for each dwelling unit on residential properties, and non-residential properties are billed on a tiered system. Tiered bills are based on multiples of the 2,030 square feet of imperviousness in the SBU rate of $6/monthly. Mixed-use properties are charged a combination of these rates.

The stormwater enterprise fund and utility fee provide the resources needed to operate and maintain the Town's stormwater system, fund capital improvements, and comply with the state and federal requirements of having an MS-4 program for water quality improvement. Capital improvements address both drainage problems and water quality improvement needs.

The Town has a Stormwater Credit Program for anyone treating runoff onsite that offers up to a 35% reduction on your stormwater utility fee.

What is the Downtown Watershed Study?

Towne Branch Watershed

Watershed Area = 1,284 acres

The Town recently received a grant from the Virginia Department of Conservation and Recreation to conduct a Downtown Watershed Study. The goal of this study is to evaluate drainage and flooding problems within the Towne Branch Watershed, and to develop a list of planned stormwater improvements to reduce flood risk.

What is Stormwater?

Stormwater is the runoff resulting from a rain event. Problems with stormwater occur when a large amount of rainfall happens in a short period of time. The ground becomes saturated and cannot absorb the water, so it becomes runoff. Impervious surfaces such as concrete and asphalt also prevent the ground from absorbing runoff. The runoff drains through the Downtown area in storm sewer systems, where it ultimately ends up in Towne Branch at Depot Park, which then drains into Crab Creek as shown on the Watershed Map to the right.

What can we do about Stormwater issues?

You have already taken the first step to help address our stormwater issues – by attending the community meeting. The next step is to provide your comments on the drainage, erosion and flooding problems in the study area to our team. We will develop a list of stormwater improvement recommendations to reduce or eliminate flooding for presentation at the next project meeting.

Drainage and Flooding Issues

Identifying, evaluating and reducing erosion, drainage and flooding concerns is the primary focus of this Downtown Watershed Study. Knowing more about these types of issues, with your help, can help inform this study.

There are at least seventeen (17) known drainage issues at this time. Your help is needed to make sure we account for all known issues within the study area.

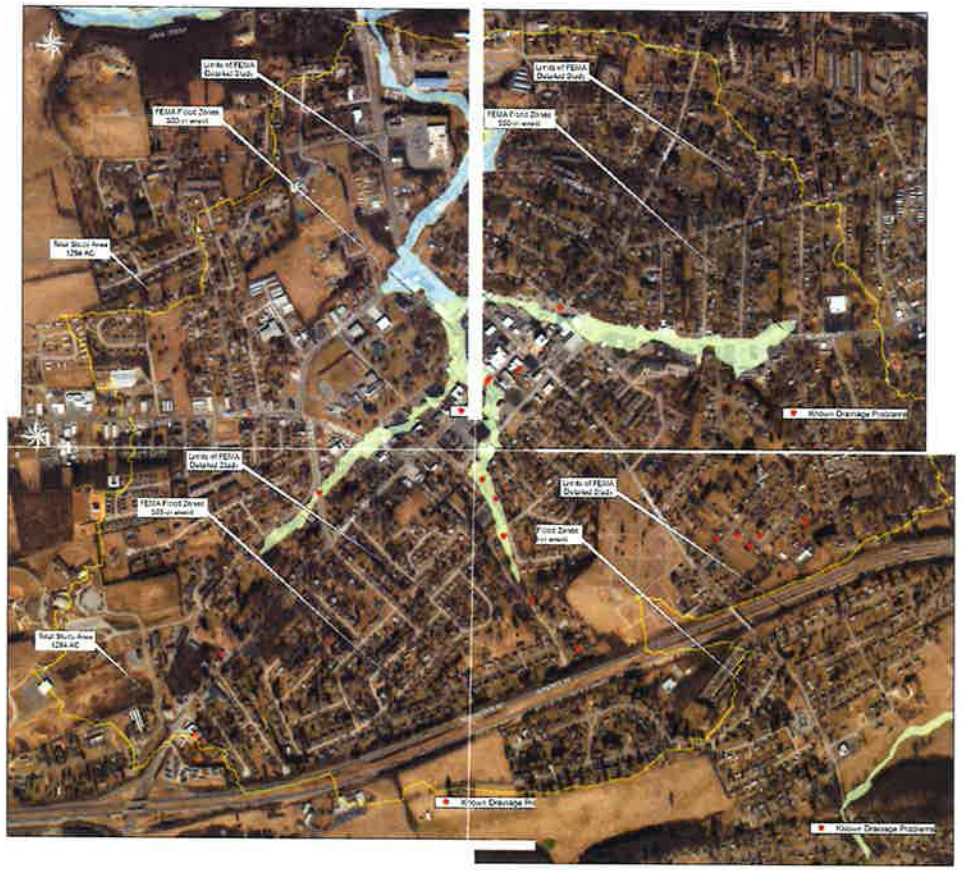
Street Flooding

Building Flood Risk

Stream Erosion


N
CRAB CREEK
Limits of FEMA
Detailed Study
FEMA Flood Zones
500-yr event
Total Study Area
1,284 AC
TOWN BRANCH
STONE ST
DEPOT ST
ROANOKE ST
RADFORD ST
MAIN ST
S FRANKLIN ST
INTERSTATE 81
0
750
1,500
3,000
4,500
6,000
Feet
Known Drainage Problems

Quadrant Maps
on Tables
(30”x30” size)



SIGN IN SHEET

Christiansburg Downtown Watershed Study
Community Meeting on October 26, 2017

Name	E-Mail	Phone Number	Check for Updates?
Bryant Phillips	bryant@bglk.net	804-363-5986	N
HAROLD SHELTON			
Greg Duncan	gduncan134@AOL.com	5403810438	
SUSAN Trulove (for Crab Creek)	mail@thegablesatcrabcreek.com	540-818-9679	
JUSTIN SANDERS Downtown Christiansburg Inc	jsanders@downtownchristiansburg.org	276-608-1640	y
Yvonne Alderman	hyvonne alderman	540-250-8921	y
Michael + Connie Jones	MJONES 502745@yahoo.com	818-1386	yes
Scott Woodrum	scott.woodrum@gmail.com	540-641-3688	y
JOHN BURKE	john.burke@vt.edu		✓
Phillis Shelif		382-0401	

(2)

SIGN IN SHEET

Christiansburg Downtown Watershed Study
Community Meeting on October 26, 2017

Name	E-Mail	Phone Number	Check for Updates?
Daniel maderic	danielmaderic@gmail.com	382-2018	

Christiansburg Downtown Watershed Study
Community Meeting on October 26, 2017
Comment Form

Name: HAROLD SHELTON

1. Was this meeting helpful in understanding the Watershed Study goals? ✓ Yes _____ No

2. Would you like to be added to the Town's mailing list for future announcements and updates about this study? If so, provide an email address.

NO E-MAIL

3. Are you aware of any highly eroded streams or ditches in the study area? If so, where?

609, 602/604 SOUTH FRANKLIN ST

4. Are you aware of any drainage or flooding concerns in the study area? If so, where?

SEE ABOVE

5. How would you prioritize the needs in the Downtown Area for the stormwater program?

(Rank these from 1-4, with #1 as the highest priority need)

____ Inspect and maintain the Town's stormwater systems downtown

____ Reduce Building Flood Risks / Damage from Large Floods

____ Reduce Street Flooding Issues / More Frequent and Smaller Storm Events

____ Improve Local Water Quality (through Stormwater Management)

6. Do you have other comments related to stormwater for the Downtown Watershed Study?

Please provide Comment Forms by **November 24, 2017**

You can mail the comment forms to: 100 E. Main Street, Christiansburg, VA 24073 or drop them off at the Engineering Department at Town Hall. Call for more information at (540) 382-6120

Further information about the Downtown Watershed Study can be found on the project website
http://www.christiansburg.org/watershed

Christiansburg Downtown Watershed Study
Community Meeting on October 26, 2017
Comment Form

Name: Michael & Connie Jones 818-1386 Call/Come over anytime

1. Was this meeting helpful in understanding the Watershed Study goals? _____Yes _____No

2. Would you like to be added to the Town's mailing list for future announcements and updates about this study? If so, provide an email address.

MJones502745@yahoo.com

3. Are you aware of any highly eroded streams or ditches in the study area? If so, where?

Yes Chrisman Street / Phlegar Street

4. Are you aware of any drainage or flooding concerns in the study area? If so, where?

Yes 460 Chrisman Street
Christiansburg VA 24073

5. How would you prioritize the needs in the Downtown Area for the stormwater program?

(Rank these from 1-4, with #1 as the highest priority need)

3 Inspect and maintain the Town's stormwater systems downtown

1 Reduce Building Flood Risks / Damage from Large Floods

2 Reduce Street Flooding Issues / More Frequent and Smaller Storm Events

4 Improve Local Water Quality (through Stormwater Management)

6. Do you have other comments related to stormwater for the Downtown Watershed Study?

would covering our culvert & our neighbors help? our neighbors culvert isn't as deep as ours and water comes out of his first befor ours floods.

Please provide Comment Forms by **November 24, 2017**

You can mail the comment forms to: 100 E. Main Street, Christiansburg, VA 24073 or drop them off at the Engineering Department at Town Hall. Call for more information at (540) 382-6120

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http://www.christiansburg.org/watershed

Christiansburg Downtown Watershed Study
Community Meeting on October 26, 2017
Comment Form

Name: Willis Webb

1. Was this meeting helpful in understanding the Watershed Study goals? _____Yes _____No

2. Would you like to be added to the Town's mailing list for future announcements and updates about this study? If so, provide an email address.

_____

3. Are you aware of any highly eroded streams or ditches in the study area? If so, where?

_____

_____

_____

4. Are you aware of any drainage or flooding concerns in the study area? If so, where?

345 Robin Road Back yard has drainage grate that must be kept free of leaves, grass clippings etc to prevent flooding of house.

5. How would you prioritize the needs in the Downtown Area for the stormwater program?

(Rank these from 1-4, with #1 as the highest priority need)

____ Inspect and maintain the Town's stormwater systems downtown

____ Reduce Building Flood Risks / Damage from Large Floods

____ Reduce Street Flooding Issues / More Frequent and Smaller Storm Events

____ Improve Local Water Quality (through Stormwater Management)

6. Do you have other comments related to stormwater for the Downtown Watershed Study?

_____

_____

_____

Please provide Comment Forms by **November 24, 2017**

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Further information about the Downtown Watershed Study can be found on the project website
http://www.christiansburg.org/watershed

Christiansburg Downtown Watershed Study
Community Meeting on October 26, 2017
Comment Form

Name: GREG DUNCAN

1. Was this meeting helpful in understanding the Watershed Study goals? X Yes ____ No

2. Would you like to be added to the Town's mailing list for future announcements and updates about this study? If so, provide an email address.

500 ROANOKE ST. CBURG 24073

3. Are you aware of any highly eroded streams or ditches in the study area? If so, where?

4. Are you aware of any drainage or flooding concerns in the study area? If so, where?

BEHIND HOUSE AT 500 ROANOKE ST.

5. How would you prioritize the needs in the Downtown Area for the stormwater program?

(Rank these from 1-4, with #1 as the highest priority need)

- ____ Inspect and maintain the Town's stormwater systems downtown
- 1 Reduce Building Flood Risks / Damage from Large Floods
- ____ Reduce Street Flooding Issues / More Frequent and Smaller Storm Events
- ____ Improve Local Water Quality (through Stormwater Management)

6. Do you have other comments related to stormwater for the Downtown Watershed Study?

Please provide Comment Forms by **November 24, 2017**

You can mail the comment forms to: 100 E. Main Street, Christiansburg, VA 24073 or drop them off at the Engineering Department at Town Hall. Call for more information at (540) 382-6120

Further information about the Downtown Watershed Study can be found on the project website
http://www.christiansburg.org/watershed

Rissmeyer, Don

From: Melissa Demmitt (Powell) <mdemmitt@christiansburg.org>
Sent: Tuesday, November 28, 2017 1:39 PM
To: Justin St. Clair
Subject: Downtown Watershed submission

First Name

Ed

Last Name

Savage

Was this meeting helpful in understanding the Watershed Study goals?

Yes

Would you like to be added to the Town's mailing list for future announcements and updates about this study? If so, provide an email address.

mail@crabcreek.info

Are you aware of any highly eroded streams or ditches in the study area? If so, where?

9 Radford St has doubled in width and depth since last year. I am concerned about what it could do underneath the buildings if the amount of water flow is increased

Are you aware of any drainage or flooding concerns in the study area? If so, where?

How would you prioritize the following needs in the Downtown Area for the stormwater program?

Inspect and maintain the Town's stormwater systems downtown

1

Reduce Building Flood Risks / Damage from Large Floods

1

Reduce Street Flooding Issues / More Frequent and Smaller Storm Events

Improve Local Water Quality (through Stormwater Management)

Rissmeyer, Don

From: Melissa Demmitt (Powell) <mdemmitt@christiansburg.org>
Sent: Tuesday, November 28, 2017 1:40 PM
To: Justin St. Clair
Subject: Downtown watershed submission

Was this meeting helpful in understanding the Watershed Study goals?

No

Would you like to be added to the Town's mailing list for future announcements and updates about this study? If so, provide an email address.

tacy7@msn.com

Are you aware of any highly eroded streams or ditches in the study area? If so, where?

Commerce and Hickok, behind Old Town Mall and under Greater Valley Insurance. Recent weather events have shown the culvert along Old Town Mall parking lot is compromised and contributed to adjacent erosion.

Are you aware of any drainage or flooding concerns in the study area? If so, where?

West Main & Hickok, flooding overflows Hickok and private parking lots at Commerce. Flooding and overflow at Depot and College.

How would you prioritize the following needs in the Downtown Area for the stormwater program?

Inspect and maintain the Town's stormwater systems downtown

3

Reduce Building Flood Risks / Damage from Lar Floods

2

Reduce Street Flooding Issues / More Frequent and Smaller Storm Events

1

Improve Local Water Quality (through Stormwat Management)

4

Do you have other comments related to stormwater for the Downtown Watershed Study?

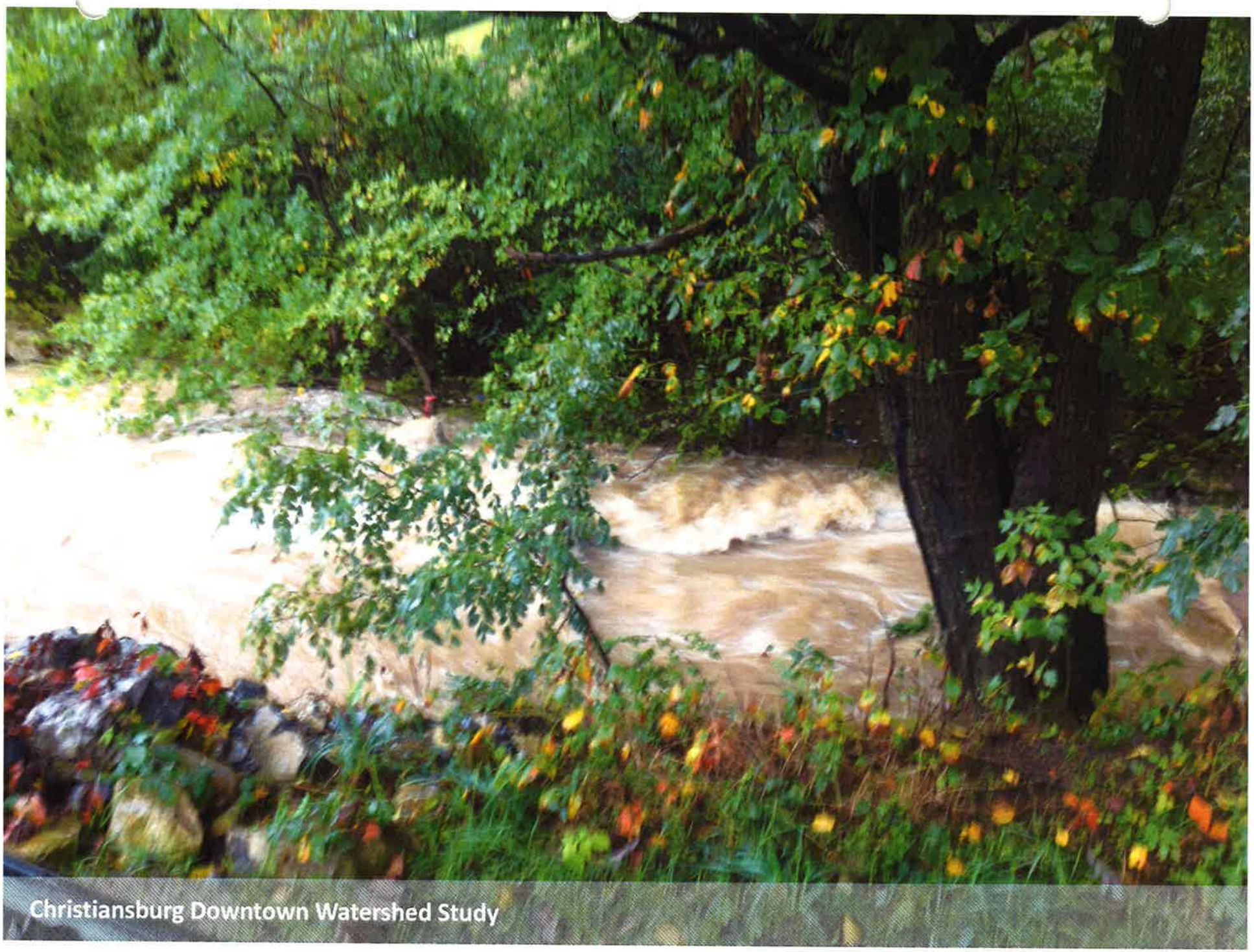
Christiansburg Downtown Watershed Study

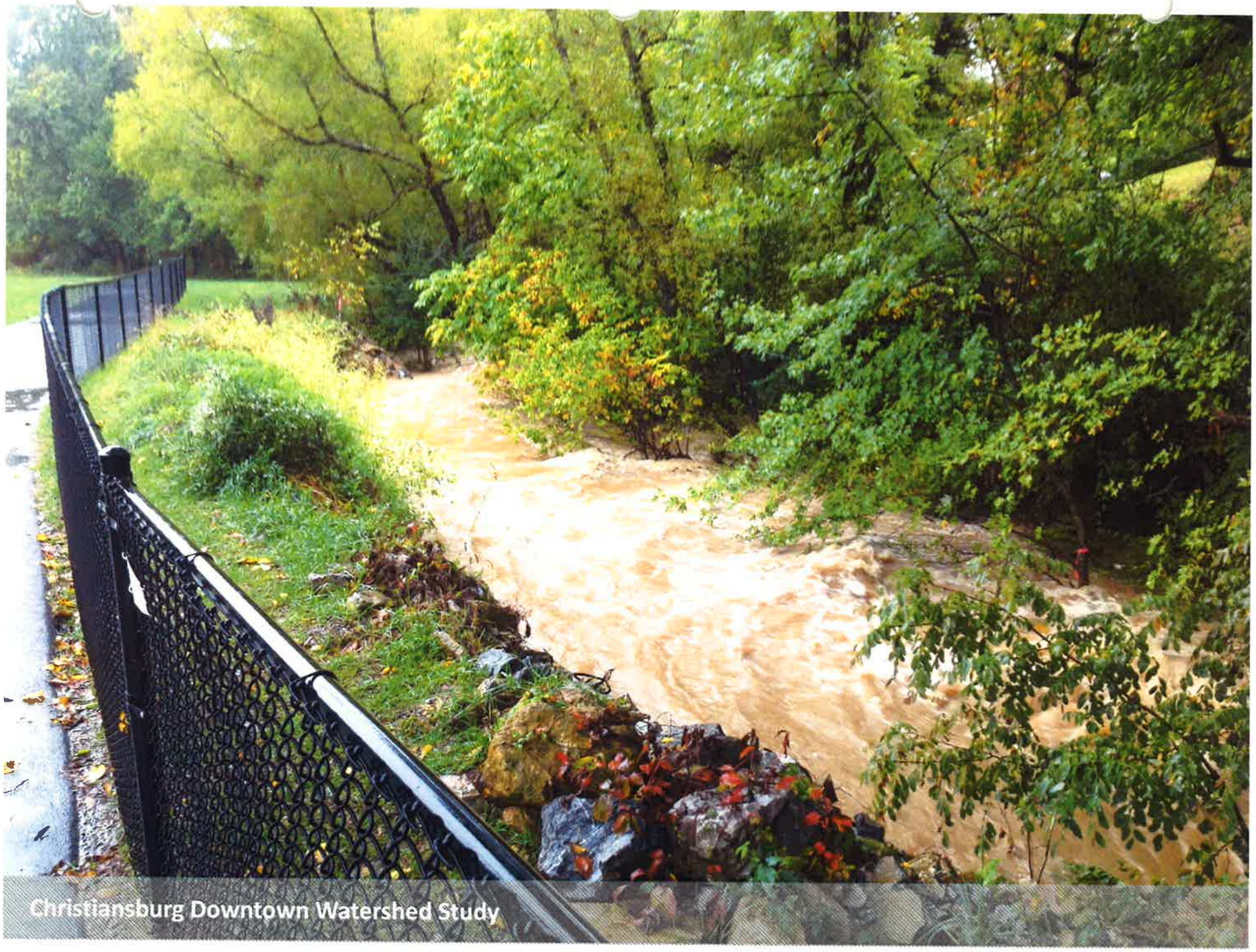
Flood Photos

October 26, 2017 – 6-8pm

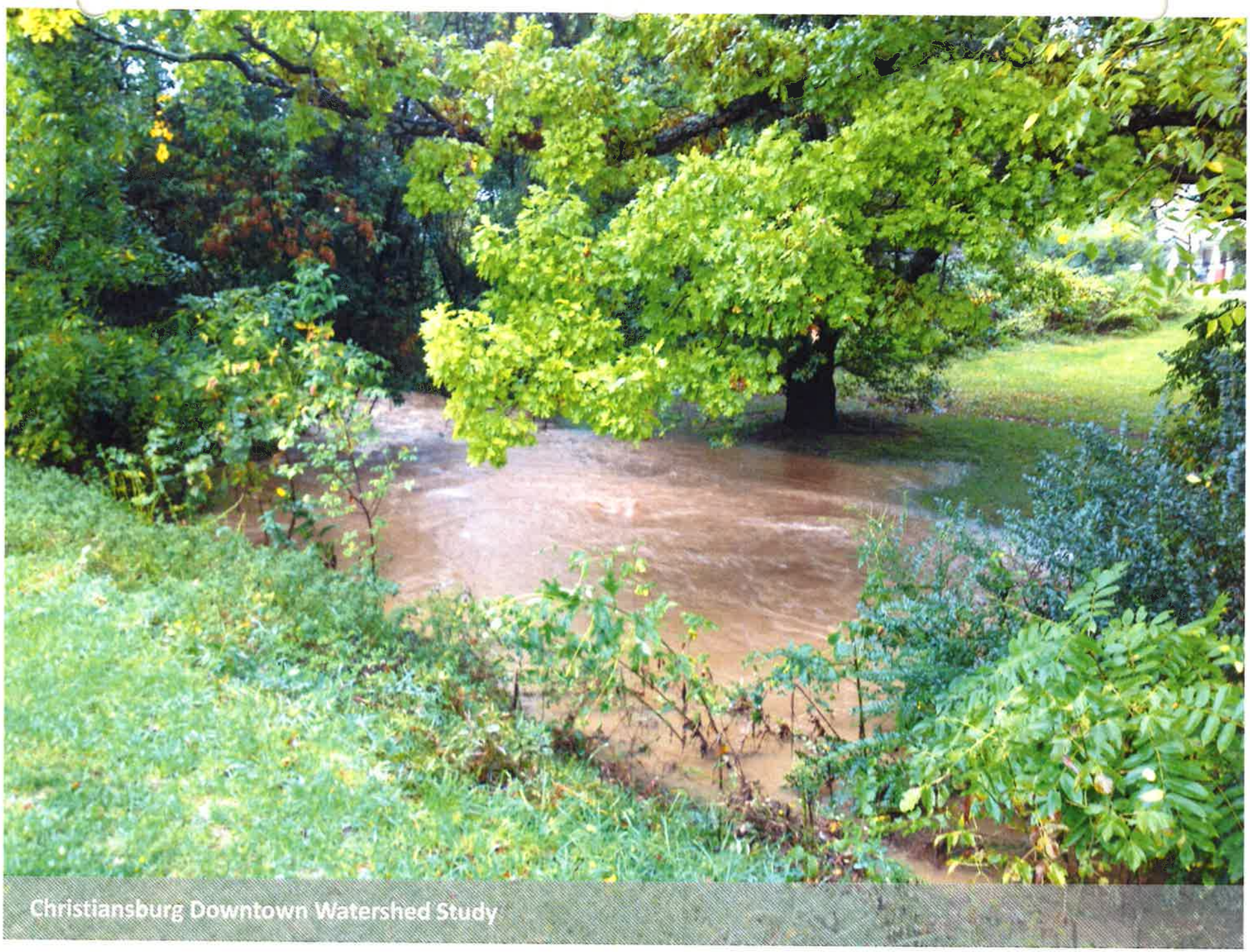
Town Council Chambers


Christiansburg Downtown Watershed Study


Christiansburg Downtown Watershed Study


Christiansburg Downtown Watershed Study


Christiansburg Downtown Watershed Study


Christiansburg Downtown Watershed Study


STOP
09/29/2015 12:19
Christiansburg Downtown Watershed Study


09/29/2015 12:20
Christiansburg Downtown Watershed Study


09/29/2015 12:21
Christiansburg Downtown Watershed Study


STOP
ALL WAY
09/29/2015 12:21
Christiansburg Downtown Watershed Study


09/29/2015 12:23
Christiansburg Downtown Watershed Study


09/29/2015 12:23
Christiansburg Downtown Watershed Study

Christiansburg Downtown Watershed Study

Christiansburg Downtown Watershed Study

Christiansburg Downtown Watershed Study

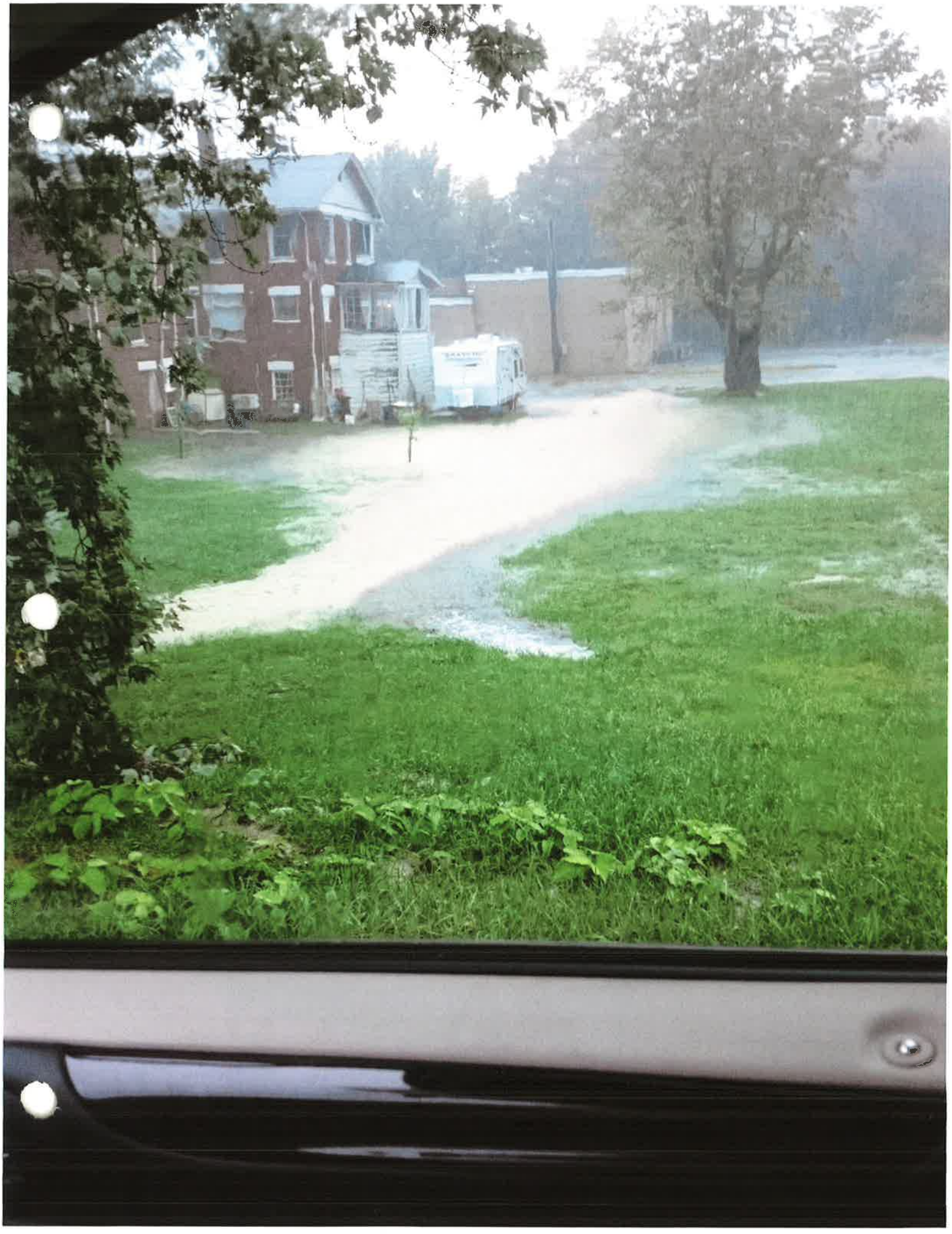
Christiansburg Downtown Watershed Study

Christiansburg Downtown Watershed Study

Thank you for attending!


400 ROANOKE STREET


ROCKWOOD



NEW RIVER VALLEY [HTTPS://WWW.WSLS.COM/NEWS/VIRGINIA/NEW-RIVER-VALLEY]

Study focuses on reducing flooding in Christiansburg

The study is expected to last through July 2018

By **Erin Brookshier [https://www.wsls.com/author/ebrookshier]** - Virginia Today Reporter

Posted: 6:03 AM, October 25, 2017
Updated: 6:03 AM, October 25, 2017

CHRISTIANSBURG, Va. - The town of Christiansburg is working to address issues with flooding in the downtown area and along Towne Branch. It's all part of an ongoing study to determine and address the problem areas.

One of the most important phases of the study kicks off this week as part of a community meeting. The town is looking for businesses and homes that tend to see issues with flooding, whether it's every time it rains or just every once in awhile.

Town leaders are asking community members to come out on Thursday night and share their concerns and stories. They are also asked to bring along any pictures or video for documentation, if they have it.

This is all information that will be used in the bigger plan, as a consultant team works to evaluate drainage and flooding problems along the creek, map out the floodplains and eventually develop a list of planned drainage improvements to put in place.

Wayne Nelson, the engineering director for the town of Christiansburg, says the team has already started to zero in on certain areas where he and others have seen repeated issues with flooding.

"When there's a big rain event here, it's all hands on deck," he says. "We're all out in the field, we're all answering calls, trying to help people because that's what we do."

Nelson says these are issues the town has been working to address, and thanks to a $75,000 grant from the Virginia Department of Conservation and Recreation and a matching $75,000 from the town of Christiansburg, the downtown watershed study is now the first step in a longer path to address and solve the flooding issues in Christiansburg.

The study is expected to last through July 2018. When the study is finished, the town will begin working to secure funding to make the necessary replacements and updates.

"We are looking at large infrastructure projects [at Thursday's meeting], but I think we can also help homeowners with some suggestions of things they might be able to do around their homes to help relieve the immediate flooding they experience," says Nelson.

Some of the infrastructure updates that have been put in place to address flooding issues like this in the past include a piping project to redirect water. The town has also used stormwater detention and retention projects, where town engineers can hold water back, releasing it at a slower rate that would lead to less flooding and less damage.

At this point, it's too early to know which, if either, of those methods would be used on these particular flooding issues. That's what town leaders and consultants on the project will be working to determine as part of the ongoing study.

The community meeting will take place at Town Hall on Thursday from 6 to 8 p.m. For more information, click here. [http://www.christiansburg.org/Index.aspx?NID=1030&PREVIEW=YES]

APPENDIX D

Hickok Street Improvements, Phase I

Town of Christiansburg

Hickok Street Improvements

Phase 1

Consultant Study

October 31, 2017

Table of Contents

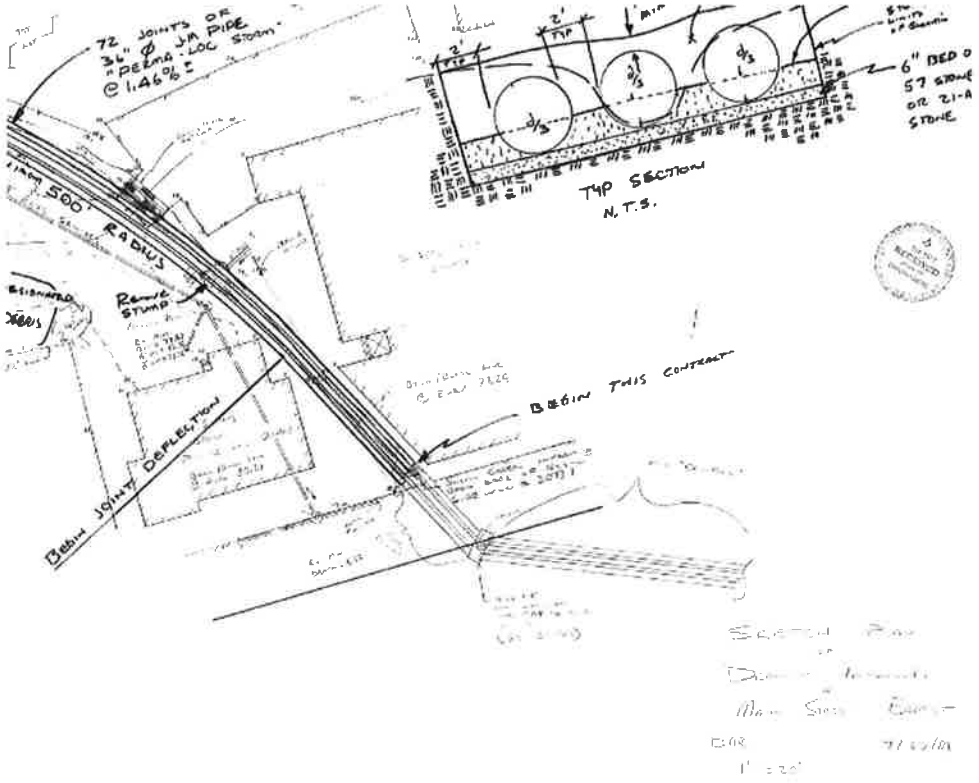
Section 1 - Purpose and Scope

The Town of Christiansburg is pursuing drainage improvements to a portion of W. Main Street between Hickok Street and S. Franklin Street. A portion of the current drainage facilities within W. Main Street have been in service for over almost 60 years and are creating issues for the Town. These drainage facilities capture and drain portions of W. Main Street and adjacent areas beneath W. Main Street and beneath existing occupied structures (45 and 49W. Main Street) on the north side of the street. It is possible to remove portion of the flooring from these structures and observe flowing water. Therefore, the Town has concerns with the liability and public safety with this existing drainage system and wants to make improvements to eliminate the use of the drainage structure beneath these structures.

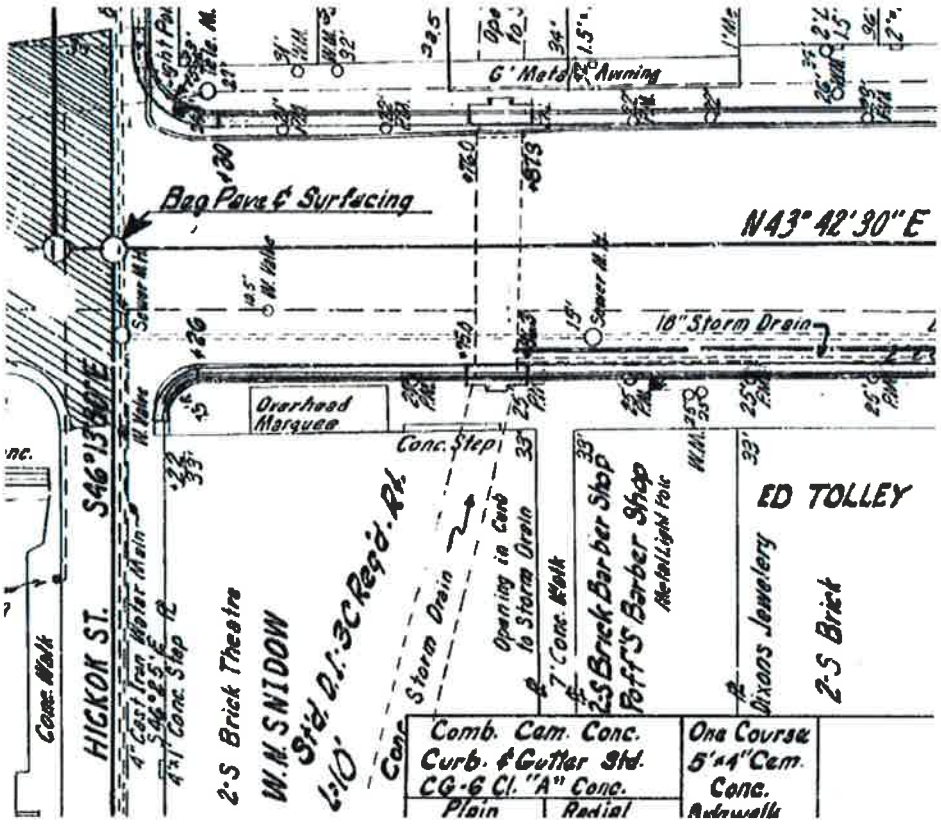
The scope of this drainage improvement project will start in the parking lot of Christiansburg Professional Park (90 College Street) at an existing drainage inlet and upstream of an existing 72-inch culvert. The drainage system will proceed in a southerly direction across Commerce Street to Hickok Street. Along Hickok Street the drainage system will cross W. Main Street and proceed approximately 200-foot south to a connection with an existing drainage system of 3-36-inch culverts. The length of the drainage system will be approximately 650-foot.

Section 2 - Site Description & Assessment

W. Main Street is a two-lane street with parallel parking on each side of the street. The southern portion of Hickok Street is a two-lane street with no parking with the northern portion being a two-lane street with parking on both sides of the street. The current storm drainage system comes beneath Hickok Street from behind Main Street Baptist Church at 100 W. Main Street via 3-36-inch diameter culverts, image below.



The system then crosses the parking lot of Advanced Home Care at 48 W. Main Street before crossing beneath W. Main Street. The type of crossing beneath W. Main Street appears to be an open-bottom box type structure constructed prior to 1960 as shown in the plan (0011-060-101-C-501) excerpt shown below.


6' Metal Awning
Bag Pave & Surfacing
N43° 42' 30" E
18" Storm Drain
Overhead Marquee
Conc. Step
ED TOLLEY
HICKOR ST.
S46° 15' 30" E
2-S Brick Theatre
W.M. SNIDOW
Std. D.I. 3C Reqd. Rt.
Storm Drain
Opening in Curb to Storm Drain
7' Conc. Walk
2-S Brick Barber Shop
Poff's Barber Shop
Neon Light Pole
Dixons Jewelery
2-S Brick
Comb. Cam. Conc. Curb & Gutter Std. CG-6 Cl. "A" Conc.
Plain
Radial
One Course 5'x1" Cem. Conc.
Conc. Walk

From W. Main Street the drainage system goes beneath the structure at 49 W. Main Street. This structure appears to consist of concrete modular blocks for the sides, corrugated metal for the top and natural bottom, see photograph below. The dimensions are approximately 8-foot wide by 6-foot tall.

After passing beneath the structure at 49 W. Main Street there is a very short open channel before the drainage system goes beneath the structure at 45 W. Main Street. This open channel is shown in the photograph below.

From here the drainage system is contained in a closed system beneath the rear parking lot of these structures before discharging to an open channel of approximately 35-foot in length. The drainage system then changes to a closed system of 72-inch diameter pipe beneath Commerce Street and the parking lot of Christiansburg Professional Park. After approximately 225-foot downstream the system discharges to an open channel before going beneath Graham Street.

When constructing a large drainage system within limits of existing streets and developed areas there are always going to be some challenges and constraints. Typically, it is necessary to keep existing systems in service during construction or at least minimize interruptions. These existing systems would include, but limited to domestic water, sanitary sewer, electrical, telephone, drainage, and traffic. The Town would need agreements with the local

property owners to obtain easements where they are not present and provide plans concerning parking disruptions.

Ideally, the drainage improvements would be constructed from a downstream to upstream direction so that existing storm flows could be maintained. As the system is constructed the tie-in of inlets along the drainage system's alignment would be connected.

The installation of the drainage improvements will necessitate the adjustment and relocation of various utilities. A portion of sanitary sewer adjacent to Commerce Street will be lowered to allow a crossing beneath the drainage improvements at Hickok Street. The existing sanitary sewer system along Hickok Street north of W. Main Street will be relocated to the western side of Hickok Street. Portions of the sanitary sewer in W. Main Street will be lowered to provide clearance for the drainage improvements.

The 16-inch domestic water line along W. Main Street will be lowered to provide clearance for the drainage improvements with the 4-inch domestic water line along Hickok Street south of W. Main Street will be relocated.

In our conversation with Verizon there is an existing wooden duct bank on the north side of W. Main Street crossing Hickok Street. This duct bank is anywhere between 5 to 8-foot deep and contains fiber optic cable. It is anticipated with these improvements this duct bank will require adjustment/relocation.

With the amount of work involved with these drainage improvements it would be recommended the Town close Hickok Street for the duration of the project with a portion of W. Main Street closed temporary.

Section 3 – Design & Conceptual Plan

The drainage area associated with this drainage improvement is separated into two drainage basins. The point of analysis for Basin #1 is near the intersection of Hickok Street and Commerce Street. This location is prior to a connection of an existing 54" drainage pipe from the west. The point of analysis for Basin #2 is the end of the drainage improvements. Using the StreamStats version 4 program by USGS the hydrology information used in the preliminary design is presented in the table below.

Basin	Area (ac)	2-Year	10-Year	50-Year	100-Year
1	256	57.7	196	410	523
2	531	98.6	319	648	819

A tail water elevation using the above information was calculated for the downstream open channel. A hydraulic model using the hydrology information and tail water elevation was developed with Bentley System's software package StormCAD®. The sizing of the drainage system is based upon a design storm event of 10-years, a minimum cover of 1-foot and a hydraulic grade line that does not exit the system.

The conceptual plan depicts the major items of work associated with the W. Main Street drainage improvements. The start of the drainage system will be a VDOT junction box providing a connection of the existing downstream 72-inch culvert and 72-inch culvert beneath Commerce Street with the new 10-foot by 4-foot box culvert. To parallel Commerce Street and remain within existing right of way a VDOT junction box will be provided at the change of direction of the box culvert. At the intersection of Commerce Street and Hickok Street the box culvert will make a 90-degree bend to

parallel Hickok Street. Approximately 125-foot upstream will a VDOT junction box providing connection to an existing 54-inch culvert from the south. Beginning at this location the box culvert will change to an 8-foot by 3-foot box culvert. Because Hickok Street is offset at W. Main Street the box culvert will include a 45-degree bend along with a break in the slope of the box. This portion of the drainage system will provide multiple connections to the existing drainage systems in W. Main Street. The drainage improvements will terminate with the use of a VDOT junction box to provide connection to the existing set of 36-inch culverts from the south.

Along with the drainage improvements the conceptual plan depicts the anticipated utility adjustments and relocations. These are anticipated to be domestic water, sanitary sewer and telephone.

The conceptual plan is provided in Appendix A of this report.

Section 4 - Preliminary Cost Estimate & Preliminary Project Schedule

Preliminary Cost Estimate

Using the conceptual drawing the major work items of the project were quantified, and using historical bid data, a project cost estimate was developed. This preliminary cost estimate includes preliminary engineering, VDOT reviews, construction engineering and inspection and construction. Because this preliminary cost estimate was developed from a conceptual drawing with no surveying information a 20% contingency is included. The cost breakdown is as follows:

- *Preliminary Engineering $286,800*
- *VDOT Review $66,000*
- *Construction Engineering and Inspection $132,000*
- *Construction $2,190,922*
- ***Total $2,675,722***

Refer to Appendix B for the more detailed breakdown of major work items and associated costs.

Preliminary Project Schedule

The preliminary project schedule was developed using the VDOT LAP Scheduling Tool and anticipated dates of tasks. The schedule of major items of the project are as follows:

- *Authorize PE Phase 9/27/2018*
- *30% Plan Development 6/13/2019*
- *60% Plan Development 12/12/2019*
- *90% Plan Development 2/14/2020*
- *PS&E Package 11/06/2020*

- *Bid Opening 1/04/2021*
- *End Construction 1/24/2022*

Refer to Appendix C for a copy of the completed VDOT LAP Scheduling Tool spreadsheet for this project

Section 5 - Conclusions & Recommendations

It is our opinion this project will improve the safety citizens and reduce the liability to the Town of Christiansburg with the re-routing of storm water and thus eliminating the flow of storm water beneath occupied structures and providing additional capacity. Furthermore, it is our opinion these improvements will have a positive impact to upstream properties with the increased capacity.

We recommend the Town of Christiansburg submit this project to VDOT requesting funding under the Revenue Sharing Program.

APPENDIX A

Conceptual Plan

PROPOSED VDOT STANDARD JB-1 CONNECTION TO EXISTING 72" PIPE

EXISTING 72" STORM DRAIN CONNECT TO JB-1

EXISTING DRAINAGE STRUCTURE TO BE ABANDONED IN PLACE (FLOWABLE FILL)

EXISTING DRAINAGE STRUCTURE TO BE BACKFILLED WITH #57 STONE

EXTEND EXISTING STORM DRAIN TO PROPOSED JUNCTION BOX

EXTEND EXISTING STORM DRAIN TO PROPOSED JUNCTION BOX

CONNECT EXISTING CURB INLET TO PROPOSED MANHOLE

EXISTING DRAINAGE STRUCTURE TO BE REMOVED WITH ENDS CAPPED

PROPOSED 10'X4' BOX CULVERT

PROPOSED VDOT STANDARD JB-1

COMMERCE STREET

PROPOSED 10'X4' BOX CULVERT

PROPOSED VDOT DI-2A INLET AND VDOT JB-1 TOWER TYPE "C"

PROPOSED STANDARD VDOT JB-1 TOWER TYPE "C" WITH IC-2 FRAME AND COVER

PROPOSED 30" RCP STORM DRAIN

PROPOSED 30" RCP STORM DRAIN

CONNECT EXISTING DRAIN INLET TO PROPOSED BOX CULVERT

ABANDON STORM DRAIN IN PLACE (FLOWABLE FILL)

CONNECT EXISTING CURB INLET TO PROPOSED JB-1

PROPOSED VDOT STANDARD JB-1

CONNECT EXISTING STORM DRAIN TO BOX CULVERT

REPLACE EXISTING STRUCTURE WITH STANDARD VDOT JB-1 TOWER TYPE "C" AND VDOT DI-2A INLET

PROPOSED 30" RCP STORM DRAIN CONNECT TO BOX CULVERT

RELOCATED 4" WATER LINE

12+00 13+00 14+00 15+00 16+00 16+35

HICKOK ST. SW

CONNECT EXISTING STORM DRAIN TO JB-1

HICKOK ST. NW

PROPOSED 8'X3' BOX CULVERT

PROPOSED VDOT STANDARD JB-1 CONNECTION TO EXISTING

RELOCATED 8" SANITARY SEWER LINE

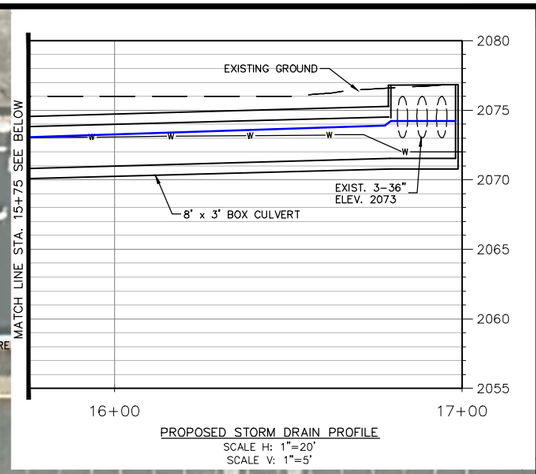
RELOCATED 8" SANITARY SEWER LINE

CONNECT EXISTING STORM DRAIN TO BOX CULVERT

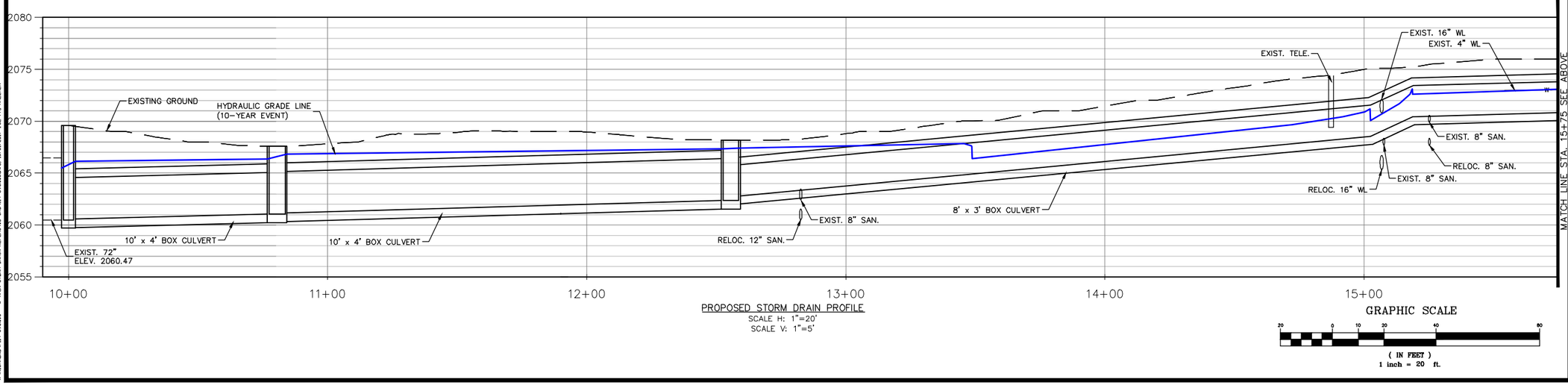
RELOCATED 16" WATER LINE

WEST MAIN ST.(U.S. RTE. 11 & 460)

WEST MAIN ST.(U.S. RTE. 11 & 460)



PROPOSED STORM DRAIN PROFILE
SCALE H: 1"=20'
SCALE V: 1"=5'



PROPOSED STORM DRAIN PROFILE
SCALE H: 1"=20'
SCALE V: 1"=5'

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS
100 GATEWAY CENTRE PARKWAY, SUITE 200
RICHMOND, VIRGINIA 23235
(804) 276-6231 FAX: (804) 276-6233
WWW.AMTENGINEERING.COM

OWNER

TOWN OF CHRISTIANSBURG
CHRISTIANSBURG VA.

REGISTRATION STAMP

PROJECT TITLE

HICKOK STREET IMPROVEMENTS PHASE 1

TOWN OF CHRISTIANSBURG, VA
100 E. MAIN ST.
CHRISTIANSBURG, VIRGINIA

REVISIONS

MARK	DATE	DESCRIPTION

AMT FILE NO.	P114-395.005
DATE:	October 31, 2017
SCALE:	1"=20'
DESIGNED BY:	DEC
DRAWN BY:	MPH
CHECKED BY:	DJR

SHEET TITLE

STORM DRAIN LAYOUT

SHEET

C-1.0

SHEET 1 OF 1

X:\RICHMOND\P114-395\05 - V MAIN STORM DRAIN\REPLACE\05-CAD\114-395SDS.DWG, 10/31/2017 3:02 PM, MHELMER

APPENDIX B

Preliminary Cost Estimate

HICKOK STREET IMPROVEMENTS PHASE 1

PRELIMINARY COST ESTIMATE

31-Oct-17

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$19,000.00	1	LS	$19,000.00
2	Engineering Design	$220,000.00	1	LS	$220,000.00
3	Construction Engineering and Inspection	$110,000.00	1	LS	$110,000.00
4	Allowance for VDOT Review and Inspection	$55,000.00	1	LS	$55,000.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$404,000.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$111,000.00	1	LS	$111,000.00
6	Bonds, Taxes, Permits, and Insurance	$33,000.00	1	LS	$33,000.00
7	Traffic Control	$49,000.00	1	LS	$49,000.00
8	As-Builts/Survey Stakeout	$17,000.00	1	LS	$17,000.00
	GENERAL CONDITIONS SUBTOTAL				**$210,000.00**
	DEMOLITION				
9	Removal of Curb and Gutter	$25.00	300	LF	$7,500.00
10	Removal of Curb Inlet	$1,000.00	2	EA	$2,000.00
11	Removal of Storm Sewer Pipe	$20.00	390	LF	$7,800.00
12	Removal of Manhole	$1,000.00	5	EA	$5,000.00
13	Removal of Sanitary Sewer	$20.00	485	LF	$9,700.00
14	Removal of Water Line	$15.00	230	LF	$3,450.00
15	Saw Cut Sidewalk	$10.00	250	LF	$2,500.00
16	Saw Cut Asphalt	$8.00	1400	LF	$11,200.00
17	Saw Cut Curb and Gutter	$12.00	14	LF	$168.00
	DEMOLITION SUBTOTAL				**$49,318.00**
	EARTHWORK & EROSION AND SEDIMENT CONTROL				
18	Inlet Protection	$200.00	6	EA	$1,200.00
19	Safety Fence	$10.00	1,500	LF	$15,000.00
20	Structural Excavation	$45.00	2,500	CY	$112,500.00
21	Structural Backfill	$40.00	1,400	CY	$56,000.00
22	Dewatering	$20,000.00	1	LS	$20,000.00
23	Removal of Trench Rock	$125.00	400	CY	$50,000.00
24	Flowable Backfill for Abandoned Structures	$300.00	400	CY	$120,000.00
	EARTHWORK & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$374,700.00**
	STORMWATER MANAGEMENT				

HICKOK STREET IMPROVEMENTS PHASE 1

PRELIMINARY COST ESTIMATE

31-Oct-17

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
25	8' x 15' Junction Box ((3) 36" CMP Culvert to 8' x 3' Box Culvert)	$20,000.00	1	EA	$20,000.00
26	12' x 6' Junction Box (8' x 3' Box Culvert to 56" CMP Culvert)	$20,000.00	1	EA	$20,000.00
27	10' x 6' Junction Box (10' x 4' Box Culvert to 10' X 4' Box Culvert)	$20,000.00	1	EA	$20,000.00
28	10' x 10' Junction Box (10' x 4' Box Culvert to 72" CMP Culvert)	$20,000.00	1	EA	$20,000.00
29	Box Culvert (10' x 4')	$1,000.00	235	LF	$235,000.00
30	Box Culvert (8' x 3')	$800.00	440	LF	$352,000.00
31	15" RCP Storm Drain Pipe	$115.00	45	LF	$5,175.00
32	18" RCP Storm Drain Pipe	$150.00	55	LF	$8,250.00
33	30" RCP Storm Drain Pipe	$200.00	90	LF	$18,000.00
34	4' X 5' JB-1 With Type "C" Tower	$3,700.00	2	EA	$7,400.00
35	2' x 5' JB-1 With Type "C" Tower	$3,300.00	1	EA	$3,300.00
35	VDOT DI-1 Drain Inlet	$3,000.00	2	EA	$6,000.00
36	VDOT DI-2A Curb Inlet	$4,000.00	2	EA	$8,000.00
37	VDOT IC-2 Frame and Cover	$750.00	4	EA	$3,000.00
38	Cap Existing 36" Culvert	$500.00	3	EA	$1,500.00
39	Concrete Bulkhead	$600.00	10	CY	$6,000.00
	STORMWATER MANAGEMENT SUBTOTAL				**$733,625.00**
	SITE IMPROVEMENTS				
40	Street Pavement (Full Section)	$100.00	1,850	SY	$185,000.00
41	Parking Lot Pavement	$50.00	850	SY	$42,500.00
42	Concrete Sidewalk (4" Thick)	$65.00	250	SY	$16,250.00
43	CG-6 Curb and Gutter	$50.00	300	LF	$15,000.00
44	Type B Class I Pave. Line Marking 4"	$3.00	750	LF	$2,250.00
45	10' Wide "Streetprint" Crosswalk	$1,500.00	3	EA	$4,500.00
46	Tree Replacement	$500.00	2	EA	$1,000.00
47	Brick Ribbon	$50.00	80	LF	$4,000.00
	SITE IMPROVEMENTS SUBTOTAL				**$270,500.00**

HICKOK STREET IMPROVEMENTS PHASE 1

PRELIMINARY COST ESTIMATE

31-Oct-17

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	UTILITY ADJUSTMENTS				
48	4" Water Line Relocation	$40.00	185	LF	$7,400.00
49	16" Water Line Relocation	$190.00	55	LF	$10,450.00
50	8" PVC Gravity Sewer Main	$60.00	280	LF	$16,800.00
51	16" PVC Gravity Sewer Main	$135.00	185	LF	$24,975.00
52	Sanitary Sewer Manholes	$4,000.00	7	EA	$28,000.00
53	Underground Telephone Relocation	$100,000.00	1	LS	$100,000.00
	UTILITY ADJUSTMENTS SUBTOTAL				**$187,625.00**
	SUBTOTAL CONSTRUCTION COST				**$1,825,768.00**
	CONTINGENCY	**20%**			**$365,154.00**
	CONSTRUCTION COST				**$2,190,922.00**
	TOTAL DESIGN/CONSTRUCTION ENGINEERING INSPECTION COST				**$349,000.00**
	TOTAL VDOT REVIEW AND INSPECTION				**$55,000.00**
	CONTINGENCY	**20%**			**$80,800.00**
	TOTAL DESIGN/CEI/VDOT REVIEW				**$484,800.00**
	PROJECT BUDGET				**$2,675,722.00**

Notes:

1) Easement acquisition is not included
2) Environmental permits assume no requirements for mitigation.

