PIGEON RIVER FLOOD RISK REDUCTION PLAN

TOWN OF CANTON

HAYWOOD COUNTY, NORTH CAROLINA

PRELMINARY ENGINEERING REPORT
UPPER PIGEON RIVER FLOOD RISK REDUCTION PLAN

TOWN OF CANTON

CANTON, HAYWOOD COUNTY, NORTH CAROLINA

CAMERON M. LONG, PE

Cameron Long
Digitally signed by Cameron Long
Date: 2024.10.25 11:25:14 -04'00'

55 Broad Street
Asheville, North Carolina 28801
828.252.0575

Firm License No.: C-0459

OCTOBER 2024

PROJECT NO. 23.03009

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

In August 2021, Tropical Storm Fred devastated many communities in Haywood and Transylvania Counties. In Haywood County, within the Pigeon River watershed, six people died and over 400 structures were destroyed or damaged, including Canton's Town Hall. Canton's drinking water treatment plant and Evergreen Packaging's wastewater treatment works, which also receives the Town's wastewater, were damaged resulting in service interruptions. Farmers throughout the area lost their crops and businesses were closed for several days. Many of these noted impacts are part of a repetitive loss cycle that started in September 2004 with Hurricanes Frances and Ivan which delivered similar destruction in the watershed. Mitigation efforts and buy-outs following this event provided some benefit, but more investment is required to further improve community resiliency.

In May 2023, Evergreen Packaging announced the closure of the paper mill in downtown Canton. Evergreen was the single largest employer in the region and the loss of the mill creates both significant hardship and opportunity for the Town. The mill property straddles the Pigeon River in the heart of the Town and is predominantly within the FEMA regulated floodplain of the river. The Town of Canton is seeking ownership of the mill and exploring potential beneficial reuse of the property including riparian corridor restoration and restoring floodplain function to align with a future vision for economic grown centered around eco-tourism. The Town is working with various partners including the Coastal Dynamics Design Lab (CDDL) of NC State University and American Flood Coalition (AFC) to explore project alternatives that can reduce flood risk and increase Town resiliency.

The Town is also coordinating with Haywood Waterways Association (HWA) who has contracted with McGill Associates to create this Preliminary Engineering Report – Flood Risk Reduction Plan. The goals of the Flood Risk Reduction Plan for the Upper Pigeon River include:

1. Prepare a hydraulic model to serve as the foundation to explore opportunities to achieve greater flood resilience in the Town of Canton.

2. Coordinate with CDDL and AFC to identify collaborative projects that benefit the Town of Canton and the Pigeon River watershed.

3. Evaluate and prioritize flood reduction alternatives, identify potential benefits, establish potential cost of implementation, and provide the basis for pursuing future grant funding.

Several alternatives were evaluated for flood reduction benefit using the U.S. Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS) model version 6.5. A 2D model domain with an input hydrograph supported by United States Geological Survey (USGS) gage data was used to evaluate the alternatives. Some of the alternatives evaluated rely on project measures also evaluated by CDDL of NC State University in their Hydraulic Modeling for Floodprint Project in Canton, NC. Alternatives selected for reporting in this report include the CDDL Scenario D, identified as CDDL D, along with different variations on that alternative.

Ultimately, four alternative scenarios were selected based on flood risk reduction benefit, anticipated costs, and their ability to be phased over a longer duration if needed. The reported alternatives include floodplain benching, bridge removal/widening, flow diversion, and removal of low head dams. The average reduction in water surface elevation and opinions of probable cost are summarized below.

Scenario	Opinion of Probable Cost	Average Water Surface Reduction in Town (ft)
Alternative 1 - CDDL D with Upstream Flood Storage	$ 46,130,000	5.71
Alternative 2 – Upstream Flood Storage	$ 3,940,000	1.30
Alternative 3 - CDDL D	$ 45,150,000	5.68
Alternative 4 - CDDL D Without Bridges	$ 35,810,000	5.45

Figures that identify various alternative features are included in section 3.2. Estimated opinion of probable costs associated with reported alternatives and their major features are also included in Appendix C. These alternatives can be implemented as complete projects or in phases that help the community reach their community goals related to flood resiliency, watershed restoration, and economical enhancements.

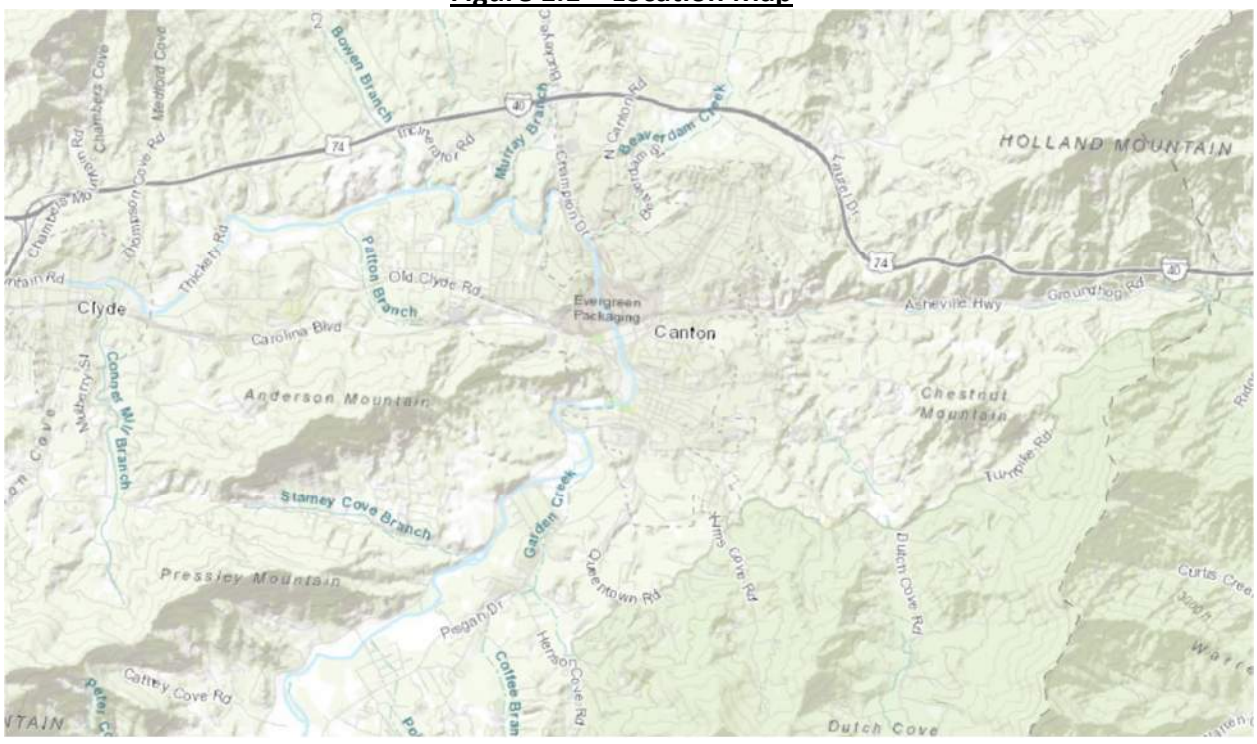
It should be noted that even the most robust selected alternative, Alternative 1- CDDL D with Upstream Flood Storage, still results in significant structural flooding in the Town of Canton as shown on floodplain figures in Appendix B. This indicates that future plans within the Town should also include relocating critical infrastructure outside of floodplains, floodproofing, land acquisition to preserve existing floodplain function, and planning common use areas that can also be used for flood reduction benefit.

1.0 PROJECT BACKGROUND

1.1 Location

The Pigeon River stretches from Haywood County, North Carolina into East Tennessee, spans dozens of miles of national forests, drains much of the northeastern portions of the Great Smoky Mountains National Park, and ultimately flows into the French Broad River. Near the river's headwaters, the Haywood County communities of Cruso, Canton, and Clyde were founded along the banks of the river as it courses its way through the Southern Appalachian Mountains. The county contains several major subranges of the Blue Ridge Mountains, including some of the highest mountains east of the Mississippi River. The Pigeon River Watershed drains through narrow mountain valleys and natural drainage features over 2,500 vertical feet before reaching the first major community in the Town of Canton. The areas upstream of Canton are relatively remote with extensive forest, rural residential, and agricultural land uses. Canton, itself, is a historic mill town with unique assets and opportunities for business and recreation situated twenty miles west of Asheville. The project location can be seen below in **Figure 1.1**.

Figure 1.1 – Location Map



1.2 History and Need

In August 2021, Tropical Storm Fred devastated many communities in Haywood and Transylvania Counties. In Haywood County, within the Pigeon River watershed, six people died and over 400 structures were destroyed or damaged, including Canton's Town Hall. Canton's drinking water treatment plant and Evergreen Packaging's wastewater treatment works, which also receives the Town's wastewater, were damaged resulting in service interruptions. Farmers throughout the area lost their crops and businesses were closed for several days. Many of these noted impacts are part of a repetitive loss cycle that started in September 2004 with Hurricanes Frances and Ivan which delivered similar destruction in the watershed. Mitigation efforts and buy-outs following this event provided some benefit, but more investment is required to further improve community resiliency.

In May 2023, Evergreen Packaging announced the closure of the paper mill in downtown Canton. Evergreen was the single largest employer in the region and the loss of the mill has created both significant hardship and opportunity for the Town. The mill property straddles the Pigeon River and is predominantly within the FEMA regulated floodplain of the river. The mill's closure has compounded the burden on the Town as it has already strained to recover from repetitive flood damage. Despite the difficult circumstances, the Town of Canton is committed to flood resiliency and mitigation and is exploring potential beneficial reuse of the mill property including riparian corridor restoration and restoring floodplain function at the mill property and elsewhere along the Pigeon River. The Town is working with various partners to explore various aspects of project including the Haywood Waterways Association (HWA), Coastal Dynamics Design Lab (CDDL) of NC State University, the American Flood Coalition (AFC), and others. In the endeavor to reduce future flooding in the Pigeon River Basin, increase resiliency in Haywood County communities, and to reduce risks to local drinking water, water supply, and wastewater treatment works, Haywood Waterways Association has contracted McGill Associates (McGill) to assist with development of riverine modeling to simulate flood conditions occurring within the project area and identify alternative best management practices that reduce flooding and increase resiliency within the Town of Canton.

1.3 Goals for Development of a Flood Risk Reduction Plan

The current needs for flood resilience in Haywood County Communities are well suited for development of a flood risk reduction plan with the following goals:

1. Prepare a hydraulic model to serve as the foundation to explore opportunities to achieve greater flood resilience in the Town of Canton.

2. Coordinate with CDDL and AFC to identify collaborative projects that benefit the Town of Canton and the Pigeon River watershed.

3. Evaluate and prioritize flood reduction alternatives, identify potential benefits, establish potential cost of implementation, and provide the basis for pursuing future grant funding.

A flood risk reduction plan, if adopted, can provide actionable items for mitigating flood risks in a community and can serve as a basis for future efforts in removing or reducing flood risk in developed and developing areas.

2.0 MODELING

2.1 Data Acquisition

McGill obtained data from numerous sources prior to, and during, model development. The collection of historical flood information included review of historical aerial imagery, historical flood records, high-water marks surveyed by United States Army Corps of Engineers (USACE), historic precipitation, and other anecdotal information from HWA and the North Carolina Flood Inundation Mapping and Alert Network (FIMAN). McGill obtained Light Detection and Ranging (LiDAR) from NC Spatial Data Download, land cover data from the National Land Cover Database, and parcel data from the county. Effective hydraulic models for the Upper Pigeon River and some associated major tributaries were obtained from the North Carolina Floodplain Mapping Program (NCFMP). Supplemental channel cross sections and physical survey of points on structures were also conducted to bolster the LiDAR-derived terrain. CDDL provided the draft report of "Hydraulic Modeling for Floodprint Project in Canton, NC" prepared by Dr. Doll and Dr. Kurki-Fox for Coastal Dynamics Design Lab and NC State University College of Design. They also provided terrain inputs for model scenarios described in the draft report which describes the use of hydraulic modeling to test the flood reduction benefits of bridge modification and floodplain modifications along the Pigeon River in Canton, NC.

2.2 Hydrology

The model for this study models the Tropical Storm Fred event exclusively using a hydrograph created from the USGS stream gage data near town (Gage Site Number 3456991). The start time of the simulation was selected after an initial peak and captured the major peak of the storm event before stopping on the receding limb of the hydrograph. It was applied upstream at the beginning of the model domain. That is approximately 4.5 miles upstream from the gage location. The start time was shifted by 45 minutes to account for the travel time and to better align with what was observed at the gage location. There was some attenuation in peak flow at the gage location when compared to the downloaded data albeit minor. The model was calibrated using the gage information and is discussed further below.

The current approach to hydrology is efficient in evaluating the flood risk reduction benefit of alternatives seeking to store or attenuate flood waters. Future modeling efforts may benefit by modeling additional flood events. Modeling of future flood events would prove helpful and overall model accuracy could be improved via hydrologic inputs with additional precipitation gages in the watershed and additional stream gages along the reach.

2.3 Hydraulics

All hydraulic modeling was conducted using The U.S. Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS) model Ver. 6.5. The hydraulic modeling effort began with review of the Effective Flood Insurance Rate Map (FIRM) model from the North Carolina Flood Mapping Program (NCFMP). The effective model is a one-dimensional model that runs from the confluence of the East Fork Pigeon River and the West Fork Pigeon River downstream to the confluence with Richland Creek. Although associated with a detailed study, the effective model contains gaps of greater than 1000 feet between cross sections, lacks detail in modeling structures, and completely ignores some prominent geographic features in the Town of Canton.

An existing conditions model was created within HEC-RAS utilizing two-dimensional methodologies. This allows greater terrain resolution across the model, more accurate flow direction and velocity outputs, and the ability to better understand how potential alternatives would impact the routing of storm flows through project sites and the town. Concurrently, CDDL produced their draft report to summarize CDDL modeling efforts. Collaboration during model development allowed the existing conditions model for this project to evaluate the CDDL existing conditions and certain CDDL alternatives in more detail.

The model extends from approximately 0.8 miles downstream of the confluence of the East Fork Pigeon River and the West Fork Pigeon River until approximately 1.3 miles downstream of the Blackwell Drive bridge. **Figure 2.1** displays the model extents. The existing conditions terrain was established by utilizing LiDAR for the model area and supplementing that elevation data with cross sectional survey conducted at fourteen locations along the reach. The channel surface was created by integrating survey data into respective 1D cross sections and generating an interpolated Digital Elevation Model (DEM). This methodology applies the survey data in the immediate vicinity where it occurred without amending the bathymetry from the effective model where supplemental survey did not occur. The newly generated channel DEM was integrated back into the model terrain at edge of water, or nearby point, to assimilate with the LiDAR. The detail added by supplemental survey was not inconsequential as seen in **Figure 2.2**, comparing a cross section from the effective model and a surveyed cross section. A map of supplemental survey locations is shown in Appendix A.

Figure 2.1 – Model Extents

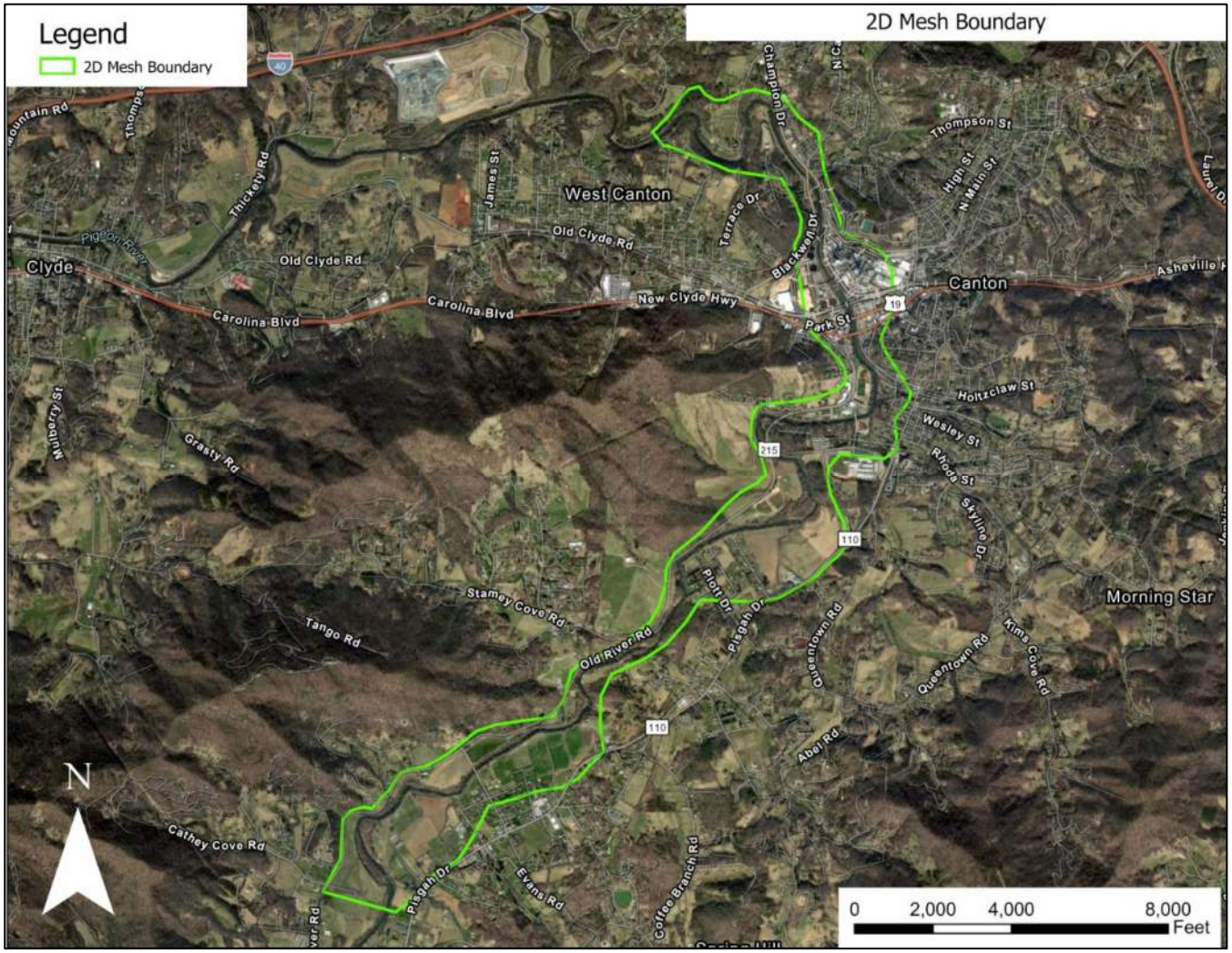
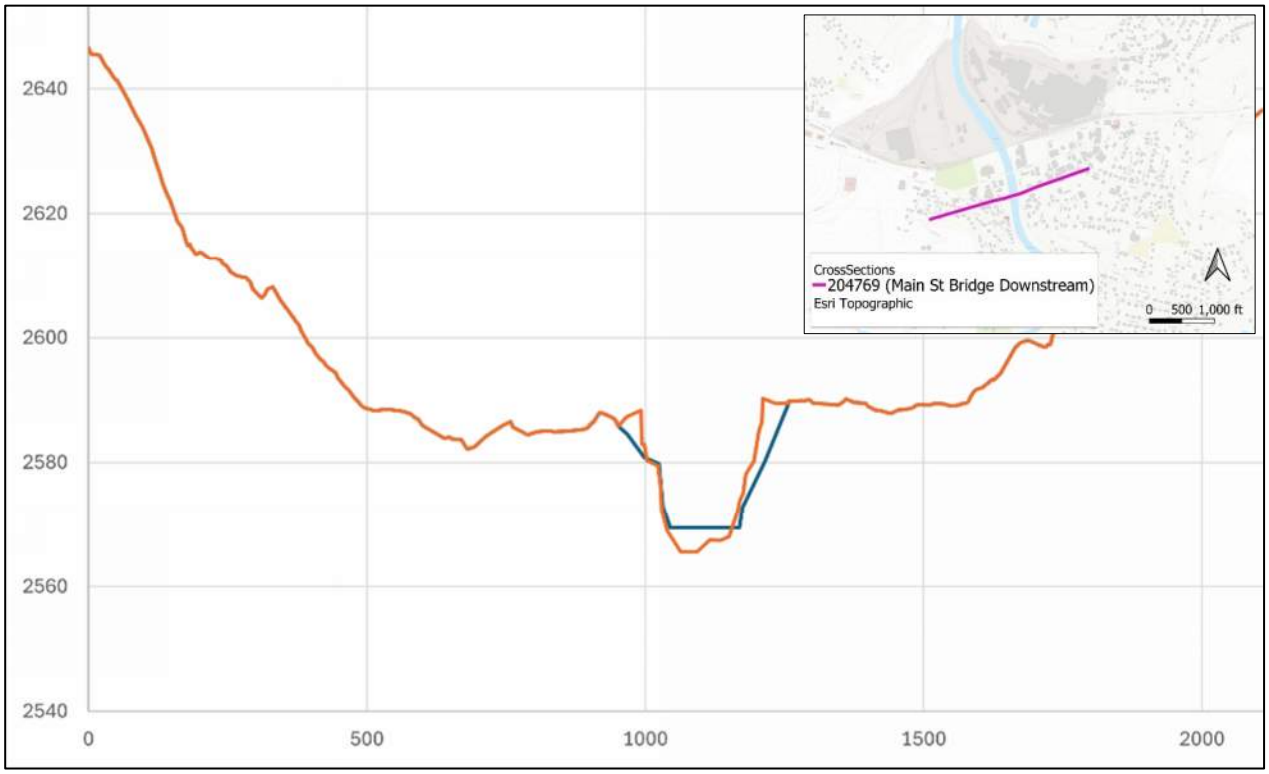
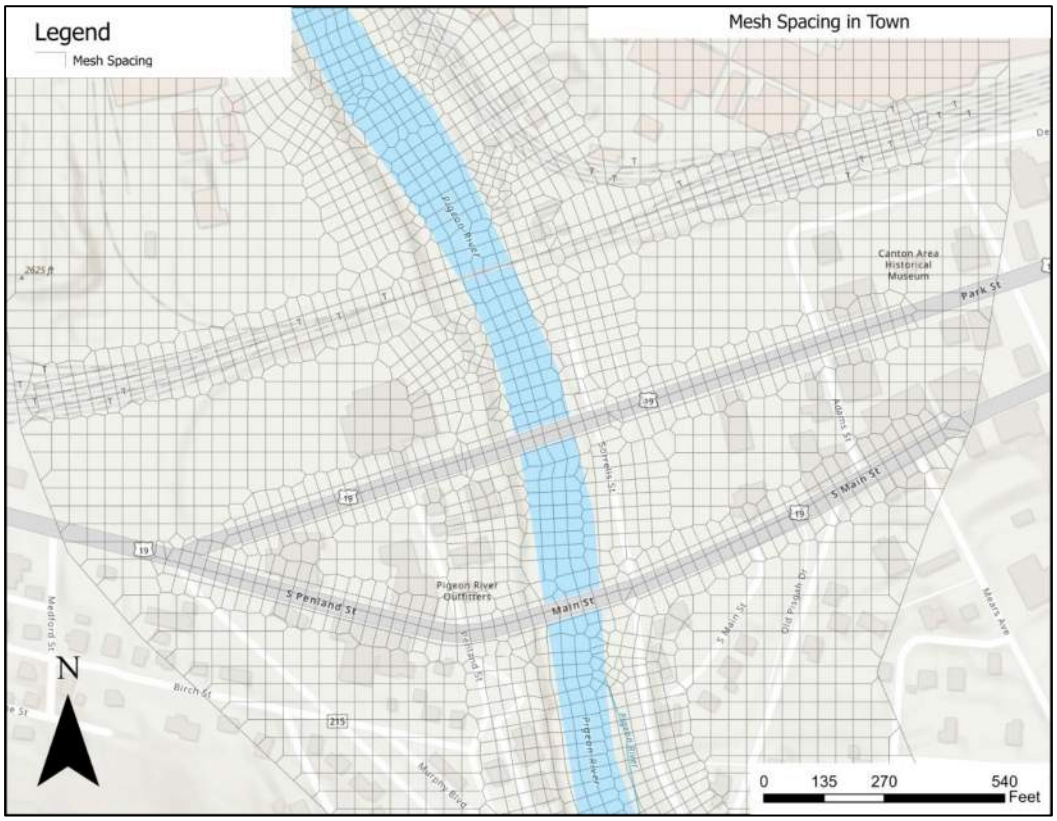


Figure 2.2 – Example Comparison of Survey (Orange) and Effective Model Cross Section (Blue) at Main Street Bridge



A land cover layer was established with the National Land Cover Database information and associated Manning's roughness coefficients. Within the model extents, the computational mesh was created with varying cell sizes to balance resolution, run time, and overall model stability. The base cell size for the model is 40 feet but reduces to 30 feet in refinement areas for the channel, near changes in terrain slope (break lines), and at storage area connections. This mesh resolution is exemplified in **Figure 2.3.**

Figure 2.3 – Mesh Resolution



In addition to adding resolution compared to prior models for the Pigeon River, buildings were represented within the model by modifying Manning's roughness coefficients to 1 within building footprints. Bridge geometries were evaluated for suitability of detail and supplemented with physical survey in several locations including portions of the utility catwalk near the mill property, Park Street bridge, Main Street bridge, and the Penland Street bridge (near Canton Recreation Park). Physical survey was also conducted at the two low head dams located between the regional railroad crossing and the utility catwalk near the mill property. The low head dams and all bridges within the model were modeled with SA/2D Area Connections dependent on structure type and in all cases, the mesh was reinforced as break lines in the structure locations.

The modeling effort concentrated on Tropical Storm Fred. The boundary conditions applied to the model were a hydrograph at the upstream limit and a normal depth at the downstream limit.

Gage data available from USGS for Tropical Storm Fred bolstered the model calibration process. Alterations to geometric model inputs and Manning's roughness coefficients were used to calibrate the model results to thirteen observed high-water marks from Tropical Storm Fred surveyed by USACE. The average deviation between recorded high-water marks surveyed after Tropical Storm Fred and the water surface elevation output for existing conditions was

approximately 0.2 feet, where the average indicates the model generally over predicted the water surface elevation. The model calibration results are shown in **Table 2.1 and** summarized in **Table 2.2**. **Figure 2.4** shows the locations and values of surveyed high-water marks and **Figure 2.5** and **Figure 2.6** display the differences between high-water marks and the existing conditions water surface elevation. **Figure 2.7** illustrates the inundation extents near downtown Canton. Additional model results are shown in Appendix B.

Table 2.1 – Model Calibration Results

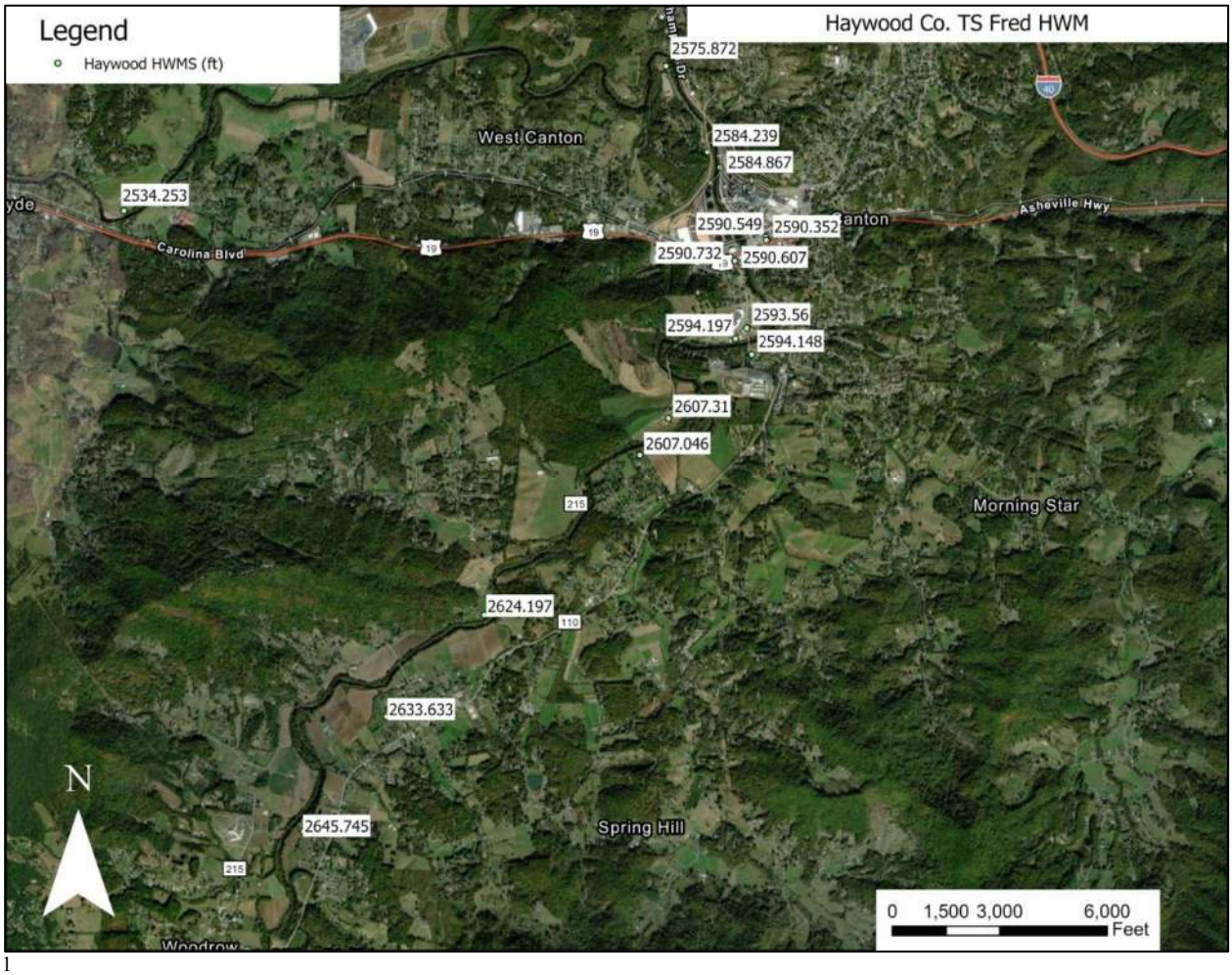
PT	Location	Recorded HWM[1]	Existing Conditions WSE	Difference [EC-HWM] (ft)
34	Pinnacle Church	2575.87	2576.4	0.53
19	1 Blackwell Dr.	2584.5	2584.26	-0.24
20	West Gate Guard Station at the Mill	2584.867	2585.44	0.57
21	Fire Department	2590.549	2590.39	-0.16
22	Police Department	2590.352	2590.4	0.05
23	69 Park St.	2590.329	2590.47	0.14
24	10 Penland Street	2590.607	2591.52	0.91
25	Bethel Christian Academy	2590.732	2591.29	0.56
26	Canton Armory	2593.56	2593.63	0.07
27	Aquatic Center	2594.197	2594.8	0.60
28	Pisgah Baseball Field	2594.148	2594.04	-0.11
29	324 Brookside Drive	2607.046	2606.97	-0.08
30	Cold Mountain Nursery	2633.633	2633.06	-0.57

[1]Recorded HWM surveyed by USACE

Table 2.2 – Model Calibration Summary

Area	Average Differences in Water Surface Elevation Between Tropical Storm Fred High-Water Marks and Existing Conditions Model (ft)
Downtown	0.30
Canton Recreation Park	0.19
Upstream of PHS Fields	-0.02

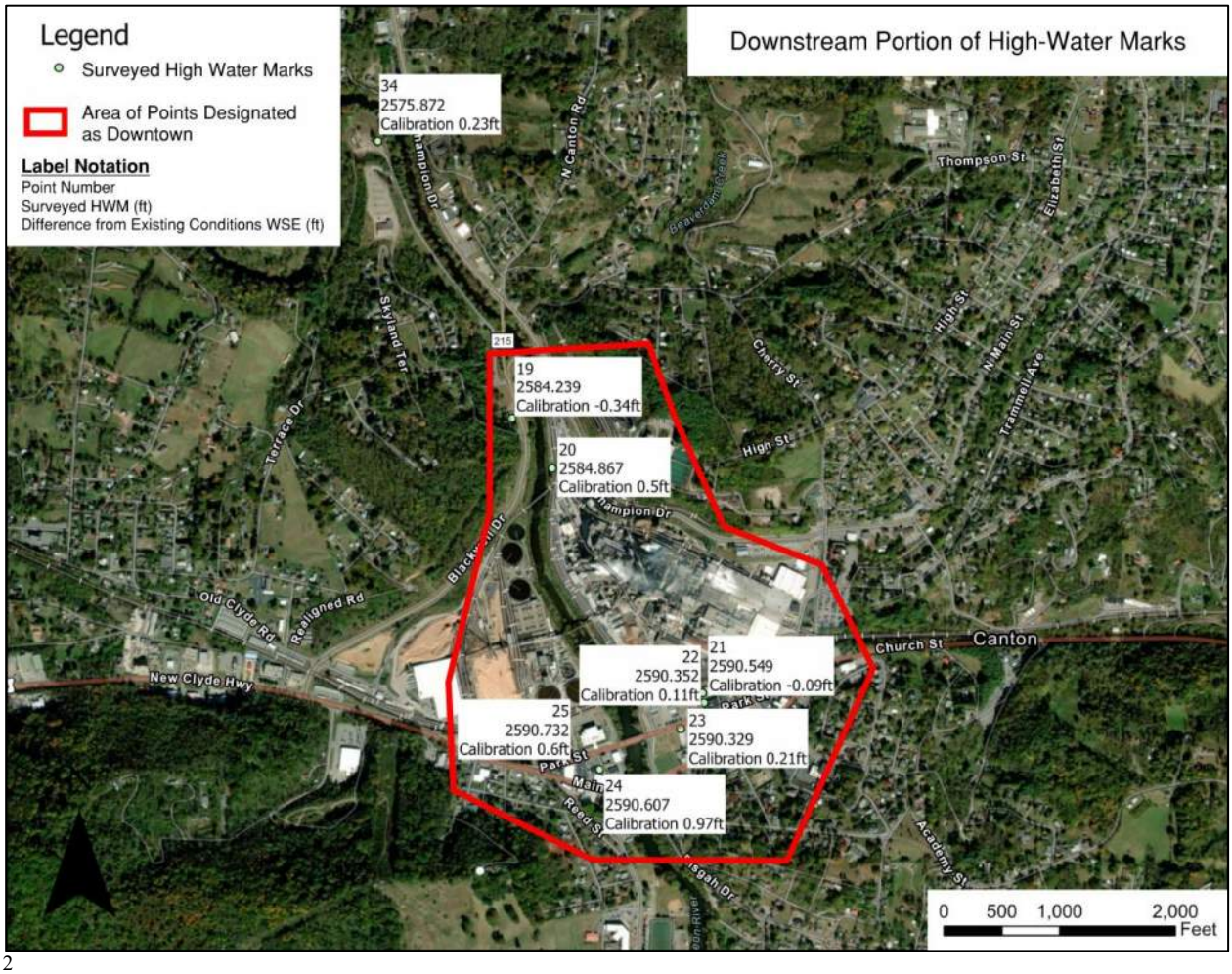
Figure 2.4 – Surveyed High-Water Marks



[1]

[1] Tropical Storm Fred High Water Marks Surveyed by USACE

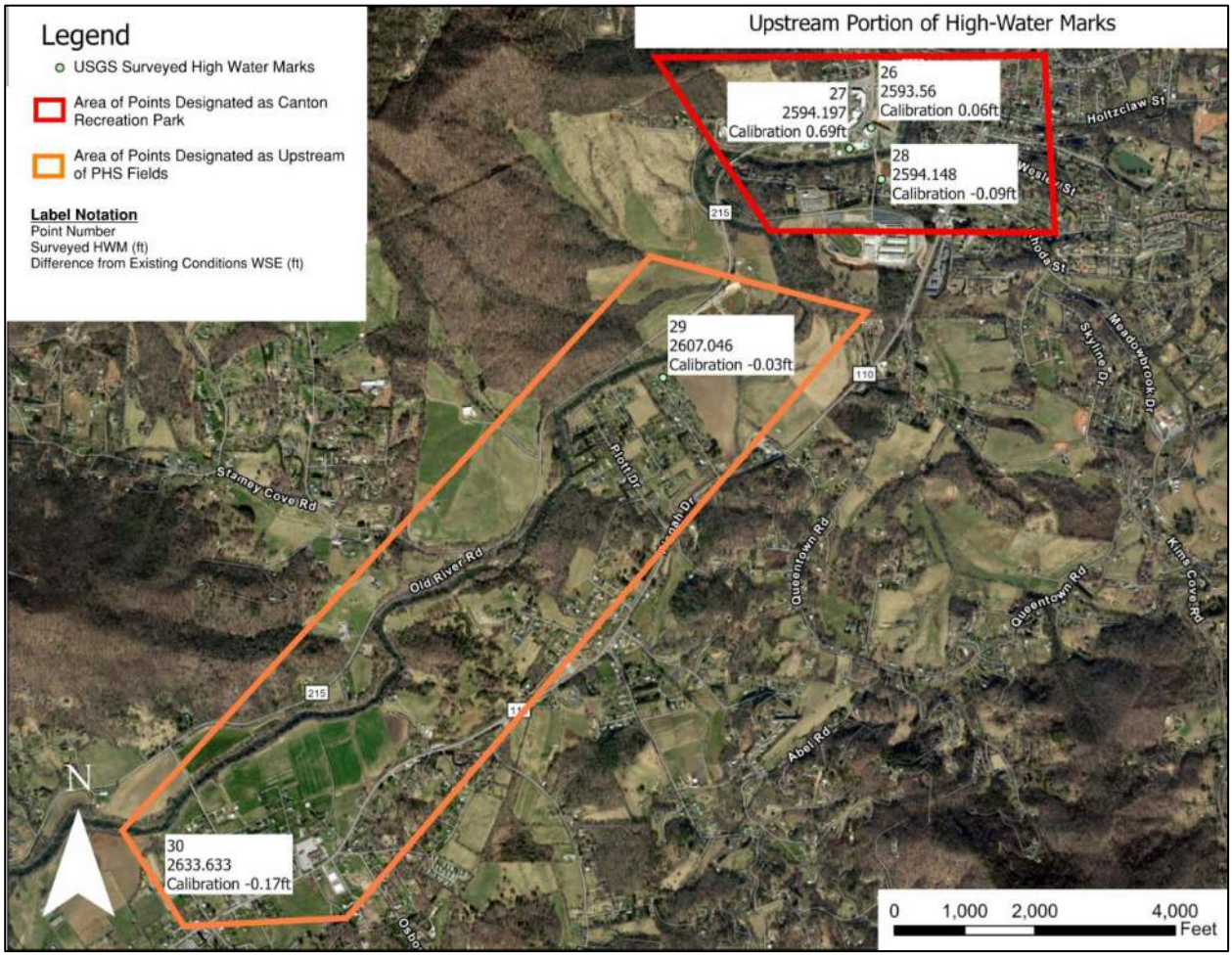
Figure 2.5 – Calibration Map (Downstream)



[2]

[2] Tropical Storm Fred High Water Marks Surveyed by USACE

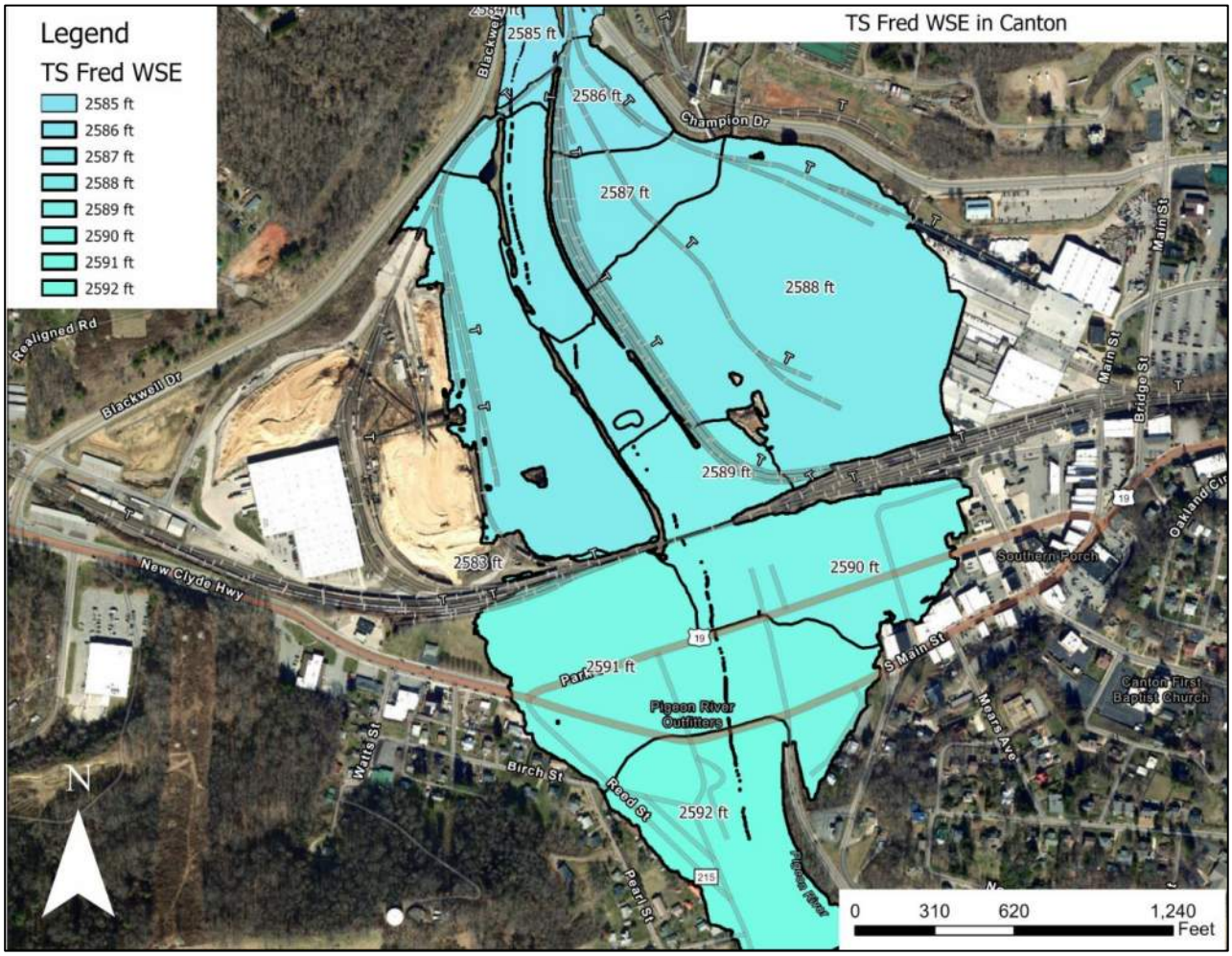
Figure 2.6 – Calibration Map (Upstream)



[3]

[3] Tropical Storm Fred High Water Marks Surveyed by USACE

Figure 2.7 – Water Surface Elevation and Flood Extents in Canton



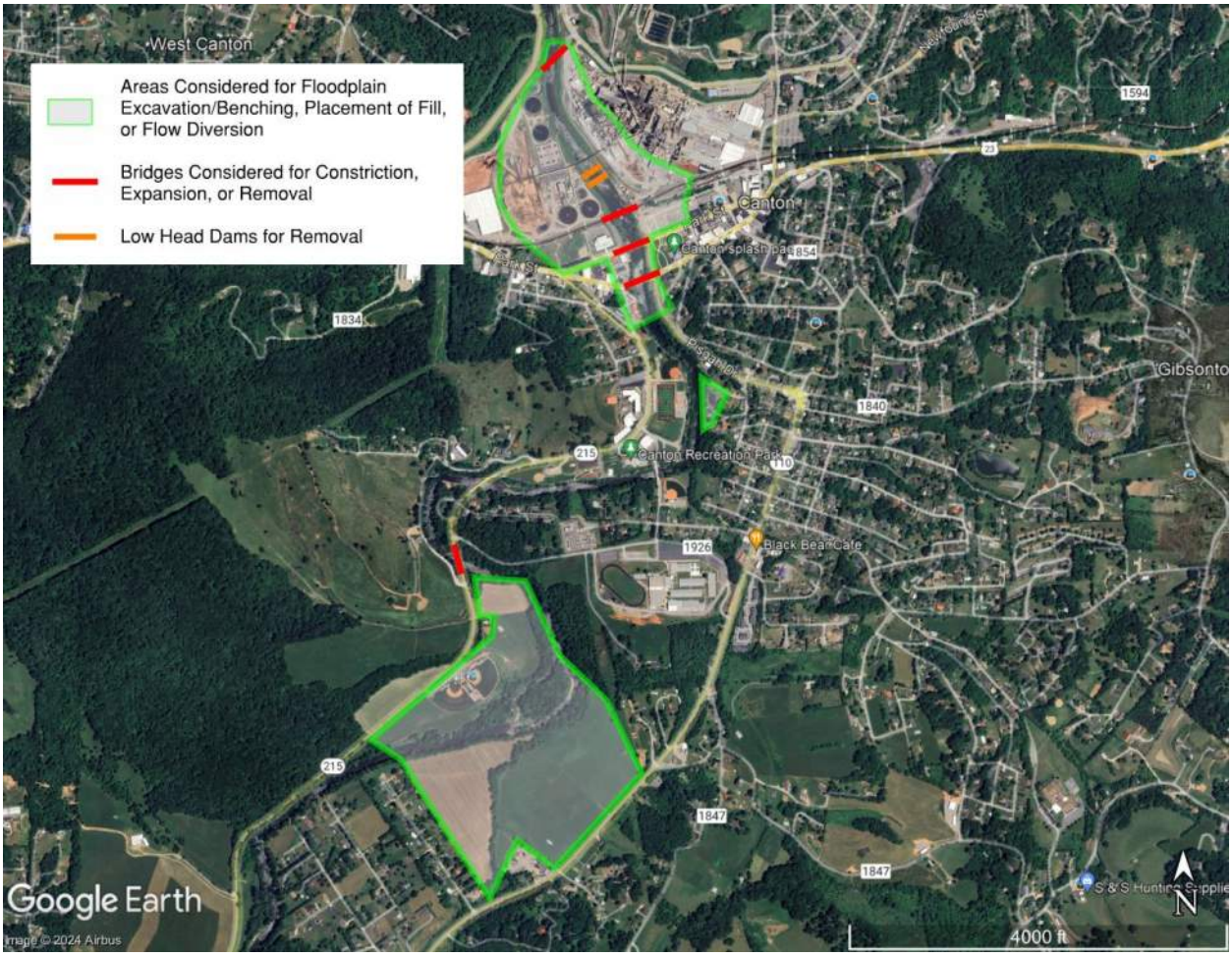
3.0 ALTERNATIVES

3.1 Overview

With the existing conditions model established, amendments to the terrain and structures were conducted to evaluate several potential alternatives for flood risk reduction. There are various activities and potential projects that may reduce flood risk in Canton. While every possibility could not be explored, an investigation was conducted on the following potential locations and types of activities to help make an informed decision on which projects should be combined into model scenarios that would carry forward into further evaluation.

