Grimes County Thoroughfare Plan

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A graduate professional paper submitted to

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by

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Table of Contents

Table of Contents (Figures)

Table of Contents (Tables)

Introduction

Texas A&M University through the program Texas Target Communities ("TTC") began a partnership with Grimes County in Fall 2015 to produce a thoroughfare plan. Over the last six months, the author of this report has collaborated with TTC and the County to create the Grimes County Thoroughfare Plan (GCTP).

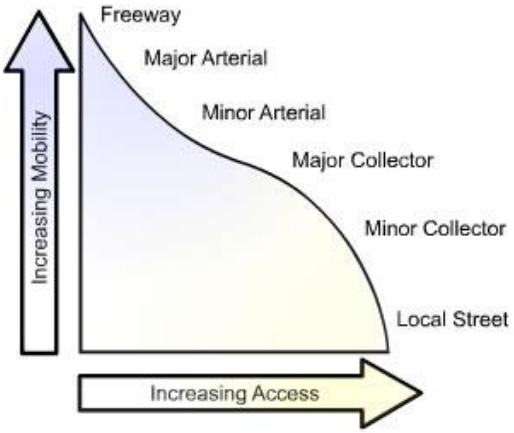
What Is a Thoroughfare Plan?

A thoroughfare plan has been defined as "a long-range plan that identifies the location and type of roadway facilities that are needed to meet projected long-term growth within [an] area". Its purpose is not to assemble a list of future construction projects, but instead to "preserve corridors" to be kept clear in the event that a road is built (City of Temple, 2008, p. 5A-1). The GCTP is a document that evaluates the current state of the Grimes County transportation system, predicts how the system will grow in coming decades, and offers tools to the community to guide that growth in a positive direction.

Why Create a Thoroughfare Plan?

The functional classification system proposed in this plan will assist in setting minimum design standards for roads of different capacities and uses, with the intent of enhancing safety and level of service. As Figure 1 illustrates, a major goal of functional classification of roads is to balance access and mobility according to community needs. Mobility describes a thoroughfare's ability to transport individuals from one point to another, with less concern for reaching destinations between them. On the other hand, when access is prioritized, a road will contain many opportunities for entering or exiting, which may limit its speed (Federal Highway Administration, 2013).

Figure 1: Access versus Mobility



Source: Reprinted from FHWA (2015b).

A road functional classification hierarchy helps to divide roads into categories ranging from high mobility / low access to low mobility / high access. The more precisely roads are classified, the more effectively traffic flows can be understood and road design and improvements can accommodate these flows. The County has divided its roads into five basic classification levels, which the GCTP has refined and increased to six to meet standards recommended by the Federal Highway Administration (FHWA).

A thoroughfare plan usually incorporates road cross-section drawings, as does the GCTP. Cross-sections provide a street level view of design standards laid out in the functional classification hierarchy, such as lane width. These sketches help bridge the gap between design and construction, and they are useful for communicating the potential effects of the thoroughfare plan to all members of the community.

Furthermore, the GCTP maps possible expansions to the Grimes County transportation system in coming decades. With construction of State Highway 249 expected to begin in the southeast corner of the County, and with the possible introduction of the Dallas-Houston high speed rail, the GCTP will help to mitigate undesirable environmental effects and help the County take advantage of positive economic impacts associated with these projects. Any other new roads planned for Grimes County are also included in the GCTP.

Structure of the Document

This document consists of six parts:

In Chapter 1, a County profile sets the stage and lays out the context in which the GCTP is being applied.

Chapter 2 summarizes the community engagement process and resulting transportation goals and priorities.

Chapter 3 presents a literature review, building a foundation of case studies and concepts that will guide later chapters.

In Chapter 4, a survey of existing conditions pinpoints locations where new roads are either needed or desired. The high priority intersection map highlights key areas for safety improvements. The suitability map in this chapter is meant to serve as a blueprint for selecting right-of-ways for potential road additions.

Chapter 5 contains the components of the thoroughfare plan. A road functional classification hierarchy, explained above, is proposed. Next, the standards in the hierarchy are mapped across the County's road system, and finally, sketches of each classification level provide a glimpse of how they would be constructed and landscaped.

Chapter 6 continues by offering a look at Grimes County's future and past budgets, along with some special projects for which funding has already been set aside. Available funds and possible grants are identified, and next steps for implementation are recommended.

The conclusion sums up the thoroughfare plan and notes further challenges and opportunities in moving Grimes County's roads and people forward.

1.0 County Profile

1.1 Location

Grimes County is located in East Texas, positioned east of College Station and northwest of Houston (Fig. 2). The County is included in the Brazos Valley Council of Governments, with Anderson as County seat. Navasota constitutes the largest city, with population 7,351 in 2014 (U.S. Census, 2014b). Other settlements in the area include Bedias, Iola, Plantersville, Richards, Roans Prairie, Shiro, Stoneham, and Todd Mission, all with populations under 500.

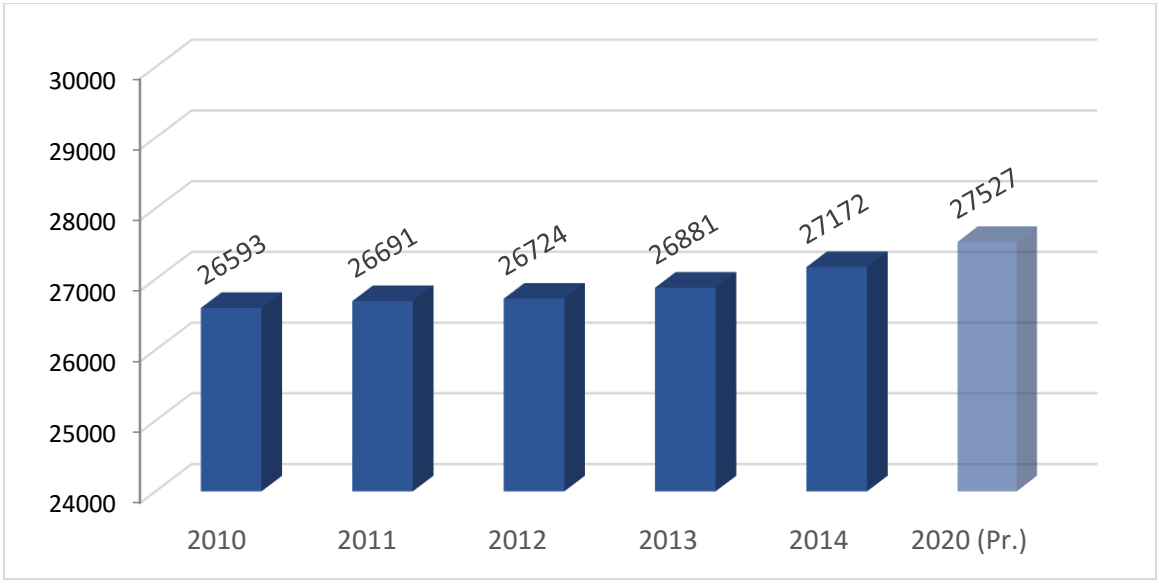
Figure 2: Location of Grimes County in Texas

Source: Bennbennick (2006).

1.2 Population Count and Growth

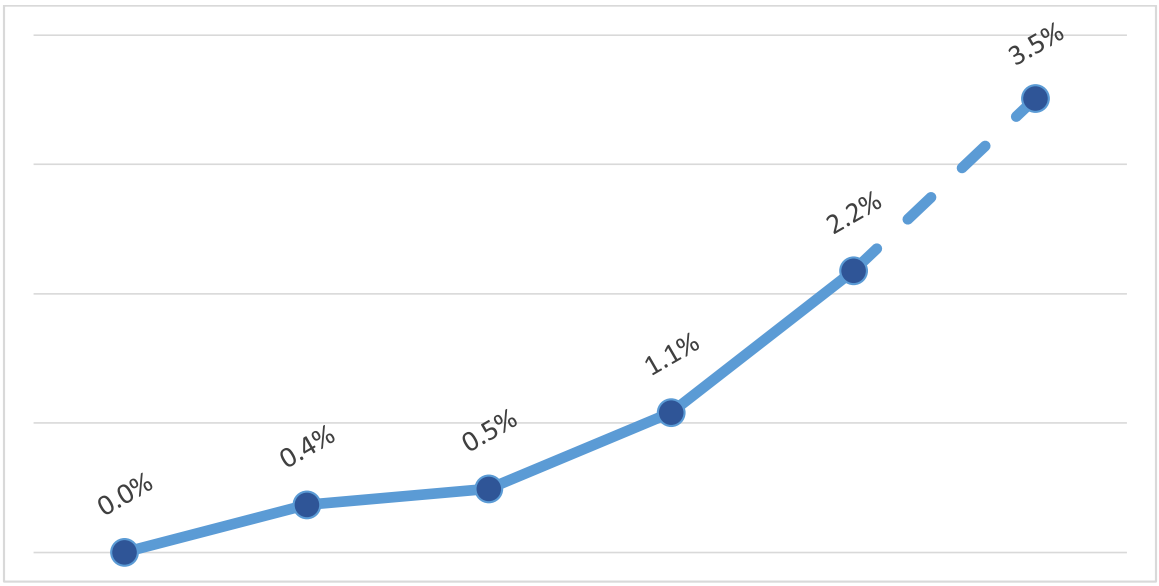
As of 2014, the U.S. Census Bureau estimated the population of Grimes County at 27,172. County population from 2010 to 2014 and projected population in 2020 are visible in Figure 3. Population growth has accelerated since 2010, with a 2.2% increase between 2013 and 2014, shown in Figure 4. The 2020 population is projected at 27,527, representing a smaller annual growth rate over the next six years than in previous years. Grimes County's population count is growing slowly compared to Texas and the United States (Fig. 5). This moderate yet consistent rise in population requires that the road system be maintained and expanded to keep pace with an increase in County residents.

Figure 3: County Population, 2010-2014, 2020



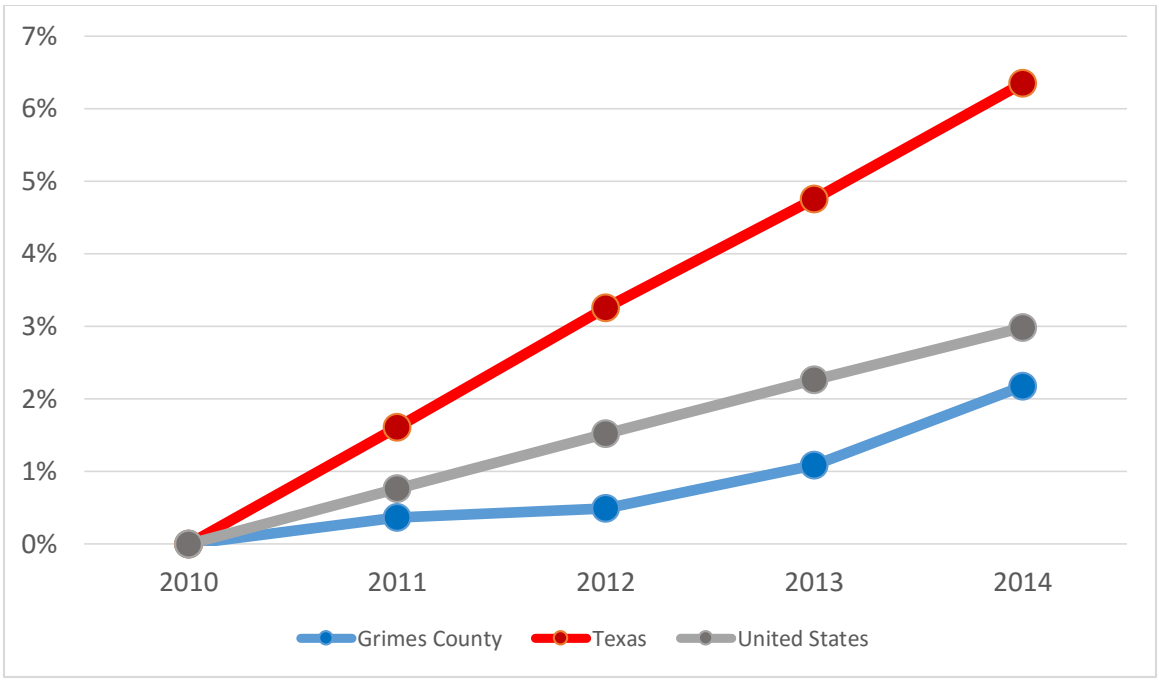
Source (2010-2014): U.S. Census (2014b).
Source (2020): City of Navasota (2015).

Figure 4: County Population Growth, 2010-2014, 2020



Source (2010-2014): U.S. Census (2014b).
Source (2020): City of Navasota (2015).

Figure 5: County, State, and National Population Growth Compared, 2010-2014

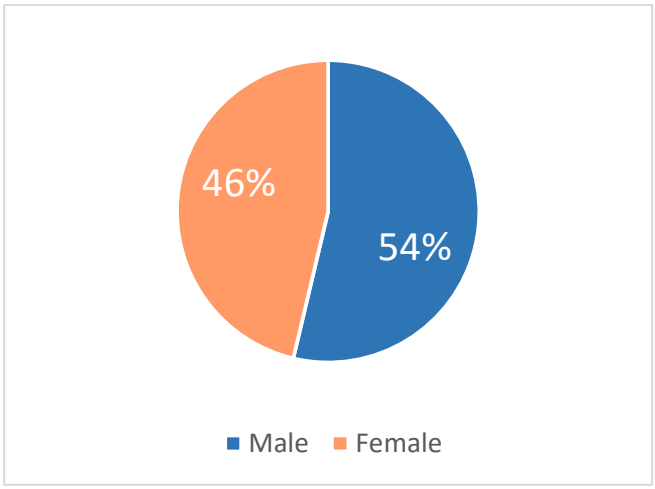


Source: U.S. Census (2014b).

1.3 Gender, Race, and Age

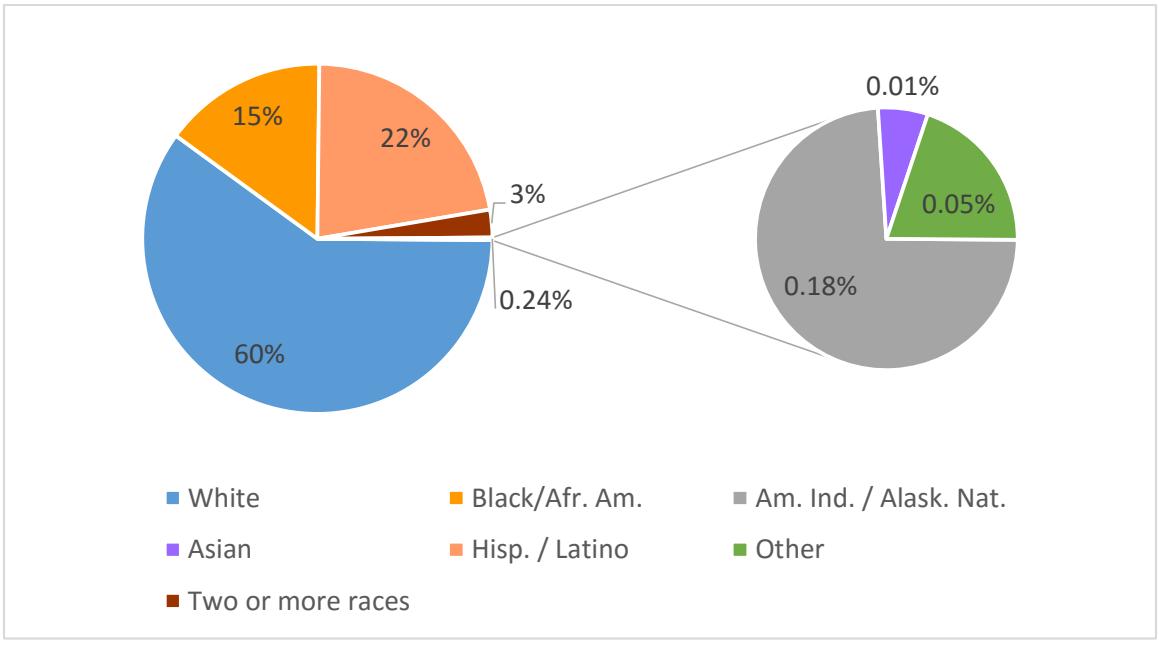
Grimes County contains slightly more males than females (Fig. 6). The three largest race groups are White, Hispanic / Latino, and Black / African American and are visualized in Figure 7. Ages are well distributed, with most people aged between 25 and 44 and a median age of 39 (U.S. Census, 2014a). Given that most County residents fall within young-to-middle adulthood, their tendency to drive is high.

Figure 6: County Gender Distribution, 2014



Source: U.S. Census (2014a).

Figure 7: County Race Distribution, 2014



Source: U.S. Census (2014a).

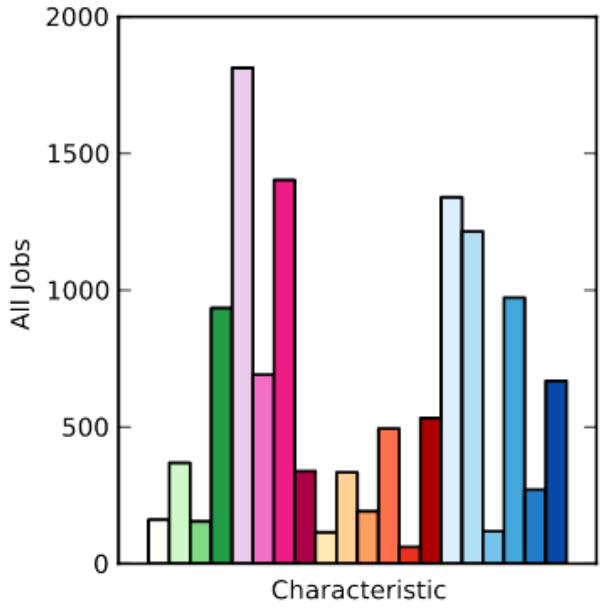
1.4 Income and Education

Median household income in Grimes County is $46,652, compared with the Texas median household income of $52,576. 11.6% of the County's residents possess a bachelor's degree or higher, compared to Texas' 27.1% (U.S. Census, 2014a). Low income will restrict some residents' ability to own cars, making design for all modes of transportation essential.

1.5 Workforce Industry Sectors

Figure 8 charts County job counts by industry. 12,181 workers lived in Grimes County in 2014. Highest job counts are found in manufacturing, retail trade, and educational services, in that order. This heavy emphasis on manufacturing highlights a need for durable roads that can support freight traffic.

Figure 8: County Workforce Composition - Job Count by Industry Sector, 2014



	Count	Share
Total All Jobs	12,181	100.0%
Agriculture, Forestry, Fishing and Hunting	161	1.3%
Mining, Quarrying, and Oil and Gas Extraction	369	3.0%
Utilities	155	1.3%
Construction	935	7.7%
Manufacturing	1,813	14.9%
Wholesale Trade	691	5.7%
Retail Trade	1,403	11.5%
Transportation and Warehousing	339	2.8%
Information	115	0.9%
Finance and Insurance	334	2.7%
Real Estate and Rental and Leasing	192	1.6%
Professional, Scientific, and Technical Services	494	4.1%
Management of Companies and Enterprises	62	0.5%
Administration & Support, Waste Management and Remediation	532	4.4%
Educational Services	1,340	11.0%
Health Care and Social Assistance	1,215	10.0%
Arts, Entertainment, and Recreation	119	1.0%
Accommodation and Food Services	973	8.0%
Other Services (excluding Public Administration)	271	2.2%
Public Administration	668	5.5%

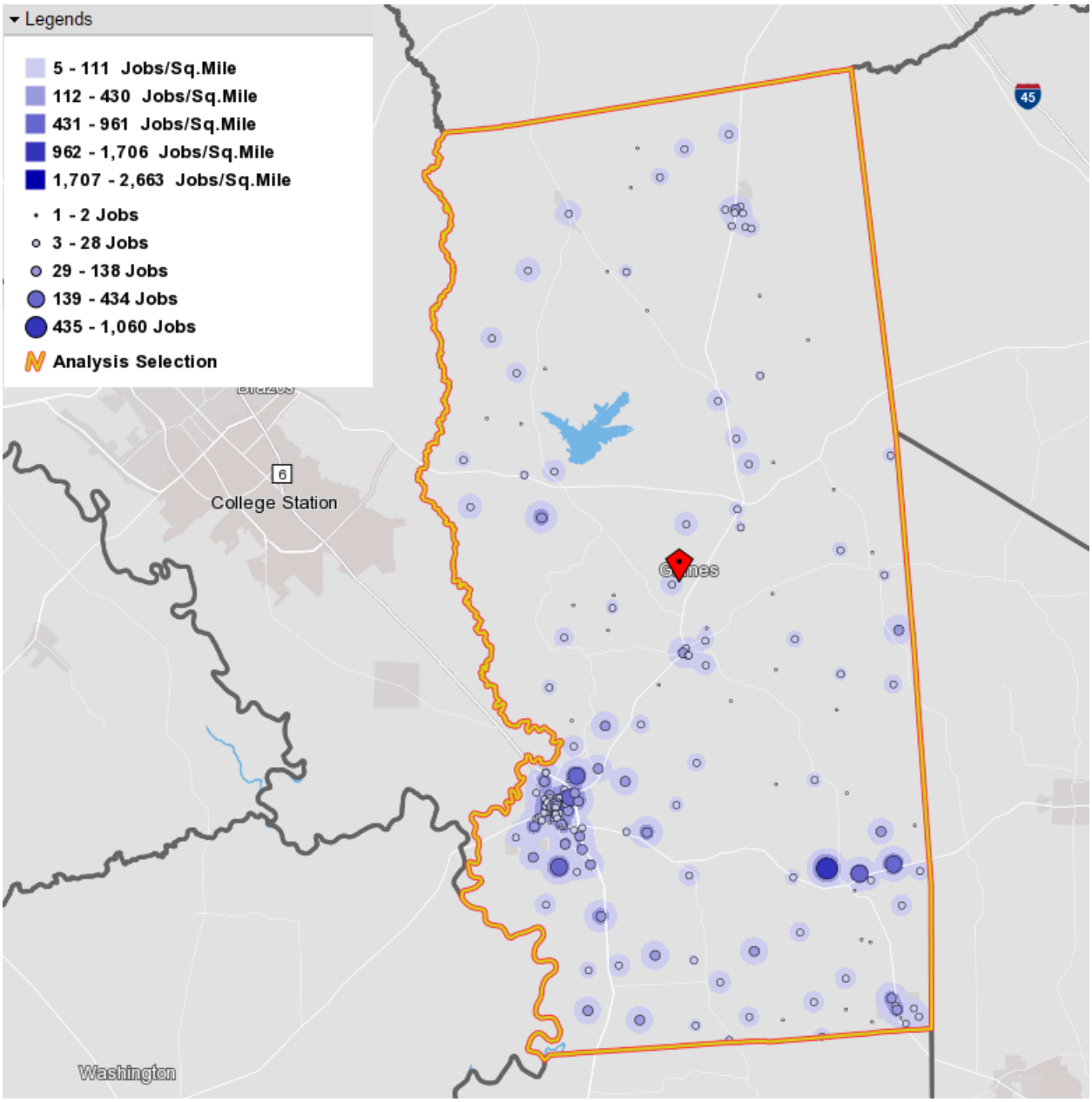
Source: U.S. Census (2014c).