APPENDIX C

Preliminary Project Schedule

Project Name	Parish Street Improvements Phase 1
Local Project #	To Be Determined
UPC #	To Be Determined

Notes: Prepared by A Morton Thomas, & Associates, Inc. for Town of Christiansburg

Schedule Factors

Start Date	7/2/2018		
Target Finish	9/30/2021	38	months
Funding:	State		
Roadway Maintained By:	Locality		

	PE	RW	CN
Phases:	Yes	Yes - participating	Yes
Estimate:	239,000		2,381,722

Public Involvement: Posting of Willingness

Plan Design: RFP - New Consultant

Environmental Document: PCE

Programming Schedule

	PE	RW	CN
Start	9/27/2018		11/20/2020
End	11/20/2020	11/20/2020	1/24/2022

Task #	Subtasks	Factors	Responsible	Duration (Working Days) Baseline	Custom	Planned Schedule Start Date	End Date	Start	End	Actual Schedule Start Date	End Date	Duration	Preceding Activities
Project Initiation													
1A	**Pre-scoping**			0				1	0				
1A-1	Evaluate project		Locality	0				1	0				
1A-2	Submit application for funding		Locality	0				1	0				1A-1
1A-3	Application selection process		VDOT	0				1	0				1A-2
10	**Agreement Execution**			60		7/3/2018	9/24/2018	1	60				1A
10-1	Prepare Agreement		VDOT	10		7/3/2018	7/16/2018	1	10				1A-3
10-2	Council Resolution		Locality	30		7/17/2018	8/27/2018	11	40				10-1
10-3	Execute Agreement		Locality	20		8/28/2018	9/10/2018	41	50				10-2
10-4	Execute/Distribute Agreement		VDOT	10		9/11/2018	9/24/2018	51	60				10-3
12	**Authorize PE Phase**			3		9/25/2018	9/27/2018	61	63				10
12-1	Federal Authorization		VDOT	0				61	60				10-4
12-2	Open project Budget		VDOT	3		9/25/2018	9/27/2018	61	63				12-1
12-3	Notify Locality		VDOT	1		9/25/2018	9/25/2018	61	61				12-1
Preliminary Design													
28	**Consultant Procurement**			105		9/28/2018	2/21/2019	64	168				12
28-1	RFP Prep		Locality	5		9/28/2018	10/4/2018	64	68				12-2 12-3
28-2	RFP Review		VDOT	5		10/5/2018	10/11/2018	69	73				28-1
28-3	Advertise RFP		Locality	20		10/12/2018	11/8/2018	74	93				28-2
28-4	Shortlist/Interviews		Locality	20		11/9/2018	12/6/2018	94	113				28-3
28-5	Pre-Award Evaluation Prep		Locality	10		12/7/2018	12/20/2018	114	123				28-4
28-6	Pre-Award Evaluation		VDOT	10		12/21/2018	1/3/2019	124	133				28-5
28-7	Scope Contract		Locality	15		1/4/2019	1/24/2019	134	148				28-6
28-8	Execute Contract		Locality	20		1/25/2019	2/21/2019	149	168				28-7
OR 28-9	*Utilize eligible On-Call/Approve Task Order*		Locality	0				64	63				12-2 12-3
22	**Scoping**			135		9/28/2018	4/4/2019	64	198				12
22-1	Develop Scoping report		Locality	130		9/28/2018	3/28/2019	64	193				12
22-2	Review Scoping Report		VDOT	5		3/29/2019	4/4/2019	194	198				22-1
Plan and Specification Development													
36F	**30% Plan Development**			80		2/22/2019	6/13/2019	169	248				12 28
36F-1	Develop 30% Plans		Locality	115	80	2/22/2019	6/13/2019	169	248				12 28
36F-2	Review 30% Plans		VDOT	0				249	248				36F-1
32	**Value Engineering**			0				249	248				36F
32-1	Perform VE Study		Locality	0				249	248				36F-2
36P	**60% Plan Development**			40		10/18/2019	12/12/2019	339	378				36F 22 25X
36P-1	Develop 60% Plans		Locality	60	40	10/18/2019	12/12/2019	339	378				36F-2 22 25X
36P-2	Review 60% Plans		VDOT	0				379	378				36P-1

Project Name	Polish Street Improvements Phase I
Local Project #	To Be Determined
UPC #	To Be Determined

Notes: Prepared by A Morton Thomas, & Associates, Inc. for Town of Christiansburg

Schedule Factors

Start Date	7/2/2018	38	months
Target Finish	9/20/2021		
Funding:	State		
Roadway Maintained By:	Locally		

Phases:	PE	RW	CN
	Yes	Yes - participating	Yes
Estimate:	239,000		2,381,722

Public Involvement: Posting of Willingness

Plan Design: RFP - New Consultant

Environmental Document: PCE

Programming Schedule

	PE	RW	CN
Start	9/27/2018		11/20/2020
End	11/20/2020	11/20/2020	1/24/2022

Task #	Subtasks	Factors	Responsible	Duration (Working Days) Baseline	Duration (Working Days) Custom	Planned Schedule Start Date	Planned Schedule End Date	Start	End	Actual Schedule Start Date	Actual Schedule End Date	Actual Schedule Duration	Preceding Activities
65P	**90% Plan Review**			25		1/13/2020	2/14/2020	400	424				36P, 25X, 18, 47, 60X, 32
65P-1	Develop 90% Plans and estimate		Locality	45	25	1/13/2020	2/14/2020	400	424				36P, 25X, 18, 47, 60X, 32
65P-2	Review 90% Plans and estimate		VDOT	0				425	424				65P-1
65P-3	Obtain DBE Goal		VDOT	0				425	424				65P-1
72B	**Bidability Review**			25		1/13/2020	2/14/2020	400	424				36P, 25X, 18, 47, 60X, 32
72B-1	Develop draft bid document		Locality	45	25	1/13/2020	2/14/2020	400	424				36P, 25X, 18, 47, 60X, 32
72B-2	Review draft bid document		VDOT	0				425	424				72B-1
Environmental													
17	**Environmental Review Process (ERP)**			15		9/28/2018	10/18/2018	64	78				12
17-1	Prepare EQ-429 & map		Locality	10		9/28/2018	10/11/2018	64	73				12-2
17-2	Review EQ-429		VDOT	5		10/12/2018	10/18/2018	74	78				17-1
18	**State Environmental Review Process (SERP)**			75		9/28/2018	1/10/2019	64	138				12
18-1	Prepare EQ-429 & map		Locality	10		9/28/2018	10/11/2018	64	73				12-2
18-2	Provide Preliminary Environmental Inventory Report		VDOT	65		10/12/2018	1/10/2019	74	138				18-1
25	**Draft Environmental Document**			90		6/14/2019	10/17/2019	249	338				17, 36P
25-1	Prepare NEPA Concurrence Form		Locality	0				249	248				17-2, 36P
25-2	Review NEPA Concurrence		VDOT	25		6/14/2019	7/18/2019	249	273				25-1
25-3	Prepare Draft NEPA		Locality	65		7/19/2019	10/17/2019	274	338				25-2
25-4	Review Draft NEPA		VDOT	0				339	338				25-3
25X	**Posting Environmental Document**			0				339	338				25
25X-1	Approved Document		VDOT	0				339	338				25-4
70	**Environmental Permits**			1		10/18/2019	10/18/2019	339	339				25X, 18
70-1	Obtain necessary permits		Locality	1		10/18/2019	10/18/2019	339	339				25X, 18
Public Involvement													
47	**Posting of Willingness**			21		12/13/2019	1/10/2020	379	399				25X, 18, 36P
47-1	Prepare Posting of Willingness Package		Locality	10		12/13/2019	12/26/2019	379	388				25X-1, 18, 36P
47-2	Initial Posting (15 days from expiration of notice)		Locality	6		12/27/2019	1/3/2020	389	394				47-1
47-3	Second Posting (5-7 days prior to expiration)		Locality	5		1/6/2020	1/10/2020	395	399				47-2
48	**Public Hearing**			0				400	399				25X, 18, 36P, 47
48-1	Prepare Draft Project Information Sheet		Locality	0				400	399				25X-1, 18, 36P, 47
48-2	Initial Notice in paper		Locality	0				400	399				48-1
48-3	Review Draft Project Information Sheet		VDOT	0				400	399				48-1
48-4	Second Notice in paper		Locality	0				400	399				48-2
48-5	Prepare Final Project Information Sheet		Locality	0				400	399				48-3
48-6	Review Final Project Information Sheet		VDOT	0				400	399				48-5
48X	**Public Hearing Meeting**			0				400	399				48

Project Name	Fulton Street Improvements Phase 1
Local Project #	To Be Determined
UPC #	To Be Determined

Notes: Prepared by A Morton Thomas, & Associates, Inc. for Town of Christiansburg

Schedule Factors

Start Date:	7/2/2018	38	months
Target Finish:	9/20/2021		
Funding:	State		
Roadway Maintained By:	Locally		

	PE	RW	CN
Phases:	Yes	Yes - participating	Yes
Estimate:	239,000		2,981,732

Public Involvement: Posting of Willingness

Plan Design: RFP - New Consultant

Environmental Document: PCE

Programming Schedule

	PE	RW	CN
Start	9/27/2018		11/20/2020
End	11/20/2020	11/20/2020	1/24/2022

Task #	Subtasks	Factors	Responsible	Duration (Working Days) Baseline	Duration (Working Days) Custom	Planned Schedule Start Date	Planned Schedule End Date	Start	End	Actual Schedule Start Date	Actual Schedule End Date	Actual Schedule Duration	Preceding Activities
	48X-1 Date of Public Hearing		Locality	0				400	399				48-4 48-6
	49 Review/Adopt Public Hearing Information			0				400	399				48X
	49-1 Allow for close of written comment period		Locality	0				400	399				48-4 48-6
	49-2 Prepare PH Transcript		Locality	0				400	399				49-1
	49-3 VDOT L&D approval		VDOT	0				400	399				49-2
Right-of-Way Authorization													
	51 Furnish RW plans for review			0				400	399				22 35X 18 47 49 36P
	51-1 Prepare RW plans, RW 301, RW estimate for review		Locality	0				400	399				22 35X 18 47 49 36P
	51-2 RW plan review		VDOT	0				400	399				51-1
	51-3 NEPA Re-eval @ RW		VDOT	0				400	399				51-1
	52 RW Authorization			0				400	399				51
	52-1 Request Federal Authorization		VDOT	0				400	399				51-2 51-3
	60X Notice to Proceed			0				400	399				52
	60X-1 NTP issued		VDOT	0				400	399				52-1
	69 RW Acquisition & Utility Relocation			195		1/13/2020	10/9/2020	400	594				60X 47 49 22 36P 18
	69-1 *RW Acquisition*	Yes/No											
	69-1a Lower risk, few parcels (1-10), appraisal needed	Yes	Locality	130		1/13/2020	7/10/2020	400	529				60X-1 18 47 35P 22 49
	69-1b Lower risk, larger project (11+ parcels), appraisal needed		Locality	0				400	399				60X-1 18 47 35P 22 49
	69-1c Lower risk, few parcels (1-10), Waiver (BAR) utilized		Locality	0				400	399				60X-1 18 47 35P 22 49
	69-1d Lower risk, larger project (11+ parcels), Waiver (BAR) utilized		Locality	0				400	399				60X-1 18 47 35P 22 49
	69-2 *Utility Relocation*												
	69-2a Few utility relocations (1-3)	Yes	Locality	65		7/13/2020	10/9/2020	530	594				60X-1 18 47 35P 22 49 69-1a 69-1b 69-1c 69-1d
	69-2b Moderate utility relocations (4-6)		Locality	0				530	529				60X-1 18 47 35P 22 49 69-1a 69-1b 69-1c 69-1d
	69-2c Many utility relocations (7+)		Locality	0				530	529				60X-1 18 47 35P 22 49 69-1a 69-1b 69-1c 69-1d
Advertisement/Award													
	72 Prepare for Advertisement			20		10/12/2020	11/6/2020	595	614				69 65P 72B 70
	72-1 Prepare PS&E package		Locality	10		10/12/2020	10/23/2020	595	604				65P-1 69 72B 70
	72-2 Review PS&E package		VDOT	10		10/26/2020	11/6/2020	605	614				72-1
	66 NEPA Re-evaluation at CN			0				615	614				72
	66-1 Request Re-evaluation when final plans submitted)		VDOT	0				615	614				72
	69X RW/Utilities Certification @ PS&E			0				615	614				66
	69X-1 Provide letter		Locality	0				615	614				66
	69X-2 Review and provide certification		VDOT	0				615	614				69X-1
	79 Construction Advertisement			0				615	614				72 66 69X
	79-1 Submit for authorization/Receive Authorization		VDOT	0				615	614				72-1 66-1 69X

Project Name	Hickok Street Improvements Phase 1
Local Project #	To Be Determined
UPC #	To Be Determined

Notes: Prepared by A Morton Thomas, & Associates, Inc. for Town of Christiansburg

Schedule Factors

Start Date	7/2/2018		
Target Finish	9/20/2021	38	months
Funding:	State		
Roadway Maintained By:	Locally		

	PE	RW	CN
Phases:	Yes	Yes - participating	Yes
Estimate:	239,000		2,961,722

Public Involvement: Posting of Willingness

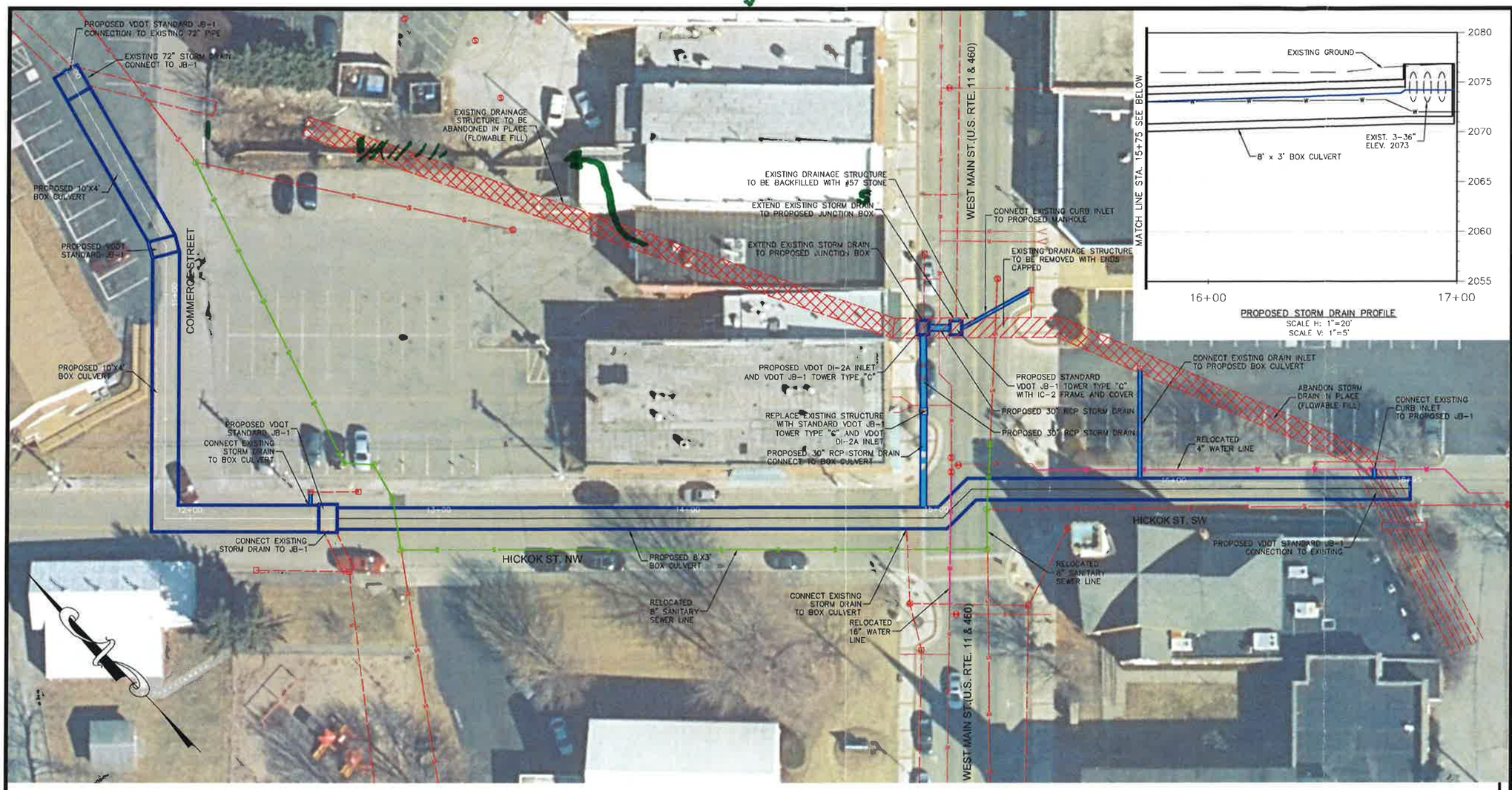
Plan Design: RFP - New Consultant

Environmental Document: PCE

Programming Schedule

	PE	RW	CN
Start	9/27/2018		11/20/2020
End	11/20/2020	11/20/2020	1/24/2022

Task #	Subtasks	Factors	Responsible	Duration (Working Days) Baseline	Duration (Working Days) Custom	Planned Schedule Start Date	Planned Schedule End Date	Start	End	Actual Schedule Start Date	Actual Schedule End Date	Actual Schedule Duration	Preceding Activities
80	**Advertise Project**			10		11/9/2020	11/20/2020	615	624				72, 79
80-1	Notify Locality Federal authorization received		VDOT	0				615	614				72, 79
80-2	Submit for advertisement		Locality	10		11/9/2020	11/20/2020	615	624				80-1
X	**Advertisement Period**			15		11/23/2020	12/11/2020	625	639				80
X-1	Advertise for a period not less than 21 days		locality	15		11/23/2020	12/11/2020	625	639				80-2
82	**Bid Opening**			16		12/14/2020	1/4/2021	640	655				X-1
82-1	Bid opening/Review bids		Locality	15		12/14/2020	1/1/2021	640	654				X-1
82-2	Submit award estimate and Appendix S-A Certification (State projects only)		Locality	1		1/4/2021	1/4/2021	655	655				82-1
82-3	Award Concurrence (DBE & Funding) - Federal projects only		VDOT	0				655	654				82-1
84	**Award Contract**			25		1/5/2021	2/8/2021	656	680				82
84-1	Executing contract with low bidder to NTP		Locality	25		1/5/2021	2/8/2021	656	680				82-2
Construction													
91	**Construction**			160		2/9/2021	9/20/2021	681	840				84
91-1	Submittal of Form C-5 with start and end dates		Locality	280	160	2/9/2021	9/20/2021	681	840				84-1
95	**Closeout**			90		9/21/2021	1/24/2022	841	930				91
95-1	Submit final invoice		Locality	45		9/21/2021	11/22/2021	841	885				91-1
95-2	Begin closeout		VDOT	45		11/23/2021	1/24/2022	886	930				95-1



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OWNER

TOWN OF CHRISTIANSBURG
CHRISTIANSBURG VA

REGISTRATION STAMP

PROJECT TITLE

HICKOK STREET IMPROVEMENTS PHASE 1

TOWN OF CHRISTIANSBURG, VA
100 E. MAIN ST.
CHRISTIANSBURG, VIRGINIA

REVISIONS

MARK	DATE	DESCRIPTION

AMT FILE NO.	P114-395.005
DATE:	October 31, 2017
SCALE:	1"=20'
DESIGNED BY:	DEC
DRAWN BY:	MPH
CHECKED BY:	DJR

SHEET TITLE

STORM DRAIN LAYOUT

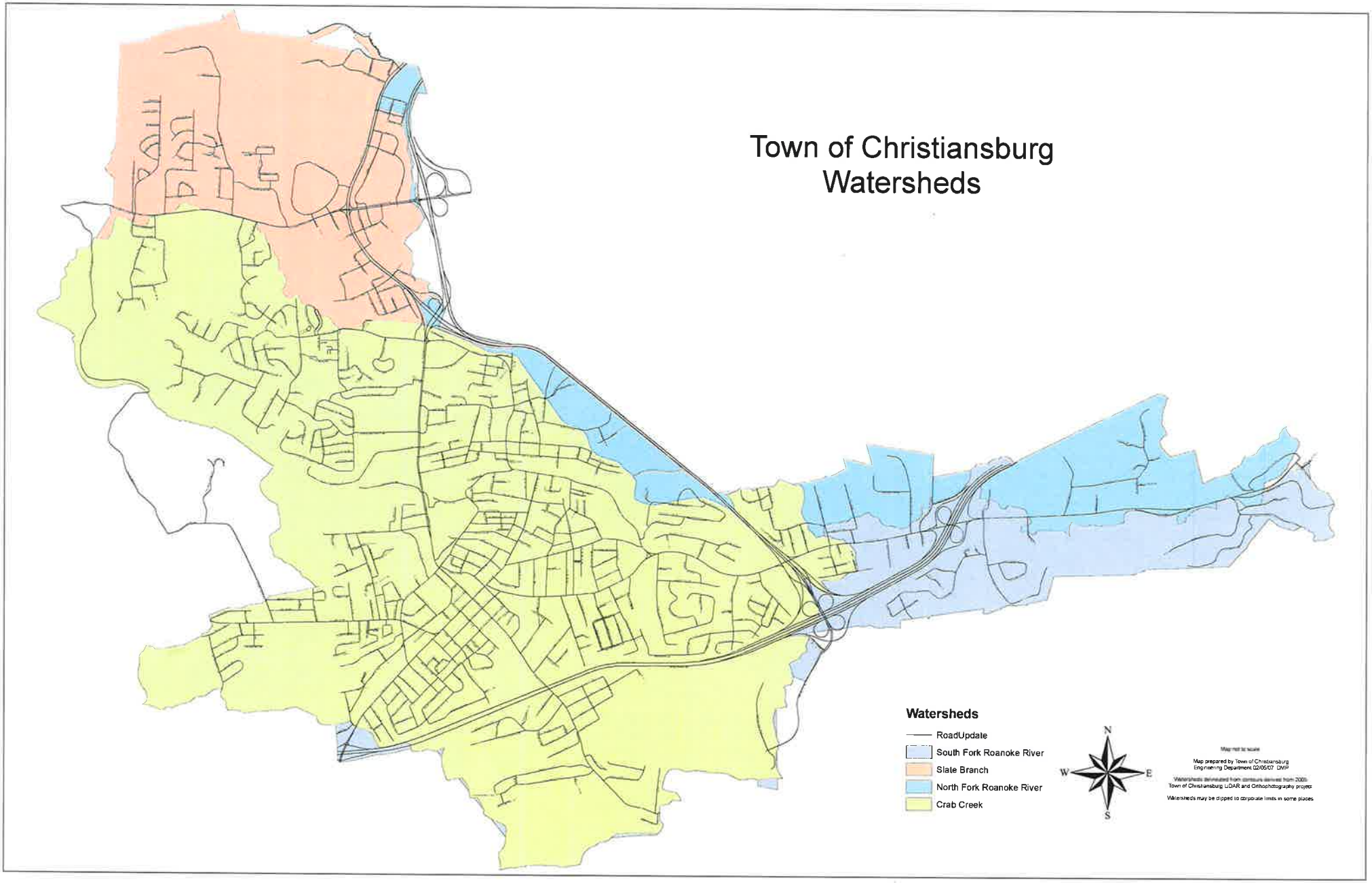
SHEET

C-1.0

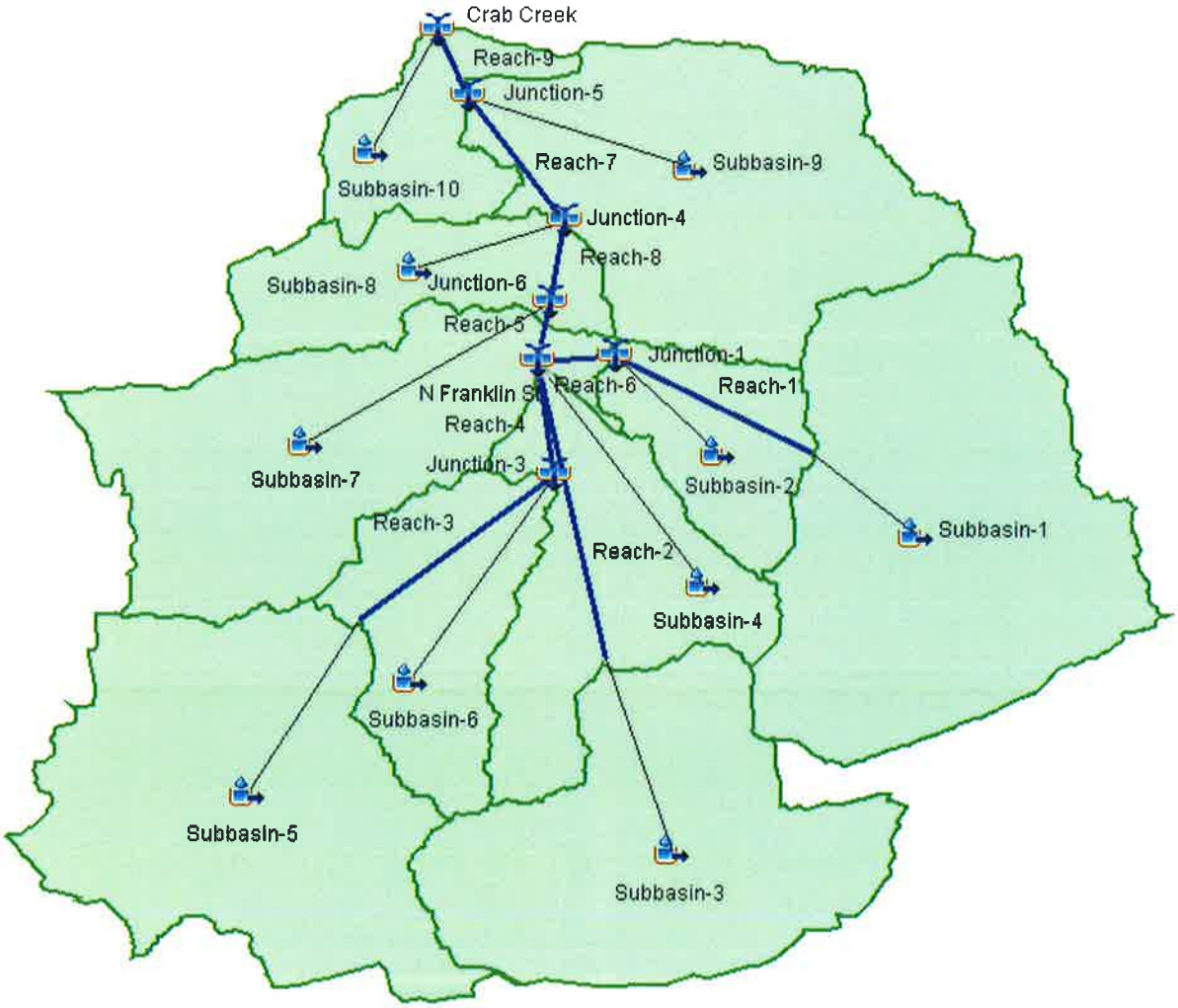
SHEET 1 OF 1

APPENDIX E
Hydrology Results

Town of Christiansburg Watersheds

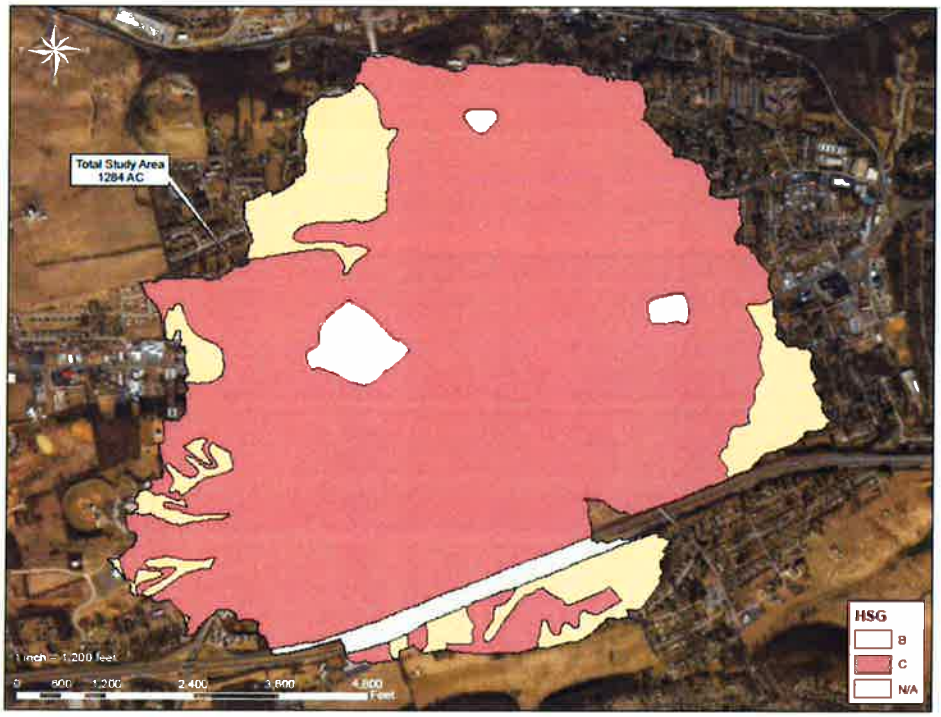


HEC-HMS Network Diagram



Drainage Area Map

Soils Map



Watershed Summary Table

Sub-basin	Area (Ac)	CN	Tc (hr)
1	230	78	0.617
2	54	87	0.224
3	198	78	0.273
4	80	84	0.266
5	171	76	0.369
6	104	84	0.29
7	157	83	0.349
8	65	74	0.268
9	177	81	0.355
10	48	78	0.214
Total =	**1284**	**80**	**0.993**

Soils Summary Table

Hydrologic Soil Group	Area (acre)	Percent Area (%)
B	172	13.4
C	1055	82.2
N/A (Assumed D)	57	4.4
Total =	1284	100

Supporting Calcs Table

ID	HSG	Land Use	Area	CN	DA_Area	CN_Part	Sub-B CN	CN_Part_Tot	B CN
1	B	Forested (Evergreen)	11.8156	58	229.528	2.98571	78	0.533931838	80
1	B	Grassland	13.641	58	229.528	3.44698	78	0.616419327	80
1	B	Impervious (100%)	5.60809	98	229.528	2.39445	78	0.428196482	80
1	B	Impervious (90%)	5.7574	90	229.528	2.25753	78	0.403711348	80
1	C	Forested (Evergreen)	23.7473	72	229.528	7.44922	78	1.332136659	80
1	C	Grassland	96.4804	72	229.528	30.2647	78	5.412197502	80
1	C	Impervious (100%)	29.6254	98	229.528	12.649	78	2.26199866	80
1	C	Impervious (90%)	38.2521	90	229.528	14.999	78	2.682253598	80
1	D	Forested (Evergreen)	0.103801	79	229.528	0.035727	78	0.006388967	80
1	D	Grassland	0.403307	79	229.528	0.138812	78	0.024823608	80
1	D	Impervious (100%)	1.41251	98	229.528	0.60309	78	0.107849876	80
1	D	Impervious (90%)	2.68142	90	229.528	1.05141	78	0.188022316	80
2	C	Forested (Evergreen)	5.10881	72	54.0731	6.80254	87	0.286585552	80
2	C	Grassland	10.9698	72	54.0731	14.6066	87	0.615365651	80
2	C	Impervious (100%)	14.8154	98	54.0731	26.8509	87	1.131205484	80
2	C	Impervious (90%)	23.1791	90	54.0731	38.5796	87	1.625328397	80
3	B	Forested (Evergreen)	7.85364	58	171.218	2.66042	76	0.354895938	80
3	B	Grassland	16.9055	58	171.218	5.72673	76	0.763937903	80
3	B	Impervious (100%)	4.45295	98	171.218	2.54873	76	0.339997669	80
3	B	Impervious (90%)	6.08913	90	171.218	3.20072	76	0.426972398	80
3	B	Pasture	5.63289	61	171.218	2.00684	76	0.26770911	80
3	C	Forested (Evergreen)	15.3445	72	171.218	6.45262	76	0.860770318	80
3	C	Grassland	61.2117	72	171.218	25.7405	76	3.433752449	80
3	C	Impervious (100%)	13.9605	98	171.218	7.99057	76	1.065931001	80
3	C	Impervious (90%)	14.6783	90	171.218	7.71558	76	1.029248668	80
3	C	Pasture	3.5921	74	171.218	1.5525	76	0.207100994	80
3	D	Forested (Evergreen)	1.66339	79	171.218	0.767488	76	0.102381909	80
3	D	Grassland	12.1451	79	171.218	5.60375	76	0.747532762	80
3	D	Impervious (100%)	3.97372	98	171.218	2.27444	76	0.303406851	80
3	D	Impervious (90%)	3.71488	90	171.218	1.95271	76	0.260488973	80
4	C	Forested (Evergreen)	10.3671	72	103.726	7.19618	84	0.581556386	80
4	C	Grassland	35.5178	72	103.726	24.6542	84	1.992418651	80
4	C	Impervious (100%)	24.6463	98	103.726	23.2857	84	1.881827674	80
4	C	Impervious (90%)	33.1949	90	103.726	28.8022	84	2.327640573	80
5	B	Forested (Evergreen)	0.636071	58	197.778	0.186533	78	0.028743234	80
5	B	Grassland	14.429	58	197.778	4.23142	78	0.652028039	80

ID	HSG	Land Use	Area	CN	DA_Area	CN_Part	Sub-B CN	CN_Part_Tot	B CN
5	B	Impervious (100%)	1.16611	98	197.778	0.577813	78	0.08903641	80
5	B	Impervious (90%)	3.46719	90	197.778	1.57776	78	0.243120844	80
5	B	Pasture	0.505478	61	197.778	0.155903	78	0.024023382	80
5	C	Forested (Evergreen)	25.2449	72	197.778	9.19027	78	1.416146541	80
5	C	Grassland	87.6029	72	197.778	31.8914	78	4.914202227	80
5	C	Impervious (100%)	27.0453	98	197.778	13.4011	78	2.06499937	80
5	C	Impervious (90%)	31.784	90	197.778	14.4635	78	2.228707662	80
5	C	Pasture	0.122585	74	197.778	0.045866	78	0.007067586	80
5	D	Forested (Evergreen)	0.428244	79	197.778	0.171057	78	0.026358484	80
5	D	Grassland	3.05687	79	197.778	1.22103	78	0.188150816	80
5	D	Impervious (100%)	1.16383	98	197.778	0.576684	78	0.088862324	80
5	D	Impervious (90%)	1.12586	90	197.778	0.512329	78	0.078945784	80
6	C	Forested (Evergreen)	7.34645	72	80.3259	6.58498	84	0.412108971	80
6	C	Grassland	24.9989	72	80.3259	22.4077	84	1.402346841	80
6	C	Impervious (100%)	13.7439	98	80.3259	16.768	84	1.049392865	80
6	C	Impervious (90%)	24.6816	90	80.3259	27.6541	84	1.730684339	80
6	D	Forested (Evergreen)	0.387707	79	80.3259	0.381307	84	0.023863425	80
6	D	Grassland	3.20488	79	80.3259	3.15198	84	0.197260854	80
6	D	Impervious (100%)	2.26575	98	80.3259	2.76428	84	0.172997612	80
6	D	Impervious (90%)	3.69667	90	80.3259	4.14188	84	0.25921208	80
7	B	Forested (Evergreen)	1.20538	58	156.789	0.445899	83	0.054469579	80
7	B	Grassland	3.40094	58	156.789	1.25809	83	0.153684125	80
7	B	Impervious (100%)	2.73363	98	156.789	1.70864	83	0.20872182	80
7	B	Impervious (90%)	4.28357	90	156.789	2.45885	83	0.300365759	80
7	C	Forested (Evergreen)	12.522	72	156.789	5.7503	83	0.702438393	80
7	C	Grassland	51.5334	72	156.789	23.665	83	2.890835224	80
7	C	Impervious (100%)	27.1833	98	156.789	16.9908	83	2.075536133	80
7	C	Impervious (90%)	41.4101	90	156.789	23.7702	83	2.903693908	80
7	C	Pasture	0.064865	74	156.789	0.030615	83	0.003739764	80
7	D	Forested (Evergreen)	0.13272	79	156.789	0.066873	83	0.008168936	80
7	D	Grassland	6.17853	79	156.789	3.11313	83	0.380289466	80
7	D	Impervious (100%)	1.80736	98	156.789	1.12968	83	0.137997998	80
7	D	Impervious (90%)	4.3335	90	156.789	2.48751	83	0.303866872	80
8	B	Forested (Evergreen)	4.08269	58	65.1179	3.63642	74	0.184491535	80
8	B	Grassland	19.249	58	65.1179	17.1449	74	0.869837668	80
8	B	Impervious (100%)	3.23373	98	65.1179	4.86664	74	0.246906132	80
8	B	Impervious (90%)	6.8778	90	65.1179	9.50587	74	0.482274275	80
8	C	Forested (Evergreen)	5.98486	72	65.1179	6.61738	74	0.335728753	80
8	C	Grassland	13.9638	72	65.1179	15.4396	74	0.783318099	80
8	C	Impervious (100%)	5.6888	98	65.1179	8.56143	74	0.434358961	80

ID	HSG	Land Use	Area	CN	DA_Area	CN_Part	Sub-B CN	CN_Part_Tot	B CN
8	C	Impervious (90%)	6.03722	90	65.1179	8.34409	74	0.423332446	80
9	B	Grassland	0.003832	58	176.784	0.001257	81	0.000173163	80
9	B	Impervious (90%)	0.009967	90	176.784	0.005074	81	0.00069889	80
9	C	Forested (Evergreen)	31.6002	72	176.784	12.87	81	1.772655622	80
9	C	Grassland	72.1257	72	176.784	29.3751	81	4.045987924	80
9	C	Impervious (100%)	32.9719	98	176.784	18.2779	81	2.517515159	80
9	C	Impervious (90%)	37.5342	90	176.784	19.1085	81	2.631914144	80
9	D	Forested (Evergreen)	0.112814	79	176.784	0.050414	81	0.006943719	80
9	D	Grassland	1.80759	79	176.784	0.807763	81	0.111257441	80
9	D	Impervious (100%)	0.12188	98	176.784	0.067564	81	0.009305947	80
9	D	Impervious (90%)	0.49542	90	176.784	0.252216	81	0.034739062	80
10	B	Forested (Evergreen)	3.56478	58	48.1654	4.29265	78	0.161087845	80
10	B	Grassland	11.5702	58	48.1654	13.9326	78	0.522842526	80
10	B	Impervious (100%)	5.35516	98	48.1654	10.8959	78	0.408884428	80
10	B	Impervious (90%)	8.25422	90	48.1654	15.4235	78	0.578789434	80
10	C	Forested (Deciduous)	0.002807	72	48.1654	0.004195	78	0.000157462	80
10	C	Forested (Evergreen)	3.15493	72	48.1654	4.71614	78	0.176980032	80
10	C	Grassland	5.61971	72	48.1654	8.40062	78	0.315245173	80
10	C	Impervious (100%)	3.30461	98	48.1654	6.72374	78	0.252318058	80
10	C	Impervious (90%)	7.09419	90	48.1654	13.2559	78	0.497447634	80
10	D	Forested (Evergreen)	0.095497	79	48.1654	0.156632	78	0.005877855	80
10	D	Grassland	0.014978	79	48.1654	0.024566	78	0.000921898	80
10	D	Impervious (100%)	0.054864	98	48.1654	0.11163	78	0.00418905	80
10	D	Impervious (90%)	0.079477	90	48.1654	0.148507	78	0.005572961	80

HEC-HMS Hydrology Results

2-yr Event

Hydrologic Element	Drainage Area (Ac)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-1	229.528	166.9	01May2017, 13:16	0.96
Reach-1	229.528	166.9	01May2017, 13:24	0.96
Subbasin-2	54.073088	111.8	01May2017, 13:02	1.53
Junction-1	283.601088	187.3	01May2017, 13:23	1.07
Reach-6	283.601088	187.3	01May2017, 13:24	1.07
Subbasin-5	197.7792	199.3	01May2017, 13:07	0.96
Reach-3	197.7792	199.3	01May2017, 13:17	0.96
Subbasin-6	80.3264	129.7	01May2017, 13:04	1.32
Junction-3	278.1056	255.1	01May2017, 13:15	1.07
Reach-4	278.1056	255.1	01May2017, 13:17	1.07
Subbasin-3	171.2192	176.0	01May2017, 13:04	0.86
Reach-2	171.2192	176.0	01May2017, 13:13	0.86
Subbasin-4	103.7248	173.8	01May2017, 13:03	1.32
N Franklin St	836.650688	655.4	01May2017, 13:13	1.06
Reach-5	836.650688	655.4	01May2017, 13:14	1.06
Subbasin-7	156.7872	219.6	01May2017, 13:06	1.26
Junction-6	993.437888	844.8	01May2017, 13:09	1.09
Reach-8	993.437888	844.8	01May2017, 13:12	1.09
Subbasin-8	65.12	75.9	01May2017, 13:04	1.03
Junction-4	1058.557888	890.3	01May2017, 13:11	1.08
Reach-7	1058.557888	890.3	01May2017, 13:14	1.08
Subbasin-9	176.784	218.9	01May2017, 13:06	1.13
Junction-5	1235.341888	1056.6	01May2017, 13:12	1.09
Reach-9	1235.341888	1056.6	01May2017, 13:13	1.09
Subbasin-10	48.165376	62.3	01May2017, 13:02	0.96
Crab Creek	1283.507264	1079.2	01May2017, 13:13	1.09

10-yr Event

Hydrologic Element	Drainage Area (Ac)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-1	229.528	361.6	01May2017, 13:15	1.98
Reach-1	229.528	361.6	01May2017, 13:23	1.98
Subbasin-2	54.073088	198.0	01May2017, 13:01	2.75
Junction-1	283.601088	397.2	01May2017, 13:22	2.13
Reach-6	283.601088	397.2	01May2017, 13:23	2.13
Subbasin-5	197.7792	425.7	01May2017, 13:07	1.98
Reach-3	197.7792	425.7	01May2017, 13:17	1.98
Subbasin-6	80.3264	242.8	01May2017, 13:04	2.48
Junction-3	278.1056	531.4	01May2017, 13:14	2.13
Reach-4	278.1056	531.4	01May2017, 13:16	2.13
Subbasin-3	171.2192	391.3	01May2017, 13:04	1.83
Reach-2	171.2192	391.3	01May2017, 13:13	1.83
Subbasin-4	103.7248	325.1	01May2017, 13:03	2.48
N Franklin St	836.650688	1383.3	01May2017, 13:13	2.11
Reach-5	836.650688	1383.3	01May2017, 13:14	2.11
Subbasin-7	156.7872	420.2	01May2017, 13:06	2.39
Junction-6	993.437888	1729.4	01May2017, 13:10	2.15
Reach-8	993.437888	1729.4	01May2017, 13:13	2.15
Subbasin-8	65.12	157.2	01May2017, 13:03	2.02
Junction-4	1058.557888	1816.8	01May2017, 13:12	2.15
Reach-7	1058.557888	1816.8	01May2017, 13:15	2.15
Subbasin-9	176.784	437.2	01May2017, 13:06	2.22
Junction-5	1235.341888	2136.1	01May2017, 13:12	2.16
Reach-9	1235.341888	2136.1	01May2017, 13:13	2.16
Subbasin-10	48.165376	131.1	01May2017, 13:01	1.98
Crab Creek	1283.507264	2181.1	01May2017, 13:13	2.15

25-yr Event

Hydrologic Element	Drainage Area (Ac)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-1	229.528	500.2	01May2017, 13:15	2.72
Reach-1	229.528	500.2	01May2017, 13:23	2.72
Subbasin-2	54.073088	255.1	01May2017, 13:01	3.58
Junction-1	283.601088	545.9	01May2017, 13:22	2.88
Reach-6	283.601088	545.9	01May2017, 13:23	2.88
Subbasin-5	197.7792	586.3	01May2017, 13:06	2.72
Reach-3	197.7792	586.3	01May2017, 13:16	2.72
Subbasin-6	80.3264	319.1	01May2017, 13:04	3.28
Junction-3	278.1056	726.2	01May2017, 13:14	2.88
Reach-4	278.1056	726.2	01May2017, 13:16	2.88
Subbasin-3	171.2192	546.7	01May2017, 13:03	2.54
Reach-2	171.2192	546.7	01May2017, 13:12	2.54
Subbasin-4	103.7248	427.2	01May2017, 13:03	3.28
N Franklin St	836.650688	1898.0	01May2017, 13:12	2.86
Reach-5	836.650688	1898.0	01May2017, 13:13	2.86
Subbasin-7	156.7872	556.8	01May2017, 13:05	3.18
Junction-6	993.437888	2350.7	01May2017, 13:10	2.91
Reach-8	993.437888	2350.7	01May2017, 13:13	2.91
Subbasin-8	65.12	215.6	01May2017, 13:03	2.73
Junction-4	1058.557888	2467.4	01May2017, 13:12	2.90
Reach-7	1058.557888	2467.4	01May2017, 13:15	2.90
Subbasin-9	176.784	588.1	01May2017, 13:06	2.99
Junction-5	1235.341888	2890.1	01May2017, 13:12	2.91
Reach-9	1235.341888	2890.1	01May2017, 13:13	2.91
Subbasin-10	48.165376	180.0	01May2017, 13:01	2.72
Crab Creek	1283.507264	2950.5	01May2017, 13:13	2.91

50-yr Event

Hydrologic Element	Drainage Area (Ac)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-1	229.528	619.0	01May2017, 13:15	3.36
Reach-1	229.528	619.0	01May2017, 13:23	3.36
Subbasin-2	54.073088	302.6	01May2017, 13:01	4.28
Junction-1	283.601088	673.2	01May2017, 13:22	3.53
Reach-6	283.601088	673.2	01May2017, 13:23	3.53
Subbasin-5	197.7792	724.1	01May2017, 13:06	3.36
Reach-3	197.7792	724.1	01May2017, 13:16	3.36
Subbasin-6	80.3264	383.2	01May2017, 13:03	3.96
Junction-3	278.1056	892.3	01May2017, 13:14	3.53
Reach-4	278.1056	892.3	01May2017, 13:16	3.53
Subbasin-3	171.2192	680.7	01May2017, 13:03	3.17
Reach-2	171.2192	680.7	01May2017, 13:12	3.17
Subbasin-4	103.7248	512.6	01May2017, 13:03	3.96
N Franklin St	836.650688	2338.4	01May2017, 13:12	3.51
Reach-5	836.650688	2338.4	01May2017, 13:13	3.51
Subbasin-7	156.7872	672.3	01May2017, 13:05	3.86
Junction-6	993.437888	2880.5	01May2017, 13:10	3.57
Reach-8	993.437888	2880.5	01May2017, 13:13	3.57
Subbasin-8	65.12	265.9	01May2017, 13:03	3.36
Junction-4	1058.557888	3022.1	01May2017, 13:12	3.55
Reach-7	1058.557888	3022.1	01May2017, 13:15	3.55
Subbasin-9	176.784	715.7	01May2017, 13:06	3.66
Junction-5	1235.341888	3531.6	01May2017, 13:12	3.57
Reach-9	1235.341888	3531.6	01May2017, 13:13	3.57
Subbasin-10	48.165376	221.7	01May2017, 13:01	3.36
Crab Creek	1283.507264	3605.1	01May2017, 13:13	3.56

100-yr Event

Hydrologic Element	Drainage Area (Ac)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-1	229.528	749.6	01May2017, 13:15	4.07
Reach-1	229.528	749.6	01May2017, 13:23	4.07
Subbasin-2	54.073088	353.9	01May2017, 13:01	5.05
Junction-1	283.601088	813.0	01May2017, 13:22	4.25
Reach-6	283.601088	813.0	01May2017, 13:23	4.25
Subbasin-5	197.7792	875.3	01May2017, 13:06	4.07
Reach-3	197.7792	875.3	01May2017, 13:16	4.07
Subbasin-6	80.3264	452.9	01May2017, 13:03	4.71
Junction-3	278.1056	1074.5	01May2017, 13:14	4.25
Reach-4	278.1056	1074.5	01May2017, 13:16	4.25
Subbasin-3	171.2192	828.3	01May2017, 13:03	3.86
Reach-2	171.2192	828.3	01May2017, 13:12	3.86
Subbasin-4	103.7248	605.2	01May2017, 13:03	4.71
N Franklin St	836.650688	2822.3	01May2017, 13:12	4.23
Reach-5	836.650688	2822.3	01May2017, 13:13	4.23
Subbasin-7	156.7872	797.7	01May2017, 13:05	4.60
Junction-6	993.437888	3461.2	01May2017, 13:10	4.29
Reach-8	993.437888	3461.2	01May2017, 13:13	4.29
Subbasin-8	65.12	321.4	01May2017, 13:03	4.05
Junction-4	1058.557888	3630.3	01May2017, 13:12	4.27
Reach-7	1058.557888	3630.3	01May2017, 13:15	4.27
Subbasin-9	176.784	854.7	01May2017, 13:06	4.39
Junction-5	1235.341888	4234.2	01May2017, 13:12	4.29
Reach-9	1235.341888	4234.2	01May2017, 13:13	4.29
Subbasin-10	48.165376	267.3	01May2017, 13:01	4.07
Crab Creek	1283.507264	4321.9	01May2017, 13:13	4.28

500-yr Event

Hydrologic Element	Drainage Area (Ac)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-1	229.528	1102.4	01May2017, 13:14	6.01
Reach-1	229.528	1102.4	01May2017, 13:22	6.01
Subbasin-2	54.073088	488.8	01May2017, 13:01	7.10
Junction-1	283.601088	1189.0	01May2017, 13:21	6.22
Reach-6	283.601088	1189.0	01May2017, 13:22	6.22
Subbasin-5	197.7792	1281.5	01May2017, 13:06	6.01
Reach-3	197.7792	1281.5	01May2017, 13:16	6.01
Subbasin-6	80.3264	637.2	01May2017, 13:03	6.74
Junction-3	278.1056	1562.7	01May2017, 13:14	6.22
Reach-4	278.1056	1562.7	01May2017, 13:16	6.22
Subbasin-3	171.2192	1226.6	01May2017, 13:03	5.77
Reach-2	171.2192	1226.6	01May2017, 13:12	5.77
Subbasin-4	103.7248	850.1	01May2017, 13:02	6.74
N Franklin St	836.650688	4124.0	01May2017, 13:12	6.19
Reach-5	836.650688	4124.0	01May2017, 13:13	6.19
Subbasin-7	156.7872	1130.1	01May2017, 13:05	6.62
Junction-6	993.437888	5019.9	01May2017, 13:10	6.26
Reach-8	993.437888	5019.9	01May2017, 13:13	6.26
Subbasin-8	65.12	471.8	01May2017, 13:03	5.96
Junction-4	1058.557888	5262.8	01May2017, 13:12	6.24
Reach-7	1058.557888	5262.8	01May2017, 13:15	6.24
Subbasin-9	176.784	1225.4	01May2017, 13:05	6.38
Junction-5	1235.341888	6117.3	01May2017, 13:12	6.26
Reach-9	1235.341888	6117.3	01May2017, 13:13	6.26
Subbasin-10	48.165376	389.7	01May2017, 13:01	6.01
Crab Creek	1283.507264	6242.8	01May2017, 13:13	6.25

Comparison of Peak Discharges (2-yr Storm)

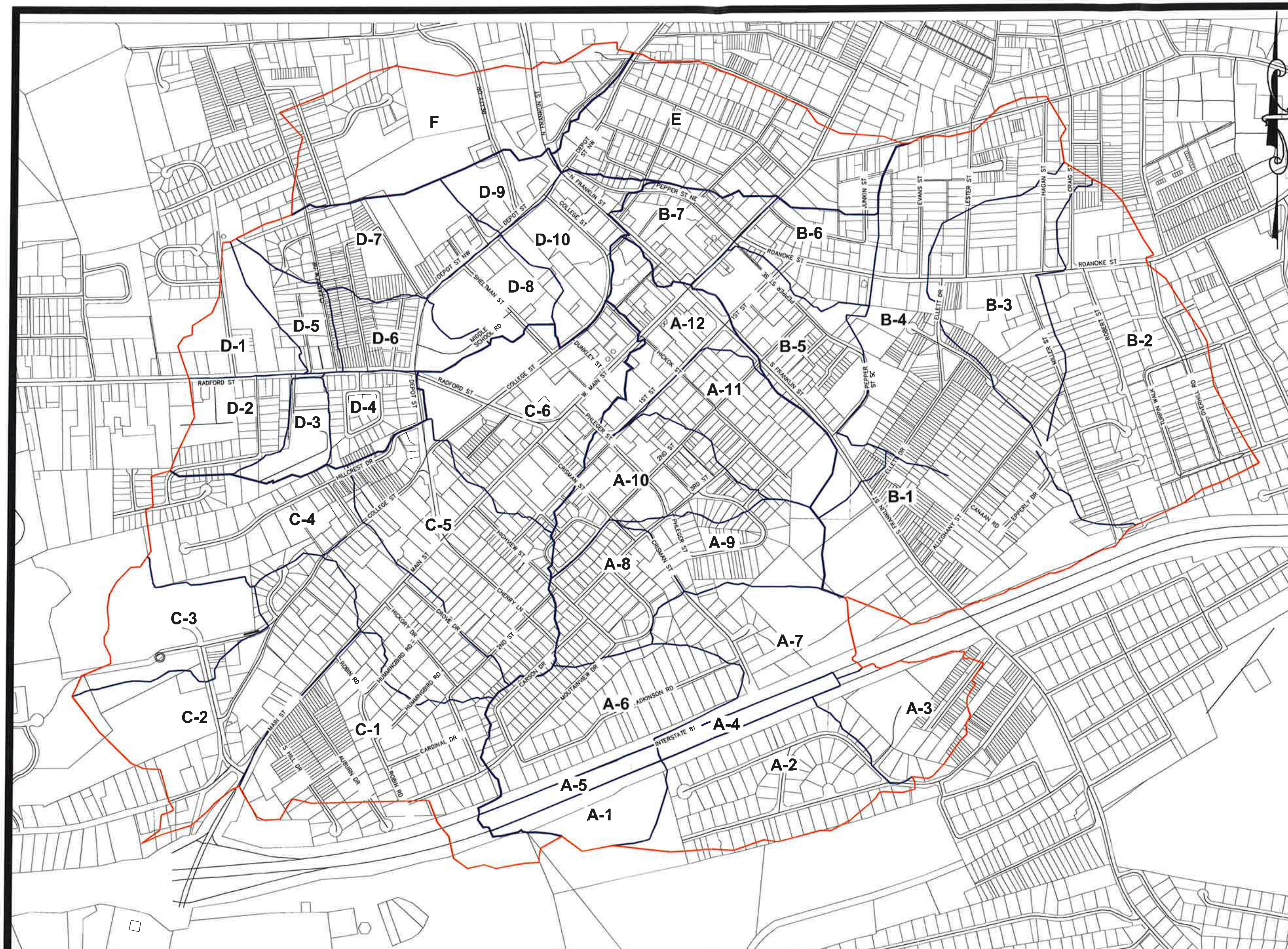
Hydrology Method	$Q_{2\text{-yr}}$
Urban Regression Equation	419
StreamStats	699
FEMA Published Data	N/A
AMT TR-55 Entire Watershed	**700**
AMT HEC-HMS Model	**1,079**
WSSI HEC-RAS Model	530

Comparison of Peak Discharges (10-yr Storm)

Hydrology Method	$Q_{10\text{-yr}}$
Urban Regression Equation	768
StreamStats	1,340
FEMA Published Data	1,360
AMT TR-55 Entire Watershed	**1,512**
AMT HEC-HMS Model	**2,181**
WSSI HEC-RAS Model	1,515

Comparison of Peak Discharges (100-yr Storm)

Hydrology Method	$Q_{100\text{-yr}}$
Urban Regression Equation	1,437
StreamStats	2,840
FEMA Published Data	2,390
AMT TR-55 Entire Watershed	**3,040**
AMT HEC-HMS Model	**4,322**
WSSI HEC-RAS Model	2,653



A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS
105 ARBOR DRIVE, SUITE 200
CHRISTIANSBURG, VIRGINIA 24073
(540) 251-5134 FAX (540) 251-5135
WWW.AMTENGINEERING.COM

REVISIONS		
MARK	DATE	DESCRIPTION

DOWNTOWN STORM DRAIN DRAINAGE AREA MAP

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=800'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

DA

SHEET 1 OF 15

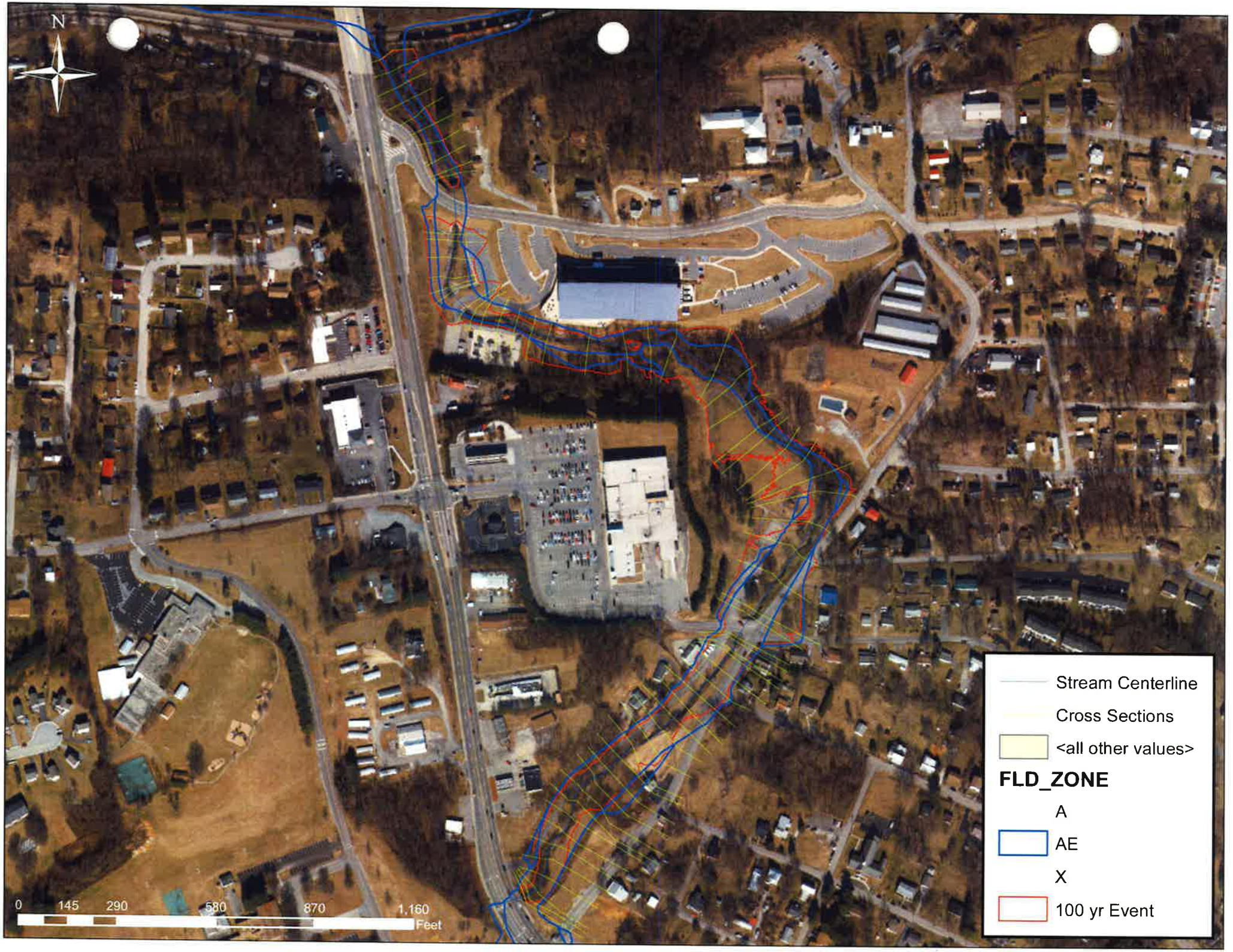
APPENDIX F
Floodplain Modeling


N
0
145
290
580
870
1,160
Feet
Stream Centerline
Cross Sections
2 yr Event


N
0
145
290
580
870
1,160
Feet
Stream Centerline
Cross Sections
10 yr Event


N
0
145
290
580
870
1,160
Feet
Stream Centerline
Cross Sections
25 yr Event


N
0
145
290
580
870
1,160
Feet
Stream Centerline
Cross Sections
50 yr Event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580
870
1,160
Feet
Stream Centerline
Cross Sections
<all other values>
FLD_ZONE
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X
100 yr Event


N
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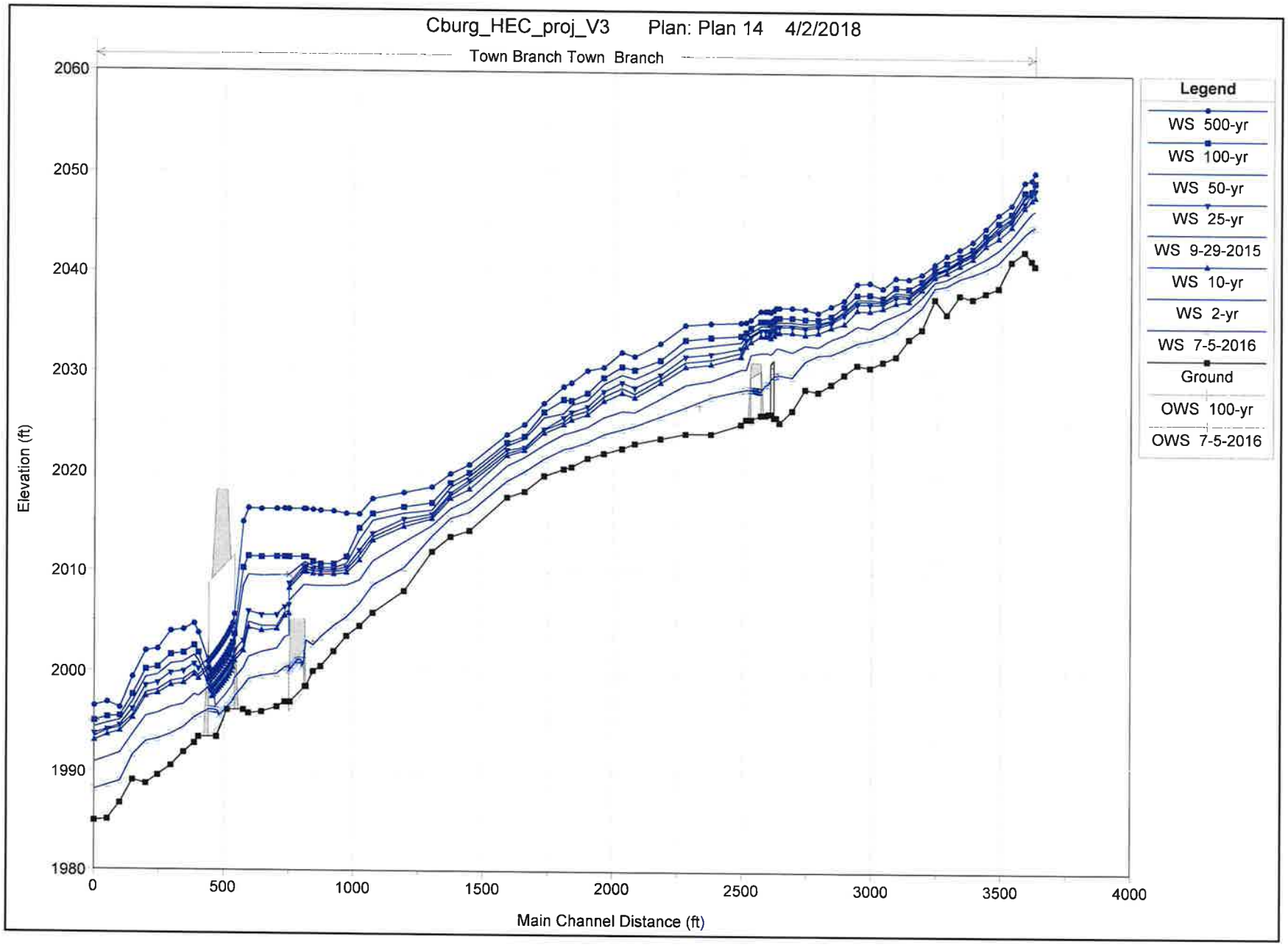
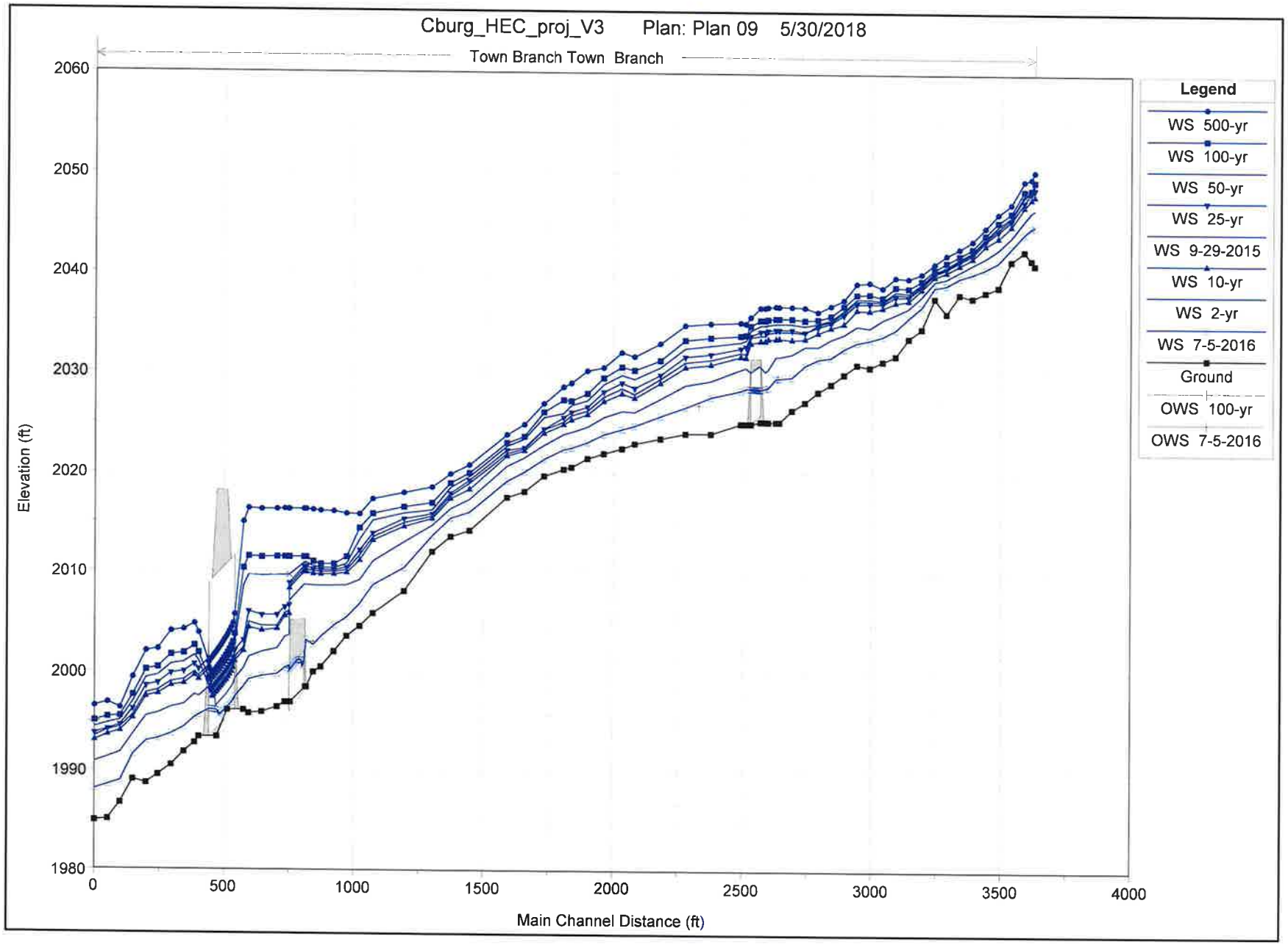
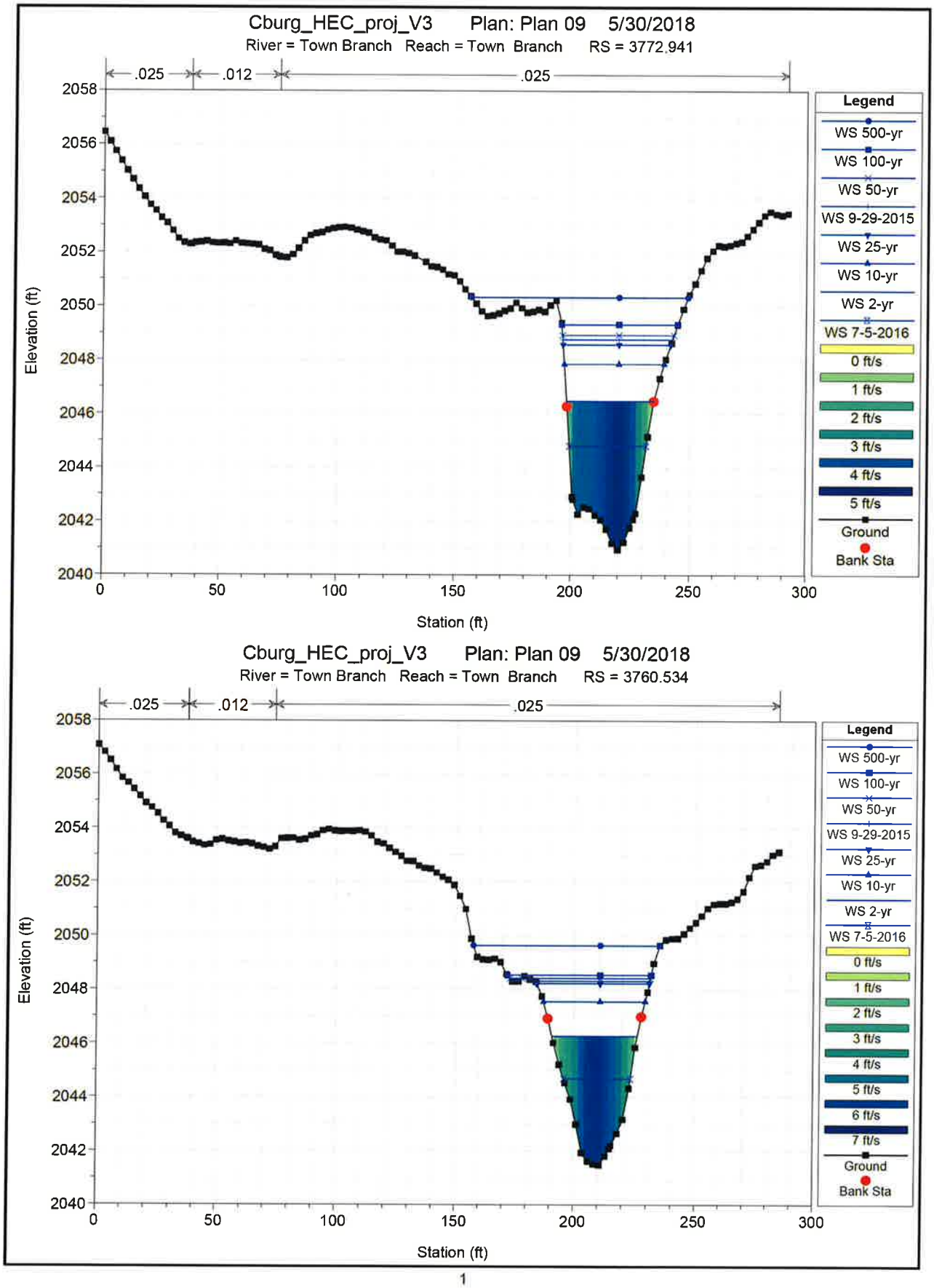
145
290
580
870
1,160
Feet
Stream Centerline
Cross Sections
500 yr Event