The primary locations considered for potential projects were the east side of the river on the former mill property extending upstream to Park Street, the west side of the river on the wastewater treatment plant property extending upstream to Main Street, current Town of Canton owned parcels located near or along the river, and both sides of the river near the Pisgah High School baseball Field extending into the neighboring agricultural fields. The primary activities considered were expansion/contraction or removal of bridges, provision of flood storage, floodplain restoration, and removal of low head dams. **Figure 3.1** displays potential areas and activities for alternatives. The first use of each alternative would be to reduce flood risk in the Town of Canton, but other beneficial uses were considered in the selection of model scenarios including, but not limited to; expansion of park and recreation areas, providing greater access to the river and floodplain areas, increasing safety for uses of the river, and increasing safety and emergency services access during flood events. **Appendix C** contains representative cross sections detailing the floodplain benching, bridge widenings, and berm fill for upstream flood storage.

Figure 3.1 – Potential Locations and Activities for Alternatives



The selection of scenarios focused on flood reduction benefit and the ability to implement alternatives in phases. The extent of flooding and degree of damage in Town during Tropical Storm Fred, and confirmed by the modeling, set the stage that a substantial alternative may be required to significantly reduce the flood risk. Even if the most impactful alternative is selected, flood risk will not be eliminated during a future event equivalent to Tropical Storm Fred.

A review of preliminary results revealed Scenario D as presented in the CDDL draft report seemed like a realistic alternative to carry forward which would maximize benefit without unreasonably extensive work to the former mill property and in town. The CDDL draft report scenario D and a floodplain bench / land conservation with an earthen berm to constrict flow and increase flood storage near the Pisgah High School baseball fields was the most robust alternative evaluated. As a standalone project, Alternative 2 has a relatively lower cost and can provide a minor flood risk reduction benefit with the construction of a berm near the Pisgah High School baseball fields. This alternative also includes low-head dam removals in town and includes purchasing nearby

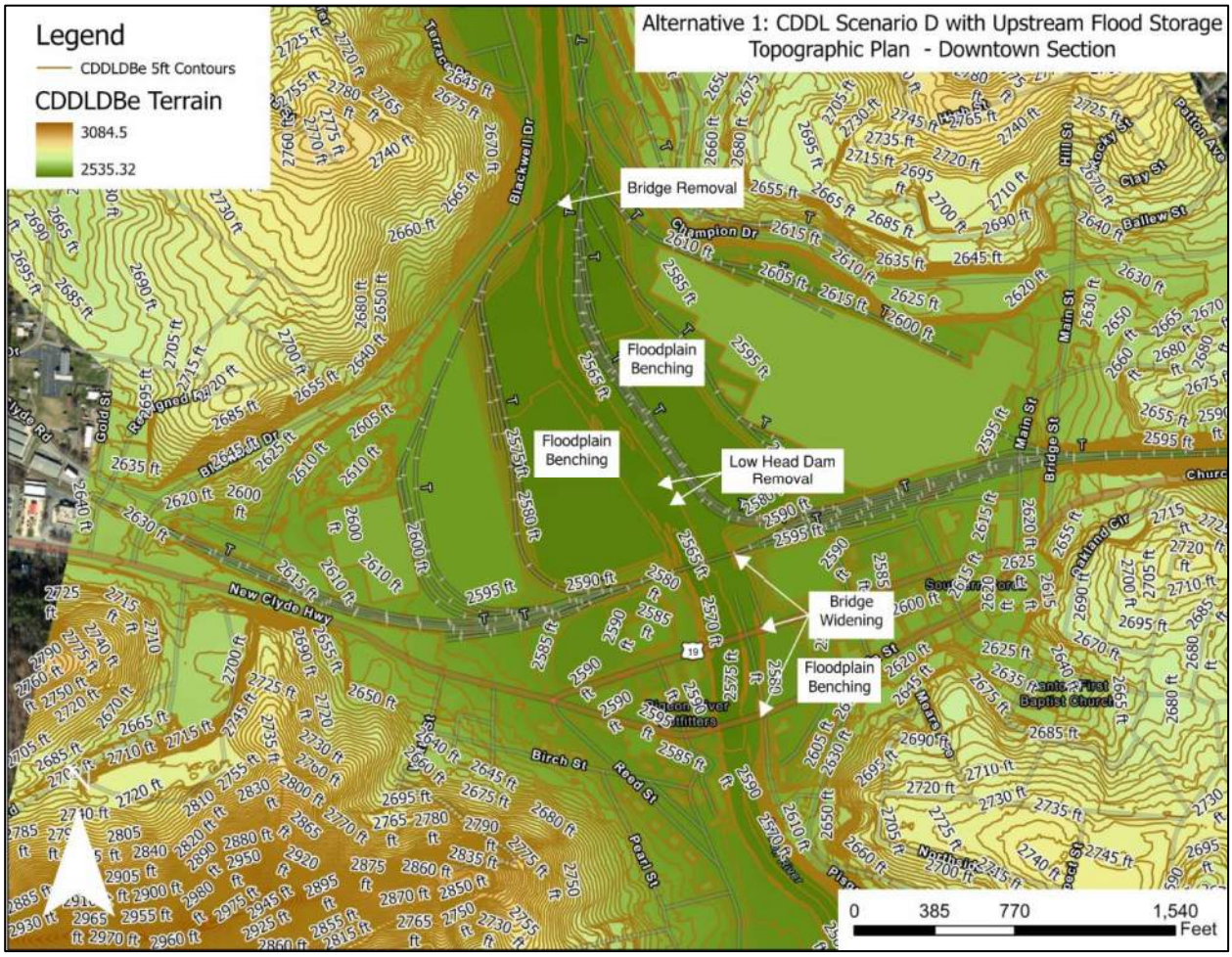
agricultural fields for land conservation activities. These purchases would protect the valley upstream of Canton from future development, thereby preserving the existing flood storage capacity and also conserving agricultural lands. The remainder of the alternatives selected for this plan include combinations or modifications of CDDL Scenario D and the berm project.

3.2 Descriptions of Alternatives

3.2.1 Alternative 1: CDDL Scenario D with Upstream Flood Storage

Alternative 1 represents the modeled scenario with the most associated work and the highest reduction in water surface elevation in the Town of Canton. It includes construction of a berm on the agricultural property adjacent to the Pisgah High School baseball fields, removal of the service railroad on the downstream end of the former mill property, removal of the two low head dams downstream of Park Street, expansion of the regional railroad crossing toward the east, modification of the Park Street and Main Street Bridges, removal of the wastewater treatment plant and a western section of the mill, excavation of floodplain at the wastewater treatment plant site and western portion of the mill, and placement of fill to raise the land surface at the floodplain fringe. **Figure 3.2** shows the site plan in town and near the baseball fields. Topographic illustrations of the four alternatives are in Appendix C.

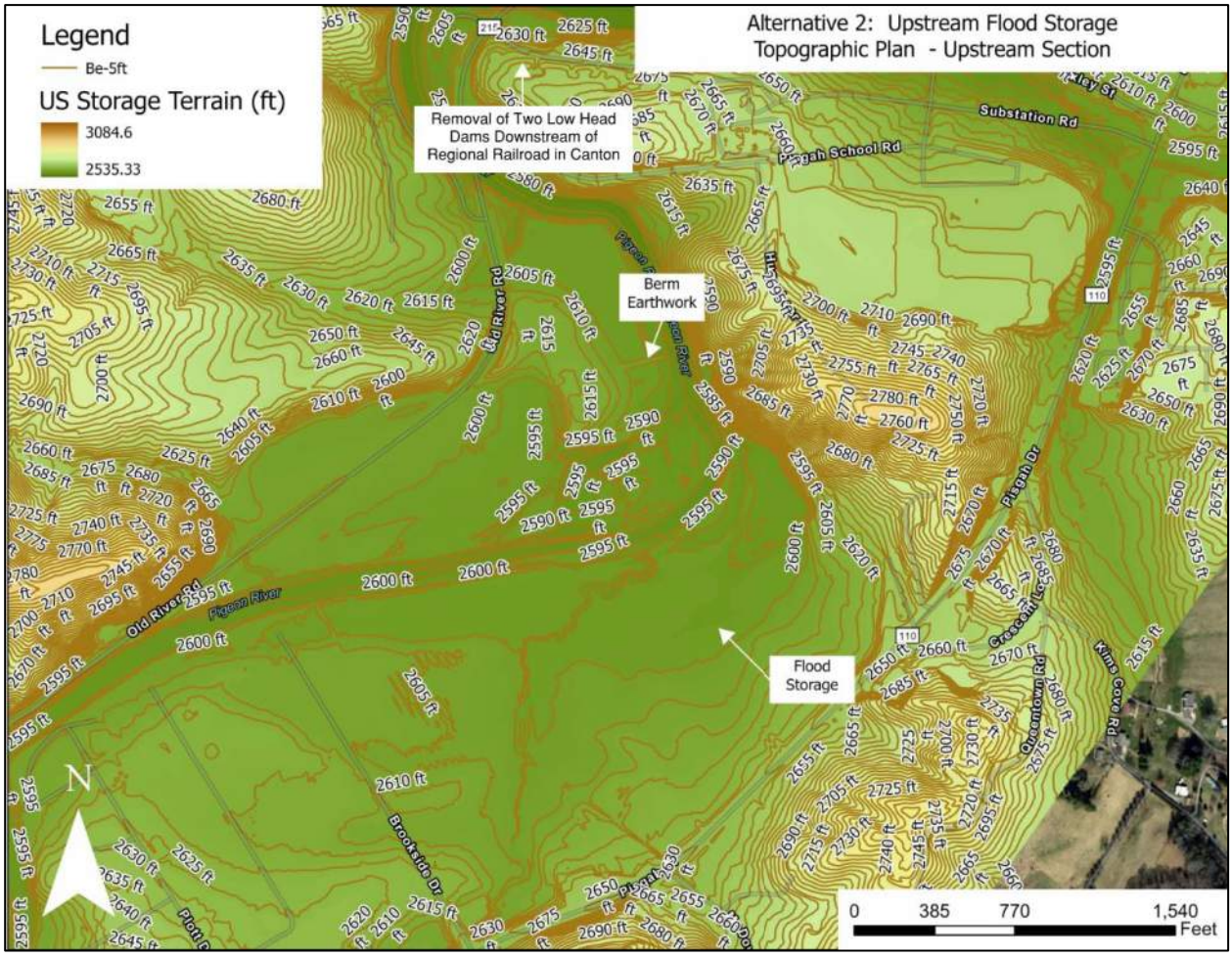
Figure 3.2 – Alternative 1 Topographic Plan Schematic



3.2.2 Alternative 2: Upstream Flood Storage

Alternative 2 represents the scenario with the least associated work and the lowest reduction in water surface elevation seen in town. However, it also has a substantially lower cost. It includes construction of a berm on the agricultural property adjacent to the Pisgah High School baseball fields and removal of the two low head dams downstream of Park Street. The topographic plan for Alternative 2 is shown in **Figure 3.3**.

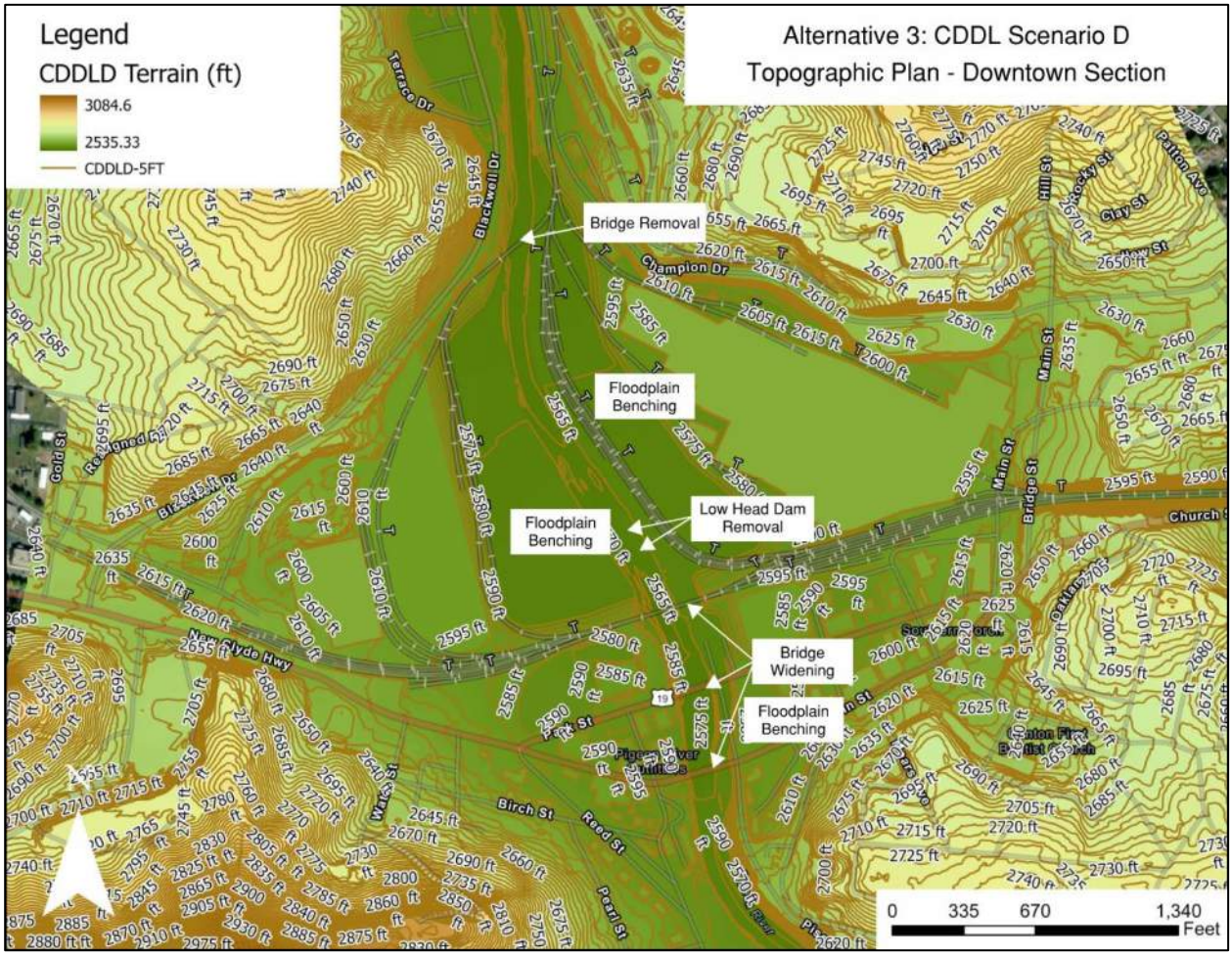
Figure 3.3 – Alternative 2 Topographic Plan Schematic



3.2.3 Alternative 3: CDDL Scenario D

Alternative 3 is the same plan as presented in the CDDL draft report. This alternative includes removal of the plant service railroad on the downstream end of the former mill property, removal of the two low head dams downstream of Park Street, expansion of the regional railroad crossing toward the east, modification of the Park Street and Main Street Bridges, removal of the wastewater treatment plant and a western section of the mill, excavation of floodplain at the wastewater treatment plant site and western portion of the mill, and placement of fill to raise the land surface at the floodplain fringe. The topographic plan for Alternative 3 is shown in **Figure 3.4**.

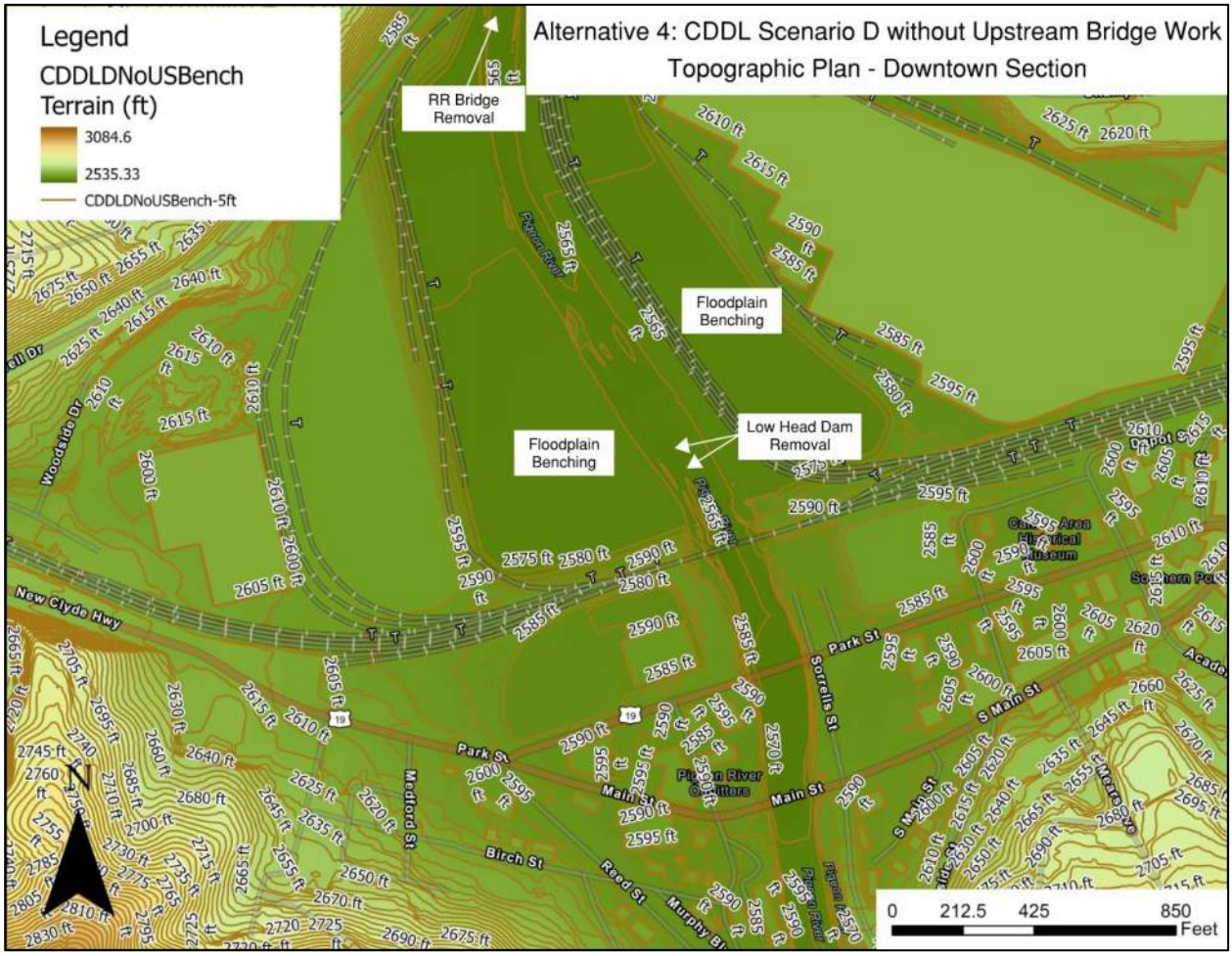
Figure 3.4 – Alternative 3 Topographic Plan Schematic



3.2.4 Alternative 4: CDDL Scenario D without Upstream Bridge Work

Alternative 4 is like Alternative 3 but with an attempt to reduce costs while maintaining flood risk reduction benefit. It includes removal of the plant service railroad on the downstream end of the former mill property, removal of the two low head dams downstream of Park Street, removal of the wastewater treatment plant and a western section of the mill, excavation of floodplain at the wastewater treatment plant site and western portion of the mill, and placement of fill to raise the land surface at the floodplain fringe. It excludes the expansion of railroad and roadway bridges closest to downtown Canton. **Figure 3.5** illustrates the topographic plan for Alternative 4.

Figure 3.5 – Alternative 4 Topographic Plan Schematic



3.3 Alternative Results

The four alternatives indicate varying levels of reduction in water surface throughout the model. Appendix B contains a table of water surface elevations at key points for all alternatives. **Tables 3.1** summarizes the anticipated changes in water surface for existing conditions and the alternatives.

Table 3.1 – Summary of Average Difference in Water Surface Elevation at Survey Points

Average Increase/Decrease In Water Surface Elevation from Existing Conditions Model at High Water Marks - Tropical Storm Fred (ft)				
Area	**Alternative 1 - CDDL D with Upstream Flood Storage**	**Alternative 2 – Upstream Flood Storage**	**Alternative 3 - CDDL D**	**Alternative 4 - CDDL D Without Bridges**
Downtown	-4.80	-1.10	-4.74	-2.97
Canton Recreation Park	-1.43	-0.27	-1.42	-0.99
Upstream of PHS Fields	0.04	0.03	-0.01	-0.01

As indicated in Table 3.1, there is consistent reduction if flood depths in downtown Canton and near Canton Recreation Park. However, Alternative 1 and Alternative 2 may cause a rise in water surface upstream of the Pisgah High School baseball fields. If either of these alternatives are considered for implementation, additional design consideration will be required to avoid potential backwater impacts to existing residential structures. This may include constructing berms, structure elevation, and/or buyouts. Alternatively, the differences in water surface elevation at structures in downtown Canton are significantly more favorable. While none of the alternatives completely remove flood risk from the buildings in the Town of Canton, Alternatives 1, 3, and 4 remove approximately 25 structures from the inundation boundary completely. Further information of flood depths and model outputs can be found in Appendix B.

3.4 Alternative Costs

An opinion of probable cost was developed for each alternative. The costs are not detailed engineer's estimates and should only be used for planning and budgeting purposes. Costs were developed based on assumed construction year, 2027. Much of the anticipated costs are attributed to excavation-related activities. Costs for the alternatives are shown in **Table 3.2**. The opinions of probable cost are further detailed in Appendix C.

Table 3.2 – Opinion of Probable Cost

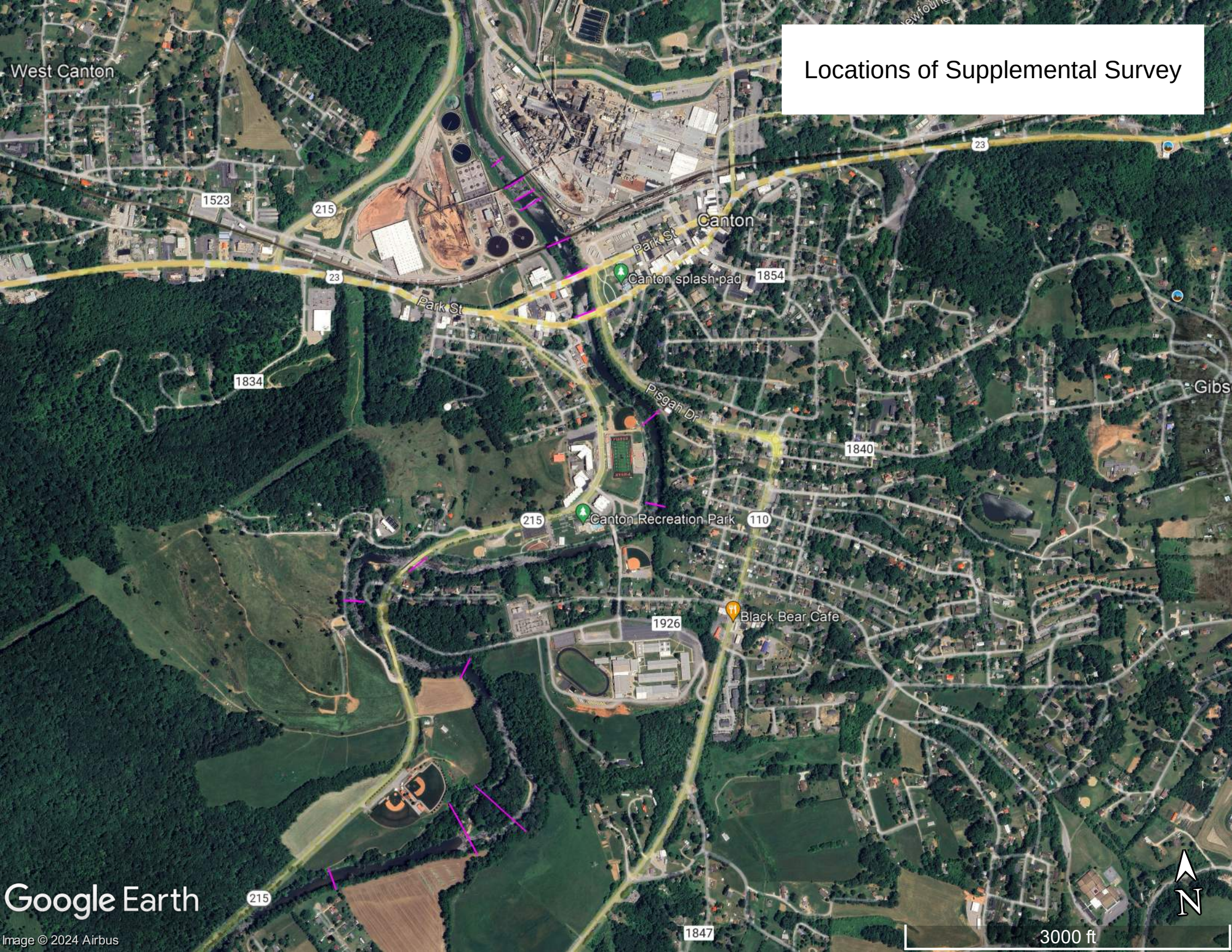
Opinion of Probable Cost	
Alternative 1 - CDDL D with Upstream Flood Storage	$ 46,130,000
Alternative 2 – Upstream Flood Storage	$ 3,940,000
Alternative 3 - CDDL D	$ 45,150,000
Alternative 4 - CDDL D Without Bridges	$ 35,810,000

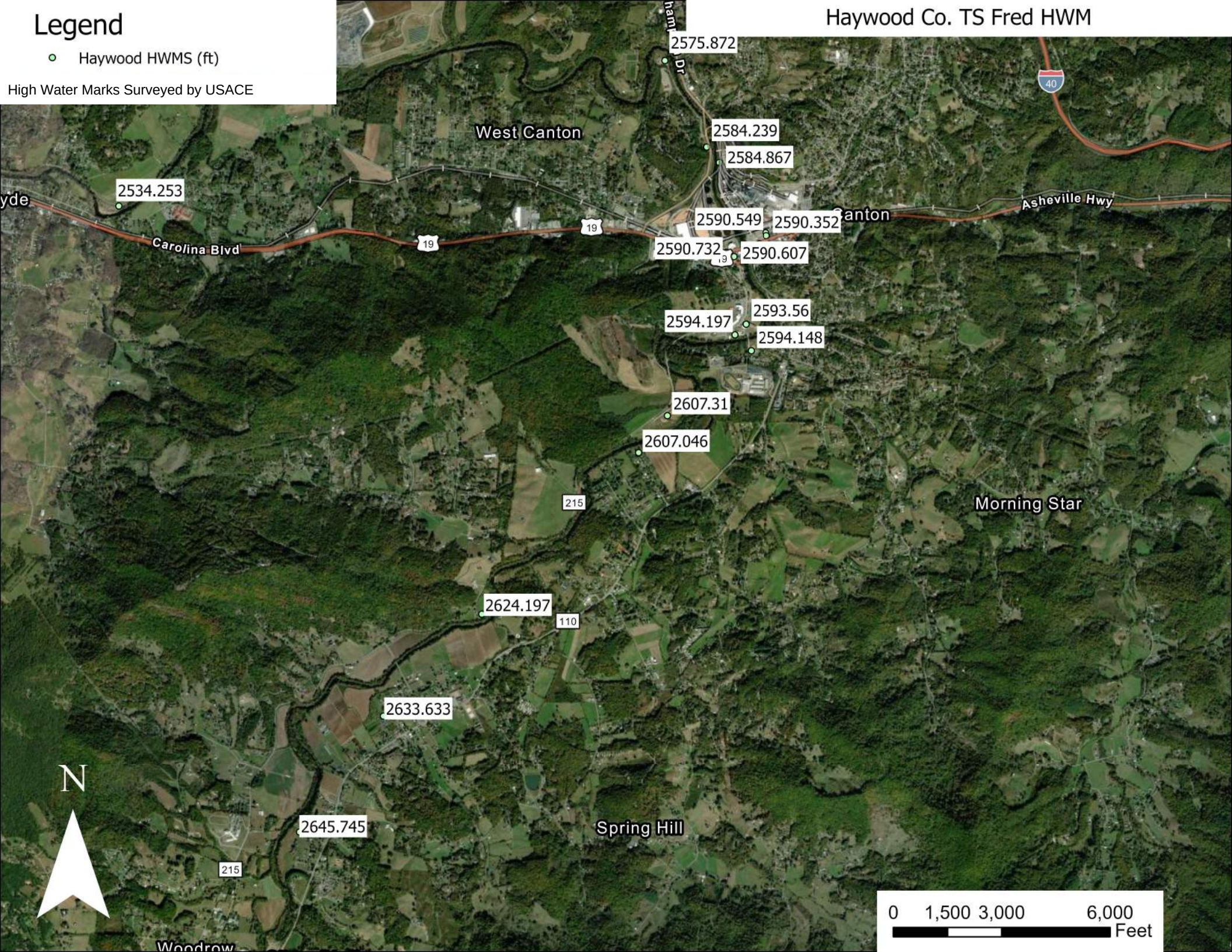
4.0 CONCLUSIONS AND RECOMMENDATIONS

Implementation of any of the four alternatives must consider the pros and cons of each including the reduction in flood risk, costs, economic benefits, environmental impacts, residual risk, and more. Considering the future potential uses of these areas is important in visualizing more subjective benefits for various alternatives. The desire to conserve agricultural lands may be a coincident benefit of Alternative 2 which seeks to preserve existing flood storage and optimize capacity. As any of the projects reach the design stage, the community can consciously consider future land use and capitalize on opportunities for recreation and other economically beneficial uses for the area. The results of the model alternatives indicate that removal of the low head dams and floodplain benching on the former mill site and the wastewater treatment plant provide the greatest reduction in water surface elevation in the Town of Canton. For that reason, pursuit of such floodplain benching projects, in part or in whole, would benefit the Town of Canton. Continued reduction in flood risk could be compounded from there to include removal of the plant service railroad bridge, expansion of other bridges, flow diversion upstream of town, or other alternatives as funding allows. In addition to the mill site and wastewater treatment plant, there are other priority areas that compound mitigation of flood risk and preservation of existing floodplains. Such areas extend downstream to Blackwell Drive, upstream to Canton Recreation Park, and include the areas on either side of the river near the Pisgah High School Baseball Fields as far upstream as Brookside Drive and as far downstream as Old River Road.

This report intentionally evaluated alternatives individually as well as in combination to explore the potential for phased implementation. Next steps should include establishing a plan for incremental flood risk reduction based on prioritized alternatives which progress towards ever better flood resiliency and seeking funding opportunities that support the implementation of the plan. The strategic implementation plan should explore how economic development goals may compliment flood risk reduction planning, refinement or expansion of flood risk reduction analyses, existing and future cooperative partnerships, land ownership and potential acquisitions, access to initial capital funding as well as the cost of future operations and maintenance.

Appendix A – Additional Data


Locations of Supplemental Survey
West Canton
1523
215
23
Canton
Park St
Canton splash pad
1854
23
Park St
1834
Pisgah Dr
Gibs
1840
215
Canton Recreation Park
110
Black Bear Cafe
1926
215
1847
Google Earth
Image © 2024 Airbus
N
3000 ft

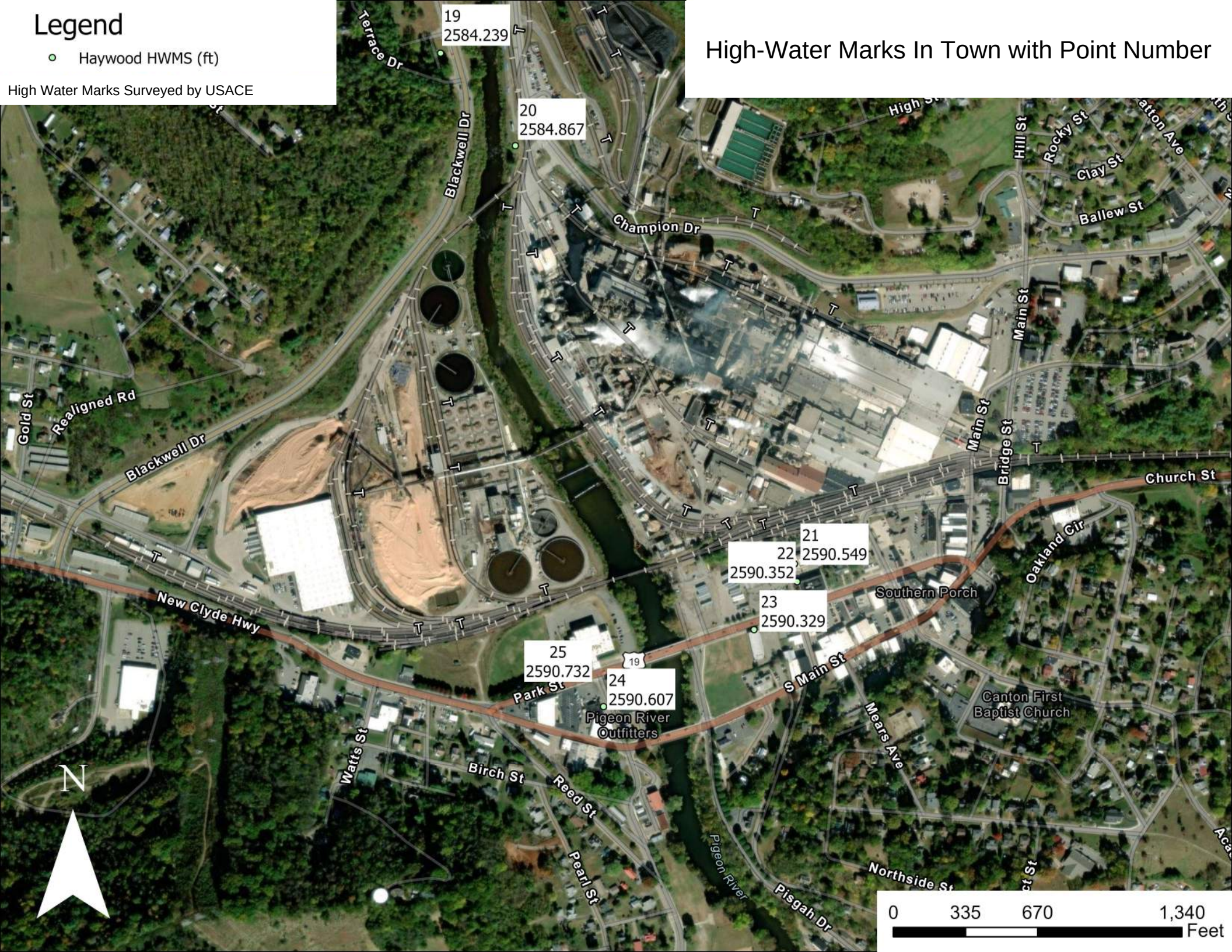

Legend
Haywood HWMS (ft)
High Water Marks Surveyed by USACE
Haywood Co. TS Fred HWM
2575.872
West Canton
2584.239
2584.867
2534.253
Carolina Blvd
Asheville Hwy
2590.549
2590.352
2590.732
2590.607
2594.197
2593.56
2594.148
2607.31
2607.046
Morning Star
2624.197
2633.633
2645.745
Spring Hill
Woodrow
19
215
110
40
N
0 1,500 3,000 6,000
Feet

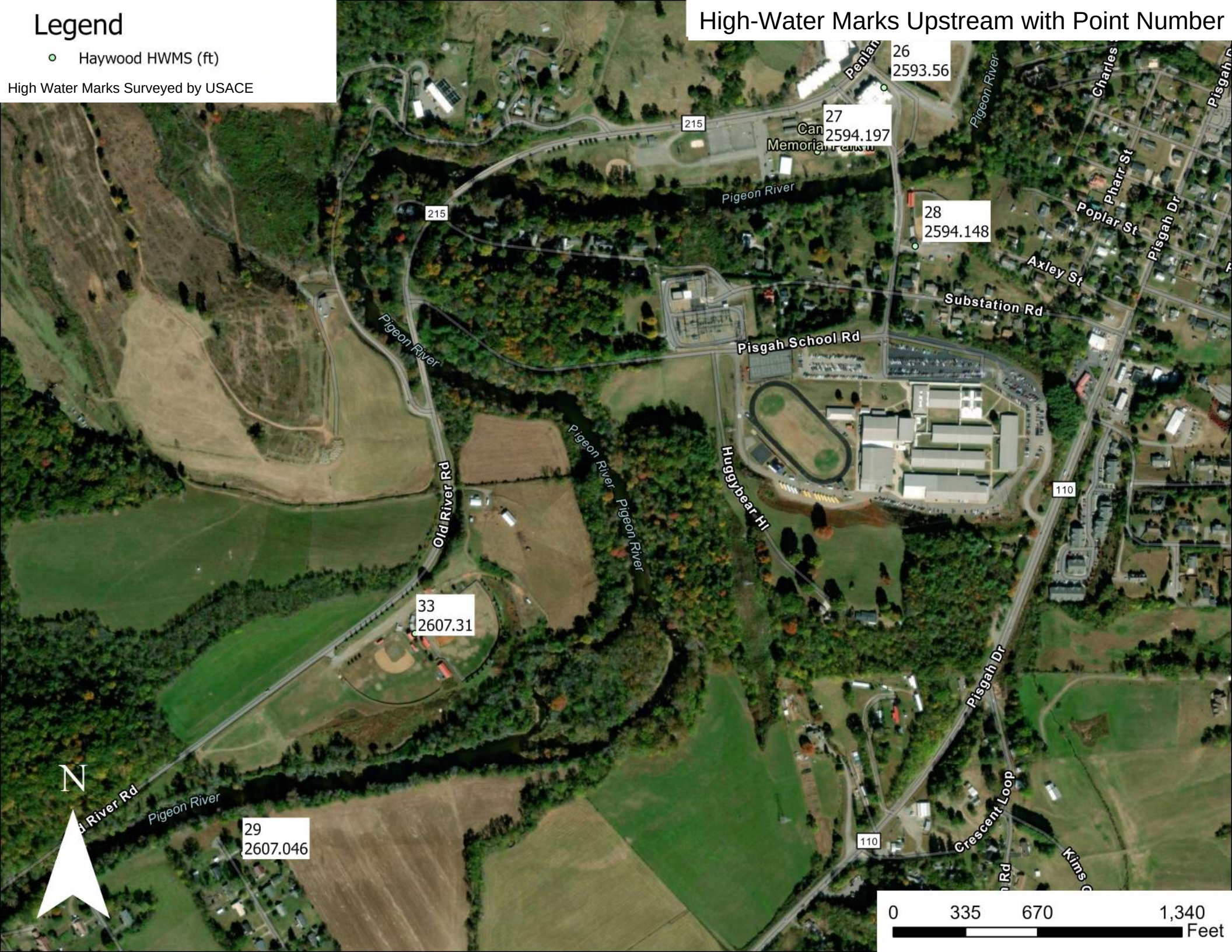
High-Water Marks In Town with Point Number

