TOWN OF MOUNT CRAWFORD URBAN DEVELOPMENT AREA NON-MOTORIZED INFRASTRUCTURE EVALUATION

Prepared for: Town of Mount Crawford

JUNE 2022

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ACKNOWLEDGMENTS

The Office of Intermodal Planning and Investment (OIPI) thanks the following project partners for their time and input: Town of Mount Crawford, Rockingham County, Central Shenandoah Planning District Commission (CSPDC), and the Virginia Department of Transportation (VDOT). Additionally, OIPI thanks the consultant team at Foursquare ITP and Toole Design Group for supporting the project.

Unless credited otherwise, all photos, maps, and illustrations in this study were provided by OIPI, its project partners, or its consultants.

ABOUT GAP-TA

The Growth and Accessibility Planning Technical Assistance (GAP-TA) program supports Virginia localities in planning and developing multimodal transportation opportunities. The program has four components, and each component has differences in eligible applicants, eligible activities, expected outcomes, and application evaluation criteria. Component 1 involves conducting multi-modal planning within existing or planned Urban Development Areas or Growth Areas. Component 2 involves developing or evaluating strategies to address emerging planning issues. Component 3 involves developing an accessibility planning process, Finally, Component 4 involves conducting multi-modal planning outside urbanized areas. Visit vtrans.org/about/gap-ta for more information about the GAP-TA program.

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INTRODUCTION

The **Town of Mount Crawford Urban Development Area Non-Motorized Infrastructure Evaluation** is a study to evaluate the Town's existing multimodal network, identify and develop projects with planning-level cost estimates to inform potential grant applications, and review and provide recommendations for multimodal language in local ordinances. This document aims to:

1. Identify existing bicycle and pedestrian facilities and examine population characteristics and employment distribution.
2. Conduct a needs assessment based on previous studies and existing conditions.
3. Summarize pedestrian and bicycle connectivity gaps in the study area.
4. Identify pedestrian and bicycle projects.
5. Prioritize and estimate the cost of the identified projects.
6. Suggest zoning and subdivision ordinances language amend supporting multimodal facility development.

The study is a project through the Commonwealth of Virginia's Office of Intermodal Planning and Investment's (OIPI) Growth and Accessibility Planning (GAP) Technical Assistance Program. Localities across the Commonwealth can apply to the GAP program for technical assistance that falls into one of the program's four component areas:

1. Conduct multimodal planning within existing or planned Urban Development Areas (UDAs).
2. Develop or evaluate strategies to address emerging planning issues.
3. Develop an accessibility planning process.
4. Conduct multimodal planning outside urbanized areas.

This project was envisioned to address Component 4 of the GAP Program.

The project study area covers a 1.35 square mile area of Rockingham County, Virginia, centered on the Town of Mount Crawford, a small community of just under 500 residents. The study area extends slightly beyond the Town boundaries to include sections of roadway along Parsons Court, Friedens Church Road, Old Bridgewater Road, Dinkel Avenue, and US 11. These additional roadways were included in the study as they connect the Town to adjacent communities, notably nearby Bridgewater. The study area boundaries and roadways, shown in **Figure 1**, include on-street facilities and intersection crossings in the following roadway segments:

- **Dinkel Avenue** between US 11 and Bridgewater Town Boundary at Hickory Lane (1.65 miles)
- **Friedens Church Road** from US 11 to the Mount Crawford Park and Ride (0.6 miles)
- **US 11** from Mount Crawford Town Hall to Monger Park (1.5 miles)
- **Old Bridgewater Road / North River Road** from the eastern Town boundary to Dinkel Avenue (1.09 miles)
- **Crawford Street** from the US 11 intersection to North Cemetery Drive (0.52 miles)
- **North Cemetery Drive** between the US 11 intersection and Crawford Street (0.05 miles)
- **Parsons Court** from the US 11 intersection to the Mount Crawford Park and Ride Lot (0.50 miles)
- **Mill Street Road** from the intersection of US 11 to Dayspring Nazarene Church (0.32 miles)
- **Cantermill Lane** (0.27 miles)
- **Bridle Bit Lane** (0.17 miles)
- **Ruritan Road** (0.1 miles)

Figure 1: Mount Crawford Study Area

EXISTING CONDITIONS

This section provides an overview of the existing bicycle and pedestrian infrastructure, population and employment distribution in the study area, and select demographic characteristics.

Existing Infrastructure

Existing bicycle and pedestrian infrastructure facilities within the study area were identified using InteractiveVTrans[1] and verified during a field assessment in April 2022. The study area's bicycle and pedestrian infrastructure is limited to sidewalks along US 11 in the heart of Mount Crawford, mapped in **Figure 4**. As seen in **Figure 4**, sidewalks are present only on sections of US 11 within the entire study area, and when present, sidewalks are four feet wide and only on one side of the street. In addition, some stretches of the existing sidewalks have obstructions, such as telephone poles and fire hydrants or overgrown bushes or trees (**Figure 2**). Besides the reduced extents of sidewalks within the study area, none of the intersections have marked pedestrian crossings.

Additionally, relevant points of discussion during the site visit with the Town Manager and staff from the Central Shenandoah Planning District Commission (CSPDC) included:

- Existing sidewalks do not provide ample connectivity for residences and commercial properties.
- Pedestrian amenities at the intersection of US 11 and Parsons Court, including sidewalks and crosswalks, are needed to better serve existing and future residents.
- Pedestrian and bicycle connections to the Mount Crawford Park/Baseball Diamond are lacking; sidewalks are only existing on the opposite side of US 11 with no crosswalks.
- There are no pedestrian or bicycle facilities between the heart of the Town and the Town Hall building (**Figure 3**), the planned boat launch on the North River behind the Town Hall, and destinations in Bridgewater, Virginia.
- There is no pedestrian or bicycle connectivity outside the study area along Old Bridgewater Road, Dinkel Avenue, and US 11.

Figure 2: Sidewalk Obstructions Along US 11 in the Town of Mount Crawford.

Figure 3: Unmarked Crossings and Lack of Pedestrian or Bicycle Facilities Along US 11 Between the Town Southern Limit and the Intersection with Mill Street.

1 InteractiveVTrans is a web-based application with VTrans-related data available at https://www.vtrans.org/interactvtrans/map-explorer

Figure 4: Existing Bicycle and Pedestrian Infrastructure Facilities

Demographic and Employment Analysis

While the concentration of residents and jobs indicates potential demand for active transportation infrastructure, the presence of specific population groups reinforces this need and calls for facilities that are accessible for all. In this context, the maps in this section show the population density, the location of major employers, and a composite sociodemographic need scoring—a relative measure that estimates the need for pedestrian and cycling infrastructure within the study area. All population and demographic data is from the American Community Survey 2019 5-Year Estimates.

Figure 5 shows the population density by Census block, calculated as residents per acre, and locates major employers within the study area. Analyzing population density helps identify where pedestrian and cycling infrastructure will impact the highest number of residents. The highest population density is seen along US 11, followed by the blocks east of Old Bridgewater Road, in the heart of the Town. Major employers are all along US 11, with three of the four north of Friedens Church Road / Dinkel Avenue. Ensuring these areas have adequate pedestrian and cycling infrastructure can help provide key connections to job opportunities.

Additionally, certain population subgroups disproportionately benefit from walking and bicycling infrastructure. These groups include:

- **Persons with disabilities,** many of whom cannot drive and/or have difficulty driving. Accessible pedestrian infrastructure can expand their mobility and safety.
- **Low-income individuals,** typically because the cost of owning and operating a car can be burdensome.
- **Older adults** who, as they age, often become less comfortable or less able to operate a vehicle.
- **Youth** who are too young to drive or do not have access to a personal vehicle.
- **People without access to an automobile**, whether it be by choice or due to financial or legal reasons, often have no other transportation options besides walking, cycling, and using transit.

Figure 6 shows the composite sociodemographic need score for each Census block, based on the densities of each of those five population subgroups.[1] The highest need is found along US 11 on the block bounded by Mill Street and Old Bridgewater Road and the block north of Layman Road and south of South Cemetery Drive. There is a great need for pedestrian and cycling infrastructure along US 11 and the neighborhood west of US 11 along Mill Street, Old Bridgewater Road, Ruritan Road, and Cantermill Lane.

1 The scoring methodology and individual density maps can be seen in Appendix A.

Figure 5: Mount Crawford Population Density and Major Employers

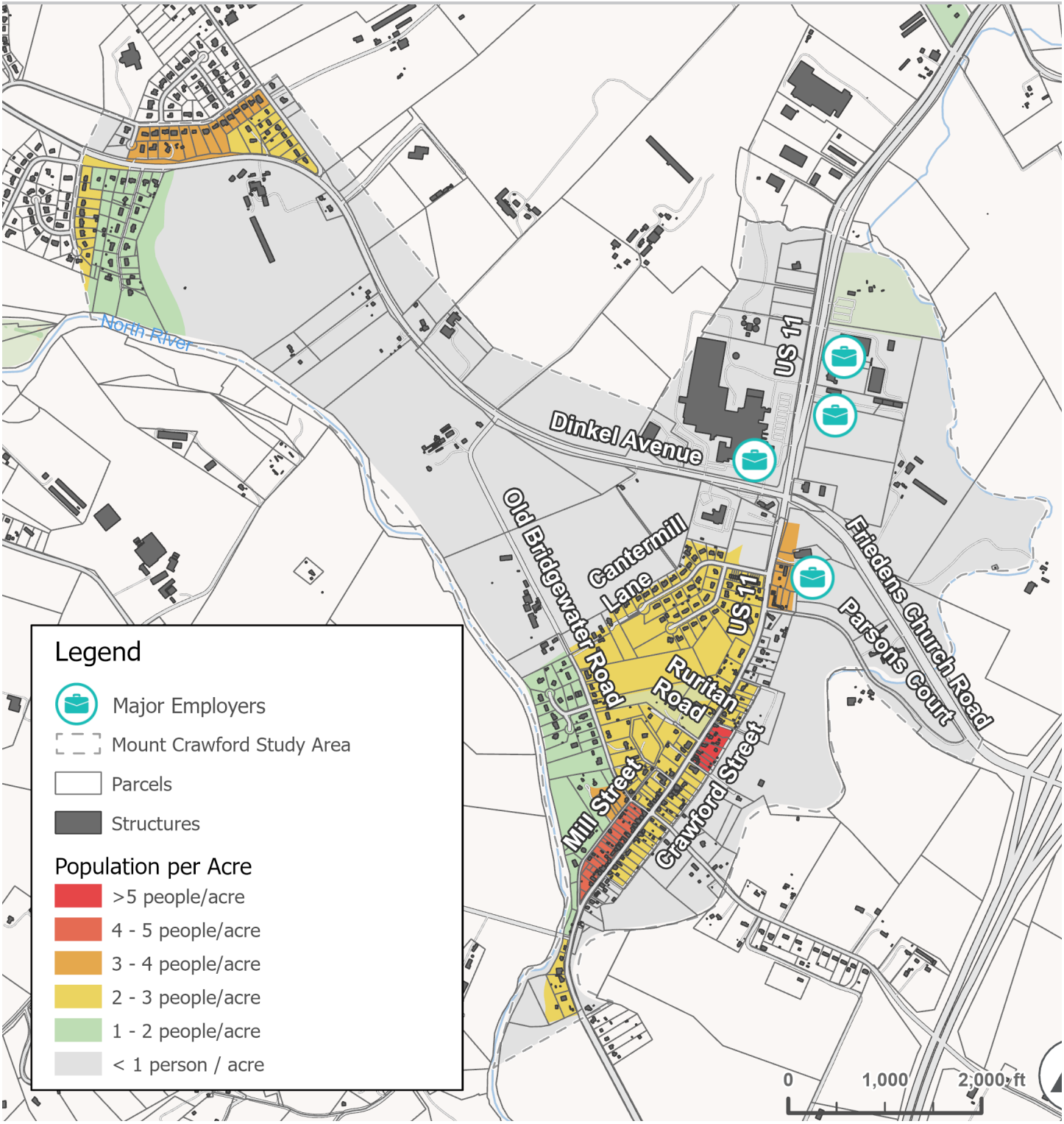
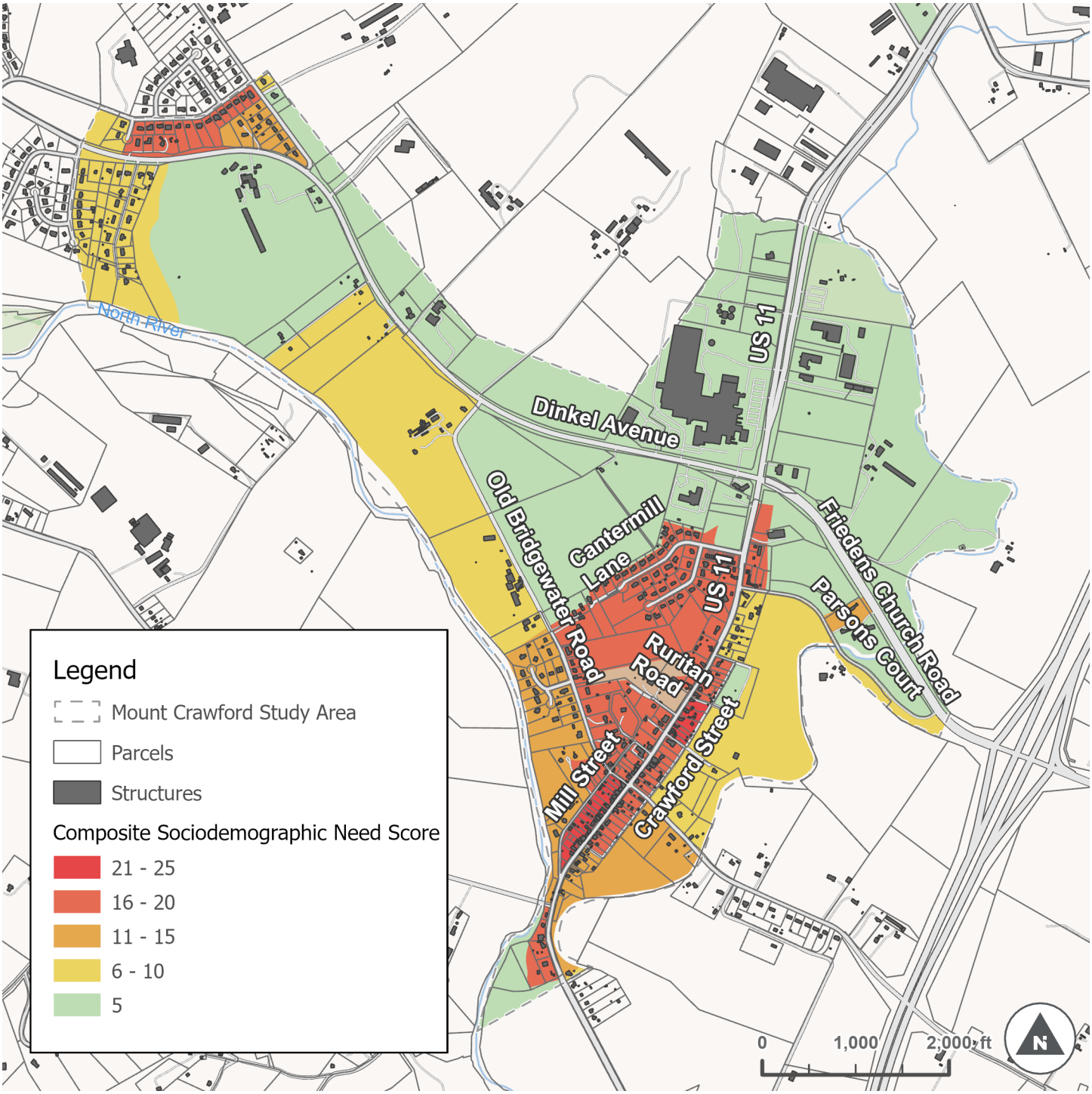


Figure 6: Mount Crawford Sociodemographic Need



NEEDS ASSESSMENT

This section provides an overview of the need for bicycle and pedestrian infrastructure based on previously identified needs, traffic characteristics, and current pedestrian and bicyclist travel patterns in the study area.

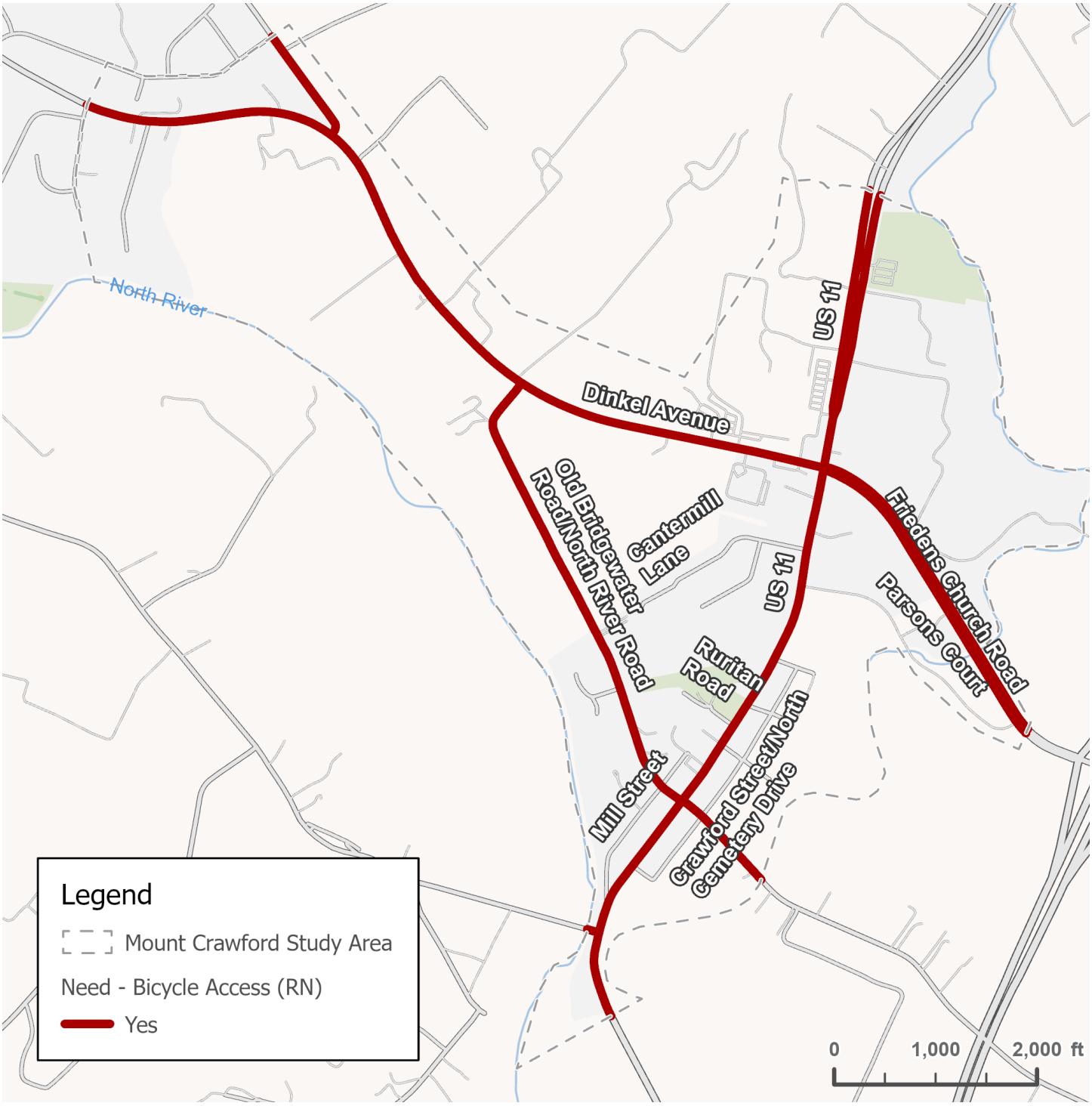
VTrans Needs

Virginia's Statewide Transportation Plan (VTrans) is a multimodal transportation plan that advances the Commonwealth Transportation Board's (CTB) vision for transportation. VTrans identifies and prioritizes locations with transportation needs using data-informed transparent processes. Among VTrans-collected datasets relevant to this study are:

- **WalkScore™:** Another variable that can help determine needs is the areas WalkScore™. WalkScore™ is a third-party metric utilized by VTrans that is "based on proximity of various amenities within a 5 to 30-minute walk from the Census block". All Census blocks within the study area are considered car-dependent, meaning that almost all errands require a car for adequate accessibility.
- **Crash Data:** VDOT maintains a database of reported roadway accidents, including the types of users involved and the severity of the accident. Between 2015 and 2020, there were one pedestrian-involved accident and one cyclist-involved accident within the study area. The pedestrian-involved accident occurred on US 11 in 2016, just south of Old Bridgewater Road, and the cyclist-involved accident occurred on Friedens Church Road just west of Parsons Court in 2018.
- **Mid-Term Needs:** VTrans identifies mid-term needs based on several statewide metrics. According to the plan, the main corridors within the study area qualify as needs under the Need Category 3.7: Need for Bicycle Access to Activity Centers (**Figure 7**). These are the entire extension of US 11, Old Bridgewater Road, Dinkel Avenue, and Friedens Church Road within the study area. The needs represent corridors that facilitate bicycling to activity centers (areas of regional importance that have a high density of economic and social activity).

