



North Central Texas
Council of Governments

Integrating Transportation and Stormwater Infrastructure

Hydraulic Modeling for the Village Creek Watershed

June 2026



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Integrating Transportation and Stormwater Infrastructure (TSI) HEC-RAS Modeling for the Village Creek Watershed

U.S. Army Corps of Engineers

1. Executive Summary

This report presents an enhanced two-dimensional (2D) hydraulic model of the Village Creek Watershed, based on the Base Level Engineering (BLE) Study from the Texas Water Development Board (TWDB). Using the refined Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) derived runoff results, the model estimates flood depths and peak water surface elevations across the integrating Transportation and Stormwater Infrastructure (TSI) study area.

Enhancements to the BLE model include the addition of 66 structures, comprised of 41 bridges and 25 culverts, with as-built data or standard assumptions, refined computational meshes at crossings, updated terrain from the latest topographic data, and conversion of rain-on-grid inputs to boundary-applied inflow hydrographs. Various simulation plans cover existing (2020) and future (2070) land use conditions across a range of recurrence intervals (2- to 500-year).

The enhanced model provides a tool for flood assessment, hydraulic analysis, and evaluating potential impacts of future development within the watershed.

2. HEC-RAS Methodology

2.1. Original Model

The BLE study for the Lower West Fork Trinity Watershed (HUC-08: 12030102) obtained from TWDB was used as the basis for the enhanced hydraulic model. The 2023 study includes the development of 2D hydraulic models for seven Hydrologic Unit Code (HUC) -10 watersheds within the Lower West Fork Trinity Watershed. The BLE Village Creek watershed model (HUC-10: 1203010204 above Lake Arlington) served as the starting point for the hydraulic modeling developed for this project.

Precipitation depths for this analysis were derived from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall data. HEC-HMS was used to develop a simplified hydrologic model to generate rainfall-runoff estimates, which were then applied in a rain-on-grid 2D hydraulic simulation using the Hydrologic Engineering Center – River Analysis System

(HEC-RAS) model. The hydraulic model was used to estimate flood depths and peak water surface elevations across the study area.

2.2. Enhanced Model

Several modifications were implemented to the original BLE hydraulic model to more accurately represent existing conditions and to evaluate potential impacts of future development within the study area. The primary modifications included changes in the terrain, addition of structures, and the conversion of the rain-on-grid approach to inflow hydrographs. The following chapters provide additional details on each of the modifications done in the hydraulics model.

2.2.1 Structures Data

Bridges and culverts were added to the BLE model at major crossings to more accurately represent hydraulic conditions, including velocity, water surface elevation (WSE), and flow rate at those locations. A total of 66 structures were added, including 41 bridges and 25 culverts.

As-built data was used as inputs for these structures when available. If as-built information was not provided or if data was missing from the document, the following assumptions and procedures were applied:

- No as-built information provided: Major bridge parameters, including total length, number of piers, and width, were obtained using the Texas Department of Transportation (TxDOT) Open Data Portal.
- Missing bridge dimensions: If bridge dimensions (span lengths, widths, or heights) were not provided, measurement tools were applied directly to the document using the sheet scale.
- Unknown elevation datum: In cases where elevations were reported in an undetermined datum—such as some as-builts setting the channel bottom to zero—an offset was applied to align the roadway elevation from the Light Detection and Ranging (LiDAR) with the converted elevation in the current datum. Additionally, for structures with as-built documentation dated prior to 1987, a conversion from the National Geodetic Vertical Datum of 1929 (NGVD 29) to the North American Vertical Datum of 1988 (NAVD 88) was adopted. The conversion factor, typically ranging from 0.0 to 0.2 feet, was selected based on the specific crossing location.

Table 1 lists the added structures, and **Figure 1** shows their locations within the Village Creek watershed. The TxDOT IDs used for the National Bridge Inventory (NBI) are listed for the applicable crossings.