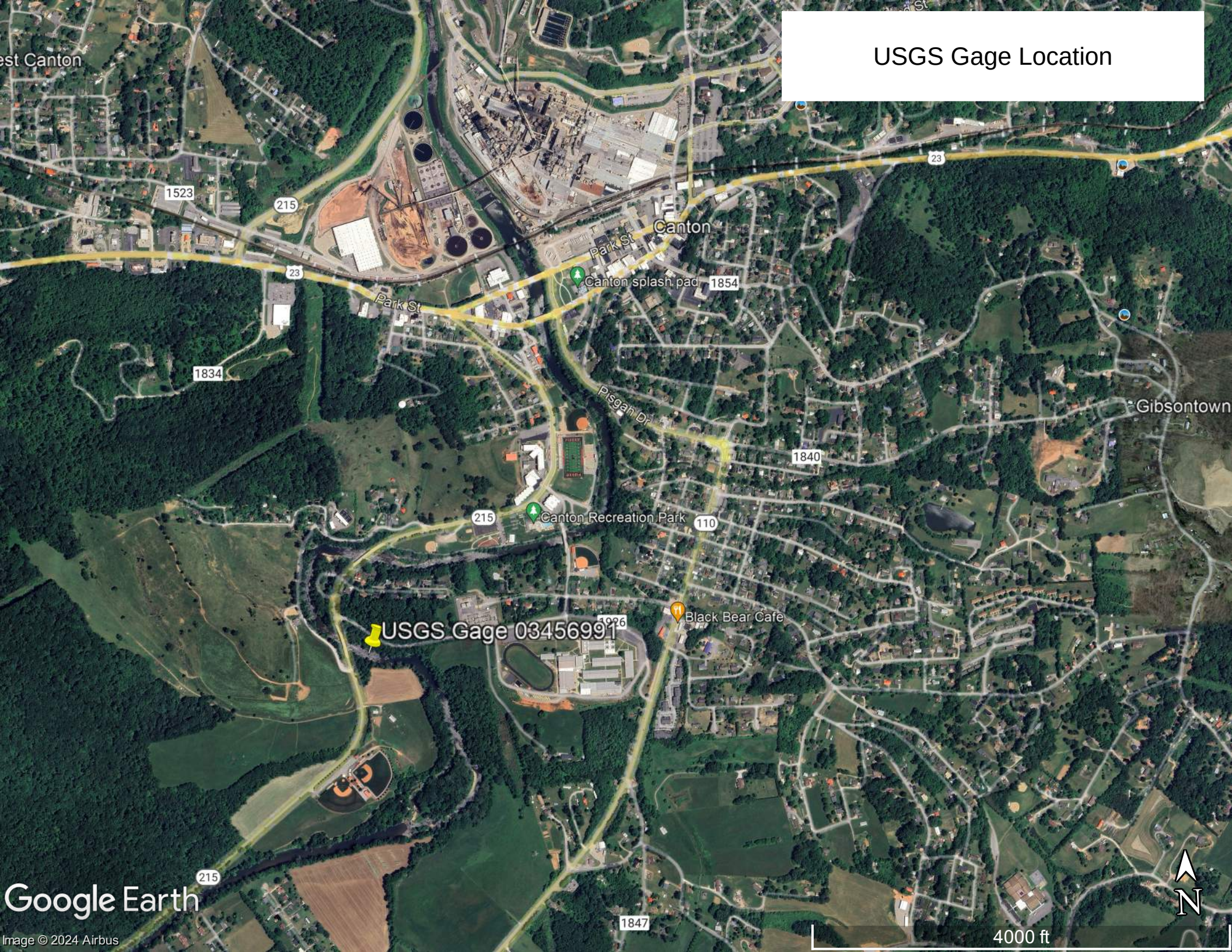
Legend

- Haywood HWMS (ft)

High Water Marks Surveyed by USACE




Legend
Haywood HWMS (ft)
High Water Marks Surveyed by USACE
High-Water Marks Upstream with Point Number
26
2593.56
27
2594.197
28
2594.148
33
2607.31
29
2607.046
Pigeon River
Pisgah School Rd
Substation Rd
Axley St
Poplar St
Pharr St
Pisgah Dr
Old River Rd
Huggybear Hl
Crescent Loop
215
110
N
0
335
670
1,340
Feet


USGS Gage Location
Canton
Park St
Canton splash pad
Canton Recreation Park
Black Bear Cafe
USGS Gage 03456991
Pisgah Dr
Gibsontown
1523
215
23
1854
1834
1840
110
1847
Google Earth
Image © 2024 Airbus
N
4000 ft

USGS Gage Data

USGS	Gage Site No: 3456991	
Date	Time (EDT)	Discharge (cfs)
8/17/2021	8:00	926
8/17/2021	8:15	926
8/17/2021	8:30	919
8/17/2021	8:45	912
8/17/2021	9:00	904
8/17/2021	9:15	897
8/17/2021	9:30	890
8/17/2021	9:45	890
8/17/2021	10:00	890
8/17/2021	10:15	890
8/17/2021	10:30	890
8/17/2021	10:45	897
8/17/2021	11:00	897
8/17/2021	11:15	919
8/17/2021	11:30	933
8/17/2021	11:45	977
8/17/2021	12:00	1010
8/17/2021	12:15	1070
8/17/2021	12:30	1130
8/17/2021	12:45	1200
8/17/2021	13:00	1270
8/17/2021	13:15	1340
8/17/2021	13:30	1440
8/17/2021	13:45	1560
8/17/2021	14:00	1730
8/17/2021	14:15	1970
8/17/2021	14:30	2310
8/17/2021	14:45	2710
8/17/2021	15:00	3200
8/17/2021	15:15	3840
8/17/2021	15:30	4610
8/17/2021	15:45	5410
8/17/2021	16:00	6410
8/17/2021	16:15	7620
8/17/2021	16:30	9070
8/17/2021	16:45	10400
8/17/2021	17:00	11400
8/17/2021	17:15	12200
8/17/2021	17:30	13000
8/17/2021	17:45	13900
8/17/2021	18:00	15000
8/17/2021	18:15	16100
8/17/2021	18:30	17700
8/17/2021	18:45	20300
8/17/2021	19:00	23700
8/17/2021	19:15	27700
8/17/2021	19:30	31000
8/17/2021	19:45	34200
8/17/2021	20:00	36100
8/17/2021	20:15	37100
8/17/2021	20:30	36800
8/17/2021	20:45	36400
8/17/2021	21:00	35300
8/17/2021	21:15	34100
8/17/2021	21:30	32600
8/17/2021	21:45	30800
8/17/2021	22:00	29000

USGS	Gage Site No: 3456991	
Date	Time (EDT)	Discharge (cfs)
8/17/2021	22:15	26900
8/17/2021	22:30	25000
8/17/2021	22:45	22700
8/17/2021	23:00	20700
8/17/2021	23:15	18300
8/17/2021	23:30	15900
8/17/2021	23:45	13800
8/18/2021	0:00	12000
8/18/2021	0:15	10500
8/18/2021	0:30	9620
8/18/2021	0:45	8930
8/18/2021	1:00	8410
8/18/2021	1:15	7990
8/18/2021	1:30	7710
8/18/2021	1:45	7270
8/18/2021	2:00	6950
8/18/2021	2:15	6620
8/18/2021	2:30	6320
8/18/2021	2:45	6060
8/18/2021	3:00	5790
8/18/2021	3:15	5470
8/18/2021	3:30	5240
8/18/2021	3:45	5080
8/18/2021	4:00	4900
8/18/2021	4:15	4740
8/18/2021	4:30	4630
8/18/2021	4:45	4460
8/18/2021	5:00	4360
8/18/2021	5:15	4210
8/18/2021	5:30	4090
8/18/2021	5:45	3980
8/18/2021	6:00	3890
8/18/2021	6:15	3800
8/18/2021	6:30	3690
8/18/2021	6:45	3600
8/18/2021	7:00	3630
8/18/2021	7:15	3560
8/18/2021	7:30	3500
8/18/2021	7:45	3410
8/18/2021	8:00	3340
8/18/2021	8:15	3280
8/18/2021	8:30	3220
8/18/2021	8:45	3150
8/18/2021	9:00	3110
8/18/2021	9:15	3050
8/18/2021	9:30	3000
8/18/2021	9:45	2950
8/18/2021	10:00	2910
8/18/2021	10:15	2870
8/18/2021	10:30	2830
8/18/2021	10:45	2790
8/18/2021	11:00	2740
8/18/2021	11:15	2710
8/18/2021	11:30	2680
8/18/2021	11:45	2640
8/18/2021	12:00	2610

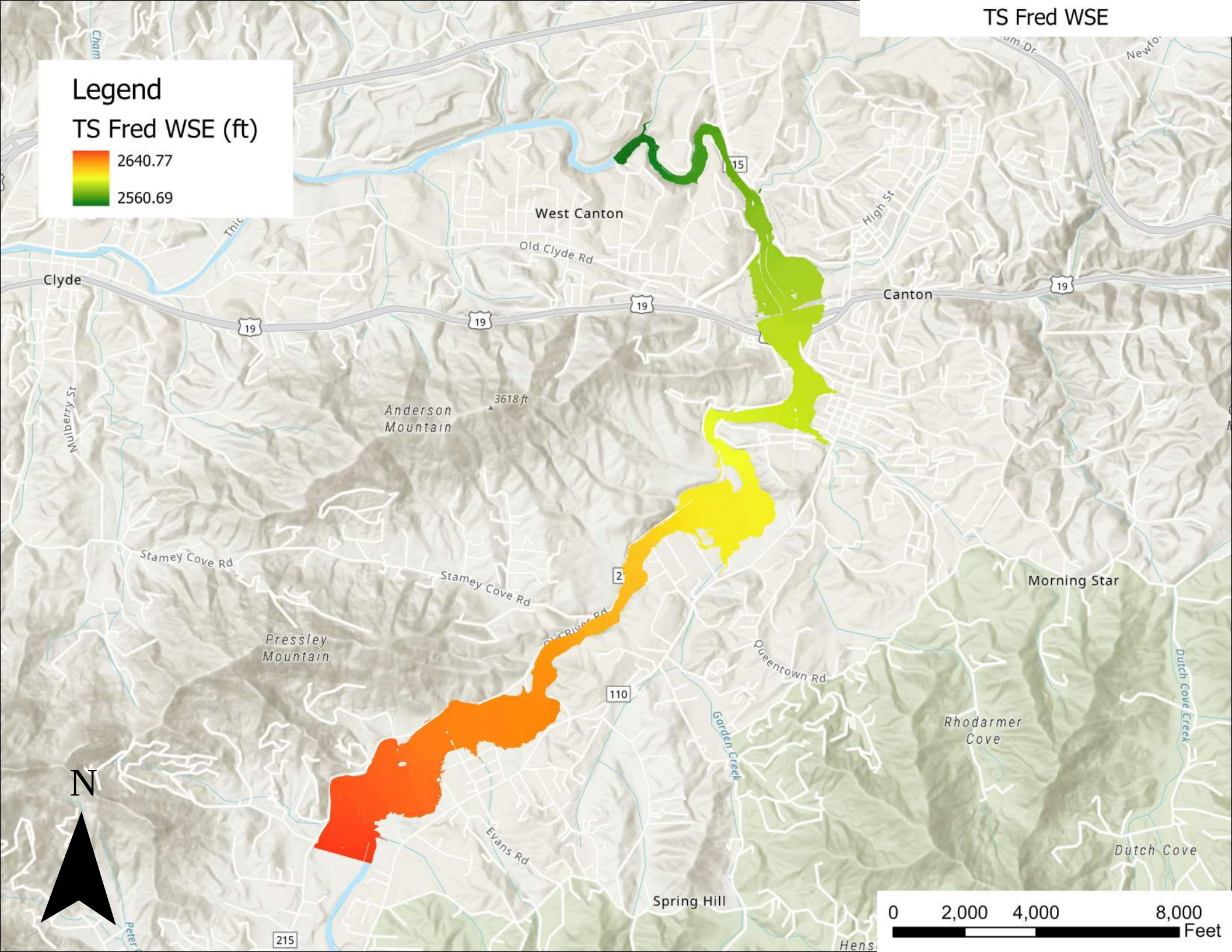
Appendix B – Model Results

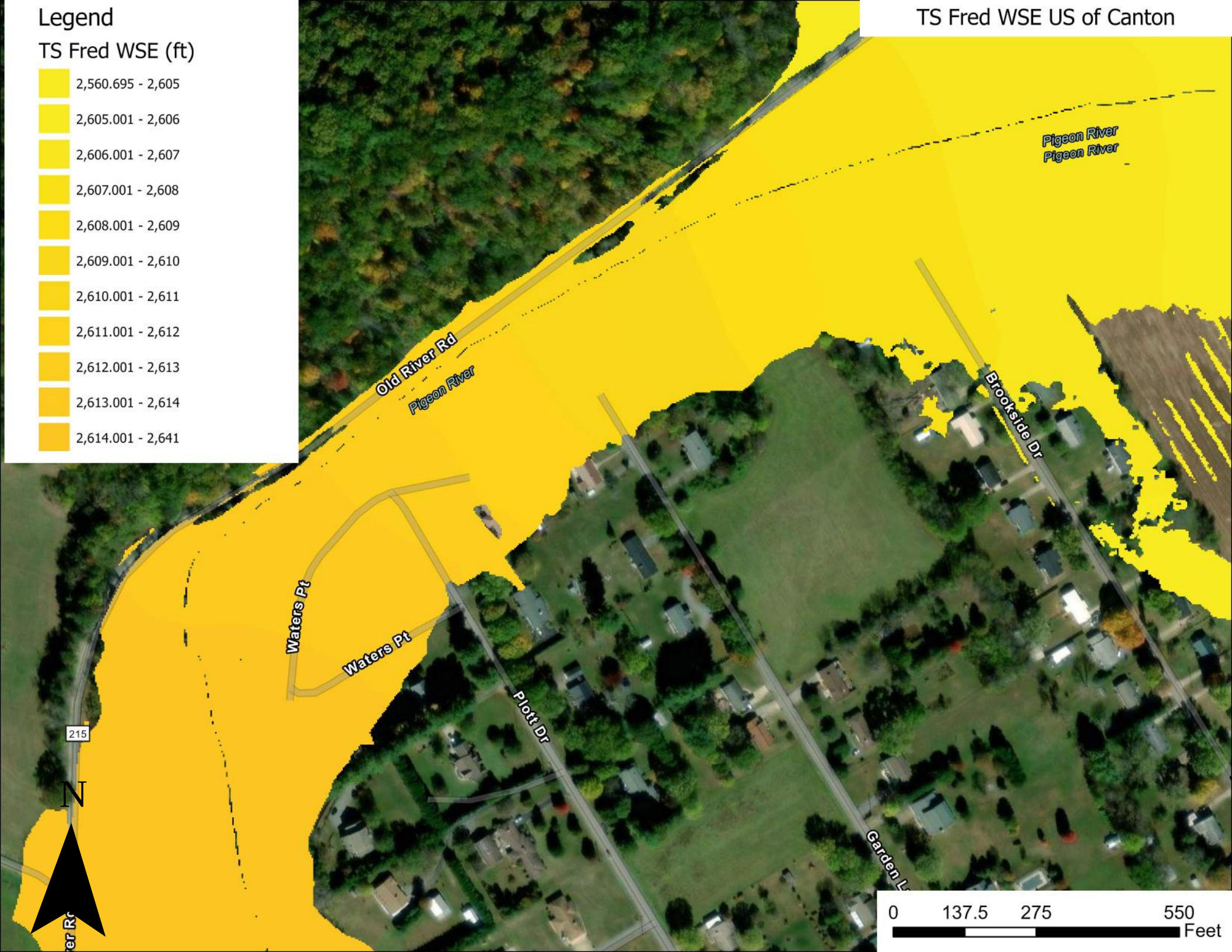
Existing Conditions – Tropical Storm Fred

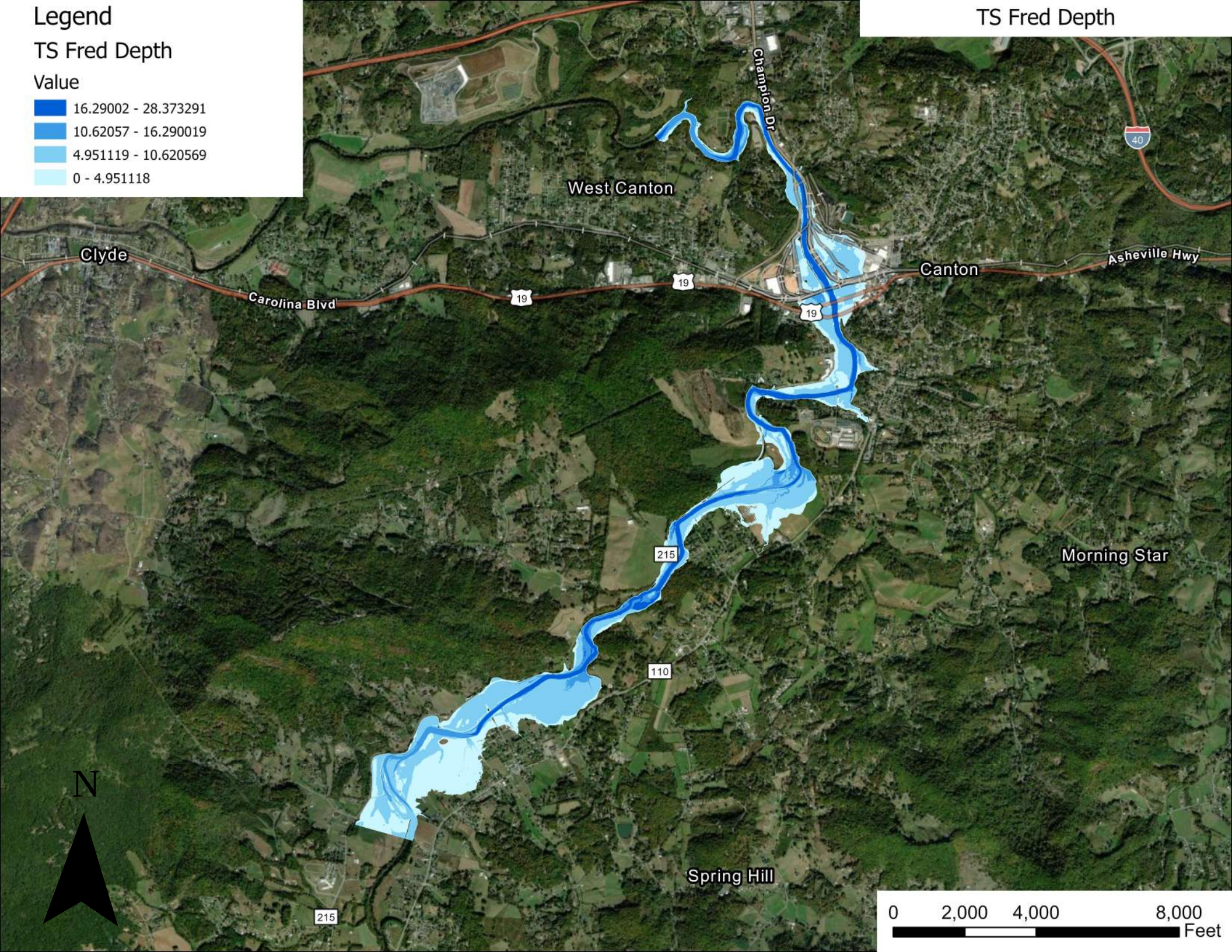
Comparison of Water Surface Elevations (ft) between Surveyed High Water Marks (HWM) and Existing Conditions Model (EC)

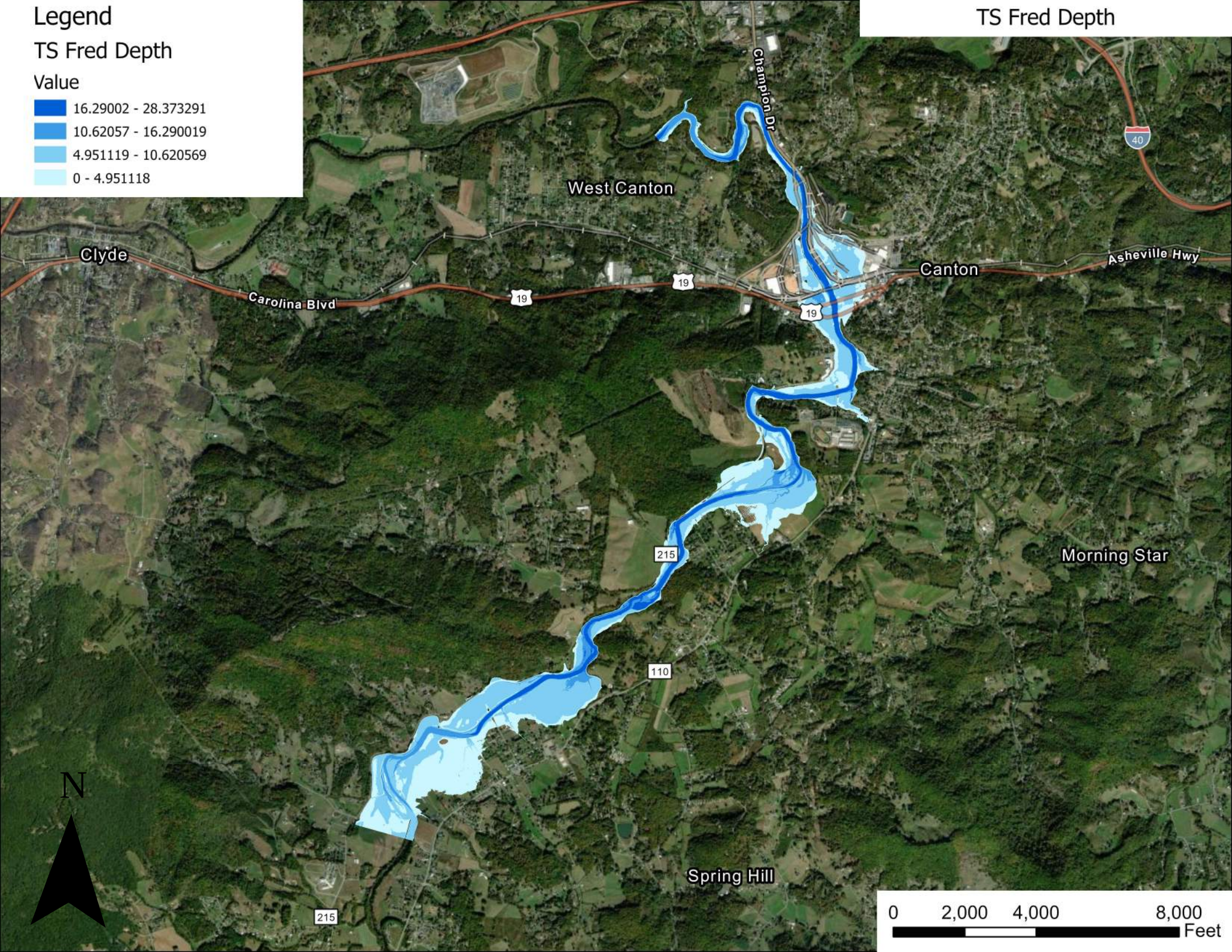
PT	Location	Recorded HWM	Existing Conditions WSE	Difference [EC-HWM] (ft)
34	Pinnacle Church	2575.87	2576.40	0.53
19	1 Blackwell Dr.	2584.50	2584.26	-0.24
20	West Gate Guard Station at the Mill	2584.87	2585.44	0.57
21	Fire Department	2590.55	2590.39	-0.16
22	Police Department	2590.35	2590.40	0.05
23	69 Park St.	2590.33	2590.47	0.14
24	10 Penland Street	2590.61	2591.52	0.91
25	Bethel Christian Academy	2590.73	2591.29	0.56
26	Canton Armory	2593.56	2593.63	0.07
27	Aquatic Center	2594.20	2594.80	0.60
28	Pisgah Baseball Field	2594.15	2594.04	-0.11
29	324 Brookside Drive	2607.05	2606.97	-0.08
30	Cold Mountain Nursery	2633.63	2633.06	-0.57

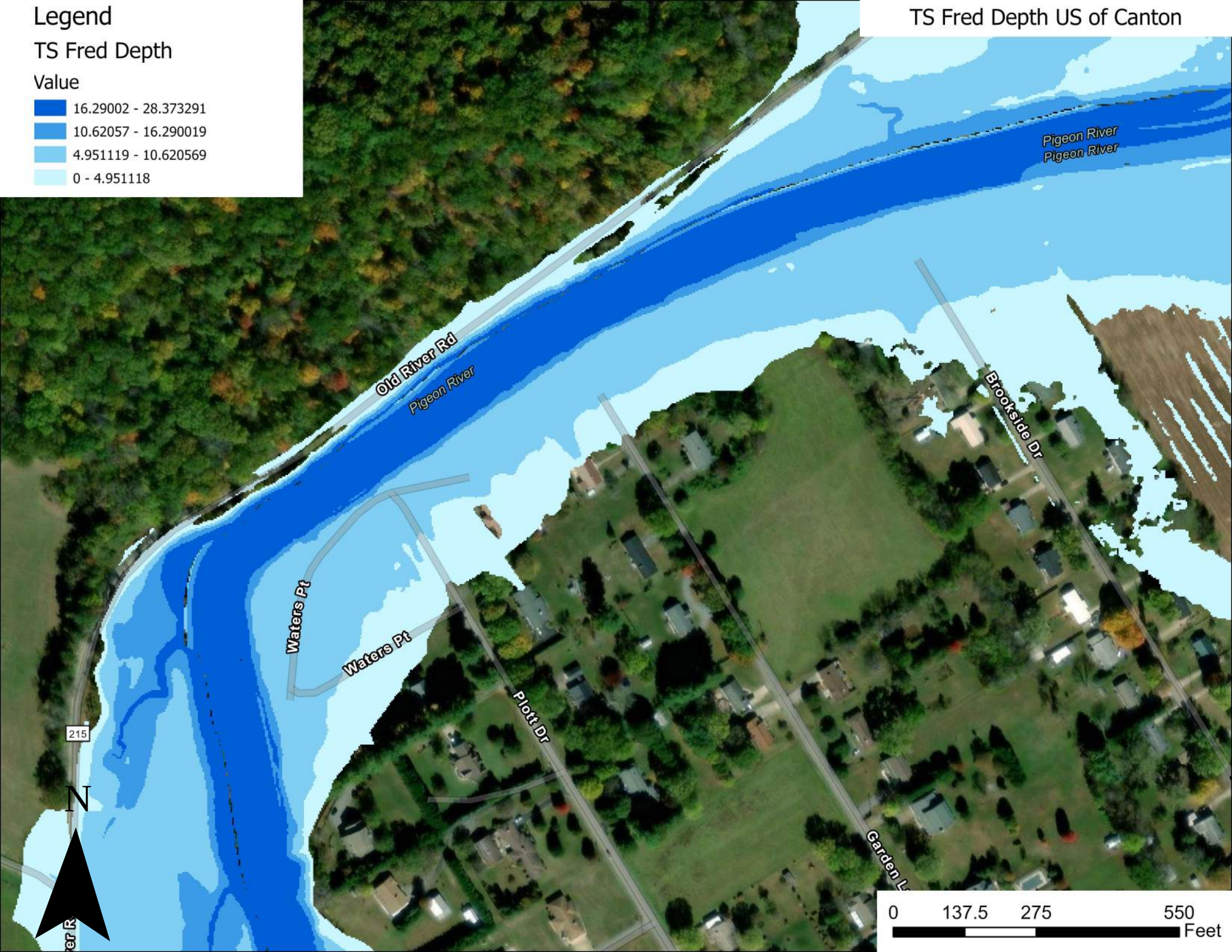
Average	0.18
Maximum	0.91
Minimum	-0.57

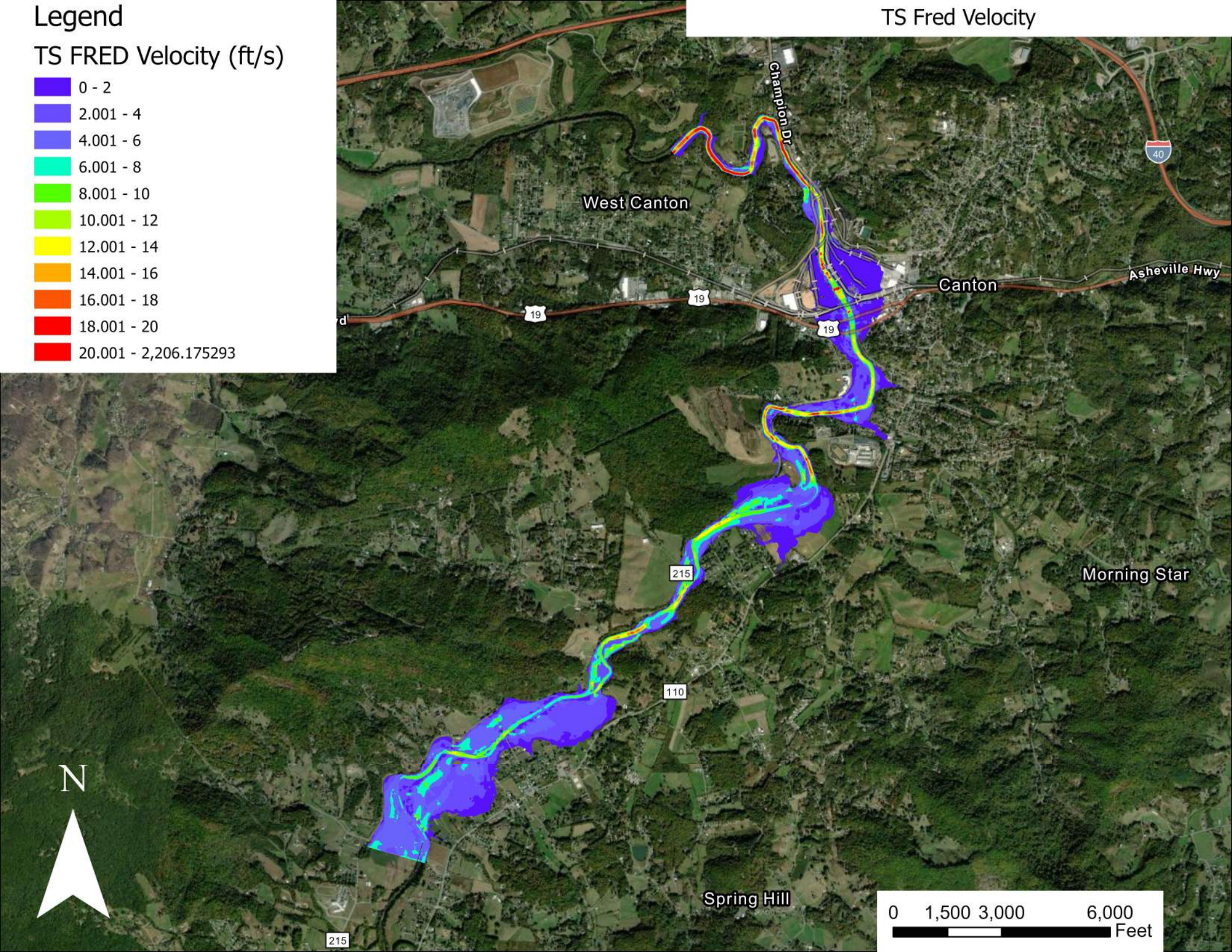

TS Fred WSE
Legend
TS Fred WSE (ft)
2640.77
2560.69
West Canton
Old Clyde Rd
Clyde
Canton
High St
19
15
Anderson Mountain
3618ft
Mulberry St
Stamey Cove Rd
Pressley Mountain
Morning Star
Queentown Rd
Garden Creek
Rhodarmer Cove
Dutch Cove Creek
Dutch Cove
Evans Rd
Spring Hill
110
215
N
0
2,000
4,000
8,000
Feet

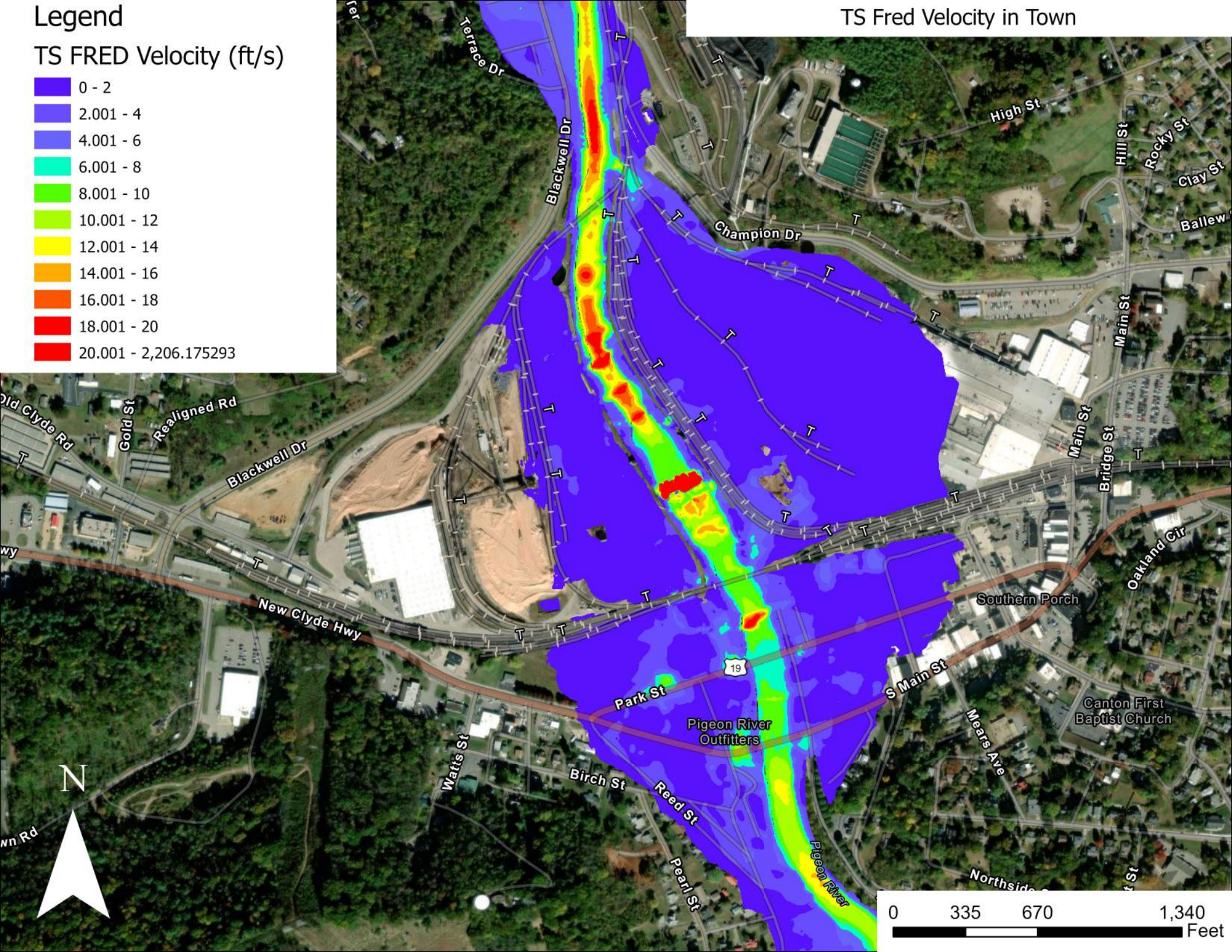

TS Fred WSE US of Canton
Legend
TS Fred WSE (ft)
2,560.695 - 2,605
2,605.001 - 2,606
2,606.001 - 2,607
2,607.001 - 2,608
2,608.001 - 2,609
2,609.001 - 2,610
2,610.001 - 2,611
2,611.001 - 2,612
2,612.001 - 2,613
2,613.001 - 2,614
2,614.001 - 2,641
Pigeon River
Pigeon River
Old River Rd
Pigeon River
Brookside Dr
Waters Pt
Waters Pt
Plott Dr
215
N
0
137.5
275
550
Feet

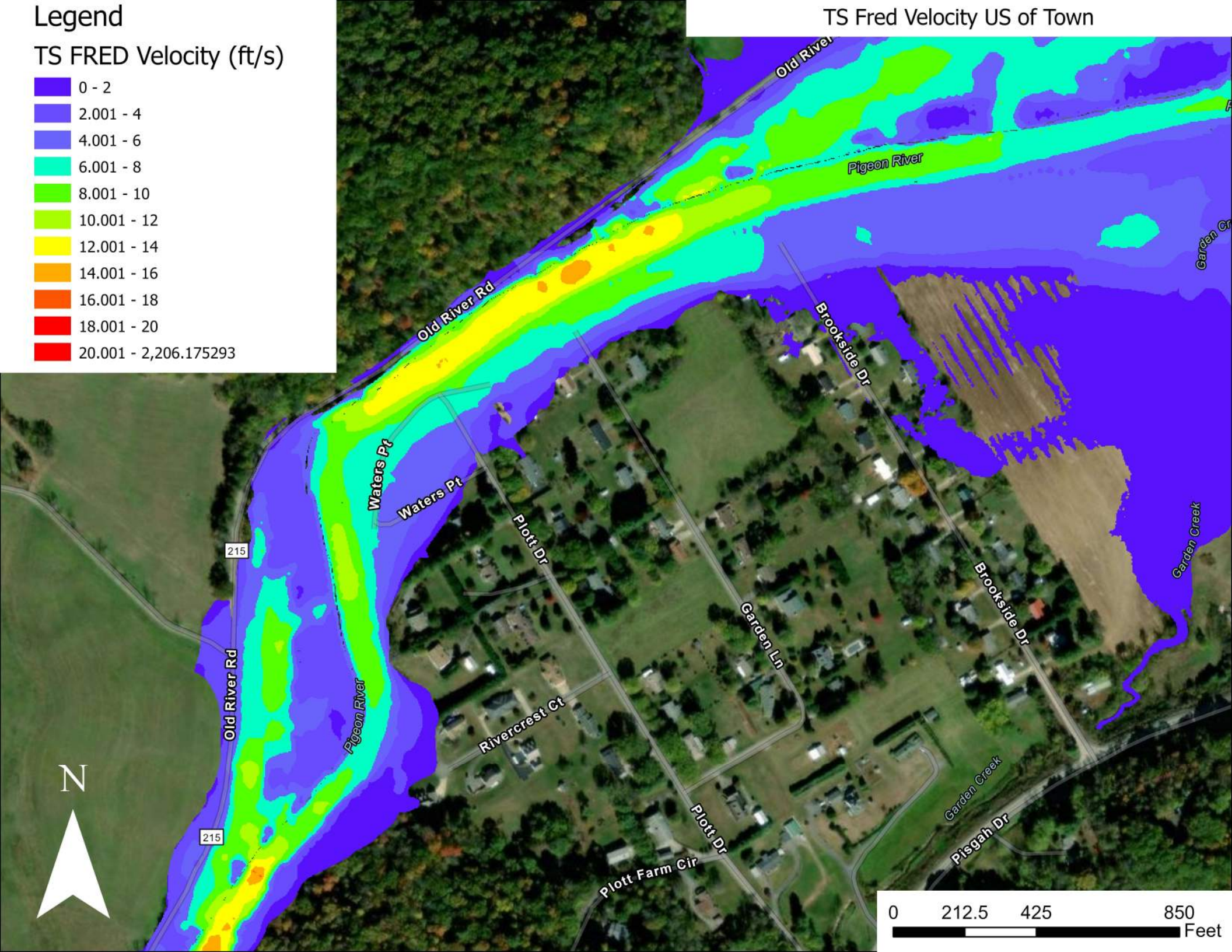

Legend
TS Fred Depth
Value
16.29002 - 28.373291
10.62057 - 16.290019
4.951119 - 10.620569
0 - 4.951118
TS Fred Depth
West Canton
Champion Dr
Clyde
Carolina Blvd
19
Canton
Asheville Hwy
40
215
Morning Star
110
Spring Hill
N
0
2,000
4,000
8,000
Feet


Legend
TS Fred Depth
Value
16.29002 - 28.373291
10.62057 - 16.290019
4.951119 - 10.620569
0 - 4.951118
TS Fred Depth
West Canton
Champion Dr
Clyde
Carolina Blvd
19
Canton
Asheville Hwy
40
215
Morning Star
110
Spring Hill
N
0
2,000
4,000
8,000
Feet

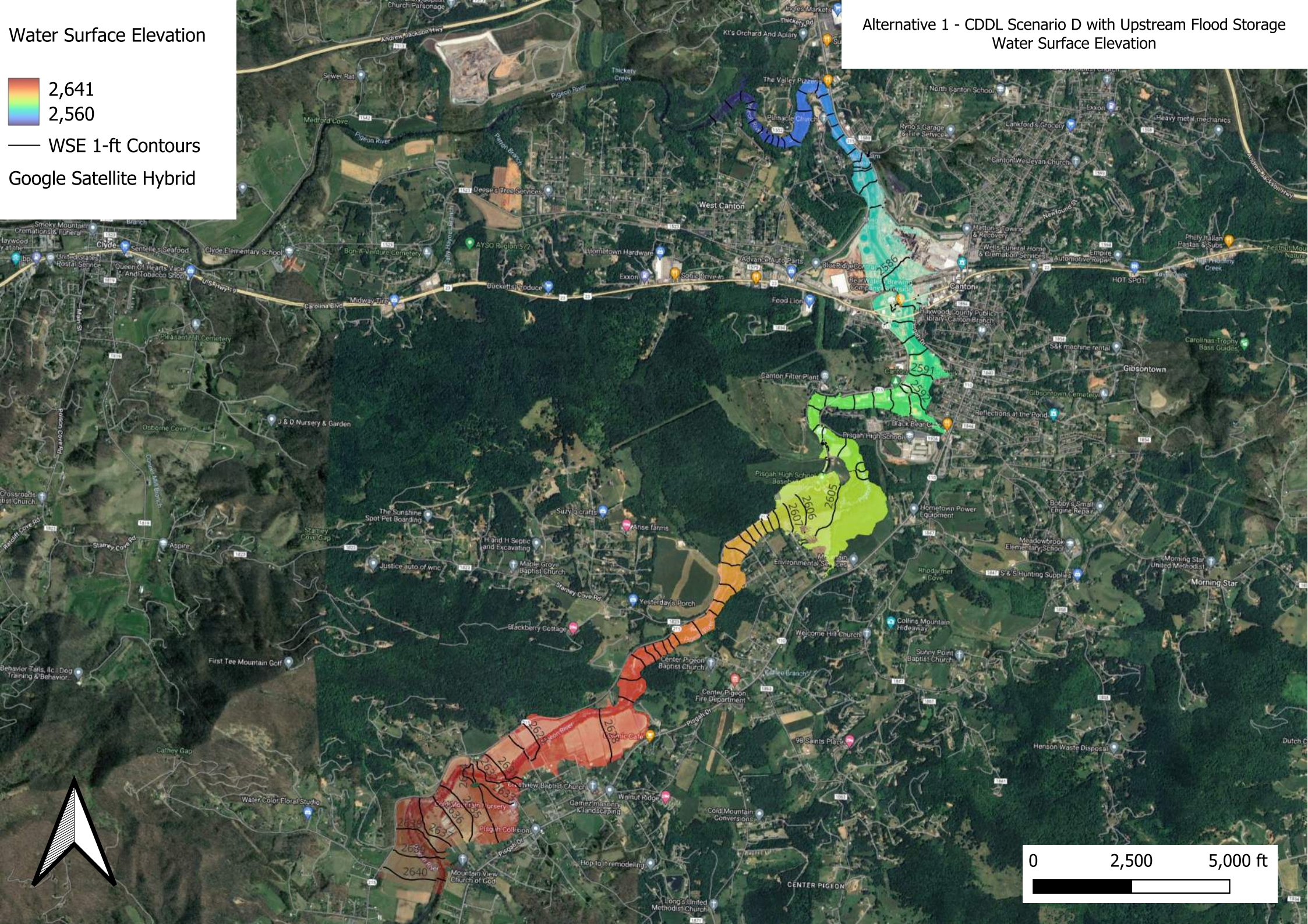

Legend
TS Fred Depth
Value
16.29002 - 28.373291
10.62057 - 16.290019
4.951119 - 10.620569
0 - 4.951118
TS Fred Depth US of Canton
Pigeon River
Pigeon River
Old River Rd
Pigeon River
Brookside Dr
Waters Pt
Waters Pt
Plott Dr
215
N
0
137.5
275
550
Feet