VTrans Mid-term Needs provide a foundation for the identification of active transportation network gaps as well as the prioritization of their mitigation. These needs are noted in the plan as transportation challenges that should be addressed within ten years.

Figure 7: VTrans Bicycle Access Mid-term Needs



Traffic Volume and Speeds

Traffic volumes and speed limits (or observed operating speeds) on a roadway are crucial inputs in selecting the most appropriate bicycle and pedestrian facilities. Overall, the greater the traffic volume and speed, the greater separation is recommended for cycling and walking comfort. Conversely, on low-volume and low-speed streets, the need for separation is less critical, and it may be appropriate for pedestrians and bicyclists to share the roadway with motor vehicles. **Figure 8** and **Figure 9** show traffic volume and posted speed limits, respectively, in the study area. As seen, both volume and speeds are the highest on Dinkel Avenue, Friedens Church Road, and US 11's northernmost segment. Old Bridgewater Road presents moderate-low traffic volumes but speed limits ranging from 25 mph east of US 11 and 45 mph outside the Town limit. Traffic volume on all local residential streets is low, and the speed limit is 25 mph.

Figure 8: Traffic Volume – 2019 Annual Average Daily Traffic (AADT)

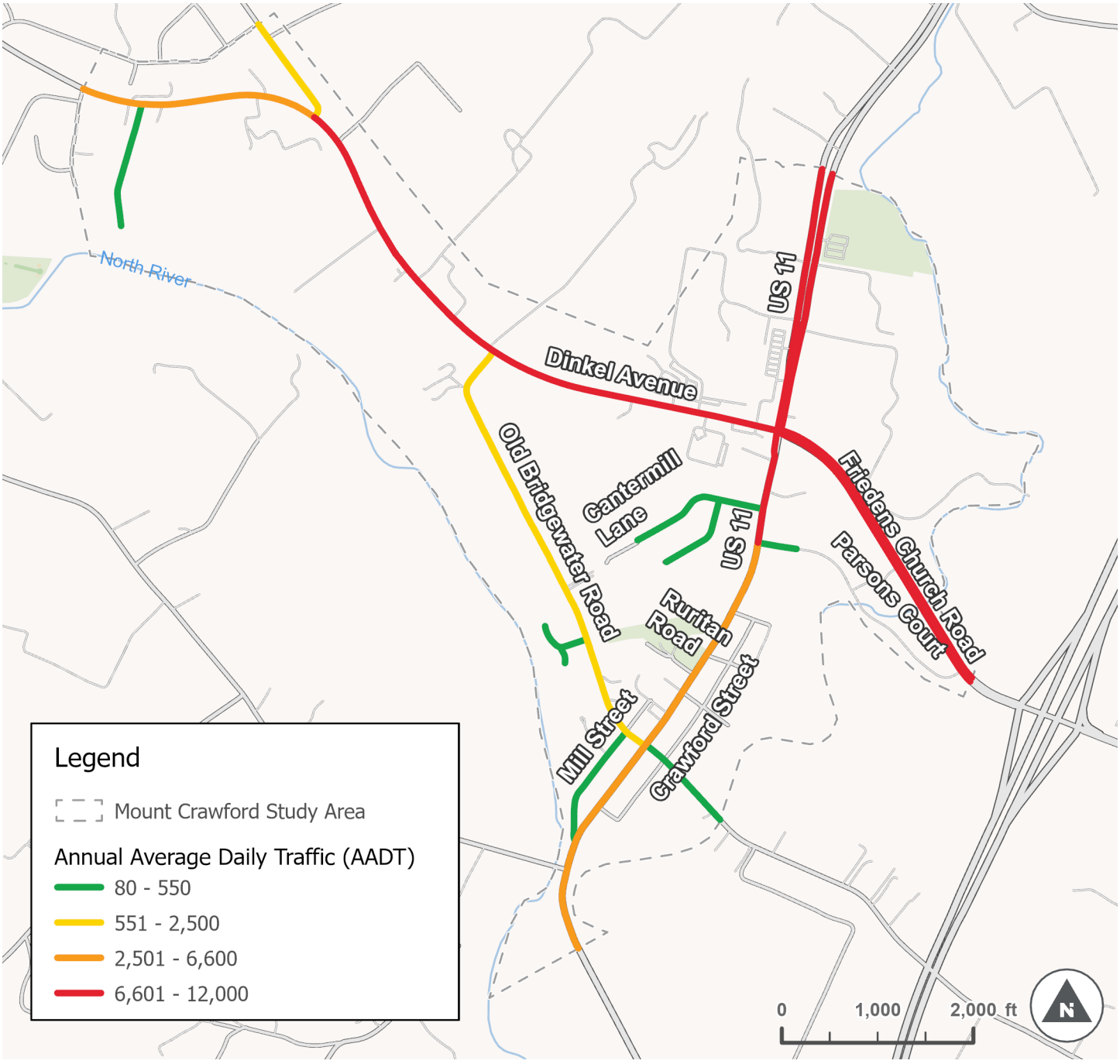
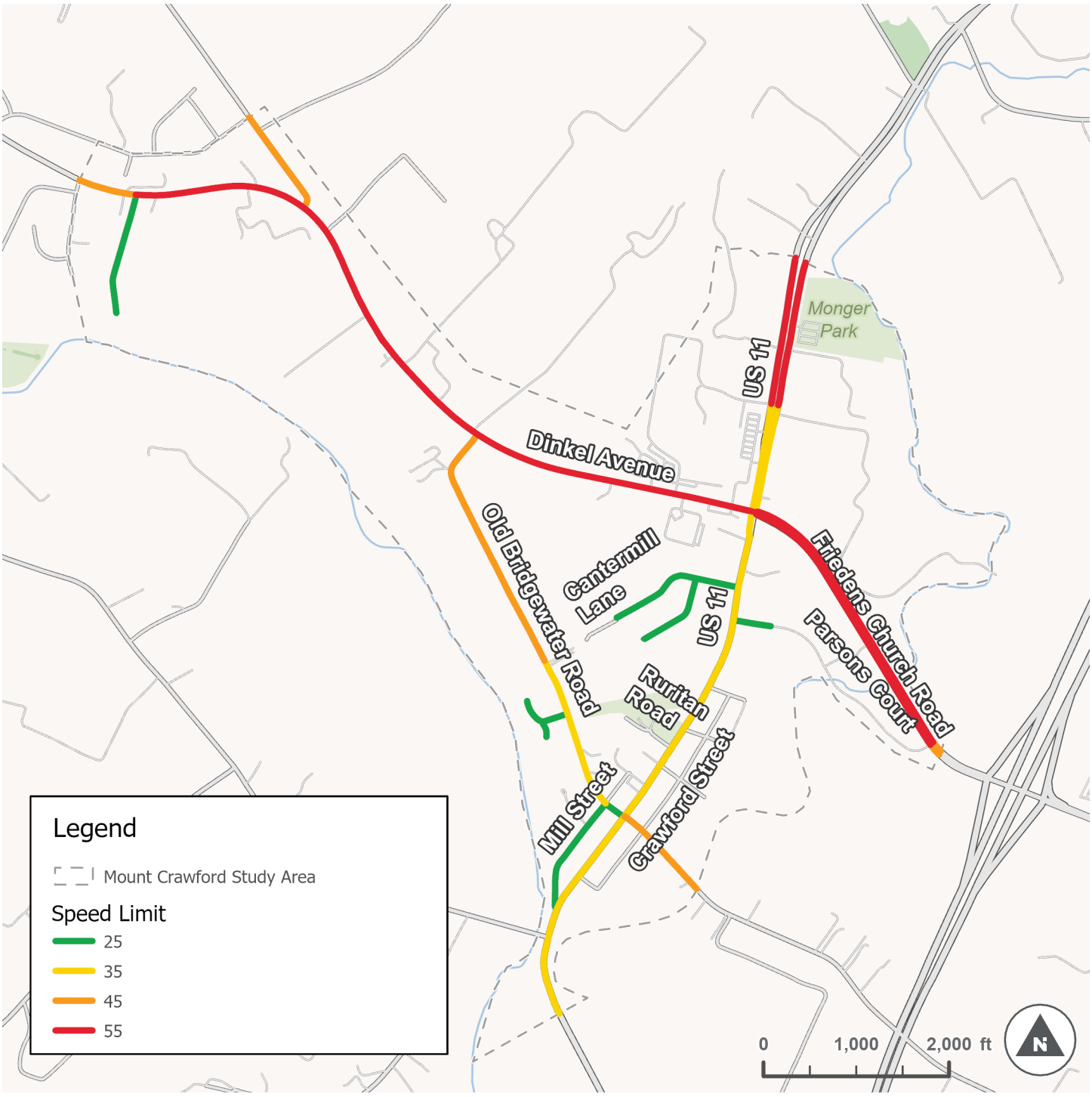


Figure 9: Posted Speed Limits

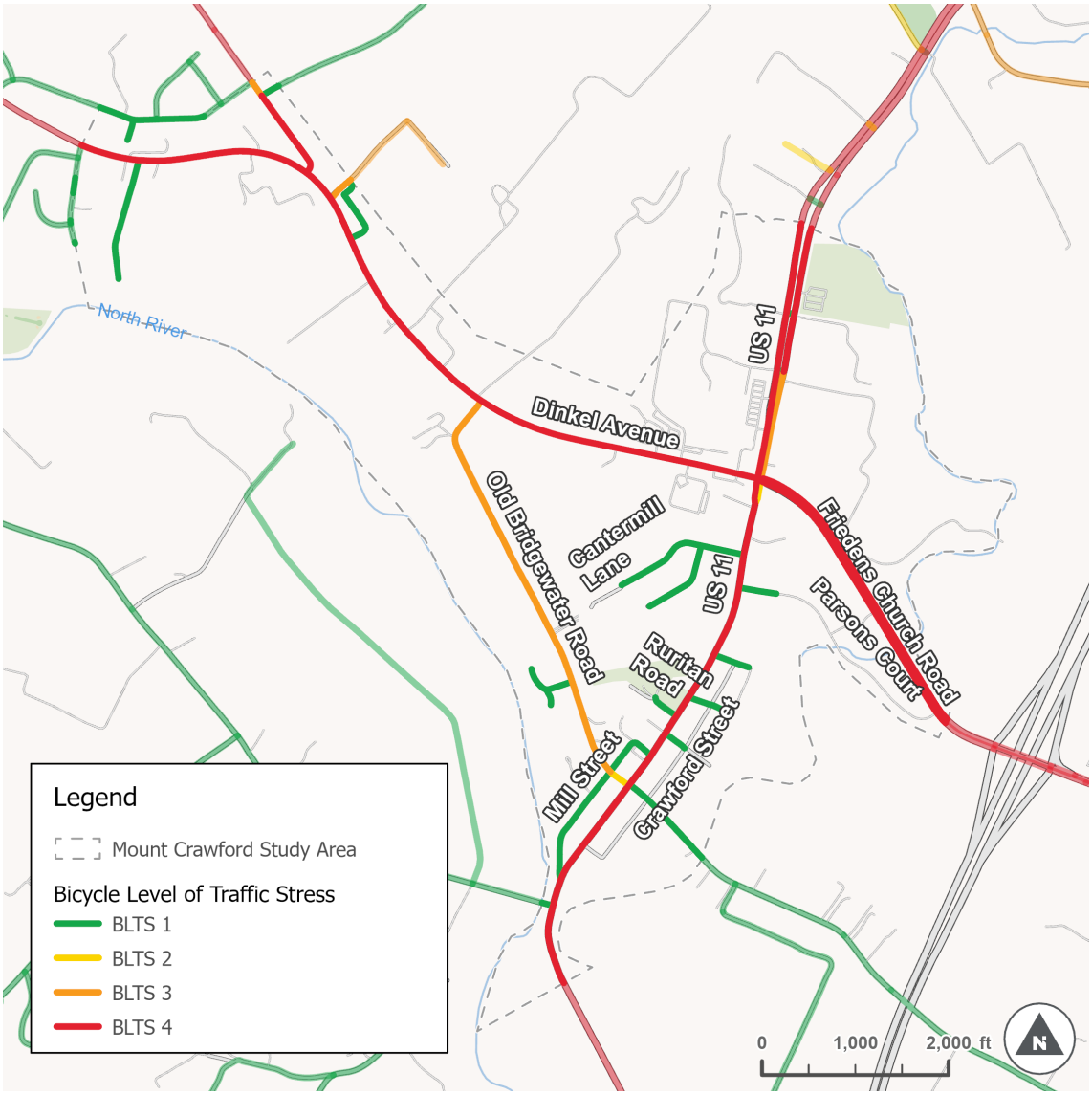


Bicycle Levels of Traffic Stress (BLTS)

A bicycle level of traffic stress (BLTS) analysis rates linkages in the cycling transportation network (i.e., roads and multi-use trails) by their approachability for cyclists. Cycling comfort level and risk tolerance vary by individual. Still, a commonly used framework divides the public into four types based on interest in cycling: strong and fearless, enthused and confident, interested but concerned, and no-way / no-how. In this context, a BLTS analysis ranks street segments on a scale of one to four, with four representing a very high-stress environment, suitable only for strong and fearless cyclists, and one representing a low-stress environment, suitable for interested but concerned cyclists of all ages and abilities. Interested but concerned individuals, willing to cycle in places with limited to no interaction with automobiles, make up most of the population; accordingly, developing a cycling network infrastructure that attracts these potential cyclists is critical.

Variables used in calculating BLTS include the presence of cycling infrastructure, the number of travel lanes, posted speed limits, annual average daily traffic (AADT), and historical crash data, as described in **Appendix B**. **Figure 10** shows BLTS scores for street segments in the study area and highlights the gaps in the transportation network that pose barriers to cycling in Mount Crawford. US 11, Friedens Church Road, and Dinkel Avenue are categorized as having the highest level of traffic stress, and most of Old Bridgewater Road is BLTS "3." While there are BLTS "1" streets in the study area, the network of streets most cyclists feel comfortable riding along is broken up by the BLTS "4" segments.

Figure 10: Mount Crawford Bicycle Level of Traffic Stress (BLTS)



Pedestrian and Bicycle Travel Patterns

Understanding existing travel patterns helps identify locations where infrastructure enhancements would improve the experience and comfort of pedestrian and bicyclist journeys in the study area. Data generated by StreetLight Data was used better to understand local travel patterns for pedestrians and bicyclists. StreetLight Data analyzes travel flows from electronic devices to compile indices illustrating cycling and pedestrian activities, resulting in a granular picture of active transportation trips in the study area. Both bicycle and pedestrian traffic indices for trips occurring within Mount Crawford and the surrounding area were analyzed for a typical day in the summer of 2021 to determine areas of activity.

Figure 11 represents the average volume of pedestrian trips along roadways in the study area. Some of the trips are concentrated near existing pedestrian infrastructure, and this set of data helps to illustrate that providing residents with adequate activity transportation facilities can facilitate increased multimodal traffic.

Specifically, trips are concentrated:

- Near Cantermill Lane, a residential cul-de-sac
- Along US 11, the Town's main street with some existing pedestrian infrastructure
- On Old Bridgewater Road between US 11 and Angler Landing
- **Figure 12** represents the average volume of bicycle trips along roadways in the study area, and trips are concentrated:
- On the outskirts of the Town of Mount Crawford, along the roadways that provide access outside of the study area towards the Town of Bridgewater and the City of Harrisonburg
- Within the Town of Mount Crawford, bicycle trips are fewer and concentrated on Old Bridgewater Road, Mill Street, and US 11 between Mill Street and Airport Road.