Cburg_HEC_proj_V3 Plan: Plan 14 4/2/2018
Town Branch Town Branch
Elevation (ft)
2060
2050
2040
2030
2020
2010
2000
1990
1980
0
500
1000
1500
2000
2500
3000
3500
4000
Main Channel Distance (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
Ground
OWS 100-yr
OWS 7-5-2016


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
Town Branch Town Branch
Elevation (ft)
2060
2050
2040
2030
2020
2010
2000
1990
1980
0
500
1000
1500
2000
2500
3000
3500
4000
Main Channel Distance (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
Ground
OWS 100-yr
OWS 7-5-2016


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3772.941
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.025
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
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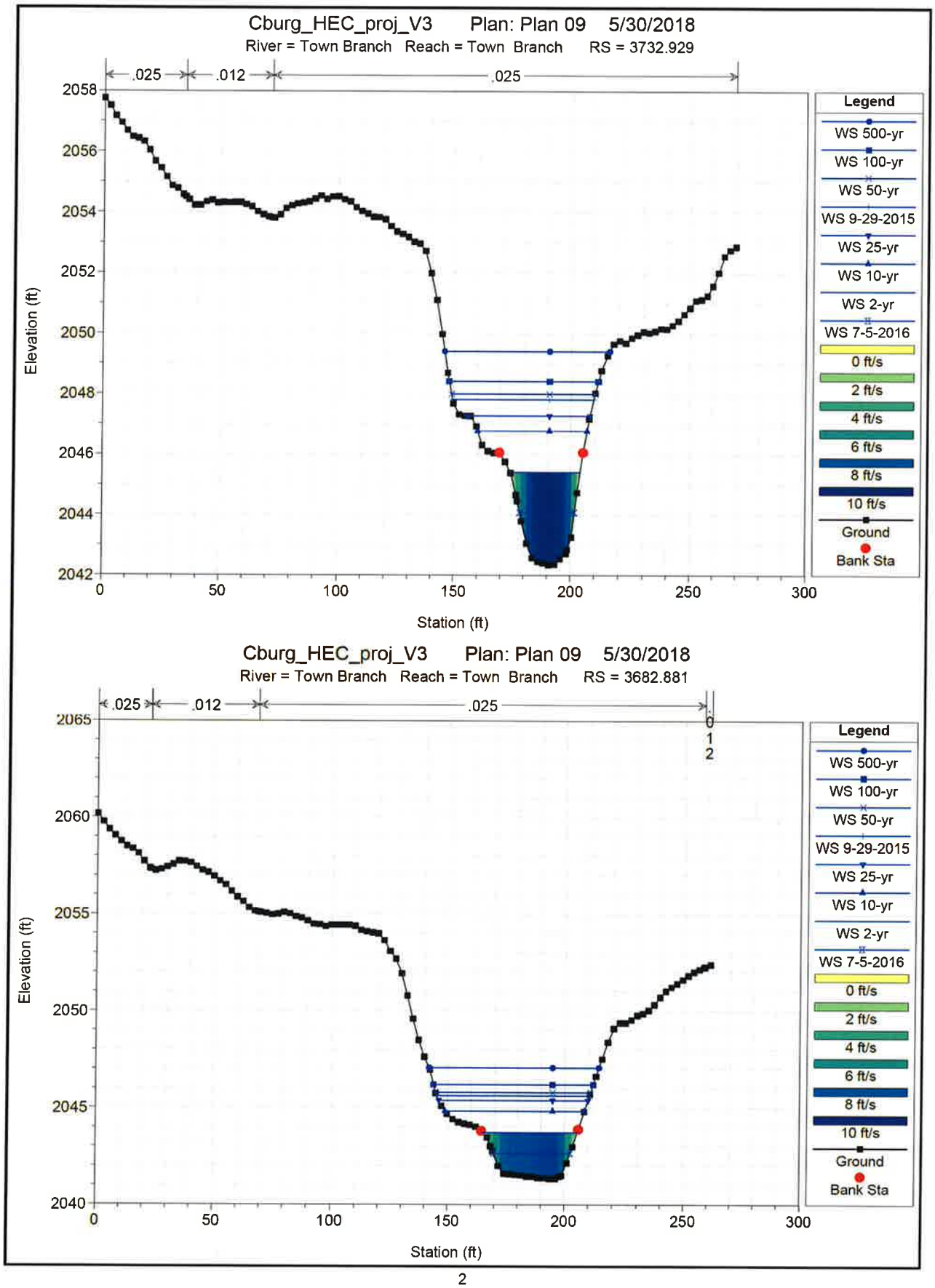
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
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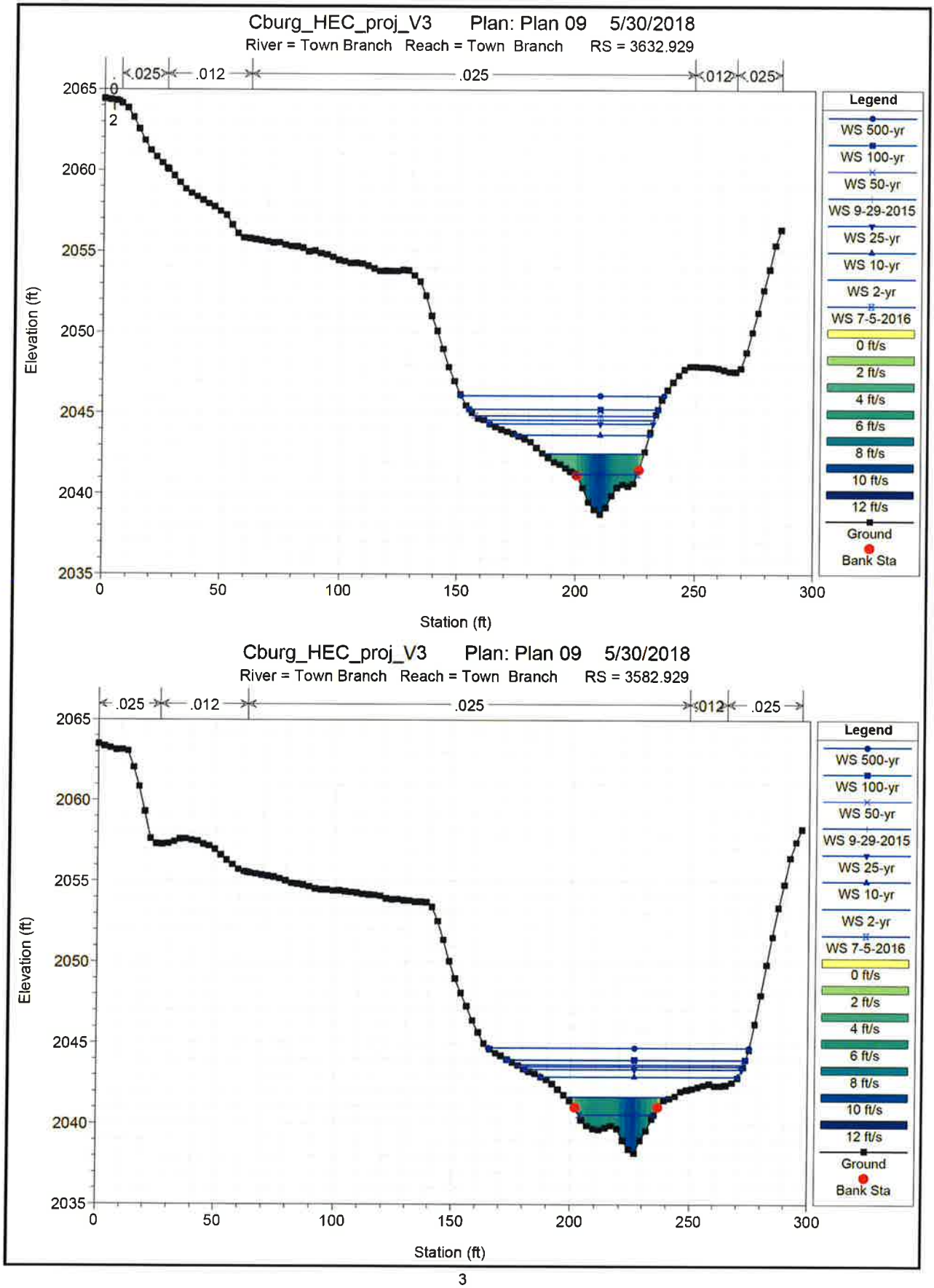
.012
.025
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3632.929
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.025
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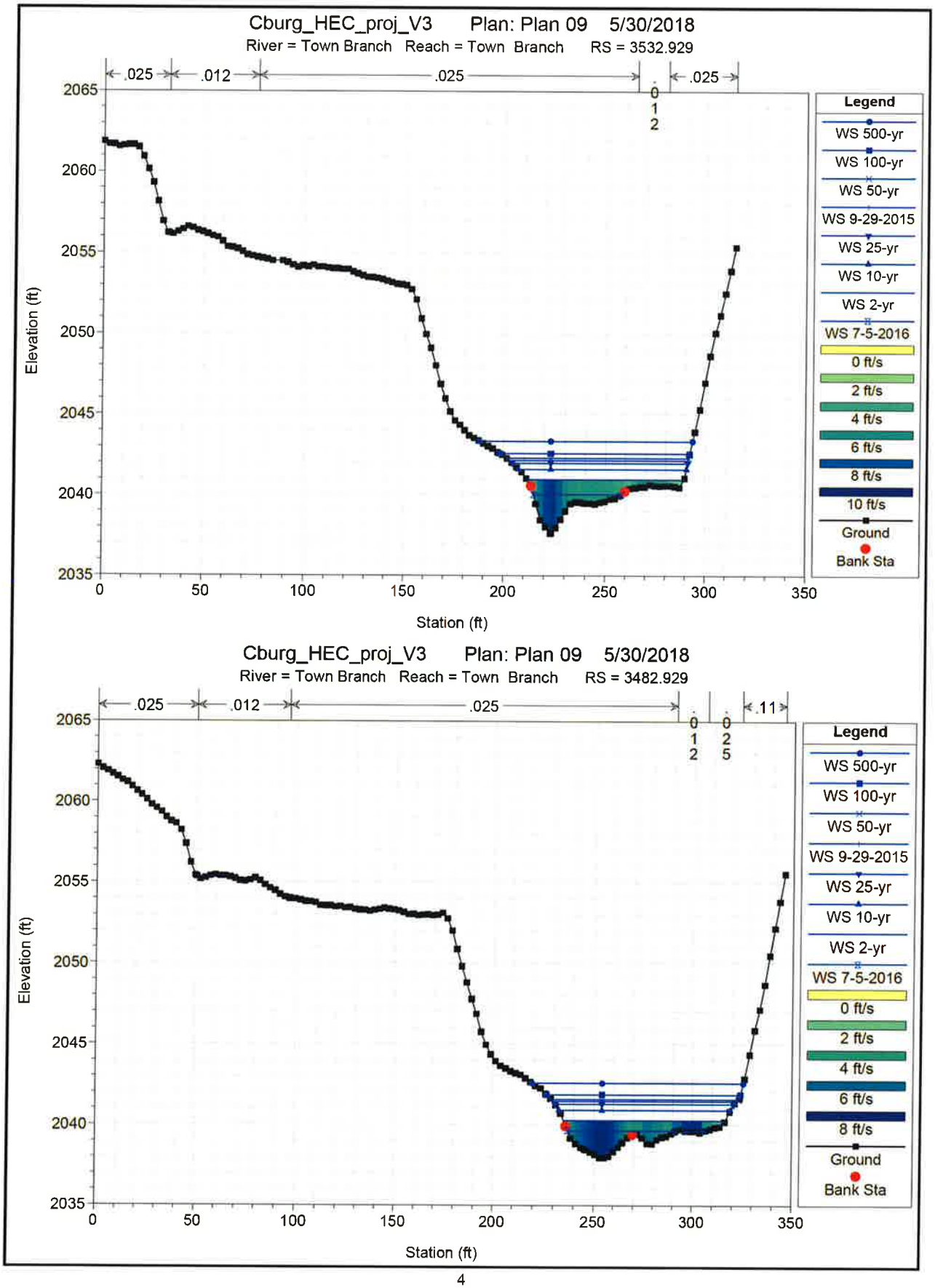
1
2
Elevation (ft)
2065
2060
2055
2050
2045
2040
2035
0
50
100
150
200
250
300
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3582.929
.025
.012
.025
.012
.025
Elevation (ft)
2065
2060
2055
2050
2045
2040
2035
0
50
100
150
200
250
300
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3532.929
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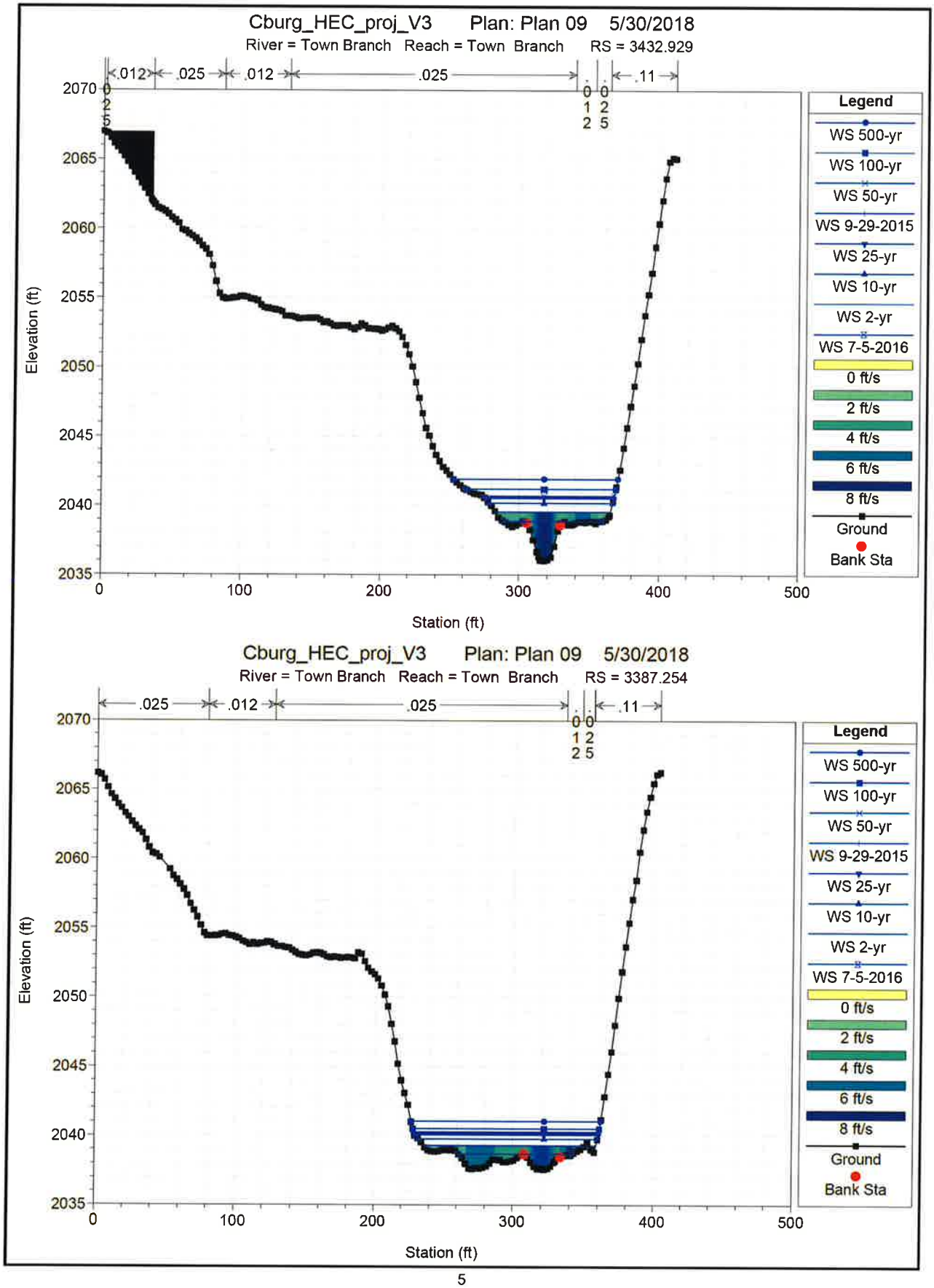
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3482.929
.025
.012
.025
.11
0
1
2
0
2
5
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3432.929
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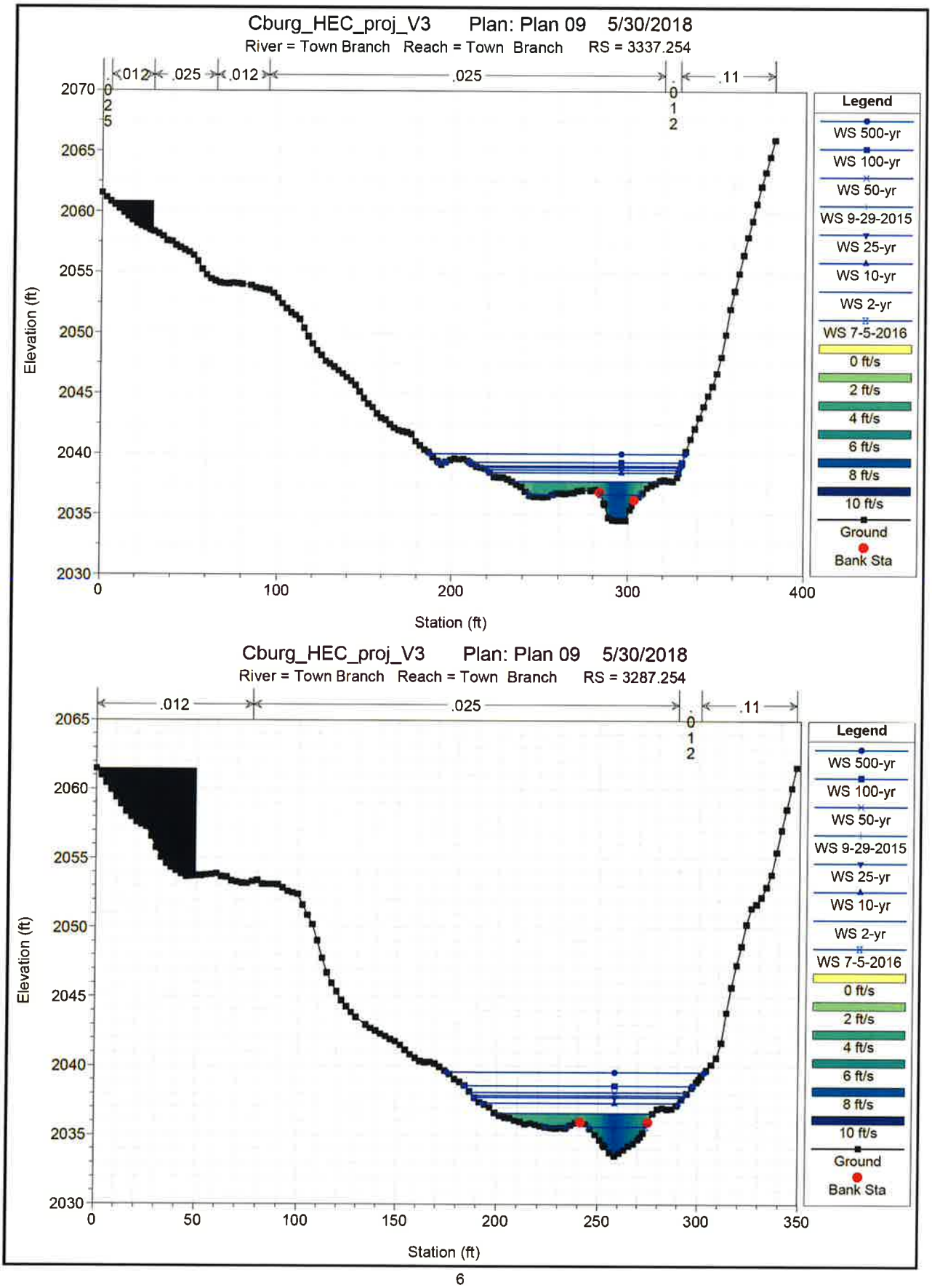
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3387.254
.025
.012
.025
.11
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta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River = Town Branch Reach = Town Branch RS = 3337.254
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Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3287.254
.012
.025
.11
.012
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
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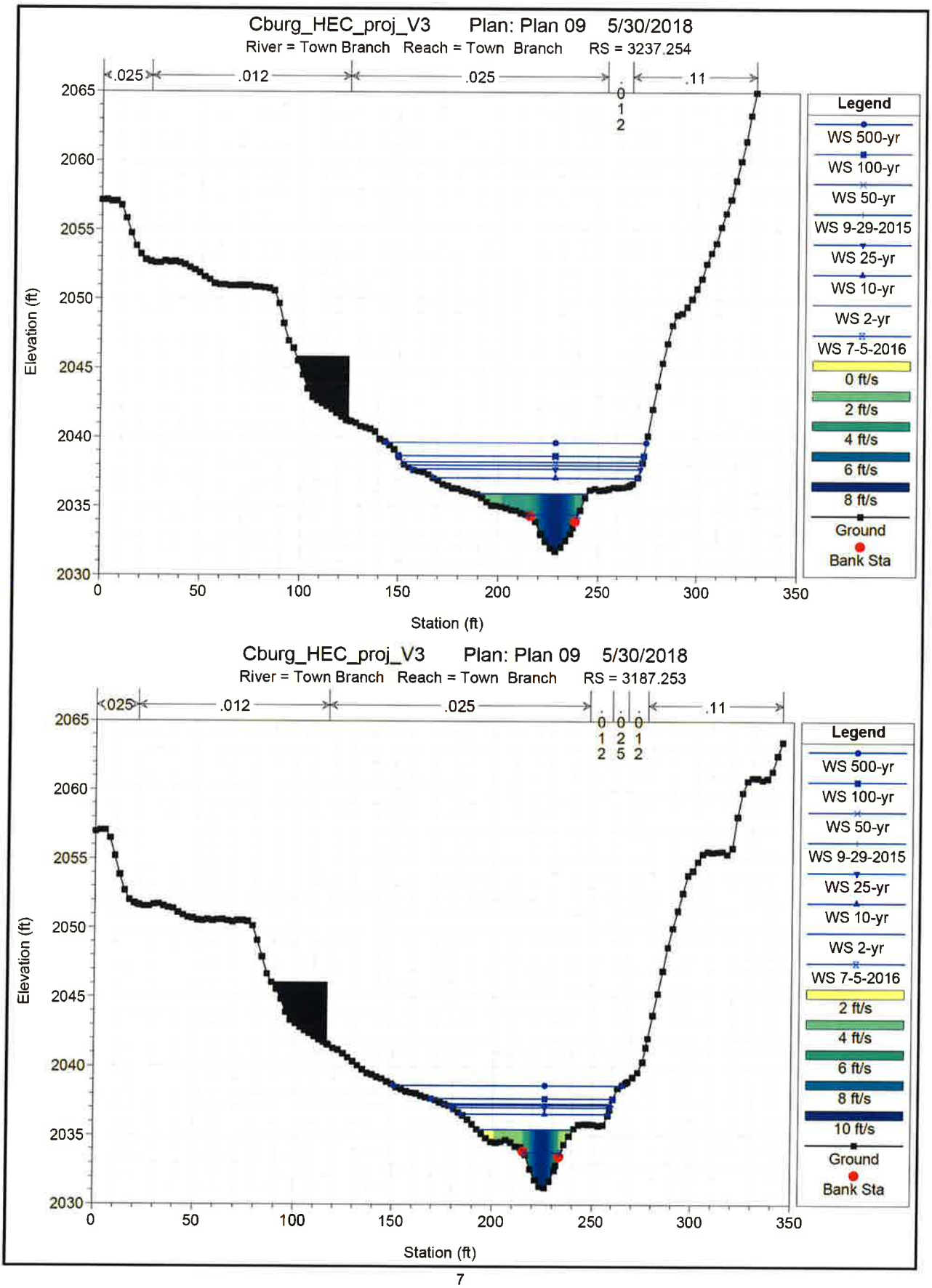
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3237.254
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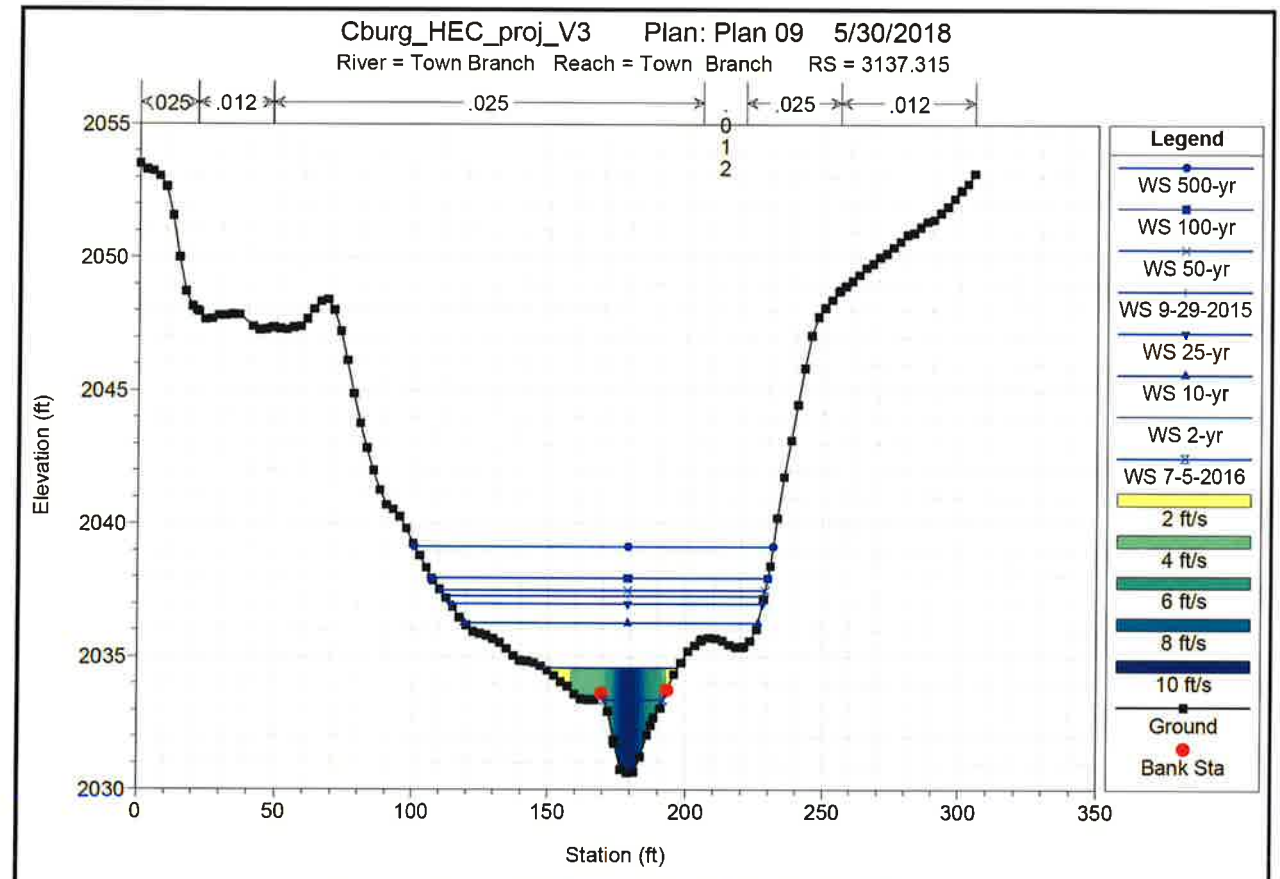
.025
.11
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3187.253
.025
.012
.025
.11
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3137.315
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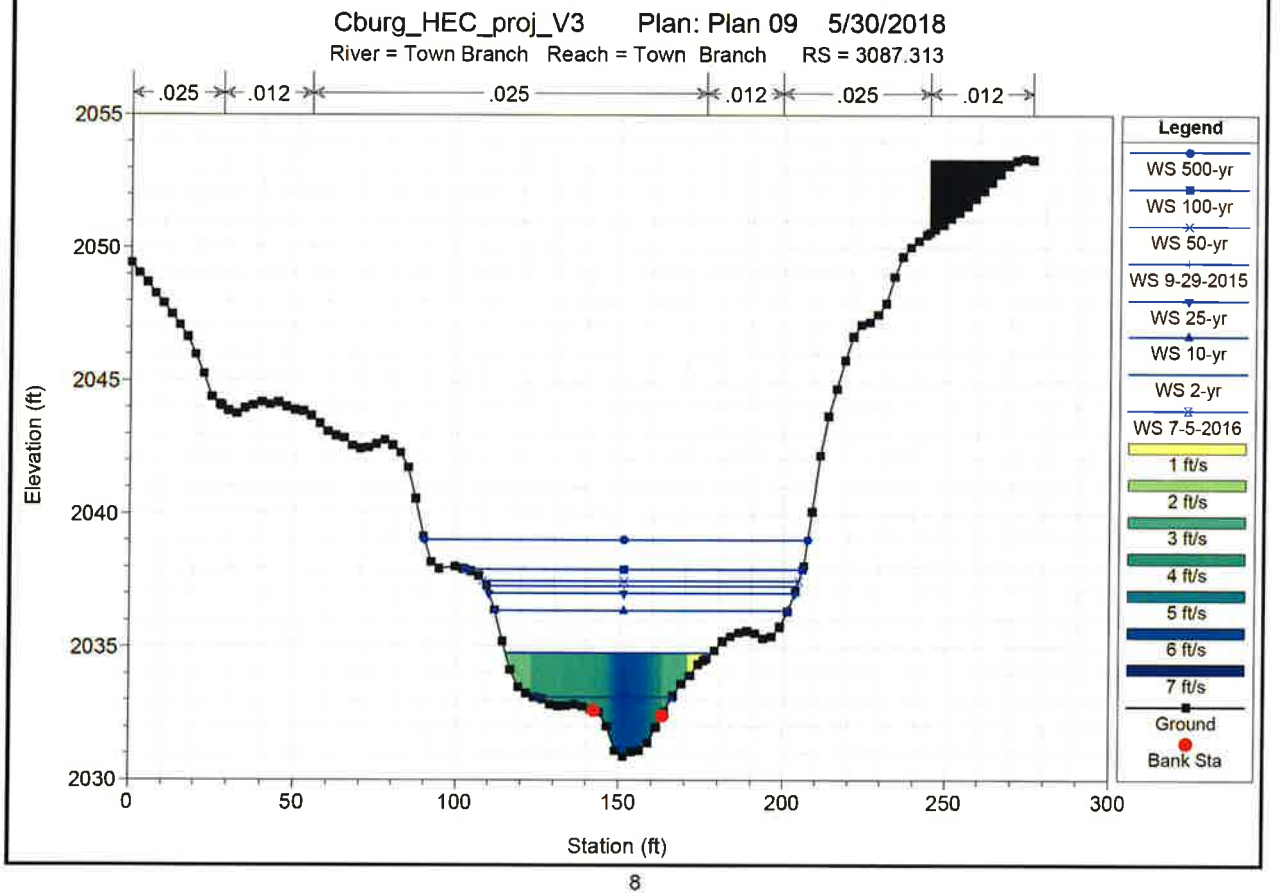
.025
.012
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3087.313
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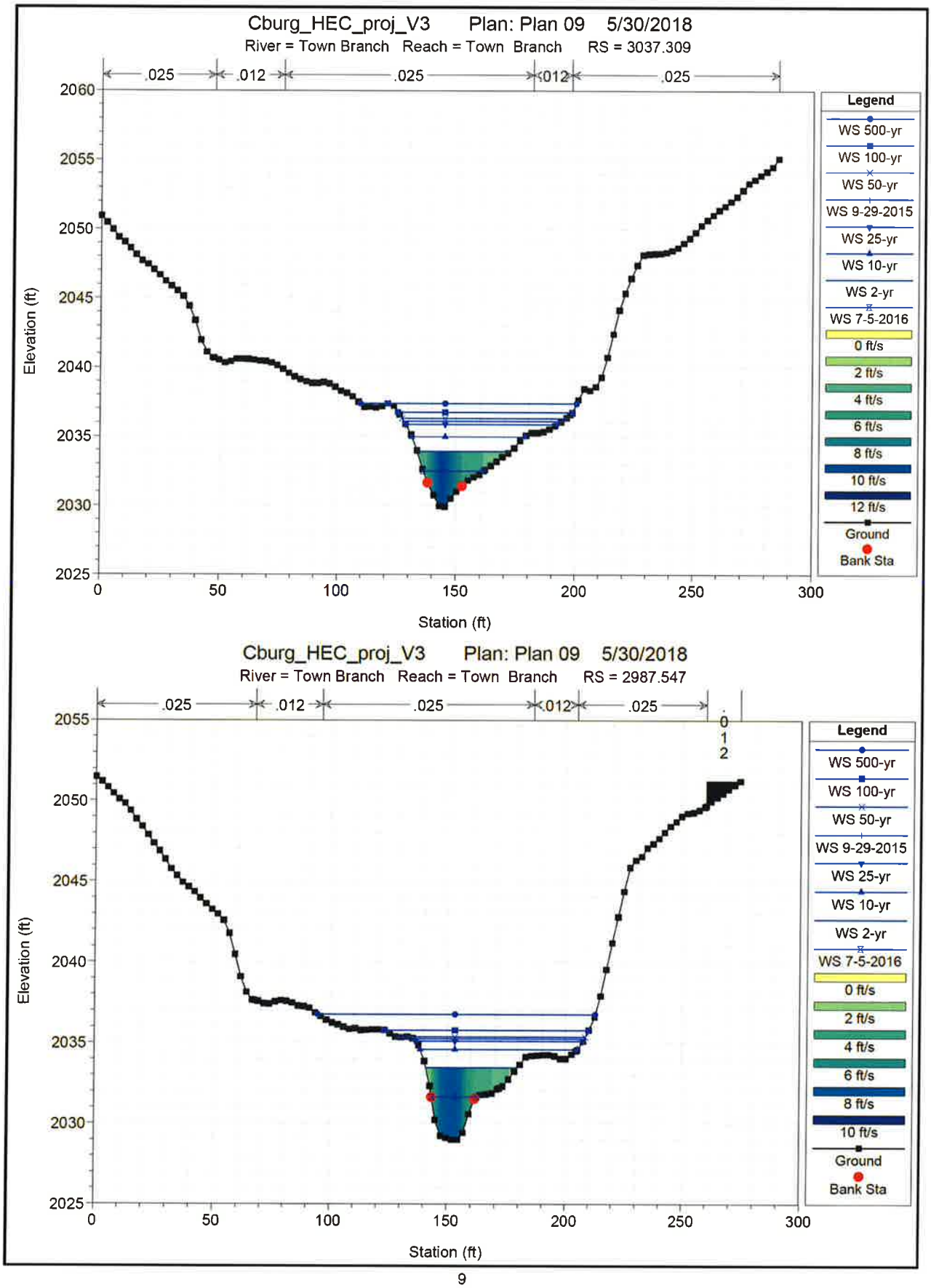
.012
.025
.012
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 3037.309
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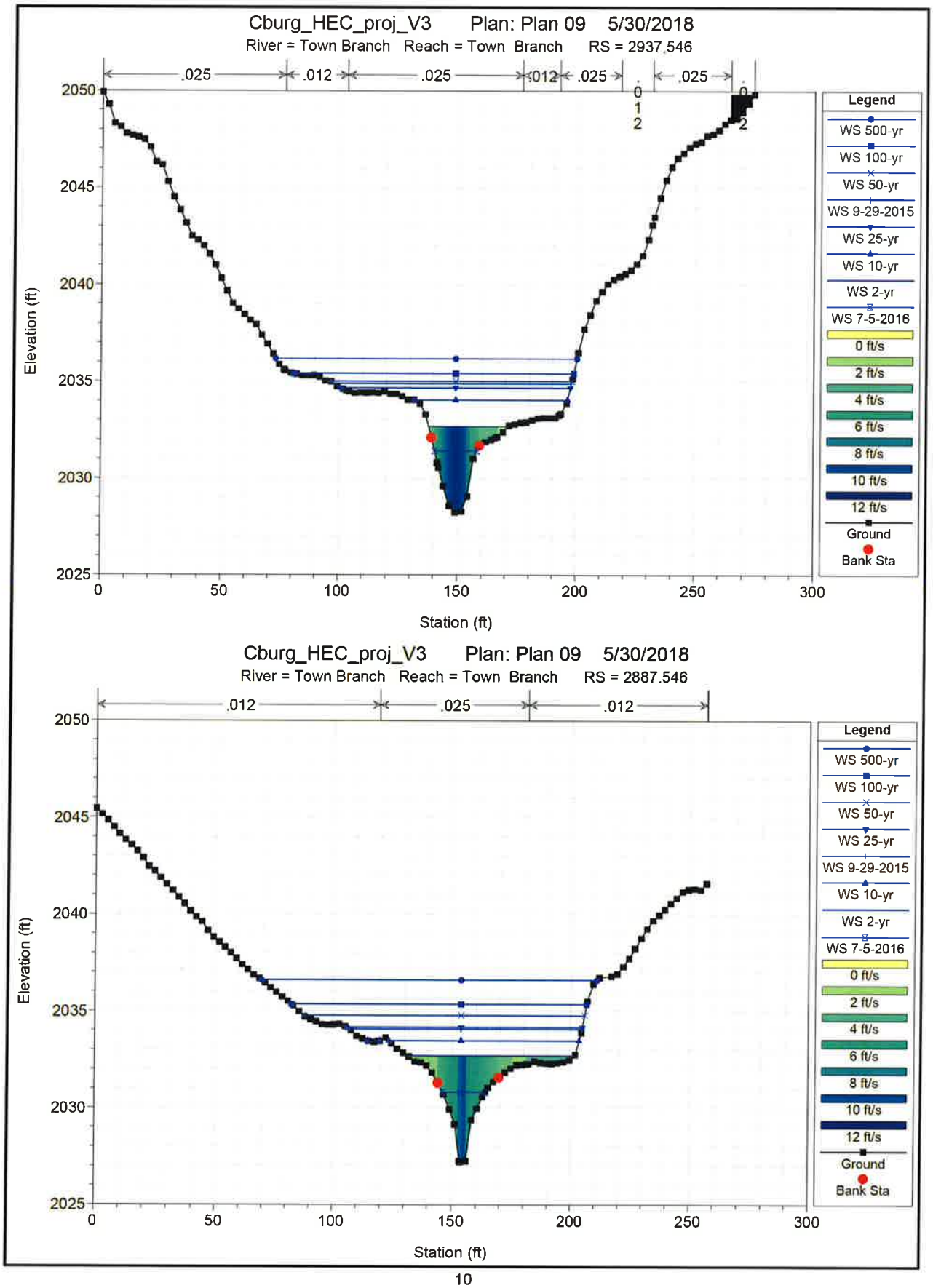
.025
.012
.025
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2987.547
.025
.012
.025
.012
.025
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2937.546
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.012
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2
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2
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 9-29-2015
WS 25-yr
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Elevation (ft)
2050
2045
2040
2035
2030
2025
0
50
100
150
200
250
300
Station (ft)
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2887.546
.012
.025
.012
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Elevation (ft)
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2025
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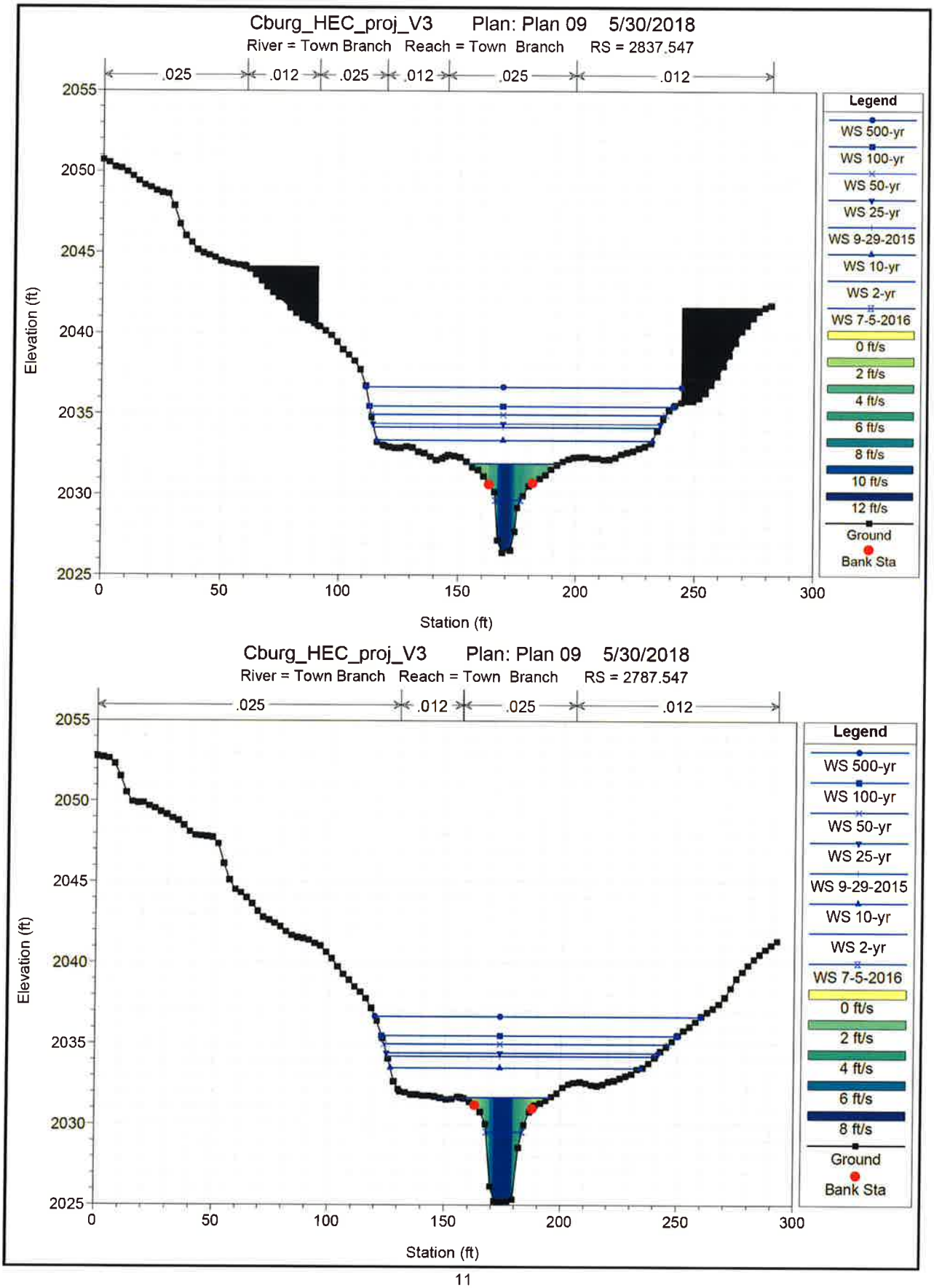
150
200
250
300
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2837.547
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.012
.025
.012
.025
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Elevation (ft)
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2040
2035
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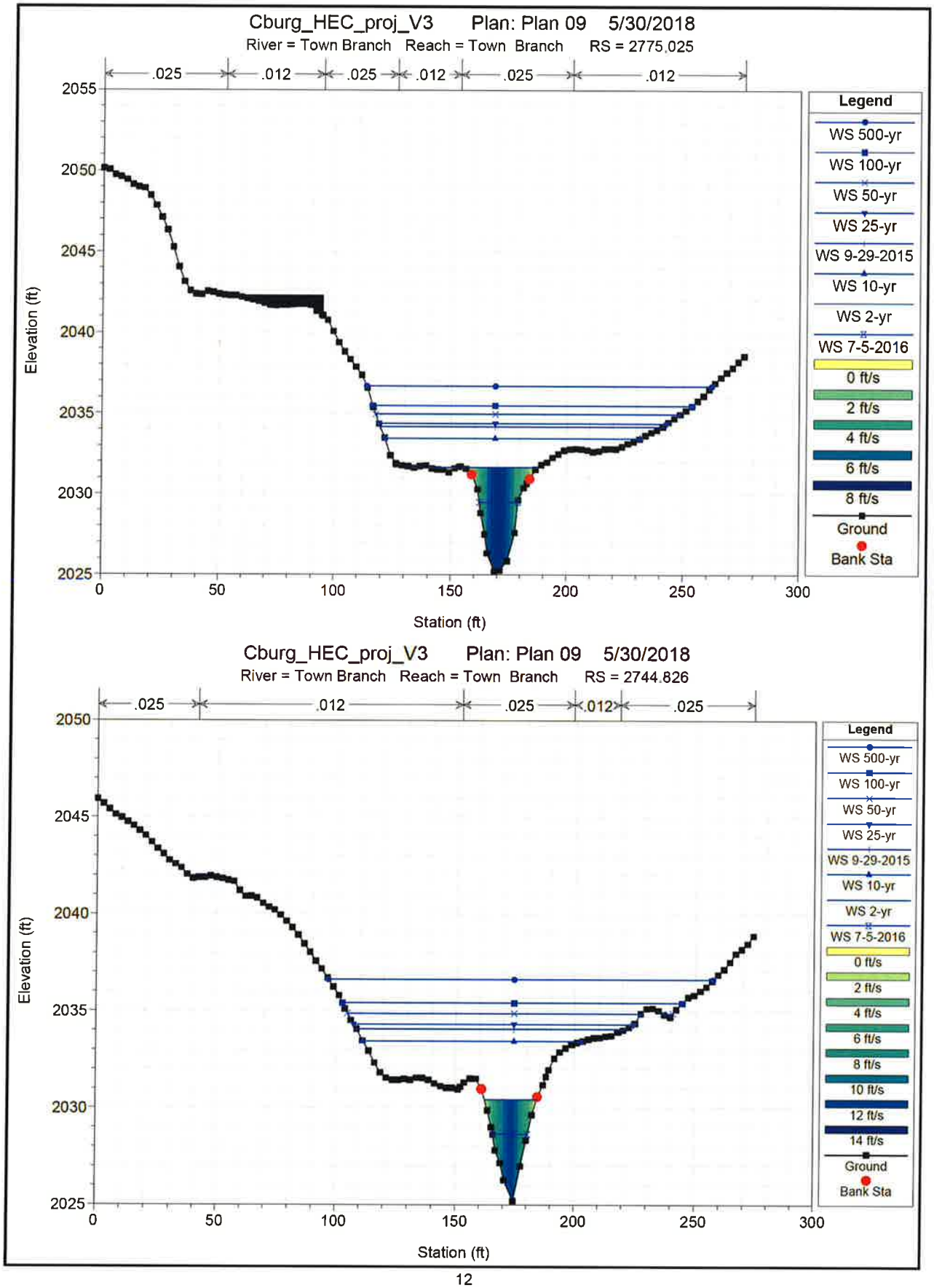
2025
0
50
100
150
200
250
300
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2787.547
.025
.012
.025
.012
Elevation (ft)
2055
2050
2045
2040
2035
2030
2025
0
50
100
150
200
250
300
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta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River = Town Branch Reach = Town Branch RS = 2775.025
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.012
.025
.012
.025
.012
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2744.826
.025
.012
.025
.012
.025
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
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4 ft/s
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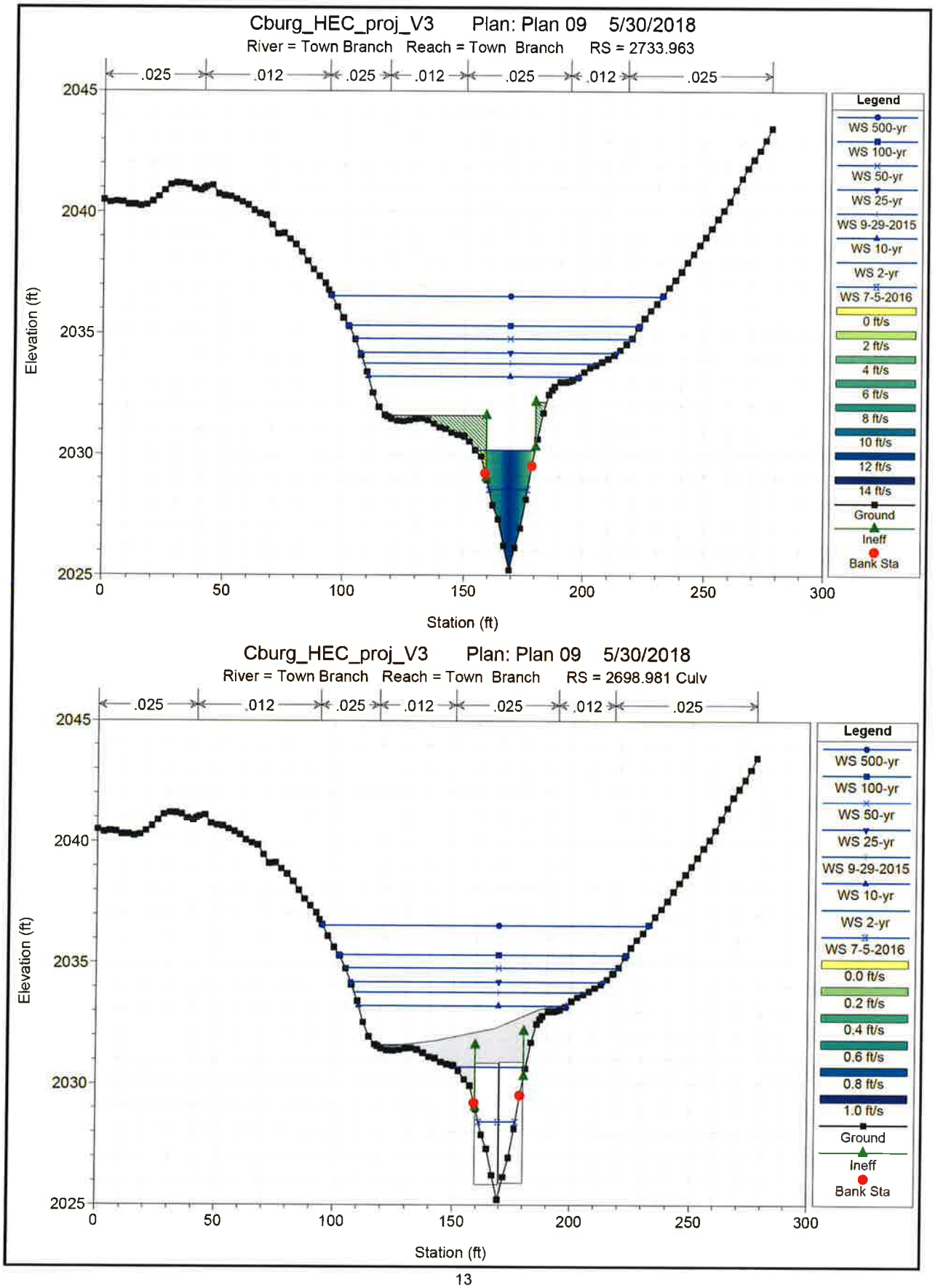
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2733.963
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.025
.012
.025
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
2045
2040
2035
2030
2025
0
50
100
150
200
250
300
Station (ft)
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2698.981 Culv
.025
.012
.025
.012
.025
.012
.025
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
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2030
2025
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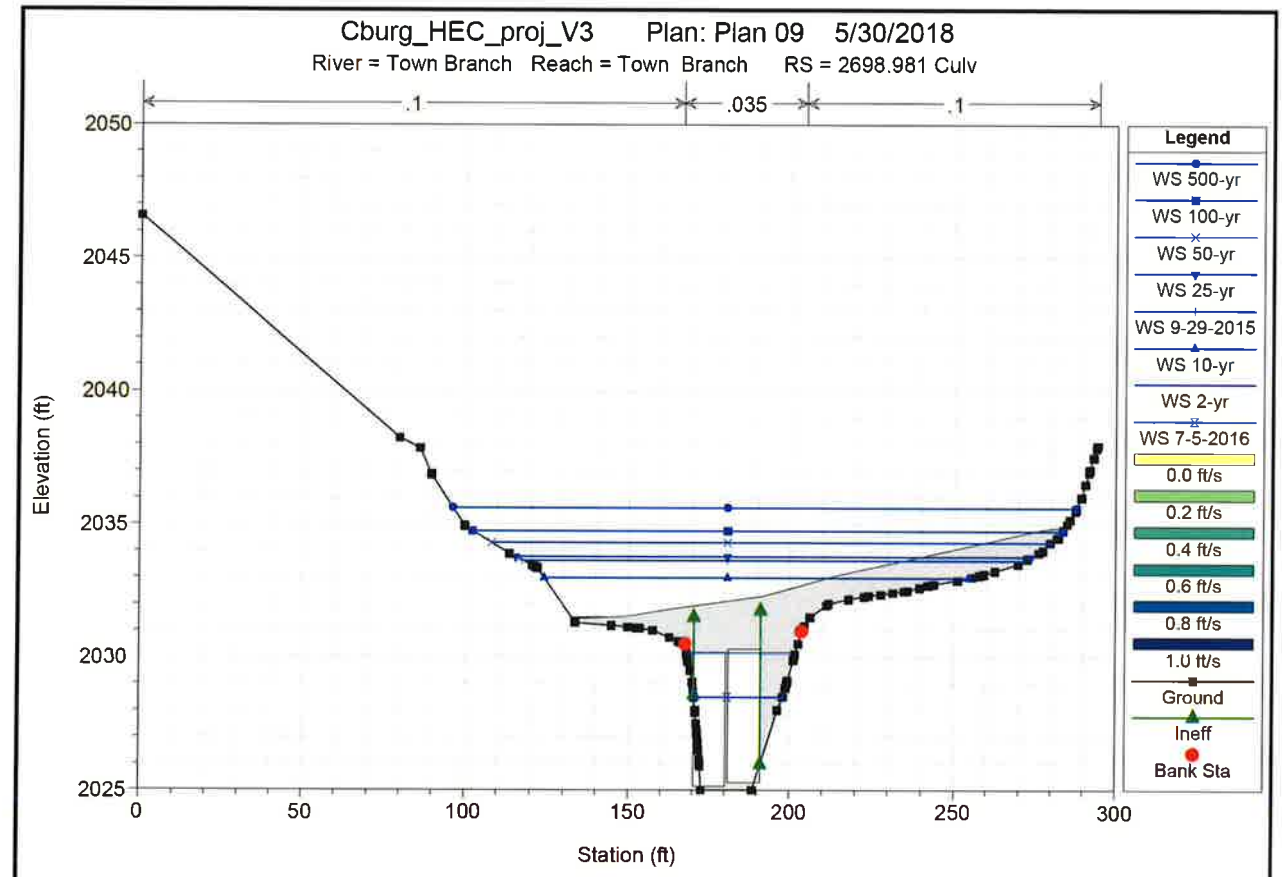
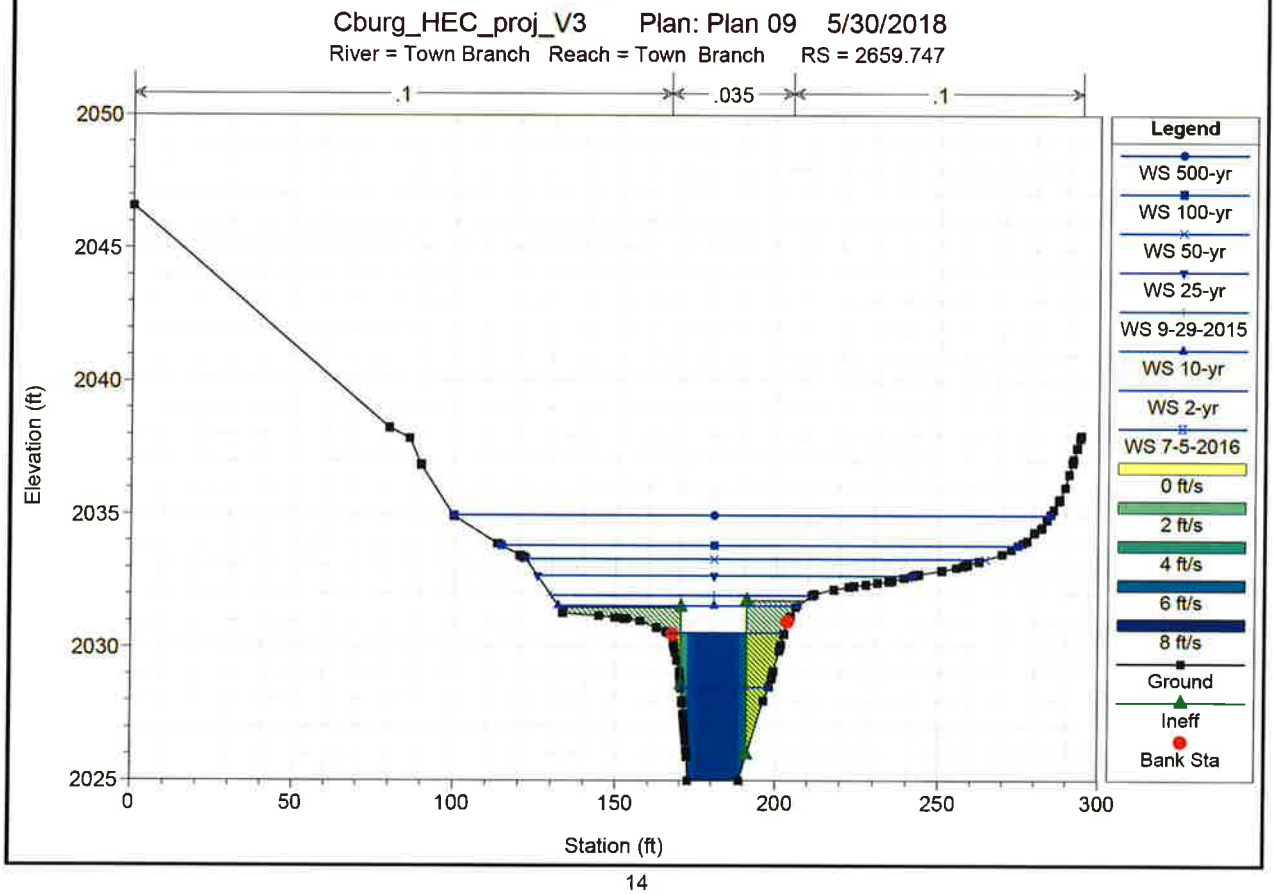
150
200
250
300
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2698.981 Culv
.1
.035
.1
2050
2045
2040
2035
2030
2025
Elevation (ft)
0
50
100
150
200
250
300
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Ineff
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2659.747
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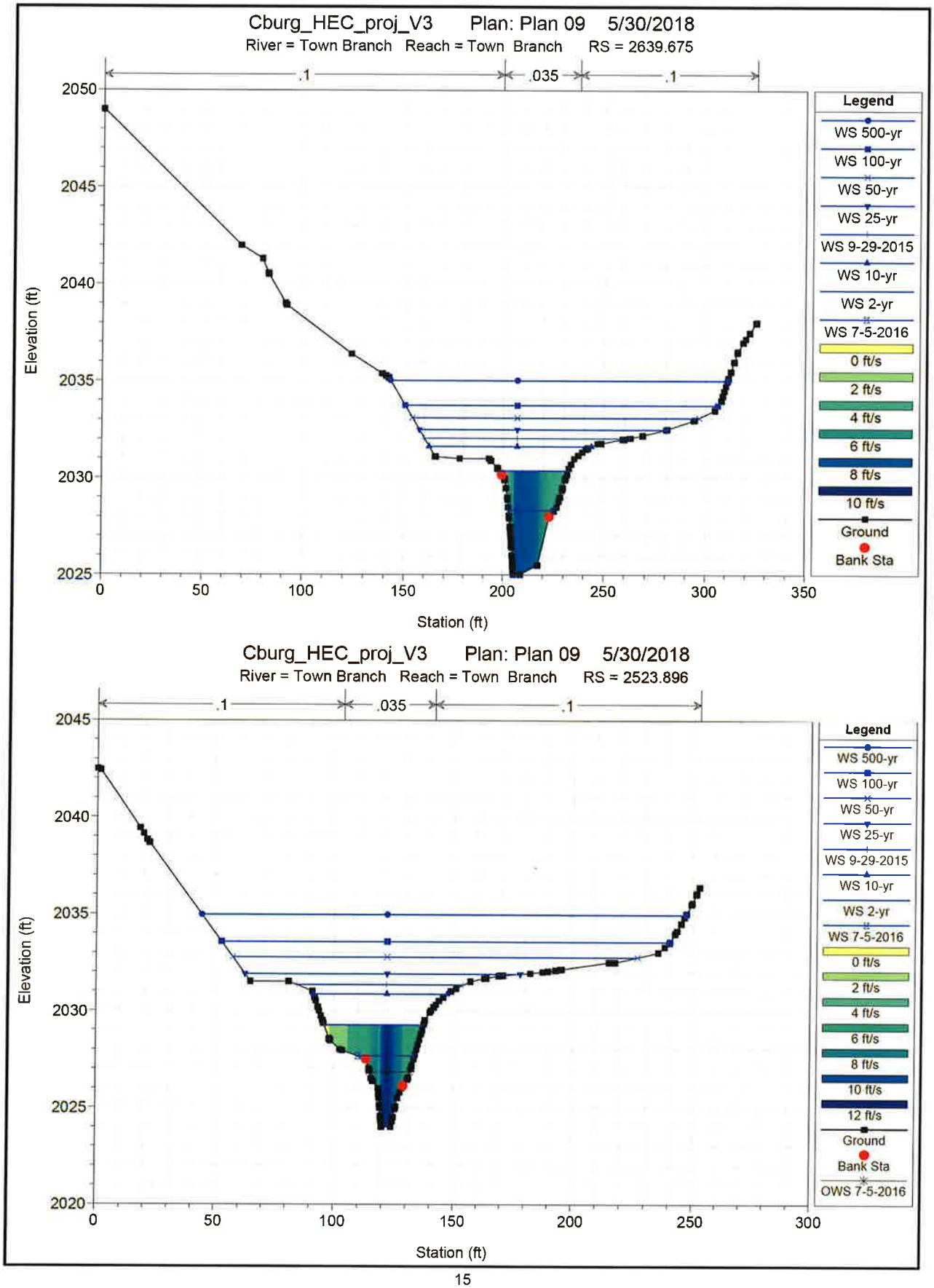
.035
.1
2050
2045
2040
2035
2030
2025
Elevation (ft)
0
50
100
150
200
250
300
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Ineff
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2639.675
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.035
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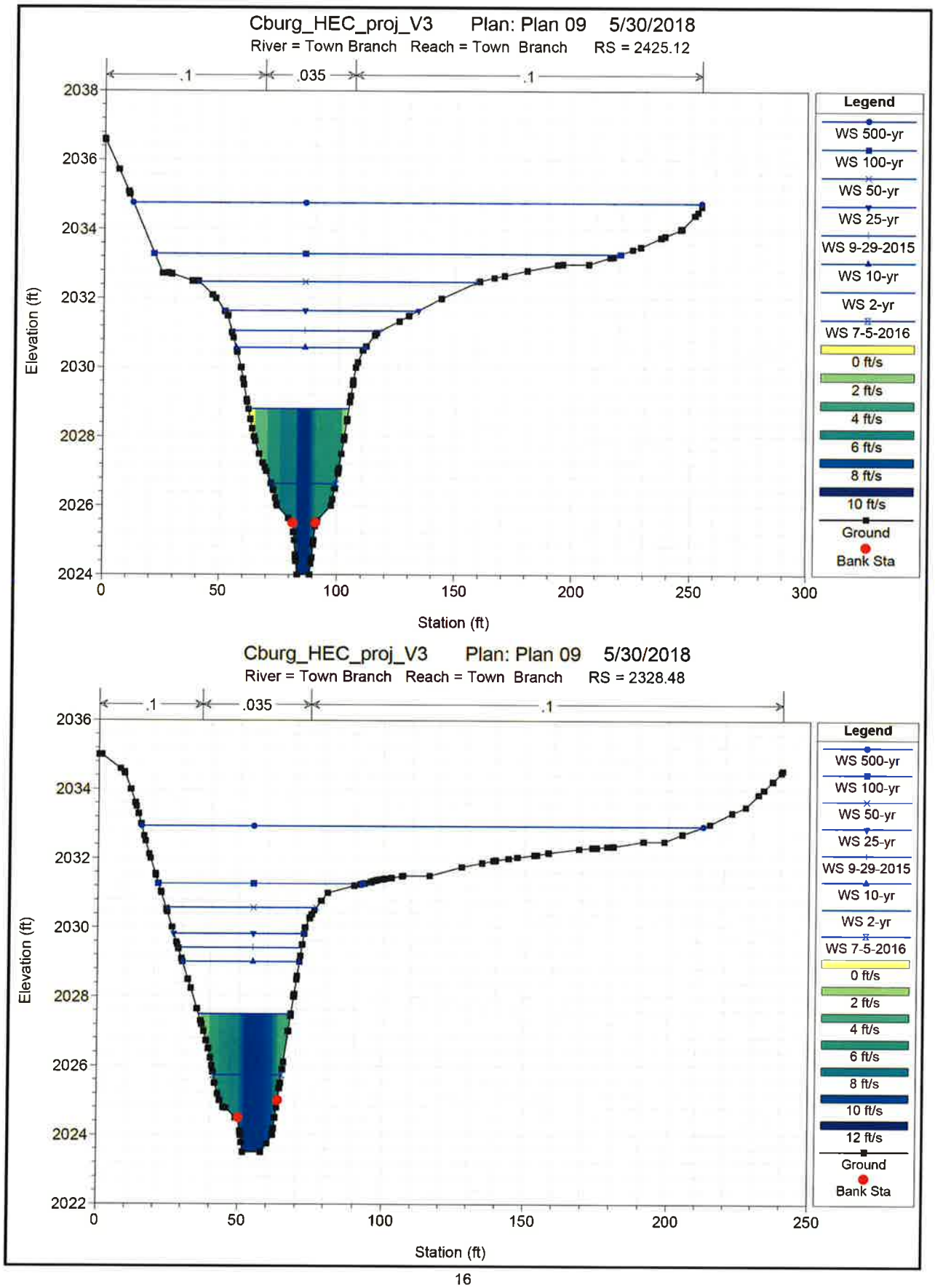
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2523.896
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
OWS 7-5-2016