1.6 Traffic Movement

An overview of workers' travel behavior will assist in understanding traffic flows within Grimes County. Figure 9 displays County job centers, shown as circles with a solid outline, and jobs in areas surrounding those centers, depicted using transparent buffers. A pattern of decentralization can be detected, with many small job centers scattered around the County. Larger concentrations exist in the southwest and southeast portions of the County, corresponding to the City of Navasota and the Texas Renaissance Festival site in Todd Mission. Because workplaces are spread out across rural and urban areas, roads in all locations—from small dirt roads to four-lane highways—deserve attention.

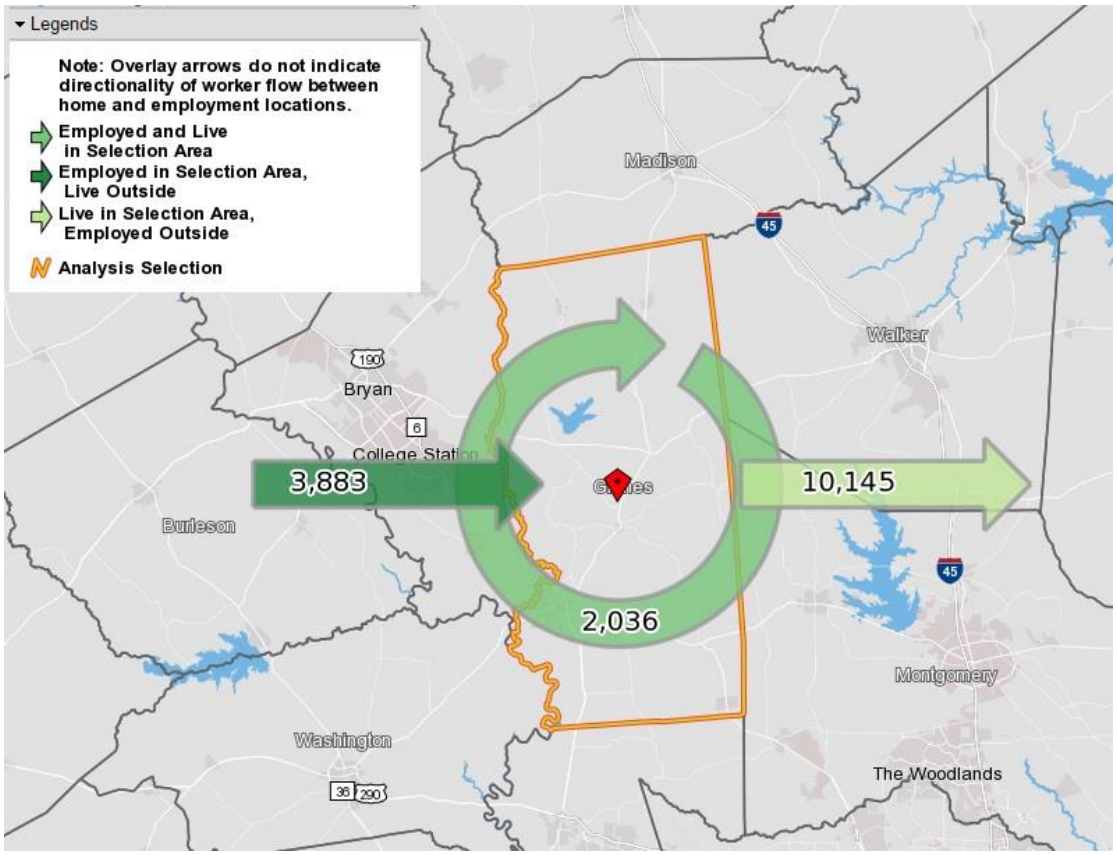
The inflow-outflow map (Fig. 10) illustrates patterns of commuting into and out of Grimes County. Almost three times as many employees commute from the County as commute into the County. Figures 11 and 12 reveal that the leading work destinations for people living in Grimes County are within Houston, Bryan / College Station, and Navasota city limits. Commuters will rely heavily on highways for work travel, emphasizing the importance of a well-maintained, well-connected system of arterial roads.

Figure 9: County Job Centers, 2014



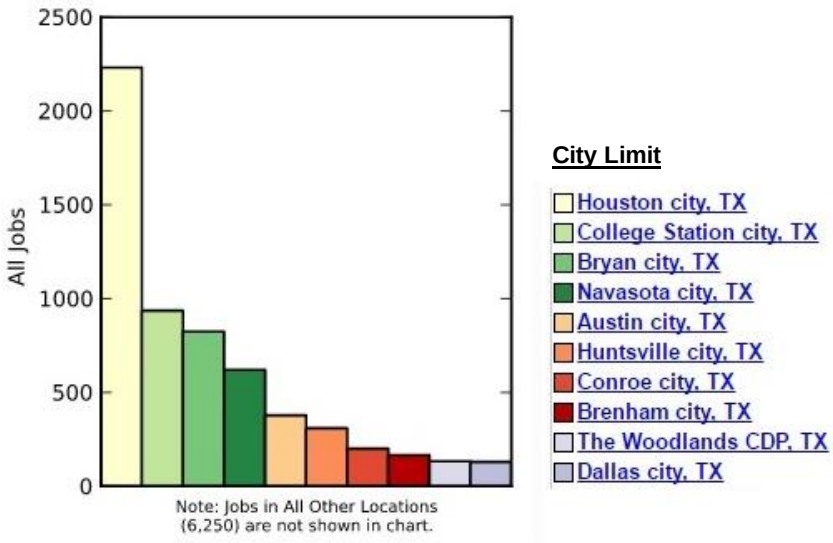
Source: U.S. Census (2014c).

Figure 10: Inflow-Outflow Map, 2014



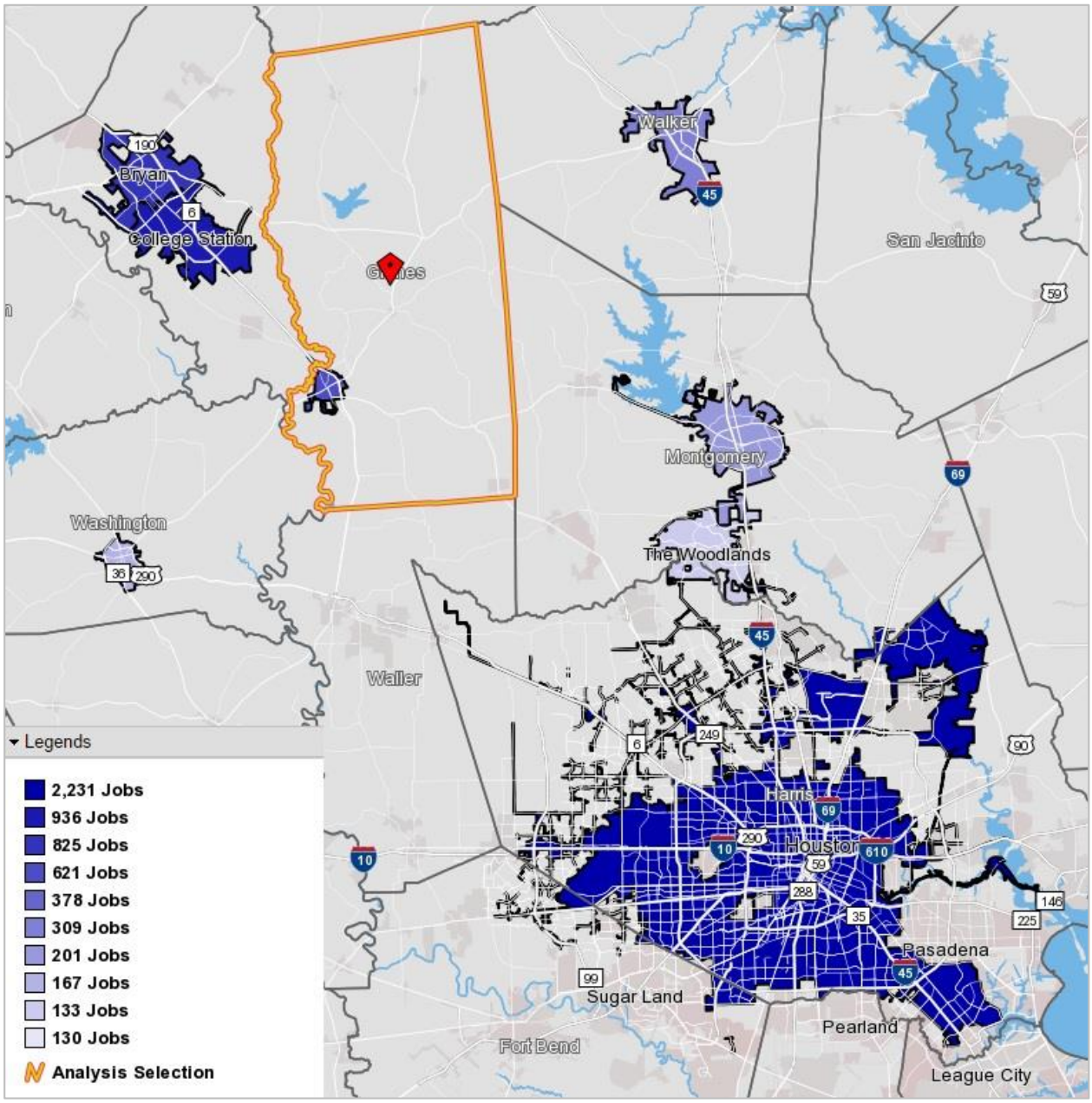
Source: U.S. Census (2014c).

Figure 11: Work Destinations of County Residents - Job Count by Work Place, 2014



Source: U.S. Census (2014c).

Figure 12: Work Destinations of County Residents – Map, 2014



Source: U.S. Census (2014c).

2.0 Community Transportation Vision and Local Priorities

The creation of any plan affecting a community requires local input, and each step of the GCTP has involved guidance and feedback from County officials. This chapter outlines the community engagement process woven into the GCTP, as well as goals and priorities that have been identified as valuable to Grimes County.

2.1 Community Engagement Process

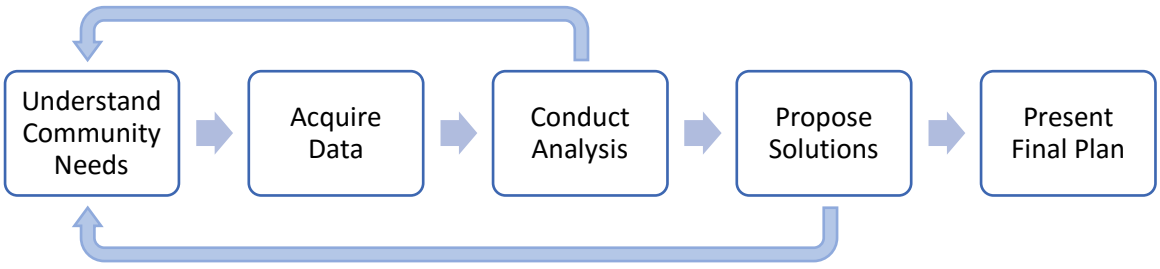
A core team of Grimes County officials—Judge Ben Leman, Road and Bridge Administrator Greg Blake, and 9-1-1 Addressing Coordinator Katherine Lee—met monthly with representatives from Texas A&M University and Texas Target Communities ("TTC") to guide the formation of the GCTP. Table 1 shows a record of meeting dates, attendees, and topics. Some meetings occurred within the setting of Texas A&M University in the absence of the Grimes County core team, though results of these conversations were relayed to the County during later meetings.

Figure 13: Judge Ben Leman and Lauren Simcic at the Feb 24 Core Team Meeting

Source: Masterson (2016).

Figure 14 illustrates the steps involved in producing the GCTP. First, the core team met with TTC representatives and the author to discuss community transportation needs. Second, data was acquired in the form of spreadsheets and geographic information system (GIS) shapefiles. Third, the author conducted analyses to produce maps showing land suitability and high priority intersections. The core team reviewed these products at a meeting on February 24, 2016. Feedback from the meeting was then applied, requiring additional data acquisition and analysis. Fourth, the author proposed solutions to County transportation problems through a functional classification hierarchy and road-cross-section diagrams. Core team members helped refine those elements at the April 8 meeting. Fifth and finally, all products and feedback were brought together, and a presentation of the final plan will take place in Grimes County on April 29.

Figure 14: Community Feedback in the Grimes County Thoroughfare Plan Process



Source: Simcic (2016d).

Table 1: Community Involvement and Meeting Record

Date	Attendees	Topic
Dec. 3, 2015	John Cooper, Jaimie Masterson, Ben Leman	Grimes County's interest in a thoroughfare plan
Dec. 16, 2015	Lauren Simcic, John Cooper, Jaimie Masterson, Ben Leman, Greg Blake, Katherine Lee	Work plan for completion of GCTP; Overview of County transportation needs
Weekly, Jan. – Apr.	Lauren Simcic, Jaimie Masterson	Weekly progress and challenges
Jan. 19, 2016	Lauren Simcic, Wei Li	Work plan and data acquisition for completion of GCTP
Jan. 25, 2016	Lauren Simcic, Katherine Lee	Obtaining GIS data for Existing Conditions chapter and land suitability analysis
Jan 29, 2016	Lauren Simcic, Greg Blake	"Drive along" tour to become familiar with classification levels of Grimes County roads, road maintenance and construction techniques, and proposed locations of SH 249 and high speed rail (HSR)
Feb. 10, 2016	Lauren Simcic, Texas A&M Student Senate, outside speakers	Texas A&M student body's official position on the use of eminent domain to obtain land for Grimes County HSR
Feb. 12, 2016	Lauren Simcic, Sam Nobles	Intersections of greatest concern due to frequency of accidents
Feb. 15, 2016	Lauren Simcic, Tim Lomax	Engineering concepts applied to problem intersections
Feb. 16, 2016	Lauren Simcic, Wei Li	Feedback and corrections to land suitability analysis; Recommended content of County profile
Feb. 19, 2016	Lauren Simcic, Greg Blake	Tailoring the draft road classification hierarchy to current pavement quality and right-of-way of county roads[1]
Feb. 24, 2016	Lauren Simcic, Jaimie Masterson, Ben Leman, Greg Blake, Katherine Lee	Feedback and corrections to introduction and Chapters 4 and 5 of GCTP
Mar. 11, 2016	Lauren Simcic, Shuman Tan	Representing TxDOT accident data visually
Mar. 28, 2016	Lauren Simcic, Greg Blake, Katherine Lee	Improving readability of figures and text in GCTP first draft; Obtaining GIS data for County power lines and proposed HSR
Apr. 8, 2016	Lauren Simcic, Ben Leman, Greg Blake	Potential road extensions throughout County based on land suitability analysis and proposed road classification hierarchy

[1] A note on capitalization: "county road" or "County Road" refers to a specific road classification type, while "County road" indicates any road contained in Grimes County.

2.2 Transportation Vision and Goals

In addition to shaping analysis and presentation of the document, the meetings produced the following goals:

1. Provide logical classifications and connections throughout the County, maximizing connections to proposed State Highway 249.
2. Ensure safe travel for vehicles and bicycles through regular maintenance and flood preparedness.
3. Maximize economic development in the vicinity of roads across the County.

2.3 Local Priorities

Grimes County possesses a unique ecological, infrastructural, political, and economic background, which offers challenges and opportunities to its future road system. Some unique factors influencing the thoroughfare plan include: flooding, vehicle and bicycle safety, proposed State Highway 249, a proposed high speed rail project, and the potential for development near roads. These are addressed below:

2.3.1 Flooding

Grimes County demonstrates a high flood risk, as evidenced by widespread road damage inflicted by flooding in May 2015. Gravel and dirt road surfaces can be swept away by flood waters, and paving with asphalt or chipseal is considered an essential preventative measure. FEMA funding covers 75 percent of approved flood-related repairs but does not allow for preemptive paving (D. Lily, personal communication, Feb. 12, 2016).

Figure 15: Flooding on FM 1774, May 2015

Source: McDermand (2015).

2.3.2 Road Safety

Grimes County has expressed concern over the number of accidents occurring due to low visibility at intersections (S. Nobles, personal communication, Feb. 12, 2016). Visibility is limited when roads meet at acute, rather than right, angles, and when curving paths are combined with steep slopes (Vermont DOT, 2012). Furthermore, bicycle safety is hindered by the absence of any designated bike lanes in the County.

Figure 16: Yield Sign at Unknown Intersection

Source: "YIELD Sign-Controlled" (2015).

2.3.3 Introduction of State Highway 249

The Texas Department of Transportation (TxDOT) is preparing to extend SH 249 northward from its current stopping point in Pinehurst, through Todd Mission toward Navasota (TxDOT, 2014a). This project calls for precautions to avoid flooding of the new road. In addition, care must be taken to designate new right-of-ways connecting SH 249 to nearby subdivisions, while avoiding interference with existing roads.

2.3.4 Potential Houston-Dallas High Speed Rail

Texas Central Partners' high speed rail project is intended to cut north-south through Grimes County, perhaps with a stop near the County's center. The rail carries with it a host of potential issues—including its positioning on a hill-like structure called a berm, which will require underpasses at intersections with roads; limited connectivity between the east and west sides of the County resulting in slower emergency response; and devaluation of profitable farm and ranch land (G. Blake, personal communication, Jan. 29, 2016). In the event that the rail is built, special care must be taken to ensure that logical connections in the road network between properties are maintained.

Figure 17: Proposed HSR Routes through County, Sept. 2015

Source: Reprinted from Christian (2015).

2.3.5 Development Near Roads

Newly constructed and long-existing roads both offer opportunities for nearby development. As roads are built, expanded, and repaired, communication with nearby landowners is necessary to establish cooperation that allows for new residential, commercial, and industrial development. Infrastructure such as power lines and sewage must also be taken into account; construction where these systems are already in place will likely occur at a lower cost to the developer.

Figure 18: Mallett Brother Barbeque, Navasota

Source: "William W." (2010).

3.0 Literature Review

This literature review serves a dual purpose. First, it presents exemplary thoroughfare and transportation plans that can be applied to the GCTP. Second, it summarizes the sources used in crafting design standards for the road cross-section diagrams in Chapter 5.

3.1 Case Studies

Case studies were selected based on their quality of execution and their relevance to Grimes County. Key points of each chosen plan or project are outlined below.

3.1.1 Tomball, Texas

Reaching a population of 11,299 by July 2014 (U.S. Census, 2014d), Tomball draws much of its growth from nearby Houston and Exxon oil company (History of the City, n.d.). The city is situated northwest of Houston and has benefited from the metropolitan area's outward expansion. Located northwest of Tomball, Navasota may soon experience a similar stimulus to its population and economy.

Figure 19: Aerial View of Tomball Roads

Source: Tomball Festival (2016).

The 2009 City of Tomball Major Thoroughfare Plan Report touches on two concerns that apply to Navasota: incorporating city zoning ordinances into transportation planning, and establishing truck routes to control congestion and properly direct vehicles carrying hazardous materials. Navasota has its own zoning map and can benefit from a combined treatment of zoning and transportation. Additionally, Navasota contains Business State Highway 6, more commonly known as N. LaSalle Street, though this two-lane road is not solely designated for industrial traffic. As the City grows, expansion of Business SH 6 may prove necessary.

Tomball's thoroughfare plan map features clear differentiation between functional classification of roads through line thickness, pattern, and color. The thoroughfare plan map for Navasota included in Chapter 5 integrates similar visuals.

3.1.2 Livingston County, New York

Connect Livingston: Linking Our Communities, published in 2013, is the transportation connectivity plan for Livingston County, New York. This document has been praised by the Federal Highway Administration for its thorough examination of the County's existing conditions, as well as its community outreach efforts. Livingston County is largely rural, allowing for comparison with Grimes County. Taking inspiration from *Connect Livingston*, Chapters 2 and 4 of this plan explore demographics, income, job centers, and commuting patterns within the County. Finally, *Connect Livingston* provides a detailed action plan; the GCTP will likewise lay the groundwork for implementation in Chapter 6.

3.1.3 Catawba County, North Carolina

Though it houses more than five times the population of Grimes County (U.S. Census, 2014d), Catawba County in North Carolina experiences some similar challenges, including constrained right-of-way widths and the need to prioritize roads for improvement. The 2009 "Thoroughfare Plan for Catawba County" stands out in its methods for identifying high priority intersections for safety upgrades by examining traffic volumes and crash data in tandem. Likewise, Chapter 3 of this plan will pinpoint intersections with high traffic and recorded fatal crashes, and Chapter 7 will provide recommendations for ensuring safety at these points.

3.1.4 Weatherford, Texas

With nearly 28,000 residents (U.S. Census, 2014d), Weatherford greatly exceeds Navasota in population. However, the guiding concepts of the 2009 City of Weatherford Thoroughfare Plan can be applied across a variety of contexts. The plan addresses ideas such as context sensitive solutions, complete streets, and access management, which are also used to guide the Grimes County Transportation Plan. The connection between these broad concepts and the products of the Weatherford plan is well explained, and the GCTP aims to achieve the same clear communication.

Figure 20: Weatherford Downtown Cafe, Weatherford, TX

Source: City of Weatherford (2013).

3.1.5 Arlington, Texas

The 2011 City of Arlington Thoroughfare Development Plan offers a unique road classification hierarchy that is based on a flexible design matrix. Rather than setting a single numerical benchmark to which all roads of a certain type must adhere, the flexible design matrix offers a range of values. This adaptability allows for unique thoroughfare identities and blending of the road with nearby land uses. The technique used by Arlington would also serve Grimes County, where land uses vary considerably between urban and rural areas, and lane widths are often limited by narrow easements—portions of private land set aside for public infrastructure—along property lines.

Figure 21: Bicycle Lane, Arlington, TX

Source: City of Arlington (2011).

3.2 Design Standards

To ensure unity in components of the proposed plan, a foundation of design principles is required. These ideas can shape roads to match the surrounding atmosphere, promote physical activity, boost commercial development, manage congestion, and improve safety for every mode of travel, as the sections below will elaborate. Below are explanations of three principles shaping the GCTP: Context Sensitive Solutions (CSS), complete streets, and access management.