Figure 11: StreetLight Data Average Pedestrian Trip Volume

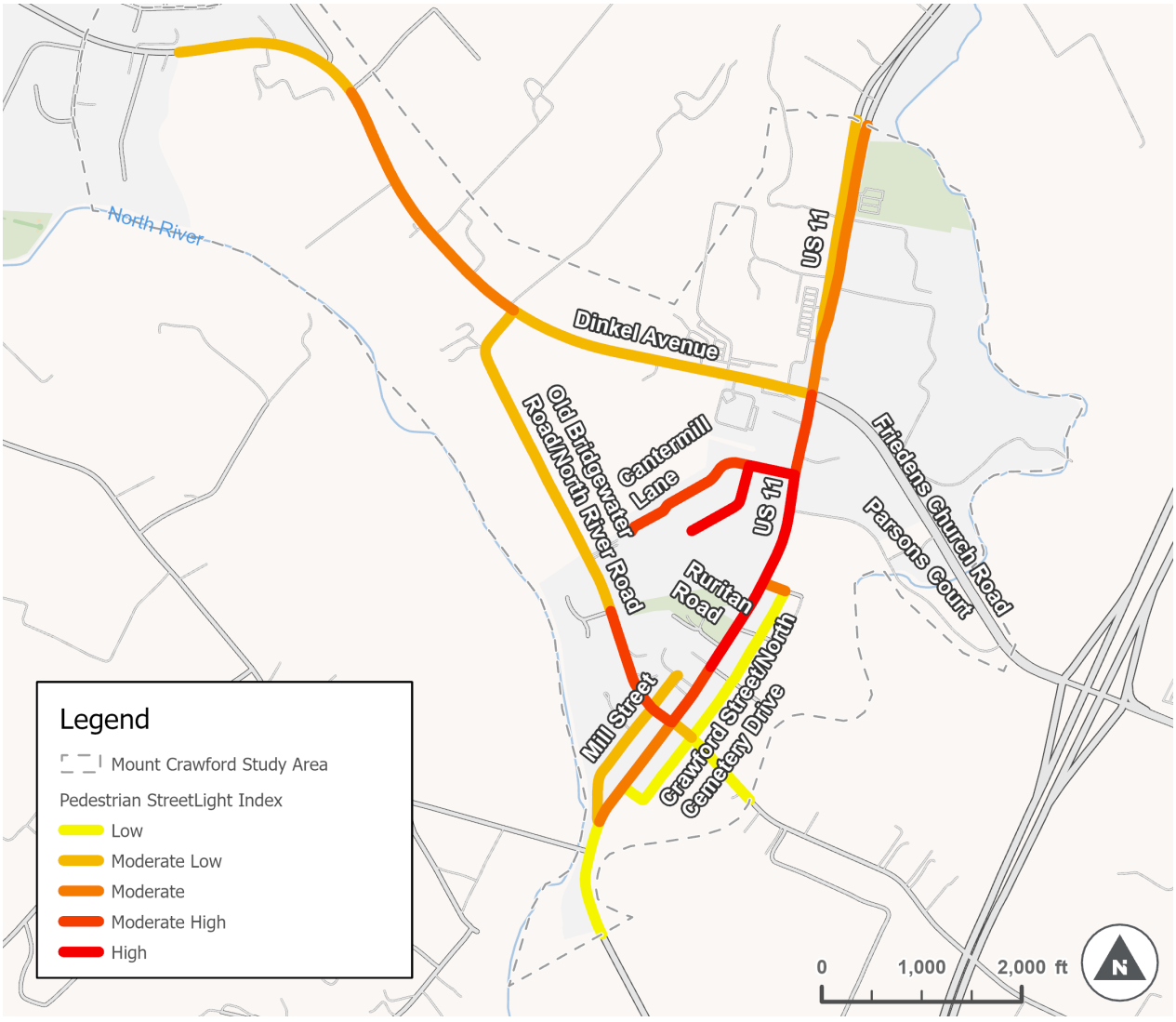
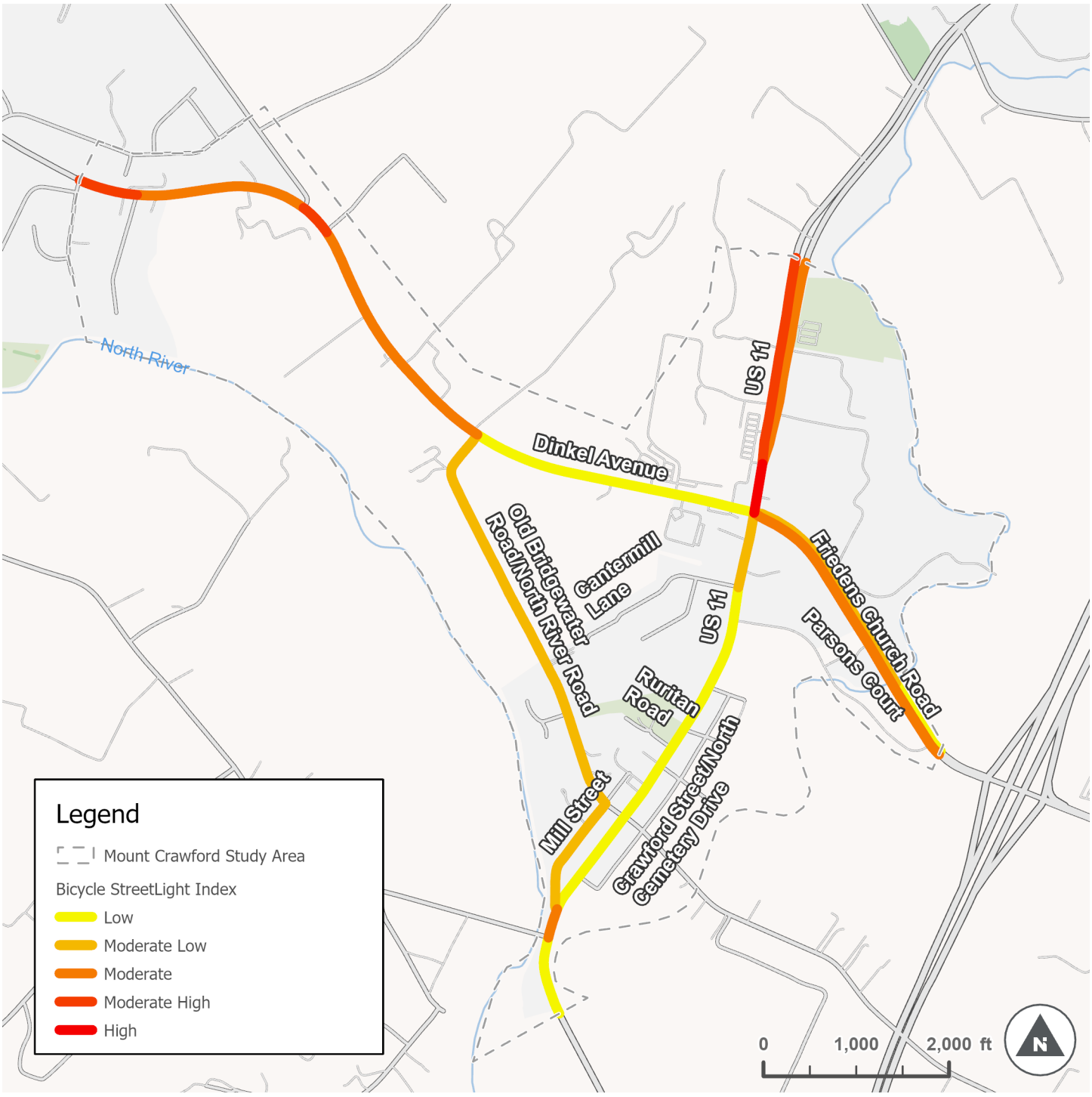


Figure 12: StreetLight Data Average Bicycle Trip Volume

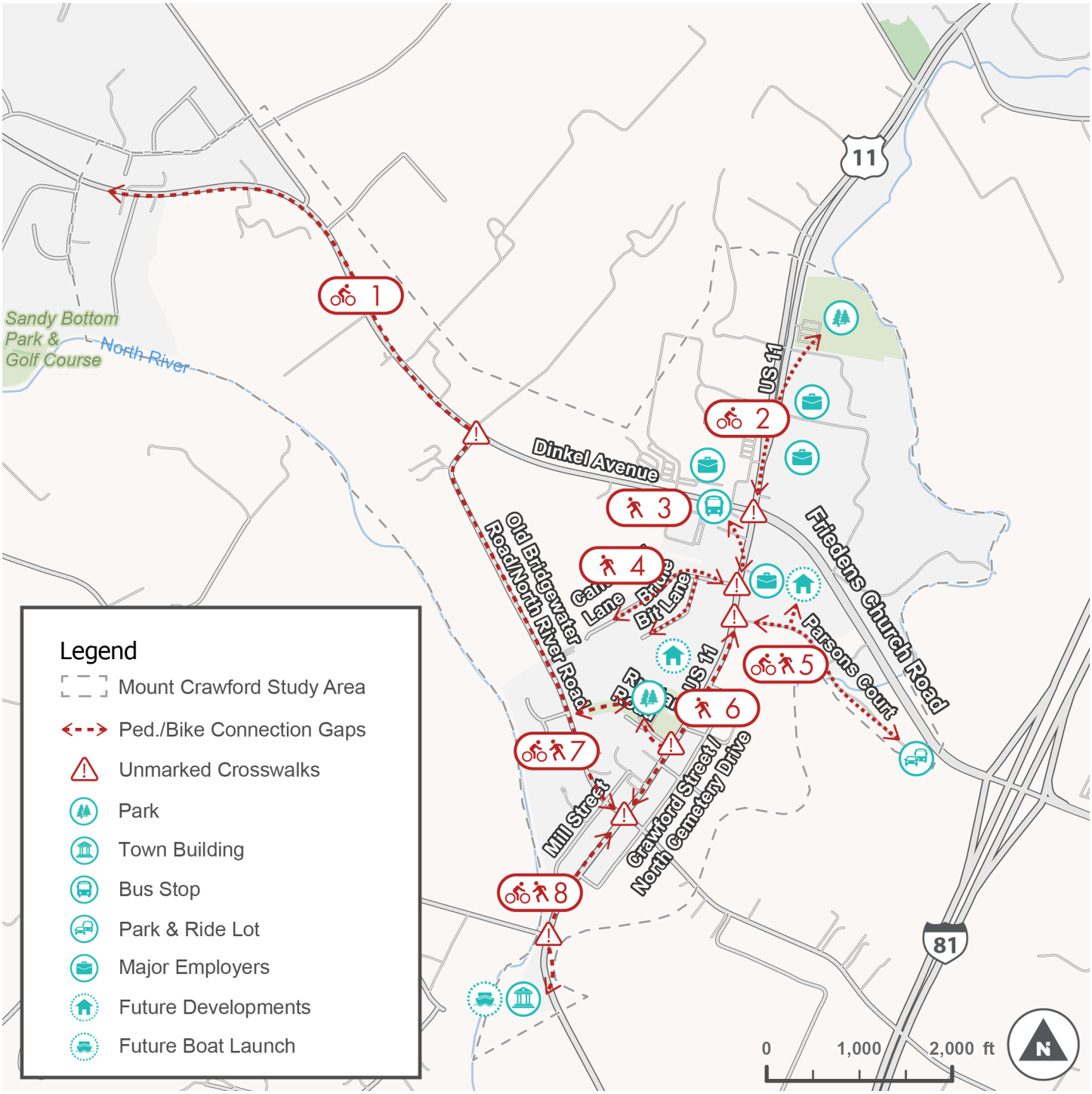


CONNECTIVITY GAPS

Existing infrastructure and points of interest—including transit infrastructure, green spaces, major employers, and future developments—were a starting point for identifying connectivity gaps. Considering those and findings from the Existing Conditions and Needs Assessment sections, **Figure 13** depicts the major connectivity gaps in the study area informing the project identification. These gaps are:

1. Bicycle connection to the Town of Bridgewater
    - Dinkel Avenue and Old Bridgewater Road are identified as VTrans Bicycle Access Mid-term Needs, with BLTS scores of "3" and "4" and moderate to high bicycle trip volumes.
2. Bicycle connection to Monger Park and major employers on US 11
    - US 11 north of the intersection with Dinkel Avenue/Friedens Church Road is identified as a VTrans Bicycle Access Mid-term Need, presents BLTS scores of "3" and "4," and carries a high bicycle trip volume.
3. Pedestrian connection to the bus stop on Dinkel Avenue
    - The bus stop is disconnected from the existing segments of sidewalk and areas with high pedestrian trip volumes.
4. Pedestrian facilities in residential development
    - These residential streets concentrate the highest Streetlight Data average pedestrian trip volume in the study area.
5. Pedestrian connection to future residential and commercial development and bicycle connection to the park-and-ride lot
    - Despite the current low traffic volume, Parsons Court is set to connect to Friedens Church Road with the implementation of the new development and can be used as an alternative bicycle route to Friedens Church Road.
6. Pedestrian facilities on US 11 (Main Street), Ruritan Park, and Crawford Street
    - Existing sidewalks lack maintenance, have obstructions, and are limited to one side of the street without marked crossings; most of the population and pedestrian trip volumes are concentrated along this central stretch of US 11; Main Street, Ruritan Park, and Crawford Street were cited as the most popular walking routes on the public survey and open house conducted in May 2020 as part of the Comprehensive Plan development.
7. Pedestrian and bicycle connections on Old Bridgewater Road within the Town limits
    - This stretch of Old Bridgewater Road shows a moderate-high pedestrian trip volume and is identified as a VTrans Bicycle Access Mid-term Need.
8. Bicycle and pedestrian connection to the Town Hall building and future boat launch
    - Also identified as a VTrans Bicycle Access Mid-term Need, this stretch of the US 11 lacks sidewalks and marked crossings; it is the only roadway between the Town's main residential area and the Town Hall building; it was indicated as the preferred location for future improvements on the public survey and open house conducted in May 2020 as part of the Comprehensive Plan development.

Figure 13: Connectivity Gaps and Points of Interest



PROJECT IDENTIFICATION

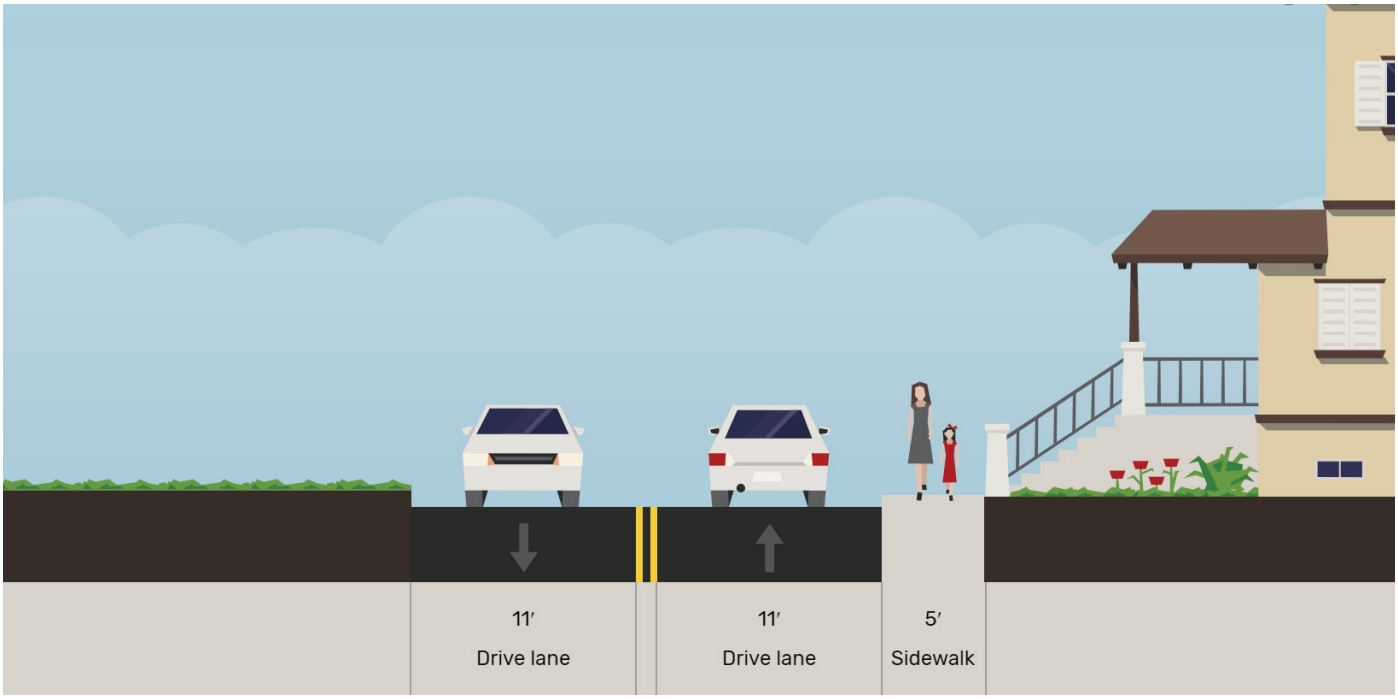
Bicycle and pedestrian facility projects were identified based on the connectivity gaps identified in the **Connectivity Gaps** section. This section describes each proposed project. The projects outlined in this section help develop an interconnected network of bicycle and pedestrian paths within the Town. Today there is a limited number of trips that can be easily accomplished on foot or by bike. Moreover, the existing roadway network makes it challenging to walk or cycle from Mount Crawford to nearby destinations beyond the Town boundary.

The study team identified 11 different projects (Projects A to I). Many of which are further subdivided into segments based on changing existing conditions and available right-of-way through the corridor. In the case of one project (Project F, Dinkel Avenue from Old Bridgewater Road to Hickory Lane), the study team has identified three alternatives to consider. Additionally, the study team discussed future potential projects with Town Manager and Central Shenandoah Planning District Commission (CSPDC) staff mapped in **Appendix C**.

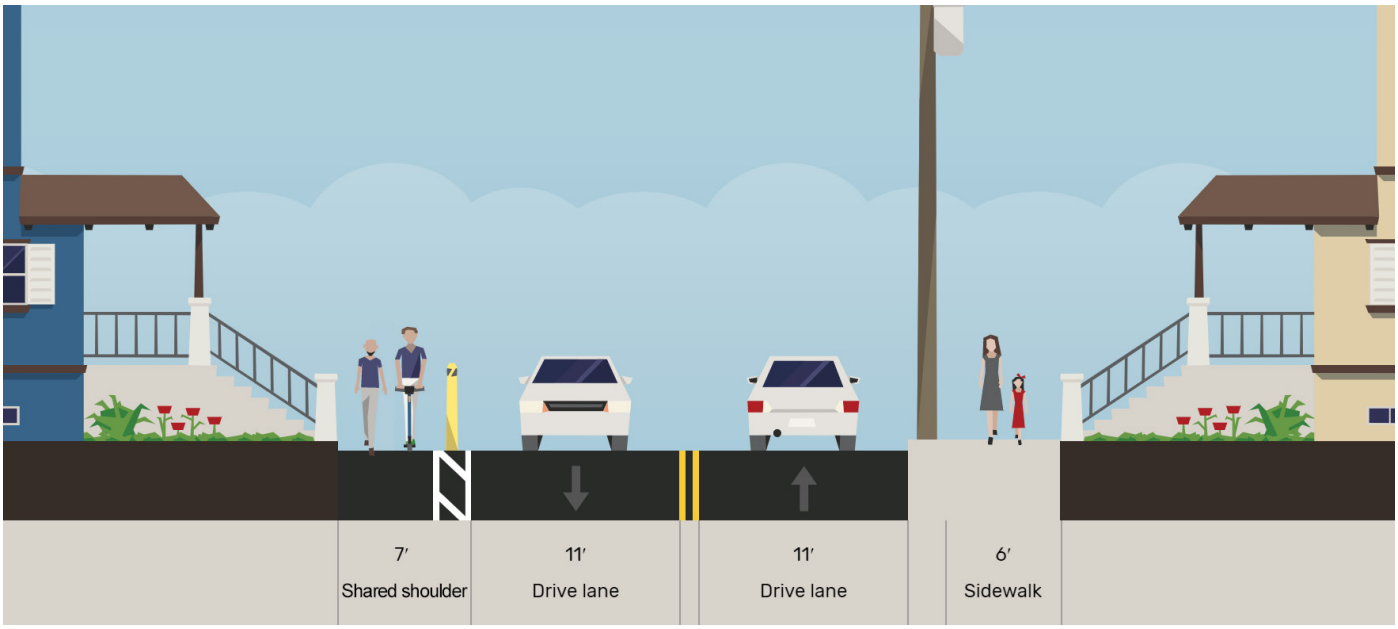
PROJECT A: US 11 CORRIDOR

Purpose: US 11 functions as Mount Crawford's Main Street. The proposed improvements (**Figure 14**) would create a continuous pedestrian facility along the roadway from the Town's southern boundary to Monger Park, a public park north of the Town limits.

Segments	Extents	Description	Additional Right-of-Way Needs
A1	Study area boundary to Mill Street (0.18 miles)	Construct a five-foot sidewalk along the alignment. South of Airport Road the sidewalk should be run along the southbound lane to provide a direct link to destinations like the Town Hall. North of Airport Road, the sidewalk would have to run adjacent to the northbound lane due to the terrain. A new crosswalk is needed at the intersection of US 11 and Airport Road.	Five feet for sidewalk, curb, and gutter. Roadway is wide enough to accommodate a sidewalk if lanes are reconfigured.



Segments	Extents	Description	Additional Right-of-Way Needs
A2	Mill Street to Dinkel Avenue (0.73 miles)	Construct a continuous six-foot sidewalk along the road. Between Mill Street and Parsons Court, space constraints would limit the sidewalk to the northbound side of the road only. The southbound side would feature a seven-foot wide paved shoulder. From Parsons Court to Dinkel Avenue, sidewalks would be on both sides of the road.	Six feet of sidewalk ROW required between Parsons Court and Dinkel Avenue. South of Parsons, recommendations fit within existing ROW.