Table 1: List of SA/2D Connections

TxDOT ID	Type	Feature Crossed	Facility Carried
022200V00115001	Culvert	Chambers Creek	Enon Avenue
022200V00115002	Culvert	Chambers Creek	Enon Avenue
022200V00115003	Bridge	Chambers Creek	Enon Avenue
022200V00130001	Culvert	Chambers Creek	Forest Hill Drive
022200133001021	Bridge	Deer Creek	Main Street
022200TT5578001	Culvert	North Fork Deer Creek	Davis Road
022200133001018	Bridge	Deer Creek	FM 1187 EB Frontage Road
022200133001017	Bridge	Deer Creek	FM 1187 WB Frontage Road
022200109402021	Bridge	Deer Creek	FM 731
022200TT0195001	Culvert	Deer Creek	Hampton Road
022200001402346	Bridge	Deer Creek	IH35W - SB Frontage Road
022200001402348	Bridge	Deer Creek	IH35W - NB Frontage Road
022200AA0328001	Culvert	Deer Creek	McCart Avenue
022200109401005	Culvert	North Fork Deer Creek	FM 731
22200TT3320001	Culvert	North Fork Deer Creek	Monarch Avenue
022200AA0619001	Culvert	Elm Branch	Wilson Road
01270001403237	Culvert	Johnson Creek	IH 35W SB Frontage Road
021270001403050	Culvert	Johnson Creek	IH 35W Main Lanes
021270001403238	Culvert	Johnson Creek	IH 35W NB Frontage Road
022200HH0015001	Culvert	Kennedale Creek	Averett Road
022200017202188	Bridge	Kennedale Creek	BU 287 P
022200HH0100002	Bridge	Kennedale Creek	Dick Price Road
022200HH0100001	Bridge	Kennedale Creek	Valley Lane
021270DD0115001	Culvert	Booger Creek	Dobson Street
021270AA0703001	Bridge	Quil Miller Creek Tributary	County Road 602
021270337201004	Culvert	Quil Miller Creek Tributary	Renfro Street
021270337201003	Bridge	Quil Miller Creek	FM 3391
021270337201002	Bridge	Quil Miller Relief	FM 3391
021270DD0501001	Bridge	Quil Miller Creek	Fox Lane
021270DD0993002, 021270DD0993003	Bridge*	Quil Miller Creek	Hidden Creek Parkway
021270001403241	Bridge	Quil Miller Creek	IH 35W SB Frontage Road
021270001403239	Bridge	Quil Miller Creek	IH 35W NB Frontage Road
021270DD1045001	Culvert	Shannon Creek Tributary	Elk Drive
021270DD0624002	Bridge	Shannon Creek	Chandler Drive
021270109403018	Bridge	Shannon Creek	FM 731 SB
021270109403017	Bridge	Shannon Creek	FM 731 NB
021270001901026	Bridge	Shannon Creek	SH 174 SB
021270001901037	Bridge	Shannon Creek	SH 174 NB

TxDOT ID	Type	Feature Crossed	Facility Carried
022200L00045001	Bridge	South Creek	Anglin Drive
021270DD0995002	Culvert	Timber Creek Tributary	Village Creek Parkway
022200DD0961001	Culvert	Timber Creek	McCall Street
022200DD0995001	Culvert	Timber Creek	Village Creek Parkway
022200HH0170001	Bridge	Village Creek Tributary	Bowman Spring Road
022200L00365005	Bridge	Village Creek Tributary	Forest Hill Drive
022200001402007	Culvert	Village Creek Tributary	IH 35W
022200AA0616002	Bridge	Village Creek Tributary	Rendon Road
022200AA0667001	Culvert	Village Creek Tributary	Stephenson Levy Road
022200017202187	Bridge	Village Creek	BU 287 P
22200AA0657002	Bridge	Village Creek	Burleson Retta Road
021270G00036001	Culvert	Village Creek	Clubhouse Drive
021270G00055001	Culvert	Village Creek	Country Club Drive
021270DD0340001	Culvert	Village Creek	County Road 714
021270DD0115002	Bridge	Village Creek	Dobson Street
022200ZE7730001	Bridge	Village Creek	Everman Kennedale Burleson Road
022200133002012	Bridge	Village Creek	FM 1187
021270337201001	Bridge	Village Creek	FM 3391
021270109404006	Bridge	Village Creek	FM 731
022200L00365006	Bridge	Village Creek	Forest Hill Drive
21270DD1060001, 021270DD1060002	Bridge*	Village Creek	Hidden Creek Parkway
022200237405234	Bridge	Village Creek	IH 20 EB Frontage Road
022200237405717	Bridge	Village Creek	IH 20 WB Frontage Road
021270001403049	Bridge	Village Creek	IH 35W SB Frontage Road
021270001403233	Bridge	Village Creek	IH 35W NB Frontage Road
022200AA0616003	Bridge	Village Creek	Rendon Road
021270001901028	Culvert	Village Creek	SH 174
022200AA0616001	Bridge	Village Creek	Shelby Road