3.2.1 Context Sensitive Solutions

CSS is defined by the City of Weatherford Thoroughfare Plan as "the practice of developing transportation projects that serve all users and meet the needs of the neighborhoods through which they pass" (2013, p. 20). CSS relies on some of the same measures as traditional thoroughfare planning—including traffic counts, traffic demand, and level of service—though these are not the only factors considered. The New York State Department of Transportation summarizes the varied interests encompassed by CSS: "CSS strives to balance environmental, scenic, aesthetic, cultural, and natural resources, as well as community and transportation service needs" (qtd. in ITE, 2010, p. 211).

Noted in *Context Sensitive Design Around the Country* (TRB, 2004) as an example of well executed CSS, Asylum Avenue in West Hartford, Connecticut, bears a resemblance to E. Washington Avenue in Navasota. Asylum Avenue is classified by the Connecticut Department of Transportation as a minor urban arterial, and Grimes County has classified E. Washington Avenue as a primary municipal road, equivalent to a major urban arterial. Both streets exhibit a more intimate neighborhood feel than their classification levels imply.

Figure 22: Asylum Avenue, West Hartford, CT

Source: TRB (2004).

A raised center median and street parking have assisted in revitalizing Asylum Avenue, and it is expected that narrower traffic lanes would slow traffic to further increase livability. In a similar fashion, the GCTP cross-section diagram for a major urban arterial adjusts the existing dimensions of East Washington Avenue, adding a raised median, preserving street parking, and narrowing lanes to allow room for bicycle lanes and wider sidewalks.

Because much of Grimes County is characterized by small towns, CSS may assist in introducing safety measures to its rural main streets. Smart Growth America (2010) acknowledges several causes of danger on rural main streets, which often contain an uneasy combination of automobiles, farming equipment, and pedestrians. Speed limits are generally higher, contributing to crashes. A 2009 FHWA study concluded that narrowing lane widths in town centers is effective in reducing vehicle speed. These findings have been applied to cross-sections for rural roads in Chapter 5; the minor collector and local street sketches suggest 10-foot lanes.

3.2.2 Complete Streets

Complete streets "are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities" and "make it easy to cross the street, walk to shops, and bicycle to work," according to the National Complete Streets Coalition (Smart Growth America, 2016). Streets designed within this framework can give Grimes County residents the option of a healthy and stress-relieving walking or biking trip in areas where, currently, only driving is possible. In addition, complete streets have been found to promote the success of adjacent businesses by attracting customers and drawing in private investment (Smart Growth America, n.d.).

The State of Vermont has gained national recognition for its Road Design Standards and complete street guidelines, which accommodate a range of transportation modes while retaining rural character. The Vermont Agency of Transportation (2012) endorses these and other components of complete streets: access management, bike lanes, crosswalks, pavement maintenance, roadway reconfiguration (or "road diets"), separate paths for non-motorized traffic, adequate shoulder and sidewalk widths, and street lighting.

Salt Lake City offers an example of a successfully implemented complete street project. In 2014 a street revitalization initiative was enacted on 300 South in the downtown area. Diagonal parking spaces were straightened and shifted to make room for protected bicycle lanes and street parking. This project has stimulated a 30 percent increase in bike traffic in the 6 months since its completion. Furthermore, within that time period, an 8.8 percent sales increase was recorded for businesses along 300 South, compared with a 7 percent increase citywide (Anderson, 2015).

Figure 23: Parallel Parking and Bicycle Lanes on 300 South, Salt Lake City, UT

Source: Reprinted from Anderson (2015).

Guidelines from various institutions for minimum sidewalk, center median, and bicycle lane widths for the GCTP have been compiled in Table 2.

Table 2: Safe Widths for Select Road Elements

Road Design Element	Width (ft)	Source
Sidewalk	5 – 6	Safe Routes to School
Center median (rural multi-lane highway)	76	TxDOT Roadway Design Manual
Bicycle lane	4 – 5	AASHTO *Guide for the Development of Bicycle Facilities*

The GCTP gives significant attention to the introduction of bicycle lanes to Grimes County roads. The urban minor arterial cross-section sketch draws inspiration from Houston's Lamar Cycle Track. This two-way separated bike route bordering downtown Lamar Street is intended to provide an attractive path to encourage biking and reduce conflicts between cyclists and drivers (Lamar Cycle Track Page, n.d.).

Figure 24: Lamar Cycle Track Design, Houston

Source: Lamar Cycle Track Page (n.d.).

3.2.3 Access Management

The Navasota Comprehensive Plan calls for access management on major corridors in the City. Access management comprises "a set of techniques that state and local governments can use to control access to highways, major arterials, and other roadways," with increased capacity of roads, congestion management, and reduced crashes as anticipated benefits (FHWA, 2015a). The FHWA notes several approaches to access management, which encompass "access spacing, including spacing between signalized intersections and distance between driveways; turning lanes, including dedicated left- and right-turn lanes, as well as indirect left turns and U-turns, and roundabouts; and median treatments, including two-way left-turn lanes and raised medians" (FHWA, 2015a). The GCTP incorporates left and right turn lanes, two-way left turn lanes, and raised medians into its proposed designs for urban and rural arterials and major collectors.

Figure 25: Center Median on Bridgeport Way, University Place, WA

Source: TRB (2004).

4.0 Existing Conditions

Figure 26: Aerial View of SH 90 and CR 444

Source: Google Earth.

A survey of existing conditions has been conducted to shape and support recommendations offered in the thoroughfare plan. Overviews of the current road classification system, paving surfaces, traffic accidents, and traffic volumes within Grimes County are shown below. A land suitability analysis is also presented to visualize ideal locations for future thoroughfares. Finally, a map displaying parcels owned by key landowners near proposed SH 249 is included. The GCTP appendix provides GIS data sources for figures in this and subsequent chapters.

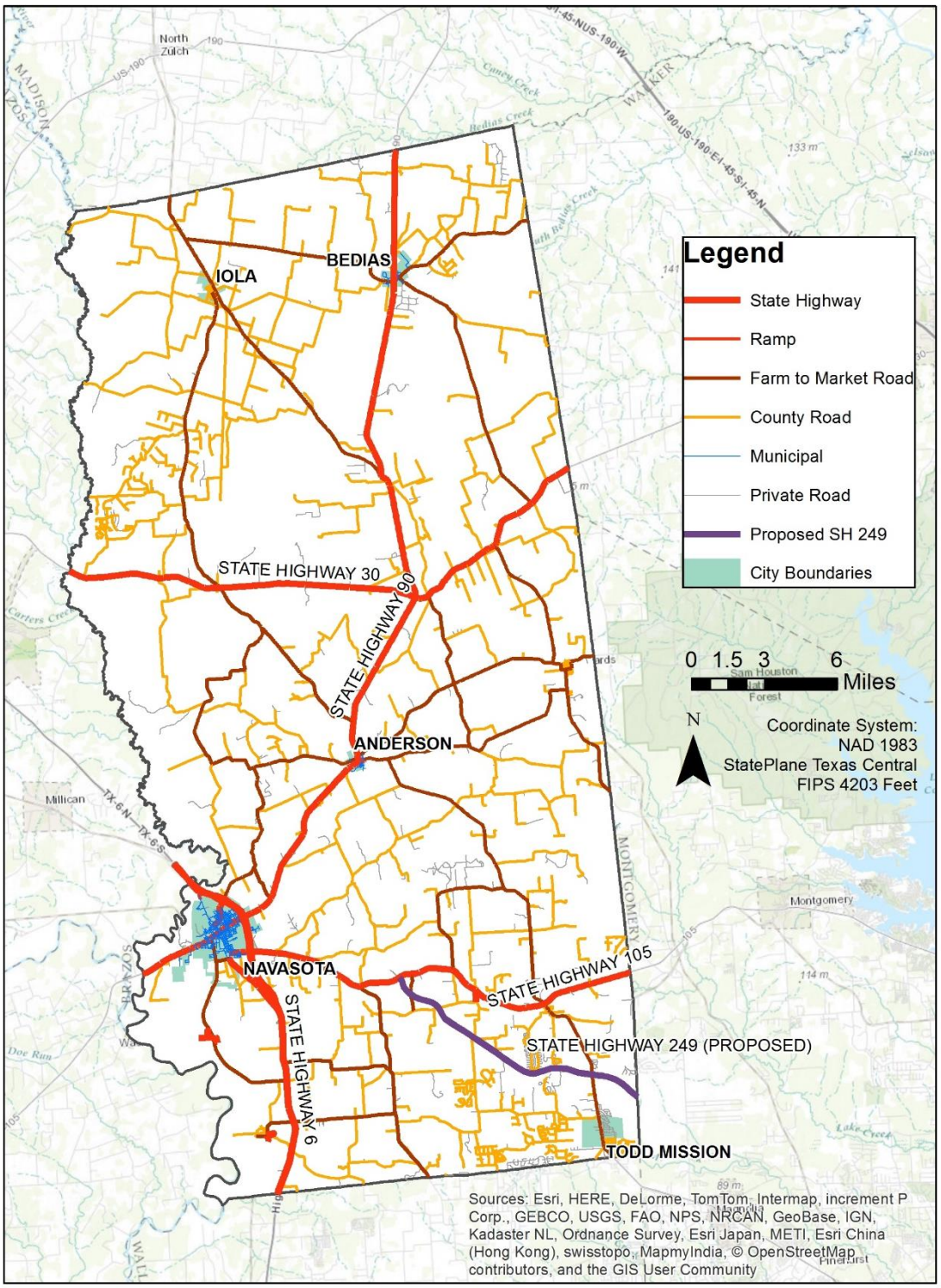
4.1 Road Functional Classification Hierarchy

A road functional classification hierarchy sorts roads into categories based on intended function and design characteristics. As Figure 27 illustrates, Grimes County's existing hierarchy divides roads into five main categories: State Highway, Farm to Market, county, municipal, and private. While the present levels allow for some differentiation between high and low capacity thoroughfares, it is recommended that the County reclassify its county, municipal, and private roads into major collectors, minor collectors, and local streets. This transition will generate a classification scheme that can be applied across urban and rural areas. Additionally, these more nuanced categories will serve to identify medium capacity roads that hold potential for growth.

4.2 Paving Surface Types

Figure 28 lays out road paving surface types, which were considered as one factor for producing the proposed functional classification hierarchy in Chapter 5. The map demonstrates that most asphalted roads correspond to state highways and Farm to Market roads. Remaining roads are paved with chipseal, gravel, dirt, or grass, with some concrete in urban areas. A tendency toward gravel county roads is visible in the north portion of the County, and dirt county roads are common in the south. Dirt roads are especially vulnerable to flood damage, as water can easily sweep away their surfaces (D. Lily, personal communication, Feb. 12, 2016), so the south end of Grimes County may warrant attention in paving projects.

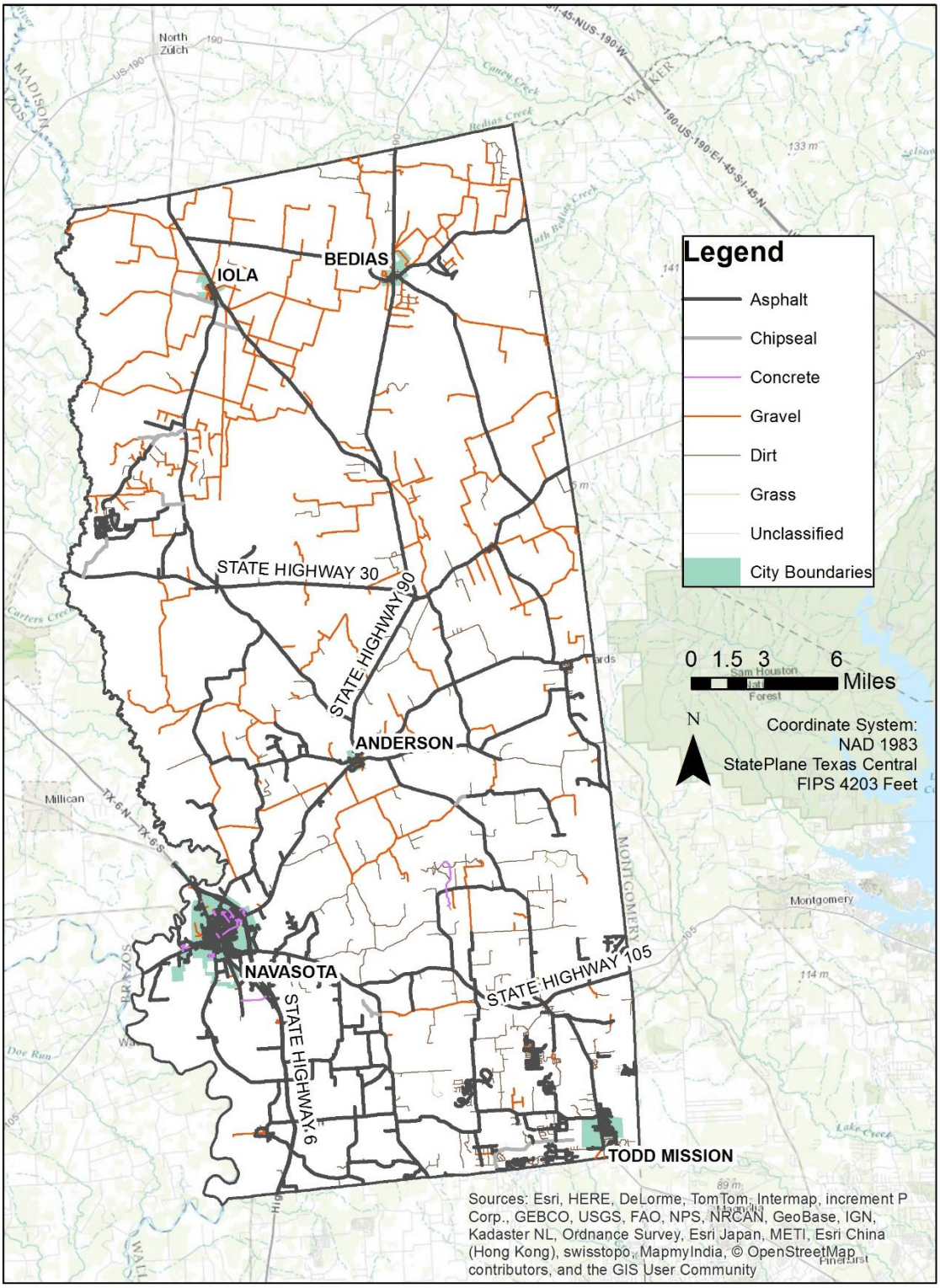
Figure 27: Existing Road Functional Classification System



Sources: Generated by author from Lee (2016), TxDOT (2016b).

[2] The SH 249 route is approximate and may change.

Figure 28: Existing Road Paving Surface Types

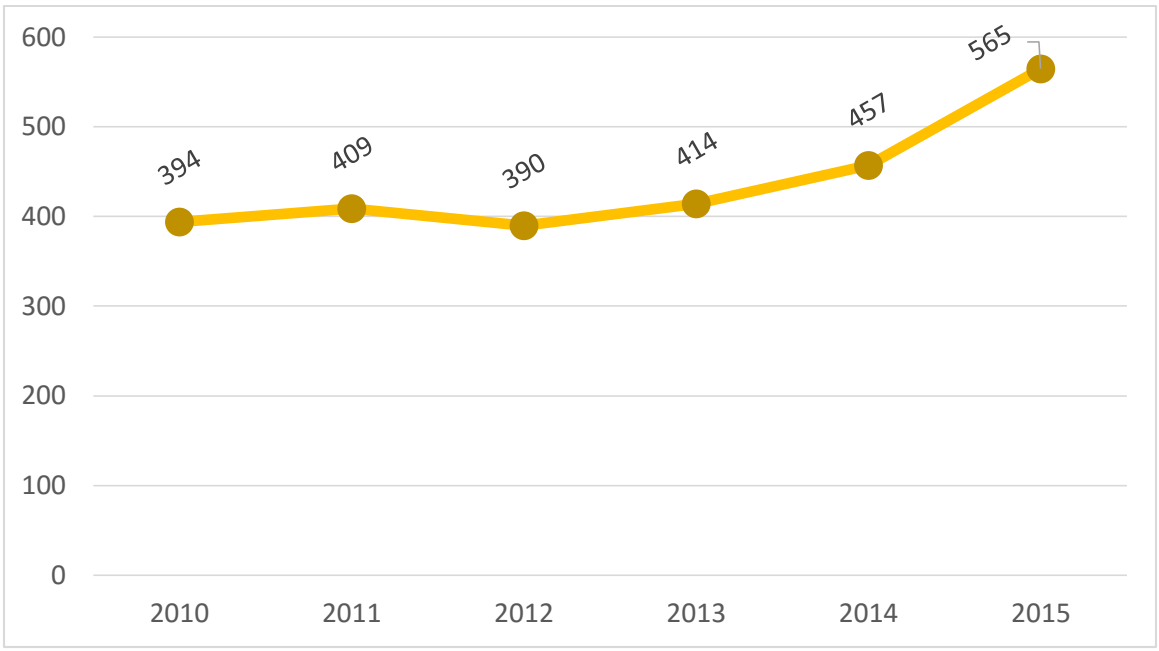


Source: Generated by author from Lee (2016).

4.3 Traffic Accidents

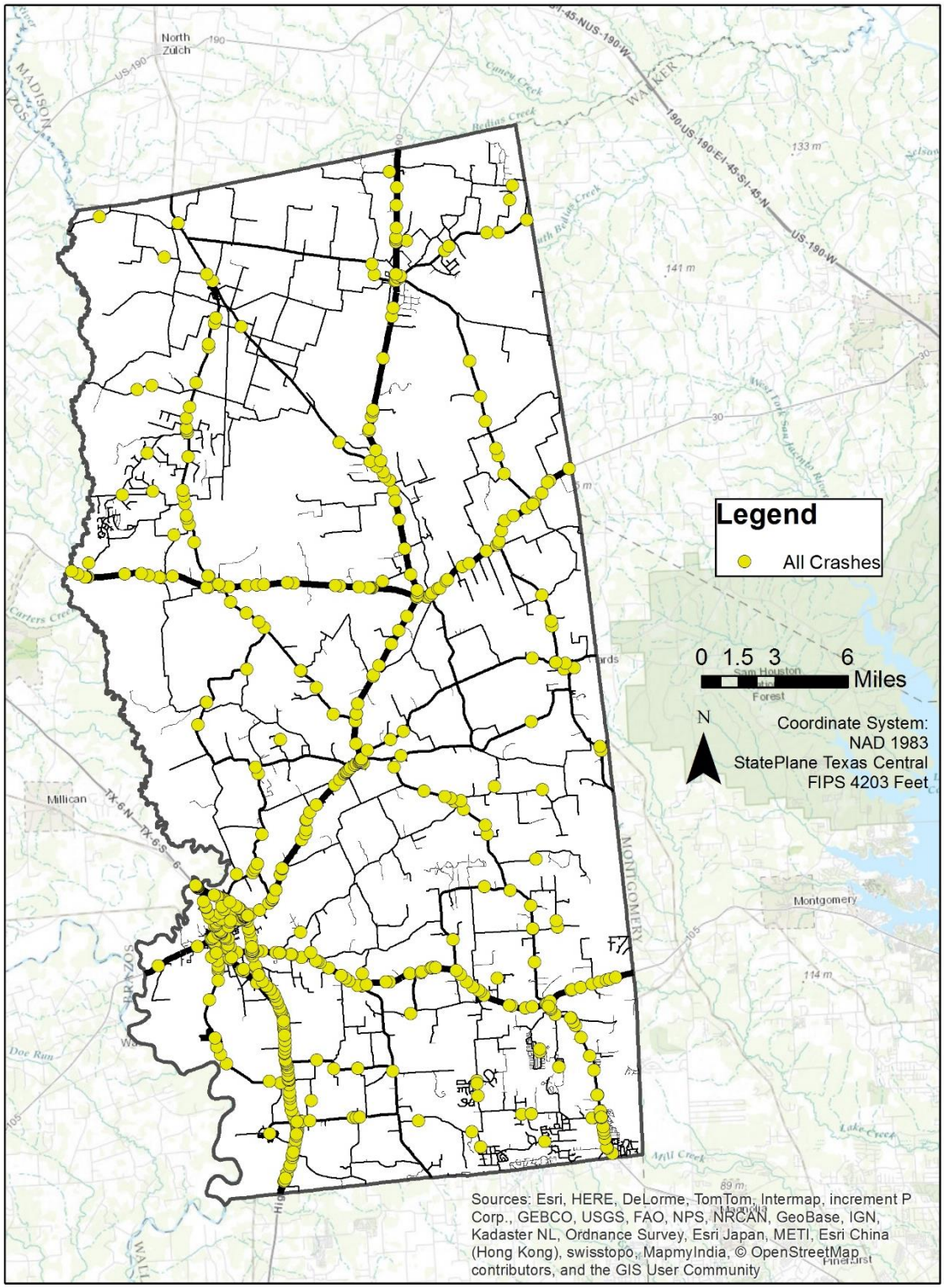
Because the GCTP prioritizes safety, a survey of traffic crash data is valuable. As is expressed by the trend in Figure 29, the number of crashes in Grimes County has risen at an increasing rate from 2010 to 2015. Figure 30 shows locations of all recorded traffic collisions in Grimes County from January 2015 to February 2016, and Figures 31 and 32 plot fatal crashes and crashes involving a bicyclist, respectively, from January 2010 to February 2016. The map of all crashes indicates that, while collisions occur on major and minor roads in all parts of the County, crashes are especially concentrated on arterial roads (state highways and Farm to Market roads) and near Navasota. Almost all fatal crashes occurred on arterials, implying that safety upgrades on these roads should constitute a priority for TxDOT. All bicycle crashes are clustered in and around Navasota, highlighting the importance of introducing bicycle routes in the City and other population centers.