A3	Dinkel Avenue to Monger Park (0.51 miles)	Construct a 10-foot wide shared-use path along the northbound side of the roadway. Add crosswalks where the path intersects the roadway.	10-feet ROW for pathway

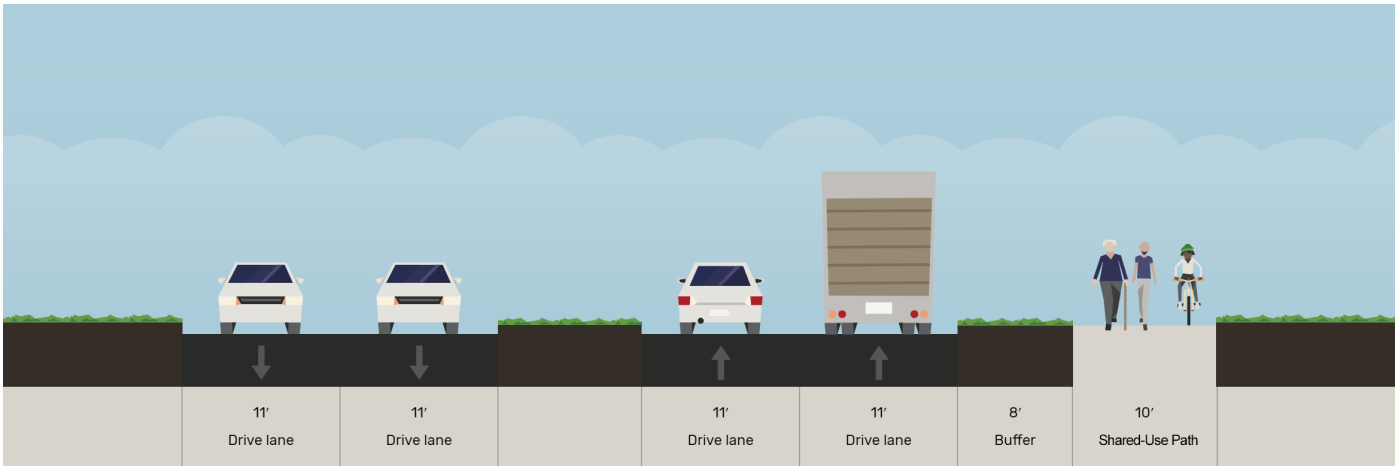


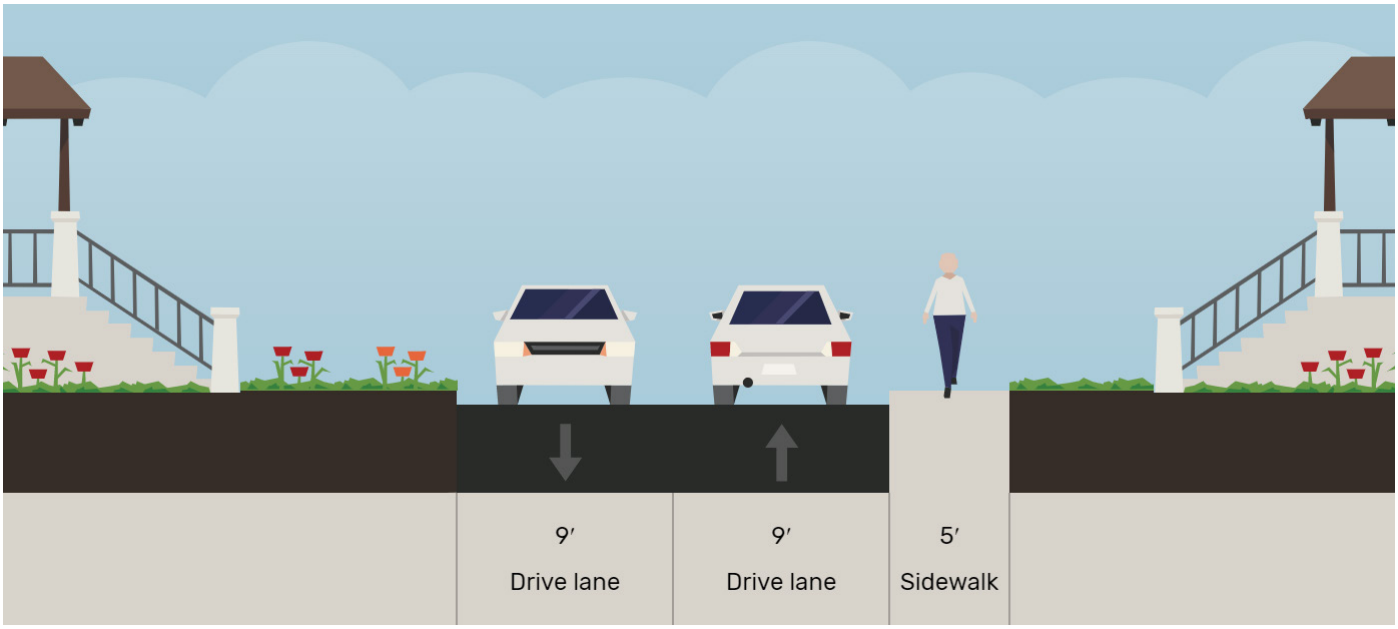
Figure 14: Project A – US 11 Improvements

PROJECT B: OLD BRIDGEWATER ROAD PEDESTRIAN AND CYCLIST IMPROVEMENTS

Purpose: Old Bridgewater Road provides the most direct path between the center of Mount Crawford and the adjacent Town of Bridgewater. Along the road a series of improvements (**Figure 15**) would improve pedestrian and cyclist access within the constraints of the narrow available ROW.

Segments	Extents	Description	Additional Right-of-Way Needs
B1	US 11 to 125 Old Bridgewater Road (0.12 miles)	The road is constrained by buildings on both sides and cannot accommodate a new sidewalk or bicycle lane. Designate a short segment of Bridgewater as a shared-use street, with signage and stripping to make drivers aware that they are sharing space with other users.	Two-foot widening of the roadway

Segments	Extents	Description	Additional Right-of-Way Needs
B2	125 Old Bridgewater Road to Town Line (0.24 miles)	Construct a five-foot sidewalk on the westbound side of the road.	Five feet of ROW for sidewalk



B3	Town Line to Dinkel Avenue (0.53 miles)	Construct paved shoulders to accommodate bicyclists and pedestrians in the rural segment of the roadway.	14 feet of ROW is required as the construction of the shoulder would trigger minimum lane width adjustments

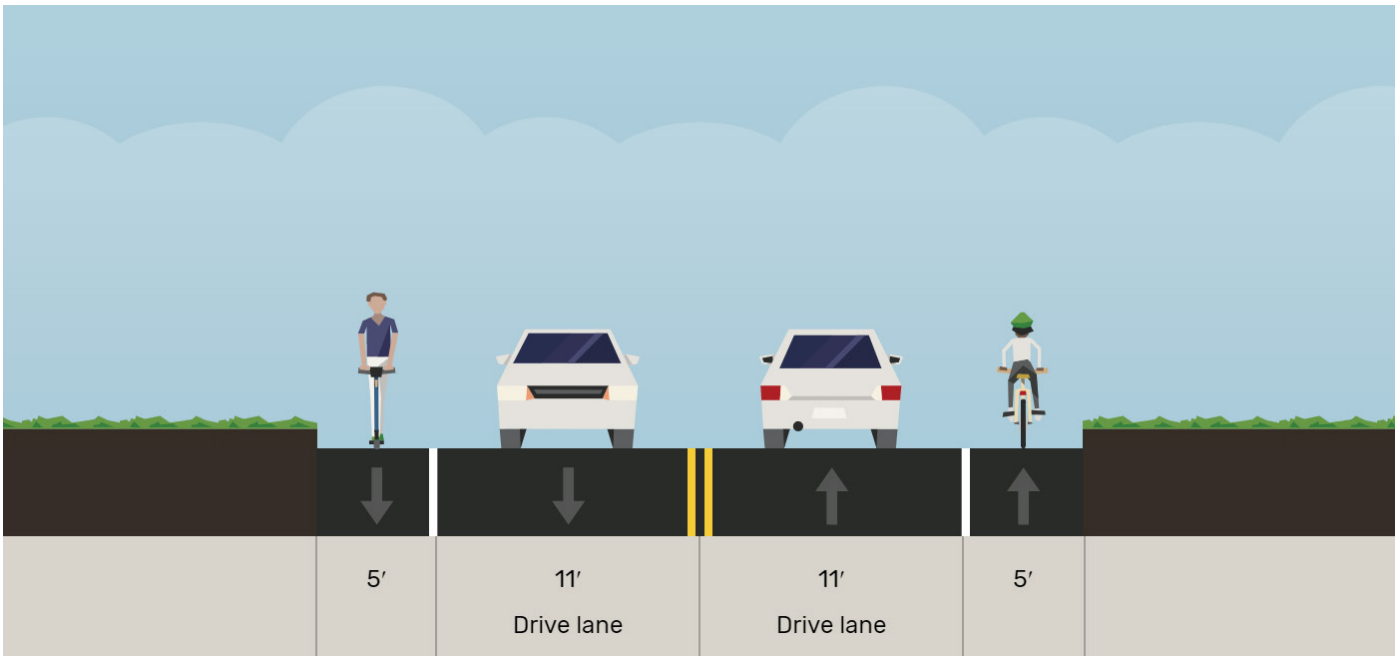


Figure 15: Project B: Old Bridgewater Road Improvements

PROJECT C: OLD BRIDGEWATER ROAD PEDESTRIAN AND CYCLIST IMPROVEMENTS

Purpose: Project would link Old Bridgewater Road to the Mount Crawford Community Park. Improvements **(Figure 16)** could tie into future planned development on adjacent properties.

Segments	Extents	Description	Additional Right-of-Way Needs
C1	US 11 to end of road (0.10 miles)	Designate the roadway as a shared-use road with signage and restriping. This short roadway segment would accommodate pedestrians and cyclists	None
C2	Ruritan Road to Old Bridgewater Road (0.12 miles)	Construct a path connecting the end of Ruritan Road to Old Bridgewater Road. The path would link homes on Old Bridgewater directly to the park.	New 10-foot ROW

Figure 16: Project C – Ruritan Road Connector

PROJECT D: CANTERMILL LANE AND BRIDLE BIT LANE SIDEWALKS

Purpose: These two cul-de-sac streets serve a small residential subdivision. New sidewalks **(Figure 17)** on the roads would provide residents with dedicated pedestrian facilities that would link to improvements on US 11.

Segments	Extents	Description	Additional Right-of-Way Needs
D1	Cantermill Lane and Bridle Bit Lane	Construct 5-foot sidewalks on both sides of the street	10 feet of ROW (five feet on either side)

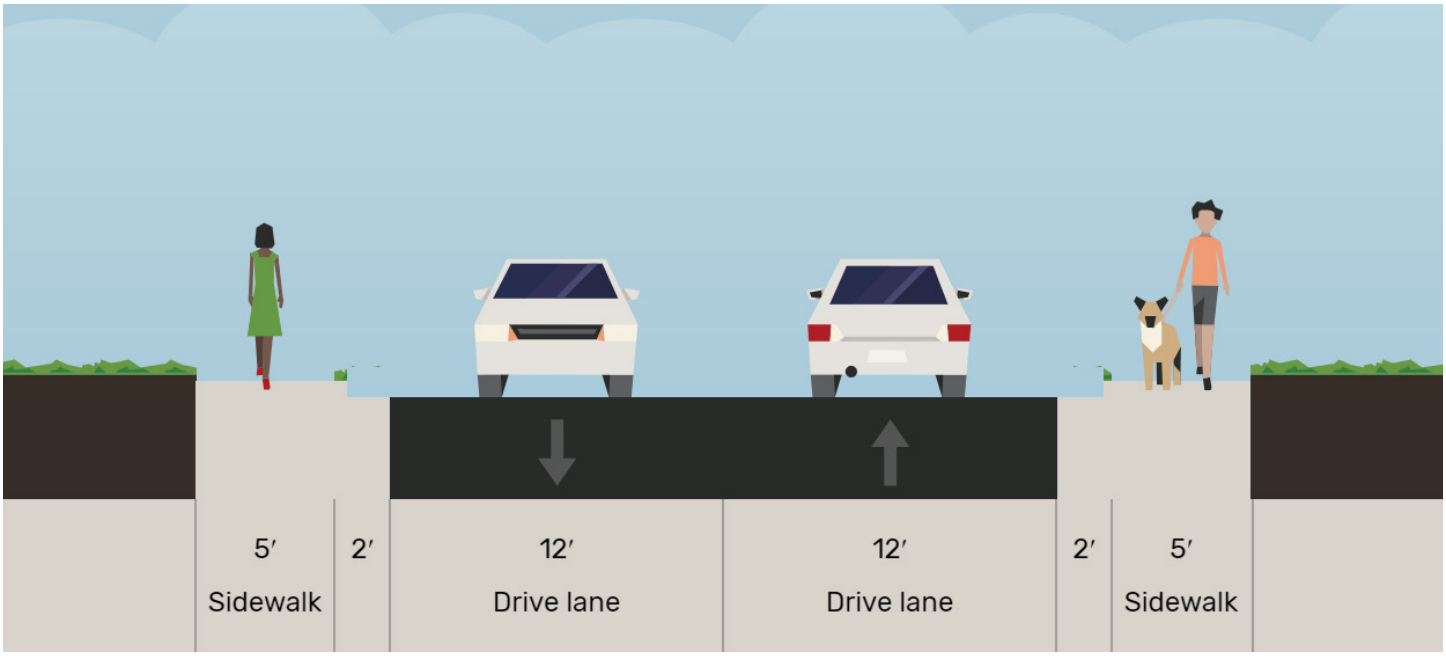
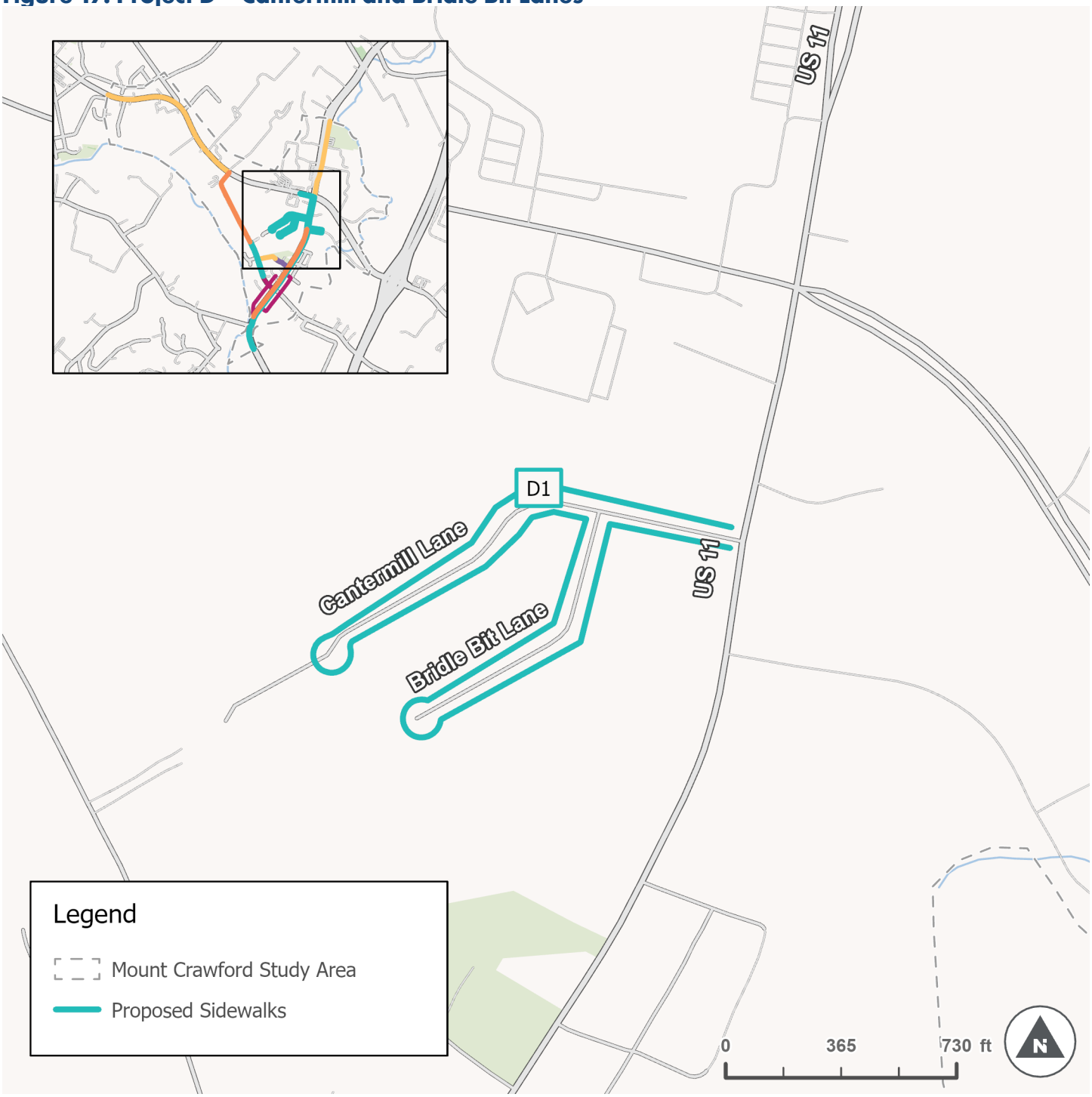


Figure 17: Project D – Cantermill and Bridle Bit Lanes



PROJECT E: PARSONS COURT SIDEWALK

Purpose: A new residential development is planned to link to Parsons Court. The project would construct a short segment of the sidewalk to link the sub-division to US 11 **(Figure 18)**.

Segments	Extents	Description	Additional Right-of-Way Needs
E1	US 11 to border of new sub-division (0.08 miles)	Construct 5-foot sidewalks on both sides of the street	10 feet of ROW (five feet on either side)