* Given the short distance between the two bridges and their similar structural profiles, the bridges were combined into a single structure to more accurately represent hydraulic conditions and prevent stability issues.

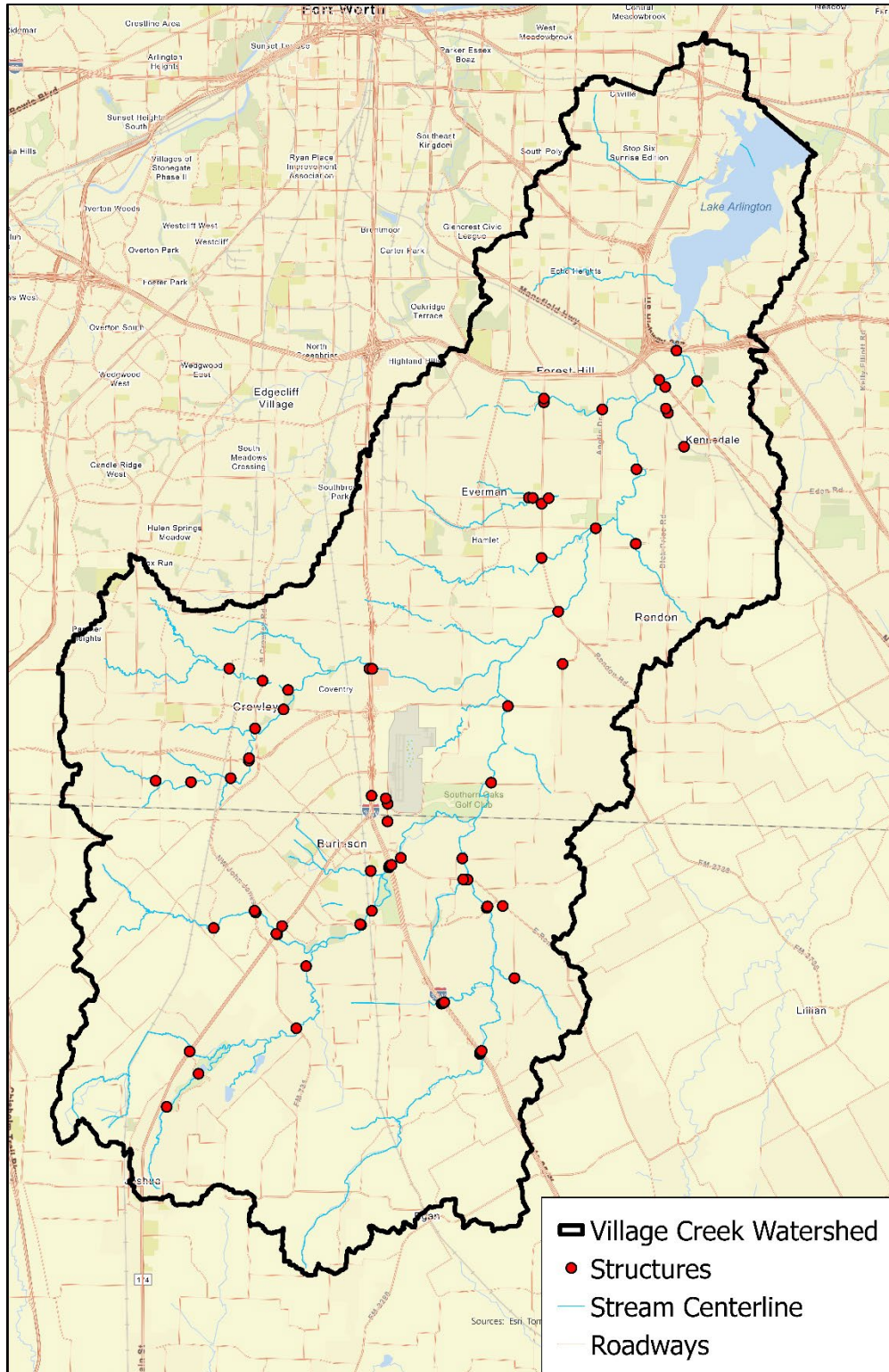


Figure 1: Locations of 2D Structures

2.2.2 2D Mesh

At each bridge location, the computational mesh was refined to ensure that a minimum of two cells spanned the full length of each bridge structure. For culverts, the mesh configuration was developed to include all culvert barrels within a single computational cell upstream and a single cell downstream except for cases where the mesh was too fine. These refinements were achieved by adjusting the near spacing, near repeats, and far spacing of the 2D mesh connections.

Breaklines were modified to accommodate the structures and associated mesh cells. To prevent interference with the mesh around the structures, the breaklines representing the stream and roadway were shortened in the vicinity of each structure, ensuring that the mesh configuration at these locations adhered to the strategy described in the previous paragraph. Once these adjustments were made, the modifications were implemented by enforcing all breaklines.

2.2.3 Unsteady Flow Data

The HEC-HMS version 4.11 model developed for this watershed was used to provide inflows for the 2D HEC-RAS model for this watershed. This replaced the rain-on-grid approach from the BLE model. Documentation of this model is provided in the “HEC-HMS Modeling for the Village Creek Watershed” report.

In addition to the five original BLE plans corresponding to the 2-, 10-, 50-, 100-, and 500-year storms, five plans representing 2020 existing conditions and five plans representing 2070 future conditions were developed for the same recurrence intervals. All additional plans utilize the same geometric configuration, with variations only in the assigned unsteady flow data.

2.2.4 Terrain and Manning’s Number Layer Updates