TS Fred Velocity
Legend
TS FRED Velocity (ft/s)
0 - 2
2.001 - 4
4.001 - 6
6.001 - 8
8.001 - 10
10.001 - 12
12.001 - 14
14.001 - 16
16.001 - 18
18.001 - 20
20.001 - 2,206.175293
West Canton
Champion Dr
Canton
Asheville Hwy
Morning Star
Spring Hill
19
40
215
110
N
0 1,500 3,000 6,000
Feet


Legend
TS FRED Velocity (ft/s)
0 - 2
2.001 - 4
4.001 - 6
6.001 - 8
8.001 - 10
10.001 - 12
12.001 - 14
14.001 - 16
16.001 - 18
18.001 - 20
20.001 - 2,206.175293
TS Fred Velocity in Town
Terrace Dr
Blackwell Dr
High St
Hill St
Rocky St
Clay St
Champion Dr
Main St
Old Clyde Rd
Gold St
Realigned Rd
Blackwell Dr
Bridge St
Oakland Cir
Southern Porch
New Clyde Hwy
19
Park St
S Main St
Canton First Baptist Church
Pigeon River Outfitters
Mears Ave
Watts St
Birch St
Reed St
Pearl St
Pigeon River
N
0
335
670
1,340
Feet


Legend
TS FRED Velocity (ft/s)
0 - 2
2.001 - 4
4.001 - 6
6.001 - 8
8.001 - 10
10.001 - 12
12.001 - 14
14.001 - 16
16.001 - 18
18.001 - 20
20.001 - 2,206.175293
TS Fred Velocity US of Town
Old River
Pigeon River
Old River Rd
Brookside Dr
Garden Cr
Waters Pt
Waters Pt
Plott Dr
Garden Creek
215
Old River Rd
Brookside Dr
Garden Ln
Pigeon River
Rivercrest Ct
Garden Creek
Plott Dr
Pisgah Dr
215
Plott Farm Cir
N
0
212.5
425
850
Feet

Alternative 1 – CDDL Scenario D with Upstream Flood Storage


Water Surface Elevation
2,641
2,560
WSE 1-ft Contours
Google Satellite Hybrid
Alternative 1 - CDDL Scenario D with Upstream Flood Storage
Water Surface Elevation
0
2,500
5,000 ft

Alternative 1 - CDDL Scenario D with Upstream Flood Storage
Water Surface Elevation Near Downtown Canton

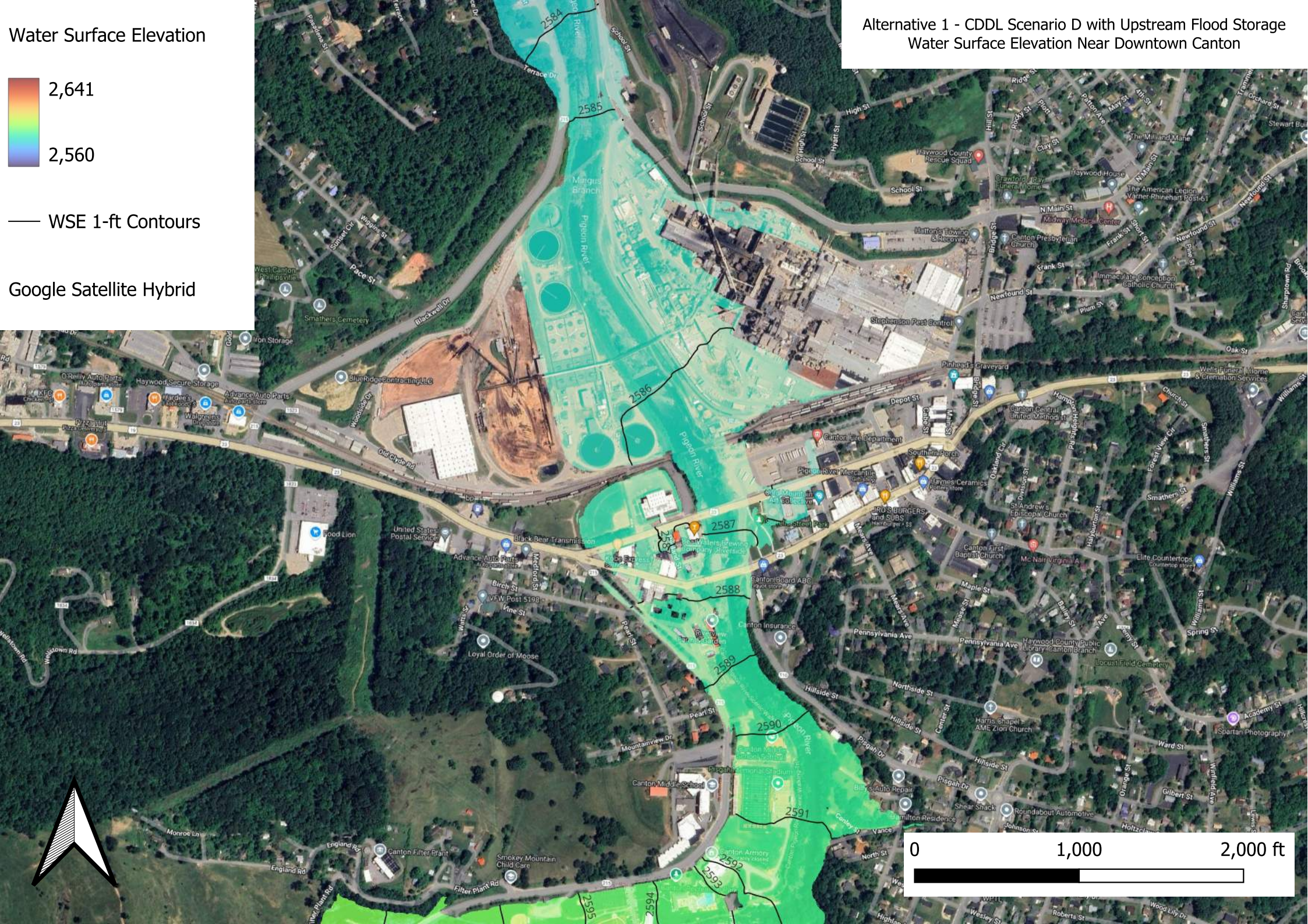
Water Surface Elevation

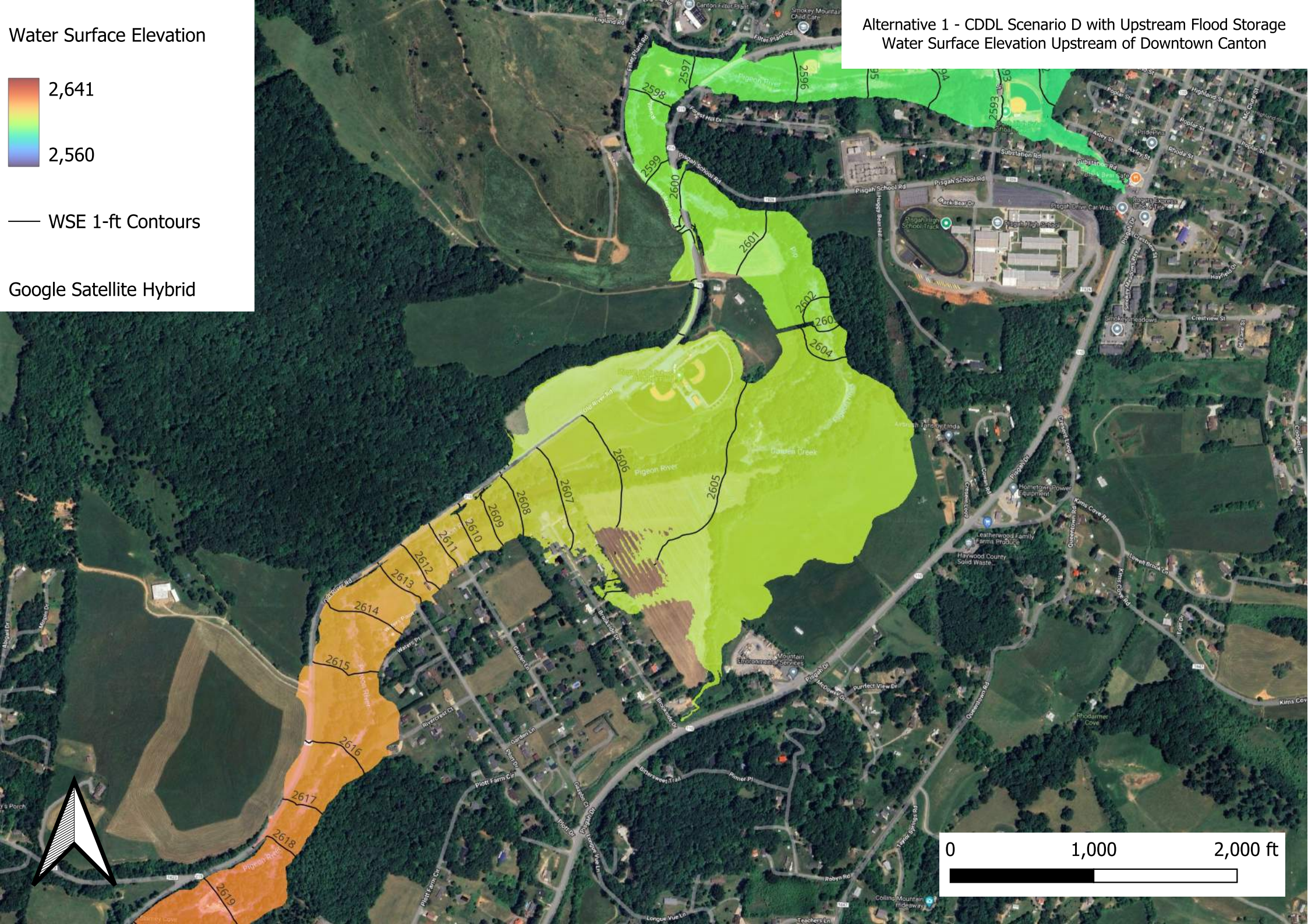
2,641

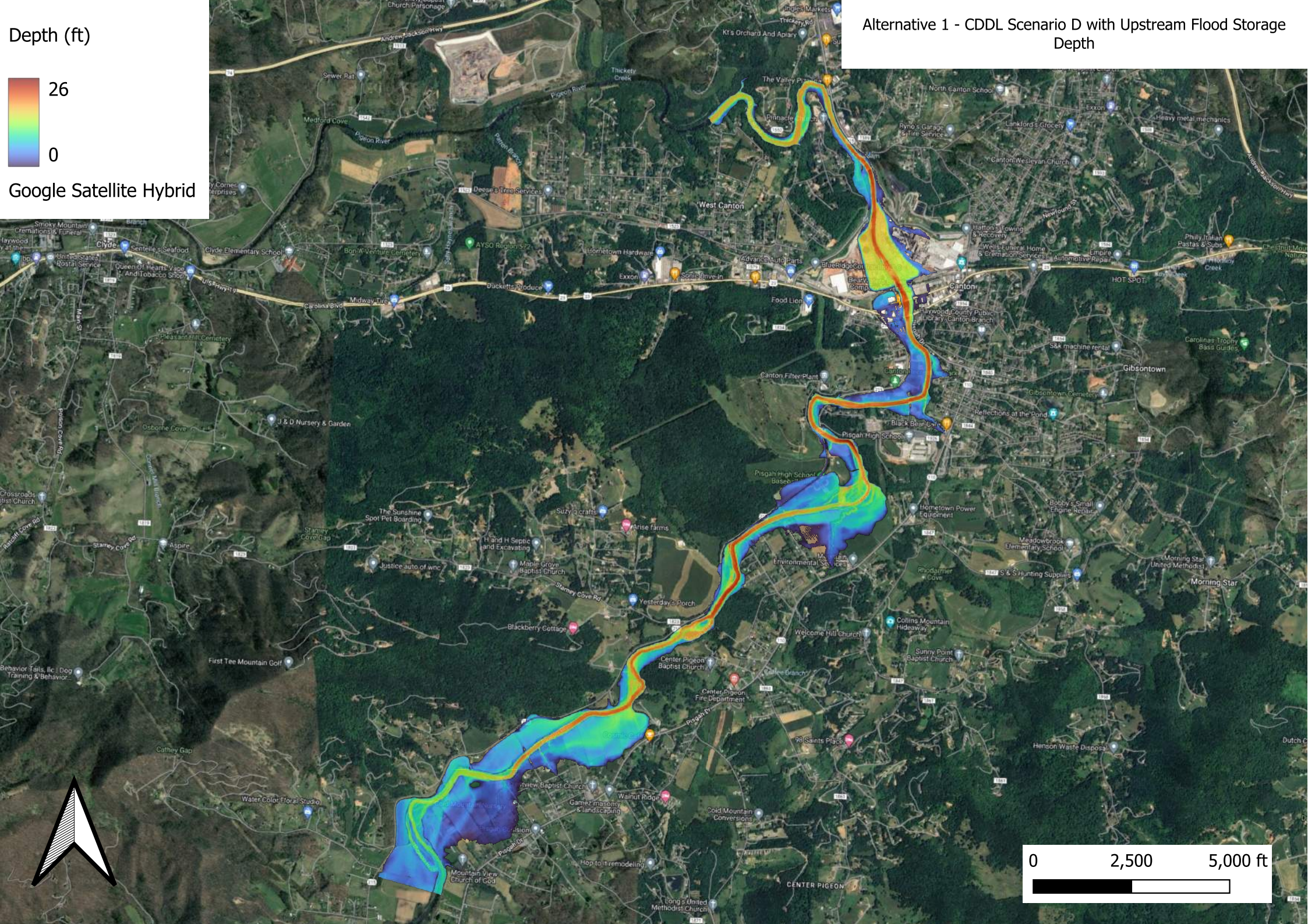
2,560

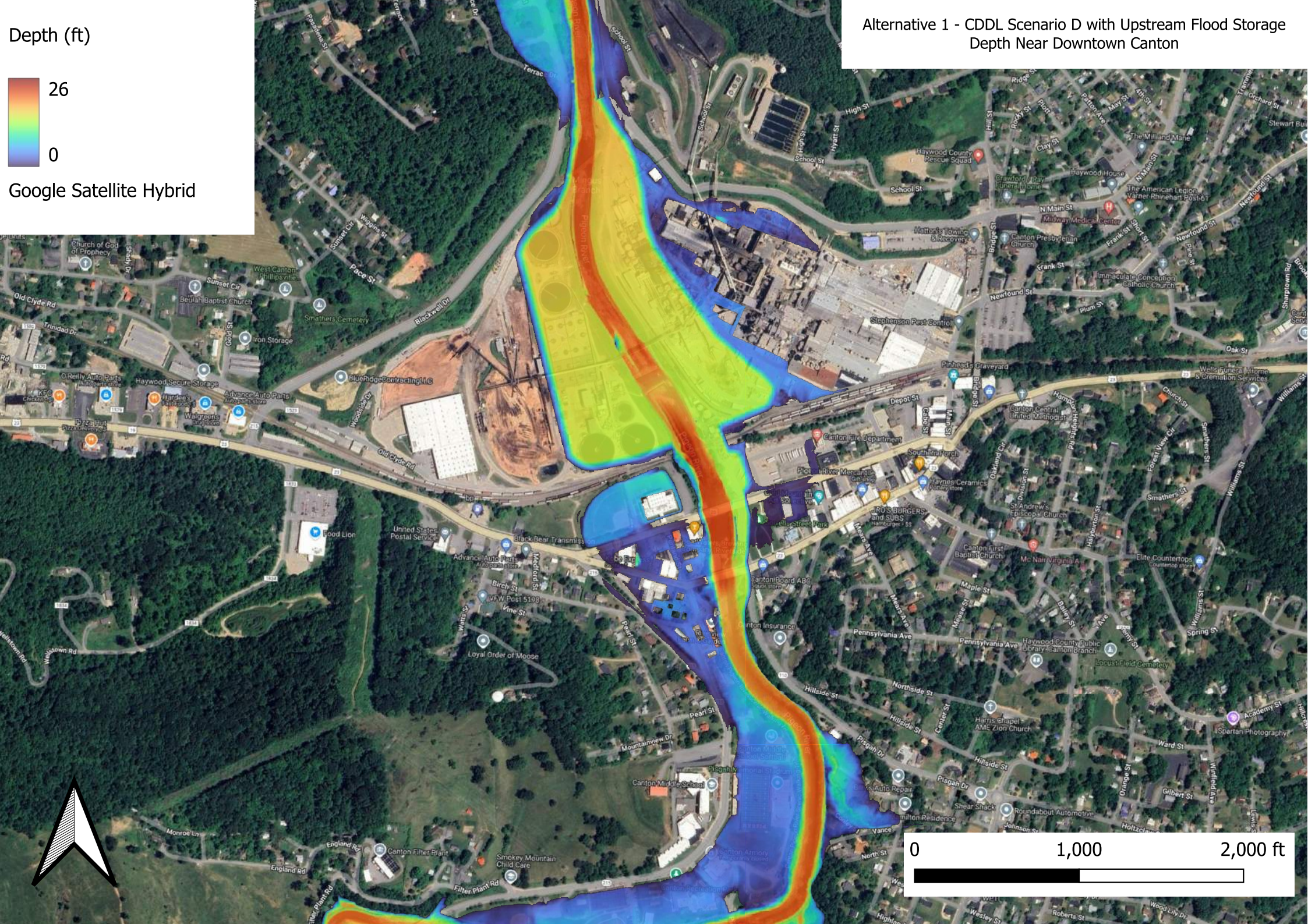
WSE 1-ft Contours

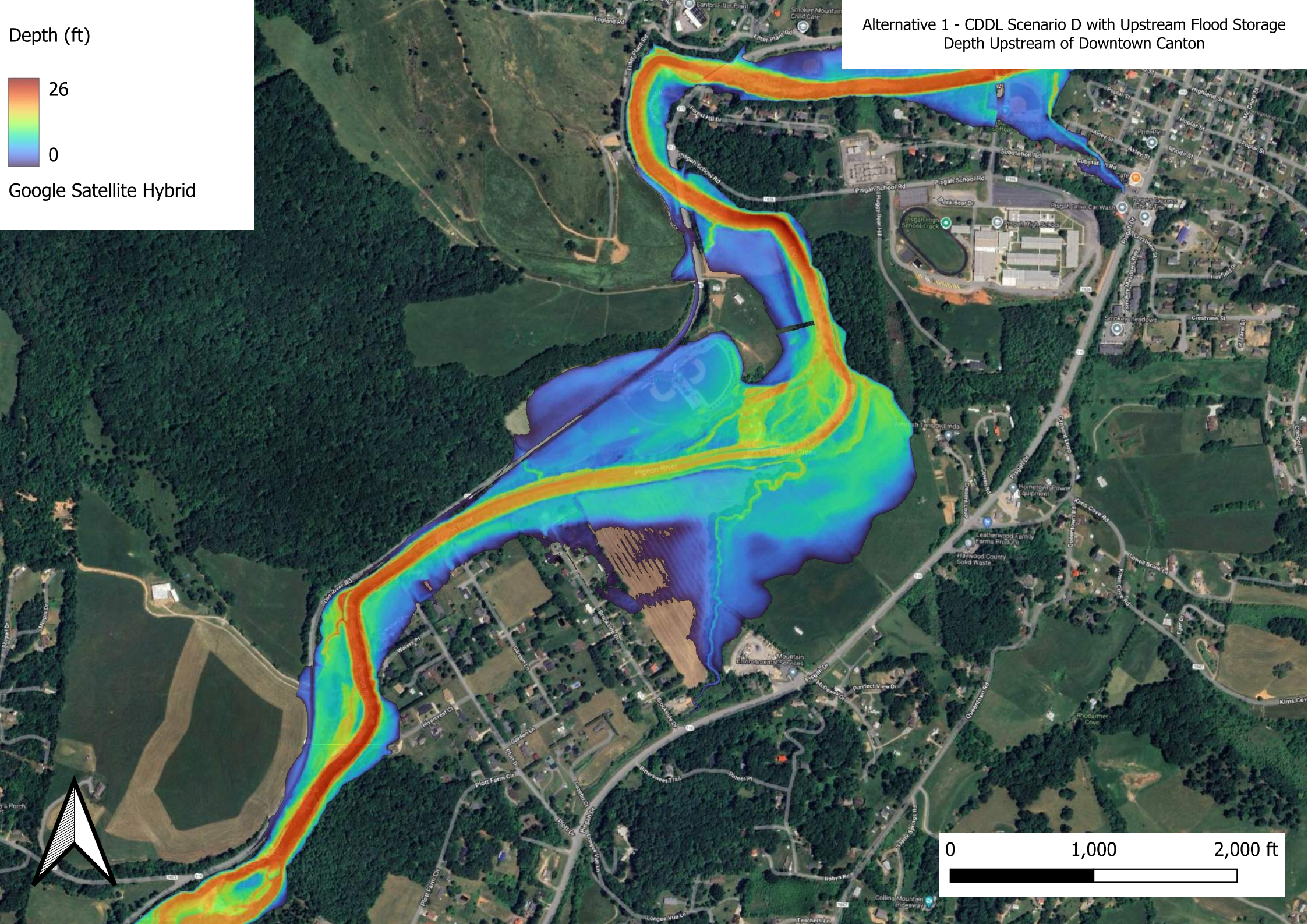
Google Satellite Hybrid

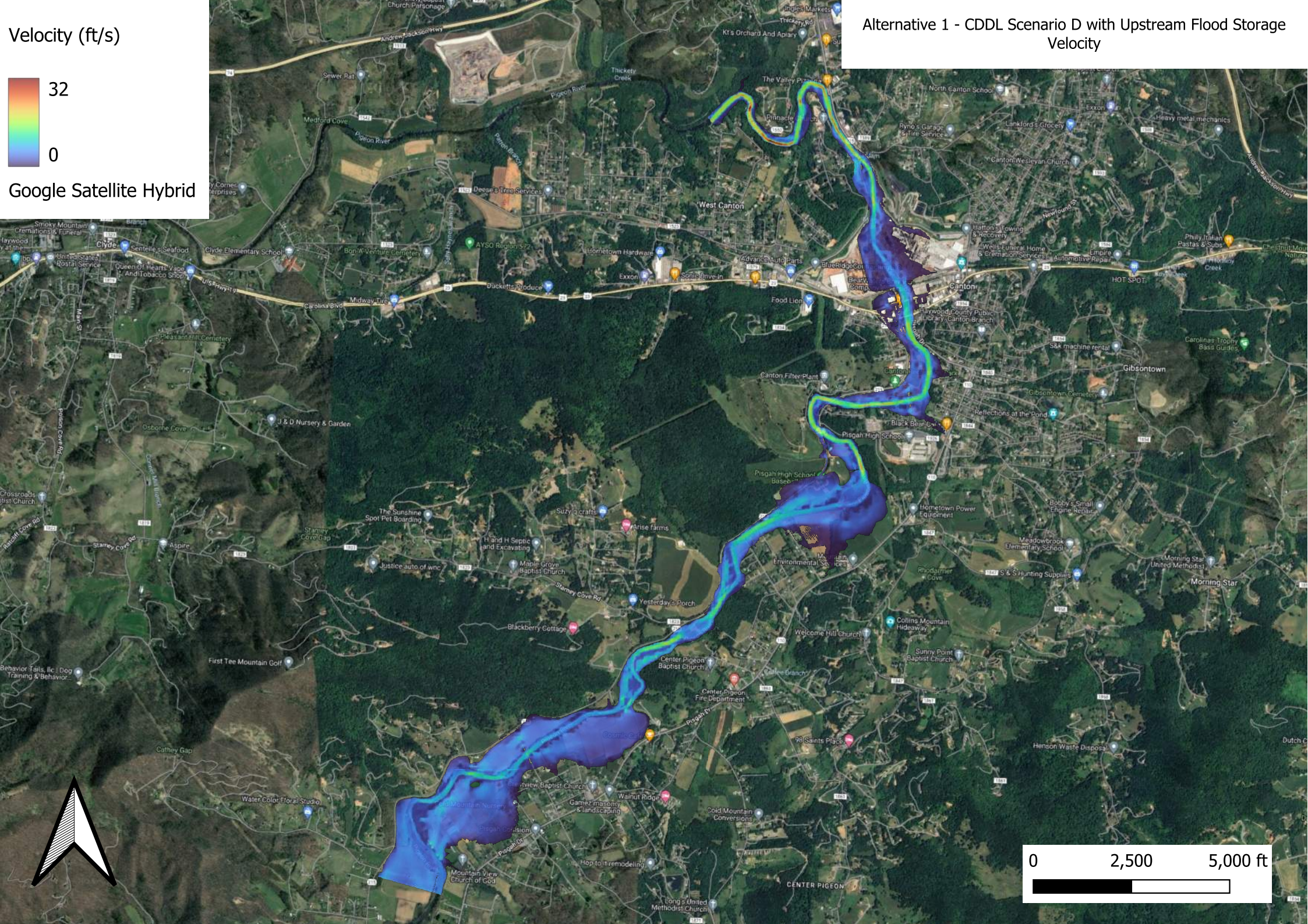


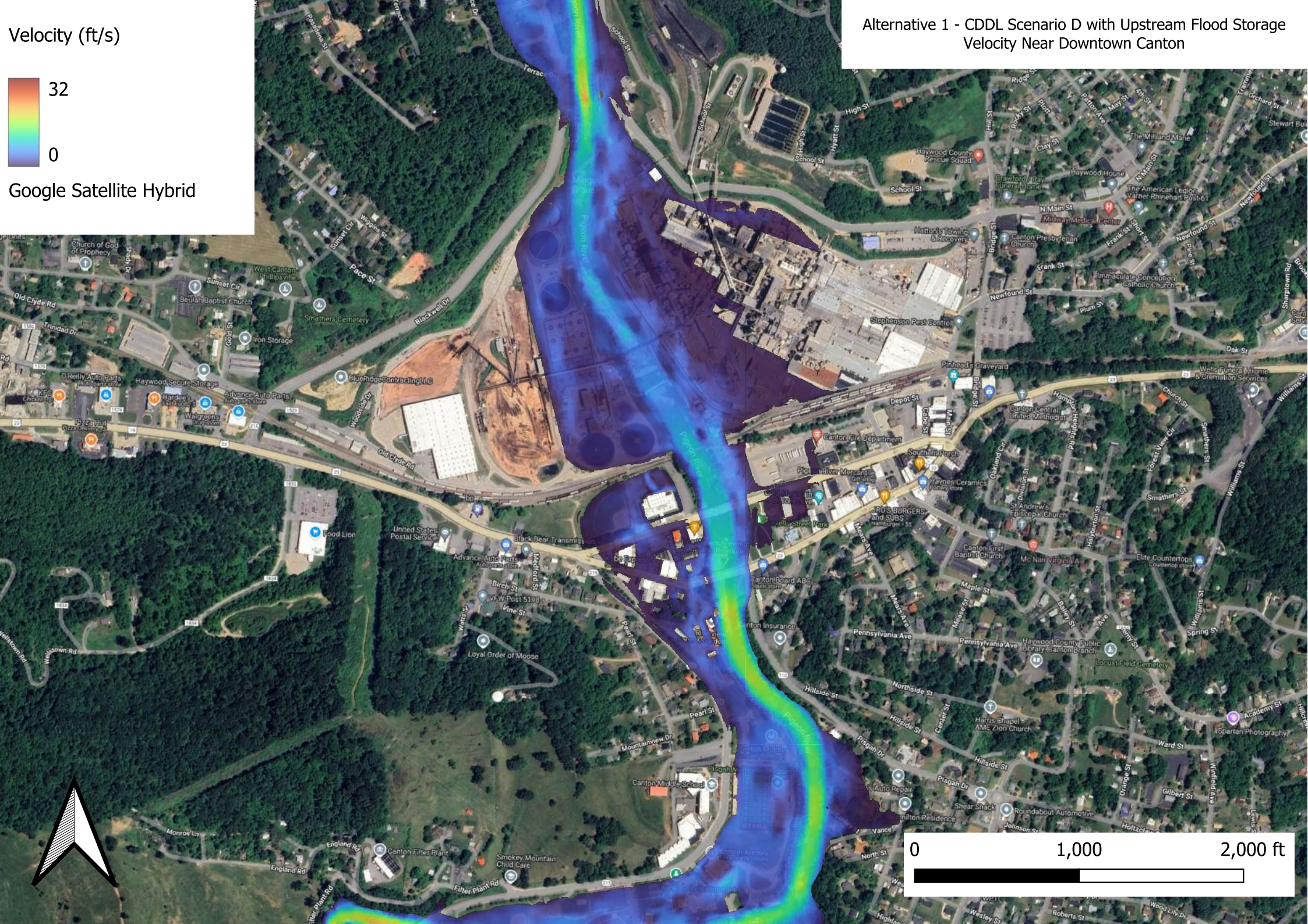

Water Surface Elevation
2,641
2,560
WSE 1-ft Contours
Google Satellite Hybrid
Alternative 1 - CDDL Scenario D with Upstream Flood Storage
Water Surface Elevation Upstream of Downtown Canton
0
1,000
2,000 ft

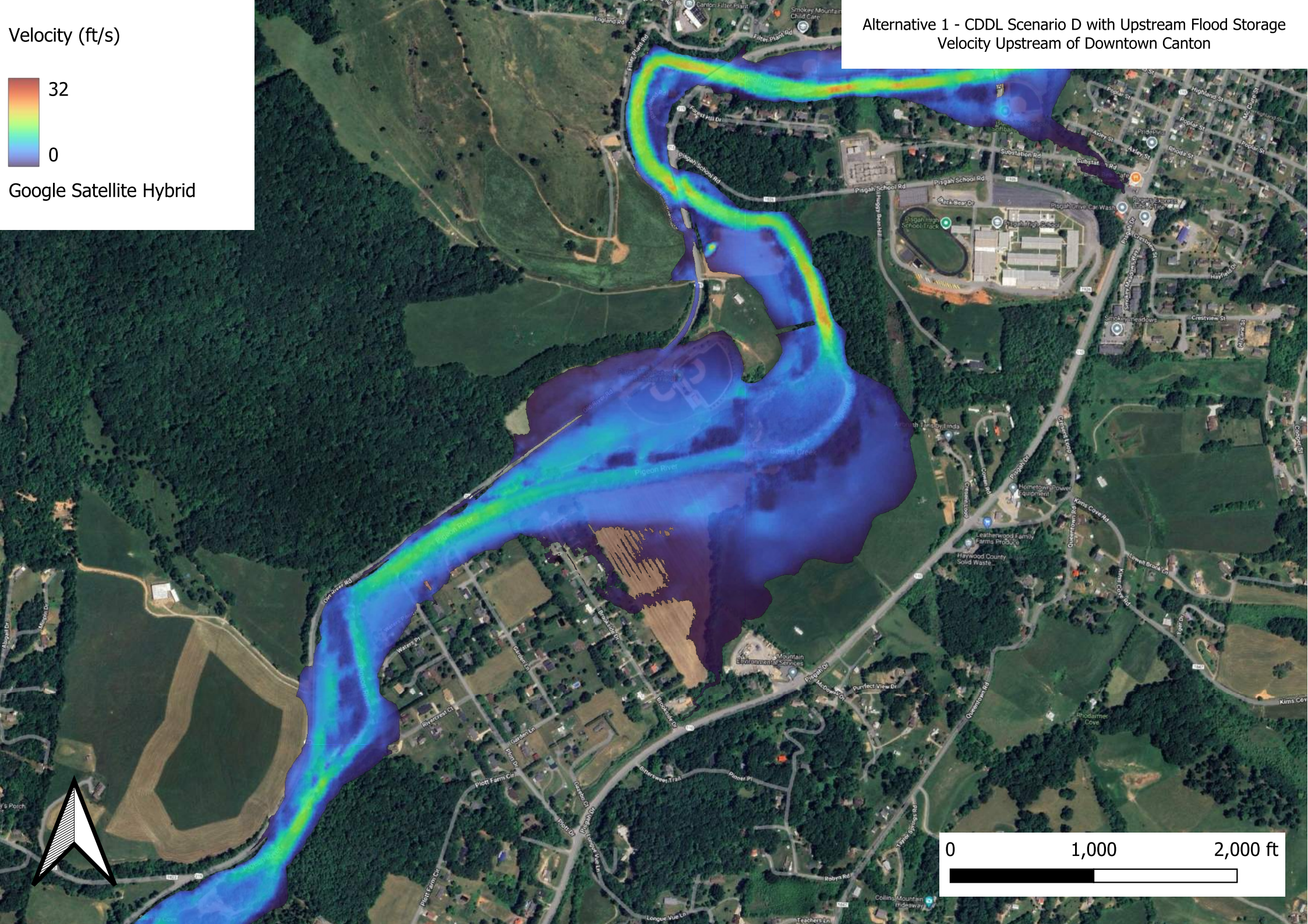

Depth (ft)
26
0
Google Satellite Hybrid
Alternative 1 - CDDL Scenario D with Upstream Flood Storage Depth
0
2,500
5,000 ft


Depth (ft)
26
0
Google Satellite Hybrid
Alternative 1 - CDDL Scenario D with Upstream Flood Storage
Depth Near Downtown Canton
0
1,000
2,000 ft

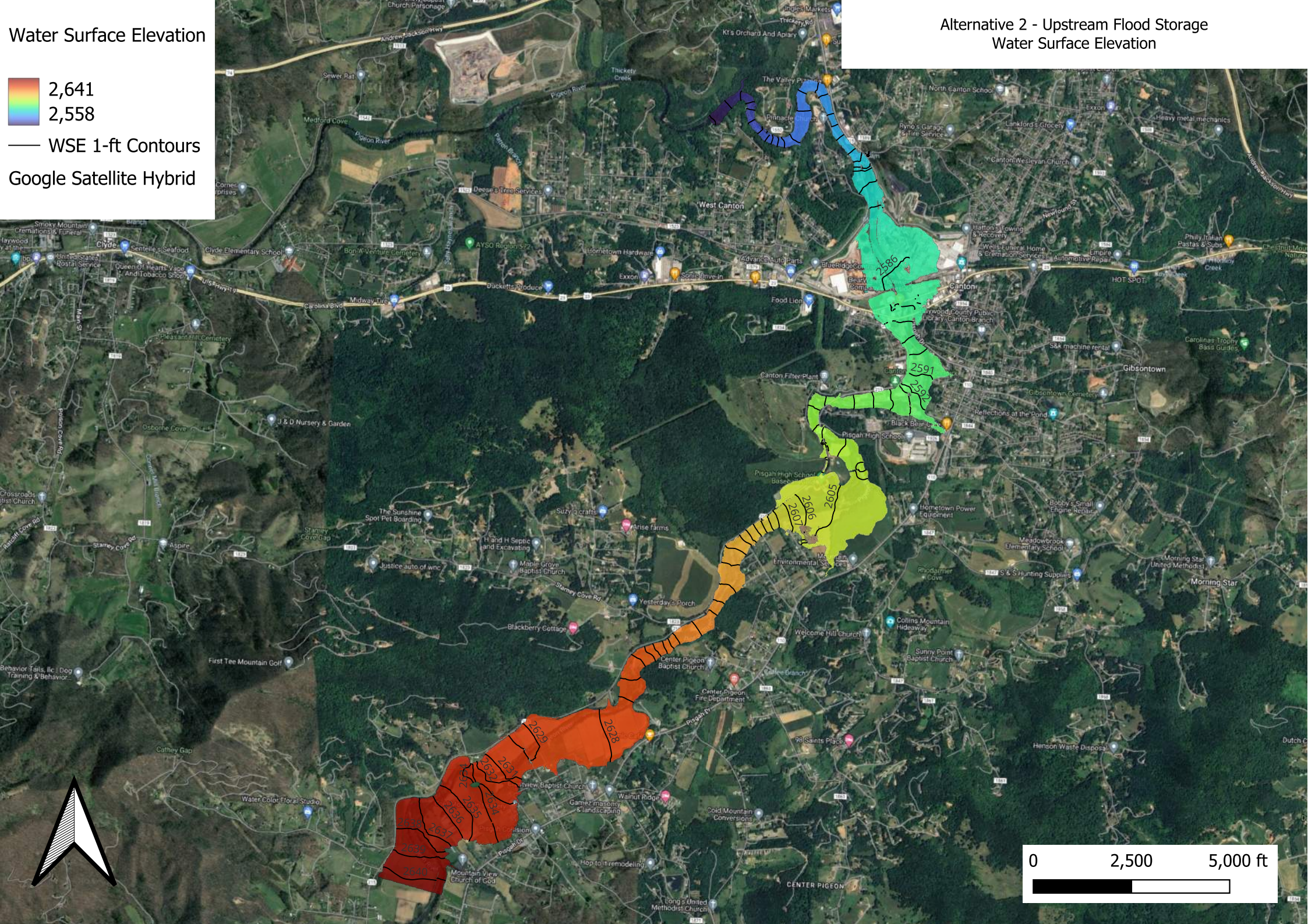

Depth (ft)
26
0
Google Satellite Hybrid
Alternative 1 - CDDL Scenario D with Upstream Flood Storage
Depth Upstream of Downtown Canton
0
1,000
2,000 ft

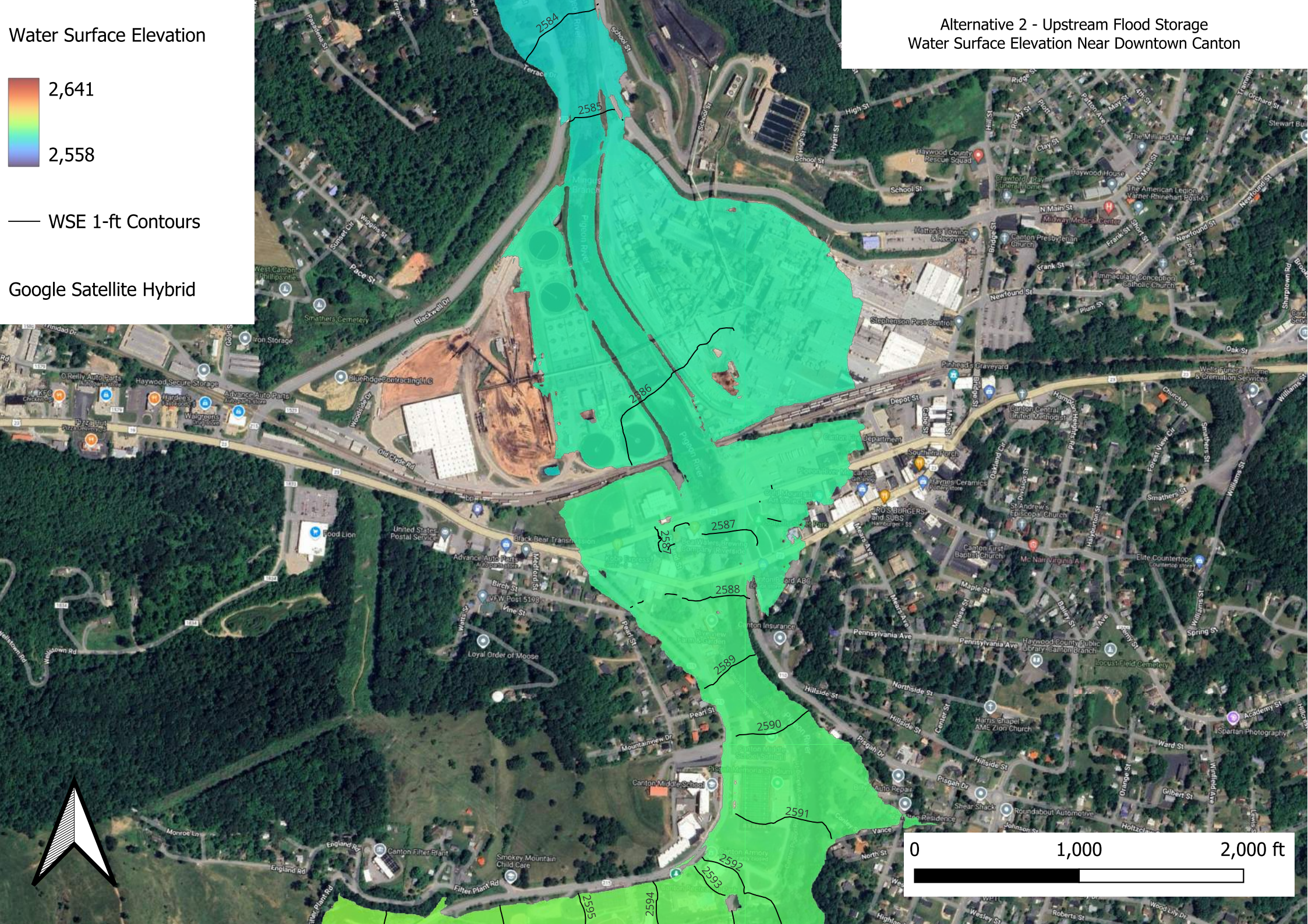

Velocity (ft/s)
32
0
Google Satellite Hybrid
Alternative 1 - CDDL Scenario D with Upstream Flood Storage
Velocity
0
2,500
5,000 ft