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2425.12
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.035
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Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2328.48
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
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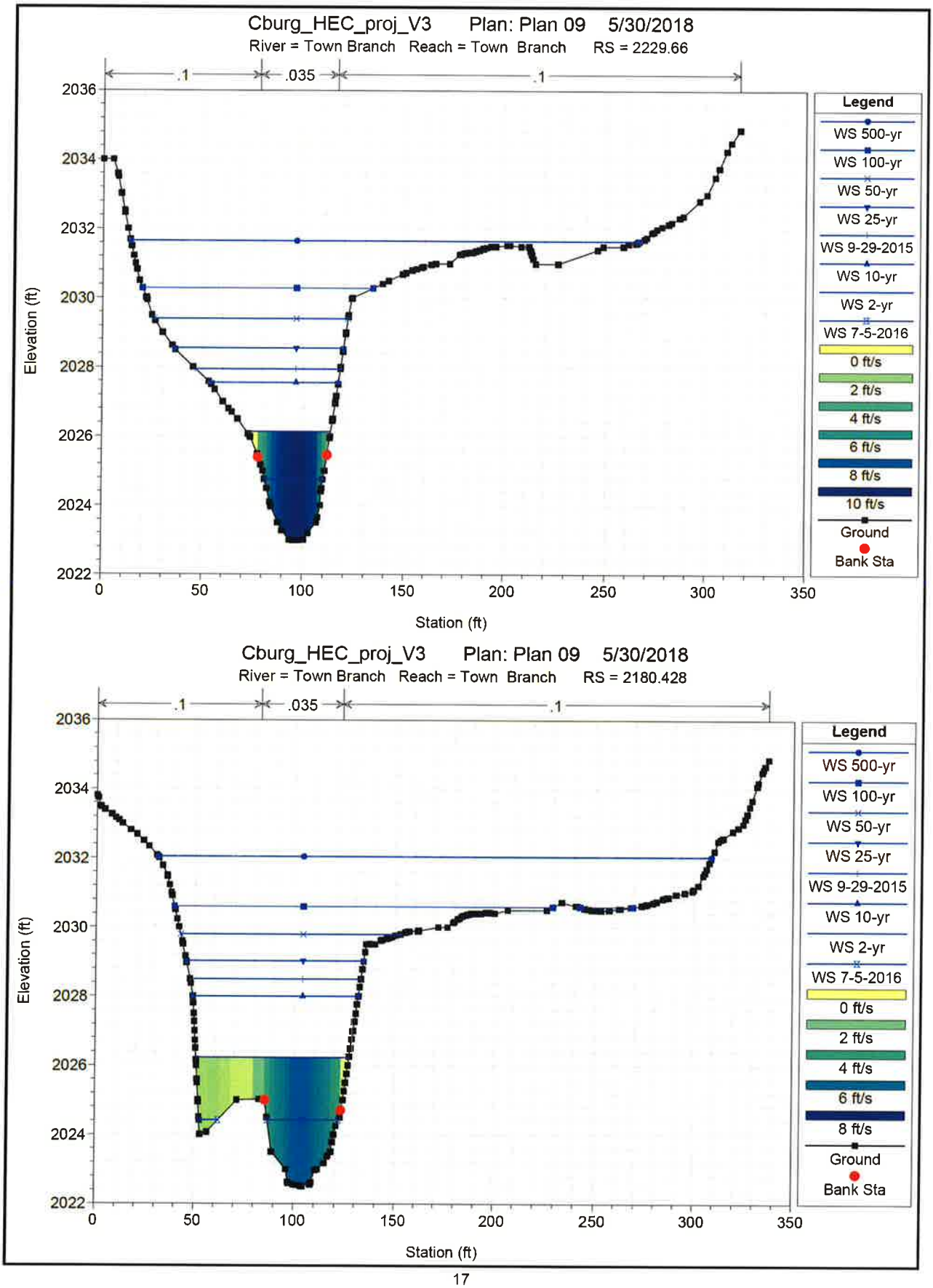
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2229.66
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.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2180.428
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
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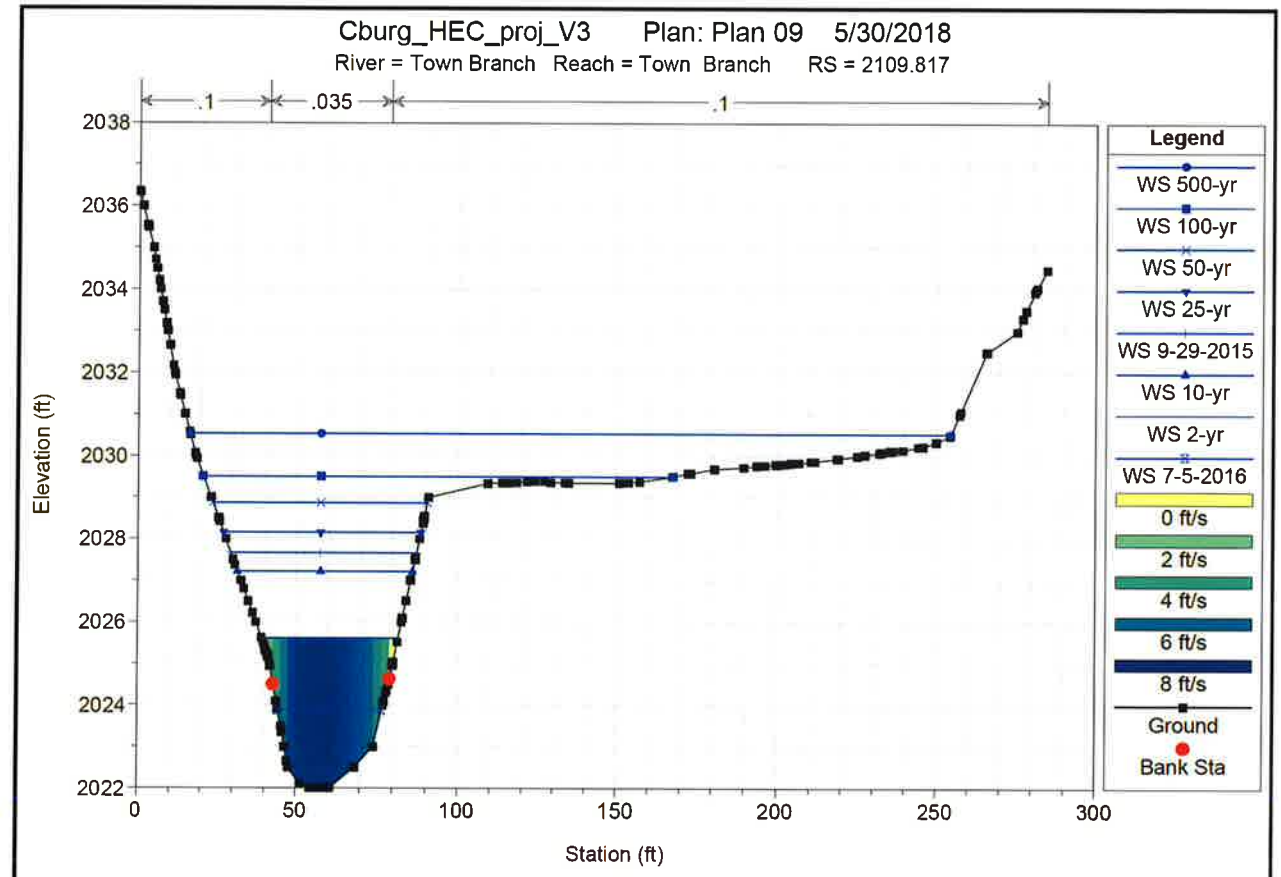
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2109.817
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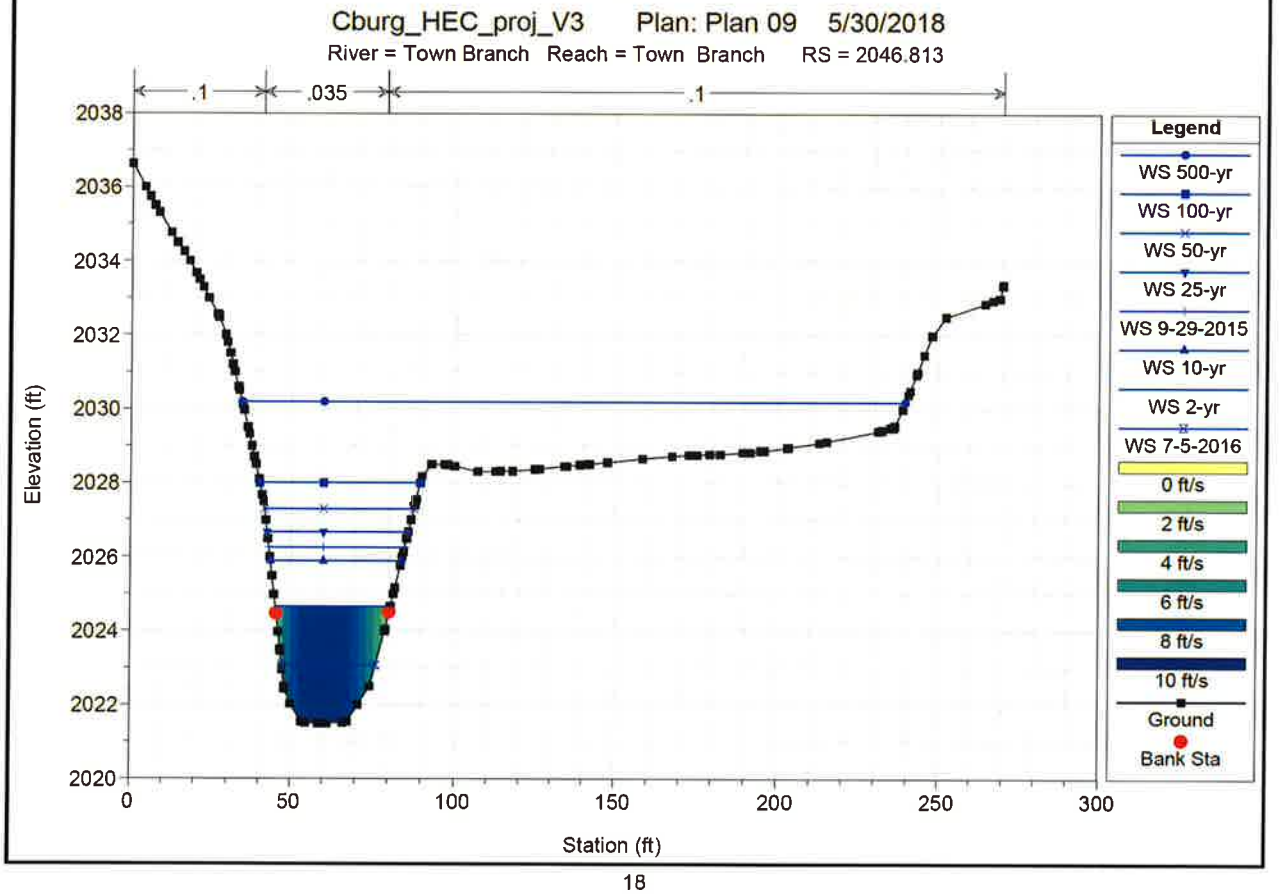
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 2046.813
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Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
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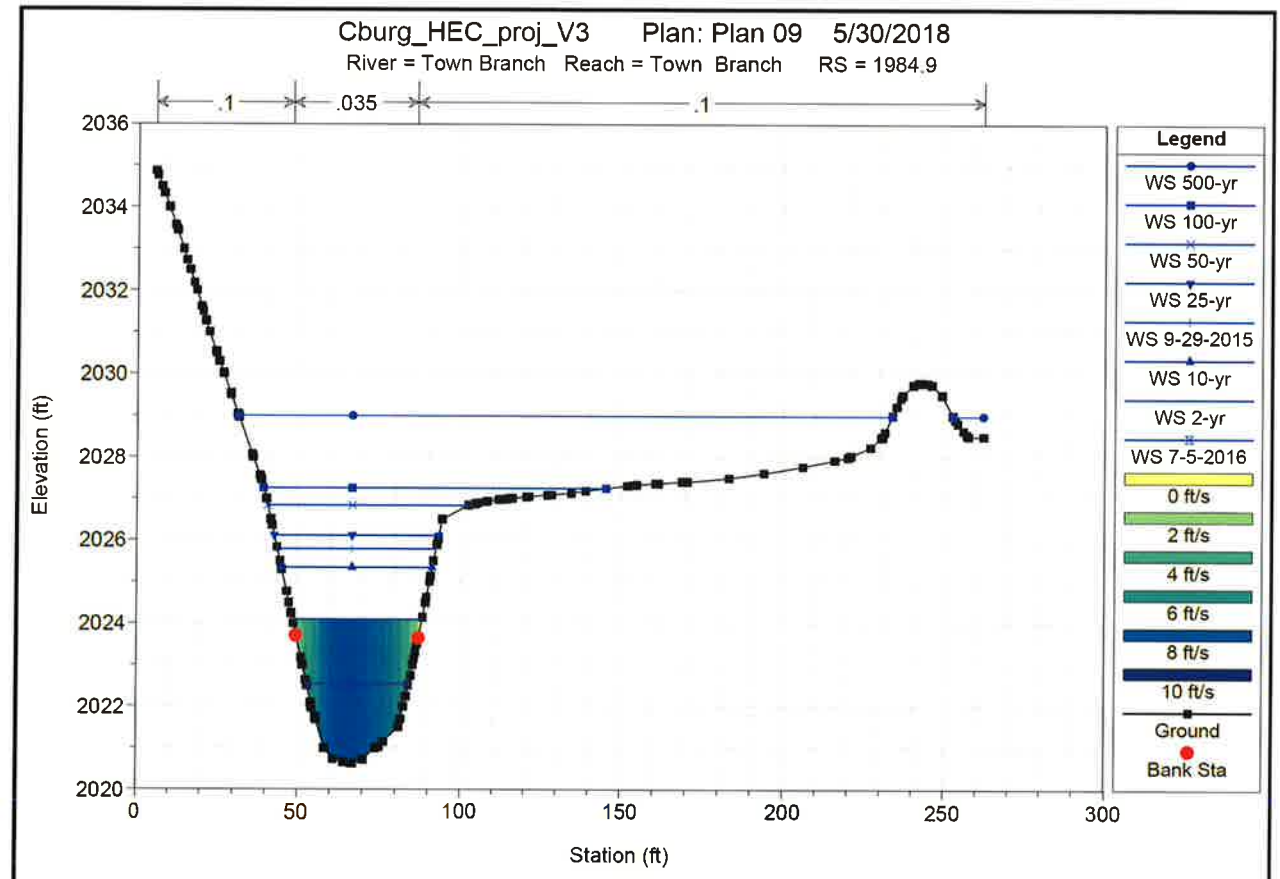
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1984.9
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.035
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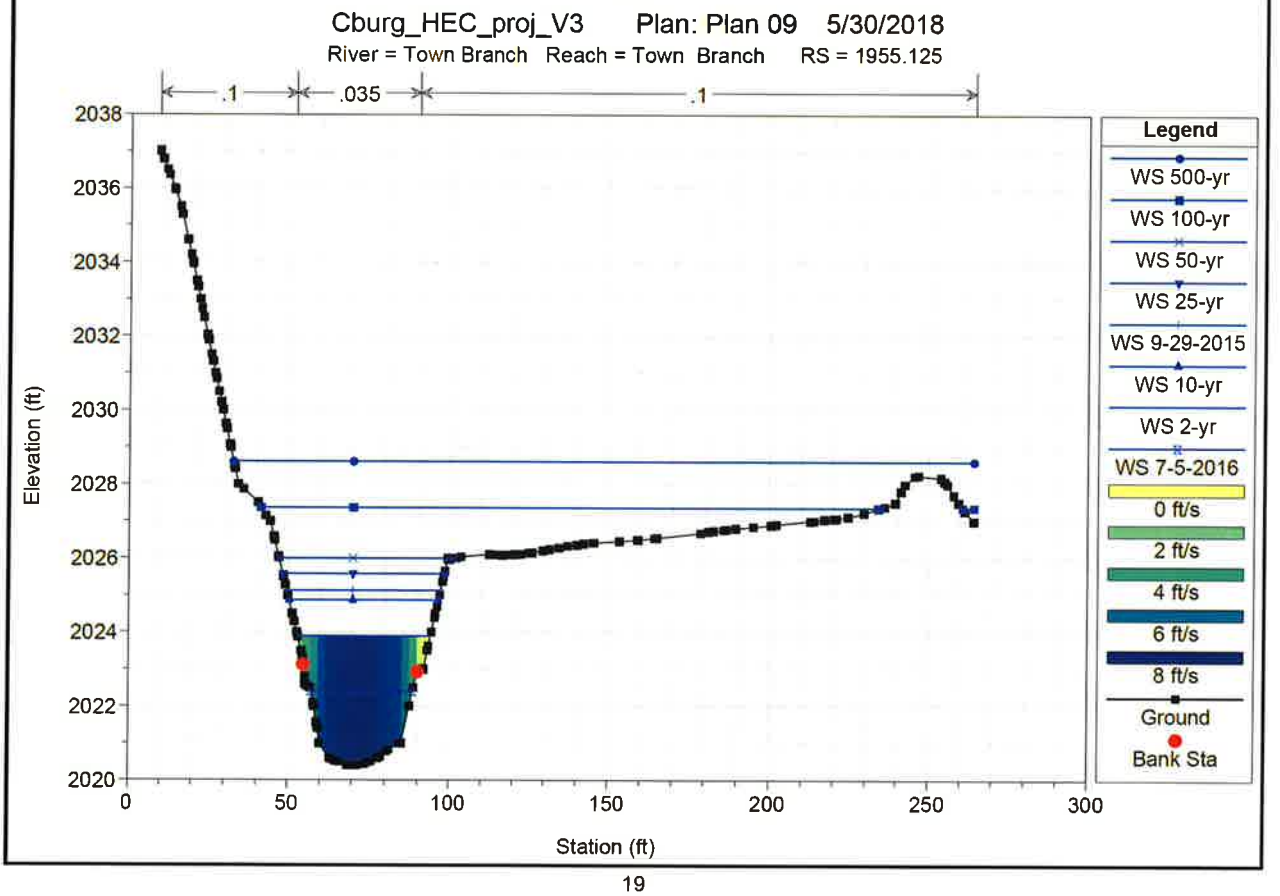
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1955.125
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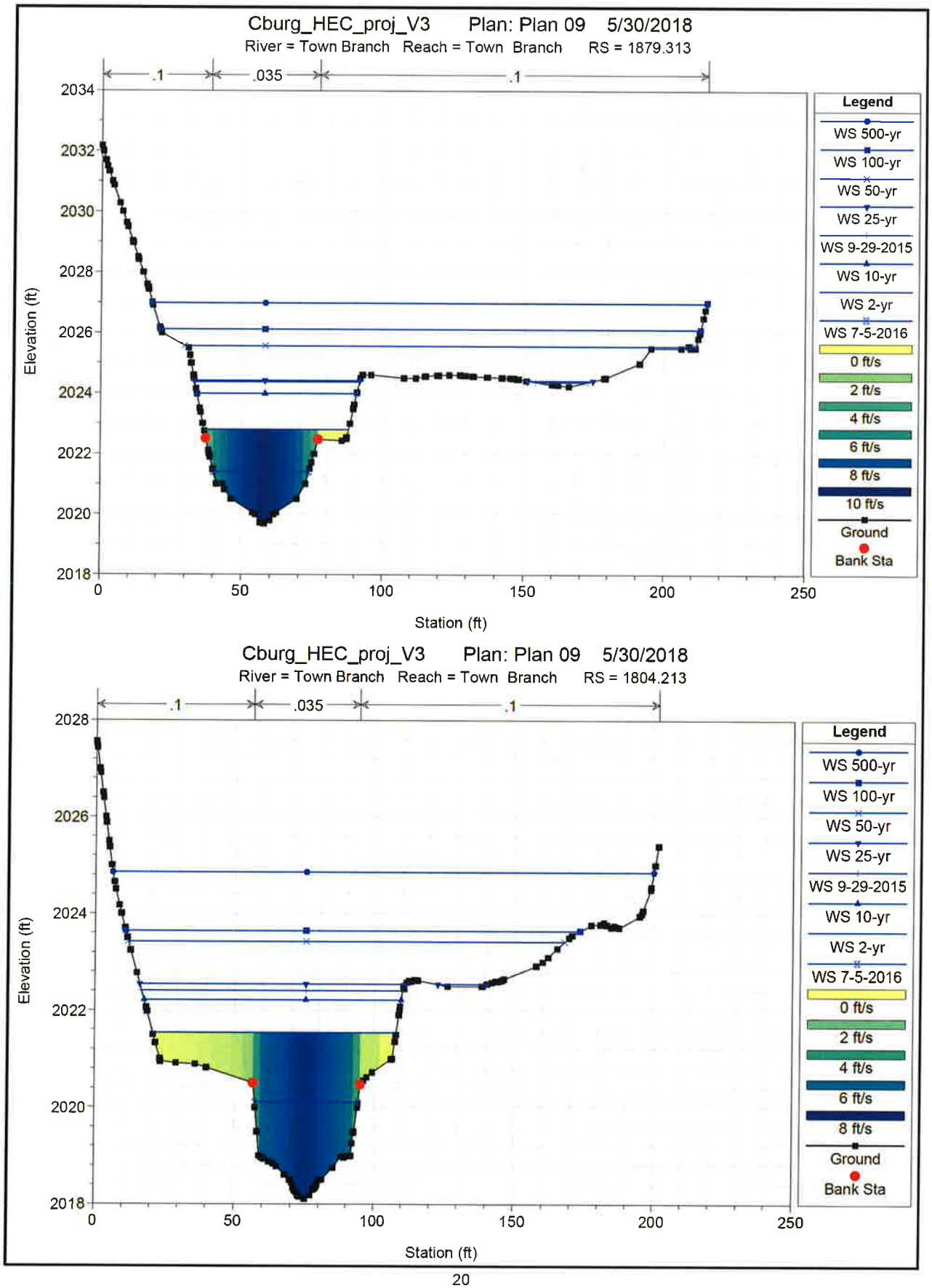
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta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River = Town Branch Reach = Town Branch RS = 1879.313
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.035
.1
2034
2032
2030
2028
2026
2024
2022
2020
2018
Elevation (ft)
0
50
100
150
200
250
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1804.213
.1
.035
.1
2028
2026
2024
2022
2020
2018
Elevation (ft)
0
50
100
150
200
250
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
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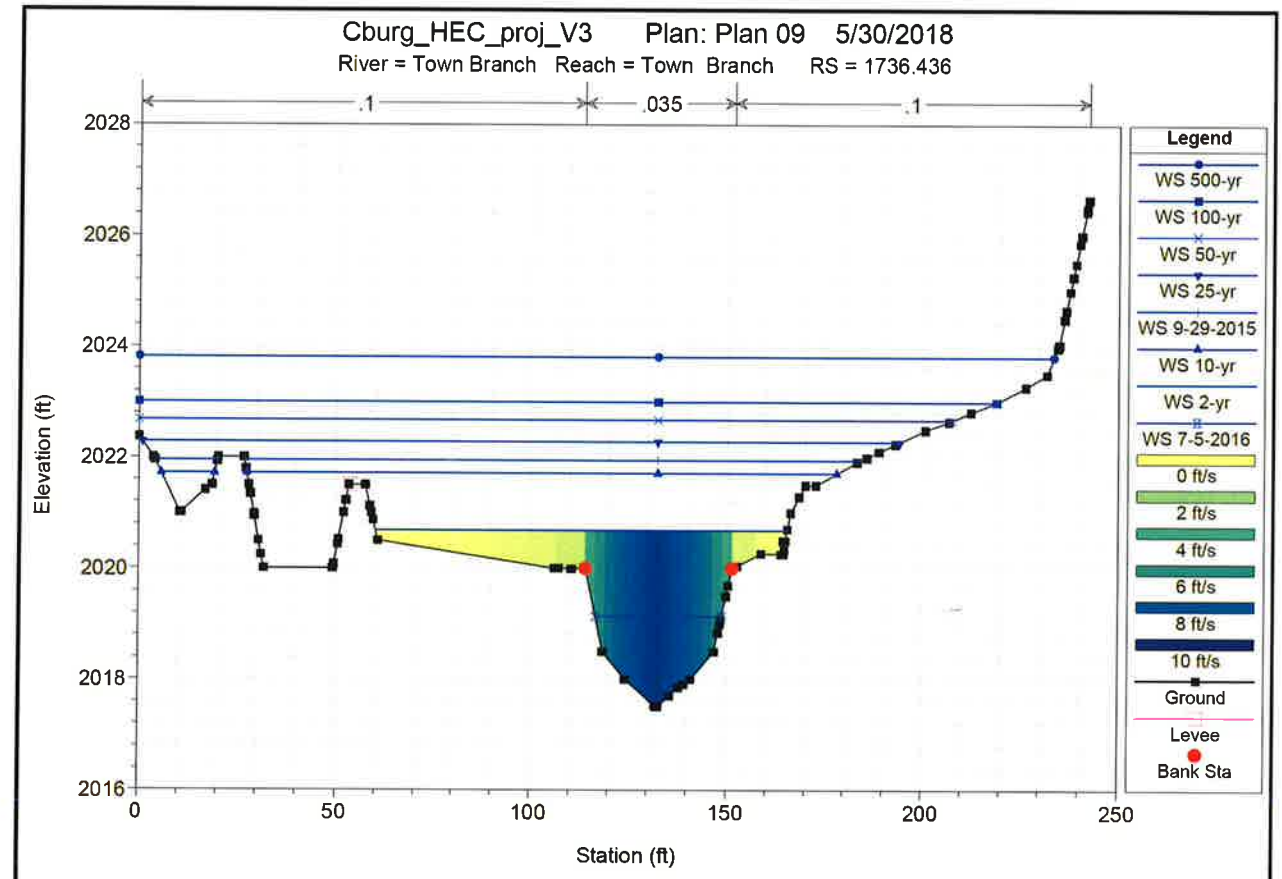
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta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River = Town Branch Reach = Town Branch RS = 1736.436
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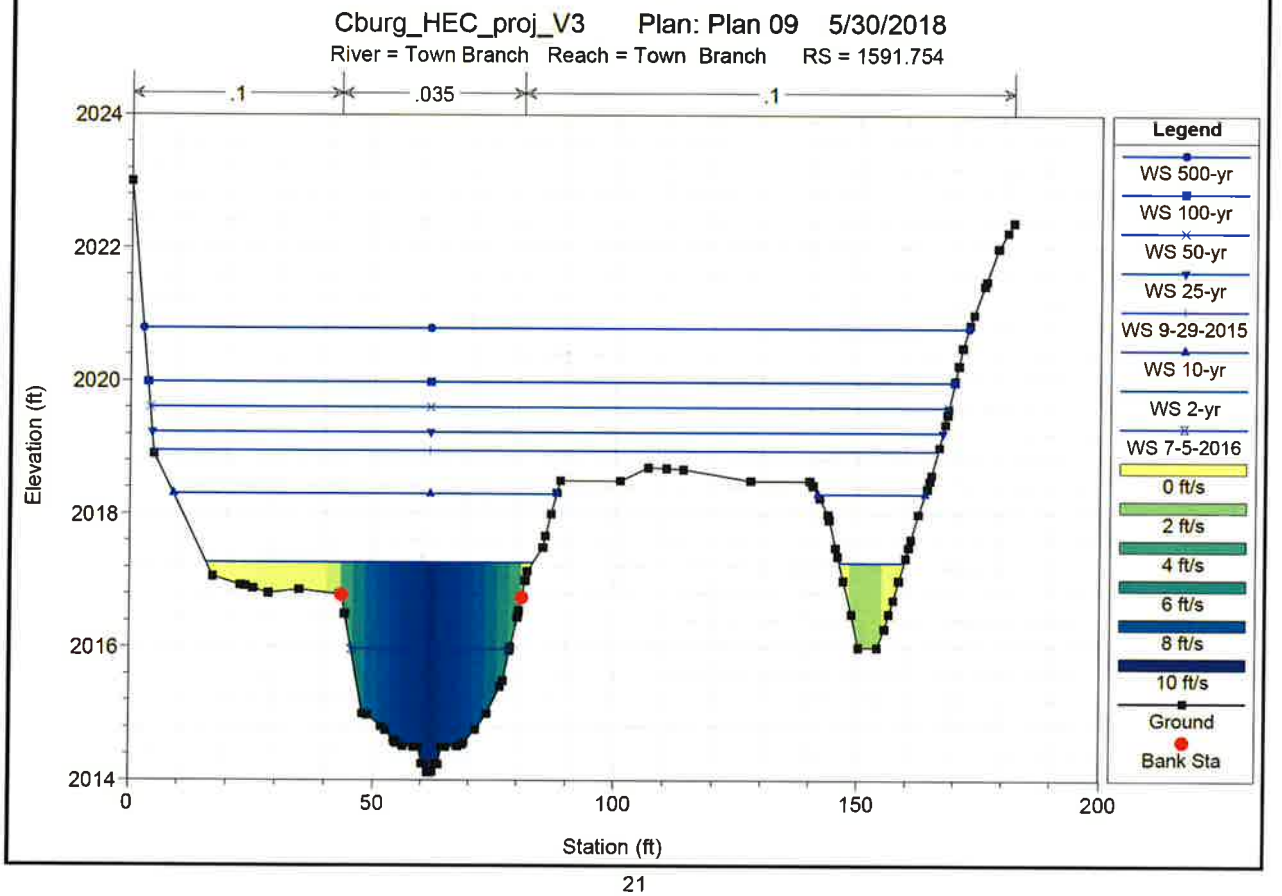
2028
2026
2024
2022
2020
2018
2016
Elevation (ft)
0
50
100
150
200
250
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Levee
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1591.754
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.035
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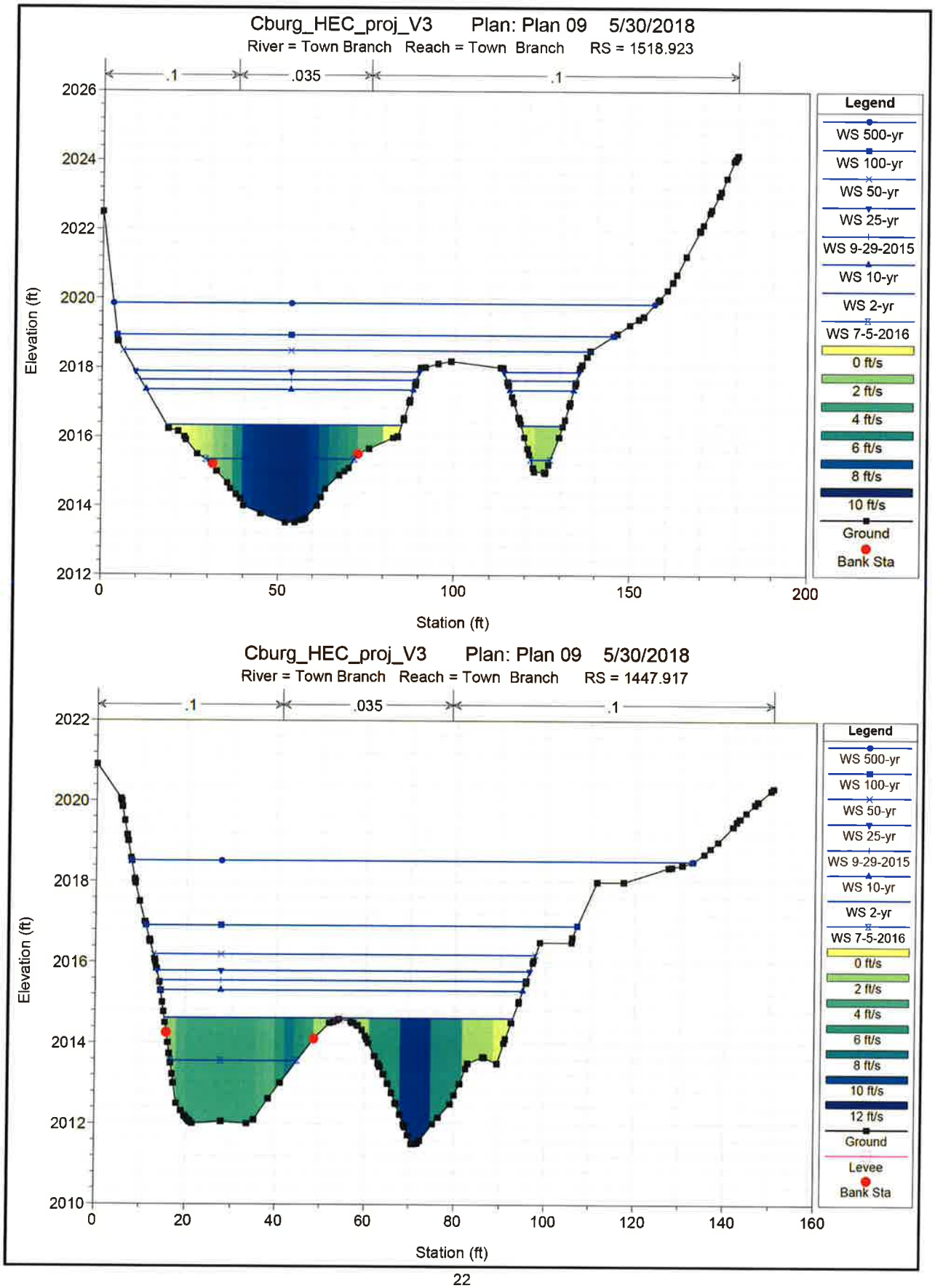
2024
2022
2020
2018
2016
2014
Elevation (ft)
0
50
100
150
200
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1518.923
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.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1447.917
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
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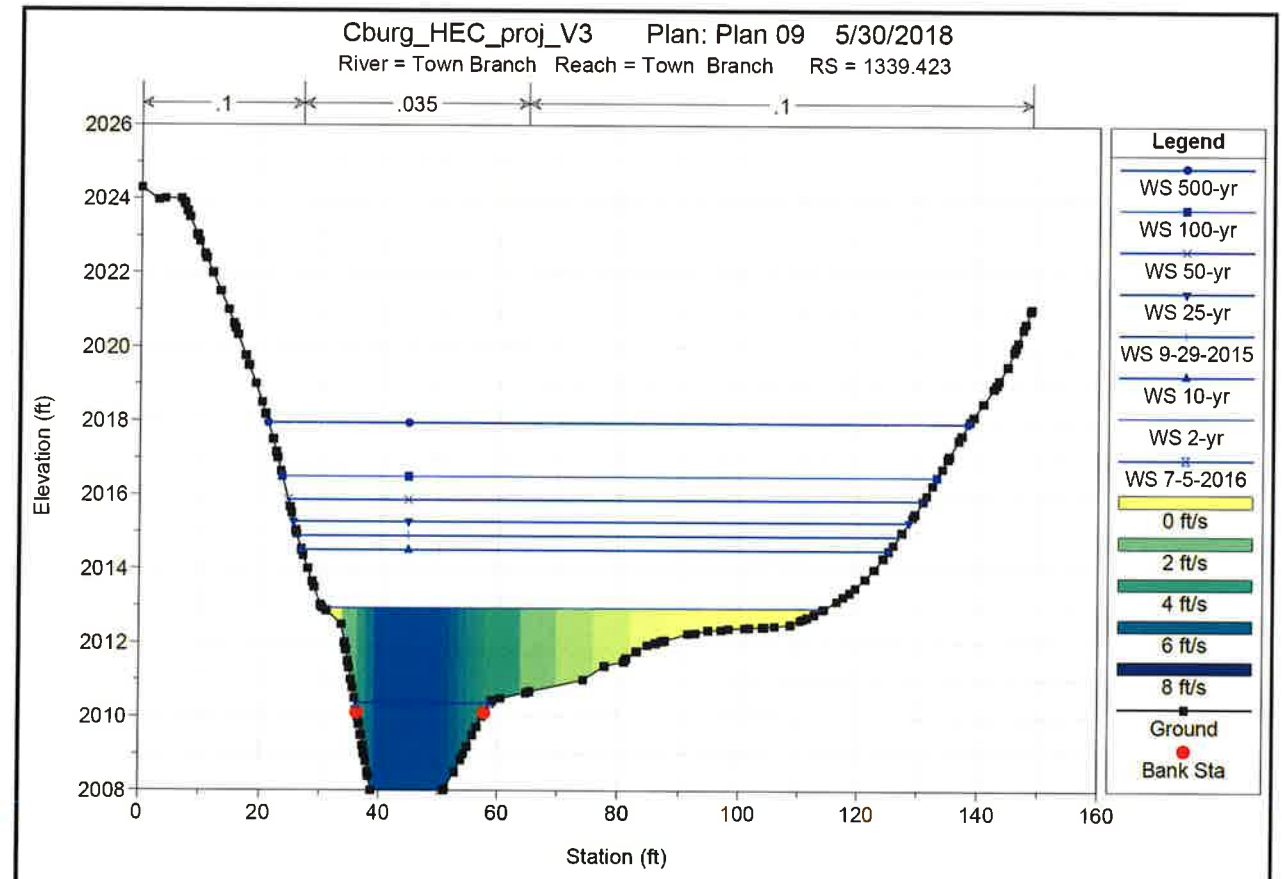
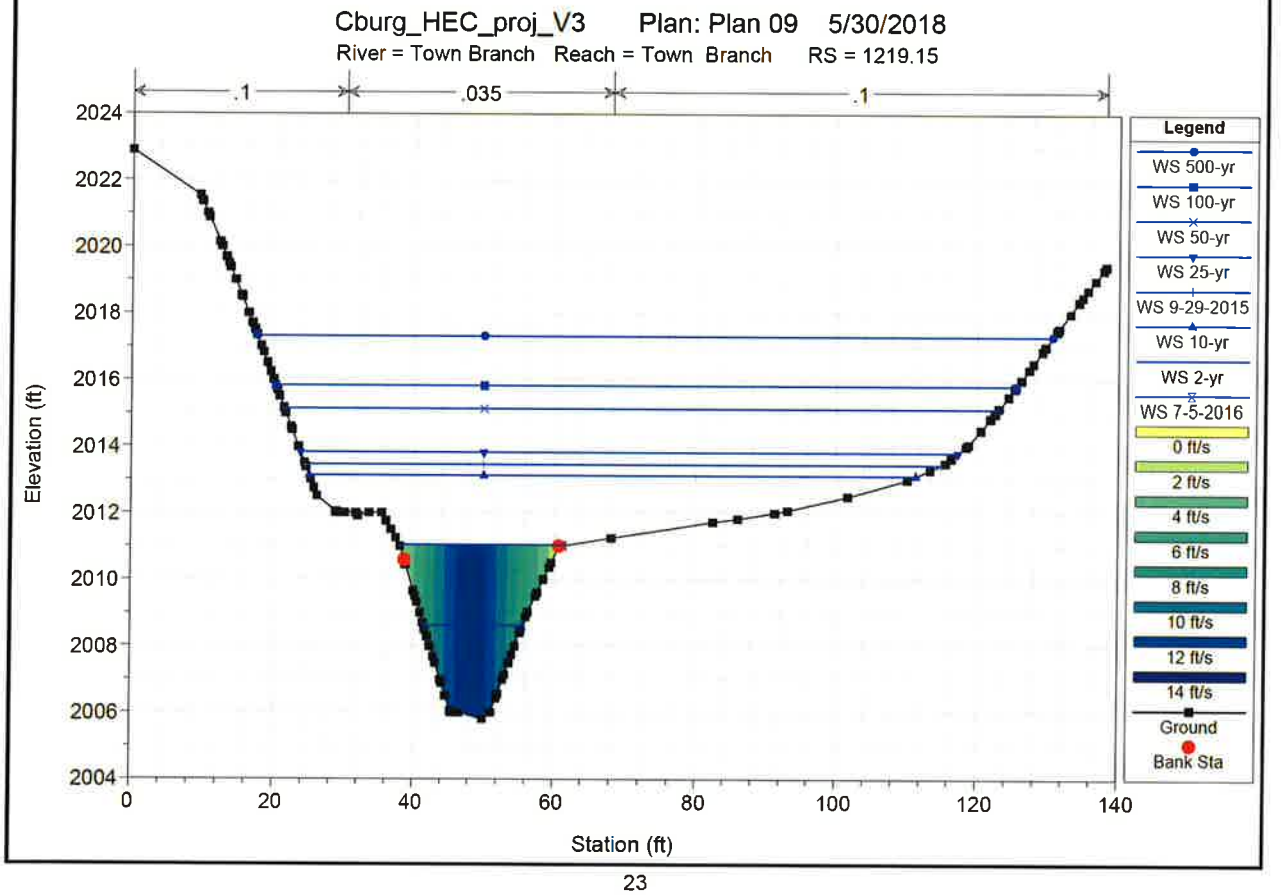
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Levee
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1339.423
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1219.15
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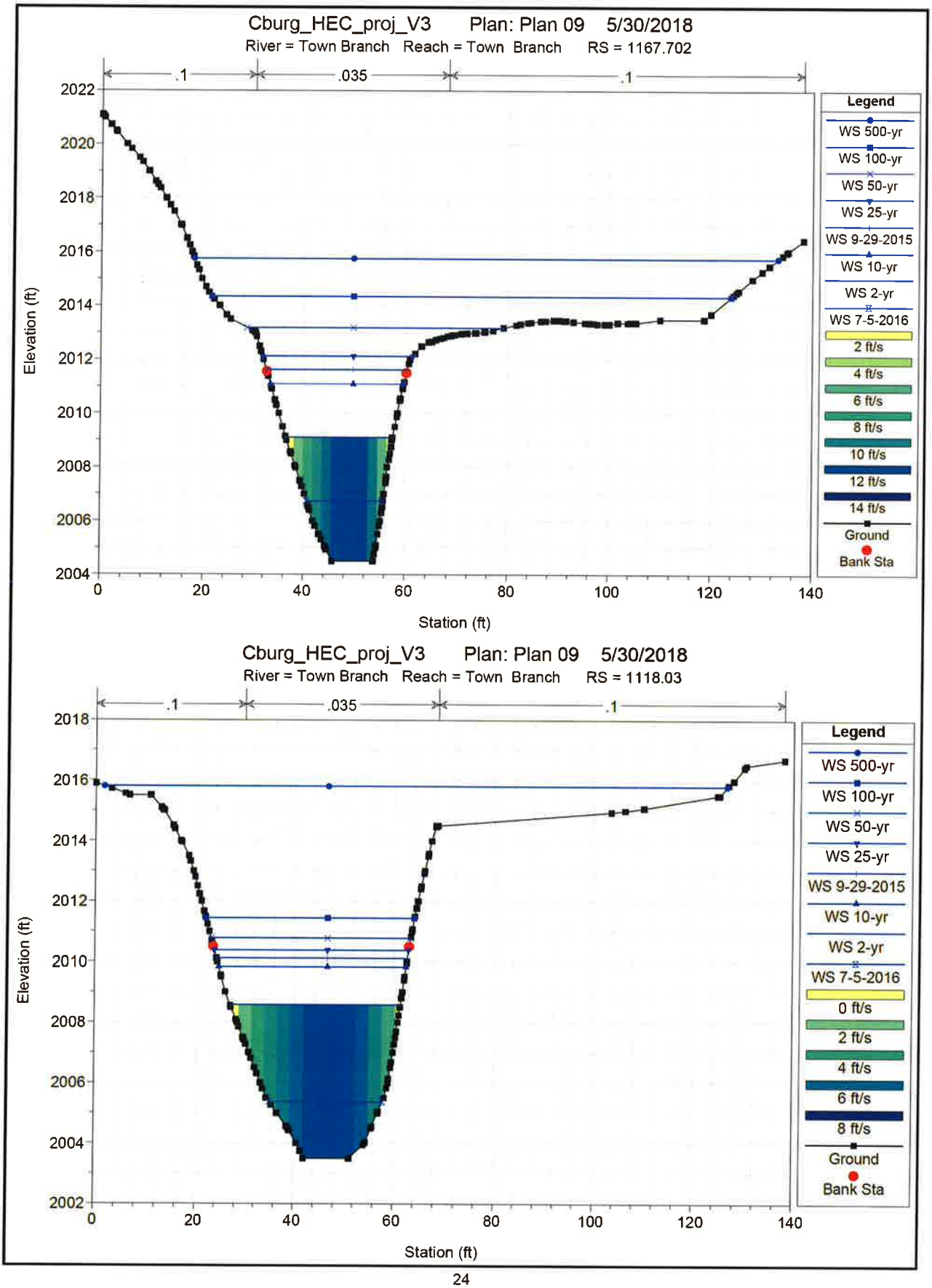
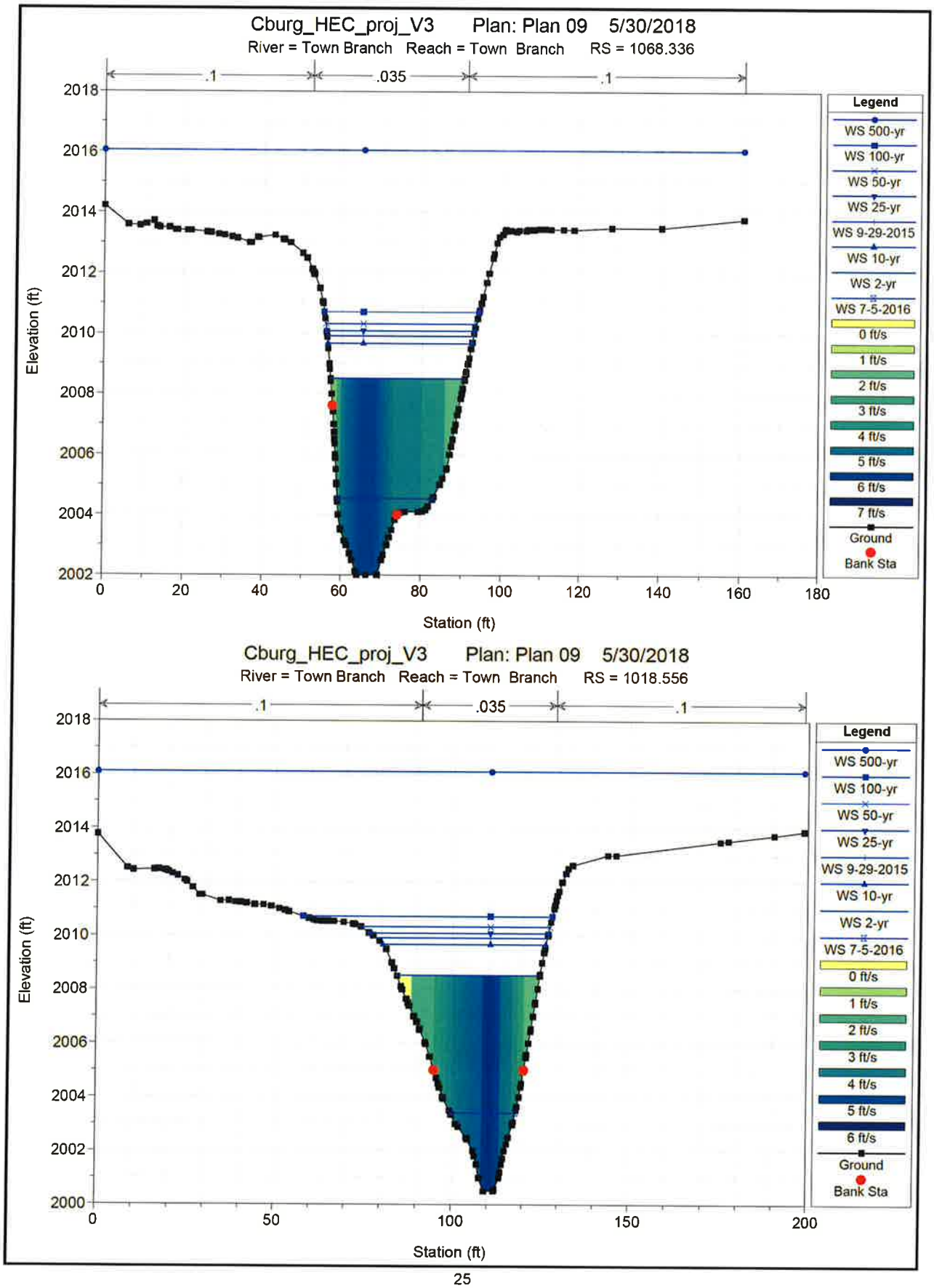
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1167.702
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1118.03
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1068.336
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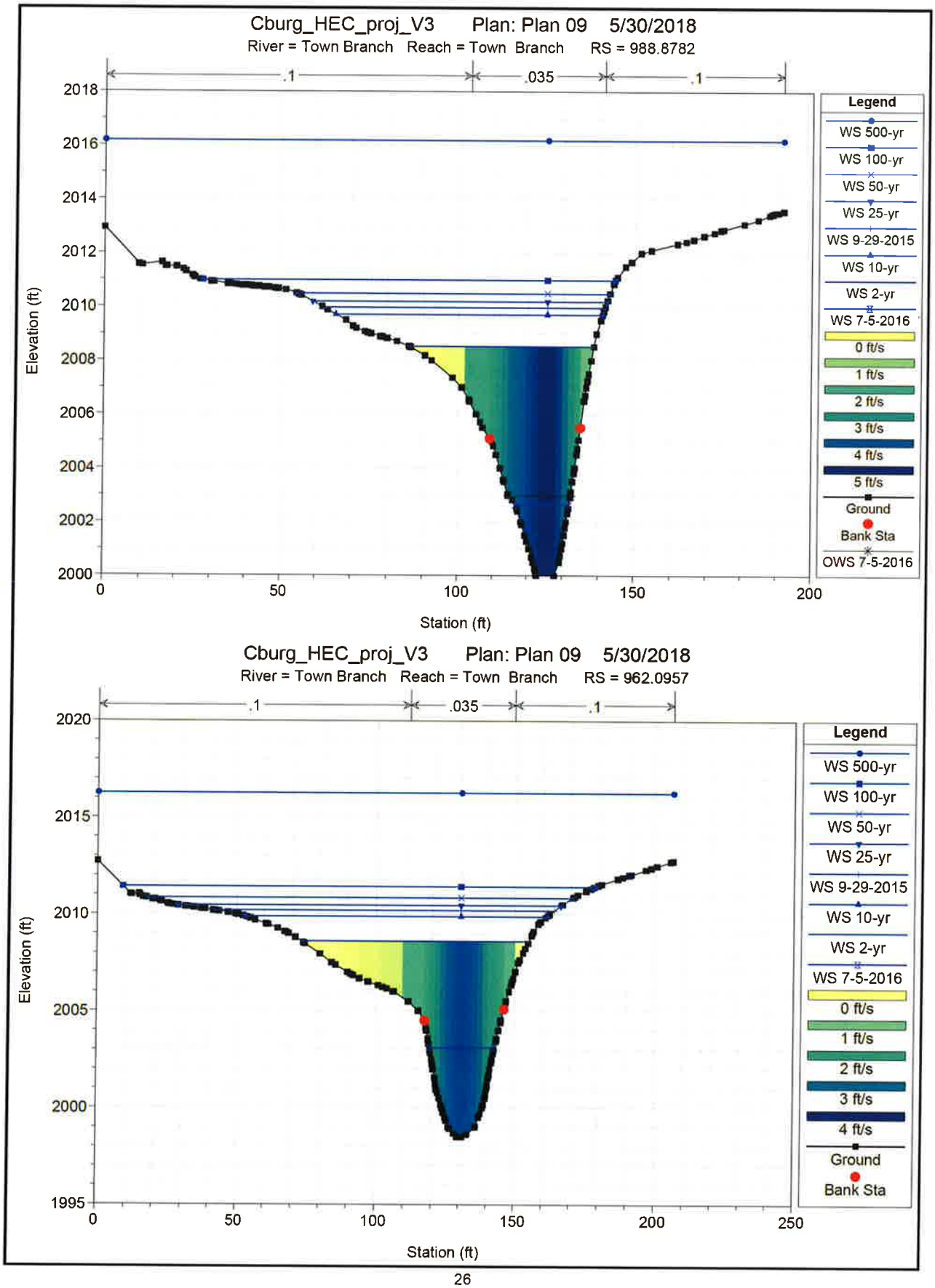
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 1018.556
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 988.8782
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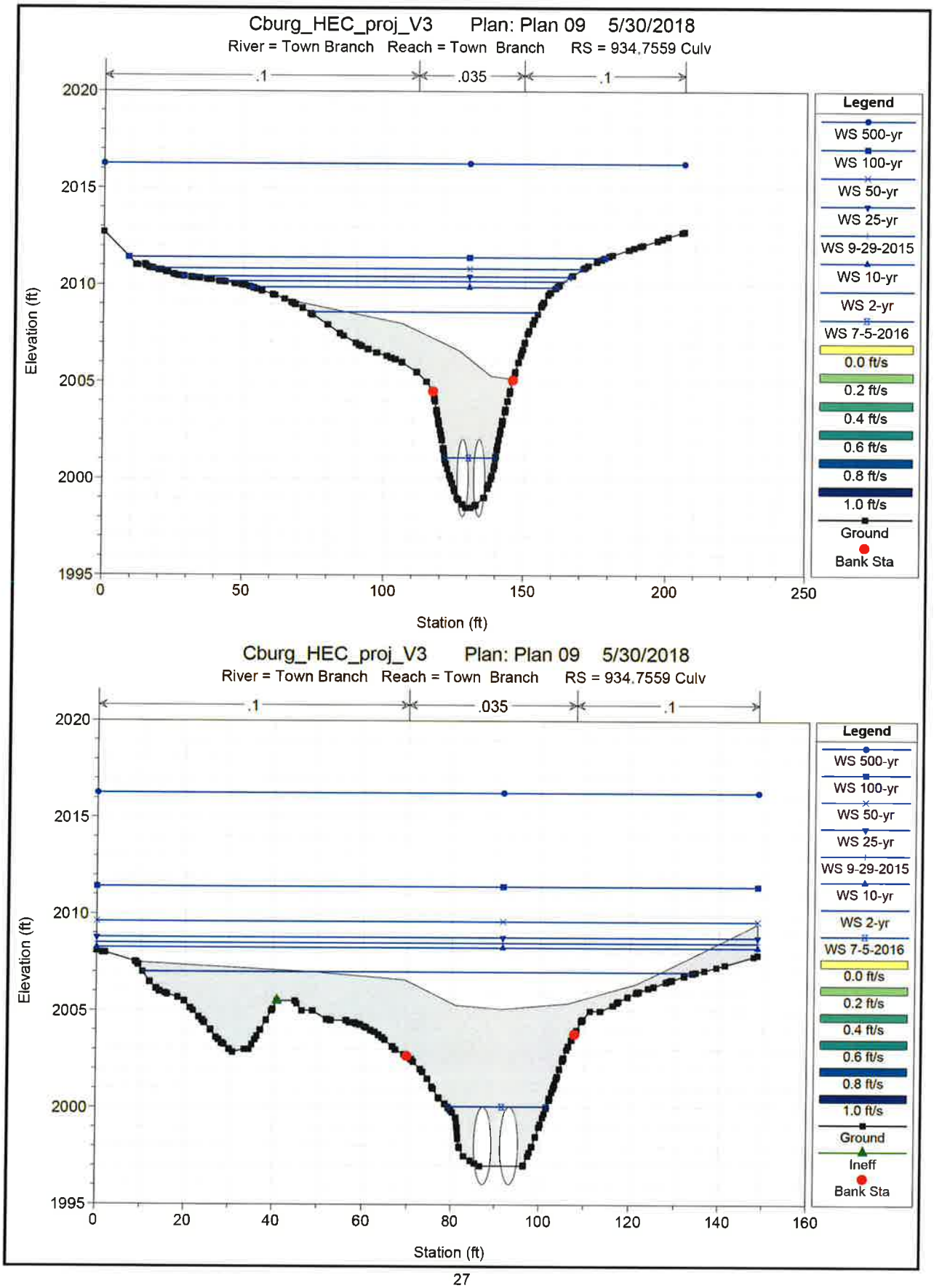
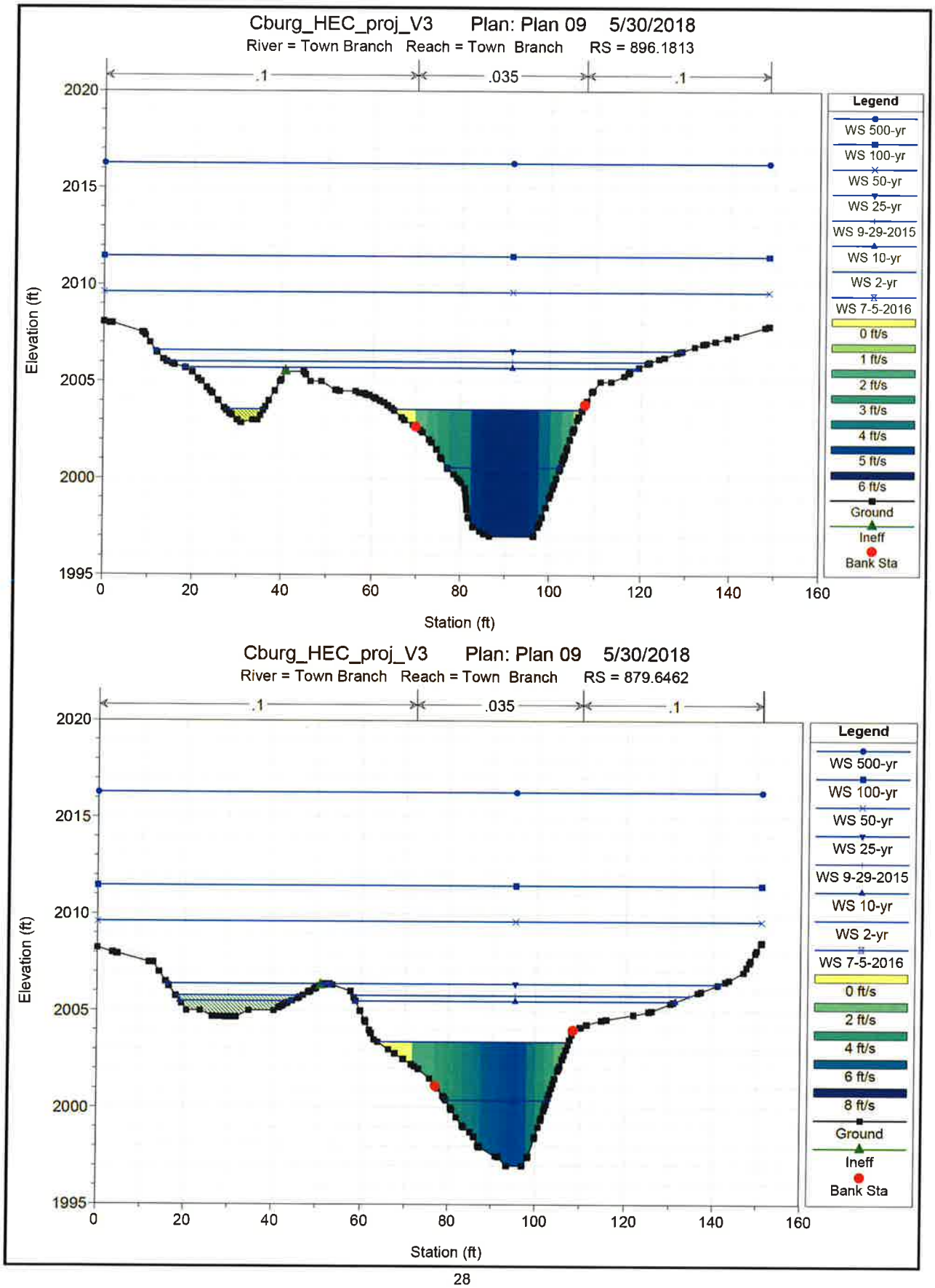
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Bank Sta
OWS 7-5-2016
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 962.0957
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
Ground
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 934.7559 Culv
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 934.7559 Culv
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Ineff
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 896.1813
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.035
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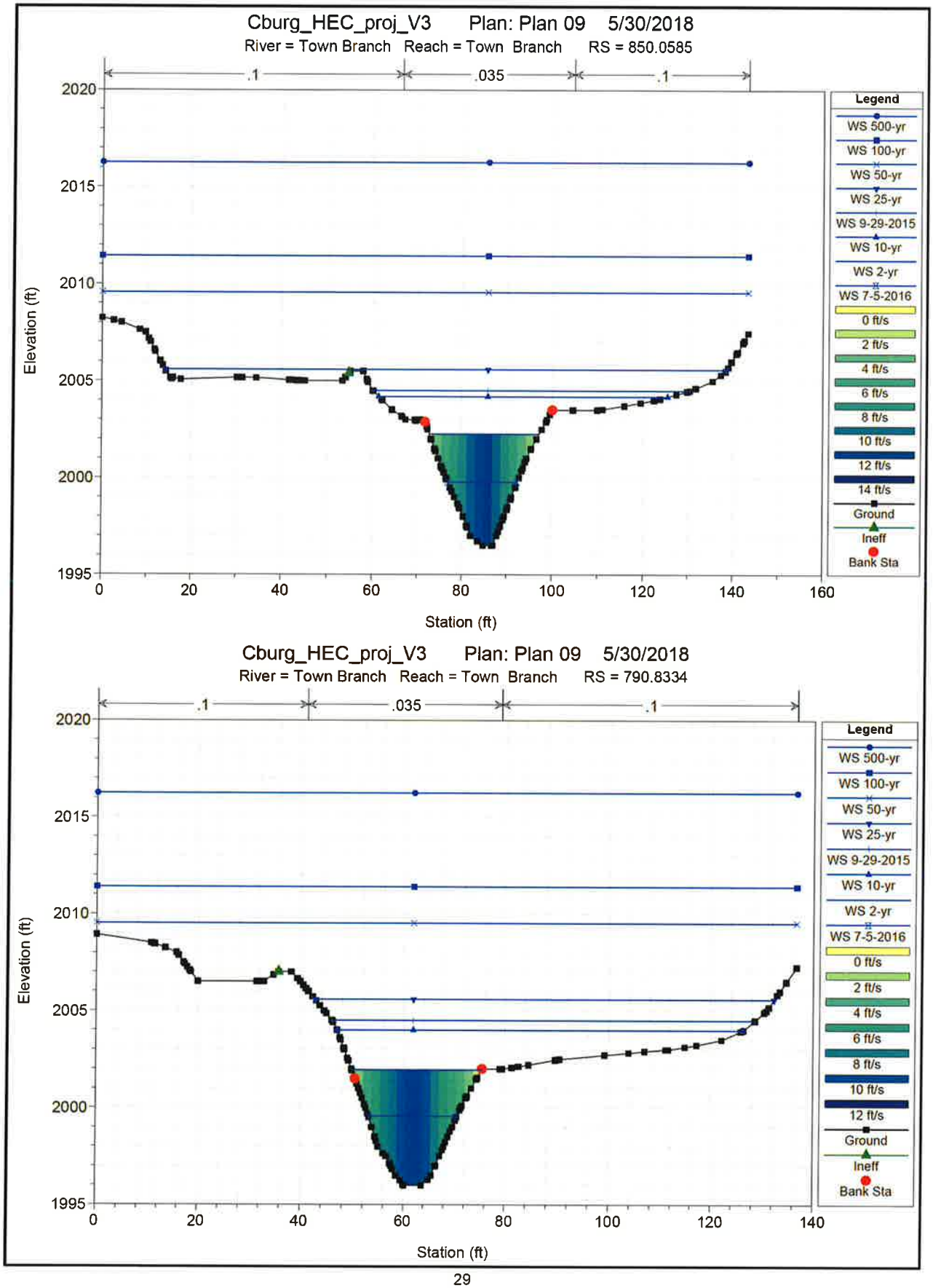
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Ineff
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 879.6462
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Ineff
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 850.0585
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.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Ineff
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 790.8334
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
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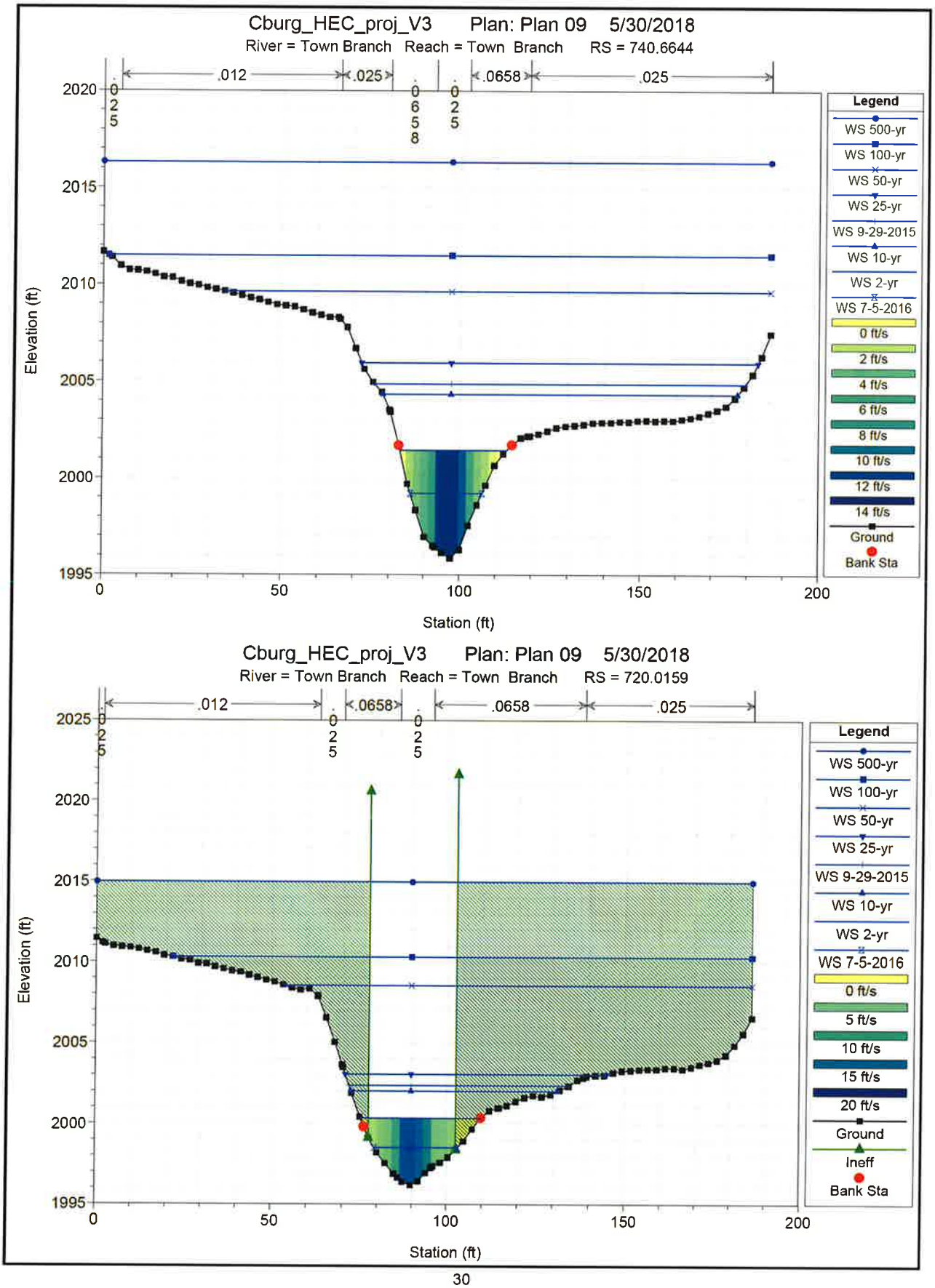
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 740.6644
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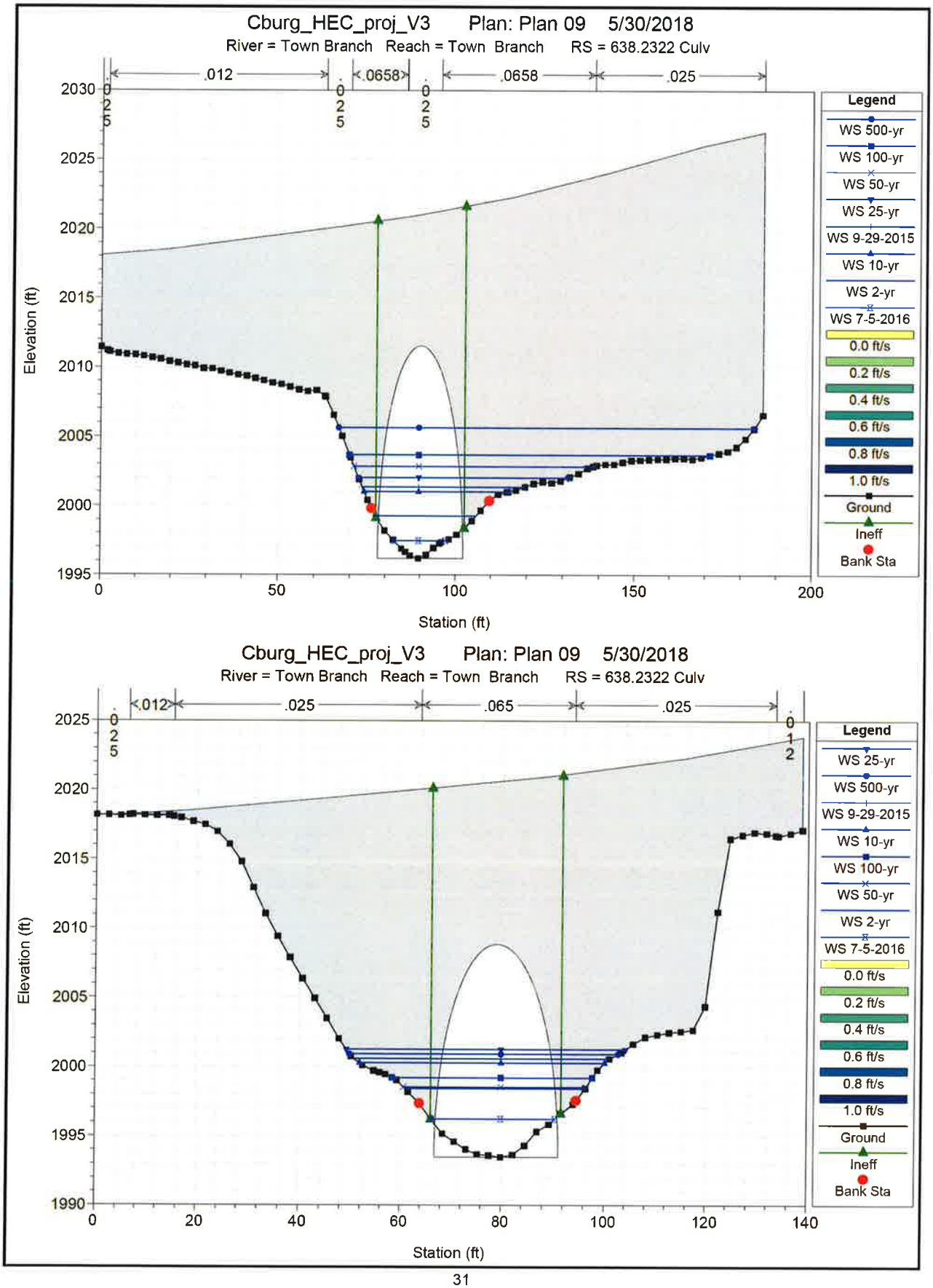
.0658
.025
.025
.0658
.025
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 720.0159
.012
.0658
.0658
.025
.025
.025
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
5 ft/s
10 ft/s
15 ft/s
20 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 638.2322 Culv
.012
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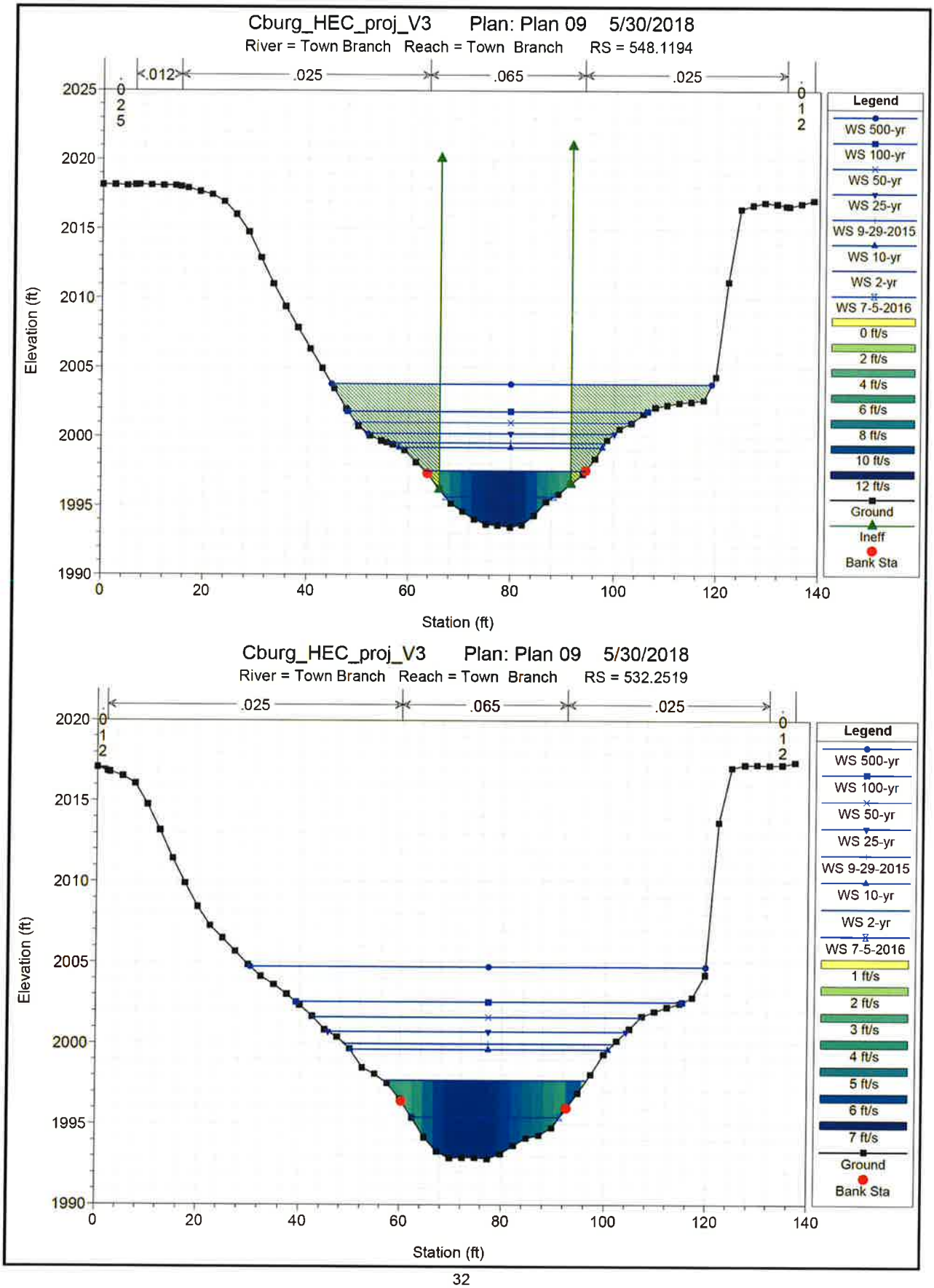
.025
.025
.025
.025
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Ineff
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 638.2322 Culv
.012
.025
.065
.025
.025
.012
Elevation (ft)
Station (ft)
Legend
WS 25-yr
WS 500-yr
WS 9-29-2015
WS 10-yr
WS 100-yr
WS 50-yr
WS 2-yr
WS 7-5-2016
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Ineff
Bank Sta