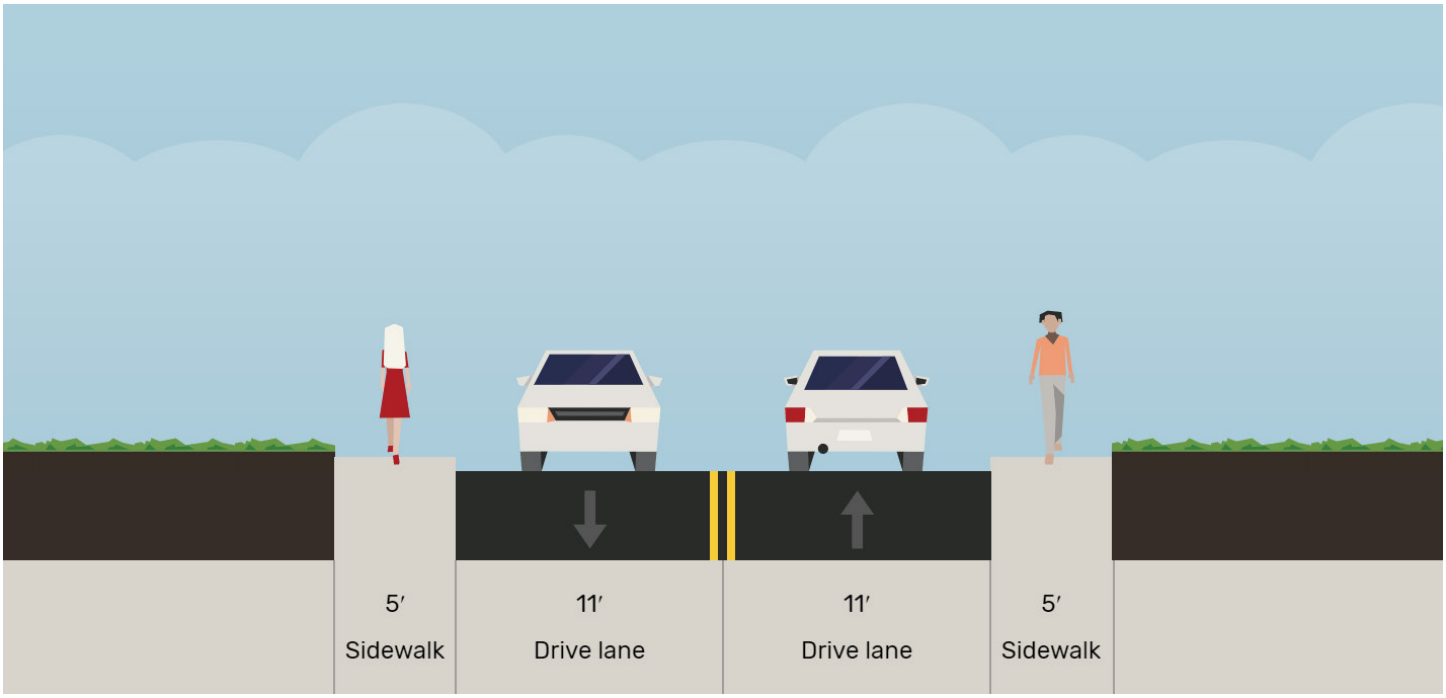


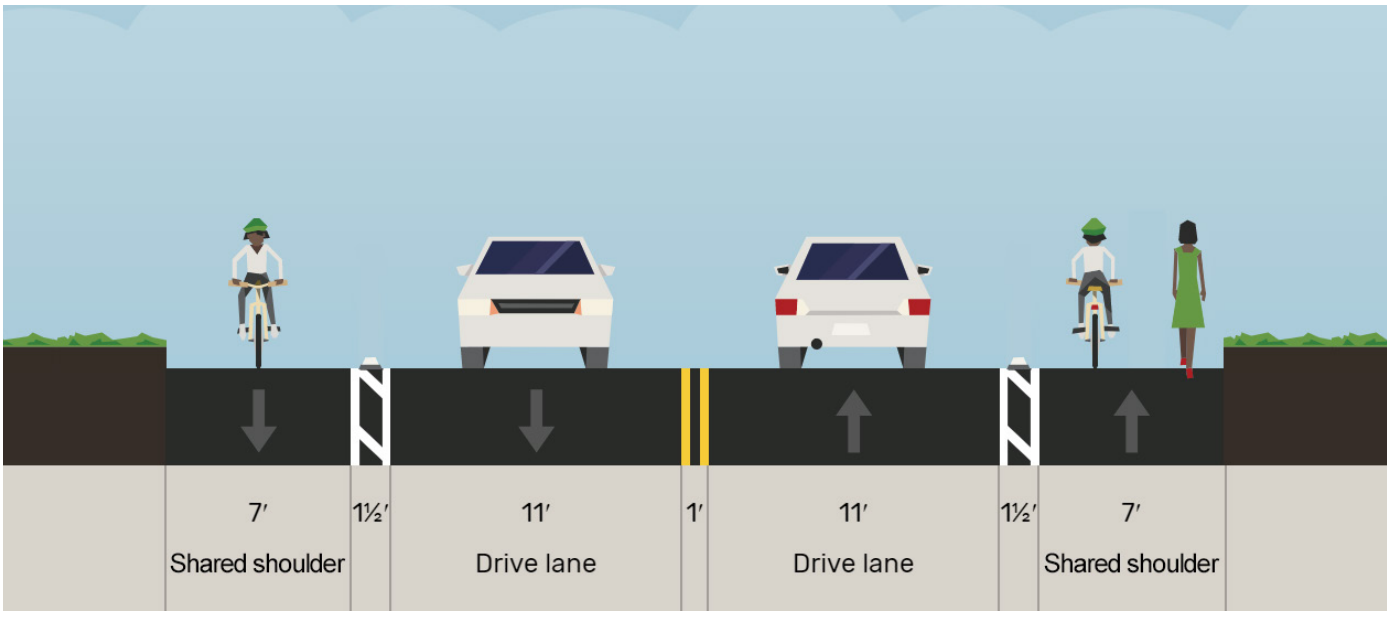
Figure 18: Project E – Parsons Court

PROJECT F: DINKEL AVENUE

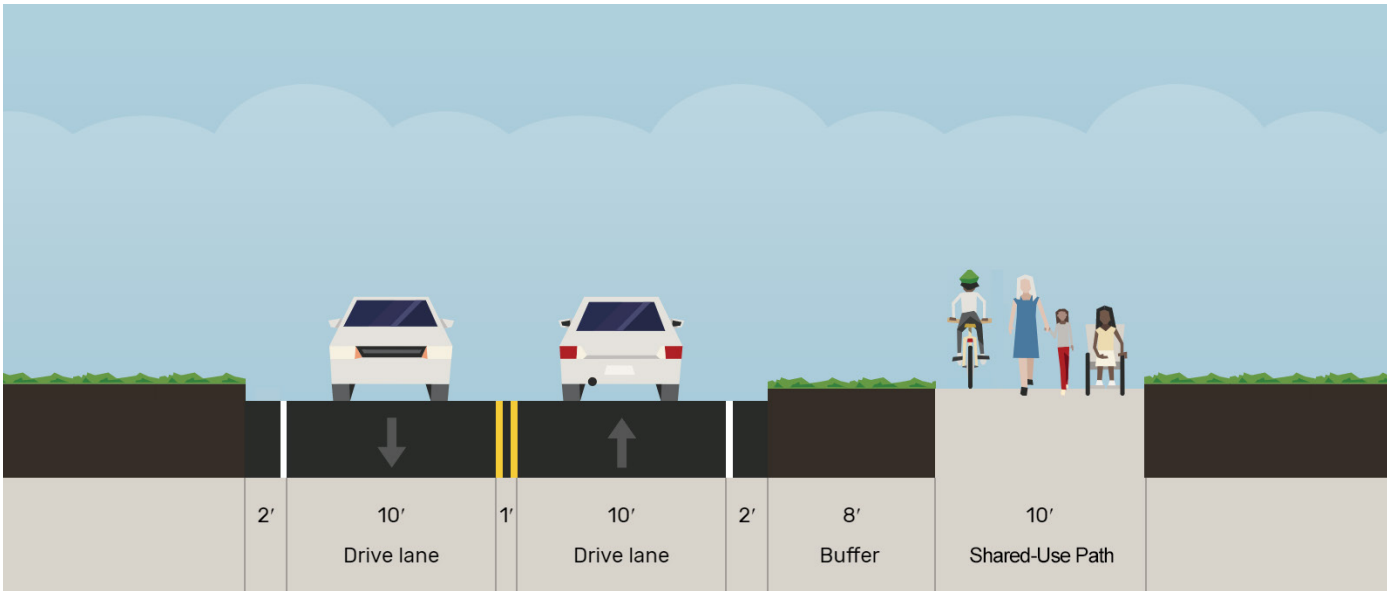
Purpose: Dinkel Avenue is an important arterial connecting Bridgewater to Mount Crawford. This project **(Figure 19: Project F – Dinkel Avenue)** would improve multimodal transportation on the corridor.

Segments	Extents	Description	Additional Right-of-Way Needs
F1	US 11 to Dinkel Ave / US 11 Bus Stop	Construct a short segment of a five-foot wide sidewalk on the eastbound side of Dinkel Avenue to connect the bus stop with the intersection of Dinkel Avenue and US 11.	Five-feet ROW for the sidewalk.
F2	Old Bridgewater Road to Hickory Lane	The study team identified three alternatives for better accommodating cyclists and pedestrians on Dinkel: ▪ Option A: Widen and restripe the road to create buffered seven-foot shoulders along Dinkel Avenue. ▪ Option B: Construct a multi-use trail parallel to the road for cyclists and pedestrians. ▪ Option C: Construct five-foot-wide bike lanes with a two-foot buffer from travel lanes.	▪ Option A: Seven feet ▪ Option B: 10 feet ▪ Option C: Four feet

Option A



Option B



Option C

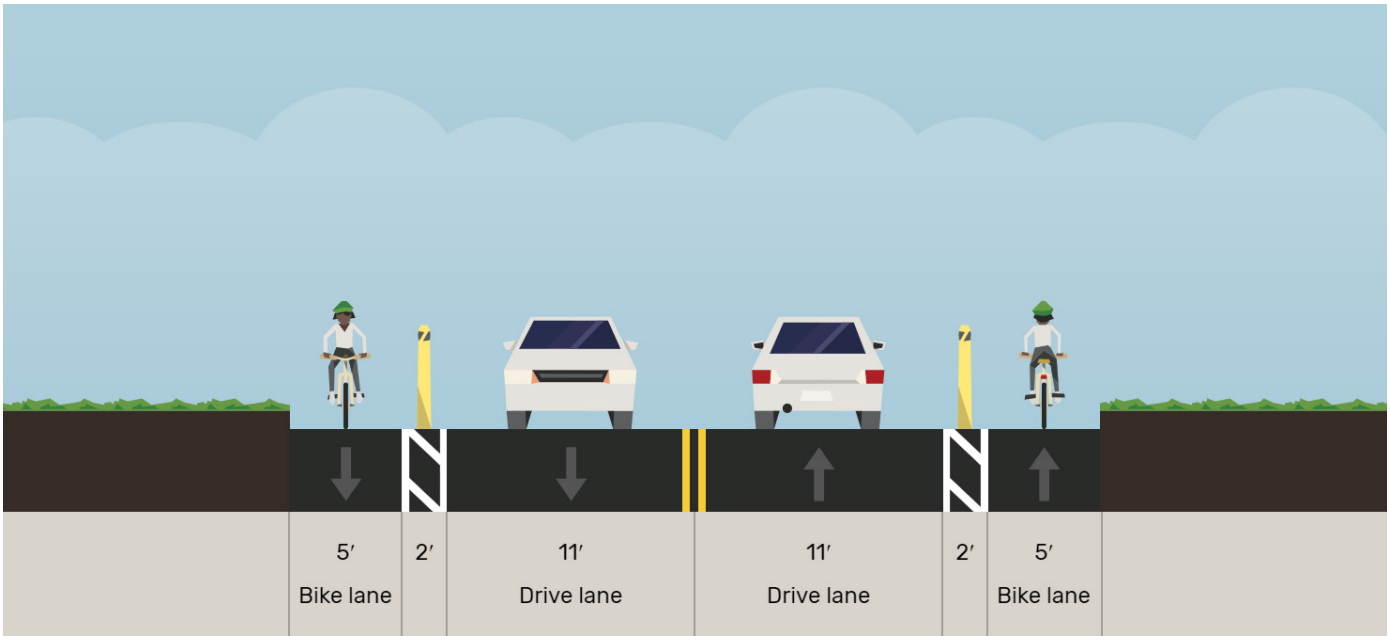


Figure 19: Project F – Dinkel Avenue

PROJECT G: FRIEDENS CHURCH ROAD

Purpose: Friedens Church Road is a continuation of Dinkel Avenue east of US 11. The study team did not identify any infrastructure needs along this roadway segment.

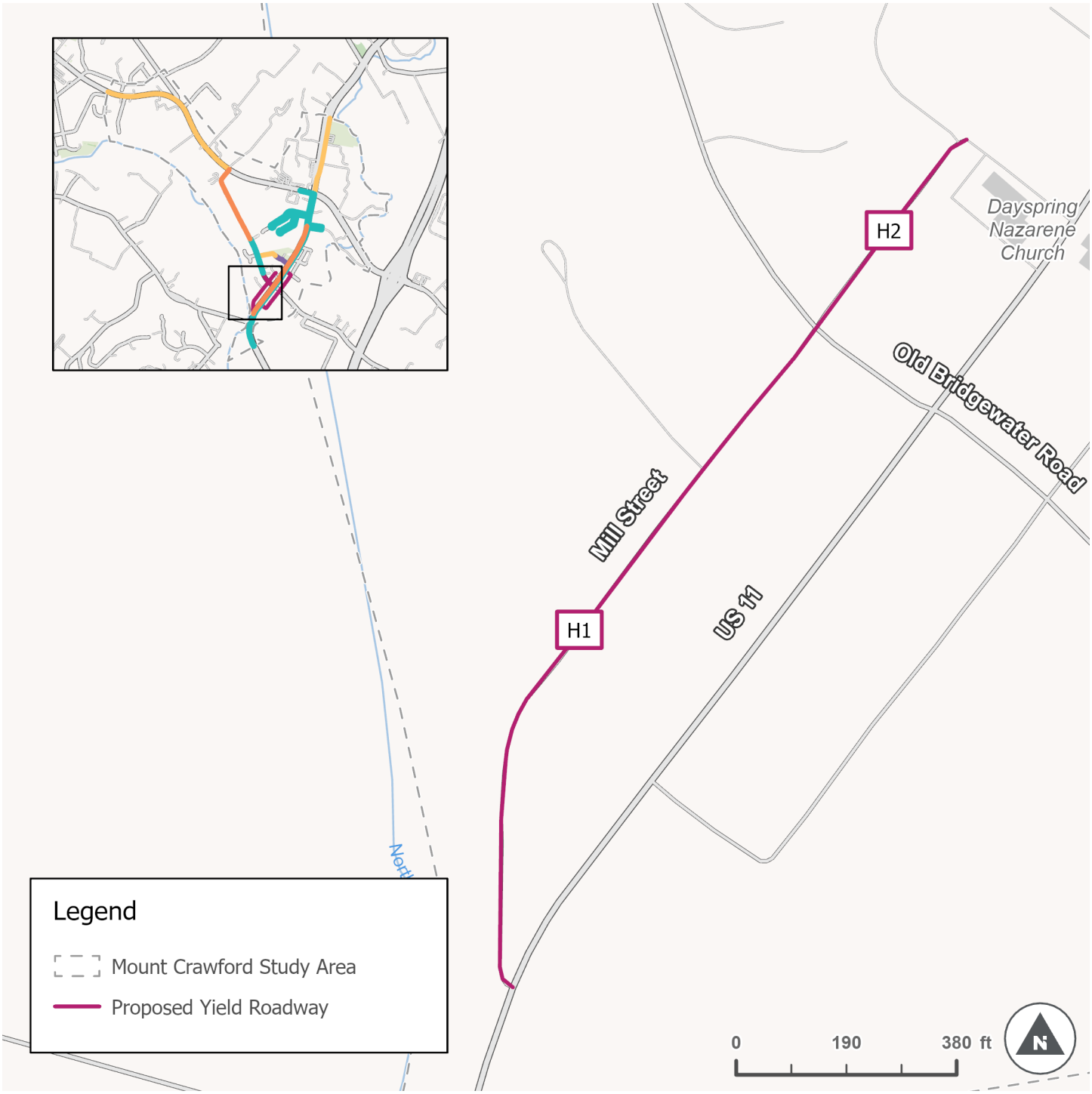
Segments	Extents	Description	Additional Right-of-Way Needs
G1	US 11 to Park and Ride	None	None

PROJECT H: MILL STREET RENOVATION

Purpose: Mill Street serves as an alleyway for homes along US 11. The roadway already serves as an informal pedestrian and bicycling route parallel to US 11. The project proposes repaving the road and signing it as a shared-use yield roadway **(Figure 20)**.

Segments	Extents	Description	Additional Right-of-Way Needs
H1	US 11 to Old Bridgewater Lane	Repave roadway and add markings and signage to indicate Mill Street is a shared-use roadway where cars yield to cyclists and pedestrians.	None
H2	Old Bridgewater to Dayspring Nazarene Church	Pave roadway. Add markings and signage to indicate Mill Street is a shared-use roadway where care yield to cyclists and pedestrians	None

Figure 20: Project H – Mill Street



PROJECT I: CRAWFORD STREET RENOVATION

Purpose: Crawford Street serves as an alleyway for homes along the east side US 11. The roadway already serves as an informal pedestrian and bicycling route parallel to US 11. The project proposes repaving the road and signing it as a yield roadway **(Figure 21)**.

Segments	Extents	Description	Additional Right-of-Way Needs
I1	Entire extent of Crawford Street	Repave roadway and add markings and signage to indicate Crawford Street is a shared-use roadway where cars yield to cyclists and pedestrians.	None

Figure 21: Project I – Crawford Street

PROJECT PRIORITIZATION AND COST ESTIMATION

This section presents both the prioritization and cost of all proposed projects in the study area. The study team developed a prioritization methodology based on demand, safety, and public input. While VTrans Mid-Term needs were consulted in the development of recommendations, they were not used for prioritization due to the lack of sufficient data resolution in such a small study area.

This analysis considers prioritization and costs separately as the study team wanted priorities to reflect needs. Prioritizing based on cost would result in implementing lower priority projects first instead of more critical roadway segments that significantly impact bicycle and pedestrian use.

Prioritization Methodology

The prioritization relies on a scoring system that categorizes assigned projects as "low," "medium," or "high" in the categories of demand, safety, and public input. Behind the demand rating in each category are specific metrics pulled from the existing conditions and needs assessment analyses.

Demand

The demand score was based on five measures listed in **Table 1**. These measures relate to travel demand based on existing travel volumes or area characteristics. Projects could received between -1 and 1 point per measure, which were and the composite score is an a averaged of each five measures into a composite score classified as "low," "medium," or "high" and assigned a final score of -1, 0, or 1, respectively.

Table 1: Demand Scoring Schema

Measure	Values	Points Assigned
Population Density **(Figure 5)**	> 4 people / acre	1
	2 to 4 people / acre	0
	< 2 people / acre	-1
Composite sociodemographic Need Score (**Figure 6**, see **Appendix A** for methodology)	> 15 points	1
	6 to 15 points	0
	< 6 points	-1
Pedestrian Trip Volume Index from StreetLight (**Figure 11**)	> 5 points	1
	2 to 5 points	0
	< 2 points	-1
Bicycle Trip Volume Index from StreetLight (**Figure 12**)	> 53 points	1
	9 to 53 points	0
	< 9 points	-1
Points of Interest (**Figure 13**)	More than one point of interest on corridor	1
	One point of interest on corridor	0
	No point of interest	-1

Safety

The safety score was based on the four measures, listed in **Table 2**. Projects received between -1 and 1 point per measure, which were averaged into a composite score classified as "low," "medium," or "high" and assigned a final score of -1, 0, or 1, respectively.

Table 2: Safety Scoring Schema

Measure	Values	Points Assigned
Traffic Volume - 2019 Annual Average Daily Traffic (AADT) **(Figure 8)**	> 2,500	1
	551 to 2,500	0
	550 or less	-1
Speed Limit **(Figure 9)**	> 35 mph	1
	35 mph	0
	25 mph or less	-1
Bicycle Levels of Traffic Stress **(Figure 10)**	BLTS 3 or 4	1
	BLTS 2	0
	BLTS 1	-1
Pedestrian- or bike-involved crash (2018 – 2021)	At least one crash on the corridor	1
	No crash on corridor	0

Public Input

As part of Mount Crawford's comprehensive plan update, the Town and CSPDC engaged stakeholders through a public open house and survey. Road segments were assigned points based on how frequently they were mentioned in public engagement as key walking routes. Any roadway with more than ten public comments received 1 point, segments with up to ten comments received 0 points, and segments without any public comments received -1 point.

Score Aggregation

The metrics within each prioritization category were averaged and defined as "low," "medium," or "high." Then the scores for each category were summed together, resulting in demand, safety, and public input receiving equal weight. The final aggregate score for projects ranged from negative two to positive three. These scores were again translated to "low," "medium," and "high." Projects with an aggregate score of one or more were labeled as a high priority. Projects with a score between zero and one were labeled as a medium priority. Finally, any project with a negative score was labeled low priority.