Figure 29: Annual Number of Crashes in Grimes County, 2010 – Feb. 2016



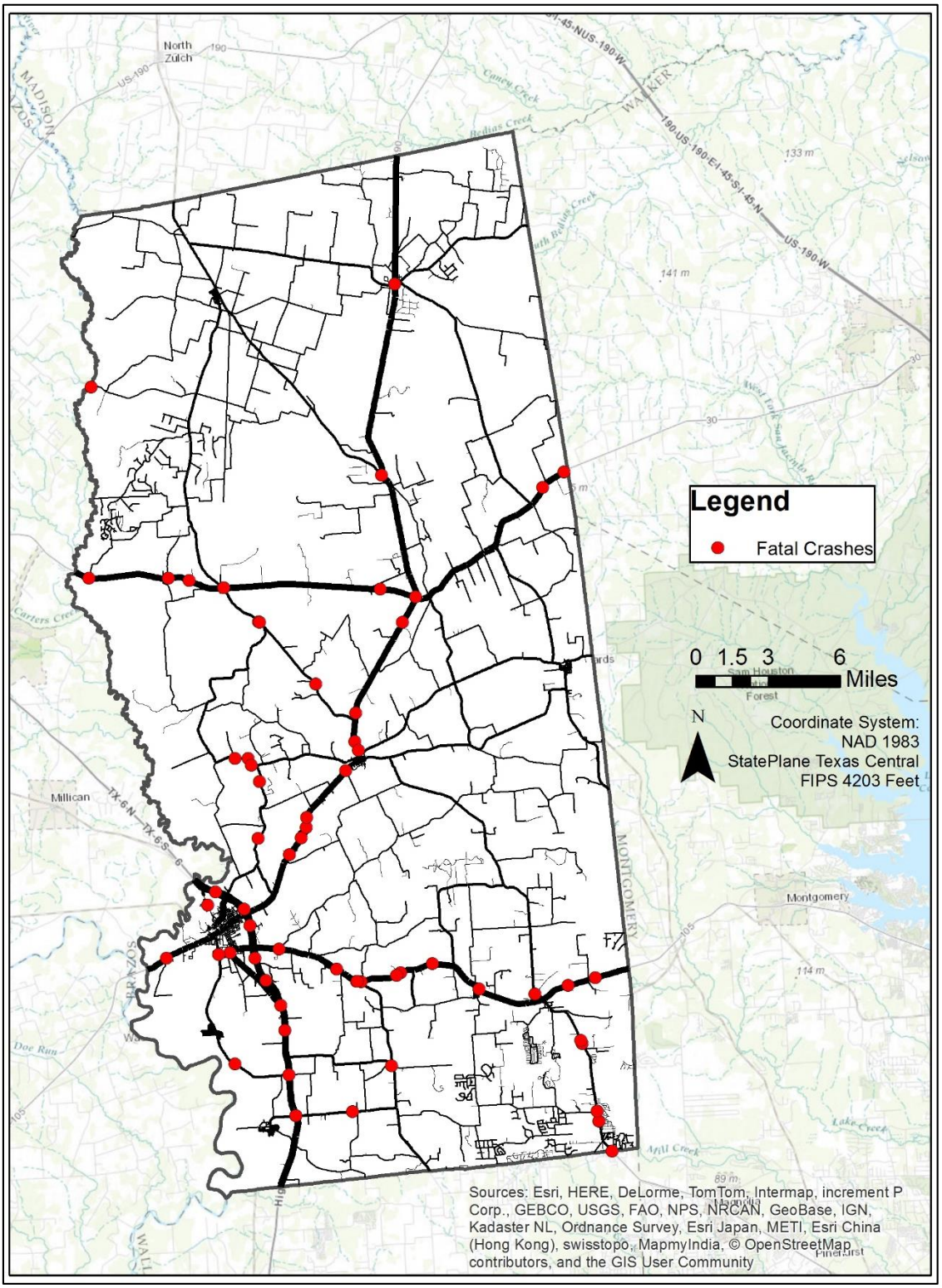
Source: TxDOT (2016a).

Figure 30: All Traffic Crashes in County, 2015 - Feb. 2016



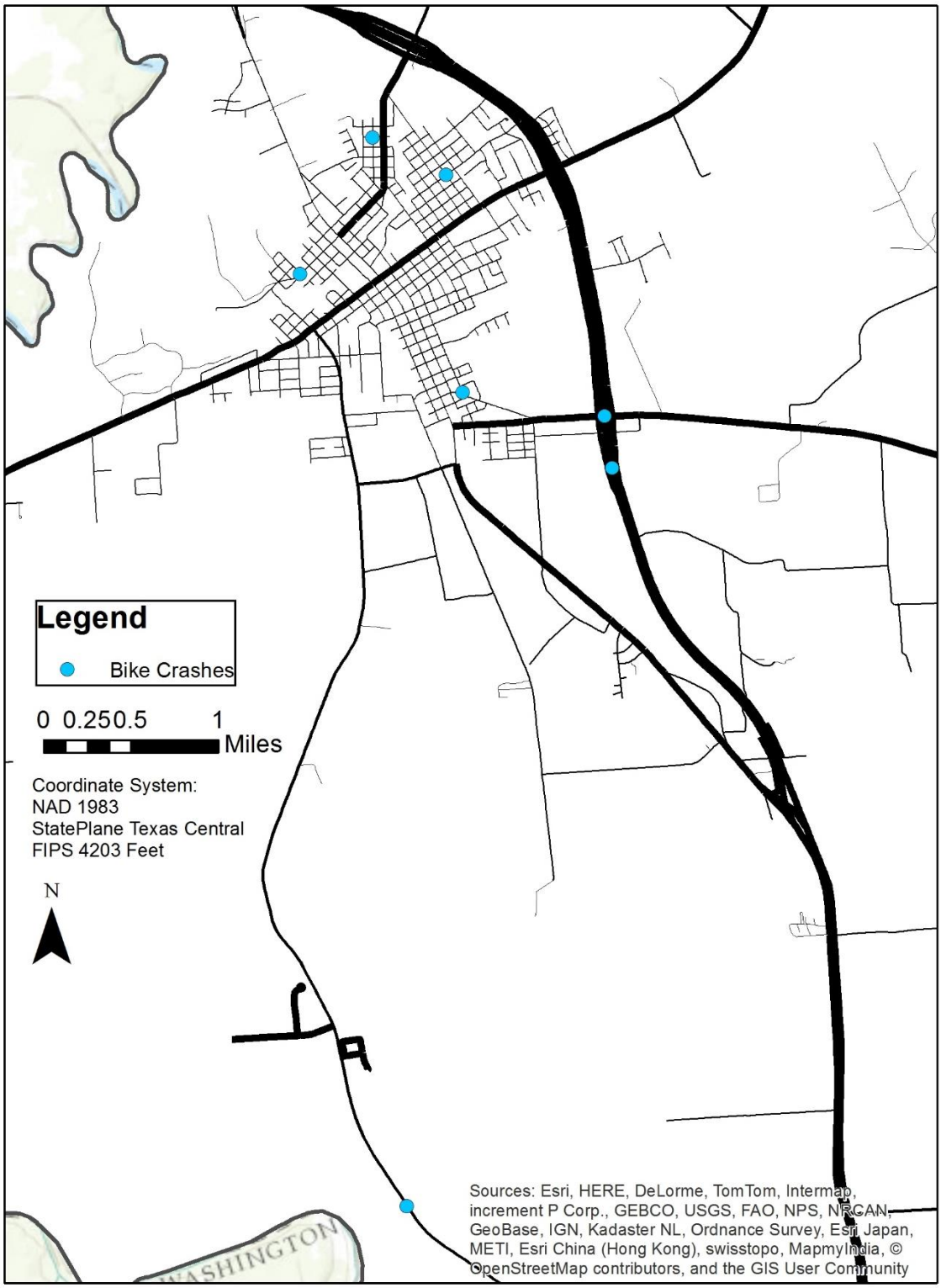
Source: Generated by author from Lee (2016), TxDOT (2016a).

Figure 31: Fatal Crashes in County, 2010 - Feb. 2016



Source: Generated by author from Lee (2016), TxDOT (2016a).

Figure 32: Crashes Involving a Bicyclist in County, 2010 - Feb. 2016



Source: Generated by author from Lee (2016), TxDOT (2016a).

4.4 Traffic Volumes

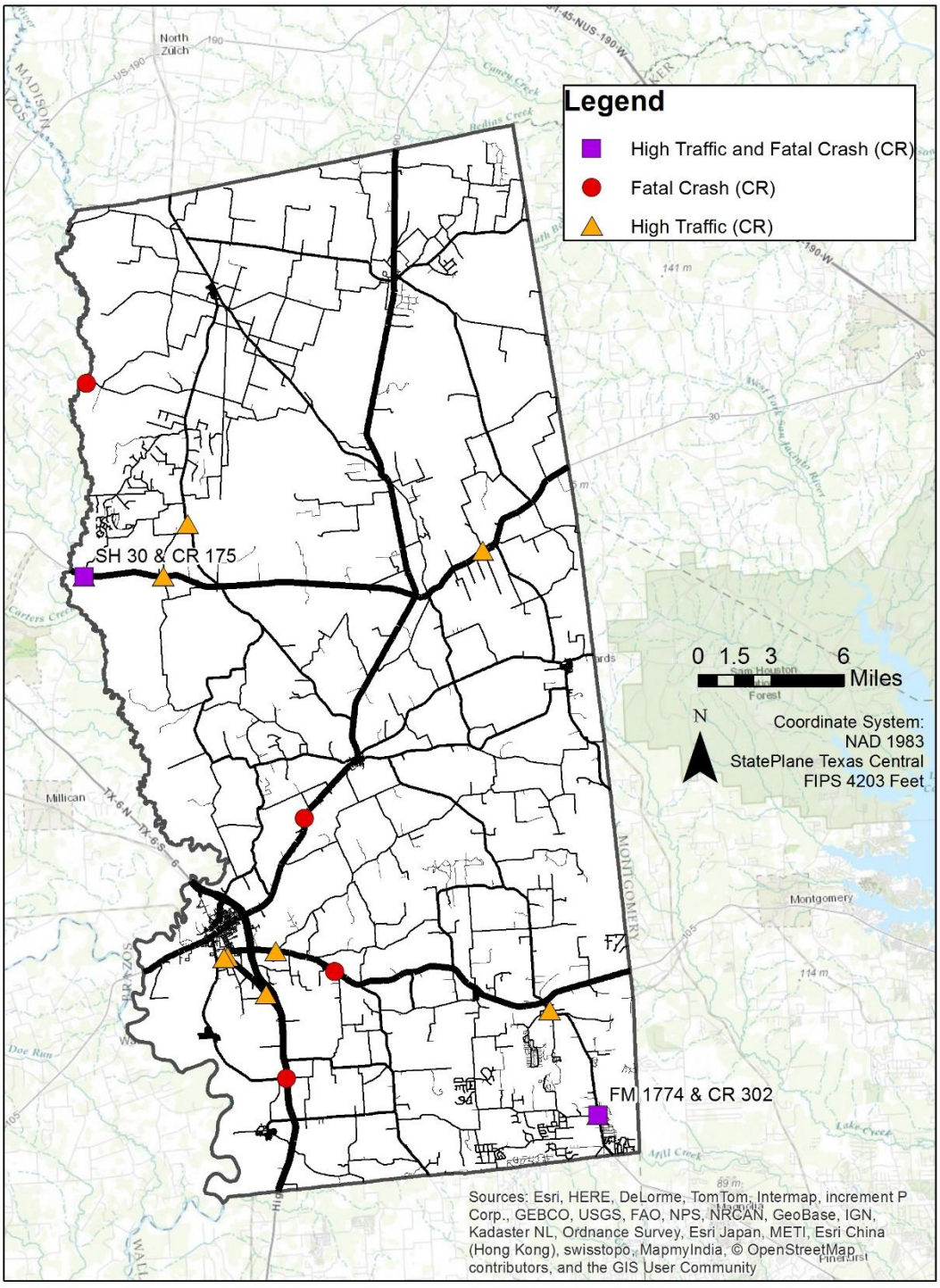
Traffic counts were conducted by the Road and Bridge Department for select county roads in 2013 through 2015. This information is useful for determining present and future functional classification levels. To conduct a count, a device was placed at the intersection of two roads to sense and count vehicles moving in one direction. The duration of counting periods ranged from 1 to 15 days. Of the locations studied, Table 3 provides a list of the 10 intersections with highest traffic counts per day. Figure 33 overlaps traffic counts and fatal crashes to pinpoint high priority intersections of county roads. Any intersection including at least one county road that exhibits a fatal crash incident from 2010 to 2016 and one of the top 10 traffic counts is indicated by a purple square symbol.

Table 3: County Road Intersections with Highest Traffic Counts, 2013-2015

Rank	Intersection	Vehicles Per Day	Month / Year of Count
1	SH 30 & CR 229W	5,588	Sept. 2013
2	FM 1774 & CR 302	1,920	Feb. 2013
3	FM 379 & CR 419N	982	Oct. / Nov. 2014
4	FM 379 & CR 418	972	Oct. / Nov. 2014
5	SH 30 & CR 174	686	May 2013
6	FM 1774 & CR 202	634	Feb. 2013
7	SH 105 & CR 446	562	Feb. 2013
8	FM 244 & CR 174	530	May 2013
9	SH 30 & CR 175	519	May 2013
10	SH 6 & CR 452E	484	Oct. / Nov. 2014

Source: Burns (2015).

Figure 33: High Priority County Road Intersections

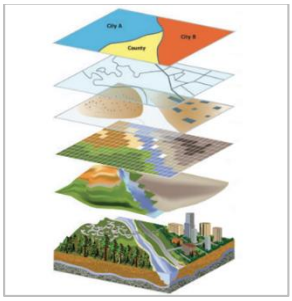


Source: Generated by author from Lee (2016), Burns (2015).

[3] High priority intersections (purple) include at least one county road, with a fatal crash between 2010 and 2016 (red) and one of the top 10 traffic counts from 2013 to 2015 (orange).

4.5 Land Suitability Analysis

Figure 34: Land Suitability Analysis Process Example



Source: Reprinted from ESRI (2016).

Land suitability analysis "aims at identifying the most appropriate spatial pattern for future land uses according to [specified] requirements, preferences, or predictors" (Malczewski, 2004, p. 4). An analysis was conducted using Esri ArcGIS software to discover areas in the County that are best suited for roads. Reduced cost for building new roads is expected in highly suitable areas due to existing infrastructure and potential partnerships with developers. A thorough explanation of the data and methods used is included in the appendix.

Figure 35 shows four categories of suitability applied to land in Grimes County, with corresponding suitability values outlined in Table 4. Most land in the County displays medium suitability, with highly suitable clusters near and between Navasota and Anderson and around Todd Mission. Unsuitable land can largely be found in the west, where floodplains are concentrated These findings are in agreement with the core team's assessment of the County's natural, social, and economic landscape (B. Leman & G. Blake, personal communication, Apr. 8, 2016).

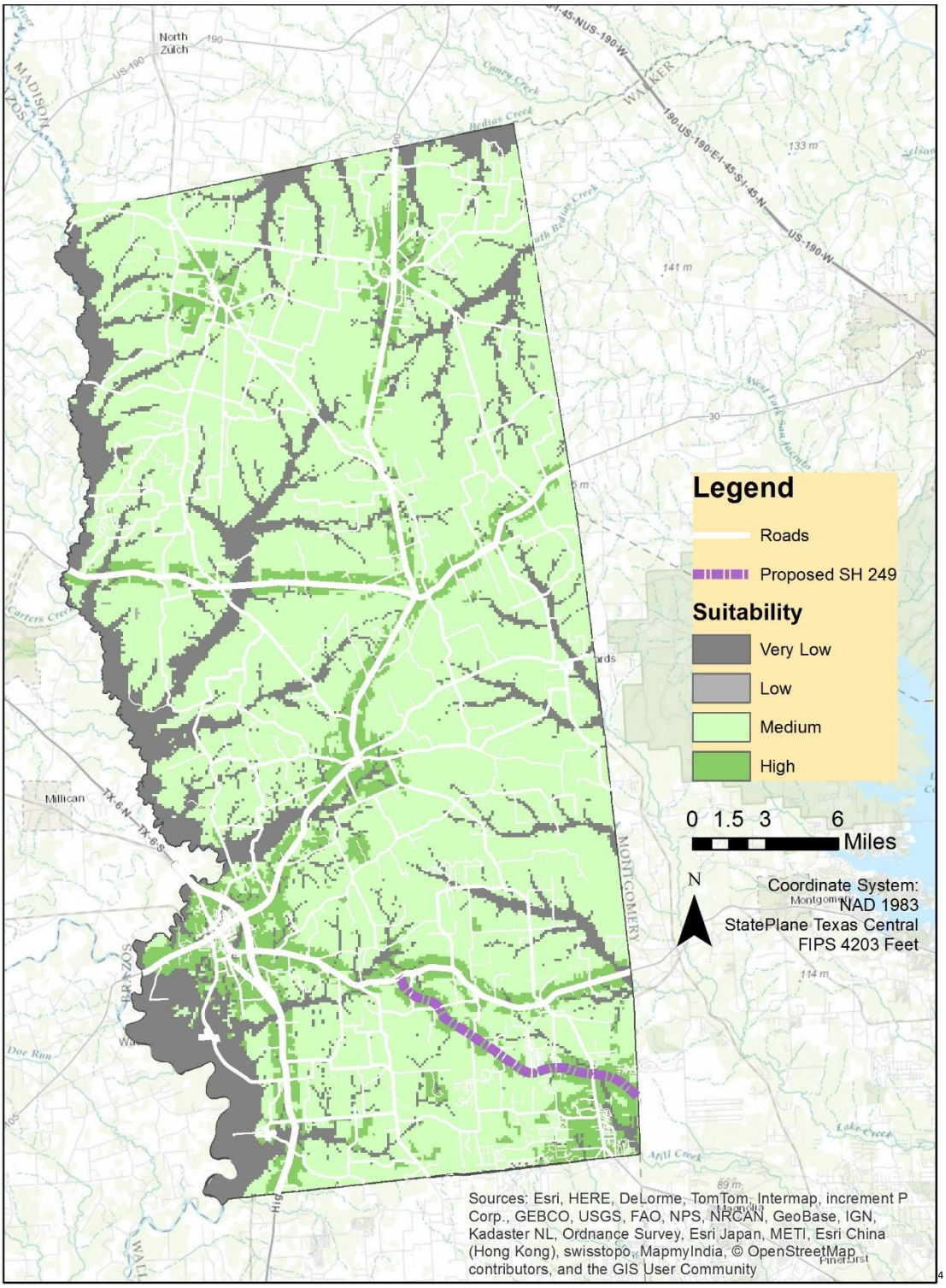
Table 4: Land Suitability Categories and Corresponding Values

Suitability Category	Suitability Value
Very Low	0
Low	0.001 – 1.5
Medium	1.501 – 3
High	3.001 – 4.6

4.6 Key Landowners Near Proposed SH 249

To aid community engagement efforts, a map of key landowners and subdivisions near proposed SH 249 has been generated (Fig. 36). Parcel data from the Grimes County Appraisal district was grouped by owner. Then landowners in possession of more than 100 acres within 1 mile of SH 249 were identified using buffers and selection queries. Subdivisions are included, as roads connecting residential areas to the proposed highway may emerge. By considering the existing conditions summarized in this section, officials, residents, and consultants of Grimes County can equip themselves to prioritize roads for improvement and maintenance, select environmentally and financially feasible locations for future thoroughfares, and serve the interests of multiple stakeholder groups.

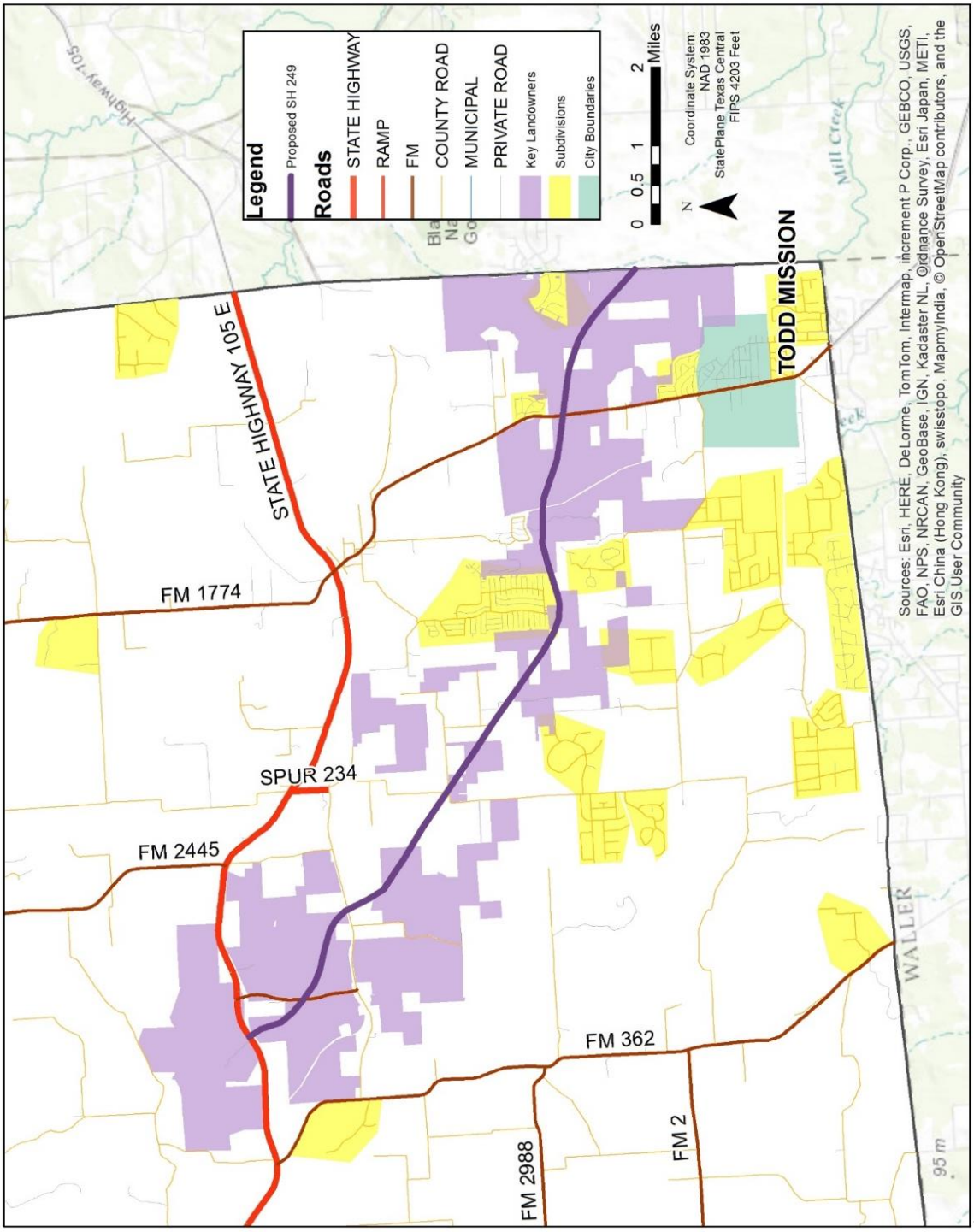
Figure 35: Land Suitability Analysis Map



Source: Generated by author from Lee (2016), TxDOT (2016b), U.S. Census (2010).