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 548.1194
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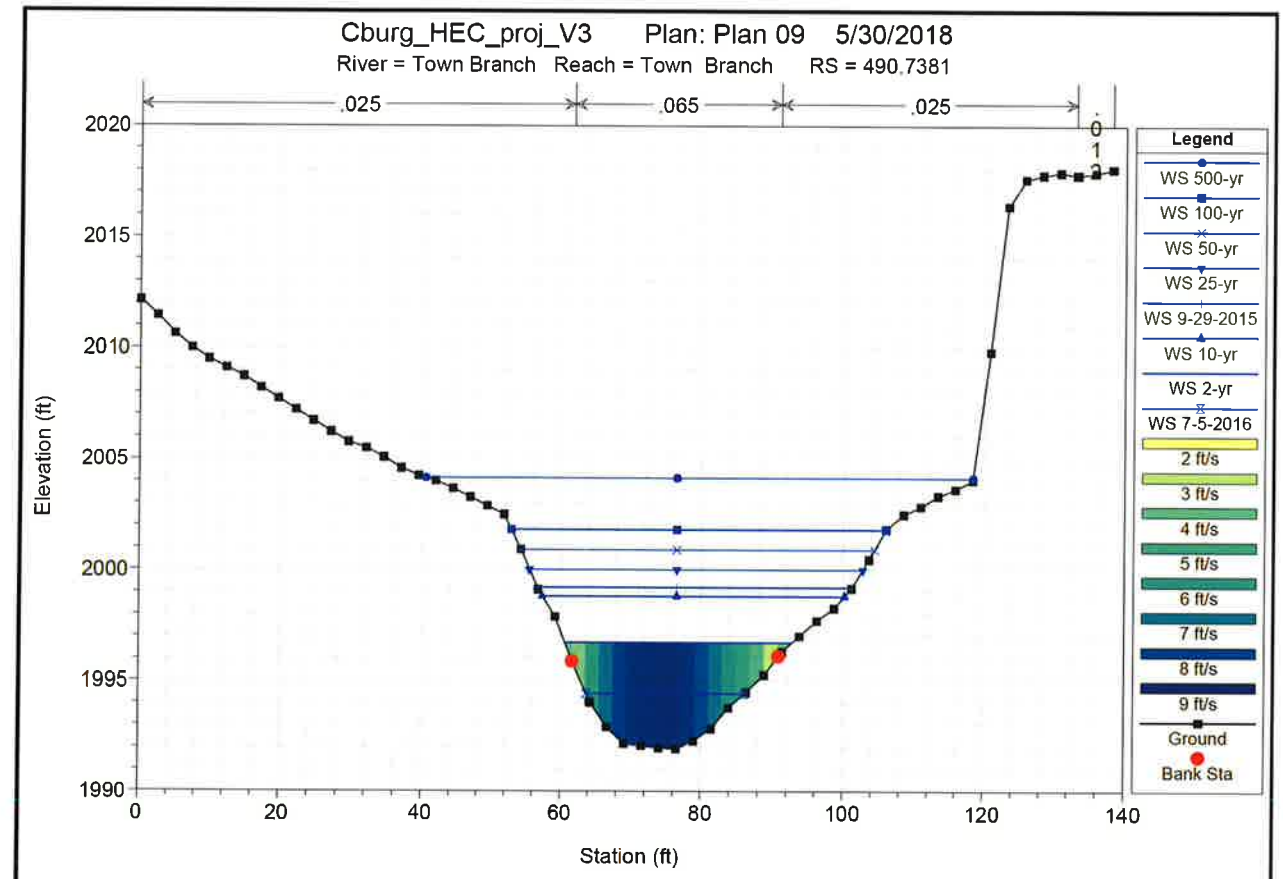
.025
.065
.025
0.025
0.012
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 532.2519
.025
.065
.025
0.012
0.012
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 490.7381
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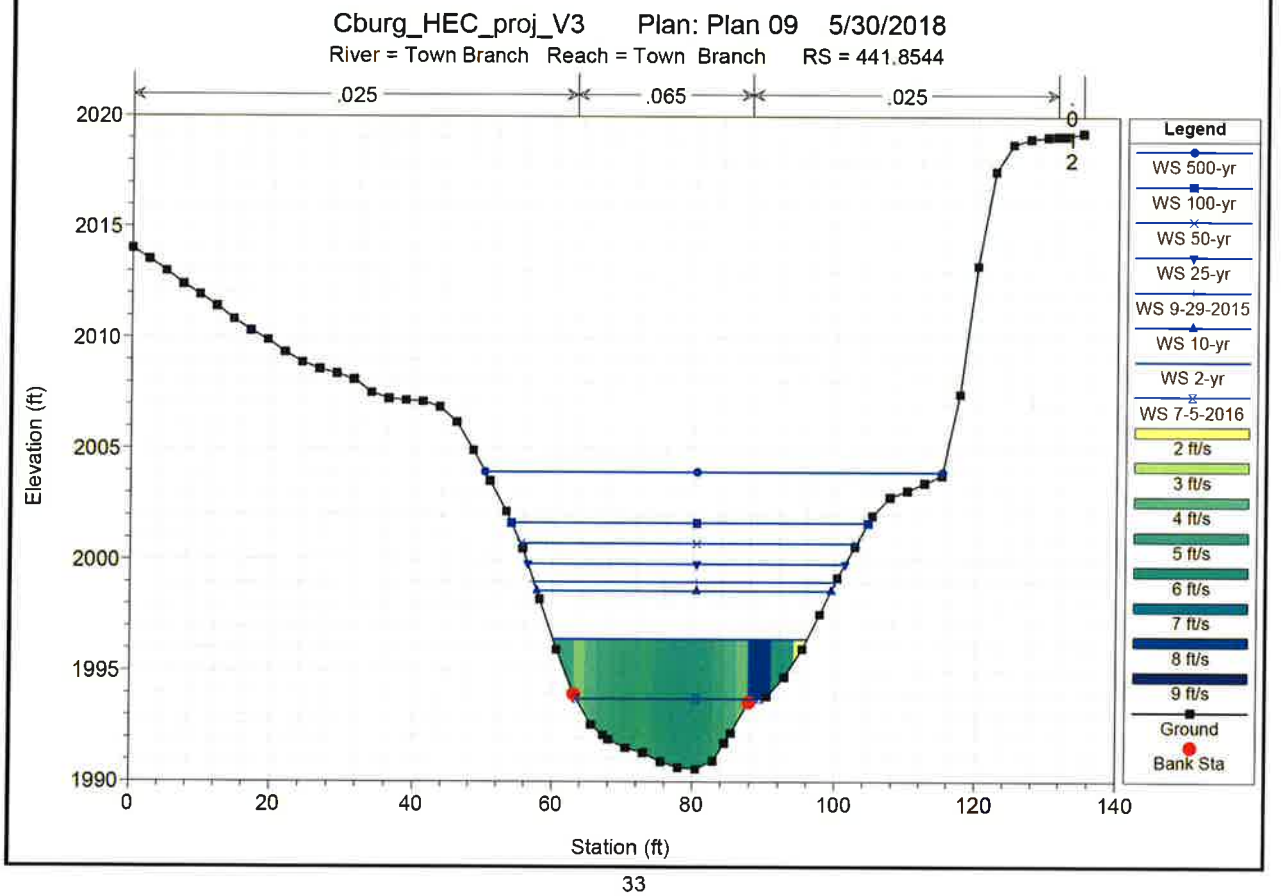
.065
.025
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 441.8544
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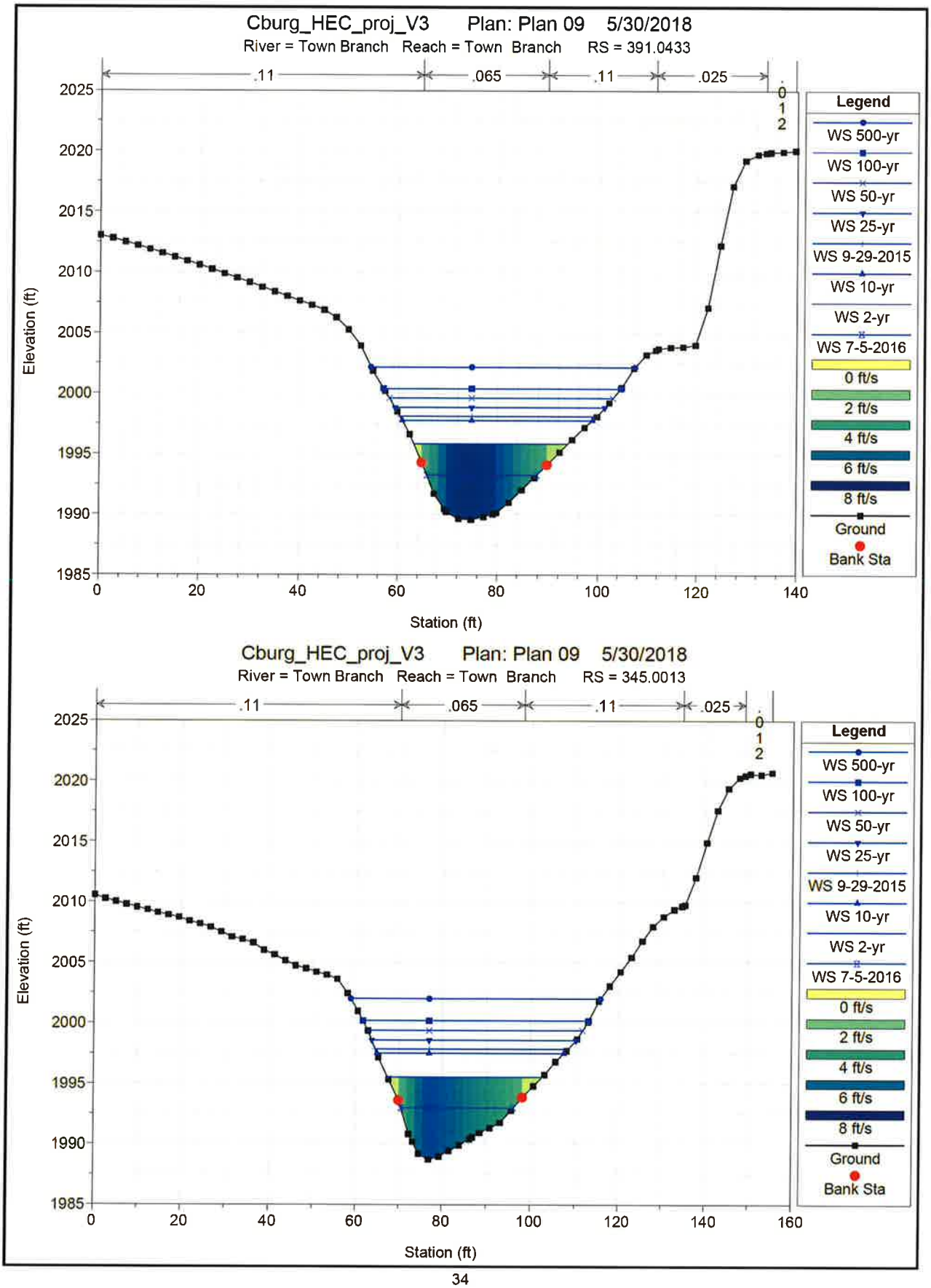
.065
.025
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 391.0433
.11
.065
.11
.025
0
1
2
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
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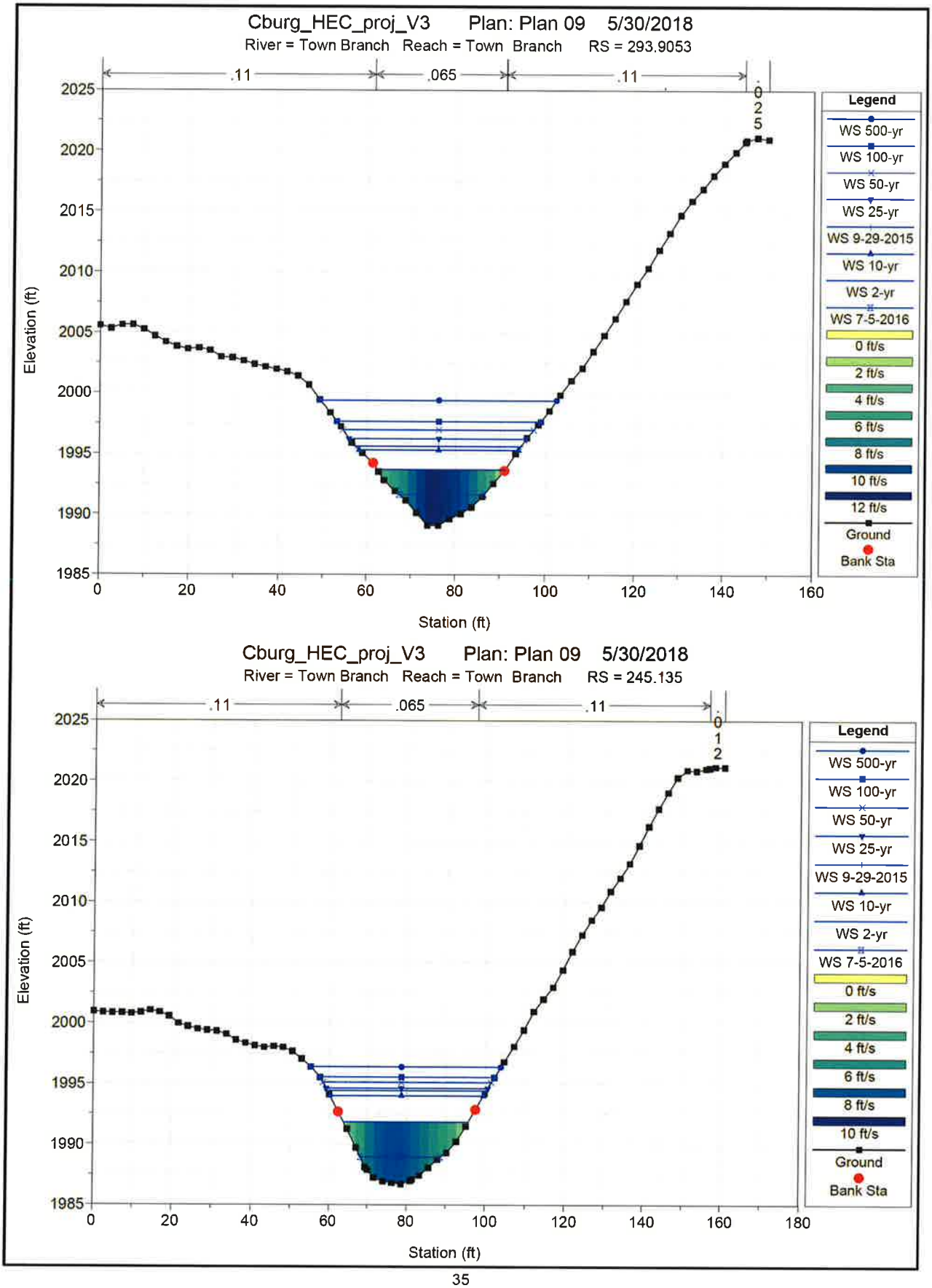
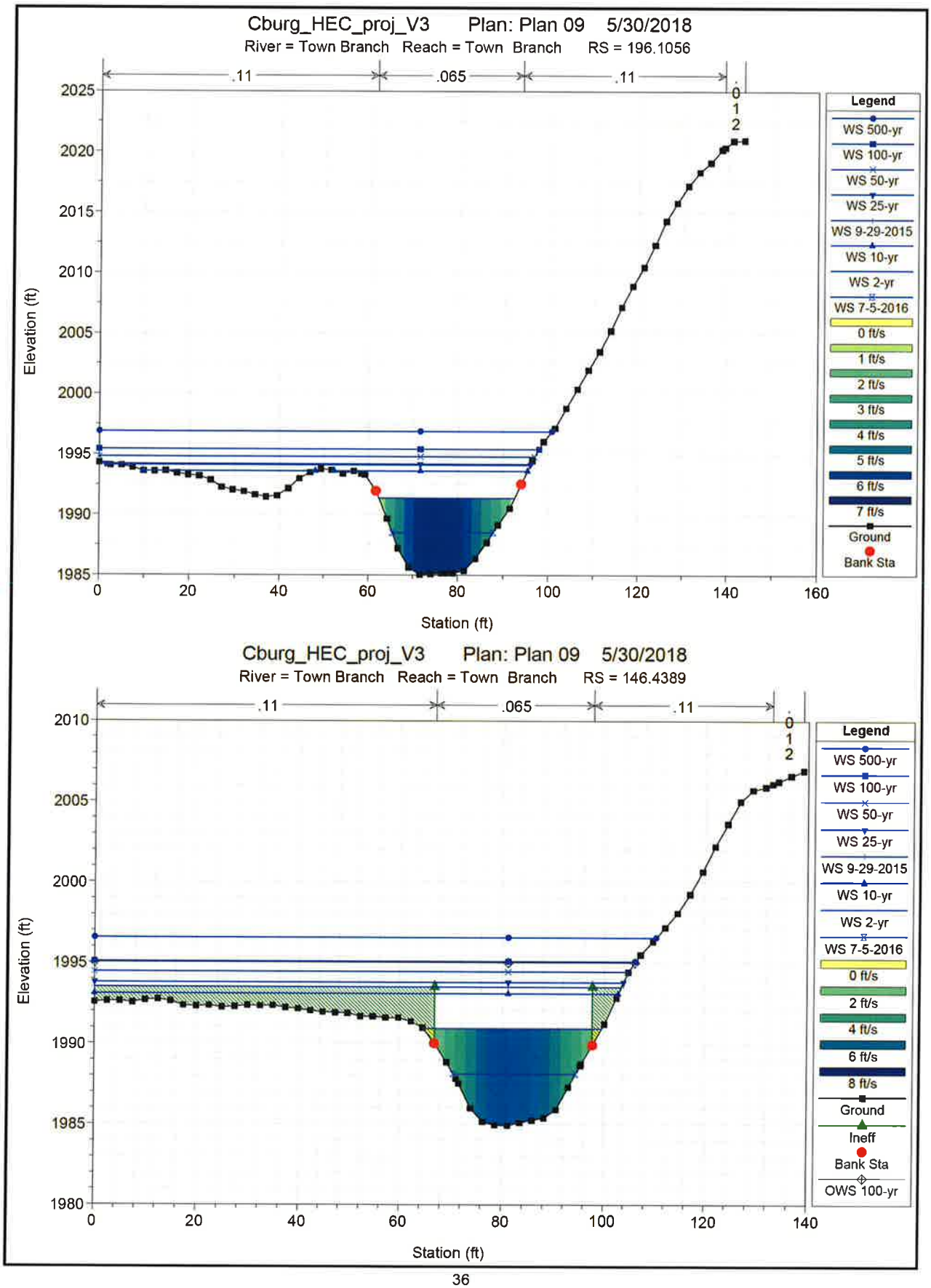
.11
.065
.11
.025
Legend
Elevation (ft)
Station (ft)


Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 293.9053
.11
.065
.11
.025
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 245.135
.11
.065
.11
.012
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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.065
.11
0
1
2
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Cburg_HEC_proj_V3 Plan: Plan 09 5/30/2018
River = Town Branch Reach = Town Branch RS = 146.4389
.11
.065
.11
Elevation (ft)
Station (ft)
Legend
WS 500-yr
WS 100-yr
WS 50-yr
WS 25-yr
WS 9-29-2015
WS 10-yr
WS 2-yr
WS 7-5-2016
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Ineff
Bank Sta
OWS 100-yr

RECORD DRAWING

RIPARIAN BUFFER RESTORATION AREA

LIMITS OF TREE SURVEY

MINOR BANK GRADING AND PLANTINGS

UTILIZE EXISTING BEDROCK AND CHANNEL ALIGNMENT

EX. STACKED STONE WALL (POSSIBLE MILL WORKS)

EX. STACKED STONE WALL

EX. RIPRAP

PRESERVE/ENHANCE EXISTING OXBOW WETLAND

CONSTRUCTION ACCESS VIA EXISTING GRAVEL PATH AT SKATE PARK

CHRISTIANSBURG SKATE PARK

STOCKPILE/ STAGING AREA

BANKFULL BENCH

TRIBUTARY STABILIZATION

CONSTRUCTION ACCESS ROAD

MODIFIED CROSS VANES

AIR TOPO BOUNDARY

ROSA PETERS PARK

CREATE OXBOW WETLAND

GRADE BANK AT 2.5:1 (MAX.) SLOPE.

BID ALTERNATIVE FOR LOWERING SANITARY SEWERS

PROPOSED TRAIL RELOCATION (MAX. SHIFT 4-FT)

PLAYGROUND

EX. ROCK MATTRESSES AND GABIONS

MINOR BANK GRADING AND PLANTINGS (STA: 10+00-14+30)

NORTH FRANKLIN STREET

SARA STREET NORTHWEST

WADES LANE NORTHWEST

MILL LANE NORTHEAST

HARLESS STREET NORTHEAST

DEPOT STREET NORTHEAST

SCHOOL LANE NORTHEAST

STONE STREET NORTHEAST

60 30 0 60 120 180

SCALE: 1"=60'

APPROVED BY:

ENGINEERING _____ DATE

PLANNING _____ DATE

Wetland Studies and Solutions, Inc.
A DAVEY company
5300 Wellington Branch Drive • Suite 100
Gainesville, Virginia 20155
Phone: 703-679-5600 • Fax: 703-679-5601
www.wetlandstudies.com

Towne Branch Stream Restoration
Final Design
Christiansburg, Virginia

Overall Site Exhibit

COMMONWEALTH OF VIRGINIA
NATHAN A. STALEY
Lic. No. 047145
PROFESSIONAL ENGINEER
9/14/2017

REVISIONS

No.	Date	Description	Rev. By	App. By

SCALE: 1"=60'

DATE: AUGUST 2017

Horizontal Datum: VCS NAD 83

Vertical Datum: NAVD 88

Boundary and Topo Source: WSSI and Town Digital Data

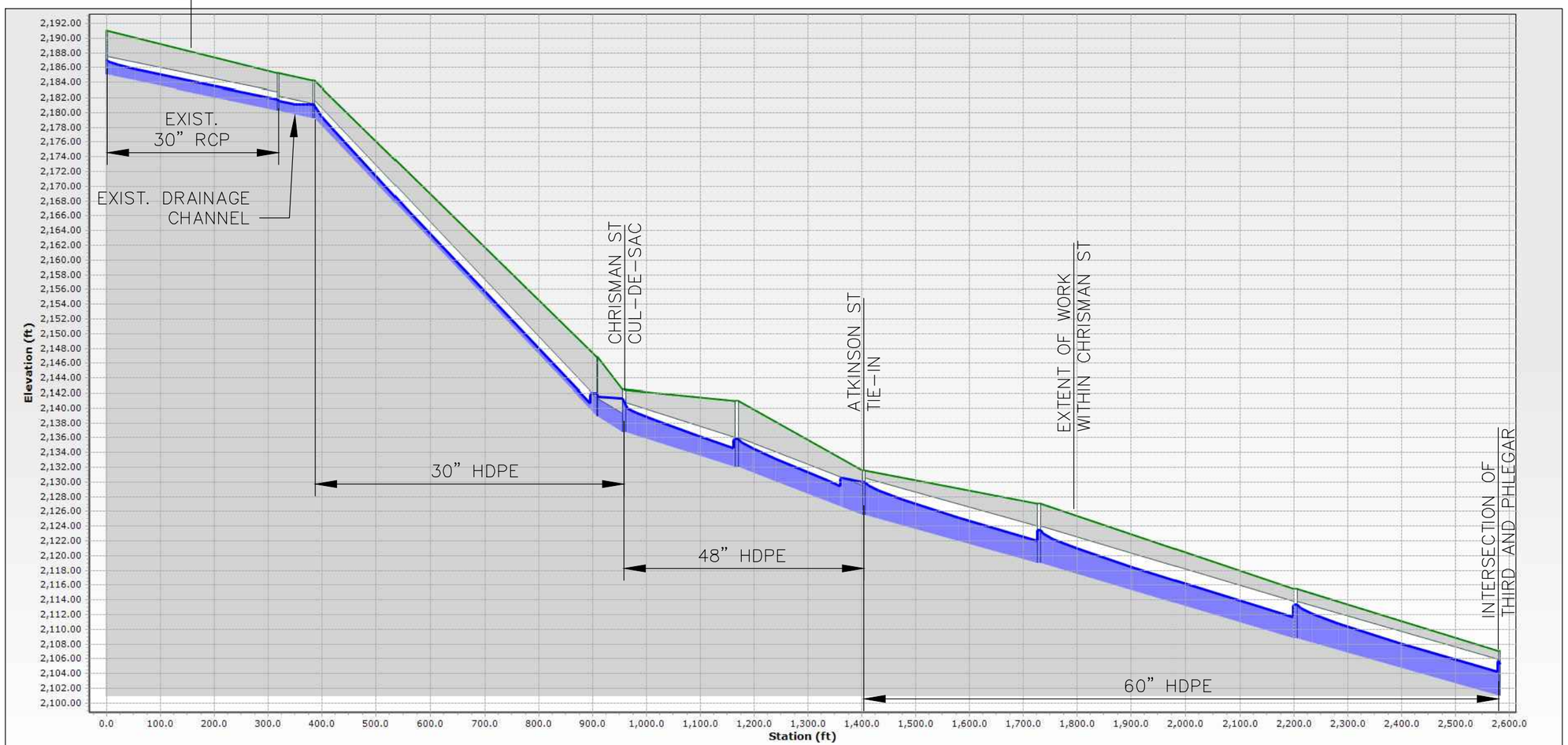
Design	Draft	Approved
NAS	NAS	FRG

Sheet # 2 of 31

Computer File Name:

APPENDIX G

Storm Drain Analysis



A. MORTON THOMAS AND ASSOCIATES, INC.
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REVISIONS

MARK	DATE	DESCRIPTION

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

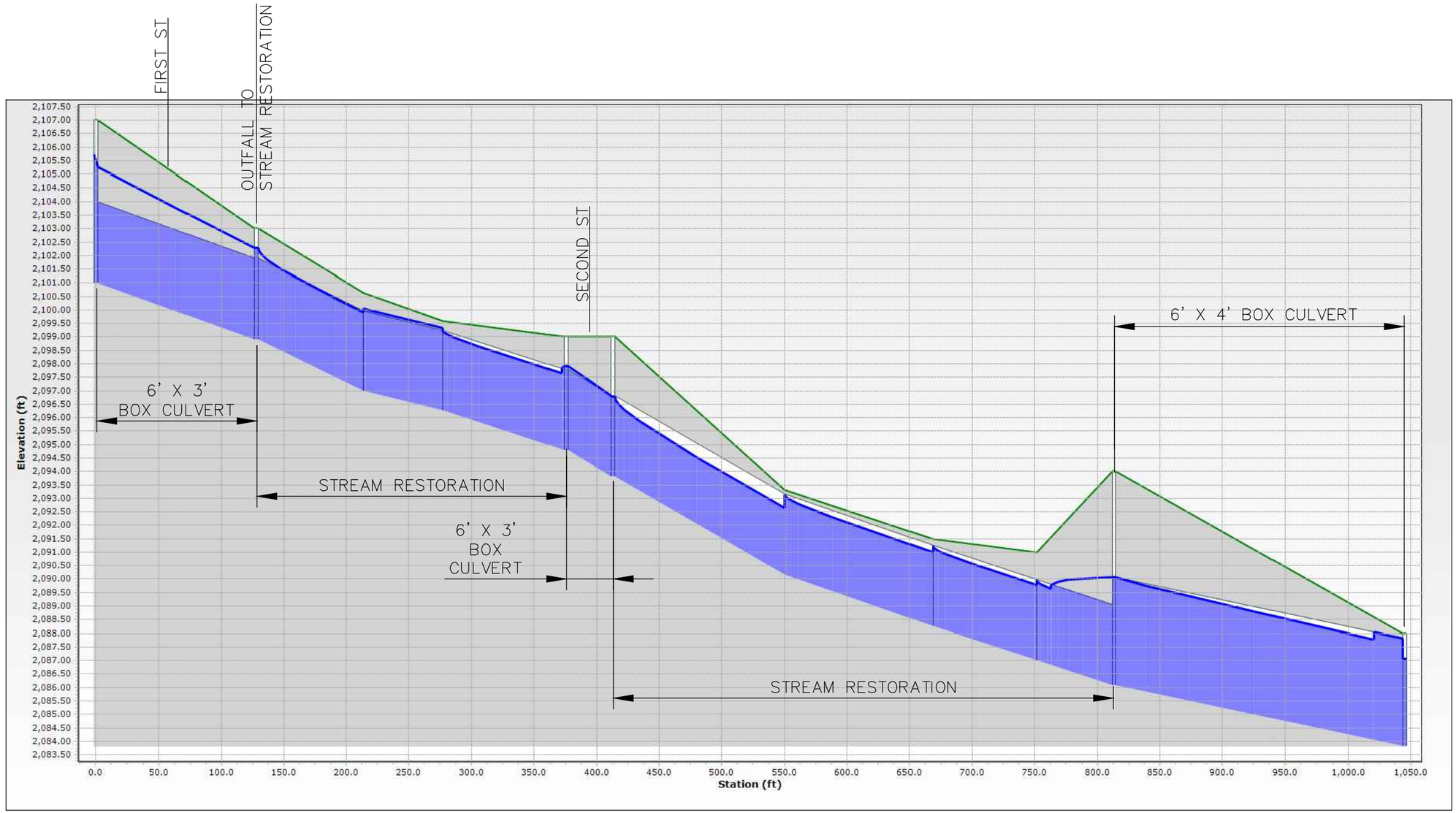
AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	N/A
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

PR-1

SHEET 1 OF 8

CHRISMAN STREET / PHLEGAR STREET
DRAINAGE IMPROVEMENTS PHASE I



CHRISMAN STREET /
PHLEGAR STREET DRAINAGE
IMPROVEMENTS PHASE II

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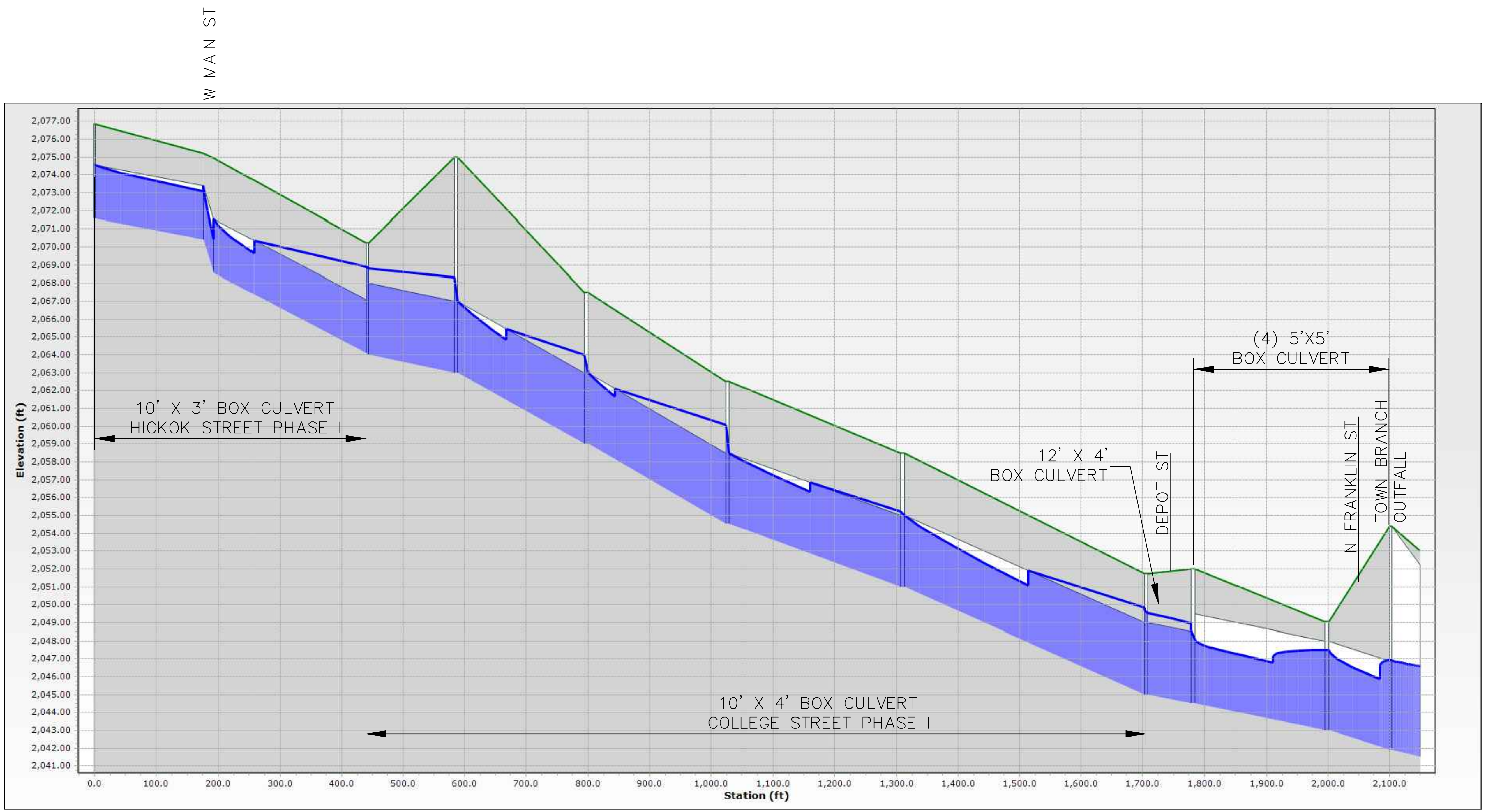
MARK	DATE	DESCRIPTION

CHRISTIANSBURG WATERSHED STUDY
TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	N/A
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET
PR-2
SHEET 2 OF 8



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CHRISTIANSBURG WATERSHED STUDY

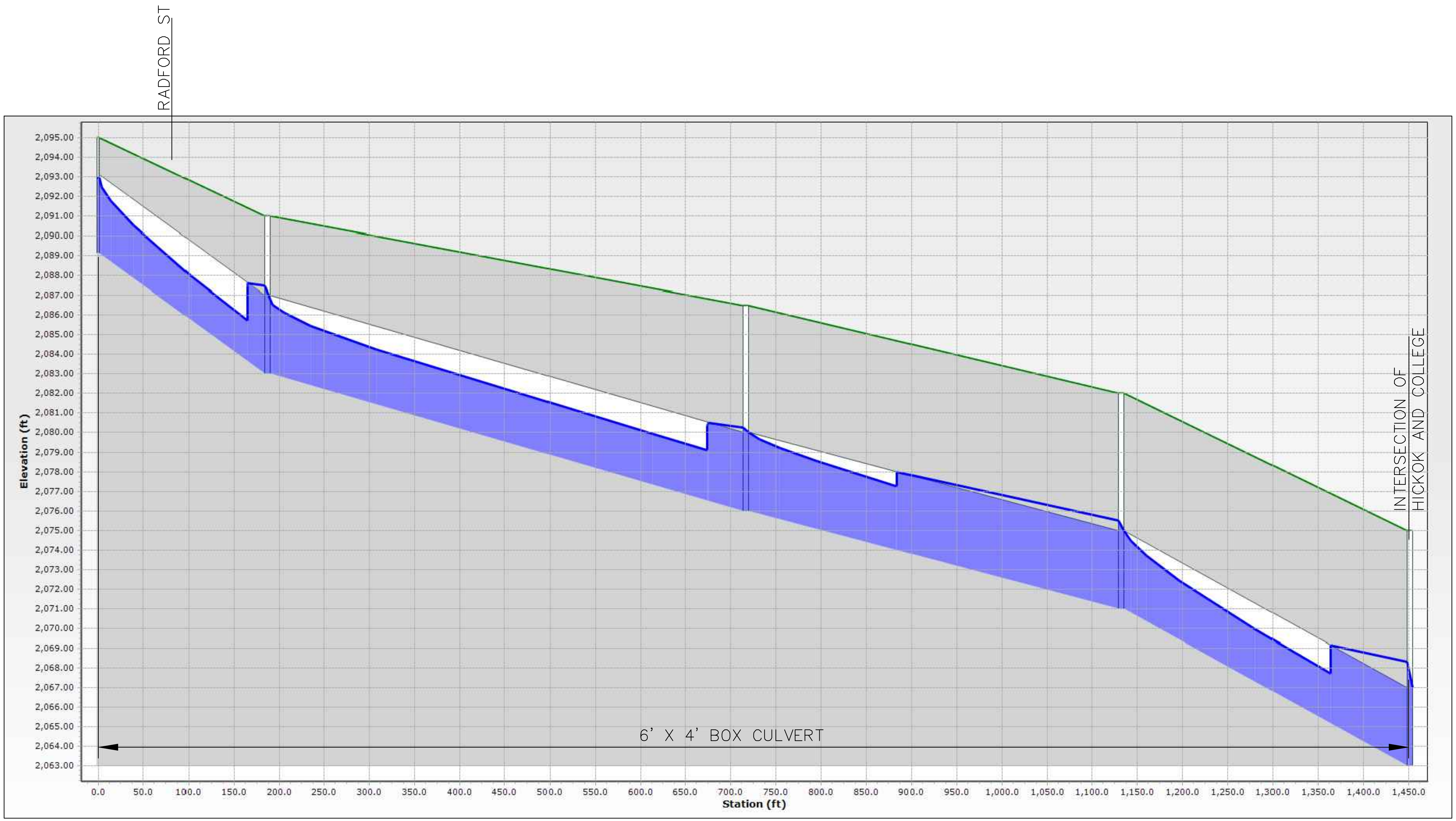
TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	N/A
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

COLLEGE STREET PHASE I/
HICKOK STREET PHASE I
DRAINAGE IMPROVEMENTS

SHEET
PR-3

SHEET 3 OF 8



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REVISIONS		
MARK	DATE	DESCRIPTION

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

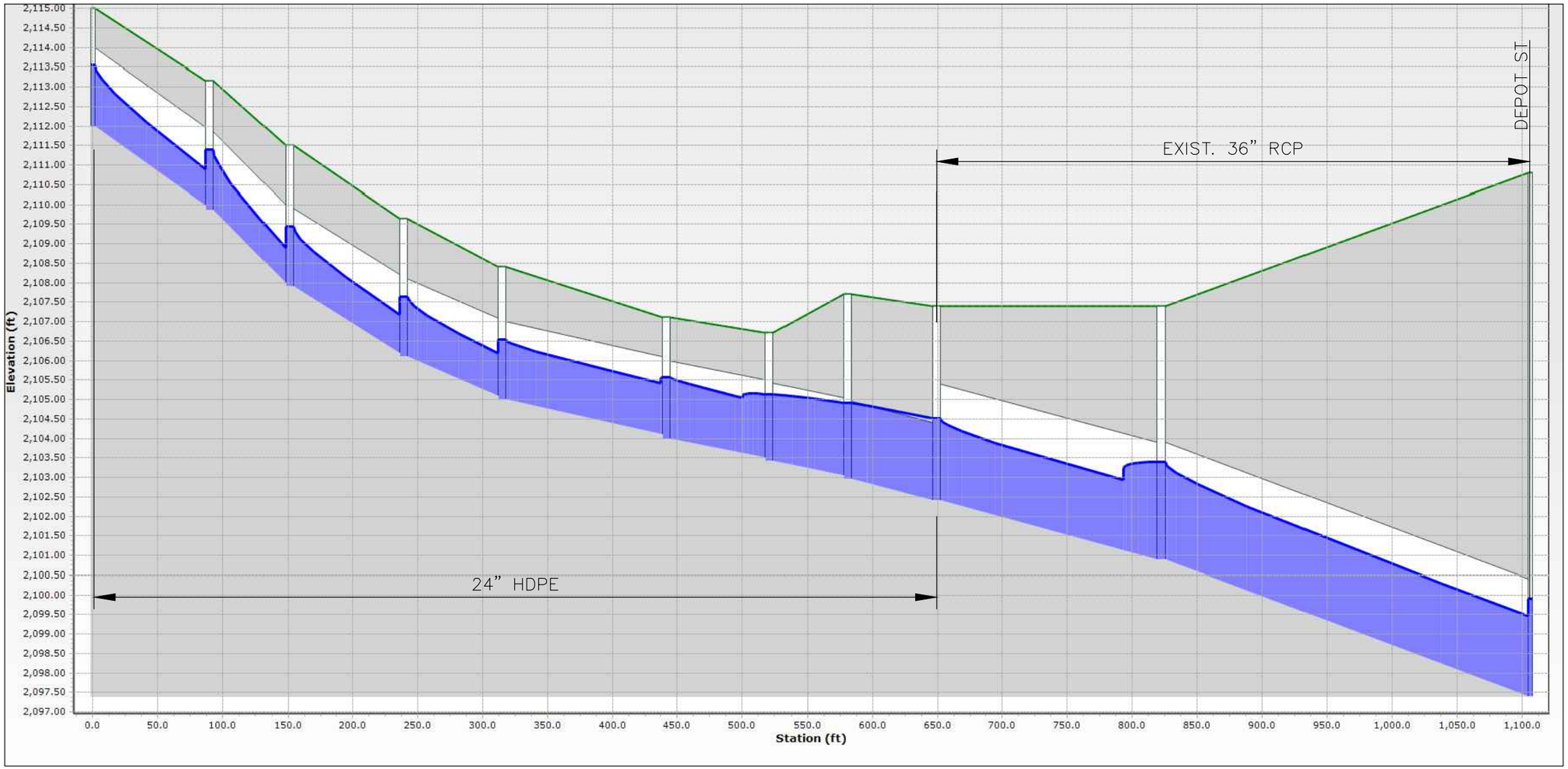
AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	N/A
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

PR-4

SHEET 4 OF 8

COLLEGE STREET PHASE II
DRAINAGE IMPROVEMENTS



RADFORD STREET
DRAINAGE IMPROVEMENTS

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ENGINEERING SURVEYING
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WWW.AMTPAVEPRO.COM

REVISIONS

MARK	DATE	DESCRIPTION

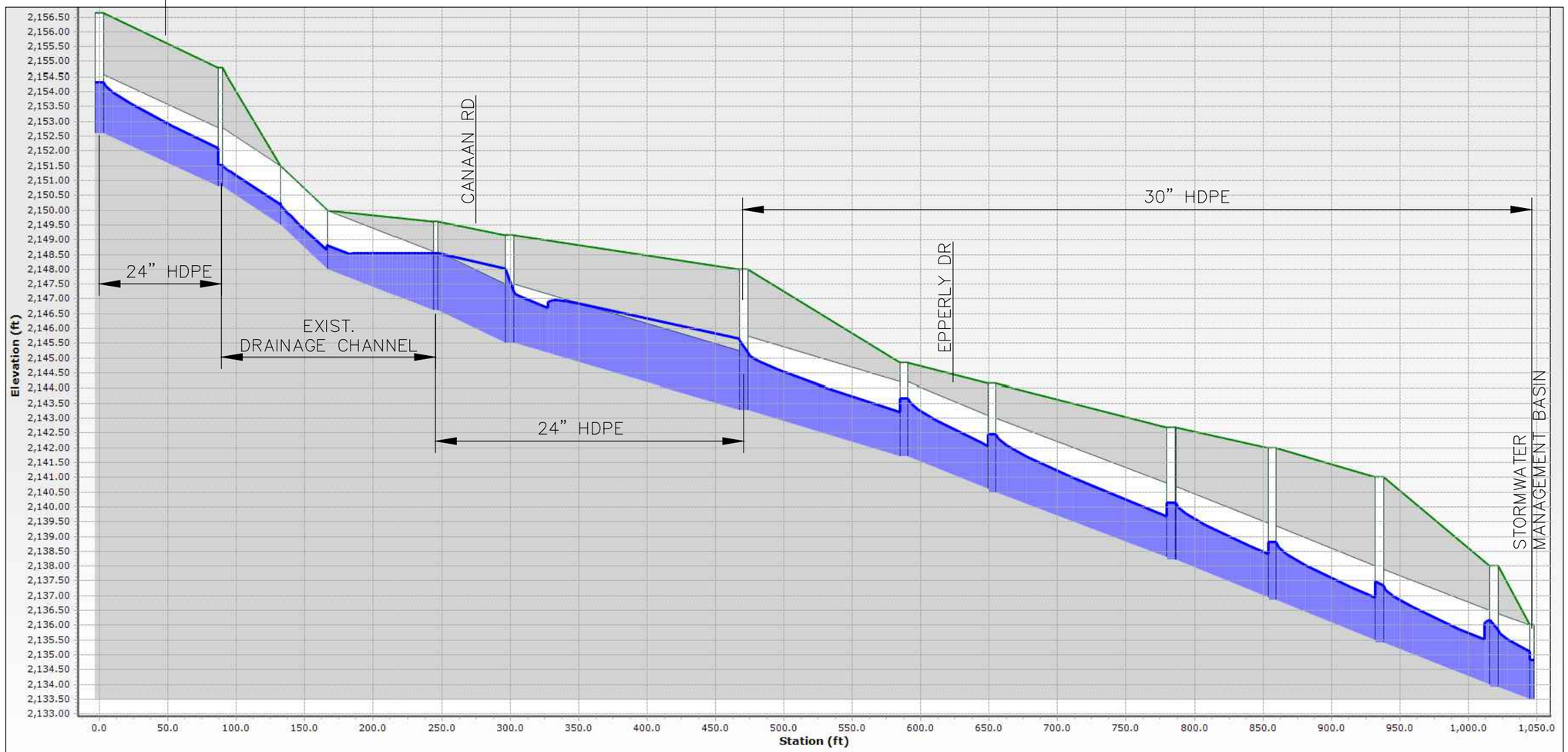
CHRISTIANSBURG WATERSHED STUDY
TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	N/A
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

PR-5

SHEET 5 OF 8



ALLEGHANY STREET /
CANAAN ROAD /
EPPERLY DRIVE
DRAINAGE IMPROVEMENTS

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CONSULTING ENGINEERS
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WWW.AMTPEGAVEPRO.COM

REVISIONS

MARK	DATE	DESCRIPTION

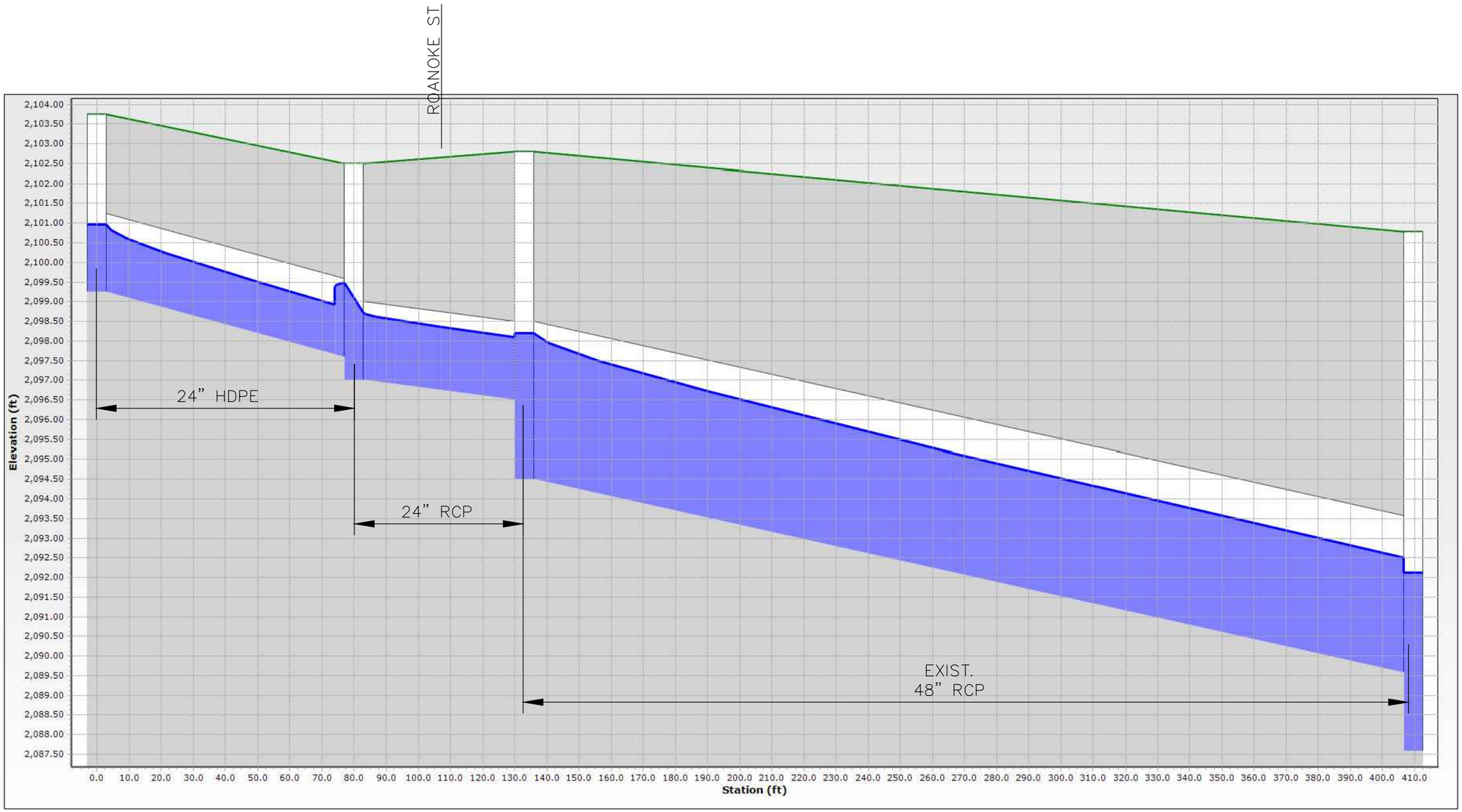
CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	N/A
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

PR-6



ROANOKE STREET
DRAINAGE IMPROVEMENTS

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ENGINEERING SURVEYING
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REVISIONS