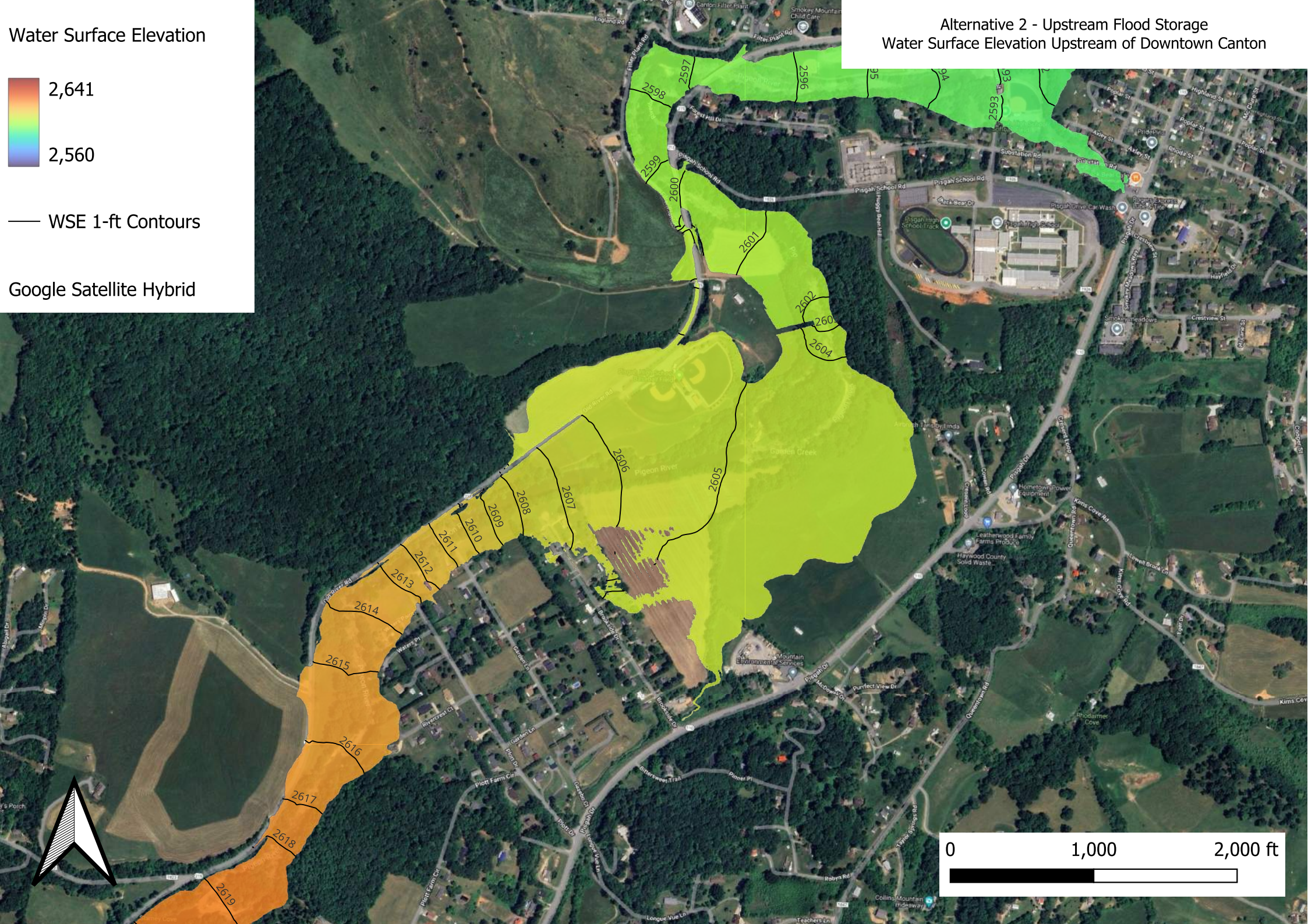

Alternative 1 - CDDL Scenario D with Upstream Flood Storage
Velocity Near Downtown Canton
Velocity (ft/s)
32
0
Google Satellite Hybrid
0
1,000
2,000 ft

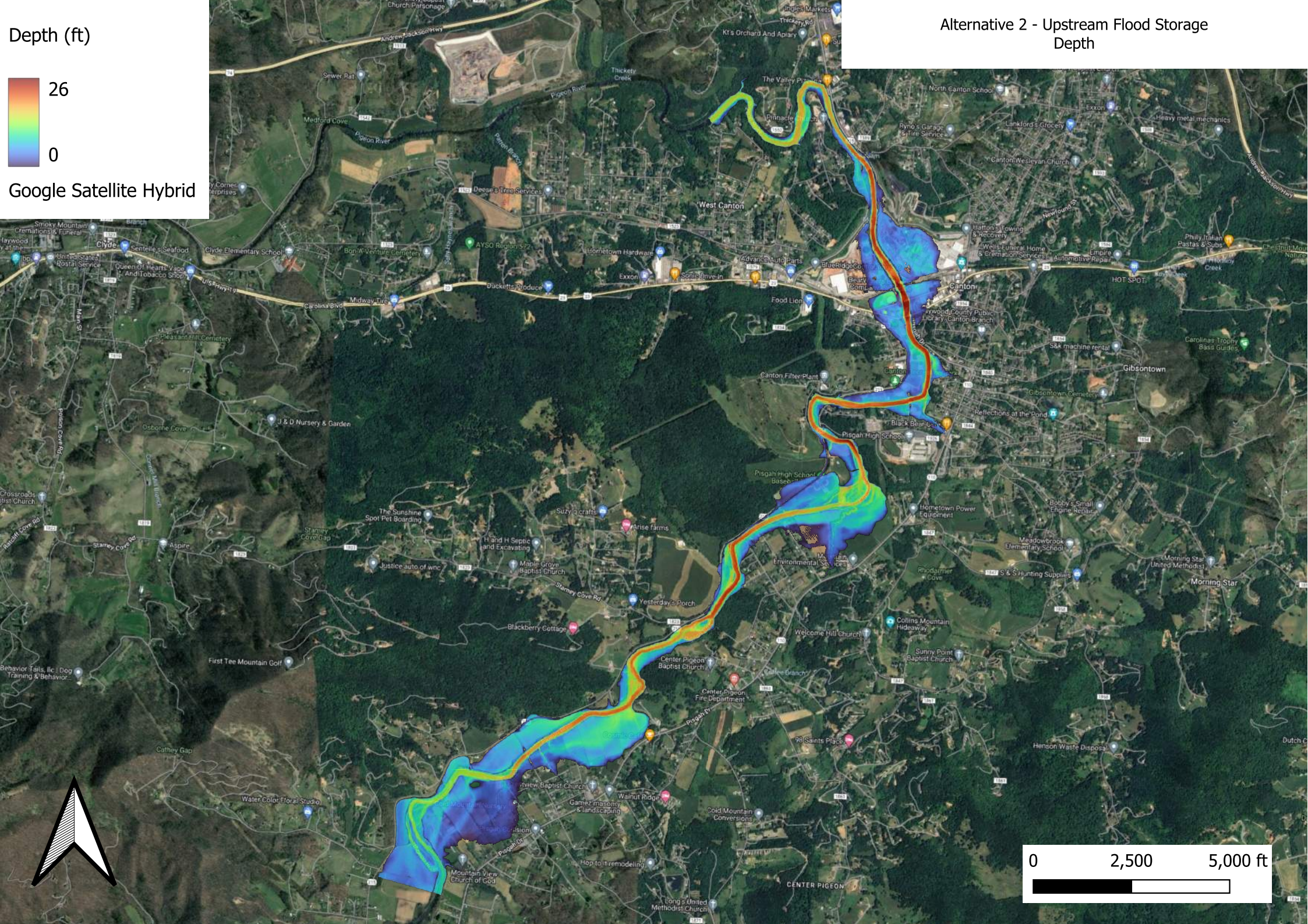

Alternative 1 - CDDL Scenario D with Upstream Flood Storage
Velocity Upstream of Downtown Canton
Velocity (ft/s)
32
0
Google Satellite Hybrid
0
1,000
2,000 ft

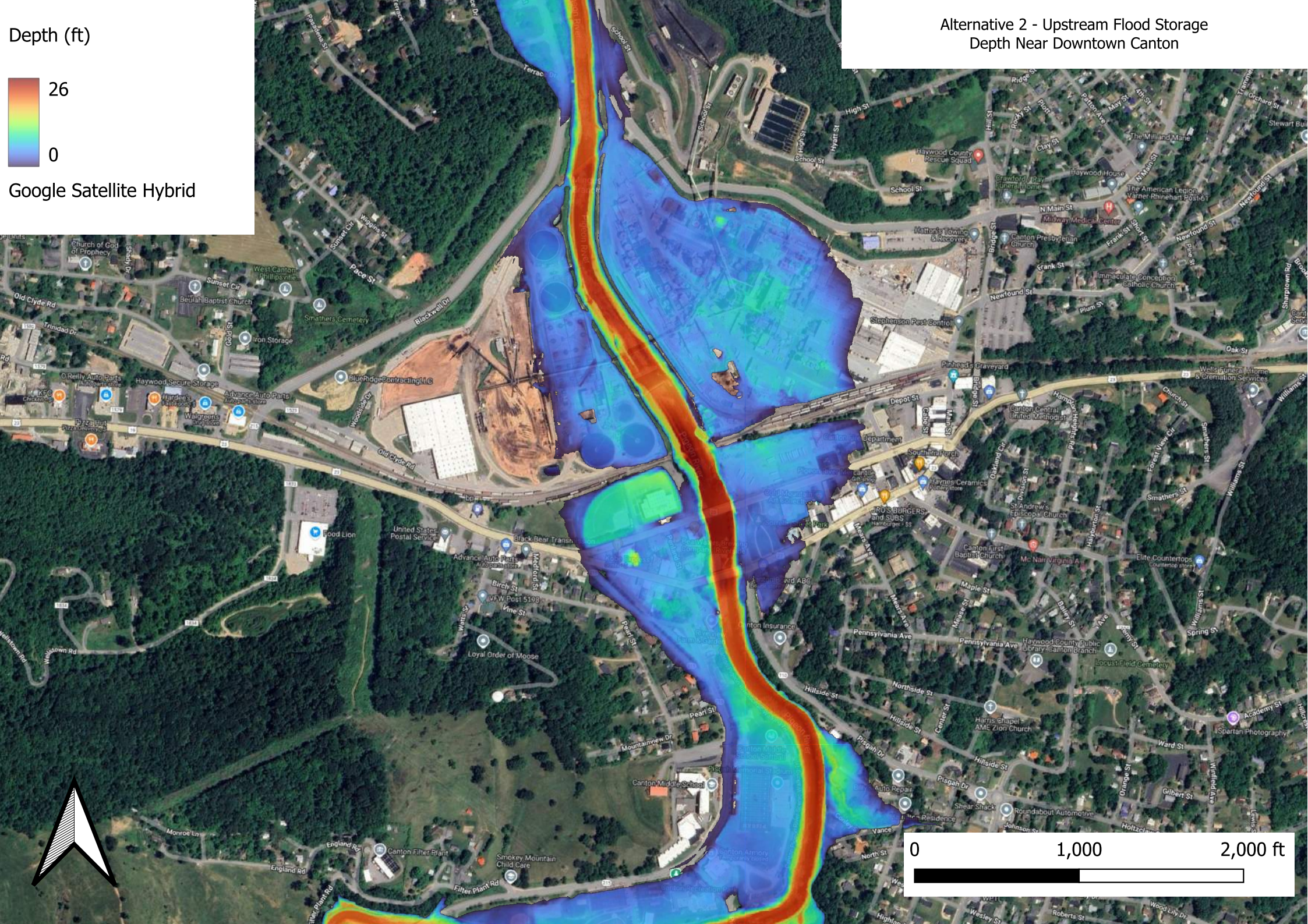
Alternative 2 –Upstream Flood Storage

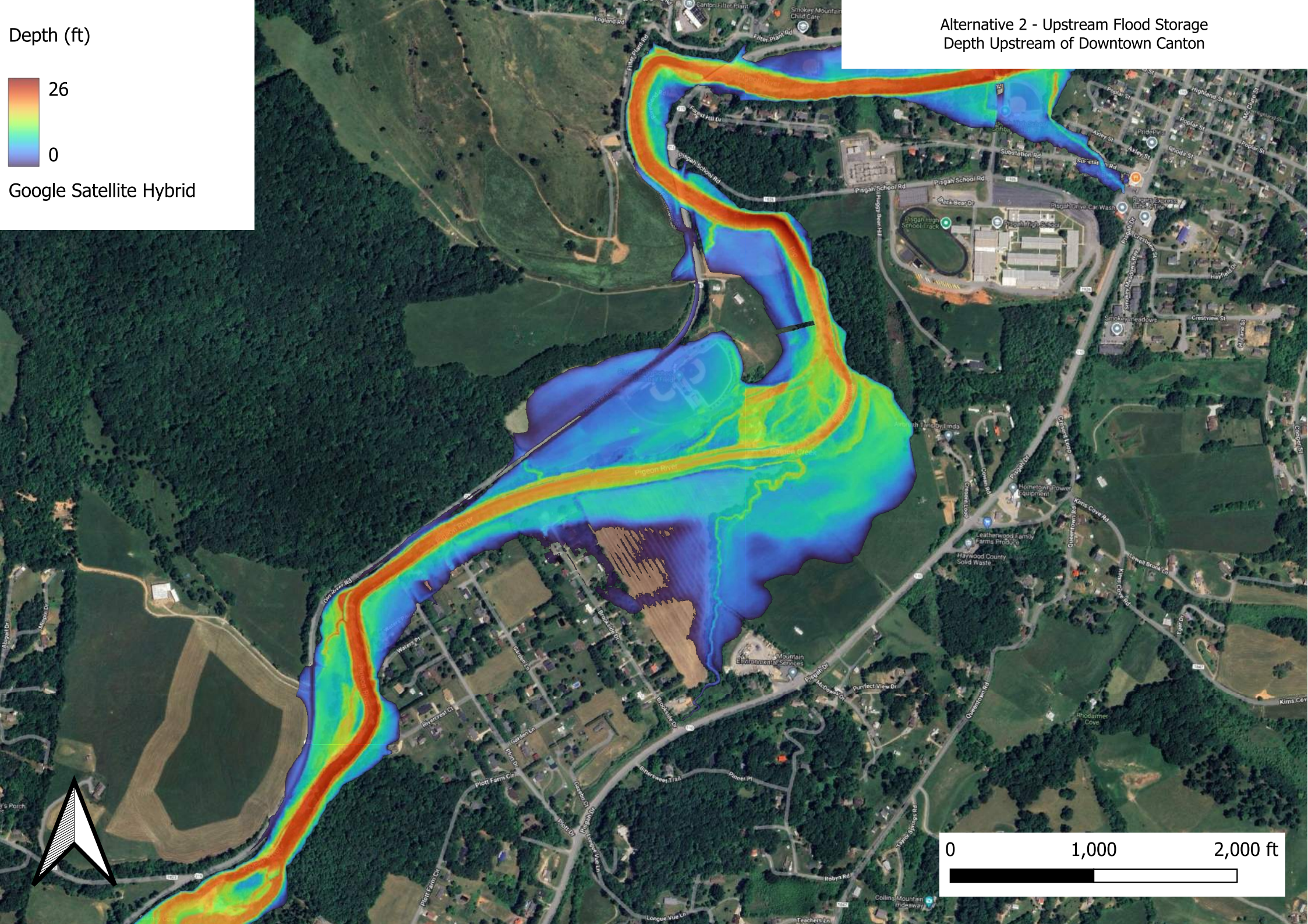

Water Surface Elevation
2,641
2,558
WSE 1-ft Contours
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Water Surface Elevation
2586
2591
2605
2606
2607
2628
2629
2631
2632
2634
2635
2636
2637
2638
2639
2640
0
2,500
5,000 ft

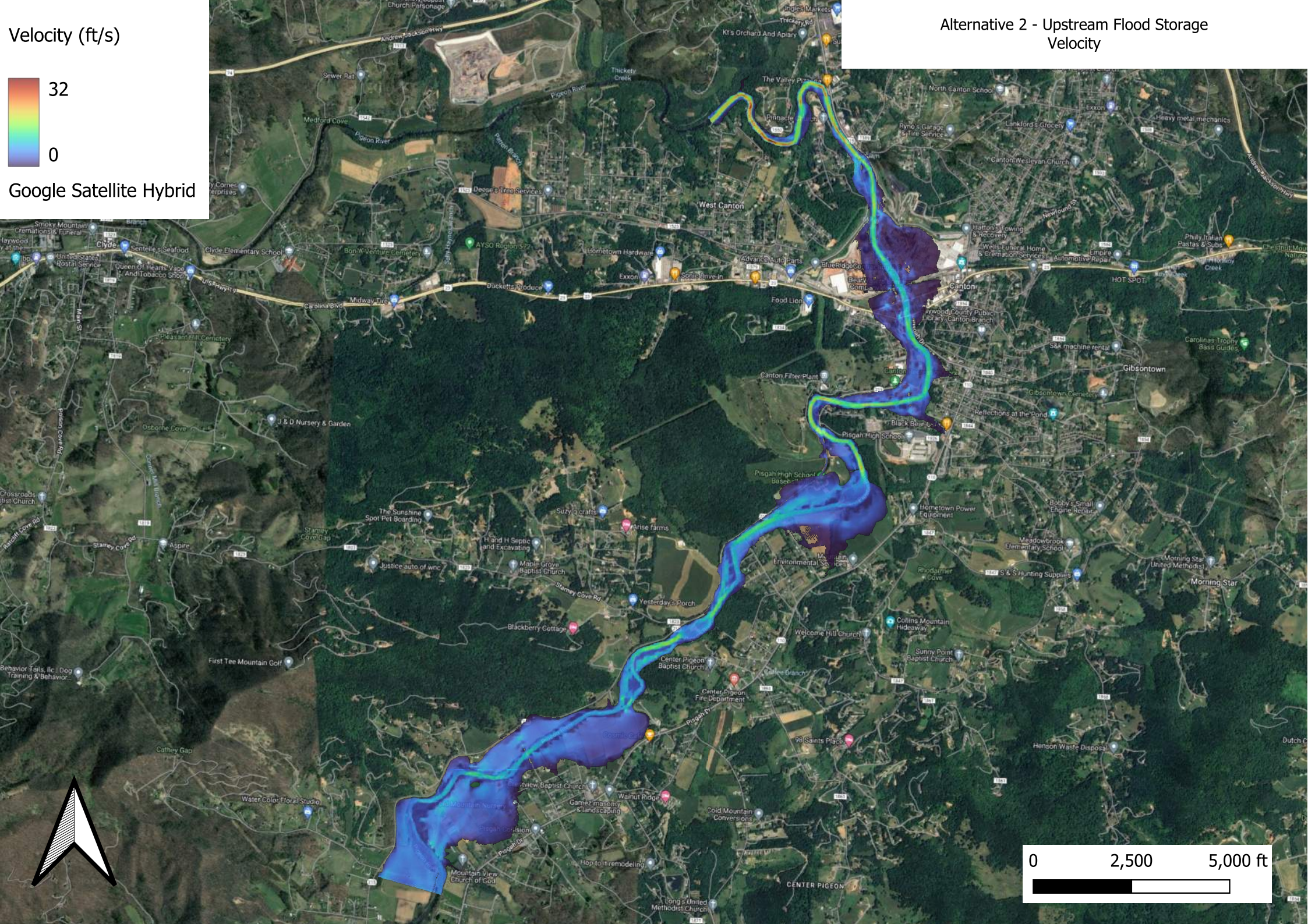

Water Surface Elevation
2,641
2,558
WSE 1-ft Contours
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Water Surface Elevation Near Downtown Canton
2584
2585
2586
2587
2588
2589
2590
2591
2592
2593
2594
2595
0
1,000
2,000 ft

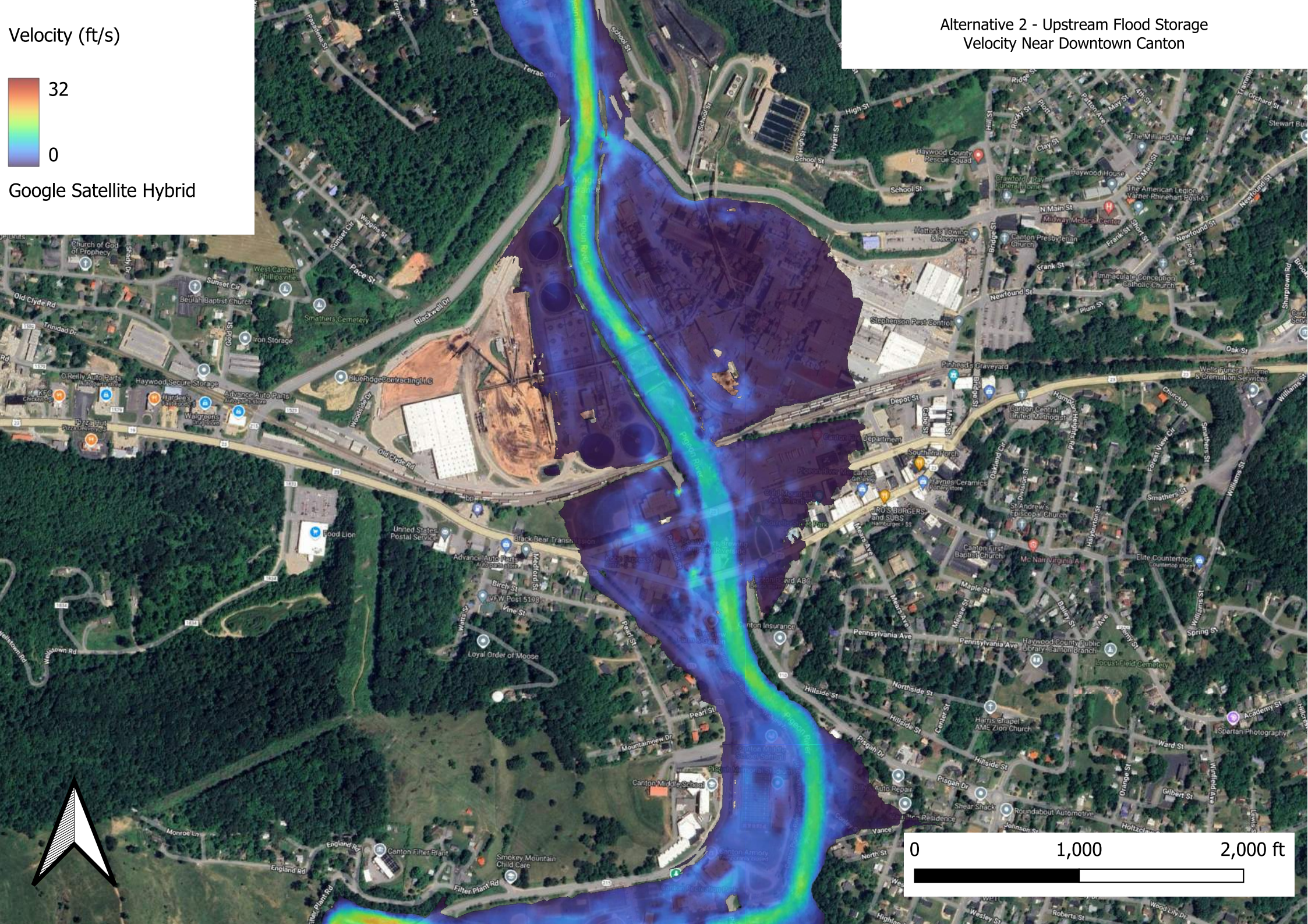

Water Surface Elevation
2,641
2,560
WSE 1-ft Contours
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Water Surface Elevation Upstream of Downtown Canton
2597
2596
2598
2599
2600
2601
2602
2604
2606
2605
2607
2608
2609
2610
2611
2612
2613
2614
2615
2616
2617
2618
2619
0
1,000
2,000 ft

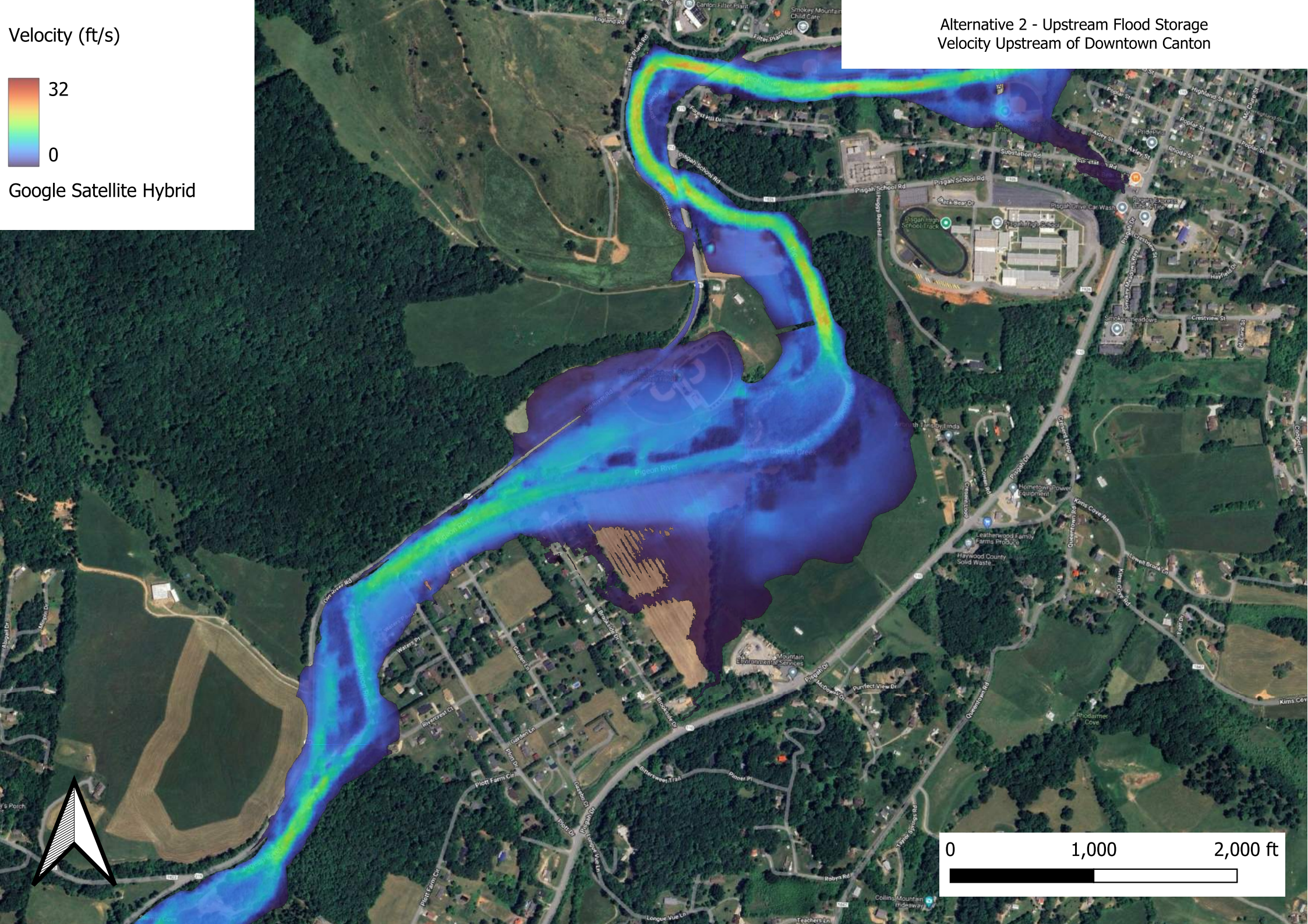

Depth (ft)
26
0
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Depth
0
2,500
5,000 ft


Depth (ft)
26
0
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Depth Near Downtown Canton
0
1,000
2,000 ft

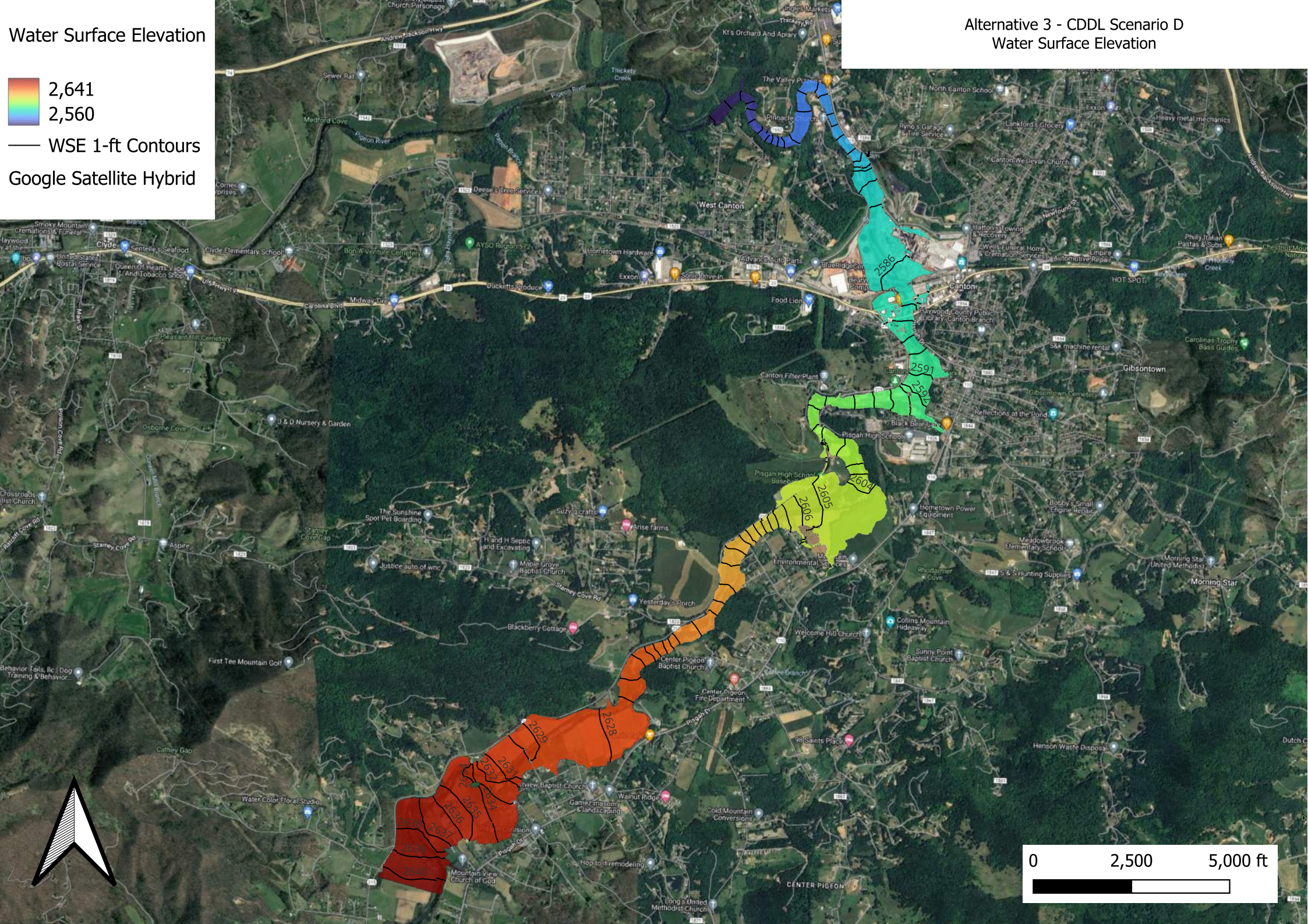

Depth (ft)
26
0
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Depth Upstream of Downtown Canton
0
1,000
2,000 ft


Velocity (ft/s)
32
0
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Velocity
0
2,500
5,000 ft


Velocity (ft/s)
32
0
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Velocity Near Downtown Canton
0
1,000
2,000 ft


Velocity (ft/s)
32
0
Google Satellite Hybrid
Alternative 2 - Upstream Flood Storage
Velocity Upstream of Downtown Canton
0
1,000
2,000 ft

Alternative 3 – CDDL Scenario D


Water Surface Elevation
2,641
2,560
WSE 1-ft Contours
Google Satellite Hybrid
Alternative 3 - CDDL Scenario D
Water Surface Elevation
2586
2591
2592
2604
2605
2606
2628
2629
2631
2632
2634
2635
2636
2637
2638
2639
2640
0
2,500
5,000 ft