The BLE terrain was updated by Freese and Nichols (FNI) to incorporate lake bathymetry data and terrain modifications for culverts. FNI stitched together the BLE terrain and a surface generated from the TWDB bathymetric survey of Lake Arlington dated December 2007. Terrain modifications were applied to approximate smaller culverts not modeled as Storage Area/2D Flow Area (SA/2D) connections, adjust culvert inverts to match flowlines, and improve stability of crossings.

The Manning’s roughness layer was updated by FNI to better reflect current land cover conditions, as the source BLE land cover was a post-processed version of the National Land Cover Dataset (NLCD) that did not increase the model resolution. FNI processed the source NLCD and added delineations of the roadway network based on the 2019 North Central Texas Council of Governments (NCTCOG) roads dataset and the channel. The roads were defined using buffers based upon NCTCOG road type (shown in **Table 2**). The channel was defined based on a semi-automated process that combines 10-year depths with a 25-foot buffer of the BLE stream centerlines. **Table 3** lists the Manning’s n values adopted for each land cover area present in the enhanced model.

Table 2: NCTCOG Road Type and Buffer Width Applied

Road Type	Buffer (ft)
Access Ramp	8
Connecting Road*	n/a
Driveway	5
Major Arterial	18
Minor Arterial	12
Other	5
Primary Highway	30
Private Road	5
Secondary Highway	20
Service Road	8
Trail	5
*Generally covered by highway buffers	

Table 3: Manning's n Values by Land Cover

Land Cover	n
Grassland-Herbaceous	0.03
Deciduous Forest	0.12 (0.16)*
Shrub-Scrub	0.06
Developed, Open Space	0.04
Cultivated Crops	0.04
Pasture-Hay	0.04
Open Water	0.03 (0.033)*
Developed, High Intensity	0.12
Developed, Medium Intensity	0.08
Developed, Low Intensity	0.06
Emergent Herbaceous Wetlands	0.08
Woody Wetlands	0.1 (0.12)*
Mixed Forest	0.12 (0.16)*
Barren Land Rock-Sand-Clay	0.03
Evergreen Forest	0.12 (0.16)*
Channel	0.04
Roads	0.02
*BLE modification to default value	

3. Results and Conclusions

Existing flood risk within the Village Creek watershed is distributed across many locations. When evaluated against National Structure Inventory (NSI) building data and the road network dataset, the 100-year 2020 flood event affects 653 structures (WSE above NSI ground elevation) and 13.3 miles of road (depth greater than 6 inches). This is shown in **Figure 2**.