[4] The SH 249 route is approximate and may change.

Figure 36: Key Landowners Near Proposed SH 249



Source: Generated by author from Lee (2016), TxDOT (2016b).

[5] The SH 249 route is approximate and may change. Key landowners are individuals in possession of more than 100 acres of land within 1 mile of proposed SH 249.

5.0 Thoroughfare Plan

This chapter synthesizes information from previous sections to form the Grimes County Thoroughfare Plan. A new road classification hierarchy is presented in the form of tables, maps, and cross-section diagrams. A special focus is directed to the City of Navasota, identifying main corridors in the area and proposing several road extensions.

5.1 Functional Classification of Roads: Why and How?

The Federal Highway Administration (2013) has identified several purposes served by functional classification, which can be applied to Grimes County:

- To provide the framework of highways for creating mobility and connecting cities and other major traffic generators within the County
- To provide a basis for assigning jurisdictional responsibility according to overall importance of the road
- To provide for minimum design standards according to function
- To provide a basis for evaluation of present and future needs
- To provide a basis for allocation of funds

The FHWA has adopted separate road classification schemes for urban and rural areas. Urban areas are further divided into urban and small urban. Table 5 summarizes population thresholds for urban, small urban, and rural areas. Navasota is the only city in the County that qualifies as small urban; the remainder are rural.

Descriptions and examples corresponding to each classification level, both rural and local, are listed in Table 6.

Table 5: FHWA Urban-Rural Population Thresholds

Area Type	Population Threshold
Urban	50,000 and up
Small Urban	Starting at 5,000 and below 50,000
Rural	Below 5,000

Source: FHWA (2013).

Table 6: Descriptions of Road Functional Classification Levels

Functional Classification	Urban / Rural	Description[1]	Example
Major Arterial	Urban	*High mobility, low access road connecting major urban destinations, transitioning into rural major arterials*	State Highway 6 in Navasota
	Rural	*High mobility, low access road allowing for travel between major urban clusters, into and out of County*	State Highway 90 between Navasota and Anderson
Minor Arterial	Urban	*Somewhat high mobility, low access road serving trips of moderate length, providing urban connections to rural collectors*	LaSalle St. (Business SH 6) in Navasota
	Rural	*Road with greater trip length and travel density than rural collector, connecting cities, supplementing rural principal arterials*	FM 39 near Iola
Major Collector	Urban	*Road with balanced mobility and access, serving residential and commercial/ industrial areas, linking local streets and arterials*	Blackshear St. in Navasota
	Rural	*Mid-level mobility road connecting medium size towns to larger towns or arterials*	County Road 202 in Plantersville
Minor Collector	Urban	*Lower mobility, higher access road, serving low density development, usually for distances less than three-quarters of a mile*	Judson Ave. in Navasota
	Rural	*Mid-level mobility road, serving small communities and ensuring proximity of all developed areas to a minor collector*	Pinebrook Dr., extending from CR 202 near Plantersville
Local	Urban	*Low mobility, high access road, providing direct access to adjacent land*	White St. in Navasota
	Rural	*Low mobility, high access road, providing access to adjacent land, allowing for travel over short distances*	Sycamore St., extending from Pinebrook Dr. near Plantersville
Single Artery	Rural	*Single-lane low-maintenance road within or between properties*	Small dirt road

[1] Adapted from FHWA (2013).

5.2 Proposed Road Functional Classification Hierarchy

The hierarchy below was produced using State and County design standards, input from local officials, and on-site observation of various road types in Grimes County.

Table 7: Proposed Road Functional Classification Hierarchy

Functional Classification	Urban / Rural	One- / Two-Way	Number of Lanes	Lane Width (ft)	Outside Shoulder Width (ft)	Speed Limit (mph)	Surface Type
Major Arterial[1]	Urban	Two-way	2 – 4	11 – 12	4 – 10	60	Asphalt
	Rural	Two-way	2 – 4	12	8 – 10	60 – 70	Asphalt
Minor Arterial[1]	Urban	Two-way	2 – 4	11 – 12	4 – 10	60	Asphalt
	Rural	Two-way	2 – 4	12	4 – 10	60 – 70	Asphalt
Major Collector[1]	Urban	Two-way	2	10 – 12	3 – 8	35[2]	Asphalt
	Rural	Two-way	2	10 – 12	2 – 10	40 – 50	Asphalt or gravel
Minor Collector[2]	Urban	Two-way	2	8	1	25 – 35	Asphalt or concrete
	Rural	One- or two-way	1 – 2	7	1	25 – 35	Asphalt, gravel, or dirt
Local[3]	Urban	One- or two-way	1 – 4	Min. 10[3]	No shoulder	30[1]	Asphalt or concrete
	Rural	One- or two-way	1 – 2	Min. 9[2]	No shoulder	30[1]	Gravel or dirt
Single Artery[2]	Rural	One-way	1	N/A	No shoulder	N/A	Gravel, dirt, or grass

[1] Design recommendations obtained from TxDOT (2014b) unless otherwise noted.
[2] From G. Blake, personal communication, Feb. 10, 2016, unless otherwise noted.
[3] From Grimes County (2014) unless otherwise noted.
[4] A one-way minor collector or local street may have one or two lanes, while a single artery road consistently has one lane.

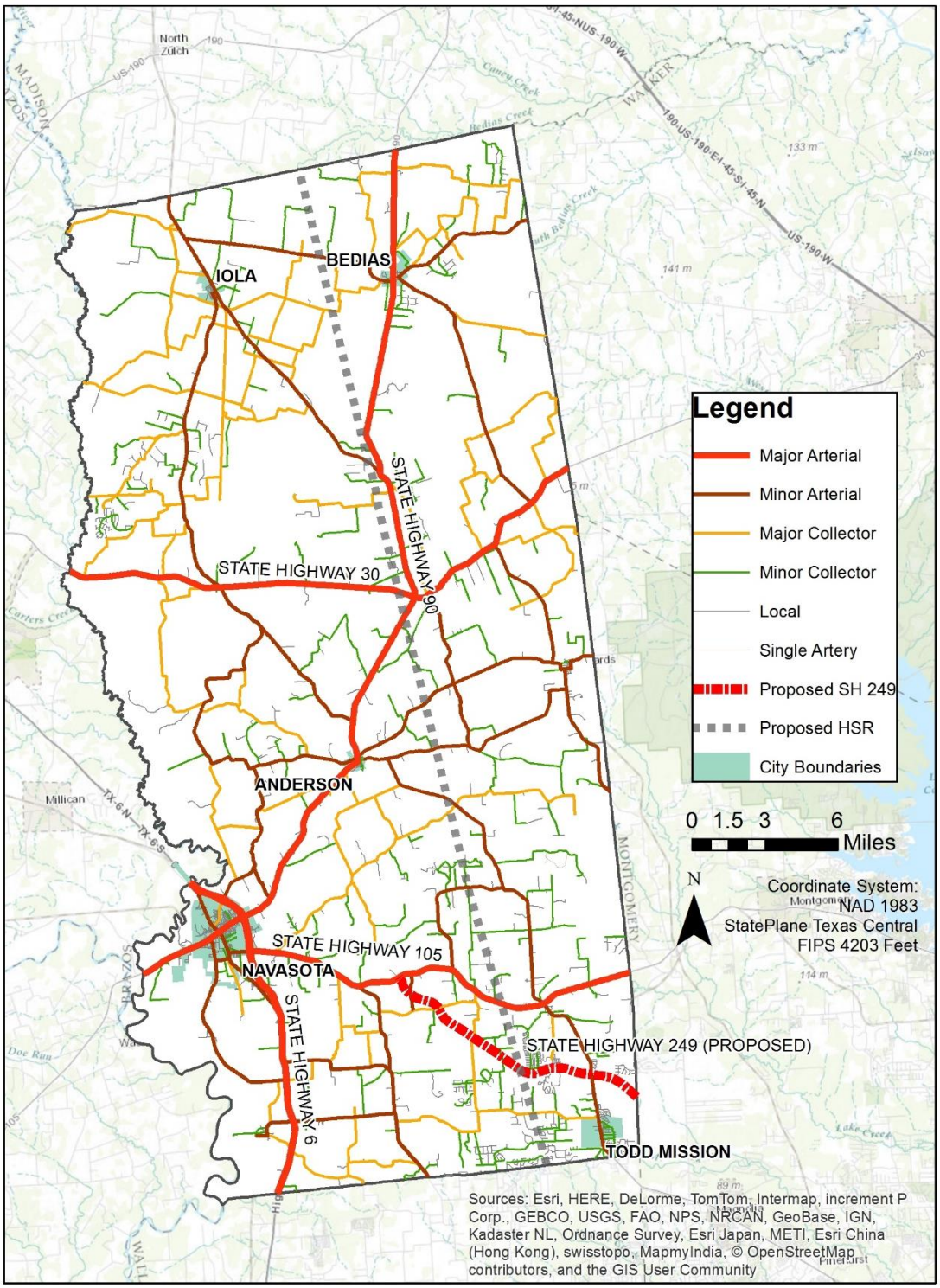
Figure 37 shows a reclassification of Grimes County roads according to the suggested hierarchy. Factors determining classification level included: connectivity with arterial roads, traffic volume, speed limit, paving surface, length, and classification under the current hierarchy. In addition, the probable route of the high speed rail has been added to the map. It is expected that the rail will be positioned slightly east of the high power transmission line running north-south through the County (K. Lee, personal communication, Mar. 28, 2016)

Figure 38 takes a closer look at Navasota. It highlights roads designated in the 2015 – 2025 Navasota Comprehensive Plan as important corridors: E. Washington Avenue (major arterial), N. LaSalle Street (minor arterial), Blackshear Street (major collector), Gibbs Street, and Judson Avenue (minor collectors). The Navasota Comprehensive Plan recommends three roads projects, marked on the map: (A) an extension of Spur 515 to FM 379, (B) extending Manley Street to the east and Judson Street to the south, and (C) a thoroughfare connection between FM 3090, SH 90, and SH 105. Manley Street could be classified as a minor collector or local street, and an extension would confirm its classification as the former.

Figure 39 offers a decision making map for the area surrounding proposed SH 249. Roads are displayed with new functional classifications, and intersections of existing roads with SH 249 are marked with circles whose colors match the classification level of the intersected road. These points represent opportunities for development, where offices or retail might gravitate. The land suitability analysis had been laid out under the road network. The features of this map can be considered together to select the best locations for new thoroughfares near the proposed highway. For example, if County staff wish to identify highly suitable land near an intersection of SH 249 with a major collector, several options are visible here. Furthermore, a road expected to connect SH 249 to the Crown Ranch subdivision is included and marked as a major collector.

Figure 40 imitates the previous figure by layering reclassified roads on the land suitability analysis to aid decision making.

Figure 37: Roads Reclassified According to Proposed Hierarchy

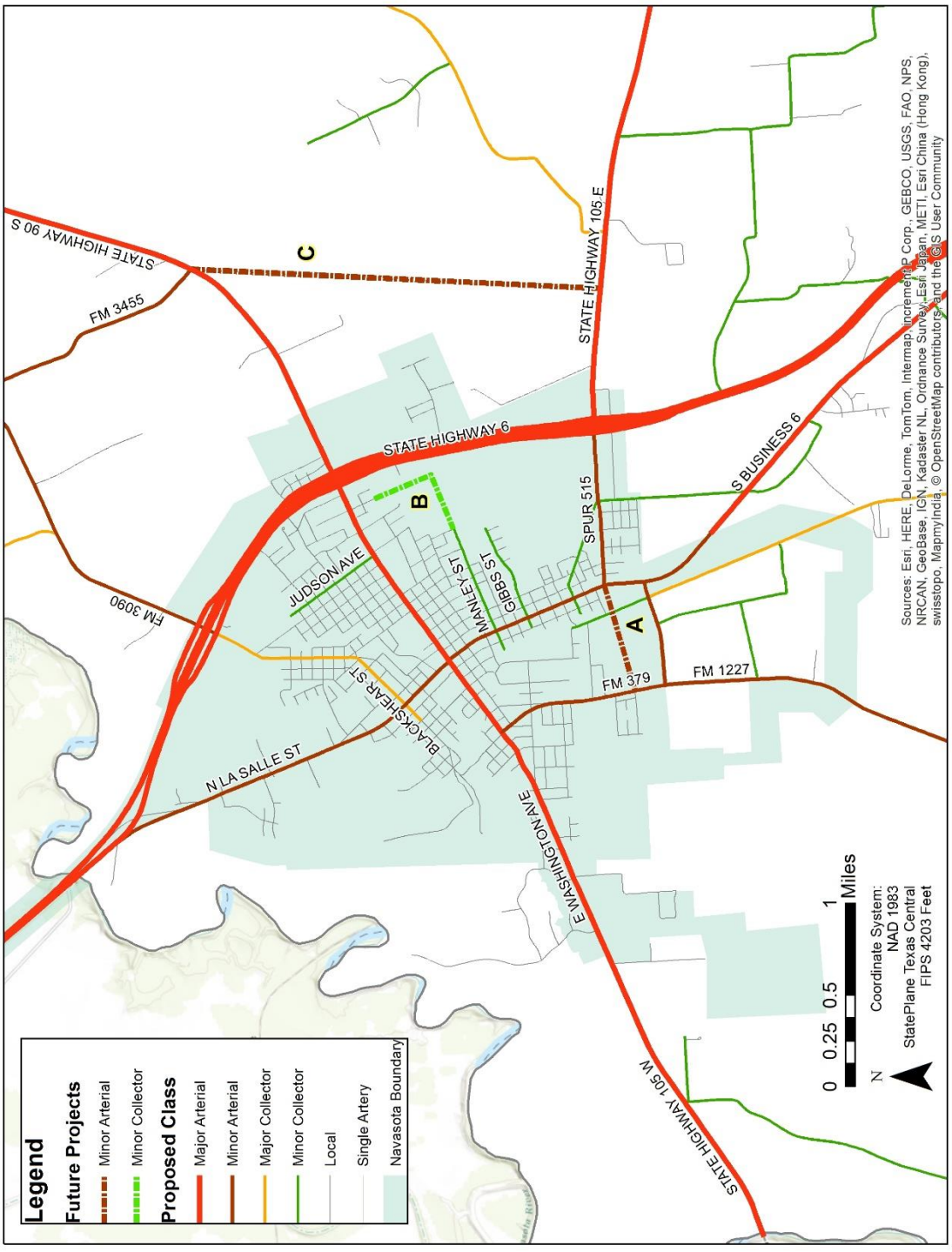


[6]

Source: Generated by author from Lee (2016), TxDOT (2016b), Simcic (2016b).

[6] Routes for SH 249 and HSR are approximate and may change.

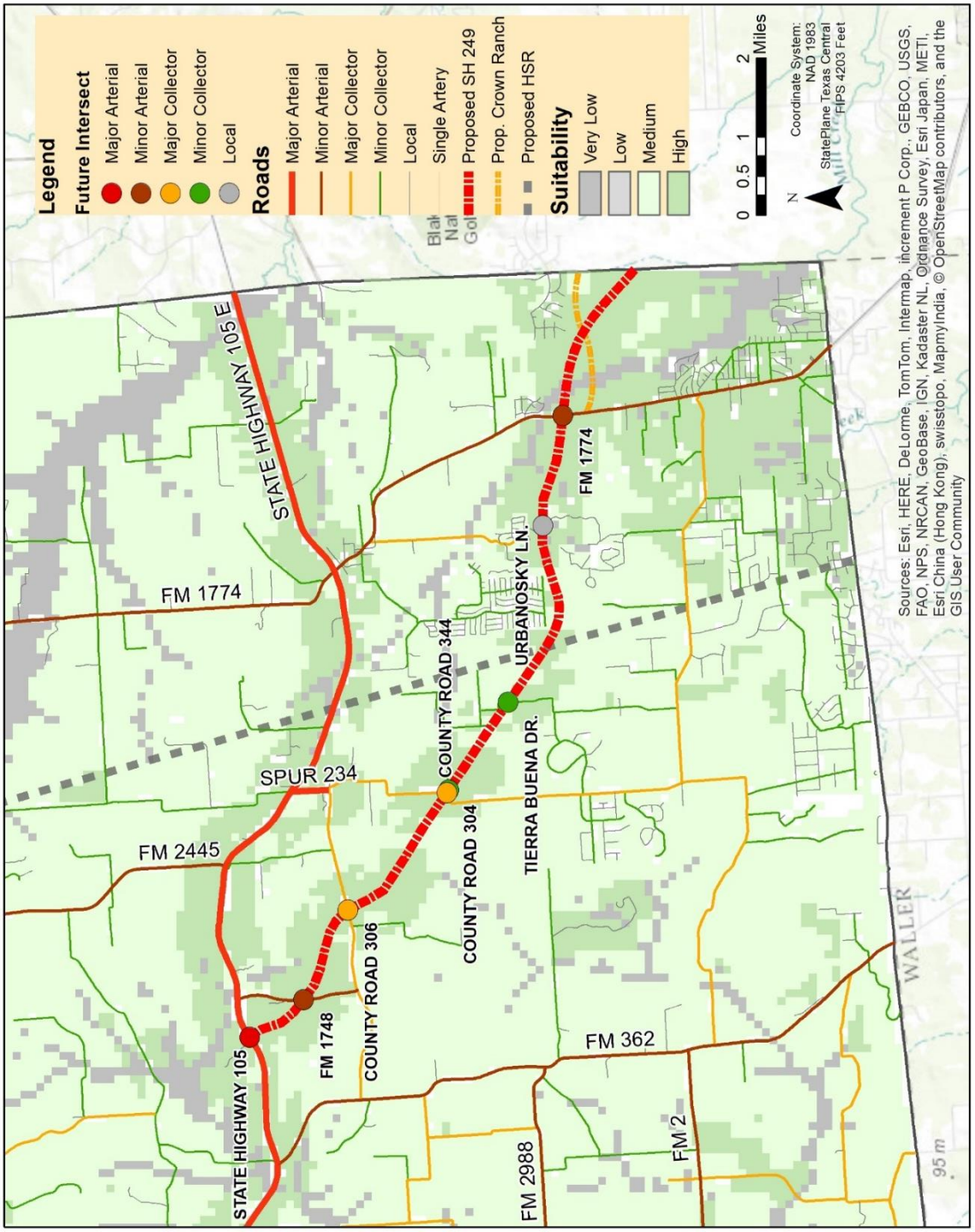
Figure 38: Roads Reclassified - Navasota



Source: Generated by author from Lee (2016), Simcic (2016c).

[7] Potential new roads include (A) an extension of Spur 515 to FM 379, (B) extending Manley Street to the east and Judson Street to the south, and (C) a thoroughfare connection between FM 3090, SH 90, and SH 105.

Figure 39: Anticipated Proposed SH 249 Intersections and Land Suitability

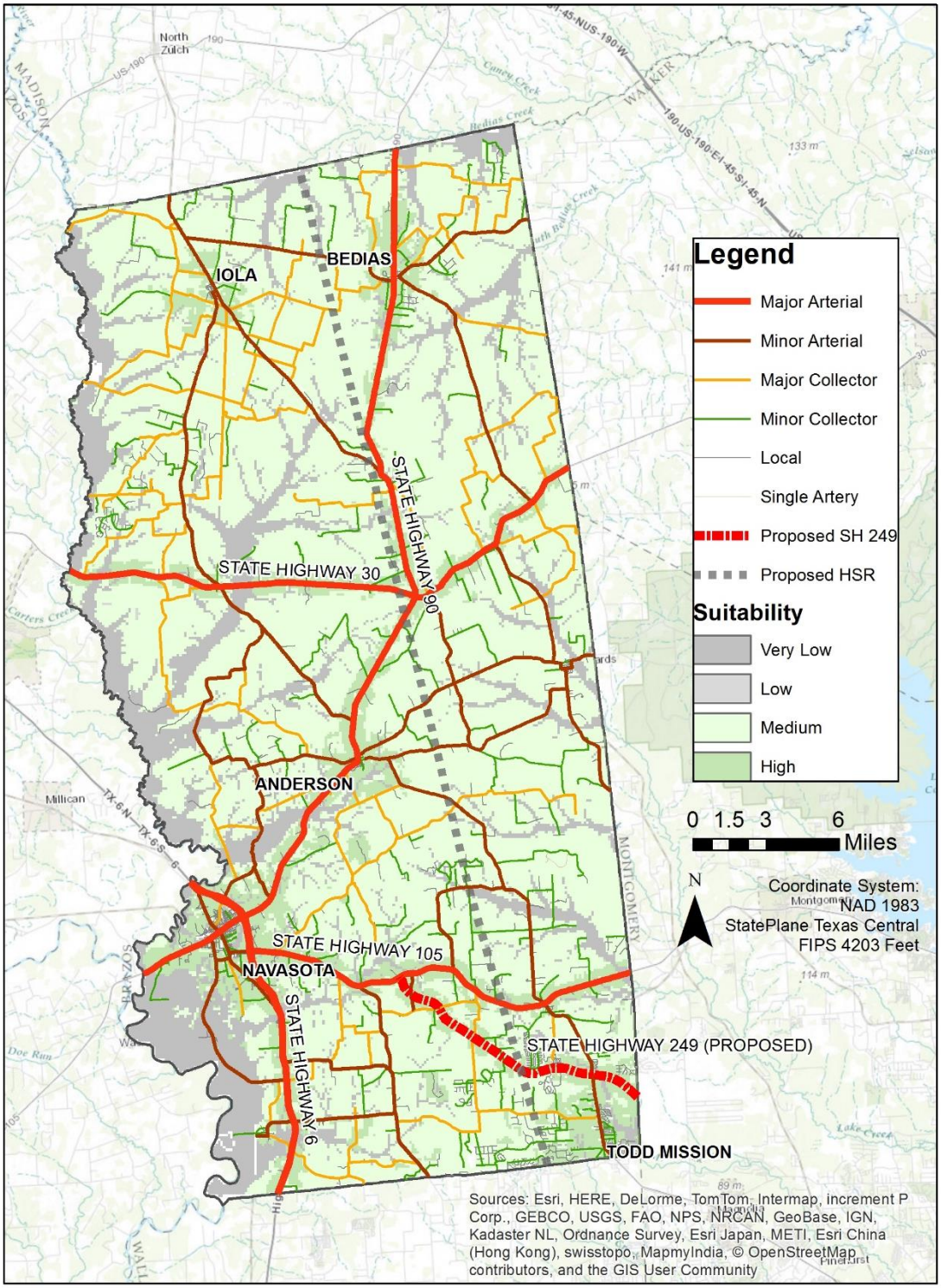


[8]

Source: Generated by author from Lee (2016), TxDOT (2016b), U.S. Census (2010), Simcic (2016b), Simcic (2016c).