Alternative 3 - CDDL Scenario D
Water Surface Elevation Near Downtown Canton

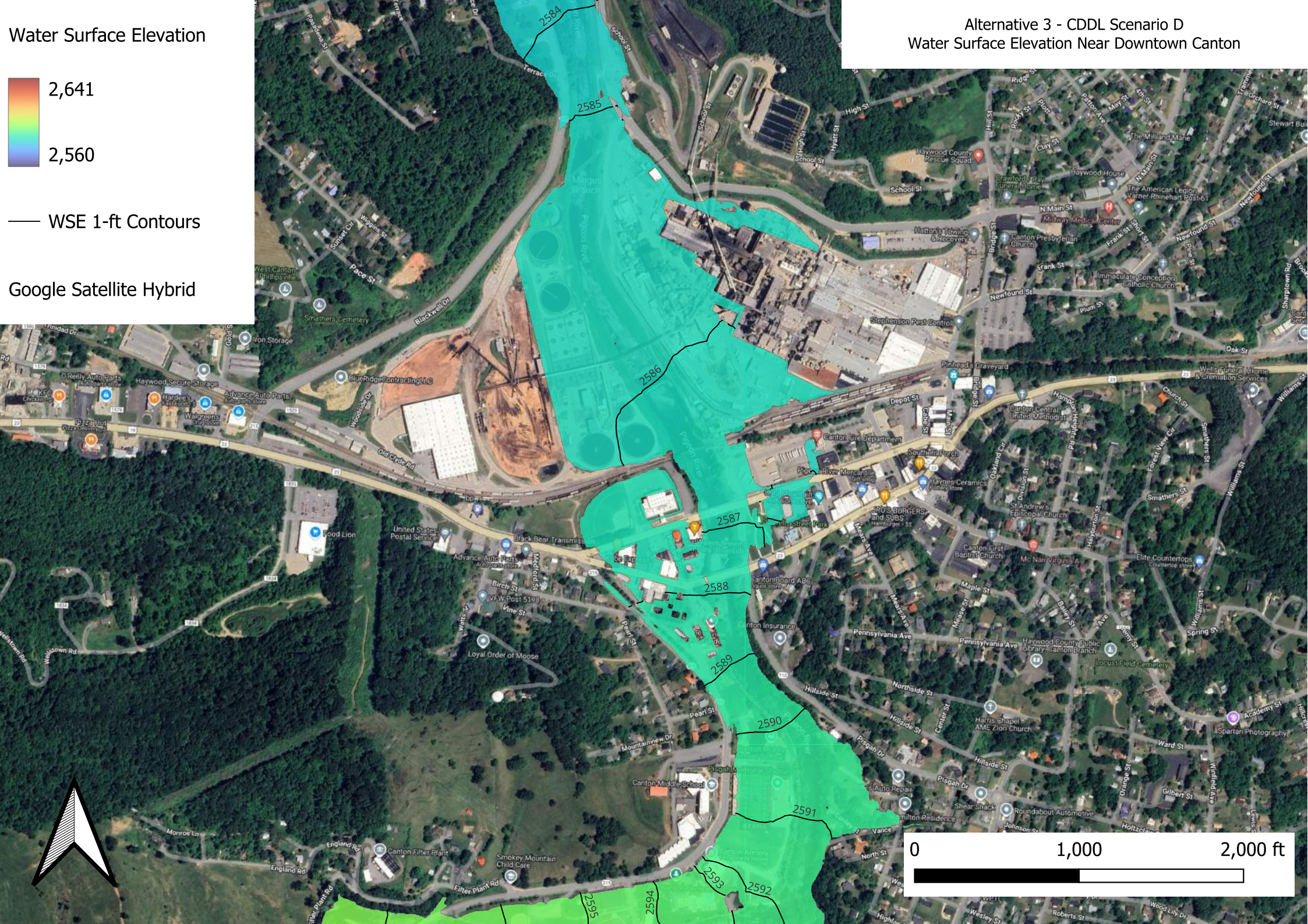
Water Surface Elevation

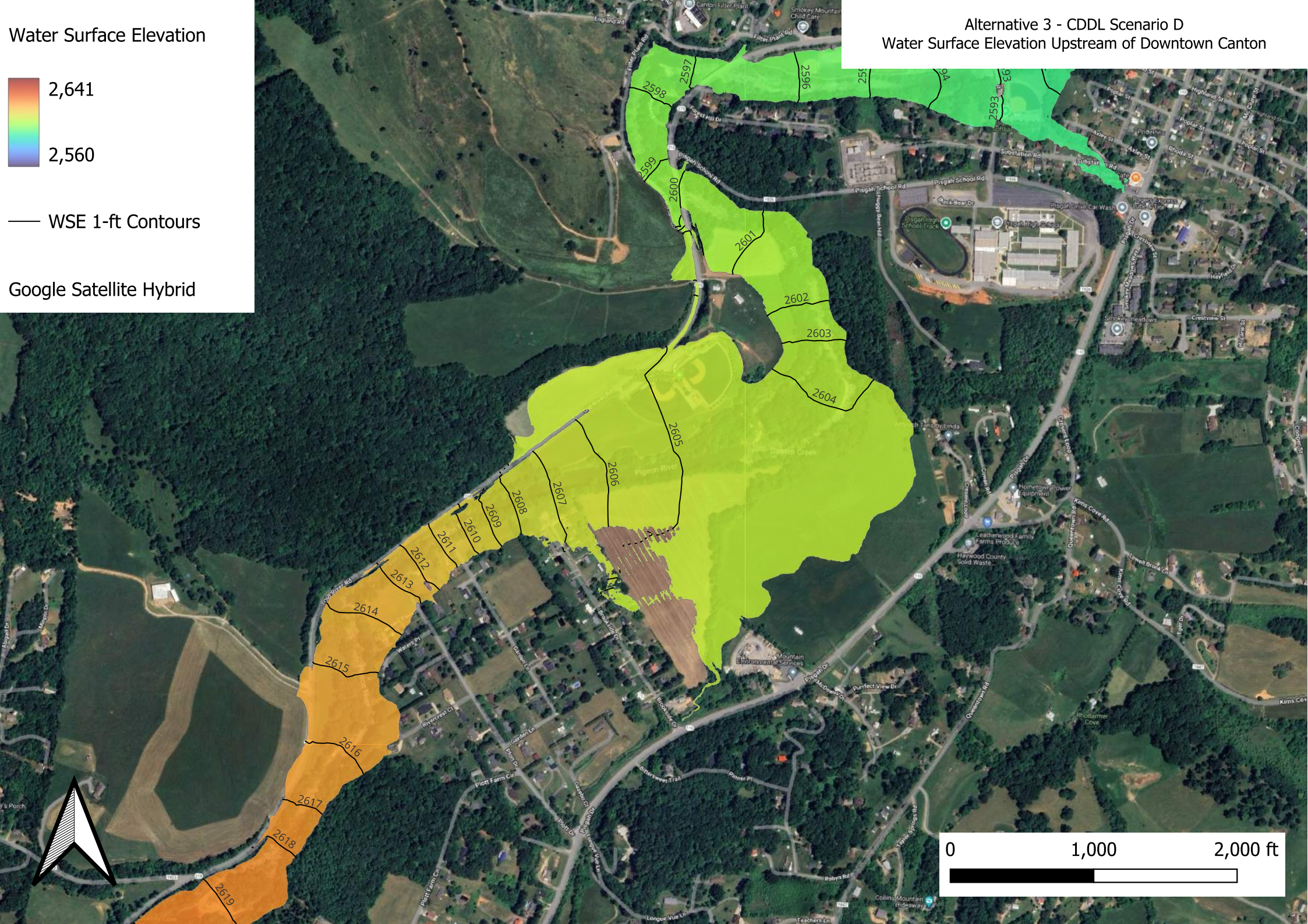
2,641

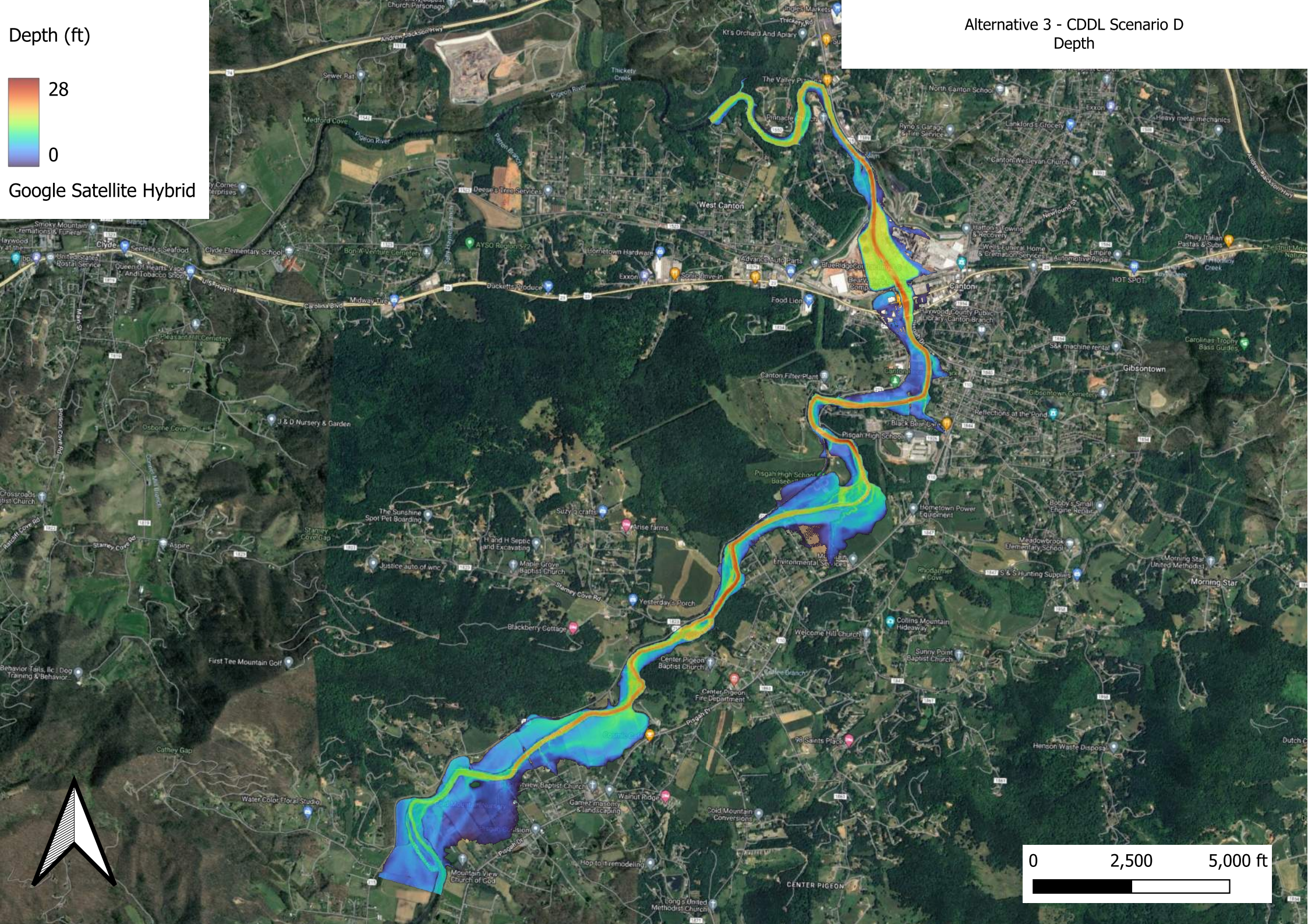
2,560

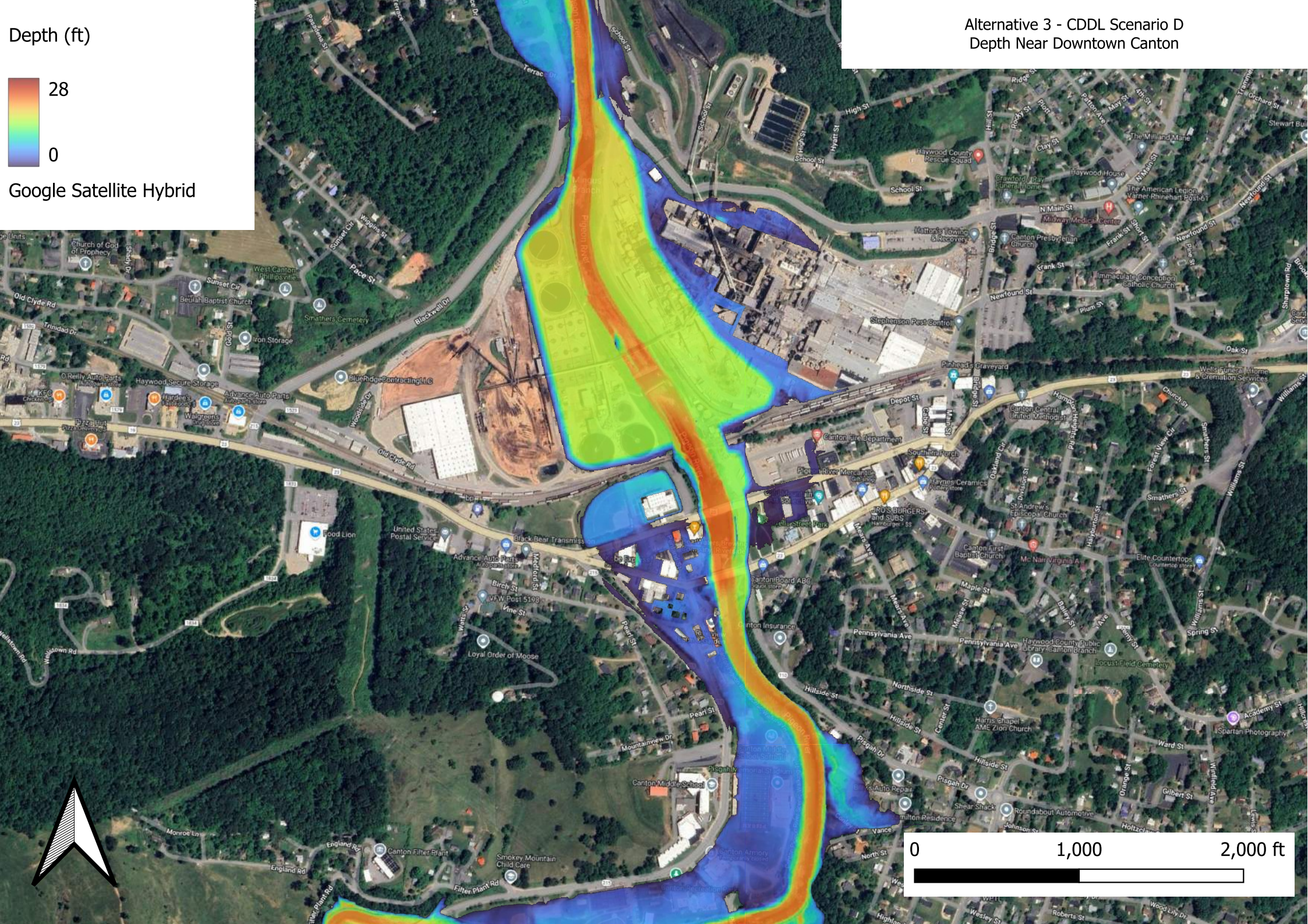
WSE 1-ft Contours

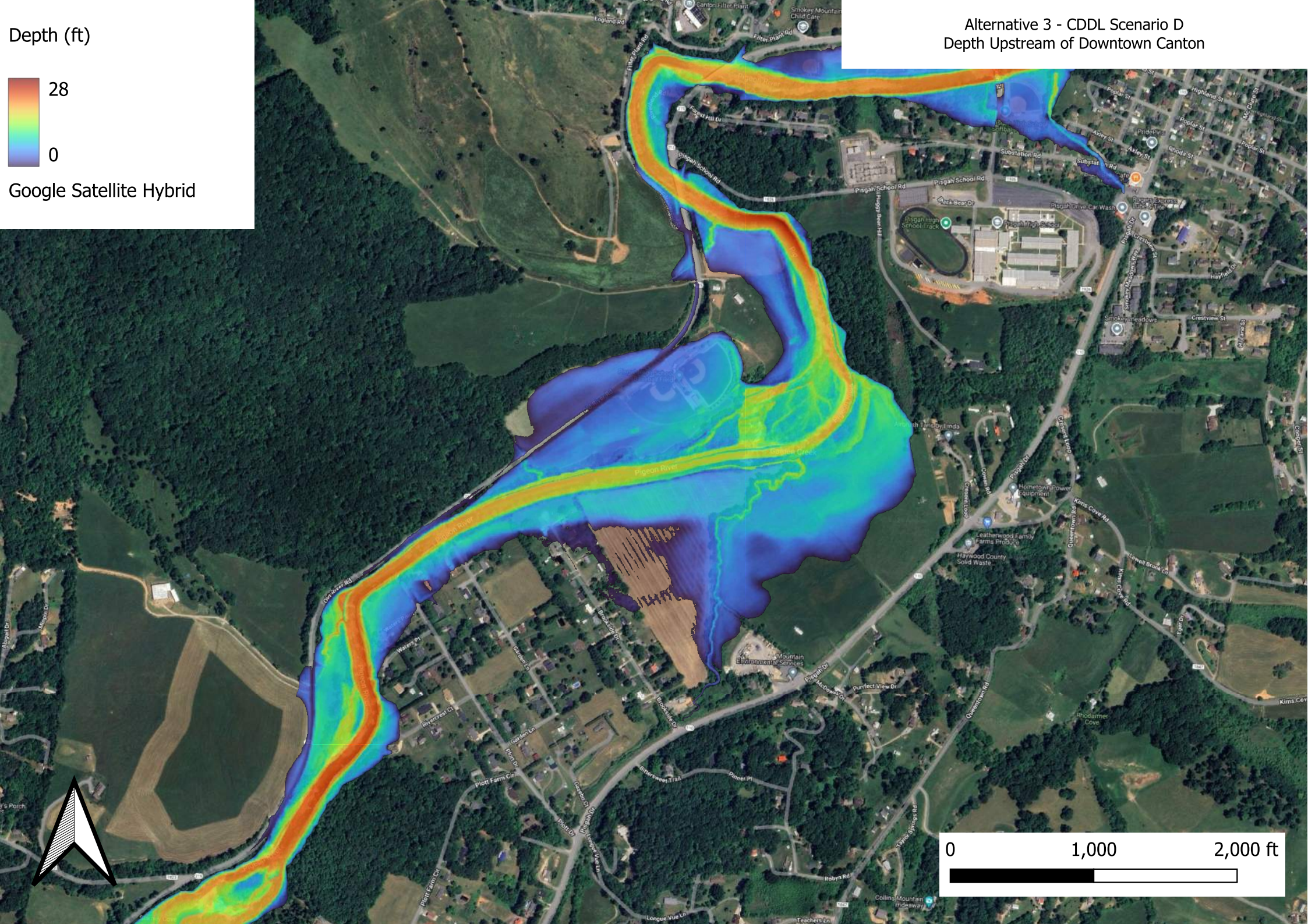
Google Satellite Hybrid

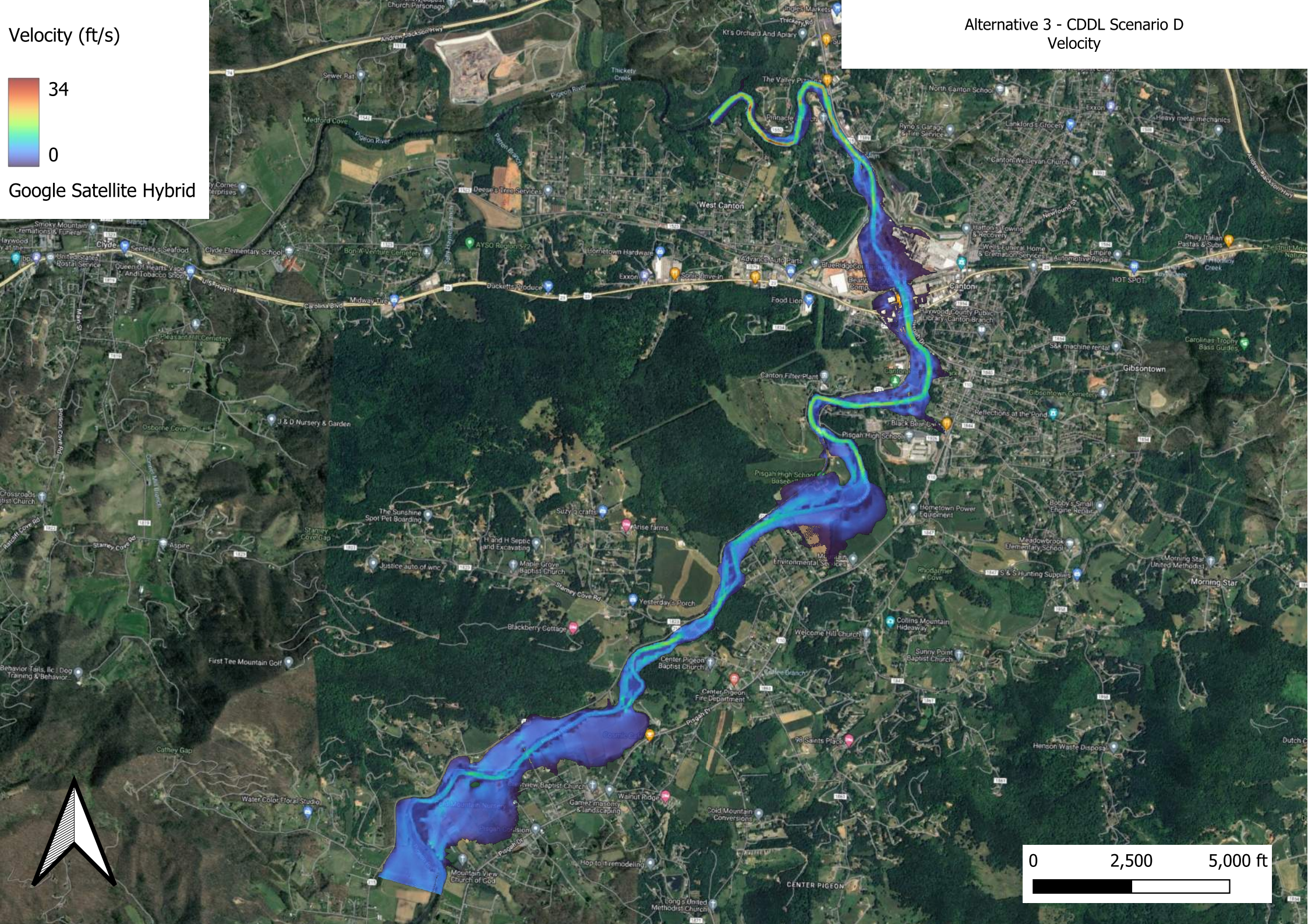


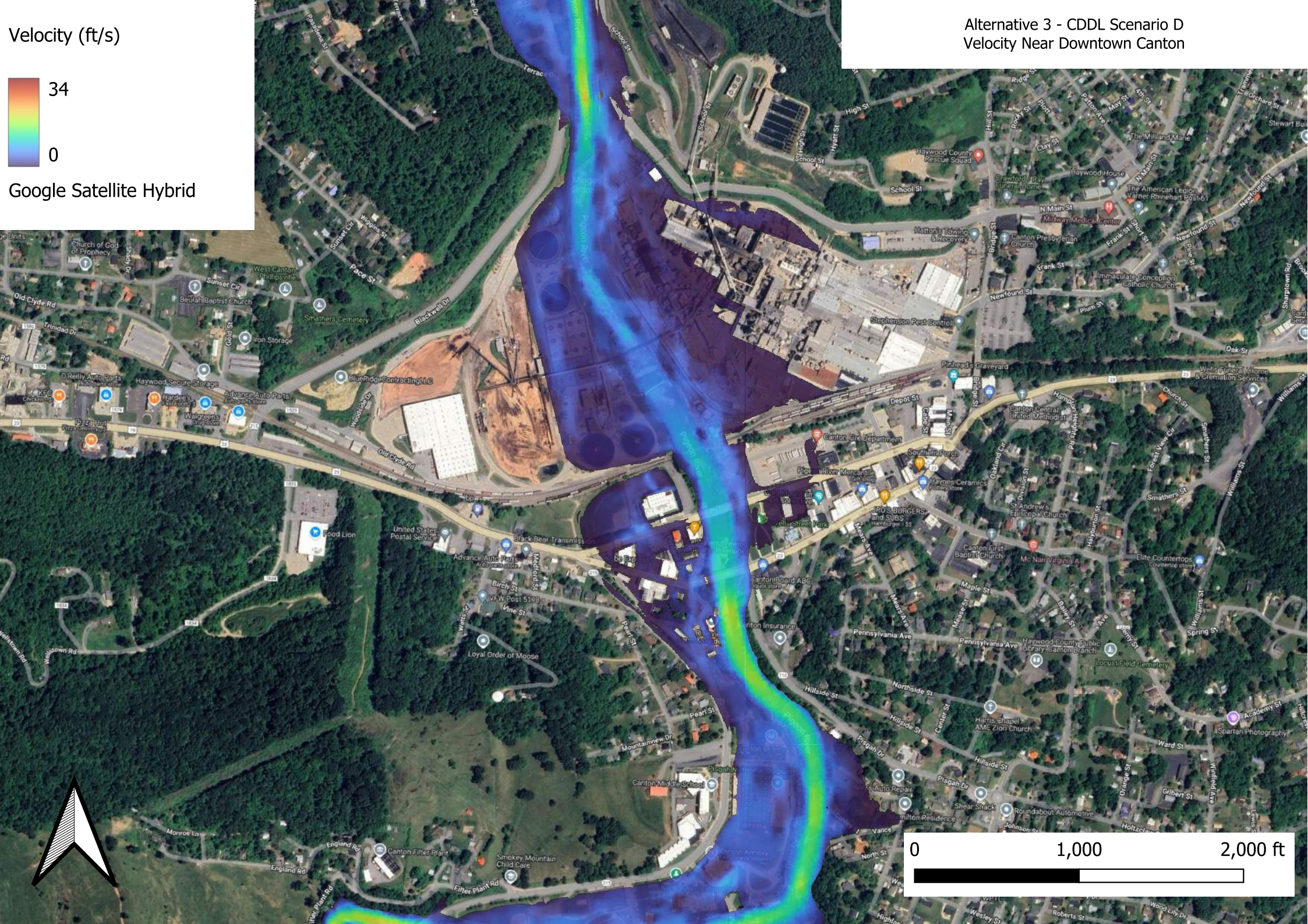

Water Surface Elevation
2,641
2,560
WSE 1-ft Contours
Google Satellite Hybrid
Alternative 3 - CDDL Scenario D
Water Surface Elevation Upstream of Downtown Canton
2597
2596
2598
2599
2600
2601
2602
2603
2604
2605
2606
2607
2608
2609
2610
2611
2612
2613
2614
2615
2616
2617
2618
2619
0
1,000
2,000 ft

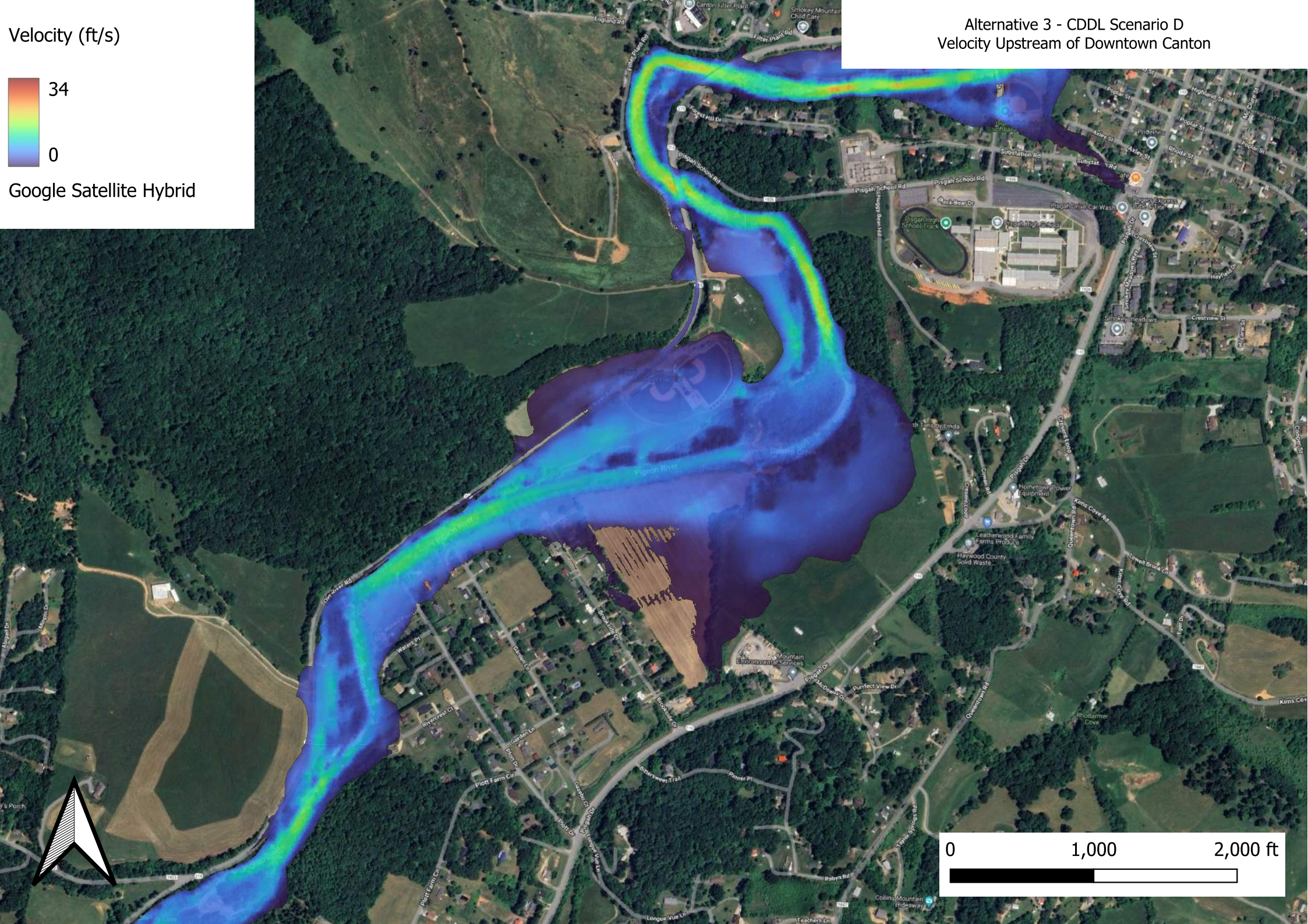

Depth (ft)
28
0
Google Satellite Hybrid
Alternative 3 - CDDL Scenario D
Depth
0
2,500
5,000 ft


Depth (ft)
28
0
Google Satellite Hybrid
Alternative 3 - CDDL Scenario D
Depth Near Downtown Canton
0
1,000
2,000 ft

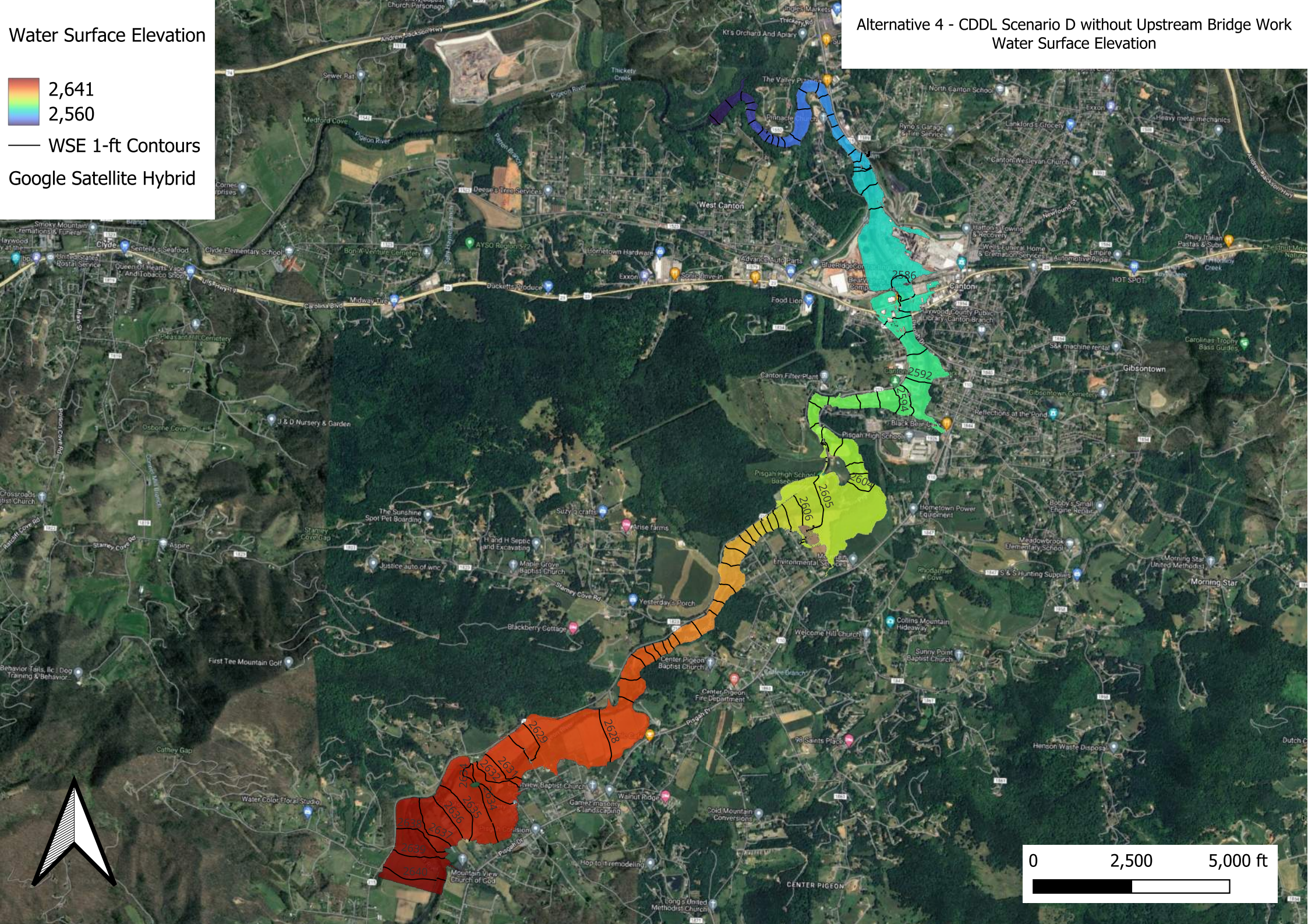

Depth (ft)
28
0
Google Satellite Hybrid
Alternative 3 - CDDL Scenario D
Depth Upstream of Downtown Canton
0
1,000
2,000 ft

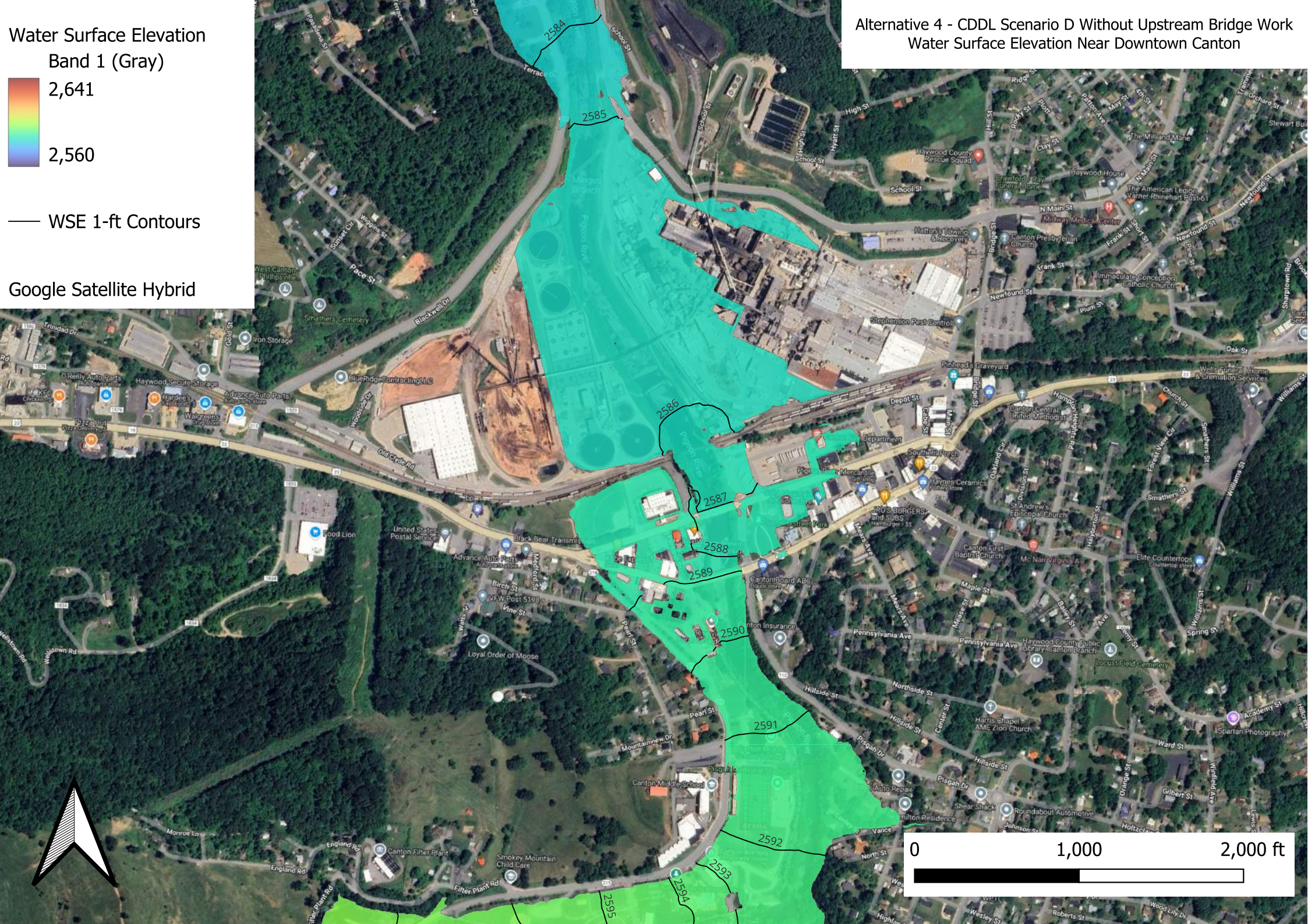

Velocity (ft/s)
34
0
Google Satellite Hybrid
Alternative 3 - CDDL Scenario D
Velocity
0
2,500
5,000 ft

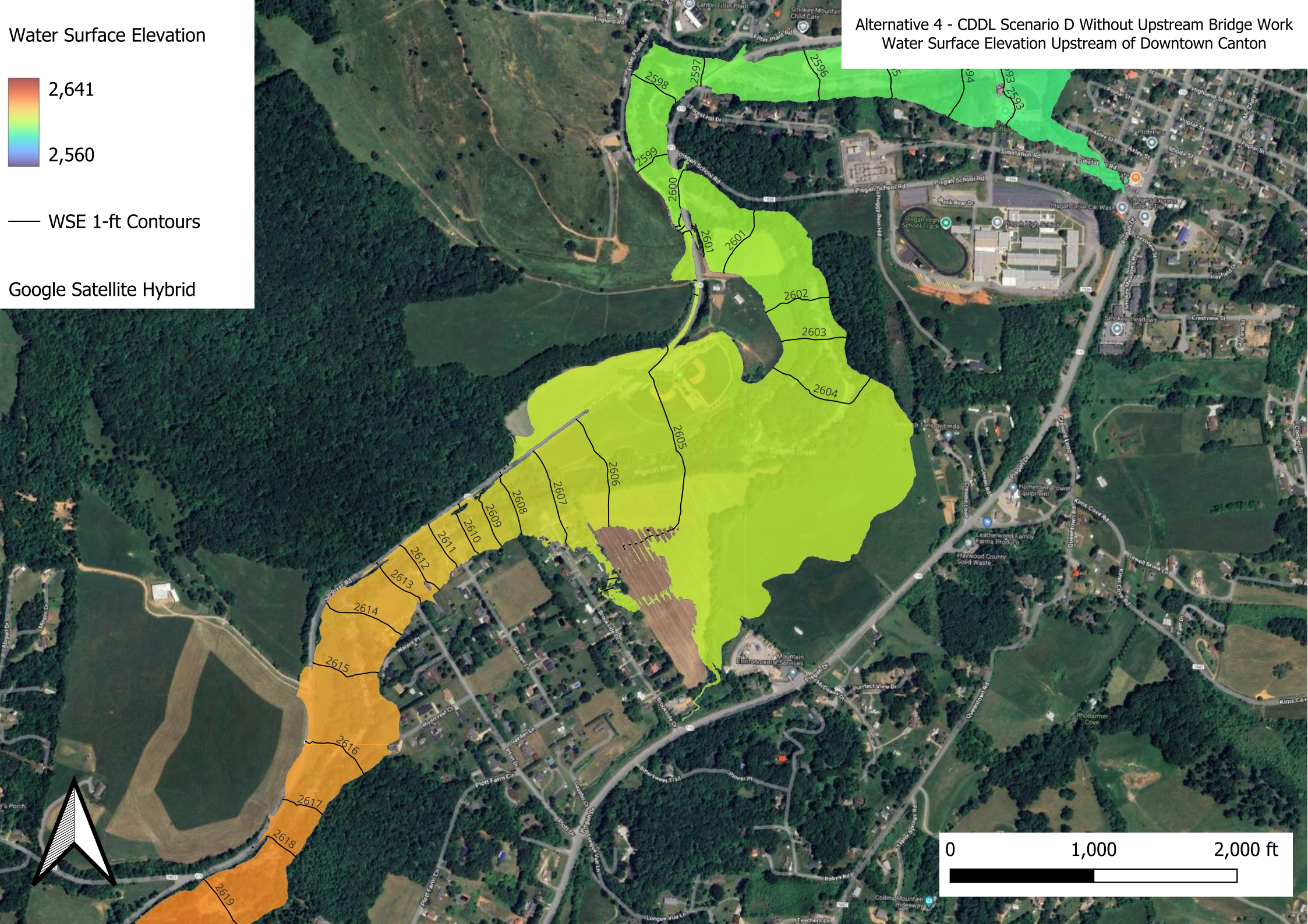

Velocity (ft/s)
34
0
Google Satellite Hybrid
Alternative 3 - CDDL Scenario D
Velocity Near Downtown Canton
0
1,000
2,000 ft

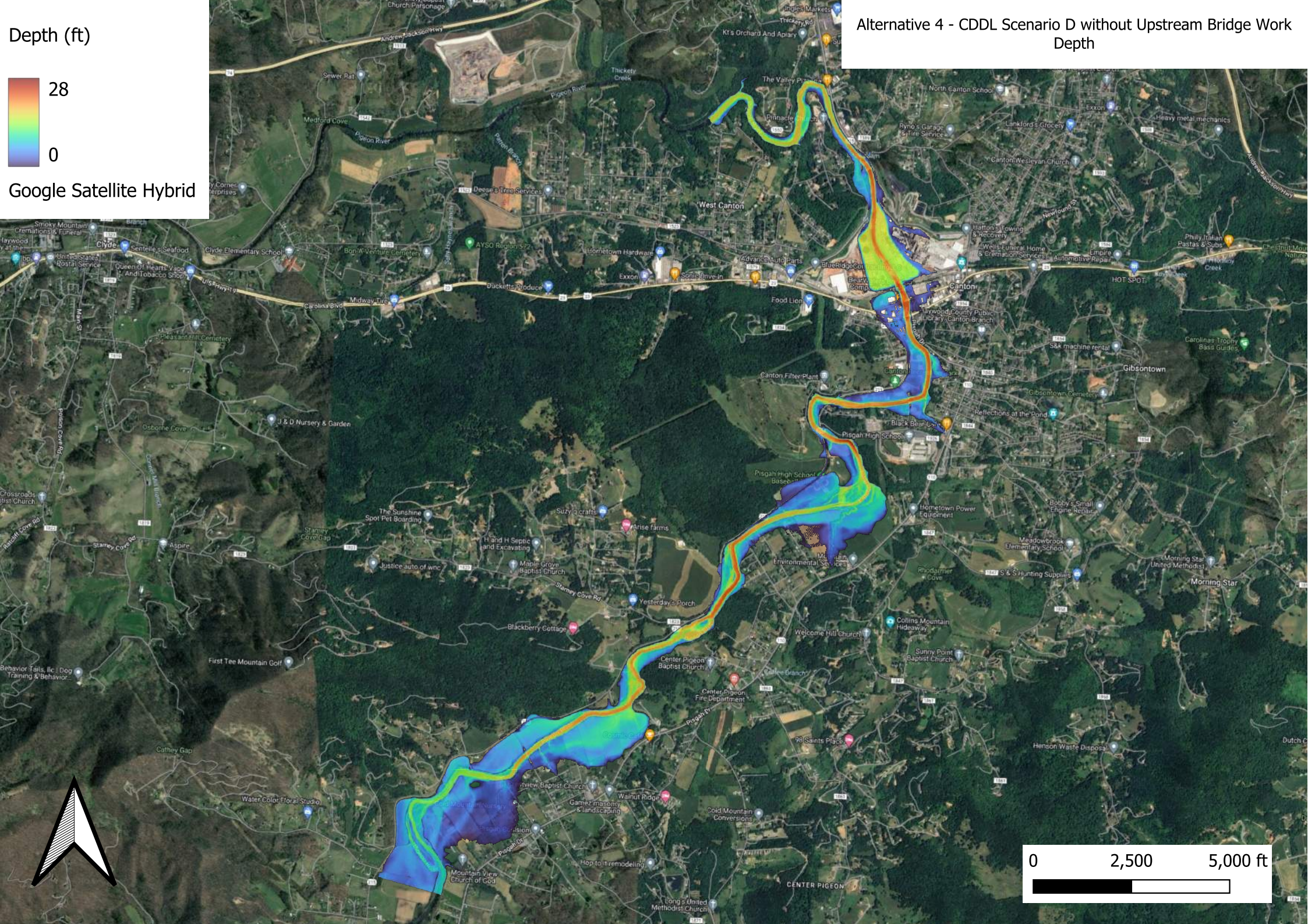

Velocity (ft/s)
34
0
Google Satellite Hybrid
Alternative 3 - CDDL Scenario D
Velocity Upstream of Downtown Canton
0
1,000
2,000 ft

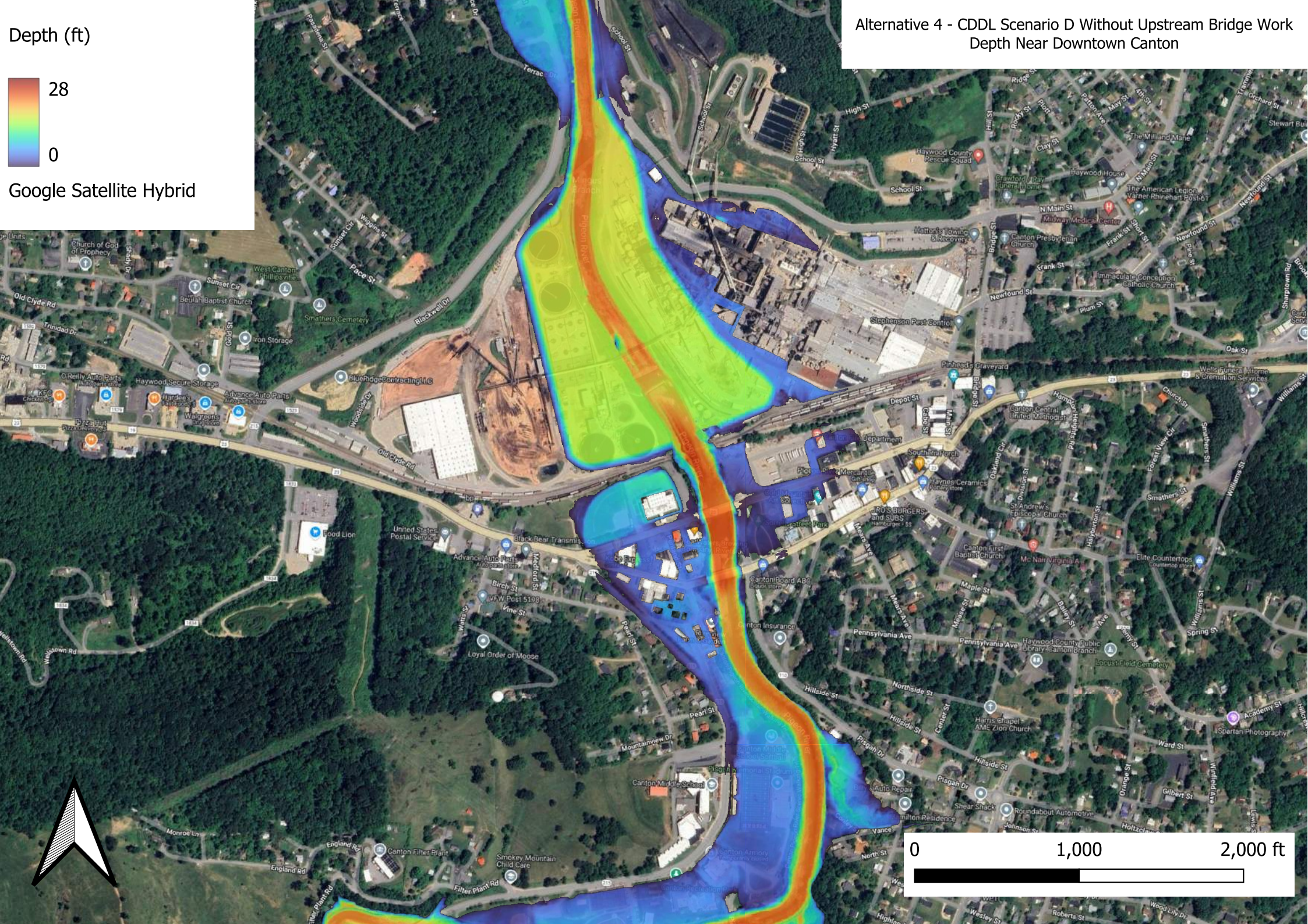
Alternative 4 – CDDL Scenario D without Upstream Bridge Work

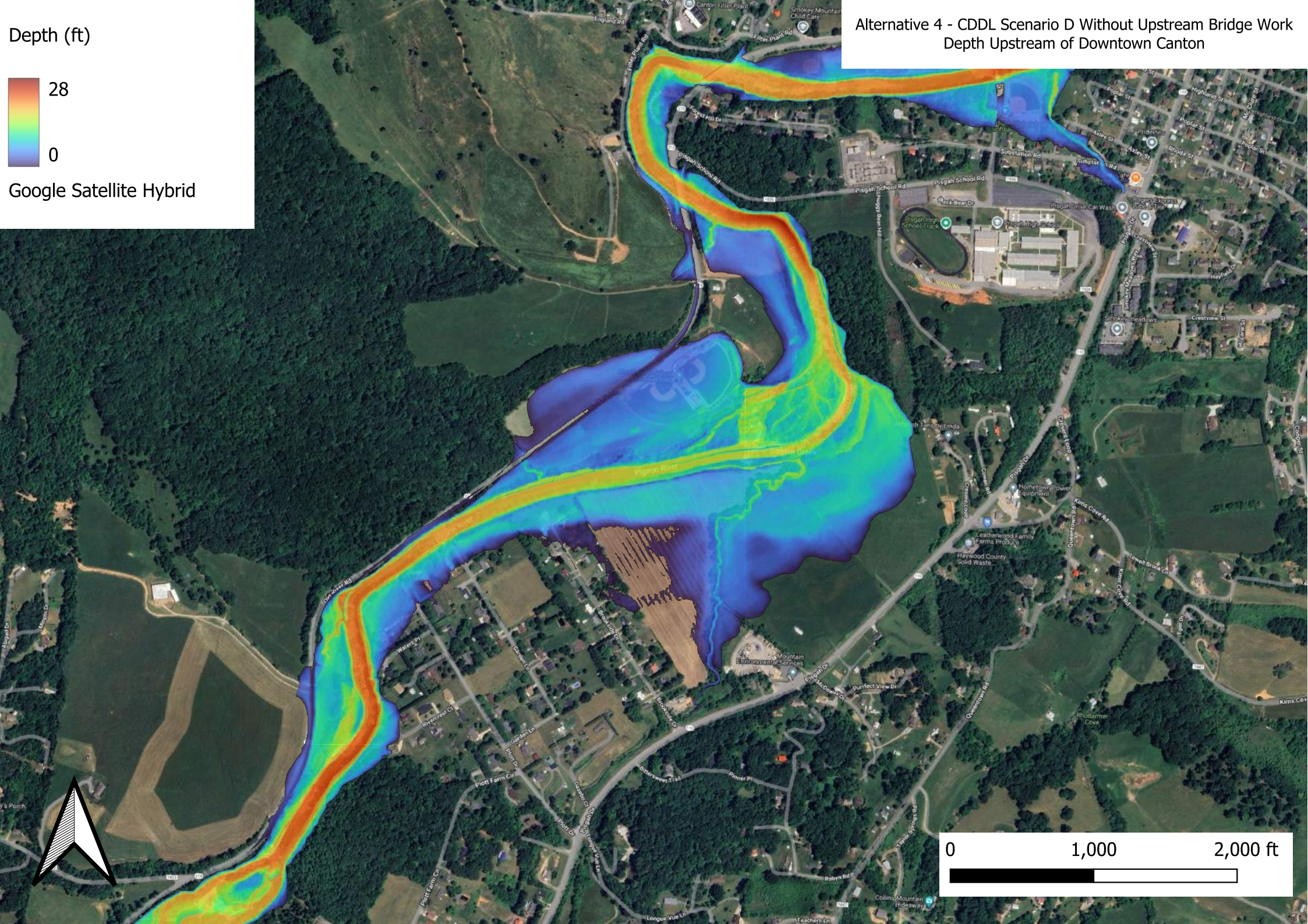

Water Surface Elevation
2,641
2,560
WSE 1-ft Contours
Google Satellite Hybrid
Alternative 4 - CDDL Scenario D without Upstream Bridge Work
Water Surface Elevation
2586
2592
2594
2604
2605
2606
2628
2629
2631
2632
2634
2635
2636
2637
2639
2640
0
2,500
5,000 ft