MARK	DATE	DESCRIPTION

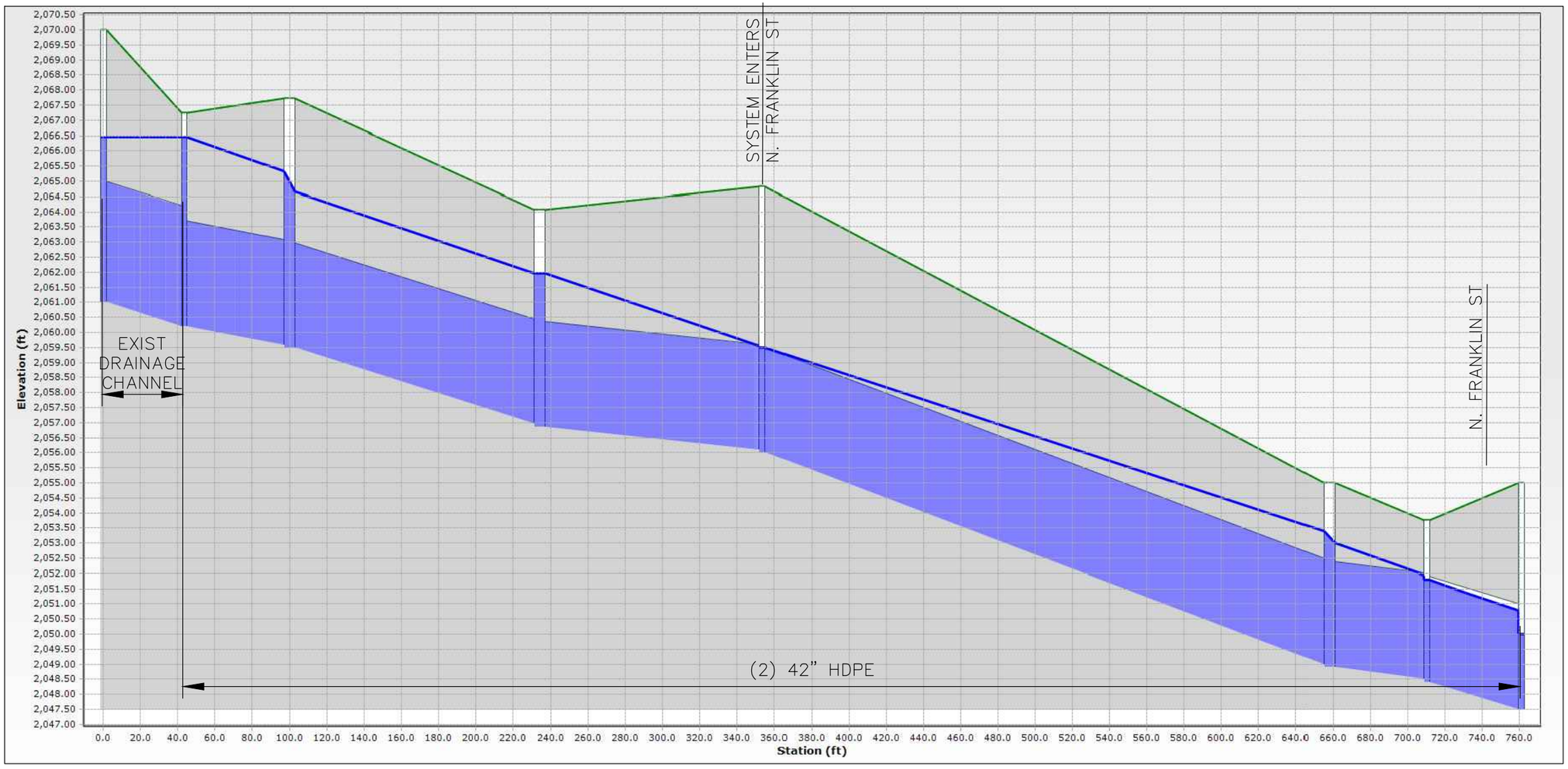
CHRISTIANSBURG
WATERSHED STUDY
TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	N/A
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

PR-7

SHEET 7 OF 8



NORTH FRANKLIN STREET
DRAINAGE IMPROVEMENTS

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ENGINEERING SURVEYING
CHRISTIANSBURG, VIRGINIA 24073
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MARK	DATE	DESCRIPTION

CHRISTIANSBURG WATERSHED STUDY
TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	N/A
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

PR-8

SHEET 8 OF 8

APPENDIX H

Conceptual Improvement Plans

A. MORTON THOMAS AND ASSOCIATES, INC.
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105 ARBOR DRIVE, SUITE 200
CHRISTIANSBURG, VIRGINIA 24073
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REVISIONS		
MARK	DATE	DESCRIPTION

EXISTING CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	E-1

SHEET 2 OF 15

AMT
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CONSULTING ENGINEERS
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CHRISTIANSBURG, VIRGINIA 24073

REVISIONS		
MARK	DATE	DESCRIPTION

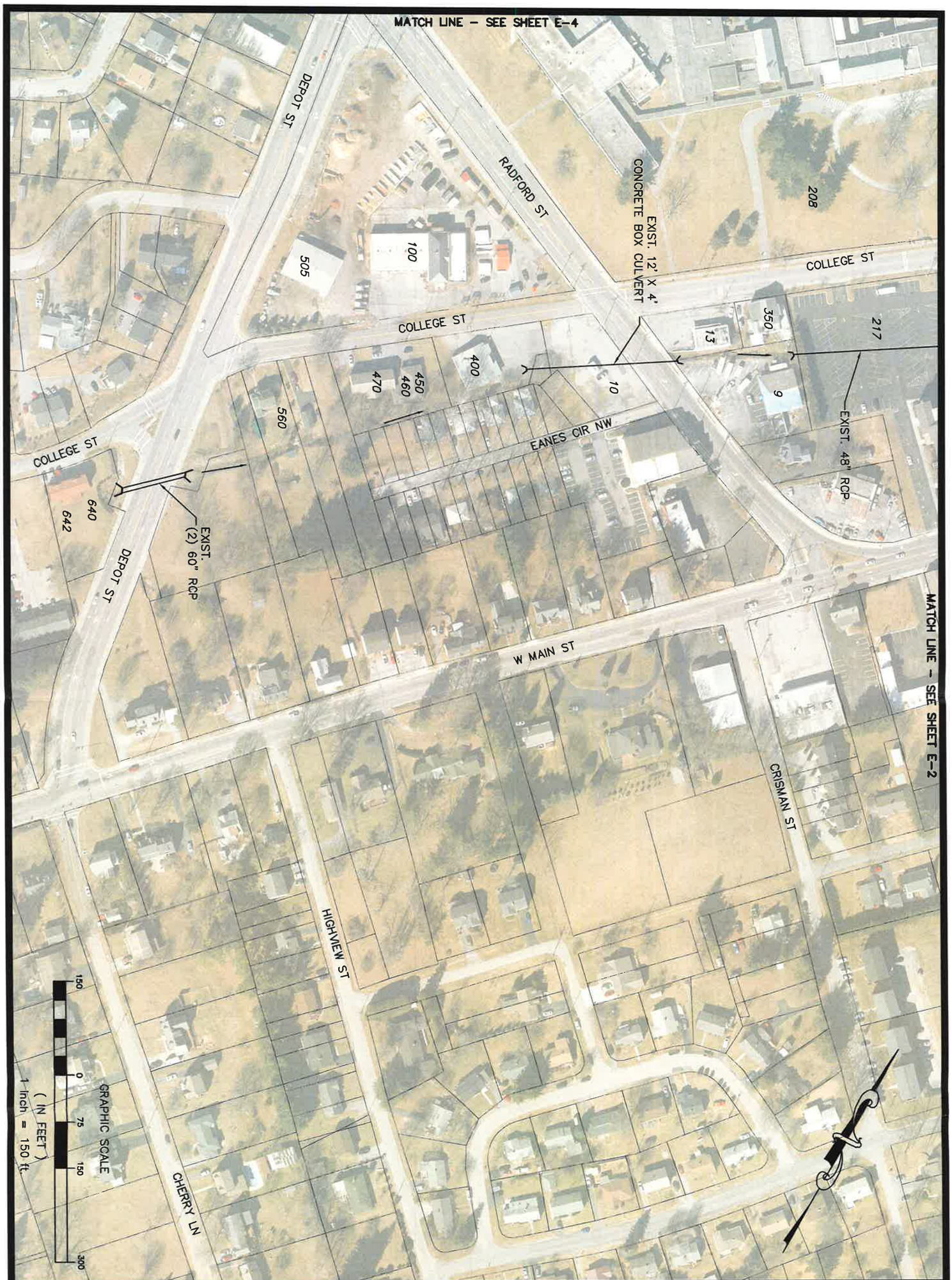
EXISTING CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	E-2

SHEET 3 OF 15



EXISTING CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

REVISIONS		
MARK	DATE	DESCRIPTION

A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS
105 ARBOR DRIVE, SUITE 200
CHRISTIANSBURG, VIRGINIA 24073
(540) 251-5134 FAX: (540) 251-5135
WWW.AMTENGINEERING.COM

AMT FILE NO. 17-0626.001
DATE: 4-3-18
SCALE: 1"=150'
DESIGNED BY: MH/EC
DRAWN BY: MH/EC
CHECKED BY: DJR

SHEET E-3

AMT
A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS

REVISIONS		
MARK	DATE	DESCRIPTION

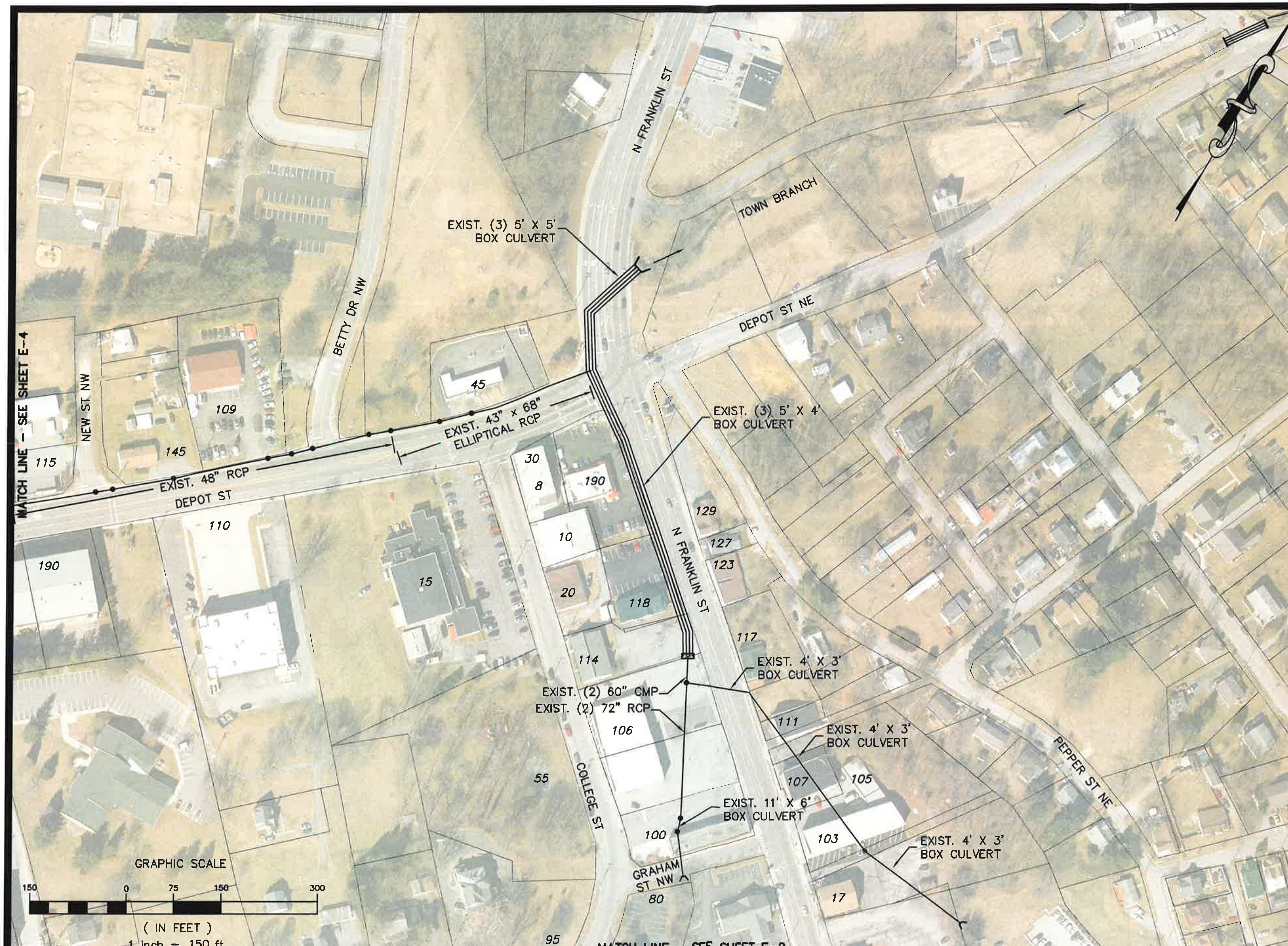
EXISTING CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	E-4

SHEET 5 OF 15



AMT
A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS

MARK	DATE	DESCRIPTION
REVISIONS		

EXISTING CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	E-5
SHEET 6 OF 15	

A. MORTON THOMAS AND ASSOCIATES, INC.

MARK	DATE	REVISIONS DESCRIPTION

EXISTING CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=100'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	E-6

SHEET 7 OF 15

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CHRISTIANSBURG, VIRGINIA 24073
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REVISIONS		
MARK	DATE	DESCRIPTION

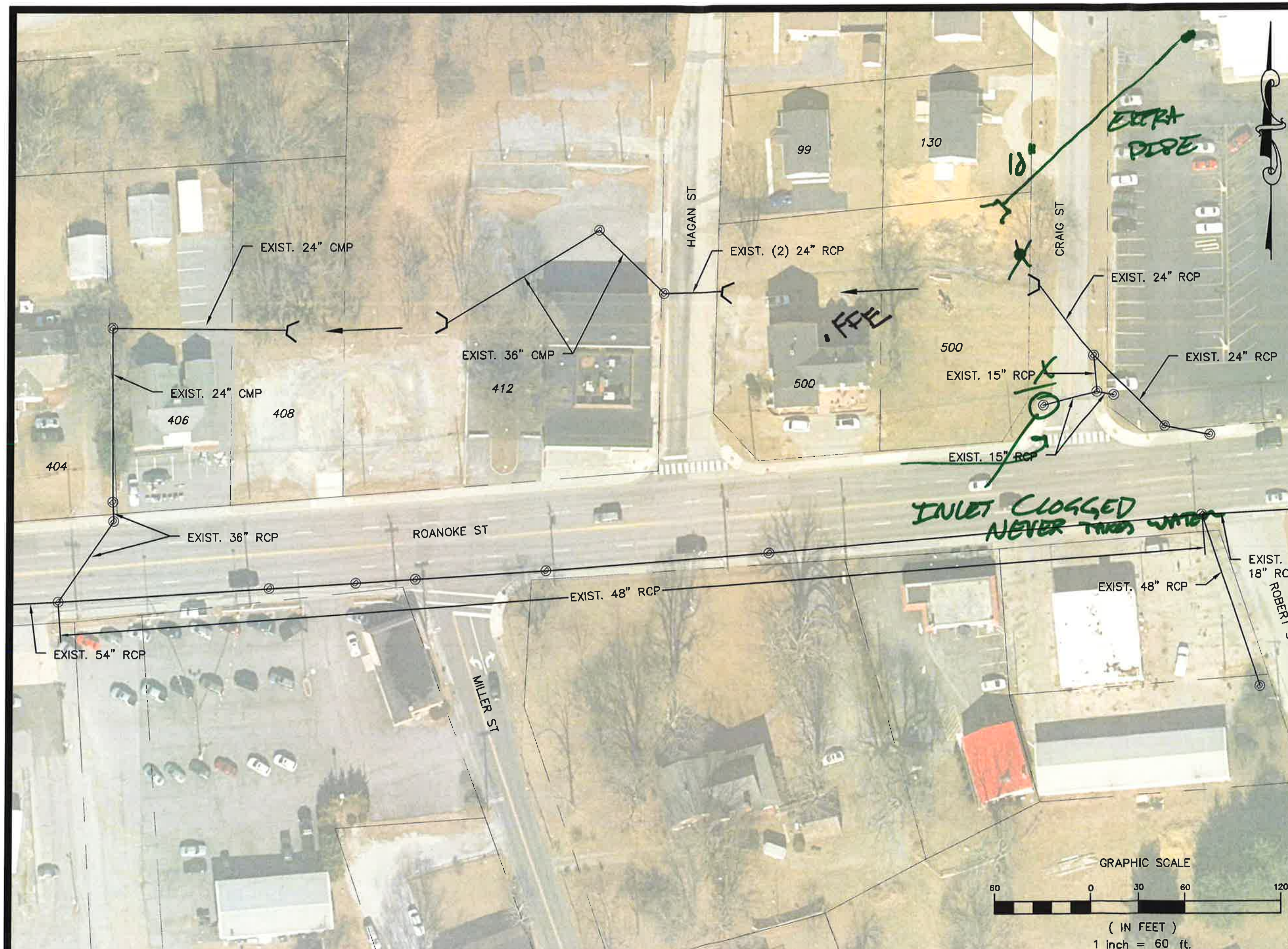
EXISTING CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=50'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	E-7

SHEET 8 OF 15



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REVISIONS		
MARK	DATE	DESCRIPTION

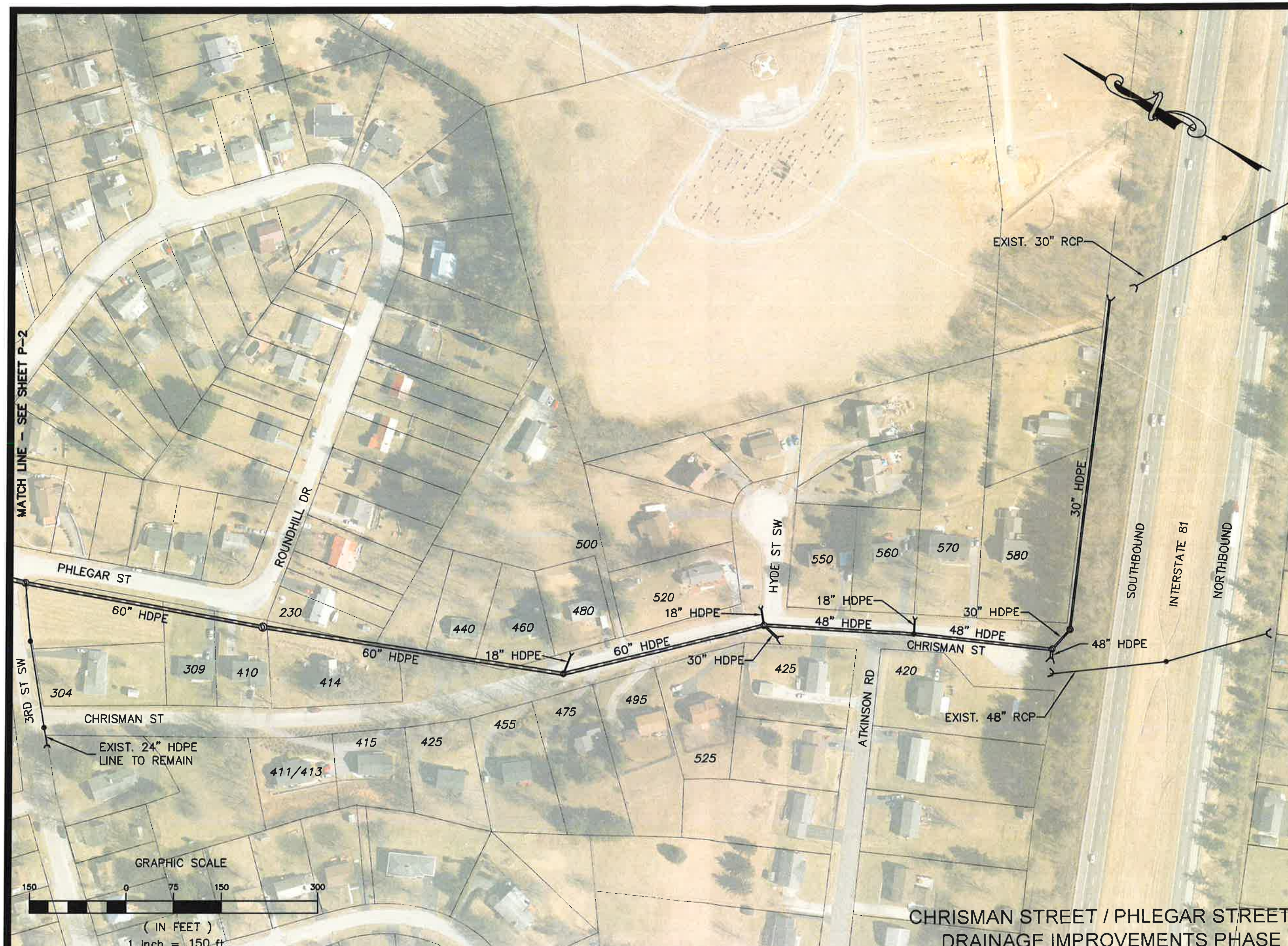
EXISTING CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=60'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	E-8

SHEET 9 OF 17



MATCH LINE - SEE SHEET P-2
EXIST. 30" RCP
30" HDPE
500
550
560
570
580
520
480
460
440
230
PHLEGAR ST
ROUNDHILL DR
HYDE ST SW
SOUTHBOUND
INTERSTATE 81
NORTHBOUND
60" HDPE
60" HDPE
60" HDPE
18" HDPE
18" HDPE
18" HDPE
48" HDPE
48" HDPE
30" HDPE
30" HDPE
48" HDPE
CHRISMAN ST
3RD ST SW
304
309
410
414
425
420
ATKINSON RD
495
475
455
CHRISMAN ST
415
425
411/413
525
EXIST. 48" RCP
EXIST. 24" HDPE LINE TO REMAIN
GRAPHIC SCALE
150
0
75
150
300
(IN FEET)
1 inch = 150 ft.

CHRISMAN STREET / PHLEGAR STREET
DRAINAGE IMPROVEMENTS PHASE I

AMT
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CHRISTIANSBURG, VIRGINIA 24073
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REVISIONS		
MARK	DATE	DESCRIPTION

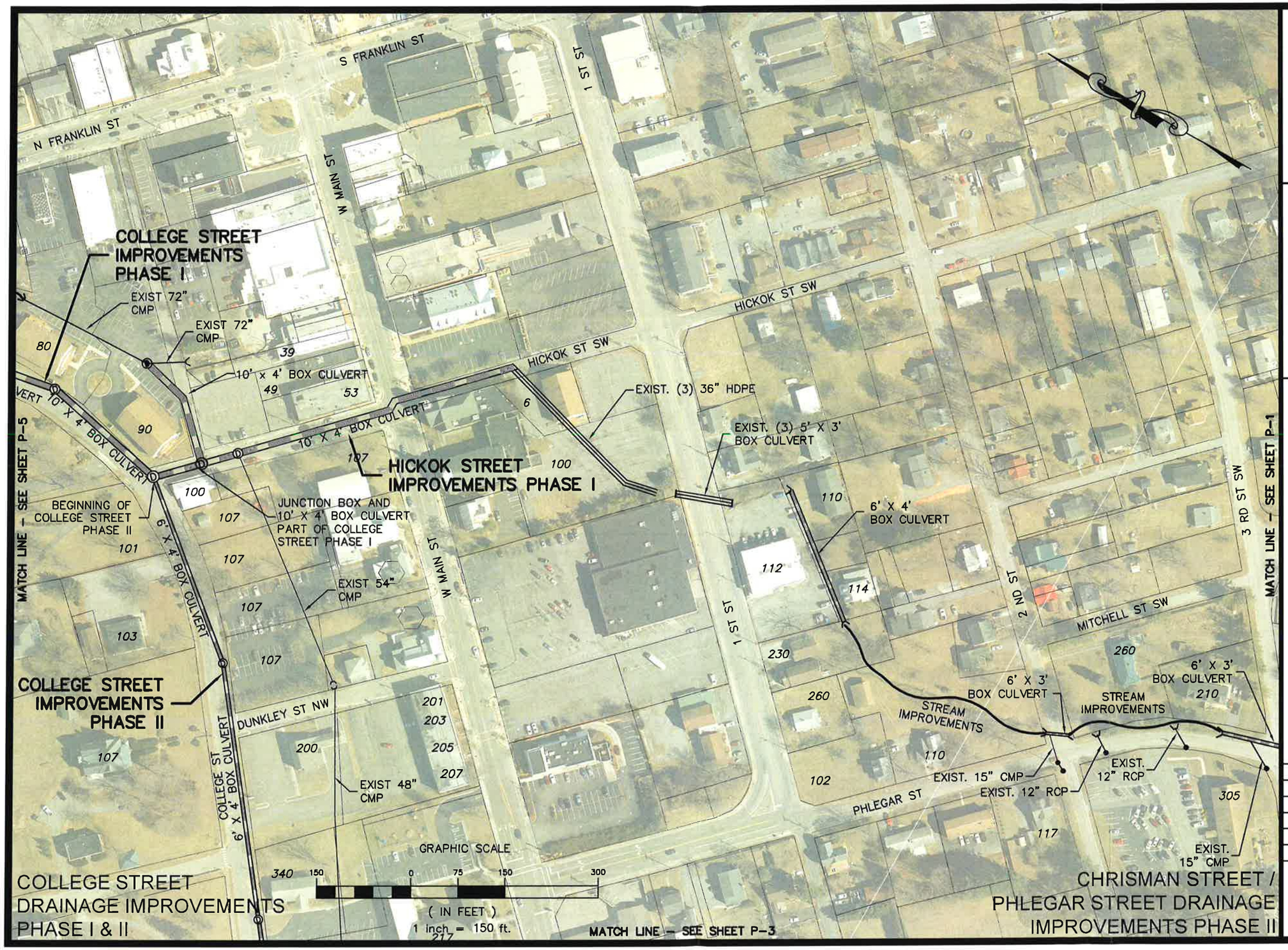
PROPOSED CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	P-1

SHEET 10 OF 17



A. MORTON THOMAS AND ASSOCIATES, INC.
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105 ARROWHEAD E., SUITE 206
CHRISTIANSBURG, VIRGINIA 24073
PHONE: (540) 381-2747
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REVISIONS

MARK	DATE	DESCRIPTION

PROPOSED CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

P-2

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MARK	DATE	DESCRIPTION

PROPOSED CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

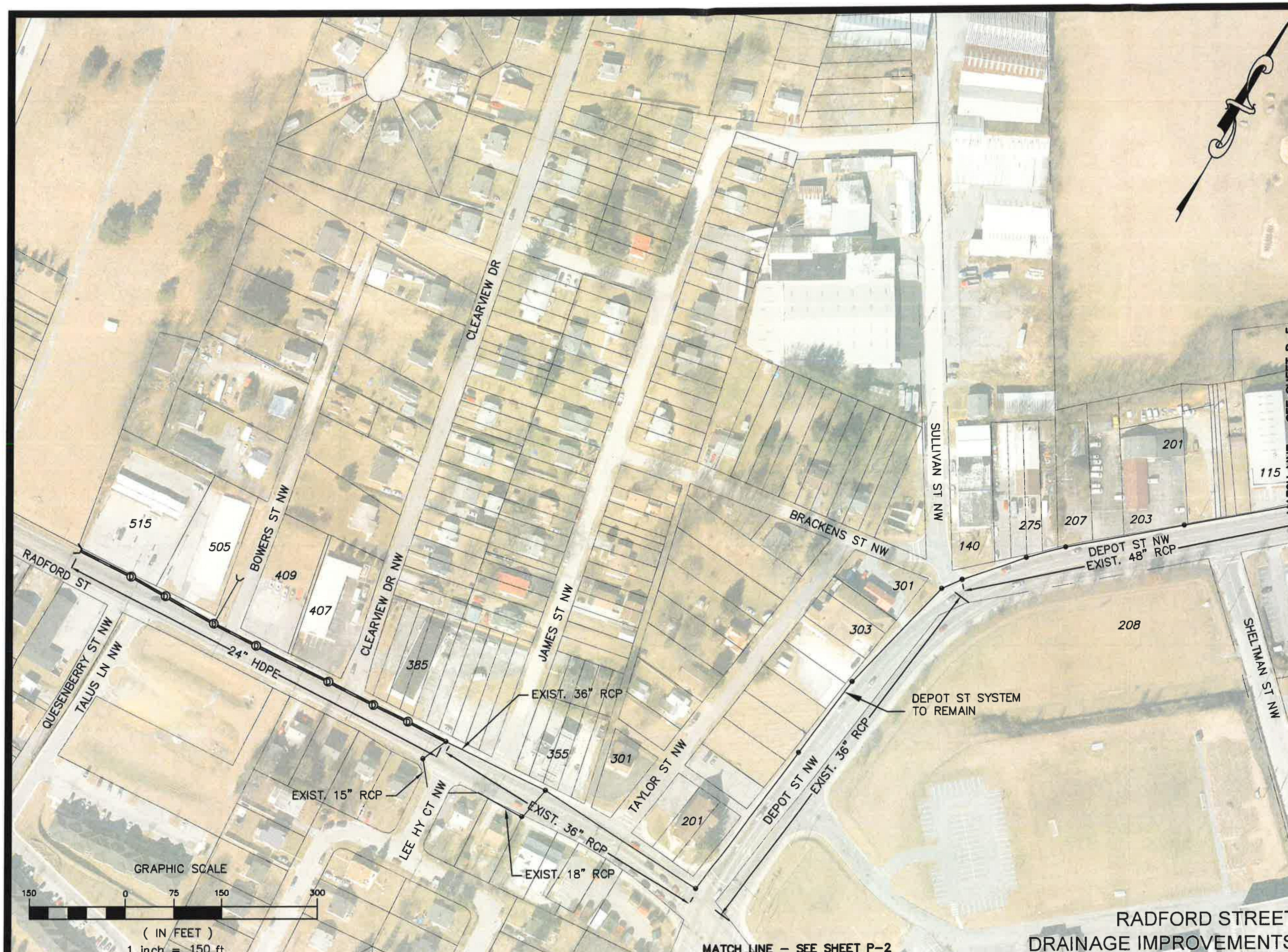
TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

P-3

SHEET 12 OF 17



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CONSULTING ENGINEERS

MARK	DATE	DESCRIPTION
REVISIONS		

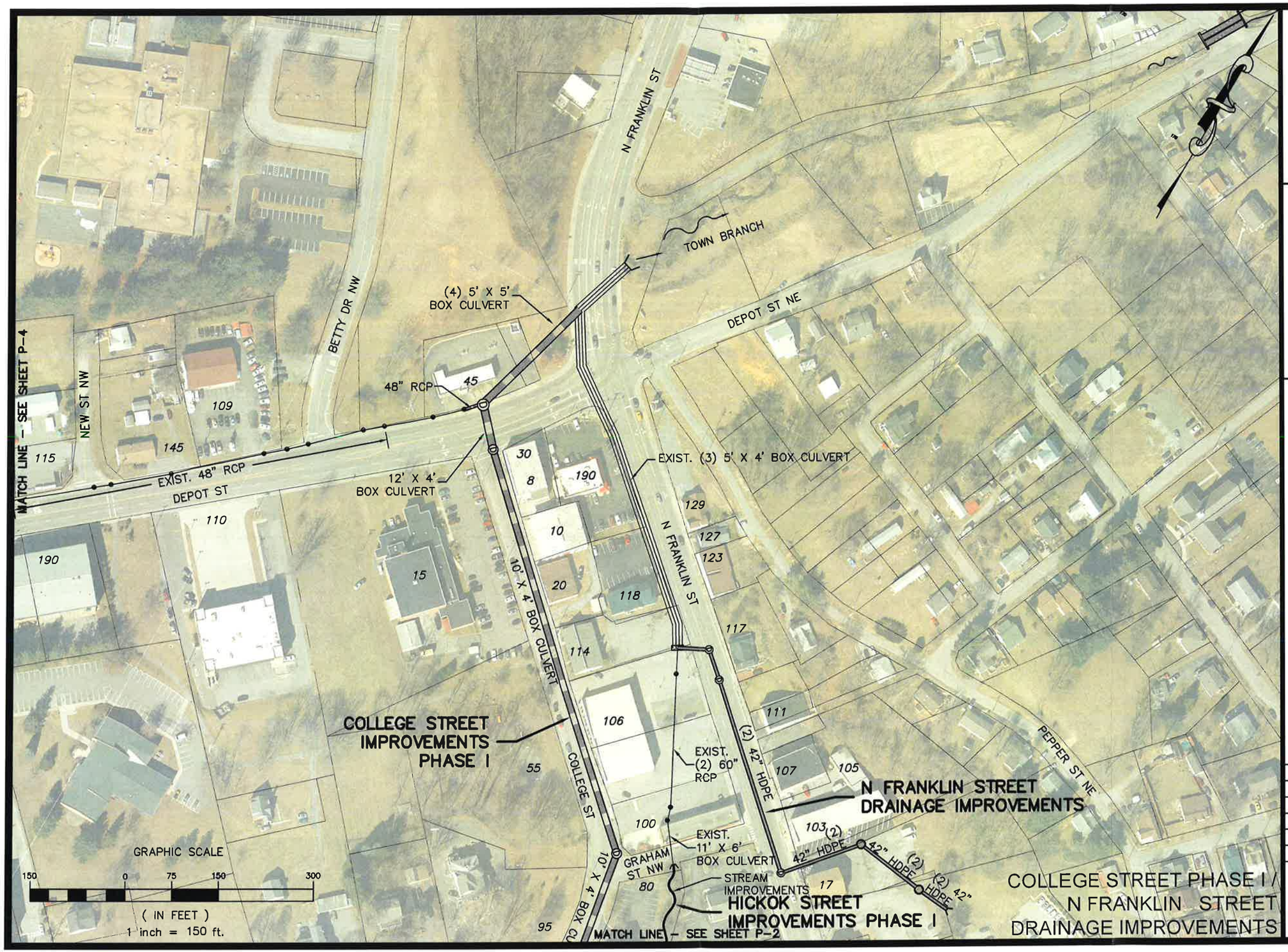
PROPOSED CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	P-4

SHEET 13 OF 17



A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS
107 ARBOR DRIVE, SUITE 200
CHRISTIANSBURG, VIRGINIA 24073
(540) 251-5140 FAX (540) 251-5151
WWW.AMTENGINEERING.COM

REVISIONS

MARK	DATE	DESCRIPTION

PROPOSED CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=150'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR

SHEET

P-5

SHEET 14 OF 17

ALLEGHANY STREET /
CANAAN ROAD /
EPPERLY DRIVE
DRAINAGE IMPROVEMENTS

AMT
A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS

MARK	DATE	DESCRIPTION
REVISIONS		

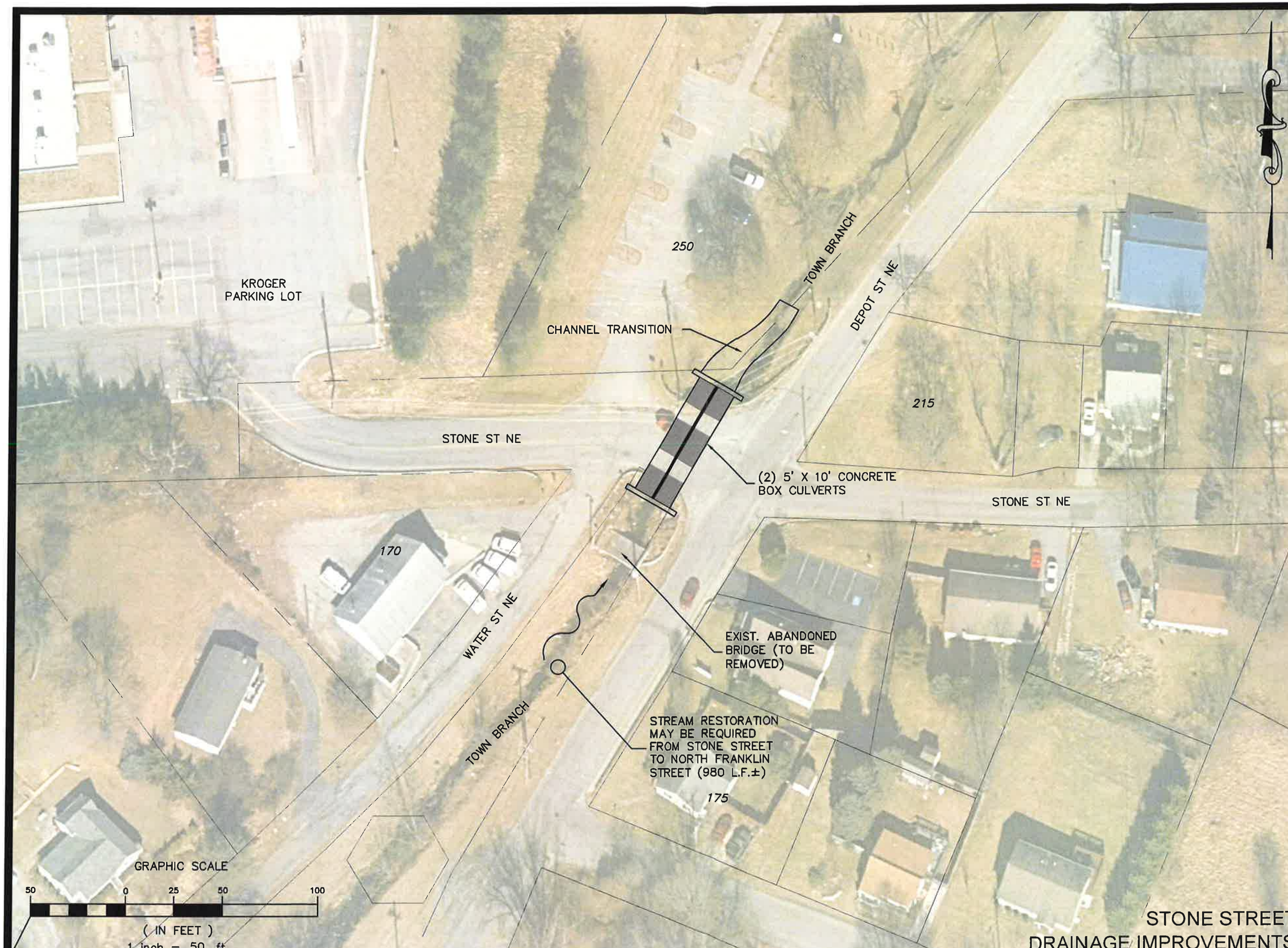
PROPOSED CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=100'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	P-6

SHEET 15 OF 17



STONE STREET DRAINAGE IMPROVEMENTS

AMT

A. MORTON THOMAS AND ASSOCIATES, INC.

REVISIONS		
MARK	DATE	DESCRIPTION

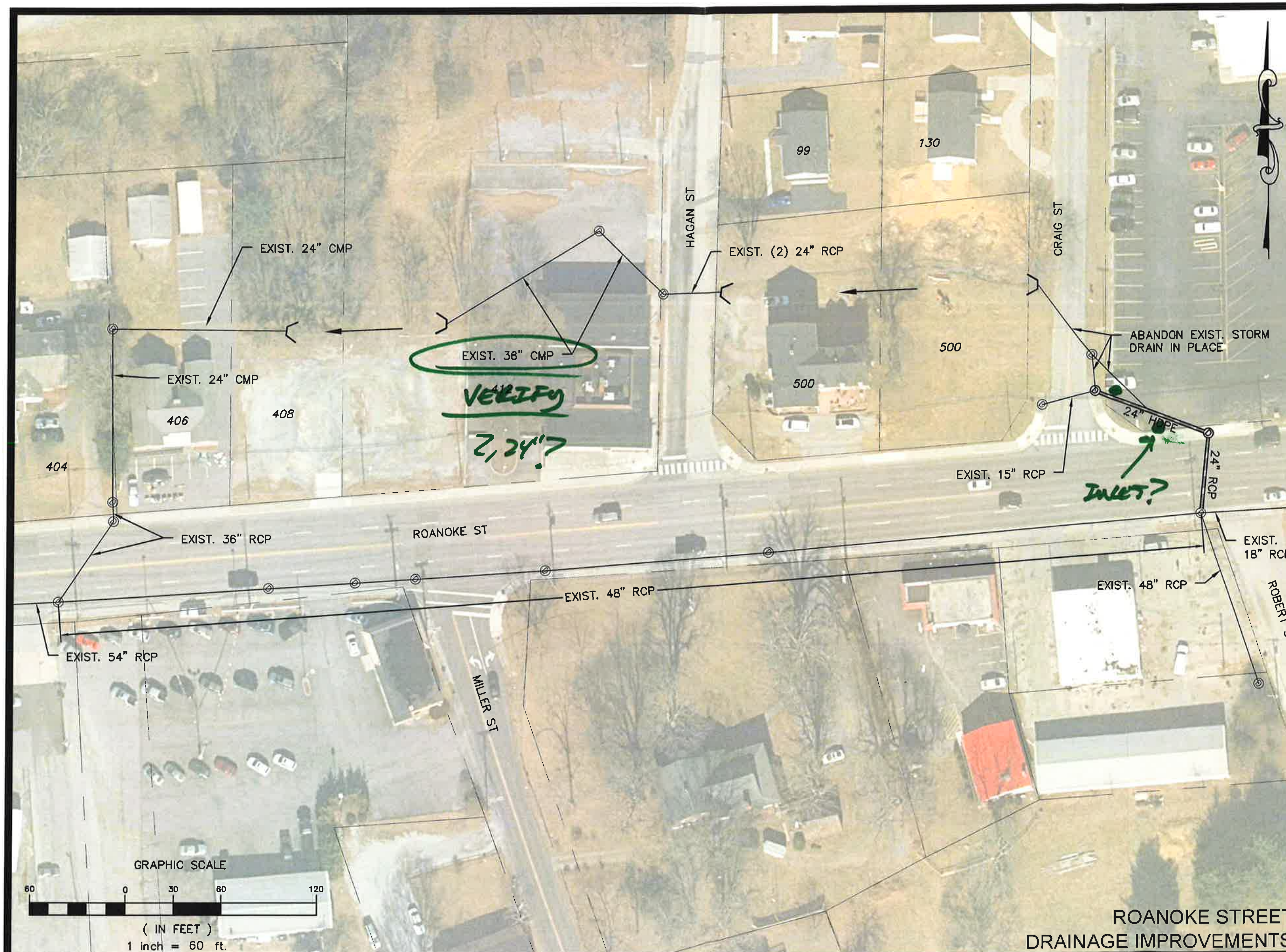
PROPOSED CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=50'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	P-7

SHEET 16 OF 17



ROANOKE STREET DRAINAGE IMPROVEMENTS

AMT

A. MORTON THOMAS AND ASSOCIATES, INC.

REVISIONS

MARK	DATE	DESCRIPTION

PROPOSED CONDITIONS

CHRISTIANSBURG WATERSHED STUDY

TOWN OF CHRISTIANSBURG, VA

AMT FILE NO.	17-0626.001
DATE:	4-3-18
SCALE:	1"=60'
DESIGNED BY:	MH/EC
DRAWN BY:	MH/EC
CHECKED BY:	DJR
SHEET	P-8

SHEET 17 OF 17

APPENDIX I

Cost Estimate / Ranking Criteria

Town of Christiansburg - Downtown Watershed Study

CIP Project Descriptions

ID	Project Name	Budget	Description
1	Chrisman / Phlegar Street Drainage Improvements: Phase I	$2,800,000	This project collects runoff from existing 30" RCP and 48" RCP pipes under Interstate 81, and conveys the runoff in a closed drainage system along Chrisman Street, then crossing over to Phlegar Street following the alignment of the existing pipes. Recommended pipe sizes increase from 36" initially, to between 48" and 60" in diameter at 3rd Street SW.
2	Chrisman / Phlegar Street Drainage Improvements: Phase II	$1,300,000	Starting at the intersection of Phlegar Street and 3rd Street SW, this project is a series of small box culverts and open channels that convey runoff from the upper watershed to an existing triple 5'x3' box culvert under 1st Street. The channel alignment requires easements across some private properties, and may include stream stabilization measures.
3	Hickok Street Drainage Improvements: Phase I	$2,700,000	This project conveys runoff in a proposed 10'x4' box culvert under Hickok Street SW to the intersection with Commerce Street, removing a section of drainage conveyance that goes under the existing buildings on West Main Street. Runoff is conveyed either north along Commerce Street to a connection with the existing 72" CMP or west along Hickok Street to College Street, where it connects to the College Street Drainage Improvements (Phase I).
4	College Street Drainage Improvements: Phase I	$4,250,000	This project improves drainage by connecting the Hickok Street Drainage Improvement to a proposed 10'x4' box culvert under College Street, which conveys runoff to Depot Street. At Depot Street, a 12'x4' box culvert connects to a recommended quadruple 5'x5' box culvert for the last section of piping, to the outfall into Town Branch. This improvement also requires a connection to the 48" RCP in Depot Street and the Triple 5'x4' box culvert in North Franklin Street, as parallel drainage systems.
5	College Street Drainage Improvements: Phase II	$2,750,000	This project improves drainage, starting with known flooding concerns at the intersection of College Street / Radford Street, and running along College Street in a 6'x4' box culvert. At Hickok Street, the 6'x4' box culvert combines with the runoff from the Hickok Street Drainage Improvement, to be conveyed downstream under College Street (Phase I).
6	North Franklin Street Drainage Improvements	$1,500,000	This project is currently being designed for the Town, using VDOT revenue sharing funds. It requires a combination of 42" and 60" pipes to collect runoff from below the parking lots at Town Hall, and improves conveyance of this runoff to the outfall at Town Branch. It also eliminates a section of existing storm drain that is going under some buildings on North Franklin Street.
7	Radford Street Drainage Improvements	$1,100,000	This project is smaller than some others in the downtown area, and addresses clogged inlets and undersized pipes along the north side of Radford Street. By increasing the pipe size from 15" to 24" and adding adequately sized throat lengths on the drainage inlets, runoff can be intercepted and conveyed into the existing 36" RCP at Lee Hy Court, then draining along Radford Street to Depot Street and into the downtown area. New sidewalks may also be considered for this area.
8	Alleghany St / Canaan Rd / Epperly Drive: Drainage Improvements	$750,000	This project helps address surface water and groundwater concerns from the Sunset Cemetery and Alleghany Street in areas along Canaan Road and Epperly Drive, by replacing existing 15" pipes with 24" and 30" pipes. Runoff is then conveyed into the rear yards on the south side of Epperly Drive, behind the First Church of God, with a pipe extension to an existing stormwater management basin (dry detention). During engineering design, the Town may choose to retrofit the existing basin to help proect existing drainage systems downstream and to promote improved water quality in the watershed.
9	Stone Street Culvert Replacement at Town Branch	$640,000	This project replaces an existing quadruple 48" CMP with a dual 10'x5' box culvert, providing increased capacity to convey the 2-year storm under Stone Street without overtopping onto Depot Street. 10-year and 100-year flood depths are reduced with this culvert replacement. Possible impacts of the larger pipes on the stream restoration project in Depot Park will need to be evaluated, as well as the flood reduction benefits of eliminating the abandoned bridge near Stone Street. Enhanced water quality can also be considered with this project, by developing a stream restoration project from Stone Street to North Franklin Street, creating a linear park or greenway concept.
10	Roanoke Street Drainage Improvements	$210,000	This project begins at an existing curb inlet near Wade's Foods which has a small diameter pipe draining to Craig Street. The recommendation is to eliminate runoff from Craig Street into the open channel behind 500 Roanoke Street by installing a storm drain system that conveys runoff from the Wade's Foods parking lot and Craig Street to Roanoke Street, where it ties into the existing storm drain system.

CHRISMAN STREET/PHLEGAR STREET DRAINAGE IMPROVEMENTS PHASE I					
PRELIMINARY COST ESTIMATE					
9-Mar-18					
ITEM NO.	**DESCRIPTION**	**UNIT PRICE**	**QUANTITY**	**UNIT**	**COST**
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$40,000.00	1	LS	$40,000.00
2	Engineering Design	$180,000.00	1	LS	$180,000.00
3	Allowance for VDOT Review and Inspection	$18,000.00	1	LS	$18,000.00
4	Construction Engineering and Inspection	$140,000.00	1	LS	$140,000.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$378,000.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$75,000.00	1	LS	$75,000.00
6	Bonds, Taxes, Permits, and Insurance	$25,000.00	1	LS	$25,000.00
7	As-Builts/Survey Stakeout	$15,000.00	1	LS	$15,000.00
8	Traffic Control	$25,000.00	1	LS	$25,000.00
	GENERAL CONDITIONS SUBTOTAL				**$115,000.00**
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL				
9	Removal of Pipe and Structures	$15,000.00	1	LS	$15,000.00
10	Clearing and Grubbing	$5,000.00	1	LS	$5,000.00
11	Erosion and Sediment Control	$20,000.00	1	LS	$20,000.00
12	Excavation and Grading	$90,000.00	1	LS	$90,000.00
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$110,000.00**
	STORMWATER MANAGEMENT				
13	EW-1 Endwall	$4,000.00	5	EA	$20,000.00
14	Precast Manhole/Inlets	$6,000.00	6	EA	$36,000.00
15	JB-1 Junction Box (60" HDPE to 6' x 3' Box Culvert)	$10,000.00	1	EA	$10,000.00
16	18" HDPE Storm Drain Pipe	$200.00	75	LF	$15,000.00
17	30" HDPE Storm Drain Pipe	$250.00	585	LF	$146,250.00
18	48" HDPE Storm Drain Pipe	$500.00	460	LF	$230,000.00
19	60" HDPE Storm Drain Pipe	$675.00	1,155	LF	$779,625.00
	STORMWATER MANAGEMENT SUBTOTAL				**$1,236,875.00**
	SITE IMPROVEMENTS				
20	Asphalt Replacement	$150.00	1,600	SY	$240,000.00
21	Sanitary Sewer Relocation	$20,000.00	1	LS	$20,000.00
22	Water Line Relocation	$15,000.00	1	LS	$15,000.00
23	Topsoil and Permanent Seeding	$8,000.00	1	LS	$8,000.00
24	Landscaping	$5,000.00	1	LS	$5,000.00
	SITE IMPROVEMENTS SUBTOTAL				**$288,000.00**
	SUBTOTAL CONSTRUCTION COST				**$2,127,875.00**
	CONTINGENCY	**30%**			**$638,363.00**
	CONSTRUCTION COST				**$2,800,000.00**

Notes:

1) Location of storm sewer does not appear to be in conflict with utility poles.
2) There is no information on gas/underground power/fiber optic. Contingency Budget.
3) Cost does not include cost associated with permanent easement acquisition.

CHRISMAN STREET/PHLEGAR STREET DRAINAGE IMPROVEMENTS PHASE II					
PRELIMINARY COST ESTIMATE					
9-Mar-18					
ITEM NO.	**DESCRIPTION**	**UNIT PRICE**	**QUANTITY**	**UNIT**	**COST**
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$17,000.00	1	LS	$17,000.00
2	Engineering Design	$97,000.00	1	LS	$97,000.00
3	Allowance for VDOT Review and Inspection	$8,000.00	1	LS	$8,000.00
4	Construction Engineering and Inspection	$65,000.00	1	LS	$65,000.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$187,000.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$60,000.00	1	LS	$60,000.00
6	Bonds, Taxes, Permits, and Insurance	$20,000.00	1	LS	$20,000.00
7	As-Builts/Survey Stakeout	$10,000.00	1	LS	$10,000.00
8	Traffic Control	$20,000.00	1	LS	$20,000.00
	GENERAL CONDITIONS SUBTOTAL				**$110,000.00**
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL				
9	Removal of Pipe and Structures	$10,000.00	1	LS	$10,000.00
10	Clearing and Grubbing	$5,000.00	1	LS	$5,000.00
11	Erosion and Sediment Control	$20,000.00	1	LS	$20,000.00
12	Excavation and Grading	$25,000.00	1	LS	$25,000.00
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$60,000.00**
	STORMWATER MANAGEMENT				
13	EW-1 Endwall	$4,000.00	4	EA	$16,000.00
14	Precast Manhole/Inlet	$6,000.00	1	EA	$6,000.00
15	Box Culvert (6' x 3')	$550.00	160	LF	$88,000.00
16	Box Culvert (6' x 4')	$600.00	225	LF	$135,000.00
17	Stream Restoration/Ditch Grading	$450.00	710	LF	$319,500.00
	STORMWATER MANAGEMENT SUBTOTAL				**$564,500.00**
	SITE IMPROVEMENTS				
18	Asphalt Replacement	$150.00	250	SY	$37,500.00
19	Sanitary Sewer Relocation	$15,000.00	1	LS	$15,000.00
20	Water Line Relocation	$10,000.00	1	LS	$10,000.00
21	Topsoil and Permanent Seeding	$5,000.00	1	LS	$5,000.00
	SITE IMPROVEMENTS SUBTOTAL				**$67,500.00**
	SUBTOTAL CONSTRUCTION COST				**$989,000.00**
	CONTINGENCY	**30%**			**$296,700.00**
	CONSTRUCTION COST				**$1,300,000.00**

Notes:

1) Two utility poles potentially in conflict with storm sewer. Congingency budget.
2) There is no information on gas/underground power/fiber optic. Contingency Budget.
3) Cost does not include cost associated with permanent easement acquisition.

COLLEGE STREET PHASE 1 DRAINAGE IMPROVEMENTS					
PRELIMINARY COST ESTIMATE					
9-Mar-18					
ITEM NO.	**DESCRIPTION**	**UNIT PRICE**	**QUANTITY**	**UNIT**	**COST**
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$53,570.00	1	LS	$53,570.00
2	Engineering Design	$267,850.00	1	LS	$267,850.00
3	Allowance for VDOT Review and Inspection	$26,785.00	1	LS	$26,785.00
4	Construction Engineering and Inspection	$214,280.00	1	LS	$214,280.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$562,485.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$50,000.00	1	LS	$50,000.00
6	Bonds, Taxes, Permits, and Insurance	$40,000.00	1	LS	$40,000.00
7	As-Builts/Survey Stakeout	$10,000.00	1	LS	$10,000.00
8	Traffic Control	$50,000.00	1	LS	$50,000.00
	GENERAL CONDITIONS SUBTOTAL				**$150,000.00**
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL				
9	Erosion and Sediment Control	$50,000.00	1	LS	$50,000.00
10	Excavation and Grading	$125,000.00	1	LS	$125,000.00
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$175,000.00**
	STORMWATER MANAGEMENT				
11	EW-1 Endwall	$3,000.00	1	EA	$3,000.00
12	Stormwater Structures	$22,500.00	6	EA	$135,000.00
13	Box Culvert (12' x 4')	$1,200.00	75	LF	$90,000.00
14	Box Culvert (10' x 4')	$1,000.00	1,150	LF	$1,150,000.00
15	Box Culvert ((4) 5' X 5')	$2,400.00	215	LF	$516,000.00
	STORMWATER MANAGEMENT SUBTOTAL				**$1,894,000.00**
	SITE IMPROVEMENTS				
16	Asphalt Pavement Replacement	$150.00	2,610	SY	$391,500.00
17	CG-6 Curb and Gutter	$50.00	1,100	LF	$55,000.00
18	Type B Class I Pave. Line Marking 4"	$3.00	1,000	LF	$3,000.00
19	Sanitary Sewer Relocation	$5,000.00	1	LS	$5,000.00
20	Water Line Relocation	$5,000.00	1	LS	$5,000.00
	SITE IMPROVEMENTS SUBTOTAL				**$459,500.00**
	SUBTOTAL CONSTRUCTION COST				**$3,240,985.00**
	CONTINGENCY	**30%**			**$972,296.00**
	CONSTRUCTION COST				**$4,220,000.00**

Notes:

1) Minimal sanitary sewer on College Street.
2) Water line crossings at Radford Street and Depot Street crossing. May need to adjust water line or or storm alignment along College Street.
3) Location of storm sewer may require some utility pole relocation.
4) There is no information on gas/underground power/fiber optic.
5) Cost does not include cost associated with permanent easement acquisition.

COLLEGE STREET PHASE 2 DRAINAGE IMPROVEMENTS					
PRELIMINARY COST ESTIMATE					
9-Mar-18					
ITEM NO.	**DESCRIPTION**	**UNIT PRICE**	**QUANTITY**	**UNIT**	**COST**
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$26,775.00	1	LS	$26,775.00
2	Engineering Design	$151,725.00	1	LS	$151,725.00
3	Allowance for VDOT Review and Inspection	$17,850.00	1	LS	$17,850.00
4	Construction Engineering and Inspection	$133,875.00	1	LS	$133,875.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$330,225.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$50,000.00	1	LS	$50,000.00
6	Bonds, Taxes, Permits, and Insurance	$35,000.00	1	LS	$35,000.00
7	As-Builts/Survey Stakeout	$10,000.00	1	LS	$10,000.00
8	Traffic Control	$50,000.00	1	LS	$50,000.00
	GENERAL CONDITIONS SUBTOTAL				**$145,000.00**
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL				
9	Erosion and Sediment Control	$45,000.00	1	LS	$45,000.00
10	Excavation and Grading	$90,000.00	1	LS	$90,000.00
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$135,000.00**
	STORMWATER MANAGEMENT				
11	EW-1 Endwall	$3,000.00	1	EA	$3,000.00
12	Stormwater Structures	$15,000.00	3	EA	$45,000.00
13	Box Culvert (6' X 4')	$600.00	1,450	LF	$870,000.00
	STORMWATER MANAGEMENT SUBTOTAL				**$918,000.00**
	SITE IMPROVEMENTS				
14	Asphalt Pavement Replacement	$150.00	3,250	SY	$487,500.00
15	CG-6 Curb and Gutter	$50.00	1,500	LF	$75,000.00
16	Type B Class I Pave. Line Marking 4"	$3.00	1,500	LF	$4,500.00
17	Sanitary Sewer Relocation	$10,000.00	1	LS	$10,000.00
18	Water Line Relocation	$10,000.00	1	LS	$10,000.00
	SITE IMPROVEMENTS SUBTOTAL				**$587,000.00**
	SUBTOTAL CONSTRUCTION COST				**$2,115,225.00**
	CONTINGENCY	**30%**			**$634,568.00**
	CONSTRUCTION COST				**$2,750,000.00**

Notes:

1) Minimal sanitary sewer on College Street.
2) Water line crossings at Radford Street and Depot Street crossing. May need to adjust water line or or storm alignment along College Street.
3) Location of storm sewer may require some utility pole relocation.
4) There is no information on gas/underground power/fiber optic.
5) Cost does not include cost associated with permanent easement acquisition.

RADFORD STREET DRAINAGE IMPROVEMENTS					
PRELIMINARY COST ESTIMATE					
9-Mar-18					
ITEM NO.	**DESCRIPTION**	**UNIT PRICE**	**QUANTITY**	**UNIT**	**COST**
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$15,000.00	1	LS	$15,000.00
2	Engineering Design	$75,000.00	1	LS	$75,000.00
3	Allowance for VDOT Review and Inspection	$8,000.00	1	LS	$8,000.00
4	Construction Engineering and Inspection	$60,000.00	1	LS	$60,000.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$158,000.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$25,000.00	1	LS	$25,000.00
6	Bonds, Taxes, Permits, and Insurance	$10,000.00	1	LS	$10,000.00
7	As-Builts/Survey Stakeout	$2,000.00	1	LS	$2,000.00
8	Traffic Control	$20,000.00	1	LS	$20,000.00
	GENERAL CONDITIONS SUBTOTAL				**$57,000.00**
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL				
8	Removal of Pipe and Structures	$15,000.00	1	LS	$15,000.00
9	Excavation/Grading	$25,000.00	1	LS	$25,000.00
10	Erosion and Sediment Control	$10,000.00	1	LS	$10,000.00
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$50,000.00**
	STORMWATER MANAGEMENT				
11	Precast Manhole/Inlet	$6,000.00	7	EA	$42,000.00
12	24" HDPE Storm Drain Pipe	$225.00	600	LF	$135,000.00
	STORMWATER MANAGEMENT SUBTOTAL				**$177,000.00**
	SITE IMPROVEMENTS				
13	ROW Asphalt Replacement	$100.00	1,100	SY	$110,000.00
14	Sidewalk Replacement	$65.00	350	SY	$22,750.00
15	CG-6 Curb and Gutter	$50.00	650	LF	$32,500.00
16	Type B Class I Pave. Line Marking 4"	$3.00	750	LF	$2,250.00
17	Sanitary Sewer Relocation	$15,000.00	1	LS	$15,000.00
18	Water Line Relocation	$10,000.00	1	LS	$10,000.00
	SITE IMPROVEMENTS SUBTOTAL				**$192,500.00**
	SUBTOTAL CONSTRUCTION COST				**$792,500.00**
	CONTINGENCY	**30%**			**$237,750.00**
	CONSTRUCTION COST				**$1,100,000.00**

Notes:

1) Sanitary sewer adjustment may be required.
2) Water line adjustment may be required.
3) There is no information on gas/underground power/fiber optic.
4) Cost does not include cost associated with permanent easement acquisition.

ALLEGHANY STREET DRAINAGE IMPROVEMENTS

PRELIMINARY COST ESTIMATE

9-Mar-18

ITEM NO.	DESCRIPTION	UNIT PRICE	QUANTITY	UNIT	COST
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$10,000.00	1	LS	$10,000.00
2	Engineering Design	$50,000.00	1	LS	$50,000.00
3	Allowance for VDOT Review and Inspection	$5,000.00	1	LS	$5,000.00
4	Construction Engineering and Inspection	$40,000.00	1	LS	$40,000.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$105,000.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$25,000.00	1	LS	$25,000.00
6	Bonds, Taxes, Permits, and Insurance	$10,000.00	1	LS	$10,000.00
7	Traffic Control	$5,000.00	1	LS	$5,000.00
8	As-Builts/Survey Stakeout	$3,000.00	1	LS	$3,000.00
	GENERAL CONDITIONS SUBTOTAL				**$43,000.00**
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL				
9	Removal Pipe and Structures	$15,000.00	1	LS	$15,000.00
10	Clearing and Grubbing	$3,000.00	1	LS	$3,000.00
11	Excavation/Grading	$25,000.00	1	LS	$25,000.00
12	Erosion and Sediment Control	$20,000.00	1	LS	$20,000.00
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$63,000.00**
	STORMWATER MANAGEMENT				
13	EW-1 Endwall	$4,000.00	4	EA	$16,000.00
14	Precast Manhole/Inlet	$6,000.00	9	EA	$54,000.00
15	24" HDPE Storm Drain Pipe	$225.00	440	LF	$99,000.00
16	30" HDPE Storm Drain Pipe	$250.00	600	LF	$150,000.00
	STORMWATER MANAGEMENT SUBTOTAL				**$319,000.00**
	SITE IMPROVEMENTS				
17	ROW Asphalt Replacement	$300.00	20	SY	$6,000.00
18	Sanitary Sewer Relocation	$15,000.00	1	LS	$15,000.00
19	Water Line Relocation	$10,000.00	1	LS	$10,000.00
20	Topsoil and Permanent Seeding	$8,000.00	1	LS	$8,000.00
21	Landscaping/Amenities	$4,000.00	1	LS	$4,000.00
	SITE IMPROVEMENTS SUBTOTAL				**$43,000.00**
	SUBTOTAL OPINION OF PROBABLE CONSTRUCTION COST				**$573,000.00**
	CONTINGENCY	**30%**			**$172,000.00**
	CONSTRUCTION COST				**$750,000.00**

Notes:

1) Location of storm sewer does not appear to be in conflict with utility poles.
2) Four sanitary sewer crossings, likely sanitary sewer adjustment required.
3) Four water line crossings, likely water line adjustment required.
4) There is no information on gas/underground power/fiber optic. Contingency Budget.
5) Cost does not include cost associated with permanent easement acquisition.