[8] Routes for SH 249 and HSR are approximate and may change. Future intersections of SH 249 and existing roads are represented by circles colored according to intersected roads' proposed classifications.

Figure 40: Proposed Road Classification and Land Suitability



[9]

Source: Generated by author from Lee (2016), TxDOT (2016b), U.S. Census (2010), Simcic (2016b).

[9] Routes for SH 249 and HSR are approximate and may change.

5.3 Road Cross-Section Diagrams

Road cross-section diagrams for urban and rural streets ranging from major arterial to local street are displayed in Figures 42 to 51. These illustrations take into account the unique limitations to Grimes County's road system. In many cases, narrow easements between properties limit right-of-way for rural roads (G. Blake, personal communication, Jan. 29, 2016). Urban roads likewise experience constrained widths, as buildings are already in place and cannot be moved. An example of working within these boundaries is visible in Figure 42, which adheres to the existing right-of-way and sidewalks of Navasota's E. Washington Avenue, displayed in Figure 41.

The sketches of urban roads are suggestions for the City of Navasota and will only hold authority if approved by the City.

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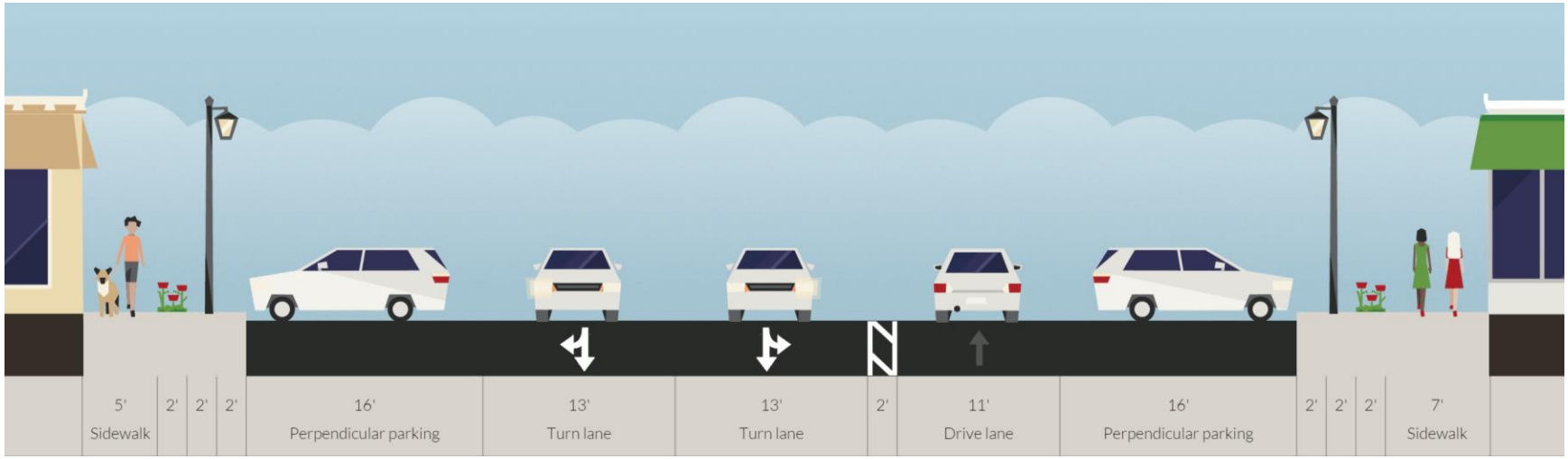
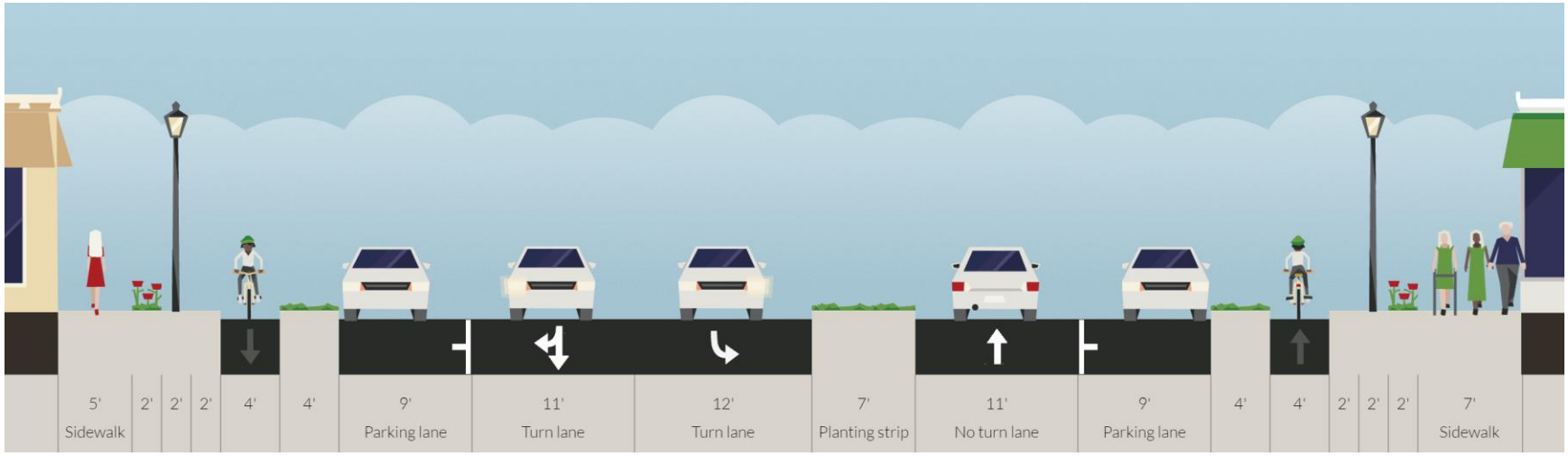
Figure 41: Existing Dimensions of E. Washington Ave. at N. LaSalle St., Navasota



Source: Simcic (2016a).

At present, E. Washington Avenue's wide sidewalks and bright landscaping create a welcoming environment for pedestrians. Opportunities for improvement in bicycle facilities exist. At 13 feet across, the two eastbound lanes are wider than necessary. Street parking is situated diagonally, occupying a considerable portion of the right-of-way.

Figure 42: Urban Major Arterial Cross-Section

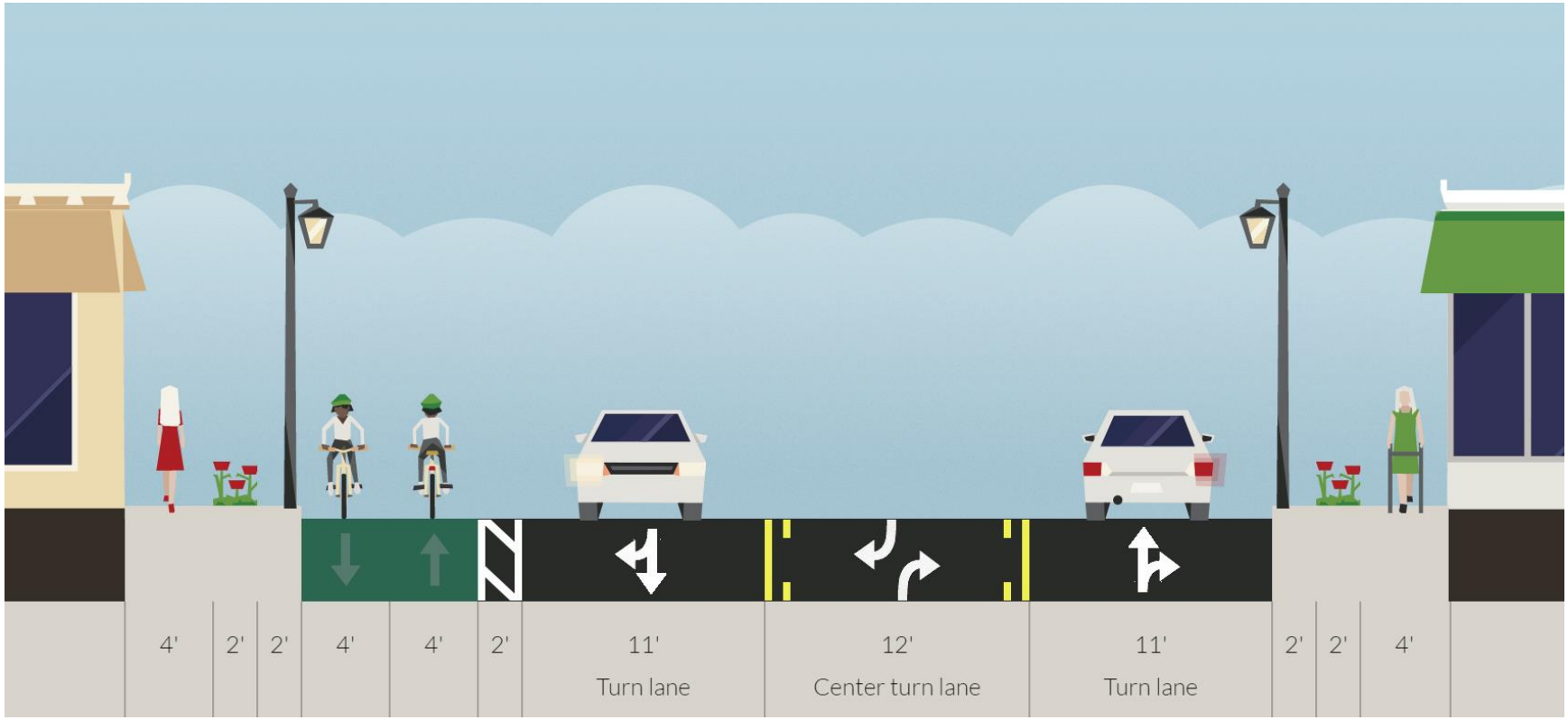


Source: Simcic (2016a).

This proposed cross-section for an urban major arterial narrows traffic lanes and features parallel street parking, freeing up space for bike lanes and a buffer shielding bicyclists from car traffic. The wide center median and reduced lane widths draw from access management principles. Adherance to E. Washington Avenue's current sidewalk widths lends feasibility to the design.

A transition from angle to parallel parking will reduce available car parking spots, which may be of concern to businesses along the avenue. In fact, increased bicycle and pedestrian traffic is expected to boost sales, as is supported through a report by Salt Lake City, included in Chapter 3. Research suggests that parallel parking is also safer than angle parking; the Oregon Department of Transportation (2001). Reviewed a series of before-and-after studies and discovered that crash rates decreased by as much as 63 percent when angle parking was converted to a parallel alignment.

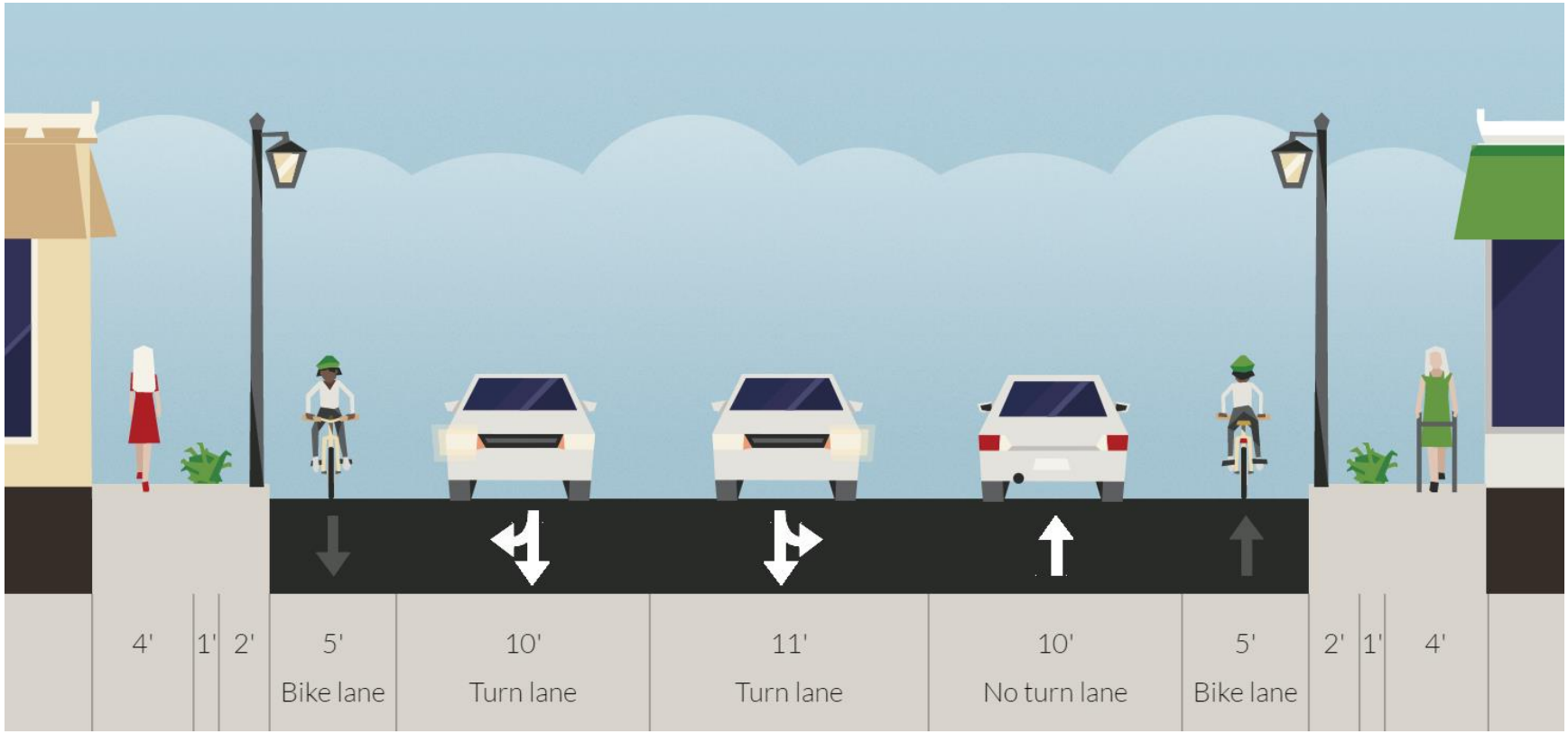
Figure 43: Urban Minor Arterial Cross-Section



Source: Simcic (2016a).

The urban minor arterial sketch includes a two way turn lane and a separated two way bicycle route. The bike route is expected to protect residents who ride bicycles and to motivate cycling behavior, so that eventually a two lane route is appropriate for the volume of cyclists. Lighted sidewalks with decorative buffers “complete” this street.

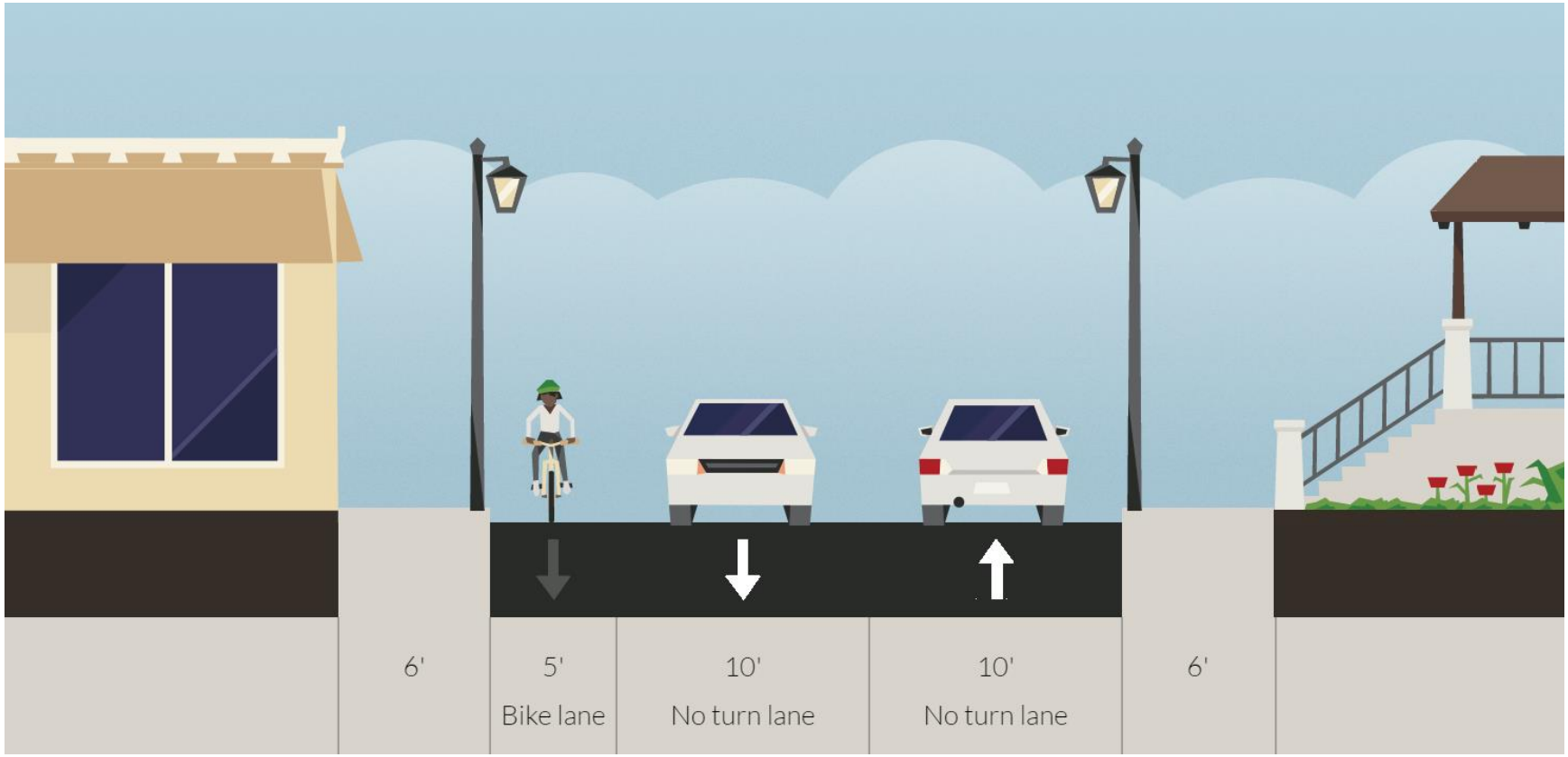
Figure 44: Urban Major Collector Cross-Section



Source: Simcic (2016a).

Two traffic lanes are recommended for the urban major collector, with an additional left turn lane as needed. Because of lower speeds and traffic volumes, bicycle lanes adjacent to traffic are appropriate. Like previous sketches, this design incorporates buffered sidewalks and street lighting.

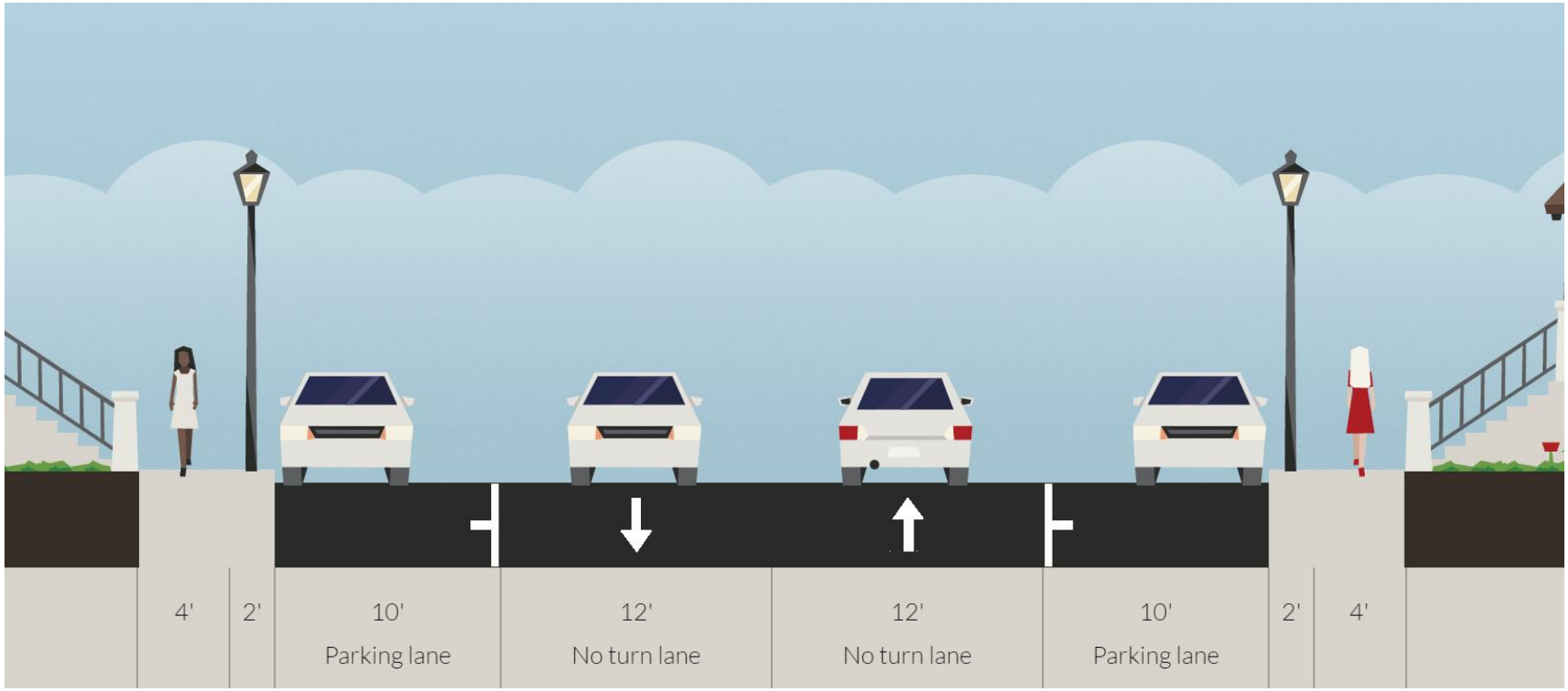
Figure 45: Urban Minor Collector Cross-Section



Source: Simcic (2016a).

The proposed urban minor collector is suited for narrower easements. Lower traffic volumes require only two through traffic lanes and one bicycle lane. Although sidewalk buffers are removed, ample sidewalk widths and lighting remain.