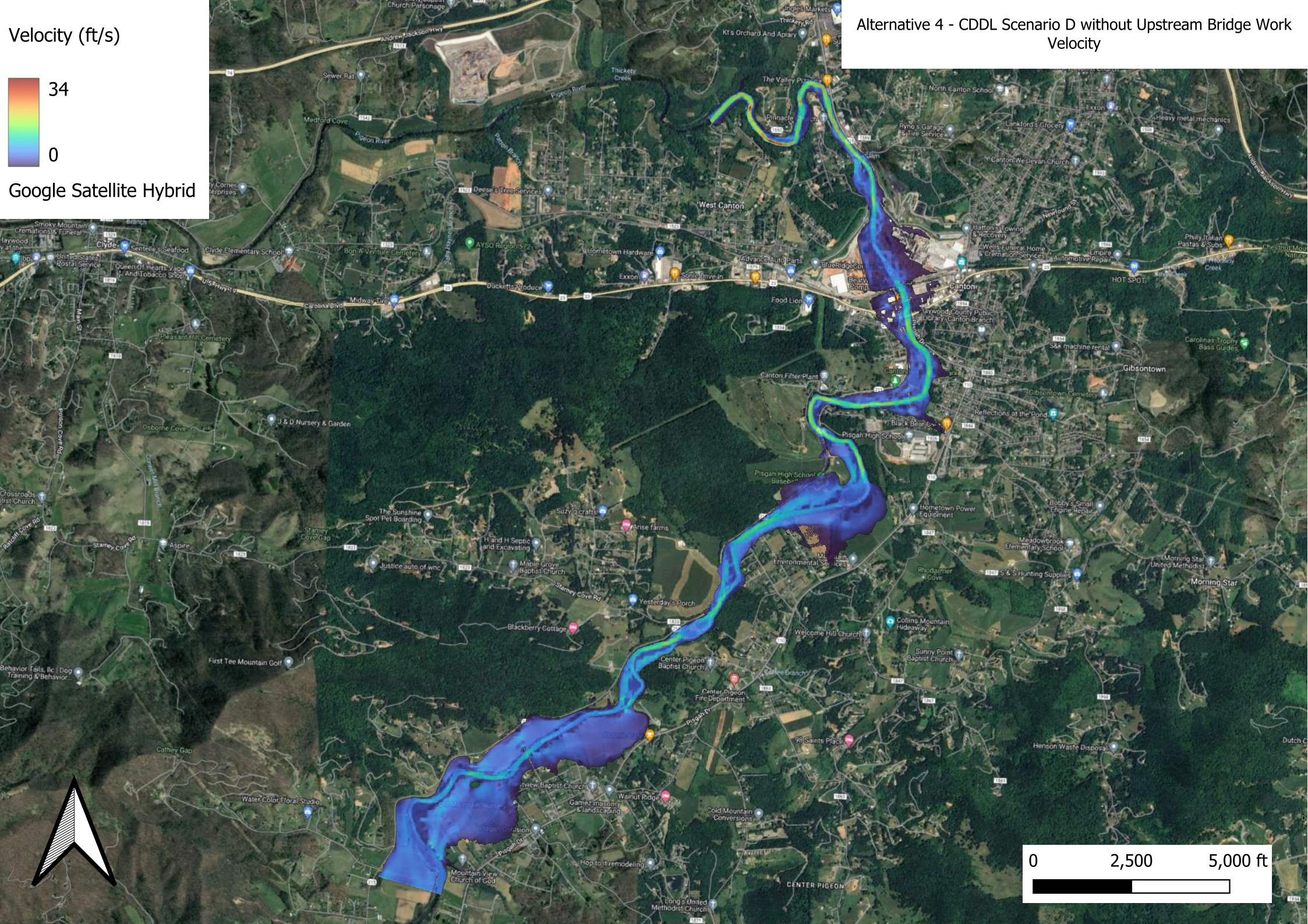

Alternative 4 - CDDL Scenario D Without Upstream Bridge Work
Water Surface Elevation Near Downtown Canton
Water Surface Elevation
Band 1 (Gray)
2,641
2,560
WSE 1-ft Contours
Google Satellite Hybrid
2584
2585
2586
2587
2588
2589
2590
2591
2592
2593
2594
2595
Pigeon River
Mingus Branch
School St
High St
Hyatt St
Pace St
Blackwell Dr
Old Clyde Rd
Depot St
Main St
Cabe St
Bridge St
Newfound St
Frank St
Plum St
Oak St
Church St
Pennsylvania Ave
Maple St
Spring St
Hillside St
Northside St
Pisgah Dr
Ward St
Gilbert St
Mountainview Dr
Pearl St
Birch St
Vine St
Medford St
Meers Ave
Williams St
Smathers St
Forest View Cir
Oakland Cir
Division St
Halliburton St
Academy St
Orange St
Winfield Ave
Center St
Vance
North St
Roberts St
Wesley St
Wood Lily Dr
Monroe Ln
England Rd
Filter Plant Rd
Smathers Cemetery
Iron Storage
Haywood Secure Storage
BlueRidge Contracting LLC
O'Reilly Auto Parts
Advance Auto Parts
Hardee's
Walgreens
Pizza Hut
KFC
Food Lion
United States Postal Service
Black Bear Transmission
VFW Post 5198
Loyal Order of Moose
Canton Middle School
Canton Filter Plant
Smokey Mountain Child Care
Haywood County Rescue Squad
Crawford Ray Funeral Home
Haywood House
The American Legion Verner Rhinehart Post 67
Midway Medical Center
Canton Presbyterian Church
Immaculate Conception Catholic Church
Stephenson Pest Control
Pinhead's Graveyard
Wells Funeral Home & Cremation Services
Canton Central United Methodist
Haynes Ceramics
Southern Porch
IRO'S BURGERS and SUBS
St Andrew's Episcopal Church
Canton First Baptist Church
Mc Nair Virginia A
Elite Countertops
Haywood County Public Library-Canton Branch
Locust Field Cemetery
Harris Chapel AME Zion Church
Spartan Photography
Roundabout Automotive
Shear Shack
Canton Board ABC
Canton Insurance
Hattem's Towing & Recovery
The Milliard Mane
0
1,000
2,000 ft

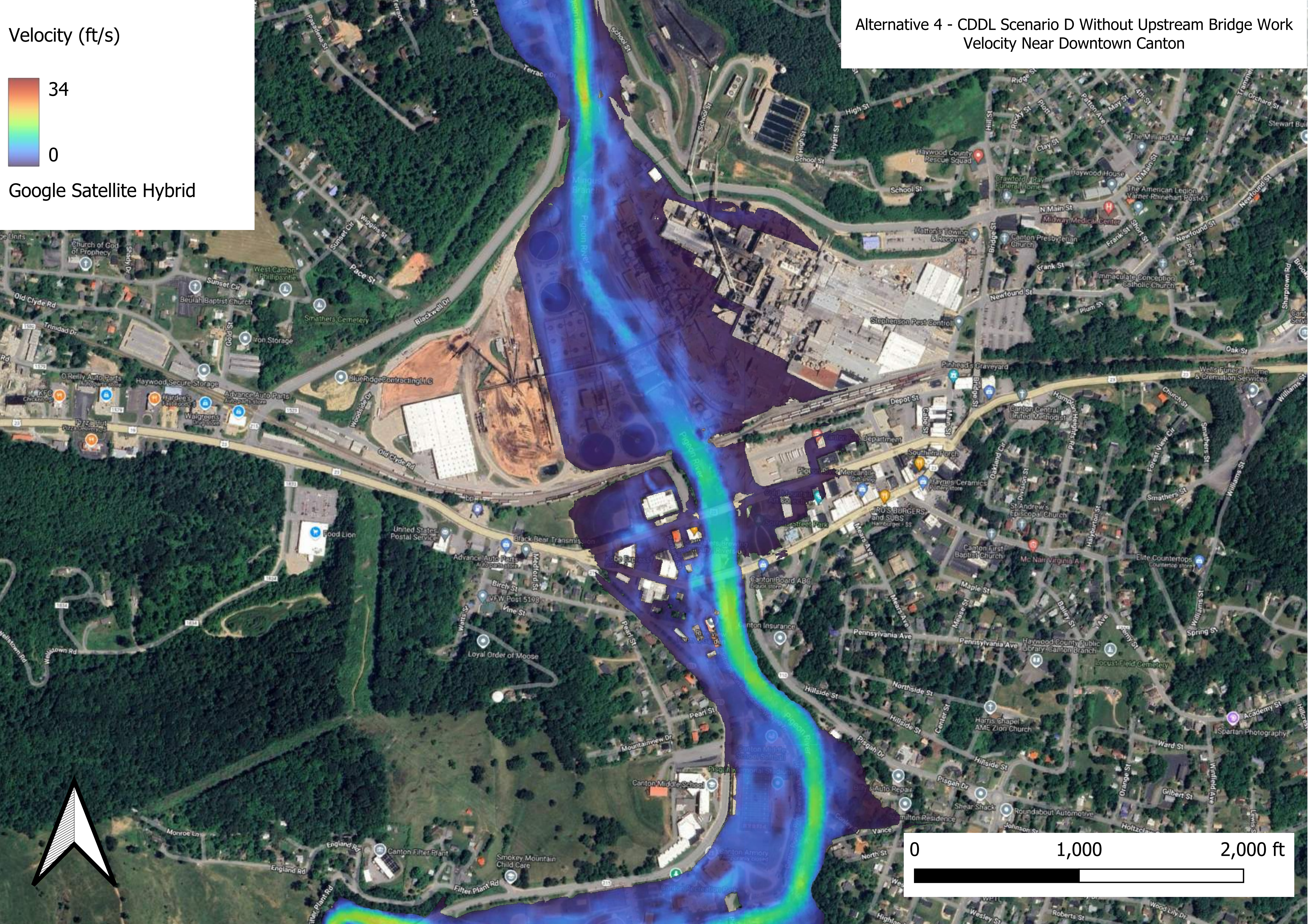

Alternative 4 - CDDL Scenario D Without Upstream Bridge Work
Water Surface Elevation Upstream of Downtown Canton
Water Surface Elevation
2,641
2,560
WSE 1-ft Contours
Google Satellite Hybrid
2596
2597
2598
2599
2600
2601
2602
2603
2604
2605
2606
2607
2608
2609
2610
2611
2612
2613
2614
2615
2616
2617
2618
2619
Pigeon River
Garden Creek
Pisgah School Rd
Substation Rd
Crestview St
Kims Cove Rd
Queentown Rd
Pisgah Dr
Crescent Loop
Leatherwood Family Farms Produce
Haywood County Solid Waste
Hometown Power Equipment
Mountain Environmental Services
Collins Mountain Hideaway
0
1,000
2,000 ft

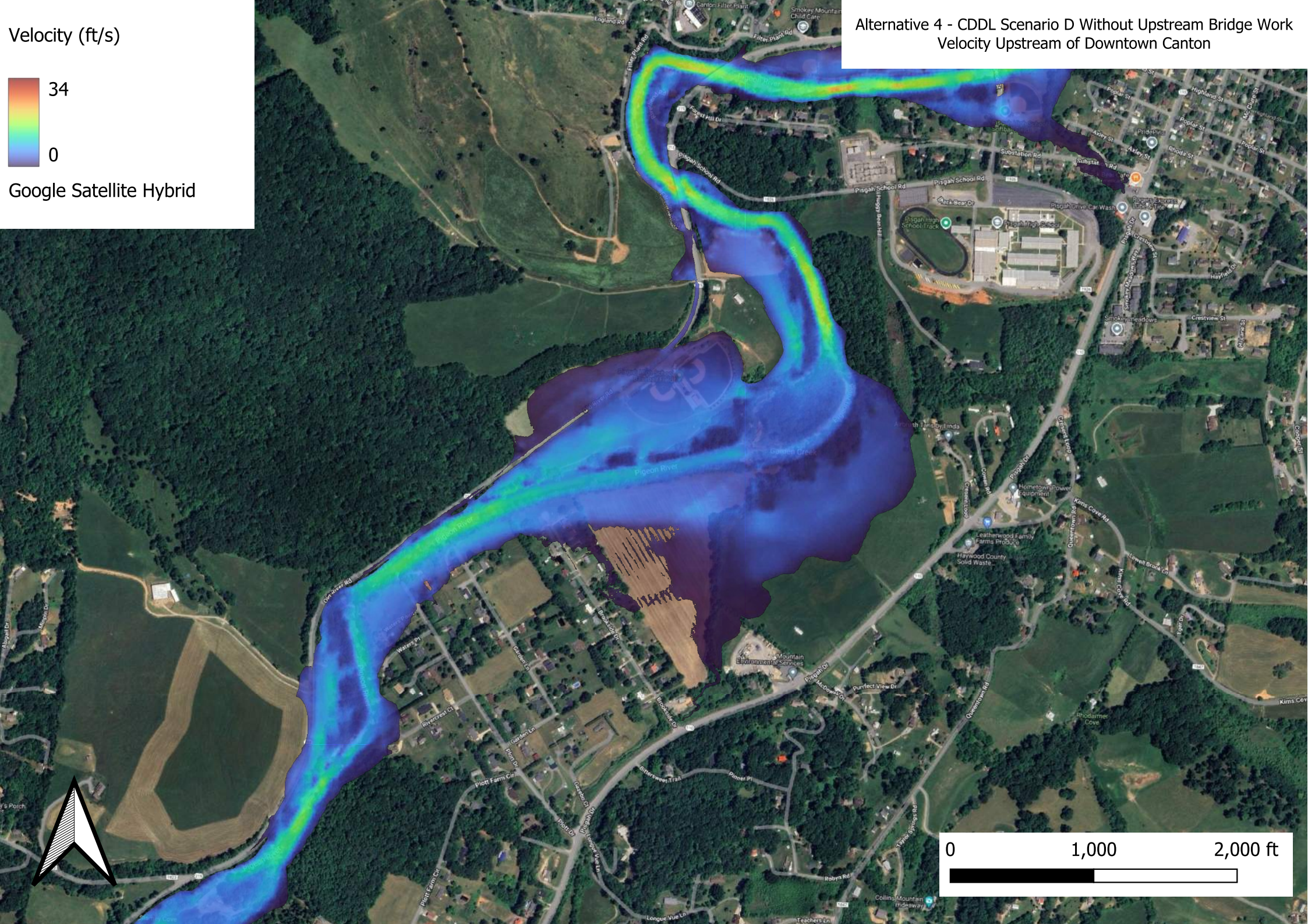

Depth (ft)
28
0
Google Satellite Hybrid
Alternative 4 - CDDL Scenario D without Upstream Bridge Work Depth
0
2,500
5,000 ft


Depth (ft)
28
0
Google Satellite Hybrid
Alternative 4 - CDDL Scenario D Without Upstream Bridge Work
Depth Near Downtown Canton
0
1,000
2,000 ft


Depth (ft)
28
0
Google Satellite Hybrid
Alternative 4 - CDDL Scenario D Without Upstream Bridge Work
Depth Upstream of Downtown Canton
0
1,000
2,000 ft


Velocity (ft/s)
34
0
Google Satellite Hybrid
Alternative 4 - CDDL Scenario D without Upstream Bridge Work
Velocity
0
2,500
5,000 ft


Alternative 4 - CDDL Scenario D Without Upstream Bridge Work
Velocity Near Downtown Canton
Velocity (ft/s)
34
0
Google Satellite Hybrid
0
1,000
2,000 ft

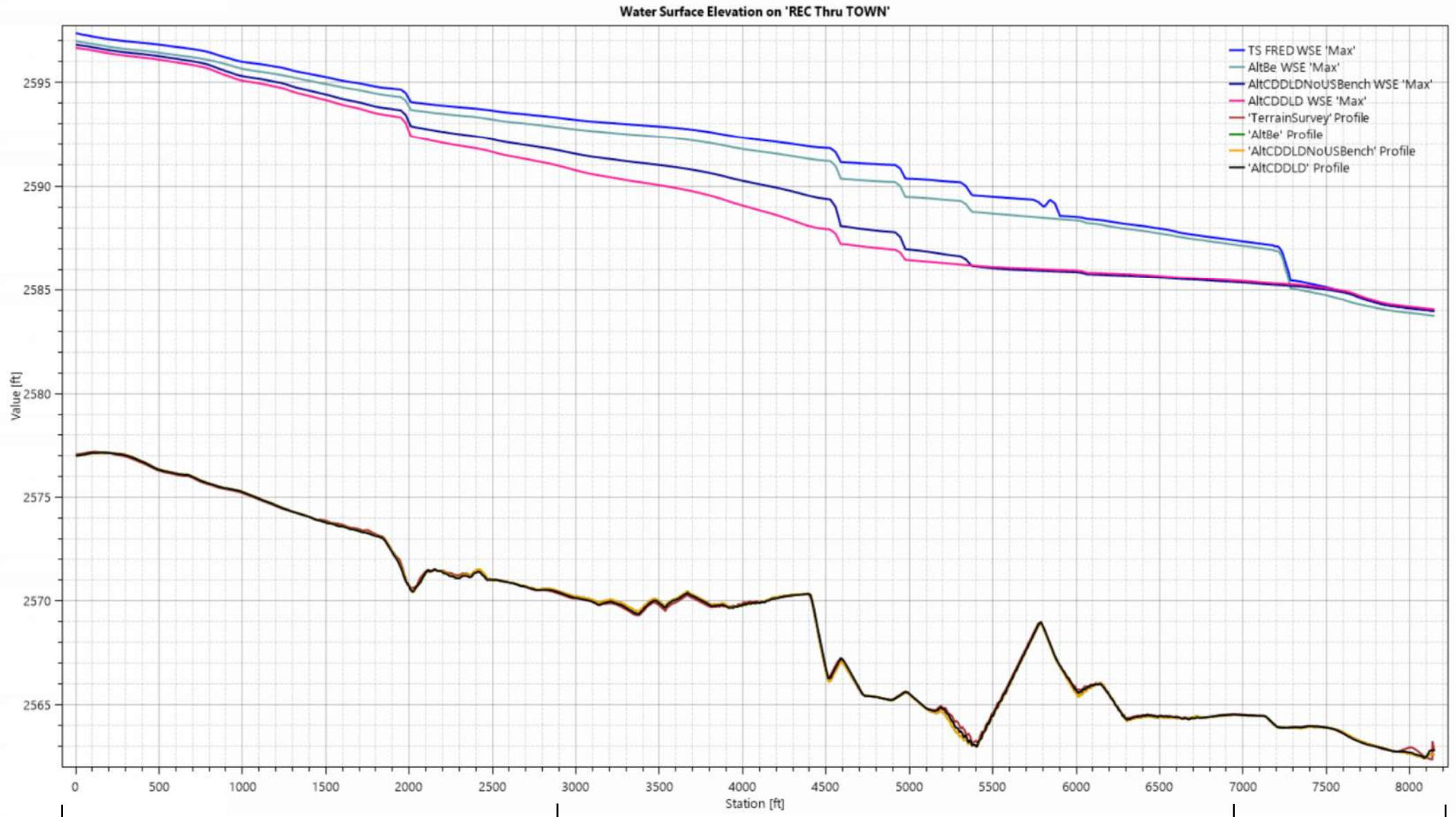

Velocity (ft/s)
34
0
Google Satellite Hybrid
Alternative 4 - CDDL Scenario D Without Upstream Bridge Work
Velocity Upstream of Downtown Canton
0
1,000
2,000 ft

Comparisons of Existing Conditions and Alternatives

Comparison of Water Surface Elevations (ft) between USGS Surveyed High Water Marks (HWM), Existing Conditions Model (EC), and Alternatives

PT	Location	Water Surface Elevations and Differences (ft)										
		Recorded HWM	Existing Conditions	Difference [EC-HWM]	Alternative 1 - CDDL Scenario D with Berm	Difference [A1-EC]	Alternative 2 - Berm	Difference [A2-EC]	Alternative 3 - CDDL Scenario D	Difference [A3-EC]	Alternative 4 - CDDL Scenario D without Upstream Bridge Work	Difference [A4-EC]
34	Pinnacle Church	2575.87	2576.10	0.23	2576.19	0.09	2575.69	-0.41	2576.21	0.11	2576.15	0.05
19	1 Blackwell Drive	2584.50	2584.16	-0.34	2584.12	-0.04	2583.79	-0.37	2584.14	-0.02	2584.07	-0.09
20	West Gate Mill Guard Station	2584.87	2585.37	0.50	2585.13	-0.24	2584.92	-0.45	2585.15	-0.22	2585.07	-0.30
21	Fire Department	2590.55	2590.46	-0.09	2585.25	-5.20	2589.45	-1.00	2585.33	-5.12	2587.50	-2.96
22	Police Department	2590.35	2590.47	0.11	2585.25	-5.22	2589.46	-1.01	2585.33	-5.14	2587.50	-2.97
23	69 Park Street	2590.33	2590.54	0.21	2585.60	-4.94	2589.50	-1.04	2585.66	-4.89	2587.50	-3.04
24	10 Penland Street	2590.61	2591.58	0.97	2587.15	-4.42	2590.40	-1.18	2587.19	-4.39	2588.48	-3.10
25	Bethel Christian Academy	2590.73	2591.34	0.60	2587.11	-4.23	2590.05	-1.29	2587.15	-4.19	2588.53	-2.81
26	Canton Armory	2593.56	2593.62	0.06	2591.80	-1.83	2593.24	-0.38	2591.81	-1.81	2592.34	-1.29
27	Aquatic Center	2594.20	2594.89	0.69	2593.92	-0.97	2594.74	-0.15	2593.94	-0.95	2594.22	-0.67
28	Pisgah High Softball Field	2594.15	2594.06	-0.09	2592.56	-1.50	2593.79	-0.26	2592.58	-1.48	2593.04	-1.02
29	324 Brookside Drive	2607.05	2607.02	-0.03	2607.13	0.11	2607.13	0.11	2606.99	-0.03	2607.00	-0.02
30	Cold Mountain Nursery	2633.63	2633.47	-0.17	2633.47	0.00	2633.51	0.04	2633.47	0.00	2633.47	0.00

Comparison of Water Surface Elevations (ft) from Upstream of the Pigeon Street Bridge to Downstream of the Blackwell Drive Bridges

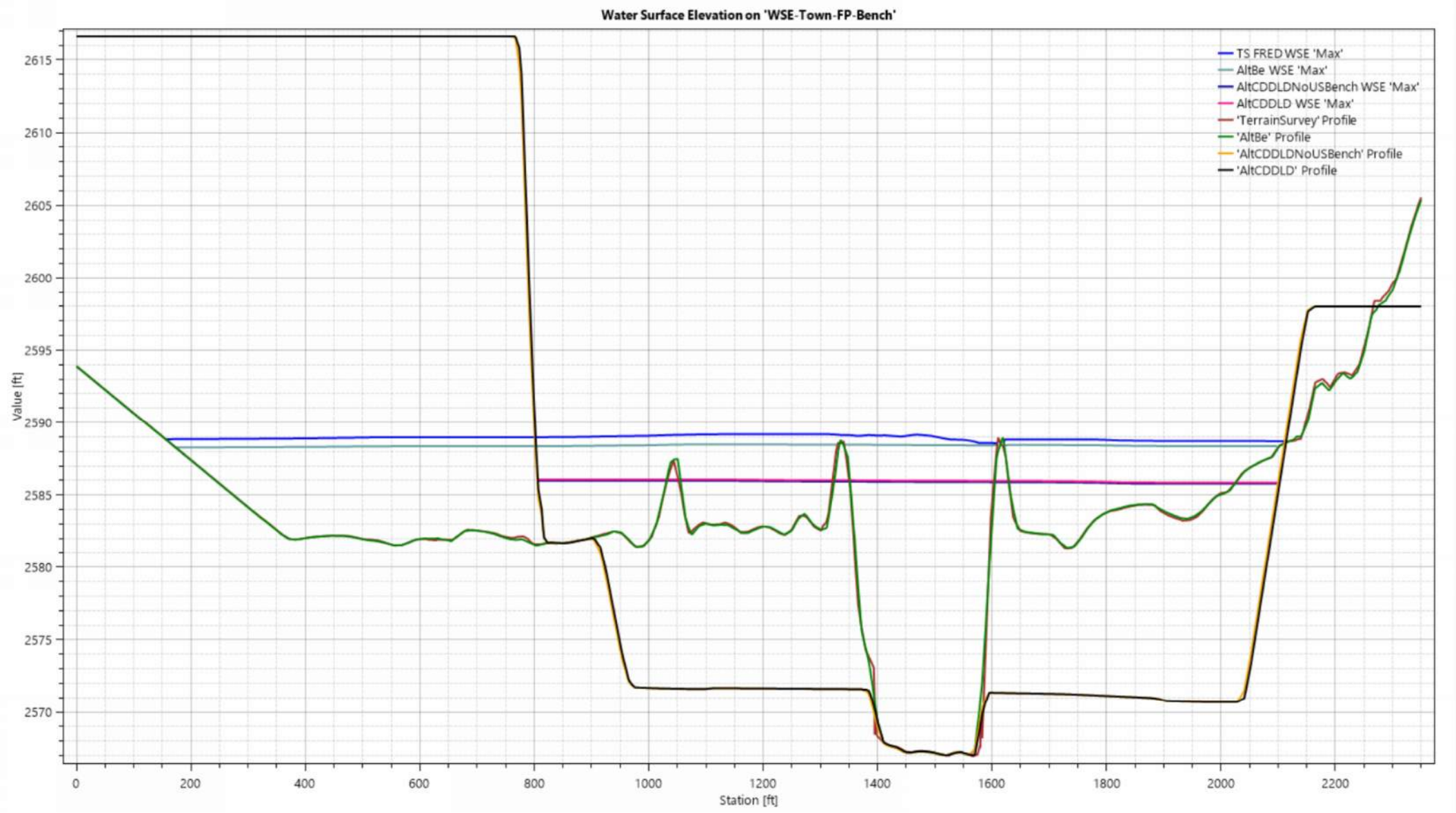


Canton Recreation Park

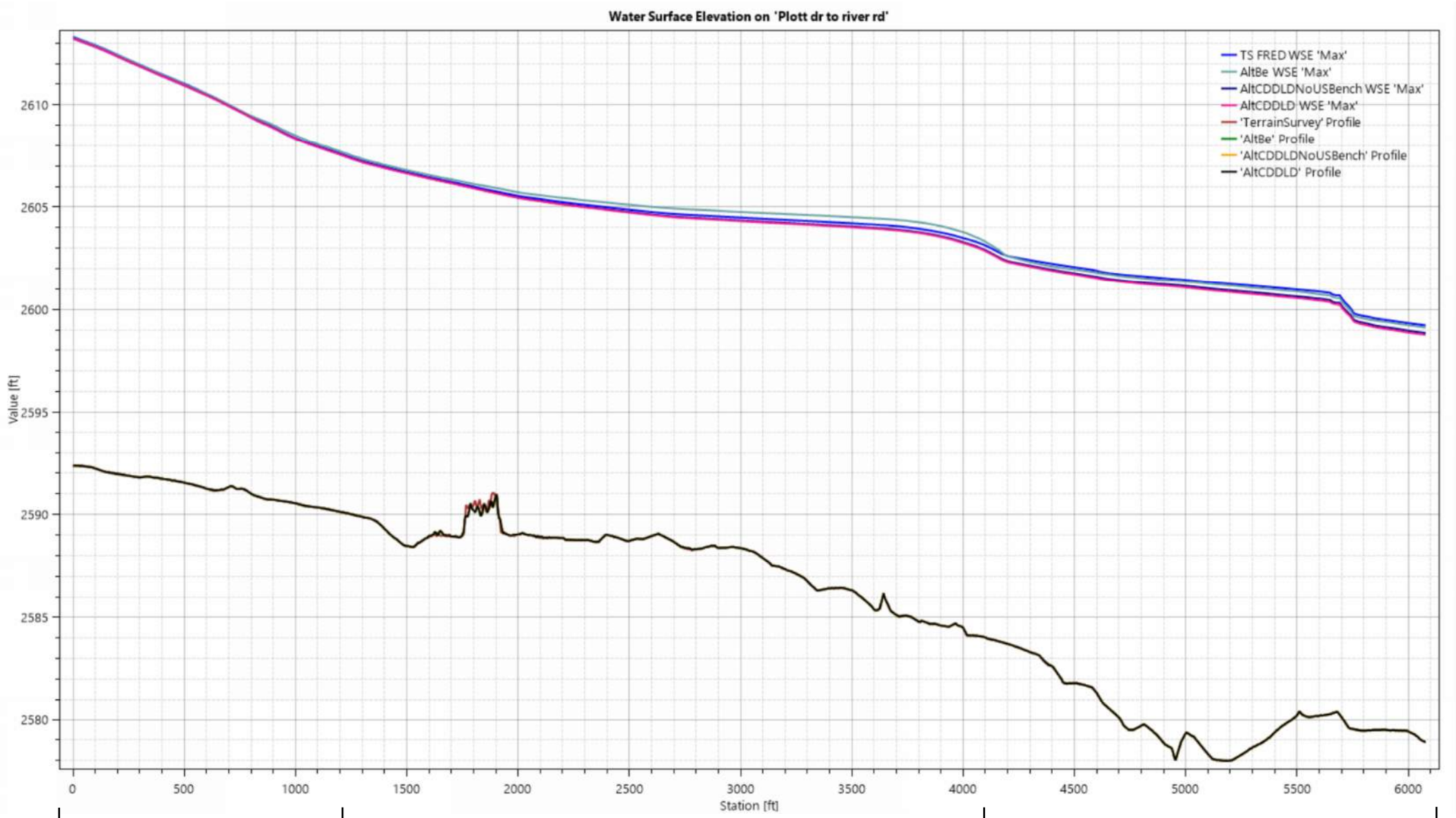
Downtown Canton and Former Mill Propert

Downstream of Canton

Comparison of Alternative Terrains and Water Surface Elevations (ft) Downstream of the Regional Railroad



Comparison of Water Surface Elevations (ft) from Plott Drive to the River Road Bridge

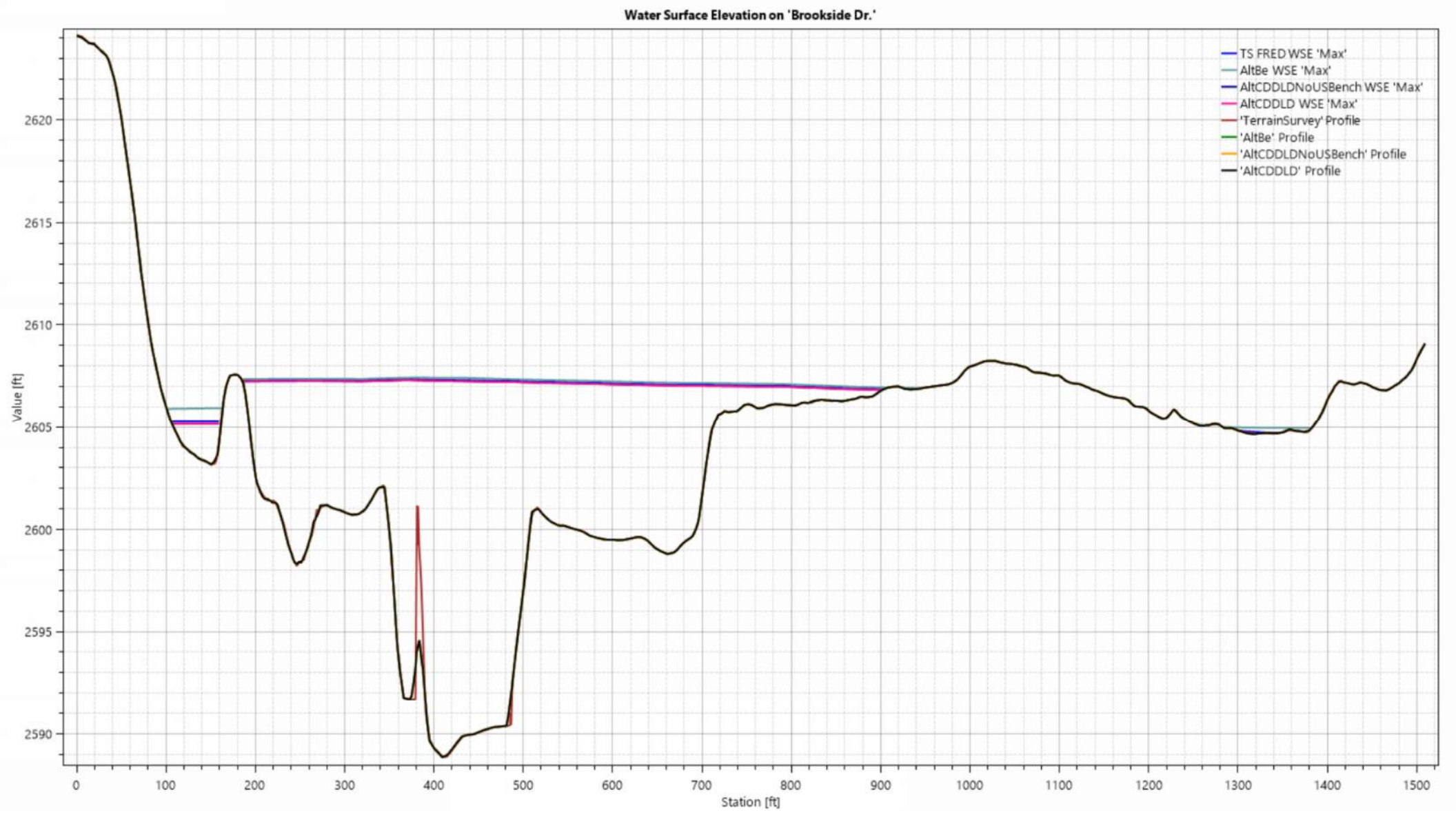


Near Upstream Neighborhood

Near Pisgah High School Baseball Fields With Surrounding Agricultural Areas

Downstream to River Road Bridge

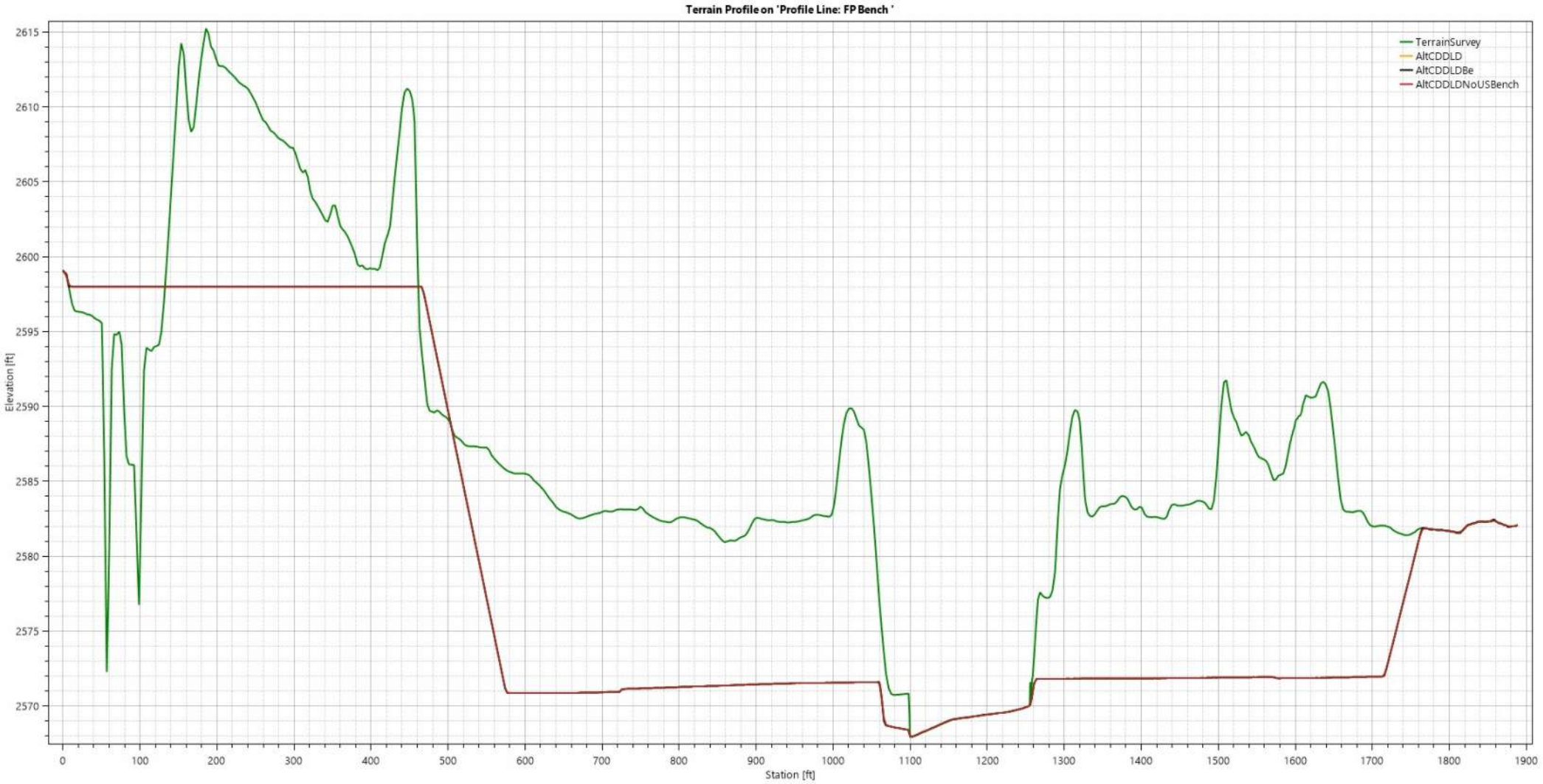
Comparison of Water Surface Elevations (ft) Near Brookside Drive