Prioritization Results

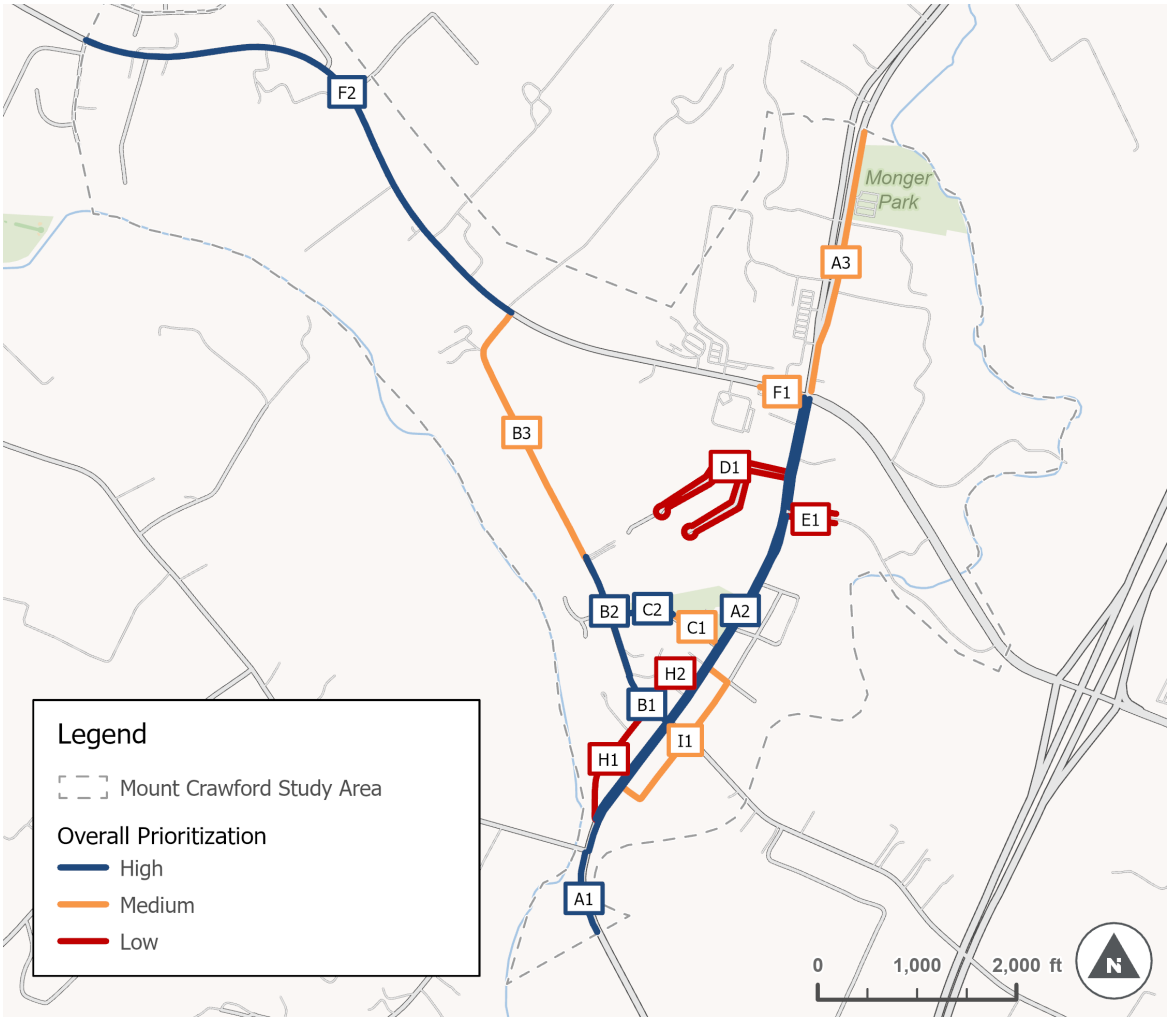
Table 3 lists project scores by category and final prioritization, and **Figure 22** maps the prioritized projects. While the prioritization process identified a few projects as a high priority, the US 11 segment between Mill Street and Dinkel Avenue rose as the highest priority in the study area (Project A2). US 11 serves as Mount Crawford's Main Street, connecting nearly all the major destinations in the Town. Improving this corridor with adequate sidewalks, crossings, and shoulders is critical to building a safe and comfortable pedestrian network. Segments of Old Bridgewater Road (Projects B1 and B2), the Ruritan Road Connector (Project C2), and Dinkel Avenue between Old Bridgewater Road (Project F1) and the Town of Bridgewater also ranked as "high." Projects B1, B2, and C2 would work together to provide pedestrian access to residents living west of US 11 and, along with project F1, help better link the Town to Bridgewater and the Community Park. In addition to the remaining segments of US 11, Old Bridgewater Road, Ruritan Road, and Dinkel Avenue, Crawford Street (Project I) also was categorized as a medium-need segment primarily due to public input. Improvements to Crawford Street would turn this alleyway into an alternate path for pedestrians and cyclists parallel to US 11. The remaining projects ranked as low priorities due to a lower safety-related priority on local roads, except for Friedens Church Road, which ranks low due to lower demand and public input scores..

Table 3: Overall Project Prioritization

Street	Starting Point	Ending Point	Project Number	Demand	Safety	Public Input	Overall Score	Priority
US 11	Study area boundary	Airport Road	A1	0	1	0	1	High
	Airport Road	Mill Street		0	1	0	1	High
	Mill Street	Parsons Court	A2	1	1	1	3	High
	Parsons Court	Dinkel Avenue		0	1	-1	0	High
	Dinkel Avenue	Monger Park	A3	1	0	0	1	Medium
Old Bridgewater Road	US 11	125 Old Bridgewater Road	B1	1	0	0	1	High
	125 Old Bridgewater Road	Town Limit	B2	1	0	0	1	High
	Town Limit	Dinkel Avenue	B3	0	0	0	0	Medium
Ruritan Road	US 11	End of Road	C1	1	-1	0	0	Medium
Shared Path	Ruritan Road	Old Bridgewater Road	C2	1	0	0	1	High
Cantermill Lane	US 11	End of lane	D1	0	-1	0	1	Low
Bridle Bit Lane	Cantermill Lane	End of lane		0	-1	0	-1	Low
Parsons Court	US 11	Friedens Church Road	E1	0	-1	-1	-2	Low

Street	Starting Point	Ending Point	Project Number	Demand	Safety	Public Input	Overall Score	Priority
Dinkel Avenue	US 11	Old Bridgewater Road	F1	-1	1	0	0	**Medium**
	Old Bridgewater Road	Hickory Lane	F2	0	1	0	1	**High**
Friedens Church Road	US 11	Parsons Court	G1	-1	1	-1	-1	**Low**
Mill Street	US 11	Old Bridgewater Road	H1	0	-1	0	-1	**Low**
	Old Bridgewater Road	Dayspring Nazarene Church	H2	0	-1	0	-1	**Low**
Crawford Street	US11	US11	I1	-1	0	1	0	**Medium**

Figure 22: Map of Prioritized Projects



Cost Analysis

Improvement costs were estimated using the VDOT Transportation and Mobility Planning Division Planning Level Cost Estimates workbook. The version utilized by the study team had been updated by the Staunton District to reflect recent sidewalk costs. When constructing roadway or active transportation infrastructure, several factors can impact costs, from the need to acquire land to the local terrain. These planning level cost estimates were based on unit costs derived from previously completed projects. Additional design and engineering would need to be done to refine these costs based on local conditions. To reflect cost unknowns, the study team applied between a 25 and 50 percent contingency onto projects. Moreover, percentage-based adjustment factors were applied to account for right-of-way acquisition and utilities. A full inventory of cost assumptions by project is available in **Appendix D** of this report.

Based on the cost estimation tool, the study team estimates that all improvements would cost between $8.2 and $24 million. These estimates represent the cost of the proposed enhancements themselves and do not incorporate any investments that might be completed in tandem with the improvements. For example, the community may elect to reconstruct a roadway as part of a proposed sidewalk project. The cost of the high-priority investments is estimated to range between $3.5 million and $15.6 million; this high range of costs is due to the high variation in costs among the three alternatives for project F2. **Table 4** presents the full cost estimates by project.

Table 4: Project Cost Estimates

Street	Starting Point	Ending Point	Project Number	Planning-Level Cost Estimation	
				Low	High
US 11	Study area boundary	Airport Road	A1	$210,000	$654,000
	Airport Road	Mill Street		$77,000	$241,000
	Mill Street	Parsons Court	A2	$1,175,000	$3,609,000
	Parsons Court	Dinkel Avenue		$695,000	$2,169,000
	Dinkel Avenue	Monger Park	A3	$1,448,000	$2,329,000
Old Bridgewater Road	US 11	125 Old Bridgewater Road	B1	$59,000	$91,000
	125 Old Bridgewater Road	Town Limit	B2	$289,000	$934,000
	Town Limit	Dinkel Avenue	B3	$1,226,000	$1,922,000
Ruritan Road	US 11	End of Road	C1	$9,000	$14,000
Shared Path	Ruritan Road	Old Bridgewater Road	C2	$207,000	$332,000
Cantermill Lane	US 11	End of lane	D1	$404,000	$1,308,000
Bridle Bit Lane	Cantermill Lane	End of lane		$254,000	$824,000
Parsons Court	US 11	Friedens Church Road	E1	$192,000	$622,000
Dinkel Avenue	US 11	Old Bridgewater Road	F1	$210,000	$675,000
	Old Bridgewater Road	Hickory Lane	F2	$2,037,000	$3,181,000
				$4,699,000	$7,560,000
				$813,000	$1,255,000
Friedens Church Road	US 11	Parsons Court	G1	-	-
Mill Street	US 11	Old Bridgewater Road	H1	$361,000	$384,000
	Old Bridgewater Road	Dayspring Nazarene Church	H2	$101,000	$107,000
Crawford Street	US11	US11	I1	$549,000	$584,000

LAND USE REGULATION CHANGES

This study was tasked with identifying how the Town of Mount Crawford could better incorporate pedestrian access into its existing land-use regulations. The study team reviewed the Town's existing subdivision ordinance and zoning code and has identified possible changes to the code to promote more pedestrian-friendly development.

Pedestrian Facility Ordinance

Mount Crawford's existing zoning and subdivision ordinances do not include any requirements for the construction of new sidewalks in new developments. The Town could consider amending the existing zoning code to require that all new developments include a pedestrian facility along their roadside frontage, be it along an existing roadway or a newly constructed road. At a minimum, sidewalk requirements could be placed on zoning categories that would likely generate pedestrian demand, including:

- R-1 Residential District
- R-PUD Planned Unit Residential Development
- B-1 Business District
- P-1 Public Use District

The pedestrian facility ordinance could be considered for other zones as well. One potential strategy to use the zoning code to promote the build-out of sidewalks is to create a zoning overlay along key corridors that would require sidewalks to be built regardless of the zone type in that overlay.

The City of Fairfax's zoning ordinance includes a pedestrian facility requirement in its zoning code that could be a model for Mount Crawford (see §4.4. of the code starting on pages 4-93). The code only applies to new development but makes some exemptions for construction on properties with an existing structure:

- Residential properties can be enlarged, renovated, or repaired without triggering a requirement for a pedestrian facility. If the existing property was to be redevelopment (e.g., home demolished and rebuilt), the property would need to include a pedestrian facility
- Non-residential properties are exempt from providing a pedestrian if there is no increase in gross floor area or no more than a 10 percent increase in the impervious surface on the site.
- The pedestrian facility requirement in the code can be met by constructing a sidewalk, pedestrian path, or multi-use trail. The code specifies the minimum width of each facility, where these facilities can be located, and any requirements for public easement. Generally, sidewalks are required parallel to any street frontage, while pedestrian paths are provided as part of multi-building developments, mid-block to allow connecting to abutting streets, or at the end of cul-de-sacs to connect to adjoining blocks. Multi-use trails are provided in accordance with adopted plans.

The City of Lynchburg is another community in Virginia with a sidewalk ordinance in its zoning code (Sec. 35.2-67.1.) Similar to the City of Fairfax, the ordinance applies to all new development and redeveloped property that meet a size threshold of 15,000 gross square feet of developed area per 100 linear feet of primary street frontage. The code makes exemptions to places where the street cross-slope exceed 25 percent or on streets with fewer than 100 projected daily vehicular trips based on project demand.

Finally, the Village of Holmen, Wisconsin is an example of a community comparable to Mount Crawford in size with an existing village sidewalk zoning ordinance.

Other Zoning Changes

Alleyways

The study team identified potential modifications to alleyway regulations in the subdivision and zoning ordinance that could improve pedestrian access. An increasingly common practice in residential development is to have garages face a rear alleyway, freeing up street frontage and eliminating frequent curb cuts along sidewalks. The existing land use ordinances impede the construction of alley garages for new development. The subdivision ordinance outright prohibits the use of alleys at the rear or side of residential lots. The R-1 zone stipulates that "no accessory building may be closer than ten feet to any property line or structure." Amendments to both requirements would enable alleyways front by garages to the rear of residential properties.

Figure 23: Example of Rear Alleys and Garages in a Contemporary Suburban Subdivision

Design Guidelines

While not directly related to pedestrian access, the Town could explore the implementation of urban design guidelines that contribute to a more pedestrian-friendly public realm. Possible areas to be addressed by such urban design guidelines include (but are not limited to):

- Location of parking to the rear or side of development
- Establishment of street frontages with limited curb cuts
- Provision of a buffer distance between the roadway and sidewalk to provide space for street furniture and landscaping.
- Landscaping requirements along new sidewalks, including guidance on street trees to provide shade.
- Revisions to set-back requirements to align with the historic built environment, notably along the US 11 Main Street corridor.

VDOT has a guide to help local governments implement land-use regulations that promote smart growth titled Transportation Efficient Land Use Planning and Design. Several communities in Virginia have adopted urban design guidelines and standards. The Town of Ashland provides a good example of urban design guidelines that address the intersection of land-use and streetscape design.

APPENDIX A: DEMOGRAPHIC ANALYSIS MAPS

Certain population subgroups disproportionately benefit from walking and bicycling infrastructure. These groups include:

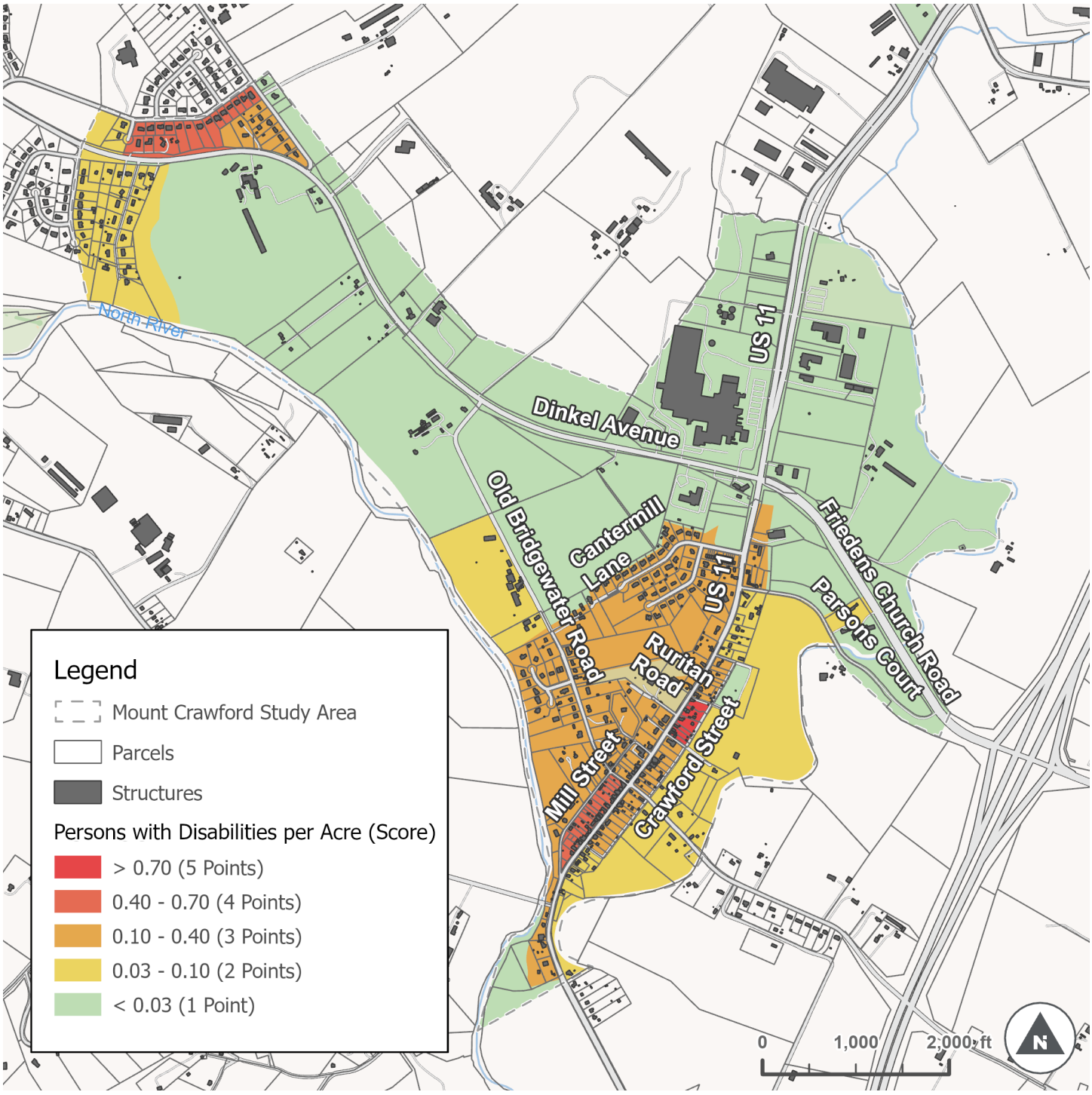
- Persons with disabilities, many of whom cannot drive and/or have difficulty driving. Accessible pedestrian infrastructure can expand their mobility and safety.
- Low-income individuals, typically because the cost of owning and operating a car can be burdensome.
- Older adults, who, as they age, often become less comfortable or less able to operate a vehicle.
- Youth who are too young to drive or do not have access to a personal vehicle.
- People without access to an automobile, whether it be by choice or due to financial or legal reasons, often have no other transportation options besides walking, cycling, and using transit.

With density ranges differing for each demographic analysis, the analyses utilize a Jenks Natural Breaks Classification Method to assign each block to one of five density categories. For each analysis, depending on the natural break category into which it falls, a score from 1 (lowest density) to 5 (highest density) is assigned to each block. The composite sociodemographic need score for each block is the sum of its scores in each preceding analysis. For example, if a block falls in the highest density category for each of the five demographic analyses, it will end up with a sociodemographic need value of 25 (5+5+5+5+5). The lowest possible sociodemographic need score is 5 (1+1+1+1+1).

Persons with Disabilities

The density of persons with disabilities is shown in Figure 24. The greatest concentration in the study area is found along US 11 and in the western boundary of the study area. Another cluster is seen along Dinkel Avenue and College View Drive in Bridgewater, Virginia.