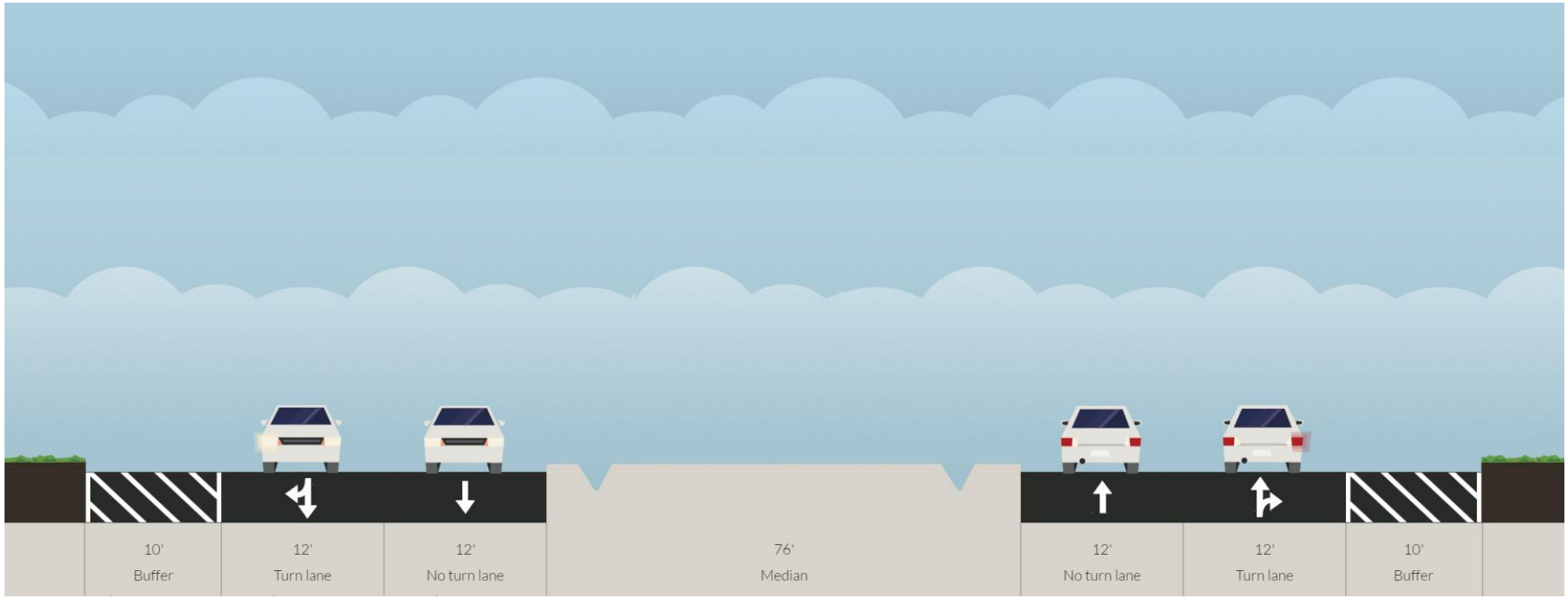
Figure 46: Urban Local Street Cross-Section



Source: Simcic (2016a).

The urban local street cross-section suggests two through lanes and two lanes for street parking. Observation of Navasota roads reveals that the City's local streets frequently exceed the 10-foot minimum established in the Grimes County Subdivision Rules and Regulations; therefore, lanes in this sketch range from 10 to 12 feet. In sensitivity to the quiet residential context, bicycle lanes are omitted, though Navasota's road system is compact enough that an individual could easily walk from a local street to a minor collector and then enter a bicycle lane.

Figure 47: Rural Major Arterial Cross-Section



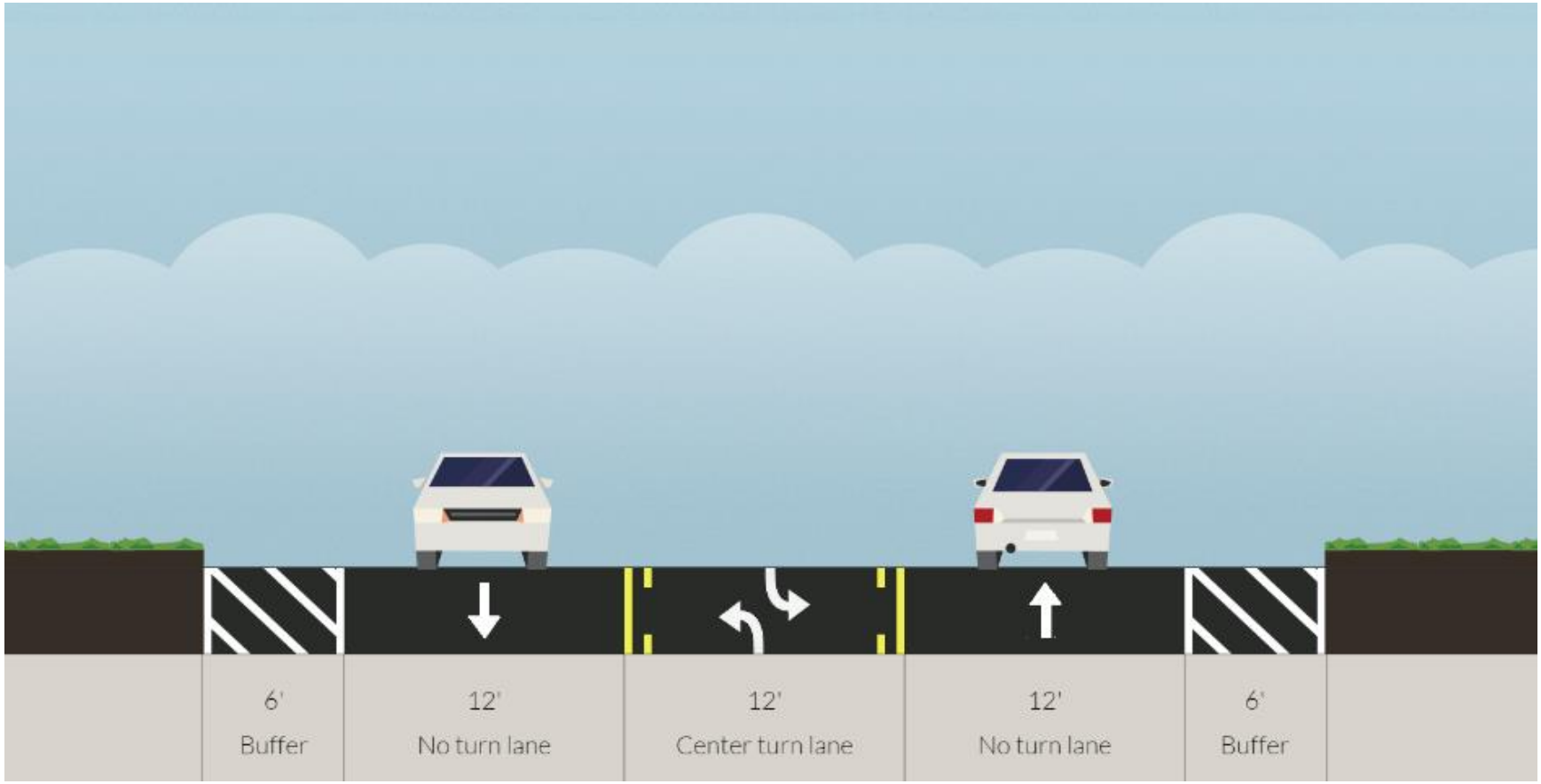
[10]

Source: Simcic (2016a).

The rural major arterial diagram adheres to TxDOT standards with a 76 foot median. This distance provides a spot in which longer trucks can wait to make a left turn or U-turn. Wide 12-foot traffic lanes and 10-foot shoulders allow for minimum conflicts between cars. Drivers in outside lanes may make right turns as exits permit. Bicycle travel is discouraged on major and minor rural arterials due to the large volume of cars moving at high speeds.

[10] The center median is not drawn to scale, as indicated by the triangular breaks.

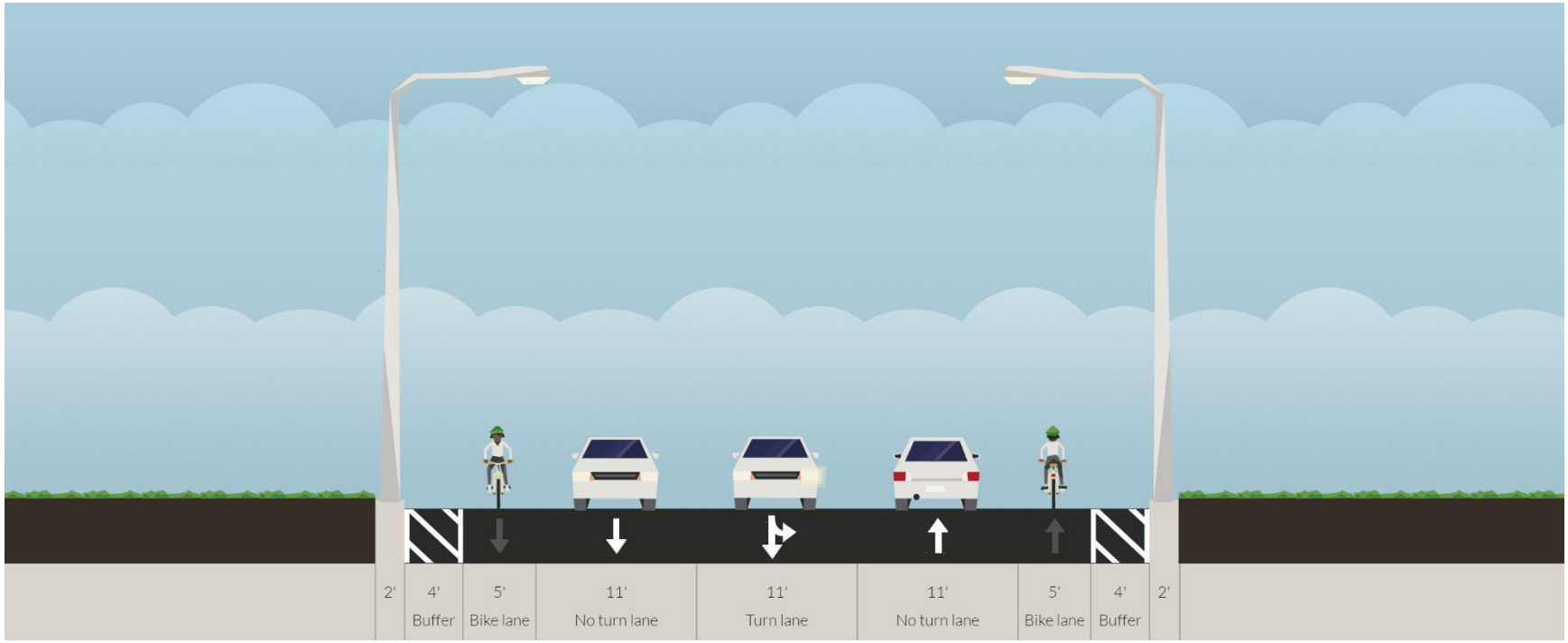
Figure 48: Rural Minor Arterial Cross-Section



Source: Simcic (2016a).

The rural minor arterial cross-section implements access management through a two way turn lane. This feature can help to reduce crashes caused by motorists attempting to turn left across a solid yellow line (T. Lomax, personal communication, Feb. 15, 2016). The design includes one lane of traffic in each direction and a 6-foot shoulder.

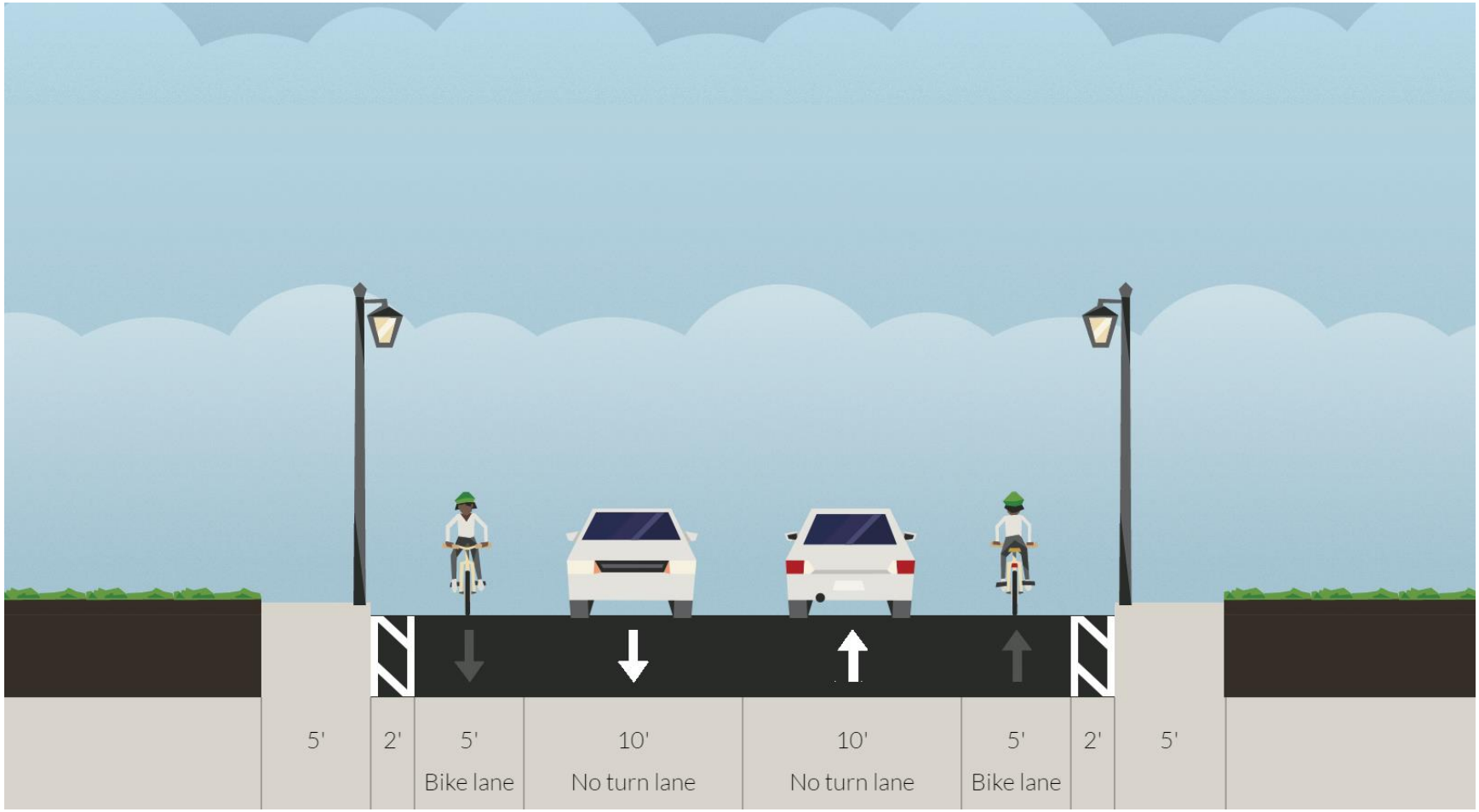
Figure 49: Rural Major Collector Cross-Section



Source: Simcic (2016a).

Similarly to the rural minor arterial, the rural major collector cross-section recommends one lane of traffic in each direction. In the place of a two way turn lane, left turn lanes can be introduced as needed. The 35 MPH speed limit on most county roads allows for the addition of bicycle lanes with 5-foot widths to ensure safety. Street lighting and shoulders further contribute to the protection of drivers and cyclists.

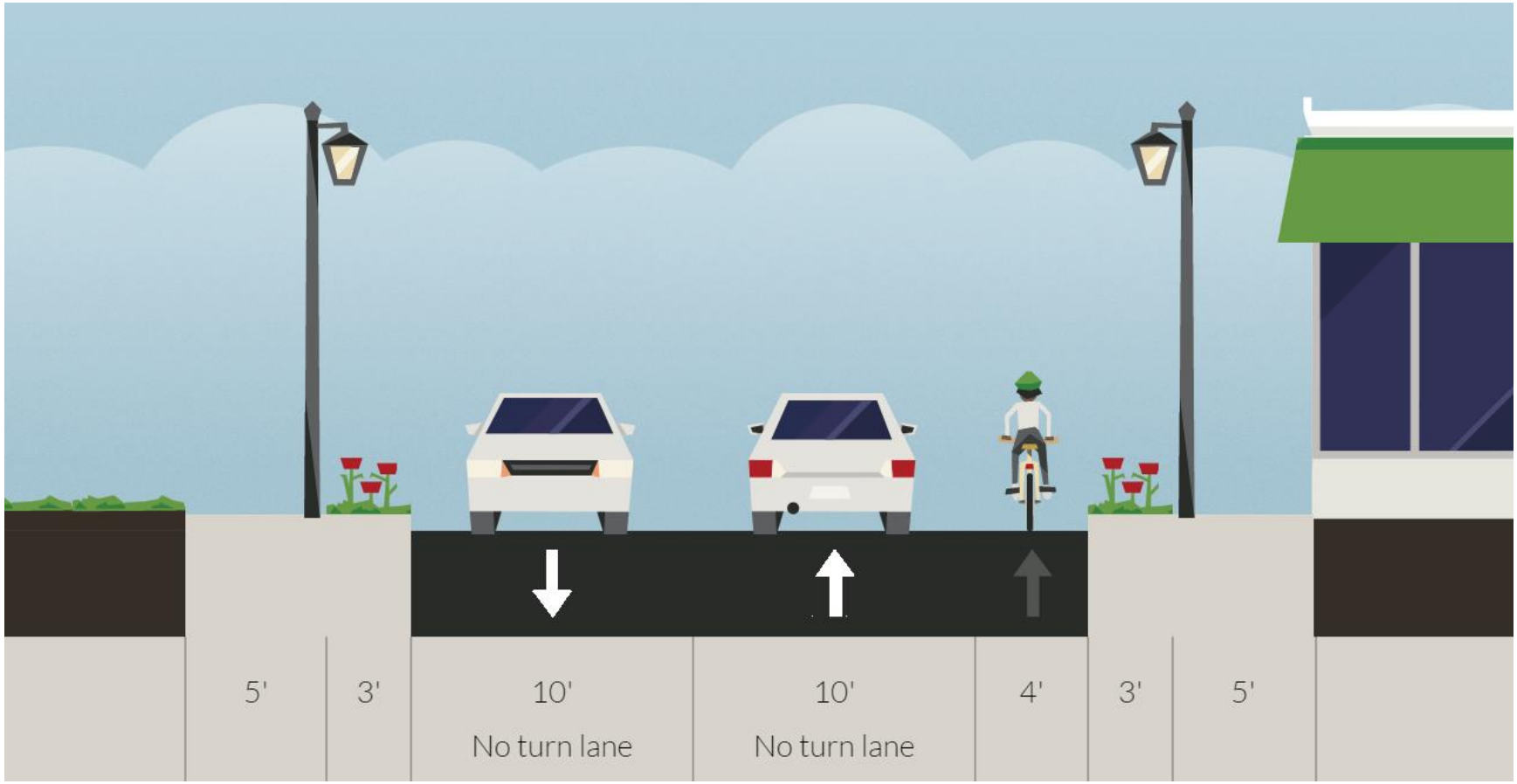
Figure 50: Rural Minor Collector Cross-Section



Source: Simcic (2016a).

An example of a rural minor collector might contain moderately wide bicycle lanes and sidewalks. Modest lane and shoulder widths are intended to accommodate narrower right of ways.

Figure 51: Rural Local Street Cross-Section



Source: Simcic (2016a).

As many of Grimes County's local roads are located in small towns and subdivisions, the proposed design is framed in the context of residential and light commercial use. 10-foot lanes are expected to cause a slowing of traffic, previously explored in Chapter 3. Buffered sidewalks and one bicycle lane are depicted here, with narrower widths chosen to promote a cozy neighborhood ambience.

6.0 Implementation and Funding Options

Implementation has been described as “what follows after plans are written and adopted” (Leone, Barnes, & Sharpe, 2015, p. 52) and encompasses the process by which ideas on a paper become completed projects. A key component of effective implementation is clearly communicated next steps, drawing from a thorough understanding of future expenses and potential funding sources. The following sections outline proposed action steps and fiscal considerations related to the GCTP.

6.1 Action Steps

The following action steps have been developed to support the goals presented in Chapter 2:

A. Update and adopt new subdivision rules to guarantee that proposed road functional classification hierarchy standards become policy.
B. Coordinate with Texas Central Partners to minimize disruptions across roadways.
C. Consult the land suitability map (Fig. 35 and 40) when planning road extensions in the County, paying particular attention to floodplains.
D. Prioritize road improvements at “high priority intersections” (Fig. 33).
E. Coordinate with TxDOT to maximize economic opportunities at road intersections with State Highway 249.
F. Coordinate the GCTP with regional partners—including the Brazos Valley Council of Governments; cities of Navasota, Anderson, Iola, and Todd Mission; and other local communities.

The above points provide a starting point for transitioning the GCTP from potential to reality. The County will encounter complex challenges during the implementation process, which are expanded in the conclusion.

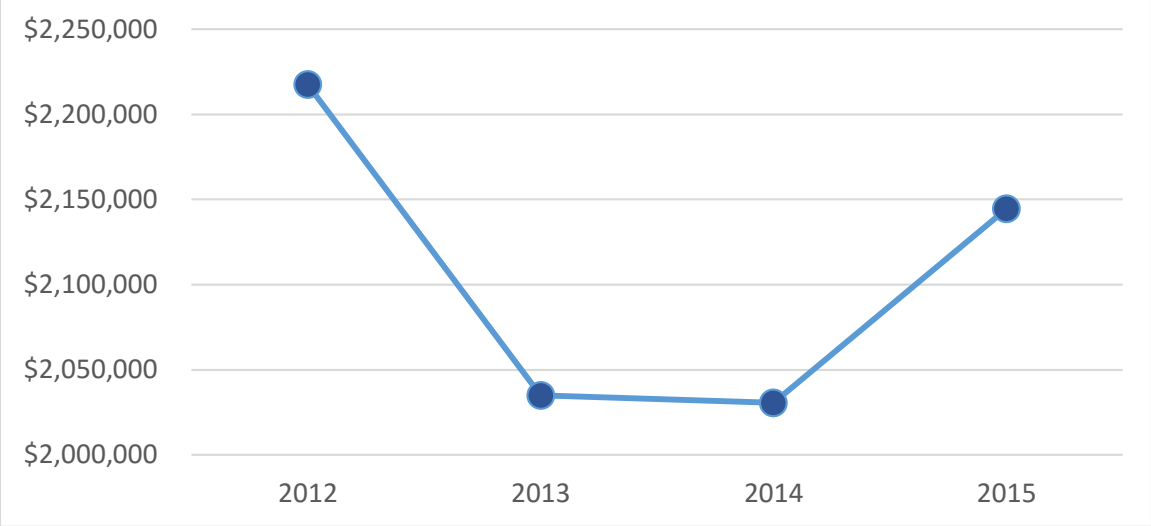
6.2 Funding Considerations

To prepare for implementation of the GCTP, it is necessary to understand funding and expenses affecting the Grimes County Road and Bridge Department. Relevant topics include: past and present County budget fund balances, FEMA-subsidized repairs to flooded roads, the County's road paving schedule, and TxDOT's maintenance schedule. A cost estimate for construction of the cross-section designs in Chapter 5 is presented, along with grants to help cover the calculated expenses.