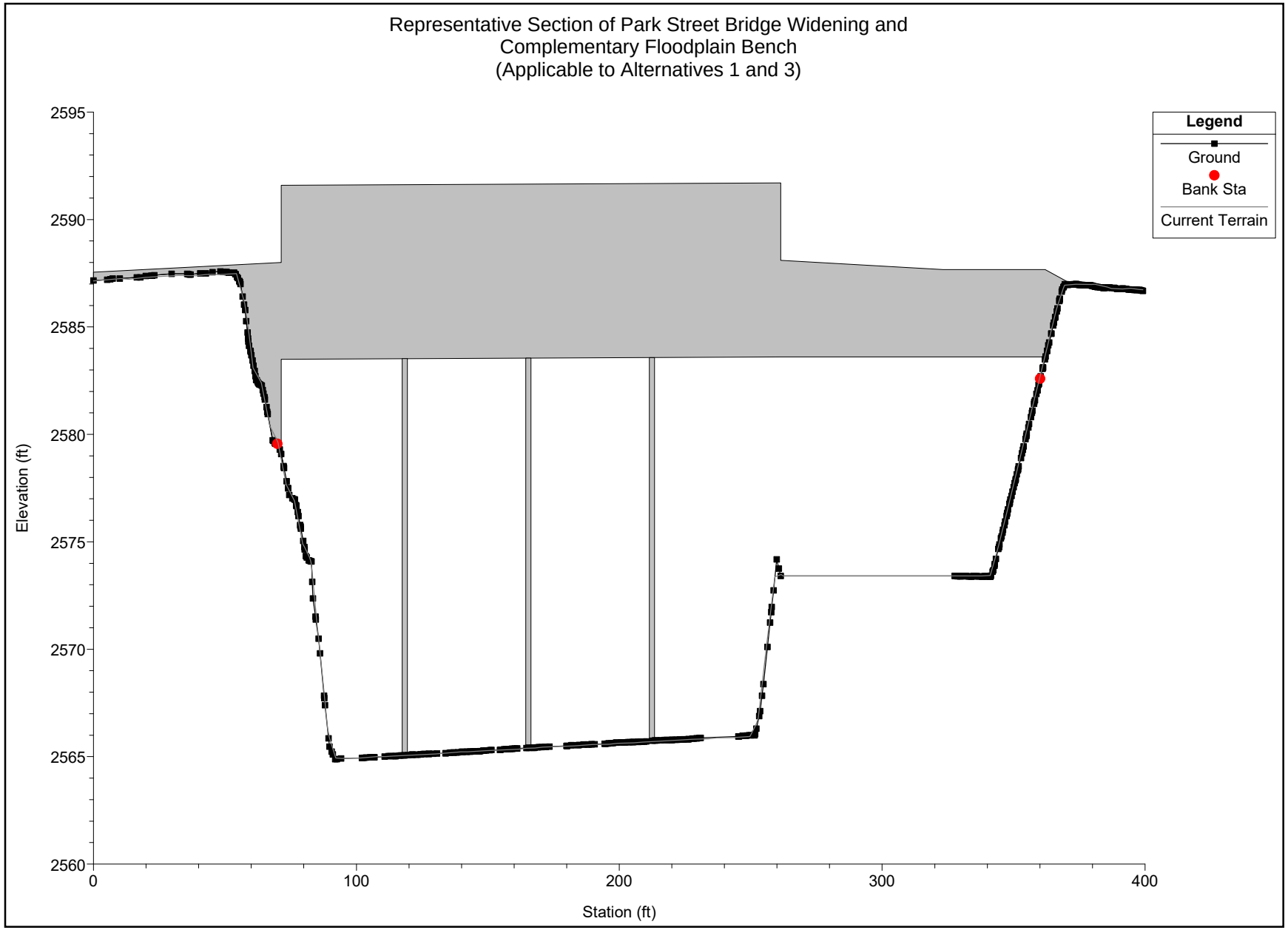


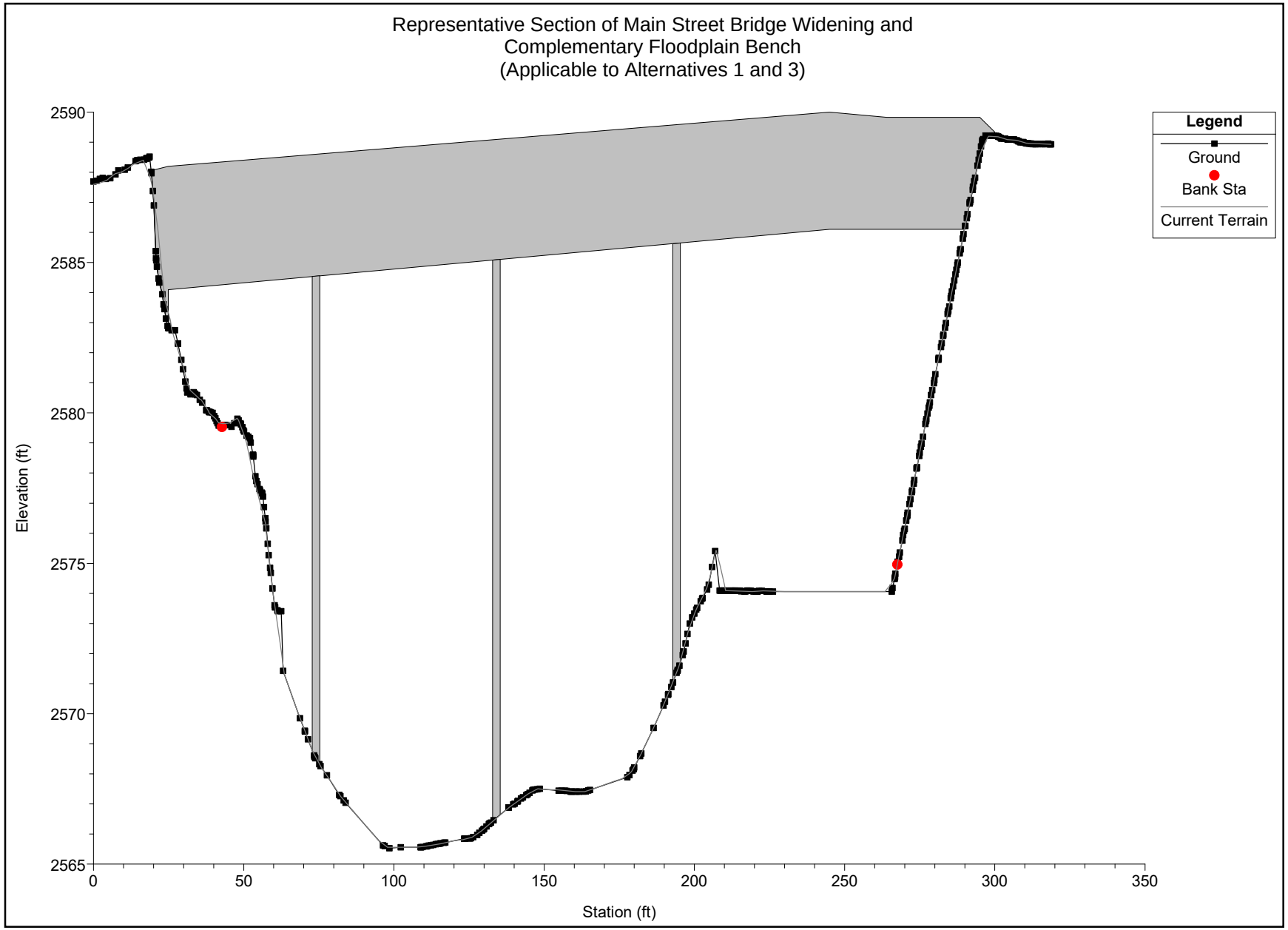
Appendix C – Alternatives Information

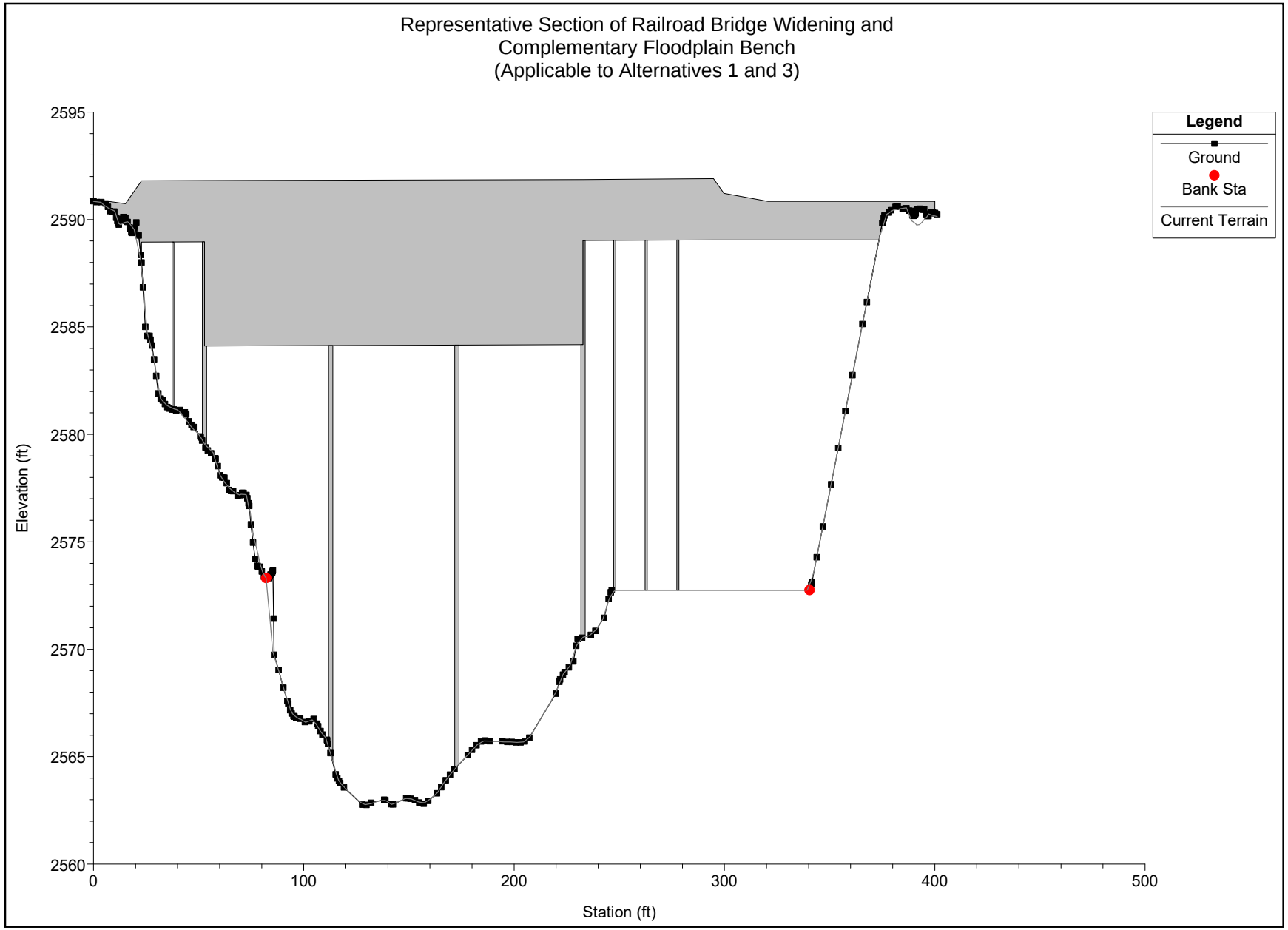
Representative Cross Sections

Representative Section of Floodplain Bench Near
Downtown Canton
(Applicable to Alternatives 1, 3, and 4)

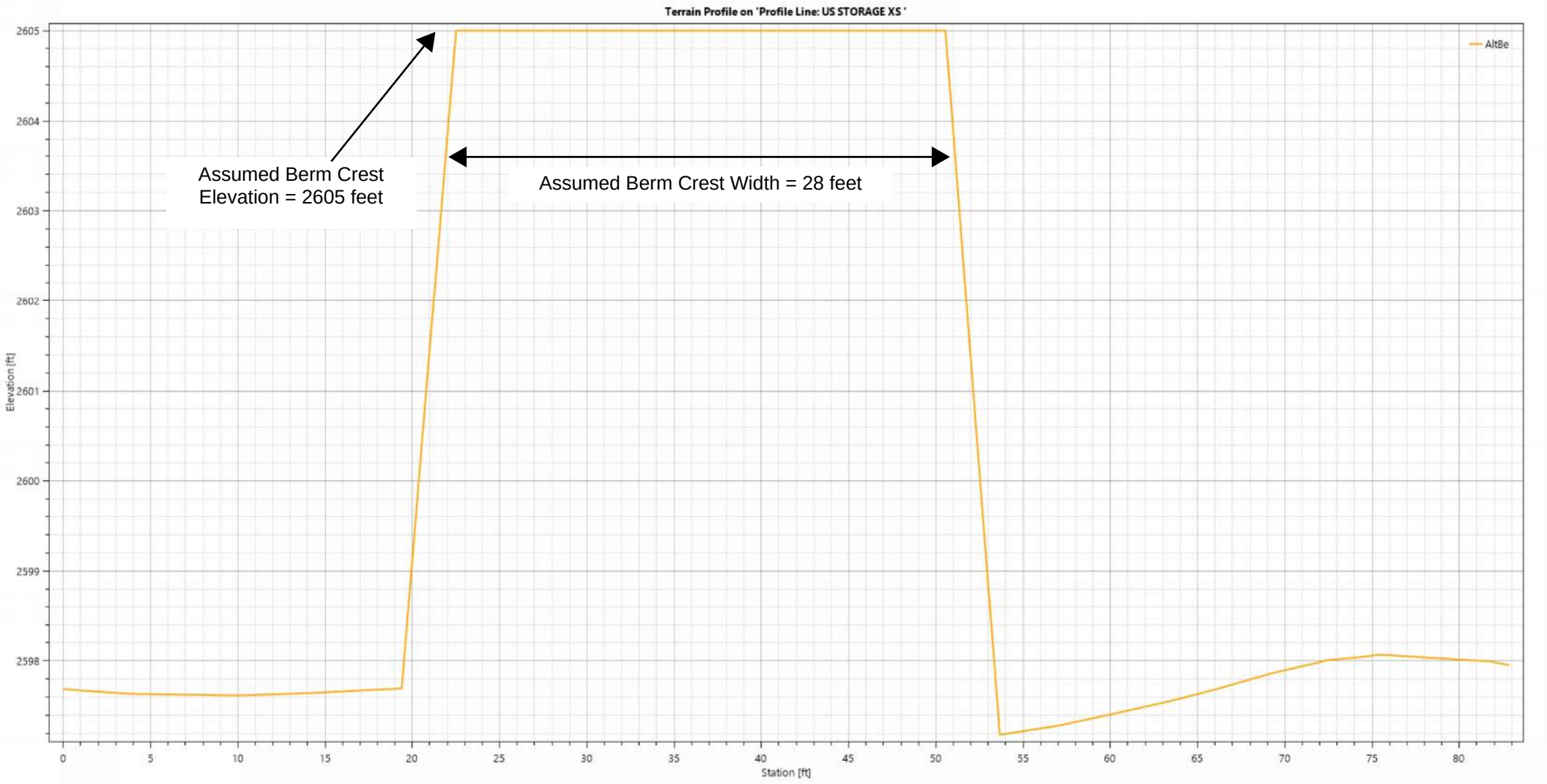



Representative Section of Park Street Bridge Widening and
Complementary Floodplain Bench
(Applicable to Alternatives 1 and 3)
Legend
Ground
Bank Sta
Current Terrain
Elevation (ft)
2595
2590
2585
2580
2575
2570
2565
2560
0
100
200
300
400
Station (ft)

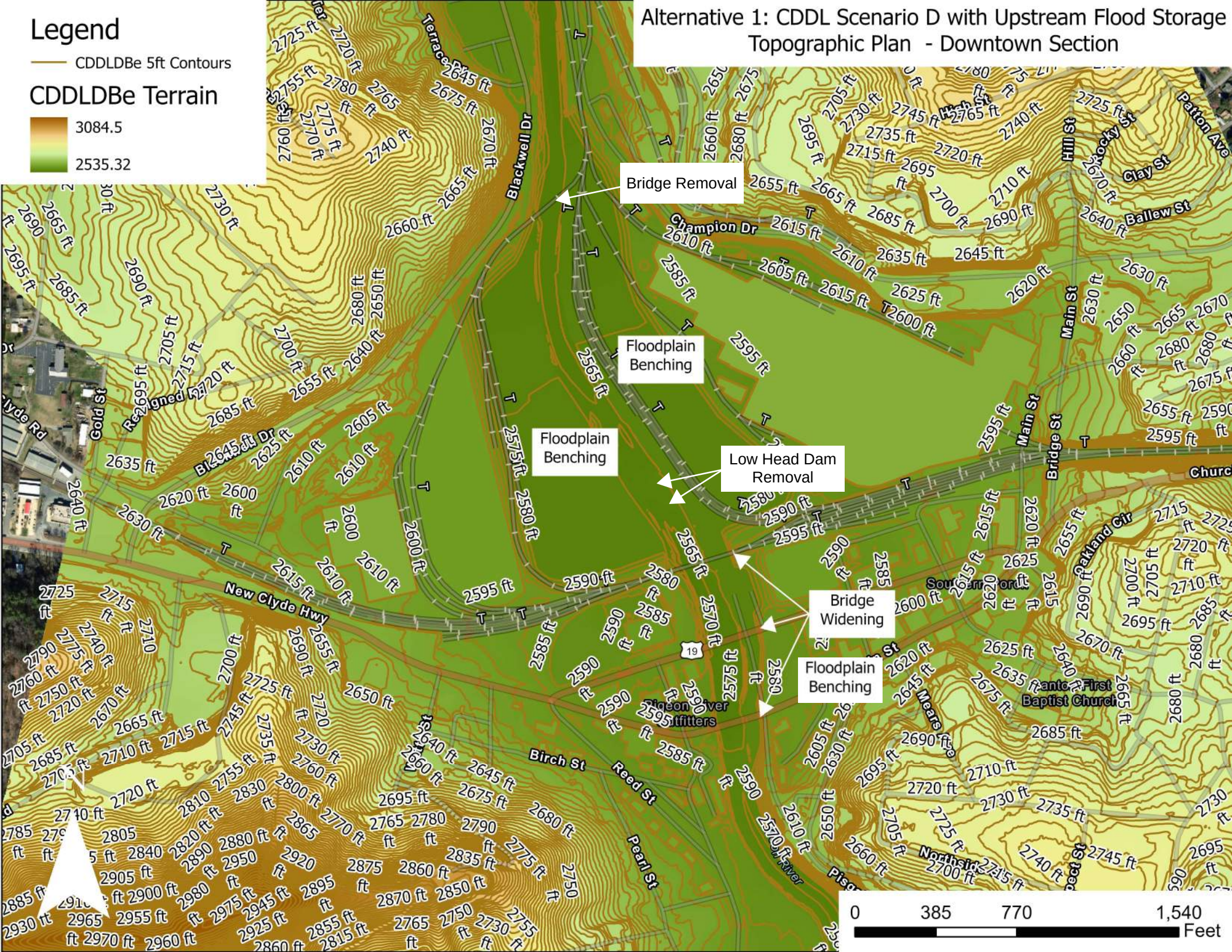

Representative Section of Main Street Bridge Widening and
Complementary Floodplain Bench
(Applicable to Alternatives 1 and 3)
Legend
Ground
Bank Sta
Current Terrain
Elevation (ft)
2590
2585
2580
2575
2570
2565
0
50
100
150
200
250
300
350
Station (ft)

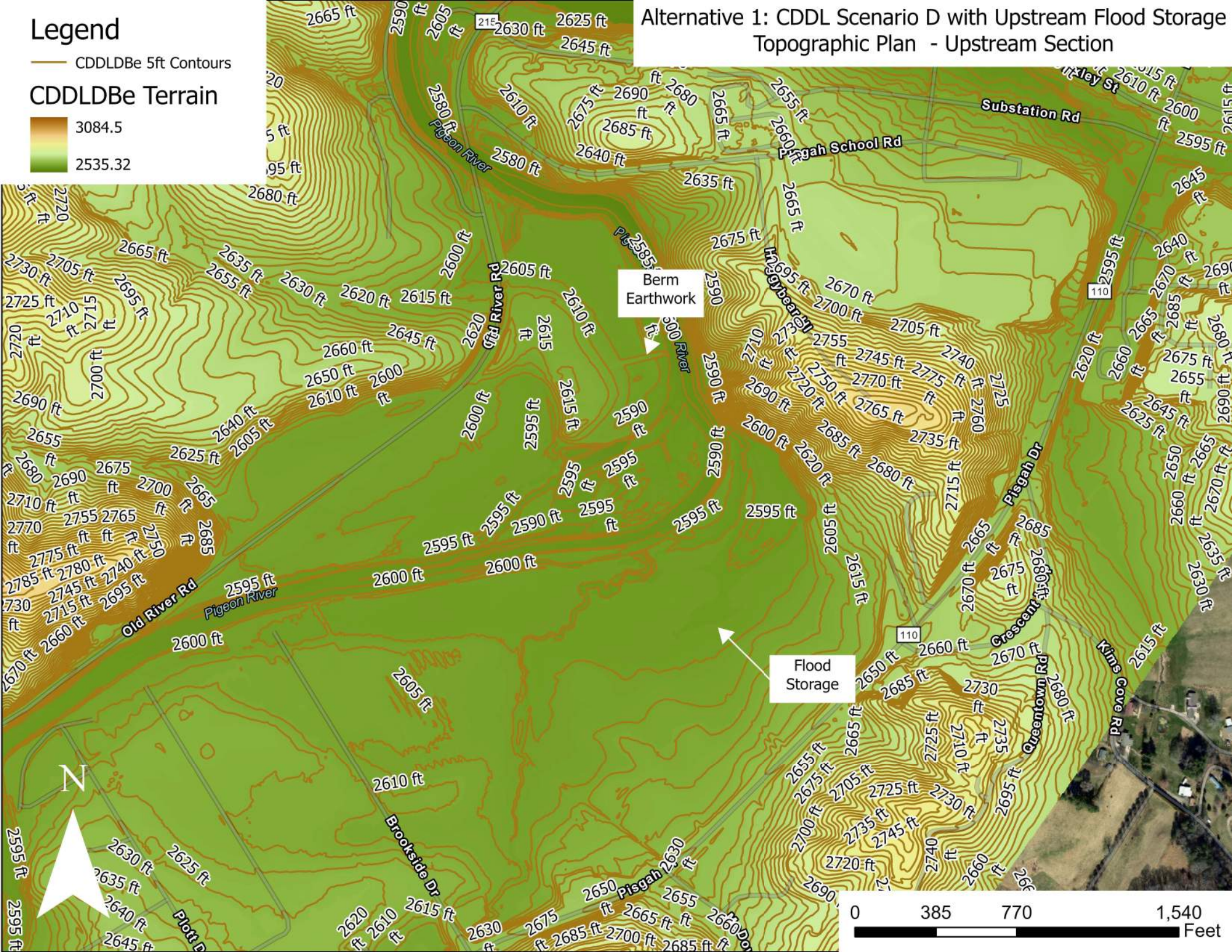

Representative Section of Railroad Bridge Widening and
Complementary Floodplain Bench
(Applicable to Alternatives 1 and 3)
Legend
Ground
Bank Sta
Current Terrain
Elevation (ft)
2595
2590
2585
2580
2575
2570
2565
2560
0
100
200
300
400
500
Station (ft)

Representative Section of Berm Fill for Upstream Flood Storage
(Applicable to Alternatives 1 and 2)



Alternative 1 – CDDL Scenario D with Upstream Flood Storage


Alternative 1: CDDL Scenario D with Upstream Flood Storage
Topographic Plan - Downtown Section
Legend
CDDLDBe 5ft Contours
CDDLDBe Terrain
3084.5
2535.32
Bridge Removal
Floodplain Benching
Floodplain Benching
Low Head Dam Removal
Bridge Widening
Floodplain Benching
Blackwell Dr
Champion Dr
Main St
Bridge St
New Clyde Hwy
Birch St
Reed St
Pearl St
Hill St
Clay St
Ballew St
Oakland Cir
Mears Ave
0
385
770
1,540
Feet


Alternative 1: CDDL Scenario D with Upstream Flood Storage
Topographic Plan - Upstream Section
Legend
CDDLDBe 5ft Contours
CDDLDBe Terrain
3084.5
2535.32
Berm Earthwork
Flood Storage
Old River Rd
Pigeon River
Brookside Dr
Pisgah School Rd
Substation Rd
Pisgah Dr
Queentown Rd
Crescent Dr
Kims Cove Rd
Haggybear Ct
N
0
385
770
1,540
Feet

Alternative 1 - CDDL Scenario D with Upstream Flood Storage

Pigeon River Flood Risk Reduction Plan - Conceptual Design and Construction Cost Estimates

Alternative #1 - CDDLD + Upstream Flood Storage

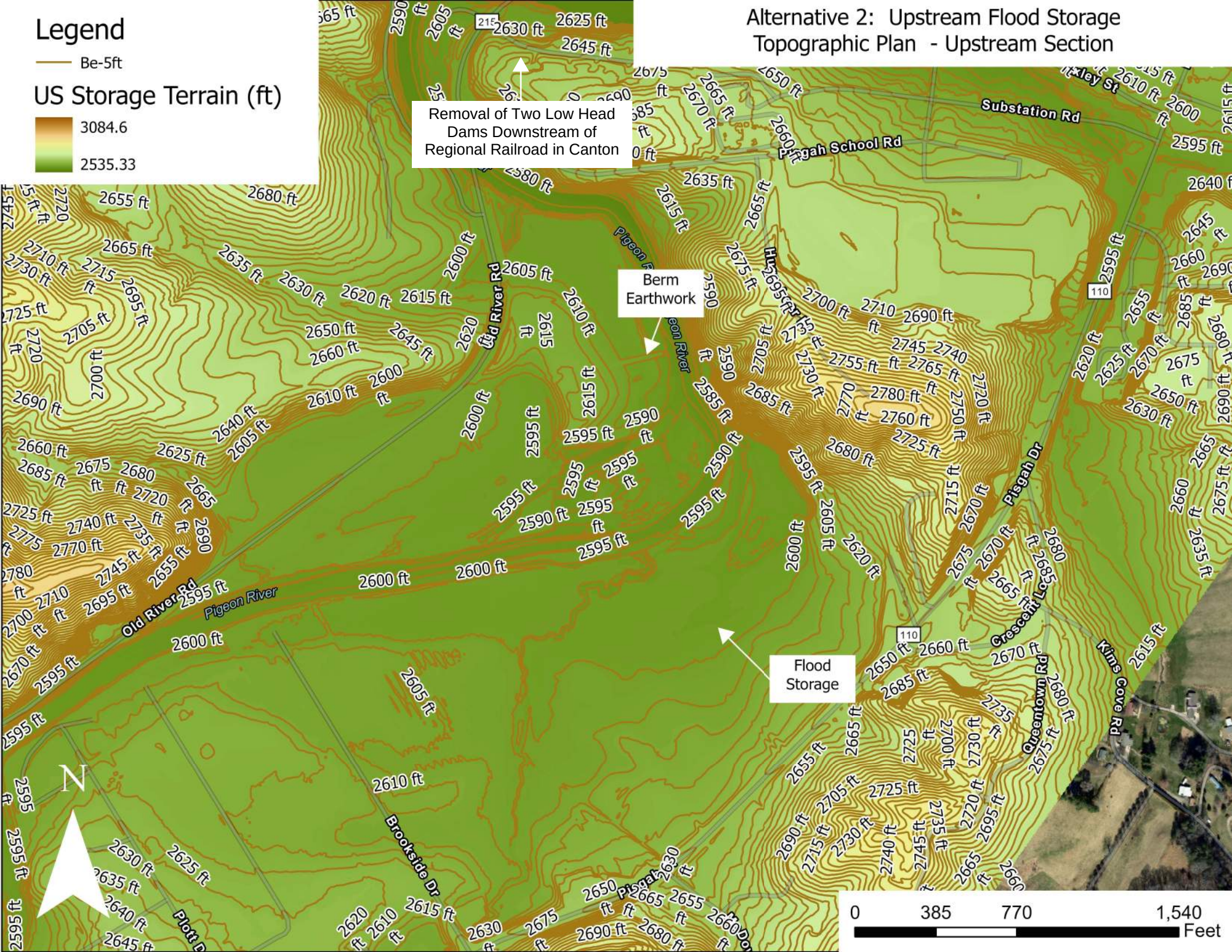
Work Item Description	Unit	Unit Price	Quantity	Cost	Remarks
Bridge Extension Roadway (Park Street)	SQFT	$300	6000	$1,800,000	60' width x 100' length
Bridge Extension Roadway (Main Street)	SQFT	$300	3000	$900,000	50' width x 60' length
Bridge Extension (near WWTP) Railroad	LNFT	$10,000	100	$1,000,000	Single Track 100' length
Bridge Removal - Blackwell Dr NB	SQFT	$15	11400	$171,000	300' (L) x 38' (W)
Bridge Removal - Blackwell Dr SB	SQFT	$15	7220	$108,300	190' (L) x 38' (W)
Bridge Removal - Railroad Connector	SQFT	$15	5800	$87,000	300'(L) x 20' (W)
*Floodplain Excavation and Disposal	CUYD	$20	579,082	$11,581,640	
Mill Site Demo for Floodplain Benching	LPSM	$1,000,000	1	$1,000,000	
WWTP Site Demo for Floodplain Benching	LPSM	$1,000,000	1	$1,000,000	
Upstream Flood Storage Berm Construction	CUYD	$75	2,500	$187,500	2500 CUYD
Inline Structure Demo - Low Flow Weirs	EA	$200,000	2	$400,000	< 15-ft tall
Stream Restoration - Low Flow Weirs and Flood Storage Berm	LNFT	$750	500	$375,000	
Riparian Forest Buffers	ACRE	$20,000	5.00	$100,000	4,000' (L) x 50' (W)
Land Acquisition Costs	LPSM	$651,000	1	$651,000	Berm property and Ag. fields
Drainage Improvements	LPSM	$50,000	1	$50,000	
Utility Relocation	LPSM	$50,000	1	$50,000	
			Subtotal	**$19,461,440**	
		% of above Subtotal			
Mobilization	LPSM	10%		$1,947,000	
Construction Survey and Staking	LPSM	5%		$974,000	
Contractor Quality Control & Testing	LPSM	3%		$584,000	
Temporary Erosion Control	LPSM	3%		$584,000	
Clearing and Grubbing	LPSM	2%		$390,000	
Temporary Traffic Control	LPSM	4%		$779,000	
			Subtotal	**$24,719,440**	
Contingency (Required for all projects)	30%	$7,416,000			
Inflation (Assumed 5% per year)	5%	$5,065,349			
Total Construction (CN)	2027	**$37,200,789**			

Preliminary Engineering (PE) (Required for all projects)	12%	**$4,464,095**	
Construction Engineering (CE) (Required for all projects)	12%	**$4,464,095**	

Total Project Cost	**$46,128,978**	
Total Project Cost (Rounded)	**$46,130,000**	

***Floodplain bench Excavation and Dispolal costs could vary significantly. Potential soil contamination has been reported on the Mill site. Cost of soil testing and remediation is not included. Beneficial reuse of soil is also excluded.**

Alternative 2 –Upstream Flood Storage


Alternative 2: Upstream Flood Storage
Topographic Plan - Upstream Section
Legend
Be-5ft
US Storage Terrain (ft)
3084.6
2535.33
Removal of Two Low Head Dams Downstream of Regional Railroad in Canton
Berm Earthwork
Flood Storage
Old River Rd
Pigeon River
Pisgah School Rd
Substation Rd
Pisgah Dr
Queentown Rd
Kims Cove Rd
Brookside Dr
N
0
385
770
1,540
Feet

Alternative 2 - Upstream Flood Storage

Pigeon River Flood Risk Reduction Plan - Conceptual Design and Construction Cost Estimates

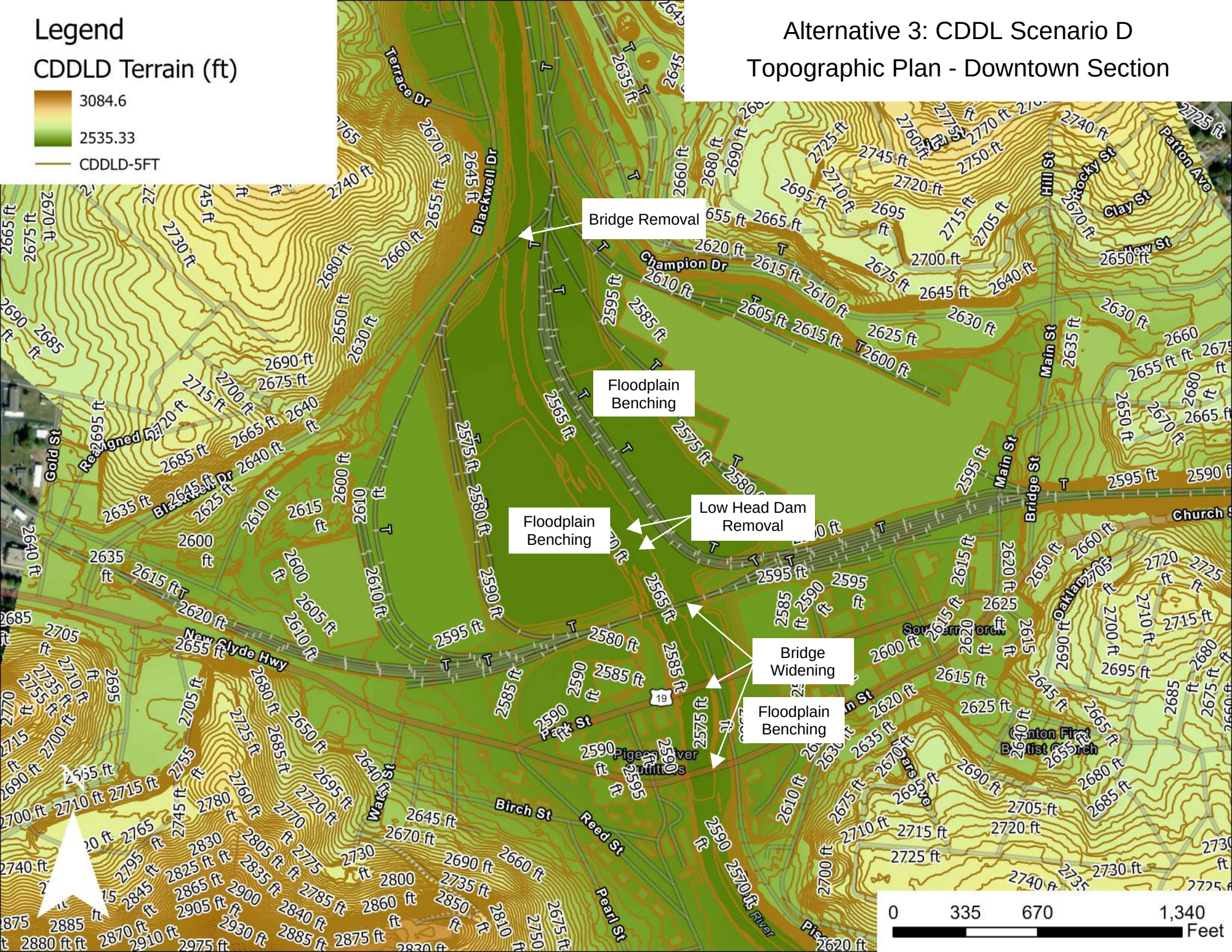
Alternative #2 - Upstream Flood Storage and Inline Structure Removal

Work Item Description	Unit	Unit Price	Quantity	Cost	Remarks
Upstream Flood Storage Berm Construction	CUYD	$75	2,500	$187,500	2500 CUYD
Inline Structure Demo - Low Flow Weirs	EA	$200,000	2	$400,000	< 15-ft tall
Stream Restoration - Low Flow Weirs and Flood Storage Berm	LNFT	$750	500	$375,000	
Land Acquisition Costs	LPSM	$651,000	1	$651,000	Berm Property and Ag. Fields
Drainage Improvements	LPSM	$10,000	1	$10,000	
Utility Relocation	LPSM	$10,000	1	$10,000	
			Subtotal	**$1,633,500**	
		% of above Subtotal			
Mobilization	LPSM	10%		$164,000	
Construction Survey and Staking	LPSM	5%		$82,000	
Contractor Quality Control & Testing	LPSM	5%		$82,000	
Temporary Erosion Control	LPSM	5%		$82,000	
Clearing and Grubbing	LPSM	3%		$50,000	
Temporary Traffic Control	LPSM	1%		$17,000	
			Subtotal	**$2,110,500**	
Contingency (Required for all projects)	30%	$634,000			
Inflation (Assumed 7% per year)	5%	$432,602			
Total Construction (CN)	2027	**$3,177,102**			

Preliminary Engineering (PE) (Required for all projects)	12%	**$381,252**	
Construction Engineering (CE) (Required for all projects)	12%	**$381,252**	

Total Project Cost	**$3,939,606**	
Total Project Cost (Rounded)	**$3,940,000**	

Alternative 3 – CDDL Scenario D


Legend
CDDLD Terrain (ft)
3084.6
2535.33
CDDLD-5FT
Alternative 3: CDDL Scenario D
Topographic Plan - Downtown Section
Bridge Removal
Floodplain Benching
Low Head Dam Removal
Floodplain Benching
Bridge Widening
Floodplain Benching
Terrace Dr
Blackwell Dr
Champion Dr
Main St
Bridge St
Hill St
Rocky St
Clay St
Patton Ave
Gold St
Realigned Blackwell Dr
New Clyde Hwy
Depot St
Birch St
Reed St
Pearl St
Water St
Oakland St
Church St
Pigeon River Outfitters
Pisgah River
0
335
670
1,340
Feet

Alternative 3 - CDDL Scenario D

Pigeon River Flood Risk Reduction Plan - Conceptual Design and Construction Cost Estimates

Alternative #3 - CDDL D

Work Item Description	Unit	Unit Price	Quantity	Cost	Remarks
Bridge Extension Roadway (Park Street)	SQFT	$300	6000	$1,800,000	60' width x 100' length
Bridge Extension Roadway (Main Street)	SQFT	$300	3000	$900,000	50' width x 60' length
Bridge Extension (near WWTP) Railroad	LNFT	$10,000	100	$1,000,000	Single Track 100' length
Bridge Removal - Blackwell Dr NB	SQFT	$15	11400	$171,000	300' (L) x 38' (W)
Bridge Removal - Blackwell Dr SB	SQFT	$15	7220	$108,300	190' (L) x 38' (W)
Bridge Removeal - Railroad Connector	SQFT	$15	5800	$87,000	300'(L) x 20' (W)
*Floodplain Excavation and Disposal	CUYD	$20	579,082	$11,581,640	
Mill Site Demo for Floodplain Benching	LPSM	$1,000,000	1	$1,000,000	
WWTP Site Demo for Floodplain Benching	LPSM	$1,000,000	1	$1,000,000	
Inline Structure Demo - Low Flow Weirs	EA	$200,000	2	$400,000	< 15-ft tall
Stream Restoration - Low Flow Weirs	LNFT	$750	400	$300,000	
Riparian Forest Buffers	ACRE	$20,000	5.00	$100,000	4,000' (L) x 50' (W)
Land Acquisition Costs	LPSM	$501,000	1	$501,000	Agricultural Fields
Drainage Improvements	LPSM	$50,000	1	$50,000	
Utility Relocation	LPSM	$50,000	1	$50,000	
			Subtotal	**$19,048,940**	
		% of above Subtotal			
Mobilization	LPSM	10%		$1,905,000	
Construction Survey and Staking	LPSM	5%		$953,000	
Contractor Quality Control & Testing	LPSM	3%		$572,000	
Temporary Erosion Control	LPSM	3%		$572,000	
Clearing and Grubbing	LPSM	2%		$381,000	
Temporary Traffic Control	LPSM	4%		$762,000	
			Subtotal	**$24,193,940**	
Contingency (Required for all projects)	30%	$7,259,000			
Inflation (Assumed 7% per year)	5%	$4,957,770			
Total Construction (CN)	2027	**$36,410,710**			

Preliminary Engineering (PE) (Required for all projects)	12%	**$4,369,285**	
Construction Engineering (CE) (Required for all projects)	12%	**$4,369,285**	

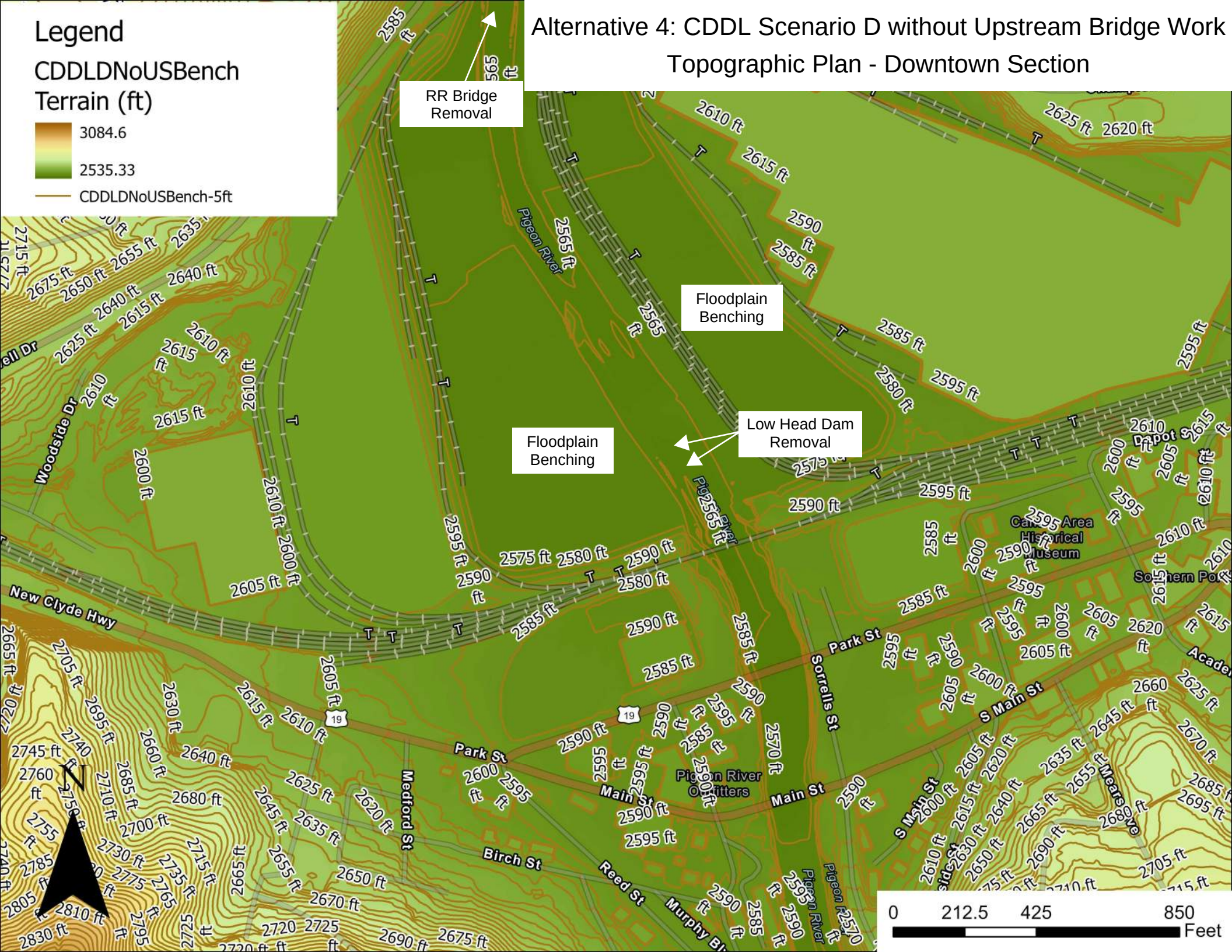
Total Project Cost	**$45,149,280**	
Total Project Cost (Rounded)	**$45,150,000**	

***Floodplain bench Excavation and Dispolal costs could vary significantly. Potential soil contamination has been reported on the Mill site. Cost of soil testing and remediation is not included. Beneficial reuse of soil is also excluded.**

Alternative 4 – CDDL Scenario D without Upstream Bridge Work

Alternative 4: CDDL Scenario D without Upstream Bridge Work

Topographic Plan - Downtown Section



Alternative 4 - CDDL Scenario D without Upstream Bridge Work

Pigeon River Flood Risk Reduction Plan - Conceptual Design and Construction Cost Estimates

Alternative #4 - CDDL D Without Bridge Work

Work Item Description	Unit	Unit Price	Quantity	Cost	Remarks
Bridge Removal - Blackwell Dr NB	SQFT	$15	11400	$171,000	300' (L) x 38' (W)
Bridge Removal - Blackwell Dr SB	SQFT	$15	7220	$108,300	190' (L) x 38' (W)
Bridge Removeal - Railroad Connector	SQFT	$15	5800	$87,000	300'(L) x 20' (W)
*Floodplain Excavation and Disposal	CUYD	$20	579,082	$11,581,640	
Mill Site Demo for Floodplain Benching	LPSM	$1,000,000	1	$1,000,000	
WWTP Site Demo for Floodplain Benching	LPSM	$1,000,000	1	$1,000,000	
Inline Structure Demo - Low Flow Weirs	EA	$200,000	2	$400,000	< 15-ft tall
Stream Restoration - Low Flow Weirs	LNFT	$750	400	$300,000	
Riparian Forest Buffers	ACRE	$20,000	5.00	$100,000	4,000' (L) x 50' (W)
Land Acquisition Costs	LPSM	$501,000	1	$501,000	Agricultural Fields
Drainage Improvements	LPSM	$50,000	1	$50,000	
Utility Relocation	LPSM	$50,000	1	$50,000	
			Subtotal	**$15,348,940**	
		% of above Subtotal			
Mobilization	LPSM	10%		$1,535,000	
Construction Survey and Staking	LPSM	5%		$768,000	
Contractor Quality Control & Testing	LPSM	3%		$461,000	
Temporary Erosion Control	LPSM	3%		$461,000	
Clearing and Grubbing	LPSM	2%		$307,000	
Temporary Traffic Control	LPSM	2%		$307,000	
			Subtotal	**$19,187,940**	
Contingency (Required for all projects)	30%	$5,757,000			
Inflation (Assumed 7% per year)	5%	$3,931,946			
Total Construction (CN)	2027	**$28,876,886**			

Preliminary Engineering (PE) (Required for all projects)	12%	**$3,465,226**	
Construction Engineering (CE) (Required for all projects)	12%	**$3,465,226**	

Total Project Cost	**$35,807,339**	
Total Project Cost (Rounded)	**$35,810,000**	

***Floodplain bench Excavation and Dispolal costs could vary significantly. Potential soil contamination has been reported on the Mill site. Cost of soil testing and remediation is not included. Beneficial reuse of soil is also excluded.**