With the future increases in impervious surface area in the Village Creek watershed, flood risk increases. The 100-year 2070 flood event affects 1,222 structures (WSE above NSI ground elevation) and 15.1 miles of road (depth greater than 6 inches). This is shown in **Figure 3**. The increase in 100-year flood elevations from the 2020 to 2070 existing storm events is shown in **Figure 4**.

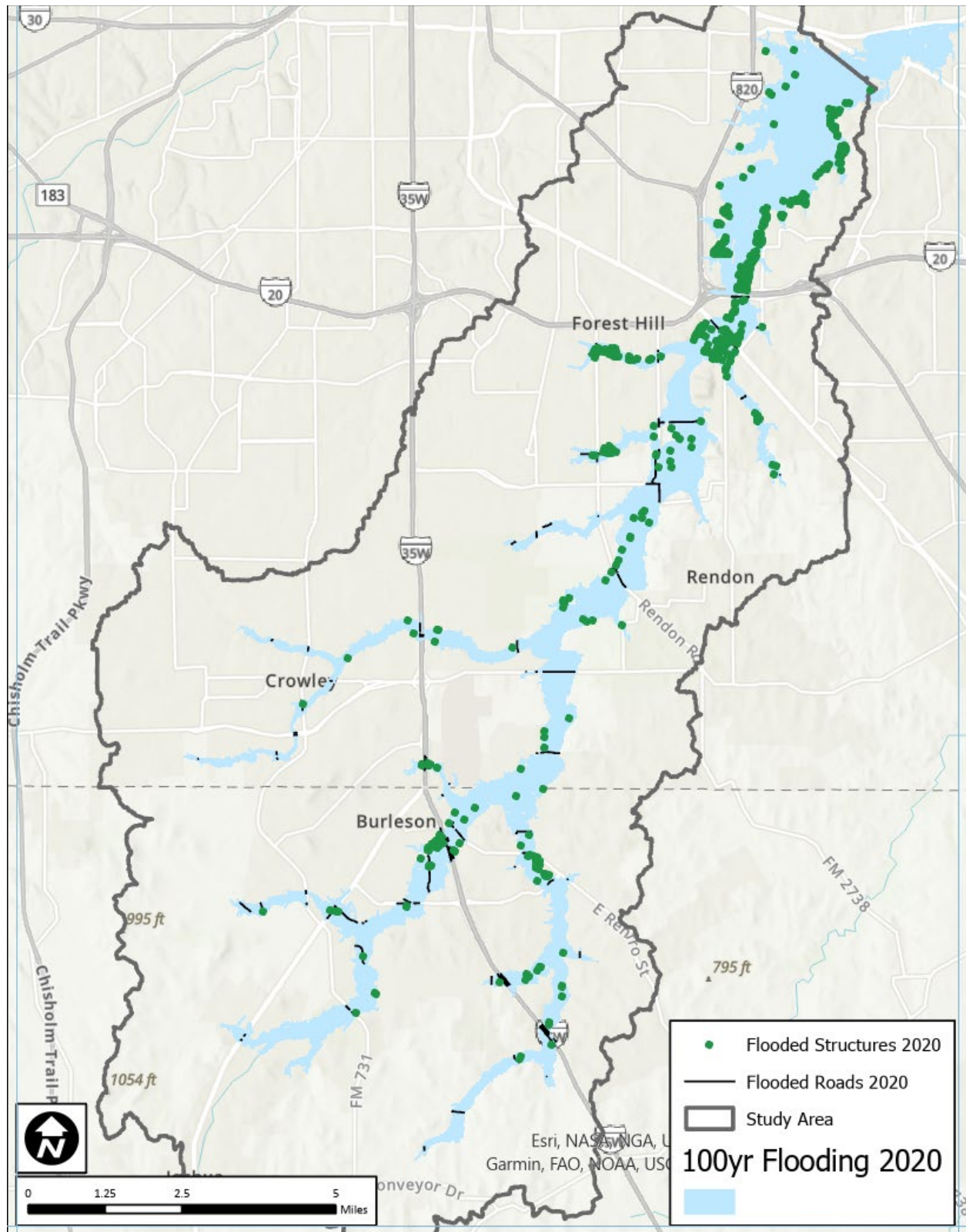


Figure 2: Existing Conditions, 100-year Flooding in 2020

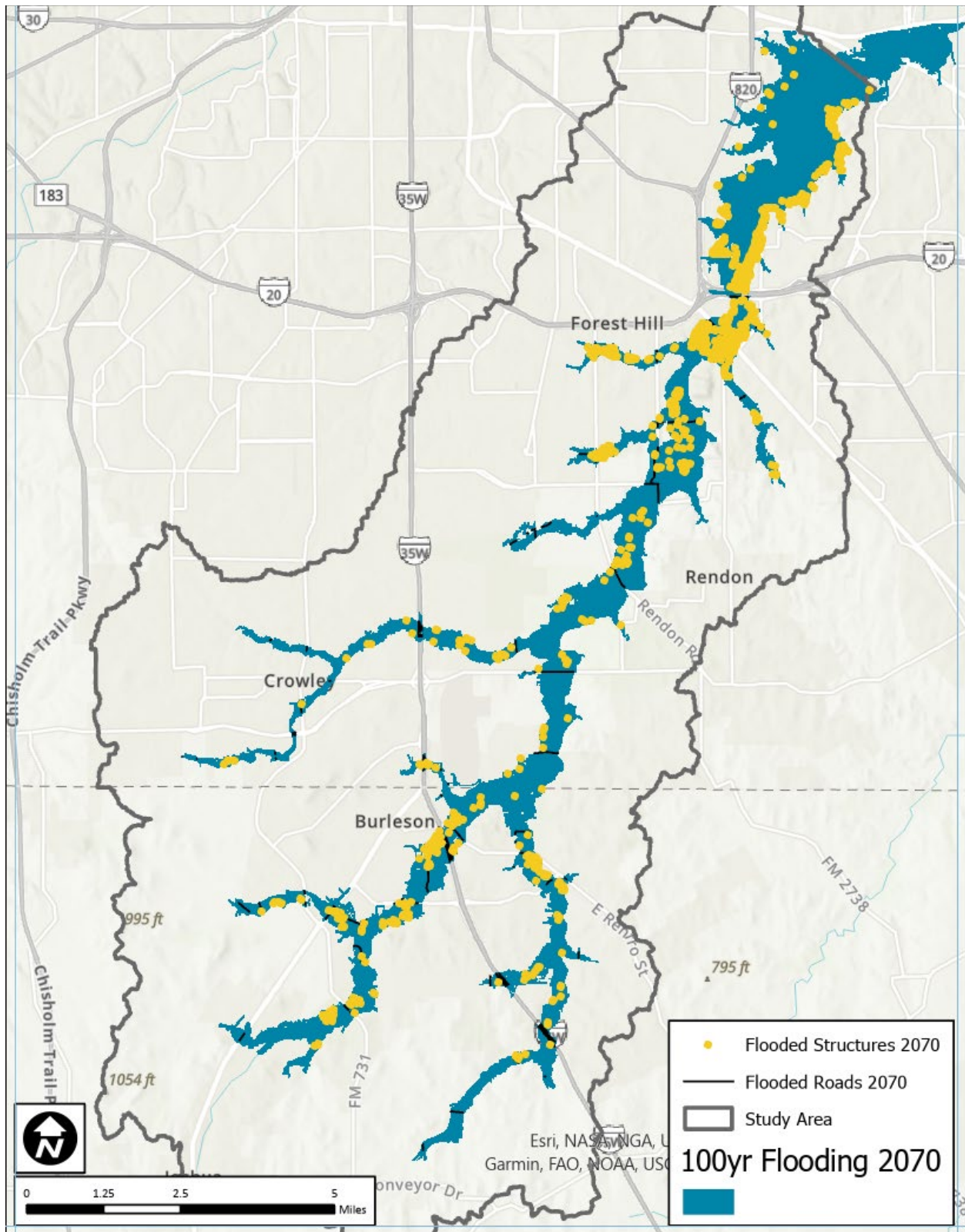