STONE STREET DRAINAGE IMPROVEMENTS					
PRELIMINARY COST ESTIMATE					
10-Apr-18					
ITEM NO.	**DESCRIPTION**	**UNIT PRICE**	**QUANTITY**	**UNIT**	**COST**
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$8,000.00	1	LS	$8,000.00
2	Engineering Design	$57,000.00	1	LS	$57,000.00
3	Allowance for VDOT Review and Inspection	$4,000.00	1	LS	$4,000.00
4	Construction Engineering and Inspection	$45,000.00	1	LS	$45,000.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$114,000.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$17,000.00	1	LS	$17,000.00
6	Bonds, Taxes, Permits, and Insurance	$10,000.00	1	LS	$10,000.00
7	Traffic Control	$17,000.00	1	LS	$17,000.00
8	As-Builts/Survey Stakeout	$4,000.00	1	LS	$4,000.00
	GENERAL CONDITIONS SUBTOTAL				**$48,000.00**
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL				
9	Removal Pipe and Structures	$15,000.00	1	LS	$15,000.00
10	Channel Excavation	$40.00	955	CY	$38,200.00
11	Erosion and Sediment Control	$20,000.00	1	LS	$20,000.00
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$73,200.00**
	STORMWATER MANAGEMENT				
12	Concrete Class A4	$1,200.00	16	CY	$19,200.00
13	Reinforcement Steel	$5.00	1,350	LB	$6,750.00
14	Box Culvert ((2) 10' x 5')	$2,300.00	65	LF	$149,500.00
15	Stream Bank Stabilization	$90.00	270	TON	$24,300.00
	STORMWATER MANAGEMENT SUBTOTAL				**$199,750.00**
	SITE IMPROVEMENTS				
16	ROW Asphalt Replacement	$150.00	250	SY	$37,500.00
17	Guardrail Terminal	$3,000.00	4	EA	$12,000.00
18	Guardrail GR-2	$30.00	130	LF	$3,900.00
	SITE IMPROVEMENTS SUBTOTAL				**$53,400.00**
	SUBTOTAL OPINION OF PROBABLE CONSTRUCTION COST				**$489,000.00**
	CONTINGENCY	**30%**			**$147,000.00**
	CONSTRUCTION COST				**$640,000.00**

Notes:

1) Sanitary sewer adjustment may be required.
2) Water line adjustment may be required.
3) There is no information on gas/underground power/fiber optic.
4) Cost does not include cost associated with permanent easement acquisition.

ROANOKE STREET DRAINAGE IMPROVEMENTS					
PRELIMINARY COST ESTIMATE					
10-Apr-18					
ITEM NO.	**DESCRIPTION**	**UNIT PRICE**	**QUANTITY**	**UNIT**	**COST**
	CONSULTANT / VDOT REVIEWS				
1	Surveying	$4,000.00	1	LS	$4,000.00
2	Engineering Design	$23,000.00	1	LS	$23,000.00
3	Allowance for VDOT Review and Inspection	$1,000.00	1	LS	$1,000.00
4	Construction Engineering and Inspection	$14,000.00	1	LS	$14,000.00
	CONSULTANT / VDOT REVIEWS SUBTOTAL				**$42,000.00**
	GENERAL CONDITIONS				
5	Mobilization and Temporary Facilities	$5,000.00	1	LS	$5,000.00
6	Bonds, Taxes, Permits, and Insurance	$3,000.00	1	LS	$3,000.00
7	Traffic Control	$7,000.00	1	LS	$7,000.00
8	As-Builts/Survey Stakeout	$1,000.00	1	LS	$1,000.00
	GENERAL CONDITIONS SUBTOTAL				**$16,000.00**
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL				
9	Removal Pipe and Structures	$3,000.00	1	LS	$3,000.00
10	Flowable Backfill for Abandoned Structures	$400.00	15	CY	$6,000.00
11	Erosion and Sediment Control	$2,000.00	1	LS	$2,000.00
	SITE PREPARATION & EROSION AND SEDIMENT CONTROL SUBTOTAL				**$11,000.00**
	STORMWATER MANAGEMENT				
12	Precast Manhole/Inlet	$6,000.00	3	EA	$18,000.00
13	24" HDPE Storm Drain Pipe	$225.00	75	LF	$16,875.00
14	24" RCP Storm Drain Pipe	$350.00	45	LF	$15,750.00
	STORMWATER MANAGEMENT SUBTOTAL				**$50,625.00**
	SITE IMPROVEMENTS				
14	ROW Asphalt Replacement	$300.00	50	SY	$15,000.00
15	Parking Lot Asphalt Replacement	$100.00	100	SY	$10,000.00
16	Sidewalk Replacement	$100.00	10	SY	$1,000.00
17	Commercial Entrance Gutter	$2,500.00	1	EA	$2,500.00
18	Water Line Relocation	$5,000.00	1	LS	$5,000.00
	SITE IMPROVEMENTS SUBTOTAL				**$33,500.00**
	SUBTOTAL OPINION OF PROBABLE CONSTRUCTION COST				**$154,000.00**
	CONTINGENCY	**30%**			**$47,000.00**
	CONSTRUCTION COST				**$210,000.00**

Notes:

1) Sanitary sewer adjustment may be required.
2) Water line adjustment may be required.
3) There is no information on gas/underground power/fiber optic.
4) Cost does not include cost associated with permanent easement acquisition.

Christiansburg Downtown Watershed Study – Ranking Criteria

Due to the high cost of $18 million for implementation of all ten (10) capital improvement projects described in this downtown watershed study, AMT developed an Excel workbook that includes a prioritization and ranking approach to each CIP project. A description of each of the ranking criterion is provided below, to assist in future updates by the Town. The Excel workbook can also be modified along with the weighting of these criteria, to support future project prioritization.

Safety & Property Damage (Max. 30 Points)	
Potential for Loss of Life / Injuries (30 Points)	This category is for drainage problems with severe flooding and a history of creating the potential for loss of life of serious injury to those affected.
Structure Flooding / Potential Damage (20 Points)	This category is for flood risks involving commercial or residential buildings at risk of potential damage, including buildings with flood flows running underneath them.
Roadway Overtopping - Commercial Area (16 Points)	This category is for roadway flooding in predominantly commercial or highly developed areas that has affected adjacent properties.
Roadway Overtopping - Residential Area (12 Points)	This category is for roadway flooding in predominantly residential or less developed areas that has affected adjacent properties.
Excessive Gutter Spread / Hydroplaning Risk (6 Points)	This category is for roadway flooding where the flooding affects are contained within the roadway (depth of less than one foot) where there is a risk of vehicle hydroplaning.
No Safety Concerns (0 Points)	Flood depths in the roadway of less than six inches are not considered a flood risk, for the purposes of project ranking.

Number of Properties Directly Affected (Max. 20 Points)	
Greater than 25 (20 Points)	This category is for drainage improvement projects that will directly benefit at least 25 adjacent or nearby properties.
11 to 25 (16 Points)	This category is for drainage improvement projects that will directly benefit between 11 and 25 adjacent or nearby properties.
6 to 10 (12 Points)	This category is for drainage improvement projects that will directly benefit between 6 and 10 adjacent or nearby properties.
2 to 5 (8 Points)	This category is for drainage improvement projects that will directly benefit between 2 and 5 adjacent or nearby properties.
One Property (4 Points)	This category is for drainage improvement projects that will directly benefit only one adjacent property.

Ease of Implementation (Max. 15 Points)	
Funded, Within R/W, Simple Design and No Neighborhood Opposition (15 Points)	This category is for drainage improvement projects that will be easy to implement because the project is already funded, it's entirely within existing rights of way or easements, it is a simple project to design and build, and there is no known neighborhood opposition.
Very Feasible (3 out of 4 factors) (10 Points)	This category is for projects meeting 3 of the 4 criteria noted above.
Somewhat Feasible (2 out of 4 factors) (5 Points)	This category is for projects meeting 2 of the 4 criteria noted above.
Possibly Feasible (1 out of 4 factors) (0 Points)	This category is for projects meeting 1 of the 4 criteria noted above.

Environmental Factors (Max. 10 Points)	
Potential Water Quality Benefits (10 Points)	This category is for drainage improvement projects that create a clear opportunity to also improve water quality.
Minimal Environmental Benefits (5 Points)	This category is for drainage improvement projects that might result in water quality benefits to a limited extent.
Environmental Impacts or No Benefits (0 Points)	This category is for drainage improvement projects with no anticipated environmental benefits or that are anticipated to cause environmental impacts that cannot easily be mitigated.

Cost Effectiveness (Max. 25 Points)
This category requires a calculation of the total project cost, divided by the watershed acres contributing to the project area. The resulting "$/acre" is then ranked relative to the other projects with the most cost-effective project receiving the maximum score of 25 points. In this study, the cost effectiveness for the Stone Street Box Culvert was so good, that it was removed from the relative ranking of the other projects. This allows the College Street (Phase I) project to also receive the full 25 points for having the largest contributing drainage area.

Town of Christiansburg - Downtown Watershed Study

Summary of CIP Rankings

Description of Study Results	Weighed Value	Project ID									
		6	3	9	4	2	1	8	5	10	7
		North Franklin Street Drainage Improvements	Hickok Street Drainage Improvements, Phase I	Stone Street Culvert Replacement at Town Branch	College Street Drainage Improvements, Phase I	Chrisman / Phlegar Street Drainage Improvements, Phase II	Chrisman / Phlegar Street Drainage Improvements, Phase I	Alleghany St / Canaan Rd / Epperly Drive: Drainage Improvements	College Street Drainage Improvements, Phase II	Roanoke Street Drainage Improvements	Radford Street Drainage Improvements
Safety & Property Damage (Max. 30 Points)											
Potential for Loss of Life / Injuries	30										
Structure Flooding / Potential Damage	20	20	20				20				
Roadway Overtopping - Commercial Area	16			16	16	16			16	16	
Roadway Overtopping - Residential Area	12							12			
Excessive Gutter Spread / Hydroplaning Risk	6										6
No Safety Concerns	0										
Number of Properties Directly Affected (Max. 20)											
Greater than 25	20						20				
10 to 25	16	16			16			16	16		
6 to 10	12		12	12		12					
2 to 5	8									8	8
One property	4										
Ease of Implementation (Max. 15)											
Funded, Within R/W, Simple Design and No Neighborhood Opposition	15										
Very Feasible (3 out of 4 factors)	10	10	10	10				10			
Somewhat Feasible (2 out of 4 factors)	5				5		5		5	5	5
Possibly Feasible (1 out of 4 factors)	0					0					
Environmental Factors (Max. 10)											
Potential Water Quality Benefits (Moderate)	10					10		10			
Minimal Environmental Benefits	5	5	5	5	5		5		5	5	5
Environmental Impacts or No Benefits	0										
Cost Effectiveness (Max. 25)											
Based on the ratio of $ per watershed acre	25	20	21	25	25	18	6	5	11	3	1
Project Score (100 Max.) =		71	68	68	67	56	56	53	53	37	25
Project Ranking =		1	2	3	4	5	6	7	8	9	10

Town of Christiansburg - Downtown Watershed Study

Cost Effectiveness Factor for Ranking Criteria

Project Cost Effectiveness				
Project ID	Project Cost	Project Watershed	Proj. Cost / Proj. Watershed	Weighed Value
1	$2,800,000	151	$18,543	5.9
2	$1,300,000	218	$5,963	18.2
3	$2,700,000	531	$5,085	21.3
4	$4,250,000	979	$4,341	25.0
5	$2,750,000	272	$10,110	10.7
6	$1,500,000	279	$5,376	20.2
7	$1,100,000	14	$78,571	1.4
8	$750,000	36	$20,833	5.2
9	$640,000	1,083	$591	25.0
10	$210,000	5	$40,385	2.7
SUM =	$18,000,000	1,083	$4,341	25.0

Note - Project #9 was given a maximum score of 25 points, and removed from the relative weighting calculations for the other nine projects, because it does not represent a Q10 solution for the entire watershed, making it a different type of project requiring separate scoring for cost effectiveness.

APPENDIX J

Community Meeting No. 2

The Christiansburg Downtown Watershed Study is nearly complete!

The Town of Christiansburg received a grant from the Virginia Department of Conservation and Recreation to conduct a downtown watershed study. The goal of this study is to evaluate drainage and flooding problems along Towne Branch and its floodplains and to develop a list of planned drainage improvements by the Town.

The consultant has been investigating issues and evaluation solutions over the past six months. We are inviting you to a community meeting on **Thursday, May 10,** from **4 to 7 p.m.** in Council Chambers at Christiansburg Town Hall, 100 E. Main St. The Town's consultant will present findings from the study and we will be able to talk with those in attendance about the proposed solutions to flooding and drainage issues in downtown Christiansburg.

For more information about this meeting, please visit **www.christiansburg.org/watershed.**

SIGN IN SHEET

Christiansburg Downtown Watershed Study
Community Meeting on May 10, 2018

Name	E-Mail	Phone Number	Check for Updates?
TC MEMBER	ON FILE	ON FILE	
Willis Webb			
Virginia Webb			
Linda Hart	NIH	382-4704	
James W. Caldwell	NO	382-1635	
MARK H. FOLGHT	MFOLGHT@T-L.COM	540.639.1097	
Gren Duncan MARCI STINE	gduncan134@AOL.COM	540 230 3948	
Russell Stine	NO	540-382-8932	
Bob Poff	bob@valley-wide.com	381-0200	
Merissa Sachs	MSachs@christiansburg.org	540 257 0158	

SIGN IN SHEET

Christiansburg Downtown Watershed Study
Community Meeting on May 10, 2018

Name	E-Mail	Phone Number	Check for Updates?
John Burke	john.burke@vt.edu	540-951-7059	✓

Christiansburg Downtown Watershed Study
Community Meeting on May 10, 2018
Comment Form

Name: _____

1. Was the meeting helpful in understanding the drainage improvements? _____Yes _____No

2. Would you like to be added to the Town's mailing list for future announcements and updates about downtown drainage improvements? If so, please provide an email address.

_____

3. Will the drainage improvements address your concerns? If not, please explain below:

_____Yes _____No

_____

_____

_____

_____

_____

_____

_____

4. Do you have other comments related to this Downtown Watershed Study?

_____

_____

_____

_____

_____

_____

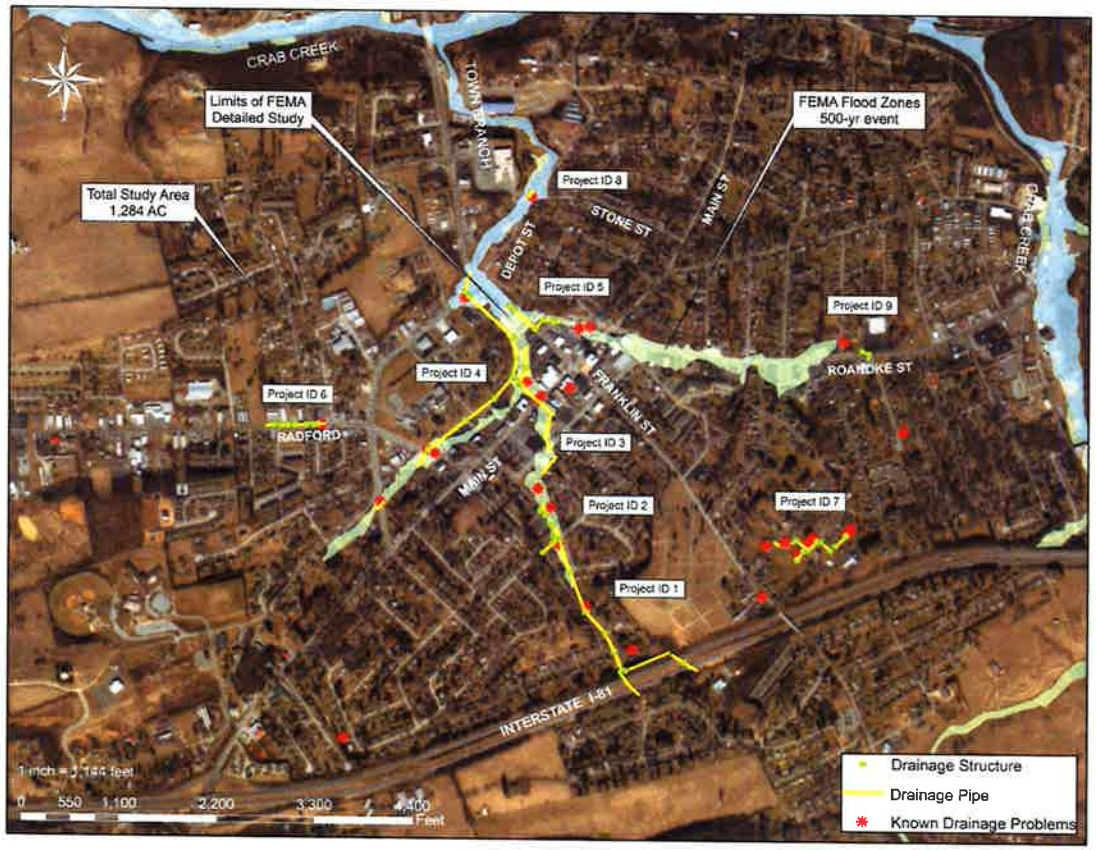
Please provide comments by **May 24, 2018**

You can mail the comment forms to: 100 E. Main Street, Christiansburg, VA 24073 or drop them off in the Engineering Department at Town Hall. Call for more information at (540) 382-6120.

Further information about this Downtown Watershed Study and an online version of this survey can also be found on the project website: http://www.christiansburg.org/watershed

Drainage Improvement Recommendations

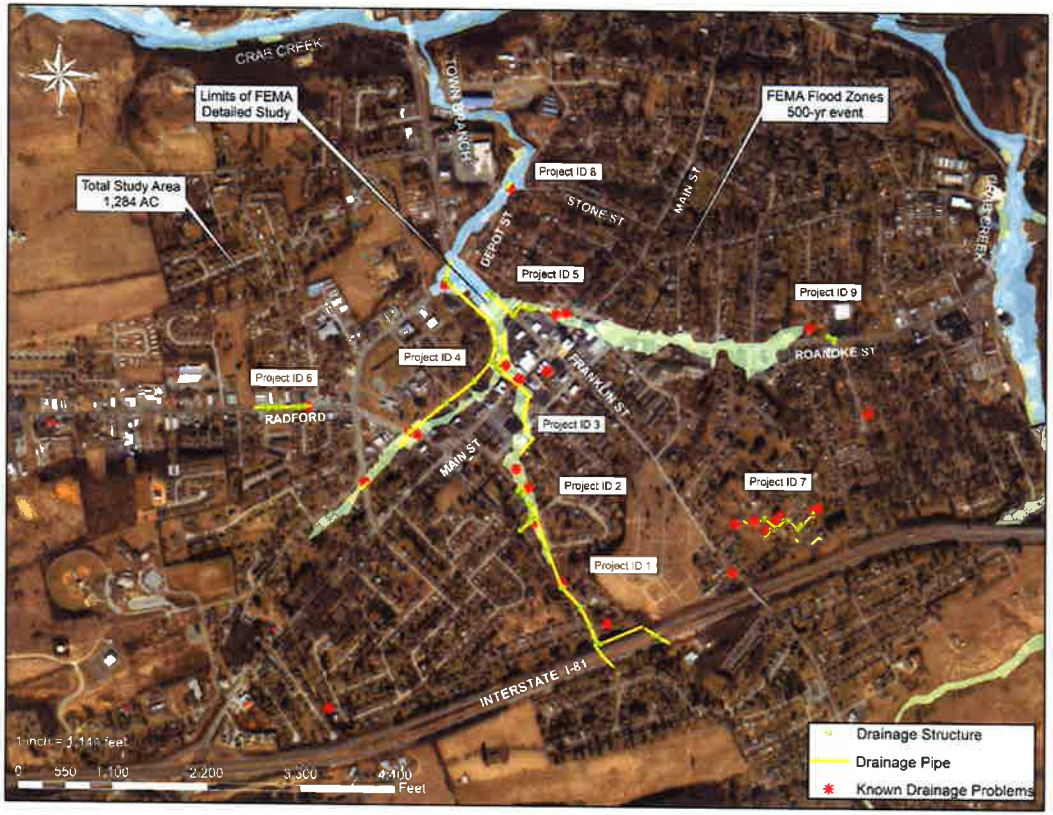
Seventeen (17) known drainage issues were evaluated within this watershed study, and nine (9) drainage improvement projects are proposed throughout the watershed to help reduce or eliminate flood risks.



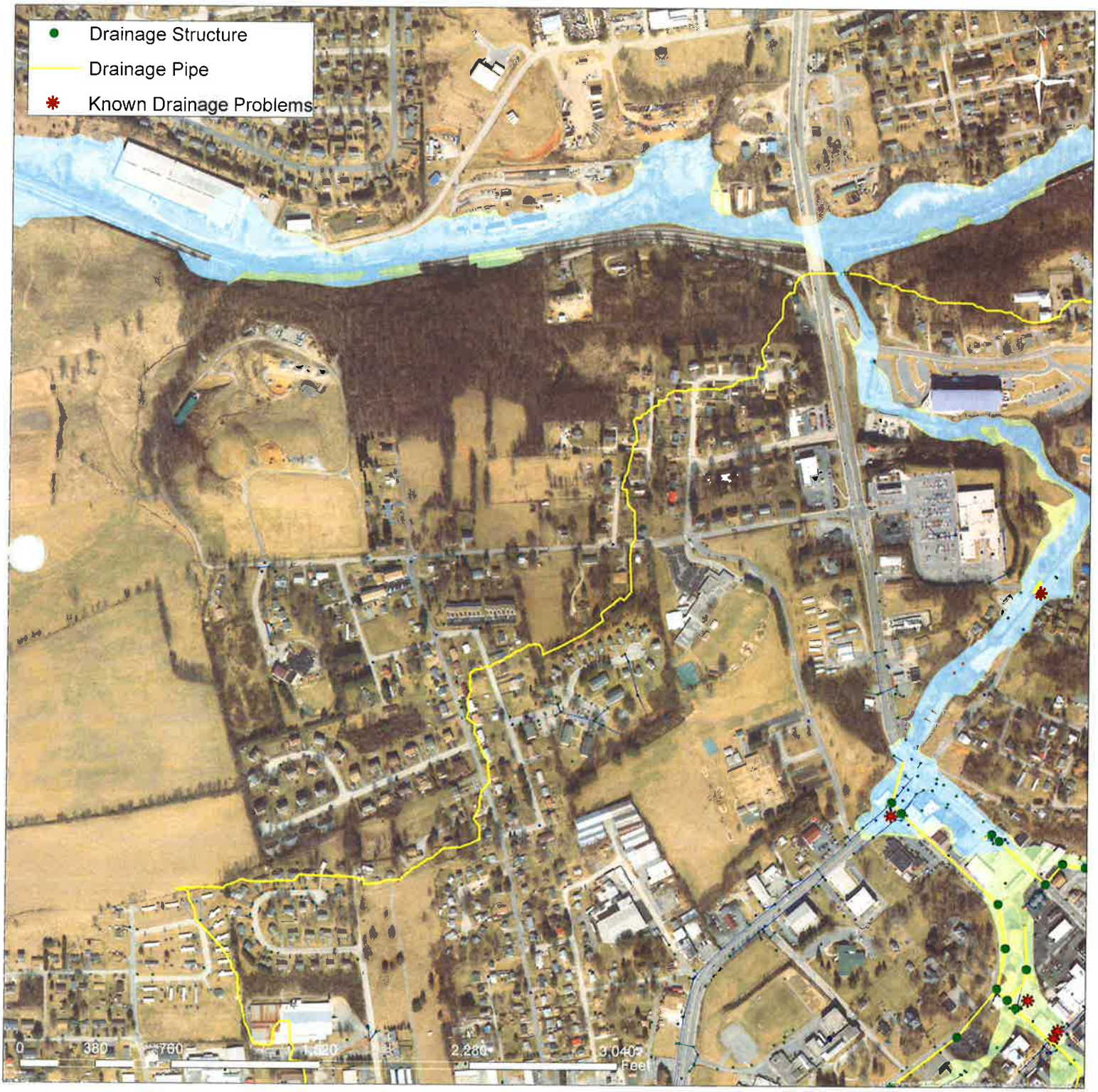
Project ID	Project Name	Project Cost	Description
1	Chrisman / Phlegar Street Drainage Improvements: Phase I	$2,800,000	This project collects runoff from existing 30" RCP and 48" RCP pipes under Interstate 81, and conveys the runoff in a closed drainage system along Chrisman Street, and then crossing over to Phlegar Street following the alignment of the existing pipes. Recommended pipe sizes increase from 36" initially, to between 48" and 60" in diameter at 3rd Street SW.
2	Chrisman / Phlegar Street Drainage Improvements: Phase II	$1,300,000	Starting at the intersection of Phlegar Street and 3rd Street SW, this drainage improvement is a series of small box culverts and open channels that convey runoff from the upper watershed to an existing triple 5'x3' box culvert under 1st Street. The current alignment requires easements across some private properties, and may include stream stabilization measures.
3	Hickok Street Drainage Improvements	$2,700,000	This project conveys runoff in a proposed 10'x4' box culvert under Hickok Street SW to the intersection with Commerce Street, removing a section of drainage conveyance that goes under the existing buildings on both sides of West Main Street. Runoff is then conveyed in public rights of way; either north along Commerce Street to a connection with an existing 72" CMP or west along Hickok Street to College Street, where it connects to the College Street Drainage Improvements that are recommended in this study (See ID #4).
4	College Street Drainage Improvements	$6,900,000	This project improves drainage starting with a known flooding concern at the intersection of College Street / Radford Street, and running along College Street in a 6'x4' box culvert. The pipe size increases to a 10'x4' box culvert at Hickok Street, until it reaches Depot Street, where a Quadruple 5'x5' box culvert is recommended for the last segment of piping, to the outfall into Town Branch. This improvement also requires a connection to the Triple 5'x4' box culvert under North Franklin Street which is significantly undersized without the College Street Drainage Improvements to divert runoff into a parallel drainage system.
5	North Franklin Street Drainage Improvements	$1,500,000	This project is currently being designed by Gay & Neal, Inc. (GNI) for the Town, using VDOT revenue sharing funds as a cost share. It requires a combination of 42" and 60" pipes to collect runoff from below the parking lots at Town Hall, and improves conveyance of this runoff to the outfall at Town Branch. It also eliminates a section of existing storm drain that is going under some buildings on N. Franklin Street.
6	Radford Street Drainage Improvements	$1,100,000	This project is smaller than some others in the downtown area, and addresses clogged inlets and undersized pipes along the north side of Radford Street. By increasing the pipe size from 15" to 24" and adding adequately sized throat lengths on the drainage inlets, runoff can be intercepted and conveyed into the existing 36" RCP at Lee Hy Court, then draining along Radford Street to Depot Street into the downtown area. New sidewalks may also be considered for this area, by combining project goals.
7	Alleghany St / Canaan Rd/ Epperly Drive: Drainage Improvements	$750,000	This project helps convey excess runoff from the Sunset Cemetery and Alleghany Street, under Canaan Road and Epperly Drive, by replacing exisitng 15" pipes with 24" and 30" pipes. Runoff is then conveyed into the rear yards on the south side of Epperly Drive, behind the First Church of God, with a pipe extension to the existing stormwater management basin. During engineering design, the Town may evaluate the water quality and flood reduction benefits of the existing basin, and consider modifications to optimize the basins' performance in protecting existing drainage systems downstream and promoting improved water quality in the watershed.
8	Stone Street Culvert Replacement at Town Branch	$640,000	This project replaces an existing quadruple 48" CMP with a dual 10'x5' box culvert, providing increased capacity to convey the 2-year storm under Stone Street without overtopping onto Depot Street. 10-year and 100-year flood depths are also reduced with this culvert replacement. Possible impacts of the larger pipe sizes on the stream restoration project in Depot Park will need to be evaluated, as well as the flood reduction benefits of eliminating the abandoned bridge that is just upstream of Stone Street. Enhanced water quality treatment benefits can also be considered for this project, by extending the completed stream restoration project from Stone Street to North Franklin Street, creating a linear park or public greenway as part of this downtown improvement plan.
9	Roanoke Street Drainage Improvements	$210,000	This storm drain system begins neat an existing curb inlet near the Wade's Foods and has small diameter pipes draininge towards Craig Street. The objective of this improvement recommendation is to remove most of the runoff from the open channel behind 500 Roanoke Street by installing new inlets at Craig Street and Roanoke Street that will accept flow from the existing inlet in the Wade's Foods parking lot and then crossing Roanoke Street to tie to the existing storm drain system near Robert Street.

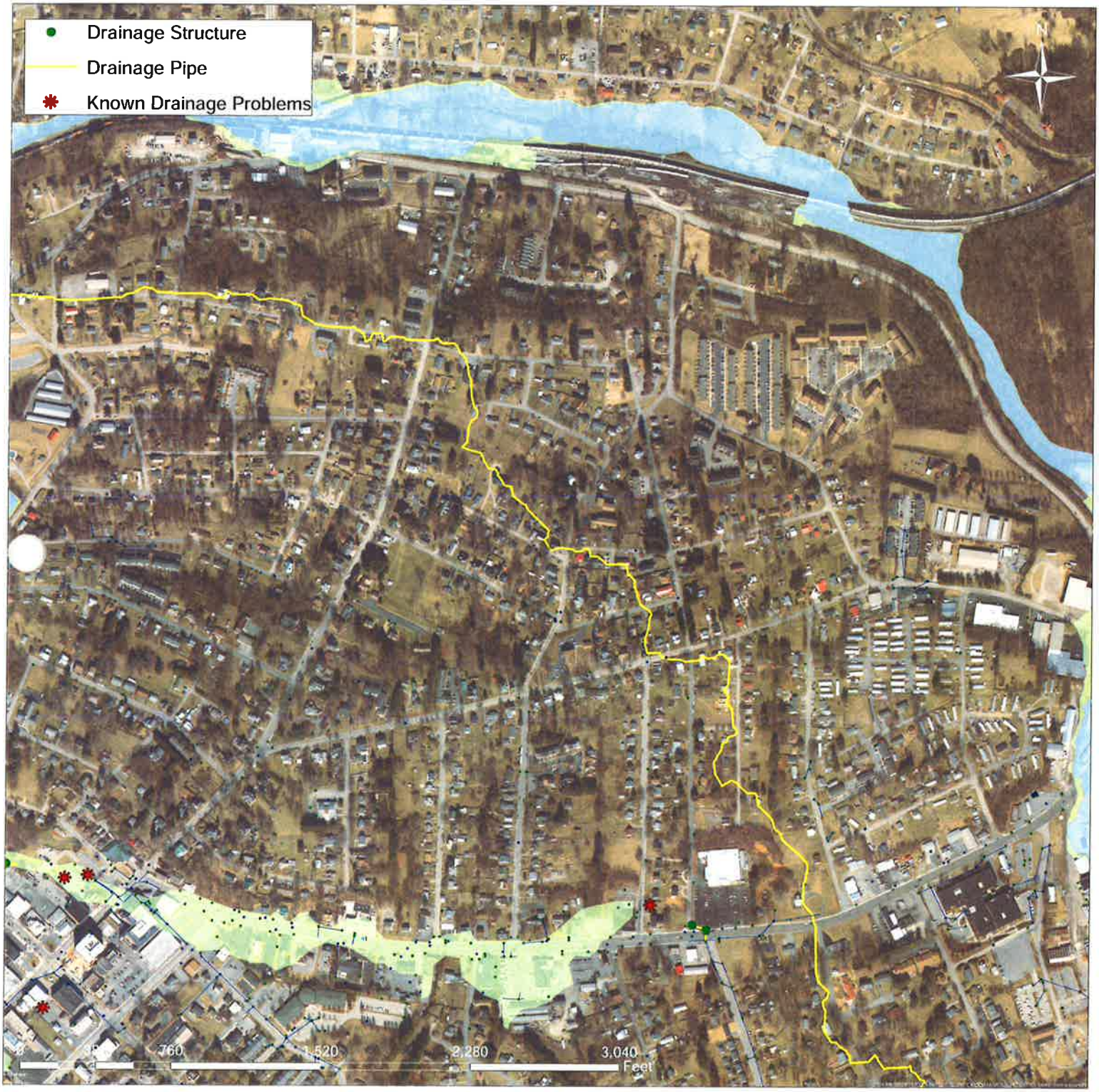
Ranking and Prioritizing Improvement Recommendations

$17.4 million is estimated to be needed to address all known drainage problems within the watershed, so project prioritization and ranking criteria were developed as shown below. Top ranked projects are recommended for funding and implementation at the earliest opportunity, including securing funding support from VDOT and others.



Description of Study Results	Weighed Value	Project ID 1	2	3	4	5	6	7	8	9
		Chrisman / Phlegar Street Drainage Improvements: Phase I	Chrisman / Phlegar Street Drainage Improvements: Phase II	Hickok Street Drainage Improvements	College Street Drainage Improvements	North Franklin Street Drainage Improvements	Radford Street Drainage Improvements	Alleghany St / Canaan Rd / Epperly Drive: Drainage Improvements	Stone Street Culvert Replacement at Town Branch	Roanoke Street Drainage Improvements
Safety & Property Damage (Max. 30 Points)										
Potential for Loss of Life / Injuries	30									
Structure Flooding / Potential Damage	20	20		20		20				20
Roadway Overtopping - Commercial Area	16		16		16				16	
Roadway Overtopping - Residential Area	12							12		
Excessive Gutter Spread / Hydroplaning Risk	6						6			
No Safety Concerns	0									
Number of Properties Directly Affected (Max. 20)										
Greater than 25	20				20			20		
10 to 25	16	16				16				
6 to 10	12		12	12					12	
2 to 5	8						8			8
One property	4									
Ease of Implementation (Max. 15)										
Funded, Within R/W, Simple Design and No Neighborhood Opposition	15									
Very Feasible (3 out of 4 factors)	10					10		10	10	
Somewhat Feasible (2 out of 4 factors)	5	5		5			5			5
Possibly Feasible (1 out of 4 factors)	0		0		0					
Environmental Factors (Max. 10)										
Potential Water Quality Benefits (Moderate)	10		10	10				10	10	
Minimal Environmental Benefits	5	5			5	5	5			5
Environmental Impacts or No Benefits	0									
Cost Effectiveness (Max. 25)										
Based on the ratio of $ per watershed acre	25	7	21	25	18	24	2	6	25	3
Project Score (100 Max.) =		53	59	72	59	75	26	58	73	41
Project Ranking =		7	6	3	5	1	9	4	2	8


Drainage Structure
Drainage Pipe
Known Drainage Problems
0
380
760
1,520
2,280
3,040
Feet


Drainage Structure
Drainage Pipe
Known Drainage Problems
760
1,520
2,280
3,040
Feet


Drainage Structure
Drainage Pipe
Known Drainage Problems
N
0
380
760
1,520
2,280
3,040
Feet


Drainage Structure
Drainage Pipe
Known Drainage Problems
No
0
380
760
1,520
2,280
3,040
Feet

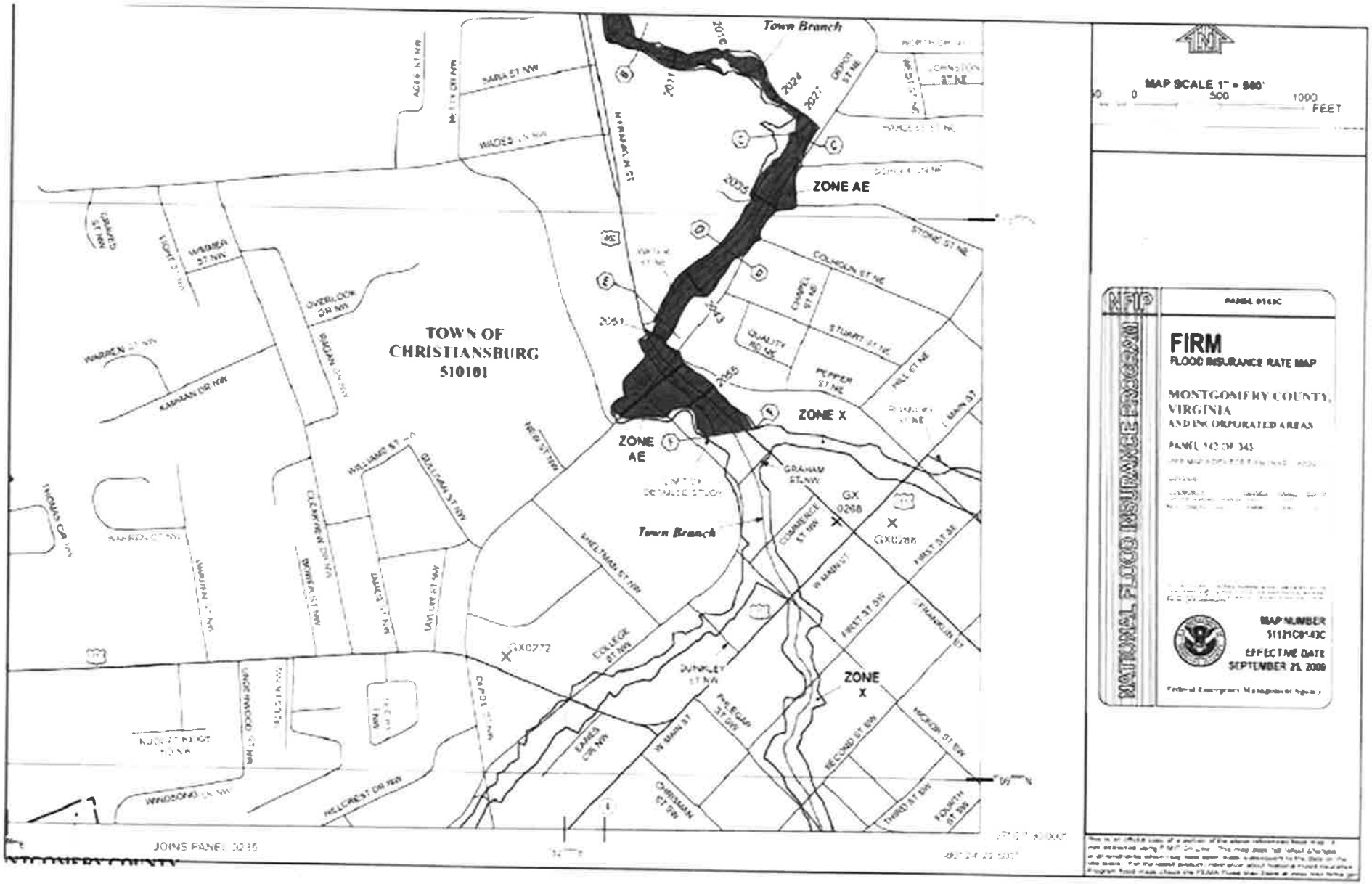
Christiansburg Downtown Watershed Study

Community Meeting

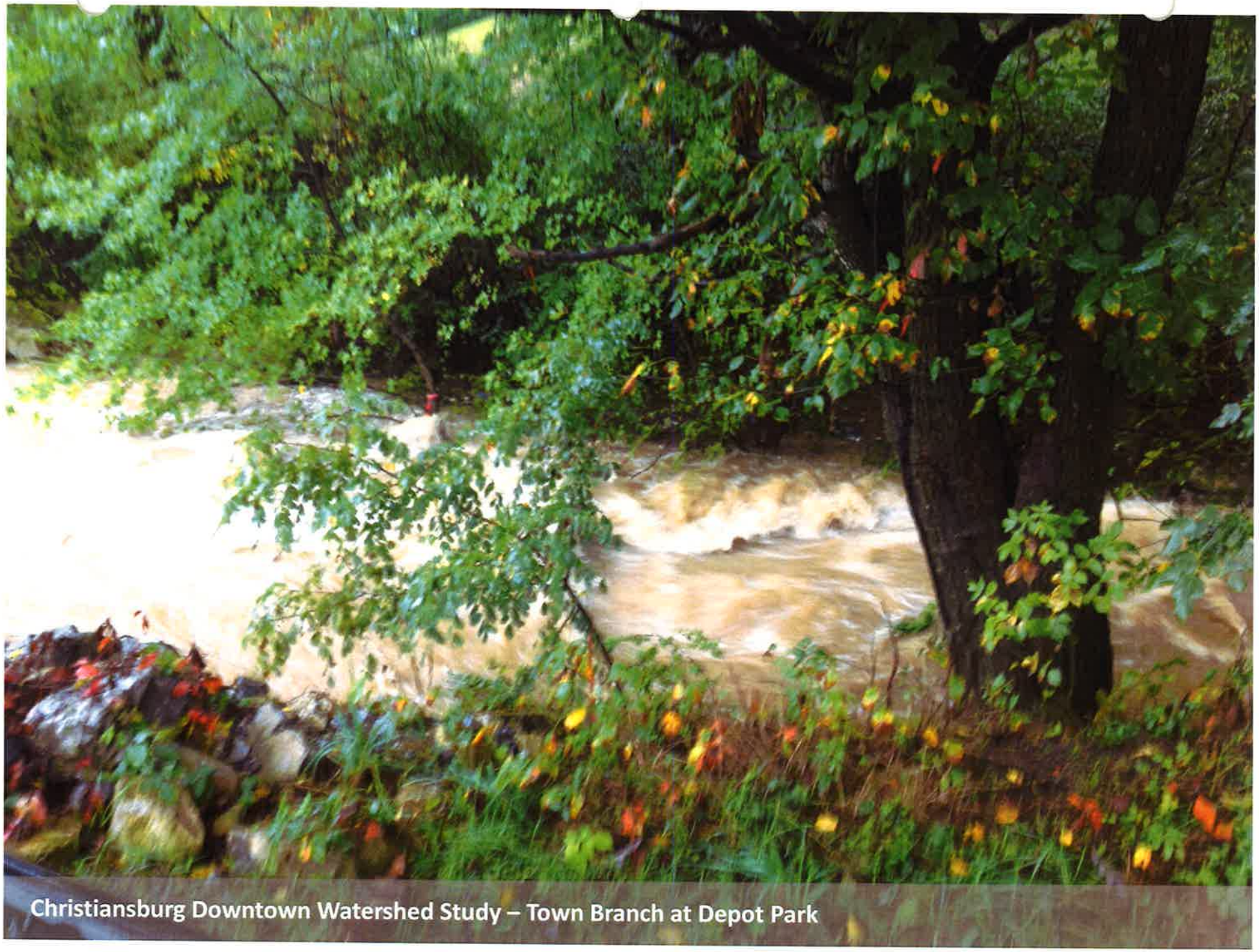
May 10, 2018 - 4-7pm

Town Council Chambers

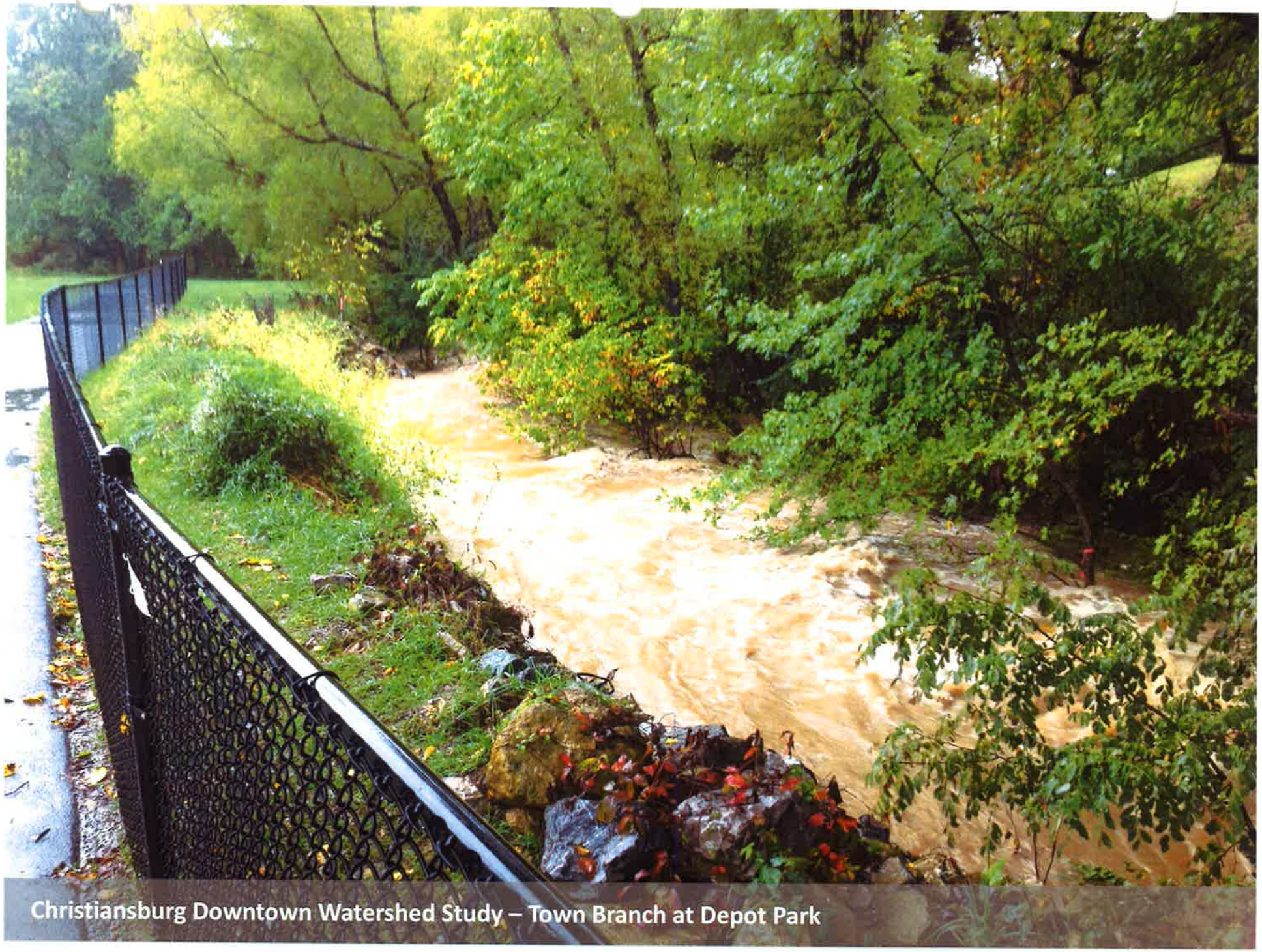
FEMA Flood Insurance Rate Map



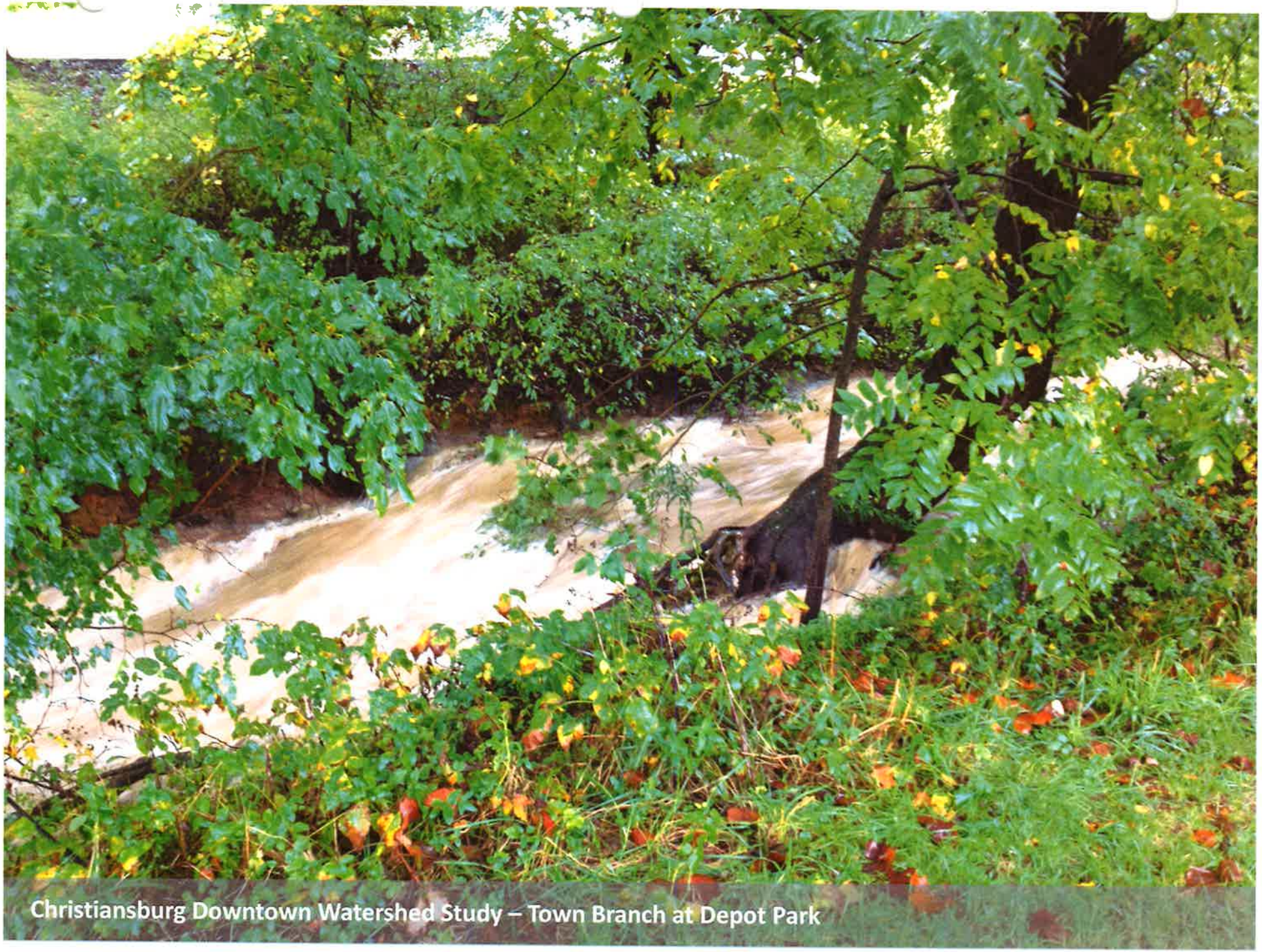
Christiansburg Downtown Watershed Study – Town Branch at Depot Park



Christiansburg Downtown Watershed Study – Town Branch at Depot Park

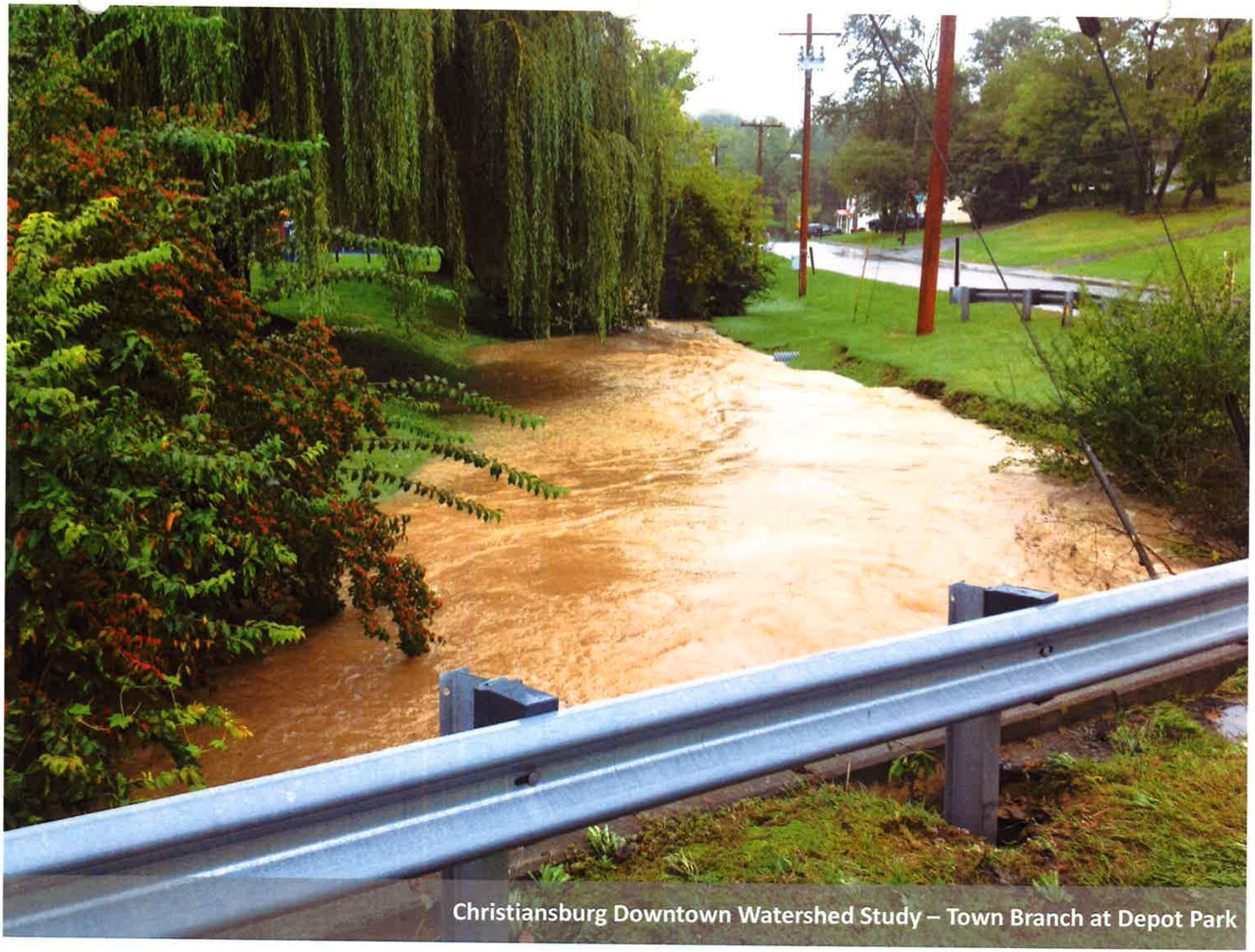


Christiansburg Downtown Watershed Study – Town Branch at Depot Park



Christiansburg Downtown Watershed Study – Town Branch at Depot Park

Christiansburg Downtown Watershed Study – Town Branch at Depot Park


Christiansburg Downtown Watershed Study – Town Branch at Depot Park

Christiansburg Downtown Watershed Study – Stone Street Intersection

Christiansburg Downtown Watershed Study – Stone Street Intersection

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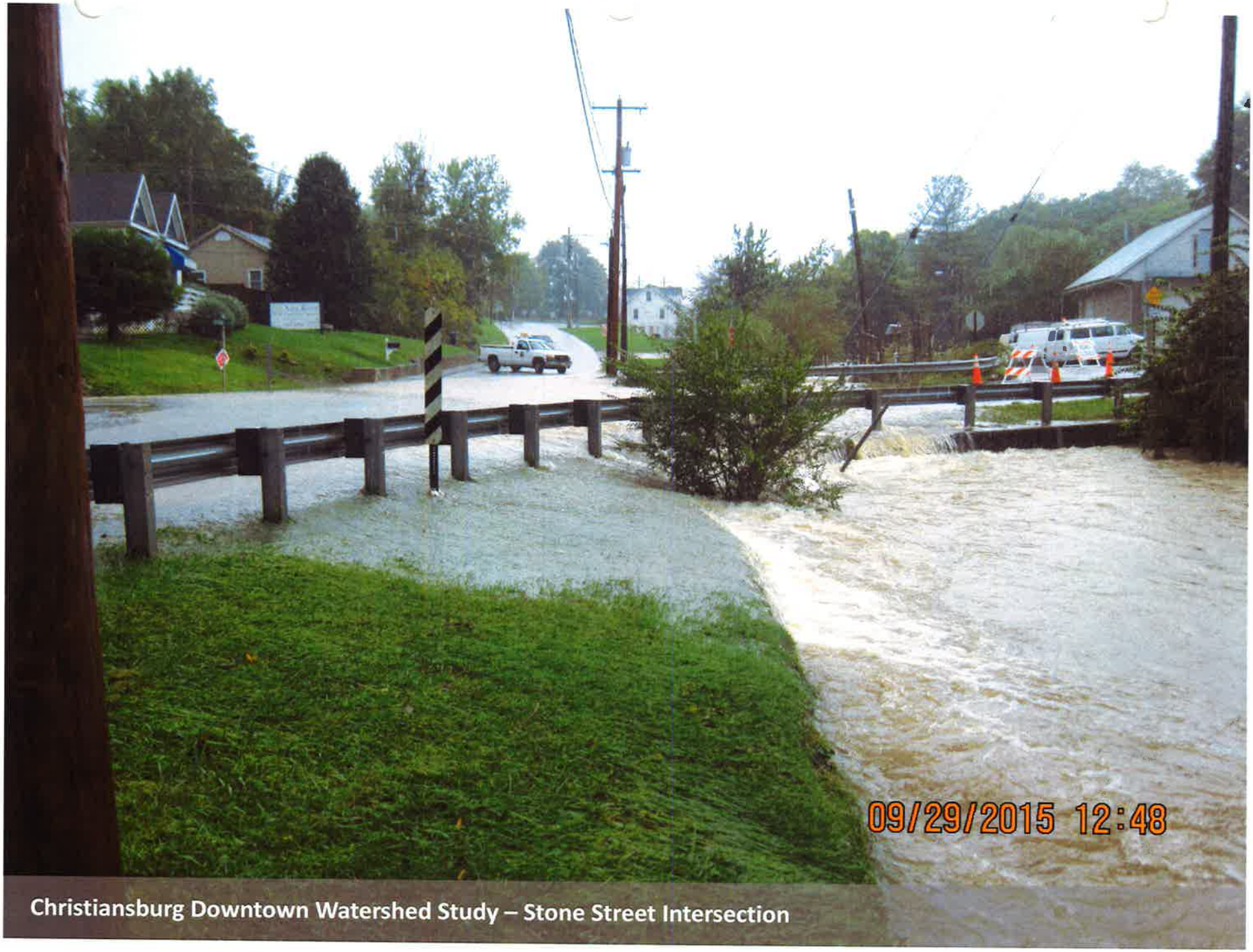
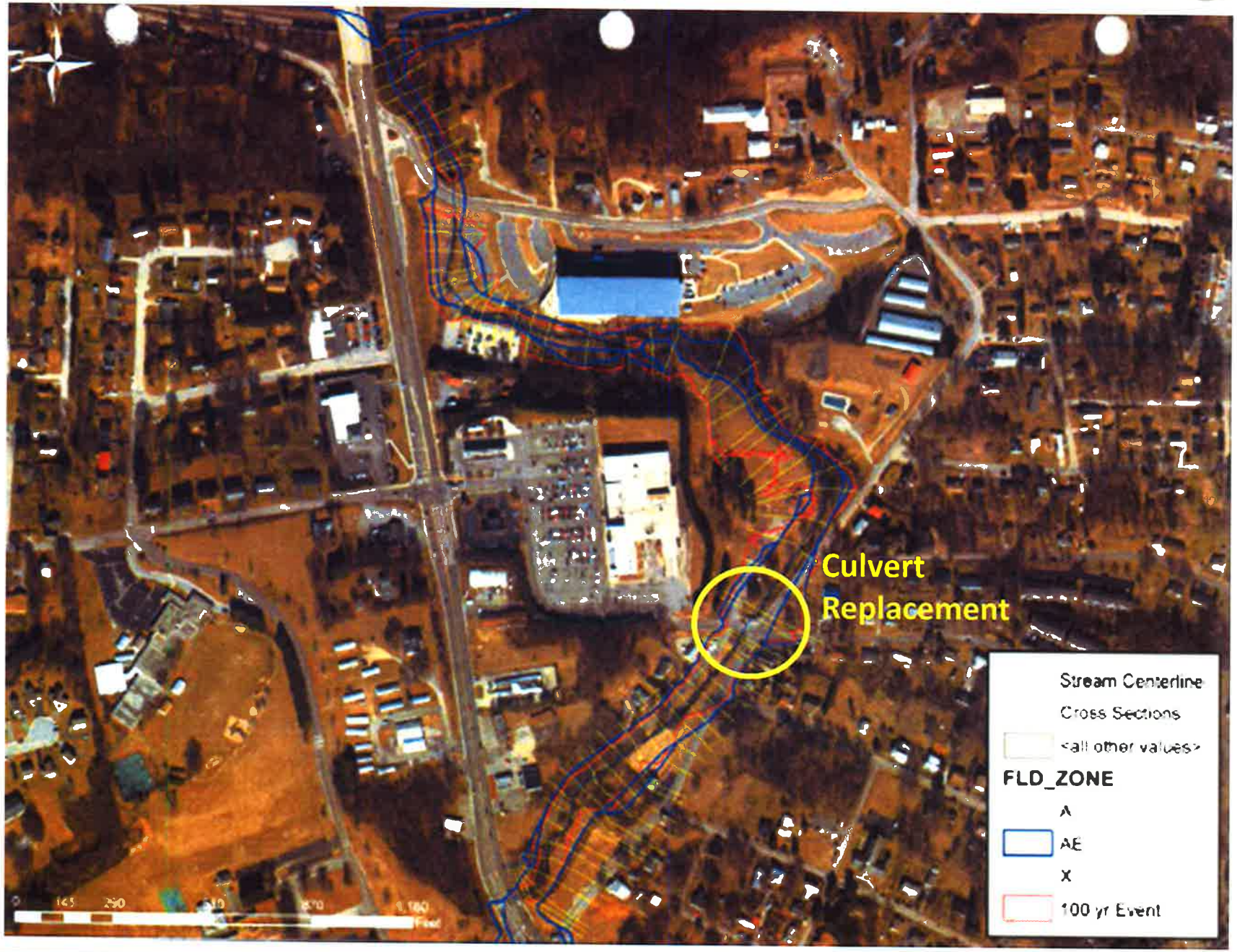
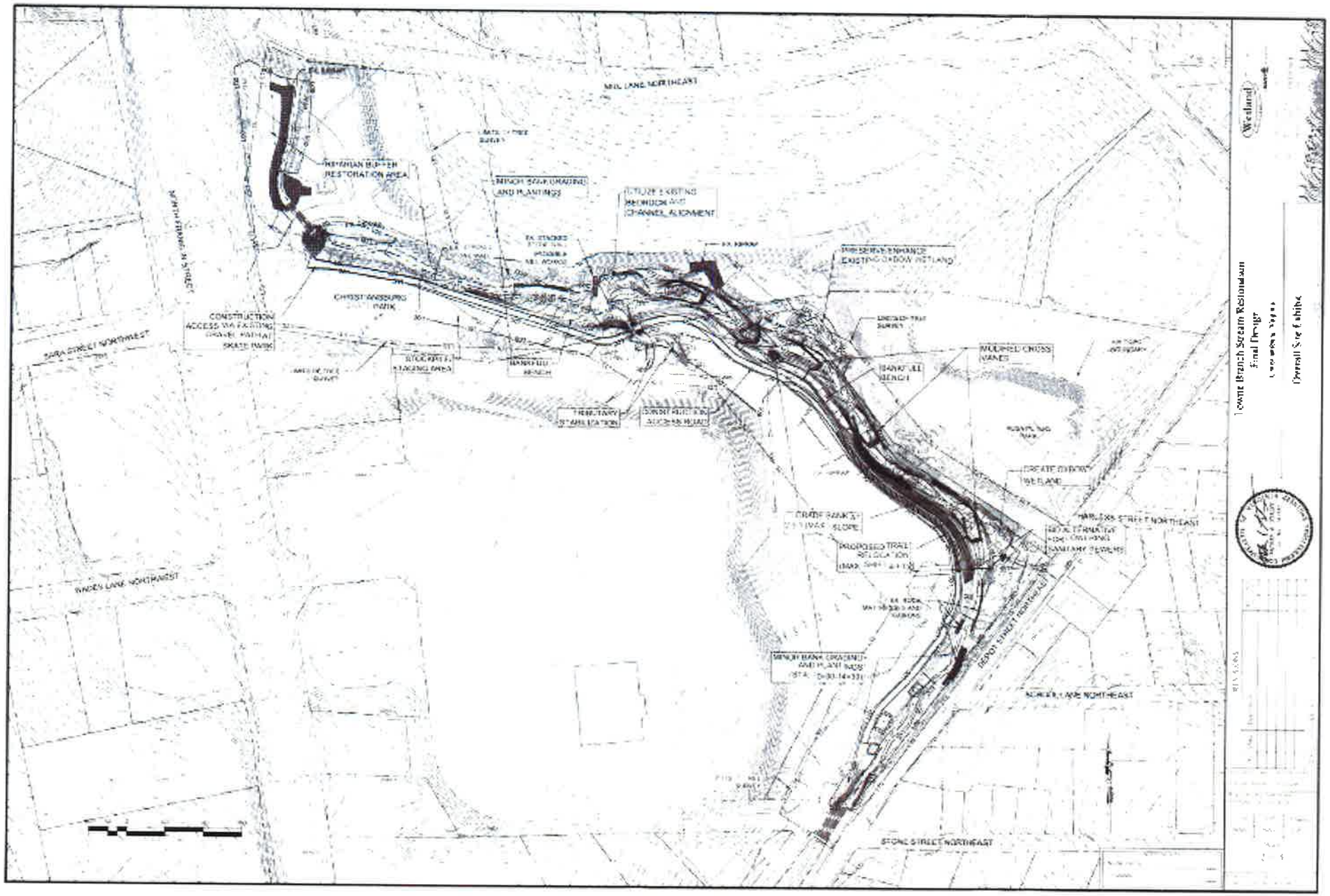
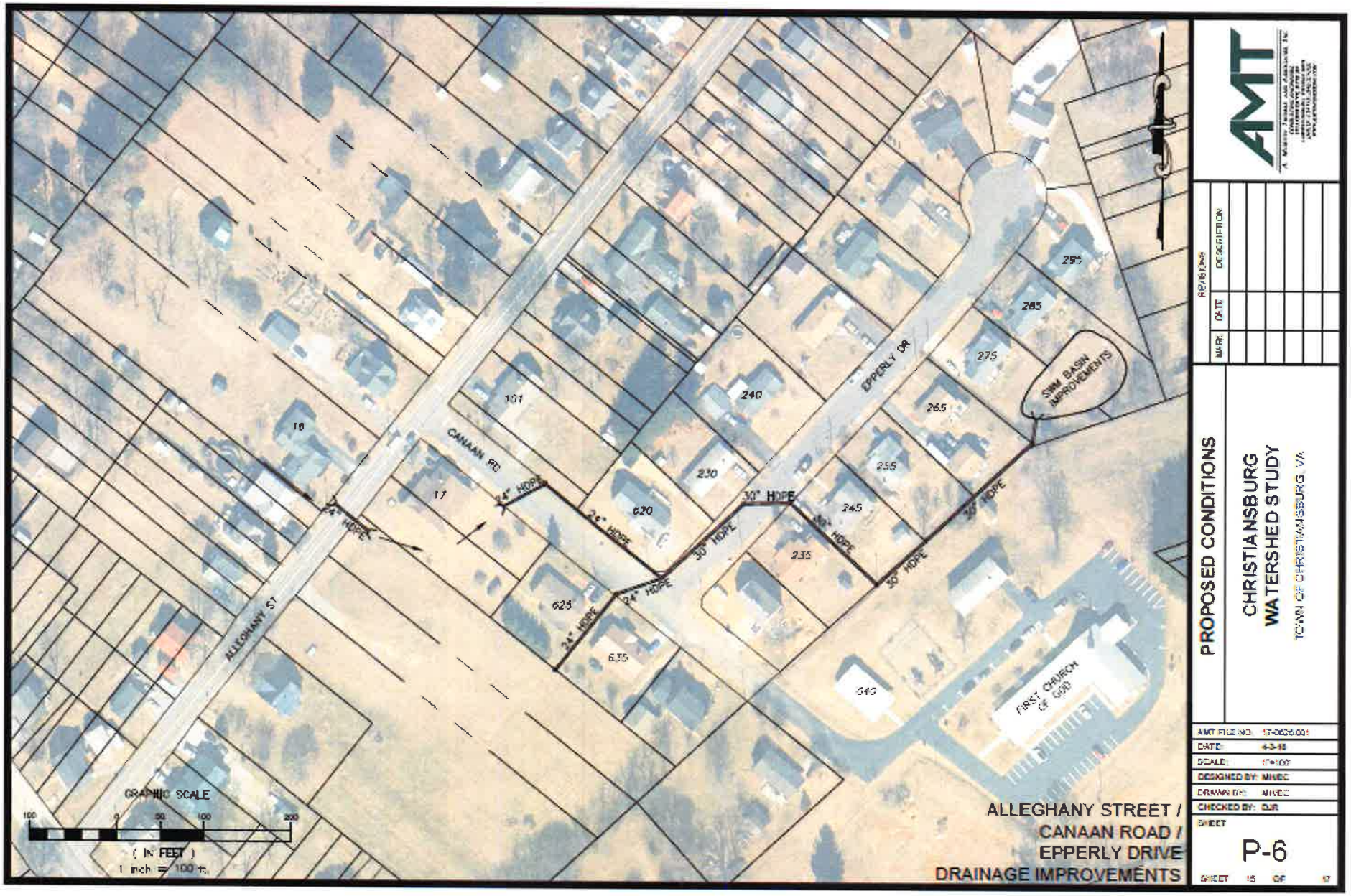