6.2.1 County Road and Bridge Budget

Figure 52 depicts information obtained from the Grimes County Auditor. The total amounts allocated to the Road and Bridge Department from 2012 to 2015, known as fund balances, are shown. Fund balances are made available at the end of the year, so an amount for 2016 has not yet been released. Funding dropped from 2012 to 2013, remained roughly the same from 2013 to 2014, and rose in 2015.

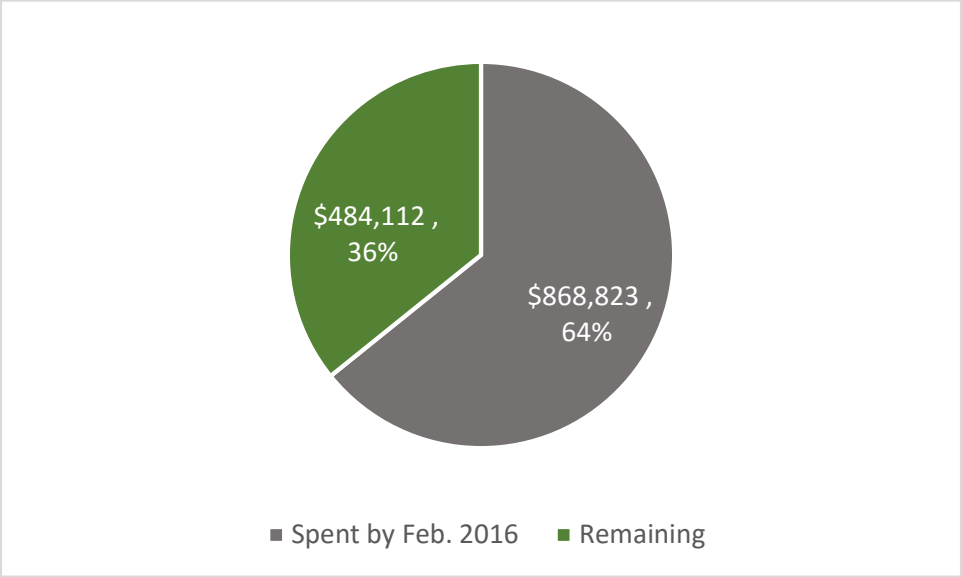
Figure 52: County Road and Bridge Department Fund Balance, 2012-2015



Source: Grimes County (2015).

Despite a trend toward increased financial backing, the Road and Bridge Department is experiencing a shortage of funds for road resurfacing projects. As Figure 53 illustrates, the "Materials" subcategory of the County budget was granted $868,823 for the entire 2016 fiscal year, and almost two-thirds of that amount has already been spent. Increased allocations to road resurfacing are encouraged in future budgets.

Figure 53: Road Materials Budget and Expenditures, 2016



Source: G. Blake, personal communication, Mar. 28, 2016.

6.2.2 Repairs to Flooded Roads

FEMA is enacting four projects—one for each precinct— in cooperation with the County. Table 8 summarizes the individual costs of labor, materials, and equipment for each project, as well as the total costs and amounts to be paid by the County. In keeping with standard protocol, FEMA will contribute 75 percent of the total cost. Grimes County has already fully funded the projects out of its 2015 budget and is expecting a $407,517 reimbursement from FEMA, reducing County expenses to $135,839 (D. Lily, personal communication, Feb. 12, 2016).

Table 8: FEMA Flood Repair Projects

Project / Precinct	Estimated Costs				
	Labor	Materials	Equipment	Project Total	County Cost
1	$16,778.88	$101,010.44	$41,325.25	$159,114.57	$39,778.64
2	$16,137.98	$143,127.92	$36,937.99	$196,203.89	$49,050.97
3	$1,691.15	$14,476.91	$4,357.00	$20,525.06	$5,131.27
4	$12,831.66	$124,181.81	$30,498.50	$167,511.97	$41,877.99
Grand Total	**$47,439.67**	**$382,797.08**	**$113,118.74**	**$543,355.49**	**$135,838.87**

Source: Lily (2016).

6.2.3 County Road Paving Schedule

The County has identified 47 roads for full or partial chip-sealing. For the purposes of this report, full paving includes a flexible base, first seal, and second seal, and partial paving entails only the second seal. Projects delayed in 2015 are considered high priority for 2016. Table 9 summarizes the locations, paving types, lengths, and costs of high priority projects. Historically, Grimes County has chip-sealed approximately 10 miles of road per year. With almost 7 miles of road not completed in 2015, time will only permit 3 to 5 additional miles.

Table 9: County Road Paving Schedule, 2016

County Road	Paving Type	Paving Start Point	Paving End Point	Length (ft)	Width (ft)	County Cost
CR 172	Full	End of HMAC	Roese	3,300	18[11]	$19,531
Roese	Full	South Fork	Dead End	11,300	18	$66,878
Jubilee	Full	Skillett Bend	Dead End	2,470	18	$14,618
Skillett Bend	Full	Jubilee	Dead End	1,610	18	$9,529
Piney Oaks	Full	Gilpin	Dead End	1,710	18	$10,120
Autumn Oaks	Full	Gilpin	Dead End	1,827	18	$10,813
Gilpin	Full	FM 244	Dead End	5,798	18	$34,315
Carter	Full	Clark	Lonestar	3,350	18	$19,827
Glennswood Dr.	Partial	Bus. SH 6	Dead End	2,110	18	$7,343
Dogwood Pl.	Partial	Bus. SH 6	Glennswood	800	18	$2,784
Magnolia Trl.	Partial	Bus. SH 6	Glennswood	935	18	$3,254
Hidden Trl.	Partial	Magnolia Trl.	Dead End	470	18	$1,636
Piney Ct.	Partial	Glennswood	Dead End	190	18	$661
Briar Cir.	Partial	Glennswood	Dead End	165	18	$574
Pin Oak Trace	Partial	Glennswood	Dead End	285	18	$992
					Total	**$202,874**

Source: Cochrane et al. (2015).

6.2.4 TxDOT Maintenance Schedule

TxDOT has planned the following road improvement projects for Grimes County in 2016. Table 10 contains the location, repairs, and intended completion date of each project. Projects highlighted in yellow, which deal with SH and FM roads in or near Navasota, may merit expedited deadlines.

[11] All roads will be paved at the standard 18 foot width for county roads.

Table 10: TxDOT Grimes County Maintenance Schedule, 2016

Road / Intersection	Intended Repairs	Completion Date
CR 182 at Yorke Creek	Replace bridge	Mar. 2016
SH 6, from south Navasota to Grimes County line	Improve / replace / remove crossovers	Aug. 2016
CR 162 at Navasota River Relief	Replace bridge	Aug. 2016
FM 3090 at Spring Creek, Holland Creek, and Holland Creek Relief	Relocate roadway	Aug. 2016
FM 1696, from FM 39 intersection to SH 90 int.	Rehabilitate roadway	FY 2016
Business SH 6 at FM 379	Rehabilitate roadway	FY 2016
SH 515, from Bus. SH 6 to SH 6	Rehabilitate roadway	FY 2016

Source: Chad Bohne, email communication, Mar. 2, 2016.

6.2.5 Cross-Section Diagram Cost Estimates

Table 11 shows estimated costs of enacting the Chapter 5 cross-section diagrams across the County. A step-by-step explanation of the calculation process is available in the appendix. The sizeable grand total can be addressed in pieces by beginning with priority areas, such as those laid out in Figure 33. In addition, the County is encouraged to apply for federal and other grant funding.

Table 11:Cross-Section County-Wide Implementation Cost Summary

Road Class	Total Cost / ft.	Total Cost Across County
Urban Major Arterial	$45.47	**$726,428.72**
Urban Minor Arterial	$86.67 (+ bike path cost)	**$1,905,266.61**
Urban Major Collector	$91.23	**$996,049.14**
Urban Minor Collector	$52.94	**$900,403.52**
Urban Local Street	$36.00	**$8,973,108.00**
Rural Major Collector	$43.53	**$42,882,839.49**
Rural Minor Collector	$68.53	**$101,211,340.23**
Rural Local Street	$106.56	**$141,390,521.28**
Subtotal		**$298,985,956.99**
Grand Total with Lighting and Bicycle Path		**$299,426,956.99**

6.2.6 Available Grants

These and other grants and programs can provide funding and technical assistance as components of the GCTP are implemented:

- Community Development Block Grant Program for Rural Texas, Texas Department of Agriculture
- Community Development Fund (Rural), Texas Dept. of Agriculture
- Texas Capital Fund (Rural), Texas Dept. of Agriculture
- Disaster Relief Fund (Rural), Texas Dept. of Agriculture
- Urgent Need Fund (Rural), Texas Dept. of Agriculture
- Sustainable Communities Initiative, HUD
- National Complete Streets Coalition, Smart Growth America
- Bicycle Friendly Communities Program, League of American Bicyclists
- Walk Friendly Community, FHWA
- Pre-Disaster Mitigation Program, FEMA
- Flood Mitigation Assistance Grants, Texas Water Development Board
- Main Street Program, Gonzales Economic Development Corporation
- Safe Routes to School, U.S. Department of Transportation (USDOT)
- Transportation, Community, & System Preservation, USDOT
- Transportation Infrastructure Finance and Innovation Act, USDOT
- Transportation Investments Generating Economic Recovery, USDOT
- Transportation Planning Capacity Building Program, USDOT
- Transportation Enhancement Activities, USDOT and FHWA
- Transportation Elimination and Railway-Highway Crossing programs, USDOT and FHWA
- Federal Lands Highway Program, USDOT and FHWA
- National Scenic Byways, USDOT and FHWA
- Job Access and Reverse Commute Grants, USDOT and FHWA
- Pass-Through Financing program, TxDOT

7.0 Conclusion

This document has addressed the community character, transportation goals and needs, and existing conditions of roads and land suitability for future roads in Grimes County. Built on a foundation of literature, the road functional classification hierarchy and cross-section diagrams have outlined a framework for safe, streamlined road design promoting a strong community identity. By prioritizing connected, complete thoroughfares through policy and budgeting, Grimes County can promote growth and refinement of its road system.

Figure 54: Downtown Navasota

Source: Moore (2008).

The County will face several key transportation issues in coming years. As Grimes County looks ahead, the following issues of safety, infrastructure, and cooperation will prove relevant:

7.1 Design for Safe Intersections

While the road design standards proposed in this plan will help bolster safety, intersections with high crash rates will require additional improvements, such as clearer signage and curve adjustments to bring intersection angles closer to 90 degrees (T. Lomax, personal communication, Feb. 15, 2016). Consistent resurfacing and paving will likewise contribute to road safety.

7.2 Green Infrastructure

As new roads are constructed over time, the County can benefit from a focus on green infrastructure. When applied to an area's transportation system, green infrastructure means managing stormwater runoff through the introduction of environmentally friendly features like permeable pavements and planting strips. These techniques focus more on absorbing water than transferring it to a different location, which assists with flood protection and water conservation (EPA, 2015).

Figure 55: Example of Permeable Pavement

Source: EPA (2015).

7.3 High Speed Rail Underpass Flooding and Possibility of Insolvency

In the event that Texas Central Partners completes the high speed rail project, a variety of measures will be necessary to maintain connectivity in the County's road network. Careful design is required to avoid flooding of underpasses in the rail's berm structure (G. Blake, Jan. 29, 2016). In addition, the possibility of insolvency must be considered. It is important to establish beforehand how landowners and the County as a whole will be compensated if the rail fails to turn a profit and suspends operations.

7.4 Regional Cooperation

Communication between Grimes County, its cities, and unincorporated areas is essential to implementing the GCTP. For example, the cross-section diagrams proposed here for Navasota will require further polishing through dialogue between the County and the City. Additionally, negotiations with property owners for widening easements to expand right-of-ways will help contribute to the quality of rural roads. Regular meetings for the purpose of engaging and informing the community about transportation issues are encouraged, beginning with a public presentation of the GCTP scheduled for April 29, 2016.

7.5 Paving the Way, Driving Forward

The Navasota Comprehensive Plan expresses a desire for "infrastructure that addresses the primary concerns of utilities, mobility, and safety" (2015, p. 8). The Grimes County Thoroughfare Plan has presented a road map to make that vision a reality. The components of this plan are intended to nurture an already vibrant community. It seeks to help residents to reach places more easily, to transform streets into destinations where neighbors can meet, and to attract development to give people more opportunities to live, work, and play. By consistently utilizing and re-evaluating the ideas and tools laid out in this thoroughfare plan, Grimes County can pave the way for a bright future.

Figure 56: Antique Store Owner Joseph Gust, Anderson

Source: Simcic (2016e).

Appendix

The appendix contains data sources and calculations referenced in the Thoroughfare Plan.

A1 Data Sources

GIS analysis was performed using data layers recorded in Table 12. Many of these layers are contained in the Microsoft Access file, Grimes.mdb, obtained from Katherine Lee at the Grimes County 9-1-1 Addressing Department. Data are listed in order of first appearance in a figure.

Table 12: Data Layers and Sources

GIS Data Layer	Source	Date Obtained	Alterations by Author
Grimes County Outline	Grimes.mdb	Jan. 25, 2016	None
Grimes County City Boundaries	Grimes.mdb	Jan. 25, 2016	None
Grimes County Roads	Sent by email from Katherine Lee, Grimes 9-1-1	Mar. 4, 2016	Clipped to Grimes County outline; displayed by road class and surface type; added 'FuncClass' field to select and reclassify roads by hand
State Highway 249 Extension	Sent by email from Adam Breznicky, TxDOT	Jan. 26, 2016	Clipped to County outline
Crash Point Data, 01/10/2010 – 02/04/2016	TxDOT crash data request (http://www.txdot.gov/apps-cg/crash_records/form.htm)	Feb. 17, 2016	Created separate layers for all, fatal, and bicycle crashes
High Traffic County Road Intersections	Traffic count spreadsheet created by Bobbie Burns, Grimes R&B	Jan. 29, 2016	Calculated traffic volume per day for all intersections; digitized 10 highest traffic intersections by hand in ArcMap
FEMA Floodplain	Grimes.mdb	Jan. 25, 2016	None
Population Density	2010 U.S. Census counts by block group, 2010 TIGER/Line Texas block groups shapefile	Feb. 20, 2016	Created separate layer for block groups in Grimes county; divided block group population by calculated acreage to obtain population density
Grimes County Land Parcels	Grimes.mdb (orig. Grimes County Appraisal District)	Jan. 25, 2016	Key landowners: dissolved parcels into multipart features and calculated acreage. Parcel size: dissolved parcels into non-multipart features and calculated acreage. Parcel value per acre: divided total land market value ('TotalLandM' field) by acreage.
Grimes County Subdivisions	Sent by email from Katherine Lee, Grimes 9-1-1	Mar. 4, 2016	None
Proposed High Speed Rail Route	Created by author	Mar. 31, 2016	Digitized path about 300 ft east of high powered transmission line in Google Earth; exported as .kmz file and converted to vector
Proposed Road Extensions	Created by author	Apr. 9, 2016	Digitized by hand in ArcMap using input from Apr. 8 meeting

A2 Land Suitability Analysis Criteria

The land suitability analysis map in Chapter 4 was produced through the following methods:

A process called simple additive weighting was used. In this process, variables that affect suitability are chosen and mapped across the study region. Variable values are reclassified according to a scale—in this case, from 1 to 5, with 1 representing low suitability and 5 signifying high suitability. Next, each variable is assigned a weight to indicate its relative importance compared to other variables. Finally, each variable value is multiplied by its corresponding weight, then the results of all the calculations are added together to produce one suitability value. The chosen variables, values, and weights are summarized in Table 13 on the next page.

Floodplains were given a pass/fail rating to ensure that all land with a 1 percent or higher chance of flooding is excluded from the analysis. Proximity to roads, and especially highways, was considered for several reasons. First, a short thoroughfare standing alone has little effectiveness in transporting vehicles. Second, commercial development will be drawn to areas with a road network in place, creating a need for additional roads. First-person observation and parcel values from LandWatch.com helped to determine the distance threshold for nearness to roads and highways. It was noted that development density declines in quarter-mile intervals as distance from a road increases, and property values take a sizeable dip one half-mile from a highway.

Proximity to cities and population density were incorporated to ensure that as many people are served by new roads as possible. Cities also furnish valuable infrastructure to facilitate development. Distance benchmarks for cities are based on personal observation, and population classification values were chosen in uneven increments to compensate for the very low population density in most of the County. Since various locations in the County contain less than 50 people per square mile—a very low density that argues against the need for a road—the scale begins at 50 and continues in increments of 200.

Parcel size and land value per acre were included, as larger and more highly priced parcels are more likely to be purchased by developers. Suitability values for parcel size were assigned according to counsel from Greg Blake (email communication, Feb. 4, 2016). Land values per acre are distributed such that the median price per acre for the Gulf Coast-Brazos Bottom Region—$5,650—is the midpoint of the interval assigned a value of 3 (Texas A&M University, 2016). The result is that land with a value exceeding the regional norm is granted medium or high suitability for this variable.

Weights were assigned based on input from the Grimes County core team. The system used first divided weights into three main categories: distance from roads (40%), population characteristics (25%), and parcel characteristics (35%). These categories were further subdivided according to the communicated importance of each variable. The County highly values development along major thoroughfares, explaining the 20% weights applied to road and highway proximity. Population density was emphasized less, as it follows a similar pattern as proximity to cities, and was given a weight of 7.5%.

Table 13: Land Suitability Analysis Criteria

Description	Value Assignment	Weight (%)
FEMA floodplain	Pass/fail 1 percent chance of flood = 0 Less than 1 percent chance = 1	N/A
Proximity to any road	Outside 1 mile = 1 Between 1 and ¾ mile = 2 Between ¾ and ½ mile = 3 Between ½ and ¼ mile = 4 Within ¼ mile = 5	20
Proximity to highways	Outside ½ mile = 3 Within ½ mile = 5	20
Proximity to cities	Outside 2 miles = 1 2 to 1 ½ miles = 2 1 ½ to 1 mile = 3 1 to ½ mile = 4 Within ½ mile = 5	17.5
Population density	0 – 50 people/ sq. mi. = 0 51 – 250 = 1 251 – 450 = 2 451 – 650 (empty)[12] = 3 651 – 850 (empty) = 4 Over 850 = 5	7.5
Parcel size	Up to 50 acres = 1 51 – 100 = 2 101 – 300 = 3 301 – 500 = 4 Over 500 = 5	17.5
Land value per acre	Up to $2,260 = 1 $2,261-4,520 = 2 $4,521-6,780 = 3 $6,781-9,040 = 4 Over $9,040 = 5	17.5

[12] An “empty” value assignment indicates that no land falls within that increment.

A3 Cross-Section Diagram Cost Calculations

The process utilized in calculating the total costs of cross-section diagrams is detailed below:

Table 14 presents a cost calculation matrix. This tool separates the calculation technique into several steps. First, a count of elements that require monetary investment from each of the 10 cross-sections is inserted in the first, third, and fifth columns. Second, the cost per linear foot corresponding to these elements is included in the second, fourth, and sixth columns. Third, the count of each element is multiplied by its cost. The products are added together to obtain the total cost per foot for each design. Fourth, to estimate the price of covering every foot of road in the County with one of these cross sections, the length in feet of all roads under a given classification in the proposed hierarchy (see Fig. 37) was multiplied by the cost per foot of that class. Length in feet was acquired using a simple calculation in ArcMap. Fifth, the individual costs for each diagram were summed to produce a subtotal. Finally, expected prices of lighting and the urban minor arterial bicycle path were added to the subtotal to produce one final cost estimate.

Cost per foot of individual elements was obtained from the FHWA (2002); Miller (1993); “Plant S.F.” (n.d.); and Bushell, Poole, Zegeer, & Rodriguez (2013). These numbers were adjusted for element width. For example, the FHWA estimates sidewalk costs at $15 per foot at a width of 5 feet. For a 6-foot sidewalk, the number was multiplied by 6/5, yielding $18 as the new cost.

Costs of lighting and bicycle paths were calculated separately. Bushell et al. recommend pricing lighting by location, as streetlights form an interconnected network. The authors estimated the cost per location at $3,600. Grimes County contains roughly 50 locations—40 subdivisions and 10 cities—so $3,600 was multiplied by 50 with a product of $180,000.

Bushell et al. provide a uniform median cost for any bicycle path, which is $261,000, and that estimate was used here.

Table 14: Cross-Section Diagram Cost Calculation Matrix

Road Class	New Sidewalks	Sidewalk Cost / ft.	New Bike Lanes	Bike Lane Cost / ft.	Additional Expenses	Add. Exp. Cost / ft.	Total Cost / ft.	Total Length (ft.)	Total Cost
Urban Major Arterial	0	$0	2	$13.56	Medians (3), Road markings	Med: $18 RM: $0.35	$45.47	15,976	**$726,428.72**
Urban Minor Arterial	2	$27	1 bike path	Not available in feet	Two way turn lane, landscaping, striping	TWTL: $0.35 L: $30 Str: $2.32	$86.67 (+ bike path cost)	21,983	**$1,905,266.61**
Urban Major Collector	2	$21	2	$16.94	Turn lane, landscaping	TL: $0.35 L: $15	$91.23	10,918	**$996,049.14**
Urban Minor Collector	2	$18	1	$16.94	None	$0	$52.94	17,008	**$900,403.52**
Urban Local Street	2	$18	0	$0	None	$0	$36.00	249,253	**$8,973,108.00**
Rural Major Collector	0	$0	2	$16.94	Turn lane, shoulders	TL: $0.35 Sh: $9.30	$43.53	985,133	**$42,882,839.49**
Rural Minor Collector	2	$15	2	$16.94	Shoulders	$4.65	$68.53	1,476,891	**$101,211,340.23**
Rural Local Street	2	$24	1	$13.56	Landscaping	L: $45	$106.56	1,326,863	**$141,390,521.28**
								Subtotal	**$298,985,956.99**
								Grand Total with Lighting and Bicycle Path	**$299,426,956.99**

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