Figure 3: Existing Conditions, 100-year Flooding in 2070

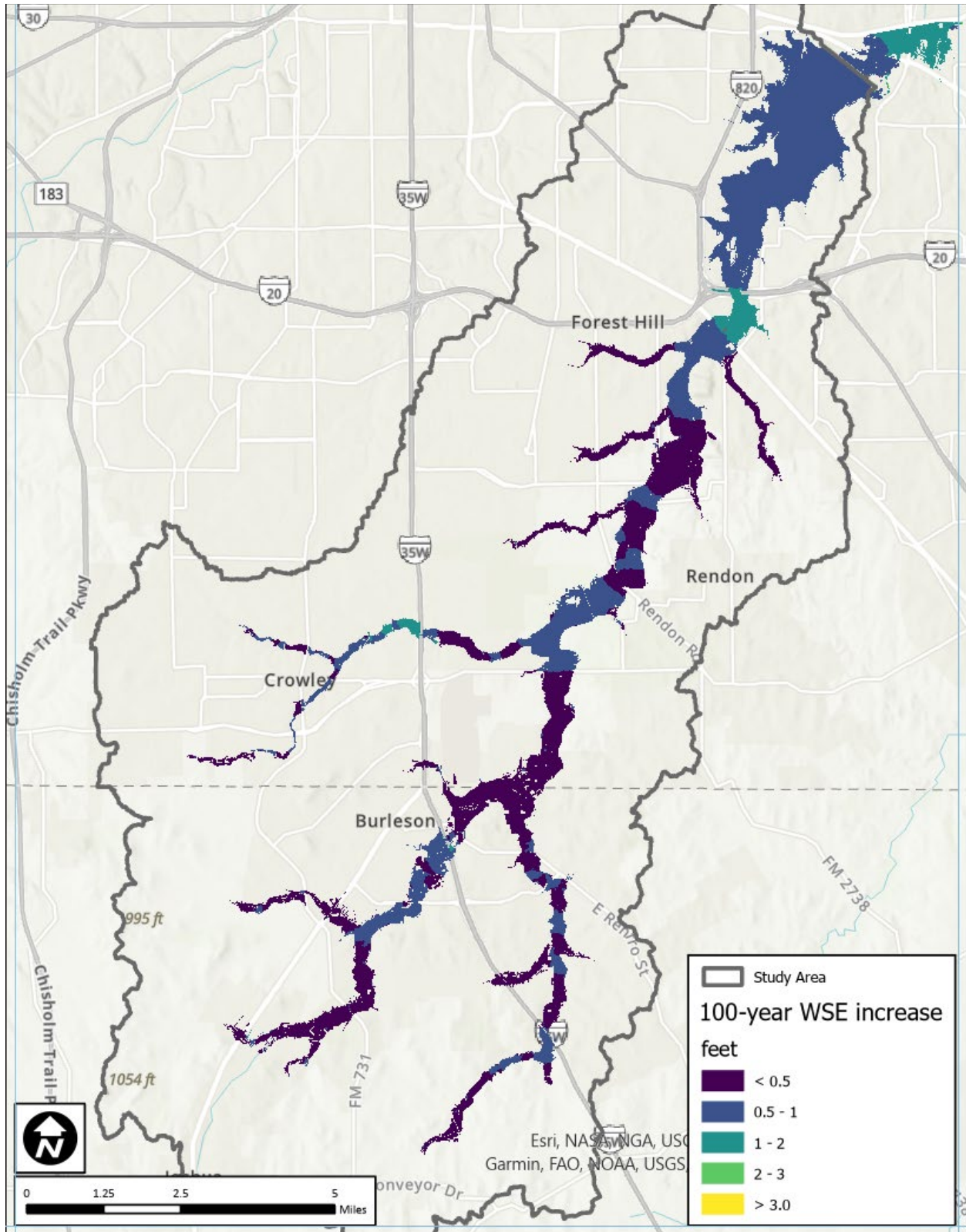


Figure 4: Increase in 100-year flood elevations from 2020 to 2070 without TSI projects

4. References

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