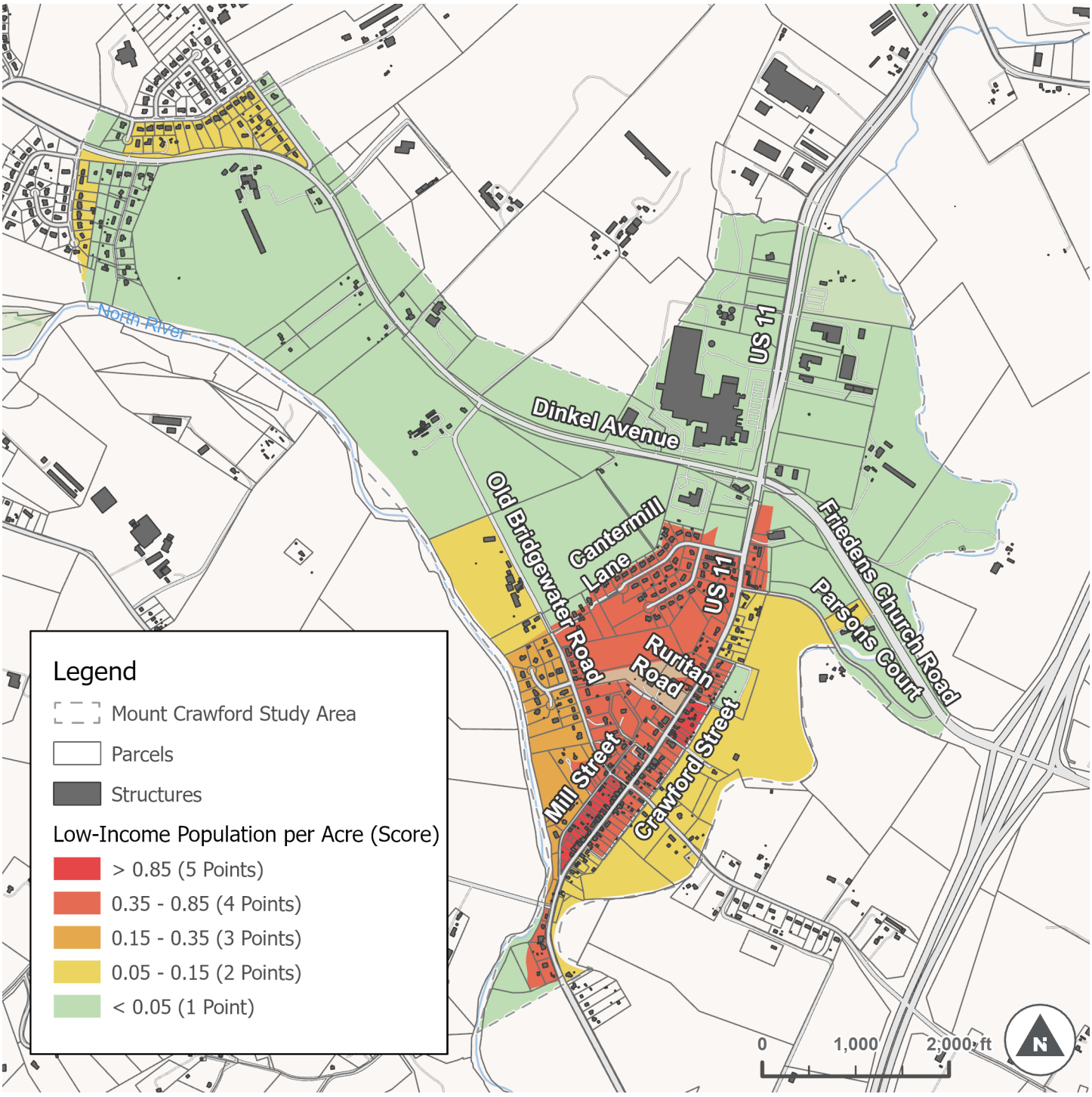
Figure 24: Density of Persons with Disabilities



Low-Income Population

The low-income population—defined as the population living in a household with an annual income less than 150 percent of the federal poverty line—is shown in **Figure 25**. The low-income population is concentrated along US 11 in the heart of Mount Crawford.

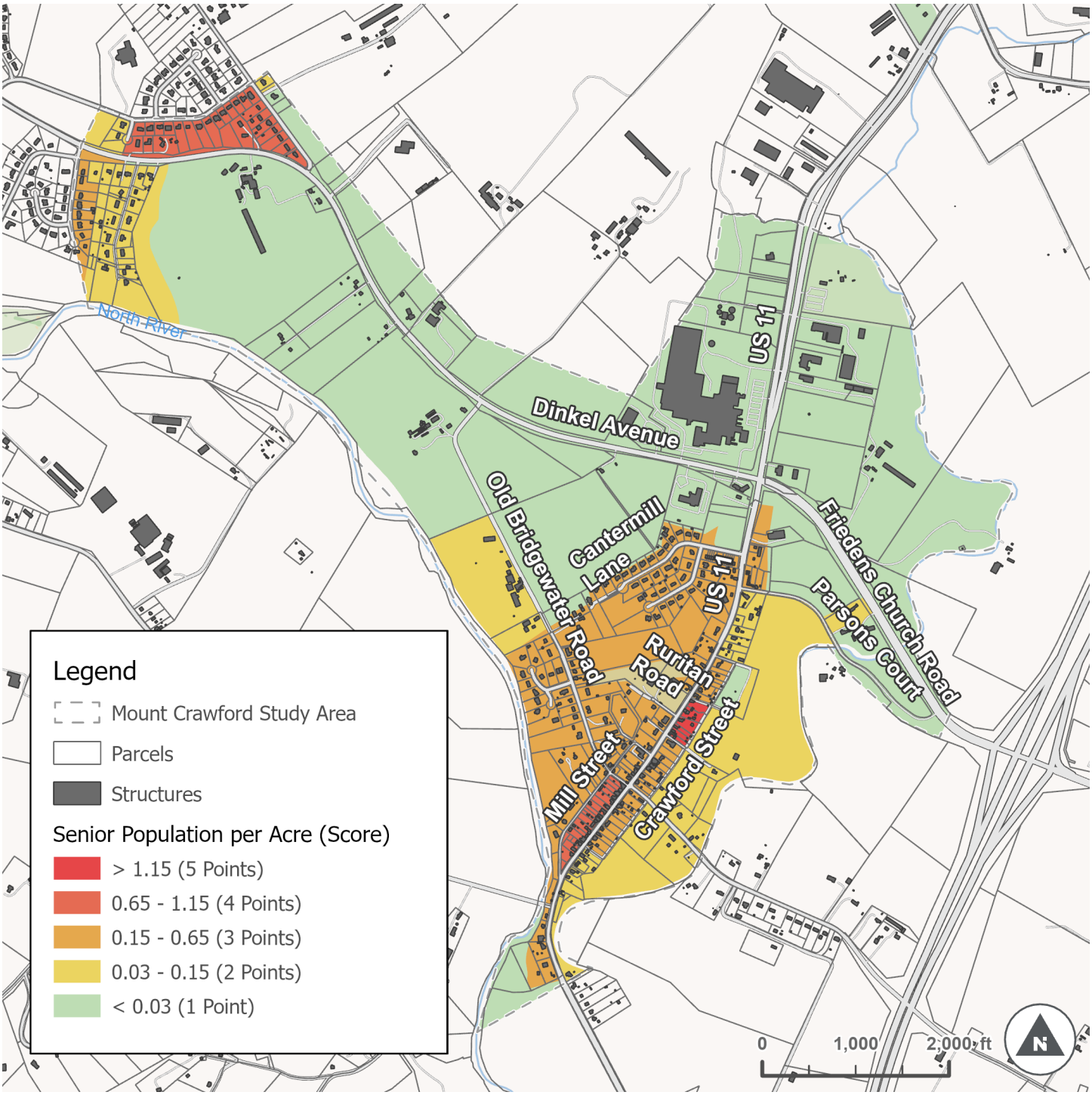
Figure 25: Mount Crawford Low-Income Population Density



Senior Population

The density of seniors aged 65 years and older is shown in **Figure 26**. Age and disability status appear closely correlated in the study area. The highest concentration of seniors is within the heart of Mount Crawford along US 11.

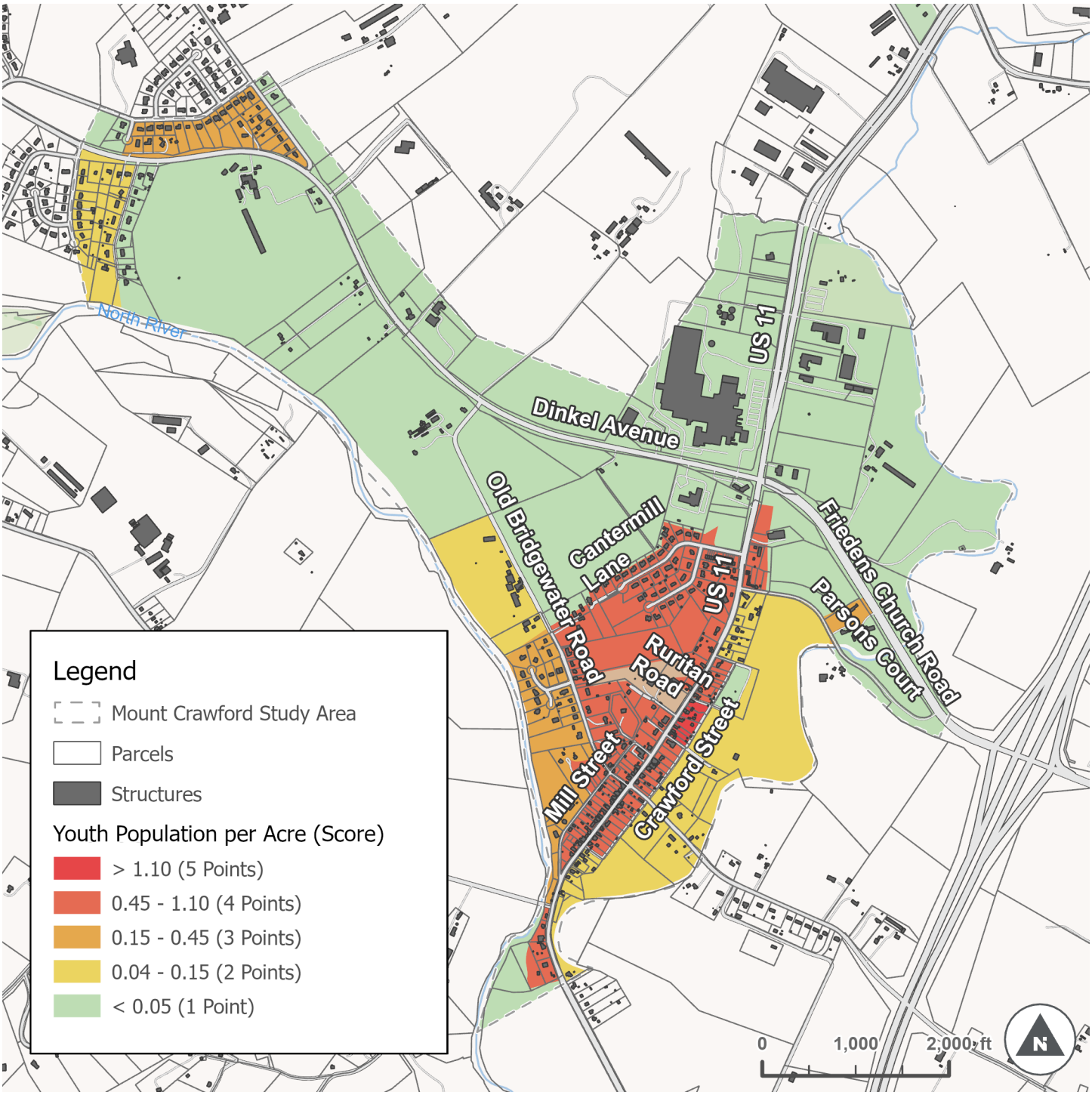
Figure 26: Mount Crawford Senior Population Density



Youth Population

The density of youth—individuals aged 17 years or younger—is shown in **Figure 27**. With the exception of one block north of North Cemetery Drive and south of Parsons Court, all of the blocks along US 11 have a high youth population density. Blocks west of US 11, north of Old Bridgewater Road, and east of Cantermill Lane also have a high youth population density.

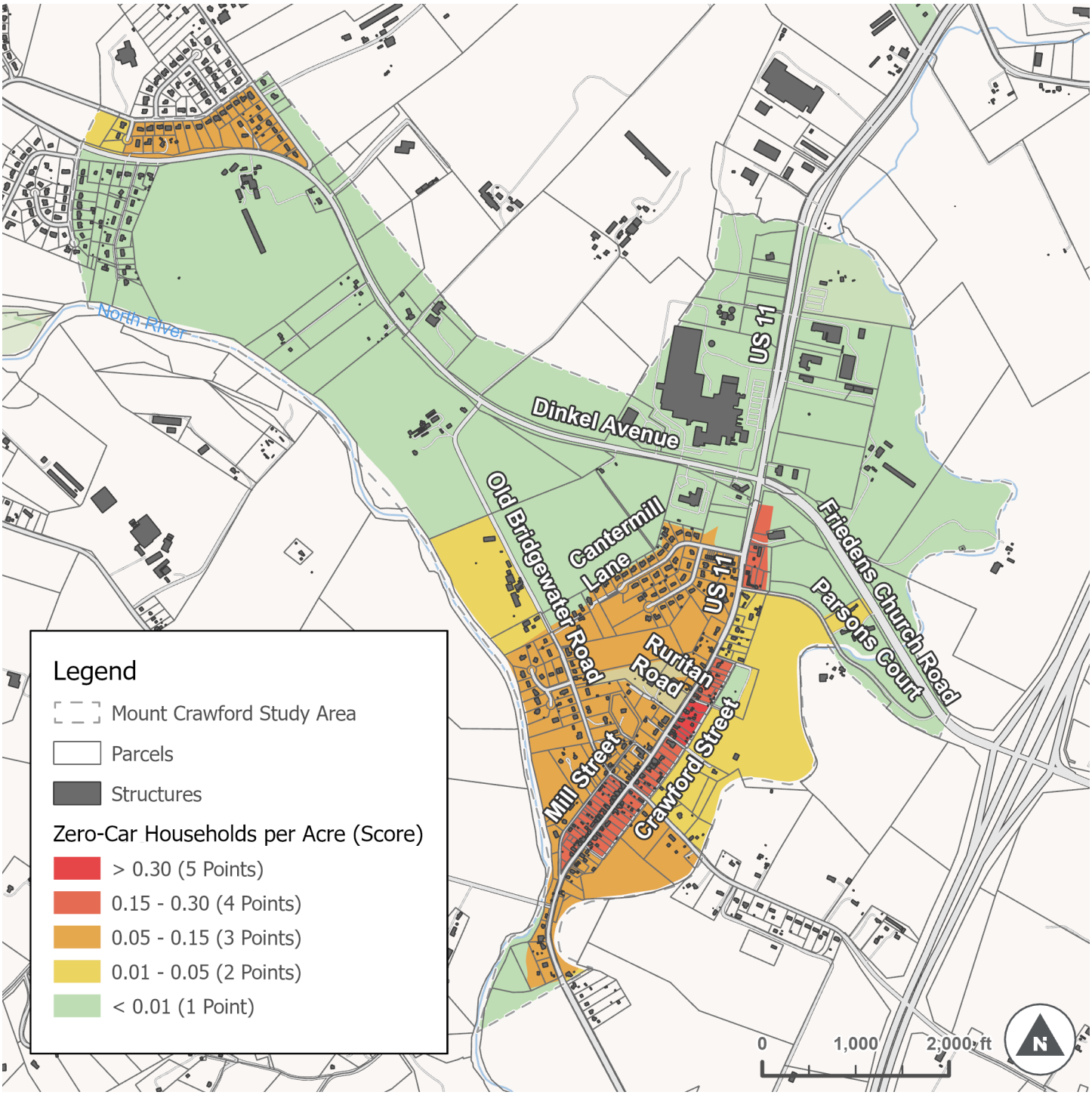
Figure 27: Mount Crawford Youth Population Density



Zero-Car Household Population

The density of zero-car households is shown in **Figure 28**. The highest zero-car household population density is found on the block of US 11 between Layman Road and South Cemetery Drive. Several other blocks along US 11 show a high density of zero-car households. Residents who do not have access to an automobile are more likely to use active transportation infrastructure, suggesting a great need along US 11.

Figure 28: Mount Crawford Zero-Car Household Population Density



APPENDIX B: BLTS METHODOLOGY

Variables used in ranking street segments[1] include the presence of cycling infrastructure[2], the number of travel lanes, posted speed limits, annual average daily traffic (AADT) where available, and historical crash data. **Table 1** summarizes the assignment of LTS scores based on each of these variables except historical crash data.[3] Serving as a proxy for several difficult to operationalize variables, historical crash data instead informs a one-point upward adjustment in the BLTS score for segments longer than 0.02 miles with more than the median number of crashes per mile from 2017 to 2020.

Table 5: BLTS Street Segment Scoring Rubric

		AADT		
		≤3,000	3,001-6,000	≥6,001
Speed Limit	**Lanes**	**Mixed Traffic**		
≤25	≤3	1	2	3
	4 or 5	3	3	3
	≥6	4	4	4
>25	≤3	3	4	4
	4 or 5	4	4	4
	≥6	4	4	4
Speed Limit	**Lanes**	**Sharrows**		
≤25	≤3	1	1	3
	4 or 5	3	3	3
	≥6	4	4	4
>25	≤3	3	4	4
	4 or 5	4	4	4
	≥6	4	4	4
Speed Limit	**Lanes**	**Dedicated Lanes**		
≤25	≤3	1	1	2
	4 or 5	1	2	3
	≥6	2	3	4
>25	≤3	2	2	3
	4 or 5	2	3	4
	≥6	3	4	4

1 Virginia Geographic Information Network. (2021). Virginia Road Centerlines. Retrieved September 3, 2021, from https://www.arcgis.com/home/search.html?q=owner%3A%22VGIN%22&t=content&restrict=false.

2 Virginia Department of Transportation (2019). Bicycle Facility Inventory. Retrieved September 3, 2021, from https://www.virginiaroads.org/datasets/VDOT::bicycle-facility-inventory-view/about

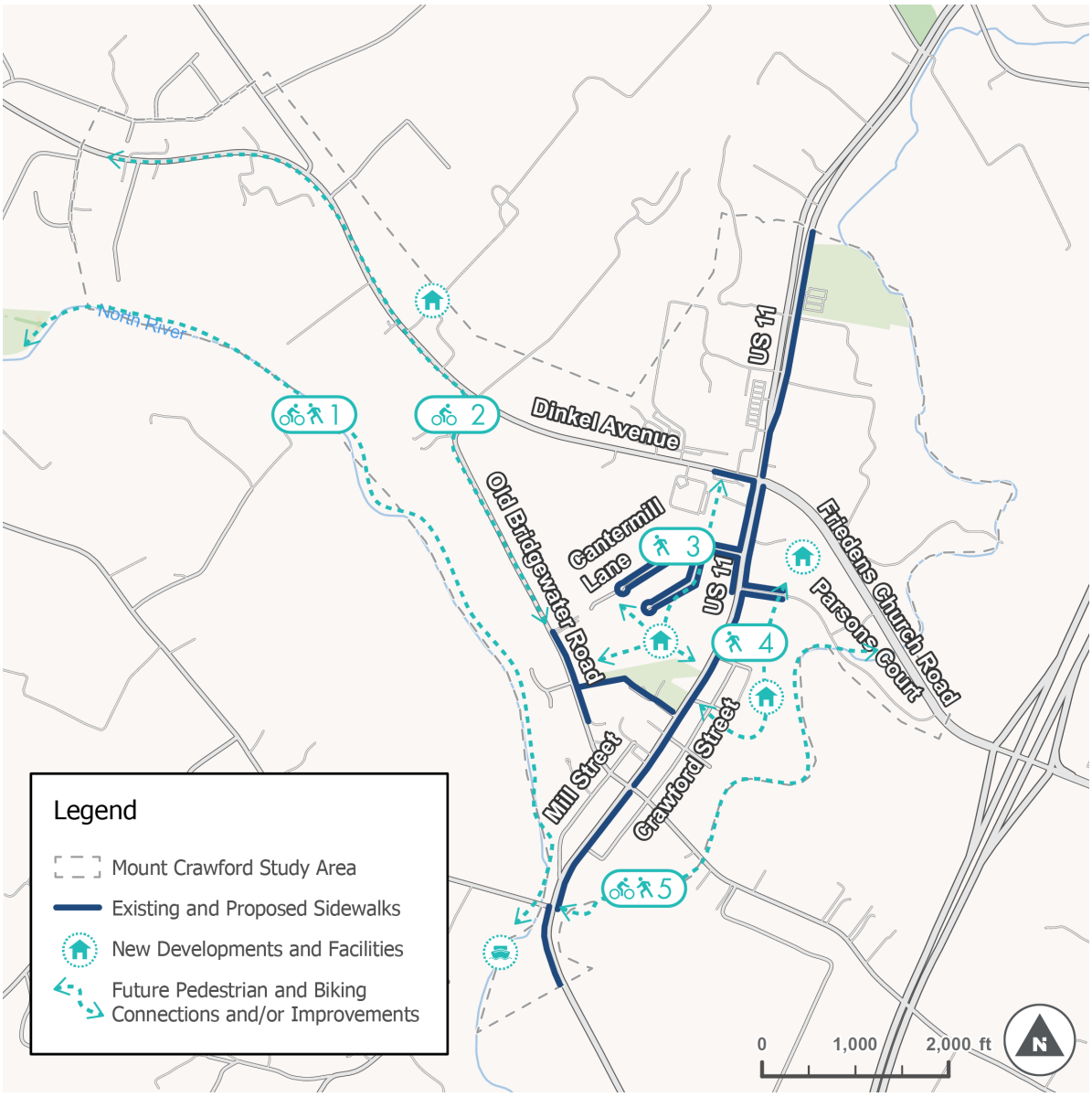
3 Virginia Department of Transportation. (2017). Virginia Crashes. Retrieved July 22, 2021, from https://www.virginiaroads.org/datasets/VDOT::virginia-crashes/explore.