Christiansburg Downtown Watershed Study – Stone Street Intersection



Christiansburg Downtown Watershed Study – Stone Street Box Culvert Replacement - $0.64M


MILL LANE NORTHEAST
CONSTRUCTION ACCESS VIA EXISTING GRAVEL PATHWAY
SARA STREET NORTHWEST
WADEN LANE NORTHWEST
DEPOT STREET NORTHEAST
STONE STREET NORTHEAST
Town Branch Stream Restoration
Final Design
Overall Site Exhibit



Christiansburg Downtown Watershed Study – Alleghany St / Canaan Rd / Epperly Drive - $0.75M


STOP
09/29/2015 12:19
Christiansburg Downtown Watershed Study - Second and Phlegar Street

Christiansburg Downtown Watershed Study – Phlegar Street

Christiansburg Downtown Watershed Study – between Chrisman and Phlegar Street

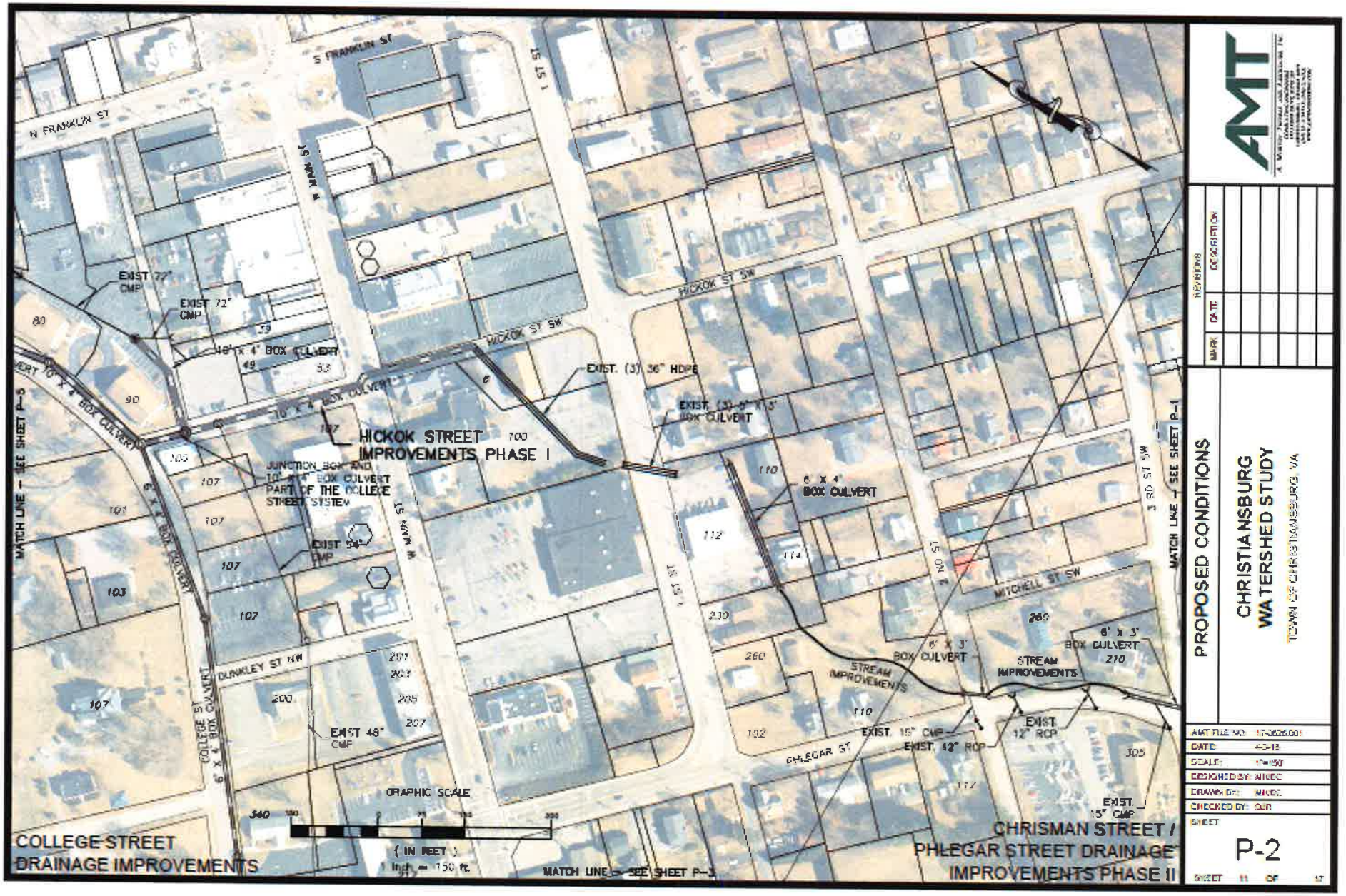

09/29/2015 12:21
Christiansburg Downtown Watershed Study – Phlegar Street

Christiansburg Downtown Watershed Study – Third and Phlegar Street

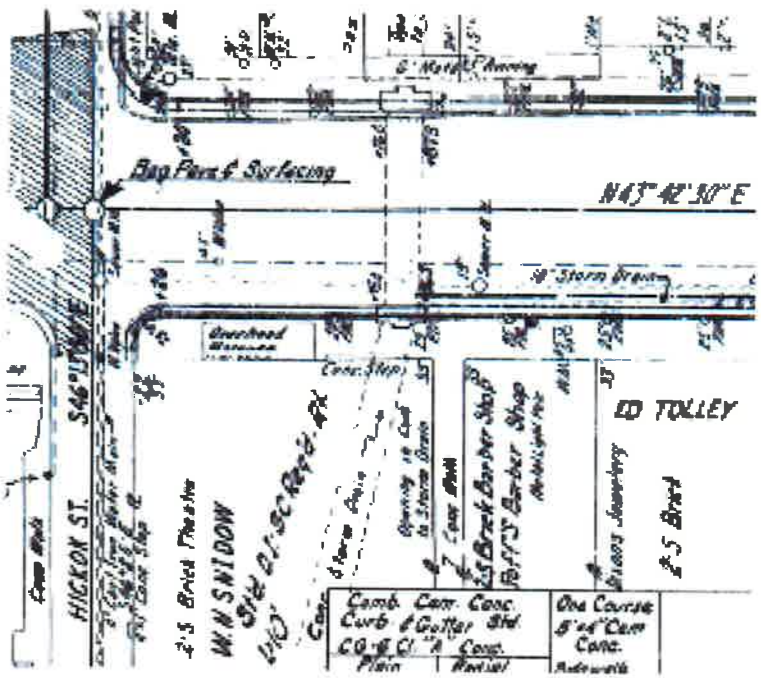
Christiansburg Downtown Watershed Study – Phlegar Street

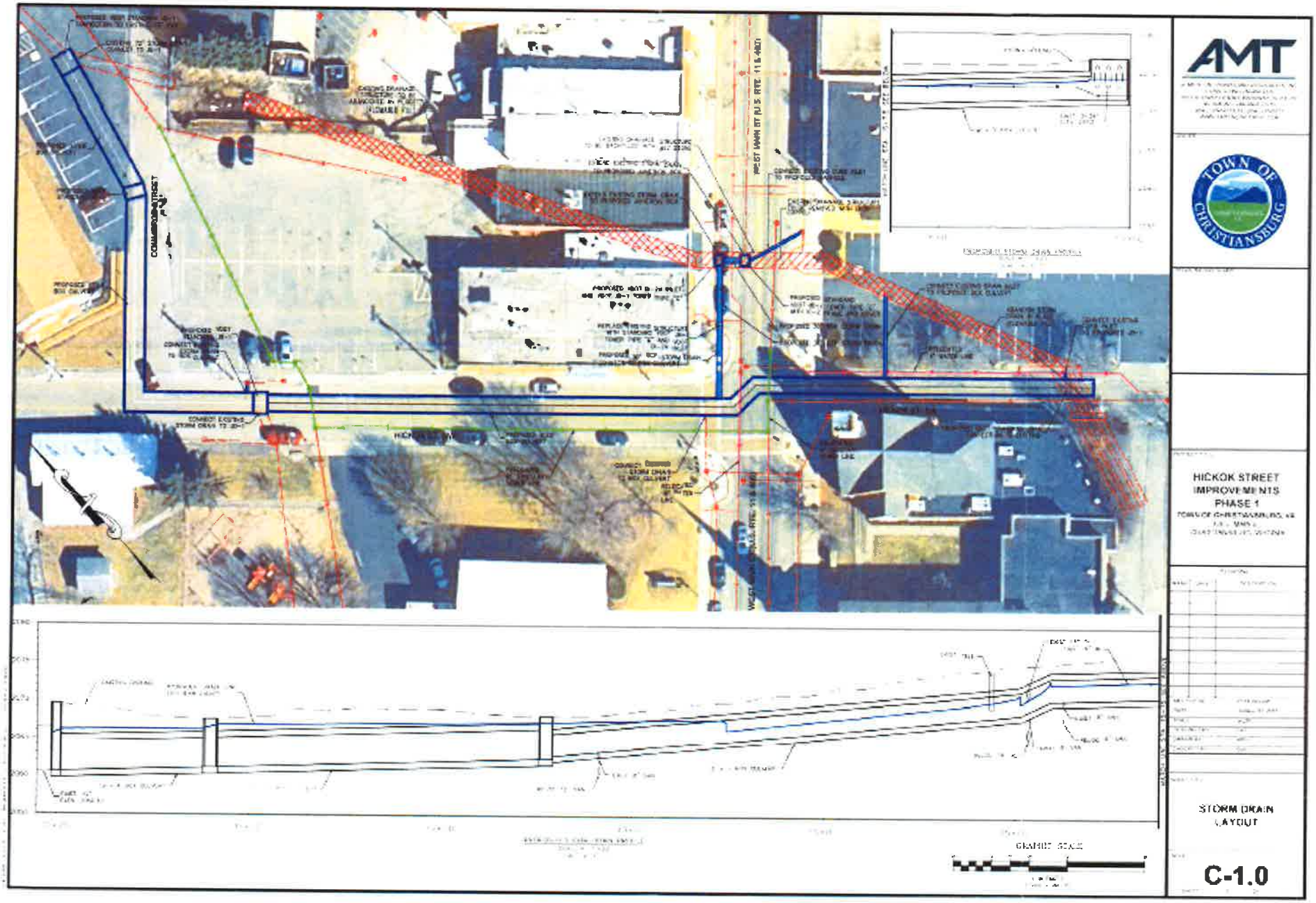

09/29/2015 12:23

Christiansburg Downtown Watershed Study – Chrisman / Phlegar Street: Phase I - $2.8M



Christiansburg Downtown Watershed Study – Chrisman / Phlegar Street: Phase II - $1.3M

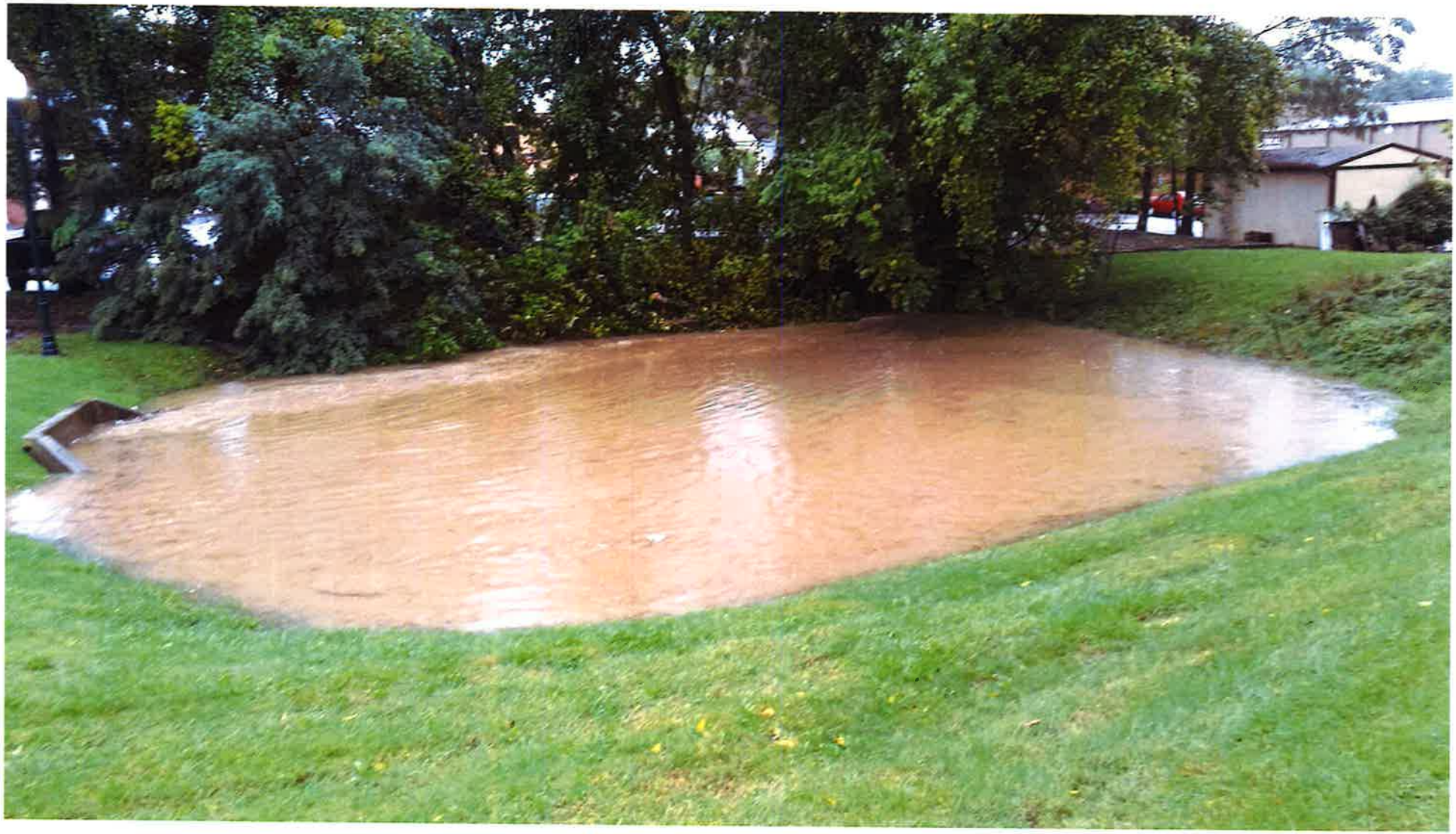

Bag Pave & Surfacing
N 43° 48' 30" E
Storm Drain
ED TOLLEY
HICKOK ST.
2-S Brick Theatre
W N SNIDOW
Conc. Steps
Comb. Cem. Conc.
Curb & Gutter Std.
One Course
2-S Brick



Christiansburg Downtown Watershed Study – Hickok Street - $2.7M

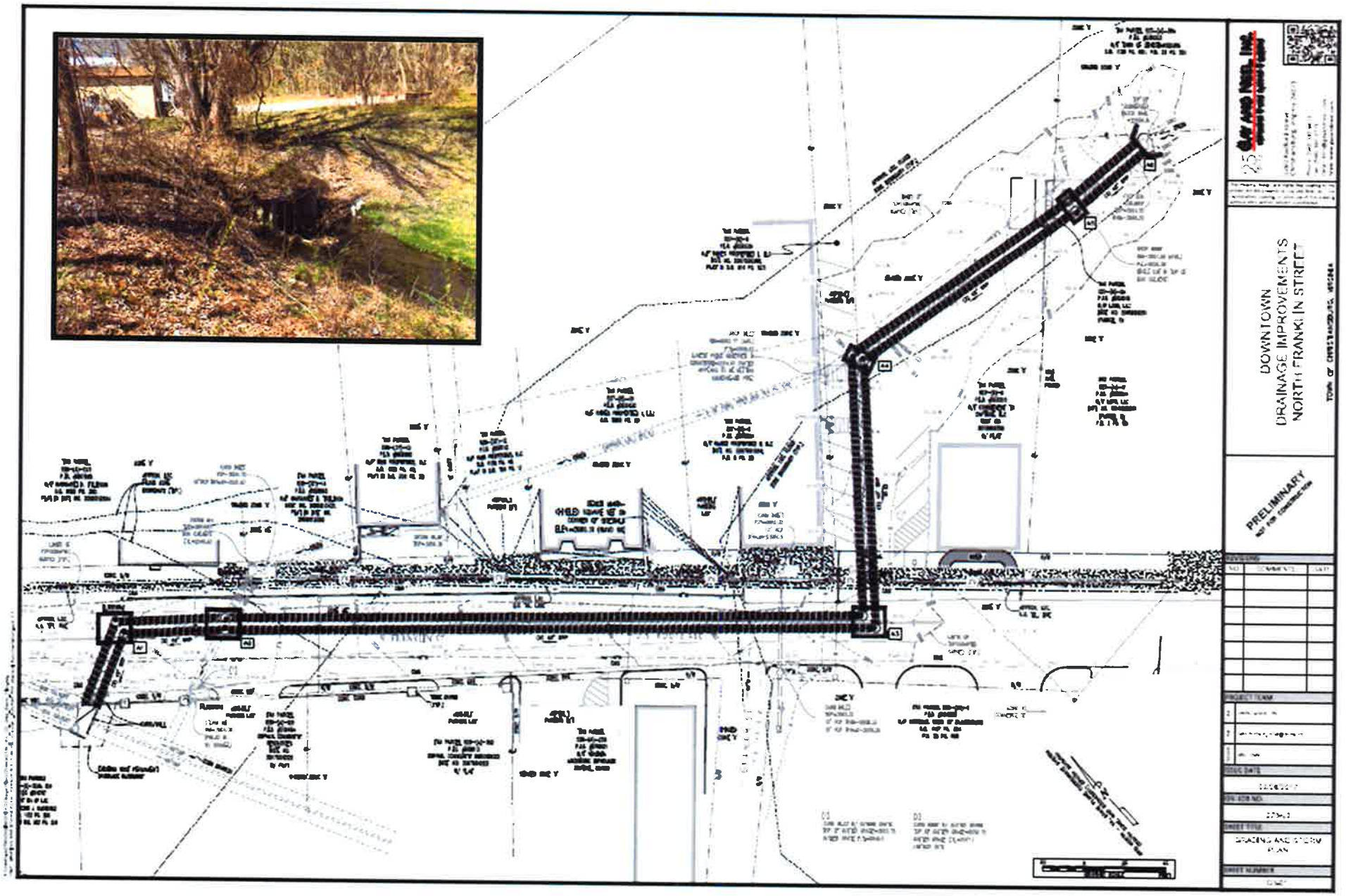
Christiansburg Downtown Watershed Study – near Town Hall Parking Lot

Christiansburg Downtown Watershed Study – near Town Hall Parking Lot



Christiansburg Downtown Watershed Study – near Town Hall Parking Lot

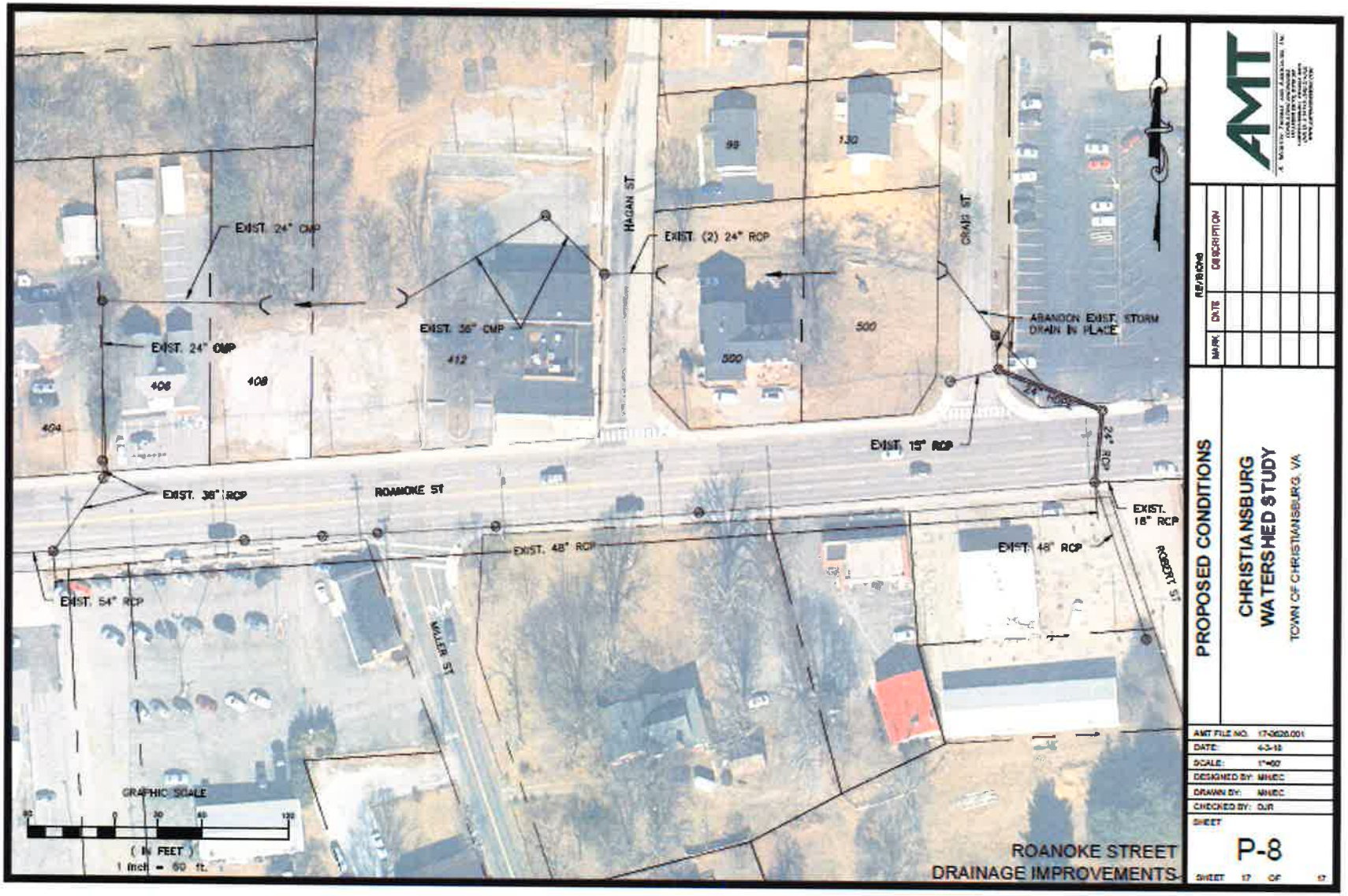
Christiansburg Downtown Watershed Study
– near Town Hall Parking Lot



Christiansburg Downtown Watershed Study – North Franklin Street - $1.0M

Christiansburg Downtown Watershed Study – 500 Roanoke Street

Christiansburg Downtown Watershed Study – 500 Roanoke Street



Christiansburg Downtown Watershed Study – Roanoke Street - $0.21M

Christiansburg Downtown Watershed Study – Radford Street - $1.1M

NEW RIVER VALLEY [HTTPS://WWW.WSLS.COM/NEWS/VIRGINIA/NEW-RIVER-VALLEY]

Study focuses on reducing flooding in Christiansburg

The study is expected to last through July 2018

By Erin Brookshier [https://www.wsls.com/author/ebrookshier] - Virginia Today Reporter

Posted: 6:03 AM, October 25, 2017
Updated: 6:03 AM, October 25, 2017

CHRISTIANSBURG, Va. - The town of Christiansburg is working to address issues with flooding in the downtown area and along Towne Branch. It's all part of an ongoing study to determine and address the problem areas.

One of the most important phases of the study kicks off this week as part of a community meeting. The town is looking for businesses and homes that tend to see issues with flooding, whether it's every time it rains or just every once in awhile.

Town leaders are asking community members to come out on Thursday night and share their concerns and stories. They are also asked to bring along any pictures or video for documentation, if they have it.

This is all information that will be used in the bigger plan, as a consultant team works to evaluate drainage and flooding problems along the creek, map out the floodplains and eventually develop a list of planned drainage improvements to put in place.

Wayne Nelson, the engineering director for the town of Christiansburg, says the team has already started to zero in on certain areas where he and others have seen repeated issues with flooding.

"When there's a big rain event here, it's all hands on deck," he says. "We're all out in the field, we're all answering calls, trying to help people because that's what we do."

Christiansburg Downtown Watershed Study

Thank you for attending!

APPENDIX K

Town Council Presentation Materials

Christiansburg Downtown Watershed Study

Proposed Projects

1. CHRISMAN / PHLEGAR ST. PHASE I
2. CHRISMAN / PHLEGAR ST. PHASE II
3. HICKOK ST. (FARMERS MARKET)
4. COLLEGE ST. PHASE I
5. COLLEGE ST. PHASE II
6. NORTH FRANKLIN ST.
7. RADFORD ST.
8. ALLEGHANY ST. / CANAAN RD. / EPPERLY DR.
9. STONE ST. CULVERT
10. ROANOKE ST.

WHAT'S HAPPENING?

Town Branch is a tributary to Crab Creek with a 1,284-acre watershed that includes Christiansburg's downtown area and surrounding residential neighborhoods.

Recent storm events, such as the one in September 2015, have caused flooding problems throughout the watershed; including areas along Phlegar and Chrisman Street, and at the Stone Street crossing of Town Branch.

As a result, the Town secured a **2017 Dam Safety, Flood Prevention and Protection Assistance Fund** grant to conduct a downtown watershed study.

The study evaluates flooding issues, identifies capital improvement projects, prioritizes those needs, and explores ways to align infrastructure projects with ongoing and future community needs.

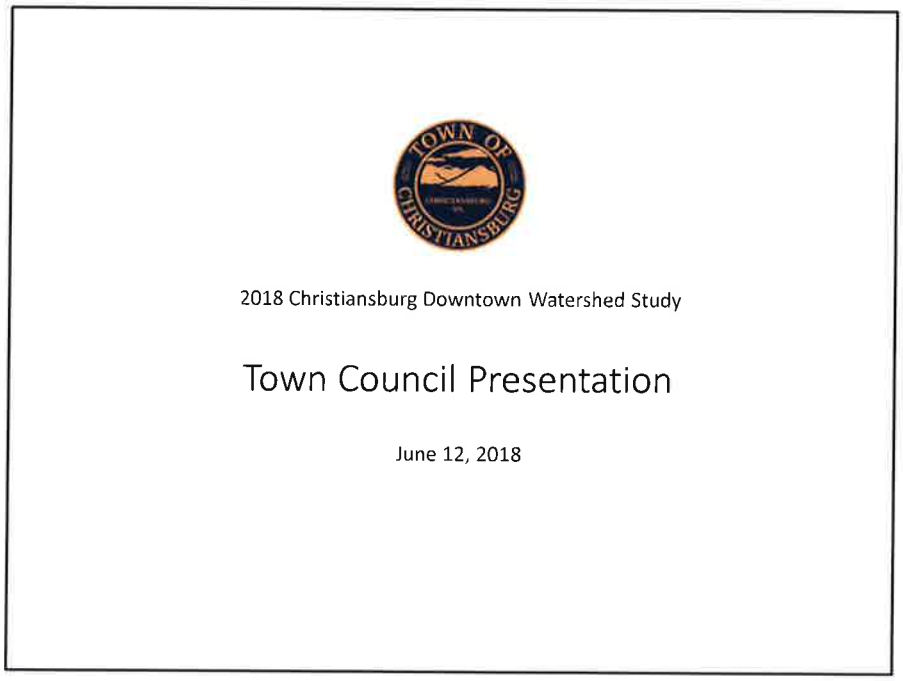
Proposed projects will require a long-term investment for implementation; an estimated total of $18 million. This can be done through the **Town's Stormwater Enterprise Fund** (established in 2016), as well as outside funding sources that can help leverage local investment in reducing flood risks.

Community meetings provided the opportunity to discuss flooding issues and potential stormwater quality improvements throughout the watershed. An additional concept being considered is the **Town Branch Walkable Watershed.** This concept proposes investing in stormwater quality and flood reduction strategies throughout the watershed, along with developing a network of greenway and on-street routes that better connect Depot Park to Downtown destinations along Town Branch.

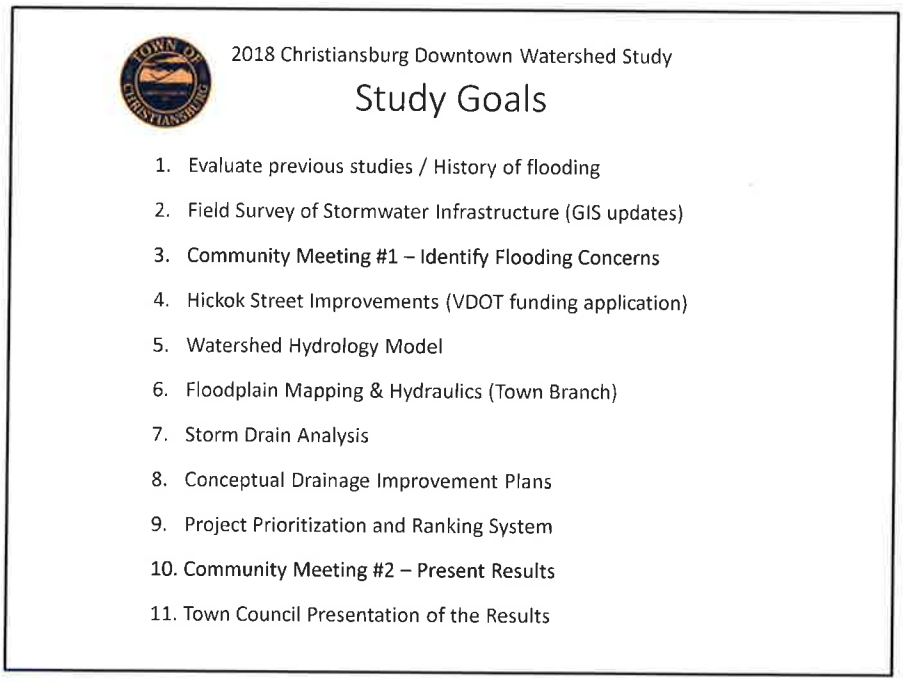
Get more updates @
https://www.christiansburg.org/watershed

WALKABLE WATERSHED CONCEPT

Christiansburg Downtown Watershed Study



I want to start by thanking Town Council for this opportunity to present the results of our Downtown Watershed Study for the Town of Christiansburg. The study was conducted by A. Morton Thomas and Associates in association with Hill Studio, working closely with Town Staff and interested residents. Partial funding for this study was provided by the Virginia Department of Conservation and Recreation - through the Dam Safety, Flood Prevention and Protection Assistance Fund.

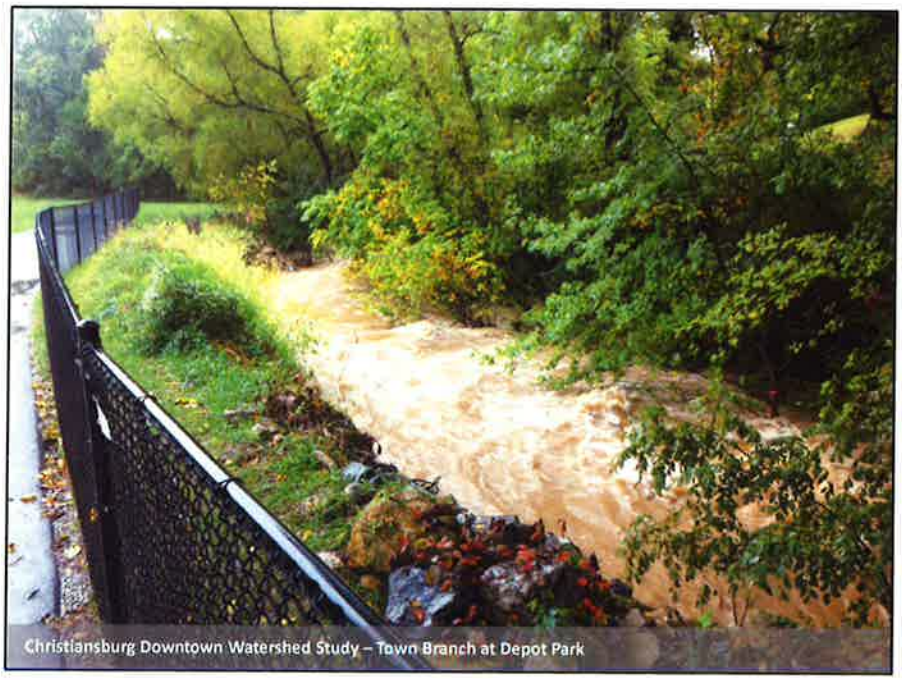


The study evaluates flooding issues, identifies capital improvement project needs, prioritizes those needs, and explores ways to align drainage infrastructure projects in the downtown area and surrounding residential neighborhoods within the Town Branch Watershed. Eleven (11) study goals were established at the outset, including two community meetings.

The first community meeting on October 26, 2017 included the presentation of 18 known drainage and flooding issues for discussion and citizen input. As a result, the list grew to 28 locations, designated as "red asterisks" on this watershed map. Flood photos were also provided by Town Staff and concerned residents, to help document the history of flooding throughout the watershed.

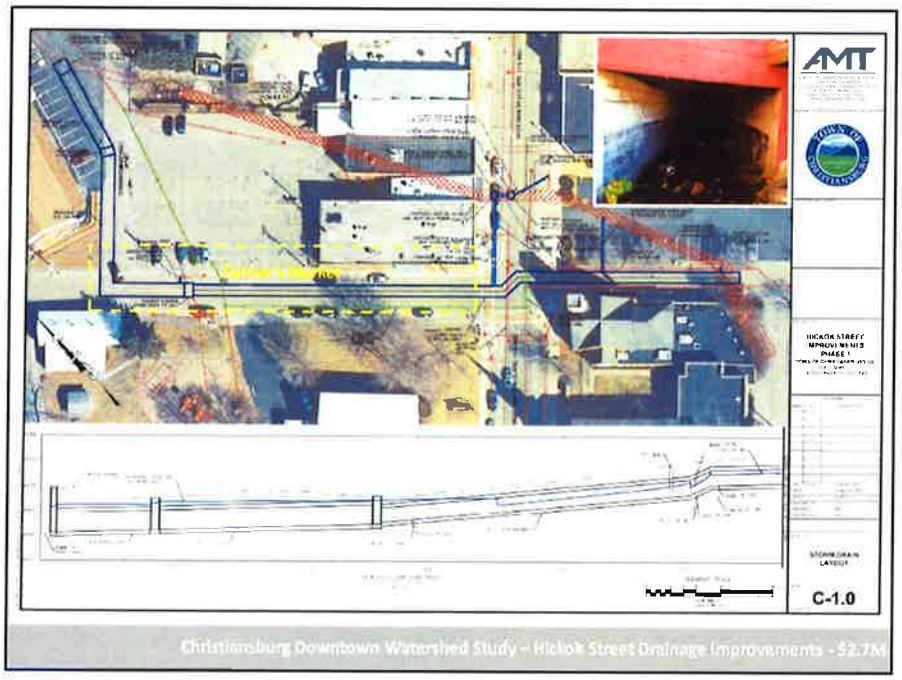
These flood photos on Canaan Road are from April 1992, showing how excess runoff from the Sunset Cemetery and South Franklin Street areas are causing issues in this residential neighborhood near the First Church of God.

This photo from September 2015 provides an example of the flooding at Phlegar and Chrisman Streets, where undersized inlets and pipes create areas of standing water during large storm events. Runoff through this neighborhood comes from 2 culverts under Interstate 81, at its headwaters.

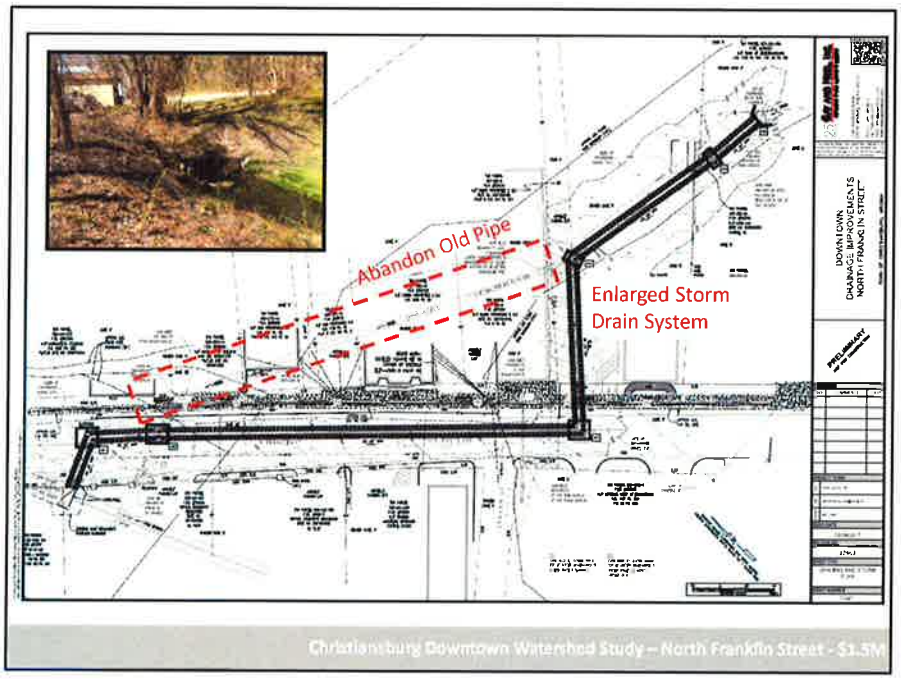


This photo in Depot Park shows runoff in Town Branch just after a large storm event. The peak discharges in Town Branch can cause stream instability and stream bank erosion, leading to water quality concerns. This is one of the reasons the Town recently completed a stream restoration project in Depot Park. Consideration for a second stream restoration project from Stone Street upstream to North Franklin Street could help further improve water quality in Town Branch before reaching Crab Creek.

Large peak flows in Town Branch can also lead to flood stages that overtop the corrugated metal pipes at Stone Street, causing street flooding and temporary road closures. For this location, we have recommended the installation of a dual 10' x 5' box culvert which conveys a 2-year storm event under the roadways without overtopping. This is considered a high priority project in the study.

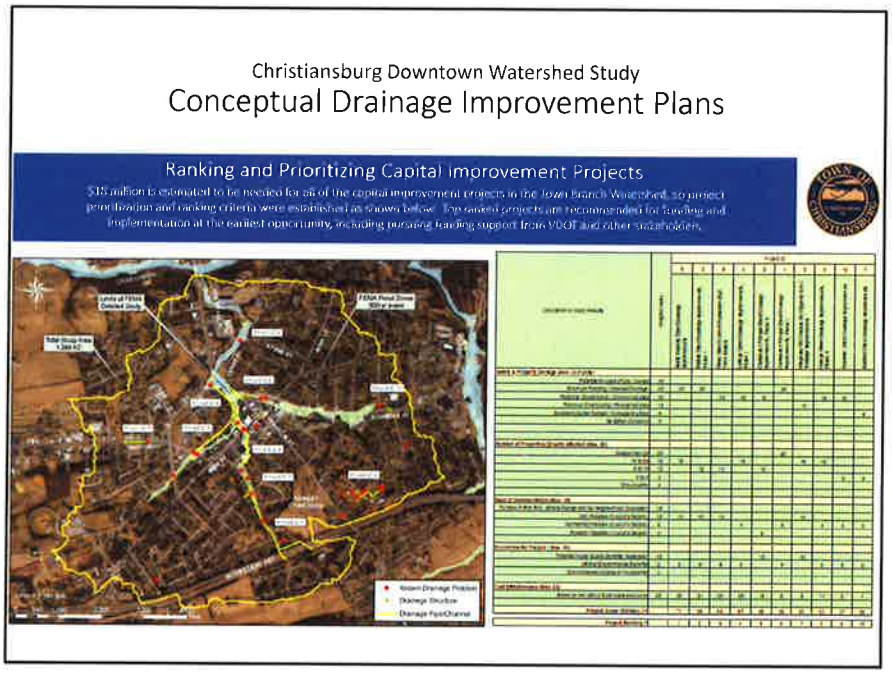


An early success for this study was helping the Town get selected by VDOT for partial funding of the Hickok Street Drainage Improvement Project. This high priority project will replace older drainage structures going underneath three existing buildings on West Main Street, shown in red above, by relocating the Town drainage system to Hickok Street, enlarging it, and improving drainage infrastructure underneath the Downtown Farmer's Market.

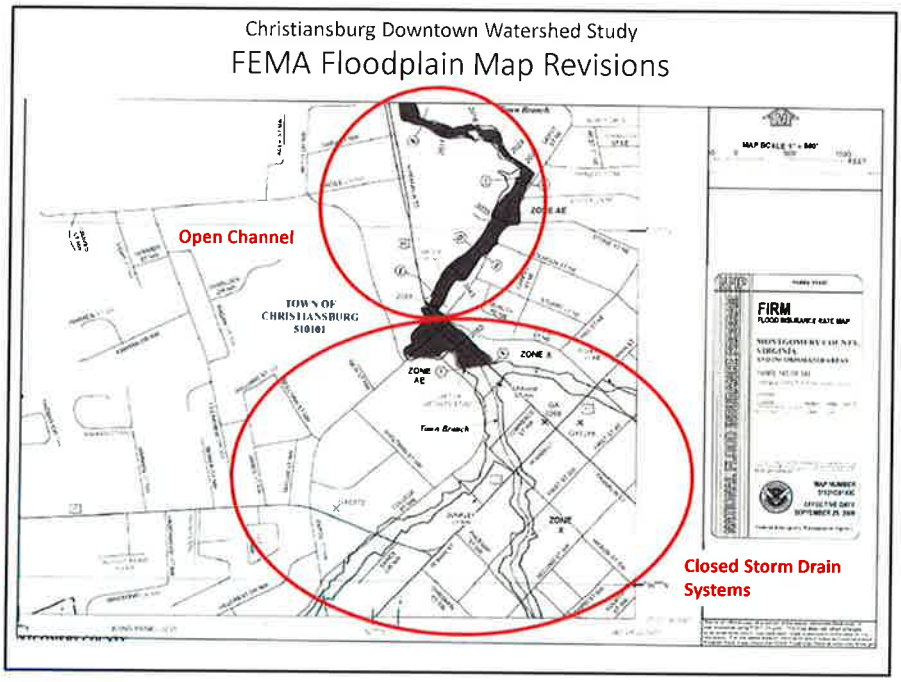


Another high priority project is the North Franklin Street project which also has VDOT revenue sharing funds, and is already being designed. To reduce flooding near the parking lots behind Town Hall, this project provides an enlarged storm drain system to convey runoff to an existing box culvert in North Franklin Street. This also allows the Town to abandon older pipes going under the existing buildings on the north side of the road.

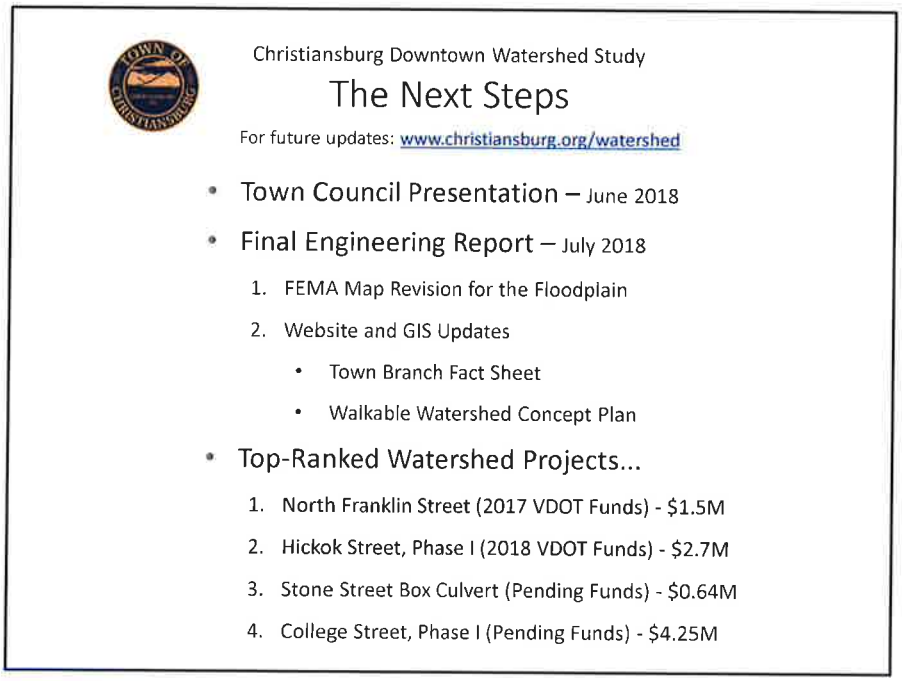
In total, there are 10 drainage improvement project recommendations totaling an estimated $18 million dollars to fully implement. Project locations, descriptions, and budgets are summarized on this presentation board and can be posted to the Town's project website and incorporated into the Town's GIS database. There is also a project fact sheet for this study that can be posted to the project website and distributed at future meetings.



Due to the high cost of the entire watershed program, the ten (10) projects were evaluated and ranked to help establish priorities. Projects summarized in this table are sorted by rank, with the North Franklin Street Project ranked as #1. Other highly ranked projects include Hickok Street (Phase I), College Street (Phase I) and the Box Culvert at Stone Street.



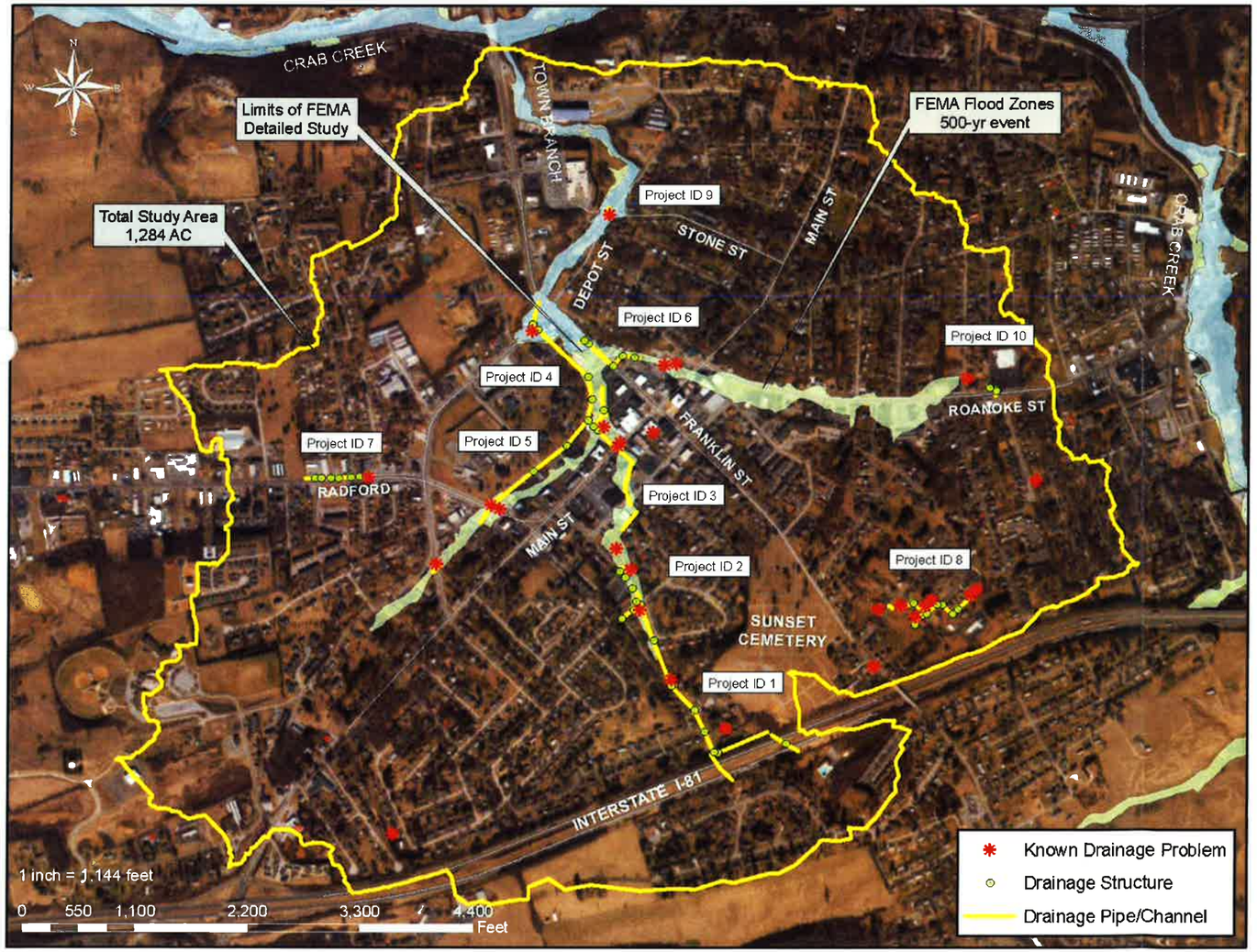
Revisions to the Town Branch Floodplain are also a goal of this study. The Town and AMT are in discussions with FEMA about establishing more accurate floodplain limits in the Zone AE designation below North Franklin Street and eliminating the designation of a special flood hazard area on North Franklin Street, which is now a closed storm drain system. A designated Zone X or AO is likely to remain upstream as currently shown on the FEMA map, to provide an approximate zone for risk of shallow flooding outside the special flood hazard area, during larger storm events that overtop the 10-year drainage systems that are planned.



To conclude this watershed study, AMT will now work with Town Staff to finalize the engineering report, submit a floodplain map revision request to FEMA, and update the Town's GIS databases and project website. Town Staff can then closeout the DCR grant and start implementing drainage improvement projects as directed by Town Council through your Stormwater Enterprise Fund, with outside funding support where possible. Additional information and updates can also be posted to the project website. Thank you for your time and I look forward to answering any questions.

Drainage Improvement Recommendations

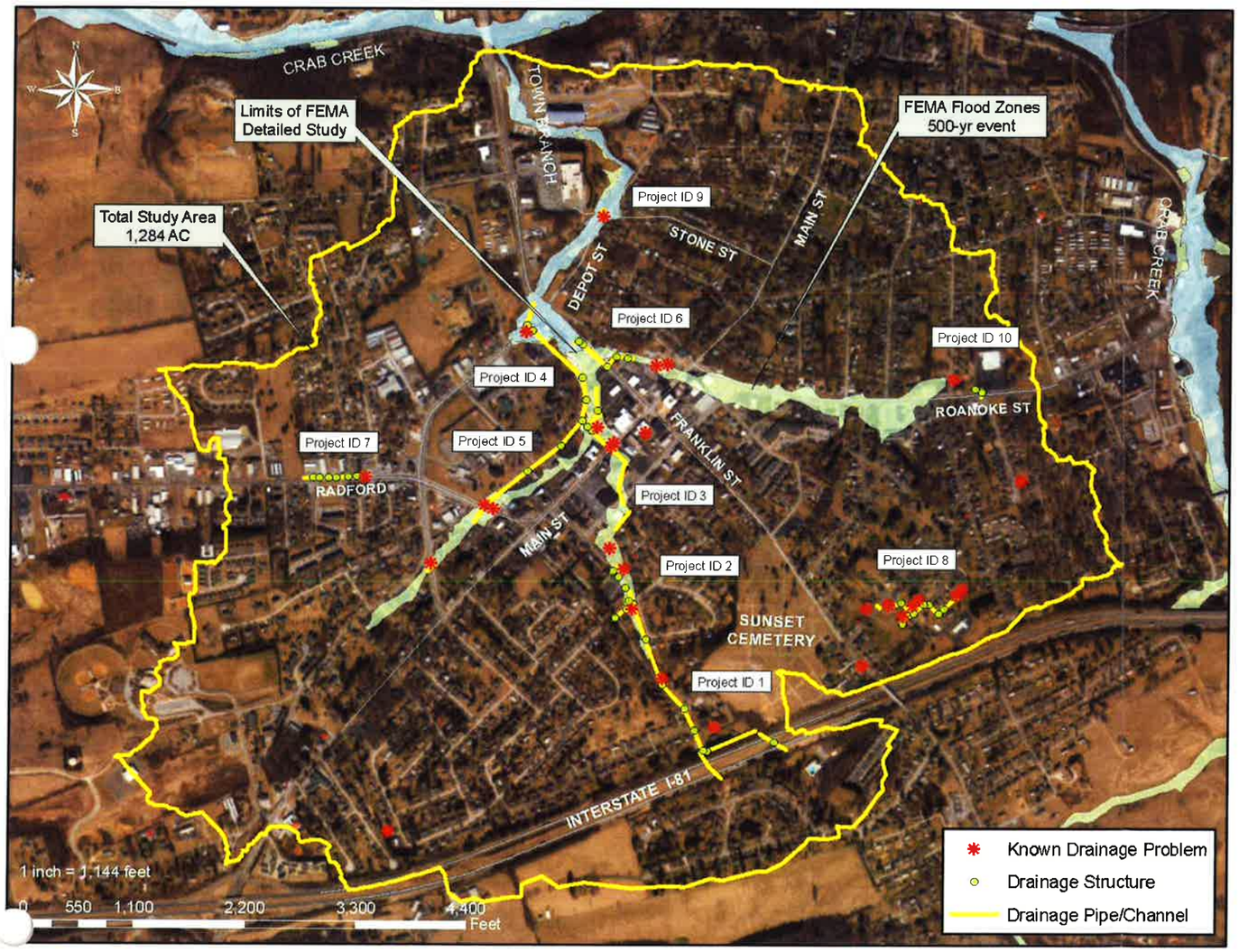
Twenty-Eight (28) identified drainage problems were evaluated in this watershed study, and ten (10) drainage improvement plans are recommended to help reduce or eliminate flood risks.



ID	Project Name	Budget	Description
1	Chrisman / Phlegar Street Drainage Improvements: Phase I	$2,800,000	This project collects runoff from existing 30" RCP and 48" RCP pipes under Interstate 81, and conveys the runoff in a closed drainage system along Chrisman Street, then crossing over to Phlegar Street following the alignment of the existing pipes. Recommended pipe sizes increase from 36" initially, to between 48" and 60" in diameter at 3rd Street SW.
2	Chrisman / Phlegar Street Drainage Improvements: Phase II	$1,300,000	Starting at the intersection of Phlegar Street and 3rd Street SW, this project is a series of small box culverts and open channels that convey runoff from the upper watershed to an existing triple 5'x3' box culvert under 1st Street. The channel alignment requires easements across some private properties, and may include stream stabilization measures.
3	Hickok Street Drainage Improvements: Phase I	$2,700,000	This project conveys runoff in a proposed 10'x4' box culvert under Hickok Street SW to the intersection with Commerce Street, removing a section of drainage conveyance that goes under the existing buildings on West Main Street. Runoff is conveyed either north along Commerce Street to a connection with the existing 72" CMP or west along Hickok Street to College Street, where it connects to the College Street Drainage Improvements (Phase I).
4	College Street Drainage Improvements: Phase I	$4,250,000	This project improves drainage by connecting the Hickok Street Drainage Improvement to a proposed 10'x4' box culvert under College Street, which conveys runoff to Depot Street. At Depot Street, a 12'x4' box culvert connects to a recommended quadruple 5'x5' box culvert for the last section of piping, to the outfall into Town Branch. This improvement also requires a connection to the 48" RCP in Depot Street and the Triple 5'x4' box culvert in North Franklin Street, as parallel drainage systems.
5	College Street Drainage Improvements: Phase II	$2,750,000	This project improves drainage, starting with known flooding concerns at the intersection of College Street / Radford Street, and running along College Street in a 6'x4' box culvert. At Hickok Street, the 6'x4' box culvert combines with the runoff from the Hickok Street Drainage Improvement, to be conveyed downstream under College Street (Phase I).
6	North Franklin Street Drainage Improvements	$1,500,000	This project is currently being designed for the Town, using VDOT revenue sharing funds. It requires a combination of 42" and 60" pipes to collect runoff from below the parking lots at Town Hall, and improves conveyance of this runoff to the outfall at Town Branch. It also eliminates a section of existing storm drain that is going under some buildings on North Franklin Street.
7	Radford Street Drainage Improvements	$1,100,000	This project is smaller than some others in the downtown area, and addresses clogged inlets and undersized pipes along the north side of Radford Street. By increasing the pipe size from 15" to 24" and adding adequately sized throat lengths on the drainage inlets, runoff can be intercepted and conveyed into the existing 36" RCP at Lee Hy Court, then draining along Radford Street to Depot Street and into the downtown area. New sidewalks may also be considered for this area.
8	Alleghany St / Canaan Rd / Epperly Drive: Drainage Improvements	$750,000	This project helps address surface water and groundwater concerns from the Sunset Cemetery and Alleghany Street in areas along Canaan Road and Epperly Drive, by replacing existing 15" pipes with 24" and 30" pipes. Runoff is then conveyed into the rear yards on the south side of Epperly Drive, behind the First Church of God, with a pipe extension to an existing stormwater management basin (dry detention). During engineering design, the Town may choose to retrofit the existing basin to help proect existing drainage systems downstream and to promote improved water quality in the watershed.
9	Stone Street Culvert Replacement at Town Branch	$640,000	This project replaces an existing quadruple 48" CMP with a dual 10'x5' box culvert, providing increased capacity to convey the 2-year storm under Stone Street without overtopping onto Depot Street. 10-year and 100-year flood depths are reduced with this culvert replacement. Possible impacts of the larger pipes on the stream restoration project in Depot Park will need to be evaluated, as well as the flood reduction benefits of eliminating the abandoned bridge near Stone Street. Enhanced water quality can also be considered with this project, by developing a stream restoration project from Stone Street to North Franklin Street, creating a linear park or greenway concept.
10	Roanoke Street Drainage Improvements	$210,000	This project begins at an existing curb inlet near Wade's Foods which has a small diameter pipe draining to Craig Street. The recommendation is to eliminate runoff from Craig Street into the open channel behind 500 Roanoke Street by installing a storm drain system that conveys runoff from the Wade's Foods parking lot and Craig Street to Roanoke Street, where it ties into the existing storm drain system.

Ranking and Prioritizing Capital Improvement Projects

$18 million is estimated to be needed for all of the capital improvement projects in the Town Branch Watershed, so project prioritization and ranking criteria were established as shown below. Top ranked projects are recommended for funding and implementation at the earliest opportunity, including pursuing funding support from VDOT and other stakeholders.



Description of Study Results	Weighed Value	Project ID 6	3	9	4	2	1	8	5	10	7
		North Franklin Street Drainage Improvements	Hickok Street Drainage Improvements, Phase I	Stone Street Culvert Replacement at Town Branch	College Street Drainage Improvements, Phase I	Chrisman / Phlegar Street Drainage Improvements, Phase II	Chrisman / Phlegar Street Drainage Improvements, Phase I	Alleghany St / Canaan Rd / Epperly Drive: Drainage Improvements	College Street Drainage Improvements, Phase II	Roanoke Street Drainage Improvements	Radford Street Drainage Improvements
Safety & Property Damage (Max. 30 Points)											
Potential for Loss of Life / Injuries	30										
Structure Flooding / Potential Damage	20	20	20				20				
Roadway Overtopping - Commercial Area	16			16	16	16			16	16	
Roadway Overtopping - Residential Area	12							12			
Excessive Gutter Spread / Hydroplaning Risk	6										6
No Safety Concerns	0										
Number of Properties Directly Affected (Max. 20)											
Greater than 25	20						20				
10 to 25	16	16			16			16	16		
6 to 10	12		12	12		12					
2 to 5	8									8	8
One property	4										
Ease of Implementation (Max. 15)											
Funded, Within R/W, Simple Design and No Neighborhood Opposition	15										
Very Feasible (3 out of 4 factors)	10	10	10	10				10			
Somewhat Feasible (2 out of 4 factors)	5				5		5		5	5	5
Possibly Feasible (1 out of 4 factors)	0					0					
Environmental Factors (Max. 10)											
Potential Water Quality Benefits (Moderate)	10					10		10			
Minimal Environmental Benefits	5	5	5	5	5		5		5	5	5
Environmental Impacts or No Benefits	0										
Cost Effectiveness (Max. 25)											
Based on the ratio of $ per watershed acre	25	20	21	25	25	18	6	5	11	3	1
Project Score (100 Max.) =		71	68	68	67	56	56	53	53	37	25

Project Ranking =		1	2	3	4	5	6	7	8	9	10