APPENDIX C: FUTURE POTENTIAL PROJECTS

Figure 29 maps future potential pedestrian and bicycle projects discussed with Town Manager and Central Shenandoah Planning District Commission. These projects aim to either provide additional off-street pedestrian and bicycle facilities or desired connections as new developments are built and include:

1. Riverwalk along North River connecting the Town's future boat launch and the Town of Bridgewater
2. Improved bicycle facility along Old Bridgewater Road and Dinkel Avenue as the Town population grows
3. Pedestrian connections between existing residential developments and future developments to create a connected network of paths for pedestrians independent of the existing residential cul-de-sacs
4. Similarly, new developments east of US 11 should also provide a connected pedestrian network parallel to US 11
5. Riverwalk along the North River branch along the eastern limit of the Town.

Figure 29: Future Potential Projects



APPENDIX D: GENERAL COSTING ASSUMPTIONS

- Costs based on the VDOT Transportation and Mobility Planning Division Planning Level Cost Estimates workbook Staunton District Template.
- In instances where example costs are from prior years, costs are inflated to 2022 dollars, assuming a three-percent inflation rate.
- A 25 percent contingency was standard. Certain projects with greater implementation unknowns were assigned a higher 50 percent contingency.
- Curb and gutter costs are equal to 100 percent of sidewalk construction costs.
- All project cost rounded to the nearest thousand.

Costing Assumptions by Project

Project A1, US 11: Sidewalk
Length: 0.22 miles

Assumptions:

- Sidewalk on SB of US 11 crossing at Airport Road to NB on US 11.
- Construction of one crosswalk.
- Restriping of the roadway.
- Curb and gutter costs.
- Right-of-way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project A1: Study Area Boundary to Airport Road

Planning-Level Cost Estimation				
Project Length: 0.16 mi	**Low**		**High**	
5ft sidewalk	$	58,000	$	188,000
Roadway restriping	$	10,000	$	15,000
One crosswalk	$	5,000	$	10,000
Base Segment Cost	$	73,000	$	213,000
Curb and gutter	$	58,000	$	188,000
ROW and utilities (residential/suburban low density)	$	38,000	$	122,000
Contingency	$	42,000	$	131,000
Total Segment Cost	$	210,000	$	654,000

Project A1: Airport Road to Mill Street

Planning-Level Cost Estimation				
Project Length: 0.06 mi	**Low**		**High**	
5ft sidewalk	$	22,000	$	71,000
Roadway restriping	$	4,000	$	6,000
Base Segment Cost	$	25,000	$	76,000
Curb and gutter	$	22,000	$	71,000
ROW and utilities (residential/suburban low density)	$	14,000	$	46,000
Contingency	$	14,000	$	47,000
Total Segment Cost	$	77,000	$	241,000

Project A1: Study Area Boundary to Mill Street

Total Project Cost	$	287,000	$	895,000

Project A2, US 11: Sidewalk
Length: 0.94 miles

Assumptions:
- 0.72 miles of sidewalk on one side of the road.
- 0.22 miles of sidewalk on both sides of the road.
- Curb and gutter costs.
- Restriping of roadway (southbound lane shoulder fits within the existing paved right-of-way.
- Construction of 20 crosswalks
- Right-of-way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project A2: Mill Street to Parsons Court

Planning-Level Cost Estimation		
Project Length: 0.16 mi	**Low**	**High**
6ft sidewalk	$ 314,000	$ 1,015,000
Roadway restriping	$ 44,000	$ 66,000
One crosswalk	$ 65,000	$ 130,000
Base Segment Cost	$ 423,000	$ 1,211,000
Curb and gutter	$ 314,000	$ 1,015,000
ROW and utilities (residential/suburban low density)	$ 204,000	$ 660,000
Contingency	$ 235,000	$ 722,000
Total Segment Cost	$ 1,175,000	$ 3,609,000

Project A2: Parsons Court to Dinkel Avenue

Planning-Level Cost Estimation		
Project Length: 0.72 mi	**Low**	**High**
6ft sidewalk	$ 192,000	$ 620,000
Roadway restriping	$ 14,000	$ 20,000
One crosswalk	$ 35,000	$ 70,000
Base Segment Cost	$ 240,000	$ 711,000
Curb and gutter	$ 192,000	$ 620,000
ROW and utilities (residential/suburban low density)	$ 125,000	$ 403,000
Contingency	$ 139,000	$ 434,000
Total Segment Cost	$ 695,000	$ 2,169,000

Project A2: Mill Street to Dinkel Avenue

Total Project Cost	$ 287,000	$ 895,000

Project A3, US 11: 10-ft Shared-Use Path
Length: 0.51 miles

Assumptions:
- 10-foot off-road shared-use path running parallel to US 11.
- No curb and gutter costs.
- Right-of-way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project A3: Dinkel Avenue to Monger Park

Planning-Level Cost Estimation		
Project Length: 0.51 mi	**Low**	**High**
10ft Shared-Use Path	$ 702,000	$ 1,129,000
Base Segment Cost	$ 702,000	$ 1,129,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ 456,000	$ 734,000
Contingency	$ 290,000	$ 466,000
Total Segment Cost	$ 1,448,000	$ 2,329,000

Project A3: Dinkel Avenue to Monger Park

Total Project Cost	$ 1,448,000	$ 2,329,000

Project B1, Old Bridgewater Road:
Length: 0.12 miles

Assumptions:
- Two-foot widening of the roadway.
- Restriping of roadway and signage.
- No curb and gutter costs.
- 50 percent contingency to account for additional costs related to traffic calming that are not captured in the cost model.
- Right-of-way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project B1: US 11 to 125 Old Bridgewater Road

Planning-Level Cost Estimation		
Project Length: 0.12 mi	**Low**	**High**
2ft of additional pavement	$ 15,000	$ 24,000
Roadway restriping	$ 15,000	$ 22,000
Base Cost	$ 30,000	$ 46,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ 10,000	$ 15,000
Contingency	$ 12,000	$ 19,000
Total Segment Cost	$ 59,000	$ 91,000

Project B1: US 11 to 125 Old Bridgewater Road

Total Project Cost	$ 59,000	$ 91,000

Project B2, Old Bridgewater Road:
Length: 0.24 miles

Assumptions:
- Sidewalk on one side of the road. No curb and gutter costs.
- Curb and gutter costs.
- Right-of-way acquisition and utility costs are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project B2: 125 Old Bridgewater Road to Town Limit

Planning-Level Cost Estimation		
Project Length: 0.24 mi	**Low**	**High**
5ft sidewalk	$ 87,000	$ 282,000
Base Segment Cost	$ 87,000	$ 282,000
Curb and gutter	$ 87,000	$ 282,000
ROW and utilities (residential/suburban low density)	$ 57,000	$ 183,000
Contingency	$ 58,000	$ 187,000
Total Segment Cost	$ 289,000	$ 934,000

Project B2: 125 Old Bridgewater Road to Town Limit

Total Project Cost	$ 289,000	$ 934,000

Project B3, Old Bridgewater Road:
Length: 0.53 miles

Assumptions:
- 14-foot widening of the roadway.
- Restriping of the roadway.
- Fifty percent contingency due to the amount of additional right-of-way required.
- No curb or drainage costs.
- Right-of-way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project B3: Town Limit to Dinkel Avenue

Planning-Level Cost Estimation		
Project Length: 0.53 mi	**Low**	**High**
14ft of additional pavement	$ 463,000	$ 727,000
Roadway restriping	$ 65,000	$ 98,000
Base Cost	$ 528,000	$ 825,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ 301,000	$ 473,000
Contingency	$ 382,000	$ 600,000
Total Segment Cost	$ 1,226,000	$ 1,922,000

Project B3: Town Limit to Dinkel Avenue

Total Project Cost	$ 1,226,000	$ 1,922,000

Project C1, Ruritan Road Connector:
Length: 0.1 miles

Assumptions:
- Restriping of the roadway.
- No curb and gutter costs.
- No right-of-way acquisition costs.
- Fifty percent contingency to account for lack of cost model detail related to traffic calming infrastructure.

Project C1: US 11 to End of the road

Planning-Level Cost Estimation		
Project Length: 0.10 mi	**Low**	**High**
Restriping	$ 6,000	$ 9,000
Base Cost	$ 6,000	$ 9,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ -	$ -
Contingency	$ 3,000	$ 5,000
Total Cost	$ 9,000	$ 14,000

Project C1: US 11 to End of the road

Total Project Cost	$ 9,000	$ 14,000

Project C2, Ruritan Park: Shared-Use Path
Length: 0.12 miles

Assumptions:
- 10-foot multi-use path on the newly acquired right-of-way.
- No curb and gutter costs.

Project C2: Ruritan Road to Old Bridgewater Road

Planning-Level Cost Estimation*		
Project Length: 0.12 mi	**Low**	**High**
10ft Shared-Use Path	$ 165,000	$ 266,000
Base Cost	$ 165,000	$ 266,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ -	$ -
Contingency	$ 41,000	$ 66,000
Total Cost	$ 207,000	$ 332,000

*All project cost rounded to the nearest thousand

Project C2: Ruritan Road to Old Bridgewater Road

Total Project Cost	$ 207,000	$ 332,000

Project D1, Cantermill Lane and Bridle Bit Lane:
Length: 0.44 miles

Assumptions:
- Sidewalks on both sides of the street.
- No curb and gutter costs.
- 10-feet of new right of way.
- Right of way acquisition and utility are the following percentage of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project D1a: US 11 to End of Lane

Planning-Level Cost Estimation				
Project Length: 0.27 mi	**Low**		**High**	
5ft Sidewalk (NB)	$	98,000	$	317,000
5ft Sidewalk (SB)	$	98,000	$	317,000
Base Cost	$	196,000	$	635,000
Curb and gutter	$	-	$	-
ROW and utilities (residential/suburban low density)	$	127,000	$	412,000
Contingency	$	81,000	$	262,000
Total Cost	$	404,000	$	1,308,000

Project D1b: Cantermill Lane to End of Lane

Planning-Level Cost Estimation				
Project Length: 0.17 mi	**Low**		**High**	
5ft Sidewalk (NB)	$	62,000	$	200,000
5ft Sidewalk (SB)	$	62,000	$	200,000
Base Cost	$	123,000	$	400,000
Curb and gutter	$	-	$	-
ROW and utilities (residential/suburban low density)	$	80,000	$	260,000
Contingency	$	51,000	$	165,000
Total Cost	$	254,000	$	824,000

Project D1: Cantermill Lane and Bridle Bit Lane

Total Project Cost	$	658,000	$	2,132,000

Project E1, Parsons Court:
Length: 0.08 miles

Assumptions:
- Sidewalks on both sides of the street.
- Curb and gutter costs.
- Ten feet of new right of way.
- Right-of-way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project E1: US 11 to New Development

Planning-Level Cost Estimation				
Project Length: 0.08 mi	**Low**		**High**	
5ft Sidewalk (NB)	$	29,000	$	94,000
5ft Sidewalk (SB)	$	29,000	$	94,000
Base Cost	$	58,000	$	188,000
Curb and gutter	$	58,000	$	188,000
ROW and utilities (residential/suburban low density)	$	38,000	$	122,000
Contingency	$	38,000	$	125,000
Total Cost	$	192,000	$	622,000

Project E1: US 11 to New Development

Total Project Cost	$	192,000	$	622,000

Project F1, Dinkel Avenue:
Length: 0.07 miles

Assumptions:
- Sidewalks on one side of the street.
- Curb and gutter costs.
- Five feet of new right-of-way.
- Right of way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project F1: US 11 to Old Bridgewater Road

Planning-Level Cost Estimation				
Project Length: 0.07 mi	**Low**		**High**	
5ft Sidewalk (EB)	$	62,000	$	200,000
One Crosswalk	$	5,000	$	10,000
Base Cost	$	67,000	$	210,000
Curb and gutter	$	62,000	$	200,000
ROW and utilities (residential/suburban low density)	$	40,000	$	130,000
Contingency	$	27,000	$	85,000
Total Cost	$	210,000	$	675,000

Project F1: US 11 to New Development

Total Project Cost	$	210,000	$	675,000

Project F2, Dinkel Avenue Option A:
Length: 1.65 miles

Assumptions:
- Seven-foot Road widening.
- Restriping of the roadway.
- No curb and gutter costs.
- Fifty percent contingency due to the length of the corridor and land acquisition costs.
- Right-of-way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project F2 Option A: Old Bridgewater Road to Hickory Lane

Planning-Level Cost Estimation		
Project Length: 1.65 mi	**Low**	**High**
7ft additional widening	$ 720,000	$ 1,132,000
Roadway restriping	$ 203,000	$ 304,000
Base Cost	$ 923,000	$ 1,436,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ 468,000	$ 736,000
Contingency	$ 645,000	$ 1,010,000
Total Cost	$ 2,037,000	$ 3,181,000

Project F2 Option A: Old Bridgewater Road to Hickory Lane

Total Project Cost	$ 2,037,000	$ 3,181,000

Project F2, Dinkel Avenue Option B:
Length: 1.65 miles

Assumptions:
- 10-foot wide multi-use path.
- No curb and gutter costs.
- Right-of-way acquisition and utility are the following percentages of construction costs for low and high estimates, respectively: 50 percent and 65 percent.
- Construction of two crosswalks.

Project F2 Option B: Old Bridgewater Road to Hickory Lane

Planning-Level Cost Estimation		
Project Length: 1.65 mi	**Low**	**High**
10ft Shared-Use Path	$ 2,272,000	$ 3,653,000
Two crosswalks	$ 10,000	$ 20,000
Base Cost	$ 2,282,000	$ 3,673,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ 1,477,000	$ 2,375,000
Contingency	$ 940,000	$ 1,512,000
Total Cost	$ 4,699,000	$ 7,560,000

Project F2 Option B: Old Bridgewater Road to Hickory Lane

Total Project Cost	$ 4,699,000	$ 7,560,000

Project F2, Dinkel Avenue Option C:
Length: 1.65 miles

Assumptions:
- Two foot road widening.
- Restriping of roadway.
- No curb and gutter costs.
- 50 percent contingency due to length of corridor and land acquisition costs.
- Right of way acquisition and utility are the following percentage of construction costs for low and high estimates, respectively: 50 percent and 65 percent.

Project F2 Option C: Old Bridgewater Road to Hickory Lane

Planning-Level Cost Estimation		
Project Length: 1.65 mi	**Low**	**High**
2-ft additional widening	$ 206,000	$ 323,000
Roadway restriping	$ 203,000	$ 304,000
Base Cost	$ 409,000	$ 627,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ 134,000	$ 210,000
Contingency	$ 271,000	$ 419,000
Total Cost	$ 813,000	$ 1,255,000

Project F2 Option C: Old Bridgewater Road to Hickory Lane

Total Project Cost	$ 813,000	$ 1,255,000

Project H1/H2, Mill Street:
Length: 0.32 miles

Assumptions:
- Construction of 12-foot-wide paved roadway.
- No right-of-way or utility costs.
- No curb and gutter costs.
- Restriping of the roadway.

Project H1: US 11 to Old Bridgewater Road

Planning-Level Cost Estimation*		
Project Length: 0.25 mi	**Low**	**High**
One additional lane (12-ft widening)	$ 252,000*	$ 252,000
Roadway restriping	$ 31,000	$ 6,000
Base Cost	$ 283,000	$ 298,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ -	$ -
Contingency	$ 78,000	$ 86,000
Total Cost	$ 361,000	$ 384,000

*No low cost listed, high cost used

Project H2: Old Bridgewater Road to Dayspring Nazarene Church

Planning-Level Cost Estimation		
Project Length: 0.07 mi	**Low**	**High**
One additional lane (12-ft widening)	$ 71,000*	$ 71,000
Roadway restriping	$ 9,000	$ 13,000
Base Cost	$ 79,000	$ 83,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ -	$ -
Contingency	$ 22,000	$ 24,000
Total Cost	$ 101,000	$ 107,000

*No low cost listed, high cost used

Project H2: Old Bridgewater Road to Dayspring Nazarene Church

Total Project Cost	$ 462,000	$ 491,000

Project I1, Crawford Street:
Length: 0.38 miles

Assumptions:
- Construction of 12-foot-wide paved roadway.
- No right-of-way or utility costs.
- No curb and gutter cost.
- Restriping of the roadway.

Project I1: US 11 to US 11

Planning-Level Cost Estimation		
Project Length: 0.38 mi	**Low**	**High**
One additional lane (12-ft widening)	$ 383,000*	$ 383,000
Roadway restriping	$ 47,000	$ 70,000
Base Cost	$ 430,000	$ 453,000
Curb and gutter	$ -	$ -
ROW and utilities (residential/suburban low density)	$ -	$ -
Contingency	$ 119,000	$ 131,000
Total Cost	$ 549,000	$ 584,000

*No low cost listed, high cost used

Project I1: US 11 to US 11

Total Project Cost	$ 549,000	$ 584,000

APPENDIX E: PROJECT SEGMENT CHARACTERISTICS

Table 6: Existing Conditions of Each Project Segment

Street	Starting Point	Ending Point	Project	Site Characteristics						
				Function Class.	Traffic Volume (AADT)	Speed Limit	Right-of-Way (ft)	Road Lane Width (ft)	Road Shoulder Width (ft)	Obstructions[1]
US 11	Study area boundary	Airport Road	A1	Minor Arterial	6,000	35	28	12	2	Yes
	Airport Road	Mill Street		Minor Arterial	6,000	35	30	13	2	Yes
	Mill Street	Parsons Court	A2	Minor Arterial	7,300	35	36	11	7	Yes
	Parsons Court	Dinkel Avenue		Minor Arterial	7,300	35	48	10	4	Yes
	Dinkel Avenue	Monger Park	A3	Minor Arterial	12,000	55	88	11	2	Yes
Old Bridgewater Road	US 11	125 Old Bridgewater Road	B1	Major Collector	620	25	18	-	-	Yes
	125 Old Bridgewater Road	Town limit	B2	Major Collector	620	35	18	-	-	Yes
	Town limit	Dinkel Avenue	B3	Major Collector	560	45	18	-	-	Yes
Ruritan Road	US 11	End of road	C1	Local	-	25	17	-	-	Yes
Shared Path	Ruritan Road	Old Bridgewater Road	C2	-	-	-	-	-	-	None
Cantermill Lane	US 11	End of lane	D1	Local	340	25	28	-	-	None
Bridle Bit Lane	Cantermill Lane	End of lane		Local	100	25	28	-	-	None
Parsons Court	US 11	Friedens Church Road	E1	Local	80	25	22	-	-	Yes
Dinkel Avenue	US 11	Old Bridgewater Road	F1	Major Arterial	10,000	55	30	12	3	Yes
	Old Bridgewater Road	Hickory Lane	F2	Major Arterial	9,400	45	32	11	5	Yes

1 Obstructions are listed in **Appendix D** as part of the cost estimation assumptions.

Street	Starting Point	Ending Point	Project	Site Characteristics						
				Function Class.	Traffic Volume (AADT)	Speed Limit	Right-of-Way (ft)	Road Lane Width (ft)	Road Shoulder Width (ft)	Obstructions[1]
Friedens Church Road	US 11	Parsons Court	G1	Major Arterial	12,000	55	80	12	5	Yes
Mill Street	US 11	Old Bridgewater Road	H1	Local	-	25	16	-	-	Yes
	Old Bridgewater Road	Dayspring Nazarene Church	H2	Local	-	25	9	-	-	
Crawford Street	US 11	US 11	I1	Local	-	-	10	-	-	Yes